PLC Suite Host Message Protocol Specification

Version 1.0010
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Texas Instruments Proprietary Information

Revision History

Revision	Status	Date	Comment
0.1	Draft	12/07/2009	Initial draft
0.2	Draft	12/18/2009	Updated SET_INFO to support different configuration types. Added CL IPv4 system configuration type.
0.3	Draft	01/01/2010	Changed GET_MAC_PIB, added SET_MAC_PIB. Added items to LOAD_SYSTEM_CONFIG.
0.4	Draft	02/04/2010	Added CRC16 section.
0.5	Draft	02/09/2010	Changes to LOAD_SYSTEM_CONFIG, SET_INFO. Updated PHY PIB message. Updated SET_INFO PHY TX to include ROBO and PRM. Updated ALARM and SET_ALARM to allow for data. Updated CONNECT and DISCONNECT for connection types and allow for data.
0.6	Draft	04/12/2010	Changed DATA_TRANSFER message definition. Removed IEC-432 capability (replaced by LLC only). Changed definition and implementation of RPY.
0.7	Draft	04/22/2010	Added Ipv4 UDP Control Port to GET_SYSTEM_INFO and LOAD_SYSTEM_CONFIG. Removed TEST_CONNECTION. Updated CL Alarm. Added status codes.
0.8	Draft	06/27/2010	Added CLEAR_PHY_PIB and CLEAR_MAC_PIB.
0.9	Draft	08/04/2010	Added G3 related comments. Renamed to HCT Connection Type, removed deprecated HCT connection types. Combined PHY and MAC into a single PIB message. Major revision to System Configuration messages to support PRIME and G3.
0.92	Draft	08/19/2010	Merged PRIME and G3 specification documents.
0.93	Draft	08/24/2010	Update G3 PIB messages to include length.
0.94	Draft	09/02/2010	Updated G3 SET_INFO.
0.95	Draft	09/13/2010	Updated for G3 Release.
0.96	Draft	9/14/2010	Added FW upgrade for PRIME.
0.96	Draft	10/4/2010	Fixed “status” code for G3 for Discover, Attach, Detach.
0.96	Draft	10/5/2010	Fixed “extended address”.
0.96	Draft	10/5/2010	Added CFR indication in DATA_XFER.confirm and DATA_XFER.indicate to distinguish them.
0.96	Draft	10/6/2010	Modified CL alarms to be: 1: auto-attach.request confirm and 2: auto-detach.request confirm.
0.96	Draft	10/8/2010	Modify DISCOVER.confirm to return PAN descriptor list instead of PAN ID list.
0.96	Draft	10/8/2010	Added G3 alarms: 0x41, 0x42, 0x43.
0.96	Draft	10/8/2010	Added DISCOVERY type 2 (route discovery) and type 3 (path discovery)
0.96	Draft	10/28/2010	Fixed clear_mac_pib for G3 (removed index field)
0.96	Draft	11/3/2010	Change FW_UPGRADE.data_reply to include CRC and CRC valid flag to address PRIME WG contribution (ZIV) on FW upgrade: PRIME FW upgrade image complete ambiguous.
0.97	Draft	11/5/2010	Added diagnostic message (from diagnostic message spec) for flash FW.
0.98	Draft	03/24/2011	Making G3 tone map changes and other corrections
0.981	Draft	04/12/2011	Adding the G3 D8PSK Modulation to the G3 Configuration table
0.982	Draft	07/07/2011	Corrected G3 PHY TX parameter msg format and added tone mask description.
0.983	Draft	08/01/2011	Added the G3 Segment size to the system info message. Added the Coherent modulation flags
1.0000		08/25/2011	Made the ROBO flag a reserved field for the G3 TX Phy parameters.
1.0001	Draft	12/12/2011	Added the Upload Firmware image messages
1.0002	Draft	1/03/2012	Added Vendor and Product Id’s. Made non-supported G3 system info fields reserved. Added the PRM flags to the sys info (0x01) and load config (0x0c) (Prime

			PHY config TLV (0x0004))
1.0003	Draft	1/11/2012	Moved the Vendor and Product Id fields from the system info message and created a new Get_Info message that returns TLV's with the required information
1.0004	Draft	2/01/2012	Added the Get_Info G3_PHY_TX and G3_PHY_RX Parameters Removed the Band Selection from the System Info Message Added the TMR flag with the COH flag for G3 Added the COH and TMR flags to the G3 Configuration TLV (0x0008) Flipped the first two bytes of the Tone Mask description. Added the G3 MAC Segment size back to the G3 Config TLV Added the FLEX LITE Band configuration. Corrected list of reserved message Ids Change the tonemask length for G3 V5.0.0.0 to 14 bytes. Added the CRC32 implementation
1.0005	Draft	2/06/2012	Changed tone mask values. Removed the test mode flag from the G3 PHY TX/RX Messages Added the TX PHY Attenuation/Gain TLV's
1.0006	Draft	2/29/2012	Adding the DSP Firmware CRC32 Get_Info Message
1.0007	Draft	3/19/2012	Changed the PRIME Modulation definitions.
1.0008	Draft	3/29/2012	Changed the G3Get PIB Request and Response to send/receive one G3 MAC PIB at a time. Changed the Clear G3 PIB message to send one PIB at a time Changed the Set G3 PIB message to send one PIB at a time. Changed the G3 Load Config message to send on configuration type at a time.. Changed the G3 PHY PIB messages to send one PHY PIB at a time.
1.0009	Draft	4/20/2012	Added note to the Read and Write Blobs that there are no CRC values in this message.
1.0010	Draft	5/03/2012	Removed a confusing reference to the PRIME spec in the PRIME detach message

Sign Off List

Group	Name	Date	Comment
SW	Lu, Xiaolin		

Table of Contents

1.0 Introduction

This specification describes the Application Specific Interface (APIs) during run time of TI Power Line Communication Device. The API can be implemented in a host MCU (or on a PC) that also implements some custom application features and requires power line communications. The messaging protocol works on hardware peripheral interfaces such as UART, SPI, USB, Ethernet, etc..

1.1 System Overview

The TI plcSUITE features a host-controller UART interface (up to 115200 baud), an SPI interface (400kHz), or other HW interfaces such as SCI and I^2C fast mode interface (400 kHz). It has an eMeter emulated SW works self-contained (APPEMU-embedded) as well as working together with an emulated eMeter application on a host processor through host APIs (APPEMU-hosted). Under “hosted” environment, upon receiving a command from the host, the PLC device performs the desired function and returns a response. When system is running under “hosted” mode, PLC device is waiting for commands from either host processor or diagnostic tool. This document only describes host APIs.

If the PLC device receives a frame from the power line media it sends it to the host asynchronously. Figure 1 shows the TI plcSUITE top-level configuration for both “embedded” as well as “hosted” application operations.

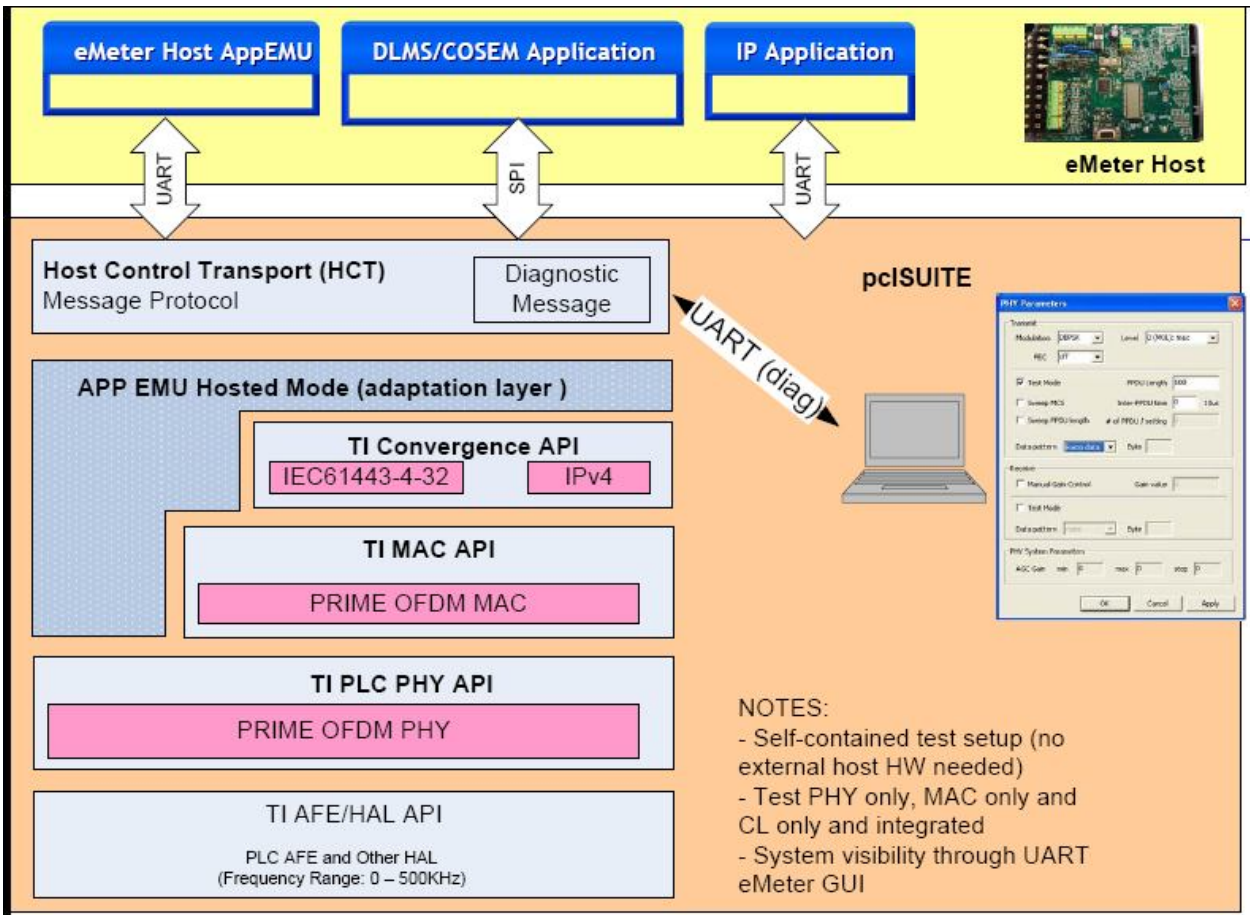


Figure 1 TI PLC SUITE SW Configuration and Host API Interfaces

2.0 Message Formats and APIs

2.1 Message Formats

Figure 2 shows the message format that is used for host to PLC communications. Little Endian format (least significant octet first, most significant octet last) is used for messages. All messages are 16-bit aligned. Messages are padded with 0 to 1 octets if necessary to meet the 16-bit alignment. A pad octet contains value '0' (zero).

Messages are formatted as: message header + message body + (padding) as described in Figure 2.

Message Header	Message Body	(0-1) padding octets

Figure 2 Message Format

Figure 3 Shows the Message Header Format.

Offset	Length Octets	bits							
		7	6	5	4	3	2	1	0
0	1	Message Type							
1	1	ORG	RPY	RESV		SEQ			
2	1	Message Payload Length LSB							
3	1	Message Payload Length MSB							
4	2	Message Header CRC16							
6	2	Message Payload CRC16							

Figure 3 Message Header Format

Field	*Description*
Message Type	Message Type identifier.
ORG	Message origination. A value of 1 represents the message originated from the host, and value of 0 represents the message originated from the receiver.
RPY	Acknowledgement reply bit. If this bit is set, the receiver shall acknowledge receipt of the message by echoing back the message header, with either new CRCs supplied or the CRCs set to 0, with the RPY bit set, and no additional payload. The RPY is only used in DATA_TRANSFER.indicate.
RESV	Reserved bits, ignored.
SEQ	Sequence Number. This is the 4 bit message sequence number, starting with 0 and incrementing by 1 for each message sequence. The Sequence Number should be set to 0 unless specified in the message definition.
Message Payload Length	A 16 bit number representing the length of the message payload plus the length of the Message Header CRC16 and Message Payload CRC16 (a message with no payload will have a length of 4). The maximum message payload length supported is 1500Bytes.
Message Header CRC16	The CRC16 of the message header, from the Message Type to the Message Payload Length, but not including the Message Header CRC or the Message Payload CRC. ***A value of 0 denotes no CRC16 present***. See CRC16 implementation in the appendix for CRC details.
Message Payload CRC16	The CRC16 of the message payload data. ***A value of 0 denotes no CRC16 present***. See CRC16 implementation in the appendix for CRC details.

Figure 4 Message Header Fields Description

2.2 API List

Table 1 defines the host APIs supported by the TI PLC device.

Message Type	PRIME Standard	G3 Standard	Description
0x00	DATA TRANSFER	DATA TRANSFER	Application specific Data messages
0x01	GET_SYSTEM_INFO	GET_SYSTEM_INFO	Get system (HW/SW) info
0x02	GET_PHY_PIB	GET_PHY_PIB	Get PHY PIB attributes from PLC device
0x03	GET_MAC_PIB	GET_MAC_PIB	Get MAC PIB attributes from PLC device
0x04	SET_INFO	SET_INFO	Set certain configuration to PLC device
0x05	SHUTDOWN	SHUTDOWN	Reset PLC device
0x06	SETUP_ALARM	SETUP_ALARM	Setup alarm notifications
0x07	ALARM	ALARM	Alarm Notification
0x08	NW_REGISTER	NETWORK_START	Initiate network registration process
0x09	NW_UNREGISTER		Initiate network un-registration process
0x0a	CONNECT	CONNECT	MAC Initiate connection setup process
0x0b	DISCONNECT	DISCONNECT	MAC Initiate connection teardown process
0x0c	LOAD_SYSTEM_CONFIG	LOAD_SYSTEM_CONFIG	Load system configuration data
0x0d	SET_MAC_PIB	SET_MAC_PIB	Set MAC PIB attributes from PLC device
0x0e	CLEAR_PHY_PIB	CLEAR_PHY_PIB	Clear certain PHY PIB attributes.
0x0f	CLEAR_MAC_PIB	CLEAR_MAC_PIB	Clear certain MAC PIB attributes.
0x10	ATTACH	ATTACH	PRIME CL-432 Establish Request and Confirm
0x11	DETACH	DETACH	PRIME CL-432 Release Request and Confirm
0x12		DISCOVER	Network Discovery
0x13	FIRMWARE_UPGRADE		FW Upgrade process.
0x14	Get Info	Get Info	Gets miscellaneous PLC data
0x15 - 0x2F	Reserved	Reserved	
0x30 - 0x3F	Reserved	Reserved	
0x80 - 0xfe	Diagnostic messages		
0xff	Reserved		

Table 1 TI PLC Device Host Commands/APIs

2.3 API Specifications

2.3.1 DATA_TRANSFER

Message Type 0x00

The DATA_TRANSFER message is used to transfer application data to/from the host. DATA_TRANSFER message can be either initiated by host (TX) or by PLC (RX).

The contents of the DATA_TRANSFER are determined by the current device mode (see GET_SYSTEM_INFO).

The DATA_TRANSFER message may be RPY capable (please refer to the specific DATA_TRANSFER mode for details).

