Mate Serial Communications Guide

This guide is only relevant to Mate Code Revs. of 3.30 and greater

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Revision History

Revision 2.0:

    1. Added revision history.
    2. Corrected some typos.
    3. Added more typos.
    4. Added Hub description to *Mate Overview*.
    5. Added Baud rate description to *Hardware* section.
    6. Changed inverter address description in *FX Status Page*.
    7. Added to FX mode descriptions in *FX Status Page*.
    8. Added to AC mode descriptions in *FX Status Page*.
    9. Changed bit 5 warning mode description in *FX Status Page*.
    10. Added *MX Status Page*.
    11. Changed the description in *Commands* section.
    12. Added information to *Command Timing*.

Revision 3.0:

    1. Added Grid-Tie comm. information to FX Status Page section.
        a. Changed FX operational mode bytes to reflect GT info.
        b. Removed GT info from AC mode bytes.

Revision 3.01

    1. Added to the Misc. byte definition for the FX (pg. 8)
        a. Added note to divide all currents by 2 if the Unit has 230VAC output.

Revision 3.02   1. Clarified MX60 chksum calculations. (pg .12)

Introduction

The purpose of this document is to describe the hardware and software protocols required to communicate with the OutBack Power Systems Mate™ remote controller via a PC. This information is only relevant to Mate Code Revs. of 3.30 and greater.

Mate Overview

The Mate controller is designed to report status and control the operating modes of OutBack Power Systems power conversion equipment. The Mate communicates with OutBack products through a proprietary serial communication link, and receives pre defined status pages from whatever type of OutBack product it is connected to. The Mate is also capable of issuing commands to OutBack products. At this point, commands are limited to controlling an FX inverter. The Mate can be directly connected to a single OutBack device, or to multiple devices using an OutBack HUB.

Figure 1A shows the Mate directly connected to an OutBack FX or MX, obviously only the device directly connected to the Mate can be controlled.

Figure 1

Figure 1B shows the Mate connected to an OutBack STACK board. This is a low cost stacking board that allows the FX's to communicate with each other as is required for stacking. The STACK board also has jacks to connect each device to a Mate. The Mate can only communicate with the device that is plugged into a corresponding jack. By manually plugging and unplugging the Mate, all the devices can be setup and programmed. Plugging the Mate into the master inverter, allows the Mate to control the entire system via the master FX. In figure 1B FX1 would be programmed as the master, and FX 2 as the slave. To control the system as a whole the Mate would be normally left connected to FX 1. In this configuration the Mate would only report the status of FX 1, it does not have any 'knowledge' of FX 2. FX 1 communicates with FX 2 directly as a stacked pair, so when the Mate tells FX 1 to turn on/off or change modes, FX 2 will follow suit. At this time OutBack offers a STACK2 and a STACK4, for 2 and 4 FX units respectively.

Figure 1C shows a Mate connected to an OutBack HUB. The HUB allows the Mate to communicate with up to 10 products simultaneously. All products connected to the HUB can report back status to the Mate, but PC control of all the products is still via the master.
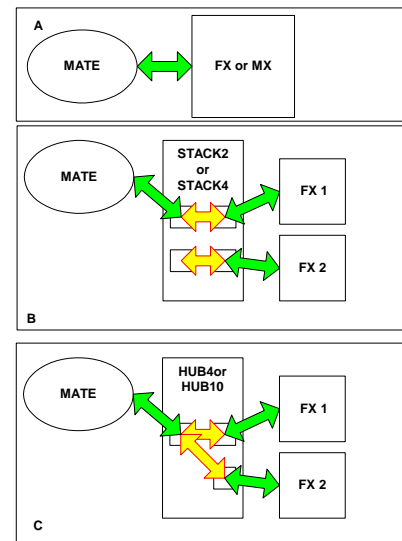

Hardware

In addition to a LCD and buttons for display and control, an OutBack Mate provides an isolated RS232 port for PC communication in the form of a female DB9 connector, running at a baud rate of 19200, 8 bits, no parity, 1 stop bit. The Mates' serial port is optically isolated from the rest of the OutBack products it is connected too. This isolation requires that the Mate 'steals' power from the PC in order to communicate. Figure 2 shows which lines of a standard PCs' serial port are used. All pin numbers and names are referenced from the PC.

