MILPOWER SOURCE

SOFTWARE INTERFACE MANUAL

This Manual is applicable to Uninterruptible Power Supplies (UPS) of the following series:

M110BA, M120BA, M130BA, M140BA and M359-1

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1. Introduction

This document provides the information necessary to control and monitor MPS Uninterruptible Power Supplies (UPS) via its RS-232 interface. The basic functionality of the UPS (input and output control, status display by front panel LED indicators, etc.) is available to the user at any time. However, additional and enhanced control and monitoring functions are possible with the built-in RS-232 interface that supports a simple and effective protocol. With an RS-232 compliant TTY terminal or a PC emulating a TTY terminal, the user can issue short mnemonic keyboard commands to the UPS, and watch the UPS-generated responses and status mnemonic messages displayed on the terminal's screen. It is assumed that the reader is familiar with the UPS operation. Detailed information on the UPS is provided in the User's Manual (available at MPS website: www.milpower.com).

2 Communication Interface and Parameters

2.1 Communication Interface

The RS232 serial communication interface is available through connector J4 (a DB9 female connector located on the rear panel of the UPS.) Table 2.1 shows the standard RS232 pin assignment. On the Table below, the entry "Input" in the I/O column designates a receiver pin of the UPS. "Output" designates a transmitter pin of the UPS.

Table 2.1 - RS232 Connector J4 Pin Assignment (The UPS is a DTE)

Pin	I/O	Symbol	Description
1	Internally shorted to J3 pin 5. (not used by RS232 link)		
2	Input	RXD	Receive Data
3	Output	TXD	Transmit Data
4	Output	DTR	Data Terminal Ready
5	---------	SG	Signal Ground
6	Input	DSR	Data Set Ready
7	Output	RTS	Request To Send
8	Input	CTS	Clear To Send
9	Internally shorted to J3 pin 9. (not used by RS232 link)		

2.2 Communication Parameters

The UPS implements the standard RS232 communication protocol using the parameters listed below:

Baud rate:	1200
Data bits:	7
Stop bits:	1
Parity:	Even
Mode:	Full duplex
Handshake:	Hardware RTS/CTS, DTR/DSR
UPS is DTE	

3   RS-232 Link Messages

The UPS supports two types of link messages: <u>Host Commands</u> and <u>Status Reports</u>. Host Commands are sent <u>to</u> the UPS and control its various functions. Status Reports are generated <u>by</u> the UPS and indicate the status of internal variables and operational modes. These two types are explained in the following paragraphs.

3.1   Host Commands

Host Commands are formatted as ASCII sequences. The first two characters are alphabetic (may be lower or upper case) which represent the command mnemonic, followed by a single digit parameter. The sequence is normally terminated with a single "carriage return" (may be followed by a "line feed"). Each command is characterized by the following attributes:

Criticality: A critical command affects the state of the UPS output, either turning it off or on. For critical commands, a second CR (may also be followed by a LF) <u>must</u> be received within three seconds of the first CR or the command is ignored. This reduces the risk of inadvertent system shutdown or turn-on due to operator's error.

Latchability: A latched command remains in effect from the time it is received until it is canceled by an opposing command. An unlatched command is executed only once.

Volatility: A non-volatile command affects parameter values or operational modes that are maintained in the UPS Controller's Battery-Backed RAM and are kept as long as the Battery Pack is connected. A standard shutdown does not affect those values or modes.

Table 3.1 summarizes all valid Host Commands in alphabetical order. Each command is described in detail in the following paragraphs, also listed in alphabetical order.

