CURTIS

Manual

Models **3140 / 3141**

CAN Instrumentation

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Read Instructions Carefully!

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1—INTRODUCTION

The Curtis Models 3140 / 3141 CAN instruments are designed to display critical vehicle and motor controller data on an easy-to-read and attractive LCD. The displays includes three 10mm digits and six 5mm digits and all digits are in 16-segment format to allow use of the full alpha numeric character set. Models 3140 / 3141 integrate seamlessly with Model F2A and other CANopen-based motor controllers.

The 3140 / 3141 include the following:

- Integrates seamlessly with Curtis Model F2A (and other CANopen-based motor controllers) thereby reducing the amount of development work by the vehicle designer.
- Attractive fixed-segment, transflective LCD with 16-segment digits and informative icons allows intuitive reading in all lighting conditions and battery-powered vehicle environments.
- Optional integral CAN termination resistor allows flexibility in customer vehicle design.
- Industry standard 52mm panel cutout allows the use of exising panel/tool designs thereby lowering development cost.
- Battery State-of-Charge (BSOC) can be calculated in the 3140 / 3141 or sent to the 3140 / 3141 by the Model F2A (or equivalent CANopen-based motor controller).
- In addition to the 3 and 6 digit portions of the LCD, a percent symbol, wrench symbol, hourglass icon and decimal point are also present which provides more comprehensive information about vehicle status.
- Single unit operates from 24, 36, to 48 VDC allowing use on many models of battery-powered vehicles.
- Optional backlighting and LCD heater allow use in low-light and cold-store applications.
- Integrated 6-pin Mini-Universal MATE-N-LOCK connector allows for an easy and environmentally protected connection.
- Environmentally protected (IP65 front, IP54 rear) to allow use in harsh environments.
- CE compliance, UL recognition and RoHS2 compliance ensure compatibility with global regulatory standards.
- Model 3141 includes 3 LED indicators to identify critical warnings and vehicle status.

Figure 1
Curtis model 3140 CAN instrument.

Figure 2
Curtis model 3141 CAN instrument.

CANopen Convenience

Models 3140 / 3141 are CANopen compliant, responding to the standard NMT, PDO and SDO communications as well as the DS301 required identity and standard objects. The Curtis CANopen extensions allow additional features, such as OEM and User default configurations. Models 3140/3141 will receive a single SDO and respond with a single SDO. These SDO's are fixed, simplifying the interface to a VCL-enabled device. All programmable parameters and viewable values within the 3140/3141 are accessible via standard SDO transfer.

