INCOM Communications Standard - Part A

Powering Business Worldwide

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INCOM Communications Standard

August 2011

A reference guide for programming INCOM system communications – including the INCOM RS-232 and INCOM/UDP protocols.

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1 INTRODUCTION

Eaton's INCOM (INdustrial COMmunications) Network is designed to provide two-way, half-duplex communication between a network master and a variety of Eaton products such as breakers, meters or protective relays. Control and monitoring is performed over a network consisting of dedicated twisted-pair wires. The basis of this network is a semi-custom integrated circuit that has been developed to provide a simple, low-cost interface to the network. This integrated circuit provides the following network functions:

Carrier generation and detection:

- Data modulation/demodulation
- Address decoding
- Generation and checking of a 5-bit-cyclic redundant BCH error code

The INCOM communications protocol is master/slave. An INCOM network can have one master and up to 1,000 slaves. The INCOM communications protocol is based on 33-bit message packets. A typical INCOM network transaction consists of one or more 33-bit message packets transmitted by the master and one or more 33-bit message packets transmitted by a slave in response.

Any computer or programmable device with an RS-232c communications port or the PC ISA bus or Ethernet network interface may function as an INCOM network master. An RS-232c based INCOM network master requires the use of a gateway device such as the Eaton Master INCOM Network Translator (MINT), RS-232 Product-Operated Network Interface (PONI) or PMCOM5. These gateway devices convert the 33-bit binary messages used on the Eaton INCOM Local Area Network (LAN) to and from 10-byte ASCII encoded hexadecimal RS-232c messages. A personal computer with at least one available ISA card slot can alternatively use Eaton's Computer-Operated Network Interface (CONI) for interfacing to the INCOM network. The CONI's direct PC-bus interface provides a more efficient network interface than the MINT. An Ethernet network interface can be used to communicate over Ethernet using Eaton EPONI, EMINT or PXG products.

This document is intended for users or original equipment manufacturers (OEMs) who want to develop their own software for an INCOM network master. It includes descriptions of the communications protocol at the INCOM chip level (i.e., 33-bit messages) and the communications protocols at the product level (which are combinations of 33-bit messages). Information on the CONI's PC interface, the MINT's ASCII translation and the Ethernet protocol are also provided.

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2 INCOM PROTOCOL – INCOM CHIP LEVEL

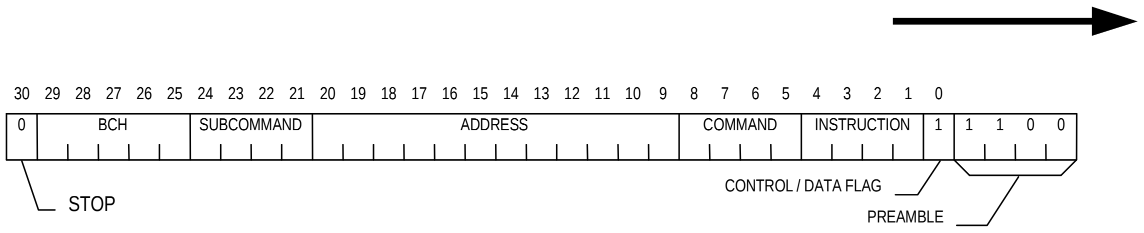
There are two basic types of INCOM messages:

- INCOM control messages
- INCOM data messages

2.1 INCOM Control Message

The format for an INCOM control message follows. The message is 33 bits long and is sent with the least significant bit (LSB) first. A number of the bits are generated by the INCOM chip. These are the Start, Stop, and BCH error detection code. These bits are not described in this document.

The bits of an INCOM control message are defined as follows:

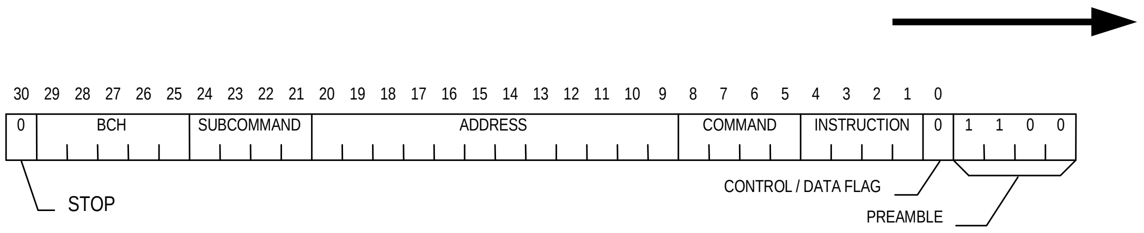


Bit Number	Mnemonic	Definition
-	STR	Start Bits = 11
0	C/D	Control Bit = 1 for Control Messages
1-4	INST	Instruction Field
5-8	COMM	Command Field
9-20	ADDRESS	Address of Product (Slave Device)
21-24	SCOMM	Subcommand Field
25-29	BCH	BCH Error Detection Field
30	STP	Stop Bit = 0

2.2 INCOM Data Message

The format for an INCOM data message follows. The message is 33 bits long and is sent with the least significant bit (LSB) first. A number of the bits are generated by the INCOM chip. These are the Start, Stop and BCH error detection code. These bits are not described in this document.

The bits of an INCOM data message are defined as follows:



Bit Number	Mnemonic	Definition
-	STR	Start Bits = 11
0	C/D	Control Bit = 0 for Data Messages
1-4	INST	Instruction Field
5-8	COMM	Command Field
9-20	ADDRESS	Address of Product (Slave Device)
21-24	SCOMM	Subcommand Field
25-29	BCH	BCH Error Detection Field
30	STP	Stop Bit = 0

3 INCOM NETWORK – SLAVE DEVICE TYPES

There are two types of INCOM slave devices (products):

- ◆ Stand-Alone Slave
- ◆ Expanded-Mode Slave

3.1 Stand-Alone Slave

A Stand-Alone Slave device on an INCOM network can control one digital output and monitor up to two status (digital) inputs. An example of a Stand-Alone Slave device is the Cutler-Hammer Addressable Relay. A Stand-Alone Slave device uses INCOM control messages exclusively for its communications.

3.2 Expanded-Mode Slave

The Expanded-Mode Slave is a device on an INCOM network that can send and/or receive many data values over the INCOM network including analog and digital I/O data, configuration or setpoint information, and trip data. The following Eaton products are examples of Expanded-Mode Slave devices.

- ◆ IQ Analyzer Line Metering System
- ◆ Digitrip 1050, 1150, and Optim Trip Units
- ◆ Digitrip 1150 NRX Trip Units
- ◆ FP-6000 Feeder Protection Relay

An Expanded-Mode Slave device uses INCOM control messages and INCOM data messages for its communications.

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4 STAND-ALONE SLAVE COMMUNICATIONS STANDARD

4.1 Standard Stand-Alone Slave-to-Master Command Set

There are seven commands that an INCOM network master may send to a Stand-Alone Slave device. Three of the commands (INST = 8, 9, and F) require the slave to send a reply. A Stand-Alone Slave device's reply is a control message of one of the following formats:

• C/D	= 1
• INST	= INST value sent by the master (echoed).
• COMM	= COMM value sent by the master (echoed).
• ADDRESS	= ADDRESS of slave
• SCOMM	= SCOMM value sent by the master (echoed), except bits 2 and 3 of the SCOMM field (bits 25 and 26 of the 33-bit message) contain the status of the device (two status bits or digital inputs).

4.2 Standard Master-to-Stand-Alone Slave Command Set

There are seven commands that the master may send to a Stand-Alone Slave device. These commands are listed as follows.

Instruction Code	Command	Subcommand	Command Definition
0	F	F	Energize Relay/Restore Load/Start (no reply)
1	F	F	De-Energize Relay/Shed Load/Stop (no reply)
5	F	F	Block De-Energize Relay/Shed Load/Stop – up to 16 slaves
8	F	F	Energize Relay/Restore Load/Start and Reply
9	F	F	De-Energize Relay/Shed Load/Stop and Reply
E	F	F	De-Energize Relay/Shed Load/Stop-All Stand Alone Slaves
F	x	x	Send Status

x = Don't Care

Note: All commands except "Send Status" (INST=F) require two consecutive transmissions. Commands with the INST=8 and INST=9 require following sequence:

Command -> Reply -> Repeat Command -> Reply.

4.2.1 Energize Relay/Restore Load/Start – Do Not Reply (0,F,F)

This command requests the specifically addressed slave device to energize its relay, restore its load, or start, depending on the function of the device. The Stand-Alone Slave does not send a reply message. The format of the Energize Relay/Restore Load/Start command message is as follows. This message must be sent two consecutive times by the INCOM master.

- ◆ C/D = 1
- ◆ INST = 0
- ◆ COMM = F
- ◆ ADDRESS = ADDRESS of the Stand-Alone Slave
- ◆ SCOMM = F

4.2.2 De-Energize Relay/Shed Load/Stop – Do Not Reply (1,F,F)

This command requests the specifically addressed slave device to de-energize its relay, shed its load or stop, depending on the function of the device. The Stand-Alone Slave does not send a reply message. The format of the De-Energize Relay/Shed Load/Stop command message is as follows. This message must be sent two consecutive times by the INCOM master.

- ◆ C/D = 1
- ◆ INST = 1
- ◆ COMM = F
- ◆ ADDRESS = ADDRESS of the Stand-Alone Slave
- ◆ SCOMM = F

4.2.3 Block De-Energize Relay/Shed Load/Stop – Up to 16 Slaves (5,F,F)

This command requests a block of up to 16 Stand-Alone Slave devices to de-energize their relay, shed their load or stop, depending on the function of each device. None of the Stand-Alone Slaves will send a reply message. The format of the Block De-Energize Relay/Shed Load/Stop command message is as follows. This message must be sent two consecutive times by the INCOM master.

- ◆ C/D = 1
- ◆ INST = 5
- ◆ COMM = F
- ◆ ADDRESS B3-B0 = F
- ◆ B11-B4 = Most significant 8 bits of the Stand-Alone Slave's INCOM address
- ◆ SCOMM = F

4.2.4 Energize Relay/Restore Load/Start – Send Reply (8,F,F)

This command requests the specifically addressed slave device to energize its relay, restore its load or start, depending on the function of the device. The Stand-Alone Slave will send a reply message. (Refer to Standard Stand-Alone Slave-to-Master Command Set, on Page 7 for information about the reply message.) The format of the Energize Relay/Restore Load/Start command message is as follows. This message must be sent two consecutive times. The slave will send a reply after each transmission of the command by the master.

- C/D = 1
- INST = 8
- COMM = F
- ADDRESS = ADDRESS of the Stand-Alone Slave
- SCOMM = F

4.2.5 De-Energize Relay/Shed Load/Stop – Send Reply (9,F,F)

This command requests the specifically addressed slave device to de-energize its relay, shed its load, or stop, depending on the function of the device. The Stand-Alone Slave will send a reply message. (Refer to Standard Stand-Alone Slave-to-Master Command Set, on Page 7 for information on the reply message.) The format of the De-Energize Relay/Shed Load/Stop command message is as follows. This message must be sent two consecutive times. The slave will send a reply after each transmission of the command by the master.

- C/D = 1
- INST = 9
- COMM = F
- ADDRESS = ADDRESS of the Stand-Alone Slave
- SCOMM = F

4.2.6 De-Energize Relay/Shed Load/Stop All Stand-Alone Slaves (E,F,F)

This command requests all Stand-Alone Slave devices on the INCOM network to de-energize their relay, shed their load or stop, depending on the function of each device. None of the Stand-Alone Slaves will send a reply message. The format of the De-Energize Relay/Shed Load/Stop all Stand-Alone Slaves command message follows. This message must be sent two consecutive times.

- C/D = 1
- INST = E
- COMM = F
- ADDRESS = FFF
- SCOMM = F

4.2.7 Request for Transmission of Status (F,x,x)

This command requests the specifically addressed slave device to transmit its status (i.e., its two status bits/digital inputs). The Stand-Alone Slave will send a reply message. (Refer to Standard Stand-Alone Slave-to-Master Command Set, on Page 7 for information on the reply message.) The format of the Request for Transmission of Status command message follows.

◆	C/D	= 1
◆	INST	= F
◆	COMM	= Don't Care (not used)
◆	ADDRESS	= ADDRESS of the Stand-Alone Slave
◆	SCOMM	= Don't Care (not used)

5 EXPANDED-MODE SLAVE COMMUNICATIONS STANDARD

5.1 Standard Expanded-Mode Slave-to-Master Command Set

There are 7 special cases in which an Expanded-Mode Slave product, in response to a command from the master, may send a return command message to the master. These are as follows:

- Acknowledge (ACK) Reply
- Negative Acknowledge (NACK) Reply
- Product Buffer Not Yet Available
- Sub-Network Product Not Responding
- Checksum Error
- Downloaded Value Out of Range
- Product Not in a State That Allows the Requested Action

The next 7 sections describe these Slave-to-Master command messages.

5.1.1 Acknowledge (ACK) Reply (3 1 0)

Some INCOM commands require the product to transmit an acknowledge (ACK) message. The positive acknowledge indicates that the product accepted the present command or the data transmission was completed successfully. The format of the ACK message is as follows:

- C/D = 1
- INST = 3
- COMM = 1
- ADDRESS = address of slave (See Note 1.)
- SCOMM = 0

Note 1: Some products may use address 000H or FFFH.

5.1.2 Negative Acknowledge (NACK) Reply (3 1 1)

The product will transmit a negative acknowledge (NACK) rather than an ACK in response to certain conditions. The negative acknowledge indicates that the product has not accepted the COMM and SCOMM command request. The format of the NACK message is as follows:

- C/D = 1
- INST = 3
- COMM = 1
- ADDRESS = address of slave (See Note 2.)
- SCOMM = 1

Note 2: Products will only respond to INCOM messages containing a good BCH value.

The conditions that a product will respond with a NACK include, but are not limited to the following:

- The product received an INCOM control message that it does not recognize, that is, an INCOM control message with INST=3, and COMM and SCOMM values that it does not support. Products should not respond to control messages if INST is not equal to 3.
- The PONI received an INCOM control message that it cannot process due to a communications error between the PONI and the product.

5.1.3 Product Buffer Not Yet Available (3 1 5)

This response can be sent to the master in response to a buffer request, should the product not be ready to send the requested buffer. The format of the Product Buffer Not Yet Available message is as follows:

- C/D = 1
- INST = 3
- COMM = 1
- ADDRESS = Address of slave
- SCOMM = 5

5.1.4 Sub-Network Product Not Responding (3 1 9)

This response can be sent to the master in response to a Process Sub-Network Command that cannot be processed because the target subnetwork product not responding. This response is used by subnetwork masters only. The format of the Sub-Network Product Not Responding message is as follows:

- C/D = 1
- INST = 3
- COMM = 1
- ADDRESS = Address of slave
- SCOMM = 9

5.1.5 Checksum Error (3 1 A)

This response can be sent to the master in response to a Download Setpoints command that cannot be processed due to a checksum error on downloaded data. (See Download Setpoints (3 F 9) on page 119.) The format of the Checksum Error message is as follows:

- C/D = 1
- INST = 3
- COMM = 1
- ADDRESS = Address of slave
- SCOMM = A

5.1.6 Downloaded Value Out of Range (3 1 B)

This response can be sent to the master in response to a Download Setpoints command that cannot be processed due to an out-of-range value within the downloaded data(See Download Setpoints (3 F 9) on page 119.) The format of the Downloaded Value Out of Range message is as follows:

- ◆ C/D = 1
- ◆ INST = 3
- ◆ COMM = 1
- ◆ ADDRESS = Address of slave
- ◆ SCOMM = B

5.1.7 Product Not in a State That Allows the Requested Action (3 1 C)

This response can be sent to the master in response to a command that cannot be processed because the target product is not in a state that allows the requested action. The format of the Product Not in a State That Allows the Requested Action message is as follows:

- ◆ C/D = 1
- ◆ INST = 3
- ◆ COMM = 1
- ◆ ADDRESS = Address of slave
- ◆ SCOMM = C

5.2 Standard Master-to-Expanded-Mode Slave Command Set

A number of standard Master-to-Slave commands for the INCOM family are described in the following sections. All of these commands utilize C/D=1 and thus only the INST, COMM, and SCOMM specifications are given.

The words “Transmit” and “Receive” in the command definitions are used with respect to the product. If the message is a Transmit command, the result will be the transmission of data from the product to the master. Likewise, a Receive command that is transmitted from the master to the product will be followed by data transmissions from the master which are to be received by the product.

There are eight such classes of standard Master-to-Expanded-Mode Slave commands:

	INST	COM	SCOMM
Standard Slave-Buffer Transmissions	3	0	0-F
Standard Multiblock Setpoint Block Sizes	3	1	F
Standard System Management Buffer Transmissions	3	A	3-7
Product-Specific Slave-Buffer Transmissions	3	C	8-F
Standard Slave Actions	3	D	0,1,3
Standard Master-Buffer Transmissions	3	D	8-F
Product-Specific Master-Buffer Transmissions	3	F	8-F
Broadcast Command	D	0-F	0-F

Note: All other COMM and SCOMM combinations are reserved for future use.

These communications data buffers are outlined in the following sections. The concept of a standard data buffer includes a specification for the formatting of analog data in engineering units. The next section outlines this format.

5.2.1 IMPACC 24-Bit Floating Point Number Format

The IMPACC family consists of a number of products that send similar analog parameters (such as currents and voltages). Each parameter is sent as a single data transmission with the bytes defined as follows.

Byte	Description
BYTE0	Low-order byte of 16-bit magnitude
BYTE1	High-order byte of 16-bit magnitude
BYTE2	Scale byte

Bit	Definition
B7	0 => the value in BYTE0 and BYTE1 is a 16-bit unsigned integer
	1 => the value in BYTE0 and BYTE1 is a 16-bit signed integer
B6	0 => data is invalid
	1 => data is valid
B5	0 => multiplier as power of 2
	1 => multiplier as power of 10
B4-B0	=> multiplier's exponent in 5-bit signed integer form.

This allows a magnitude of multiplier to range from:

2^{-16} to 2^{+15} (B5 = 0)

or 10^{-16} to 10^{+15} (B5 = 1)

Example 1: The following chart shows 2 ways to represent 41,300.

MSB Byte 2 Byte 1 Byte 0 LSB

0	1	1	0	0	0	0	0	1	0	1	0	0	0	0	1	0	1	0	1	0	1	0	0

MSB Byte 2 Byte 1 Byte 0 LSB

0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	1	1	1	0	1

Example 2: The following chart shows the representation of -79.46.

MSB Byte 2 Byte 1 Byte 0 LSB

1	1	1	1	1	1	1	0	1	1	1	0	0	0	0	0	1	1	1	1	0	1	1	0

5.2.2 Standard Expanded-Mode Slave-Buffer Transmissions (0 0-F)

The following lists display the Standard Slave-Buffer command set and buffer number definitions.

5.2.2.1 *Standard Slave Buffer Command Set*

Instruction Code	Command	Subcommand	Command Definition
3	0	0	Transmit Status/ID
3	0	1	Reserved
3	0	2	Transmit Status/ID and Status/Cause-of-Status
3	0	3	Transmit All Standard Buffers
3	0	4	Transmit Standard Buffers Supported Map
3	0	5	Transmit Current Buffer
3	0	6	Transmit Line-to-Line Voltage Buffer
3	0	7	Transmit Line-to-Neutral Voltage Buffer
3	0	8	Transmit Power Buffer(1)
3	0	9	Transmit Power Buffer(2)
3	0	A	Transmit Energy Buffer
3	0	B	Transmit Saved Energy Buffer
3	0	C	Transmit Saved Reactive Energy Buffer
3	0	D-E	Reserved
3	0	F	Receive Expanded Transmit Buffer Number

5.2.2.2 *Standard Slave Buffer Command Set – Expanded Buffer Number Definitions*

Buffer Number	Definition	Time Stamp
N=000001	Transmit Temperature Buffer	
N=000002	Transmit Demand Currents Buffer	
N=000003	Transmit Current Buffer	
N=000004	Transmit Line-to-Line Voltage Buffer	
N=000005	Transmit Line-to-Neutral Voltage Buffer	
N=000006	Transmit Power Buffer	
N=000007	Transmit Per-Phase Power Buffer	
N=000008	Transmit System Energy Buffer	
N=000009	Transmit Total Harmonic Distortion Buffer	
N=00000A	Transmit Demand Current Buffer & Peak Demand Avg. Current	With time stamp
N=00000B	Transmit Demand and Peak Demand Currents	With time stamp
N=00000C	Transmit Demand and Peak Demand Power	With time stamp
N=00000D	Transmit Min/Max Current Buffer	With time stamp
N=00000E	Transmit Min/Max L-L Voltage Buffer	With time stamp
N=00000F	Transmit Min/Max L-N Voltage Buffer	With time stamp

Standard Slave Buffer Command Set – Buffer Definitions (Continued)

Buffer Number	Definition	Time Stamp
N=000010	Transmit Min/Max PF-Displacement Buffer	With time stamp
N=000011	Transmit Min/Max PF-Apparent Buffer	With time stamp
N=000012	Transmit Min/Max Power/Frequency Buffer	With time stamp
N=000013	Transmit Min/Max Current %THD Buffer	With time stamp
N=000014	Transmit Min/Max Voltage %THD Buffer	With time stamp
N=000015	Transmit Crest Factor Buffer	
N=000016	Transmit Min/Max Per Phase Real Power	With time stamp
N=000017	Transmit Min/Max Per Phase Reactive Power	With time stamp
N=000018	Transmit Min/Max Per Phase Voltampere Apparent Power	With time stamp
N=000019	Transmit Min/Max Currents Buffer	Without time stamp
N=00001A	Transmit Demand and Peak Demand Current	Without time stamp
N=00001B	Transmit Demand and Peak Power	Without time stamp
N=00001C	Transmit Min/Max Voltage Buffer	Without time stamp
N=00001D	Transmit Min/Max Power/Frequency/PF Buffer	Without time stamp
N=00001E	Transmit Min/Max Current %THD Buffer	Without time stamp
N=00001F	Transmit Min/Max Voltage %THD Buffer	Without time stamp
N=000020	Transmit Min/Max Current THD Magnitude Buffer	With time stamp
N=000021	Transmit Min/Max Voltage THD Magnitude Buffer	With time stamp
N=000022	Transmit Whole Load Center Energy Buffer	
N=000023	Transmit APC (Whole Load Center) Saved Energy Buffer	
N=000024	Operations Count, Runtime Buffer	
N=000025	Motor Data Maximum Values Buffer	
N=000026	Motor Trip Counters Buffer	
N=000027	Motor Alarm Counters Buffer	
N=000028	Motor Data Buffer	
N=000029	Transmit Trip Unit Energy Buffer	
N=00002A	Transmit Trip Unit Current THD Buffer	
N=00002B	Transmit Trip Unit Current Crest Factor Buffer	
N=00002C	Transmit Trip Unit Current Min/Max Power Factor Buffer	
N=00002D	FP Relay Currents Buffer	
N=00002E	Line-to-Ground Voltage Buffer	
N=00002F	FP Relay Min/Max Currents Buffer	
N=000030	Current/Voltage Phasors Buffer	
N=000031	Sequence Phasors Buffer	
N=000032	Min/Max System Power Factor Buffer	
N=000033	FP-5000 Feeder Protection Relay Counters Buffer	
N=000034	Transmit Time of Use Watt-Hours Buffer	

Standard Slave Buffer Command Set – Buffer Definitions (Continued)

Buffer Number	Definition
N=000035	Transmit Time of Use VAR-Hours Buffer
N=000036	Transmit Time of Use VA-Hours Buffer
N=000037	Transmit Time of Use Peak Average Current Demand Buffer
N=000038	Transmit Time of Use Peak System Watt Demand Buffer
N=000039	Transmit Time of Use Peak System VAR Demand Buffer
N=00003A	Transmit Time of Use Peak System VA Demand Buffer
N=00003B	Transmit MPCV Phasing Voltage Phasors Buffer
N=00003C	Transmit THD Magmitude Buffer
N=00003D	Transmit Trip Unit Health Buffer
N=00003E	Transmit Motor Trip Counters 2 Buffer
N=00003F	Transmit Motor Alarm Counters 2 Buffer
N=000042	Transmit Min/Max Motor Buffer
N=000043	Transmit Analog Inputs Min/Max Data Buffer
N=000044	Transmit RTD Maximum Values Buffer
N=0000A5	Transmit Test Packer
N=0003E7	Transmit ASCII CAM ID
N=0003E8	Transmit Standard ASCII Device ID
N=FC0000	Transmit IQ Analyzer Event Log Summary Buffer
N=Fcxyyy	Transmit IQ Analyzer Event Log Buffer
N=FE0004	Transmit Phase Angles of Event
N=FF0000	Transmit IQ Analyzer Trend Summary Buffer
N=FF00yy	Transmit IQ Analyzer Trend Header Buffer

5.2.3 Transmit Status/ID (3 0 0)

This command will cause the product to respond with one data message that has the following format:

MSB Byte 2								Byte 1								Byte 0							LSB
S7	S6	S5	S4	S3	S2	S1	S0	P5	P4	P3	P2	P1	P0	V3	V2	V1	V0	D5	D4	D3	D2	D1	D0

Where:

D5 D4 D3 D2 D1 D0 => Division Code

V3 V2 V1 V0 => Communications Software Version

P5 P4 P3 P2 P1 P0 => Product ID

S4 S3 S2 S1 S0 => Product-Defined Status Bits

S7 S6 S5 => Standard Status Bits

Status Bit	Definition		
S7 S6	0 0	Opened, Off or Ready	(Normal Inactive)
	0 1	Closed, On or Running	(Normal Active)
	1 0	Tripped	(Abnormal Inactive)
	1 1	Alarmed	(Abnormal Active)
S5	Opened or Off condition (set by remote communications)		
S4	Product-specific: For products that support the (3 0 2) Transmit Status/Cause-of-Status Buffer. This bit is set when the product updates (makes a change to) the (3 0 2) Transmit Status/Cause-of-Status Buffer. For products that do not support the (3 0 2) Transmit Status/Cause-of-Status Buffer. This bit is set when the product powers up and is cleared when the product receives a request for the (3 0 0) Transmit Status/ID Buffer.		
S3	Product-specific: For products that support the Time-Stamped Event Data Buffers (3 C B) command. Bit=1 indicates the product has a Time-Stamped Event Data Buffer that has not been released by the INCOM master. [Note: Some products reset this bit (i.e., release the buffer) when the buffer is read, such as upon receiving the (3 C B) command.]		

S2,S1,S0 Product-specific: The communications software version is not necessarily the same as the product software version. The communications version is incremented each time the product version is changed in an area that affects the communications response, such as the addition or modification of a product data buffer.

5.2.4 Transmit Extended Status/ID (3 0 1)

This command is used by products which support INCOM Plug N' Play. A full description of INCOM Plug N' Play is beyond the scope of this document. This command is described here only for reference purposes. Please refer to the INCOM Plug n' Play Slave Requirements Specification. When this command is received, the product responds with two data messages as shown below. The first message is identical to the (3 0 0) response and the second message contains three extended status fields. These three extended status fields are to be interpreted as follows by the INCOM master:

- ♦ If the product is known by the master (the Product ID, Communication Version and Division/Class Code are recognized), the master will display product-specific text for each code.
- ♦ If the Plug n' Play Division/Class Code is recognized by the master but the product is unknown, the master will display class-specific text for each code.
- ♦ If Division/Class Code is not recognized by the master, the master will display the generic text for each code.
- ♦ The master may obtain product-specific status strings using string tables 0x0101...0x010A for any product.

Message 1:

MSB Byte 2 Byte 1 Byte 0 LSB

Byte 2								Byte 1								Byte 0							
S7	S6	S5	S4	S3	S2	S1	S0	P5	P4	P3	P2	P1	P0	V3	V2	V1	V0	D5	D4	D3	D2	D1	D0

Where:

D5 D4 D3 D2 D1 D0 => Division Code

V3 V2 V1 V0 => Communications Software Version

P5 P4 P3 P2 P1 P0 => Product ID

S6 S5 S4 S3 S2 S1 => Class Specific Status Bits

S7 S0 => Standard Status Bits

Status Bit	Definition
S7	0 = Normal, 1 = Alarm
S6 – S2	Class Specific Status
S0	(3 A 8) Change Notification

Message 2:

MSB Byte 2 Byte 1 Byte 0 LSB

Byte 2								Byte 1								Byte 0							
P7	P6	P5	P4	P3	P2	P1	P0	S4	S3	S2	S1	S0	C10	C9	C8	C7	C6	C5	C4	C3	C2	C1	C0

Where:

C10 C9 C8 C7 C6 C5 C4 C3 C2 C1 C0 => Cause of Status Code

S4 S3 S2 S1 S0 => Secondary Status Code

P7 P6 P5 P4 P3 P2 P1 P0 => Primary Status Code

Four codes in each of the following status definitions have been designated “product-defined.” These codes are used for status that is not defined in the generic table. The codes are not “dynamic,” meaning they do not change with time. All devices with identical division, product, and version codes must employ the same product-specific status code definition. A list of these codes is available in the device INCOM protocol specification.

5.2.5 Transmit Status/Cause-of-Status Codes (3 0 2)

This command will cause the product to respond with one data message that has the following format:

Message	Byte	Description
1	Byte0	Status/Cause-of-Status – Cause of Status Code
	Byte1	Reserved=0
	Byte2	Bit — Definition
		B0-B3 Primary Status Code
		B4-B7 Secondary Status Code

5.2.6 Standard IMPACC Primary Status Codes

Status Code	Short Description	Long Description
0	--	Status of the device is unknown.
1	OPEN	Device or breaker is open.
2	CLOSED	Device or breaker is closed.
3	TRIP	Device is tripped (protective).
4	ALARM	Device is in a device-declared alarm condition.
5	ON	Status of the input is ON; Device is operational.
6	OFF	Status of the input is OFF; Device is non-operational.
7	READY	Device is in ready mode. (Device is ready to start.)
8	START --	Device is in Start mode. (Device is starting. This is a transition from READY to RUN.)
9	RUN	Device or motor is running.
10	STOP	Device or motor is stopped.
11	LCKOUT	Device is locked out.
12	XFER	Device has a status of transferred.
13	--	Reserved for future use

Standard IMPACC Primary Status Codes – Continued

Status Code	Short Description	Long Description
14	--	Reserved for future use
15	--	Reserved for future use

5.2.7 Standard IMPACC Secondary Status Codes

Status Code	Short Description	Long Description
0	--	Secondary Status of the device is unknown.
1	--	Secondary Status is not applicable.
2	PROGRAM	Program mode
3	PWRUP	Powered up
4	TEST	Test
5	--	Reserved for future use
6	--	Reserved for future use
7	--	Reserved for future use
8	--	Reserved for future use
9	--	Reserved for future use
10	--	Reserved for future use
11	--	Reserved for future use
12	--	Reserved for future use
13	--	Reserved for future use
14	--	Reserved for future use
15	--	Reserved for future use

5.2.8 Standard IMPACC Cause-of-Status Codes

Cause of Status Code	Short Description	Long Description
0	--	Cause of Status is unknown.
1	NORM	Device is in Normal operating mode.
2	EXTT --	External trip – Device trip status was caused by a command sent over INCOM.
3	LDPU	Device is in Long Delay pickup (timing out to a trip).
4	LDT	Long Delay Trip
5	SDT	Short Delay Trip
6	INST	Short Delay Trip
7	DISC	Short Delay Trip
8	GNDT	Ground Trip
9	PLUG	Invalid Plug – Device has tripped due to a bad or missing rating plug.
10	NPOW --	Negative Power – Device is running with reverse (negative) power.
11	ORID	Override Trip
12	TEST	Device is in Test Trip mode.

Standard IMPACC Cause-of-Status Codes – Continued

Cause of Status Code	Short Description	Long Description
13	RAM	Device has a RAM failure.
14	ROM	Device has a ROM failure.
15	OV	Over Voltage
16	UV	Under Voltage
17	PUBL	Phase Unbalance
18	PLOS	Phase Loss
19	PREV	Reverse Phase
20	RSEQ	Reverse Sequence
21	OFRQ	Over Frequency
22	UFRQ	Under Frequency
23	NEUT	Neutral
24	L-PI	Phase Current Loss
25	L-PV	Phase Voltage Loss
26	ACT	Alarm Active
27	BAD	Bad Frame
28	HL	High Load
29	LOCKOUT	Lockout
30	POWERUP	Powered Up
31	MCR	Making Current Release
32	HI INST	High Instantaneous
33	SETMIS	Setpoints Mismatch
34	SETXFER	Setpoints Transfer Failure
35	OTEMP	Over Temperature
36	IG	Ground Current
37	FAILURE	Failure
38	ACCBUS	Accessory Bus
39	THD	THD (total harmonic distortion)
40	PF	Power Factor
41	KWDMD	kW Demand
42	KVADMD	kVA Demand
43	OPCOUNT	Operations Count
44	HISTORY	Historical (i.e., the device has tripped and been successfully reclosed)
45	--	Reserved
…		…
…		…
255	--	Reserved

5.2.9 Transmit All Standard Buffers (3 0 3)

The standard buffers are those defined by INST=3, COMM=0, and SCOMM=5 through C. Those buffers that are supported are sent in sequence starting with the SCOMM=5 buffer and ending with the SCOMM=A buffer. The first message from the slave is a data message that outlines which of the 16 standard commands are supported. The BYTE2 of the message contains the number of Expanded Buffers that are supported by the slave.

The format of the first response message is as follows.

MSB				Byte 2							Byte 1								Byte 0				LSB
0	0	Y	Y	Y	Y	Y	Y	0	0	0	0	0	CA	C9	C8	C7	C6	C5	C4	C3	C2	C1	C0

Where:

CX = 1 indicates that INST=3, COMM = 0, and SCOMM =X is supported.

