ORBIT ACS - User Manual

solartron metrology

orbitacs

AMETEK®
ULTRA PRECISION TECHNOLOGIES

1 GENERAL

1.1 DOCUMENTATION CROSS REFERENCE

503083	SI100 Data Sheet	
503085	SI200 Data Sheet	
503094	Orbit® ACS and Digital Probe User Leaflet	Detailing the specific requirements for using the Digital Probe such as mounting details
503113	SI100 & SI200 Quick Keypad Guide	
503116	Orbit ACS Modbus Parameter Map	

1.2 TRADEMARKS AND COPYRIGHTS

1.3 CONTACT INFORMATION

For updated information, troubleshooting guide and to see our full range of products, visit our website:
http://www.solartronmetrology.com

2 TABLE OF CONTENTS

3 INTRODUCTION

This manual specifically caters for the Orbit ACS (Automation and Control System) products, SI100 and SI200.

The Orbit ACS Modbus Interface module (MODIM) is covered in a separate manual.

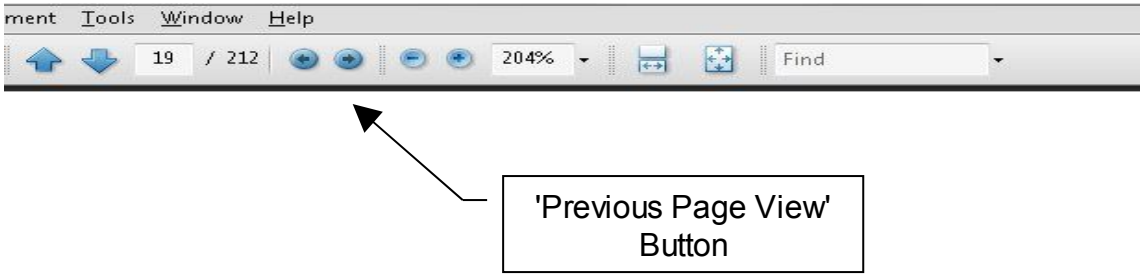
3.1 SCOPE

The Orbit® ACS system provides products specifically designed to create small linear measurement systems with simple PLC interfacing or products which can be stand-alone readouts. Each module contains an integral LCD display and keypad for setting up and visual display of measurements. Basic Input output is provided by discrete lines or a serial interface configured in various ASCII formats or Modbus RTU over RS485 or RS232. For larger measurement systems, Solartron's Orbit Digital Measurement System which is a PC based system may be a more flexible solution.

The Orbit ACS system comprises three main types: the SI100, SI200 and Modbus Interface Module (MODIM). These products are defined in the relevant data sheets.

3.2 NAVIGATE THIS DOCUMENT

This is a large document, to aid electronic navigating the document, the following Navigation tip may be useful:
It is often necessary to jump to another item and then go back to where you jumped from.
This can be done in Adobe Reader by using the 'Previous Page View' button:



Other PDF readers will have a similar 'Previous Page View' option.

4 SAFETY SUMMARY

WARNING statements identify conditions or practices that could result in personal injury or loss of life. **CAUTION** statements identify conditions or practices that could result in damage to the equipment or other property **Symbols in this manual**  Indicates cautionary or other information	**Warnings and Cautions** **Warning:** Do not operate in an explosive atmosphere. **Warning:** this equipment is not intended for safety critical applications **Warning:** do not exceed maximum ratings as specified in this document under individual modules. **Caution: Low Voltage** This equipment operates below the SELV and is therefore outside the scope of the Low Voltage Directive **Service and Repair**  CAUTION: This equipment contains no user serviceable parts. Return to supplier for all service and repair

All of the Products are CE marked and comply with EN61000-6-3 Electrical Emissions and EN61000-6-2 Electrical Immunity and EN61326-1.

5 GLOSSARY OF TERMS AND BASIC SYSTEM INFORMATION

5.1 TERMS ASSOCIATED WITH THE ORBIT ACS HARDWARE

Display

The Liquid Crystal Display on the top of the SI100, SI200 modules providing displayed information

Keypad

The five way keypad on the top of the SI100, SI200 allowing functional and menu navigation

Discrete Inputs

Lines into the SI100, SI200 that allow remote control of certain parameters

Discrete Outputs

Lines out of the SI100.SI200 that can be used to drive external loads. These can be set either as NPN or PNP configuration

Serial Interface

Either ASCII protocols (as defined in this manual) or Modbus RTU or Modbus ASCII. The serial bus can be configured as either RS232 or RS485 signal levels.

Digital Probe
A standard Solartron product that can be connected to the SI200 to form a two channel measurement device.

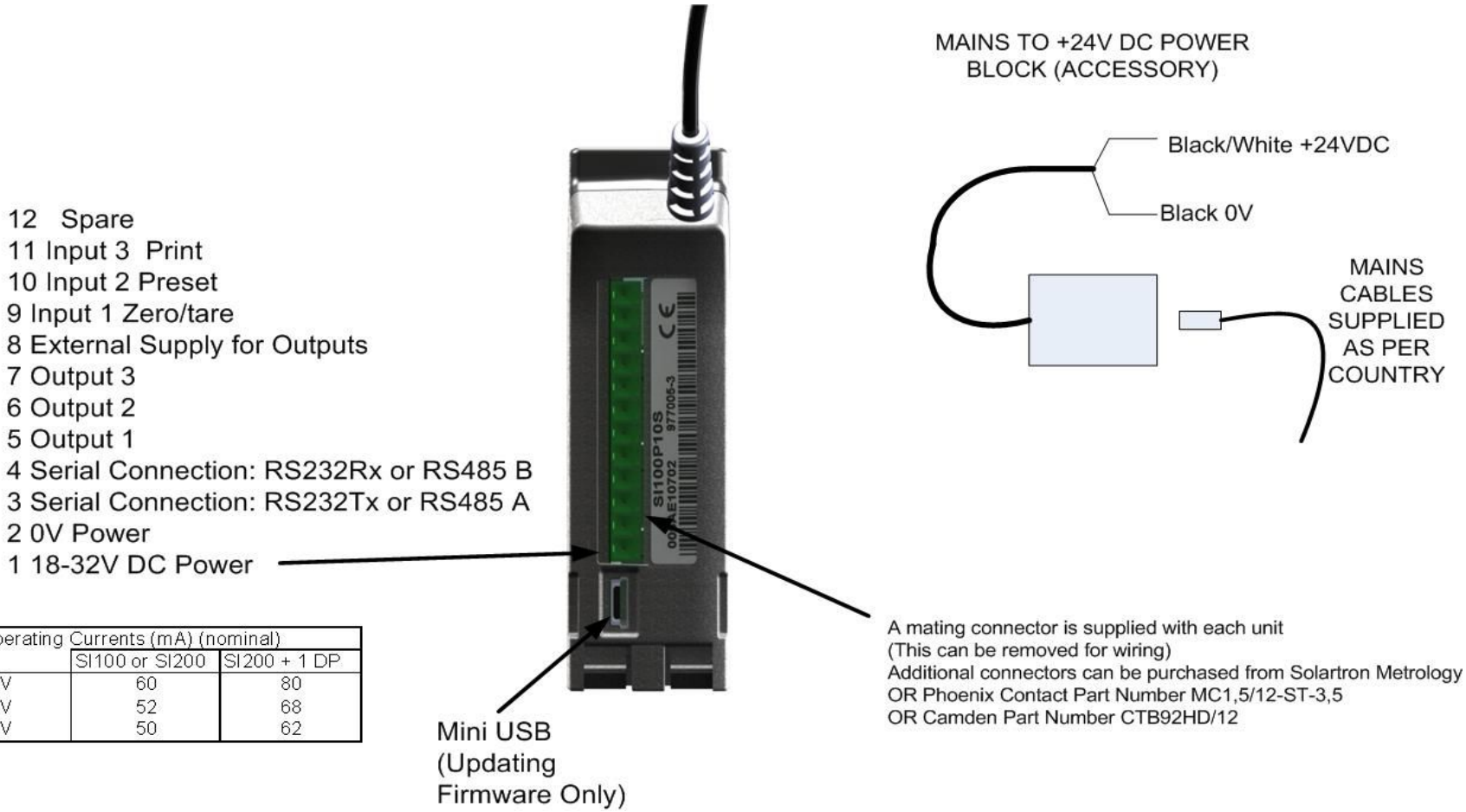
CONNECTION UNIT

SI100: Base Module to allow the unit to be mounted on a DIN rail or screwed down to a mounting plate

SI200: A 3 way connector housed in a case on the base of the SI200, which allows a Digital probe to be connected to form a two channel product

6 ELECTRICAL INSTALLATION

This section describes how to connect the unit



Operating Currents (mA) (nominal)		
	SI100 or SI200	SI200 + 1 DP
18V	60	80
24V	52	68
32V	50	62

NB. For RS232 connection, the 0V connection must be connected to the RS232 GND

DO NOT CONNECT ANY POWER SOURCES TO THE 9 WAY D DYPE OF THE SI200

6.1 GROUNDING, CABLES AND POWER SUPPLIES

It is advisable to provide a good ground point for the SI100 or SI200.

The SI100 is a standalone unit, normally the probe would be connected to ground, there is no specific need to ground the electronics module.

The SI200 can be connected to a Solartron Digital Probe using the nine way connector, if both the SI200 and the Digital Probe are mounted on a DIN rail additional grounding can be performed using the grounding bracket (see diagram)

The digital probe has two indication LEDS. The blue led is on when the SI200 and digital probe are communicating. The red led will flash if there is not enough power reaching it. This may indicate a fault with the SI200.

If the unit is the first or last device in a multi-drop RS485 network, to meet the termination requirements we recommend the fitting of a 120Ω resistor across pins 3 and 4 of the 12 way connector.

