MODBUS INTERFACE DESCRIPTION

The data space for the meter consists of two blocks of registers that may be selectively accessed using the standard Modbus Functions listed below. Paragraph references are to the document "MODBUS APPLICATION PROTOCOL SPECIFICATION V1.1b".

6.3 03 (0x03) Read Holding Registers
6.4 04 (0x04) Read Input Registers
6.6 06 (0x06) Write Single Register
6.12 16 (0x10) Write Multiple registers

The blocks of registers are:
1) Metered Values
2) Device Control Registers

Each block of registers may be located anywhere in the Modbus Register Space by changing selected registers in the device control block. Default register addresses are:

Metered Values - Registers 1000 to 1047
Control Registers - Registers 2000 to 2084

The above listed instructions all access the same data space so that, for instance, Function 03 (Read Holding Registers) and Function 04 (Read Input Registers) both address the same register blocks. Most of the write instructions are restricted and their successful use depends in some cases upon the successful entering of passwords, etc. Restrictions will be listed in the section which describes the registers. For details of the correct byte sequence for the Modbus functions and responses, see the above referenced Modbus Specification.

The following functions are also partially supported:

6.7 07 (0x07) Read Exception Status (Serial Line only)
6.8 08 (0x08) Diagnostics (Serial Line only)
6.8.1 Sub-function codes supported by the serial line devices
6.9 11 (0x0B) Get Comm Event Counter (Serial Line only)
6.10 12 (0x0C) Get Comm Event Log (Serial Line only)
6.13 17 (0x11) Report Slave ID (Serial Line only)

Read Functions 03 and 04.

These read functions may be used to access all defined registers. Registers that are defined but restricted (such as the current value of passwords) will read back as zeros (0x00). Attempts to read beyond the defined data blocks will result in the appropriate Modbus exception message.

Write Single Register Function 06

This command may be used to write single register values only. It may not be used to write individual registers in a defined array of registers except that individual pairs of bytes of the Customer Identification Array may be written with this command as long as the correct priority level has been established by the previous entry of the appropriate password. In every case where the use of this function is appropriate, the same action may be achieved using a single register write with Function 10.

Write Multiple Register Function 10

Within the data block of Metered Value registers, this command is usable only to enter new values into the sets of registers that carry the values of the resettable Summed Accumulation registers. Not all meters use all four of these registers and not all meters allow the entry of new data into the SA registers.

Meter Configuration

The basic metering engine measures the amount of power flowing into or out of each of the (up to) four current inputs, each cycle of the associated voltage input. The power flowing is accumulated until a unit of 10 watt hours is reached, and then a count is injected into the associated Accumulated Power register. There is one register for power flowing into the load and another for power flowing in the reverse direction. The voltage input associated with each current input varies by meter model. For instance, a meter that measured the power flowing to four separate loads from a single phase would use the same voltage input for each of the four power measurement channels, while a three phase meter would use separate voltage inputs for each of the (in this case) three power measuring channels. The counts that increment the Accumulated Power registers are also routed to one or more of a set of four Summed Accumulation (SA) Registers. Depending on the meter configuration, these SA registers may count up or down in response to input counts, and Registers 2-4 may be resettable by the user. These registers are intended to accumulate the values that are used by the customer for total power monitoring. For instance, a three phase, unidirectional meter would accumulate counts from all six registers associated with its active inputs into the same SA register. A second register may accumulate the same counts but be resettable via a Modbus or EZNet command to keep track of the power associated with a particular job. All 12 of the possible meter registers are readable using Modbus or EZNet communications.

On LCD versions of the meter, the contents of the SA registers are displayed on the LCD. Meters that have mechanical counters instead of LCDs generally display total power on the mechanical counter(s), but the meaning of the counts and the units accumulated vary by meter type and reference must be made to the individual meter data sheet.

The meter also monitors voltage, current, power, frequency and power factor for each input. These values are averaged for 64 cycles of the input voltage and the values made available via communications commands. It should be noted that the calculations involved in measuring RMS values of voltage and current assume that the voltage and current waveforms are sinusoidal. The measurement of consumed and instantaneous power do not rely on such assumptions.

