A KOHLER COMPANY

CURTIS

# Manual

# Model **3150R**

## Digital Instrumentation

**» Software Device Profile: 2.0.0.0 «**

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Read Instructions Carefully!



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The Curtis Difference

You feel it when you drive it

# 1 — OVERVIEW

The Curtis Model 3150R gauge provides a 1.54 inch (39.1 mm), 240 × 240 pixel LCD that enables visualization of critical information and a unique brand identity through a fully customizable user interface. The device provides five preset user interfaces that can be used as out-of-the-box applications. Curtis engineers can customize the 3150R to meet OEM or market requirements.

**Figure 1-1**
*Curtis Model 3150R*


All models provide inputs for CAN and a pin that can be configured as either a switch input or a lift lockout driver. Some models include two switch inputs; other models provide two serial communication interface (SCI) inputs for Curtis controllers that support the SCI.

The 3150R complies with relevant US and international regulations. For details on regulatory compliance, see the Specifications appendix.

## USING THIS MANUAL

The next section describes the 3150R's features. The following list describes the chapters that apply to various types of tasks:

- Vehicle operators should read the Using the 3150R chapter.
- Technicians who work on installation and wiring, or who need information on specifications, should read the Installation, Wiring and Configuration chapter and the Specifications appendix.
- Application developers should be familiar with the following chapters:
  - Program Menu Parameters
  - Monitor Menu Parameters
  - CANopen Communications

# FEATURES

The following sections describe the 3150R's major features.

## Display Elements

The 3150R's display elements include the following:

- Icons that indicate states such as on/off. For example, icons indicate whether the seat belt is on or lift lockout is active.
- Indicators for the active speed mode and transmission state.
- Speedometer.
- Hour meter that indicates the running time of the 3150R, devices on the CANbus, or Curtis controllers that support the SCI.
- Message center that broadcasts custom information.
- Battery discharge indicator (BDI) that shows the battery's state-of-charge.

## Fault Codes

The 3150R displays fault codes. The fault data comes from the CANbus or from the SCI.

## LCD Heater

The 3150R includes an LCD heater for cold temperatures. When the LCD heater is enabled, the minimum operating temperature is extended to –40°C.

**Note:** For more information on the 3150R's features, see the data sheet on the Curtis Instruments CAN & Serial Instrumentation page at https://www.curtisinstruments.com/products/can-serial-instrumentation-programmable/.

# TECHNICAL SUPPORT

For technical support, contact your Curtis distributor or the Curtis sales-support office in your region.

# CONVENTIONS

The following topics describe conventions used in this manual.

## Numeral System Notation

The following table describes how this manual denotes decimal, binary, and hexadecimal numbers.

**Note**: The letter *n* in the format column represents a digit.

| Numeral System | Format | Example |
|---|---|---|
| Decimal | Either of the following:<br>• *nnn*<br>• *nnn*d | • 127<br>• 127d |
| Hexadecimal | Either of the following:<br>• *nnn*h<br>• 0x*nnn* | • 62Ah<br>• 0x62A |
| Binary | *nnn*b | 1011b |

In addition, some CANopen examples have hexadecimal values without notation. Those examples are formatted with a monospace font and with the bytes delimited by spaces, as shown in the following example:

```
21 FF 01 11 22 01 00 00
```

## Miscellaneous Conventions

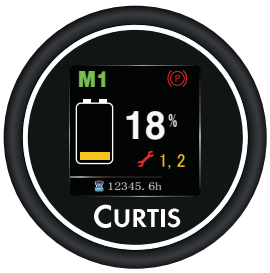
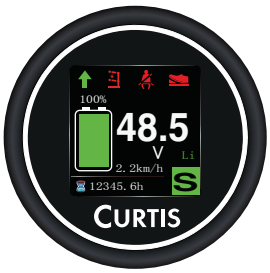
- *RO* means read-only.
- *RW* means read-write.
- *N/A* means not applicable.

# 2 — USING THE 3150R

The 3150R provides five user interfaces. The user interfaces are known as GUI *n*, where *n* is a number. GUIs 1, 2, 4 and 5 are for controllers that support CANopen. GUI 3 is for controllers that support the serial communication interface.

The following table summarizes the user interfaces.

**Table 2-1 User Interfaces**

| User Interface | Example | Description |
|---|---|---|
| GUI 1 |  | Displays all 3150R functions other than lithium battery voltage. |
| GUI 2 |  | Displays all 3150R functions other than lithium battery voltage. Many of GUI 2's icons look differently than those for GUIs 1, 4 and 5. |
| GUI 3 |  | Displays the following items for Curtis controllers that support the SCI:<br>• Speed mode<br>• Parking brake status<br>• BDI status<br>• Fault codes<br>• Hour meter |
| GUI 4 |  | Designed for applications that display lithium battery voltage.<br>The difference between GUI 4 and GUI 1 is that GUI 4 displays the lithium battery voltage in the area where GUI 1 displays the speed. GUI 4 displays the speed below the battery voltage. |
| GUI 5 |  | Designed for applications that prominently display the remaining battery charge. GUI 5 does not provide a speedometer and does not support faults for dual traction controllers, hydraulic pumps and steering controllers. |

The following topics describe GUIs 1, 2, 4 and 5. GUI 3 has significant differences with the other user interfaces and is described separately.

## SPEED MODE ICONS

A controller's speed mode determines the active acceleration and deceleration rates and maximum forward and reverse speeds. The speed modes balance fuel economy and vehicle power.

The speed mode icons indicate the controller's active speed mode. All GUIs other than GUI 3 provide the following icons:

| Speed Mode | Description | Icon (GUIs 1, 4 and 5) | Icon (GUI 2) |
|---|---|---|---|
| High mode | The speed mode with the fastest maximum speeds and acceleration/deceleration rates.<br>**Note:** High mode and power mode have the same characteristics. Some OEMs describe this mode as high mode, others as power mode. | H | H |
| Economy mode | Maximizes fuel economy by providing lower maximum speeds and acceleration/deceleration rates than high, power and standard modes. | E | E |
| Turtle mode | The speed mode with the slowest maximum speeds and acceleration/deceleration rates. | | |
| Standard mode | A balance of maximum speeds, acceleration/deceleration rates and fuel efficiency. | S | S |
| Power mode | Power mode has the same characteristics as high mode. | P | P |

## TRANSMISSION STATE ICONS

The following table describes icons that indicate the controller's transmission state:

| Transmission State | Icon (GUIs 1, 4 and 5) | Icon (GUI 2) |
|---|---|---|
| Forward gear | | |
| Reverse gear | | |
| Neutral | N | N |

## SIGNAL ICONS

The signal icons display on the top of the screen and indicate vehicle actions and states. The following table describes the signal icons and the conditions that cause them to display.

**Note:** If there are more active icons than can be simultaneously displayed, the device will cycle through the icons.

| Function | Display Condition | Icon |
|---|---|---|
| Lift lock | Lift lockout is active. |  |
| Guardrail | Reminds the vehicle operator to close the guardrail for safety purposes. The guardrail icon is typically used for order pickers. |  |
| Parking brake | The parking brake is set. |  |
| Safety pedal | The safety pedal is active. |  |
| Seat | The vehicle operator has left the seat. |  |
| Seat belt | The vehicle operator is not wearing the seatbelt. |  |
| Lift | The lift function is active. |  |
| Lower | The lower function is active. |  |
| Fault | The controller is reporting one or more active faults. |  |
| Low BDI alarm | The battery's state of charge is low. |  |

## BDI ICON

The BDI icon uses color to indicate the BDI percentage, which measures the amount of remaining battery charge. The color reflects whether the battery is sufficiently charged, is starting to get low, or is in urgent need of charging. The BDI percentages that define these statuses depend upon how the 3150R is configured.

In all user interfaces other than GUI 2, the icon displays the BDI percentage. GUI 2 uses a battery at the bottom of the icon to indicate the approximate BDI percentage.

The following table describes the BDI icon.

**Note:** The examples below are for a configuration where the BDI status is Warning when the BDI percentage is between 10–19% and Low when the BDI percentage is between 0–9%.

| BDI Status | GUIs 1, 3, 4 and 5 | GUI 2 | Comments |
|---|---|---|---|
| Okay |   |  | |
| Warning |   |  | When the BDI status is Warning, the low BDI alarm icon,  , flashes. |
| Low |   |  | When the BDI status is Low, the low BDI alarm icon flashes, the lift is locked and the lift lock icon,  , flashes. |

## LITHIUM BATTERY VOLTAGE

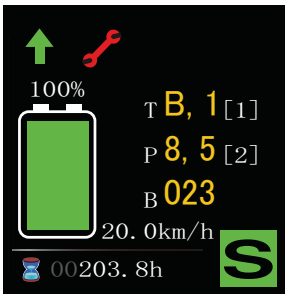
GUI 4 displays the lithium battery voltage. The text “Li” displays under the voltage:


## SPEEDOMETER

GUIs 1, 2 and 4 display a speedometer. The speed is displayed in km/h or mph, depending upon how the device is configured.

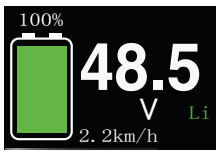
In GUIs 1 and 2, the speedometer is prominently displayed and looks as follows:


In GUI 1, if a fault is active and the transmission state is not neutral, the fault codes display in the speedometer area and the speed is displayed below the fault codes:




In GUI 2, if a fault is active the speedometer is hidden for five seconds. After five seconds the speedometer is restored and the fault code displays above it:

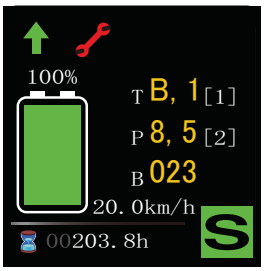

In GUI 4, the speedometer is displayed under the lithium battery voltage:



## FAULT CODES

The user interfaces have different ways of displaying fault codes, as described in the following table.

