



Fault Insertion Unit Communications Specification

Part Number: 8800-00008

Revision History

REV	DATE	DESCRIPTION	PREPARED BY	APPROVED BY
1.0	11/18/16	Initial Release	T. Henault	S. Hoenig
1.1	2/16/19	Added part number	P. Tortora	G. Gothing

Table of Contents

1	Overview	5
2	RS-485	6
2.1	General Overview	6
2.2	Commands	7
2.2.1	Connect – C	7
2.2.2	Disconnect – D	7
2.2.3	Voltage Measurement - V	7
2.2.4	Current Measurement – I	7
2.2.5	Generate Fault - F	7
2.2.6	SW Version – H	8
2.2.7	Relay State - S	8
2.2.8	Interlock State – L	8
2.2.9	Interlock Override – O	8
2.2.10	Relay Contact Cycle Count – N	9
3	CAN	10
3.1	Frames List	10
3.1.1	Incoming Frames (to FIU)	10
3.1.2	Outgoing Frames (from FIU)	10
3.2	Signals of Incoming Frames (to FIU)	11
3.2.1	Set Open Circuit Fault (Open_Fault)	11
3.2.2	Set Open Circuit Fault All (Open_Fault_All)	11
3.2.3	Set Short Circuit Fault (Short_Fault)	12
3.2.4	Set Voltage Measurement (Measure_V)	12
3.2.5	Set Current Measurement (Measure_I)	12
3.2.6	Interlock Override (Interlock_Override)	12
3.3	Signals of Outgoing Frames (from FIU)	12
3.3.1	Relay State Ch. 1-12 (Relay_State_01_12)	12
3.3.2	Relay State Ch. 13-24 (Relay_State_13_24)	12
3.3.3	Relay Contact Cycle Count- Channel 1 (Relay_Count_01)	13
3.3.4	Relay Contact Cycle Count- Channel 2 (Relay_Count_02)	13
3.3.5	Relay Contact Cycle Count- Channel 3 (Relay_Count_03)	13
3.3.6	Relay Contact Cycle Count- Channel 4 (Relay_Count_04)	13
3.3.7	Relay Contact Cycle Count- Channel 5 (Relay_Count_05)	14
3.3.8	Relay Contact Cycle Count- Channel 6 (Relay_Count_06)	14
3.3.9	Relay Contact Cycle Count- Channel 7 (Relay_Count_07)	14
3.3.10	Relay Contact Cycle Count- Channel 8 (Relay_Count_08)	14
3.3.11	Relay Contact Cycle Count- Channel 9 (Relay_Count_09)	14

3.3.12	Relay Contact Cycle Count- Channel 10 (Relay_Count_10)	15
3.3.13	Relay Contact Cycle Count- Channel 11 (Relay_Count_11)	15
3.3.14	Relay Contact Cycle Count- Channel 12 (Relay_Count_12)	15
3.3.15	Relay Contact Cycle Count- Channel 13 (Relay_Count_13)	15
3.3.16	Relay Contact Cycle Count- Channel 14 (Relay_Count_14)	15
3.3.17	Relay Contact Cycle Count- Channel 15 (Relay_Count_15)	15
3.3.18	Relay Contact Cycle Count- Channel 16 (Relay_Count_16)	16
3.3.19	Relay Contact Cycle Count- Channel 17 (Relay_Count_17)	16
3.3.20	Relay Contact Cycle Count- Channel 18 (Relay_Count_18)	16
3.3.21	Relay Contact Cycle Count- Channel 19 (Relay_Count_19)	16
3.3.22	Relay Contact Cycle Count- Channel 20 (Relay_Count_20)	16
3.3.23	Relay Contact Cycle Count- Channel 21 (Relay_Count_21)	17
3.3.24	Relay Contact Cycle Count- Channel 22 (Relay_Count_22)	17
3.3.25	Relay Contact Cycle Count- Channel 23 (Relay_Count_23)	17
3.3.26	Relay Contact Cycle Count- Channel 24 (Relay_Count_24)	17
3.3.27	Software Version (Software_Version)	17
3.3.28	Interlock State (Interlock_State)	17

