Application Note 211

Embedded Power for
Business-Critical Continuity

RoHS
2002/95/EC

EMERSON
Network Power

1. Introduction

This application note describes the Power Management Bus™ (PMBus™) serial bus interface of the Emerson Network Power UFE series of front-end power supplies. The UFE series is designed to draw wide range input power and provide flexible (variable), isolated, floating, power-limited output in two configurations, 24 V and 48 V. Each configuration also provides an auxiliary output of 11 V at 250 mA. The UFE series also includes automatic-regulating fans for selfcooling. Automatic regulation of the cooling fans means getting the quietest possible operation while at the same time maximizing fan life. In addition to power conversion, the UFE series provides an enhanced set of features via PMBus™ serial communication.

While the use of PMBus™ serial communication is not required for operation, PMBus™ serial communication is a very powerful tool that can greatly enhance and completes the feature set of the UFE series. The PMBus™ serial communications interface implementation includes 68 commands (some commands are only available to manufacturing) that will enable functions such as adjustment of the output voltage (while power conversion is active), monitor a number of key input, output, and internal parameters, store and retrieve up to 176 bytes of EEPROM data, enable/disable the power conversion process, and store and restore default operating conditions to name a few.

2. Related Documents

2.1 PMBus™ Power System Management Protocol Specification

The Power Management Bus ("PMBus™") is an open standard protocol that defines a means of communicating with power conversion and other devices.

For more information, please see the System Management Interface Forum Web site: http://www.powersig.org and click on the PMBus link or go to http://pmbus.org.

3. Functional Description

Within 2-seconds of initial power up the PMBus™ interface can be used to it's full capabilities, including changing the output voltage of the converter, change the general power conversion parameters, and store up to 176 bytes of information in non-volatile memory. It is also possible to enable or disable the PMBus™ interface by use of a discrete signal pin by the name of "Comm-En-H".

By default, this discrete signal pin is pulled high internally, which automatically enables the PMBus™ interface. However, for troubleshooting purposes, when the "Comm-En-H" signal pin is pulled low, the SMBus interface is physically isolated from the rest of the SMBus bus. Pulling this discrete signal pin low will also reset the SMBus hardware internally in the power supply, which can be quite valuable in resolving frozen SMBus interface issues.

The PMBus™ interface included with the UFE series is designed to comply with revision 1.1 of the PMBus Specification. The UFE series includes use of the discrete signal pins CONTROL and SMBALERT# as described in the PMBus™ specification revision 1.1. Use of Packet Error Checking (PEC) is optional and user selectable in the UFE series. In order for a UFE series device to notify the host that they want to communicate important information, the SMBALERT# signal is used. Some of the 68 commands are only available for use by manufacturing. Table 1 provides all relevant PMBus™ command support details. Please note that some write functionality with some commands is limited or disabled completely.

4. Command Details and PMBus™ Requirements

The error response from the UFE series complies with section 10.6.1 of the PMBus™ specification revision 1.1.