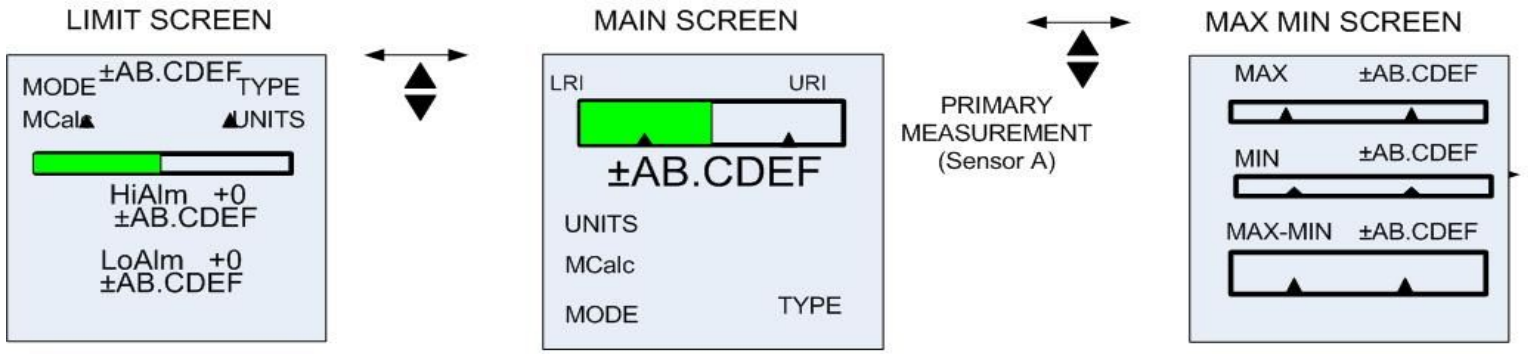
7 MECHANICAL INSTALLATION

The SI100 and SI200 is not a sealed instrument and care should be taken when installing the instrument in environments where contamination can come into contact with the unit.

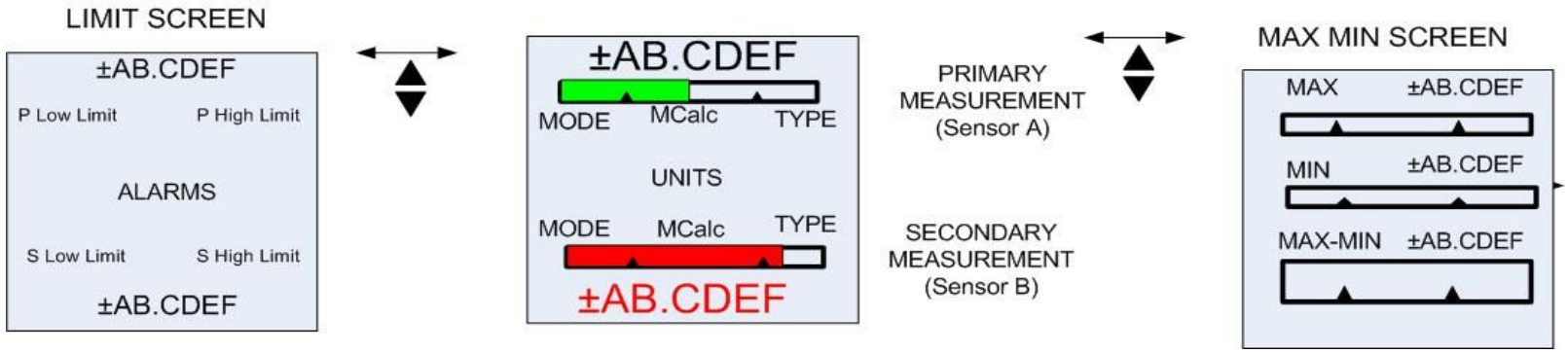
It is advisable to protect the unit and if regular access to the keypad is required use a remote switch connected to the discrete inputs to perform the required user action.

8 FUNCTIONS AND DISPLAYS

8.1 SI100 AND SI200 DISPLAYS

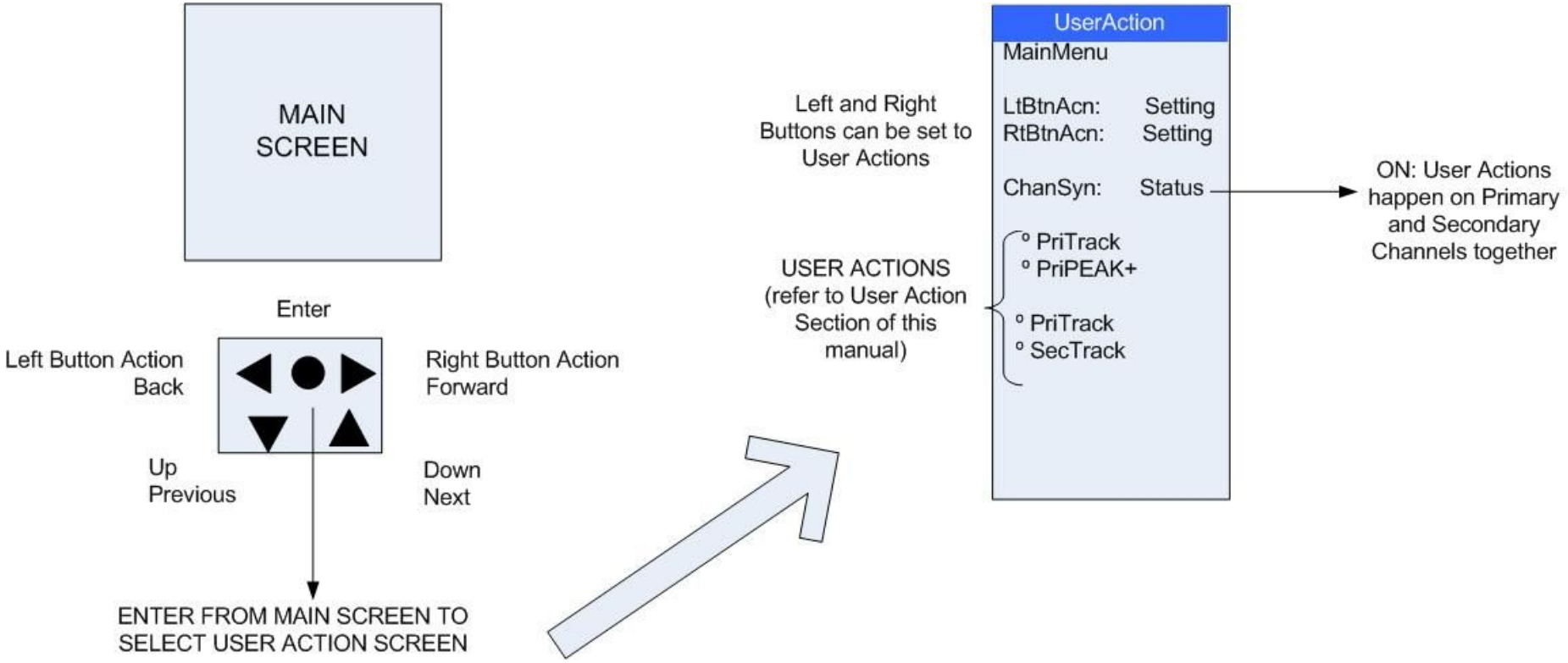


SI100 & SI200	TYPE	MODE	UNITS	Mcalc
	TRACK PEAK+ PEAK-	ABS ZERO PRESET	mm inches mils	A MAXA-MINA
SI200				B, A+B, A-B (A+B)/2, (A-B)/2 MAXB-MINB



8.2 SI100 AND SI200 ACTIONS

The SI100 and SI200 can perform actions either via the keypad or the 4 discrete inputs



The Actions are described in the following table

ACTION	DESCRIPTION	COMMENT	SI100	SI200
PriTrack	Sets the Primary Channel into **TRACK** type measurement	The display follows the probe movement in both directions	☻	☻
PriPeak+	Sets the Primary Channel into **PEAK+** type. measurement	The display shows the most positive value	☻	☻
PriPeak-	Sets the Primary Channel into **PEAK-** type measurement.	The display shows the most negative value	☻	☻
PriPKRST	**RESETS** the Primary Channel to the current probe reading when in PEAK+ or PEAK- type measurement.	The display shows the current probe reading immediately following the PriPKRST action and then operates as either PEAK+ or PEAK- depending on which measurement type is set.	☻	☻
PriABS	Sets the Primary Channel to **ABSOLUTE** Mode directly displays the probe measurement. (no zero or offset)		☻	☻
PriZERO	Sets the Primary Channel to **ZERO** Mode directly displays the probe measurement.	The display and value of the serial output is set to ZERO. All further measurements are with respect to this new zero. (Example: If the measuring range is 0 to 10mm and the absolute reading is 4mm, on PriZERO action the display and value of the serial output will be zero. Then if the probe is moved to it to an absolute position of 6mm the display and serial output will indicate +2mm)	☻	☻
PriPreset	Sets the Primary Channel on SI200 to **PRESET** Mode directly displays the probe measurement.	The display and value of the serial output is set to the **PRESET VALUE** for Primary Channel. All further measurements are with respect to this new value. (Example: If the measuring range is 0 to 10m, the absolute reading is 4mm,and teh Primary Channel Preset is 20 then following a PriPRESET action the display and value of the serial output will be 20mm. Then if the probe is moved to it to an absolute position of 6mm the display and serial output will indicate +22mm)	☻	☻
PAMxRST	If the Primary display is MaxA-MinA resets the Maximum A value to zero		☻	☻
PAMnRST	If the Primary display is MaxA-MinA resets the Minimum A value to 0		☻	☻