The Mate requires that the DTR (pin 4) be driven high (set) and that RTS (pin 7) be driven low (cleared), in order to power the port. The Mate transmits data on the RX(pin 2) line, and listens for commands on the TX(pin 3) line. GND (pin 5) is ground. No other pins are used by the Mate.

The Mate uses the same uart to communicate with Outback products that it does to talk to the PC. This requires that all PC to Mate comms. must be initiated by the Mate. Once a second the Mate will transmit a string of ASCII formatted data to the PC. Simultaneously the Mate will listen for PC sent commands.

Figure 2

Communication Protocol

The only communication protocol supported at this time is an ASCII formatted status information dumped from devices connected to the Mate. This scheme will also allow for simple commands to be passed from the PC to an OutBack product via the Mate. I'll use the term status page to indicate the data from a single device. The status pages sent from an FX have a different content then those from an MX, however the format is the same. I'll start with describing the FX Status page.

FX Status Page

The status page the Mate emits for each FX connected is 49 Bytes long. Referring to the Figure 3 the byte definitions are as follows:

Figure 3

BYTE
1. This is an ASCII(10) New Line character denoting the start of the status page.
2. This is the Inverter address.
3. ASCII(44) a comma as a data separator.
4. High byte of Inverter current.
5. Low byte of Inverter current.
6. ASCII(44) a comma as a data separator.
7. High byte of Charger current..
8. Low byte of Charger current.
9. ASCII(44) a comma as a data separator.
10. High byte of Buy current..
11. Low byte of Buy current.
12. ASCII(44) a comma as a data separator.
13. High byte of the AC input voltage.
14. Middle byte of AC input voltage.
15. Low byte of AC input voltage.
16. ASCII(44) a comma as a data separator.
17. High byte of the AC output voltage.
18. Middle byte of AC output voltage.
19. Low byte of AC output voltage.
20. ASCII(44) a comma as a data separator.
21. High byte of Sell current.
22. Low byte of Sell current.
23. ASCII(44) a comma as a data separator.
24. High byte of FX operating mode.
25. Low byte of FX operating mode.
26. ASCII(44) a comma as a data separator.
27. High byte of FX Error mode.
28. Middle byte of FX Error mode.
29. Low byte of FX Error mode.
30. ASCII(44) a comma as a data separator.
31. High byte of FX AC mode.
32. Low byte of FX AC mode
33. ASCII(44) a comma as a data separator.
34. High byte of FX battery voltage.
35. Middle byte of FX battery voltage.
36. Low byte of FX battery voltage.
37. ASCII(44) a comma as a data separator.
38. High byte of FX Misc.
39. Middle byte of FX Misc.
40. Low byte of FX Misc.
41. ASCII(44) a comma as a data separator.
42. High byte of FX Warning mode.
43. Middle byte of FX Warning mode.

44. Low byte of FX Warning mode.
45. ASCII(44) a comma as a data separator.
46. High byte of Chksum.
47. Middle byte of Chksum.
48. Low byte of Chksum.
49. ASCII(13) carriage return. Denotes end of status page.

Inverter Address: For a directly connected FX this will be a '0'(ASCII(48)). If a HUB is used, the address will correspond to the port the FX is plugged into. Ascii(49) – Ascii(58) for Ports 1-10.

Inverter current: '00' to '99' This is AC current the FX is delivering to loads. One amp increments.

Charger current: '00' to '99' This is AC current the FX is taking from the AC input and delivering to the batteries. One amp increments.

Buy current: '00' to '99' This is AC current the FX is taking from the AC input and delivering to the batteries **and** pass thru loads. One amp increments

AC input voltage: '000' to '256' The voltage seen at the FXs AC input terminals. One volt increments. If Misc byte bit 1 set, then this number must be multiplied by 2. See Misc. byte definition below.

AC output voltage: '000' to '256' The voltage on the FXs output AC terminals. One volt increments. If Misc byte bit 1 set, then this number must be multiplied by 2. See Misc. byte definition below.

