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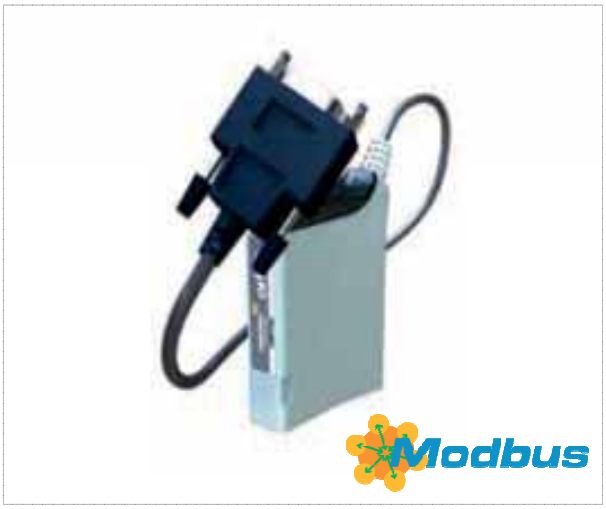
MODIM

MODBUS INTERFACE MODULE

A PLC Interface Module for Orbit®3



Description

Solartron Metrology, the world leader in measurement innovation, introduces a MODBUS Interface Module (MODIM) which provides an easy to use gateway between MODBUS PLCs and Solartron Metrology's Orbit®3 Digital Measurement System which is a flexible and highly accurate measuring system. The Orbit®3 system can also interface to any sensor with an analogue output as well as the myriad of linear measurement sensors manufactured by Solartron Metrology. This means that the system can be used for temperature, pressure, force, rotary measurement and linear displacement, providing all these process variables to a PLC through one simple MODBUS communications interface.

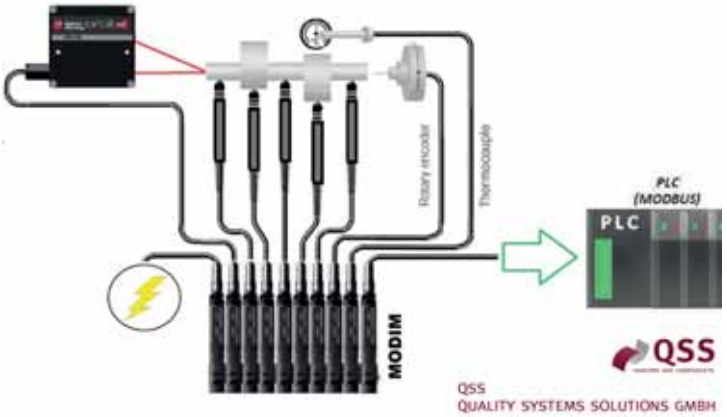
Features

MODBUS RTU up to 115200 baud

Access complex sensor networks with varying interfaces through a set of MODBUS parameters in a single device

Connects to all Solartron Gauging Probes, Displacement, Orbit® LT, and Orbit® LTH.

Simple network set up via a PC application.