PMxMnRST	If the Primary display is MaxA-MinA resets this value to zero or the PRESET value		☻	☻
PRINT	Sends the measurement and other data out via the serial communications link	Note the serial communications must be set to match the receiving device	☻	☻
PBMxRST	If the Primary display is MaxB-MinB resets the Maximum B value to zero		☻	☻
PBMnRST	If the Primary display is MaxB-MinB resets the Minimum A value to 0		☻	☻
PMxMnRST	If the Primary display is MaxB-MinB resets this value to zero or the PRESET value		☻	☻
SecTrack	Sets the Secondary Channel on SI200 into **TRACK** type measurement	The display follows the probe movement in both directions	☻	☻
SecPeak+	Sets the Secondary Channel on SI200 into **PEAK+** type. measurement	The display shows the most positive value	☻	☻
SecPeak-	Sets the Secondary Channel on SI200 into **PEAK-** mode	The display shows the most negative value		☻
SecPKRST	**RESETS** the Secondary Channel to the current probe reading when in PEAK+ or PEAK- type measurement.	The display shows the current probe reading immediately following the PKRST action and then operates as either PEAK+ or PEAK- depending on which measurement type is set.		☻
SecABS	Sets the Secondary Channel on SI200 to **ABSOLUTE** Mode directly displays the probe measurement. (no zero or offset)	See PriABS		☻
SecZERO	Sets the Secondary Channel on SI200 to **ZERO** Mode directly displays the probe measurement.	See PriZERO		☻
SecPreset	Sets the Secondary Channel on SI200 to **PRESET** Mode directly displays the probe measurement.	See PriPRESET (note the Primary and Secondary Preset values can be different		☻
SAMxRST	If the Secondary display is MaxA-MinA resets the Maximum A value to zero			☻
SAMnRST	If the Secondary display is MaxA-MinA resets the Minimum A value to 0			☻

SMxMnRST	If the Secondary display is MaxA-MinA resets this value to zero or the PRESET value			☻
SBMxRST	If the Secondary display is MaxB-MinB resets the Maximum B value to zero			☻
SBMnRST	If the Secondary display is MaxB-MinB resets the Minimum A value to 0			☻
SMxMnRST	If the Secondary display is MaxB-MinB resets this value to zero or the PRESET value			☻

8.3 MENU SCREENS

The MENU Screens are used to set up the SI100 and SI200 operating modes.

Some of the menu screens require numbers to be entered.
Use the ◄ and ► to move to the digit required to be adjusted and use ▲ to increment and ▼ to decremented.
The number will be increased or decreased by the magnitude of the digit selected, see below

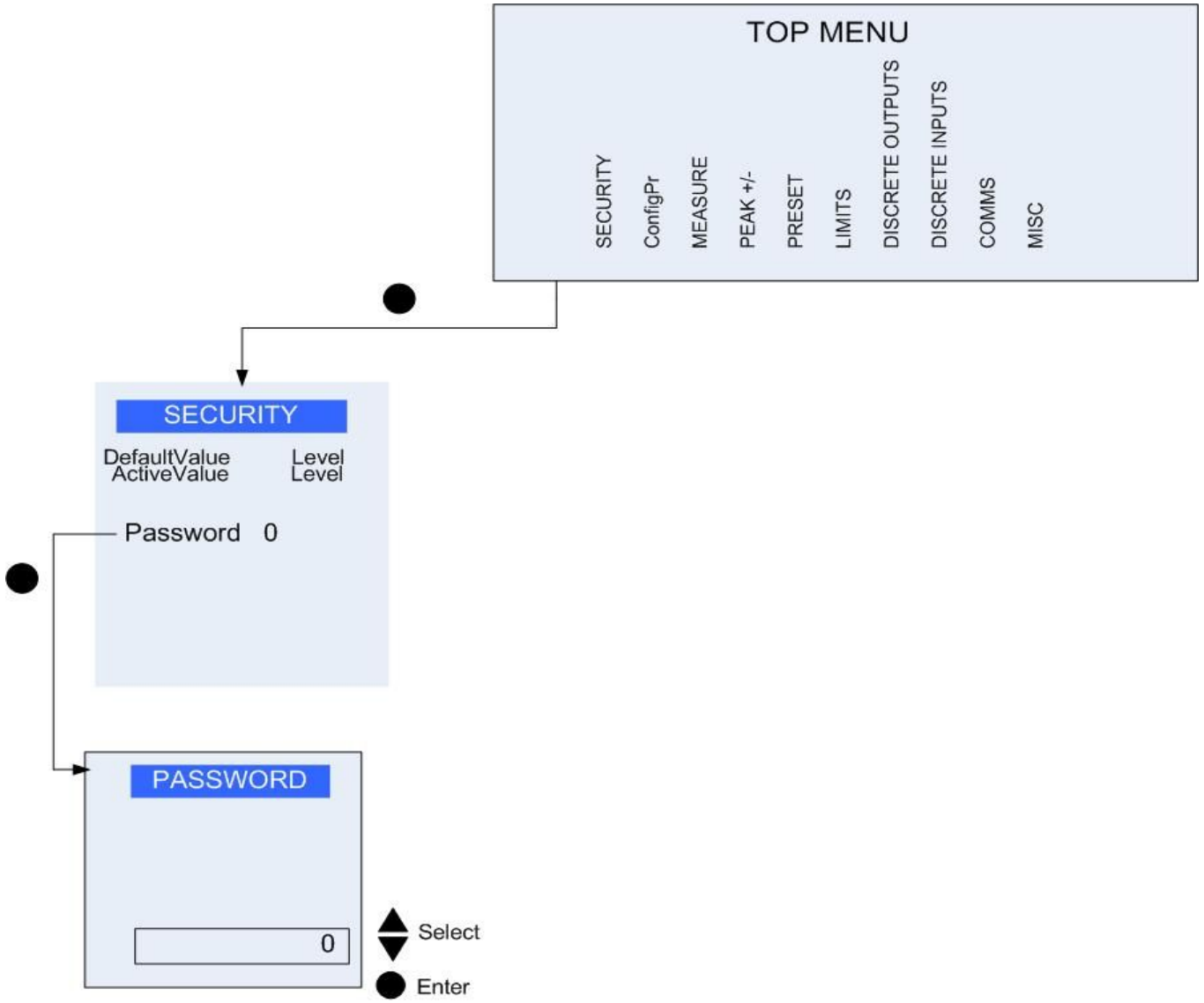
		1000	100	10	1		1/10	1/100	1/1000	1/10000	1/100000	1/1000000
Min	+/-	1000	100	10	1		0.1	0.01	0.001	0.0001	0.00001	0.000001
Max	+/-	9999	999	90	9		0.9	0.09	0.009	0.0009	0.00009	0.000009

Examples

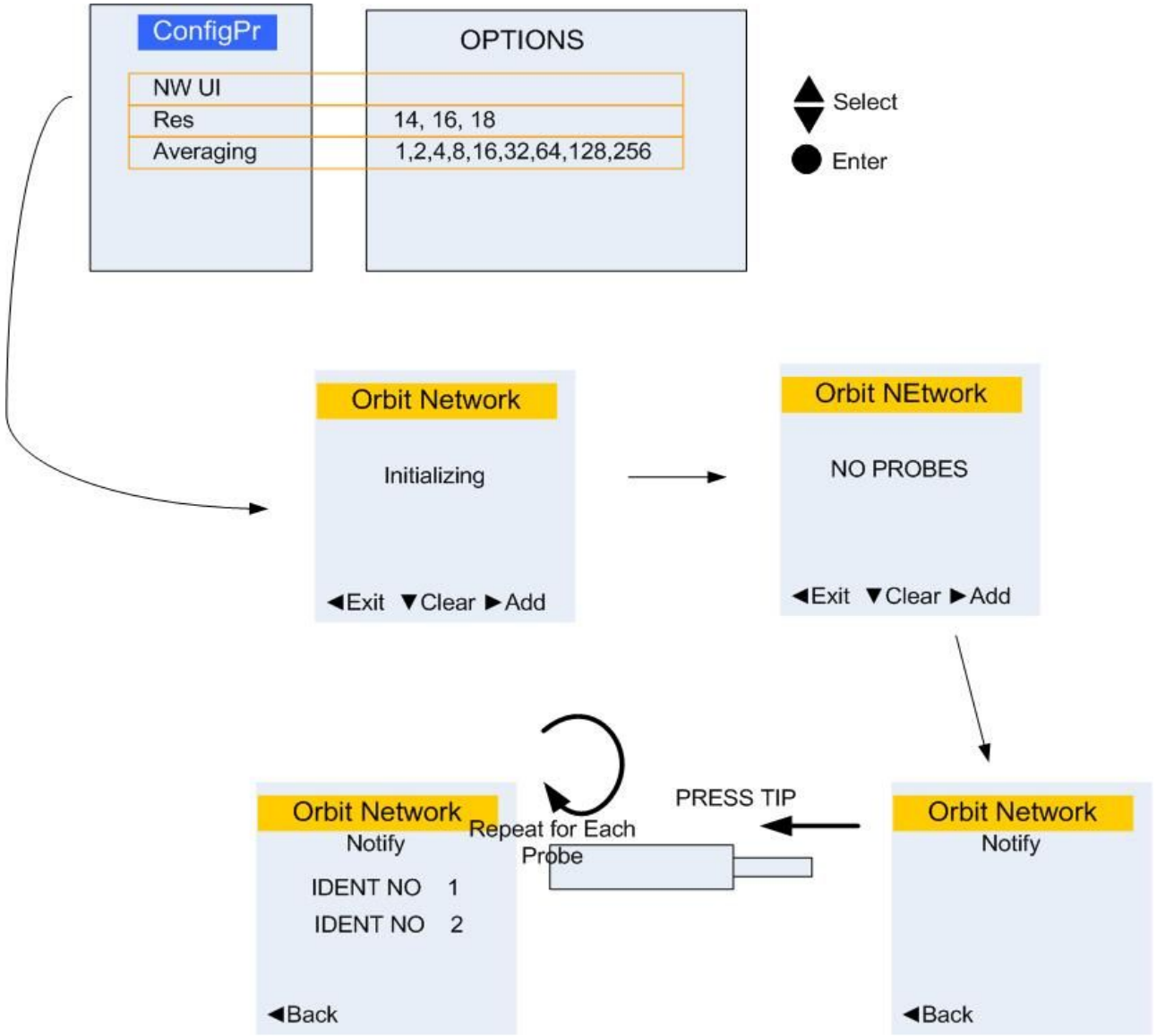
+		2	●	1	2	3	4							
	▼													
+		1	●	1	2	3	4				2.1234	-	1	= 1.1234
	▼													
+		0	●	1	2	3	4				1.1234	-	1	= 0.1234
	▼													
-		0	●	8	7	6	6				0.1234	-	1	= -0.8766
▲														
+		9	●	1	2	3	4				-0.877	+	10	= 9.1234
				▼										
+		9	●	0	2	3	4				9.1234	-	0.1	= 9.0234
				▼										
+		8	●	9	2	3	4				9.0234	-	0.1	= 8.9234

TIP: Set the most significant digits first.

