# ECON.A312

# ECON.A312 User manual production firmware 1.11

| Dana Belgium N.V. | ECON.A312 User manual – production firmware 1.11 |
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| Ten Briele 3, 8200 Brugge<br>Belgium | Date: 04-Apr-2018 |
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**WARNING NOTICE**

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| ⚠ This safety alert symbol indicates that you have to observe this notice in order to ensure your personal safety, the safety of persons working in the environment of the machinery, as well as to prevent damage to property.<br><br>Notices referring only to property damage have no safety alert symbol. |

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| This symbol indicates notices you have to observe. |

**COMPETENT AND QUALIFIED PERSONNEL**

The ECON.A312, as transmission controller and as part of wider vehicle systems, may only be set up and used in conjunction with this documentation. Non-observance of the warnings can result in severe personal injury or property damage.

Commissioning, operation, service or maintenance of the programmable ECON.A312, may only be performed by competent and qualified personnel.

Within the context of the applicable safety guidelines in this documentation, the competent and qualified persons are defined as persons who are authorized to commission, operate, service or maintain the ECON.A312, the transmission and vehicle control systems and its circuits in accordance with established safety practices and standards.

**SCOPE OF THE ECON.A312 USER MANUAL**

The ECON.A312 user manual describes in detail the possible functionalities that are supported, as well as the calibration capabilities, the diagnostic modes, the error reporting capabilities, the CAN messages, and the configuration management.

Although the ECON.A312 user manual gives a detailed description of the ECON.A312 functioning, it can not cover every possible contingency to be met in connection with design, installation, operation or maintenance.

Should further information be desired or should particular problems arise which are not covered sufficiently by the ECON.A312 user manual, then the matter should be referred to the local Dana Spicer Off-Highway sales office.

The contents of this documentation shall not become part of or modify any prior or existing agreement, commitment or relationship. The sales contract contains the entire obligation of Dana Spicer Off-Highway. The warranty contained in the contract between the parties is the sole warranty of Dana Spicer Off-Highway. Any statements contained herein do not create new warranties or modify the existing warranty.

## ENVIRONMENTAL CONDITIONS

The ECON.A312 is designed to be used in off-highway vehicles and to be exposed to the severe environmental conditions these vehicles operate in.

> ⚠ For more information on maximum ratings, operating limits, environmental conditions as well as electromagnetic compatibility (EMC) standards and limits, Refer to the document "APC312 Hardware technical leaflet.V1.01.pdf".

# CHAPTER 1 : ECON.A312 Functional Specification

# 1 ECON.A312 functional specification

## 1.1 General

The **ECON.A312** advanced programmable control system brings a new level of technology to serve powershift transmission families with electrically actuated valves, but without electronic controlled modulation.
In addition, the **ECON.A312** supports SAE J1939 compliant CAN 2.0B protocols facilitating vehicle networking. Integration with other compatible on-board systems keeps the total system cost low through elimination of redundancy and by reducing the amount of copper required to implement the system. CAN-bus implementations allow seamless integration with any configurable central vehicle display providing a common user interface to all vehicle functions including the transmission controller.
Some specific configuration controller parameters can be optimised by the OEM by means of a user-friendly, PC-based parameter and configuration editor, called “Dashboard”.
Thanks to the CAN 2.0B, the **ECON.A312** can even be used in applications requiring integrated use of transmission and engine for vehicle control under the most demanding conditions.
Furthermore, advanced tools for system optimisation and troubleshooting as well as tools to support end-of-line programming are available.

## 1.2 Applicable hardware platform

The controller hardware which is applicable for the ECON.A312 is the APC312.
The full product name is ECON.A312, where “ECON.A” identifies the firmware for powershift transmission families with ON/OFF technology for direction and range clutches (optionally the direction clutches are modulated hydraulically). The “312” identifies the APC312 hardware.

## 1.3 Overview of the ECON.A312 main features

- full electrical control of gear selection
- automatic and manual gear shifting logics
- turbine speed monitoring
- transmission control related features like lockup, declutch, 4WD/2WD, …
- throttle and brake pedal calibration (if connected to the ECON.A312)
- fast system diagnosis and trouble shooting by means of remote display (RD.120)
- advanced system diagnosis and trouble shooting by means of SAE J1939 compliant CAN messages
- takes care of all transmission related functions for achieving optimal shifting performance and reliability
- takes care of all transmission related characteristics for achieving maximum protection for the transmission and the vehicle and safety for the driver
- pc-user tool: Dashboard
- configuration set management to allow the OEM to configure different vehicle setups
- re-programmable / upgradeable by use of appropriate PC based tools (integrated in Dashboard)

## 1.4 Operating Modes

The ECON.A312 has a number of different operating modes. Some of these modes can be activated upon request, others are activated automatically at the appropriate moment.

### 1.4.1 Normal operation mode

In most cases the ECON.A312 is in normal operation mode. This is the mode where all normal transmission control logics are active, as required for normal operation of the vehicle.

In normal operation mode, there are 3 possible display modes on the RD.120:

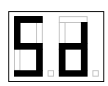
- **Normal display mode**: shows typical information useful during normal operation like selected gear, vehicle speed and shift lever position. If the ECON.A312 is started up without pressing the “M”-button, the ECON.A312 initializes in the normal display mode.
- **Diagnostic display mode**: can be activated to provide a number of diagnostic screens that allow the user to verify the turbine speed, engine speed, speed ratio, battery voltage, output speed, the digital inputs of the ECON.A312, etc… If the “M”-button is pressed while starting up the ECON.A312, it initializes in the diagnostic display mode.
- **Error display mode**: can be activated to check the different active and/or inactive errors that might be present. The error display mode can be envoked from the normal display mode or from the diagnostic display mode, by pushing the “M”-button during 2 seconds and then releasing the “M”-button when “AF” appears.

For more information about the display modes, refer to CHAPTER 1 – 1.12.

### 1.4.2 Transmission Shut down mode

When the ECON.A312 detects a problem related to the transmission control, it changes from the normal operation mode to the transmission shut down mode. The F-LED starts blinking. The error code(s) are available in the active error display “AF”.

This transmission shut down mode can be recognized in the normal display “gear position”. The RD.120 shows:




In this mode, the ECON.A312 sets the transmission related outputs to a safe state to ensure safety for the transmission, vehicle and driver. This safe state is <u>neutral highest gear</u>. All normal operation of the transmission is disabled in the transmission shut down mode.

Once the vehicle has come to standstill and the shift lever was placed in neutral, the ECON.A312 changes from the transmission shut down mode to the transmission limp home mode.

<u>REMARK</u>: if the problem is too severe, the ECON.A312 remains in shut down mode, even when the vehicle has come to standstill and the shift lever was placed in neutral.

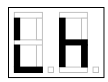
<u>REMARK</u>: if the detected problem is related to the drum speed or the output speed (from which vehicle speed is calculated), the ECON.A312 can’t detect the vehicle standstill condition any longer. Due to this, the ECON.A312 can’t change over to limp home mode when the vehicle has come to standstill and shift lever was placed in neutral. In case of a drum or output speed related fault, the operator has to reset the ECON.A312 before the ECON.A312 can change over to limp home mode (a reset is a controlled power down, followed by power up, refer to CHAPTER 1 – 1.5 for details).

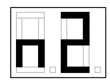
### 1.4.3 Transmission Limp home mode

In limp home mode, the driver has the opportunity to drive the vehicle home or to a service station for solving the problem. To know what the problem is, the error display mode of the RD.120 can be envoked and the error code can be looked up in the ECON.A312 error code list “ECON.A312 Error code list - production firmware 1.11.pdf”. An alternative way of troubleshooting is making use of Dashboard, which shows you the error codes and explanations immediately.

The transmission limp home mode is activated after transmission shut down mode was active first and afterwards the transition conditions to switch to limp home mode are fulfilled: the vehicle has come to standstill and the shift lever was placed in neutral (see transmission shut down mode).

This limp home mode can be recognized in the normal display mode “gear position”.
The RD.120 shows the code “LH” in alternation with the actual gear position, e.g.:





At the moment limp home mode is initialized, the transmission is in neutral, because one of the transition conditions for changing over to limp home gear is that the shift lever was placed in neutral.

In limp home mode, the transmission has reduced functionality:

- Only 1 range gear is allowed by the ECON.A312. This range gear is called “limp home gear”. The “limp home gear” is normally equal to the “lowest gear in automatic mode” (e.g. 2nd gear). If the “lowest gear in automatic mode” can not be granted (e.g. because the actual problem is related to a range solenoid and this problem inhibits selection of the lowest gear in automatic mode), the ECON.A312 selects another range gear as “limp home gear”.
- Direction changes are only allowed at vehicle standstill. Note; if the vehicle speed is not available (e.g. because the actual problem is related to the drum or output speed sensor), direction changes are allowed at all vehicle speeds.

Once the problem is solved, the F-LED stops blinking. The error codes are now available in the inactive error display mode (“IF”) and all error codes in the active error display mode have disappeared (“AF” = “— — “). The ECON.A312 stays in limp home mode. To exit the limp home mode, the ECON.A312 needs to be reset (controlled power down, followed by power up, refer to CHAPTER 1 – 1.5 for details).

<u>REMARK</u>: For applications where several machines are coupled (e.g. locomotives, industrial tractors…), the fixed “limp home gear” might cause damage to the transmission. At the moment one machine is in limp home mode (e.g. in N2) and this machine is being towed by the other machines, the transmission of the machine being towed easily reaches and exceeds its overspeeding limit. The OEM has to inform Dana in case of applications where several machines might be coupled by the end-users. In this case, the ECON.A312 will be programmed to stay in shut down mode and it does not change to limp home mode when a problem is detected. This ensures that the machine with problems is forced in neutral highest gear and does not overspeed during towing.

### 1.4.4 Calibration mode

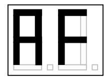
This mode can be activated by the RD.120 display or by use of the CAN bus.
It is used to calibrate analog signals, such as the throttle pedal and the brake pedal. During this mode, all logics of the normal operation mode are active, so the vehicle can be operated normally.

Refer to CHAPTER 1 – 2 for details.

### 1.4.5 ECON.A312 restricted mode

If the ECON.A312 detects an internal problem, it automatically changes to the ECON.A312 restricted mode (not to be confused with the transmission shut down mode).
Typically this occurs at power-up of the ECON.A312, e.g. when the ECON.A312 data flash can not be read or is corrupt, or when a conflicting configuration was programmed (error in data file or configuration set), etc…

When the ECON.A312 is in restricted mode, RD.120 displays:




In ECON.A312 restricted mode, all outputs of the ECON.A312 are set to inactivate state.
Only some strictly limited internal housekeeping is still done by the firmware.
The result is that the transmission is in neutral highest gear.

REMARK: notice the difference;

- in transmission shut down mode, the outputs are set to a safe state value in accordance with the detected problem
- in ECON.A312 restricted mode, all outputs are turned off because a correct output control can not be guaranteed anymore

But the final result is the same: the transmission is forced in neutral highest gear.

To exit this mode, the cause of the problem needs to be fixed first.
Re-programming the ECON.A312 with a correct data file can solve the problem.
However, if it's actually an internal defect of the ECON.A312, replacing the ECON.A312 is necessary.

The reported error codes can help to determine the necessary action(s) needed to solve the problem.

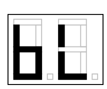
### 1.4.6 Bootloader mode (= programming mode)

This special mode needs to be activated in order to reprogram the ECON.A312 with new firmware. It is activated by the "Dana CAN Firmware XML Flashtool" when an application firmware upgrade procedure is performed.

The bootloader mode is also activated when the ECON.A312 does not find a valid application firmware during its initialization.

With this mode activated, the application firmware containing all logics of the normal operation, is not activated, so the vehicle can not be operated.

The bootloader mode starts up with the following RD.120 display:




The "D" and "F"-LED are blinking with alternation

Refer to CHAPTER 1 – 1.12.3 for details.

## 1.5 Controlled power down

During operation of the ECON.A312, data and signals are monitored to assure the correct functioning of the transmission. Also, when using Dana GDE tool or Dashboard, specific parameters can be set and/or adapted. To ensure that this information is safeguarded during a period of inactivity of the ECON.A312, this information is automatically flashed into the ECON.A312 data flash memory when the ECON.A312 is turned off.
Flashing of data is only triggered after the the ECON.A312 has detected following sequence:

Step 1: the ECON.A312 detects power loss on the **Wake** input (**Wake** – pin A13)
Step 2: the ECON.A312 detects that the **P**ermanent **P**ow**e**r line (**PPWR** – pin A7) remains at high voltage level for 1 second.
Step 3: data flashing is started.
Step 4: when the flashing of the necessary information into the data flash memory is finalized, the ECON.A312 shuts down itself.

This process is called “controlled power down”.

REMARK: It is strongly recommended to connect the **P**ermanent **P**ow**e**r line (**PPWR** – pin A7) directly to BAT+, like indicated on the wiring diagram. This will guarantee the high voltage level detection at PPWR of step 2, and it will guarantee that the “controlled power down” with correct data flashing is executed.
Alternatively, the **P**ermanent **P**ow**e**r line (**PPWR** – pin A7) may also be controlled by another control unit (like CVC – Central Vehicle Controller), as long as the control unit takes into account a substantial time difference between power loss at **Wake** input (**Wake** – pin A13) and power loss at **P**ermanent **P**ow**e**r line (**PPWR** – pin A7). We recommend a time difference of minimum 5 sec. in this case.

REMARK: If an incorrect power down occurs (e.g. switching off the **Wake** input and **PPWR** line at the same time, because they are both connected to the ignition key), the data is not flashed at all and the data is lost. The power supply architecture where **Wake** input and **PPWR** line are both connected to the ignition key is incorrect and must be avoided!

## 1.6 Basic connections to the ECON.A312

Following paragraphs describe the basic connections to be made to the ECON.A312.
These connections are commonly used by the ECON.A312 to provide:

- standard transmission functionality:
  - direction shifts
  - range shifts
- standard transmission protections:
  - downshift protection
  - direction change protection
  - automatic upshifts when overspeeding limit is reached in neutral
  - automatic upshifts when overspeeding limit is reached in forward or reverse

### 1.6.1 Shift lever

The shift lever is the main interface with the driver. The ECON.A312 needs shift lever information to detect the driver’s request.

At least forward, neutral and reverse request information must be available for the ECON.A312. Normally also the range request information is available for the ECON.A312. However, range request information is not absolutely necessary. Suppose there is only forward, neutral and reverse request information, then the ECON.A312 can be programmed to shift in automatic mode between 1$^{st}$ gear and the maximum range gear available for the actual direction.

### 1.6.1.1 I/O configuration

The ECON.A312 can be programmed to interact with a large number of shift levers, which can be grouped into 4 main models:

- Bump type shift lever (wired): this type of shift lever generates pulse signals for up- and downshifting, while it generates stable signals for the direction (forward and reverse).
- Standard shift lever (wired): this type of shift lever generates a different output pattern for each position. The ECON.A312 can be programmed to accommodate any standard shift lever, provided it does not use more than 6 wires to determine its position, and provided there are no invalid or disturbing output patterns when changing the shift lever position.
- Forward – Reverse shift lever (wired): this type of shift lever generates a stable signal for forward & reverse position, but has no range position and no range position signals.
- CAN shift lever: the ECON.A312 can receive the shift lever position via the CAN message CVC_TO_TC_1. Refer to CHAPTER 3 – 1.5.1 for details.

<u>REMARK</u>: The ECON.A312 can be programmed to read the shift lever information from 2 different shift levers on one vehicle, where one shift lever is the master and the other is the slave. Possible combinations are:

| | | Slave | | |
|---|---|---|---|---|
| | | Standard | Bump | Forward - Reverse |
| Master | CAN | ☑ | ☑ | ☑ |
| | Standard | | | ☑ |
| | Bump | | | ☑ |

<u>Example 1</u>:
(1) from CAN message CVC_TO_TC_1 (Master)
(2) from a bump type shift lever (Slave)
The CAN shift lever is the master. When CAN message CVC_TO_TC_1.Byte 1 equals “1111 1111”, it means that the ECON.A312 must read the shift lever information from the wired shift lever.
When CAN message CVC_TO_TC_1.Byte 1 does not equal “1111 1111”, it means that the ECON.A312 must read the shift lever information from the CAN message CVC_TO_TC_1.Byte 1.

<u>Example 2</u>:
(1) from standard shift lever (Master)
(2) from a Forward-Reverse shift lever (Slave)
The standard shift lever is the master. When the standard shift lever is in forward or reverse, the ECON.A312 reads the direction position and range position of this standard shift lever.
When the standard shift lever is in neutral, the ECON.A312 reads the direction position from the Forward-Reverse shift lever and reads the range position from the standard shift lever.

When changing from one shift lever source to the other, following conditions can (optionally) be programmed:

- The newly selected shift lever source must be placed in neutral, before forward or reverse can again be selected on the transmission
- The vehicle must be at standstill, before forward or reverse can again be selected on the transmission

REMARK: The ECON.A312 can also be programmed to read the shift lever information from 2 different shift levers on one vehicle, where both shift levers act as master. In this case, first both shift levers have to be in neutral (state “A”). Then, when one of the shift levers is placed in direction, this shift lever is in charge. When the shift lever in charge is later returned to the neutral position, the ECON.A312 is again in state “A”, after which any of the shift levers can become in charge again, when placed in direction. When both shift levers are placed in direction, by accident of mistake, none of the shift levers are in charge. In this case the ECON.A312 forces the transmission in neutral, until the driver places both shift levers in neutral again.

Check the application specific wiring diagram to see how the shift lever needs to be connected to the ECON.A312.

#### 1.6.1.2 Function

The shift lever is used to select the desired direction and range gear. The ECON.A312 can be programmed with different logics and options to control the selection of direction and range gears. Refer to CHAPTER 1 – 1.8 and CHAPTER 1 – 1.9 for details.

In manual mode (refer to CHAPTER 1 – 1.9.3 for details), the ECON.A312 places the transmission in a direction and range gear equal to the shift lever position: e.g. if the shift lever is in R2, the ECON.A312 places the transmission in R2.

REMARK: When there is risk for transmission damage, the ECON.A312 transmission protections like downshift protection, direction change protection, overspeeding protections overrule this general behaviour. In this way, the transmission direction and/or range gear can be different than the shift lever position. Some ECON.A312 functions (e.g. declutch, parking brake, PTO, etc…) can also overrule the general behaviour.

In automatic mode (refer to CHAPTER 1 – 1.9.4 for details), the shift lever position determines the maximum range gear the transmission shifts to: e.g. when the shift lever is in F3 with a 4 speed transmission, the transmission shifts automatically between F1 ←→ F2 ←→ F3 and does not shift to 4$^{th}$ gear.

REMARK: The ECON.A312 can be programmed with a debounce delay before accepting new shift lever positions. This debounce delay can be programmed separately per shift lever position (e.g. F3) and separately for direction acceptance (“F”) and range acceptance (“3”). Normally such a debounce delay is not necessary, but when necessary, a typical timing is 200~300 msec.

The desired behaviour can be chosen by the OEM in the ECON.A312 “Purchase Order Description”.

## 1.6.2 Speed sensors

The ECON.A312 needs to know the turbine speed, the transmission output speed and the vehicle speed to protect the transmission in all circumstances and to provide basic transmission functionalities as well as optional functionalities.

To know the turbine speed, the output speed and the vehicle speed, the ECON.A312 measures the drum speed with a drum speed sensor or measures an output speed with an output speed sensor. From this measured drum or output speed, the ECON.A312 calculates the turbine speed, the output speed and the vehicle speed.

REMARK: It is the transmission model that determines whether the drum speed or the output speed is measured (some transmission models have speed sensor provision on a clutch drum, while other transmissions have speed sensor provision at the output section). On 1 transmission you have either a drum speed sensor or an output speed sensor. They are never combined.

The ECON.A312 can also read the engine speed. The engine speed is necessary for:

- Direction shifts (refer to 1.8 for details)
- Load sensed automatic shifting (refer to 1.9.4.1 for details)
- System pressure Protection (refer to 1.10.5 for details)
- Automatic kickdown (refer to 1.11.8 for details)
- Load sensed automatic lockup (refer to 1.11.9 for details)
- Short direction engagement (refer to 1.11.12 for details)
- Power Take In (PTI) (refer to 1.11.19 for details)
- Vehicle speed limitation (refer to 1.11.21 for details)

In case none of these functions is desired, the ECON.A312 does not need to know the engine speed information and an engine speed sensor is not needed.

### 1.6.2.1 Drum speed sensor

If the transmission model has drum speed sensor provision on the transmission case, the drum speed sensor has to be installed there.

#### 1.6.2.1.1 I/O configuration

An inductive speed sensor or magneto-resistive speed sensor has to be connected to one of the 2 available ECON.A312 speed inputs. The type of speed sensor (inductive or magneto-resistive) depends on the transmission model.

Check the application specific wiring diagram to see how the drum speed sensor needs to be connected to the ECON.A312.

#### 1.6.2.1.2 Function

The drum speed sensor is installed on the transmission case and reads a clutch drum speed. From this clutch drum speed, the ECON.A312 calculates the turbine speed, the transmission output speed and the vehicle speed. These speeds are the most vital information for the ECON.A312 and they are used for a wide variety of ECON.A312 functionalities and protections.

## 1.6.2.2 Output speed sensor

If the transmission model has output speed sensor provision at the output section of the transmission, the output speed sensor has to be installed there.

### 1.6.2.2.1 I/O configuration

An inductive speed sensor or a Hall Effect speed senor has to be connected to one of the 2 available ECON.A312 speed inputs. The type of speed sensor (inductive or Hall Effect) depends on the transmission model.

Check the application specific wiring diagram to see how the output speed sensor needs to be connected to the ECON.A312.

### 1.6.2.2.2 Function

The output speed sensor is installed on the output section of the transmission and reads a speed that is proportional to the output speed. From this speed, the ECON.A312 calculates the turbine speed, the real output speed and the vehicle speed. These speeds are the most vital information for the ECON.A312 and they are used for a wide variety of ECON.A312 functions & protections.

## 1.6.2.3 Engine Speed sensor

The engine speed information comes from an engine speed sensor installed on the converter housing or from the engine controller via the CAN message EEC1.

### 1.6.2.3.1 I/O configuration

The engine speed signal can be provided to the ECON.A312 by:

- Use of a speed sensor directly connected to the ECON.A312:
  An inductive speed sensor or magneto-resistive speed sensor has to be connected to one of the 2 available ECON.A312 speed inputs. The type of speed sensor (inductive or magneto-resistive), depends on the transmission or converter model.
- Use of a CAN message – the ECON.A312 can receive the engine speed signal via the CAN message EEC1. Refer to CHAPTER 3 – 2.2 for details.

Check the application specific wiring diagram to see how the speed sensor needs to be connected to the ECON.A312.

### 1.6.2.3.2 Function

The engine speed information is needed for certain features of the ECON.A312. The most important features that need the engine are:

- Direction shifts (refer to 1.8 for details)
- Load sensed automatic shifting (refer to 1.9.4.1 for details)
- System pressure Protection (refer to 1.10.5 for details)
- Automatic kickdown (refer to 1.11.8 for details)
- Load sensed automatic lockup (refer to 1.11.9 for details)
- Short direction engagement (refer to 1.11.12 for details)
- Power Take In (PTI) (refer to 1.11.19 for details)
- Vehicle speed limitation (refer to 1.11.21 for details)

### 1.6.3 Power supply

The ECON.A312 power supply connections are:

BATTERY +

- Pin A7: **P**ermanent **P**ower (**PPWR**) → connect directly to BAT+ via automotive 15A fuse

IGNITION KEY

- Pin A2: **S**witched **P**ow**er** (**SPWR**) → connect to ignition key via automotive 10A fuse
- Pin A4: **S**witched **P**ow**er** (**SPWR**) → connect to ignition key via automotive 10A fuse
- Pin B7: **S**witched **P**ow**er** (**SPWR**) → connect to ignition key via automotive 10A fuse
- Pin B9: **S**witched **P**ow**er** (**SPWR**) → connect to ignition key via automotive 10A fuse
- Pin A13: **Wake** input (**WAKE**) → connect to ignition key via automotive 10A fuse

BATTERY -

- Pin A20: **G**rou**nd (GND)** → connect directly to BAT –
- Pin A26: **G**rou**nd (GND)** → connect directly to BAT –
- Pin B23: **G**rou**nd (GND)** → connect directly to BAT –
- Pin B24: **G**rou**nd (GND)** → connect directly to BAT –
- Pin B34: **G**rou**nd Se**nse **(GNDSE)** → connect directly to BAT –

Each ground pin shall be connected directly and separately to BAT –

The above power supply configuration is necessary for correct functioning of the ECON.A312. Refer to CHAPTER 1 – 1.5 for details.

### 1.6.4 Transmission Control Valve

The main interface between the ECON.A312 and the transmission is the control valve.

The ECON.A312 activates outputs (forward output / reverse output / forward high output / range outputs) that are connected to the solenoids of the control valve (forward solenoid / reverse solenoid / splitter solenoid / range solenoids). The activation of these solenoids results in activation of 1 direction clutch (forward clutch / reverse clutch / forward high clutch) and 1 range clutch (1$^{st}$ clutch / 2$^{nd}$ clutch / 3$^{rd}$ clutch / 4$^{th}$ clutch).

Depending on the transmission model, some clutches can have hydraulic modulation.

### 1.6.5 Throttle pedal position information

The throttle pedal position information can be used for several purposes, e.g.:

- take into account the intention of the driver for automatic range shifting
- take into account the intention of the driver for automatic lockup engagement and disengagement
- to control the engine speed via TSC1 for the function “throttle reduction”
- to control the engine speed via TSC1 for the function “vehicle speed limitation”
- to control the engine speed via TSC1 for the function “high engine idle”
- to control the engine speed via TSC1 for the function “engine shut down”

There are several valid implementations for informing the ECON.A312 about the throttle pedal position. Check the **X**'s in below table to know which implementations are valid. It depends on the needed functions (automatic range shifting, automatic lockup, TSC1 engine speed control).

| Valid throttle pedal information … | … for automatic range shifting | … for automatic lockup | … for TSC1 engine speed control |
|---|---|---|---|
| No throttle pedal information | | | |
| CAN message EEC2 | **X** | **X** | **X** |
| CAN message CVC_TO_TC_2 | **X** | **X** | **X** |
| Hall effect sensor (voltage 500 – 4500 mV) | **X** | **X** | **X** |
| Potentiometer (resistance 500 – 4500 Ω) | **X** | **X** | **X** |
| Idle/not idle switch (alone) | **X** | | |
| Full/half throttle pedal switch (alone) | | | |
| Idle/not idle + full/half throttle pedal switch | **X** | **X** | |

### 1.6.5.1 I/O configuration

Throttle pedal information via CAN message EEC2
The throttle pedal is wired to the engine controller. The engine controller broadcasts the throttle pedal position on the CAN-bus via the CAN message EEC2. Refer to CHAPTER 3 – 2.3 for details.

Throttle pedal information via CAN message CVC_TO_TC_2
The throttle pedal is wired to the central vehicle controller. The central vehicle controller broadcasts the throttle pedal position on the CAN-bus via the CAN message CVC_TO_TC_2. Refer to CHAPTER 3 – 1.5.2 for details.

Throttle pedal information via Hall Effect sensor
A Hall Effect sensor is wired to an analog voltage input of the ECON.A312. The ECON.A312 reads throttle pedal position between 0 % (not pressed) and 100 % (full throttle). The ECON.A312 can read throttle pedal information between 500 mV and 4500 mV.
This means that the operational voltage range of the Hall Effect sensor must be in the range of 500 – 4500 mV.
An example of a valid operational range: 1200 mV (0% pressed) - 3200 mV (100% pressed).
An example of an invalid operational range: 1200 mV (0% pressed) to 4700 mV (100% pressed).

REMARK: A throttle pedal calibration needs to be done to program the ECON.A312 with the correct idle and full throttle pedal values. Refer to CHAPTER 1 – 2 for details.

Throttle pedal information via potentiometer
A potentiometer is wired to an analog input of the ECON.A312. The ECON.A312 reads throttle pedal position between 0 % (not pressed) and 100 % (full throttle). The ECON.A312 can read throttle pedal information between 500 Ω and 4500 Ω.
This means that the resistance of the potentiometer must be in the range of 500 – 4500 Ω.
An example of a valid operational range: 1600 Ω (0% pressed) to 3900 Ω (100% pressed).
An example of an invalid operational range: 350 Ω (0% pressed) to 3400 Ω (100% pressed).

REMARK: A throttle pedal calibration needs to be done to program the ECON.A312 with the correct idle and full throttle pedal values. Refer to CHAPTER 1 – 2 for details.

REMARK: Optionally an RC-filter can be configured on the throttle pedal signal, for dampening the throttle pedal position.

REMARK: When the throttle pedal information is an analog value 0%-100% (via EEC2, CVC_TO_TC_2, Hall Effect sensor or potentiometer), the ECON.A312 also distinguishes 3 separate zones : “idle” zone – “half throttle” zone – “full throttle” zone.

Throttle pedal information via “idle/not idle” switch alone
A switch is installed under the throttle pedal to detect if the throttle pedal is pressed or released. If the throttle pedal is pressed, the ECON.A312 reads the input signal as “not idle”. If the throttle pedal is released, the ECON.A312 reads the input signal as “idle”. In this way, the throttle pedal position is separated in 2 zones for the ECON.A312: “idle” zone and “not idle” zone. An echo of the “idle/not idle” position is available in the CAN message TC_TO_CVC_2. Refer to CHAPTER 3 – 1.6.2 for details.

Throttle pedal information via “idle/not idle” switch and “full throttle/half throttle” switch
2 Switches are installed under the throttle pedal:

a) one to detect if the throttle pedal is pressed or released
b) another one to detect if the throttle pedal is in full or half throttle position

With this information, the ECON.A312 distinguishes 3 separate zones for the throttle pedal position: “idle” zone – “half throttle” zone – “full throttle” zone. An echo of the “idle/not idle” position and the “full throttle/half throttle” position is available in the CAN message TC_TO_CVC_2. Refer to CHAPTER 3 – 1.6.2 for details.

Check the application specific wiring diagram to see how the throttle pedal signal needs to be connected to the ECON.A312.

#### 1.6.5.2 Function

Speed sensed automatic shifting → use of throttle pedal information

- when there is only “idle/not idle” detection
    - Speed sensed automatic upshifts are only allowed if the driver has the intention to accelerate the vehicle. In case the vehicle is driving downhill and the driver releases the throttle pedal, the transmission makes no automatic upshifts. This ensures engine braking. Of course, if the transmission overspeeding limit is reached, the ECON.A312 triggers an upshift to protect the transmission against overspeeding.
    - Automatic up- and downshifts happen at fixed vehicle speed limits.
- when there is “idle/not idle” and “full throttle/half throttle” detection or when there is throttle pedal information via EEC2 or via CVC_TO_TC_2, via half effect sensor or via potentiometer
    - Speed sensed automatic upshifts are only allowed if the driver has the intention to accelerate the vehicle. In case the vehicle is driving downhill and the driver releases the throttle pedal, the transmission makes no automatic upshifts. This ensures engine braking. Of course, if the transmission overspeeding limit is reached, the ECON.A312 triggers an upshift to protect the transmission against overspeeding.
    - Automatic up- and downshifts happen at fixed vehicle speed limits. But there are separate up- and downshift limits for the half throttle zone and the full throttle zone. Automatic up- and downshifts in the full throttle zone happen at higher vehicle speeds than in the half throttle zone.

For more details about speed sensed automatic shifting, refer to CHAPTER 1 – 1.9.4.2.

Load sensed automatic shifting → use of throttle pedal information

- when there is only "idle/not idle" detection
  - Load sensed automatic upshifts are only allowed if the driver has the intention to accelerate the vehicle. For more information, refer to "Speed sensed automatic shifting → use of throttle pedal information / when there is only "idle/not idle" detection".

  - Load sensed automatic upshifts are made when the speed ratio exceeds a certain limit and when the turbine speed exceeds a certain limit:
    - the speed ratio limit is function of the turbine speed
    - the turbine speed limit is fixed, independent of the throttle position

  - Automatic downshifts are triggered when the speed ratio (= turbine speed / engine speed) drops below a certain limit (typical at a speed ratio of 0.25 ~ 0.50). When the driver releases his foot off the throttle pedal, the engine speed drops to idle and the speed ratio increases above 1.00 (braking mode). In this way, automatic downshifts are very late, because it takes a long time before the speed ratio has decreased from more than 1.00 to about 0.25 ~ 0.50. When the driver accelerates again, while the speed ratio is still above the downshift limit, the engine speed increases and the speed ratio drops. At that moment, an unexpected automatic downshift is triggered. This late downshift when the throttle pedal is released or the unexpected downshift when the throttle pedal is pressed again, results in poor performance of automatic shifting. The solution in the ECON.A312 is: when the driver releases his foot off the throttle pedal, automatic downshifts are triggered at a higher turbine speed. In this way, the automatic downshifts with throttle pedal released, are triggered sooner. This avoids the unexpected downshifts when the throttle pedal is pressed again.

- when there is "idle/not idle" and "full throttle/half throttle" detection or when there is throttle pedal information via EEC2 or via CVC_TO_TC_2, via half effect sensor or via potentiometer
  - Load sensed automatic upshifts are only allowed if the driver has the intention to accelerate the vehicle. For more information, refer to "Speed sensed automatic shifting → use of throttle pedal information / when there is only "idle/not idle" detection".

  - Load sensed automatic upshifts are made when the speed ratio exceeds a certain limit and when the turbine speed exceeds a certain limit:
    - the speed ratio limit is function of the turbine speed
    - there is 1 turbine speed limit for the "half throttle" zone and 1 turbine speed limit for the "full throttle" zone

  - Automatic downshifts are triggered when the speed ratio drops below a certain limit (typical at a speed ratio of 0.25 ~ 0.50). When the driver releases his foot off the throttle pedal, automatic downshifts are triggered at a higher turbine speed. In this way, the automatic downshifts with throttle pedal released, are triggered sooner. This avoids the unexpected downshifts when the throttle pedal is pressed again. For more information, refer to "Load sensed automatic shifting → use of throttle pedal information / when there is only "idle/not idle" detection".

For more details about load sensed automatic shifting, refer to CHAPTER 1 – 1.9.4.1.

Automatic lockup → use of throttle pedal information
In case of automatic lockup, there must be throttle pedal information via EEC2, via CVC_TO_TC_2, via Hall Effect sensor, via potentiometer or via “idle/not idle” switch in combination with “full throttle/half throttle” switch. In this way, the ECON.A312 can make distinction between “idle” zone, “half throttle” zone and “full throttle” zone.

The lockup engagement and lockup disengagement turbine speed limits depend on the throttle pedal zone “idle” – “half throttle” – “full throttle”. Also the turbine speed (= engine speed) to make an automatic upshift out of lockup, depends on the throttle pedal position zone.

For more details about automatic lockup, refer to CHAPTER 1 – 1.11.9.

TSC1 engine speed control → use of throttle pedal information
In case the ECON.A312 controls the engine speed via TSC1 for the function “engine throttle reduction”, “vehicle speed limitation”, “high engine idle” or “engine shut down”, the ECON.A312 reads the throttle pedal information from the CAN message EEC2, the CAN message CVC_TO_TC_2, Hall Effect sensor or potentiometer.
When the concerned function is not active, the ECON.A312 converts the throttle pedal position % into a target engine speed in the CAN message TSC1.
When the concerned function is active, the ECON.A312 takes into account the throttle pedal position, but also takes into account other transmission/vehicle condtions for calculating the target engine speed. Then the ECON.A312 puts this target engine speed in the CAN message TSC1.

For more details about “high engine idle” refer to CHAPTER 1 – 1.11.15.
For more details about “vehicle speed limitation” refer to CHAPTER 1 – 1.11.21.
For more details about “engine shut down” refer to CHAPTER 1 – 1.11.22.
For more details about “engine throttle reduction” refer to CHAPTER 1 – 1.11.23.

The desired behaviour can be chosen by the OEM in the ECON.A312 “Purchase Order Description”.

## 1.7 Optional connections to the ECON.A312

Besides standard transmission functionality and standard transmission protections, the ECON.A312 can provide:

- optional transmission functionality, e.g.
  - declutch
  - kickdown
  - vehicle loaded/not loaded detection to define the “lowest gear in automatic mode”
  - …
- optional transmission protections, e.g.
  - neutral selection when converter output temperature is too high
  - neutral selection when the system pressure is too low
- optional vehicle protections, e.g.
  - neutral selection when the operator present switch detects the operator is not present
  - neutral lock protection

The implementation of these functions requires inputs and/or outputs.
The ECON.A312 has 10 digital inputs and 12 analog inputs (of which 10 voltage and 2 resistive).
The ECON.A312 also supports CAN communication for receiving functional input information.

Every functional input with digital information (e.g. shift lever, parking brake state, vehicle loaded/not loaded detection, declutch request when service brakes are applied, operator present/not present, etc…) can be implemented via a wired input or via a CAN-message.
If the functional input is implemented via a wired input, it can be wired to one of the 10 digital inputs of the ECON.A312, but occasionally it can also be wired to one of the 10 analog voltage inputs of the ECON.A312, which in this case is functioning as a digital input. This is typically done when there are more than 10 digital inputs needed. In case of a wired input, the logical request can have a straight relation with the physical request (e.g. declutch “on” when wire B13 activated), or it can have an inverted relation (e.g. declutch “off” when wire B13 activated). The wired input may be connected to a monostable or a bistable switch.

REMARK: The above flexibility (digital, analog or CAN / straight or inverted relation / monostable or bistable) can be programmed separately for every single functional input.

REMARK: The above flexibility is available in the customization phase of the concerned ECON.A312 (when completing the POD = “Purchase Order Description”). But once the ECON.A312 is programmed, the functional input information must come via the programmed channel (digital input, analog input or CAN bus) and in the programmed format (straight or inverted relation / monostable or bistable).

REMARK: It is possible to program a functional input as an OR relation of 2 or more physical inputs. E.g. the ECON.A312 can be programmed to read the kickdown request from 2 sources: e.g. (source 1) digital input DI 5 = wire B13 and (source 2) CAN message CVC_TO_TC_1 bit 4.1-4.2. When there is a kickdown request on digital input DI 5 OR there is a kickdown request in CAN message CVC_TO_TC_1 bit 4.1-4.2, the ECON.A312 sees a kickdown request. It is also possible to program a functional input as an AND relation of 2 or more physical inputs.

The functional inputs with analog information “converter out temperature”, “transmission sump temperature” and “system pressure” must be implemented via a wired analog input.

The functional inputs with analog information “analog throttle pedal position” and “analog brake pedal position” can be implemented via a wired analog input or with a CAN message.

The ECON.A312 has 9 digital outputs. These are functional outputs. “Functional” outputs refer to outputs that are controlled by the ECON.A312 to activate the transmission control valve solenoids, to activate transmission options like PTO, high/low range, 4WD/2WD, and to activate optional functions like speed dependent output, etc…

REMARK: The RD.120 connections are not considered as functional outputs: LIN communication is established with the dedicated pin B26 and the RD.120 is powered via the the ignition key and grounded to BAT-. Refer to the application specific wiring diagram for connection details.

REMARK: The speedometer output is not considered as functional output: a square wave signal is generated on dedicated speedometer pin B33. It alternates between 0V and +10V.

## 1.8 Direction shifts

> Please note that all limit values mentioned in this document are values for reference only. They are intended to indicate the typical order of magnitude these limits usually have, allowing to understand their function. The limits on a specific ECON.A312 application are normally different and depend on the calculations in the approval.

The engagement of directional clutches appears in 3 different ways:

- Direction changes
  The transmission changes from FWD to REV, REV to FWD, NTRL to FWD, NTRL to REV at vehicle speed, and no standstill was detected while the transmission was in NTRL.

- Direction engagements
  The transmission changes from NTRL to FWD, or from NTRL to REV, and vehicle standstill was detected while the transmission was in NTRL. Note that this does not necessarily mean that there is vehicle standstill at the moment FWD or REV engagement takes place.

- Direction re-engagements
  The transmission changes from FWD to NTRL and back to FWD, or from REV to NTRL and back to REV at vehicle speed while no vehicle standstill was detected in NTRL.

### 1.8.1 Direction Changes (F – N – R / R – N – F)

When a direction change is requested, the ECON.A312 checks up to 3 limits before the direction change is actually executed:

- The vehicle speed must be lower than the "direction change vehicle speed limit". When making a direction change, the kinetic energy of the vehicle has to be absorbed by the clutch pack of the newly engaged directional clutch. This energy is transformed into heat which has to be dissipated by the transmission oil. If the kinetic energy is too high, the transmission oil cannot dissipate the heat sufficiently, and the clutch pack risks to burn. From this explanation, it is clear that the "direction change vehicle speed limit" is function of the transmission clutch design and is function of the vehicle weight.
- Optionally, the engine speed must be lower than the "direction change engine speed limit"
- Optionally, the throttle pedal position % must be lower than the "direction change throttle pedal position limit".
  By setting a limitation on the engine speed or throttle pedal position, the direction changes are made at low engine torque. In this way, it is ensured that they are smooth.

If a direction change is requested and the vehicle speed exceeds the "direction change vehicle speed limit" and/or the engine speed exceeds the "direction change engine speed limit" (optional) and/or the throttle pedal position % exceeds the "throttle pedal position limit" (optional), the direction change is not executed.

Instead, the warning lamp is activated and the ECON.A312 takes one of the following actions:

- Force NTRL and wait until the conditions are fulfilled (refer to CHAPTER 1 – 1.8.1.1 for details), or:
- Keep the original driving direction engaged and start downshifting in the original driving direction until the vehicle speed has dropped below the direction change speed limit (refer to CHAPTER 1 – 1.8.1.2 for details).

The range gear that is selected after a direction change depends on the range shifting mode (manual or automatic).

In <u>automatic mode</u>, the range gear selected after a direction change depends on the shift lever range position in the newly engaged direction:

- If the shift lever range position in the newly engaged direction is higher than or equal to the "forward/reverse gear" (= "lowest gear in automatic mode" = parameter), the range gear selected after a direction change equals the "forward/reverse gear".
  - E.g. "forward/reverse gear" = 2nd
    - Shift lever: F4 → N4 → R4
    - Transmission: F4 → N4 → R2
  - E.g. "forward/reverse gear" = 1st
    - Shift lever: F4 → N4 → R4
    - Transmission: F4 → N4 → R1
  - E.g. "forward/reverse gear" = 2nd
    - Shift lever: F2 → N2 → R2
    - Transmission: F2 → N2 → R2
- If the shift lever range position in the newly engaged direction is lower than the "forward/reverse gear", the range gear selected after a direction change equals the shift lever range position in the newly engaged direction.
  - E.g. "forward/reverse gear" = 2nd
    - Shift lever: F1 → N1 → R1
    - Transmission: F1 → N1 → R1
  - E.g. "forward/reverse gear" = 3rd
    - Shift lever: F2 → N2 → R2
    - Transmission: F2 → N2 → R2

After the execution of a direction change, a shift delay is taken into account. After this delay, the transmission shifts again automatically according to the programmed automatic shift curves (or shift points).

In <u>manual mode</u>, the range gear selected after a direction change equals the shift lever range position in the newly engaged direction.

| | | |
|---|---|---|
| E.g. | Shift lever: | F2 → N2 → R2 |
| | Transmission: | F2 → N2 → R2 |
| E.g. | Shift lever: | F2 → N2 → N3 → N4 → R4 |
| | Transmission: | F2 → N2 → R4 |
| | Note: In this example, the transmission does not shift to N3 and N4 while it is in neutral. This is due to range shift delays. | |

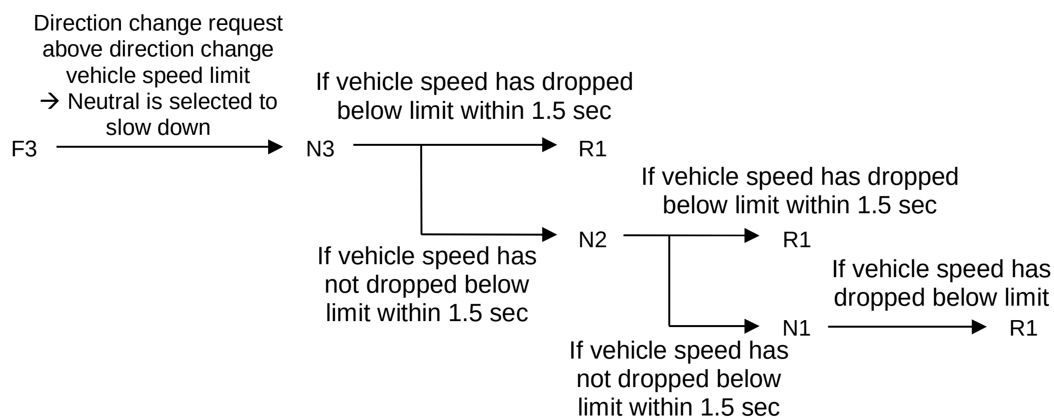
The desired behaviour can be chosen by the OEM in the ECON.A312 "Purchase Order Description".

#### 1.8.1.1 Low speed direction changes

“Low speed” direction changes are typically used on forklift trucks, trains, terminal tractors, aircraft tow tractors, etc. where smooth direction changes at low vehicle speed are desired. Typically, the engine speed must be low as well for making a direction change. In case engine speed is not measured, an alternative solution is to take the throttle pedal idle position into account.

When the direction change is requested, but it is not allowed (vehicle speed too high, engine speed too high or throttle pedal pressed), the transmission is forced in neutral. It stays in neutral until the direction change conditions are fulfilled, and then the direction change is executed.

REMARK: While the transmission is forced in neutral, normal up- and downshifts in neutral can be executed, based on the vehicle speed.




Example: Low speed direction change in automatic mode with forward/reverse gear 1st

The desired behaviour can be chosen by the OEM in the ECON.A312 “Purchase Order Description”.

### 1.8.1.2 High speed direction changes

“High speed” direction changes are typically used on loaders, backhoe loaders, telescopic boomhandlers, etc. where fast direction changes are desired at full throttle. This reduces the duration of the Y-cycle and increases productivity.

Typically, the direction change is executed at high engine speed with the throttle pedal fully pressed. So, the engine speed condition and throttle pedal position are typically not taken into account during “high speed” direction changes.

When a direction change is requested and it is not allowed (because the vehicle speed is too high), the ECON.A312 re-engages the transmission in the driving direction and performs a downshift in order to profit from engine braking. This slows down the vehicle, and when the vehicle speed drops below the “direction change vehicle speed limit”, the direction change is actually executed. If however, the vehicle speed does not drop below the “direction change vehicle speed limit” within 2 seconds, subsequent downshifts are made until the vehicle speed finally drops below the “direction change vehicle speed limit”.

These “braking” downshifts can be programmed in 2 ways in the ECON.A312:

- <u>Safe braking downshifts</u>
  Braking downshifts are only granted if there is no risk of overspeeding in the lower gear.

  <u>REMARK</u>: Standard, the ECON.A312 is programmed with safe braking downshifts.

  <u>REMARK</u>: When programmed with safe braking downshifts, the ECON.A312 can get in the situation where it is not allowed to put the transmission in the newly requested direction and it is not allowed to perform a braking downshift in the original driving direction. The direction gear and range gear remain unchanged at that moment. When the driver keeps applying full throttle in this situation, the vehicle can continue driving in a direction that is opposite to the shift lever direction. However, when the engine controller accepts the CAN message TSC1, the ECON.A312 can be programmed to reduce the engine speed via TSC1 speed / torque limitation. In this way, the ECON.A312 makes sure that the transmission direction gets equal to the shift lever direction in a reasonable time. Of course, this is only possible if there is an engine controller and if the engine controller listens to the TSC1 message from the ECON.A312.

- <u>Unconditional braking downshifts</u>
  The braking downshifts are granted unconditionally and are executed with fixed delays between each 2 downshifts (typically 2 seconds). Because unconditionally, these braking downshifts can create overspeeding in the lower gear and can damage the range clutch of the lower gear.

  <u>REMARK</u>: The unconditional braking downshifts are not the standard settings in the ECON.A312 controller. These settings are only made upon specific request of the OEM with the agreement of the OEM that all warranty claims on range clutch failures will be denied by Dana.

<u>Example 1</u>: Automatic mode with “Forward / reverse gear” = $2^{nd}$ and vehicle speed > “direction change vehicle speed limit”:

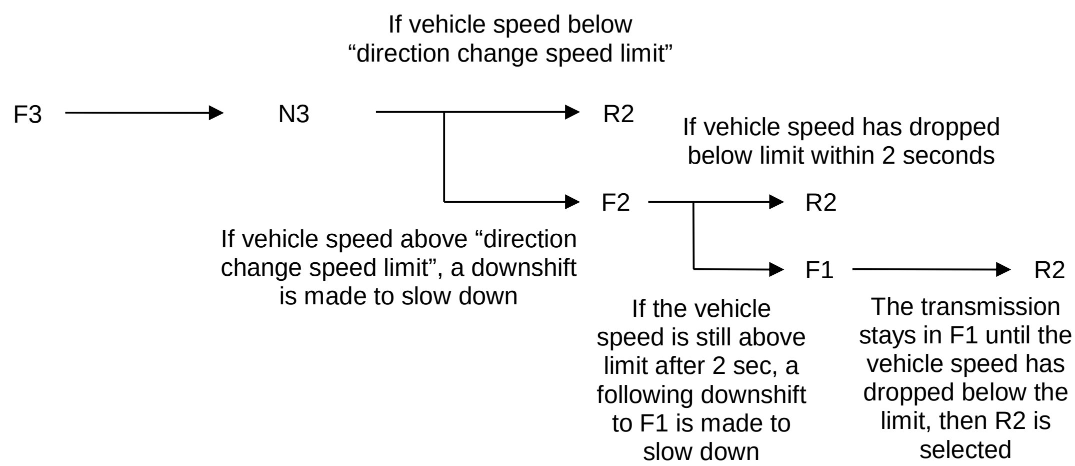
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Shift lever: | F4 | → | N4 | → | R4 | | |
| Transmission: | F3 | → | N3 | → | F2 ….. | → | R2 |
| | | | | Re-engagement of forward in lower gear (F2) for engine braking | | | At the moment the vehicle speed has dropped below direction change vehicle speed limit |

Example 2: Automatic mode with "Forward / reverse gear" = 2nd and vehicle speed < direction change speed limit

| | | | | | |
|---|---|---|---|---|---|
| Shift lever: | F4 | → | N4 | → | R4 |
| Transmission: | F3 | → | N3 | → | R2 |

Example 3: Automatic mode with "Forward / reverse gear" = 2nd

| | | | | | |
|---|---|---|---|---|---|
| Shift lever: | F4 | → | N4 | → | R4 |
| Transmission: | | | | | |




The desired behaviour can be chosen by the OEM in the ECON.A312 "Purchase Order Description".

### 1.8.2 Direction engagements (N – F / N – R)

When a direction engagement is requested, the ECON.A312 checks the same "direction change vehicle speed limit" as is checked during direction changes.

Optionally, the engine speed must be lower than the "direction engagement engine speed limit". Note that this "direction engagement engine speed limit" is a different parameter than the "direction change engine speed limit".

Optionally, the throttle pedal position % must be lower than the "direction engagement throttle pedal position limit". Note that this "direction engagement throttle pedal position limit" is a different parameter than the "direction change throttle pedal position limit".

If a direction engagement is requested and the vehicle speed exceeds the "direction change vehicle speed limit" and/or the engine speed exceeds the "direction engagement engine speed limit" (optional) and/or the throttle pedal position % exceeds the "direction engagement throttle pedal position limit" (optional), the direction engagement is not executed and the transmission remains in neutral. The warning lamp is activated until all 3 conditions are fulfilled. Then, the newly selected direction is granted on the transmission and the warning lamp is switched off.

The range gear that is selected after a direction engagement is determined in exactly the same way as for direction changes.

Example 1: Automatic mode with "Forward / reverse gear" = 2$^{nd}$

| | | | |
|---|---|---|---|
| Shift lever: | N4 | → | R4 |
| Transmission: | N2 | → | R2 |

Example 2: Automatic mode with "Forward / reverse gear" = 2$^{nd}$

| | | | |
|---|---|---|---|
| Shift lever: | N1 | → | F1 |
| Transmission: | N1 | → | F1 |

Example 3: Manual mode

| | | | |
|---|---|---|---|
| Shift lever: | N4 | → | R4 |
| Transmission: | N4 | → | R4 |

The desired behaviour can be chosen by the OEM in the ECON.A312 "Purchase Order Description".

### 1.8.3 Direction re-engagement (F – N – F / R – N – R)

When a direction re-engagement is requested, the driver requests to re-engage the clutch (e.g. forward) corresponding with the driving direction (also forward).
This implicates that the kinetic energy of the machine does not need to be absorbed in the directional clutch (e.g. forward). So, there is no risk of burning this directional clutch and the direction engagement may be performed at whatever vehicle speed.
For this reason, the "direction change vehicle speed limit" is not taken into account when making a direction re-engagement.

Optionally, the engine speed must be lower than the "direction re-engagement engine speed limit". Note that this "direction re-engagement engine speed limit" is a different parameter than the "direction change" and "direction engagement engine speed limit".

Optionally, the throttle pedal position % must be lower than the "direction re-engagement throttle pedal position limit". Note that this direction re-engagement throttle pedal position limit is a different parameter than the direction change and direction engagement throttle pedal position limit.

If a direction re-engagement is requested and the engine speed exceeds the "direction re-engagement engine speed limit" (optional) and/or the throttle pedal pedal position % exceeds the "direction re-engagement throttle pedal position limit" (optional), the direction re-engagement is not executed and the transmission remains in neutral. The warning lamp is activated until the engine speed and/or throttle pedal conditions are fulfilled: then the direction re-engagement is granted on the transmission and the warning lamp is switched off.

The range gear that is selected after a direction re-engagement equals the range gear that was obtained in neutral.

Example 1: Automatic mode with "Forward / reverse gear" = 2nd

| | | | | | |
|---|---|---|---|---|---|
| Shift lever: | F4 | → | N4 | → | F4 |
| Transmission: | F2 | → | N2 | → | F2 |

Example 2: Automatic mode with "Forward / reverse gear" = 2nd

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Shift lever: | F4 | → | N4 | … | … … … | … | … | → | F4 |
| Transmission: | F3 | → | N3 | → | driving downhill | → | N4 | → | F4 |

Example 3: Automatic mode with "Forward / reverse gear" = 2nd

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Shift lever: | F4 | → | N4 | … | … … … | … | … | → | F4 |
| Transmission: | F4 | → | N4 | → | slowing down | → | N3 | | |
| | | | | → | slowing down | → | N2 | → | F2 |

Example 4: Manual mode

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Shift lever: | F1 | → | N1 | → | N2 | → | F2 |
| Transmission: | F1 | → | N1 | → | N2 | → | F2 |

The desired behaviour can be chosen by the OEM in the ECON.A312 "Purchase Order Description".

### 1.8.4 Neutral selection

When the driver selects neutral with the shift lever, the transmission is always placed in neutral. This is needed for normal operation of the vehicle. But it also ensures that the driver can **always** bring the transmission to neutral in case of a dangerous situation.