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Aemetstrasse 5 CH-8344 Bäretswil
Telefon +41 44 242 00 00
Telefax +41 44 242 00 10
www.qss.ch
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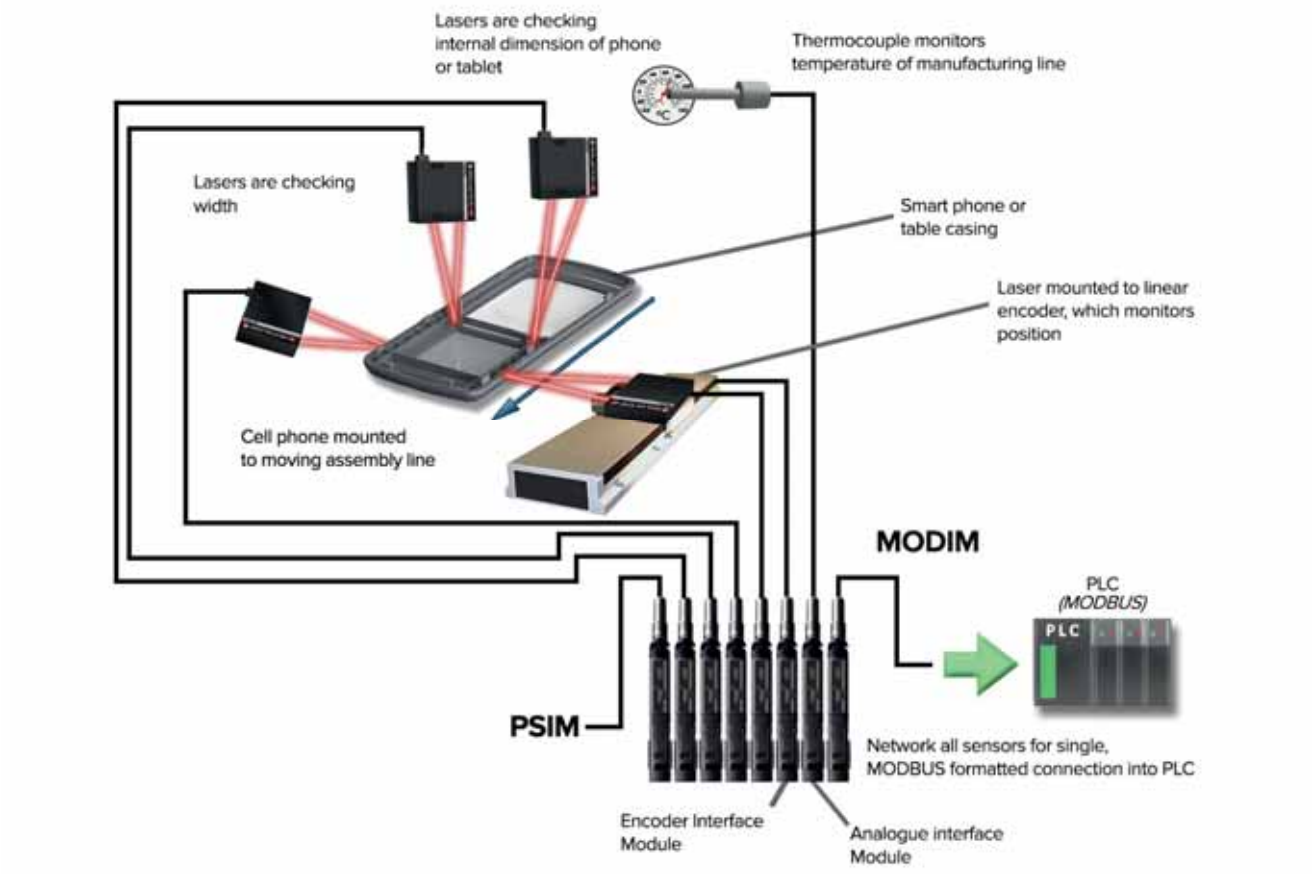
MODIM Setup

Sample Application



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MODIM Electronics Interface	
Network Protocol	MODBUS RTU SLAVE
Hardware Serial Interface	RS485
Data Transfer	Individual Readings of Network Module Data
	Synchronised readings of Network Module data
Baud Rates	Up to 115,200
Maximum Network Size (Note 1)	Up to 150 modules

ORBIT Network	
Orbit Modules	Linear Displacement Sensors range 0.25mm to 300mm. Analogue Input Modules 0-10V, 4-20mA. Rotary Encoder Modules and Non Contact Laser Modules
Orbit Measurement (Note 3)	Standard Mode

Environmental	
Sealing	IP43
Storage Temperature (ºC)	-20 to +70
Operating Temperature (ºC)	5 to 60
EMC Emissions	EN61000-6-3 and EN61326
EMC Immunity	EN61000-6-2 and EN61326
Power (Note 2)	5±0.25 VDC @ 0.06A typical

Material	
Body	ABS and Nylon

Note1 : The Network size refers to the Orbit Network to which the MODIM provides a gateway

Note2: The power is for the MODIM only, the Orbit Network will require additional power depending on the modules that make up the network (Typically each Orbit module will require 60mA @ 5V DC nominal) Refer to User Manual for Details

Note3: The Orbit Network can be set to operate in various measurement modes however the MODIM only allows configuration of Orbit Standard mode to facilitate the two MODIM Data Transfer methods

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SI 100 & SI 200

Single and Dual Channel systems for easy connections into PLC or Automation

Description

Solartron Metrology, the world leader in linear measurement innovation, introduces two new Orbit®3 based systems for easy, low cost connections into PLCs and process control systems. The SI 100 is a single channel, stand alone system, while the SI 200 also connects to an Orbit®3 probe for a two channel reading.