Sell current: '00' to '99' This is the AC current the FX is delivering from the batteries to the AC input. . One amp increments

DATA	MODE
"00"	Inv Off
"01"	Search
"02"	Inv On
"03"	Charge
"04"	Silent
"05"	Float
"06"	EQ
"07"	Charger Off
"08"	Support
"09"	Sell Enabled
"10"	Pass Thru
"90"	FX Error
"91"	AGS Error
"92"	Com Error

Figure 4

FX operational mode: '00' to '99' Currently reported modes are shown in figure 4.
Inverter off, search, and on are self explanatory.

Charge refers to a bulk – absorption cycle.

Silent and float correspond to user programmed end of charge behavior.

EQ is a user initiated charge state.

Charger Off means that the user has manually turned the charger off.

NOTE:
(Older Mates reported Errors using a "07", this is an incompatibility between older Mates (pre rev 3.30 and newer). Pre 3.30 Mates did not actually report any FX mode of greater then "08" even though the were defined.

Support means that the FX is drawing power from the batteries to support the AC source it is connected to. Grid-Tie inverters will display support whenever power being removed from the batteries does not exceed the AC loads of the system. An example would be:
A Grid-Tie FX has a SellRE setting of 25.6VDC and 600W of AC load on its output. DC sources are contributing 300W to the battery. The GTFX will hold the battery @ 25.6VDC by converting the excess 300W of DC power to AC. The FX Mode would display Support with the Inverter Current meter showing 300W of production, the Buy Current would show 300W of buying current, for 600W of total AC Load current. If the AC load is removed the GTFX would have an FX mode of Sell Enabled, and show 300W of Sell Current.
Support mode is also used to indicate battery power being used to Support a generator when the FX is in Gen Support mode.

Sell Enabled means that the FX is exporting more power then it has AC loads. This excess power is flowing out the FXs AC input. Its quantity is measured with the Sell Current meter.

Pass Thru means that the FXs converter is off. The FX is only passing thru the AC from its AC input. This mode is the result of the FX waiting for some sell criteria (like the five minute timer, or battery voltage to be > then the SellRE setpoint) before it starts selling.

FX Error means that the FX has shut down for the reason shown in the Error Bytes.

AGS Error means that the Mate has either tried to automatically start the generator in Advanced Gen Start mode and failed, or that the gen started then stopped unexpectedly.

Comm Error means that the Mate has lost communications with one or more of the OutBack devices connected to it. (This error is not yet implemented in Mate Code Rev. 3.30.)

Error modes: '000' to '256' This is an ASCII expression of an 8 bit byte, with each bit representing a different error. Referring to Figure 5, a returned '132' would be an overtemp and backfeed error. Errors will shut down the FX they occur on, if a master in a stacked system errors, it will shut the whole system down.

BIT #	Value	ERROR
1	1	Low VAC output
2	2	Stacking Error
3	4	Over Temp.
4	8	Low Battery
5	16	Phase Loss
6	32	High Battery
7	64	Shorted output
8	128	Backfeed

Figure 5

AC mode: '00' to '99' This data represents the status of the AC input. No AC is pretty straight forward, AC Drop means that AC is present but, it is not yet within valid parameters or the FX has been told not to use it (Drop). AC Use means AC is present and valid, and the FX will utilize it.

DATA	MODE
"00"	No AC
"01"	AC Drop
"02"	AC Use

Figure 6

Battery Voltage: '000' to '999' A 24.8 Vdc battery voltage will be sent as '248'. The Resolution of battery voltage is .1V for 12V systems, .2 for 24V systems, and .4 for 48V systems.

Misc. Byte: '000' to '256' This is an ASCII expression of an 8 bit byte, with each bit representing a different condition. Only 2 of the bits are used at this time. Bit 1 indicates a FX with greater than 200 V ac output. If this bit is set, then AC input and output voltages must be multiplied by 2 *and all currents must be divided by 2*.Bit 8 indicates the status of the FX AUX output. A bit value of 1 in the 8th bit means the Aux output is active.

BIT #	Value	
1	1	230V unit
2	2	Reserved/used by FX
3	4	Reserved/used by FX
4	8	Reserved/used by FX
5	16	Reserved/used by FX
6	32	Reserved/used by FX
7	64	Reserved/used by FX
8	128	AUX output ON

Figure 7

Warning modes: '000' to '256' This is an ASCII expression of an 8 bit byte, with each bit representing a different error. Referring to Figure 8, a returned '010' would be AC input low voltage and freq. FXs with warnings will continue to operate. See figure 8.