**Note:** If there are more faults than the active user interface can display simultaneously, the 3150R periodically cycles through the fault codes.

| GUI(s) | Example | Comments |
|---|---|---|
| GUIs 1 and 4 |  | The screen displays up to three fault codes simultaneously. The details depend upon the GUI:<br>• GUI 1: Fault codes display in the speedometer area. If the transmission state is not neutral, the speedometer displays below the fault codes.<br>• GUI 4: Fault codes display in the lithium battery voltage area. The voltage is hidden. If the transmission state is not neutral, the speedometer displays below the fault codes. |
| GUI 2 |  | The screen displays one fault code at a time. A warning symbol displays above the fault code.<br>When a fault is active, the speedometer is hidden for five seconds. After five seconds the speedometer is restored and the fault code displays above it. |
| GUI 5 |  | The screen displays one fault code at a time. GUI 5 is not designed to display faults for the following controllers:<br>• Dual traction (left and right controllers)<br>• Pump<br>• Steering |

Fault codes are preceded by *fault source indicators* that identify the components with active faults. The fault source indicators depend upon the user interface:

### Table 2-2 Fault Source Indicators

| Fault Source | GUIs 1 and 4 | GUI 2 | GUI 5 |
|---|---|---|---|
| Traction controller | T | TRA | TRA |
| Right traction controller | TR | TRA_R | *N/A* |
| Left traction controller | TL | TRA_L | *N/A* |
| Pump controller | P | HYD | *N/A* |
| Steering controller | S | STR | *N/A* |
| BMS (Battery Management System) | B | BAT | BAT |
| Lift lock driver (Overcurrent)<br>**Note:** This fault does not have a fault code. | OC | OverCurrent | OC |

The fault code format depends upon the active user interface. The following table describes how the user interfaces display two-character fault codes for traction, pump and steering controller faults. The fault code characters range from 0–9 and A–F:

| GUI(s) | Description |
|---|---|
| GUIs 1 and 4 | Faults are displayed in the following format:<br>• Fault source indicator<br>• The fault code, which consists of a character, a comma, and another character.<br>• If the fault has a fault type, the fault type is displayed within brackets.<br>In the following example, the traction and pump faults have fault types and the BMS fault does not:<br>T B, 1 [1]<br>P 8, 5 [2]<br>B 023 |
| GUI 2 | Faults are displayed in the following format:<br>• Fault source indicator<br>• A colon<br>• The fault code, which consists of a character, a period, and another character.<br>TRA: 1.2<br>**Note:** GUI 2 does not display fault types. |
| GUI 5 | Faults are displayed in the following format:<br>• Fault source indicator<br>• A colon<br>• The fault code, which consists of a character, a comma, and another character.<br>• If the fault has a fault type, the fault type is displayed within brackets.<br>TRA: 1,2 [2] |

BMS and lift lock driver overcurrent faults have different formats:

- BMS fault codes consist of three characters:

BAT:013

- Lift lock driver Overcurrent faults do not have fault codes. Instead, the screen displays only the fault source indicator (OC or OverCurrent) described in Table 2-2. The following example is from GUI 2:

OverCurrent

## HOUR METER

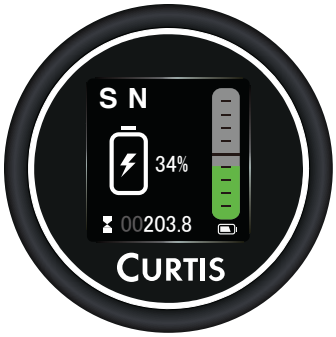
The hour meter indicates the running time of the 3150R, devices on the CANbus, or Curtis controllers connected to the SCI ports. The first example below is for GUIs 1, 4 and 5, and the second is for GUI 2:



The hour meter measures time in 0.1 hour units. The maximum value is 99,999.9 hours. After the hour meter reaches its maximum value, the hour meter resets to 0.0 hours.

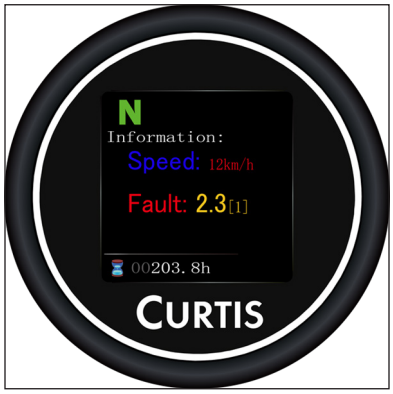
## CHARGING ICON

To indicate that the battery is charging, a charging icon replaces the BDI icon. GUI 2 has a different icon than GUIs 1, 4 and 5:

| User Interface(s) | Example |
|---|---|
| GUIs 1, 4 and 5 |   |
| GUI 2 |   |

## MESSAGE CENTER

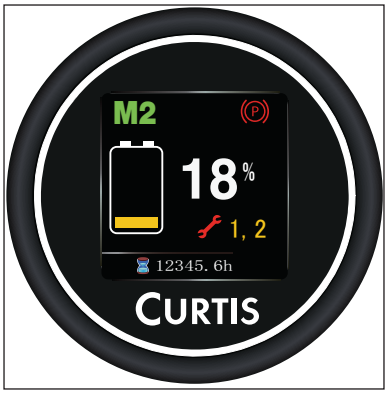
The device provides a message center. The messages that are broadcast depend upon how the device is configured. Messages are displayed within a rectangular area and can be formatted with different font sizes and colors. In the following example, the message consists of three lines that begin with "Information", "Speed", and "Fault":



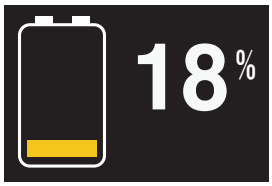

## GUI 3

GUI 3 is designed for Curtis controllers that support the serial communication interface. GUI 3 displays the following screen while the 3150R waits for the controller to connect:


When the controller connects with the 3150R, the main GUI 3 screen is displayed:



The following table describes the items contained by GUI 3:

| Item | Description |
|---|---|
|  | The controller's active speed mode:<br>M1 = Speed mode 1<br>M2 = Speed mode 2 |
|  | Displays when the parking brake is active. |
|  | The BDI icon. For information on the colors that indicate the BDI status, see BDI Icon. |
|  | Displays a fault code when the controller has an active fault. |
|  | The hour meter, which indicates the running time of the 3150R or the controller, depending upon how the device is configured.<br>The hour meter measures time in 0.1 hour units. The maximum value is 99,999.9 hours. After the hour meter reaches its maximum value, the hour meter resets to 0.0 hours. |

# 3 — INSTALLATION, WIRING AND CONFIGURATION

This chapter explains how to install and wire Model 3150R.

## INSTALLATION

Fix the 3150R by using the provided mounting bracket. The recommended panel cutout is ø52.0±0.4 mm, with a panel thickness between 0.8–6.4 mm.