YYYYYY = number of Expanded Buffers which are supported.

Note: All products respond to the with the "Transmit All Buffers" request with the message above. Bits C5-CF are set to zero if none of the standard buffers are supported.

5.2.10 Transmit Current Buffer (3 0 5)

The Current Buffer response consists of 4 data messages, each containing an IMPACC 24-bit Floating Point Number. Currents are expressed in amperes. The parameters sent are listed as follows.

Message	Description	Unit
1	Phase current IA	Amperes
2	Phase current IB	Amperes
3	Phase current IC	Amperes
4	Current IX (Note)	Amperes

Note: Current IX will usually be ground current. For some products, this current may be either fourth pole current or neutral current. These latter cases will not have ground current.

5.2.11 Transmit Line-to-Line Voltage Buffer (3 0 6)

The Line-to-Line Voltage Buffer response consists of 3 data messages, each containing an IMPACC 24-Bit Floating Point number. Voltage is expressed in volts. The parameters sent are listed as follows.

Message	Description	Unit
1	Line-to-line voltage VAB	Volts
2	Line-to-line voltage VBC	Volts
3	Line-to-line voltage VCA	Volts

5.2.12 Transmit Line-to-Neutral Voltage Buffer (3 0 7)

The Line-to-Neutral Voltage Buffer response consists of 3 data messages, each containing an IMPACC 24-Bit Floating Point number. Voltage is expressed in volts. The parameters sent are listed as follows.

Message	Description	Unit
1	Line-to-neutral voltage VAN	Volts
2	Line-to-neutral voltage VBN	Volts
3	Line-to-neutral voltage VCN	Volts

5.2.13 Transmit Power Buffer(1) (3 0 8)

The Power Buffer(1) response consists of 3 data messages, each containing an IMPACC 24-Bit Floating Point number. The parameters sent are outlined below. The first is the system's present power value in watts, the second is the power demand, and the third is the energy in units of watt-hours.

Message	Description	Unit
1	Power	Watts
2	Power demand watts	
3	Energy	Watt-hours

5.2.14 Transmit Power Buffer(2) (3 0 9)

The Power Buffer response consists of 3 data messages, each containing an IMPACC 24-Bit Floating Point number. The parameters sent are outlined below. The first is the system's present frequency, the second is vars, and the third is power factor.

Message	Description	Unit
1	Frequency	Hertz
2	Reactive power	Vars
3	Power factor	

5.2.15 Transmit Energy Buffer (3 0 A)

The Energy Buffer response consists of 1 data message. This data message contains a 24-bit unsigned integer number representing the value for energy in units of kilowatt-hours.

The maximum range for energy is 0-16,777,215 kWh.

5.2.16 Transmit Saved Energy Buffer (3 0 B)

The Saved Energy Buffer response consists of 5 data messages containing 3 energy values.

Message	Byte	Description	
1	Byte0	Reserved	
	Byte1	Reserved	
	Byte2	Bit	Definition
		B0	1=First time (3 0 B) buffer has been polled since the Save Energy command was received.
		B1	0=Values are 32-bit data word format (0 - 999,999,999) Rollover occurs at 999,999,999 kWh/kVAh. 1=Values are per the following format: Energy=(B3 * 65,536)+(B2 * 256)+B1+(B0 / 256) Rollover occurs at 9,999,999 kWh/kVAh.
		B2	1=Energy (forward) value is available.
		B3	1=Energy (reverse) value is available.
		B4	1=kVAh value is available.
		B5-B6	Reserved
		B7	1=Set when Energy has been reset to zero (either as a result of a Slave Action command or power-up initialization). Reset upon Slave Action (3 0 6).
2	Byte0	Energy (forward) Byte0	(kWh)
	Byte1	Energy (forward) Byte1	
	Byte2	Energy (forward) Byte2	
3	Byte0	Energy (forward) Byte3	
	Byte1	Energy (reverse) Byte0	(kWh)
	Byte2	Energy (reverse) Byte1	
4	Byte0	Energy (reverse) Byte2	
	Byte1	Energy (reverse) Byte3	
	Byte2	kVAhours Byte0	(kVAh)
5	Byte0	kVAh Byte1	
	Byte1	kVAh Byte2	
	Byte2	kVAh Byte3	

5.2.17 Transmit Saved Reactive Energy Buffer (3 0 C)

The Saved Reactive Energy Buffer response consists of 4 data messages containing 2 energy values.

Message	Byte	Description		
1	Byte0	Reserved		
	Byte1	Reserved		
	Byte2	Bit	Definition	
		B0	1=First time (3 0 C) buffer has been polled since the Save Energy command was received.	
		B1	0=Values are 32-bit data word format. (0 - 999,999,999) Rollover occurs at 999,999,999 kWh/kVAh. 1=Values are per the following format: Energy=(B3 * 65536)+(B2 * 256)+B1+(B0 / 256) Rollover occurs at 9,999,999 kWh/kVAh.	
		B2	1=kVARh (leading) value is available.	
		B3	1=kVARh (lagging) value is available.	
		B4-B6	Reserved	
		B7	1=Set when Energy has been reset to zero (either as a result of a Slave Action command or power-up initialization). Reset upon Slave Action (3 0 6).	
2	Byte0	kVARh (leading) Byte0		(kVARh)
	Byte1	kVARh (leading) Byte1		
	Byte2	kVARh (leading) Byte2		
3	Byte0	kVARh (leading) Byte3		
	Byte1	kVARh (lagging) Byte0		(kVARh)
	Byte2	kVARh (lagging) Byte1		
4	Byte0	kVARh (lagging) Byte2		
	Byte1	kVARh (lagging) Byte3		
	Byte2	Reserved		

5.2.18 Transmit Supported Standard Buffer List (3 0 F) N = 000000

Message	Byte	Description
1	Byte0	Number of additional data messages = X-1
	Byte1	(3 0 x) Expanded Slave Mode Buffers Supported – LSB
	Byte2	(3 0 x) Expanded Slave Mode Buffers Supported – MSB
2		(3 0 F) Expanded Buffer Supported List
X		(3 0 F) Expanded Buffer Supported List

The (3 0 x) Expanded Slave Mode Buffers Supported bits (Message 1, Bytes 1 and 2) are defined as follows:

MSB		Byte 2								Byte 1					LSB
CF	CE	CD	CC	CB	CA	C9	C8	C7	C6	C5	C4	C3	C2	C1	C0

Where:

CX=1 indicates that INST=3, COMM = 0, and SCOMM=X is supported.

Each message of the (3 0 F) Expanded Buffer Supported List (messages 2 through X) contains an expanded buffer number (N) that the product supports. This list may vary with communications versions.

5.2.18.1 *Transmit Temperature Buffer (N=000001)*

This buffer consists of the temperature in degrees Celsius for 6 motor windings temperatures, 2 motor bearings temperatures, 2 load bearings temperature and 1 ambient temperature. The buffer is sent as 5 data messages with bytes defined as follows.

Message	Byte	Description
1	Byte0	Number of additional data messages
	Byte1	Winding Temperature 1
	Byte2	Winding Temperature 2
2	Byte0	Winding Temperature 3
	Byte1	Winding Temperature 4
	Byte2	Winding Temperature 5
3	Byte0	Winding Temperature 6
	Byte1	Motor Bearing 1 Temperature
	Byte2	Motor Bearing 2 Temperature
4	Byte0	Load Bearing 1 Temperature
	Byte1	Load Bearing 2 Temperature
	Byte2	Auxiliary Temperature
5	Byte0	VALIDITY 1
	Byte1	VALIDITY 2
	Byte2	

Temperatures are presented as binary numbers, range 0 to 255 degrees Celsius. The VALIDITY bytes are used to represent the presence of a selected sensor. The VALIDITY bytes are defined as follows:

```
VALIDITY 1 = b7    b6    b5    b4    b3    b2    b1    b0
             MB2   MB1   WT6   WT5   WT4   WT3   WT2   WT1


VALIDITY 2 = b7    b6    b5    b4    b3    b2    b1    b0
                                     DEV   AUX   LB2   LB1
```

If a bit is set, its associated temperature is valid. The DEV bit represents a device interface control bit.

5.2.18.2 Transmit Demand Currents(1) Buffer (N=000002)

The Transmit Demand Currents Buffer response consists of four data messages, each containing an IMPACC 24-Bit Floating Point Number. Currents are expressed in amperes. The parameters sent are outlined below.

Message	Byte	Description	Unit	Format
1	Byte0	No. of additional msgs = 4		
2		Peak demand current phase A	amps	IMPACC 24-Bit Float
3		Peak demand current phase B	amps	IMPACC 24-Bit Float
4		Peak demand current phase C	amps	IMPACC 24-Bit Float
5		Peak demand current phase X	amps	IMPACC 24-Bit Float

Note: Peak demand current phase X will usually be ground current. For some products, this current may be either fourth pole current or neutral current. These latter cases will not have ground current.

5.2.18.3 Transmit Currents Buffer (N=000003)

Message	Byte	Description	Unit	Format
1	Byte0	No. of additional msgs = 6		
2		Phase A current	amps	IMPACC 24-Bit Float
3		Phase B current	amps	IMPACC 24-Bit Float
4		Phase C current	amps	IMPACC 24-Bit Float
5		Ground current	amps	IMPACC 24-Bit Float
6		Neutral current	amps	IMPACC 24-Bit Float
7		Average phase current	amps	IMPACC 24-Bit Float

5.2.18.4 Transmit Line-to-Line Voltage Buffer (N=000004)

Message	Byte	Description	Unit	Format
1	Byte0	No. of additional msgs = 4		
2		Line-to-line voltage VAB	volts	IMPACC 24-Bit Float
3		Line-to-line voltage VBC	volts	IMPACC 24-Bit Float
4		Line-to-line voltage VCA	volts	IMPACC 24-Bit Float
5		Average line-to-line voltage	volts	IMPACC 24-Bit Float

5.2.18.5 Transmit Line-to-Neutral Voltage Buffer (N=000005)

Message	Byte	Description	Units	Format
1	Byte 0	No. of additional msgs = 5		
2		Line-to-neutral voltage VAN	volts	IMPACC 24-Bit Float
3		Line-to-neutral voltage VBN	volts	IMPACC 24-Bit Float
4		Line-to-neutral voltage VCN	volts	IMPACC 24-Bit Float
5		Average line-to-neutral voltage	volts	IMPACC 24-Bit Float
6		Neutral-to-ground voltage	volts	IMPACC 24-Bit Float

5.2.18.6 Transmit Power Buffer (N=000006)

Message	Byte	Description	Unit	Format
1	Byte 0	No. of additional msgs = 8		
2		Real power – 3-phase	watts	IMPACC 24-Bit Float
3		Reactive power – 3-phase	vars	IMPACC 24-Bit Float
4		Voltamperes – 3-phase	VA	IMPACC 24-Bit Float
5		PF displacement – 3-phase		IMPACC 24-Bit Float
6		PF apparent – 3-phase		IMPACC 24-Bit Float
7		Frequency	Hz	IMPACC 24-Bit Float
8		K-Factor		IMPACC 24-Bit Float
9		THD Factor		IMPACC 24-Bit Float

5.2.18.7 Transmit Per-Phase Power Buffer (N=000007)

Message	Byte	Description	Unit	Format
1	Byte 0	No. of additional msgs = 15		
2		Real power – phase A	watts	IMPACC 24-Bit Float
3		Real power – phase B	watts	IMPACC 24-Bit Float
4		Real power – phase C	watts	IMPACC 24-Bit Float
5		Reactive power – phase A	vars	IMPACC 24-Bit Float
6		Reactive power – phase B	vars	IMPACC 24-Bit Float
7		Reactive power – phase C	vars	IMPACC 24-Bit Float
8		Voltamperes – phase A	VA	IMPACC 24-Bit Float
9		Voltamperes – phase B	VA	IMPACC 24-Bit Float
10		Voltamperes – phase C	VA	IMPACC 24-Bit Float
11		PF displacement – phase A		IMPACC 24-Bit Float
12		PF displacement – phase B		IMPACC 24-Bit Float
13		PF displacement – phase C		IMPACC 24-Bit Float
14		PF apparent – phase A		IMPACC 24-Bit Float
15		PF apparent – phase B		IMPACC 24-Bit Float
16		PF apparent – phase C		IMPACC 24-Bit Float

5.2.18.8 *Transmit System Energy Buffer (N=000008)*

Message	Byte	Description	Unit	Format
1	Byte0	No. of additional msgs = 12		
	Byte1	Engineering Units power of 10 3=K units, 6=M units		
	Byte2	Reserved = 0		
2	Byte0	watt-hours (fwd) Byte0	xxWh	32-bit unsigned integer
	Byte1	watt-hours (fwd) Byte1		
	Byte2	watt-hours (fwd) Byte2		
3	Byte0	watt-hours (fwd) Byte3		
	Byte1	watt-hours (rev) Byte0	xxWh	32-bit unsigned integer
	Byte2	watt-hours (rev) Byte1		
4	Byte0	watt-hours (rev) Byte2		
	Byte1	watt-hours (rev) Byte3		
	Byte2	watt-hours (net) Byte0	xxWh	32-bit signed integer
5	Byte0	watt-hours (net) Byte1		
	Byte1	watt-hours (net) Byte2		
	Byte2	watt-hours (net) Byte3		
6	Byte0	var-hours (leading) Byte0	xxVARh	32-bit unsigned integer
	Byte1	var-hours (leading) Byte1		
	Byte2	var-hours (leading) Byte2		
7	Byte0	var-hours (leading) Byte3		
	Byte1	var-hours (lagging) Byte0	xxVARh	32-bit unsigned integer
	Byte2	var-hours (lagging) Byte1		
8	Byte0	var-hours (lagging) Byte2		
	Byte1	varhours (lagging) Byte3		
	Byte2	var-hours (net) Byte0	xxVARh	32-bit signed integer

Transmit System Energy Buffer (N=000008) – Continued

Message	Byte	Description	Unit	Format
9	Byte0	var-hours (net) Byte1		
	Byte1	var-hours (net) Byte2		
	Byte2	var-hours (net) Byte3		
10	Byte0	VA-hours Byte0	xxVAh	32-bit unsigned integer
	Byte1	VA-hours Byte1		
	Byte2	VA-hours Byte2		
11	Byte0	VA-hours Byte3		
	Byte1	Time last reset – Hour (0-23)		Packed BCD
	Byte2	Time last reset – Minute (0-59)		
12	Byte0	Time last reset – Second (0-59)		
	Byte1	Date last reset – Month (1-12)		
	Byte2	Date last reset – Day (1-31)		
13	Byte0	Date last reset – Year (0-99)		
	Byte1	Reserved		
	Byte2	Reserved		

Note: All time and dates in buffers N=0x08,0x0A, 0x0B, 0x0C, 0x0D, 0x0E, 0x0F, 0x10, 0x11, 0x12, 0x13, 0x14, 0x15, 0x16, 0x17, 0x18, 0x20, 0x21, 0x25, 0x26, 0x27, 0x29, 0x2C, 0x2F, 0x32, 0x33, 0x3C, 0x3D, 0x3E,0x3F,0x42, and 0x43 are in the following format:

Name	Byte	Description	Format	
Time	Byte0	Hour (0-23)	Packed BCD	
	Byte1	Minute (0-59)	Packed BCD	
	Byte2	Second (0-59)	Packed BCD	
Date	Byte0	Month (1-12)	Packed BCD	Note: Month=0 indicates the time
	Byte1	Day (1-31)	Packed BCD	and date are not
	Byte2	Year (0-99)	Packed BCD	available.

5.2.18.9 Transmit Total Harmonic Distortion (THD) Buffer (N=000009)

Message	Byte	Description	Unit	Format
1	Byte 0	No. of additional msgs = 10		
2		% THD – phase A current	%	IMPACC 24-Bit Float
3		% THD – phase B current	%	IMPACC 24-Bit Float
4		% THD – phase C current	%	IMPACC 24-Bit Float
5		% THD – neutral current	%	IMPACC 24-Bit Float
6		% THD – L-L voltage VAB	%	IMPACC 24-Bit Float
7		% THD – L-L voltage VBC	%	IMPACC 24-Bit Float
8		% THD – L-L voltage VCA	%	IMPACC 24-Bit Float
9		% THD – L-N voltage VAN	%	IMPACC 24-Bit Float
10		% THD – L-N voltage VBN	%	IMPACC 24-Bit Float
11		% THD – L-N voltage VCN	%	IMPACC 24-Bit Float

5.2.18.10 Transmit Demand Current and Peak Demand Average Current Buffer (N=00000A)

Message	Byte	Description	Unit	Format
1	Byte 0	No. of additional msgs = 8		
	Byte 1	Demand Window	minutes	
	Byte 2	Reserved		
2		Demand current (3-phase avg)	amps	IMPACC 24-Bit Float
3		End time of last demand window		
4		Date of last demand window		
5		Peak demand current (3-phase average)	amps	IMPACC 24-Bit Float
6		Time of peak		
7		Date of peak		
8		Time last reset		
9		Date last reset		

5.2.18.11 *Transmit Demand and Peak Demand Currents Buffer* (N=00000B)

Message	Byte	Description	Unit	Format
1	Byte0	No. of additional msgs = 16		
	Byte1	Demand Window	minutes	
	Byte2	Reserved		
2		Demand current phase A	amps	IMPACC 24-Bit Float
3		Demand current phase B	amps	IMPACC 24-Bit Float
4		Demand current phase C	amps	IMPACC 24-Bit Float
5		End time of last demand window		
6		Date of last demand window		
7		Peak demand current phase A	amps	IMPACC 24-Bit Float
8		Time		
9		Date		
10		Peak demand current phase B	amps	IMPACC 24-Bit Float
11		Time		
12		Date		
13		Peak demand current phase C	amps	IMPACC 24-Bit Float
14		Time		
15		Date		
16		Time last reset		
17		Date last reset		

5.2.18.12 Transmit Peak Demand Power Buffer (N=00000C)

Message	Byte	Description	Unit	Format
1	Byte0	No. of additional msgs = 16		
	Byte1	Demand Window	minutes	
	Byte2	Reserved		
2		Demand watts (real power)	watts	IMPACC 24-Bit Float
3		Demand vars (reactive power)	vars	IMPACC 24-Bit Float
4		Demand VA (apparent power)	VA	IMPACC 24-Bit Float
5		End time of last demand window		
6		Date of last demand window		
7		Peak demand (real power)	watts	IMPACC 24-Bit Float
8		Time		
9		Date		
10		Peak demand (reactive power)	vars	IMPACC 24-Bit Float
11		Time		
12		Date		
13		Peak demand (apparent power)	VA	IMPACC 24-Bit Float
14		Time		
15		Date		
16		Time last reset		
17		Date last reset		

5.2.18.13 *Transmit Min/Max Current Buffer (N=00000D)*

Message	Byte	Description	Unit	Format
1	Byte0	No. of additional msgs = 32		
2		Minimum – phase A current	amps	IMPACC 24-Bit Float
3		Time		
4		Date		
5		Maximum – phase A current	amps	IMPACC 24-Bit Float
6		Time		
7		Date		
8		Minimum – phase B current	amps	IMPACC 24-Bit Float
9		Time		
10		Date		
11		Maximum – phase B current	amps	IMPACC 24-Bit Float
12		Time		
13		Date		
14		Minimum – phase C current	amps	IMPACC 24-Bit Float
15		Time		
16		Date		
17		Maximum – phase C current	amps	IMPACC 24-Bit Float
18		Time		
19		Date		
20		Minimum – ground current	amps	IMPACC 24-Bit Float
21		Time		
22		Date		
23		Maximum – ground current	amps	IMPACC 24-Bit Float
24		Time		
25		Date		
26		Minimum – neutral current	amps	IMPACC 24-Bit Float
27		Time		
28		Date		
29		Maximum – neutral current	amps	IMPACC 24-Bit Float
30		Time		
31		Date		
32		Time last reset		
33		Date last reset		

5.2.18.14 Transmit Min/Max L-L Voltage Buffer (N=00000E)

Message	Byte	Description	Unit	Format
1	Byte0	No. of additional msgs = 20		
2		Minimum – L-L voltage VAB	volts	IMPACC 24-Bit Float
3		Time		
4		Date		
5		Maximum – L-L voltage VAB	volts	IMPACC 24-Bit Float
6		Time		
7		Date		
8		Minimum – L-L voltage VBC	volts	IMPACC 24-Bit Float
9		Time		
10		Date		
11		Maximum – L-L voltage VBC	volts	IMPACC 24-Bit Float
12		Time		
13		Date		
14		Minimum – L-L voltage VCA	volts	IMPACC 24-Bit Float
15		Time		
16		Date		
17		Maximum – L-L voltage VCA	volts	IMPACC 24-Bit Float
18		Time		
19		Date		
20		Time last reset		
21		Date last reset		

5.2.18.15 *Transmit Min/Max L-N Voltage Buffer (N=00000F)*

Message	Byte	Description	Unit	Format
1	Byte0	No. of additional msgs = 26		
2		Minimum – L-N voltage VAN	volts	IMPACC 24-Bit Float
3		Time		
4		Date		
5		Maximum – L-N voltage VAN	volts	IMPACC 24-Bit Float
6		Time		
7		Date		
8		Minimum – L-N voltage VBN	volts	IMPACC 24-Bit Float
9		Time		
10		Date		
11		Maximum – L-N voltage VBN	volts	IMPACC 24-Bit Float
12		Time		
13		Date		
14		Minimum -– L-N voltage VCN	volts	IMPACC 24-Bit Float
15		Time		
16		Date		
17		Maximum – L-N voltage VCN	volts	IMPACC 24-Bit Float
18		Time		
19		Date		
20		Minimum – neutral-ground vltg	volts	IMPACC 24-Bit Float
21		Time		
22		Date		
23		Maximum – neutral-ground vltg	volts	IMPACC 24-Bit Float
24		Time		
25		Date		
26		Time last reset		
27		Date last reset		

5.2.18.16 *Transmit Min/Max PF-Displacement Buffer (N=000010)*

Message	Byte	Description	Format
1	Byte0	No. of additional msgs = 26	
2		Minimum – phase A PF (disp)	IMPACC 24-Bit Float
3		Time	
4		Date	
5		Maximum – phase A PF (disp)	IMPACC 24-Bit Float
6		Time	
7		Date	
8		Minimum -– phase B PF (disp)	IMPACC 24-Bit Float
9		Time	
10		Date	
11		Maximum – phase B PF (disp)	IMPACC 24-Bit Float
12		Time	
13		Date	
14		Minimum – phase C PF (disp)	IMPACC 24-Bit Float
15		Time	
16		Date	
17		Maximum – phase C PF (disp)	IMPACC 24-Bit Float
18		Time	
19		Date	
20		Minimum – system PF (disp)	IMPACC 24-Bit Float
21		Time	
22		Date	
23		Maximum – system PF (disp)	IMPACC 24-Bit Float
24		Time	
25		Date	
26		Time last reset	
27		Date last reset	

5.2.18.17 Transmit Min/Max PF-Apparent Buffer (N=000011)

Message	Byte	Description	Format
1	Byte0	No. of additional msgs = 26	
2		Minimum – phase A PF (apparent)	IMPACC 24-Bit Float
3		Time	
4		Date	
5		Maximum – phase A PF (apparent)	IMPACC 24-Bit Float
6		Time	
7		Date	
8		Minimum – phase B PF (apparent)	IMPACC 24-Bit Float
9		Time	
10		Date	
11		Maximum – phase B PF (apparent)	IMPACC 24-Bit Float
12		Time	
13		Date	
14		Minimum – phase C PF (apparent)	IMPACC 24-Bit Float
15		Time	
16		Date	
17		Maximum – phase C PF (apparent)	IMPACC 24-Bit Float
18		Time	
19		Date	
20		Minimum – system PF (apparent)	IMPACC 24-Bit Float
21		Time	
22		Date	
23		Maximum – system PF (apparent)	IMPACC 24-Bit Float
24		Time	
25		Date	
26		Time last reset	
27		Date last reset	

5.2.18.18 *Transmit Min/Max Power/Frequency Buffer (N=000012)*

Message	Byte	Description	Format
1	Byte0	No. of additional msgs = 26	
2		Minimum – real power	IMPACC 24-Bit Float
3		Time	
4		Date	
5		Maximum – real power	IMPACC 24-Bit Float
6		Time	
7		Date	
8		Minimum –reactive power	IMPACC 24-Bit Float
9		Time	
10		Date	
11		Maximum – reactive power	IMPACC 24-Bit Float
12		Time	
13		Date	
14		Minimum – voltamperes	IMPACC 24-Bit Float
15		Time	
16		Date	
17		Maximum – voltamperes	IMPACC 24-Bit Float
18		Time	
19		Date	
20		Minimum – frequency	IMPACC 24-Bit Float
21		Time	
22		Date	
23		Maximum – frequency	IMPACC 24-Bit Float
24		Time	
25		Date	
26		Time last reset	
27		Date last reset	

5.2.18.19 Transmit Min/Max Current %THD Buffer (N=000013)

Message	Byte	Description	Format
1	Byte0	No. of additional msgs = 26	
2		Minimum – % THD phase A current	IMPACC 24-Bit Float
3		Time	
4		Date	
5		Maximum – % THD phase A current	IMPACC 24-Bit Float
6		Time	
7		Date	
8		Minimum – % THD phase B current	IMPACC 24-Bit Float
9		Time	
10		Date	
11		Maximum – % THD phase B current	IMPACC 24-Bit Float
12		Time	
13		Date	
14		Minimum – % THD phase C current	IMPACC 24-Bit Float
15		Time	
16		Date	
17		Maximum – % THD phase C current	IMPACC 24-Bit Float
18		Time	
19		Date	
20		Minimum – % THD phase neut. current	IMPACC 24-Bit Float
21		Time	
22		Date	
23		Maximum – % THD phase neut. current	IMPACC 24-Bit Float
24		Time	
25		Date	
26		Time last reset	
27		Date last reset	

5.2.18.20 Transmit Min/Max Voltage %THD Buffer (N=000014)

Message	Byte	Description	Unit	Format
1	Byte0	No. of additional msgs = 38		
2		Minimum – % THD L-L voltage	VAB	IMPACC 24-Bit Float
3		Time		
4		Date		
5		Maximum – % THD L-L voltage	VAB	IMPACC 24-Bit Float
6		Time		
7		Date		
8		Minimum – % THD L-L voltage	VBC	IMPACC 24-Bit Float
9		Time		
10		Date		
11		Maximum – % THD L-L voltage	VBC	IMPACC 24-Bit Float
12		Time		
13		Date		
14		Minimum – % THD L-L voltage	VCA	IMPACC 24-Bit Float
15		Time		
16		Date		
17		Maximum – % THD L-L voltage	VCA	IMPACC 24-Bit Float
18		Time		
19		Date		
20		Minimum – % THD L-N voltage	VAN	IMPACC 24-Bit Float
21		Time		
22		Date		
23		Maximum – % THD L-N voltage	VAN	IMPACC 24-Bit Float
24		Time		
25		Date		
26		Minimum – % THD L-N voltage	VBN	IMPACC 24-Bit Float
27		Time		
28		Date		
29		Maximum – % THD L-N voltage	VBN	IMPACC 24-Bit Float
30		Time		
31		Date		
32		Minimum – % THD L-N voltage	VCN	IMPACC 24-Bit Float
33		Time		

Transmit Min/Max Voltage %THD Buffer (N=000014) – Continued

Message	Byte	Description	Unit	Format
34		Date		
35		Maximum – % THD L-N voltage	VCN	IMPACC 24-Bit Float
36		Time		
37		Date		
38		Time last reset		
39		Date last reset		

5.2.18.21 *Transmit Crest Factor Buffer (N=000015)*

Message	Byte	Description
1	Byte0	Number of additional msgs = 7
	Byte1	IA crest factor x 256 – low byte
	Byte2	IA crest factor x 256 – high byte
2	Byte0	IB crest factor x 256 – low byte
	Byte1	IB crest factor x 256 – high byte
	Byte2	IC crest factor x 256 – low byte
3	Byte0	IC crest factor x 256 – high byte
	Byte1	IG crest factor x 256 – low byte
	Byte2	IG crest factor x 256 – high byte
4	Byte0	In crest factor x 256 – low byte In
	Byte1	crest factor x 256 – high byte
	Byte2	VAN crest factor x 256 – low byte
5	Byte0	VAN crest factor x 256 – high byte
	Byte1	VBN crest factor x 256 – low byte
	Byte2	VBN crest factor x 256 – high byte
6	Byte0	VCN crest factor x 256 – low byte
	Byte1	VCN crest factor x 256 – high byte
	Byte2	VAB crest factor x 256 – low byte
7	Byte0	VAB crest factor x 256 – high byte
	Byte1	VBC crest factor x 256 – low byte
	Byte2	VBC crest factor x 256 – high byte
8	Byte0	VCA crest factor x 256 – low byte
	Byte1	VCA crest factor x 256 – high byte
	Byte2	Reserved

5.2.18.22 Transmit Min/Max Per Phase Real Power Buffer (N=000016)

Message	Byte	Description	Unit	Format
1	Byte0	No. of additional msgs=20	watts	
2		Minimum – Real power phase A	watts	IMPACC 24-Bit Float
3		Time		
4		Date		
5		Maximum – Real power phase A	watts	IMPACC 24-Bit Float
6		Time		
7		Date		
8		Minimum – Real power phase B	watts	IMPACC 24-Bit Float
9		Time		
10		Date		
11		Maximum – Real power phase B	watts	IMPACC 24-Bit Float
12		Time		
13		Date		
14		Minimum – Real power phase C	watts	IMPACC 24-Bit Float
15		Time		
16		Date		
17		Maximum – Real power phase C	watts	IMPACC 24-Bit Float
18		Time		
19		Date		
20		Time last reset		
21		Date last reset		

5.2.18.23 Transmit Min/Max Per Phase Reactive Power Buffer (N=000017)

Message	Byte	Description	Unit	Format
1	Byte0	No. of additional msgs = 20		
2		Minimum – Reactive power phase A	vars	IMPACC24-Bit Float
3		Time		
4		Date		
5		Maximum – Reactive power phase A	vars	IMPACC 24-Bit Float
6		Time		
7		Date		
8		Minimum – Reactive power phase B	vars	IMPACC 24-Bit Float
9		Time		
10		Date		
11		Maximum – Reactive power phase B	vars	IMPACC 24-Bit Float
12		Time		
13		Date		
14		Minimum – Reactive power phase C	vars	IMPACC 24-Bit Float
15		Time		
16		Date		
17		Maximum – Reactive power phase C	vars	IMPACC 24-Bit Float
18		Time		
19		Date		
20		Time last reset		
21		Date last reset		

5.2.18.24 Transmit Min/Max Per Phase Volt Ampere (Apparent Power) Buffer (N=000018)

Message	Byte	Description	Unit	Format
1	Byte0	No. of additional msgs =20		
2		Minimum – VA phase A	VA	IMPACC 24-Bit Float
3		Time		
4		Date		
5		Maximum – VA phase A	VA	IMPACC 24-Bit Float
6		Time		
7		Date		
8		Minimum – VA phase B	VA	IMPACC 24-Bit Float
9		Time		
10		Date		
11		Maximum – VA phase B	VA	IMPACC 24-Bit Float
12		Time		
13		Date		
14		Minimum – VA phase C	VA	IMPACC 24-Bit Float
15		Time		
16		Date		
17		Maximum – VA phase C	VA	IMPACC 24-Bit Float
18		Time		
19		Date		
20		Time last reset		
21		Date last reset		

5.2.18.25 Transmit Min/Max Currents Buffer (N=000019)

Message	Byte	Description	Unit	Format
1	Byte0	No. of additional msgs= 10		
2		Minimum – phase A current	amps	IMPACC 24-Bit Float
3		Maximum – phase A current	amps	IMPACC 24-Bit Float
4		Minimum – phase B current	amps	IMPACC 24-Bit Float
5		Maximum – phase B current	amps	IMPACC 24-Bit Float
6		Minimum – phase C current	amps	IMPACC 24-Bit Float
7		Maximum – phase C current	amps	IMPACC 24-Bit Float
8		Minimum – Ground current	amps	IMPACC 24-Bit Float
9		Maximum – Ground current	amps	IMPACC 24-Bit Float
10		Minimum – Neutral current	amps	IMPACC 24-Bit Float
11		Maximum – Neutral current	amps	IMPACC 24-Bit Float

5.2.18.26 Transmit Demand and Peak Demand Current Buffer (N=00001A)

Message	Byte	Description	Unit	Format
1	Byte0	No. of additional msgs = 10		
	Byte1	5-minute window update counter (range: 0-251)		
	Byte2	Optional – demand window period (1-60 minutes)		
2		Demand current (window) ph A	amps	IMPACC 24-Bit Float
3		Demand current (window) ph B	amps	IMPACC 24-Bit Float
4		Demand current (window) ph C	amps	IMPACC 24-Bit Float
5		Demand ground current (window)	amps	IMPACC 24-Bit Float
6		Demand neutral current (window)	amps	IMPACC 24-Bit Float
7		Peak demand current phase A	amps	IMPACC 24-Bit Float
8		Peak demand current phase B	amps	IMPACC 24-Bit Float
9		Peak demand current phase C	amps	IMPACC 24-Bit Float
10		Peak demand current ground	amps	IMPACC 24-Bit Float
11		Peak demand current neutral	amps	IMPACC 24-Bit Float

