



CURTIS INSTRUMENTS INC.
200 KISCO AVE
MOUNT KISCO, NY 10549 USA

ENGINEERING SPECIFICATION
NO. 17661041
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REVISION A

Model 3100R CANOpen Implementation

Note: The revision level of this document and any referenced documents must be verified for latest issue before use.

	APPROVALS	DATE	REVISIONS (SEE SHEET 2)
WRITER	G. Lau	11/14/05	
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	<p>CURTIS INSTRUMENTS INC. 200 KISCO AVE MOUNT KISCO, NY 10549 USA</p>	<p>ENGINEERING SPECIFICATION NO. 17661041 PAGE 3 OF 13 DATE 06/05/07 REVISION A</p>
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1.0 Introduction

Model 3100R contain the following display elements:

- 1) Ten bar display.
- 2) 6-digit 7-segment/digit numeric display.
- 3) Seven icons: battery, fuel, wrench, hourglass, colon, decimal point and percent sign.

Model 3100R also features a warning LED and two optional buttons.

Each display element can be activated independently via a CAN message.

Curtis Outline & Installation drawings 17661001-0001 and 17661001-0002 show the arrangement of the display elements.

2.0 General CAN Bus Configuration

2.1 Baud Rate

The Curtis CANopen implementation is capable of supporting baud rates of 10 kbps, 20 kbps, 50 kbps, 100 kbps, 125kbps, 250kbps, and 500 kbps. Baud rates above 500 kbps are not supported. The default baud rate per Curtis factory programming upon delivery is 125kbps.

2.3 Slave Node ID

The Slave Node ID is a 7-bit value that identifies up to 126 slave devices (the value of 0 is reserved for broadcast messages). Model 3100R can only be configured as a Slave device. The default Slave Node ID per Curtis factory programming is 0x7b (decimal 123).

3.0 Device Power Up.

Upon power-up, Model 3100R initializes the CAN interface, announces the Initialization/BOOTUP state by issuing a single heartbeat with the Device State set to a value of zero, and then proceeds to enter the Pre-Operational State.

While in the Pre-Operational State, the device will accept NMT and SDO CAN messages. At this point, the CAN Master issues an NMT (global or local) with the Command Specifier set to 1 (Start Remote Node Command) to force the Model 3100R to enter the Operational State. Once in the Operational State, normal CAN communication can begin.

4.0 Heartbeat.

Model 3100R issues a Heartbeat every 100 msec.

Heartbeats have Device Length Code (DLC) of one. The single byte transmitted holds the NMT Device State, which on Model 3100R can be one of following:

<u>Byte Value</u>	<u>NMT Device State</u>
0	Initialization/Bootup

4 Stopped
5 Operational State
127 Pre-Operational State

Before issuing a CAN message, it is recommended that the CAN Master first wait for a heartbeat, to ensure that the device is in the Operational State. Model 3100R will not accept PDO CAN messages, outside of the Operational State.

4.1 Heartbeat Format:

CAN Identifier

11	10	9	8	7	6	5	4	3	2	1
1	1	1	0	id7	id6	id5	id4	id3	id2	id1

Id7..id1 = Factory pre-configured id for this device. Factory default is 0x7b.

Byte 1 = Device State.

5.0 Updating the Display Elements.

The CAN master updates the display by sending it a PDO1-MOSI. The 11-bit CAN Identifier for PDO1-MOSI is 0100sssssss, where sssssss is the factory programmed Model 3100R id. The PDO's contents are statically assigned at power up and cannot be re-mapped via SDO commands.

Data sent via PDO1_MOSI can be divided into two categories: data that pertains to the 6-digit portion of the display and data used to update the 10-bar and icons. A given message either contains data for the 6-digits portion or data for the 10-bar/icons, but not both. Data from each category can in turn be specified in several formats as detailed below.

The general procedure for updating the display via PDO1_MOSI is as follows:

- 1) Specify to which portion of the display (6-digit or the 10-bar/icons) you are writing to by clearing or setting the MC bit of the Control Byte (byte 1 of PDO1_MOSI).
- 2) Specify which of the available formats you are using for your data. For the 6-digit portion, data can be sent as either an ascii string of six characters, a 32-bit number or a 4-character string followed by a 16-bit number. For the 10-bar portion, data can be sent as either a 10-bit bitmap or a 0 to 100 percent value.
- 3) Determine whether or not a response to the PDO is required by setting or clearing the RE bit.
- 4) Specify whether you want the data placed in a buffer or transferred to display memory by setting/clearing the DR bit.
- 5) Fill bytes 2 through 8 with display information.