Besides neutral selection with the shift lever, the ECON.A312 can also force the transmission in neutral because of other triggers, e.g.:

- During initialization, the ECON.A312 forces the transmission in neutral, even when the shift lever is in forward or reverse position.
- After initialization, the ECON.A312 still forces the transmission in neutral, even with the shift lever in forward or reverse position. The driver has to cycle the shift lever through neutral and back into forward (or reverse) position, only then forward (or reverse) is engaged on the transmission.
- An ECON.A312 protection can decide to force the transmission in neutral, e.g.:
    - Direction change, direction engagement and direction re-engagement protection (refer to CHAPTER 1 – 1.8.1, CHAPTER 1 – 1.8.2 and CHAPTER 1 – 1.8.3 for details).
    - Operator Present protection (refer to CHAPTER 1 – 1.11.3 for details)
    - Neutral selection when parking brake is activated (refer to CHAPTER 1 – 1.11.11 for details)
    - Neutral selection when the converter out temperature is too high (refer to CHAPTER 1 – 1.10.6 for details)
    - Neutral selection when the system pressure is too low (refer to CHAPTER 1 – 1.10.5 for details)
    - Neutral lock protection (refer to CHAPTER 1 – 1.11.4 for details)
    - Immediate neutral lock (refer to CHAPTER 1 – 1.11.5 for details)
    - …
- An ECON.A312 function can decide to force the transmission in neutral:
    - Declutch (refer to CHAPTER 1 – 1.11.2 for details)
    - High / Low Range selection (refer to CHAPTER 1 – 1.11.13 for details)
    - 4WD/2WD selection (refer to CHAPTER 1 – 1.11.16 for details)
    - …
- Transmission shut down (refer to CHAPTER 1 – 1.4.2 for details):
  If the ECON.A312 detects a severe problem that makes safe transmission control impossible, the transmission shut down mode is activated. Transmission shut down mode disables all shift functionality and ensures a safe transmission condition (neutral highest gear).
- ECON.A312 restricted mode (refer to CHAPTER 1 – 1.4.5 for details):
  If the ECON.A312 has detected an internal problem, it automatically switches to the ECON.A312 restricted mode. As a result all power to the outputs of the ECON.A312 is turned off, so this mode disables all shift functionality and ensures a safe transmission condition (all outputs off = neutral highest gear).
- Invalid Shift lever Request:
  If an invalid shift lever pattern is detected by the ECON.A312, neutral is forced because the information about the driver's request is not reliable anymore.

The desired behaviour can be chosen by the OEM in the ECON.A312 "Purchase Order Description".

## 1.9 Range Shifts

Please note that all limit values mentioned in this document are values for reference only. They are intended to indicate the typical order of magnitude these limits usually have, allowing to understand their function. The limits on a specific ECON.A312 application are normally different and depend on the calculations in the approval.

### 1.9.1 Manual / automatic mode selection

The ECON.A312 can be programmed in 3 different ways:

- to work in manual mode only
- to work in automatic mode only
- to work in manual as well as in automatic mode

#### 1.9.1.1 I/O configuration

Necessary I/O: 1 digital input (standard) or none (optionally)

Typically, the manual/automatic mode selection is implemented with a bistable switch installed on the dashboard. It can be connected to the ECON.A312 by:

- Use of a wired input
- Use of a CAN message – the ECON.A312 can receive the manual/automatic mode selection via the CAN message CVC_TO_TC_1. Refer to CHAPTER 3 – 1.5.1 for details.

Instead of a bistable selection switch, the ECON.A312 can also be programmed with other triggers for manual/automatic selection:

- A monostable signal from a push button, to toggle between manual and automatic mode. In this case there is possibility to program the ECON.A312 to initialize in manual mode or to initialize in automatic mode. There is also possibility to allow toggling between manual and automatic mode in all directions (forward, neutral and reverse) or to allow toggling only in neutral.
  Remark: The ECON.A312 can be programmed to add the condition that the manual / automatic push button must be pressed for allowance of direction engagement (Fwd or Rev).
  Remark: The ECON.A312 can be programmed to force manual mode when a direction engagement (Fwd or Rev) happens.
  Remark: The ECON.A312 can be programmed to force manual mode when an up- or downshift request is made with a bump type shift lever. In this case, the ECON.A312 will also interpret this up-or downshift request as a real up- or downshift request: the ECON.A312 will execute an up- or downshift on the transmission.
- Manual/automatic mode selection based on the range position of shift lever position.
  An example for a 4/4 speed transmission:

| Shift lever | Transmission |
|---|---|
| 1st | Manual 1st |
| 2nd | Manual 2nd |
| 3rd | Manual 3rd |
| 4th | Automatic shifting 2nd ←→ 3rd ←→ 4th |

- Manual and automatic mode are defined by the load of the vehicle. E.g. when the vehicle is loaded, the transmission operates in manual mode. When the vehicle is empty, the transmission operates in automatic mode. This needs the implementation of a "loaded/not loaded" detection switch. Refer to CHAPTER 1 – 1.11.6 for details.

REMARK: An echo of the manual/automatic mode function state is available in the CAN message TC_TO_CVC_2. Refer to CHAPTER 3 – 1.6.2 for details.

Check the application specific wiring diagram to see how the manual/automatic selection switch or push button needs to be connected to the ECON.A312.

#### 1.9.1.2 Function

The conditions to change over from manual mode to automatic mode (or vice versa) can be programmed in 3 different ways:

- Unconditional change over
- Change over only allowed at vehicle standstill
- Change over only allowed at vehicle standstill or when the shift lever position is greater than or equal to the actual transmission range gear

These conditions can be programmed separately for changing over from manual to automatic mode and for changing over from automatic to manual mode.

REMARK: After changing over from manual to automatic mode or vice versa, the ECON.A312 always takes into account the transmission safety limits before executing a range shift. E.g. when the vehicle is driving at high vehicle speed in F4 and then the driver puts the shift lever in F1 and he changes the mode from automatic to manual, manual mode is accepted immediately (in case “unconditional change over” is programmed). However, the transmission remains in F4 and does not shift down to F1, because this would cause overspeeding in the range clutch of 1st. The ECON.A312 downshift protection function takes care about this.

Other functionalities can overrule the normal manual/automatic mode selection, e.g.:

- Vehicle loaded/not loaded function: the ECON.A312 controller can be programmed to force manual mode when the vehicle is loaded. This can be used e.g. on an aircraft tow tractor: automatic shifting is disabled while the aircraft tow tractor is towing an airplane.
- High/low range control: The ECON.A312 controller can be programmed to force manual mode when the transmission is in the low range. An example is a RoRo tractor, where manual mode is forced (automatic mode disabled) while the tractor is in low range. In this way, the dangerous automatic downshift while driving on the steep slope doesn’t occur.

The desired behaviour can be chosen by the OEM in the ECON.A312 “Purchase Order Description”.

### 1.9.2 Range shift delays

After a direction change, a direction (re-)engagement, lockup disengagement or a range shift, a minimum delay is taken into account before a (new) range shift can be executed. This minimum delay is called a ‘range shift delay’ or simply ‘shift delay’. It guarantees that the previous action (e.g. direction change, lockup disengagement or other range shift) is fully completed before a (new) range shift is executed. A typical setting for range shift delay is 1.5 ~ 2.5 seconds.

### 1.9.3 Range shifts in manual mode

The principle of manual shifting is: the transmission range gear follows the shift lever range position.

Of course, transmission safety limits are always taken into account. If transmission safety is jeopardized, the transmission range gear might be different than the shift lever range position.

Some examples:

E.g. a 4/4 speed transmission, starting situation is shift lever and transmission both in F3. Then the vehicle starts driving downhill and the transmission reaches its overspeeding limit. In this case, the warning lamp is activated and the ECON.A312 triggers an upshift to F4, where the internal speeds in the transmission are acceptable again. On the RD.120, the dot on the right side of the “4” blinks to indicate that the transmission range gear is greater than the shift lever range position.

E.g. a 4/4 speed transmission, starting situation is that shift lever and transmission are both in F4 and the vehicle is driving at high speed. Then the driver requests a downshift to F3 with the shift lever. The ECON.A312 keeps the transmission in F4, because there would be overspeeding in F3. The warning lamp is activated to indicate the driver that he has made an inappropriate request. On the RD.120, the dot on the right side of the “4” blinks to indicate that the transmission range gear is greater than the shift lever range position.

### 1.9.4 Range shifts in automatic mode

The principle of automatic shifting is: the ECON.A312 makes the transmission shift up or down automatically in order to give the machine the highest tractive effort possible.

Automatic shifting happens between a lower and an upper boundary:

- The upper boundary is the shift lever position
- The lower boundary is the ECON.A312 parameter “lowest gear in automatic mode”

<u>Example</u>: A 4/4 speed transmission with ECON.A312 programmed with “lowest gear in automatic mode” = 2$^{nd}$ and the shift lever is in F3. In this situation, the ECON.A312 lets the transmission shift automatically between F2 and F3.

<u>REMARK</u>: Other functions programmed in the ECON.A312 can influence the automatic shifting, e.g.:

- Loaded/not loaded function: there are 2 seperate parameters “lowest gear in automatic mode”, one is used when the vehicle is loaded and the other is used when the vehicle is empty. E.g. “lowest gear in automatic mode (loaded)” = 1$^{st}$ while “lowest gear in automatic mode (empty)” = 2$^{nd}$. Refer to CHAPTER 1 – 1.11.6 for details.
- Block out highest gears function: when this function is active, the highest gears are blocked out, regardless of the shift lever position. The definition of the gears that are blocked out can be programmed in the ECON.A312. Refer to CHAPTER 1 – 1.11.14 for details.

When turbine speed and engine speed are available, load sensed automatic shifting is possible.

When only turbine speed is available, and there is no engine speed, speed sensed automatic shifting is possible.

### 1.9.4.1 Load sensed automatic shifting

#### 1.9.4.1.1 Principle

Load sensed automatic shifting makes use of the speed ratio to predict whether the tractive effort in the next higher or next lower gear is greater than the tractive effort in the actual gear.

The ECON.A312 calculates the turbine speed from the measured drum or output speed sensor. The ECON.A312 measures the engine speed with the engine speed sensor or receives the engine speed information via the CAN message EEC1. The ECON.A312 then calculates the converter slip = speed ratio as:

$$\text{speed ratio} = \text{S.R.} = \frac{\text{turbine speed}}{\text{impeller speed}}$$

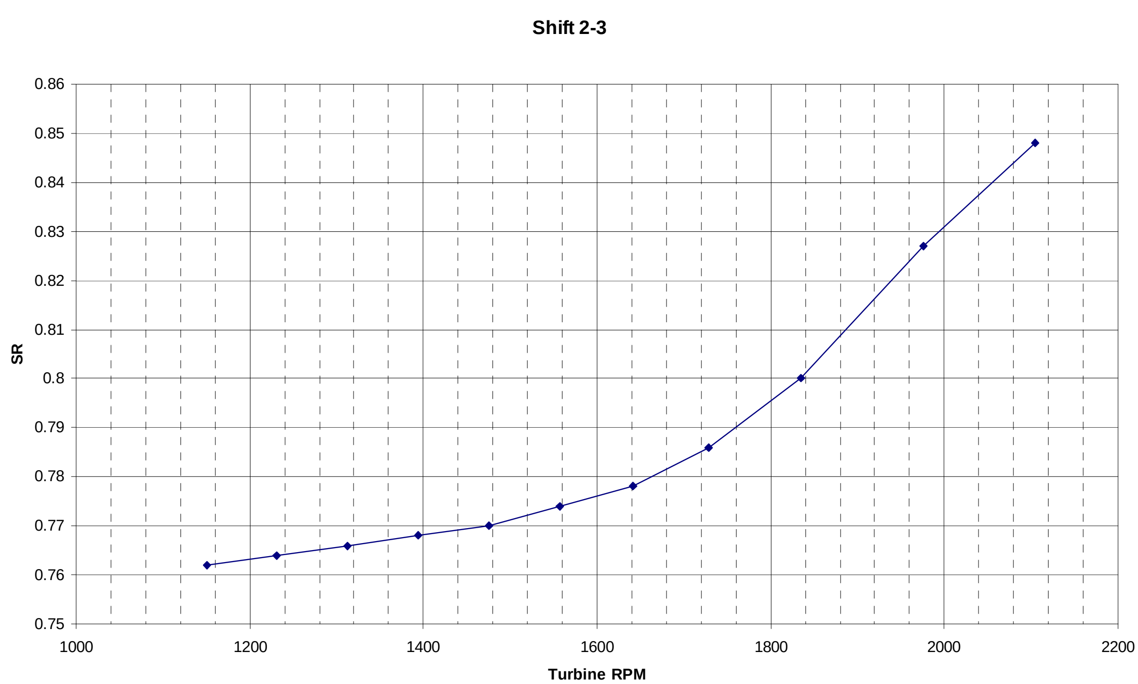
The actual speed ratio is a measure for the actual load in the torque converter and is a measure for the actual tractive effort of the vehicle.

In this way the ECON.A312 can predict, based on the calculated speed ratio, whether the tractive effort in the next higher or next lower gear is greater than the tractive effort in the actual gear. If the conclusion is that the tractive effort in the next higher gear will be greater, an upshift is triggered. If the conclusion is that the tractive effort in the next lower gear will be greater, a downshift is triggered.

#### 1.9.4.1.2 Upshifting

For each range gear, a theoretical upshift curve is calculated in the approval. This upshift curve determines the speed ratio (as function of turbine RPM) above which an upshift should be triggered to obtain more tractive effort in the next higher gear. This upshift curve is also programmed in the ECON.A312 and is used to trigger automatic upshifts.

The graph below illustrates an example of an upshift curve from 2nd to 3rd gear:

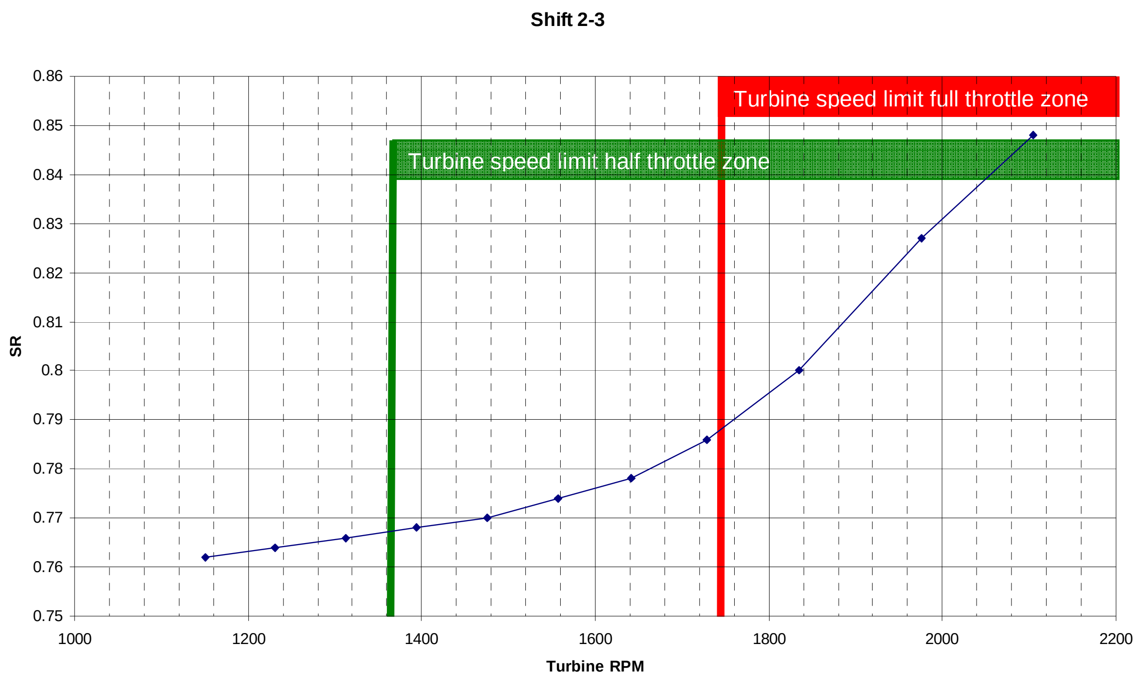


REMARK: typically the speed ratio's for load sensed automatic upshifts are between 0.60 ~ 1.00.

Upshifts are not allowed in case:

- the throttle pedal is in "low throttle" zone
- the torque converter is in braking mode (S.R. > 1.00)

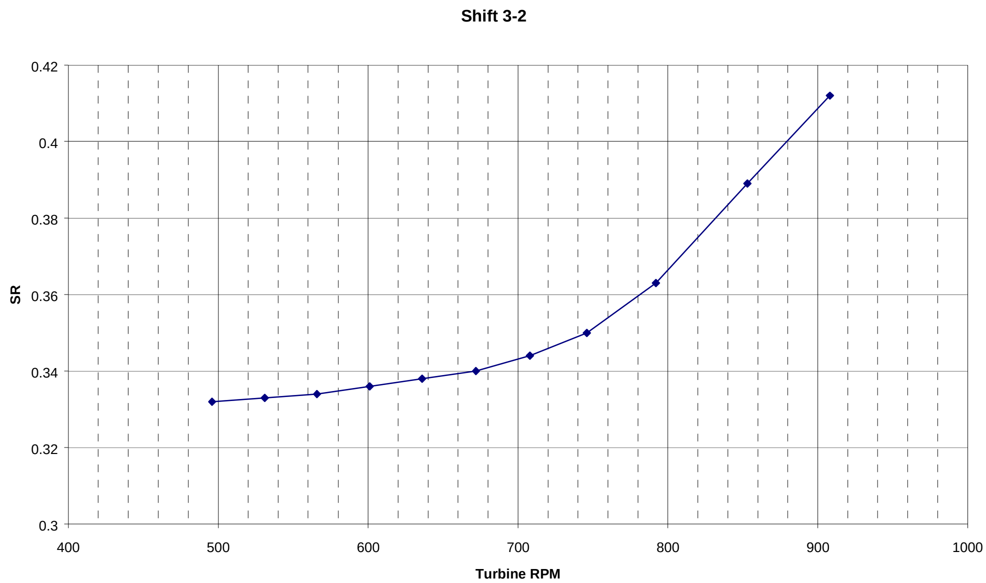
In order to give the automatic shifting a more dynamic behaviour, upshifts are only allowed above a certain turbine speed limit. There is a separate limit for the half throttle zone and for the full throttle zone.




### 1.9.4.1.3 Downshifting

For each range gear, a theoretical downshift curve is calculated in the approval. This downshift curve determines the speed ratio (as function of turbine RPM) below which a downshift should be triggered to obtain more tractive effort in the next lower gear. This downshift curve is also programmed in the ECON.A312 and is used to trigger automatic downshifts.

The graph below illustrates an example of a downshift curve from 3rd to 2nd gear:




<u>REMARK</u>: typically the speed ratio's for load sensed automatic downshifts are between 0.25 ~ 0.50.

Load sensed automatic downshifts are triggered when the speed ratio drops below a certain limit. When the driver releases his foot off the throttle pedal the engine speed drops to idle and the speed ratio increases above 1.00 (braking mode). In this way, automatic downshifts are very late, because it takes a long time before the speed ratio has decreased from more than 1.00 to about 0.25 ~ 0.50. When the driver accelerates again, while the speed ratio is still above the downshift limit, the engine speed increases and the speed ratio drops. At that moment, an unexpected automatic downshift is triggered. The late downshift when the throttle pedal is released or the unexpected downshift when the throttle pedal is pressed again, results in poor performance of load sensed automatic shifting. The solution in the ECON.A312 is: when the driver releases his foot off the throttle pedal, automatic downshifts are triggered at a higher turbine speed. In this way, the automatic downshifts with throttle pedal released, are triggered sooner. This avoids the unexpected downshifts when the throttle pedal is pressed again.

<u>REMARK</u>: By default, the ECON.A312 is programmed with a speed ratio hysteresis of 0.05 between the upshift curve and the downshift curve. This hysteresis avoids hunting between range gears. Suppose there would be no hysteresis and the transmission is in 2nd gear. When the upshift curve is reached, the transmission makes an upshift to 3rd gear. The engagement of 3rd clutch takes e.g. 1 second. During this second, there is some traction loss, which causes a drop in vehicle speed, turbine speed and speed ratio. If there would be no hysteresis, a downshift to 2nd gear would be triggered when the range shift delay has elapsed. In this way, the transmission would start hunting between 2nd and 3rd gear: 2nd → 3rd → 2nd → 3rd → … Due to the speed ratio hysteresis of 0.05 programmed in the ECON.A312, the hunting problem does not occur. However, in the unlikely event that you might encounter hunting on your machine (e.g. because of the heavy load carried or towed by your machine), it can be necessary to increase the hysteresis of 0.05 to a greater value. Please contact Dana in this case.

The desired behaviour can be chosen by the OEM in the ECON.A312 "Purchase Order Description".

### 1.9.4.2 Speed sensed automatic shifting

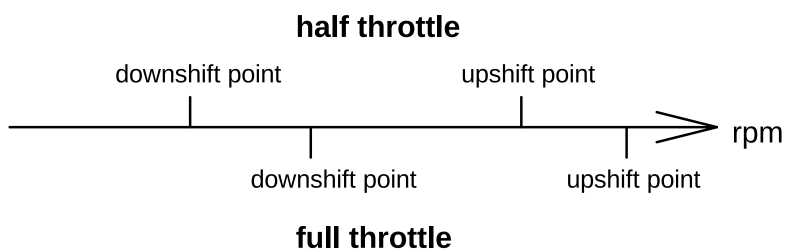
Speed sensed automatic shifts are executed at fixed turbine and vehicle speeds. The engine speed is not taken into account. In this way, speed sensed automatic shifting does not take care about the load in the converter. This last statement is not 100% correct, because there are separate upshift and downshift speed limits for the “half throttle” and “full throttle” position of the throttle pedal.

The ECON.A312 divides the throttle pedal position in 3 zones:

- “low throttle” zone (or “idle” zone)
- “half throttle” zone
- “full throttle” zone

In the “low throttle” zone, speed sensed automatic shifts are not allowed. The driver does not have the intention to accelerate the machine, so there is no reason for making an upshift. When driving downhill, the range gear remains unchanged and the machine has extra braking performance due to engine braking.

In the “half throttle” zone and the “full throttle” zone, automatic upshifts are allowed.
The upshift and downshift points for a specific range gear, are configured as per below schematic:




*Speed sensed automatic shifting – shift points*

<u>REMARK</u>: The above schematic shows that there is a certain turbine rpm hysteresis between the upshift and downshift points. This hysteresis avoids hunting between range gears. This is done for the same reason as in load sensed automatic shifting. Refer to CHAPTER 1 – 1.9.4.1 for details.

<u>REMARK</u>: Load sensed automatic shifts are executed at the theoretically calculated turbine speed, engine speed and speed ratio, taking into account the converter load. Speed sensed automatic shifts are executed at fixed vehicle speeds and the converter load is not taken into account. It is clear that load sensed automatic shifting is a better implementation than speed sensed automatic shifting.

*<u>REMARK:</u>*

*As all these parameters control the behaviour of the shifting logics, it is of the utmost importance that the Dana approval data is correct and in line with the application. The approval is the main data source for calculating the automatic shifting parameters.*

# 1.10 Transmission Protections

## 1.10.1 Downshift protection

Downshift protection is a standard transmission protection that is always enabled.

When a downshift is requested, the ECON.A312 calculates the turbine speed that would be obtained if the downshift to the lower gear would be executed, as a prediction. In case this predicted turbine speed exceeds the maximum turbine speed limit of the transmission, the downshift is not executed, because it would result in dagaming the transmission. The warning lamp is activated to indicate to the driver that he has made an inappropriate request.

As soon as the turbine speed has dropped sufficiently and the predicted turbine speed in the lower gear is not exceeding the transmission limit anymore, the downshift is executed.

REMARK: this protection is active in manual mode as well as in automatic mode.

## 1.10.2 Overspeeding protection in neutral

Overspeeding protection in neutral is a standard transmission protection that is always enabled.

When the machine is driving in neutral and the transmission output speed is increasing (e.g. when driving downhill) and the transmission output speed comes near its overspeeding limit, the warning lamp is activated to warn the driver. This is a trigger to the driver to press the service brakes. If he does not press the service brakes or the braking performance is insufficient, the machine continues gaining speed and the transmission output speed finally reaches its limit. At that moment, the “overspeeding protection in neutral” triggers an upshift to the next higher gear in neutral. In this higher gear, the transmission’s internal speeds are acceptable again.

Of course, if the machine keeps on driving downhill without sufficient braking, it can happen that the transmission reaches its limit again in this higher gear. Then a following overspeeding upshift is made to the next higher gear in neutral. This is repeated until the highest gear in neutral is reached.

REMARK: These overspeeding upshifts are made in automatic and in manual mode.

REMARK: These overspeeding upshifts are made to gears above the shift lever position. If the OEM does not want such overspeeding upshifts above the shift lever position, they can be disabled in the ECON.A312 program. However, this is only done upon specific request of the OEM with the agreement of the OEM that all warranty claims on range clutch failures will be denied by Dana.

REMARK: When the vehicle and transmission speeds decrease again afterwards, downshifts are executed so that the transmission comes again to the most appropriate gear.

E.g. 4/4 speed transmission / manual mode / shift lever = N2
Transmission: N2 → overspeeding limit reached → N3 → overspeeding limit reached → N4 → output speed drops → when the downshift protection function calculates that there will be no more overspeeding in N3 → downshift to N3 → when the downshift protection function calculates that there will be no more oveerspeeding in N2 → downshift to N2

E.g. 4/4 speed transmission / automatic mode / shift lever = N4 / “forward/reverse gear” = 2nd
Transmission: N2 → overspeeding limit reached → overspeeding upshift → N3 → overspeeding limit reached → overspeeding upshift → N4 → ouput speed drops → automatic downshift → N3 → automatic downshift → N2

### 1.10.3 Overspeeding protection in Forward and Reverse

Overspeeding protection in forward and reverse is a standard transmission protection that is always enabled.

When the machine is driving in forward or reverse and the turbine speed is increasing (e.g. when driving downhill) and the turbine speed comes near its overspeeding limit, the warning lamp is activated to warn the driver. This is a trigger to the driver to press the service brakes. If he does not press the service brakes or the braking performance is insufficient, the machine continues gaining speed and the turbine speed finally reaches its limit. At that moment, the “overspeeding protection in forward and reverse” triggers an upshift to the next higher gear in forward or reverse. In this higher gear, the transmission’s internal speeds are acceptable again.

Of course, if the machine keeps on driving downhill without sufficient braking, it can happen that the transmission reaches its limit again in this higher gear. Then a following overspeeding upshift is made to the next higher gear in forward or reverse. This is repeated until the highest gear in forward or reverse is reached.

REMARK: These overspeeding upshifts are made in automatic and in manual mode.

REMARK: These overspeeding upshifts are made to gears above the shift lever position. If the OEM does not want such overspeeding upshifts above the shift lever position, they can be disabled in the ECON.A312 program. However, this is only done upon specific request of the OEM with the agreement of the OEM that all warranty claims on range clutch failures will be denied by Dana.

REMARK: When the vehicle and transmission speeds decrease again afterwards, downshifts are executed, so that the transmission comes again to the most appropriate gear.

E.g. 4/4 speed transmission / manual mode / shift lever = F2
Transmission: F2 → overspeeding limit reached → F3 → overspeeding limit reached → F4 → turbine speed drops → when the “downshift protection” function calculates that there will be no more overspeeding in F3 → downshift to F3 → when the “downshift protection” function calculates that there will be no more oveerspeeding in F2 → downshift to F2

E.g. 4/4 speed transmission / automatic mode / shift lever = R4 / “forward/reverse gear” = 2nd
Transmission: R2 → overspeeding limit reached → overspeeding upshift → R3 → overspeeding limit reached → overspeeding upshift → R4 → turbine speed drops → automatic downshift → R3 → automatic downshift → R2

### 1.10.4 Direction change protection

Direction change protection is a standard transmission protection that is always enabled.

The direction change protection inhibits direction changes when the vehicle speed is above the “direction change vehicle speed limit”. When making a direction change, the kinetic energy of the vehicle has to be absorbed by the clutch pack of the newly engaged directional clutch. This energy is transformed into heat which has to be dissipated by the transmission oil. If the kinetic energy is too high, the transmission oil cannot dissipate the heat sufficiently, and the clutch pack risks to burn. From this explanation, it is clear that the “direction change vehicle speed limit” is function of the transmission clutch design and is function of the vehicle weight.

REMARK: The maximum direction change speed limit is calculated in the approval. The OEM can choose the “direction change speed limit” to be programmed in the ECON.A312. However, it must be equal to or lower than the calculated limit in the approval.

### 1.10.5 System pressure protection

System pressure protection is an optional transmission protection.

When the system pressure is too low, the transmission is forced in neutral.

#### 1.10.5.1 I/O configuration

Necessary I/O: 1 digital or 1 analog input

System pressure information can be shared with the ECON.A312 via:

- A pressure switch wired to a digital input. The pressure switch provides an active signal when the system pressure is too low and an inactive signal when the system pressure is ok (or vice versa). The digital information from the pressure switch can also be received via the CAN message CVC_TO_TC_1. Refer to CHAPTER 3 – 1.5.1 for details.

  REMARK: An echo of the system pressure status is available in the CAN message TC_TO_CVC_2. Refer to CHAPTER 3 – 1.6.2 for details.

- An analog pressure sensor. The OEM can order an analog pressure sensor from Dana: part number 4212000. This pressure sensor is supplied as ship loose part with the ECON.A312. The OEM has to foresee a pressure sensor provision, in which the system pressure sensor can be mounted. Please note that there is no direct provision on the transmission.

  REMARK: An echo of the system pressure value is available in the CAN message TC_TO_CVC_1. Refer to CAHPTER 3 – 1.6.1 for details.

REMARK: The 2 implentations (switch or sensor) can't be combined on 1 application.

Check the application specific wiring diagram to see how the pressure switch or the pressure sensor needs to be connected to the ECON.A312.

#### 1.10.5.2 Function

When the ECON.A312 detects that the system pressure is too low for some seconds, the ECON.A312 forces the transmission in neutral. When the system pressure recovers to normal pressure values, the transmission remains in neutral. In order to re-engage forward (or reverse) on the transmission, the driver has to physically cycle the shift lever through neutral and back to forward (or reverse).

Direction and range shifts are not allowed when the system pressure is too low.

REMARK: By mechanical design, the transmission oil pump is coupled to the combustion engine. This implicates that engine rpm fluctuations (e.g. due to increasing or decreasing engine load) can have an influence on the system pressure of the transmission. Also the startup behaviour of the engine has an influence on the transmission system pressure. The ECON.A312 is programmed to filter out these influences of engine startup and engine rpm fluctuations.

The desired behaviour can be chosen by the OEM in the ECON.A312 "Purchase Order Description".

## 1.10.6 Converter out temperature protection

Converter out temperature protection is an optional transmission protection.

This protection monitors the converter out temperature of the transmission oil. When the temperature is too high, the transmission is forced in neutral.

### 1.10.6.1 I/O configuration

Necessary I/O: 1 digital or 1 analog input

Converter out temperature information can be shared with the ECON.A312 via:

- A temperature switch wired to a digital input. The temperature switch provides an active signal when the converter out temperature is above 120°C and an inactive signal when the system temperature is below 120°C (or vice versa). The digital information from the converter out temperature switch can also be received via the CAN message CVC_TO_TC_1. Refer to CHAPTER 3 – 1.5.1 for details.

  REMARK: An echo of the converter out temperature status is available in the CAN message TC_TO_CVC_2. Refer to CHAPTER 3 – 1.6.2 for details

- An analog temperature sensor. The OEM can order an analog temperature sensor from Dana: part number 4211988. This temperature sensor is supplied as ship loose part with the ECON.A312. The OEM has to foresee a temperature sensor provision, in the hose going from converter out port to the cooler in port. Please note that there is no direct provision on the transmission.

  REMARK: An echo of the converter out temperature value is available in the CAN message TC_TO_CVC_1. Refer to CHAPTER 3 – 1.6.1 for details.

REMARK: The 2 implentations (switch or sensor) can't be combined on 1 application.

Check the application specific wiring diagram to see how the temperature switch or the temperature sensor needs to be connected to the ECON.A312.

### 1.10.6.2 Function

When the ECON.A312 detects that the converter out temperature is too high (above 120°C), the ECON.A312 forces the transmission in neutral after a certain time (30 sec). When the converter out temperature drops again and returns to normal temperature values, the transmission remains in neutral. In order to re-engage forward (or reverse) on the transmission, the driver has to physically cycle the shift lever through neutral and back to forward (or reverse).

The desired behaviour can be chosen by the OEM in the ECON.A312 "Purchase Order Description".

## 1.11 Optional functions

### 1.11.1 Seat Orientation

The seat orientation function is used on vehicles where the operator's seat is mounted on a rotational console, on which also the shift lever is mounted. The rotational seat console has 2 positions: "normal" position and "rotated" position.

The seat orientation function guarantees that the driving direction always corresponds with the shift lever direction, as experienced by the driver, independently of the position of the rotational console.

#### 1.11.1.1 I / O configuration

Necessary I/O: 1 digital input

Typically, a position detection switch is installed on the rotational seat console.

The seat orientation signal can be supplied to the ECON.A312 by:
- Use of a wired input
- Use of a CAN message – the ECON.A312 can receive the "seat orientation" signal via the CAN message CVC_TO_TC_1. Refer to CHAPTER 3 – 1.5.1 for details.

REMARK: An echo of the seat orientation function state is available in the CAN message TC_TO_CVC_2. Refer to CHAPTER 3 – 1.6.2 for details.

Check the application specific wiring diagram to see how the seat orientation switch needs to be connected to the ECON.A312.

#### 1.11.1.2 Function

The ECON.A312 reads the position of the rotational seat console from the position detection switch: "normal" position or "rotated" position.

The ECON.A312 can be programmed in 2 different ways for accepting a new seat orientation:

- Conditional acceptation:
  - (Optionally) the vehicle must be at standstill
  - (Optionally) the shift lever and transmission must be in neutral
  - (Optionally) the parking brake must be applied. Remark that this condition is only possible if parking brake status is available for the ECON.A312. Refer to CHAPTER 1 – 1.11.11 for details.

- Unconditional acceptation: as soon as the seat orientation signal toggles, the ECON.A312 accepts the new seat orientation and immediately selects the new corresponding direction on the transmission. However, the "direction change protection" function can inhibit the selection of the opposite direction if direction change conditions are not fulfilled. Refer to CHAPTER 1 – 1.8.

When the rotational seat console is in the "normal" position, forward on the shift lever corresponds with forward on the transmission. When the rotational seat console is in the "rotated" position, forward on the shift lever corresponds with reverse on the transmission.

When the seat orientation function is used in combination with the function "block out highest gear(s)" (see CHAPTER 1 – 1.11.14), the ECON.A312 can be programmed in 2 different ways:

1. The gears that are blocked out are defined by the transmission direction: e.g. when the transmission is in Fwd, all gears are allowed (F1 – F2 – F3); when the transmission is in Rev, only R1 is allowed and R2 and R3 are blocked out. The seat orientation has no influence.
2. The gears that are blocked out are defined by the seat orientation: e.g. when the seat is in the "normal" position, all gear in Fwd are allowed (F1 – F2 – F3) and in Rev, only R1 is allowed. When the seat is in the "rotated" position, all gear in Rev are allowed (R1 – R2 – R3) and in Fwd, only F1 is allowed.

The desired behaviour can be chosen by the OEM in the ECON.A312 "Purchase Order Description".

## 1.11.2 Declutch

With the declutch function the transmission is forced in neutral based on an input trigger and independently of the shift lever position.

A typical application where declutch function is used, is a fork lift truck. When high engine rpm is needed for the hydraulics, but machine acceleration is not wanted (e.g. when manipulating the forks), the driver presses the brake pedal and the throttle pedal at the same time. The ECON.A312 detects that the brake pedal is pressed and forces the transmission in neutral. By applying the throttle pedal, the engine power is used by the hydraulics to manipulate the forks.

### 1.11.2.1 I / O configuration

<u>Necessary I/O</u>: 1 digital input

Typically a switch is activated when the service brakes are pressed: a position switch on the brake pedal or a pressure switch in the brake lines. It can also be a push button on the hydraulic's joystick or a push button on the dashboard.

Declutch signal can be supplied to the ECON.A312 by:

- Use of a wired input
- Use of a CAN message – the ECON.A312 can receive the "declutch request" via the CAN message CVC_TO_TC_1. Refer to CHAPTER 3 – 1.5.1 for details.

<u>REMARK</u>: An echo of declutch request is available in the CAN message TC_TO_CVC_2. Refer to CHAPTER 3 – 1.6.2 for details.

Check the application specific wiring diagram to see how the declutch switch or push button needs to be connected to the ECON.A312.

### 1.11.2.2 Function

When declutch is requested, neutral is forced on the transmission, and when declutch is not requested anymore, the ECON.A312 re-engages direction on the transmission, provided the direction re-engagement conditions are fulfilled.

For declutch activation (= neutral selection), the following conditions must be fulfilled:

- declutch request
- and (optionally): vehicle speed low enough

For declutch deactivation (= direction re-engagement), the following conditions must be fulfilled:

- no declutch request
- or (optionally): vehicle speed exceeds the “declutch vehicle speed limit”

Example 1:
A switch is installed under the brake pedal, and when the driver presses the service brakes, the transmission is forced in neutral. When the driver releases the service brakes, the transmission re-engages forward (or reverse). There is no relation with the vehicle speed.

Example 2:
A push button is installed on the hydraulic’s joystick, and when the driver pushes the button, the transmission is forced in neutral, provided the vehicle speed is lower than 5 km/h.
When the vehicle speed increases above 5 km/h, (this can happen when the vehicle is driving downhill), the transmission remains in neutral. Only when the driver releases the push button, the transmission re-engages forward (or reverse).

Example 3:
A switch is installed under the brake pedal, and when the driver presses the service brakes, the transmission is forced in neutral, provided the vehicle speed is lower than 8 km/h. When the vehicle speed increases above 9 km/h (this can happen when the vehicle is driving downhill), or when the driver releases the service brakes, the transmission re-engages forward (or reverse).

REMARK: The vehicle speed limit for declutch activation is typically used to implement 2 different behaviours, depending on the vehicle speed:

- Force neutral when the vehicle speed is low. This is done to operate the hydraulics at high engine rpm without accelerating the machine, e.g. for manipulating the forks on a fork lift truck
- Keep forward (or reverse) engaged when the vehicle speed is high, in order to give the machine extra engine braking performance.

The desired behaviour can be chosen by the OEM in the ECON.A312 “Purchase Order Description”.

## 1.11.3 Operator present protection

The “operator present protection” function is used to force the transmission in neutral when the operator is not present in the operator’s seat. This is done to prevent that the vehicle drives off by accident, e.g. when the operator hits the shift lever accidently when leaving the cabin.

REMARK: “Operator present protection” and “neutral lock protection” have the same goal: prevent forward (or reverse) engagement when the operator is not present. On 1 vehicle, only 1 protection can be implemented: “operator present protection” ór “neutral lock protection”.
“Operator present protection” is the best implementation.

### 1.11.3.1 I/O configuration

Necessary I/O: 1 digital input

An “operator presence switch” is installed in the operator’s seat. Normally, the switch gives a positive signal to the ECON.A312 when the operator is present and gives no signal when the operator is absent (or exceptionally vice versa).

The operator presence signal can be supplied to the ECON.A312 by:

- Use of a wired input
- Use of a CAN message – the ECON.A312 can receive the “operator presence” signal via the CAN message CVC_TO_TC_1. Refer to CHAPTER 3 – 1.5.1 for details.

REMARK: An echo of the "operator present function state" is available in the CAN message TC_TO_CVC_2. Refer to CHAPTER 3 – 1.6.2 for details.

Check the application specific wiring diagram to see how the "operator presence switch" needs to be connected to the ECON.A312.

#### 1.11.3.2 Function

When the operator presence switch detects that there is no operator in the operator's seat, the ECON.A312 forces the transmission in neutral after a certain delay (typically 2.0 ~ 3.0 seconds).

The delay is a debouncing delay to be absolutely sure that the operator has left the seat and that the status "operator not present" is real and is not due to a bumpy road or temporary lower pressure on the operator's seat.

When the operator presence switch detects that the operator has returned in the operator's seat, the ECON.A312 keeps the transmission in neutral. To be able to select forward (or reverse) again, the operator has to cycle the shift lever physically through neutral and then reselect forward (or reverse) with the shift lever. This is the standard implementation in the ECON.A312.

REMARK: when the operator is out of the seat and selects direction on the shift lever, the transmission remains forced in neutral.

There is an alternative implementation: when the operator presence switch detects that the operator has returned in the operator's seat, the ECON.A312 keeps the transmission in neutral. To be able to select forward (or reverse) again, the operator has to press the service brakes. In this case, an extra digital input is needed:

- service brakes signal → refer to CHAPTER 1 – 1.11.17 for details
- or declutch request → refer to CHAPTER 1 – 1.11.2 for details

The ECON.A312 can also be programmed to allow forward (or reverse) re-engagement if one of the conditions is fulfilled: "shift lever is cycled through neutral" ór "service brakes is pressed".

The desired behaviour can be chosen by the OEM in the ECON.A312 "Purchase Order Description".

### 1.11.4 Neutral lock protection

The "neutral lock protection" function is used to force the transmission in neutral when the operator is not present in the operator's seat. This is done to prevent that the vehicle drives off by accident, e.g. when the operator hits the shift lever accidently when leaving the cabin.

REMARK: "Neutral lock protection" and "operator present protection" have the same goal: prevent forward (or reverse) engagement when the operator is not present. On 1 vehicle, only 1 protection can be implemented: "neutral lock protection" ór "operator present protection". "Operator present protection" is the best implementation.

### 1.11.4.1 I/O configuration

Necessary I/O: 1 digital input (in case of standard and CAN shift lever)
or none (in case of bump type shift lever)

"Neutral lock protection" can be implemented without I/O when a bump type shift lever is used. In this case, the "neutral lock state" is defeated by an upshift request with the bump type shift lever.

If a standard or CAN shift lever is used, the neutral lock protection needs 1 digital input. The "neutral lock state" is defeated with the "neutral lock reset" signal typically coming from a push button. This "neutral lock reset" signal can be supplied to the ECON.A312 by:

- Use of a wired input
- Use of a CAN message – the ECON.A312 can receive the "neutral lock reset" signal via the CAN message CVC_TO_TC_1. Refer to CHAPTER 3 – 1.5.1 for details.

REMARK: An echo of the "neutral lock function state" is available in the CAN message TC_TO_CVC_2 message. Refer to CHAPTER 3 – 1.6.2 for details.

Check the application specific wiring diagram to see how the "neutral lock reset" push button needs to be connected to the ECON.A312.

### 1.11.4.2 Function

When the shift lever has been in neutral and the vehicle has been standing still for a certain time (typically 2.0 ~3.0 seconds), the ECON.A312 assumes that the operator is not in the operator's seat anymore and forces the transmission in neutral.

REMARK: Of course, the assumption that the operator is not in the operator's seat when the shift lever is in neutral and the vehicle at standstill for some seconds, is not always correct. It could be that the operator is still there. The "operator presence switch" in the operator's seat is more accurate: you are 100% sure that the operator is present or not. This is the first reason why the "operator presence protection" is a better implementation than the "neutral lock protection".

To be able to reselect forward (or reverse), the neutral lock state must be defeated with a push button. In case of "operator present protection", the operator must return in the seat and cycle the shift lever physically through neutral and then reselect forward (or reverse) with the shift lever. This is a much more natural procedure for the operator. This is the second reason why the "operator presence protection" is a better implementation than the "neutral lock protection".

REMARK: when the vehicle is equipped with a bump type shift lever, the "neutral lock reset" signal can be replaced by a specific sequence on the shift lever: the "neutral lock state" can be defeated by selecting forward (or reverse), followed by requesting an upshift. This resets the "neutral lock state", but it does not result in a real upshift.

REMARK: it is possible to program the ECON.A312 with a link between the parking brake function and the neutral lock function; in this case, the ECON.A312 activates its parking brake output for closing the parking brake, whenever the ECON.A312 is in the neutral lock state.

REMARK: it is possible to program the ECON.A312 so that the "neutral lock reset" signal must be active ***while*** (meaning ***not after***) selecting forward or reverse. An example application is where the neutral lock reset signal is connected to the service brakes, and the driver has to press the service brakes while selecting forward or reverse to engage the direction.

The desired behaviour can be chosen by the OEM in the ECON.A312 "Purchase Order Description".

## 1.11.5 Immediate neutral lock protection

"Immediate neutral lock protection" is exactly the same function as the normal "neutral lock protection", except that the neutral lock state is triggered with a request signal.

### 1.11.5.1 I/O configuration

Necessary I/O: 2 digital inputs (standard and CAN shift lever)
or 1 digital input (bump type shift lever)

When a bump type shift lever is used, "immediate neutral lock protection" only needs the signal "immediate neutral lock request". The "neutral lock state" is defeated with an upshift request on the bump type shift lever.

When a standard or CAN shift lever is used, "immediate neutral lock protection" needs the signals "immediate neutral lock request" and "neutral lock reset".

The "immediate neutral lock request" signal can be connected to the ECON.A312 by:

- Use of a wired input

The "neutral lock defeat" signal can be connected to the ECON.A312 by:

- Use of a wired input
- Use of a CAN message – the ECON.A312 can receive the "neutral lock defeat" signal via the CVC_TO_TC_1 message. Refer to CHAPTER 3 – 1.5.1 for details.

REMARK: An echo of the "neutral lock function state" is available in the CAN message TC_TO_CVC_2. Refer to CHAPTER 3 – 1.6.2 for details.

Check the application specific wiring diagram to see how the "immediate neutral lock request" and "neutral lock reset" signals need to be connected to the ECON.A312.

### 1.11.5.2 Function

If "immediate neutral lock" is requested, the ECON.A312 locks the transmission in neutral.

To be able to reselect forward (or reverse), the "neutral lock state" can be defeated with a push button.

REMARK: when the vehicle is equipped with a bump type shift lever, the "neutral lock defeat" signal can be replaced by a specific sequence on the shift lever: the "neutral lock state" can be defeated by selecting forward (or reverse), followed by requesting an upshift. This defeats the "neutral lock state", but it does not result in a real upshift.

REMARK: the "immediate neutral lock request" must be off before the "neutral lock state" can be defeated.

The desired behaviour can be chosen by the OEM in the ECON.A312 "Purchase Order Description".

## 1.11.6 Vehicle loaded / not loaded function

The "vehicle loaded/not loaded" function is used to select the most appropriate "lowest gear in automatic mode". When the vehicle is loaded, 1st gear is needed to have maximum tractive effort. When the vehicle is not loaded, 2nd gear (or higher) is needed, so that the vehicle can start off in a faster range gear than 1st gear.

Besides this standard use of the "vehicle loaded/not loaded" function, there are also 2 other uses, that can be programmed upon request:

- The "vehicle loaded/not loaded" function is used to force manual mode and allow manual range shifts only at vehicle standstill (when the ECON.A312 detects "vehicle loaded"). This function can be used on aircraft tow tractors to inhibit range shifts when the aircraft tow tractor is at speed and towing an airplane.
- The "vehicle loaded/not loaded" function is used to distinghuish 2 seperate "direction change vehicle speed limits" in function of the vehicle state: loaded or not loaded.

### 1.11.6.1 I/O configuration

Necessary I/O: 1 digital input

The "vehicle loaded/not loaded" signal can be supplied to the ECON.A312 by:

- Use of a wired input
- Use of a CAN message – the ECON.A312 can receive the "loaded/not loaded" signal via the CAN message CVC_TO_TC_1. Refer to CHAPTER 3 – 1.5.1 for details.

REMARK: An echo of the "loaded/not loaded detection" is available in the CAN message TC_TO_CVC_2. Refer to CHAPTER 3 – 1.6.2 for details.

Check the application specific wiring diagram to see how the "vehicle loaded/not loaded" detection switch needs to be connected to the ECON.A312.

### 1.11.6.2 Function

Vehicle loaded/not loaded function → to determine the "lowest gear in automatic mode"

When the vehicle is loaded and in automatic mode, the transmission shifts automatically between 1st gear and the shift lever position. In this way, the vehicle has maximum tractive effort when it is loaded.

When the vehicle is not loaded and in automatic mode, the transmission shifts automatically between 2nd gear and the shift lever position. In this way, the vehicle starts off in a higher and faster range gear than 1st gear.

REMARK: the ECON.A312 can also be programmed to start in 3rd gear (or higher) when the vehicle is not loaded. The OEM can specify the desired "lowest gear in automatic mode" when the vehicle is not loaded, in the ECON.A312 "Purchase Order Description".

Vehicle loaded/not loaded function → to force manual mode (optional)

When the ECON.A312 detects that the vehicle is loaded, it forces the transmission in manual mode and allows manual range shifts only at vehicle standstill. This function can be used on aircraft tow tractors to inhibit range shifts when the aircraft tow tractor is at speed and towing an airplane.

Vehicle loaded/not loaded function → to determine the "direction change speed limit" (optional)

The "vehicle loaded/not loaded" function is used to make the "direction change vehicle speed limit" dependent on the vehicle load:

- there is 1 direction change speed limit when the vehicle is loaded (e.g. 3 km/h)
- there is 1 direction change speed limit when the vehicle is not loaded (e.g. 7 km/h)

The desired behaviour can be chosen by the OEM in the ECON.A312 "Purchase Order Description".

## 1.11.7 Range shift inhibition

With the "range shift inhibition" function, the ECON.A312 inhibits range shifting upon request. This "inhibit range shift request" can come from a selection switch in the cabin, but it can also come from a switch or device that detects specific vehicle conditions in which range shifts should be inhibited.

The ECON.A312 can be programmed to accept range shift inhibition requests, depending on:

- the transmission direction: forward or reverse
- the range shift mode: manual or automatic
- the range shift type: upshift or downshift

In below example, upshifts in automatic mode can be inhibited upon request, while inhibition requests are ignored for downshifts and are ignored in manual mode:

<table>
<tr><th></th><th>Upshifts</th><th>Downshifts</th></tr>
<tr><td>Manual mode Forward</td><td colspan="2" rowspan="2">Inhibition request ignored</td></tr>
<tr><td>Manual mode Reverse</td></tr>
<tr><td>Automatic mode Forward above F/R gear</td><td rowspan="4">Inhibition request accepted</td><td rowspan="4">Inhibition request ignored</td></tr>
<tr><td>Automatic mode Reverse above F/R gear</td></tr>
<tr><td>Automatic mode Forward below F/R gear</td></tr>
<tr><td>Automatic mode Reverse below F/R gear</td></tr>
</table>

REMARK: Optionally, "range shift inhibition" can be ignored when the vehicle is at standstill.

### 1.11.7.1 I/O configuration

Necessary I/O: 1 digital input

The "range shift inhibition" signal comes from a request switch in the cabin or from a switch or device that detects specific vehicle conditions in which range shifts should be inhibited.

The "range shift inhibition" signal can be supplied to the ECON.A312 by:

- Use of a wired input
- Use of a CAN message – the ECON.A312 can receive the "range shift inhibition" request via the CAN message CVC_TO_TC_1. Refer to CHAPTER 3 – 1.5.1 for details.

REMARK: An echo of the "range shift inhibition function state" is available in the CAN message TC_TO_CVC_2. Refer to CHAPTER 3 – 1.6.2 for details.

Check the application specific wiring diagram to see how the "range shift inhibition" switch needs to be connected to the ECON.A312.

#### 1.11.7.2 Function

When an up- or downshift is requested and the “range shift inhibition request” is active, the ECON.A312 checks:

- the actual transmission direction (forward or reverse)
- the actual range shift mode (manual mode / automatic mode below the “direction change gear” / automatic mode above the “direction change gear”)

If range shift inhibition can be accepted for the actual direction and the actual mode, the up- or downshift is inhibited.  The transmission remains in the current range gear.

REMARK: Optionally range shift inhibition is overruled at vehicle standstill.  In this case, range shifts are always allowed at vehicle standstill, regardless the state of the range shift inhibition request.

REMARK: When the range shift inhibition is active, the transmission overspeeding protections can still force an upshift if needed.  If the transmission reaches its overspeeding limits (when driving downhill) an upshift is triggered to protect the transmission.  Once an overspeeding upshift has occurred, and afterwards the speed drops sufficiently again, no downshift is triggered, because the range shift inhibition is still active.

The desired behaviour can be chosen by the OEM in the ECON.A312 “Purchase Order Description”.

## 1.11.8 Kickdown

The kickdown function is typically used to reduce the duration of the Y-cycle of loader, backhoe loader and telescopic boom handler applications.

If there would be no kickdown function on such applications, the Y-cycle sequence would look like:

F2 → downshift for more tractive effort → F1 → direction change → R1 → upshift → R2

This sequence is not efficient in several ways:

- The driver has to manually twist the shift lever twice:
  - first down to F1
  - and then up again to R2
- When reverse is selected, the machine drives off in R1, which is a slow gear. The transmission stays in R1 for a minimum time (respecting the “range shift delay”, typically 1.5 ~ 2.5 seconds) and then the transmission makes an upshift to R2.

Conclusion: without kickdown function, the Y-cycle is annoying for the driver and too slow.

With the manual kickdown function, the downshift to F1 is made by making use of a push button, which is typically installed at the top of the shift lever. When the kickdown is executed and afterwards the opposite direction is selected with the shift lever, the transmission is immediately put in 2nd gear. E.g.:

F2 → kickdown for more tractive effort → F1 → direction change → R2

It is clear that this kickdown sequence is more efficient:

- The driver does not have to twist the shift lever twice, he only has to push the kickdown button once
- When selecting reverse, the machine drives off in R2 right away, which is a faster gear than R1 and the upshift from R1 to R2 is not needed anymore.

With the automatic kickdown function, engine speed and output speed are monitored continuously and when the engine speed is sufficiently high (e.g. >2000 rpm) while the output speed is sufficiently low (e.g. < 100 rpm) for some time (e.g. 2.0 seconds), the ECON.A312 detects that the machine needs more tractive effort and makes an automatic kickdown to the lower gear.

REMARK: Kickdown can also be programmed from other gears. However, it is only possible from gears lower than or equal to the “forward/reverse gear” = “lowest gear in automatic mode”.

### 1.11.8.1 I/O configuration

Necessary I/O: 1 digital input (for manual kickdown)
or engine speed and drum/output speed (for automatic kickdown)

For manual kickdown, a push button is needed (typically installed at the top of the shift lever).

The “manual kickdown request” signal can be supplied to the ECON.A312 by:

- Use of a wired input
- Use of a CAN message – the ECON.A312 can receive the “manual kickdown request” signal via the CAN message CVC_TO_TC_1. Refer to CHAPTER 3 – 1.5.1 for details.

REMARK: An echo of the “manual kickdown request” is available in the CAN message TC_TO_CVC_2. Refer to CHAPTER 3 – 1.6.2 for details.

Check the application specific wiring diagram to see how the “manual kickdown request” signal needs to be connected to the ECON.A312.

For automatic kickdown, no switch or push button is needed: the kickdown is based on the engine speed and the transmission output speed.

Check the application specific wiring diagram to see how the engine speed sensor and drum/output speed sensor need to be connected to the ECON.A312.

### 1.11.8.2 Function

Combinations of kickdown and range shifting

The rules for combinations are:

- on 1 application you can have both manual and automatic kickdown
- on 1 application you can have both manual and automatic range shifting
- manual kickdown can be used in combination with manual and automatic range shifting
- automatic kickdown can be used in combination with manual and automatic range shifting

Manual kickdown (3 possible implementations):

- Single kickdown: the kickdown request results in a downshift to the lower gear, a following kickdown request results in an upshift to the original gear again. This deactivates the kickdown mode.
  E.g.: F3 → kickdown → F2 → kickdown → F3
  E.g.: F3 → kickdown → F2 → direction change → R3

- Standard multiple kickdown: the kickdown request results in a downshift to the lower gear, following kickdown requests result in following downshifts, until 1st gear is reached.
  E.g.: F3 → kickdown → F2 → kickdown → F1 → kickdown (= no effect, remains in F1)
  E.g.: F3 → kickdown → F2 → kickdown → F1 → direction change → R3
  E.g.: F3 → kickdown → F2 → direction change → R3

  The ECON.A312 can be programmed to allow automatic upshifts out of kickdown:
  E.g.: F3 → kickdown → F2 → accelerate → auto upshift to F3
  E.g.: F3 → kickdown → F2 → kickdown → F1 → accelerate → auto upshift to F2 … F3

- Cyclic multiple kickdown: the kickdown request results in a downshift to the lower gear, following kickdown requests result in following downshifts. If 1st gear is reached, and again a kickdown request is made, the transmission makes an upshift to the gear where kickdown was started.
  E.g.: F3 → kickdown → F2 → kickdown → F1 → kickdown → F3
  E.g.: F3 → kickdown → F2 → kickdown → F1 → direction change → R3
  E.g.: F3 → kickdown → F2 → direction change → R3
  The ECON.A312 can be programmed to allow automatic upshifts out of kickdown.

