Eaton Corporation

X-format Communications Protocol (XCP) Specification

Revision C1 - Public

Connectivity Systems Group

Last updated 13-Feb-09

Revision History

Rev	Date	Who	Description of Changes
A	12/10/98	TJB	Initial release created from BCM Spec. revision AE
A1	7/12/99	DRL	Created special version for distribution outside the company
A2	7/12/99	DRL	This version based on rev A. Added preliminary support for Kilimanjaro, Summa and Aurora. Also added battery configuration details. Added Extended Limits Block extensions for Barracuda.
B	7/26/00	DRL, FT	Revised to support Cheetah, Deluxe, Luxury, Summa Manifold, IPDD, Kudzu and Axxium Tower. Reused meter numbers 54-56 for line to neutral bypass volts. Reused alarm number 157, added alarm numbers 208-218. Added description to status block to indicate how to use when outlet controls are available in the UPS. Removed definitions for Elemental Data blocks. Enhanced and modified Submodule Select command.
B1	08/13/01	BRY	Revised for release to COMPAQ.
C	11/16/01	TJB	Revisions for latest products: Summa, Akula, Cheetah, IPDD
			Added New alarms and Meters for Summa and Akula. Added IBVM data to Battery Data block, and Test 02 Battery Commissioning Test, 03 Test Alternate AC Input, 04 Flash the LEDs, and FF Report Capabilities to Request a Systems Test command. Many user-suggested text changes and other updates.
			Added section on S/D recommendations, removed Connector pinouts and other Physical Layer detail. Removed Custom Alarm cmds.
			Added Scratchpad, Set Power Strategy & Hawk Block Cmds.
			Removed "Interrupting Sequences for Unrequested Alarms" requirement.
			Added Table of Standard and Custom Parameters to Extended Limits block.
			Redrew figures for Min/Max Input limits, and added section relating limits to meters, with new Meters and Standard Params to aid in drawing.
			Created Appendices A (Non-standard cmds) and B (Private Test cmds).
			Next release should involve major restructuring of how this protocol is presented.
C1	02/13/09	BRY	Updated for public use. Updated corporate references.

Table of Contents

1   Introduction

1.1   History of Powerware communication protocols

In 1997, after the acquisition of IPM and Deltec/FPS, Powerware Corporation (formerly, Exide Electronics) was in a position where the corporation's UPS products were actively employing 4 different protocols:

- Binary Computer Mode (BCM) was used, at various revision levels, in the Powerware Prestige, Plus 6-36, Plus 80-500, and Series 6000/7000 UPS lines. The oldest implementation, for the AST 5, was begun in 1987. The Plus 6-36 and Series 6000/7000 also implemented Ascii Computer Mode (ACM) for modem transfer.

- FPS and Deltec UPSs used UPScode II in all their products having serial communication. This protocol was first used in 19__.

- Deltec added a binary extension to UPScode II, mainly for load shedding control. This was first used in the PowerRite Max series in 1996.

- The IPM products used "P" records for serial communication, starting in 1991; this protocol was similar to Motorola S-records.

- The Best Products UPSs used a variety of similar protocols, which were unified under the Best Power Common Protocol (BPCP) driver.

By 1997, there was a widespread recognition that Powerware needed to offer UPS, adapter, and software products that correctly interoperate with each other. It was determined that one of the keys to this was to develop one standard for communication to and from all Powerware UPSs. This document describes that protocol, which has survived into UPS products designed and built with the Eaton Corporation name on them.

1.2   Goal of this document

"To describe a standard serial communications protocol for Powerware-branded UPSs from Eaton Corporation and its subsidiaries"

1.3   Scope of this standard

This standard covers the following areas:

Protocol Transport
This standard specifies:
- the details of Binary and ASCII communication packets: headers, length specifiers, and checksums
- minimum/maximum response timing for all communications
- specify the protocol to be used for modem connections

Operation
This standard specifies:
- reliable, standard means for discovering the UPS and learning its capabilities
- mechanism for validating control commands
- response to all commands
- details of an unrequested data mode
- compatibility with Microsoft Plug-n-Play
- interaction with user or printer terminal modes

Data blocks
This standard specifies:

- standard blocks for identification, configuration, meters, status, alarms, events, history, statistics, battery,
- UPS topology, and alarm action levels
- non-standard blocks for waveform or parallel configuration data extensions.

Control and Configuration Commands

This standard specifies:
- commands for turning the UPS or outlets On and Off, with delays
- commands for setting other UPS modes
- commands for setting configuration parameters
- means of directing commands for multiple modules
- Some, but only some, of the complex behaviors for On / Off control are addressed here; other aspects are addressed in other UPS behavior documents.

Implementation Details

This standard specifies:
- which requirements must be implemented in UPSs
- means of customizing messages for OEMs and foreign languages
- guides for UPS and software developers

This Serial Communications Specification will <u>not</u> address features or requirements of
- Hardware requirements are now addressed in a separate document
- Communication Software
- the protocol used for network packets

1.4   Other documents

Refer to the following documents for supplemental information regarding this specification:

Document Title	Location / Source / Filename
EIA RS-232-C: Interface between DTE and DCE Equipment	Electronic Industries Association
EIA/TIA -562: Electrical Characteristics for an Unbalanced Digital Interface	Electronic Industries Association
EIA/TIA-574: 9 Position Non-Synchronous Interface between DTE and DCE Equipment	Electronic Industries Association
Plug and Play External COM Device Specification	http://www.microsoft.com/hwdev/download/respec/pnpcom.rtf
Binary Computer Mode Serial Communications Software Functional Specification, Rev AE (164-196-009)	SWLAB_FS2:\ SYS\ SW\BCMSPEC\BINCSPAE\ BCMAE_V1.DOC
Concept for the UPScode II Serial Interface Protocol	1002889F.DOC
X-Slot definition	05146437
XCP-compatible DB9 Specification	164700346
15-pin Relay Connector Specification	TBD
Outlet Control Behaviors	XCPOutProp5.xls and Outlet_Control_Logic_C.doc
SubModule Select Routing	SelectSub2.doc

2   Hardware Requirements

Editor's Note: This whole section to be removed, as it is covered in other documents now.
Refer to documents:
    164700346: XCP-compatible DB9 Specification
    05146437: X-Slot Specification document

    TBD: 15-pin Relay Connector Specification

3 Protocol Transport specifications

3.1 Performance and timing

1. For reliable communication with UPSs with limited CPUs, communication software must be able to implement a SendCommand->WaitForResponse->SendCommand sequence: after sending a command, a host must be able to wait for the UPS response to be completed before sending the next command.

2. The following table lists the timing constraints for both the Direct- and Modem-based serial connections. These timings are independent of baud rate for the range of 1200-19200 baud. The table indicates whether it is the UPS or the connected "host" who is responsible for keeping this timing. For reference, one character at 1200 baud is transmitted in about 8.3 ms.

3. There is a reliability requirement for serial data of no greater than 0.1% loss in receiving commands or sending valid response sequences. This does not include additional losses that may be due to the host software or its software operating environment.

Timing Parameter	Responsible	Min	Max
Delay before beginning to Send Response. This does not apply to routing commands and encapsulated packets. Refer to the XCP Routing Spec for additional information.	UPS		2 sec
Inter-character Delay	Both		0.25 sec
Inter-sequence Delay	UPS		0.5 sec
Delay after sending control or authorization commands before sending next command	Host	0.25 sec	15 sec
Worst Case Delay before communicating an alarm condition	UPS		3 sec
Duration of command authorization, once sent (Authorizaion is cleared by first command that follows, whether data or control)	UPS		16 sec
Duration that UPS must stay in communication mode after last received command (except Unrequested Mode)	UPS	30 sec	
Duration that UPS serial port must stay at 1200 baud after receiving PnP trigger (unless commanded to change by software)	UPS	30 sec	

3.2 Direct serial connections

3.2.1 Direct Serial Basics

1. Most commands generate a response from the UPS; the (few) exceptions are carefully noted as such.
2. Hardware handshaking may be used, but is not required by this protocol and may not be implemented by UPSs or communication devices.
3. Software handshaking (XON/XOFF) may NOT be used, as these are common values for binary data.
4. Each command must be sent in a separate packet (Header, command, checksum); there cannot be more than one command in a packet.
5. There will be one response to one command or request (not multiple different data blocks in response to a command); as indicated in Response Format, one response may be made up of multiple sequences.

3.2.2 Direct Serial Command Format

All commands (control commands, data requests, and the authorization block) are formatted as follows:

	Header		Data		Checksum
# Bytes:	1	1	nnn		1
	SFD	LEN	CMD	PARAM	CSUM
Example:	0xAB	0x03	0x8A	0x2C	0x01	0x9B

SFD (Start Frame Delimiter): 10101011 = 0xAB
LEN (Size): number of bytes (nnn) in the DATA field (excluding header and checksum bytes)
CMD: first byte is the control code, which tells which command is being requested.
PARAM: optional data field containing additional bytes of information for the command
CSUM: Two's complement checksum of preceding bytes, including the SFD and Size bytes.

The 8-bit sum of all bytes, including the Checksum, is non-zero if the packet contents have been corrupted. A zero sum indicates that the contents *probably* haven't been corrupted.

3.2.3 Direct Serial Response Format

The response packet sent back to the host from the UPS is formatted as follows:

	Header				Data				Checksum
# Bytes:	1	1	1	1	nnn				1
	SFD	BLOCK #	LEN	SEQ	DATA				CSUM
Example:	0xAB	0x09	0x04	0x81	0x31	0x8A	0x2C	0x01	0xDF

SFD (Start Frame Delimiter): 10101011 = 0xAB

BLOCK #: byte value that indicates which data block is being sent. It normally equals the data block request value (e.g., 0x31) less 0x30 (e.g., 0x01). The command response block value is 0x09 for almost all non-data (control) commands.

LEN (Size): number of bytes (nnn) in the DATA field (excluding header and checksum bytes). Maximum LEN value is 121 in one sequence; minimum is 1 byte.

SEQuence: byte value giving the sequence number of this packet in relation to transmission of an entire block. These packets are numbered in ascending order with the first one being 0x01. If a packet is the last one in a sequence, then the high order bit of this field (0x80) will be set in addition to the final sequence number.

DATA: the data bytes

CSUM: Two's complement 8-bit checksum of preceding bytes, includes the SFD through DATA   bytes.

Multiple packets: If the data to be sent in response to the data block request exceeds 121 bytes, or if limited resources in the UPS necessitate sending less than 121 bytes per packet, then the data block response is divided into sequences (packets) of data. UPS implementers should attempt to maximize the number of bytes in a data packet in order to maximize the data throughput. The packets which make up the response are sent one after the other until all have been sent, and only then can the next command be processed.

The SEQuence numbering for a 3-sequence response would be: 0x01, 0x02, 0x83.

The SEQuence number for a single packet response would be 0x81.

Note for UPS developers: There is a way to maximize the number of bytes per sequence even in devices with small (eg, 16 byte) transmit buffers. Try to pack as many bytes, up to 121, as can fit in each sequence, because it's inefficient to send 4-16 bytes with their own header and checksum; for example, with 4 bytes of data:

          <AB 05 04 01 (data) Csum> -- the 5 bytes of overhead are 56% of each sequence.

To maximize throughput, an effective strategy for small buffers is to transmit a block of data like this:

          Transmit: AB 05 70 81

          Transmit: data

          Transmit: more data

          Transmit: yet more data

          Transmit: last data and checksum,

where the device has kept a running checksum as it has been sending.

3.3 Modem-based serial connections: ASCII Computer Mode (ACM)

When communicating UPS data via modem, it is necessary to encode the binary data into a limited set of ASCII characters to prevent:

- Inadvertently sending a character sequence which could be interpreted as requesting that the modem go into command mode.
- Inadvertently putting the modem into test mode or altering its defaults, if the modem were to hang up due to external circumstances.

3.3.1 Modem Serial Basics

1. The same set of commands and responses are used as for Direct serial connections.
2. Each binary byte is encoded into two ASCII characters by dividing it into two 4-bit nibbles, and adding 0x30 to each 0-9 nibble or 0x37 to each A-F nibble. Thus, a binary 0xA5 becomes ASCII 0x41, 0x35 (printable characters "A5"). This ASCII encoding only applies to XCP commands and responses, and not to other UPS menu, configuration or status "screens".
3. An optional <CR><LF> sequence may be sent after the checksum.
4. For modem-based serial connections, a different, password-based mechanism is used for authorizing control commands; see the section on Command Authorization.

3.3.2 Modem Serial Command and Response Format

The set of commands and responses is the same as for Direct serial connections; the following example illustrates the ASCII encoding of a binary command:

# Bytes:	1	1	nnn			1
	SFD	LEN	DATA			CSUM
Example:	0xAB	0x03	0x8A	0x2C	0x01	0x9B

# Bytes:	2		2		2x nnn						2	
	SFD		LEN		DATA						CSUM	
Example:	0x41	0x42	0x30	0x33	0x38	0x41	0x32	0x43	0x30	0x31	0x39	0x42

3.4 Byte Ordering

Unless indicated otherwise, the order of

- Integers and Longs is LSB first
- Strings is left-most character first (normal order)

3.5   Data and Map Formats

Several data formats are supported for the Meters and Statistics blocks; the format used for each meter is indicated by the value of its non-zero map byte.

Type: **Floating Point**   Map Value: 0x*WR*   Example: 0x51

> For a floating-point meter, the byte in the Meter Map *suggests* how to display the meter value.
>
> The map byte is a packed Binary Coded Decimal (BCD) value. The upper nibble, '*W*', of the BCD value gives the number of places recommended to display the meter data at its maximum value. This includes the decimal point. For example, if the maximum value were '100.0' then the upper nibble would be a 5. The lower nibble, '*R*', informs you of how many digits are intended to be shown to the right of the decimal point. In the case above, the lower nibble would be 1, giving a BCD value of 0x51 for the Meter Map entry.
>
> The maximum value permitted for floating point map values is 0x97. The lower nibble 'R' must not exceed (the value of the upper nibble) 'W' - 2, to allow for the "0." prefix.
>
> Data format for floating point meters:

The meter values are expressed in 32-bit IEEE-754 floating-point format. Following the LSB first convention, a value of 3.141592654 decimal = 0x40490FDB (hex float), and the transmission sequence is DB 0F 49 40.

Type: **Fixed Point Integer**   Map Value: 0xF*n*   Example: 0xF0

If the meter value is a 32 bit signed integer, then the map byte value would be 0xFn (which is an invalid BCD number). For whole-valued integers, the map byte value is ordinarily 0xF0. If the lower nibble value, n, is non-zero, then it indicates a fixed-point format, and n is the number of bits in the value after the decimal. A common example would be to have a 24.8 format, with a map byte of 0xF8; e.g., a meter value of 0x00003BC0 would correspond to 59.75   To convert the reading to real units, divide the reading by 2^n; for the example above, 0x00003BC0 / 2^8 = 59.75

Type: **Seconds**   Map Value: 0xE2   Example: 0xE2

If the units of a meter are time in Seconds (e.g., Meter 36, Battery Time Remaining), then the map byte is specified as 0xE2. 0xE2 is preferred for new implementations, but 0xF0 may be found in older implementations.

3.5.1   Date Format for Meters

Type: **Date**   Map Value: 0xE0   Example: 0xE0
If a Date meter (e.g., Meter 73) is used, then it should be specified as 0xE0 in the Meter Map.

Data format for Date Meters:
This is a 32-bit representation of the date. It may be either Year:Month:Day format or Year:Julian Date format. The Month:Day format uses values 1-12 for month and 1-31 for day. The Julian Date format uses the same two bytes for the number of days from the beginning of the year (February 1st is Julian Day 32); the range is 1-366. Byte 0 is transmitted first for these meters. The form and its fields are as follows:

Byte Number	0	1	2	3
Fields	DD	MM	YY	FCC

> **F**: The MSBit is a one-bit field containing a flag. Bit cleared = Julian Date Format.
> Bit set = Month:Day Format.

CC YY: This is the value of the year. Values range from 1900-7999. This is a packed BCD value.

MM: If in Month:Day format, this is the month; values range from 1-12. If in Julian Date format, this is the upper (most significant) byte of the days. This is a packed BCD value.

DD: If in Month:Day format, this is the number of days; values range from 1-31. If in Julian Date format, this is the lower (least significant) byte of the days. This is a packed BCD value.

Note that for XCP Commands and the Status block delays, the Date and Time byte orders are the reverse of the order shown here for Meter formats.

3.5.2   Time Format for Meters

Type: **Time**   Map Value: 0xE1   Example: 0xE1
If a Time variable (e.g., Meter 74) is used, then it should be specified as 0xE1 in the Meter Map.

Data format for Time Meters:
This is a 32-bit representation of time. Byte 0 is transmitted first for these meters. The format is as follows:

Byte Number	0	1	2	3
Fields	CC	SS	MM	HH

HH: Hours, values range from 0-23. This is a packed BCD value.

MM: Minutes, values range from 0-59. This is a packed BCD value.

SS: Seconds, values range from 0-59. This is a packed BCD value.

CC: Hundredths of seconds, values range from 0-99. This is a packed BCD value.

Note that for XCP Commands and the Status block delays, the Date and Time byte orders are the reverse of the order shown here for Meters.

4 Operational Requirements

4.1 UPS Discovery

A fast, reliable means of "discovering" that an Powerware UPS is serially connected is essential to minimize communication software overhead and customer frustration. Either (preferably both) of the following methods MUST be implemented in both the UPS and software products to achieve this goal (refer to the Timing table):

4.1.1 Discovery with MS Plug-n-Play

This is the preferred method for discovery, if only one is implemented.

Microsoft's PnP spec calls for a desktop device to respond with fixed binary data at 1200 baud with 7-bit format after the DTR line is pulsed low for 200 ms (+/- 35 ms) and then raised for 200 ms and held. (The RTS and DSR lines are also involved but are not critical for detecting PnP stimulus; see the PnP spec. However, if you want your UPS to be detected by a Microsoft PnP operating system like Windows 98 or Windows 2000, then you must implement and assert DSR). The UPS must enter communication mode after this for a period, and the software can connect at 1200 baud.

Step	Host Software	UPS
1)	Start PnP event (DTR low 200 ms, then high 200 ms)	
2)		UPS changes to 1200 baud, 7 bits, and sends PnP string . UPS then stays at 1200 baud, but using 8-bit format.
3)	(Host may ignore PnP string) Host requests Comm Capabilities block from UPS	
4)		UPS responds with Comm Capabilities block
5)	Host changes to desired baud rate (usually the highest supported baud rate) with Set Comm Parameter cmd	
6)		UPS responds with ACK block at 1200 baud, then changes to requested baud rate.
7)	Host sends "Set Unrequested Mode" or "Set Requested Mode Only" command	
8)		UPS responds with Identification block
9)	Proceed to Identification and Capabilities	

Exception Handling:

1. After 30 seconds (minimum), if there is no communication from the host at 1200 baud, the UPS will revert to its configured baud rate and mode.

2. If the UPS does not send the PnP string or respond to the serial Set Mode command within the 0.5 second timeout period, the host should then try the Discovery with Baud Hunting.

3. If the UPS cannot support 7-bit mode when transmitting the PnP message, it can achieve an equivalent result in 8-bit mode if it sets the MSbit to 1 before transmitting. This appears to the host as 7-bit data with 2 Stop bits, which is not a problem.

4. If the UPS does not ACK the Set Comm Param command (to change the baud rate), then both the UPS and host stay at 1200 baud for futher XCP communication.

5. If the UPS does not support the Send Comm Capabilities data block (command 0x42), the host software should continue to communicate at 1200 baud.

4.1.2 Discovery with Baud Hunting
This is the "classic" method for discovery.

The host tries to connect at a series of baud rates, and assumes that the UPS may be in a terminal or printer mode which must be exited first.

Step	Host Software	UPS
1)	(Host starts at its preferred or configured baud rate.)	
2)	Host sends the Menu Backout Character (ESC), in case the UPS is down in a menu mode, at the current baud rate. Wait 80-100 ms.	(UPS may respond with text, e.g., a higher level menu)
3)	Host sends the Authorization block (necessary for some older UPSs, and good for synchronizing XCP receive engines)	(No response from UPS)
4)	After a 0.5 sec pause, Host sends "Set Unrequested Mode" or "Set Requested Mode Only" command	
5)		UPS responds with Identification block and enters Communication mode
6)	Proceed to Identification and Capabilities	

Exception Handling:

1. If the UPS does not respond to the serial Set Requested / Unrequested Mode command within the 0.5 second timeout period, the host should then choose the next baud rate to attempt, and go back to step 2). The host should continue to cycle through the baud rates until it establishes a connection at one of them.

4.2   Identification and Capabilities of the UPS

Following Discovery of the UPS, the host must determine which UPS model it is and what its data and control capabilities are. The following method achieves that:

Step	Host Software	UPS
1)	Host processes the identification block returned in response to the "Set Requested/Unrequested Mode" command	
2)	Host sends the Command List data request.	UPS responds with Command List data.
3)	If the UPS implements the Communication Capabilities data block, the host requests it.	UPS responds with Communication Capabilities.
4)	If the host desires a different baud rate, it sends the Set Comm Parameter command.	UPS responds with a command acknowledgement at the current baud rate.
5)	Host switches to the new baud rate.	UPS switches to the new baud rate, and sets it as the default for communications.
6)	Host requests other blocks with capabilities and configuration information.	
7)	Host sends configuration and control commands with the "tell capabilities" value set (-1) to learn which parameters can be set.	UPS responds with ACK or other block indicating capabilities.

Exception Handling:

1. Older UPSs (before BCM rev AE) did not implement the Command List data block. Host must then try and wait for NACK or timeout to see if commands are implemented.

2. If the Command List is not implemented, then none of the commands added in BCM rev AE or new to this Comm Spec have been implemented. See the Command Summary in Appendix A.

3. The Host Software normally should complete steps 3-5 during the Discovery phase, and does not need to repeat them in this phase.

4.3 Authorization of Commands

There are two methods to "authorize" control commands, depending upon whether the host is directly serially connected or connected via a modem. In the first case, the Standard Auth Block is sent to provide an extra measure of protection against line noise.

All commands 0x80 or greater are considered "Control commands" and must be preceded by an Authorization command. The few exceptions to this rule are the
- Set Requested-Only or Unrequested Mode commands (0xA0 and A1)
- Select SubModule Command (0xCE)
- Authorization Code (0xCF) itself

Since the WAN connection might permit an unauthorized entry, control and configuration commands must be preceded by a Password Block. This 6-character (fixed length) password must be stored in the UPS.

The host must wait for at least 0.25 seconds after sending the authorization before sending the control command (see Timing). See the Command Summary for a list of which commands require authorization.

The control authorization will expire when any valid command (control or data) is received, or after 16 seconds.

4.3.1 Standard Authorization Block

The standard authorization code ("Auth Block"), used only for directly serially connected UPSs, is exactly as follows:

SFD	Size	(Code)	DATA			CSUM
0xAB	0x04	0xCF	0x69	0xE8	0xD5	0x5C

The 3 additional bytes following "CF" CMD byte provide additional code authentication.

4.3.2 Password Authorization

The password authorization code is always used for modem connected UPSs but may be used in general where higher security is desired. It is as follows:

SFD	Size	(Code)	Password						CSUM
0xAB	0x07	0xCF	PW1	PW2	PW3	PW4	PW5	PW6	XX

The 6 additional bytes following "CF" are a password. Note that all 6 bytes MUST be present.
The password is case sensitive; all printable ASCII characters are legal.
A UPS may implement several password authorization levels, with different passwords for each level. The subsequent command is only authorized at the authorization level given by the password.

4.4   Response to Commands

The response to all data request commands (0x30 to 0x5F) is the requested data block; these are described in the next chapter. However, there is a data block reserved to serve as the response to control and configuration commands: the Command Acknowledge Block ("ACK block").

Each data block response in this document is described with the following format:

1. Requesting Command: the command byte or bytes used to request the data block
2. Structure of Data Response: the structure of the response data, without the header and checksum, and independent of the means of dividing the block into multiple sequences
3. Additional Field Descriptions: optional, for those fields which require a longer explanation
4. Exceptions: Notes on known variations in UPS implementations
5. Example(s): Optional example(s) of simple responses

4.4.1   Command Acknowledge Block

Purpose:

To positively indicate whether the command was received and accepted.

Requesting Command:

This block is returned in response to:

- Any control command (except the authorization blocks, standard or password, and the "Set Unrequested / Requested Only Mode" commands)
- Any configuration setting command
- Any data request command which cannot be carried out

Structure of Data Response:

Bytes	Name	Description / Values
1	ACK Value	Indicates whether the command was accepted, or why it was rejected. ACK Values are listed below.
LEN -1	Command Echo	These bytes are a copy of the data field (command code byte plus any additional data bytes) of the command being acknowledged.

Additional Field Descriptions:

The ACK Values are:

ACK	Response	Description	
0x31	Accepted	Accepted and executed (or execution in progress)	
0x32	Not Implemented	Recognized but not implemented	
0x33	Busy	Recognized but not currently able to execute (busy)	
0x34	Unrecognized	Unrecognized -- e.g., command byte not in valid range, or command has been corrupted (bad checksum)	
0x35	Parameter out of range	Command recognized, but its Parameter value is out of range	
0x36	Parameter invalid	Command recognized, but its Parameter is invalid (e.g., no such parameter, bad Outlet number)	
0x37	Accepted with parameter adjusted	Accepted, with parameter adjusted to nearest good value	

The "Parameter out of range" response reflects an unacceptable *value* in the command; the "Parameter invalid" response occurs when a secondary command byte (Parameter number), which is *not the value* portion of the command, is invalid.

Exceptions: UPSs with BCM rev W or earlier do not implement the ACK block.

Example(s):
Accepted: If the command sent to the UPS was

	Header		Data		Checksum
# Bytes:	1	1	nnn		1
	SFD	LEN	CMD	PARAM	CSUM
Example:	0xAB	0x03	0x8A	0x2C	0x01	0x9B

Then the response block, if the command was Accepted, would be (again, ignoring the header and checksum bytes):

	Header				Data			Checksum
# Bytes:	1	1	1	1	nnn			1
	SFD	BLK #	LEN	SEQ	DATA			CSUM
Example:	0xAB	0x09	0x04	0x81	0x31	0x8A	0x2C	0x01	0xDF

Example(s) (continued):

Parameter out of range: Returned if set Low Batt Minutes Remaining to 180, when the UPS only supports it to 10 minutes max.

Parameter invalid: Returned if set Horn status to 5 (only 0, 1, or 2 are valid).

Accepted with parameter adjusted: Returned if set Low Batt Minutes to 8, but the UPS decides to set it to 5 (the closest valid value when the only choices are 2 and 5).

4.4.2   Commands with No Responses
There is a response to almost all commands, either a data block or the ACK response shown in the last section. However, there are a few cases where there is no response to a command:

- Authorization Command: There is no response to an Auth command.

- Control command without valid Authorization: If a control command is sent which was not immediately preceded by an Authorization command, then there is no response to the command.

- Bad Checksum or Timeout: if a command has a bad checksum, or missing byte(s) so that it times out, no response is returned from the UPS. Note that if one byte is missing from a command, that the SFD byte of the following command may be taken as the last byte of the first command (which should have been the checksum byte), so both commands may be lost. However, in a good implementation of the UPS XCP Engine, the command will timeout and the XCP engine will be reset to Looking for SFD before the second command is sent.

4.5   Unrequested Data Output

One customer-requested shutdown software application has one "master" host connected to the UPS to send and receive serial data, and one or more "slave" hosts which can receive output from the UPS, but not send commands or requests to it. Unrequested Mode is required to ensure timely data updates for the slave hosts if the master host should become unavailable. In this mode:

- The UPS enters Unrequested mode when sent the "Set Unrequested Mode" command. It does not leave this mode until specifically commanded to do so with an "Exit XCP" or "Set Requested-Only Mode" command.
- Status and alarm information is provided every 30 seconds if there are no input requests from the master host.
- The status and alarms will also be sent whenever there is a change in status or alarms.
- Identification information must also be sent periodically, at least once every 2 minutes.
- It is recommended that the Meters block be sent every 30 seconds as well.
- It is recommended that the UPS be able to restart in Unrequested Mode if it was in this mode at the time of the last power down.

4.6   Compatibility with User Terminal and Printer modes

Some UPSs have a User Terminal and/or Printer mode. If one is implemented, the following requirements apply:

- The initial power-up mode must either be the Communication mode, a "printer" mode, or a neutral mode. The UPS should remember the last mode it was in and start in this mode.
- There is a standard character, <ESC> (0x1B), used to back out of the menus and exit the Terminal mode. This is required so that the Communication Software can reliably back out of the menus, in case the UPS was left in terminal mode.
- An Exit XCP command (0xFA) is used to exit the Communication mode and return to Terminal mode.
- Menu, Printer and Communication modes are exclusive; the UPS can only be in one at a time.
- There is a timeout option for Communication mode; may leave after no communication for 30 seconds (minimum) unless in Unrequested mode (see Timing).
- May make plain text service command requests while in Communication mode.
- If the Baud Rate is changed in Communication Mode, the new baud rate should be saved as the "Configured" Baud Rate

The following diagram illustrates the states for Printer, Menu, and Comm Spec modes, including the means of transition. The "Neutral" state may not exist as more than a transient, or it may be a stable state.

PowerUp

Menu Backout
Character
(ESC)

Neutral
Mode

Exit Comm
Mode Cmd

Go To Menu
Character

Configured for
-- OR --
Goto Cmd for
Comm Mode

Top Level
Menu Mode

Menu Backout
Character
(ESC)

Configured for
-- OR --
Goto Char for
Printer Mode

Exit Printer
Mode Char

Unrequested
Comm Mode

Next Level
Menu Mode

Printer
Mode

Exit Comm
Mode Cmd
-- OR --
30s Timeout

Unrequested
Mode

Requested
Only Mode

Plug n Play Event
(from any mode)

Normal
Comm Mode

The following diagram illustrates the states for Baud Rate, including the means of transition.
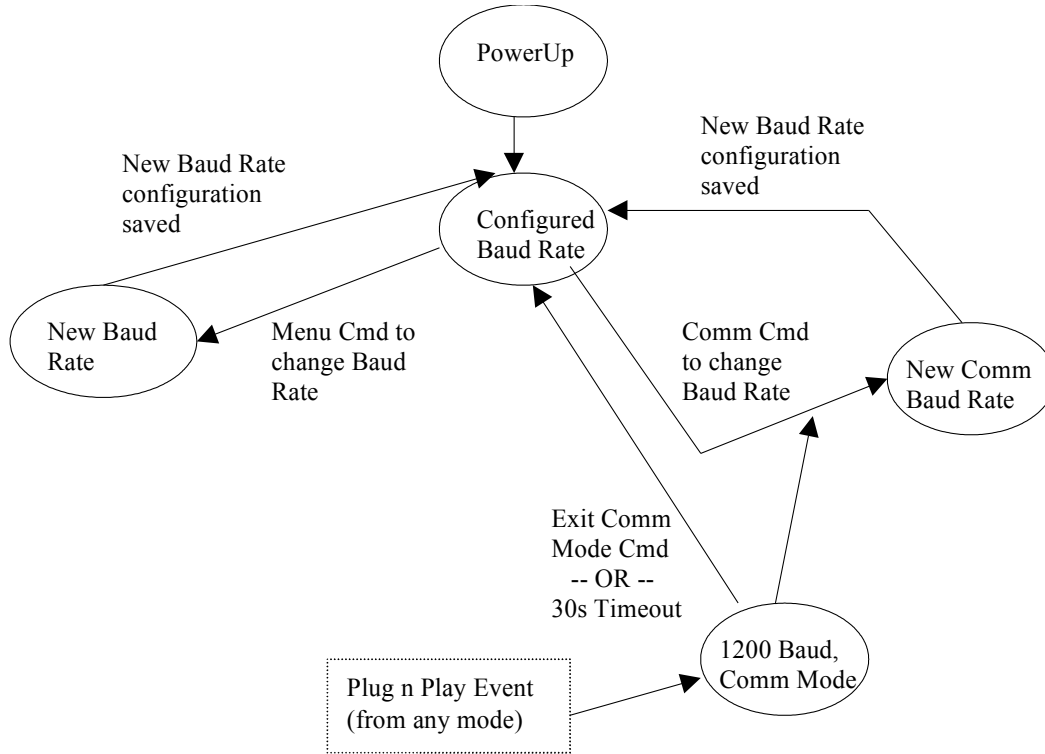
4.7   Plain-text Service Commands

While in Communication mode, some UPSs will implement commands that use human- readable input and output. This is an option for service personnel with minimal tools available (terminal program). The commands and responses will vary from model to model, and are thus not covered by this standard. They may be similar to the current UPScode commands and responses.

