PSM INSTRUMENTATION LTD

ict 1000 Series
Hydrostatic Level Transmitter

Functionality & Communications Protocol

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1.0 Introduction

The ICT can operate as a Modbus slave via RS485.

For further information on standard Modbus protocol refer to www.modbus.org

The ICT 1000 series manual (reference Man049) will detail specific hardware connections and installation.

The purpose of this manual provides the information required to set up Modbus communication between an ICT and an external device.

PSM also provides a PC utility called iSS to enable the user to configure the operational parameters of the ict. Refer to section 6 of this manual

The iSS utility is available free from our website
http://www.psm-sensors.co.uk

Hardware Platform

ICT 1000 Series with digital mode enabled

ICT Firmware

V2.2 and above

Communications Speed

9600bps, 8 data bits, No Parity, 1 stop bit

Modbus ID

If factory configured the ict will be set to the following default Modbus ID

Serial Number = Modbus ID

The last two digits of the serial number will be the default Modbus ID

If the ict is supplied non-factory configured the default Modbus ID will be 01

2.0 Communications Protocol

The software protocol of this instrument is MODBUS. The MODBUS standard has been adhered to in respect of all message framing, CRC checking, exception handling and in the broad significance of register groupings and Function Numbers; in other words, in all matters of syntax.

However, the semantics of individual messages and the details of the significance and interpretation of particular data values are specific to this ict. implementation.

The Diagnostics Function (Function 8) shall be extended to allow for some special functionality.

MODBUS Protocol

This Section outlines the variant of the MODBUS protocol supported, including all the parameters supported by it and any constraints that exist on their values and applicability.

The key concepts of MODBUS data addressing are the Register Address and Register Group. This can be thought of as an index mechanism into a memory structure arranged as several flat one-dimensional arrays. For ict, the concept of Register Address has been translated into the idea of Parameter Address, and Register Group into Parameter Group.

There are two Parameter Groups.

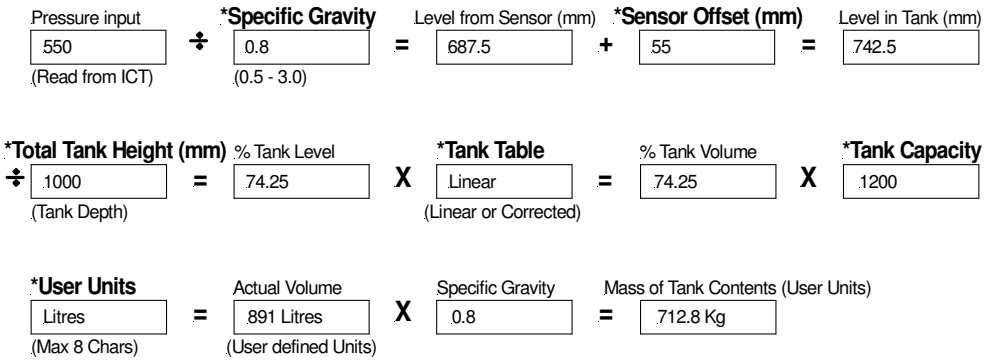
- The Single-bit Group
- The 16-bit Group

All values accessible via the protocol are assigned an index number unique within their Group, which is its Parameter Address. This, or an address range including it, must be supplied in any message requiring access to the relevant Parameter. Some Parameters may occupy more than one address.

3.0 Functionality Overview

This section of the manual details the functionality of the ICT.

Overview of instrument measurement calculations



* **Emboldened** fields are user configurable parameters.

Pressure Input

This is the value the ICT is measuring in mmH2O

Specific Gravity

This field is used to key in the correct specific gravity value of the contents being measured.

Level from Sensor (mm)

This is the value the ICT is measuring in mmH2O with the SG factor applied to provide a true level above sensor

Sensor Offset (mm)

This field is used to enter the fitting height of the instrument from the bottom of the tank. This may be a positive or negative value.

Level in Tank (mm)

This is the value the ICT is measuring in mm, taking account of the position of the instrument in the tank.

Total Tank Height (mm)

This field is used to enter the total height of the tank.

% Tank Level

This is the value the ICT is measuring in percent, taking account of the total tank height.

Tank Table

The 4-20mA output can be linear or corrected for non-linear shaped tanks using the programmable look up table to provide a direct output in volumetric units. This benefit is also available for the analogue 4-20mA output.

% Tank Volume

This is the value the ICT is measuring in percent, taking account of the tank table.

% Tank Capacity

This field is used to enter the total capacity of the tank.

User Units

This field is used to enter the units of measure. Maximum 8 characters.

Actual Volume

This is the volumetric value the ICT is measuring, taking account of the tank capacity.

Mass of Tank Contents

This is the value the ICT is measuring in mass.

Duty Name

This field is used to enter the user defined name of the instrument location. Maximum 32 characters.

3.1 Additional Digital Functionality

Temperature Measurement

The ICT has the capability of measuring the temperature of the medium in which it is immersed and providing the value for reading via Modbus

Alarms

The ICT can provide two different types of Alarm; Rate of Change Alarms and Absolute Alarms. Their operation is described below.

Rate of Change Alarms

Two such Alarms are provided. One uses the Pressure Value as its input, and the other uses the Temperature Value as its input. Both Alarms can be set to trigger if the rate of change exceeds a defined limit within a defined time period. Once one of these Alarms has triggered, its status will be saved into non-volatile memory, so that any intervening power-downs will not remove the alarm condition. The relevant alarm condition may be cleared via the Digital Communications facility only.

Absolute Alarms

Two Absolute Alarms are provided that may be configured. These can be set to operate with respect to either:

- Percentage Tank Volume
- Percentage Tank Level
- Temperature
- Scaled Pressure
- Non-scaled Pressure

Each Alarm may be set to operate as either a Rising or as a Falling Alarm.

Rising Alarms trigger when their Source Value is greater than their Alarm Set-point and Falling Alarms trigger when their Source Value is less than their Alarm Set-point.

Each Alarm is provided with a definable Hysteresis value, which will prevent the Alarm de-activating until the Source Value has crossed a suitable threshold in the safe direction.

In addition, each Alarm is provided with a Debounce Timeout, which prevents the Alarm from triggering until the Alarm's limit has been active continuously for more than a certain number of seconds. This timeout is also applied to the Alarm's deactivation.

Each Alarm is provided with both latching and non-latching status indicators. The latching status will operate in the same way as the Rate of Change Alarms.

i.e. it will need to be explicitly cleared via the Digital Communications facility. The non-latching status may be used as a Control Point.

The Alarm Sources and the Analogue Output Source are independent of each other.

4.0 Analogue Output Functionality

The ICT provides a standard 4-20mA current output, the output value can be modified by any Zero and Span parameter settings, and also subject to the Force Zero and Force Span parameters.

Zero and Span applies when the Analogue Output Source is set to scaled pressure only.

In cases where the Output Source is set to Percentage Level or Volume, the Zero and Range Offset parameters apply.

In the case where the Output Source is set to Actual Pressure, this is scaled according to the maximum and minimum Pressure Calibration Point.

Zero and Span

The Zero point is defined as the Output Value at which the output of the 4-20mA loop is exactly 4.0mA when the Analogue Output Source is set to Scaled Pressure.

The Span point is defined as the number of units above the Zero Point at which the output of the 4-20mA loop is exactly 20.0mA when the Analogue Output Source is set to Scaled Pressure.

These are parameters employed in scaling the 4-20mA analogue input such that it provides a value of 0 to 100% over the required span (normally the tank depth).

The output of the Analogue Output module may be inverted by setting the Invert Output Flag. This has the effect of driving the current output towards the 4mA point as the Output Value increases and driving the current output towards the 20mA point as the Output Value decreases.

The Invert Output Flag is accessible via the Digital Communications facility. The default state of the Invert Output Flag is reset (off), signifying that the output is not inverted.

Percentage Zero and Range Offset

The Percentage Zero Offset is defined as the Output Value at which the output of the 4-20mA loop is exactly 4.0mA when the Analogue Output Source is set to either Percentage Tank Volume or Percentage Tank level.

The Percentage Range Offset is defined as the Output Value at which the output of the 4-20mA loop is exactly 20.0mA when the Analogue Output Source is set to either Percentage Tank Volume or Percentage Tank Depth.

Reserve Error

The mA output can be configured to force a high state (23mA) or a low state (3.8mA) under fault conditions.

Force Zero Band

The Force Zero parameter can be set as a band around the zero output point such that if the actual demanded Output Value falls within the band, the ICT will output exactly 4mA if the Invert Output Flag is not set, or 20mA if the Invert Output Flag is set.

The band is expressed as a percentage of Span. The band is symmetrical about the zero point.

For example, with a non-inverted output, if the Force Zero parameter is set to a value of 3%, then the output current shall be clamped to 4mA whenever the Output Value is within the range of +3% to -3%.