1 Overview

The Fault Insertion Unit (FIU) is designed to be used in conjunction with the BS1200 to generate open faults and short to ground faults. It also has switching that allows precision current and voltage measurements to be taken using an external DMM. The intent of this document is to define the low level command necessary to communicate with the FIU over RS-485 or CAN. For most users, it is highly recommended that the FIU LabVIEW drivers provided by Bloomy are used for communication as they provide all the checks necessary to prevent accidental shorting of BS1200 channels.

The FIU supports 24 BS1200 channels. Each of the 24 channels allow switching to a shared DMM bus for current readings, voltage readings, and fault to ground. Extreme care must be taken to avoid shorting channels on this bus. For systems with multiple FIUs, this bus may also be shared between them.

The Fault Insertion Unit (FIU) is configurable to communicate using RS-485 or CAN bus. In order to use the RS-485 protocol, the box must be set to 0-7. For use with CAN bus, the box must be set to 8-15.

2 RS-485

2.1 General Overview

Commands sent to the FIU over the RS-485 interface should use a baud rate of 115200, 8 data bits, no parity, and 1 stop bits. Format for the commands is shown below. All data is sent as ASCII text and is case sensitive. Some commands do not require all parameters. Refer to information later in this section for command details. Messages that are shorter than 4 characters (not including <CR>) or with a CRC error will be ignored by the FIU.

Outbound Message Format:

<CMD><FIU #><Channel #><Data><CRC><CR>

<CMD> = Command, details are below.

<FIU #> = 0 – 7 specifying the physical FIU the command is destined for.

<Channel #> = 01 – 24 to specify the FIU channel. 99 to specify all channels for some commands.

<Data> = Message Payload

<CRC> = 00 – FF Two digit hex sum of message prior to checksum

<CR> = All messages terminate with carriage return

Return Message Format:

<Return Code><Data><CRC><CR>

<Return Code> = 0- Success-No Data, 1- Success-Data, 2- Syntax Error, 3- Error with Data

<Data> = Message Payload (Only present with return codes 1 & 3)

<CRC> = 00 – FF Two digit hex sum of message prior to checksum

<CR> = All return messages terminate with carriage return

2.2 Commands

2.2.1 Connect - C

Sets the specified channel or all channels to the “Connected” state.

Command Format: C<FIU #><Channel #><CRC><CR>

Valid Channels: 01 – 24, 99 for all

Return Codes: 0, 2

2.2.2 Disconnect - D

Sets the specified channel or all channels to the “Disconnected” state.

Command Format: D<FIU #><Channel #><CRC><CR>

Valid Channels: 01 – 24, 99 for all

Return Codes: 0, 2

2.2.3 Voltage Measurement - V

Configures the specified channel to the “DMM Voltage Measurement” state.

Command Format: V<FIU #><Channel #><CRC><CR>

Valid Channels: 01 – 24

Return Codes: 0, 2

2.2.4 Current Measurement - I

Configures the specified channel to the “DMM Current Measurement” state.

Command Format: I<FIU #><Channel #><CRC><CR>

Valid Channels: 01 – 24

Return Codes: 0, 2

2.2.5 Generate Fault - F

Configures the specified channel to the “Ground Fault” state.

Command Format: F<FIU #><Channel #><CRC><CR>

Valid Channels: 01 – 24

Return Codes: 0, 2

2.2.6 SW Version – H

Returns the version of the software running on the FIU.

Command Format: H<FIU #><CRC><CR>

Return Codes: 1, 2

Return Data: ASCII Version in format XX.XX

2.2.7 Relay State - S

Returns the current state of all channels of the FIU. The state is sent back as a string of 24 characters, with each character representing a channel. The first character will be channel 1. The state/character correspond to the commands used to set them – C, D, V, I, F

Command Format: S<FIU #><CRC><CR>

Return Codes: 1, 2

Return Data: String of 24 characters (C, D, V, I, F). Channel 1 is first and channel 24 last.