The binary UPS commands may be intermixed with the ASCII service commands while in Communication mode; that is, they don't require a separate mode.

5 Standard Data blocks

The requirements in this section are for the protocol overall; specific UPS models will not implement all these protocol items. The Command List block should indicate which data blocks have been implemented.

5.1 UPS Capabilities

The UPS will use the following data blocks to indicate its capabilities:

1. The Identification block in response to the "Set Unrequested / Requested-Only Mode" command.
2. The Command List block
3. The Communication Capabilities and Communication Port List blocks
4. The Config and Extended Limits blocks
5. Responses to configuration commands with the parameter field set to "Show Capabilities (0xFF)". The commands which do this (described in their sections below) are:
    - The Waveform Block request
    - The Set Config Parameters command
    - The Set Communications Parameter command
    - Request a Systems Test command
    - Set Scratchpad Sector command
    - Set Power Strategy Command

5.1.1 Command List Block

Purpose:

The Command List Block lists all the commands implemented in this UPS. This is valuable for communication software to help it quickly determine the communication and control capabilities of a UPS.

Requesting Command:

SFD	LEN	Cmd Byte	Csum		
0xAB	0x01	0x40	XX		

Structure of Data Response:

The block 0x10 response is:

Bytes	Name	Description / Values
1	NUM CMDS	The number of commands implemented listed in this block. Note that this will not include any private commands implemented.
1	ENTRY LEN	How many bytes reported below for each command; currently = 1
		Table of Commands, each containing:
1@	CMD BYTE	Binary code for each implemented command (see Command Summary)

Note: the value "1@" ("one apiece") means that there is one byte per entry/row in the block's table.
The total length of this block, including the first two bytes, is reported in the ID Block's field, "Size of the Command List block".

Additional Field Descriptions:

None

Exceptions:

UPS revisions prior to BCM rev AE do not implement this block.

Example(s):

5.1.2 Communication Capabilities Block
Purpose:

> The UPS can indicate what its communication capabilities are to the communication software, so the software can know what maximum baud rate is supported, what size commands to send, and what the maximum response size could be.

Some of these fields can be changed with the Set Communication Parameters command.

Requesting Command:

SFD	LEN	Cmd Byte	Comm Port	Csum		
0xAB	0x02	0x42	0, 1-n	XX		

For Comm Port, 0 = this port; other 1-n values indicate specific ports.

Structure of Data Response:
The block 0x12 response is:

Bytes	Name	Description / Values
1	Comm Port ID	Which Comm Port is reported; if the request was for 0 ("this" port), this response always indicates the correct port number. The first Comm Port ID = 1.
1	Num Bauds	Number of Baud Rates to follow
		Table of Supported Baud Rates
2@	BAUDn	Each supported baud rate is listed
1	Max Cmd Len	Maximum length command that can be received in the UPS input buffer, including header and checksum.
2	Max Resp Len	Largest data block response that the UPS can send (total data bytes)

Additional Field Descriptions:

Exceptions:
Added for new Comm Spec; not implemented in older UPSs
There may be only one baud rate supported on some UPSs

Example(s):

5.1.3 Communication Port List Block

Purpose:

The UPS can indicate how many communication ports it has, and then, for each, what the current baud rate and communication parameters are, what it is used for, and a list of outlets that are assigned to this port.
Some of these fields can be changed with the Set Communication Parameters command.

Requesting Command:

SFD	LEN	Cmd Byte	Csum		
0xAB	0x01	0x44	XX		

Structure of Data Response:

The block 0x14 response is:

Bytes	Name	Description / Values
1	Num Comm Ports	Number of Comm Ports described in this block, 1-n
1	"This" Comm Port ID	Which Comm Port is reporting this block.
		Table of Comm Ports, listing values for each Comm Port:
1@	Comm Port ID	ID for each Comm Port. The first Comm Port ID = 1.
2@	BAUDn	The current baud rate for this port
1@	Serial Config	Similar to that in the Config block; described below
1@	Port Usage	What this Comm Port is being used for: 0 = Unknown usage, No communication occurring. 1 = Undefined / Unknown communication occurring 2 = Waiting to communicate with a UPS 3 = Communication established with a UPS 4 = Waiting to communicate with software or adapter 5 = Communication established software (e.g., LanSafe) or adapter (e.g., ConnectUPS) 6 = Communicating with a Display Device 7 = Multi-drop Serial channel 8 = Communicating with an Outlet Controller
1@	Num Outlets	Number of Outlets "assigned to" (controlled by) this Comm Port
		Table of Assigned Outlets for this Comm Port
1@	Outletn	Each assigned Outlet is listed (1-64)

Additional Field Descriptions:

When an Outlet is "assigned" to a Comm Port with the Set Comm Parameter command, it means that when the UPS receives a Load Control command which does not contain the optional Outlet field, it should perform the action only on the assigned Outlets.
Under this protocol, Outlets do not have to be exclusively assigned to one Comm Port, though the UPS implementation could add this requirement.

Serial Configuration byte
This is similar to that in the [Comm Setup](#) of the Config block.

Bit	Field	Values
7	(Unused)	0
6	STOP BITS	0 = 1 stop bit 1 = 2 stop bits
5	SOFTWARE HANDSHAKE (XON/XOFF)	0 = Software Handshaking Disabled 1 = Software Handshaking Enabled
4	HARDWARE HANDSHAKE	0 = Hardware Handshaking Disabled 1 = Hardware Handshaking Enabled
3	DATA BITS	0 = 7 data bits 1 = 8 data bits
2-0	PARITY	000 = none 001 = odd 010 = even 011 = mark 100 = space

Exceptions:
Added for new Comm Spec; not implemented in older UPSs
The lengths of Comm Port entries will vary with the number of Outlets assigned, so this block must be carefully parsed.
If a UPS has only one (external) serial port, it is not required to implement this block.

Example(s):

5.1.4   Setting to Requested and Unrequested Modes

Purpose:

To put the UPS into XCP Requested-Only mode or XCP Unrequested mode, as described above in Unrequested Data.

Requesting Command: Send Only Requested Alarm & ID Blocks

SFD	LEN	Cmd Byte	Csum		
0xAB	0x01	0xA0	XX		

Requesting Command: Send Unrequested Alarm & ID Blocks

SFD	LEN	Cmd Byte	Csum		
0xAB	0x01	0xA1	XX		

Structure of Data Response:
The response to this command is the ID Block implemented by this UPS.

Additional Field Descriptions:

Exceptions:
On some UPSs, this command requires an Authorization block, so host software should always precede these commands with an Auth command. The UPS itself should not require the Auth command for these commands, however.
Some older UPSs will have no response to this command.

Example(s):

5.2   Identification and Configuration
The UPS must have a way of reporting its Identification and Configuration information, including:

- Model name (must not have Manufacturer in the text)
- VA rating
- "manufacturer"
- Serial and model or CTO numbers
- Customer-set identification string
- nominal input and output volts, amps, VA, power, and frequency
- Identification of submodules: version, name or part #

There are 3 blocks defined to do this; they are:

- Standard ID data block
- Configuration data block
- Extended Limits data block

The response to the Send Unrequested / Requested Only Mode commands is always to send the Identification block implemented in the UPS.

Some other blocks which describe relatively static information about the UPS are

- Communication Capabilities block
- UPS Topology block

5.2.1   Standard ID Block Request

Purpose:
To provide basic identification and capabilities information for this UPS.

Requesting Command:

SFD	LEN	Cmd Byte	Csum		
0xAB	0x01	0x31	XX		

Structure of Data Response:
The block 0x01 response is:

Bytes	Name	Description / Values
1	Num CPUs	The count of CPU version numbers which follows this byte
2@	CPU Versions	See below
1	KVA Rating	Two cases: 1) If non-zero, than this byte is the KVA rating of the UPS. In this case, there is no Extended VA Rating field. 2) If zero, then the next two bytes give the Extended VA Rating. This is the preferred implementation.
(2)	Extended VA Rating	If present (KVA rating field equals 0), then this field is the UPS VA rating divided by 50; e.g., a value of 0x000F would be for a 750 VA UPS.
1	Output Phases	This byte is the number of output phases for the unit.
1	Output Phase Angle	This byte provides the output phase angle, in degrees.
1	Message Length	This byte is the number of bytes (dml) that follow in the Descriptive Message.
(dml)	Descriptive Message	The descriptive message is a string of ASCII character bytes that describe the unit type. An example would be 'Powerware 150 Model 125'.
1	Meter Map Size	This byte gives the length of the Meter Map (next mms bytes).
(mms)	Meters Map	This table of bytes describes the type of metered data that will be received. See the Meters Map Table for a description of these bytes
1	Alarm Map Size	This byte gives the length of the Alarm Map (next ams bytes).
(ams)	Alarm Map	This table of bytes describes which alarm types are present in the system. See the Alarm Map Table for a description of these bytes.
2	Config Block Length	This word is the number of bytes in the data field of the Configuration block. Its presence can be used to determine that this unit can respond to a Config block request. Also, if this value is zero, then no configuration block is available but a statistics map MAY be present.
1	Statistics Map Size	This gives the length of the Statistics Map (next sms bytes). Its presence can be used to determine that this unit can respond to a Statistics block request. Additionally, if this value is zero, then no statistics block is available.
(sms)	Statistics Map	This table of bytes describes the type of statistics data that will be received. See the Statistics Map Table for a description of these bytes.
2	Size of the Alarm History Log	Value indicates the maximum possible number of bytes in this block for this UPS. On UPSs conforming to BCM revs before AE, there may be an Alarm History log of up to 3600 bytes, even though this field is not present.
2	Size of the Custom Events block	Set to 0.
2	Size of the Topology block	Size of the UPS Topology block; size 0 if there is no UPS Topology block.
1	Maximum Supported Command Length	Indicates the longest binary command that this UPS can process (including the header and checksum bytes). May be the length of the UPS' receive buffer.
2	Size of the Command List block	Number of bytes in the Command List block; size 0 if there is no Command List block.
2	Size of the Outlet Monitoring block	Size of the Outlet Monitoring block; size 0 if there is no Outlet block.
2	Size of the Alarm block	Maximum Size of the Active Alarms block

Additional Field Descriptions:

CPU Versions: Each Version number consists of two two-digit BCD values, with Minor version number given in the first byte, and Major version number given in the second.
A value of 0x0317 is Version 3.17.

The fixed order for the first five CPUs is defined as:

Order	Version for CPU:	Description
1	Control Panel	These two bytes are for the Control Panel or Communications Board Software Version Number. If there is only one CPU, this is the only version number given.
2	Inverter	These 2 bytes are for the Version Number of the Inverter or Central Control Unit (CCU) CPU.
3	Rectifier	These 2 bytes are for the Version Number of the Rectifier Software CPU.
4	Net Interface Card	These 2 bytes are for the Version Number of the Network Interface Card CPU (internal or external network).
5	Display Controller	If a separate display controller is used.

If the second or third CPUs are not implemented, but the third or fourth are, then placeholder values of 00.00 must be given for the missing CPUs.
There may be more than 5 CPUs, as indicated in the Num CPUs field.

Exceptions:

The absolute byte positions will change depending on the size of the data fields, such as the number of CPU software version numbers, the KVA Rating, the message length, the meter map size, and the alarm map size.

Unimplemented features may truncate this block; implementations before BCM Rev AE did not include the fields after the Statistics map.

Example(s):

None.

5.2.1.1   Meters Map for Standard ID Block

The Meter Map describes both which meters are present and what their formats are for the Meters data block. Each byte in the Meter Map corresponds to a single meter value. If the byte in the Meter Map is 00, then the meter value is not present in the Meter data block, which only contains valid meter values. If the byte in the Meter Map is non-zero, then the meter is present and its value indicates the data format of that meter. The (historic) Meter Map is shown in the table on the following pages.

Notes:

Obsolescence warning
The Meter Map is now maintained –and extended -- in a separate document, a spreadsheet named XcpMeterMap.xls. **Refer to that document or the appropriate public .pdf version, not the following table, for the latest Meter Map details.**

The locations of various points named in the Meter Map and Status block are illustrated in the following drawing of a typical, but not universal, UPS topology:
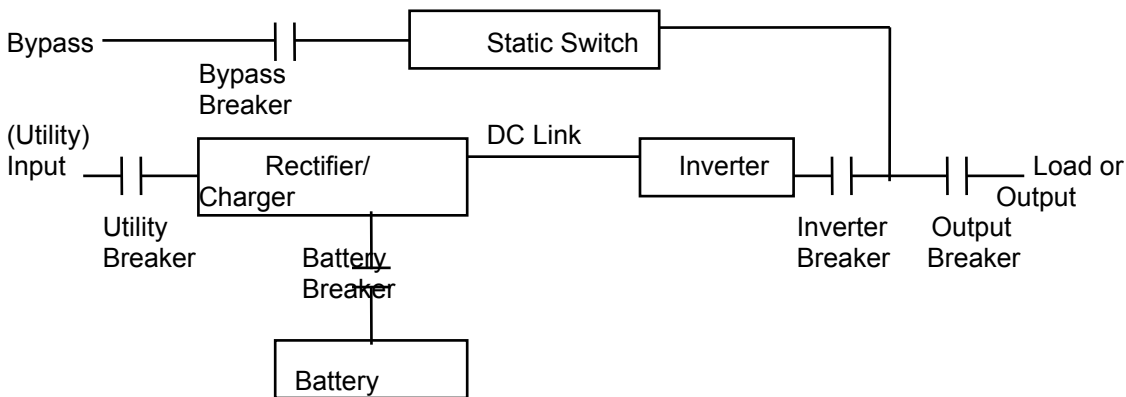
   Bypass: in the Meter Map, refers to measurements for a physically separate utility feed than the Rectifier Input. UPSs with a single utility feed (where Bypass and Rectifier Input are always tied together) should report Input (not Bypass) Voltage and Frequency. Some current models violate this convention and report "Bypass" meter values, so communication software must accommodate this deviation.

   Output: some UPSs have reported Inverter meter values as Output; note that the intention is that "Output" describes what the customer's load sees as input. (Parallel UPSs with Critical Load breakers have a slightly different definition).

   Bar Chart: fixed, 100% rated value of parameter of interest; can be compared to actual reading to make a graphical bar chart.

   Service measures: some of the meters are designated as "Service Measures", which means that they supply information whose meaning is somewhat specific to a given UPS model and which may not be in standard units (e.g., RMS Amps). These meters are intended to supply troubleshooting information to trained service personnel, and should only appear in special service-related displays, and not in user interfaces for average users.

   Deprecated variables: these are meters which have been obsoleted (the original name is shown in parentheses). In the interest of maintaining backwards compatibility and avoiding confusion, their locations may not be reused until the indicated date, after which new meters can be assigned to these locations in the meter map.

Byte / Meter #	Meter Name	Description
1	OUTPUT VOLTS AB	RMS Voltage measured at the Output of the UPS
2	OUTPUT VOLTS BC	(i.e. that applied to the load), measured phase to phase. 'AB' is
3	OUTPUT VOLTS CA	phase A to B.
4	INPUT VOLTS AB	RMS Voltage measured at the Utility Input of the UPS,
5	INPUT VOLTS BC	measured phase to phase. 'AB' is phase A to B.
6	INPUT VOLTS CA	
7	INVERTER VOLTS AB	RMS Voltage measured at the output of the Inverter,
8	INVERTER VOLTS BC	measured phase to phase. 'AB' is phase A to B.
9	INVERTER VOLTS CA	
10	BYPASS VOLTS AB	RMS Voltage measured at the input of the Bypass feed,
11	BYPASS VOLTS BC	if the UPS has a separate Bypass feed, measured phase to phase.
12	BYPASS VOLTS CA	'AB' is phase A to B.
13	MAIN LOGIC POWER	Measure of the power supply for the UPS's logic, normally the unregulated supply, measured in DC Volts. Service Measure.
14	SECONDARY V+ POWER	Measures of a bipolar supply for UPS control or analog circuits,
15	SECONDARY V- POWER	measured in DC Volts. Service Measures
16	INVERTER AVG CURRENT PHASE A	A measure of the current output from the Inverter phases, but not an rms measure. Service Measures
17	INVERTER AVG CURRENT PHASE B	
18	INVERTER AVG CURRENT PHASE C	
19	INPUT CURRENT PHASE A	A measure of the Input phase currents for the UPS,
20	INPUT CURRENT PHASE B	in RMS Amps.
21	INPUT CURRENT PHASE C	
22	OUTPUT WATTS	Output and input power measurements.
23	INPUT WATTS	(Units: Watt)
24	OUTPUT VA	(Units: VA)
25	INPUT VA	
26	OUTPUT POWER FACTOR	(Dimensionless value, 0.00 to 1.00; values outside this range mean "unknown")
27	INPUT POWER FACTOR	
28	OUTPUT FREQUENCY	Frequency measurements (Hz)
29	INPUT FREQUENCY	
30	INVERTER FREQUENCY	
31	BYPASS FREQUENCY	
32	DC LINK VOLTS	DC voltage rectifier to inverter. Service Measure
33	BATTERY CURRENT	Battery measurements; discharge current is a negative current reading. DC Amps.
34	BATTERY VOLTAGE	
35	% BATTERY LEFT	% of useful stored energy remaining (0% is fully discharged)
36	BATTERY TIME REMAINING	Estimated seconds until DCUV for the current load and state of charge of the battery (even if not "On Battery")
37	BATTERY CHARGE TIME	Estimated seconds required to fully charge (Float) the battery

38	PEAK INVERTER CURRENT PHASE A	A measure of the Inverter output peak phase current values. Service Measures
39	PEAK INVERTER CURRENT PHASE B	
40	PEAK INVERTER CURRENT PHASE C	
41	AVG INPUT CURRENT 3 PHASE SUM	Average sum of the 3 phase input currents. Service Measure
42	BATTERY DCUV BAR CHART	Battery voltage lower limit at which inverter must shut down; may vary dynamically with load.
43	INPUT CURRENT BAR CHART	To compare against Input Phase Currents. RMS Amps.
44	LOW BATTERY WARNING V BAR CHART	Battery voltage level at which UPS signals Low Battery warning; may vary dynamically with load.
45	DC VOLTS BAR CHART	To compare against DC Link Volts. DC Volts. Service Measure
46	BATTERY CHARGING CURRENT BAR CHART	Value is for Battery Charging current limit; may vary with load. DC Amps.
47	BATTERY DISCHARGING CURRENT BAR CHART	Value is for 100% rated Battery Discharge current. DC Amps.
48	- - UNUSED - -	--
49	- - UNUSED - -	--
50	- - UNUSED - -	--
51	- - UNUSED - -	--
52	- - UNUSED - -	--
53	- - UNUSED - -	--
54	BYPASS VOLTS PHASE A	RMS Voltage measured at the input of the Bypass feed, if the UPS has a separate Bypass feed, measured line to neutral.
55	BYPASS VOLTS PHASE B	
56	BYPASS VOLTS PHASE C	
57	INPUT VOLTS PHASE A	RMS Voltage measured at the Utility Input of the UPS,
58	INPUT VOLTS PHASE B	measured phase to neutral.
59	INPUT VOLTS PHASE C	
60	INVERTER VOLTS PHASE A	Apparent Inverter output phase voltages, measured phase to
61	INVERTER VOLTS PHASE B	neutral (may be scaled by transformer to nearly match output
62	INVERTER VOLTS PHASE C	volts while On Inverter). Though these should be just Service Measures, some older UPSs report these instead of Output Volts per phase; note in this case that there may be differences between these readings and the actual Output voltage seen by the Load (e.g., when the Output Breaker is Open)
63	AMBIENT TEMPERATURE	Temperature measurements, in degrees Centigrade.
64	HEATSINK TEMPERATURE	At main power unit in the module; normally, the Inverter.
65	POWER SUPPLY TEMPERATURE	Could be rectifier, charger, boost converter, or control power supply.
66	LOAD CURRENT PHASE A	Output RMS phase currents, in RMS Amps (which may be
67	LOAD CURRENT PHASE B	estimated from Inverter output, and not fully account for
68	LOAD CURRENT PHASE C	output filter losses, transformers, or while On Bypass)
69	LOAD CURRENT PHASE A BAR CHART	100% rated values for the Output Phase Currents bar charts.
70	LOAD CURRENT PHASE B BAR CHART	RMS Amps.
71	LOAD CURRENT PHASE C BAR CHART	
72	OUTPUT VA BAR CHART	Rated VA of the UPS (Units: VA)
73	DATE	See Time and Date Format section

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74	TIME	
75	POSITIVE DC LINK RAIL VOLTAGE	Voltages for bipolar DC links. Service Measures.
76	NEGATIVE DC LINK RAIL VOLTAGE	
77	AUTO-BALANCE VOLTAGE	DC Voltage content of Output. Service Measure.
78	BATTERY TEMPERATURE	In degrees Centigrade
79	OUTPUT VOLTS A	Output voltages to the load measured (or determined)
80	OUTPUT VOLTS B	for phase to neutral.
81	OUTPUT VOLTS C	
82	NEUTRAL CURRENT	RMS current in the output neutral line. RMS Amps.
83	OUTPUT WATTS PHASE A	Output watts, measured line to neutral
84	OUTPUT WATTS PHASE B	Output watts, measured line to neutral
85	OUTPUT WATTS PHASE C	Output watts, measured line to neutral
86	OUTPUT WATTS PHASE A, B, C BAR CHART	100% rated value for the output watts per phase bar charts
87	RECTIFIER DC CURRENT	DC current rectifier to DC link. Service measure
88	POSITIVE BATTERY VOLTAGE	Voltages for bipolar battery
89	NEGATIVE BATTERY VOLTAGE	Voltages for bipolar battery
90	POSITIVE BATTERY CURRENT	Currents for bipolar battery, DC Amps; discharge current is a negative reading
91	NEGATIVE BATTERY CURRENT	Currents for bipolar battery, DC Amps; discharge current is a negative reading

5.2.1.2   Alarm Map for Standard ID Block

The Alarm Map describes which Standard alarms are present in the <u>Active Alarms</u> data block. If the bit in the Alarm Map is 0, then the alarm value is not present in the Standard Alarms section of the Active Alarms data block which only contains the state of valid system alarms. The (historic) Alarm Map is shown in the table on the following pages. Each bit of an Alarm Map byte represents a possible Standard Alarm in the Active Alarms data block. For example, if the first Alarm Map byte were set to 0x43, then the first 3 bytes in the Active Alarms data block would correspond to Standard Alarms 0, 1, and 7.

Also shown are the Standard Alarm Numbers, as used by the Event History Log, and whether each is an Alarm (+) or just a Status (-). Statuses are non-alarming events that should not appear in the Active Alarms block, but may be used in the <u>Alarm History</u> block.

Obsolescence warning
The Alarm Map is now maintained –and significantly extended -- in a separate document, a spreadsheet named XcpAlarmMap.xls. **Refer to that document or the appropriate public .pdf version, not the following table, for the latest Alarm Map details.**

Num	Byte	Bit	A / S	Alarm Description	Definition/Comments
0	1	0	+	Inverter AC over voltage	Inverter fault: measured inverter output voltage has exceeded the upper voltage limit specification for normal operation
1		1	+	Inverter AC under voltage	Inverter fault: measured inverter output voltage is less than the lower voltage limit specification for normal operation
2		2	+	Inverter under or over frequency	Inverter fault: measured inverter output frequency is outside of either the upper or lower frequency limit specification for normal operation
3		3	+	Bypass AC over voltage	Bypass fault: measured bypass input voltage has exceeded the upper voltage limit specification for normal operation **Note: to be used only on those UPSs that have a separate bypass input**
4		4	+	Bypass AC under voltage	Bypass fault: measured bypass input voltage is less than the lower voltage limit specification for normal operation **Note: to be used only on those UPSs that have a separate bypass input**
5		5	+	Bypass under or over frequency	Bypass fault: measured bypass input frequency is outside of either the upper or lower frequency limit specification for normal operation **Note: to be used only on those UPSs that have a separate bypass input**
6		6	+	Input AC over voltage	Input (Utility) fault: measured input voltage has exceeded the upper voltage limit specification for normal operation
7		7	+	Input AC under voltage	Input (Utility) fault: measured input voltage is less than the lower voltage limit specification for normal operation
8	2	0	+	Input under or over frequency	Input (Utility) fault: measured input frequency is outside of either the upper or lower frequency limit specification for normal operation

9		1	+	Output AC over voltage	Output fault: measured output voltage has exceeded the upper voltage limit specification for normal operation
10		2	+	Output AC under voltage	Output fault: measured output voltage is less than the lower voltage limit specification for normal operation
11		3	+	Output under or over frequency	Output fault: measured output frequency is outside of either the upper or lower frequency limit specification for normal operation
12		4	+	Remote emergency power off	The UPS has shutdown due to the activation of the remote EPO signal.
13		5	+	Remote go to Bypass	The UPS has transferred to bypass. The load is no longer protected but it is powered via the bypass input.
14		6	+	Building alarm 6	A dry contact closure has been detected on the building alarm 6 input. The building alarms are a set of inputs that are activated via dry contacts. The user may use them for any purpose.
15		7	+	Building alarm 5	A dry contact closure has been detected on the building alarm 5 input.
16	3	0	+	Building alarm 4	A dry contact closure has been detected on the building alarm 4 input.
17		1	+	Building alarm 3	A dry contact closure has been detected on the building alarm 3 input.
18		2	+	Building alarm 2	A dry contact closure has been detected on the building alarm 2 input.
19		3	+	Building alarm 1	A dry contact closure has been detected on the building alarm 1 input.
20		4	+	Static switch over temperature	The static switch operating temperature has been exceeded. The static switch is usually a semiconductor relay used as a bypass contactor in reverse transfer UPSs.
21		5	+	Charger over temperature	Charger fault: The battery charger operating temperature has been exceeded.
22		6	+	Charger logic power fail	Charger fault: The battery charger's power supply to its digital logic circuitry has failed.
23		7	+	Charger over voltage or current	Charger fault: The battery charger output is operating beyond either its voltage limit or its current limit.
24	4	0	+	Inverter over temperature	Inverter fault: measured inverter temperature exceeds the upper temperature limit specification for normal operation
25		1	+	Output overload	Output fault: The measured UPS output current limit or calculated or measured power limit has been exceeded.
26		2	+	Rectifier input over current	Rectifier fault: The measured rectifier input current exceeds the upper current limit specification for normal operation.
27		3	+	Inverter output over current	Inverter fault: The measured inverter output current exceeds the upper current limit specification for normal operation.
28		4	+	DC link over voltage	DC Link fault: measured DC link voltage has exceeded the upper voltage limit specification for normal operation
29		5	+	DC link under voltage	DC Link fault: measured DC link voltage is less than the lower voltage limit specification for normal operation

30		6	+	Rectifier failed	Rectifier fault: The rectifier has failed
31		7	+	Inverter fault	Inverter fault: The inverter has failed.
32	5	0	+	Battery contactor fail	Battery fault: The battery contactor or relay has failed.
33		1	+	Bypass breaker fail	Bypass fault: The bypass breaker or relay has failed.
34		2	+	Charger failure	Charger fault: The battery charger has failed.
35		3	+	Ramp up failed	Inverter fault: The inverter failed to ramp up its output to its normally operating point when so commanded.
36		4	+	Static switch failure	Indicates failure of the static switch. This could be either failure to close or failure to open. The static switch is used in place of or to supplement (speed up) a circuit breaker or contactor.
37		5	+	Analog board A/D reference fail	This indicates that the analog voltage reference for an A/D converter is out of tolerance.
38		6	+	Bypass uncalibrated	This is a warning that the bypass input voltage sensor has not been calibrated.
39		7	+	Rectifier uncalibrated	This is a warning that the rectifier/utility input voltage sensor has not been calibrated.
40	6	0	+	Output uncalibrated	This is a warning that the system/critical output voltage sensor has not been calibrated.
41		1	+	Inverter uncalibrated	This is a warning that the inverter output voltage sensor has not been calibrated.
42		2	+	DC voltage uncalibrated	This is a warning that the DC link voltage sensor has not been calibrated.
43		3	+	Output current uncalibrated	This is a warning that the system/critical output current sensor has not been calibrated.
44		4	+	Rectifier current uncalibrated	This is a warning that the rectifier/utility input current sensor has not been calibrated.
45		5	+	Battery current uncalibrated	This is a warning that the battery current sensor has not been calibrated.
46		6	+	Inverter On/Off stat failure	Indicates that the inverter has failed to perform the requested function. If it was asked to turn On, it did not. If it was asked to turn Off, it did not.
47		7	+	Battery current limit	Indicates that the battery is operating at maximum current capability. In conjunction with other alarms, may also indicate that a failure has occurred due to excessive battery current.
48	7	0	+	Inverter Startup Failure	An attempt to start the Inverter module failed.
49		1	+	Analog board A/D stat failure	This indicates that the analog-to-digital converter has failed self-test.
50		2	+	Output current over 100%	Indicates that the system/critical bus is operating at greater than 100% of its current output rating.
51		3	+	Battery ground fault	Indicates that a leakage path exists between a battery connection and ground.
52		4	+	Waiting for charger sync	Indicates that the phase-lock-loop on a phase-controlled battery charger/rectifier is not in lock.
53		5	+	Non-Volatile RAM failure	Indicates that a non-volatile memory device in the UPS control or communications logic has failed.
54		6	+	Analog board A/D time out	This indicates that the analog-to-digital converter has failed to complete a conversion within the expected time frame.
55		7	+	Shutdown imminent	Indicates that the UPS has entered a state where it _may_ abruptly stop operating without further notice, in less than the Low Battery Warning time. However, it may continue to operate indefinitely, even with this alarm being asserted. Differs from Automatic