Should the demanded Output Value leave the band in either direction, the current output shall resume its normally scaled operation.

Should a System Error occur that requires that Reserve Error Values be output, they will take precedence over the Force Zero Band operation.

Force Span Band

The Force Span parameter can be set as a band around the maximum output point such that if the actual demanded Output Value falls within the band, the system shall output exactly 20mA if the Invert Output Flag is not set or 4mA if the Invert Output Flag is set.

The band is expressed as a percentage of Span. The band is symmetrical about the maximum point.

For example, with a non-inverted output, if the Force Span parameter is set to a value of 3%, then the output current shall be clamped to 20mA whenever the Output Value is within the range of +97% to -103%.

Should the demanded Output Value leave the band in either direction, the current output will resume its normal operation.

Should a System Error occur that requires that Reserve Error Values be out put, they will take precedence over the Force Span Band operation.

5.0 Functions Supported

The following MODBUS Function Numbers are supported by the ict, and bear the significance assigned to them here.

Function Code (Hex)	MODBUS name	PSM significance
01 / 02	Read Coil/Input Status	Read bit-field value(s). (e.g. System Error log or other Status information)
03 / 04	Read Holding/Input Register	Reads one or more 16-bit value.
05	Force Single Coil	Write bit-field value(s). (e.g. The Invert Output bit)
06	Preset Single Register	Writes one 16-bit value.
08	Diagnostics	Obtains diagnostic information and controls special communications modes, such as Firmware Reprogramming mode.
10	Preset Multiple Registers	Writes one or more 16-bit values.
100	User Definable Function	Used to allow the setting of a unit's Communications Address by identifying the unit using its Unique Serial Number.

Communications Modes

Access to certain parameters is restricted by a Communications Mode discipline.

The default Mode on every power-up is Normal Operation. This grants read access to a large number of parameters, with the exception of those that have little or no bearing on the normal functioning of the unit.

The next level is Set-up Mode, which grants write access to many of the configurable parameters, but does not unlock any parameters not required by normal User Commissioning and Maintenance operations.

If Set-up Mode is entered, and there is no communications activity for a period longer than 5 minutes, the unit shall revert to Normal Operation.

Entry to Set-up Mode is accomplished by accessing special command sub-functions of the Diagnostics Function.

The Diagnostics Function has a special message format that consists of the MODBUS message frame containing a two-byte Sub-function Number, which is always followed by a two-byte Parameter Word.

The Loop Back Query sub-function is used only to establish the presence of a unit on the communications bus.

The other sub-functions control the unit's Communications Modes and carry out Non-volatile RAM read and write operations.

Sub-function Name	No. (hex.)	Notes
Loop-back query	00	Parameter Word must contain 0x0000. Reply will be an exact echo of the query.
Enter Setup Mode	01	Parameter Word must contain 0xA5A5 for entry into Set-up Mode. Any other value causes unit to enter Normal Operation.
Write Non-volatile Functional Block	10	Parameter Word must contain a legal Functional Block Number.
Read Non-volatile Functional Block	11	Parameter Word must contain a legal Functional Block Number.

Parameters Supported

The following parameters are supported. In the case of parameters that may be written as well as read, the table gives their default value, and their maximum and minimum values. In the case of parameters whose numeric value signifies some non-numeric state or selection, the translation is given in the Notes column.

The NVB column gives the number of the Non-volatile Block to which the parameter belongs. Volatile and read only parameters do not belong to any Block. Whenever a change is made to a parameter belonging to a Non-volatile Block, the Write Non-volatile Block Diagnostics Command must be issued with the correct Block Number in order to make sure that the value will be retained over a power-down.

1-bit Parameters

Address	Name	De-fault	Notes	NVB
0	Pressure Rate of Change Alarm	n/a	Set when the Pressure Alarm condition is active. Latching. Non-volatile. Must be cleared by writing to the Clear Pressure Alarm bit.	n/a
1	Tempera-ture Rate of Change Alarm	n/a	Set when the Temperature Alarm condition is active. Latching. Non-volatile. Must be cleared by writing to the Clear Temperature Alarm bit.	n/a
2	Latching Absolute Alarm 1 Active	n/a	Set when the Absolute Alarm 1 condition is active. Latching. Non-volatile. Must be cleared by writing to the Clear Alarm 1 Latch bit.	n/a
3	Latching Absolute Alarm 2 Active	n/a	Set when the Absolute Alarm 2 condition is active. Latching. Non-volatile. Must be cleared by writing to the Clear Alarm 2 Latch bit.	n/a
4	Absolute Alarm / Control 1 Active	n/a	Set when the Absolute Alarm 1 condition is active, clear when it is inactive. Non-latching. Volatile.	n/a
5	Absolute Alarm / Control 2 Active	n/a	Set when the Absolute Alarm 2 condition is active, clear when it is inactive. Non-latching. Volatile.	n/a
6	Pressure Input Fail	n/a	Set when the system reports a Pressure Input failure. Non-latching.	n/a
7	Temp. Input Fail	n/a	Set when the system reports a Temperature Input failure.	n/a
8	Loop Current Fail	n/a	Set when the system reports an internal Loop Current failure.	n/a

Address	Name	Default	Notes	NVB
9	Possible Loop Fault	n/a	Set when the system reports a Loop Current Failure that may not be caused by this unit.	n/a
10	EEPROM Config. Block Fail	n/a	Set when the system reports an EEPROM read or write failure in the Configuration Block	n/a
11	EEPROM Setup Block Fail	n/a	Set when the system reports an EEPROM read or write failure in the Setup Block	n/a
12	EEPROM Identity Block Fail	n/a	Set when the system reports an EEPROM read or write failure in the Identity Block	n/a
13	EEPROM Diag. Block Fail	n/a	Set when the system reports an EEPROM read or write failure in the Diagnostics Block	n/a
14	Forced Zero Active	n/a	Set when the Analogue Output value lies within the Forced Zero Band.	n/a
15	Forced Span Active	n/a	Set when the Analogue Output value lies within the Forced Span Band.	n/a
16	Low Error active	n/a	Set when the Analogue Input is being requested to output an Error Low current value.	n/a
17	High Error active	n/a	Set when the Analogue Input is being requested to output an Error High current value.	n/a
18	Digital Only Active	n/a	Set when Digital Only Mode is active. Cleared if 4-20mA loop in use. Used to distinguish between the use of Digital Mode as a response to an unexpected voltage drop and its use as a configured option	n/a
19	Battery Low	n/a	Set when the Voltage Monitor detects that the supply voltage has dropped to 6V or less.	n/a

Address	Name	De-fault	Notes	NVB
20	Invert Output	0	Set when the Analogue Output range is to be inverted	6
21	User Units Active	0	Set when the Analogue Output and Primary MV show user-defined units.	6
22	Error High on Pressure Alarm	0	When set the Analogue Output is forced to the Error High value when the appropriate error condition is active. Note that the system shall ensure that only one of the Error High or Error Low bits is set for each error condition. The setting requested last shall automatically override the previous setting.	6
23	Error High on Temperature Alarm	0		
24	Error High on Pressure Fail	0		
25	Error High on Temperature Fail	0		
26	Error High on EEPROM Config. Block Fail	0		
27	Error High on EEPROM Setup Block Fail	0		
28	Error High on EEPROM Identity Block Fail	0		
29	Error High on EEPROM Diag. Block Fail	0		

Address	Name	Default	Notes	NVB
30	Error Low on Pressure Alarm	0	When set the Analogue Output is forced to the Error Low value when the appropriate error condition is active. Note that the system shall ensure that only one of the Error High or Error Low bits is set for each error condition. The setting requested last shall automatically override the previous setting.	6
31	Error Low on Temperature Alarm	0		
32	Error Low on Pressure Fail	0		
33	Error Low on Temperature Fail	0		
34	Error Low on EEPROM Config. Block Fail	0		
35	Error Low on EEPROM Setup Block Fail	0		
36	Error Low on EEPROM Identity Block Fail	0		
37	Error Low on EEPROM Diag. Block Fail	0		
38	Absolute Alarm 1 Enable	0	Setting this bit will enable Absolute Alarm 1. Clearing it will disable the Alarm.	6
39	Absolute Alarm 1 Sense	0	Setting this bit will cause Absolute Alarm 1 to activate if the value of the currently selected Alarm Source parameter exceeds the Alarm Set-point. Clearing the bit will cause the Alarm to activate when the Alarm Set-point exceeds the value of the currently selected Alarm Source parameter.	6
40	Absolute Alarm 2 Enable	0	Setting this bit will enable Absolute Alarm 2. Clearing it will disable the Alarm.	6