REMARK: When there is a kickdown request, the ECON.A312 "downshift protection" function calculates the turbine speed that would be obtained in the lower gear after the kickdown. If the calculated turbine speed in the lower gear is too high, the ECON.A312 does not execute the kickdown but memorises the kickdown request typically for 5.0 seconds (parameter). As soon as the turbine speed is sufficiently low within this period of 5.0 seconds, the kickdown is executed. If however the vehicle has not sufficiently slowed down within this period, the request is dropped and the kickdown is not executed. A new kickdown request is needed to trigger the kickdown.

Automatic kickdown:

Automatic kickdown downshifts are executed based on the engine speed and the transmission output speed:  when the engine speed is sufficiently high (e.g. >2000 rpm), while the output speed is sufficiently low (e.g. < 100 rpm) for some time (e.g. 2.0 seconds), the ECON.A312 detects that the machine needs more tractive effort and makes an automatic kickdown to the lower gear.

When an automatic kickdown is executed, the ECON.A312 can be programmed to allow automatic upshifts out of kickdown.

E.g.: F2 / engine speed 1500 rpm / output speed 400 rpm → output speed drops below 100 rpm and engine speed increases above 2000 rpm → automatic kickdown to F1 → engine speed remains high and turbine speed increases again → automatic upshift out of kickdown → F2

The following remarks are applicable for both, manual and automatic kickdown:

REMARK: Typically a kickdown is desired at a very specific moment during the work, when the driver feels the need for extra tractive effort of a lower gear, e.g. 1st gear.  An automatic kickdown might come just too early or just too late for the driver.  Therefor, automatic kickdown is not the preferred implementation.  Manual kickdown is the preferred implementation.  A manual kickdown always comes at the right moment: when the driver makes the request.

REMARK:

- Specific range shift delay timings can be programmed for kickdown shifts, separate from the normal range shift delays
- Specific range shift delay timings can be programmed for upshifts out of kickdown, separate from the normal range shift delays.

REMARK: There are several ways to exit kickdown mode:

- When a direction change is made:
  E.g.: F2 → kickdown → F1 (in kickdown mode) → direction change → R2 (not in kickdown mode anymore)
- When a manual upshift out of kickdown is made
  E.g.: F2 → 1st manual kickdown request → F1 (in kickdown mode) → 2nd manual kickdown request → manual upshift out of kickdown → F2 (not in kickdown mode anymore)
- When the shift lever is lowered until it is equal to the transmission range gear position:
  E.g.: F2 → kickdown → F1 (in kickdown mode) → shift lever lowered to 1st → F1 (but not in kickdown mode anymore) → shift lever increased to 2nd → F2
- When an automatic upshift is made out of kickdown and the gear from which the kickdown was once started, is reached again:
  E.g.: F2 → kickdown → F1 (in kickdown mode) → engine speed and turbine speed sufficiently high to make an automatic upshift → F2 (not in kickdown mode anymore).
  Remark: it is possible to enable/disable the option of automatic upshifts out of kickdown after a manual kickdown.

The desired behaviour can be chosen by the OEM in the ECON.A312 “Purchase Order Description”.

### 1.11.9 Lockup

The torque converter is a hydraulic coupling between the engine and the transmission, and it has the characteristic to multiply the engine torque, typically with a factor 2.5 or 3.0 at stall. “Torque converter” is often abbreviated to “converter”.
The converter contains an impeller, a stator and a turbine. The speed of the impeller is different than the speed of the turbine. When the transmission is in driving mode, the impeller rotates faster than the turbine. In driving mode, engine power is transferred through the converter into the transmission, to the wheels. When the transmission is in braking mode, the impeller rotates slower than turbine and vehicle energy is partially absorbed by the engine and partially by the converter.

REMARK: the difference in speed between impeller and turbine is expressed as speed ratio:

$$\text{speed ratio} = \text{S.R.} = \frac{\text{turbine speed}}{\text{impeller speed}}$$

When the transmission is in driving mode, there is loss of efficiency in the converter due to the oil movement in the converter. This loss of efficiency is converted into heat. Even when the converter barely slips (speed ratio almost 1.00), there is still an efficiency loss in the converter. A lockup converter can overcome this efficiency loss. In a lockup converter, the turbine and impeller are mechanically coupled (by closing the lockup clutch), when the turbine speed is almost equal to the impeller speed. Due to the mechanical coupling, the turbine and impeller speed are equal in lockup and there is no slip in the converter. As a consequence, there is almost no effiency loss in the converter.

Lockup use for efficiency reasons is typical in applications where the vehicle drives at high speed for long distance, e.g. railway applications.

When a transmission *without lockup* is in braking mode, the vehicle energy is partially aborbed by the engine and partially by the converter. When a transmission *with lockup* is in braking mode, the vehicle energy is completely absorbed by the engine which results in higher braking performance. For this reason, lockup can also be used in applications where extra engine braking performance is needed, e.g. in mine applications. In these applications driving downhill over long distances is common practice. At that moment engine braking via lockup is used to avoid that the service brakes get overheated.

Additionally, when the vehicle is equipped with an exhaust brake, jake brake or a retarder, the OEM can provide a signal to the ECON.A312 to inform that this brake is active. At that moment the, the ECON.A312 automatically engages lockup.

REMARK: whether lockup is needed for higher efficiency or for improved braking performance, the best choice for lockup engagement is automatic lockup. In automatic lockup the ECON.A312 checks transmission speed, engine speed, throttle pedal position and then engages and disengages lockup at appropriate speeds.

### 1.11.9.1 I/O configuration

Necessary I/O: 1 digital output is used to activate the lockup solenoid on the lockup valve. This lockup valve activates the lockup clutch of the converter. The lockup clutch finally closes the converter in lockup.

Necessary I/O: turbine speed and engine speed. For more information about turbine speed and engine speed, refer to CHAPTER 1 – 1.6.2.

Necessary I/O: throttle pedal information (via EEC2, via CVC_TO_TC_2, via Hall Effect sensor, via potentiometer or via “idle/not idle” switch in combination with “full throttle/half throttle” switch). For more information about the throttle pedal information, refer to CHAPTER 1 – 1.6.5.

Necessary I/O: Several digital input signals can be used:
- Manual lockup request
- Automatic lockup enable / disable
- Exhaust brake status signal
- Jake brake status signal
- Retarder status signal

REMARK: The digital input signals needed for a specific application depend on the desired lockup functionality.

The “manual lockup request”, the “automatic lockup enable/disable”, the “exhaust brake” status signal and/or the “retarder active” feedback signal can be supplied to the ECON.A312 by:
- Use of a wired input
- Use of a CAN message – the ECON.A312 can receive these requests/signals via the CAN message CVC_TO_TC_1. Refer to CHAPTER 3 – 1.5.1 for details.

REMARK: An echo of these requests/signals is available in the CAN message TC_TO_CVC_2. Refer to CHAPTER 3 – 1.6.2 for details.

Check the application specific wiring diagram to see how the different switches (“manual lockup request” switch, “automatic lockup enable/disable” switch, “exhaust brake” status signal, “jake brake” status signal and/or “retarder” status signal), the throttle pedal and the speed sensors need to be connected to the ECON.A312.

### 1.11.9.2 Function

The ECON.A312 can be programmed to operate in manual lockup mode ór in automatic lockup mode. The ECON.A312 can’t be programmed to operate in both modes on 1 vehicle.

Manual lockup

The driver makes a lockup request with a switch in the cabin.

When lockup is requested manually:
- and the engine speed is sufficiently above the idle speed: lockup is engaged
- and the engine speed is too close to the idle speed: lockup is not engaged

Once manual lockup is engaged, and the engine speed drops and comes too close to the idle speed, lockup is disengaged automatically.

REMARK: if the exhaust brake, jake brake or retarder is activated while manual lockup is not requested, the ECON.A312 activates lockup. The exhaust brake, jake brake and retarder function have priority over the manual lockup function.

Automatic lockup

The driver enables the automatic lockup mode with a “lockup enable/disable” switch in the cabin.

When the automatic lockup mode is disabled, automatic lockup is not allowed and the transmission operates in converter mode continuously.

REMARK: if the exhaust brake, jake brake or retarder is activated while automatic lockup mode is disabled, the ECON.A312 activates lockup. The exhaust brake, jake brake and retarder function have priority over the automatic lockup function.

When the automatic lockup mode is enabled, automatic lockup is allowed and the ECON.A312 activates and deactivates the converter lockup automatically based on:

- Engine speed
- Turbine speed
- Throttle pedal position

The ECON.A312 engages lockup automatically when the turbine speed and the speed ratio reach their ‘lockup engagement’ limits. These limits are function of the throttle pedal position. The ECON.A312 also checks that the engine speed is sufficiently above the engine idle speed, before it engages lockup.

The ECON.A312 disengages lockup automatically when the turbine speed (= engine speed) drops below its ‘lockup disengagement’ limit. This limit is function of the throttle pedal position.

The ECON.A312 disengages lockup and triggers an upshift automatically when the turbine speed (= engine speed) exceeds the “automatic upshift out of lockup” limit.

Lockup engagement when exhaust brake, jake brake or retarder active

When the exhaust brake is activated (at the moment extra braking performance is needed), the ECON.A312 is informed. At that moment the ECON.A312 checks that:

- the turbine speed is above the “exhaust brake lockup engagement” limit (resp. “jake brake lockup engagement” limit / “retarder lockup engagement” limit)
- the engine speed is sufficiently above the engine idle speed

If these conditions are fulfilled, the ECON.A312 automatically engages lockup.

The ECON.A312 disengages lockup automatically when the turbine speed (= engine speed) drops below the “exhaust brake lockup disengagement” limit (resp. “jake brake lockup disengagement” limit / “retarder lockup disengagement” limit) or when the exhaust brake (resp. jake brake / retarder) is deactivated again.

REMARK: The exhaust brake function (resp. jake brake function / retarder function) has priority over the manual and automatic lockup function.

The desired behaviour can be chosen by the OEM in the ECON.A312 “Purchase Order Description”.

### 1.11.10 Neutral engine start

Neutral engine start is a general safety feature on a vehicle. It ensures that the engine can only be started when the shift lever and the transmission are in neutral. There are several possibilities for implementation.

The easiest and best implementation is to wire the engine starter relay directly to the shift lever. When the shift lever is in forward or reverse, the starter relay is opened and the engine can not be started. When the shift lever is in neutral, the starter relay is closed and the engine can be started.

The best implementation for the starter relay is an N.C. (**N**ormal **C**losed) relay: when the shift lever is in neutral, the wire to the starter relay is not activated, the N.C. relay is closed and the engine can be started. When the shift lever is in forward or reverse, the wire to the starter relay is activated, the N.C. relay is opened and the engine can not be started.

The implementation with an N.O. (**N**ormal **O**pen) relay has a serious drawback: in case the battery is weak, and the shift lever is in neutral, the wire to the starter relay is activated, the N.O. relay is closed and the engine can be started. Because the battery is weak, the battery voltage drops during engine start. Due to this voltage drop, the N.O. relay opens again and the engine start procedure is stopped. The result is: the engine can not be started when the battery is weak.

If the above implementation via the shift lever is not possible on the specific application, another solution is that the ECON.A312 activates an output to control the engine starter relay. This is done with the function “Neutral engine start”.

For the same reason as explained above, the best implementation is with an N.C. (**N**ormal **C**losed) relay: when the ECON.A312 detects that the shift lever is in neutral, the output to the starter relay is not activated, the N.C. relay is closed and the engine can be started. When the shift lever is in forward or reverse, the wire to the starter relay is activated, the N.C. relay is opened and the engine can not be started.

REMARK: During initialization of the ECON.A312, all outputs are off. This means that the neutral engine start output of the ECON.A312 is off and that the N.C. relay is closed and that the engine can be started even when the shift lever is in forward or reverse. However this is not a real problem, because also the ECON.A312 outputs connected to the control valve are off during initialization, which results in neutral on the transmission. The vehicle does not “jump” forward (or reverse).

REMARK: After initialization, the ECON.A312 forces the transmission in neutral and waits till the driver physically cycles the shift lever through neutral and then reselects forward (or reverse) with the shift lever.

The implementation with an N.O. (**N**ormal **O**pen) engine starter relay connected to an ECON.A312 output, gives problems when the battery is weak. This is due to the same reason as explained above.

#### 1.11.10.1 I/O configuration

Necessary I/O: none (for implementation via shift lever wiring)
or 1 digital output (for implementation via ECON.A312)

Check the application specific wiring diagram to see how the engine starter relay needs to be connected to the shift lever or to the ECON.A312.

#### 1.11.10.2 Function

The best implementation for the neutral engine start function is with an N.C. (**N**ormal **C**losed) relay. For this reason, the below explanation is made with the example of an N.C. relay.

When the ECON.A312 detects that the shift lever is in neutral, the output to the starter relay is not activated, the N.C. relay is closed and the engine can be started. When the shift lever is in forward or reverse, the wire to the starter relay is activated, the N.C. relay is opened and the engine can not be started.

REMARK: During initialization of the ECON.A312, all outputs are off. In this way the engine can be started during initialization even with the shift lever in forward (or reverse), while the transmission stays in neutral. The vehicle does not “jump” forward (or reverse). After initialization, the ECON.A312 forces the transmission in neutral and waits till the driver physically cycles the shift lever through neutral and then reselects forward (or reverse) with the shift lever.

The best implementation for the “neutral engine start” function is to wire the engine starter relay directly to the shift lever. For this reason, the “neutral engine start” function is not included in the ECON.A312 “Purchase Order Description”. However, if the OEM insists on having the “neutral engine start” function controlled by the ECON.A312, this should be requested on page 7 of the “Purchase Order Description”, where special requests can be formulated.

### 1.11.11 Parking Brake

When the parking brake is applied, the ECON.A312 forces the transmission in neutral.
In this way:

- the driver can not drive the machine against the parking brake
- the driver can not stall the converter (in case there is not enough tractive effort to drive off). Stalling the converter results in transmission heating, which can damage the transmission if the temperature rises above 120°C.

#### 1.11.11.1 I/O configuration

I/O configuration for standard parking brake:

- 1 digital input to read the parking brake state

I/O configuration for parking brake n°1 and n°2:

- 1 digital input to read the parking brake request
- 1 digital output to apply/release the parking brake
- (optionally) 1 digital input to read the state of the service brakes

The “parking brake state” or “parking brake request” signal and the “service brakes state” signal can be supplied to the ECON.A312 by:

- Use of a wired input
- Use of a CAN message – the ECON.A312 can receive the “parking brake state” or “parking brake request” and the “service brakes state” signal via the CAN message CVC_TO_TC_1. Refer to CHAPTER 3 – 1.5.1 for details.

REMARK: An echo of the “parking brake state” or “parking brake request” and an echo of the “service brakes state” is available in the CAN message TC_TO_CVC_2. Refer to CHAPTER 3 – 1.6.2 for details.

Check the application specific wiring diagram to see how the “parking brake state”, the “parking brake request” or the “service brakes state” signal needs to be connected to the ECON.A312.

#### 1.11.11.2 Function

Standard functionality for the parking brake:

- The ECON.A312 reads the status of the parking brake: applied or released. When the parking brake is applied, the transmission is forced in neutral. When the parking brake is released, the transmission remains in neutral. Forward (or reverse) can only be re-engaged after physically cycling the shift lever through neutral and then reselect forward (or reverse).

Optional functionalities for the parking brake:

- optional parking brake n° 1:
  The ECON.A312 receives a parking brake request. When parking brake is requested and the vehicle is at standstill, the parking brake is applied by an ECON.A312 output and the transmission is forced in neutral. When the parking brake request disappears, the parking brake remains applied and the transmission remains forced in neutral, until the driver presses the service brakes. After pressing the service brakes, the parking brake is released by the ECON.A312 output and forward or reverse can again be selected on the transmission. The function 'short direction engagement' can only be used in combination with "optional parking brake n° 1". Refer to CHAPTER 1 – 1.11.12 for details.
- optional parking brake n° 2 :
  The ECON.A312 receives a parking brake request. When parking brake is requested and the vehicle is at standstill, the transmission is forced in neutral and the parking brake is applied by an ECON.A312 output. When the parking brake request disappears, the parking brake is released by the same ECON.A312 output and the transmission remains in neutral. Forward (or reverse) can only be re-engaged after physically cycling the shift lever through neutral and then reselect forward (or reverse).

REMARK: If desired, the ECON.A312 can be programmed to allow forward (or reverse) selection immediately when the parking brake is released. This means that the ECON.A312 does not wait for the driver to cycle the shift lever through neutral and to reselect forward (or reverse).

REMARK: If desired, the ECON.A312 can be programmed to allow forward (or reverse) selection (after parking brake release) at the moment one of following 2 conditions are fulfilled:

- the service brakes are pressed
- the shift lever has been cycled through neutral and back to forward (or reverse)

### 1.11.12 Short direction engagement

Forward and reverse are normally selected with the shift lever. But with the function "short direction engagement", forward and reverse can also be selected with an external forward selection push button and an external reverse selection push button.

The selection of forward direction and reverse direction is limited in time:

- when the push button is released, neutral is reselected
- when the "short direction engagement" timer has expired (e.g. 2.0 seconds), neutral is reselected

REMARK: The "short direction engagement" function can only be used in combination with an "enable switch" and "optional parking brake functionality n° 1". The enable switch is an extra security for the operator that enables the short direction engagement. The ECON.A312 releases and applies the parking brake automatically when the "short direction engagement" function is active.

#### 1.11.12.1 I/O configuration

The "short direction engagement" function can only be used in combination with "optional parking brake functionality n° 1". For this reason, the necessary I/O contains:

- 1 digital input to read the parking brake request
- 1 digital output to apply/release the parking brake
- 1 digital input to read the state of the service brakes

Further necessary I/O:

- 1 digital input to enable the "short direction engagement"
- 1 digital input to read the "short forward engagement" request
- 1 digital input to read the "short reverse engagement" request
- Engine speed information. Refer to CHAPTER 1 – 1.6.2.3 for details.

REMARK: the "short forward engagement" and "short reverse engagement" request can be supplied to the ECON.A312 by use of a wired input.

Check the application specific wiring diagram to see how the "parking brake" request, "service brakes" state signal, "enable switch", "short forward engagement" request, "short reverse engagement" request, engine speed sensor and "parking brake activation" output must be connected to the ECON.A312.

#### 1.11.12.2 Function

Forward and reverse are normally selected with the shift lever. But with the optional function "short direction engagement", forward and reverse can also be selected with an external forward selection push button and an external reverse selection push button.

A signal on the "short forward engagement" push button or on the "short reverse engagement" push button results in forward (or reverse) engagement if the following conditions are fulfilled:

- shift lever is in neutral
- parking brake is requested
- the parking brake is applied (with the ECON.A312 output)
- the engine speed is sufficiently low
- the "enable switch" is activated

When these conditions are fulfilled, forward (or reverse) is engaged and at the same time the parking brake is released (with the ECON.A312 output). Now the vehicle drives off. The range gear in which the vehicle drives off, is always in the 3$^{rd}$ gear.

The engagement of forward (or reverse) is limited in time. Neutral is reselected:

- when the push button is released
- when the "short direction engagement" timer has expired (e.g. 2 seconds)

When neutral is reselected, the parking brake is applied at the same moment (even when there is vehicle speed). Now the vehicle stops again.

A minimum delay between 2 "short direction engagements" (e.g. 0.5 sec) is taken into account.

### 1.11.13 High/low range control

A 6/6 speed transmission is a 3/3 speed full power shift transmission with a high/low range selection at the output section. Similarly, an 8/8 speed transmission is a 4/4 speed full power shift transmission with a high/low range selection at the output section.

Once in the low range (or in high range), the vehicle can drive in 3 speeds forward and 3 speeds reverse (for a 6/6 speed transmission). Similarly, the vehicle can drive in 4 speeds forward and 4 speeds reverse (for an 8/8 speed transmission). Changing from high range to low range (or vice versa) is controlled by the ECON.A312 and is performed at vehicle standstill and transmission neutral.

REMARK: a "high/low range" transmission is not the same as a "splitter" transmission.

REMARK: this function cannot be combined with the function "real vehicle speed". Refer to CHAPTER 1 – 1.11.14 for details.

### 1.11.13.1 I/O configuration

Necessary I/O:
- A high/low range selection switch
- A high/low range output to actuate high/low range on the transmission

Typically, a "high/low range selection" switch is installed on the dashboard. The "high/low range selection" signal can be supplied to the ECON.A312 by:
- Use of a wired input
- Use of a CAN message – the ECON.A312 can receive the "high/low range selection" signal via the CAN message CVC_TO_TC_1. Refer to CHAPTER 3 – 1.5.1 for details.

REMARK: An echo of the "high/low range selection" signal is available in the CAN message TC_TO_CVC_2. Refer to CHAPTER 3 – 1.6.2 for details.

Check the application specific wiring diagram to see how the "high/low range selection" switch needs to be connected to the ECON.A312.

The high/low range output is typically connected to a pneumatic valve which in its turn controls the position of the high/low range actuator. The high/low range actuator puts the transmission in high range or in low range.

Check the application specific wiring diagram to see how the pneumatic valve (which controls the high/low range actuator), needs to be connected to the ECON.A312.

### 1.11.13.2 Function

On the transmission, the high/low range selection is mechanically implemented with splines. For this reason, changing from low range to high range (and vice versa) must be done at vehicle standstill. To assure that these changeovers are 100 % protected, the selection of high and low range is controlled by the ECON.A312.

The OEM has to install a selection switch in the cabin, so that the driver can make a selection between low and high range. If the driver toggles the selection from low to high range (or vice versa), the ECON.A312 waits till the vehicle comes to standstill. When the vehicle has stopped, the ECON.A312 forces the transmission in neutral and then executes the changeover from low to high range (or vice versa). When the new range is engaged (after about 2.5 seconds), forward or reverse is re-engaged automatically on the transmission.

REMARK: If desired, the ECON.A312 can be programmed to allow forward (or reverse) re-engagements only after a physical cycle through neutral and reselection of forward (or reverse) with the shift lever.

The desired behaviour can be chosen by the OEM in the ECON.A312 "Purchase Order Description".

### 1.11.14 Block out highest gear(s)

Transmission range gear(s) are blocked out by default or upon request:

- Blocked out by default → the range gears are blocked out without any trigger
  E.g.: a 4/4 speed transmission → F4, N4 and R4 are blocked by default. Maximum gear is 3rd.
- Blocked out upon request → the range gears are blocked out upon request
  E.g.: a 4/4 speed transmission → F4, N4 and R4 are blocked out when a digital input is active. Maximum gear is 3rd. When the digital input is inactive, all gears are available. Maximum gear is 4th.

#### 1.11.14.1 I/O configuration

Necessary I/O:
When the transmission range gear(s) are blocked out by default, no input is needed.
When the transmission range gear(s) are blocked out upon request, this request can be made by:

- Use of one wired input
- Use of a combination of (maximum 6) inputs. In this case, every input combination defines a set of range gears that are blocked out.
  E.g.: a 4/4 speed transmission

| Digital input 5 | Digital input 6 | Result |
|---|---|---|
| 0 | 0 | All gears are available |
| 0 | 1 | F4, N4 and R4 are blocked out |
| 1 | 0 | F3, F4, N3, N4, R3 and R4 are blocked out |

- Use of a CAN message – the ECON.A312 can receive the “block out highest gear(s)” request via the CAN message CVC_TO_TC_2. Refer to CHAPTER 3 – 1.5.2 for details.

REMARK: An echo of the “block out highest gear(s)” request is available in the CAN message TC_TO_CVC_2. Refer to CHAPTER 3 – 1.6.2 for details.

Check the application specific wiring diagram to see how the “block out highest gear(s)” request signal needs to be connected to the ECON.A312.

#### 1.11.14.2 Function

Transmission range gear(s) are blocked out by default or upon request:

- Blocked out by default → the range gears are blocked out without any trigger
- Blocked out upon request → the range gears are blocked out upon request

The gear(s) that are blocked out must form one sequence up to the highest gear.
E.g.: 4/4 speed application → blocking out F3 and F4 → F3 and F4 are sequential and they go up to the highest gear (4th)

The gear(s) that are blocked out can be programmed separately for neutral, forward and reverse.
E.g.: 4/4 speed application → blocking out 3rd and 4th in reverse while in forward and neutral all gears are allowed.

REMARK: When the “block out highest gear(s)” function is active, the default configuration is that the transmission overspeeding protections are still active. If the transmission reaches its overspeeding limits (when driving downhill) an upshift is triggered to protect the transmission. This upshift is made even to gears that are blocked out. Once an overspeeding upshift to a blocked out gear has occurred, and afterwards the speed drops sufficiently again, a downshift is triggered.

If the OEM doesn't want that the overspeeding upshifts can be made to gears that are blocked out, these overspeeding upshifts can be disabled in the ECON.A312 program. However, this is only done upon specific request of the OEM with the agreement of the OEM that all warranty claims on range clutch failures will be denied by Dana.

REMARK: Another name for this function is: "limit gear position".

REMARK: In case the gear limitation request is communicated via CAN message CVC_TO_TC_2, there are 2 configuration options. The 2 options have different fault reactions by the ECON.A312 in case of missing CVC_TO_TC_2 message or invalid gear limitation information in Byte 4 of CVC_TO_TC_2:

- Fault reaction option 1: the ECON.A312 continues gear limitation as per last correctly received CVC_TO_TC_2 gear limitation information
- Fault reaction option 2: the ECON.A312 switches over to a default gear limitation (default can e.g. be 1st gear, 2nd gear, …)

Note: the time-out for missing gear limitation information (i.e. when CVC_TO_TC_2 message is missing) is parameter adjustable. The time-out for invalid gear limitation information in Byte 4 of CVC_TO_TC_2 is 0 (immediate reaction).

The desired behaviour can be chosen by the OEM in the ECON.A312 "Purchase Order Description".

### 1.11.15 High engine idle

In case an electronic controlled engine is used, the "high engine idle" function can be used to adapt the relation between the throttle pedal position and the requested engine speed.

#### 1.11.15.1 I/O configuration

Necessary I/O: digital request = "high engine idle" request
analog throttle pedal information

The "high engine idle" request signal can be supplied to the ECON.A312 by:

- Use of a wired input
- Use of a CAN message – the ECON.A312 can receive the "high engine idle" request signal via the CAN message CVC_TO_TC_1 message. Refer to CHAPTER 3 – 1.5.1 for details

REMARK: An echo of the "high engine idle" request is available in the CAN message TC_TO_CVC_2. Refer to CHAPTER 3 – 1.6.2 for details.

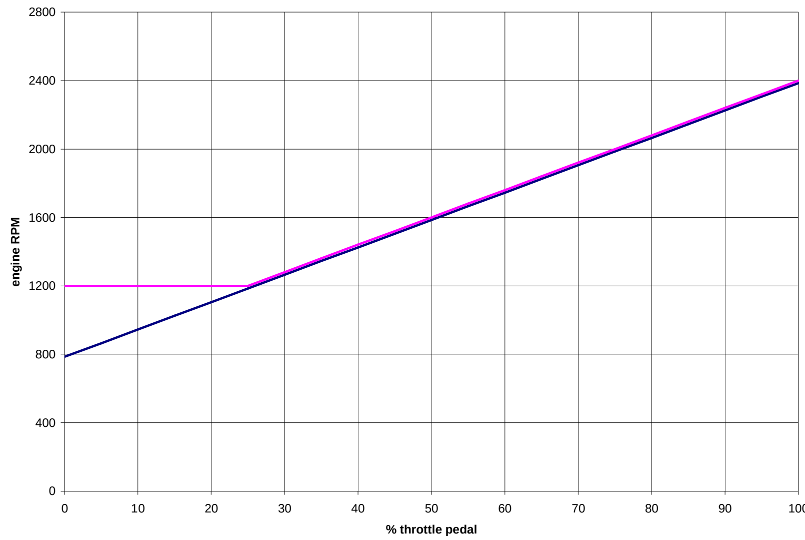
The analog throttle pedal information can be supplied to the ECON.A312 by use of a throttle pedal sensor wired to an analog input or via the CAN message EEC2 (refer to CHAPTER 2 – 2.3 for details) or via the CAN message CVC_TO_TC_2 (refer to CHAPTER 2 -1.5.2 for details).

Check the application specific wiring diagram to see how the "high engine idle" request signal and the analog throttle pedal sensor need to be connected to the ECON.A312.

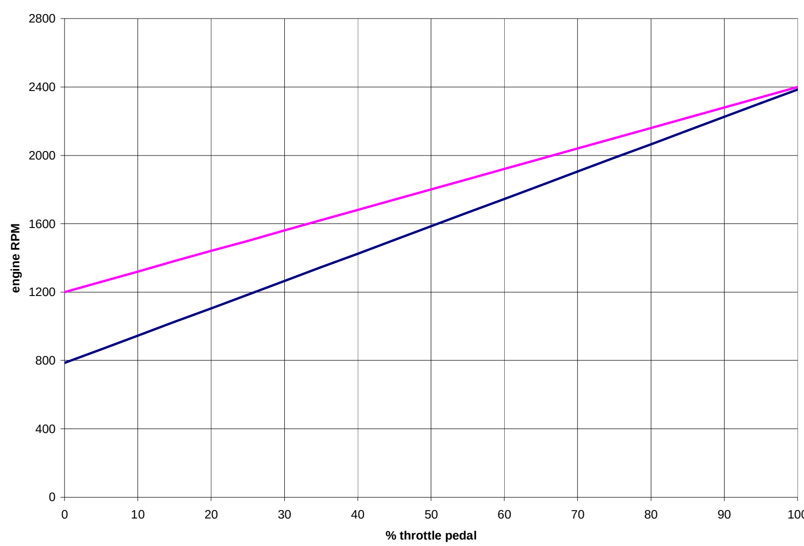
### 1.11.15.2 Function

When an electronic controlled engine is available, engine speed can be requested via the CAN message TSC1. Refer to CHAPTER 3 – 2.4 for details. The default relation between the throttle pedal position and the requested engine speed is lineair and is programmed in the ECON.A312. See blue curve in below examples.

The “high engine idle” function adapts this default relation upon the “high engine idle” request. The adaptation involves clipping of the engine idle speed to a minimum. In below example, the minimum engine idle speed is clipped to 1200 rpm:




<u>REMARK</u>: Optionally, there is the possibility to rescale the default relation over the whole throttle pedal range (0%-100%):




The desired behaviour can be chosen by the OEM in the ECON.A312 “Purchase Order Description”.

## 1.11.16 4 Wheel Drive/2 Wheel Drive control (4WD/2WD)

4WD/2WD control is used for transmissions that have the 4WD/2WD or “front disconnect” option available. For transmissions without this option, the function 4WD/2WD makes no sense.

With 4WD/2WD control, the driver can engage or disengage 4WD on the transmission with a “4WD/2WD selection” switch in the cabin.

### 1.11.16.1 I/O configuration

Necessary I/O: 1 digital selection = “4WD/2WD selection”
1 digital output for “4WD engagement/disengagement” on the transmission

Typically, a bistable switch is installed on the dashboard, which allows the selection of 4WD/2WD.

The “4WD/2WD selection” signal can be supplied to the ECON.A312 by:

- Use of a wired input
- Use of a CAN message – the ECON.A312 can receive the “4WD/2WD selection” signal via the CAN message CVC_TO_TC_1. Refer to CHAPTER 3 – 1.5.1 for details.

REMARK: An echo of the “4WD/2WD function state” is available in the CAN message TC_TO_CVC_2. Refer to CHAPTER 3 – 1.6.2 for details.

The “4WD/2WD engagement/disengagement” output engages and disengages 4WD on the transmission.

Check the application specific wiring diagram to see how the “4WD/2WD selection” signal and the “4WD/2WD engagement/disengagement” output need to be connected to the ECON.A312.

### 1.11.16.2 Function

If the driver toggles the selection from 4WD to 2WD (or vice versa), the ECON.A312 waits till the vehicle comes to standstill. When the vehicle has stopped, the ECON.A312 forces the transmission in neutral and then executes the engagement or disengagement of 4WD.
When 4WD is completely engaged or disengaged (after about 2.5 seconds), forward or reverse is re-engaged automatically on the transmission.

REMARK: If desired, the ECON.A312 can be programmed to allow forward (or reverse) re-engagements only after a physical cycle through neutral and reselection of forward (or reverse) with the shift lever.

The desired behaviour can be chosen by the OEM in the ECON.A312 “Purchase Order Description”.

### 1.11.17 Service brakes

"Service brakes" is not a function on its own, but the service brakes state "pressed" or "released" can be used by other functions, like the "operator present protection" function (refer to CHAPTER 1 – 1.11.3 for details) and the "parking brake" function (refer to CHAPTER 1 – 1.11.11 for details).

#### 1.11.17.1 I/O configuration

Necessary I/O: 1 digital or analog signal

The service brakes state "pressed" or "released" can be supplied to the ECON.A312 by:

- Use of a position or pressure switch that shares its information via:
  - a wired digital input signal
  - a CAN message – the ECON.A312 can receive the 'service brakes' state signal via the CAN message CVC_TO_TC_1. Refer to CHAPTER 3 – 1.5.1 for details.
- Use of a position sensor that share its information via:
  - a wired analog input signal
  - a CAN message – the ECON.A312 can receive the 'brake pedal' position via the CAN message CVC_TO_TC_2. Refer to CHAPTER 3 – 1.5.2 for details.

REMARK: An echo of the 'service brakes' state is available in the CAN message TC_TO_CVC_2. Refer to CHAPTER 3 – 1.6.2 for details.

REMARK: An echo of the 'brake pedal' position is available in the CAN message TC_TO_CVC_3. Refer to CHAPTER 3 – 1.6.3 for details.

Check the application specific wiring diagram to see how the position switch, position sensor or pressure switch needs to be connected to the ECON.A312.

#### 1.11.17.2 Function

The "service brakes" signal can be used as re-engagement condition in the 'operater presence protection' function. Refer CHAPTER 1 – 1.11.3 for details.

The 'service brakes' signal can be used as re-engagement / parking brake release condition in the 'parking brake' function (optional parking brake n° 1). Refer to CHAPTER 1 – 1.11.11 for details.

The desired behaviour can be chosen by the OEM in the ECON.A312 "Purchase Order Description".

### 1.11.18 Power take out (PTO)

"PTO" stands for Power Take Out.

The PTO is a transmission output shaft that is used to drive an auxiliary device (e.g. a winch) through the converter (not directly by the engine). PTO is not standard available on the transmission, it is an option selectable on the transmission POD. Some transmission models, have the option "PTO with spline engagement", other transmissions have the option "PTO with clutch engagement", while others do not have the PTO available. For transmissions without this option, the ECON.A312 function PTO makes no sense.

#### 1.11.18.1 I/O configuration

Necessary I/O: 1 digital request = “PTO request”
1 digital output for activation of PTO

The “PTO request” signal typically comes from a bistable switch installed on the dashboard.

The “PTO request” signal can be connected to the ECON.A312 by:

- Use of a wired input
- Use of a CAN message – the ECON.A312 can receive the “PTO request” signal via the CAN message CVC_TO_TC_2. Refer to CHAPTER 3 – 1.5.2 for details.

The digital output is used to activate and deactivate the PTO on the transmission.

Check the application specific wiring diagram to see how the “PTO request” signal and the PTO actuator need to be connected to the ECON.A312.

#### 1.11.18.2 Function

In case the PTO is the spline version, PTO (de)activation must be executed at vehicle standstill. The OEM has to install a request switch in the cabin, so that the driver can request the (de)activation of the PTO output. If the driver makes a request for PTO (de)activation, the ECON.A312 waits till the vehicle comes to standstill. When the vehicle has stopped, the ECON.A312 forces the transmission in neutral and then executes the PTO (de)activation. When the PTO (de)activation is finalized (after about 2.5 seconds), forward (or reverse) can be re-engaged on the transmission. In the spline version, the PTO shaft is driven through the forward (or reverse) clutch. This means that forward and reverse selection must be possible when PTO is activated. Because the PTO shaft is driven through the forward/reverse clutch, the PTO can rotate clockwise and counter clockwise. As a consequence, it is also named "bi-directional PTO".

In case the PTO is the clutch version, PTO (de)activation may be executed at vehicle standstill and also at vehicle speed. The OEM has to install a request switch in the cabin, so that the driver can request the (de)activation of the PTO output. The ECON.A312 (de)activates the PTO by closing/opening the PTO clutch. The PTO shaft is driven directly by the converter (not through the forward/reverse clutch). This means that activation of the forward/reverse clutch is not necessary for rotation of the PTO. Because the PTO is not driven through the forward/reverse clutch, it can only rotate in 1 direction. As a consequence, it is also named "uni-directional PTO".

For both, spline and clutch version of the PTO, extra conditions for PTO (de)activation can be programmed:

- the vehicle must have been at standstill for a certain time
- the shift lever and the transmission must be in neutral
- the engine speed must be below a specified engine speed limit

Once PTO is active, forward and reverse must be allowed for the spline version of PTO, because the PTO shaft is driven through the forward (or reverse) clutch.

Once PTO is active, there are 2 options for the direction engagement (for the clutch version):

- forward and reverse are allowed
- neutral is forced

Once PTO is active, there are 4 options for the range shifts (for both, spline and clutch version):

- lock the transmission in the actually engaged range gear
- force the transmission in a predefined (= programmed) range gear
- allow manual range shifts at vehicle standstill
- allow manual range shifts at vehicle speed

The desired behaviour can be chosen by the OEM in the ECON.A312 “Purchase Order Description”.

## 1.11.19 Power take in (PTI)

"PTI" stands for Power Take In.

The PTI is physically the same shaft as the PTO shaft. But now, the shaft is used inverted: it is not used to drive an auxiliary device ("take out" power from transmission to PTO shaft), but it is used to "take in" power from a second engine attached to the PTI input. This engine is normally an electrical engine. The power taken in via the PTI input, is transfered through the transmission range gears to the normal transmission output(s) and finally to the wheels of the vehicle.

An example of PTI is a railway maintenance vehicle. When the vehicle moves from one location to another, the power comes from a combustion or electrical engine, via the torque converter, through the direction and range clutches, to the transmission output and finally to the wheels. When the railway maintenance vehicle is in maintenance mode, a constant low speed is needed, which can not be achieved with the normal engine/converter combination. At that moment, PTI is engaged and the second electrical engine drives the wheels via the PTI input shaft, through the transmission range gears to the normal transmission output(s).

Some transmission models, have the option PTO/PTI (with spline engagement), while other do not have this option available. For transmissions without this option, the function PTI makes no sense.

### 1.11.19.1 I/O configuration

Necessary I/O: 1 digital request = “PTI request”
1 digital output for activation of PTI

The “PTI request” signal typically comes from a bistable switch installed on the dashboard.

The “PTI request” signal can be connected to the ECON.A312 by:
- Use of a wired input
- Use of a CAN message – the ECON.A312 can receive the “PTI request” signal via the CAN message CVC_TO_TC_2. Refer to CHAPTER 3 – 1.5.2 for details.

The digital output is used to activate and deactivate the PTI on the transmission.

Check the application specific wiring diagram to see how the “PTI request” signal and the PTI actuator need to be connected to the ECON.A312.

Optionally, a second digital output can be activated by the ECON.A312 during PTI control. This digital output gives feedback information at the moment PTI is completely engaged. It serves as an input for the controller of the electrical engine attached to the PTI. In this way, this controller can let the electrical engine start up and run, only when PTI is completely engaged.

Check the application specific wiring diagram to see on which ECON.A312 pins the PTI feedback output is available.

#### 1.11.19.2 Function

The PTI can only be realized with the spline version of PTO. The PTI (de)activation must be executed at vehicle standstill. The OEM has to install a request switch in the cabin, so that the driver can request the (de)activation of the PTI input. If the driver makes a request for PTI (de)activation, the ECON.A312 waits till the vehicle comes to standstill. When the vehicle has stopped, the ECON.A312 forces the transmission in neutral and then executes the PTI (de)activation. The PTI (de)activation is finalized after about 2.5 seconds. When PTI is activated, the ECON.A312 has the option to activate an output to indicate to the controller of the electrical engine attached to the PTI shaft, that the PTI shaft is completely engaged and that the electrical engine can be started. When the PTI shaft is engaged, the combustion engine attached to the converter remains active to foresee system pressure and transmission lubrication. As a safety protection, the ECON.A312 forces the transmission in neutral when PTI is engaged. This assures that no power is entered into the transmission from the combustion engine attached to the converter.

An extra condition for PTI (de)activation can be programmed:

- the vehicle must have been at standstill for a certain time
- the shift lever and the transmission must be in neutral
- the engine speed must be below a specified engine speed limit

Once PTI is active, there are 4 options for the range shifts:

- lock the transmission in the actually engaged range gear
- force the transmission in a predefined (= programmed) range gear
- allow manual range shifts at vehicle standstill
- allow manual range shifts at vehicle speed

The desired behaviour can be chosen by the OEM in the ECON.A312 “Purchase Order Description”.

### 1.11.20 Transmission sump temperature

The “transmission sump temperature” function is used to monitor transmission sump temperature.

#### 1.11.20.1 I/O configuration

<u>Necessary I/O</u>: Sump temperature information can be shared with the ECON.A312 via an analog temperature sensor. The OEM can order an analog temperature sensor from Dana: part number 4211988. This temperature sensor is supplied as ship loose part with the ECON.A312. The OEM has to foresee a temperature sensor provision. Please note that there is no direct provision on the transmission.

Check the application specific wiring diagram to see how the sump temperature sensor needs to be connected to the ECON.A312.

#### 1.11.20.2 Function

The OEM has to make a provision for mounting the temperature sensor on a location where the sump temperature of the transmission can be measured. Please note that there is no direct provision on the transmission.

The ECON.A312 broadcasts the transmission sump temperature in byte 4 of CAN message TC_TO_CVC_1. Refer to CHAPTER 3 – 1.6.1 for details.

### 1.11.21 Vehicle speed limitation

The vehicle speed limitation function allows the ECON.A312 to limit the vehicle speed to a predefined (= programmed) speed value.

#### 1.11.21.1 I/O configuration

The J1939-71 compliant CAN message TSC1 is used by the ECON.A312 to control the engine speed for vehicle speed limitation. Refer to CHAPTER 3 – 2.4 for details.

When the vehicle speed limitation is used, it is important that the engine controller gives the highest priority to the CAN message TSC1 coming from the ECON.A312.

When filling in the ECON.A312 “Purchase Order Description”, the OEM has to choose the priority for the TSC1 message coming from the ECON.A312, higher than the priority of TSC1 messages sent by other controllers, if any.

In case the TSC1 message is broadcasted by the ECON.A312, but the ECU can not read the TSC1 message from the CAN-bus (e.g. due to defect of the CAN-bus), the ECU can not limit the engine speed as requested by the ECON.A312. Due to this external defect, Dana can not take any responsibility for the fact that the vehicle speed limitation is failing.

#### 1.11.21.2 Function

The ECON.A312 limits the vehicle speed to a certain predefined vehicle speed by use of the CAN messge TSC1.

When the vehicle speed is sufficiently below the vehicle speed limit, the vehicle speed limitation function is disabled.

When the vehicle speed approaches the vehicle speed limit, the vehicle speed limitation is activated. The ECON.A312 uses a closed loop PID regulation to limit or reduce the engine speed via the CAN message TSC1 in order to limit the vehicle speed. When afterwards, the vehicle speed has dropped again sufficiently below the vehicle speed limit, the vehicle speed limitation function is deactivated again.

The vehicle speed limit or maximum vehicle speed allowed can be modified “on-the-fly” through CAN message CVC_TO_TC_4. This means that vehicle can be at speed and at any direction (Forward/Neutral/Reverse) when the maximum vehicle speed allowed is changed, and there is no need to reset the APC312. Refer to CHAPTER 3 – 1.7.1 for details.

REMARK: The ECON.A312 controls the vehicle speed by acting on the engine speed. But it has to be taken into account that due to a cumulation of control loops (ECU and transmission controller), and due to a wide variety of disturbances and parameters (transmission torque converter, vehicle mass, vehicle acceleration, vehicle deceleration, terrain conditions, …), there is not a simple relation between the target and the real vehicle speed. This means that the control reactivity and accuracy of the ECON.A312 vehicle speed limitation function is limited.

### 1.11.22 Engine shut down

When the vehicle has been standing still in neutral for a certain time (e.g. 5 minutes), the ECON.A312 activates a digital output or limits the engine speed to 0 rpm and/or limits the engine torque to 0% in the CAN message TSC1 in order to shut down the engine.

#### 1.11.22.1 I/O configuration

The “engine shut down” function can be implemented by:

- Use of a digital output
- Use of the CAN message – TSC1. Refer to CHAPTER 3 – 2.4 for details.

Check the application specific wiring diagram to see how the “engine shut down” output needs to be connected to the ECON.A312.

#### 1.11.22.2 Function

The ECON.A312 activates the engine shut down output or limits the engine speed to 0 rpm or limits the engine torque to 0% in the CAN message TSC1, when the machine has been standing still, with engine at idle, throttle pedal released and transmission in neutral for a certain time (this time needs to be specified by the OEM). By doing so, the engine is shut down.

The desired behaviour can be chosen by the OEM in the ECON.A312 “Purchase Order Description”.

### 1.11.23 Engine throttle reduction

Range shift quality can (sometimes) be improved by the use of throttle reduction.

#### 1.11.23.1 I/O configuration

The “engine throttle reduction” function can be implemented by:

- Use of a digital output
- Use of the CAN message – TSC1. Refer to CHAPTER 3 – 2.4 for details.

Check the application specific wiring diagram to see how the “throttle reduction” output needs to be connected to the ECON.A312.

#### 1.11.23.2 Function

With this technique, the engine speed/torque is reduced before making a range shift. This is done by cutting off the air/fuel supply to engine for some 100 msec's before a range shift is executed or by setting the TSC1 engine speed limit to idle and/or the engine torque limit to 0% for some 100 msec's before a range shift is executed.

Throttle reduction needs tuning on the machine. For this reason, a visit from Dana is needed (at the expense of the OEM). The level of improvement depends on various factors such as engine reaction, vehicle model, transmission model, etc. and therefor the level of range shift quality improvement can not be guarenteed in advance.

The desired behaviour can be chosen by the OEM in the ECON.A312 "Purchase Order Description".

### 1.11.24 Torque limitation by engine derating

In case the vehicle is equipped with an engine that is too powerful for the transmission (e.g. when there are high power requirements for the hydraulics), the maximum torque capacity of the transmission could be exceeded. The ECON.A312 provides a countermeasure to limit the engine torque when the transmission torque reaches its limit. This engine torque limitation (or "engine derating") is established via TSC1 message with torque control mode.

Note that this engine torque limitation is not programmed by default. It is programmed upon request from the OEM.

#### 1.11.24.1 I/O configuration

The J1939-71 compliant CAN message TSC1 is used by the ECON.A312 to control the engine torque for engine derating. Refer to CHAPTER 3 – 2.4 for details.

When engine derating is used, it is important that the ECU gives the highest priority to the CAN message TSC1 coming from the ECON.A312.

When filling in the ECON.A312 "Purchase Order Description", the OEM has to choose the priority for the TSC1 message coming from the ECON.A312, higher than the priority of TSC1 messages sent by other controllers, if any.

In case the TSC1 message is broadcasted by the ECON.A312, but the ECU can not read the TSC1 message from the CAN-bus (e.g. due to defect of the CAN-bus), the ECU can not limit the engine torque, as it was requested by the ECON.A312. Due to this external defect, Dana can not take any responsibility for the fact that the engine derating is failing.

#### 1.11.24.2 Function

When the transmission torque reaches its limit, the ECON.A312 limits the engine torque via TSC1 message and by using a PID regulation. In this way, it is assured that the transmission torque stays below its maximum value.

Engine derating needs a tuning on the machine by a Dana engineer. A tuning is necessary because the engine's reaction on torque limitation depends on the engine model and/or ECU settings. For this reason, a visit from Dana is needed (at the expense of the OEM).
Small and brief overshoots above the transmission limit can happen, but cause no harm.

### 1.11.25 Speedometer

The speedometer output function can be used to indicate the vehicle speed on a speedometer.

#### 1.11.25.1 I/O configuration

The speedometer signal is available on the dedicated speedometer output pin B33 of the ECON.A312.

The signal is a square wave signal alternating between 0V and +10V.

Check the application specific wiring diagram to see how the speedometer needs to be connected to the ECON.A312.

#### 1.11.25.2 Function

The speedometer output of the ECON.A312 is a frequency output on pin B33 that generates a square wave signal between 0V and +10V. The frequency of the speedometer signal is proportional to the vehicle speed.

In the ECON.A312 "Purchase Order Description", the OEM has to specify the conversion factor of the applicable speedometer.

The conversion can be expressed in:

- Hz per km/h:

  E.g.: when the conversion factor is 15 Hz per km/h and the vehicle speed is 20 km/h, then the square wave signal has a frequency of 300 Hz.

  Minimum conversion factor = 1 Hz per km/h
  Maximum conversion factor = 100 Hz per km/h

- pulses per km:

  E.g.: when the conversion factor is 100'000 pulses per km and the vehicle speed is 20 km/h, then the square wave signal has a frequency of 556 Hz.

  Minimum conversion factor = 3'600 pulses per km
  Maximum conversion factor = 360'000 pulses per km

REMARK: [Hz per km/h] and [pulses per km] are 2 different ways to tell the same:

1 Hz per km/h = 3'600 pulses per km.

The OEM has to specify the conversion factor of the applicable speedometer in the ECON.A312 "Purchase Order Description". This conversion factor will then be programmed in the ECON.A312.

## 1.11.26 Speed dependent output

The speed dependent output function is used to activate an output, based on vehicle speed or engine speed.

### 1.11.26.1 I/O configuration

Up to 3 digital outputs can be programmed to provide the speed dependent output function.

Check the application specific wiring diagram to see how the speed dependent output(s) needs to be connected to the ECON.A312.

### 1.11.26.2 Function

The speed dependent output(s) is (are) activated and deactivated based on vehicle speed or engine speed. There are multiple possibilities:

- Speed dependent output as function of vehicle speed:

  The ECON.A312 can be programmed to activate a digital output in case the vehicle speed exceeds a certain limit.

  > E.g.: The digital output is activated when the vehicle speed exceeds 5 km/h and the output is deactivated when the vehicle speed drops below 4 km/h.

  The ECON.A312 can be programmed to activate a digital output in case the vehicle speed drops below a certain limit.

  > E.g.: The digital output is activated when the vehicle speed drops below 8 km/h and the output is deactivated when the vehicle speed exceeds 10 km/h.

- Speed dependent output as function of engine speed:

  The ECON.A312 can be programmed to activate a digital output in case the engine speed exceeds a certain limit.

  > E.g.: the digital output is activated when the engine speed exceeds 1200 rpm and the output is deactivated when the engine speed drops below 1100 rpm.

  The ECON.A312 can be programmed to activate a digital output in case the engine speed drops below a certain limit.

  > E.g.: The digital output is activated when the engine speed drops below 1500 rpm and the output is deactivated when the engine speed exceeds 1700 km/h.

The desired behaviour can be chosen by the OEM in the ECON.A312 “Purchase Order Description”.

### 1.11.27 Warning lamp output

The "warning lamp output" function is used to warn the driver for dangerous conditions of the transmission (with respect to speeds, temperature or pressure) or to indicate to the driver that he has made a request (e.g. a direction change request or downshift request) at too high speed.

#### 1.11.27.1 I/O configuration

The warning lamp output is available in 2 different ways:

- Use of a wired digital output
- Use of a CAN message: the warning lamp output function is available in the CAN message TC_TO_CVC_1. Refer to CHAPTER 3 – 1.6.1 for details.

Optionally, the ECON.A312 can be programmed with 2 or 3 separate warning lamp outputs. In this case, each warning lamp output indicates one or more specific warnings.
E.g. warning lamp output 1 indicates speed related warnings, warning lamp 2 indicates excessive converter out temperature, warning lamp 3 indicates low system pressure.

Check the application specific wiring diagram to see how the warning lamp output needs to be connected to the ECON.A312.

#### 1.11.27.2 Function

The warning lamp output function is used to warn the driver for dangerous conditions of the transmission:

- Transmission is almost overspeeding
- Transmission is overspeeding
- Maximum vehicle speed exceeded
- Oil pressure too low (note that a pressure sensor or switch is needed in this case)
- Converter out temperature limit exceeded (note that a converter out temperature sensor or converter out temperature switch is needed in this case)

REMARK: For each of the above warning conditions, the ECON.A312 can be programmed to let the warning lamp blink slowly, blink normally, blink fast or be activated continuously. In case 2 warning conditions exist at the same time, the condition with the fastest blinking has priority. E.g. when the transmission is overspeeding [continuous] while the system pressure is low [fast blinking]), the warning lamp will blink fast. The priority is 1. fast blinking 2. normal blinking 3. slow blinking and 4. continuously activated. By default all the warning conditions are programmed with a continuous warning signal, except the converter out temperature warning (normal blinking) and low system pressure (fast blinking).

The warning lamp output function is also used to indicate the driver that he has made a request that can not be granted:

- Direction change request at too high vehicle speed / engine speed / throttle pedal position %
- Direction engagement request at too high vehicle speed / engine speed / throttle pedal position %
- Direction re-engagement request at too high engine speed / throttle pedal position %
- Downshift request at too high turbine or output speed

Although not programmed by default, the “warning lamp” output function can also indicate:

- That neutral lock is active
- That there is an active error on the RD120 display

In case one of these 2 none default triggers for the “warning lamp” is desired or one of default triggers for the “warning lamp” is not desired, this should be requested on page 6 of the “Purchase Order Description”, where special requests can be formulated.

### 1.11.28 Gear dependent output

The “gear dependent output” function is used to activate an ECON.A312 output based on the gear selected on the transmission.

#### 1.11.28.1 I/O configuration

1 digital output can be programmed to provide the ‘gear dependent output’ function.

Check the application specific wiring diagram to see how the “gear dependent output” needs to be connected to the ECON.A312.

#### 1.11.28.2 Function

The ECON.A312 can be programmed to activate a digital output as function of the activated gear on the transmission.

E.g.: the gear dependent output is activated when the transmission is in F3, N3 or R3.

E.g.: the gear dependent output is activated when the transmission is in N1, N2, R1 or R2.

The desired behaviour can be chosen by the OEM in the ECON.A312 “Purchase Order Description”.

### 1.11.29 Reverse alert output

The “reverse alert output” function can be used to activate an output when the shift lever is in reverse and/or the transmission is in reverse and/or the vehicle is driving in reverse.

#### 1.11.29.1 I/O configuration

1 digital output can be programmed to provide the ‘reverse alert output’ function.

Check the application specific wiring diagram to see how the “reverse alert output” needs to be connected to the ECON.A312.

#### 1.11.29.2 Function

The “reverse alert output” is activated when one (or more) of below conditions is fulfilled:

- Shift lever is in reverse
- Transmission is in reverse
- Vehicle driving direction is reverse

### 1.11.30 Real vehicle speed for mechanical high/low range

When the transmission is equipped with a mechanical high/low range, the ECON.A312 does not know whether the transmission is in high range or in low range. In this case, as a safety measure, the ECON.A312 assumes that the transmission is in high range. Consequently, when the transmission is mechanically in the high range, the vehicle speed calculation by the ECON.A312 is correct. However, when the transmission is mechanically in the low range, the vehicle speed calculation by the ECON.A312 is too high. Although the vehicle speed is not correct in this case, the transmission is continuously protected by the ECON.A312, because the ECON.A312 assumes higher vehicle speed than real. In this case, the vehicle speed readout on the RD.120, in the concerned CAN messages and on the speedometer is also too high.