					Shutdown Pending (#206) in that it may not be a fault condition, but rather a <u>state</u> like all Outlets have shutdown countdowns in progress that will be completed in less than Low Battery Warning Time. **Note: This alarm is optional; however, if it is implemented, activating it will force monitoring software to do a panic OS shutdown.**
56	8	0	+	Battery low		Indicates that the battery voltage and/or energy is below the predetermined "low battery warning" level. **Note: This alarm is Required (to support Shutdown). Activating this alarm will force monitoring software to do a panic OS shutdown.**
57		1	+	Utility fail		Indicates that the utility input power is not within predetermined limits. This could be, but is not limited to, over voltage, under voltage, over or under frequency..
58		2	+	Output short circuit		Indicates that the UPS has detected an abnormally low impedance placed on its output.
59		3	+	Utility not present		Indicates that the utility input is not present. This differs from alarm #57 in that the detected voltage is (near) zero in this case.
60		4	+	Full time charging		Indicates that the battery charger is constantly on. This usually indicates that the battery was severely discharged or that the battery has failed.
61		5	+	Fast Bypass command		Indicates that the "fast bypass" command was issued to the bypass control logic. "Fast bypass" applies to those systems that have a static switch wrapped around the bypass breaker or contactor.
62		6	+	A/D error		It has been detected that the A/D converter has performed incorrectly.
63		7	+	Internal communication failure		A non-recoverable error has occurred on an internal device network.
64	9	0	+	Rectifier failed self-test		The rectifier/charger has failed self-test.
65		1	+	Rectifier EEPROM failure		An EEPROM device contained within the rectifier module has failed.
66		2	+	Rectifier EPROM failure		A ROM device contained within the rectifier module has failed.
67		3	+	Input line voltage loss		This is very similar to alarm numbers 57 and 59 but specifically indicates that the input voltage is out of range.
68		4	+	Battery DC over voltage		Indicates that the battery voltage has exceeded a predetermined limit. Operating with this alarm set will likely cause permanent battery and/or system damage.
69		5	+	Power supply over temperature		One or more of the control or logic power supplies in the UPS is operating beyond its rated temperature.
70		6	+	Power supply failure		One or more of the control or logic power supplies in the UPS has failed.
71		7	+	Power supply 5 volt fault		The primary logic supply in the UPS has failed.
72	10	0	+	Power supply +/-12 volt fault		The secondary logic supply in the UPS has failed.
73		1	+	Heatsink over temperature		A heatsink at some unspecified location in the UPS has failed.
74		2	+	Heatsink temperature sensor failed		A heatsink temperature sensor at some unspecified location in the UPS has failed.
75		3	+	Rectifier current over 125%		The rectifier/charger input or output current has

					exceeded 125% of its rating.
76		4	+	Rectifier fault interrupt failed	A test of the rectifier fault interrupt has failed to generate a fault response.
77		5	+	Rectifier power capacitor fault	The rectifier power capacitor has failed.
78		6	+	Inverter program stack error	The inverter firmware has detected that the internal program stack has overflowed, underflowed or otherwise been corrupted.
79		7	+	Inverter control board failed self-test	The inverter module has failed either its power up self test or it continuous self test.
80	11	0	+	Inverter A/D converter self-test failed	One or more of the A/D converters on the inverter module failed self-test.
81		1	+	Inverter ram self-test failure	One or more of the RAM memory devices on the inverter module failed self-test.
82		2	+	NonVolatile Memory CheckSum Failure	A test of the device EEPROM has detected a checksum failure. The device either hasn't been programmed or now contains suspect data.
83		3	+	Program CheckSum Failure	A test of the device ROM has detected a checksum or CRC error. The device's operating code is therefore suspect and should be replaced or reflashed.
84		4	+	Inverter CPU self-test failed	One or more of the CPUs in the inverter module failed self-test.
85		5	+	Network not responding	This alarm was originally meant to indicate that no packet traffic or response to token-passing attempts was being detected on the RS-485 multi-drop network in a Powerware Plus 6. This has since been expanded to indicate that any network connected to or within the UPS is not functioning correctly.
86		6	+	Front panel self-test failure	The front panel or communications board has failed self-test.
87		7	+	Node EEPROM verification error	The base, shared, EEPROM data in this module does not match the data read from other modules.
88	12	0	+	Output AC over voltage test failed	The UPS self test function for verifying correct operation of the output AC over voltage detector has failed to generate an AC over voltage fault.
89		1	+	Output DC over voltage	A DC output of the UPS has been detected to be greater than the predetermined limit for this voltage.
90		2	+	Input phase rotation error	The input phases are not in the sequence A B C.
91		3	+	Inverter ramp up test failed	The inverter was commanded to start a ramp-up sequence and it failed to start.
92		4	+	Inverter off command	A command has been received to turn the inverter off. This command may come from a local control panel or from a remote source.
93		5	-	Inverter on command	A command has been received to turn the inverter on. This command may come from a local control panel or from a remote source.
94		6	+	To bypass command	A command has been received to transfer the load from the inverter to bypass. This command may come from a local control panel or from a remote source.
95		7	-	From bypass command	A command has been received to transfer the load from bypass to the inverter. This command may come from a local control panel or from a remote source.
96	13	0	-	Auto mode command	A command has been received to enable automatic normal reverse transfer UPS operation. This command may come from a local control panel or from a remote source.

97		1	+	Emergency shutdown command	An Emergency Power Off (EPO) command has been received to shutdown the UPS immediately without delay. This command may come from a local control panel or from a remote source.
98		2	+	Setup switch open	The setup switch has been activated. This indicates that the UPS is currently in setup mode instead of in normal operating mode. This alarm has been used in the past to test the alarm functions of the UPS.
99		3	+	Inverter AC over voltage (interrupt)	An immediate-mode interrupt has occurred indicating that the inverter output voltage has exceeded a predetermined limit.
100		4	+	Inverter AC under voltage (interrupt)	An immediate-mode interrupt has occurred indicating that the inverter output voltage has dropped below a predetermined limit.
101		5	+	Absolute DCOV/ACOV (interrupt)	An immediate-mode interrupt has occurred indicating that either the DC link voltage or the UPS AC output voltage has reached a critically high over voltage point.
102		6	+	Phase A current limit	Phase A of the UPS output is in current limit.
103		7	+	Phase B current limit	Phase B of the UPS output is in current limit.
104	14	0	+	Phase C current limit	Phase C of the UPS output is in current limit.
105		1	+	Bypass not available	The bypass input voltage is not available for transfer to. This may be due to: over/under voltage, over/under frequency, out of phase lock.
106		2	+	Rectifier breaker open	The rectifier/charger input breaker is open.
107		3	+	Battery contactor open	The battery contactor/breaker is open.
108		4	+	Inverter contactor open	The inverter output contactor/breaker is open.
109		5	-	Bypass breaker open	The bypass breaker is open.
110		6	+	Inverter board ACOV interrupt test failed	The inverter AC over voltage detector self-test failed.
111		7	+	Inverter over temperature trip	The inverter temperature has exceeded it s rating operating temperature.
112	15	0	+	Inverter board ACUV interrupt test fail	The inverter AC under voltage detector self-test failed.
113		1	+	Inverter voltage feedback error	The feedback voltage used to regulate the inverter output has been detected to be at an unreasonable value.
114		2	+	DC under voltage timeout	The DC link has been in an undervoltage state for a period long enough to invoke a critical action handler.
115		3	+	AC under voltage timeout	The AC output has been in an undervoltage state for a period long enough to invoke a critical action handler.
116		4	+	DC under voltage while charger is full on	The charger is unable to supply enough energy to raise the DC link to its minimum operating level.
117		5	+	Inverter voltage bias error	The DC component of the inverter output waveform is too high.
118		6	+	Rectifier phase rotation	On a multi-phase system, the rectifier input phases are out of sequence.
11		7	+	Bypass phase rotation	On a multi-phase system, the bypass input phases are

					out of sequence.
120	16	0	+	System interface board failure	Primarily for parallel systems, this indicates that the system interface board has failed.
121		1	+	Parallel board failure	The board used for paralleling control has failed.
122		2	+	Loss of load sharing phase A	For parallel systems, this indicates that this UPS power module can no longer perform load sharing on phase A.
123		3	+	Loss of load sharing phase B	For parallel systems, this indicates that this UPS power module can no longer perform load sharing on phase B.
124		4	+	Loss of load sharing phase C	For parallel systems, this indicates that this UPS power module can no longer perform load sharing on phase C.
125		5	+	DC over voltage timeout	The DC link has been in an overvoltage state for a period long enough to invoke a critical action handler.
126		6	+	Battery totally discharged	The battery has been discharged to its maximum discharged state.
127		7	+	Inverter phase bias error	The phase offset component of the inverter output waveform is out of controllable range.
128	17	0	+	Inverter voltage bias error	The DC component of the inverter output waveform is too high. (duplicate of alarm #117)
129		1	-	DC link bleed complete	The DC link bleed-down is complete.
130		2	+	Large charger input current	Based of the current operating state of the charger, the input current to the charger is unreasonably high.
131		3	+	Inverter voltage too low for ramp level	During inverter ramp up, the inverter output voltage has not stayed within the expected limit band.
132		4	+	Loss of redundancy	For an "n+1" parallel system, one of the power modules has failed or been turned off. The load is supported, but the system is no longer has redundant protection.
133		5	+	Loss of sync bus	For a parallel system, this module has detected that the sync bus is not active.
134		6	+	Rectifier breaker shunt tripped	The rectifier input breaker has been intentionally shunt tripped. This is usually due to an emergency power off command.
135		7	+	Loss of charger sync	In a phase-controller charger, the charger is not synchronized to its input voltage. This implies that the charger is not working at this time.
136	18	0	+	Inverter low level test timeout	The inverter has failed its low level self test.
137		1	+	Output breaker open	The UPS output breaker or relay is open.
138		2	-	Control power on	Control power has been applied. This alarm is set when the controls first power up. It is used to record the date and time of return of power after a power fail.
139		3	-	Inverter on	The inverter is on.
140		4	-	Charger on	The charger is on.
141		5	-	Bypass on	The bypass is available.
142		6	+	Bypass power loss	The bypass input has insufficient power available to supply the current load.

14 3		7	-	On Manual / Maintenance Bypass	A user has flipped the switch (e.g., Maintenance Bypass) that bypasses the UPS. The switch must be flipped back to let the UPS protect the load.
14 4	19	0	-	Bypass manual turn off	The bypass has been given a manual turn off command.
14 5		1	-	Inverter bleeding dc link voltage	The inverter is being used to bleed the DC link voltage down to a safe level.
14 6		2	+	CPU ISR Error	One of the Central Processing Units (CPU or control microprocessor) has erroneously entered one of its Interrupt Service Routines (ISR), implying that it has received a spurious interrupt input.
14 7		3	+	System ISR restart	The system has gone through a firmware self-restart.
14 8		4	-	Parallel dc	The DC busses are operating in parallel
14 9		5	+	Battery Needs Service	A battery problem has been detected. It may need to be replaced, or its connections and fuses need to be checked.
15 0		6	-	Battery charging	The battery is being charged.
15 1		7	+	Battery not charged	The battery is not fully charged.
15 2	20	0	-	Disabled Battery time	The battery time remaining calculation and/or reporting ahs been disabled.
15 3		1	-	Series 7000 enable	This is unique to the Series 7000, indicating that is a Series 7000 (Powerware 375 family member).
15 4		2	-	Other ups on	In a parallel system, this indicates that one of the other UPSs in currently on.
15 5		3	-	Parallel inv	Two or more inverters are currently operating in parallel.
15 6		4	-	UPS in parallel	This UPS is in parallel operation with at least one other UPS.
15 7		5	-	Output Breaker/Relay Failure	An Output Breaker or Relay has been found to fail; may be stuck either open or closed with this alarm.
15 8		6	-	Control power off	Control power has been removed. . This alarm is either set when the controls detect that they are about to lose power or it is set when power is restored but before the last recorded operating time before a power loss is updated with the current date and time. It is used to record the date and time of a power fail.
15 9		7	+	Level 2 Overload - Phase A	The load on this UPS output phase exceeds its rated current or power by more than a small margin over 100%. The inverter cannot sustain this overload for very long without shutting down due to overheating.
16 0	21	0	+	Level 2 Overload - Phase B	
16 1		1	+	Level 2 Overload - Phase C	
16 2		2	+	Level 3 Overload - Phase A	The load on this UPS output phase exceeds its rated current or power by more than the Level 2 margin. The inverter can only sustain this overload for a very short time without shutting down due to overheating.
16 3		3	+	Level 3 Overload - Phase B	
16		4	+	Level 3 Overload - Phase C	

16 5		5	+	Level 4 Overload - Phase A	The load on this UPS output phase exceeds its rated current or power by more than the Level 3 margin. The inverter cannot sustain this excessive overload and will shut down immediately, transferring the load to bypass, if available.
16 6		6	+	Level 4 Overload - Phase B	
16 7		7	+	Level 4 Overload - Phase C	
16 8	22	0	+	UPS On Battery	The UPS is drawing power from the battery in order to power the load. This alarm is not activated during non-alarming On Battery events, such as Quick Battery Test or Tap Switching. **Note: This alarm is Required (to support Shutdown). Activating this alarm will eventually result in an OS shutdown.**
16 9		1	+	UPS On Bypass	The UPS is on bypass. The critical load does not have power protection.
17 0		2	+	Load Dumped (Load Power Off)	The load power is off. This alarm is used to record the date and time of a power off event.
17 1		3	-	Load On Inverter	The inverter is supplying power to the load. This may be true even if the UPS is on battery or bypass is not available.
17 2		4	-	UPS On Command	An "UPS ON" command has been issued to the UPS. This alarm is used to record the date and time of this event.
17 3		5	-	UPS Off Command	An "UPS OFF" command has been issued to the UPS. This alarm is used to record the date and time of this event.
17 4		6	+	Low Battery Shutdown	The UPS has shutdown due to running on battery for a long enough time to exhaust the battery capacity.
17 5		7	-	Auto On Enabled	The UPS state is set so that it will power up automatically when input power is applied.
17 6	23	0	+	Software Incompatibility Detected	In a multi-module system or internally to a UPS with multiple controllers, the firmware versions in place are not compatible with each other.
17 7		1	+	Inverter Temperature Sensor Failed	The temperature sensor in the inverter module has failed.
17 8		2	-	DC Start Occurred	The UPS has been started on battery when AC input power is not present. This alarm is used to record the date and time of this event.
17 9		3	-	In Parallel Operation	The UPS is operating in normal parallel mode.
18 0		4	-	Syncing to Bypass	The inverter output waveform is being synchronized (phase and frequency locked) to the bypass source.
18 1		5	-	Ramping UPS Up	The UPS is being started up.
18 2		6	-	Inverter On Delay	The built-in delay before starting the inverter up is running.
18 3		7	-	Charger On Delay	The built-in delay before starting the charger up is running.
18 4	24	0	+	Waiting for Util Input	Used only when an auto-restart is enabled. The UPS controls are powered but the UPS can not start because input power is not yet present.

185		1	-	Close Bypass Breaker	This is set during UPS ramp up when the UPS is ready for the user to close the output breaker.
186		2	-	Temporary Bypass Operation	The UPS had to transfer to bypass temporarily. This is expected to be a transient condition.
187		3	-	Syncing to Output	Used in parallel systems, this indicates that the local inverter is being phase locked to the critical bus waveform.
188		4	+	Bypass Failure	This is very similar to alarm #105 but more generic. This includes things like static switch and bypass breaker failure.
189		5	+	Auto OFF Command Executed	An "Auto mode Off" command has been issued to the UPS and processing is complete. The UPS will not turn On automatically when power is restored.
190		6	-	Auto ON Command Executed	An "Auto mode On" command has been issued to the UPS and processing is complete. The UPS will turn On automatically when power is restored.
191		7	+	Battery Test failed	A battery test has been executed and the results are that the battery has failed and needs to be replaced.
192	25	0	+	Fuse Failure	At least one fuse in the UPS has failed and needs to be replaced.
193		1	+	Fan Failure	At least one fan in the UPS has failed.
194		2	+	Site Wiring Fault	There is a fault in the input wiring, other than Phase Rotation; e.g., Ground/Neutral reversed.
195		3	+	Backfeed Contactor Failure	The contactor or relay designed to prevent voltage from backfeeding out from the UPS input appears to have failed.
196		4	-	On Buck/Voltage Reducer	On a line-interactive UPS, the input voltage is too high for the desired output range so the transformer tap has been changed to lower the effective input voltage to match the output voltage.
197		5	-	On Boost/Voltage Step Up	On a line-interactive UPS, the input voltage is too low for the desired output range so the transformer tap has been changed to raise the effective input voltage to match the output voltage.
198		6	-	On Double Boost/Voltage Step Up	On a line-interactive UPS, the input voltage is extremely low for the desired output range so the transformer tap has been changed to raise the effective input voltage to the maximum possible in order to match the output voltage.
199		7	+	Batteries Disconnected	The UPS has detected that (some of) the Batteries are not connected and there is no or seriously reduced backup power.
200	26	0	+	UPS Cabinet OverTemperature	The temperature inside the UPS cabinet or enclosure has exceeded its upper limit.
201		1	+	Transformer OverTemperature	An Input or Output Transformer used by the UPS has exceeded its upper temperature limit.
202		2	+	Ambient UnderTemperature	An ambient temperature probe has detected that the temperature is below its lower limit.
203		3	+	Ambient OverTemperature	An ambient temperature probe has detected that the temperature is above its upper limit.
204		4	+	Cabinet Door Open	The door or cover of the UPS has been opened.
205		5	+	Cabinet Door Open with Voltage Present	The door or cover of the UPS has been opened, and dangerous voltages are present which could shock

					anyone touching them.
20 6		6	+	Automatic Shutdown Pending	A condition exists in the UPS which will lead to the loss of power to the loads in less than the Low Battery Warning Time, unless the condition is cleared / removed. Unlike Shutdown Imminent (#55), due to fault like Overload while On Battery. **Note: This alarm is optional; however, if it is implemented, activating this alarm will force monitoring software to do a panic OS shutdown.**
20 7		7	+	Tap-switching Relay Failure	A fault has been detected in the relays which switch transformer taps.
20 8	27	0	+	Unable to Charge Batteries	The charger circuit has determined this; may be due to bad batteries or open circuit in connections to the batteries.
20 9		1	+	Startup Failed – Check EPO Reset	User attempted to start up the UPS but the system was unable to comply. It is most likely that the EPO is being continuously asserted. The user may need to activate the EPO Reset button to clear this condition.
21 0		2	+	Automatic Startup Pending	This is a warning that the UPS has a scheduled automatic startup condition pending. The UPS could turn on at any time without any additional warning.
21 1		3	+	Modem failed	The UPS has detected that a modem connected to it has failed or the UPS is unable to communicate with the modem.
21 2		4	-	Incoming Modem Call Started	A modem connected to the UPS has received an incoming call and has begun to negotiate a connection.
21 3		5	-	Outgoing Modem Call Started	A modem connected to the UPS has gone off hook and has begun to either dial a number or negotiate a connection.
21 4		6	-	Modem Connection Established	A modem connected to the UPS has established a connection with a remote modem or paging service.
21 5		7	-	Modem Call Completed Successfully	A modem connected to the UPS has successfully completed an entire transaction sequence as expected.
21 6	28	0	+	Modem Call Completion Failed	A modem connected to the UPS has failed to successfully complete a transaction sequence as expected.
21 7		1	+	Input Breaker Failed	Input or Utility fault: The input or utility breaker has failed.
21 8		2	-	System Initialization In Progress	The UPS is undergoing a startup delay caused by the necessity to initialize various internal values, load code modules, etc. (AKA "Inverter EEP Loading")
21 9		3	+	AutoCalibration failed	An attempt to automatically (re-) calibrate the UPS has failed.
22 0		4	+	Selective Trip of Module	A UPS module has been taken out of a parallel system, usually due to improper load sharing or other fault.
22 1		5	+	Inverter Output Failure	The inverter output has failed, and cannot support the load. The reasons for this alarm are, for example: inverter over or under voltage, over or under frequency, distorted waveform, output out-of window, etc.
22 2		6	+	Abnormal Output Voltage at Startup	The UPS has detected an inappropriate voltage at its output before it is providing output. For example:

					some output voltage is detected before the UPS is supplying output power; in a parallel system, the output voltage is not in an acceptable range.
223		7	+	Rectifier OverTemperature	Rectifier fault: temperature of a rectifier component has exceeded its upper temperature limit.
224	29	0	+	Configuration Error	Improper system configuration has been detected. The reasons for this alarm are, for example: unmatched power rating data, conf data out of limits, improper sub-unit identification, etc
225		1	+	Redundancy loss due to overload	The specified power rating of an "n+1" parallel system has been exceeded. The load is supported, but the system lacks redundant protection while this overload persists.
226		2	+	On Alternate AC Source	On systems with dual AC inputs, the power is currently being supplied by the Alternate (not the Preferred) Source.
227		3			

Other Standard Event Values:

The following Event values are not included in any Alarm Map, but may be found in Alarm History logs:

901-924	-	Output Relay nn On/Closed	(where nn is outlet or load group 01-24)
925-949	+	Output Relay nn Failed	Indicates that a failure has occurred for outlet or load group nn (where nn is outlet 01-24)

5.2.1.3   Statistics Map for Standard ID Block

The Statistics Map describes the type of data contained in the Statistics data block. The data in the Statistics data block can be any one of the data formats described for Meters. Each byte in the Statistics Map corresponds to a single statistics value. If the byte in the Statistics Map is 00, then the statistics value is not present in the Statistics data block which only contains valid statistics values. The Statistics Map is shown in the table on the following pages.

Category	Byte	Description
Monthly/ Total Counts	1	Monthly # times UPS on battery < 1 min
	2	Total # times UPS on battery < 1 min
	3	Monthly # times UPS on battery < 2 min
	4	Total # times UPS on battery < 2 min
	5	Monthly # times UPS on battery > 3 min
	6	Total # times UPS on battery > 3 min
	7	Monthly # times UPS on battery < 4 min
	8	Total # times UPS on battery < 4 min
	9	Monthly # times UPS on battery > 4 min
	10	Total # times UPS on battery > 4 min
	11	Monthly # times battery totally discharged
	12	Total # times battery totally discharged
	13	Monthly # times bypass ACUV
	14	Total # times bypass ACUV
	15	Monthly # times bypass ACOV

	16	Total # times bypass ACOV	
	17	Monthly # times bypass uf/of	
	18	Total # times bypass uf/of	
	19	Monthly # times building alarm #1 occurs	
	20	Total # times building alarm #1 occurs	
	21	Monthly # times building alarm #2 occurs	
	22	Total # times building alarm #2 occurs	
	23	Monthly # times building alarm #3 occurs	
	24	Total # times building alarm #3 occurs	
	25	Monthly # times on generator event occurs	
	26	Total # times on generator event occurs	
	27	Monthly # times loss of charger sync occurs	
	28	Total # times loss of charger sync occurs	
	29	Monthly # times charger ovoi	
	30	Total # times charger ovoi	
	31	Monthly # times UPS on battery > 5 sec	
	32	Total # times UPS on battery > 5 sec	
	33	Monthly # times unit was Hot Started	
	34	Total # times unit was Hot Started	
	35	Monthly # times utility was not available	
	36	Total # times utility was not available	
Accumulative Times:	37	accumulative time inverter supplied load	
	38	accumulative time bypass supplied load	
	39	accumulative time on battery with load	
	40	elapsed time that ups is currently supplying load while on battery	
	41	accumulative time on generator	
	42	accumulative down time	
	43	accumulative time control logic is powered	
	44	accumulative time that utility is normal	
	45	accumulative time ups is supplying load	
	46	accumulative time that output is normal	
	47	accumulative rectifier ACUV time	
	48	accumulative rectifier ACOV time	
	49	accumulative time load > 30% rated	
	50	accumulative time load > 75% rated	
	51	accumulative time load > 100% rated	
	52	accumulative time ACUV but not on battery	
Utility Measures	53	maximum negative frequency deviation	
	54	maximum positive frequency deviation	
	55	Minimum utility voltage	
	56	Maximum utility voltage	
	57	Average Utility voltage	
Load Statistics	58	Average VA	
	59	Average Watts	
	60	Maximum load current	
Statistics	61	starting date and time for Total	

Resets Dates		
	62	counts and Accumulative Times
	63	starting date for utility ACUV time
	64	and time
	65	starting date for utility ACOV time
	66	and time
	67	starting date for utility measures
	68	and time
	69	starting date for load statistics
	70	and time

5.2.2   Config Block Request

Purpose:

This data block contains setup and type information about the UPS.

All positions of data in this block are fixed. Unused or unimplemented fields should contain a 00 placeholder value.

Requesting Command:

SFD	LEN	Cmd Byte	Csum		
0xAB	0x01	0x36	XX		

Structure of Data Response:

The block 0x06 response is:

Offset	Bytes	Name	Description / Values
00	2	Machine type code	Indicates which family of UPS this is (Prestige, etc.) – See Machine Codes
02	2	Model Number	(9125, etc.) See below
04	2	Model Configuration Word	
06	2	Input Frequency deviation limit	(in Hz/100). Normally the same as Bypass/Utility frequency deviation in Extended Limits block.
08	2	Nominal Output Voltage	
10	2	Nominal Output Frequency	
12	2	Output Phase Angle (degrees)	
14	8	Hardware Modules Installed	Bit map – See below
22	6	Battery Data	See below
28	2	Option Modules Installed	
30	4	Communications Setup	See Comm Setup
34	2	Output Voltage Adjustment Setting	
36	2	Front Panel Version Number	Same as ID Block CPU #1, or 0000 if not used
38	2	Inverter Version Number	Same as ID Block CPU #2, or 0000 if not used
40	2	Rectifier Version Number	Same as ID Block CPU #3, or 0000 if not used
42	2	Network Interface Version Number	Same as ID Block CPU #4, or 0000 if not used
44	2	Display Controller Version Number	Same as ID Block CPU #5, or 0000 if not used
46	1	OEM type (00 & FF = Powerware)	
47	1	Length of the Extended Limits Configuration Block	(0=None, 255 = more than 254 bytes) See Extended Limits block
48	16	Part Number	16 character Text field
64	16	Serial Number	16 character Text field
80	8	Multi-module bitmap	(1 = module present)
88	8	Network (Ethernet) Address	
96	8	TCP/IP (IP) Address	(4 bytes used, 8 reserved)
104	2	Network Interface Serial Configuration	

Additional Field Descriptions:

5.2.2.1   BYTES 00 - 01 Machine Type Code

Indicates which family of UPSs this one belongs to. Communication software should check within a range of values; e.g., any value between 90 and 99 is a variant of Powerware Plus 50-500.
Machine type code is a binary number, not BCD; the values in this table are in decimal format, not hex.

Code	Description
0	Unknown
10	Network Adapter
20	PowerWare Premier
30	PowerWare Plus (AST)
50	PowerWare Plus (ALC)
60	PowerWare System 20/50
70	PowerWare System 80-375
80	PowerWare Prestige
81	PowerWare Prestige SE
90	PowerWare Plus 40-750
91	Kaytu / Plus 750
100	Series 3000 UPM (Uninterruptible Power Module)
110	Series 3000 SMS (Single Module System)
120	Series 3000 HBCC (Parallel Bypass Control Cabinet)
130	Series 3000 HTBCC (Hot Tie Bypass Control Cabinet)
140	Series 3000
150	X-Slot Multi-Port Module
200	Telecom Rectifier
210	NetUPS (Line Interactive)
220	IPM UPS
230	UPScode II type UPSs
240	Outlet Control Module
241	IDM / IPDD
250	Powerware Profile
260	Barracuda
270	Nautilus
280	Summa Manifold
281	Summa Power Processor Module
290	Aurora (Cheetah)
291	Phoenixtec Deluxe
292	Phoenixtec Luxury
293	Bonsai (Dual AC Input Cheetah)
300	Kilimanjaro
310	Kudzu 10-60 KVA
320	Akula
330	Axxium Tower / 9120 / Sola 650
340	Dual Input 3-Phase Static Switch Module
350	Axxium Pro (PW 9170)
360	Newave 93XX

BYTES 02 - 03 Model Number

Model Number is the value used in marketing literature, i.e. 3/5/9 Power Protection model number (e.g., 9125). If the model number exceeds 16-bits (e.g., 93100), convert the initial 9 to a 1 (13100) to keep it in the 16-bit range.

(In older firmware & models, this field was done in deci-units, usually KVA *10.)

BYTES 04 - 05 Model Configuration Data

A UPS model-specific field, available for model-specific information. If not used, a default value of 0000 should be used.

BYTES 14 - 15 Hardware Modules Installed (bytes 1 & 2)
A UPS model-specific field, available for model-specific information. If not used, a default value of 0000 should be used.

BYTES 16 - 17 Hardware Modules Installed (bytes 3 & 4)
Byte 16 is used to determine the validity of Status Block byte 2.
Byte 17 is used to determine the validity of Status Block byte 4.
If a bit is set here, then the corresponding Status block bit is valid or available; if the bit is clear here, then the corresponding Status block bit is not implemented or not applicable and should be ignored.

Byte	Bit	Status block Bit Field
17	15	Utility (Rectifier Input) Breaker
	14	Bypass Breaker/Contactor
	13	Static Switch
	12	Battery Breaker
	11	Inverter Output Breaker/Contactor
	10	Load Breaker
	9	Other Breaker #1
	8	Other Breaker #2
16	7	Utility Present
	6	Rectifier On
	5	Low Battery Warning
	4	Inverter On
	3	On Battery
	2	On Bypass
	1	Output Breaker Closed
	0	Bypass Installed

BYTES 18 - 21 Hardware Modules Installed (bytes 5-8)

These bytes are not currently defined and are reserved.

5.2.2.2   BYTES 22 - 27 Battery Data

Bytes 22 and 23:
Undefined at this time.

Bytes 24 and 25: BATTERY DCUV VALUE

   Per cell voltage value used to cause the inverter to shutdown due to DCUV at full rated load.

   Values are: (volts/cell) * 100 (i.e. value of 167 means 1.67 volts per cell,
        value of 175 means 1.75 volts per cell)

Byte 26: NUMBER OF BATTERY STRINGS

        .
        The number of Internal and External Battery Strings attached to this UPS.
        This value may be settable with Set Config Param #15, Battery Data1 Set.

Byte 27: Undefined at this time.

BYTES 28-29 Option Modules Installed

   There are currently no defined Option Modules.

5.2.2.3   BYTES 30-33 Communications Setup

SERIAL PORT 1   BYTES 31 and 30
SERIAL PORT 2   BYTES 33 and 32

BYTE 31 / 33								BYTE 30 / 32							
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
BAUD RATE										STP BIT	SW HND	HW HND	DAT BIT	PARITY	

Byte	Bit	Field	Values
31 / 33	15-8	BAUD RATE	0 = undefined
			1 = 110
			2 = 150
			3 = 300
			4 = 600
			5 = 1200
			6 = 2400
			7 = 4800
			8 = 9600
			9 = 19200
			10 = 38400
30 / 32	7	(Unused)	0
	6	(Unused)	0
	5	STOP BITS	0 = 1 stop bit
			1 = 2 stop bits
	4	SOFTWARE HANDSHAKE (XON/XOFF)	0 = Software Handshaking Disabled
			1 = Software Handshaking Enabled
	3	HARDWARE HANDSHAKE	0 = Hardware Handshaking Disabled
			1 = Hardware Handshaking Enabled
	2	DATA BITS	0 = 7 data bits
			1 = 8 data bits
	1-0	PARITY	00 = none 01 = odd 10 = even 11 = space or mark

For example, 19200 baud, 8 Data bits, 1 Stop bit, No Parity or Handshaking would be 0x0904

BYTES 34-35   Output Voltage Adjustment Setting

PERCENT OF OUTPUT VOLTAGE ADJUSTMENT - Amount to adjust output Up or Down from Nominal.
Permitted range: +/- 10 (+/- 10%). 00 means no adjustment.