5.2.18.27 Transmit Demand and Peak Demand Power Buffer (N=00001B)

Message	Byte	Description	Unit	Format
1	Byte0	No. of additional msgs= 6		
	Byte1	5-minute window update counter (range: 0-251)		
	Byte2	Demand window period (1-60 minutes)		
2		Demand watts (window)	watts	IMPACC 24-Bit Float
3		Demand vars (window)	vars	IMPACC 24-Bit Float
4		Demand voltamperes (window)	VA	IMPACC 24-Bit Float
5		Peak demand watts	watts	IMPACC 24-Bit Float
6		Peak demand vars	vars	IMPACC 24-Bit Float
7		Peak demand voltamperes	VA	IMPACC 24-Bit Float

5.2.18.28 Transmit Min/Max Voltage Buffer (N=00001C)

Message	Byte	Description	Unit	Format
1	Byte0	No. of additional msgs = 14		
2		Minimum L-L voltage VAB	volts	IMPACC 24-Bit Float
3		Maximum L-L voltage VAB	volts	IMPACC 24-Bit Float
4		Minimum L-L voltage VBC	volts	IMPACC 24-Bit Float
5		Maximum L-L voltage VBC	volts	IMPACC 24-Bit Float
6		Minimum L-L voltage VCA	volts	IMPACC 24-Bit Float
7		Maximum L-L voltage VCA	volts	IMPACC 24-Bit Float
8		Minimum L-N voltage VAN	volts	IMPACC 24-Bit Float
9		Maximum L-N voltage VAN	volts	IMPACC 24-Bit Float
10		Minimum L-N voltage VBN	volts	IMPACC 24-Bit Float
11		Maximum L-N voltage VBN	volts	IMPACC 24-Bit Float
12		Minimum L-N voltage VCN	volts	IMPACC 24-Bit Float
13		Maximum L-N voltage VCN	volts	IMPACC 24-Bit Float
14		Minimum N-G voltage	volts	IMPACC 24-Bit Float
15		Maximum N-G voltage	volts	IMPACC 24-Bit Float

5.2.18.29 Transmit Min/Max Power/Frequency/Power Factor Buffer (N=00001D)

Message	Byte	Description	Unit	Format
1	Byte0	No. of additional msgs=12		
2		Minimum real power	watts	IMPACC 24-Bit Float
3		Maximum real power	watts	IMPACC 24-Bit Float
4		Minimum reactive power	vars	IMPACC 24-Bit Float
5		Maximum reactive power	vars	IMPACC 24-Bit Float
6		Minimum volt-amperes	VA	IMPACC 24-Bit Float
7		Maximum volt-amperes	VA	IMPACC 24-Bit Float
8		Minimum frequency	Hz	IMPACC 24-Bit Float
9		Maximum frequency	Hz	IMPACC 24-Bit Float
10		Minimum system PF (disp)		IMPACC 24-Bit Float
11		Maximum system PF (disp)		IMPACC 24-Bit Float
12		Minimum system PF (apparent)		IMPACC 24-Bit Float
13		Maximum system PF (apparent)		IMPACC 24-Bit Float

5.2.18.30 Transmit Min/Max Current % THD Buffer (N=00001E)

Message	Byte	Description	Unit	Format
1	Byte0	No. of additional msgs= 8		
2		Minimum ph. A current %THD	%	IMPACC 24-Bit Float
3		Maximum ph. A current %THD	%	IMPACC 24-Bit Float
4		Minimum ph. B current %THD	%	IMPACC 24-Bit Float
5		Maximum ph. B current %THD	%	IMPACC 24-Bit Float
6		Minimum ph. C current %THD	%	IMPACC 24-Bit Float
7		Maximum ph. C current %THD	%	IMPACC 24-Bit Float
8		Minimum neutral current %THD	%	IMPACC 24-Bit Float
9		Maximum neutral current %THD	%	IMPACC 24-Bit Float

5.2.18.31 *Transmit Min/Max Voltage % THD Buffer (N=00001F)*

Message	Byte	Description	Unit	Format
1	Byte0	No. of additional msgs = 12		
2		Minimum L-L voltage VAB %THD	%	IMPACC 24-Bit Float
3		Maximum L-L voltage VAB %THD	%	IMPACC 24-Bit Float
4		Minimum L-L voltage VBC %THD	%	IMPACC 24-Bit Float
5		Maximum L-L voltage VBC %THD	%	IMPACC 24-Bit Float
6		Minimum L-L voltage VCA %THD	%	IMPACC 24-Bit Float
7		Maximum L-L voltage VCA %THD	%	IMPACC 24-Bit Float
8		Minimum L-N voltage VAN %THD	%	IMPACC 24-Bit Float
9		Maximum L-N voltage VAN %THD	%	IMPACC 24-Bit Float
10		Minimum L-N voltage VBN %THD	%	IMPACC 24-Bit Float
11		Maximum L-N voltage VBN %THD	%	IMPACC 24-Bit Float
12		Minimum L-N voltage VCN %THD	%	IMPACC 24-Bit Float
13		Maximum L-N voltage VCN %THD	%	IMPACC 24-Bit Float

5.2.18.32 Transmit Min/Max Current THD Magnitude Buffer (N=000020)

Message	Byte	Description	Format
1	Byte0	No. of additional msgs = 26	
2		Minimum ph A current THD magnitude	IMPACC 24-Bit Float
3		Time	
4		Date	
5		Maximum ph A current THD magnitude	IMPACC 24-Bit Float
6		Time	
7		Date	
8		Minimum ph B current THD magnitude	IMPACC 24-Bit Float
9		Time	
10		Date	
11		Maximum ph B current THD magnitude	IMPACC 24-Bit Float
12		Time	
13		Date	
14		Minimum ph C current THD magnitude	IMPACC 24-Bit Float
15		Time	
16		Date	
17		Maximum ph C current THD magnitude	IMPACC 24-Bit Float
18		Time	
19		Date	
20		Minimum neut. current THD magnitude	IMPACC 24-Bit Float
21		Time	
22		Date	
23		Maximum neut. current THD magnitude	IMPACC 24-Bit Float
24		Time	
25		Date	
26		Time last reset	
27		Date last reset	

5.2.18.33 Transmit Min/Max Voltage THD Magnitude Buffer (N=000021)

Message	Byte	Description	Format
1	Byte0	No. of additional msgs = 38	
2		Minimum voltage VAB THD magnitude	IMPACC 24-Bit Float
3		Time	
4		Date	
5		Maximum voltage VAB THD magnitude	IMPACC 24-Bit Float
6		Time	
7		Date	
8		Minimum voltage VBC THD magnitude	IMPACC 24-Bit Float
9		Time	
10		Date	
11		Maximum voltage VBC THD magnitude	IMPACC 24-Bit Float
12		Time	
13		Date	
14		Minimum voltage VCA THD magnitude	IMPACC 24-Bit Float
15		Time	
16		Date	
17		Maximum voltage VCA THD magnitude	IMPACC 24-Bit Float
18		Time	
19		Date	
20		Minimum voltage VAN THD magnitude	IMPACC 24-Bit Float
21		Time	
22		Date	
23		Maximum voltage VAN THD magnitude	IMPACC 24-Bit Float
24		Time	
25		Date	
26		Minimum voltage VBN THD magnitude	IMPACC 24-Bit Float
27		Time	
28		Date	
29		Maximum voltage VBN THD magnitude	IMPACC 24-Bit Float
30		Time	
31		Date	
32		Minimum voltage VCN THD magnitude	IMPACC 24-Bit Float
33		Time	
34		Date	

Transmit Min/Max Voltage THD Magnitude Buffer (N=000021) – Continued

Message	Byte	Description	Format
35		Maximum voltage VCN THD magnitude	IMPACC 24-Bit Float
36		Time	
37		Date	
38		Time last reset	
39		Date last reset	

5.2.18.34 Transmit APC Energy Buffer (N=000022)

Message	Byte	Description	Format
1	Byte0	No. of additional msgs = 2	
	Byte1	Engineering Units	Signed, power-of-ten
	Byte2	Mantissa Multiplier	Signed, power-of-two
2	Byte0	Energy Byte0 (LSB)	
	Byte1	Energy Byte1	
	Byte2	Energy Byte2	Unsigned 48-bit in units of watt-hours
3	Byte0	Energy Byte3	
	Byte1	Energy Byte4	
	Byte2	Energy Byte5 (MSB)	

Engineering Units = -128 implies that the energy value is invalid.

Energy = $2^{\text{Mantissa multiplier}}$ * (48-bit energy value) * $10^{\text{Engineering Units}}$

5.2.18.35 Transmit Whole Load Center Energy Buffer (N=000023)

Message	Byte	Description	Unit
1	Byte0	No. of additional msgs = 5	
	Byte1	Engineering Units	Signed, power-of-ten
	Byte2	Mantissa Multiplier	Signed, power-of-two
2	Byte0	Forward Energy Byte0 (LSB)	
	Byte1	Forward Energy Byte1	
	Byte2	Forward Energy Byte2	Unsigned 48-bit in units of watt-hours
3	Byte0	Forward Energy Byte3	
	Byte1	Forward Energy Byte4	
	Byte2	Forward Energy Byte5 (MSB)	
4	Byte0	Bit / Definition B0 1=First time this buffer has been polled since the Save Energy command was received. B1 1=Energy has been reset, cleared by (3 D 0) (3 0 6). B2-B3 Reserved B4 1=Forward energy value is available. B5 1=Reverse energy value is available. B6-B7 Reserved	
	Byte1	Engineering Units	Signed, power-of-ten
	Byte2	Mantissa Multiplier	Signed, power-of-two
5	Byte0	Reverse Energy Byte0 (LSB)	
	Byte1	Reverse Energy Byte1	
	Byte2	Reverse Energy Byte2	Unsigned 48-bit in units of watt-hours
6	Byte0	Reverse Energy Byte3	
	Byte1	Reverse Energy Byte4	
	Byte2	Reverse Energy Byte5 (MSB)	

Engineering Units = -128 implies that the energy value is invalid.

Energy = $2^{\text{Mantissa multiplier}}$ * (48-Bit energy value) * $10^{\text{Engineering Units}}$

5.2.18.36 Operations Count, Runtime Buffer (N=000024)

Message	Byte	Description	Format
1	Byte0	No. of additional msgs = 4	
2		Operations Counts since last reset	24-bit unsigned integer
3		Run Time since last reset (hours)	24-bit unsigned integer
4		Time last reset	
5		Date last reset	

5.2.18.37 Motor Data Maximum Values Buffer (N=000025)

Message	Byte	Description	Format
1	Byte0	No. of additional msgs = 28	
2		Max. phase current during startup	IMPACC 24-Bit Float
3		Time	
4		Date	
5		Max. phase current during run mode	IMPACC 24-Bit Float
6		Time	
7		Date	
8		Maximum phase unbalance	IMPACC 24-Bit Float
9		Time	
10		Date	
11		Maximum winding temperature	IMPACC 24-Bit Float
12		Time	
13		Date	
14		Maximum motor bearing temperature	IMPACC 24-Bit Float
15		Time	
16		Date	
17		Maximum load bearing temperature	IMPACC 24-Bit Float
18		Time	
19		Date	
20		Time last reset	
21		Date last reset	
22		Operations Count since last reset	24-bit unsigned integer
23		Run Time since last reset (hours)	24-bit unsigned integer
24		No. Emergency Overrides since reset	24-bit unsigned integer
25		Time last reset	
26		Date last reset	
27		Total Trip Operations Count	24-bit unsigned integer
28		Total Run Time	24-bit unsigned integer
29		Total Operations Count	24-bit unsigned integer

5.2.18.38 Motor Trip Counters Buffer (N=000026)

Message	Byte	Description	Format
1	Byte0	No. of additional msgs = 9	
2	Byte0	No. of Ground Fault Trips	8-bit unsigned integer
	Byte1	No. of I^2T Trips	8-bit unsigned integer
	Byte2	No. of IOC Trips	8-bit unsigned integer
3	Byte0	No. of Jam Trips	8-bit unsigned integer
	Byte1	No. of Under Load Trips	8-bit unsigned integer
	Byte2	No. of Phase Unbalance Trips	8-bit unsigned integer
4	Byte0	No. of Winding Temp Trips	8-bit unsigned integer
	Byte1	No. of Motor Bearing Trips	8-bit unsigned integer
	Byte2	No. of Load Bearing Trips	8-bit unsigned integer
5	Byte0	No. of Auxiliary Temp Trips	8-bit unsigned integer
	Byte1	No. of Phase Reversal Trips	8-bit unsigned integer
	Byte2	No. of Incomplete Seq. Trips	8-bit unsigned integer
6	Byte0	No. of Remote Trips	8-bit unsigned integer
	Byte1	No. of Differential Trips	8-bit unsigned integer
	Byte2	No. of INCOM Trips	8-bit unsigned integer
7	Byte0	No. of Starts Per Time Trips	8-bit unsigned integer
	Byte1	No. of Time Between Strts Trips	8-bit unsigned integer
	Byte2	No. of Transition Trips	8-bit unsigned integer
8	Byte0	No. of Trip Bypass Operations	8-bit unsigned integer
	Byte1	No. of Zero-Speed Switch Trips	8-bit unsigned integer
	Byte2	Reserved = 0	
9		Time last reset	
10		Date last reset	

5.2.18.39 Motor Alarm Counters Buffer (N=000027)

Message	Byte	Description	Format
1	Byte0	No. of additional msgs = 6	
2	Byte0	No. of Ground Fault Alarms	8-bit unsigned integer
	Byte1	No. of I^2T Alarms	8-bit unsigned integer
	Byte2	No. of Jam Alarms	8-bit unsigned integer
3	Byte0	No. of Under Load Alarms	8-bit unsigned integer
	Byte1	No. of Phase Unbalance Alarms	8-bit unsigned integer
	Byte2	No. of Winding Temp Alarms	8-bit unsigned integer
4	Byte0	No. of Motor Bearing Alarms	8-bit unsigned integer
	Byte1	No. of Load Bearing Alarms	8-bit unsigned integer
	Byte2	No. of Auxiliary Temp Alarms	8-bit unsigned integer
5	Byte0	No. of Starts Per Time Alarms	8-bit unsigned integer
	Byte1	No. of RTD Failure Alarms	8-bit unsigned integer
	Byte2	No. of URTD Comm. Failure Alarms	8-bit unsigned integer
6		Time last reset	
7		Date last reset	

5.2.18.40 Motor Data Buffer (N=000028)

Message	Byte	Description	Format
1	Byte0	No. of additional msgs = 6	
2		Phase A current as % of FLA	IMPACC 24-Bit Float
3		Phase B current as % of FLA	IMPACC 24-Bit Float
4		Phase C current as % of FLA	IMPACC 24-Bit Float
5		Percent phase unbalance	IMPACC 24-Bit Float
6		Percent of thermal capacity used	IMPACC 24-Bit Float
7	Byte0	Time until next start can occur	Minutes, 255=Invalid
	Byte1	Remaining starts in Starts/Time	Minutes, 255=Invalid
	Byte2	Time left on oldest start	Minutes, 255=Invalid

5.2.18.41 Transmit Trip Unit Energy Buffer (N=000029)

Message	Byte	Description	Unit	Format
1	Byte0	No. of additional msgs= 6		
	Byte1	Engineering Units power of 10	3=K units, 6=M units	
	Byte2	Reserved = 0		
2	Byte0	watt-hours (fwd) Byte0	xxWh	32-bit unsigned integer
	Byte1	watt-hours (fwd) Byte1		
	Byte2	watt-hours (fwd) Byte2		
3	Byte0	watt-hours (fwd) Byte3		
	Byte1	watt-hours (rev) Byte0	xxWh	32-bit unsigned integer
	Byte2	watt-hours (rev) Byte1		
4	Byte0	watt-hours (rev) Byte2		
	Byte1	watt-hours (rev) Byte3		
	Byte2	VA-hours Byte0	xxVAh	32-bit unsigned integer
5	Byte0	VA-hours Byte1		
	Byte1	VA-hours Byte2		
	Byte2	VA-hours Byte3		
6	Byte0	Time last reset – Hour (0-23)		Packed BCD
	Byte1	Time last reset – Minute (0-59)		
	Byte2	Time last reset – Second (0-59)		
7	Byte0	Date last reset – Month (1-12)		
	Byte1	Date last reset – Day (1-31)		
	Byte2	Date last reset – Year (0-99)		

5.2.18.42 Transmit Trip Unit Current THD Buffer (N=00002A)

Message	Byte	Description	Unit	Format
1	Byte0	Number of additional messages = 5		
2		% THD – phase A current	%	IMPACC 24-Bit Float
3		% THD – phase B current	%	IMPACC 24-Bit Float
4		% THD – phase C current	%	IMPACC 24-Bit Float
5		% THD – neutral current	%	IMPACC 24-Bit Float
6		% THD – ground current	%	IMPACC 24-Bit Float

5.2.18.43 Transmit Trip Unit Current Crest Factor Buffer (N=00002B)

Message	Byte	Description	Unit	F ormat
1	Byte0	Number of additional data messages = 5		
	Byte1	Reserved = 0		
	Byte2	Reserved = 0		
2		Crest Factor – phase A current	%	IMPACC 24-Bit Float
3		Crest Factor – phase B current	%	IMPACC 24-Bit Float
4		Crest Factor – phase C current	%	IMPACC 24-Bit Float
5		Crest Factor – neutral current	%	IMPACC 24-Bit Float
6		Crest Factor – ground current	%	IMPACC 24-Bit Float

5.2.18.44 Transmit Trip Unit Current Min/Max Power Factor Buffer (N=00002C)

Message	Byte	Description	Format
1	Byte0	Number of additional data messages = 8	
	Byte1	Reserved = 0	
	Byte2	Reserved = 0	
2		Minimum – system PF (apparent)	IMPACC 24-Bit Float
3		Time	
4		Date	
5		Maximum – system PF (apparent)	IMPACC 24-Bit Float
6		Time	
7		Date	
8		Time last reset	
9		Date last reset	

5.2.18.45 ~~5.2.17.45~~ FP Relay Currents Buffer (N=00002D)

Message	Byte	Description	Unit	Format
1	Byte0	No. of additional msgs = 8		
2		Phase A current	amps	IMPACC 24-Bit Float
3		Phase B current	amps	IMPACC 24-Bit Float
4		Phase C current	amps	IMPACC 24-Bit Float
5		Ground current	amps	IMPACC 24-Bit Float
6		Neutral current	amps	IMPACC 24-Bit Float
7		Average phase current	amps	IMPACC 24-Bit Float
8		IR current	amps	IMPACC 24-Bit Float
9		IX current	amps	IMPACC 24-Bit Float

5.2.18.46 Line-to-Ground Voltage Buffer (N=00002E)

Message	Byte	Description	Unit	Format
1	Byte0	No. of additional msgs = 5		
2	Byte1	Current ID Field (CT connect setting value)		
	Byte2	Reserved		
3		Line-to-ground voltage VAG	volts	IMPACC 24-Bit Float
4		Line-to-ground voltage VBG	volts	IMPACC 24-Bit Float
5		Line-to-neutral voltage VCG	volts	IMPACC 24-Bit Float
6		Average line-to-ground voltage	volts	IMPACC 24-Bit Float
7		VX voltage	volts	IMPACC 24-Bit Float

5.2.18.47 FP Relay Min/Max Currents Buffer (N=00002F)

Message	Byte	Description	Unit	Format
1	Byte0	No. of additional msgs = 32		
2		Minimum – phase A current	amps	IMPACC 24-Bit Float
3		Time		
4		Date		
5		Maximum – phase A current	amps	IMPACC 24-Bit Float
6		Time		
7		Date		
8		Minimum – phase B current	amps	IMPACC 24-Bit Float
9		Time		
10		Date		
11		Maximum – phase B current	amps	IMPACC 24-Bit Float
12		Time		
13		Date		
14		Minimum – phase C current	amps	IMPACC 24-Bit Float
15		Time		
16		Date		
17		Maximum – phase C current	amps	IMPACC 24-Bit Float
18		Time		
19		Date		
20		Minimum – IX current	amps	IMPACC 24-Bit Float
21		Time		
22		Date		
23		Maximum – IX current	amps	IMPACC 24-Bit Float
24		Time		
25		Date		
26		Minimum – IR current	amps	IMPACC 24-Bit Float
27		Time		
28		Date		
29		Maximum – IR current	amps	IMPACC 24-Bit Float
30		Time		
31		Date		
32		Time last reset		
33		Date last reset		

5.2.18.48 Current/Voltage Phasors Buffer (N=000030)

Message	Byte	Description	Unit	Format
1	Byte0	No. of additional msgs = 24		
	Byte1	Current ID field (CT connect setting value)		
		3-wire Ir = Ia + Ib + Ic	Ix = Ig	
		4 Ct In Ir = Ig = Ia + Ib + Ic + In	Ix = In	
		4 Ct Ig Ir = In + Ig = Ia + Ib + Ic	Ix = Ig	
	Byte2	Reserved		
2		Phase A current magnitude	amps	IMPACC 24-Bit Float
3		Phase A current angle	degrees	IMPACC 24-Bit Float
4		Phase B current magnitude	amps	IMPACC 24-Bit Float
5		Phase B current angle	degrees	IMPACC 24-Bit Float
6		Phase C current magnitude	amps	IMPACC 24-Bit Float
7		Phase C current angle	degrees	IMPACC 24-Bit Float
8		Ix current magnitude	amps	IMPACC 24-Bit Float
9		Ix current angle	degrees	IMPACC 24-Bit Float
10		Ir current magnitude	amps	IMPACC 24-Bit Float
11		Ir current angle	degrees	IMPACC 24-Bit Float
12		L-L voltage VAB magnitude	volts	IMPACC 24-Bit Float
13		L-L voltage VAB angle	degrees	IMPACC 24-Bit Float
14		L-L voltage VBC magnitude	volts	IMPACC 24-Bit Float
15		L-L voltage VBC angle	degrees	IMPACC 24-Bit Float
16		L-L voltage VCA magnitude	volts	IMPACC 24-Bit Float
17		L-L voltage VCA angle	degrees	IMPACC 24-Bit Float
18		L-N voltage VAN magnitude	volts	IMPACC 24-Bit Float
19		L-N voltage VAN angle	degrees	IMPACC 24-Bit Float
20		L-N voltage VBN magnitude	volts	IMPACC 24-Bit Float
21		L-N voltage VBN angle	degrees	IMPACC 24-Bit Float
22		L-N voltage VCN magnitude	volts	IMPACC 24-Bit Float
23		L-N voltage VCN angle	degrees	IMPACC 24-Bit Float
24		Vx voltage magnitude	volts	IMPACC 24-Bit Float
25		Vx voltage angle	degrees	IMPACC 24-Bit Float

5.2.18.49 Sequence Phasors Buffer (N=000031)

Message	Byte	Description	Unit	Format
1	Byte0	No. of additional msgs=14		
	Byte1	Reserved		
	Byte2	Reserved		
2		3I0 current magnitude	amps	IMPACC 24-Bit Float
3		3I0 current angle	degrees	IMPACC 24-Bit Float
4		I1 current magnitude	amps	IMPACC 24-Bit Float
5		I1 current angle	degrees	IMPACC 24-Bit Float
6		I2 current magnitude	amps	IMPACC 24-Bit Float
7		I2 current angle	degrees	IMPACC 24-Bit Float
8		Percent Unbalanced	%	IMPACC 24-Bit Float
9		3V0 current magnitude	volts	IMPACC 24-Bit Float
10		3V0 current angle	degrees	IMPACC 24-Bit Float
11		V1 current magnitude	volts	IMPACC 24-Bit Float
12		V1 current angle	degrees	IMPACC 24-Bit Float
13		V2 current magnitude	volts	IMPACC 24-Bit Float
14		V2 current angle	degrees	IMPACC 24-Bit Float
15		Percent Unbalanced	%	IMPACC 24-Bit Float

5.2.18.50 Min/Max System Power Factor Buffer (N=000032)

Message	Byte	Description	Format
1	Byte0	No. of additional msgs = 14	
2		Minimum systempower factor (apparent)	IMPACC 24-Bit Float
3		Time	
4		Date	
5		Maximum system power factor (apparent)	IMPACC 24-Bit Float
6		Time	
7		Date	
8		Minimum system power factor (disp.)	IMPACC 24-Bit Float
9		Time	
10		Date	
11		Maximum system power factor (disp.)	IMPACC 24-Bit Float
12		Time	
13		Date	
26		Time last reset	
27		Date last reset	

5.2.18.51 FP-5000 Feeder Protection Relay Counters Buffer – History Log Buffer (N=000033)

This buffer supports the transmission of historical information maintained by the device. This information includes number of hours of operation, number of times powered up, number of trips, number of breaker operations, and number of accumulated interrupted amps. This buffer supports the Total History Log and the Breaker History Log. The accumulated interrupted amps are 32-bit unsigned integers; the other counters are 16-bit unsigned integers. The data for this buffer is located on appropriate word and long-word boundaries to prevent data tearing when the values are written into the INCOM transmit buffer as words and long words. The Total History values are reset when the device receives a Reset Total History Log Slave Action command (3 D 0>03:00:0x0E). The Breaker History values are reset when the device receives a Reset Breaker History Log Slave Action command (3 D 0->03:00:0x0F).

Message	Byte	Description
1	Byte0	No. of additional msgs = 25
	Byte1	Reserved
	Byte2	Total History # of operating hours (low byte)
2	Byte0	Total History # of operating hours (high byte)
	Byte1	Total History # of times powered up (low byte)
	Byte2	Total History # of times powered up (high byte)
3	Byte0	Total History # of IOC trips (low byte)
	Byte1	Total History # of IOC trips (high byte)
	Byte2	Total History # of TOC trips (low byte)
4	Byte0	Total History # of TOC trips (high byte) Byte1
		Total History # of Unbalance trips (low byte)
	Byte2	Total History # of Unbalance trips (high byte)
5	Byte0	Total History # of Voltage trips (low byte)
	Byte1	Total History # of Voltage trips (high byte)
	Byte2	Total History Total # of Trips (low byte)
6	Byte0	Total History Total # of Trips (high byte)
	Byte1	Reserved
	Byte2	Reserved
7	Byte0	Reserved
	Byte1	Reserved
	Byte2	Reserved

FP-5000 Feeder Protection Relay Counters Buffer – History Log Buffer (N=000033) – Continued

Message	Byte	Description
8	Byte0	Reserved
	Byte1	Reserved
	Byte2	Reserved
9	Byte0	Reserved
	Byte1	Reserved
	Byte2	Reserved
10	Byte0	Reserved
	Byte1	Reserved
	Byte2	Reserved
11	Byte0	Reserved
	Byte1	Reserved
	Byte2	Reserved
12	Byte0	Reserved
	Byte1	Total History # of breaker operations (low byte)
	Byte2	Total History # of breaker operations (high byte)
13	Byte0	Total History IA Accum interrupted amps (LSB)
	Byte1	Total History IA Accum interrupted amps
	Byte2	Total History IA Accum interrupted amps
14	Byte0	Total History IA Accum interrupted amps (MSB)
	Byte1	Total History IB Accum interrupted amps (LSB)
	Byte2	Total History IB Accum interrupted amps
15	Byte0	Total History IB Accum interrupted amps
	Byte1	Total History IB Accum interrupted amps (MSB)
	Byte2	Total History IC Accum interrupted amps (LSB)

FP-5000 Feeder Protection Relay Counters Buffer – History Log Buffer (N=000033) – Continued

Message	Byte	Description	Format
16	Byte0	Total History IC Accum interrupted amps	
	Byte1	Total History IC Accum interrupted amps	
	Byte2	Total History IC Accum interrupted amps (MSB)	
17	Byte0	Total History Log Time last reset hour (0-23)	Packed BCD
	Byte1	Minute (0-59)	Packed BCD
	Byte2	Second (0-59)	Packed BCD
18	Byte0	Total History Log Date last reset month (1-12)	Packed BCD
	Byte1	Day (1-31)	Packed BCD
	Byte2	Year (0-99)	Packed BCD
19	Byte0	Reserved	
	Byte1	Reserved	
	Byte2	Reserved	
20	Byte0	Reserved	
	Byte1	Breaker History # of breaker operations (low byte)	
	Byte2	Breaker History # of breaker operations (high byte)	
21	Byte0	Breaker History IA Accum interrupted amps (LSB)	
	Byte1	Breaker History IA Accum interrupted amps	
	Byte2	Breaker History IA Accum interrupted amps	
22	Byte0	Breaker History IA Accum interrupted amps (MSB)	
	Byte1	Breaker History IB Accum interrupted amps (LSB)	
	Byte2	Breaker History IB Accum interrupted amps	
23	Byte0	Breaker History IB Accum interrupted amps	
	Byte1	Breaker History IB Accum interrupted amps (MSB)	
	Byte2	Breaker History IC Accum interrupted amps (LSB)	

FP-5000 Feeder Protection Relay Counters Buffer – History Log Buffer (N=000033) – Continued

Message	Byte	Description	Format
24	Byte0	Breaker History IC Accum interrupted amps	
	Byte1	Breaker History IC Accum interrupted amps	
	Byte2	Breaker History IC Accum interrupted amps (MSB)	
25	Byte0	Breaker History Log Time last reset hour (0-23)	Packed BCD
	Byte1	Minute (0-59)	Packed BCD
	Byte2	Second (0-59)	Packed BCD
26	Byte0	Breaker History Log Date last reset month(1-12)	Packed BCD
	Byte1	Day (1-31)	Packed BCD
	Byte2	Year (0-99)	Packed BCD

5.2.18.52 Transmit Time of Use Watt-Hours Buffer (N=000034)

Message	Byte	Description	Format
1	Byte0	Number of additional data messages = 6	
	Byte1	Engineering Units power of 10 (3=kVAh, 6=MVAh)	
	Byte2	Reserved=0	
2	Byte0	Rate1 watt-hours (net) Byte0 (LSB)	32-bit signed integer
	Byte1	Rate1 watt-hours (net) Byte1	
	Byte2	Rate1 watt-hours (net) Byte2	
3	Byte0	Rate1 watt-hours (net) Byte3 (MSB)	
	Byte1	Rate2 watt-hours (net) Byte0 (LSB)	32-bit signed integer
	Byte2	Rate2 watt-hours (net) Byte1	
4	Byte0	Rate2 watt-hours (net) Byte2	
	Byte1	Rate2 watt-hours (net) Byte3 (MSB)	
	Byte2	Rate3 watt-hours (net) Byte0 (LSB)	32-bit signed integer
5	Byte0	Rate3 watt-hours (net) Byte1	
	Byte1	Rate3 watt-hours (net) Byte2	
	Byte2	Rate3 watt-hours (net) Byte3 (MSB)	
6	Byte0	Rate4 watt-hours (net) Byte0 (LSB)	32-bit signed integer
	Byte1	Rate4 watt-hours (net) Byte1	
	Byte2	Rate4 watt-hours (net) Byte2	
7	Byte0	Rate4 watt-hours (net) Byte3 (MSB)	
	Byte1	Reserved=0	
	Byte2	Reserved=0	

5.2.18.53 Transmit Time of Use VAR-Hours Buffer (N=000035)

Message	Byte	Description	Format
1	Byte0	Number of additional data messages = 6	
	Byte1	Engineering Units power of 10 (3=kVAh, 6=MVAh)	
	Byte2	Reserved=0	
2	Byte0	Rate1 var-hours (net) Byte0 (LSB)	32-bit signed integer
	Byte1	Rate1 var-hours (net) Byte1	
	Byte2	Rate1 var-hours (net) Byte2	
3	Byte0	Rate1 var-hours (net) Byte3 (MSB)	
	Byte1	Rate2 var-hours (net) Byte0 (LSB)	32-bit signed integer
	Byte2	Rate2 var-hours (net) Byte1	
4	Byte0	Rate2 var-hours (net) Byte2	
	Byte1	Rate2 var-hours (net) Byte3 (MSB)	
	Byte2	Rate3 var-hours (net) Byte0 (LSB)	32-bit signed integer
5	Byte0	Rate3 var-hours (net) Byte1	
	Byte1	Rate3 var-hours (net) Byte2	
	Byte2	Rate3 var-hours (net) Byte3 (MSB)	
6	Byte0	Rate4 var-hours (net) Byte0 (LSB)	32-bit signed integer
	Byte1	Rate4 var-hours (net) Byte1	
	Byte2	Rate4 var-hours (net) Byte2	
7	Byte0	Rate4 var-hours (net) Byte3 (MSB)	
	Byte1	Reserved=0	
	Byte2	Reserved=0	

5.2.18.54 Transmit Time of Use VA Hours Buffer (N=000036)

Message	Byte	Description	Format
1	Byte0	Number of additional data messages = 6	
	Byte1	Engineering Units power of 10 (3=kVAh, 6=MVAh)	
	Byte2	Reserved=0	
2	Byte0	Rate1 VA-hours (net) Byte0 (LSB)	32-bit unsigned integer
	Byte1	Rate1 VA-hours (net) Byte1	
	Byte2	Rate1 VA-hours (net) Byte2	
3	Byte0	Rate1 VA-hours (net) Byte3 (MSB)	
	Byte1	Rate2 VA-hours (net) Byte0 (LSB)	32-bit unsigned integer
	Byte2	Rate2 VA-hours (net) Byte1	
4	Byte0	Rate2 VA-hours (net) Byte2	
	Byte1	Rate2 VA-hours (net) Byte3 (MSB)	
	Byte2	Rate3 VA-hours (net) Byte0 (LSB)	32-bit unsigned integer
5	Byte0	Rate3 VA-hours (net) Byte1	
	Byte1	Rate3 VA-hours (net) Byte2	
	Byte2	Rate3 VA-hours (net) Byte3 (MSB)	
6	Byte0	Rate4 VA-hours (net) Byte0 (LSB)	32-bit unsigned integer
	Byte1	Rate4 VA-hours (net) Byte1	
	Byte2	Rate4 VA-hours (net) Byte2	
7	Byte0	Rate4 VA-hours (net) Byte3 (MSB)	
	Byte1	Reserved=0	
	Byte2	Reserved=0	

