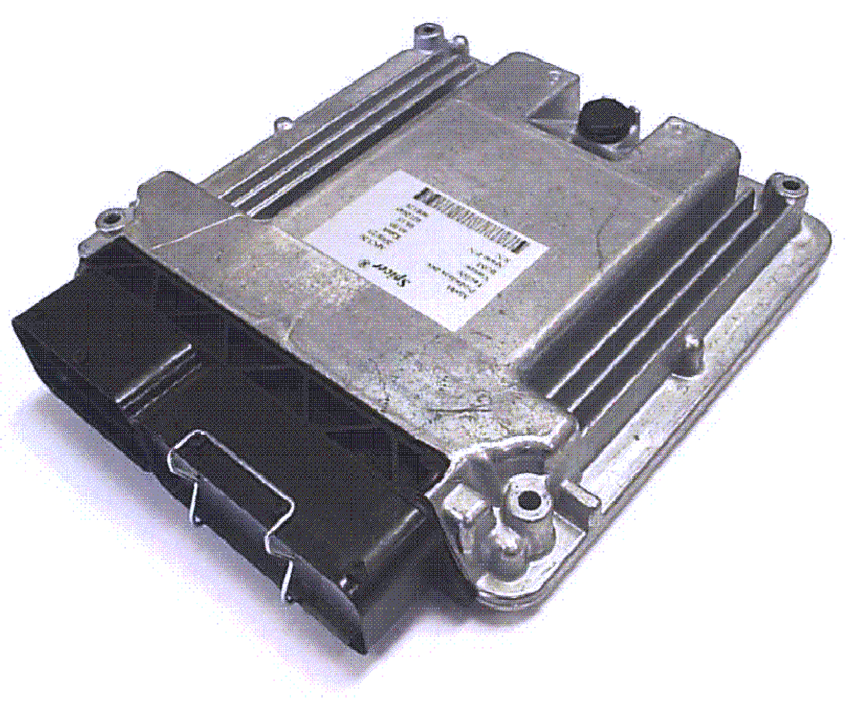
ECON.A



ECON.A User manual – prototype firmware 5.7pp

CONTENTS

WARNING NOTICE

⚠	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. Notices referring only to property damage have no safety alert symbol.

ℹ	This symbol indicates notices you have to observe.

COMPETENT AND QUALIFIED PERSONNEL

The ECON.A, 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.A, 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.A, the transmission and vehicle control systems and its circuits in accordance with established safety practices and standards.

SCOPE OF THE ECON.A USER MANUAL

The ECON.A 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.A user manual gives a detailed description of the ECON.A 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.A 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.A 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 "APC122 Hardware technical leaflet – document version V22.pdf".

CHAPTER 1 : ECON.A functional specification

1 ECON.A functional specification

1.1 General

The **ECON.A** 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.A** 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.
Thanks to the CAN 2.0B, the **ECON.A** 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.A is the APC122.
The full product name is ECON.A122, 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 “122” identifies the APC122 hardware.

1.3 Overview of the ECON.A 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.A)
- 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 the Dashboard tool)

1.4 Operating Modes

The ECON.A 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.A 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:

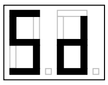
- **Normal display mode**: shows typical information useful during normal operation like selected gear, vehicle speed and shift lever position. If the ECON.A is started up without pressing the "M"-button, the ECON.A initializes in the normal display mode.
- **Diagnostic display mode**: can be activated 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.A, … . If the "M"-button is pressed while starting up the ECON.A, 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 Shutdown mode

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

This transmission shutdown mode can be recognized in the normal display "gear position". The RD.120 shows:



In this mode, the ECON.A 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 shutdown mode.

Once the vehicle has come to standstill, the ECON.A changes from the transmission shutdown mode to the transmission limphome mode.

<u>REMARK</u>: if the problem is too severe, the ECON.A remains in shutdown mode, even when the vehicle has come to standstill.

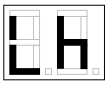
<u>REMARK</u>: if the detected problem is related to the drum speed or the output speed (from which vehicle speed is calculated), the ECON.A can not detect vehicle standstill any longer. In this case, the condition for changing from the transmission shutdown to the transmission limphome mode is not "vehicle standstill" but is a reset of the ECON.A (a reset is a controlled power down, followed by power up, refer to CHAPTER 1 – 1.5 for details).

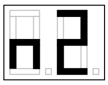
1.4.3 Transmission Limphome mode

As the name suggests, in limphome 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.A error code list “ECON.A Error code list - prototype firmware 5.7pp.pdf”. An alternative way of troubleshooting is making use of Dashboard, which shows you the error code(s) and explanation(s) immediately.

The transmission limphome mode is activated after transmission shutdown mode was active first and the transition conditions to switch to limphome mode are fulfilled (see transmission shutdown mode).

This limphome 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 limphome mode is initialized, the transmission remains in neutral, even if the shift lever were in forward or reverse. Now, the driver first has to cycle the shift lever through neutral and back into forward (or reverse) before forward (or reverse) is actually engaged on the transmission.

In limphome mode, the transmission has reduced functionality:

- Only 1 range gear is allowed by the ECON.A. This range gear is called “limphome gear”. The “limphome 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.A selects another range gear as ”limphome 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.A stays in limphome mode. To exit the limphome mode, the ECON.A 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 “limphome gear” might cause damage to the transmission. At the moment one machine is in limphome mode (e.g. in N2) and is being towed by the other machines, the transmission of the machine being towed easily reaches and exceeds its overspeeding limit. For this reason, the OEM has to inform DANA that several machines might be coupled by the end-users. In this case, the ECON.A will be programmed to stay in shutdown mode and it does not change to limphome 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 analogue 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.A Shutdown mode

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

In the ECON.A shutdown mode, all power to the outputs of the ECON.A is cut off with a relay. The transmission is forced in neutral highest gear. Only some strictly limited internal housekeeping is still done by the firmware.

REMARK: please notice the difference with transmission shutdown mode: there, the outputs are set to a safe state value in accordance with the detected problem, while in the ECON.A shutdown mode all outputs are turned off because a correct output control can not be guaranteed anymore. However, 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.A with a correct data file can solve the problem, but if it is actually an internal defect of the ECON.A, replacing the ECON.A is necessary.

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

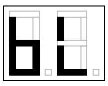
1.4.6 Bootloader mode (= programming mode)

This special mode needs to be activated in order to reprogram the ECON.A 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.A 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 powerdown

During operation of the ECON.A, data and signals are monitored to assure the correct functioning of the transmission. Also, when using DANA GDE tool or Dashboard tool, specific parameters can be set and/or adapted. To ensure that this information is safeguarded during a period of inactivity of the ECON.A, this information is automatically flashed into the ECON.A data flash memory when the ECON.A is turned off. Flashing data is triggered by the power loss on the **S**witched **Pow**er line (**SPWR** – pin 21), while the **P**ermanent **Pow**er line (**PPWR** – pin 45) stays active for an advised minimum time of 5 sec. When the flashing of the necessary information into the data flash memory is finalized, the ECON.A shuts down itself.

This process is called “controlled power down”.

<u>REMARK</u>: If an incorrect powerdown occurs (e.g. switching off the SPWR and PPWR at the same time), the data is not flashed at all (=lost) or the flashing is interrupted with the result that the data flash memory becomes corrupt. This is reported with the error code **9C.1F** after the next power up. This error is automatically removed after a new correct powerdown cyclus.

1.6 Basic connections to the ECON.A

Following paragraphs describe the basic connections to be made to the ECON.A.
These connections are commonly used by the ECON.A 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.A needs shift lever information to detect the driver’s request.

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

1.6.1.1 I/O configuration

The ECON.A 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.A 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 and Reverse position, but has no range position and no range position signals.
- CAN shift lever: the ECON.A can receive the shift lever position via the CAN message CVC_TO_TC_1. Refer to CHAPTER 3 – 1.5.1 for details.

REMARK: The ECON.A can be programmed to read the shift lever information from 2 different sources on one and the same vehicle. One shift lever is the master and the other is the slave. Possible combinations are:

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

Example 1:
(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.A 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.A must read the shift lever information from the CAN message CVC_TO_TC_1.Byte 1.

Example 2:
(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.A reads the direction position and range position of this standard shift lever.
When the standard shift lever is in neutral, the ECON.A 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

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

1.6.1.2 Function

The shift lever is used to select the desired direction and range gear. The ECON.A can be programmed with different logics and options to control the selection of directions 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.A puts 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.A puts the transmission in R2.

REMARK: When there is risk for transmission damage, the ECON.A 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.A functions (e.g. declutch, parking brake, PTO, …) 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 beyond 3rd gear.

REMARK: The ECON.A 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.A ”Purchase Order Description”.

1.6.2 Speed sensors

The ECON.A 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.A 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.A 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.A 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.A 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.A 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.A.

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.A calculates the turbine speed, the transmission output speed and the vehicle speed. These speeds are the most vital information for the ECON.A and they are used for a wide variety of ECON.A 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, a hall effect speed senor or a magneto-resistive speed sensor has to be connected to one of the 2 available ECON.A speed inputs. The type of speed sensor (inductive, hall effect or magneto-resistive) 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.A.

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.A calculates the turbine speed, the real output speed and the vehicle speed. These speeds are the most vital information for the ECON.A and they are used for a wide variety of ECON.A functionalities and 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.A by:

- Use of a speed sensor directly connected to the ECON.A:
  An inductive speed sensor or magneto-resistive speed sensor has to be connected to one of the 2 available ECON.A speed inputs. The type of speed sensor (inductive or magneto-resistive), depends on the transmission model.
- Use of a CAN message – the ECON.A 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.A.

1.6.2.3.2 Function

The engine speed information is needed for certain features of the ECON.A. 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.A power supply connections are:

BATTERY **+**

- Pin 45: **P**ermanent **Pow**er (**PPWR**) → connect directly to battery + via a 500mA **fast** fuse or a 1A **fast** fuse
- Pin 20: **P**ermanent **Pow**er (**PPWR**) → connect directly to battery + via a 10A fuse
- Pin 60: **P**ermanent **Pow**er (**PPWR**) → connect directly to battery + via a 10A fuse
  Note: pin 20 and 60 are fused together → only 1 fuse of 10A is needed.
- Pin 21: **S**witched **Pow**er (**SPWR**) → connect to the ignition key

BATTERY **-**

- Pin 05: **Gr**ou**nd (GND)** → connect directly to battery –
- Pin 44: **Gr**ou**nd (GND)** → connect directly to battery –

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

1.6.4 Transmission Control Valve

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

The ECON.A 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 shutdown”

There are several valid implementations for informing the ECON.A 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 one of the 4 analogue inputs of the ECON.A. The ECON.A reads throttle pedal position between 0 % (not pressed) and 100 % (full throttle). The ECON.A 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.A 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 one of the 4 analogue inputs of the ECON.A. The ECON.A reads throttle pedal position between 0 % (not pressed) and 100 % (full throttle). The ECON.A 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.A with the correct idle and full throttle pedal values. Refer to CHAPTER 1 – 2 for details.

REMARK: When the throttle pedal information is an analogue value 0%-100% (via EEC2, CVC_TO_TC_2, hall effect sensor or potentiometer), the ECON.A:

- uses this 0%-100% analogue value
- 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/at the throttle pedal to detect if the throttle pedal is pressed or released. If the throttle pedal is pressed, the ECON.A reads the input signal as “not idle”. If the throttle pedal is released, the ECON.A reads the input signal as “idle”. In this way, the throttle pedal position is separated in 2 zones for the ECON.A: “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 ánd “full throttle/half throttle” switch

2 Switches are installed under/at the throttle pedal:

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

With this information, the ECON.A can distinguish 3 separate zones for the throttle pedal position: “idle” zone, “half throttle” zone and “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.A.

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. Off course, if the transmission overspeeding limit is reached, the ECON.A 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 or 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. Off course, if the transmission overspeeding limit is reached, the ECON.A 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
  - o 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".
  - o 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
  - o 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.A 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 or via half effect sensor or via potentiometer
  - o 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".
  - o 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
  - o 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.

<u>Automatic lockup → use of throttle pedal information</u>
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.A 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.

<u>TSC1 engine speed control → use of throttle pedal information</u>
In case the ECON.A controls the engine speed via TSC1 for the function "engine throttle reduction", "vehicle speed limitation", "high engine idle" or "engine shutdown", the ECON.A 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.A converts the throttle pedal position % into a target engine speed in the CAN message TSC1.
When the concerned function is active, the ECON.A 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.A 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 shutdown" 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.A "Purchase Order Description".

1.7 Optional connections to the ECON.A

Besides standard transmission functionality and standard transmission protections, the ECON.A 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 "operator not present"
  - neutral lock protection

The implementation of these functions requires inputs and/or outputs. The ECON.A has 8 digital inputs and 4 analogue inputs in total. The ECON.A also has a CAN bus connection to receive functional inputs via CAN messages.

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, …) 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 8 digital inputs of the ECON.A, but it can also be wired to one of the 4 analogue inputs of the ECON.A, which in this case is functioning as a digital input. This is typically done when there are more than 8 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 52 activated), or it can have an inverted relation (e.g. declutch "off" when wire 52 activated). The wired input may be connected to a monostable or a bistable switch.

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

REMARK: It is possible to program a functional input as an OR relation of 2 or more physical inputs. E.g. the ECON.A can be programmed to read the kickdown request from 2 sources: e.g. (1) digital input DI 4 = wire 55 and (2) CAN message CVC_TO_TC_1 bit 4.1-4.2. When there is a kickdown request on digital input DI4 OR there is a kickdown request in CAN message CVC_TO_TC_1 bit 4.1-4.2, the ECON.A sees a kickdown request. It is also possible to program a functional input as an AND relation of 2 or more physical inputs.

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

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

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

The ECON.A has 9 digital outputs. These are functional outputs. "Functional" outputs refer to outputs that are controlled by the ECON.A 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,… .

REMARK: The RD.120 connections are not considered as functional outputs: the LIN communication is established with the dedicated pin n° 8 and the RD.120 is powered with the dedicated pin n° 51.

REMARK: The speedometer output is not considered as functional output: the square wave signal [-10V;+10V] is generated on the dedicated speedometer pin n° 42.

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.A 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.A 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.A takes following action:

- Force neutral and wait until the conditions are fulfilled (refer to CHAPTER 1 – 1.8.1.1 for details).
- 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 automatic mode, 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” = 3rd
  Shift lever: F4 → N4 → R4
  Transmission: F4 → N4 → R3
  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 manual mode, 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.

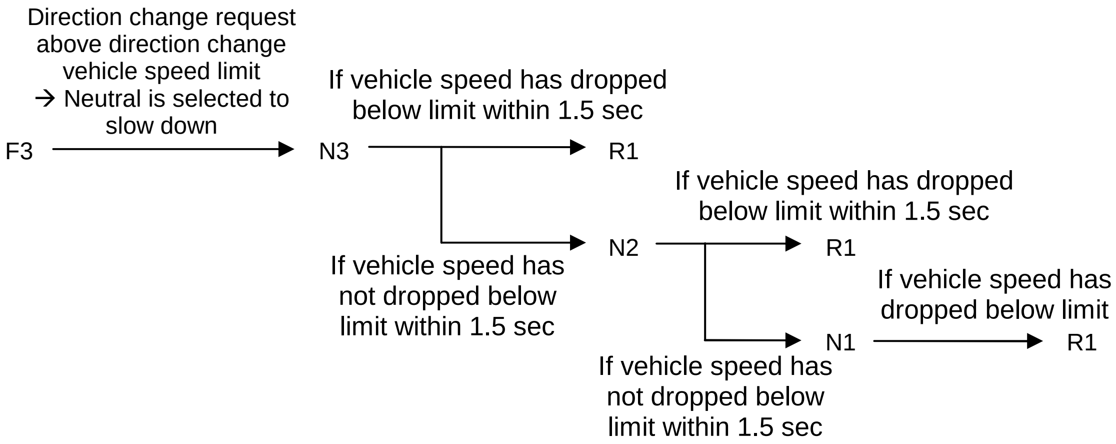
The desired behaviour can be chosen by the OEM in the ECON.A ”Purchase Order Description”.

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.A ”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.A 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 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.A:

- <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.A is programmed with safe braking downshifts.

  <u>REMARK</u>: When programmed with safe braking downshifts, the ECON.A 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 (forever) drive in a direction that is opposite to the shift lever direction. However, when the engine controller accepts the CAN message TSC1, the ECON.A can be programmed to reduce the engine speed via TSC1 speed / torque limitation. In this way, the ECON.A makes sure that the transmission direction gets equal to the shift lever direction in a reasonable time. Off course, this is only possible if there is an engine controller and if the engine controller listens to the TSC1 message from the ECON.A.

- <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.A 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" = 2nd and vehicle speed > "direction change vehicle speed limit":

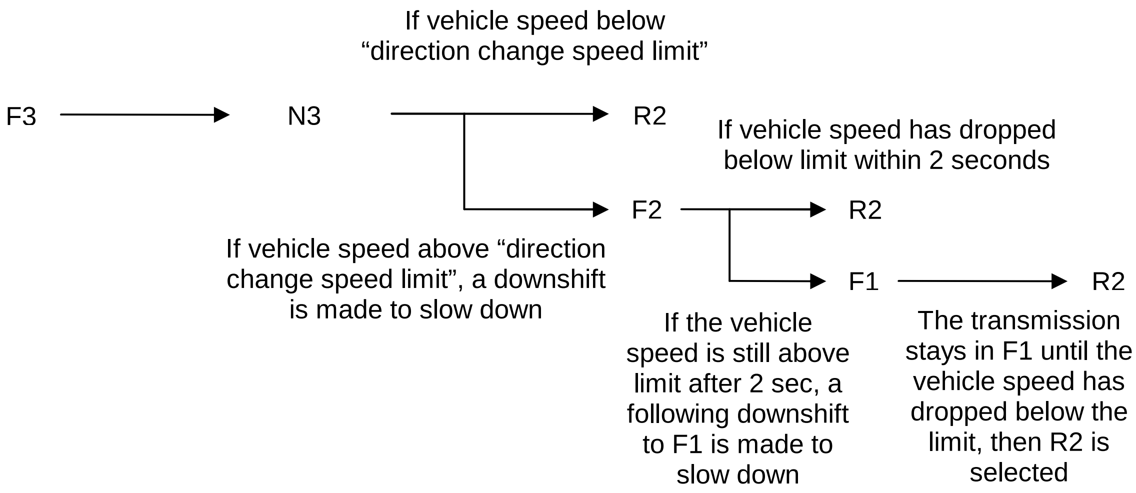
Shift lever:	F4	→	N4	→	R4		
Transmission:	F3	→	N3	→	F2 …..	→	R2
					Re-engagement of forward in lower gear (F2) to profit from engine braking		At the moment the vehicle speed has dropped below direction change vehicle speed limit

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

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

<u>Example 3</u>: 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.A ”Purchase Order Description”.

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

When a direction engagement is requested, the ECON.A 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" = 2nd

Shift lever:	N4	→	R4
Transmission:	N2	→	R2

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

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.A "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.A "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.A can also force the transmission in neutral because of other triggers, e.g.:

- During initialization, the ECON.A forces the transmission in neutral, even when the shift lever is in forward or reverse position.
- After initialization, the ECON.A 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.A 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.A 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 shutdown (refer to CHAPTER 1 – 1.4.2 for details):
  If the ECON.A detects a severe problem that makes safe transmission control impossible, the transmission shutdown mode is activated. Transmission shutdown mode disables all shift functionality and ensures a safe transmission condition (neutral highest gear).
- ECON.A shutdown (refer to CHAPTER 1 – 1.4.5 for details):
  If the ECON.A has detected an internal problem, it automatically switches to the ECON.A shutdown mode. As a result all power to the outputs of the ECON.A 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.A, 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.A "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.A application are normally different and depend on the calculations in the approval.

1.9.1 Manual / automatic mode selection

The ECON.A 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.A by:

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

In stead of a bistable selection switch, the ECON.A 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.A 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.A 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.A can be programmed to add force manual mode when a direction engagement (Fwd or Rev) happens.
  Remark: The ECON.A 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.A will also interpret this up-or downshift request as a real up- or downshift request: the ECON.A will execute an up- or downshift on the transmission.
- "Shift lever position based" manual/automatic selection. The mode depends on the range position of the shift lever. 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.A.

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.A 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.A 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.A 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.A 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 can never occur.

The desired behaviour can be chosen by the OEM in the ECON.A ”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.

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

Some examples:

E.g. Suppose a 4/4 speed transmission, with 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.A 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. Suppose a 4/4 speed transmission, with shift lever and transmission 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.A 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.A 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.A parameter "lowest gear in automatic mode"

Example: A 4/4 speed transmission with ECON.A programmed with "lowest gear in automatic mode" = 2nd and the shift lever is in F3. In this situation, the ECON.A lets the transmission shift automatically between F2 and F3.

REMARK: Other functions programmed in the ECON.A 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)" = 1st while "lowest gear in automatic mode (empty)" = 2nd. 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.A. 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.A calculates the turbine speed from the measured drum or output speed sensor. The ECON.A measures the engine speed with the engine speed sensor or receives the engine speed information via the CAN message EEC1. The ECON.A then calculates the converter slip = speed ratio as:

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

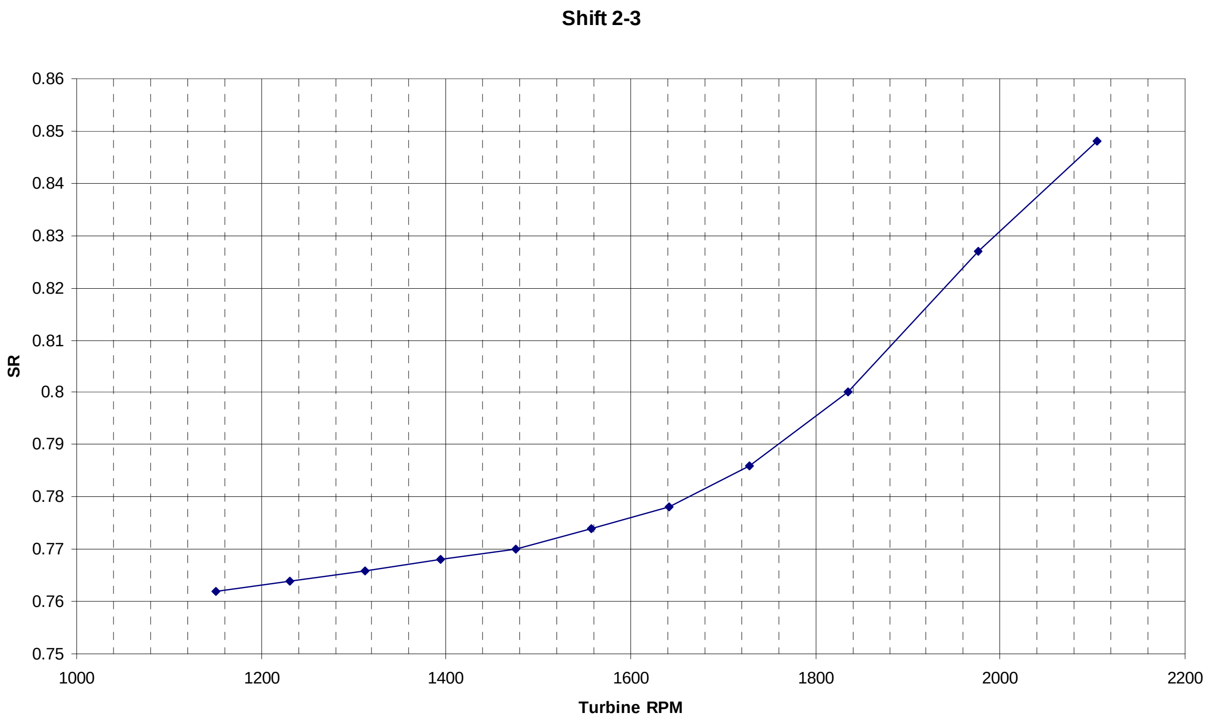
The actual speed ratio is a measure for the actual load in the torque converter and is a measure for the actual tractive effort of the vehicle.

In this way the ECON.A 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.A and is used to trigger automatic upshifts.

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

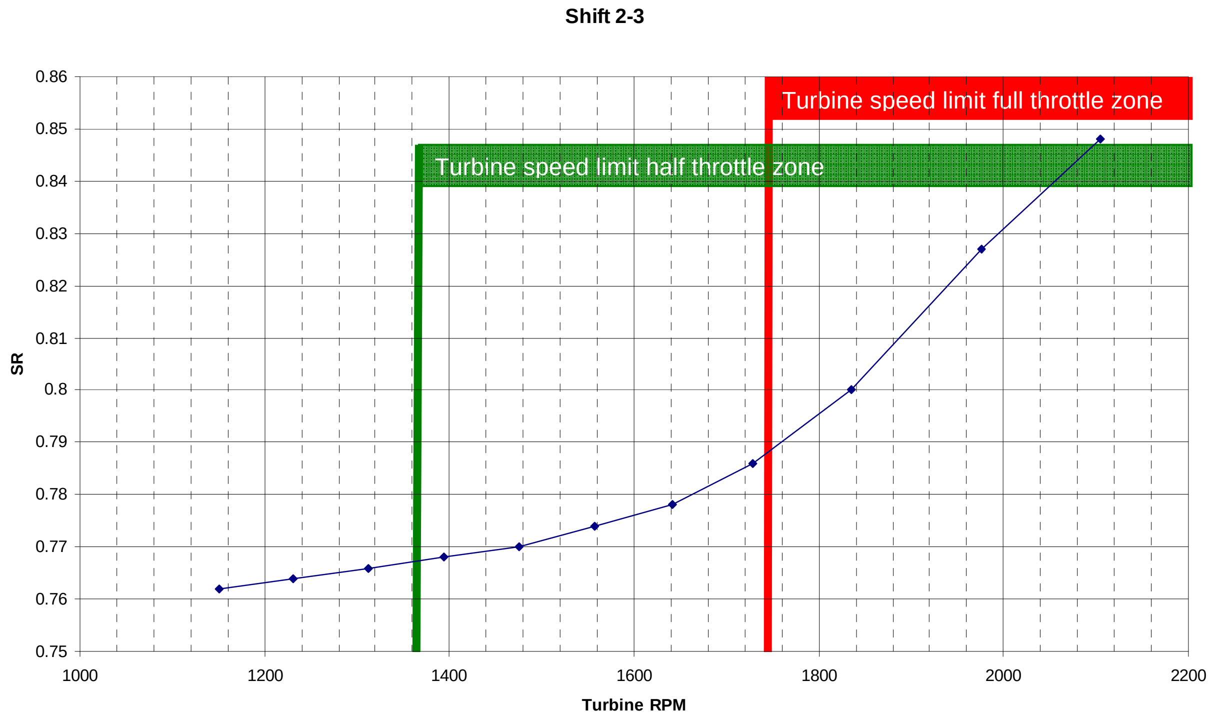


REMARK: typically the speed ratio's for load sensed automatic upshifts are between 0.60 ~ 1.00.