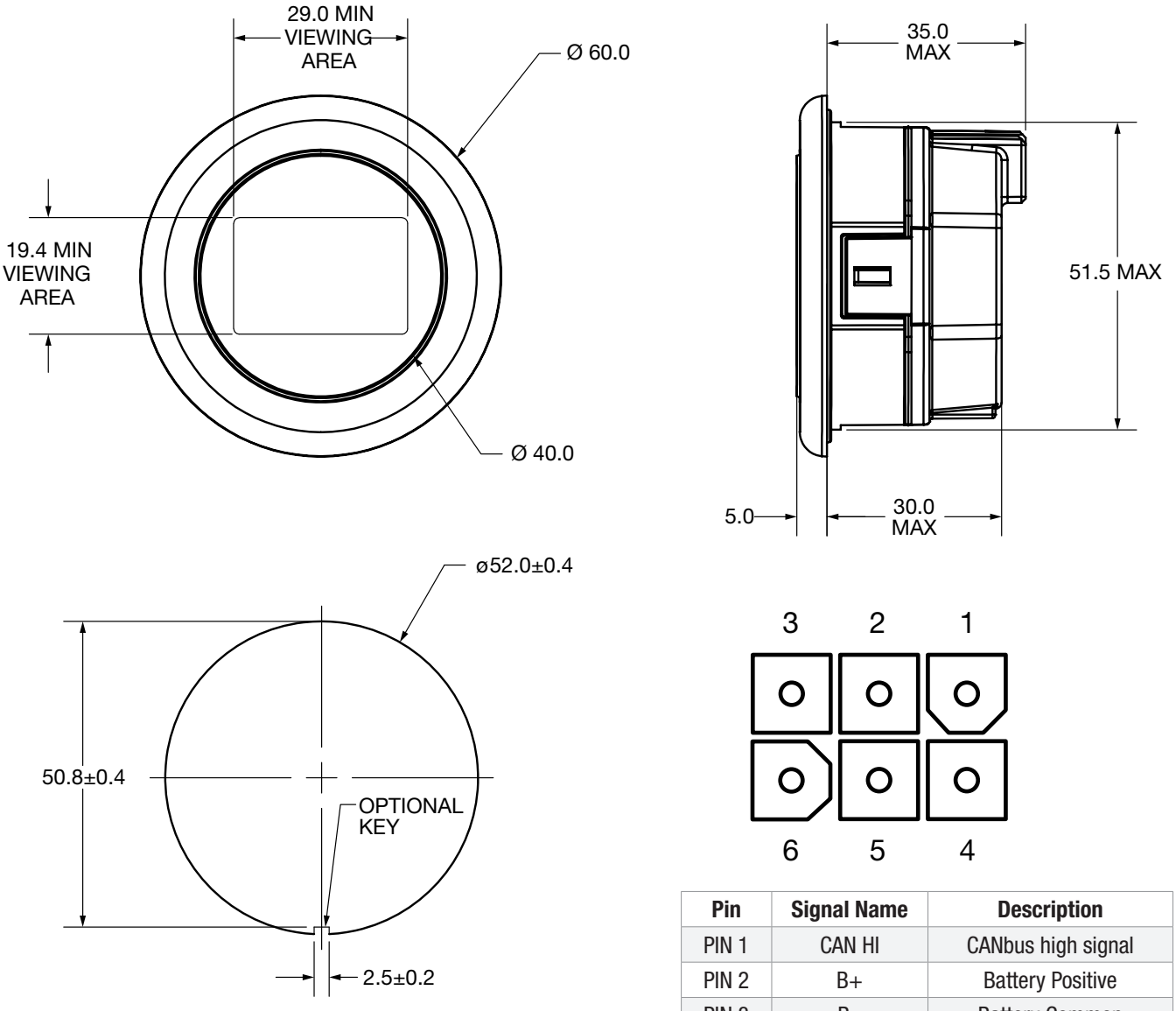
2 — INSTALLATION AND WIRING

MOUNTING THE INSTRUMENT

The outline and dimensions for Models 3140 / 3141 are shown in Figure 3.

Figure 3

3140 / 3141 product dimensions in mm.



Pin	Signal Name	Description
PIN 1	CAN HI	CANbus high signal
PIN 2	B+	Battery Positive
PIN 3	B–	Battery Common
PIN 4	Heater B–	LCD Heater B–
PIN 5	Heater B+	LCD Heater B+
PIN 6	CAN LO	CANbus low signal

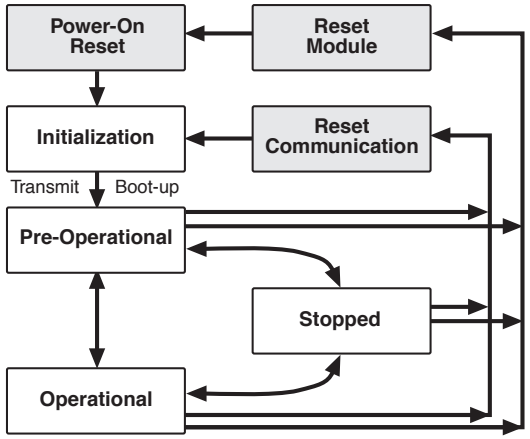
NOTE: The LCD Heater B+ and LCD Heater B– pins must be tied to B+ and B–, respectively.

3 — CANopen COMMUNICATIONS

Models 3140 / 3141 adhere to the industry standard CANopen communication protocol and thus will easily connect into many CAN systems, including those using the Curtis AC and Vehicle System controllers (such as Models F2A, 1234/36/38, 1298, 1310, and enGage VII). Any CANopen-compatible master can be programmed to control Models 3140 / 3141.

MINIMUM STATE MACHINE

Models 3140 / 3141 will run the CANopen minimum state machine as defined by CiA. The CANopen minimum state machine has four defined states: Initialization, Pre-Operational, Operational, and Stopped.



When Models 3140 / 3141 power up, they goes to the Initialization state; this is also known as the Boot-up state. No CAN communications from Models 3140 / 3141 are transmitted in this state although Models 3140/ 3141 listen to the CANbus. When Models 3140 / 3141 have completed their startup and self-tests, they issue an initialization heartbeat message and automatically go to the Pre-Operational state.