Address	Name	Default	Notes	NVB
41	Absolute Alarm 2 Sense	0	Setting this bit will cause Absolute Alarm 2 to activate if the value of the currently selected Alarm Source parameter exceeds the Alarm Set-point. Clearing the bit will cause the Alarm to activate when the Alarm Set-point exceeds the value of the currently selected Alarm Source parameter.	6
42	Clear Alarm 1 Latch	0	Writing a zero to this bit shall clear the Latching Absolute Alarm 1 Active bit. 1 is not a legal value.	n/a
43	Clear Alarm 2 Latch	0	Writing a zero to this bit shall clear the Latching Absolute Alarm 2 Active bit. 1 is not a legal value.	n/a
44	Clear Pressure Alarm	0	Writing a zero to this bit shall clear the Pressure Alarm bit. 1 is not a legal value.	n/a
45	Clear Temperature Alarm	0	Writing a zero to this bit shall clear the Temperature Alarm bit. 1 is not a legal value.	n/a
46	Force Analogue Output %	0	Volatile R/W bit – set this to make the Analogue output use the value in the Forced Analogue Output parameter rather than the currently selected output source.	n/a
47	Force PWM Output	0	Volatile R/W bit – set this to make the PWM output use the value in the Forced PWM Output parameter rather than the currently selected output source.	n/a
48	Error High on Absolute Alarm 1	0	When set the Analogue Output is forced to the Error High value when the appropriate alarm condition is active.	
49	Error High on Absolute Alarm 2	0		

Address	Name	Default	Notes	NVB
50	Error Low on Abso-lute Alarm 1	0	When set the Analogue Output is forced to the Error Low value when the appropriate alarm condition is active.	
51	Error Low on Abso-lute Alarm 2	0		

16-bit Parameters

Address	Name	Default	Max.	Min.	Notes	NVB
0	Primary MV HI	n/a	n/a	n/a	High and low words of the Primary Measured Value as indicated by the setting of the Analogue Output Source parameter. The following settings of the Analogue Output Source parameter cause this parameter to show: 0 = %Level, not scaled by %Zero Offset or %Range Offset 1 = %Volume, similarly not scaled 2 = Pressure, scaled by Zero & Span 3 = Actual Pressure, not scaled	n/a
1	Primary MV LO	n/a	n/a	n/a		
2	Secondary MV	n/a	n/a	n/a	Temperature in 0.1 degrees C	n/a
3	Status Word	n/a	n/a	n/a	Copy of the first 16 Status Bits.	n/a

Address	Name	Default	Max	Min.	Notes	NVB
4	Actual Pressure HI	n/a	n/a	n/a	The raw but calibrated Pressure Value. Made available for those circumstances in which the Primary MV is outputting User-defined Units. Used to calculate Volume and Level values.	n/a
5	Actual Pressure LO	n/a	n/a	n/a		
6	User Units chars 1 & 2	n/a	n/a	n/a	The current Engineering Units as defined in Setup Parameters 234 to 237.	n/a
7 – 8	Chars 3 to 6					
9	User Units chars 7 & 8					
10	Number of Decimal Places	n/a	n/a	n/a	Position of the implicit decimal point in the Primary MV parameter's value, as defined in Set-up Parameter 238.	n/a
11	Level from Sensor HI	n/a	n/a	n/a	The level from the Sensor, calculated as (Actual Pressure / Specific Gravity), and expressed in units of 0.1mm. Range is -100,000 to 1,000,000.	
12	Level from Sensor LO	n/a	n/a	n/a		
13	Actual Tank Level	n/a	n/a	n/a	Result of adding the Zero Level Offset parameter to the Level from Sensor parameter, giving a result in units of 1mm between 0 and 50,000	
14	Percentage of Tank Depth HI	n/a	n/a	n/a	This value is calculated as (Actual Tank Level / Tank Depth) to a resolution of 4 decimal places. It can be used as input to the Lookup Table to obtain Percentage of Tank Volume.	
15	Percentage of Tank Depth LO	n/a	n/a	n/a		

Address	Name	Default	Max.	Min.	Notes	NVB
16	Percentage of Tank Volume HI	n/a	n/a	n/a	This value is the result of looking up the Percentage of Tank Volume based on the Percentage of Tank Level. The result is given to a resolution of 4 decimal places.	
17	Percentage of Tank Volume LO	n/a	n/a	n/a		
18	Actual Volume HI	n/a	n/a	n/a	This value is calculated as (Tank Capacity * Percentage of Tank Volume) the units are User Units to a resolution of 0.1.	
19	Actual Volume LO					
20	Tank Contents HI	n/a	n/a	n/a	This parameter gives the current contents of the tank in units that depend upon those used in the Tank Capacity parameter. If the units of Capacity are litres, then this parameter shows kilograms. If the units of Capacity are cubic metres, then this shows tonnes. The value is calculated as (Actual Volume * Specific Gravity). The maximum value of this parameter is 1,500,000,000, in units of 0.001 kilos/ tonnes.	
21	Tank Contents LO	n/a	n/a	n/a		
100	Max. Pressure HI	0	0	0	High and low words of running snapshot of Maximum pressure since last zeroed. May be set to zero in Set-up Mode. Other values not accepted.	11
101	Max. Pressure LO					
102	Max. Temperature	0	n/a	n/a	Maximum temperature of process since last zeroed. May be set to zero in Set-up Mode. Other values not accepted.	11
103	Min. Temperature	1000	n/a	n/a	Minimum temperature since last reset to 1000. May be reset in Set-up mode. Other values not accepted.	11

Address	Name	Default	Max.	Min.	Notes	NVB
104	Zero point HI	0	495,000	-100,000	Pressure at which Primary MV reads 0 and Analogue Output delivers 4mA.	7
105	Zero point LO					
106	Span HI	500,000	500,000 minus Zero value	500	Pressure at which Primary MV reads MAX and Analogue Output delivers 20mA.	7
107	Span LO					
108	Force Zero Band	0	10	0	Expressed as percentage of present range units.	7
109	Force Span Band	0	10	0	Expressed as percentage of present range units.	7
110	Operating Mode	0	2	0	0 = Analogue and Digital 1 = Digital only 2 = Sleep	7
111	Pressure Alarm Period	0	240	0	The time-base used to measure variations in Pressure, expressed in minutes. A value of zero deactivates the Pressure Alarm function.	8
112	Pressure Alarm Detection Limit	-100	100	-100	Variation in Pressure, expressed as a percentage variation of current Span that, if exceeded in the Alarm Period, will cause a Pressure Alarm Condition to activate.	8
113	Temperature Alarm Period	0	240	0	The time-base used to measure variations in Temperature, expressed in minutes. A value of zero deactivates the Temperature Alarm function.	8
114	Temperature Alarm Detection Limit	100	100	-100	Variation in Temperature, expressed as a number of degrees C that, if exceeded in the Alarm Period, will cause a Temperature Alarm Condition to activate.	8
115	Communications Address	1	253	1	Communications Address. If changed the unit will not respond to subsequent messages until the new address is used.	10

Address	Name	Default	Max.	Min.	Notes	NVB
116	Communica-tions Settings	0	2	0	Parity settings: 0 = No Parity 1 = Odd Parity 2 = Even Parity	10
117	Profile Points Used	0	25	0	The number of profile points actually used. If an attempt is made to set this parame-ter to 0 while the Analogue Output Source is set to either Level or Volume, the write will be rejected. If this parameter is set to 0, both Analogue Output Source and Alarm Source parameters will reject val-ues that refer to Volume or Level.	7
118	%Level Lookup Point 1 HI	0	0x00F F	0	User definable Tank Profile Points that operate as the input side of a Lookup Ta-ble that interpolates be-tween Percentage Level and Percentage Volume. The limits for the values in these tables are treated as unsigned 24-bit numbers, in the range 0 to 1,000,000	9
119	%Level Lookup Point 1 LO	0	0xFFF F	0		
120	%Level Lookup Point 2 HI	0	0x00F F	0		
121	%Level Lookup Point 2 LO	0	0xFFF F	0		
122 – 165	%Level Lookup Points 3 to 24 HI and LO	…	…	…		
166	%Level Lookup Point 25 HI	0	0x00F F	0		
167	%Level Lookup Point 25 LO	0	0xFFF F	0		

Address	Name	Default	Max.	Min.	Notes	NVB
168	%Volume Lookup Point 1 HI	0	0x00FF	0	User definable Tank Profile Points that will be applied to the fully processed pressure input in order to produce a Percentage Volume Output when required by the setting of the Analogue Output Source parameter. The limits for the values in these tables are treated as unsigned 24-bit numbers, in the range 0 to 1,000,000	9
169	%Volume Lookup Point 1 LO	0	0xFFFF	0		
170	%Volume Lookup Point 1 HI	0	0x00FF	0		
171	%Volume Lookup Point 1 LO	0	0xFFFF	0		
172 – 167	%Volume Lookup Points 3 to 24 HI and LO	…	…	…		
216	%Volume Lookup Point 25 HI	0	0x00FF	0		
217	%Volume Lookup Point 25 LO	0	0xFFFF	0		
218	Network ID chars 1 & 2	0x20	Printable characters only.			9
219 – 232	Chars 3 to 30	0x20				
233	Network ID chars 31 & 32	0x20				