Features

Integral Readout with colour LCD Display and keypad.

Set tolerance and process limits via keypad

Detachable probe plug on housing for easy installation. *(Gauging probes, Block Gauges & Flexures only)*

Replace probe with no calibration or reprogramming

Modbus output (RTU or ASCII) over RS485 or RS232

Programmable discrete I/O (4 inputs, 3 outputs)

Multiple formulas available for SI 200 (A+B, A-B, etc.)

Available with all Solartron Gauging probes, Displacement sensors, Orbit LT, and LTH.

SI 200 can stack laser with gauging probe or displacement sensor.

24V DC Power Supply

Modbus

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SI 100 Applications

Simple height check measurement to PLC via MODBUS

Chip height check with Orbit LT. Measurement sent to PLC on print command via RS232

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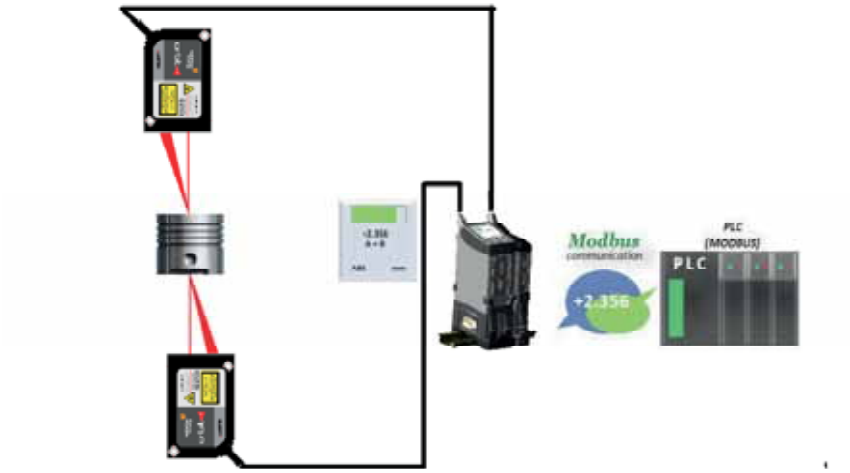
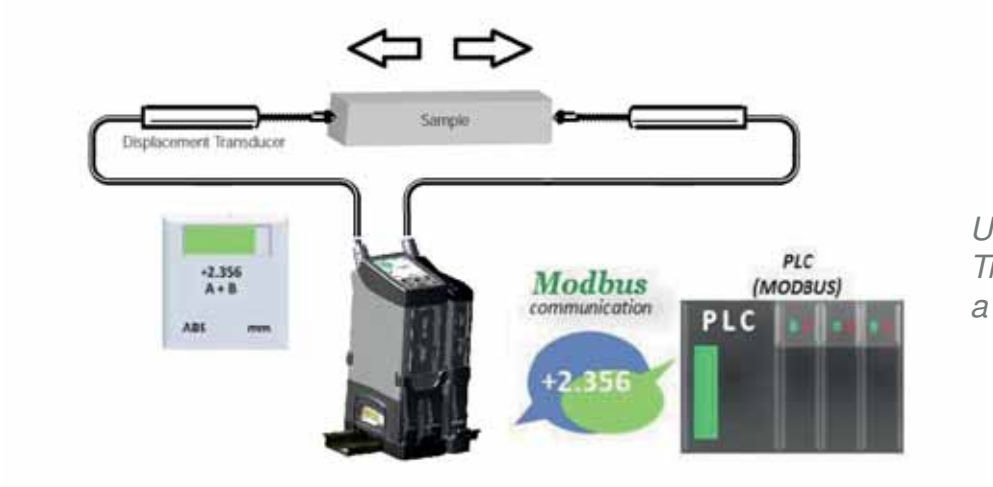
SI 200 Applications

Simple diameter check

Use 2 Orbit LT Lasers for piston height check





Use 2 S-Series Transducers to monitor a sample under strain

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Pin Configuration

12	Input 4
11	Input 3
10	Input 2
9	Input 1
8	Output Supply In
7	Output 3
6	Output 2
5	Output 1
4	Modbus B (RS485 or RS232)
3	Modbus A (RS485 or RS232)
2	0V Power in Return
1	18-32 V DC Power In