Command Code Name Reference	Command Code Number (Hexadecimal)	Read/Write Support	Number of Data Bytes	Factory Default Setting (Hexadecimal)	PMBus Specification Reference Section
OPERATION	01	Y/Y	1	80	12.1
ON_OFF_CONFIG	02	Y/Y	1	11	12.2
CLEAR_FAULTS	03	N/N	0	N/A	10.2.3
WRITE_PROTECT	10	Y/Y	1	00	11.1
RESTORE_DEFAULT_ALL	12	N/N	0	N/A	11.3
STORE_USER_ALL	15	N/N	0	N/A	11.6
RESTORE_USER_ALL	16	N/N	0	N/A	11.7
VOUT_MODE	20	Y/N	1	40	7.2\7.3\7.3\8..3.3
VOUT_COMMAND	21	Y/Y	2	9E 02	7.2\7.3\7.3\8..3.3
VOUT_TRIM	22	Y/Y	2	00 00	13.3
VOUT_MAX	24	Y/Y	2	E0 03	13.5
COEFFICIENTS	30	Y/N	6	Variable dependent	7.2.3\14.2
VOUT_OV_FAULT_RESPONSE	41	Y/N	1	8C	10.5.1\15.3
VOUT_UV_WARN_LIMIT	43	Y/Y	2	A4 00	15.5
VOUT_UV_FAULT_LIMIT	44	Y/Y	2	A0 00	15.6
VOUT_UV_FAULT_RESPONSE	45	Y/N	2	00 00	15.7
IOUT_OC_FAULT_RESPONSE	47	Y/N	1	FB	10.5.2\15.9
OT_FAULT_LIMIT	4F	Y/N	2	8F 00	15.17
OT_FAULT_RESPONSE	50	Y/N	1	C0	10.5.1\15.18
OT_WARN_LIMIT	51	Y/N	2	8A 00	15.19
STATUS_BYTE	78	Y/N	1	00	10\17.1
STATUS_WORD	79	Y/N	2	00	10\17.2
STATUS_VOUT	7A	Y/N	1	00	10\17.3
STATUS_IOUT	7B	Y/N	1	00	10\17.4
STATUS_INPUT	7C	Y/N	1	00	10\17.5
STATUS_TEMPERATURE	7D	Y/N	1	00	10\17.6
STATUS_CML	7E	Y/N	1	00	10\17.7
STATUS_OTHER	7F	Y/N	1	00	10\17.8
STATUS_MFR_SPECIFIC	80	Y/N	1	00	10\17.9
READ_VOUT	8B	Y/N	2	Variable	18.4
READ_IOUT	8C	Y/N	2	Variable	18.5
READ_TEMPERATURE_1	8D	Y/N	2	Variable	18.6
READ_TEMPERATURE_2	8E	Y/N	2	Variable	18.6
MFR_SPECIFIC_04	D4	Y/N	2	Variable	18.8*
PMBUS_REVISION	98	Y/N	1	11	22.1

Table 1 - PMBus™ Command Support Table

Command Code Name Reference	Command Code Number (Hexadecimal)	Read/Write Support	Number of Data Bytes	Factory Default Setting (Hexadecimal)	PMBus Specification Reference Section
MFR_ID	99	Y/N	5	04 41 54 53 4E	22.2.1
MFR_MODEL	9A	Y/N	17	Variable	22.2.2
MFR_REVISION	9B	Y/N	3	Variable	22.2.3
MFR_LOCATION	9C	Y/N	5	Variable	22.2.4
MFR_DATE	9D	Y/N	7	Variable	22.2.5
MFR_SERIAL	9E	Y/N	9	Variable	22.2.6
MFR_VIN_MIN	A0	Y/N	2	60 01	22.3.1
MFR_VIN_MAX	A1	Y/N	2	50 04	22.3.2
MFR_IIN_MAX	A2	Y/N	2	Variable	22.3.3
MFR_PIN_MAX	A3	Y/N	2	Variable	22.3.4
MFR_VOUT_MIN	A4	Y/N	2	Variable	22.3.5
MFR_VOUT_MAX	A5	Y/N	2	Variable	22.3.6
MFR_IOUT_MAX	A6	Y/N	2	Variable	22.3.7
MFR_POUT_MAX	A7	Y/N	2	Variable	22.3.8
MFR_TAMBIENT_MAX	A8	Y/N	2	6E 00	22.3.9
MFR_TAMBIENT_MIN	A9	Y/Y	2	00 00	22.3.10
USER_DATA_00	B0	Y/Y	17	Variable	23
USER_DATA_01	B1	Y/Y	17	Variable	23
USER_DATA_02	B2	Y/Y	17	Variable	23
USER_DATA_03	B3	Y/Y	17	Variable	23
USER_DATA_04	B4	Y/Y	17	Variable	23
USER_DATA_05	B5	Y/Y	17	Variable	23
USER_DATA_06	B6	Y/Y	17	Variable	23
USER_DATA_07	B7	Y/Y	17	Variable	23
USER_DATA_08	B8	Y/Y	17	Variable	23
USER_DATA_09	B9	Y/Y	17	Variable	23
USER_DATA_10	BA	Y/Y	17	Variable	23
MFR_SPECIFIC_01	D1	Y/Y	1	Variable	24
MFR_SPECIFIC_02	D2	Y/N	3	Variable	24
MFR_SPECIFIC_03	D3	Y/N	13	0C 36 33 30 30 33 30 35 2D 30 30 30 30	24
MFR_SPECIFIC_06*	D6	Y/N	1	Variable	24
MFR_SPECIFIC_07*	D7	Y/N	1	Variable	24

