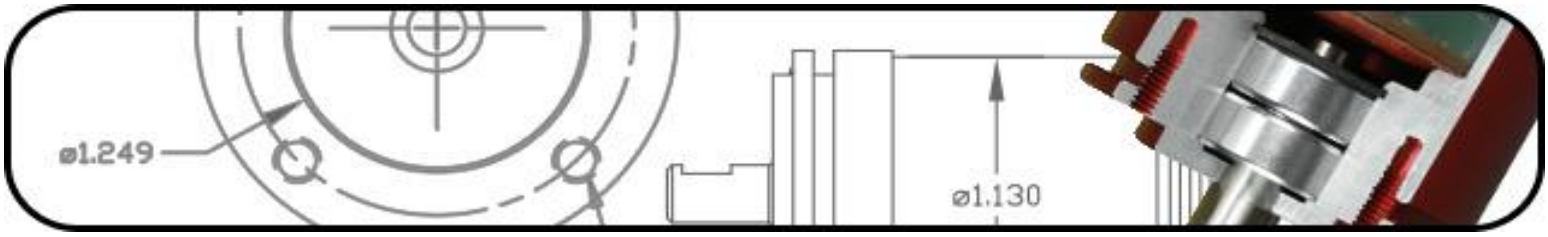


Joral J1939 Encoder Manual

JORAL
Capture CREATIVITY

V 1.2

Table of Contents

JORAL

General Information

The Joral J1939 Encoder is a rotary encoder designed for efficient CAN communication.

Each encoder has a source address, which is used by the computer/controller to identify each encoder or device on a CAN bus line. A resistor tag may be attached to an encoder to change the source address, allowing for multiple encoders to share the same bus line.

The Joral encoder uses two different types of messages to communicate with the controller. The first type of message is the status message, which is transmitted from the encoder to the controller every 50 milliseconds. This message contains information about the current state of the encoder (RPM, position, turning direction, count).

The second type of message is the settings message, which is made by the user and transmitted to the encoder. This message is used to modify certain settings on the encoder that affect how it behaves (RPM resolution, which direction causes the encoder to count up, whether to save the count to memory, etc.).

By setting a specific bit in this message, an additional settings status message will be periodically sent from the encoder to the controller containing information on the current settings on the encoder. This message is also sent out automatically on startup as well as any time a change is made to the values in memory.

Encoder Initialization

Upon powering up the encoder, it is important to wait 500 milliseconds before starting communications. Additionally, it is recommended to send the appropriate initialization message each time the encoder is power cycled to ensure the encoder has the preferred settings before using it (see page 7).

Resistor Addressing

A “1-7 tag” wired resistor can be applied to change the source address from the default value. One wire of the resistor tag must be connected to the Common Ground pin and the other must be connected to the SA (source address) Select pin.

The encoder only reads the address tag once on power up, and it does not save the address value to memory. As such, the address tag must be connected to the encoder at the beginning of each power cycle in order to go into effect.

It is recommended that either 1% tolerance resistors or Joral tags are used.

Below shows what tag resistor (1-7) corresponds to what address for outgoing status messages as well as what PGN for incoming settings messages*. Contact the factory if more addresses are required.

TAG #	Ohms	Address (outgoing status message)	PGN (incoming settings message)
none	No Resistor	210	65451 = FFAB hex
1	590	211	65452 = FFAC hex
2	976	212	65453 = FFAD hex
3	1500	213	65454 = FFAE hex
4	2260	214	65455 = FFAF hex
5	3400	215	65456 = FFB0 hex
6	5360	216	65457 = FFB1 hex
7	9530	217	65458 = FFB2 hex

* Outgoing status messages have a PGN of 65450 (hex FFAA), and incoming settings messages must have a source address of 39 (hex 27). Both of these values are constant unless different values are request by the customer on order.

Encoder J1939 Messages

J1939 uses a 29 bit header called a CAN ID. The CAN ID consists of the message priority, Parameter Group Number (PGN), and Source Address (SA).

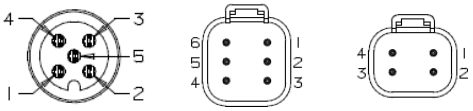
The Priority field indicates the priority of the message. The priority is between 0 and 7, 0 being the highest priority and 7 being the lowest priority.

The PGN consists of multiple parameters about the data field. Therefore the content of the data field is identified by the PGN.