Mini-USB Port for configuration via a PC and firmware updates

- **Input pins can be set Active Hi or Active Lo**
- **Output pins can be Active Hi or Active Lo and set to NPN, PNP or Logic**
- **DIN Rail mount**
- **Input pins are programmable (typical functions: Zero, Print, Preset)**

Serial Output Options

The SI 100 and SI 200 have a standard Modbus interface (RTU or ASCII). However, pins 3 & 4 can also be configured as an ASCII Serial Interface mode, allowing the user to select from several different protocols, including compatibility with Solartron's SI 1500, SI 3500 and C55.

Accessories

+24V Power Block with Mains Leads. Available with UK, EU, and US plugs
Spare T-con Mounts
USB to Mini-USB cable for PC connection

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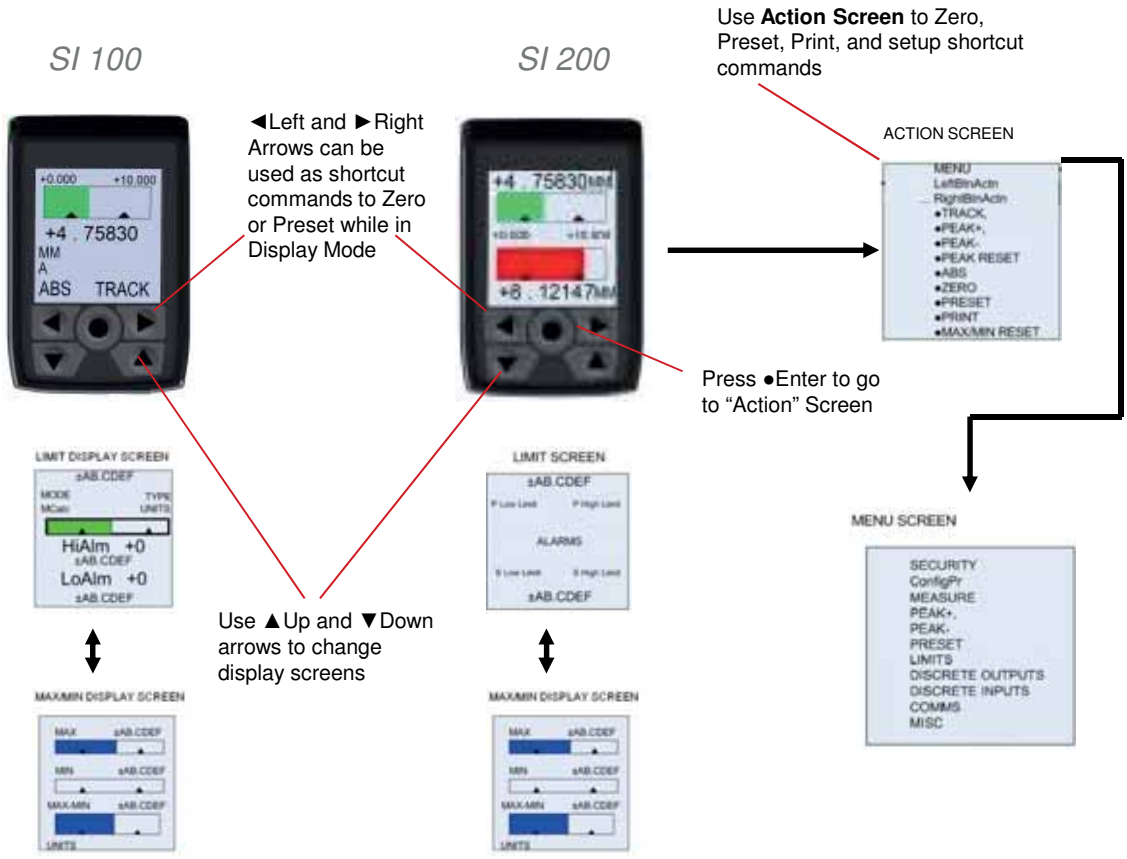
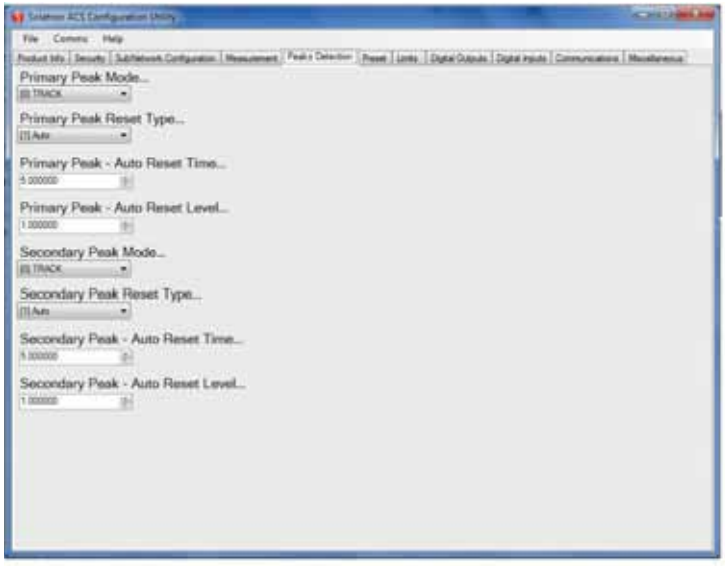
Display and Interface