Table 3.1 - Host Commands Summary

Command Mnemonic [1]	Description
AB0	Disable Automatic Battery Test
AB1	Enable Automatic Battery Test
AL0	Disable Audible Alarm
AL1	Enable Audible Alarm
AR0	Disable Automatic Reset
AR1	Enable Automatic Reset
BM0	Disable Battle Mode
BM1	Enable Battle Mode
BT1	Battery Test Request
EB0	Set Empty Bat Level to 0% (default)
EB1	Set Empty Bat Level to 10%
EB2	Set Empty Bat Level to 20%
EB3	Set Empty Bat Level to 30%
EB4	Set Empty Bat Level to 40%
EB5	Set Empty Bat Level to 50%
EB6	Set Empty Bat Level to 60%
EB7	Set Empty Bat Level to 70%
ES1	Request Major Status
ES2	Request Extended Status
ES3	Request Diagnostic Status
IP0	Disable Input Power Limit Feature
IP5	Set Input Power Limit to 60% of the Nominal Output Rating [2]
IP6	Set Input Power Limit to 75% of the Nominal Output Rating [2]
IP7	Set Input Power Limit to 85% of the Nominal Output Rating [2]
IP8	Set Input Power Limit to 95% of the Nominal Output Rating [2]
IP9	Set Input Power Limit to 105% of the Nominal Output Rating [2]
LB0	Set low bat level to 35% (default)
LB1	Set low bat level to 10%
LB2	Set low bat level to 20%
LB3	Set low bat level to 30%
LB4	Set low bat level to 40%
LB5	Set low bat level to 50%
LB6	Set low bat level to 60%
LB7	Set low bat level to 70%
LB8	Set low bat level to 80%
LB9	Set low bat level to 90%
PR1	Protection Reset
SB0	Standby Request Off
SB1	Standby Request On
SD1	Remote Shutdown
SR1	System Reset
SW1	Get Software ID
UV0	Disable Undervoltage Protection
UV1	Enable Undervoltage Protection

Notes: (1) **For the sake of brevity, the terminating CR, LF are omitted.**
   (2) **Nominal Output Rating is 1KW for M110BA, 1.5KW for M120BA and M130BA and 2KW for the M140BA and M359-1.**

3.1.1   Disable Automatic Battery Test

Mnemonic: **AB0**

Attributes: **Non-Critical, Latched, Non-Volatile**

Description:
Disables the Automatic Battery Test Feature.

3.1.2   Enable Automatic Battery Test

Mnemonic: **AB1**

Attributes: **Non-Critical, Latched, Non-Volatile**

Description:
Enables the Automatic Battery Test Feature. Fifteen seconds after the reception of this command, the UPS initiates a battery test. From that time on and until the feature is disabled, battery tests will be performed once every twenty-four hours of operation, and also fifteen seconds after UPS turn-on. The twenty-four hour timer is reset every time a battery test is performed (either manually from the UPS panel or by issuing the Battery Test Request Command, BT1). This assures that an automatic test is initiated no sooner than twenty four hours from the last test.

3.1.3   Disable Audible Alarm

Mnemonic: **AL0**

Attributes: **Non-Critical, Latched, Non-Volatile**

Description:
Disables the audible alarm.

3.1.4   Enable Audible Alarm

Mnemonic: **AL1**

Attributes: **Non-Critical, Latched, Non-Volatile**

Description:
Enables the audible alarm. Any one of the following conditions will activate the alarm. The conditions are listed in descending order of priority.

>   **Over Temperature Warning / Shutdown**
>   **Low Battery**
>   **Input Power Loss (battery operation)**

3.1.5   Disable Automatic Reset

Mnemonic: **AR0**

Attributes: **Non-Critical, Latched, Non-Volatile**

Description:
Disables the Automatic Reset Feature.

3.1.6   Enable Automatic Reset

Mnemonic: **AR1**

Attributes: **Non-Critical, Latched, Non-Volatile**

Description:
Enables the Automatic Reset feature. This causes the UPS to attempt automatic recovery from shutdowns caused by a fault (e.g. overload, overvoltage, output shorted, etc.) This command has the same effect as if the non-latched Protection Reset Command is issued after every fault-related shutdown. If this feature is enabled, then each fault causes a shutdown of the output (Standby Mode) for about five seconds, after which the UPS attempts to re-establish the output. If the fault persists, the cycle repeats four times. On the fifth cycle the UPS will stay off (Standby Mode) for three minutes before attempting to re-start. The fault counter decrements by one every ten seconds of normal operation (i.e. output OK).