5.1 PDO1_MOSI Data Format:

Section 9 provides a summary of PDO1_MOSI in tabular format. You might want to refer to that section first before reading this one.

5.2 PDO1, Byte 1 (Control Byte)

Byte 1 is the control byte and is used to specify the contents of the rest of the message.

7	6	5	4	3	2	1	0
DR	RE	0	0	MC	Format		

Display Refresh Bit (DR) – When this bit is 0, data is placed in a buffer and the display is not updated. Set this bit to 1 to force a display refresh. This bit can be used to synchronize the contents of the display, given that data pertaining to the 6-digit display and that pertaining to the 10-bar are sent in separate PDO's. In a typical application, one PDO would be sent first with the DR bit cleared to 0 and the other PDO would be sent at a later time with its DR bit set to 1. The contents of the first PDO would be placed in a buffer and the entire display would be updated when the second PDO is received. Note that the display will not be refreshed unless the device receives, at some point, a PDO with the DR bit set to one.

Response Enable Bit (RE) – The CAN master can specify whether or not a response to the incoming PDO is to be issued.

0 = Do not reply to this PDO message.

1 = Reply to this PDO message.

Reserved Bits (bits 5 and 4) – These bits are not used and should be cleared to 0.

Message Category Bit (MC) –

0 = Data is destined for 6-digit portion of the display.

1 = Data is destined for 10-bar and icons.

Data Format (bits 2..0) --

When the MC bit is cleared (6-digit data):

000: Data is being sent as a string of 6 ascii characters.

001: Data is being sent as a 32-bit binary value.

002: Mixed mode format. The first half of the message consists of four ascii character. The second half is specified by a 16-bit binary value.

Values 010b to 111b are not currently used.

When the MC bit is set (10-bar/icons data):

000: 10-Bar data is being sent as a 10-bit bitmap (see section for bit assignment).

001: 10-Bar data is being sent as a percent (0..100%), to be displayed in Curtis BDI Format.

010: 10-Bar data is being sent as a percent (0..100%), to be displayed in generic bar format.

011: Special mode, used to send flashing information for time interval t2.

Values 100b to 111b are not currently used.

5.3 Byte 2 through Byte 7 contents for 6-digit portion of display:

When the data format is specified as 000b, bytes 2 through byte 7 hold a string of 6 ascii characters. Byte 2 is the left most character. The table in section 16 shows the ascii character mapping.

When the data format is specified as 001b, byte 2 .. byte 5 hold a 32-bit binary value. Byte 2 is the least significant byte. Byte 5 is the most significant byte. Byte 6 specifies the zero-blanking and byte 7 holds a left-shift count. The zero-blanking field holds a value between 0 and 6 and represents the number of digits to be shown when the 32-bit binary value is zero. The numeric value is right justified by default. The left-shift count specifies the number of blank spaces to be inserted to the right of the least significant digit.

When the data format is specified as 002b, bytes 2, 3, 4, and 5 hold a four character ascii string. Bytes 6 and 7 hold a 16-bit binary value, with byte 6 the LSB. In this display mode, the four character ascii string is left justified, while the 16-bit binary value is right justified. The zero blanking is set to 1. The ascii characters are written first. If the 16-bit binary value and ascii string overlap, the corresponding character from the ascii string are overwritten.

5.4 Byte 8 contents for 6-digit portion of display:

Byte 8 controls flashing of each digit. A '1' causes the corresponding character to flash.

7	6	5	4	3	2	1	0
0	0	Flash Digit1	Flash Digit2	Flash Digit3	Flash Digit4	Flash Digit5	Flash Digit6

PDO1, Byte 8 bit assignment.

The flashing period is 1 second. The flashing duty cycle is 0.5 seconds on / 0.5 seconds off. When flashing is enabled, characters are blanked during the first 0.5 second time interval.