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)

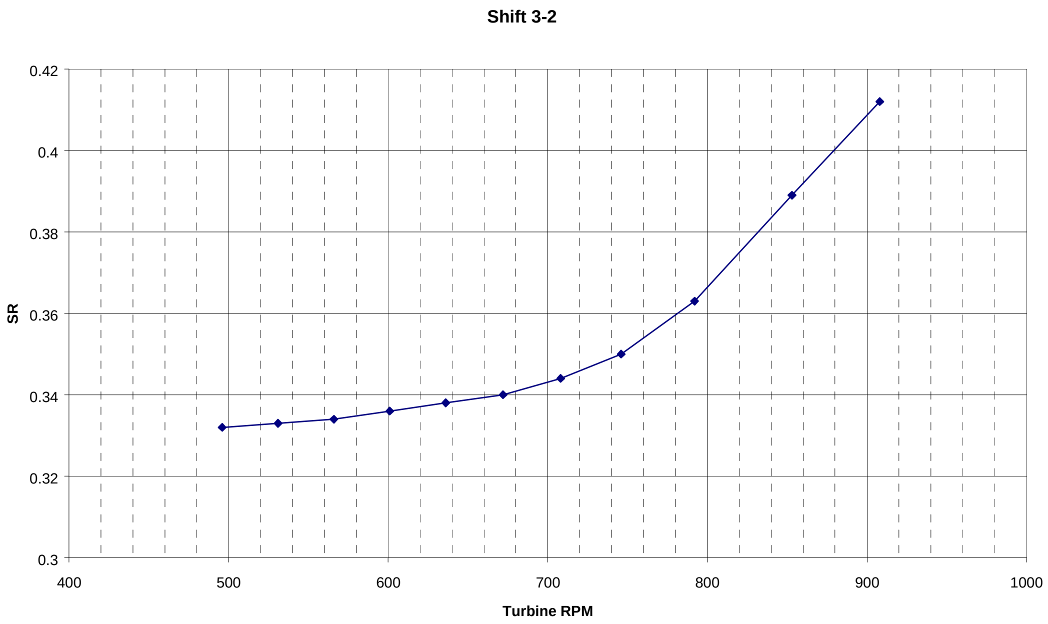
In order to give the automatic shifting a more dynamic behaviour, upshifts are only allowed above a certain turbine speed limit. There is a separate limit for the half throttle zone and for the full throttle zone.



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.A and is used to trigger automatic downshifts.

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



REMARK: 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.A 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.

REMARK: By default, the ECON.A 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.A, 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.A "Purchase Order Description".

1.9.4.2 Speed sensed automatic shifting

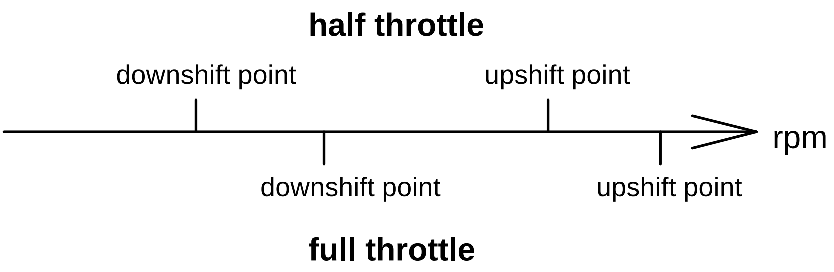
Speed sensed automatic shifts are executed at fixed turbine and vehicle speeds. The engine speed is not taken into account. In this way, speed sensed automatic shifting does not take care about the load in the converter. This last statement is not 100% correct, because there are separate upshift and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

The ECON.A 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

REMARK: 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.

REMARK: 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.

REMARK:

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.A 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.

Off 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.A 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.

Off 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.

<u>REMARK</u>: These overspeeding upshifts are made in automatic and in manual mode.

<u>REMARK</u>: 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.A 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.

<u>REMARK</u>: 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” = 2^{nd}
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.

<u>REMARK</u>: 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.A. 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 analogue input

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

- A pressure switch wired to a digital input. The pressure switch generates an active signal when the system pressure is too low and no 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 analogue pressure sensor. The OEM can order an analogue pressure sensor from DANA: part number 4212000. This pressure sensor is supplied as ship loose part with the ECON.A. 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 not 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.A.

1.10.5.2 Function

When the ECON.A detects that the system pressure is too low, the ECON.A 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: Due to the mechanical design of the transmission, 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.A 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.A ”Purchase Order Description”.

1.10.6 Converter out temperature protection

Converter out temperature protection is an optional transmission protection.

It 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 analogue input

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

- A temperature switch wired to a digital input. The temperature switch generates an active signal when the converter out temperature is above 120° C and no signal if 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 analogue temperature sensor. The OEM can order an analogue temperature sensor from DANA: part number 4211988. This temperature sensor is supplied as ship loose part with the ECON.A. 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 not 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.A.

1.10.6.2 Function

When the ECON.A detects that the converter out temperature is too high (above 120°C), the ECON.A forces the transmission in neutral after a certain time. 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.A ”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.A by:

- Use of a wired input
- Use of a CAN message – the ECON.A 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.A.

1.11.1.2 Function

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

The ECON.A 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.A. Refer to CHAPTER 1 – 1.11.11 for details.

- Unconditional acceptation: as soon as the seat orientation signal toggles, the ECON.A 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.A 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.A ”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 the 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.A 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

Necessary I/O: 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.

The declutch signal can be supplied to the ECON.A by:

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

REMARK: An echo of the 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.A.

1.11.2.2 Function

When declutch is requested, neutral is forced on the transmission, and when declutch is not requested anymore, the ECON.A 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.A "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 with his knee when stepping out of the vehicle.

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.A 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.A by:

- Use of a wired input
- Use of a CAN message – the ECON.A 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.A.

1.11.3.2 Function

When the operator presence switch detects that there is no operator in the operator's seat, the ECON.A 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.A 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.A.

There is an alternative implementation: when the operator presence switch detects that the operator has returned in the operator's seat, the ECON.A 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 pressed/released → refer to CHAPTER 1 – 1.11.17 for details
- declutch request → refer to CHAPTER 1 – 1.11.2 for details

The ECON.A 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.A "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 driver hits the shift lever with his knee when stepping out of the vehicle.

<u>REMARK</u>: "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

<u>Necessary I/O</u>: 1 digital input (standard and CAN shift lever)
or none (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.A by:

- Use of a wired input
- Use of a CAN message – the ECON.A 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.A.

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.A assumes that the operator is not in the operator's seat (anymore) and forces the transmission in neutral.

REMARK: Off 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 (= reset) 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.

The desired behaviour can be chosen by the OEM in the ECON.A "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.A by:

- Use of a wired input

The "neutral lock reset" signal can be connected to the ECON.A by:

- Use of a wired input
- Use of a CAN message – the ECON.A can receive the "neutral lock reset" 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.A.

1.11.5.2 Function

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

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

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: 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.A "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.A 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.A by:

- Use of a wired input
- Use of a CAN message – the ECON.A 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.A.

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.A 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.A “Purchase Order Description”.

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

When the ECON.A 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.A ”Purchase Order Description”.

1.11.7 Range shift inhibition

With the “range shift inhibition” function, the ECON.A 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.A 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.A by:

- Use of a wired input
- Use of a CAN message – the ECON.A 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.A.

1.11.7.2 Function

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

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.A ”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.A 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.A by:

- Use of a wired input
- Use of a CAN message – the ECON.A 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.A.

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.A.

1.11.8.2 Function

Combinations of kickdown and range shifting
The rules for combinations are:

- on 1 application you can only have 1 type of kickdown: manual or 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

The valid combinations are:

- application with only manual range shifting and with manual kickdown
- application with only manual range shifting and with automatic kickdown
- application with only automatic range shifting and with manual kickdown
- application with only automatic range shifting and with automatic kickdown
- application with manual and automatic range shifting and with manual kickdown
- application with manual and automatic range shifting and with automatic kickdown

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.A 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.A can be programmed to allow automatic upshifts out of kickdown.

REMARK: When there is a kickdown request, the ECON.A “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.A 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.A 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.A 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: between consecutive kickdown downshifts, the normal “range shift delays” are applicable. The “range shift delays” are also applicable for an upshift out of kickdown.

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 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 → automatic kickdown → F1 (in kickdown mode) → engine speed and turbine speed sufficiently high to make an automatic upshift → F2 (not in kickdown mode anymore)

The desired behaviour can be chosen by the OEM in the ECON.A ”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 a 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.A to inform that this brake is active. At that moment the, the ECON.A 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.A 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
- Feedback signal “exhaust brake active”
- Feedback signal “retarder active”

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 active” feedback signal and/or the “retarder active” feedback signal can be supplied to the ECON.A by:

- Use of a wired input
- Use of a CAN message – the ECON.A 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 active” feedback signal and/or “retarder active” feedback signal), the throttle pedal and the speed sensors need to be connected to the ECON.A.

1.11.9.2 Function

The ECON.A can be programmed to operate in manual lockup mode or to operate in automatic lockup mode. The ECON.A can not 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 or retarder is activated, while manual lockup is not requested, the ECON.A activates lockup. The exhaust brake and retarder function have priority over the manual lockup function.

Automatic lockup

The driver enables the automatic lockup mode with an “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 or retarder is activated, while automatic lockup mode is disabled, the ECON.A activates lockup. The exhaust 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.A activates and deactivates the converter lockup automatically based on:

- Engine speed
- Turbine speed
- Throttle pedal position

The ECON.A 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.A also checks that the engine speed is sufficiently above the engine idle speed, before it engages lockup.

The ECON.A 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.A 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 active

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

- the turbine speed is above its “exhaust brake lockup engagement” limit
- the engine speed is sufficiently above the engine idle speed

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

The ECON.A disengages lockup automatically when the turbine speed (= engine speed) drops below its “exhaust brake lockup disengagement” limit or when the exhaust brake is deactivated again.

REMARK: The exhaust brake function has priority over the manual and automatic lockup function.

Lockup engagement when retarder active

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

- the turbine speed is above its “retarder lockup engagement” limit
- the engine speed is sufficiently above the engine idle speed

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

The ECON.A disengages lockup automatically when the turbine speed (= engine speed) drops below its “retarder lockup disengagement” limit or when the retarder is deactivated again.

REMARK: The retarder function has priority over the manual and automatic lockup function.

The desired behaviour can be chosen by the OEM in the ECON.A ”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.A 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.A 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.A, all outputs are off. This means that the neutral engine start output of the ECON.A 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.A 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.A 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.A 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.A)

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.A.

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.A 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.

<u>REMARK</u>: During initialization of the ECON.A, 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.A 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.A "Purchase Order Description". However, if the OEM insists on having the "neutral engine start" function controlled by the ECON.A, this should be requested on page 6 of the "Purchase Order Description", where special requests can be formulated.

1.11.11 Parking Brake

When the parking brake is applied, the ECON.A 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

<u>I/O configuration for standard parking brake</u>:

- 1 digital input to read the parking brake state

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

- 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.A by:

- Use of a wired input
- Use of a CAN message – the ECON.A 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.

<u>REMARK</u>: 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.A.

1.11.11.2 Function

Standard functionality for the parking brake:

- The ECON.A 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.A receives a parking brake request. When parking brake is requested and the vehicle is at standstill, the parking brake is applied by an ECON.A 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.A 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.A 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.A output. When the parking brake request disappears, the parking brake is released by the same ECON.A 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.A can be programmed to allow forward (or reverse) selection immediately when the parking brake is released. This means that the ECON.A does not wait for the driver to cycle the shift lever through neutral and to reselect forward (or reverse).

REMARK: If desired, the ECON.A 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 "optional parking brake functionality n° 1": the ECON.A 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 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.A by use of a wired input.

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

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.A output)
- the engine speed is sufficiently low

When these conditions are fulfilled, forward (or reverse) is engaged and at the same time the parking brake is released (with the ECON.A output). Now the vehicle drives off. The range gear in which the vehicle drives off, is equal to the range gear that was obtained in neutral.

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.A 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 vehiclespeed". 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.A by:

- Use of a wired input
- Use of a CAN message – the ECON.A 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.A.

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.A.

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.A.

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.A waits till the vehicle comes to standstill. When the vehicle has stopped, the ECON.A 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.A 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.A "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.
- 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. When the digital input is inactive, all gears are available.

1.11.14.1 I/O configuration

<u>Necessary I/O</u>:
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.A 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.

<u>REMARK</u>: 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.A.

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

<u>REMARK</u>: When the “block out highest gear(s)” function is active, 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.

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

<u>REMARK</u>: Another name for this function is: “limit gear position”.

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
analogue throttle pedal information

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

- Use of a wired input
- Use of a CAN message – the ECON.A 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.

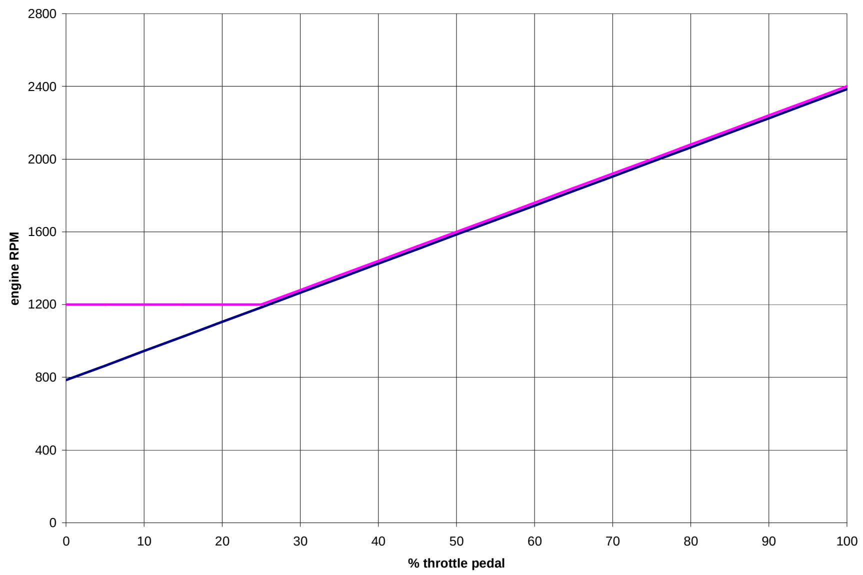
The analogue throttle pedal information can be supplied to the ECON.A by use of a throttle pedal sensor wired to an analogue input or via the CAN message EEC2 (refer to CHAPTER 2 – 2.3 for details) or via the CAN message CVC_TO_TC_2 (refer to CHAPTER 2 -1.5.2 for details).

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

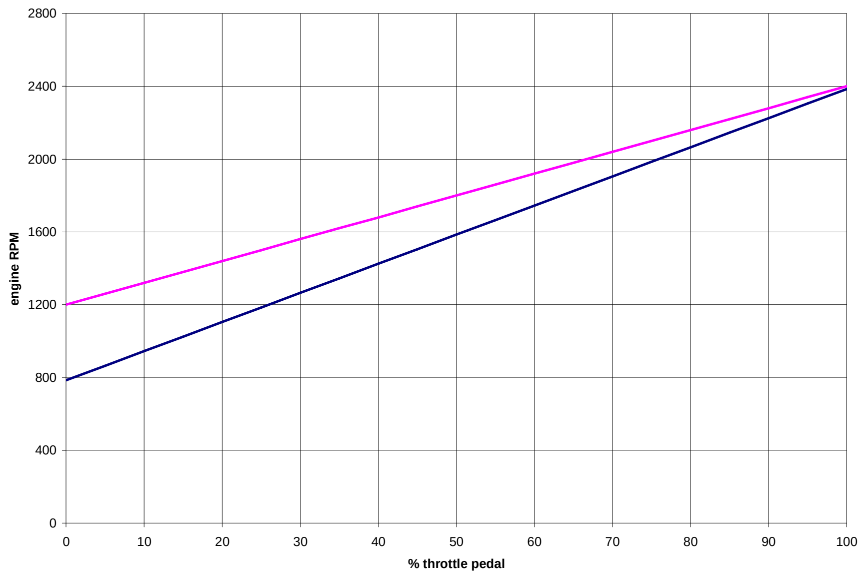
1.11.15.2 Function

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.A. 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:



REMARK: 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.A "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.A by:

- Use of a wired input
- Use of a CAN message – the ECON.A 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.A.

1.11.16.2 Function

If the driver toggles the selection from 4WD to 2WD (or vice versa), the ECON.A waits till the vehicle comes to standstill. When the vehicle has stopped, the ECON.A 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.A 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.A ”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 analogue signal

The service brakes state “pressed” or “released” can be supplied to the ECON.A by:

- Use of a position or pressure switch that shares its information via:
    - a wired digital input signal
    - a CAN message – the ECON.A 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 analogue input signal
    - a CAN message – the ECON.A 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.A.

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.A ”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.A 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.A by:

- Use of a wired input
- Use of a CAN message – the ECON.A 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.A.

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.A waits till the vehicle comes to standstill. When the vehicle has stopped, the ECON.A 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.A (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.A ”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.A by:

- Use of a wired input
- Use of a CAN message – the ECON.A 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.A.

Optionally, a second digital output can be activated by the ECON.A 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.A 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.A waits till the vehicle comes to standstill. When the vehicle has stopped, the ECON.A 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.A 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.A 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.A ”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

Necessary I/O: Sump temperature information can be shared with the ECON.A via an analogue temperature sensor. The OEM can order an analogue temperature sensor from DANA: part number 4211988. This temperature sensor is supplied as ship loose part with the ECON.A. 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.A.

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.A 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.A to limit the vehicle speed to a predefined (= programmed) value.

1.11.21.1 I/O configuration

The J1939-71 compliant CAN message TSC1 is used by the ECON.A 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.A.

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

In case the CAN message TSC1 is broadcasted by the ECON.A, but the ECU can not read the CAN message TSC1 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.A. 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.A 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.A 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.

REMARK: The ECON.A 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.A vehicle speed limitation function is limited.

1.11.22 Engine shutdown

When the vehicle has been standing still in neutral for a certain time (e.g. 5 minutes), the ECON.A 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 shutdown” 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 shutdown” output needs to be connected to the ECON.A.

1.11.22.2 Function

The ECON.A activates the engine shutdown 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 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.A ”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.A.

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 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 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.A ”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.A 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 CAN message TSC1 in 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.A 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.A.

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

In case the CAN message TSC1 is broadcasted by the ECON.A, but the ECU can not read the CAN message TSC1 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.A. 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.A limits the engine torque via CAN message TSC1 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 (service) 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 42 of the ECON.A.

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

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

1.11.25.2 Function

The speedometer output of the ECON.A is a frequency output (pin n° 42) that generates a square wave signal between -10V and +10V. The frequency of the speedometer signal is proportional to the vehicle speed.

In the ECON.A "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.A "Purchase Order Description". This conversion factor will then be programmed in the ECON.A.

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.A.

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.A 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.A 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.A 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.A 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.A ”Purchase Order Description”.

1.11.27 Warning lamp output

The “warning lamp output” function is used to warn the driver of dangerous conditions for 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.A 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.A.

1.11.27.2 Function

The warning lamp output function is used to warn the driver of dangerous conditions for 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.A 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

REMARK: In case there is a free digital output, the warning lamp output is programmed by default in the ECON.A program and it is programmed by default with all above mentioned warning lamp triggers. If the warning lamp should not be activated for your application, please uncheck the warning lamp selection box in the ECON.A "Purchase Order Description".

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.A 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.A.

1.11.28.2 Function

The ECON.A 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.A "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.A.

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.A does not know whether the transmission is in high range or in low range. In this case, as a safety measure, the ECON.A122 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.A is correct. However, when the transmission is mechanically in the low range, the vehicle speed calculation by the ECON.A is too high. Although the vehicle speed is not correct in this case, the transmission is continuously protected by the ECON.A, because the ECON.A 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.A 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.A 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.A calculates the real vehicle speed and shows it correctly on the RD.120 and in the concerned CAN messages and the ECON.A puts the correct frequency on the speedometer output pin 42, resulting in correct vehicle speed readout on the speedometer.

<u>REMARK</u>: this function cannot be combined with the function “high/low range”. Refer to CHAPTER 1 – 1.11.13 for details.

1.11.30.1 I/O configuration

<u>Necessary I/O</u>:

- 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.A 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
OFF	OFF	Neutral position
OFF	ON	Low range
ON	OFF	High range
ON	ON	Impossible combination

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

1.11.30.2 Function

On a transmission with mechanical high/low range, the ECON.A can not 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.A 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.A 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.A. In this case, the ECON.A shows "- -" in the RD.120 display "SP" (vehicle speed in km/h) and in the RD.120 display "rS" (vehicle speed in mph). The ECON.A 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.A.

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.A reacts in the same way as when both position switches are OFF. Additionally the ECON.A gives error codes "5X.02" and "5Y.02" reflecting the impossible combination.

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

1.12 RD.120 display

The ECON.A 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 for the APC**120**). The RD.120 is optional and can be selected in the POD ("Purchase Order Description") of the ECON.A.
The communication between the ECON.A and RD.120 is established with the dedicated LIN bus.

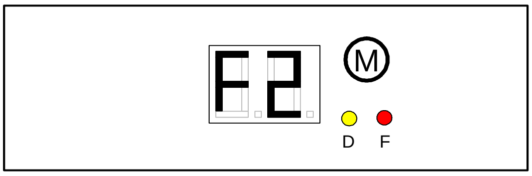
1.12.1 RD.120 – hardware

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

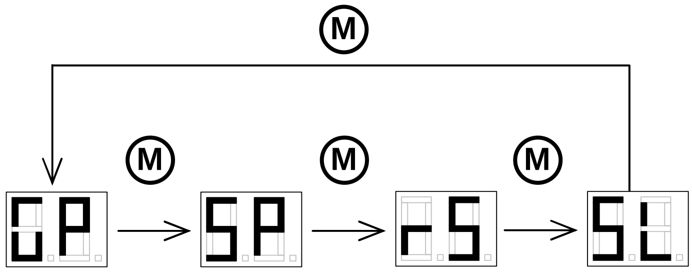
1.12.2 RD.120 – display modes

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.A is started up without pressing the "M"-button, the ECON.A 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.A, etc. If the "M"-button is pressed while starting up the ECON.A, 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.

1.12.2.1 Normal display mode

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

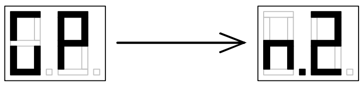


Changing between the different displays is done by pressing the "M"-button.

REMARK: The ECON.A 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.



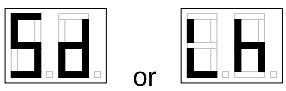
As long as the "M"-button is pressed "GP" (**G**ear **P**osition) is shown on the display. When the "M"-button is released, the display changes to the actual direction and range gear.

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.

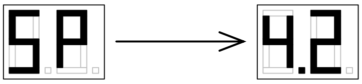
When the transmission range gear is higher than the shift lever range position in automatic mode or when the transmission range gear is different than the shift lever range position in manual mode, the dot after the range gear indication blinks.

REMARK: 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

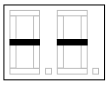
This display shows the vehicle speed expressed in km/h.



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.

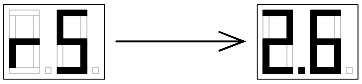
REMARK: The RD.120 shows two dashes (as illustrated below) when the vehicle speed is not available:



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

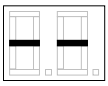
This display shows the vehicle speed expressed in mph.



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.

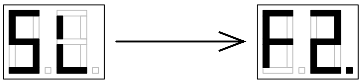
REMARK: The RD.120 shows two dashes (as illustrated below) when the vehicle speed is not available:



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.

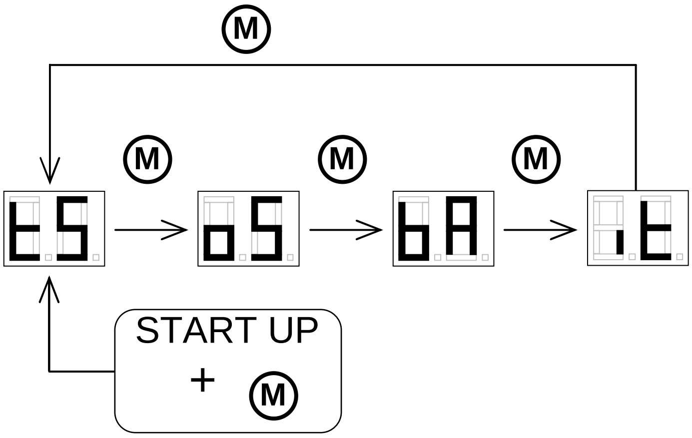
If the shift lever direction differs from the actual transmission direction, the dot after the direction indication blinks.

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).

1.12.2.2 Diagnostic display mode

This display mode is activated by pressing the "M"-button during power up of the ECON.A. 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.A itself.

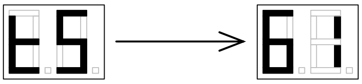
By default, the diagnostic display mode contains **at least** the following displays:



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

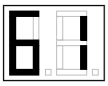
1.12.2.2.1 Turbine speed display

This display shows the actual turbine speed.

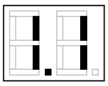


REMARK: As long as the "M"-button is pressed (however less than 2 sec.), "tS" (**t**urbine **S**peed) is shown on the display. When the "M"-button is released, the display changes to the actual turbine speed value.

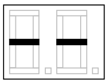
For speeds below 1000 rpm, turbine speed is shown with 10 rpm resolution. The below example shows a turbine speed between 605 and 614 rpm:



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:



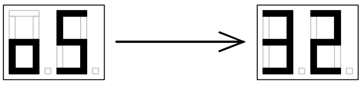
REMARK: The RD.120 shows two dashes (as illustrated below) when the turbine speed is not available:



Typically this is the case when the transmission is in neutral (in neutral the ECON.A 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.

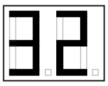
1.12.2.2.2 Output speed display

This display shows the actual output speed.

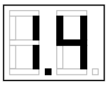


REMARK: As long as the "M"-button is pressed (however less than 2 sec.), "OS" (**O**utput **S**peed) is shown on the display. When the "M"-button is released, the display changes to the actual output speed value.

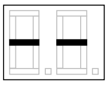
For speeds below 1000 rpm, output speed is shown with 10 rpm resolution. The below example shows an output speed between 315 rpm and 324 rpm:



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:



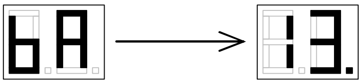
REMARK: The RD.120 shows two dashes (as illustrated below) when the output speed is not available:



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

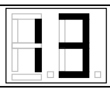
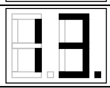
This display shows the battery supply voltage.



