RICO Quick Troubleshooting Guide

Curtis 1207 / 1207A Controller

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*Notes:

1) Not all parameters listed in the “Handheld Programmer” section have the ability to be changed.
2) Any parameter change should be approved by Rico

GLOSSARY OF FEATURES AND FUNCTIONS

Acceleration/deceleration rate

The acceleration rate is the time required for the controller to increase from 0% to 100% duty factor. The shape of the acceleration curve is controlled by the dynamic throttle response, which is linear.

If you have a MultiMode™ controller, the acceleration rates in Mode 1 and in Mode 2 are independently adjustable via the handheld programmer. If you have a 1207 controller with the MultiMode™ feature disabled (i.e., a single-mode controller), you can adjust the acceleration rate mechanically via the appropriate trimpot located on top of the controller.

Anti-tiedown

Before enabling Mode 1 operation, the anti-tiedown function checks that the mode selection switch has been released after the last cycling of the brake switch. This feature discourages operators from taping or otherwise "tying down" the mode switch. If Mode 1 is already selected before the brake is released, the controller remains in Mode 2 until the mode switch is released and pressed again.

Arcless contactor switching

The controller output duty factor is quickly reduced to zero any time a direction is de-selected, so that the controller current will be reduced to zero before the direction contactor drops out.

BB *(= Belly Button; see Emergency reverse)*

Brake

The brake must be released (brake input "high") for the controller to operate. This is a safety interlock used on most material handling vehicles.

Cycling the brake or KSI clears most faults and enables operation.

Contactor drivers and circuits

These controllers can accommodate up to four external contactors: forward, reverse, main, and shunt. Some vehicles may have no main contactor, or the main contactor may be wired directly to the KSI or brake signal, bypassing the controller.

Various protections provided for the contactor drivers ensure that the contactors operate correctly; see *Fault detection.*

The shunt winding of a compound motor can be wired directly to the shunt driver, provided that the maximum current does not exceed the driver's current rating.

Creep speed at first throttle

Creep speed is activated when a direction is first selected. The output maintains creep speed until the throttle is rotated out of the throttle deadband (typically 10% of throttle). Creep speed is adjustable from 0 to 25% of the controller duty factor; the adjustment can be made mechanically (via the appropriate trimpot on top of the 1207 controller) or electronically (via the handheld programmer).

Current limiting

Curtis PMC controllers limit the motor current to a preset maximum. This feature protects the controller from damage that might result if the current were limited only by motor demand. PWM output to the power section is reduced smoothly until the motor current falls below the set limit level.

In addition to protecting the controller, the current limit feature also protects the rest of the system. By eliminating high current surges during vehicle acceleration, stress on the motor and batteries is reduced and their efficiency enhanced. Similarly, there is less wear and tear on the vehicle drivetrain, as well as on the ground on which the vehicle rides (an important consideration with golf courses and tennis courts, for example).

If you have a MultiMode™ controller, the main current limit, plug current limit, and ramp start current limit in Mode 1 and in Mode 2 are independently adjustable via the handheld programmer. If you have a 1207 controller with the MultiMode™ feature disabled (i.e., a single-mode controller), you can adjust the main and plug current limits mechanically via the appropriate trimpots located on top of the controller.

In addition, the emergency reverse current limit can be set via the handheld programmer.

Current multiplication

During acceleration and during reduced speed operation, the Curtis PMC controller allows more current to flow into the motor than flows out of the battery. The controller acts like a dc transformer, taking in low current and high voltage (the full battery voltage) and putting out high current and low voltage. The battery needs to supply only a fraction of the current that would be required by a conventional controller (in which the battery current and motor current are always equal). The current multiplication feature gives vehicles using Curtis PMC controllers dramatically greater driving range per battery charge.

Deceleration rate

The deceleration rate is the time required for the controller to decrease from 100% duty factor to zero. The deceleration rate is fixed, and cannot be adjusted. The shape of the deceleration curve is controlled by the dynamic throttle response, which is linear.

Emergency reverse

Emergency reverse is activated when the brake is released, KSI is activated, and the emergency reverse switch (the BB, or "belly button" switch) is pressed. After the BB switch is released, normal controller operation is not resumed until neutral (no direction) is selected or until the brake is cycled (brake, then brake release). However, repeatedly pressing the BB switch will reactivate the emergency reverse function each time.

Because emergency reverse immediately powers the reverse contactor, some arcing may occur.

Fault detection

An internal microcontroller automatically maintains surveillance over the functioning of the controller. When a fault is detected, the appropriate fault code is signalled via the LED, externally visible on top of the controller. The diagnostic codes flashed by the LED are listed in Section 5, Troubleshooting.

If the fault is critical, the controller is disabled. More typically, the fault is a remediable condition and temporary—for example, an undervoltage fault is cleared when the condition is removed.

The automatic fault detection system includes:

contactor coil open / shorted driver (F/R and shunt contactors)
contactor driver overcurrent / contactor coil short
contactor welded
emergency reverse circuit check
M- output fault
memory checks upon start-up
overvoltage cutoff
power supply out of range (internal)
throttle fault
undervoltage cutback
watchdog (external and internal)
watchdog (internal)

Fault recording

Fault events are recorded in the controller's memory. Multiple occurrences of the same fault are recorded as one occurrence.

The fault event list can be loaded into the programmer for readout. The Special Diagnostics mode provides access to the controller's diagnostic history file—the entire fault event list created since the diagnostic history file was last cleared. The Diagnostics mode, on the other hand, provides information about only the currently active faults.

Fault recovery (including recovery from disable)

Almost all faults require a cycling of the KSI or brake input to reset the controller and enable operation.

The only exceptions are these:

FAULT	RECOVERY
anti-tiedown	release and re-select Mode 1
contactor overcurrent	when condition clears
emergency reverse	BB re-applied or brake cycled
HPD	lower throttle to below HPD threshold
overvoltage	when battery voltage drops below overvoltage
SRO	when proper sequence is followed
thermal cutback	when temperature comes within range
throttle fault	clears when condition gone
undervoltage	when battery voltage rises above undervoltage

High-pedal-disable (HPD)

The HPD feature prevents the vehicle from being started while the throttle is applied. The controller can be programmed to have HPD based on either brake input or KSI.

