DTS Modbus Map
Revision R23D

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1 SCOPE

1.1 IDENTIFICATION

This is a universal document that describes the Modbus RTU and Modbus/TCP Communications register map specification for the Measurlogic family of AC and DC energy sub-meters and transducers. Features are model dependent.

This document applies to models **DTS 305**, **DTS 307**, **DTS 310**, **DTS SMX**, **DTS SKT**, and **DTS DC3**.

ATTENTION

Meter capabilities are model dependant. Some registers may not be applicable to certain meter models, or certain wiring topologies.

1.2 INTRODUCTION

The DTS family of meters is a range of compact DIN-rail, panel, weatherproof or socket mounted energy meters and transducers, with communications and I/O capability. Models are available for single-phase, 3-Phase 2 or 4-Quadrant, and DC measurement applications. Some models are available with optional backlit LCD display.

Depending on the meter model, the remote communications is provided either through:

- **A RS-485 port using the Modbus RTU protocol.** In this case the serial communications parameters of the device must match those of the master. Each Modbus device on the RS-485 bus is identified by a different Modbus address. The serial communication parameters and Modbus address can be changed using DTSConfig.
- **An Ethernet port using the Modbus/TCP protocol.** In this case each device is identified by a different IP address, and since there is only one device per Ethernet interface, and thus only one device per IP address, the Modbus address of the device itself is always 100. *(See Note 2 below).*

Unless specified, the default Modbus address will be 100.

ATTENTION

Embedded Ethernet meters with firmware version V2.81 and later will also respond to Modbus address 101 thru 150, in addition to the standard Modbus address of 100. This is to facilitate host applications (such as AcquiSuite ®) that require all devices to have a unique Modbus address, even though they already have unique IP addresses.

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2 MODBUS INTERFACE SPECIFICATION

2.1 GENERAL INFORMATION

2.1.1 Modbus Registers

The measured values of the AC and DC energy sub-meters and transducers are available in Modbus registers. For convenience, all the DTS registers are arranged in the same space, and since some registers can be written, "Holding Registers" in the 4x Region were chosen for everything.

All the Modbus Registers in the DTS are **signed 32-bit Integer values**, so all require two Modbus 16-bit registers for each value. The DTS register order is **LO-HI**, therefore, the 16-bit Modbus register at the address given in the Modbus map below is the **LO** register, and the next consecutive 16-bit Modbus register is the **HI** register.

Unless stated otherwise, our published Modbus registers addresses are all **1-Based** addresses in the **"Holding Registers"** in the **4x region**, as per the Modbus recommendations. However, some Modbus Master applications require a **0-based** Modbus address (to match the 0-based address in the actual Modbus message), in which case, simply subtract one from the Modbus registers addresses shown in this document. Depending on your Modbus Master application, you may need to prefix the Modbus address with a **'4'**. Note that your Modbus Master application must support **5-digit** register numbers to support addresses > 9999. Here are some examples to illustrate these issues:

Meter Register Name	Modbus Address As Shown In This Document	1-Based Modbus Address With '4' Prefix	0-Based Modbus Address With '4' Prefix
Voltage_LN_1	11001	**4**11001	**4**11000
Current_1	11025	**4**11025	**4**11024
EnergyP_Total	14007	**4**14007	**4**14006

Another source of confusion is that the **"Holding Registers"** is commonly referred to the **"4x Region"** but the **"Function Code"** in the Modbus message is actually **"0x03"** and not **"0x04".** Ensure that your Modbus host application is using the **"0x03" function code** or states that it is addressing the **"Holding Registers"**.

Reading from the **"Input Registers"** in the **"3x Region"** using the **"0x04" function code** will **NOT** always return the same value as the corresponding "Holding Register", because some of these registers are being used for other purposes and floating point measurement values.

The Modbus implementation in the DTS family supports the following function codes

01 (0x01) – Read Coils (0x Region)
02 (0x02) – Read Discrete Inputs (1x Region)
03 (0x03) – Read Holding Registers (4x Region)
04 (0x04) – Read Input Registers (3x Region)
05 (0x05) – Write Single Coil
06 (0x06) – Write Single Register
15 (0x0F) – Write Multiple Coils
16 (0x10) – Write Multiple Registers

2.1.2 Measurement Register Subsets

Depending on the meter model, and also on the way in which the meter is connected and configured, not all of the available channels may be used, and thus not all of the measurement registers described in this document will be applicable. If only one or two channels are connected, then only registers applicable to those channels will contain measurement information. In addition, registers that contain processed information, such as Total or Average, will also contain valid information.

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2.1.3 Power and Energy Register Resolutions and Roll Over

In order to handle the very wide range of possible Power and Energy values due to the flexibility of the DTS Family, it is necessary to vary the Modbus register resolution according to the total power levels being measured. The Modbus register resolutions for the power and the energy registers are the same, therefore a finer resolution provides more significant digits of measured power values, but decreases the total energy accumulation time before the energy registers overflow, and visa versa. The following table shows the ***suggested*** resolutions for various Total Power ranges. These provide 4 or 5 significant digits of power, while still allowing energy to accumulate for over a year before the register overflows:

Total Power			Register Resolution	EnerPowDivider	Energy Roll Over
		< 10 kW	0.1 W	100	99,999.9999 kWh
>= 10 kW	and	< 100 kW	1 W	1,000	999,999.999 kWh
>= 100 kW	and	< 1 MW	10 W	10,000	9,999,999.99 kWh
>= 1 MW	and	< 10 MW	100 W	100,000	99,999,999.9 kWh
>= 10 MW	and	< 100 MW	1 kW	1,000,000	999,999,999 kWh
>= 100 MW	and	< 1 GW	10 kW	10,000,000	9,999,999,990 kWh
>= 1 GW	and	< 10 GW	100 kW	100,000,000	99,999,999,900 kWh

The internal 32-bit energy registers always contain nine significant digits, so will accumulate up to 999,999,999 and then rollover to zero. The rollover point for different energy resolutions is also shown in the table above. ***For example:***

Example Service	Total Power	Register Resolution	EnerPowDivider	Energy Roll Over
Single Phase 3-Wire 120V/240V 200A	48 kW	1 W	1,000	999,999.999 kWh
3-Phase 3/4-Wire 120V/208V 600A	216 kW	10 W	10,000	9,999,999.99 kWh
3-Phase 3-Wire 277V/480V 3000A	2.5 MW	100 W	100,000	99,999,999.9 kWh

The “EnerPowDivider” factor is used to scale the register resolution of the Power and Energy registers values.