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.

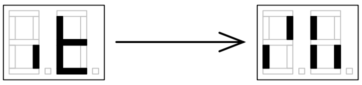
This display shows the battery supply voltage on the switched power line. When the decimal part of the supply voltage is lower than 0.5 V, no unit dot is lights up. When the decimal part is equal to or greater than 0.5V, the unit dot lights up.

Examples:

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

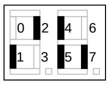
1.12.2.2.4 Input test display

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



REMARK: As long as the “M”-button is pressed (however less than 2 sec), “it” (**i**nput **t**est) is shown on the display. When the “M”-button is released, the display changes to the actual input test.

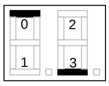
The input test shows the status of digital input 0 to digital input 7. When the input is activated, the corresponding segment lights up.



Input test layout

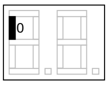
The above example shows that digital inputs 1, 2, 4, 5 and 7 are activated.

When an analogue input is used as a digital input, the input test shows the status of this analogue input. When the input is activated, the corresponding segment lights up.

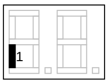


Input test layout

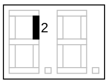
The above example shows that analogue inputs 0 and 3 are used as digital inputs and that they are activated. Analogue inputs 1 and 2 or not activated or they are not used as digital input.



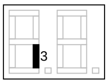
This segment lights up when digital input 0 on wire 59 is activated.



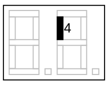
This segment lights up when digital input 1 on wire 58 is activated.



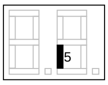
This segment lights up when digital input 2 on wire 57 is activated.



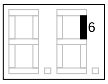
This segment lights up when digital input 3 on wire 56 is activated.



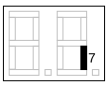
This segment lights up when digital input 4 on wire 55 is activated.



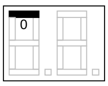
This segment lights up when digital input 5 on wire 54 is activated.



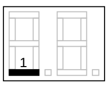
This segment lights up when digital input 6 on wire 53 is activated.



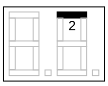
This segment lights up when digital input 7 on wire 52 is activated.



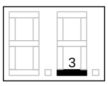
This segment lights up when analogue input 0 on wire 25 is activated.



This segment lights up when analogue input 1 on wire 27 is activated.

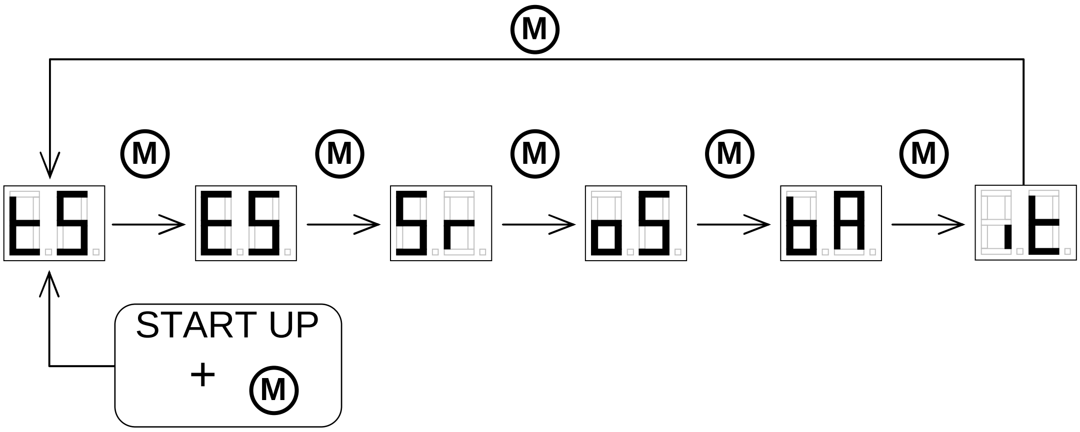


This segment lights up when analogue input 2 on wire 29 is activated.



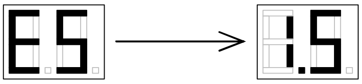
This segment lights up when analogue input 3 on wire 14 is activated.

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”:



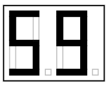
1.12.2.2.5 Engine speed display

This display shows the actual engine speed.

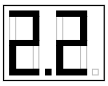


REMARK: As long as the “M”-button is pressed (however less than 2 sec), “ES” (**E**ngine **S**peed) is shown on the display. When the “M”-button is released the display changes to the actual engine speed value.

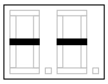
For speeds below 1000 rpm, engine speed is shown with 10 rpm resolution. The below example shows an engine speed between 585 rpm and 594 rpm:



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:



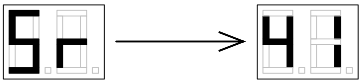
REMARK: The RD.120 shows two dashes (as illustrated below) when the engine speed is not available:



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

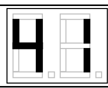
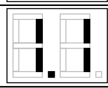
This display shows the actual speed ratio.



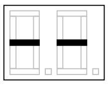
REMARK: As long as the “M”-button is pressed (however less than 2 sec), “Sr” (**S**peed **r**atio) is shown on the display. When the “M”-button is released, the display changes to the actual speed ratio value.

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	

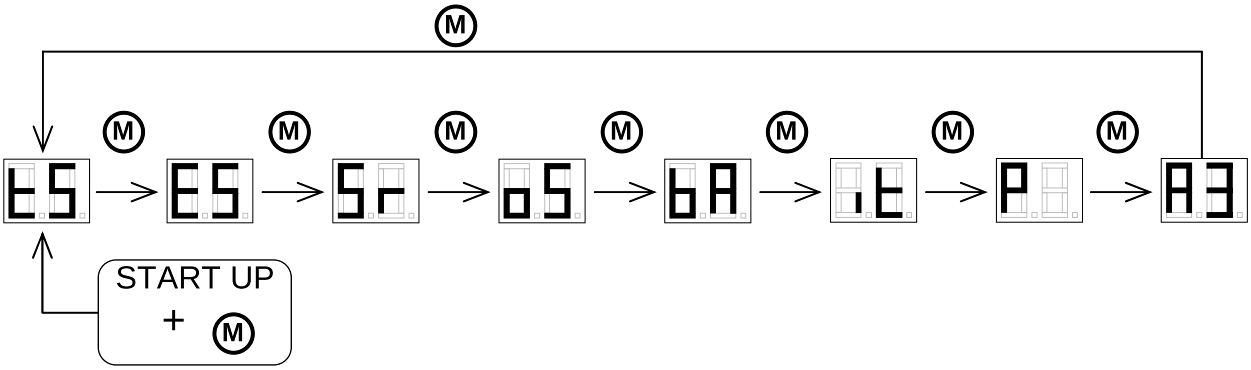
REMARK: The RD.120 shows two dashes (as illustrated below) when the speed ratio is not available:



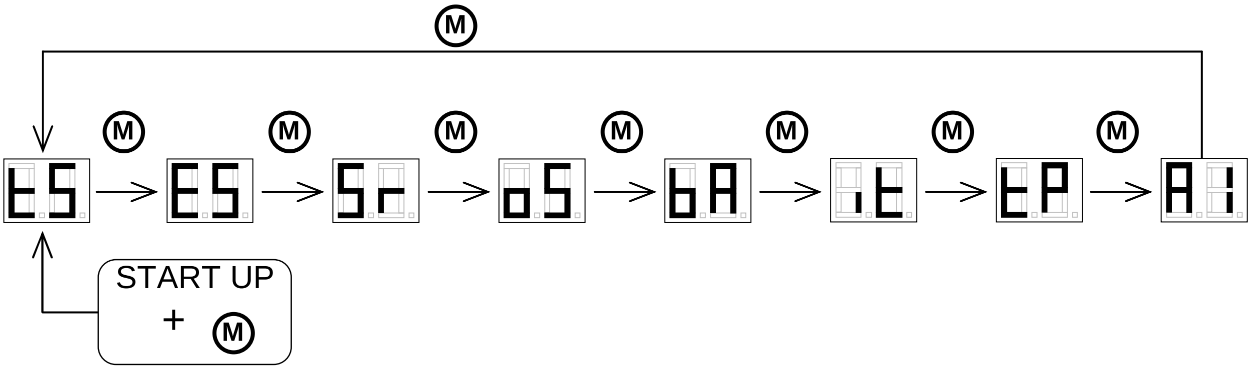
Typically this is the case when the transmission is in neutral (this condition does not allow the ECON.A to calculate the speed ratio because the turbine speed is unknown at that moment) or when the drum speed sensor, the output speed sensor or engine speed sensor is not connected or has an electrical 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, analogue throttle pedal information, converter out temperature, sump temperature, etc., the diagnostic display mode is extended by default with displays reflecting this information.

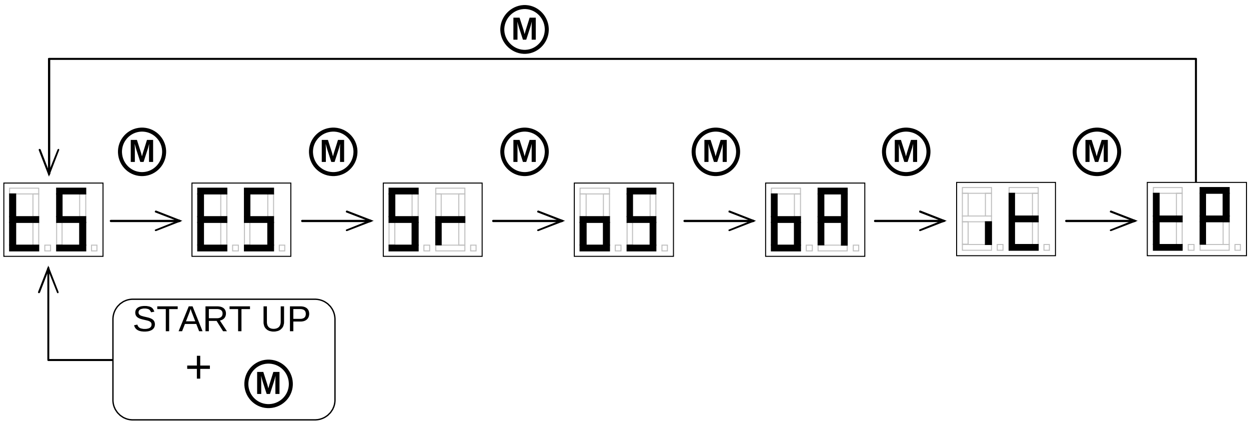
For example, when the system pressure is measured with analogue input 3, the diagnostic display mode is extended by default with the displays “P” and “A3”:



For example, when the throttle pedal position is measured with analogue input 1, the diagnostic display mode is extended by default with the displays “tP” and “A1”:

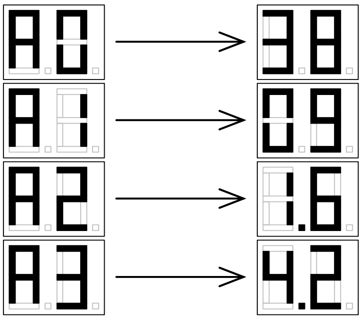


For example, when the throttle pedal position is read from the CAN message EEC2, the diagnostic display mode is extended by default with the displays “tP”. In this case there is no display related to an analogue input, because it is not applicable:



1.12.2.2.7 Analogue input displays

These 4 displays show the electrical value (in V or in Ω) of the 4 analogue inputs of the ECON.A.



REMARK: As long as the “M”-button is pressed (however less than 2 sec), “Ax” (**A**nalogue input **x** = **0**, **1**, **2** or **3**) is shown on the display. When the “M”-button is released, the display changes to the actual electrical value (V or Ω) of the concerned analogue input.

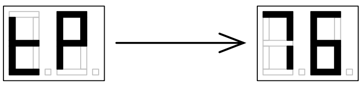
For analogue inputs measuring resistance, there is no unit dot. The resistance is shown with 100 Ω resolution. The example “A0” above shows a resistance of 3800 Ω. The example “A1” above shows a resistance of 900 Ω.

For analogue inputs measuring voltage, there is a unit dot. The voltage is shown with 0.1V resolution. The example “A2” above shows a voltage of 1.6 V. The example “A3” above shows a voltage of 4.2 V.

REMARK: Only relevant analogue input displays are shown: analogue input displays for analogue inputs that are not configured in the ECON.A, are not shown.

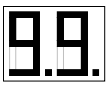
Throttle pedal position display

This display shows the actual throttle pedal position in %.

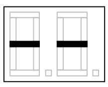


REMARK: As long as the “M”-button is pressed (however less than 2 sec), “tP” (**t**hrottle **P**edal) is shown on the display. When the “M”-button is released, the display changes to the actual throttle pedal position value.

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:



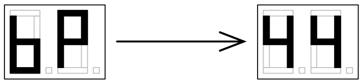
REMARK: The RD.120 shows two dashes (as illustrated below) when the throttle pedal position is not available:



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.

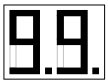
1.12.2.2.9 Brake pedal position display

This display shows the actual brake pedal position in %.

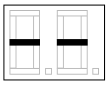


REMARK: As long as the “M”-button is pressed (however less than 2 sec), “bP” (**b**rake **P**edal) is shown on the display. When the “M”-button is released, the display changes to the actual brake pedal position value.

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:



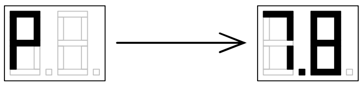
REMARK: The RD.120 shows two dashes (as illustrated below) when the brake pedal position is not available:



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.

1.12.2.2.10 System pressure display

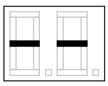
This display shows the actual system pressure.



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.

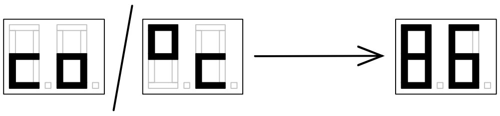
REMARK: The RD.120 shows two dashes (as illustrated below) when the system pressure is not available:



Typically this is the case when the system pressure sensor is not connected or has an electrical problem.

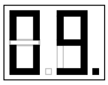
1.12.2.2.11 Converter out temperature display (in °C)

This display shows the actual converter out temperature in °C.



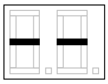
REMARK: As long as the “M”-button is pressed (however less than 2 sec), “co” (**C**onverter **o**ut temperature) and “°C” are shown in alternation on the display. When the “M”-button is released, the display changes to the actual converter out temperature.

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.

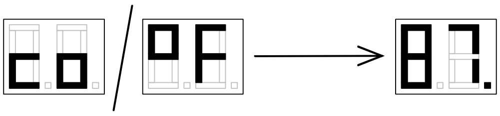
REMARK: The RD.120 displays two dashes (as illustrated below) when the converter out temperature is not available:



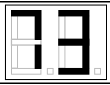
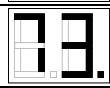
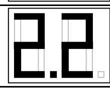
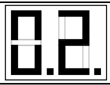
Typically this is the case when the converter out temperature sensor is not connected or has an electrical problem.

1.12.2.2.12 Converter out temperature display (in °F)

This display shows the actual converter out temperature in °F.

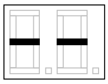


REMARK: As long as the “M”-button is pressed (however less than 2 sec), “Co” (**C**onverter **o**ut temperature) and “°F” are shown in alternation on the display. When the “M”-button is released, the display changes to the actual converter out temperature. The converter out temperature is shown with 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.

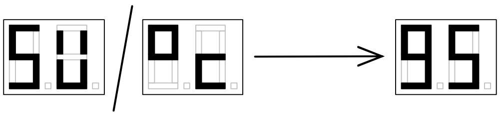
REMARK: The RD.120 displays two dashes (as illustrated below) when the converter out temperature is not available:



Typically this is the case when the converter out temperature sensor is not connected or has an electrical problem.

1.12.2.2.13 Sump temperature display (in °C)

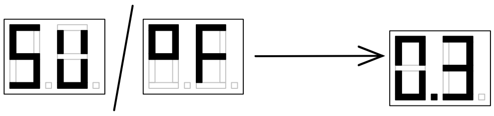
This display shows the actual sump temperature in °C.



This display functions in the same way as the display “converter out temperature in °C”. Refer to CHAPTER 1 – 1.12.2.2.11.

1.12.2.2.14 Sump temperature display (in °F)

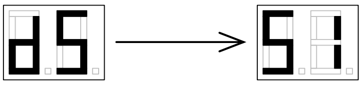
This display shows the actual sump temperature in °F.



This display functions in the same way as the display “converter out temperature in °F”. Refer to CHAPTER 1 – 1.12.2.2.12.

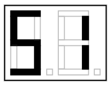
1.12.2.2.15 Drum speed display

This (optional) display shows the actual drum speed.

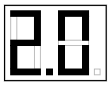


<u>REMARK</u>: As long as the “M”-button is pressed (however less than 2 sec.), “dS” (**d**rum **S**peed) is shown on the display. When the “M”-button is released, the display changes to the actual drum speed value.

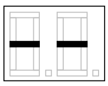
For speeds below 1000 rpm, drum speed is shown with 10 rpm resolution. The below example shows a drum speed between 505 rpm and 514 rpm:



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:

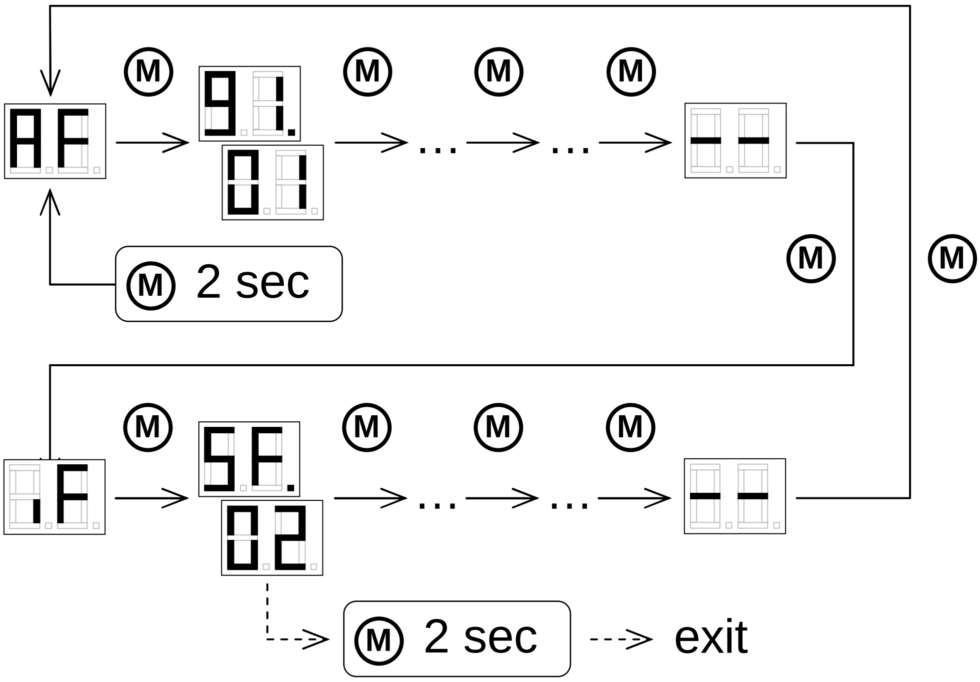


Typically this is the case when the drum speed sensor or output speed sensor is not connected or has an electrical problem.

1.12.2.3 Error display mode

If the ECON.A 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.A Error code list - prototype firmware 5.7pp.pdf"

ℹ	*The error display mode only applies to the volatile error memory!* *To access the permanent error logging information, either use a DANA Dashboard tool or use the CAN messages DM1, DM2 and DM3 for interpretation.*

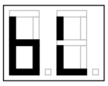
1.12.3 Bootloader mode (= programming mode)

The bootloader mode is activated during the programmation of the ECON.A with (new) firmware. Programming (new) firmware into the ECON.A can be done with the “DANA CAN Firmware XML Flashtool”.

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

1.12.3.1 Bootloader mode active

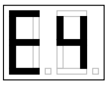
Initially the yellow “D”-LED and the red “F”-LED blink with alternation, while the display shows:



The programming process consists of 3 steps:

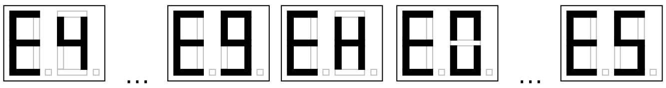
1.12.3.1.1 Step 1: Erasing

The first step is erasing the existing contents of the program flash:



“E” stands for “**E**rasing”, the number on the right indicates the number of the sector that is currently being erased.

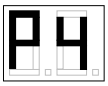
The erasing process starts at sector 4 and goes up to sector 10 (“H”), followed by on-chip sector 0 up to on-chip sector 5:



The red “F”-LED lights up continuously to indicate this step.

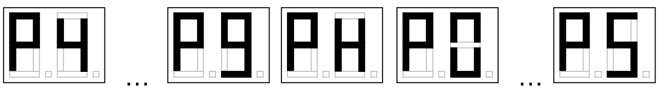
1.12.3.1.2 Step 2: Programming & verification

After the erasing step, the actual programming starts:

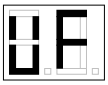


“P” stands for “**P**rogramming”, the number on the right indicates the number of the sector currently being programmed.

The programming process starts at sector 4 and can last to sector 10 (“H”), possibly followed by on-chip sector 0 to on-chip sector 5. This depends on the number of sectors that are needed to download the complete program:



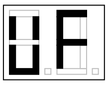
The yellow “D”-LED lights up continuously to indicate this step.
Every time a sector is programmed, a verification is performed:



Both the yellow “D”-LED and the red “F”-LED light up continuously to indicate this step.

1.12.3.1.3 Step 3: Verification

Finally a verification of the complete programmed firmware is performed:



Both the yellow “D”-LED and the red “F”-LED light up continuously to indicate this step.

> When the programming of the ECON.A is completed successfully, the ECON.A automatically restarts and tries to activate the new application firmware. If this succeeds, the ECON.A 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.A can not successfully activate the application firmware, bootloader mode is automatically activated again.

2 Calibration of analogue input signals

The ECON.A supports calibration procedures for the analogue input signals “throttle pedal” and “brake pedal”.

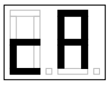
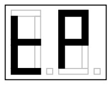
Calibration of the throttle pedal and brake pedal signals ensures that the ECON.A reads the throttle pedal and brake pedal values correctly during normal operation.

Calibration needs to be done at the following moments:

- When the vehicle is built in production at the OEM
- When the sensor of the analogue input signal is replaced
- When the ECON.A is replaced or a firmware and/or APT-file upgrade is performed
- When an error code indicates that the calibration is invalid

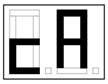
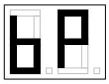
2.1 Calibration via the RD.120

The calibration mode is envoked by keeping the “M”-button pressed for 10 sec during start up and initialization of the ECON.A. 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

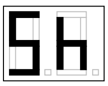
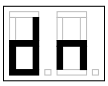
These displays indicate that you have entered the calibration mode, and that throttle pedal or brake pedal is ready to be calibrated.

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.A. After the reset, the ECON.A starts up again in normal display mode and normal operation mode.

<u>REMARK</u>: The throttle pedal calibration mode is only enabled in case there is an analogue throttle pedal (hall effect sensor or potentiometer) wired to the ECON.A. The same is true for the throttle pedal: the brake pedal calibration mode is only enabled in case there is an analogue brake pedal (hall effect sensor or potentiometer) wired to the ECON.A.

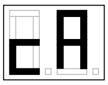
REMARK: In case the analogue throttle or brake pedal information is shared with the ECON.A via CAN communication, no calibration of the ECON.A is needed. In this case, the concerned calibration mode is disabled in the ECON.A.

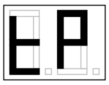
REMARK: The order of calibration (throttle pedal or brake pedal first) can be programmed in the ECON.A upon desire. By default, the throttle pedal calibration comes first.

2.1.1 Calibration of the throttle pedal sensor via the RD.120

For the throttle pedal, 2 points are calibrated: 0% and 100%.

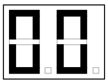
To start the throttle pedal calibration, activate the calibration mode by pressing the “M”-button during 10 sec at startup of the ECON.A. In case the RD.120 does not show “cA” alternating with “tP”, then press the “M”-button shortly until it shows:



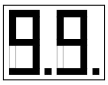
alternating with


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.A to the driver. First the ECON.A presents:



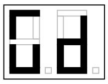
The driver has to release the throttle pedal completely and confirm the 0% calibration by pressing the “M”-button shortly. Then the ECON.A presents:



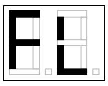
The driver has to press the throttle pedal completely and confirm the 100% calibration by pressing the “M”-button shortly.

Finally, the ECON.A 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.

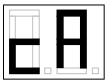
REMARK: to have the new calibration values activated, a controlled power down of the ECON.A is needed. In this way, the values are saved in the ECON.A’s permanent flash memory. Refer to CHAPTER 1 – 1.5 for details.

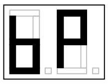
Only at the next power up these new values will be used.

2.1.2 Calibration of the brake pedal sensor via the RD.120

For the brake pedal, 2 points are calibrated: 0% and 100%.

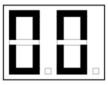
To start the brake pedal calibration, activate the calibration mode by pressing the “M”-button during 10 sec at startup of the ECON.A. In case the RD.120 does not show “cA” alternating with “bP”, then press the “M”-button shortly until it shows:



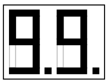
alternating with


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.A to the driver. First the ECON.A presents:



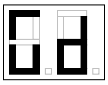
The driver has to release the brake pedal completely and confirm the 0% calibration by pressing the “M”-button shortly. Then the ECON.A presents:



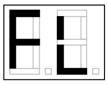
The driver has to press the brake pedal completely and confirm the 100% calibration by pressing the “M”-button shortly.

Finally, the ECON.A 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.A is needed. In this way, the values are saved in the ECON.A’s permanent flash memory. Refer to CHAPTER 1 – 1.5 for details.

Only at the next power up these new values will be used.