BYTES 48-63 Part Number
BYTES 64-79 Serial Number
These are fixed-length,16-byte ASCII text messages used to uniquely identify the UPS.
In Some UPSs, the Part Number field gives the last 16 digits of the CTO (Configured To Order) number (factory set).

BYTES 80-87 Multi-module bitmap (1 = module present)
If there are no other modules besides the UPS, all bytes should have a value of 0.
Otherwise, there should be a bit set for each addressable module, starting with module 1 at location Byte 80, Bit 0.

BYTES 88-95   Network (MAC/Ethernet) Address
BYTES 96-103   TCP/IP (IP) Address (4 bytes used, 8 reserved)
Network addresses (both physical and IP) will appear in the configuration block low byte first and high byte last (so that 90.1.2.3 would be 03, 02, 01, 5A, 00, 00, 00, 00).

BYTES 104-105 Network Interface Serial Configuration
Used to indicate which serial port(s) could have a UPS attached, and which have established a connection to the UPS.

BYTE 105								BYTE 104							
15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
PORTS	INSTALLED	BIT	MAP					UPS	CONNECTION	BIT	MAP				

PORTS INSTALLED BIT MAP - Bit Map of physical serial ports installed on this network adapter,
where bit 8 = COM1, bit 9 = COM2, etc.

UPS CONNECTION BIT MAP -   Of the "PHYSICAL PORTS INSTALLED", which ones have   established communications with a known UPS.

Exceptions:

Non-networked UPSs might only implement the first 88 (or less) bytes. Network adapters will add the remaining bytes up to 105.

Example(s):

5.2.3   Extended Limits Block Request

Purpose:

The Extended Limits (Limits Configuration) data block provides additional configuration information (beyond that in the Config block) about nominal input, output, bypass, battery, and other meters. This block has two sections, Fixed-position Parameters, and the Table of Standard and Custom Parameters.

The Fixed-position Parameters always exist in the first 31 bytes of the block. These are fixed-byte positions. Unimplemented readings will be represented with a 0 value, which is not a valid value for most of the readings in this block.

The Table of Standard and Custom Parameters is an extension of this block to permit sets of standard and custom parameters which may vary from UPS to UPS. Only those parameters which are part of this UPS are present in the table, which is sparsely filled and may not be listed in numerical order.

Those fields which are writeable can be changed with the Set Config Parameter command.

Requesting Command:

SFD	LEN	Cmd Byte	Csum		
0xAB	0x01	0x3C	XX		

Structure of Data Response:

The block 0x0C response is:

Fixed-position Parameters:

Offset	Bytes	Name	Description / Values
0	2	Nominal Input Voltage	(V rms) Use line-to-line values unless line-to-neutral are known and more commonly stated for this UPS.
2	2	Nominal Input Frequency	(Hz)
4	2	Nominal "Extended" True Power Rating	(Watts/50) The weight of the least significant bit is 50 Watts; multiply the value by 50 Watts to get the Watts rating of the unit.
6	2	Comm Spec Version Implemented	Given with two ASCII characters; e.g., for version AE, the 'A' character would be in byte 6 and 'E' in byte 7. For version "A", byte 6 = space and byte 7 = 'A'.
8	2	Bypass/Utility Frequency Deviation Limits	(in Hz/100) See below
10	2	Bypass Voltage Low Deviation Limit / Transfer to Boost Voltage	(V rms)
12	2	Bypass Voltage High Deviation Limit / Transfer to Buck Voltage	(V rms)
14	2	Bypass/Utility Phase Deviation Limits	(degrees) The maximum phase difference between the Inverter Output and the Bypass or Utility Input at which the UPS will still attempt to transfer from Inverter to Bypass.
16	1	Low Batt Minutes Remaining	How many minutes of UPS power remain once the low battery alarm is given for the full rated load.
17	1	Horn Status:	0 if disabled, 1 if enabled, 2 if muted. See below.
18	2	Minimum Supported Input Voltage	(V rms)
20	2	Maximum Supported Input Voltage	(V rms)
22	2	Utility Return Stabilization Delay	(seconds)
24	1	Minimum Battery Capacity for Return	(%)
25	1	Ambient Temperature Lower	(deg C)

		Alarm Limit	
26	1	Ambient Temperature Upper Alarm Limit	-
27	1	Misc Configuration Flags	See below
28	1	Mask for Misc Config Flags	See below
29	1	Percent Load for Sleep	Maximum % load at which the UPS may still enter the power-saving Sleep mode (turning off Outlets) while On Battery. A value of 0 means that Sleep mode is disabled.
30	1	Onset Delay for Sleep	Number of minutes to wait when On Battery before initiating Sleep mode. 0 means that Sleep mode is disabled.

Table of Standard and Custom Parameters:

31	1	Number of parameters listed in this Table (NCP). If the UPS does not list parameter values, then this field may be absent, or has value zero (0).	Shows the number of parameters that are listed here. The parameters may be listed in any order.
	3* NCP	Listed parameters, each 3 bytes: 1st byte is parameter number, the next word (LSB sent first) is the parameter value	The listed parameters may be writeable or read-only. Note that the MSB of the bit-map parameters show the valid parameter bits in the LSB.

Additional Field Descriptions:

BYTES 8-9 Bypass/Utility Frequency Deviation Limits

For an On-Line UPS, the maximum deviation in the Bypass or Input Frequency from Nominal for which the Bypass is still considered "available" for transfers.

For a Line-Interactive UPS, the maximum deviation in the Utility Frequency before the UPS goes to Battery.

BYTE 17 Horn Status

When Disabled (0), the alarm should never sound. Use of this value is not recommended for safety reasons.

Setting to Muted when the horn is sounding will temporarily silence the horn, until the alarm clears; during this time, this variable should be read as Muted (2). After the alarm clears, this variable should return to Enabled (1).

Setting to Muted when there is no horn should have no effect.

For Safety reasons, certain alarms may never be silenced, such as "Output Power About To Be Applied to Load", where someone may be working with unpowered output wiring which will shortly become powered.

BYTES 22-23   Utility Return Stabilization Delay

How many consecutive seconds of normal AC power the UPS must see, after a UPS shutdown, before it re-applies power to the load. May also be used as a start-up delay to allow the batteries some time to recharge.

A 0 value allows immediate restart (no delay beyond the UPS-dependent start-up delay).

This is one component of the "Down Time" for the Load Power Off & Restart command (0x8A). Note that the total "Down Time", including hardware-based delays, must be a minimum of 5-10 seconds, to give powered equipment sufficient time to do a full power-off reset.

BYTES 24 Minimum Battery Capacity for Return

The minimum percent charge that the Batteries must have, after a UPS shutdown, before the UPS re-applies power to the load.

A 0 value allows immediate restart (no delay).

If both the Utility Return Stabilization Delay and the Minimum Battery Capacity for Return are non-zero values, then the UPS will not restore load power until *both* are satisfied.

5.2.3.1 Bypass Deviation and Line Regulation Voltages:

The meaning of these parameters differs somewhat between On-Line and Line-Interactive UPSs; their relationships to utility volts and UPS status are shown in the following two figures. See also **Using XCP Data to Draw Meter Limits** to see how Software developers employ these and other parameters to construct meaningful graphic meters for the customer.

On-Line UPS

UPS STATUS

ON BATTERY

Max Supported Input Volts Bytes **20-21**

140V

UPS SUPPORTING LOAD

Bypass Volt High Deviation Limit Bytes **12-13**

130V

120V

SYSTEM NORMAL

Input Volts Meter

Nominal Input Volts Bytes **0-1**

110V

100V

UPS SUPPORTING LOAD

Bypass Volt Low Deviation Limit Bytes **10-11**

90V

ON BATTERY

Min Supported Input Volts Bytes **18-19**
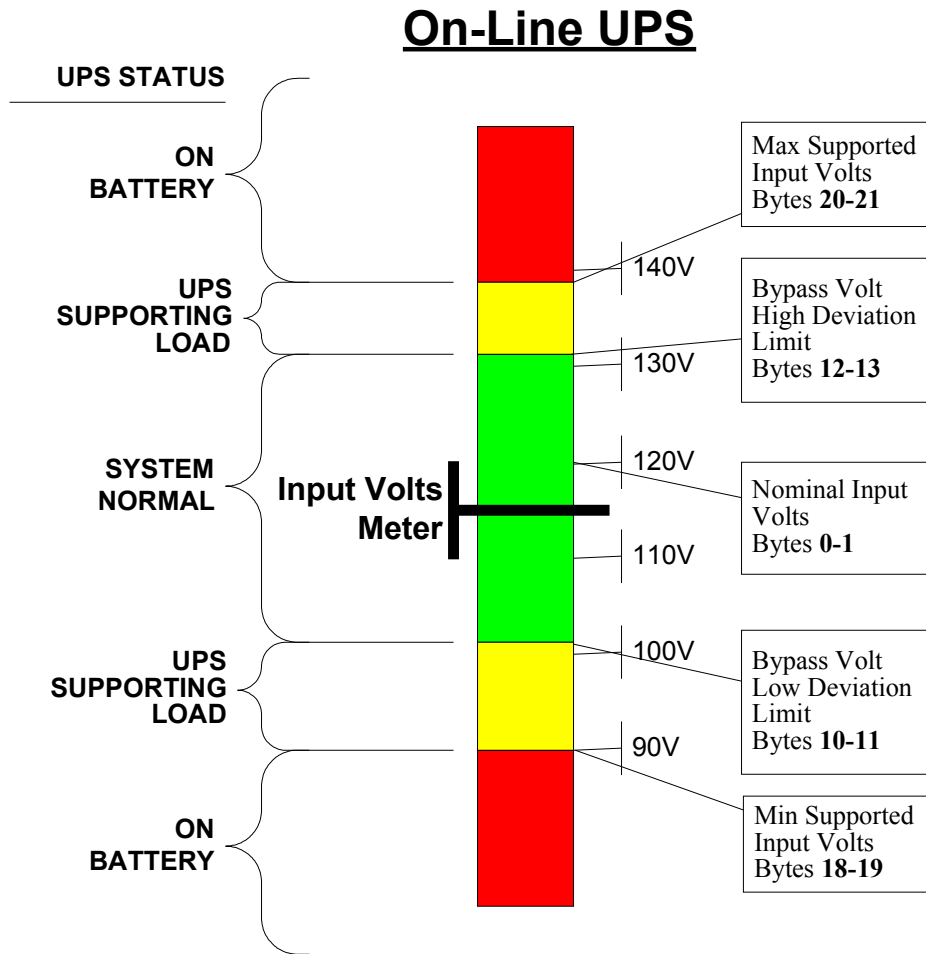
For an On-Line UPS, the Bypass Deviation parameters specify what a "good" or "available" Bypass (or Input) is. If these parameters are all within the specified limits, if the UPS must transfer to bypass, it will do so. If not within limits, the Alarm, "Bypass Not Available" should be set, and the UPS will drop load rather than attempt to transfer to this bypass. Note that for the Status "UPS SUPPORTING LOAD", alarms are present (otherwise, Status would be SYSTEM NORMAL); the most likely alarm here is "Bypass Not Available", but may also include "Utility Fail" and others.

For On-Line UPSs, the Input and Bypass Meters and Limits should not be combined in an actual display meter (like that above) if the UPS has a separate Bypass feed or if Min/Max Bypass Limits equal the Input Limits.

Line-Interactive UPS

UPS STATUS

ON BATTERY

ON BUCK / REDUCER

SYSTEM NORMAL

Input Volts Meter

ON BOOST/ STEP UP

ON BATTERY

140V — Max Supported Input Volts Bytes **20-21**

130V — Transfer to Buck/ Reducer Voltage Bytes **12-13**

120V — Nominal Input Volts Bytes **0-1**

110V

100V — Transfer to Boost/ Step Up Voltage Bytes **10-11**

90V — Min Supported Input Volts Bytes **18-19**
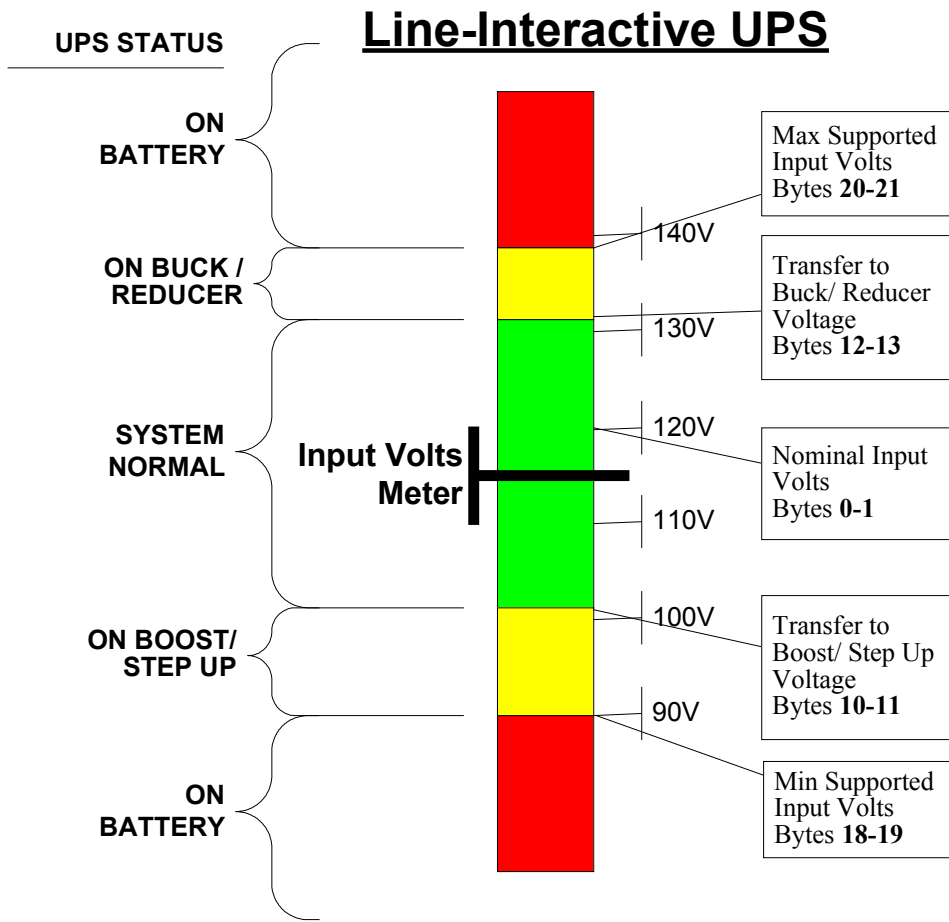
For Line-Interactive UPSs, when outside the System Normal range, the UPS will first use the Buck / Boost feature to try to restore the output to within regulation without going On Battery. However, if the utility voltage falls outside the Buck / Boost limits, then the UPS will transfer to On Battery.

Actual UPS Status transitions near the limits are influenced by Load and Hysteresis factors; consequently, it would be difficult for monitoring software to anticipate precisely the voltage that will cause a transition from one Status to the next. Some On-Line UPSs can support the load without dropping On Battery even outside the Max / Min Supported Volts range; these limits are specified at full-rated load, and with lesser loads, greater range is possible (and desirable).

Some Powerware UPSs may implement these voltages as settable items through the "Set Config Parameters" command.

BYTES 25-26 Ambient Temperature Lower and Upper Alarm Limits
Set points for triggering Ambient Under- and OverTemperature alarms, when compared to the Ambient Temperature meter reading (Meter 63). In units of degrees Centigrade. A value of 0 means that no limit has been set; however, negative values for the Lower Alarm Limit are permitted.

BYTES 27-28 Misc. Configuration Flags and Mask
Byte 27 holds various Configuration Flags, defined in the table below. Byte 28 holds a bitmask which shows which of these flags are valid in a given UPS (Byte 28 bit set to 1 if the flag in Byte 27 is valid). If an implemented flag bit field is 0, then the flag is clear. Unused flag bit fields (Byte 27) should normally be 0, but are not required to be so.

Bit	Meaning	Comments
0	1 = Site Fault Alarm is Enabled	
1	1 = Autodetect Input Voltage	May only take effect on the next Powerup and then be cleared.

5.2.3.2   BYTES 31- Table of Standard and Custom Parameters

Although these bytes were added to list the Custom parameters, a UPS may list here also any of the well-known Standard parameters 0x01-7F.

The following ranges for parameters are defined:

Range	Usage	Defined
0x01 – 7F	Standard Parameters	See List of Well-Known (Standard) Parameters.
0x80 – AF	Custom Parameters	Defined by the individual UPS's XCP Compliance doucment
0xB0 – FE	Reserved Parameters	
0xFF	Request Param Capabilities	

If the UPS does not list the parameters, then the response length is 30, or, byte 31 is zero and no parameter values are listed.

It is required for Bit-map Parameters that the MSB show which of the bits in the LSB are valid parameters.

Exceptions:
This block was added at rev AD, and the Ambient Temperature Limits were added at rev AE.

Misc. Configuration Flags and Mask were added at XCP rev A.
UPSs may define model-specific functions for these bits.

The Table of Standard and Custom Parameters was added at XCP Rev C.

Example(s):

If the Table of Standard and Custom Parameters is present, then the byte at offset 31 is the number of the listed parameters, and the following 3-byte fields list their numbers and values. For example:

Offset	Value	Description / Values
31	4	Four parameter number & values are listed.
32	0x0B 0x1234	Parameter #11 value is 0x1234
35	0x81 0x4321	Parameter #0x81 value is 0x4321
38	0x89 0x2233	Parameter #0x89 value is 0x2233
41	0x85 0x4254	Parameter #0x85 value is 0x4254

5.2.4 Request Scratchpad Data

Purpose:
The Scratchpad Data block provides the contents of the specified sector of 16 bytes of non-volatile memory. This data is set by the Set Scratchpad Sector command.
These sectors must be fetched one at a time; there is no bulk request for "all sectors".
Scratchpad data has no meaning to the UPS; it contains whatever monitoring software wants to put in it.

Requesting Command:

	SFD	LEN	CMD	Sector	Csum
	0xAB	0x02	0x45	1-n	XX
Bytes	1	1	1	1	1

The number of sectors, n, can be determined with the Set Scratchpad Sector command, using a sector number of 0xFF.

Structure of Data Response:
The block 0x15 response is:

Bytes	Name	Description / Values
1	Sector number	Sector Number, 1-n
16	Scratchpad data	16 bytes of data from this Scratchpad sector

Additional Field Descriptions:

Exceptions:
This command is new with XCP rev C.
The initial contents of Scratchpad are undefined; however, most types of non-volatile memory are initialized to byte values of 0xFF.
Scratchpad Block 1 may be reserved for internal software applications designed by Powerware Corporation.

Example(s):
If the Scratchpad capabilities for this UPS have shown that there are at least 3 sectors available, and we want to see the 3rd one, the following are the command and response:

Request Scratchpad Sector #3:

	SFD	LEN	CMD	Sector	Csum
	0xAB	0x02	0x45	3	XX
Bytes	1	1	1	1	1

And the response would be (assuming contents of 0x01-0x10 stored in the 16 bytes of sector 3), one byte per field illustrated:

SFD	BLK	LEN	SEQ	Sector Number
0xAB	0x15	0x11	0x81	0x03

CONTENTS OF Sector																Csum
0x01	0x02	0x03	0x04	0x05	0x06	0x07	0x08	0x09	x0A	0 x0B	0 x0C	x0D	0 x0E	0 x0F	0x10	XX

5.2.5 UPS Topology Data Block

Purpose:

This block gives the UPS a way of reporting its Topology information, so that an appropriate mimic screen or one-line diagram can be drawn.

Support for paralleling and multi-modules are included.
The data in this block is static and cannot be changed by the user.

Requesting Command:

SFD	LEN	Cmd Byte	Csum		
0xAB	0x01	0x43	XX		

Structure of Data Response:

The block 0x13 response is:

Bytes	Name	Description / Values
2	Overall Topology	See Overall Topology Definitions
1	Number of Elements	Total Number of Elements described in the Table of UPS Elements next in this block. Always set to 0.

Additional Field Descriptions:

Overall Topology Definitions

The Overall Topology field describes the type of UPS roughly to the communication software. Defined values are:

Value	Overall Topology
0x0000	None; use the Table of Elements
0x0010	Off-line switcher, Single Phase
0x0020	Line-Interactive UPS, Single Phase
0x0021	Line-Interactive UPS, Two Phase
0x0022	Line-Interactive UPS, Three Phase
0x0030	Dual AC Input, On-Line UPS, Single Phase
0x0031	Dual AC Input, On-Line UPS, Two Phase
0x0032	Dual AC Input, On-Line UPS, Three Phase
0x0040	On-Line UPS, Single Phase
0x0041	On-Line UPS, Two Phase
0x0042	On-Line UPS, Three Phase
0x0050	Parallel Redundant On-Line UPS, Single Phase
0x0051	Parallel Redundant On-Line UPS, Two Phase
0x0052	Parallel Redundant On-Line UPS, Three Phase
0x0060	Parallel for Capacity On-Line UPS, Single Phase
0x0061	Parallel for Capacity On-Line UPS, Two Phase
0x0062	Parallel for Capacity On-Line UPS, Three Phase
0x0102	System Bypass Module, Three Phase
0x0122	Hot-Tie Cabinet, Three Phase
0x0200	Outlet Controller, Single Phase
0x0222	Dual AC Input Static Switch Module, 3 Phase

Exceptions:
The Table of UPS Elements is undefined; therefore, this byte should indicate that the Number of Elements is 0.

Example(s):

5.3   Meters

5.3.1   Standard Meters Block Request

Purpose:
The Standard Meters block contains the measured values of the unit. This consists of the input and output voltages, currents and frequencies, the battery voltage, and the temperature, as well as other measured values. A few data items are fixed "bar chart" values, useful for setting the scale of a bar graph of other meters (e.g., Load Current).

Requesting Command:

SFD	LEN	Cmd Byte	Csum		
0xAB	0x01	0x34	XX		

Structure of Data Response:
Most measured values are in 32 bit IEEE-754 floating point format or are 32 bit integers (see Formats). Which data type is being used for a given meter value is transmitted as part of the Standard ID block in the Meter Map section. Each meter value consists of four bytes of data, independent of the data type.

Additional Field Descriptions:

Exceptions:

Example(s):

5.4 Alarms and Events

The sections here deal with definitions used for the Active Alarms and Alarm/Event History blocks.

5.4.1 Action Levels

Each alarm or event has an associated Action Level when it was True or Active. This level is defined by the UPS and may vary depending upon the circumstances.

The difference between an Alarm and an Event is simply that Events have an action level of "no action required" (e.g., Notification or Advisory), but Alarms always do require some action.

The following table lists the Action Levels:

Value	Name of Action Level	Description of Action to be Taken	Examples
0	System Normal	None	(Normal)
2	OFF	An Indicator, LED, or Switch is OFF; no action required	Front Panel LED
3	ON	An Indicator, LED, or Switch is ON; no action required	Front Panel LED
4	Notification	Simple Event Notification; no action required	Some Events
6	Advisory	User should be aware that a condition exists which does not threaten the protected equipment, but that might need to be checked.	Building Alarm Shutdown Scheduled Some Events
8	Warning	User should be aware that a condition exists which does not currently threaten the protected equipment but that it indicates an underlying problem and may lead to a situation that will.	On Battery Battery not charged Output Overload On Buck/Boost
10	Schedule PM	A condition exists which must be addressed by scheduling service for the UPS	Battery Health Low
12	Immediate Service	A condition exists which can threaten the protected equipment; it must be addressed today.	On Bypass Fan Failure
14	Non-Critical Shutdown	A condition exists in which the UPS may not be able to continue protecting all loads; non-critical equipment should be shutdown at this time.	
16	Shutdown Required	The UPS can only provide power to the protected equipment for less than the configured Low Battery Warning Time; all protected equipment should commence shutdown procedures immediately.	Low Battery Shutdown Pending Shutdown Imminent
18	Load Power Off	The UPS is not providing power to the protected equipment at this time.	UPS Off by Command DCUV
20	Safety Hazard	A condition exists which may imperil personnel near the UPS.	Door Ajar with Voltage Present
32	User Status (Information Only)	Status conditions that are User oriented.	On Battery, Unit Normal, Input Breaker Closed
33	Service Status (Information Only)	Status conditions that are service oriented	Inverter On, Input Filter closed
34	Command	UPS Control Commands	UPS ON, UPS OFF, etc.
35	Notice Level 1 (Information Only)	Notice conditions that are for Information only. These Notices require no action. In some UPS products, the message is displayed on the Active Alarm/Notice Screen and the Notice Lamp will light when the associated bit is active.	Input Ac Under Voltage, Equalizing Battery, etc.
36	Notice Level 2 (User Interaction)	Notice conditions that tell the User to do something. In some UPS products, the message is displayed on the Active Alarm/Notice Screen and	User is being told to close the Input Breaker.

		the Notice Lamp will light when the associated bit is active.	
37	Notice Level 3 (Protection Level)	Notice conditions that inform the User that the level of load protection has increased or decreased. In some UPS products, the message is displayed on the Active Alarm/Notice Screen and the Notice Lamp will light when the associated bit is active.	Bypass is Not Available, System Not Redundant, System redundant, etc.
38	Notice Level 4 (Investigate UPS)	The user should investigate the UPS. In some UPS products, the message is displayed on the Active Alarm/Notice Screen and the Notice Lamp will light when the associated bit is active.	Building Alarms, Emergency Transfer to Bypass
39	Notice Level 5	Not Defined.	
40	Notice Level 6	Not Defined	
41	Alarm Level 1 (User Alarm – User action required)	The User should note the condition and may need to take immediate action. In some UPS products, the message is displayed on the Active Alarm/Notice Screen and the Alarm Lamp will light when the associated bit is active..	Check Modem, Battery Voltage Low, etc..
42	Alarm Level 2	Not defined.	
43	Alarm Level 3 (Shutdown is Imminent)	This alarm condition indicates that shutdown of the UPS could occur. The Shutdown could result in a load loss. In some UPS products, the message is displayed on the Active Alarm/Notice Screen and the Alarm Lamp will light when the associated bit is active..	Load Over 100% Over-Temperature, etc.
44	Alarm Level 4 (Schedule Service)	A condition in the UPS has been detected that requires servicing but could be scheduled and does not require immediate service. In some UPS products, the message is displayed on the Active Alarm/Notice Screen and the Alarm Lamp will light when the associated bit is active..	Check Battery, Redundant Fan Failure, etc..
45	Alarm Level 5 (Service Information)	A technically oriented alarm condition. The user should call for service to evaluate the condition. These conditions may clear but may indicate a pending problem. In some UPS products, the message is displayed on the Active Alarm/Notice Screen and the Alarm Lamp will light when the associated bit is active..	Inverter Current Limit, Inverter Overload, Rectifier Over voltage, DC Link Over voltage
46	Alarm Level 6 (Service Required)	Service of the UPS is required. In some UPS products, the message is displayed on the Active Alarm/Notice Screen and the Alarm Lamp will light when the associated bit is active..	Inverter Failure, Fan Failure, etc.

5.4.2 Mapping Action Levels to Trap/Pager Levels:

In the Powerware PowerMIB and in the paging adapters, there are 4 levels of alarms and events defined; these are mapped to the Action Levels according to the following table:

Value	Name of Action Level	Trap / Pager Level
0	System Normal	"Informational"
2	OFF	"Informational"
3	ON	"Informational"
4	Notification	"Informational"
6	Advisory	"Informational"
8	Warning	"Minor Alarm"
10	Schedule PM	"Minor Alarm"
12	Immediate Service	"Major Alarm"
14	Non-Critical Shutdown	"Major Alarm"
16	Shutdown Required	"Critical Alarm"
18	Load Power Off	"Critical Alarm"
20	Safety Hazard	"Major Alarm"

5.4.3 "Well-Known" Traps:

When the UPS is used with SNMP adapters, it is necessary to map the Alarms and some Events to the "Well-Known" Traps of the Standard UPS MIB (RFC 1628) or the Powerware PowerMIB.
For Standard Alarms, the mapping to "Well-Known" Traps is fixed (see ConnectUPS file Alm2Msg.h).

Val	Well-Known MIB Alarm	Tag	MIB Source
0	none	WKA_NOT	
1	upsAlarmBatteryBad	WKA_BBD	RFC 1628
2	upsAlarmOnBattery	WKA_OBT	RFC 1628
3	upsAlarmLowBattery	WKA_LBT	RFC 1628
4	upsAlarmDepletedBattery	WKA_BDC	RFC 1628
5	upsAlarmTempBad	WKA_TMP	RFC 1628
6	upsAlarmInputBad	WKA_INF	RFC 1628
7	upsAlarmOutputBad	WKA_OBD	RFC 1628
8	upsAlarmOutputOverload	WKA_OOL	RFC 1628
9	upsAlarmOnBypass	WKA_OBP	RFC 1628
10	upsAlarmBypassBad	WKA_BNA	RFC 1628
11	upsAlarmOutputOffAsRequested	WKA_ORQ	RFC 1628
12	upsAlarmUpsOffAsRequested	WKA_OFR	RFC 1628
13	upsAlarmChargerFailed	WKA_RCT	RFC 1628
14	upsAlarmUpsOutputOff	WKA_NOO	RFC 1628
15	upsAlarmUpsSystemOff	WKA_OFF	RFC 1628
16	upsAlarmFanFailure	WKA_FAN	RFC 1628
17	upsAlarmFuseFailure	WKA_FUS	RFC 1628
18	upsAlarmGeneralFault	WKA_FAL	RFC 1628
19	upsAlarmDiagnosticTestFailed	WKA_TST	RFC 1628
20	upsAlarmCommunicationsLost	WKA_LST	RFC 1628
21	upsAlarmAwaitingPower	WKA_AWA	RFC 1628
22	upsAlarmShutdownPending	WKA_SDP	RFC 1628
23	upsAlarmShutdownImminent	WKA_SDI	RFC 1628
24	upsAlarmTestInProgress	WKA_TIP	RFC 1628
51	xupsBuildingAlarm	WKA_BDA	PowerMIB
52	xupsBreakerOpen	WKA_BRK	PowerMIB
53	xupsAmbientTempBad	WKA_ATB	PowerMIB

5.4.4   Active Alarms Data Block

Purpose:

The Active Alarms block consists of a byte of data for each Alarm possible for this UPS. If the value of the byte is zero then the Alarm is in the inactive (System Normal) state. A non-zero value indicates the active state, as described below. The ID block contains a bitmap of all the possible Standard Alarms in the Alarm Map section.

In XCP, Alarms differ from Status information in that "Alarms are alarming" whereas "Status is information". The consequence of this is that monitoring software actions may be driven by Alarm events, whereas actions (like Shutdown) should not be driven Status conditions.

Requesting Command:

SFD	LEN	Cmd Byte	Csum		
0xAB	0x01	0x35	XX		

Structure of Data Response:

For Data block 0x05:

Bytes	Name	Description / Values
		Section for Standard Alarms
ALM-LEN	Standard Alarm data bytes	Table of data for the Standard Alarms (one byte per Alarm)

Additional Field Descriptions:

ALM-LEN: The number of Standard Alarms presented. This count must equal the number of bits Set (valid) in the Alarm Map for this UPS.