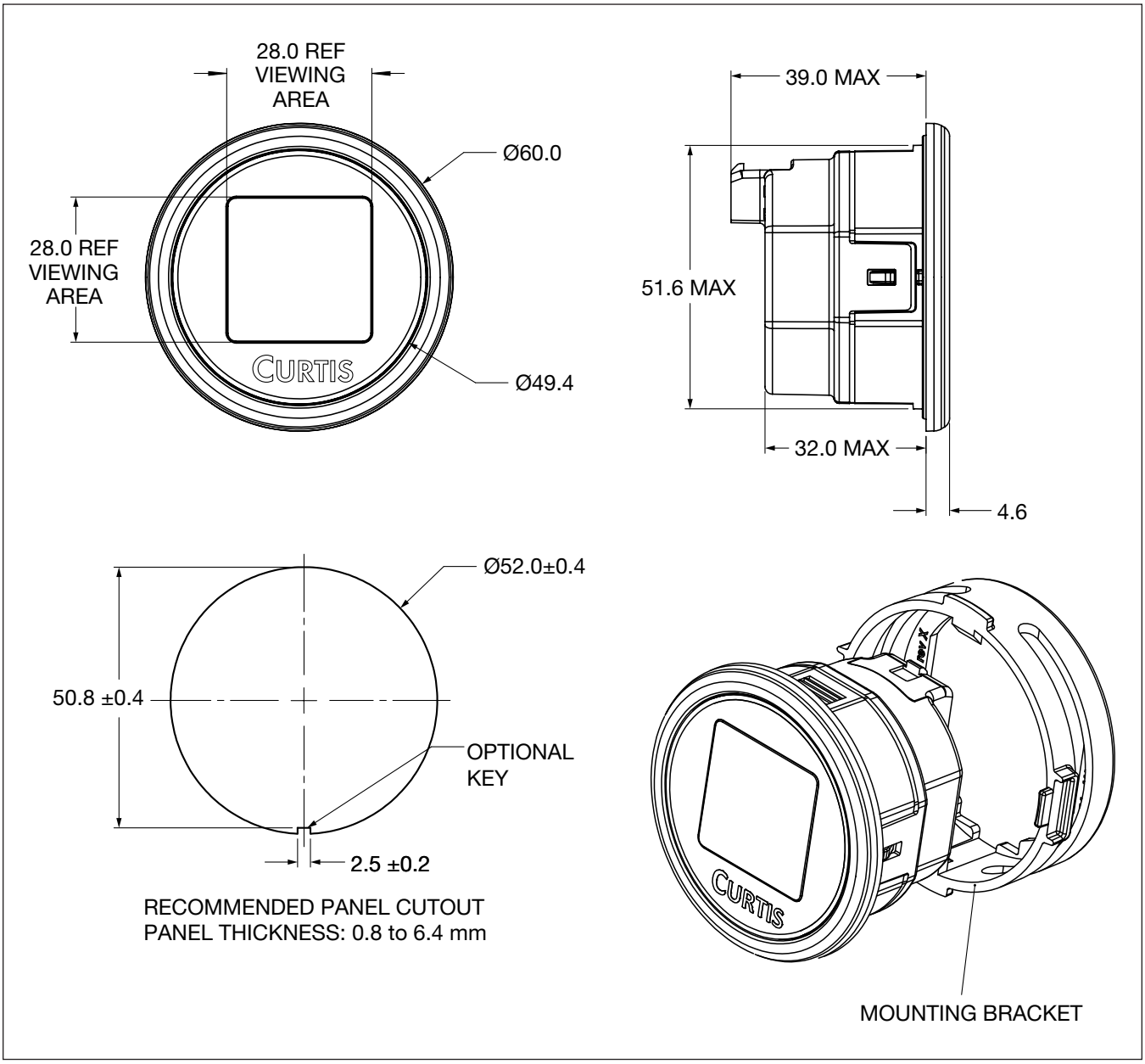



**Figure 3-1**
*Mounting Dimensions*

## I/O CONNECTOR

The mating connector is an 8-pin Mini-Universal MATE-N-LOK housing from TE Connectivity. The front is sealed to IP67. The rear is sealed to IP65 for electronic components and IP40 for the connector. You can increase the connector's protection to IP54 by using the parts listed in Table 3-2.

The following tables list the TE Connectivity parts for IP40 and IP54 protection.

**Table 3-1 Mating Connector Parts—IP40 Protection**

| Part | TE Connectivity Part Number |
|---|---|
| Connector Housing | 770579-1 |
| Terminal (18–22 AWG) | 770904-*X* |

**Table 3-2 Mating Connector Parts—IP54 Protection**

| Part | TE Connectivity Part Number |
|---|---|
| Connector Housing | 794821-1 |
| Terminal (18–22 AWG) | 770904-*X* |
| Interface Seal | 794772-8 |
| Single Wire Seal or Gang Seal | 794758-1 or 1586359-8 |
| Cavity Plug Seal (for unused terminal positions) | 794995-1 |

## I/O PINS

The following table describes the I/O pins.

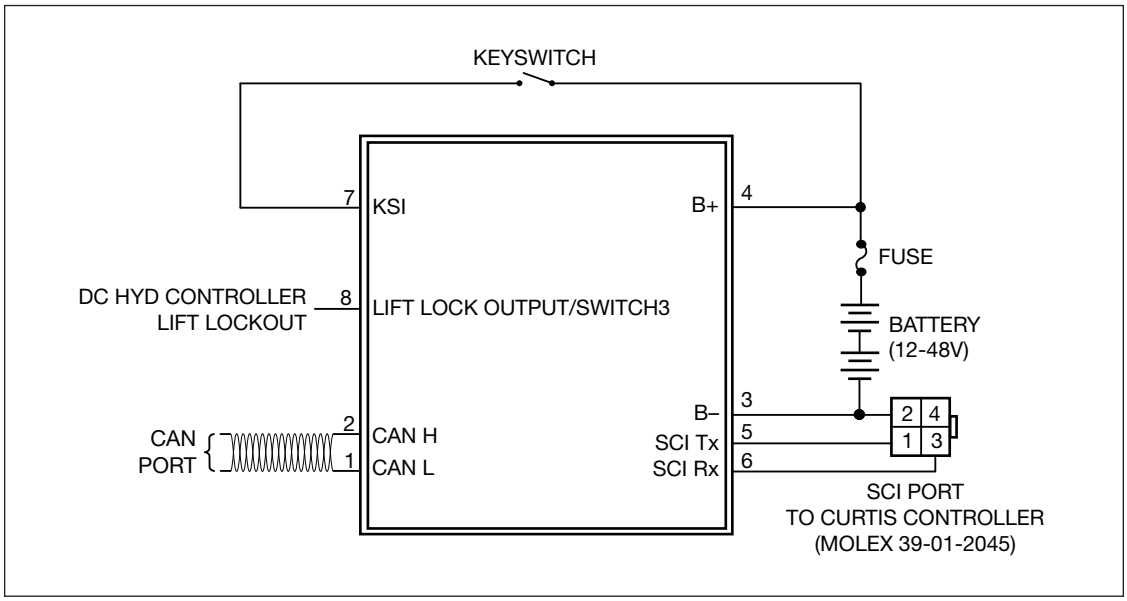
| Pin | Signal Name | Description |
|---|---|---|
| 1 | CAN Low | CANbus low signal |
| 2 | CAN High | CANbus high signal |
| 3 | B– | Battery negative |
| 4 | B+ | Battery positive |
| 5 | SCI Tx / SW1 | Serial communication interface Tx or Switch 1<br>**Note:** Some models use pins 5–6 for a serial port, other models use these pins for Switch 1 and Switch 2. |
| 6 | SCI Rx / SW2 | Serial communication interface Rx or Switch 2 |
| 7 | KSI | Keyswitch |
| 8 | Lift Lockout Output / SW3 | Lift lockout output or Switch 3 |

## WIRING DIAGRAM

Figure 3-2 is a typical wiring diagram for a model with a serial port and with pin 8 configured as a lift lockout output.

**Note:** The diagram may differ from your application's requirements. However, Model 3150R provides the I/Os and programmable parameters needed to meet almost all requirements. To discuss how to implement your application, contact your Curtis distributor or the Curtis sales and support office in your region.

**Figure 3-2**
*Wiring Diagram*




## OPERATING VOLTAGE

The following table describes the operating voltages:

| Minimum Voltage | Nominal Voltage | Maximum Voltage |
|---|---|---|
| 9V | 12–48V | 60V |

The 3150R withstands reverse polarity connections continuously.

**Note:** All voltages listed in this manual are DC voltages. Use the Nominal Voltage parameter to specify the voltage for your application.

## OPERATING CURRENT

The operating current depends upon the B+ voltage and whether the LCD heater is enabled:

| B+ Voltage | LCD Heater Disabled | LCD Heater Enabled |
|---|---|---|
| 9V | 100mA | 350mA |
| 12V | 72mA | 390mA |
| 24V | 36mA | 200mA |
| 36V | 25mA | 140mA |
| 48V | 20mA | 100mA |
| 60V | 16mA | 80mA |

**Note:** The LCD Heater Enable parameter enables the heater.

## I/Os

The following topics describe how to connect and configure the I/Os.

### Battery Connections

Connect the battery to the B– and B+ inputs (pins 3 and 4). Curtis recommends that you include a fuse in the circuit that connects the battery to the B+ input, as shown in Figure 3-2. The fuse protects the power system from external shorts. Size the fuse according to the application's requirements.

### Keyswitch Input

Connect a keyswitch to the keyswitch (pin 7) and B+ inputs. The operating voltage is the same as the device's operating voltage. The input is active high when switched to B+.

### Switch Inputs

Model 3150R provides up to three switch inputs. Some models use pins 5–6 as the Switch 1 and Switch 2 inputs, while other models use pins 5–6 as a serial port.

All models include the Switch 3 input (pin 8). Pin 8 can also be used as a lift lockout output. To configure pin 8 as the Switch 3 input, set the 32 bit CAN object `0x6709:05` to 1.

The switch inputs are active high when switched to B+. The inputs' operating voltages are the same as the device's operating voltage. The following table describes the switch input specifications:

| Specification | Minimum | Maximum |
|---|---|---|
| Input Active High Threshold Voltage | 6.0V | The maximum B+ voltage |
| Input Impedance | 148kΩ | 152kΩ |

## Lift Lockout Output

Pin 8 can be configured as a lift lockout output. The output is active when the BDI percentage is less than the percentage specified by the Lift Lockout parameter. The output withstands voltage turn-off spikes that are typical of inductive loads.

To configure pin 8 as a lift lockout output, set the 32-bit CAN object `0x6709:05` to 0.

The following table describes the lift lockout driver specifications:

| Specification | Minimum | Maximum | Condition |
|---|---|---|---|
| Continuous Current | 0A | 0.5A | *N/A* |
| Off Voltage | *N/A* | 75V | *N/A* |
| On Voltage | 0V | 1V | I = 1A DC |

## Serial Communication Interface (SCI) Port

Some models use pins 5-6 as an SCI port. The port is used to read the following data from Curtis controllers that support the SCI:

- BDI percentage
- Hour meter
- Speed mode
- Parking brake status
- Fault codes

When a controller is connected to the serial port, the 3150R automatically gets speed mode, parking brake status and fault code data from the controller. The gauge also gets the BDI percentage and hour meter data from the controller if the following parameters specify SCI:

- BDI Source
- Hourmeter Source

**Note:** GUI 3 displays data for the controller connected to the serial port.

## CAN Connections

To connect the gauge to the CANbus, connect CAN Low and CAN High to pins 1 and 2. Use twisted-pair wiring to minimize the likelihood of picking up a voltage bias on only one signal.

Some models include a 120Ω terminating resistor.

**Note:** For information on Model 3150R's CAN parameters and features, see CAN Menu and CANopen Communications.

# 4 — PROGRAM MENU PARAMETERS

The programmable parameters allow you to configure the gauge so that it meets your application's requirements. Curtis programming devices provide a user-friendly way to read and write to the parameters.