2.3.1.1 Device Mode LLC

Under LLC mode, the application interfaces with IEC61334-4-32 LLC layer for data transmissions for PRIME standard and 6LowPAN adaptation layer for G3 standard. There are 2 types of data transfer sequences supported under LLC mode.

1. Message Sequence for Data Transmit from host to PLC in Push Mode (PRIME):

DATA_TRANSFER.Request: (message from host to PLC)

DATA_TRANSFER.Request is used to command the PLC to transmit an L_SDU to the media.

Length	Bits							
Octets	7	6	5	4	3	2	1	0
2	Mode							
1	Destination LSAP							
1	Source LSAP							
2	Destination Address							
4	reserved							
var	Data							

Field	*Description*
Mode	A value of 0x01 defines this as a DATA_TRANSFER.Request
Destination LSAP	The Destination LSAP where the data is being sent to.
Source LSAP	The Source LSAP where the data is originating from.
Destination Address	The 12-bit Destination Address where the data is being sent to.
reserved	Reserved field.
Data	L_SDU data to be sent.

DATA_TRANSFER.Confirm: (message from PLC to host)

The DATA_TRANSFER.Confirm is used to indicate to the host the status of the L_SDU transmission.

Length	Bits							
Octets	7	6	5	4	3	2	1	0
2	Mode							
1	Destination LSAP							
1	Source LSAP							
2	Destination Address							
4	reserved							
2	Status							

Field	*Description*
Mode	A value of 0x02 defines this as a DATA_TRANSFER.Confirm
Destination LSAP	The Destination LSAP where the data was sent to.
Source LSAP	The Source LSAP where the data originated from.
Destination Address	The 12-bit Destination Address where the data was sent to.
reserved	Reserved field.
Status	The status of the request. The list of status codes can be found at Table 4 Message Status Code Definitions.

2. Message Sequence for Data Receive initiated by PLC (PRIME):

DATA_TRANSFER.Indication: (message from PLC to host)

DATA_TRANSFER.Indication is used to indicate an L_SDU has been received and passed to the host.

Length	Bits							
Octets	7	6	5	4	3	2	1	0
2	Mode							
1	Destination LSAP							
1	Source LSAP							
2	Destination Address							
4	reserved							
2	Source Address							
4	reserved							
var	Data							

Field	*Description*
Mode	A value of 0x03 defines this as a DATA_TRANSFER.Indication
Destination LSAP	The Destination LSAP where the data was sent to.
Source LSAP	The Source LSAP where the data originated from.
Destination Address	The 12-bit Destination Address where the data was sent to.
reserved	Reserved field.
Source Address	The 12-bit Source Address where the data was sent from.
reserved	Reserved field.
Data	L_SDU data that was sent.

For G3 standard, there are also 2 types of data transfer sequences supported under LLC mode.

1. Message Sequence for Data Transmit from host to PLC in Push Mode (G3):

DATA_TRANSFER.request: (message from host to PLC) to command the PLC to transmit an L_SDU to the media.

Length	Bits							
Octets	7	6	5	4	3	2	1	0
1	NSDU handle							
1						QoS	SEC	D-route
var	L_SDU Data							

Field	*Description*
NDSU Handle	NSDU Handle. Random number between 0x00-0xff.
QoS	0 – standard priority, 1 – higher priority
SEC	Security Enabled: 1 – enabled, 0 – disabled
D-Route	Discovery Route: 1- enabled, 0 - disabled
L_SDU Data	G3 uses the IPv6 standard to address service nodes. The IPv6 header must be placed here. Any type of IPv6 packet may be sent.

DATA_TRANSFER.confirm: (message from PLC to host) to indicate to the host the status of the L_SDU transmission.

Length	Bits							
Octets	7	6	5	4	3	2	1	0
1	NSDU Handle (random number between 0x00-0xFF)							
1	CFM	reserved						
2	Status							

Field	*Description*
NDSU Handle	NSDU Handle. Random number between 0x00-0xff.
CFM	Confirmation Flag. = ‘1’
Status	

Status Code	Status Value
STAT_SUCCESS	0
STAT_INVALID_IPV6_FRAME	0x84
STAT_INVALID_REQUEST	0x85
STAT_NO_KEY	0x86
STAT_BAD_CCM_OUTPUT	0x87
STAT_ROUTE_ERROR	0x88
STAT_BT_TABLE_FULL	0x89
STAT_FRAME_NOT_BUFFERRED	0x8a
MAC_STAT_CHANNELL_ACCESS_FAILURE	0xe1

MAC_STAT_INVALID_ADDRRESS	0xf5
MAC_STAT_NO_ACK	0xe9
MAC_STAT_COUNTER_ERROR	0xdb
MAC_STAT_FRAME_TOO_LONG	0xe5
MAC_STAT_UNAVAILABLE_KEY	0xf3
MAC_STAT_UNSUPPORTED_SECURITY	0xdf
MAC_STAT_INVALID_PARAMETER	0xe8

or any status values returned from security suite or the MCPS-DATA.confirm primitive

2. Message Sequence for Data Receive initiated by PLC (G3):

DATA_TRANSFER.Indication: (message from PLC to host) to indicate an L_SDU has been received and passed to the host.

Length	Bits							
Octets	7	6	5	4	3	2	1	0
1	Link Quality Indicator (0x00-0xFF)							
1	CFM	reserved						SEC
var	Data Payload							

Field	*Description*
LQI	Link Quality Indicator measured on received packet
CFM	Confirmation Flag. = ‘0’
Data Payload	G3 uses the IPv6 standard to address service nodes. The IPv6 header will be placed here. Any type of IPv6 packet may be sent.

2.3.1.2 Device Mode MAC

Under MAC mode, application is interfacing with PRIME/G3 MAC layer directly for data transmissions. There are 2 types of data transfer sequences supported under MAC mode.

1. Message Sequence of Data Transfer (message from host to PLC)

DATA_TRANSFER.Request:

Length	bits							
Octets	7	6	5	4	3	2	1	0
2	HCT Connection Handle							
var	Data Payload							

Field	*Description*
HCT Connection Handle	The connection handle returned from the CONNECT message.
Data Payload	The transfer data.

DATA_TRANSFER.Reply:

The DATA_TRANSFER Reply is used to indicate to the host the status of the data packet transmission. When the device sends RX data to the host, the host shall not send a DATA_TRANSFER Reply message.

Length	bits							
Octets	7	6	5	4	3	2	1	0
2	Status							

Field	*Description*
Status	The status of the request. The list of status codes can be found at Table 4 Message Status Code Definitions.

2. Message Sequence for Data Reception Indication from PLC

DATA_TRANSFER.Indication: (message from PLC to host)

DATA_TRANSFER.Indication is used to indicate a MAC SDU has been received and need to pass to the host.

Length	bits							
Octets	7	6	5	4	3	2	1	0
2	HCT Connection Handle							
var	Data Payload							

Field	*Description*
HCT Connection Handle	The connection handle returned from the CONNECT message.
Data Payload	The transfer data.

2.3.2 GET_SYSTEM_INFO

Message Type 0x01
The GET_SYSTEM_INFO message is used to retrieve information from the PLC device. It is always initiated by the host.

GET_SYSTEM_INFO Request:

This message does not have message body.

GET_SYSTEM_INFO Response: PRIME

Len	Offset	PRIME (LLC Mode)	Len	Offset	PRIME (IPv4 Mode)	Len	Offset	PRIME (IPv6 Mode)
4	0	Firmware Version	4	0	Firmware Version	4	0	Firmware Version
2	4	Device Serial Number Length	2	4	Device Serial Number Length	2	4	Device Serial Number Length
16	6	Device Serial Number	16	6	Device Serial Number	16	6	Device Serial Number
1	22	Device Type	1	22	Device Type	1	22	Device Type
1	23	Device Mode	1	23	Device Mode	1	23	Device Mode
2	24	Hardware Revision	2	24	Hardware Revision	2	24	Hardware Revision
6	26	EUI/MAC Address	6	26	EUI/MAC Address	6	26	EUI/MAC Address
1	32	Port Assignments	1	32	Port Assignments	1	32	Port Assignments
1	33	PHY Settings	1	33	PHY Settings	1	33	PHY Settings
6	34	Reserved	6	34	Reserved	6	34	Reserved
1	40	ARQ and PAC Flags	1	40	ARQ and PAC Flags	1	40	ARQ and PAC Flags
1	41	Security Profile	1	41	Security Profile	1	41	Security Profile
2	42	Reserved	4	42	Source IPv4 Add	8	42	Address Prefix
2	44	Reserved	4	46	Net Mask	8	50	Source Address
2	46	Reserved	4	50	Gateway	2	58	UDP Port
			2	54	UPD Port			
Total Message Length Excluding the two 16 bit CRC values								
48			56			60		

GET_SYSTEM_INFO Response: G3, FLEX OFDM and PLC LITE

Len	Offset	G3	Len	Offset	FLEX OFDM	Len	Offset	PLC LITE
4	0	Firmware Version	4	0	Firmware Version	4	0	Firmware Version
2	4	Reserved	2	4	Device Serial Number Length	2	4	Device Serial Number Length
16	6	Reserved	16	6	Device Serial Number	16	6	Device Serial Number
1	22	Device Type	1	22	Device Type	1	22	Device Type
1	23	Device Mode	1	23	Device Mode	1	23	Device Mode
2	24	Hardware Revision	2	24	Hardware Revision	2	24	Hardware Revision
6	26	Reserved	6	26	EUI/MAC Address	6	26	Reserved
1	32	Port Assignments	1	32	Port Assignments	1	32	Port Assignment
1	33	Reserved	1	33	PHY Settings	1	33	PHY Mode
6	34	Reserved	6	34	Reserved	6	34	Reserved
1	40	TMR and COH Flags	1	40	ARQ and PAC Flags	1	40	Reserved
1	41	Reserved	1	41	Security Profile	1	41	Reserved
2	42	Reserved	2	42	Reserved	2	42	Source Id
8	44	Long Address	2	44	Reserved	2	44	Destination Id
6	52	Reserved	2	46	Reserved	2	46	Band
						2	48	Start Tone
Total Message Length Excluding the two 16 bit CRC values								
745 8			48			50		

Table 2 System Configuration Info Field Definitions

Field	*Description*
Firmware Version	A 32-bit value representing the firmware version, in the format of **`MAJOR.MINOR.REVISION.BUILD`**.
Serial Number Length	The length of valid octets in the 16 octet serial number.
Serial Number	A 16 octet value representing the device serial number.
Device Type	The device type. The following are the supported device types: Device Type — Description 1 — PRIME IEC-432-LLC convergence 2 — PRIME IP convergence 3 — G3 4 — FLEX
Device Mode	Device Application Mode dependant on the Device Type is as follows: Normal Mode — 0 — This is device normal operation mode for device type of: 1. PRIME IEC4-32 LLC 2. PRIME IPv4/IPv6 3. G3 MAC Mode — 1 — Device is operating in MAC mode with Embedded AppEMU running in the device. LLC Mode — 2 — Device is operating in LLC mode with Embedded AppEMU on top of IEC432-LLC P2P Mode — 3 — Device is operating in Point-to-Point test mode for all device types. MAC Mode (no eAppEmu) — 4 — Device is operating in MAC Mode without Embedded AppEMU running in the device. Applicable only to PRIME device types. PHY Mode — 5 — Device is operating in PHY Mode for all device types. G3 Embedded App Emu — 7 — G3 Device running the Embedded AppEmu. Applicable only to G3 devices
Hardware Revision	The hardware revision. A value of zero (0) represents pre Rev D hardware, otherwise the revision is the hardware revision (Rev D would be indicated by 68 (0x44, 'D')). Rev D hardware has an onboard EEPROM, older hardware does not.
EUI	Service Node EUI or MAC address

Port Assignments

					Diag Port		Data Port

Data Port designation.

Value	Description
0	SCI-A
1	SCI-B

Diagnostics Port designation.

Value	Description
0	SCI-A
1	SCI-B

PHY Settings

	IP Flag	Auto Mode			PRM Flag	PRIME PHY Mode

IP flag:

Value	Description
0	IPv4
1	IPv6

Auto Mode:
Flag that controls whether, in Device Normal Mode (Device Mode 0) the device attempts to automatically register and connect on the network, or if the Host manually controls the start with CL_Establish and CL_Release.

Value	Description
0	Manual Mode
1	Automatic Mod

PRM Flag:

Value	Description
0	PRM off
1	PRM on

PRIME PHY mode:

Value	Description
0	Prime Mode (default)
1	ROBO Mode

ARQ and PAC Flags

						Dflt. PAC	Dflt. ARQ

MAC Default ARQ:

Value	Description
0	MAC ARQ disabled (default)
1	MAC ARQ enabled

MAC Default PAC:

Value	Description
0	MAC PAC disabled (default)
1	MAC PAC enabled

TMR and Coherent Modulation Flags

		TMR Flag		COH Flag			

Coherent Modulation Flag:

Value	Description
0	Coherent Modulation disabled
1	Coherent Modulation enabled

TMR Flag

Value	Description
0	ToneMask Request disabled
1	ToneMask Request enabled

Security Profile

MAC default security profile

IP Address Prefix

This field only used for device type PRIME IPv6. For other device types this field is not present.

Device Type	Len	Description
PRIME CL IPv6	8 octets	Address Prefix
G3	2 octets	Reserved
All others	0 octets	

Source Address or Long Address

A variable length source address is dependant on the device type as follows:

Device Type	Len	Description
PRIME CL IPv4	4 octets	Source Address
PRIME CL IPv6	8 octets	Source Address
G3	8 octets	Long Address
All others	0 octets	

Gateway

A variable length multiple defined Address Field whose value is dependant on the device type as follows:

Device Type	Len	Description
PRIME CL IPv4	4 octets	Gateway
All others	0 octets	

UDP control port

UDP Control Port. Valid Range: 1024-65535. Default: 8099. Only present in device type PRIME-IP.

2.3.3 GET_PHY_PIB

Message Type 0x02

The GET_PHY_PIB message is used by host to retrieve PLC PHY PIB information on the device. This message is always initiated by the host. An array of PHY PIB IDs are sent to the device, and the device will reply will an array of PHY PIB TLVs.

Message Sequence initiated by host:

GET_PHY_PIB Request:

Length	Bits							
Octets	7	6	5	4	3	2	1	0
2	Attribute ID							
	[. . .]							

For G3 only one PHY PIB request can be sent at a time

Field	*Description*
Attribute ID	One or more Attribute IDs, as defined in Tables 1 - 2 (Section 6.1.1.1 - 6.1.1.2) of the PRIME Spec v1.3E.

GET_PHY_PIB Reply:

Length	Bits							
Octets	7	6	5	4	3	2	1	0
2	Status							
2	Attribute ID							
2	Attribute Length							
var	Attribute Value							
	[. . .]							

For G3 only one PHY PIB will be returned at a time

Field	*Description*
Status	The status of the request. The list of status codes can be found at Table 4 Message Status Code Definitions.

Attribute ID	Attribute ID, as defined in Tables 1 - 2 (Section 6.1.1.1 - 6.1.1.2) of the PRIME Spec v1.3E.
Attribute Length	Attribute Length for the ID, as defined in Tables 1 - 2 (Section 6.1.1.1 - 6.1.1.2) of the PRIME Spec v1.3E.
Attribute Value	Attribute Value for the ID, as defined in Tables 1 - 2 (Section 6.1.1.1 - 6.1.1.2) of the PRIME Spec v1.3E.