When correct vehicle speed readout on the RD.120, in the concerned CAN messages and on the speedometer is necessary or desired, there is a solution. The ECON.A312 can be programmed to read the mechanical position of the high/low range with 2 digital signals. 2 switches need to be installed by the OEM to read the mechanical position of the high/low range. With these 2 switches, the ECON.A312 can detect low range, high range or neutral position of the mechanical high/low range (when both switches are in the off status). With this knowledge of the position of the high/low range, the ECON.A312 calculates the real vehicle speed and shows it correctly on the RD.120 and in the concerned CAN messages and the ECON.A312 puts the correct frequency on the speedometer output pin B33, resulting in correct vehicle speed readout on the speedometer.

REMARK: this function can’t be combined with the function “high/low range”. Refer to CHAPTER 1 – 1.11.13 for details.

#### 1.11.30.1 I/O configuration

Necessary I/O:

- One position switch reflecting the mechanical engagement of low range
- One position switch reflecting the mechanical engagement of high range

The 2 position switches can be supplied to the ECON.A312 by use of a wired input.

The combination of the 2 wired inputs reflects the status of the mechanical high/low range. Suppose digital input 5 is reflecting the high range and digital input 6 is reflecting the low range:

| Digital input 5 | Digital input 6 | Status of the mechanical high/low range |
|---|---|---|
| 0 | 0 | Neutral position |
| 0 | 1 | Low range |
| 1 | 0 | High range |
| 1 | 1 | Impossible combination |

Check the application specific wiring diagram to see how the 2 position switches need to be connected to the ECON.A312.

### 1.11.30.2 Function

On a transmission with mechanical high/low range, the ECON.A312 can't control the selection of the high and low range. The OEM has to implement the mechanical selection of high and low range.

In this case, by default, the ECON.A312 is programmed to continuously assume high range for vehicle speed calculation. The consequences are:

- when the transmission is in high range, the calculated vehicle speed is correct
- when the transmission is in low range, the calculated vehicle speed is higher than the real vehicle speed. This results in too high vehicle speed readout on the RD.120, in the concerned CAN messages and on the speedometer.
- the transmission is protected under all circumstances

If correct vehicle speed calculation is necessary or desired also for the low range, the OEM has to implement 2 position switches to reflect:

- the mechanical engagement of the low range
- the mechanical engagement of the high range
- the neutral position of the low/high range

In this case, the ECON.A312 will be programmed to calculate correct vehicle speed under all circumstances. This results in correct vehicle speed readout on the RD.120, in the concerned CAN messages and on the speedometer.

In case both position switches are OFF (reflecting the neutral position of the mechanical high/low range), the vehicle speed is unknown for the ECON.A312. In this case, the ECON.A312 shows "- -" on the RD.120 display "SP" (vehicle speed in km/h) and on the RD.120 display "rS" (vehicle speed in mph). The ECON.A312 shows a vehicle speed of 0 in the concerned CAN messages and on the speedometer. The transmission is forced in neutral. When afterwards, low or high range is again selected, the transmission remains in neutral. To be able to select forward (or reverse) again, the operator has to cycle the shift lever physically through neutral and then reselect forward (or reverse) with the shift lever. This is the standard implementation in the ECON.A312.

In case both position switches are ON (impossible combination reflecting the mechanical engagement of high range and low range at the same time), the ECON.A312 reacts in the same way as when both position switches are OFF. Additionally the ECON.A312 gives error codes "5X.02" and "5Y.02" reflecting the impossible combination, where X = digital input number.

The desired behaviour can be chosen by the OEM in the ECON.A312 "Purchase Order Description".

# 1.12 RD.120 display

The ECON.A312 has no integrated display. For this reason, an external or “remote” display is available. The name of the display is RD.120 (**R**emote **D**isplay). The RD.120 is optional and can be selected in the POD (“Purchase Order Description”) of the ECON.A312.

The communication between the ECON.A312 and RD.120 is established with the dedicated LIN bus.

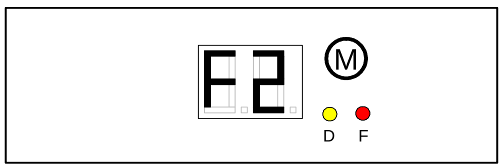
## 1.12.1 RD.120 – hardware

The RD.120 consists of:

- 2 red 7-segment displays
- 2 status LED’s (“D” & “F”)
- A push button “M” for display mode and display selection

The **D**iagnostic LED labelled **'D'** is yellow and is used to indicate diagnostic modes.

The **F**ault LED labelled **'F'** is red and is blinking when there are one or more active errors.




RD.120 Display

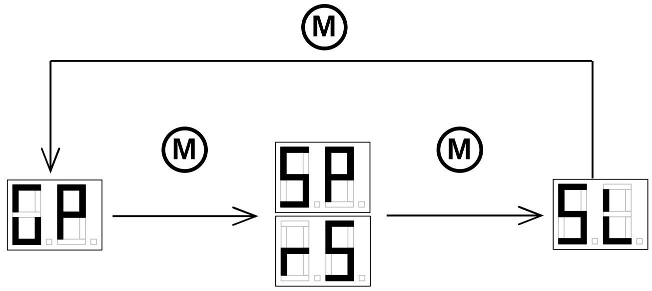
## 1.12.2 RD.120 – display modes

Different display modes can be activated:

- **Normal display mode**: shows typical information useful during normal operation like transmission gear, vehicle speed and shift lever position. If the ECON.A312 is started up without pressing the “M”-button, the ECON.A312 initializes in the normal display mode.
- **Diagnostic display mode**: can be activated to provide a number of diagnostic screens that allow the user to verify the turbine speed, engine speed, speed ratio, battery voltage, output speed, the digital inputs of the ECON.A312, etc. If the “M”-button is pressed while starting up the ECON.A312, it initializes in the diagnostic display mode.
- **Calibration display mode**: can be activated to start throttle pedal or brake pedal calibration. If the “M”-button is pressed for 10 sec while starting up the ECON.A312, it initializes in the calibration display mode. Refer to CHAPTER 1 – 2 for details.
- **Error display mode**: can be activated to check the different active and/or inactive errors that might be present. The error display mode can be envoked from the normal display mode or from the diagnostic display mode, by pushing the “M”-button during 2 seconds and then releasing the “M”-button when “AF” appears.

#### 1.12.2.1 Normal display mode

This display mode is activated by default after power up of the ECON.A312. The 'D'-LED is off. The normal display mode shows displays that are typically used by the driver during normal operation of the machine.

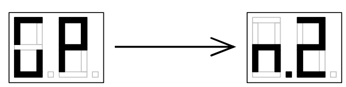



Changing between the different displays is done by pressing the "M"-button.

REMARK: The ECON.A312 normal display mode is programmed by default with the above displays. In case the OEM wishes otherwise, the normal display mode can be configured upon desire.

##### 1.12.2.1.1 Gear position display

This display shows the actual transmission direction and range gear.



As long as the "M"-button is pressed "GP" (**G**ear **P**osition) is shown on the display. When the "M"-button is released, the display changes to the actual direction and range gear.

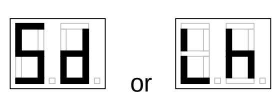
REMARK: If the "M"-button is pressed for more than 2 seconds, the error display mode is envoked. To avoid this, the "M"-button should be released before the 2 seconds have expired.

If the transmission direction differs from the shift lever direction, the dot after the direction indication blinks. In the above example the dot after the "n" blinks, to indicate that the shift lever is in direction (forward or reverse), while the transmission is in neutral.

When the transmission range gear is higher than the shift lever range position in automatic mode or when the transmission range gear is different than the shift lever range position in manual mode, the dot after the range gear indication blinks.

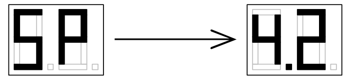
REMARK: Added the possibility to program the ECON.A312 for showing the activated transmission gear in 1 sequence without interruption, in case of splitter transmissions where one of the splitter gears is not used. E.g. for a 6/3 speed transmission where splitter gear F4 is not used, normally the RD.120 will report F1, F2, F3, F5 and F6 as forward gears. With the new option, it is possible to show F1, F2, F3, F4 and F5 instead.

REMARK: Transmission "**S**hut **d**own" or "**L**imp **h**ome" are only shown in this "GP" display:



#### 1.12.2.1.2 Vehicle speed display in km/h

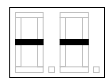
This display shows the vehicle speed expressed in km/h.




REMARK: As long as the “M”-button is pressed (however less than 2 sec.), “SP” (**SP**eed) is shown on the display. When the “M”-button is released, the display changes to the actual vehile speed.

For speeds below 10 km/h, the speed is shown with 0.1 km/h resolution. For speeds above 10 km/h, the speed is shown with 1 km/h resolution. The above example shows a vehicle speed of 4.2 km/h.

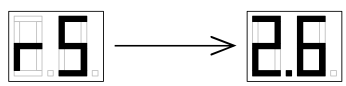
REMARK: The RD.120 shows two dashes (as illustrated below) when the vehicle speed is not available:



Typically this is the case when the drum speed sensor or output speed sensor is not connected or has an electrical problem.

#### 1.12.2.1.3 Vehicle speed display in mph

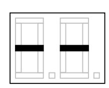
This display shows the vehicle speed expressed in mph.




REMARK: As long as the “M”-button is pressed (however less than 2 sec.), “rS” (**r**oad **S**peed) is shown on the display. When the “M”-button is released, the display changes to the actual vehicle speed.

For speeds below 10 mph, speed is shown with 0.1 mph resolution. For speeds above 10 mph, speed is shown with 1 mph resolution. The above example shows a vehicle speed of 2.6 mph.

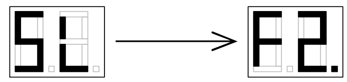
REMARK: The RD.120 shows two dashes (as illustrated below) when the vehicle speed is not available:



Typically this is the case when the drum speed sensor or output speed sensor is not connected or has an electrical problem.

#### 1.12.2.1.4 Shift lever position display

This display shows the actual shift lever position.



REMARK: As long as the "M"-button is pressed (however less than 2 sec.), "SL" (**S**hift **L**ever) is shown on the display. When the "M"-button is released, the display changes to the actual shift lever position.

If the shift lever direction differs from the actual transmission direction, the dot after the direction indication blinks.

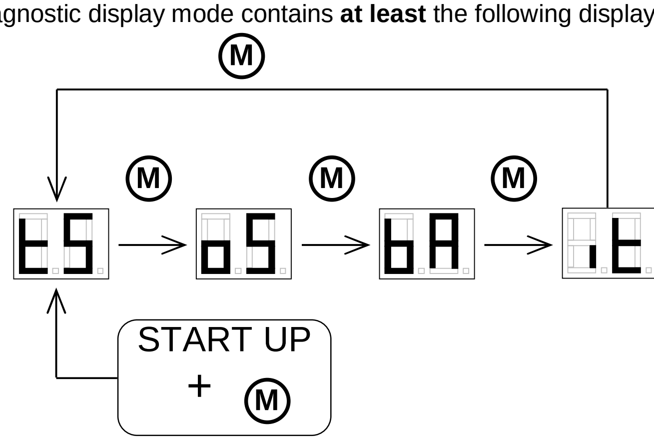
When the shift lever range position is lower than the actual transmission gear in automatic mode or when the shift lever range position is different than the transmission range gear in manual mode, the dot after the range gear indication blinks. In the above example the dot after the "2" blinks, to indicate that the shift lever range position (2nd) is lower than the actual transmission range gear (3rd or 4th).

REMARK: Added the possibility to program the ECON.A312 for showing the shift lever position in 1 sequence without interruption, in case of splitter transmissions where one of the splitter gears is not used. E.g. for a 6/3 speed transmission where splitter gear F4 is not used, normally the RD.120 will report F1, F2, F3, F5 and F6 as forward gears. With the new option, it is possible to show F1, F2, F3, F4 and F5 instead.

### 1.12.2.2 Diagnostic display mode

This display mode is activated by pressing the "M"-button during power up of the ECON.A312. The diagnostic display mode shows displays that are typically used to do diagnostics and troubleshooting in case there is a problem with the machine wiring, with the sensors, with the switches, with connections in the connectors or with the ECON.A312 itself.

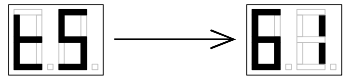
By default, the diagnostic display mode contains **at least** the following displays:




Changing between the different display modes is done by pressing the "M"-button.

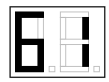
#### 1.12.2.2.1 Turbine speed display

This display shows the actual turbine speed.

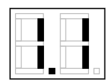


<u>REMARK</u>: As long as the “M”-button is pressed (however less than 2 sec.), “tS” (**t**urbine **S**peed) is shown on the display. When the “M”-button is released, the display changes to the actual turbine speed value.

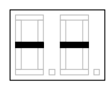
For speeds below 1000 rpm, turbine speed is shown with 10 rpm resolution. The below example shows a turbine speed between 605 and 614 rpm:



For speeds above 1000 rpm, turbine speed is shown with 100 rpm resolution and the 1000 unit dot lights up. The below example shows a turbine speed between 1050 rpm and 1149 rpm:



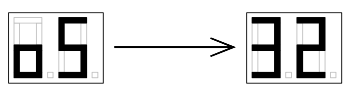
<u>REMARK</u>: The RD.120 shows two dashes (as illustrated below) when the turbine speed is not available:



Typically this is the case when the transmission is in neutral (in neutral the ECON.A312 can not calculate the turbine speed because the transmission speed is measured on an intermediate clutch drum or on the output, while forward and reverse clutch are open) or when the drum speed sensor or output speed sensor is not connected or has an electrical problem.

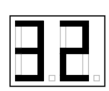
#### 1.12.2.2.2 Output speed display

This display shows the actual output speed.

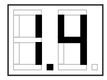


<u>REMARK</u>: As long as the “M”-button is pressed (however less than 2 sec.), “OS” (**O**utput **S**peed) is shown on the display. When the “M”-button is released, the display changes to the actual output speed value.

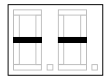
For speeds below 1000 rpm, output speed is shown with 10 rpm resolution. The below example shows an output speed between 315 rpm and 324 rpm:



For speeds above 1000 rpm, output speed is shown with 100 rpm resolution and the 1000 unit dot lights up. The below example shows an output speed between 1350 rpm and 1449 rpm:



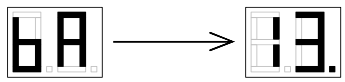
REMARK: The RD.120 shows two dashes (as illustrated below) when the output speed is not available:



Typically this is the case when the drum speed sensor or output speed sensor is not connected or has an electrical problem.

#### 1.12.2.2.3 Battery supply voltage display

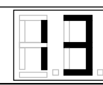
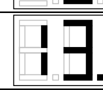
This display shows the battery supply voltage.



REMARK: As long as the “M”-button is pressed (however less than 2 sec), “bA” (**bA**ttery voltage) is shown on the display. When the “M”-button is released, the display changes to the actual battery voltage.

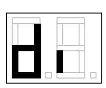
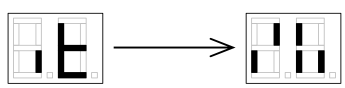
This display shows the battery supply voltage on the switched power line. When the decimal part of the supply voltage is lower than 0.5 V, no unit dot is lights up. When the decimal part is equal to or greater than 0.5V, the unit dot lights up.

Examples:

| | |
|---|---|
| SPWR voltage 13.0V – 13.4V |  |
| SPWR voltage 13.5V – 13.9V |  |

#### 1.12.2.2.4 Digital input test display

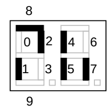
The digital input test is used to verify the operation of the shift lever and digital inputs.

 alternating with 

REMARK: First, “di” (**d**igital **i**nput) “it” (**i**nput **t**est) is shown on the display. When the “M”-button is pressed again, the display changes to the actual digital input test.

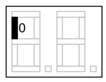
The input test shows the status of digital input 0 to digital input 9.

When the digital inputs 0 – 9 are activated, the corresponding segment lights up.

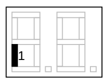



Input test layout

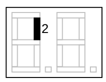
The above example shows that digital inputs 1, 2, 4, 5, 7 and 8 are activated.



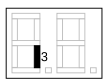

This segment lights up when digital input 0 on wire A15 is activated.



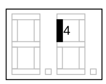

This segment lights up when digital input 1 on wire A17 is activated.



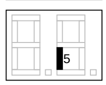

This segment lights up when digital input 2 on wire A19 is activated.



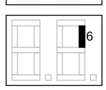

This segment lights up when digital input 3 on wire A21 is activated.




This segment lights up when digital input 4 on wire B11 is activated.

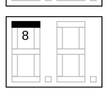



This segment lights up when digital input 5 on wire B13 is activated.

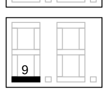



This segment lights up when digital input 6 on wire B15 is activated.


This segment lights up when digital input 7 on wire B17 is activated.

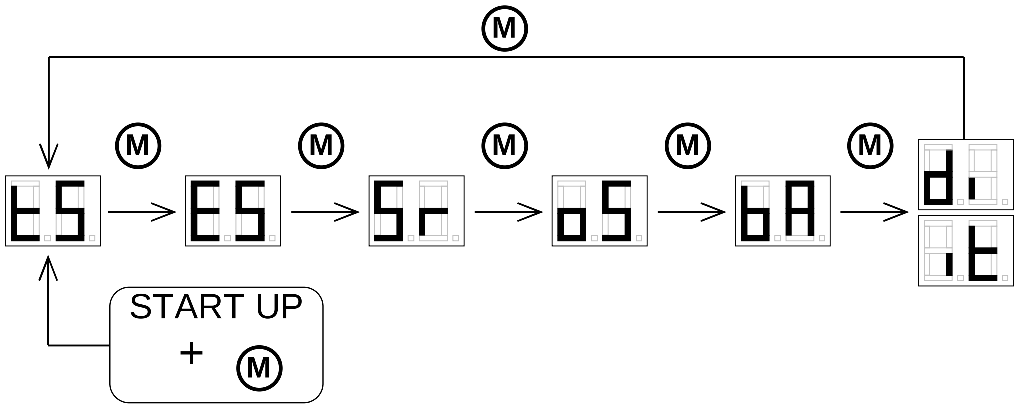



This segment lights up when digital input 8 on wire A25 is activated.



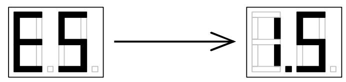

This segment lights up when digital input 9 on wire B12 is activated.

In case the engine speed is available (with engine speed sensor or via CAN message EEC1), the diagnostic display mode is extended by default with the displays “ES” and “Sr”:



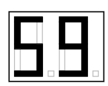

#### 1.12.2.2.5 Engine speed display

This display shows the actual engine speed.

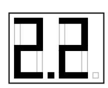


REMARK: As long as the “M”-button is pressed (however less than 2 sec), “ES” (**E**ngine **S**peed) is shown on the display. When the “M”-button is released the display changes to the actual engine speed value.

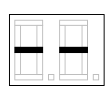
For speeds below 1000 rpm, engine speed is shown with 10 rpm resolution. The below example shows an engine speed between 585 rpm and 594 rpm:



For speeds above 1000 rpm, engine speed is shown with 100 rpm resolution and the 1000 unit dot lights up. The below example shows an engine speed between 2150 rpm and 2249 rpm:



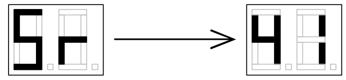
REMARK: The RD.120 shows two dashes (as illustrated below) when the engine speed is not available:



Typically this is the case when the engine speed sensor is not connected or has an electrical problem, or when the CAN message EEC1 has timed out on the CAN-bus or if the CAN-bus itself is not connected or has an electrical problem.

#### 1.12.2.2.6 Speed ratio display

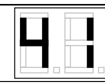
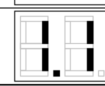
This display shows the actual speed ratio.



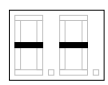
REMARK: As long as the “M”-button is pressed (however less than 2 sec), “Sr” (**S**peed **r**atio) is shown on the display. When the “M”-button is released, the display changes to the actual speed ratio value.

The speed ratio (see CHAPTER 1 – 1.9.4.1 for details) is expressed as fraction, so there is no unit. For ratios below 1.00, the resolution is 0.01. For ratios above 1.00, the resolution is 0.1 and the unit dot lights up in that case.

Examples:

| | |
|---|---|
| Speed ratio = 0.41 |  |
| Speed ratio = 1.07 |  |

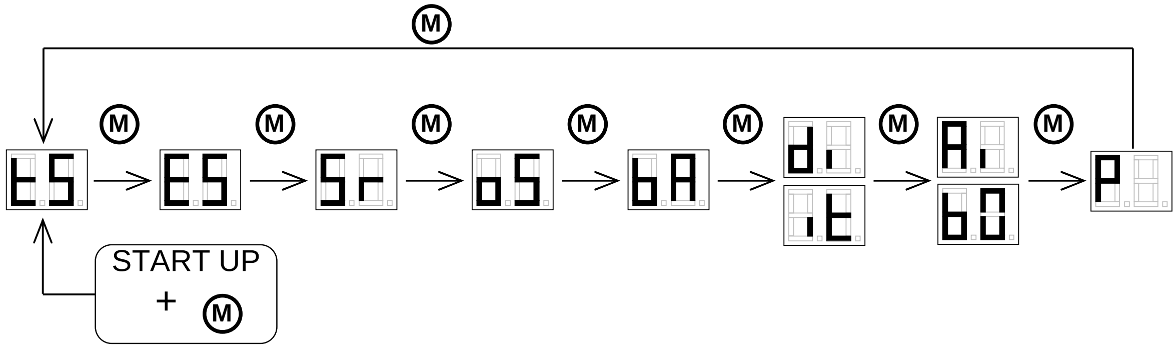
REMARK: The RD.120 shows two dashes (as illustrated below) when the speed ratio is not available:



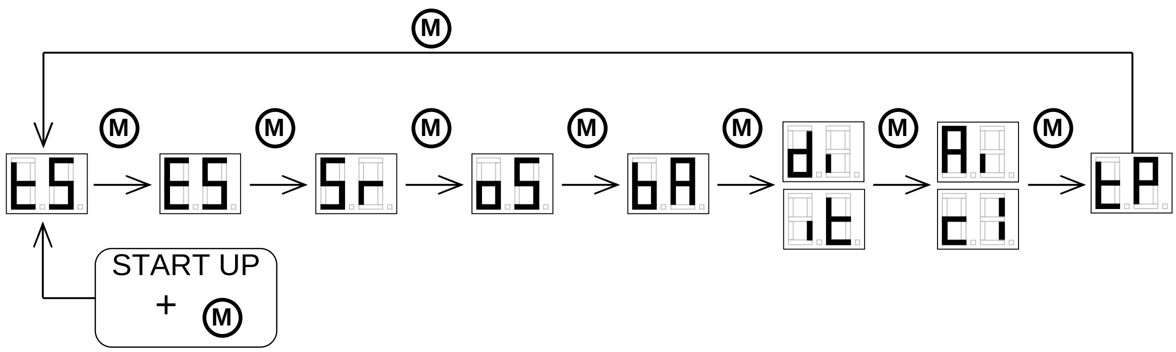
Typically this is the case when the transmission is in neutral (this condition does not allow the ECON.A312 to calculate the speed ratio because the turbine speed is unknown at that moment) or when the drum speed sensor, the output speed sensor or engine speed sensor is not connected or has an electrical problem, or when the CAN message EEC1 has timed out on the CAN-bus or if the CAN-bus itself is not connected or has an electrical problem.

In case other information is available, like system pressure, analog throttle pedal information, converter out temperature, sump temperature, etc., the diagnostic display mode is extended by default with displays reflecting this information.

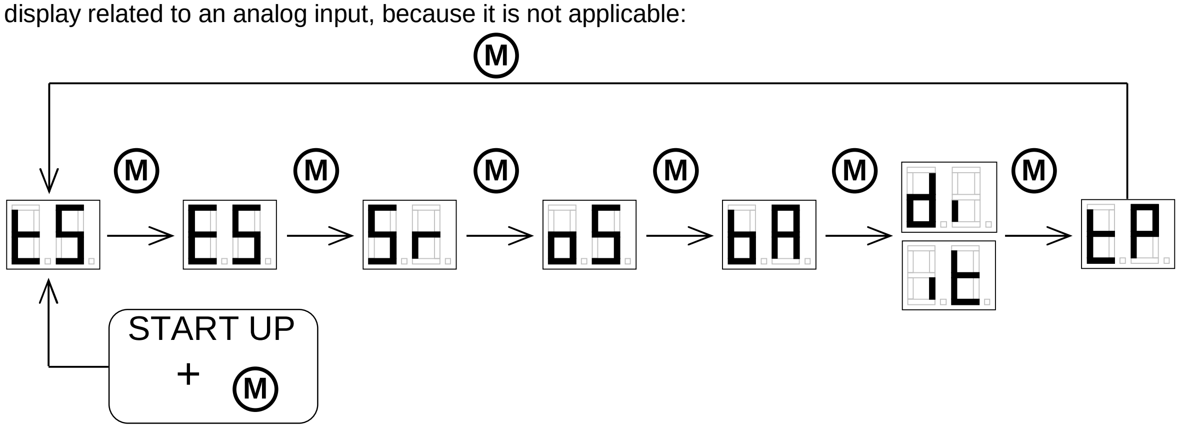
For example, when the system pressure is measured with analog voltage (type 2B) input 0, the diagnostic display mode is extended by default with the displays “b0” and “P”:




For example, when the throttle pedal position is measured with analog voltage (type 2C) input 1, the diagnostic display mode is extended by default with the displays “c1” and “tP”:



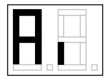

For example, when the throttle pedal position is read from the CAN message EEC2, the diagnostic display mode is extended by default with the displays “tP”.  In this case there is no display related to an analog input, because it is not applicable:

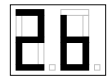


#### 1.12.2.2.7 Analog input (type 2B) displays

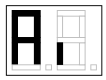
5 displays show the voltage of the 5 ECON.A312 analog voltage inputs of type 2B.

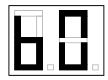
They are initiated with the announcement of **A**nalog **i**nputs of type **2B**:

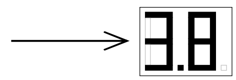


alternating with



When pressing the "M"-button again, the first available analog input display is shown, e.g. analog input n° 0 of type 2B:



alternating with




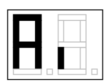

When the "M"-button is pressed again, the display changes to the actual voltage of the concerned analog input. The measured voltage is indicated with a unit dot. The voltage is shown with 0.1V resolution. The example "Ai" /" b0" above shows a voltage of 3.8 V.

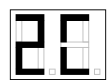
REMARK: Only relevant analog input displays are shown: analog input displays for analog inputs that are not configured in the ECON.A312, are not shown.
Possible analog input displays are "Ai" / "b0" through "Ai" / "b4".

#### 1.12.2.2.8 Analog input (type 2C) displays

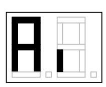
5 displays show the voltage of the 5 ECON.A312 analog voltage inputs of type 2C.

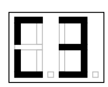
They are initiated with the announcement of **A**nalog **i**nputs of type **2C**:

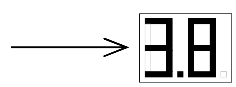


alternating with



When pressing the "M"-button again, the first available analog input display is shown, e.g. analog input n° 3 of type 2C:



alternating with




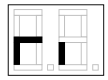

When the "M"-button is pressed again, the display changes to the actual voltage of the concerned analog input. The measured voltage is indicated with a unit dot. The voltage is shown with 0.1V resolution. The example "Ai" /" C3" above shows a voltage of 3.8 V.

REMARK: Only relevant analog input displays are shown: analog input displays for analog inputs that are not configured in the ECON.A312, are not shown.
Possible analog input displays are "Ai" / "C0" through "Ai" / "C4".

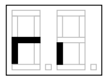
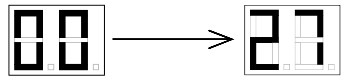
#### 1.12.2.2.9 Resistive input displays

2 displays show the resistance of the 2 ECON.A312 resistive inputs.

They are initiated with the announcement of **R**esistive **i**nputs:



When pressing the “M”-button again, the first available resistive input display is shown, e.g. resistive input n° 0:

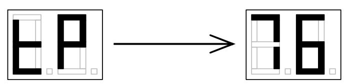
 alternating with 

When the “M”-button is pressed again, the display changes to the actual resistance of the concerned input. The measured resistance is indicated without unit dot. The resistance is shown with 100 Ω resolution. The example “ri” / “00” above shows a resistance of 2700 Ω.

REMARK: Only relevant resistive input displays are shown: resistive input displays for resistive inputs that are not configured in the ECON.A312, are not shown.
Possible analog input displays are “ri” / “00” and “ri” / “01”.

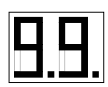
#### 1.12.2.2.10 Throttle pedal position display

This display shows the actual throttle pedal position in %.

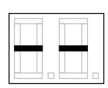


REMARK: As long as the “M”-button is pressed (however less than 2 sec), “tP” (**t**hrottle **P**edal) is shown on the display. When the “M”-button is released, the display changes to the actual throttle pedal position value.

The throttle pedal is shown with 1 % resolution. The above example shows 76 %.
When the throttle pedal is 100 %, the throttle pedal position display shows:



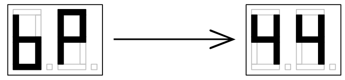
REMARK: The RD.120 shows two dashes (as illustrated below) when the throttle pedal position is not available:



Typically this is the case when the throttle pedal sensor is not connected or has an electrical problem, or when the CAN message EEC2 or CVC_TO_TC_2 has timed out on the CAN-bus or if the CAN-bus itself is not connected or has an electrical problem.

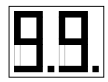
#### 1.12.2.2.11 Brake pedal position display

This display shows the actual brake pedal position in %.

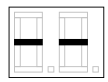



REMARK: As long as the "M"-button is pressed (however less than 2 sec), "bP" (**b**rake **P**edal) is shown on the display. When the "M"-button is released, the display changes to the actual brake pedal position value.

The brake pedal is shown with 1 % resolution. The above example shows 44 %. When the brake pedal is 100 %, the brake pedal position display shows:



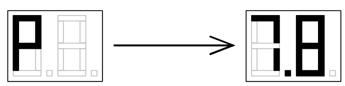

REMARK: The RD.120 shows two dashes (as illustrated below) when the brake pedal position is not available:



Typically this is the case when the brake pedal sensor is not connected or has an electrical problem, or when the CAN message CVC_TO_TC_2 has timed out on the CAN-bus or if the CAN-bus itself is not connected or has an electrical problem.

#### 1.12.2.2.12 System pressure display

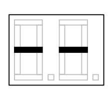
This display shows the actual system pressure.




REMARK: As long as the "M"-button is pressed (however less than 2 sec), "P" (System **P**ressure) is shown on the display. When the "M"-button is released, the display changes to the actual system pressure value.

For system pressures below 10 bar, the system pressure is shown with 0.1 bar resolution. The unit dot lights up. For system pressures above 10 bar, the system pressure is shown with 1 bar resolution. The above example shows 7.8 bar.

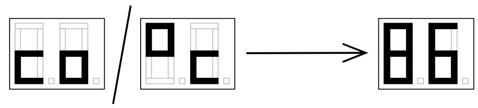
REMARK: The RD.120 shows two dashes (as illustrated below) when the system pressure is not available:



Typically this is the case when the system pressure sensor is not connected or has an electrical problem.

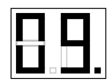
#### 1.12.2.2.13 Converter out temperature display (in °C)

This display shows the actual converter out temperature in °C.



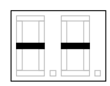
REMARK: As long as the "M"-button is pressed (however less than 2 sec), "co" (**C**onverter **o**ut temperature) and "°C" are shown in alternation on the display. When the "M"-button is released, the display changes to the actual converter out temperature.

The converter out temperature is shown with 1°C resolution. The above example shows 86°C. When the converter out temperature is above 100°C the unit dot lights up. The maximum temperature that can be shown is 150°C. Below example shows 109°C:



When the converter out temperature is below 0°C, the temperature is shown with blinking numbers.

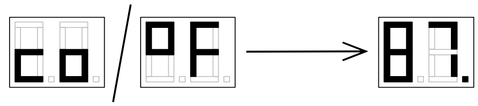
REMARK: The RD.120 displays two dashes (as illustrated below) when the converter out temperature is not available:



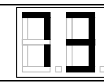
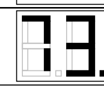
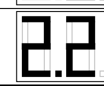
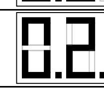
Typically this is the case when the converter out temperature sensor is not connected or has an electrical problem.

#### 1.12.2.2.14 Converter out temperature display (in °F)

This display shows the actual converter out temperature in °F.

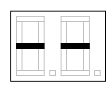


REMARK: As long as the "M"-button is pressed (however less than 2 sec), "Co" (**C**onverter **o**ut temperature) and "°F" are shown in alternation on the display. When the "M"-button is released, the display changes to the actual converter out temperature. The converter out temperature is shown with 1°F resolution.

| Converter out temperature | Activated dots | | Example | |
|---|---|---|---|---|
| | Left | Right | Temperature [ °F] | RD.120 |
| <100°F | | | 73°F |  |
| >=100°F and < 200°F | | activated | 173°F |  |
| >=200°F and < 300°F | activated | | 222°F |  |
| >=300°F | activated | activated | 302°F |  |

The maximum temperature that can be shown is 302°C. When the converter out temperature is below 0°C, the temperature is shown with blinking numbers.

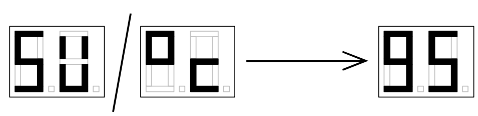
REMARK: The RD.120 displays two dashes (as illustrated below) when the converter out temperature is not available:



Typically this is the case when the converter out temperature sensor is not connected or has an electrical problem.

#### 1.12.2.2.15 Sump temperature display (in °C)

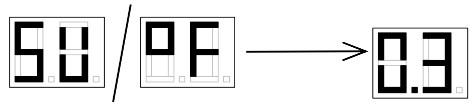
This display shows the actual sump temperature in °C.



This display functions in the same way as the display "converter out temperature in °C". Refer to CHAPTER 1 – 1.12.2.2.13.

#### 1.12.2.2.16 Sump temperature display (in °F)

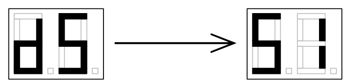
This display shows the actual sump temperature in °F.




This display functions in the same way as the display “converter out temperature in °F”. Refer to CHAPTER 1 – 1.12.2.2.14.

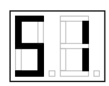
#### 1.12.2.2.17 Drum speed display

This (optional) display shows the actual drum speed.

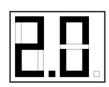



<u>REMARK</u>: As long as the “M”-button is pressed (however less than 2 sec.), “dS” (**d**rum **S**peed) is shown on the display. When the “M”-button is released, the display changes to the actual drum speed value.

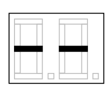
For speeds below 1000 rpm, drum speed is shown with 10 rpm resolution. The below example shows a drum speed between 505 rpm and 514 rpm:




For speeds above 1000 rpm, drum speed is shown with 100 rpm resolution and the 1000 unit dot lights up. The below example shows a drum speed between 1950 rpm and 2049 rpm:



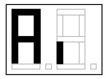
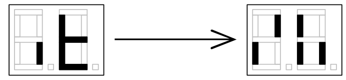

<u>REMARK</u>: The RD.120 displays two dashes (as illustrated below) when the drum speed is not available:




Typically this is the case when the drum speed sensor or output speed sensor is not connected or has an electrical problem.

### 1.12.2.2.18 Analog input test display

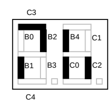
The analog input test display is used to verify the operation of analog inputs which are used for reading digital information.

 alternating with 

REMARK: First, “Ai” (**A**nalog **i**nput) / “it” (**i**nput **t**est) is shown on the display. When the “M”-button is pressed again, the display changes to the actual analog input test.

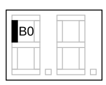
The input test shows the status of analog input B0 through B4 and analog input C0 through C4. Note that only the status of analog inputs are shown, which are actually used for reading digital information.

When the analog inputs B0 – B4, C0 –C4 are activated, the corresponding segment lights up.

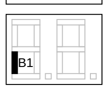



Analog input test layout

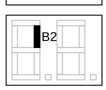
The above example shows that analog inputs B1, B2, B4, C0, C2 and C3 are activated.



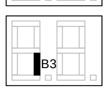
This segment lights up when analog input B0 on wire A9 is activated.



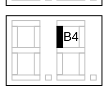
This segment lights up when analog input B1 on wire A11 is activated.



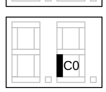
This segment lights up when analog input B2 on wire B3 is activated.



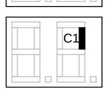
This segment lights up when analog input B3 on wire B5 is activated.



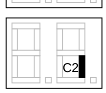
This segment lights up when analog input B4 on wire A10 is activated.



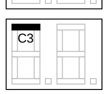
This segment lights up when analog input C0 on wire A16 is activated.



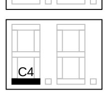
This segment lights up when analog input C1 on wire A18 is activated.



This segment lights up when analog input C2 on wire B4 is activated.



This segment lights up when analog input C3 on wire B8 is activated.

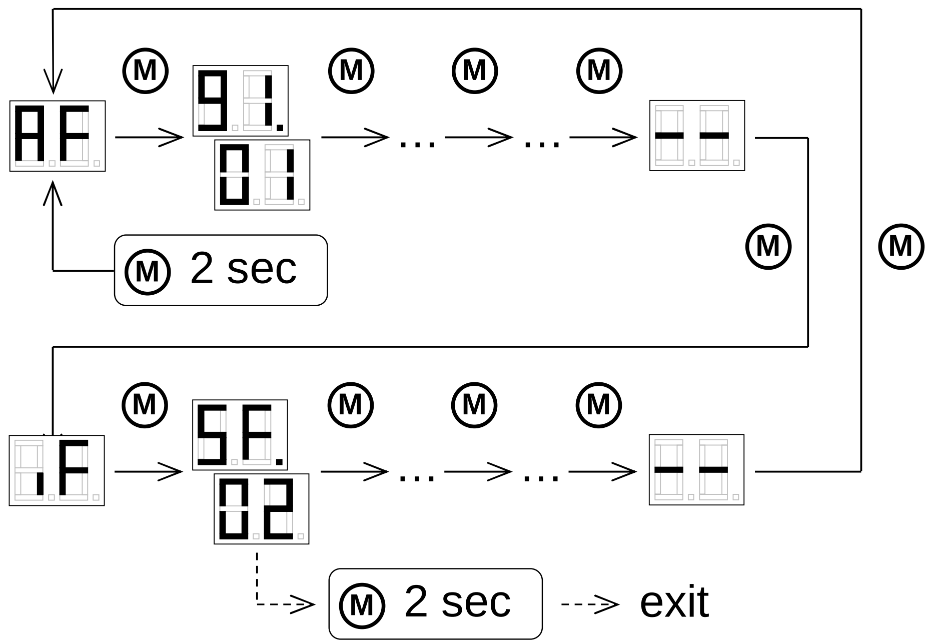


This segment lights up when analog input C4 on wire B20 is activated.

### 1.12.2.3 Error display mode

If the ECON.A312 is in the normal display mode or in the diagnostic display mode and a problem is detected, the F-LED starts blinking in order to draw the attention of the driver.

The driver can visualize the error code related to the detected problem, by activating the error display mode. It can be activated by pressing the “M”-button for more than 2 seconds.




Changing between the different active faults (“AF”) and inactive faults (“IF”) is done by pressing the “M”-button shortly.

REMARK: In order to exit the error display mode and return to the original display mode (= the mode before the error display mode was activated), the “M”-button must be pressed again for 2 seconds. The above schematic shows the exit from “5F.02”. However, exiting the error display mode can be done from every display position in the error display mode.

There are two phases in the error display mode. The first phase “**AF**” shows the **A**ctive **F**aults, while the second phase “**IF**”shows the **I**nactive **F**aults.

REMARK: In case there is an active error, the F-LED lights up continuously in the error display mode. In case all active errors have disappeared, the F-LED is switched off.

The error codes are explained in a seperate document. Refer to “ECON.A312 Error code list – production firmware 1.11.pdf”

*The error display mode only applies to the volatile error memory!*
*To access the permanent error logging information, either use a Dashboard or use the CAN messages DM1, DM2 and DM3 for interpretation.*

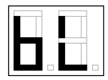
## 1.12.3 Bootloader mode (= programming mode)

The bootloader mode is activated during the programmation of the ECON.A312 with (new) firmware. Programming (new) firmware into the ECON.A312 can be done with the “Dana CAN Firmware XML Flashtool”.

The bootloade mode is also activated when the ECON.A312 does not find a valid application firmware during its initialization.

### 1.12.3.1 Bootloader mode active

Initially the yellow “D”-LED and the red “F”-LED blink with alternation, while the display shows:



The programming process consists of 3 steps:

#### 1.12.3.1.1 Step 1: Erasing

The first step is erasing the existing contents of the program flash.
Sectors L08, L09, M0, M1, H0 and H1 are erased.

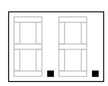
#### 1.12.3.1.2 Step 2: Programming & verification

After the erasing step, the actual programming starts.
Sectors L08, L09, M0, M1, H0 and H1 are programmed.

#### 1.12.3.1.3 Step 3: Verification

Finally a verification of the complete programmed firmware is performed.

During the erasing, programming and verification procedure the RD.120 continuously shows:



The “D”-LED and “F”-LED are continuously off during the erase, programming and verification procedure.

> When the programming of the ECON.A312 is completed successfully, the ECON.A312 automatically restarts and tries to activate the new application firmware. If this succeeds, the ECON.A312 is not longer in bootloader mode, but starts up in normal mode again (see CHAPTER 1 – 1.4.1 for details).
>
> However, if the ECON.A312 can not successfully activate the application firmware, bootloader mode is automatically activated again.

# 2 Calibration of analog input signals

The ECON.A312 supports calibration procedures for the analog input signals “throttle pedal” and “brake pedal”.

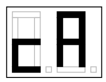
Calibration of the throttle pedal and brake pedal signals ensures that the ECON.A312 reads the throttle pedal and brake pedal values correctly during normal operation.

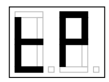
Calibration needs to be done at the following moments:

- When the vehicle is built in production at the OEM
- When the sensor of the analog input signal is replaced
- When the ECON.A312 is replaced or a firmware and/or APT-file upgrade is performed
- When an error code indicates that the calibration is invalid

## 2.1 Calibration via the RD.120

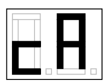
The calibration mode is envoked by keeping the “M”-button pressed for 10 sec during start up and initialization of the ECON.A312. After these 10 sec, the following display appears on the RD.120:

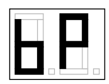


alternating with



“cA” = **cA**libration and “tP” = **t**hrottle **P**edal

or



alternating with



“cA” = **cA**libration and “bP” = **b**rake **P**edal

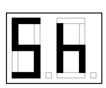
These displays indicate that you have entered the calibration mode, and that throttle pedal or brake pedal is ready to be calibrated.

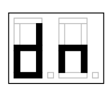
Now the “M”-button must be released.

To start the actual calibration, press the “M”-button again for minimum 2 sec. Refer to CHAPTER 1 – 2.1.1 and CHAPTER 1 – 2.1.2 for details about the actual calibration procedure itself.

To select the next available calibration option, press the “M”-button shortly.

After scrolling through the different calibration displays, the final display is:



alternating with



“Sh” / “dn”= **Sh**ut **d**ow**n**

From this display, the calibration mode can be left by keeping the “M”-button pressed for minimum 2 sec. This causes a reset of the ECON.A312. After the reset, the ECON.A312 starts up again in normal display mode and normal operation mode.

REMARK: The throttle pedal calibration mode is only enabled in case there is an analog throttle pedal (Hall Effect sensor or potentiometer) wired to the ECON.A312.
The same is true for the brake pedal: the brake pedal calibration mode is only enabled in case there is an analog brake pedal (Hall Effect sensor or potentiometer) wired to the ECON.A312.

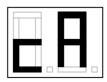
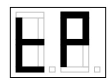
REMARK: In case the analog throttle or brake pedal information is shared with the ECON.A312 via CAN communication, no calibration of the ECON.A312 is needed. In this case, the concerned calibration mode is disabled in the ECON.A312.

REMARK: The order of calibration (throttle pedal or brake pedal first) can be programmed in the ECON.A312 upon desire. By default, the throttle pedal calibration comes first.

### 2.1.1 Calibration of the throttle pedal sensor via the RD.120

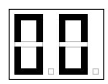
For the throttle pedal, 2 points are calibrated: 0% and 100%.

To start the throttle pedal calibration, activate the calibration mode by pressing the "M"-button during 10 sec at startup of the ECON.A312. In case the RD.120 does not show "cA" alternating with "tP", then press the "M"-button shortly until it shows:

 alternating with 

The throttle pedal calibration can be started by pressing the "M"-button during minimum 2 sec.

During throttle pedal calibration, the 2 calibration points (0% and 100%) are presented by the ECON.A312 to the driver. First the ECON.A312 presents:

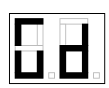


The driver has to release the throttle pedal completely and confirm the 0% calibration by pressing the "M"-button shortly. Then the ECON.A312 presents:

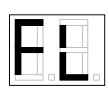
The driver has to press the throttle pedal completely and confirm the 100% calibration by pressing the "M"-button shortly.

Finally, the ECON.A312 gives feedback whether the calibration was successful or not.

If it the calibration were successful, the RD.120 shows "Gd" (**G**oo**d**):



If there were problem during calibration, the RD.120 shows "FL" (**F**ai**L**ed):



In the latter case, the values of the failed calibration are ignored and the default values are used.

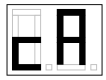
***REMARK: to have the new calibration values activated, a controlled power down of the ECON.A312 is needed. In this way, the values are saved in the ECON.A312's permanent flash memory. Refer to CHAPTER 1 – 1.5 for details.***

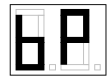
***Only at the next power up these new values will be used.***

### 2.1.2 Calibration of the brake pedal sensor via the RD.120

For the brake pedal, 2 points are calibrated: 0% and 100%.

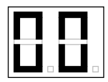
To start the brake pedal calibration, activate the calibration mode by pressing the “M”-button during 10 sec at startup of the ECON.A312. In case the RD.120 does not show “cA” alternating with “bP”, then press the “M”-button shortly until it shows:



alternating with



The brake pedal calibration can be started by pressing the “M”-button during minimum 2 sec.

During brake pedal calibration, the 2 calibration points (0% and 100%) are presented by the ECON.A312 to the driver. First the ECON.A312 presents:

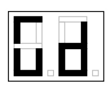



The driver has to release the brake pedal completely and confirm the 0% calibration by pressing the “M”-button shortly. Then the ECON.A312 presents:

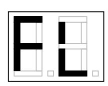

The driver has to press the brake pedal completely and confirm the 100% calibration by pressing the “M”-button shortly.

Finally, the ECON.A312 gives feedback whether the calibration was successful or not.

If it the calibration were successful, the RD.120 shows “Gd” (**G**oo**d**):




If there were problem during calibration, the RD.120 shows “FL” (**F**ai**L**ed):




In the latter case, the values of the failed calibration are ignored and the default values are used.

***REMARK: to have the new calibration values activated, a controlled power down of the ECON.A312 is needed. In this way, the values are saved in the ECON.A312’s permanent flash memory. Refer to CHAPTER 1 – 1.5 for details.***

***Only at the next power up these new values will be used.***

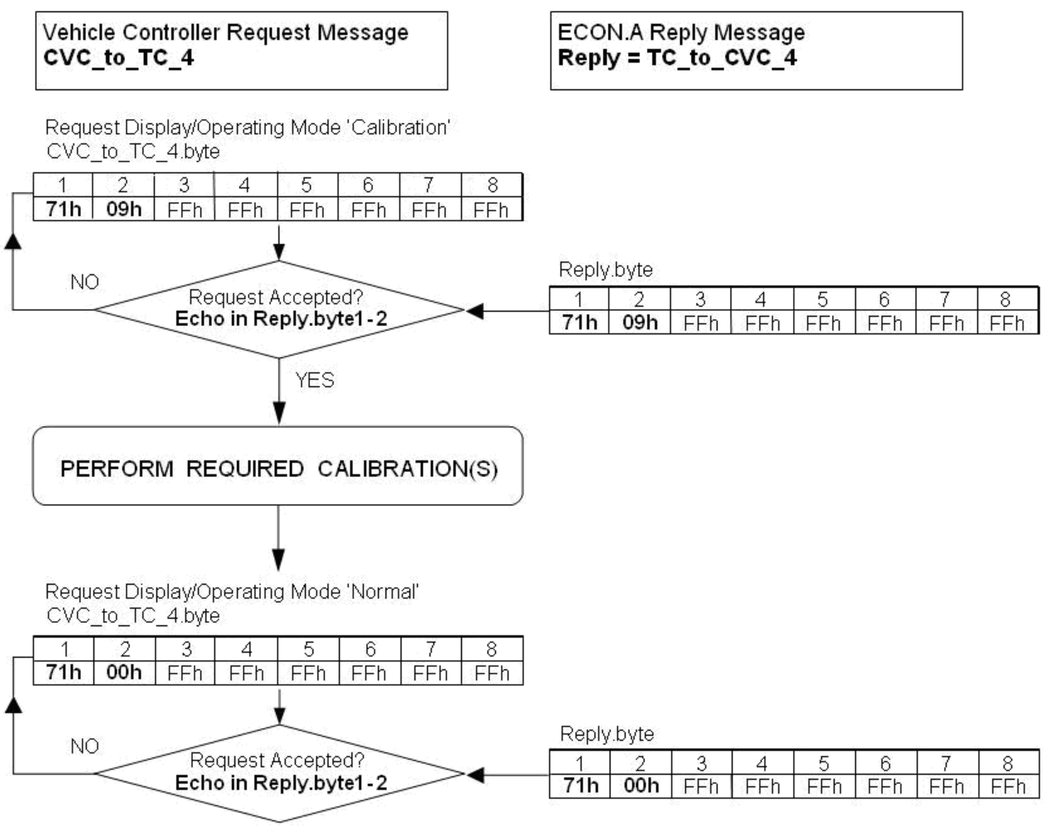
## 2.2 Calibration via CAN communication

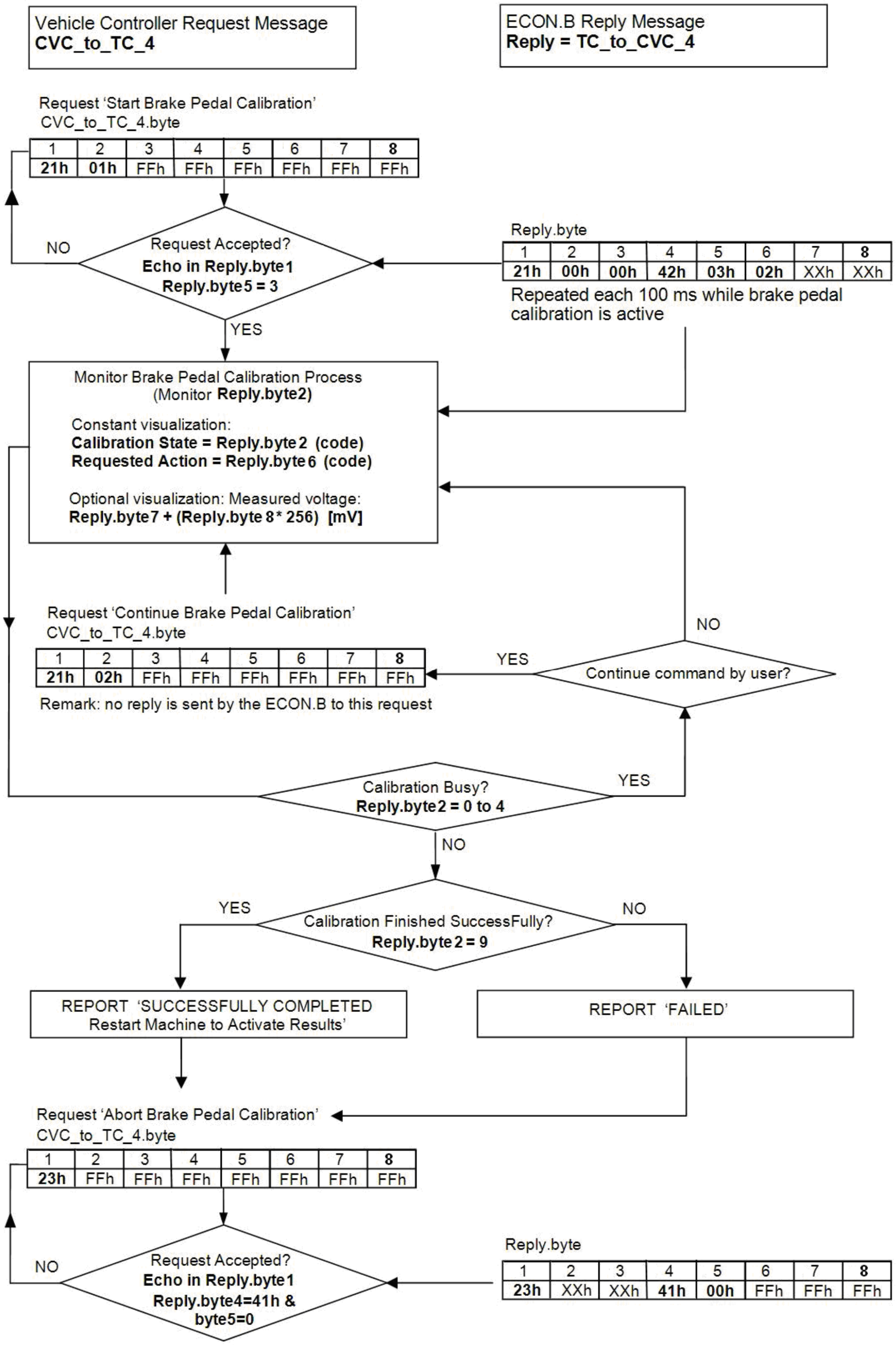
Analog inputs can be calibrated via the RD.120 display as described above. But they can also be calibrated via CAN communication.

This is useful on machines where there is no RD.120 present and where the operator has an interface with a central vehicle controller (e.g. dashboard display) that is connected to the same CAN bus network as the ECON.A312. It also allows to do the calibration using Dashboard.

The chart below and on the following page explains how the different messages are linked together for execution of pedal calibration. The chart uses the codes for calibration of the brake pedal signal, but the principal is identical for the throttle pedal calibration. The details of all used CAN messages are fully described in CHAPTER 3.

