FLEXnet DC Programming & Guidelines

PURPOSE:

This document provides a detailed description of the FLEXnet DC Battery Monitor (FN-DC), its operation, and the best way to use it in different applications.

SCOPE:

Although specifically related to the FN-DC, much of the information herein also applies to OutBack products and how to best use them for proper battery charging and management. This document covers battery charging issues and considerations as well as system design details for solar systems.

DEFINITIONS:

Definitions and acronyms will be provided, usually where first used. It is expected that the reader has a technical background and is familiar with OutBack Power products and renewable energy systems.

REFERENCES:

- FLEXnet DC Spec Sheet
- FLEXnet DC Owner's Manual
- MATE3 Overview Guide
- MATE3 Programming Guide
- MATE3 USB Card Owner's Manual
- EnergyCell RE Battery Owner's Manual

INTRODUCTION:

The FN-DC is a battery monitoring device whose main purpose is to monitor the battery voltage and the current going in and out of the battery. The FN-DC allows the user to implement logic based on the state of charge of the battery. (This is as opposed to the simple voltage measurements used by other OutBack products.) It allows the user to set specific criteria, at the system level, to determine when the battery has been fully charged. The FN-DC has an internal memory that keeps a historical data record of 128 days.

The FN-DC communicates directly with the MATE3 System Display via the HUB Communications Manager. The FN-DC's basic function is to integrate the DC currents from all OutBack devices in the system. The FN-DC accomplishes this with the use of three current shunts — one for all of the inverters, one for all of the PV charge controllers and one for an additional external DC source/load. Alternatively, in a two-inverter system, a shunt may be assigned to each inverter and the third shunt to the charge controller(s). Together, the shunts are wired such that their center point is the negative terminal of the battery bank. In this way, the FN-DC is able to sample the net positive (charging) current that goes into the battery and the net negative (discharging) current that comes out of the battery. This allows the FN-DC to keep track of the total energy that goes into and out of the battery. In addition to the DC currents, the FN-DC also samples the battery voltage through a direct connection to the positive bus and the negative bus of the system. This enables the FN-DC to make independent measurements and voltage-based decisions.

SPECIAL FUNCTIONS AND MODES:

Battery State of Charge

The FN-DC reports the state of charge of the battery to the MATE3 by using the Battery AH value and the Charge Factor value in its calculations. The MATE3 will report a state of charge of 100% once the Battery Charge Factor has been met, or once the Charged Parameters have been met.

Float Mode

This is a safety mode for batteries that are not able to reach the expected voltages. If triggered, the Float Mode will cause the state of charge to jump to 100% to protect the battery. This mode is triggered whenever the net ampere-hour value returned to the battery is greater than zero, the net charging current is positive, and the battery voltage is less than the Charged Parameters Met Voltage by 0.4V (this is independent of system voltage). Once triggered, the MATE3 will report a state of charge of 100%.

The Float Mode is especially helpful when the system is programmed to make decisions based on state of charge. For example, if the batteries cannot reach the Charged Parameters Met voltage, but the generator has put enough ampere-hours into the batteries such that the total AH value is positive, the inverter will stop the generator via the AGS setting by using the state of charge value.

A second condition that will trigger the Float Mode is if the absorb timer is set too low and the net Ampere-hours become positive during the float stage. The extent of the state of charge "jump" will largely depend on the programmed Battery Charge Factor.

Charged Parameters

The Charged Parameters are a set of criteria that are used to establish the basis for determining when the system has charged the batteries. The user has complete control of the set points and can change them to meet the batteries' charging requirements — either as they age or as the system changes. To accomplish this task, the FN-DC samples the battery voltage and charging currents from the inverters and charge controllers. It compares them to the FN-DC's programming. The three main set points that are used to determine when the Charged Parameters have been met are the Charged Voltage, Charged Return Amps, and Time. These parameters are found under the Battery Setup Menu.
Once the Charged Parameters are met, the following happens:

- The top green LED indicator on the FN-DC flashes (immediately)
- Days since parameters met resets to zero (immediately)
- Charge parameters flag goes high (immediately) — status bit 1. Please review the FLEXnet DC Data Stream section of the MATE3 USB Card Owner's Manual for more information.
- If the Enable Auto-Grid Tie Control is set to Y, then the inverters are "allowed" to sell.
- If the Enable Charge Termination Control is set to Y, then the inverters will stop the absorb step and will move on to the float step or silent step (if the Float Timer <= the Absorb Timer).