2.3.4 GET_MAC_PIB

Message Type 0x03

The GET_MAC_PIB message is used by host to retrieve PLC MAC PIB information on the device. This message is always initiated by the host. An array of MAC PIB IDs are sent to the device, and the device will reply will an array of MAC PIB TLVs.

Message Sequence initiated by host for PRIME:

GET_MAC_PIB Request:

Length	Bits							
Octets	7	6	5	4	3	2	1	0
2	Attribute ID							
	[. . .]							

Field	*Description*
Attribute ID	One or more Attribute IDs, as defined in Tables 3 - 7 (Section 6.1.2.1 – 6.1.2.4) of the PRIME Spec v1.3E.

GET_MAC_PIB Reply:

Length	Bits							
Octets	7	6	5	4	3	2	1	0
2	Status							
2	Attribute ID							
2	Attribute Length							
var	Attribute Value							
	[. . .]							

Field	*Description*
Status	The status of the request. The list of status codes can be found at Table 4 Message Status Code Definitions.
Attribute ID	Attribute ID, as defined in Tables 3 - 7 (Section 6.1.2.1 – 6.1.2.4) of the PRIME Spec v1.3E.
Attribute Length	Attribute Length for the ID, as defined in Tables 3 - 7 (Section 6.1.2.1 – 6.1.2.4) of the PRIME Spec v1.3E.
Attribute Value	Attribute Value for the ID, as defined in Tables 3 - 7 (Section 6.1.2.1 – 6.1.2.4) of the PRIME Spec v1.3E.

Message Sequence initiated by host for G3:

GET_PIB Request:

Length	Bits							
Octets	7	6	5	4	3	2	1	0
4	Attribute ID							
2	Attribute Index							

Field	*Description*
Attribute ID	Attribute ID defined in Table 86 of 802.15.4-2006 and Clause 5.2 of G3 MAC spec.
Attribute Index	The index within the table of the specified IB attribute to read. This parameter is valid only for IB attributes that are tables.

GET_PIB Reply:

Length	Bits							
Octets	7	6	5	4	3	2	1	0
2	Status							
4	Attribute ID							
2	Attribute Index							
2	Attribute Length							
var	Attribute Value							

Field	*Description*
Status	Status Code: Status Value STAT_SUCCESS: 0 STAT_ERR_FAILURE: 0x81 STAT_UNSUPPORTED_ATTRIBUTE: 0x90 STAT_INVALID_INDEX: 0x91
Attribute ID	Attribute ID defined in Table 86 of 802.15.4-2006 and Clause 5.2 of G3 MAC spec.
Attribute Index	The index within the table of the specified IB attribute to read. This parameter is valid only for IB attributes that are tables.
Attribute Length	Attribute Length for the ID,defined in Table 86 of 802.15.4-2006 and Clause 5.2 of G3 MAC spec.
Attribute Value	Attribute Value for the ID, defined in Table 86 of 802.15.4-2006 and Clause 5.2 of G3 MAC spec.

2.3.5 SET_INFO

Message Type 0x04

The SET_INFO message is used by host to set certain system parameters in the PLC device. This message is always initiated from host.

Message Sequence initiated by host:

SET_INFO Request:

Length Octets	bits							
	7	6	5	4	3	2	1	0
2	INFO_Type							
2	INFO_Length							
var	INFO_Value							

Field	***Description***
INFO_Type	Type of information being set.
INFO_Length	Length of INFO_Value, in octets.
INFO_Value	Value depending on the INFO_Type.

INFO_Type - TLV IDs

Id	*Description*
0x0000	PRIME PHY TX Parameters
0x0001	PRIME PHY RX Parameters
0x0002	G3 PHY TX Parameters
0x0003	G3 PHY RX Parameters
0x0004	Vendor and Product Id's
0x0005	Reserved
0x0006	Reserved
0x0007	Reserved
0x0008	Reserved
0x0009	TX PHY Attenuation / Gain Parameters
0x000A	Reserved

INFO TYPE - TLV:

0x0000 – PRIME PHY TX Parameters:

Length	bits							
Octets	7	6	5	4	3	2	1	0
1	reserved							
1						PRM	ROBO	FEC
2	Modulation							
2	TX Level							

Field	***Description***
FEC	A value of 1 for FEC ON, value of 0 for FEC OFF.
ROBO	A value of 1 for ROBO Mode, value of 0 for PRIME Mode (default).
PRM	A value of 1 to set PHY to PRM mode, value of 0 for non designated mode. Note that if PRM mode is specified, Modulation and TX Level are ignored.
Modulation	TX Modulation:

Value	Description
0x0000	DBPSK
0x0001	DQPSK
0x0002	D8PSK
0x0003	DBPSK + 1/4 repetition (ROBO only, FEC always ON)
0x0004	DBPSK + 1/8 repetition (ROBO only, FEC always ON)

TX Level	Transmission Level, 0-7 (refer to PRIME spec v1.3).

0x0001 – PRIME PHY RX Parameters:

Length Octets	bits							
	7	6	5	4	3	2	1	0
1	reserved							
1							ROBO	AGC
2	Gain Value							

Field	***Description***
Gain Value	Manual gain value of 0 – 7 if AGC = 0. If AGC = 1, this field is ignored.
AGC	Automatic Gain Control. A value of 1 for AGC ON, value of 0 for AGC OFF
ROBO	A value of 1 for ROBO Mode, value of 0 for PRIME Mode (default).

0x0002 – G3 PHY TX Parameters

Length Octets	bits							
	7	6	5	4	3	2	1	0
1		Band Sel			COH			TMR
1	Reserved						Modulation	
2	TX Level							
10/ 12/ 14	Tone Mask							

Field	*Description*
Flag (Byte 0)	<table><tr><td>TMR</td><td>Tone Map Request Mode 0 = disabled – non designated mode 1 = Enabled – PHY set to Tone Mask Req Mode. Note that if TMR mode is specified modulation and TX Level are ignored.</td></tr><tr><td>COH</td><td>Coherent Modulation 0 = Disabled 1 = Enabled</td></tr><tr><td>Band Sel</td><td>Band Selection 0 = Cenelec 1 = Cenelec/FCC</td></tr></table>
Modulation	TX Modulation: Value – Description 0x00 – ROBO 0x01 – BPSK 0x02 – QPSK 0x03 – 8PSK
TX Level	Transmission Level, 0-32 (refer to G3 spec).
Tone Mask	Set spectral mask (static) where tones start, stop and notch. UINT8 toneMask[0] bit6-bit0: number of tones in the band. UINT8 toneMask[1]: tone number for the first tone in the band. UINT8 toneMask[2] – [11]: tone mask, 1 indicates the tone is on, 0 indicates the tone is off. Firmware versions 1.3.1 and earlier use 10 bytes. Firmware versions later than 1.3.1 and less than 5.0.0.0 use 12 bytes. Firmware versions later and equal to 5.0.0.0 user 14 bytes

Example tone mask definition:

Band	Tone mask
Cenelec A 36	17.24.ff.ff.ff.ff.0f.00.00.00.00.00.00.00
Cenelec A 25	17.24.ff.ff.00.f8.0f.00.00.00.00.00.00.00
Cenelec B	3f.10.ff.ff.00.00.00.00.00.00.00.00.00.00
Cenelec BC	3f.1a.ff.ff.ff.03.00.00.00.00.00.00.00.00
Cenelec BCD	3f.20.ff.ff.ff.ff.00.00.00.00.00.00.00.00
FCC low band	21.24.ff.ff.ff.ff.0f.00.00.00.00.00.00.00
FCC high band	45.24.ff.ff.ff.ff.0f.00.00.00.00.00.00.00
FCC full band	21.48.ff.ff.ff.ff.ff.ff.ff.ff.ff.00.00.00

0x0003 – G3 PHY RX Parameters

Length	bits							
Octets	7	6	5	4	3	2	1	0
1	reserved							
1		Band Sel			COH	BLI		AGC
2	Gain Value							
10/ 12/ 14	Tone Mask							

Field	*Description*
Gain Value	Manual gain value of 0 – 7 if AGC = 0. If AGC = 1, this field is ignored.
AGC	Automatic Gain Control. A value of 1 for AGC ON, value of 0 for AGC OFF.
BLI	Block Level Interleaver. A value of 1 for BLI ON, value of 0 for BLI OFF.
COH	Coherent Modulation. A value of 1 for COH on and 0 for COH off
Band Select	Band Selection 0 = Cenelec 1 = Cenelec/FCC
Tone Mask	Set spectral mask (static) where tones start, stop and notch. UINT8 toneMask[0] bit6-bit0: number of tones in the band UINT8 toneMask[1]: tone number for the first tone in the band UINT8 toneMask[2] – [11]: tone mask, 1 indicates the tone is on, 0 indicates the tone is off. Firmware versions 1.3.1 and earlier use 10 bytes. Firmware versions later than 1.3.1 and less than 5.0.0.0 use 12 bytes. Firmware versions later and equal to 5.0.0.0 user 14 bytes

0x0004 – Vendor/Product ID:

Length	bits							
Octets	7	6	5	4	3	2	1	0
2	Vendor ID							
16	Product ID							

Field	***Description***
Vendor ID	Vendor ID (assigned by Prime Alliance for PRIME)
Product ID	Vendor Specifics Identifier in ASCII, terminating with a NULL character

0x0009 – TX PHY Attenuation/Gain Parameters:

Length	bits							
Octets	7	6	5	4	3	2	1	0
1	TX Gain / Attenuation							
1	TX PGA Attenuation							

Field	***Description***
TX Gain / Attenuation	The range is from -6 dB (-60 or 0xC4) to 3dB (30 or 0x1E) in 0.1 dB steps
TX PGA Attenuation	0 = 0 dB 1 = -3 dB 2 = -6 dB
Product ID	Vendor Specifics Identifier in ASCII, terminating with a NULL character

SET_INFO Reply:

Length	bits							
Octets	7	6	5	4	3	2	1	0
2	Status							

Field	***Description***

Status	The status of the request. The list of status codes can be found at Table 4 Message Status Code Definitions.

2.3.6 SHUT_DOWN

Message Type 0x05

The Shutdown message is used to shutdown or reset the device.

Message Sequence initiated by host

SHUT_DOWN Request:

Length	bits							
Octets	7	6	5	4	3	2	1	0
2	Reset_Type							

Field	*Description*
Reset_Type	The type of shutdown or reset to perform.

Value	Description
0x0000	Soft reset
0x0001	Soft shutdown

SHUT_DOWN Reply:

Length	bits							
Octets	7	6	5	4	3	2	1	0
2	Status							

Field	*Description*
Status	The status of the request. The list of status codes can be found at Table 4 Message Status Code Definitions.

2.3.7 SETUP_ALARM

Message Type 0x06

The SETUP_ALARM message is used by host to set up alarm or event notifications from device to the host.

Message Sequence initiated by host:

SETUP_ALARM Request:

Length	bits							
Octets	7	6	5	4	3	2	1	0
2	Alarm Type							
2	Alarm Length							
var	Alarm Value							
	. . .							

Field	***Description***
Alarm Type	The type of the alarm that is requested.

Value	Description
0x0001	Network Deregistered
0x0002	Connect Request
0x0003	Disconnect Indication
0x0004	Network Registration Started
0x0005	Network Registration Complete
0x0006	Connect Complete
0x0007	G3 Network Status Indication
0x0040	PHY received PPDU header CRC fail detected
0x0041	PHY received PPDU header syntax error detected
0x0080	Terminal node is promoted to a switch node
0x0081	Switch node is demoted to a terminal node
0x00c0	CL Alarm
0x00ff	General Error

Alarm Length	If SET_ALARM requires additional data, this defines the length of the data (in octets).
Alarm Value	Additional SET_ALARM data.

0x0006 – Connect Complete:
Not available.

0x0001 – Network Deregistered: PRIME
0x0002 – Connect Request Received: PRIME
0x0003 – Disconnect Indication: PRIME
0x0004 – Network Register Started: PRIME
0x0005 – Network Register Complete: PRIME
0x0007 – G3 Network Status Indication: G3
0x0040 – PHY received PPDU header CRC fail detected: PRIME & G3
0x0041 – PHY received PPDU header syntax error detected: PRIME & G3
0x0042 – PHY preamble detection failure: G3
0x0080 – Terminal node is promoted to a switch node: PRIME
0x0081 – Switch node is demoted to a terminal node: PRIME
0x00c0 – CL Alarm: Convergence Layer Alarm: PRIME

0x00ff – General Alarm:

Length	bits							
Octets	7	6	5	4	3	2	1	0
1								CLR

Field	*Description*
Clear	Clear the ALARM SETUP, i.e., the host no longer wants the ALARM notification.

SET_ALARM Reply:

Length	Bits							
Octets	7	6	5	4	3	2	1	0
2	Status							

Field	*Description*
Status	The status of the request. The list of status codes can be found at Table 4 Message Status Code Definitions.

2.3.8 ALARM

Message Type 0x07

The ALARM message is used by PLC to notify the host of an ALARM previously requested by the SET_ALARM message. It is an ALARM_INDICATION messaging that contains the alarm type as well as specific alarm information, in TLV (type, length and value) format.

Message Sequence initiated by device:

ALARM Message Sequence (initiated by PLC):

ALARM:

Length	Bits							
Octets	7	6	5	4	3	2	1	0
2	Alarm Type							
2	Alarm Length							
var	Alarm Value							

Field	*Description*
Alarm Type	The type of the alarm that is requested.

Value	Description
0x0001	Network Deregistered
0x0002	Connect Request
0x0003	Disconnect Indication
0x0004	Network Registration Started
0x0005	Network Registration Complete
0x0006	Connect Complete
0x0007	G3 Network Status Indication
0x0040	PHY received PPDU header CRC fail detected
0x0041	PHY received PPDU header syntax error detected
0x0042	PHY preamble detection failure (G3 standard)
0x0080	Terminal node is promoted to a switch node
0x0081	Switch node is demoted to a terminal node
0x00c0	CL Alarm
0x00ff	General Error

Alarm Length	If an ALARM_INDICATION has a value to return, this defines the length of the value (in octets).
Alarm Value	If an ALARM_INDICATION value.

ALARM VALUE:

0x0001 – Network Deregistered for PRIME:

Length	bits							
Octets	7	6	5	4	3	2	1	0
2	Reason							

Field	*Description*
Reason	The reason for the deregistration 0x00 – deregistration initiated by remote node 0x01 – deregistration initiated by local node (connectivity problem)

0x0002 – Connect Request ALARM for PRIME:

Length	bits							
Octets	7	6	5	4	3	2	1	0
2	HCT Connection Type							
2	HCT Connection Handle							
2	Connection Data Length							
var	Connection Data							

Field	*Description*
HCT Connection Type	Type of connection requested. The following are valid connection types: Value – Description 0x0006 – reserved 0x00fd – PRIME MAC Connection
HCT Connection Handle	The handle of the connection. This handle is used in all further messages relating to the connection.
Connection Data Length	Length of Connection Data. This field is connection type specific.
Connection Data	Connection Data. The contents of the connection data is dependant on the connection type.