The default value of the “EnerPowDivider” is 10,000, which represents a resolution of 10W. The value of “EnerPowDivider” should always be confirmed by reading register 16045 (See Section 2.6.3).

The default “EnerPowDivider” value of 10,000 is suitable for most (208V-480V, 50A to 1600A) sub-metering applications, so will not generally need to be changed. If you have a significantly smaller or larger system, you may need to configure your meter with a different “EnerPowDivider” value. **Please consult Measurlogic Inc for advice in this regard.**

In order to obtain the engineering value of a power or energy, the values read from the power or energy registers MUST be scaled using a simple formula based on the value in the “EnerPowDivider”.

EngineeringValue = ((RegisterValue * EnerPowDivider) / 1000)	**W**
EngineeringValue = ((RegisterValue * EnerPowDivider) / 1000) / 1000	**kW**

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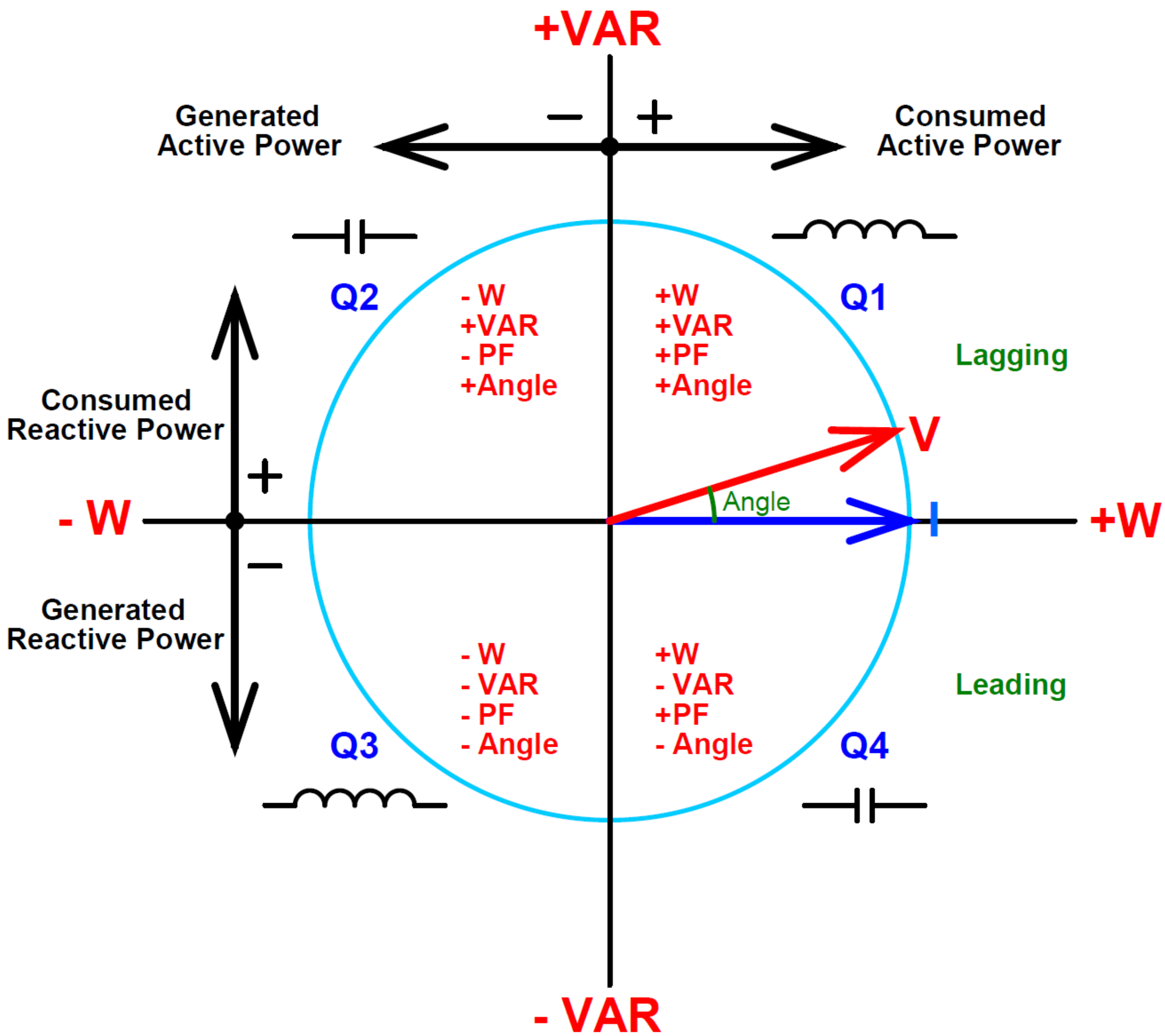
2.1.4 Polar Diagram and Sign of Measurement Values



The above polar diagram illustrates the geometric representation of active and reactive powers, and is based on the *"recommended geometric representation"* in accordance with clauses 12 and 14 of IEC 60375, and Annex C of IEC 62053-23.