5.2.18.55 Transmit Time of Use Peak Average Current Demand Buffer (N=000037)

Message	Byte	Description	Format
1	Byte0	Number of additional data messages = 4	
	Byte1	Reserved=0	
	Byte2	Reserved=0	
2		Peak Average Current Demand (amps) at Rate1	IMPACC 24-Bit Float
3		Peak Average Current Demand (amps) at Rate2	IMPACC 24-Bit Float
4		Peak Average Current Demand (amps) at Rate3	IMPACC 24-Bit Float
5		Peak Average Current Demand (amps) at Rate4	IMPACC 24-Bit Float

5.2.18.56 Transmit Time of Use Peak System Watt Demand Buffer (N=000038)

Message	Byte	Description	Format
1	Byte0	Number of additional data messages = 4	
	Byte1	Reserved=0	
	Byte2	Reserved=0	
2		Peak System Watt Demand at Rate1	IMPACC 24-Bit Float
3		Peak System Watt Demand at Rate2	IMPACC 24-Bit Float
4		Peak System Watt Demand at Rate3	IMPACC 24-Bit Float
5		Peak System Watt Demand at Rate4	IMPACC 24-Bit Float

5.2.18.57 *Transmit Time of Use Peak System VAR Demand Buffer (N=000039)*

Message	Byte	Description	Format
1	Byte0	Number of additional data messages = 4	
	Byte1	Reserved=0	
	Byte2	Reserved=0	
2		Peak System var Demand at Rate1	IMPACC 24-Bit Float
3		Peak System var Demand at Rate2	IMPACC 24-Bit Float
4		Peak System var Demand at Rate3	IMPACC 24-Bit Float
5		Peak System var Demand at Rate4	IMPACC 24-Bit Float

5.2.18.58 *Transmit Time of Use Peak System VA Demand Buffer (N=00003A)*

Message	Byte	Description	Format
1	Byte0	Number of additional data messages = 4	
	Byte1	Reserved=0	
	Byte2	Reserved=0	
2		Peak System VA Demand at Rate1	IMPACC 24-Bit Float
3		Peak System VA Demand at Rate2	IMPACC 24-Bit Float
4		Peak System VA Demand at Rate3	IMPACC 24-Bit Float
5		Peak System VA Demand at Rate4	IMPACC 24-Bit Float

5.2.18.59 *MPCV Phasing Voltage Phasors Buffer (N=00003B)*

Message	Byte	Description	Format
1	Byte0	Number of additional data messages = 8	
	Byte1	Reserved=0	
	Byte2	Reserved=0	
2		Phase A Direct Phasing Voltage	IMPACC 24-Bit Float
3		Phase A Quadrature Phasing Voltage	IMPACC 24-Bit Float
4		Phase B Direct Phasing Voltage	IMPACC 24-Bit Float
5		Phase B Quadrature Phasing Voltage	IMPACC 24-Bit Float
6		Phase C Direct Phasing Voltage	IMPACC 24-Bit Float
7		Phase C Quadrature Phasing Voltage	IMPACC 24-Bit Float
8		Pos. Sequence Direct Phasing Voltage	IMPACC 24-Bit Float
9		Pos. Sequence Quad. Phasing Voltage	IMPACC 24-Bit Float

5.2.18.60 Total Harmonic Distortion Buffer (N=00003C)

Message	Byte	Description	Format
1	Byte0	Number of additional data messages = 10	
	Byte1	Reserved=0	
	Byte2	Reserved=0	
2		THD – Phase A current (amperes)	IMPACC 24-Bit Float
3		THD – Phase B current	IMPACC 24-bit float
4		THD – phase C current	IMPACC 24-bit float
5		THD – neutral current	IMPACC 24-bit float
6		THD – L-L voltage VAB (volts)	IMPACC 24-bit float
7		THD – L-L voltage VBC	IMPACC 24-bit float
8		THD – L-L voltage VCA	IMPACC 24-bit float
9		THD – L-N voltage VAN	IMPACC 24-bit float
10		THD – L-N voltage VBN	IMPACC 24-bit float
11		THD – L-N voltage VCN	IMPACC 24-bit float

5.2.18.61 Trip Unit Health Buffer (N=00003D)

Message	Byte	Description	Format
1	Byte0	Number of additional data messages = 4	
	Byte1	Reserved=0	
	Byte2	Reserved=0	
2	Byte0	No. of INST/SDT Faults	(0 – 255)
	Byte1	No. of LDT/GFT Faults	(0–255)
	Byte2	Reserved	
3		Time of Last Breaker Operation	
4		Date of Last Breaker Operation	
5	Byte0	Trip Unit Maximum Temperature	value=(31/70)((95 - ^{o}C)+32
	Byte1	Operations Count MS Byte	
	Byte2	Operations Count LS Byte	

5.2.18.62 Motor Trip Counters 2 Buffer (N=00003E)

Message	Byte	Description	Format
1	Byte0	No. of additional msgs = 5	
2	Byte0	No. of Voltage unbalance trips	8-bit unsigned integer
	Byte1	No. of Underfrequency Trips	8-bit unsigned integer
	Byte2	No. of Overfrequency Trips	8-bit unsigned integer
3	Byte0	No. of Overvoltage Trips	8-bit unsigned integer
	Byte1	No. of Undervoltage Trips	8-bit unsigned integer
	Byte2	No. of Underpower Trips	8-bit unsigned integer
4	Byte0	No. of Power Factor Trips	8-bit unsigned integer
	Byte1	Reserved = 0	
	Byte2	Reserved = 0	
5	Time last reset		
6	Date last reset		

5.2.18.63 Motor Alarm Counters 2 Buffer (N=00003F)

Message	Byte	Description	Format
1	Byte0	No. of additional msgs = 5	
	Byte1	Reserved=0	
	Byte2	Reserved=0	
2	Byte0	No. of Voltage Unbalance Alarms	8-bit unsigned integer
	Byte1	No. of Under Frequency Alarms	8-bit unsigned integer
	Byte2	No. of Over Frequency Failure	8-bit unsigned integer
3	Byte0	No. of Over Voltage Alarms	8-bit unsigned integer
	Byte1	No. of Under Voltage Alarms	8-bit unsigned integer
	Byte2	No. of Under Power Alarms	8-bit unsigned integer
4	Byte0	No. of Power Factor Alarms	8-bit unsigned integer
	Byte1	Reserved = 0	
	Byte2	Reserved = 0	
5		Time last reset	
6		Date last reset	

5.2.18.64 Motor Min/Max Buffer (N=000042)

Message	Byte	Description	Format
1	Byte0	No. of additional msgs = 17	
	Byte1	Reserved=0	
	Byte2	Reserved=0	
2		Minimum – L-G voltage (volts)	IMPACC 24-Bit Float
3		Time	
4		Date	
5		Maximum – L-G voltage (volts)	IMPACC 24-Bit Float
6		Time	
7		Date	
8		Maximum voltage phase unbalance (%)	IMPACC 24-Bit Float
9		Time	
10		Date	
11		Reserved = 0	
12		Reserved = 0	
13		Reserved = 0	
14		Reserved = 0	
15		Reserved = 0	
16		Reserved = 0	
17		Time last reset	
18		Date last reset	

5.2.18.65 *Min/Max Analog Input Buffer (N=000043)*

Message	Byte	Description	Format
1	Byte0	No. of additional msgs = 26	
	Byte1	Reserved=0	
	Byte2	Reserved=0	
2		Minimum – Analog Input 1	IMPACC 24-bit float
3		Time of minimum – Analog Input 1	
4		Date of minimum – Analog Input 1	
5		Maximum – Analog Input 1	IMPACC 24-bit float
6		Time of maximum – Analog Input 1	
7		Date of maximum – Analog Input 1	
8		Minimum – Analog Input 2	IMPACC 24-bit float
9		Time of minimum – Analog Input 2	
10		Date of minimum – Analog Input 2	
11		Maximum – Analog Input 2	IMPACC 24-bit float
12		Time of maximum – Analog Input 2	
13		Date of maximum – Analog Input 2	
14		Minimum – Analog Input 3	IMPACC 24-bit float
15		Time of minimum – Analog Input 3	
16		Date of minimum – Analog Input 3	
17		Maximum – Analog Input 3	IMPACC 24-bit float
18		Time of maximum – Analog Input 3	
19		Date of maximum – Analog Input 3	
20		Minimum – Analog Input 4	IMPACC 24-bit float
21		Time of minimum – Analog Input 4	
22		Date of minimum – Analog Input 4	
23		Maximum – Analog Input 4	IMPACC 24-bit float
24		Time of maximum – Analog Input 4	
25		Date of maximum – Analog Input 4	
26		Time last reset	
27		Date last reset	

5.2.18.66 Max RTD Buffer (N=000044)

Message	Byte	Description	Format
1	Byte0	Number of additional data messages = 35	
	Byte1	Reserved=0	
	Byte2	Reserved=0	
2		Maximum – RTD1 Temperature (deg C)	IMPACC 24-bit float
3		Time of minimum	
	Byte0	Hour (0-23)	Packed BCD
	Byte1	Minute (0-59)	Packed BCD
	Byte2	Second (0-59)	Packed BCD
4		Date of minimum	
	Byte0	Month (1-12)	Packed BCD
	Byte1	Day (1-31)	Packed BCD
	Byte2	Year (0-99)	Packed BCD
5		Maximum – RTD2 Temperature (deg C)	IMPACC 24-bit float
6		Time of maximum	
	Byte0	Hour (0-23)	Packed BCD
	Byte1	Minute (0-59)	Packed BCD
	Byte2	Second (0-59)	Packed BCD
7		Date of maximum	
	Byte0	Month (1-12)	Packed BCD
	Byte1	Day (1-31)	Packed BCD
	Byte2	Year (0-99)	Packed BCD
8		Maximum – RTD3 Temperature (deg C)	IMPACC 24-bit float
9		Time of minimum	
	Byte0	Hour (0-23)	Packed BCD
	Byte1	Minute (0-59)	Packed BCD
	Byte2	Second (0-59)	Packed BCD
10		Date of minimum	
	Byte0	Month (1-12)	Packed BCD
	Byte1	Day (1-31)	Packed BCD
	Byte2	Year (0-99)	Packed BCD
11		Maximum – RTD4 Temperature (deg C)	IMPACC 24-bit float

Max RTD Buffer (N=000044) - Continued

Message	Byte	Description	Format
12		Time of maximum	
	Byte0	Hour (0-23)	Packed BCD
	Byte1	Minute (0-59)	Packed BCD
	Byte2	Second (0-59)	Packed BCD
13		Date of maximum	
	Byte0	Month (1-12)	Packed BCD
	Byte1	Day (1-31)	Packed BCD
	Byte2	Year (0-99)	Packed BCD
14		Maximum – RTD5 Temperature (deg C)	IMPACC 24-bit float
15		Time of Maximum	
	Byte0	Hour (0-23)	Packed BCD
	Byte1	Minute (0-59)	Packed BCD
	Byte2	Second (0-59)	Packed BCD
16		Date of Maximum	
	Byte0	Month (1-12)	Packed BCD
	Byte1	Day (1-31)	Packed BCD
	Byte2	Year (0-99)	Packed BCD
17		Maximum – RTD6 Temperature (deg C)	IMPACC 24-bit float
18		Time of maximum	
	Byte0	Hour (0-23)	Packed BCD
	Byte1	Minute (0-59)	Packed BCD
	Byte2	Second (0-59)	Packed BCD
19		Date of maximum	
	Byte0	Month (1-12)	Packed BCD
	Byte1	Day (1-31)	Packed BCD
	Byte2	Year (0-99)	Packed BCD
20		Maximum – RTD7 Temperature (deg C)	IMPACC 24-bit float
21		Time of maximum	
	Byte0	Hour (0-23)	Packed BCD
	Byte1	Minute (0-59)	Packed BCD
	Byte2	Second (0-59)	Packed BCD

Max RTD Buffer (N=000044) - Continued

Message	Byte	Description	Format
22		Date of maximum	
	Byte0	Month (1-12)	Packed BCD
	Byte1	Day (1-31)	Packed BCD
	Byte2	Year (0-99)	Packed BCD
23		Maximum – RTD8 Temperature (deg C)	IMPACC 24-bit float
24		Time of maximum	
	Byte0	Hour (0-23)	Packed BCD
	Byte1	Minute (0-59)	Packed BCD
	Byte2	Second (0-59)	Packed BCD
25		Date of maximum	
	Byte0	Month (1-12)	Packed BCD
	Byte1	Day (1-31)	Packed BCD
	Byte2	Year (0-99)	Packed BCD
26		Maximum – RTD9 Temperature (deg C)	IMPACC 24-bit float
27		Time of maximum	
	Byte0	Hour (0-23)	Packed BCD
	Byte1	Minute (0-59)	Packed BCD
	Byte2	Second (0-59)	Packed BCD
28		Date of maximum	
	Byte0	Month (1-12)	Packed BCD
	Byte1	Day (1-31)	Packed BCD
	Byte2	Year (0-99)	Packed BCD
29		Maximum – RTD10 Temperature (deg C)	IMPACC 24-bit float
30		Time of maximum	
	Byte0	Hour (0-23)	Packed BCD
	Byte1	Minute (0-59)	Packed BCD
	Byte2	Second (0-59)	Packed BCD
31		Date of maximum	
	Byte0	Month (1-12)	Packed BCD
	Byte1	Day (1-31)	Packed BCD
	Byte2	Year (0-99)	Packed BCD

Max RTD Buffer (N=000044) - Continued

Message	Byte	Description		Format
32		Maximum – RTD11 Temperature (deg C)		IMPACC 24-bit float
33		Time of maximum		
		Byte 0 Hour	(0-23)	Packed BCD
		Byte 1 Minute	(0-59)	Packed BCD
		Byte 2 Second	(0-59)	Packed BCD
34		Date of maximum		
		Byte 0 Month	(1-12)	Packed BCD
		Byte 1 Day	(1-31)	Packed BCD
		Byte 2 Year	(0-99)	Packed BCD
35		Time last reset		
		Byte 0 Hour	(0-23)	Packed BCD
		Byte 1 Minute	(0-59)	Packed BCD
		Byte 2 Second	(0-59)	Packed BCD
36		Date last reset		
		Byte 0 Month	(1-12)	Packed BCD
		Byte 1 Day	(1-31)	Packed BCD
		Byte 2 Year	(0-99)	Packed BCD

5.2.18.67 Transmit Test Packet (N=0000A5)

Message	Byte	Description
1	Byte0	Number of additional data messages = 42
	Byte1	01H
	Byte2	02H
2	Byte0	03H
	Byte1	04H
	Byte2	05H
	.	
	.	
	.	
43	Byte0	7EH
	Byte1	7FH
	Byte2	80H

5.2.18.68 Transmit ICAM ID (N=0003E7)

Message	Byte	Description
1	Byte0	Number of additional data messages = 5
	Byte1	ICAM Division Code
	Byte2	ICAM Product ID
2	Byte0	ICAM style
	Byte1	ICAM firmware revision
	Byte2	ICAM firmware version
3	Byte0	ICAM communication version
	Byte1	ICAM setpoints version
	Byte2	ICAM event version
4	Byte0	Reserved = 0
	Byte1	Device Division Code
	Byte2	Device Product ID
5	Byte0	Device style
	Byte1	Device firmware revision
	Byte2	Device firmware version ASCII
6	Byte0	Device communication version
	Byte1	Device setpoints version
	Byte2	Device event version

5.2.18.69 Transmit Standard ASCII Device ID (N=0003E8)

Message	Byte	Description
1	Byte0	Number of additional data messages = 2
	Byte1	ASCII character
	Byte2	ASCII character
2	Byte0	ASCII character
	Byte1	ASCII character
	Byte2	ASCII character
3	Byte0	ASCII character
	Byte1	ASCII character
	Byte2	ASCII character

5.2.18.70 Transmit IQ Analyzer Event Log Summary Buffer (N=FC0000)

Message	Byte	Description
1	Byte0	Number of additional data messages = 4
	Byte1	Event Number (low byte) (16-bit event counter, waveform index in the IQ Analyzer)
	Byte2	Event Number (high byte)
2	Byte0	Index# (low byte) (event index 0 to Maximum Events)
	Byte1	Index# (high byte)
	Byte2	Flags

Bit	Definition
B0	0=No events logged
B1-B7	Reserved=0

Message	Byte	Description
3	Byte0	Maximum Events (low byte) (504 in the IQ Analyzer Logger)
	Byte1	Maximum Events (high byte)
	Byte2	Maximum Events/Buffer=10
4	Byte0	Time last reset (hour) BCD
	Byte1	Time last reset (minute) BCD
	Byte2	Time last reset (second) BCD
5	Byte0	Time last reset (month) BCD
	Byte1	Time last reset (day) BCD
	Byte2	Time last reset (year) BCD

5.2.18.71 Transmit IQ Analyzer Event Log Buffer (N = FCxyyy)

In the IQ Analyzer, there are 504 buffers (yyy=1 to 1F8); the FP-5000 has 100 buffers (yyy=001 to 064). The "x" parameter dictates the number of events to be transmitted (1 to A).

Message	Byte	Description
1	Byte0	Number of additional messages = 6 times "x" (6 to 60)
	Byte1	Reserved=0
	Byte2	Reserved=0
2	Byte0	yyy (low byte) [1-64H (1-100_{10}) in FP5000, 1-1F8H (1-504_{10}) in the IQ Analyzer]
	Byte1	yyy (high byte)
	Byte2	Event Number of yyy (low byte) (agrees with the waveform number in the IQ Analyzer)
3	Byte0	Event Number of yyy (high byte)
	Byte1	Event Cause of yyy (low byte)
	Byte2	Event Cause of yyy (high byte)
4	Byte0	1/100 of Second (0-99) BCD
	Byte1	Hour (0-23) BCD
	Byte2	Minute (0-59) BCD
5	Byte0	Second (0-59) BCD
	Byte1	Month (1-12) BCD
	Byte2	Day (1-31) BCD
6	Byte0	Year (0-99) BCD
	Byte1	Millisecond Digit (0-9) BCD (reserved=0 in the IQ Analyzer)
	Byte2	Data (Byte0) (reserved=0 in the IQ Analyzer)
7	Byte0	Data (Byte1) (reserved=0 in the IQ Analyzer)
	Byte1	Data (Byte2) (reserved=0 in the IQ Analyzer)
	Byte2	Data (Byte3) (reserved=0 in the IQ Analyzer)
8-13		Event "yyy"+1 (optional, based upon "x")
14-19		Event "yyy"+2 (optional, based upon "x")
20-25		Event "yyy"+3 (optional, based upon "x")

Transmit IQ Analyzer Event Log Buffer (N = Fcxyyy) – Continued

Message	Byte	Description
26-31		Event "yyy"+4 (optional, based upon "x")
32-37		Event "yyy"+5 (optional, based upon "x")
38-43		Event "yyy"+6 (optional, based upon "x")
44-49		Event "yyy"+7 (optional, based upon "x")
50-55		Event "yyy"+8 (optional, based upon "x")
56-61		Event "yyy"+9 (optional, based upon "x")
56-62		

Cause (hex)	Description on IQ Analyzer Face	XX Parameters
01XX	Magnitude THD (IA thru VLL)	See Subcause #1
02XX	Percent THD (IA thru VLL)	See Subcause #1
03XX	Minimum (All – IA thru PF-A)	See Subcause #1
04XX	Maximum (All – IA thru PF-A)	See Subcause #1
05XX	Max Demand (IA thru IAVG, watts through VA)	See Subcause #1
060X	Voltage Sag	1=(L-N), 2=(L-L)
062X	Voltage Swell	1=(L-N), 2=(L-L)
06FF	CBEMA Sag/Swell (for reporting back via IMPACC)	
0610	Voltage Interruption – any phase	
0630	Voltage dv/dt – any phase	
07XX	Frequency – variation from system setting	1=high, 2=low, 3=high or low
08XX	Current Unbalance	None
09XX	Voltage Unbalance	None
0AXX	Remote Input # (1-3)	1 to 3
0BXX	Manual Capture	None
0CXX	Min/Max Update	None
20XX	(new) Alarm Hardware	1=Hardware
		2=High Neutral
		3=Rev Sequence
21XX	(new) Relay	0-3 (Relay 1-4 ON)
4-7	(Relay 1-4 OFF)	
22XX	(new) Power Up	None

Transmit IQ Analyzer Event Log Buffer (N = Fcxyyy) – Continued

Cause (hex)	Description on IQ Analyzer Face	XX Parameters
23XX	(new) Reset	1=Demand Power
		2=Energy
		3=Min/Max
		4=Relays
		5=Events (all, including log)
		60-63(hex)=Trend[y+1]
23XX	(new) Reset	64(hex), All Trends [1-4]
		7=Demand Amps
2401	(new) Change Settings (change with user password)	
2402	(new) Change Calibration (change with factory password)	
25XX	(new) IMPACC	1=STARTED
		2=STOPPED (timeout)
		3=BUSY STUCK on PONI

Subcause#1 (hex)	Subcause#1 Description
1-6	Ia, Ib, Ic, In, Ig, Average 3-Phase Line Current
9	Worst Case from Ia, Ib, and Ic
11-13	VAN, VBN, VCN
14-16	VAB, VBC, VCA
17	Neutral-to-Ground Voltage (Vng)
18	Average Line-to-Neutral Voltage
19	Average Line-to-Line Voltage
20	System watts
30	System vars
40	System VA
50	System Apparent Power Factor
51	System Displacement Power Factor

5.2.18.72 Transmit Phase Angles of Event (Factory Test) (N=FE0004)

Message	Byte	Description	Format
1	Byte0	Number of additional data messages = 2	
	Byte1	Reserved	
	Byte2	Reserved	
2		Phase of Va	IMPACC 24-Bit Float
3		Phase of Vb	IMPACC 24-Bit Float
4		Phase of Vc	IMPACC 24-Bit Float
5		Phase of Ia	IMPACC 24-Bit Float
6		Phase of Ib	IMPACC 24-Bit Float
7		Phase of Ic	IMPACC 24-Bit Float
8		Phase of In	IMPACC 24-Bit Float
9		Phase of Ig	IMPACC 24-Bit Float

5.2.18.73 Transmit IQ Analyzer Trend Summary Buffer (N=FF0000)

Message	Byte	Description
1	Byte0	Number of additional data messages = 30
	Byte1	Reserved=0
	Byte2	Reserved=0
2	Byte0	Trend1 Number of Assigned Buffers (0-64H)
	Byte1	Trend1 Open Buffer Index (0-64H)
	Byte2	Trend1 Newest Buffer Index (0-64H)
3	Byte0	Trend1 Item1
	Byte1	Trend1 Item2
	Byte2	Trend1 Item3
4	Byte0	Trend1 Item4
	Byte1	Trend1 Item5
	Byte2	Trend1 Item6
5	Byte0	Trend1 Number of Minutes between Samples 0-5040 (low byte)
	Byte1	Trend1 Number of Minutes between Samples (high byte)
	Byte2	Trend1 Oldest Buffer Index (0-64H)
6	Byte0	Trend1 Number of Bytes Per Sample
	Byte1	Trend1 Serial ID (low byte) (Incremented upon closure of
	Byte2	Trend1 Serial ID (high byte) Trend1 buffer)
7	Byte0	Trend1 Time last reset (hour) BCD
	Byte1	Trend1 Time last reset (minute) BCD
	Byte2	Trend1 Time last reset (second) BCD
8	Byte0	Trend1 Time last reset (month) BCD
	Byte1	Trend1 Time last reset (day) BCD
	Byte2	Trend1 Time last reset (year) BCD

Transmit IQ Analyzer Trend Summary Buffer (N=FF0000) – Continued

Message	Byte	Description
9	Byte0	Trend1 Maximum Number of Buffers (0-64H)
	Byte1	Trend2 Number of Assigned Buffers (0-64H)
	Byte2	Trend2 Open Buffer Index (0-64H)
10	Byte0	Trend2 Newest Buffer Index (0-64H)
	Byte1	Trend2 Item1
	Byte2	Trend2 Item2
11	Byte0	Trend2 Item3
	Byte1	Trend2 Item4
	Byte2	Trend2 Item5
12	Byte0	Trend2 Item6
	Byte1	Trend2 Number of Minutes between Samples 0-5040 (low byte)
	Byte2	Trend2 Number of Minutes between Samples (high byte)
13	Byte0	Trend2 Oldest Buffer Index (0-64H)
	Byte1	Trend2 Number of Bytes Per Sample
	Byte2	Trend2 Serial ID (low byte) (Incremented upon closure of any Trend2 buffer)
14	Byte0	Trend2 Serial ID (high byte)
	Byte1	Trend2 Time last reset (hour) BCD
	Byte2	Trend2 Time last reset (minute) BCD
15	Byte0	Trend2 Time last reset (second) BCD
	Byte1	Trend2 Time last reset (month) BCD
	Byte2	Trend2 Time last reset (day) BCD
16	Byte0	Trend2 Time last reset (year) BCD
	Byte1	Trend2 Maximum Number of Buffers (0-64H)
	Byte2	Trend3 Number of Assigned Buffers (0-64H)

Transmit IQ Analyzer Trend Summary Buffer (N=FF0000) – Continued

Message	Byte	Description
17	Byte0	Trend3 Open Buffer Index (0-64H)
	Byte1	Trend3 Newest Buffer Index (0-64H)
	Byte2	Trend3 Item1
18	Byte0	Trend3 Item2
	Byte1	Trend3 Item3
	Byte2	Trend3 Item4
19	Byte0	Trend3 Item5
	Byte1	Trend3 Item6
	Byte2	Trend3 Number of Minutes between Samples 0-5040 (low byte)
20	Byte0	Trend3 Number of Minutes between Samples (high byte)
	Byte1	Trend3 Oldest Buffer Index (0-64H)
	Byte2	Trend3 Number of Bytes Per Sample
21	Byte0	Trend3 Serial ID (low byte) (Incremented upon closure of any Trend 3 buffer.)
	Byte1	Trend3 Serial ID (high byte)
	Byte2	Trend3 Time last reset (hour) BCD
22	Byte0	Trend3 Time last reset (minute) BCD
	Byte1	Trend3 Time last reset (second) BCD
	Byte2	Trend3 Time last reset (month) BCD
23	Byte0	Trend3 Time last reset (day) BCD
	Byte1	Trend3 Time last reset (year) BCD
	Byte2	Trend3 Maximum Number of Buffers (0-64H)
24	Byte0	Trend4 Number of Assigned Buffers (0-64H)
	Byte1	Trend4 Open Buffer Index (0-64H)
	Byte2	Trend4 Newest Buffer Index (0-64H)

Transmit IQ Analyzer Trend Summary Buffer (N=FF0000) – Continued

Message	Byte	Description
25	Byte0	Trend4 Item1
	Byte1	Trend4 Item2
	Byte2	Trend4 Item3
26	Byte0	Trend4 Item4
	Byte1	Trend4 Item5
	Byte2	Trend4 Item6
27	Byte0	Trend4 Number of Minutes between Samples 0-5040 (low byte)
	Byte1	Trend4 Number of Minutes between Samples (high byte)
	Byte2	Trend4 Oldest Buffer Index (0-64H)
28	Byte0	Trend4 Number of Bytes Per Sample
	Byte1	Trend4 Serial ID (low byte) (Incremented upon closure of any Trend4 buffer)
	Byte2	Trend4 Serial ID (high byte)
29	Byte0	Trend4 Time last reset (hour) BCD
	Byte1	Trend4 Time last reset (minute) BCD
	Byte2	Trend4 Time last reset (second) BCD
30	Byte0	Trend4 Time last reset (month) BCD
	Byte1	Trend4 Time last reset (day) BCD
	Byte2	Trend4 Time last reset (year) BCD
31	Byte0	Trend4 Maximum Number of Buffers (0-100)
	Byte1	Reserved=0
	Byte2	Reserved=0

5.2.18.74 Transmit IQ Analyzer Trend Header Buffer (N=FF00yy), yy = [01-64]

Message	Byte	Description	
1	Byte0	Number of additional data messages = 10	
	Byte1	Trend Number (1-4)	
	Byte2	Next Buffer (0-64H), 0=no next buffer	
2	Byte0	Hour (BCD)	Time Created
	Byte1	Minute (BCD)	
	Byte2	Second (BCD)	
3	Byte0	Month (BCD)	
	Byte1	Day (BCD)	
	Byte2	Year (BCD)	
4	Byte0	Hour (BCD)	Time Closed (0=still open)
	Byte1	Minute (BCD)	
	Byte2	Second (BCD)	
5	Byte0	Month (BCD)	
	Byte1	Day (BCD)	
	Byte2	Year (BCD)	
6	Byte0	Item1	
	Byte1	Item2	
	Byte2	Item3	
7	Byte0	Item4	
	Byte1	Item5	
	Byte2	Item6	
8	Byte0	Minutes (low byte)	
	Byte1	Minutes (high byte)	
	Byte2	Number of Bytes Per Sample	

Transmit IQ Analyzer Trend Header Buffer (N=000067), yy = [01-64] – Continued

Message	Byte	Description	
9	Byte0	Byte Index 0-900 (low byte)	
	Byte1	Byte Index (high byte)	
	Byte2	Previous Buffer (0-64H) 0=no previous buffer	
10	Byte0	Energy Exponent (0=units, 3=kilo units, 6=mega units)	
	Byte1	Power Exponent (0=units, 3=kilo units, 6=mega units)	
	Byte2	Reserved=0	
11	Byte0	Buffer Y Serial ID (low byte)	(Copied from Trend Summary
	Byte1	Buffer Y Serial ID (high byte)	when the buffer is closed.)
	Byte2	Reserved=0	

5.2.19 INCOM Plug N' Play Slave-Buffers

This section describes selected INCOM control message from the master and one or more data messages returned from an INCOM Plug N' Play slave. Refer to the INCOM Plug n' Play Slave Requirements Specification.for complete information.

5.2.19.1 INCOM Plug N' Play Slave Buffer CommandSet List

Instruction Code	Command	Subcommand	Command Definition
3	8	0	Transmit Supported Command List
3	8	2	Transmit Supported Slave Action List
3	8	4	Transmit Supported (Dxx) Broadcast List
3	8	8	Transmit Supported SubNetwork
3	A	8	Transmit Change Notification Buffer

5.2.20 Transmit Product Specific Slave-Buffers (3 C 8-F)

This transmission consists of an INCOM control message from the master and one or more data messages returned from the slave. BYTE0 of the first data message indicates the number of additional messages are to be sent. The transmission consists of the following steps.

1. The master sends a slave a request for a Product-Specific Buffer Transmission.
2. The slave responds by sending one to 44 data messages. The first byte of the first message indicates the number of additional messages.

5.2.20.1 Product-Specific Slave-Buffer Command Set List

Instruction Code	Command	Subcommand	Command Definition
3	C	8	FLAGS Buffer request
3	C	9	SETPOINTS Buffer request
3	C	A	Defined Per-Product Buffer request
3	C	B	Time-Stamped Event Data Buffer request
3	C	C	Defined Per Product Buffer request
3	C	D	Defined Per Product Buffer request
3	C	E	Defined Per Product Buffer request
3	C	F	Transmit Expanded Buffer request

5.2.21 Transmit FLAGS Buffer (3 C 8)

BYTE0 of the first message from the slave contains the number of additional data messages that will follow.

Message	Byte	Name	Description
1	Byte0		Number of additional data messages
	Byte1	Flag0:	Product-specific
	Byte2	Flag1:	Product-specific
…	…		
N	Byte0	FlagN:	Product-specific

5.2.22 Transmit SETPOINTS Buffer (3 C 9)

5.2.22.1 Transmit Single-Block SETPOINTS Buffer (3 C 9)

Slave devices that support one block (packet of up to 62 messages) of setpoint values use the (3 C 9) command to transmit those values. BYTE0 of the first message from the slave indicates the number of additional data messages (up to 43). BYTE2 and BYTE1 of the first message contains the product firmware version and revision number, formatted as follows.

Message	Byte	Description
1	Byte0	Number of additional data messages=N
	Byte1	Firmware Revision (00 to 255 decimal)
	Byte2	Firmware Version (00 to 255 decimal)
2		Setpoints – bytes 0 to 2
3		Setpoints – bytes 3 to 5
.		.
.		.
.		.
n		Setpoints – bytes 3n-6 to 3n-4
n+1	Byte0	Sum of the bytes in the previous n messages – low byte
	Byte1	Sum of the bytes in the previous n messages – high byte
	Byte2	One's complement of the low byte

5.2.22.2 *Transmit Multi-Block SETPOINTS Definition Buffer (3 C 9)*

Slave devices that support multiple blocks (packets of up to 62 messages) and groups of setpoint values use the (3 C F) command to transmit those values. For these devices, the (3 C 9) command is used to transmit the number of groups supported and the number of blocks within each group. The format of the reply message is as follows:

- BYTE0 of the first message from the slave indicates the number of additional data messages (up to 43).
- BYTE2 and BYTE1 of the first message contains the product firmware version and revision number formatted as shown.