For Standard Alarm bytes, the value of the data byte indicates the Action Level for this Alarm. A 0 value means "System Normal" (no alarm) and any other value indicates the severity of the alarm condition.

Exceptions:

Note that the Alarm Block does NOT contain the "Event Only" items marked with the "+" in the Alarm Map.
In BCM revision AE and earlier, the contents of the alarm data byte were not meaningful, except to distinguish between the 0 and "non-zero" cases. Thus, for these legacy UPSs, the data contents do not indicate Action Levels.

Example(s):

5.4.5   Alarm / Event History Log Data Block

Purpose:
The Event History Log (or "Alarm History block") is a list of the last "N" system alarms that have occurred in the past. This gives a record of which alarms have occurred, when they occurred, and when they cleared. This is generally a service level interest, to ascertain power quality characteristics, to estimate battery aging, or to record the sequence of events that led to loss of power protection.

Partial Retransmission: Since this block can be very lengthy and is more likely to experience transmission errors, it is recommended that the method for retransmission of a portion of it be implemented. The request for Event History Log is expanded to include an optional retransmission start and stop range.

Requesting Command:

SFD	LEN	Cmd Byte	Start Address	Stop Address	Csum
0xAB	0x01	0x32			XX
0xAB	0x05	0x32	xxxx	xxxx	XX

The retransmission range can start with byte #0 and ends with byte #n which contains the last byte of data.

Structure of Data Response:
The block 0x02 response can contain from 0 to 400 Alarm History entries. When this block is sent, the order of the entries is oldest first.

Each alarm consists of a 9 byte format shown in the following table. This means the size of the data block can be as much as 3600 bytes long. The length should be indicated in the Standard ID block.

Byte #	Name	Description / Values
1-2	Alarm/Event Number	<u>Bit 0</u>: Inactive/Active Flag - indicates whether this alarm or event has Occurred or has Cleared. If set to 0 the alarm has Cleared. A 1 indicates the active condition. <u>Bits 1-15</u>: Alarm/Event Number - gives number of Alarm or Event that has occurred. This value comes from the standard Alarm Map .
3	Month	Indicates the month, etc, that the alarm or event became active or cleared.
4	Day	
5	Year	
6	Hour	This is a BCD value which has a value from 0 to 23.
7	Minutes	
8	Seconds	
9	Centi-Seconds	Indicates Hundredths of Seconds (0.01s) for the time-stamp.

Additional Field Descriptions:
Bytes 3-9 in each entry give the date and time when the alarm occurred or cleared. The date and time are sent as 7 packed Binary Coded Decimal (BCD) numbers.

It is not necessary to indicate in the Alarm Map which alarms may be represented in the Event History Log , since these events have an absolute mapping defined by this specification. For example, non-alarming states like "Load On Inverter" and transient conditions like "UPS On Command" may appear in the Alarm History but not have their bit set in the Alarm Map (or, therefore, appear in the Active Alarms block).

Exceptions:
The UPS cannot update this block while in the process of transmitting it.

To insure that retransmitted data is the same as the original data, the UPS must track whether the Alarm History log has changed since the full history was last transmitted, and NACK any retransmission requests if the Alarm History has changed since the last request.

Example(s):
An entry of {0x0183, 0x03, 0x13, 0x98, 0x08, 0x57, 0x38, 0x10} indicates a Fan Failure (Alarm
193) Occurred at 8:57:38.10 AM on 3/13/1998.

As an example of requesting retransmission, if the alarm block contains 200 entries, using 9 bytes each, there are 1800 binary data bytes to be sent. This will take 1800/121 = 15 data packets. To request just the last 100 bytes (bytes 1700 through 1799) the following command would be sent:
{ 0xAB 0x05 0x32 0x06A4 0x0707 csum }

5.5   UPS Status

5.5.1   Standard UPS Status Data Block

Purpose:
The Status block shows the status of the unit, including

- Overall UPS status
- The state of breakers and outlets, rectifier, inverter, input, and output
- Basic Topology-related status: On Battery, Low Battery, Buck/Boost, On Bypass, Load Power Normal/Off
- Status of pending shutdown or startup delays

Status reporting when outlets are present:
There is a separate status block for each outlet group. Each of these status blocks contains only the status and associated timers for the specified outlet. Bytes 1-4 of these status blocks may only reflect the status of the outlet and not necessarily the status of the overall UPS. For example, the Overall UPS Status may be "On Battery" (F0) but the individual outlet status blocks may be reporting "Outlet Switch Open" (21) because their outlet switch are open.

The status of the overall UPS can still be obtained by using either the short command with no outlet number included or it can be obtained by using the long command with an outlet number of "0" specified. This overall UPS status does not take into account any timers that may be running for individual outlets.

If the UPS, independently of the outlet load groups, does not have the capability to perform timed shutdowns, startups and reboots, then the status block reported for the overall UPS will only be 4 bytes in length. In this case, the individual status blocks for the outlets would still be 20 bytes long.

Requesting Command:
One byte command for whole UPS, two byte command for specific Outlets.

SFD	LEN	Cmd Byte	Outlet #	Csum	
0xAB	0x01	0x33	(none)	XX	
0xAB	0x02	0x33	1-64, or 0 for whole UPS	XX	

Structure of Data Response:
The block 0x03 response is (using Byte # instead of Offset, in keeping with tradition of this block):

Bytes	Byte #	Name	Description / Values
1	1	Overall Status	The Byte 1 status values are listed below.
1	2	Topology Status	A bitmap of status items; it is described below
1	3	Sub-Module ID	Bits 0-6: Indicates the number of the sub-module whose Status information is given. If the sub-module ID is 0, then this unit is not a multi-module unit. Systems with sub-modules have module numbers starting with number 1, not number 0. See Select Sub-Module command. Bit 7: Undefined.
1	4	Breaker Status	A bitmap of the status of certain breakers and relays; described below
1	5	Status of On/Off Delays	A bitmap indicating which delays (and which types of delays) are pending. Described below.

6	6-11	UPS ON Delay	The delayed UPS ON Time in <u>Date:Time format</u> or minutes or seconds. If Date:Time format is used, all six bytes contain significant data. E.g., this format is (BCD values): A0 01 03 22 16 20 (for non-Julian 3/22/2001 16:20) If Minutes or Seconds format is used, only the first two bytes contain data (LSByte first) and the last four bytes are present and are filled with zeros. -1 is the appropriate value when there is no pending delay.
6	12-17	UPS OFF Delay	The delayed Load Power OFF Time in Date:Time format or minutes or seconds. Same formats as UPS ON Delay.
2	18-19	UPS Load Power Off Delay (secs)	The delay data, in seconds, for Delayed Load Power OFF and Restart value. -1 is the appropriate value when there is no pending delay.
1	20	Primary Outlet	The number, 1-64, of the main outlet or load group whose delays are being reported. Selected by the Outlet Number in the request for this block. Value is 0 if Status is being reported for the whole UPS (or sub-module). If the UPS does not have controllable Outlets, this byte should not be included in the Status block response.

Additional Field Descriptions:

BYTE 1: Overall Status

Status	Value	Comment
ON BATTERY STATUS	F0	The UPS is drawing all its power from the Battery
OUTPUT OVERLOAD	E0	Output Current is greater than 100% of the rated value
RECTIFIER OVERLOAD	D0	The Rectifier or Charger is experiencing an overcurrent condition
INVERTER RAMPING UP	90	While On Bypass or with the Output Breaker Open, the UPS is Ramping Up the Inverter's Output Voltage.
SYNCING TO BYPASS	80	The Inverter is trying to match the phase of the Bypass in preparation for a transfer to Inverter
RECTIFIER RAMPING	70	The Rectifier or Charger is turning on and establishing its normal operating point.
ON MAINTENANCE BYPASS	64	The UPS has been placed in Manual / Maintenance Bypass mode. The UPS cannot automatically switch to protect the load.
ON BUCK/REDUCER	63	A line-interactive UPS is operating on its Buck winding to reduce the Utility voltage to a normal range.
ON BOOST/STEP UP	62	A line-interactive UPS is operating on its Boost winding to increase the Utility voltage to a normal range.
ON DOUBLE BOOST	61	A line-interactive UPS is operating on its second Boost winding to further increase the Utility voltage to reach a normal range.
ON BYPASS	60	An On-Line UPS is supplying load from its automatic Bypass.
HIGH EFFICIENCY MODE	51	For Hybrid UPSs, this indicates that the UPS is System Normal but in its High Efficiency mode.
SYSTEM NORMAL	50	The UPS is in its Normal state, with no Alarms; for an On-Line UPS, this means On Inverter; for a Line-Interactive, this means straight through Utility.
UPS SUPPORTING LOAD	40	A degraded form of System Normal or UPS ON, when there is some Alarm condition, but the Load is not being immediately affected.
UPS ON	30	Similar to System Normal, but for special units that may not, for instance, have a battery or bypass installed. The Inverter is On and power is being supplied to the Load.

OUTLET SWITCH OPEN	21	The UPS is providing power, but the Outlet addressed via this Status block is open, so no power is being supplied to the Load.
OUTPUT BREAKER OPEN	20	The Inverter is On or UPS controls are powered, but the Output Breaker is open, so no power is being supplied to the Load.
MODULE FAILURE	11	Module Failure – This module can't be started.
UPS OFF	10	Most of the UPS is powered down; UPS communications are still active, and may be used to turn the UPS On.

Note that, for byte 1, more than one status may be active, however, only the highest priority status will be sent. Software should decode these Status values as part of a range of values, where the X0 value indicates the basic meaning of the Status. If a new, unknown status is used, display software should report the value at the base of the range (e.g., if 0x43 is found, report "UPS SUPPORTING LOAD " (0x40)).

BYTE2: Topology Status Bits   (0 = FALSE, 1 = TRUE)

Bit		Comment
7	Utility Present	The Utility voltage is both present AND within tolerance on voltage and frequency.
6	Rectifier On	Rectifier or Charger turned On
5	Low Battery Warning	On Battery and the Battery Time Remaining is less than the "Low Battery Warning" time
4	Inverter On	
3	On Battery	
2	On Bypass	
1	Output Breaker Closed	The breaker or relay connecting to the Output of the UPS (or the Outlet relay) is Closed when this bit is set.
0	Bypass Installed	This On-Line UPS module has a Bypass installed which can support the load when not On Inverter.

Use Byte 16 in the Configuration block to determine which of the above bits represents a valid item (e.g., whether a breaker is present in the UPS). Bit values for invalid items are effectively "Don't Cares".

BYTE4: Breaker Status   (0 = OPEN, 1 = CLOSED)

Bit	Function
7	Utility (Rectifier Input) Breaker or Relay
6	Bypass Breaker/Contactor
5	Static Switch
4	Battery Breaker or Relay
3	Inverter Output Breaker/Contactor
2	Load Breaker (in parallel systems)
1	Other Breaker #1
0	Other Breaker #2

Use Byte 17 in the Configuration block to determine which of the above bits represents a valid item (e.g., whether a breaker is present in the UPS). Bit values for invalid items are effectively "Don't Cares".

BYTE5: Status of ON/OFF Delays

Bit	Function
7	Reserved
6	"0" = Data contained in bytes 6-11 is ON delay in Minutes "1" = Data contained in bytes 6-11 is ON delay (or running AutoOn delay) in Seconds
5	"0" = Data contained in bytes 12-17 is OFF delay in Minutes "1" = Data contained in bytes 12-17 is OFF delay in Seconds
4	"0" = No Delayed Load Power Off & Restart in bytes 18-19 "1" = Data contained in bytes 18-19 is delay in seconds until Load Power Off & Restart
3	"0" = Delayed UPS ON is NOT pending (in bytes 6-11) "1" = Delayed UPS ON is pending
2	"0" = Data contained in bytes 6-11 is Date:Time ON delay "1" = Data contained in bytes 6-11 is 16-bit minutes or seconds (see bit 6)
1	"0" = Delayed Load Power OFF is NOT pending (in bytes 12-17) "1" = Delayed Load Power OFF is pending
0	"0" = Data contained in bytes 12-17 is Date:Time OFF delay "1" = Data contained in bytes 12-17 is 16-bit minutes or seconds (see bit 5)

Exceptions:

Bytes 3 through 19 may not be present in all units. Bytes after 19 were added after BCM rev AE. The SIZE field of this packet can be used to determine the number of bytes present.

Added Byte5, bits 5 and 6 definitions at XCP Rev A.

When a UPS has individually controlled Outlets, and thus supports the Outlet Monitoring block and individual Outlet Status blocks, the whole UPS Status should only consist of the first 4 bytes; this is because it is difficult to say which delay values should be used. However, when all Outlets are open, this Status should reflect that, with Overall Status Byte 1 value of "Output Breaker Open" (0x20) or "UPS Off" (0x10), as appropriate.

The Load Power Off & Restart delay in bytes 18-19 is set only by the Load Power Off & Restart command (0x8A).

The contents of the Status blocks for individual Outlets must be coordinated with the OUTL STATEn values in the Outlet Monitoring block (e.g., indicate "On with Pending OFF" when there is a pending shutdown).

Example(s):

5.5.2   Outlet Monitoring Block

Purpose:
The Outlet Monitoring Block provides data on the state of the outlets (receptacles or load groups) for a UPS, PDM, or receptacle controller. Each Outlet may control one or more physical outlets.
The Auto ON / OFF delays can be set with the Set Outlet Parameter command.

Requesting Command:

LEN	Cmd Byte	Parameters				
0x01	0x41	(none)				

Structure of Data Response:
The block 0x11 response is:

Bytes	Name	Description / Values
1	NUM OUTLS	Number of Outlets associated with this UPS; the minimum if this block is implemented is 2.
1	SIZE OUTL	The number of bytes in each Outlet's entry; currently = 6.
		Each Outlet's entry consists of
1@	OUTLn	The number of the Outlet in this entry.
1@	OUTL STATEn	Current State of the Outlet: 1 = On/Closed, 2 = Off/Open, 3 = On with Pending Off, 4 = Off with Pending On, 5 = Unknown, 6= Reserved/Unknown, 7= Failed and Closed, 8=Failed and Open
2@	AutoOFF DLYn	Seconds delay after the UPS goes On Battery before the Output is Automatically turned OFF. A value of -1 means that this Output should never be turned Off automatically, but must be turned Off only by command. 16-bit integer, LSByte first.
2@	AutoON DLYn	Seconds delay after the Outlet is signaled to turn On before the Output is Automatically turned ON. A value of -1 means that this Output should never be turned On automatically, but must remain Off and be turned On only by command. 16-bit integer, LSByte first.

Additional Field Descriptions:
The AutoOFF DLYn can be used to prioritize loads in the event of a prolonged power outage; less critical loads will turn off earlier to extend battery time for the more critical loads. If the utility power is restored before the AutoOff delay counts down to 0 on an outlet, that outlet will not turn Off.

AutoOn delay has three purposes:
1. To coordinate the automatic startup of various outlets, when the normal auto-sequencing of 1 second per outlet is not adequate. For example, they may be used to power up hard disk arrays before CPU units are started.
2. To force additional "Down Time" during Load Power Off and Restart (0x8A) commands for equipment to be reset, when the standard "Down Time" is not long enough.
3. For the –1 value, to ensure that loads won't be powered until commanded, following power-up or a Load Power Off & Restart command.

The recommended defaults are AutoOFF DLYn = -1 and AutoON DLYn = 0. These parameters are set by the Set Outlet Parameter command.

The OUTL STATEn field should be coordinated with the fields in the Status block for this Outlet (eg, correct overall Status byte, pending delays indicated).

Exceptions:
This block was added at revision AE of this Specification; UPSs conforming to earlier revisions do not implement this block.

In BCM rev AE only, the Outlets 1 to n were numbered 11 to n+10 in this block (and the Set Outlet Parameter command).

Example(s):

5.6   Utility Statistics Data block

Purpose:

The Statistics block provides data on the utility power quality for the past month and since the last statistics reset for such parameters as number of times on battery for x minutes, how long the UPS has been operating or how long on battery, what the utility frequency deviations have been, and what the utility and UPS availability have been. Provision for some load statistics is also made.

Requesting Command:

LEN	Cmd Byte	Parameters				
0x01	0x38	(none)				

Structure of Data Response:

The block 0x08 response is dependent upon which Statistics are available in this UPS. Available measures are indicated by the Statistics Map in the ID block. Each measure is a 4-byte value whose format is given in the Statistics Map.

Additional Field Descriptions:

To provide MIB compliance, a measure of UpsLineBads (times the UPS went to Battery) is necessary; Statistic #36, " Total   # times utility was not available", is useful for this; finer resolution and rough estimates of Battery aging can be provided by implementing Statistics 2, 4, 6, 8, and 10 (On Battery total counts).

Exceptions:

If the Statistics Map size is 0, then this block is not implemented.

Example(s):

5.7   Battery data block

Purpose:

The battery test data block provides
- Results of the last Battery Test (sampled utility voltage, input voltage and battery data from two samples)
- Status of any reporting external battery cabinets.
- ABM Status of the main and any reporting external battery cabinets.
- IBVM data per string: Battery Health, Battery Voltage, Current and Temperature readings

Requesting Command:

SFD	LEN	Cmd Byte	Csum		
0xAB	0x01	0x3B	XX		

Structure of Data Response:

Positions in this block are not fixed, so it should be parsed.   Note that the number of strings may vary dynamically, shortening or lengthening this block.

The last known results are reported in this block.

Unimplemented readings will be represented with a 0 value, which is not a valid value for any of the readings in this block.

The block 0x0B response is:

Bytes	Name	Description / Values
1	Battery Status	See table below
4	Battery Volts at T1	32-bit floating point Battery Voltage at time T1 (start of test period, after initial delay time) in the Battery Test
4	Battery Volts at T2	32-bit floating point Battery Voltage at time T2 (end) in the Battery Test
1	Test Duration	Number of seconds between the sampling times T1 and T2
4	Utility Voltage / Battery Current at T1	32-bit floating point Input Voltage measured before starting Battery Test, or overall Battery Current at time T1
4	Input Current / Battery Current at T2	32-bit floating point Input Current measured before starting Battery Test, or overall Battery Current at time T2
1	Number of Battery Cabinets or Strings	The number of battery cabinets or strings reporting their status (from 0 up to a maximum of64)
1@	Cabinet or String Status Entry	The Battery Status of each battery cabinet or string (same values as for the Battery Status byte). There is one byte for each cabinet indicated by the Number of Battery Cabinets byte.
1	Number of ABM Statuses	The number of battery cabinets reporting ABM (Advanced Battery Management) Status. Normally either 1 or (Number of Battery Cabinets + 1), where the 1 is for the main UPS battery. 0 means there is no ABM status available. Individual strings within a cabinet do not report individual ABM statuses, since they share one charger and thus all have the same ABM status.
1@	ABM Status Entry	The ABM status of each reporting battery cabinet. ABM Status values are: 1 = Charging, 2 = Discharging, 3 = Floating, 4 = Resting, 5 = Unknown
1	Number of IBVM entries	Number of IBVM data row entries which will follow. The Status of each string has been given in the table of Cabinet or String Statuses above.
		The data that follows are the fields for each IBVM row entry.
1@	Length of this IBVM row	Number of bytes to follow for this row entry for IBVM data for this Battery String.

	entry	The length of each string's entry may be different. Battery Strings which are Not Installed would normally report 0 length. If the String was Removed, or added, the length would normally change from normal length to 0, or from 0 to normal length, respectively. However, some UPSs may implement disconnected strings with the same byte length as installed strings, but will have 0 in all fields. External Battery Strings may have very limited data.
2@	IBVM String ID	Two ASCII characters, normally I1 to Ix for Internal Strings and E1 to Ex for External Strings, but may use other characters as appropriate. The String ID is given with the first character in the first byte of this field
1@	String Battery Health	Non-dimensional measure of Battery Health. 100 is a full capacity, new battery.
1@	String Temperature	Temperature Reading in deg C for the string
4@	String Battery Current	32-bit floating point (live) reading for the Battery Current
1@	Number of Battery Voltage Readings	Number of Individual Battery Voltage Readings which follow
4@@	Individual Battery Voltage Readings	32-bit floating point (live) readings for the Voltage at each Battery in the string

Additional Field Descriptions:

The 1-byte Battery Status values are:

Value	Meaning
0	No test has been requested since control power on
1	Battery test IN PROGRESS - Test data is being updated
2	Battery test has completed - data IS valid; batteries PASSED the test
3	Test ABORTED - test could not be performed at this time (e.g., because UPS is already On Battery, or battery not presently charged). In some implementations, the test has been scheduled and will begin when batteries have been fully charged. Test data represents previous test results.
4	Bad battery has been detected (test FAILED)
5	Test SCHEDULED – The Test could not be performed at this time, but will be performed at some future point when the system has the proper conditions (e.g., full battery charge). Test data represents previous test results
6	Battery String Removed– The string was present previously, but it has now been removed. There will be no (valid) IBVM data from this string.
7	Battery String Not Installed – The string was not installed at the last power up. There will be no (valid) IBVM data from this string.

The "Test data" refers to the first 6 fields, which are always present; on simple UPSs, the meter readings may be all 0s.

If there are multiple IBVM strings, then the overall Battery Status should not indicate FAILED unless all of the Battery strings fail.

Floating ABM status means that the charger is temporarily charging the battery to its float voltage (similar to equalizing the batteries).
Resting is the state when the charger is disabled or the battery is fully charged and none of the other actions (charging/discharging/floating) is being done.

Exceptions:
Battery Test requests the unit to go on battery for a period of time to determine the state of the battery. The UPS will determine whether the Battery test can be performed at that time.

In the case where a Battery Test is aborted or cannot be initiated, the UPS should continue to report the STAT as "test aborted" until another Battery Test is initiated.

The original specification called for Input Volts and Current right before the test to be reported; some later implementations report Battery Current at times T1 and T2. This latter data is combined with the Battery Voltage readings at T1 and T2 to compute the battery impedance, $\Delta V/\Delta I$.

Example(s):
In the case where a UPS has Internal Battery Strings 1, 2, and 4, each consisting of 4 batteries, with Internal Battery String 3 Removed, plus one External Battery Cabinet (with little data reporting), the resulting Battery Data block would look like:

1	4	4	1	4	4	(bytes)	
Ovr-Sts	V-T1	V-T2	t-Dur	V-Util	I-Inp	(Test data)	
2	48.0	47.5	30	230.0	14.2		

1	1	1	1	1	1	(bytes)
N-Str	Sts-1	Sts-2	Sts-3	Sts-4	Sts-E1	(Table of 5 entries)
5	2	2	6	2	2	(all installed passed, I3 Removed)

1	1	(bytes)
N-ABM	ABM	
1	4	(Only 1 ABM: Resting)

1	(bytes)
N-IBVM	
5	(Table of 5 IBVM entries to follow)

1	2	1	1	4	1	4	4	4	4
Len	ID	Health	Temp	I-Batt	N-Batts	V-B1	V-B2	V-B3	V-B4
25	I1	100	37	1.2	4	11.8	11.9	12.0	12.1

1	2	1	1	4	1	4	4	4	4
Len	ID	Health	Temp	I-Batt	N-Batts	V-B1	V-B2	V-B3	V-B4
25	I2	100	37	1.2	4	11.8	11.9	12.0	12.1

1	
Len	
0	(I3 is Removed at this time)

1	2	1	1	4	1	4	4	4	4
Len	ID	Health	Temp	I-Batt	N-Batts	V-B1	V-B2	V-B3	V-B4
25	I4	100	37	1.2	4	11.8	11.9	12.0	12.1

1	2	
Len	ID	
2	E1	(no data except Status given above)

Exceptions:
The IBVM data was added to this block at XCP Rev C.

5.8   Test Results Data Block

Purpose:

The Test Results Data block provides results of any requested Systems Tests. These tests are initiated by the Request Systems Test command.

Requesting Command:

SFD	LEN	Cmd Byte	Csum		
0xAB	0x01	0x3F	XX		

Structure of Data Response:

This block should be parsed, as it may contain information from more than one module.
The last known results are reported in this block.
Unimplemented readings will be represented with a 0 value, which is not a valid value for any of the readings in this block.
The block 0x0F response is:

Bytes	Name	Description / Values
1	Number of Modules	The Number of Modules reporting results of Systems Tests (from 0 up to a maximum of 16)
1	Result Entry Length	How many bytes reported below for each module's results (currently only two bytes are defined)
1@	Test Results Status	The Results of the Last Test run for each module.
1@	Number of Last Test	The Test Number of the Last Test run for each module.

Additional Field Descriptions:

The 1-byte Test Results Status values are:

Value	Meaning
0	No test has been requested since control power on
1	Systems test IN PROGRESS - data is NOT valid
2	Systems test PASSED
3	Test ABORTED - test could not be performed at this time (e.g., because UPS is On Battery)
4	Systems Test FAILED)

The currently defined Test Numbers are:
5.8.1.1.1.1.1   01: Initiate General Systems Test
5.8.1.1.1.1.2   02: Schedule Battery Commissioning Test
                  5.8.1.1.1.1.3   03: Test Alternate AC Input
                       04: Flash the Lights Test

Exceptions:

In the case where a Systems Test was aborted or could not be initiated, the UPS should continue to report the Status as "test aborted" until another General Systems Test is initiated.

Example(s):

6 Control and Configuration Commands

All of the commands described in this section cause some action of the UPS. In this, they are different than the Data block requests described in the last section. Two other differences that apply to all these control commands, *unless otherwise noted*, are:

1. Each of these commands must be immediately preceded by an authorization command (either standard Auth block or, for ACM or NetBCM, Password Authorization block.

2. The response to each of these commands is the Command Acknowledge (ACK) block.

6.1 Load Control Commands

The Load Control commands are BRIEFLY described in this section. For full behavioral details, see document Outlet Control Logic.doc.
The distinguishing features of these commands are:

*   used to turn the UPS On or Off, or put it On Bypass

*   with or without delays

*   delays in minutes or seconds or date & time

*   with or without restart after the UPS turns Off

*   action / countdown commences on command or automatically

*   action directed to the whole UPS or to an individual Outlet ("Load Group")

*   whether or not the command can be aborted while counting down

*   For Outlets, followed by optional AutoOn or sequence delay

Recommendations:
1. For shutdown while On Battery, normally use the Delayed Load Power Off & Restart command, so the UPS will automatically turn back On when utility power is restored.
2. For scheduled shutdowns, use whichever commands are (most easily) implemented in the UPS:
    Scheduled UPS Off in "n" Minutes and Scheduled UPS On in "n" Minutes Scheduled UPS Off and On at Date & Time
3. For quickly turning the UPS On or Off, use the immediate UPS On or Off commands. These are basically special cases of the Scheduled On / Off commands, with delay of 0.
4. The UPS should not automatically restart after executing an immediate or Scheduled Off command; the intent is to turn the UPS Off until commanded to turn it back On. However, if an On delay is scheduled, the UPS will come back On after that delay elapses.
5. For controlling individual Outlets, on UPSs which permit this control, the best approach is to use the above commands with the optional Outlet address field. However, some UPSs may have Outlets that can only be controlled via the Set Outlet Parameter command.
6. For UPSs with Outlet control, not specifying an Outlet address or specifying an Outlet address of 255 directs the UPS to apply the command to ALL Outlets.
7. The Conditional Delayed Load Power Off & Restart command is not recommended for shutdown software, and it is not widely implemented.

The results of these commands, and any pending On/Off actions, may be monitored via the Status block or the Outlet Monitoring block.

6.1.1   Delayed Load Power Off & Restart Command

Purpose:
This is the command most often used by shutdown software to turn off the load power.
The UPS will remove load power after the specified delay (in seconds), and then will restore load power:
1.   When the Utility Input is within an acceptable range, AND
2.   After the Utility Stabilization delay (from the Extended Limits block), AND
3.   After a UPS-dependent internal start-up delay

Control Command:
The length byte specifies which fields are present.

SFD	LEN	Cmd Byte	Delay Secs		Outlet #	Csum
0xAB	0x02	0x8A	0-255			XX
0xAB	0x03	0x8A	0-65,534			XX
0xAB	0x04	0x8A	0-65,534		1-64, 255	XX

Additional Field Descriptions:
The DELAY Seconds data field is
         a) one byte with a range of 0 to 255 seconds (for a maximum delay of 4 minutes, 15 seconds), or
         b) two bytes with a range of 0 to 65,534 seconds (if size = 3 or 4)

When the length is 4 bytes, then the 4th byte specifies the number of the Outlet that is to be controlled by this command. An Outlet address of 255 directs the command to be applied to ALL Outlets.

UPS Action/Response:
This command might cancel any commands already issued with pending On/Off action (Delayed UPS On/Off for "n" Minutes or until Date & Time).
The pending delay must be reported as the UPS Load Power Off Delay (bytes 18-19) in the Status Block.
Once issued, this command cannot be canceled (except by the Off or On buttons or EPO).   However, the delay may be increased by a subsequent 0x8A command with a longer delay.

The Utility Stabilization delay plus the internal start-up delay make up the "Down Time" that the output is Off. The "Down Time" must be a minimum of 5-10 seconds, to give powered equipment sufficient time to do a full power-off reset.

For Outlets, the AutoOn delay is added to the "Down Time".

Exceptions:
Some UPSs may implement only the 2 or 3 byte length. For all new designs, the length of 3 bytes (4 bytes for Outlet control) is strongly recommended.
The 4th byte for Outlets is added at XCP rev A.

Example(s):

Load Power Off & Restart is the most important shutdown command. It cannot be overriden or replaced by other shutdown commands, like the 0x8B, 0x93 or 0x97:3. The simple priority list, showing which can pre-empt which commands, is:

Command (Hex value)	Can Pre-empt Command:
Off / On Button or EPO	All others
Load Power Off & Restart (0x8A)	Shorter 0x8A delays Other Pending Off commands (93, 94, 97:3)
Immediate Power Off (0x8B) Off in "n" Minutes (0x93) Off by Date & Time (0x94) Outlet Off Paramter (0x97:3)	Only can replace other command delays in this group (93, 94, 97:3)

6.1.2   Scheduled UPS On / Off in "n" Minutes

Purpose:
These two commands are often used by shutdown software to schedule regular, long-term shutdowns and subsequent restarts; one application is to turn the UPS Off at the end of the work day to conserve energy costs. A UPS which implements the Scheduled Off command will normally also implement the Scheduled On command.

Control Command: Scheduled UPS **ON** in "n" Minutes

SFD	LEN	Cmd Byte	Delay Mins	Outlet #	Csum	
0xAB	0x03	0x91	0-65530		XX	
0xAB	0x04	0x91	0-65530	1-64, 255	XX	

Control Command: Scheduled UPS **OFF** in "n" Minutes

SFD	LEN	Cmd Byte	Delay Mins	Outlet #	Csum	
0xAB	0x03	0x93	0-65530		XX	
0xAB	0x04	0x93	0-65530	1-64, 255	XX	

Additional Field Descriptions:
The DELAY Minutes data field is two bytes (LS byte first) with a range of 0 to 65530 minutes. This allows for up to a 65530 minute delay (approximately 45 days).

Time delays for both Scheduled On/Off commands is relative to "now". The On or Off delay countdown commences immediately after the command is sent.

Setting the delay time to zero is a special case which causes any pending "delayed UPS On / Off for n minutes" commands to be aborted (cleared).

When the length is 4 bytes, then the 4th byte specifies the number of the Outlet that is to be controlled by this command. An Outlet address of 255 directs the command to be applied to ALL Outlets.