Table 1 - PMBus™ Command Support Table (cont)

* For UFE2000-96S48P01J only

0x01 - OPERATION
Limited write support:
There is no support for either margining low or high or soft off. This means that bits [3:0] are don't care, bits [5:4] are don't care when disabling power conversion and [00] when enabling power conversion. Setting of bit [6] is not supported. A data byte of 0x80 enables power conversion, and a data byte of 0x00 disables power conversion. No other values are necessary and some will produce an appropriate error response.

0x02 - ON_OFF_CONFIG
Limited write support:
There is no support for using the programmed turn off delay, clearing of bit [0]. Attempts to set bit [0] will produce an appropriate error response.

0x03 - CLEAR_FAULTS
This command complies fully with the PMBus™ specification revision 1.1.

0x10 - WRITE_PROTECT
This command complies fully with the PMBus™ specification revision 1.1.

0x12 - RESTORE_DEFAULT_ALL
This command complies fully with the PMBus™ specification revision 1.1
Sending this command will result in the following registers being overwritten (restored) by factory defaults:
OPERATION
ON_OFF_CONFIG
VOUT_COMMAND
VOUT_TRIM
VOUT_MAX
MFR_SPECIFIC_01

0x15 - STORE_USER_ALL
This command complies fully with the PMBus™ specification revision 1.1
Sending this command will result in the following registers being saved as default for start up:
OPERATION
ON_OFF_CONFIG
VOUT_COMMAND
VOUT_TRIM
VOUT_MAX
MFR_SPECIFIC_01

0x16 -RESTORE_USER_ALL
This command complies fully with the PMBus™ specification revision 1.1 Sending this command will result in the following registers being overwritten (restored) by user stored defaults:
OPERATION
ON_OFF_CONFIG
VOUT_COMMAND
VOUT_TRIM
VOUT_MAX
MFR_SPECIFIC_01

0x20 - VOUT_MODE
This command complies fully with the PMBus™ specification revision 1.1
DIRECT format is used for all voltage related commands.

0x21 - VOUT_COMMAND
This command complies fully with the PMBus™ specification revision 1.1.
The resolution of this command is 10-bit, which over the adjustment range limits of 42 Vmin to 57 Vmax (UFE2000 models) or 21 Vmin to 28.5 Vmax (UFE1300 models), gives an overall resolution of 15.5 mV/bit and 7.76 mV/bit respectively. The accuracy of this command at the factory default output voltage is +/- 0.5% over all operation conditions and voltages. For specific operating conditions, the VOUT_TRIM command can be used to increase the accuracy to +/- 3 bits.

0x22 - VOUT_TRIM
This command complies fully with the PMBus™ specification revision 1.1 The resolution of this command is still 15.5 mV/bit for the UFE2000 models and 7.76 mV/bit for the UFE1300 models, however the limits are reduced to +/- 0.977 V (signed 7-bit) for the UFE2000 models and +/- 0.489 V (signed 7-bit) for the UFE1300 models. The accuracy of this command is +/- 3 bits.

0x24 - VOUT_MAX
This command complies fully with the PMBus™ specification revision 1.1 The resolution of this command is 10-bit, which over the adjustment range limits of 42 Vmin to 57 Vmax (UFE2000 models) or 21 Vmin to 28.5 Vmax (UFE1300 models), gives an overall resolution of 15.5 mV/bit and 7.76 mV/bit respectively. The accuracy of this command at the factory default output voltage is +/- 0.5% over all operation conditions and voltages.

