

***GIMA***

***Modbus Communications***

***December 2008***

## 1 Safety

The **GIMA** is intended for connection to dangerous voltages giving a risk of electric shock. Refer to the safety/installation instructions in the **GIMA Operating Manual** before connecting the communications.

### WARNING

The meter contains no user serviceable parts. Installation and commissioning should only be carried out by qualified personnel

## 2 Programming

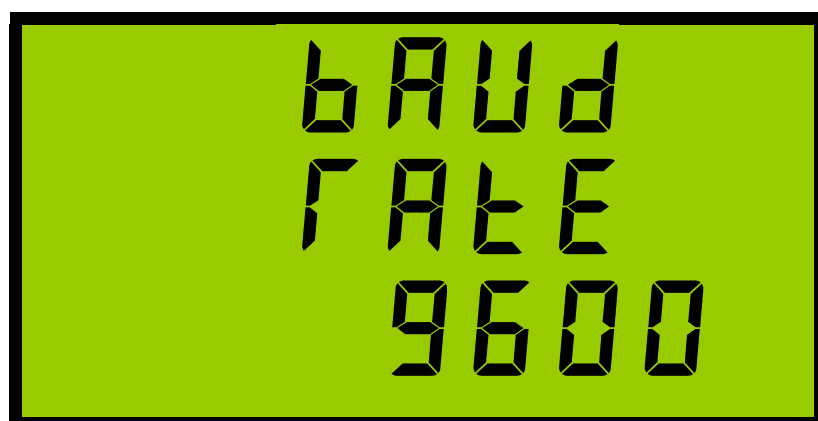
Meters fitted with the Modbus option have two additional stages in the front panel programming menu.

### To enter programming mode:

Hold Amp and scroll together for 5 Seconds.

Press **←** repeatedly until the required setup page is displayed.

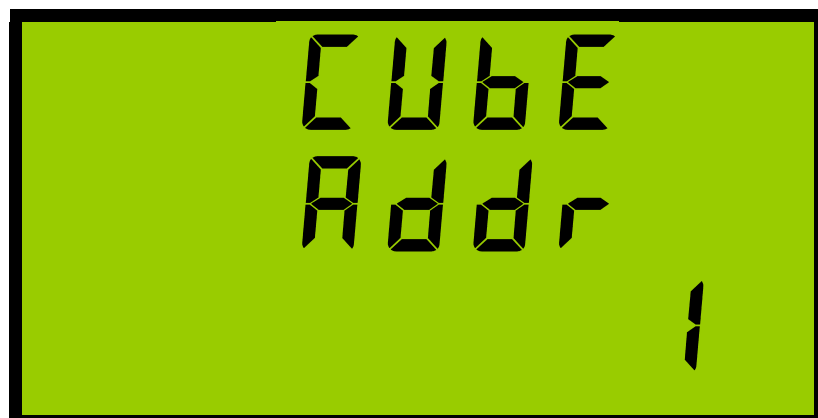
### RS485 Baud Rate



Press **▲** or **▼** to select from the list of valid baud rates. (4800-19200)

Press **←** to accept the set value.

### Modbus Meter ID



Press **▲** or **▼** to increment or decrement the value within the valid range (1-247).

Press **←** to accept the set value.

For full information on entering and using programming mode refer to the latest "**GIMA Operators Manual**"

### 3 Connection

#### 3.1 Cable Selection

A dedicated, screened twisted pair cable is required to provide basic RS485 connection. A second twisted pair may be used for 0V connection if required. The cable should be chosen to suit the data rate and maximum length to be installed. The EIA RS-485-A standard provides curves that relate cable length to data rate for 24 AWG screened, twisted pair, telephone cable with a shunt capacitance of 50pf/m. For baud rates up to 19,200 the standard suggests a maximum length of 1200m for this type of cable. If other types of cable are to be used it is recommended that the cable supplier is consulted as to the suitability for use with RS485 to 19,200 baud.

#### 3.2 Signal 0V and Cable Shield

A signal 0V termination is provided on each meter. Although RS485 does not strictly require a signal 0V, it is recommended this is connected as shown in the diagram below. This creates a known reference for the isolated RS485 system thereby reducing potential common-mode errors in the meter's RS485 driver circuit.