Restart the device after you change a parameter marked as [PCF]. If the device is not restarted, a Parameter Change fault will occur.

The parameters are grouped into menus. This chapter describes the main menu and the menus contained by the Program menu. The gauge also provides read-only parameters on the Monitor menu and Information menu.

The following columns in the parameter description tables contain multiple types of information:

- **Parameter** and **CAN Index**: The parameter name, followed by the CAN index and sub-index. This column also identifies parameters marked as [PCF].

  **Note:** CAN indexes and sub-indexes are delimited by colons. For example, a parameter with an index of `0x640F` and a sub-index of `0x00` would be represented as `0x640F:00`.

- **Values** and **Raw Values**: The allowed values as displayed in Curtis programming devices, followed by allowed values in raw units suitable for CAN messages.
- **Access Level** and **Default Value**. The parameter's access level for Curtis programming devices, followed by the default value.

**Note:** Writes to parameters are automatically saved to the 3150R's EEPROM. A "save" command using the CANopen Store Parameters object (`0x1010:01`) is not required.

## SET HOURMETERS MENU

The following table describes the parameters for configuring the hour meter.

SET HOURMETERS MENU

| PARAMETER<br>CAN INDEX | VALUES<br>RAW VALUES | DATA SIZE | ACCESS LEVEL<br>DEFAULT VALUE | DESCRIPTION |
|---|---|---|---|---|
| **Hourmeter Source**<br>`0x6709:00` | Enumerated<br>0–2 | 32-bit | OEM Dealer<br>3150 | Specifies the data source for the hour meter:<br>0 = 3150<br>1 = CAN<br>2 = SCI |
| **Reset KSI Hourmeter**<br>`0x6451:00` | Off/On<br>0–1 | 32-bit | OEM Dealer<br>Off | Resets the 3150R's keyswitch hour meter. |
| **Set KSI Hourmeter**<br>`0x6414:00` | 0–99999.9 hours<br>0-999999 | 32-bit | OEM Dealer<br>0.0 hr | Specifies the time indicated by the 3150R's keyswitch hour meter. |

## CAN MENU

The following table describes the parameters on the CAN menu.

**Note:** The CAN menu also contains the RPDO 1–4 Byte Map and TPDO 1–4 Byte Map menus, which specify the objects for which the PDOs transmit and receive data.

CAN MENU

| PARAMETER<br>CAN INDEX | VALUES<br>RAW VALUES | DATA SIZE | ACCESS LEVEL<br>DEFAULT VALUE | DESCRIPTION |
|---|---|---|---|---|
| **CAN Node ID**<br>`0x2000:01` | 1–127<br>1–127 | 32-bit | OEM Dealer<br>46 | Specifies the device's node ID. |
| **CAN Baud Rate**<br>`0x2001:01` | –1 to 4<br>–1 to 4 | 32-bit | OEM Dealer<br>0 | Specifies the baud rate:<br>–1 = 100 Kbps<br>0 = 125 Kbps<br>1 = 250 Kbps<br>2 = 500 Kbps<br>3 = 800 Kbps<br>4 = 1 Mbps |
| **Auto Operation**<br>`0x6557:00` | 0–1<br>0–1 | 32-bit | OEM Dealer<br>1 | Specifies the NMT state when the device powers up:<br>0 = Pre-operational<br>1 = Operational |
| **Message Center Node ID**<br>`0x7022:00` | 1–127<br>1–127 | 32-bit | OEM Dealer<br>80 | Specifies the node ID for the message center. |

## RPDO and TPDO Byte Map Menus

The parameters on the RPDO 1–4 Byte Map and TPDO 1–4 Byte Map menus are used to configure PDOs. RPDOs 1–3 and TPDO1 are preconfigured. Modify a preconfigured PDO only if the application does not require the PDO's preconfigured functions.

The menus contain parameters with the same names, allowed values, and data sizes. The only differences between parameters of the same name are their CAN indexes and default values. The following table describes the PDO Byte Map menus' parameters and Table 4-1 lists the parameters' CAN indexes and default values.

CAN MENU — RPDO AND TPDO BYTE MAP MENU

| PARAMETER | VALUES<br>RAW VALUES | DATA SIZE | ACCESS LEVEL | DESCRIPTION |
|---|---|---|---|---|
| **Length** | 0–8<br>0–8 | 8-bit | OEM Dealer | Specifies the number of objects mapped to the PDO. |
| **Map 1** | 0–FFFFFFFFh<br>0–FFFFFFFFh | 32-bit | OEM Dealer | Specifies the PDO's first mapped object. |
| **Map 2** | 0–FFFFFFFFh<br>0–FFFFFFFFh | 32-bit | OEM Dealer | Specifies the PDO's second mapped object. |
| **Map 3** | 0–FFFFFFFFh<br>0–FFFFFFFFh | 32-bit | OEM Dealer | Specifies the PDO's third mapped object. |
| **Map 4** | 0–FFFFFFFFh<br>0–FFFFFFFFh | 32-bit | OEM Dealer | Specifies the PDO's fourth mapped object. |
| **Map 5** | 0–FFFFFFFFh<br>0–FFFFFFFFh | 32-bit | OEM Dealer | Specifies the PDO's fifth mapped object. |
| **Map 6** | 0–FFFFFFFFh<br>0–FFFFFFFFh | 32-bit | OEM Dealer | Specifies the PDO's sixth mapped object. |
| **Map 7** | 0–FFFFFFFFh<br>0–FFFFFFFFh | 32-bit | OEM Dealer | Specifies the PDO's seventh mapped object. |
| **Map 8** | 0–FFFFFFFFh<br>0–FFFFFFFFh | 32-bit | OEM Dealer | Specifies the PDO's eighth mapped object. |

### Table 4-1 PDO Byte Map Menus — CAN Indexes and Default Values

| PARAMETER | PDO | CAN INDEX | DEFAULT VALUE |
|---|---|---|---|
| Length | RPDO1 | 0x1600:00 | 7 |
| Map 1 | RPDO1 | 0x1600:01 | 0x66020008 |
| Map 2 | RPDO1 | 0x1600:02 | 0x6B000008 |
| Map 3 | RPDO1 | 0x1600:03 | 0x6A010008 |
| Map 4 | RPDO1 | 0x1600:04 | 0x66070008 |
| Map 5 | RPDO1 | 0x1600:05 | 0x66080010 |
| Map 6 | RPDO1 | 0x1600:06 | 0x66000008 |
| Map 7 | RPDO1 | 0x1600:07 | 0x66010008 |
| Map 8 | RPDO1 | 0x1600:08 | 0 |
| Length | TPDO1 | 0x1A00:00 | 5 |
| Map 1 | TPDO1 | 0x1A00:01 | 0x66090008 |
| Map 2 | TPDO1 | 0x1A00:02 | 0x660A0008 |
| Map 3 | TPDO1 | 0x1A00:03 | 0x660B0008 |
| Map 4 | TPDO1 | 0x1A00:04 | 0x660C0008 |
| Map 5 | TPDO1 | 0x1A00:05 | 0x64140020 |
| Map 6 | TPDO1 | 0x1A00:06 | 0 |
| Map 7 | TPDO1 | 0x1A00:07 | 0 |
| Map 8 | TPDO1 | 0x1A00:08 | 0 |
| Length | RPDO2 | 0x1601:00 | 6 |
| Map 1 | RPDO2 | 0x1601:01 | 0x65100010 |
| Map 2 | RPDO2 | 0x1601:02 | 0x65120010 |
| Map 3 | RPDO2 | 0x1601:03 | 0x66040008 |
| Map 4 | RPDO2 | 0x1601:04 | 0x6B020008 |
| Map 5 | RPDO2 | 0x1601:05 | 0x66050008 |
| Map 6 | RPDO2 | 0x1601:06 | 0x6A020008 |
| Map 7 | RPDO2 | 0x1601:07 | 0 |
| Map 8 | RPDO2 | 0x1601:08 | 0 |
| Length | TPDO2 | 0x1A01:00 | 0 |
| Map 1 | TPDO2 | 0x1A01:01 | 0 |
| Map 2 | TPDO2 | 0x1A01:02 | 0 |
| Map 3 | TPDO2 | 0x1A01:03 | 0 |
| Map 4 | TPDO2 | 0x1A01:04 | 0 |
| Map 5 | TPDO2 | 0x1A01:05 | 0 |
| Map 6 | TPDO2 | 0x1A01:06 | 0 |
| Map 7 | TPDO2 | 0x1A01:07 | 0 |
| Map 8 | TPDO2 | 0x1A01:08 | 0 |
| Length | RPDO3 | 0x1602:00 | 4 |
| Map 1 | RPDO3 | 0x1602:01 | 0x66030008 |
| Map 2 | RPDO3 | 0x1602:02 | 0x6B010008 |
| Map 3 | RPDO3 | 0x1602:03 | 0x6A000008 |
| Map 4 | RPDO3 | 0x1602:04 | 0x6B030008 |
| Map 5 | RPDO3 | 0x1602:05 | 0 |
| Map 6 | RPDO3 | 0x1602:06 | 0 |
| Map 7 | RPDO3 | 0x1602:07 | 0 |
| Map 8 | RPDO3 | 0x1602:08 | 0 |