- The reference of this diagram is the current vector (I) (fixed on right hand line).
- The voltage vector (V) varies its direction according to the phase angle.
- The phase angle between voltage (V) and current (I) is taken to be positive in the mathematical sense (counter clockwise).

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2.1.5 Measurlogic DTS Power Factor Format

Unfortunately, there is no standard format, that we know of, for representing the Power Factor (PF). You will find a huge variation in the manner in which power and energy meter manufacturers represent the Power Factor. The Power Factor registers in the Register Tables below use the **"Measurlogic DTS Power Factor"** format that has been consistently presented in our meters since the first Measurlogic DTS meter was released.

The value –32,767 represents a PF of -1.000, and +32,767 represents a PF of +1.000, with the other values representing the fraction between these numbers.

A normalized PF value in the range [-1.000 ... 0 ... +1.000] is obtained by dividing the "PowerFactor_DTS_X" register value by 32,767.

NOTES

- The Power Factor registers in the DTS meters are 32-bit registers, even though the value in these registers will never exceed +32,676 or -32,767. Negative Power Factors are sign-extended to the full 32-bits.
- The **DTS PF** value is **POSITIVE** when the meter is measuring **CONSUMED (+) power**.
- The **DTS PF** value is **NEGATIVE** when the meter is measuring **GENERATED (-) power**.
- The **sign of the PF value does NOT indicate leading or lagging** *(see Section 2.1.5.2 below)*. You MUST use the sign of the values in the PowerQ (VAR) registers (or the ACosPF registers) to determine the VAR hemisphere, and thus leading or lagging.

EXAMPLES

DTS PF Register Value	PF Value /32767	W Value Sign	VAR Value Sign	ACosPF Value Degrees	Lagging or Leading	Quadrant
+ 31,128	+ 0.954	[+]	[+]	+ 17.4	Lagging	Q1
+ 31,129	+ 0.954	[+]	[-]	- 17.4	Leading	Q4
- 31,128	- 0.954	[-]	[+]	+ 162.6	Lagging	Q2
- 31,127	- 0.954	[-]	[-]	- 162.6	Leading	Q3

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2.1.5.1 Measurlogic DTS Power Factor Format (Advanced Use)

The DTS Measurlogic Power Factor format is structured in such a way that the full four-quadrant information can be deciphered from it, by examining the Least Significant Bit (LSB) of the PF value, which is the same as the PF value being even or odd.

The Least Significant Bit (LSB) of the **DTS Power Factor Format** register is *intentionally* used in our format to indicate the VAR hemisphere. You can think of the LSB as the "sign bit" for the VARs being measured:

- If the **LSB** of the **PF** value is **"0",** (PF Value is **EVEN**), then the **VARs** are **POSITIVE** **(The Current is LAGGING the Voltage).**
- If the **LSB** of the **PF** value is **"1"**, (PF Value is **ODD**), then the **VARs** are **NEGATIVE** **(The Current is LEADING the Voltage).**

EXAMPLES

DTS PF Register Value	DTS PF Register Even/Odd	PF Value /32767	DTS PF 32-Bit Reg HEX	DTS PF LSB Value	Lagging or Leading	Quadrant
+ 31,12**8**	**Even**	**+** 0.954	0000 799**8**	→ 100**0**	Lagging	Q1
+ 31,12**9**	**Odd**	**+** 0.954	0000 799**9**	→ 100**1**	Leading	Q4
- 31,12**8**	**Even**	**-** 0.954	FFFF 866**8**	→ 100**0**	Lagging	Q2
- 31,12**7**	**Odd**	**-** 0.954	FFFF 866**9**	→ 100**1**	Leading	Q3

2.1.5.2 Power Factor Sign Discussion

Many manufacturers use the sign of the Power Factor to represent leading or lagging. Firstly, there is no standard convention for whether (+) is lagging and (-) is leading, or visa-versa. Secondly, this is mathematically incorrect:

Power Factor is defined ratio of Watts (W) to Volt-Amps (VA). Volt-Amps is the product of Vrms and Irms, and is thus always positive. Therefore, by definition, the sign of Power Factor follows the sign of the Power.

This is not just Measurlogic's interpretation. IEEE 1459-2010 uses this correct definition. Please also see http://powerstandards.com/Shymanski/draft.pdf for an independent discussion (especially sections III, IV and V).

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2.2 AC MEASUREMENT REGISTERS

Please refer to Section 2.1.1 for details about the Modbus regions, function codes, register order and other related conventions used by the DTS meters.

2.2.1 Measurement Values

Description		Units	Resolution	Modbus Address Instantaneous	Minimum	Maximum
Voltage_LN_1		V	0.1	11001	11601	12201
Voltage_LN_2		V	0.1	11003	11603	12203
Voltage_LN_3		V	0.1	11005	11605	12205
Voltage_LN_Average		V	0.1	11007	11607	12207
Voltage_LL_12		V	0.1	11009	11609	12209
Voltage_LL_23		V	0.1	11011	11611	12211
Voltage_LL_31		V	0.1	11013	11613	12213
Voltage_LL_Average		V	0.1	11015	11615	12215
Current_1		A	0.001	11025	11625	12225
Current_2		A	0.001	11027	11627	12227
Current_3		A	0.001	11029	11629	12229
Current_Average		A	0.001	11031	11631	12231
Current_Total		A	0.001	11033	11633	12233
Current_Neutral		A	0.001	11035	11635	12235
Frequency_1		Hz	0.01	11041	11641	12241
Frequency_2		Hz	0.01	11043	11643	12243
Frequency_3		Hz	0.01	11045	11645	12245
Frequency_Average		Hz	0.01	11047	11647	12247
PowerP_1	(Active)	W	See pg 5	11049	11649	12249
PowerP_2		W	See pg 5	11051	11651	12251
PowerP_3		W	See pg 5	11053	11653	12253
PowerP_Total		W	See pg 5	11055	11655	12255
PowerS_1	(Apparent)	VA	See pg 5	11057	11657	12257
PowerS_2		VA	See pg 5	11059	11659	12259
PowerS_3		VA	See pg 5	11061	11661	12261
PowerS_Total		VA	See pg 5	11063	11663	12263
PowerQ_1	(Reactive)	VAR	See pg 5	11065	11665	12265
PowerQ_2		VAR	See pg 5	11067	11667	12267
PowerQ_3		VAR	See pg 5	11069	11669	12269
PowerQ_Total		VAR	See pg 5	11071	11671	12271
DemandP_Total	(Active)	W	See pg 5	11257	11857	12457
DemandS_Total	(Apparent)	W	See pg 5	11259	11859	12459