The SA represents the source address of the controller application.

29 bit CAN ID Structure		
28 – 26	25 – 8	7 – 0
Priority	PGN	SA

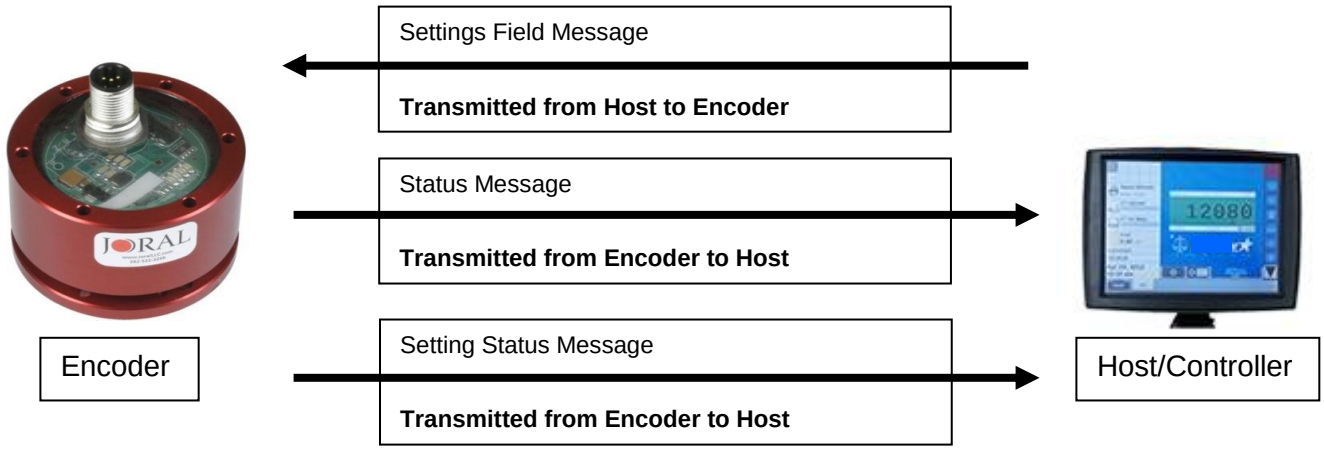
Connections/Wiring



M12 DE6 DE4

Signal	M12	DE6	DE4	Cable
V+	1	3	3	BRN
Common	3	4, 6	4	BLU
CAN H	2	1	1	WHT
CAN L	4	2	2	BLK
SA Select	5	5		PNK

Message Types and Transmission



Non-Zero Power Encoder Settings Message Data Field Structure

The encoder has 12 different setting fields (shown below) that can be altered to suit various applications. A setup message consists of a CAN ID and the 8 byte data field.
If a given field is bit filled – set to all 1's – in a message, the encoder will ignore that field and make no changes to it. This is useful if you only want to make changes to a few specific fields without having to change all of them.
Below are the 12 setup fields and how to alter to manipulate them.

Byte	Field	Bit	MSB/LSB* Description
0	ZERO COUNT	0 1	00 = no action 01 = reset the 32 bit COUNT to zero
	ZERO POSITION	2 3	00 = no action 01 = sets the current position as the zero absolute position
	RPM RATE	4 5	RPM is calculated by running average on specified intervals 00 = Slow RPM Calculation (3 seconds) 01 = Medium RPM Calculation (1 second) 10 = Fast RPM Calculation (0.1 seconds)
	DIRECTION	6 7	00 = CW Direction Counts Up 01 = CCW Direction Counts Up
1	SAVE COUNT	8 9	00 = no action 01 = Save the current COUNT to memory. On power up the COUNT will start at the last saved COUNT value.
	POWER-UP CLEAR COUNT	10 11	00 = no action 01 = At power up the COUNT will reset to 0
	SAVE ON POSITION CHANGE	12 13	00 = Disable automatic save when the position changes 01 = Enable automatic save COUNT value when the position changes NOTE: This is only active when SAVE COUNT = 01
	ENABLE SETTINGS STATUS MESSAGE	14 15	00 = Disable Periodic Setting Status Message PGN 65449 01 = Enable Periodic Setting Status Message PGN 65449
2	RPM RESOLUTION	16 17 18 19	Sets the resolution of the RPM value in the Status message PGN 65450 0000 = 0.125 rpm per bit 0001 = 1 rpm per bit 0010 = 2 rpm per bit 0011 = 3 rpm per bit
	Unused	20-21	**
	CHANGE ADDRESS***	22-23	01 = Modifies the source address offset to the value specified in Byte 3
3	NEW ADDRESS OFFSET***	24-28	-This field is the new source address offset. The offset may be any value between 0 and 30, allowing for source addresses from 210 to 240.
	LOAD COUNT TRIGGER***	29 30	10 = Triggers the LOAD COUNT VALUE to be set as the new COUNT VALUE
	LOAD COUNT SIGN***	31	0 = Sets LOAD COUNT to a positive value, 1 = Sets LOAD COUNT to a negative value
4-7	LOAD COUNT VALUE***	32-63	- This field is filled with the desired COUNT value you wish to set the encoder at - For the encoder to have the value you wish set, the LOAD COUNT TRIGGER field **has to be set to 01.**