*Before a calibration can be started using CAN, the calibration mode has to be activated in the ECON.A312 first. Without this calibration mode activated, any attempt to start a specific calibration is ignored by the ECON.A312.*
*After completing all the required calibrations, the ECON.A312 can be set back to normal operating mode. This is optional, because restarting the ECON.A312 will be needed anyway to activate the new calibration results, and restarting the ECON.A312 automatically deactivates the calibration mode.*




Vehicle Controller Request Message
CVC_to_TC_4
ECON.B Reply Message
Reply = TC_to_CVC_4
Request 'Start Brake Pedal Calibration'
CVC_to_TC_4.byte
1 2 3 4 5 6 7 8
21h 01h FFh FFh FFh FFh FFh FFh
Request Accepted?
Echo in Reply.byte1
Reply.byte5 = 3
NO
YES
Reply.byte
1 2 3 4 5 6 7 8
21h 00h 00h 42h 03h 02h XXh XXh
Repeated each 100 ms while brake pedal calibration is active
Monitor Brake Pedal Calibration Process
(Monitor Reply.byte2)
Constant visualization:
Calibration State = Reply.byte2 (code)
Requested Action = Reply.byte6 (code)
Optional visualization: Measured voltage:
Reply.byte7 + (Reply.byte8 * 256) [mV]
Request 'Continue Brake Pedal Calibration'
CVC_to_TC_4.byte
1 2 3 4 5 6 7 8
21h 02h FFh FFh FFh FFh FFh FFh
Remark: no reply is sent by the ECON.B to this request
Continue command by user?
YES
NO
Calibration Busy?
Reply.byte2 = 0 to 4
YES
NO
Calibration Finished SuccessFully?
Reply.byte2 = 9
YES
NO
REPORT 'SUCCESSFULLY COMPLETED
Restart Machine to Activate Results'
REPORT 'FAILED'
Request 'Abort Brake Pedal Calibration'
CVC_to_TC_4.byte
1 2 3 4 5 6 7 8
23h FFh FFh FFh FFh FFh FFh FFh
Request Accepted?
Echo in Reply.byte1
Reply.byte4=41h &
byte5=0
NO
Reply.byte
1 2 3 4 5 6 7 8
23h XXh XXh 41h 00h FFh FFh FFh

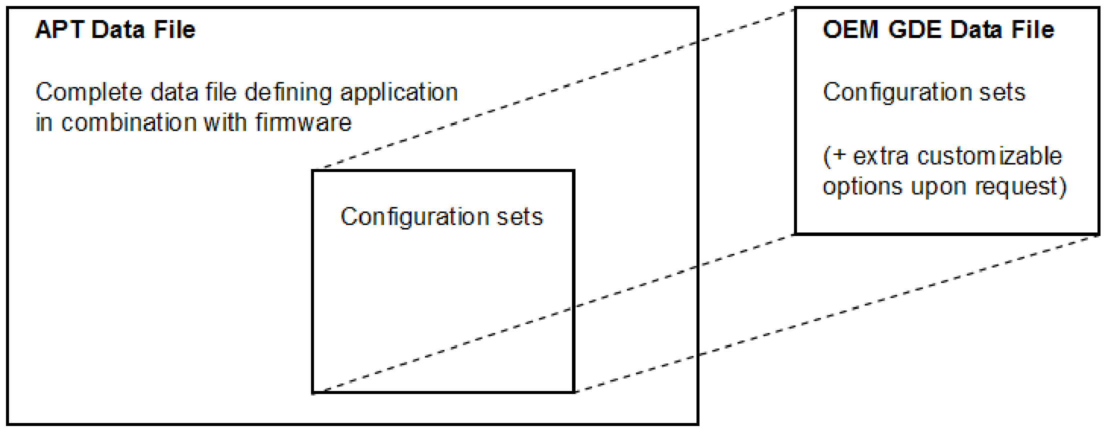
# CHAPTER 2 : ECON.A312 Configuration Sets Description

# 1 Introduction

The configuration sets are created to provide OEM Engineering a windowed view on all relevant parameters to allow option selection and machine functionality definition in the ECON.A312.

This chapter describes the structure and the contents of the configuration sets. It also contains the information needed for practical use of these configuration sets, both for setting the contents of a set as for selecting a predefined configuration set. This can be handled both using the Dana GDE tool and using CAN communication.

For a better understanding, the diagram below shows the situation of the configuration sets within the total amount of available parameters.




An essential part of each ECON.A312 is the so called APT file. This is a complete data file delivered by Dana containing all parameters needed to get a fully operational ECON.A312. Together with the ECON.A312 firmware, it defines a complete application. As a rule, these APT files are read-only to the OEM user.
As the diagram shows, the configuration sets are a part of that complete APT file, so they are an essential part of the parameters.

The so called OEM GDE Data file is a reduced version of the full APT file, where only the configuration sets are accessible for editing. This way the OEM user can overwrite the standard settings as they are provided in the APT file supplied by Dana.
This allows management of configuration sets completely under the responsibility of the OEM user, without needing a large quantity of different APT files from Dana.

Remark: in highly exceptional cases, such an OEM GDE data file could contain some parameters that are not a part of the configuration sets, but nevertheless need to be customized by the OEM user. This will be investigated case by case and is to be defined together with Dana.

Before choosing to define such extra parameters that need to be customized by the OEM user, some careful consideration is needed. As is explained in the next paragraphs, configuration sets can be managed in different ways: on the one hand PC tools like OEM Engineering GDE and Dashboard, CAN messages on the other hand.
Be aware that extra parameters that are not a part of these configuration sets can only be managed by using the OEM Engineering GDE.

# 2 Using Configuration Sets

## 2.1 Basic concept

Each column in the “ConfSets” header (see further) represents a machine configuration. For all the available options (rows) a suitable value can be selected. These values are boundary checked to prevent the user entering unsafe data.

Once the different configuration sets are created, one of these sets is selected by simply picking its index from the list of available sets and activating it by downloading it to the controller. This can either be done using the GDE and APT tool or using a CAN message (see CHAPTER 3 for details).

## 2.2 Configuration Set Parameters Description

The following paragraphs describe the different configuration set parameters available in the ECON.A312. This means that any combination of the following parameters can be combined to different configuration sets.
The maximum number of configuration sets that can be defined is 20.

### 2.2.1 Configuration Set Name (GDE only)

This is a text parameter that allows the user to specify any name for the configuration set up to 8 characters long.
This name is also used as the column title of each configuration set and more importantly for the list of selectable configuration sets (see CHAPTER 2 – 3.3 for details).
When you specify a new name, it will not immediately be reflected there! This will only be updated after downloading your changes into an ECON.A312, closing the GDE, restarting it and then performing an upload again. Alternatively leaving the GDE open and performing an ‘Upload Groups’ will also refresh the parameters label info and reflect your changes after the next upload.
Because the name of the configuration is very important for reference to a set, it is recommend to make sure that the correct names are reflected in the list of selectable configuration sets (see CHAPTER 2 – 3.3 for details) before saving your changes and distributing this file in your production environment (see CHAPTER 2 – 3.2 for details).

REMARK: When using CAN messages to reference a configuration set, this name is not relevant. Instead an index value needs to be used to address the correct configuration set (see CHAPTER 3 for details).

### 2.2.2 Shift lever Type

Specify the type of shift lever on the machine (Standard / Bump Type / CAN Type / Combined)
For the selection of a standard or a bumptype shift lever, a fixed wiring of the shift lever outputs to the ECON.A312 is expected. Check the application specific wiring diagram to see how the shift lever needs to be connected to the ECON.A312.

REMARK: A combination of a CAN Type and wired shift lever (Standard / Bump Type) can be configured upon request. The CAN Type will always have precedence on the wired shiftlever, if a valid pattern is given over CAN. Refer to CHAPTER 1 – 1.6.1 for details.

### 2.2.3 Digital input features

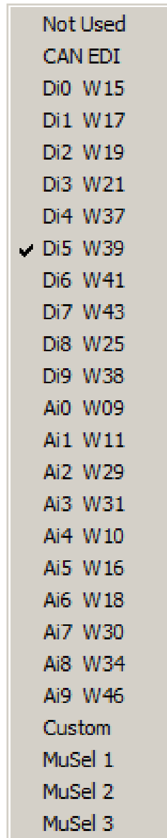
#### 2.2.3.1 Available digital input features

The available digital input features are:

- DI Declutch (refer to CHAPTER 1 – 1.11.2 for details)
- DI Auto/Manual Shifting (refer to CHAPTER 1 – 1.9.1 for details)
- DI Kickdown Request (refer to CHAPTER 1 – 1.11.8 for details)
- DI Neutral Lock Reset (refer to CHAPTER 1 – 1.11.4 for details)
- DI Throttle Pedal Idle (refer to CHAPTER 1 – 1.6.5 for details)
- DI Throttle Pedal Full (refer to CHAPTER 1 – 1.6.5 for details)
- DI Vehicle Loaded/Not Loaded (refer to CHAPTER 1 – 1.11.6 for details)
- DI Parking Brake State (refer to CHAPTER 1 – 1.11.11 for details)
- DI Disconnect 4WD/2WD (refer to CHAPTER 1 – 1.11.16 for details)
- DI High Low Range Selector (refer to CHAPTER 1 – 1.11.13 for details)
- DI System Pressure (refer to CHAPTER 1 – 1.10.5 for details)
- DI Servicebrake Pressed (refer to CHAPTER 1 – 1.11.17 for details)
- DI Operator Present (refer to CHAPTER 1 – 1.11.3 for details)
- DI Seat Orientation (refer to CHAPTER 1 – 1.11.1 for details)
- DI Inhibit Upshift (refer to CHAPTER 1 – 1.11.7 for details)
- DI Oil Temperature (refer to CHAPTER 1 – 1.10.6 for details)
- DI Lockup Enable (refer to CHAPTER 1 – 1.11.9 for details)
- DI Exhaust (refer to CHAPTER 1 – 1.11.9 for details)
- DI Retarder (refer to CHAPTER 1 – 1.11.9 for details)
- DI High Idle (refer to CHAPTER 1 – 1.11.15 for details)
- DI Immediate Neutral Lock (refer to CHAPTER 1 – 1.11.5 for details)
- DI PTO/PTI (refer to CHAPTER 1 – 1.11.18 and CHAPTER 1 – 1.11.19 for details)
- DI Block out highest gears (refer to CHAPTER 1 – 1.11.14 for details)

### 2.2.3.2 Digital input feature activation

For each available digital input feature, enabling the feature is possible by selecting an available signal source. For digital input features, these are the options to choose from:




If the signal is wired, choose one of the available digital input wires from the drop down list presented.
If the signal is sent over the CAN bus, following the protocol as described in the ECON.A312 CAN EDI description, select the option “CAN EDI”. Refer to CHAPTER 3 for details.
If the function is not to be used, select “Not Used”.

<u>REMARK</u>: The “Custom” defined source option is available to allow a more complex (virtual) definition of the input signal. This option is only available for the auto/manual shifting input functionality, e.g. the transition between automatic or manual gearshifting can be defined by the shift leverposition.

### 2.2.3.3 Digital input feature logics inversion

To activate/deactivate a feature, 2 types of digital input signals can be applied: mono- and bistable signals.

Monostable signals are signals that can only rest in 1 state, this means, to activate a digital input feature, the signal has to be applied in the form of a pulse and to deactivate the feature the pulse signal has to be applied again.

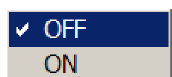
Bistable signals are signals that can rest in 2 states, this means, to activate a digital input feature, the signal has to be applied continuously and to deactivate the feature the signal has to be removed.

There is a possibility to invert the logics of the input; this can be applied to both types of digital input signals.


If "No" is selected, the signal (pulse or constant) needs to be high to have the feature active.
If "Yes" is selected, the logic is inverted.

### 2.2.3.4 Digital input feature inactive default value

In case a digital input feature is not activated ("Not Used"), the default value determines whether the feature is always active or not:




For some feature this is not useful at all. For others, like "DI Auto/Manual Shifting" this can be used to for activating manual mode by default for a specific configuration set (when set to "OFF") or activating automatic mode by default for a specific configuration set (when set to "ON") for a specific configuration set.

## 2.2.4 Digital output features

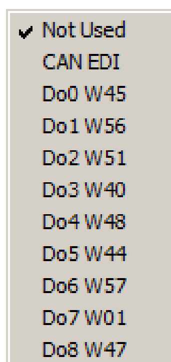
### 2.2.4.1 Available digital output features

The available digital output features are:

- DO Disconnect 4WD/2WD (refer to CHAPTER 1 – 1.11.16 for details)
- DO High Low Range Selector (refer to CHAPTER 1 – 1.11.13 for details)
- DO Throttle Reduction (refer to CHAPTER 1 – 1.11.23 for details)
- DO Neutral Engine Start (CHAPTER 11.11.10 for details)
- DO Warning Lamp (refer to CHAPTER 1 – 1.11.27 for details)
- DO Lockup (refer to CHAPTER 1 – 1.11.9 for details)
- DO Gear Dependent (refer to CHAPTER 1 – 1.11.28 for details)
- DO Speed Dependent (up to 3 outputs) (refer to CHAPTER 1 – 1.11.26 for details)
- DO PTO/PTI (refer to CHAPTER 1 – 1.11.18 and CHAPTER 1 – 1.11.19 for details)
- DO PTI Enable (refer to CHAPTER 1 – 1.11.19 for details)
- DO Reverse alert (refer to CHAPTER 1 – 1.11.29 for details)
- DO Parking brake (refer to CHAPTER 1 – 1.11.11 for details)

### 2.2.4.2 Digital output feature activation

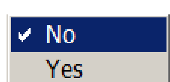
As with the digital input features, for each available digital output feature, enabling the feature is possible by selecting an available output:




If the ouput is wired, choose one of the available digital output wires from the drop down list presented.
If the function is active and it is sent over the CAN bus, following the protocol as described in the ECON.A312 CAN EDI description, select the option “CAN EDI”.
If the function is not to be used, select “Not Used”.

### 2.2.4.3 Digital output feature logics inversion

Identical to the digital input features, there is a possibility to invert the logics of the output:




If “No” is selected, the digital output signal will be equal to the value got from the output feature. If “Yes” is selected, the logic is inverted.

## 2.2.5 Analog input features

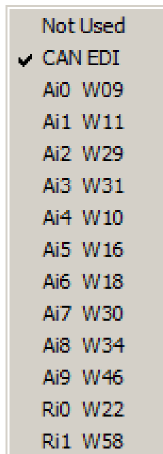
### 2.2.5.1 Available analog input features

Named as they are presented in the GDE tool, the available analog input features are:

- AI Throttle Pedal (refer to CHAPTER 1 – 1.6.5 for details)
- AI Brake Pedal

### 2.2.5.2 Analog input feature activation

For each available analog input feature, enabling the feature is possible by selecting an available signal source:




If the signal is wired, choose one of the available analog input wires from the drop down list presented.
If the is sent over the CAN bus, following the protocol as described in the ECON.A312 CAN EDI description, select the option “CAN EDI”
If the function is not to be used, select “Not Used”.

## 2.2.6 Max vehicle speed

This sets the absolute maximum vehicle speed that is allowed for a specific vehicle configuration. This limit will be used by the vehicle speed limitation feature if available (refer to CHAPTER 1 – 1.11.21 for details).

### 2.2.7 Max DirChg/Engage vehicle speed

This sets the maximum vehicle speed to allow a direction change or engagement to be performed. If a direction change is requested when the vehicle speed is higher than this value, the shift will be postponed until the actual speed has dropped below this limit. If it does and the request for a direction change is still detected on the shift lever, the shift will be performed if no other limitations are active.

The maximum allowed direction change vehicle speed is determined by the application approval, and is intended to prevent damage to the transmission clutches (overheating and friction plate damage caused by dissipation of too much power in the direction clutches). It can therefore not be exceeded at all!
Using a lower limit might be desirable in some cases to prevent direction changes on the machine at speeds that might represent a dangerous situation on the machine or the direct environment.

REMARK: How the ECON.A312 reacts exactly if the shift needs to be postponed because the vehicle speed limit is exceeded, depends on the selections made as described in CHAPTER 1 – 1.8.1 and CHAPTER – 1.8.2.

REMARK: Each type of OEM application has to be approved by Dana.

### 2.2.8 Max DirRe-engage Vehicle Speed

This sets the maximum vehicle speed to allow a direction re-engage to be performed. If a direction re-engage is requested when the vehicle speed is higher than this value, the shift will be postponed until the actual speed has dropped below this limit. If it does and the request for a direction change is still detected on the shift lever, the shift will be performed if no other limitations are active.

The maximum allowed direction re-engage vehicle speed is determined by the application approval, and is intended to prevent damage to the transmission clutches (overheating and friction plate damage caused by dissipation of too much power in the direction clutches). It can therefore not be exceeded at all!
Using a lower limit might be desirable in some cases to prevent direction re-engages on the machine at speeds that might represent a dangerous situation on the machine or the direct environment.

REMARK: How the ECON.A312 reacts exactly if the shift needs to be postponed because the vehicle speed limit is exceeded, depends on the selections made as described in CHAPTER 1 – 1.8.3.

REMARK: Each type of OEM application has to be approved by Dana.

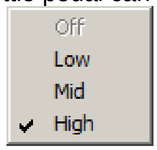
### 2.2.9 Max DirChg Engine Speed

This value limits the engine speed to perform a direction change.

Unlike the maximum vehicle speed limit, this maximum engine speed usually has not been set for transmission protection, and therefore, it is an optional limit.

### 2.2.10 Max DirChg Throttle Pedal State

Similar to the direction change speed limitations, this value limits the throttle pedal state to perform a direction change. Throttle pedal can have the state low, mid or high.




Unlike the maximum speed limitations, this limit hasn't been set for transmission protection. It is used for the driver to be forced to release the throttle pedal to a state in which the direction change is allowed.

REMARK: When a throttle pedal state is selected, this means that the state itself, and all the states below are allowed to make a direction change.

### 2.2.11 Max DirEngage Engine Speed

This value limits the engine speed to perform a direction engagement.

Unlike the maximum vehicle speed limit, this maximum engine speed usually has not been set for transmission protection, and therefore, it is an optional limit.

### 2.2.12 Max DirEngage Throttle Pedal State

Similar to the direction change speed limitations, this value limits the throttle pedal state to perform a direction engagement. Throttle pedal can have the state low, mid or high.

Unlike the maximum speed limitations, this limit hasn't been set for transmission protection. It is used for the driver to be forced to release the throttle pedal to a state in which the direction engagement is allowed.

REMARK: When a throttle pedal state is selected, this means that the state itself, and all the states below are allowed to make a direction engagement.

### 2.2.13 Max DirRe-engage Engine Speed

This value limits the engine speed to perform a direction re-engagement.

Unlike the maximum vehicle speed limit, this maximum engine speed usually has not been set for transmission protection, and therefore, it is an optional limit.

### 2.2.14 Max DirRe-engage Throttle Pedal State

Similar to the direction change speed limitations, this value limits the throttle pedal state to perform a direction re-engagement. Throttle pedal can have the state low, mid or high.

Unlike the maximum speed limitations, this limit hasn't been set for transmission protection. It is used for the driver to be forced to release the throttle pedal to a state in which the direction re-engagement is allowed.

REMARK: When a throttle pedal state is selected, this means that the state itself, and all the states below are allowed to make a direction re-engagement.

### 2.2.15 Tyre Rolling Radius

Specifies the rolling radius of the machine tyres.

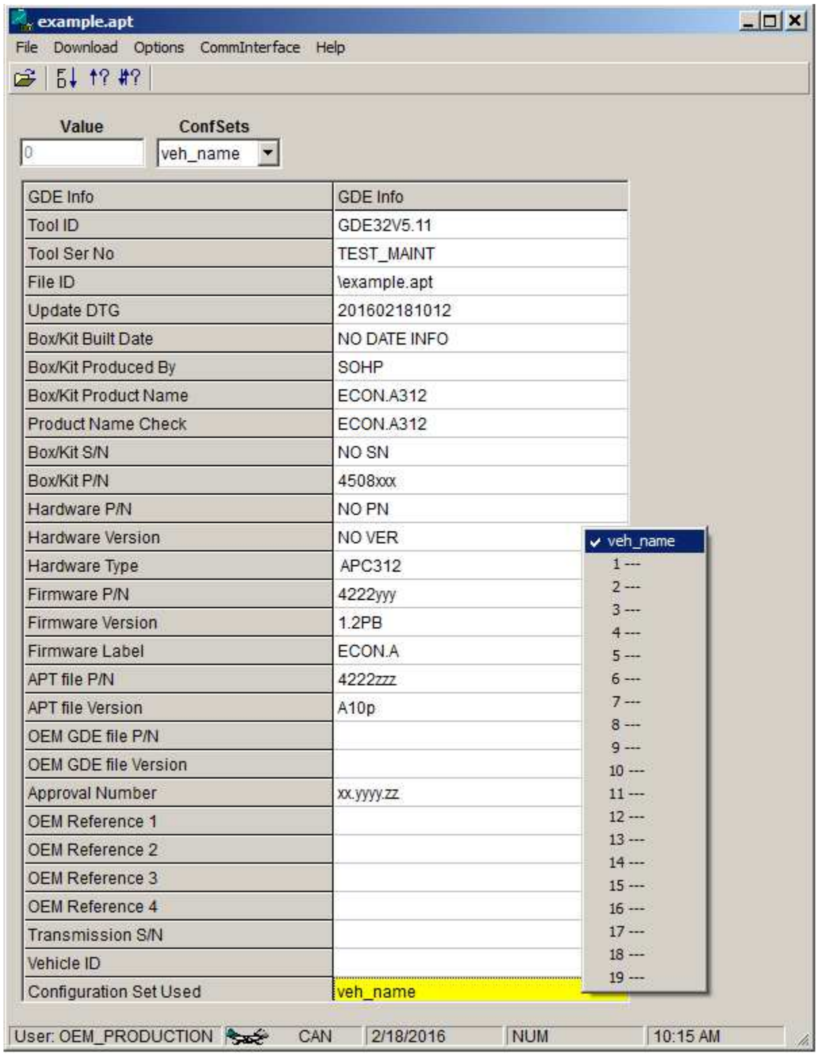
A range of different values to cover different tyre options can be specified here. However, the range of allowed values is limited. The limits on this value depend on the application approval and are determined by Dana for each application.

### 2.2.16 Axle Reduction

Specifies the axle reduction factor for the vehicle's axle.

A range of different values to cover possible different axle options can be specified here. However, the range of allowed values is limited. The limits on this value depend on the application approval and are determined by Dana for each application.

## 2.2.17 ConfigSet ID




The final relevant parameter to the configuration sets is this ConfigSet ID. It is located in the header 'GDE Info' and it selects the configuration set that will be activated each power up.
If you click this parameter value, a list automatically presents the available configuration sets as named by the parameter 'Config Name' described in paragraph 0. Selecting one will make it active after performing a download to the controller and automatically resetting the controller.

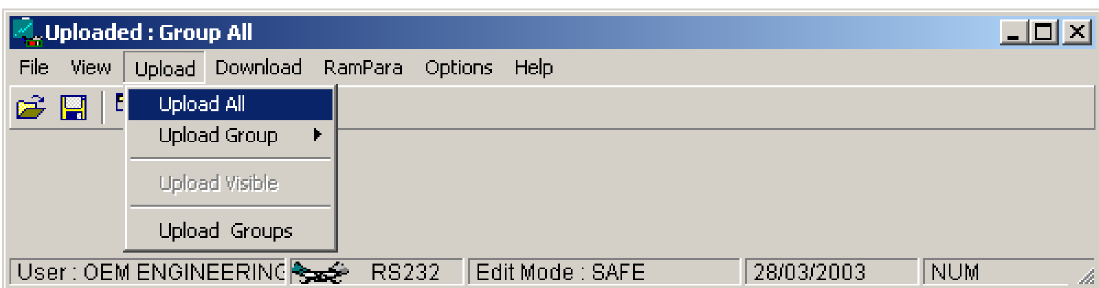
REMARK: When using CAN messages to reference a configuration set, this ConfigSet ID is represented by a corresponding index value to address the correct configuration set.

# 3 Configuration Set Management: GDE

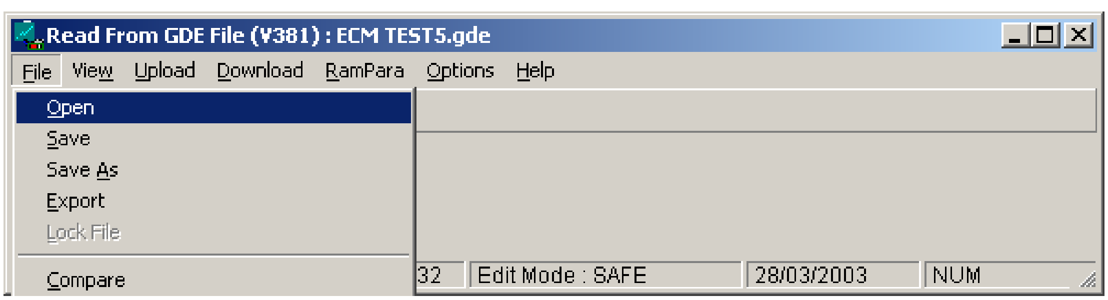
One of the ways to manage the configuration sets is by using the GDE tool. To have all the necessary access rights to change the relevant parameters, a GDE tool with OEM Engineering license is required.
This OEM Engineering level GDE tool allows the user to access and change the parameters described above.
An OEM engineer can prepare the different configuration sets in accordance to the different machines that are being produced.
Once this is performed (for a certain type of drive train, being engine and transmission), this information is saved to a specific file that will be programmed into the ECON.A312 controllers for machines with that drive train.
All information for the different configuration sets as defined by OEM engineering are downloaded into the flash memory of the ECON.A312 controller. That way a desired machine configuration can easily be selected in the production line or at an OEM service centre without having to configure a long list of parameters.
This will be possible by using a GDE with a different access level, being OEM Production.

## 3.1 Editing Config Sets with OEM Engineering GDE

When connected to an ECON.A312, using the GDE tool you can access the existing configuration settings in that controller by performing an upload.




Normally these configuration sets would be prepared in an office environment where there is not always a setup with a connected ECON.A312 available. In that case you just open an existing file that has been saved by you earlier or that you have received from Dana.




Selecting the Header 'ConfSets' presents the table where all configurations are available for editing.
You can now edit all the required parameters to create your desired machine configurations and provide an appropriate name.
These changes can be saved to a file with a name of your choice. That file will then be used in the production line to customize each machine to the correct configuration.

REMARK: after performing an upload from an ECON.A312, the GDE tool will always be in safe edit mode. This is to prevent accidental changing of parameters. If you want to change to normal editing mode for changing the configuration set parameters, simply click the key icon in the taskbar or use the Edit / Save Mode to disable this safe edit mode.

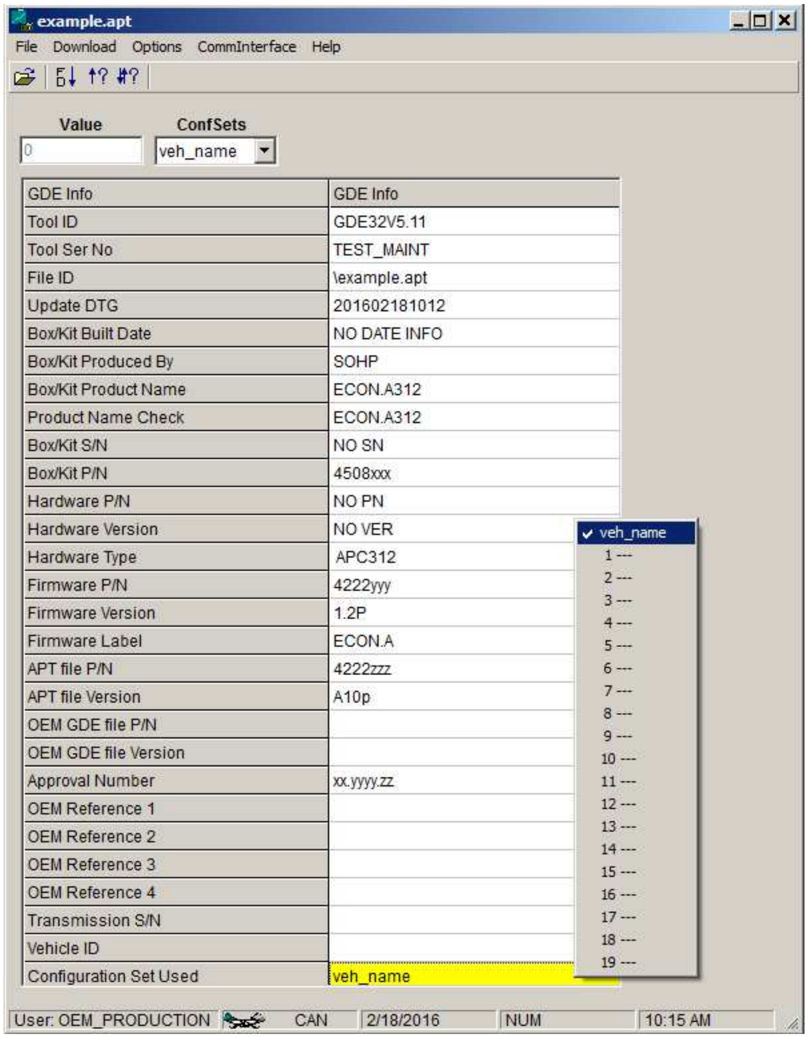
## 3.2 Managing Configuration Sets with GDE

To help avoid problems in your production line, here are some suggestions:

- For each drive train you will need 1 file where you can define different machine configurations. It is necessary to keep at least 1 file per drive train because of some specific settings and limits that are related to the approval of each drive train! Therefore it is not recommended to create machine configurations for machines with a different drive train in the same file!
- The first time you will create such a file for a drive train with a number of different configurations defined, you would best start form a file received from Dana. Alternatively you can also start from an upload on an ECON.A312 with correct settings.
- Be absolutely sure to use the GDE tool with OEM Engineering Level license!
- You will save your settings to a file with a name that is clear and non-confusing for you and your organization.
- Make sure that the names that you have specified for each configuration are reflected in the relevant. Reminder: after changing the names, download your changes into an ECON.A312, restart your GDE tool and perform an upload from that controller again. The changed names will now be reflected in all relevant fields, so you can save this to your file that you will use.
- When changes are made to the contents of the configuration sets within the file of one drive train, it is recommended to always save this to the same filename (if this is possible). This way a high number of lots of similar GDE files can be avoided, which was one of the main intentions of using configuration sets in the first place!

## 3.3 Selecting Config Sets with OEM Production GDE

At production level (and service centres if desired by OEM), the user will have an OEM Production level GDE tool. This version of the GDE tool offers a very limited view of the parameters that easily allows selecting a file and downloading it to the ECON.A312 controller.
The only parameter of the configuration sets that this production level will be able to access is the ConfigSet ID. This way it is possible to select the correct machine configuration set at the end of the production line and download it into the ECON.A312.




Apart from selecting the Configuration ID, there are 2 more parameters that can be set with this OEM Production level GDE:

- Transmission S/N: here the serial number of the transmission built into the machine being programmed can be entered. It is recommended to do this because this is valuable information for service purposes.
- Vehicle ID: this is a text parameter where any text up to 7 characters can be entered. This can be a vehicle type name, a vehicle production serial number, etc…

REMARK: All ECON.A312's are programmed with a data file when they are delivered to the OEM. By default the first configuration set (index = 0) will be activated!

## 3.4 Upload machine config with OEM Production GDE

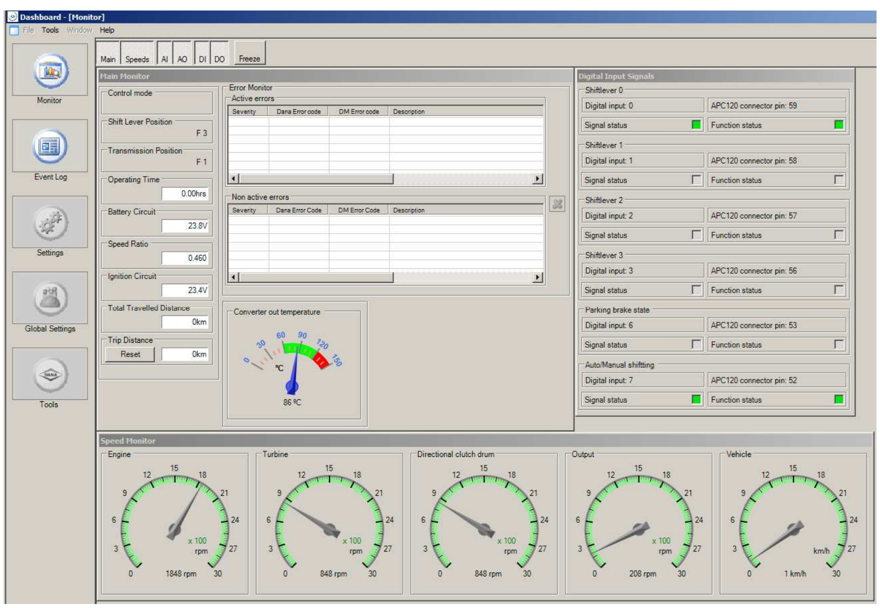
If the OEM user wants to keep track of the settings on all of the machines by logging the downloaded settings, the OEM Production level GDE tool allows to upload the data from an ECON.A312 controller and save it to a file.
It is recommended to perform this upload of the settings after the full calibration has been performed (throttle pedal, brake pedal, transmission automatic tuning). That way all the settings specific for that machine are incorporated in that file.

REMARK: After an upload has been performed using the OEM Production level GDE tool, the download option will automatically be disabled! This is done deliberately to avoid accidental downloading of machine specific calibrated data into another machine.
To enable this download option again, simply open a saved file. This way downloading becomes a conscious choice of selecting a specific desired file to download.

# 4 Configuration Set Management: Dashboard

Dana provides a PC tool called “Dashboard”, which also contains the configuration set management functionality. On top of that, Dashboard is a multi-functional tool which also provides a lot of other features:

- signal monitoring
- data logging
- error logging
- calibration interface
- integrated PC tools like APT & GDE, Firmware Flashtool,…
- 2 user levels with differentiated options available (OEM definable)
- …




***Due to its specific format, a description of Dashboard is not included directly in this user manual and is presented in a separate document. Refer to the document “Dashboard Leaflet.pdf”.***

# 5 Configuration Set Management: CAN

As an alternative (or as a supplement) to using the Dana PC tools to manage the configuration sets, there is the possibility to use CAN communication if this is available.
By sending a specific command in a CAN message to the ECON.A312 controller, an existing configuration set can be selected on the machine.
The CVC (Central Vehicle Controller) could be configured to automatically request the correct configuration set for that machine.
After a set has been selected using CAN, a controlled power down (key switch) of the machine will be necessary to make it active. It is not allowed to switch between different configuration sets while the machine is running! Refer to CHAPTER 1 – 1.5 for details.
If a configuration set has been selected and activated, all parameters available in that configurations set can also be adapted using a specific CAN message, which provides full control of the values of each parameter in the active selected configuration set.

## 5.1 Conditions for Reading and Setting Values on CAN

To be able to use the functionality of the parameters available in the configuration sets, there are some conditions.
Absolutely essential is that a valid configuration set must be selected and activated before it is possible to even just read the actual values of these parameters.
If there is a configuration set active, reading the actual values and the corresponding minimum and maximum values is possible at all times.
To write a new value to any of these parameters however, some extra conditions are to be fulfilled:

- The machine needs to be at standstill
- The shift lever needs to be in the ‘Neutral’ position
- If there is a parking brake signal available to the ECON.A312, the parking brake must be engaged

If one of these conditions is not fulfilled, this will be reported by a specific code in the acknowledgement message.

If these conditions are OK, the value of any of the available parameters can be changed by sending the correct codes in a CAN message
However, there are some extra restrictions on accepting the new value:

- the index needs to address an existing parameter in the configuration
- the new value must be within the allowed minimum to maximum range of that parameter

Again, if one of these conditions is not fulfilled, the appropriate code will be returned in the acknowledgement message.

Refer to CHAPTER 2 – 5.2 till CHAPTER 2 – 5.6 for details.

## 5.2 Selecting a Configuration Set: CVC_TO_TC_4

To select a configuration set in the ECON.A312, a CAN message is provided that is also used for reading and writing other values in the ECON.A312. Refer to CHAPTER 3 – 1.7.1.9 for details. Below this message is explained when used to select a configuration set in the ECON.A312.

### 5.2.1 CVC_TO_TC_4 defined for Configuration Set Selection

| Message Name | CVC_TO_TC_4 |
|---|---|
| Message ID | CFF23XXH<br>(XX is the Central Vehicle Controller's address) |
| Originator | Central Vehicle Controller, Service monitor |
| Repetition rate | as required |
| DLC | 8 |
| Byte 1 | 80h = Request code for configuration set selection |
| Byte 2 | 00h = read request: just read the currently active configuration set<br>01h = write request to select a specified configuration set |
| Byte 3 | Index to requested configuration set, if a write request is sent |
| Byte 4 | FFh = reserved |
| Byte 5 | FFh = reserved |
| Byte 6 | FFh = reserved |
| Byte 7 | FFh = reserved |
| Byte 8 | FFh = reserved |

### 5.2.2 CVC_TO_TC_4.Byte 2

- 00h = read request: read the currently active configuration set
- 01h = write request: select a newly specified configuration set

### 5.2.3 CVC_TO_TC_4.Byte 3

When there is a write request to select a configuration set, this is where the index to the desired configuration set is specified.
Range = 0 – 19 (20 configuration sets available in total)

REMARK: To avoid confusion and remain consequent, it is recommended to set this byte to the value FFh if there is no write request, although it has no influence at all.

### 5.2.4 ECON.A312 reply Configuration Set Selection: TC_TO_CVC_4

Each time a configuration set read or write request is sent by using the CVC_TO_TC_4 message as described above, a reply message will be sent by the ECON.A312. This is the standard reply message that is linked to the CVC_TO_TC_4 message. Refer to CHAPTER 3 -1.7.2.8 for details. Below this reply message is explained when used to read or write a configuration set index.

### 5.2.5 TC_TO_CVC_4 defined for Configuration Set Selection

| Message Name | TC_TO_CVC_4 |
|---|---|
| Message ID | 0xCFF3303<br>(0x03 is the Transmission Controller's address) |
| Originator | Central Vehicle Controller, Service monitor |
| Repetition rate | On request |
| DLC | 8 |
| Byte 1 | Echo of **CVC_TO_TC_4.Byte 1** |
| Byte 2 | Reply code to operation code of **CVC_TO_TC_4.Byte 2** |
| Byte 3 | Index of Newly Requested Configuration Set |
| Byte 4 | Index of Currently Active Configuration Set |
| Byte 5 | 0xFF = reserved |
| Byte 6 | 0xFF = reserved |
| Byte 7 | 0xFF = reserved |
| Byte 8 | 0xFF = reserved |

### 5.2.6 TC_TO_CVC_4.Byte 2

Depending on what has been requested in **CVC_TO_TC_4.Byte 2** and the result of the consequent action, this reply code can have several values:

- **echo of CVC_TO_TC_4.byte 2** (value 0x00 or 0x01) in normal situations

  Normal situations are:
  - The request was to read the actual value of the currently active configuration set
  - The request was to select a new configuration set and this new index was accepted

- **0xFF** = the index of the requested configuration set (CVC_TO_TC_4.byte 3) is invalid.

  To retry the write operation of the configuration set index, make sure that a valid index is specified.

### 5.2.7 TC_TO_CVC_4.Byte 3

Here the index value of the new requested configuration set index is shown.
There are different values possible:

- **echo of CVC_TO_TC_4.byte 3** (=requested index):

  There was a write request and the request to select a new configuration set was accepted

- **Currently active index**

  There was a read request for the currently active configuration set, or there was a write request, but the index to the requested configuration set is unvalid

- **0xFF**

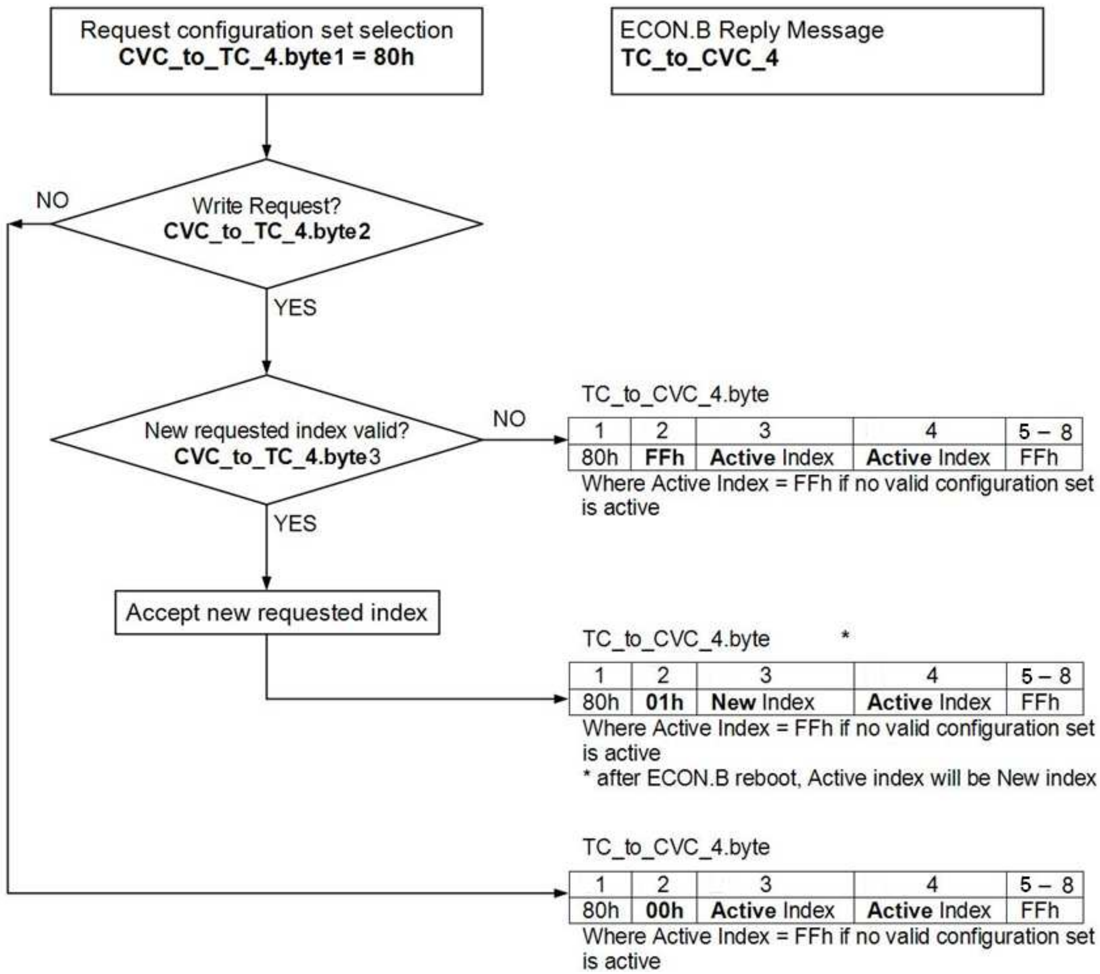
  No valid configuration set is active

### 5.2.8 TC_TO_CVC_4.Byte 4

This byte shows the index of the configuration set that is currently active.
If this shows 0xFF this means that there is no valid configuration set active.

**IMPORTANT REMARK:** When there is no write request to select a new configuration request, TC_TO_CVC4.byte3 and TC_TO_CVC4.byte4 will show the same value. When a new configuration set has been selected successfully however, TC_TO_CVC4.byte3 and TC_TO_CVC4.byte4 will show a different index value. Only after a controlled power down of the ECON.A312 (key contact) and a restart, the new configuration set will be activated! Refer to CHAPTER 1 – 1.5 for details.
This can be checked by reading the active configuration set index after power up and verifying that it corresponds to the selected one.

## 5.3 Communication Overview Selecting a Config Set



## 5.4 Reading and Writing Values: CVC_TO_TC_4

To read and write values in the parameters of the configuration sets, a CAN message is provided that is also used for reading and writing other values in the ECON.A312. Refer to CHAPTER 3 - 1.7.1.10 for details. This message is explained here when used to read and write values in the configuration set parameters.

Remark: after successful writing a new parameter value with CVC_TO_TC_4 message, the new parameter value is only effective after a clean power down and reset of the ECON.A312.
The only exception is the parameter “Max Vehicle Speed” (index 0xC2) which is immediately effective. For this parameter, no reset of the ECON.A312 is needed.

### 5.4.1 CVC_TO_TC_4 defined for Configuration Set Parameter handling

| | |
|---|---|
| Message Name | CVC_TO_TC_4 |
| Message ID | 0xCFF23XX<br>(XX is the Central Vehicle Controller’s address) |
| Originator | Central Vehicle Controller, Service monitor |
| Repetition rate | as required |
| DLC | 8 |
| Byte 1 | 0x81 = Request code for reading configuration set parameter value<br>0x86 = Request code for writing configuration set parameter value |
| Byte 2 | Index to configuration set parameter |
| Byte 3 | New value, in case the write request is active |
| Byte 4 | |
| Byte 5 | 0xFF = reserved |
| Byte 6 | 0xFF = reserved |
| Byte 7 | 0xFF = reserved |
| Byte 8 | 0xFF = reserved |

### 5.4.2 CVC_TO_TC_4.Byte 1

- 0x81 = Read the parameter value referred to by the index in byte 2. This is possible at all times, provided there is a valid configuration active.
- 0x86 = Write the new desired value (as specified byte 3-4) to the parameter referred to by the index in byte 1.

### 5.4.3 CVC_TO_TC_4.Byte 2

This byte is used to set an index to the configuration set parameter that needs to be read or written. For a detailed list of all supported index values, refer to CHAPTER 2 – 5.4.5.

## 5.4.4 CVC_TO_TC_4.Byte 3-4

When there is a write request to set a configuration set parameter to a desired value, this is where the new value needs to be specified. For a read request, this is not relevant.

Data format:
New value = byte3 + byte4 x 256
Refer to the table in 5.4.5 for specific scaling factors.

## 5.4.5 Configuration Set Parameter - Index and Format List

<table>
<tr><th>CAN Index Byte 2 (Hex)</th><th colspan="2">Configuration Set Parameter</th><th>Value Byte 3-4</th><th>Format Byte 3-4</th></tr>
<tr><td>00</td><td>DI Declutch</td><td>Signal Source</td><td rowspan="32">0=Not Used<br>1=CAN<br>2=Di0 W15<br>3=Di1 W17<br>4=Di2 W19<br>5=Di3 W21<br>6=Di4 W37<br>7=Di5 W39<br>8=Di6 W41<br>9=Di7 W43<br>10=Di8 W25<br>11=Di9 W38<br>12=Ai0 W11<br>13=Ai1 W41<br>14=Ai2 W41<br>15=Ai3 W41<br>16=Ai4 W25<br>17=Ai5 W27<br>18=Ai6 W29<br>19=Ai7 W14<br>20=Ai8 W34<br>21=Ai9 W46<br>22= Custom<br>23= - - -<br>24= - - -<br>25= - - -</td><td rowspan="32">none</td></tr>
<tr><td>01</td><td>DI Auto/Manual Mode</td><td>Signal Source</td></tr>
<tr><td>02</td><td>DI Kickdown</td><td>Signal Source</td></tr>
<tr><td>03</td><td>DI Neutral Lock Reset</td><td>Signal Source</td></tr>
<tr><td>04</td><td>DI Throttle Pedal Idle Position</td><td>Signal Source</td></tr>
<tr><td>05</td><td>DI Throttle Pedal Full Position</td><td>Signal Source</td></tr>
<tr><td>09</td><td>DI Parking Brake</td><td>Signal Source</td></tr>
<tr><td>0A</td><td>DI Loaded/Not Loaded</td><td>Signal Source</td></tr>
<tr><td>0B</td><td>DI 4WD/2WD</td><td>Signal Source</td></tr>
<tr><td>0C</td><td>DI High Low Range Selection</td><td>Signal Source</td></tr>
<tr><td>0D</td><td>DI Redundant Neutral</td><td>Signal Source</td></tr>
<tr><td>0E</td><td>DI Oil System Pressure</td><td>Signal Source</td></tr>
<tr><td>0F</td><td>DI Service Brakes</td><td>Signal Source</td></tr>
<tr><td>10</td><td>DI Operator Presence</td><td>Signal Source</td></tr>
<tr><td>11</td><td>DI Seat Orientation</td><td>Signal Source</td></tr>
<tr><td>12</td><td>DI Inhibit Shifting</td><td>Signal Source</td></tr>
<tr><td>13</td><td>DI Lockup Enable</td><td>Signal Source</td></tr>
<tr><td>14</td><td>DI Exhaust Brake</td><td>Signal Source</td></tr>
<tr><td>15</td><td>DI Retarder Brake</td><td>Signal Source</td></tr>
<tr><td>16</td><td>DI Oil Temperature</td><td>Signal Source</td></tr>
<tr><td>17</td><td>DI – Dana Reserved -</td><td>Signal Source</td></tr>
<tr><td>18</td><td>DI High Idle</td><td>Signal Source</td></tr>
<tr><td>26</td><td>DI Custom Function 1</td><td>Signal Source</td></tr>
<tr><td>27</td><td>DI Custom Function 2</td><td>Signal Source</td></tr>
<tr><td>28</td><td>DI Custom Function 3</td><td>Signal Source</td></tr>
<tr><td>29</td><td>DI Custom Function 4</td><td>Signal Source</td></tr>
<tr><td>2A</td><td>DI Custom Function 5</td><td>Signal Source</td></tr>
<tr><td>2B</td><td>DI Custom Function 6</td><td>Signal Source</td></tr>
<tr><td>2C</td><td>DI Custom Function 7</td><td>Signal Source</td></tr>
<tr><td>2D</td><td>DI Custom Function 8</td><td>Signal Source</td></tr>
<tr><td>2E</td><td>DI Custom Function 9</td><td>Signal Source</td></tr>
<tr><td>2F</td><td>DI Custom Function 10</td><td>Signal Source</td></tr>
</table>

| | | | | |
|---|---|---|---|---|
| 30 | DO Park Brake | Signal Source | 0=Not Used<br>1=CAN<br>2=Do0 W45<br>3=Do1 W56<br>4=Do2 W51<br>5=Do3 W40<br>6=Do4 W48<br>7=Do5 W44<br>8=Do6 W57<br>9=Do7 W01<br>10=Do8 W47 | none |
| 33 | DO 4WD/2WD | Signal Source | | |
| 34 | DO High Low Range | Signal Source | | |
| 35 | DO Engine Throttle Reduction | Signal Source | | |
| 36 | DO Neutral Engine Start | Signal Source | | |
| 39 | DO Lockup | Signal Source | | |
| 3A | DO Gear Dependant | Signal Source | | |
| 3B | DO Custom Function 1 | Signal Source | | |
| 3C | DO Custom Function 2 | Signal Source | | |
| 3D | DO Custom Function 3 | Signal Source | | |
| 3E | DO Custom Function 4 | Signal Source | | |
| 3F | DO Custom Function 5 | Signal Source | | |
| 40 | DI Declutch | Invert Logic? | 0 = Mo Inv Y<br>1 = Mo Inv N<br>2 = Bi Inv Y<br>3 = Bi Inv N | none |
| 41 | DI Auto/Manual Mode | Invert Logic? | | |
| 42 | DI Kickdown | Invert Logic? | | |
| 43 | DI Neutral Lock Reset | Invert Logic? | | |
| 44 | DI Throttle Pedal Idle Position | Invert Logic? | | |
| 45 | DI Throttle Pedal Full Position | Invert Logic? | | |
| 49 | DI Parking Brake | Invert Logic? | | |
| 4A | DI Loaded/Not Loaded | Invert Logic? | | |
| 4B | DI 4WD/2WD | Invert Logic? | | |
| 4C | DI High Low Range Selection | Invert Logic? | | |
| 4D | DI Redundant Neutral | Invert Logic? | | |
| 4E | DI Oil System Pressure | Invert Logic? | | |
| 4F | DI Service Brakes | Invert Logic? | | |
| 50 | DI Operator Presence | Invert Logic? | | |
| 51 | DI Seat Orientation | Invert Logic? | | |
| 52 | DI Inhibit Shifting | Invert Logic? | | |
| 53 | DI Lockup Enable | Invert Logic? | | |
| 54 | DI Exhaust Brake | Invert Logic? | | |
| 55 | DI Retarder Brake | Invert Logic? | | |
| 56 | DI Oil Temperature | Invert Logic? | | |
| 57 | DI – Dana Reserved - | Invert Logic? | | |
| 58 | DI High Idle | Invert Logic? | | |
| 66 | DI Custom Function 1 | Invert Logic? | | |
| 67 | DI Custom Function 2 | Invert Logic? | | |
| 68 | DI Custom Function 3 | Invert Logic? | | |
| 69 | DI Custom Function 4 | Invert Logic? | | |
| 6A | DI Custom Function 5 | Invert Logic? | | |
| 6B | DI Custom Function 6 | Invert Logic? | | |
| 6C | DI Custom Function 7 | Invert Logic? | | |
| 6D | DI Custom Function 8 | Invert Logic? | | |
| 6E | DI Custom Function 9 | Invert Logic? | | |
| 6F | DI Custom Function 10 | Invert Logic? | | |
| 70 | DO Park brake | Invert Logic? | | |
| 73 | DO 4WD/2WD | Invert Logic? | | |
| 74 | DO High Low Range | Invert Logic? | | |
| 75 | DO Engine Throttle Reduction | Invert Logic? | | |
| 76 | DO Neutral Engine Start | Invert Logic? | | |

| | | | | |
|---|---|---|---|---|
| 79 | DO Lockup | Invert Logic? | | |
| 7A | DO Gear Dependant | Invert Logic? | | |
| 7B | DO Custom Function 1 | Invert Logic? | | |
| 7C | DO Custom Function 2 | Invert Logic? | | |
| 7D | DO Custom Function 3 | Invert Logic? | | |
| 7E | DO Custom Function 4 | Invert Logic? | | |
| 7F | DO Custom Function 5 | Invert Logic? | | |
| 80 | DI Declutch | Default State | | |
| 81 | DI Auto/Manual Mode | Default State | | |
| 82 | DI Kickdown | Default State | | |
| 83 | DI Neutral Lock Reset | Default State | | |
| 84 | DI Throttle Pedal Idle Position | Default State | | |
| 85 | DI Throttle Pedal Full Position | Default State | | |
| 89 | DI Parking Brake | Default State | | |
| 8A | DI Loaded/Not Loaded | Default State | | |
| 8B | DI 4WD/2WD | Default State | | |
| 8C | DI High Low Range Selection | Default State | | |
| 8D | DI Redundant Neutral | Default State | | |
| 8E | DI Oil System Pressure | Default State | | |
| 8F | DI Service Brakes | Default State | | |
| 90 | DI Operator Presence | Default State | | |
| 91 | DI Seat Orientation | Default State | | |
| 92 | DI Inhibit Shifting | Default State | | |
| 93 | DI Lockup Enable | Default State | | |
| 94 | DI Exhaust Brake | Default State | | |
| 95 | DI Retarder Brake | Default State | | |
| 96 | DI Oil Temperature | Default State | | |
| 97 | DI – Dana Reserved - | Default State | | |
| 98 | DI High Idle | Default State | 0 = OFF<br>1 = ON | none |
| A6 | DI Custom Function 1 | Default State | | |
| A7 | DI Custom Function 2 | Default State | | |
| A8 | DI Custom Function 3 | Default State | | |
| A9 | DI Custom Function 4 | Default State | | |
| AA | DI Custom Function 5 | Default State | | |
| AB | DI Custom Function 6 | Default State | | |
| AC | DI Custom Function 7 | Default State | | |
| AD | DI Custom Function 8 | Default State | | |
| AE | DI Custom Function 9 | Default State | | |
| AF | DI Custom Function 10 | Default State | | |
| B0 | DO Park Brake | Default State | | |
| B3 | DO 4WD/2WD | Default State | | |
| B4 | DO High Low Range | Default State | | |
| B5 | DO Engine Throttle Reduction | Default State | | |
| B6 | DO Neutral Engine Start | Default State | | |
| B9 | DO Lockup | Default State | | |
| BA | DO Gear Dependant | Default State | | |
| BB | DO Custom Function 1 | Default State | | |
| BC | DO Custom Function 2 | Default State | | |
| BD | DO Custom Function 3 | Default State | | |
| BE | DO Custom Function 4 | Default State | | |

| | | | | |
|---|---|---|---|---|
| BF | DO Custom Function 5 | Default State | | |
| C0 | Max Dir Chg Engine Speed | Value | limited value | rpm |
| C1 | Max Dir Chg/Eng Vehicle Speed | Value | limited value | kph x 256 |
| C2 | Max Vehicle Speed | Value | limited value | kph x 256 |
| C3 | Max Dir Eng Engine Speed | Value | limited value | rpm |
| C4 | Max Dir Reeng Engine Speed | Value | limited value | rpm |
| C5 | Max Dir Reeng Vehicle Speed | Value | limited value | kph x 256 |
| C6 | Dir Chg Throttle Pos Allowed | Value | Throttle pedal State | none |
| C7 | Dir Eng Throttle Pos Allowed | Value | | |
| C8 | Dir Reeng Throttle Pos Allowed | Value | | |
| D1 | DO Custom Function 1 | Function | 0 = Not Used<br>1 = Sp Dep 1<br>2 = Sp Dep 2<br>3 = Sp Dep 3<br>4 = RevAlert<br>5 = PTO/PTI<br>6 = PTI Ena<br>7 = DM Brake<br>8 = Warn 1<br>9 = Warn 2<br>10 = Warn 3<br>11 – 255 = - - - | |
| D2 | DO Custom Function 2 | Function | | |
| D3 | DO Custom Function 3 | Function | | |
| D4 | DO Custom Function 4 | Function | | |
| D5 | DO Custom Function 5 | Function | | |
| D6 | DI Custom Function 1 | Function | | |
| D7 | DI Custom Function 2 | Function | | |
| D8 | DI Custom Function 3 | Function | | |
| D9 | DI Custom Function 4 | Function | | |
| DA | DI Custom Function 5 | Function | | |
| DB | DI Custom Function 6 | Function | | |
| DC | DI Custom Function 7 | Function | | |
| DD | DI Custom Function 8 | Function | | |
| DE | DI Custom Function 9 | Function | | |
| DF | DI Custom Function 10 | Function | | |
| E0 | Tyre Rolling Radius | Value | limited value | m x 1024 |
| E1 | Axle Reduction | Value | limited value | ratio x 100 |
| E2 | Shift lever | Type | 0 = Not used<br>1 = Standard<br>2 = Bump type<br>3 = CAN type<br>4 = Combined<br>5 = FR type | none |
| E3 | Dana Reserved | Type | Not applicable | Not applicable |
| E4 | DI Limit Gearpos | Type | 0 = Not used<br>1 = Wired<br>2 = CAN type | none |
| F0 | AI Throttle Pedal | Signal Source | 0 = Not Used<br>1 = CAN EDI<br>2 = Ai0 W09<br>3 = Ai1 W11<br>4 = Ai2 W29<br>5 = Ai3 W31<br>6 = Ai4 W10<br>7 = Ai5 W16<br>8 = Ai6 W18<br>9 = Ai7 W30<br>10 = Ai8 W34<br>11 = Ai9 W46<br>12 = Ri0 W22<br>13 = Ri1 W58 | none |
| F1 | AI Brake Pedal | Signal Source | | |

## 5.5 ECON.A312 reply Parameter Read/Write Request: TC_TO_CVC_4

Each time a parameter read or write request is sent by using the CVC_TO_TC_4 message as described above, a reply message is sent by the ECON.A312. This is the standard reply message that is linked to the CVC_TO_TC_4 message. Refer to CHAPTER 3 – 1.7.2.9 for details. This reply message is explained here when used to read and write values in the configuration set parameters.