A cable shield is used to attenuate noise picked up from external sources. This should be continuous, and cover as much of the signal pairs as possible. It is recommended that the shield should be connected to ground at the host (PC) only. The cable shield should **not** be used as the 0V connection.

#### 3.3 Terminating Resistors

In order to minimise signal errors due to noise over long cable lengths, terminating resistors may be fitted. These match the RS485 device impedance to that of the cable. Two 120Ω resistors, one at the host port terminals and the other at the most remote meter terminals are recommended for this purpose.

##### 3.3.1 Connection To Meters

The bus should be taken to meters at each location for termination, using the meter terminals as a loop in-out connection. The use of spurs should be avoided wherever possible.

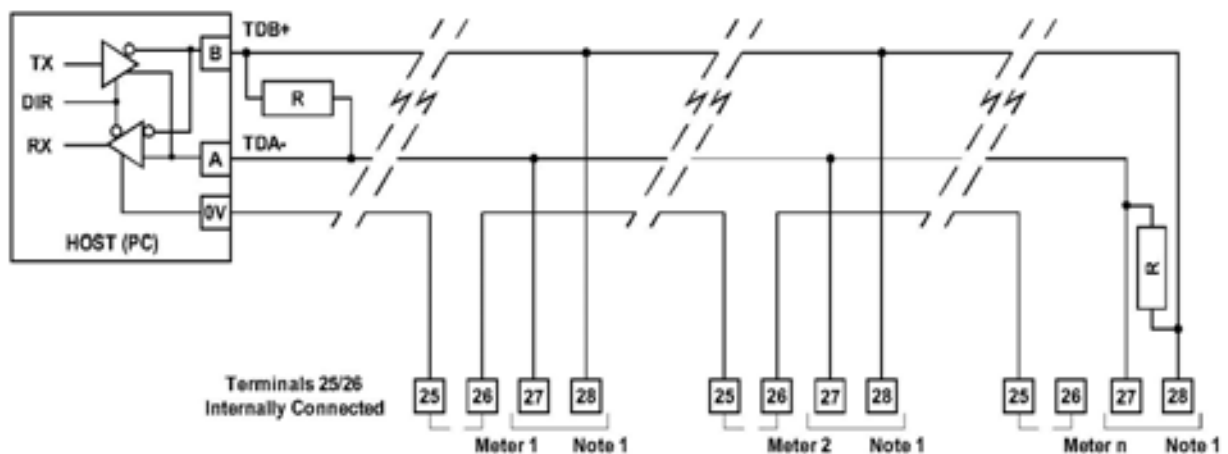


Figure 3-1 Basic RS485 To Internal Modbus Option

Note 1 Depending on application these leads may need to be reversed.

## 4 Protocol

### 4.1 Modbus Commands

The **GIMA** meter supports the following standard Modbus commands:

<b>Command</b>	<b>Function</b>	<b>Broadcast</b>
03	Read Multiple Holding Registers	No
04	Read Multiple Input Registers	No
06	Preset a Single Register	Yes
08 (SF=00)	Sub Function 00 only (Loop Back)	No
16	Preset Multiple Registers	Yes

### 4.2 Exception Responses

If the meter receives a Modbus command, with no errors and a valid address, it will attempt to handle the query and provide an appropriate response. If the meter cannot handle the query a standard Modbus exception response is sent (except broadcast queries). An exception response is characterised by its function byte which has 80H added to that sent in the query. The following exceptions codes are supported:

<b>Code</b>	<b>Function</b>
1	Preset data is out of range for parameter
2	Function cannot access requested register address

## 5 Modbus Data Tables

### 5.1 Using The Tables

For convenience, meter data is organised in tables of like information with the same format. An entire table may be read with a single Modbus **command 3** (Holding Registers). For compatibility with the Modbus standard each register contains a single data **Word** (16 bits). Data in the meter is stored as:

#### Unsigned Integer (U-INT)

16-bit data in the range 0 to 65,535. This is used for parameters such as CT prim as this can never be negative.

#### Signed Integer (S-INT)

16-bit data in the range –32,767 to +32,767. This is used for parameters such as instantaneous kW, which may have a negative value indicating export power.