Configurator Software

Connect SI 100/200 to PC via Mini-USB to USB cable. Then use Solartron provided software to configure unit, and backup settings to PC file!



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Orbit ACS Digital Gauging Probes (with connector between probe and electronivs module)

Product

Spring Push Axial Cable	SIxxxP/1/S	SIxxxP/2/S	SIxxxP/5/S	SIxxxP/10/S	SIxxxP/20/S	SIxxx6P/2/S
Spring Push Radial Cable	SIxxxPR/1/S	SIxxxPR/2/S	SIxxxPR/5/S	SIxxxPR/10/S	SIxxxPR/20/S	N/A
Pneumatic Axial Cable	N/A	SIxxxP/2/P	SIxxxP/5/P	SIxxxP/10/P	SIxxxP/20/P	N/A
Pneumatic Radial Cable	N/A	SIxxxPR/2/P	SIxxxPR/5/P	SIxxxPR/10/P	SIxxxPR/20/P	N/A
Measuring Range (mm)	1	2	5	10	20	2
Body Diameter	8h6					6h6

Note SIxxx can be either SI100 or SI200

Performance

Accuracy (% of Reading)[1]	0.2		0.15			0.2
Repeatability µm[2]	0.15					
Resolution µm -user selectable	<0.01		<0.05		<0.1	<0.01
Alarm Outputs - selectable High, OK, Low	3 outputs either NPN, PNP, logic Programable Active Hi or Lo					
Discrete Inputs - user selectable	eg. Print, Zero, Preset (see manual for other options)					
Update Rate for I/O discretes (ms)	5					
Bandwidth of Electronics (Hz) - user selectable	460, 230, 115, 58, 29, 14, 7,4					
Communications Interface Protocol	MODBUS (RTU or ASCII) or Solartron Serial Formats					
Communications Interface Hardware	RS485 or RS232 (User selectable) Up to 115,200 Baud					
Update Rate for Serial Data (ms)	25					
Pre Travel (mm)	0.15					
Post Tavel (mm)	0.35	0.85				0.35
Tip Force (N) at Middle of Range ±20%						
Spring Push	0.7					
Pneumatic at 0.4 bar	N/A	0.8	0.85	0.7		N/A
Pneumatic at 1 bar	N/A	2.8		2.5		N/A

Environmental

Sealing for Probe	IP65 with gaiter or IP50 without gaiter
Sealing for Probe Interface Electronics	Top and Front: IP41, Rear: IP20, In line connector: IP67
Storage Temperature (ºC)	-20 to +70
Probe Operating Temperature with Gaiter (ºC)	+5 to +80
Probe Operating Temperature without Gaiter (ºC)	-10 to +80
Electronics Operating Temperature (ºC)	0 to 60
EMC	Emissions EN61000-6-3, EN61326
	Immunity EN61000-6-2, EN61326
Power	18 to 32 VDC @ 0.07A typical

Material

Probe Body	Stainless Steel
Probe Tip (options)	Nylon, Ruby, Silicon Nitride, Tugsten Carbide
Gaiter (standard)	Fluoroelastomer
Cable	PUR
Electronics Module	ABS