Type = 0x00fd – MAC Connection:

Connect Data:

Length	bits							
Octets	7	6	5	4	3	2	1	0
1								ARQ
1	MAC Connection Type							
2	CfBytes							
6	Destination Address							
var	Additional Connection Data							

Field	***Description***
MAC Connection Type	The MAC Type that defines the convergence sublayer that ould be used for this connection type.
CfBytes	The number of Contention Free Bytes (see the PRIME Specification for details).
Destination Address	Connected Device Destination Address of type EUI48.
Additional Connection Data	Additional connection data that may be required for the Connection Type. For example, AppEMU (Connection Type 0xfa) requires 1 3 octet Provider ID and a 6 octet ASCII Serial Number.

0x0003 – Disconnect Indication for PRIME:

Length Octets	bits							
	7	6	5	4	3	2	1	0
2	HCT Connection Type							
2	HCT Connection Handle							
2	Disconnect Data Length							
var	Disconnect Data							

Field	*Description*
HCT Connection Type	Type of connection requested. The following are valid connection types: Value – Description 0x0006 – reserved 0x00fd – PRIME MAC Connection
HCT Connection Handle	The handle of the connection. This handle is used in all further messages relating to the connection.
Disconnect Data Length	Length of Disconnect Data. This field is connection type specific.
Disconnect Data	Disconnect Data. The contents of the connection data is dependant on the connection type.

0x00fd – MAC connection:

Disconnect Data:

Length Octets	bits							
	7	6	5	4	3	2	1	0
2	Reason							

Field	*Description*
Reason	The reason for the disconnection: Type – Description 0x0000 – The request was initiated by the remote node 0x0001 – The release is because of a connectivity problem

0x0004 – Network Register Started: PRIME
0x0005 – Network Register Complete: PRIME
No additional data.

0x0006 – Connect Complete:
Not available.

0x0007 – G3 Network Status Indication

Length	bits							
Octets	7	6	5	4	3	2	1	0
2	Status							
var	Additional Info							

Field	*Description*
Status	PAN_ID_CONFLICT, or any other status code returned by MLME-COMM-STATUS indication
Additional Info	The eventual additional information to the status or event in string format

0x0040 – PHY received PPDU header CRC fail detected: PRIME and G3
0x0041 – PHY received PPDU header syntax error detected: PRIME and G3
0x0042 – PHY preamble detection failure: (G3 only)

No additional data.

0x0080 – Terminal node is promoted to a switch node: PRIME
0x0081 – Switch node is demoted to a terminal node: PRIME

Not supported.

0x00c0 – CL Alarm:

Length Octets	bits 7	6	5	4	3	2	1	0
2	CL Alarm							
var	Alarm Data							

Field	*Description*
Alarm	CL Alarm.

Type	Description
0x0001	CL Auto Attach.confirm: CL automatically sent out an Attach.request
0x0002	CL Auto Detach.confirm: CL automatically sent out a Detach.request

Alarm Data For Type = 0x0001 Alarm data is as following. Refer 2.3.17 for field definitions.

Length Octets	bits 7	6	5	4	3	2	1	0
2	Status							
2	Device Identifier Length							
var	Device Identifier							
2	Source Address							
2	Base Address							

For Type = 0x0002 Alarm Data is as following. Refer 2.3.18 for field definitions.

Length Octets	bits 7	6	5	4	3	2	1	0
2	Status							
2	Destination Address							

0x0001 – SEND_PACKET_ERROR:

Length Octets	bits 7	6	5	4	3	2	1	0
2	Error							

Field	*Description*
Error	Error Code. The list of error codes can be found at Table 4 Message Status Code Definitions.

0x0002 – RECV_PACKET_ERROR:

Length	bits							
Octets	7	6	5	4	3	2	1	0
2	Error							

Field	*Description*
Error	Error Code. The list of error codes can be found at Table 4 Message Status Code Definitions.

0x00ff – General Error:

Length	bits							
Octets	7	6	5	4	3	2	1	0
2	Error							
var	Information							

Field	*Description*
Error	Error Code.

Type	Description
0x0001	The port receiving HCT messages has discarded data.
0x0004	An HCT message has been discarded by the device port.

Information	Extended error information, dependant on the error.

0x0001 – PORT_DISCARDED:

The port receiving messages has discarded data. This is normally due to a port communications error.

Length	Bits							
Octets	7	6	5	4	3	2	1	0
2	Number of octets discarded							

Field	*Description*
Number of octets discarded	Number of octets discarded from the port, usually due to the attempt to resync to the message framing or other port error.

0x0004 – MESSAGE_DISCARDED:

The port receiving messages has discarded a message. This is normally due to a communications error.

Length Octets	Bits							
	7	6	5	4	3	2	1	0
1	Message Type							
1	ORG	RPY	RESV		SEQ			
2	Reason							

Field	***Description***
Message Type	Discarded Message Type.
ORG, RPY, RESV, SEQ	Discarded message ORG, RPY, RESV and SEQ.
Reason	The reason for the discard. The list of status codes can be found at Table 4 Message Status Code Definitions.

ALARM_Reply (sent by the host):

Length	Bits							
Octets	7	6	5	4	3	2	1	0
2	Alarm Type							
2	Data Length							
var	Data Value							

Field	***Description***
Alarm Type	The type of the alarm that is received by host.

Value	Description
0x0001	Network Deregistered
0x0002	Connect Request
0x0003	Disconnect Indication
0x0004	Network Registration Started
0x0005	Network Registration Complete
0x0006	Connect Complete
0x0040	PHY received PPDU header CRC fail detected
0x0041	PHY received PPDU header syntax error detected
0x0080	Terminal node is promoted to a switch node
0x0081	Switch node is demoted to a terminal node
0x00c0	CL Alarm
0x00ff	General Error

Data Length	If an ALARM_INDICATION has a value to return, this defines the length of the value (in octets).
Data Value	The ALARM_INDICATION Reply data.

0x0001 – Network Deregistered:
Not implemented.

0x0002 – Connect Request Reply:

Length Octets	bits							
	7	6	5	4	3	2	1	0
1	reserved							
1								Accept
2	HCT Connection Type							
2	HCT Connection Handle							
2	Connection Data Length							
var	Connection Data							

Field	***Description***
Accept	Flag if connection is accepted. Value – Description 0 – Connection is rejected 1 – Connection is accepted
HCT Connection Type	Type of connection requested. The following are valid connection types: Value – Description 0x0006 – G3 virtual mapping connection 0x00fd – PRIME MAC Connection
HCT Connection Handle	The handle of the connection. This handle is used in all further messages relating to the connection.
Connection Data Length	Length of Connection Data.
Connection Data	The Connection Negotiation Data. The contents of the connection data is dependent on the connection type.

0x0006 – G3 virtual mapping connection:
0x00fd – MAC connection:
Additional connection data may be supplied if required.

0x0003 – Disconnect Indication:

Length	bits							
Octets	7	6	5	4	3	2	1	0
2	HCT Connection Type							
2	HCT Connection Handle							
2	Disconnect Data Length							
var	Disconnect Data							

Field	***Description***
HCT Connection Type	Type of connection requested. The following are valid connection types: Value – Description 0x0006 – G3 virtual mapping connection 0x00fd – PRIME MAC Connection
HCT Connection Handle	The handle of the connection. This handle is used in all further messages relating to the connection.
Disconnect Data Length	Length of Disconnect Data. This field is connection type specific.
Disconnect Data	Disconnect Data. The contents of the connection data is dependant on the connection type.

0x0006 – G3 virtual mapping connection:
0x00fd – MAC connection:
No additional data required.

0x0004 – Network Register Complete:
0x0005 – Connect Complete:
0x0040 – PHY received PPDU header CRC fail detected:
0x0041 – PHY received PPDU header syntax error detected:
0x0080 – Terminal node is promoted to a switch node:
0x0081 – Switch node is demoted to a terminal node:
0x00c0 – CL Alarm:
0x00ff – General Alarm:
Not implemented.

2.3.9 NETWORK_REGISTER or NETWORK_START

Message Type 0x08

The NETWORK_REGISTER message is used by the host to start the network registration procedure if the message sequence is initiated by host. When the process is complete, the host is notified by the reply message.

For G3 standard, this message is working as NETWORK_START.

Message Sequence initiated by PRIME host:

NETWORK_REGISTER Request:

Length	Bits							
Octets	7	6	5	4	3	2	1	0
2	Registration Type							
2	Registration Data Length							
var	Registration Data							

Field	***Description***
Registration Type	The type of registration. The following are the supported types:
Registration Data Length	The length of the Registration Data.
Registration Data	Variable length data needed for registration, whose content is dependent on the Registration Type.

Value	Description
0x0000	Automatically register.
0x0001	Register to a specific SNA.
0x0002	Register to a specific EUI48.

0x0000 – Automatically Register:

No registration data necessary.

0x0001 – Register to a specific SNA:

Length	Bits							
Octets	7	6	5	4	3	2	1	0
6	SNA							

Field	*Description*
SNA	Sub-Network Address.

0x0002 – Register to a specific EUI48:

Length	Bits							
Octets	7	6	5	4	3	2	1	0
6	EUI48							

Field	*Description*
EUI-48	Universal MAC Address (IEEE Std 802-2001)

NETWORK_REGISTER Reply:

Length	bits							
Octets	7	6	5	4	3	2	1	0
2	Status							
6	SNA							
6	EUI48							

Field	*Description*
Status	The status of the request. The list of status codes can be found at Table 4 Message Status Code Definitions.
SNA	Sub-Network Address through which the registration is received.
EUI-48	Switch Node Address through which the registration request is received.

Message Sequence initiated by G3 host:

NETWORK_START.request:

Length	Bits							
Octets	7	6	5	4	3	2	1	0
2	PAN ID							

Field	*Description*
PAN ID	The Pan ID, ranging from 0x0000-0xffff.

NETWORK_START.confirm:

Length	Bits							
Octets	7	6	5	4	3	2	1	0
2	Status							

Field	*Description*
Status	The status of the request. The list of status codes can be found at Table 4 Message Status Code Definitions.

2.3.10 NETWORK_UNREGISTER

Message Type 0x09

The NETWORK_UNREGISTER message is used by host to start the network deregistration procedure. When the process is complete, the host is notified by the reply message. This message shall only be used under PRIME MAC mode.

Message Sequence initiated by host:

NETWORK_UNREGISTER Request:
This message does not have message body.

NETWORK_UNREGISTER Reply:

Length	bits							
Octets	7	6	5	4	3	2	1	0
2	Status							

Field	*Description*
Status	The status of the request. The list of status codes can be found at Table 4 Message Status Code Definitions.

2.3.11 CONNECT

Message Type 0x0a

The Connect message is used by host to start the PRIME MAC connection procedure. When the process is complete, the host is notified by a reply message. This message shall only be used for MAC mode.

For G3, this message is used to establish a mapping between device destination address, security profile and QoS.

Message Sequence initiated by host:

CONNECT Request:

Length	bits							
Octets	7	6	5	4	3	2	1	0
2	HCT Connection Type							
2	Connection Data Length							
var	Connection Data							

Field	***Description***
HCT Connection Type	Type of connection requested. The following are valid connection types: Value — Description 0x0006 — G3 virtual mapping connection 0x00fd — PRIME MAC Connection
Connection Data Length	Length of CONNECTION_REQUEST Data. This field is connection type specific.
Connection Data	Connection Data. The contents of the connection data is dependant on the connection type.

0x0006 – G3 virtual mapping connection

Length	bits							
Octets	7	6	5	4	3	2	1	0
1	Security-Level							
1	Key Index							
1	Addr mode							
1	QoS							
2	PAN ID							
var	Destination Address							

Field	***Description***
Security-Level	
Key Index	
Addr Mode	
QoS	
PAN ID	The Pan ID, ranging from 0x0000-0xffff.
Destination Address	The destination address, as follows:

Mode	Len	Description
Short address	2 octets	G3 Short Address
Long Address	8 octets	Extended Addresses

0x00fd – PRIME MAC connection:

Length Octets	Bits							
	7	6	5	4	3	2	1	0
1								ARQ
1	MAC Connection Type							
2	CfBytes							
6	Destination Address							
var	Additional Connection Data							

Field	*Description*
ARQ	If 1, MAC ARQ is enabled, 0 MAC ARQ is disabled.
MAC Connection Type	The MAC Type that defines the convergence sublayer that should be used for this connection type.
CfBytes	The number of Contention Free Bytes (see the PRIME Specification for details).
Destination Address	Connected Device Destination Address of type EUI48.
Additional Connection Data	Additional connection data that may be required for the Connection Type. For example, AppEMU (Connection Type 0xfa) requires 1 3 octet Provider ID and a 6 octet ASCII Serial Number.

CONNECT Reply:

Length Octets	bits							
	7	6	5	4	3	2	1	0
2	Status							
2	HCT Connection Handle							
2	HCT Connection Type							
2	Connection Data Length							
var	Connection Data							

Field	***Description***
Status	The status of the request. The list of status codes can be found at Table 4 Message Status Code Definitions.
HCT Connection Handle	The 16bit HCT connection handle returned from CONNECT.
HCT Connection Type	Type of connection requested. The following are valid connection types: Value – Description 0x0006 – G3 virtual mapping connection 0x00fd – PRIME MAC Connection
Connection Data Length	Length of Connection Data. This field is connection type specific.
Connection Data	Connection Data. The contents of the connection data is dependant on the connection type.

0x0006 – G3 virtual mapping connection
No additional data returned.

0x00fd – PRIME MAC connection:

Connection Data:

Length Octets	Bits							
	7	6	5	4	3	2	1	0
6	Node Address							
var	Connection Negotiation Data							

Field	***Description***
Node Address	EUI48 address of the node that initiated the connection
Connection Negotiation Data	The MAC Connection Negotiation Data.

2.3.12 DISCONNECT

Message Type 0x0b

The DISCONNECT message is used by host to start the disconnection process. When the process is complete, the host is notified by the reply message. This message shall only be used under MAC mode.

Message Sequence initiated by host:

DISCONNECT Request:

Length Octets	bits 7	6	5	4	3	2	1	0
2	HCT Connection Type							
2	HCT Connection Handle							
2	Disconnect Data Length							
var	Disconnect Data							

Field	*Description*
HCT Connection Type	Type of connection requested. The following are valid connection types: Value — Description 0x0006 — G3 virtual mapping connection 0x00fd — PRIME MAC Connection
HCT Connection Handle	The 16bit connection handle returned from CONNECT.
Disconnection Data Length	Length of Disconnect Data. This field is connection type specific.
Disconnection Data	Disconnect Data. The contents of the disconnection data is dependant on the connection type.

0x0006 – G3 virtual mapping connection:
No additional data returned.

0x00fd – MAC connection:

Disconnect Data:

Length	bits							
Octets	7	6	5	4	3	2	1	0
2	Connection Handle							

Field	*Description*
HCT Connection Handle	The MAC connection handle.

DISCONNECT Reply:

Length	bits							
Octets	7	6	5	4	3	2	1	0
2	Status							
2	HCT Connection Type							
2	HCT Connection Handle							
2	Disconnect Data Length							
Var	Disconnect Data							

Field	*Description*
Status	The status of the request. The list of status codes can be found at Table 4 Message Status Code Definitions.
HCT Connection Type	Type of connection requested. The following are valid connection types: Value – Description 0x0006 – G3 virtual mapping connection 0x00fd – PRIME MAC Connection
HCT Connection Handle	The 16bit connection handle.
Disconnect Data Length	Length of disconnect Data. This field is connection type specific.
Disconnect Data	Disconnect Data. The contents of the disconnect data is dependant on the connection type.