* Throughout the Description column the Most Significant Bit (MSB) is on the left and the Least Significant Bit (LSB) is on the right.

** All unused bits have no action on the encoder and should all be set to 0.

*** LOAD COUNT and CHANGE ADDRESS features are optional.

JORAL

It is important to have a clear understanding of the terms and fields POSITION and COUNT when using the Joral J1939 encoder. POSITION refers to the absolute position of the encoder shaft based on the 0 to 360 degree rotation of the shaft and the counts per revolution (CPR) the encoder is programmed to (i.e. if the CPR is set to 1024, at the angle 0 degrees the POSITION is 0 and at the angle 360 degrees the POSITION is 1024). The COUNT refers to the number of rotations multiplied by the CPR (i.e. if the CPR is set to 1000, and two and a half rotations are made, the COUNT will be 2500).

Non-Zero Power Encoder Sample Settings Message

Sample Message

The following is a screen shot from a CAN DataLogger showing message 65451 **to the encoder from the controller.**

Message	Length	Data
18FFAB27h	8	44 04 01 00 00 00 00 00

This sample message does not use the Memory Save Feature. It is a single turn application where the primary interest is in reading the position of the sensor.

This message:
- Does not use the Memory Save Feature
- Sets the RPM RATE to slow and the DIRECTION to CCW
- Sets the current POSITION of the encoder to zero with the ZERO POSITION field

- The **Message** portion of the screen shot shows the CAN ID
- The **18** shows the priority of the message (priority is 6)
- The **FFAB** shows the PGN of the message (FFAB in hex equals 65451)
- The **27** shows the source address of the message (27 in hex equals 39 in decimal)
- The Data portion of the screen shot is broken down in the following table.
  Only bytes 0-2 are broken down because all of the others are not used.
  Note that byte 0 is on the right and byte 2 is on the left.

Byte	(bit7) Byte 2 (bit0)				(bit7) Byte 1 (bit0)				(bit7) Byte 0 (bit0)			
Byte Value	01 hex				04 hex				44 hex			
Field	-		RPM RESOLUTION		ENABLE SETTING STATUS	SAVE ON POSITION CHANGE	POWER-UP CLEAR COUNT	SAVE COUNT	DIRECTION	RPM RATE	ZERO POSITION	ZERO COUNT
Bits	00	00	00	01	00	00	01	00	01	00	01	00
Action because of given bits	-		Resolution is 1 RPM per bit		Periodic Settings status message is disabled	Does NOT save position when position changes	At power-up COUNT resets to 0	No action	CCW direction counts up	Set to slow RPM calc-ulation	Sets current position as zero absolute position	No action

1000100 = 44 hex

Encoder Memory Save Feature

ONLY FOR NON-ZERO POWER ENCODERS

The Joral J1939 Encoder has two different memory save features. The activation of these memory save features relies on the settings message. These two features each have their own field in the data section of the settings message. The two features and the names of their fields are SAVE COUNT and SAVE ON POSITION CHANGE.

To activate the SAVE COUNT feature the least significant bit (LSB) for the SAVE COUNT field must be set to 1 and the most significant bit (MSB) must be set to 0. When the SAVE COUNT field setting message is sent the current POSITION and COUNT at that moment are saved to memory. When power is lost and then restored the encoder reads the internal memory and restores the COUNT and POSITION that were saved the moment the settings message was sent. To disable this feature, a message should be sent with the LSB of the POWER-UP CLEAR COUNT field set to 1 and the MSB of that field set to 0.