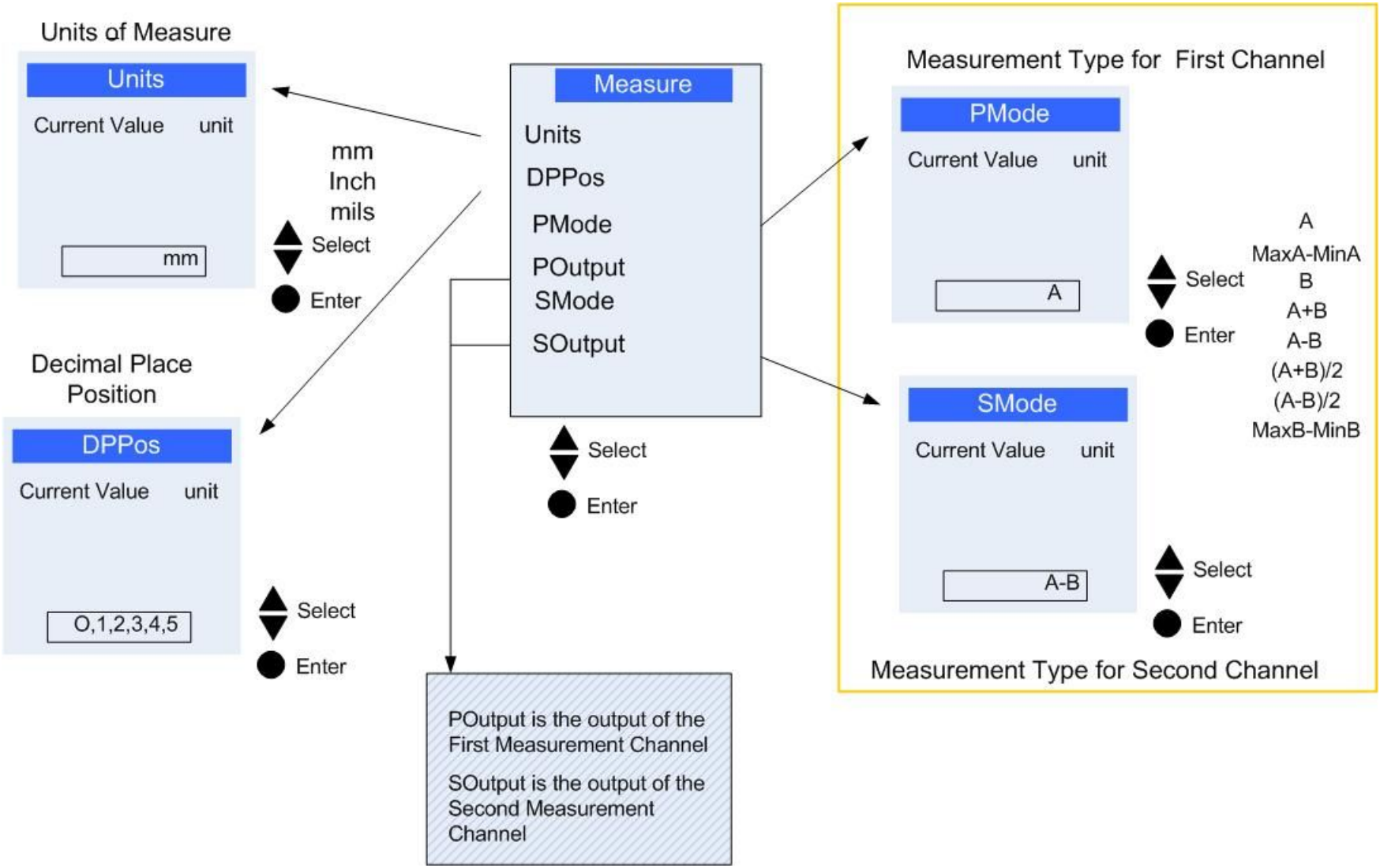
TOP LEVEL MENU



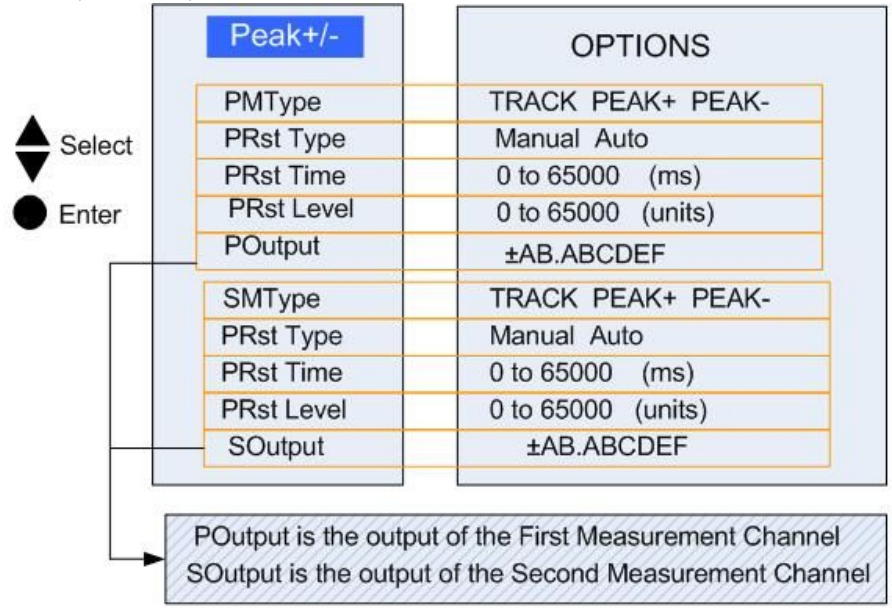
Configure Probe(s)