Message	Byte	Description
1	Byte0	Number of additional data messages = N-1
	Byte1	Firmware Revision
	Byte2	Firmware Version
2	Byte0	LSB of Setpoints Sequence Number
	Byte1	MSB of Setpoints Sequence Number
	Byte2	Number of Groups
3	Byte0	1st Group Number = 01
	Byte1	# of blocks in 1st Group
	Byte2	2nd Group Number = 02
4	Byte0	# of blocks in 2nd Group
	Byte1	3rd Group Number = 03
	Byte2	# of blocks in 3rd Group
.	.	
.	.	
.	.	
N-1	Byte0	Reserved = 0
	Byte1	Reserved = 0
	Byte2	Reserved = 0
N	Byte0	LSB of checksum
	Byte1	MSB of checksum
	Byte2	Complement of checksum

Transmit Multi-Block SETPOINTS Definition Buffer (3 C 9) – Continued

Note 1: Product firmware version = version . revision

Examples:	If Byte2 = 2FH (47 decimal)
	Byte1 = 1CH (28 decimal)
	Then the firmware version display shows: 47.28
	If Byte2 = 3H (3 decimal)
	Byte1 = 1H (1 decimal)
	Then the firmware version display shows: 3.01

5.2.23 Transmit (Unacknowledged) Time-Stamped Event Data Buffer (3 C B)

This request is for use with products that provide "time-stamping" of event data. Time-stamping is provided by a product in one of two forms:

- Offset time stamp
- Real-Time Clock (RTC) time stamp

An RTC time stamp is used by all INCOM subnetwork masters and by some slave devices. Most INCOM devices use the Offset time stamp method.

Note: Refer to the device protocols documented in the following sections of this manual to determine the type of time-stamping performed by a particular product.

5.2.23.1 Offset Time Stamp

Time-stamping is provided without the use of an RTC in a product by using the INCOM network master to supply a reference time mark. This reference time mark consists of a Fast Status request (3 0 0) or Fast Status with ACK (3 0 1). When the product receives a Fast Status request, it resets an onboard Event Time Offset Clock. Should the product perform an event such as a protective trip, the product records the value of the Event Time Offset Clock at the instant of the event. The value of the Event Time Offset Clock then represents the elapsed time between the last time mark (Fast Status) received from the master and the time at which the event occurred. The resolution of the product Event Time Offset Clock is assumed to be 1/256 of a second.

The INCOM network master, having recorded its own RTC value when the reference time mark (Fast Status request) was issued, can then compute the actual time of the event.

When an event occurs, the product typically records the following data into a Time-Stamped Event Data Buffer:

1. Event Time Offset Clock
2. Metered values
3. Flags
4. Setpoints

The product Event Time Offset Clock continues to run. If the product can store more than one event buffer, the newest event will overwrite the oldest event. If the product can store only one event buffer, the previously recorded event buffer will be overwritten. If the product does not support time resolution of 1/256 of a second, then BYTE0 of Message 2 will be zero. Products that do not support the time-stamping of events will send a value of 0FFFFFFH for the event time offset. The value of 0FFFFFEH will indicate over range for the event time offset.

5.2.23.2 RTC Time Stamp

Products that have an onboard RTC record the value of the RTC at the instant an event occurs. In addition, subnetwork masters which have an onboard RTC provide a calculated RTC value for the time of the event. When an event occurs, the product typically records the following data into a Time-Stamped Event Data Buffer:

1. RTC value at time of event
2. Metered values
3. Flags
4. Setpoints

If the product can store more than one event buffer, the newest event will overwrite the oldest event. If the product can store only one event buffer, the previously recorded event buffer will be overwritten.

5.2.23.3 Receiving TIME-STAMPED EVENT DATA Buffers

The network master is notified of the existence of an unreleased Time-Stamped Event Data Buffer by a status bit in the response to a Transmit Fast Status Request. The network master may subsequently request that the product transmit the unreleased Time-Stamped Event Data (3 C B).

When an unreleased event data buffer is read by the master, the buffer is retained at the product. Each time the buffer is requested the product sends the data buffer for the oldest unreleased event.

For products that can store more than one Time-Stamped Event Data Buffer, the oldest unreleased event data buffer must be released before the next Time-Stamped Event Data Buffer can be read by the master. The master issues the Receive Slave Action Number (3 D 0) command and sends the Release Time-Stamped Event Data Buffer action number to acknowledge it has read the current buffer and to inform the product to advance its internal index of event buffers to the next unreleased Time-Stamped Event Data Buffer. The master may then read the Time-Stamped Event Data Buffer for the next event. This is a cyclic procedure in which the event data buffers are read from the oldest to the most recent event.

If the master sends the Slave Action command to acknowledge a Time-Stamped Event Data Buffer when in fact there are no unreleased Time-Stamped Event Data buffers available in the product, the product will respond with the Product Not in a State That Allows the Requested Action Slave-to-Master command. (See Product Not in a State That Allows the Requested Action (3 1 C) Page 13.)

[Note: Some older products may respond with a NACK (3 1 1)]. If no unreleased Time-Stamped Event Data buffers are available at the product, the product responds to Transmit Time-Stamped Event Data (3 C B) request with the Buffer Not Yet Available Slave-to-Master command.

All Time-Stamped Event Data buffers can be reset (released) by using a Receive Slave Action Number (3 D 0) command with the Reset Time-Stamped Event Data Buffers action message. (See Reset on Page 110.)

5.2.23.3.1 Time-Stamped Event Data Buffers Transmitted by Products That Use the Offset

Time Stamp

Message	Byte	Description
1	Byte0	Number of additional data messages.
	Byte1	Time-Stamped Event Data Buffer number.
	Byte2	Number of additional unreleased Time-Stamped Event Data Buffer(s) available, excluding the buffer currently being read.
2	Byte0	Trip Time Offset
	Byte1	"
	Byte2	"

Where Event Time Offset in seconds = 256*BYTE2 + BYTE1.BYTE0/256

Subsequent messages are sent sequentially as though the master had sent in order the following requests.

1.	Transmit All Standard Buffers	(3 0 3)
2.	(Optional) – Transmit FLAGS Buffer Request	(3 C 8)
3.	(Optional) – Transmit SETPOINTs Buffer Request	(3 C 9)
4.	(Optional) – Transmit Product-Specific Buffer(s)	(3 C X)
5.	(Optional) – Transmit Other Data	

Note: Some products do not include all of their standard (3 0 X) buffers in the Event Data Buffer. Such products will indicate in the buffer supported map (third message) which standard buffers are included in the Event Data Buffer. Refer to the appropriate section in this document for more information.

5.2.23.3.2 Time-Stamped Event Data Buffers Transmitted by Products That Use the Real-Time Clock Time Stamp

Time-Stamped Event Data Buffers received from a product with an RTC will have two additional INCOM data messages and the format of the time offset will be different than if the product did not have an RTC. These differences result from the fact that the product calculates the time and date that the event occurred. See Section Transmit Status/Cause-of-Status Codes (3 0 2), (Page 21) for information about communicating with products on subnetworks. See Receive Current Date and Time (3 D 8) on Page 117 for information about updating an RTC.

Message	Byte	Description		
1	Byte0	Number of additional data messages		
	Byte1	Time-Stamped Event Data Buffer number		
	Byte2	Number of additional unacknowledged Time-Stamped Event Data buffers available (pertaining to the device addressed) excluding the buffer currently being read.		
2	Byte0	Total number of events (all devices) currently buffered		
	Byte1	1/100 second	(0-99)	Packed BCD
	Byte2	Hour	(0-23)	Packed BCD
3	Byte0	Minute	(0 - 59)	Packed BCD
	Byte1	Second	(0 - 59)	Packed BCD
	Byte2	Month	(1 - 12)	Packed BCD (See Note 1 below.)
4	Byte0	Day	(1 - 31)	Packed BCD
	Byte1	Year	(0 - 99)	Packed BCD
	Byte2	Buffer Type	0 = Trip Event	
			1 = Alarm Event	
			80H = No Response Event	
			81H= Transfer Event	

Note 1: A value of negative 1 (0 F F_{HEX}) for the month is used to indicate that the slave device's clock may not be synchronized with the master's clock (i.e., that the slave device has not received an "Update Time" message from the master). When the "Month of Trip" is negative 1, the remainder of the time stamp (day, hour, etc.) is the time the trip occurred relative to when the slave device was last powered up.

Subsequent messages are sent sequentially as though the master had sent in order the following requests:

1. Transmit All Standard Buffers	(3 0 3)
2. (Optional) – Transmit FLAGS Buffer Request	(3 C 8)
3. (Optional) – Transmit SETPOINTs Buffer Request	(3 C 9)
4. (Optional) – Transmit Product Specific Buffer(s)	(3 C X)
5. (Optional) – Transmit Other Data	

Time-Stamped Event Data Buffers Transmitted by Products That Use the Real-Time Clock Time Stamp – Continued

Note 2: Some products do not include all of their standard (3 0 X) buffers in the Event Data buffer. Such products will indicate in the buffer supported map (fifth message) which standard buffers are included in the Event Data buffer. Please refer to the appropriate device-specific section in this IL for more information.

5.2.24 Transmit Expanded Buffer Command (3 C F)

The Expanded Buffer command allows for the use of additional standard responses beyond those covered by INST=3, COMM=C and SCOMM=8 to E. The Expanded Buffer command consists of the following communications sequence.

1. The master sends a slave Transmit Expanded Buffer Number command.
2. The slave responds with ACK.
3. The master sends the slave the Expanded Buffer number as a single data message.
4. The slave sends the requested buffer as a series of data messages. The BYTE0 of the first data message specifies the total number data messages to follow.
5. The Expanded Buffer number "N" is sent as a 24-bit binary number. A minimum of 10ms must be allowed between consecutive data transmissions to ensure proper slave reception.

5.2.25 Standard Expanded-Mode Slave Action (3 D 0 and 3 D 1)

There are a number of standardized requests that result in the slave or product performing an action. These are listed as follows.

Standard Slave Action Command Set

Instruction Code	Command	Subcommand	Command Definition
3	D	0	Receive Requested Slave Action Number
3	D	1	Process Sub-Network Command

5.2.25.1 Receive Slave Action Number (3 D 0)

The Slave Action number allows for the passing of commands such as open, close or reset. The multiple transmission requirement allows for more security as well as flexibility.

1. The master sends a slave Receive Slave Action Number command.
2. The slave responds with ACK.
3. The master sends the slave an action number as single data message.
4. The slave performs the requested action.
5. The slave responds with ACK or NACK. (The NACK is returned if the requested action cannot be performed.)
6. The action number N is sent as a 24-bit binary number.

5.2.25.1.1 Reset

This request is used to request one of many reset options.

BYTE2 = 0: Indicates Reset Applications

BYTE2	BYTE1	BYTE0	Definition
0	0	0	Reset Trip (IQ 1000)
0	0	1	Reset Alarm
0	0	2	Reset Trip
0	0	3	Reset Powered-Up Indication
0	0	4	Reset (Peak) Demand Watts
0	0	8	Reset Energy (Kilowatt-Hours)
0	0	10h	Reset Device Software
0	0	20h	Reset Time Stamped Event Data Buffers
0	0	40h	Reset (Synchronize) Demand Watts Window
0	0	80h	Snapshot Command
0	1	1	Reset (Peak) Demand Currents
0	1	2	Reset Operations Count (Or Trigger Counters)
0	1	3	Reset Run Time
0	1	4	Reset All Min/Max Values
0	1	5	Unlock Waveform Buffer (Clear Upload In Progress)
0	1	6	Reset Discrete Input Counters
0	1	Dh	Reset Min/Max Currents
0	1	Eh	Reset Min/Max L-L Voltages
0	1	Fh	Reset Min/Max L-N Voltages
0	1	10h	Reset Min/Max PF-Apparent
0	1	11h	Reset Min/Max PF-Displacement
0	1	12h	Reset Min/Max Power
0	1	13h	Reset Min/Max Current THD
0	1	14h	Reset Min/Max Voltage THD
0	1	16h	Reset Min/Max Per Phase Power
0	1	24h	Reset Op Count, Runtime, And Override Count
0	1	25h	Reset Motor Data Maximum Values
0	1	26h	Reset Motor Trip Counters
0	1	27h	Reset Motor Alarm Counters
0	1	2Ch	Reset Min/Max PF-Apparent (DT 1150)
0	1	3Eh	Reset Motor Trio Counters 2
0	1	3Fh	Reset Motor Alarm Counters 2
0	1	42h	Reset Motor Min/Max
0	2	X	Reset Locked-Trigger #X (X=Trigger Number)
0	2	Fh	Reset Event Logs
0	3	1	Reset Source 1 Available Time

Reset – Continued

BYTE2 = 0: Indicates Reset Applications

BYTE2	BYTE1	BYTE0	Definition
0	3	2	Reset Source 1 Connect Time
0	3	3	Reset Source 1 Run Time
0	3	4	Reset Source 2 Available Time
0	3	5	Reset Source 2 Connect Time
0	3	6	Reset Source 2 Run Time
0	3	7	Reset Load Energized Time
0	3	8	Reset Transfer Status
0	4	0	Reset All Sensors Running Totals/Reset Inactivity Bit 0 (Digital Input Modules and Pulse Input modules)
0	4	X	Reset Tamper Flag For Sensor #X
0	5	0	Reset All Sensors Min/Max Values
0	5	X	Reset Sensor #X Min/Max Values
0	6	X	Reset On-Time Load #X
0	6	Ffh	Reset On-Time All Loads
0	7	X	Reset Cycle Count Load #X
0	7	Ffh	Reset Cycle Count All Loads

5.2.25.1.2 Circuit Breaker Open-Close

This request is used to open or close a circuit breaker.

BYTE2 = 1: Indicates Circuit Breaker Applications

BYTE2	BYTE1	BYTE0	Definition
1	0	0	Open Request
1	0	1	Close Request
1	0	2	Trip Request
1	0	3	Bypass All On/Protective Close
1	0	4	Bypass All Off/Clear Protective Close
1	0	5	Bypass All Restore
1	0	8	Enable Maintenance Mode
1	0	0	Disable Maintenance Mode
1	0	3Dh	Reset Health Buffer
1	1	X	De-Energize Load #X
1	1	Ffh	De-Energize All Loads
1	2	X	Energize Load #X
1	2	Ffh	Energize All Loads

5.2.25.1.3 Motor Start-Stop

This request is used to send the motor starter commands.

BYTE2 = 2: Indicates Motor Starter Applications

BYTE2	BYTE1	BYTE0	Definition
2	0	0	No Action
2	0	1	Start Fast-Forward
2	0	2	Start Fast-Reverse
2	0	3	Stop
2	0	4	Start
2	0	5	Start Slow-Forward
2	0	6	Start Slow-Reverse
2	0	7	Set Direction To Forward
2	0	8	Set Direction To Reverse
2	0	A	Emergency Override

5.2.25.1.4 System Control

This request is used for handling system requests.

BYTE2 = 3: Indicates System Control

BYTE2	BYTE1	BYTE0	Definition
3	0	0	Release Time-Stamped Event Buffer
3	0	1	Capture Waveform
3	0	2	Reset Incom Slave-Interface Statistics
3	0	3	Reset Product-Specific Statistics
3	0	4	Acknowledge Triggered Event(S)
3	0	5	Reset Sub-Network Master INCOM Statistics
3	0	6	Acknowledge Energy-Reset [Std. Buffers (3 0 B) And (3 0 C)]
3	0	7	Save Setpoints And Begin Execution Using New Setpoints
3	0	8	Release Time-Stamped Minor Event Buffer
3	0	9	Release Time-Stamped Motor Start Profile Buffer
3	0	A	Abort Setpoints Buffer Change
3	0	B	Release Trend Buffer – Release Data Log In Single-Pass Mode
3	0	C	Trigger Data Logging
3	0	E	Reset Total History Log
3	0	F	Reset Breaker History Log

5.2.25.1.5 Relay Control

This request is used for controlling relay outputs.

BYTE2 = 4: Indicates Relay Control

BYTE2	BYTE1	BYTE0	Definition
4	1	X	Activate Relay Output #X (X=Relay Output Number: 0-255)
4	2	X	Deactivate Relay Output #X (X=Relay Output Number: 0-255)

5.2.25.1.6 Automatic Transfer Switch Control

This request is used for controlling an Automatic Transfer Switch.

BYTE2 = 5: Indicates Automatic Transfer Switch Control

BYTE2	BYTE1	BYTE0	Definition
5	0	1	Initiate ATS test/reset trend 1
5	0	2	Bypass timer, transfer now/reset trend 2
5	0	4	Initiate manual transfer/reset trend 3
5	0	5	Cancel ATS test/reset trend 4
5	0	6	Go to Emergency
5	0	7	Cancel Go to Emergency
5	0	F	Reset all trends

5.2.25.1.7 Product-Specific Control

This request is used for Product-Specific Controls.

BYTE2	BYTE1	BYTE0	Definition
6	1	0	Communication Logic State Off
6	1	X	Turn On Switch #X/Comm Logic State #X
6	2	X	Turn Off Switch #X/Select Active Group #X
6	3	X	Toggle Switch #X
6	4	X	Reset Energy Switch #X
6	4	Ffh	Reset All Energy Switches
6	5	X	Reset Demand Switch #X
6	5	Ffh	Reset All Demand Switches
6	6	X	Reset Logic Latches
6	7	0	Reset Automatic Recloser Lockout

5.2.26 Process Sub-Network Command (3 D 1)

This request is used for communicating with devices on a subnetwork. A slave device that is the master of another INCOM network will process this command. Other (non-subnetwork master) devices will respond with a NACK upon receiving this command.

As a rule, subnetwork masters will know what devices are attached to their local network. They continually poll the devices for their standard and device-specific buffers and keep an image of this data.

The (3 D 1) command informs a subnetwork master that one or more data messages will follow. The first data message contains the address of a device on the subnetwork and one of the standard INCOM commands. If the command is a request for a specific buffer, the subnetwork master responds to the request by sending the appropriate data stored in its RAM-memory image of the device's data. Otherwise, the subnetwork master sends the first message as a control message to the target device. Upon receiving an ACK from the target device, the subnetwork master sends the subsequent messages received from the master (if any) to the target device. The subnetwork master then waits for the target device's response, and then returns this response to the master.

1. The master sends the Process Sub-Network command to the subnetwork master.
2. Subnetwork master responds with a Fast Status data message containing the status of the subnetwork master.
3. The master sends the address of the target device, command, and subcommand values to the subnetwork master as a data message.
4. Subnetwork master verifies that the target device is on its local network (by checking a list it keeps internally). If the device doesn't exist, a "Sub-Network Product Not Responding" message is returned to the master. Note: Refer to Page 12 for more information on the Sub-Network Product Not Responding (3 1 9) Message.
5. If the target device exists and the command is a request for status or for one of the device's data buffers (commands 0 or C), the subnetwork master obtains the requested information from its local image of the target device's data and returns it to the master.
6. If the target device exists and the command is a request for control action or to download information, the following actions take place:
   - ◆ The subnetwork master sends an ACK message to the master.
   - ◆ The master sends the remainder of the data messages to the subnetwork master. (Note: If setpoints are being downloaded, each data message except for the last one downloaded from the master is immediately followed by an ACK message from the subnetwork master.)
   - ◆ The subnetwork master sends the control request/download to the target device or in some cases, it may process the control request/download locally. If the control request/download is sent to the target device, the response from the target device (ACK or NACK) is sent to the master. If the command/download is processed locally by the subnetwork master, an ACK message is sent to the master if the command is accepted, otherwise a NACK is sent.

   Note: All INCOM control messages sent by the subnetwork master to the main network master contain the INCOM network address of the subnetwork master. ACK, NACK, and any other control messages received by the subnetwork master from devices on the subnetwork will have their address field modified by the subnetwork master before they are forwarded onto the main network.

Process Sub-Network Command (3 D 1) – Continued

The format of the Process Sub-Network command message is as follows:

C/D	= 1
INST	= 3
COMM	= D
ADDRESS	= Address of subnetwork master
SCOMM	= 1

The format of the first data message to be sent by the master following a Process Sub-Network command message is as follows:

C/D	0	(Note)
BYTE0 low nibble	INST	(of message to be sent)
BYTE0 high nibble	COMM	(")
BYTE1 low nibble	A0	(")
BYTE1 high nibble	A1	(")
BYTE2 low nibble	A2	(")
BYTE2 high nibble	SCOMM	(")

Note: While C/D = 0 in the received message from the master, C/D = 1 when passed through to the target. Should the master send additional data messages after the first, they are passed on to the target as data messages with C/D = 0.

5.2.27 Standard Master-Buffer Transmissions (3 D 8-3 D F)

This section will be further developed as the specification for buffers to be sent to a product are defined.

Instruction Code	Command	Subcommand	Command Definition
3	D	8	Receive Current Date and Time
3	D	9	Receive INCOM Address
3	D	A	Reserved
3	D	B	Reserved
3	D	C	Reserved
3	D	D	Reserved
3	D	E	Reserved
3	D	F	Receive Expanded Transmit Buffer Number

5.2.27.1 Receive Current Date and Time (3 D 8)

This command is used to send the Real-Time Clock (RTC) setting data (current date and time) to a slave. The RTC data is contained in 3 data messages transmitted by the master.

After the slave receives this command it will transmit an ACK. After the ACK is received by the master it will transmit the following 3 data messages. The master should delay at least 30 milliseconds (ms) between the sending of each message. After the master sends the last data message, the slave will transmit an ACK.

Message	Byte	Description		Format
1	Byte0	Number of additional data messages=2		
	Byte1	1/100 second	(0-99)	Packed BCD
	Byte2	Hour	(0-23)	Packed BCD
2	Byte0	Minute	(0-59)	Packed BCD
	Byte1	Second	(0-59)	Packed BCD
	Byte2	Month	(1-12)	Packed BCD
3	Byte0	Day of month	(1-31)	Packed BCD
	Byte1	Year	(0-99)	Packed BCD
	Byte2	Day of Week	(1-7) 1=Sunday 2=Monday, etc.	Packed BCD

5.2.27.2 Receive INCOM Address (3 D 9)

This command is used to send a new INCOM network address and baud rate to a slave. The INCOM address is contained in the first data message transmitted by the master. The second data message contains a checksum. The slave responds to the initial command and each subsequent valid data message with an ACK.

Message	Byte	Description	
1	Byte0	Number of additional data messages = 1	
	Byte1	INCOM Address – MSB	
		Bit	Definition
		B3-B0	bits 11-8 of the INCOM address
		B7-B4	0100 = 1,200-baud ASK modulation
			1101 = 9,600-baud FSK modulation
	Byte2	INCOM Address – LSB (B0-B7 of the INCOM address)	
2	Byte0	Sum of the bytes in the previous message – low byte	
	Byte1	Sum of the bytes in the previous message – high byte	
	Byte2	One's complement of the low byte	

Note: The INCOM device responds to both data messages with (3 1 0) Acknowledge messages. The response to the first data message contains the device's old (current) INCOM address. The response to the second data message contains the device's new INCOM address.

5.2.28 Product-Specific Master-Buffer Transmissions (3 F 8-3 F F)

This transmission consists of a command message and one or more data messages. BYTE0 of the first data message indicates the number of additional messages that will be sent.

1. The master sends a slave the Product-Specific Master-Buffer Transmission message.
2. The slave responds with ACK.
3. The master sends one or more messages. The first byte of the first message indicates the number of additional messages.

   Note: For most commands, the slave will send an ACK message after each data message it receives from the master. For one command, (3 F 8), the master sends three consecutive messages to the slave. In this latter case, the master should insert a 20-ms (or greater) delay between consecutive data messages.
4. In all cases, the slave responds after the last downloaded data message with an ACK.

Instruction Code	Command	Subcommand	Command Definition
3	F	8	General Download – 1 ACK at end of download
3	F	9	Download Setpoints – Each message is ACKed.
3	F	A	Product-Dependent – Each message is ACKed.
3	F	B	Product-Dependent – Each message is ACKed.
3	F	C	Reserved
3	F	D	Reserved
3	F	E	Reserved
3	F	F	Receive Expanded Receive Buffer

5.2.28.1 General Download (3 F 8)

1. The master sends a slave the Product Specific Master-Buffer Transmission message.
2. The slave responds with ACK.
3. The master sends 1 to 44 messages. The first byte of the first message indicates the number of additional messages. The master should delay at least 30ms between the sending of each message.
4. The slave responds after the last downloaded data message with an ACK.

5.2.28.2 Download Setpoints (3 F 9)

1. The master sends a slave the Download Setpoints message (3 F 9).
2. The slave responds with ACK.
3. The master sends the first data message. The first byte of this message indicates the number of additional messages.
4. The slave responds with ACK.
5. The master sends the next data message (containing setpoint values).
6. The slave responds with ACK.
7. Steps 5 and 6 are repeated until the setpoint buffer is downloaded.

Download Setpoints (3 F 9) – Continued

8. The master sends a data message containing a checksum for the previously downloaded data messages. The checksum is a 16-bit summation of the bytes contained in the previously sent data messages. The format of the checksum message is as follows:
   - ◆ Byte0 = Sum of the bytes in the previously downloaded messages – low byte.
   - ◆ Byte1 = Sum of the bytes in the previously downloaded messages – high byte.
   - ◆ Byte2 = One's complement of the low byte of the checksum.
9. The slave responds with ACK if the checksum is valid and the setpoints are accepted. The slave responds with NACK if the setpoints are not accepted.

   Note: If the checksum received by the device is incorrect, or if any of the downloaded setpoint values are detected as not within an acceptable range, all of the downloaded setpoints are discarded by the device.

5.2.29 Broadcast Commands (D X X)

A number of standard master Broadcast commands for the INCOM family are described in the following. All of these commands utilize C/D=1.

Instruction Code	Command	Subcommand	Command Definition
D	0	0	Save Energy Buffer Request
D	0	1	Reset Demand Window
D	E	2	Capture Waveform
D	E	3	Synchronize Real-Time Clock
D	F	E	Reserved for watchdog timer usage
D	F	F	Reserved for handheld programmers

Note: The Synchronize RTC command's ADDRESS field contains the current seconds and 1/100 of a second. The format is as follows:

ADDRESS = Second and 1/100 second where:

Bits 0-6 contains current 1/100 seconds	(0-99)
Bits 7-11 contain current seconds	(0-31)

Note: It is recommended that the Broadcast Synchronize RTC command be transmitted during the time period from the 15th to the 31st second of the minute.

5.2.30 Transmit System Management Buffers (3 A 3-3 A 7)

This transmission consists of an INCOM control message from the master and one or more data messages returned from the slave.

1. The master sends a slave a request for a System Management Buffer Transmission.
2. The slave responds by sending one to 43 data messages.

Instruction Code	Command	Subcommand	Command Definition
3	A	3	Transmit PONI Configuration
3	A	4	Transmit INCOM Slave-Interface Statistics
3	A	5	Transmit Product-Specific Statistics
3	A	6	Transmit Sub-Network Master INCOM Statistics
3	A	7	Transmit Checksum of Previous Data Packet

5.2.30.1 Transmit PONI Configuration Buffer (3 A 3)

This buffer is supported by the PONI. It contains two messages containing the PONI's dip-switch settings (baud rate and PONI mode), the PONI version, and its program checksum. The format of the response is as follows.

Message	Byte	Description	
1	Byte0	PONI mode and INCOM baud rate	
		Bit	Definition
		B1-B0	00=PONI is in Buffered PONI mode
			01=PONI is in PONI mode
			10=PONI is in TSF mode
			11=LPONI
		B2	1=1,200 baud; 0=9,600 baud INCOM
		B7-B3	Reserved
	Byte1	PONI Firmware Version	
	Byte2	PONI Firmware Revision	
2		PONI firmware checksum (24-bit unsigned integer)	

5.2.30.2 Transmit INCOM Slave-Interface Statistics Buffer (3 A 4)

The INCOM Slave-Interface Statistics Buffer consists of 10 INCOM messages that contain the values for several INCOM communications-related counters. These counters are maintained by slave devices, including subnetwork masters, which are slave devices on the main network. The counters provide a measure of the integrity of the slave device's INCOM interface to its master. The format of the response is as follows.

Message	Byte	Description
1	Byte0	Number of additional data messages = 9
	Byte1	Reserved=0
	Byte2	Reserved=0
2		Number of messages received from the master with BCH errors. See notes 1 and 2.
3		Number of INCOM overrun errors See notes 1 and 2.
4		Number of messages received (total) from the INCOM master. See notes 1, 2, and 3.
5		Number of broadcast messages received from the master. See notes 1, 2, and 4.
6		Number of uncompleted slave action requests from the master. See notes 1, 2, and 5.
7		Number of invalid commands received from the INCOM master. See notes 1 and 2.
8		Reserved=0
9		Reserved=0
10		Reserved=0

Note 1: The format of the data in messages 2-7 is as follows:

	Byte	Description
	Byte0	B0-B7 of a 20-bit unsigned value
	Byte1	B8-B15 of a 20-bit unsigned value
Byte2	Bit	Definition
	B0-B3	Bits 16-19 of a 20-bit unsigned value
	B4-B6	Reserved=0
	B7	Validity: 1=valid, 0=invalid

Note 2: These counter values should not roll over. They should hold their count at their highest possible value until a Reset command (3 0 2) is sent to the slave device.

Note 3: This counter value should include the number of erroneous messages (if any) that are received (that is, messages with BCH error and invalid command messages).

Note 4: This should include all Broadcast (D X X) messages received, even those not acted upon by the device.

Note 5: This indicates the number of times a (3 D 0) command is received and is not followed by a data messages containing a valid request.

5.2.30.3 *Transmit Product-Specific Statistics Buffer (3 A 5)*

The Product-Specific Statistics Buffer consists of 10 INCOM messages. The definition and format of the data contained in this buffer is product-specific. Please refer to the applicable section of this document for implementation details for each device. The format of the response is as follows.

Message	Byte	Description
1	Byte0	Number of additional data messages = 9
	Byte1	Reserved=0
	Byte2	Reserved=0
2		Product -specific information
3		Product -specific information
4		Product- specific information
5		Product -specific information
6		Product -specific information
7		Product -specific information
8		Product- specific information
9		Product -specific information
10		Product -specific information

Note: The Product-Specific Statistics Buffer can be reset via the Slave Action (3 D 0) command (Byte2=3, Byte1=0, Byte0=3). See System Control on Page 112 for additional information.

5.2.30.4 Transmit Sub-Network Master INCOM Statistics Buffer (3 A 6)

The Sub-Network Master INCOM Statistics Buffer consists of 10 INCOM messages. It contains values for several INCOM communications-related counters maintained by the subnetwork master. Therefore, it provides a measure of the communications integrity of the subnetwork. The Transmit Sub-Network Master INCOM Statistics request can be sent directly to the subnetwork master, or sent as a "pass-through" using the (3 D 1) command to the slave device. The subnetwork master will process both types of requests. (The pass-through version is not actually sent to the slave device.) The subnetwork master responds to the direct request with the totals for the subnetwork. It responds to pass-through requests with the values that pertain to the particular device that was addressed. The format of the response is as follows.

Message	Byte	Description
1	Byte0	Number of additional data messages = 9
	Byte1	Reserved=0
	Byte2	Reserved=0
2		Number of messages received from slave(s) with a BCH error. See Notes 1 and 3.
3		Number of no-responses (slave communications timeouts). See Notes 1 and 3.
4		Number of invalid Fast Status responses from the slave(s). See Notes 1 and 3.
5		Number of unexpected messages received on the subnetwork. See Notes 1, 2, and 3.
6		Number of subnetwork transmit failures. See Notes 1, 2, and 3.
7		Number of messages received (total) from the slave. See Notes 1 and 3.
8-10		Reserved=0

Note 1: The format of the data in messages 2-7 is as follows:

Byte	Description	
Byte0	B0-B7 of a 20-bit unsigned value	
Byte1	B8-B15 of a 20-bit unsigned value	
Byte2	Bit	Definition
	B0-B3	Bits 16-19 of a 20-bit unsigned value
	B4-B6	Reserved=0
	B7	Validity: 1=valid, 0=invalid

Note 2: Values for messages 5 and 6 are maintained for the system, but not for each device.

Note 3: These counter values should not roll over. They should hold their count at their highest possible value until a Reset command (3 0 5) is sent to the subnetwork master.

5.2.30.5 Transmit Checksum of Previous Data Buffer (3 A 7)

This transmission consists of an INCOM control message from the master and one data message returned from the slave. The response should contain the slave-computed checksum on the most recently sent data buffer. The format of the response message is as follows.

Message	Byte	Description
1	Byte0	Sum of the bytes in the previous data buffer transmitted – low byte
	Byte1	Sum of the bytes in the previous data buffer transmitted – high byte
	Byte2	One's complement of the low byte

This command applies to the data buffers that are returned in response to the following INCOM control commands: (3 0 3) through (3 0 F); (3 A 3) through (3 A 6); and (3 C 8) through (3 D 1).

Note: All messages of the previously transmitted data buffer are included in the checksum calculation (including any messages that may contain another checksum).

5.3 Standard IMPACC System Functions

5.3.1 Subnetwork Master Demand Synchronization

A subnetwork master device may support up to three methods or modes of operation for synchronizing the computation of demand watts and/or demand vars. They are as follows.

1. Internal (The subnetwork master uses an internal timer or clock to determine the demand window interval.)
2. External pulse (A contact input sensed by the subnetwork master is used to determine the demand windows interval.)
3. IMPACC (INCOM communication)

These operational modes are mutually exclusive and user-selectable. Regardless of the mode, the subnetwork master device will perform a demand calculation upon sensing the applicable synchronization signal.

5.3.1.1 IMPACC Mode

In the IMPACC mode, the Broadcast Save Energy Buffer request (D 0 0) and the Slave Action Save Energy Buffer request (3 D 0 – 0 0 80h) serve as triggers for the subnetwork master's calculation of power demand for each of the energy metering devices on its subnetwork. In addition, the subnetwork master supports the following protocol to provide energy data for the IMPACC master's logging of energy. This energy data is sent in the Transmit Saved Energy (3 0 B) and Transmit Saved Reactive Energy (3 0 C) buffers which are fabricated by the subnetwork master for each energy monitoring device on its subnetwork (including IQ Energy Sentinels – regardless of Communications Version; Digitrip Optim 1050s; and Digitrip 810s and 910s).