Address	Name	Default	Max.	Min.	Notes	NVB
234	User Units chars 1 & 2	0x20	Printable characters only.		Engineering Units	7
235 – 236	Chars 3 to 6	0x20				
237	User Units chars 7 & 8	0x20				
238	Number of Decimal Places	1	3	0	Indicates the position of the implicit decimal point in the Primary MV parameter's value.	7
239	Specific Gravity	1,000	3,000	500	Specific Gravity of the contents of the tank being measured. Used to derive the Level from Sensor parameter, as (Actual Pressure / Specific Gravity). Units are 0.001.	7
240	Zero Level Offset HI	0	100,000	-100,000	This value is added to the Level from Sensor parameter to obtain the Actual Tank Level. It is expressed in units of 1mm.	7
241	Zero Level Offset LO					
242	Tank Depth	10,000	50,000	0	This value is used to divide the Actual Tank Level parameter to obtain the Percentage of Tank Depth value. Units are 1mm.	7
243	Tank Capacity HI	100,000	500,000	0	This value is used to obtain the actual volume of the tank contents from the Percentage Volume as delivered by interpolation from the % Volume Lookup Table. Units must be litres or cubic metres only to a 0.1 unit resolution.	7
244	Tank Capacity LO					

Address	Name	Default	Max.	Min.	Notes	NVB
245	Percentage Zero Offset HI	0	1,000,000	0	The value specifies the Percentage Level or Volume at which the Analogue Output will show its minimum normal value (4.0mA). It only affects the Analogue Output, and does not affect any of the numeric output values that are accessed via MODBUS communications.	
246	Percentage Zero Offset LO					
247	Percentage Range Offset HI	1,000,000	1,000,000	0	The value specifies the Percentage Level or Volume at which the Analogue Output will show its maximum normal value (20.0mA). It only affects the Analogue Output, and does not affect any of the numeric output values that are accessed via MODBUS communications.	7
248	Percentage Range Offset LO					
249	User Filter Time Constant	0	1200	0	This parameter controls the action of the User Definable Input Filter. The units are 0.25 second. A value of 0 means that no filtering is performed.	7
250	Analogue Output Source	0	3	0	Specifies the parameter that will drive the 4-20mA Output. Each value signifies a different output source, as follows: 0 = %Volume, scaled by %Zero Offset and % Range Offset 1 = %Level, similarly scaled 2 = Pressure, scaled by Zero and Span 3 = Actual Pressure, not scaled. If the Profile Points Used parameter is set to zero, any attempt to write values 0 or 1 to this parameter will be rejected.	7
251	Absolute Alarm 1 Source	0	4	0	Values from 0 to 4 signify the following possible Alarm Sources: 0 = Volume 1 = Level 2 = Temperature 3 = Scaled Pressure 4 = Non-scaled Pressure If the Profile Points Used parameter is set to zero, any attempt to write values 0 or 1 to this parameter will be rejected.	8

Address	Name	De-fault	Max.	Min.	Notes	NVB
252	Absolute Alarm 1 Setpoint HI	0	1,000,000	-100,000	This parameter's units are the least significant digit of whichever Alarm Source is selected; for example, if Level is the selected Source, then the units are 0.0001%. If Temperature is the source, then units are 0.1 °C.	8
253	Absolute Alarm 1 Setpoint LO					
254	Absolute Alarm 1 Hysteresis HI	1	1,000,000	1	This parameter is expressed in the same units as the Alarm Set-point. Once an Alarm is active, it will not de-activate until it reaches a value that exceeds Set-point plus or minus the value of Alarm Hysteresis, depending on whether the Alarm is a Rise or a Fall Alarm. The value of Hysteresis is always a positive number expressing the difference between the Set-point and the point beyond which the Alarm should deactivate.	8
255	Absolute Alarm 1 Hysteresis LO					
256	Absolute Alarm 2 Source	0	4	0	Values from 0 to 4 signify the following possible Alarm Sources: 0 = Volume 1 = Level 2 = Temperature 3 = Scaled Pressure 4 = Non-scaled Pressure If the Profile Points Used parameter is set to zero, any attempt to write values 0 or 1 to this parameter will be rejected.	8
257	Absolute Alarm 2 Setpoint HI	0	1,000,000	-100,000	This parameter's units are the least significant digit of whichever Alarm Source is selected; for example, if Level is the selected Source, then the units are 0.0001%. If Temperature is the source, then units are 0.1 °C.	8
258	Absolute Alarm 2 Setpoint LO					

Address	Name	De-fault	Max.	Min.	Notes	NVB
259	Absolute Alarm 2 Hysteresis HI	1	1,000,000	1	This parameter is expressed in the same units as the Alarm Set-point. Once an Alarm is active, it will not de-activate until it reaches a value that exceeds Set-point plus or minus the value of Alarm Hysteresis, depending on whether the Alarm is a Rise or a Fall Alarm. The value of Hysteresis is always a positive number expressing the difference between the Set-point and the point beyond which the Alarm should deactivate.	8
260	Absolute Alarm 2 Hysteresis LO					
261	Absolute Alarm 1 Debounce Time	0	300	0	This is a hold-off timer which will prevent Alarm 1 from activating until its limit has been constantly exceeded for the number of seconds in this parameter.	8
262	Absolute Alarm 2 Debounce Time	0	300	0	This is a hold-off timer which will prevent Alarm 2 from activating until its limit has been constantly exceeded for the number of seconds in this parameter.	8
263	Forced Analogue Output %	n/a	1,156	0	Expressed in units of 0.1%. Used to override the normal output percentage value to aid Analogue Output Calibration.	n/a
1000	Serial Number HI	n/a	n/a	n/a	High and low words of unit's serial number. Programmed at manufacture.	10
1001	Serial Number LO	n/a	n/a	n/a		
1002	Customer ID	n/a	n/a	n/a	Programmed at manufacture. Format TBD.	10
1003	Equipment ID	n/a	n/a	n/a	Identifier that is assigned by PSM to this type and model of equipment. Programmed at Man-ufacture.	10
1004	Firmware Version	n/a	n/a	n/a	Version of firmware that is currently programmed into the unit.	10

Address	Name	Default	Max	Min	Notes	NVB
1005	Factory Serial Number HI	n/a	n/a	n/a	High and low words of unit's factory serial number. Programmed at manufacture.	10
1006	Factory Serial Number LO	n/a	n/a	n/a		

Note: Within the standard Modbus communication protocol it is possible to read a block of registers with a single command. Since the ict has been developed for use in hazardous areas where multiple units can be connected on a single data loop it has been developed with a low power CPU to meet the I.S. energy limitations. This means that block read commands should be limited to a maximum of 10 registers per discrete command

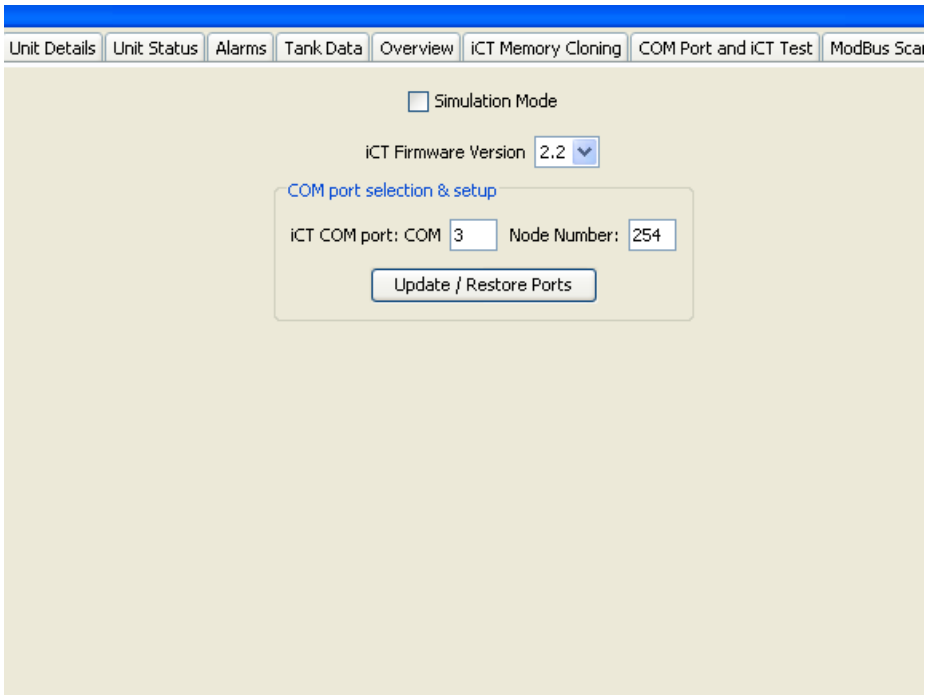
6.0 ISS Configuration Utility

This section of the manual details the functionality of the ISS - Configuration Utility.