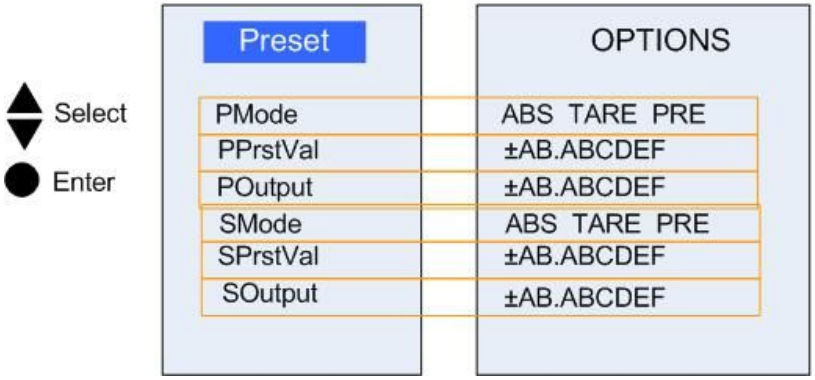


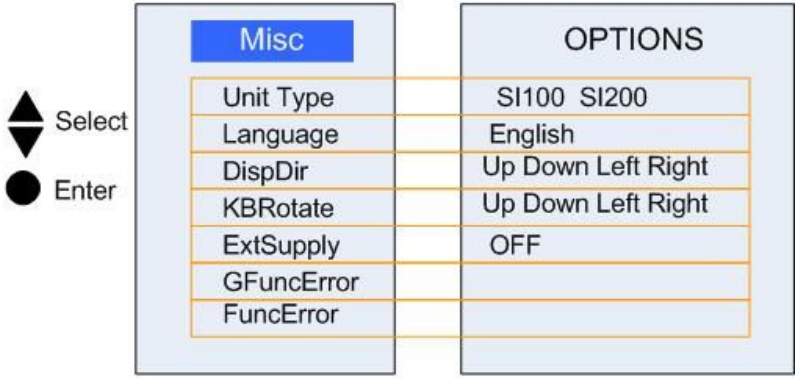
Measure Menu



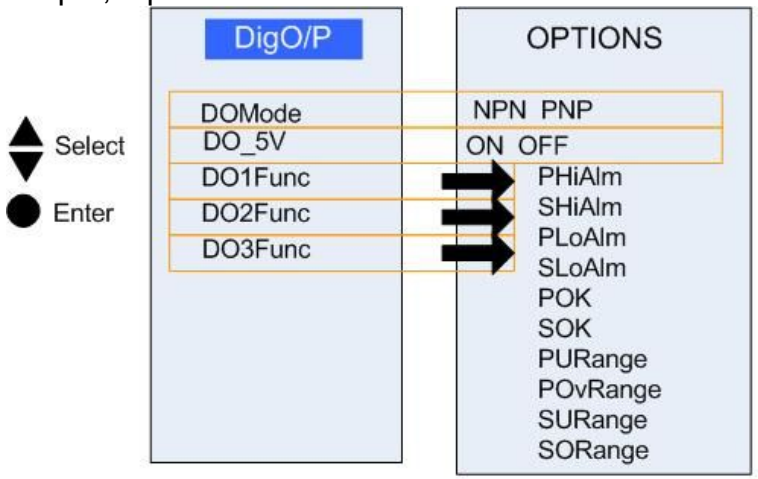
Peak, Preset, Limits and Misc Menu

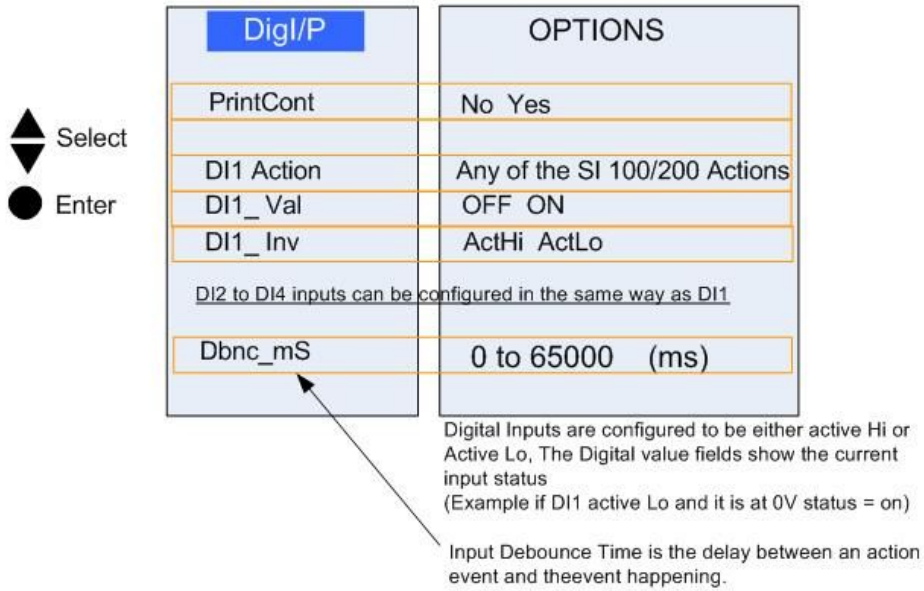


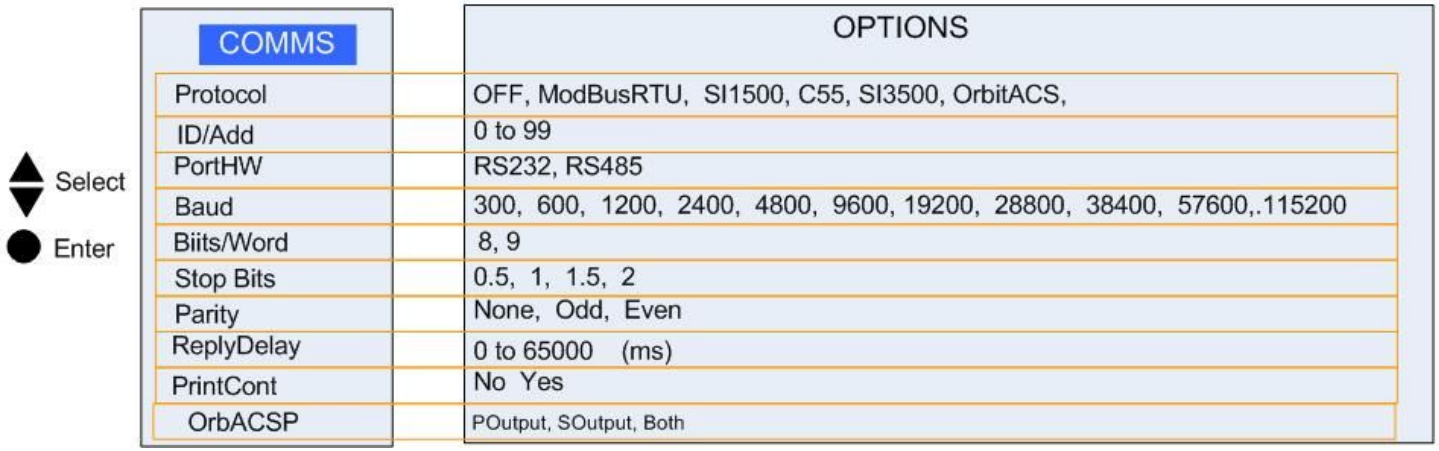




Output, Input and Communications Menu







9 SCALEING FUNCTION

Certain SI variants that have sensors other than probes connected can be rescaled. This is useful for the OrbitACS Laser Sensor

The scaleing is accessed via the Configuration Menu

Select Module and Rescale

10 SECURITY LEVELS

The SI100 and SI200 products have functions that can be set using different levels of security passwords. The default level on power on is level 0. The table below indicates the functions available at different security settings. This feature allows the SI100/200 to be set up by a technician and blocks an operator from changing any parameter settings.

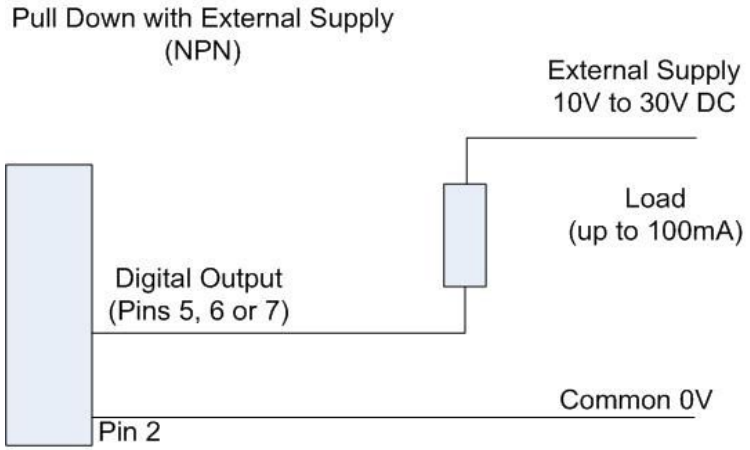
The unit is shipped with the following passwords which may be reset by the user.
NOTE: if the password is lost/forgotten the unit cannot currently be reset.

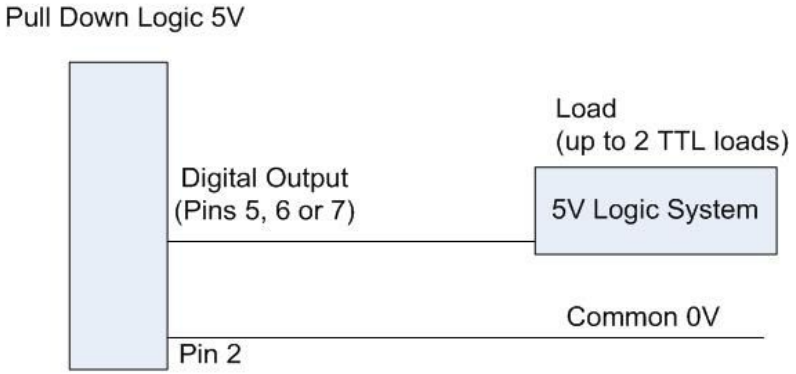
level	Password	Description	Functions
0	No password	Normal Operation	Access Action Screen Access MENU (Read Only) Operator cannot change set up configurations
1	1234	Future Options	
2	2345	Future Options	
3	3456	Future Options	
4	4567	Configuration 1	Main Set Up Mode used to change parameters
5	5678	Future Options	
6	6789	Future Options	

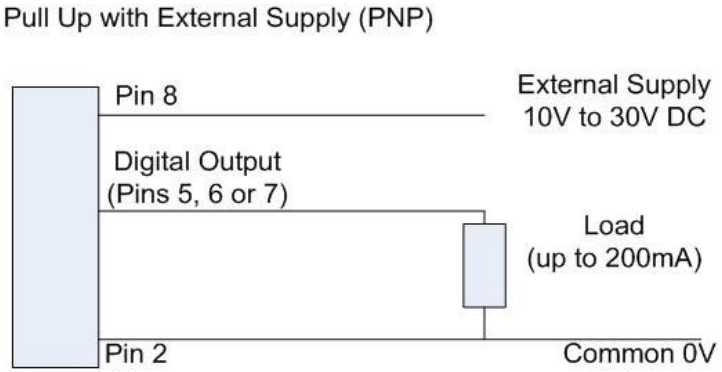
7	Not Published	Solartron Only	

11 OUTPUTS

The SI100 and SI200 have three digital outputs. These can be connected in various ways and either powered from an internal 5V supply or an external supply. The output configurations are shown below, the output type is set in the Digital Output MENU



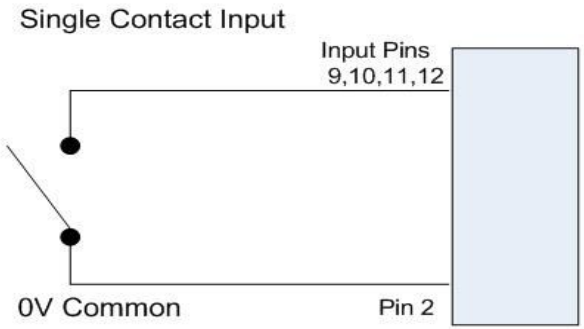


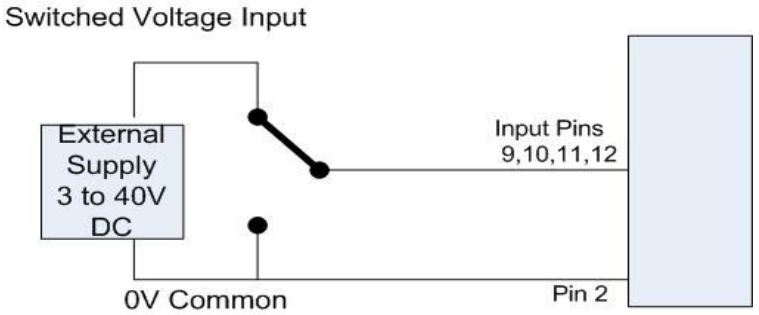


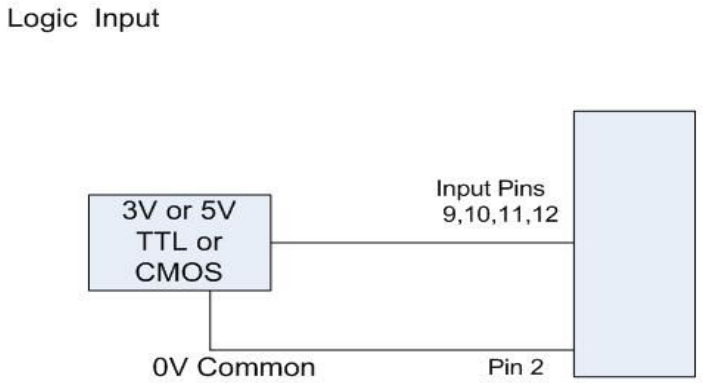
12 DIGITAL INPUTS

12.1.1 Digital Inputs Configuration Options

The SI100 and 200 has four digital inputs which may be connected as shown. These can be allocated to perform any of the SI100 or SI200 actions