0x0006 – G3 virtual mapping connection:
No additional data returned.

0x00fd – MAC connection:

Disconnect Data:

Length	bits							
Octets	7	6	5	4	3	2	1	0
2	Connection Handle							

Field	*Description*
Connection Handle	The MAC connection handle.

2.3.13 LOAD_SYSTEM_CONFIG

Message Type 0x0c

The LOAD_SYSTEM_CONFIG message is used by the host to load system configuration parameters at the start of the system. After system starts (registered, etc), this message is not allowed.

Message Sequence initiated by host:

LOAD_SYSTEM_CONFIG Request:

Length Octets	Bits							
	7	6	5	4	3	2	1	0
2	Config Type							
2	Config Length							
var	Configuration							
	[…]							

For G3 only one configuration message may be sent at a time

Field	*Description*
Config Type	The type of configuration. The following are the supported types:

Value	Description
0x0001	Port designation
0x0003	System Configuration
0x0004	PHY Configuration
0x0005	MAC Configuration
0x0006	CL IPv4/v6 Configuration
0x0007	PRIME LLC Configuration
0x0008	G3 configuration
0x0009	FLEX LITE Band configuration

Config Length	Length of configuration.
Configuration	Configuration, of length Config_Length.

0x0001 – Port designation:

Length Octets	bits							
	7	6	5	4	3	2	1	0
1					Diag Port		Data Port	

Field	*Description*
Data Port	Data Port designation. Value – Description 0 – SCI-A 1 – SCI-B
Diag Port	Diagnostics Port designation. Value – Description 0 – SCI-A 1 – SCI-B

0x0003 – System Configuration:

Length Octets	bits							
	7	6	5	4	3	2	1	0
2	Serial Number Length / Reserved for G3							
16	Serial Number / Reserved for G3							
6	EUI / Reserved for G3							
1	Device Mode							
1			Auto Mode					

Field	*Description*
Serial Number Length	Service Node Serial Number Length. This specifies how many octets in the 16 octet Serial Number are valid.
Serial Number	Service Node Serial Number.
EUI	Service Node EUI
Device Mode	Refer Table 2 System Configuration Info Field Definitions
Apply RPY	Refer Table 2 System Configuration Info Field Definitions
Auto Mode	Flag that controls whether, in Device Normal Mode (Device Mode 0) the device attempts to automatically register and connect on the network, or if the Host manually controls the start with ATTACH and DETACH. This byte is reserved for G3.

0x0004 – PRIME PHY configuration:

Length	bits							
Octets	7	6	5	4	3	2	1	0
1						PRM Flag	PHY Mode	

Field	*Description*
PHY Mode	PPDU Header Mode.

Value	Description
0	Prime Mode (default)
1	ROBO Mode

Field	*Description*
PRM Flag	PRM Off or On

Value	Description
0	PRM Off (default)
1	PRM On

0x0005 – PRIME MAC configuration:

Length	bits							
Octets	7	6	5	4	3	2	1	0
6	Reserved							
1	MAC_Default_Security_Profile							
1							Dflt. PAC	Dflt. ARQ

Field	*Description*
MAC_Default_Security_Profile	The default MAC security profile. Valid range: 0-255
Dflt. ARQ	A value of 1 represents that MAC ARQ is enabled by default, a value of 0 indicates MAC ARQ is disabled by default.
Dflt. PAC	A value of 1 represents that MAC PAC is enabled by default, a value of 0 indicates MAC PAC is disabled by default.

0x0006 – CL IPv4/v6 configuration:

Configuration Data:

Length Octets	bits							
	7	6	5	4	3	2	1	0
1								IP flag
1	Reserved							
8	CL IPv6 Address Prefix							
8	CL IPv4/v6 Source Address							
4	CL IPv4 Netmask							
4	CL IPv4 Gateway							
2	CL IPv4/v6 UDP Control Port							

Field	***Description***
IP Flag	IP version flag: Value: 0 = IPv4; 1 = IPv6
CL IPv6 Address Prefix	IPv6 prefix address.
CL IPv4/v6 Source Address	Source Address. PRIME CL IPv4: 4 octets – Source Address PRIME CL IPv6: 8 octets – Source Address
CL IPv4 Netmask	IPv4 Netmask
CL IPv4 Gateway	IPv4 Gateway.
CL IPv4/v6 UDP Control Port	UDP Control Port (default:8099).

0x0007 – LLC configuration:

Configuration Data:

Length Octets	bits 7	6	5	4	3	2	1	0
2	LLC Source LSAP							
2	LLC Default Destination LSAP							
2	LLC Default Destination Node Address							

Field	*Description*
LLC Source LSAP	
LLC Default Destination LSAP	
LLC Default Destination Node Address	

0x0008 – G3 configuration:

Configuration Data:

Length Octets	bits 7	6	5	4	3	2	1	0
1							COH	TMR
1	Reserved							
8	G3 Long Address							
4	Reserved							
2	G3 MAC Segment Size (obsolete)							

Field	*Description*
TMR	0 = Tone mask request mode non-designated 1 = Tone mask request mode enabled
COH	0 = Coherent Modulation disabled 1 = Coherent Modulation enabled
G3 Long Address	Device long address
G3 Mac Segement Size	This field is obsolete in newer versions of the PLC firmware. It should be always be set to 239 to remain compatible with older versions for the Firmware.

0x0009 – FLEX LITE Band configuration:

Length Octets	bits							
	7	6	5	4	3	2	1	0
2	FLEX LITE BAND							
2	Start tone							

Field	*Description*
FLEX LITE BAND	

Value	Description
0	Full Band
1	Half Band

LOAD_SYSTEM_CONFIG Reply:

Length Octets	bits							
	7	6	5	4	3	2	1	0
2	Status							

Field	*Description*
Status	The status of the request. The list of status codes can be found at Table 4 Message Status Code Definitions.

2.3.14 SET_MAC_PIB

Message Type 0x0D

The SET_MAC_PIB message is used to set PLC PIB information on the device. This message is always initiated from host. An array of PIB TLVs are sent to the device.

Message Sequence initiated by host for PRIME:

SET_ PIB Request:

Length	bits							
Octets	7	6	5	4	3	2	1	0
2	Attribute ID							
2	Attribute Length							
var	Attribute Value							
	[. . .]							

For G3 only one MAC PIB may be set at a time.

Field	*Description*
Attribute ID	Attribute ID, as defined in Tables 1 - 7 (Section 6.1.1.1 - 6.1.1.2, 6.1.2.1 – 6.1.2.4, 6.1.2.5) of the PRIME Spec v1.3E.
Attribute Length	Attribute Length for the ID, as defined in Tables 1 - 7 (Section 6.1.1.1 - 6.1.1.2, 6.1.2.1 – 6.1.2.4, 6.1.2.5) of the PRIME Spec v1.3E.
Attribute Value	Attribute Value for the ID, as defined in Tables 1 - 7 (Section 6.1.1.1 - 6.1.1.2, 6.1.2.1 – 6.1.2.4, 6.1.2.5) of the PRIME Spec v1.3E.

SET_ PIB Reply:

Length	bits							
Octets	7	6	5	4	3	2	1	0
2	Status							

Field	*Description*
Status	The status of the request. The list of status codes can be found at Table 4 Message Status Code Definitions.

Message Sequence initiated by host for G3:

SET_ PIB Request:

Length	bits							
Octets	7	6	5	4	3	2	1	0
4	Attribute ID							
2	Attribute Index							
2	Attribute Length							
var	Attribute Value							

Field	*Description*
Attribute ID	Attribute ID defined in Table 86 of 802.15.4-2006 and Clause 5.2 of G3 MAC spec.
Attribute Index	The index within the table of the specified IB attribute to read. This parameter is valid only for IB attributes that are tables.
Attribute Length	Attribute Length for the ID,defined in Table 86 of 802.15.4-2006 and Clause 5.2 of G3 MAC spec.
Attribute Value	Attribute value for writable attribute from Table 86 of 802.15.4-2006 and Clause 5.2 of G3 MAC spec.

SET_ MAC_PIB Reply:

Length	bits							
Octets	7	6	5	4	3	2	1	0
2	Status							

Field	*Description*	
Status	Status Code	Status Value
	STAT_SUCCESS	0
	STAT_ERR_FAILURE	0x81
	STAT_UNSUPPORTED_ATTRIBUTE	0x90
	STAT_INVALID_INDEX	0x91
	STAT_READ_ONLY	0x92

2.3.15 CLEAR_PHY_PIB

Message Type 0x0e

The CLEAR_PHY_PIB message is used by host to clear certain PLC PHY PIB information on the device. This message is always initiated by the host. An array of Attribute IDs are used to list the PHY PIBs to be cleared.

Message Sequence initiated by host:

CLEAR_PHY_PIB Request:

Length	bits							
Octets	7	6	5	4	3	2	1	0
2	Attribute ID							
	[. . .]							

For G3 only one PHY PIB may be cleared at a time

Field	*Description*
Attribute ID	Attribute ID, as defined in Tables 1 - 2 (Section 6.1.1.1 - 6.1.1.2) of the PRIME Spec v1.3E.

CLEAR_PHY_PIB Reply:

Length	bits							
Octets	7	6	5	4	3	2	1	0
2	Status							

Field	*Description*
Status	The status of the request. The list of status codes can be found at Table 4 Message Status Code Definitions.

2.3.16 CLEAR_MAC_PIB

Message Type 0x0f

The CLEAR_MAC_PIB message is used by host to clear certain PLC MAC PIB information on the device. This message is always initiated by the host. An array of Attribute IDs are used to list the MAC PIBs to be cleared.

Message Sequence initiated by host for PRIME:

CLEAR_MAC_PIB Request:

Length	bits							
Octets	7	6	5	4	3	2	1	0
2	Attribute ID							
	[. . .]							

For G3 only one MAC PIB may be cleared at a time

Field	*Description*
Attribute ID	Attribute ID, as defined in Tables 3 - 7 (Section 6.1.2.1 – 6.1.2.4) of the PRIME Spec v1.3E.

CLEAR_MAC_PIB Reply:

Length	bits							
Octets	7	6	5	4	3	2	1	0
2	Status							

Field	*Description*
Status	The status of the request. The list of status codes can be found at Table 4 Message Status Code Definitions.

Message Sequence initiated by host for G3:

CLEAR_MAC_PIB Request:

Length	bits							
Octets	7	6	5	4	3	2	1	0
4	Attribute ID							

Field	*Description*
Attribute ID	Attribute ID defined in Table 86 of 802.15.4-2006 and Clause 5.2 of G3 MAC spec.

CLEAR_MAC_PIB Reply:

Length	bits							
Octets	7	6	5	4	3	2	1	0
2	Status							

Field	*Description*	
Status	Status Code	Status Value
	STAT_SUCCESS	0
	STAT_UNSUPPORTED_ATTRIBUTE	0x90
	STAT_INVALID_INDEX	0x91
	STAT_READ_ONLY	0x92

2.3.17 ATTACH

Message Type 0x10

The ATTACH message is used by the host to initiate the process of registering the device identifier with the Base Node and the Base Node allocates the destination_address to the service node session. For G3 standard, it allows a Service Node to join the network.

Message Sequence initiated by PRIME host:

ATTACH.Request:

Length	Bits							
Octets	7	6	5	4	3	2	1	0
2	Device Identifier Length							
var	Device Identifier							

Field	*Description*
Device Identifier Length	Length of the Device Identifier.
Device Identifier	Equivalent to COSEM "logical device name" which is defined as an octet-string of up to the Device Identifier Length.

ATTACH.Confirm:

Length	bits							
Octets	7	6	5	4	3	2	1	0
2	Status							
2	Device Identifier Length							
var	Device Identifier							
2	Source Address							
2	Base Address							

Field	*Description*
Status	The status of the request. The list of status codes can be found at Table 4 Message Status Code Definitions.
Device Identifier Length	Length of the Device Identifier.
Device Identifier	Used to identify which ATTACH.request this ATTACH.confirm is for, of length Device Identifier Length..
Source Address	The address assigned to the 4-32 CL session by the base node (12-bit)
Base Address	Base node address (12-bit)

Message Sequence initiated by G3 host:

ATTACH.Request:

Length	Bits							
Octets	7	6	5	4	3	2	1	0
2	PAN ID							
2	Reserved							

Field	*Description*
PAN ID	The Pan ID, ranging from 0x0000-0xffff.

ATTACH.Confirm:

Length	bits							
Octets	7	6	5	4	3	2	1	0
2	Status							
2	Network Address							
2	PAN ID							

Field	*Description*
Status	The status of the request:
Network Address	Network address assigned by PanCoord. Valid values are 0x0001 – 0xfff7 and 0xffff.
PAD ID	The Pan ID, ranging from 0x0000-0xffff.

Status Code	Status Value	Comment
STAT_SUCCESS	0	Successful
STAT_INVALID_REQUEST	0x85	Not valid message
STAT_NOT_PERMITTED	0x8d	Rejected by PANcoord
STAT_ERR_FAILURE	0x81	Internal error

Message Sequence initiated by PLC for G3 to indicate the successful completion of a new device attached to the network.

ATTACH.indication:

Length Octets	Bits							
	7	6	5	4	3	2	1	0
8	Network Address 1							
8	Network Address 2							
8	Extended Address							
1	Capability Info							
1	reserved							

Field	***Description***
Network Address 1	The IPv6 Address Prefix
Network Address 2	The IPv6 Address Suffix
Extended Address	The 64-bit Device Address
Capability Info	Capability Info as defined in Fig 56 of 802.15.4-2006

2.3.18 DETACH

Message Type 0x11

The CL_RELEASE message is used by host to leave the network, close the convergence layer session and any resources it may hold.

Message Sequence initiated by PRIME host:

DETACH.request:

Length	Bits							
Octets	7	6	5	4	3	2	1	0
2	Destination Address							

Field	*Description*
Destination Address	The address allocated to the service node 4-32 session by the base node.

DETACH.confirm:

Length	bits							
Octets	7	6	5	4	3	2	1	0
2	Status							
2	Destination Address							

Field	*Description*
Status	The status of the request. The list of status codes can be found at Table 4 Message Status Code Definitions.
Destination Address	The address allocated to the service node 4-32 session by the base node.

Message Sequence initiated by G3 host:

DETACH.request:

Length	Bits							
Octets	7	6	5	4	3	2	1	0
8	Extended Address							

Field	***Description***
Extended Address	The 64-bit network address of the device to remove from the network. If the Extended Address is NULL and the device is not PAN coordinator, the device removes itself from the network.

DETACH.confirm:

Length	bits							
Octets	7	6	5	4	3	2	1	0
2	Status							
8	Extended Address							

Field	***Description***
Status	The status of the request.
Destination Address	The 64-bit network address of the device to remove from the network. If NULL, the device removes itself from the network.

Status Code	Status Value	Comment
STAT_SUCCESS	0	Successful
STAT_INVALID_REQUEST	0x85	Not valid message
STAT_UNKNOWN_DEVICE	0x8e	Rejected by PANcoord
STAT_ERR_FAILURE	0x81	Internal error

Message Sequence initiated by PLC for G3 standard:

DETACH.indication:

Length	Bits							
Octets	7	6	5	4	3	2	1	0
8	Extended Address							

Field	***Description***
Extended Address	The 64-bit network address of the device to remove from the network.