Reg Offset	Reg Address		Size	Default Value		
Dec	Dec	Hex	Regs		Description	Units
Metered Values						
0	1000	3E8	2	0	Acc. Pwr. Ph. 1 10Wh (Imp - Pos)	10 watt hr.
2	1002	3EA	2	0	Acc. Pwr. Ph. 2 10Wh (Imp - Pos)	10 watt hr.
4	1004	3EC	2	0	Acc. Pwr. Ph. 3 10Wh (Imp - Pos)	10 watt hr.
6	1006	3EE	2	0	Acc. Pwr. Ph. 4 10Wh (Imp - Pos)	10 watt hr.
8	1008	3F0	2	0	Acc. Pwr. Ph. 1 10Wh (Exp - Neg)	10 watt hr.
10	1010	3F2	2	0	Acc. Pwr. Ph. 2 10Wh (Exp - Neg)	10 watt hr.
12	1012	3F4	2	0	Acc. Pwr. Ph. 3 10Wh (Exp - Neg)	10 watt hr.
14	1014	3F6	2	0	Acc. Pwr. Ph. 4 10Wh (Exp - Neg)	10 watt hr.
16	1016	3F8	2	0	Summed accumulation Counter 1	10 watt hr.
18	1018	3FA	2	0	Summed accumulation Counter 2	10 watt hr.
20	1020	3FC	2	0	Summed accumulation Counter 3	10 watt hr.
22	1022	3FE	2	0	Summed accumulation Counter 4	10 watt hr.
24	1024	400	1	0	Phase 1 Voltage	0.1 Volt
25	1025	401	1	0	Phase 1 Current	0.1 Amp
26	1026	402	2	0	Phase 1 Power	0.1 Watt
28	1028	404	1	0	Phase 1 Frequency	0.1 Hz.
29	1029	405	1	0	Phase 1 Power Factor	x 0.01
30	1030	406	1	0	Phase 2 Voltage	0.1 Volt
31	1031	407	1	0	Phase 2 Current	0.1 Amp
32	1032	408	2	0	Phase 2 Power	0.1 Watt
34	1034	40A	1	0	Phase 2 Frequency	0.1 Hz.
35	1035	40B	1	0	Phase 2 Power Factor	x 0.01
36	1036	40C	1	0	Phase 3 Voltage	0.1 Volt
37	1037	40D	1	0	Phase 3 Current	0.1 Amp
38	1038	40E	2	0	Phase 3 Power	0.1 Watt
40	1040	410	1	0	Phase 3 Frequency	0.1 Hz.
41	1041	411	1	0	Phase 3 Power Factor	x 0.01
42	1042	412	1	0	Phase 4 Voltage	0.1 Volt
43	1043	413	1	0	Phase 4 Current	0.1 Amp
44	1044	415	2	0	Phase 4 Power	0.1 Watt
46	1046	416	1	0	Phase 4 Frequency	0.1 Hz.
47	1047	417	1	0	Phase 4 Power Factor	x 0.01
Device Control Registers						
0	2000	7D0	4	"operator"	Enter Supervisor Password	ASCII
4	2004	7D4	4	"password"	Enter Master pasword	ASCII
8	2008	7D8	1	hidden	Enter OEM Password	Hex
9	2009	7D9	1	hidden	Davidge Password	Hex
10	2010	7DA	1	0	Protection Level	Hex
11	2011	7DB	2	Ser No+01H	Serial number/address	Hex
13	2013	7DD	2	03E8H	Modbus Data register base address	Hex
14	2015	7DE	2	07D0H	Modbus Control register base address	Hex
15	2017	7DF	1	DFH	Modbus copy of CCMODE	Hex
16	2018	7E0	1	0	Response Delay	12.91 msec
17	2019	7E1	5	Varies	Modbus Copy of Option Bytes	ASCII
22	2024	7E6	1	0	Reset Meter	N/A
23	2025	7E7	10	Varies	Customer Identification array	ASCII

Table 1: Modbus Registers

The configuration of the Modbus registers is listed in Table 1, above. Details of individual registers are as follows:

The first 12 pairs of registers register the power flowing through the monitored circuits. Each set of registers contains 4 bytes, counting power in units of 10 watt hours. The counters are arranged so that they reset to zero when the maximum count of the binary equivalent of 99,999,999 decimal (corresponding to 999,999.99 KWHrs) is exceeded. Byte order follows Modbus convention with the least significant byte occupying the low end (right hand side) of the highest number register. The registers are Read Only. Positive power is defined as when the current phase is within +/- 90 degrees of the voltage vector.