To activate the SAVE ON POSITION CHANGE feature the LSB for the SAVE ON POSITION CHANGE field must be set to 1 and the MSB must be set to 0. It is important to note that for the SAVE ON POSITION CHANGE field to be activated the SAVE COUNT field **must be activated as well**. When the SAVE ON POSITION CHANGE field is activated the encoder will save the current POSITION and COUNT to memory whenever the POSITION changes. When power is lost and then restored the encoder reads the internal memory and restores the POSITION and COUNT. In addition, the counter will be adjusted based on any movement made while power was off, up to 180 degrees of rotation.

NOTE: It is crucial that you do not constantly send these settings messages every [X] milliseconds or seconds as the encoder memory can only be set a limited number of times.

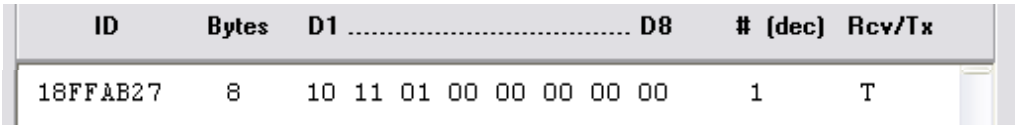
The Joral J1939 Encoder is available with FRAM and EEPROM memory.

Sample SAVE ON POSITION CHANGE Message

ONLY FOR NON ZERO POWER ENCODERS

Sample Message

Below is a screen shot from a CAN Data Logger showing a settings message sent **from a controller to the encoder.**



ID	Bytes	D1 ..... D8	# (dec)	Rcv/Tx
18FFAB27	8	10 11 01 00 00 00 00 00	1	T

This Message:

- Sets the RPM RATE to medium

- Activates the SAVE ON POSITION CHANGE field

- Sets the RPM RESOLUTION field to 1

- Sets clockwise (CW) to count up

Below is the data section of the message broken down. Only bytes 0-2 are broken down because the LOAD COUNT feature is not being used and thus bytes 3-7 are unused. Note that byte 0 is on the right and byte 2 is on the left.

Byte	2								1								0							
Byte Value	01								11								10							
Field	-				RPM RESOLUTION				ENABLE SETTING STATUS		SAVE ON POSTION CHANGE		POWER UP CLEAR COUNT		SAVE COUNT		DIR.		RPM RATE		ZERO POS.		ZERO COUNT	
Bit Value	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0

Description	-	Sets RPM resolution to 1	Disables status msg. / no action	Activates save on position change	Disables power up clear count / no action	Activates save count	Sets CW to count up	Sets RPM rate to medium	No action	No action

JORAL

Status Message Data Field Structure

Byte	Bit	Function for each CPR: 8192	4096	2048	1024/1000	512	Description	
0	0	POSITION bit0 LSB	POS. 0 LSB	POS. 0 LSB	POS. 0 LSB	POS. 0 LSB	ABSOLUTE POSITION of the encoder 0 to PPR at: .70 degrees per count (512) .36 degrees per count (1000) .35 degrees per count (1024) .17 degrees per count (2048) .08 degrees per count (4096) .04 degrees per count (8192)	
	1	POSITION bit1	POS. 1	POS. 1	POS. 1	POS. 1		
	2	POSITION bit2	POS. 2	POS. 2	POS. 2	POS. 2		
	3	POSITION bit3	POS. 3	POS. 3	POS. 3	POS. 3		
	4	POSITION bit4	POS. 4	POS. 4	POS. 4	POS. 4		
	5	POSITION bit5	POS. 5	POS. 5	POS. 5	POS. 5		
	6	POSITION bit6	POS. 6	POS. 6	POS. 6	POS. 6		
	7	POSITION bit7	POS. 7	POS. 7	POS. 7	POS. 7		
1	8	POSITION bit8	POS. 8	POS. 8	POS. 8	POS. 8		
	9	POSITION bit9	POS. 9	POS. 9	POS. 9	unused		
	10	POSITION bit10	POS 10	POS 10	unused	unused		
	11	POSITION bit11	POS 11	unused	unused	unused	For 512-4096	For 8192
	12	POSITION bit12	CCW LSB	CCW LSB	CCW LSB	CCW LSB	00 = current direction is CW 01 = current direction is CCW	n/a
	13	unused	CCW MSB	CCW MSB	CCW MSB	CCW MSB		
	14	CW Rotation Flag LSB	CW LSB	CW LSB	CW LSB	CW LSB	00 = current direction is CCW 01 = current direction is CW	
	15	CW Rotation FLAG MSB	CW MSB	CW MSB	CW MSB	CW MSB		
2	16	RPM bit0 LSB	RPM – 10 bits RPM, 10 bits, 0 to 4096, default resolution is 3 rpm per bit (0 to 3000rpm) Resolution of the rpm value can be adjusted by setting the RPM RESOLUTION value. RPM is calculated by running average on specified intervals 00 (slow) averages 3 sec of counts per rpm calc 01 (medium) averages 1 sec of counts per rpm calc 02 (fast) averages 100 msecs of counts per rpm calc					
	17	RPM bit1						
	18	RPM bit2						
	19	RPM bit3						
	20	RPM bit4						
	21	RPM bit5						
	22	RPM bit6						
	23	RPM bit7						
3	24	RPM bit8						
	25	RPM bit9 MSB						
	26	Reserved						
	27	Reserved						
	28	POS Count Flag LSB	Positive Count Flag - 2 bits 01 means count is positive					
	29	POS Count Flag MSB						
	30	NEG Count LSB	Negative Count Flag - 2 bits 01 means count is negative					
	31	NEG Count MSB						