2.3.19 DISCOVER

Message Type 0x12

The DISCOVER message is used by host to start an active SCAN on existing POS for networks. This message is only used for G3 standard.

Message Sequence initiated by G3 host:

DISCOVER.request for network discovery:

Length	Bits							
Octets	7	6	5	4	3	2	1	0
1	Discover Type							
1	Duration							

Field	*Description*
Discover Type	Discover Type. The following are the supported types: Value — Description 0x00 — Network Discover 0x01 — Route Discover 0x02 — Path Discover
Duration	The number of seconds the active scan lasts for Type 0x00 (Network Discover)

DISCOVER.confirm for network discovery:

Length Octets	bits							
	7	6	5	4	3	2	1	0
2	Status							
2	PAN Count (N)							
var	N * PAN Desc							

Field	***Description***
Status	The status of the request. The status code is defined as following:

Discovery Type	Status Code	Status Code Value
Network Discover	STAT_SUCCESS	0x0000
	STAT_NO_BEACON	0x008B
	STAT_ERR_FAILURE	0x0081
Route Discover	STAT_SUCCESS	0x0000
	STAT_INVALID_REQUEST	0x0085
	STAT_ROUTE_ERR	0x0088
Path Discover	STAT_SUCCESS	0x0000
	STAT_INVALID_REQUEST	0x0085
	STAT_ROUTE_ERR	0x0088

PAN Count The number of PAN coordinators found

PAN Desc PanDescriptor defined below:

Length Octets	Bits							
	7	6	5	4	3	2	1	0
1	CoordAddressMode (0x2 or 0x3)							
1	LQI (beacon received signal quality)							
2	CoordPANId (0x0000-0xffff)							
2/8	CoordAddress							

DISCOVER.request for route discovery:

Length Octets	Bits							
	7	6	5	4	3	2	1	0
1	Discover Type (0x01)							
1	MaxHops (0x00-0x07)							
2	dstAddr							

Field	***Description***
Discover Type	Discover Type. The following are the supported types: Value — Description 0x00 — Network Discover 0x01 — Route Discover 0x02 — Path Discover
MaxHops	Maximum number of hops allowed for the route discovery.
dstAddr	Short unicast destination address for route discovery

DISCOVER.confirm for route discovery:

Length Octets	bits							
	7	6	5	4	3	2	1	0
2	Status							

Field	***Description***
Status	The status of the request. The status code is defined as following:

Discovery Type	Status Code	Status Code Value
Network Discover	STAT_SUCCESS	0x0000
	STAT_NO_BEACON	0x008B
	STAT_ERR_FAILURE	0x0081
Route Discover	STAT_SUCCESS	0x0000
	STAT_INVALID_REQUEST	0x0085
	STAT_ROUTE_ERR	0x0088
Path Discover	STAT_SUCCESS	0x0000
	STAT_INVALID_REQUEST	0x0085
	STAT_ROUTE_ERR	0x0088

DISCOVER.request for path discovery:

Length Octets	Bits							
	7	6	5	4	3	2	1	0
1	Discover Type (0x02)							
1	reserved							
2	dstAddr (0-1199)							

Field	***Description***
Discover Type	Discover Type. The following are the supported types: Value — Description 0x00 — Network Discover 0x01 — Route Discover 0x02 — Path Discover
dstAddr	Short unicast destination address for path discovery

DISCOVER.confirm for path discovery:

Length Octets	bits							
	7	6	5	4	3	2	1	0
2	Status							
2	dstAddr (0-1199)							
Var	NSDU							

Field	*Description*
Status	The status of the request. The status code is defined as following:

Discovery Type	Status Code	Status Code Value
Network Discover	STAT_SUCCESS	0x0000
	STAT_NO_BEACON	0x008B
	STAT_ERR_FAILURE	0x0081
Route Discover	STAT_SUCCESS	0x0000
	STAT_INVALID_REQUEST	0x0085
	STAT_ROUTE_ERR	0x0088
Path Discover	STAT_SUCCESS	0x0000
	STAT_INVALID_REQUEST	0x0085
	STAT_ROUTE_ERR	0x0088

dstAddr Short unicast destination address of path discovery

NSDU Buffer containing address of nodes constituting the path

Length Octets	bits							
	7	6	5	4	3	2	1	0
2	Number of Devices (N)							
2*N	N* devAddr							

.

2.3.20 FW_UPGRADE

Message Type 0x13

The follow describes the message sequence of the FW_UPGRADE and its Message Payload Definitions.

Message Sequence initiated by PLC:

1. FIRMWARE_UPGRADE.preperation_request: PLC to host

Length	Bits							
Octets	7	6	5	4	3	2	1	0
2	Message Sub-Type = 0x0001							
2	Page Size							
4	Image Size							
4	Image CRC							

Field	*Description*
Page Size	The PLC receives a firmware image in fixed sized pages (except for the last page). The page size can be one of 32, 64, 128 or 192 bytes. The page size value is provided to the PLC by the base node at the beginning of a firmware upgrade session.
Image Size	The size of the "upgrade" image in bytes. This is also provided to the PLC by the base node at the beginning of a firmware upgrade session.
Image CRC	CRC of the "upgrade" image. This is also provided to the PLC by the base node at the beginning of a firmware upgrade session.

2. FIRMWARE_UPGRADE.preperation_reply: host to PLC

Length	Bits							
Octets	7	6	5	4	3	2	1	0
2	Message Sub-Type = 0x0001							
2	Status							

Field	*Description*
Status	0x0000 - SUCCESS 0x0004 - PAYLOAD_CRC_ERROR 0x5001 - Host does not support firmware upgrade

3. FIRMWARE_UPGRADE.data_indicate: PLC to host

Length Octets	Bits 7	6	5	4	3	2	1	0
2	Message Sub-Type = 0x0000							
4	Page Index							
Var	Page contents							

Field	*Description*
Page Index	The position of this page within the firmware image.
Page Contents	The contents of the page as an array of bytes

4. FIRMWARE_UPGRADE.data_reply: host to PLC

Length Octets	Bits 7	6	5	4	3	2	1	0
2	Message Sub-Type = 0x0000							
2	Status							
4	Page Index							
2	CRC Valid Flag							
4	CRC							

Field	*Description*
Status	0x0000 - SUCCESS 0x0004 - PAYLOAD_CRC_ERROR 0x5001 - Host does not support firmware upgrade 0x5006 - Host not prepared for firmware upgrade 0x5007 – Length of the “page contents” field is invalid.
Page Index	The position of this page within the firmware image.
CRC Valid Flag	1 – host set CRC field. 0 – CRC field not valid
CRC	CRC calculated over received FW image. Only valid when CRC Valid Flag is set to non-zero.

Step 3. Step 4 will repeat until the last page of the FW is received.

5. FIRMWARE_UPGRADE.crc_request: PLC to Host
   This message requests the host to report the CRC status.

Length	Bits							
Octets	7	6	5	4	3	2	1	0
2	Message Sub-Type = 0x0002							

6. FIRMWARE_UPGRADE.crc_reply: Host to PLC

Length	Bits							
Octets	7	6	5	4	3	2	1	0
2	Message Sub-Type = 0x0002							
2	Status							
4	CRC							

Field	***Description***
Status	0x0000 - SUCCESS 0x5001 - Host does not support firmware upgrade 0x5002 - Host does not have an "upgrade" image (to flash and reboot) 0x5003 - "Upgrade" image is incomplete 0x5004 - "Upgrade" image did not pass CRC check 0x5005 - "Upgrade" image is bad/Incompatible
CRC	CRC of the "upgrade" image as calculated by the host.

7. FIRMWARE_UPGRADE.flash_request: PLC to Host
   This message requests the host to flash the received FW image to the PLC sub-system.

Length	Bits							
Octets	7	6	5	4	3	2	1	0
2	Message Sub-Type = 0x0003							

8. FIRMWARE_UPGRADE.flash_reply: Host to PLC
   This message indicates Host is ready to flash the newly received image to the PLC sub-system.

Length	Bits							
Octets	7	6	5	4	3	2	1	0
2	Message Sub-Type = 0x0003							
2	Status							

Field	*Description*
Status	0x0000 - SUCCESS 0x5001 - Host does not support firmware upgrade 0x5002 - Host does not have an "upgrade" image (to flash and reboot) 0x5003 - "Upgrade" image is incomplete 0x5004 - "Upgrade" image did not pass CRC check 0x5005 - "Upgrade" image is bad/Incompatible

After the upgraded FW is flashed and restarted, the following message sequence is used by the PLC to request the host to mark the "upgrade" image as the "active" image. Depending on the implementation, the image marked as "active" till this point can be deleted or archived. Note that the host will no longer have an "upgrade" image after this request has been handled (since it has been marked "active").

9. FIRMWARE_UPGRADE.activate_request: PLC to Host

Length	Bits							
Octets	7	6	5	4	3	2	1	0
2	Message Sub-Type = 0x0004							

10. FIRMWARE_UPGRADE.activate_reply: Host to PLC

Length	Bits							
Octets	7	6	5	4	3	2	1	0
2	Message Sub-Type = 0x0004							
2	Status							

Field	*Description*
Status	0x0000 - SUCCESS 0x5001 - Host does not support firmware upgrade 0x5002 - Host does not have an "upgrade" image. 0x5003 - "Upgrade" image is incomplete 0x5004 - "Upgrade" image did not pass CRC check 0x5005 - "Upgrade" image is bad/Incompatible

During the process of firmware upgrade, it is possible that the PLC concentrator to initiate a "Abort" to the upgrade. PLC will indicate to the host that the currently running firmware upgrade process has been aborted. The host is required to delete the "upgrade" image if it has one and do any required clean ups.

11. FIRMWARE_UPGRADE.abort_request:

Length	Bits							
Octets	7	6	5	4	3	2	1	0
2	Message Sub-Type = 0x000F							
2	Flag							

Field	*Description*
Flag	0 - Do not flash the "active" image and do not reboot the PLC 1 - Flash the "active" image and reboot the PLC

12. FIRMWARE_UPGRADE.abort_reply:

Length	Bits							
Octets	7	6	5	4	3	2	1	0
2	Message Sub-Type = 0x000F							
2	Status							

Field	*Description*
Status	0x0000 - Success 0x0004 - PAYLOAD_CRC_ERROR 0x5001 - Host does not support firmware upgrade 0x5002 - Host does not have an "upgrade" image

2.3.21 GET_INFO

Message Type 0x14

The GET_INFO message is used by host to retrieve certain system parameters in the PLC device. This message is always initiated from host.
A GET_INFO TLV ID is sent to the device, and the device will reply the GET_INFO TLVs.

GET_INFO Request:

Length	Bits							
Octets	7	6	5	4	3	2	1	0
2	Get Info TLV ID							

GET_INFO Reply:

Length	Bits							
Octets	7	6	5	4	3	2	1	0
2	Status							
2	TLV ID							
2	TLV Length							
var	TLV Value							

Field	***Description***
Status	The status of the request. The list of status codes can be found at Table 4 Message Status Code Definitions.
TLV ID	
TLV Length	TLV Length for the ID, as defined in the following tables
TLV Value	TLV Value for the ID, as defined in the following tables

TLV IDs

Id	*Description*
0x0000 – 0x0001	Reserved
0x0002	G3 PHY TX Parameters
0x0003	G3 PHY RX Parameters
0x0004	Vendor and Product Id's
0x0005	Reserved
0x0006	Reserved
0x0007	Reserved
0x0008	Reserved
0x0009	TX PHY Attenuation / Gain
0x000A	Get Firmware CRC32 value

0x0002 – G3 PHY TX Parameters - The message currently implemented in G3 versions 5.0.0.0 and above.

Length Octets	bits							
	7	6	5	4	3	2	1	0
2	TLV Id = 0x0002							
2	Length = 18							
1		Band Sel			COH			TMR
1	Reserved						Modulation	
2	TX Level							
14	Tone Mask							

Field	***Description***
Flag (Byte 0)	<table><tr><td>TMR</td><td>Tone Map Request Mode 0 = disabled – non designated mode 1 = Enabled – PHY set to Tone Mask Req Mode. Note that if TMR mode is specified modulation and TX Level are ignored.</td></tr><tr><td>COH</td><td>Coherent Modulation 0 = Disabled 1 = Enabled</td></tr><tr><td>Band Sel</td><td>Band Selection 0 = Cenelec 1 = Cenelec/FCC</td></tr></table>
Modulation	TX Modulation: Value – Description 0x00 – ROBO 0x01 – BPSK 0x02 – QPSK 0x03 – 8PSK
TX Level	Transmission Level, 0-32 (refer to G3 spec).
Tone Mask	Set spectral mask (static) where tones start, stop and notch. UINT8 toneMask[0] bit6-bit0: number of tones in the band UINT8 toneMask[1]: tone number for the first tone in the band UINT8 toneMask[2] – [11]: tone mask, 1 indicates the tone is on, 0 indicates the tone is off.

Example tone mask definition:

Band	Tone mask
Cenelec A 36	17.24.ff.ff.ff.ff.0f.00.00.00.00.00.00.00
Cenelec A 25	17.24.ff.ff.00.f8.0f.00.00.00.00.00.00.00
Cenelec B	3f.10.ff.ff.00.00.00.00.00.00.00.00.00.00
Cenelec BC	3f.1a.ff.ff.ff.03.00.00.00.00.00.00.00.00
Cenelec BCD	3f.20.ff.ff.ff.ff.00.00.00.00.00.00.00.00
FCC low band	21.24.ff.ff.ff.ff.0f.00.00.00.00.00.00.00
FCC high band	45.24.ff.ff.ff.ff.0f.00.00.00.00.00.00.00
FCC full band	21.48.ff.ff.ff.ff.ff.ff.ff.ff.ff.00.00.00

0x0003 – G3 PHY RX Parameters - The message currently implemented in G3 versions 5.0.0.0 and above.

Length	bits							
Octets	7	6	5	4	3	2	1	0
2	TLV Id = 0x0003							
2	Length = 14/16/18 depending length of Tone Mask							
1	reserved							
1		Band Sel			COH	BLI		AGC
2	Gain Value							
14	Tone Mask							

Field	***Description***
Gain Value	Manual gain value of 0 – 7 if AGC = 0. If AGC = 1, this field is ignored.
AGC	Automatic Gain Control. A value of 1 for AGC ON, value of 0 for AGC OFF.
BLI	Block Level Interleaver. A value of 1 for BLI ON, value of 0 for BLI OFF.
COH	Coherent Modulation. A value of 1 for COH on and 0 for COH off
Band Select	Band Selection 0 = Cenelec 1 = Cenelec/FCC
Tone Mask	Set spectral mask (static) where tones start, stop and notch. UINT8 toneMask[0] bit6-bit0: number of tones in the band UINT8 toneMask[1]: tone number for the first tone in the band UINT8 toneMask[2] – [11]: tone mask, 1 indicates the tone is on, 0 indicates the tone is off.