Acc. Pwr. Ph. 1 10Wh (Imp - Pos)
Acc. Pwr. Ph. 2 10Wh (Imp - Pos)
Acc. Pwr. Ph. 3 10Wh (Imp - Pos)
These three sets of 2 registers each, accumulate positive power on the corresponding phase inputs.

Acc. Pwr. Ph. 4 10Wh (Imp - Pos)
This set of 2 registers is used only in the DM versions of the meter and accumulates positive power for input 4.

Acc. Pwr. Ph. 1 10Wh (Exp - Neg)
Acc. Pwr. Ph. 2 10Wh (Exp - Neg)
Acc. Pwr. Ph. 3 10Wh (Exp - Neg)
Acc. Pwr. Ph. 4 10Wh (Exp - Neg)
These four pairs of registers work the same as the corresponding positive power registers. They accumulate power only when the current vector is more than 90 degrees from the voltage vector. Phase 4 is used only on DM registers with the bidirectional option, or when a meter is wired incorrectly. Note: I am not sure whether this will be implemented (due to memory constraints) but the register is included for symmetry and future use.

Summed Accumulation Counter 1
Summed Accumulation Counter 2
Summed Accumulation Counter 3
Summed Accumulation Counter 4
These four pairs of registers form counters that accumulate totals of the power increments that feed the individual phases. Detailed functioning of these counters varies depending on the meter model. For instance, on a standard 3 phase meter, SA counters 1 and 2 are both incremented every time any of the phase input registers are incremented and provide a total power reading. SA Counter 2 is settable and resettable with a 2 register write to the applicable Modbus register address, if a correct supervisor password has been entered (see below for entry of passwords). SA Register 1 is never resettable. On the 3 phase meter mentioned SA registers 3 and 4 are not used.

The next four blocks of six registers contain blocks of data that represent the average readings of voltage, current, power, frequency and power factor for the preceding block of 64 ac line cycles on each input. The registers are thus updated every 1.07 seconds. The first 6 registers report Channel 1.

The values for Ch4 are only significant on a DM meter.

Phase 1 Voltage
This 2 byte number reads the RMS value of the voltage on voltage input 1 in units of 0.1 volts. The accuracy of the reading is dependent on the voltage waveform and may differ significantly from the true RMS reading for wave shapes that differ significantly from sinusoidal.

Phase 1 Current
This 2 byte number reads the RMS value of the current on current input 1 in units of 0.1 amps. The accuracy of the reading is dependent on the current waveform and may differ significantly from the true RMS reading for wave shapes that differ significantly from sinusoidal.

Phase 1 Power
This pair of Modbus registers should be read as a sign digit followed by a three byte number (high byte first). The first digit is either 0 representing positive power or -1 (0FFH) representing negative power. The next three digits read out the average true RMS power over the preceding 64 cycle interval in units of 0.1 watts.

Phase 1 Frequency
This register (2 bytes) gives the frequency of the voltage 1 input in units of 0.1 Hz. Note that each phase is metered and monitored separately and there is no assumption or requirement for each phase to be the same frequency.

Phase 1 Power Factor
This register should be read as two separate bytes. The high byte encodes the Lead or Lag of the current waveform with respect to the voltage. A value of -1 (0FFH) indicates a LAG condition. A value of zero indicates a power factor of 1 and a value of +1 indicates a LEAD power factor.
The second byte carries the power factor in units of 0.01.

The next three blocks of registers follow the same pattern.

Phase 2 Voltage
Phase 2 Current
Phase 2 Power
Phase 2 Frequency
Phase 2 Power Factor
Phase 3 Voltage
Phase 3 Current
Phase 3 Power
Phase 3 Frequency
Phase 3 Power Factor
Phase 4 Voltage
Phase 4 Current
Phase 4 Power

Phase 4 Frequency

Phase 4 Power Factor

The remainder of the registers are concerned with the control and registration of the meter and generally will occupy a separate piece of Modbus address space from the above block of power measurement registers. The first five sets of registers are concerned with establishing priority levels to permit or inhibit various meter control functions. There are five levels of protected access to the registers protected by four passwords.

Supervisor Password

This password defaults to "operator" unless changed during meter configuration. Unless a higher level password has been previously entered correctly, the supervisor password must be written to the appropriate series of registers (7D0 in default configuration) in a 4 register write, to raise the security level to 1. If a higher level of password has already been entered, then entering a password into the supervisor password address resets that password to the one entered. At or above security level 1, the resettable SA counters may be set by writing all zeros to them in a 2 register write.