3.1.7   Disable Battle Mode

Mnemonic: **BM0**

Attributes: **Non-Critical, Latched, Non-Volatile**

Description:
Disables Battle Mode.

3.1.8   Enable Battle Mode

Mnemonic: **BM1**

Attributes: **Non-Critical, Latched (temporarily), Non-Volatile**

Description:
Enables Battle Mode. This command remains in effect for ten minutes from the last time it was issued, and then it is reset. While in Battle Mode, the following conditions <u>will not</u> cause the UPS to switch to the Standby Mode (and disconnect the output):

1. **Over Temperature**

2. **Undervoltage Protection**

3. **Prolonged Overload**

4. **Empty Battery Condition. This means that if the Empty Bat Level is set to any value other than "EB0" (the default), the UPS <u>will not</u> shutdown if the battery charge drops below the set level, provided that the UPS operates on battery power and battle mode is active. However, the UPS will shutdown unconditionally if the battery protection circuit detects an over-discharge condition.**
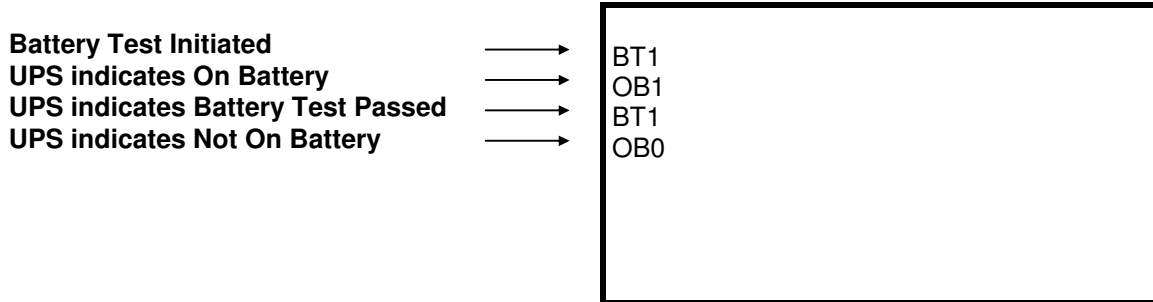
3.1.9   Battery Test

Mnemonic: BT1

Attributes: Non-Critical, Non-Latched, Volatile

Description:
Causes the UPS to initiate a single battery test sequence. Upon completion of the test, the UPS will send one of the Battery Test Response Messages. A sample battery test sequence which ends successfully as would appear on screen is shown in Figure 3.1.1. The first "BT1" is the user-entered command. The second "BT1" indicates a successful test. For information on other possible responses, refer to paragraph 3.2.3.

Battery Test Initiated	→	BT1
UPS indicates On Battery	→	OB1
UPS indicates Battery Test Passed	→	BT1
UPS indicates Not On Battery	→	OB0

Figure 3.1.1   Battery Test Sample Session

3.1.10 Set Empty Battery Level

Mnemonic: EB0 through EB7

Attributes: Non-Critical, Latched, Non-Volatile

Description:
Sets the "Empty Battery Level" (in percent of battery charge) to the to the levels shown in Table 3.1.1. When the Empty Battery Level is set to the default value (EB0 , 0%) and the battery charge reaches this level, only the "Empty Bat" (BE1) status message is set (actual battery disconnect will occur only when the battery monitor circuit senses that the battery is fully depleted and should be disconnected to avoid over-discharge.) When the Empty Battery Level is set to any value other than the default and the battery charge drops below this level, the battery will be disconnected in order to preserve some of its charge. If the UPS is fed from the battery at that time, this will cause a shutdown.

Note: "Empty Bat Level" must always be smaller than "Low Bat Level". If a newly received "Empty Bat Level" value is greater than the currently stored "Low Bat Level" value, the latter will be forced to the level listed in the right column of Table 3.1.2.