2.2.8 Interlock State – L

Return the state of the 24V interlock input located on the FIU.

Command Format: L<FIU #><CRC><CR>

Return Codes: 1, 2

Return Data: 0 = Interlock Inactive (0V), 1 = Interlock Active (24V)

2.2.9 Interlock Override – O

When set to 1, forces the interlock relays used to control any connected BS1200 to the closed state thereby enabling the BS1200 outputs. When set to 0 (default), the relays are controlled by the 24V interlock signal.

Command Format: O<FIU #><0 or 1><CRC><CR>

Return Codes: 0, 2

2.2.10 Relay Contact Cycle Count – N

Returns the number of cycles the relays on the specified channel have experienced. For each relay (K1 – K5), 8 characters are returned representing the hexadecimal value.

Command Format: N<FIU #><Channel #><CRC><CR>

Valid Channels: 01 – 24

Return Codes: 1, 2

Return Data: 40 characters with 8 characters per relay. The first group of 8 represents K1 while the last group represents K5.

NOTE: This function is not currently supported.

3 CAN

The FIU CAN bus runs at 1MBaud (unless configured to a different value). The FIUs should always share a CAN network separate from other devices.

3.1 Frames List

All messages use 11 bit arbitration IDs. The least significant 4 bits specify the FIU Box ID.

3.1.1 Incoming Frames (to FIU)

Msg ID		Base Arb ID		Frame Name	Description
[Hex]	[Dec]	[Hex]	[Dec]		
10	16	100	256	Open_Fault	Sets specified cell to open circuit fault
12	18	120	288	Open_Fault_All	Sets all cells to open circuit fault
14	20	140	320	Short_Fault	Sets specified cell to short circuit fault
16	22	160	352	Measure_V	Connects specified cell to DMM for voltage measurement
18	24	180	384	Measure_I	Connects specified cell to DMM for current measurement
1A	26	1A0	416	Interlock_Override	Overrides default interlock state

3.1.2 Outgoing Frames (from FIU)

Msg ID		Base Arb ID		Frame Name	Description
[Hex]	[Dec]	[Hex]	[Dec]		
1C	28	1C0	1280	Relay_State_01_12	Returns the status of channels 1-12.
1D	29	1D0	464	Relay_State_13_24	Returns the status of channels 13-24.
1E	30	1E0	480	Relay_Count_01	Returns the number of cycles each relay in channel 1 has undergone
20	32	200	512	Relay_Count_02	Returns the number of cycles each relay in channel 2 has undergone
22	34	220	544	Relay_Count_03	Returns the number of cycles each relay in channel 3 has undergone
24	36	240	576	Relay_Count_04	Returns the number of cycles each relay in channel 4 has undergone
26	38	260	608	Relay_Count_05	Returns the number of cycles each relay in channel 5 has undergone
28	40	280	640	Relay_Count_06	Returns the number of cycles each relay in channel 6 has undergone
2A	42	2A0	672	Relay_Count_07	Returns the number of cycles each relay in channel 7 has undergone
2C	44	2C0	704	Relay_Count_08	Returns the number of cycles each relay in channel 8 has undergone
2E	46	2E0	736	Relay_Count_09	Returns the number of cycles each relay in channel 9 has undergone
30	48	300	768	Relay_Count_10	Returns the number of cycles each relay in channel 10 has undergone
32	50	320	800	Relay_Count_11	Returns the number of cycles each relay in channel 11 has undergone