2.2.2 Measurement Values (Continued)

Description	Units	Resolution	Instantaneous	Modbus Address Minimum	Maximum
PowerFactor_DTS_1	Special	1/32767	11101	11701	12301
PowerFactor_DTS_2	Special	1/32767	11103	11703	12303
PowerFactor_DTS_3	Special	1/32767	11105	11705	12305
PowerFactor_DTS_Overall	Special	1/32767	11107	11707	12307
ACosPF_1	deg	0.1	11125	11725	12325
ACosPF_2	deg	0.1	11127	11727	12327
ACosPF_3	deg	0.1	11129	11729	12329
ACosPF_Overall	deg	0.1	11131	11731	12331
Voltage_Unbalance_LN_1	%	0.01	11141	11741	12341
Voltage_Unbalance_LN_2	%	0.01	11143	11743	12343
Voltage_Unbalance_LN_3	%	0.01	11145	11745	12345
Voltage_Unbalance_LN_Worst	%	0.01	11147	11747	12347
Voltage_Unbalance_LL_12	%	0.01	11149	11749	12349
Voltage_Unbalance_LL_23	%	0.01	11151	11751	12351
Voltage_Unbalance_LL_31	%	0.01	11153	11753	12353
Voltage_Unbalance_LL_Worst	%	0.01	11155	11755	12355
Current_Unbalance_1	%	0.01	11157	11757	12357
Current_Unbalance_2	%	0.01	11159	11759	12359
Current_Unbalance_3	%	0.01	11161	11761	12361
Current_Unbalance_Worst	%	0.01	11163	11763	12363
Current_SingleCycle_1	A	0.001	11225	11825	12425
Current_SingleCycle_2	A	0.001	11227	11827	12427
Current_SingleCycle_3	A	0.001	11229	11829	12429
Current_SingleCycle_Average	A	0.001	11231	11831	12431
Current_SingleCycle_Total	A	0.001	11233	11833	12433

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2.2.3 Measurement Nett Counter Values

These counters contain the **nett** energy values. By convention, imported/consumed energies are positive, and exported/generated energies are negative. Therefore, the values in these counters may be positive or negative.

Description		Units	Resolution	Modbus Address Instantaneous
EnergyP_1	(Active)	Wh	See pg 5	14001
EnergyP_2		Wh	See pg 5	14003
EnergyP_3		Wh	See pg 5	14005
EnergyP_Total		Wh	See pg 5	14007
EnergyS_1	(Apparent)	VAh	See pg 5	14009
EnergyS_2		VAh	See pg 5	14011
EnergyS_3		VAh	See pg 5	14013
EnergyS_Total		VAh	See pg 5	14015
EnergyQ_1	(Reactive)	VARh	See pg 5	14017
EnergyQ_2		VARh	See pg 5	14019
EnergyQ_3		VARh	See pg 5	14021
EnergyQ_Total		VARh	See pg 5	14023

2.2.4 Measurement Split Counter Values (Advanced use only)

These counters contain the energies that have been accumulated in each operational area and are therefore always positive values. There are import/consumed and exported/generated counters for both the active and reactive hemispheres. Similarly, each of the four quadrants each have active and reactive counters.

Description	Units	Resolution	Modbus Address Instantaneous
EnergyP_Total_Imp	Wh	See pg 5	14025
EnergyP_Total_Exp	Wh	See pg 5	14027
EnergyQ_Total_Imp	VARh	See pg 5	14029
EnergyQ_Total_Exp	VARh	See pg 5	14031
EnergyP_Total_Q1	Wh	See pg 5	14033
EnergyQ_Total_Q1	VARh	See pg 5	14035
EnergyP_Total_Q2	Wh	See pg 5	14037
EnergyQ_Total_Q2	VARh	See pg 5	14039
EnergyP_Total_Q3	Wh	See pg 5	14041
EnergyQ_Total_Q3	VARh	See pg 5	14043
EnergyP_Total_Q4	Wh	See pg 5	14045
EnergyQ_Total_Q4	VARh	See pg 5	14047

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2.3 DC MEASUREMENT REGISTERS

2.3.1 Measurement & Counter Values

Please refer to Section 2.1.1 for details about the Modbus regions, function codes, register order and other related conventions used by the DTS meters.

ATTENTION

The Amp_Hr registers are only available for DTS DC meters with firmware version V3.04 and later.

The applicable registers for the legacy single channel DTS DC meters are the XXXX_1 (Channel 1) registers.

