

# **RICO Quick Troubleshooting Guide**

## **Curtis 1207B 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.

The acceleration rates in Mode 1 and in Mode 2 are independently adjustable via the handheld programmer.

### **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** (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**

The 1207B controller 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 via the handheld programmer.

### **Current limiting**

Curtis 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).

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, as is the emergency reverse current limit.

### **Current multiplication**

During acceleration and during reduced speed operation, the Curtis 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 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 Fault » Fault History menu provides access to the controller’s diagnostic history file—the entire fault event list created since the diagnostic history file was last cleared. The Fault » System Faults menu, 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
emergency reverse	BB re-applied <u>or</u> 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 1	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.

## 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 1207B 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 1207B 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.

The plug current limits in Mode 1 and in Mode 2 are independently adjustable via the handheld programmer.

### **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 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.

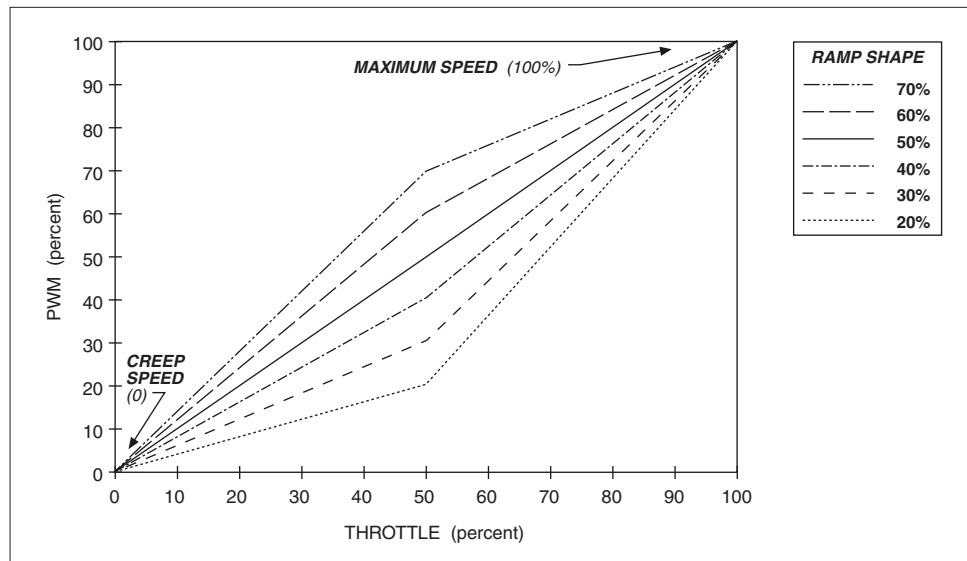
The quick-start throttle factor is adjustable via the handheld programmer.



## Ramp shape (throttle map)

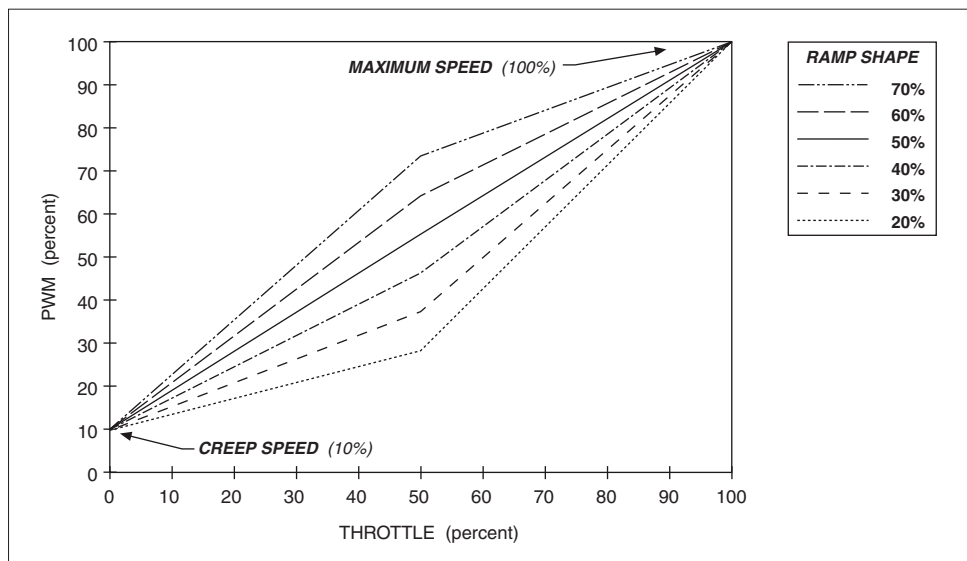
“Ramp shape” is a programmable parameter that determines the static throttle map of the 1207B controller. Eleven preprogrammed ramp shapes are available, in 5% steps between 20% and 70% (20, 25, 30, 35, 40, 45, 50, 55, 60, 65, and 70%). The ramp shape number refers to the PWM output at half throttle, 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.