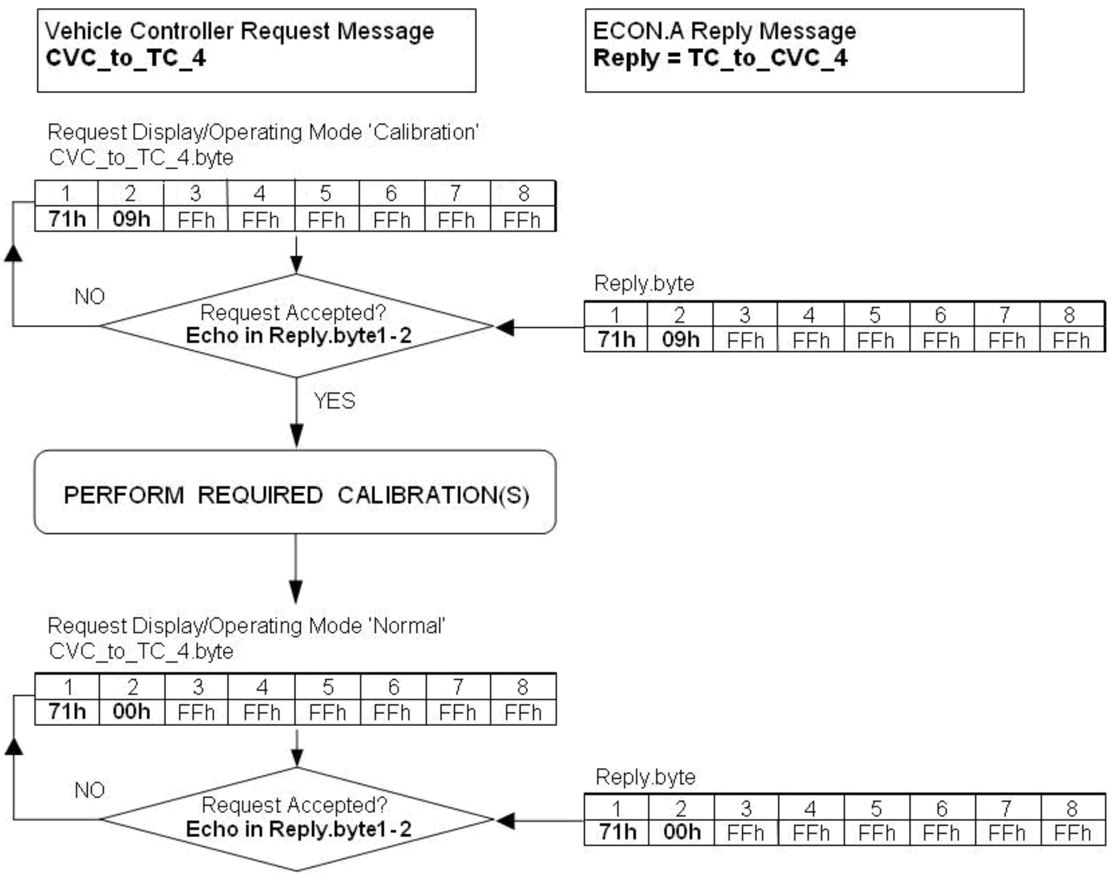
2.1.3 Calibration via CAN communication

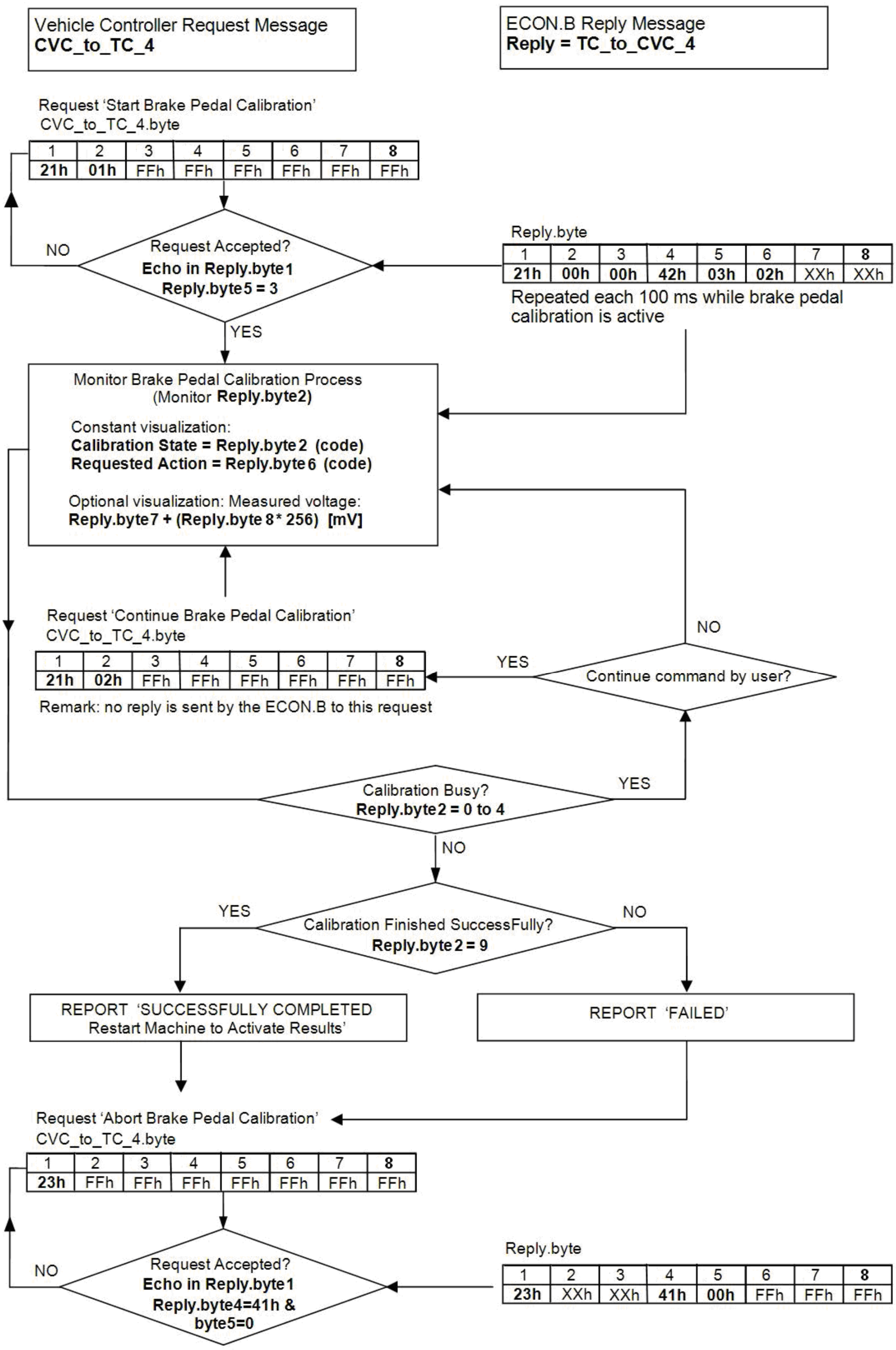
Analogue inputs can be calibrated via the RD.120 display as described above. But they can also be calibrated via CAN communication.

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.A. It also allows to do the calibration using DANA's "Dashboard" tool (PC-based diagnostic tool).

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.A first. Without this calibration mode activated, any attempt to start a specific calibration is ignored by the ECON.A.
After completing all the required calibrations, the ECON.A can be set back to normal operating mode. This is optional, because restarting the ECON.A will be needed anyway to activate the new calibration results, and restarting the ECON.A 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
NO
Request Accepted?
Echo in Reply.byte1
Reply.byte5 = 3
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
YES
NO
Continue command by user?
Calibration Busy?
Reply.byte2 = 0 to 4
YES
NO
YES
Calibration Finished SuccessFully?
Reply.byte2 = 9
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
NO
Request Accepted?
Echo in Reply.byte1
Reply.byte4=41h &
byte5=0
Reply.byte
1 2 3 4 5 6 7 8
23h XXh XXh 41h 00h FFh FFh FFh

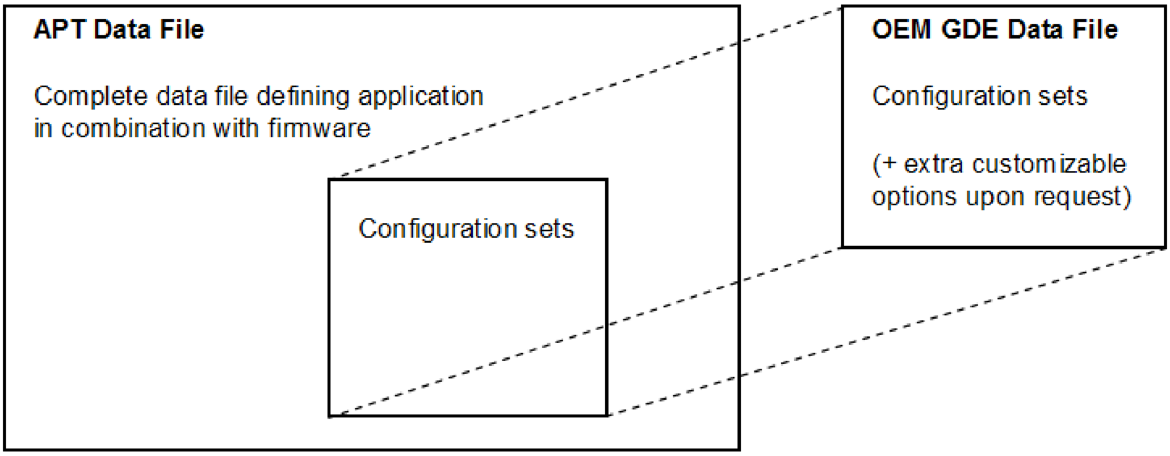
CHAPTER 2 : ECON.A Configuration Sets Description

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.A.

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.A 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.A. Together with the ECON.A 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.A. 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 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.A, 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.A is expected. Check the application specific wiring diagram to see how the shift lever needs to be connected to the ECON.A.

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

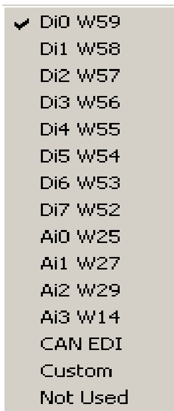
2.2.3.1 Available digital input features

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.A 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”.

REMARK: 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/desactivate 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, to desactivate 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, to desactivate the feature, the signal has to be removed.

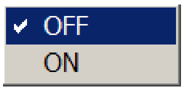
There is a possibility to invert the logics of the input ; this can be applied to both types of digital input signals.

If “No” is selected, the signal (pulse or constant) will need to be high to have the feature active.
If “Yes” is selected, the logic is inverted.

REMARK: with an ECON.A that has so called “switch to ground” digital input signals, the logic is acting that way that a connection to ground turns the digital input feature on.

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 will not be useful at all. For others, like “DI Auto/Manual Shifting” this can be used to make a selection to have a feature always active 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)

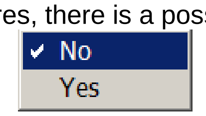
2.2.4.2 Digital output feature activation

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.A 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

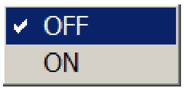
Identical to the digital input features, there is a possibility to invert the logics of the output:



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.

2.2.4.4 Digital output feature inactive default value

Other than for the digital input features, in case a digital output feature is not activated the feature will not be active. The default value is only used for reporting over CAN the default value for an output state when no valid output is known for the feature.



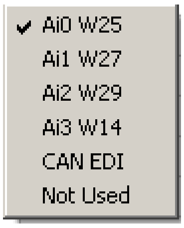
2.2.5 Analogue input features

2.2.5.1 Available analogue input features

Named as they are presented in the GDE tool, the available analogue input features are:
- AI Throttle Pedal (refer to CHAPTER 1 – 1.6.5 for details)
- AI Brake Pedal

2.2.5.2 Analogue input feature activation

For each available analogue input feature, enabling the feature is possible by selecting an available signal source :



If the signal is wired, choose one of the available analogue input wires from the drop down list presented.
If the is sent over the CAN bus, following the protocol as described in the ECON.A 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 – 1.11.23 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.

<u>REMARK</u>: How the ECON.A will react exactly if the shift needs to be postponed because the vehicle speed limit is exceeded, will depend on the selections made as described in CHAPTER 1 – 1.8.1 and CHAPTER – 1.8.2.

<u>REMARK</u>: 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.

<u>REMARK</u>: How the ECON.A will react exactly if the shift needs to be postponed because the vehicle speed limit is exceeded, will depend on the selections made as described in CHAPTER 1 – 1.8.3.

<u>REMARK</u>: Each type of OEM application has to be approved by DANA.

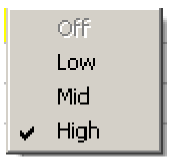
2.2.9 Max DirChg Engine Speed

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.

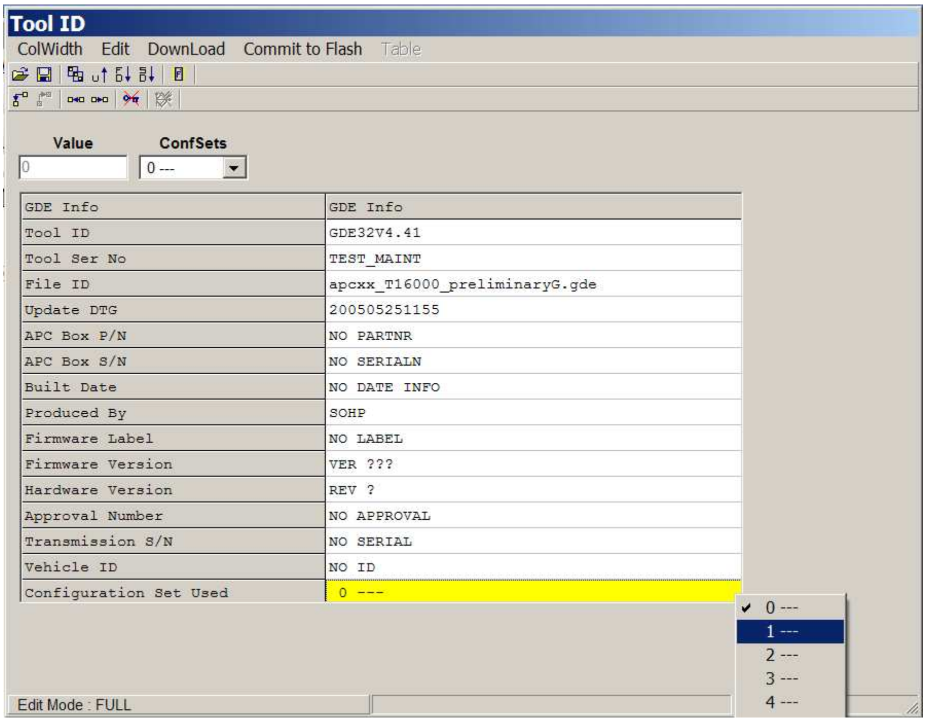
A range of different values to cover different tyre options can be specified here. However, the range of allowed values is limited. The limits on this value depend on the application approval and are determined by DANA for each application.

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.

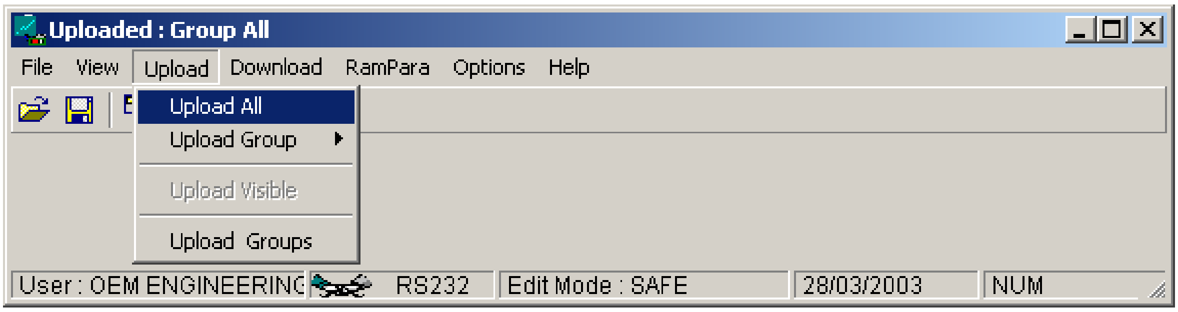
REMARK : When using CAN messages to reference a configuration set, this ConfigSet ID is represented by a corresponding index value to address the correct configuration set.

3 Configuration Set Management: GDE

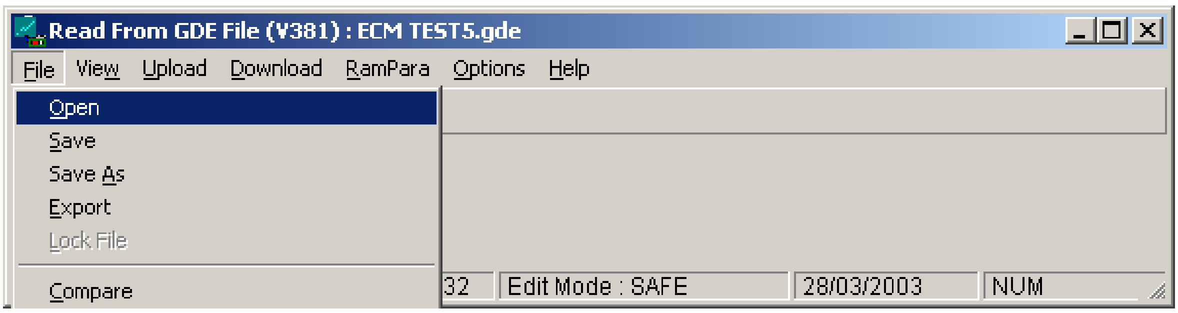
One of the ways to manage the configuration sets is by using the GDE tool. To have all the necessary access rights to change the relevant parameters, a GDE tool with OEM Engineering license is required.
This OEM Engineering level GDE tool allows the user to access and change the parameters described 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.A 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.A 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.A, 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.A 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.A, 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.

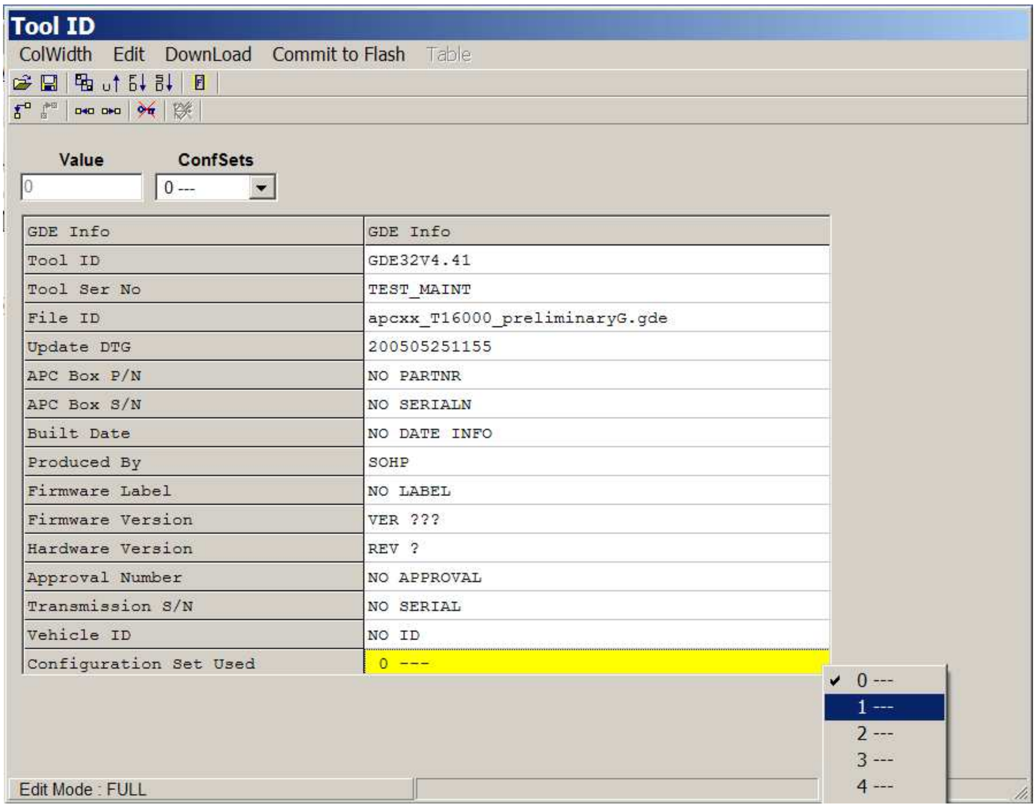
3.2 Managing Configuration Sets with GDE

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.A 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.A, 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.A 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.A.



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.A'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 Uploading machine config with OEM Production GDE

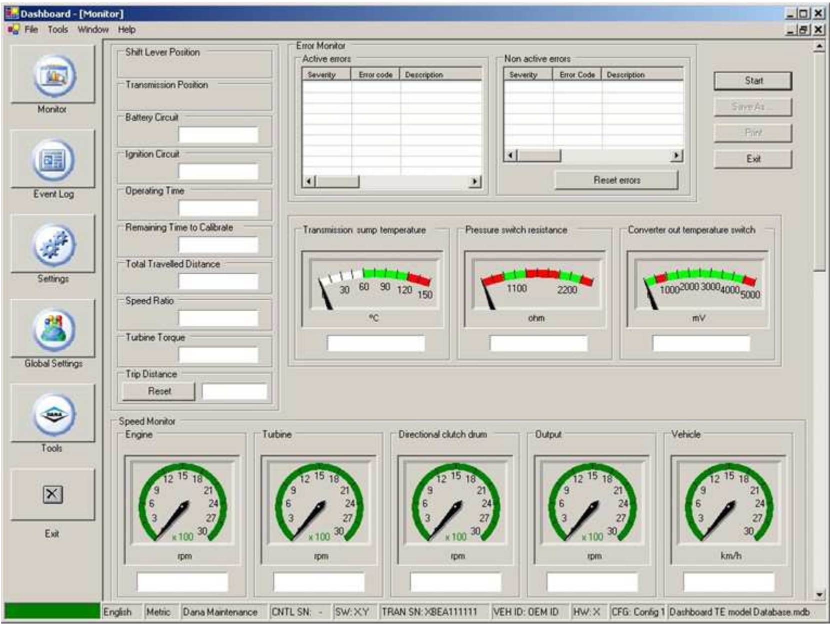
If the OEM user wants to keep track of the settings on all of the machines by logging the downloaded settings, the OEM Production level GDE tool allows to upload the data from an ECON.A controller and save it to a file.
It is recommended to perform this upload of the settings after the full calibration 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 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 tool is not included directly in this user manual and is presented in a separate document.***
> ***Refer to the document “DashboardDiagnostic.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.A controller, an existing configuration set can be selected on the machine.
The central vehicle controller (CVC) 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.A, 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 to CHAPTER 2 – 5.6 for details.

5.2 Selecting a Configuration Set: CVC_TO_TC_4

To select a configuration set in the ECON.A, a CAN message is provided that is also used for reading and writing other values in the ECON.A. 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.A.

5.2.1 CVC_TO_TC_4 defined for Configuration Set Selection

Message Name	CVC_TO_TC_4
Message ID	CFF23XXH (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 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.A 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.A. 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	CFF3303H (03 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	FFh = reserved
Byte 6	FFh = reserved
Byte 7	FFh = reserved
Byte 8	FFh = 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 00h or 01h) 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

- **FF(hex)** = 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

- FF(hex)

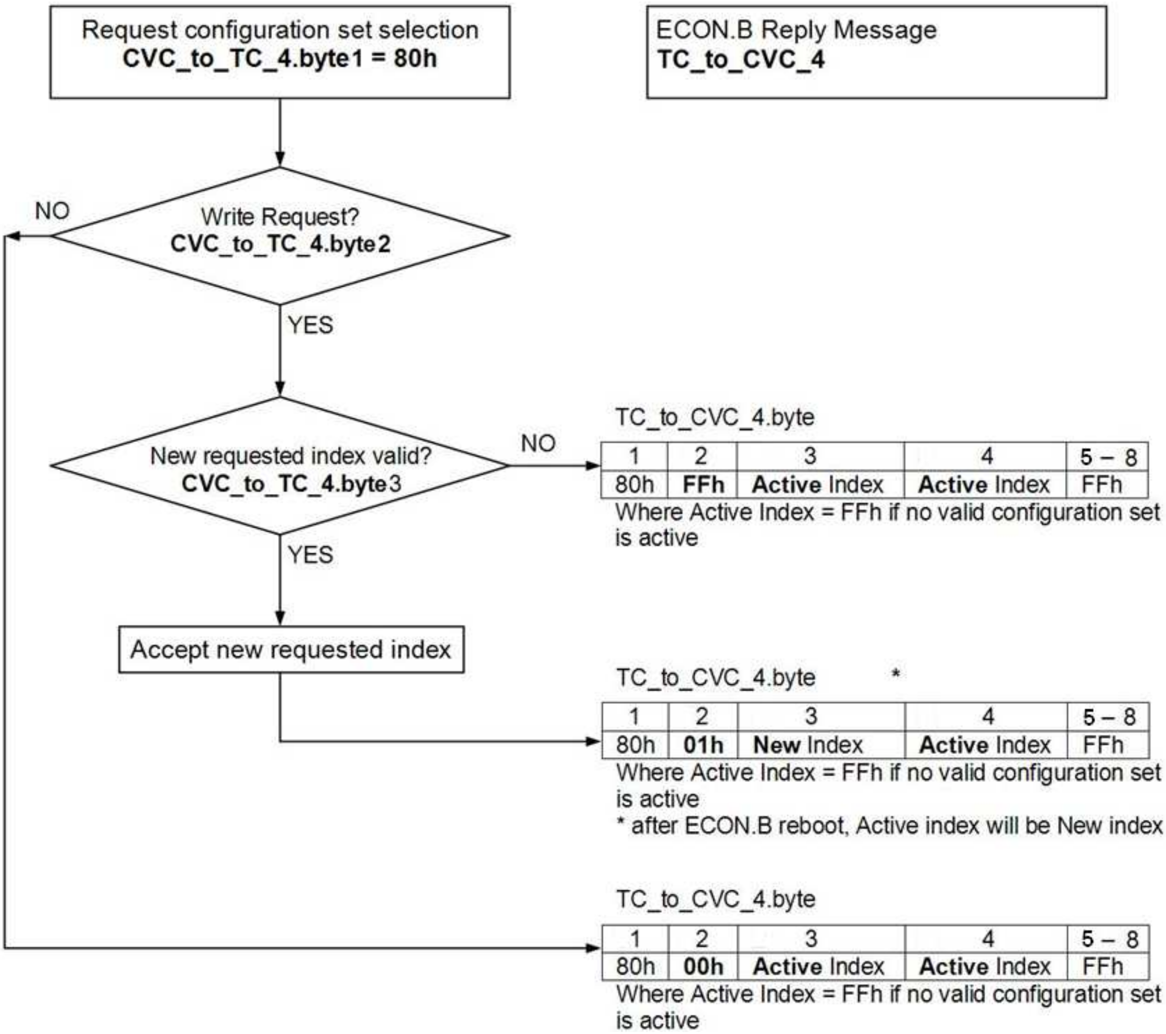
  No valid configuration set is active

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 FF(hex) 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.A (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.A. 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.