2.3.2 Measurement Values

Description	Units	Resolution	Instantaneous	Modbus Address Minimum	Maximum
Voltage_DC_1	V	0.1	11001	11601	12201
Current_DC_1	A	0.001	11025	11625	12225
Current_DC_2	A	0.001	11027	11627	12227
Current_DC_3	A	0.001	11029	11629	12229
Current_DC_Average	A	0.001	11031	11631	12231
Current_DC_Total	A	0.001	11033	11633	12233
Power_DC_1	W	See pg 5	11049	11649	12249
Power_DC_2	W	See pg 5	11051	11651	12251
Power_DC_3	W	See pg 5	11053	11653	12253
Power_DC_Total	W	See pg 5	11055	11655	12255
Demand_DC_Total	W	See pg 5	11257	11857	12457
Current_DC_Unbalance_1	%	0.01	11157	11757	12357
Current_DC_Unbalance_2	%	0.01	11159	11759	12359
Current_DC_Unbalance_3	%	0.01	11161	11761	12361
Current_DC_Unbalance_Worst	%	0.01	11163	11763	12363

2.3.3 Measurement Nett Counter Values

These counters contain the **nett** energy and Ah values. By convention, imported/consumed energy and Ah values are positive, and exported/generated energies are negative. Therefore, the values in these counters may be positive or negative.

Description		Units	Resolution	Modbus Address Instantaneous
Energy_DC_1		Wh	See pg 5	14001
Energy_DC_2		Wh	See pg 5	14003
Energy_DC_3		Wh	See pg 5	14005
Energy_DC_Total		Wh	See pg 5	14007
Amp_Hr_DC_1	(Nett)	Ah	0.001	14017
Amp_Hr_DC_2	(Nett)	Ah	0.001	14019
Amp_Hr_DC_3	(Nett)	Ah	0.001	14021
Amp_Hr_DC_Total	(Nett)	Ah	0.001	14023

2.3.4 Measurement Split Counter Values (Advanced use only)

These counters contain the energy and Ah values that have been accumulated in the imported/consumed and exported/generated operational areas. The values in these registers are always positive.

Description		Units	Resolution	Modbus Address Instantaneous
Energy_DC_Total_Imp		Wh	See pg 5	14025
Energy_DC_Total_Exp		Wh	See pg 5	14027
Amp_Hr_DC_1_Imp	(Consumed)	Ah	0.001	14033
Amp_Hr_DC_1_Exp	(Generated)	Ah	0.001	14035
Amp_Hr_DC_2_Imp	(Consumed)	Ah	0.001	14037
Amp_Hr_DC_2_Exp	(Generated)	Ah	0.001	14039
Amp_Hr_DC_3_Imp	(Consumed)	Ah	0.001	14041
Amp_Hr_DC_3_Exp	(Generated)	Ah	0.001	14043
Amp_Hr_DC_Total_Imp		Ah	0.001	14045
Amp_Hr_DC_Total_Exp		Ah	0.001	14047

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2.4 DEMAND REGISTERS

2.4.1 Demand Registers (Active)

Description	Register Name		Units	Resolution	Modbus Address
Total Active Demand	DemandP_Total	(Active)	W	See pg 5	11257
Maximum Total Active Demand	DemandP_TotMax	(Active)	W	See pg 4	12457
Maximum Demand Timestamp	DemandP_TotTime	(Active)	Sec	1	14057
Demand Sliding Window Period	DemandP_Interval	(Active)	Sec	1	18389
Demand Update Period	DemandP_Update	(Active)	Sec	1	18391

The "DemandP_Tot" value is a **sliding (or windowed) average** of the total active power over a specified time period, called the **Demand Interval** period. The Demand values are updated at a regular period, called the **Demand Update** period. These values default to 15 minutes and 1 minute respectively, so by default, there are 15 sub-intervals in the demand interval period. The following tables give a visual to this concept.

Interval: 5 min
Update: 1 min
■■■■■: Demand Window Position

Dmd Tot		2.0kW							
Time	1	2	3	4	5	6	7	8	9
Active P	1kW	1kW	2kW	1kW	4kW	2kW	2kW	3kW	1kW

Dmd Tot			2.2kW						
Time	1	2	3	4	5	6	7	8	9
Active P	1kW	1kW	2kW	1kW	4kW	2kW	2kW	3kW	1kW

Dmd Tot				2.4kW					
Time	1	2	3	4	5	6	7	8	9
Active P	1kW	1kW	2kW	1kW	4kW	2kW	2kW	3kW	1kW

2.4.2 Demand Registers (Apparent)

Description	Register Name		Units	Resolution	Modbus Address
Total Apparent Demand	DemandS_Total	(Active)	VA	See pg 5	11259
Maximum Tot Apparent Demand	DemandS_TotMax	(Active)	VA	See pg 4	12459
Maximum Demand Timestamp	DemandS_TotTime	(Active)	Sec	1	14059
Demand Sliding Window Period	DemandS_Interval	(Active)	Sec	1	18405
Demand Update Period	DemandS_Update	(Active)	Sec	1	18405

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2.4.3 Configuring The Demand Parameters

The following description applies to both the active and apparent demand parameters. Replace the “X” in the names below with “P” or “S” appropriately.

Note that the “DemandX_Interval” and “DemandX_Update” configuration parameters are specified in seconds, so the default values are 900 and 60 seconds respectively.

The network variable “DemandX_Tot” is the continuous Demand value, “DemandX_TotMax” records the maximum positive demand value, and “DemandX_TotTime” is the time stamp when that maximum occurred.

The “DemandX_Interval” and “DemandX_Update” configuration parameters may be changed by writing a new time period (in seconds) to these configuration parameters. For proper operation, the “DemandX_Interval” must be an integer multiple of the “DemandX_Update”, and this multiple (number of sub-intervals) may not exceed 60. Note that if either of these parameters is changed, the meter must be reset by writing 0xF40055AA (Hex) or 4093662634 (Decimal) to the Command Register 40001. (See section 2.6.5).

When a maximum reset is performed, the “DemandX_TotMax” will be reset to the present “DemandX_Tot” value, and the “DemandX_TotTime” will be reset to the current time.

All the maximum values in the DTS meter can be reset by writing 0xF0020000 (Hex) or 4026662912 (Decimal) to the Command Register 40001. (See section 2.6.5).