Sequence

1. The master sends a Broadcast Save Energy Buffer request (D 0 0) to all subnetwork masters. The (D 0 0) command informs all subnetwork masters that energy logging and demand calculations are required by the main network master. Alternately, a (0 0 80h) Slave Action command (3 D 0) may be sent to individual subnetwork master(s) as required.
2. The subnetwork master immediately modifies its FLAGS Buffer as follows. (See the FLAGS Buffer description on Page 128.)
   - Sets the "IMPACC Synchronization In-Process" bit (3 C 8) Message 1, Byte1, Bit 1.
   - Clears the "IMPACC Synchronization Complete" bit (3 C 8) Message 1, Byte1, Bit 0.

   Note: A subnetwork master can only process one Save Energy Buffer request at a time. If the subnetwork master receives a new Save Energy Buffer request while it is processing a previous Save Energy Buffer request, it will ignore the new request. Further, if the main network master sends a Slave Action Save Energy Buffer request (3 D 0 – 0 0 80h) while the subnetwork master is processing a previous Save Energy Buffer request, the subnetwork master will reply with a Product Not in a State that allows the Requested Action (3 1 C) NACK.
3. The subnetwork master immediately clears the first-time-energy-polled-bit (Message 1, Byte2, Bit 0) within each Saved Energy Buffer (3 0 B) and Saved Reactive Energy Buffer (3 0 C) for each of its slave devices that support energy monitoring.
4. The subnetwork master sends the Broadcast Save Energy Buffer request (D 0 0) on its subnetwork twice in quick succession.
5. The subnetwork master then reads the Saved Energy Buffers from all subnetwork devices and uses this data to build it own Saved Energy Buffers (3 0 B) and/or (3 0 C) for each

subnetwork device. If any subnetwork device's energy snapshot has not been saved [e.g., the device did not respond to (D 0 0) broadcast], then the subnetwork master must issue a Slave Action Save Energy Buffer request (3 D 0 – 0 0 80h) to take a snapshot of the energy of those particular subnetwork devices. Upon successful reading of a Saved Energy snapshot from a subnetwork device, the subnetwork master will modify the appropriate (3 0 B) and/or (3 0 C) buffers for the applicable subnetwork device as follows:

- ◆ Sets (3 0 B) Message 1, Byte2, Bit 0
- ◆ Sets (3 0 C) Message 1, Byte2, Bit 0

If the subnetwork device does not indicate reception of the subnetwork master's Saved Energy snapshot command, the subnetwork master will indicate this via the first-time-energy-polled-bit (Message 1, Byte2, Bit 0) within each Saved Energy Buffer (3 0 B) and Saved Reactive Energy Buffer (3 0 C) for each such subnetwork device.

6. After the Saved Energy (3 0 B) and (3 0 C) buffers for all of the subnetwork devices have been updated and the subnetwork master has completed the demand calculations for all subnetwork devices, the logging process is complete and the subnetwork master modifies its FLAGS Buffer as follows:
   - ◆ Clears the "IMPACC Synchronization In-Process" bit (3 C 8) Message 1, Byte1, Bit 1.
   - ◆ Sets the "IMPACC Synchronization Complete" bit (3 C 8) Message 1, Byte1, Bit 0.
7. The master then requests the Saved Energy (3 0 B) and/or (3 0 C) buffer(s) for each subnetwork device utilizing the Pass-Through (3 D 0) command, and performs its appropriate data logging.
8. Upon receiving the first request for any subnetwork device's Saved Energy Buffer (after Step 6), the subnetwork master modifies its FLAGS Buffer as follows:
   - ◆ Clears the "IMPACC Synchronization Complete" bit (3 C 8) Message 1, Byte1, Bit 0.

   Additionally, as each Saved Energy (3 0 B) and/or (3 0 C) buffer for a subnetwork device is requested by the main network master, the subnetwork master will modify that (3 0 B) and/or (3 0 C) buffer as follows:
   - ◆ Clears (3 0 B) Message 1, Byte2, Bit 0.
   - ◆ Clears (3 0 C) Message 1, Byte2, Bit 0.

   Note: The IMPACC main network master can verify that each subnetwork master has received the synchronization trigger (Broadcast Save Energy Buffer request or Slave Action command) by checking the subnetwork master FLAGS Buffer as follows:

   "IMPACC Synchronization In-Process" bit (3 C 8) Message 1, Byte1, Bit 1 is set, or

   "IMPACC Synchronization Complete" bit (3 C 8) Message 1, Byte1, Bit 0 is set.

   Note: The FLAGS Buffer (3 C 8) Message 1, Byte1, Bit 2 is used to indicate that the subnetwork master is configured and ready to respond to the IMPACC mode of synchronization trigger:

   "IMPACC Synchronization Ready" bit (3 C 8) Message 1, Byte1, Bit 2 is set.

All retries of energy snapshots for subnetwork devices are handled by the subnetwork master. The subnetwork master sends a (3 1 C) (Product Not in a State that Allows the Requested Action) NACK to the main network master if the main network master attempts to pass through a Slave Action command to a subnetwork device request for a Save Energy (3 D 0, 0 0 80h). The subnetwork master should take no longer than 10 seconds to complete the energy logging and demand calculations in the IMPACC mode of synchronization trigger.

5.3.2 Sub-Network Master Flags Buffer Description (3 C 8)

Message	Byte	Description	
1	Byte0	Number of additional data messages = 1	
	Byte1	Demand synchronization status	
		Bit	Definition
		B0	IMPACC Synchronization Complete (1 = complete)
		B1	IMPACC Synchronization In-Process (1 = in-process)
		B2	IMPACC Synchronization Ready (1 = ready)
		B7-B3	Reserved = 0
	Byte2	Synch Type (type of demand synchronization) setpoint	
2		Reserved = 0	

5.3.3 Supporting Multi-Block Setpoints

Increasing demand for added functionality in our protection products has forced us to look closely at the communications protocol used to upload and download device setpoints. Protection products currently in development will utilize a setpoints buffer well in excess of the traditional 128-byte (43 message) limit. In the future event the 768-byte (256-message) maximum buffer size limit may be challenged.

5.3.3.1 Terminology

The setpoints buffer is all of the setpoints values in a device. A setpoints buffer can be divided into groups.

A setpoints group is a logical set of blocks within the setpoints buffer that are functionally related and can be independently updated (meaning a change in one group has no effect on any other function). There can be a maximum of 60 setpoints groups in any device. Each setpoints group is identified by a number in the range [01,02,…, N-1, N] where 01<= N <= 60.

A setpoints block is a packet of up to 62 messages containing setpoints values that are communicated in a contiguous stream of data messages. A setpoints group cannot be safely changed unless all the blocks within a group are changed simultaneously (coherently).

There can be a maximum of 128 blocks in any group. Each setpoints block is identified by a number in the range [01,02,…, N-1, N] where 01<= N <= 128.

The Setpoints Sequence Number is a 16-bit number held at the device. The Setpoints Sequence Number is incremented by the device whenever setpoints are saved. The Setpoints Sequence Number is embedded in to every setpoints block as it is sent. Only the device can modify the Setpoints Sequence Number.

Setpoints Buffer

Group 01, Block 01
Group 01, Block 02
Group 01, Block J Group 02, Block 01
Group 02, Block 02
.
Group 02, Block K Group 03, Block 01
Group 03, Block 02
.
Group 03, Block L Group N, Block 1
.
Group N, Block M

5.3.3.2 Size Limitation of Multi-Block Setpoints

There is an 8-byte protocol overhead on each block:

- Number of additional data messages
- Firmware Revision
- Firmware Version
- LSB of Setpoints Sequence Number
- MSB of Setpoints Sequence Number
- LSB of Checksum
- MSB of Checksum
- Complement of LSB of Checksum

Assuming 62 messages per block, 60 groups and 128 blocks per group, the maximum number of bytes of usable (excluding protocol overhead) setpoint data that can be transferred is:

1,367,040 bytes = (62 msg * 3 bytes/msg - 8 bytes) * 60 * 128

5.3.3.3 Uploading of Setpoints

In order to permit network masters to determine and upload dynamically the setpoints groups that are supported by a product using the Multi-Block Setpoints protocol, the Transmit Setpoints Buffer (3 C 9) and Multi-Block Setpoint Data Packet Size Description (3 1 F) commands may be used. The (3 C 9) data can be used to determine which groups are supported and the number of blocks comprising each group:

Message	Byte	Description
1	Byte0	Number of additional data messages = N-1
	Byte1	Firmware Revision
	Byte2	Firmware Version
2	Byte0	LSB of Setpoints Sequence Number
	Byte1	MSB of Setpoints Sequence Number
	Byte2	Number of Groups
3	Byte0	1st Group Number = 01
	Byte1	# of blocks in 1st Group
	Byte2	2nd Group Number = 02
4	Byte0	# of blocks in 2nd Group
	Byte1	3rd Group Number = 03
	Byte2	# of blocks in 3rd Group
	.	
	.	
N-1	Byte0	Reserved = 0
	Byte1	Reserved = 0
	Byte2	Reserved = 0
N	Byte0	LSB of checksum
	Byte1	MSB of checksum
	Byte2	Complement of checksum

The (3 1 F) N=51xxyy data can be used to determine the number of messages in any specific block:

1	Byte0	Number of additional data messages = 3
	Byte1	Block # yy
	Byte2	Group # xx

Uploading of Setpoints – Continued

Message	Byte	Description
2	Byte0	LSB of Setpoints Sequence Number
	Byte1	MSB of Setpoints Sequence Number
	Byte2	Reserved = 0
3	Byte0	Number of messages in this setpoints data block
	Byte1	Reserved = 0
	Byte2	Reserved = 0
4	Byte0	LSB of checksum
	Byte1	MSB of checksum
	Byte2	Complement of checksum

To upload the setpoints from a product, the network master uses the Transmit Expanded Buffer (3 C F) protocol. The Expanded Buffer Number (N) will be used to designate that setpoints are being requested as well to identify the specific setpoints packet as follows:

BYTE2 (most significant byte)

80_{10} = Transmit setpoints packet

BYTE1

Group Number (e.g. Functional Group [01,02,03,…,X])

BYTE0

Block Number ([01,02,03,…,Y])

The first two data messages of the product response will contain the Setpoints Group, Setpoints Block and Setpoints Sequence numbers are as follows:

Message	Byte	Description
1	Byte0	Number of additional data messages
	Byte1	Block # yy
	Byte2	Group # xx
2	Byte0	LSB of Setpoints Sequence Number
	Byte1	MSB of Setpoints Sequence Number

For every setpoint packet uploaded, the Setpoints Sequence Number should match. Any difference indicates that the setpoints have changed during the upload process.

5.3.3.4 Downloading of Setpoints

Each setpoints group may be independently downloaded to a product. To ensure that all blocks with a group were received, it is a requirement that each group be sent in its entirety and in order from Block Number 01 to the last block in the group. To download one or more groups, a network master performs the following steps to satisfy the protocol:

1. The network master sends the command (3 F B), Download Setpoints Buffer Request. [See Download Setpoints Buffer Request (3 F B) on Page 138.] The product is in remote program mode.
2. The network master downloads the first block in the group using the (3 F 9) Download Setpoints command. [See Section 5.3.8, Receive Multi-Block Setpoint Data Packet (3 F 9), on Page 136.]
3. The network master downloads the next block in the group using the (3 F 9) Download Setpoints command.
4. The network master repeats Step 3 until the all blocks in the group have been downloaded.
5. The network master repeats Step 2 until all groups have been downloaded.
6. The network master sends the Slave Action command (3 D 0 – 3 0 7). Exit program mode and start execution using downloaded setpoints. [See SLAVE ACTION Description (3 D 0) on Page 136.]

Note: The network master may abort downloading of setpoints at any point after Step 1 and prior to Step 6 by sending the Slave Action command (3 D 0 – 3 0 A). Abort downloading of setpoints and exit program mode. [See Section SLAVE ACTION Description (3 D 0) on Page 136.] Upon receiving this command in this context, the device will have no setpoint changes.

5.3.4 Multi-Block Setpoint Data Packet Size Description (3 1 F)

Transmit Setpoint Data Block Size (N = 51xxyyH)

BYTE2 (most significant byte)

81_{10} = Transmit setpoint block size

BYTE1

Group Number (e.g. Functional Group [01,02,03,…,X])

BYTE0

Block Number ([01,02,03,…,Y])

Message	Byte	Description
1	Byte0	Number of additional data messages = 3
	Byte1	Block # yy
	Byte2	Group # xx
2	Byte0	LSB of Setpoints Sequence Number
	Byte1	MSB of Setpoints Sequence Number
	Byte2	Reserved = 0
3	Byte0	Number of messages in this setpoints data block
	Byte1	Reserved = 0
	Byte2	Reserved = 0
4	Byte0	LSB of checksum MSB of
	Byte1	checksum Complement of
	Byte2	checksum

5.3.5 Transmit Multi-Block SETPOINT Buffer Description (3 C 9)

Message	Byte	Description
1	Byte0	Number of additional data messages = N-1
	Byte1	Firmware Revision
	Byte2	Firmware Version
2	Byte0	LSB of Setpoints Sequence Number
	Byte1	MSB of Setpoints Sequence Number
	Byte2	Number of groups
3	Byte0	1st Group Number = 01
	Byte1	# of blocks in 1st Group
	Byte2	2nd Group Number = 02
4	Byte0	# of blocks in 2nd Group
	Byte1	3rd Group Number = 03
	Byte2	# of blocks in 3rd Group
	.	
	.	
	.	
N-1	Byte0	Reserved = 0
	Byte1	Reserved = 0
	Byte2	Reserved = 0
N	Byte0	LSB of checksum
	Byte1	MSB of checksum
	Byte2	Complement of checksum

5.3.6 Multi-Block Setpoint Data Packet Description (3 C F)

Transmit Setpoint Data Packet (N = 50xxyyH)

BYTE2 (most significant byte)

80_{10} = Transmit setpoints

BYTE1

Group Number (e.g. Functional Group [01,02,03,…,X])

BYTE0

Block Number ([01,02,03,…,Y])

Message	Byte	Description
1	Byte0	Number of additional data messages = Q-1
	Byte1	Block # yy
	Byte2	Group # xx
2	Byte0	LSB of Setpoints Sequence Number
	Byte1	MSB of Setpoints Sequence Number
	Byte2	Setpoints Data
3		Setpoints Data
4		Setpoints Data
5		Setpoints Data
	.	
	.	
	.	
Q-1		Setpoints Data
Q	Byte0	LSB of checksum MSB of
	Byte1	checksum Complement of
	Byte2	checksum

Note 1: For every setpoint packet uploaded, the Setpoints Sequence Number should match. Any difference indicates that the setpoints have changed during the upload process. The network master should re-initiate uploading of any previously uploaded setpoint group(s).

5.3.7 SLAVE ACTION Description (3 D 0)

Byte2	Byte1	Byte0	Definition
3	0	7	Exit program mode and start execution using downloaded setpoints.
3	0	0Ah	Abort downloading setpoints and exit program mode.

5.3.8 Receive Multi-Block Setpoint Data Packet (3 F 9)

Receive Device Setpoints (Block #xxyy)

Message	Byte	Description
1	Byte0	Number of additional data messages = Q-1
	Byte1	Block # yy
	Byte2	Group # xx
2	Byte0	Setpoints sequence number LSB
	Byte1	Setpoints sequence number MSB
	Byte2	Setpoints Data
3		Setpoints Data
4		Setpoints Data
5		Setpoints Data
	.	
	.	
	.	
Q-1		Setpoints Data
Q	Byte0	LSB of checksum MSB of
	Byte1	checksum Complement of
	Byte2	checksum

Note 1: The network master must have previously sent the Download Setpoints Buffer (3 F B) request.

Note 2: Byte1 and Byte2 of Message 1 contain the packet number <Group # xx, Block #yy> of the setpoints. This packet number allows the receiving product to identify uniquely the block position within the setpoints buffer. Each setpoints group may be independently downloaded to a product. To ensure that all blocks with a group were received, it is a requirement that each group be sent in its entirety and in order from Block Number 01 to the last block in the group. If a block is sent out of order, the product device will:

- Respond to Message 1 with a (3 1 1) NACK message, and
- Discard previously received setpoints and will respond to any further (3 F 9) commands with a (3 1 C) NACK message until the command (3 F B) Download Setpoints Buffer Request is sent and the download is re-initiated.

Receive Multi-Block Setpoint Data Packet (3 F 9) – Continued

Receive Device Setpoints (Block #xxyy)

Note 3: Byte0 and Byte1 of Message 2 contain the Setpoints Sequence Number.

If the Setpoints Sequence Number (Message 2, Byte0, Byte 1) does not match the product's current Setpoints Sequence Number, the product will:

- Respond to Message 2 with a (3 1 5) NACK "Buffer Not Available" response,
- Discard previously received setpoints and will respond to any further (3 F 9) commands with a (3 1 C) NACK message until the command (3 F B) Download Setpoints Buffer request is sent and the download is re-initiated.

Note 4: The device may perform range checking on the setpoints as they are downloaded. If a setpoints message is deemed valid, the device responds with a (3 1 0) ACK message. If an out-of-range setpoint value is detected, the product will:

- Respond with a (3 1 B) NACK message,
- Discard previously received setpoints and will respond to any further (3 F 9) commands with a (3 1 C) NACK message until the command (3 F B) Download Setpoints Buffer Request is sent and the download is re-initiated.

Note 5: The product will require that (3 F 9) Download Setpoints commands must follow within 5 seconds of each other. If this timing requirement is violated, the product will discard previously received setpoints and will respond to any further (3 F 9) commands with a (3 1 C) NACK message until the command (3 F B) Download Setpoints Buffer Request is sent and the download is re-initiated.

Note 6: The device responds to the last data message with one of the following messages:

Response	Definition
(3 1 0) ACK	The new setpoint packet was accepted. (The checksum was valid.)
(3 1 A) NACK	The new setpoints packets were not accepted because of a communications checksum error.
(3 1 B) NACK	The new setpoints were not accepted because of an out-of-range setpoint value.

If the response is a NACK, the product will discard previously received setpoints and will respond to any further (3 F 9) commands with a (3 1 C) NACK message until the command (3 F B) Download Setpoints Buffer request is sent and the download is re-initiated.

Note 7: It is recommended that the INCOM master re-read the device setpoints group(s) subsequent to their download. A check should be made to verify the new settings match the downloaded values.

5.3.9 Download Setpoints Buffer Request (3 F B)

Message	Byte	Description
1	Byte0	Number of additional data messages = 2
	Byte1	Setpoints sequence number – LSB
	Byte2	Setpoints sequence number – MSB
2	Byte0	Node address of Network Master – LSB
	Byte1	Node address of network Master – MSB
	Byte2	02 = Download setpoints request
3	Byte0	Checksum (sum of previous 2 messages) – LSB
	Byte1	Checksum (sum of previous 2 messages) – MSB
	Byte2	Complement of checksum LSB

Note 1: The product will respond with an ACK message after each message it receives. If there is a previously requested setpoints download in progress, the product will respond to the last message with a (3 1 C) NACK ("Product Not in a State That Allows the Requested Action") response. Additionally, if the Setpoints Sequence Number (Message 1, Byte1, Byte2) does not match the product’s current Setpoints Sequence Number, the product will respond to the last message with a (3 1 5) NACK ("Buffer Not Yet Available") response.

Note 2: Upon accepting a Download setpoints request, the product will:

1. Store the node address of the network master (Message 2, bytes 0 and 1) into the "Network Master Node Address" field in the FLAGS buffer.
2. Set the "Setpoints Data Upload in Progress" bit in the FLAGS buffer.
3. Enter remote program mode. Local front panel requests to change setpoints are locked out. This lockout will be cleared when the product receives the (3 0 7) Slave Action command. (“Exit program mode and start execution using downloaded setpoints.”)
4. Require that the first (3 F 9) Download Setpoints command to follow be received within 30 seconds. Subsequent (3 F 9) commands, if any, must follow within 30 seconds of each other. Additionally, the (3 0 7) Slave Action command must be sent within 30 seconds of the last (3 F 9) command. If this timing requirement is violated, the product will discard previously received setpoints and respond to any further (3 F 9) commands or (3 0 7) Slave Action command with a (3 1 C) NACK message.

5.4 Programming Considerations for IMPACC Master Communications

5.4.1 IMPACC Device Communications Standards

All IMPACC Expanded Slave Mode devices support the transmission of Fast Status. The Fast Status contains “Division Code” and “Product ID” fields that uniquely identify the product, and implicitly, the communications buffers the product supports. The Fast Status also contains the “Communications Version” field. This field contains a number that is incremented when a new version of an existing product is created, and the new product supports data and commands not available in the previous version. As a general rule, new versions of products support all of the data and commands that are supported in the previous version of the same product. Consequently, master software written for a specific product (identified by a specific division code/product ID) should work with all newer revisions of the same product. Of course, any new data and/or commands added to the product will require enhancement to the master software to utilize the new data and commands.

The Fast Status message format follows the standard defined in Section 5.2.3 on Page 18.

All IMPACC Expanded Slave Mode devices, at a minimum, support transmission of the following communications buffers (in addition to Fast Status):

	Reference
Transmit All Standard Buffers (3 0 3)	Page 24
Transmit Setpoints Buffer (3 C 9)	Page 103
Transmit INCOM Slave-Interface Statistics (3 A 4)	Page 122

The Transmit Setpoints Buffer contains the slave product’s firmware version and revision as specified on Page 103.

5.4.2 IMPACC Device Response Times

Some IMPACC devices must be given much as 20ms to process an incoming message.

Note: On average, the time to process an incoming message is much smaller for most IMPACC devices.

As a result of this phenomenon, INCOM network masters should abide by the following rules to ensure the robustness of the INCOM communications: (Note: The rules are based on a 9,600-baud or higher rate).

1. The INCOM master should insert a 20ms wait (dwell) after all Broadcast commands (Page 120) and between any consecutive (non-acknowledged) INCOM 33-bit messages sent to the same slave device.
2. For INCOM masters that make up polling lists, where a polling list is a sequence of INCOM 33-bit messages that are sent in rapid succession, the following rules apply:
    - All transmissions to a specific device must be in consecutive order. Contiguous commands to the same product/address are allowed, but the master should not attempt to re-establish communications to a device after communicating to other devices in the list.
    - The last message in the list (to be transmitted) should be a global command to disable the INCOM interfaces of all the devices. A Fast Status (3 0 0) request sent to address zero will perform this task.
    - The master must dwell 20ms after the completion of each polling list, before starting the next polling list.

6 CONI-PC INTERFACE

The CONI-III may be configured via a dip-switch SW4-1 to operate in one of two possible modes.

In the CONI-1a compatibility mode (or Mode 1), the CONI-III operates like a CONI-1a. In this mode, the CONI can queue a single transmission message and can buffer multiple receive messages (up to 1,024 receive messages).

In Mode 2, the CONI-III can queue multiple transmission messages and can buffer the messages it receives in response to those transmissions. The CONI-III can buffer a maximum of 256 outgoing (TX) messages and 1,024 incoming (RX) messages.

In both modes of operation, all data and control information from the PC's processor is passed to the CONI-III through I/O registers located on the CONI-III card. The CONI-III does not respond to processor memory commands.

6.1 Register Definitions

The CONI-III utilizes 12 I/O port addresses for the passing of control and data information. The 12 addresses are consecutive. Users can select the starting address via 6 dip switches on the CONI-III card. Each I/O port provides access to an 8-bit register. Six of the I/O port registers are read-only, 3 are write only, and 3 can be read and written. The purpose for each I/O port is summarized below:

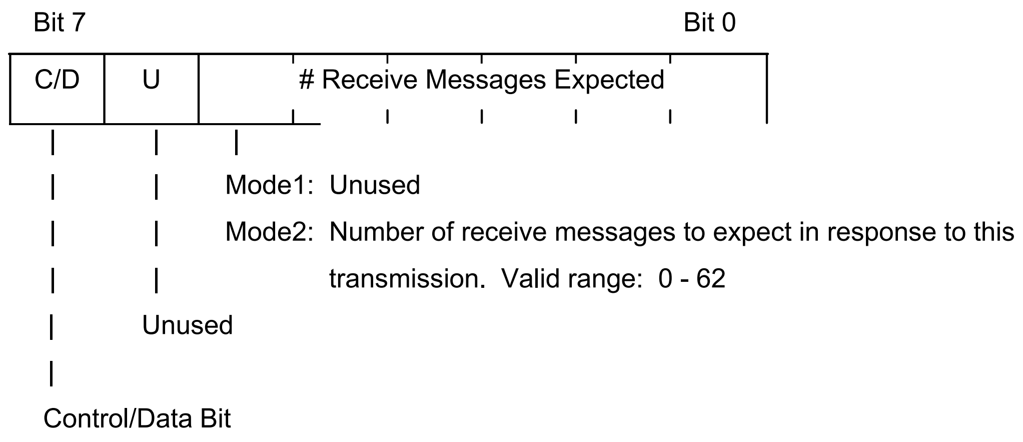
Location	Read/Write	Purpose
xx0 - xx3	Write	Used to output 33-bit INCOM messages to the CONI-III for subsequent transmission on the INCOM network.
xx4 - xx7	Read	Used to input 33-bit INCOM messages received by the CONI-III from the INCOM network.
xx8	Write	Used to control the transfer of information to and from the CONI-III.
xx8-xx9	Read	Used to monitor the status of the CONI-III.
xx9	Write	Used to set the amount of time that the CONI-III will wait between the last received message and the next transmit message when transmitting a sequence in Mode 2.
xxA	Write	Used to set the amount of time the CONI-III should wait for responses on the INCOM network.
xxA	Read	Resets the CONI-III.
xxB	Read	Used to monitor the status and version of the CONI-III.

Note: Users can select xx via dip switches SW1-1 through SW1-6 on the CONI-III. Its range is 00 to $3F_{HEX}$. Read-registers xx9 and xxB, and write-register xxA are used for Mode 2 only. The remaining registers are used for both operational modes.

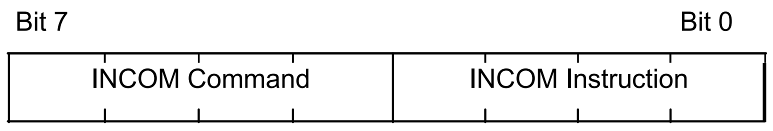
6.1.1 Tx Buffer: xx0$_{HEX}$ - xx3$_{HEX}$ (Write)

The Transmit Buffer consists of 4-byte-wide write-only registers accessed at I/O addresses xx0$_{HEX}$ through xx3$_{HEX}$. A message to be transmitted is loaded into these I/O locations by the PC's processor. The processor should write to these registers only when a message is not in the process of being transmitted (Mode 1) or in the process of being queued (Mode 2) as indicated by the contents of the status register. The registers may be loaded in any order. The format of the Transmit Buffer shown below is for a message with the Control/Data Bit (b2) set to 1. Field definitions change for messages with the Control/Data bit (b2) set to 0, but the bit mapping is identical.

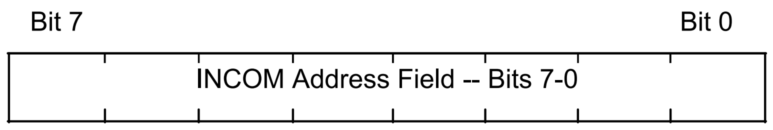
I/O Port xx0 -- Write


Bit 7
Bit 0
C/D
U
# Receive Messages Expected
Mode1: Unused
Mode2: Number of receive messages to expect in response to this transmission. Valid range: 0 - 62
Unused
Control/Data Bit

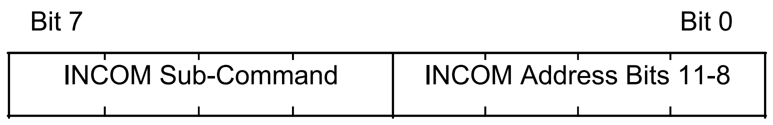
I/O Port xx1 -- Write



I/O Port xx2 -- Write



I/O Port xx3 -- Write

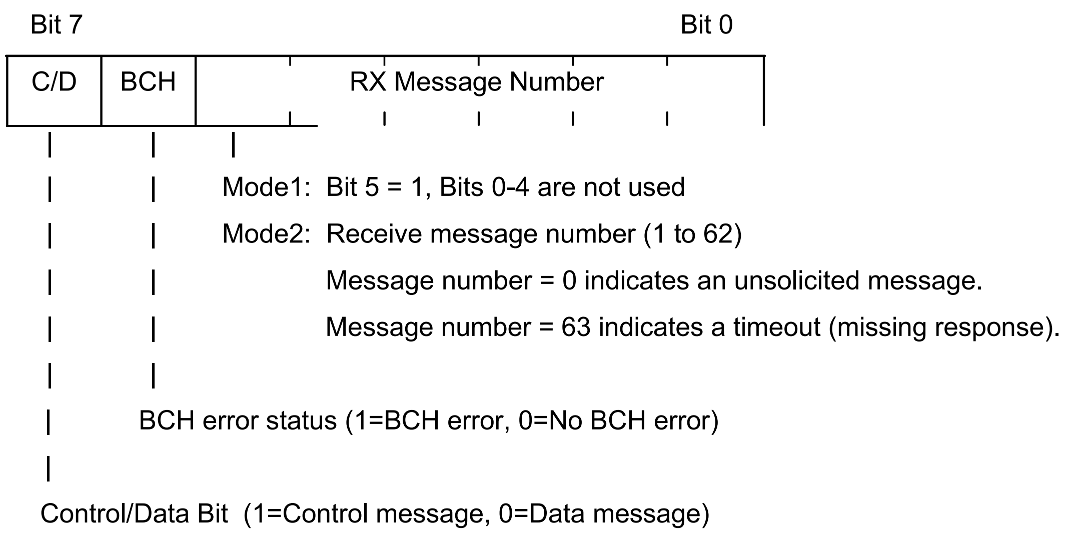


6.1.2 Rx Buffer: xx4$_{HEX}$ - xx7$_{HEX}$ (Read)

The Receive Buffer consists of 4-byte-wide read-only registers accessed at I/O addresses xx4$_{HEX}$ - xx7$_{HEX}$. All messages received by the CONI-III from the INCOM network are passed to the PC through this 4-byte buffer. The CONI-III will write into the Receive Buffer only when the Rx Control Bit in the Status Register is set (SR:1=1). The PC's processor may read the Receive Buffer in any order after the Rx Control Bit has been reset by the CONI (SR:1=0). After the message has been read by the PC's processor, it should set the Rx Control Bit by writing the Acknowledge Receive bit in the Control Register (CR:1=1).

Note: During Mode 1 operation, control of the Receive Buffer should be quickly returned to the CONI-III, since only one additional message can be buffered by the INCOM integrated circuit. During Mode 2 operation, the CONI-III buffers up to 1,024 receive messages, and timing is not as critical.

I/O Port xx4 -- Read



Mode1: Bit 5 = 1, Bits 0-4 are not used

Mode2: Receive message number (1 to 62)

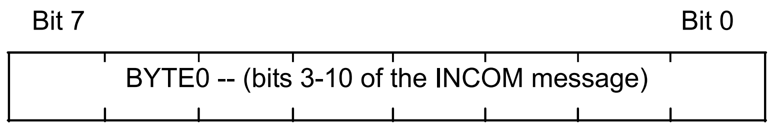
Message number = 0 indicates an unsolicited message.

Message number = 63 indicates a timeout (missing response).

