

MultiCube

Modbus Data Tables

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1. Introduction

This document is intended as a supplement to the MultiCube Modbus Options Installation and operation guide. It is advisable to read both documents. It is designed for software engineers setting up Modbus SCADA software to take readings from MultiCube RTU meters.

Data in the MultiCube may be accessed using Command 3 ***Read Holding Registers*** or Command 4 ***Read Input Registers***.

This guide assumes Holding Registers are accessed in the address range 40001 to 465536. The data is mirrored in the address range 30001 to 365536.

Modbus Data Tables

2. Accumulated Energy Readings

Data Address	Data	Access
40513	Zero	Read Only
40514	Energy DP	Read Only
40515	kWh	Read / Write
40516		
40517	kVAh	Read / Write
40518		
40519	kvarh (Inductive)	Read / Write
40420		
40521	kvarh (Capacitive)	Read / Write
40522		

A single Modbus register is insufficient to store energy readings greater than 65536. The MultiCube therefore uses two consecutive registers for each energy value.

Most Modbus software systems allow data to be read and converted to Long Integers automatically. This is the recommended method of reading energy data from the meter.

Alternatively read each register separately then calculate the energy value as:

$$\text{Energy Reading} = (\text{Reg1} \times 65536) + \text{Reg2}$$

The energy value is returned exactly as it appears on the meter display but has the decimal point removed. The position of the decimal point is dependant on the setup of the CT and PT values and remains constant after commissioning.

Note: Address 40513 always returns 0. This allows the **Energy DP** value to be read as a Long integer at 40513 if required.

The decimal point may be added as a scaling factor after the data is received.

This may be done by manually configuring the Modbus software or automatically using the **Energy DP** value:

Energy DP	Scale as kWh
2	x 0.0001
3	x 0.001
4	x 0.01
5	x 0.1
6	x 1
7	x 10
8	x 100
9	x 1000

For example a meter displaying a value of 1234567.8 kWh would return a value of 12345678 using Modbus. The **Energy DP** value would be returned as 5.

From the above table the Modbus software would calculate:

$$12345678 \times 0.1 = 1234567.8 \text{ kWh}$$

3. Instantaneous Meter Readings

3.1 Data Registers

Data Address	Data	Scaling	Access
42817	kW 3-Ph	Power Scale	Read Only
42818	kVA 3-Ph	Power Scale	Read Only
42819	kvar 3-Ph	Power Scale	Read Only
42820	PF 3-Ph	41000	Read Only
42821	Frequency	4100	Read Only
42822	Phase 1 Volts	Ph Volts Scale	Read Only
42823	Phase 1 Amps	Amps Scale	Read Only
42824	Phase 1 kW	Power Scale	Read Only
42825	Phase 2 Volts	Ph Volts Scale	Read Only
42826	Phase 2 Amps	Amps Scale	Read Only
42827	Phase 2 kW	Power Scale	Read Only
42828	Phase 3 Volts	Ph Volts Scale	Read Only
42829	Phase 3 Amps	Amps Scale	Read Only
42830	Phase 3 kW	Power Scale	Read Only
42831	Phase 1 PF	41000	Read Only
42832	Phase 2 PF	41000	Read Only
42833	Phase 3 PF	41000	Read Only
42834	Ph1-Ph2 Volts	Ln Volts Scale	Read Only
42835	Ph2-Ph3 Volts	Ln Volts Scale	Read Only
42836	Ph3-Ph1 Volts	Ln Volts Scale	Read Only
42837	Neutral Current	Amps Scale	Read Only

Data Address	Data	Scaling	Access
43073	Phase 1 kVA	Power Scale	Read Only
43074	Phase 2 kVA	Power Scale	Read Only
43075	Phase 3 kVA	Power Scale	Read Only
43076	Phase 1 kvar	Power Scale	Read Only
43077	Phase 2 kvar	Power Scale	Read Only
43078	Phase 3 kvar	Power Scale	Read Only