If the Net Discharge Current goes negative for one minute, then:

- The MATE3 will report a 100% state of charge
- Zero data for all three channels

Once the Charge Parameters have been met, and there has been a one-minute discharge, and the discharge continues, then when the state of charge drops to 90%:

- The FN-DC calculates cycle efficiencies and displays them in the MATE3 Battery Stats screen. **NOTE**: The first few cycles will not be meaningful as there is no discharge data.
- Another charge cycle begins.

BATTERY SETUP MENU:

This is the initial menu that allows the user to set the parameters for the FN-DC. This menu will affect the following modes:

- Battery State of Charge
- Float Mode
- High Battery Transfer
- FLEXnet DC Relay
- Charged Parameters
- FLEXnet DC Advanced Control
    - Enable Charge Termination Control
    - Enable Auto Grid-Tied Control
    - Low SOC Warning
    - Critical SOC Warning

Charged Voltage

This is the minimum voltage that the battery must reach during the Bulk or Absorb stages. Since the charging source (inverters and charge controllers) will drive the battery voltage up to its Absorb set point, the Charged Voltage should be programed below (0.4V for 48V, 0.2V for 24V and 0.2V for 12V systems) the Absorb Voltage set point of the charging source. For example, if the inverter's Absorb Voltage is set to 58.4V, then the Charged Voltage in the FN-DC should be set to 58.0V. This will guarantee that the Charged Voltage value in the FN-DC will always be met as the charging source will drive the battery voltage up to its Absorb set point.

Charged Return Amps

This is the current that the batteries must decrease down to during the Absorb stage of the charging cycle. The decay of the current during the Absorb stage is completely dictated by the battery and/or system loads. The duration the Absorb stage, however, is controlled by the Absorb Timer value of the charging source. If the Charged Return Amps is set too low, the battery will take too long to reach the current and the Absorb stage will terminate before the Charged Return Amps can be reached and the charge parameters will not be met. If it is set too high, the Charged Return Amps will be met, but the batteries will be undercharged. This parameter does not control the Absorb stage. (Only the charging source can terminate the Absorb stage based on its Absorb Timer value.) A good starting point is to select 1 to 3% of the battery bank's 100-hour rate. This current will change throughout the battery's and system's life. Consult with the battery manufacturer for a specific recommendation.

Time

This sets the minimum duration (in minutes) in which the Charged Voltage and the Charged Return Amps must be held at. The Time parameter has a default value of 1 minute and a range of 0 to 240 minutes. This set point should be programmed based on the type and age of the battery, loads on the system, and the programmed Charged Return Amps. Once the Charged Voltage and the Charged Return Amps are found, the system should allow the batteries to remain at those levels for some time. It

is this period where the overcharge will take place and full state of charge will be reached by the battery bank. The length of time that is programmed is dictated by the size of the charging source, the Battery Charge Factor, the system loads, and the battery type. Consult with the battery manufacturer for a specific recommendation.

Battery AH (Ampere-hours)

This value is used in the battery state of charge calculations. The Battery AH setting has a default value of 400Ah and a range of 100-10,000Ah. As the battery is discharged, the FN-DC will integrate the current and sum the net negative ampere-hours that are removed from the battery. If the appropriate battery capacity (in ampere-hours) is not entered, the FN-DC will report an erroneous state of charge. The battery capacity and the discharge currents should be considered together such that they are a good representation of the system. Programming a nominal capacity, like the 100-hour rate, will lead to errors as it is unlikely that the system will discharge the batteries at the 100-hour rate.

Using the EnergyCell 200RE battery as an example (with a 100-hour capacity of 200 ampere-hours): This battery will deliver 200 ampere-hours only while being discharged with a discharge current of 2ADC. A higher discharge current will translate to a lower capacity (in ampere-hours), which will directly affect the state of charge calculations that are reported in the MATE3. An extreme example would be having a discharge current of 40ADC, where the battery would only be able to deliver 133 ampere-hours before being completely discharged, but having the FN-DC erroneously reporting that the state of charge of the batteries is 66%, when they are, in fact, completely discharged.