BIT #	Value	Warning
1	1	AC Input Freq High
2	2	AC Input Freq Low
3	4	Input VAC High
4	8	Input VAC Low
5	16	Buy Amps > Input size
6	32	Temp sensor failed
7	64	Comm Error
8	128	Fan Failure

Figure 8

Chksum: '000' to '999' This is a simple additive chksum of the decimal values of the Status page.
Example:
0,00,00,00,119,000,00,00,000,01,254,008,000,031
0+0+0+0+0+0+0+1+1+9+0+0+0+0+0+0+0+0+0+0+0+1+2+5+4+0+0+8+0+0+0=031
0,00,00,00,120,000,00,02,000,01,254,008,000,025
0+0+0+0+0+0+0+1+2+0+0+0+0+0+0+0+2+0+0+0+0+1+2+5+4+0+0+8+0+0+0=025

MX Status Page

The status page the Mate emits for each MX connected is 49 Bytes long. Referring to the Figure 9 the byte definitions are as follows:

Figure 9

BYTE

1. This is an ASCII(10) New Line character denoting the start of the status page.
2. This is the MX address.
3. ASCII(44) a comma as a data separator.
4. Unused, ASCII(48).
5. Unused, ASCII(48).
6. ASCII(44) a comma as a data separator.
7. High byte of Charger current.
8. Low byte of Charger current.
9. ASCII(44) a comma as a data separator.
10. High byte of PV current.
11. Low byte of PV current.
12. ASCII(44) a comma as a data separator.
13. High byte of the PV input voltage.
14. Middle byte of PV input voltage.
15. Low byte of PV input voltage.
16. ASCII(44) a comma as a data separator.
17. High byte of Daily KWH.
18. Middle byte of Daily KWH.
19. Low byte of Daily KWH.
20. ASCII(44) a comma as a data separator.
21. Unused, ASCII(48).
22. Unused, ASCII(48).
23. ASCII(44) a comma as a data separator.
24. High byte of MX Aux mode.
25. Low byte of MX Aux mode.
26. ASCII(44) a comma as a data separator.
27. High byte of MX Error mode.
28. Middle byte of MX Error mode.
29. Low byte of MX Error mode.
30. ASCII(44) a comma as a data separator.
31. High byte of MX charger mode.
32. Low byte of MX charger mode.
33. ASCII(44) a comma as a data separator.
34. High byte of MX battery voltage.
35. Middle byte of MX battery voltage.
36. Low byte of MX battery voltage.
37. ASCII(44) a comma as a data separator.
38. Unused, ASCII(48).
39. Unused, ASCII(48).
40. Unused, ASCII(48).
41. ASCII(44) a comma as a data separator.
42. Unused, ASCII(48).
43. Unused, ASCII(48).

44. Unused, ASCII(48).
45. ASCII(44) a comma as a data separator.
46. High byte of Chksum.
47. Middle byte of Chksum.
48. Low byte of Chksum.
49. ASCII(13) carriage return. Denotes end of status page.

MX Address: For directly connected MX this will be an 'A' ASCII(65). If a HUB is used, the address will correspond to the port the MX is plugged into. Ascii(66) – Ascii(75) for Ports 1-10.

Charger current: '00' to '99' This is DC current the MX is delivering to the batteries. One amp increments.

PV current: '00' to '99' This is DC current the MX is taking from the PV panels. One amp increments

PV panel voltage: '000' to '256' The voltage seen at the MXs PV input terminals. One volt increments.

Daily KWH: '000' to '999' Running total of KWatt Hours produced by the PV array. Formatted as XX.X (999 = 99.9 KWH). This number is reset every morning when the MX wakes up, or every 24 hours in locations with no nightfall.

MX Aux mode: '00' to '99' This shows what Aux output mode is being run on the MX. Refer to MX manual for mode descriptions.

DATA	MODE
"00"	Disabled
"01"	Diversion
"02"	Remote
"03"	Manual
"04"	Vent Fan
"05"	PV Trigger

Figure 10

Error modes: '000' to '256' This is an ASCII expression of an 8 bit byte, with each bit representing a different error. MX Error modes are not implemented at this time.