In the Pre-Operational state, the 3140/3141 can receive and respond to SDOs and NMT commands, and will send its heartbeat. It will not receive or send PDOs. After receiving an Operational State NMT command, the 3140 / 3141 will enter the Operational state (full normal operation).

In the Operational state, Models 3140 / 3141 will start receiving and responding to PDOs and process all other necessary CANopen messages.

BAUD RATES

Models 3140 / 3141 will run at one of seven selectable baud rates: 20kbps, 50kbps, 125 kbps, 250 kbps, 500 kbps, 800 kbps, and 1 Mbps.

The baud rate can be changed by an SDO. Changes in the baud rate require an NMT reset to make the new rate active.

NODE ADDRESSES

The node address of the Models 3140/3141 can be 1 to 127 and is used by CANopen to route messages to Models 3140 / 3141 and to denote messages from Models 3140 / 3141. The node address is part of the COB-ID and therefore also plays a part in message priority and bus arbitration.

Changes to the node address require an NMT reset or power-cycle.

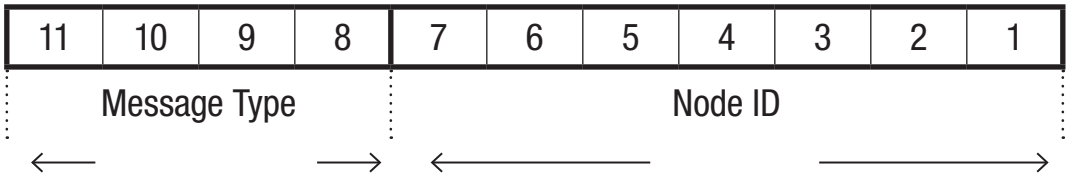
STANDARD MESSAGE IDENTIFIERS

Models 3140 / 3141 will produce—and respond to—the standard message types with the following CANopen identifiers.

Message Type	Message Identifier
NMT	0000 – 0x00
PDO-MISO	0011 – 0x03
PDO-MOSI	0100 – 0x04
SDO-MISO	1011 – 0x0B
SDO-MOSI	1100 – 0x0C
HEARTBEAT	1110 – 0x0E

The 11-bit identification field is a fixed part of the CANopen specification called the Communication OBject IDentification (COB-ID). This field is used for arbitration on the bus. The COB-ID with the lowest value gets priority and wins arbitration. Consequently, NMT messages have the highest priority of the standard message types, and the heartbeat has the lowest priority.

The standard organization of the COB-ID puts the message type in the upper four bits, and the Node ID in the bottom seven bits:



NMT MESSAGES

NMT (Network Management Transmission) messages are the highest priority message available. The NMT message puts Models 3140 / 3141 into one of the four defined states. These messages have 1 byte of data sent by the master; the slave does not respond with any data to an NMT. Models 3140 / 3141 state value is transmitted with each heartbeat message.

Value	State
0x00	Initialization (or “boot-up”)
0x04	Stopped
0x05	Operational
0x7F	Pre-Operational

The NMT message identifier consists of the standard message type (NMT) in the top four bits; the bottom seven bits must be set to zero.

The first data byte of the NMT command is the command specifier:

Value	Command Specifier
0x01	Enter the Operational state
0x02	Enter the Stopped state
0x80	Enter the Pre-Operational state
0x81	Reset 3140 / 3141 (warm boot)
0x82	Reset the CANbus

The second byte of the NMT command defines whether this NMT is for all slaves on the bus (data byte = 00h) or for a specific node (data byte = Node ID of Models 3140 / 3141).

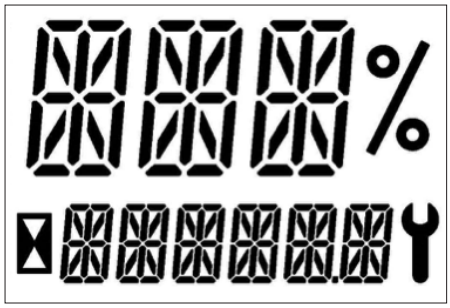
HEARTBEAT MESSAGES

The heartbeat message is a very low priority message, periodically sent by each slave device on the bus. The heartbeat message has a single byte of data and requires no response. Once Models 3140 / 3141 are in the Pre-Operational state, the next heartbeat will be issued and will continue until communication is stopped.