**Table 4-1 PDO Byte Map Menus — CAN Indexes and Default Values, cont'd**

| PARAMETER | PDO | CAN INDEX | DEFAULT VALUE |
|---|---|---|---|
| Length | TPDO3 | 0x1A02:00 | 0 |
| Map 1 | TPDO3 | 0x1A02:01 | 0 |
| Map 2 | TPDO3 | 0x1A02:02 | 0 |
| Map 3 | TPDO3 | 0x1A02:03 | 0 |
| Map 4 | TPDO3 | 0x1A02:04 | 0 |
| Map 5 | TPDO3 | 0x1A02:05 | 0 |
| Map 6 | TPDO3 | 0x1A02:06 | 0 |
| Map 7 | TPDO3 | 0x1A02:07 | 0 |
| Map 8 | TPDO3 | 0x1A02:08 | 0 |
| Length | RPDO4 | 0x1603:00 | 0 |
| Map 1 | RPDO4 | 0x1603:01 | 0 |
| Map 2 | RPDO4 | 0x1603:02 | 0 |
| Map 3 | RPDO4 | 0x1603:03 | 0 |
| Map 4 | RPDO4 | 0x1603:04 | 0 |
| Map 5 | RPDO4 | 0x1603:05 | 0 |
| Map 6 | RPDO4 | 0x1603:06 | 0 |
| Map 7 | RPDO4 | 0x1603:07 | 0 |
| Map 8 | RPDO4 | 0x1603:08 | 0 |
| Length | TPDO4 | 0x1A03:00 | 0 |
| Map 1 | TPDO4 | 0x1A03:01 | 0 |
| Map 2 | TPDO4 | 0x1A03:02 | 0 |
| Map 3 | TPDO4 | 0x1A03:03 | 0 |
| Map 4 | TPDO4 | 0x1A03:04 | 0 |
| Map 5 | TPDO4 | 0x1A03:05 | 0 |
| Map 6 | TPDO4 | 0x1A03:06 | 0 |
| Map 7 | TPDO4 | 0x1A03:07 | 0 |
| Map 8 | TPDO4 | 0x1A03:08 | 0 |

# BDI MENU

The following table describes the parameters on the BDI menu.

**Note:** The BDI menu contains the BDI Setup menu.

BDI MENU

| PARAMETER<br>CAN INDEX | VALUES<br>RAW VALUES | DATA SIZE | ACCESS LEVEL<br>DEFAULT VALUE | DESCRIPTION |
|---|---|---|---|---|
| **Nominal Voltage**<br>`0x6555:00` | Enumerated<br>0–3 | 32-bit | OEM Dealer<br>24V | Specifies the battery's nominal voltage:<br>0 = 12V<br>1 = 24V<br>2 = 36V<br>3 = 48V |
| **BDI Source**<br>`0x6709:01` | Enumerated<br>0–2 | 32-bit | OEM Dealer<br>3150 | Specifies the data source for the BDI data:<br>0 = 3150<br>1 = CAN<br>2 = SCI (serial) |
| **Lift Lockout**<br>`0x6408:00` | 0.0–20.0%<br>0–200 | 32-bit | OEM Dealer<br>10.0% | Specifies the BDI percentage below which lift lockout and the low BDI alarm are activated and the BDI icon is red. |
| **BDI Low Alarm**<br>`0x640A:00` | 0–50.0%<br>0–500 | 32-bit | OEM Dealer<br>20.0% | Specifies the BDI percentage below which the low BDI alarm is activated. When the BDI percentage is below BDI Low Alarm and greater than or equal to Lift Lockout, the BDI icon is yellow. |

## BDI Setup Menu

The BDI Setup menu is displayed when the 3150R is the data source for BDI data. The parameters configure how the gauge calculates the BDI percentage.

### BDI MENU — BDI SETUP MENU

| PARAMETER<br>CAN INDEX | VALUES<br>RAW VALUES | DATA SIZE | ACCESS LEVEL<br>DEFAULT VALUE | DESCRIPTION |
|---|---|---|---|---|
| **Charge Full**<br>`0x6404:00` | 1.500–2.500V<br>1500–2500 | 32-bit | OEM Dealer<br>2.350V | Specifies the battery cell voltage above which the battery is considered charged.<br>Charge Full must be at least 0.200V above Charge Empty. |
| **Charge Empty**<br>`0x6405:00` | 1.500–2.500V<br>1500–2500 | 32-bit | OEM Dealer<br>2.100V | Specifies the battery cell voltage above which the battery is considered as starting to charge.<br>Charge Empty must be at least 0.200V below Charge Full and at least 0.010V above Discharge Full. |
| **Discharge Full**<br>`0x6402:00` | 1.500–2.500V<br>1500–2500 | 32-bit | OEM Dealer<br>2.040V | Specifies the battery cell voltage at which the state of charge is considered 100%.<br>Discharge Full must be at least 0.120V more than Discharge Empty and must be between the following values:<br>• Charge Empty: 0.010V<br>• OCR Reset: 0.030V |
| **Discharge Empty**<br>`0x6403:00` | 1.500–2.500V<br>1500–2500 | 32-bit | OEM Dealer<br>1.730V | Specifies the battery cell voltage at which the state of charge is considered 0%.<br>Discharge Empty must be at least 0.120V below Discharge Full. |
| **OCR Reset**<br>`0x6406:00` | 1.500–2.500V<br>1500–2500 | 32-bit | OEM Dealer<br>2.090V | Specifies the battery cell voltage above which the BDI percentage is reset to 100%. OCR Reset is checked only once; the check occurs when the gauge is powered up.<br>OCR Reset must be at least 0.030V above Discharge Full and at least 0.010V less than Charge Empty. |
| **Integration Rate**<br>`0x6407:00` | 2–600 minutes<br>2-600 | 32-bit | OEM Dealer<br>30 minutes | Specifies the minimum time for the BDI algorithm to decrease the BDI percentage from 100% to 0% or increase the percentage from 0% to 100%. |

# MISC MENU

The following table describes the parameters on the Misc menu.

MISC MENU

| PARAMETER<br>CAN INDEX | VALUES<br>RAW VALUES | DATA SIZE | ACCESS LEVEL<br>DEFAULT VALUE | DESCRIPTION |
|---|---|---|---|---|
| **HYD Controller Enable**<br>`0x6556:00` | Off/On<br>0–1 | 32-bit | OEM Dealer<br>On | Specifies whether fault codes for the hydraulic controller are displayed. |
| **Speed Unit**<br>`0x6021:00` | Enumerated<br>0–1 | 32-bit | OEM Dealer<br>KPH | Specifies the speedometer's unit of measurement:<br>0 = KPH<br>1 = MPH |
| **GUI Select**<br>`0x6709:02` | Enumerated<br>0–4 | 32-bit | OEM Dealer<br>GUI-1 | Specifies the user interface:<br>0 = GUI-1<br>1 = GUI-2<br>2 = GUI-3<br>3 = GUI-4<br>4 = GUI-5 |
| **Logo Select**<br>`0x6553:00` | 0–1<br>0–1 | 32-bit | OEM Dealer<br>0 | Indicates whether a logo displays after the device first powers up.<br>0 = No logo<br>1 = Curtis logo |
| **LCD Heater Enable**<br>`0x6709:03` | Off/On<br>0–1 | 32-bit | OEM Dealer<br>On | Indicates whether the LCD heater is disabled.<br>**Note:** If the gauge is powered by the external 12V supply of a Curtis motor controller, disable the LCD heater. This is because of the controllers' external power supply limits. |

# 5 — MONITOR MENU PARAMETERS

The Monitor menu contains the Hourmeters menu.



## HOURMETERS MENU

The following table describes the KSI Hourmeter parameter.

HOURMETERS MENU

| PARAMETER<br>CAN INDEX | VALUES<br>RAW VALUES | DATA SIZE | ACCESS LEVEL | DESCRIPTION |
|---|---|---|---|---|
| **KSI Hourmeter**<br>`0x6700:00` | 0.0–99999.9 hours<br>0–999999 | 32-bit | Field Basic | Indicates how many hours are on the keyswitch hour meter. |

# 6 — INFORMATION MENU PARAMETERS

The Information menu contains the following read-only parameters:

INFORMATION MENU

| PARAMETER<br>CAN INDEX | VALUES<br>RAW VALUES | DATA SIZE | ACCESS LEVEL | DESCRIPTION |
|---|---|---|---|---|
| **Model Number**<br>`0x6505:00` | –32768 to 32767<br>–32768 to 32767 | 32-bit | Field Basic | Indicates the model number. |
| **Serial Number**<br>`0x1018:04` | 0–999999<br>0–999999 | 32-bit | Field Basic | Indicates the serial number. |
| **CDEV**<br>`0x6501:00` | –2147483648 to 2147483647<br>–2147483648 to 2147483647 | 32-bit | Field Basic | Indicates the device profile's version. |
| **OS Version**<br>`0x6500:00` | –2147483648 to 2147483647<br>–2147483648 to 2147483647 | 32-bit | Field Basic | Indicates the operating system's version. |

# 7 — CANopen COMMUNICATIONS

Model 3150R complies with the CAN in Automation (CiA) CANopen 301 specification. This chapter describes the gauge's CANopen features.

Some familiarity with CANopen is a prerequisite. For CANopen information, see the following pages on the CiA web site:

- Overview: https://www.can-cia.org/canopen/
- Specifications: https://www.can-cia.org/groups/specifications/

## BYTE AND BIT SEQUENCE ORDER

CANopen message byte sequences are transmitted with the least significant byte first (little-endian format).