### 5.5.1 TC_TO_CVC_4 defined for Configuration Set Parameter handling

| Message Name | TC_TO_CVC_4 |
|---|---|
| Message ID | 0xCFF3303<br>(0x03 is the Transmission Controller's address) |
| Originator | Central Vehicle Controller, Service monitor |
| Repetition rate | On request |
| DLC | 8 |
| Byte 1 | Echo of **CVC_TO_TC_4.Byte 1** |
| Byte 2 | Reply code to operation code of **CVC_TO_TC_4.Byte 2** |
| Byte 3 | Active Configuration Set Parameter Value |
| Byte 4 | |
| Byte 5 | Minimum Allowed Configuration Set Parameter Value |
| Byte 6 | |
| Byte 7 | Maximum Allowed Configuration Set Parameter Value |
| Byte 8 | |

### 5.5.2 TC_TO_CVC_4.Byte 2

Depending on what has been requested in **CVC_TO_TC_4.Byte 2** and the result of the consequent action, this reply code can have several values:

- **echo of CVC_TO_TC_4.byte2** in normal situations ( **0x00** to **0xF1** )

  Normal situations are:
  - The request was to read the actual value of a valid configuration set parameter
  - The request was to write a new value to a configuration set parameter and this new value was accepted and the operation completed successfully.

- **0xFB** = a request to write a new value to a configuration set parameter was sent, but the machine conditions to allow this where not fulfilled! These machine conditions are the ones described in CHAPTER 2 – 5.1.

  To retry the write operation of the configuration set parameter, make sure that these conditions are fulfilled first.

- **0xFD** = a request to write a new value to a configuration set parameter was sent but the value was not accepted because it is not within the allowed range!

  Make sure to specify a value within the allowed range. Refer to CHAPTER 2 – 5.5.4 and 5.5.5 for details about the minimum and maximum values.

- **0xFE** = a request was made containing a non-existing index to a configuration set parameter. Make sure to use only supported index values. Refer to CHAPTER 2 – 5.4.5 for details.

### 5.5.3 TC_TO_CVC_4.Byte 3-4: Active Value

Here the active value for the configuration set parameter is reported. The data format is identical to the format in CVC_TO_TC_4.Byte3-4.

Data format:

Active value = Byte3 + Byte4 x 256

When a write request was sent, the active value will be the new requested value in case the new value was accepted.
Identical to requested values in CVC_TO_TC_4.Byte3-4, refer to the table in CHAPTER 2 – 5.4.5 for specific scaling factors.

REMARK: When a problem results in having no value to return at all, TC_TO_CVC_4.Byte3-4 contains 0xFFFF. This is the case with TC_TO_CVC_4.Byte2 being 0xFE.

### 5.5.4 TC_TO_CVC_4.Byte 5-6: Minimum Value

In an identical format to TC_TO_CVC_4.Byte 3-4, these bytes contain the minimum allowed value for the referred configuration set parameter.

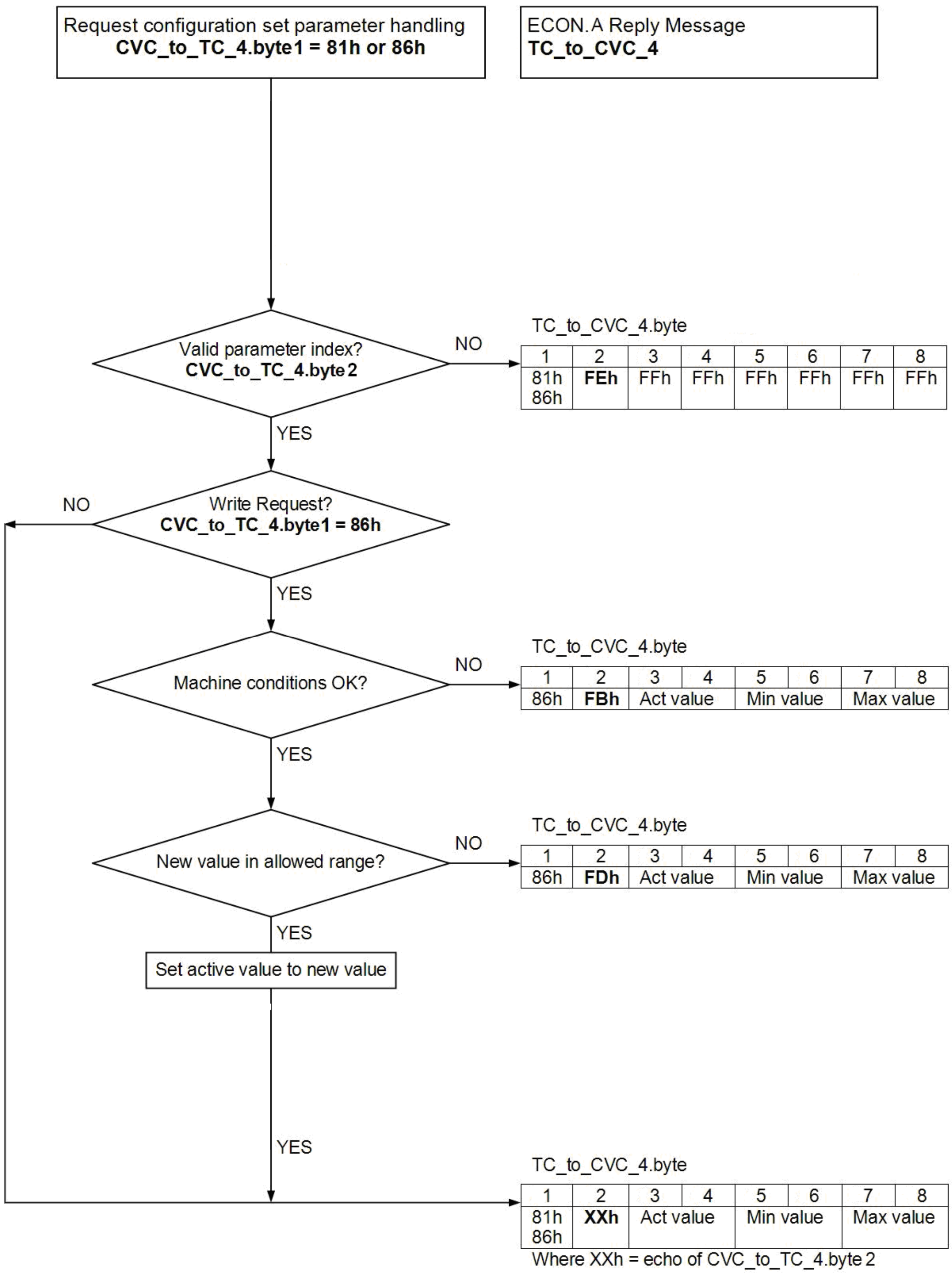
REMARK: When a problem results in having no value to return at all, TC_TO_CVC_4.byte5-6 contains 0xFFFF. This is the case with TC_TO_CVC_4.Byte2 being 0xFE.

### 5.5.5 TC_TO_CVC_4.Byte 7-8: Maximum Value

In an identical format to TC_TO_CVC_4.Byte 3-4, these bytes contain the minimum allowed value for the referred configuration set parameter.

REMARK: When a problem results in having no value to return at all, TC_TO_CVC_4.Byte7-8 contains 0xFFFF. This is the case with TC_TO_CVC_4.byte2 being 0xFE.

## 5.6 Communication Overview Config Set Parameters



# 5.7 Managing Configuration Sets with CAN

## 5.7.1 Selecting a configuration set

As mentioned in the description above, the first thing to do is select a valid configuration and activate it.
Considering the CAN communication protocol to select a configuration set, the following sequence is an example of how this could be done.

- Determine what configuration index is required. This can be an input from a user interface device or can be coded in the vehicle software.
- At power up of the machine, first read the currently active configuration set by sending CVC_TO_TC_4 with Byte1 = 0x80 and Byte2 = 0x00. Refer to CHAPTER 2 – 5.2 for details.
- Check if the active configuration set index matches the required one. If it does, then there is nothing more to do.
- If the active configuration set index does not match the required one, send a request to select the index that you need by sending CVC_TO_TC_4 with Byte1 = 0x80, Byte2 = 0x01 and Byte2 containing the requested index (see details above). Remember to check the ECON.A312 reply (TC_TO_CVC_4) to confirm that the new requested index has indeed been accepted!
- Signal a request for a controlled power down, if possible with some indication as to why the power down is needed (on a display, perhaps). Refer to CHAPTER 1 – 1.5 for details.
- After rebooting the machine, the new selected configuration set index will be activated and the check at power up will see that the correct configuration has been activated, so no further action is necessary.

REMARK: All ECON.A312's are programmed with a data file when they are delivered to the OEM. By default the first configuration set (index = 0) will be activated!

## 5.7.2 Editing configuration set parameters

Once a configuration set is selected and activated, you might want to read and/or change the settings of certain parameters available in that configuration set.
Below is a suggestion for when a user interface device like a menu driven display would be used to manage setting of parameters on a machine. Please use the representation in CHAPTER 2 – 5.6 for a schematic overview of the read and/or write operation of a configuration set parameter.
A general guideline to use the CAN communication to manage these settings is the following:

- Determine which parameters of the available parameters in the configuration sets you want to set (this could be all available).
- For these parameters read the actual values, mainly to get the minimum and maximum allowed values for this parameter. This reading of the desired values can happen in a loop where the index is incremented at each new request. The rate at which the messages follow each other in sequence will be determined by the loop time to send the request and interpret the ECON.A312 reply. However, a minimum interval of 100 ms between 2 messages is recommended.
- Once the desired parameter values have been read, the user could change any of these parameters within the allowed range for each of these parameters. Each time the user enters a new value, the corresponding write request CAN message can be sent to the ECON.A312.

- It is strongly recommended to check if the new selected value for the parameter has indeed been accepted by interpreting the ECON.A312 reply message. If this reply is not used as an acknowledgement for the write request, it could occur that a requested value is not accepted for some reason. This would result in a behavior on the machine not corresponding to what the user thought had been selected!
- For automatic setting of specific parameters at power up of the machine, an automatic loop could be programmed in the vehicle control software. This could check the actual value of some parameters, check it to a desired value and if these do not correspond, the desired value can be written. Again make sure to interpret the ECON.A312 reply message to see if the newly requested value was accepted.
- The specific codes in the ECON.A312 reply messages can be used to notify the user through a display if there would be a problem with accepting any desired value, so the appropriate action can be taken.
- IMPORTANT: Remember that even after successfully writing new values to these parameters of the configuration, they will only be activated after a reboot of the ECON.A312 (a restart of the machine). Also note that the engine of the machine does not have to be running to set new values to these parameters, so just turning the key contact on is sufficient to manage the desired transmission parameters.

# CHAPTER 3 : ECON.A312 CAN EDI Protocol Description

# 1 General

## 1.1 Proprietary messages vs standard messages

Where possible, the standard messages provided by the SAE J1939 standard are used. However, a lot of transmission application specific information is not provided in any of the standard messages.
The J1939 standard leaves room to implement proprietary messages. In these proprietary messages, information that is not available in the standard messages can be implemented upon need/desire. Dana has implemented a number of proprietary messages.
Within these Dana proprietary messages, the normal rules of the J1939 regarding parameter ranges etc. are respected whenever possible.

*REMARK: to keep the bus load to a minimum, sometimes these proprietary messages can contain information that is also available in different standard messages. By grouping data that is not provided in standard messages together with data that is available in J1939 standard messages into these proprietary messages, the number of necessary messages could be reduced to a minimum. Otherwise the necessary information would be scattered over a significantly higher amount of messages, increasing the complexity and load on the CAN bus.*

## 1.2 Proprietary messages PGN

The PGN's used for the Dana proprietary messages are specified in the message definitions on the following pages. These PGN's are the default PGN's programmed in the ECON.A312. However, the SAE J1939 has no rules on how the PGN's available for proprietary use, should be used by different manufacturers. For this reason, there is always the possibility of conflict when 2 or more different manufacturers use the same PGN for proprietary messages. In case of such a conflict, Dana will investigate the feasibility of using an alternative PGN in agreement with the OEM and/or other manufacturers involved. If feasible, Dana will implement an alternative PGN.

## 1.3 Repetition rate

For each message listed below, the repetition rate of the message is set to the default recommended value. However, specific applications might require a different repetition rate for certain proprietary or standard messages. In this case, Dana will investigate the feasibility of changing the repetition rate in agreement with the OEM and/or other manufacturers involved. If feasible, Dana will implement a different repition rate.

## 1.4 Message priority

For each message listed below, the priority in the message identifier is set to the default recommended value. However, specific applications might require a different priority for certain proprietary or standard messages. In this case, Dana will investigate the feasibility of using another priority in agreement with the OEM and/or other manufacturers involved. If feasible, Dana will give the concerned message(s) a different priority.

## 1.5 Proprietary messages from Central Vehicle Controller (CVC) to Transmission Controller (TC)

### 1.5.1 CVC_TO_TC_1: Standard remote transmission control

**Message identifier: 0xCFF20xx (Hex)  (CAN 2.0 B →29 bit identifier)**

| Priority code + $R_{bit (= 0)}$ + $DP_{bit (= 0)}$ | Message ID | Address sender |
|---|---|---|
| **C** (Hex) = **01100** (Bin) → **Priority = 3** (Dec) | **0xFF20** (Hex) = **65312** (Dec) | Example: **0x27** (Hex) = **39** (Dec) |

**Originator:** CVC = Central Vehicle Controller
**Repetition rate:** 20 msec
**Timeout:** 500 msec
**DLC:** 8

| | | Value | Detail |
|---|---|---|---|
| Byte 1 | Bit 1.1<br>Bit 1.2 | Direction selection | **Shift lever position** (if not used: all bits should be 1)<br>Bit 1.2 Bit 1.1<br>0 0 : neutral<br>0 1 : forward<br>1 0 : reverse<br>1 1 : reserved |
| | Bit 1.3<br>…<br>Bit 1.6 | Range Selection | Bit 1.6 Bit 1.5 Bit 1.4 Bit 1.3<br>0 0 0 1 : 1st<br>0 0 1 0 : 2nd<br>0 0 1 1 : 3rd<br>0 1 0 0 : 4th<br>0 1 0 1 : 5th<br>0 1 1 0 : 6th<br>0 1 1 1 : 7th<br>1 0 0 0 : 8th<br>All other bitpatterns are reserved |
| | Bit 1.7<br>Bit 1.8 | Fault state of shift lever | Bit 1.8 Bit 1.7<br>0 0 : no fault detected on shift lever<br>0 1 : fault detected on shift lever (neutral will be forced)<br>1 0 : reserved (neutral will be forced)<br>1 1 : function not supported over CAN |
| Byte 2 | Bit 2.1<br>Bit 2.2 | Declutch Request | **Declutch** (if not used: all bits should be 1)<br>Bit 2.2 Bit 2.1<br>0 0 : no declutch request<br>0 1 : declutch request<br>1 0 : reserved<br>1 1 : function not supported over CAN |
| | Bit 2.3<br>Bit 2.4 | Parking Brake status<br>or<br>Parking Brake request | **Parking brake** (if not used: all bits should be 1)<br>Bit 2.4 Bit 2.3<br>0 0 : parking brake status is “off” / no parking brake request<br>0 1 : parking brake status is “on” / parking brake request<br>1 0 : reserved<br>1 1 : function not supported oven CAN |
| | Bit 2.5<br>Bit 2.6 | Neutral lock reset request | **Neutral lock reset** (if not used: all bits should be 1)<br>Bit 2.6 Bit 2.5<br>0 0 : no neutral lock reset request<br>0 1 : neutral lock reset request<br>1 0 : reserved<br>1 1 : function not supported over CAN |

| | | | |
|---|---|---|---|
| | Bit 2.7<br>Bit 2.8 | Operator present status | **Operator present** (if not used: all bits should be 1)<br>Bit 2.8 Bit 2.7<br>0 0 : operator is NOT present<br>0 1 : operator is present<br>1 0 : reserved<br>1 1 : function not supported over CAN |
| Byte 3 | Bit 3.1<br>…<br>Bit 3.4 | Not used | **Reserved**<br>Bits 3.1 … 3.4 must be = $1111_{(Bin)}$ |
| | Bit 3.5<br>Bit 3.6 | Automatic / manual mode selection | **Auto/manual mode selection** (if not used: all bits should be 1)<br>Bit 3.6 Bit 3.5<br>0 0 : manual mode selection<br>0 1 : automatic mode selection<br>1 0 : reserved<br>1 1 : function not supported over CAN |
| | Bit 3.7<br>Bit 3.8 | Loaded / Not Loaded status | **Loaded/not loaded** (if not used: all bits should be 1)<br>Bit 3.8 Bit 3.7<br>0 0 : vehicle is not loaded = empty<br>0 1 : vehicle is loaded<br>1 0 : reserved<br>1 1 : function not supported over CAN |
| Byte 4 | Bit 4.1<br>Bit 4.2 | Kickdown request | **Kickdown** (if not used: all bits should be 1)<br>Bit 4.2 Bit 4.1<br>0 0 : no kickdown request<br>0 1 : kickdown request<br>1 0 : reserved<br>1 1 : function not supported over CAN |
| | Bit 4.3<br>Bit 4.4 | 4WD/2WD request | **4WD/2WD** (if not used: all bits should be 1)<br>Bit 4.4 Bit 4.3<br>0 0 : 2WD request<br>0 1 : 4WD request<br>1 0 : reserved<br>1 1 : function not supported over CAN |
| | Bit 4.5<br>Bit 4.6 | Not used | **Reserved**<br>Bits 4.5 and 4.6 must be = $11_{(Bin)}$ |
| | Bit 4.7<br>Bit 4.8 | Inhibit Shifting enable/disable request | **Inhibit shifting** (if not used: all bits should be 1)<br>Bit 4.8 Bit 4.7<br>0 0 : inhibit shifting disable request<br>0 1 : inhibit shifting enable request<br>1 0 : reserved<br>1 1 : function not supported over CAN |

| | | | |
|---|---|---|---|
| Byte 5 | Bit 5.1<br>Bit 5.2 | Seat console orientation | **Seat orientation** (if not used: all bits should be 1)<br>Bit 5.2 Bit 5.1<br>0 0 : seat console orientated in normal position<br>0 1 : seat console orientated in inverted position<br>1 0 : reserved<br>1 1 : function not supported over CAN |
| | Bit 5.3<br>Bit 5.4 | Not used | **Reserved**<br>Bits 5.3 and 5.4 must be = $11_{(Bin)}$ |
| | Bit 5.5<br>Bit 5.6 | Throttle pedal position: idle/not idle | **Throttle pedal idle/not idle** (if not used: all bits should be 1)<br>Bit 5.6 Bit 5.5<br>0 0 : throttle pedal not idle<br>0 1 : throttle pedal idle<br>1 0 : reserved<br>1 1 : function not supported over CAN |
| | Bit 5.7<br>Bit 5.8 | Throttle pedal position: full/half throttle | **Throttle pedal full/not Full** (if not used: all bits should be 1)<br>Bit 5.8 Bit 5.7<br>0 0 : throttle pedal in half throttle position<br>0 1 : throttle pedal in full throttle position<br>1 0 : reserved<br>1 1 : function not supported over CAN |
| Byte 6 | Bit 6.1<br>Bit 6.2 | Lockup enable (auto lockup)<br>or<br>lockup request (manual lockup) | **Lockup enable or lockup request** (if not used: all bits should be 1)<br>Bit 6.2 Bit 6.1<br>0 0 : lockup disabled / no lockup request<br>0 1 : lockup enabled / lockup request<br>1 0 : reserved<br>1 1 : function not supported over CAN |
| | Bit 6.3<br>Bit 6.4 | High engine idle request | **High engine idle request** (if not used: all bits should be 1)<br>Bit 6.4 Bit 6.3<br>0 0 : no high engine idle request<br>0 1 : high engine idle request<br>1 0 : reserved<br>1 1 : function not supported over CAN |
| | Bit 6.5<br>Bit 6.6 | High/low range request | **High/low range request** (if not used: all bits should be 1)<br>Bit 6.6 Bit 6.5<br>0 0 : low range request<br>0 1 : high range request<br>1 0 : reserved<br>1 1 : function not supported over CAN |
| | Bit 6.7<br>Bit 6.8 | Not used | **Reserved**<br>Bits 6.7 and 6.8 must be = $11_{(Bin)}$ |

<table>
<tr><td rowspan="4">Byte 7</td><td>Bit 7.1<br>Bit 7.2</td><td>System pressure status</td><td><u>System pressure status</u> (if not used: all bits should be 1)<br><u>Bit 7.2</u> <u>Bit 7.1</u><br>0 0 : system pressure too low<br>0 1 : system pressure ok<br>1 0 : reserved<br>1 1 : function not supported over CAN</td></tr>
<tr><td>Bit 7.3<br>Bit 7.4</td><td>Service brakes pressed or released</td><td><u>Service brakes pressed/released</u><br>(if not used: all bits should be 1)<br><u>Bit 7.4</u> <u>Bit 7.3</u><br>0 0 : service brakes released<br>0 1 : service brakes pressed<br>1 0 : reserved<br>1 1 : function not supported over CAN</td></tr>
<tr><td>Bit 7.5<br>Bit 7.6</td><td>Not used</td><td><u>Reserved</u><br>Bits 7.5 and 7.6 must be = $11_{(Bin)}$</td></tr>
<tr><td>Bit 7.7<br>Bit 7.8</td><td>Converter out temperature status</td><td><u>Converter out temperature status</u><br>(if not used: all bits should be 1)<br><u>Bit 7.8</u> <u>Bit 7.7</u><br>0 0 : converter out temperature ok<br>0 1 : converter out temperature too high (> 120°C)<br>1 0 : reserved<br>1 1 : function not supported over CAN</td></tr>
<tr><td rowspan="3">Byte 8</td><td>Bit 8.1<br>Bit 8.2</td><td>Exhaust brake status</td><td><u>Exhaust brake status</u> (if not used: all bits should be 1)<br><u>Bit 8.2</u> <u>Bit 8.1</u><br>0 0 : exhaust brake not active<br>0 1 : exhaust brake active<br>1 0 : reserved<br>1 1 : function not supported over CAN</td></tr>
<tr><td>Bit 8.3<br>Bit 8.4</td><td>Retarder status</td><td><u>Retarder status</u> (if not used: all bits should be 1)<br><u>Bit 8.4</u> <u>Bit 8.3</u><br>0 0 : retarder not active<br>0 1 : retarder active<br>1 0 : reserved<br>1 1 : function not supported over CAN</td></tr>
<tr><td>Bit 8.5<br>…<br>Bit 8.8</td><td>Not Used</td><td><u>Reserved</u><br>Bits 8.5 … 8.8 must be = $1111_{(Bin)}$</td></tr>
</table>

## 1.5.2 CVC_TO_TC_2: Optional remote transmission control 1

**Message identifier: 0xCFF21xx $_{(Hex)}$ (CAN 2.0 B → 29 bit identifier)**

| Priority code + $R_{bit\,(=0)}$ + $DP_{bit\,(=0)}$ | Message ID | Address sender |
|---|---|---|
| **C** $_{(Hex)}$ **= 01100** $_{(Bin)}$ **→ Priority = 3** $_{(Dec)}$ | **0xFF21** $_{(Hex)}$ **= 65313** $_{(Dec)}$ | Example: **0x27** $_{(Hex)}$ **= 39** $_{(Dec)}$ |

**Originator:** **CVC = Central Vehicle Controller**
**Repetition rate:** **20 msec**
**Timeout:** **500 msec**
**DLC:** **8**

<table>
<tr><th></th><th></th><th>Value</th><th>Detail</th></tr>
<tr><td>Byte 1</td><td>Bit 1.1<br>…<br>Bit 1.8</td><td>Throttle pedal position feedback</td><td><u>Throttle pedal position</u> (if not used : all bits should be 1)<br>Conversion: throttle pedal position = (Byte 1) x 0.4 [%]<br>0 = 0 %<br>250 = 100 %<br>254 = fault related to throttle pedal position sensing<br>255 = measurement not supported</td></tr>
<tr><td>Byte 2</td><td>Bit 2.1<br>…<br>Bit 2.8</td><td>Brake pedal position feedback</td><td><u>Brake pedal position</u> (if not used : all bits should be 1)<br>Conversion: brake pedal position = (Byte 2) x 0.4 [%]<br>0 = 0 %<br>250 = 100 %<br>254 = fault related to brake pedal position sensing<br>255 = measurement not supported</td></tr>
<tr><td>Byte 3</td><td>Bit 3.1<br>…<br>Bit 3.8</td><td>Not Used</td><td><u>Reserved</u><br>Bits 3.1 … 3.8 must be = 1111 1111$_{(Bin)}$ = 0xFF</td></tr>
<tr><td>Byte 4</td><td>Bit 4.1<br>…<br>Bit 4.8</td><td>Block out highest gear(s)</td><td><u>Block out highest gear(s)</u> (if not used : all bits should be 1)<br>Bit 4.1 … bit 4.6 define the maximum range gear that is allowed for every direction (forward, neutral and reverse).<br><br>Example:
<table>
<tr><th colspan="6">Bit</th><th colspan="3">Maximum allowed range gear</th></tr>
<tr><td>4.6</td><td>4.5</td><td>4.4</td><td>4.3</td><td>4.2</td><td>4.1</td><td>F</td><td>N</td><td>R</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>4</td><td>4</td><td>4</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>3</td><td>3</td><td>3</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>3</td><td>3</td><td>1</td></tr>
</table>
<u>REMARK</u>: The above table is only an example. The OEM can choose the definition of the different bit-patterns and related “maximum allowed range gear”.<br><br>
<table>
<tr><th><u>Bit 4.8</u></th><th><u>Bit 4.7</u></th><th></th></tr>
<tr><td>0</td><td>0</td><td>: no fault in the block out highest gear(s) pattern</td></tr>
<tr><td>0</td><td>1</td><td>: fault detected the block out highest gear(s) pattern</td></tr>
<tr><td>1</td><td>0</td><td>: reserved</td></tr>
<tr><td>1</td><td>1</td><td>: function not supported over CAN</td></tr>
</table></td></tr>
</table>

<table>
<tr><td rowspan="2">Byte 5</td><td>Bit 5.1<br>Bit 5.2</td><td>PTO/PTI enable/ disable request</td><td><u>PTO/PTI</u> (if not used : all bits should be 1)<br><u>Bit 5.2</u> <u>Bit 5.1</u><br>0 0 : PTO or PTI disable request<br>0 1 : PTO or PTI enable request<br>1 0 : reserved<br>1 1 : function not supported over CAN</td></tr>
<tr><td>Bit 5.3<br>…<br>Bit 5.8</td><td>Dead man control</td><td><u>Dead man control</u> (if not used : all bits should be 1)<br><u>Dead man front pedal</u><br><u>Bit 5.4</u> <u>Bit 5.3</u><br>0 0 : dead man front pedal not applied<br>0 1 : dead man front pedal applied<br>1 0 : reserved<br>1 1 : function not supported over CAN<br><br><u>Dead man rear pedal</u><br><u>Bit 5.6</u> <u>Bit 5.5</u><br>0 0 : dead man rear pedal not applied<br>0 1 : dead man rear pedal applied<br>1 0 : reserved<br>1 1 : function not supported over CAN<br><br><u>Dead man reset request</u><br><u>Bit 5.8</u> <u>Bit 5.7</u><br>0 0 : no dead man reset request<br>0 1 : dead man reset request<br>1 0 : reserved<br>1 1 : function not supported over CAN</td></tr>
<tr><td>Byte 6<br>Byte 7<br>Byte 8</td><td>Bit 6.1<br>…<br>Bit 8.8</td><td>Not Used</td><td><u>Reserved</u><br>Bits 6.1 … 6.8 must be = 1111 $1111_{(Bin)}$ = 0xFF<br>Bits 7.1 … 7.8 must be = 1111 $1111_{(Bin)}$ = 0xFF<br>Bits 8.1 … 8.8 must be = 1111 $1111_{(Bin)}$ = 0xFF</td></tr>
</table>

### 1.5.3 CVC_TO_TC_3: optional remote transmission control 2

**Message identifier: 0xCFF22xx (Hex)** **(CAN 2.0 B → 29 bit identifier)**

| Priority code + $R_{bit\,(=0)}$ + $DP_{bit\,(=0)}$ | Message ID | Address sender |
|---|---|---|
| **C** (Hex) **= 01100** (Bin) **→ Priority = 3** (Dec) | **0xFF22** (Hex) **= 65314** (Dec) | Example: **0x27** (Hex) **= 39** (Dec) |

**Originator:** **CVC = Central Vehicle Controller**
**Repetition rate:** **20 msec**
**Timeout:** **500 msec**
**DLC:** **8**

| | | Value | Detail |
|---|---|---|---|
| Byte 1 | Bit 1.1<br>Bit 1.2 | Redundant safety neutral request | **Redundant Safety Neutral**<br>(if not used : all bits should be 1)<br>Bit 1.2 Bit 1.1<br>0 0 : no redundant safety neutral request<br>0 1 : redundant safety neutral request<br>1 0 : reserved (will also result in a safety neutral request)<br>1 1 : function not supported over CAN (will also result in a safety neutral request)<br>REMARK: this is a redundant signal to request neutral seperately from the normal shift lever signal (for safety reasons). |
| | Bit 1.3<br>…<br>Bit 1.8 | Not used | **Reserved**<br>Bits 1.3 … 1.8 must be = 1111 11(Bin) |
| Byte 2<br>Byte 3<br>Byte 4<br>Byte 5<br>Byte 6<br>Byte 7<br>Byte 8 | Bit 2.1<br>…<br>Bit 8.8 | Not used | **Reserved**<br>Bits 2.1 … 2.8 must be = 1111 1111(Bin) = 0xFF<br>Bits 3.1 … 3.8 must be = 1111 1111(Bin) = 0xFF<br>Bits 4.1 … 4.8 must be = 1111 1111(Bin) = 0xFF<br>Bits 5.1 … 5.8 must be = 1111 1111(Bin) = 0xFF<br>Bits 6.1 … 6.8 must be = 1111 1111(Bin) = 0xFF<br>Bits 7.1 … 7.8 must be = 1111 1111(Bin) = 0xFF<br>Bits 8.1 … 8.8 must be = 1111 1111(Bin) = 0xFF |

# 1.6 Proprietary messages from Transmission Controller (TC) to Central Vehicle Controller (CVC)

## 1.6.1 TC_TO_CVC_1: Standard transmission info

**Message identifier: 0xCFF3003 (Hex) (CAN 2.0 B → 29 bit identifier)**

| Priority code + $R_{bit\ (=0)}$ + $DP_{bit\ (=0)}$ | Message ID | Address sender |
|---|---|---|
| **C (Hex) = 01100 (Bin) → Priority = 3 (Dec)** | **0xFF30 (Hex) = 65328 (Dec)** | **0x03 (Hex) = 3 (Dec)** |

**Originator:** **ECON.A312**
**Repetition rate:** **20 msec**
**DLC:** **8**

| | | Value | Detail |
|---|---|---|---|
| Byte 1 | Bit 1.1<br>Bit 1.2 | Echo of direction selection | **Shift lever position**<br>Bit 1.2 Bit 1.1<br>0 0 : neutral<br>0 1 : forward<br>1 0 : reverse<br>1 1 : reserved |
| | Bit 1.3<br>…<br>Bit 1.6 | Echo of range Selection | Bit 1.6 Bit 1.5 Bit 1.4 Bit 1.3<br>0 0 0 1 : 1st<br>0 0 1 0 : 2nd<br>0 0 1 1 : 3rd<br>0 1 0 0 : 4th<br>0 1 0 1 : 5th<br>0 1 1 0 : 6th<br>0 1 1 1 : 7th<br>1 0 0 0 : 8th<br>All other bitpatterns are invalid |
| | Bit 1.7<br>Bit 1.8 | Echo of fault state of shift lever | Bit 1.8 Bit 1.7<br>0 0 : no fault detected on shift lever<br>0 1 : fault detected on shift lever (neutral is forced)<br>1 0 : reserved<br>1 1 : function not supported over CAN |
| Byte 2 | Bit 2.1<br>Bit 2.2 | Echo of transmission direction | **Gear position**<br>Bit 2.2 Bit 2.1<br>0 0 : neutral<br>0 1 : forward<br>1 0 : reverse<br>1 1 : reserved |
| | Bit 2.3<br>…<br>Bit 2.6 | Echo of transmission range gear | Bit 2.6 Bit 2.5 Bit 2.4 Bit 2.3<br>0 0 0 1 : 1st<br>0 0 1 0 : 2nd<br>0 0 1 1 : 3rd<br>0 1 0 0 : 4th<br>0 1 0 1 : 5th<br>0 1 1 0 : 6th<br>0 1 1 1 : 7th<br>1 0 0 0 : 8th<br>All other bitpatterns are invalid |
| | Bit 2.7<br>Bit 2.8 | Echo of fault state of transmission control outputs | Bit 2.8 Bit 2.7<br>0 0 : no fault detected on transmission control outputs<br>0 1 : fault detected on transmission control outputs<br>1 0 : reserved<br>1 1 : function not supported over CAN |

| | | | |
|---|---|---|---|
| Byte 3 | Bit 3.1<br>Bit 3.2 | Indication that active errors are present | **Active errors**<br>Bit 3.2 Bit 3.1<br>0 0 : there are no active errors<br>0 1 : there is one or more active errors present<br>1 0 : reserved<br>1 1 : function not supported over CAN |
| | Bit 3.3<br>Bit 3.4 | Indication that inactive errors are present | **Inactive errors**<br>Bit 3.4 Bit 3.3<br>0 0 : there are no inactive errors<br>0 1 : there is one or more inactive errors present<br>1 0 : reserved<br>1 1 : function not supported over CAN<br>REMARK: Only valid for inactive errors in the volatile error memory. |
| | Bit 3.5<br>Bit 3.6 | Indication of a warning | **Warning indication**<br>Bit 3.6 Bit 3.5<br>0 0 : the warning indication is OFF<br>0 1 : the warning indication is ON<br>1 0 : reserved<br>1 1 : function not supported over CAN<br>REMARK: The exact trigger(s) for the warning indication are application specific. Refer to CHAPTER 1 – 1.11.27 for details. |
| | Bit 3.7<br>Bit 3.8 | Direction or range shift in progress | **Shift in progress**<br>Bit 3.8 Bit 3.7<br>0 0 : no shift in progress<br>0 1 : a (direction or range) shift is in progress<br>1 0 : reserved<br>1 1 : function not supported over CAN |
| Byte 4 | Bit 4.1<br>…<br>Bit 4.8 | Sump temperature | **Sump temperature**<br>Conversion: Temperature = (Byte 4) – 50 [°C]<br>0 = -50 °C<br>250 = 200 °C<br>254 = fault related to temperature sensor<br>255 = measurement not supported<br>REMARK: only the analog temperature measurement is indicated here. Refer to CHAPTER 1 – 1.10.6 details. |

<table>
<tr>
<td>Byte 5</td>
<td>Bit 5.1<br><br>…<br><br>Bit 5.8</td>
<td>Converter out Temperature</td>
<td>
<u>Converter out temperature</u><br><br>
Depending on the selection in the POD, converter out temperature is reported in °C (metric selected) or °F (imperial selected).<br><br>
<u>Metric</u><br>
Conversion : Temperature = (Byte 5) * (resolution factor) - 50 [°C]<br>
0 = -50 °C<br>
250 = 200 °C<br><br>
Resolution factor is 1<br><br>
<u>REMARK:</u> Use the correct resolution factor for Byte 5<br>
E.g.: Byte 5 = 151:<br>
Converter out temperature = (151 * 1) - 50 = 101°C<br><br>
<u>Imperial</u><br>
Conversion: Temperature = (Byte 5) * (resolution factor) - 80 [°F]<br><br>
0 = -80°F<br>
250 = 420°F<br><br>
Resolution factor is 2<br><br>
<u>REMARK:</u> Use the correct resolution factor for Byte 5<br>
E.g.: Byte 5 = 151:<br>
Converter out temperature = (151 * 2) - 80 = 222°F<br>
254 = fault related to temperature sensor<br>
255 = measurement not supported<br><br>
<u>REMARK</u>: only the analog temperature measurement is indicated here. Refer to CHAPTER 1 – 1.11.20 for details.
</td>
</tr>
</table>

| | | | |
|---|---|---|---|
| Byte 6 | Bit 6.1<br>…<br>Bit 6.8 | Vehicle speed | **<u>Vehicle speed</u>**<br>Conversion: Vehicle speed = (Byte 6) * (resolution factor)      [km/h]<br><br>In case the controller is programmed with metric units and the maximum application vehicle speed is <= 80 km/h, the resolution factor is defined as;<br>resolution factor = 0.1   for   0 < Byte 6 < 100  (  0 .. 10 km/h)<br>resolution factor = 0.2   for   100 < Byte 6 < 200  (10 .. 30 km/h)<br>resolution factor = 1   for   200 < Byte 6 < 250  (30 .. 80 km/h)<br><br><u>REMARK:</u> Use the correct resolution factor for each portion of Byte 6<br>E.g.: Byte 6 = 211:<br>Vehicle speed = (100 * 0.1) + (100 * 0.2) + (11 * 1) = 41 km/h<br><br>In case the controller is programmed with metric units and the maximum application vehicle speed is > 80 km/h and <= 150 km/h, the resolution factor is defined as;<br>resolution factor = 0.2   for   0 < Byte 6 < 100  (  0 .. 20 km/h)<br>resolution factor = 0.5   for   100 < Byte 6 < 140  (20 .. 40 km/h)<br>resolution factor = 1   for   140 < Byte 6 < 250  (40 .. 150 km/h)<br><br><u>REMARK:</u> Use the correct resolution factor for each portion of Byte 6<br>E.g.: Byte 6 = 211:<br>Vehicle speed = (100 * 0.2) + (40 * 0.5) + (71 * 1) = 111 km/h<br><br>Conversion: vehicle speed = (Byte 6) * (resolution factor)      [miles/h]<br><br>In case the controller is programmed with imperial units and the maximum application vehicle speed is <= 45 miles/h (max 72.4 km/h), the resolution factor is defined as;<br>resolution factor = 0.1   for   0 < Byte 6 < 200  (  0 .. 20 miles/h)<br>resolution factor = 0.5   for   200 < Byte 6 < 250  (20 .. 45 miles/h)<br><br><u>REMARK:</u> Use the correct resolution factor for each portion of Byte 6<br>E.g.: Byte 6 = 211:<br>Vehicle speed = (200 * 0.1) + (11 * 0.5) = 25.5 miles/h<br><br>In case the controller is programmed with imperial units and the maximum application vehicle speed is > 45 miles/h and <= 89 miles/h (max 144.8 km/h), the resolution factor is defined as;<br>resolution factor = 0.1   for   0 < Byte 6 < 100  (  0 .. 10 miles/h)<br>resolution factor = 0.3   for   100 < Byte 6 < 200  (10 .. 40 miles/h)<br>resolution factor = 1   for   200 < Byte 6 < 250  (40 .. 90 miles/h)<br><br><u>REMARK:</u> use the correct resolution factor for each portion of Byte 6<br>E.g.:  Byte 6 = 211:<br>Vehicle speed = (100 * 0.1) + (100 * 0.3) + (11 * 1) = 51 miles/h<br><br>254 = fault related to the speed sensor for vehicle speed calculation<br>255 = measurement not supported |

| | | | |
|---|---|---|---|
| Byte 7 | Bit 7.1<br>…<br>Bit 7.8 | System pressure | **System Pressure**<br>Conversion: System pressure = (Byte 7) * (resolution factor) [bar]<br>In case the controller is programmed with metric units and the maximum application system pressure is <= 80 bar, the resolution factor is defined as;<br>resolution factor = 0.1 for 0 < Byte 7 < 100 ( 0 .. 10 bar)<br>resolution factor = 0.2 for 100 < Byte 7 < 200 (10 .. 30 bar)<br>resolution factor = 1 for 200 < Byte 7 < 250 (30 .. 80 bar)<br>REMARK: Use the correct resolution factor for each portion of Byte 7<br>E.g.: Byte 7 = 148:<br>System pressure = (100 * 0.1) + (48 * 0.2) + (0 * 1) = 19.6 bar<br>Conversion: System pressure = (Byte 7) * (resolution factor) [psi]<br>In case the controller is programmed with imperial units and the maximum application system pressure is <= 550 psi (max 38 bar), the resolution factor is defined as;<br>resolution factor = 1 for 0 < Byte 7 < 100 ( 0 .. 100 psi)<br>resolution factor = 2 for 100 < Byte 7 < 200 (100 .. 300 psi)<br>resolution factor = 5 for 200 < Byte 7 < 250 (300 .. 550 psi)<br>REMARK: Use the correct resolution factor for each portion of Byte 7<br>E.g.: Byte 7 = 148:<br>System pressure = (100 * 1) + (48 * 2) + (0 * 5) = 196 psi<br>254 = fault related to pressure sensor<br>255 = measurement not supported<br>REMARK: in case a switch is used instead of a sensor, the following values are reported:<br>- no pressure detected = 0 = 0 bar<br>- pressure detected = 150 = 20 bar |
| Byte 8 | Bit 8.1<br>…<br>Bit 8.8 | Not used | **Reserved**<br>Bits 8.1 … 8.8 must be = 1111 1111$_{(Bin)}$ = 0xFF |

### 1.6.2 TC_TO_CVC_2: Optional Transmission info 1

**Message identifier: 0xCFF3103 $_{(Hex)}$ (CAN 2.0 B → 29 bit identifier)**

| Priority code + $R_{bit\ (=0)}$ + $DP_{bit\ (=0)}$ | Message ID | Address sender |
|---|---|---|
| **C $_{(Hex)}$ = 01100 $_{(Bin)}$ → Priority = 3 $_{(Dec)}$** | **0xFF31 $_{(Hex)}$ = 65329 $_{(Dec)}$** | **0x03 $_{(Hex)}$ = 3 $_{(Dec)}$** |

**Originator:** **ECON.A312**
**Repetition rate:** **100 msec**
**DLC:** **8**

| | | Value | Detail |
|---|---|---|---|
| Byte 1 | Bit 1.1<br>…<br>Bit 1.8 | Gear position code | **<u>Gear position code</u>**<br>0xFF = transmission shut down mode active<br>0x7F = transmission limp home mode active<br><br>0x00 = normal operation<br>0x06 = system pressure too low<br>0x07 = converter out temperature too high<br>0x08 = sump temperature too high<br>0x10 = declutch active<br>0x11 = parking brake activated<br>0x12 = neutral lock active<br>0x13 = operator not seated<br>0x14 = redundant safety neutral active<br>0x15 = high/low range control in progress<br>0x16 = 4WD/2WD control in progress<br>0x17 = seat orientation control in progress<br>0x18 = PTO or PTI active<br>0x19 = neutral forced due to throttle pedal idle position<br>0x1F = wait for the driver for cycling the shift lever through neutral and back into forward or reverse<br>0x20 = kickdown active<br>0x30 = direction change protection active due to excessive vehicle speed<br>0x31 = direction change protection active due to excessive engine speed<br>0x32 = downshift protection active<br>0x40 = calibration mode active<br><br><u>REMARK</u>: The codes have a priority. The above list shows the codes in descending priority: 0xFF has the highest priority and 0x40 has the lowest priority. E.g.: if code 0x13 and 0x30 would exist at the same moment, Byte 1 shows the code 0x13. |

| | | | |
|---|---|---|---|
| Byte 2 | Bit 2.1<br>Bit 2.2 | Echo of the declutch request | **Declutch request echo** (if not used: all bits will be 1)<br>Bit 2.2 Bit 2.1<br>0 0 : echo that declutch is not requested<br>0 1 : echo that declutch is requested<br>1 0 : reserved<br>1 1 : function not supported over CAN |
| | Bit 2.3<br>Bit 2.4 | Echo of the parking brake status<br>or<br>echo of the parking brake request | **Parking brake echo** (if not used: all bits will be 1)<br>Bit 2.4 Bit 2.3<br>0 0 : echo that parking brake is released or echo that parking brake is not requested<br>0 1 : echo that parking brake is activated or echo that parking brake is requested<br>1 0 : reserved<br>1 1 : function not supported over CAN |
| | Bit 2.5<br>Bit 2.6 | Neutral lock function state | **Neutral lock function state** (if not used: all bits will be 1)<br>Bit 2.6 Bit 2.5<br>0 0 : neutral lock function not activate<br>0 1 : neutral lock function active<br>1 0 : reserved<br>1 1 : function not supported over CAN |
| | Bit 2.7<br>Bit 2.8 | Operator present function state | **Operator present function state** (if not used: all bits will be 1)<br>Bit 2.8 Bit 2.7<br>0 0 : operator present protection not active<br>0 1 : operator present protection active<br>1 0 : reserved<br>1 1 : function not supported over CAN |
| Byte 3 | Bit 3.1<br>…<br>Bit 3.4 | Not used | **Reserved**<br>Bits 3.1 … 3.4 are = $1111_{(Bin)}$ = 0xF |
| | Bit 3.5<br>Bit 3.6 | Automatic/ manual mode function state | **Automatic/manual mode function state** (if not used: all bits will be 1)<br>Bit 3.6 Bit 3.5<br>0 0 : manual mode is active<br>0 1 : automatic mode is active<br>1 0 : reserved<br>1 1 : function not supported over CAN |
| | Bit 3.7<br>Bit 3.8 | Echo of loaded/not loaded detection | **Loaded/not loaded detection echo** (if not used: all bits will be 1)<br>Bit 3.8 Bit 3.7<br>0 0 : echo that vehicle "not loaded" is detected<br>0 1 : echo that vehicle "loaded" is detected<br>1 0 : reserved<br>1 1 : function not supported over CAN |

| | | | |
|---|---|---|---|
| Byte 4 | Bit 4.1<br>Bit 4.2 | Echo of the kickdown request | **Kickdown request pending** (if not used: all bits will be 1)<br>Bit 4.2 Bit 4.1<br>0 0 : echo that no kickdown request is pending<br>0 1 : echo that kickdown request is pending<br>1 0 : reserved<br>1 1 : function not supported over CAN |
| | Bit 4.3<br>Bit 4.4 | 4WD/2WD function state | **4WD/2WD function state** (if not used: all bits will be 1)<br>Bit 4.4 Bit 4.3<br>0 0 : transmission is in 2WD<br>0 1 : transmission is in 4WD<br>1 0 : reserved<br>1 1 : function not supported over CAN |
| | Bit 4.5<br>Bit 4.6 | Kickdown function state | **Kickdown mode** (if not used: all bits will be 1)<br>Bit 4.6 Bit 4.5<br>0 0 : kickdown mode is not active<br>0 1 : kickdown mode is active<br>1 0 : reserved<br>1 1 : function not supported over CAN |
| | Bit 4.7<br>Bit 4.8 | Inhibit shifting function state | **Inhibit shifting function state** (if not used: all bits will be 1)<br>Bit 4.8 Bit 4.7<br>0 0 : inhibit shifting is inactive<br>0 1 : inhibit shifting is active<br>1 0 : reserved<br>1 1 : function not supported over CAN |
| Byte 5 | Bit 5.1<br>Bit 5.2 | Seat orientation function state | **Seat orientation function state**<br>(if not used: all bits will be 1)<br>Bit 5.2 Bit 5.1<br>0 0 : seat console in normal orientation → no inversion of direction outputs<br>0 1 : seat console in inverted orientation → inversion of direction outputs<br>1 0 : reserved<br>1 1 : function not supported over CAN |
| | Bit 5.3<br>Bit 5.4 | Not used | **Reserved**<br>The bits 5.3 and 5.4 are = $11_{(Bin)}$ |
| | Bit 5.5<br>Bit 5.6 | Echo of the throttle pedal position: idle/not idle | **Throttle pedal idle/not idle echo**<br>(if not used: all bits will be 1)<br>Bit 5.6 Bit 5.5<br>0 0 : echo that throttle pedal is not in idle position<br>0 1 : echo that throttle pedal is in idle position<br>1 0 : reserved<br>1 1 : function not supported over CAN |
| | Bit 5.7<br>Bit 5.8 | Echo of the throttle pedal position: full/half throttle | **Throttle pedal full/half throttle echo**<br>(if not used: all bits will be 1)<br>Bit 5.8 Bit 5.7<br>0 0 : echo that throttle pedal is in half throttle position<br>0 1 : echo that throttle pedal is in full throttle position<br>1 0 : reserved<br>1 1 : function not supported over CAN |

| | | | |
|---|---|---|---|
| Byte 6 | Bit 6.1<br>Bit 6.2 | Echo of the manual lockup request<br>or<br>echo of the automatic lockup status | **Lockup echo** (if not used: all bits will be 1)<br>Bit 6.2 Bit 6.1<br>0 0 : echo that manual lockup is not requested<br>echo that automatic lockup is disabled<br>0 1 : echo that manual lockup is requested<br>echo that automatic lockup is enabled<br>1 0 : reserved<br>1 1 : function not supported over CAN |
| | Bit 6.3<br>Bit 6.4 | Echo of the high engine idle request | **High engine idle request echo** (if not used: all bits will be 1)<br>Bit 6.4 Bit 6.3<br>0 0 : echo that high engine idle is not requested<br>0 1 : echo that high engine idle is requested<br>1 0 : reserved<br>1 1 : function not supported over CAN |
| | Bit 6.5<br>Bit 6.6 | Echo of the high/low range selection | **High/low range selection echo** (if not used: all bits will be 1)<br>Bit 6.6 Bit 6.5<br>0 0 : echo that low range is selected<br>0 1 : echo that high range is selected<br>1 0 : reserved<br>1 1 : function not supported over CAN |
| | Bit 6.7<br>Bit 6.8 | Echo of the redundant safety neutral request | **Redundant safety neutral echo** (if not used: all bits will be 1)<br>Bit 6.8 Bit 6.7<br>0 0 : echo that redundant safety neutral is not requested<br>0 1 : echo that redundant safety neutral is requested<br>1 0 : reserved<br>1 1 : function not supported over CAN |
| Byte 7 | Bit 7.1<br>Bit 7.2 | Echo of the system pressure status | **System pressure status echo** (if not used: all bits will be 1)<br>Bit 7.2 Bit 7.1<br>0 0 : echo that the system pressure is not ok (too low)<br>0 1 : echo that the system pressure is ok<br>1 0 : reserved<br>1 1 : function not supported over CAN |
| | Bit 7.3<br>Bit 7.4 | Echo of the service brakes state: pressed or released | **Service brake state echo** (if not used: all bits will be 1)<br>Bit 7.4 Bit 7.3<br>0 0 : echo that the service brakes are released<br>0 1 : echo that the service brakes are pressed<br>1 0 : reserved<br>1 1 : function not supported over CAN |
| | Bit 7.5<br>Bit 7.6 | Echo of the block out highest gear(s) request | **Block out highest gear(s) request echo** (if not used: all bits will be 1)<br>Bit 7.6 Bit 7.5<br>0 0 : echo that blocking out of the highest gear(s) is not requested<br>0 1 : echo that blocking out of the highest gear(s) is requested<br>1 0 : reserved<br>1 1 : function not supported over CAN |

| | | | |
|---|---|---|---|
| Byte 7 | Bit 7.7<br>Bit 7.8 | Echo of the converter out temperature status | **Converter out temperature status echo**<br>(if not used: all bits will be 1)<br>Bit 7.8 Bit 7.7<br>0 0 : echo that the converter out temperature is ok<br>0 1 : echo that the converter out temperature is too high (>120°C)<br>1 0 : reserved<br>1 1 : function not supported over CAN<br><br>REMARK: only the digital temperature measurement is indicated here. |
| Byte 8 | Bit 8.1<br>Bit 8.2 | Echo of the exhaust brake status detection | **Exhaust brake status detection echo**<br>(if not used: all bits will be 1)<br>Bit 8.2 Bit 8.1<br>0 0 : echo of the detection that the exhaust brake is not active<br>0 1 : echo of the detection that the exhaust brake is active<br>1 0 : reserved<br>1 1 : function not supported over CAN |
| | Bit 8.3<br>Bit 8.4 | Echo of the retarder status detection | **Retarder status detection echo** (if not used: all bits will be 1)<br>Bit 8.4 Bit 8.3<br>0 0 : echo of the detection that the retarder is not active<br>0 1 : echo of the detection that the retarder is active<br>1 0 : reserved<br>1 1 : function not supported over CAN |
| | Bit 8.5<br>Bit 8.6 | Reverse alert | **Reverse alert**<br>Bit 8.6 Bit 8.5<br>0 0 : reverse alert OFF<br>0 1 : reverse alert ON<br>1 0 : reserved<br>1 1 : function not supported over CAN |
| | Bit 8.7<br>Bit 8.8 | Not Used | **Reserved**<br>The bits 8.7 - 8.8 must be = $11_{(Bin)}$ |

### 1.6.3 TC_TO_CVC_3: Optional transmission info 2

**Message identifier: 0xCFF3203 $_{(Hex)}$ (CAN 2.0 B → 29 bit identifier)**

| Priority code + $R_{bit (= 0)}$ + $DP_{bit (= 0)}$ | Message ID | Address sender |
|---|---|---|
| **C $_{(Hex)}$ = 01100 $_{(Bin)}$ → Priority = 3 $_{(Dec)}$** | **0xFF32 $_{(Hex)}$ = 65330 $_{(Dec)}$** | **0x03 $_{(Hex)}$ = 3 $_{(Dec)}$** |

**Originator:** **ECON.A312**
**Repetition rate:** **100 msec**
**DLC:** **8**

| | | Value | Detail |
|---|---|---|---|
| Byte 1 | Bit 1.1 … Bit 1.8 | Echo of the throttle pedal position | **<u>Throttle pedal position echo</u>** (if not used: all bits will be 1)<br>Conversion: throttle pedal position = byte 0 x 0.4 [%]<br>0 = 0 %<br>250 = 100 %<br>254 = fault related to throttle pedal position sensing<br>255 = measurement not supported |
| Byte 2 | Bit 2.1 … Bit 2.8 | Echo of the brake pedal position | **<u>Brake pedal position echo</u>** (if not used: all bits will be 1)<br>Conversion: brake pedal position = byte 1 x 0.4 [%]<br>0 = 0 %<br>250 = 100 %<br>254 = fault related to brake pedal position sensing<br>255 = measurement not supported |
| Byte 3<br>Byte 4 | Bit 3.1 … Bit 4.8 | Not used | **<u>Reserved</u>**<br>Bits 3.1 … 3.8 must be = 1111 1111$_{(Bin)}$ = 0xFF<br>Bits 4.1 … 4.8 must be = 1111 1111$_{(Bin)}$ = 0xFF |
| Byte 5 | Bit 5.1<br>Bit 5.2 | Echo of the PTO or PTI request | **<u>PTO / PTI request echo</u>** (if not used: all bits will be 1)<br><u>Bit 5.2</u> <u>Bit 5.1</u><br>0 0 : echo that PTO or PTI is not requested<br>0 1 : echo that PTO or PTI is requested<br>1 0 : reserved<br>1 1 : function not supported over CAN |
| | Bit 5.3 … Bit 5.8 | Not used | **<u>Reserved</u>**<br>Bits 5.3 … 5.8 must be = 1111 11$_{(Bin)}$ |
| Byte 6<br>Byte 7 | Bit 6.1 … Bit 7.8 | Engine speed | **<u>Engine speed</u>**<br>Conversion: engine speed = [ (Byte 7) * 256 + (Byte 6) ] * 0.125 [RPM]<br>Note: this is the engine speed internally known by the ECON.A312. The origin of this engine speed information can be a speed measurement by the ECON.A312 itself or it can be CAN message EEC1. |
| Byte 8 | Bit 8.1 … Bit 8.8 | Not used | **<u>Reserved</u>**<br>Bits 8.1 … 8.8 must be = 1111 1111$_{(Bin)}$ = 0xFF |

# 1.7 Proprietary messages between the CVC (Central Vehicle Controller) and the ECON.A312: send – receive

## 1.7.1 CVC_TO_TC_4: Context specific data – send

### 1.7.1.1 CVC_TO_TC_4 ⇔ TC_TO_CVC_4 Principle

*Unlike the other messages supported by the ECON.A312, the CVC_TO_TC_4 and the TC_TO_CVC_4 are linked together. They form a “send-receive” system, where CVC_TO_TC_4 is used to send a request to the ECON.A312. In return, the ECON.A312 replies with TC_TO_CVC_4.*

*As a consequence of this send-receive system, these messages can only be use by 1 CAN device communicating with the ECON.A312. If it would be used by more than 1 CAN device, it is almost sure that interference will occur.*

The CVC_TO_TC_4 message is a request message that is used for reading and writing a wide range of data in a non-cyclic way. Most data that can be accessed through this CVC_TO_TC_4 message can be labelled as “setup information” that determines the transmission functionality and machine functionality.