The screen shots used in this manual may differ from the software, as the ISS Configuration Utility is constantly being reviewed and enhanced to meet customer requirements.

Communications Settings
Simulation Mode

'Checking' this box enables the use of the utility without a unit connected, thus allowing for configuration files to be generated 'offline'



ict Firmware Version

This should be set to the firmware version of the ict in use (see 'Unit Details' tab).

ict COM Port

This should be set to the number for the COM port used to communicate with the ict

Node Number

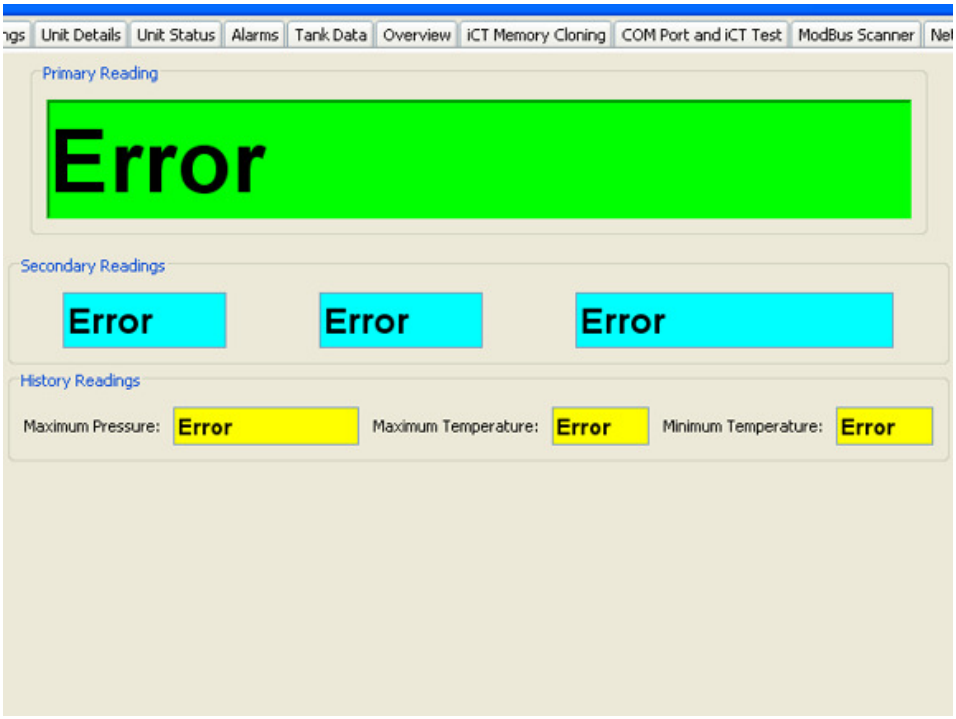
This should be set to the ModBus ID of the unit being communicated with.
Incorrect setting of this value will result in failed communications.
When only one ict is connected to the communications port, address 254 can be used to communicate with any ict regardless of it's configured ModBus ID.

NOTE: Using address 254 will lead to communications conflicts if more than one ict is connected.

Meter Display

Primary Reading

The field reports the current pressure recorded by the ict in units of mmH2O @ 20℃.



Secondary Readings

These three fields report supply line voltage (volts), process temperature (℃ & ℉) and mA Loop Current flow (mA).

History Readings

These fields report the extreme's experienced by the unit within it's operational lifetime.

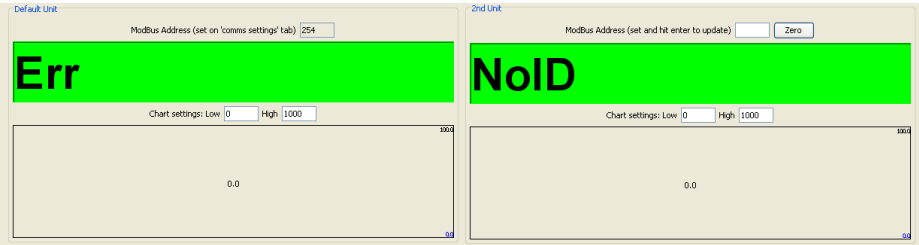
Maximum Pressure

Indicates the maximum pressure experienced by the unit.

Maximum / Minimum Temperature

Indicate the highest and lowest process temperatures experienced by the unit.

Dual Meter Display
Default Unit



The default unit (left side) indicates the current pressure (mmH2O) for the unit with a ModBus ID as configured on the settings tab.

2nd Unit

The 2nd Unit can be configured using 'ModBus Address' (see below) to read the current pressure of a second unit connected to the communications network.

Modbus Address

Sets the ModBus ID of the second unit to be monitored.

Chart Settings

The chart's below each readout indicate the level given chart high / low settings. These can be used to view the stability of level in a tank etc.

Low

Used to define the high-point of the bar chart (in mmH2O).

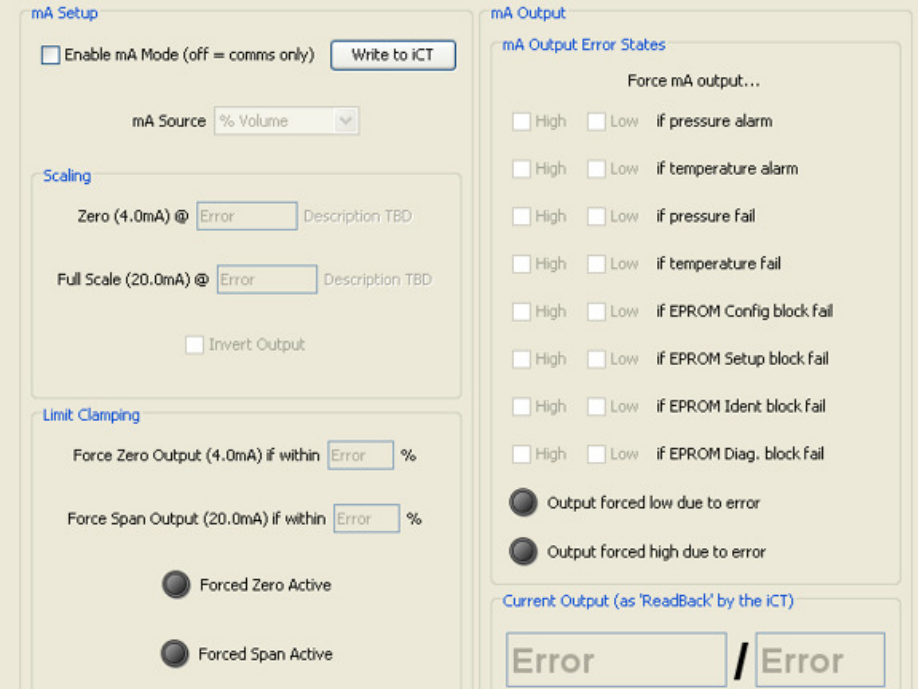
High

Used to define the low-point of the bar chart (in mmH2O).

mA Loop Settings Display

mA Setup

Once ANY settings are changed on this page, the “Write to ict” button must be clicked to update the ict with the changes.



Enable mA Mode

‘Check’ or ‘Uncheck’ this box to enable or disable the 4-20mA loop.
When in the ‘unchecked’ state, none of the other parameters will be available for edit

mA Source

Use this field to indicate where the course for the 4-20mA signal should be originated

This can be configured for %Level, %Volume, Scaled Pressure and Absolute Pressure.

The function of the “Scaling” parameters will change depending on the setting of this parameter (i.e. mASource = %Level / Scaling = % fuction. mASource = ScaledPressure / Scaling = mmH2O).

Scaling

The scaling parameters are used to define the scaling of the 4-20mA signal, i.e. at what level / volume the output will read 4mA and at what level / volume the 4-20mA output will read 20mA.

Zero

This field is used to set the 4mA point.

This parameter can be in units of % or mmH2O depending on the setting of the mA Source parameter. The text beside the field will indicate the units in use.

Full Scale

This field is used to set the 20mA point.

This parameter can be in units of % or mmH2O depending on the setting of the mA Source parameter. The text beside the field will indicate the units in use.

Limit Clamping

The 4-20mA output can be 'clamped' to the limits of 4mA or 20mA when the signal is within a certain percentage of the limit.

Force Zero

This parameter is used to define at what % range level the mA output is clamped to 4mA.

A setting of 0% will result in no 4mA clamping.

Force Span

This parameter is used to define at what % range level the mA output is clamped to 20mA.