5.4.1 CVC_TO_TC_4 defined for Configuration Set Parameter handling

Message Name	CVC_TO_TC_4
Message ID	CFF23XXH (XX is the Central Vehicle Controller's address)
Originator	Central Vehicle Controller, Service monitor
Repetition rate	as required
DLC	8
Byte 1	81h = Request code for reading configuration set parameter value 86h = 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	FFh = reserved
Byte 6	FFh = reserved
Byte 7	FFh = reserved
Byte 8	FFh = reserved

5.4.2 CVC_TO_TC_4.Byte 1

- 81h = 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.
- 86h = 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

CAN Index (byte 2)	Configuration Set Parameter		Value in byte 3-4	Format of byte 3-4
00	DI Declutch	Signal Source	0=Di0 W59 1=Di1 W58 2=Di2 W57 3=Di3 W56 4=Di4 W55 5=Di5 W54 6=Di6 W53 7=Di7 W52 8=Ai0 W25 9=Ai1 W27 10=Ai2 W29 11=Ai3 W14 12=CAN 13=Custom 14=Not used	none
01	DI Auto/Manual Mode	Signal Source		
02	DI Kickdown	Signal Source		
03	DI Neutral Lock Reset	Signal Source		
04	DI Throttle Pedal Idle Position	Signal Source		
05	DI Throttle Pedal Full Position	Signal Source		
09	DI Parking Brake	Signal Source		
0A	DI Loaded/Not Loaded	Signal Source		
0B	DI 4WD/2WD	Signal Source		
0C	DI High Low Range Selection	Signal Source		
0D	DI Redundant Neutral	Signal Source		
0E	DI Oil System Pressure	Signal Source		
0F	DI Service Brakes	Signal Source		
10	DI Operator Presence	Signal Source		
11	DI Seat Orientation	Signal Source		
12	DI Inhibit Shifting	Signal Source		
13	DI Lockup Enable	Signal Source		
14	DI Exhaust Brake	Signal Source		
15	DI Retarder Brake	Signal Source		
16	DI Oil Temperature	Signal Source		
17	DI – DANA Reserved -	Signal Source		
18	DI High Idle	Signal Source		
26	DI Custom Function 1	Signal Source		
27	DI Custom Function 2	Signal Source		
28	DI Custom Function 3	Signal Source		
29	DI Custom Function 4	Signal Source		
2A	DI Custom Function 5	Signal Source		
2B	DI Custom Function 6	Signal Source		
2C	DI Custom Function 7	Signal Source		
2D	DI Custom Function 8	Signal Source		
2E	DI Custom Function 9	Signal Source		
2F	DI Custom Function 10	Signal Source		
30	DO Park Brake	Signal Source	0=Do0 W33 1=Do1 W31	none
33	DO 4WD/2WD	Signal Source		

34	DO High Low Range	Signal Source	2=Do2 W48 3=Do3 W18 4=Do4 W46 5=Do5 W17 6=Do6 W35 7=Do7 W01 8=Do8 W03 9=CAN EDI 10=Not Used		
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 1 = Mo Inv N 2 = Bi Inv Y 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 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 1 = Sp Dep 1 2 = Sp Dep 2 3 = Sp Dep 3 4 = RevAlert 5 = PTO/PTI 6 = PTI Ena 7 = DM Brake 8 = Warn 1 9 = Warn 2 10 = Warn 3 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 = Standard 1 = Bump type 2 = CAN type	none
E3	DANA Reserved	Type	Not applicable	Not applicable
E4	DI Limit Gearpos	Type	0 = Wired 1 = CAN type 2 = not used	none
F0	AI Throttle Pedal	Signal Source	0 = Ai0 W25 1 = Ai1 W27 2 = Ai2 W29 3 = Ai3 W14 4 = CAN EDI 5 = Not Used	none
F1	AI Brake Pedal	Signal Source		

5.5 ECON.A 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 will be sent by the ECON.A. 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	CFF3303H (03 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 (**0 to F1(hex)**)

  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.

- **FB(hex)** = 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.

- **FD(hex)** = 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 (see the minimum – maximum values further)

- **FE(hex)** = 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 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 will contain FFFF (hex). This is the case with TC_TO_CVC_4.byte2 being FE(hex).

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.

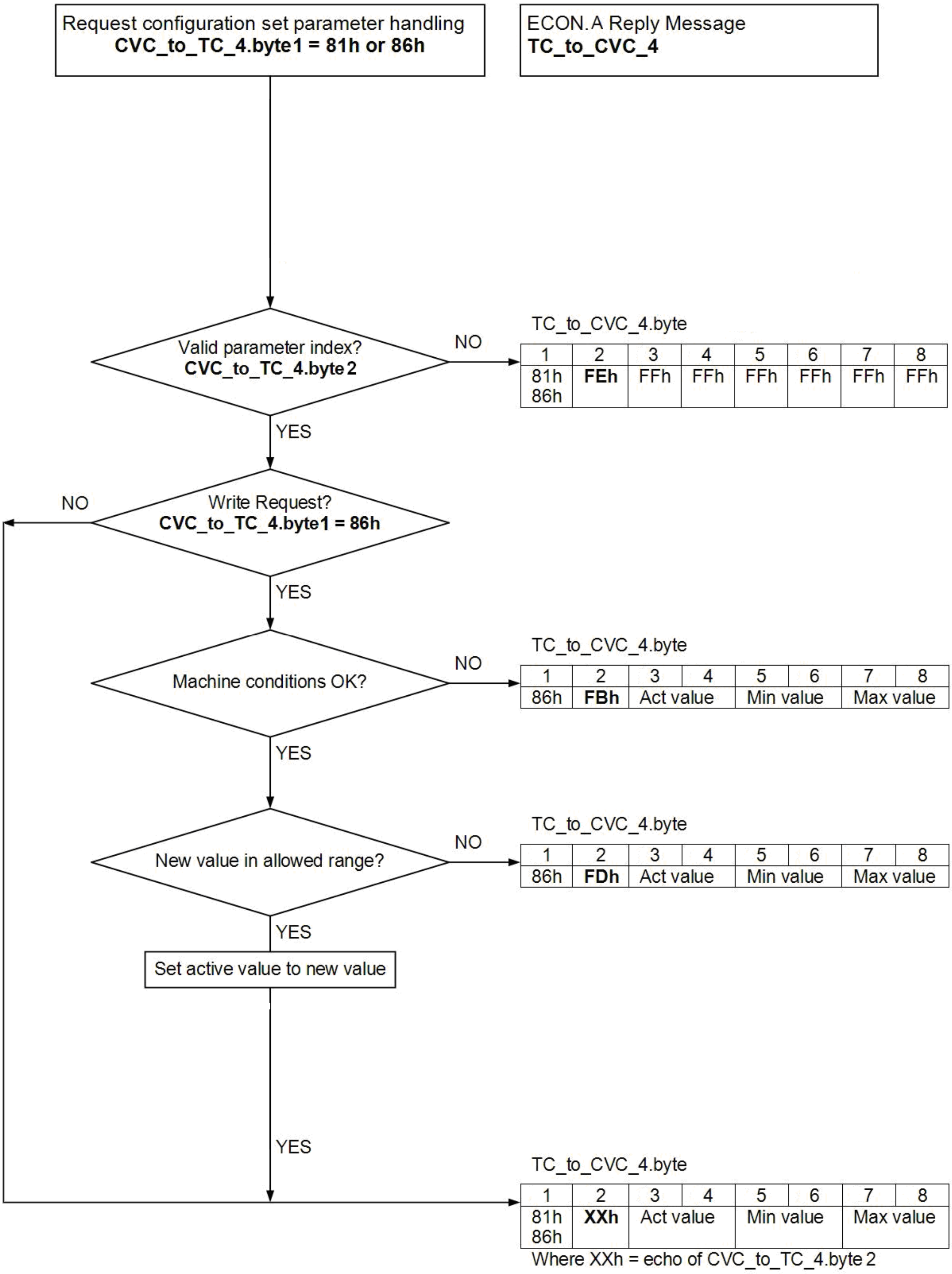
REMARK: When a problem results in having no value to return at all, TC_TO_CVC_4.byte5-6 will contain FFFF (hex). This is the case with TC_TO_CVC_4.byte2 being FE(hex) .

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 will contain FFFF (hex). This is the case with TC_TO_CVC_4.byte2 being FE(hex).

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 = 80h and byte2 = 00h. 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 = 80h, byte2 = 01h and byte2 containing the requested index (see details above). Remember to check the ECON.A 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.A'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.A 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.A.

- It is strongly recommended to check if the new selected value for the parameter has indeed been accepted by interpreting the ECON.A 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.A reply message to see if the newly requested value was accepted.
- The specific codes in the ECON.A 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.A (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.A 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.A.
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 plausibility of using an alternative PGN in agreement with the OEM and/or other manufacturers involved. If plausible, 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 plausibility of changing the repetition rate in agreement with the OEM and/or other manufacturers involved. If plausible, 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 plausibility of using another priority in agreement with the OEM and/or other manufacturers involved. If plausible, 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: CFF20xx $_{\text{(Hex)}}$ **(CAN 2.0 B →29 bit identifier)**

Priority code + $R_{\text{bit (= 0)}}$ + $DP_{\text{bit (= 0)}}$	Message ID	Address sender
C $_{\text{(Hex)}}$ = 01100 $_{\text{(Bin)}}$ → Priority = **3** $_{\text{(Dec)}}$	**FF20** $_{\text{(Hex)}}$ **= 65312** $_{\text{(Dec)}}$	Example : **27** $_{\text{(Hex)}}$ **= 39** $_{\text{(Dec)}}$

Originator: **CVC = Central Vehicle Controller**
Repetition rate: **20 msec**
Timeout: **500 msec**
DLC: **8**

		Value	Detail
Byte 1	Bit 1.1 Bit 1.2	Direction selection	**Shift lever position** (if not used: all bits should be 1) Bit 1.2 / Bit 1.1 0 0 : neutral 0 1 : forward 1 0 : reverse 1 1 : reserved
	Bit 1.3 … Bit 1.6	Range Selection	Bit 1.6 / Bit 1.5 / Bit 1.4 / Bit 1.3 0 0 0 1 : 1st 0 0 1 0 : 2nd 0 0 1 1 : 3rd 0 1 0 0 : 4th 0 1 0 1 : 5th 0 1 1 0 : 6th 0 1 1 1 : 7th 1 0 0 0 : 8th All other bitpatterns are reserved
	Bit 1.7 Bit 1.8	Fault state of shift lever	Bit 1.8 / Bit 1.7 0 0 : no fault detected on shift lever 0 1 : fault detected on shift lever (neutral will be forced) 1 0 : reserved (neutral will be forced) 1 1 : function not supported over CAN
Byte 2	Bit 2.1 Bit 2.2	Declutch Request	**Declutch** (if not used: all bits should be 1) Bit 2.2 / Bit 2.1 0 0 : no declutch request 0 1 : declutch request 1 0 : reserved 1 1 : function not supported over CAN
	Bit 2.3 Bit 2.4	Parking Brake status or Parking Brake request	**Parking brake** (if not used: all bits should be 1) Bit 2.4 / Bit 2.3 0 0 : parking brake status is "off" / no parking brake request 0 1 : parking brake status is "on" / parking brake request 1 0 : reserved 1 1 : function not supported oven CAN
	Bit 2.5 Bit 2.6	Neutral lock reset request	**Neutral lock reset** (if not used: all bits should be 1) Bit 2.6 / Bit 2.5 0 0 : no neutral lock reset request 0 1 : neutral lock reset request 1 0 : reserved 1 1 : function not supported over CAN

	Bit 2.7 Bit 2.8	Operator present status	**Operator present** (if not used: all bits should be 1) Bit 2.8 Bit 2.7 0 0 : operator is NOT present 0 1 : operator is present 1 0 : reserved 1 1 : function not supported over CAN
Byte 3	Bit 3.1 … Bit 3.4	Not used	**Reserved** Bits 3.1 … 3.4 must be = $1111_{(Bin)}$
	Bit 3.5 Bit 3.6	Automatic / manual mode selection	**Auto/manual mode selection** (if not used: all bits should be 1) Bit 3.6 Bit 3.5 0 0 : manual mode selection 0 1 : automatic mode selection 1 0 : reserved 1 1 : function not supported over CAN
	Bit 3.7 Bit 3.8	Loaded / Not Loaded status	**Loaded/not loaded** (if not used: all bits should be 1) Bit 3.8 Bit 3.7 0 0 : vehicle is not loaded = empty 0 1 : vehicle is loaded 1 0 : reserved 1 1 : function not supported over CAN
Byte 4	Bit 4.1 Bit 4.2	Kickdown request	**Kickdown** (if not used: all bits should be 1) Bit 4.2 Bit 4.1 0 0 : no kickdown request 0 1 : kickdown request 1 0 : reserved 1 1 : function not supported over CAN
	Bit 4.3 Bit 4.4	4WD/2WD request	**4WD/2WD** (if not used: all bits should be 1) Bit 4.4 Bit 4.3 0 0 : 2WD request 0 1 : 4WD request 1 0 : reserved 1 1 : function not supported over CAN
	Bit 4.5 Bit 4.6	Not used	**Reserved** Bits 4.5 and 4.6 must be = $11_{(Bin)}$
	Bit 4.7 Bit 4.8	Inhibit Shifting enable/disable request	**Inhibit shifting** (if not used: all bits should be 1) Bit 4.8 Bit 4.7 0 0 : inhibit shifting disable request 0 1 : inhibit shifting enable request 1 0 : reserved 1 1 : function not supported over CAN

Byte 5	Bit 5.1 Bit 5.2	Seat console orientation	**<u>Seat orientation</u>** (if not used: all bits should be 1) <u>Bit 5.2</u> <u>Bit 5.1</u> 0 0 : seat console orientated in normal position 0 1 : seat console orientated in inverted position 1 0 : reserved 1 1 : function not supported over CAN
	Bit 5.3 Bit 5.4	Not used	**<u>Reserved</u>** Bits 5.3 and 5.4 must be = $11_{(Bin)}$
	Bit 5.5 Bit 5.6	Throttle pedal position: idle/not idle	**<u>Throttle pedal idle/not idle</u>** (if not used: all bits should be 1) <u>Bit 5.6</u> <u>Bit 5.5</u> 0 0 : throttle pedal not idle 0 1 : throttle pedal idle 1 0 : reserved 1 1 : function not supported over CAN
	Bit 5.7 Bit 5.8	Throttle pedal position: full/half throttle	**<u>Throttle pedal full/not Full</u>** (if not used: all bits should be 1) <u>Bit 5.8</u> <u>Bit 5.7</u> 0 0 : throttle pedal in half throttle position 0 1 : throttle pedal in full throttle position 1 0 : reserved 1 1 : function not supported over CAN
Byte 6	Bit 6.1 Bit 6.2	Lockup enable (auto lockup) or lockup request (manual lockup)	**<u>Lockup enable or lockup request</u>** (if not used: all bits should be 1) <u>Bit 6.2</u> <u>Bit 6.1</u> 0 0 : lockup disabled / no lockup request 0 1 : lockup enabled / lockup request 1 0 : reserved 1 1 : function not supported over CAN
	Bit 6.3 Bit 6.4	High engine idle request	**<u>High engine idle request</u>** (if not used: all bits should be 1) <u>Bit 6.4</u> <u>Bit 6.3</u> 0 0 : no high engine idle request 0 1 : high engine idle request 1 0 : reserved 1 1 : function not supported over CAN
	Bit 6.5 Bit 6.6	High/low range request	**<u>High/low range request</u>** (if not used: all bits should be 1) <u>Bit 6.6</u> <u>Bit 6.5</u> 0 0 : low range request 0 1 : high range request 1 0 : reserved 1 1 : function not supported over CAN
	Bit 6.7 Bit 6.8	Not used	**<u>Reserved</u>** Bits 6.7 and 6.8 must be = $11_{(Bin)}$

<table>
<tr><td rowspan="4">Byte 7</td><td>Bit 7.1
Bit 7.2</td><td>System pressure status</td><td><u>System pressure status</u> (if not used: all bits should be 1)
<u>Bit 7.2</u> <u>Bit 7.1</u>
0 0 : system pressure too low
0 1 : system pressure ok
1 0 : reserved
1 1 : function not supported over CAN</td></tr>
<tr><td>Bit 7.3
Bit 7.4</td><td>Service brakes pressed or released</td><td><u>Service brakes pressed/released</u>
(if not used: all bits should be 1)
<u>Bit 7.4</u> <u>Bit 7.3</u>
0 0 : service brakes released
0 1 : service brakes pressed
1 0 : reserved
1 1 : function not supported over CAN</td></tr>
<tr><td>Bit 7.5
Bit 7.6</td><td>Not used</td><td><u>Reserved</u>
Bits 7.5 and 7.6 must be = 11_(Bin)</td></tr>
<tr><td>Bit 7.7
Bit 7.8</td><td>Converter out temperature status</td><td><u>Converter out temperature status</u>
(if not used: all bits should be 1)
<u>Bit 7.8</u> <u>Bit 7.7</u>
0 0 : converter out temperature ok
0 1 : converter out temperature too high (> 120°C)
1 0 : reserved
1 1 : function not supported over CAN</td></tr>
<tr><td rowspan="3">Byte 8</td><td>Bit 8.1
Bit 8.2</td><td>Exhaust brake status</td><td><u>Exhaust brake status</u> (if not used: all bits should be 1)
<u>Bit 8.2</u> <u>Bit 8.1</u>
0 0 : exhaust brake not active
0 1 : exhaust brake active
1 0 : reserved
1 1 : function not supported over CAN</td></tr>
<tr><td>Bit 8.3
Bit 8.4</td><td>Retarder status</td><td><u>Retarder status</u> (if not used: all bits should be 1)
<u>Bit 8.4</u> <u>Bit 8.3</u>
0 0 : retarder not active
0 1 : retarder active
1 0 : reserved
1 1 : function not supported over CAN</td></tr>
<tr><td>Bit 8.5
…
Bit 8.8</td><td>Not Used</td><td><u>Reserved</u>
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: CFF21xx (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)	**FF21** (Hex) **= 65313** (Dec)	Example : **27** (Hex) **= 39** (Dec)

Originator: **CVC = Central Vehicle Controller**
Repetition rate: **20 msec**
Timeout: **500 msec**
DLC: **8**

		Value	Detail
Byte 1	Bit 1.1 … Bit 1.8	Throttle pedal position feedback	**Throttle pedal position** (if not used : all bits should be 1) Conversion: throttle pedal position = (Byte 1) x 0.4 [%] 0 = 0 % 250 = 100 % 254 = fault related to throttle pedal position sensing 255 = measurement not supported
Byte 2	Bit 2.1 … Bit 2.8	Brake pedal position feedback	**Brake pedal position** (if not used : all bits should be 1) Conversion: brake pedal position = (Byte 2) x 0.4 [%] 0 = 0 % 250 = 100 % 254 = fault related to brake pedal position sensing 255 = measurement not supported
Byte 3	Bit 3.1 … Bit 3.8	Not Used	**Reserved** Bits 3.1 … 3.8 must be = 1111 1111(Bin) = FF(Hex)
Byte 4	Bit 4.1 … Bit 4.8	Block out highest gear(s)	**Block out highest gear(s)** (if not used : all bits should be 1) Bit 4.1 … bit 4.6 define the maximum range gear that is allowed for every direction (forward, neutral and reverse). Example: (see table below) REMARK: The above table is only an example. The OEM can choose the definition of the different bit-patterns and related “maximum allowed range gear”. Bit 4.8 / Bit 4.7 0 0 : no fault in the block out highest gear(s) pattern 0 1 : fault detected the block out highest gear(s) pattern 1 0 : reserved 1 1 : function not supported over CAN

Example (Byte 4):

Bit						Maximum allowed range gear		
4.6	4.5	4.4	4.3	4.2	4.1	F	N	R
0	0	0	0	0	0	4	4	4
0	0	0	0	0	1	3	3	3
0	0	0	0	1	0	3	3	1

Byte 5	Bit 5.1 Bit 5.2	PTO/PTI enable/ disable request	**PTO/PTI** (if not used : all bits should be 1) Bit 5.2 Bit 5.1 0 0 : PTO or PTI disable request 0 1 : PTO or PTI enable request 1 0 : reserved 1 1 : function not supported over CAN
	Bit 5.3 … Bit 5.8	Dead man control	**Dead man control** (if not used : all bits should be 1) **Dead man front pedal** Bit 5.4 Bit 5.3 0 0 : dead man front pedal not applied 0 1 : dead man front pedal applied 1 0 : reserved 1 1 : function not supported over CAN **Dead man rear pedal** Bit 5.6 Bit 5.5 0 0 : dead man rear pedal not applied 0 1 : dead man rear pedal applied 1 0 : reserved 1 1 : function not supported over CAN **Dead man reset request** Bit 5.8 Bit 5.7 0 0 : no dead man reset request 0 1 : dead man reset request 1 0 : reserved 1 1 : function not supported over CAN
Byte 6 Byte 7 Byte 8	Bit 6.1 … Bit 8.8	Not Used	**Reserved** Bits 6.1 … 6.8 must be = 1111 1111$_{(Bin)}$ = FF$_{(Hex)}$ Bits 7.1 … 7.8 must be = 1111 1111$_{(Bin)}$ = FF$_{(Hex)}$ Bits 8.1 … 8.8 must be = 1111 1111$_{(Bin)}$ = FF$_{(Hex)}$

1.5.3 CVC_TO_TC_3: optional remote transmission control 2

Message identifier: CFF22xx (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)	**FF22** (Hex) **= 65314** (Dec)	Example : **27** (Hex) **= 39** (Dec)

Originator: **CVC = Central Vehicle Controller**
Repetition rate: **20 msec**
Timeout: **500 msec**
DLC: **8**

		Value	Detail
Byte 1	Bit 1.1 Bit 1.2	Redundant safety neutral request	**Redundant Safety Neutral** (if not used : all bits should be 1) Bit 1.2 Bit 1.1 0 0 : no redundant safety neutral request 0 1 : redundant safety neutral request 1 0 : reserved (will also result in a safety neutral request) 1 1 : function not supported over CAN (will also result in a safety neutral request) REMARK: this is a redundant signal to request neutral seperately from the normal shift lever signal (for safety reasons).
	Bit 1.3 … Bit 1.8	Not used	**Reserved** Bits 1.3 … 1.8 must be = 1111 11(Bin)
Byte 2 Byte 3 Byte 4 Byte 5 Byte 6 Byte 7 Byte 8	Bit 2.1 … Bit 8.8	Not used	**Reserved** Bits 2.1 … 2.8 must be = 1111 1111(Bin) = FF(Hex) Bits 3.1 … 3.8 must be = 1111 1111(Bin) = FF(Hex) Bits 4.1 … 4.8 must be = 1111 1111(Bin) = FF(Hex) Bits 5.1 … 5.8 must be = 1111 1111(Bin) = FF(Hex) Bits 6.1 … 6.8 must be = 1111 1111(Bin) = FF(Hex) Bits 7.1 … 7.8 must be = 1111 1111(Bin) = FF(Hex) Bits 8.1 … 8.8 must be = 1111 1111(Bin) = FF(Hex)

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: CFF3003 $_{(Hex)}$ (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** $_{(Dec)}$	**FF30** $_{(Hex)}$ **= 65328** $_{(Dec)}$	**03** $_{(Hex)}$ **= 3** $_{(Dec)}$

Originator: **ECON.A**
Repetition rate: **20 msec**
DLC: **8**

		Value	Detail
Byte 1	Bit 1.1 Bit 1.2	Echo of direction selection	**Shift lever position** Bit 1.2 / Bit 1.1 0 0 : neutral 0 1 : forward 1 0 : reverse 1 1 : reserved
	Bit 1.3 … Bit 1.6	Echo of range Selection	Bit 1.6 / Bit 1.5 / Bit 1.4 / Bit 1.3 0 0 0 1 : 1st 0 0 1 0 : 2nd 0 0 1 1 : 3rd 0 1 0 0 : 4th 0 1 0 1 : 5th 0 1 1 0 : 6th 0 1 1 1 : 7th 1 0 0 0 : 8th All other bitpatterns are invalid
	Bit 1.7 Bit 1.8	Echo of fault state of shift lever	Bit 1.8 / Bit 1.7 0 0 : no fault detected on shift lever 0 1 : fault detected on shift lever (neutral is forced) 1 0 : reserved 1 1 : function not supported over CAN
Byte 2	Bit 2.1 Bit 2.2	Echo of transmission direction	**Gear position** Bit 2.2 / Bit 2.1 0 0 : neutral 0 1 : forward 1 0 : reverse 1 1 : reserved
	Bit 2.3 … Bit 2.6	Echo of transmission range gear	Bit 2.6 / Bit 2.5 / Bit 2.4 / Bit 2.3 0 0 0 1 : 1st 0 0 1 0 : 2nd 0 0 1 1 : 3rd 0 1 0 0 : 4th 0 1 0 1 : 5th 0 1 1 0 : 6th 0 1 1 1 : 7th 1 0 0 0 : 8th All other bitpatterns are invalid
	Bit 2.7 Bit 2.8	Echo of fault state of transmission control outputs	Bit 2.8 / Bit 2.7 0 0 : no fault detected on transmission control outputs 0 1 : fault detected on transmission control outputs 1 0 : reserved 1 1 : function not supported over CAN

Byte 3	Bit 3.1 Bit 3.2	Indication that active errors are present	**Active errors** Bit 3.2 Bit 3.1 0 0 : there are no active errors 0 1 : there is one or more active errors present 1 0 : reserved 1 1 : function not supported over CAN
	Bit 3.3 Bit 3.4	Indication that inactive errors are present	**Inactive errors** Bit 3.4 Bit 3.3 0 0 : there are no inactive errors 0 1 : there is one or more inactive errors present 1 0 : reserved 1 1 : function not supported over CAN REMARK: Only valid for inactive errors in the volatile error memory.
	Bit 3.5 Bit 3.6	Indication of a warning	**Warning indication** Bit 3.6 Bit 3.5 0 0 : the warning indication is OFF 0 1 : the warning indication is ON 1 0 : reserved 1 1 : function not supported over CAN REMARK: The exact trigger(s) for the warning indication are application specific. Refer to CHAPTER 1 – 1.11.27 for details.
	Bit 3.7 Bit 3.8	Direction or range shift in progress	**Shift in progress** Bit 3.8 Bit 3.7 0 0 : no shift in progress 0 1 : a (direction or range) shift is in progress 1 0 : reserved 1 1 : function not supported over CAN
Byte 4	Bit 4.1 … Bit 4.8	Sump temperature	**Sump temperature** Conversion: Temperature = (Byte 4) – 50 [°C] 0 = -50 °C 250 = 200 °C 254 = fault related to temperature sensor 255 = measurement not supported REMARK: only the analogue temperature measurement is indicated here. Refer to CHAPTER 1 – 1.10.6 details.
Byte 5	Bit 5.1 … Bit 5.8	Converter out Temperature	**Converter out temperature** Conversion : Temperature = (Byte 5) – 50 [°C] 0 = -50 °C 250 = 200 °C 254 = fault related to temperature sensor 255 = measurement not supported REMARK: only the analogue temperature measurement is indicated here. Refer to CHAPTER 1 – 1.11.20 for details.

