DTS Modbus Map
Version 2.7U

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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 101**, **DTS 105**, **DTS 305**, **DTS 310**, **DTS SMX**, **DTS SKT**, and **DTS DC**.

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.

- 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 per IP address, the Modbus address of the device itself is always 100.

Unless specified, **the default Modbus address will be 100**. The communication parameters and Modbus address can be changed using DTSConfig.

NOTE

Capabilities are model dependant, so some registers may not be applicable to certain models.

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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 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 16-bit Modbus register is the **HI** register.

Our published Modbus registers addresses are all **1-based** addresses in the **4x region**, as per the Modbus recommendations. Depending on your Modbus Master application, you may need to prefix the Modbus address with a '4' (e.g. 411001 for Voltage_LN_1). Note that some Modbus Master applications require 0-based Modbus addresses. In this case, simply subtract one from the Modbus registers addresses shown below.

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

- 01 (0x01) – Read Coils
- 02 (0x02) – Read Discrete Inputs
- 03 (0x03) – Read Holding Registers
- 04 (0x04) – Read Input Registers
- 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

An internal divider, called "EnerPowDivider", is used to scale the register resolution of the Power and Energy registers values. The default value of the "EnerPowDivider" in the DTS is 100, which represents a resolution of 0.1W. The value of "EnerPowDivider" can be obtained from register 16045.

When using DTS Config to configure the attached DTS, the "EnerPowDivider", and hence the resolution scaling, is automatically configured according to the ranges in the above table. When manually configuring the DTS by setting the service voltage and current directly from the host application, it will also be necessary to manually setup "EnerPowDivider" according to the ranges in the above table.

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 * 0.001 (W)

This equation produces engineering values in Watts. If kWatts are required, simply divide again by 1000.

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2.2 AC MEASUREMENT REGISTERS

2.2.1 Measurement Values

Description		Units	Resolution	Instantaneous	Modbus Address 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 4	11049	11649	12249
PowerP_2		W	See pg 4	11051	11651	12251
PowerP_3		W	See pg 4	11053	11653	12253
PowerP_Total		W	See pg 4	11055	11655	12255
PowerS_1	(Apparent)	VA	See pg 4	11057	11657	12257
PowerS_2		VA	See pg 4	11059	11659	12259
PowerS_3		VA	See pg 4	11061	11661	12261
PowerS_Total		VA	See pg 4	11063	11663	12263
PowerQ_1	(Reactive)	VAR	See pg 4	11065	11665	12265
PowerQ_2		VAR	See pg 4	11067	11667	12267
PowerQ_3		VAR	See pg 4	11069	11669	12269
PowerQ_Total		VAR	See pg 4	11071	11671	12271
DemandP_Total	(Active)	W	See pg 4	11257	11857	12457
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

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2.2.2 Measurement Values (Continued)

Description	Units	Resolution	Instantaneous	Modbus Address Minimum	Maximum
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 4	14001
EnergyP_2		Wh	See pg 4	14003
EnergyP_3		Wh	See pg 4	14005
EnergyP_Total		Wh	See pg 4	14007
EnergyS_1	(Apparent)	VAh	See pg 4	14009
EnergyS_2		VAh	See pg 4	14011
EnergyS_3		VAh	See pg 4	14013
EnergyS_Total		VAh	See pg 4	14015
EnergyQ_1	(Reactive)	VARh	See pg 4	14017
EnergyQ_2		VARh	See pg 4	14019
EnergyQ_3		VARh	See pg 4	14021
EnergyQ_Total		VARh	See pg 4	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 4	14025
EnergyP_Total_Exp	Wh	See pg 4	14027
EnergyQ_Total_Imp	VARh	See pg 4	14029
EnergyQ_Total_Exp	VARh	See pg 4	14031
EnergyP_Total_Q1	Wh	See pg 4	14033
EnergyQ_Total_Q1	VARh	See pg 4	14035
EnergyP_Total_Q2	Wh	See pg 4	14037
EnergyQ_Total_Q2	VARh	See pg 4	14039
EnergyP_Total_Q3	Wh	See pg 4	14041
EnergyQ_Total_Q3	VARh	See pg 4	14043
EnergyP_Total_Q4	Wh	See pg 4	14045
EnergyQ_Total_Q4	VARh	See pg 4	14047

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2.3 DC MEASUREMENT REGISTERS