0x30 - COEFFICIENTS
This command complies fully with the PMBus™ specification revision 1.1, however only reads are supported.
This command will provide the necessary responses for these variables:
VOUT_COMMAND
VOUT_TRIM
VOUT_MAX
VOUT_UV_WARN_LIMIT
VOUT_UV_FAULT_LIMIT
OT_FAULT_LIMIT
OT_WARN_LIMIT
READ_VOUT
READ_IOUT
READ_TEMPERATURE_1
READ_TEMPERATURE_2
READ_VFAN_1
MFR_VIN_MIN
MFR_VIN_MAX
MFR_IIN_MAX
MFR_PIN_MAX
MFR_VOUT_MIN
MFR_VOUT_MAX
MFR_IOUT_MAX
MFR_POUT_MAX
MFR_TAMBIENT_MAX
MFR_TAMBIENT_MIN
*All variables used in the UFE series use the DIRECT mode for calculation.

0x41 - VOUT_OV_FAULT_RESPONSE
This command complies fully with the PMBus™ specification revision 1.1, however only reads are supported. The response of A UFE series product will always be to shut down the output after 1 retry, after 4 seconds. After 10 seconds this process will reset and allow another OV and retry before disabling power conversion and latching off, requiring reset by OPERATION command toggle, discrete CONTROL pin toggle, or AC line toggle before re-enable of power conversion.

0x43 - VOUT_UV_WARN_LIMIT
This command complies fully with the PMBus™ specification revision 1.1. Do not exceed the limits of adjustment, 15.00 V to 57.00 V or an appropriate error response will occur.
The default setting is 41.00 V. The accuracy of this setting is +/- 5%.

0x44 - VOUT_UV_FAULT_LIMIT
This command complies fully with the PMBus™ specification revision 1.1. Do not exceed the limits of adjustment, 15.00 V to 57.00 V or an appropriate error response will occur.
The default setting is 40.00 V. The accuracy of this setting is +/- 5%.

0x45 - VOUT_UV_FAULT_RESPONSE
This command complies fully with the PMBus™ specification revision 1.1, however only reads are supported. A UV will be reported but power conversion will not be interrupted until the OC threshold is reached.

0x47 - IOUT_OC_FAULT_RESPONSE
This command complies fully with the PMBus™ specification revision 1.1, however only reads are supported. An OC will be reported and power conversion will be disabled for 1.8 s before power conversion enable again for 200 ms. This will repeat continuously until the source of the OC condition is removed.
The default data byte for this variable is 0xFB.
Delay time units (bits [2:0]) are 600 ms, 3 x 600 ms = 1.8 s.

0x4F - OT_FAULT_LIMIT
This command complies fully with the PMBus™ specification revision 1.1, however only reads are supported.
The default setting is 103°C. The accuracy of this setting is +/- 2%.

0x50 -OT_FAULT_RESPONSE
This command complies fully with the PMBus™ specification revision 1.1, however only reads are supported. An OT will be reported and power conversion will be interrupted until the OT reset threshold is reached. There is about 9°C hysteresis for this function.
The default data byte is 0xC0.

0x51 - OT_WARN_LIMIT
This command complies fully with the PMBus™ specification revision 1.1, however only reads are supported.
The default setting is 98°C. The accuracy of this setting is +/- 2%.

0x78 - STATUS_BYTE
This command complies fully with the PMBus™ specification revision 1.1, however only reads are supported.

0x79 - STATUS_WORD
This command complies fully with the PMBus™ specification revision 1.1, however not all data byte bits are functional.
Bits [3:0] of the high data byte are not functional.

0x7A - STATUS_VOUT
This command complies fully with the PMBus™ specification revision 1.1, however not all data byte bits are functional.
Bits [2:0] and 6 of the data byte are not functional.

0x7B - STATUS_IOUT
This command complies fully with the PMBus™ specification revision 1.1, however not all data byte bits are functional.
Only bit 6 of the data byte is functional.

0x7C - STATUS_INPUT
This command complies fully with the PMBus™ specification revision 1.1, however not all data byte bits are functional.
Only bits 4 and 7 of the data byte are functional.

0x7D - STATUS_TEMPERATURE
This command complies fully with the PMBus™ specification revision 1.1, however not all data byte bits are functional.
Only bits 6 and 7 of the data byte are functional.