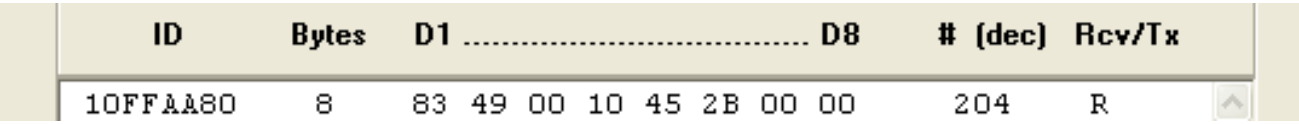
Byte	Bit	Function for each CPR: 8192	4096	2048	1024/1000	512	Description
4	32	COUNT bit0					Bytes 4-7 consist of the COUNT value. COUNT counts up and down over multiple turns as the direction is sensed and according to the DIRECTION field setting. COUNT is equal to the <u>number of rotations multiplied by the CPR.</u> For example, if a 1000 CPR encoder makes 1.5 rotations, the COUNT will be 1500.
	33	COUNT bit1					
	34	COUNT bit2					
	35	COUNT bit3					
	36	COUNT bit4					
	37	COUNT bit5					
	38	COUNT bit6					
	39	COUNT bit7					
5	40	COUNT bit8					
	41	COUNT bit9					
	42	COUNT bit10					
	43	COUNT bit11					
	44	COUNT bit12					
	45	COUNT bit13					
	46	COUNT bit14					
	47	COUNT bit15					
6	48	COUNT bit16					
	49	COUNT bit17					
	50	COUNT bit18					
	51	COUNT bit19					
	52	COUNT bit20					
	53	COUNT bit21					
	54	COUNT bit22					
	55	COUNT bit23					
7	56	COUNT bit24					
	57	COUNT bit25					
	58	COUNT bit26					
	59	COUNT bit27					
	60	COUNT bit28					
	61	COUNT bit29					
	62	COUNT bit30					
	63	COUNT bit31					

JORAL

Sample Status Message

Sample Message from a 4096 PPR Encoder

The following screen shot is from a CAN Data Logger showing an encoder status message. Message and Data values are shown as hex values, not decimal.



ID	Bytes	D1 ..... D8	# (dec)	Rcv/Tx
10FFAA80	8	83 49 00 10 45 2B 00 00	204	R

- The **ID** portion of the screen shot shows the CAN ID
- The **10** shows the priority of the message (priority is 4).
- The **FFAA** shows the PGN of the message (FFAA in hex equals 65450 in decimal)
- The **80** shows the source address of the message (80 in hex equals 128 in decimal)

Byte	Byte 7				Byte 6				Byte 5				Byte 4				Byte 3				Byte 2				Byte 1				Byte 0			
Byte Value	**00**				**00**				**2B**				**45**				**10**				**00**				**49**				**83**			
Bit Value	00	00	00	00	00	00	00	00	00	10	10	11	01	00	01	01	00	01	00	00	00	00	00	00	01	00	10	01	10	00	00	11
Field	COUNT																N	P	-	RPM					CW	CCW	POSITION					
Description	2B45 hex = 11077 decimal																-	P	-	RPM = 0					CW	-	100110000011 = 983 hex = 2435 decimal					

JORAL

Setting Status Message from Encoder PGN 65449

ONLY FOR NON-ZERO POWER ENCODERS

When the setting status message is enabled in the settings data field, the encoder will transmit a message with the current values of the encoder settings in addition to the regular status message. Bits 14-15 in the settings message field enable the transmission of this message. The default state is to not send this message except on changes to memory.