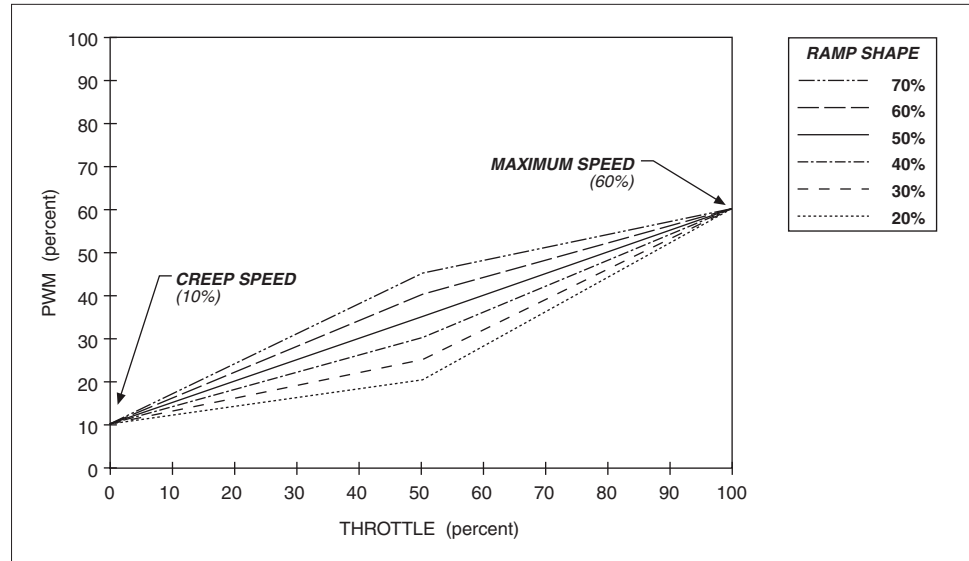
Changing either the maximum speed setting or the creep speed setting changes the output range of the controller. Ramp shape output is always a percentage of that range. Ramp shapes with the creep speed setting raised to 10% are shown in Figure A-2.

**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  $\{[.30 \times 50\%] + 10\% = 25\%$ ).

### 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 1200 Series controllers, the 1207B allows 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. The maximum speed settings in Mode 1 and in Mode 2 are independently adjustable via the handheld programmer; the maximum creep speed and the maximum emergency reverse speed are similarly adjustable.

## 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 Monitor 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 1207B 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 1207B controller accepts a variety of throttle inputs, through various combinations of its four throttle input pins. The most commonly used throttles can all be hooked up directly: 5k $\Omega$ –0 and 0–5k $\Omega$  2-wire rheostats, 3-wire pots, 0–5V throttles, 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.