0x7E - STATUS_CML
This command complies fully with the PMBus™ specification revision 1.1.

0x7F - STATUS_OTHER
This command complies fully with the PMBus™ specification revision 1.1, however not all data byte bits are functional.
Only bits 7 and [1:0] of the data byte are functional.

0x80 - STATUS_MFR_SPECIFIC
This command complies fully with the PMBus™ specification revision 1.1, however not all data byte bits are functional.
Bit 7 indicates when there is an internal ambient over temperature fault.
Bit 6 indicates when there is an internal ambient over temperature warning.
Bit 5 indicated when the 12V-aux output is out of regulation.

0x8B - READ_VOUT
This command complies fully with the PMBus™ specification revision 1.1
The accuracy of the data is +/- 5%.

0x8C - READ_IOUT
This command complies fully with the PMBus™ specification revision 1.1
The accuracy of the data is +/- 15% and uses the DIRECT data format

0x8D - READ_TEMPERATURE_1
This command complies fully with the PMBus™ specification revision 1.1
The accuracy of the data is +/- 3°C and uses the DIRECT data format. This temperature represents the internal power supply hot spot.

0x8D - READ_TEMPERATURE_1
This command complies fully with the PMBus™ specification revision 1.1
The accuracy of the data is +/- 3°C and uses the DIRECT data format. This temperature represents the internal ambient temperature at fan inlet.

0xD4 - MFR_SPECIFIC_04
This command complies fully with the PMBus™ specification revision 1.0
The accuracy of the data is +/- 5% and uses the DIRECT data format, units are in Volts. This command was re-defined in version 1.1 of the specification, however the UFE series does not read the fan speed directly so fan voltage is the only indication of how fast the fans are going. Maximum fan voltage is 12 V and minimum fan voltage is 6 V. A direct correlation between fan voltage and fan speed can't be interpolated because of unknown pressure conditions.

0x98 - PMBUS_REVISION
This command complies fully with the PMBus™ specification revision 1.1
The only command that doesn't comply with version 1.1 is command 0x92, READ_VFAN_1, details are provided as to the reasoning in that section.

0x99 - MFR_ID
This command complies fully with the PMBus™ specification revision 1.1 The data field will consist of 1 data length byte followed by 4 data bytes, "ATSN".

0x9A - MFR_MODEL
This command complies fully with the PMBus™ specification revision 1.1
The data field will consist of 1 data length byte followed by 16 data bytes, starting with "UFE".

0x9B - MFR_REVISION
This command complies fully with the PMBus™ specification revision 1.1
The data field will consist of 1 data length byte followed by 2 data bytes.

0x9C - MFR_LOCATION
This command complies fully with the PMBus™ specification revision 1.1
The data field will consist of 1 data length byte followed by 4 data bytes.

0x9D - MFR_DATE
This command complies fully with the PMBus™ specification revision 1.1
The data field will consist of 1 data length byte followed by 6 data bytes.

0x9E - MFR_SERIAL
This command complies fully with the PMBus™ specification revision 1.1
The data field will consist of 1 data length byte followed by 8 data bytes.

0xA0 - MFR_VIN_MIN
This command complies fully with the PMBus™ specification revision 1.1
The data format used is DIRECT mode.
The default value is 88 V.

0xA1 - MFR_VIN_MAX
This command complies fully with the PMBus™ specification revision 1.1
The data format used is DIRECT mode.
The default value is 276 V.

0xA2 - MFR_IIN_MAX
This command complies fully with the PMBus™ specification revision 1.1
The data format used is DIRECT mode.
The default value is 15 A.

0xA3 - MFR_PIN_MAX
This command complies fully with the PMBus™ specification revision 1.1
The data format used is DIRECT mode.
The default value is 2300 W.

0xA4 - MFR_VOUT_MIN
This command complies fully with the PMBus™ specification revision 1.1
The data format used is DIRECT mode.
The default value is 42.00 V for the UFE 2000 series, and 21.00 V for the UFE 1300 series.