Brake-type HPD

To start the vehicle, the controller must receive a brake input (brake released) before receiving a throttle input. Controller operation will be disabled immediately if pedal demand (throttle input) is greater than 25% duty factor at the time the brake is released (brake input "high"). Normal controller operation is regained by reducing the throttle demand to less than 25%.

Sequencing delay, which can be set with the handheld programmer, provides a variable delay before disabling the controller. If the brake is applied while the throttle is above the HPD threshold (25%), HPD is not activated if the brake is then released before the delay time elapses.

KSI-type HPD

The HPD feature can be activated by KSI input instead of brake input, if preferred. To start the vehicle, the controller must receive a KSI input before receiving a throttle input.

KSI

KSI (Key Switch Input) provides power to the logic board, and initializes and starts diagnostics. In combination with the brake input, KSI enables all logic functions.

Some vehicles may have no keyswitch (KSI simply tied to B+) or may have the key permanently turned on.

LED

A Status LED located on top of the controller flashes a fault identification code if a fault is detected by the controller. The fault codes are listed in Table 1. The code will continue to flash until the fault condition has been cleared during active fault detection. This will typically happen after cycling KSI for power-up fault conditions, and cycling the brake for faults detected during operation. NOTE: In 1207 models, the Status LED is on the adjustment panel under the sliding protective cover.

MOSFET

A MOSFET (Metal Oxide Semiconductor Field Effect Transistor) is a type of transistor characterized by its fast switching speeds and very low losses.

MultiMode™

The MultiMode™ feature of these controllers allows the vehicle to be operated with two distinct sets of characteristics. The two modes can be programmed to be suitable for operation under different conditions, such as slow precise maneuvering in Mode 2 and faster, long distance travel in Mode 1. The following parameters can be set independently in the two modes:

— main current limit
— plug current limit
— ramp start current limit
— acceleration rate
— maximum speed

The operating mode is selected by means of the mode selection switch. If Mode 1 is not selected, the controller operates by default in Mode 2. When the controller returns to Mode 2 from Mode 1, it automatically changes the main current limit, the plug current limit, the ramp start current limit, the acceleration rate, and the maximum speed to their Mode 2 values.

If the anti-tiedown feature is active, Mode 1 must be re-selected each time the brake is released.

Neutral brake

The optional neutral brake feature provides automatic plug braking in neutral. If this option is not selected, the vehicle is free to coast in neutral. The neutral brake plug current limit is programmable.

Overtemperature

At overtemperature (from 85°C to 95°C), the drive current limit is linearly decreased from full set current down to zero. (Plug current, however, is not reduced—in order to provide full vehicle braking under all thermal conditions.) The operating PWM frequency is shifted to 1.5 kHz when the controller is operating in the overtemperature range.

Overvoltage protection

Overvoltage resets the microprocessor, inhibits PWM, and opens the contactors, thereby shutting down the controller. Overvoltage can result during battery charging or from an improperly wired controller. Controller operation resumes

when the voltage is brought within the acceptable range. The cutoff voltage and re-enable voltage are percentages of the battery voltage, and are set at the factory.

Plug braking

Plug braking takes place when a series motor is driven electrically in a direction opposite from the direction it is turning. The 1207/1207A controls the field current to obtain smooth and controlled plug braking torque. During plug braking, the maximum current limit is automatically changed to the plug current limit, and the PWM frequency is changed to 1.5 kHz. NOTE: Plug current limit on the 1207/1207A controls the field current. The armature current in plug mode will be higher than the field current.

There are two types of plug braking control — fixed and variable. The fixed plug current limit is set to a fixed level. The variable plug current limit varies the current limit to correspond to the throttle position.

If you have a MultiMode™ controller, the plug current limits in Mode 1 and in Mode 2 are independently adjustable via the handheld programmer. If you have a 1207 controller with the MultiMode™ feature disabled (i.e., a single-mode controller), you can adjust the plug current limit mechanically via the appropriate trimpot located on top of the controller.

PWM

Pulse width modulation (PWM), also called "chopping," is a technique that switches battery voltage to the motor on and off very quickly, thereby controlling the speed of the motor. Curtis PMC 1200 series controllers use high frequency PWM—15 kHz—which permits silent, efficient operation.

Quick-start

Upon receiving a quick throttle demand from neutral, the controller will exceed normal acceleration momentarily in order to overcome inertia. The "quick-start" algorithm is applied each time the vehicle passes through neutral and is not in plug mode. If the vehicle is in plug, the quick-start function is disabled, allowing normal plug braking to occur.

The quick-start throttle factor is adjustable via the handheld programmer.

Ramp shape (throttle map)

"Ramp shape" is a programmable parameter that determines the static throttle map of the 1207/1207A controller. Eleven preprogrammed ramp shapes are available, in 5% steps between 20% and 70% (20, 25, 30, 35, 40, 45, 50, 55, 60,

65, and 70%). The ramp shape number refers to the PWM output at half throttle, as a percentage of its full range. For example, if maximum speed is set at 100% and creep speed is set at 0, a ramp shape of 50% will give 50% output at half throttle. The 50% ramp shape corresponds to a linear response. The six "even number" ramp shapes for maximum and creep speeds set at 100% and 0 are shown in Figure A-1.

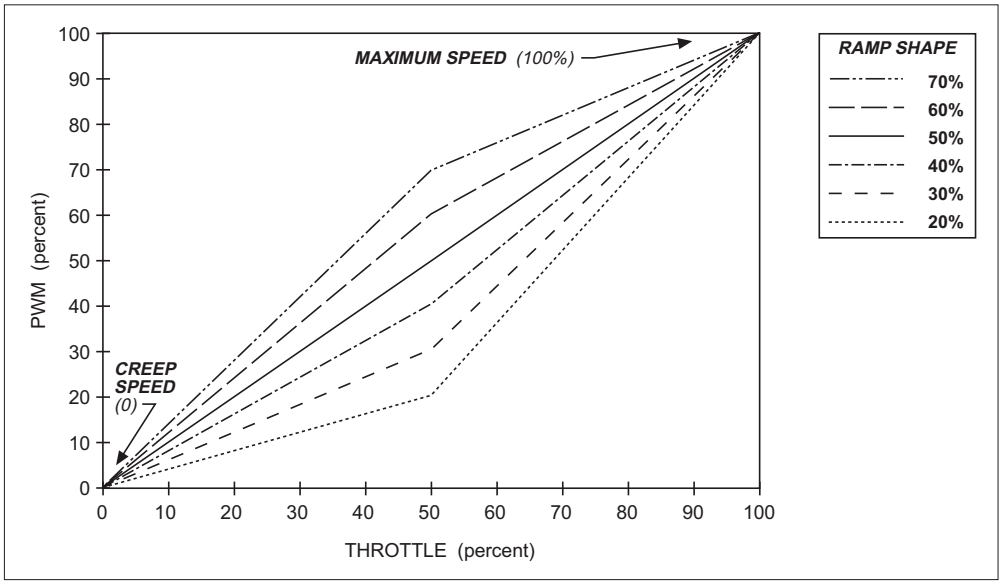


Fig. A-1 *Ramp shape (throttle map) for controller with maximum speed set at 100% and creep speed set at 0.*

Changing either the maximum speed setting or the creep speed setting changes the output range of the controller. Ramp shape output is always a percentage of that range. Ramp shapes with the creep speed setting raised to 10% are shown in Figure A-2.