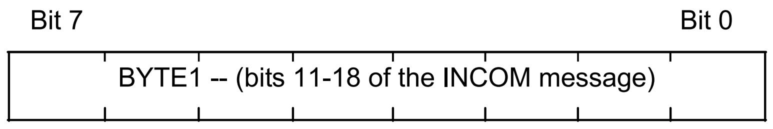
BCH error status (1=BCH error, 0=No BCH error)

Control/Data Bit (1=Control message, 0=Data message)

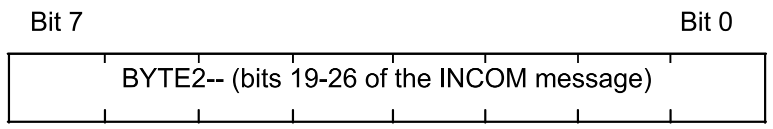
I/O Port xx5 -- Read



I/O Port xx6 -- Read



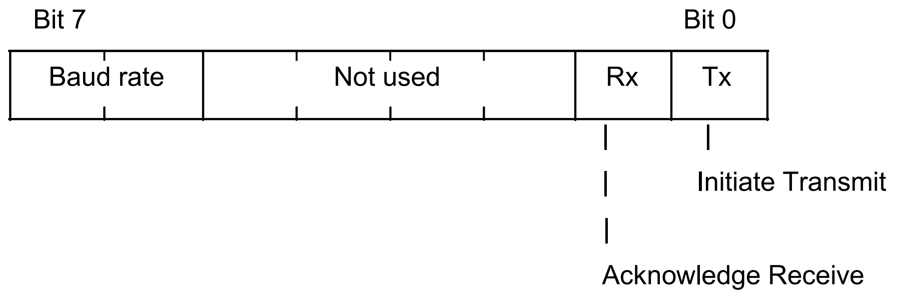
I/O Port xx7-- Read



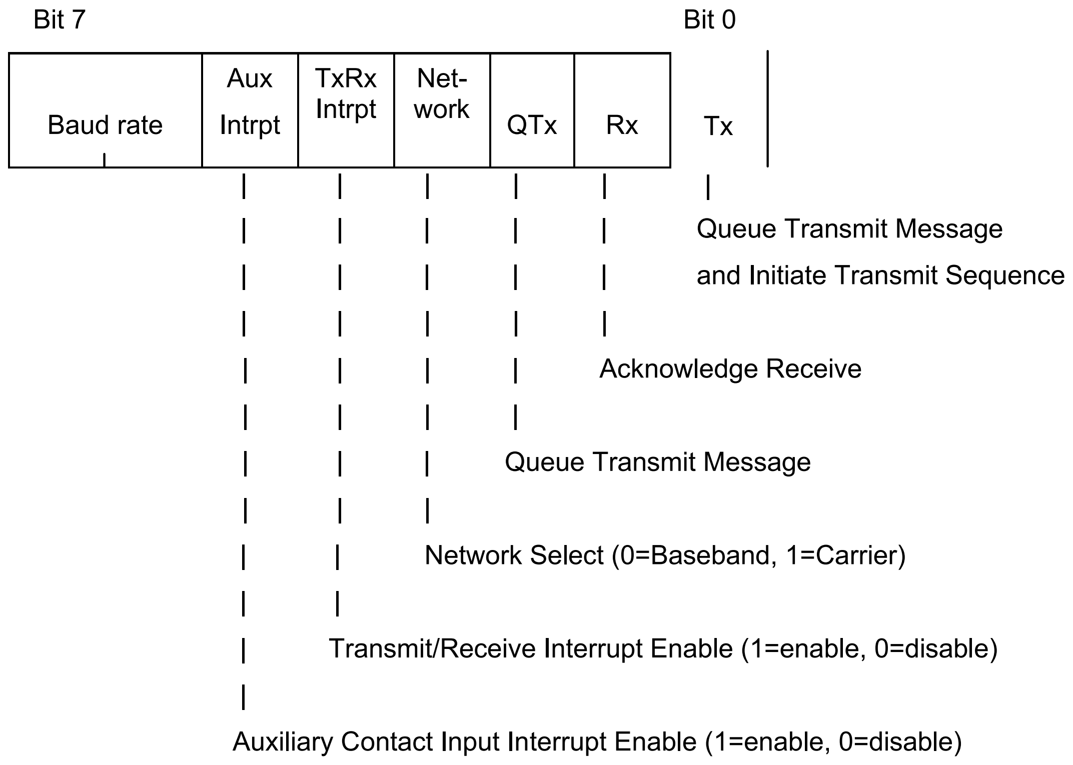
6.1.3 Control Register: xx8$_{HEX}$ (Write)

The Control Register (CR) is used by the PC's processor to control the CONI-III interface. The format of this register is as follows.

I/O Port xx8 -- Write (Mode 1)



I/O Port xx8 -- Write (Mode 2)


Bit 7
Bit 0
Baud rate
Aux Intrpt
TxRx Intrpt
Net-work
QTx
Rx
Tx
Queue Transmit Message and Initiate Transmit Sequence
Acknowledge Receive
Queue Transmit Message
Network Select (0=Baseband, 1=Carrier)
Transmit/Receive Interrupt Enable (1=enable, 0=disable)
Auxiliary Contact Input Interrupt Enable (1=enable, 0=disable)

The definition of bits in this register has been designed so that independent operation of the various functions on the CONI-III can share this common Control Register. Bit 0 (zero) fields have been defined to have no effect on their associated control function. For example, initiating the transmitter (SR=01$_{HEX}$) will not affect operation of the receiver or change the baud rate.

6.1.3.1 Bit 0: Initiate Transmit

Mode 1: When the Control Register is written with a 1 in bit 0 (CR:0=1), the contents of the Transmit Buffer will be transmitted. Once a message transmission is initiated, additional writes to bit 0 (zero) are ignored until the CONI-III completes the transmission. Writing a 0 in bit 0 of the Control Register has no effect.

Mode 2: When the Control Register is written with a 1 in bit 0 (CR:0=1), the CONI-III copies the contents of the Tx Buffer into its internal transmit-message queue. Then the CONI-III transmits the first queued message. It waits for any expected receive messages. After receiving the expected number of messages, or after a communications timeout, the CONI-III sends the second queued message. This process continues until all queued messages are transmitted and expected response messages are received by the CONI-III. Once the Initiate Transmit bit is set by the PC processor, the CONI-III ignores additional writes of 1 in bit 0 until the operation is complete. Writing a 0 in bit 0 of the Control Register has no effect.

6.1.3.2 Bit 1: Acknowledge Receive

The Control Register (CR) should be written with Bit 1 set (CR:1-1) whenever a receive message has been processed and the Receive Buffer is available to the CONI. Writing a zero to Bit 1 will have no effect.

Note: This definition for bit 1 applies to both modes of the CONI-III.

6.1.3.3 Bit 2: Queue Transmit Message

Mode 1: Not used. Writing either a zero or a one to bit 2 will have no effect.

Mode 2: This bit is used by the PC processor to queue TX messages on to the CONI-III for a multiple-transmission sequence. Specifically, when the Control Register is written with a 1 in bit 2 (CR2=1), the CONI-III copies the contents of the TX Buffer into its internal message queue. Writing a zero to bit 2 will have no effect.

Note: The Queue Transmit Message bit (Bit 2) can be used to queue a maximum of 255 transmit messages on to the CONI-III. The last transmit-message of a multiple transmit-message sequence must be queued by using Bit 0 (the Queue Transmit Message and Initiate Transmit Sequence bit).

Bit 7 of Port xx0 and Ports xx1-xx3 (Tx Buffer) must be pre-loaded with the message to be transmitted. Bits 0-5 of TX Buffer Port xx0 must be pre-loaded with the number of RX (receive) messages the CONI-III is to expect as the result of the transmission. The CONI-III's receive-message queue can hold a maximum of 1,024 RX messages.

6.1.3.4 Bit 3: Network

Mode 1: Not used. Writing either a zero or a one to Bit 3 will have no effect.

Mode 2: This bit selects the transceiver to be used. It is read and acted upon when Transmit is initiated – see Bit 0 "Initiate Transmit." A zero (CR:3=0) selects baseband while a one (CR:3=1) selects INCOM carrier.

6.1.3.5 Bit 4: Transmit/Receive Interrupt Enable

Mode 1: Not used. Writing either a zero or a one to Bit 4 will have no effect.

Mode 2: This bit enables the CONI-III transmit/receive interrupt. When it is set (CR:4=1), the CONI-III issues a PC hardware interrupt whenever it sets either Bit 2 or Bit 3 of the Status Register (SR:2=1 Rx Queue Empty/Tx Sequence Complete, or SR:3=1 Rx Message Placed in Rx Buffer). When it is not set (CR:4=0), the CONI-III will not issue PC interrupts when it sets Status Register bits 2 and 3. In this latter mode of operation, the PC processor must periodically poll the CONI-III status register to determine when the CONI-III has completed a transmit or receive action.

6.1.3.6 Bit 5: Auxiliary Contact Input Interrupt Enable

Mode 1: Not used. Writing either a zero or a 1 to Bit 5 will have no effect.

Mode 2: This bit enables the CONI-III auxiliary contact input interrupt. When it is set (CR:5=1), the CONI-III issues a PC hardware interrupt whenever it sets Bit 6 of the Status Register – indicating the auxiliary contact input changed state from “off” to “on.” When it is not set (CR:4=0), the CONI-III will not issue PC interrupts when it sets Status Register Bit 6. In this latter mode of operation, the PC processor must periodically poll the CONI-III status register to determine when the auxiliary contact input has changed state.

6.1.3.7 Bits 6-7: Baud Rate

Mode 1: These 2 bits are used in conjunction with Switch SW4-2 to select the transmit and receive baud rate of the INCOM network. They are read and acted upon by the CONI-III when the PC processor initiates a Transmission (See Bit 0: Initiate Transmit, Page 144). A zero value in bits 6 and 7 will leave the current carrier baud rate unchanged. The following values are available.

CR: 7, 6	CONI-III	CONI-III
	SW4-2	SW4-2
	set to "ASK"	set to "FSK"
00	Unchanged	Unchanged
01	19.2K-baud baseband	76.8K-baud baseband
10	1,200-baud ASK	9,600-baud FSK
11	300-baud ASK	4,800-baud FSK

Mode 2: These 2 bits are used in conjunction with bit 3 and Switch SW4-2 to select the baud rate for the INCOM network. They are read and acted upon by the CONI-III when the PC processor initiates a transmission, that is, when it sets Bit 0 “Queue Tx Message and Initiate Transmit.” A zero value in bits 6 and 7 will leave the current baud rate unchanged. The following values are available.

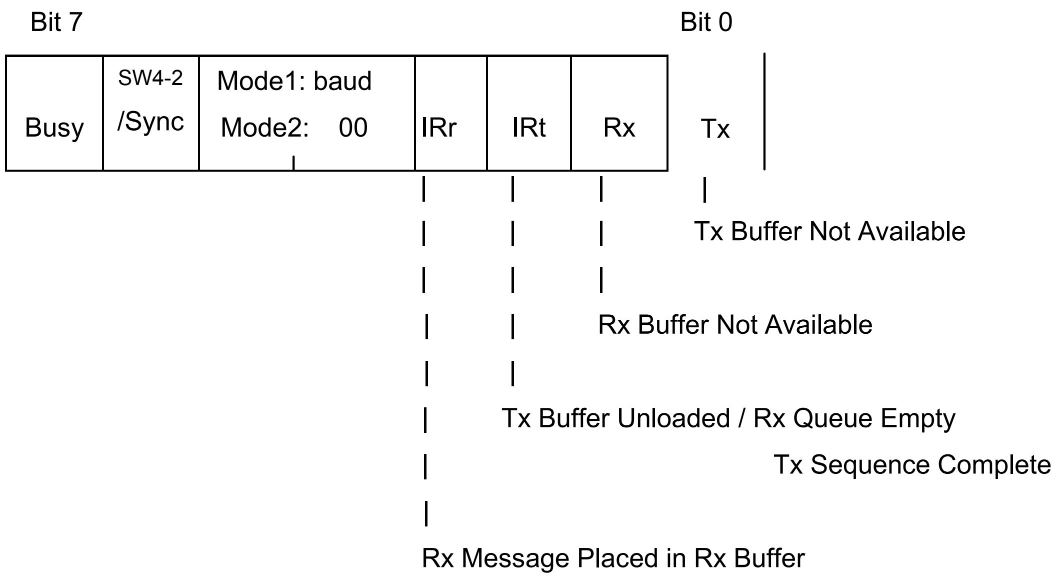
Bits 6-7: Baud Rate – Continued

CR: 7, 6	CR:3=0 (Baseband)	CR:3=1 (Carrier) SW4-2 set to "ASK"	CR:3=1 (Carrier) SW4-2 set to "FSK"
00	Unchanged	Unchanged	Unchanged
01	19.2K baud	300 ASK	4,800 FSK
10	153.6K baud	1,200-baud ASK	9,600-baud FSK
11	76.8K baud	300-baud ASK	4,800-baud FSK

6.1.4 Status Register 1: xx8$_{HEX}$ (Read)

The Status Register (SR) is used by the CONI-III to inform the PC processor the state of the CONI-III card. The contents of this register are read from I/O location xx8h. The format of this register is as follows:

I/O Port xx8 -- Read



6.1.4.1 *Bit 0: Tx Buffer Not Available*

This status bit indicates the availability of the Transmit Buffer to the PC processor.

Mode 1: A 1 (SR:0=1) indicates that the CONI-III is transferring the contents of the Transmit Buffer to the INCOM for transmission on the network. During this time the PC's processor should not write to the Transmit Buffer registers. A zero (SR:0=0) indicates that the Transmit Buffer is available to the PC's processor. After reset, SR:0=0.

Mode 2: A 1 (SR:0=1) indicates that the CONI-III is transferring the contents of the Transmit Buffer to the CONI-III's internal message queue. During this time, the PC processor should not write to the Transmit Buffer (I/O ports xx0-xx3). A zero (SR:0=0) indicates that the Transmit Buffer is available to the PC processor. After reset, SR:0=0.

6.1.4.2 Bit 1: Rx Buffer Not Available

This status bit indicates the availability of the Receive Buffer to the PC processor. A one (SR:1=1) indicates that the Receive Buffer is not available. Reading the Receive Buffer during this time will produce meaningless data. A zero (SR:1=0) indicates that the buffer contains a valid message and the PC processor may safely read the contents. After reset, and after the PC Processor sets the Acknowledge Receive Bit (CR:1=1), SR:1=1.

6.1.4.3 Bit 2: Tx Buffer Unloaded / Rx Queue Empty (Tx Sequence Complete)

Mode 1: This status bit indicates the completion of the last transmission request. This bit will be set (SR:2=1) after the Transmit Buffer has been loaded into the INCOM integrated circuit and transmission is initiated. It will be set at the same time the optional interrupt request is set. This bit will be cleared (SR:2=0) after the status read operation. Note that the actual message transmission will still be in progress at the time the Transmitter Interrupt Request is set.

Mode 2: This status bit indicates the receive-message queue is empty. It will be set (SR:2=1) by the CONI-III when it receives a Receive Acknowledge (CR:1=1) from the PC Processor and the receive-message queue is empty. It will also be set by the CONI-III upon completion of a transmit sequence that has no expected receive-messages associated with it. This bit will be cleared (SR:2=0) after the status read operation.

6.1.4.4 Bit 3: Rx Message Placed in Rx Buffer

Mode 1: This status bit indicates a message has been received from the INCOM network and has been placed in the Rx Buffer. This bit will be set (SR:3=1) after the Receive Buffer has been loaded with the message received by the INCOM integrated circuit. It will be reset at the status read operation.

Mode 2: This bit indicates that a receive message has been moved from the CONI-III's internal receive-message queue to the Rx Buffer. This bit will be set (SR:3=1) after each Rx message is loaded into the Receive Buffer from the message queue. This bit will be cleared (SR:3=0) after the status read operation.

6.1.4.5 Bits 5-4: Mode and Baud Rate

These two status bits indicate the mode the CONI-III is operating in, and if the CONI-III is in Mode 1, they (along with Bit 6) indicate the baud rate of the INCOM integrated circuit.

SR:5-4	SR:6	Mode	INCOM Baud Rate
00	don't care	2	See Status Register 2.
01	0	1	19.2K-baud baseband
01	1	1	76.8K-baud baseband
10	0	1	1,200-baud ASK
10	1	1	9,600-baud FSK
11	0	1	300-baud ASK
11	1	1	4,800-baud FSK

6.1.4.6 Bit 6: Baud Rate or SYNC Interrupt Request

Mode 1: This status bit indicates the status of the FSK/ASK selection switch (SW4-2). It is used in conjunction with Bits 5-4 to indicate the baud rate of the INCOM integrated circuit. Refer to the Bits 5-4 section (above) for additional information.

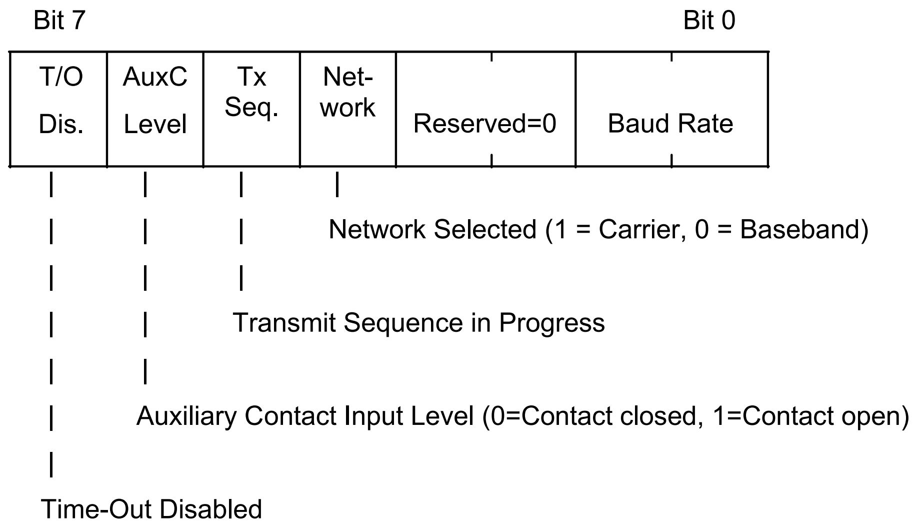
Mode 2: This status bit indicates a Demand-Window Synchronization pulse has been received by the CONI-III. This bit will be set (SR:6=1) after the synchronization pulse causes a normally-open relay to close. This bit will be cleared (SR:6=0) after the status read operation.

6.1.4.7 Bit 7: INCOM Busy

This status bit indicates the status of the INCOM integrated circuit. It will be a one (SR:7=1) whenever the INCOM is busy demodulating a network message or is in the process of transmitting on the INCOM network.

6.1.5 Status Register 2: xx9$_{HEX}$ (Read)

I/O Port xx9 -- Read


Bit 7
Bit 0
T/O Dis.
AuxC Level
Tx Seq.
Net-work
Reserved=0
Baud Rate
Network Selected (1 = Carrier, 0 = Baseband)
Transmit Sequence in Progress
Auxiliary Contact Input Level (0=Contact closed, 1=Contact open)
Time-Out Disabled

Status Register 2 is used when the CONI-III is configured for Mode 2 operation. Status Register 2 does not provide meaningful information when the CONI-III is configured for Mode 1.

6.1.5.1 Bits 1-0: Baud Rate

These two status bits along with Status Bit 4 indicate the baud rate of the INCOM communications.

SR2:1-0	SR2:4	Baud Rate
00	0	Invalid
01	0	19.2K-baud baseband
10	0	153.6K-baud baseband
11	0	76.8K-baud baseband
00	1	1,200-baud ASK (carrier)

01	1	300-baud ASK (carrier)

SR2:1-0	SR2:4	Baud Rate
10	1	9,600-baud FSK (carrier)
11	1	4,800-baud FSK (carrier)

6.1.5.2 Bit 4: Transceiver Selection

This bit indicates the currently selected transceiver. A zero indicates the baseband transceiver was selected via the most recent write to the Control Register. A 1 indicates the carrier transceiver was selected via the most recent write to the Control Register. Refer to Control Register: xx8HEX (Write) on Page 143 for additional information.

6.1.5.3 Bit 5: Transmit Sequence in Progress

This bit indicates the CONI-III is currently processing a transmit sequence. This Transmit Sequence in Progress is set (SR2:5=1) by the CONI-III upon its receiving the Initiate Transmit command (CR:0=1) from the PC processor. It will remain set until all of the queued transmit-messages are transmitted and all of the expected receive-messages are received (or timed-out).

6.1.5.4 Bit 6: Auxiliary Contact Input Level

This bit indicates the current level of the auxiliary contact input.

6.1.5.5 Bit 7: Time-Out Disabled

This bit indicates the INCOM Time-Out Delay is disabled. The INCOM Time-Out Delay is used by CONI-III to determine whether a device is communicating or not and is defined in Write-Register xxA. The timeout is disabled by setting the timeout value to infinity (by setting bit 7 of I/O port xxA to 1).

6.1.6 Mode2 Transmit Delay Register: xx9$_{HEX}$ (Write)

This byte-wide register contains bits which determine the delay to be inserted by the CONI-III before each transmission. The delay is applied before each message the CONI-III transmits when operating in Mode 2. The delay is set by setting/clearing specific bits in the register. The delays specified are additive. On reset, the register will be initialized to 08$_{HEX}$ (512 ms).

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
8,192 µs	4,096 µs	2,048 µs	1,024 µs	512 µs	256 µs	128 µs	64 µs

6.1.7 INCOM Time-Out Register: xxA$_{HEX}$ (Write)

This byte-wide register contains bits which determine the timeout delay used by the CONI-III to determine whether a device is communicating or not. The timeout is applied to each message the CONI-III expects to receive. The timeout delay is set by setting/clearing specific bits in the register. The timeout delays specified are additive. On reset, the register will be initialized to all ones (infinite timeout delay).

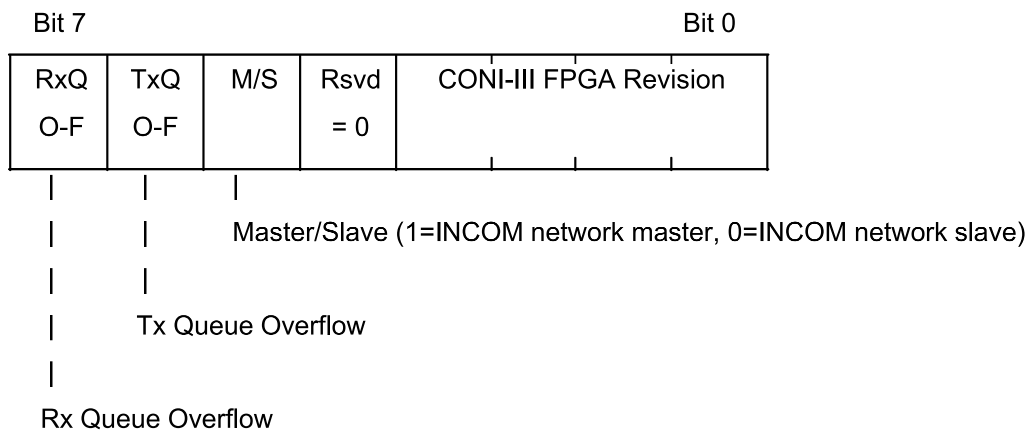
Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Infinity	1,000ms	250ms	64ms	16ms	8ms	4ms	1ms

6.1.8 CONI Reset: xxA$_{HEX}$ (Read)

A read operation from this address will produce invalid data and will initiate a hardware reset of the CONI card.

6.1.9 Status Register 3: xxB$_{HEX}$ (Read)

I/O Port xxB -- Read



Status Register 3 is used when the CONI-III is configured for Mode 2 operation. Status Register 3 does not provide meaningful information when the CONI-III is configured for Mode 1.

6.1.9.1 Bits 3-0: CONI-III FPGA Revision

These 4 bits indicate the revision of the CONI-III's Field Programmable Gate Array.

SR3:3-0	FPGA Revision
0000	Beta
0001	Release 1

6.1.9.2 Bit 5: Master/Slave

This status bit is set (SR3:5=1) if switch SW1-3 is off, indicating the CONI-III is configured to be an INCOM network master. This status bit is reset (SR3:5=0) if switch SW1-3 if on – indicating the CONI-III is configured to be an INCOM network slave.

6.1.9.3 Bit 6: Tx Queue Overflow

This status bit is set (SR3:6=1) if the PC processor attempts to queue more transmit messages than can fit on the CONI-III (that is, more than 256). A correctly programmed PC processor should prevent this error from occurring. If this error occurs, a reset command should be issued to the CONI-III.

6.1.9.4 Bit 7: Rx Queue Overflow

This status bit is set (SR3:7=1) when the CONI-III receives more messages than can fit in the receive-message queue. If and when this condition occurs, the CONI-III will suspend the receiving of INCOM messages until the PC processor reads all of the messages in the receive-message queue (empties the queue). It is cleared (SR3:7=0) when the PC processor acknowledges its receipt of the last receive-message in the queue.

Note: The receive-message queue does not wrap around. The queue pointers are reset upon powerup, when the CONI-III is reset, and when the PC processor empties the queue (reads the latest receive message).

6.2 Initialization

The CONI is initialized by the hardware reset signal "PC_RESET" received from the ISA processor bus. Software reset is performed by reading address xxAh. After reset, the CONI will have the following state:

- The contents of the Rx and Tx buffers are zero.
- Status Register 1 contents will be one of the following values:
  - 22h –if the CONI-III's switches are set for Mode 1 ASK operation.
  - 62h – if the CONI-III's switches are set for Mode 1 FSK operation.
  - 02h – if the CONI-III's switches are set for Mode 2 operation.
- Status Register 2 contents will be D2$_{HEX}$. (Assumes the Aux contact input is open.)
- Status Register 3 contents will one of the following values:
  - FPGA version number (00$_{HEX}$ - 0F$_{HEX}$) for Mode 1 or Mode 2 master operation.
  - FPGA version number + 40$_{HEX}$ (40$_{HEX}$ - 4F$_{HEX}$) for Mode 2 slave operation.
- The carrier baud rate will be set to 1,200 or 9,600, depending on the FSK/ASK switch.
- The baseband baud rate will be set to 153.6K baud.
- No message transmission will be in progress.
- The CONI will be prepared to receive a message from the carrier-based INCOM network.
- The default value contained in the Time-Out Register will be 0FF$_{HEX}$, (The INCOM timeout will be disabled.).
- The default value contained in the Control Register will be 88$_{HEX}$ (Mode 2) or 80$_{HEX}$ (Mode1).
- The default value contained in the Mode 2 Transmit Delay Register will be initialized to 08$_{HEX}$ (512 ms).

Note: After the PC processor resets the CONI-III (reads port address xxA$_{HEX}$), it must wait for a 22h, 62h, or 02h to appear in the status register before issuing any commands (or writes) to the CONI-III's registers.

6.3 Mode 1 Operation

6.3.1 Transmit Operation for Mode 1

Whenever a message is to be transmitted, Status Register Bit 0 (SR:0) should be checked to determine if the Transmit Buffer is available to the PC processor. A one (1) indicates that the CONI has not yet completed unloading the previous message from the Transmit Buffer. A zero in SR:0 indicates that the Transmit Buffer is available and may be filled with a new message. After the Transmit Buffer has been loaded, the Initiate Transmit bit in the Control Register (CR:0) should be set to request that the message in the Transmit Buffer be transmitted.

The CONI-III will set the Tx Buffer Not Available bit in the Status Register (SR:0=1) in response to writing CR:0=1. The new transmit message will be loaded into the INCOM integrated circuit when it is available. After the message has been loaded into the INCOM and transmission initiated, SR:0 will be reset, an interrupt request set, and SR:2 set.

The PC processor can either poll the Status Register (SR:0) or respond to the interrupt request to determine completion. Since bits 2 and 3 of the Status Register are reset after the status read operation, the program must keep track of these completion flags. The hardware implementation of these flags (SR:2 and SR:3) will only reset each flag if it was read as a one. This prevents clearing the flag erroneously if the status read and completion occur simultaneously.

The actual message transmission on the INCOM network will continue after the Status Register update. The INCOM Busy flag (SR:7) will remain set until the message has been completely transmitted by the INCOM. Remember that the INCOM Busy flag (SR:7) is also asserted by receive operations of the INCOM.

6.3.2 Receive Operation in Mode 1

The CONI-III will receive all messages on the INCOM network except those transmitted by itself. Whenever a message is detected, the INCOM circuit will demodulate it and load the received message into its internal shift register. If the Receive Buffer is available at the completion of the message (SR:1-0), the CONI-III will transfer the contents of the INCOM shift register to the Receive Buffer, set the Receiver Interrupt Request flag (SR:3=1), and request a PC processor interrupt. If the Receive Buffer is not available (SR:1=1), the message will remain in the INCOM shift register until the PC processor software releases the Receive Buffer by clearing SR:1.

When the PC processor responds to the Receiver Interrupt, or polls the Status Register (SR:3=1), it may read the message stored in the Receive Buffer (3 0 4h – 3 0 7h). Caution must be exercised in reading the Status Register, since SR:2 and SR:3 are cleared after reading. A status of one (1) in either of these bits indicates an operation has been completed by the CONI-III or the CONI-III requires service. This status must be saved for processing by the appropriate software routine.

All messages should have the BCH Error Status flag checked for a data error (RB304:6=1) and should be discarded if the flag is set. After the message has been read from the CONI, the PC processor must free the Receive Buffer for additional messages by setting the Acknowledge Receive bit in the Control Register (CR:1=1). Failure to release the Receive Buffer will cause all future messages to be ignored by the CONI-III.

6.4 Mode 2 Operation

6.4.1 Transmit / Receive Operation for Mode 2

Prior to initiating a transmission sequence, the PC processor must set the communications baud rate for the INCOM network being used. The baud rate is set by writing to the Control Register, I/O port xx8. (Bits 6-7 are used to define the baud rate.)

Prior to initiating a transmission sequence, the PC processor must also set the INCOM Time-Out Register (I/O port xxA$_{HEX}$) to an appropriate value. (Note: The appropriate value depends on the communications baud rate of the selected INCOM network and on the worst-case message-response latencies of the slave devices.)

Prior to initiating a transmission sequence, the PC processor optionally can set the Mode 2 Transmit Delay Register (I/O port xx8$_{HEX}$) to an appropriate value. (Note: The appropriate value depends on the slave devices to which communications are being sent. The default value of 08$_{HEX}$ or 512 μs is appropriate for most IMPACC devices. However, for the Breaker Interface Module Comm Versions 0 and 1, it is recommended that the Mode2 Transmit Delay Register be set to 4E$_{HEX}$ or 4992 μs.)

Whenever a message or a sequence of messages is to be transmitted, Status Register bit 0 (SR:0) should be checked to determine if the CONI-III is ready to queue a transmission request. A one indicates that the CONI-III has not yet completed its previously requested operation.

A zero in SR:0 indicates that the Tx Buffer is available and may be used to queue a new message to be transmitted.

Assuming the CONI-III is ready to queue a transmission request (SR:0=0), the PC processor loads the Tx Buffer (ports xx0-xx3) with a message to be transmitted and the number of messages the CONI-III should expect to receive immediately following the transmission. After the Tx Buffer is loaded, and if there are additional transmit messages to be sent, the PC processor requests the CONI-III queue the message contained in the Tx Buffer. This is done by setting the Control Register "Queue Transmit Message" bit (CR:2=1). The PC Processor then checks (waits) for the completion of the queue request by checking Status Register bit 0 (SR:0). A zero indicates the message has been queued and the Tx Buffer is available for the next transmit message. The PC processor then loads the Tx Buffer with the next message to be transmitted and the number of messages the CONI-III should expect to receive immediately following its transmission.

This sequence of loading messages continues until the last transmit-message is loaded in Tx Buffer. After loading the last transmit message into the Tx Buffer, the PC processor initiates the transmit/receive operation by writing a byte to the Control Register I/O port (xx8) with bit 3 set appropriately to select the desired network (CR:3=0 for baseband or CR:3=1 for carrier) and with bit 0 set to a 1 (CR:0=1).

Upon receiving the command to initiate a transmit (sequence), the CONI-III transmits the first queued transmit message. It then waits up to a prespecified amount of time for each receive message, storing each message it receives in its internal receive-message queue. Each receive message is stored with a message number. The message number is set to 1 for the first expected response message, set to 2 for the second, and so on. If the CONI-III doesn't receive an expected message within the prespecified time, it stores a message with the message number set to 63. (Note: The message body itself will be meaningless in this case since no message was actually received).

A message received subsequent to a timed-out response will be assigned a message number corresponding to its time slot. (For example, if 4 receive messages are expected, and a timeout occurs on the second and third messages, the CONI-III stores message numbers of 1, 63, 63, and 4 for the four messages respectively). Upon receiving the last expected message or upon timing out on the last message, the CONI-III pauses momentarily (see Mode 2 Transmit Delay Register) and then transmits the second queued message and waits for its corresponding receive messages. This process continues until all of the queued transmit messages are transmitted and their response messages received (or timed-out). Upon completion, the CONI-III copies the first message contained in the received-message queue to the Rx Buffer, sets Status Register Bit 3 (SR:3=1), and requests a PC Processor Interrupt.

When the PC processor responds to the Receive Interrupt, or polls the Status Register (SR:3=1), it may read the message stored in the Rx Buffer (I/O ports xx4 - xx7).

Note: Use caution when reading the Status Register, since SR:2, SR:3, and SR:6 are cleared after reading. A status of one (1) in any of these bits indicates an operation has been completed by the CONI-III or the CONI-III requires service. This status must be saved for processing by the appropriate software routine.

After reading the message stored in the Rx Buffer, the PC processor must free the Rx Buffer for the next message by setting the Acknowledge Receive Bit in the Control Register (CR:1=1). Upon receiving the Acknowledge Receive command, the CONI-III sets the Status Register "Rx Buffer Not Available" Bit (SR:1=1), and copies the next message contained in the receive-message queue to the Rx Buffer. It then sets Status Register Bit 3 (SR:3=1), and requests another PC processor interrupt. This process continues until the last message stored in the receive message queue is transferred to the PC processor. After the PC processor reads the last message and sets the Acknowledge Receive (CR:1=1), the CONI-III sets Status Register Bit 2 (Tx Queue Empty), and requests a PC processor interrupt. This informs the PC processor that the Tx Sequence is complete and that all receive-messages have been read from the CONI-III.

If and when the CONI-III receives an unsolicited message, it stores the message in its receive message queue and sets its message number to zero (0).

Warnings:

- Failure to release the Receive Buffer will prevent the CONI-III from informing the PC processor of the presence of additional messages.
- All messages should have the BCH Error Status flag checked for a data error (RB304:6=1) and should be discarded if the flag is set.
- All messages with message numbers of zero or 63 should be discarded.
- All receive messages from a transmit message sequence should be discarded if there are any unsolicited messages (messages with message number equal to zero) included in the responses.

6.5 PC Interrupt Usage

The CONI-III can be configured to use IRQ 3, 4, 5, 7, or 9. This is configured via Switch SW2.

Note: IRQ3 is the COM2 port interrupt.

IRQ4 is the COM1 port interrupt.

The uses for interrupts IRQ5, IRQ7, and IRQ9 may depend on the brand and model of the personal computer being used and the optional cards installed.

The IRQ assigned to the CONI-III must be unique, that is, not assigned to any other function in the personal computer.

7 RS-232/ASCII TO INCOM

7.1 Overview

Any computer or programmable device with an RS-232 communications port may function as an INCOM network master. An RS-232-based INCOM network master requires the use of a gateway device such as Eaton's Master INCOM Network Translator (MINT), RS-232 PONI, PMCOM5. The gateway device converts the 33-bit binary messages used on the INCOM Local Area Network (LAN) to and from 10-byte ASCII encoded hexadecimal RS-232 messages.