Byte 6	Bit 6.1 … Bit 6.8	Vehicle speed	**Vehicle speed** Conversion: vehicle speed = (Byte 6) * (resolution factor) [km/h] where: resolution factor = 0.1 for 0 < Byte 6 < 100 (0 .. 10 km/h) resolution factor = 0.2 for 100 < Byte 6 < 200 (10 .. 30 km/h) resolution factor = 1 for 200 < Byte 6 < 250 (30 .. 80 km/h) REMARK: use the correct resolution factor for each portion of Byte 6 E.g.: Byte 6 = 211: Vehicle speed = (100 * 0.1) + 100 * 0.2 + 11 * 1 = 41 km/h 254 = fault related to the speed sensor for vehicle speed calculation 255 = measurement not supported
Byte 7	Bit 7.1 … Bit 7.8	System pressure	**System Pressure** Conversion: System pressure = (Byte 7) * (resolution factor) [bar] where: resolution factor = 0.1 for 0 < Byte 7 < 100 (0 .. 10 bar) resolution factor = 0.2 for 100 < Byte 7 < 200 (10 .. 30 bar) resolution factor = 1 for 200 < Byte 7 < 250 (30 .. 80 bar) REMARK: use the correct resolution factor for each portion of Byte 7 E.g.: Byte 7 = 148: System pressure = (100 * 0.1) + 48 * 0.2 + 0 * 1 = 19.6 bar 254 = fault related to pressure sensor 255 = measurement not supported REMARK: in case a switch is used instead of a sensor, the following values are reported: - no pressure detected = 0 = 0 bar - pressure detected = 150 = 20 bar
Byte 8	Bit 8.1 … Bit 8.8	Not used	**Reserved** Bits 8.1 … 8.8 must be = $1111\ 1111_{(Bin)}$ = $FF_{(Hex)}$

1.6.2 TC_TO_CVC_2: Optional Transmission info 1

Message identifier: CFF3103 $_{(Hex)}$ (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** $_{(Dec)}$	**FF31** $_{(Hex)}$ **= 65329** $_{(Dec)}$	**03** $_{(Hex)}$ **= 3** $_{(Dec)}$

Originator: **ECON.A**
Repetition rate: **100 msec**
DLC: **8**

		Value	Detail
Byte 1	Bit 1.1 … Bit 1.8	Gear position code	**Gear position code** FF$_{(Hex)}$ = transmission shutdown mode active 7F$_{(Hex)}$ = transmission limphome mode active 00$_{(Hex)}$ = normal operation 10$_{(Hex)}$ = declutch active 11$_{(Hex)}$ = parking brake on 12$_{(Hex)}$ = neutral lock active 13$_{(Hex)}$ = operator not seated 14$_{(Hex)}$ = redundant safety neutral active 20$_{(Hex)}$ = kickdown active 30$_{(Hex)}$ = direction change protection active due to excessive vehicle speed 31$_{(Hex)}$ = direction change protection active due to excessive engine speed 32$_{(Hex)}$ = downshift protection active 40$_{(Hex)}$ = calibration mode active REMARK: The codes have a priority. The above list shows the codes in descending priority: FF$_{(Hex)}$ has the highest priority and 40$_{(Hex)}$ has the lowest priority. E.g.: if code 13$_{(Hex)}$ and 30$_{(Hex)}$ would exist at the same moment, Byte 1 shows the code 13$_{(Hex)}$.
Byte 2	Bit 2.1 Bit 2.2	Echo of the declutch request	**Declutch request echo** (if not used: all bits will be 1) Bit 2.2 Bit 2.1 0 0 : echo that declutch is not requested 0 1 : echo that declutch is requested 1 0 : reserved 1 1 : function not supported over CAN
	Bit 2.3 Bit 2.4	Echo of the parking brake status or echo of the parking brake request	**Parking brake echo** (if not used: all bits will be 1) Bit 2.4 Bit 2.3 0 0 : echo that parking brake is released or echo that parking brake is not requested 0 1 : echo that parking brake is activated or echo that parking brake is requested 1 0 : reserved 1 1 : function not supported over CAN
	Bit 2.5 Bit 2.6	Neutral lock function state	**Neutral lock function state** (if not used: all bits will be 1) Bit 2.6 Bit 2.5 0 0 : neutral lock function not activate 0 1 : neutral lock function active 1 0 : reserved 1 1 : function not supported over CAN

		Value	Detail
	Bit 2.7 Bit 2.8	Operator present function state	**Operator present function state** (if not used: all bits will be 1) Bit 2.8 Bit 2.7 0 0 : operator present protection not active 0 1 : operator present protection active 1 0 : reserved 1 1 : function not supported over CAN
Byte 3	Bit 3.1 … Bit 3.4	Not used	**Reserved** Bits 3.1 … 3.4 are = $1111_{(Bin)}$ = $F_{(Hex)}$
	Bit 3.5 Bit 3.6	Automatic/ manual mode function state	**Automatic/manual mode function state** (if not used: all bits will be 1) Bit 3.6 Bit 3.5 0 0 : manual mode is active 0 1 : automatic mode is active 1 0 : reserved 1 1 : function not supported over CAN
	Bit 3.7 Bit 3.8	Echo of loaded/not loaded detection	**Loaded/not loaded detection echo** (if not used: all bits will be 1) Bit 3.8 Bit 3.7 0 0 : echo that vehicle "not loaded" is detected 0 1 : echo that vehicle "loaded" is detected 1 0 : reserved 1 1 : function not supported over CAN
Byte 4	Bit 4.1 Bit 4.2	Echo of the kickdown request	**Kickdown request echo** (if not used: all bits will be 1) Bit 4.2 Bit 4.1 0 0 : echo that kickdown is not requested 0 1 : echo that kickdown is requested 1 0 : reserved 1 1 : function not supported over CAN
	Bit 4.3 Bit 4.4	4WD/2WD function state	**4WD/2WD function state** (if not used: all bits will be 1) Bit 4.4 Bit 4.3 0 0 : transmission is in 2WD 0 1 : transmission is in 4WD 1 0 : reserved 1 1 : function not supported over CAN
	Bit 4.5 Bit 4.6	Not used	**Reserved** Bits 4.5 and 4.6 are = $11_{(Bin)}$
	Bit 4.7 Bit 4.8	Inhibit shifting function state	**Inhibit shifting function state** (if not used: all bits will be 1) Bit 4.8 Bit 4.7 0 0 : inhibit shifting is inactive 0 1 : inhibit shifting is active 1 0 : reserved 1 1 : function not supported over CAN

Byte 5	Bit 5.1 Bit 5.2	Seat orientation function state	**Seat orientation function state** (if not used: all bits will be 1) Bit 5.2 Bit 5.1 0 0 : seat console in normal orientation → no inversion of direction outputs 0 1 : seat console in inverted orientation → inversion of direction outputs 1 0 : reserved 1 1 : function not supported over CAN
	Bit 5.3 Bit 5.4	Not used	**Reserved** The bits 5.3 and 5.4 are = $11_{(Bin)}$
	Bit 5.5 Bit 5.6	Echo of the throttle pedal position: idle/not idle	**Throttle pedal idle/not idle echo** (if not used: all bits will be 1) Bit 5.6 Bit 5.5 0 0 : echo that throttle pedal is not in idle position 0 1 : echo that throttle pedal is in idle position 1 0 : reserved 1 1 : function not supported over CAN
	Bit 5.7 Bit 5.8	Echo of the throttle pedal position: full/half throttle	**Throttle pedal full/half throttle echo** (if not used: all bits will be 1) Bit 5.8 Bit 5.7 0 0 : echo that throttle pedal is in half throttle position 0 1 : echo that throttle pedal is in full throttle position 1 0 : reserved 1 1 : function not supported over CAN
Byte 6	Bit 6.1 Bit 6.2	Echo of the manual lockup request or echo of the automatic lockup status	**Lockup echo** (if not used: all bits will be 1) Bit 6.2 Bit 6.1 0 0 : echo that manual lockup is not requested echo that automatic lockup is disabled 0 1 : echo that manual lockup is requested echo that automatic lockup is enabled 1 0 : reserved 1 1 : function not supported over CAN
	Bit 6.3 Bit 6.4	Echo of the high engine idle request	**High engine idle request echo** (if not used: all bits will be 1) Bit 6.4 Bit 6.3 0 0 : echo that high engine idle is not requested 0 1 : echo that high engine idle is requested 1 0 : reserved 1 1 : function not supported over CAN
	Bit 6.5 Bit 6.6	Echo of the high/low range selection	**High/low range selection echo** (if not used: all bits will be 1) Bit 6.6 Bit 6.5 0 0 : echo that low range is selected 0 1 : echo that high range is selected 1 0 : reserved 1 1 : function not supported over CAN

	Bit 6.7 Bit 6.8	Echo of the redundant safety neutral request	**Redundant safety neutral echo** (if not used: all bits will be 1) Bit 6.8 Bit 6.7 0 0 : echo that redundant safety neutral is not requested 0 1 : echo that redundant safety neutral is requested 1 0 : reserved 1 1 : function not supported over CAN
Byte 7	Bit 7.1 Bit 7.2	Echo of the system pressure status	**System pressure status echo** (if not used: all bits will be 1) Bit 7.2 Bit 7.1 0 0 : echo that the system pressure is not ok (too low) 0 1 : echo that the system pressure is ok 1 0 : reserved 1 1 : function not supported over CAN
	Bit 7.3 Bit 7.4	Echo of the service brakes state: pressed or released	**Service brake state echo** (if not used: all bits will be 1) Bit 7.4 Bit 7.3 0 0 : echo that the service brakes are released 0 1 : echo that the service brakes are pressed 1 0 : reserved 1 1 : function not supported over CAN
	Bit 7.5 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) Bit 7.6 Bit 7.5 0 0 : echo that blocking out of the highest gear(s) is not requested 0 1 : echo that blocking out of the highest gear(s) is requested 1 0 : reserved 1 1 : function not supported over CAN
	Bit 7.7 Bit 7.8	Echo of the converter out temperature status	**Converter out temperature status echo** (if not used: all bits will be 1) Bit 7.8 Bit 7.7 0 0 : echo that the converter out temperature is ok 0 1 : echo that the converter out temperature is too high (>120°C) 1 0 : reserved 1 1 : function not supported over CAN REMARK: only the digital temperature measurement is indicated here.
Byte 8	Bit 8.1 Bit 8.2	Echo of the exhaust brake status detection	**Exhaust brake status detection echo** (if not used: all bits will be 1) Bit 8.2 Bit 8.1 0 0 : echo of the detection that the exhaust brake is not active 0 1 : echo of the detection that the exhaust brake is active 1 0 : reserved 1 1 : function not supported over CAN
	Bit 8.3 Bit 8.4	Echo of the retarder status detection	**Retarder status detection echo** (if not used: all bits will be 1) Bit 8.4 Bit 8.3 0 0 : echo of the detection that the retarder is not active 0 1 : echo of the detection that the retarder is active 1 0 : reserved 1 1 : function not supported over CAN
	Bit 8.5 … Bit 8.8	Not Used	**Reserved** The bits 8.5 … 8.8 must be = $1111_{(Bin)}$

1.6.3 TC_TO_CVC_3: Optional transmission info 2

Message identifier: CFF3203 $_{(Hex)}$ **(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** $_{(Dec)}$	**FF32** $_{(Hex)}$ **= 65330** $_{(Dec)}$	**03** $_{(Hex)}$ **= 3** $_{(Dec)}$

Originator: **ECON.A**
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) Conversion: throttle pedal position = byte 0 x 0.4 [%] 0 = 0 % 250 = 100 % 254 = fault related to throttle pedal position sensing 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) Conversion: brake pedal position = byte 1 x 0.4 [%] 0 = 0 % 250 = 100 % 254 = fault related to brake pedal position sensing 255 = measurement not supported
Byte 3 Byte 4	Bit 3.1 … Bit 4.8	Not used	**<u>Reserved</u>** Bits 3.1 … 3.8 must be = 1111 1111 $_{(Bin)}$ = FF $_{(Hex)}$ Bits 4.1 … 4.8 must be = 1111 1111 $_{(Bin)}$ = FF $_{(Hex)}$
Byte 5	Bit 5.1 Bit 5.2	Echo of the PTO or PTI request	**<u>PTO / PTI request echo</u>** (if not used: all bits will be 1) <u>Bit 5.2</u> <u>Bit 5.1</u> 0 0 : echo that PTO or PTI is not requested 0 1 : echo that PTO or PTI is requested 1 0 : reserved 1 1 : function not supported over CAN
	Bit 5.3 … Bit 5.8	Not used	**<u>Reserved</u>** Bits 5.3 … 5.8 must be = 1111 11 $_{(Bin)}$
Byte 6 Byte 7	Bit 6.1 … Bit 7.8	Engine speed	**<u>Engine speed</u>** Conversion: engine speed = [(Byte 7) * 256 + (Byte 6)] * 0.125 [RPM] Note: this is the engine speed internally known by the ECON.A. The origin of this engine speed information can be a speed measurement by the ECON.A itself or it can be CAN message EEC1.
Byte 8	Bit 8.1 … Bit 8.8	Not used	**<u>Reserved</u>** Bits 8.1 … 8.8 must be = 1111 1111 $_{(Bin)}$ = FF $_{(Hex)}$

1.7 Proprietary messages between the CVC (Central Vehicle Controller) and the ECON.A: 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.A, 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.A. In return, the ECON.A 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.A. 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.A 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.A to be able to give a correct reply to the request.

Most request codes sent to the ECON.A result in a reply message from the ECON.A. 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 = $FF_{(Hex)}$.
- "Request codes" that require extra information to be specified to the ECON.A: 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: CFF23xx $_{(Hex)}$ (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** $_{(Dec)}$	**FF23** $_{(Hex)}$ **= 65315** $_{(Dec)}$	Example : **27** $_{(Hex)}$ **= 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	**<u>Request code</u>** (if do nothing: all bits should be 1) **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.** **Supported "request codes":** 00 $_{(Hex)}$ = HW serial number 01 $_{(Hex)}$ = HW partnumber 02 $_{(Hex)}$ = HW version 03 $_{(Hex)}$ = SW partnumber 04 $_{(Hex)}$ = SW version 05 $_{(Hex)}$ = APT-file partnumber 06 $_{(Hex)}$ = APT-file version 07 $_{(Hex)}$ = OEM GDE-file partnumber 08 $_{(Hex)}$ = OEM GDE-file version 09 $_{(Hex)}$ = Product name FF $_{(Hex)}$ = do nothing
Byte 2 Byte 3 Byte 4 Byte 5 Byte 6 Byte 7 Byte 8	Bit 2.1 … Bit 8.8	Not used	**<u>Reserved</u>** These bytes have no relevance with the above request codes. Bits 2.1 … 2.8 must be = 1111 1111 $_{(Bin)}$ = FF $_{(Hex)}$ Bits 3.1 … 3.8 must be = 1111 1111 $_{(Bin)}$ = FF $_{(Hex)}$ Bits 4.1 … 4.8 must be = 1111 1111 $_{(Bin)}$ = FF $_{(Hex)}$ Bits 5.1 … 5.8 must be = 1111 1111 $_{(Bin)}$ = FF $_{(Hex)}$ Bits 6.1 … 6.8 must be = 1111 1111 $_{(Bin)}$ = FF $_{(Hex)}$ Bits 7.1 … 7.8 must be = 1111 1111 $_{(Bin)}$ = FF $_{(Hex)}$ Bits 8.1 … 8.8 must be = 1111 1111 $_{(Bin)}$ = FF $_{(Hex)}$

The "request codes" for reading the identification data are supported when the ECON.A is in the bootloader operating mode. This allows identification of the ECON.A even in this special programming mode.

1.7.1.4 CVC_TO_TC_4: Identification data (writable)

		Value	Detail
Byte 1	Bit 1.1 … Bit 1.8	Request code	**Request code** **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.** **Supported "request codes":** $0A_{(Hex)}$ = DANA transmission serial number $0B_{(Hex)}$ = OEM Vehicle ID $0C_{(Hex)}$ = OEM Reference 1 $0D_{(Hex)}$ = OEM Reference 2 $0E_{(Hex)}$ = OEM Reference 3 $0F_{(Hex)}$ = OEM Reference 4 **REMARK:** Request codes $0A_{(Hex)}$ to $0F_{(Hex)}$ 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.A. The only restriction is that the data can only contain maximum 7 ASCII character values per field.
Byte 2 Byte 3 Byte 4 Byte 5 Byte 6 Byte 7 Byte 8	Bit 2.1 … Bit 8.8	Data	**Read Request:** For sending a read request for the actual identification parameter, set all bits to 1 = all bytes to $FF_{(Hex)}$ **Write Request = Set value:** $0A_{(Hex)}$ = DANA Transmission serial number Byte 2 – 5: ASCII serial number prefix (e.g.: NBEA) Each byte represents the ASCII code value of 1 character of the prefix Byte 6 – 8: serial number (e.g.: 123456) Serial number = (Byte 8) * 2^{16} + (Byte 7) * 2^{8} + (Byte 6) $0B_{(Hex)}$ = Vehicle ID $0C_{(Hex)}$ = OEM Reference 1 $0D_{(Hex)}$ = OEM Reference 2 $0E_{(Hex)}$ = OEM Reference 3 $0F_{(Hex)}$ = OEM Reference 4 Byte 2 – 8: 7 character ASCII string, containing the Vehicle ID or OEM reference 1, 2, 3 or 4

The request codes for reading the identification data are supported when the ECON.A is in the bootloader operating mode.This allows identification of the ECON.A 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 … Bit 1.8	Request code	**Request code** **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.** **Supported "request codes":** $40_{(Hex)}$ = read/reset the resetable distance day counter $41_{(Hex)}$ = read the total travelled distance
Byte 2	Bit 2.1 … Bit 2.8	Command code	**Command code** For $40_{(Hex)}$ = read/reset the resetable distance day counter $01_{(Hex)}$ = reset the value of the distance day counter $FF_{(Hex)}$ = just read the current value of the distance day counter For $41_{(Hex)}$ = total travelled distance The total travelled distance counter can not be reset. This byte must be set to $FF_{(Hex)}$ to read the current value of the total travelled distance.
Byte 3 Byte 4 Byte 5 Byte 6 Byte 7 Byte 8	Bit 3.1 … Bit 8.8	Not used	**Reserved** These bytes have no relevance for these "request codes". Bits 3.1 … 3.8 must be = $1111\ 1111_{(Bin)}$ = $FF_{(Hex)}$ Bits 4.1 … 4.8 must be = $1111\ 1111_{(Bin)}$ = $FF_{(Hex)}$ Bits 5.1 … 5.8 must be = $1111\ 1111_{(Bin)}$ = $FF_{(Hex)}$ Bits 6.1 … 6.8 must be = $1111\ 1111_{(Bin)}$ = $FF_{(Hex)}$ Bits 7.1 … 7.8 must be = $1111\ 1111_{(Bin)}$ = $FF_{(Hex)}$ Bits 8.1 … 8.8 must be = $1111\ 1111_{(Bin)}$ = $FF_{(Hex)}$

1.7.1.6 CVC_TO_TC_4: Error info (from volatile memory)

		Value	Detail
Byte 1	Bit 1.1 … Bit 1.8	Request code	**Request code** **The following "request codes" can be used to read the error info from the ECON.A and clear the error buffer of inactive errors. For the description of the reply format, refer to CHAPTER 3 – 1.7.2.4.** **Supported "request codes":** $1A_{(Hex)}$ = 1st active error info $1B_{(Hex)}$ = next active error info $1C_{(Hex)}$ = 1st inactive error info $1D_{(Hex)}$ = next inactive error info $14_{(Hex)}$ = clear inactive errors buffer
Byte 2 Byte 3 Byte 4 Byte 5 Byte 6 Byte 7 Byte 8	Bit 2.1 … Bit 8.8	Not used	**Reserved** These bytes have no relevance for these "request codes". The bits 2.1 … 2.8 must be = $1111\ 1111_{(Bin)}$ = $FF_{(Hex)}$ The bits 3.1 … 3.8 must be = $1111\ 1111_{(Bin)}$ = $FF_{(Hex)}$ The bits 4.1 … 4.8 must be = $1111\ 1111_{(Bin)}$ = $FF_{(Hex)}$ The bits 5.1 … 5.8 must be = $1111\ 1111_{(Bin)}$ = $FF_{(Hex)}$ The bits 6.1 … 6.8 must be = $1111\ 1111_{(Bin)}$ = $FF_{(Hex)}$ The bits 7.1 … 7.8 must be = $1111\ 1111_{(Bin)}$ = $FF_{(Hex)}$ The bits 8.1 … 8.8 must be = $1111\ 1111_{(Bin)}$ = $FF_{(Hex)}$

Usage of CVC_TO_TC_4 to read ECON.A error info (from volatile memory)

In the ECON.A, 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" $1A_{(Hex)}$ in CVC_TO_TC_4.
To read the rest of the active errors, repeat sending the "request code" $1B_{(Hex)}$ in CVC_TO_TC_4.
As long as there are active errors present, the ECON.A replies the error info. When all the active errors have been monitored, the ECON.A replies with "fault area" = $FF_{(Hex)}$ and "fault type" = $FF_{(Hex)}$ to indicate this (refer to CHAPTER 3 – 1.7.2.4 for details). To repeat reading all the active errors, send the "request code" $1A_{(Hex)}$ again, followed by repeating "request code" $1B_{(Hex)}$ 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.A), but are not longer active now. To read the inactive error with highest priority, send the "request code" $1C_{(Hex)}$ in CVC_TO_TC_4. To read the rest of the inactive errors, repeat sending the "request code" $1D_{(Hex)}$ in CVC_TO_TC_4 until all inactive errors have been monitored.

There is one more extra "request code" = $14_{(Hex)}$. 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.A, a rate of 100 ms or longer is recommended, to avoid unnecessary high load on the CAN-bus and the ECON.A.

<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.A. The ECON.A 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" (a DANA diagnostics PC tool).

1.7.1.7 CVC_TO_TC_4: Display/operating mode selection

		Value	Detail
Byte 1	Bit 1.1 … Bit 1.8	Request code	**<u>Request code</u>** **The following code can be used to select a specific display mode or operating mode in the ECON.A. For the description of the reply format, refer to CHAPTER 3 – 1.7.2.5.** **Supported “request codes”:** 71$_{(Hex)}$ = select display/operating mode
Byte 2	Bit 2.1 … Bit 2.8	Display / operating mode	**<u>Display/Operating mode</u>** **This byte specifies the requested display/operating mode.** **Supported “display/operating modes”:** 00$_{(Hex)}$ = normal display mode / normal operating mode 01$_{(Hex)}$ = diagnostic display mode / normal operating mode 09$_{(Hex)}$ = calibration display mode / calibration operating mode 0A$_{(Hex)}$ = error display mode / normal operating mode <u>REMARK</u>: upon receipt of the new mode, the ECON.A immediately changes its display andoperating mode. The request is dropped when the controller is powered down or when a new mode is selected.
Byte 3 Byte 4 Byte 5 Byte 6 Byte 7 Byte 8	Bit 3.1 … Bit 8.8	Not used	**<u>Reserved</u>** These bytes have no relevance for the above “request code”. Bits 3.1 … 3.8 must be = 1111 1111$_{(Bin)}$ = FF$_{(Hex)}$ Bits 4.1 … 4.8 must be = 1111 1111$_{(Bin)}$ = FF$_{(Hex)}$ Bits 5.1 … 5.8 must be = 1111 1111$_{(Bin)}$ = FF$_{(Hex)}$ Bits 6.1 … 6.8 must be = 1111 1111$_{(Bin)}$ = FF$_{(Hex)}$ Bits 7.1 … 7.8 must be = 1111 1111$_{(Bin)}$ = FF$_{(Hex)}$ Bits 8.1 … 8.8 must be = 1111 1111$_{(Bin)}$ = FF$_{(Hex)}$

1.7.1.8 CVC_TO_TC_4: Calibration Control

		Value	Detail
Byte 1	Bit 1.1 … Bit 1.8	Request code	**<u>Request code</u>** **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.** **For a detailed description of the correct usage and the context of these codes, refer to the CHAPTER 1 – 2.** **Supported "request codes":** 20$_{(Hex)}$ = throttle pedal calibration 21$_{(Hex)}$ = brake pedal calibration 22$_{(Hex)}$ = transmission calibration 23$_{(Hex)}$ = abort calibration in process **<u>REMARK</u>: these "request codes" are only accepted, in case the display/operating mode of the ECON.A 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	**<u>Command code</u>** **<u>Calibration types handling</u>** For the request codes 20$_{(Hex)}$, 21$_{(Hex)}$, 22$_{(Hex)}$, the "command code" can be the following: 01$_{(Hex)}$ = start the calibration 02$_{(Hex)}$ = jump to the next calibration phase **<u>Abort Calibration or Activating Heating Mode</u>** For the request codes 23$_{(Hex)}$ this "command code" has no meaning: all bits should be set to 1: FF$_{(Hex)}$ = not relevance <u>REMARK</u>: 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 Byte 4 Byte 5 Byte 6 Byte 7 Byte 8	Bit 3.1 … Bit 8.8	Not used	**<u>Reserved</u>** These bytes have no relevance for the above request codes. Bits 3.1 … 3.8 must be = 1111 1111$_{(Bin)}$ = FF$_{(Hex)}$ Bits 4.1 … 4.8 must be = 1111 1111$_{(Bin)}$ = FF$_{(Hex)}$ Bits 5.1 … 5.8 must be = 1111 1111$_{(Bin)}$ = FF$_{(Hex)}$ Bits 6.1 … 6.8 must be = 1111 1111$_{(Bin)}$ = FF$_{(Hex)}$ Bits 7.1 … 7.8 must be = 1111 1111$_{(Bin)}$ = FF$_{(Hex)}$ Bits 8.1 … 8.8 must be = 1111 1111$_{(Bin)}$ = FF$_{(Hex)}$

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** **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.** **For a detailed description of the correct usage and context of these codes, refer to the CHAPTER 2 – 5 for details.** **Supported "request codes":** $80_{(Hex)}$ = configuration set selection
Byte 2	Bit 2.1 … Bit 2.8	Command code	**Command code** **Supported "command codes":** $00_{(Hex)}$ = read request: read the currently active configuration set $01_{(Hex)}$ = 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) If the "command code" is $01_{(Hex)}$ in order to select a configuration set, the index of the desired configuration set is specified here If the "command code" is $00_{(Hex)}$, this byte is not relevant and must be set to $FF_{(Hex)}$.
Byte 4 Byte 5 Byte 6 Byte 7 Byte 8	Bit 4.1 … Bit 8.8	Not used	**Reserved** These bytes have no relevance with the above request codes. Bits 4.1 … 4.8 must be = $1111\ 1111_{(Bin)}$ = $FF_{(Hex)}$ Bits 5.1 … 5.8 must be = $1111\ 1111_{(Bin)}$ = $FF_{(Hex)}$ Bits 6.1 … 6.8 must be = $1111\ 1111_{(Bin)}$ = $FF_{(Hex)}$ Bits 7.1 … 7.8 must be = $1111\ 1111_{(Bin)}$ = $FF_{(Hex)}$ Bits 8.1 … 8.8 must be = $1111\ 1111_{(Bin)}$ = $FF_{(Hex)}$

1.7.1.10 CVC_TO_TC_4: Configuration set parameter handling

		Value	Detail
Byte 1	Bit 1.1 … Bit 1.8	Request code	**<u>Request code</u>** **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.** **For a detailed description of the correct usage and context of these codes, refer to the CHAPTER 2 – 5 for details.** **Supported "request codes":** $81_{(Hex)}$ = read the value of the addressed configuration set parameter $86_{(Hex)}$ = write a new value into the addressed configuration set parameter
Byte 2	Bit 2.1 … Bit 2.8	Parameter Index	**<u>Parameter index</u>** **The "parameter index" is the index value of the parameter that needs to be addressed.** Valid range for the "parameter index" = $00_{(Hex)}$ – $F1_{(Hex)}$ **For the complete list of "parameter index" values, refer to CHAPTER 2 – 5.4.5.**
Byte 3 Byte 4	Bit 3.1 … Bit 4.8	New Parameter Value	**<u>New parameter value</u>** If the "request code" $86_{(Hex)}$ 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: New parameter value = (Byte 3) + (Byte 4) x 256 The exact meaning of the parameter value depends on the addressed parameter. Refer to CHAPTER 2 for details about the addressed parameters. If the "request code" $81_{(Hex)}$ is used to read the actual value of the parameter addressed with "parameter index", byte 3 and 4 must be equal to $FF_{(Hex)}$.
Byte 5 Byte 6 Byte 7 Byte 8	Bit 5.1 … Bit 8.8	Not used	**<u>Reserved</u>** These bytes have no relevance with the above request codes. Bits 5.1 … 5.8 must be = $1111\ 1111_{(Bin)}$ = $FF_{(Hex)}$ Bits 6.1 … 6.8 must be = $1111\ 1111_{(Bin)}$ = $FF_{(Hex)}$ Bits 7.1 … 7.8 must be = $1111\ 1111_{(Bin)}$ = $FF_{(Hex)}$ Bits 8.1 … 8.8 must be = $1111\ 1111_{(Bin)}$ = $FF_{(Hex)}$

1.7.1.11 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.A in a CAN bus network.