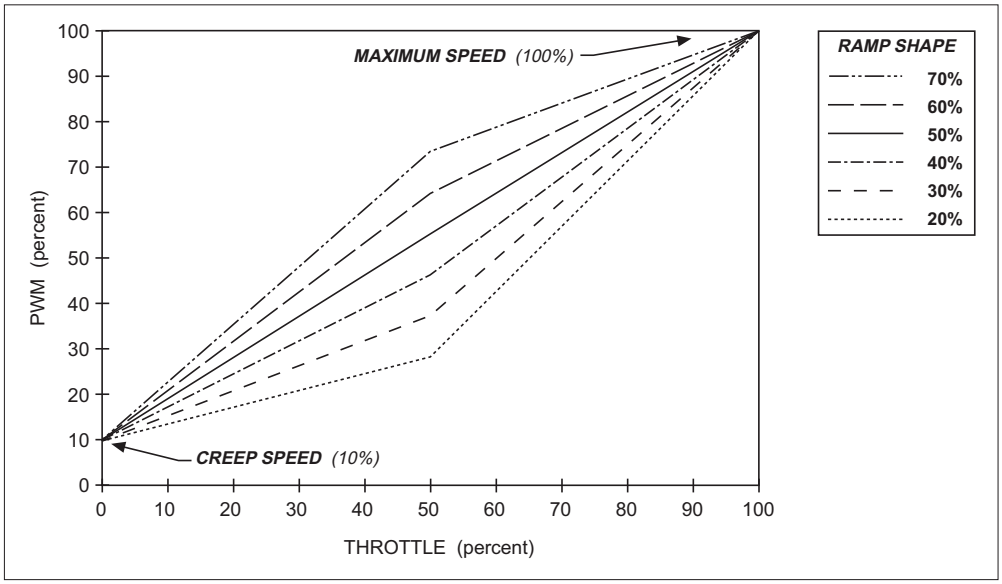


Fig. A-2 *Ramp shape (throttle map) for controller with maximum speed set at 100% and creep speed set at 10%.*

In Figure A-3, the creep speed is kept at 10% and the maximum speed setting dropped to 60%.

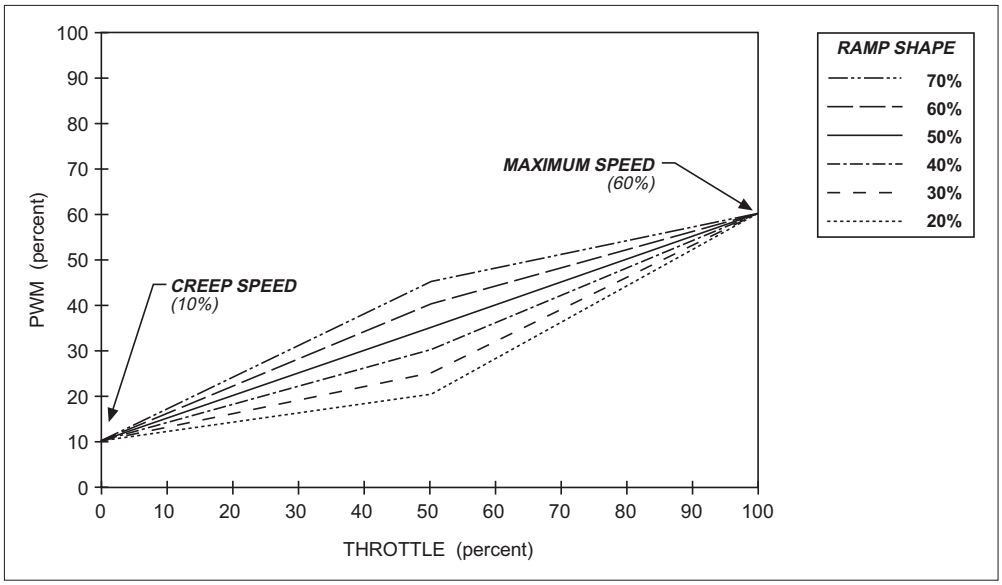


Fig. A-3 *Ramp shape (throttle map) for controller with maximum speed set at 60% and creep speed set at 10%.*

In all cases, the ramp shape number is the PWM output at half throttle, as a percentage of its full range. So, for example, in Figure A-3, a 50% ramp shape gives 35% PWM output at half throttle (halfway between 10% and 60%). A 30% ramp shape gives 25% PWM at half throttle (30% of the range {which is 50%, from 10% to 60%}, starting at 10% output, or {[.30 x 50%] + 10%} = 25%).

Ramp start

The ramp start feature allows the vehicle to be started with a higher plug current limit to prevent rolling downhill. Ramp start increases the plug current limit for the selected direction only. When the opposite direction is selected, ramp start will be canceled and a 3-step sequence must be followed to re-activate it:

STEP 1. select a direction for more than 1 second,
STEP 2. return to neutral, and
STEP 3. re-select the same direction.

Once the vehicle is operating in ramp start mode, it will continue to do so until the opposite direction is selected for more than one second.

When the brake is first released, the ramp start current limit level will be obtained when either direction is selected in plug braking mode. In ramp start mode, either direction selected will allow the ramp start current limit level. This condition remains until the other direction is selected for more than one second. The new direction then becomes the decision direction, and the 3-step ramp start sequence is required to regain the ramp start current limit level in plug.

The ramp start current limit is adjustable via the handheld programmer. The Mode 1 and Mode 2 ramp start current limits can be set independently.