A setting of 0% will result in no 20mA clamping.

mA Output Error States

As mentioned earlier in this document, the 4-20mA loop can be used to indicate fault or alarm states.

The checkboxes in this area are used to define when the 4-20mA output is forced into a high / low error state under the conditions indicated.

Current Output

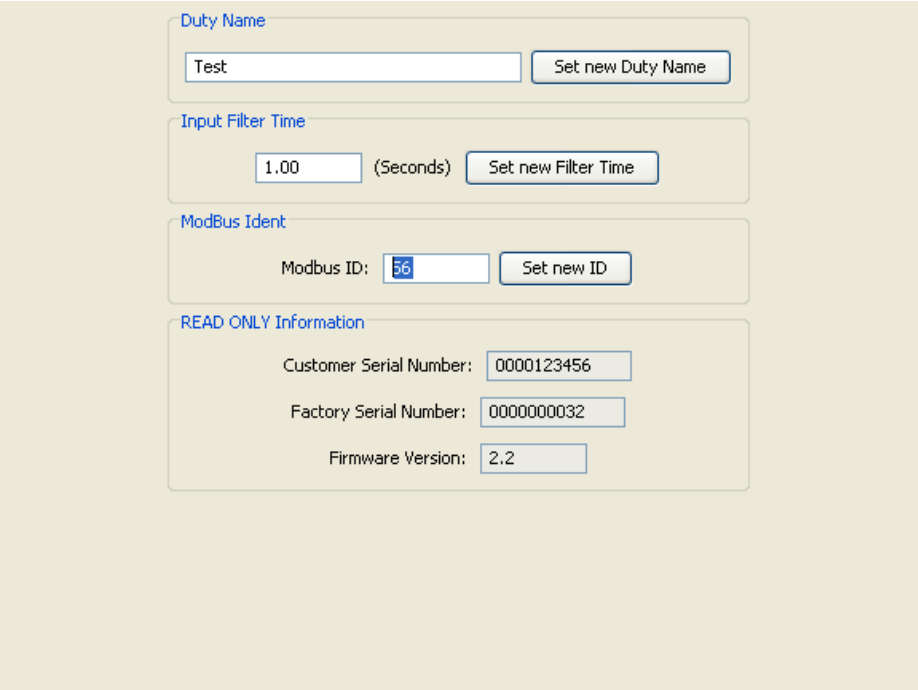
The fields in this section indicate the current 4-20mA output state in mA and %.

NOTE: The current output is provided by the ict, any changes to the settings on this page will not take effect on the current output until they are successfully written to the ict (using the "Write to ict" button).

Unit Details

Duty Name

Indicates the currently configured duty name (up to 32 characters).



If changed, the “Set New Duty Name” button should be clicked to update the ict with the changed information.

Input Filter Time

This indicates the currently configured input filter level (in seconds with 0.25 second resolution)

If this value is changed the “Set new Filter Time” button must be clicked to update the ict.

NOTE: Higher filter time settings will give a more stable signal that is less responsive to change. Lower filter time settings will provide a measurement that is more responsive to change but less stable.

Modbus Ident

Indicates the current Modbus ID and allows the user to change the Modbus Ident.


Bits 0-15
(0) Pressure Rate of Change Alarm
(1) Temperature Rate of Change Alarm
(2) Latching Absolute Alarm 1 Active
(3) Latching Absolute Alarm 2 Active
(4) Absolute Alarm / Control 1 Active
(5) Absolute Alarm / Control 2 Active
(6) Pressure Input Fail
(7) Temp. Input Fail
(8) Loop Current Fail
(9) Possible Loop Fault
(10) EEPROM Config. Block Fail
(11) EEPROM Setup Block Fail
(12) EEPROM Identity Block Fail
(13) EEPROM Diag. Block Fail
(14) Forced Zero Active
(15) Forced Span Active
Bits 16-31
(16) Low Error active
(17) High Error active
(18) Digital Only Active
(19) Battery Low
(20) Invert Output
(21) User Units Active
(22) Error High on Pressure Alarm
(23) Error High on Temperature Alarm
(24) Error High on Pressure Fail
(25) Error High on Temperature Fail
(26) Error High on EEPROM Config. Block Fail
(27) Error High on EEPROM Setup Block Fail
(28) Error High on EEPROM Identity Block Fail
(29) Error High on EEPROM Diag. Block Fail
(30) Error Low on Pressure Alarm
(31) Error Low on Temperature Alarm
Bits 32-47
(32) Error Low on Pressure Fail
(33) Error Low on Temperature Fail
(34) Error Low on EEPROM Config. Block Fail
(35) Error Low on EEPROM Setup Block Fail
(36) Error Low on EEPROM Identity Block Fail
(37) Error Low on EEPROM Diag. Block Fail
(38) Absolute Alarm 1 Enable
(39) Absolute Alarm 1 Sense
(40) Absolute Alarm 2 Enable
(41) Absolute Alarm 2 Sense
(42) Clear Alarm 1 Latch
(43) Clear Alarm 2 Latch
(44) Clear Pressure Alarm
(45) Clear Temperature Alarm
(46) Force Analogue Output %
(47) Force PWM Output

Unit Status

Each indicator shows the current state of the status flag's within the ict

Green = False / Clear
Red = True / Set

Each indicator will flash yellow briefly while the flag is read from the unit.


Refresh ALL Alarm Parameters from iCT
Comms Activity:
Absolute Alarms
Alarm 1
Enabled
Type High
Source % Volume
Setpoint Error Volume (%)
Hysteresis Error Same units as 'Setpoint'
Debounce Error Whole Seconds (0-300)
Current Status
Latched Status Clear
Write Settings to iCT (will also clear latch)
Alarm 2
Enabled
Type High
Source % Volume
Setpoint Error Volume (%)
Hysteresis Error Same units as 'Setpoint'
Debounce Error Whole Seconds (0-300)
Current Status
Latched Status Clear
Write Settings to iCT (will also clear latch)
Deviation Alarms
Pressure Alarm
Enabled (see 'Period' setting)
Period Error Whole Minutes (1-240, 0=Off)
Limit Error Percent of Span
Status Clear
Write Settings to iCT (will also clear status)
Temperature Alarm
Enabled (see 'Period' setting)
Period Error Whole Minutes (1-240, 0=Off)
Limit Error Percent of Span
Status Clear
Write Settings to iCT (will also clear status)

Alarms
Absolute Alarms

Use the settings within these areas to setup the absolute alarms.

For more details regarding the functionality of these alarms please see the relevant section of this document.

The “Current Status” indicator shows green / red depending on the current state. The “Latched Status” indicator shows green / red if the alarm has ever occurred since last cleared.

The “Write Settings to ict” button must be used to write any changes to the ict.