2.3.1 Measurement & Counter Values

Description		Units	Resolution	Instantaneous	Modbus Address Minimum	Maximum
Voltage_DC		V	0.1	11001	11601	12201
Current_DC		A	0.001	11025	11625	12225
Power_DC		W	See pg 4	11049	11649	12249
Demand_DC		W	See pg 4	11257	11857	12457
Energy_DC	(Nett)	Wh	See pg 4	14001		
Energy_DC_Imp	(Consumed)	Wh	See pg 4	14025		
Energy_DC_Exp	(Generated)	Wh	See pg 4	14027		

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2.4 OTHER REGISTERS

2.4.1 Special Registers

Description	Units	Resolution	Modbus Address Instantaneous
DTS_SerialNumber		1	10003
DTS_FW_Version		0.0001	10009
DTS_Model_ID		1	10015
VoltagePrimary	V	0.1	16001
VoltageSecondary	V	0.1	16003
CurrentPrimary	A	0.001	16009
CurrentSecondary	A	0.001	16011
EnerPowDivider		1	16045

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

Description	Units	Resolution	Modbus Address Instantaneous	
Rem_Baudrate		1	16119	9600 or 19200
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.

Caution

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	Reserved

Parity: 0=None, 1=Odd, 2=Even
DataBits: This should always be 8 for Modbus RTU.
StopBits: 1 or 2. The default is 1.
Reserved: Not Used – Should always be zero.

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

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2.4.4 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

2.4.5 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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2.4.6 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-101/5
IO_Channel_1	AO/DO	DO/DI	DO/DI	DO	DO/DI	AO
IO_Channel_2	AO/DO	DO/DI	DO/Di		DO/DI	AO
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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2.5 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 PICS for each of meter model may be requested from Measurlogic Inc.

The base register address for the SunSpec Map is at 50001.

2.5.1 AC Meters

The DTS 310, DTS SMX and DTS 305 range of AC meters have been tested and certified by the SunSpec Alliance.

The DTS AC meters contain three SunSpec blocks: The Common Block, the Meter Model Block (201, 202, 203, 204) and the End Block. The layout of each of these blocks is described in the SunSpec Specification documents, or the applicable PICS document.

Block Type	Address	SunSpec Block IDs	SunSpec Version
Common Block	50001 - 50069	1	1.4
Meter Model Block	50070 - 50176	201, 202, 203, 204	1.1
End Block	50177 - 50178	0xFFFF	1.4

2.5.2 DC Meters

The DTS DC range of DC meters has been tested and certified by the SunSpec Alliance.

The DTS DC meters contain three SunSpec blocks: The Common Block, the Advanced String Combiner Model Block (404) and the End Block. The layout of each of these blocks is described in the SunSpec Specification documents, or the applicable PICS document.

Block Type	Address	SunSpec Block IDs	SunSpec Version
Common Block	50001 - 50069	1	1.4
Advanced String Combiner Model Block	50070 – 50096	404 (N=0)	1.2
End Block	50097 - 50098	0xFFFF	1.4

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3 REVISION HISTORY

Version	Date	Description	Authority
1.0		Initial Release	JBS
1.1	10-Apr-2008	Updated registers and added details on Modbus 4X region	JBS
1.2	14-Apr-2008	Added Min and Max registers	JBS
1.3	25-Jun-2008	Added Single Cycle Current registers	JBS
1.4	20-Aug-2008	Added Special Registers and added more explanations	JAS
1.5	28-Aug-2008	Corrected Modbus Baudrate and Address register numbers	JAS
1.6	23-Feb-2009	Added Input and Output Status Registers, and manual Output setting	JAS
1.7	01-Sep-2010	Updated new physical address	JBS
1.8	13-Oct-2010	Generalize for DTS Family of meters. Other small structural changes.	JAS
1.9	14-Jan-2011	Add Enhanced Input Features & GeneralCounter's and Coils	JAS
2.0	21-Jan-2011	Add I/O capability table for different DTS models	JAS
2.1	31-Aug-2011	Restructure document and add Table of Contents	JAS
2.2	02-Sep-2011	Moved Units & Resolution columns to next to Description for clarity	JAS
2.3	20-Sep-2011	Added "Remote RS-485 Communications Registers" section	JAS
2.4	09-Dec-2011	Added Digital Output Channels 11 to 18 & Neutral Current	JAS
2.5	04-May-2012	Added SunSpec Alliance Modbus Specification information	JAS
2.6	27-Aug-2012	Added rollover information for the energies	JAS
2.7	17-Oct-2012	Added SunSpec Model 404 for DTS DC	JAS

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