5.5 Byte 2 through Byte 4 contents for 10-bar and icons portion of display.

Bytes 2, 3 and 4 carry bar and icon information. Bar information can be sent in one of two data formats: as a 10-bit bitmap, in which 1 bit is assigned to each bar, or as a 0 to 100 numeric value. The 0 to 100 numeric value itself can be further displayed in one of two different formats: a generic format in which each bar represents a 10% increment or the custom Curtis BDI format, where the leftmost bar represents 0% and bars 2 through 10 each represents 11% increments. Bits 2..0 of Byte 1 are used to specified the 10-bar display format.

5.6 Bytes 5 through 7 contents for 10-bar and icons portion of the display.

Bytes 5 through 7 carry flashing information. One bit is assigned to each bar and icon. A '1' causes the corresponding display element to flash.

The flashing period is 1 second. The flashing duty cycle is 0.5 seconds on / 0.5 seconds off. When flashing is enabled, the corresponding display element is normally blanked during the first 0.5 second time interval. A special format (Format = 011b) allows for flashing during the second 0.5 second time interval. Using both time intervals allows for bars and icons to alternate in a fashion similar to the way Curtis BDI traditionally indicate battery empty.

6.0 Model 3100R Reply to PDO1_MOSI

When a reply to PDO1_MOSI is requested by setting the Control Byte RE bit (see section 5.2), Model 3100R responds with a PDO1_MISO. The CAN identifier for the reply is 0011mmsssss, where mm is the master id and sssss is the factory programmed Model 3100R id.

The contents of the reply vary depending on whether or not the unit has been fitted with buttons.

6.1 PDO1_MISO Reply for Model 3100R Devices Without Buttons

For devices without buttons, the reply consists of a single byte (DLC = 1). In this case, Model 3100R sends back the Control Byte (Byte 1) of the PDO1_MOSI it is replying to.

6.2 PDO1_MISO Reply for Model 3100R Devices Fitted with Buttons

For devices fitted with buttons, the reply consists of 6 bytes of information. Byte 1 is the Control Byte of the PDO1_MOSI. Bytes 2 through 6 contain information about the state of the buttons.

6.2.1 PDO1_MISO Byte 2, Button Status

Byte 1 is used to report the status of each button. Bit 0 is set if the right button is being pressed and cleared if the button is not pressed. Bit 1 serves the same function for the left button. Bits 2 through 7 are not used and are always cleared.

7	6	5	4	3	2	1	0
0	0	0	0	0	0	LB	RB

6.2.2 PDO1_MISO Byte 3 through Byte 6, Button Counters

Bytes 3 through 6 make up four 8-bit counters which are used to indicate how long a button has been pressed or released. The counter resolution is 100msec. A count of 10, for instance, indicates 1 second.

PDO1_MISO, Byte 2	Left button pressed count
PDO1_MISO, Byte 3	Left button released count
PDO1_MISO, Byte 4	Right button pressed count
PDO1_MISO, Byte 5	Right button released count

Byte 2 indicates the length of time the left button has been pressed, while byte 3 indicates the length of time the left button has been left idle. While the left button is active (pressed), byte 2 reports how long the operator has been pressing it and byte 3 is set to a count of 0. When the left button is inactive (not pressed), byte 2 is set to a count of 0 and byte 3 reports the time of inactivity.

Bytes 4 and 5 serve the same function as bytes 2 and 3 but for the right button.

The counters saturate when they reach a count of 250 (25 seconds).

7.0 Changing the Device Node ID and Baud Rate

Units are shipped from the factory set to a default node id of 0x7b and a default baud rate of 125 kbps. These settings can be changed via expedited SDO transfers. Following the SDO request, the new settings will not take effect and will not be stored in non-volatile memory, until an NMT with the Command Specifier set to 129 (Reset Node) or 130 (Reset Communication) is issued.

Note: Cycling power will not cause the new settings to be stored in non-volatile memory. Only a Reset Node or Reset Communication NMT will accomplish that.

Follow these steps to change the node id and/or baud rate:

- 1) Send an expedited SDO Write transfer to change the node id, if required. Wait for a write response.
- 2) Send an expedited SDO Write transfer to change the baud rate, if required. Wait for a write response.
- 3) Send an NMT with Command Specifier set to 129 or to 130.
- 4) At this point, the CAN master should update its baud rate and slave node id parameters to match the new settings.
- 5) Wait for a heartbeat from the 3100R issued at the proper baud rate and node id.