[1] Accuracy 0.1µm or % reading, whichever greater

[2] Obtained by repeated operation against a carbide target with side load applied to bearing

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Instrumentation Functionality

Measurement	
Measurement Modes - SI100	A, MAX-MIN
Measurement Modes - SI200	A,B, A+B, A-B, (A+B)/2, (A-B)/2, MAXA-MINA, MAXB-MINB
Measurement Types	Track, Peak+, Peak-
Measurement Modes	Absolute, Zero (tare), Preset
Measurement Units	mm, inches or mils

Display	
Analogue	Bar representing reading
Digital	Digital up to 5 decimal places mm (6 for inches)
Warnings	Red bar and red digital reading indicates measurment outside of limits

Keypad	
Type	Sealed Membrane

The SI 100 and SI 200 can also be ordered connected directly to the digital gauging probe for higher accuracy.

The SI100 and SI200 can also be ordered with the connector between the digital gauging probe and the Electronics Module placed in line along the cable.

Performance specifications will vary if the SI100 or SI200 is supplied connected to other transducers or laser products – see the Solartron website or contact your local sales office/distributor for further information.

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Drawing

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SI400

A Four Channel system for easy connections into PLC or Automation

Description

Solartron Metrology, the world leader in linear measurement innovation, introduces a new Orbit®3 based system for easy, low cost connections into PLCs and process control systems. The SI400 will connect to, and power, three additional sensors for a four channel reading. You can even combine gauging probes, Orbit® LT, and Orbit® LTH on the same stack of modules. No other digital system offers this!

Features

Integral Readout with colour LCD Display and keypad.

Set tolerance and process limits via keypad

Detachable probe plug on housing for easy installation. *(Gauging probes, Block Gauges & Flexures only)*

Replace probe with no calibration or reprogramming

Modbus output (RTU or ASCII) over RS485 or RS232

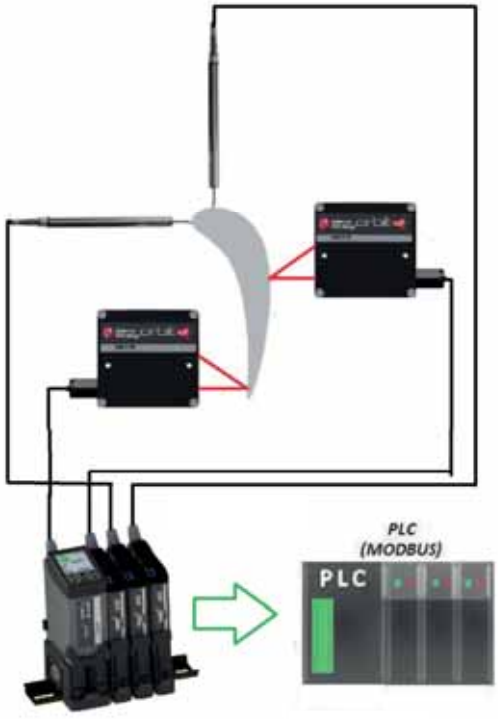
Programmable discrete I/O (4 inputs, 3 outputs)

Track, Peak, and Max-Min Modes for each channel

24 VDC Power Supply

Works with Gauging Probes (all types), Displacement, Orbit® LT, and Orbit® LTH.