MX Charge mode: '00' to '99' This data represents the MXs charger mode. See Figure 11.

DATA	MODE
"00"	Silent
"01"	Float
"02"	Bulk
"03"	Absorb
"04"	EQ

Figure 11

Battery Voltage: '000' to '999' A 24.8 Vdc battery voltage will be sent as '248'. The Resolution of battery voltage is .1V for 12V systems, .2 for 24V systems, and .4 for 48V systems.

Chksum: '000' to '999' This is a simple additive chksum of the decimal values of the Status page.
      NOTE: Since the MX address is an alpha character, it's checksum needs to be calculated differently then the FX's numerical address. Addresses reported for the MX will be 'A" (ASCII 66) through 'K" (ASCII 75) corresponding to ports 1-10. The value to use for Chksum calculations should be the received ASCII value – 48 (For the received character 'A" the chksum value to be used would be 66-44, or 18.
Example:
0,00,00,00,119,000,00,00,000,01,254,008,000,031
0+0+0+0+0+0+0+1+1+9+0+0+0+0+0+0+0+0+0+0+1+2+5+4+0+0+8+0+0+0=031
0,00,00,00,120,000,00,02,000,01,254,008,000,025
0+0+0+0+0+0+0+1+2+0+0+0+0+0+0+0+2+0+0+0+0+1+2+5+4+0+0+8+0+0+0=025

Commands

The Mate will accept the following commands for controlling FXs only. The Mate only passes these commands to the master inverter in a HUB stacked system. The master will change the modes of all slaved inverters to suit. ON, SEARCH, OFF, USE, DROP, AUX ON, and AUX OFF. ON will turn the FX to ON mode, if no AC input is being used the inverter will provide a constant output. SEARCH will place the FX in Search mode, allowing for a pulsed AC output when load levels drop below the programmed limits for that FX. OFF will not allow the FX to invert. It will still charge and pass through AC depending on the AC mode. These commands will only be passed onto the master inverter in a HUB based system. USE will allow the AC input to be used if it meets the programmed limits of the FX. DROP will not allow AC input to be utilized, unless there is an error. Errors will cause the FX to change the AC mode to USE. AUX ON energizes the 12V Aux output of the FX, AUX OFF de-energizes it. AUX control is only available for master inverters on a HUB. For more information on FX operational modes, download the FX manual at http://www.outbackpower.com/manuals.htm .

Commands are sent as ASCII characters, the same character is sent twice for error checking. Figure 12 shows a chart of utilized commands.

DATA	ASCII	COMMAND
"OO"	ASCII(79) ASCII(79)	ON
"SS"	ASCII(83) ASCII(83)	SEARCH
"FF"	ASCII(70) ASCII(70)	OFF
"UU"	ASCII(85) ASCII(85)	USE
"DD"	ASCII(68) ASCII(68)	DROP
"ZZ"	ASCII(90) ASCII(90)	AUX ON
"XX"	ASCII(88) ASCII(88)	AUX OFF

Figure 12

Command Timing

The Mate will send a Status Page for each FX it is connected to, either directly or via a HUB. A Mate directly connected to a FX will send out a single Status Page per second, if a HUB is used, Status Pages for all FXs will be transmitted once a second. The Mate listens for commands starting with the first byte it transmits, it will continue to listen for ~200 to 250 mS after transmission starts (See Figure 13).
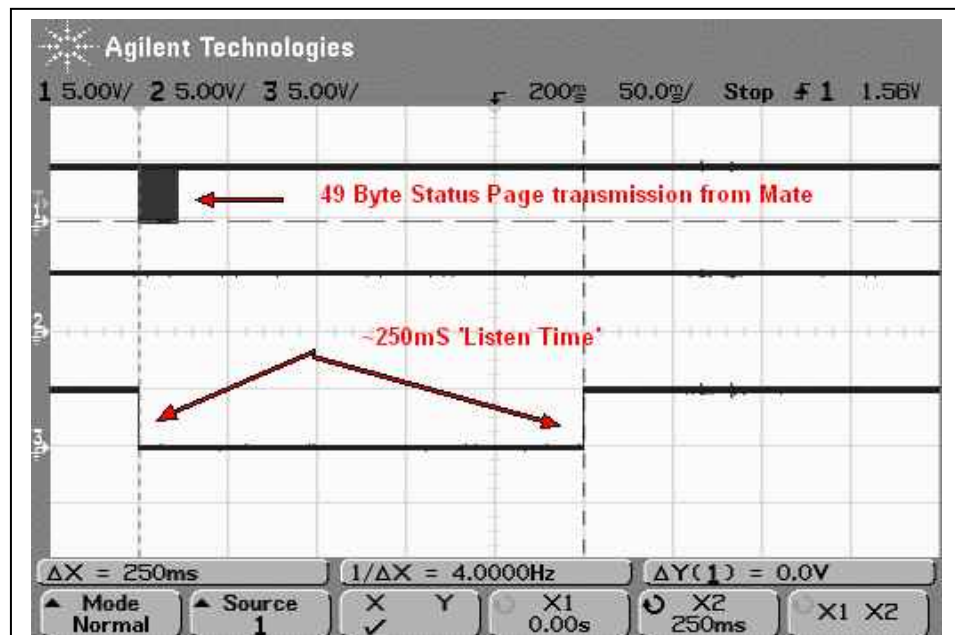