Empty Bat Level	Forced Low Bat Level (if Empty Bat Level > Low Bat Level)
0%	NA
10%	40%
20%	40%
30%	50%
40%	60%
50%	70%
60%	70%
70%	80%

Table 3.1.2   Forced Low Bat Levels

3.1.11 Request Major Status Report

Mnemonic: **ES1**

Attributes: **Non-Critical, Non-Latched, Volatile**

Description:
Requests a Major Status Report. The UPS responds by sending a Major Report Message. A sample session as would appear on screen is shown in Figure 3.1.1 For description of the various message elements, refer to paragraph 3.2.1.

```
ES1
IF0 OF0 OB0 LB0 BE0 BF0 IC0 CF0 TW0 AF0 LW0 BM0
```

Figure 3.1.2   Major Status Report Sample Session

3.1.12 Request Extended Status Report

Mnemonic: **ES2**

Attributes: **Non-Critical, Non-Latched, Volatile**

Description:
Requests an Extended Status Report. The UPS responds by sending an Extended Report Message. A sample session as would appear on screen is shown in Figure 3.1.3. For description of the various message elements, refer to paragraph 3.2.2

```
ES2
IF0 OF0 OB0 LB0 BE0 BF0 IC0 CF0 TW0 AF0 LW0 BM0
AL1 AB0 AR0 UV0 LD5 IP0 CH8 LL0 EL0 AC1 DC0
```

Figure 3.1.3   Extended Status Report Sample Session

3.1.13 Request Diagnostic Status Report

Mnemonic: ES3

Attributes: Non-Critical, Non-Latched, Volatile

Description:
Requests a Diagnostic Status Report. The UPS responds by sending an Diagnostic Report Message. A sample session as would appear on screen is shown in Figure 3.1.4. For description of the various message elements, refer to paragraph 3.2.3

```
ES3
OL0 TS0 OV0 DO0 OS0 SF0 UB0 SB0
```

Figure 3.1.4   Diagnostic Status Report Sample Session

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3.1.14 Set Power Limit Level

Mnemonic: **IP0, IP6 through IP9**

Attributes: **Non-Critical, Latched, Non-Volatile**

Description:
This feature may be used when the UPS is fed from an input power source with rating that is lower than the UPS input rating. In many cases the input AC source (not the UPS) can support the steady state demands, but not the full input current into the UPS during instantaneous peak demand of the load. When equal to "IP0", this feature is disabled. When not equal to "IP0", it defines the level of input power at which the battery will be connected and the internal charger will be momentarily disabled (in order to reduce the loading on the AC source during momentary over-demand (see Table 3.1). The actual battery connection is delayed by one to ten seconds from the onset of the overload, depending upon the ratio of the overload to the Input Power Limit setting.

Delay = $\dfrac{Pol}{Pol - Pset}$**[in seconds]**   **Equ. 3.1**

where:
Pol **is the Input power during overload**
$Pset$ **is the Input Power Limit setting per Table 3.1**

Example:
Assuming that the M130BA-1A is used to feed a system whose steady state (average) power consumption is 800W, but occasionally requires peak power of 1.5KW for a short duration (a few minutes). However, the only available source is a limited-power outlet with a circuit breaker rated for 16A.   The peak input power of the M130BA-1A may be calculated using the following formula:

$Pin = (Pout + Pchg) \times 1.2$ **Equ. 3.2**

where:
Pin **is the input power into the UPS**
$Pout$ **is the output power from the UPS**
$Pchg$ **is the internal charger consumption (0 to 400W depending upon the charging state of the**
battery)

Substituting the steady state system consumption (0.8KW) and the instantaneous peak demand of the system into Equation 3.2 yields:

Pin **(steady state) =** (800 +400) X 1.2 = 1,140W **Resulting in a nominal input current of 10Amp.**
Pin **(peak) =** (1,500 +400) X 1.2 = 2,280W **Resulting in a nominal input current of 20Amp.**

The 20Amp is definitely exceeds the capability of the 16A outlet. To overcome this problem the user has to set the Input Power Limit to1.6KW by entering IP9 (105% of the M130BA Nominal Rating of 1.5KW). This setting will allow the AC outlet to fully support the instantaneous load. When the 1.6KVA threshold (set by IP9) will be exceeded, the UPS control will disable the charger and after a delay of 3.5 seconds (per Equ. 3.1) will connect the battery and the UPS input current will be reduced to below 10Arms.