8.0 CAN Watchdog

	<p>CURTIS INSTRUMENTS INC. 200 KISCO AVE MOUNT KISCO, NY 10549 USA</p>	<p>ENGINEERING SPECIFICATION NO. 17661041 PAGE 9 OF 13 DATE 06/05/07 REVISION A</p>
-----------------------------------------------------------------------------------	-------------------------------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------------------------------------

A watchdog timer for the CAN system is implemented to ensure proper operation. If 3 seconds elapse without an NMT, SDO or PDO message received, the watchdog is failed and the 3100R transitions to the Stopped state. All CAN-controlled elements are then put into a known state. CAN-controlled Instruments are forced to their minimum value, CAN-controlled Icons are turned off and the message '-----' is displayed. Once in the error state, an NMT is required to transition the unit to the operational state, followed by a valid PDO message to refresh the display.

The CAN watchdog timer is disabled immediately following an initial power-up. This is done to allow enough time for the CAN Master to initialize all devices on the bus. The CAN watchdog will remain disabled until 25 seconds elapse or an NMT message is received. Once enabled, the CAN watchdog timer will resume normal operation and will timeout if 3 seconds elapse without an NMT, SDO or PDO message received.

8.0 System Configuration Objects

Index (hex)	Sub-Index (hex)	Description	Type	Acc.	Default Value	PDO Mapping?
1000h	00h	Device Type Additional Information (2 bytes) Device Profile Number (2 bytes) Bits 15..0 = Non-standard profile	unsigned32	ro	0000h 0000h	No
1001h	00h	Error Register Bit 7..1 = 0 (reserved) Bit 0 = Generic error	unsigned8	ro	0	No
1008h	00h	Manufacturer Device Name Four visible ASCII characters	vis-string	const	'3100 '	No
1009h	00h	Manufacturer HW Version Four visible ASCII characters	vis-string	const	'Rxxx' (note 8.1)	No
100Ah	00h	Manufacturer SW Version Four visible ASCII characters	vis-string	const	4 char string (note 8.2)	No
1018h	00h	Identity Object No. of entries	unsigned8	ro	05h	No
	01h	Vendor ID	unsigned32	ro	00004349h	No
	02h	Optional Product Code	unsigned32	ro	00000000h	No
	03h	Optional Revision Number Byte 0,1 (MSBs): Major revision Byte 2,3 (LSBs): Minor revision	unsigned32	ro	00000000h	No
	04h	Optional Serial Number	unsigned32	ro	00000000h	No
2000h	00h	CAN Node ID	Unsigned8	rw	111 1011b	No
2001h	00h	CAN Baud Rate	Unsigned8	rw	4 (note 8.3)	No

Note 8.1: HW version starts with the letter 'R' (for round 52mm pkg) followed by a 3-digit sequential number.

R001 = Beta Hardware version 1.

Note 8.2: Software version returns a four char string.

0001 = Beta Software version 1.

Note 8.3: Baud Rate Settings:

0 = 10 kbits/sec	4 = 125 kbits/sec
1 = 20 kbits/sec	5 = 250 kbits/sec
2 = 50 kbits/sec	6 = 500 kbits/sec
3 = 100 kbits/sec	

	CURTIS INSTRUMENTS INC. 200 KISCO AVE MOUNT KISCO, NY 10549 USA	ENGINEERING SPECIFICATION NO. 17661041 PAGE 11 OF 13 DATE 06/05/07 REVISION A
-----------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------	------------------------------------------------------------------------------------------------------------------------------

9.0 Static mapping for PDO1_MOSI

CAN Identifier = 0100ssssss
 ssss = Model 3100R ID

9.1 Data for 6-digit portion of display (Control Byte, bit 3 = 0).

Byte 1 (Control Byte)	xx00 0000 (Format = 000)	xx00 0001 (Format = 001)	xx00 0010 (Format = 010)
Byte 2	Ascii Char1 (Leftmost Char)	32-bit number (Byte 4, LSB)	Ascii Char1 (Leftmost Char)
Byte 3	Ascii Char2	32-bit number (Byte 3)	Ascii Char2
Byte 4	Ascii Char3	32-bit number (Byte 2)	Ascii Char3
Byte 5	Ascii Char4	32-bit number (Byte 1, MSB)	Ascii Char4
Byte 6	Ascii Char5	Zero blanking	16-bit number (LSB)
Byte 7	Ascii Char6 (Rightmost Char)	Shift Count	16-bit number (MSB)
Byte 8	Flash Register Mask	Flash Register Mask	Flash Register Mask