Figure 13

If a 2 byte command is received during this 'Listen Time', the Mate will cease listening to the PC and process the received command (See figure 14).

An invalid command will be ignored by the Mate. The result of any valid command will be shown in the next seconds' Status Page.

At this time commands will only be sent to the master FX on any STACK or HUB stacked system. The slaves will follow all operational mode changes of the FX except AUX ON and AUX OFF. Only the masters AUX output can be controlled at this time.
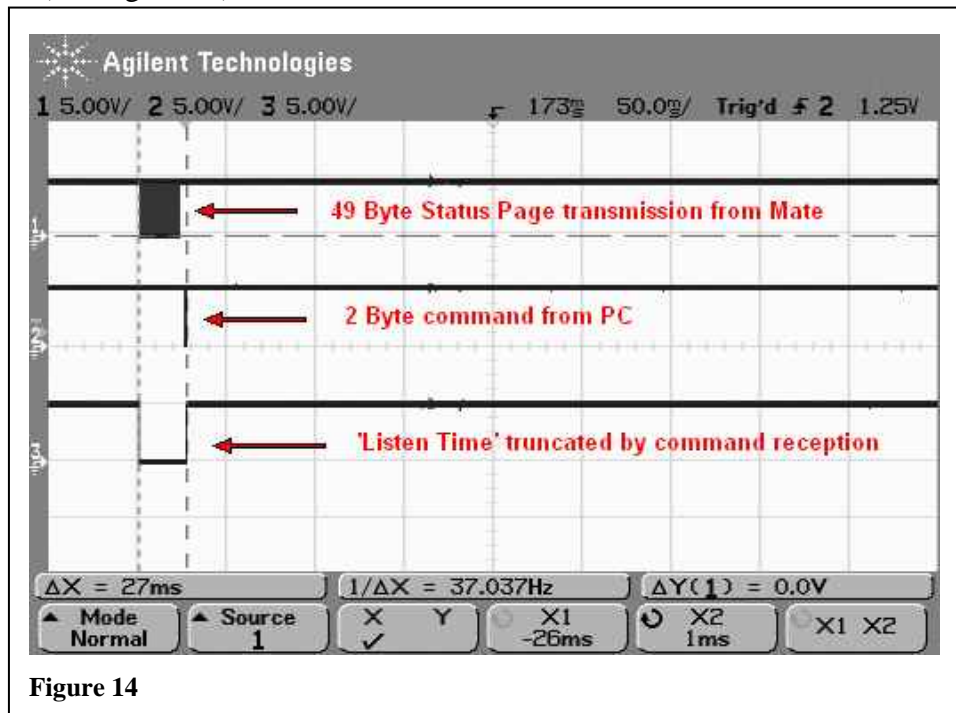

Figure 14

It is also important to note that a users pressing any of the Mate buttons interrupts both Status page transmissions and listen time for 2 seconds. A button press will cease all PC communications until no button has been pressed for 2 seconds.

More Information

Information on FX setup, programming, and operational modes can be found on the OutBack web site http://www.outbackpower.com/manuals.htm . Questions and comments can be directed to matedev@outbackpower.com .