#### Long Integer (LONG)

32-bit data in the range 0 to 4,294,967,295. This is used for parameters such as kWh, which may have large values. Each LONG requires two consecutive Modbus data words. Standard software often handles long integer reads, however, a LONG may be calculated from the individual data words as:

$$\text{LONG} = (65536 \times \text{High Word}) + \text{Low Word}$$

**Note:** Table data values corresponding to measurements not available on an individual GIMA (eg Harmonics on Meter Type 1) may return zero.

### 5.2 Energy Registers

<b>Data Address</b>	<b>Modbus Register</b>	<b>Data</b>	<b>Access</b>
512	40513	eScale High Word	Read Only
513	40514	eScale Low Word	
514	40515	kWh High Word	Read/Write
515	40516	kWh Low Word	
516	40517	kVAh High Word	Read/Write
517	40518	kVAh Low Word	
518	40519	kvarh Inductive High Word	Read/Write
519	40520	kvarh Inductive Low Word	
520	40521	kvarh Capacitive High Word	Read/Write
521	40522	kvarh Capacitive Low Word	
522	40523	Import kvarh High Word	Read/Write
523	40524	Import kvarh Low Word	
524	40525	Export kWh High Word	Read/Write
525	40526	Export kWh Low Word	
526	40527	Export kvarh High Word	Read/Write
527	40528	Export kvarh Low Word	

Energy registers are stored as long integer representations of the number displayed on the meter without decimal point or scaling. For example if the meter displays 123456.78kWh, the Holding Registers 40515-40516 will contain the long integer 12345678. This number may be scaled in Wh or kWh, using eScale as:

$$\text{Wh} = \text{Holding Reg}[40513] \times 10^{(\text{eScale}-3)}$$

$$\text{kWh} = \text{Holding Reg}[40513] \times 10^{(\text{eScale}-6)}$$

The eScale constant is set, along with the kWh register resolution and scaling, by the CT primary and nominal voltage programmed settings. The display scaling and eScale therefore remain constant once a meter is installed and commissioned. A read of eScale High Word always returns zero.

### Example:

If the meter displays 1234567.8 kWh then eScale would be 5 and the Holding Register 40513 would contain 12345678.

The host would calculate the scaled energy reading as:

$$12345678 \times 10^{(5-3)} = 12345678 \times 100 = 1,234,567,800 \text{ Wh}$$

or  $12345678 \times 10^{(5-6)} = 12345678 \times 0.1 = 1,234,567.8 \text{ kWh}$

The host programmer could take two approaches to interpreting the data from the meter:

- ✓  Enter a fixed scaling factor (x100 for Wh or x0.1 for kWh in above example). This would be set for each meter in the system based on its display after commissioning.
- ✓  Use the transmitted eScale constant, as shown above, to automatically position the decimal point in the interpreted result.

## 5.3 Instantaneous Meter Values

<b>Data Address</b>	<b>Modbus Register</b>	<b>Data</b>	<b>Scaling</b>
2816	42817	System kW	Kp
2817	42818	System kVA	Kp
2818	42819	System kvar	Kp
2819	42820	System PF	1000 = 1.000
2820	42821	Frequency	5000 = 50.00
2821	42822	Phase 1 Volts	Kvp
2822	42823	Phase 1 Amps	Ki
2823	42824	Phase 1 kW	Kp
2824	42825	Phase 2 Volts	Kvp
2825	42826	Phase 2 Amps	Ki
2826	42827	Phase 2 kW	Kp
2827	42828	Phase 3 Volts	Kvp
2828	42829	Phase 3 Amps	Ki
2829	42830	Phase 3 kW	Kp
2830	42831	Phase 1 PF	1000 = 1.000
2831	42832	Phase 2 PF	1000 = 1.000
2832	42833	Phase 3 PF	1000 = 1.000
2833	42834	Ph1-Ph2 Volts	Kvl
2834	42835	Ph2-Ph3 Volts	Kvl
2835	42836	Ph3-Ph1 Volts	Kvl
2836	42837	Neutral Current	Ki
2837	42838	Amps Scale Ki	-
2838	42839	Phase Volts Scale Kvp	-
2839	42840	Line Volts Scale Kvl	-
2840	42841	Power Scale Kp	-

**Note:** All values in this table are Signed Integers with read only access.

Instantaneous readings are provided as signed integer values with no decimal point or legend (e.g. kW or MW). Scaling factors are provided to enable conversion of the raw data to real numbers in basic unit form (amps, volts, watts, VA, or var). These scaling factors are constant values calculated as a function of CT and PT Primary programming.