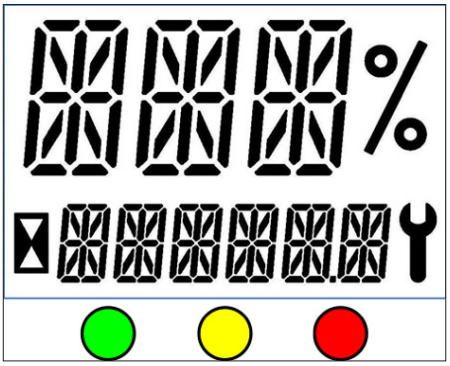
The heartbeat message has only one data byte. The top bit is reserved and should be set to zero. The bottom 7 bits hold the current NMT device state as defined previously.

LCD LAYOUT

The LCD layout for Models 3140/3141 is shown below. It features three large 16-segment characters, six small 16-segment characters, an hourglass icon, percent icon, wrench (service) icon and a decimal point.



Model 3141 features 3 fixed color LEDs located below the LCD as shown below. The LEDs are controllable through CAN messages as described later in this document.



Byte 8, the LED Command byte, is only used for Model 3141 with LEDs. Each LED can be commanded to be off, on or blinking. See Table 1 for details.

Table 1 LED Command Bit Assignments and Definitions

	Byte 8							
Bit Position	7	6	5	4	3	2	1	0
Display Element	Reserved		Red LED		Yellow LED		Green LED	
Function			On/Off/ Blink		On/Off/ Blink		On/Off/ Blink	

POWER-UP SEQUENCE

Upon power-up or transition from Pre-operational to Operational state, the 3140 / 3141 will go through a three-second diagnostic sequence. The LCD will be blank for the first second, then turn on all segments for one second, then blank for one second. The LCD will show all asterisks for five seconds after the power up sequence is complete, or whenever the NMT state is Operational but PDOs have not yet been received. This sequence will be aborted if PDO message processing has been started (3140 / 3141 commanded to Operational state and PDO messages received).

EMERGENCY MESSAGE PROCESSING

Emergency messages are not supported on this product. The product is simple enough that there are no errors.

PDO MESSAGE PROCESSING

When the Master sends a Slave device a PDO (PDO-RX, Master Out, Slave In), the Slave device will respond with a corresponding PDO-RX within 16 milliseconds.

PDO1_RX

Byte 1	Command_Word Low Byte	CAN object 0x3000
Byte 2	Command_Word High Byte	CAN object 0x3000
Byte 3	Large_Text_Char_1 (leftmost)	CAN object 0x3001, sub-index 0x01
Byte 4	Large_Text_Char_2	CAN object 0x3001, sub-index 0x02
Byte 5	Large_Text_Char_3 (rightmost)	CAN object 0x3001, sub-index 0x03
Byte 6	Backlight percent	CAN object 0x3005, sub-index 0x00
Byte 7	Hour meter enable	CAN object 0x3010, sub-index 0x01
Byte 8	LED Command (Model 3141 only)	CAN object 0x3003, sub-index 0x00

Any data bytes in excess of seven (for 3140) or eight (for 3141) will be ignored. If a byte is not present in the PDO message received, the object mapped to that byte will not change as a result of the PDO reception.

Byte 1, bit 0 determines if the 3 large text characters displays the ASCII text sent in Bytes 3 – 5 or the internal BSoC calculation. Byte 1, bits 1 – 2 command the 3 large text characters to be on, off or blinking. Byte 1, bit 3 determines if the 6 small text characters displays the ASCII text sent in PDO2_RX or the internal hour meter. Byte 1, bits 4 – 5 command the 6 small text characters to be on, off or blinking. See Table 2 for details.

PDO2_RX

Byte 1	Small_Text_Char_1	CAN object 0x3001, sub-index 0x01
Byte 2	Small_Text_Char_2	CAN object 0x3001, sub-index 0x02
Byte 3	Small_Text_Char_3	CAN object 0x3001, sub-index 0x03
Byte 4	Small_Text_Char_4	CAN object 0x3001, sub-index 0x04
Byte 5	Small_Text_Char_5	CAN object 0x3001, sub-index 0x05
Byte 6	Small_Text_Char_6	CAN object 0x3001, sub-index 0x06

Any data bytes in excess of six will be ignored.

Byte 2 is used to command the percent icon (%), wrench icon, hourglass icon and the decimal point. Each of these elements can be commanded to be off, on or blinking. See Table 3 for details.