Transmission Repetition Rate = 100 milliseconds

Byte	Bits	Description
0	0-7	SAVE ON POSITION CHANGE, SAVE COUNT, DIRECTION, RPM RATE (see figure below)
1	8-15	RPM Resolution (RPM per bit)
2	16-23	EE Read Status
3	24-31	EE Bank
4	32-39	Error Codes
5-7	40-63	EE Write Count

Priority = 4

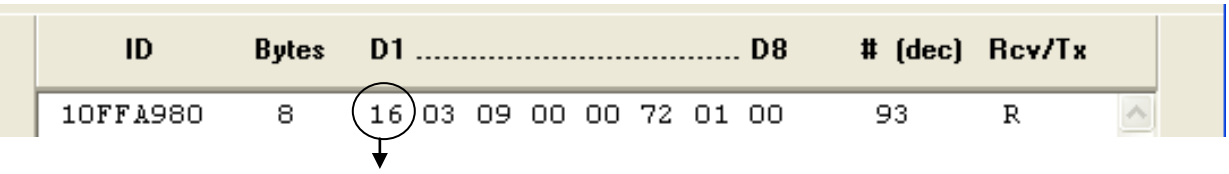
Data Length = 8 bytes

Byte 0							
7	6	5	4	3	2	1	0
Status of SAVE ON POSITION CHANGE setting		Status SAVE COUNT setting		Status of DIRECTION setting		Status of RPM RATE setting	

If the EE Bank value is 54 (36 in hexadecimal), the encoder is using FRAM memory. Otherwise, the encoder is using EEPROM memory.

Sample Setting Status Message

The following is a screen shot from a CAN Analyzer that shows a message **from the encoder to the controller** that displays the current values of the encoder settings.



ID	Bytes	D1 ..... D8	# (dec)	Rcv/Tx
10FFA980	8	16 03 09 00 00 72 01 00	93	R

	Bit	7	6	5	4	3	2	1	0
Byte 0	Bit Value	**0**	**0**	**0**	**1**	**0**	**1**	**1**	**0**
	Description	Value of SAVE ON POSTION CHANGE setting		Value of SAVE COUNT setting		Value of DIRECTION Setting		Value of RPM RATE setting	

Byte 0: - RPM RATE = Fast

- DIRECTION = CCW counts up
- SAVE COUNT = at power up COUNT resets to last saved COUNT
- SAVE ON POSITION CHANGE = No action

Byte 1: RPM Resolution (RPM per bit) = 3

Byte 2: EE Read Status = 9

Byte 3: EE Bank = 0

Byte 4: Error Codes = 0

Bytes 5-7: EE Write Count = 172h = 370

Each byte gets its value from their 8 bits. In this case the bits in byte 0 make up the binary value 00010110 which is equal to 16 in hex which is the value of the byte

JORAL

Error Codes

The setting status message will transmit error codes depending on the status of the memory on the encoder. On power-up, the encoder will check for FRAM memory. If FRAM memory is unavailable or corrupt, the encoder will use EEPROM memory instead.

FOR FRAM MEMORY:

11: FRAM memory is usable, encoder is using the first bank of available memory

12: FRAM memory is usable, encoder is using the second bank of available memory

13: FRAM memory is usable, encoder is using the third bank of available memory

88: An error occurred writing to FRAM memory; if this error occurs, the encoder should be power cycled, after which it will either move to the next FRAM bank or switch to EEPROM memory

FOR EEPROM MEMORY:

0: EEPROM memory is usable; the EE Bank and EE Read Status registers will tell which bank of memory is being used

2: EEPROM memory is corrupt, and settings cannot be saved to memory

3: An error occurred when trying to write to memory

Zero Power Encoder Settings Message Data Field Structure

The zero power encoder has 9 different setting fields (shown below) that can be altered to suit various applications. A setup message consists of a CAN ID and the 8 byte data field. Below are the 9 setup fields and how to alter their bits to manipulate them.