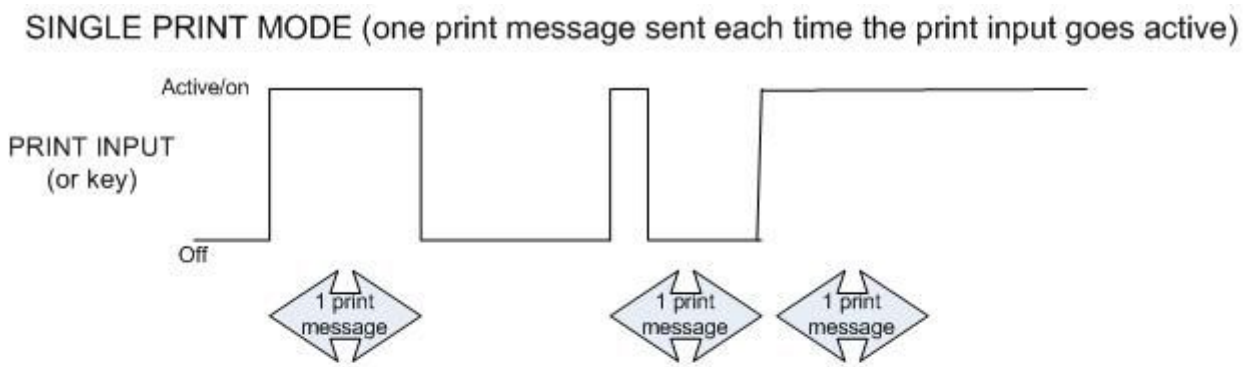


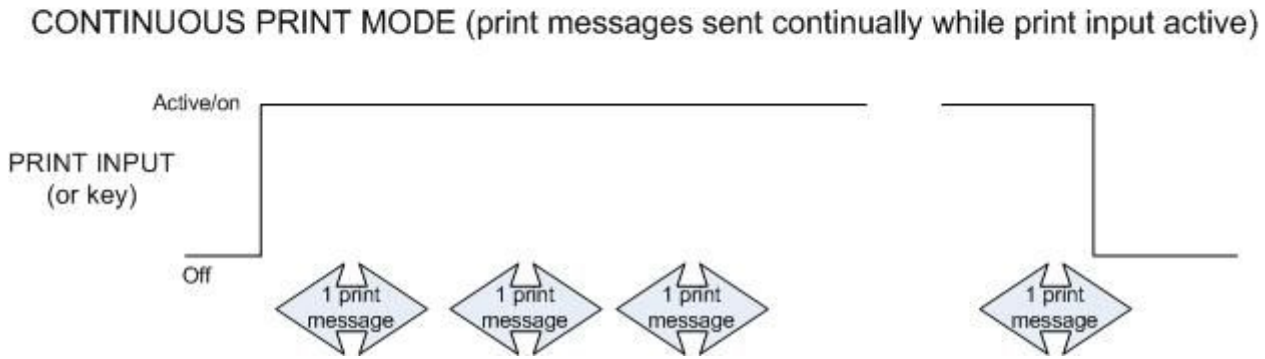


Note
Input pins can be set active high or active low

12.1.2 Discrete Print Input

The discrete print input works in the same way as the print key. However the Print action is different depending if the orbit ACS is in Single Print or Continuous Print Mode





Note a delay can be set between print outputs using the COMMS menu (ReplyDelay).

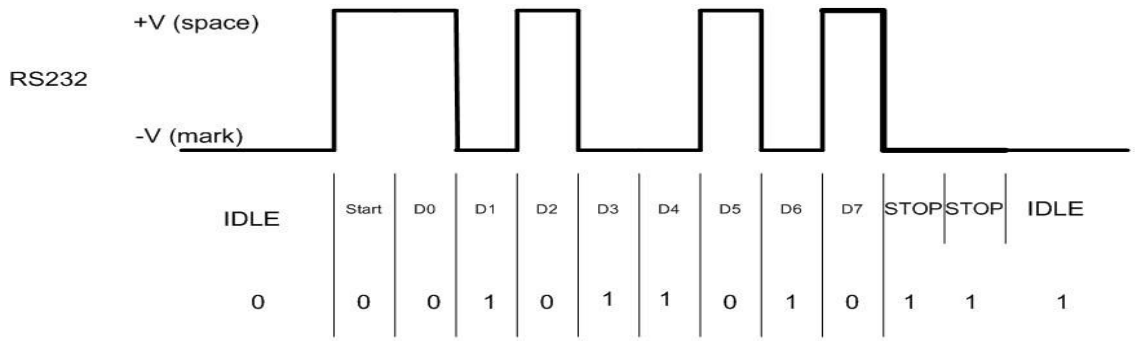
13 TIMING AND MEASUREMENT INFORMATION

Parameter	Update rate	Comment
Measurement Reading Rate	5 mS	
Digital Output Update	5 mS from measurement	
Response to Digital Input	5 mS	
Probe Reading Rate	256uS	The probe connected tot he SI100 and SI200 and any external digital probes are updated at this rate Averaging is applied at this rate. i.e. 16 x averaging will complete every 4.096mS
Probe Averaging	1,2,4,8,16,32,64,128,256 cycles	Averaging is applied at this rate. i.e. 16 x averaging will complete every 4.096mS
Measurement Bandwidth (electronics)	4,8,16,32,64,128,256, 512 Hz	Measurement bandwidth directly related to the Probe averaging value 1 – 512Hz 256 - 4Hz
Resolution	14 bits 16 bits default 18 bits	To calculate the resolution for a probe 1 bit = Probe Range (microns)/2^resolution

14 SERIAL COMMUNICATIONS (GENERAL)

The SI100 and SI200 has several options for Serial Communications.

14.1 RS232 AND RS485 SIGNAL LEVELS



Orbit ACS RS232 Specification

EIA/TIA-232 specification

Input (Rx) Voltage Range ± 25V
Output (Tx) Voltage range ± 13V

Orbit ACS RS285 Specification

EIA RS-485 Compliant
Minimum Differential Input voltage 200 mV
Max Output/Input Voltage -9V to +14V

14.2 TYPICAL RS232 WIRING

Most Computers use a 9 way D Type which uses PIN2 Rx, PIN3 Tx and Pin5 GND

To connect the SI100 RS232 use the table below

SI100 SI200	9 Way D Type
PIN3 (Tx)	PIN 2 (Rx)
PIN4 (Rx)	PIN 3 (Tx)
PIN 2 (0V)	PIN 5 GND

15 ASCII BASED SERIAL COMMUNICATIONS PROTOCOL

15.1 ORBIT ACS SERIAL COMMUNICATIONS PROTOCOL

Response to “^P” ASCII serial command, Print Key or Print Discrete Input

Sign	READING Right aligned with DP set by precision												Space	UNITS					Space	Limits	Space	READING TYPE					Space	MODE							Space	Channel	Space	Carriage Retu	Line Feed
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
+					X	.								m	m					<		A	b	s				A								1		\r	\n
-					X	.	X							i	n	c	h			=		T	a	r	e			B								2			
					X	.	X	X						m	i	l				>		P	r	e				A	+	B									
					X	.	X	X	X											!								A	-	B									
					X	.	X	X	X	X										?								(	A	+	B	)	/	2					
					X	.	X	X	X	X	X																		(	A	-	B	)	/	2					
					X	.	X	X	X	X	X	X																	M	x	A	-	M	n	A					
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Example																																							
Measurment =12.234 inches preset applied, within limits, Computed Measurment A+B																																							
+				1	2	.	2	3	4					i	n	c	h			=		P	r	e				A	+	B								\r	\n

Limits		
<		Below low limit
=		Between low and high limit
>		Above high limit
!		Out of range
?		No Probe

NOTES

Orbit ACS has one Print Command as per the described format

Baud rates: 300.600,1200,4800,9600,19200,28800,38400, 57600, 115200

Data Bits 8, 9

Stop Bits 0.5, 1, 1.5, 2

Configure Data Word bits and Parity

The Data/Word setting is for the totally number of data bits including any Parity bit that may be set.

i. e 8 bits with Even Parity equates to 7 data bits with Even Parity.

Therefore set the receiving device to 7,E

The full list is:

8,E (set receiver to 7,E)

8,O (set receiver to 7,O)

8,N (set receiver to 8,N)

9,E (set receiver to 8,E)

9,O (set receiver to 8,O)

9,N (set receiver to 9,N)

ReplyDly' set the delay before a print (in mS). This helps with slower systems being unable to cope with the speed of returned comms messages

Channel selected by 'OrbACSP' parameter.

1 = Primary Channel

2 = Secondary Channel

If 'Both' option is selected, both channels will be printed in sequence.