0xA5 - MFR_VOUT_MAX
This command complies fully with the PMBus™ specification revision 1.1
The data format used is DIRECT mode.
The default value is 57.00 V for the UFE 2000 series, and 28.50 V for the UFE 1300 series.

0xA6 - MFR_IOUT_MAX
This command complies fully with the PMBus™ specification revision 1.1
The data format used is DIRECT mode.
The default value is 56.20A for the UFE 2000 series, and 70.20 A for the UFE 1300 series.

0xA7 - MFR_POUT_MAX
This command complies fully with the PMBus™ specification revision 1.1
The data format used is DIRECT mode.
The default value is 2000 W for the UFE 2000 series, and 1300 W for the UFE 1300 series.

0xA8 - MFR_TAMBIENT_MAX
This command complies fully with the PMBus™ specification revision 1.1
The data format used is DIRECT mode. The default value is 70°C.

0xA9 - MFR_TAMBIENT_MIN
This command complies fully with the PMBus™ specification revision 1.1
The data format used is DIRECT mode. The default value is –40 °C.

0xB0 TO 0XBA - USER_DATA_00 to _10
These commands comply fully with the PMBus™ specification revision 1.1.

These commands use the Block Write – Block Read Process Call specified in [A03] The length of a write can be anywhere from 1 to 16 bytes in length, the length byte followed by 1 to 16 data bytes. The length of a read MUST be 17 bytes total, the length byte followed by 16 data bytes. Failure to read out all 16 data bytes will produce the appropriate error response. Because this information is being written directly to EEPROM, up to 128 ms may be required after a write is finished before the next block can be written to. This is to allow sufficient time for the data buffer to empty from the previous byte.

0xD1 - MFR_SPECIFIC_01
This command complies fully with the PMBus™ specification revision 1.1. This command is used to change the basic functionality of the power supply or run certain tests. Bits [7:5] are not used.

Bit 4 is used to enable and disable the use of PEC. If bit 4 is set, PEC will be used. The command used to set this bit will not use PEC, and the command used to turn off PEC will use PEC. The use of PEC is default off, bit 4 is clear.

Bit 3 is used to test the functionality of the OR-ing FETs. When set, the bit will stay set for 1.5 seconds until the test is finished, then it will automatically be cleared. Be careful to only test this in redundant systems that can afford a 1.5 second drop out of one of the units in the system without incident. By default, this function is disabled, bit 3 is clear.

Bit 2 is used to enable the 45-second communications watchdog timer. Every communication resets the timer. If no communication is observed for 45 seconds the timer times out and operation will revert to the default operation state, set up by the STORE_USER_ALL command. By default, this function is disabled, bit 2 is clear.

Bit 1 is used to enable active mode on the output voltage for the purpose of current sharing without the output voltage changing with load (voltage droop current sharing). Use of this mode requires connection of the current sharing pin between units. If bit 1 is clear, active mode is enabled. This command complies fully with the PMBus™ specification revision 1.1 The data field will consist of 1 data length byte followed by 4 data bytes.

Bit 0 is used to enable droop mode on the output voltage for the purpose of current sharing without the use of an extra pin (active current sharing). If bit 0 is clear, droop mode is enabled. If Bit 0 is clear, then Bit 1 must not be clear, and vice versa. The user can't use both droop and active sharing at the same time.

0xD2 - MFR_SPECIFIC_02
This command complies fully with the PMBus™ specification revision 1.1 This command is used to find out how long, in number of hours, a UFE series power supply has been in operation. The resolution is 1 hour per bit and there are 3 data bytes.

0xD3 - MFR_SPECIFIC_03
This command complies fully with the PMBus™ specification revision 1.1 This command is used to read out the revision of the software inside a UFE series supply. The format used is Block Read and consists of 1 length byte, followed by 12 ASCII encoded data bytes.

0xD6 - MFR_SPECIFIC_06*
This command complies fully with the PMBus™ specification revision 1.1 This command is used to read out the high line or low line from the PSU. The format used is Block Read and consists of 1 length byte, followed by 1 ASCII encoded data bytes. 8'b1000_0000 (0x80H) represent low line, 8'b0000_0000 (0x00H) represents high line.