Table 2 Command Word Bit Assignments and Definitions.

Byte 1								
Bit Position	7	6	5	4	3	2	1	0
Display Element	Reserved		Small text		Small text source	Large text		Large text source
Function			On/Off/ Blink		0 = CAN 1 = hour meter[1]	On/Off/ Blink		0 = CAN 1 = BSoC[2]

Byte 2								
Bit Position	7	6	5	4	3	2	1	0
Display Element	Decimal Point		Hourglass		Wrench		Percent	
Function	On/Off/ Blink		On/Off/ Blink		On/Off/ Blink		On/Off/ Blink	

[1] *If hour meter is selected as the source, the hourglass icon will blink when the hour meter is enabled (counting).*

[2] *If BSoC is selected as the source, the percent icon will be turned on.*

On/Off/ Blink: 00 = off, 01 = on, 10 = blink, 11 = reserved (Off)

If the large text source is set to BSoC, then the On/Off/Blink commands for the large text and percent icon are ignored.

If the small text source is set to hour meter, then the On/Off/Blink commands for the small text and hourglass icon are ignored.

PDO1_TX

Byte 1	Bplus_mV Low Byte	CAN object 0x3030, sub-index 0x00
Byte 2	Bplus_mV High Byte	CAN object 0x3030, sub-index 0x00
Byte 3	BDI_percent	CAN object 0x3020, sub-index 0x00
Byte 4	Hour meter Value Byte 0	CAN object 0x3010, sub-index 0x00
Byte 5	Hour meter Value Byte 1	CAN object 0x3010, sub-index 0x00
Byte 6	Hour meter Value Byte 2	CAN object 0x3010, sub-index 0x00
Byte 7	Hour meter Value Byte 3	CAN object 0x3010, sub-index 0x00

PDO2_TX

No PDO2_TX message is transmitted by the 3140 / 3141.

4 — DEVICE PARAMETER OBJECTS

DICTIONARY OBJECTS

The following Table identifies the variables that should be externally accessible for the 3140 / 3141.

Table 3: CAN Object Dictionary

CAN Index	Sub-Index	Name	Length (Bytes)	Read/ Write	NVM[3]	Default Value
0x1000	0x00	canopen_mandatory_device_type	4	R	Y	0x00
0x1001	0x00	canopen_mandatory_error_register	1	R	Y	0x00
0x1002	0x00	canopen_status_register	4	R	Y	0x00
0x1008	0x00	canopen_device_name	4	R	Y	" 3140 / 3141"
0x1009	0x00	canopen_hardware_version (major.minor)	4	R	Y	" 0001" = 00.01
0x100A	0x00	canopen_firmware_revision (major.minor)	4	R	Y	" 0001" = 00.01
0x1010	0x00	canopen_store_parameters_struct_length	1	R	Y	0x01
0x1010	0x01	canopen_store_all_parameters. Send "save" (65766173h) to save NVM parameters to EEPROM.	4	R/W	Y	0x00000001
0x1011	0x00	canopen_restore_parameters_struct_length	1	R	Y	0x01
0x1011	0x01	canopen_reststore_all_parameters. Send "load" (64616F6Ch) to restore parameters	4	R/W	N	0x00000001
0x1014	0x00	canopen_EMCY_COB_ID	2	R	Y	0x80 + Node_ID
0x1017	0x00	canopen_heart_beat_rate	2	R	Y	100ms
0x1018	0x00	canopen_mandatory_identity_struct_length	1	R	Y	0x01
0x1018	0x01	canopen_mandatory_identity_vendor_id	4	R	Y	0x00004349
0x1400	0x00	can_pdo_RX_1_struct_length	1	R	Y	0x02
0x1400	0x01	can_pdo_RX_1_cob_id	2	R	Y	0x200 + Node_ID
0x1400	0x02	can_pdo_RX_1_trans_type	1	R	Y	0xFE
0x1401	0x00	can_pdo_RX_2_struct_length	1	R	Y	0x02
0x1401	0x01	can_pdo_RX_2_cob_id	2	R	Y	0x300 + Node_ID
0x1401	0x02	can_pdo_RX_2_trans_type	1	R	Y	0xFE
0x1600	0x00	can_pdo_RX_1_length	1	R	Y	0x06 (3140) 0x07 (3141)