34	52	340	832	Relay_Count_12	Returns the number of cycles each relay in channel 12 has undergone
36	54	360	864	Relay_Count_13	Returns the number of cycles each relay in channel 13 has undergone
38	56	380	896	Relay_Count_14	Returns the number of cycles each relay in channel 14 has undergone
3A	58	3A0	928	Relay_Count_15	Returns the number of cycles each relay in channel 15 has undergone
3C	60	3C0	960	Relay_Count_16	Returns the number of cycles each relay in channel 16 has undergone
3E	62	3E0	992	Relay_Count_17	Returns the number of cycles each relay in channel 17 has undergone
40	64	400	1024	Relay_Count_18	Returns the number of cycles each relay in channel 18 has undergone
42	66	420	1056	Relay_Count_19	Returns the number of cycles each relay in channel 19 has undergone
44	68	440	1088	Relay_Count_20	Returns the number of cycles each relay in channel 20 has undergone
46	70	460	1120	Relay_Count_21	Returns the number of cycles each relay in channel 21 has undergone
48	72	480	1152	Relay_Count_22	Returns the number of cycles each relay in channel 22 has undergone
4A	74	4A0	1184	Relay_Count_23	Returns the number of cycles each relay in channel 23 has undergone
4C	76	4C0	1216	Relay_Count_24	Returns the number of cycles each relay in channel 24 has undergone
4E	78	4E0	1248	Software_Version	Returns the current firmware version running on the FIU
50	80	500	1280	Interlock_State	Returns active or inactive interlock state

3.2 Signals of Incoming Frames (to FIU)

3.2.1 Set Open Circuit Fault (Open_Fault)

Signal	Start bit	# of bits	Scaling factor	Scaling offset	Range	Units
Enable	0	1	1	0	0 or 1	N/A
Channel	1	7	1	0	1-24	N/A

3.2.2 Set Open Circuit Fault All (Open_Fault_All)

Signal	Start bit	# of bits	Scaling factor	Scaling offset	Range	Units
Enable	0	1	1	0	0 or 1	N/A

3.2.3 Set Short Circuit Fault (Short_Fault)

Signal	Start bit	# of bits	Scaling factor	Scaling offset	Range	Units
Enable	0	1	1	0	0 or 1	N/A
Channel	1	7	1	0	1-24	N/A

3.2.4 Set Voltage Measurement (Measure_V)

Signal	Start bit	# of bits	Scaling factor	Scaling offset	Range	Units
Enable	0	1	1	0	0 or 1	N/A
Channel	1	7	1	0	1-24	N/A

3.2.5 Set Current Measurement (Measure_I)

Signal	Start bit	# of bits	Scaling factor	Scaling offset	Range	Units
Enable	0	1	1	0	0 or 1	N/A
Channel	1	7	1	0	1-24	N/A

3.2.6 Interlock Override (Interlock_Override)

Signal	Start bit	# of bits	Scaling factor	Scaling offset	Range	Units
Enable	0	1	1	0	0 or 1	N/A

3.3 Signals of Outgoing Frames (from FIU)

3.3.1 Relay State Ch. 1-12 (Relay_State_01_12)

The return value for each channel is an enumerated value 0-4 that corresponds to the following:

0=Connected, 1=Disconnected, 2=Voltage Measurement, 3=Current Measurement, 4=Ground Fault

Signal	Start bit	# of bits	Scaling factor	Scaling offset	Range	Units
CH_01	0	4	1	0	0-4	N/A
CH_02	4	4	1	0	0-4	N/A
CH_03	8	4	1	0	0-4	N/A
CH_04	12	4	1	0	0-4	N/A
CH_05	16	4	1	0	0-4	N/A
CH_06	20	4	1	0	0-4	N/A
CH_07	24	4	1	0	0-4	N/A
CH_08	28	4	1	0	0-4	N/A
CH_09	32	4	1	0	0-4	N/A
CH_10	36	4	1	0	0-4	N/A
CH_11	40	4	1	0	0-4	N/A
CH_12	44	4	1	0	0-4	N/A

3.3.2 Relay State Ch. 13-24 (Relay_State_13_24)

The return value for each channel is an enumerated value 0-4 that corresponds to the following:

0=Connected, 1=Disconnected, 2=Voltage Measurement, 3=Current Measurement, 4=Ground Fault