To convert raw data to real numbers:

$$R = I \times 10^{(K-3)}$$

Where:

- I** = Integer number
- K** = Relevant Scaling Factor
- R** = Real number result

### Example:

If the meter is programmed with CT Primary=50Amps and PT Primary=415V:

LCD values would be scaled as: 50.00A, 240.0V, 415.7V<sub>LL</sub> and 36.00kW.

Scaling factors would be: I Scale=1, **Kvp**=2, **Kvl**=2, **Kp**=4.

Integer Values would be transmitted as: 5000, 2400, 4157 and 3600

Amps would be calculated as  $5000 \times 10^{(1-3)} = 5000/100 = 50.00A$

Phase Volts would be calculated as  $2400 \times 10^{(2-3)} = 2400/10 = 240.0V$

Line Volts would be calculated as  $4157 \times 10^{(2-3)} = 4157/10 = 415.7V$

3-Ph Power would be calculated as  $3600 \times 10^{(4-3)} = 3600 \times 10 = 36000W$

### 5.4 Additional Instantaneous Values

<b>Data Address</b>	<b>Modbus Register</b>	<b>Data</b>	<b>Scaling</b>
3072	43073	Phase 1 kVA	Kp
3073	43074	Phase 2 kVA	Kp
3074	43075	Phase 3 kVA	Kp
3075	43076	Phase 1 kvar	Kp
3076	43077	Phase 2 kvar	Kp
3077	43078	Phase 3 kvar	Kp

**Note:** All values in this table are Signed Integers with read only access.

### 5.5 Peak Hold Values

<b>Data Address</b>	<b>Modbus Register</b>	<b>Data</b>	<b>Scaling</b>
3328	43329	Peak Hold Ph1 Amps	Ki
3329	43330	Peak Hold Ph2 Amps	Ki
3330	43331	Peak Hold Ph3 Amps	Ki
3331	43332	Peak Hold Ph1 Volts	Kvp
3332	43333	Peak Hold Ph2 Volts	Kvp
3333	43334	Peak Hold Ph3 Volts	Kvp
3334	43335	Peak Hold kW Demand	Kp – 1
3335	43336	KW Demand Period	1-60 Minutes
3336	43337	KW Demand	Kp – 1

**Note:** All values in this table are Signed Integers with read/write access except 43336 and 43337, which have read only access.

### 5.6 Meter Setup

<b>Data Address</b>	<b>Modbus Register</b>	<b>Data</b>	<b>Scaling</b>
3584	43585	CT Primary	10 - 25,000 Amps
3585	43586	Nominal Volts	10 - 55,000 Volts
3586	43587	Pulse 1 Rate	1-1000 Counts/Pulse
3587	43588	Pulse 2 Rate (= Pulse 1 Rate)	1-1000 Counts/Pulse
3588	43589	Baud	96 = 9600baud etc
3589	43590	Modbus ID	0 – 247
3590	43591	Meter Model	MultiCube = 100
3591	43592	Meter Type	1 - 6
3592	43593	Firmware Version	Eg. 0x1A = 1.10
3593	43594	Current Demand Period	1 = 10Sec, 2=20Sec etc
3594	43595	Pulse ON Time	1 = 100ms, 2=200ms etc
3595	43596	Security Code	0 - 9999

**Note:** All values in this table are unsigned Integers with read/write access except 43591-43593 which are read only.

### 5.7 Peak Hold Current Demand

Data Address	Modbus Register	Data	Scaling
3840	43841	Peak Ph1 Amps Demand	Ki
3841	43842	Peak Ph2 Amps Demand	Ki
3842	43843	Peak Ph3 Amps Demand	Ki
3843	43844	Peak Ph1 Volts Demand	Kv
3844	43845	Peak Ph2 Volts Demand	Kv
3845	43846	Peak Ph3 Volts Demand	Kv