Battery Charge Factor

The Battery Charge Factor (BCF) is the parameter available to the user to program the assumed charge efficiency of the battery. The Charge Factor has a default value of 94% and a range of 65-100%. The FN-DC will use the Charge Factor in its calculations to reach a state of charge of 100%. For example, if the battery is assumed to be 90% efficient and the BCF is set at 90%, a 100 ampere-hours discharge will translate to an input of 111 ampere-hours during the charge. Typical efficiency (overcharge) ranges for flooded batteries are 110-130% and for VRLA batteries 105-120%. A good starting point for flooded batteries is 115% (BCF of 87%) and for VRLA batteries 110% (BCF of 90%). These numbers will have to be changed as the battery ages. Consult with the battery manufacturer for a specific recommendation.

FLEXnet DC Initialization:

Since the FN-DC assumes that the batteries are fully charged when it is initially turned on, the battery bank must be fully charged prior to turning on the FN-DC. Use the battery manufacturer's instructions on how to commission and fully charge the battery bank to bring it to a full state of charge. This step may take several days depending on the system and the type of battery. Failure to take this critical step will result in a chronically undercharged battery and therefore a reduced performance and a reduced life.

The FN-DC has to be independently programmed via the MATE3. Unless it is programmed, the FN-DC will use its default settings, which will likely not work in most applications. Once the settings are programmed into the FN-DC, they will stay in nonvolatile memory. The measured values (Ah in/out, state of charge) will be lost if system power is lost, but the recorded values (that are transferred to nonvolatile memory) will not be lost. The FN-DC will need a few cycles to gain accuracy as it will not have any initial discharge data to use in its calculations.

A Note on Current Shunts

Although OutBack products come equipped with 100A and 500A current shunts, the FD-NC has the ability to work with shunts as high as 1000A. The only requirement is that the voltage and current ratio (resistance) of the shunt remain the same. For example, the 500A shunts have a ratio of 0.0001 at 500A and 50mV. A 1000A shunt should have a voltage of 1000A at 100mV.

Concluding Remarks

The charging needs of the batteries will change whenever the system undergoes a significant change. For example, if the system was designed with a specific depth of discharge and the system loads have grown, the charging set points of the FN-DC and other outback devices will have to be adjusted accordingly. As the batteries age, their charging needs will change and the FN-DC must be adjusted to ensure that the batteries are receiving a proper charge. Also, if the charging sources are reduced in capacity, then the set points of the FN-DC should reflect that change as well. A successful system is one that is adjusted to meet the ever-changing needs of the batteries.

About OutBack Power Technologies

OutBack Power Technologies is a leader in advanced energy conversion technology. OutBack products include true sine wave inverter/chargers, maximum power point tracking charge controllers, and system communication components, as well as circuit breakers, batteries, accessories, and assembled systems.

Grid/Hybrid™

As a leader in off-grid energy systems designed around energy storage, OutBack Power is an innovator in Grid/Hybrid system technology, providing the best of both worlds: grid-tied system savings during normal or daylight operation, and off-grid independence during peak energy times or in the event of a power outage or an emergency. Grid/Hybrid systems have the intelligence, agility and interoperability to operate in multiple energy modes quickly, efficiently, and seamlessly, in order to deliver clean, continuous and reliable power to residential and commercial users while maintaining grid stability.

Contact Information

Address:	Corporate Headquarters 17825 – 59th Avenue N.E. Suite B Arlington, WA 98223 USA	European Office Hansastrasse 8 D-91126 Schwabach, Germany
Telephone:	+1.360.435.6030 +1.360.618.4363 (Technical Support) +1.360.435.6019 (Fax)	+49.9122.79889.0 +49.9122.79889.21 (Fax)
Email:	Support@outbackpower.com	
Website:	http://www.outbackpower.com	

Disclaimer

UNLESS SPECIFICALLY AGREED TO IN WRITING, OUTBACK POWER TECHNOLOGIES:

(a) MAKES NO WARRANTY AS TO THE ACCURACY, SUFFICIENCY OR SUITABILITY OF ANY TECHNICAL OR OTHER INFORMATION PROVIDED IN ITS MANUALS OR OTHER DOCUMENTATION.

(b) ASSUMES NO RESPONSIBILITY OR LIABILITY FOR LOSS OR DAMAGE, WHETHER DIRECT, INDIRECT, CONSEQUENTIAL OR INCIDENTAL, WHICH MIGHT ARISE OUT OF THE USE OF SUCH INFORMATION. THE USE OF ANY SUCH INFORMATION WILL BE ENTIRELY AT THE USER'S RISK.

OutBack Power Technologies cannot be responsible for system failure, damages, or injury resulting from improper installation of their products.

Information included in this manual is subject to change without notice.

Notice of Copyright

Trademarks