Modbus Data Tables

Data Address	Data	Scaling	Access
43329	PK Hold I1	Amps Scale	Read / Write
43330	PK Hold I2	Amps Scale	Read / Write
43331	PK Hold I3	Amps Scale	Read / Write
43332	PK Hold V1	Ph Volts Scale	Read / Write
43333	PK Hold V2	Ph Volts Scale	Read / Write
43334	PK Hold V3	Ph Volts Scale	Read / Write
43335	Peak kW MD	Power Scale - 1	Read / Write
43336	MD Period	Scaled in Minutes	Read / Write
43337	kW MD	Power Scale - 1	Read Only

Data Address	Data	Scaling	Access
43841	Peak I1 MD	Amps Scale	Read / Write
43842	Peak I2 MD	Amps Scale	Read / Write
43843	Peak I3 MD	Amps Scale	Read / Write
43844	Peak V1 MD	Ph Volts Scale	Read / Write
43845	Peak V2 MD	Ph Volts Scale	Read / Write
43846	Peak V3 MD	Ph Volts Scale	Read / Write

Data Address	Data	Scaling	Access
44097	I1 Demand	Amps Scale	Read Only
44098	I2 Demand	Amps Scale	Read Only
44099	I3 Demand	Amps Scale	Read Only
44100	V1 Demand	Ph Volts Scale	Read Only
44101	V2 Demand	Ph Volts Scale	Read Only
44102	V3 Demand	Ph Volts Scale	Read Only

Data Address	Data	Scaling	Access
44353	V1 % THD	410	Read Only
44354	V2 % THD	410	Read Only
44355	V3 % THD	410	Read Only
44356	I1 % THD	410	Read Only
44357	I2 % THD	410	Read Only
44358	I3 % THD	410	Read Only

Data Address	Data	Scaling	Access
44609	kW MD	Power Scale - 1	Read Only
44610	kVA MD	Power Scale - 1	Read Only
44611	kvar MD	Power Scale - 1	Read Only
44612	Peak kW MD	Power Scale - 1	Read / Write
44613	Peak kVA MD	Power Scale - 1	Read / Write
44614	Peak kvar MD	Power Scale - 1	Read / Write

3.2 Scaling Instantaneous Values

Scaling of all instantaneous values is affected only by the CT and PT setup constants. Scaling therefore remains constant once a meter has been commissioned. Scaling factors for all instantaneous meter readings may be accessed as Modbus data.

Data Address	Data	Access
42838	Amps Scale	Read Only
42839	Ph Volts Scale	Read Only
42840	Ln Volts Scale	Read Only
42841	Power Scale	Read Only

The Modbus data tables return the number as it appears on the LCD display with the decimal point removed. The decimal point may be added manually in the Modbus software or automatically using the following table to convert to basic SI units (Volts, Amps, Watts, VA etc).

Scaling	Scale as V, A W etc	Scale as kV, kA, kW etc
2	x 0.1	x 0.0001
3	x 1	x 0.001
4	x 10	x 0.01
5	x 100	x 0.1
6	x 1000	x 1
7	x 10,000	x 10
8	x 100,000	x 100
9	x 1,000,000	x 1000

Modbus Data Tables

4. Meter Setup Parameters

Data Address	Data	Scaling	Access
43585	CT Primary	x 1	Read / Write
43586	PT Primary	x 1	Read / Write
43587	Pulse 1 Rate	Energy DP	Read / Write
43588	Pulse 2 Rate	Energy DP	Read / Write
43589	Baud Rate	x 1	Read / Write
43590	Modbus ID	x 1	Read / Write
43591	Meter Model	N/A	Read / Write
43592	Meter Type	N/A	Read / Write
43593	Meter Software	101 = V1.01	Read / Write
43594	V/I MD Period	Minutes	Read / Write