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2.5 TIME REGISTERS

ATTENTION
The time registers are available in the DTS range of meters with firmware V2.91 and later.
The **DTS 305**, **DTS 310**, **DTS SMX**, **DTS SKT** and **DTS DC** meters are fitted with a battery backup Real Time Clock (RTC). Real time will be maintained while the meter is powered off if the internal backup battery is good.
The **DTS 307** meter is NOT fitted with a battery backup RTC so will have reduced time functionality. The DTS 307 meter will maintain real time while the meter is powered on only. After a power interruption, the time will be restored to the time shortly before the meter lost power.

The internal format for all *time* registers in the Modbus Holding Registers of the DTS range of meters is the 32-bit UNIX time format, which is the number of seconds since January 1, 1970 00:00:00. This standard time format allows addition and subtraction arithmetic operations to be performed on times. In addition, any of the many available tools and websites can be used to convert to and from the YYYY-MM-DD hh:mm:ss human readable format, such as http://www.epochconverter.com/.

It is recommended that the real time clock in the meter be set to Universal Time Coordinated (UTC) Time, otherwise known as Greenwich Mean Time (GMT), so that the time reference of the meter does not change with different time zones and/or if daylight savings is in effect.

The "UTC_TimeZone" register is provided to store the current Time Zone *offset* from GMT (in seconds). The value in this register can easily be added to the current time in the "UTC_Time" register to get the local time. However, the user must manually adjust the "UTC_TimeZone" value to accommodate any daylight savings changes. See section 2.5.4 for more details and examples.

The "UTC_TimeLastSet" register contains the time that the real time clock was last set. This enables a host computer to easily calculate if it is time to re-synchronize the real time clock of the meter with its own reference time.

An example of a time in 32-bit UNIX format:

Year	**Month**	**Day**	**Hour**	**Minute**	**Seconds**
2016	01	14	21	25	10
UTC Time:	1452806710				

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It does require some processing power to convert between 32-bit UNIX time format and the YYYY-MM-DD hh:mm:ss human readable format. Since this could be problematic for embedded controllers with limited processing resources, a more convenient 32-bit Packed Time (P32) format version (or view) is available in the same register offsets in the Modbus Input Registers.

The individual elements of the date and time are packed into a 32-bit word in such a way that they can easily be extracted using 8-Bit logic and shift operations only. Since arithmetic operations are not valid for P32 times, the Time Zone offset is always applied to the P32 Time registers.

The Packed 32-bit Time Format:

Legend:
Y – Year (2 Digit)
M – Month
D – Day
h – Hour
m – Minute
s – Second

Bits 31..24	Bits 23..16	Bits 15..8	Bits 7..0
YYYY YYMM	MMDD DDDh	hhhh mmmm	mmss ssss
0100 0000	0101 1101	0101 0110	0100 1010

Therefore, the same example in P32 Time format:

Year	Month	Day	Hour	Minute	Seconds
2016	01	14	21	25	10
P32 Time:	1079858762 (decimal) or 0x405D564A (Hex)				

2.5.1 UTC Time Registers

The 32-bit UNIX format UTC Time Registers may be **read** from the **Modbus Holding Registers**. Writing to these registers will have no effect.

Description	Register Name	Units	Resolution	Modbus Address with '4' Prefix
UNIX Format UTC Time	UTC_Time	Sec	1	**4**14079
When time was last set	UTC_TimeLastSet	Sec	1	**4**14077
Max Demand UTC Timestamp	UTC_DemandP_TotTime	Sec	1	**4**14057

2.5.2 Packed 32-bit Time Registers

The Packed 32-bit format P32 Time Registers may be **read** from the **Modbus Input Registers**:

Description	Register Name	Units	Resolution	Modbus Address with '3' Prefix
P32 Format Local Time	P32_Time	Sec	1	**3**14079
When time was last set	P32_TimeLastSet	Sec	1	**3**14077
Max Demand Local Timestamp	P32_DemandP_TotTime	Sec	1	**3**14057

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2.5.3 Setting the Real Time Clock

The Real Time Clock (RTC) in the meter may be set using either the 32-bit UNIX UTC or the Packed 32-bit P32 time formats. The new time value is simply written to the appropriate register as shown in the table below. This automatically sets the "UTC_TimeLastSet" register to the same time.

Note that UTC/GMT time should be written to the "UTC_TimeSet" register, and local time to the "P32_TimeSet" register (the Time Zone offset will be applied). These registers are both **Modbus Holding Registers.**

Description	Register Name	Units	Resolution	Modbus Address with the '4' Prefix
UTC Time Set	UTC_TimeSet	Sec	1	**4**44001
P32 Local Time Set	P32_TimeSet	Sec	1	**4**44003

Note that these two registers will always be zero when they are read.

2.5.4 Setting the Time Zone Register

The Time Zone Register can be **read** or **written** in the **Modbus Holding Registers**:

Description	Register Name	Units	Resolution	Modbus Address with '4' Prefix
Time Zone Offset	UTC_TimeZone	Sec	1	**4**16193

The "UTC_TimeZone" register is the *offset* from GMT of the current time zone. The Time Zone offset is in seconds so that it can simply be added to the present time in the "UTC_Time" register to get the local time.

Regions of the earth in the western hemisphere have negative Time Zone offsets, and regions in the eastern hemisphere have positive Time Zone offsets. If you know Time Zone in hours, multiply this by 3600 to get the offset in seconds. For example: Mountain Standard Time (MST) is GMT-7:00, so the UTC_TimeZone value is -25,200.

Here are the UTC_TimeZone values for the most common time zones in the USA.