Response to "^PQxxx" ASCII serial command (where xxx = the module address)

Sign	READING Right aligned with DP set by precision												Space	UNITS					Space	Limits	Space	READING TYPE					Space	MODE							Space	Address			Period	Channel	Space	Carriage Re	Line Feed
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43
+					X	.								m	m					<		A	b	s				A								0	0	1	.	1		\r	\n
–					X	.	X							i	n	c	h			=		T	a	r	e			B								0	0	2		2			
					X	.	X	X						m	i	l				>		P	r	e				A	+	B						0	0	3					
					X	.	X	X	X											!								A	-	B						0	0	4					
					X	.	X	X	X	X										?								(	A	+	B	)	/	2		0	0	5					
					X	.	X	X	X	X	X																	(	A	-	B	)	/	2		0	0	6					
					X	.	X	X	X	X	X	X																M	x	A	-	M	n	A		0	0	7					
																												M	x	B	-	M	n	B		0	0	8					
				X	X	.																																					
				X	X	.	X																													Up to							
				X	X	.	X	X																																			
				X	X	.	X	X	X																											2	5	0					
				X	X	.	X	X	X	X																																		
				X	X	.	X	X	X	X	X																																	
				X	X	.	X	X	X	X	X	X																																	
			X	X	X	.																																					
			X	X	X	.	X																																				
			X	X	X	.	X	X																																			
			X	X	X	.	X	X	X																																		
			X	X	X	.	X	X	X	X																																	
			X	X	X	.	X	X	X	X	X																																	
			X	X	X	.	X	X	X	X	X	X																																	

Example																																											
Measurment =12.234 inches preset applied, within limits, Computed Measurment A+B, Unit Address 110, channel 2 (secondary)																																											
+				1	2	.	2	3	4					i	n	c	h			=		P	r	e				A	+	B						1	1	0	.	2		\r	\n

Response to “^D” ASCII serial command returns Status of discrete Inputs and outputs

0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
D	i	n	.●	A	B	C	D		D	o	u	t	E	F	G	\r	\n

where A, B, C, D are logic levels for the discrete inputs: 1,2,3,4

and E, F, G are logic levels for the discrete outputs: 1,2,3

15.2 SI3500 COMPATIBILITY PROTOCOL

Response to "^O" ASCII serial command, Print Key or Print Discrete Input

Sign	READING Right aligned with DP set by precision												Space	UNITS					Space	Limits	Space	Carriage Retu	Line Feed
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
+												X		m	m					^		\r	\n
-											X	X		i	n	c	h			=			
										X	X	X		m	i	l				>			
										X	.	X								!			
									X	X	.	X											
								X	X	X	.	X											
									X	.	X	X											
								X	X	.	X	X											
							X	X	X	.	X	X											
								X	.	X	X	X											
							X	X	.	X	X	X											
						X	X	X	.	X	X	X											
							X	.	X	X	X	X											
						X	X	.	X	X	X	X											
					X	X	X	.	X	X	X	X											
						X	.	X	X	X	X	X											
					X	X	.	X	X	X	X	X											
				X	X	X	.	X	X	X	X	X											
			X	X	X	.	X	X	X	X	X	X											

Example																							
Measurment =12.234 inches preset applied, within limits																							
+							1	2	.	2	3	4		i	n	c	h			=		\r	\n

Limits

<	Below low limit
=	Between low and high limit
>	Above high limit
!	Out of range

NOTE

Not All SI3500 Serial Commands have been implemented

15.3 SI1500 COMPATIBILITY PROTOCOL

SI1500

Response to ">Rxx\r\n" ASCII serial command only
Where xx is the Device ID.

15.4 C55 COMPATIBILITY PROTOCOL

Command		Unit ID		Limits	Sign	READING Right aligned with DP set by precision, LH digits are '0'							Carriage Return	Line Feed
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
<	R	x	x	<	+	X	X	.	X	X	X	X	\r	\n
				=	-	0	X	X	.	X	X	X		
				>		0	0	X	X	.	X	X		
						0	0	0	X	X	.	X		
						0	0	0	0	0	X	X		

There is an variation to the above. →

Command		Unit ID		Limits	Sign	READING Right aligned with DP set by precision, LH digits are '0'						Carriage Return	Line Feed
0	1	2	3	4	5	6	7	8	9	10	11	12	13
<	R	X	X	<	+	0	0	X	X	X	X	\r	\n
				=	-								
				>									

Special case if number of DP is set to 0
i.e. one byte less for the reading

Read Alarm limits

Response to ">Sxx\r\n" ASCII serial command only

same packet length issue with no DPs set

Command		Unit ID		Sign	Upper LIMIT Always shown with 4 DPs							Comma	Sign	Lower LIMIT Always shown with 4 DPs							Carriage Return	Line Feed
0	1	2	3	5	5	6	7	8	9	10	11	12	12	13	13	13	13	13	13	13	12	13
<	S	X	X	+	X	X	.	X	X	X	X	,	+	X	X	.	X	X	X	X	\r	\n

C55

Response to 'Print' key press or discrete 'Print' input

Note. The LineFeed & Carriage Return characters are reversed

Sign	READING Format is XXXX.XXXX with leading zeros replaced by spaces									Space	Space	UNITS					Limits	Line Feed	Carriage Return
0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
+				X	.	X						m	m				<	\n	\r
-				X	.	X	X					i	n	c	h		=		
				X	.	X	X	X				m	i	l			>		
				X	.	X	X	X	X								!		
			X	X	.	X													
			X	X	.	X	X												
			X	X	.	X	X	X											
		X	X	X	.	X													
		X	X	X	.	X	X												

Example																		
Measurment =12.234 inches within limits																		
+			1	2	.	2	3	4				i	n	c	h		=	\n	\r

Orbit ACS Implemetation of C55

The Orbit ACS emulation provides proper mm, inch, mil conversions
The C55 always prints in ‘mm’

Not supported by the emulation:
No “None” units
7 Data bits with No Parity

Extras
We allow the following extra Comms setup options
Baud Rates: 300, 600, 4800, 28800, 38400, 57600, 115200
Stop bits: 1.5, 2

We allow up to 4 DPs to be outputted, regardless of the number size
i.e. C55 only allows x.xxxx up to xxx.xx
we provide x.xxxx up to xxx.xxxx

15.5 ASCII CHARACTER SET

	0	1	2	3	4	5	6	7
0	NUL	DLE	space	0	@	P	`	p
1	SOH	DC1 XON	!	1	A	Q	a	q
2	STX	DC2	"	2	B	R	b	r
3	ETX	DC3 XOFF	#	3	C	S	c	s
4	EOT	DC4	$	4	D	T	d	t
5	ENQ	NAK	%	5	E	U	e	u
6	ACK	SYN	&	6	F	V	f	v
7	BEL	ETB	'	7	G	W	g	w
8	BS	CAN	(	8	H	X	h	x
9	HT	EM	)	9	I	Y	i	y
A	LF	SUB	*	:	J	Z	j	z
B	VT	ESC	+	;	K	[	k	{
C	FF	FS	,	<	L	\	l	|
D	CR	GS	-	=	M	]	m	}
E	SO	RS	.	>	N	^	n	~
F	SI	US	/	?	O	_	o	del

Example ASCII “A” is HEX 41

16 MODBUS BASED SERIAL COMMUNICATIONS PROTOCOL

16.1 INTRODUCTION

The SI series of products support the Modbus communications protocol. More information regarding the Modbus protocol can be found online at www.modbus.org, with the full specification downloadable here: - http://www.modbus.org/docs/Modbus_Application_Protocol_V1_1b.pdf

Modbus Communications can be performed over a number of hardware layers including RS232 (single point-to-point communications) and RS485 (multi-drop network communications).

The SI100 and SI200 are Modbus slaves. They can be given a Modbus address (set in comm menu). A Modbus master can read and write from the units to set parameters or read from parameters. The Modbus parameter table for the device family is detailed in section 14.2.8.

The SI range supports Modbus RTU and Modbus ASCII . Modbus RTU uses raw binary data whereas Modbus ASCII uses the data encoded as ASCII. (RTU is the most widely used).

16.2 OVERVIEW OF MODBUS COMMUNICATIONS

16.2.1 Modbus Master/Slave

The Modbus protocol is a Master/Slave (or Client/Server) system, with a single ‘Master’ controlling a network of one or more ‘Slaves’.

The Master unit controls all communications, so whether it needs to read from one slave unit (reading inputs), write to another (setting outputs/configuration), or transfer information from one unit to another, it does so with a command/response message pair.

16.2.2 Modbus Unit ID

Each Modbus message contains a Unit ID (address), the servers listen to the Modbus communications and if they hear a message containing their UnitID they accept this message and respond. The SI100 and SI200 can have their address set in the COMMS menu.

16.2.3 Parameters

Each Slave unit will have within its help structure or documentation a ‘Parameter Map’, which details all the Parameters that are available, the conditions they are constrained by (limits, read / write privileges etc) and the function of the Parameter.

Modbus ‘Registers’ are 16 bit registers; often within industrial applications these 16 bit registers are ganged together to represent 32 bit data and 64 bit data, as well as floating point type information and Strings. The details about the number of registers a ‘Parameter’ consumes should be clearly detailed within the unit’s documentation.

It is, however dangerous to read the 16 bit registers that make up a more complex ‘Parameter’ individually with separate message, as there is no way of knowing if the data was updated in-between reads, resulting in a corrupted value once the complex ‘Parameter’ is re-constructed.

The SI Series of products protect against this issue and will not allow the individual registers of a more complex parameter to be read individually, they must all be read with a single ‘Read Multiple Registers’ type command.

An Integer type parameter (consisting of a single or multiple 16-bit registers), can also include information to several decimal places. This is indicated within the Parameter Map by way of an inferred decimal place position; a Parameter with a decimal place position defined as ‘0’ has no decimal places included, a decimal place position of ‘3’ for instance would mean three decimal places of accuracy are included in the integer value.

Please refer to the example below for how an Integer value can be interpreted with decimal place precision.

Integer Value	Decimal Place Position	Inferred value
123456789	0	123456789
123456789	1	12345678.9
123456789	2	1234567.89
123456789	3	123456.789
123456789	4	12345.6789
123456789	5	1234.56789
And	So	On

Parameters can also be ‘signed’ or ‘unsigned’. However, Two’s Compliment negative mathematics is always employed for signed values.

16.2.4 Master Command Messages

Each message the Master transmits onto the network will at least include a ‘Node Address’ (also often referred to as a ‘Slave Address’ or ‘ID’), as well as a ‘Function Code’, a ‘Parameter Address’ and finally a ‘Checksum’. As well as these variables certain commands may also include a ‘Parameter Count’ and ‘Data’.

Once the Master has transmitted the message, it awaits a response from the relevant Slave on the network up to a time limit generally referred to as a Timeout.

The Master system should generally include a retry mechanism and suitable Timeout period for the type of Slave units on the network.