Signal	Start bit	# of bits	Scaling factor	Scaling offset	Range	Units
CH_13	0	4	1	0	0-4	N/A
CH_14	4	4	1	0	0-4	N/A
CH_15	8	4	1	0	0-4	N/A
CH_16	12	4	1	0	0-4	N/A
CH_17	16	4	1	0	0-4	N/A
CH_18	20	4	1	0	0-4	N/A
CH_19	24	4	1	0	0-4	N/A
CH_20	28	4	1	0	0-4	N/A
CH_21	32	4	1	0	0-4	N/A
CH_22	36	4	1	0	0-4	N/A
CH_23	40	4	1	0	0-4	N/A
CH_24	44	4	1	0	0-4	N/A

3.3.3 Relay Contact Cycle Count- Channel 1 (Relay_Count_01)

Signal	Start bit	# of bits	Scaling factor	Scaling offset	Range	Units
K1	0	8	1	0	0-255	N/A
K2	8	8	1	0	0-255	N/A
K3	16	8	1	0	0-255	N/A
K4	24	8	1	0	0-255	N/A
K5	32	8	1	0	0-255	N/A

NOTE: This function is not currently supported.

3.3.4 Relay Contact Cycle Count- Channel 2 (Relay_Count_02)

Signal	Start bit	# of bits	Scaling factor	Scaling offset	Range	Units
K1	0	8	1	0	0-255	N/A
K2	8	8	1	0	0-255	N/A
K3	16	8	1	0	0-255	N/A
K4	24	8	1	0	0-255	N/A
K5	32	8	1	0	0-255	N/A

NOTE: This function is not currently supported.

3.3.5 Relay Contact Cycle Count- Channel 3 (Relay_Count_03)

Signal	Start bit	# of bits	Scaling factor	Scaling offset	Range	Units
K1	0	8	1	0	0-255	N/A
K2	8	8	1	0	0-255	N/A
K3	16	8	1	0	0-255	N/A
K4	24	8	1	0	0-255	N/A
K5	32	8	1	0	0-255	N/A

NOTE: This function is not currently supported.

3.3.6 Relay Contact Cycle Count- Channel 4 (Relay_Count_04)

Signal	Start bit	# of bits	Scaling factor	Scaling offset	Range	Units
K1	0	8	1	0	0-255	N/A
K2	8	8	1	0	0-255	N/A
K3	16	8	1	0	0-255	N/A
K4	24	8	1	0	0-255	N/A

K5	32	8	1	0	0-255	N/A
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NOTE: This function is not currently supported.

3.3.7 Relay Contact Cycle Count- Channel 5 (Relay_Count_05)

Signal	Start bit	# of bits	Scaling factor	Scaling offset	Range	Units
K1	0	8	1	0	0-255	N/A
K2	8	8	1	0	0-255	N/A
K3	16	8	1	0	0-255	N/A
K4	24	8	1	0	0-255	N/A
K5	32	8	1	0	0-255	N/A

NOTE: This function is not currently supported.

3.3.8 Relay Contact Cycle Count- Channel 6 (Relay_Count_06)

Signal	Start bit	# of bits	Scaling factor	Scaling offset	Range	Units
K1	0	8	1	0	0-255	N/A
K2	8	8	1	0	0-255	N/A
K3	16	8	1	0	0-255	N/A
K4	24	8	1	0	0-255	N/A
K5	32	8	1	0	0-255	N/A

NOTE: This function is not currently supported.

3.3.9 Relay Contact Cycle Count- Channel 7 (Relay_Count_07)

Signal	Start bit	# of bits	Scaling factor	Scaling offset	Range	Units
K1	0	8	1	0	0-255	N/A
K2	8	8	1	0	0-255	N/A
K3	16	8	1	0	0-255	N/A
K4	24	8	1	0	0-255	N/A
K5	32	8	1	0	0-255	N/A

NOTE: This function is not currently supported.