It should be noted that the Input Power Limit would be affective only if the circuit breaker has a response time longer than the 3.5 seconds delay on the UPS input limit.

3.1.15 Set Low Battery Level

Mnemonic: **LB0 through LB9**

Attributes: **Non-Critical, Latched, Non-Volatile**

Description:
Sets the "Low Battery Level" (in percent of battery charge) to the levels shown in Table 3.1.1. When the battery charge drops below this level, the "Low Bat" panel indicator turns on, the audible alarm sounds and the status message LB1 is set.

Note: "Empty Bat Level" must always be smaller than "Low Bat Level". If a newly received "Low Bat Level" value is smaller than the currently stored "Empty Bat Level" value, the latter will be forced to the level listed in the right column of Table 3.1.3

Low Bat Level	Forced Empty Bat Level (if Low Bat Level < Empty Bat Level)
35%	0%
10%	0%
20%	0%
30%	0%
40%	10%
50%	20%
60%	40%
70%	50%
80%	NA
90%	NA

Table 3.1.3   Forced Empty Bat Levels

3.1.16 Protection Reset

Mnemonic: **PR1**

Attributes: **Critical, Non-Latched, Volatile**

Description:
This command allows the UPS to recover from a shutdown caused by a fault condition (e.g. overload, overvoltage, output shorted, etc.). If issued following a shutdown, the UPS will attempt to turn on the output.

3.1.17 Standby Request Off

Mnemonic: **SB0**

Attributes: **Critical, Latched, Volatile**

Description:
This command resets the request for standby, causing the UPS to reconnect the output.

3.1.18 Standby Request On

Mnemonic: **SB1**

Attributes: **Critical, Latched, Volatile**

Description:
This command allows the host to turn off the UPS output without a complete shutdown (Standby Mode). The UPS responds to this command by entering the "Standby State" during which the UPS output is disconnected, but communications and battery charging are still active.

3.1.19 Remote Shutdown

Mnemonic: **SD1**

Type: **Critical, Non-latched, Volatile**

Description:
This command allows the host to shutdown the UPS (in case of input power loss) prior to complete depletion of the internal battery. The UPS responds to this command by disconnecting the UPS output and battery. If input power is not available, this will cause an immediate and total UPS shutdown. When input power recovers, the UPS will automatically turn on and provide output power. If input power is on when the Remote Shutdown command is received, the UPS will reconnect the output and battery after a minimum delay of five seconds and resume "Normal" operation (assuming other internal conditions do not prevent this.)

3.1.20 System Reset

Mnemonic: **SR1**

Attributes: **Critical, Non-Latched, Volatile**
Description:
This command is similar to the Protection Reset Command PR1. In addition, it resets all user-definable parameters to their default values as listed below:

Automatic Battery Test:	**Disabled**
Under Voltage Protection:	**Disabled**
Automatic Reset:	**Disabled**
Audible Alarm:	**Enabled**
Battle Mode:	**Disabled**
Low Battery Level:	**35%**
Empty Battery Level:	**0%**
Input Power Limit:	**Disabled**

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3.1.21 Get Software ID

Mnemonic: **SW1**

Attributes: **Non-Critical, Non-Latched, Volatile**

Description:
Requests the UPS Controller's firmware ID. The following string is an example of what would be shown on screen:

UPS Control Program Version 3.00D 95/06/10 Copyright Milpower Source, Inc. 1995

3.1.22 Disable Undervoltage Protection

Mnemonic: **UV0**

Attributes: **Non-Critical, Latched, Non-Volatile**

Description:
Disables the Undervoltage Protection Feature. The effect of this command is latched and non-volatile.