		Value	Detail
Byte 1	Bit 1.1 … Bit 1.8	DANA reserved request code	**DANA Reserved Request code** **The following codes are exclusively reserved for DANA applications and are not to be used by any other device.** **15** (Hex) **16** (Hex) **17** (Hex) **18** (Hex) **25** (Hex) **26** (Hex) **30** (Hex) **34** (Hex) **35** (Hex) **36** (Hex) **3A** (Hex) **3B** (Hex) **3C** (Hex) **3D** (Hex) **82** (Hex) **83** (Hex) **84** (Hex) **85** (Hex) **A0** (Hex) **AA** (Hex) **AB** (Hex) **AC** (Hex) **AD** (Hex) **AE** (Hex)
Byte 2 Byte 3 Byte 4 Byte 5 Byte 6 Byte 7 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: CFF3303 (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)	**FF33** (Hex) **= 65331** (Dec)	**03** (Hex) **= 3** (Dec)

Originator: **ECON.A**
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.A, 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.A. In return, the ECON.A 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.A. 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 … Bit 1.8	Reply code	**Reply code** **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.** **Supported "reply codes":** 00$_{(Hex)}$ = HW serial number 01$_{(Hex)}$ = HW partnumber 02$_{(Hex)}$ = HW version 03$_{(Hex)}$ = SW partnumber 04$_{(Hex)}$ = SW version 05$_{(Hex)}$ = APT-file partnumber 06$_{(Hex)}$ = APT-file version 07$_{(Hex)}$ = OEM GDE-file partnumber 08$_{(Hex)}$ = OEM GDE-file version 09 $_{(Hex)}$ = Product name 0A$_{(Hex)}$ = DANA transmission serial number 0B$_{(Hex)}$ = OEM Vehicle ID 0C$_{(Hex)}$ = OEM Reference 1 0D$_{(Hex)}$ = OEM Reference 2 0E$_{(Hex)}$ = OEM Reference 3 0F$_{(Hex)}$ = OEM Reference 4
Byte 2 Byte 3 Byte 4 Byte 5 Byte 6 Byte 7 Byte 8	Bit 2.1 … Bit 8.8	Requested data	**Requested data** **The format of the requested data depends on the "reply code":** 00$_{(Hex)}$ = HW serial number 01$_{(Hex)}$ = HW partnumber 02$_{(Hex)}$ = HW version 03$_{(Hex)}$ = SW partnumber 04$_{(Hex)}$ = SW version 05$_{(Hex)}$ = APT-file partnumber 06$_{(Hex)}$ = APT-file version 07$_{(Hex)}$ = OEM GDE-file partnumber 08$_{(Hex)}$ = OEM GDE-file version 09$_{(Hex)}$ = Product name Byte 2 – 8: 7 character ASCII string, containing the HW serial number, HW partnumber,… 0A$_{(Hex)}$ = DANA transmission serial number Byte 2 – 5: ASCII serial number prefix (e.g.: NBEA) Each byte represents the ASCII code value of 1 character of the prefix Byte 6 – 8: serial number (e.g.: 123456) Serial number = (Byte 8) * 2^{16} + (Byte 7) * 2^{8} + (Byte 6) 0B$_{(Hex)}$ = Vehicle ID 0C$_{(Hex)}$ = OEM Reference 1 0D$_{(Hex)}$ = OEM Reference 2 0E$_{(Hex)}$ = OEM Reference 3 0F$_{(Hex)}$ = OEM Reference 4 Byte 2 – 8: 7 character ASCII string, containing the Vehicle ID or OEM reference 1, 2, 3 or 4 ***In case the requested identification parameter is not available (e.g. when there is no valid application present with ECON.A in bootloader mode), the ECON.A replies with bytes 2 – 8 = FF$_{(Hex)}$.***

1.7.2.3 TC_TO_CVC_4: Resetable/total distance counter

		Value	Detail
Byte 1	Bit 1.1 … Bit 1.8	Reply code	**Reply code** **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.** **Supported "reply codes":** $40_{(Hex)}$ = resetable distance day counter $41_{(Hex)}$ = total travelled distance
Byte 2 Byte 3 Byte 4 Byte 5	Bit 2.1 … Bit 5.8	Distance	**Travelled distance** **The conversion for the travelled distance is:** distance = [(Byte 5)*2^{24} + (Byte 4)*2^{16} + (Byte 3)*2^{8} + (Byte 2)] / 10 [km] or [miles]* * the ECON.A can be programmed to report the travelled distance in km or in miles.
Byte 6 Byte 7 Byte 8	Bit 6.1 … Bit 8.8	Not used	**Reserved** These bytes have no relevance for the above "reply codes". Bits 6.1 … 6.8 are = $1111\ 1111_{(Bin)}$ = $FF_{(Hex)}$ Bits 7.1 … 7.8 are = $1111\ 1111_{(Bin)}$ = $FF_{(Hex)}$ Bits 8.1 … 8.8 are = $1111\ 1111_{(Bin)}$ = $FF_{(Hex)}$

1.7.2.4 TC_TO_CVC_4: error info (from volatile memory)

		Value	Detail
Byte 1	Bit 1.1 … Bit 1.8	Reply code	**Reply code** **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.** **Supported "reply codes":** $1A_{(Hex)}$ = 1st active error info $1B_{(Hex)}$ = next active error info $1C_{(Hex)}$ = 1st inactive error info $1D_{(Hex)}$ = next inactive error info $14_{(Hex)}$ = clear inactive errors buffer
Byte 2	Bit 2.1 … Bit 2.8	Fault area	**Fault area** The "fault area" is the first part of the error code defining the fault. E.g.: error code = 5F.02 → fault area = $5F_{(Hex)}$
Byte 3	Bit 3.1 … Bit 3.8	Fault Type	**Fault type** The fault type is the second part of the error code defining a fault. E.g.: error code = 5F.02 → fault area = $02_{(Hex)}$
Byte 4 Byte 5	Bit 4.1 … Bit 5.8	Number of occurrences	**Number of occurrences** This is an indication of the number of times this error has occurred since the most recent power up (volatile info). Conversion: number of occurrences = (Byte 5) * 256 + (Byte 4)
Byte 6 Byte 7	Bit 6.1 … Bit 7.8	Not used	**Reserved** These bytes have no relevance for the above "reply codes". Bits 6.1 … 6.8 are = $1111\ 1111_{(Bin)}$ = $FF_{(Hex)}$ Bits 7.1 … 7.8 are = $1111\ 1111_{(Bin)}$ = $FF_{(Hex)}$
Byte 8	Bit 8.1 … Bit 8.8	Fault severity	**Fault severity** The "fault severity" is a number indicating the severity of the fault: $01_{(Hex)}$ = severe warning - need to stop immediately $02_{(Hex)}$ = warning – service urgently $03_{(Hex)}$ = info – report and service $04_{(Hex)}$ = exceed parameter code - info $09_{(Hex)}$ = DANA info $FF_{(Hex)}$ = fault group not supported

***REMARK*: 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 $FF_{(Hex)}$ (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.A Error code list - prototype firmware 5.7pp.pdf".

1.7.2.5 TC_TO_CVC_4: Display/operating mode selection

		Value	Detail
Byte 1	Bit 1.1 … Bit 1.8	Reply code	**Reply code** **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.** **Supported "reply codes":** $71_{(Hex)}$ = selected display/operating mode
Byte 2	Bit 2.1 … Bit 2.8	Selected display / operation mode	**Selected display/operation mode** **Feedback of the current display/operation mode of the ECON.A. This feedback can be used to check if the requested display/operating mode was accepted.** **Supported values :** $00_{(Hex)}$ = normal display mode $01_{(Hex)}$ = diagnostic display mode $09_{(Hex)}$ = calibration display/operating mode $0A_{(Hex)}$ = error display mode $10_{(Hex)}$ = bootloader display/operating mode REMARK: The bootloader mode (= programming mode), can only be activated by the "DANA CAN Firmware XML Flashtool".
Byte 3 Byte 4 Byte 5 Byte 6 Byte 7 Byte 8	Bit 3.1 … Bit 8.8	Not used	**Reserved** These bytes have no relevance for the above "reply codes". Bits 3.1 … 3.8 are = $1111\ 1111_{(Bin)}$ = $FF_{(Hex)}$ Bits 4.1 … 4.8 are = $1111\ 1111_{(Bin)}$ = $FF_{(Hex)}$ Bits 5.1 … 5.8 are = $1111\ 1111_{(Bin)}$ = $FF_{(Hex)}$ Bits 6.1 … 6.8 are = $1111\ 1111_{(Bin)}$ = $FF_{(Hex)}$ Bits 7.1 … 7.8 are = $1111\ 1111_{(Bin)}$ = $FF_{(Hex)}$ Bits 8.1 … 8.8 are = $1111\ 1111_{(Bin)}$ = $FF_{(Hex)}$

1.7.2.6 TC_TO_CVC_4: Calibration control: analogue input signals

		Value	Detail
Byte 1	Bit 1.1 … Bit 1.8	Reply code	**<u>Reply code</u>** **When a calibration request has been accepted, TC_TO_CVC_4 is sent each 100 msec as long as the calibration mode is active.** **For a detailed description of the correct usage and context of this "reply codes", refer to the CHAPTER 1 – 2.1.3 for details.** **Supported "reply codes":** $20_{(Hex)}$ = throttle pedal calibration $21_{(Hex)}$ = brake pedal calibration $22_{(Hex)}$ = transmission calibration
Byte 2	Bit 2.1 … Bit 2.8	Calibration phase number	**<u>Calibration phase number</u>** $00_{(Hex)}$ = calibration of the analogue input minimum value (0%) $01_{(Hex)}$ = calibration of the analogue input low value $02_{(Hex)}$ = calibration of the analogue input middle value $03_{(Hex)}$ = calibration of the analogue input high value $04_{(Hex)}$ = calibration of the analogue input maximum value (100%) $05_{(Hex)}$ = calibration failed $06_{(Hex)}$ = calibration on hold $09_{(Hex)}$ = calibration successfully completed
Byte 3	Bit 3.1 … Bit 3.8	Not used	**<u>Reserved</u>** This byte has no relevance for the above "reply codes". Bits 3.1 … 3.8 are = $0000\ 0000_{(Bin)}$ = $00_{(Hex)}$
Byte 4	Bit 4.1 … Bit 4.8	ASCII Code	**<u>Calibration ASCII code</u>** ASCII code value of a character representing the active calibration option: $54_{(Hex)}$ = 'T' = throttle pedal calibration $42_{(Hex)}$ = 'B' = brake pedal calibration $41_{(Hex)}$ = 'A' = abort calibration $46_{(Hex)}$ = 'F' = forward clutch calibration $52_{(Hex)}$ = 'R' = reverse clutch calibration $53_{(Hex)}$ = 'S' = splitter clutch calibration $31_{(Hex)}$ = '1' = 1st clutch calibration $32_{(Hex)}$ = '2' = 2nd clutch calibration $33_{(Hex)}$ = '3' = 3rd clutch calibration $34_{(Hex)}$ = '4' = 4th clutch calibration
Byte 5	Bit 5.1 … Bit 5.8	Status	**<u>Calibration status</u>** $00_{(Hex)}$ = calibration not active $03_{(Hex)}$ = calibration active

Byte 6	Bit 6.1 … Bit 6.8	User intervention	**User intervention** This code specifies the use action required during the calibration procedure: $00_{(Hex)}$ = no action required – do nothing $01_{(Hex)}$ = push pedal or lever related to the analogue input signal $02_{(Hex)}$ = release pedal or lever related to the analogue input signal $03_{(Hex)}$ = select neutral $04_{(Hex)}$ = select forward $05_{(Hex)}$ = stop vehicle (vehicle movement detected) $06_{(Hex)}$ = heat up transmission (temperature too low) $07_{(Hex)}$ = engine speed control busy – do nothing $08_{(Hex)}$ = hold pedal, lever, ... of anlog input signal in current position $09_{(Hex)}$ = check error code $0A_{(Hex)}$ = apply parking brake
Byte 7 Byte 8	Bit 7.1 … Bit 8.8	Analogue input value	**Analogue input value** Feedback about the measured value of the analogue input signal that is being calibrated currently: Conversion: Analogue 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** **When the calibration procedure is aborted after receipt of “request code $23_{(Hex)}$, the ECON.A replies with the “reply code” $23_{(Hex)}$ in a single reply.** **For a detailed description of the correct usage and context of this “reply code”, refer to CHAPTER 1 – 2.1.3.** **Supported “reply codes”:** $23_{(Hex)}$ = aborted calibration
Byte 2 Byte 3	Bit 2.1 … Bit 3.8	Not used	**Not relevant** $XX_{(Hex)}$ = value can be anything, depending on calibration mode.
Byte 4	Bit 4.1 … Bit 4.8	ASCII Code	**Calibration ASCII code** ASCII code value of a character indicating that the calibration is aborted: $41_{(Hex)}$ = ‘A’ = aborted calibration
Byte 5	Bit 5.1 … Bit 5.8	Calibration status	**Calibration status** Value indicating that the calibration is not active (because aborted): $00_{(Hex)}$ = Calibration not active
Byte 6 Byte 7 Byte 8	Bit 6.1 … Bit 8.8	Not used	**Reserved** These bytes have no relevance for the above “reply codes”. Bits 6.1 … 6.8 are = $1111\ 1111_{(Bin)}$ = $FF_{(Hex)}$ Bits 7.1 … 7.8 are = $1111\ 1111_{(Bin)}$ = $FF_{(Hex)}$ Bits 8.1 … 8.8 are = $1111\ 1111_{(Bin)}$ = $FF_{(Hex)}$

1.7.2.8 TC_TO_CVC_4: Configuration set selection

		Value	Detail
Byte 1	Bit 1.1 … Bit 1.8	Reply code	**Reply code** **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.** **For a detailed description of correct usage and context of these codes, refer to CHAPTER 2 – 5 for details.** **Supported "reply codes":** $80_{(Hex)}$ = configuration set selection
Byte 2	Bit 2.1 … Bit 2.8	Command acceptance code	**Command acceptance code** The "command acceptance code" indicates whether or not the "command code" of the requesting CVC_TO_TC_4 was accepted or not: $00_{(Hex)}$ = read request of currently active configuration set accepted $01_{(Hex)}$ = write request to select a specified configuration set accepted $FF_{(Hex)}$ = write request to select a specified configuration set NOT accepted
Byte 3	Bit 3.1 … Bit 3.8	Newly selected configuration set index	**Newly selected configuration set index** The "newly selected configuration set index" gives feedback about the newly selected configuration set , via the sequence number of this configuration set: $00_{(Hex)}$ - $14_{(Hex)}$ = 0 – $20_{(Dec)}$ 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". 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". 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". In case there is no valid configuration set selected, the index is $FF_{(Hex)}$.

Byte 4	Bit 4.1 … Bit 4.8	Active Configuration Set Index	**Active configuration set index** The “active configuration set index” gives feedback about the active configuration set , via the sequence number of this configuration set: $00_{(Hex)}$ - $14_{(Hex)}$ = 0 – $20_{(Dec)}$ In case no valid configuration is selected, the “active configuration set index” equals $FF_{(Hex)}$. However, this should never occur during normal operation of the ECON.A, because this would mean that no configuration set is activated. In this case, normal operation would not be possible. 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.A (refer to CHAPTER 1 – 1.5 for details) and reset, the new configuration set is activated in the ECON.A. This can be checked after reset of the ECON.A: the “selected configuration set index” has become = to the “active configuration set index”.
Byte 5 Byte 6 Byte 7 Byte 8	Bit 5.1 … Bit 8.8	Not used	**Reserved** These bytes have no relevance for the above “reply code”. Bits 5.1 … 5.8 are = 1111 $1111_{(Bin)}$ = $FF_{(Hex)}$ Bits 6.1 … 6.8 are = 1111 $1111_{(Bin)}$ = $FF_{(Hex)}$ Bits 7.1 … 7.8 are = 1111 $1111_{(Bin)}$ = $FF_{(Hex)}$ Bits 8.1 … 8.8 are = 1111 $1111_{(Bin)}$ = $FF_{(Hex)}$

1.7.2.9 TC_TO_CVC_4: Configuration set parameter handling

		Value	Detail
Byte 1	Bit 1.1 … Bit 1.8	Reply code	**<u>Reply code</u>** **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.** **For a detailed description of correct usage and context of these codes, refer to CHAPTER 2 – 5 for details.** **Supported "reply codes":** $81_{(Hex)}$ = reading the value of the addressed configuration set parameter $86_{(Hex)}$ = writing a new value to the addressed configuration set parameter
Byte 2	Bit 2.1 … Bit 2.8	Parameter index acceptance	**<u>Parameter index acceptance</u>** 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: $00_{(Hex)}$ – $F1_{(Hex)}$ = index to a valid configuration set parameter (for the complete list of "parameter index" values, refer to CHAPTER 2 – 5.4.5) $FB_{(Hex)}$ = writing a new value was not accepted because some machine conditions are not fulfilled (refer to CHAPTER 2 – 5.1 for details) $FD_{(Hex)}$ = writing a new value was not accepted because the specified value is out of the allowed range $FE_{(Hex)}$ = read/write request was not accepted because a non-existing configuration set parameter was addressed
Byte 3 Byte 4	Bit 3.1 … Bit 4.8	Active parameter value	**<u>Active parameter value</u>** Active value of the addressed parameter: Conversion: parameter value = (Byte 3) + (Byte 4) x 256
Byte 5 Byte 6	Bit 5.1 … Bit 6.8	Minimum parameter value	**<u>Minimum parameter value</u>** Minimum allowed value of the addressed parameter: Conversion: minimum value = (Byte 5) + (Byte 6) x 256
Byte 7 Byte 8	Bit 7.1 … Bit 8.8	Maximum parameter value	**<u>Maximum parameter value</u>** Maximum allowed value of the addressed parameter: 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 $FFFF_{(Hex)}$ in case there is a problem with the addressing of the configuration set parameter. The "parameter index acceptance" in byte 2 equals $FE_{(Hex)}$ in this case.

2 SAE J1939 Standard CAN messages supported by the ECON.A

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.A 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.A 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 powerdown and reset of the ECON.A (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.A.

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.

<u>REMARK</u>: for a description of the error codes reported in these Diagnostic Messages, refer to CHAPTER 4 and to the error code list "ECON.A Error code list - prototype firmware 5.7pp.pdf".

2.2 EEC1: Electronic Engine Controller # 1

Message identifier: CF00400 (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)	**F004** (Hex) **= 61444** (Dec)	**00** (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.A: 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.A: value is irrelevant.
Byte 3	Bit 3.1 … Bit 3.8	Actual engine – percent torque	Not interpreted by ECON.A: value is irrelevant.
Byte 4	Bit 4.1 … Bit 5.8	Engine speed	**Engine speed** Conversion: engine speed = [(Byte 5) * 256 + (Byte 4)] * 0.125 [RPM]
Byte 5			
Byte 6	Bit 6.1 … Bit 6.8	Source address of controlling device for engine control	Not interpreted by ECON.A: value is irrelevant.
Byte 7	Bit 7.1 … Bit 7.4	Engine starter mode	Not interpreted by ECON.A: 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.A: value is irrelevant.

Remark: Refer to the SAE J1939-71 standard for details.

2.3 EEC2: Electronic engine controller # 2

Message identifier: CF00300 $_{(Hex)}$ **(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** $_{(Dec)}$	**F003** $_{(Hex)}$ **= 61443** $_{(Dec)}$	**00** $_{(Hex)}$ **= 0** $_{(Dec)}$

Originator: **engine controller**
Repetition rate: **50 msec**
Timeout: **500 msec**
DLC: **8**

		Value	Detail
Byte 1	Bit 1.1 Bit 1.2	Accelerator pedal low idle switch	Not interpreted by ECON.A: value is irrelevant.
	Bit 1.3 Bit 1.4	Accelerator pedal kickdown switch	
	Bit 1.5 … Bit 1.8	Not used	
Byte 2	Bit 2.1 … Bit 2.8	Accelerator pedal position	**Accelerator pedal position** Conversion: accelerator pedal position = (Byte 2) * 0.4 [%] REMARK: accelerator pedal = throttle pedal.
Byte 3	Bit 3.1 … Bit 3.8	Load at current speed	Not interpreted by ECON.A: value is irrelevant.
Byte 4	Bit 4.1 … Bit 4.8	Remote accelerator pedal position	**Remote accelerator pedal position** Conversion: remote accelerator pedal position = (Byte 2) * 0.4 [%] REMARK: when there is no remote accelerator pedal, byte 4 must = FF$_{(Hex)}$. 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. Example 1: Byte 2 = 91$_{(Hex)}$ = 145$_{(Dec)}$ = 58% Byte 4 = 0$_{(Hex)}$ = 0$_{(Dec)}$ = 0% Example 2: Byte 2 = 0$_{(Hex)}$ = 0$_{(Dec)}$ = 0% Byte 4 = ED$_{(Hex)}$ = 237$_{(Dec)}$ = 95% In the abnormal situation that both accelerator pedals are pressed, the ECON.A uses the greatest value. Example 3: Byte 2 = 91$_{(Hex)}$ = 145$_{(Dec)}$ = 58% Byte 4 = ED$_{(Hex)}$ = 237$_{(Dec)}$ = 95% The accelerator pedal position for the ECON.A 95%.
Byte 5	Bit 5.1 … Bit 8.8	Not used	**Reserved** These bytes have not defined and must be = FF$_{(Hex)}$. 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 FF$_{(Hex)}$). Bits 5.1 … 5.8 are = 1111 1111$_{(Bin)}$ = FF$_{(Hex)}$ Bits 6.1 … 6.8 are = 1111 1111$_{(Bin)}$ = FF$_{(Hex)}$ Bits 7.1 … 7.8 are = 1111 1111$_{(Bin)}$ = FF$_{(Hex)}$ Bits 8.1 … 8.8 are = 1111 1111$_{(Bin)}$ = FF$_{(Hex)}$
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: C000003 $_{(Hex)}$ (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** $_{(Dec)}$	**0000** $_{(Hex)}$ = **0000** $_{(Dec)}$	**03** $_{(Hex)}$ = **3** $_{(Dec)}$

Originator: **ECON.A**
Repetition rate: **10 msec to engine / 50 msec to retarder**
DLC: **8**

		Value	Detail
Byte 1	Bit 1.1 Bit 1.2	Engine override control mode	**Engine override control mode** These bits define the “override control mode” for engine control: $00_{(Bin)}$: override disabled $01_{(Bin)}$: speed control $10_{(Bin)}$: torque control $11_{(Bin)}$: speed/torque control
	Bit 1.3 Bit 1.4	Engine requested speed control conditions	**Engine requested speed control conditions** Desired engine governor characteristic during engine speed control: $00_{(Bin)}$: transient optimized for driveline disengaged and non-lockup $01_{(Bin)}$: stability optimized for driveline disengaged and non-lockup $10_{(Bin)}$: stability optimized for driveline disengaged and/or lockup (vehicle) $11_{(Bin)}$: stability optimized for driveline disengaged and/or lockup (PTO)
	Bit 1.5 Bit 1.6	Override control mode priority	**Override control mode priority** Defines the priority of the CAN message TSC1 sent by the ECON.A: $00_{(Bin)}$: highest priority $01_{(Bin)}$: high priority $10_{(Bin)}$: medium priority $11_{(Bin)}$: low priority
	Bit 1.7 Bit 1.8	Not used	**Reserved** The bits 1.7 and 1.8 are set to $11_{(Bin)}$
Byte 2 Byte 3	Bit 2.1 … Bit 3.8	Engine requested speed / speed limit	**Engine requested speed/speed limit** 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. Conversion : engine speed = [(Byte 3) * 256 + (Byte 2)] * 0.125 [RPM]
Byte 4	Bit 4.1 … Bit 4.8	Engine requested torque / torque limit	**Engine requested torque/torque limit** 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. The torque is indicated as a percentage of the reference engine torque. Conversion: enginetorque (%) = (Byte 4) – 125 [%]

Byte 5 Byte 6 Byte 7 Byte 8	Bit 5.1 … Bit 8.8	Not used	**Reserved** These bytes have no relevance with the above request codes. The bits 5.1 … 5.8 are set to 1111 1111$_{(Bin)}$ = FF$_{(Hex)}$ The bits 6.1 … 6.8 are set to 1111 1111$_{(Bin)}$ = FF$_{(Hex)}$ The bits 7.1 … 7.8 are set to 1111 1111$_{(Bin)}$ = FF$_{(Hex)}$ The bits 8.1 … 8.8 are set to 1111 1111$_{(Bin)}$ = FF$_{(Hex)}$

Remark : Refer to the SAE J1939-71 standard for details.