Reset

Almost all faults require a cycling of the KSI or brake input to reset the controller and enable operation; see *Fault recovery* for exceptions.

Sequencing delay

Sequencing delay allows the brake to be cycled within a set time (the sequencing delay), in order to prevent inadvertent activation of HPD or SRO. This feature is useful in applications where the brake switch may bounce or be momentarily cycled during operation. The delay can be set with the handheld programmer from 0 to 3 seconds, where 0 corresponds to no delay.

Shunt field control

The shunt field of a compound motor can be directly controlled by using the shunt winding driver (if the current requirement meets the contactor driver specifications). The shunt is activated while a direction is selected, as long as the controller is not in plug braking mode. A programmable delay is available for the shunt drive. This delays the shunt turn-on until some time after the reversing contactors have shuttled. The delay can be set with the handheld programmer from 0 to 0.5 seconds, where 0 corresponds to no delay.

Smooth, stepless operation

Like all Curtis PMC 1200 Series controllers, the 1207 and 1207A models allow superior operator control of the vehicle's drive motor speed. The amount of current delivered to the motor is set by varying the "on" time (duty cycle) of the controller's power MOSFET transistors. This technique—pulse width modulation (PWM)—permits silent, stepless operation.

Speed settings

The maximum speed setting defines the upper-limit speed as a percentage of PWM output at full throttle. If you have a MultiMode™ controller, the maximum speed settings in Mode 1 and in Mode 2 are independently adjustable via the handheld programmer. If you have a 1207 controller with the MultiMode™

feature disabled (i.e., a single-mode controller), you can adjust the maximum speed mechanically via the trimpot labeled "LOW" on top of the controller.

The maximum creep speed setting is also adjustable via these two methods; see *Creep speed*. The maximum emergency reverse speed is adjustable only via the programmer.

Static-return-to-off (SRO)

The SRO feature prevents the vehicle from being started when "in gear." SRO checks the sequencing of brake input—or of KSI and brake input—relative to a direction input. The brake input must come on before a direction is selected. If a direction is selected before or simultaneously (within 50 msec) with the brake input, the controller is disabled. There are three types of SRO: SRO relative to brake input alone (Type "1" in the programming menu); SRO relative to both KSI and brake input (Type "2"); and SRO relative to KSI, brake, and forward inputs (Type "3"). The handheld programmer can be used to set the controller to operate with any of these types of SRO, or with no SRO (SRO Type "0").

If your controller is programmed so that both KSI and brake input are required (SRO Type "2"), the following sequence must be followed to enable the controller: STEP 1, KSI on; STEP 2, brake released (brake input "high"); and STEP 3, direction selected. The interval between steps 1 and 2 is the same as between steps 2 and 3; that is, KSI input must precede brake input by at least 50 msec. Once the controller is operational, turning off either KSI or the brake causes the controller to turn off; re-enabling the controller requires the 3-step sequence.

Similarly, if your controller is programmed so that KSI, brake, and forward inputs are all required (SRO Type "3"), they must be provided in that sequence in order to enable the controller. Note, however, that operation is allowed if a reverse input precedes the brake input; this can be useful when operating a walkie on ramps.

Sequencing delay, which can be set with the handheld programmer, provides a variable delay before disabling the controller. If the brake is applied while direction is selected, SRO is not activated if the brake is then released before the delay time elapses.

Temperature compensation for current limits

Full temperature compensation provides constant current limits throughout the normal operating range (heatsink temperatures of -25°C to +85°C). The temperature sensor is also used to calculate and display the heatsink temperature on the handheld programmer.

Temperature extreme current-limit cutback (see *Overtemperature, Undertemperature)*

Temperature extreme data storage

The maximum and minimum temperatures read at the heatsink at any time during powering of the controller are stored in the controller's memory. These values (which can be accessed via the programmer's Test Menu) are cleared each time the controller's diagnostic history file is cleared.

Throttle map

The throttle map (duty factor as a function of throttle position) is adjustable, so that you can provide the proper feel for the many types of vehicles that use the 1207 controller. The throttle map parameter is called "ramp shape"; see *Ramp shape* for more information.

Throttle response

The dynamic throttle response (duty factor as a function of time) is shaped by the acceleration rate setting. Dynamic throttle response is linear. The newest throttle input is mapped to the throttle map, and the controller then automatically accelerates (or decelerates) through a straight line until the new throttle demand is obtained.

Throttle types

The 1207 and 1207A controllers accept a variety of throttle inputs, through various combinations of their four throttle input pins. The most commonly used throttles can all be hooked up directly: 5kΩ–0 and 0–5kΩ 2-wire rheostats, 3-wire pots, 0–5V throttles, 0–10V throttles (1207 only), and the Curtis ET-XXX electronic throttle.

Throttle full range produces 0–100% duty factor at the controller output (unless limited by other conditions). Throttle fault detect is performed on the throttle input signals and virtually eliminates the possibility of runaway operation. Adjustments and settings are independent of throttle type. However, throttle fault conditions will vary by throttle type.

Undertemperature

When the controller is operating at less than -25°C, the current limit is cut back to approximately one-half of the set current. The operating PWM frequency is shifted to 1.5 kHz when the controller is operating at undertemperature.

Undervoltage protection

Undervoltage protection automatically disables the controller output if battery voltage is detected below the undervoltage point at start-up, or when the battery voltage is pulled below the undervoltage point by an external load. The undervoltage cutback point is set in ROM, and is not adjustable.

During normal operation, the controller duty factor will be reduced when the batteries discharge down to less than the undervoltage level. If the motor current is such that the batteries are being pulled below the minimum point, the duty factor will be reduced until the battery voltage recovers to the minimum level. In this way the controller "servos" the duty factor around the point which maintains the minimum allowed battery voltage.

If the voltage continues to drop below the undervoltage level to a severe undervoltage condition (due to battery drain or external load), the controller continues to behave in a predictable fashion, with its output disabled.

Watchdog (external, internal)

The external watchdog timer guards against a complete failure of the microprocessor, which would incapacitate the internal watchdog timer. This independent system check on the microprocessor meets the EEC's requirement for backup fault detection.