3.1.23 Enable Undervoltage Protection

Mnemonic: **UV1**

Attributes: **Non-Critical, Latched, Non-Volatile**

Description:
Enables the Undervoltage Protection Feature. This causes the UPS to disconnect the output and go into "Standby Mode" whenever an Undervoltage condition (Vout <= 103Vac) is detected for at least three seconds.

3.2   Status Reports

Status reports are formatted as ASCII sequences. The first two characters are letters which represent the status mnemonic, followed by a single digit parameter. The sequence is terminated with "carriage return" (CR) and a "line feed" (LF).

The UPS Controller maintains a set of variables that represent its internal status. The set is divided into four groups: Major, Extended, Battery Test Response, and Diagnostic. Each group is discussed in the following paragraphs. For the sake of brevity, the terminating CR LF sequence is omitted from the mnemonics.

3.2.1   Major Status Reports

The Major Status Group (see Table 3.2.1) contains twelve critical "TRUE / FALSE" report pairs. Whenever a "TRUE" condition is detected (either failure or a non-standard mode of operation) it is reported immediately, but just once. When the condition disappears, the "FALSE" report is sent once within ten seconds. The host can request a complete Major Status Report by issuing the "ES1" command.

Mnemonic	Status	Condition Described by Status
AF0	No Internal Failure	No internal failure
AF1	Internal Failure Detected	UPS Controller has detected an internal failure
BE0	Battery Is Not Empty	Battery charge is above "Empty Battery Level"
BE1	Battery Is Empty	Battery charge is below "Empty Battery Level"
BF0	Not Battery Failed	No Battery Failure
BF1	Battery Failed	Battery failure detected (not during battery test)
BM0	Battle Mode Off	Indicates that the UPS is not in Battle Mode
BM1	Battle Mode On	Indicates that the UPS is in Battle Mode
CF0	Not Charger Failure	No charger failure
CF1	Charger Failure	Indicates that the battery charger has failed
IC0	Valid Charge Data	See note 1
IC1	Invalid Charge Data	See note 1
IF0	Input OK	Input voltage is in range to support fully-loaded output
IF1	Input Fail	Input voltage is too low to support fully-loaded output
LB0	Not Low Battery	Battery charge is above "Low Battery Level"
LB1	Low Battery	Battery charge is below "Low Battery Level"
LW0	No High Load Warning	Load level is below 100% of rated level.
LW1	High Load Warning	Load level is above 100% of rated level.
OB0	Not on Battery	UPS operates on AC power
OB1	On Battery	UPS operates on battery power
OF0	Output OK	$V_{out} \geq 103 V_{rms}$
OF1	Output Fail	$V_{out} < 103 V_{rms}$
TW0	Not Over Temp. Warning	UPS is not in Over Temperature Warning state
TW1	Over Temp. Warning	UPS is in Over Temperature Warning state

Table 3.2.1 Major Status Group

Notes:
1. Indicates that the charge level information is invalid due to backup power loss sustained by the UPS controller. This message also signifies that all user-definable parameters (including the non-volatile ones) were reset to their default values.

3.2.2   Extended Status Reports

The Extended Status Group (see Table 3.2.2) contains ten less critical status report types. When the host issues the "ES2" command, both the complete Major and Extended reports are sent.