Modbus



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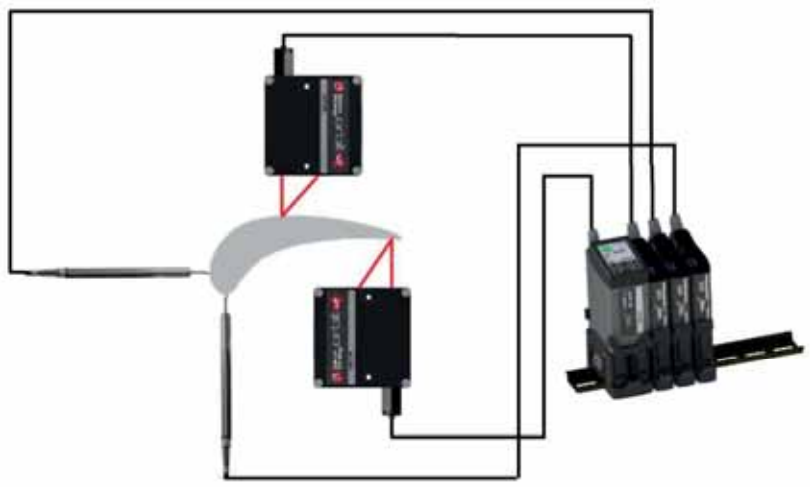
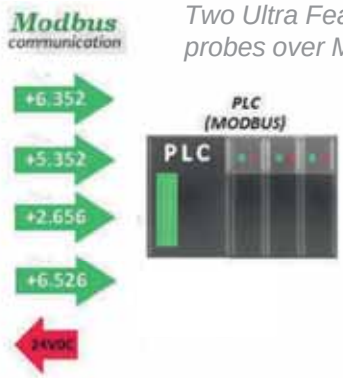
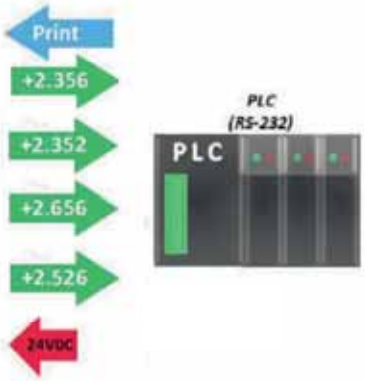
SI 400 Applications

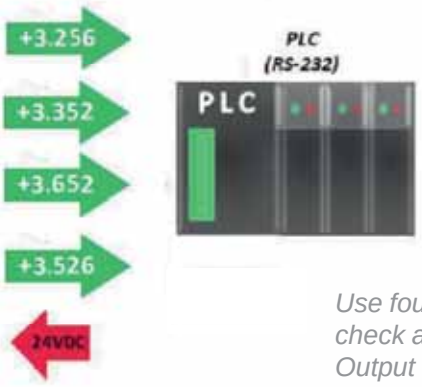




Checking a jet engine turbine blade with two Orbit® LTH Lasers, and Two Ultra Feather Touch probes over Modbus

Check four corners of cell phone glass with Ultra Feather Touch Probes, via Print command over RS232





Use four mini-probes to check a diameter. Output to PLC via RS232.

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Pin Configuration

12	Input 4
11	Input 3
10	Input 2
9	Input 1
8	Output Supply In
7	Output 3
6	Output 2
5	Output 1
4	Modbus B (RS485 or RS232)
3	Modbus A (RS485 or RS232)
2	0V Power in Return
1	18-32 V DC Power In

Mini-USB Port for configuration via a PC and firmware updates

- **Input pins can be set Active Hi or Active Lo**
- **Output pins can be Active Hi or Active Lo and set to NPN, PNP or Logic**
- **DIN Rail mount**
- **Input pins are programmable (typical functions: Zero, Print, Preset)**