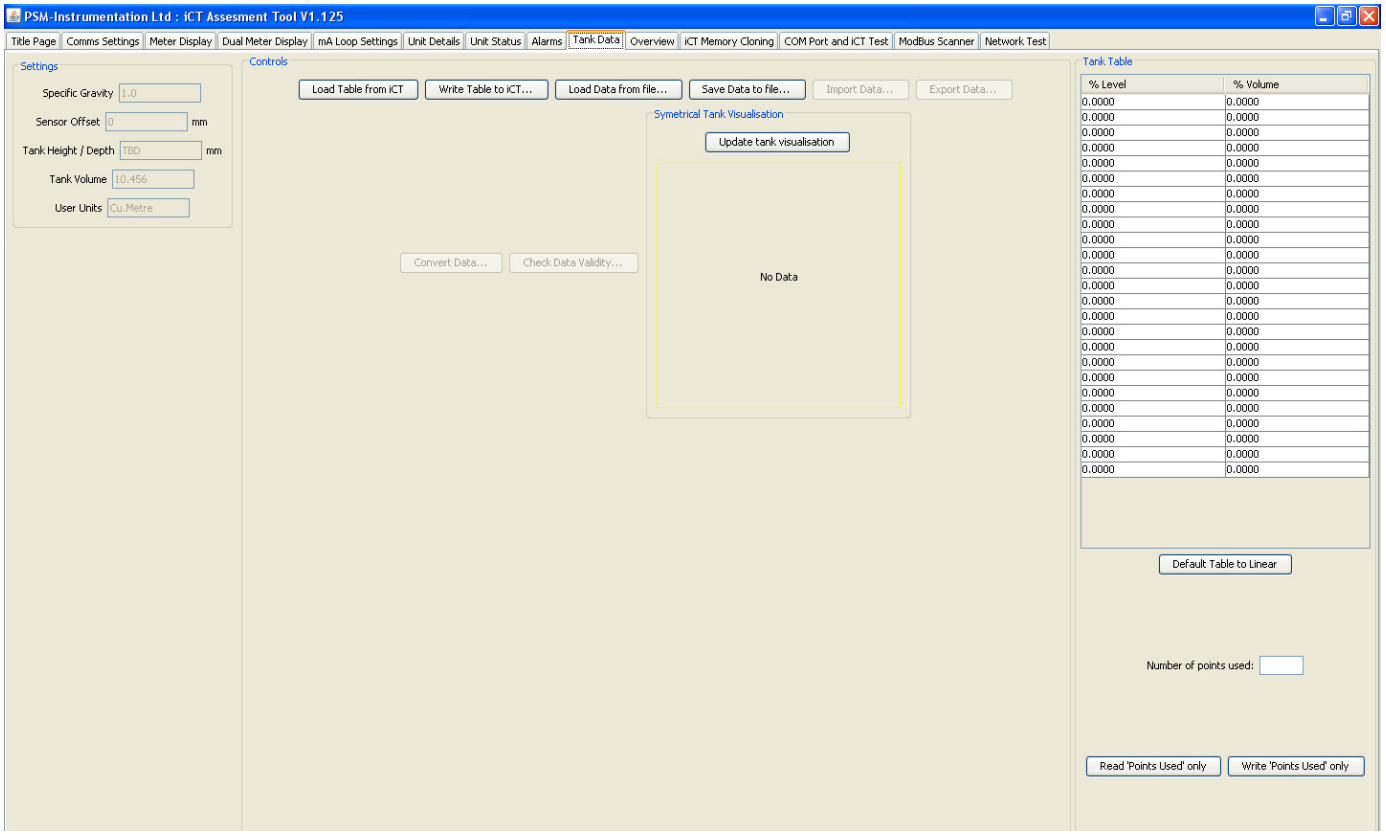
Deviation Alarms

Use the settings within these areas to setup the deviation alarms.

For more details regarding the functionality of these alarms please see the relevant section of this document.

The “Status” indicator shows green / red if the alarm has ever occurred since last cleared.

The “Write Settings to ict” button must be used to write any changes to the ict.


PSM-Instrumentation Ltd : iCT Assesment Tool V1.125
Title Page
Comms Settings
Meter Display
Dual Meter Display
mA Loop Settings
Unit Details
Unit Status
Alarms
Tank Data
Overview
iCT Memory Cloning
COM Port and iCT Test
ModBus Scanner
Network Test
Settings
Specific Gravity
1.0
Sensor Offset
0
mm
Tank Height / Depth
TBD
mm
Tank Volume
10.456
User Units
Cu.Metre
Controls
Load Table from iCT
Write Table to iCT...
Load Data from file...
Save Data to file...
Import Data...
Export Data...
Symetrical Tank Visualisation
Update tank visualisation
Convert Data...
Check Data Validity...
No Data
Tank Table
% Level
% Volume
Default Table to Linear
Number of points used:
Read 'Points Used' only
Write 'Points Used' only

Tank Data

This tab is used to configure the tank-profile.

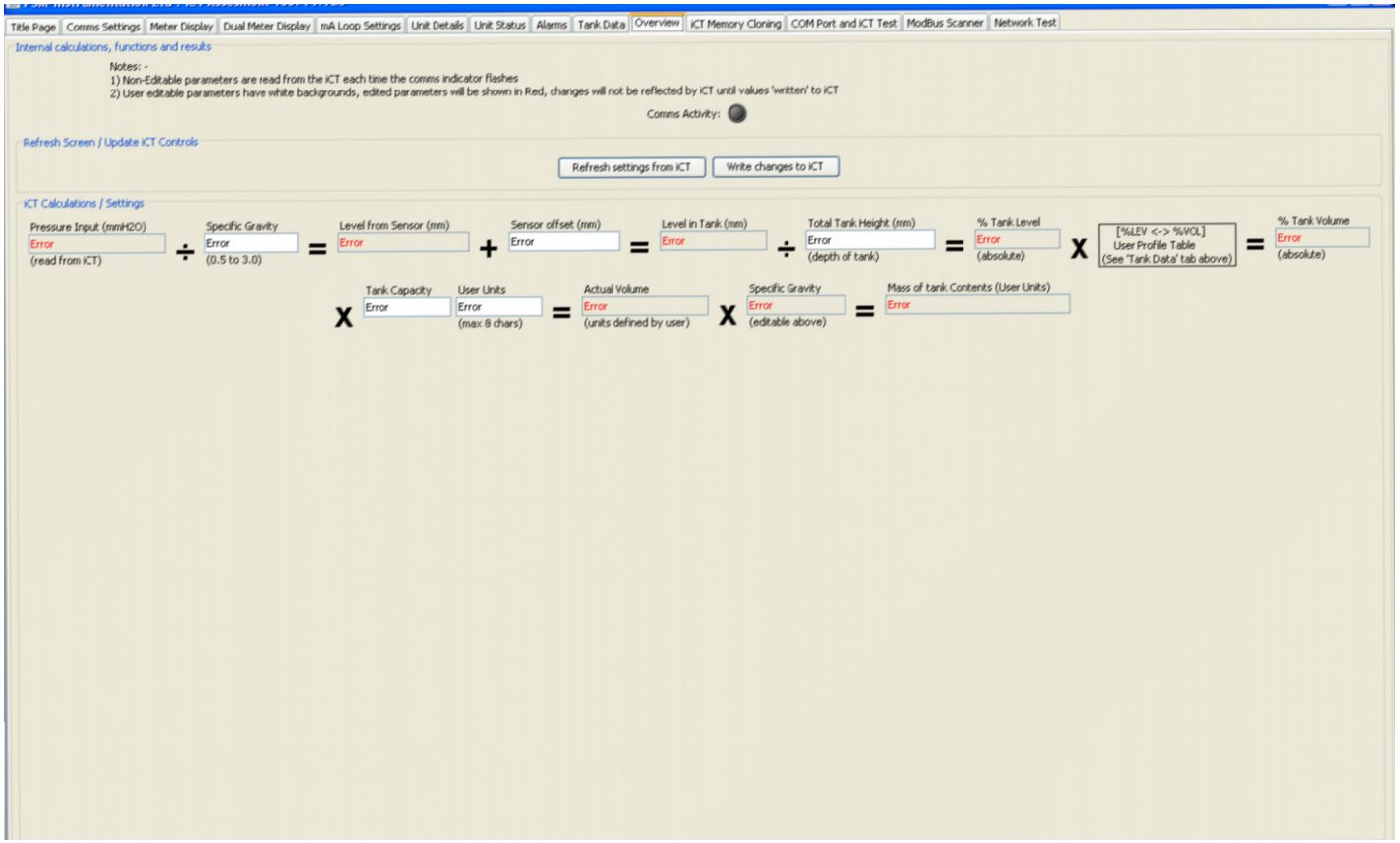
The table is used to enter %Level Vs %Volume values. NOTE: Each column must contain equal or incrementing values, decrementing values are not acceptable.

The “Number of Points Used” field should be set to the number of rows used to define the tank profile.

The buttons on this tab can be used to read the current information from the ict as well as write any changes to it.

There are also buttons for reading / writing the data to / from file.

The “Symmetrical Tank Visualisation” area will display a 2 dimensional, symmetrical representation of the tank as configured in the profile table when the “Update Tank Visualisation” button is pressed. This can be used to check the settings within the profile table for sanity.


Title Page
Comms Settings
Meter Display
Dual Meter Display
mA Loop Settings
Unit Details
Unit Status
Alarms
Tank Data
Overview
iCT Memory Cloning
COM Port and iCT Test
ModBus Scanner
Network Test
Internal calculations, functions and results
Notes: -
1) Non-Editable parameters are read from the iCT each time the comms indicator flashes
2) User editable parameters have white backgrounds, edited parameters will be shown in Red, changes will not be reflected by iCT until values 'written' to iCT
Comms Activity:
Refresh Screen / Update iCT Controls
Refresh settings from iCT
Write changes to iCT
iCT Calculations / Settings
Pressure Input (mmH2O)
Error
(read from iCT)
÷
Specific Gravity
Error
(0.5 to 3.0)
=
Level from Sensor (mm)
Error
+
Sensor offset (mm)
Error
=
Level in Tank (mm)
Error
÷
Total Tank Height (mm)
Error
(depth of tank)
=
% Tank Level
Error
(absolute)
X
[%LEV <-> %VOL]
User Profile Table
(See 'Tank Data' tab above)
=
% Tank Volume
Error
(absolute)
X
Tank Capacity
Error
User Units
Error
(max 8 chars)
=
Actual Volume
Error
(units defined by user)
X
Specific Gravity
Error
(editable above)
=
Mass of tank Contents (User Units)
Error