UPS Action/Response:
The pending delay may be reported as the UPS On (bytes 6-11) or UPS Off Delay (bytes 12-17) in the Status Block.
When the On delay countdown has completed for an Outlet, it must then execute the AutoOn delay before turning On.

Exceptions:
In some UPS implementations, the command may be carried out 0-59 seconds sooner than implied by the command; make allowance for this error in the choice of delay time.

The 4th byte is added at XCP rev A.

Example(s):

6.1.3   Schedule UPS On / Off at Date & Time

Purpose:
These two commands are often used by shutdown software to schedule regular, long-term shutdowns and subsequent restarts; one application is to turn the UPS Off at the end of the work day to conserve energy costs.

Control Command: Schedule UPS **ON** at Date & Time

SFD	LEN	Cmd Byte	Delay Date	Delay Time	Outlet #	Csum	
0xAB	0x07	0x92	FYY YY MM DD	HH MM		XX	
0xAB	0x08	0x92	FYY YY MM DD	HH MM	1-64, 255	XX	
1	1	1	4	2	1	1	(Bytes)

Control Command: Schedule UPS **OFF** at Date & Time

SFD	LEN	Cmd Byte	Delay Date	Delay Time	Outlet #	Csum	
0xAB	0x07	0x94	FYY YY MM DD	HH MM		XX	
0xAB	0x08	0x94	FYY YY MM DD	HH MM	1-64, 255	XX	
1	1	1	4	2	1	1	(Bytes)

Additional Field Descriptions:
The DATE data field is four bytes using the standard Date format and the TIME data field is the first two bytes (hours & minutes) of the standard Time format.
The order is reversed from their Meters formats, however; the DATE and TIME fields are formatted so that the byte immediately following the "92h" code byte is the most significant byte of the year variable and the byte immediately preceding the checksum or Outlet Number byte is the least significant byte of the time variable (Minutes).

The On or Off delay countdown commences immediately after the command is sent.

Setting the delay fields to zero is a special case which causes any pending "delayed UPS On / Off at Date & Time" commands to be aborted (cleared).

When the length is 8 bytes, then the 8th byte specifies the number of the Outlet that is to be controlled by this command. An Outlet address of 255 directs the command to be applied to ALL Outlets.

UPS Action/Response:
The pending delay may be reported as the UPS On (bytes 6-11) or UPS Off Delay (bytes 12-17) in the Status Block.
When the On delay countdown has completed for an Outlet, it must then execute the AutoOn delay before turning On.

Recommendations for UPS developers:
1. It is preferred that Load Power Off & Restart commands don't clear the On / Off by Date & Time delays.
2. At Power-up, check to see if a scheduled On/Off by Date & Time should have been executed and take the appropriate action.
3. Store these delays in non-volatile memory so that the user's intention is retained through any power losses.

Exceptions:
Only some UPSs with Real-Time Clock capability implement this command.

The 8th byte is added at XCP rev A.

Example(s):
For Schedule Outlet #2 **OFF** at (Gregorian or non-Julian) March 16, 2001, 17:30:

SFD	LEN	Cmd Byte	Delay Date				Delay Time		Outlet #
0xAB	0x07	0x94	0xA0	0x01	0x03	0x16	0x17	0x30	0x02

6.1.4   UPS On / Off Commands

Purpose:
The "UPS ON" command causes the UPS (or Outlet) to immediately go from any state (except one which requires a manual reset) to "System Normal" or "UPS supplying load".

The "UPS Off / Load Power Off" command (formerly called "Load Dump") is the immediate mode version of "Delayed UPS OFF until Date & Time" and "Delayed UPS OFF for "n" Minutes" and is the logical complement of "UPS ON". It does not cause the UPS to go to Bypass.

Control Command: UPS **ON**

SFD	LEN	Cmd Byte	Outlet #	Csum		
0xAB	0x01	0x89		XX		
0xAB	0x02	0x89	1-64, 255	XX		

Control Command: UPS **OFF** / Load Power Off

SFD	LEN	Cmd Byte	Outlet #	Csum		
0xAB	0x01	0x8B		XX		
0xAB	0x02	0x8B	1-64, 255	XX		

Additional Field Descriptions:
When the length is 2 bytes, then the 2nd byte specifies the number of the Outlet that is to be controlled by this command. An Outlet address of 255 directs the command to be applied to ALL Outlets.

UPS Action/Response:
When the On command is for an Outlet, it must then execute the AutoOn delay before turning On.

Exceptions:
The 2nd byte is added at XCP rev A.

Example(s):

6.1.5   Set Outlet Parameter

Purpose:
The Set Outlet Parameter is used to manage fields in the Outlet Monitoring block. It is most commonly used to set the automatic On/Off delays for the Outlets. It may also be used (by a central management station) to turn Outlets On or Off, singly or all together. However, the normal route for controlling outlets (by their supported loads) should be to use the regular load control commands with the Outlet Number extension.

Control Command:

SFD	LEN	Cmd Byte	PARAM	Outlet Number	Value	Csum
0xAB	0x05	0x97	pp	nn	-1 to 32767	XX

Additional Field Descriptions:
The list of Parameters which may be set are:

PARAM	Function	Normal Values
1	Set Automatic Off Delay of Outlet nn	30-32767 seconds; -1 means no Auto Off Delay (outlet won't turn Off while On Battery until commanded) (0-30 are valid but ill-advised) This is the "AutoOFF DLYn" reported in the Outlet Monitoring block.
2	Set Automatic On Delay of Outlet nn	0-32767seconds; -1 means no Automatic Restart (outlet won't turn On until commanded at Powerup or after Load Power Off & Restart command executes) This is the "AutoON DLYn" reported in the Outlet Monitoring block. Non-zero values of AutoOn delay specify how many seconds to wait after an On event before actually turning the Outlet On. 0 is a special case which normally means to just use the default outlet sequence delay after an On event before actually turning the Outlet On.
3	Turn Outlet nn Off with Delay	0 - 32767 seconds 0 means Abort countdown
4	Turn Outlet nn On with Delay	0 - 32767 seconds 0 means Abort countdown

Outlets are numbered 1 to n for this command.

If an Outlet Address of 255 is used, it means "All Outlets" (The UPS may implement All On/Off sequentially, rather than simultaneously)

When set, the first two parameters are to be stored permanently in the UPS as configuration; the second two cause the selected action after the given delay.

The Automatic Off delay is timed from when the UPS first goes On Battery; when the UPS has been On Battery for a duration equal to the programmed Automatic Off delay, that Outlet will be turned off. If the utility power is restored before the countdown completes, the Outlet will not be turned Off.

The Automatic On delay is timed from when the UPS is first turned On, either by power-up, by command, or by pushing the On button. If there is a pending (scheduled) On delay, this automatic delay is added to it. See document Outlet Control Logic.doc for a much fuller treatment of this parameter's operation.

UPS Action/Response:
When the Outlet On delay countdown has completed, it must then execute the AutoOn delay before turning On.

Exceptions:
All unused Outlet Numbers have no meaning, and the command will be NACK'd with the Bad Parameter response.

In BCM rev AE, the Outlet addressing for Outlets 1 to n was done as 11 to 10+n.

Example(s):

6.1.6   Go To Bypass Command

Purpose:
The "Go To Bypass" command causes the UPS to transfer the load from the inverter to the bypass.

Control Command:

SFD	LEN	Cmd Byte	Delay Secs	Csum		
0xAB	0x01	0x88		XX		
0xAB	0x03	0x88	0-65530	XX		

Additional Field Descriptions:
If the length is 3 bytes, then a delay (in seconds) is given for going to Bypass.

UPS Action/Response:

Exceptions:
If the bypass is "not available", the implementation of the UPS control firmware will determine if this action is taken or not. If this action is not taken, then the BUSY NACK response must be issued by the UPS.
At one time, this command was called "UPS Off" because it turned the Inverter Off and went to Bypass.
The optional delay field was added at XCP rev A.

Example(s):

6.2 UPS Test Commands

6.2.1 Initiate Battery Test

Purpose:
Battery Test causes the unit to go on battery for a period of time to determine the state of the battery. This period is approximately the sum of "Start Delay" and "Duration".
The results of the test can be examined with the Battery Data block.

Control Command:

SFD	LEN	Cmd Byte	Start Delay Secs	Duration Secs	Csum	
0xAB	0x03	0xB1	1 - 255	1 - 255	XX	

Additional Field Descriptions:
"Start Delay" and "Duration" are 8-bit integers (a single byte each) that contain a time value expressed in seconds. "Start Delay" is the time to delay after going on battery before the UPS takes the first reading. "Duration" is the interval between the first and the second readings.

UPS Action/Response:
A "Control Command Acknowledge Block" should be sent (immediately) in response to this command.
If the test cannot be initiated at this time, the UPS may respond with the "BUSY" Acknowledgement Block, and subsequent Battery Test Data blocks will indicate a value of "test aborted (3)".

For UPS systems that perform a precise Battery Test that cannot be carried out immediately (e.g., for DC Expert, where a full battery charge is required), this command may result in a Battery Data Status value of "5 – SCHEDULED" until the test is performed. There may be a delay of many hours to a few days before this test occurs.

Exceptions:
In some early UPS implementations, for the case when the test cannot be initiated, the UPS incorrectly responds with a Battery Test Data block (instead of the Acknowledgement block) indicating that the test was aborted.

Example(s):
The command values commonly used are {0x03, 0xB1, 0x0A, 0x1E} for 10 sec Start Delay and 30 sec test Duration.

6.2.2   Request Systems Test Command

Purpose:
The Request a Systems Test command is used to request specific tests of the UPS system. The following tests are currently defined
>   01: Initiate General Systems Test
>   02: Schedule Battery Commissioning Test
>   03: Test Alternate AC Input
>   04: Flash the Lights Test
>   FF: Report Systems Test Capabilities

Control Command:

	SFD	LEN	Cmd Byte	Test Type	Param	Csum	
	0xAB	0x02	0xB2	1,2,3, FF		XX	
	0xAB	0x03	0xB2	4	nnn	XX	
(Bytes)	1	1	1	1	1	1	

Additional Field Descriptions:
"Test Type" has the following defined values:
1)   General Systems Test
    UPS MIB type General Test of all main subsystems (especially important for Line-Interactive UPSs)
General Systems Test causes the unit to quickly assess the UPS's ability to perform its critical function of providing backup power in case of power failure. It does this by testing the subsystems indicated by the value of Test Type. The results of the test can be examined with the Test Results block. If the test cannot be initiated at this time, the UPS will respond with the "BUSY" Acknowledgment Block, and subsequent Test Results Data blocks will indicate a value of "test aborted (3)" in the MODn RESU field for the selected submodule.

2)   Schedule Battery Commissioning Test
This command requests that a Battery Test be scheduled to occur when the UPS has the correct conditions to perform the test. When scheduled, the Overall Battery Status will have a value of "5 – SCHEDULED" until the test is performed. There may be a delay of many hours to a few days before this test occurs.

3)   Test Alternate AC Input
This command requests that the UPS switch to its Alternate AC Input for a short time, just to verify that the alternate utility source is good (or not) and that the input switching circuit is working properly. If the alternate utility source is out of tolerance, the UPS will drop on Battery until it can switch back to the main utility source. The duration of this test is not defined, and is set by the UPS.

4)   Flash the Lights Test
Causes the UPS to Flash all of its LEDs On and Off, and activate the Horn while the LEDs are On, for the number of times indicated by the Param value in the command. The UPS designer may choose the period and duty cycle of the Flashing event to be both convenient to implement and pleasing to the operator (e.g., 1 second On and 1 second Off).
This test is used to validate the software link to a particular UPS (making sure it is the right one!) and to help locate one UPS module among a large amount of other equipment.
The result of this test is always a Pass, unless the test cannot be performed.

FF) Report Systems Test Capabilities
This command will also respond to a Test Type of FF with a list of the implemented Test Types, where the ACK response contains a list of the implemented parameters; e.g.,

---

SFD	BLK	LEN	SEQ	ACK	Command Echo		Test Types List					
0xAB	09	07	0x81	0x31	0xB2	0xFF	0x01	0x02	0x03	0x04		

UPS Action/Response:
A "Control Command Acknowledge Block" should be sent immediately in response to this command.

Exceptions:
Tests 02 Battery Commissioning Test, 03 Test Alternate AC Input, 04 Flash the Lights Test, and FF Report Capabilities were added at XCP Rev C.

Example(s):

6.3   Configuration Change Commands

6.3.1   Set Config Parameter

Purpose:
Command to change UPS configurable parameters. Most of these parameters are listed in the Extended Limits block, though a few occur in the Config block.

Control Command:

SFD	LEN	Cmd Byte	Parameters	New Value	Csum	
0xAB	0x04	0x95	1-19, 0x80-0xAF, 0xFF	Xxxx (16 bits)	XX	

Additional Field Descriptions:
PARAM is a one-byte value that indicates which parameter to be set.
New Value is a two-byte Integer with the desired replacement value.

Single byte values are to be placed in the LSB, and the MSB should be zero.

The "well-known" codes for PARAM, and the corresponding legitimate ranges (anticipated values), are:

List of Well-Known (Standard) Parameters

PARAM	Config Variable	Normal Values
1	Bypass/Utility Freq Dev Limit	0-500 Hz/100
2	Bypass Volt Low Dev	0-460 V rms
3	Bypass Volt High Dev	110-540 V rms
4	Bypass/UtilityPhase Dev Limit	5-120 degrees
5	Low Batt Minutes Remaining	1-30 minutes
6	Horn Status	0 to disable, 1 to enable, 2 to mute alarm
7	Utility Return Stabilization Delay	1-18000 seconds
8	Minimum Battery Capacity for Return	0-100 %
9	Ambient Temperature Lower Alarm Limit	10 °C
10	Ambient Temperature Upper Alarm Limit	40 °C
11	Nominal Output Voltage	0-460 V rms, or 0xFFFF for AutoDetect
12	Misc Configuration Flags	Flag bits as described in the Extended Limits block. Only LSB is usable for bit-maps.
13	Percent Load for Sleep	0 – 100%. Maximum % load at which the UPS may still enter the power-saving Sleep mode (turning off Outlets) while On Battery. A value of 0 means that Sleep mode is disabled.
14	Onset Delay for Sleep	0 – 255. Number of minutes to wait when On Battery before initiating Sleep mode. 0 means that Sleep mode is disabled.
15	Battery Data1 set	Sets Byte 26 of Battery Data in the Config block: Number of Internal and External Strings.
16	Output Voltage Low Deviation Limit	Lower limit for acceptable Output Voltage (V rms)
17	Output Voltage High Deviation Limit	(V rms)

18	Nominal Battery Voltage	For the full battery string, Vdc.
19	Max Battery Equalize Voltage	Highest voltage that the battery is charged to, Vdc.
20 – 0x7F	Future Standard Parameters	
0x80-AF	Custom Parameters	Defined for each UPS in its XCP Compliance Document
0xB0-FE	Reserved Parameters	
0xFF	Capabilities List	

Only the LSB is writeable for bit-map parameters. When setting the bit-map parameters, the MSB should be zero. When read in the Extended Limits block, the MSB shows the valid parameter bits.

When PARAM is 0xFF, this indicates that the UPS must list in the response which writeable PARAM values it has implemented. The New Value field should be 0 in this case. The Parameters might not be listed in numerical order.

UPS Action/Response:
The UPS will set the value (which can be checked in the configuration blocks) if it can, or will alter the value to the nearest supported one, or else will reject the command.

Exceptions:
Not all UPSs will allow all listed PARAM values to be set; see the XCP spec for the individual UPS for compliance. A UPS may implement any of these well-known codes, and may furthermore stipulate the conditions under which they can be changed (e.g., "the UPS must be On Inverter before changing Bypass Frequency Deviation Limits").

A UPS may implement none, one, or several custom parameters. The meaning of the custom parameters are implementation defined; see the XCP Compliance document for the individual UPS.

A UPS may implement several authorization levels. The level is set by the Authorization Block used (Standard Authorization or Password Authorization with different passwords for each level) sent before the Set Config Parameter command. It is defined in the implementation which level is required for writing a parameter. The writable parameter list (PARAM = 0xFF) lists only the parameters that are writable on the given authorization level.

Example(s):
For the PARAM = 0xFF capabilities request, the Command Response, for a UPS which implements writeable Params 5-6, 9-10, 0x81 and 0x86 would be :

SFD	BLK	LEN	SEQ	ACK	Command Echo		Capabilities List					
0xAB	09	09	0x81	0x31	0x95	0xFF	0x05	0x06	0x09	0x0A	0x81	0x86

6.3.2   Set Communication Parameter

Purpose:
Command to change the Communication mode of the UPS.

Control Command:

SFD	LEN	Cmd Byte	Comm Port	PARAM	New Value	Csum
0xAB	0x05	0x98	0, 1-n	1-6, FF	xxxx	XX

Additional Field Descriptions:
Comm Port indicates which Port's data is to be changed. 0 means "this" port; other values address specific ports. The first Comm Port ID = 1.
PARAM is a one-byte value which indicates the Communication parameter to be set.
New Value is a two-byte Integer with the desired replacement value.

Single byte values are to be placed in the LSB, and the MSB should be zero.

The "well-known" codes for PARAM, and the corresponding legitimate ranges (anticipated values), are:

PARAM	Config Variable	Normal Values
1	Baud Rate	300-19200
2	Stop Bits	0 = 1 stop bit 1 = 2 stop bits
3	Data Bits	0 = 7 data bits 1 = 8 data bits
4	Parity	000b = none 001b = odd 010b = even 011b = mark 100b = space
5	Assign Outlet to Comm Port	1-64
6	De-assign Outlet from Comm Port	1-64
7	Port Usage: Reset the port to any of these values from the Comm Port List's Port Usage assignments	0 = Reset port to Unknown usage 2 = Reset to Waiting to communicate with a UPS 4 = Reset to Waiting to communicate with software or adapter
0xFF	Capabilities List	

When PARAM is 0xFF, this indicates that the UPS must list in the response how many Comm Ports there are and which PARAM values it has implemented. The Comm Port and New Value fields should be 0 in this case. The Parameters might not be listed in numerical order.

UPS Action/Response:
When the baud rate is to be changed, the UPS should first send the Command Response at the old baud rate, then make the transition to the new baud rate.

When a serial parameter is changed, the UPS stores the new parameter as the default for communications and updates the Config block.

Changes in Outlet Assignments can be seen with the Communication Port List block.

Exceptions:
This command is new with XCP rev A.
Note that changing the number of Stop Bits or Parity could make the port non-compliant with the requirements of this protocol; therefore, they should only be changed for ports used for other purposes.

Example(s):

For the PARAM = 0xFF capabilities request, the Command Response, for a UPS which implements 3 Comm Ports and Params 1-3, would be (final length given in the response header):

SFD	BLK	LEN	SEQ	ACK	Command Echo	Capabilities List				
0xAB	09	7	0x81	0x31	0x98	3	0xFF	1	2	3

6.3.3 Set Time & Date Command

Purpose:
Sets the Real-Time Clock inside the UPS.

Control Command:

SFD	LEN	Cmd Byte	Set Date	Set Time	Csum	
0xAB	0x09	0x90	FYY YY MM DD	HH MM SS CC	XX	
1	1	1	4	4	1	(Bytes)

Additional Field Descriptions:
The DATE and TIME fields are formatted so that the byte immediately following the "90h" code byte is the most significant byte of the year variable, and the byte immediately preceding the checksum byte is the least significant byte of the time variable (hundredths of seconds). (See also the Time and Date Formats section.)

UPS Action/Response:
The Time and Date can be reported in the standard Meters block.

Exceptions:

Example(s):
To set the Time and Date to (Gregorian or non-Julian) March 16, 2001, 17:30:21:00

SFD	LEN	Cmd Byte	Date				Time			
0xAB	0x09	0x90	0xA0	0x01	0x03	0x16	0x17	0x30	0x21	0x00

6.3.4   Exit XCP Mode Commands

Purpose:

Two commands to force the communication channel to Exit from the XCP mode either to the "Main Menu" or to an unspecified mode.

Control Command: Exit XCP to "Main Menu"

SFD	LEN	Cmd Byte	Csum	
0xAB	0x01	0xFA	XX	

Control Command: Exit XCP to Unspecified Mode

SFD	LEN	Cmd Byte	Csum	
0xAB	0x01	0xFF	XX	

Additional Field Descriptions:

UPS Action/Response:

The definition of "Main Menu", as referred to by the "Exit XCP Mode" command, is intentionally left blank. The implementation of "Main Menu" is UPS specific and is beyond the scope of this document.

Refer to the XCP Compliance Document for a given UPS before using the Exit XCP to Unspecified Mode command, as its behavior is not defined by this specification.

Example(s):

6.3.5   Set Scratchpad Sector

Purpose:

Command to write 16 bytes of data to a specified Scratchpad sector in the UPS, or to inquire as to how many Scratchpad sectors are available in the UPS. Scratchpad data has no meaning to the UPS; it contains whatever monitoring software wants to put in it.

Scratchpad contents can be read by the Request Scratchpad Data command.

Control Command:

Scratchpad Capabilities Request

	SFD	LEN	Cmd Byte	Sector Number	Null byte	Csum
	0xAB	0x03	0x99	0xFF	00	XX
# of Bytes	1	1	1	1	1	1

Write 16 bytes to Scratchpad Sector n

	SFD	LEN	Cmd Byte	Sector Number	Data bytes to Write	Csum
	0xAB	0x12	0x99	1-n	xx xx xx…	XX
# of Bytes	1	1	1	1	16	1

Additional Field Descriptions:

When the Sector Number is 0xFF, this indicates that the UPS must list in the response how many Scratchpad Sectors are available.

Otherwise, sectors are numbered from 1 to n.

When writing to a Scratchpad Sector, the command must always contain 16 bytes of data.

UPS Action/Response:

The UPS will store the 16 bytes to its non-volatile memory in the indicated Scratchpad Sector.

Exceptions:

This command is new with XCP rev C.

A "BUSY" would be returned in the ACK field to indicate that another application is writing to the scratchpad area or that the system is busy and unable to store data at this time.

Example(s):

For the Sector Number 0xFF Scratchpad Capabilities request, the Command Response for a UPS which implements 4 Scratchpad Sectors would be:

	SFD	BLK	LEN	SEQ	ACK	Command Echo	Sector Echo	# of Sectors	CSUM
	0xAB	09	4	0x81	0x31	0x99	0xFF	4	Xx
Bytes	1	1	1	1	1	1	1	1	1

For a Scratchpad Sector write command, the entire command willl be echoed back

	SFD	BLK	LEN	SEQ	ACK	Command Echo	Sector Echo	Data Echo	CSUM
	0xAB	09	0x13	0x81	0x31	0x99	n	xx xx …	Xx
Bytes	1	1	1	1	1	1	1	16	1

6.3.6   Set Power Strategy Command

Purpose:

This command is used to select the Power Strategy for the UPS, choosing among High Alert, Normal, or the High Efficiency strategies. This allows the user to selectively trade off levels of power protection with energy savings.

Control Command:

SFD	LEN	Cmd Byte	Strategy Byte	Csum
0xAB	0x02	0x9A	0-4, FF	XX

Additional Field Descriptions:

The following are the defined values for the Power Strategy Byte:

Val	Strategy	Description	Motivation for this Strategy
0	Readback	Report the current setting for Power Strategy in the XCP response	(Software monitoring)
1	High Alert	The UPS shall optimize its operating state to maximize its power-protection levels.	To maximize power protection, in the presence of unfavorable incoming utility conditions
2	Standard	Balanced, normal power protection strategy. UPS will not enter HE operating mode.	Default strategy
3	Enable High Efficiency	The UPS is enabled to enter HE operating mode to optimize its operating state to maximize its efficiency, when conditions permit	To conserve power costs, when in the presence of favorable incoming utility conditions
4	Force High Efficiency	Require the UPS to enter High Efficiency mode now, without delay (for as long as utility conditions permit)	Primarily for testing or to conserve energy costs in non-working hours.
FF	Capabilities Request	Report which of these Power Strategy values are implemented in this UPS.	(Software monitoring)

Val	Strategy	Persistence	Next Strategy
1	High Alert	The UPS should maintain this mode for 24 hours or until changed by a subsequent Set Power Strategy command. Not stored in EEPROM.	Back to previous Mode 2 or 3
2	Standard	Until changed by command. Stored in EEPROM.	--
3	Enable High Efficiency	Until changed by command. Stored in EEPROM.	--
4	Force High Efficiency	Momentary, transient mode. Not stored in EEPROM.	Enable High Efficiency(3)

All UPSs are required to support Strategies 0, 1, 2 and FF as a minimum.

UPS Action/Response:

The UPS will implement the Power Strategy indicated by the command. In particular, this command lets the monitoring software tell the UPS when it may use cost-saving but reduced-protection High Efficiency Mode and when it must focus on all-out power protection (High Alert mode) due to degraded input power.

The response to this command is always the ACK block. Normally the command is echoed, except when the Strategy byte value is 0 or 0xFF. If it is set for Readback (0), then the current Strategy setting is added after the command echo. If it is Capabilities Request (0xFF), then the available Strategy byte values are listed after the command echo.

Some implementation notes on the Power Strategies:

High Alert Strategy(1):
When set to this strategy, the UPS Firmware can make tradeoffs to maximize its up time. For example:
- If the UPS has adaptive hysteresis for tap switching or adjustable limits for bypass syncing, it could immediately set these to their tightest setting.
- The UPS could adjust its charging algorithm to make sure that its batteries are topped off. For example, it might sacrifice Power-Factor Correction to increase charging current while under load.
- The UPS should postpone or preclude discharge-type battery tests, flash updates, PM tasks, etc.
- The UPS could illuminate a "High Alert" LED or indicate this mode on its LCD panel, to provide a tangible indication to the user that the service organization is indeed monitoring his UPS

Standard Strategy(2):
This would mean that HE mode is not enabled and cannot be entered automatically. The energy savings of HE mode are good, but not for everyone. This strategy lets the customer opt out.

Enable High Efficiency(3)
The UPS determines the conditions it wants before it permits the UPS to go to HE mode, but when those conditions are met, it will switch to HE mode and stay there as long as conditions permit. Conditions might include, e.g., "utility ok" for 5 hours or reaching the float mode for ABM.

Force High Efficiency(4)
This is the same as "Enable High Efficiency"(3), but with no delay for "utility ok", or ABM mode being float, before the unit switches to HE mode. This just commands the UPS to go to HE mode now (if possible), after which the mode automatically changes to "Enable High Efficiency"(3).
Since this is a transient setting, you would never see a value of "Force High Efficiency"(4) when you do a Readback (0).

Exceptions:
UPSs which don't have a High Efficiency Mode won't support HE Strategies 3 or 4. Other UPSs may chose not to support type Force to High Efficiency(4).

If the UPS doesn't implement a requested Strategy, it should NACK with "Parameter Invalid"(0x36).
If it can't "Force HE Mode" at the time of the command, could respond with "ACK with Parameter Adjusted (0x37), and change to "Enable High Efficiency"(3) strategy.

Example(s):
For the Strategy byte = 0xFF capabilities request, the Command Response, for a UPS which implements Strategies 0-3, would be :

SFD	BLK	LEN	SEQ	ACK	Command Echo		Strategies Capability List				Csum
0xAB	09	07	0x81	0x31	0x9A	0xFF	0x00	0x01	0x02	0x03	XX

For the Strategy byte = 0 Readback request, the Command Response, for a UPS currently using High Efficiency Enabled Strategy (3), would be :

SFD	BLK	LEN	SEQ	ACK	Command Echo		Current Strategy	Csum
0xAB	09	04	0x81	0x31	0x9A	0x00	0x03	XX

6.4   Select Sub-module Command for Addressing Multiple Modules

Purpose:
This command allows communication software to address individual modules within a communications node of a UPS system. This command provides a primitive form of command routing capability for the XCP protocol.

An obvious application would be a "N + 1" redundant UPS system. For example, a multi-module UPS may have multiple power processors as well as multiple load group controllers. This command would be used to select which individual power processor or load group controller module is being monitored or controlled.

This selection is in effect until a subsequent "Select Sub-module" block command is received.

Additional behavioral information is contained in document SelectSub2.doc.

Control Command:
Two byte command to address just the first node encountered.
Three byte command to route through the first node and address a submodule of the second node.
Four byte command to route through both the first node and the second node and address a submodule of the third node.
"n" byte command to address multiple layers of nodes and submodules.

SFD	LEN	Cmd Byte	First Unit ID	Second Unit ID	Third Unit ID	(additional Unit Ids)	Csum
0xAB	0x02	0xCE	0-255				XX
0xAB	0x03	0xCE	0-253	0-255			XX
0xAB	0x04	0xCE	0-253	0-253	0-255		XX
0xAB	"n"	0xCE	0-253	0-253	0-253	….	XX

Additional Field Descriptions:
Unit ID is a single byte that contains the sub-module number for multi-module systems.
A unit ID of 255 (0xFF) causes the response to be a standard ACKnowledge block with a list of unit IDs supported by this node.
Specifying a unit ID of 254 (0xFE) specifies that the host UPS or other default host node is to be selected (default unit ID). This embodies the logical concept of deselection.

UPS Action/Response:
The power system's response to this command is to send a standard ACKnowledge block. In the case of an error, the standard ACK response with the appropriate error code is made.

ACK	Response	Caused by
0x31	Accepted	SubModule Select Accepted and executed; path is valid.
0x32	Not Implemented	SubModule Select is not implemented on this UPS
0x33	Busy	Not currently able to execute the requested SubModule Select command, because the requested module is not communicating.
0x36	Parameter invalid	The requested path does not exist.

In case of a Busy or Parameter Invalid NACK, the previously established path is not changed.
More than 1 unit ID may be specified in a command. The first node processes this by selecting the submodule specified by the first data byte (first unit ID). This first node then removes this byte from the command, decrements

the length (LEN) field, calculates the resulting checksum and passes this modified command on to the newly selected node. This newly selected node then processes the command that it receives in the same manner.

Exceptions:
For the purpose of backwards compatibility, and only in the case where NetXCP is being used and the single submodule selected is number 1, the power system's response to this command is to send a standard Status block that contains the number of the module that was just selected.

Example(s):
If unit ID 255 is selected, then the response is a special ACKnowledge block. If the receiving node has four submodules that can be selected, then the sequence would appear as follows:

Command sent to node:
0xAB 0x02 0xCE 0xFF CC

Response sent back from node:
0xAB 0x09 0x07 0x81 0x31 0xCE 0xFF 0x01 0x02 0x03 0x04 CC

Where CC is the checksum byte.

By convention, the first SubMod ID listed in the response is the default SubMod ID (01 in this example).

6.5   Update Power Source Status Command

Purpose:

The UPSS command advises an IPDD which is powered by a UPS of changes in that UPS's Status. This advice is used to allow the UPS and IPDD to act as a "virtual UPS" with regard to outlet control

This command is like a reverse command, where data is sent to a device in the form of a command. By using this form, we maintain XCP's Command and Response formats while communicating this information to interested parties.

If a device (eg, IPDD) advertises that it implements this command, then software which knows about the UPS associated with that device sends this command to that device. Typically, this command is sent whenever the UPS's status changes or else every 30-120s when there is a pending shutdown / countdown.