**Note:** This manual uses the LSB 0 Numbering convention when referring to byte and bit numbers.

For example, the following table shows an SDO that writes the data 04E2h to the object with the index and sub-index 334C-01h:

| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| Control Byte | Index | | Sub-index | Data | | | |
| 2Bh | 4Ch | 33h | 01h | E2h | 04h | 00h | 00h |

Strings are read from left to right. The following example shows how the 3150R transmits an SDO segment for the string "Curtis":

| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| Control Byte | Data | | | | | | |
| 00h | 43h = "C" | 75h = "u" | 72h = "r" | 74h = "t" | 69h = "i" | 73h = "s" | |

Bit sequences are transmitted from most significant to least significant bit (big-endian format). The following example shows how the gauge transmits the bits for the value 2Bh:

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 1 | 0 | 1 | 0 | 1 | 1 |

## NODE IDs

Model 3150R's node ID is specified with the CAN Node ID parameter. The default node ID is 0x2E.

The message center has its own node ID, which is specified with the Message Center Node ID parameter. The message center's default node ID is 0x50.

**Note:** Both parameters are on the CAN menu.

## BAUD RATE

The gauge's baud rate is specified with the CAN Baud Rate parameter on the CAN menu. The default baud rate is 125 Kbps.

## MESSAGE CAN-IDs

The 3150R's CAN messages are identified by 11-bit CAN IDs. The device does not support 29-bit CAN IDs.

## EXPEDITED SDOs

The least significant byte of an expedited SDO is known as the *control byte*. The following table describes the control byte fields:

| 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|---|---|---|---|---|---|---|
| *Command Specifier* | | | 0b | *n* | | *e* | *s* |

The following list describes the control byte:

- The *Command Specifier* field indicates the SDO's transfer type. The following table describes the transfer types:

| Transfer Type | Value |
|---|---|
| Write data to a device | 001b |
| Confirm a write | 011b |
| Request data from a device | 010b |
| Device responds with requested data | 010b |
| Abort SDO | 100b |

- Bit 4 is always 0b.
- The values of bits 0–3 depend upon whether the SDO transfers data. If the SDO does **not** transfer data, these bits are always 0b. If the SDO transfers data, the bit values are as follows:
  - *n* indicates the number of unused data bytes.
  - *e* = 1b, which indicates the message contains data.
  - *s* = 1b, which indicates that the *n* field specifies the number of unused data bytes.

The following table lists the control byte values for the various transfer types:

| Transfer Type | Control Byte |
|---|---|
| Write data to a device | Depends upon the data size:<br>• 1 byte = 2Fh<br>• 2 bytes = 2Bh<br>• 3 bytes = 27h<br>• 4 bytes = 23h |
| Confirm a write | 60h |
| Request data from a device | 40h |
| Device responds with requested data | Depends upon the data size:<br>• 1 byte = 4Fh<br>• 2 bytes = 4Bh<br>• 3 bytes = 47h<br>• 4 bytes = 43h |
| Abort SDO | 80h |

# PDOs

RPDOs 1–3 and TPDO 1 and are preconfigured to transmit and receive data used by Model 3150R's user interfaces. The following topics describe PDO considerations and the preconfigured PDOs.

**Note:** RPDO4 and TPDOs 2–4 are reserved.

## PDO COB-IDs

The following table lists the bits that define a PDO COB-ID:

| Bit(s) | Description |
|---|---|
| 31 | Indicates whether the PDO is enabled. 0b indicates enabled. |
| 30 | *Reserved*. Always 0. |
| 29 | Indicates whether the COB-ID is 11 or 29 bits. The device supports only 11-bit COB-IDs, so the value is always 0. |
| 11–28 | Bits that would be set for 29-bit COB-IDs. For the 3150R, these bits = 0. |
| 7–10 | The PDO's function code. The function codes are listed below:<br>• RPDO1: 0100b<br>• RPDO2: 0110b<br>• RPDO3: 1000b<br>• RPDO4: 1010b<br>• TPDO1: 0011b<br>• TPDO2: 0101b<br>• TPDO3: 0111b<br>• TPDO4: 1001b |
| 0–6 | The device's node ID. |

For example, if the device's node ID is 2Eh and RPDO1 is enabled, the RPDO1 COB-ID is 22Eh.

## PDO Timing

The 3150R's PDOs are asynchronous and are periodically transmitted and received. The device does not support synchronous PDOs. The following list describes the PDOs' event times:

- RPDOs: 60,000ms (1 minute). If the device does not receive data within one minute, it displays *,*.
- TPDOs: 40ms

## Preconfigured PDOs

Some RPDO bytes receive fault codes and fault types for traction, pump and steering controllers. The following list describes the data for these bytes:

- Fault codes: The four most significant bits are the fault code's first character and the four least significant bits are the second character. The fault code characters range from 0–9 and A–F. 0h indicates that the component does not have an active fault. For example, if a device's fault code byte specifies B2h, the fault code is B2.
- Fault types: The fault types range from 0–99. The raw data ranges from 0–63h. 0 indicates that the fault does not have a fault type.

The following topics describe the preconfigured PDOs.

## RPDO1

| Byte(s) | Description |
|---|---|
| 0 | The fault code for the traction controller.<br>If RPDO2, byte 6, bit 5 is set to 1, the fault code is for the right traction controller. |
| 1 | The fault type for the traction controller.<br>If RPDO2, byte 6, bit 5 is set to 1, the fault type is for the right traction controller. |
| 2 | The fault code for the BMS. Fault codes range from 1–255.<br>When a BMS fault is active, the device displays the fault code only if the fault type is less than the value specified by the `bat_fault_active_level` parameter. The parameter has a CAN index and sub index of `0x6558:00` and a default value of 3. |
| 3–5 | The hour meter data:<br>• Byte 3 indicates the data's last two numbers. The data ranges from 0–63h, which represents 0–9.9.<br>• Bytes 4–5 indicate the data's first four numbers. The data ranges from 0–270Fh, which represents 0–9999.<br>For example, if byte 3 specifies 63h and bytes 4–5 specify 270Fh, the hour meter displays 99999.9 hours. |
| 6 | Indicates states that determine whether icons are displayed when bits 5–7 are set to values other than 111b:<br>• 0: Parking brake status. 1 = active<br>• 1–2: Indicates whether the lift or lower function is active:<br>– 00 = Inactive<br>– 01 = Lift active<br>– 10 = Lower active<br>– 11 = *Reserved*<br>• 3–4: Transmission State:<br>– 00 = Neutral<br>– 01 = Forward gear<br>– 10 = Reverse gear<br>– 11 = Inactive<br>• 5–7: Speed mode:<br>– 000 = Inactive<br>– 001 = High mode<br>– 010 = Standard mode<br>– 011 = Economy mode<br>– 100 = Power mode<br>– 101 = Turtle mode<br>– 110 = *Reserved*<br>– 111 = Gauge configuration mode. When 111b is specified, bytes 6–7 are used to configure the 3150R as described in Table 7-1. |
| 7 | The BDI percentage (when byte 6, bits 5–7 are set to values other than 111b).<br>The displayed data ranges from 0–100%. The raw data ranges from 0–100. |

Table 7-1 describes the data for bytes 6–7 when byte 6, bits 5–7 are set to 111b.

**Table 7-1 Gauge Configuration (RPDO1, Bytes 6–7)**

| Byte | Description |
|---|---|
| 6 | The following bits configure data sources, pin 8, and logo display:<br>• 0 = Whether CAN is the hour meter data source. 1 = active.<br>• 1 = Whether CAN is the BDI data source. 1 = active.<br>• 2 = Whether pin 8 is used as the Switch 3 input or the lift lockout output. 0 = lift lockout output.<br>• 3–4 = Whether a logo is displayed when the device is powered on:<br>– 00 = No logo<br>– 01 = Curtis logo<br>– Other values = *Reserved*<br>• 5–7 = 111 (When these bits are set to a value other than 111b, the device is not in gauge configuration mode.) |
| 7 | The following bits configure the user interface:<br>• 0–2: Select GUI:<br>– 000 = GUI-1<br>– 001 = GUI-2<br>– 010 = GUI-3<br>– 011 = GUI-4<br>– 100 = GUI-5<br>– 101–111 = *Reserved*<br>• 3: = Speed unit. 0 = km/h, 1 = mph<br>• 4–7: *Reserved* |

## TPDO1

| Byte(s) | Description |
|---|---|
| 0 | The following bits indicate various statuses. 0 = inactive, 1 = active:<br>• 0 = Switch 1 status.<br>• 1 = Switch 2 status<br>• 2 = Switch 3 status<br>• 3 = Lift lockout status<br>• 4–7: *Reserved* |
| 1 | The BDI percentage. The displayed data ranges from 0–100%. The raw data ranges from 0–100. |
| 2 | • 0–1: The handshake status. When the status is Failed, the device displays the “Comm Failed” error message, otherwise the gauge displays normally:<br>– 00 = Idle<br>– 01 = Failed<br>– 10 = Passed<br>– 11 = *Reserved*<br>• 2–7: *Reserved* |
| 3 | *Reserved.* |
| 7 | Keyswitch hour meter. The displayed data ranges from 0.0–99999.9 hours. The raw data ranges from 0–999999. |

## RPDO2

| Byte(s) | Description |
|---|---|
| 0–1 | Speedometer. The displayed data ranges from 0.0–99.9 km/h or 0.0–62.0 mph, depending upon the speed unit. The raw data ranges from 0–999. |
| 2–3 | Lithium battery voltage. The displayed data ranges from 0–99.9V. The raw data ranges from 0–9999. |
| 4 | The fault code for the pump controller. |
| 5 | The fault type for the pump controller. |
| 6 | Indicates statuses that determine whether icons and the left traction controller's fault code are displayed:<br>• 0 = Seat icon. 0 = active<br>• 1 = Seatbelt icon. 1 = active.<br>• 2 = Safety pedal icon. 1 = active.<br>• 3 = Guardrail icon. 1 = active.<br>• 4 = Battery charging icon. 1 = active.<br>• 5 = Traction left fault code data source. 1 = CAN.<br>**Note:** If bit 5 is set to 1, bytes 0–1 of RPDO1 are for the right traction fault code and fault type.<br>• 6–7 = *Reserved*. |
| 7 | Lithium battery fault type. |

## RPDO3

| Byte(s) | Description |
|---|---|
| 0 | The fault code for the left traction controller. |
| 1 | The fault type for the left traction controller. |
| 2 | The fault code for the steering controller. |
| 3 | The fault type for the steering controller. |
| 4–7 | *Reserved*. |

# MESSAGE CENTER

The message center displays application-specific messages and is available in all GUIs other than GUI 3. Messages are transmitted with block SDO transfers of up to 255 bytes. Message substrings can be formatted for font size and color and can be displayed at any set of coordinates within the message center area.