The flexibility of the CVC_TO_TC_4 message lies in the fact that byte 1 is the “request code”. This “request code” determines the expected action from the ECON.A312 controller.
Bytes 2 to 8 have a specific meaning, which is function of the “request code” in byte 1.

For some “request codes” bytes 2 to 8 are irrelevant. For other “request codes” some or all of these bytes contain extra detailed information needed by the ECON.A312 to be able to give a correct reply to the request.

Most request codes sent to the ECON.A312 result in a reply message from the ECON.A312. The reply message is TC_TO_CVC_4. The content of this message depends on the request code that was sent in the CVC_TO_TC_4 message (see description further).

Following paragraphs list all available “request codes” for the CVC_TO_TC_4 message, divided into several parts:

- “Request codes” that are purely data request: only the “request code” in byte 1 is filled in and bytes 2 to 8 are irrelevant = 0xFF.
- “Request codes” that require extra information to be specified to the ECON.A312: so some or all bytes 2 to 8 are used to define the extra information. These bytes are described separately in more detail to explain their specific meaning.

### 1.7.1.2 CVC_TO_TC_4: Message specification

**Message identifier: 0xCFF23xx $_{(Hex)}$ (CAN 2.0 B → 29 bit identifier)**

| Priority code + $R_{bit\,(=0)}$ + $DP_{bit\,(=0)}$ | Message ID | Address sender |
|---|---|---|
| **C $_{(Hex)}$ = 01100 $_{(Bin)}$ → Priority = 3 $_{(Dec)}$** | **0xFF23 $_{(Hex)}$ = 65315 $_{(Dec)}$** | Example: **0x27 $_{(Hex)}$ = 39 $_{(Dec)}$** |

**Originator:** **CVC = Central Vehicle Controller**
**Repetition rate:** **as required**
**Timeout:** **no timeout**
**DLC:** **8**

This message specification is valid for CVC_TO_TC_4, regardless of the used "request code" (byte 1).

### 1.7.1.3 CVC_TO_TC_4: Identification data (read-only)

| | | Value | Detail |
|---|---|---|---|
| Byte 1 | Bit 1.1 … Bit 1.8 | Request code | **Request code** (if do nothing: all bits should be 1)<br>**The following "request codes" can only be used to request identification data. For the description of the reply format, refer to CHAPTER 3 – 1.7.2.2.**<br>**Supported "request codes":**<br>0x00 = HW serial number<br>0x01 = HW partnumber<br>0x02 = HW version<br>0x03 = SW partnumber<br>0x04 = SW version<br>0x05 = APT-file partnumber<br>0x06 = APT-file version<br>0x07 = OEM GDE-file partnumber<br>0x08 = OEM GDE-file version<br>0x09 = Product name<br><br>0xFF = do nothing |
| Byte 2<br>Byte 3<br>Byte 4<br>Byte 5<br>Byte 6<br>Byte 7<br>Byte 8 | Bit 2.1 … Bit 8.8 | Not used | **Reserved**<br>These bytes have no relevance with the above request codes.<br><br>Bits 2.1 … 2.8 must be = 1111 1111$_{(Bin)}$ = 0xFF<br>Bits 3.1 … 3.8 must be = 1111 1111$_{(Bin)}$ = 0xFF<br>Bits 4.1 … 4.8 must be = 1111 1111$_{(Bin)}$ = 0xFF<br>Bits 5.1 … 5.8 must be = 1111 1111$_{(Bin)}$ = 0xFF<br>Bits 6.1 … 6.8 must be = 1111 1111$_{(Bin)}$ = 0xFF<br>Bits 7.1 … 7.8 must be = 1111 1111$_{(Bin)}$ = 0xFF<br>Bits 8.1 … 8.8 must be = 1111 1111$_{(Bin)}$ = 0xFF |

*The "request codes" for reading the identification data are supported when the ECON.A312 is in the bootloader operating mode. This allows identification of the ECON.A312 even in this special programming mode.*

### 1.7.1.4 CVC_TO_TC_4: Identification data (writable)

<table>
<tr><th></th><th></th><th>Value</th><th>Detail</th></tr>
<tr><td>Byte 1</td><td>Bit 1.1<br>…<br>Bit 1.8</td><td>Request code</td><td><u>Request code</u><br>The following “request codes” can be used for requesting identification data, but can also be used to write new values in the identification parameters. For the description of the reply format, refer to CHAPTER 3 – 1.7.2.2.<br>Supported “request codes”:<br>0x0A = Dana transmission serial number<br>0x0B = OEM Vehicle ID<br>0x0C = OEM Reference 1<br>0x0D = OEM Reference 2<br>0x0E = OEM Reference 3<br>0x0F = OEM Reference 4<br><br><u>REMARK</u>: Request codes 0x0A to 0x0F allow access to data fields that can be given any meaning as required by the OEM. Typically this can be used to store OEM partnumbers and/or versions in the ECON.A312. The only restriction is that the data can only contain maximum 7 ASCII character values per field.</td></tr>
<tr><td>Byte 2</td><td rowspan="7">Bit 2.1<br>…<br>Bit 8.8</td><td rowspan="7">Data</td><td rowspan="7"><u>Read Request:</u><br>For sending a read request for the actual identification parameter, set all bits to 1 = all bytes to 0xFF<br><u>Write Request = Set value:</u><br>0x0A = Dana Transmission serial number<br>Byte 2 – 5: ASCII serial number prefix (e.g.: NBEA)<br>Each byte represents the ASCII code value of 1 character of the prefix<br>Byte 6 – 8: serial number (e.g.: 123456)<br>Serial number = (Byte 8) * $2^{16}$ + (Byte 7) * $2^{8}$ + (Byte 6)<br>0x0B = Vehicle ID<br>0x0C = OEM Reference 1<br>0x0D = OEM Reference 2<br>0x0E = OEM Reference 3<br>0x0F = OEM Reference 4<br>Byte 2 – 8: 7 character ASCII string, containing the Vehicle ID or OEM reference 1, 2, 3 or 4</td></tr>
<tr><td>Byte 3</td></tr>
<tr><td>Byte 4</td></tr>
<tr><td>Byte 5</td></tr>
<tr><td>Byte 6</td></tr>
<tr><td>Byte 7</td></tr>
<tr><td>Byte 8</td></tr>
</table>

*The request codes for reading the identification data are supported when the ECON.A312 is in the bootloader operating mode.This allows identification of the ECON.A312 even in this special programming mode.*

### 1.7.1.5 CVC_TO_TC_4: Resetable/total distance counter

| | | Value | Detail |
|---|---|---|---|
| Byte 1 | Bit 1.1<br>…<br>Bit 1.8 | Request code | **<u>Request code</u>**<br>**The following "request codes" can be used to read and/or reset the distance day counter and/or to read the total travelled distance. For the description of the reply format, refer to CHAPTER 3 – 1.7.2.3.**<br><br>**Supported "request codes":**<br>0x40 = read/reset the resetable distance day counter<br>0x41 = read the total travelled distance |
| Byte 2 | Bit 2.1<br>…<br>Bit 2.8 | Command code | **<u>Command code</u>**<br><u>For 0x40 = read/reset the resetable distance day counter</u><br><br>0x01 = reset the value of the distance day counter<br>0xFF = just read the current value of the distance day counter<br><br><u>For 0x41 = total travelled distance</u><br><br>The total travelled distance counter can not be reset. This byte must be set to 0xFF to read the current value of the total travelled distance. |
| Byte 3<br>Byte 4<br>Byte 5<br>Byte 6<br>Byte 7<br>Byte 8 | Bit 3.1<br>…<br>Bit 8.8 | Not used | **<u>Reserved</u>**<br>These bytes have no relevance for these "request codes".<br><br>Bits 3.1 … 3.8 must be = 1111 1111$_{(Bin)}$ = 0xFF<br>Bits 4.1 … 4.8 must be = 1111 1111$_{(Bin)}$ = 0xFF<br>Bits 5.1 … 5.8 must be = 1111 1111$_{(Bin)}$ = 0xFF<br>Bits 6.1 … 6.8 must be = 1111 1111$_{(Bin)}$ = 0xFF<br>Bits 7.1 … 7.8 must be = 1111 1111$_{(Bin)}$ = 0xFF<br>Bits 8.1 … 8.8 must be = 1111 1111$_{(Bin)}$ = 0xFF |

### 1.7.1.6 CVC_TO_TC_4: Error info (from volatile memory)

| | | Value | Detail |
|---|---|---|---|
| Byte 1 | Bit 1.1<br>…<br>Bit 1.8 | Request code | **<u>Request code</u>**<br>**The following "request codes" can be used to read the error info from the ECON.A312 and clear the error buffer of inactive errors. For the description of the reply format, refer to CHAPTER 3 – 1.7.2.4.**<br>**Supported "request codes":**<br>0x1A = 1$^{st}$ active error info<br>0x1B = next active error info<br>0x1C = 1$^{st}$ inactive error info<br>0x1D = next inactive error info<br>0x14 = clear inactive errors buffer |
| Byte 2<br>Byte 3<br>Byte 4<br>Byte 5<br>Byte 6<br>Byte 7<br>Byte 8 | Bit 2.1<br>…<br>Bit 8.8 | Not used | **<u>Reserved</u>**<br>These bytes have no relevance for these "request codes".<br>The bits 2.1 … 2.8 must be = 1111 1111$_{(Bin)}$ = 0xFF<br>The bits 3.1 … 3.8 must be = 1111 1111$_{(Bin)}$ = 0xFF<br>The bits 4.1 … 4.8 must be = 1111 1111$_{(Bin)}$ = 0xFF<br>The bits 5.1 … 5.8 must be = 1111 1111$_{(Bin)}$ = 0xFF<br>The bits 6.1 … 6.8 must be = 1111 1111$_{(Bin)}$ = 0xFF<br>The bits 7.1 … 7.8 must be = 1111 1111$_{(Bin)}$ = 0xFF<br>The bits 8.1 … 8.8 must be = 1111 1111$_{(Bin)}$ = 0xFF |

## *Usage of CVC_TO_TC_4 to read ECON.A312 error info (from volatile memory)*

*In the ECON.A312, several errors can be active at the same time. These active errors can be read from a buffer where the errors are presented in order of priority.*
*To read the active error with the highest priority, send the "request code" 0x1A in CVC_TO_TC_4.*
*To read the rest of the active errors, repeat sending the "request code" 0x1B in CVC_TO_TC_4.*
*As long as there are active errors present, the ECON.A312 replies the error info. When all the active errors have been monitored, the ECON.A312 replies with "fault area" = 0xFF and "fault type" = 0xFF to indicate this (refer to CHAPTER 3 – 1.7.2.4 for details). To repeat reading all the active errors, send the "request code" 0x1A again, followed by repeating "request code" 0x1B until all active errors have been monitored.*

*The same principle is used for keeping track of the inactive errors. Inactive errors are errors that have been active in the past (however only since startup of the ECON.A312), but are not longer active now. To read the inactive error with highest priority, send the "request code" 0x1C in CVC_TO_TC_4. To read the rest of the inactive errors, repeat sending the "request code" 0x1D in CVC_TO_TC_4 until all inactive errors have been monitored.*

*There is one more extra "request code" = 0x14. With this "request code" all error info from the inactive error buffer can be cleared.*

*<u>REMARK</u>: when repeating the request codes for reading the error info from the ECON.A312, a rate of 100 ms or longer is recommended, to avoid unnecessary high load on the CAN-bus and the ECON.A312.*

*<u>REMARK</u>: this Dana proprietary protocol to read error info only applies to the volatile error info, which is cleared after each power up of the ECON.A312. The ECON.A312 also provides permanent error info logging. To consult this error info, use the SAE-J1939 diagnostic messages DM1, DM2 and DM3. Refer to CHAPTER 3 – 2.1 for details. Alternatively this permanent error info can also be consulted using Dashboard.*

### 1.7.1.7 CVC_TO_TC_4: Display/operating mode selection

<table>
<tr><th></th><th></th><th>Value</th><th>Detail</th></tr>
<tr><td>Byte 1</td><td>Bit 1.1<br>…<br>Bit 1.8</td><td>Request code</td><td><u>Request code</u><br>The following code can be used to select a specific display mode or operating mode in the ECON.A312. For the description of the reply format, refer to CHAPTER 3 – 1.7.2.5.<br>Supported “request codes”:<br>0x71 = select display/operating mode</td></tr>
<tr><td>Byte 2</td><td>Bit 2.1<br>…<br>Bit 2.8</td><td>Display / operating mode</td><td><u>Display/Operating mode</u><br>This byte specifies the requested display/operating mode.<br>Supported “display/operating modes”:<br>0x00 = normal display mode / normal operating mode<br>0x01 = diagnostic display mode / normal operating mode<br>0x09 = calibration display mode / calibration operating mode<br>0x0A = error display mode / normal operating mode<br><br><u>REMARK</u>: upon receipt of the new mode, the ECON.A312 immediately changes its display andoperating mode. The request is dropped when the controller is powered down or when a new mode is selected.</td></tr>
<tr><td>Byte 3</td><td rowspan="6">Bit 3.1<br>…<br>Bit 8.8</td><td rowspan="6">Not used</td><td rowspan="6"><u>Reserved</u><br>These bytes have no relevance for the above “request code”.<br><br>Bits 3.1 … 3.8 must be = 1111 1111$_{(Bin)}$ = 0xFF<br>Bits 4.1 … 4.8 must be = 1111 1111$_{(Bin)}$ = 0xFF<br>Bits 5.1 … 5.8 must be = 1111 1111$_{(Bin)}$ = 0xFF<br>Bits 6.1 … 6.8 must be = 1111 1111$_{(Bin)}$ = 0xFF<br>Bits 7.1 … 7.8 must be = 1111 1111$_{(Bin)}$ = 0xFF<br>Bits 8.1 … 8.8 must be = 1111 1111$_{(Bin)}$ = 0xFF</td></tr>
<tr><td>Byte 4</td></tr>
<tr><td>Byte 5</td></tr>
<tr><td>Byte 6</td></tr>
<tr><td>Byte 7</td></tr>
<tr><td>Byte 8</td></tr>
</table>

### 1.7.1.8 CVC_TO_TC_4: Calibration Control

| | | Value | Detail |
|---|---|---|---|
| Byte 1 | Bit 1.1 … Bit 1.8 | Request code | **Request code**<br>**The following codes can be used to control the different calibration procedures. For the description of the reply format, refer to CHAPTER 3 – 1.7.2.6 and CHAPTER 3 – 1.7.2.7.**<br><br>**For a detailed description of the correct usage and the context of these codes, refer to the CHAPTER 1 – 2.**<br>**Supported "request codes":**<br>0x20 = throttle pedal calibration<br>0x21 = brake pedal calibration<br>0x22 = transmission calibration<br>0x23 = abort calibration in process<br><br>**REMARK: these "request codes" are only accepted, in case the display/operating mode of the ECON.A312 has to be set to "calibration mode" (refer to CHAPTER 3 – 1.7.1.7)** |
| Byte 2 | Bit 2.1 … Bit 2.8 | Command code | **Command code**<br>**Calibration types handling**<br>For the request codes 0x20, 0x21, 0x22, the "command code" can be the following:<br><br>0x01 = start the calibration<br>0x02 = jump to the next calibration phase<br><br>**Abort Calibration or Activating Heating Mode**<br>For the request codes 0x23 this "command code" has no meaning: all bits should be set to 1:<br><br>0xFF = not relevant<br><br>REMARK: after starting the calibration, calibration progress messages are sent every 100 ms during the entire calibration progress (TC_TO_CVC4 message), so polling for calibration feedback is not needed. |
| Byte 3<br>Byte 4<br>Byte 5<br>Byte 6<br>Byte 7<br>Byte 8 | Bit 3.1 … Bit 8.8 | Not used | **Reserved**<br>These bytes have no relevance for the above request codes.<br><br>Bits 3.1 … 3.8 must be = 1111 $1111_{(Bin)}$ = 0xFF<br>Bits 4.1 … 4.8 must be = 1111 $1111_{(Bin)}$ = 0xFF<br>Bits 5.1 … 5.8 must be = 1111 $1111_{(Bin)}$ = 0xFF<br>Bits 6.1 … 6.8 must be = 1111 $1111_{(Bin)}$ = 0xFF<br>Bits 7.1 … 7.8 must be = 1111 $1111_{(Bin)}$ = 0xFF<br>Bits 8.1 … 8.8 must be = 1111 $1111_{(Bin)}$ = 0xFF |

### 1.7.1.9 CVC_TO_TC_4: Configuration set selection

| | | Value | Detail |
|---|---|---|---|
| Byte 1 | Bit 1.1 … Bit 1.8 | Request code | **Request code**<br>**The following code can be used to manage the different configuration sets. For the description of the reply format, refer to CHAPTER 3 – 1.7.2.8.**<br>**For a detailed description of the correct usage and context of these codes, refer to the CHAPTER 2 – 5 for details.**<br>**Supported "request codes":**<br>0x80 = configuration set selection |
| Byte 2 | Bit 2.1 … Bit 2.8 | Command code | **Command code**<br>**Supported "command codes":**<br>0x00 = read request: read the currently active configuration set<br>0x01 = write request to select a specified configuration set |
| Byte 3 | Bit 3.1 … Bit 3.8 | Configuration set index | **Configuration set index** (if read request, all bits should be 1)<br>If the "command code" is 0x01 in order to select a configuration set, the index of the desired configuration set is specified here<br>If the "command code" is 0x00, this byte is not relevant and must be set to 0xFF. |
| Byte 4<br>Byte 5<br>Byte 6<br>Byte 7<br>Byte 8 | Bit 4.1 … Bit 8.8 | Not used | **Reserved**<br>These bytes have no relevance with the above request codes.<br>Bits 4.1 … 4.8 must be = $1111\ 1111_{(Bin)}$ = 0xFF<br>Bits 5.1 … 5.8 must be = $1111\ 1111_{(Bin)}$ = 0xFF<br>Bits 6.1 … 6.8 must be = $1111\ 1111_{(Bin)}$ = 0xFF<br>Bits 7.1 … 7.8 must be = $1111\ 1111_{(Bin)}$ = 0xFF<br>Bits 8.1 … 8.8 must be = $1111\ 1111_{(Bin)}$ = 0xFF |

#### 1.7.1.10 CVC_TO_TC_4: Configuration set parameter handling

| | | Value | Detail |
|---|---|---|---|
| Byte 1 | Bit 1.1<br>…<br>Bit 1.8 | Request code | **<u>Request code</u>**<br>**The following codes can be used to manage the values of the parameters in the different configuration sets. For the description of the reply format, refer to CHAPTER 3 – 1.7.2.9.**<br>**For a detailed description of the correct usage and context of these codes, refer to the CHAPTER 2 – 5 for details.**<br>**Supported “request codes”:**<br>0x81 = read the value of the addressed configuration set parameter<br>0x86 = write a new value into the addressed configuration set parameter |
| Byte 2 | Bit 2.1<br>…<br>Bit 2.8 | Parameter Index | **<u>Parameter index</u>**<br>**The “parameter index” is the index value of the parameter that needs to be addressed.**<br>Valid range for the “parameter index” = 0x00 – 0xF1<br>**For the complete list of “parameter index” values, refer to CHAPTER 2 – 5.4.5.** |
| Byte 3<br>Byte 4 | Bit 3.1<br>…<br>Bit 4.8 | New Parameter Value | **<u>New parameter value</u>**<br>If the “request code” 0x86 is used to request a write operation of a “new parameter value” in the parameter addressed with “parameter index”, the format of the “new parameter value” is:<br>New parameter value = (Byte 3) + (Byte 4) x 256<br>The exact meaning of the parameter value depends on the addressed parameter. Refer to CHAPTER 2 for details about the addressed parameters.<br>If the “request code” 0x81 is used to read the actual value of the parameter addressed with “parameter index”, byte 3 and 4 must be equal to 0xFF. |
| Byte 5<br>Byte 6<br>Byte 7<br>Byte 8 | Bit 5.1<br>…<br>Bit 8.8 | Not used | **<u>Reserved</u>**<br>These bytes have no relevance with the above request codes.<br>Bits 5.1 … 5.8 must be = $1111\ 1111_{(Bin)}$ = 0xFF<br>Bits 6.1 … 6.8 must be = $1111\ 1111_{(Bin)}$ = 0xFF<br>Bits 7.1 … 7.8 must be = $1111\ 1111_{(Bin)}$ = 0xFF<br>Bits 8.1 … 8.8 must be = $1111\ 1111_{(Bin)}$ = 0xFF |

### 1.7.1.11 CVC_TO_TC_4: Operating time

| | | Value | Detail |
|---|---|---|---|
| Byte 1 | Bit 1.1<br>…<br>Bit 1.8 | Request code | **<u>Request code</u>**<br>**The following "request code" can be used to read the operating time.**<br>**For the description of the reply format, refer to CHAPTER 3 – 1.7.2.10.**<br><br>**Supported "request code":**<br>0x36 = read the total operating time |
| Byte 2<br>Byte 3<br>Byte 4<br>Byte 5<br>Byte 6<br>Byte 7<br>Byte 8 | Bit 2.1<br>…<br>Bit 8.8 | Not used | **<u>Reserved</u>**<br>These bytes have no relevance for the "request code".<br><br>Bits 2.1 … 2.8 must be = 1111 1111$_{(Bin)}$ = 0xFF<br>Bits 3.1 … 3.8 must be = 1111 1111$_{(Bin)}$ = 0xFF<br>Bits 4.1 … 4.8 must be = 1111 1111$_{(Bin)}$ = 0xFF<br>Bits 5.1 … 5.8 must be = 1111 1111$_{(Bin)}$ = 0xFF<br>Bits 6.1 … 6.8 must be = 1111 1111$_{(Bin)}$ = 0xFF<br>Bits 7.1 … 7.8 must be = 1111 1111$_{(Bin)}$ = 0xFF<br>Bits 8.1 … 8.8 must be = 1111 1111$_{(Bin)}$ = 0xFF |

### 1.7.1.12 CVC_TO_TC_4: Dana reserved codes

> ⚠ *Some of the "request codes" in the available range of byte 1 in CVC_TO_TC_4 are exclusively reserved for use by Dana applications.*
>
> *These codes are not intended to be used by any device for other purposes. For this reason, be sure not to use these codes when integrating the ECON.A312 in a CAN bus network.*

| | | Value | Detail |
|---|---|---|---|
| Byte 1 | Bit 1.1 … Bit 1.8 | Dana reserved request code | **Dana Reserved Request code**<br>**The following codes are exclusively reserved for Dana applications and are not to be used by any other device.**<br>**0x15, 0x16, 0x17, 0x18**<br>**0x25, 0x26**<br>**0x30, 0x34, 0x35, 0x3A, 0x3B, 0x3C, 0x3D**<br>**0x82, 0x83, 0x84, 0x85**<br>**0xA0, 0xAA, 0xAB, 0xAC, 0xAD, 0xAE** |
| Byte 2<br>Byte 3<br>Byte 4<br>Byte 5<br>Byte 6<br>Byte 7<br>Byte 8 | Bit 2.1 … Bit 8.8 | Dana reserved | **Dana reserved** |

## 1.7.2 TC_TO_CVC_4: Context specific data – receive

### 1.7.2.1 TC_TO_CVC_4: Message specification

**Message identifier: 0xCFF3303 (Hex) (CAN 2.0 B → 29 bit identifier)**

| Priority code + $R_{bit\ (=0)}$ + $DP_{bit\ (=0)}$ | Message ID | Address sender |
|---|---|---|
| **C (Hex) = 01100 (Bin) → Priority = 3 (Dec)** | **0xFF33 (Hex) = 0x65331 (Dec)** | **0x03 (Hex) = 3 (Dec)** |

**Originator:** **ECON.A312**
**Repetition rate:** **as required**
**Timeout:** **no timeout**
**DLC:** **8**

This message specification is valid for TC_TO_CVC_4, regardless of the used "reply code" (byte 1), which is always an echo of the "request code" from the corresponding request message CVC_TO_TC_4.

*Unlike the other messages supported by the ECON.A312, the CVC_TO_TC_4 and the TC_TO_CVC_4 are linked together. They form a "send-receive" system, where CVC_TO_TC_4 is used to send a request to the ECON.A312. In return, the ECON.A312 replies with TC_TO_CVC_4.*

*As a consequence of this send-receive system, these messages can only be use by 1 CAN device communicating with the ECON.A312. If it would be used by more than 1 CAN device, it is almost sure that interference will occur.*

### 1.7.2.2 TC_TO_CVC_4: Identification data

| | | Value | Detail |
|---|---|---|---|
| Byte 1 | Bit 1.1<br>…<br>Bit 1.8 | Reply code | **<u>Reply code</u>**<br>**The “reply code” is an echo of the “request code” in byte 1 of the request message CVC_TO_TC_4. The “reply code” is used as identification.**<br>**Supported “reply codes”:**<br>0x00 = HW serial number<br>0x01 = HW partnumber<br>0x02 = HW version<br>0x03 = SW partnumber<br>0x04 = SW version<br>0x05 = APT-file partnumber<br>0x06 = APT-file version<br>0x07 = OEM GDE-file partnumber<br>0x08 = OEM GDE-file version<br>0x09 = Product name<br>0x0A = Dana transmission serial number<br>0x0B = OEM Vehicle ID<br>0x0C = OEM Reference 1<br>0x0D = OEM Reference 2<br>0x0E = OEM Reference 3<br>0x0F = OEM Reference 4 |
| Byte 2<br>Byte 3<br>Byte 4<br>Byte 5<br>Byte 6<br>Byte 7<br>Byte 8 | Bit 2.1<br>…<br>Bit 8.8 | Requested data | **<u>Requested data</u>**<br>**The format of the requested data depends on the “reply code”:**<br>0x00 = HW serial number<br>0x01 = HW partnumber<br>0x02 = HW version<br>0x03 = SW partnumber<br>0x04 = SW version<br>0x05 = APT-file partnumber<br>0x06 = APT-file version<br>0x07 = OEM GDE-file partnumber<br>0x08 = OEM GDE-file version<br>0x09 = Product name<br>Byte 2 – 8: 7 character ASCII string, containing the HW serial number, HW partnumber,…<br>0x0A = Dana transmission serial number<br>Byte 2 – 5: ASCII serial number prefix (e.g.: NBEA)<br>Each byte represents the ASCII code value of 1 character of the prefix<br>Byte 6 – 8: serial number (e.g.: 123456)<br>Serial number = (Byte 8) * $2^{16}$ + (Byte 7) * $2^{8}$ + (Byte 6)<br>0x0B = Vehicle ID<br>0x0C = OEM Reference 1<br>0x0D = OEM Reference 2<br>0x0E = OEM Reference 3<br>0x0F = OEM Reference 4<br>Byte 2 – 8: 7 character ASCII string, containing the Vehicle ID or OEM reference 1, 2, 3 or 4<br>***In case the requested identification parameter is not available (e.g. when there is no valid application present with ECON.A312 in bootloader mode), the ECON.A312 replies with bytes 2 – 8 = 0xFF.*** |

### 1.7.2.3 TC_TO_CVC_4: Resetable/total distance counter

<table>
<tr><th></th><th></th><th>Value</th><th>Detail</th></tr>
<tr><td>Byte 1</td><td>Bit 1.1<br>…<br>Bit 1.8</td><td>Reply code</td><td><u>Reply code</u><br>The “reply code” is an echo of the “request code” in byte 1 of the request message CVC_TO_TC_4. The “reply code” is used as identification.<br>Supported “reply codes”:<br>0x40 = resetable distance day counter<br>0x41 = total travelled distance</td></tr>
<tr><td>Byte 2</td><td rowspan="4">Bit 2.1<br>…<br>Bit 5.8</td><td rowspan="4">Distance</td><td rowspan="4"><u>Travelled distance</u><br>The conversion for the travelled distance is:<br>distance = [(Byte 5)*2^24 + (Byte 4)*2^16 + (Byte 3)*2^8 + (Byte 2)] / 10 [km] or [miles]*<br>* The ECON.A312 can be programmed to report the travelled distance in km or in miles.</td></tr>
<tr><td>Byte 3</td></tr>
<tr><td>Byte 4</td></tr>
<tr><td>Byte 5</td></tr>
<tr><td>Byte 6</td><td rowspan="3">Bit 6.1<br>…<br>Bit 8.8</td><td rowspan="3">Not used</td><td rowspan="3"><u>Reserved</u><br>These bytes have no relevance for the above “reply codes”.<br>Bits 6.1 … 6.8 are = 1111 1111(Bin) = 0xFF<br>Bits 7.1 … 7.8 are = 1111 1111(Bin) = 0xFF<br>Bits 8.1 … 8.8 are = 1111 1111(Bin) = 0xFF</td></tr>
<tr><td>Byte 7</td></tr>
<tr><td>Byte 8</td></tr>
</table>

#### 1.7.2.4 TC_TO_CVC_4: error info (from volatile memory)

| | | Value | Detail |
|---|---|---|---|
| Byte 1 | Bit 1.1<br>…<br>Bit 1.8 | Reply code | **<u>Reply code</u>**<br>**The "reply code" is an echo of the "request code" in byte 1 of the request message CVC_TO_TC_4. The "reply code" is used as identification.**<br>**Supported "reply codes":**<br>0x1A = $1^{st}$ active error info<br>0x1B = next active error info<br>0x1C = $1^{st}$ inactive error info<br>0x1D = next inactive error info<br>0x14 = clear inactive errors buffer |
| Byte 2 | Bit 2.1<br>…<br>Bit 2.8 | Fault area | **<u>Fault area</u>**<br>The "fault area" is the first part of the error code defining the fault.<br>E.g.: error code = 5F.02 → fault area = 0x5F |
| Byte 3 | Bit 3.1<br>…<br>Bit 3.8 | Fault Type | **<u>Fault type</u>**<br>The fault type is the second part of the error code defining a fault.<br>E.g.: error code = 5F.02 → fault area = 0x02 |
| Byte 4<br>Byte 5 | Bit 4.1<br>…<br>Bit 5.8 | Number of occurrences | **<u>Number of occurrences</u>**<br>This is an indication of the number of times this error has occurred since the most recent power up (volatile info).<br>Conversion: number of occurrences = (Byte 5) * 256 + (Byte 4) |
| Byte 6<br>Byte 7 | Bit 6.1<br>…<br>Bit 7.8 | Not used | **<u>Reserved</u>**<br>These bytes have no relevance for the above "reply codes".<br>Bits 6.1 … 6.8 are = 1111 1111$_{(Bin)}$ = 0xFF<br>Bits 7.1 … 7.8 are = 1111 1111$_{(Bin)}$ = 0xFF |
| Byte 8 | Bit 8.1<br>…<br>Bit 8.8 | Fault severity | **<u>Fault severity</u>**<br>The "fault severity" is a number indicating the severity of the fault:<br>0x01 = severe warning - need to stop immediately<br>0x02 = warning – service urgently<br>0x03 = info – report and service<br>0x04 = exceed parameter code - info<br>0x09 = Dana info<br>0xFF = fault group not supported |

***<u>REMARK</u>: In order to obtain the same error code representation as on the RD.120 display, the fault area and fault type should be represented in the hexadecimal format.***

*When all active (or inactive) errors have been monitored, the "fault area" and "fault type" in the reply TC_TO_CVC_4 are 0xFF (refer to CHAPTER 3 – 1.7.1.6 for details). For a detailed description about the meaning of the error, refer CHAPTER 4 and to the error code list "ECON.A312 Error code list – production firmware 1.11.pdf".*

### 1.7.2.5 TC_TO_CVC_4: Display/operating mode selection

| | | Value | Detail |
|---|---|---|---|
| Byte 1 | Bit 1.1<br>…<br>Bit 1.8 | Reply code | **<u>Reply code</u>**<br>**The “reply code” is an echo of the “request code” in byte 1 of the request message CVC_TO_TC_4. The “reply code” is used as identification.**<br>**Supported “reply codes”:**<br>0x71 = selected display/operating mode |
| Byte 2 | Bit 2.1<br>…<br>Bit 2.8 | Selected display / operation mode | **<u>Selected display/operation mode</u>**<br>**Feedback of the current display/operation mode of the ECON.A312.**<br>**This feedback can be used to check if the requested display/operating mode was accepted.**<br>**Supported values :**<br>0x00 = normal display mode<br>0x01 = diagnostic display mode<br>0x09 = calibration display/operating mode<br>0x0A = error display mode<br>0x10 = bootloader display/operating mode<br><u>REMARK</u>: The bootloader mode (= programming mode), can only be activated by the “Dana CAN Firmware XML Flashtool”. |
| Byte 3<br>Byte 4<br>Byte 5<br>Byte 6<br>Byte 7<br>Byte 8 | Bit 3.1<br>…<br>Bit 8.8 | Not used | **<u>Reserved</u>**<br>These bytes have no relevance for the above “reply codes”.<br>Bits 3.1 … 3.8 are = 1111 $1111_{(Bin)}$ = 0xFF<br>Bits 4.1 … 4.8 are = 1111 $1111_{(Bin)}$ = 0xFF<br>Bits 5.1 … 5.8 are = 1111 $1111_{(Bin)}$ = 0xFF<br>Bits 6.1 … 6.8 are = 1111 $1111_{(Bin)}$ = 0xFF<br>Bits 7.1 … 7.8 are = 1111 $1111_{(Bin)}$ = 0xFF<br>Bits 8.1 … 8.8 are = 1111 $1111_{(Bin)}$ = 0xFF |

#### 1.7.2.6 TC_TO_CVC_4: Calibration control: analog input signals

| | | Value | Detail |
|---|---|---|---|
| Byte 1 | Bit 1.1<br>…<br>Bit 1.8 | Reply code | **Reply code**<br>**When a calibration request has been accepted, TC_TO_CVC_4 is sent each 100 msec as long as the calibration mode is active.**<br>**For a detailed description of the correct usage and context of this "reply codes", refer to the CHAPTER 1 – 2.1.3 for details.**<br>**Supported "reply codes":**<br>0x20 = throttle pedal calibration<br>0x21 = brake pedal calibration<br>0x20 = transmission calibration |
| Byte 2 | Bit 2.1<br>…<br>Bit 2.8 | Calibration phase number | **Calibration phase number**<br>0x00 = calibration of the analog input minimum value (0%)<br>0x01 = calibration of the analog input low value<br>0x02 = calibration of the analog input middle value<br>0x03 = calibration of the analog input high value<br>0x04 = calibration of the analog input maximum value (100%)<br>0x05 = calibration failed<br>0x06 = calibration on hold<br>0x09 = calibration successfully completed |
| Byte 3 | Bit 3.1<br>…<br>Bit 3.8 | Not used | **Reserved**<br>This byte has no relevance for the above "reply codes".<br>Bits 3.1 … 3.8 are = $0000\ 0000_{(Bin)}$ = 0x00 |
| Byte 4 | Bit 4.1<br>…<br>Bit 4.8 | ASCII Code | **Calibration ASCII code**<br>ASCII code value of a character representing the active calibration option:<br>0x54 = 'T' = throttle pedal calibration<br>0x42 = 'B' = brake pedal calibration<br>0x41 = 'A' = abort calibration<br>0x46 = 'F' = forward clutch calibration<br>0x52 = 'R' = reverse clutch calibration<br>0x53 = 'S' = splitter clutch calibration<br>0x31 = '1' = 1st clutch calibration<br>0x32 = '2' = 2nd clutch calibration<br>0x33 = '3' = 3rd clutch calibration<br>0x34 = '4' = 4th clutch calibration |
| Byte 5 | Bit 5.1<br>…<br>Bit 5.8 | Status | **Calibration status**<br>0x00 = calibration not active<br>0x03 = calibration active |

| | | | |
|---|---|---|---|
| Byte 6 | Bit 6.1 … Bit 6.8 | User intervention | **User intervention**<br>This code specifies the use action required during the calibration procedure:<br>0x00 = no action required - do nothing<br>0x01 = push pedal or lever related to the analog input signal<br>0x02 = release pedal or lever related to the analog input signal<br>0x03 = select neutral<br>0x04 = select forward<br>0x05 = stop vehicle (vehicle movement detected)<br>0x06 = heat up transmission (temperature too low)<br>0x07 = engine speed control busy - do nothing<br>0x08 = hold pedal, lever, ... of anlog input signal in current position<br>0x09 = check error code<br>0x0A = apply parking brake |
| Byte 7<br>Byte 8 | Bit 7.1 … Bit 8.8 | Analog input value | **Analog input value**<br>Feedback about the measured value of the analog input signal that is being calibrated currently:<br>Conversion: Analog input value = (Byte 7) + (Byte 8) * $2^8$ [mV or Ohm] |

### 1.7.2.7 TC_TO_CVC_4: Calibration control: abort command

| | | Value | Detail |
|---|---|---|---|
| Byte 1 | Bit 1.1 … Bit 1.8 | Reply code | **Reply code**<br>**When the calibration procedure is aborted after receipt of "request code 0x23, the ECON.A312 replies with the "reply code" 0x23 in a single reply.**<br>**For a detailed description of the correct usage and context of this "reply code", refer to CHAPTER 1 – 2.1.3.**<br>**Supported "reply codes":**<br>0x23 = aborted calibration |
| Byte 2<br>Byte 3 | Bit 2.1 … Bit 3.8 | Not used | **Not relevant**<br>$XX_{(Hex)}$ = value can be anything, depending on calibration mode. |
| Byte 4 | Bit 4.1 … Bit 4.8 | ASCII Code | **Calibration ASCII code**<br>ASCII code value of a character indicating that the calibration is aborted:<br>0x41 = 'A' = aborted calibration |
| Byte 5 | Bit 5.1 … Bit 5.8 | Calibration status | **Calibration status**<br>Value indicating that the calibration is not active (because aborted):<br>0x00 = Calibration not active |
| Byte 6<br>Byte 7<br>Byte 8 | Bit 6.1 … Bit 8.8 | Not used | **Reserved**<br>These bytes have no relevance for the above "reply codes".<br>Bits 6.1 … 6.8 are = $1111\ 1111_{(Bin)}$ = 0xFF<br>Bits 7.1 … 7.8 are = $1111\ 1111_{(Bin)}$ = 0xFF<br>Bits 8.1 … 8.8 are = $1111\ 1111_{(Bin)}$ = 0xFF |

### 1.7.2.8 TC_TO_CVC_4: Configuration set selection

| | | Value | Detail |
|---|---|---|---|
| Byte 1 | Bit 1.1<br>…<br>Bit 1.8 | Reply code | **Reply code**<br>**The "reply code" is an echo of the "request code" in byte 1 of the request message CVC_TO_TC_4. The "reply code" is used as identification.**<br>**For a detailed description of correct usage and context of these codes, refer to CHAPTER 2 – 5 for details.**<br>**Supported "reply codes":**<br>0x80 = configuration set selection |
| Byte 2 | Bit 2.1<br>…<br>Bit 2.8 | Command acceptance code | **Command acceptance code**<br>The "command acceptance code" indicates whether or not the "command code" of the requesting CVC_TO_TC_4 was accepted or not:<br>0x00 = read request of currently active configuration set accepted<br>0x01 = write request to select a specified configuration set accepted<br>0xFF = write request to select a specified configuration set NOT accepted |
| Byte 3 | Bit 3.1<br>…<br>Bit 3.8 | Newly selected configuration set index | **Newly selected configuration set index**<br>The "newly selected configuration set index" gives feedback about the newly selected configuration set , via the sequence number of this configuration set:<br>0x00 – 0x14 = 0 – $20_{(Dec)}$<br>The "newly selected configuration set index" = the index of the newly selected configuration in case there was a write request to select a new configuration set, and the request was accepted. The "newly selected configuration set index" ≠ the "active configuration set index".<br>The "newly selected configuration set index" = the index of the active configuration set, in case there was a write request, but the index to the newly selected configuration set was not accepted. The "newly selected configuration set index" = the "active configuration set index".<br>The "newly selected configuration set index" = the index of the active configuration set, in case there was a read request for the currently active configuration set. The "newly selected configuration set index" = the "active configuration set index".<br>In case there is no valid configuration set selected, the index is 0xFF. |

| | | | |
|---|---|---|---|
| Byte 4 | Bit 4.1 … Bit 4.8 | Active Configuration Set Index | **Active configuration set index**<br><br>The “active configuration set index” gives feedback about the active configuration set , via the sequence number of this configuration set:<br><br>0x00 – 0x14 = 0 – 20$_{(Dec)}$<br><br>In case no valid configuration is selected, the “active configuration set index” equals 0xFF. However, this should never occur during normal operation of the ECON.A312, because this would mean that no configuration set is activated. In this case, normal operation would not be possible.<br><br>REMARK: When a new configuration set has been selected successfully, the “newly selected configuration set index” is still ≠ from the “active configuration set index”. Only after a controlled power down of the ECON.A312 (refer to CHAPTER 1 – 1.5 for details) and reset, the new configuration set is activated in the ECON.A312. This can be checked after reset of the ECON.A312: the “selected configuration set index” has become = to the “active configuration set index”. |
| Byte 5<br>Byte 6<br>Byte 7<br>Byte 8 | Bit 5.1 … Bit 8.8 | Not used | **Reserved**<br><br>These bytes have no relevance for the above “reply code”.<br><br>Bits 5.1 … 5.8 are = 1111 1111$_{(Bin)}$ = 0xFF<br>Bits 6.1 … 6.8 are = 1111 1111$_{(Bin)}$ = 0xFF<br>Bits 7.1 … 7.8 are = 1111 1111$_{(Bin)}$ = 0xFF<br>Bits 8.1 … 8.8 are = 1111 1111$_{(Bin)}$ = 0xFF |

### 1.7.2.9 TC_TO_CVC_4: Configuration set parameter handling

| | | Value | Detail |
|---|---|---|---|
| Byte 1 | Bit 1.1 … Bit 1.8 | Reply code | **Reply code**<br>**The "reply code" is an echo of the "request code" in byte 1 of the request message CVC_TO_TC_4. The "reply code" is used as identification.**<br>**For a detailed description of correct usage and context of these codes, refer to CHAPTER 2 – 5 for details.**<br>**Supported "reply codes":**<br>0x81 = reading the value of the addressed configuration set parameter<br>0x86 = writing a new value to the addressed configuration set parameter |
| Byte 2 | Bit 2.1 … Bit 2.8 | Parameter index acceptance | **Parameter index acceptance**<br>This is the echo of the index of the parameter addressed in the requesting CVC_TO_TC_4. In case there was a problem with the execution of the request, a special code is replied:<br>0x00 – 0xF1 = index to a valid configuration set parameter (for the complete list of "parameter index" values, refer to CHAPTER 2 – 5.4.5)<br>0xFB = writing a new value was not accepted because some machine conditions are not fulfilled (refer to CHAPTER 2 – 5.1 for details)<br>0xFD = writing a new value was not accepted because the specified value is out of the allowed range<br>0xFE = read/write request was not accepted because a non-existing configuration set parameter was addressed |
| Byte 3<br>Byte 4 | Bit 3.1 … Bit 4.8 | Active parameter value | **Active parameter value**<br>Active value of the addressed parameter:<br>Conversion: parameter value = (Byte 3) + (Byte 4) x 256 |
| Byte 5<br>Byte 6 | Bit 5.1 … Bit 6.8 | Minimum parameter value | **Minimum parameter value**<br>Minimum allowed value of the addressed parameter:<br>Conversion: minimum value = (Byte 5) + (Byte 6) x 256 |
| Byte 7<br>Byte 8 | Bit 7.1 … Bit 8.8 | Maximum parameter value | **Maximum parameter value**<br>Maximum allowed value of the addressed parameter:<br>Conversion: maximum value = (Byte 7) + (Byte 8) x 256 |

*1) The exact meaning of the replied parameter values (active/minimum/maximum) depends on the addressed parameter. Refer to CHAPTER 2 for details about the addressed parameters.*

*2) The replied active, minimum and maximum value is 0xFFFF in case there is a problem with the addressing of the configuration set parameter. The "parameter index acceptance" in byte 2 equals 0xFE in this case.*

### 1.7.2.10 TC_TO_CVC_4: Operating time

| | | Value | Detail |
|---|---|---|---|
| Byte 1 | Bit 1.1 … Bit 1.8 | Reply code | **<u>Reply code</u>**<br>**The "reply code" is an echo of the "request code" in byte 1 of the request message CVC_TO_TC_4. The "reply code" is used as identification.**<br>**Supported "reply code":**<br>0x36 = total operating time |
| Byte 2<br>Byte 3<br>Byte 4<br>Byte 5 | Bit 2.1 … Bit 5.8 | Time | **<u>Travelled distance</u>**<br>**The conversion for the operating time is:**<br>Time = [(Byte 5)*$2^{24}$ + (Byte 4)*$2^{16}$ + (Byte 3)*$2^{8}$ + (Byte 2)] [s] |
| Byte 6<br>Byte 7<br>Byte 8 | Bit 6.1 … Bit 8.8 | Not used | **<u>Reserved</u>**<br>These bytes have no relevance for the above "reply codes".<br>Bits 6.1 … 6.8 are = $1111\ 1111_{(Bin)}$ = 0xFF<br>Bits 7.1 … 7.8 are = $1111\ 1111_{(Bin)}$ = 0xFF<br>Bits 8.1 … 8.8 are = $1111\ 1111_{(Bin)}$ = 0xFF |

# 2 SAE J1939 Standard CAN messages supported by the ECON.A312

## 2.1 Diagnostic Messages DM1, DM2 and DM3

Next to the proprietary system using the CVC_TO_TC_4 and the TC_TO_CVC_4 to handle the available error information, the ECON.A312 also supports the SAE J1939 -73 standard DM (**D**iagnostic **M**essages) error reporting system:

- CAN message DM1 reports all the errors currently active
- CAN message DM2 reports all the inactive errors (previously active, but not active anymore)
- CAN message DM3 commands the ECON.A312 to clear all the inactive errors from its memory

The DM1, DM2 and DM3 messages are linked to a permanent cyclic error buffer of up to 50 logged errors (unlike the proprietary messages CVC_TO_TC_4 and TC_TO_CVC_4 which are linked to volatile memory).
The consequence is that the DM2 error information about inactive errors remains available after controlled power down and reset of the ECON.A312 (forever, until cleared with DM3). This allows more advanced diagnostics when a vehicle needs service inspection and troubleshooting, because a history of problems can be reported by the ECON.A312.

For this reason, it is recommended to use the Diagnostic Messages system with DM1, DM2 and DM3 message in favour of the Dana proprietary CVC_TO_TC_4 and TC_TO_CVC_4 message system.