**Note:** All values in this table are Unsigned Integers with read/write access.

### 5.8 Current Demand

Data Address	Modbus Register	Data	Scaling
4096	44097	Ph1 Amps Demand	Ki
4097	44098	Ph2 Amps Demand	Ki
4098	44099	Ph3 Amps Demand	Ki
4099	44100	Ph1 Volts Demand	Kv
4100	44101	Ph2 Volts Demand	Kv
4101	44102	Ph3 Volts Demand	Kv

**Note:** All values in this table are Unsigned Integers with read only access.

### 5.9 Total Harmonic Distortion Values (NOT Available)

Data Address	Modbus Register	Data	Scaling
4352	44353	V1 % THD	1000 = 100%
4353	44354	V2 % THD	1000 = 100%
4354	44355	V3 % THD	1000 = 100%
4355	44356	I1 % THD	1000 = 100%
4356	44357	I2 % THD	1000 = 100%
4357	44358	I3 % THD	1000 = 100%

**Note:** All values in this table are Unsigned Integers with read only access.

### 5.10 Power Demand Values

Data Address	Modbus Register	Data	Scaling
4608	44609	kW Demand	Kp - 1
4609	44610	kVA Demand	Kp - 1
4610	44611	Kvar Demand	Kp - 1
4611	44612	Peak Hold kW Demand	Kp - 1
4612	44613	Peak Hold kVA Demand	Kp - 1
4613	44614	Peak Hold kvar Demand	Kp - 1

**Note:** All values in this table are signed Integers. Peak hold values have read/write access.

## 5.11 Amalgamated Data Table

Data Address	Modbus Register	Data	Scaling
7680	47681	KWh High Word	eScale
7681	47682	KWh Low Word	
7682	47683	KVAh High Word	eScale
7683	47684	KVAh Low Word	
7684	47685	Kvarh High Word	eScale
7685	47686	Kvarh Low Word	
7686	47687	Export kWh High Word	eScale
7687	47688	Export kWh Low Word	
7688	47689	Phase 1 Amps	Ki
7689	47690	Phase 2 Amps	
7690	47691	Phase 3 Amps	Kvp
7691	47692	Phase 1 Volts	
7692	47693	Phase 2 Volts	
7693	47694	Phase 3 Volts	Kvl
7694	47695	Ph1-Ph2 Volts	
7695	47696	Ph2-Ph3 Volts	
7696	47697	Ph3-Ph1 Volts	5000 = 50.00
7697	47698	Frequency	
7698	47699	Phase 1 PF	1000 = 1.000
7699	47700	Phase 2 PF	
7700	47701	Phase 3 PF	
7701	47702	System PF	Kp
7702	47703	Phase 1 kW	
7703	47704	Phase 2 kW	
7704	47705	Phase 3 kW	Kp
7705	47706	System kW	
7706	47707	Phase 1 kVA	
7707	47708	Phase 2 kVA	Kp
7708	47709	Phase 3 kVA	
7709	47710	System kVA	
7710	47711	Phase 1 kvar	Kp
7711	47712	Phase 2 kvar	
7712	47713	Phase 3 kvar	
7713	47714	System kvar	Ki
7714	47715	Ph1 Amps Demand	
7715	47716	Ph2 Amps Demand	
7716	47717	Ph3 Amps Demand	Kv
7717	47718	Ph1 Volts Demand	
7718	47719	Ph2 Volts Demand	
7719	47720	Ph3 Volts Demand	Ki
7720	47721	Peak Ph1 Amps Demand	
7721	47722	Peak Ph2 Amps Demand	
7722	47723	Peak Ph3 Amps Demand	Kv
7723	47724	Peak Ph1 Volts Demand	
7724	47725	Peak Ph2 Volts Demand	
7725	47726	Peak Ph3 Volts Demand	Kp - 1
7726	47727	kW Demand	
7727	47728	kVA Demand	
7728	47729	kvar Demand	Kp - 1
7729	47730	Peak Hold kW Demand	
7730	47731	Peak Hold kVA Demand	
7731	47732	Peak Hold kvar Demand	Ki
7732	47733	Neutral Current	
7733	47734	Amps Scale Ki	-
7734	47735	Phase Volts Scale Kvp	-
7735	47736	Line Volts Scale Kvl	-
7736	47737	Power Scale Kp	-
7737	47738	Energy Scale eScale	-

**Note:** All values in this table have read only access.

The amalgamated data table provides a copy of key variables in a single table, which may be read with a single Modbus command. The format and scaling of each parameter is identical to that found in the main tables.