3.3.10 Relay Contact Cycle Count- Channel 8 (Relay_Count_08)

Signal	Start bit	# of bits	Scaling factor	Scaling offset	Range	Units
K1	0	8	1	0	0-255	N/A
K2	8	8	1	0	0-255	N/A
K3	16	8	1	0	0-255	N/A
K4	24	8	1	0	0-255	N/A
K5	32	8	1	0	0-255	N/A

NOTE: This function is not currently supported.

3.3.11 Relay Contact Cycle Count- Channel 9 (Relay_Count_09)

Signal	Start bit	# of bits	Scaling factor	Scaling offset	Range	Units
K1	0	8	1	0	0-255	N/A
K2	8	8	1	0	0-255	N/A
K3	16	8	1	0	0-255	N/A
K4	24	8	1	0	0-255	N/A
K5	32	8	1	0	0-255	N/A

NOTE: This function is not currently supported.

3.3.12 Relay Contact Cycle Count- Channel 10 (Relay_Count_10)

Signal	Start bit	# of bits	Scaling factor	Scaling offset	Range	Units
K1	0	8	1	0	0-255	N/A
K2	8	8	1	0	0-255	N/A
K3	16	8	1	0	0-255	N/A
K4	24	8	1	0	0-255	N/A
K5	32	8	1	0	0-255	N/A

NOTE: This function is not currently supported.

3.3.13 Relay Contact Cycle Count- Channel 11 (Relay_Count_11)

Signal	Start bit	# of bits	Scaling factor	Scaling offset	Range	Units
K1	0	8	1	0	0-255	N/A
K2	8	8	1	0	0-255	N/A
K3	16	8	1	0	0-255	N/A
K4	24	8	1	0	0-255	N/A
K5	32	8	1	0	0-255	N/A

NOTE: This function is not currently supported.

3.3.14 Relay Contact Cycle Count- Channel 12 (Relay_Count_12)

Signal	Start bit	# of bits	Scaling factor	Scaling offset	Range	Units
K1	0	8	1	0	0-255	N/A
K2	8	8	1	0	0-255	N/A
K3	16	8	1	0	0-255	N/A
K4	24	8	1	0	0-255	N/A
K5	32	8	1	0	0-255	N/A

NOTE: This function is not currently supported.

3.3.15 Relay Contact Cycle Count- Channel 13 (Relay_Count_13)

Signal	Start bit	# of bits	Scaling factor	Scaling offset	Range	Units
K1	0	8	1	0	0-255	N/A
K2	8	8	1	0	0-255	N/A
K3	16	8	1	0	0-255	N/A
K4	24	8	1	0	0-255	N/A
K5	32	8	1	0	0-255	N/A

NOTE: This function is not currently supported.

3.3.16 Relay Contact Cycle Count- Channel 14 (Relay_Count_14)

Signal	Start bit	# of bits	Scaling factor	Scaling offset	Range	Units
K1	0	8	1	0	0-255	N/A
K2	8	8	1	0	0-255	N/A
K3	16	8	1	0	0-255	N/A
K4	24	8	1	0	0-255	N/A
K5	32	8	1	0	0-255	N/A

NOTE: This function is not currently supported.

3.3.17 Relay Contact Cycle Count- Channel 15 (Relay_Count_15)

Signal	Start bit	# of bits	Scaling factor	Scaling offset	Range	Units
K1	0	8	1	0	0-255	N/A

K2	8	8	1	0	0-255	N/A
K3	16	8	1	0	0-255	N/A
K4	24	8	1	0	0-255	N/A
K5	32	8	1	0	0-255	N/A

NOTE: This function is not currently supported.

3.3.18 Relay Contact Cycle Count- Channel 16 (Relay_Count_16)

Signal	Start bit	# of bits	Scaling factor	Scaling offset	Range	Units
K1	0	8	1	0	0-255	N/A
K2	8	8	1	0	0-255	N/A
K3	16	8	1	0	0-255	N/A
K4	24	8	1	0	0-255	N/A
K5	32	8	1	0	0-255	N/A

NOTE: This function is not currently supported.