Status Mnemonic	Description
AB0	Automatic Battery Test Disabled
AB1	Automatic Battery Test Enabled
AL0	Alarm Disabled
AL1	Alarm Enabled
AR0	Auto-Reset Disabled
AR1	Auto-Reset Enabled
CH0	Charge Level is 0% to 4%
CH1	Charge Level is 5% to 14%
CH2	Charge Level is 15% to 24%
CH3	Charge Level is 25% to 34%
CH4	Charge Level is 35% to 44%
CH5	Charge Level is 45% to 54%
CH6	Charge Level is 55% to 64%
CH7	Charge Level is 65% to 74%
CH8	Charge Level is 75% to 84%
CH9	Charge Level is 85% to 94%
CHA	Charge Level is greater than or equal to 95%
IP0	Input Power Limit Not Active
IP5	Input Power Limit At 60% of Nominal Rating
IP6	Input Power Limit At 75% of Nominal Rating
IP7	Input Power Limit At 85% of Nominal Rating
IP8	Input Power Limit At 95% of Nominal Rating
IP9	Input Power Limit At 105% of Nominal Rating
LD0	Load Level is 0% to 15%
LD1	Load Level is 16% to 23%
LD2	Load Level is 24% to 38%
LD3	Load Level is 39% to 53%
LD4	Load Level is 54% to 68%
LD5	Load Level is 69% to 83%
LD6	Load Level is 84% to 100%
LD7	Load Level is 101% to 115%
LD8	Load Level is 116% to 125%
LD9	Load Level is 126% to 135%
LDA	Load Level is greater than 135%
UV0	Under Voltage Protection Disabled
UV1	Under Voltage Protection Enabled

Table 3.2.2   Extended Status Group

Status Mnemonic	Description
LL0	Low Battery Warning Level is 35% (default)
LL1	Low Battery Warning Level is 10%
LL2	Low Battery Warning Level is 20%
LL3	Low Battery Warning Level is 30%
LL4	Low Battery Warning Level is 40%
LL5	Low Battery Warning Level is 50%
LL6	Low Battery Warning Level is 60%
LL7	Low Battery Warning Level is 70%
LL8	Low Battery Warning Level is 80%
LL9	Low Battery Warning Level is 90%
EL0	Empty Battery Warning Level is 0% (default)
EL1	Empty Battery Warning Level is 10%
EL2	Empty Battery Warning Level is 20%
EL3	Empty Battery Warning Level is 30%
EL4	Empty Battery Warning Level is 40%
EL5	Empty Battery Warning Level is 50%
EL6	Empty Battery Warning Level is 60%
EL7	Empty Battery Warning Level is 70%
AC1	UPS Operates On AC Input
AC0	UPS Does Not Operates On AC Input
DC1	UPS Operates On DC Input
DC0	UPS Does Not Operates On DC Input

Table 3.2.2   Extended Status Group (cont.)

3.2.3   Battery Test Response Status Reports

The Battery Test Response Status Group (see Table 3.2.3) contains five report types. When the host issues a "BT1" command, one of the reports will be sent back according to the test result.

Status Mnemonic	Description
BT1	Battery Test Passed
BT0	Battery Test Failed
BD1	Battery Test Denied because battery charge was below 85%.
BD2	Battery Test Denied because battery was supporting Input Power Limit
BD3	Battery Test Denied due to Input Voltage Failure
BD4	Battery Test Denied because output load was too low (below 35%).
BD5	Battery Test was not completed

Table 3.2.3   Battery Test Response Status Group

3.2.4   Diagnostic Status Reports

The Diagnostic Status Group (see Table 3.2.4) contains eight report types. These reports reflect the various reasons that may have caused output failure. They are stored in the UPS Controller's battery-backed RAM and are reported in response to the "ES3" host command. They are cleared automatically five minutes after output recovery, or immediately after being reported.