## 5.18 Custom Data Table

This provides a custom table containing 32 Modbus registers, selected and arranged to suit individual requirements.

To set up a custom table first write the Data Addresses of the required parameters to the following Modbus table.

<b>Data Address</b>	<b>Modbus Register</b>	<b>Data</b>	<b>Example</b>	
19200	419201	Custom Address 0	<b>514</b>	kWh High Word
19201	419202	Custom Address 1	<b>515</b>	kWh Low Word
19202	419203	Custom Address 2	<b>516</b>	kVAh High Word
19203	419204	Custom Address 3	<b>517</b>	kVAh Low Word
19204	419205	Custom Address 4	<b>518</b>	kvarh Inductive High Word
19205	419206	Custom Address 5	<b>519</b>	kvarh Inductive Low Word
19206	419207	Custom Address 6	<b>520</b>	kvarh Capacitive High Word
19207	419208	Custom Address 7	<b>521</b>	kvarh Capacitive Low Word
19208	419209	Custom Address 8	<b>522</b>	Import kvarh High Word
19209	419210	Custom Address 9	<b>523</b>	Import kvarh Low Word
19210	419211	Custom Address 10	<b>524</b>	Export kWh High Word
19211	419212	Custom Address 11	<b>525</b>	Export kWh Low Word
19212	419213	Custom Address 12	<b>526</b>	Export kvarh High Word
19213	419214	Custom Address 13	<b>527</b>	Export kvarh Low Word
19214	419215	Custom Address 14	<b>2816</b>	System kW
19215	419216	Custom Address 15	<b>2817</b>	System kVA
19216	419217	Custom Address 16	<b>2818</b>	System kvar
19217	419218	Custom Address 17	<b>2819</b>	System PF
19218	419219	Custom Address 18	<b>2820</b>	Frequency
19219	419220	Custom Address 19	<b>2821</b>	Phase 1 Volts
19220	419221	Custom Address 20	<b>3331</b>	Peak Hold Ph1 Volts
19221	419222	Custom Address 21	<b>2824</b>	Phase 2 Volts
19222	419223	Custom Address 22	<b>3332</b>	Peak Hold Ph2 Volts
19223	419224	Custom Address 23	<b>2827</b>	Phase 3 Volts
19224	419225	Custom Address 24	<b>3333</b>	Peak Hold Ph3 Volts
19225	419226	Custom Address 25	<b>2822</b>	Phase 1 Amps
19226	419227	Custom Address 26	<b>3328</b>	Peak Hold Ph1 Amps
19227	419228	Custom Address 27	<b>2825</b>	Phase 2 Amps
19228	419229	Custom Address 28	<b>3329</b>	Peak Hold Ph2 Amps
19229	419230	Custom Address 29	<b>2828</b>	Phase 3 Amps
19230	419231	Custom Address 30	<b>3330</b>	Peak Hold Ph3 Amps
19231	419232	Custom Address 31	<b>3584</b>	CT Primary

Write 514 to Modbus Register 419201 etc. The Data Addresses may be any valid Modbus register address listed in the above tables. Data Addresses in this table have read/write access. The corresponding Modbus Parameters pointed to by Custom Address 0 – Custom Address 31 are available at Modbus Addresses 419457 – 419488 (Data Addresses 19456 – 19487).

## 6 Specification

<b>Aux Mains</b>	Internally supplied from GIMA Auxiliary Requires additional 1W max
<b>Modbus</b>	RS485            Half duplex, 2 Wires + 0V RX Load:       ¼ Unit load per meter (max 128 per bus) TX Drive:       32 Unit loads maximum Protocol:        Modbus RTU/JBUS, 16-Bit CRC Baud: 4800, 9600, 19200 user programmable Address:        1-247 user programmable
<b>Isolation</b>	2.5kV (1 minute) RS485 Port from all other circuit
<b>Performance</b>	Reply: Maximum 250ms Rate: Min 10ms from reply to next request Data: Meter readings & programmable settings Maximum data length 112 Words.
<b>General</b>	Environmental: Refer to GIMA Dimensions: Add 10mm to depth of GIMA Terminals:    Rising clamp, max wire 4mm <sup>2</sup>