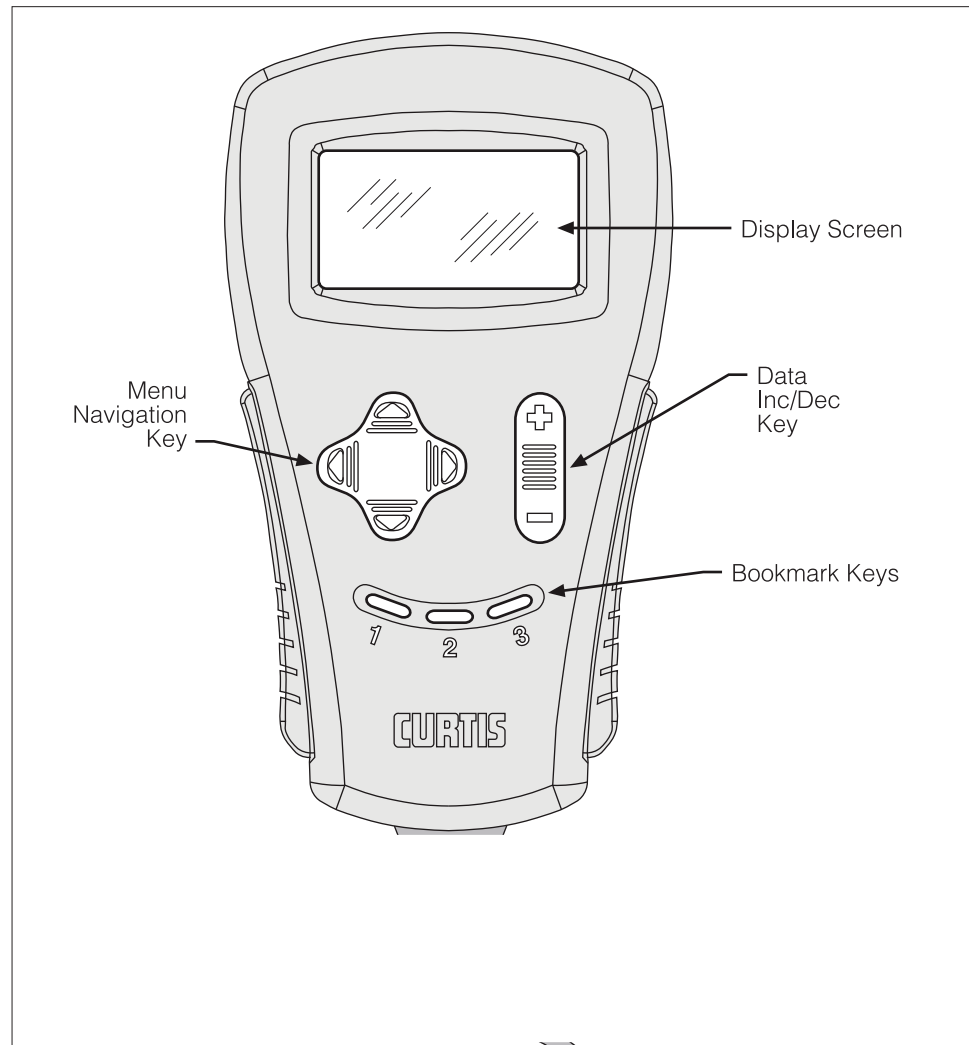
The external watchdog timer safety circuit shuts down the controller (and the microprocessor) if the software fails to generate a periodic external pulse train. This pulse train can only be created if the microprocessor is operating. If not periodically reset, the watchdog timer times out after 150 msec 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

## HANDHELD PROGRAMMER

The universal Curtis 1311 handheld programmer (optional) allows you to program, test, and diagnose Curtis programmable controllers. The programmer is powered by the host 1207B controller, via a 4-pin Molex connector on the front panel.



The Menu Navigation Key is used to scroll up and down, and move right and left, within menus.

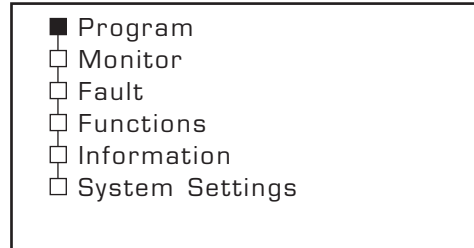
The Data Inc/Dec Key is used to increase (+) and decrease (-) values.

The three Bookmark Keys allow you to jump to frequently used parameters or monitor variables. To set a bookmark, select the item and press one of the bookmark keys for more than 2 seconds. To jump to the bookmarked location, press the appropriate bookmark key quickly (for less than 2 seconds). The bookmark keys also have another function: when adjusting the value of a parameter, you can use these keys to increase the increments by which the value changes; with Bookmark 1 pressed, for example, values change in 10-digit increments.

## PROGRAMMER OPERATION

### Menu structure

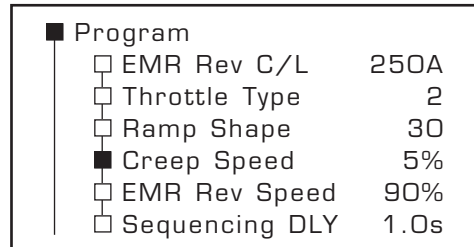
When the programmer is first plugged into the controller, it uploads information from the controller and then displays the Main Menu:



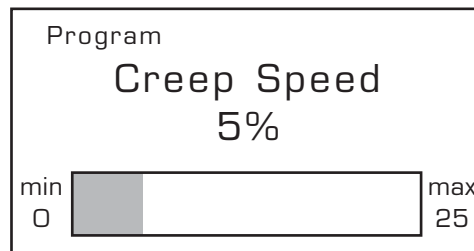
You scroll up and down the Main Menu by using the up and down arrows on the Navigation Key. A blinking square (shown here as solid black) indicates the selected item.

You can go deeper into the Main Menu by using the right arrow of the Navigation Key; you return to the Main Menu by using the left arrow.

Pressing the right arrow when the Program menu is selected will bring you to the list of programmable parameters, displayed in a second column to the right. The LCD on the programmer can show seven lines of text at a time.



Selecting a parameter (in this example, Creep Speed) and then pressing the right arrow of the Navigation Key will display a screen with additional information, which in this example is a bar graph.



To return to the list of parameters, press the left arrow. To return to the Main Menu, press the left arrow again.