The message center has a separate node ID, which is specified with the Message Center Node ID parameter.

The following steps describe the process of transmitting a message:

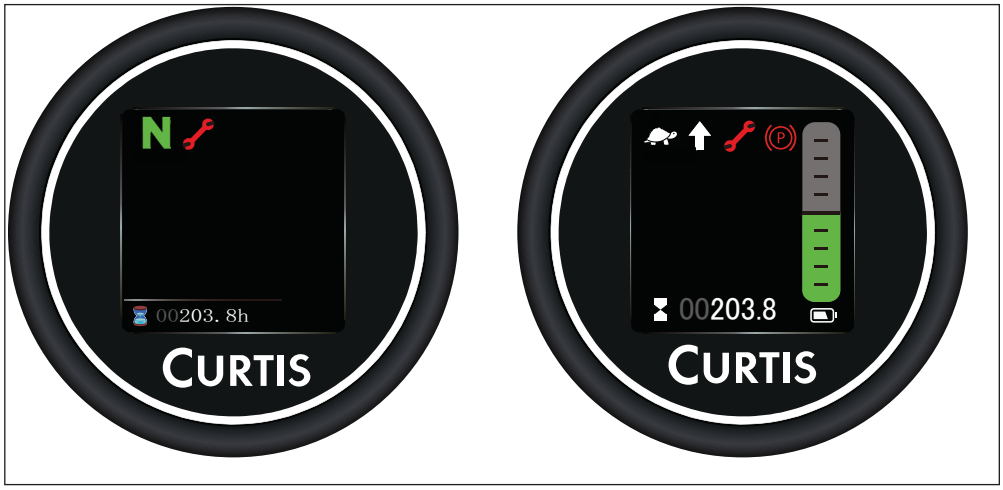
1. Enable the message center.
2. Format the message.
3. Transmit the message.
4. Clear the message.
5. Disable the message center.

The following topics describe these steps.

## Enable and Disable the Message Center

The object with an index and sub-index of `0x7021:00` enables and disables messages. The object's data size is one byte. To enable the message center, set the object to 1h.

When the message center is enabled, a rectangle highlights the message center area. Any data normally displayed in that area is hidden while the message center is active. The first example below is for GUIs 1, 4 and 5, and the second is for GUI 2:




The message center's height is 140px. The width depends upon the active GUI:

| GUI(s) | Width |
|---|---|
| 1, 4 and 5 | 240px |
| 2 | 185px |

To exit the message center, set `0x7021:00` to 0h.

## Format Messages

The following table describes the message center's default font size, color, and X and Y coordinates:

| Item | Format |
|---|---|
| Font size | • Width = 13px<br>• Height = 20px |
| Color | White |
| X and Y coordinates | (0, 19) |

You can apply one set of formats to an entire message or different formats to message substrings. Formatting instructions are preceded by opening slashes (/). If multiple substrings of a message are formatted, all instructions other than the last are followed by closing slashes.

If a formatting instruction includes invalid syntax, the device ignores the instruction.

**Note:** To display a slash, use two slashes (//).

The following tables describe the formatting indicators.

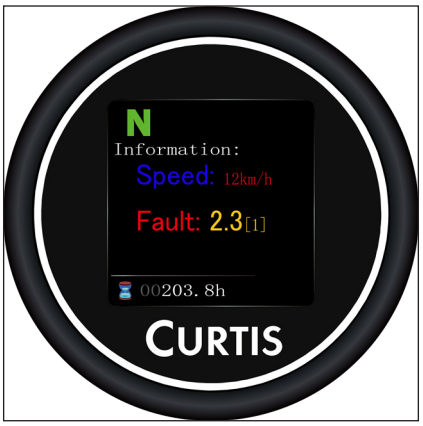
| Font Indicator | Font Size |
|---|---|
| `F0` | • Width = 13px<br>• Height = 20px |
| `F1` | • Width = 16px<br>• Height = 28px |

| Color Indicator | Color |
|---|---|
| `C0` | White |
| `C1` | Red |
| `C2` | Yellow |
| `C3` | Green |
| `C4` | Blue |
| `C5` | Orange |
| `C6` | Gray |

| Coordinate Indicator | Description |
|---|---|
| `Xn` | *n* depends upon which GUI is active and must be in the following ranges:<br>• GUIs 1,4 and 5: 0–239 (px)<br>• GUI 2: 0–184 (px) |
| `Yn` | *n* must be in the range of 19–139 (px) |

The X and Y coordinates are measured from the message center area's top left corner. If a line contains substrings with different font sizes, the text is aligned on the bottom.

For example, consider the following message:




The following string defines this message:

`Information:/X20Y60F1C4/Speed:/X120F0C1/12km//h/X20Y120F1/Fault:/X120C2/2,3/F0/[1]`

The following table describes how the message is formatted:

| Substring | Description |
|---|---|
| `Information:` | The default formats are applied because the substring is not preceded by a formatting instruction. |
| `/X20Y60F1C4/Speed:` | "Speed:" is formatted as follows:<br>• X and Y coordinates: (20,60)<br>• Font size: F1<br>• Color: Blue (C4) |
| `/X120F0C1/12km//h` | "12km/h" is formatted as follows:<br>• X coordinate: 120<br>• Font size: F0<br>• Color: Red (C1)<br>The Y coordinate is not specified, so the previously-specified Y coordinate (60) is applied. |
| `/X20Y120F1/Fault:` | "Fault:" is formatted as follows:<br>• X and Y coordinates: (20,120)<br>• Font size: F1<br>The color is not specified, so the previously-specified color (red) is applied. |
| `/X120C2/2,3` | "2,3" is formatted as follows:<br>• X coordinate:120<br>• Color: Yellow (C2)<br>The font size and Y coordinate are not specified, so the previously-specified font and Y coordinate are applied. |
| `F0/[1]` | "[1]" is formatted with the F0 font size indicator. The other formats are not specified, so the previously-specified color and coordinates are used. |

## Transmit Messages

Block SDOs are used to transmit messages. A message is displayed after the transfer is ended. The following example describes how to transmit the message for the example in the Format Messages section. The example uses 50h as the message center node ID:

| Node ID | Data Bytes (hexadecimal) | | | | | | | | Description |
|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | |
| 0x650 | 2F | 21 | 70 | 00 | 01 | 00 | 00 | 00 | Client enables the message center. |
| 0x650 | C2 | 20 | 70 | 00 | 52 | 00 | 00 | 00 | Client initiates block download. |
| 0x5D0 | A0 | 20 | 70 | 00 | 7F | 00 | 00 | 00 | Server acknowledges download request. |
| 0x650 | 01 | 49 | 6E | 66 | 6F | 72 | 6D | 61 | Client transfers segment 1. |
| 0x650 | 02 | 74 | 69 | 6F | 6E | 3A | 2F | 58 | Client transfers segment 2. |
| 0x650 | 03 | 32 | 30 | 59 | 36 | 30 | 46 | 31 | Client transfers segment 3. |
| 0x650 | 04 | 43 | 34 | 2F | 53 | 70 | 65 | 65 | Client transfers segment 4. |
| 0x650 | 05 | 64 | 3A | 2F | 58 | 31 | 32 | 30 | Client transfers segment 5. |
| 0x650 | 06 | 46 | 30 | 43 | 31 | 2F | 31 | 32 | Client transfers segment 6. |
| 0x650 | 07 | 6B | 6D | 2F | 2F | 68 | 2F | 58 | Client transfers segment 7. |
| 0x650 | 08 | 32 | 30 | 59 | 31 | 32 | 30 | 46 | Client transfers segment 8. |
| 0x650 | 09 | 31 | 2F | 46 | 61 | 75 | 6C | 74 | Client transfers segment 9. |
| 0x650 | 0A | 3A | 2F | 58 | 31 | 32 | 30 | 43 | Client transfers segment 10. |
| 0x650 | 0B | 32 | 2F | 32 | 2C | 33 | 2F | 46 | Client transfers segment 11. |
| 0x650 | 8C | 30 | 2F | 5B | 31 | 5D | 00 | 00 | Client transfers the final segment. |
| 0x5D0 | A2 | 0C | 7F | 00 | 00 | 00 | 00 | 00 | Server acknowledges the final segment. |
| 0x650 | C9 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | Client requests to disconnect. |
| 0x5D0 | A1 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | Server confirms the disconnection and the device displays the message. |

## Clear Messages

Clearing a message removes the message and restores the message center's default formatting. To clear a message, set the 8 bit object with an index and sub-index of `0x7023:00` to 1h.