0xD7 - MFR_SPECIFIC_07*
This command complies fully with the PMBus™ specification revision 1.1 This command is used to primary and secondary unit communication state. The format used is Block Read and consists of 1 length byte, followed by 1 ASCII encoded data bytes.
8'b0000_1000 (0x08H) represent primary and secondary communication working well and 8"b0000_0000 (0x00H) represent primary and secondary can't communication.(mean AC not OK)

5. SMBus Requirements

Data rates of up to 100 kHz are supported. To ensure reliable and compliant SMBus communications, a maximum rise and fall time of 300 ns on both the SMBDAT and SMBCLK lines must be achieved. Each UFE also adds about 130 pF to an SMBus bus, so it is recommended that no more than 3 UFEs be connected to any I2C bus at a time without the use of an SMBus buffer. This capacitance is due to the FET isolation/hot plug circuit, ESD protection device, as well as parasitic capacitance due to shielded routing considerations. See Figures 1 and 2 for details.

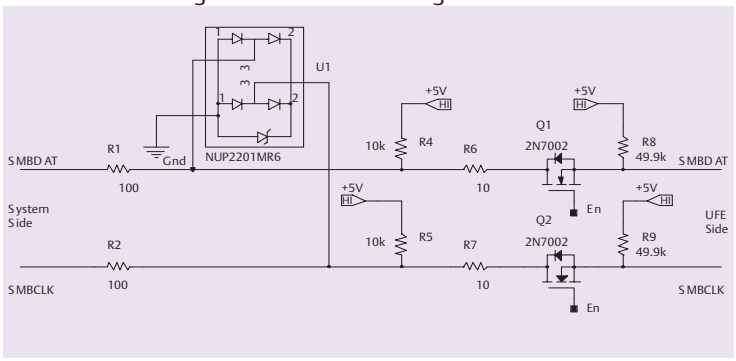

Figure 1 - Basic SMBus Schematic

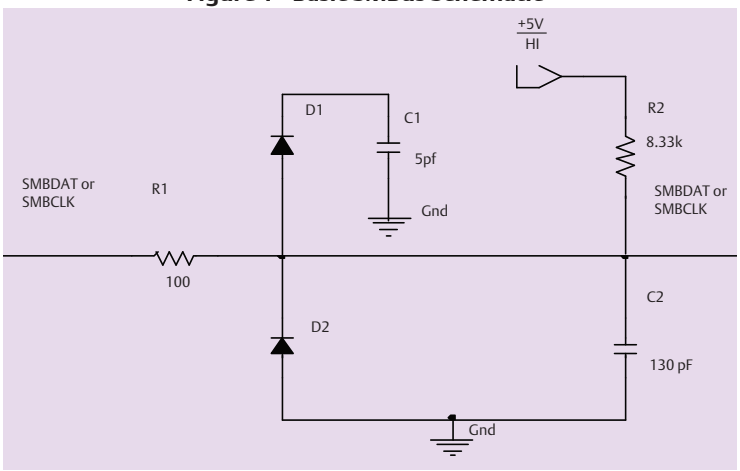

Figure 2 - Equivalent Circuit Model for the Basic SMBus Schematic

Each UFE determines it's own unique address by use of the discrete pins, PS-ID0 through PS-ID3. This allows for up to 16 unique addresses to be included in a system. However, when the optional EEPROM extended memory is installed, only 8 unique addresses can be obtained in a system because of addressing limitations in the EEPROM module only using discrete pins PS-ID0 through PS-ID2. The optional EEPROM extended memory module is Atmel part number AT24C02 or ST Microelectronics part number M24C02. This extended memory module is addressed separately from the UFE microprocessor and uses an I2C bus and can be used any time the UFE is inserted into a system and is fully functional. Refer to the "UFE I2C application note" if the use of this additional EEPROM is desired in conjunction with the PMBus™ interface. Optional EEPROM is offered so that the user can either use the available 176 bytes of internal EEPROM (USER_DATA_XX commands), or add an additional 256 bytes by I2C if desired.