Master Password

This works the same way as the supervisor password but raises the security level to 2. At this level, the Modbus base address registers the baud rate, parity and communications mode of the meter and the Customer Identification Array may be changed. The OEM password is required to change the master password from its default value of "password".

OEM Password

This is a 16 bit value that is related to the serial number of the meter and is thus varies from meter to meter. The value of the password is to be obtained from EZMeter on a need to know basis. It provides a method of changing the Master Password and the Response Delay, and enables a Hard Reset which clears the memory of the meter.

Note that the same OEM password is used in EZPlus mode to condition certain functions.

Note: We can easily switch items between priority levels to suit your system or regulatory requirements.

EZMeter Password.

The EZmeter password is used during meter configuration only. The password is tied to the assigned serial number for the meter and so is different from meter to meter, and is generated within the factory calibration system. It is one register (16 bits) long.

Protection Level

A read of this register gives a single numeric digit in the range 0 to 4 and indicates the current security level. 0 indicates no passwords successfully entered, 1 the supervisor password, 2 the master password, 3 the OEM password and 4 the EZMeter Configuration password. A write to this register sets the priority to 0.

Serial Number/Address

These 2 registers contain four bytes. The first three are the serial number of the meter expressed per

Modbus convention, high byte first. The fourth byte is the current Modbus address of the meter. The modbus address may be changed by addressing a 2 register write to this register pair. The write must be a broadcast (to Modbus address 0) with the first three bytes matching the meter serial number. and the fourth byte the new modbus address byte in the range 1 to 247.

Modbus Data Register Base Address
Modbus Control Register Base Address

These two registers are provided as a means of relocating the data register address anywhere within the Modbus address space. They may be changed only in master protection level and above and *extreme care is advised*. They should be written as a two register write and the effect takes place immediately. The control register base address should always occupy a numerically higher block of address than that of the data registers. These locations are best changed by means of the configuration option to change them.

Note: I have not yet tested the dynamic change to these registers, and am not confident that it will work as described.

Modbus Operating Mode

The lower byte of this register contains a copy of the communications mode byte for the meter. The baud rate, parity (in Modbus only) and operating mode (Modbus or EZPlus protocol) are encoded herein and may be changed by writing the new configuration to this register in Master protection level or above, and then executing a "Reset Meter" command.

Bit allocations are:-

bit	0	Reserved
bit	2 - 1	Baud Rate
	0 - 0	1200
	0 - 1	4800
	1 - 0	9600
	1 - 1	19200
bits	3, 4	Reserved

bit 5 not modbus (0 = modbus)
bit 6 even parity (0 = odd parity)
bit 7 enable parity (0 = no parity)

Note that for EZProtocol, the parity bits are ignored. It is always 8 data bits, no parity.

The value of 0FF corresponds to 19,200 baud using EZPlus Protocol. The default value for Modbus is 0DF (19,200 baud using 8 data bits and a 9th even parity bit).

Response Delay

The lower byte of this register controls the incremental delay (over and above the minimum inter-data delay specified in the document "MODBUS Over Serial Line Specification and Implementation Guide V1.02"), between the end of the data block received from the host and the time the meter starts to transmit its reply. The number programmed is the incremental delay in units of 12.91 msec. 0 corresponds to no incremental delay. The maximum delay is 255 x 12.91 msec = 3.3 seconds. The byte may be written only with OEM priority level and above. The change takes place immediately.

Option Bytes

This nine byte string identifies the Meter Type and its operating mode. The registers may be written only with EZMeter protection level (config priority).

Note: Not tested

Reset Meter

The meter may be reset by writing a pair of null characters (00H, 00H) using a single register write with at least Master priority. This is used to complete changes in communications configuration (change in baud rate, parity or protocol). It does not change the power accumulation registers, but it does interrupt the metering operation for approximately 3 seconds.

If 0FFH,0FFH is written with OEM or Config priority, a hard reset is executed. This is a drastic reset that clears out all the power accumulation registers and restores the meter to its default settings (as entered during configuration).

Customer Identification Array

This is a 20 byte array of meter memory that may be written to by the customer to record the location of the meter. It is readable at any level of priority but may be written only with the use of the Master password.