Control Command:

SFD	LEN	Cmd Byte	Length of Status Data	Status Data
0xAB	8 - 23	0xB3	4 - 19	Status block data from the UPS
1	1	1	1	4

Length of Alarm Data	Alarm Data	Csum	
1	Shutdown Imminent Alarm (Byte 7 of alarm block)	XX	
1	1	1	(Bytes)

Additional Field Descriptions:

The lengths of the Status and Alarm data areas are as indicated by the Length bytes for each.
General XCP requirements recommend providing the full 19-byte Status block and the single Shutdown Imminent Alarm, as this is the information of greatest importance to devices powered by the UPS. Receive capabilities in the IPDD limit the command length as indicated in the above command syntax.

Device Action/Response:

The response to this command is a normal ACK response block; for the example where the first 4 bytes of the Status block are sent:

SFD	BLK	LEN	SEQ	ACK	Command Echo	Status Length	Status block (cmd 0x33 first four bytes) data from the UPS
0xAB	09	09	0x81	0x31	0xB3	04	XXXXXXXX

Alarm Length	Shutdown Imminent Alarm (Byte 7 of alarm block)	Csum
01	XX	XX

Any 0xB3 command that exceeds the "Maximum Supported Command Length" will be ignored

When the 0xB3 command is received and the "Topology" Status byte 2 bit 7 byte has changed from 1 to 0 (state change indicating the Power Source has just gone to battery), an OnBattery state is recorded in the IPDD. When bit 7 changes from 0 to 1, a normal state is recorded in the IPDD.

Exceptions:
The length of this command cannot exceed the size of the device's input buffer, as reported in the ID Block's "Maximum Supported Command Length". If necessary, the length of the Status data area can be reduced to fit.

Example(s):

7   Implementation Details

7.1   Mandatory requirements for UPS implementers
To ensure Communication Software a consistent base of responses from all Powerware UPSs, the following requirements must be met by All new UPSs:
1. Must meet the Timing Requirements for Commands and Responses
2. Must provide error-free responses that conform to this specification, with proper checksums
3. Must NACK unimplemented commands or invalid parameters
4. Must respond to the PnP event and enter XCP mode immediately for Discovery
5. Must require proper Authorization of Control Commands
6. Must respond to the Set Requested-only Mode commandwith a Standard ID Block.

A Standard UPS must implement the following additional blocks and commands:
*   ID Block
*   Status Block
*   Meter Block
*   Active Alarms Block
*   Configuration Block
*   Extended Limits Block
*   Command List Block
*   Outlet Monitoring Block (if there are switchable Outlets)
*   Communication Capabilities Block
*   Set Comm Parameter command (if more than 1200 baud supported)

and must implement the following commands to reach full UPS MIB compliance:
*   UPS On Command
*   Delayed Load Power Off & Restart
*   UPS Off /Load Power Off
*   Scheduled UPS On in "n" Minutes or Scheduled UPS On at Date & Time
*   Scheduled Load Power Off in "n" Minutes or Scheduled Load Power Off at Date & Time
*   Set Config Parameter for Low Battery Warning and Horn Mute
*   Initiate Battery Test
*   Request a Systems Test

and for full support of our Power Management software strategies, the UPS must implement the following commands:
*   UPS Topology Data Block
*   Request Scratchpad Data
*   Set Outlet Parameter (if there are switchable Outlets)
*   Set Scratchpad Sector
*   Set Power Strategy

Process for deviating from these requirements:
If the developers of the UPS must choose not to meet these requirements (e.g., due to limited resources), then this deviation should be declared in the Product's PDR and XCP Compliance documents, so that management and marketing are formally and knowingly agreeing to such deviations early in the project.

7.2   Using XCP Data to Draw Meter Limits

Software developers will employ a combination of live Meter readings from the Meters Block and limit and range information from Config, Extended Limits, and the Meters Block to construct meaningful graphic meters for the customer. To ensure that the meters are drawn correctly, the UPS developers are required to provide the fields shown in this section with correct data, as long as the dynamic meter readings are provided. The Software Developers should use the guidance in this section to match the right limits data with the live readings.
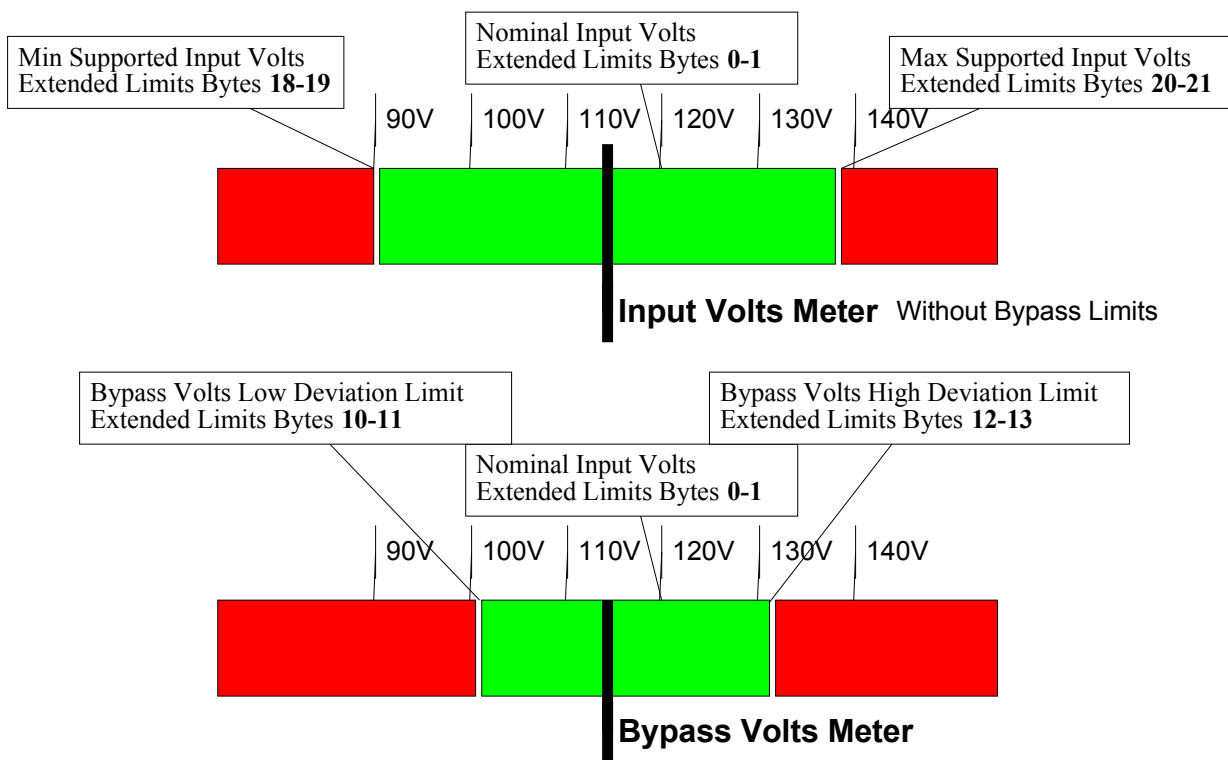
7.2.1   Input Volts
One of the most interesting meters; this helps the customer to gauge how much his UPS is helping protect his load. The following rules should be followed, however:

If the UPS provides both Input Volts Line-to-Line (Meters 7-9) and Input Volts Line-to-Neutral (Meters 57-59), make sure that the limits used match up to the meter chosen:
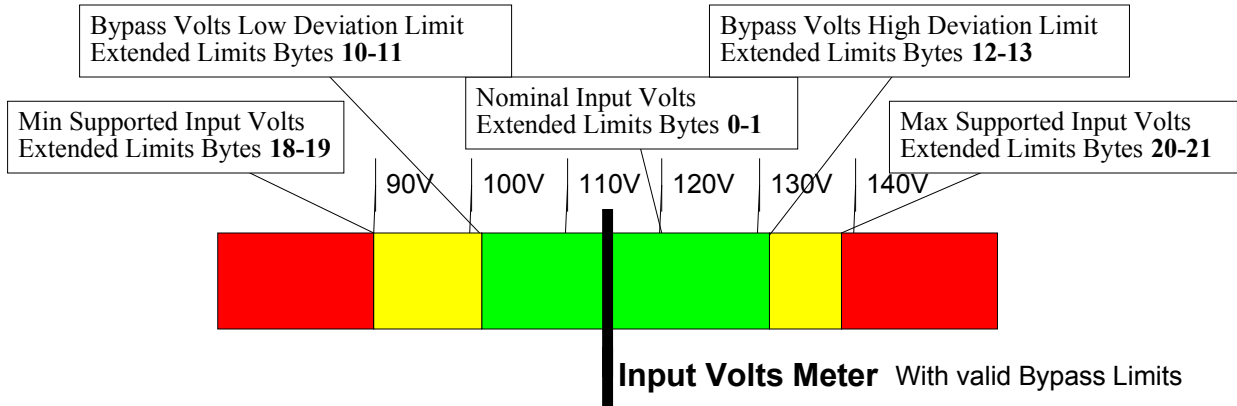- A simple guess is that if both are present, Line-to-Line is the correct choice.
- A better approach is to compare the L-L and L-N values to the Nominal Input Voltage value (Extended Limits block bytes
  0-1) when the UPS is not On Battery; the closer value is the correct choice.
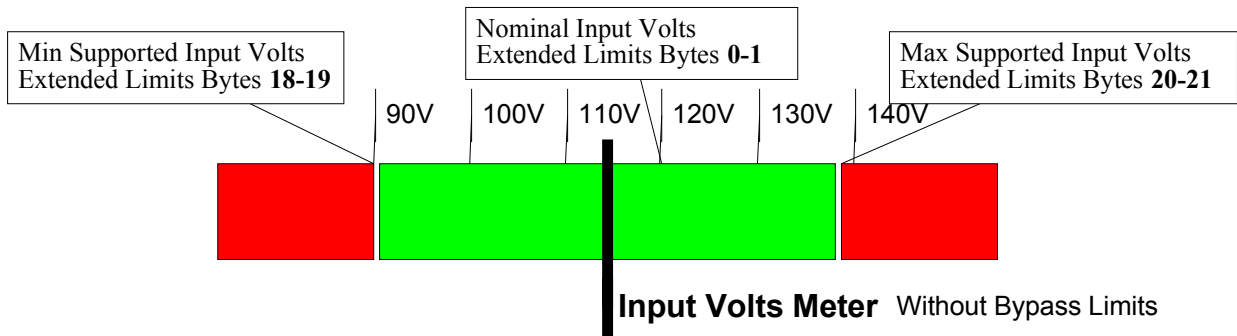
If it is an On-Line UPS,
- If it reports Bypass Meters L-L (Meters 10-12) or L-N (Meters 54-56), then draw a Bypass Volts Meter separate from Input Volts Meter like this:
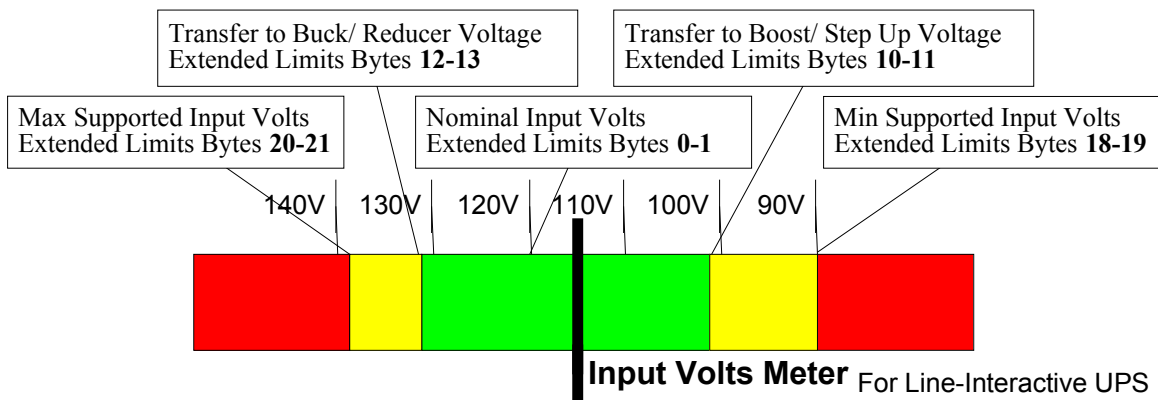

- Else (On-Line UPS, but no Bypass Meters), if the following relationships (all Extended Limits data) are true:
  Nominal Input < Bypass Volts High Deviation (bytes 12-13) < Max Supported Input Volts (bytes 20-21) AND
  Min Supported Volts (bytes 18-19) < Bypass Volts Low Deviation (bytes 10-11) < Nominal Input, AND
  have a valid "Bypass Installed" bit (Status byte 2 and mask in Config byte 16, bit 0),
  then combine the Limits into one graphical meter with yellow bands like this:

Bypass Volts Low Deviation Limit Extended Limits Bytes **10-11**

Bypass Volts High Deviation Limit Extended Limits Bytes **12-13**

Min Supported Input Volts Extended Limits Bytes **18-19**

Nominal Input Volts Extended Limits Bytes **0-1**

Max Supported Input Volts Extended Limits Bytes **20-21**

90V 100V 110V 120V 130V 140V

Input Volts Meter With valid Bypass Limits

- Otherwise (On-Line UPS, no Bypass Meters or Bypass Deviations not valid), draw the Input Meter like this:

Min Supported Input Volts Extended Limits Bytes **18-19**

Nominal Input Volts Extended Limits Bytes **0-1**

Max Supported Input Volts Extended Limits Bytes **20-21**

90V 100V 110V 120V 130V 140V

Input Volts Meter Without Bypass Limits

If it is a <u>Line-Interactive UPS</u>, then there is pretty much just one choice; draw Input Volts meter (and there is no separate Bypass meter):

Transfer to Buck/ Reducer Voltage Extended Limits Bytes **12-13**

Transfer to Boost/ Step Up Voltage Extended Limits Bytes **10-11**

Max Supported Input Volts Extended Limits Bytes **20-21**

Nominal Input Volts Extended Limits Bytes **0-1**

Min Supported Input Volts Extended Limits Bytes **18-19**

140V 130V 120V 110V 100V 90V

Input Volts Meter For Line-Interactive UPS

7.2.2   Output Volts

There is an issue with this meter, since past XCP data provided no guidance on limits. Draw the following meter with the Min / Max levels added as Standard Parameters in XCP Rev C:
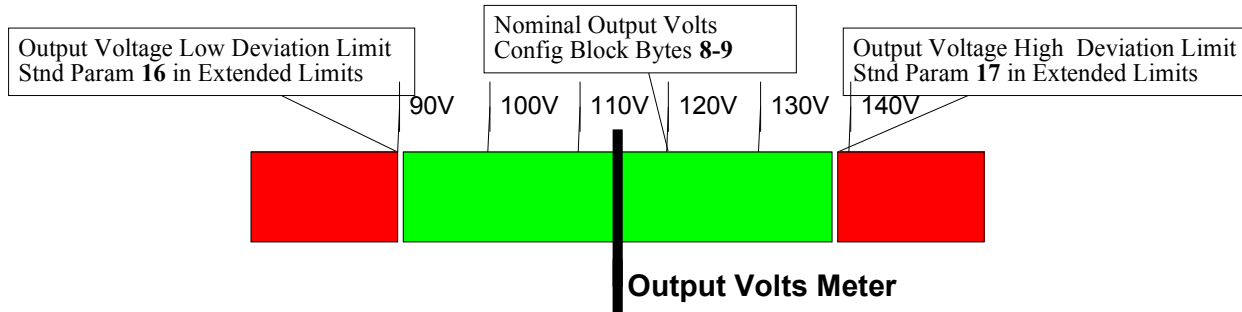

If the Min/Max limits are not provided in the Table of Standard and Custom Parameters in the Extended Limits block, then just show it as a digital readout.

7.2.3   Input and Output Current

These are relatively straight-forward meters; use the corresponding Bar Chart values from the Meters block to set the 100% level, and then draw the current reading. Anything over 100% is a Red band. Overcurrents can exceed 150%, but it would be adequate to draw a meter that pegs at 110-120%. There are complications at low load (circulating output filter currents show up even when there is no load), but its is probably best to just display what is reported, with one exception: If the outputs are all open, or UPS is Off, then Output current must be shown as 0%, regardless of the reading.

Meter	XCP Meter #	Bar Chart Meter #
Input Current, Phase A	19	43
Input Current, Phase B	20	43
Input Current, Phase C	21	43
Output Current, Phase A	66	69
Output Current, Phase B	67	70
Output Current, Phase C	68	71

Sample Meters, using Bar Chart value
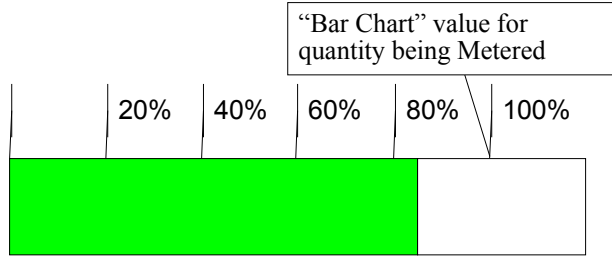
Eg, Output Current at 85%
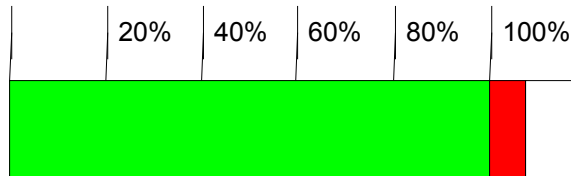
Eg, Output Current at 110%

7.2.4 Load and Power Meters

Show the <u>Output Load</u> for all phases, showing whatever quantity is most limiting (overall VA, overall Watts, or per-phase current):

- If the Outputs are all Open or the UPS status is Off (0x20 or lower), load is fixed at 0%.
- If the load is low (< 30%), use Output VA meter #24 and Output VA Bar Chart meter #72, as shown above.
- Otherwise, use the greatest of
  a) Output current % load per phase
  b) Output VA %
  c) Output Watts %, using Output Watts meter #22 and Nominal "Extended" True Power Rating (Config block bytes 4-5, multiplied by 50)

<u>Input Power and VA</u> meters don't have nominal values in XCP. While they could be drawn, they probably aren't too interesting, except for products that only have input power and not output power readings (like the IPDD).

<u>Power Factor</u> meters ALWAYS fall between 0.00 and 1.00, hopefully between 0.70 and 1.00. No nominal values (since they are load dependent). While they could be drawn, they are probably best displayed as a numeric readout, if shown.
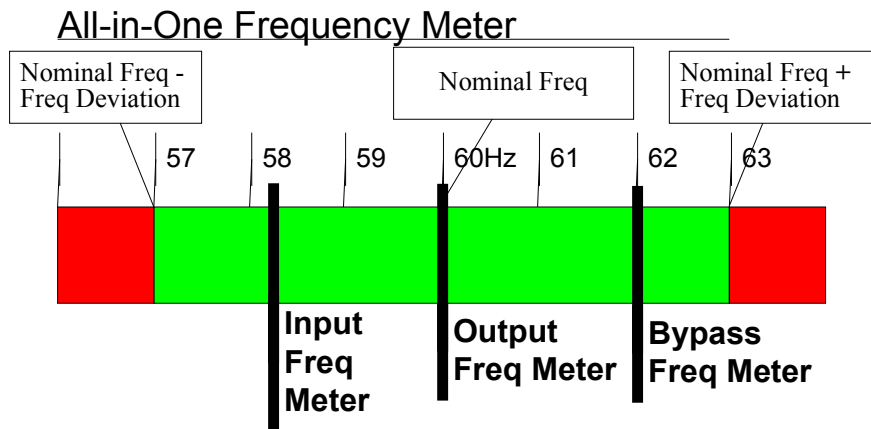
7.2.5   Frequency Meters

Obviously, these meters center around the nominal Input and Output frequencies. While nominal Input Freq = Output Freq for most UPSs, this is not always true – some UPSs act as frequency changers.

In most cases, the Input Freq Deviation Limits (Config bytes 6-7) are the same as Bypass/Utility Freq Deviation Limits (Extended Limits bytes 8-9). Bypass Frequency is only metered if there is a separate Bypass feed.

The following table shows what parameters may be used to determine Nominal and "Red" limits for Frequencies:

Frequency	XCP Meter	Nominal given by	Limits given by
Output	28	Nominal Output Freq, Config bytes 10-11	For <u>On-Line UPS</u>: Same as Inverter (but no XCP data) For <u>Line-Interactive UPS</u>: Bypass/Utility Freq Deviation Limits, Extended Limits bytes 8-9
Input	29	Nominal Input Freq, Extended Limits bytes 2-3	Input Freq Deviation Limits, Config bytes 6-7
Inverter	30	Nominal Output Freq, Config bytes 10-11	Marketing Spec; no XCP data; don't draw graphically
Bypass	31	Nominal Input Freq, Extended Limits bytes 2-3	Bypass/Utility Freq Deviation Limits, Extended Limits bytes 8-9

If there the Input and Bypass Freq Deviations are the same, and Input and Output Frequency nominals are equal, the frequency meters can all be combined in the same graphic (shown with Bypass Frequency included):


Otherwise, the different Frequency Meters could be graphed separately with a similar display.
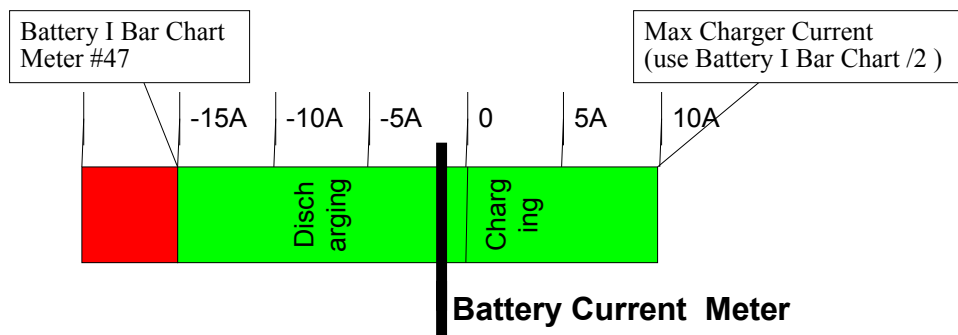
7.2.6 Battery Meters

<u>Battery Current</u> is different than almost all of the other meters in that it has a significant negative range. (The only other potentially negative-going meter is Ambient Temperature). Negative current means Discharging, and the limit to this value (Bar Chart Meter #47) usually exceeds the positive Charging current range (Bar Charter Meter #46, new in XCP rev C).

If Battery Charger I Bar Chart (Meter #46) is given, use it to construct the following graph:

Battery I Bar Chart Meter #47					Battery Charger I Bar Chart Meter #46

-15A	-10A	-5A	0	5A	10A

Discharging   Charging

Battery Current Meter
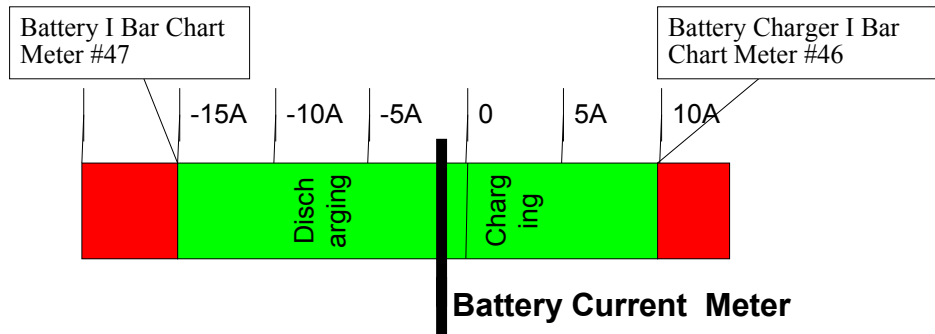
Otherwise (no Meter #46), don't show a red range on the high side; use this type of meter:

Battery I Bar Chart Meter #47					Max Charger Current (use Battery I Bar Chart /2)

-15A	-10A	-5A	0	5A	10A

Discharging   Charging

Battery Current Meter

<u>Battery Voltage</u> has several important values: its DCUV value, Low Battery Warning Level, Nominal Value, and Equalize Value (Float level in ABM). None of these values were given directly in XCP before they were added in XCP rev C.

Low Battery Warning Level and DCUV level tend to vary in a few discrete steps with the load (they rise with lighter loads to avoid a destructive battery discharge). If these limits are not given, then this drawing cannot be constructed:

Battery Voltage Meter
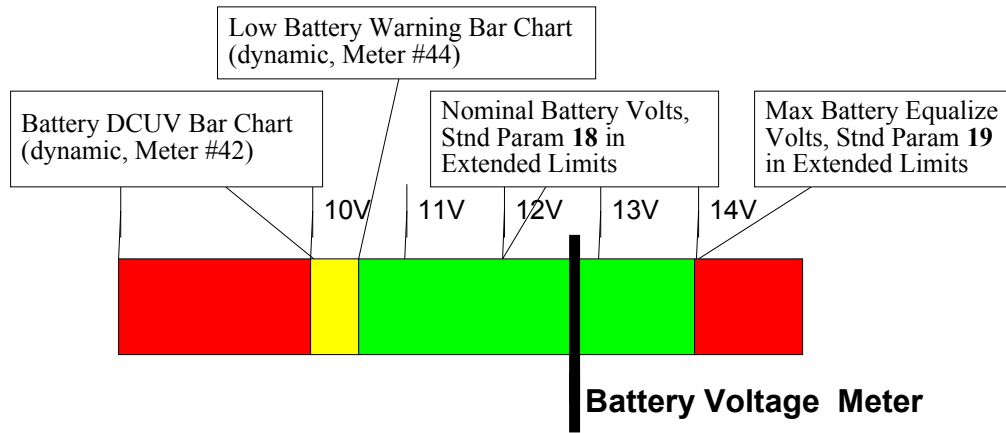
A more interesting and useful indication of Battery Voltage would be a time-based trend graph; this view of the information would be most useful to someone who was familiar with battery performance. Y-axis would be Battery Volts, with level markers or bands for Float and Nominal, and you might chart DCUV and Low Battery levels, as they could change as load is shed. (A really slick graph would have a notation when load was shed, i.e., "Outlet 2 Open here").

The Time X-axis would need to be on a dynamic scale that went from last few minutes to last 8 hours, when On Battery. When not On Battery, especially when in the ABM Rest mode, the useful time scale would be up to 30 days.

% Battery Charge is a straightforward 0-100% graph of % Battery Left, XCP Meter 35 (for those UPSs providing this meter).

Battery Time Remaining is, of course, the parameter of most interest to most customers. It is often alternated with % Battery Charge; BTR is shown only while On Battery, and % Battery Charge at the other times. It is highly dependent upon Load and starting charge level, and is also affected by battery health or age. If external Battery strings are attached, then it will increase significantly. Most of our UPSs report it conservatively, i.e., they will report 2 minutes remaining when in fact they may run 4 minutes before encountering the DCUV level. To improve the notoriously poor accuracy of the estimate would require information that is difficult to come by (e.g., specific gravity and temperature inside the battery, amount of charge at the start of discharge), the reading will always have a large uncertainty to it.

Because there is no nominal level, because the operation depends on so many variables, some of which are not measured, and because the reported value is a conservative estimate of the actual, there is no particularly useful way to graph this quantity. It may be best expressed via a digital readout.

An alternative, if it MUST be graphical, is a bar chart with a sliding scale; the Summa's LCD implemented it like this:

```
Batt Discharge
|█  █  █  █  █  █
| 10m=█
```

using per block scales of 1min, 2 mins, 5 mins, 10 mins, 30 mins, and 1 hour. This was somewhat adequate, for a simple display.

7.2.7 Ambient Temperature Meter

Ambient Temperature is the other meter with a potential negative range. Min and Max Limits are given in the Extended Limits block. Could look like this:

Ambient Temperature Lower Alarm Limit, Extended Limits byte 25

Ambient Temperature Upper Alarm Limit, Extended Limits byte 26

0 10 20 30 40 50

Ambient Temperature Meter
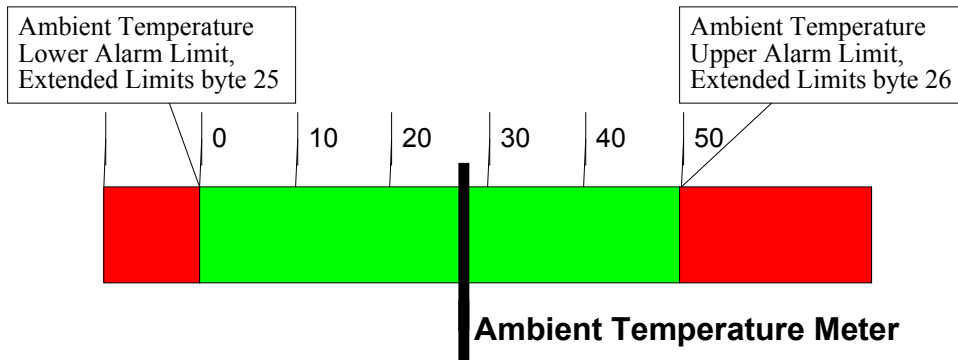
7.2.8 "Don't Display Graphically" Meters

Some of the meters are more for "Server" diagnostic purposes and have little value to "User" customers like IT managers. You might list the current reading of these meters somewhere, but there is little value in having a Meter graphic for them, as they do not have clear limits / tolerances:

Meter	Usage	XCP Meter #
INVERTER VOLTS	Service	7-9, 60-62
MAIN and SECONDARY LOGIC POWER	Service	13-15
INVERTER AVG and PEAK CURRENT	Obsolete	16-18, 38-40
INPUT WATTS and VA	User	23, 25
OUTPUT and INPUT POWER FACTOR	User	26, 27
INVERTER FREQUENCY	Service	30
DC LINK VOLTS, DC VOLTS BAR CHART, POSITIVE and NEGATIVE DC LINK RAIL VOLTAGE	Service	32, 45, 75, 76
BATTERY CHARGE TIME	User	37
AVG INPUT I 3 PHASE SUM	Obsolete	41
HEATSINK, POWER SUPPLY and BATTERY TEMPERATURE	Service	64, 65, 78
DATE and TIME	User	73, 74
AUTO-BALANCE VOLTAGE	Service	77
NEUTRAL CURRENT	Service	82

7.3   Notes to Communication Software Developers

To create correct, reliable, and robust software to communicate with Powerware UPSs, always consider the following points in your software design and development:

7.3.1   Powerware UPS Compliances
This document describes *HOW* Powerware UPSs are to implement communication features *IF* they implement them. Due to market demands or cost limitations, there is no Powerware UPS which implements all or even most of the features shown in this specification. For the same reasons, some UPS implementations deviate from the preferred implementation described in this specification (e.g., Battery Time Remaining meter may only be meaningful while On Battery). Your ultimate guide to which features are implemented and how for a given UPS is from the XCP Compliance Document for that UPS.

7.3.2   Parsing Data Blocks
Never rely on data items to be found in fixed positions in the ID (except first byte), Meters, or Alarms data blocks. You must always parse the ID block and use the information there to find the positions of Meters and Alarms. Note that the absolute positions of the Meter and Alarm Maps in the ID block can vary (e.g., as the ID Message changes its length), as can the maps' lengths (e.g., as new items are added in subsequent XCP revisions). Also, for some fixed data blocks, a UPS may implement something shorter than the fully specified block; you must check the length contained in the XCP response and not "use" fields located beyond the end of the given data.

7.3.3   Deriving Output Meters
If the Output position is not directly sensed, its meters should be derived by the software as
   a)   equal to Inverter if On Inverter, or
   b)   equal to Bypass if On Bypass, or
   c)   equal to 0 if the Output breaker is open
(adjustments for output transformers and filters necessary).