[3] *Non-Volatile Memory: these values are recalled upon power up.*

Table 3: CAN Object Dictionary continued

CAN Index	Sub-Index	Name	Length (Bytes)	Read/ Write	NVM[3]	Default Value
0x1600	0x01	can_pdo_RX_1_map_1	4	R	Y	0x30000010
0x1600	0x02	can_pdo_RX_1_map_2	4	R	Y	0x30010108
0x1600	0x03	can_pdo_RX_1_map_3	4	R	Y	0x30010208
0x1600	0x04	can_pdo_RX_1_map_4	4	R	Y	0x30010308
0x1601	0x00	can_pdo_RX_2_length	1	R	Y	0x06
0x1601	0x01	can_pdo_RX_2_map_1	4	R	Y	0x30020108
0x1601	0x02	can_pdo_RX_2_map_2	4	R	Y	0x30020208
0x1601	0x03	can_pdo_RX_2_map_3	4	R	Y	0x30020308
0x1601	0x04	can_pdo_RX_2_map_4	4	R	Y	0x30020408
0x1601	0x05	can_pdo_RX_2_map_5	4	R	Y	0x30020508
0x1601	0x06	can_pdo_RX_2_map_6	4	R	Y	0x30010608
0x2000	0x00	can_node_id_struct_length	1	R	Y	0x01
0x2000	0x01	can_node_id	1	R/W	Y	0x71
0x2001	0x00	can_baud_rate_struct_length	1	R	Y	0x01
0x2001	0x01	can_baud_rate	2	R/W	Y	0 = 125k baud
0x2003	0x00	device_info_structure_length	1	R	Y	0x07
0x2003	0x01	model_name	4	R	Y	" 3140 / 3141"
0x2003	0x02	model_family	4	R	Y	0x000000000
0x2003	0x03	serial_number	4	R	Y	0x000000000
0x2003	0x04	manufacture_date	string	R	Y	"20--/01/01"
0x2003	0x05	manufacture_location	string	R	Y	"China"
0x2003	0x06	hardware_version	4	R	Y	0x000000000
0x2003	0x07	application_package_version	4	R	Y	0x000000000
0x3000	0x00	Command_Word	2	R/W	N	0x0000
0x3001	0x00	Large_Display_Length	1	R	Y	0x03
0x3001	0x01	Large_Text_Char_1	1	R/W	N	0x20 (space)
0x3001	0x02	Large_Text_Char_2	1	R/W	N	0x20 (space)
0x3001	0x03	Large_Text_Char_3	1	R/W	N	0x20 (space)
0x3002	0x00	Small_Display_Length	1	R	Y	0x06
0x3002	0x01	Small_Text_Char_1	1	R/W	N	0x20 (space)
0x3002	0x02	Small_Text_Char_2	1	R/W	N	0x20 (space)
0x3002	0x03	Small_Text_Char_3	1	R/W	N	0x20 (space)
0x3002	0x04	Small_Text_Char_4	1	R/W	N	0x20 (space)
0x3002	0x05	Small_Text_Char_5	1	R/W	N	0x20 (space)

[3] Non-Volatile Memory: these values are recalled upon power up.

Table 3: CAN Object Dictionary continued

CAN Index	Sub-Index	Name	Length (Bytes)	Read/ Write	NVM[3]	Default Value
0x3002	0x06	Small_Text_Char_6	1	R/W	N	0x20 (space)
0x3003	0x00	LED command (model 3141 only)	1	R/W	N	0
0x3005	0x00	Backlight percent (0 – 100%)	1	R/W	N	0
0x3010	0x00	Hour meter value (internal)	4	R	Y	
0x3010	0x01	Hour meter enable (0 = disabled, 1 = enabled)	1	R/W	N	0 (disabled)
0x3010	0x02	Hour meter reset (non-zero value will reset)	1	R/W	N	0
0x3020	0x00	BDI_percent (0 – 100%)	1	R	Y	
0x3020	0x01	BDI_prescaler	2	R	Y	
0x3020	0x02	BDI_discharge_full (mV per cell)	2	R/W	Y	2050
0x3020	0x03	BDI_discharge_empty (mV per cell)	2	R/W	Y	1750
0x3020	0x04	BDI_CTR_full (mV per cell)	2	R/W	Y	2350
0x3020	0x05	BDI_CTR_empty (mV per cell)	2	R/W	Y	2100
0x3020	0x06	BDI_OCR (mV per cell)	2	R/W	Y	2090
0x3020	0x07	BDI_integration_time	1	R/W	Y	30 (minutes)
0x3020	0x08	B+_nominal (volts, 24, 36, 48)	1	R/W	Y	24
0x3030	0x00	Bplus_mV	2	R	N	B+ in millivolts
0x3050	0x00	firmware_part_number	4	R	Y	1769039001
0x3149	0x00	can_pdo_timeout_period	2	R/W	Y	0x07D0 = 2000 ms
0x3200	0x00	P_User_1	4	R/W	Y	
0x3201	0x00	P_User_2	4	R/W	Y	
0x3202	0x00	P_User_3	4	R/W	Y	
0x3203	0x00	P_User_4	4	R/W	Y	
0x3204	0x00	P_User_5	4	R/W	Y	
0x3205	0x00	P_User_6	4	R/W	Y	
0x3206	0x00	P_User_7	4	R/W	Y	
0x3207	0x00	P_User_8	4	R/W	Y	
0x3208	0x00	P_User_9	4	R/W	Y	
0x3209	0x00	P_User_10	4	R/W	Y	