0x0004 – Vendor and Product Id's

Length Octets	bits							
	7	6	5	4	3	2	1	0
2	TLV Id = 0x0004							
2	Length = 18							
2	Vendor Id							
16	Product Id							

Field	***Description***
TLV Id	0x0004
Length	18
Vendor Id	Vendor Id, UINT16 value
Product Id	Product Id – ASCII characters, null terminated The max number of characters is 15

0x0009 – TX PHY Attenuation/Gain Parameters:

Length Octets	bits							
	7	6	5	4	3	2	1	0
1	TX Gain / Attenuation							
1	TX PGA Attenuation							

Field	***Description***
TX Gain / Attenuation	The range is from -60 to (0xC4) to 30 (0x 1E) in 0.1 dB steps
TX PGA Attenuation	0 = 0 dB 1 = -3 dB 2 = -6 dB
Product ID	Vendor Specifics Identifier in ASCII, terminating with a NULL character

0x000A – Firmware CRC32

Length	bits							
Octets	7	6	5	4	3	2	1	0
4	Firmware CRC32 value							

Field	*Description*
Firmware CRC 32 value	The CRC32 of the current DSP firmware

A CRC32 value of 0xFFFFFFFF means that no CRC32 was loaded with the DSP firmware.

2.4 Diagnostic Messages

This category of messages is only used for diagnostic purpose. All the diagnostic message type ranges from 0x80 to 0xfe and its definition is defined in a separate document. For FW upgrade support the following APIs will be used.

2.4.1 Flash Firmware Image

2.4.1.1 Flash Firmware Process

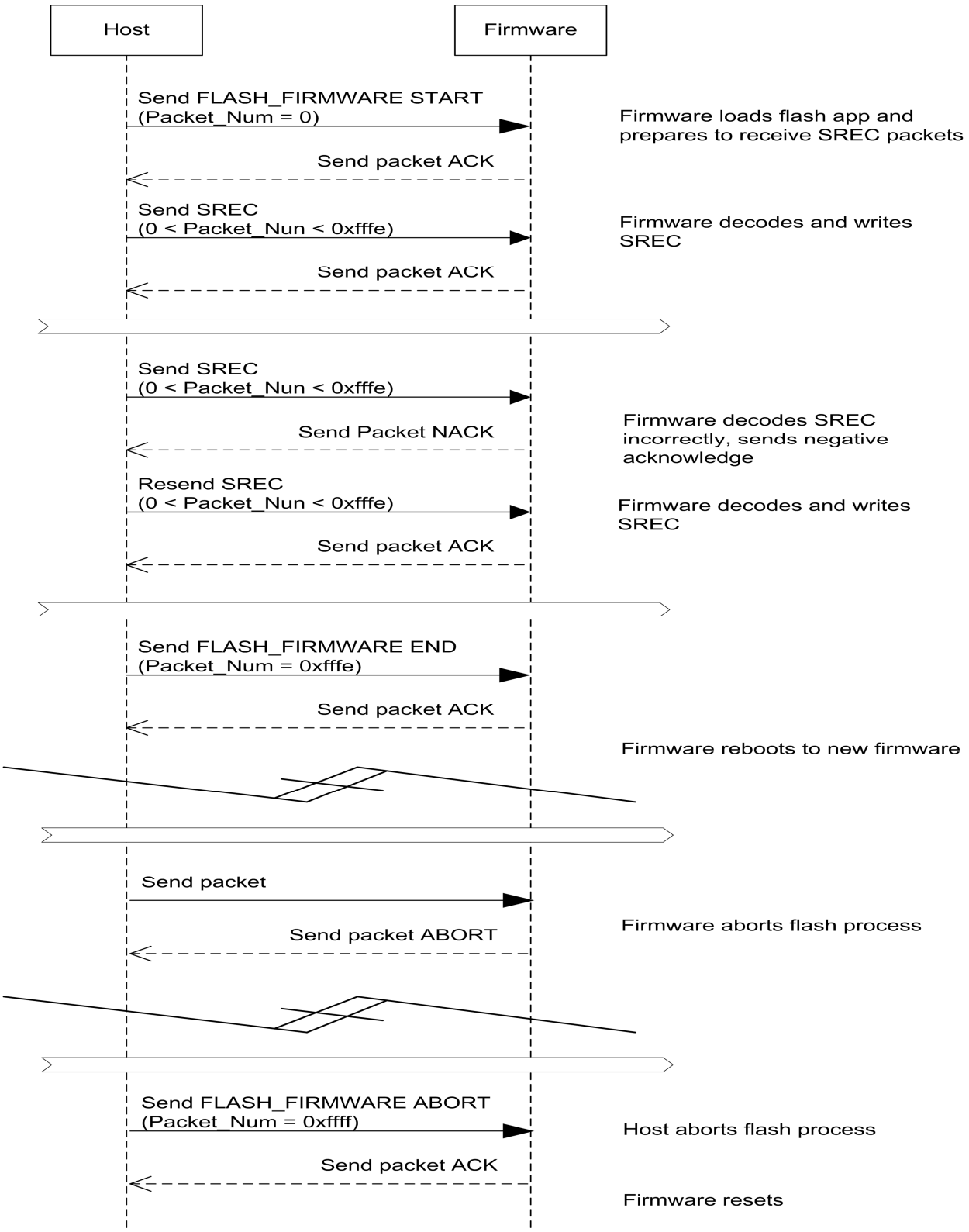
A process to flash firmware image is in place to provide an easy firmware update process as well as help minimize error conditions. Each packet sent by the host is acknowledged by the PLC before the host can send the next packet. The current packet can be resent by the host if a negative acknowledgement is received from the device.

The host can send firmware image as either SREC text format or can convert to binary format, sent as 16 bit words.

The process is as follows:

1. The host initiates the firmware flash process by sending the device a START packet. The payload is a 32bit file length (this should be the total number of bytes that will be sent).
2. The device sends an acknowledgement.
3. The host sends firmware packets (see payload type) to the device
4. For each packet, the device sends an acknowledgement.
5. The host completes the process by sending an END packet.
6. The device acknowledges the END, and reboots to the new firmware.

The following figure shows the firmware flash process.


Host
Firmware
Send FLASH_FIRMWARE START
(Packet_Num = 0)
Firmware loads flash app and prepares to receive SREC packets
Send packet ACK
Send SREC
(0 < Packet_Nun < 0xfffe)
Firmware decodes and writes SREC
Send packet ACK
Send SREC
(0 < Packet_Nun < 0xfffe)
Firmware decodes SREC incorrectly, sends negative acknowledge
Send Packet NACK
Resend SREC
(0 < Packet_Nun < 0xfffe)
Firmware decodes and writes SREC
Send packet ACK
Send FLASH_FIRMWARE END
(Packet_Num = 0xfffe)
Send packet ACK
Firmware reboots to new firmware
Send packet
Firmware aborts flash process
Send packet ABORT
Send FLASH_FIRMWARE ABORT
(Packet_Num = 0xffff)
Host aborts flash process
Send packet ACK
Firmware resets

2.4.1.2 Flash Image Messages

This diagnostic message is used to flash a firmware image to PLC. It should be noted that the message is used to allow host application to flash the new PLC image (either received from PLC network or other network) to the PLC sub-sysem.

Message sequence:

Firmware_Flash request message

```
MSG_TYP = 0x94;
MSG_ORG = '1';  // originated from host
MSG_RPY = '0';  // reply message needed
MSG_BDY =
  uint16_t HeaderCRC16;  // CRC16 of the APE message header
  uint16_t PayloadCRC16; // CRC16 of Payload, excluding
                         //   HeaderCRC16 and PayloadCRC16
  uint16_t PacketNum;    // Packet Number, in the form of:
                         //   0x0000: Start (BOF)
                         //   0xfffe: End (EOF)
                         //   0xffff: Abort
                         //   0x0001-0xfffd: Packet Number
  uint16_t PayloadType;  // Payload Type
                         //   0x0000: SREC
                         //   0x0001: binary
  uint8_t Payload[0..256]; // Firmware File packet
```

Firmware_Flash reply message

```
MSG_TYP = 0x94;
MSG_ORG = '0';  // originated from PLC
MSG_RPY = '1';  // end of message sequence
MSG_BDY =
  uint16_t HeaderCRC16;  // CRC16 of the host message header and PacketNum
  uint16_t PayloadCRC16; // CRC16 of Payload, excluding
                         //   HeaderCRC16 and PayloadCRC16
  uint16_t PacketNum;    // Packet Number or request
  uint16_t Status;
```

Possible status values are:

Status Code	Value	Comment	Action
SUCCESS	0	Success	Send next packet or other action depending on the current state of the firmware flash
ABORT	1	Abort Flash	If the action flash has not started then abort and do not send the flash packets. If the flash memory has been erased then the previous version of code would have to be sent to recover the modem.
BADCRC	2	Bad CRC	Resend the last packet
MISSING	3	Missing packet	A missing firmware packet was detected. Send this packet only.
ERASE_PENDING	4	The flash erase process has started	No action, status message only
ERASE_COMPLETE	5	Flash erase complete	No action, status message only. The modem will not begin saving the flash data in memory until this state has been reported.
UTILITY_MISSING	6	Flash utility missing	Abort the flash. The utility necessary for the modem to flash itself was not found and the modem can not be flashed.

2.4.1.3 FW Image Binary Payload Format

The payload for the Binary payload type is defined as follows:

```
uint32_t Address;           // memory location address
uint16_t Length;            // length of binary data
uint16_t Payload[0..128];   // binary data
```

2.4.2 Read Blob

This message is sent by PLC to host to read a block of binary data (Blob) from host's storage: RAM , NVRAM or flash into the PLC's local memory or vice versa. The blob is identified by the *blob_id*. Each blob has the following definition:

```
BLOB =
  uint16_t blob_id;   // blob identifie
  uint16_t blob_total_len;  // total blob length in bytes
  uint8_t  blob_data[blob_len]; // blob data in this message
```

Note: There are no header or body CRC values in this message.

PLC can use this message to read in the configuration file that is stored in the flash or NVRAM after system is booted.

Message sequence:

read_blob request message: PLC to host

```
MSG_TYP = 0x96;
MSG_ORG = '0';  // 0: originated from PLC, 1: originated from host
MSG_RPY = '0';  // need reply message
MSG_BDY =
  uint16_t blob_id; // blob id to identify the blob
  uint16_t blob_len; // length in bytes of blob to read
  uint16_t blob_addr; //start address of the blob, only exist when blob_id=4
```

read_blob reply message:

```
MSG_TYP = 0x96;
MSG_ORG = '1';  // 0: originated from PLC, 1: originated from Host
MSG_RPY = '1';  // end of message sequence (if no blob fragmentation)
MSG_BDY =
  uint16_t blob_id;  // blob id to uniquely identify the blob
  uint16_t blob_len; // total length in bytes of the blob data, if blob_len =
0, the blob data is either absent or not available
  uint8_t  blob_data[blob_len]; // when blob_id = 4, 1st 32-bit specifies the
blob start address.
```

The following table shows the receiver block id definitions.

Blob_id	Name
0	Configuration file
1	FW upgrade status info
2	DMEM_data_blob
3	PMEM_data_blob
4	Addressed Data blob

Table 3 blob_id Definitions

The data structure or definition of the configuration file is in host message specification.

When blob_id = 4, the 1st 32-bit in blob_data[blob_len] contains the address of the data that resides in PLC or host system. This allow host or PLC to perform random data read from address specified.

2.4.3 Write Blob

This message is sent by PLC to Host to write a block of binary data (Blob) into host's RAM, NVRAM or flash for storage purpose or vice versa. The blob definition is same as **Error! Reference source not found.**2.1.12.

Message sequence:

write_blob request message:

```
MSG_TYP = 0x97;
MSG_ORG = '0';  // originated from PLC
MSG_RPY = '0';  // one block data write.
MSG_BDY =
  uint16_t blob_id;   // blob identifier refer Table 2
  uint16_t blob_total_len;  // total blob length in bytes
  uint8_t  blob_data[blob_len]; // when blob_id=4, 1st 32-bit specifies the
blob start address
```

Note: There are no header or body CRC values in this message.

write_blob reply message:

```
MSG_TYP = 0x97;
MSG_ORG = '1';  // originated from Host
MSG_RPY = '1';  // no reply message needed
MSG_BDY =
  uint16_t status;

  Possible status values are:
```

Status Code	Value	Comments
OK	0	write_blob operation successful
ERR_HOST_MEM_FULL	14	there is no memory space in host that can perform this operation
ERR_CRC_CHECKSUM	15	there is CRC or check sum error in the blob data received

2.4.4 Upload Firmware Image

The upload firmware image messages will request the firmware imager from the PLC. The PLC must be in DFU mode before the image can be transferred.

2.4.4.1 Upload Firmware Image Request

Upload Firmware Image request message

```
MSG_TYP = 0x99;
MSG_ORG = '1';  // originated from host
MSG_RPY = '0';  // reply message needed
MSG_BDY =
  Uint16_t payload_length// length of the message including crc's
  uint16_t HeaderCRC16;  // CRC16 of the APE message header
  uint16_t PayloadCRC16; // CRC16 of Payload, excluding
                         //   HeaderCRC16 and PayloadCRC16
  uint16_t PacketNum;    // Packet Number, in the form of:
                         //   0x0000: Start (BOF)
                         //   0xfffe: End (EOF)
                         //   0xffff: Abort
                         //   0x0001-0xfffd: Packet Number
    uint16_t PayloadType // Payload Type but PLC always uses binary
                         // (0x01) regardless of value
```

2.4.4.2 Upload Firmware Image Reply

Upload_Firmware_Flash reply message – Packet Number equal to zero

```
MSG_TYP = 0x99;
MSG_ORG = ‘0’;  // originated from PLC
MSG_RPY = ‘1’;  // end of message sequence
MSG_BDY =
  uint16_t payload_length  // length of the message including crc’s
  uint16_t HeaderCRC16;    // CRC16 of the host message header and PacketNum
  uint16_t PayloadCRC16;   // CRC16 of Payload, excluding
                           //   HeaderCRC16 and PayloadCRC16
  uint16_t PacketNum;      // Packet Number or request
  uint16_t Status;         // Status = 0 for good request, see codes below

  uint16_t NumberOfBlocks  // Number of packets to upload
  uint16_t Block_Size      // Size of the packets, the last packet may be
                           // smaller
  Uint32_t NumberOfWords   // Image size to upload in words
```

Upload_Firmware_Flash reply message – Packet Number greater than zero

```
MSG_TYP = 0x99;
MSG_ORG = ‘0’;  // originated from PLC
MSG_RPY = ‘1’;  // end of message sequence
MSG_BDY =
  uint16_t payload_length  // length of the message including crc’s
  uint16_t HeaderCRC16;    // CRC16 of the host message header and PacketNum
  uint16_t PayloadCRC16;   // CRC16 of Payload, excluding
                           //   HeaderCRC16 and PayloadCRC16
  uint16_t PacketNum;      // Packet Number or request
  uint16_t Status;         // Status = 0 for good request, see codes below
  uint32_t Address;        // Starting address of data block
  uint16_t Length;         // Length of data block
  uint8_t  Data;           // image data
```

Possible status values are:

Status Code	Value	Comment	Action
SUCCESS	0	Success	Send next packet or other action depending on the current state of the firmware flash
ABORT	1	Abort Flash	If the action flash has not started then abort and do not send the flash packets. If the flash memory has been erased then the previous version of code would have to be sent to recover the modem.
BADCRC	2	Bad CRC	Resend the last packet
MISSING	3	Missing packet	A missing firmware packet was detected. Send this packet only.
ERASE_PENDING	4	The flash erase process has started	No action, status message only
ERASE_COMPLETE	5	Flash erase complete	No action, status message only. The modem will not begin saving the flash data in memory until this state has been reported.
UTILITY_MISSING	6	Flash utility missing	Abort the flash. The utility necessary for the modem to flash itself was not found and the modem can not be flashed.
NOT_SUPPORTED_MSG	7	This message is not supported	DFU can not handle this message. It is also used as indication that device is in DFU mode
ERASE_ERROR	8	Has problem to erase Flash	
NO_PLC_IN_FLASH	9	Valid PLC firmware is not detected in Flash	You can not upload the PLC firmware
LAST_PLC_RECORD	10	This is last PLC record from Flash	After receiving this packet, you should not send Flash Upload message to DFU
OUT_RANGE	11	Block number is out of range	Block number is out of valid range

3.0 References

4.0 Appendix

4.1 Message Status Code Definitions

Message status error codes.