Table 14 Meter Set-up

Offset	Address	Contents	Format	Bytes	Words	Access
0	3584	CT Primary	unsigned Int	2	1	Read/Write ¹⁰
1	3585	PT Primary	unsigned Int	2	1	Read/Write ¹⁰
2	3586	Pulse 1 Rate	unsigned Int	2	1	Read/Write ¹⁰
3	3587	Pulse 2 Rate	unsigned Int	2	1	Read/Write ¹⁰
4	3588	Baud Rate	unsigned Int	2	1	Read/Write ¹⁰
5	3589	Modbus ID	unsigned Int	2	1	Read/Write ¹⁰
6	3590	Meter Model	unsigned Int	2	1	Read Only
7	3591	Meter Type	unsigned Int	2	1	Read Only
8	3592	Meter Software	unsigned Int	2	1	Read Only
9	3593	V/I MD Period	unsigned Int	2	1	Read/Write ¹⁰

Notes: 10. Values in Table 14 may not be written using Command 16

4.1.1.1 Meter Set-up Values

Information about the MultiCube's configuration is available in Table 14 as unsigned integers.

- **CT Primary.** (5A - 20000A) CT Primary as displayed during meter set-up.
- **PT Primary.** (60V - 50000V) PT Primary as displayed during meter set-up.
- **Pulse 1 Rate.** (1 - 255) No. of counts of kWh register per pulse (if fitted).
- **Pulse 2 Rate.** (1 - 255) No. of counts of kvarh* register per pulse (if fitted).
- **Baud Rate.** (48, 96 or 192) RS485/422 baud rates of 4800, 9600 or 19200.
- **Modbus ID** (1 – 247). Modbus Meter Address.
- **Meter Model** A constant identifying the product range (MultiCube=100).
- **Meter Type** (1 – 6). Refer to MultiCube manual for details of meter types.
- **Meter Software** MultiCube version (e.g. 0x0014 = Version 1.04).
- **V/I MD Period** (1-255) Time period (seconds/10) for Current and Voltage Demand. Eg. A value of 6 corresponds to a demand period of 60 seconds.

* kVAh Pulsing may replace kvarh in some MultiCubes.

RTU Commands

4.1.2 Function 04 (or 03) Read Multiple Registers

Description

This function allows a number of registers from a meter table to be read in a single operation. This command is commonly used to obtain instantaneous, energy or set-up data from the meter. This command is not available as a *broadcast* command as it requires a return data packet from the meter.

Host Request

	BYTE	EXAMPLE
METER ADDRESS	1	19H
FUNCTION	2	04H
TABLE NUMBER (Address High Byte)	3	0BH
TABLE OFFSET (Address Low Byte)	4	00H
No. OF WORDS (N) (High Byte)	5	00H
No. OF WORDS (N) (Low Byte)	6	03H
CHECKSUM (High Byte)	7	B1H
CHECKSUM (Low Byte)	8	F7H

The example above shows a read of 3 consecutive Integers from the Instantaneous Data Table 11(0BH), offset 0. The meter accessed has a Modbus ID of 25 (19H).

Meter Response

	BYTE	EXAMPLE
METER ADDRESS	1	19H
FUNCTION	2	04H
NUMBER OF BYTES (2N)	3	06H
DATA REGISTER 1 (High Byte)	4	02H
DATA REGISTER 1 (Low Byte)	5	3AH
DATA REGISTER 2 (High Byte)	6	07H
DATA REGISTER 2 (Low Byte)	7	5CH
DATA REGISTER N (High Byte)	8	07H
DATA REGISTER N (Low Byte)	9	02H
CHECKSUM (High Byte)	10	51H
CHECKSUM (Low Byte)	11	E3H

The example shows a reply of 6 bytes (3 Integers) as:

3-Ph kW	=	570	(02 3A Hex)
3-Ph kVA	=	1884	(07 5C Hex)
3-Ph kvar	=	1794	(07 02 Hex)

Modbus Data Tables

4.1.3 Function 06 Preset a Single Register

Description

This function allows a single integer register in a meter table to be changed by the host. This command is commonly used to program meter parameters or to reset energy registers to zero. When broadcast (address=0) all meters on the network are addressed together but none reply.

Host Request

	BYTE	EXAMPLE
METER ADDRESS	1	19 H
FUNCTION	2	06 H
TABLE NUMBER (Address High Byte)	3	0E H
TABLE OFFSET (Address Low Byte)	4	00 H
DATA VALUE (High Byte)	5	00 H
DATA VALUE (Low Byte)	6	C8 H
CHECKSUM (High Byte)	7	89 H
CHECKSUM (Low Byte)	8	6C H

The example above shows a value of 200 (00H C8H) written to the CT Primary register (Data Table 14, offset 0). The meter accessed has a Modbus ID of 25 (19H).