2.5 ETC1: Electronic Transmission Controller #1

Message identifier: CF00203 (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** $_{(Dec)}$	**F002** $_{(Hex)}$ **= 61442** $_{(Dec)}$	**03** $_{(Hex)}$ **= 3** $_{(Dec)}$

Originator: **ECON.A**
Repetition rate: **10 msec**
DLC: **8**

		Value	Detail
Byte 1	Bit 1.1 Bit 1.2	Not used	**Reserved** The bits 1.1 and 1.2 are set to 11$_{(Bin)}$
Byte 1	Bit 1.3 Bit 1.4	Torque Converter Lockup State	**Torque converter lockup engaged** Bit 1.4 Bit 1.3 0 0 : torque converter not in lockup 0 1 : torque converter in lockup 1 0 : reserved 1 1 : function not supported over CAN *
Byte 1	Bit 1.5 Bit 1.6	Transmission Shift In Progress	**Reserved** The bits 1.5 and 1.6 are set to 11$_{(Bin)}$
Byte 1	Bit 1.7 Bit 1.8	Not used	**Reserved** The bits 1.7 and 1.8 are set to 11$_{(Bin)}$
Byte 2 Byte 3	Bit 2.1 … Bit 3.8	Output shaft speed	**Output Shaft Speed** Conversion: output shaft speed = [(Byte 3) * 256 + (Byte 2)] * 0.125 [RPM] 65534 = fault related to the output shaft speed calculation 65535 = measurement not supported
Byte 4	Bit 4.1 … Bit 4.8	Not used	**Reserved** The bits 4.1 … 4.8 are set to 1111 1111$_{(Bin)}$ = FF$_{(Hex)}$
Byte 5	Bit 5.1 … Bit 5.8	Not used	**Reserved** The bits 5.1 … 5.8 are set to 1111 1111$_{(Bin)}$ = FF$_{(Hex)}$

Byte 6 Byte 7	Bit 6.1 … Bit 7.8	Input shaft speed	**Input shaft speed** Conversion: input shaft speed = [(Byte 7) * 256 + (Byte 6)] * 0.125 [RPM] 65534 = fault related to the input shaft speed calculation 65535 = measurement not supported
Byte 8	Bit 8.1 … Bit 8.8	controller source address	**Source address of transmission controlling device** ECON.H transmission controller source address = $03_{(Hex)}$.

Remark: Refer to the SAE J1939-71 standard for details.

2.6 ETC2: Electronic Transmission Controller #2

Message identifier: 18F00503 (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** $_{(Dec)}$	**F005** $_{(Hex)}$ **= 61445** $_{(Dec)}$	**03** $_{(Hex)}$ **= 3** $_{(Dec)}$

Originator: **ECON.A**
Repetition rate: **100 msec**
DLC: **8**

		Value	Detail
Byte 1	Bit 1.1 … Bit 1.8	Transmission selected gear	**Transmission selected gear** Neutral direction : 125 Forward direction : 125 + gear position Reverse direction : 125 – gear position REMARK: when parkingbrake is applied, the value is $FB_{(Hex)}$.
Byte 2 Byte 3	Bit 2.1 … Bit 3.8	Not used	**Reserved** The bits 2.1 … 2.8 are set to $1111\ 1111_{(Bin)}$ = $FF_{(Hex)}$ The bits 3.1 … 3.8 are set to $1111\ 1111_{(Bin)}$ = $FF_{(Hex)}$
Byte 4	Bit 4.1 … Bit 4.8	Transmission current gear	**Transmission current gear** Neutral direction : 125 Forward direction : 125 + gear position Reverse direction : 125 – gear position REMARK: when parkingbrake is applied, the value is $FB_{(Hex)}$.
Byte 5 Byte 6 Byte 7 Byte 8	Bit 5.1 … Bit 8.8	Not used	**Reserved** The bits 5.1 … 5.8 are set to $1111\ 1111_{(Bin)}$ = $FF_{(Hex)}$ The bits 6.1 … 6.8 are set to $1111\ 1111_{(Bin)}$ = $FF_{(Hex)}$ The bits 7.1 … 7.8 are set to $1111\ 1111_{(Bin)}$ = $FF_{(Hex)}$ The bits 8.1 … 8.8 are set to $1111\ 1111_{(Bin)}$ = $FF_{(Hex)}$

Remark: Refer to the SAE J1939-71 standard for details.

2.7 CCVS: Cruise Control/Vehicle Speed

Message identifier: 18FEF103 $_{(Hex)}$ (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** $_{(Dec)}$	**FEF1** $_{(Hex)}$ **= 65265** $_{(Dec)}$	**03** $_{(Hex)}$ **= 3** $_{(Dec)}$

Originator: **ECON.A**
Repetition rate: **100 msec**
DLC: **8**

		Value	Detail
Byte 1	Bit 1.1 … Bit 1.8	Not used	**Reserved** The bits 1.1 … 1.8 are set to 1111 1111 $_{(Bin)}$ = FF $_{(Hex)}$
Byte 2 Byte 3	Bit 2.1 … Bit 3.8	Wheel-based vechicle speed	**Wheel-based vehicle speed** Conversion: Wheel-based vehicle speed = (Byte 3) + (Byte 2) / 256 [km/h] 65534 = fault related to the wheel based vehicle speed calculation 65535 = measurement not supported
Byte 4 Byte 5 Byte 6 Byte 7 Byte 8	Bit 4.1 … Bit 8.8	Not used	**Reserved** The bits 4.1 … 4.8 are set to 1111 1111 $_{(Bin)}$ = FF $_{(Hex)}$ The bits 5.1 … 5.8 are set to 1111 1111 $_{(Bin)}$ = FF $_{(Hex)}$ The bits 6.1 … 6.8 are set to 1111 1111 $_{(Bin)}$ = FF $_{(Hex)}$ The bits 7.1 … 7.8 are set to 1111 1111 $_{(Bin)}$ = FF $_{(Hex)}$ The bits 8.1 … 8.8 are set to 1111 1111 $_{(Bin)}$ = FF $_{(Hex)}$

Remark: Refer to the SAE J1939-71 standard for details.

CHAPTER 4 : ECON.A DIAGNOSTICS: ERROR HANDLING & REPORTING

1 Diagnostics in ECON.A

1.1 Purpose

The ECON.A is capable of detecting and handling faults to provide driver safety and diagnostic information.
To ensure this, the ECON.A primarily considers single faults and acts appropriately based on the interpretation of the fault:

- If a fault is considered safety critical, the ECON.A 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.A 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.A has built-in advanced self diagnostic functionality.

1.2.2 Powering up

Every time the ECON.A 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.A.
If such a defect is detected, the ECON.A will activate the “ECON.A Shutdown Mode” (see chapter CHAPTER 1 – 11.4.5 for details) or even shut itself completely & immediately down if needed. As a result, all power to the outputs of the ECON.A will be turned off, as if the ECON.A 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 powerdown, meaning that there will be no flashing of data: data residing in Ram will be lost.

> *To ensure that no undesired actions are taken on the loads that are controlled by the ECON.A, the internal safety relay stays off during this power up diagnostics phase (Refer to the document “*APC122 Hardware technical leaflet – document version V22.pdf*”).*

1.2.3 During operation

The ECON.A has a redundant hardware watchdog system, and a software watchdog system.

The ECON.A 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 powerdown, 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.A firmware makes use of this redundant hardware watchdog system to monitor the integrity of the running application:

- software triggered hardware watchdog reset :
  The ECON.A 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.A 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.A not to guarantee a safe & correct application behavior, the ECON.A will generate the appropriate errorcode(s).

1.2.5 Signal Diagnostics (in- & outputs)

Once the ECON.A 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.A'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.A 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.A will take the appropriate action to ensure a safe state.

- If a fault is considered safety critical, the ECON.A will act to ensure a safe transmission state., if needed by forcing transmission shutdown mode, possibly followed by transmission limphome 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 shutdown will be performed, ensuring that Ram memory data will be flashed. If not possible, no controlled powerdown 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-scenario's, 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 to 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.A. During power up and operation, the ECON.A 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.A power output (see also example error code 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 errordata 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.A there is a total of maximum 256 different error groups available.

- Groups 0 - 239 (EFhex)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 (F0 to FFhex) 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.A 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.A application released for production. Nevertheless these errors are a part of the ECON.A 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.A 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.A 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.A 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.A 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.A 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.A 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.A 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.A 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.A.
Because the error groups that are needed by the ECON.A application are not provided in the predefined SPNs of the SAE J1939 Standard, being 0h to 7EFFFhex (520191).
the ECON.A uses the SPN number range that is available for proprietary SPNs, being 7F000hex (520192) to 7FFFFhex (524287).

As a default the ECON.A uses the first available code 7F000hex 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 7F000h and 7FF00h if the default setting (7F000hex) 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.A.

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.A 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 F0 to FF 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.A 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.A error codes.

Representation	Error code	Description
DANA error “group.cause”	**20.05**	Open circuit detected on ECON.A power output 0
SAE J1939 “SPN.FMI”	**7F020.05**	

4 Permanent Error Logging

In addition to the volatile error info, the ECON.A 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.A 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.A.

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.A power output 0 has both (but not simultaneously) been shorted to ground and put in open circuit.

5 Error reporting

5.1 ECON.A 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.A 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

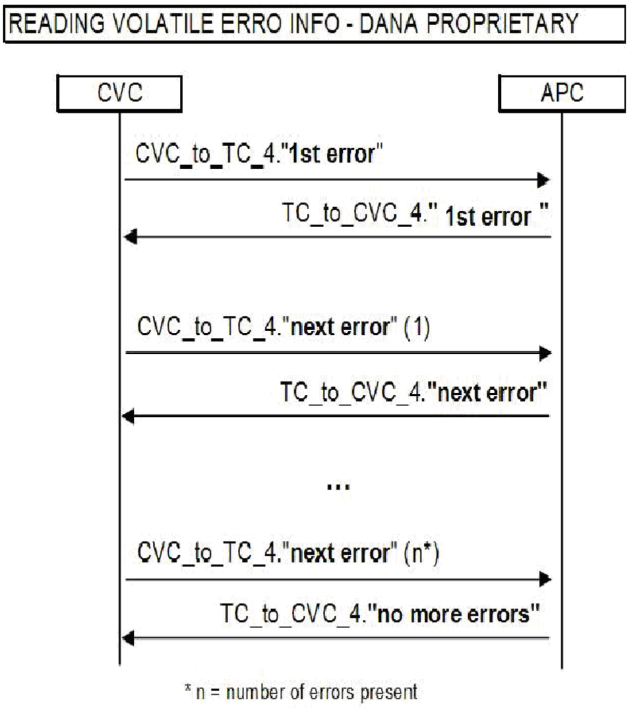
5.2.1 DANA proprietary messages

To access the volatile error memory only, a set of DANA proprietary CAN messages are provided in the ECON.A. 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.A 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.A 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.A 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

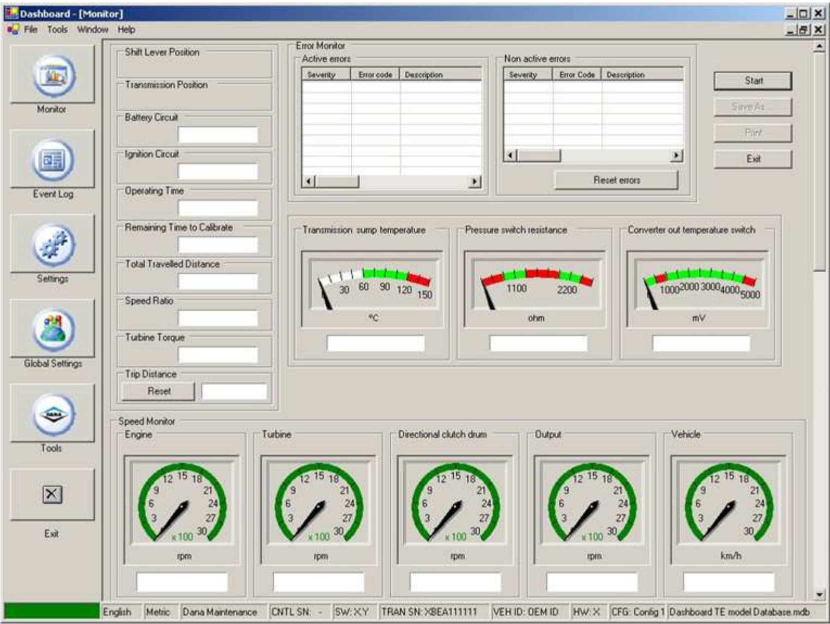
All of the diagnostic error information pertaining to the previously active (currently inactive) diagnostic trouble codes is erased.

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
- configuration management
- 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 tool is not included directly in this user manual and is presented in a separate document. ***Refer to the document “DashboardDiagnostic.pdf”.***

6 Error Dictionary

To implement the error handling as described in the previous paragraphs of this chapter, the ECON.A 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.A. 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.A. 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 59
1	1	520193	7F001	Digital Input 1 - pin 58
2	2	520194	7F002	Digital Input 2 - pin 57
3	3	520195	7F003	Digital Input 3 - pin 56
4	4	520196	7F004	Digital Input 4 - pin 55
5	5	520197	7F005	Digital Input 5 - pin 54
6	6	520198	7F006	Digital Input 6 - pin 53
7	7	520199	7F007	Digital Input 7 - pin 52
16	10	520208	7F010	Analogue Input 0 - pin 25-24
17	11	520209	7F011	Analogue Input 1 - pin 27-26
18	12	520210	7F012	Analogue Input 2 - pin 29-28
19	13	520211	7F013	Analogue Input 3 - pin 14-13
26	1A	520218	7F01A	Speed Input 0 - pin 10-09
27	1B	520219	7F01B	Speed Input 1 - pin 12-11
32	20	520224	7F020	Power Output 0 - pin 33-34
33	21	520225	7F021	Power Output 1 - pin 31-32
34	22	520226	7F022	Power Output 2 - pin 48-49
35	23	520227	7F023	Power Output 3 - pin 18-19
36	24	520228	7F024	Power Output 4 - pin 46-47
37	25	520229	7F025	Power Output 5 - pin 17-16
38	26	520230	7F026	Power Output 6 - pin 35-50
39	27	520231	7F027	Power Output 7 - pin 01-02
40	28	520232	7F028	Power Output 8 - pin 03-04
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
67	43	520259	7F043	DANA Reserved
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	Analogue Input Function: Throttle Pedal
97	61	520289	7F061	Analogue Input Function: Brake Pedal
98	62	520290	7F062	Analogue Input Function: Transmission Sump Temperature
99	63	520291	7F063	Analogue Input Function: Transmission Cooler In Temperature
100	64	520292	7F064	Analogue Input Function: Hydro Lever
101	65	520293	7F065	Analogue Input Function: System Pressure
102	66	520294	7F066	Analogue Input Function: Forward Clutch Pressure
103	67	520295	7F067	Analogue Input Function: Reverse Clutch Pressure
104	68	520296	7F068	Analogue Input Function: Forward High Clutch Pressure
105	69	520297	7F069	Analogue Input Function: 1st Clutch Pressure
106	6A	520298	7F06A	Analogue Input Function: 2nd Clutch Pressure
107	6B	520299	7F06B	Analogue Input Function: 3rd Clutch Pressure
108	6C	520300	7F06C	Analogue 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	Transmission Gear Ratio

144	90	520336	7F090	APC Permanent Power Supply Line - pin 45
145	91	520337	7F091	APC Switched Power Supply Line - pin 20-60
146	92	520338	7F092	APC External Sensor Reference Power Supply 5V Line - pin 15
147	93	520339	7F093	APC Internal Sensor Reference
148	94	520340	7F094	APC Board Temperature
149	95	520341	7F095	APC Board Speed sensor 0
150	96	520342	7F096	APC Board Speed sensor 1
151	97	520343	7F097	APC Board Vcan
152	98	520344	7F098	APC Board PWM Current 0
153	99	520345	7F099	APC Board PWM Current 1
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
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
196	C4	520388	7F0C4	Can Message CVC_TO_TC_4
197	C5	520389	7F0C5	Can Message EEC1
198	C6	520390	7F0C6	Can Message EEC2
224	E0	520416	7F0E0	Exceed Transmission Calibration Interval
225	E1	520417	7F0E1	Exceed Direction Change Vehicle Speed
226	E2	520418	7F0E2	Exceed Direction Change Engine Speed
227	E3	520419	7F0E3	Exceed Downshift Vehicle Speed
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.A is compliant to the SAE J1939 standard, the DANA error cause codes are identical to the SAE J1939 FMI codes.

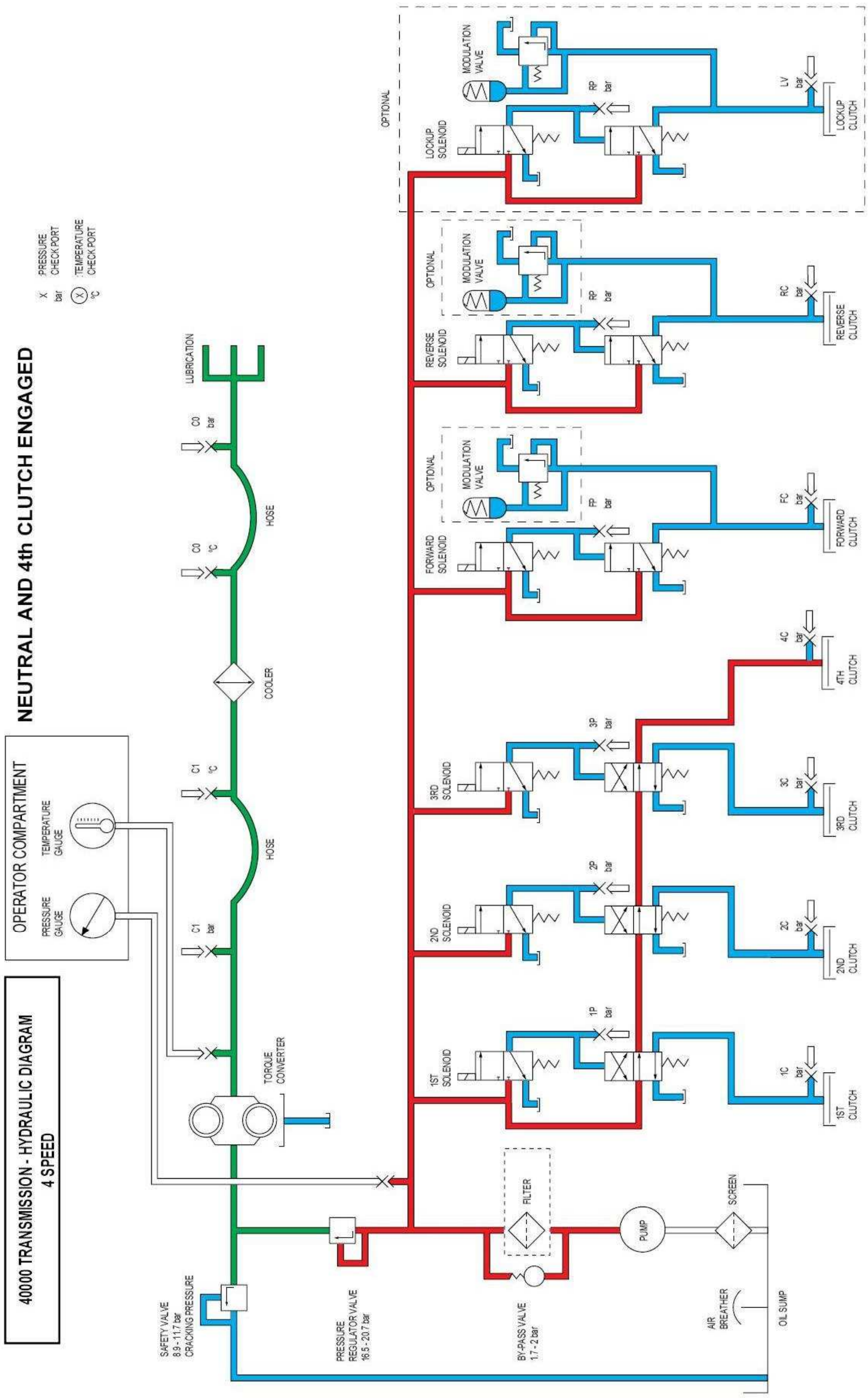
REMARK: The error cause codes used in combination with the DANA error groups F0 to FF are NOT compliant to this table! These error groups are intended for DANA use only and therefore, the causes are not to be interpreted in the standard way (as indicated by the description of these error groups).
However, this special range of error codes is not expected to be activated in an ECON.A 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

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 APC122 Hardware

The APC122 hardware description is not included directly in this user manual, instead it is presented in a separate document.
Refer to the document "APC122 Hardware technical leaflet – document version V22.pdf".

2.1 APC122 connections

This table lists the available APC122 connection pins and the function assignment overview for a ECON.A application.
It is just a general example of how the functions are typically assigned to an APC122 pin.

Check the application specific wiring diagram to see how the relevant signals for your specific application are connected.

Pin	Name	Pin Function	Application Function	Pin	Name	Pin Function	Application Function
01	AO7 (1)	Power output 7 with current feedback	Reverse alert	31	AO1 (1)	Power output 1 without current feedback	Reverse Selector
02	GND_AO7	GND for AO7		32	GND_AO1	Power output 1 ground	
03	AO8 (1)	Power output 8 with current feedback	Warning lamp	33	AO0 (1)	Power output 0 without current feedback	Forward Selector
04	GND_AO8	GND for A08		34	GND_AO0	Power output 0 ground	
05	GND	Battery ground	Battery -	35	AO6 (1)	Power output 6 without current feedback	Modulatore Selector
06	RS232_RX0	RS232 RX channel 0		36	GND_BUS	LIN/RS232/CAN bus ground	RD.120 (optional)
07	RS232_RX1	RS232 RX channel 1		37	RESET_ REQUEST	Reset request pin	DANA reserved
08	LIN_BUS	LIN BUS	RD.120 (optional)	38	RS232_TX1	RS232 TX channel 1	
09	GND_SPIN0	Speed sensor 0 ground	Engine speed	39	RS232_TX0	RS232 TX channel 0	
10	SPIN0	Speed sensor 0 input		40	GND	Digital ground	
11	GND_SPIN1	Speed sensor 1 ground	Output Speed	41	BSL_ REQUEST	Boot load strobe pin	DANA reserved
12	SPIN1	Speed sensor 1 input		42	SPEEDO_ OUT	Speed output signal	
13	GND_ANI3	Analogue input 3 ground	Transmission sump temperature	43	GND_ SPEEDO	Signal GND	
14	ANI3	Analogue input 3		44	GND	Battery ground	Battery -
15	VREF_5V	Reference voltage 5V	Sensor supply	45	PPWR	Permanent Power	Battery+
16	GND_AO5	Power output 5 ground	Accu reset	46	AO4 (1)	Power output 4 without current feedback	High/Low Selector
17	AO5 (1)	Power output 5 without current feedback		47	GND_AO4	Power output 4 ground	

Pin	Name	Pin Function	Application Function	Pin	Name	Pin Function	Application Function
18	AO3 (1)	Power output 3 without current feedback	Range selector 2	48	AO2 (1)	Power output 2 without current feedback	Range selector 1
19	GND_AO3	power output 3 ground		49	GND_AO2	Power output 2 ground	
20	PPWR	Permanent Power	Battery+	50	GND_AO6	Power output 6 ground	Modulatore Selector
21	SPWR	Switched Power	Key Contact	51	LIN_BUS_PWR	LIN bus power supply	RD.120 (optional)
22	CAN LO	CAN V2.0B BUS	J1939 CAN network	52	DI7 (2)	Digital input 7	Manual/automatic
23	CAN HI	CAN V2.0B BUS	J1939 CAN network	53	DI6 (2)	Digital input 6	Declutch request on/off
24	GND_ANI0	ANI0 ground	System pressure	54	DI5 (2)	Digital input 5	Parking brake activated/released
25	ANI0	Analogue input 0		55	DI4 (2)	Digital input 4	Kickdown request
26	GND_ANI1	ANI1 ground	Cooler In Temperature	56	DI3 (2)	Digital input 3	Shift lever range position
27	ANI1	Analogue input 1		57	DI2 (2)	Digital input 2	Shift lever range position
28	GND_ANI2	ANI2 ground	Converter out = cooler in Temperature	58	DI1 (2)	Digital input 1	Shift lever reverse request
29	ANI2	Analogue input 2		59	DI0 (2)	Digital input 0	Shift lever forward request
30	GND_VREF	Vref ground		60	PPWR	Permanent Power	Battery+

Table 1 : Example APC122 terminal ←→ function definition

3 Error code list

The ECON.A error code list shows all the possible error codes, their description and what the impact is for the ECON.A 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.A Error code list - prototype firmware 5.7pp.pdf".

REMARK: The firmware version 5.7pp is prototype firmware and the "ECON.A Error code list - prototype firmware 5.7pp.pdf" is the error code list for this prototype firmware. When the prototype firmware will be released for production, it will be released as production firmware version 5.7 and a new version of the error code list will be publicated with the name "ECON.A Error code list – production firmware 5.7.pdf".

4 History

The history of the ECON.A firmware versions is described in detail in a separate document "ECON.A Release report – prototype firmware 5.7pp.pdf".

REMARK: The firmware version 5.7pp is prototype firmware. The "ECON.A User manual – prototype firmware 5.7pp.pdf" is the user manual for this prototype firmware. The history of the ECON.A firmware versions is described in "ECON.A Release report – prototype firmware 5.7pp.pdf". When the prototype firmware will be released for production, it will be released as production firmware version 5.7 and a new version of the user manual will be publicated with the name "ECON.A User manual – production firmware 5.7.pdf". Also a new version of the release report will be publicated with the name "ECON.A Release report – production firmware 5.7.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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