Byte	Field	Bits	MSB/LSB * Description
0	ZERO COUNT	0	00 = no action 01 = reset the COUNT and POSITION to zero
		1	
	RESET POSITION OFFSET	2	01 = resets any offset applied to the POSITION; it will return the raw value
		3	
	RPM RATE	4	RPM is calculated by running average on specified intervals 00= Slow RPM Calculation (3 seconds) 01 = Medium RPM Calculation (1 second) 10 = Fast RPM Calculation (0.1 seconds)
		5	
	DIRECTION	6	00 = CW Direction Counts Up 01 = CCW Direction Counts Up
		7	
1	unused	8-13	**
	ENABLE SETTING STATUS MESSAGE	14-15	00 = Disables additional setting status message 01 = Enables additional setting status message
2	RPM RESOLUTION	16	0000 = 0.125 rpm per bit 0001 = 1 rpm per bit 0010 = 2 rpm per bit 0011 = 3 rpm per bit
		17	
		18	
		19	
	unused	20-23	**
3	unused	24-28	**
	LOAD COUNT TRIGGER***	29	10 = Triggers the LOAD COUNT VALUE to be set as the new COUNT VALUE
		30	
	LOAD COUNT SIGN***	31	0 = Sets LOAD COUNT to a positive value 1 = Sets LOAD COUNT to a negative value
4-7	LOAD COUNT VALUE***	32-63	- This field is filled with the desired COUNT value you wish to set the encoder at - For the encoder to have the value you wish set, the LOAD COUNT TRIGGER field **has to be set to 1.**

* Throughout the Description column the Most Significant Bit (MSB) is on the left and the Least Significant Bit (LSB) is on the right.

** All unused bits have no action on the encoder and should all be set to 0.

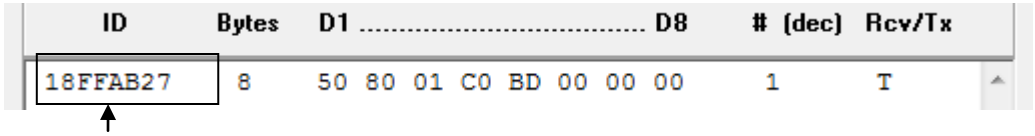
*** LOAD COUNT feature is optional

Zero Power Encoder Sample Settings Message

Sample Message

Note: The setup (settings) message is always initiated by another device to alter the encode setup

The following is a screen shot from a CAN Data Logger showing a message **to the encoder from a controller.**



ID	Bytes	D1 ..... D8	# (dec)	Rcv/Tx
18FFAB27	8	50 80 01 C0 BD 00 00 00	1	T

The **Message** portion of the screen shot shows the CAN ID.
The **18** shows the priority of the message (priority 4).
The **FFAB** shows the PGN of the message (FFAB in hex equals 65451 in decimal).
The **27** shows the source address of the message (27 in hex equals 39 in decimal).
The data potion of the screen shot is broken in the following table. Note that byte 0 is on the right and byte 7 is on the left.

Byte	(bit7) Byte 3 (bit0)								(bit7) Byte 2 (bit0)								(bit7) Byte 1 (bit0)								(bit7) Byte 0 (bit0)							
Byte Value	**C0**								**01**								**80**								**50**							
Field	SIGN	LOAD COUNT TRIGGER		-					-				RPM RESOLUTION				ENABLE SETTING STATUS MESSAGE	-							DIRECTION		RPM RATE		RESET POSITION OFFSET		ZERO COUNT	
Bit Value	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0
Description	Negative	Triggers the LOAD COUNT field		-					-				Sets RPM RESOLUTION to 1 rpm per bit				No action	-							Counter-clockwise counts up		RPM RATE to medium		No action		No action	

Byte	(bit7) Byte 7 (bit0)								(bit7) Byte 6 (bit0)								(bit7) Byte 5 (bit0)								(bit7) Byte 4 (bit0)							
Byte Value	**00**								**00**								**00**								**BD**							
Field	LOAD COUNT								LOAD COUNT								LOAD COUNT								LOAD COUNT							
Bit Value	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1	0	1

Description	Sets LOAD COUNT to 189