7.2 ASCII Message Formats

The format for the ASCII versions of the INCOM control and data message are as follows.

7.2.1 ASCII Control Message

```
                     Character Number

   10     9     8     7     6     5     4     3     2     1
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| Check Sum |    Address      |SCOMM|COMM |INST | C/D | STX |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
```

7.2.2 ASCII Data Message

```
                     Character Number

   10     9     8     7     6     5     4     3     2     1
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| Check Sum |             Data                  | C/D | STX |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
```

Note that the format for the ASCII string is similar to that for the INCOM message with the following exceptions:

1. The start-of-text control character STX replaces the 2 start bits.
2. The SCOMM character is moved to follow the COMM character rather than the address.

   Note: This applies to control messages only. For data messages containing a "Pass-Through" control message for a device on a subnetwork, the SCOMM character follows the address field.

3. Besides distinguishing between control and data messages, the C/D character is also used to indicate a BCH error.

4. The 2-character checksum replaces the 5-bit BCH error code.
5. The checksum is the 2 least significant hexadecimal values of the sum of the number values for the first 8 characters, subtracted from 100H. The STX character is assigned a number value of 2.
6. All INCOM parameters are expressed as the ASCII encoded hexadecimal value of the parameter.
7. Each character is an 8-bit binary number, transmitted as 1 start bit, 8 data, no parity, and 2 stop bits.

Examples of control and data messages are listed in the following sections.

7.2.2.1 ASCII Control Message To The MINT, RS-232 PONI, or PMCOM5

The following example is a message with INST=3, Command=4, Subcommand=B, sent to a device at INCOM address 1A5H:

```
                       Number                    ASCII
                    dec      hex         character        hex value
STX                 (2)      (2)            STX              02
C/D                  1        1             '1'              31
INST                 3        3             '3'              33
COMM                 4        4             '4'              34
SCOMM               11        B             'B'              42
Address A0         421      1A5             '5'              35
        A1                                  'A'              41
        A2                                  '1'              31
Check Sum L                  DB             'B'              42
          H                                 'D'              44
             (STX)
               v
Note: 100H - ( 2 + 1 + 3 + 4 + B + 5 + A + 1 ) = DB


                   Character Number
  10    9     8     7     6     5     4     3     2     1
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| 'D'   'B' |  1'   'A'   '5' | 'B' | '4' | '3' | '1' | STX |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
```

7.2.2.2 *ASCII Control Message Received from the MINT, RS-232 PONI, or PMCOM5 (No BCH Error)*

The following example is a message with INST=3, Command=4, Subcommand=B:

```
                   Number                      ASCII
                dec      hex         character        hex value
STX             (2)      (2)            STX              02
C/D              2        2             '2'              32
INST             3        3             '3'              33
COMM             4        4             '4'              34
SCOMM           11        B             'B'              42
Address A0     421      1A5             '5'              35
        A1                              'A'              41
        A2                              '1'              31
Check Sum L              DA             'A'              41
          H                             'D'              44
             (STX)
               v
Note: 100H - ( 2 + 2 + 3 + 4 + B + 5 + A + 1 ) = DA

                  Character Number

   10    9     8     7     6     5     4     3     2     1
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| 'D'   'A' |  1'   'A'   '5' | 'B' | '4' | '3' | '2' | STX |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
```

7.2.2.3 ASCII Data Message to or from a MINT, RS-232 PONI, or PMCOM5 (No BCH Error)

The following example is a message with the data field set to 0D4AD31H:

		number		ASCII	
		dec	hex	character	hex value
STX		(2)	(2)	STX	02
C/D		0	0	'0'	30
BYTE0	lsn	49	31	'1'	31
	msn			'3'	33
BYTE1	lsn	173	AD	'D'	44
	msn			'A'	41
BYTE2	lsn	212	D4	'4'	34
	msn			'D'	44
Check Sum	L		D2	'2'	32
	H			'D'	44

```
              (STX)
                v
Note: 100H - ( 2 + 0 + 1 + 3 + D + A + 4 + D ) = D2
```

```
                   Character Number

   10    9     8     7     6     5     4     3     2     1
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
| 'D'   '2' | 'D'   '4'   'A'   'D'   '3'   '1' | '1' | STX |
+-----+-----+-----+-----+-----+-----+-----+-----+-----+-----+
```

7.3 BCH Error and Data Flow Control ASCII Messages

7.3.1 BCH Error Characters

Should the MINT, RS-232 PONI or PMCOM5 receive a transmission from a product that contains a BCH error, there is no separate character available in the 10-character string that can be used to inform the host that the message had an error. The C/D character is used for this purpose and thus C/D is defined differently when it is part of the ASCII string than when it is part of an INCOM message. These different definitions are listed in the following 3 sections.

7.3.1.1 Messages from the Host to the MINT, RS-232 PONI, or PMCOM5

C/D	INCOM	ASCII
'0'	data	data
'1'	control	control

7.3.1.2 Messages from the MINT (RS-232 PONI or PMCOM5) to the Host

C/D	INCOM	ASCII
'0'	data	data, no BCH error
'1'	data	data, with BCH error
'2'	control	control, no BCH error
'3'	control	control, with BCH error

7.3.1.3 Messages from the Series III Gateway Interface to the Host (obsolete)

C/D	INCOM	ASCII
'0'	data	data, no BCH error
'2'	control	data, no BCH error

7.3.2 Data Flow Control Characters

In order to control the data flow and other functions of the RS-232 channel, several special characters are used in addition to those already discussed. All of the legal characters are presented in the following table together with notes about their functions.

CHAR	CHAR	HEX CODE	VALID Tx	VALID Rx	DESCRIPTION
<STX>	CTRL-B	02H	X	X	Start of ten byte message
<ACK>	CTRL-F	06H	X		Format message acknowledge
<LF>	CTRL-J	0AH		X	Used for echo screen display
<CR>	CTRL-M	0DH		X	Used for echo screen
<XON>	CTRL-G	11H	X	X	Gateway ready to accept data
<DC2>	CTRL-R	12H	X		Turn on gateway echoing (See Notes 2 and 8 below.)
<XOFF>	CTRL-S	13H	X	X	Gateway not able to accept data
<DC4>	CTRL-T	14H		X	Turn off gateway echoing
<NAK>	CTRL-U	15H	X		Format message not acknowledge
'0'-'9'		30-39H		X	ASCII encoded HEX numerics
'A'-'F'		41-46H		X	ASCII encode HEX alphas
'A'		41H	X		Echo format acknowledge
'N'		4EH	X		Echo format not acknowledge
'a'-'f'		61-66H		X	ASCII encoded HEX alphas

Notes:

1. An <ACK> or <NACK> is sent to the host by the gateway device (MINT, RS-232 PONI, or Series III Gateway Interface) immediately following the reception of a 10-character message. An <ACK> is sent if the 10 characters are valid (legal) and if the checksum is correct. A <NACK> is sent if an invalid (non-supported) character is received or if the checksum is incorrect.
2. All characters received will be echoed when the echoing is active.
3. An <XOFF> is sent immediately after 2 characters of a new message are received and the previous message processing is not yet completed. An <XON> is sent only when <XOFF> has been sent, and is transmitted when the previous message processing has completed (freed the input INCOM buffer). Hardware start/stop control of data flow is performed 1 byte prior to this software control.

   An RS-232 device communicating through a gateway may stop and start the data flow by ending the <XON> and <XOFF> characters.

4. When echoing is active (on), reception of a <CR> by the gateway willcause a <CR> and <LF> to be echoed by it. This may cause double spacing on a master device display.
5. Reception of lowercase HEX alphas are converted to hexadecimal values inside the gateway but are echoed as uppercase characters.
6. Within a 10-byte data stream representing a message from a master device, <LF>, <CR>, <DC2>, <RUB>, and <BS> are ignored as far as byte count for the message is concerned. They will not interfere with the gateway receiving a valid message if interspersed within the message. (This would not normally occur.)
7. Any characters not listed in the previous table and in the valid RX column are considered bad characters and are counted in the message byte count, but they will cause a formatting error and subsequent <NAK> to be sent when the message is complete. Characters not counted include <CR>, <LF>,<DC2> and <DC4>.
8. <DC2> echo activation is no longer supported by the latest revision of the MINT II.

7.4 RS-232C Hardware Specifications

The gateway device physical interface is a 25-pin "D" subminiature connector that utilizes the minimum 3-wire configuration outlined in the RS-232C standard. These 3 wires consist of TX, RX and common. The pins are designated as as follows. The interface cable is user-supplied. The IMPACC gateways utilize an 8-bit data word with 1 start, 2 stop bits and no parity bit. The speed is gateway-dependent. All gateways support a 1,200-bps baud rate.

HOST			IMPACC GATEWAY
RS-232 PORT	MINT/RS-232 PONI/SERIES III		GATEWAY INTERFACE
9 pin "D" pin number	25 pin "D" pin number		25 pin "D" pin number
3	2	--- TX -->	2
2	3	<-- RX ---	3
5	7	common	7

8 INCOM/UDP PROTOCOL

The purpose of this section is to define the communication protocol utilized with the Ethernet/ INCOM (EI) family of products. The family of products presently includes the EMINT, EPONI and the Power Xpert Gateway (PXG). Future products may be included based on the EPONI or EMINT hardware platforms.

1. EMINT supports the buffered mode function similar to CONI-III (such as when the master can elect to send batch commands to the EMINT). Upon receiving the batch commands, EMINT processes all the commands one by one and collects the data sent by the device. After all the commands are processed, all the messages received are then sent back in batch to the master.
2. The EPONI and PXG support buffered mode functions as described for the EMINT.
3. INCOM communication is the main focus of this specification; however, the protocol is expandable and it is possible to support other forms of communication as desired in the future.
4. The connectionless protocol, UDP, is used to exchange IP packets between the network client and EI products.
5. EMINT provides an RS-232 interface for the user to configure IP address/default gateway and socket port number.
6. The EPONI also provides an RS-232 interface as described for the EMINT.
7. The PXG provides a web interface for the user configure IP address/default gateway and socket port number.

8.1 Beginning of Message String

The INCOM/UDP protocol always prefixes a "Begin of Message" (BoMsg) string in front of every message in order to send binary data and to ensure integrity of the content. BoMsg is a variable length string defined as:

(	#	I	N	C	O	M	T	C	P	*	)	Xxxx	|

where xxxx is a string representing the number of bytes following BoMsg (not including the pipeline character, "|").

For instance, if a program intends to send the string "Testing 123.", it has to format a string (shown as follows) before sending it.

(	#	I	N	C	O	M	T	C	P	*	)	1	2	|	T	e	s	t		i	n	g		1	2	3	.

8.2 EI Product Communication Categories

This protocol specification utilizes the concepts of FunctionCategories and FunctionTypes to segment the communication interfaces of each device. FunctionCategories described major communication types and FunctionTypes are used to further segment the communication functions.

The following major FunctionCategories are supported in the present protocol version.

1. EPONI Query (wFunctionCategory=1)

- The EPONI Query category is utilized for communications directly to the EPONI product.

2. INCOM UDP (wFunction Category=2)

- ◆ The INCOM/UDP category is utilized for tunneling INCOM messages in UDP packets. This communication category is presently implemented in the EPONI, EMINT and PXG devices.

3. EMINT (or PXG) Query (wFunctionCategory=3)

   ◆ The EMINT Query category is utilized for communications directly to the EMINT pr PXG product.

4. Application Query (wFunctionCategory=4)

   ◆ The application query category should be implemented by all applications on EI devices. This application query will provide basic information about the application that is running on the device.

5. Loader Query (wFunctionCategory = 5)

   ◆ The loader query is implemented by the EMINT / PXG flash loader application.

8.3 Notes on Data Structures

This section describes communication message structures in terms of data structures. It is important to note that implementing these data structures may require the use of preprocessor pragma statements to instruct the compiler not to pad the data structures. Also further compiler pragmas may be required to swap the byte order on “little-endian” processors.

8.4 INCOM on UDP/IP

Port 5150 will be used by the EI devices to exchange information with the master PC. The message structures currently used in PowerNet DeviceServer/INCOM Handler are to be used as the basic message types. They are as follows:

```
typedef struct
{
        DWORD RxMessageNumber:        6;      // number of messages to expect
        DWORD BCH:                    1;      // not used
        DWORD C_D:                    1;      // 1 = Control, 0 Data
        DWORD Inst_Command:            8;
        DWORD AddressLOB:              8;
        DWORD AddressHi_SubCommand:   8;
} INCOM_HANDLER_CONTROL_MESSAGE;


typedef struct
{
        BYTE RxMessageNumber:         6;       // message number
        BYTE BCH:                     1;
        BYTE C_D:                     1;      // 1 = Control, 0 = Data
        BYTE  byByte1;
        BYTE  byByte2;
        BYTE byByte3;
} INCOM_HANDLER_DATA_MESSAGE;


typedef union
{
        INCOM_HANDLER_CONTROL_MESSAGE Control;
        INCOM_HANDLER_DATA_MESSAGE Data;
} INCOM_HANDLER_MESSAGE_UNION;
```

The INCOM message to send down to the EI device is embedded in the following structure.

```
typedef struct
{
     INCOM_HANDLER_MESSAGE_UNION INCOM_Message;
     WORD wRxTimeOut;         // The worse case response time between returned messages
                              // as defined in the CONI-III manual. (in milliseconds)
     WORD wDelayAfterSending; // in millisecond
} INCOM_TCPIP_MESSAGE;
```

In order to maximize performance, multiple `INCOM_TCPIP_MESSAGE` messages can be packaged and sent to the EI device to perform a batch operation. This structure following BoMsg is defined to support such function (with `wFunctionCategory` set to 2 and `byTypeOfMessage` set to 1):

```
typedef struct

{

       DWORD lHandle;               // unique message identifier sent by client

       WORD wFunctionCategory;      // 2 = INCOM_TCPIP

       BYTE byTypeOfMessage;        // 1=SendToINCOM, 2=ReplyFromINCOM, 3=UnsolicitedFromINCOM

       WORD wNumberOfMessages;      // max is 4000

       INCOM_TCPIP_MWSSAGE MessageArray[1];

} INCOM_TCPIP_MESSAGE_BATCH;
```

`INCOM_TCPIP_MESSAGE_BATCH` is a variable-length data structure. The size of the structure is computed as follows:

`sizeof(INCOM_TCPIP_MESSAGE_BATCH) + (wNumberOfMessages – 1) * sizeof(INCOM_TCPIP_MWSSAGE).`

Upon receiving INCOM_TCPIP_MESSAGE_BATCH, EI devices, just like CONI-III in buffered mode, process the message one by one and collect the data returned from the device. After all the messages are processed, the EI device sends the following data following BoMsg back to the master (with wFunctionCategory set to 2 and byTypeOfMessage set to 2):

```
typedef struct

{

       DWORD lHandle;           // unique message identifier sent by client

       WORD wFunctionCategory;  // 2 = INCOM_TCPIP

       BYTE byTypeOfMessage;    // 1=SendToINCOM, 2=ReplyFromINCOM,
3=UnsolicitedFromINCOM

       WORD wNumberOfMessages;  // max is 4000

       INCOM_TCPIP_MWSSAGE MessageArray[1];

} INCOM_TCPIP_MESSAGE_BATCH;
```

8.5 EPONI Query Functions

Socket 5150 will be used by the EPONI to support query functions. The query functions will be used by the network client to determine the state of the EPONI and its capabilities. The message structure following BoMsg is defined as (note that wFunctionCategory will be set to 1):

```
typedef struct
{
        DWORD lHandle;              // unique message identifier sent by client
        WORD wFunctionCategory;     // 1 = EPONI_QUERY
        WORD wFunction;             // defined below
        WORD wDataBytes;            // number of bytes passed in pData
        BYTE pData[1];              // data sent with the function.
} EPONI_QUERY;
```

EPONI_QUERY is a variable-length data structure. The size of the structure is computed as sizeof(EPONI_QUERY) + wDataBytes - 1.

The list of supported EPONI query functions supported are defined as follows.

Protocol Version 0.0 – As implemented by the original EPONI product

1. EPONI binary firmware upgrade (wFunction=3)

   Description: Multiple “blocks” of binary data are transferred to the EPONI utilizing this communication type.

2 EPONI event log retrieval (wFunction=4)
Description: Transfers the event log from the EPONI utilizing UDP protocol.

8.6 Application Query Functions

All new applications written for the EI family of devices should include support for the application query functions. The application query provides basic information about the application such as application name, firmware revision and protocol revision of the application.

The application query function will be utilized by the network client to determine what type of application is running on the EI-device. The Application Query function may also be used as a generic “ping” function.

The application query function is implemented with the EPONI_QUERY data structure as described by the EPONI QUERY.

The list of supported application query functions supported are defined as follows.

Protocol Version 1.0 – As implemented by the first release of the EMINT application and SRecord LOADER application.

1. Retrieve Firmware Version and Revision (wFunction=1)

   Description: This function retrieves the firmware version and revision from the application running on the product.

   Implementation: The master PC requests the application firmware revision by utilizing an EPONI query data structure with the values set, as follows:

```
typedef struct
{
       DWORD lHandle;               // unique message identifier sent by client
       WORD wFunctionCategory;      // 4 = Application Query
       WORD wFunction;              // 1 = Retrieve Firmware Version and Revision
       WORD wDataBytes;             // = 1 (to keep sizeof(EPONI_QUERY) valid )
       BYTE pData[1];               // pData[0] = 0;
} EPONI_QUERY;
```

The EI product responds to the request with the following information:

```
typedef struct
{
       DWORD lHandle;               // = handle sent by PC
       WORD wFunctionCategory;      // 4 = Application Query
       WORD wFunction;              // 1 = Retrieve Firmware Version and Revision
       WORD wDataBytes;             // = 2
       BYTE pData[1];               // pData[0] = Application Firmware Version ;
                                    // pData[1] = Application Firmware Revision ;
} EPONI_QUERY;
```

2. Retrieve Protocol Version and Revision (wFunction=2)

   Description: This function retrieves the protocol version and revision from the application running on the product.

   Implementation: The network client requests the application protocol revision by utilizing an EPONI query data structure with the values set, as follows:

```
typedef struct
{
       DWORD lHandle;               // unique message identifier sent by client
       WORD wFunctionCategory;      // 4 = Application Query
       WORD wFunction;              // 2 = Retrieve Protocol Version and Revision
       WORD wDataBytes;             // = 1 (to keep sizeof(EPONI_QUERY) valid )
       BYTE pData[1];               // pData[0] = 0;
} EPONI_QUERY;
```

The EI product responds to the request with the following information:

```
typedef struct
{
       DWORD lHandle;                // = handle sent by PC
       WORD wFunctionCategory;       // 4 = Application Query
       WORD wFunction;               // 2 = Retrieve Protocol Version and Revision
       WORD wDataBytes;              // = 2
       BYTE pData[1];                // pData[0] = Application Protocol Version ;
                                     // pData[1] = Application Protocol Revision ;
} EPONI_QUERY;
```

3. Retrieve Application Name (wFunction=3)

   Description: This function retrieves the firmware version and revision from the application.

   Implementation: The network client requests the application name by utilizing an EPONI query data structure with the values set, as follows:

```
typedef struct
{
       DWORD lHandle;                // unique message identifier sent by client
       WORD wFunctionCategory;       // 4 = Application Query
       WORD wFunction;               // 3 = Retrieve application name.
       WORD wDataBytes;              // = 1 (to keep sizeof(EPONI_QUERY) valid )
       BYTE pData[1];                // pData[0] = 0;
} EPONI_QUERY;
```

The EI product responds to the request with the following information, where "Application Name" is replaced by the actual application name, such as "EMINT" or "LOADER."

```
typedef struct
{
       DWORD lHandle;                // = handle sent by PC
       WORD wFunctionCategory;       // 4 = Application Query
       WORD wFunction;               // 1 = Retrieve application name.
       WORD wDataBytes;              // = strlen("Application Name") + 1
       BYTE pData[1];                // pData[] = "Application Name"
} EPONI_QUERY;
```

8.7 S-record Loader Query Functions

The list of supported EI product query functions supported are defined as follows.

Protocol Version 0.0 – As implemented by the original EMINT product

1. Initiate S-record Upload (Function=5)

   Description: This function instructs the product to erase the appropriate sections of memory and prepare for a S-record upload.

   Implementation: The master PC requests that an upload be initiated by utilizing an SRECORD_BATCH data structure. Note that the SRECORD_BATCH type is a simple extension of the EPONI_QUERY type with byNumberOfRecords = pData[0] and pSrecord[0] = pData[1] ;.

```
typedef struct
{
       DWORD lHandle ;               // Unique Handle for UDP Packet
       WORD  wFunctionCategory;      // 5 = SRecord Loader Query
       WORD  wFunctionType ;         // 5 = Initiate Srecord upload
       WORD  wNumberOfBytes;         // Total Number of Bytes in pSrecord + 1
       BYTE  byNumberOfRecords ;     // Number of S-Records in Packet
       BYTE  pSrecord[];             // Srecord data
} SRECORD_BATCH;
```

The initiate S-record upload function expects to receive a constant-length S0-type S-record with the following format:

```
/* Initiate Srecord Upload S0 Record */

/* S0                                 - S0 Type Record */
/* 20                                 - 32 bytes after the 0x20 (=32 decimal) itself */
/* 0000                               - Two byte dummy address */
/* 454D494E542D54455354               - ASCII Hex for "EMINT_TEST" */
/* 00                                 - Version = 0 */
/* 00                                 - Revision = 0 */
/* 01                                 - TableNumber = 1 */
/* 00400100                           - Begin Address */
/* 0002F4A3                           - Size */
/* 00400108                           - Execution Address */
/* 00E2CF8A                           - Datasum of the program */
/* 96                                 - Checksum of the S0 Record */
```

The S-records utilized by the EI products will drop the leading “S” character and reduce all ASCII-byte “pairs” to their single-byte binary equivalent.

The EI product will respond with the following EPONI_QUERY structure.

```
typedef struct
{
        DWORD lHandle;                // = handle sent by PC
        WORD wFunctionCategory;       // 5 = Srecord Loader Query
        WORD wFunction;               // 0x0005 (success) 0x8005 (failure)
        WORD wDataBytes;              // 2
        BYTE pData[0];                // pData[0] = LSB of Error Code
        BYTE pData[1];                // Pdata[1] = MSB of Error Code
} EPONI_QUERY;
```

2. Upload Srecords (Function=6)

   Description: This function will be called multiple times by the network client to upload blocks of S-records. Each S-record block can contain up to 128 S-records. The EI product will accept S-records of type S1, S2, or S3.

   Implementation: The network client uploads blocks of S-records in an SRECORD_BATCH data structure.

```
typedef struct
{
        DWORD lHandle ;               // Unique Handle for UDP Packet
        WORD  wFunctionCategory;      // 5 = Srecord Loader Query
        WORD  wFunctionType ;         // 6 = Upload Srecords
        WORD  wNumberOfBytes;         // Total Number of Bytes in pSrecord + 1
        BYTE  byNumberOfRecords ;     // Number of S-Records in Packet
        BYTE  pSrecord[];             // Srecord data
} SRECORD_BATCH;
```

The EI product will respond to each record “block” with the following EPONI_QUERY structure.

```
typedef struct
{
        DWORD lHandle;                // = handle sent by PC
        WORD wFunctionCategory;       // 5 = Srecord Loader Query
        WORD wFunction;               // 0x0006 (success) 0x8006 (failure)
        WORD wDataBytes;              // 2
        BYTE pData[0];                // pData[0] = LSB of Error Code
        BYTE pData[1];                // Pdata[1] = MSB of Error Code
} EPONI_QUERY;
```

3. Terminate S-record Upload (Function=7)

Description: This function will be called by the network client after all of the S-record blocks have been transmitted. The EI product will finalize application program storage.

Implementation: The network client resends the S0 record as sent in Initiate S-record Upload.

```
typedef struct
{
        DWORD lHandle ;               // Unique Handle for UDP Packet
        WORD  wFunctionCategory;      // 5 = Srecord Loader Query
        WORD  wFunctionType ;         // 7 = Upload Srecords
        WORD  wNumberOfBytes;         // Total Number of Bytes in pSrecord + 1
        BYTE  byNumberOfRecords ;     // Number of S-Records in Packet
        BYTE  pSrecord[];             // S0 record - see initiate Srecord Upload
} SRECORD_BATCH;
```

The EI product will respond with the following EPONI_QUERY structure.

```
typedef struct
{
        DWORD lHandle;                // = handle sent by PC
        WORD wFunctionCategory;       // 5 = Srecord Loader Query
        WORD wFunction;               // 0x0007 (success) 0x8007 (failure)
        WORD wDataBytes;              // 2
        BYTE pData[0];                // pData[0] = LSB of Error Code
        BYTE pData[1];                // Pdata[1] = MSB of Error Code
} EPONI_QUERY;
```

4. Reboot S-record Upload product (Function=10)

   Description: This function will be called by the network client after all of the S-record blocks have been transmitted.

   Implementation: The network client resends the S0 record as sent in Initiate Srecord Upload.

```
typedef struct
{
        DWORD lHandle ;               // Unique Handle for UDP Packet
        WORD  wFunctionCategory;      // 5 = Srecord Loader Query
        WORD  wFunctionType ;         // 10 = Reboot product
        WORD  wNumberOfBytes;         // Total Number of Bytes in pSrecord + 1
        BYTE  byNumberOfRecords ;     // 1 record in packet
        BYTE  pSrecord[];             // S0 reboot record - see below
} SRECORD_BATCH;
```

The S0 record should contain the following data.

S0|0F|0|0|'R'|'E'|'-'|'B'|'O'|'O'|'T'|0|0|0|0|0|F8|

The EI product will respond with the following EPONI_QUERY structure.

```
typedef struct
{
        DWORD lHandle;                       // = handle sent by PC
        WORD wFunctionCategory;              // 5 = Srecord Loader Query
        WORD wFunction;                      // 0x000A (success) 0x800A (failure)
        WORD wDataBytes;                     // 2
        BYTE pData[0];                       // pData[0] = LSB of Error Code
        BYTE pData[1];                       // Pdata[1] = MSB of Error Code
} EPONI_QUERY;
```

8.8 EMINT or PXG Query Functions

The list of supported EMINT or PXG query functions supported are defined as follows.

Protocol Version 0.0 – As implemented by the original EMINT product

1. Run SRecord Loader (wFunction = 3)

   Description: Instructs the EMINT application to set the RUN LOADER flags and to self-terminate the EMINT application. On processor reboot, the S-record loader will execute.

   This function will be called with the following data.

```
typedef struct
{
        DWORD lHandle;               // = handle sent by PC
        WORD wFunctionCategory;      // 3 = Emint Query
        WORD wFunction;              // 0x0003 - Run Srecord Loader
        WORD wDataBytes;             // 10
        BYTE pData[];                // pData[] = "RUNLOADER"
} EPONI_QUERY;
```

The EMINT or PXG product will not respond as transfer of the processor is transferred to the S-record loader application.

2. Event log retrieval (wFunction=4)

   Description: Transfers the event log from the EMINT or PXG utilizing UDP protocol.

8.9 Multiple Network Client Support

The EPONI, EMINT or PXG will support one network client (hereafter referred to as the "master") that has full privileges. The IP address for the master will be programmed during setup. The products will correctly service only one master at a time (with regard to safe retry of control commands).

8.9.1 Safe Retry

Since this protocol is based on UDP, to guard against packets lost during transmission, the master may resend the packet with the same lHandle. The EI device will save the last buffer sent to the master in response to the last command received from the master. If the EI device receives messages with a matching handle from that master, it will resend the same buffer without sending the message to the device attached. It will continue to do so until a command with a different handle is received.

8.9.2 Special Considerations

1. EI devicesI formats the data messages in the same way as CONI-III in Mode 2. Before sending the messages back to the master, the RxMessageNumber field will be numbered from 1 to 62 if the messages are valid. Zero (0) will be assigned to RxMessageNumber to indicate an unsolicited message while 63 (0x3F) will be assigned to RxMessageNumber to indicate a timeout error. For example, if the master is expecting 5 messages to return but EPONI receives only 3 messages, EPONI replies with 5 messages back to the master with RxMessageNumber set to 1, 2, and 3 respectively for the first 3 messages and RxMessageNumber set to 63 for the last 2 messages.
2. The EPONI, EMINT and PXG pass received INCOM messages back to the master without modification or changing byte ordering in the same manner as the CONI-III in Mode 2.
3. The maximum number of messages (set by wNumberOfMessages) that a master can send and receive from EI devices is 4,000. If an EI device receives more than 4,000 messages, it will discard them without processing them. An Ei deivice will only reply up to 4,000 messages even if the master is expecting to receive more than 4,000 messages. It is the responsibility of the master to monitor that these limits are not exceeded before sending messages to the EI device.

8.10 S-record Data Format

[S-record Format]

SREC(4)   UNIX 5.0 (03/21/84)   SREC(4)

- An S-record file consists of a sequence of specially formatted ASCII character strings. An S-record will be less than or equal to 78 bytes in length.
- The order of S-records within a file is of no significance and no particular order may be assumed.
- The general format of an S-record is as follows.

```
+------------------//-------------------//-----------------------+
| type | count | address  |           data | checksum |
+------------------//-------------------//-----------------------+
```

8.10.1 Terms

Type: A char[2] field. These characters describe the type of record (S0, S1, S2, S3, S5, S7, S8, or S9).

Count: A char[2] field. These characters, when paired and interpreted as a hexadecimal value, display the count of remaining character pairs in the record.

Address: A char[4, 6, or 8] field. These characters, grouped and interpreted as a hexadecimal value, display the address at which the data field is to be loaded into memory. The length of the field depends on the number of bytes necessary to hold the address. A 2-byte address uses 4 characters, a 3-byte address uses 6 characters, and a 4-byte address uses 8 characters.

Data: A char[0-64] field. These characters, when paired and interpreted as hexadecimal values, represent the memory loadable data or descriptive information.

Checksum: A char[2] field. These characters, when paired and interpreted as a hexadecimal value, display the least significant byte of the one's complement of the sum of the byte values represented by the pairs of characters making up the count, the address, and the data fields.

Each record is terminated with a line feed. If any additional or different record terminator(s) or delay characters are needed during transmission to the target system, it is the responsibility of the transmitting program to provide them.

S0 Record: The type of record is "S0" (0x5330). The address field is unused and will be filled with zeros (0x0000). The header information within the data field is divided into the following subfields.

- Mname: char[20] and is the module name.
- Ver: char[2] and is the version number.
- Rev: char[2] and is the revision number.
- Description: char[0-36] and is a text comment.

Each of the subfields is composed of ASCII bytes whose associated characters, when paired, represent 1-byte hexadecimal values in the case of the version and revision numbers, or represent the hexadecimal values of the ASCII characters comprising the module name and description.

S1 Record: The type of record field is "S1" (0x5331). The address field is interpreted as a 2-byte address. The data field is composed of memory loadable data.

S2 Record: The type of record field is "S2" (0x5332). The address field is interpreted as a 3-byte address. The data field is composed of memory loadable data.

S3 Record: The type of record field is "S3" (0x5333). The address field is interpreted as a 4-byte address. The data field is composed of memory loadable data.

S5 Record: The type of record field is "S5" (0x5335). The address field is interpreted as a 2-byte value and contains the count of S1, S2, and S3 records previously transmitted. There is no data field.

S7 Record: The type of record field is "S7" (0x5337). The address field contains the starting execution address and is interpreted as 4-byte address. There is no data field.

S8 Record: The type of record field is "S8" (0x5338). The address field contains the starting execution address and is interpreted as 3-byte address. There is no data field.

S9 Record: The type of record field is "S9" (0x5339). The address field contains the starting execution address and is interpreted as 2-byte address. There is no data field.

8.10.2 S-record Example

A typical S-record format file is shown as follows.

```
S00600004844521B
S1130000285F245F2212226A000424290008237C2A
S11300100002000800082629001853812341001813
S113002041E900084E42234300182342000824A952
S107003000144ED492
S5030004F8
S9030000FC
```

The file consists of one S0 record, four S1 records, one S5 record and an S9 record.

The S0 record is comprised as follows:

S0: S-record type S0, indicating it is a header record.

06: Hexadecimal 06 (decimal 6), indicating that 6 character pairs (or ASCII bytes) follow.

00 00: Four-character 2-byte address field, zeroes in this example.

48: ASCII H, D, and R - "HDR."

1B: The checksum.

The first S1 record is comprised as follows:

S1: S-record type S1, indicating it is a data record to be loaded at a 2-byte address.

13: Hexadecimal 13 (decimal 19), indicating that 19 character pairs, representing a 2-byte address, 16 bytes of binary data, and a 1-byte checksum, follow.

00 00: Four character 2-byte address field; hexidecimal address 0x0000, where the data which follows is to be loaded.

28 5F 24 5F 22 12 22 6A 00 04 24 29 00 08 23 7C
Sixteen character pairs representing the actual binary data.

2A : The checksum.

The second and third S1 records each contain 0x13 (19) character pairs and are ended with checksums of 13 and 52, respectively. The fourth S1 record contains 07 character pairs and has a checksum of 92.

The S5 record is comprised as follows:

S5: S-record type S5, indicating it is a count record indicating the number of S1 records.

03: Hexadecimal 03 (decimal 3), indicating that 3 character pairs follow.

00 04: Hexadecimal 0004 (decimal 4), indicating that there are 4 data records previous to this record.

F8: The checksum.

The S9 record is comprised as follows:

S9: S-record type S9, indicating that it is a termination record.

03: Hexadecimal 03 (decimal 3), indicating that 3 character pairs follow.

00 00: The address field, hexadecimal 0 (decimal 0) indicating the starting execution address.

FC: The checksum.

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