Status Mnemonic	Description
OL1	Overload Shutdown
TS1	Over Temperature Shutdown
OV1	Over Voltage Shutdown
DO1	DC Offset Shutdown
OS1	Output Shorted Shutdown
SF1	Source Fail Condition(simultaneous input power fail and empty battery).
UB1	UPS Bad Condition - shutdown due to internal failure
SB1	UPS in Standby Mode

Table 3.2.4   Diagnostic Status Group

4   Applications and Operation Examples

4.1   Normal Turn On and AC Power Loss/Recovery

Figure 4.1 shows the Major Status Reports generated upon a typical chain of events. Assuming that both Input and Output switches are off, first the Input switch is turned on. The UPS reports immediately an Output Fail. Then the Output switch is turned ON, and the UPS reports Output OK. AC power loss then occurs and the UPS immediately reports Input Fail. After a delay it sends On Battery report. When AC input recovers, the UPS reports Input OK, followed by Not On Battery report.
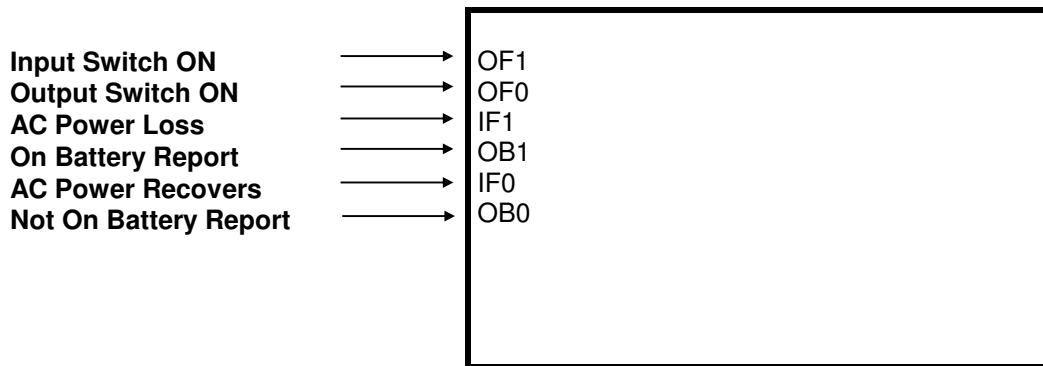
Input Switch ON	→	OF1
Output Switch ON	→	OF0
AC Power Loss	→	IF1
On Battery Report	→	OB1
AC Power Recovers	→	IF0
Not On Battery Report	→	OB0

Figure 4.1   Typical Status Reports following UPS Turn-On

4.2   Controlling Guaranteed Holdup Time

The Low Battery Level and Empty Battery Level parameters allow the user to refine his control over holdup time to support various scenarios. The actual hold-up time of the UPS at any given moment depends on the charge left in battery . For example, after a ten minute input power loss (at 1500W load) only five additional minutes of hold-up time are available for the next power interrupt unless enough time is given for battery re-charge.

Assume a UPS-powered system that has a critical mission segment during which system operation must not be interrupted for at least ten minutes (at full load). It is assumed here that at any other time uninterrupted operation is desired but not critical. In this case, setting the Low Battery Level to 70% (LB7 command) will cause the UPS to issue a Low Battery Report (LB1 status) as soon as the charge drops below 70%. This would alert the host system that it should shut down the UPS (by issuing an SD1 command) in order to guarantee a remaining minimum of 10.5 minutes (70% of 15 minutes) critical holdup time at 1500W load. During the critical mission segment the host system may ignore this Low Battery Level report and the UPS will perform an automatic shutdown only when no charge is left in the battery.

In systems where an automatic UPS shutdown is preferred over host-initiated shutdown, a slightly different approach is needed. In this case, the user has to issue a 70% Empty Battery Level command (EB7 command). During non-critical mission segments, this setting will ensure that the UPS will not discharge the battery below 70% when AC power is lost, because a shutdown will occur as soon as this threshold is crossed. Upon entering the critical mission segment the user should issue a Battle Mode Command (BM1) and refresh that command at five minutes intervals.

The Battle Mode will override the 70% Empty Battery Threshold allowing the system to utilize the full remaining capacity of the battery (10.5 minutes minimum). In this case it

may be desirable to set the Low Battery warning Level to 80% (LB8 command) so that during non-critical mission segment, the system will be forewarned prior to actual shutdown.
The default setting of the Low Battery Level is 35% and the Empty Battery Level is 0%.