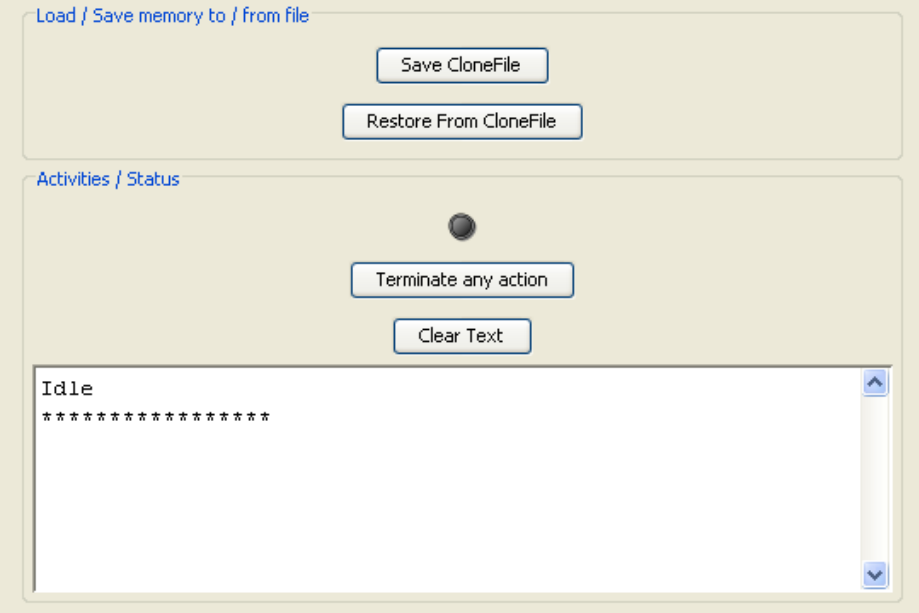
Overview

The overview page shows the chain of calculations being made by the ict, in real time, as well as the results.

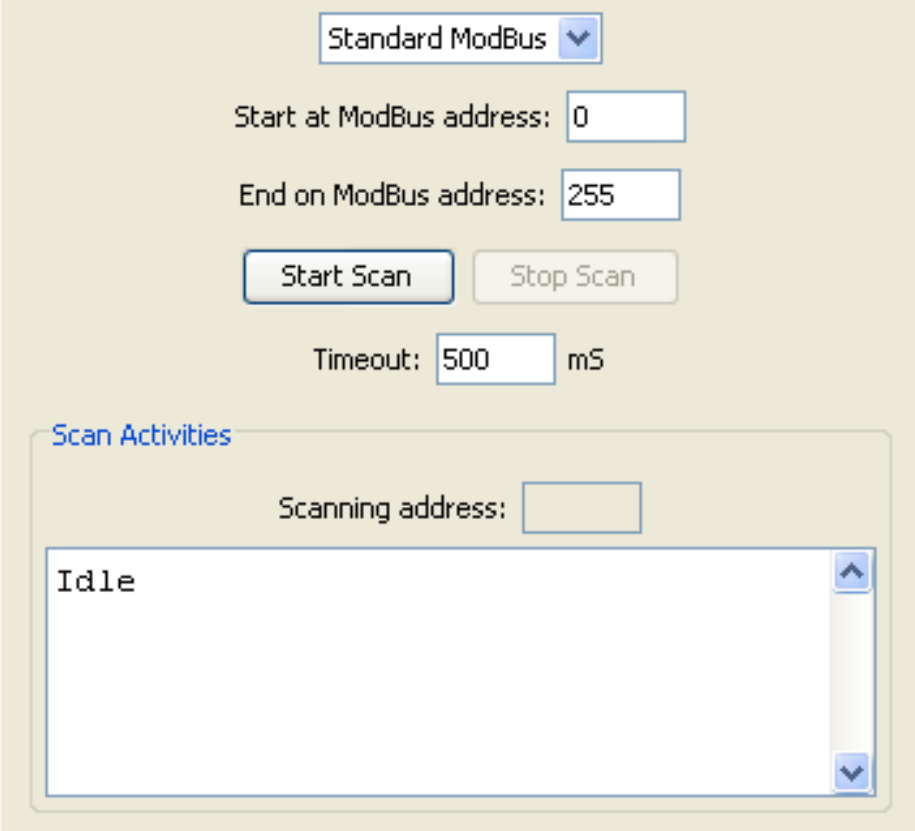
The fields with a white background are editable whereas the fields with grat background are not.

Once a field has been edited the contents will turn red until the changes are written to the ict using the “Write Changes to ict” button, when they will return to black. This is to highlight that a change has been made on screen but as the change has not been updated within the ict, it will not effect any of the calculation results shown.

ict Memory Cloning
This page is used to save full configuration of an ict to file, or set all the settings within an ict to values stored in a file.



Modbus Scanner
This page can be used to detect any ModBus device connected to a network.

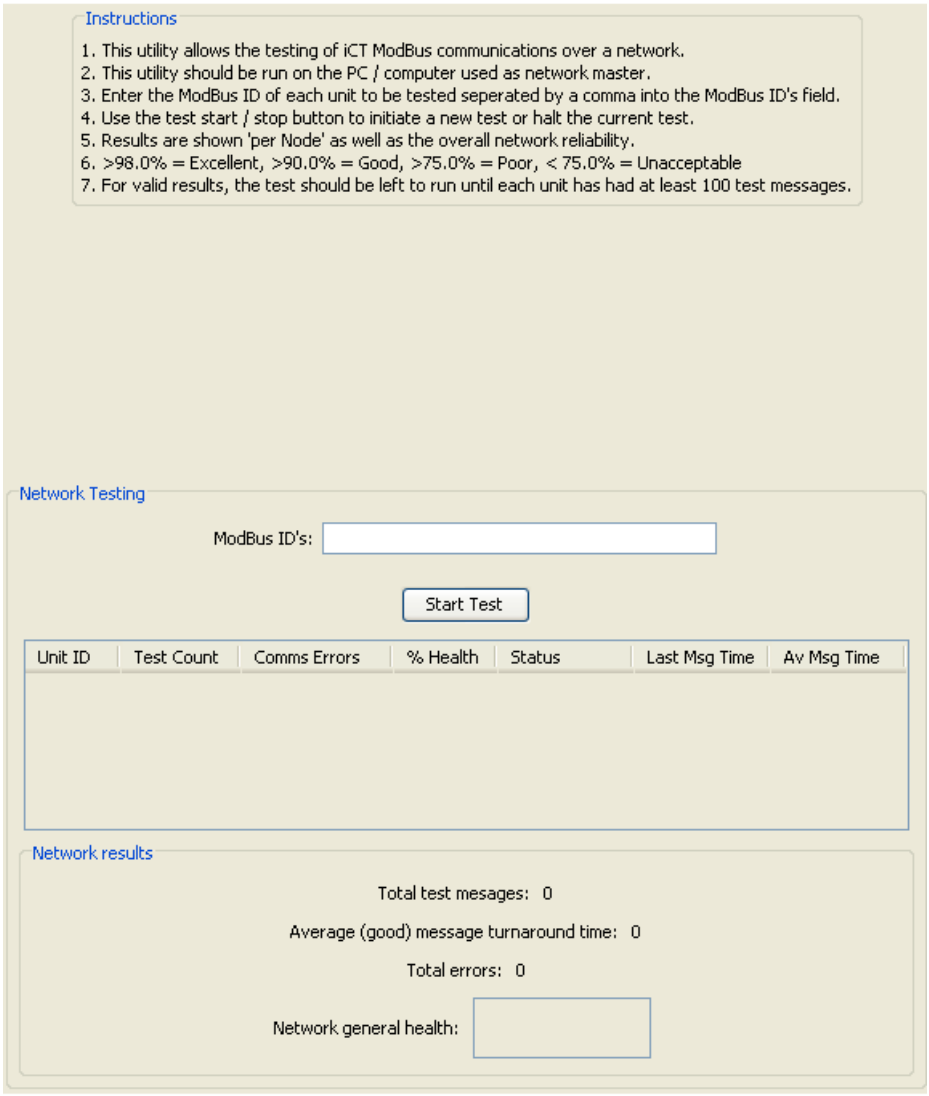


The main white area will report the findings of the scan by showing the ModBus address of any unit detected during the scan.

The Start / End at ModBus address controls the range of ModBus addresses scanned.

WARNING: This scan is not guaranteed to find every unit on a network and should be used as guidance only.

Network Test



Network Test

This page can be used to test the reliability of any ModBus network.

Enter the ModBus address of each unit on the network to be tested into the “ModBus ID’s” field, with each ModBus address separated by a comma.

The test involves reading registers 1-5 for each of the units defined.

Once the ModBus ID’s of the units to be tested have been entered, click the “Start Test” button to initiate the test.

While the test is running the reliability of each unit under test is shown in a table. Additionally the overall network health and number of corrupt / ignored messages are also shown.

Once the test is commenced, the “Start Test” button will change to show “Stop Test”. This button should be used to terminate any testing under way.

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