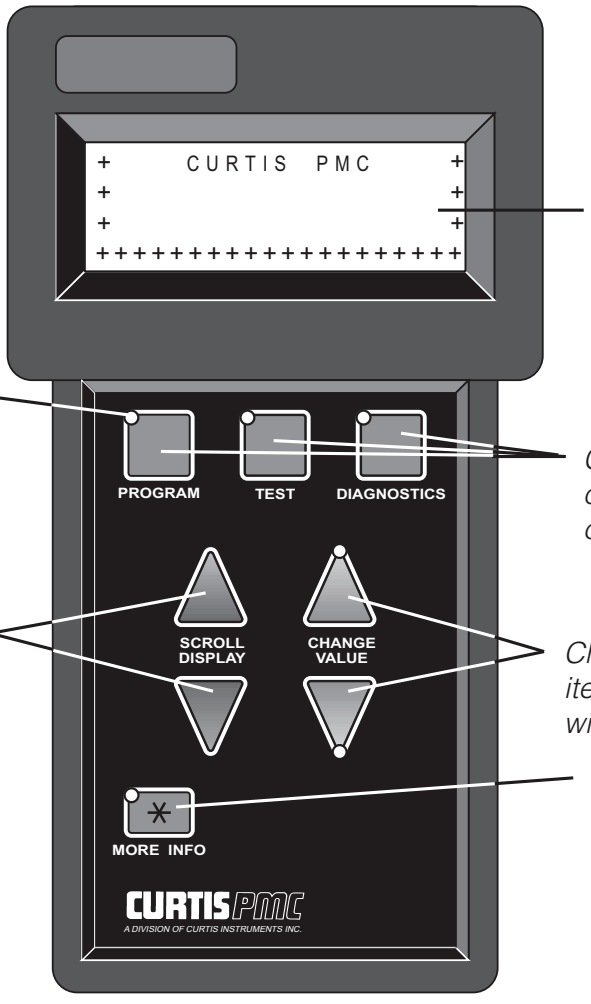
The external watchdog timer safety circuit shuts down the controller (and the microprocessor) if the software fails to generate a periodic external pulse train. This pulse train can only be created if the microprocessor is operating. If not periodically reset, the watchdog timer times out after 150 msec and turns off the controller. The external watchdog also directly disengages all contactors and directly shuts down the PWM drive to the MOSFETs. It can only be reset by cycling KSI.

The internal watchdog timer must be reset periodically by correct sequential execution of the software. If not reset, the internal timer times out and the microprocessor is "warm booted." This causes the microprocessor to shut down its outputs (thus shutting down the controller) and attempt to restart.

6 PROGRAMMER OPERATION

The universal Curtis PMC handheld programmer (optional) allows you to program, test, and diagnose Curtis PMC programmable controllers. The programmer is powered by the host controller, via an RJ11 modular connector located in the adjustment panel on top of the controller (1207 models) or via a 4-pin Molex connector on the front panel (1207A models).

When the programmer is first plugged into the controller, it displays the controller's model number, date of manufacture, and software revision code. Following this initial display, the programmer displays a prompt for further instructions.



A 4-line LCD display is presented in this window

The LED in the corner of the key lights up to identify the mode of operation

Choose the Program, Test, or Diagnostics Mode with one of these three keys

Scroll the 4-line display (up and down) with these two keys

Change the selected item's value (up or down) with these two keys

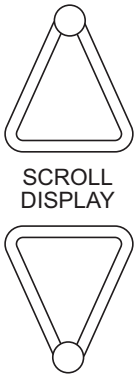
Get more information about selected items with this key. Also, use this key in combination with other keys to put the programmer in Special modes.

The programmer is operated via an 8-key keypad. Three keys select operating modes (Program, Test, Diagnostics), two scroll the display up and down, and two change the values of selected parameters. The eighth key, the MORE INFO key, is used to display further information about selected items within any of the three standard modes. In addition, when pressed together with the PROGRAM or the DIAGNOSTICS key, the MORE INFO key selects the Special Program mode or the Special Diagnostics mode.

The display window presents a 4-line LCD display. The display is visible even in bright sunlight. You can adjust the display contrast in the Special Program mode.

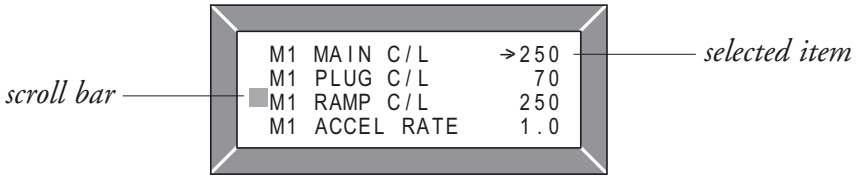
When one of the menu keys is pressed, the LED at the corner of the key lights up, identifying the mode of programmer operation. For example, if the TEST key is pressed, the LED at the corner of the key indicates that the programmer is now in the Test mode, and the Test Menu is displayed.

Four lines of a menu are displayed at a time. The item at the top of the display window is the selected item. To select an item, scroll within the menu until the desired item is positioned at the top of the display window. The selected item is always the top line. (In the Program mode, the selected item is highlighted by a flashing arrow.) To modify a parameter or obtain more information about it, it must be scrolled to the top position in the display window.



To scroll up and down within a menu, use the two SCROLL DISPLAY arrow keys. The SCROLL DISPLAY arrow keys can be pressed repeatedly or be held down. When a key is held down, the scrolling speed increases the longer the key is held.

A small scroll bar at the left of the display window provides a rough indication of the position of the four displayed items within the entire menu. That is, when the bar is at the top of the window, the top of the menu is displayed. As you scroll through the menu, the bar moves downward. When the bar is at the very bottom of the window, you have reached the end of the menu. This sample display is from the Program Menu:



CHANGE VALUE

The two CHANGE VALUE arrow keys are used to increase or decrease the value of a selected menu item. Like the SCROLL DISPLAY arrow keys, the CHANGE VALUE arrow keys can be pressed repeatedly or be held down. The longer a key is held, the faster the parameter changes. This allows rapid changing of any parameter.

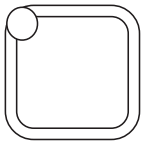
An LED on each CHANGE VALUE arrow key indicates whether the key is active and whether change is permissable. When the value of a parameter is being increased, the LED on the "up" CHANGE VALUE key is on until you reach the maximum value for that parameter. When the LED goes off, you cannot increase the value.

The MORE INFO key has three functions: (1) to display more information about the selected item, (2) to access the Special Program and Special Diagnostics modes (when used together with the PROGRAM and DIAGNOSTICS keys), and (3) to initiate certain commands (such as the Self Test).