16.2.5 Slave Unit Responses

Each and every Slave type unit on the network receives every message transmitted onto the network, so it first checks the 'Node Address' part of the message, if it finds a match with it's own configured Slave/ID/Node address, it will then process the whole message by first checking the 'Checksum', which is a value used together with a known algorithm to verify the content of the message is uncorrupted and valid to process.

Once verified as a valid message, the Slave unit then performs the function required by the Function Code element of the message and fetches the data required (Read) or sets the appropriate output / carries out the function of that parameter.

It then formulates a response message in similar format, with its own Node address and function code as a confirmation the correct Node is responding, as well as any data that was required and a calculated checksum.

The only type of message that doesn't solicit a response is a 'Broadcast' type message, which is not generally recommended as no confirmation of receipt type message is provided. The table below describes the basic elements of a Modbus Message and what their function is: -

Message Element	Description
Node Address	This indicates the Node the message is intended for (Master Transmission), or from (Slave response).
Function Code	The Function to carry out, this can be Read, Read Many, Write and Write Many type commands.
Parameter Address	The address of the parameter to read from or write to.
Parameter Count	The number of parameters to read or write.
Data	The data used to read / write from / to parameters
Checksum	The verification value used to confirm message validity.

For more details regarding the specifics of the Modbus protocol, please refer to the specification documents mentioned in section 1.1.

16.2.6 Modbus Function Codes Supported by SI Products

Within the Modbus specification, there are a number of Function Codes, not all of which are implemented by the SI Series of products. The table below shows the full list of Modbus Function Codes together with the Function Codes supported by the SI series.

Function Code	Description	SI Supported
01 (0x01)	Read Coils (single digital 'bit')	X
02 (0x02)	Read Discrete Inputs	X
03 (0x03)	Read Holding Registers	✓
04 (0x04)	Read Input Registers	✓
05 (0x05)	Write Single Coil	X
06 (0x06)	Write Single Register	✓
07 (0x07)	Read Exception Status	X
08 (0x08)	Diagnostics	X
11 (0x0B)	Get Comm Event Counter	X
12 (0x0C)	Get Comm Event Log	X
15 (0x0F)	Write Multiple Coils	X
16 (0x10)	Write Multiple registers	✓
17 (0x11)	Report Slave ID	X
20 (0x14)	Read File Record	X
21 (0x15)	Write File Record	X
22 (0x16)	Mask Write Register	X
23 (0x17)	Read/Write Multiple registers	X
24 (0x18)	Read FIFO Queue	X
43 (0x2B)	Encapsulated Interface Transport	X

16.2.7 Parameter Types

The SI series of products support the following parameter types: -

Type	Registers consumed	Details
UINT16	1	Unsigned 16-bit value
SINT16	1	Signed 16-bit value
UINT32	2	Unsigned 32-bit value
SINT32	2	Signed 32-bit value
SINT64	4	Signed 64-bit integer. Note: Usually within the SI series these are used with an inferred six decimal places.
STRING8	4	A String consisting of up to eight characters with two characters stored in each 16-bit register. Note: This string will be null terminated if less than eight characters, but not if all 8 characters are used for ASCII.
POINTER	1	This parameter is used to reference a value from another parameter. An example of it's use would be as the input parameter for a functional block – this parameter would contain a value representing the Parameter Address for the input value.

All parameter types that consume more than one 16-bit register hold their data with the most significant part first, at the lower address.

Examples: -
A SINT32 parameter at address 100 holds the most significant 16 bits at address 100 and the least significant 16 bits at address 101 (both registers must be read together with a single, multi-register read command).

A STRING8 parameter at address 110 holds the first pair of characters at that address (one 16 bit register used to hold two 8-bit chars, again most significant first), the second pair of characters reside at address 111 and so on, for a maximum of 4 registers (4 character pairs = 8 characters maximum), Note: Again all four registers must be read with a single, multi-register read command, and the string constructed accordingly. If the string is known to be only 1 or two characters long, the entire 4-register parameter must still be read as a single entity to ensure parameter integrity.

16.2.8 Parameter Map

The Orbit ACS Modbus Parameter Map is Document "503116 Orbit ACS Modbus Parameter Map.pdf", available on the Solartron Metrology Web Site.

16.2.9 ACS, Modbus Floating point

In order to provide 32 bit floating point type data for parameters, the ACS products provide a floating point interface to any parameter by way of an address offset. This provides an alternate address to read over Modbus, providing a floating point representation of any parameter.

To acquire an IEEE-754 floating point value for any parameter, add 8000 to the address of the parameter required and read 2, 16 bit registers in a multiple register read command. The data returned will be a floating point number for the parameter at address supplied -8000, i.e. Read address 8001 as a floating point will yield the floating point value for the parameter at address 1.

17 MEASUREMENT RESOLUTION, AVERAGING AND BANDWIDTH

The Orbit ACS has the ability to set the probes into three resolution options, 14 bit, 16 bit (default factory setting) and 18 bit. The table below shows the best resolution (1 bit that is theoretically possible) with different probe measurement ranges.

Range mm	0.5	1	2	5	10	20
Resolution µm (18 bit)	0.00	0.00	0.01	0.02	0.04	0.08
Resolution µm (16 bit)	0.01	0.02	0.03	0.08	0.15	0.31
Resolution µm (14 bit)	0.03	0.06	0.12	0.31	0.61	1.22

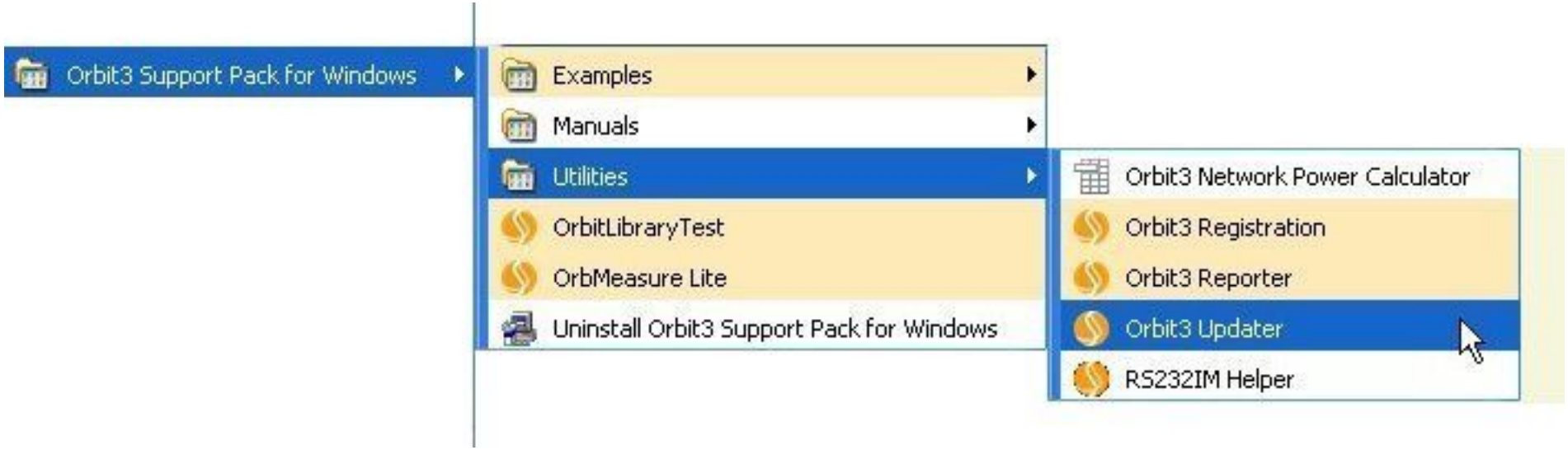
It is important to consider the resolution that can be displayed (no of decimal places) and set the probe resolution accordingly. The SI series can display up to 5 decimal places or 0.01um, so the probe resolution needs to be set to better than the displayed resolution where possible. Equally, it is of little value trying to set the display to a resolution of 0.01um if the probe cannot achieve this.

Averaging improves the signal to noise ratio, but reduces the measurement bandwidth. Generally, using a higher resolution requires more averaging. The averaging is expressed in terms of the number of base reading cycles for the probe where a reading cycle corresponds to 256uS. The update rate of the Orbit ACS is 5mS (200Hz), an averaging of 16, corresponds to a bandwidth of approximately 240Hz. The default factory setting is 16.

18 MISCELLANEOUS

18.1 FIRMWARE UPGRADES

From time to time, enhancements may become available for the Orbit ACS range.
These product firmware upgrades can be implemented out using the Orbit3 Updater utility, via the USB Mini B port on the rear of the unit.
The utility is part of the 'Orbit3 Support Pack for Windows'. It can be downloaded from the Solartron Metrology website.
Once installed, it is located here:



Follow the on screen instructions for the Updater.

Note. After running the firmware upgrade it is advisable to power cycle the Orbit ACS to allow the changes to fully take effect.

19 RETURN OF GOODS

Devices returned for service/repair/calibration should be shipped prepaid to your distributor or, if purchased directly from Solartron Metrology, to the relevant Sales Office.

The shipping container should be marked:
'For the Attention of the Customer Services Department'

The following information should accompany the device(s):

1. Contact details of company/person returning device, including return shipping instructions.

2. A statement of service required.

3. Description of the device fault and the circumstances of the failure, including application environment and length of time in service.

Alternatively there is a returns form available on our web site, follow the link to "Service Repair and Recalibration".

Please note:
A standard assessment charge is applicable on all non-warranty devices returned for repair.
Customer damage and any device found, upon inspection, to have no fault will be considered non-warranty.

Please contact the Sales Office or Distributor for warranty terms, service options and standard charges.

Adherence to these procedures will expedite handling of the returned device and will prevent unnecessary additional charges for inspection and testing to determine the condition.

Solartron Metrology reserves the right to repair or replace goods returned under warranty.

All repairs are guaranteed for 3 months (unless other-wise stated).

Solartron Metrology reserves the right to make changes without further notice to any products herein to improve reliability, function or design.
Solartron Metrology does not assume any liability arising out of the application or use of any product or circuit described herein, neither does it convey any licence under patent rights nor the rights of others.