7.3.4   XCP Changes with UPS Revisions
The exact Meters and Alarms implemented in a UPS, and certain other features, may vary from revision to revision, even within a given product line. See the section on "Parsing Data Blocks".

7.3.5   Testing of Communication Software
There is no substitute for direct testing of the UPS(s) that the Communication Software is intended to work with; although this specification, the compliance documents, and the XCP simulator provide much useful verification of design, they don't emulate the timing of the actual UPS responses.
Furthermore, to validate that your design is correct and robust, you should plan to test with at least two models of Powerware UPSs; these two models should be as different as possible, ideally the latest designed single-phase machine and one three-phase machine with an Event History Log .

7.3.6   Provision for Future Additions in UPS Implementation
Communication devices and software should be designed to permit the UPS to extend the data or command sets in the future without interfering with the data collection and control of the known features.

7.3.7   When to initiate Normal and Panic OS Shutdown

Most monitoring software has, as its most important and basic function, a function to do a "Normal" orderly shutdown of the Operating System; there is always a period of a few minutes or many seconds before the software will even begin to consider doing this. However, it sometimes also happens that there is not sufficient time for a full, orderly shutdown, and so the software must try to do a "Panic" shut down the Operating System as well as it can in the short time left, and it must begin to do so immediately, i.e., without delay.

7.3.7.1   Shutdown Recommendations for Software Developers
The following are the recommended conditions to initiate Normal or Panic Shutdown:

> **<u>Normal Shutdown Countdown</u>** begin =
>> OnBatteryAlarm (#168) ||
>> (Pending Shutdown delay <= Warning Time + OS Shutdown Time)

and
> **<u>Panic Shutdown</u>** begin =
>> Low Battery (Alarm #58) && OnBatteryAlarm (#168) ||
>> Shutdown Imminent Alarm (#55) ||
>> Automatic Shutdown Pending (#206) ||
>> (Shutdown delay <= OS Shutdown Time))

Warning Time is the delay that Shutdown Software waits while On Battery before beginning its OS Shutdown, during which it usually sends notices to users (E.g., "Shutdown in 2 minutes; please close your applications")

7.3.7.2   Shutdown Support Requirements for UPS Developers

To ensure that Shutdown Software can properly detect and manage shutdown, the implementation of these alarms is now mandatory for all UPSs:
- Low Battery (Alarm #58)
- OnBatteryAlarm (#168)

And the following alarms are required if the UPS can recognize and act on conditions that would cause a shutdown in less than Low Battery Warning time:
- Shutdown Imminent Alarm (#55)
- Automatic Shutdown Pending (#206)

7.4   Considerations for OEMs and foreign languages
Nothing specified at this time; most protocol features now are expressed in Binary values, not ASCII English, to aid communication software in supporting foreign languages.

7.5   Process for revising this Protocol
- To the extent possible, this protocol should make it simple to add new data points, features or controls in the future, still in keeping with the spirit of the released XCP specification.

- An XCP revision should be at a prototype ("P") level until one UPS, connectivity product, and communication software product that implement it have been released; then it can be released to production ("A") level.

7.6 Specific Applications of this Protocol

7.6.1 Outlet Control

The commands to monitor and control Outlets have been designed to address the following hardware and control scenarios:

Topic	Scenarios
Outlet Location:	1. The Outlet control is built into and directly controlled by the UPS 2. The Outlet control is part of a sub-module (e.g., PDM (Power Distribution Module), Receptacle Control module, or parallel UPS)
Load Control:	1. Shutdown software (e.g., OnliNet) can address individual outlets by adding the optional Outlet Number field to the conventional load control command (e.g., Delayed Off for n Minutes) 2. Shutdown software (e.g., OnliNet) can address individual or all outlets with the "Set Outlet Parameter" command to turn Outlets Off/On with short delays.
Monitoring Outlets:	1. Shutdown software will see the Status of the combined UPS and Outlet by adding the optional Outlet Number field to the request for the Status block; any pending shutdown of the UPS or the outlet will thus be seen by the device which is powered by the serial combination of the UPS and Outlet.. 2. The On/Off status of all Outlets can be seen at once with the Outlet Monitoring command. If a pending Off or On status is indicated for an Outlet, the Status block can be fetched for that Outlet to learn what the current delay time is.
Priority Auto-Load Shedding:	1. Less critical loads can be configured to automatically power down soon after a utility power loss to preserve battery time for more critical loads.
Auto Power Up:	1. The Automatic On Delay can be set to have the Outlet turn On a set number of seconds after the UPS is supplying output power. By staggering the On delays, one can prevent presenting a large load step to the UPS output at startup. 2. By setting the Automatic On Delay to -1, the Outlet will not be turned on automatically, but will wait until commanded to do so.

7.6.1.1 Affected Data blocks

If there are Outlets to be monitored and controlled, the following blocks and commands are affected:

Block / Cmd	Effect
ID block	Size of Outlet Monitoring block
Status block	Show Outlet # in byte 20. Report the overall (whole UPS) Status with only the first 4 bytes (no delays).
Command List	Adds "Send Outlet Monitoring block" and "Set Outlet Parameter" commands
Outlet Monitoring	Needs to be implemented when there are Outlets, so all Outlets can be monitored. Also indicates the number of Outlets.
Comm Capabilities	Must show the number of Outlets "assigned to" this communication port
Set Outlet Parameter	Must be implemented
Load Control Commands	Must allow the optional Outlet Number field to be used to address specific Outlets
Set Comm Parameter	Can implement Parameters to Assign and De-assign Outlets to the communication port.

7.6.1.2 Addressing Individual Outlets

To check the Status and pending delays of an Outlet, use the optional Outlet Number field in the "Send Status block" command to specify the Outlet (or the whole UPS).

To address an individual Outlet for a Load Control command (UPS On, Load Power Off, Load Power Off and Restart, Delayed On/Off for n Minutes or Date and Time) use the optional Outlet Number field in the command.

8   Appendix A: Non-Standard Commands

The commands found in these sections are not part of the normal XCP specification; most of them have alternatives in Standard XCP which should be implemented instead. They are described here, however, for those units which have used them in the past.

8.1   Waveform data

Purpose:
The Waveform Data block provides sampled waveform data on the requested item.

Requesting Command:

	SFD	LEN	CMD	Waveform	Phase	Sample Time	# Samples	Csum
	0xAB	0x07	0x3A	1-15, 0xFF	1-3	1-64K uSec	1-4000	XX
Bytes	1	1	1	1	1	2	2	

Waveform numbers and Phases are given in the tables below.
Sample Time is the requested sampling interval, in microseconds.
Number of Samples requests a specific number of samples to be collected.
Some UPSs may use other values for these parameters which are closer to their capabilities, but the response block will in all cases indicate the correct values.

Structure of Data Response:
The block 0x0A response is:

Bytes	Name	Description / Values
1	Waveform	Waveform Number, 1-15 (see Table below)
1	Phase	Phase Number 1-3 (A-C)
2	Sample Time	Sampling Interval, in microseconds
2	Offset	16-bit signed Integer value
4	Scale Factor	32-bit floating point value
1	Sample Data Point Size	0x10 - 8-bit unsigned 0x15 - 8-bit signed 0x20 - 16-bit unsigned 0x25 - 16-bit signed
2	Number of Samples	
nn	Table of Sampled Data	Total size, nn, is Number of Samples * Sample Data Point Size (1 or 2 bytes)

Additional Field Descriptions:

Waveform Numbering:

Number	Waveform Source
1	Inverter Volts
2	Utility Volts
3	Positive Rail Volts
4	Negative Rail Volts
5	Battery Volts
6	Auto Balance Volts
7	Utility (Input) Current
8	Inverter (Output) Current
9	Ambient Temperature

10	Battery Current
11	Bypass Volts
12	Bypass Current
13	Critical Bus Volts
14	Critical Bus Current
0xFF	List Waveform Capabilities

Phase Numbering

Number	Phase
1	Phase A
2	Phase B
3	Phase C

The real value for each data point is calculated by the program receiving this data as:

Real value = (Data sample - Offset) * Scale Factor

Exceptions:

The UPS may limit the number of waveforms per second (e.g., 4 per second).

Sample rate and sampling duration may be set by the UPS, overriding the requested parameters.

If the Waveform requested if 0xFF, then the response should be a Command Acknowledge block which lists the Waveform Capabilities for this UPS.

Example(s):

For the Waveform = 0xFF capabilities request, the Command Acknowledge block, for a UPS which implements Waveforms 5-6 and 9-12, would be (final length given in the response header):

SFD	BLK	LEN	SEQ	ACK	Command Echo		Waveform Capabilities List					
0xAB	9	9	0x81	0x31	0x3A	0xFF	0x05	0x06	0x09	0x0A	0x0B	0x0C

8.2   Hawk Data Block

Purpose:
The "Hawk" Data block provides richly detailed information tailored to 3-phase UPS systems. Currently there are three functions defined under this command:
- Mimic data to enable monitoring software to represent important status information and power flow (similar to one-line drawings) for either individual Uninterruptible Power Modules (UPMs) or a parallel system with a System Bypass Module (SBM).
- Battery Log data to help a service organization assess the health of the system batteries.
- History Log containing non-standard XCP event descriptions to help a service organization diagnose problem areas.

Requesting Command:

	SFD	LEN	CMD	Function	Undefined	Entry #	Csum
	0xAB	0x03	0x58	1 (Mimic)	0		XX
	0xAB	0x05	0x58	2 (Battery Log)	0	1-30	XX
	0xAB	0x05	0x58	3 (History Log)	0	1-400	XX
Bytes	1	1	1	1	1	2	

Structure of Data Response:
The three Function response types are given in the next three sections.
Each response has been designed to be short enough to fit in one response sequence; e.g., the logs are requested and reported one entry at a time.
All two-byte, integer values are given LSByte first; note that some have multipliers.

Exceptions:
The response to this command is non-standard in that the block number of the response is 0x58, which is the same as the command byte. This clearly identifies the response as Hawk Data.

Example(s):

8.2.1   Hawk Function 1: Mimic Data Response

Note that most of the data in this block can be found elsewhere within Standard XCP data; refer to document HawkBlock Data from XCP.doc for details.

Byte 1: Mimic type(0..255)

SBM w/o MBP	0x01
SBM w/ MBP	0x02
UPM w/o BYP	0x03
UPM w/ BYP	0x04

Byte 2: Mimic status

	SBM	UPM	
♦ Bit 7	STSW	RCT	1=ON;0=OFF
♦ Bit 6	CBS	RCT Input	1=ON;0=OFF
♦ Bit 5	CBP	BYP	1=ON;0=OFF
♦ Bit 4	FBP	BYP Input	1=ON;0=OFF
♦ Bit 3	BYP Input	CB1	1=ON;0=OFF
♦ Bit 2	MIS	K2	1=ON;0=OFF
♦ Bit 1	MBP	K3	1=ON;0=OFF
♦ Bit 0	MBP Input	INV	1=ON;0=OFF

SBM Capacity and Load values: 16 bits unless specified otherwise

All values in tenths -- 5000 = 500.0

Bytes 4:3   **On Line KVA**
Bytes 6:5   **On Line KW**
Bytes 8:7   **Current Capacity**
Bytes 10:9   **KVA Load**
Bytes 12:11   **KW Load**
Bytes 14:13   **Load Current**

Led Status

Mimic Type	SBM	UPM	
♦ Bit 7	Normal Led	Normal Led	1=ON;0=OFF
♦ Bit 6	Battery Led	Battery Led	1=ON;0=OFF
♦ Bit 5	Bypass Led	Bypass Led	1=ON;0=OFF
♦ Bit 4	Notice Led	Notice Led	1=ON;0=OFF
♦ Bit 3	Alarm Led	Alarm Led	1=ON;0=OFF
♦ Bit 2	Standby Led	Standby Led	1=ON;0=OFF
♦ Bit 1	UPM Present	Not used	1=present;0=not present
♦ Bit 0	Not used	Not used	

	SBM	UPM
Byte 15	SBM Led Status	Not used
Byte 16	UPM 1 Led Status	UPM Led Status
Byte 17	UPM 2 Led Status	Not used
Byte 18	UPM 3 Led Status	Not used
Byte 19	UPM 4 Led Status	Not used
Byte 20	UPM 5 Led Status	Not used
Byte 21	UPM 6 Led Status	Not used
Byte 22	UPM 7 Led Status	Not used
Byte 23	UPM 8 Led Status	Not used

Byte 24   **Parallel Status**

Bit 6 → Setup as SBM Front Panel   (1=SBM
BIT 5→ Setup as Parallel For Capacity System (1=TRUE)
BIT 4 → Setup as Parallel for Redundant System (1=TRUE)   ;
   Bit 1 → Status: System is Redundant (1=Redundant, 0=System is not redundant)
   Bit 0 → Status: MOB Closed (1=CLOSED, 0=Open)   ;

Byte 25   **Unused=0**
Byte 26   **Unused=0**
Byte 27   **Unused=0**
Byte 28   **Unused=0**
Byte 29   **Unused=0**
Byte 30   **Unused=0**
Byte 31   **Unused=0**

SBM Mimic Example:
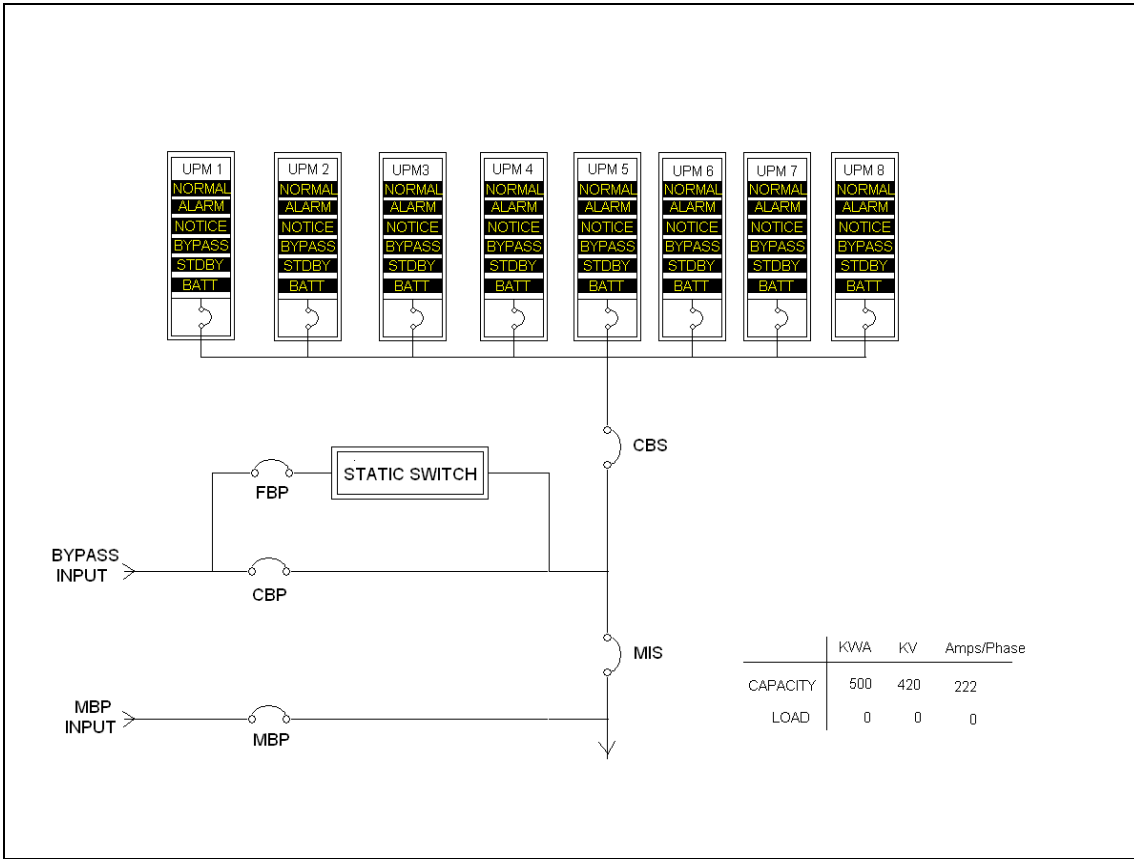
UPM Mimic Example:
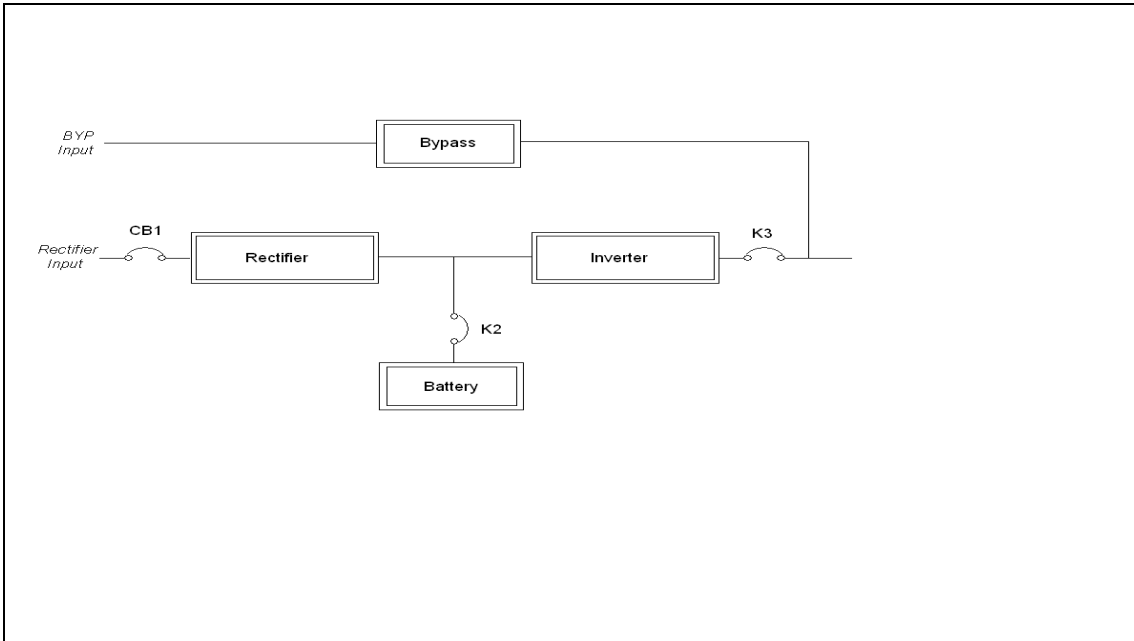
8.2.2 Hawk Function 2: Battery Log Entry Response

Overview

The **Battery Test Hawk Block** allows the **Battery Test LOG** to be extracted from a Powerware Plus system using **XCP**. As illustrated below, the **Battery Test Log** consists of up to thirty entries. Using this block, each of the thirty entries can individually be extracted. One entry is obtained with each request. Each request also provides the **Newest Entry** position and the **End of the LOG** (Number of Entries in the queue).

BATTERY TEST LOG

1	**Date/Time** **Test 1 End Voltage** **Battery Health %** **Battery Test Status**
2	**Date/Time** **Test 1 End Voltage** **Battery Health %** **Battery Test Status**

.
.
.

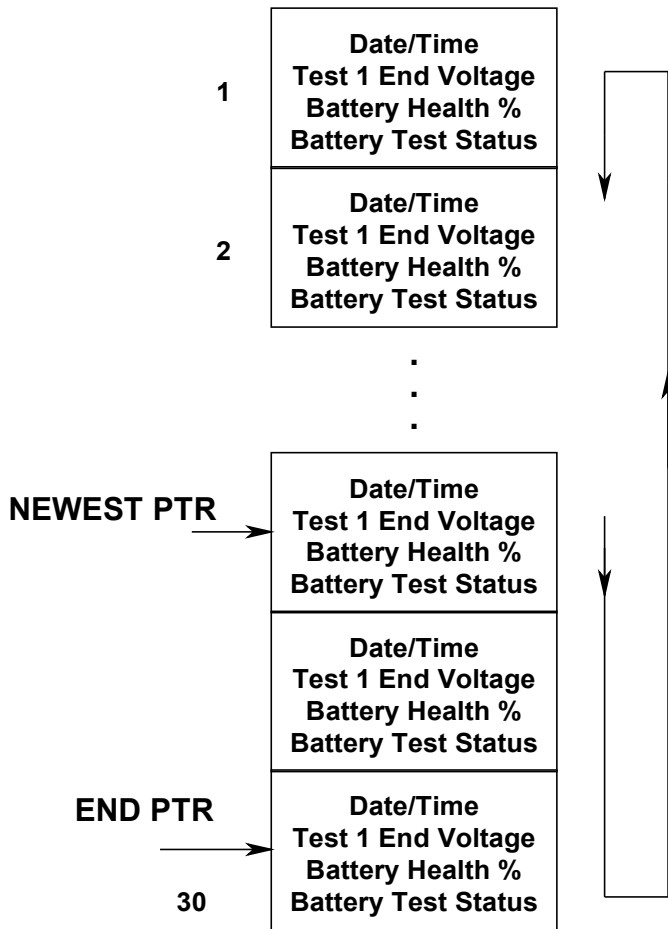|	
NEWEST PTR →	**Date/Time** **Test 1 End Voltage** **Battery Health %** **Battery Test Status**
	Date/Time **Test 1 End Voltage** **Battery Health %** **Battery Test Status**
END PTR → **30**	**Date/Time** **Test 1 End Voltage** **Battery Health %** **Battery Test Status**

Battery Test Background

The **Powerware Plus Automated Battery Test** consist of two tests, Battery Test 1and Battery Test 2. The test is typically programmed to occur periodically. During **Battery Test 1**, the battery is lightly discharged. The health of the battery is computed and the end voltage for the test is recorded. During **Battery Test 2** the Battery is discharged for a short period with 97% of the available load.

The results of the Battery test are recorded in a non-volatile log denoted the **Battery Test LOG**. This log contains the results of the last thirty Battery tests. The LOG entries are circular.

Queue Pointers

The **NEWEST LOG PTR** points to the log entry for the last Battery test performed. The **LENGTH** is the number of entries in the queue.. For instance, if the queue has only 10 entries, the **LENGTH** would be 10. If the queue is full, the will be 30.

The computer is responsible for obtaining the entire Battery Test Log. Using the Hawk block, the computer can individually read each entry in the LOG.

BATTERY TEST LOG RESPONSE

```
    BYTE   00: SFD   (xAB)
    BYTE:  01: 0x58  [HAWK BLOCK RESPONSE]
    BYTE:  02: 50    [LENGTH 50 BYTES]
    BYTE:  03: 0x81  [SEQUENCE NUMBER]
    BYTE   04: 0x02  [BATTERY TEST LOG RESPONSE]
    BYTE   05: 0     [NULL]
    BYTE 07:06: NEWEST LOG PTR     [1..30] [0=NO ENTRIES]
    BYTE 09:08: LENGTH OF QUEUE       [1..30]
    BYTE 11:10: THIS LOG PTR       [1..30]
    BYTE   12: MONTH           [1..12]
    BYTE   13: NULL            [0]  ALWAYS ZERO
    BYTE   14: DAY           [1..31]
    BYTE   15: HOUR           [0..23]
    BYTE   16: MINUTE          [0..59]
    BYTE 18:17: TEST 1 END VOLTAGE   [Tenth Volts]
    BYTE 20:19: BATTERY HEALTH     [10000=100%]
    BYTE 22:21: BATTERY TEST STATUS  [see note 1]
    BYTE   23: 0xff           [Expansion flag]
        .
        .   Bytes 24-53 = 0 if no expansion
        .
        CHECKSUM
```

Note 1: BATTERY TEST STATUS FOR THIS LOG
            0 == PASSED
            1 == TEST1 FAILED BELOW MIN VOLTS
            2 == NOT ENOUGH LOAD
            3 == BATTERY TEST WAS ABORTED
            4 == TEST2 FAILED BELOW MIN VOLTS
Note 2: Expansion Flag -- set to 0xff, when not equal
       more data will follow.

Note 3: Low Byte High Byte format

8.2.3 Hawk Function 3: History Log Entry Response
Note: The standard Alarm History block is preferred to this approach when standard XCP alarms are implemented.

HISTORY LOG RESPONSE

```
BYTE   00: SFD   (xAB)
BYTE:  01: 0x58   [HAWK BLOCK RESPONSE]
BYTE:  02: 81    [LENGTH 81 BYTES]
BYTE:  03: 0x81   [SEQUENCE NUMBER]
BYTE   04: 0x03   [ALARM  LOG RESPONSE]
BYTE   05: 0     [NULL]
BYTE 07:06: NEWEST LOG PTR      [1..400]  [0=NO ENTRIES]
BYTE 09:08: LENGTH OF QUEUE       [1..400]
BYTE 11:10: THIS LOG PTR        [1..400]
BYTE   12: MONTH         [1..12]
BYTE   13: YEAR           [,99.00.01]
BYTE   14: DAY          [1..31]
BYTE   15: HOUR          [0..23]
BYTE   16: MINUTE         [0..59]
BYTE 18:17: Milliseconds   [0..999]
BYTE 20:19: Alarm Number [1..65535]
BYTE 22:21: data value [only used by traineed service personnel]
BYTES 23..83 ASCII PRINTOUT OF THE HISTORY QUEUE ENTRY

    CHECKSUM
```

8.3 Conditional Delayed Load Power Off & Restart

Purpose:
Note: This command is not recommended for new designs.
Commence shutdown of the UPS immediately with the given delay, but cancel the shutdown if the input power is restored during the countdown.

Control Command:

SFD	LEN	Cmd Byte	Delay Secs	Csum		
0xAB	0x02	0x8E	0-255	xx		

Additional Field Descriptions:
The DELAY data field is one byte with a range of 0 to 255 seconds. This allows for up to a 255 second delay (4 minutes, 15 seconds).

Exceptions:
Most UPS implementations do not use this command. It is a bad choice for Operating System shutdown software, since the OS could shutdown but not get rebooted if the input power is restored before the delay countdown finishes.

8.4 Increment / Decrement Output Voltage

Purpose:
The "Decrement Output Voltage" command causes the UPS to decrease its output voltage set point by 1% of nominal output; the step size will actually be to the nearest approximation of 1% that the UPS can make.
The "Increment Output Voltage" command causes the UPS to increase its output voltage set point by 1% of nominal output.
Note: This same functionality can be achieved with the Set Config Parameter command, using the Nominal Output Voltage

Control Command: Decrement Output Volts

SFD	LEN	Cmd Byte	Parameters	Csum		
0xAB	0x01	0x8C	(none)	XX		

Control Command: Increment Output Volts

SFD	LEN	Cmd Byte	Parameters	Csum		
0xAB	0x01	0x8D	(none)	XX		

Additional Field Descriptions:

UPS Action/Response:
The output is decremented/incremented once each time a command is sent, up to a set limit (normally 5%).

The value for "Nominal Output Voltage" reported in the Config block is not altered by this command, but the "Output Voltage Adjustment Setting" in the Config block shows the change.

Exceptions:

Example(s):

9 Appendix B: Command Summary

Command	Code	LEN	Auth Required?	Expected Response Block #	Added at Rev
Used by responses to commands 0x31-0x4F	0x00-0x1F				
Reserved for Test commands	0x20-0x28				
Reserved for System Control commands	0x29-0x2F				
Reserved for module command	0x30				
Send ID Block	0x31	1	No	01	E
Send Event History Log	0x32	1	No	02	E
Send Status Block	0x33	1-2	No	03	E
Send Meter Block	0x34	1	No	04	E
Send Active Alarms Block	0x35	1	No	05	E
Send Configuration Block	0x36	1	No	06	U
(Reserved for BTR)	0x37				
Send Utility Statistics Block	0x38	1	No	08	U
(Reserved for Command Acknowledge)	0x39			09	X
Send Waveform Block	0x3A	7	No	0x0A	W
Send Battery Data Block	0x3B	1	No	0x0B	Z
Send Extended Limits Block	0x3C	1	No	0x0C	AD
Undefined	0x3D				
Undefined	0x3E				
Send Test Results Data Block	0x3F	1	No	0x0F	AE
Send Command List Block	0x40	1	No	0x10	AE
Send Outlet Monitoring Block	0x41	1	No	0x11	AE
Send Communication Capabilities Block	0x42	2	No	0x12	A
Send UPS Topology Data Block	0x43	1	No	0x13	A
Send Communication Port List Block	0x44	1	No	0x14	A
Request Scratchpad Data	0x45	2	No	0x15	C
Reserved for standard request expansion	0x46-0x4F				
Reserved for Extended Data blocks	0x50-0x57				
Hawk Data Block	0x58	3-5	No	0x58	C
Reserved for Extended Data blocks	0x59-0x5F				
Reserved for Model Specific commands	0x60-0x6F				
Reserved for Test commands	0x70-0x7F				
Reserved for Control Command expansion	0x80-0x87				
Go To Bypass	0x88	1, 3	Yes	09	K
UPS On Command	0x89	1-2	Yes	09	K
Delayed Load Power Off & Restart	0x8A	2-4	Yes	09	K
UPS Off /Load Power Off	0x8B	1-2	Yes	09	K
Decrement Output Voltage	0x8C	1	Yes	09	K
Increment Output Voltage	0x8D	1	Yes	09	K

Conditional Delayed Load Power Off & Restart	0x8E	1	Yes	09	K
Set Time & Date	0x90	9	Yes	09	K
Scheduled UPS On in "n" Minutes	0x91	3-4	Yes	09	U
Scheduled UPS On at Date & Time	0x92	7-8	Yes	09	U
Scheduled Load Power Off in "n" Minutes	0x93	3-4	Yes	09	U
Scheduled Load Power Off at Date & Time	0x94	7-8	Yes	09	U
Set Config Parameter	0x95	4	Yes	09	AC
Undefined	0x96				
Set Outlet Parameter	0x97	5	Yes	09	AE
Set Communication Parameter	0x98	5	Yes	09	A
Set Scratchpad Sector	0x99	3,18	Yes	09	C
Set Power Strategy	0x9A	2	Yes	09	C
Reserved for Command Expansion	0x9B-0x9F				
Send Only Requested Alarm & ID Blocks	0xA0	1	Yes	01	K
Send Unrequested Alarm & ID Blocks	0xA1	1	Yes	01	K
Initiate Battery Test	0xB1	3	Yes	09	Z
Request Systems Test Command	0xB2	2	Yes	09	AE
Update Power Source Status Command	0xB3		Yes	09	C
Reserved for Model-specific Commands	0xB8-0xBF				
Reserved for Routing Commands	0xC0-0xC3				B
Reserved Commands	0xC4-0xCA				
Reserved network command	0xCB				
Reserved network command	0xCC				
Network Interface Reset	0xCD	4	Yes	09	AB
Select SubModule	0xCE	2-7	No	09 (or 03)	AB
Authorization Code	0xCF	4,7		None	K
Exit XCP Mode to "Main Menu"	0xFA	1	Yes	09	U
Reserved network commands	0xFB-0xFD				
Exit XCP Mode (to Unspecified)	0xFF	1	Yes	09	U

All other unspecified command bytes are RESERVED to the protocol for future standard XCP commands and should not be used as "private" or test mode commands by UPS developers. Use command bytes already RESERVED for Test or Machine-specific purposes instead.

The *Expected* Response Block # is shown for each command; however, the Command Acknowledge block may be sent in response to any block request if the data response is not implemented or temporarily unavailable.