9.2 Data for 10-bar and icons portion of display (Control Byte, bit 3 = 1).

Byte 1 (Control Byte)	xx00 1000 (Format = 000)	xx00 1001 (Format = 001)	xx00 1010 (Format = 010)	xx00 1011 (Format = 011)
Byte 2	Bitmap_1	Bars as percent, 0 .. 100 (Curtis BDI format)	Bars as percent, 0 .. 100 (Generic Format)	0x00
Byte 3	Bitmap_2	Bitmap_2	Bitmap_2	0x00
Byte 4	Bitmap_3	Bitmap_3	Bitmap_3	0x00
Byte 5	Flash_Reg_1	Flash_Reg_1	Flash_Reg_1	Flash_Reg_1
Byte 6	Flash_Reg_2	Flash_Reg_2	Flash_Reg_2	Flash_Reg_2
Byte 7	Flash_Reg_3	Flash_Reg_3	Flash_Reg_3	Flash_Reg_3
Byte 8	0x00	0x00	0x00	0x00

Symbol Mapping	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
PDO1:Bitmap_1	Bar 1	Bar 2	Bar 3	Bar 4	Bar 5	Bar 6	Bar 7	Bar 8
PDO1:Bitmap_2	Bar 9	Bar 10					Bcklt	LED
PDO1:Bitmap_3	Batt	Wrench	Hour	:	.	%	Fuel	0/1

Note: bits 7 and 6 for Bitmap_2 are only used when FORMAT = 000.

Flash Reg Mapping	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Flash_Reg_1	Bar 1	Bar 2	Bar 3	Bar 4	Bar 5	Bar 6	Bar 7	Bar 8
Flash_Reg_2	Bar 9	Bar 10					Bcklt	LED
Flash_Reg_3	Batt	Wrench	Hour	:	.	%	Fuel	0/1



CURTIS INSTRUMENTS INC.
200 KISCO AVE
MOUNT KISCO, NY 10549 USA

ENGINEERING SPECIFICATION
NO. 17661041
PAGE 13 OF 13
DATE 06/05/07
REVISION A

10.0 ASCII Table Mapping.

Dec	Hex	Symbol	Dec	Hex	Symbol	Dec	Hex	Symbol
32	20	SP	64	40	SP	96	60	,
33	21	SP	65	41	8	97	61	8
34	22	..	66	42	9	98	62	9
35	23	SP	67	43	0	99	63	0
36	24	SP	68	44	1	100	64	1
37	25	0	69	45	2	101	65	2
38	26	SP	70	46	3	102	66	3
39	27	,	71	47	4	103	67	4
40	28	SP	72	48	5	104	68	5
41	29	SP	73	49	:	105	69	:
42	2A	SP	74	4A	;	106	6A	;
43	2B	SP	75	4B	'	107	6B	'
44	2C	SP	76	4C	!	108	6C	!
45	2D	-	77	4D	SP	109	6D	SP
46	2E	SP	78	4E	@	110	6E	@
47	2F	SP	79	4F	1	111	6F	1
48	30	0	80	50	2	112	70	2
49	31	:	81	51	3	113	71	3
50	32	;	82	52	'	114	72	'
51	33	;	83	53	5	115	73	5
52	34	;	84	54	6	116	74	6
53	35	;	85	55	7	117	75	7
54	36	;	86	56	8	118	76	8
55	37	;	87	57	SP	119	77	SP
56	38	;	88	58	SP	120	78	SP
57	39	;	89	59	;	121	79	;
58	3A	SP	90	5A	;	122	7A	;
59	3B	SP	91	5B	;	123	7B	SP
60	3C	;	92	5C	SP	124	7C	:
61	3D	:	93	5D	;	125	7D	SP
62	3E	;	94	5E	8	126	7E	-
63	3F	;	95	5F	-	127	7F	SP