3.3.19 Relay Contact Cycle Count- Channel 17 (Relay_Count_17)

Signal	Start bit	# of bits	Scaling factor	Scaling offset	Range	Units
K1	0	8	1	0	0-255	N/A
K2	8	8	1	0	0-255	N/A
K3	16	8	1	0	0-255	N/A
K4	24	8	1	0	0-255	N/A
K5	32	8	1	0	0-255	N/A

NOTE: This function is not currently supported.

3.3.20 Relay Contact Cycle Count- Channel 18 (Relay_Count_18)

Signal	Start bit	# of bits	Scaling factor	Scaling offset	Range	Units
K1	0	8	1	0	0-255	N/A
K2	8	8	1	0	0-255	N/A
K3	16	8	1	0	0-255	N/A
K4	24	8	1	0	0-255	N/A
K5	32	8	1	0	0-255	N/A

NOTE: This function is not currently supported.

3.3.21 Relay Contact Cycle Count- Channel 19 (Relay_Count_19)

Signal	Start bit	# of bits	Scaling factor	Scaling offset	Range	Units
K1	0	8	1	0	0-255	N/A
K2	8	8	1	0	0-255	N/A
K3	16	8	1	0	0-255	N/A
K4	24	8	1	0	0-255	N/A
K5	32	8	1	0	0-255	N/A

NOTE: This function is not currently supported.

3.3.22 Relay Contact Cycle Count- Channel 20 (Relay_Count_20)

Signal	Start bit	# of bits	Scaling factor	Scaling offset	Range	Units
K1	0	8	1	0	0-255	N/A
K2	8	8	1	0	0-255	N/A
K3	16	8	1	0	0-255	N/A
K4	24	8	1	0	0-255	N/A

K5	32	8	1	0	0-255	N/A
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NOTE: This function is not currently supported.

3.3.23 Relay Contact Cycle Count- Channel 21 (Relay_Count_21)

Signal	Start bit	# of bits	Scaling factor	Scaling offset	Range	Units
K1	0	8	1	0	0-255	N/A
K2	8	8	1	0	0-255	N/A
K3	16	8	1	0	0-255	N/A
K4	24	8	1	0	0-255	N/A
K5	32	8	1	0	0-255	N/A

NOTE: This function is not currently supported.

3.3.24 Relay Contact Cycle Count- Channel 22 (Relay_Count_22)

Signal	Start bit	# of bits	Scaling factor	Scaling offset	Range	Units
K1	0	8	1	0	0-255	N/A
K2	8	8	1	0	0-255	N/A
K3	16	8	1	0	0-255	N/A
K4	24	8	1	0	0-255	N/A
K5	32	8	1	0	0-255	N/A

NOTE: This function is not currently supported.

3.3.25 Relay Contact Cycle Count- Channel 23 (Relay_Count_23)

Signal	Start bit	# of bits	Scaling factor	Scaling offset	Range	Units
K1	0	8	1	0	0-255	N/A
K2	8	8	1	0	0-255	N/A
K3	16	8	1	0	0-255	N/A
K4	24	8	1	0	0-255	N/A
K5	32	8	1	0	0-255	N/A

NOTE: This function is not currently supported.

3.3.26 Relay Contact Cycle Count- Channel 24 (Relay_Count_24)

Signal	Start bit	# of bits	Scaling factor	Scaling offset	Range	Units
K1	0	8	1	0	0-255	N/A
K2	8	8	1	0	0-255	N/A
K3	16	8	1	0	0-255	N/A
K4	24	8	1	0	0-255	N/A
K5	32	8	1	0	0-255	N/A

NOTE: This function is not currently supported.

3.3.27 Software Version (Software_Version)

Signal	Start bit	# of bits	Scaling factor	Scaling offset	Range	Units
Major_Rev	0	8	1	0	0-99	N/A
Minor_Rev	8	8	1	0	0-99	N/A

3.3.28 Interlock State (Interlock_State)

Signal	Start bit	# of bits	Scaling factor	Scaling offset	Range	Units
Active	0	1	1	0	0 or 1	N/A