Status Code	Value	Comments
OK	0x0000	Message request success
GENERAL ERROR CODES	0x0xxx	General Message Error Codes
INVALID_PARAMETER	0x0002	Invalid message parameter(s)
FEATURE_UNSUPPORTED	0x0003	Feature is not supported
PAYLOAD_CRC_ERROR	0x0004	Payload CRC error
NO_EEPROM	0x0005	No EEPROM on the device
HEADER_CRC_ERROR	0x0006	Message Header CRC error
INVALID_HANDLE	0x0007	The handle is invalid
INVALID_FORMAT	0x0008	The message format is incorrect
RPY_NOT_BLOCKED	0x000a	An RPY unblock msg (see DATA_TRANSFER) was recv'd but not currently blocked.
INVALID_MESSAGE_LENGTH	0x000b	The message length is invali
ERR_NO_HANDLER	0x00f3	No handler for the message type
PENDING	0x00fc	The operation is pending
ERR_TIMEOUT	0x00fd	The operation timed-out
ERR_NO_MEMORY	0x00fe	Out of memory
GENERAL_FAILURE	0x00ff	General failure or error
PHY ERROR CODES	0x1xxx	PHY error codes
MAC ERROR CODES	0x2xxx	MAC error codes
CL ERROR CODES	0x3xxx	CL error codes
ECA ERROR CODES	0x4xxx	ECA error codes

Table 4 Message Status Code Definitions

4.2 CRC16 implementation

The Cyclic-Redundancy Check 16bit (CRC16) implementation is a polynomial of (x^16 + x^12 + x^5 + x^0) and is calculated with a seed value of 0 and is not inverted upon completion. A sample implementation is as follows:

```
static unsigned short crctable[256] = {
  0x0000, 0x1021, 0x2042, 0x3063, 0x4084, 0x50a5, 0x60c6, 0x70e7,
  0x8108, 0x9129, 0xa14a, 0xb16b, 0xc18c, 0xd1ad, 0xe1ce, 0xf1ef,
  0x1231, 0x0210, 0x3273, 0x2252, 0x52b5, 0x4294, 0x72f7, 0x62d6,
  0x9339, 0x8318, 0xb37b, 0xa35a, 0xd3bd, 0xc39c, 0xf3ff, 0xe3de,
  0x2462, 0x3443, 0x0420, 0x1401, 0x64e6, 0x74c7, 0x44a4, 0x5485,
  0xa56a, 0xb54b, 0x8528, 0x9509, 0xe5ee, 0xf5cf, 0xc5ac, 0xd58d,
  0x3653, 0x2672, 0x1611, 0x0630, 0x76d7, 0x66f6, 0x5695, 0x46b4,
  0xb75b, 0xa77a, 0x9719, 0x8738, 0xf7df, 0xe7fe, 0xd79d, 0xc7bc,
  0x48c4, 0x58e5, 0x6886, 0x78a7, 0x0840, 0x1861, 0x2802, 0x3823,
  0xc9cc, 0xd9ed, 0xe98e, 0xf9af, 0x8948, 0x9969, 0xa90a, 0xb92b,
  0x5af5, 0x4ad4, 0x7ab7, 0x6a96, 0x1a71, 0x0a50, 0x3a33, 0x2a12,
  0xdbfd, 0xcbdc, 0xfbbf, 0xeb9e, 0x9b79, 0x8b58, 0xbb3b, 0xab1a,
  0x6ca6, 0x7c87, 0x4ce4, 0x5cc5, 0x2c22, 0x3c03, 0x0c60, 0x1c41,
  0xedae, 0xfd8f, 0xcdec, 0xddcd, 0xad2a, 0xbd0b, 0x8d68, 0x9d49,
  0x7e97, 0x6eb6, 0x5ed5, 0x4ef4, 0x3e13, 0x2e32, 0x1e51, 0x0e70,
  0xff9f, 0xefbe, 0xdfdd, 0xcffc, 0xbf1b, 0xaf3a, 0x9f59, 0x8f78,
  0x9188, 0x81a9, 0xb1ca, 0xa1eb, 0xd10c, 0xc12d, 0xf14e, 0xe16f,
  0x1080, 0x00a1, 0x30c2, 0x20e3, 0x5004, 0x4025, 0x7046, 0x6067,
  0x83b9, 0x9398, 0xa3fb, 0xb3da, 0xc33d, 0xd31c, 0xe37f, 0xf35e,
  0x02b1, 0x1290, 0x22f3, 0x32d2, 0x4235, 0x5214, 0x6277, 0x7256,
  0xb5ea, 0xa5cb, 0x95a8, 0x8589, 0xf56e, 0xe54f, 0xd52c, 0xc50d,
  0x34e2, 0x24c3, 0x14a0, 0x0481, 0x7466, 0x6447, 0x5424, 0x4405,
  0xa7db, 0xb7fa, 0x8799, 0x97b8, 0xe75f, 0xf77e, 0xc71d, 0xd73c,
  0x26d3, 0x36f2, 0x0691, 0x16b0, 0x6657, 0x7676, 0x4615, 0x5634,
  0xd94c, 0xc96d, 0xf90e, 0xe92f, 0x99c8, 0x89e9, 0xb98a, 0xa9ab,
  0x5844, 0x4865, 0x7806, 0x6827, 0x18c0, 0x08e1, 0x3882, 0x28a3,
  0xcb7d, 0xdb5c, 0xeb3f, 0xfb1e, 0x8bf9, 0x9bd8, 0xabbb, 0xbb9a,
  0x4a75, 0x5a54, 0x6a37, 0x7a16, 0x0af1, 0x1ad0, 0x2ab3, 0x3a92,
  0xfd2e, 0xed0f, 0xdd6c, 0xcd4d, 0xbdaa, 0xad8b, 0x9de8, 0x8dc9,
  0x7c26, 0x6c07, 0x5c64, 0x4c45, 0x3ca2, 0x2c83, 0x1ce0, 0x0cc1,
  0xef1f, 0xff3e, 0xcf5d, 0xdf7c, 0xaf9b, 0xbfba, 0x8fd9, 0x9ff8,
  0x6e17, 0x7e36, 0x4e55, 0x5e74, 0x2e93, 0x3eb2, 0x0ed1, 0x1ef0
};

void CRC16_UpdateChecksum(unsigned short *pcrcvalue, const void *data, int length)
{
  unsigned short crc;
  const unsigned char *buf = (const unsigned char *) data;

  crc = *pcrcvalue;
  while (length--)
  {
    crc = (crc << 8) ^ crctable[(crc >> 8) ^ *buf++];
  }
  *pcrcvalue = crc;
}

unsigned short CRC16_BlockChecksum(const void *data, int length)
{
  unsigned short crc;

  crc = 0;
  CRC16_UpdateChecksum(&crc, data, length);
  return crc;
}
```

4.3 CRC 32 implementation

The Cyclic-Redundancy Check 32bit (CRC32) implementation is calculated with a seed value of 0 and is not inverted upon completion. A sample implementation is as follows:

```
static unsigned long crctable[256] =
{
0x00000000, 0x04C11DB7, 0x09823B6E, 0x0D4326D9, 0x130476DC, 0x17C56B6B, 0x1A864DB2, 0x1E475005,
0x2608EDB8, 0x22C9F00F, 0x2F8AD6D6, 0x2B4BCB61, 0x350C9B64, 0x31CD86D3, 0x3C8EA00A, 0x384FBDBD,
0x4C11DB70, 0x48D0C6C7, 0x4593E01E, 0x4152FDA9, 0x5F15ADAC, 0x5BD4B01B, 0x569796C2, 0x52568B75,
0x6A1936C8, 0x6ED82B7F, 0x639B0DA6, 0x675A1011, 0x791D4014, 0x7DDC5DA3, 0x709F7B7A, 0x745E66CD,
0x9823B6E0, 0x9CE2AB57, 0x91A18D8E, 0x95609039, 0x8B27C03C, 0x8FE6DD8B, 0x82A5FB52, 0x8664E6E5,
0xBE2B5B58, 0xBAEA46EF, 0xB7A96036, 0xB3687D81, 0xAD2F2D84, 0xA9EE3033, 0xA4AD16EA, 0xA06C0B5D,
0xD4326D90, 0xD0F37027, 0xDDB056FE, 0xD9714B49, 0xC7361B4C, 0xC3F706FB, 0xCEB42022, 0xCA753D95,
0xF23A8028, 0xF6FB9D9F, 0xFBB8BB46, 0xFF79A6F1, 0xE13EF6F4, 0xE5FFEB43, 0xE8BCCD9A, 0xEC7DD02D,
0x34867077, 0x30476DC0, 0x3D044B19, 0x39C556AE, 0x278206AB, 0x23431B1C, 0x2E003DC5, 0x2AC12072,
0x128E9DCF, 0x164F8078, 0x1B0CA6A1, 0x1FCDBB16, 0x018AEB13, 0x054BF6A4, 0x0808D07D, 0x0CC9CDCA,
0x7897AB07, 0x7C56B6B0, 0x71159069, 0x75D48DDE, 0x6B93DDDB, 0x6F52C06C, 0x6211E6B5, 0x66D0FB02,
0x5E9F46BF, 0x5A5E5B08, 0x571D7DD1, 0x53DC6066, 0x4D9B3063, 0x495A2DD4, 0x44190B0D, 0x40D816BA,
0xACA5C697, 0xA864DB20, 0xA527FDF9, 0xA1E6E04E, 0xBFA1B04B, 0xBB60ADFC, 0xB6238B25, 0xB2E29692,
0x8AAD2B2F, 0x8E6C3698, 0x832F1041, 0x87EE0DF6, 0x99A95DF3, 0x9D684044, 0x902B669D, 0x94EA7B2A,
0xE0B41DE7, 0xE4750050, 0xE9362689, 0xEDF73B3E, 0xF3B06B3B, 0xF771768C, 0xFA325055, 0xFEF34DE2,
0xC6BCF05F, 0xC27DEDE8, 0xCF3ECB31, 0xCBFFD686, 0xD5B88683, 0xD1799B34, 0xDC3ABDED, 0xD8FBA05A,
0x690CE0EE, 0x6DCDFD59, 0x608EDB80, 0x644FC637, 0x7A089632, 0x7EC98B85, 0x738AAD5C, 0x774BB0EB,
0x4F040D56, 0x4BC510E1, 0x46863638, 0x42472B8F, 0x5C007B8A, 0x58C1663D, 0x558240E4, 0x51435D53,
0x251D3B9E, 0x21DC2629, 0x2C9F00F0, 0x285E1D47, 0x36194D42, 0x32D850F5, 0x3F9B762C, 0x3B5A6B9B,
0x0315D626, 0x07D4CB91, 0x0A97ED48, 0x0E56F0FF, 0x1011A0FA, 0x14D0BD4D, 0x19939B94, 0x1D528623,
0xF12F560E, 0xF5EE4BB9, 0xF8AD6D60, 0xFC6C70D7, 0xE22B20D2, 0xE6EA3D65, 0xEBA91BBC, 0xEF68060B,
0xD727BBB6, 0xD3E6A601, 0xDEA580D8, 0xDA649D6F, 0xC423CD6A, 0xC0E2D0DD, 0xCDA1F604, 0xC960EBB3,
0xBD3E8D7E, 0xB9FF90C9, 0xB4BCB610, 0xB07DABA7, 0xAE3AFBA2, 0xAAFBE615, 0xA7B8C0CC, 0xA379DD7B,
0x9B3660C6, 0x9FF77D71, 0x92B45BA8, 0x9675461F, 0x8832161A, 0x8CF30BAD, 0x81B02D74, 0x857130C3,
0x5D8A9099, 0x594B8D2E, 0x5408ABF7, 0x50C9B640, 0x4E8EE645, 0x4A4FFBF2, 0x470CDD2B, 0x43CDC09C,
0x7B827D21, 0x7F436096, 0x7200464F, 0x76C15BF8, 0x68860BFD, 0x6C47164A, 0x61043093, 0x65C52D24,
0x119B4BE9, 0x155A565E, 0x18197087, 0x1CD86D30, 0x029F3D35, 0x065E2082, 0x0B1D065B, 0x0FDC1BEC,
0x3793A651, 0x3352BBE6, 0x3E119D3F, 0x3AD08088, 0x2497D08D, 0x2056CD3A, 0x2D15EBE3, 0x29D4F654,
0xC5A92679, 0xC1683BCE, 0xCC2B1D17, 0xC8EA00A0, 0xD6AD50A5, 0xD26C4D12, 0xDF2F6BCB, 0xDBEE767C,
0xE3A1CBC1, 0xE760D676, 0xEA23F0AF, 0xEEE2ED18, 0xF0A5BD1D, 0xF464A0AA, 0xF9278673, 0xFDE69BC4,
0x89B8FD09, 0x8D79E0BE, 0x803AC667, 0x84FBDBD0, 0x9ABC8BD5, 0x9E7D9662, 0x933EB0BB, 0x97FFAD0C,
0xAFB010B1, 0xAB710D06, 0xA6322BDF, 0xA2F33668, 0xBCB4666D, 0xB8757BDA, 0xB5365D03, 0xB1F740B4,
};

/// <summary>
/// Calculates the checksum of the input data array.
/// </summary>
/// <param name="data">The input data array.</param>
/// <param name="length">The length of the data array.</param>
/// <returns>Returns the CRC32 value</returns>
/// <remarks></remarks>
public static UInt32 CalculateChecksum(byte[] data, int length)
{
   UInt32 crc = CRC32_INIT_VALUE;  // equals zero
   for (int index = 0; index < length; index++)
   {
      crc = getCRC32_byte(crc, data[index]);
   }
   return crc;
}
```

```
/// <summary>
/// Calculates the CRC32 from the input byte.
/// </summary>
/// <param name="input_crc32_accum">The input_crc32_accum.</param>
/// <param name="data">The data.</param>
/// <returns>Returns the crc value</returns>
/// <remarks></remarks>
public static UInt32 getCRC32_byte(UInt32 input_crc32_accum, byte data)
{
   UInt32 i;
   UInt32 crc32_accum;

   crc32_accum = input_crc32_accum;
   i = ( crc32_accum >> 24 ) ^ ((data));
   crc32_accum = (crc32_accum << 8) ^ crctable[i];

   return crc32_accum;
}
```