*For a complete description of the contents, dynamics and usage of the DM messages DM1, DM2 and DM3, refer to the SAE J1939-73 standard.*

*REMARK: for a description of the error codes reported in these Diagnostic Messages, refer to CHAPTER 4 and to the error code list "ECON.A312 Error code list - production firmware 1.11.pdf".*

## 2.2 EEC1: Electronic Engine Controller # 1

**Message identifier: 0xCF00400 (Hex)   (CAN 2.0 B → 29 bit identifier)**

| Priority code + $R_{bit\ (=0)}$ + $DP_{bit\ (=0)}$ | Message ID | Address sender |
|---|---|---|
| **C (Hex) = 01100 (Bin) → Priority = 3 (Dec)** | **0xF004 (Hex) = 61444 (Dec)** | **0x00 (Hex) = 0 (Dec)** |

| | |
|---|---|
| **Originator:** | **engine controller** |
| **Repetition rate:** | **engine speed dependent** |
| **Timeout:** | **500 msec** |
| **DLC:** | **8** |

| | | Value | Detail |
|---|---|---|---|
| Byte 1 | Bit 1.1 … Bit 1.4 | Engine torque mode | Not interpreted by ECON.A312: value is irrelevant. |
| | Bit 1.5 … Bit 1.8 | Not used | |
| Byte 2 | Bit 2.1 … Bit 2.8 | Driver's demand engine – percent torque | Not interpreted by ECON.A312: value is irrelevant. |
| Byte 3 | Bit 3.1 … Bit 3.8 | Actual engine – percent torque | Not interpreted by ECON.A312: value is irrelevant. |
| Byte 4<br>Byte 5 | Bit 4.1 … Bit 5.8 | Engine speed | **Engine speed**<br>Conversion: engine speed = [ (Byte 5) * 256 + (Byte 4) ] * 0.125 [RPM] |
| Byte 6 | Bit 6.1 … Bit 6.8 | Source address of controlling device for engine control | Not interpreted by ECON.A312: value is irrelevant. |
| Byte 7 | Bit 7.1 … Bit 7.4 | Engine starter mode | Not interpreted by ECON.A312: value is irrelevant. |
| | Bit 7.5 … Bit 7.8 | Not used | |
| Byte 8 | Bit 8.1 … Bit 8.8 | Engine demand – percent torque | Not interpreted by ECON.A312: value is irrelevant. |

*Remark: Refer to the SAE J1939-71 standard for details.*

## 2.3 EEC2: Electronic engine controller # 2

**Message identifier: 0xCF00300 (Hex) (CAN 2.0 B → 29 bit identifier)**

| Priority code + R bit (= 0) + DP bit (= 0) | Message ID | Address sender |
|---|---|---|
| **C (Hex) = 01100 (Bin) → Priority = 3 (Dec)** | **0xF003 (Hex) = 61443 (Dec)** | **0x00 (Hex) = 0 (Dec)** |

**Originator:** **engine controller**
**Repetition rate:** **50 msec**
**Timeout:** **500 msec**
**DLC:** **8**

| | | Value | Detail |
|---|---|---|---|
| Byte 1 | Bit 1.1<br>Bit 1.2 | Accelerator pedal low idle switch | Not interpreted by ECON.A312: value is irrelevant. |
| | Bit 1.3<br>Bit 1.4 | Accelerator pedal kickdown switch | |
| | Bit 1.5<br>…<br>Bit 1.8 | Not used | |
| Byte 2 | Bit 2.1<br>…<br>Bit 2.8 | Accelerator pedal position | **Accelerator pedal position**<br>Conversion: accelerator pedal position = (Byte 2) * 0.4 [%]<br>REMARK: accelerator pedal = throttle pedal. |
| Byte 3 | Bit 3.1<br>…<br>Bit 3.8 | Load at current speed | Not interpreted by ECON.A312: value is irrelevant. |
| Byte 4 | Bit 4.1<br>…<br>Bit 4.8 | Remote accelerator pedal position | **Remote accelerator pedal position**<br>Conversion: remote accelerator pedal position = (Byte 2) * 0.4 [%]<br>REMARK: when there is no remote accelerator pedal, byte 4 must = 0xFF.<br>REMARK: in case the primary and remote accelerator pedal are both available on one machine, the value of one of those is 0% while the value of the other is 0% - 100% during normal use.<br>Example 1: Byte 2 = 0x91 = 145(Dec) = 58%<br>Byte 4 = 0x0 = 0(Dec) = 0%<br>Example 2: Byte 2 = 0x0 = 0(Dec) = 0%<br>Byte 4 = 0xED = 237(Dec) = 95%<br>In the abnormal situation that both accelerator pedals are pressed, the ECON.A312 uses the greatest value.<br>Example 3: Byte 2 = 0x91 = 145(Dec) = 58%<br>Byte 4 = 0xED = 237(Dec) = 95%<br>The accelerator pedal position for the ECON.A312 95%. |
| Byte 5 | Bit 5.1<br>…<br>Bit 8.8 | Not used | **Reserved**<br>These bytes have not defined and must be = 0xFF.<br>To avoid any confusion and following the principle of the SAE J1939 standard, it is recommended to set all bits to 1 (= all bytes to 0xFF).<br>Bits 5.1 … 5.8 are = 1111 1111(Bin) = 0xFF<br>Bits 6.1 … 6.8 are = 1111 1111(Bin) = 0xFF<br>Bits 7.1 … 7.8 are = 1111 1111(Bin) = 0xFF<br>Bits 8.1 … 8.8 are = 1111 1111(Bin) = 0xFF |
| Byte 6 | | | |
| Byte 7 | | | |
| Byte 8 | | | |

*Remark: Refer to the SAE J1939-71 standard for details.*

## 2.4 TSC1: Torque/Speed Control #1

**Message identifier: 0xC000003 (Hex)** **(CAN 2.0 B → 29 bit identifier)**

| Priority code + $R_{bit\ (=0)}$ + $DP_{bit\ (=0)}$ | Message ID | Address sender |
|---|---|---|
| **C (Hex) = 01100 (Bin) → Priority = 3 (Dec)** | **0x0000(Hex) = 0000 (Dec)** | **0x03 (Hex) = 3 (Dec)** |

**Originator:** **ECON.A312**
**Repetition rate:** **10 msec to engine / 50 msec to retarder**
**DLC:** **8**

| | | Value | Detail |
|---|---|---|---|
| Byte 1 | Bit 1.1<br>Bit 1.2 | Engine override control mode | **Engine override control mode**<br>These bits define the "override control mode" for engine control:<br>00(Bin): override disabled<br>01(Bin): speed control<br>10(Bin): torque control<br>11(Bin): speed/torque control |
| | Bit 1.3<br>Bit 1.4 | Engine requested speed control conditions | **Engine requested speed control conditions**<br>Desired engine governor characteristic during engine speed control:<br>00(Bin): transient optimized for driveline disengaged and non-lockup<br>01(Bin): stability optimized for driveline disengaged and non-lockup<br>10(Bin): stability optimized for driveline disengaged and/or lockup (vehicle)<br>11(Bin): stability optimized for driveline disengaged and/or lockup (PTO) |
| | Bit 1.5<br>Bit 1.6 | Override control mode priority | **Override control mode priority**<br>Defines the priority of the CAN message TSC1 sent by the ECON.A312:<br>00(Bin): highest priority<br>01(Bin): high priority<br>10(Bin): medium priority<br>11(Bin): low priority |
| | Bit 1.7<br>Bit 1.8 | Not used | **Reserved**<br>The bits 1.7 and 1.8 are set to 11(Bin) |
| Byte 2<br>Byte 3 | Bit 2.1<br>…<br>Bit 3.8 | Engine requested speed / speed limit | **Engine requested speed/speed limit**<br>The "engine requested speed" is the target engine speed at which the engine is expected to operate. The "engine speed limit" is the maximum engine speed below which the engine speed is expected to operate.<br>Conversion : engine speed = [ (Byte 3) * 256 + (Byte 2) ] * 0.125 [RPM] |
| Byte 4 | Bit 4.1<br>…<br>Bit 4.8 | Engine requested torque / torque limit | **Engine requested torque/torque limit**<br>The "engine requested torque" is the target engine torque at which the engine is expected to operate. The "engine torque limit" is the maximum engine torque below which the engine speed is expected to operate.<br>The torque is indicated as a percentage of the reference engine torque.<br>Conversion: enginetorque (%) = (Byte 4) – 125 [%] |

| | | | |
|---|---|---|---|
| Byte 5 | Bit 5.1 | Not used | **Reserved**<br>These bytes have no relevance with the above request codes.<br>The bits 5.1 … 5.8 are set to 1111 1111$_{(Bin)}$ = 0xFF<br>The bits 6.1 … 6.8 are set to 1111 1111$_{(Bin)}$ = 0xFF<br>The bits 7.1 … 7.8 are set to 1111 1111$_{(Bin)}$ = 0xFF |
| Byte 6 | … | | |
| Byte 7 | Bit 7.8 | | |
| Byte 8 | | | **Checksum and message counter**<br>As per SAE J1939 standard. |

*Remark : Refer to the SAE J1939-71 standard for details.*

## 2.5 ETC1: Electronic Transmission Controller #1

**Message identifier: 0xCF00203 (Hex) (CAN 2.0 B ⇒ 29 bit identifier)**

| Priority code + R$_{bit (= 0)}$ + DP$_{bit (= 0)}$ | Message ID | Address sender |
|---|---|---|
| **C $_{(Hex)}$ = 01100 $_{(Bin)}$ : Priority ⇒ 3 $_{(Dec)}$** | **0xF002 $_{(Hex)}$ = 61442 $_{(Dec)}$** | **0x03 $_{(Hex)}$ = 3 $_{(Dec)}$** |

**Originator:** **ECON.A312**
**Repetition rate:** **10 msec**
**DLC:** **8**

| | | Value | Detail |
|---|---|---|---|
| Byte 1 | Bit 1.1<br>Bit 1.2 | Not used | **Reserved**<br>The bits 1.1 and 1.2 are set to 11$_{(Bin)}$ |
| | Bit 1.3<br>Bit 1.4 | Torque Converter Lockup State | **Torque converter lockup engaged**<br>Bit 1.4 Bit 1.3<br>0 0 : torque converter not in lockup<br>0 1 : torque converter in lockup<br>1 0 : reserved<br>1 1 : function not supported over CAN * |
| | Bit 1.5<br>Bit 1.6 | Transmission Shift In Progress | **Reserved**<br>The bits 1.5 and 1.6 are set to 11$_{(Bin)}$ |
| | Bit 1.7<br>Bit 1.8 | Not used | **Reserved**<br>The bits 1.7 and 1.8 are set to 11$_{(Bin)}$ |
| Byte 2 | Bit 2.1 | Output shaft speed | **Output Shaft Speed**<br>Conversion:<br>output shaft speed = [ (Byte 3) * 256 + (Byte 2) ] * 0.125 [RPM]<br>65534 = fault related to the output shaft speed calculation<br>65535 = measurement not supported |
| Byte 3 | …<br>Bit 3.8 | | |
| Byte 4 | Bit 4.1<br>…<br>Bit 4.8 | Not used | **Reserved**<br>The bits 4.1 … 4.8 are set to 1111 1111$_{(Bin)}$ = 0xFF |
| Byte 5 | Bit 5.1<br>…<br>Bit 5.8 | Not used | **Reserved**<br>The bits 5.1 … 5.8 are set to 1111 1111$_{(Bin)}$ = 0xFF |

| | | | |
|---|---|---|---|
| Byte 6<br>Byte 7 | Bit 6.1<br>…<br>Bit 7.8 | Input shaft speed | **Input shaft speed**<br>Conversion: input shaft speed = [ (Byte 7) * 256 + (Byte 6) ] * 0.125 [RPM]<br>65534 = fault related to the input shaft speed calculation<br>65535 = measurement not supported |
| Byte 8 | Bit 8.1<br>…<br>Bit 8.8 | controller source address | **Source address of transmission controlling device**<br>ECON.A312 transmission controller source address = 0x03. |

*Remark: Refer to the SAE J1939-71 standard for details.*

## 2.6 ETC2: Electronic Transmission Controller #2

**Message identifier: 0x18F00503 (Hex) (CAN 2.0 B → 29 bit identifier)**

| Priority code + $R_{bit\,(=0)}$ + $DP_{bit\,(=0)}$ | Message ID | Address sender |
|---|---|---|
| **18 (Hex) = 11000 (Bin) → Priority = 6 (Dec)** | **0xF005 (Hex) = 61445 (Dec)** | **0x03 (Hex) = 3 (Dec)** |

**Originator:** **ECON.A312**
**Repetition rate:** **100 msec**
**DLC:** **8**

| | | Value | Detail |
|---|---|---|---|
| Byte 1 | Bit 1.1<br>…<br>Bit 1.8 | Transmission selected gear | **Transmission selected gear**<br>Neutral direction : 125<br>Forward direction : 125 + gear position<br>Reverse direction : 125 – gear position<br>REMARK: when parkingbrake is applied, the value is 0xFB. |
| Byte 2<br>Byte 3 | Bit 2.1<br>…<br>Bit 3.8 | Not used | **Reserved**<br>The bits 2.1 … 2.8 are set to 1111 1111(Bin) = 0xFF<br>The bits 3.1 … 3.8 are set to 1111 1111(Bin) = 0xFF |
| Byte 4 | Bit 4.1<br>…<br>Bit 4.8 | Transmission current gear | **Transmission current gear**<br>Neutral direction : 125<br>Forward direction : 125 + gear position<br>Reverse direction : 125 – gear position<br>REMARK: when parkingbrake is applied, the value is 0xFB. |
| Byte 5<br>Byte 6<br>Byte 7<br>Byte 8 | Bit 5.1<br>…<br>Bit 8.8 | Not used | **Reserved**<br>The bits 5.1 … 5.8 are set to 1111 1111(Bin) = 0xFF<br>The bits 6.1 … 6.8 are set to 1111 1111(Bin) = 0xFF<br>The bits 7.1 … 7.8 are set to 1111 1111(Bin) = 0xFF<br>The bits 8.1 … 8.8 are set to 1111 1111(Bin) = 0xFF |

*Remark: Refer to the SAE J1939-71 standard for details.*

## 2.7 CCVS: Cruise Control/Vehicle Speed

**Message identifier: 0x18FEF103 $_{(Hex)}$ (CAN 2.0 B → 29 bit identifier)**

| Priority code + R$_{bit\,(=0)}$ + DP$_{bit\,(=0)}$ | Message ID | Address sender |
|---|---|---|
| **C $_{(Hex)}$ = 11000 $_{(Bin)}$ → Priority = 6 $_{(Dec)}$** | **0xFEF1 $_{(Hex)}$ = 65265 $_{(Dec)}$** | **0x03 $_{(Hex)}$ = 3 $_{(Dec)}$** |

**Originator:** **ECON.A312**
**Repetition rate:** **100 msec**
**DLC:** **8**

| | | Value | Detail |
|---|---|---|---|
| Byte 1 | Bit 1.1 … Bit 1.8 | Not used | **Reserved**<br>The bits 1.1 … 1.8 are set to 1111 1111$_{(Bin)}$ = 0xFF |
| Byte 2<br>Byte 3 | Bit 2.1 … Bit 3.8 | Wheel-based vechicle speed | **Wheel-based vehicle speed**<br>Conversion:<br>Wheel-based vehicle speed = (Byte 3) + (Byte 2) / 256 [km/h]<br><br>65534 = fault related to the wheel based vehicle speed calculation<br>65535 = measurement not supported |
| Byte 4<br>Byte 5<br>Byte 6<br>Byte 7<br>Byte 8 | Bit 4.1 … Bit 8.8 | Not used | **Reserved**<br>The bits 4.1 … 4.8 are set to 1111 1111$_{(Bin)}$ = 0xFF<br>The bits 5.1 … 5.8 are set to 1111 1111$_{(Bin)}$ = 0xFF<br>The bits 6.1 … 6.8 are set to 1111 1111$_{(Bin)}$ = 0xFF<br>The bits 7.1 … 7.8 are set to 1111 1111$_{(Bin)}$ = 0xFF<br>The bits 8.1 … 8.8 are set to 1111 1111$_{(Bin)}$ = 0xFF |

*Remark: Refer to the SAE J1939-71 standard for details.*

## 2.8 VD: Vehicle Distance

**Message identifier: 0x18FEF103 (Hex) (CAN 2.0 B → 29 bit identifier)**

| Priority code + $R_{bit\ (=0)}$ + $DP_{bit\ (=0)}$ | Message ID | Address sender |
|---|---|---|
| **C (Hex) = 11000 (Bin) → Priority = 6 (Dec)** | **0xFEF1 (Hex) = 65265 (Dec)** | **0x03 (Hex) = 3 (Dec)** |

**Originator:** **ECON.A312**
**Repetition rate:** **100 msec**
**DLC:** **8**

| | | Value | Detail |
|---|---|---|---|
| Byte 1<br>Byte 2<br>Byte 3<br>Byte 4 | Bit 1.1<br>…<br>Bit 4.8 | Trip Distance | **Trip distance**<br>Conversion:<br>Trip distance = (byte 4) * $2^{24}$ + (byte 3) * $2^{16}$ + (byte 2) * $2^{8}$ + (byte 1) * 0.125 [km] |
| Byte 5<br>Byte 6<br>Byte 7<br>Byte 8 | Bit 5.1<br>…<br>Bit 8.8 | Total Vehicle Distance | **Total vehicle distance**<br>Conversion:<br>TVD = (byte 4) * $2^{24}$ + (byte 3) * $2^{16}$ + (byte 2) * $2^{8}$ + (byte 1) * 0.125 [km] |

*Remark: Refer to the SAE J1939-71 standard for details.*

# CHAPTER 4 : ECON.A312 DIAGNOSTICS: ERROR HANDLING & REPORTING

# 1 Diagnostics in ECON.A312

## 1.1 Purpose

The ECON.A312 is capable of detecting and handling faults to provide driver safety and diagnostic information.
To ensure this, the ECON.A312 primarily considers single faults and acts appropriately based on the interpretation of the fault:

- If a fault is considered safety critical, the ECON.A312 will act to ensure a safe transmission state.
- Faults which are not considered as safety critical will only be reported as diagnostic information and may possibly result in a reduced operation of the vehicle function.

## 1.2 Different Diagnostic areas

The ability of the ECON.A312 to detect and handle errors, also simply called diagnostics, can be divided into different categories:

### 1.2.1 Self Diagnostics

To ensure system integrity, the ECON.A312 has built-in advanced self diagnostic functionality.

### 1.2.2 Powering up

Every time the ECON.A312 is powered up, intensive checking occurs to detect possible defects of its own components (e.g. dataflash can not be read or is corrupt), which could prevent safe and correct operation of the ECON.A312.
If such a defect is detected, the ECON.A312 will activate the "ECON.A312 restricted Mode" (see chapter CHAPTER 1 – 1.4.5 for details) or even shut itself completely & immediately down if needed. As a result, all power to the outputs of the ECON.A312 will be turned off, as if the ECON.A312 would be turned off. This is done because a correct transmission control can not be guaranteed anymore.
Secondly, in this case, there will be no controlled power down, meaning that there will be no flashing of data: data residing in Ram will be lost.

### 1.2.3 During operation

The ECON.A312 has a redundant hardware watchdog system and a software watchdog system.

The ECON.A312 redundant hardware watchdog system consists of:

- An internal watchdog, part of the microcontroller
- A redundant external watchdog, independent and no part of the microcontroller. This is a backup system for the case the internal watchdog would fail.

Both watchdogs need to be triggered regularly by the software. If this is not done in time, the microcontroller is reset.
In this case, there will be no controlled power down, meaning that there will be no flashing of data: data residing in Ram memory will be lost. See also CHAPTER 1 – 1.5 for more information.

During operation, the ECON.A312 firmware makes use of this redundant hardware watchdog system to monitor the integrity of the running application:

- software triggered hardware watchdog reset:
  The ECON.A312 firmware contains an integrated task that monitors the integrity of all running application tasks. This is also referred to as the software watchdog monitor, where each task has its own software watchdog that needs to be triggered on time.
  If a specific task goes out of control, this software watchdog will detect this and reset the microcontroller by triggering an internal (or external, if needed by failure of the internal) hardware watchdog reset.
- hardware triggered watchdog reset:
  If the complete software would go out of control – meaning that the software watchdog is also not functioning anymore - the internal (or external, if needed by failure of the internal) hardware watchdog will be triggered, resetting the microcontroller.

### 1.2.4 Setup & Configuration Diagnostics

After establishing that the ECON.A312 can safely start the application (see self diagnostics above), an intensive initialization procedure is executed to check all relevant parameters that define the application for the firmware. Basically it will check if all individual parameter values are valid, but also check if there are no impossible combinations by interpreting relations between different parameters.
If any problem in the setup is detected that causes to ECON.A312 not to guarantee a safe & correct application behavior, the ECON.A312 will generate the appropriate errorcode(s).

### 1.2.5 Signal Diagnostics (in- & outputs)

Once the ECON.A312 is normal operation mode (see CHAPTER 1 – 1.4.1 for details), the most common defects are likely to be caused by electric problems related to the ECON.A312's in- and output signals.
Therefore, once the normal application logic is active, all in- and output signals are monitored continuously to check the validity of their values.
To prevent the ECON.A312 being too sensitive for small and temporary electrical glitches or peaks, a debouncing system is used. The tolerance of this debouncing can be fine-tuned for each specific signal, so the appropriate reaction is ensured for each signal type.

Depending on the type of fault detected and what function is assigned to the signal, the ECON.A312 will take the appropriate action to ensure a safe state.

- If a fault is considered safety critical, the ECON.A312 will act to ensure a safe transmission state, if needed by forcing transmission shut down mode, possibly followed by transmission limp home mode (see CHAPTER 1 – 1.4.2 & CHAPTER 1 – 1.4.3 for details).
- Faults which are not considered as safety critical will only be reported as diagnostic information and may possibly result in a reduced operation of the vehicle function.

Remark: a special case is the diagnostics on the power supply lines: if the power supply voltage is going beyond tolerance, if possible, a controlled shut down will be performed, ensuring that Ram memory data will be flashed.  If not possible, no controlled power down can be guaranteed, meaning that there will be no flashing of data: data residing in Ram memory will be lost.

### 1.2.6 Operational Logic Diagnostics

On top of checking the signals for electrical defects, interpretation of the function values deducted from those signals is done. Although a signal could be perfectly acceptable electrically, it can still result in an impossible value for application interpretation.
This is not only the case for single signal values, but especially for signals that are derived from a combination of different electrical signals.

By means of backup scenarios, transmission functionalities take into account the fact that the functional values might be wrong. In those cases, the most appropriate action is taken instead.

# 2 Error handling principle

## 2.1 Error structure

The error handling principle is based on the assumption that each error complies with the following structure:

- Error group or area:
  The identification of an individual signal, device, function or logical part that can be checked for one or more possible problems.
- Error cause:
  The identification of the type of problem that can be detected for the referenced error group. Each group can have one or more possible problems, but only 1 at a time can be active.

Independent of the diagnostic area (see CHAPTER 4 – 1.2 for details), each error group gets a register assigned to it in the ECON.A312. During power up and operation, the ECON.A312 will check all possible problems for each of these error groups and use these registers to handle all error information.

*Taking the error structure as described above into account, it is obvious that for each error group that is checked, there can only be 1 problem active at a time.*
*This is clearly illustrated if you take the example of an ECON.A312 power output (see also example error code in CHAPTER 4 – 3.1.3): this output can be shorted to ground, it can be shorted to battery plus or it can be an open circuit, but it can not have 2 or more of these problems at the same time.*

*REMARK: the error data and -structure which is described here is also called "volatile" data, meaning that when the controller is reset or powered down, data is lost.*

## 2.2 Error ranges

In the ECON.A312 there is a total of maximum 256 different error groups available.

- Groups 0 – 239 (0xEF) are defined to handle all signal and logic diagnostics but also the selftest and setup & configuration diagnostics. This means that all reporting of errors as a result of the different diagnostic areas will be handled in this range.

- Groups 240 to 255 (0xF0 to 0xFF) are reserved for handling errors related to setup problems that are the responsibility of Dana only. Additional to groups 0 to 239, this range only covers problems related to the setup the ECON.A312 for a specific application and can only be solved by Dana. These errors are needed for Dana interpretation during prototype phase only. They are not expected to occur in a normal ECON.A312 application released for production. Nevertheless these errors are a part of the ECON.A312 error range and it is therefore recommended that they are monitored and reported to Dana in the exceptional case that such an error would occur.

## 2.3 Debouncing

### 2.3.1 Purpose

In the realistic environment of a vehicle, electrical signals connected to the ECON.A312 are not always perfect.
Although correct wiring should ensure good signal stability (see also hardware documentation and wiring diagram), there can always be noise, glitches and peaks on an electrical signal.
To avoid that the ECON.A312 is extremely sensitive to the slightest electrical disturbance of a signal, error debouncing is used (on top of any signal filtering that might already be done in the hard- and software).
The behaviour of the debouncing in the ECON.A312 can be configured for each error group individually, so appropriate sensitivity can be selected depending on the diagnostic contents.

### 2.3.2 Usage

In principle the ECON.A312 will perform all error checking on the source signal, including a certain level of possible noise, glitches or peaks.
If the check detects a problem on a signal, it does not necessarily set the corresponding error immediately. Instead the detected problem is registered as pending, but not confirmed yet. Only if the problem is confirmed over a certain period of time, the error will be confirmed and the appropriate action will be taken.
Depending on the diagnostic area and the function, different debouncing behaviour will be used:

- Self diagnostics and setup & configuration diagnostics uses no debouncing. Due to the nature of the problems, debouncing makes no sense: the problem is present or not, so immediate action is needed upon detection.
- Signal diagnostics and operational logic diagnostics will use debouncing. Further distinction will be made based on the contents of each error group:
    - Safety critical errors will have more sensitive debouncing settings, to ensure good reactivity to prevent unsafe system behaviour.
    - Errors that are not safety critical can have less sensitive debouncing settings, making the ECON.A312 more tolerant but less reactive to errors.

After controller hardware & software initialization, the (debounced) error checking starts immediately, by default. However, for some errors it might be necessary to be more tolerant in the period just after the initialization. Therefor the ECON.A312 can be programmed for ignoring certain errors for a certain period after initialization. The duration of this ignorance period can be programmed separately for each error.

# 3 Error codes format

## 3.1 Format

In accordance with the SAE J1939-73 Standard, the ECON.A312 identification of error codes is composed of 2 independent fields:

### 3.1.1 Dana error group (SAE J1939: SPN “Suspect Parameter Number”)

This part of the error code identifies the individual signal, device, function or logical part where a problem is detected. In the example below this error group code identifies the ECON.A312 power output 0.
Dana group numbering ranges from 0 to 255.

For CAN reporting (see further), a direct link between the Dana error group code and the SAE J1939 SPN code is made in the ECON.A312.
Because the error groups that are needed by the ECON.A312 application are not provided in the predefined SPNs of the SAE J1939 Standard, being 0x0 to 0x7EFFF (520191).
The ECON.A312 uses the SPN number range that is available for proprietary SPNs, being 0x7F000 (520192) to 0x7FFFF (524287).

As a default the ECON.A312 uses the first available code 0x7F000 to indicate the Dana error group code 0. Consequently the following 255 SPN numbers will be used to indicate the other Dana error group codes.

Dana may investigate the possibility to change the SPN code offset to any value between 0x7F000 and 0x7FF00 if the default setting (0x7F000) would cause a conflict with other devices using the same codes for their proprietary SPNs. In all cases a block of 256 consecutive SPN codes in this proprietary range is needed by the ECON.A312.

### 3.1.2 Dana error cause (SAE J1939: FMI “Failure Mode Identifier”)

The second part of the error code indicates the type of problem that is detected for the referenced error group.
The SAE J1939 Standard provides 32 possible values to indicate the FMI. The meaning of each of these 32 FMI codes is fixed and predefined by the standard.

The ECON.A312 is fully compliant to the SAE J1939 Standard and therefore uses exactly the same codes to indicate the error cause. So the values of the Dana error cause and the SAE J1939 FMI will be identical to indicate a specific type of problem.
This means the same values are used for internal representation of the error cause and for CAN reporting by SAE J1939 FMI coding, so no conversion is needed.

In the example below this error cause code identifies the problem to be an open circuit. The error cause code to indicate this type of problem will always have the same value, regardless of the error group it refers to.

| | |
|---|---|
| ⚠ | *Exception: The error cause codes used in combination with the Dana error groups 0xF0 to 0xFF are NOT compliant to the SAE J1939 Standard FMI codes! These error groups are intended for Dana use only and therefore the causes are not to be interpreted in the standard way (as indicated by the description of these error groups).* |

### 3.1.3 Example

The following example illustrates how the error code will report an open circuit detected on the ECON.A312 power output 0.
In the error code representation, the 2 fields that form an error code are separated by a dot. This representation is commonly used in all documentation regarding the ECON.A312 error codes.

| Representation | Error code | Description |
|---|---|---|
| Dana error "group.cause" | **20.05** | Open circuit detected on ECON.A312 power output DO 0 |
| SAE J1939 "SPN.FMI" | **7F020.05** | |

# 4 Permanent Error Logging

In addition to the volatile error info, the ECON.A312 provides permanent error logging info. This permanent error logging contains a cyclic error buffer of up to maximum 50 logged errors.

This means that error information about previously active errors is still available even after the ECON.A312 has been powered down at the moment the error was active.
This allows more advanced diagnostics when a vehicle needs investigation when brought in for servicing, because a history of problems can be reported by the ECON.A312.

As mentioned, the permanent error logging contains a cyclic error buffer of up to maximum 50 logged errors.
Cyclic means that if the buffer is full and a new error needs to be logged, the oldest logged error will be overwritten. So basically the buffer can contain the 50 most recent different errors.

All logged errors that have become inactive can be cleared from the buffer upon request.

REMARK: If the same error becomes active and inactive several times, this does not mean that a new entry is made in the buffer each time. Instead each error has a counter to keep track of the number of times the error was activated.

REMARK: It is clear that the same error group can be present several times in this buffer, each time with a different failure cause. For example both error 20.04 and 20.05 can be in the buffer in case the ECON.A312 power output DO 0 has both (but not simultaneously) been shorted to ground and put in open circuit.

# 5 Error reporting

## 5.1 ECON.A312 display

As described in CHAPTER 1 – 1.12.3.3, the error display mode is a specific display mode that can be called on the integrated display.

To activate the fault display mode, simply press the ‘M’-button longer than 2 seconds. This can be done from any of the displays in the normal display mode

When pressing the button again after the ECON.A312 has presented the last available error code, two dashes are displayed, meaning that there are no more error group codes available.

*REMARK:*
*The error display mode only applies to the volatile error memory!*
*To access the permanent error logging information, either use a Dana PC tool or use the CAN messages for interpretation.*

## 5.2 CAN

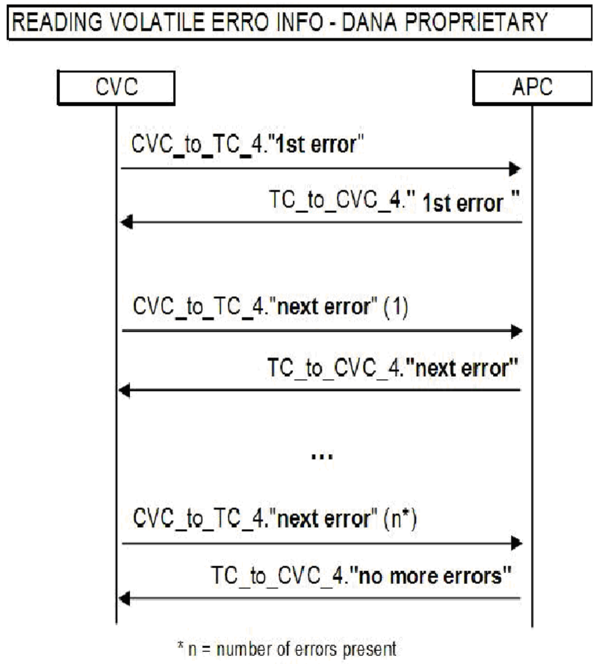
### 5.2.1 Dana proprietary messages

To access the volatile error memory only, a set of Dana proprietary CAN messages are provided in the ECON.A312. Basically these messages provide access to the volatile error memory in a very similar procedure as when using the display, but using the CAN bus.

Pro:
- It provides a simple set of single CAN frame messages to have easy access, without the need of using the SAE J1939-73 prescribed transport protocol to interpret data in multipacket CAN messages.

Con:
- These Dana proprietary messages only access the volatile error memory; it can not be used to read the permanent error logging info.
- A logical sequence of these messages must be used to read out all present error info, as the diagram below illustrates. This means these messages need some management overhead if all the error info needs to be collected and presented.

The diagram below illustrates the usage of the Dana proprietary messages to read the volatile active error info.
A similar diagram can be used for reading active and inactive error info.
For details on the data contents of these messages, Refer to CHAPTER 3 – 1.7.1.6 and CHAPTER 3 – 1.7.2.4.




## 5.2.2 SAE J1939-73 messages (recommended)

Instead of using the limited proprietary Dana protocol, the ECON.A312 supports some of the SAE J1939-73 prescribed Diagnostic Messages.

Pro:

- Standardized SAE J1939-73 diagnostic messages provide access to all error information (including error logging)
- Error info is not only available upon request, but is also broadcasted for interpretation by networked devices other than a special diagnostic tool.
- Multipacket CAN message support: all diagnostic error info is transmitted in a multipacket CAN message following the SAE J1939-21 standardized transport protocol (1 multipacket message for active and 1 for inactive errors). This means no polling mechanism is needed to read each error one by one, as with the Dana proprietary protocol.
- Any SAE J1939 compliant device can read the ECON.A312 diagnostic info.

Con:

- Support of SAE J1939 DM messages and especially transport protocol for multipacket CAN message interpretation is needed in the device that needs to read the ECON.A312 diagnostic information.

### 5.2.3 DM1: Active Diagnostic Trouble Codes

The information communicated is limited to the currently active diagnostic trouble codes.

### 5.2.4 DM2: Previously Active Diagnostic Trouble Codes

The information communicated is limited to the previously active (currently inactive) diagnostic trouble codes.

### 5.2.5 DM3: Reset of Previously Active Diagnostic Trouble Codes

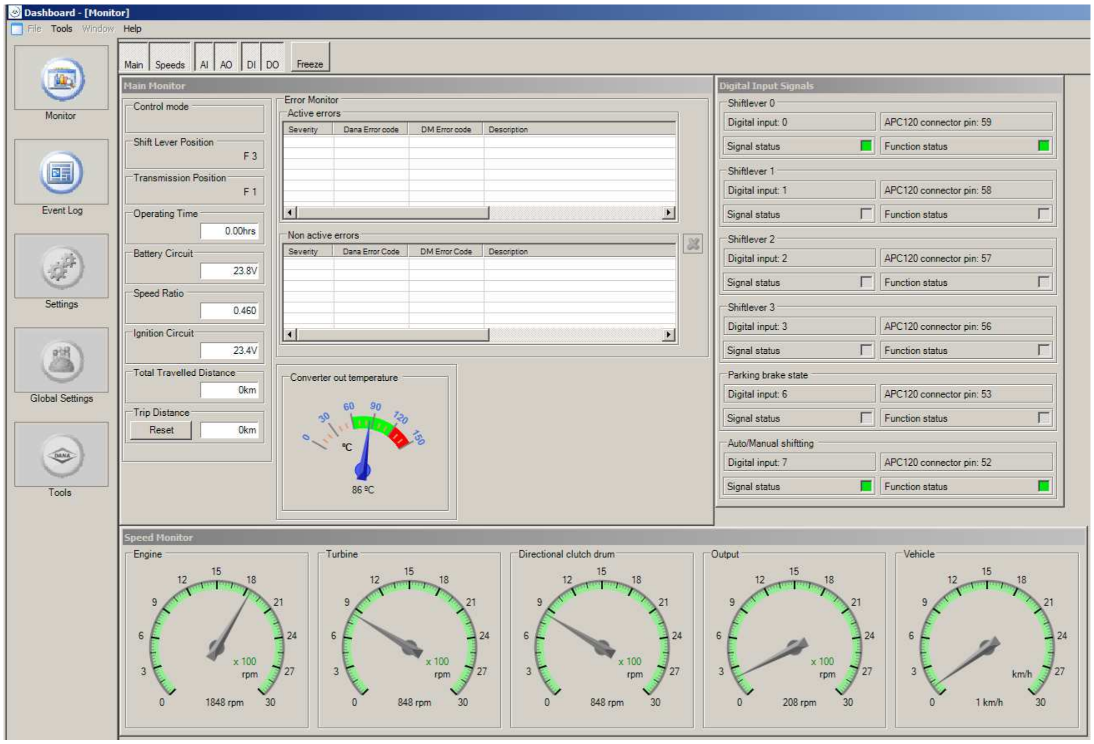
All of the diagnostic error information pertaining to the previously active (currently inactive) diagnostic trouble codes is erased.

> For details on implementation of DM1, DM2 and DM3 messages and the multipacket message transport protocol, Refer to the SAE J1939-73 & 21 Standard.

### 5.2.6 CAN based PC tool: Dashboard

Dana provides a PC tool called “Dashboard”, which also contains the functionality to handle both the volatile and the permanent error logging. On top of that, Dashboard is a multi-functional tool which also provides a lot of other features:

- signal monitoring
- data logging
- error logging
- calibration interface
- integrated specific PC tools like APT & GDE, Firmware Flashtool,…
- 2 user levels with differentiated options available (OEM definable)
- …




***Due to its specific format, a description of the Dashboard is not included directly in this user manual and is presented in a separate document. Refer to the document “Dashboard Leaflet.pdf”.***

# 6 Error Dictionary

To implement the error handling as described in the previous paragraphs of this chapter, the ECON.A312 uses a dictionary to identify all available error codes.

## 6.1 Error Groups (SAE J1939 SPNs)

The following table lists all the error groups available in the ECON.A312. It shows both the Dana error group value as the corresponding SAE J1939 SPN value that is used to identify each error group.
REMARK: the table lists all error groups that are available in the ECON.A312. Depending on the specific application, only the relevant error groups will be checked.

DANA ERROR GROUPS & SAE J1939 SPN's

SAE J1939 Proprietary SPN start address

| Dec | Hex |
|---|---|
| 520192 | 7F000 |

| Dana Group | | J1939 SPN | | Description |
|---|---|---|---|---|
| Dec | Hex | Dec | Hex | |
| 0 | 0 | 520192 | 7F000 | Digital Input 0 – pin A15 |
| 1 | 1 | 520193 | 7F001 | Digital Input 1 – pin A17 |
| 2 | 2 | 520194 | 7F002 | Digital Input 2 – pin A19 |
| 3 | 3 | 520195 | 7F003 | Digital Input 3 – pin A21 |
| 4 | 4 | 520196 | 7F004 | Digital Input 4 – pin B11 |
| 5 | 5 | 520197 | 7F005 | Digital Input 5 – pin B13 |
| 6 | 6 | 520198 | 7F006 | Digital Input 6 – pin B15 |
| 7 | 7 | 520199 | 7F007 | Digital Input 7 – pin B17 |
| 8 | 8 | 520200 | 7F008 | Digital Input 8 – pin A25 |
| 9 | 9 | 520201 | 7F009 | Digital Input 9 – pin B12 |
| 15 | F | 520207 | 7F00F | Wake Input – pin A13 |
| 16 | 10 | 520208 | 7F010 | Analog voltage type 2B input 0 – pin A9 |
| 17 | 11 | 520209 | 7F011 | Analog voltage type 2B input 1 - pin A11 |
| 18 | 12 | 520210 | 7F012 | Analog voltage type 2B input 2 - pin B3 |
| 19 | 13 | 520211 | 7F013 | Analog voltage type 2B input 3 - pin B5 |
| 20 | 14 | 520212 | 7F014 | Analog voltage type 2B input 4 - pin A10 |
| 21 | 15 | 520213 | 7F015 | Analog voltage type 2C input 0 – pin A16 |
| 22 | 16 | 520214 | 7F016 | Analog voltage type 2C input 1 – pin A18 |
| 23 | 17 | 520215 | 7F017 | Analog voltage type 2C input 2 – pin B4 |
| 24 | 18 | 520216 | 7F018 | Analog voltage type 2C input 3 – pin B8 |
| 25 | 19 | 520217 | 7F019 | Analog voltage type 2C input 4 – pin B20 |
| 26 | 1A | 520218 | 7F01A | Resistive input 0 – pin A22 |
| 27 | 1B | 520219 | 7F01B | Resistive input 1 – pin B32 |
| 28 | 1C | 520220 | 7F01C | Low side output 0 – pin A5 |
| 29 | 1D | 520221 | 7F01D | Low side output 1 – pin A8 |
| 30 | 1E | 520222 | 7F01E | Low side output 2 – pin A14 |
| 31 | 1F | 520223 | 7F01F | Low side output 3 – pin B6 |
| 32 | 20 | 520224 | 7F020 | High side output 0 – pin B19 |

| | | | | |
|---|---|---|---|---|
| 33 | 21 | 520225 | 7F021 | High side output 1 – pin B30 |
| 34 | 22 | 520226 | 7F022 | High side output 2 – pin B25 |
| 35 | 23 | 520227 | 7F023 | High side output 3 – pin B14 |
| 36 | 24 | 520228 | 7F024 | High side output 0 (with I-feedback) – pin B22 |
| 37 | 25 | 520229 | 7F025 | High side output 1 (with I-feedback) – pin B18 |
| 38 | 26 | 520230 | 7F026 | High side output 2 (with I-feedback) – pin B31 |
| 39 | 27 | 520231 | 7F027 | High side output 3 (with I-feedback) – pin A1 |
| 40 | 28 | 520232 | 7F028 | High side output 4 (with I-feedback) – pin B21 |
| 42 | 2A | 520234 | 7F02A | Speed sensor input 0 (+) – pin A3 |
| 43 | 2B | 520235 | 7F02B | Speed sensor input 1 (+) – pin A6 |
| 44 | 2C | 520236 | 7F02C | Speed sensor input 2 (+) – pin B27 |
| 45 | 2D | 520237 | 7F02D | Speed sensor input 3 (+) – pin B29 |
| 46 | 2E | 520238 | 7F02E | Speedometer output signal – pin B33 |
| 48 | 30 | 520240 | 7F030 | Digital Input Function: Declutch |
| 49 | 31 | 520241 | 7F031 | Digital Input Function: Automatic/Manual Shift |
| 50 | 32 | 520242 | 7F032 | Digital Input Function: Kickdown |
| 51 | 33 | 520243 | 7F033 | Digital Input Function: Neutral Lock Reset |
| 52 | 34 | 520244 | 7F034 | Digital Input Function: Throttle Pedal Idle Position |
| 53 | 35 | 520245 | 7F035 | Digital Input Function: Throttle Pedal Full Position |
| 54 | 36 | 520246 | 7F036 | Digital Input Function: Inching Enable |
| 55 | 37 | 520247 | 7F037 | Digital Input Function: Inching in Fwd |
| 56 | 38 | 520248 | 7F038 | Digital Input Function: Inching in Rev |
| 57 | 39 | 520249 | 7F039 | Digital Input Function: Parking Brake |
| 58 | 3A | 520250 | 7F03A | Digital Input Function: Loaded/Not loaded |
| 59 | 3B | 520251 | 7F03B | Digital Input Function: Disconnect (4WD/2WD) |
| 60 | 3C | 520252 | 7F03C | Digital Input Function: High/Low Range |
| 61 | 3D | 520253 | 7F03D | Digital Input Function: Redundant Neutral |
| 62 | 3E | 520254 | 7F03E | Digital Input Function: System Pressure |
| 63 | 3F | 520255 | 7F03F | Digital Input Function: Brake Pedal Pressed |
| 64 | 40 | 520256 | 7F040 | Digital Input Function: Operator Presence |
| 65 | 41 | 520257 | 7F041 | Digital Input Function: Seat Orientation |
| 66 | 42 | 520258 | 7F042 | Digital Input Function: Inhibit Shifting |
| 68 | 44 | 520260 | 7F044 | Digital Input Function: Oil Temperature |
| 69 | 45 | 520261 | 7F045 | Digital Input Function: Lock Up Enable |
| 70 | 46 | 520262 | 7F046 | Digital Input Function: Exhaust Brake |
| 71 | 47 | 520263 | 7F047 | Digital Input Function: Retarder Brake |
| 72 | 48 | 520264 | 7F048 | Digital Input Function: High Idle |
| 84 | 54 | 520276 | 7F054 | Limit Gear Position |
| 85 | 55 | 520277 | 7F055 | Digital Input Function: Custom Function 1 |
| 86 | 56 | 520278 | 7F056 | Digital Input Function: Custom Function 2 |
| 87 | 57 | 520279 | 7F057 | Digital Input Function: Custom Function 3 |
| 88 | 58 | 520280 | 7F058 | Digital Input Function: Custom Function 4 |
| 89 | 59 | 520281 | 7F059 | Digital Input Function: Custom Function 5 |
| 90 | 5A | 520282 | 7F05A | Digital Input Function: Custom Function 6 |
| 91 | 5B | 520283 | 7F05B | Digital Input Function: Custom Function 7 |
| 92 | 5C | 520284 | 7F05C | Digital Input Function: Custom Function 8 |
| 93 | 5D | 520285 | 7F05D | Digital Input Function: Custom Function 9 |
| 94 | 5E | 520286 | 7F05E | Digital Input Function:Custom Function 10 |
| 95 | 5F | 520287 | 7F05F | Shift lever |
| 96 | 60 | 520288 | 7F060 | Analog Input Function: Throttle Pedal |

| | | | | |
|---|---|---|---|---|
| 97 | 61 | 520289 | 7F061 | Analog Input Function: Brake Pedal |
| 98 | 62 | 520290 | 7F062 | Analog Input Function: Transmission Sump Temperature |
| 99 | 63 | 520291 | 7F063 | Analog Input Function: Transmission Cooler In Temperature |
| 101 | 65 | 520293 | 7F065 | Analog Input Function: System Pressure |
| 102 | 66 | 520294 | 7F066 | Analog Input Function: Forward Clutch Pressure |
| 103 | 67 | 520295 | 7F067 | Analog Input Function: Reverse Clutch Pressure |
| 104 | 68 | 520296 | 7F068 | Analog Input Function: Forward High Clutch Pressure |
| 105 | 69 | 520297 | 7F069 | Analog Input Function: 1st Clutch Pressure |
| 106 | 6A | 520298 | 7F06A | Analog Input Function: 2nd Clutch Pressure |
| 107 | 6B | 520299 | 7F06B | Analog Input Function: 3rd Clutch Pressure |
| 108 | 6C | 520300 | 7F06C | Analog Input Function: 4th Clutch Pressure |
| 122 | 7A | 520314 | 7F07A | Speed Sensor Input Function: Engine speed |
| 123 | 7B | 520315 | 7F07B | Speed Sensor Input Function: Turbine speed |
| 124 | 7C | 520316 | 7F07C | Speed Sensor Input Function: Drum speed |
| 125 | 7D | 520317 | 7F07D | Speed Sensor Input Function: Output speed |
| 128 | 80 | 520320 | 7F080 | APC failure over temperature |
| 129 | 81 | 520321 | 7F081 | APC failure over current |
| 130 | 82 | 520322 | 7F082 | APC failure init voltage |
| 131 | 83 | 520323 | 7F083 | APC failure ADC converter |
| 132 | 84 | 520324 | 7F084 | APC failure ground |
| 133 | 85 | 520325 | 7F085 | APC failure over power warning |
| 134 | 86 | 520326 | 7F086 | APC failure SPI |
| 135 | 87 | 520327 | 7F087 | APC failure IO Sync |
| 136 | 88 | 520328 | 7F088 | APC failure fail state enter |
| 137 | 89 | 520329 | 7F089 | APC failure jump to bootloader |
| 138 | 8A | 520330 | 7F08A | APC failure LIN communication |
| 139 | 8B | 520331 | 7F08B | APC failure CAN init |
| 140 | 8C | 520332 | 7F08C | APC failure CAN communication |
| 141 | 8D | 520333 | 7F08D | APC failure memory |
| 144 | 90 | 520336 | 7F090 | Permanent Power Supply – pin A7 |
| 145 | 91 | 520337 | 7F091 | Switched Power Supply – pin A2 & A4 |
| 146 | 92 | 520338 | 7F092 | Switched Power Supply – pin B7 & B9 |
| 147 | 93 | 520339 | 7F093 | 5V reference voltage output – pin A12 & B10 |
| 148 | 94 | 520340 | 7F094 | Internal sensor reference power supply 12V |
| 149 | 95 | 520341 | 7F095 | Internal sensor reference power supply 8V |
| 154 | 9A | 520346 | 7F09A | APC Critical Data Flash corrupt |
| 155 | 9B | 520347 | 7F09B | APC Application Data Flash corrupt |
| 156 | 9C | 520348 | 7F09C | APC Logging Data Flash corrupt |
| 157 | 9D | 520349 | 7F09D | APC application software failure |
| 158 | 9E | 520350 | 7F09E | APC application hardware failure |
| 160 | A0 | 520352 | 7F0A0 | Configuration Error: Incompatible Firmware |
| 161 | A1 | 520353 | 7F0A1 | Configuration Error: Incompatible Data File |
| 162 | A2 | 520354 | 7F0A2 | Configuration Error: I/O Double Function Assignment |
| 163 | A3 | 520355 | 7F0A3 | Configuration Error: Unavailable I/O Function Assignment |
| 164 | A4 | 520356 | 7F0A4 | Configuration Error: Impossible Function Combination Assignment |
| 176 | B0 | 520368 | 7F0B0 | Digital Output Function: Parking Brake |
| 177 | B1 | 520369 | 7F0B1 | Digital Output Function: Retarder |
| 178 | B2 | 520370 | 7F0B2 | Digital Output Function: Exhaust Brake |
| 179 | B3 | 520371 | 7F0B3 | Digital Output Function: Disconnect 4WD/2WD |
| 180 | B4 | 520372 | 7F0B4 | Digital Output Function: High Low Range Selector |

| | | | | |
|---|---|---|---|---|
| 181 | B5 | 520373 | 7F0B5 | Digital Output Function: Engine Throttle Reduction |
| 182 | B6 | 520374 | 7F0B6 | Digital Output Function: Neutral Engine Start |
| 183 | B7 | 520375 | 7F0B7 | Digital Output Function: Warning Lamp |
| 184 | B8 | 520376 | 7F0B8 | Digital Output Function: Lock Up |
| 185 | B9 | 520377 | 7F0B9 | Digital Output Function: Gear Dependant |
| 187 | BB | 520379 | 7F0BB | Digital Output Function: Custom Function 1 |
| 188 | BC | 520380 | 7F0BC | Digital Output Function: Custom Function 2 |
| 189 | BD | 520381 | 7F0BD | Digital Output Function: Custom Function 3 |
| 190 | BE | 520382 | 7F0BE | Digital Output Function: Custom Function 4 |
| 191 | BF | 520383 | 7F0BF | Digital Output Function: Custom Function 5 |
| 193 | C1 | 520385 | 7F0C1 | Can Message CVC_TO_TC_1 |
| 194 | C2 | 520386 | 7F0C2 | Can Message CVC_TO_TC_2 |
| 195 | C3 | 520387 | 7F0C3 | Can Message CVC_TO_TC_3 |
| 200 | C8 | 520392 | 7F0C8 | Can Message EEC1 |
| 201 | C9 | 520393 | 7F0C9 | Can Message EEC2 |
| 225 | E1 | 520417 | 7F0E1 | Exceed Direction Change Vehicle Speed |
| 226 | E2 | 520418 | 7F0E2 | Exceed Direction Change Engine Speed |
| 227 | E3 | 520419 | 7F0E3 | Exceed downshift protection limit |
| 228 | E4 | 520420 | 7F0E4 | Exceed Downshift Vehicle Speed |
| 229 | E5 | 520421 | 7F0E5 | Exceed transmission limit / Near transmission limit |
| 240 | F0 | 520432 | 7F0F0 | Dana Configuration error - non-standard failure mode indicator |
| 241 | F1 | 520433 | 7F0F1 | Dana Configuration error - non-standard failure mode indicator |
| 242 | F2 | 520434 | 7F0F2 | Dana Configuration error - non-standard failure mode indicator |
| 243 | F3 | 520435 | 7F0F3 | Dana Configuration error - non-standard failure mode indicator |
| 244 | F4 | 520436 | 7F0F4 | Dana Configuration error - non-standard failure mode indicator |
| 245 | F5 | 520437 | 7F0F5 | Dana Configuration error - non-standard failure mode indicator |
| 246 | F6 | 520438 | 7F0F6 | Dana Configuration error - non-standard failure mode indicator |
| 247 | F7 | 520439 | 7F0F7 | Dana Configuration error - non-standard failure mode indicator |
| 248 | F8 | 520440 | 7F0F8 | Dana Configuration error - non-standard failure mode indicator |
| 249 | F9 | 520441 | 7F0F9 | Dana Configuration error - non-standard failure mode indicator |
| 250 | FA | 520442 | 7F0FA | Dana Configuration error - non-standard failure mode indicator |
| 251 | FB | 520443 | 7F0FB | Dana Configuration error - non-standard failure mode indicator |
| 252 | FC | 520444 | 7F0FC | Dana Configuration error - non-standard failure mode indicator |
| 253 | FD | 520445 | 7F0FD | Dana Configuration error - non-standard failure mode indicator |
| 254 | FE | 520446 | 7F0FE | Dana Configuration error - non-standard failure mode indicator |
| 255 | FF | 520447 | 7F0FF | Dana Configuration error - non-standard failure mode indicator |

## 6.2 Error Causes (SAE J1939 FMIs)

This table shows all the possible error causes. Because the ECON.A312 is compliant to the SAE J1939 standard, the Dana error cause codes are identical to the SAE J1939 FMI codes.

*REMARK: The error cause codes used in combination with the Dana error groups F0 to FF are NOT compliant to this table! These error groups are intended for Dana use only and therefore, the causes are not to be interpreted in the standard way (as indicated by the description of these error groups).*
*However, this special range of error codes is not expected to be activated in an ECON.A312 application released for production.*

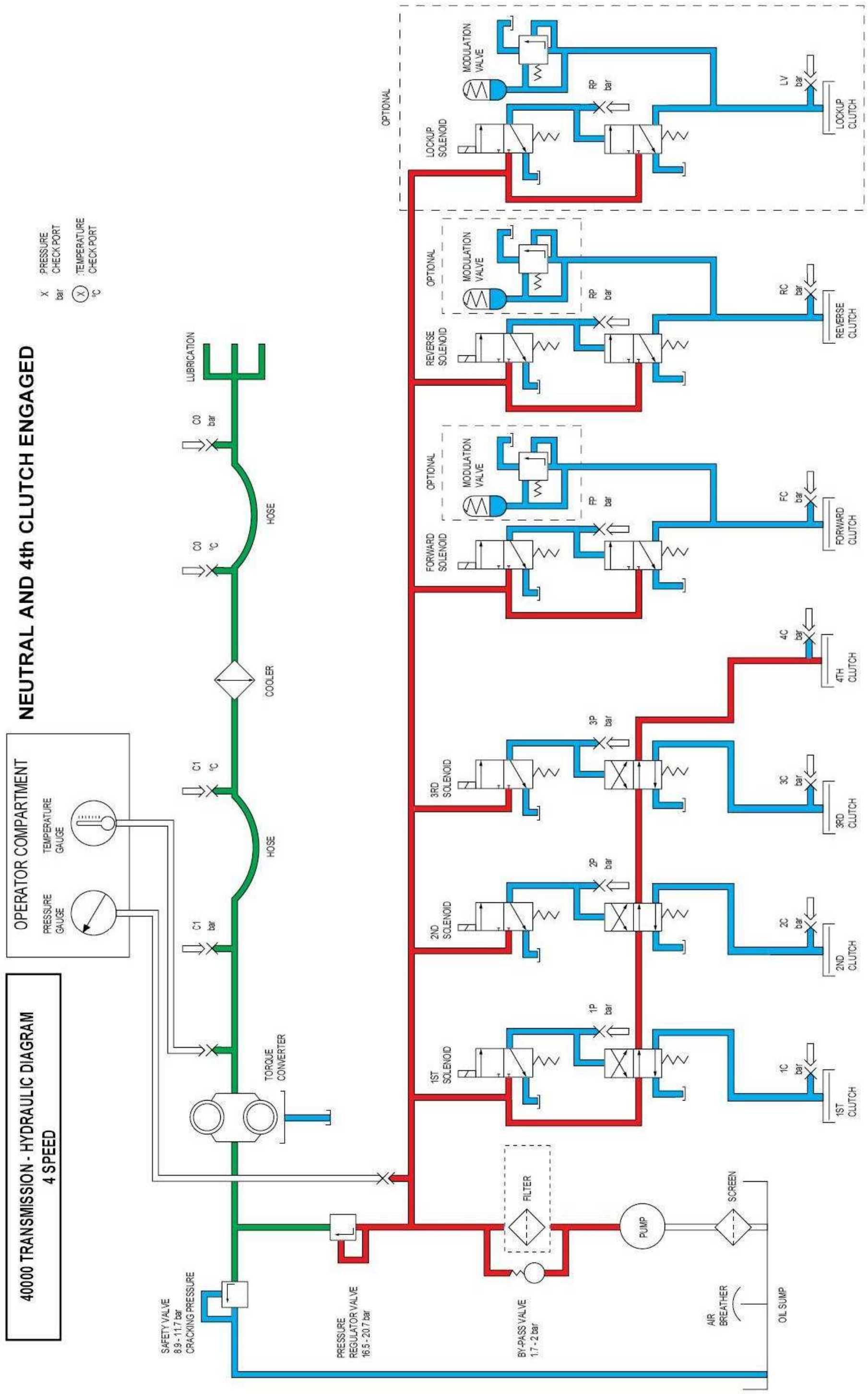
| Dana Cause = J1939 FMI | | Description |
|---|---|---|
| Dec | Hex | |
| 0 | 0 | Data Valid but Above Normal Operational Range - Most Severe |
| 1 | 1 | Data Valid but Below Normal Operational Range - Most Severe |
| 2 | 2 | Data Erratic, Intermittent, or Incorrect |
| 3 | 3 | Voltage Above Normal, or Shorted To High Source |
| 4 | 4 | Voltage Below Normal, or Shorted To Low Source |
| 5 | 5 | Current Below Normal, or Open Circuit, or Shorted to Battery+ |
| 6 | 6 | Current Above Normal, or Grounded Circuit |
| 7 | 7 | Mechanical System Not Responding, or Out of Adjustment |
| 8 | 8 | Abnormal Frequency, Pulse Width or Period |
| 9 | 9 | Abnormal Update Rate |
| 10 | A | Abnormal Rate of Change |
| 11 | B | Root Cause Not Known |
| 12 | C | Bad Intelligent Device or Component |
| 13 | D | Out of Calibration |
| 14 | E | Special Instruction (consult documentation) |
| 15 | F | Data Valid but Above Normal Operational Range - Least Severe |
| 16 | 10 | Data Valid but Above Normal Operational Range - Moderately Severe |
| 17 | 11 | Data Valid but Below Normal Operational Range - Least Severe |
| 18 | 12 | Data Valid but Below Normal Operational Range - Moderately Severe |
| 19 | 13 | Received Network Data in Error |
| 20 | 14 | SAE Reserved |
| 21 | 15 | SAE Reserved |
| 22 | 16 | SAE Reserved |
| 23 | 17 | SAE Reserved |
| 24 | 18 | SAE Reserved |
| 25 | 19 | SAE Reserved |
| 26 | 1A | SAE Reserved |
| 27 | 1B | SAE Reserved |
| 28 | 1C | SAE Reserved |
| 29 | 1D | SAE Reserved |
| 30 | 1E | SAE Reserved |
| 31 | 1F | Failure Condition Exists |

*REMARK: When a short to ground fault occurs on a high side output of the ECON.A312, and afterwards the short to ground fault disappears, the APC312 keeps reporting the short to ground fault until the ECON.A312 is powered down and reset.*

# CHAPTER 5 : APPENDICES

# 1 Hydraulic diagram example

Below a hydraulic scheme for a T40000 transmission type to illustrate the described transmission control outputs is shown. For the exact description of the operation of your specific transmission, refer to the service manual.



# 2 APC312 Hardware

***The APC312 hardware description is not included directly in this user manual, instead it is presented in a separate document.***
***Refer to the document "APC312 Hardware technical leaflet.V1.01.pdf".***

***Check the application specific wiring diagram to see how the connections to the ECON.A312 have to be made.***

## 2.1 APC312 connections

Check the application specific wiring diagram to see how the relevant signals for your specific application are connected.

# 3 Error code list

The ECON.A312 error code list shows all the possible error codes, their description and what the impact is for the ECON.A312 and for the driver. Moreover it gives an insight to what causes the problem and how to solve it.

***Due to its specific format, the referred list is not included directly in this user manual and is presented in a separate document.***
***Refer to the document "ECON.A312 Error code list - production firmware 1.11.pdf".***

# 4 History

***The history of the ECON.A312 firmware versions is described in detail in a separate document "ECON.A312 Release report – production firmware 1.11.pdf".***

# 5 Disclaimer

**Disclaimer of Liability**

We have reviewed the contents of this publication to ensure consistency with the hardware and software described. Since variance cannot be precluded entirely, we cannot guarantee full consistency. However, the information in this publication is reviewed regularly and any necessary corrections are included in subsequent editions.

**Application policiy**

Capability ratings, features and specifications vary depending upon the model type of service. Application approvals must be obtained from Dana Spicer Off-Highway Systems. We reserve the right to change or modify our product specifications, configurations, or dimensions at any time without notice.

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