## STANDARD CANopen OBJECTS

The following table describes objects required by the CANopen standard:

| Name | Index | Sub-Index | Description | Read / Write | Values Data Size |
|---|---|---|---|---|---|
| Device Type | 1000h | 00h | Indicates whether a device follows a standard CiA device profile.<br>The 3150R does not follow a standard CiA profile, so the value is 0. | RO | 0<br>32-bit |
| Error Register | 1001h | 00h | Indicates if a fault is active:<br>0 = No active fault<br>1 = One or more active faults | RO | 0–1<br>16-bit |
| Manufacturer Status Register | 1002h | 00h | *Reserved.* | *N/A* | *N/A* |
| Manufacturer Device Name | 1008h | 00h | Initiates a segmented SDO that uploads the model name and number as an ASCII string. | RO | String |
| Manufacturer's Hardware Version | 1009h | 00h | Indicates the hardware version. | RO | String |
| Manufacturer Software Version | 100Ah | 00h | *Reserved.*<br>**Note:** The CDEV and OS Version parameters indicate the software version. See Information Menu Parameters. | *N/A* | *N/A* |
| Emergency COB ID | 1014h | 00h | Indicates the Emergency Message COB-ID:<br>• 0: The COB-ID consists of the emergency message function code (0001b) and the node ID.<br>• Non-zero: The COB-ID consists of the emergency message function code (0001b) and the specified value.<br>The COB-ID's four most significant bits represent the emergency message function code. | RO | 0–16777215<br>32-bit |
| Emergency Message Inhibit Time | 1015h | 00h | Sets the minimum time that must elapse before another emergency message can be sent. | RW | 4–100 (which represents 16–400ms)<br>32-bit |
| Heartbeat Rate | 1017h | 00h | Specifies the cyclic rate of the device's heartbeat messages. | RW | 20–2000 (which represents 20–2000ms)<br>16-bit |
| Identity Object | 1018h | Provides information on the device. | | | |
| | | 00h | Indicates the size of the object. | RO | 0–127<br>8-bit |
| | | 01h | Indicates the CiA-assigned identifier of Curtis Instruments. The identifier is 4349h. | RO | 4349h<br>32-bit |
| | | 02h | Indicates the device's product code. | RO | 0–2147483647<br>32-bit |
| | | 03h | Indicates the device's Curtis CAN protocol version. The upper 2 bytes contain the major version and the lower 2 bytes contain the minor version. | RO | 0–2147483647<br>32-bit |
| | | 04h | Indicates the device's serial number. | RO | 0–999999<br>32-bit |

# APPENDIX A — CURTIS PROGRAMMING DEVICES

Curtis programming devices provide programming, diagnostic, and test capabilities for Curtis CAN devices. Two programming devices are available for the controller:

- 1313 Handheld Programmer
- Curtis Integrated Toolkit™ (CIT)

CIT has the advantage of a large, easy-to-read screen. On the other hand, the 1313 Handheld Programmer is more portable, which makes it convenient for working in the field.

The programming devices include the following features:

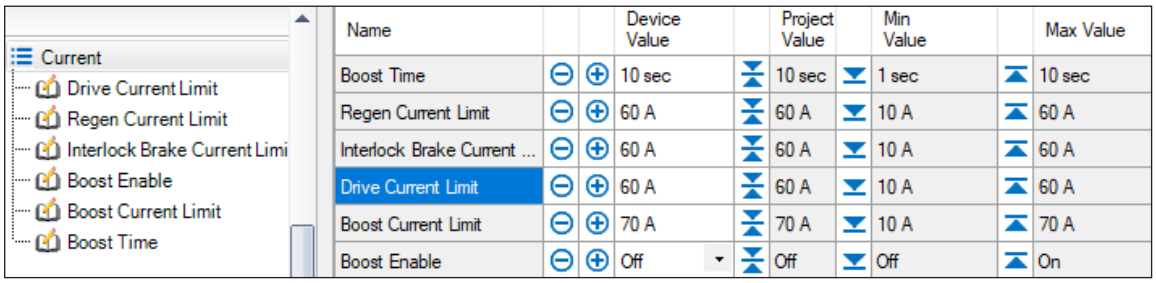
- Parameter adjustment. Save and restore the values of programmable parameters.
- Monitoring: Display real-time values during vehicle operation. These values include data for inputs and outputs.
- Diagnostics and troubleshooting:
  - Display active faults and the fault history
  - Clear the fault history
- Flashing: Update firmware of Curtis devices.

The programmers are available for the following access levels. The bullets are sorted from the highest to lowest access level:

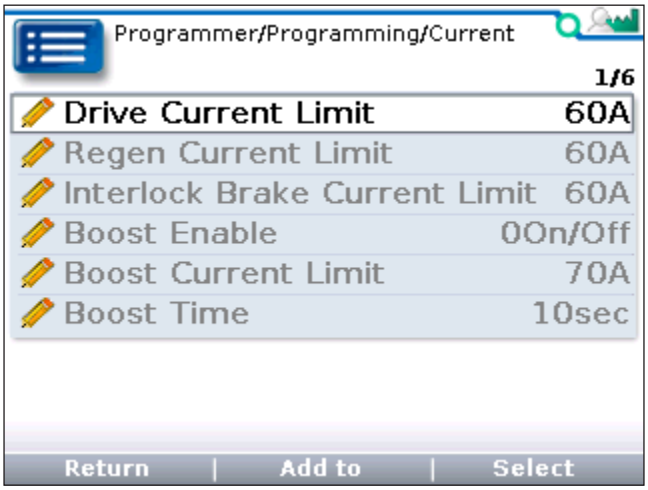
- OEM Factory
- OEM Dealer
- Field Advanced
- Field Intermediate
- Field Basic

A Curtis programmer can perform the actions available at or below its access level. For example, a Field Basic programmer can only perform actions available for the Field Basic access level, while an OEM Factory programmer can perform all actions available for any of these access levels.

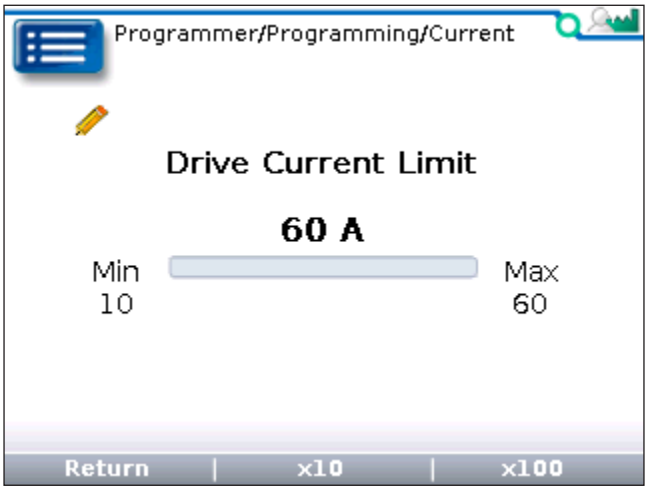
The following example shows a menu in the CIT Programmer application. You can view or edit a parameter by selecting it on the left-hand side. You can also view and edit all of a menu's parameters in one window by selecting the menu as shown below:



The following example shows the same menu in the Curtis 1313 Handheld Programmer:




To edit a parameter with the 1313 Handheld Programmer, select the parameter:




For more information on the 1313 Handheld Programmer and CIT, see https://www.curtisinstruments.com/products/programming/.

# APPENDIX B — SPECIFICATIONS

| | |
|---|---|
| **Nominal Voltage** | 12–48V |
| **Minimum Voltage** | 9V |
| **Maximum Voltage** | 60V |
| **Operating Current** | • **LCD heater off:** 16–100mA<br>• **LCD heater on:** 80–350mA |
| **Dimensions** | ø60.0 mm |
| **Operating Temperature** | • **LCD heater enabled:** –40°C to +70°C<br>• **LCD heater disabled:** –20°C to +70°C |
| **Storage Temperature** | –40°C to +85°C |
| **Humidity** | Designed to the following requirements:<br>• **Soak**: EN 60068-2-78<br>• **Cyclic**: EN 60068-2-30 |
| **Ingress Protection** | Designed to the requirements of EN 60529:<br>• Face is sealed to IP67.<br>• Rear is sealed to IP65 for electronic components and to IP40 for the connector. Optional parts can increase the connector's protection to IP54. |
| **Shock** | Designed to the requirements of EN 60068-2-27. |
| **Vibration** | Designed to the following requirements:<br>• **General**: EN 60068-2-6<br>• **Random**: EN 60068-2-64<br>• **Resonance**: EN 60068-2-6 |
| **EMC** | Designed to the following requirements:<br>• **Radiated Emissions:** EN 12895:2015+A1:2019<br>• **Radiated Immunity:** EN 12895:2015+A1:2019<br>• **Frequency Magnetic Field Immunity:** EN 12895:2015+A1:2019 |
| **CE** | Designed to the following requirements:<br>• **EMC:** EN 12895:2015+A1:2019<br>• **RoHS:** RoHS directive 2015/863/EU (RoHS 3) |
| **UL** | UL recognized component per UL583. |
| **Model Encodement** | The model number encodement is 3150R1248*yrzxxl* where:<br>• R = 52mm.<br>• 1248 = 12–48V<br>• *y* indicates whether the model has a serial port or switch inputs:<br>– S = Serial port<br>– D = Switch inputs<br>• *r* indicates whether the model includes a 120Ω CAN terminating resistor:<br>– N = No terminating resistor<br>– T = 120Ω terminating resistor<br>• *z* is reserved.<br>• *xx* is a sequential number code.<br>• *l* indicates the logo on the overlay:<br>– O = Curtis logo<br>– C = Customer logo<br>– N = No logo |

***Note:*** *Regulatory compliance of the complete system with the 3150R installed is the responsibility of the OEM.*