	USA Time Zones			
GMT Offset	**PST**	**MST**	**CST**	**EST**
Hours	-8:00	-7:00	-6:00	-5:00
Seconds	-28,800	-25,200	-21,600	-18,000
GMT Offset	**PDT**	**MDT**	**CDT**	**EDT**
Hours	-7:00	-6:00	-5:00	-4:00
Seconds	-25,200	-21,600	-18,000	-14,400

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2.6 OTHER REGISTERS

2.6.1 Special Registers

Description	Units	Resolution	Modbus Address Instantaneous
DTS_SerialNumber		1	10003
DTS_FW_Version		0.0001	10009
DTS_Model_ID		1	10015

2.6.2 CT Rating (Primary) Registers

The "CT_Rating" registers contain the CT Current Rating (Primary) for the CTs use with the meter.

- Normally the CTs that are used with the meter must ALL have the same current rating and must be sized appropriately for the panel rating. Please contact Measurlogic Inc for advice on CT selection for your application.
- The "CT_Rating_1" register is normally used for the CT Current Rating for all the CTs. Only some topologies allow different CT Current Ratings on each channel.
- The "Inverter" topology option allows the CT monitoring the Inverter output to have a different current rating, which is suitably sized for the inverter. See our *"Measurlogic DTS Modbus Addendum (Single Phase Inverter Map)"* document for more application details of the DTS meter in a single phase 3-wire system with an inverter.

Description	Units	DTS Resolution	Modbus Address	
CT_Rating_1	A	0.001	16009	CT Rating for CT 1
CT_Rating_2	A	0.001	16061	CT Rating for CT 2
CT_Rating_3	A	0.001	16063	CT Rating for CT 3 (Inverter)

2.6.3 Current Sensor Register

The "CurrentSensor" register contains information about the user configurable options for the Current Sensor Output variation. Please see the Measurlogic document *"Configuring DTS AC & DC Current Sensors"* for further details.

- This object defines the Current Sensor Type for the CTs on all three phases:
  - Rogowski Coils - Sensitivity in mV per 1000A @ 60Hz (e.g. 140mV = 140,000)
  - Shunts - Sensitivity in mV at Rated Current (e.g. 100mV = 100,000)
  - CTs (333mV/5A) - Must be zero (0).
  - Output Variations - See referenced document for codes.

Description	Units	DTS Resolution	Modbus Address	
CurrentSensor (mV Sensors) **or**	mV	0.001	16073	Current Sensor Sensitivity
CurrentSensor (Sensor Type)	None	1	16073	Current Sensor Type

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2.6.4 Other Configuration Registers (Advanced use only)

The "EnerPowDivider" register and its usage is discussed in detail in this document on Page 5.

Description	Units	DTS Resolution	Modbus Address	
EnerPowDivider		1	16045	See Details on Page 5

2.6.5 Reset Registers (Advanced use only)

The following reset actions are accomplished by writing a specific command code to Command Register.

Action	Register Description	Modbus Address Register	Value (Dec)	Value (Hex)
Reset Energy Counters	Command	40001	4278190079	0xFEFFFFFF
Reset All Minimum Values	Command	40001	4026597376	0xF0010000
Reset All Maximum Values	Command	40001	4026662912	0xF0020000
Reset All Min & Max Values	Command	40001	4026728448	0xF0030000
Reset Meter	Command	40001	4093662634	0xF40055AA

NOTE

The Command Register will be reset to zero when the specified action is completed. Since this occurs very quickly, the Command Register will generally read as zero.

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2.6.6 Remote RS-485 Communications Registers (Advanced use only)

Description	Units	Resolution	Modbus Address Instantaneous	
Rem_Baudrate		1	16119	9600/19200/38400
Parity/DataBits/StopBits/Resv		1	16121	See Below
Rem_Address		1	16123	1-247

We strongly recommend that DTS Config be used to configure the remote RS-485 communications settings of the attached DTS meter. However, if the communications parameters of the meter are changed by writing to these registers, then the communications parameters of the PC (host) must also be changed accordingly.

These settings **only** apply to **RS-485** interface, and thus only to the **Modbus RTU** protocol. These settings **MUST NOT** be changed when using **Modbus/TCP**, or any other available networking protocol. Use the **DTSsetupTCP** utility to change the networking parameters of any Ethernet meters.

WARNING

These settings affect the communications on the main remote RS-485 interface.

Writing incorrect settings to the meter it may render the meter unreachable.

The Bytes describing the Parity, DataBits and StopBits are packed into a 32-bit register as follows:

31-24	23-16	15-8	7-0
Parity	DataBits	StopBits	Attributes

Parity: 0=None, 1=Odd, 2=Even
DataBits: This should always be 8 for Modbus RTU.
StopBits: 1 or 2. The default is 1.
Attributes: Bit-0 – Terminating Resistor.

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2.6.7 Input & Output Status

Description		Modbus Address	Register Value	Coil Value
IO_Channel_1	(AO/DO/DI)	15301	See Below	0 or 1
IO_Channel_2	(AO/DO/DI)	15303	See Below	0 or 1
IO_Channel_3	(AO/DO/DI)	15305	See Below	0 or 1
IO_Channel_4	(AO/DO/DI)	15307	See Below	0 or 1
IO_Channel_5	(AO/DO/DI)	15309	See Below	0 or 1
IO_Channel_6	(AO/DO/DI)	15311	See Below	0 or 1
IO_Channel_A	(DO/DI)	15317	See Below	0 or 1
IO_Channel_B	(DO/DI)	15319	See Below	0 or 1
IO_Channel_C	(DO/DI)	15321	See Below	0 or 1
IO_Channel_D	(DO/DI)	15323	See Below	0 or 1
InputStatus_A	(DI)	15325	See Below	0 or 1
InputStatus_B	(DI)	15327	See Below	0 or 1
InputStatus_C	(DI)	15329	See Below	0 or 1
InputStatus_D	(DI)	15331	See Below	0 or 1
IO_Channel_11	(DO)	15333	See Below	0 or 1
IO_Channel_12	(DO)	15335	See Below	0 or 1
IO_Channel_13	(DO)	15337	See Below	0 or 1
IO_Channel_14	(DO)	15339	See Below	0 or 1
IO_Channel_15	(DO)	15341	See Below	0 or 1
IO_Channel_16	(DO)	15343	See Below	0 or 1
IO_Channel_17	(DO)	15345	See Below	0 or 1
IO_Channel_18	(DO)	15347	See Below	0 or 1

The value of the Registers and Coils depends on the type of I/O fitted:

AO (Analog Output): The Register value represents the value of the analog output normalized to the rated output, and where 1,000,000 represents 1.0x. Coils are not defined here and will always read as zero.