Meter Response

	BYTE	EXAMPLE
METER ADDRESS	1	19 H
FUNCTION	2	06 H
TABLE NUMBER (Address High Byte)	3	0E H
TABLE OFFSET (Address Low Byte)	4	00 H
DATA VALUE (High Byte)	5	00 H
DATA VALUE (Low Byte)	6	C8 H
CHECKSUM (High Byte)	7	89 H
CHECKSUM (Low Byte)	8	6C H

The reply format is a copy of the command confirming its validity:

NOTE: This Modbus command is limited to writing 2-byte data only. Long Integer registers may be written but the meter assumes sets upper bytes automatically to zero.

Modbus Data Tables

4.1.4 Function 08 Loop Back Diagnostic

Description

This function provides a simple means of testing the communication network and detecting if a particular meter is present. This command is not available as a *broadcast* command as it requires a return data packet from the meter.

Host Request

	BYTE	EXAMPLE
METER ADDRESS	1	19 H
FUNCTION	2	08 H
DIAGNOSTIC CODE (High Byte)	3	00 H
DIAGNOSTIC CODE (Low Byte)	4	00 H
DIAGNOSTIC DATA (High Byte)	5	03 H
DIAGNOSTIC DATA (Low Byte)	6	E8 H
CHECKSUM (High Byte)	7	E3 H
CHECKSUM (Low Byte)	8	6D H

The example above shows a command with a Loop Back Code of 0 and Diagnostic Data of 1000 (03H E8H). The meter accessed has a Modbus ID of 25 (19H).

Meter Response

	BYTE	EXAMPLE
METER ADDRESS	1	19 H
FUNCTION	2	08 H
DIAGNOSTIC CODE (High Byte)	3	00 H
DIAGNOSTIC CODE (Low Byte)	4	00 H
DIAGNOSTIC DATA (High Byte)	5	03 H
DIAGNOSTIC DATA (Low Byte)	6	E8 H
CHECKSUM (High Byte)	7	E3 H
CHECKSUM (Low Byte)	8	6D H

The reply format is a copy of the command confirming its validity:

Modbus Data Tables

4.1.5 Function 16 Preset Multiple Registers

Description

This function allows a number of registers in a meter table to be set, by the host, in a single operation. When broadcast (address=0) all meters on the network are addressed together but none reply.

Host Request

	BYTE	EXAMPLE
METER ADDRESS	1	19 H
FUNCTION	2	10 H
TABLE NUMBER (Address High Byte)	3	0D H
TABLE OFFSET (Address Low Byte)	4	03 H
NUMBER OF DATA WORDS (N) (High Byte)	5	00 H
NUMBER OF DATA WORDS (N) (Low Byte)	6	03 H
NUMBER OF DATA BYTES (2N)	7	06 H
DATA BYTE 1	8	00 H
DATA BYTE 2	9	00 H
DATA BYTE 3	10	00 H
DATA BYTE 4	11	00 H
DATA BYTE 5	12	00 H
DATA BYTE 6	13	00 H
CHECKSUM (High Byte)	14	0C
CHECKSUM (Low Byte)	15	FB

The example above simultaneously writes 00 to all three peak hold voltage registers (V1 Peak Hold = Table 13, Offset 3). The meter accessed has a Modbus ID of 25 (19H).

Meter Response

	BYTE	EXAMPLE
METER ADDRESS	1	19 H
FUNCTION	2	10 H
TABLE NUMBER (Address High Byte)	3	0D H
TABLE OFFSET (Address Low Byte)	4	03 H
NUMBER OF DATA WORDS (High Byte)	5	00 H
NUMBER OF DATA WORDS (Low Byte)	6	03 H
CHECKSUM (High Byte)	7	71 H
CHECKSUM (Low Byte)	8	7C H

The reply confirms the data address and amount of data received.