[3] *Non-Volatile Memory: these values are recalled upon power up.*

Description of variables not defined in CiA 301

Large_Display_Length: This is the length of the large text display in characters. This should be hard-coded to a value of 3.

Large_Text_Char_1: This is the ASCII code for the first (leftmost) character to be placed on the large 3-character display, if selected in Byte 1 of the Command_Word.

Large_Text_Char_2: This is the ASCII code for the second character to be placed on the large 3-character display, if selected in Byte 1 of the Command_Word.

Large_Text_Char_3: This is the ASCII code for the third (rightmost) character to be placed on the large 3-character display, if selected in Byte 1 of the Command_Word.

Small_Display_Length: This is the length of the small text display in characters. This should be hard-coded to a value of 6.

Small__Text_Char_1: This is the ASCII code for the first (leftmost) character to be placed on the small 6-character display.

Small__Text_Char_2: This is the ASCII code for the second character to be placed on the small 6-character display.

Small__Text_Char_3: This is the ASCII code for the third character to be placed on the small 6-character display.

Small__Text_Char_4: This is the ASCII code for the fourth character to be placed on the small 6-character display.

Small__Text_Char_5: This is the ASCII code for the fifth character to be placed on the small 6-character display.

Small__Text_Char_6: This is the ASCII code for the sixth (rightmost) character to be placed on the small 6-character display.

Backlight_percent: The backlight PWM duty cycle in percent.

Hour meter value: The value of the internal hour meter in 0.1 hour increments.

Hour meter enable: The enable signal for the internal hour meter. 0 = disabled; 1 = enabled.

Hour meter reset: The reset signal for the internal hour meter. A non-zero value will reset the hour meter to zero hours.

BDI_percent: The current battery state-of-charge estimate in percent.

BDI_prescaler: The prescaler value for the state-of-charge integrator.

BDI_discharge_full: The “full” parameter for the discharge curve, in mV per cell.

BDI_discharge_empty: The “empty” parameter for the discharge curve, in mV per cell.

BDI_CTR_full: The “full” parameter for the charge-tracking-reset curve, in mV per cell.

BDI_CTR_empty: The "empty" parameter for the charge-tracking-reset curve, in mV per cell.

BDI_OCR: The open-circuit reset value, in mV per cell.

BDI_integration_time: The integration time, in minutes.

B+_nominal: The nominal B+ system voltage, in volts, e.g. 24, 36, 48.

can_baud_rate_struct_length: This parameter indicates the number of CAN ports that have baud rate definitions.

can_baud_rate: This parameter is enumerated as follows:

Value	Baud Rate
-2	20k
-1	50k
0	125k
1	250k
2	500k
3	800k
4	1M

can_node_id_struct_length: This parameter indicates the number of CAN ports that have Node ID definitions.

can_node_id: 0-127 indicating the node ID of the display.

can_pdo_timeout_period: 0-32767 indicates the time in milliseconds that the last CAN-commanded data will be displayed. If no PDO1_RX messages are received within this time, all icons and the backlight will turn off, Hour meter Enable will be set to zero (stopping the internal hour meter from counting), and the large text display will show "***" until the next PDO1_RX message receipt. If the large text source is "BSoC", then the large text display will continue to show the internal BSoC calculation.
If no PDO2_RX messages are received within this time and the small text source is set for "CAN", the small text display will change to "******" until the next PDO2_RX message receipt. Otherwise, the small text display will continue to show the internal hour meter value.
Note: If both PDOs time out, then the unit enters Pre-operational mode. When this occurs, the display will go blank and the backlight will turn off.