DO (Digital Output) & DI (Digital Input): The Register value is either the debounced status of the line, or the numbers of unprocessed pulses, depending on whether the Digital I/O is being used for status or counting respectively, as configured using DTSConfig. The Coil always reflects the status of the Digital I/O line irrespective of usage.

NOTE

Coils are only available for firmware V2.29 and later.

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2.6.8 Manual Setting of Digital Outputs (Advanced use only)

Normally the digital output mapping is configured using the "Configure | Outputs" screen in DTSConfig. In order to manually set and clear the digital outputs, the mapping for that output must first be set to "None". The values that should be written to a special command register 40001 in order to set and clear the digital outputs are shown in the table. Note that register will be reset to zero when the specified action is completed.

Action	Description	Modbus Address	Set Value	Clear Value
Set or Clear Output A	Command	40001	2282225665	2282225664
Set or Clear Output B	Command	40001	2282291201	2282291200
Set or Clear Output C	Command	40001	2282356737	2282356736
Set or Clear Output D	Command	40001	2282422273	2282422272

2.6.9 General Input Counters

Description	Units	Resolution	Modbus Address Instantaneous
GeneralCounter1		1	14081
GeneralCounter2		1	14083
GeneralCounter3		1	14085
GeneralCounter4		1	14087

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2.6.10 Input and Output Capabilities

The possible number and type of inputs and outputs will vary depending on the DTS model. Furthermore, the exact number and type of inputs and outputs actually fitted to any particular meter is determined by the options specified at the time of ordering.

Channel	DTS-305	DTS-310	DTS-SMX	DTS-SKT	DTS-DC	DTS-107
IO_Channel_1	AO/DO	DO/DI	DO/DI		DO/DI	
IO_Channel_2	AO/DO	DO/DI	DO/Di		DO/DI	DO
IO_Channel_3	AO/DO	DO	DO	DO	DO	
IO_Channel_4	AO/DO					
IO_Channel_5	AO/DO					
IO_Channel_6	AO/DO					
IO_Channel_A	DO					
IO_Channel_B	DO					
IO_Channel_C	DO					
IO_Channel_D/Pulse	DO					
InputStatus_A	DI					
InputStatus_B	DI					
InputStatus_C	DI					
InputStatus_D	DI					
IO_Channel_11			DO			
IO_Channel_12			DO			
IO_Channel_13			DO			
IO_Channel_14			DO			
IO_Channel_15			DO			
IO_Channel_16			DO			
IO_Channel_17			DO			
IO_Channel_18			DO			

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2.7 SUNSPEC ALLIANCE MODBUS SPECIFICATION COMPLIANCE

The DTS range of meters support the SunSpec Alliance Modbus Specification. See www.sunspec.org for more information. The SunSpec Alliance Modbus map has been available in AC Meters from firmware V2.61, and in DC Meters from firmware V2.65. The SunSpec floating-point meter model is available for AC meters for firmware V2.93 and later. Please see our *"Measurlogic DTS Modbus Addendum (SunSpec)"* document for more details on our SunSpec implementation and exact register numbers.

The floating-point model is positioned **after** the integer model, so any applications that uses specific fixed Modbus addresses in the existing integer model will not be affected. Note that the floating-point values are derived from our standard measurement registers in the DTS meter, so will have the exact same resolution as specified in the rest of this document.

The PICS for each of meter model may be requested from Measurlogic Inc.

The base register address for the SunSpec Alliance Modbus Map is at 50001 for all the DTS meters.

2.7.1 AC Meters

The DTS 305, DTS 307, DTS 310, DTS SMX and DTS SKT range of AC meters are SunSpec Alliance compliant.

The DTS AC meters contain the following SunSpec blocks. The layout of each of these blocks is described in the SunSpec Specification documents, or the applicable PICS document.

Block Type	Address	Len	SunSpec Block IDs	SunSpec Version
32-Bit "SunS" Identifier (SID)	50001 - 50002	-	0x53756E53	1.4
Common Block	50003 - 50069	65	1	1.4
Integer Meter Model Block	50070 - 50176	105	201, 202, 203, 204	1.4
Floating Point Meter Model Block	50177 - 50302	124	211, 212, 213, 214	1.4
End Block (Firmware V2.92 and earlier)	50177 - 50178	0	0xFFFF	1.4
End Block (Firmware V2.93 and later)	50303 - 50304	0	0xFFFF	1.4

2.7.2 DC Meters

The DTS DC range of AC meters are SunSpec Alliance compliant.

The DTS DC meters contain the following SunSpec blocks. The layout of each of these blocks is described in the SunSpec Specification documents, or the applicable PICS document.

Block Type	Address	Len	SunSpec Block IDs	SunSpec Version
32-Bit "SunS" Identifier (SID)	50001 - 50002	-	0x53756E53	1.4
Common Block	50003 - 50069	65	1	1.4
Advanced String Combiner Model Block	50070 – 50096	25	404 (N=0)	1.2
End Block	50097 - 50098	0	0xFFFF	1.4

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