"More information" is available in all of the programmer operating modes. After using the MORE INFO key to display additional information about the selected item, press the MORE INFO key again to return to the original list.

OPERATING MODES:

PROGRAM, TEST, DIAGNOSTICS, SPECIAL PROGRAM, SPECIAL DIAGNOSTICS

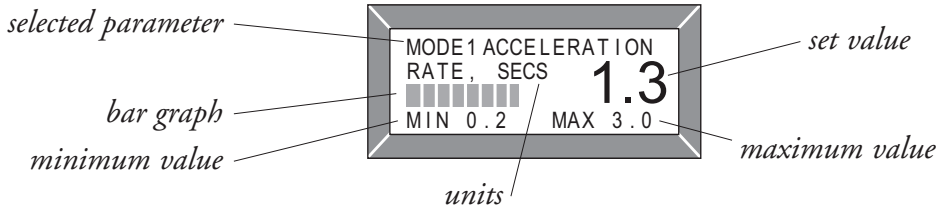


PROGRAM

In the **Program** mode, accessed by pressing the PROGRAM key, all the adjustable parameters and features of the controller are displayed (four at a time), along with their present settings. The setting of the selected item—the item at the top of the display, with the flashing arrow—can be changed, using the two CHANGE VALUE keys.

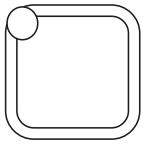
The LEDs on these keys indicate whether there is still room for change. That is, when the upper limit of a parameter's range is reached, the LED on the "up" key no longer lights up, indicating that the present value cannot be increased; when the lower limit is reached, the LED on the "down" key no longer lights up.

The MORE INFO key, when used in the Program mode, displays a bar graph along with the minimum and maximum values possible for the selected parameter. Parameters can be changed either from the main Program Menu or after the MORE INFO key has been pressed and the additional information is being displayed (see example below).



Some parameters on some controllers have dependencies on other parameters. This means that the available settings for one parameter may be dependent on the limits of another parameter. If you attempt to set a parameter (A) outside the limits imposed by another parameter (B), a message will be displayed indicating that parameter A is dependent on parameter B.

The Program Menu is presented at the end of this section. NOTE: Some items may not be available on all models.

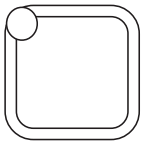


TEST

In the **Test** mode, accessed by pressing the TEST key, real-time information is displayed about the status of the inputs, outputs, and controller temperature. For example, when the status of the forward switch is displayed, it should read "On/Off/On/Off/On/Off" as the switch is repeatedly turned on and off. In the Test mode, the item of interest does not need to be the top item on the list; it only needs to be among the four items visible in the window. The Test mode is useful for checking out the operation of the controller during initial installation, and also for troubleshooting should problems occur.

The MORE INFO key, when used in the Test mode, causes additional information to be displayed about the selected item (top line in the window).

The Test Menu is presented at the end of this section. NOTE: Some items may not be available on all models.

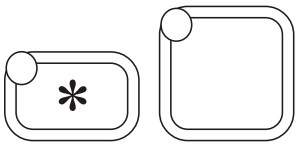


DIAGNOSTICS

In the **Diagnostics** mode, accessed by pressing the DIAGNOSTICS key, currently active faults detected by the controller are displayed.

The MORE INFO key, when used in the Diagnostics mode, causes additional information to be displayed about the selected item.

A list of the abbreviations used in the Diagnostics display is included at the end of this section.



MORE INFO PROGRAM

The **Special Program** mode allows you to perform a variety of tasks, most of which are self-explanatory. Through the Special Program Menu, you can revert to earlier settings, save controller settings into the programmer memory, load the controller settings from the programmer into a controller, clear the controller's diagnostic history, adjust the contrast of the programmer's LCD display, select the language to be displayed by the programmer, and display basic information (model number, etc.) about the controller and the programmer.

To access the Special Program mode, first press the MORE INFO key. Then, while continuing to hold the MORE INFO key, press the PROGRAM key. The LED on the PROGRAM key will light, just as when the programmer is in Program mode.

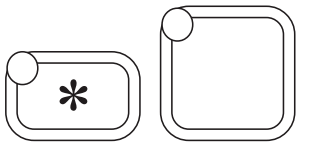
To distinguish between the Program and Special Program modes, look at the menu items in the display.

CONTROLLER CLONING

Two of the Special Program Menu items—"Save Controller Settings in Programmer" and "Load Programmer Settings into Controller"—allow you to "clone" controllers. To do this, simply program one controller to the desired settings, save these settings in the programmer, and then load them into other similar (same model number) controllers, thus creating a family of controllers with identical settings.

The MORE INFO key is used initially to access the Special Program mode, and once you are within the Special Program mode, it is used to perform the desired tasks. To adjust the contrast in the display window, for example, select "Contrast Adjustment" by scrolling until this item is at the top of the screen, and then press MORE INFO to find out how to make the adjustment.

The Special Program Menu is presented at the end of this section.



In the **Special Diagnostics** mode, the controller's diagnostic history file is displayed. This file includes a list of all faults observed and recorded by the controller since the history was last cleared. (NOTE: The maximum and minimum temperatures recorded by the controller are included in the Test Menu.) Each fault is listed in the diagnostic history file only once, regardless of the number of times it occurred.

To access Special Diagnostics, first press the MORE INFO key. Then, while continuing to hold the MORE INFO key, press the DIAGNOSTICS key. The LED on the DIAGNOSTICS key will light, just as when the programmer is in Diagnostics mode.

The MORE INFO key, when used within the Special Diagnostics mode, causes additional information to be displayed about the selected item.