* For UFE2000-96S48P01J only

The UFE SMBus addressing for the microprocessor and optional EEPROM extended memory module is detailed in Table 2.

BYTE	BIT VALUE				COMMENT
	Micro SMBus Read	Micro SMBus Write	Optional EEPROM I^2C Read	Optional EEPROM I^2C Write	
7	1	1	1	1	MSB
6	1	1	0	0	
5	1	1	1	1	
4	PS-ID3	PS-ID3	0	0	
3	PS-ID2	PS-ID2	PS-ID2 = A2	PS-ID2 = A2	
2	PS-ID1	PS-ID1	PS-ID1 = A1	PS-ID1 = A1	
1	PS-ID0	PS-ID0	PS-ID0 = A0	PS-ID0 = A0	
0	1	0	1	0	LSB, I^2C Read = "1" I^2C/SMBus Write = "0"

Table 2 - SMBus Addressing Details

The unique address of each UFE, 1-16, is referenced from Table 3.

UFE NUMBER	PS-ID3	PS-ID2	PS-ID1	PS-IS0	MICRO I^2C/SMBUS ADDRESS	*EEROM I^2C ADDRESS
1	0	0	0	0	E0	A0
2	0	0	0	1	E2	A2
3	0	0	1	0	E4	A4
4	0	0	1	1	E6	A6
5	0	1	0	0	E8	A8
6	0	1	0	1	EA	AA
7	0	1	1	0	EC	AC
8	0	1	1	1	EE	AE
9	1	0	0	0	F0	A0
10	1	0	0	1	F2	A2
11	1	0	1	0	F4	A4
12	1	0	1	1	F6	A6
13	1	1	0	0	F8	A8
14	1	1	0	1	FA	AA
15	1	1	1	0	FC	AC
16	1	1	1	1	FE	AE

Table 3 - UFE Numbering Reference, *EEPROM is optional

So in this setup, SMBus addresses from E0h to FEh are valid for the microprocessor, and addresses from A0h to AEh are valid for the optional EEPROM. Because these addresses are determined within the UFE's microprocessor firmware, the range of these addresses is capable of modification at the user's request, by application.

If the user will be using the Emerson Network Power designed chassis, PS-ID2 and PS-ID3 are set up with two DIP switches on the chassis, and PS-ID0 and PS-ID1 are setup within the chassis. This allows for minimal user setup, however it does limit the system to incorporate only four chassis each with only three power supplies, for a total of twelve unique addresses. The UFE numbers of 4, 8, 12, and 16 are not valid in this type of setup. In addition, if the optional EEPROM is being used, only six unique addresses are available for the EEPROM, making it mandatory to have multiple I2C/SMBus busses with more than six units in a system.

If more than sixteen UFEs are desired for a system, it is always possible to isolate the I2C/SMBus bus, with a buffer/driver enable line, to a chassis so that the same I2C/SMBus address can be used multiple times. This type of setup alleviates both the I2C/SMBus bus capacitance limitation as well as the maximum number of UFEs that can be incorporated into a system.

Americas
5810 Van Allen Way
Carlsbad, CA 92008
USA
Telephone: +1 760 930 4600
Facsimile: +1 760 930 0698

Europe (UK)
Waterfront Business Park
Merry Hill, Dudley
West Midlands, DY5 1LX
United Kingdom
Telephone: +44 (0) 1384 842 211
Facsimile: +44 (0) 1384 843 355

Asia (HK)
14/F, Lu Plaza
2 Wing Yip Street
Kwun Tong, Kowloon
Hong Kong
Telephone: +852 2176 3333
Facsimile: +852 2176 3888

For global contact, visit:

www.PowerConversion.com

techsupport.embeddedpower@emerson.com

Emerson Network Power.
The global leader in enabling business-critical continuity.

- AC Power
- Connectivity
- DC Power
- Embedded Computing
- **Embedded Power**
- Monitoring
- Outside Plant
- Power Switching & Controls
- Precision Cooling
- Racks & Integrated Cabinets
- Services
- Surge Protection

EmersonNetworkPower.com