## Changing parameter values

When the programmer is first connected to a 1207B controller, that controller's parameter list is uploaded to the programmer along with the present settings. You can scroll through this list and adjust parameter settings and test the results.

Select "Program" (the top item in the Main Menu), and then press the right arrow on the Navigation Key to see the list of parameters. Use the down arrow to scroll down to the parameter you wish to adjust. The present value of the parameter, and its units, will be displayed. Use the Data Inc/Dec Key to change the parameter's value.

Alternatively, before adjusting the parameter value from this screen, you can press the right arrow key. This will cause a bar graph of that parameter to appear, showing its present value and also the minimum and maximum allowed values. You can change the value of the parameter from this screen, as well, using the Data Inc/Dec Key.

The programmer automatically sends the change to the controller. The new value is set when the Data Inc/Dec Key is released.

Use the left arrow on the Navigation Key to return to the previous screen.

## Real-time monitoring

The programmer can request and display real-time data from the 1207B controller. Select "Monitor" in the Main Menu, and use the right arrow on the Navigation Key to display the list of Monitor variables. The values are periodically updated in this list view.

To view a single variable at a faster rate, select that variable in the list view and press the right arrow to show a detail screen. The update rate will be faster on this screen, because only one variable is being updated.

Use the left arrow on the Navigation Key to return to the previous screen.

## Faults and fault history

The programmer allows access to the present and past status of the 1207B controller. The controller runs continuous self-diagnostics and will record and log each error event in non-volatile memory. When the programmer is connected to the controller, this log file is automatically uploaded into the programmer.

To see the present status of the controller, use the Navigation Key to select "Fault" and then "System Faults." To see the log file, select "Fault" and then "Fault History."

It is useful to clear the fault history file after reading it. To do this, use the Navigation Key to select "Fault" and then "Clear Fault History." When asked to confirm your action, use Data Inc/Dec Key. The "+" arrow means Yes and the "-" arrow means No (that is, it cancels clearing the fault history).

## 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 (variable plug) or off (fixed plug)
High Pedal Dis	High pedal disable (HPD): type †
SRO	Static return to off (SRO): type ‡
Anti-Tiedown	Anti-tiedown: on or off
BB Check	BB wiring check: 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

\*Throttle types: *Type 1* = 5kΩ–0  
*Type 2* = 0–5V, 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

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

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

Throttle	Throttle reading, as percent of full throttle
Batt Voltage	Battery voltage
Heatsink Temp	Heatsink temperature
Max Temp	Maximum temperature seen *
Min Temp	Minimum temperature seen *
Brake Input	Brake switch: on/off
Speed Input	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
Fwd Cont	Forward contactor: on/off
Rev Cont	Reverse contactor: on/off

\* Maximum/minimum temperatures recorded since the Fault History was last cleared.

**Fault List**

This is not a menu as such, but simply a list of the possible messages you may see displayed in the “Fault » System Faults” menu or the “Fault » Fault History” menu. The messages are listed here in alphabetical order.

BB Wiring Check	BB wiring check failed
Contactor Driver Fault	Incorrect main driver feedback signal (when shunt function is disabled)
CONT DRVR OC	Contactor driver overcurrent
Currently no faults	No known faults
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
Over Voltage	Overvoltage (>33V)
SRO	Static-return-to-off (SRO) activated
Thermal Cutback	Cutback, due to over/under temp
Throttle Fault 1	Throttle input fault
Throttle Fault 2	Throttle Type changed without cycling KSI

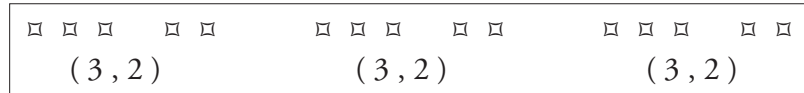
# 5

## DIAGNOSTICS AND TROUBLESHOOTING

The 1207B controller provides 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.

### 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:



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

LED CODE	EXPLANATION
<i>LED off</i>	no power or defective controller
<i>solid on</i>	defective controller
<i>single flash</i>	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 Type setting changed
3,1	contactor or shunt driver overcurrent
3,2	welded direction contactor
3,3	incorrect main driver feedback signal
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.

## 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 Fault menu, and the status of the controller inputs/outputs is displayed in the Monitor 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, enter System Faults menu (Fault » System Faults), and read the displayed fault information. In this example, the display shows “Currently no faults,” indicating the controller has not detected anything out of the norm.

STEP 3: Enter the Monitor menu, 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	Throttle Type setting changed	1. Throttle Type setting was changed without cycling KSI.
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.
3,3	Contactor Driver Fault	incorrect main driver feedback signal (when shunt driver function is disabled)	1. Main contactor driver circuit failed.
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	Over Voltage	overvoltage	1. Battery voltage >33V. 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.