P_User_1 ~ P_User_10: These objects are 32-bit general purpose non-volatile objects. These objects will be stored in EEPROM if "save" is written to canopen_store_all_parameters.

Table 4 ASCII Character Table

MSB / LSB	x000	x001	x010	x011	x100	x101	x110	x111
0000								
0001								
0010								
0011								
0100								
0101								
0110								
0111								
1000								
1001								
1010								
1011								
1100								
1101								
1110								
1111								

5 — SPECIFICATIONS

The specifications for the Curtis Models 3140 / 3141 are presented in Table 5.

Table 5 Specifications

ENVIRONMENTAL

Operating Temperature:	–10°C to +85°C (with optional LCD heater: –40°C to +85°C).
Storage Temperature:	–40°C to +85°C.
Humidity:	
Soak:	Designed to meet EN 60068-2-78.
Test Cab:	Damp Heat, Steady State, 10 days at 93% RH (±3%), 30°C.
Cyclic:	Designed to meet EN 60068-2-30.
Test Db:	Damp Heat, Cyclic (12hr + 12hr cycle). Test method variant 1. 6 cycles (each cycle is 24hrs), 90% RH.
Ingress Protection:	Designed to meet EN 60529 Face: IP65; Rear surface: IP54.
Shock:	Applicable to enclosed units only: designed to meet EN 60068-2-27: 3 shocks in all 3 axes in both directions (18 shocks in total), 500 m/s², 11ms, half sine wave.
Vibration:	The following vibration specifications are applicable to enclosed units only:
General:	Designed to meet EN 60068-2-6, Swept Sine Wave method, 5g, 20 cycles in each plane, 5 to 500 Hz, 1 Octave/min. ; Amplitude = +/– 15mm; Amplitude < +/– 15mm; Acceleration = 5g.
Random:	Designed to meet EN 60068-2-64. Test Fh: vibration, broad-band random (digital control) and guidance. Method 1, random excitation, 5hrs in each axis, 10 to 350 Hz.
Resonance:	Designed to meet EN 60068-2-6. Vibration sinusoidal, 5g, 5 mins at resonant points, 1 Octave/min, Swept Sine Wave 10 to 2000 Hz.

ELECTRICAL

Signal Name	Min.	Nominal	Max.
B+	18 V	24 – 48 V	60 V
Heater B+	18 V	24 – 48 V	60 V

Signal Name	Standard Models		Backlit Models		LCD Heater (mA)
	Typical (mA)	Max. (mA)	Typical (mA)	Max. (mA)	
B+ (24V)	14	20	24	30	140
B+ (28V)	14	20	25	31	170
B+ (36V)	14	20	25	31	140
B+ (48V)	15	21	25	32	98
B+ (60V)	15	21	26	33	82

Table 5 Specifications continued

EMC SPECIFICATIONS

Emissions (Broadband & Narrowband):	Designed to meet UN ECE/324 Addendum 9 Regulation 10 Revision 4 (6 March 2012) for an Electrical/electronic sub-assembly (ESA).
Immunity:	
ESD:	Designed to meet IEC 61000-4-2: Test level IV (8 kV contact discharge or 15 kV air discharge) according to ISO 10605:2001, Table B.1.
Radiated Imunity:	Designed to meet 30 V/m (20MHz to 1 GHz) when tested per ISO 11452–2, Absorber-Lined Chamber (single sample).
Conducted Immunity:	Designed to meet IEC 61000-4-4: Test level 4 (4 kV peak, 2.5 kHz repetition rate).

REGULATORY APPROVALS

UL:	UL recognition to UL 583
CE:	The product complies with the requirements of the EMC Standards and RoHS directive 2011/65/EU (RoHS 2).
The product conforms to the following product specifications and regulations:	**EMC:** Radiated Emissions: UN ECE/324; Radiated Immunity: ISO 11451-1 and ISO 11451-2, using the RF levels defined in BS EN 13309:2010; **Electrical Transient Conduction:** IEC 61000-4-4: Test level 4 (4 kV peak, 2.5 kHz repetition rate); **ESD:** ISO 10605: 2001. **RoHS:** RoHS directive 2011/65/EU (RoHS 2).