4.1.6 Exception Responses

When a host sends a query to an individual meter on the network it expects a normal response. In fact one of four possible events may occur as a result of the query:

- ◇ If the Options Unit receives the message with no communication errors, and can handle the query it will reply with a normal response.
- ◇ If the Options Unit does not receive the message due to a communication failure, no response will be returned and the host will eventually time-out.
- ◇ If the Options Unit receives the message but detects a communication error via its CRC, no response will be returned and the host will time-out.
- ◇ If the Options Unit receives the query with no communication errors but cannot handle the query (out of range data or address) the response will be an **Exception Response** informing the host of the nature of the error.

An Exception Response differs from a normal response in its Function Code and Data Fields.

Exception Response

	BYTE	EXAMPLE
METER ADDRESS	1	19 H
FUNCTION	2	84 H
EXCEPTION CODE	3	02 H
CHECKSUM (High Byte)	4	42 H
CHECKSUM (Low Byte)	5	C6H

EXCEPTION FUNCTION CODE

All normal function types have a most significant bit of 0 (< 80 Hex). In an Exception Response the meter sets the MSB to 1 (adds 80H to the received Function Type). The Function can therefore be used by the host to detect an Exception Response.

DATA FIELD

In an Exception Response the data field is used only to return the type of error that occurred (**Exception Code**).

The MultiCube Options Unit utilises the following Exception Codes:

Code	Meaning
1	Data out of range
2	Table and/or offset out of range for this function
3	Odd number of Integers written to Long Integer registers
9	Communications from Option Module to meter has failed

Modbus Data Tables

4.2 Modbus Diagnostics LEDs

The MultiCube Option units use 3 LEDs to aid commissioning into a Modbus system. These indicators are also useful to check continued operation of the device.

The LEDs are intelligent indicators, which are illuminated under specific conditions as follows:

VALID COMMAND 'Cmd' - Illuminated when a host command is received, surrounded by RTU frame breaks (ref **Error! Reference source not found.**) with the correct Modbus address.

ERROR/EXCEPTION 'Err' - Illuminated when a Valid Command is received as above but a CRC Error (ref **Error! Reference source not found.**) or Exception Condition (ref 4.1.6) is detected.

BUS ACTIVITY 'Bus' - Illuminated whenever changes occur on the receive input pins of the module.

5. Specification

Auxiliary Supply (Retro-Fit Options Module)

Option Module	230vac or 110vac 50/60Hz ±15% Automatic voltage selection when inserted into MultiCube MultiCube MUST be rated to match either selection.
Load	3 VA Maximum
Isolation	2.5 kV (Supply internally wired to meter auxiliary mains inputs)

Modbus Serial Comms

Bus Type	RS422 / RS485 4/2 Wires + 0V. Half Duplex
RX Loading	1/4 Unit Load Per Options Unit
TX Drive	32 Unit Loads
Protocol	Modbus RTU with 16 bit CRC. (JBUS compatible)
Baud Rate	4800, 9600 or 19200 user programmable
Address	User Programmable 1-247
Reply Time	100ms maximum from command end to reply start
Max Data Packet	Any complete Table (Energy, Instantaneous, set-up etc)
Command Rate	New command within 5ms of previous one

Mechanical (Retro-Fit Options Module)

Enclosure	Custom Options Enclosure. Material Mablex UL94-V-0
Options Unit Unfitted	W=87mm x H=59mm x L=75mm
MultiCube + Options	W=96mm x H=96mm x L= 138mm (130mm behind panel)
Weight	Approx. 200g
Terminals	Rising Cage. 0.2 - 4.0mm ² Conductors

General

Operating Temperature	-10 deg C to +65 deg C
Storage Temperature	-25 deg C to +70 deg C
Environment	IP40 (Retro-Fit Options Unit)
Humidity	<75% non-condensing

Northern Design (Electronics) Ltd,
228 Bolton Road, Bradford,
West Yorkshire, BD3 0QW, England.
Telephone: +44 (0) 1274 729533
Fax: +44 (0) 1274 721074
Email: sales@ndmeter.co.uk
Or: support@ndmeter.co.uk
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