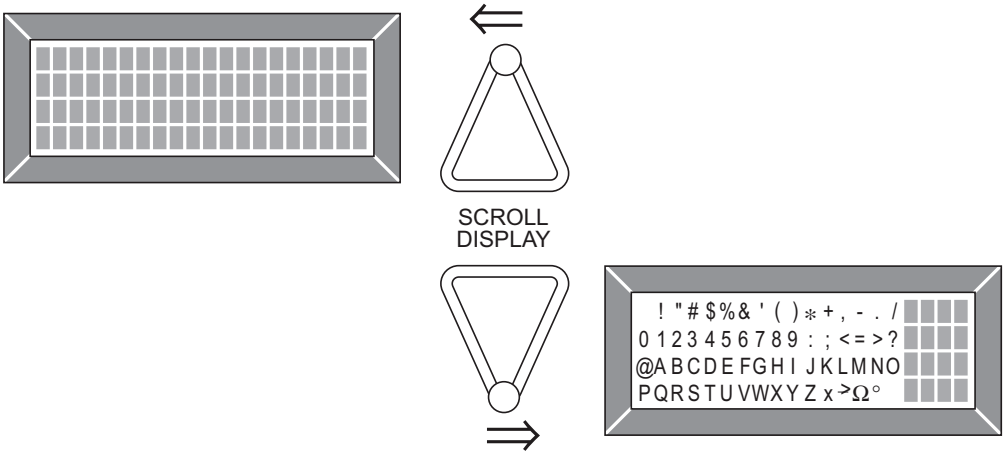
To clear the diagnostic history file, put the programmer into the Special Program mode, select "Clear Diagnostic History," and press the MORE INFO key for instructions. Clearing the diagnostic history file also resets the maximum/minimum temperatures in the Test Menu.

PEACE-OF-MIND PROGRAMMING

Each time the programmer is connected to the controller, it acquires all the controller's parameters and stores them in its temporary memory. You can revert back to these original settings at any time during a programming session via the Special Program Menu. Select "Reset All Settings" by scrolling it to the top of the display window, press the MORE INFO key, and follow the instructions displayed. Any inadvertent changing of parameters can be "undone" using this procedure—even if you can't remember what the previous settings were—**as long as the programmer has not been unplugged and power has not been removed from the controller**.

Programmer Self Test

You can test the programmer by displaying two special test screens. Press the MORE INFO key while the programmer is powering up. During the Self Test, you can toggle between the two test screens by pressing the SCROLL DISPLAY keys. The first screen turns on every LCD element, and the second screen displays all the characters used in the various menus. As part of the Self Test, you can also test the keys be pressing each one and observing whether its corner LED lights up. To exit the Self Test, unplug the programmer or turn off the controller, and then re-power it without holding the MORE INFO key.



PROGRAMMER MENUS

Items are listed for each menu in the order they appear in the actual menus displayed by the handheld programmer.

Program Menu *(not all items available on all controllers)*

EMR REV C/L	Emergency reverse current limit
THROTTLE TYPE	Throttle type*
RAMP SHAPE	Throttle map
CREEP SPEED	Creep speed, as percent PWM duty cycle
EMR REV SPEED	Emerg. reverse speed, as % PWM duty cycle
SEQUENCING DLY	Sequencing delay, in seconds
VARIABLE PLUG	Throttle-variable plug braking: on or off
HIGH PEDAL DIS	High pedal disable (HPD): type†
SRO	Static return to off (SRO): type‡
ANTI-TIEDOWN	Anti-tiedown: on or off
QUICK START	Quick-start throttle factor
M1 MAIN C/L	Mode 1 main current limit
M1 PLUG C/L	Mode 1 plug current limit
M1 RAMP C/L	Mode 1 ramp start current limit
M1 ACCEL RATE	Mode 1 acceleration rate, in seconds
M1 MAX SPEED	Mode 1 maximum speed, as % PWM output
M2 MAIN C/L	Mode 2 main current limit
M2 PLUG C/L	Mode 2 plug current limit
M2 RAMP C/L	Mode 2 ramp start current limit
M2 ACCEL RATE	Mode 2 acceleration rate, in seconds
M2 MAX SPEED	Mode 2 maximum speed, as % PWM output
NEUT BRAKE C/L	Neutral brake current limit
NEUTRAL BRAKE	Neutral brake: on or off

(Notes are on the next page.)

Program Menu Notes

(For more detail on these options, see Appendix A: Glossary of Features and Functions.)

* Throttle types
- *Type 1:* 5kΩ–0
- *Type 2:* 0–5V, 0–10V, 3-wire pot, and electronic throttles
- *Type 3:* 0–5kΩ throttles

† HPD types
- *Type 0:* no HPD
- *Type 1:* HPD on brake input
- *Type 2:* HPD on KSI

‡ SRO types
- *Type 0:* no SRO
- *Type 1:* SRO on brake input
- *Type 2:* SRO on KSI plus brake input plus a direction input
- *Type 3:* SRO on KSI plus brake input plus forward input

Test Menu *(not all items available on all controllers)*

THROTTLE %	Throttle reading, as percent of full
BATT VOLTAGE	Battery voltage
HEAT SINK °C	Heatsink temperature
MAX TEMP °C	Maximum temperature seen *
MIN TEMP °C	Minimum temperature seen *
BRAKE INPUT	Brake switch: on/off
SPEED IN	Mode switch: on (Mode 1) / off (Mode 2)
EMR REV INPUT	Emergency reverse switch: on/off
FORWARD INPUT	Forward switch: on/off
REVERSE INPUT	Reverse switch: on/off
MAIN CONTACTOR	Main contactor: on/off
FWD CONT	Forward contactor: on/off
REV CONT	Reverse contactor: on/off

* Maximum/minimum temperatures recorded since Diagnostic History was last cleared.

Special Program Menu

RESET ALL SETTINGS	Revert to original settings
CONT SETTINGS→ PROG	Save controller settings in programmer
PROG SETTINGS→ CONT	Load programmer settings in controller
CLEAR DIAG HISTORY	Clear diagnostic history memory
CONTRAST ADJUSTMENT	Adjust display contrast
LANGUAGE SELECTION	Select displayed language
PROGRAMMER INFO	Display programmer information
CONTROLLER INFO	Display controller information

Diagnostics and Special Diagnostics "Menu"

This is not a menu as such, but simply a list of the possible messages you may see displayed when the programmer is operating in either of the Diagnostics modes. The messages are listed in alphabetical order for easy reference.

BB WIRING CHECK	BB wiring check failed
CONT DRVR OC	Contactor driver overcurrent
DIR CONT WELDED	Direction contactor welded
HPD	High-pedal-disable (HPD) activated
HW FAILSAFE	Hardware failsafe activated
LOW BATTERY VOLTAGE	Low battery voltage (<16V)
M- SHORTED	M- output fault
MISSING CONTACTOR	Missing contactor
NO KNOWN FAULTS	No known faults
OVERVOLTAGE	Overvoltage (1207: >48V; 1207A: >33V)
SRO	Static-return-to-off (SRO) activated
THERMAL CUTBACK	Cutback, due to over/under temp
THROTTLE FAULT1	Throttle input fault
THROTTLE FAULT2	Throttle low input fault

5 DIAGNOSTICS AND TROUBLESHOOTING

The 1207/1207A controllers provide diagnostics information to assist technicians in troubleshooting drive system problems. The diagnostics information can be obtained in two ways: reading the appropriate display on the programmer or observing the fault codes issued by the Status LED. The Status LED is located on top of the controller. On 1207 models, it is under the sliding protective cover.

LED DIAGNOSTICS

During normal operation, with no faults present, the Status LED flashes a single flash at approximately 1 flash/second. If the controller detects a fault, a 2-digit fault identification code is flashed continuously until the fault is corrected. For example, code "3,2"—welded direction contactor—appears as:

¤ ¤ ¤ ¤ ¤	¤ ¤ ¤ ¤ ¤	¤ ¤ ¤ ¤ ¤
(3 , 2)	(3 , 2)	(3 , 2)

The codes are listed in Table 1. For suggestions about possible causes of the various faults, refer to the troubleshooting chart (Table 2).

Table 1 LED CODES

LED CODE		EXPLANATION
LED off	▬▬▬	no power or defective controller
solid on	▭	defective controller
single flash	¤	controller operational; no faults
1,2	¤ ¤¤	hardware fail-safe error
1,3	¤ ¤¤¤	M- fault or motor output short
1,4	¤ ¤¤¤¤	sequencing fault (SRO)
2,1	¤¤ ¤	5kΩ–0 or throttle wiper input fault
2,2	¤¤ ¤¤	emerg. rev. circuit check fault (BB wiring)
2,3	¤¤ ¤¤¤	high-pedal-disable fault (HPD)
2,4	¤¤ ¤¤¤¤	throttle pot low open or shorted to B+ or B-
3,1	¤¤¤ ¤	contactor or shunt driver overcurrent
3,2	¤¤¤ ¤¤	welded direction contactor
3,3	¤¤¤ ¤¤¤	[reserved for future use]
3,4	¤¤¤ ¤¤¤¤	missing contactor or shunt
4,1	¤¤¤¤ ¤	low battery voltage
4,2	¤¤¤¤ ¤¤	overvoltage
4,3	¤¤¤¤ ¤¤¤	thermal cutback
4,4	¤¤¤¤ ¤¤¤¤	[reserved for future use]

NOTE: Only one fault is indicated at a time, and faults are not queued up.

Operational faults—such as overtemperature—are cleared as soon as operation is brought within range. Non-operational faults—such as a throttle fault—usually require the brake or keyswitch to be cycled after the problem is remedied.

PROGRAMMER DIAGNOSTICS

With a programmer, diagnostics and troubleshooting is more direct than with the LED alone. The programmer presents complete diagnostic information in plain language—no codes to decipher. Faults are displayed in the Diagnostic Menu, and the status of the controller inputs/outputs is displayed in the Test Menu.

The following 4-step process is generally used for diagnosing and troubleshooting an inoperative vehicle: (1) visually inspect the vehicle for obvious problems; (2) diagnose the problem, using the programmer; (3) test the circuitry with the programmer; and (4) correct the problem. Repeat the last three steps as necessary until the vehicle is operational.

> **Example:** A vehicle that does not operate in "forward" is brought in for repair.
>
> STEP 1: Examine the vehicle and its wiring for any obvious problems, such as broken wires or loose connections.
>
> STEP 2: Connect the programmer, put it in diagnostic mode, and read the displayed fault information. In this example, the display shows "No Faults Present," indicating that the controller has not detected anything out of the norm.
>
> STEP 3: Put the programmer in test mode, and observe the status of the inputs and outputs in the forward direction. In this example, the display shows that the forward switch did not close when "forward" was selected, which means the problem is either in the forward switch or the switch wiring.
>
> STEP 4: Check or replace the forward switch and wiring and repeat the test. If the programmer shows the forward switch closing and the vehicle now drives normally, the problem has been corrected.

Refer to the troubleshooting chart (Table 2) for suggestions covering a wide range of possible faults.

Table 2 TROUBLESHOOTING CHART

LED CODE	PROGRAMMER LCD DISPLAY	EXPLANATION	POSSIBLE CAUSE
1,2	HW FAILSAFE	hardware fail-safe error	1. Controller defective.
1,3	M- SHORTED	M- output shorted	1. M- output shorted to ground. 2. Direction contactor not closing. 3. Direction contactor not closing fast enough. 4. Internal motor short to ground.
1,4	SRO	SRO fault	1. Improper sequence of KSI, brake, and direction inputs. 2. Wrong SRO type selected. 3. Brake or direction switch circuit open. 4. Sequencing delay too short.
2,1	THROTTLE FAULT 1	5kΩ–0 or wiper fault	1. Throttle input wire open. 2. Throttle input wire shorted to ground or B+. 3. Throttle pot defective. 4. Wrong throttle type selected.
2,2	BB WIRING CHECK	emerg. reverse wiring fault	1. BB wire open. 2. BB check wire open.
2,3	HPD	HPD sequencing fault	1. Improper seq. of KSI, brake, throttle inputs. 2. Wrong HPD type selected. 3. Misadjusted throttle pot.
2,4	THROTTLE FAULT 2	Pot Low broken or shorted	1. Pot Low wire open. 2. Pot Low wire shorted. 3. Wrong throttle type selected.
3,1	CONT DRVR OC	driver output overcurrent	1. Direction contactor coil shorted. 2. Shunt field shorted.
3,2	DIR CONT WELDED	welded direction contactor	1. Direction contactor stuck closed.
3,4	MISSING CONTACTOR	missing contactor or shunt	1. Direction contactor coil open. 2. Direction contactor missing. 3. Shunt field open. 4. Wire to shunt or direction contactor open.
4,1	LOW BATTERY VOLTAGE	low battery voltage	1. Battery voltage <16 volts. 2. Corroded battery terminal. 3. Loose battery or controller terminal.
4,2	OVERVOLTAGE	overvoltage	1. Battery voltage >48V (1207); >33V (1207A). 2. Vehicle operating with charger attached.
4,3	THERMAL CUTBACK	over-/under-temp. cutback	1. Temperature >85°C or <-25°C. 2. Excessive load on vehicle. 3. Improper mounting of controller. 4. Operation in extreme environments.