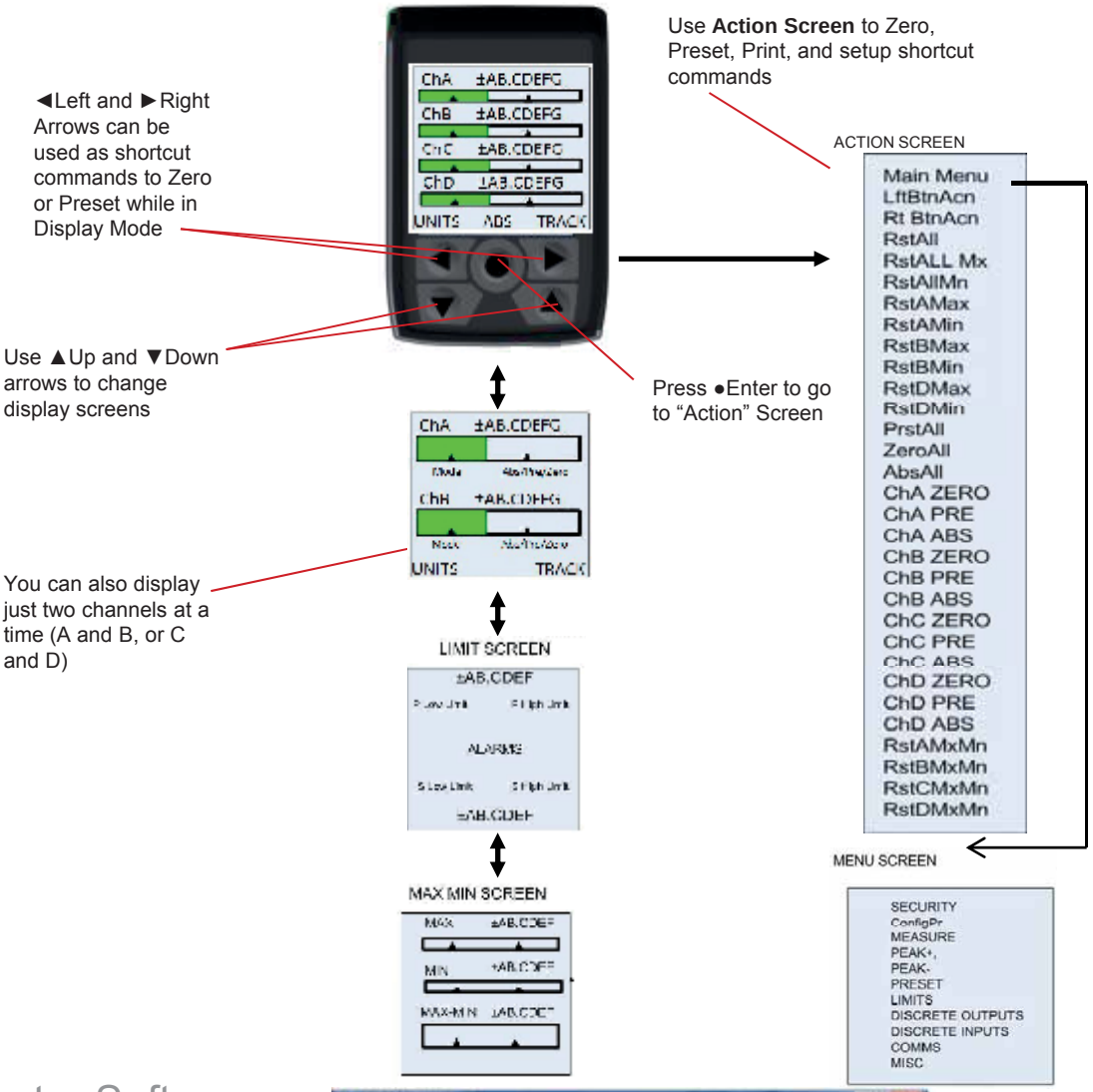
Serial Output Options

The SI400 has a standard Modbus interface (RTU or ASCII). However, pins 3 & 4 can be configured as an ASCII serial interface. (Pin 3: RS232TX, Pin 4: RS232 RX). In this mode, the user can select from several different ASCII protocols, including compatibility with Solartron's SI1500, SI3500 and C55.

Accessories

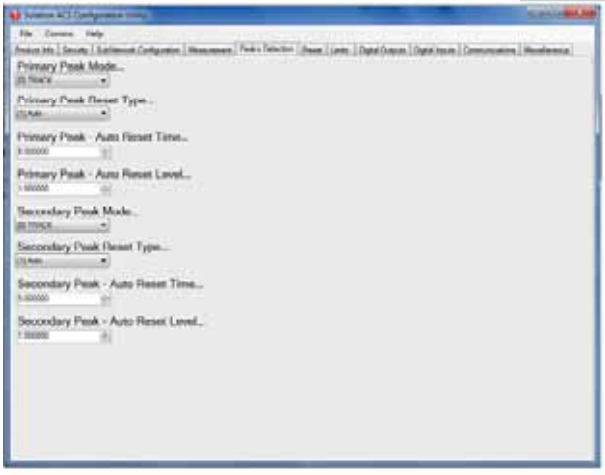
+24 V Power Block with Mains Leads. Available with UK, EU, and US plugs
Spare T-con Mounts
USB to Mini-USB cable for PC connection

Display and Interface



Configurator Software

Connect SI400 to PC via Mini-USB to USB cable. Then use Solartron provided software to configure unit, and backup settings to PC file!



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Products						
Spring Push Axial Cable	SI400P/1/S	SI400P/2/S	SI400P/5/S	SI400P/10/S	SI400P/20/S	SI400P10/2S
Spring Push Radial Cable		SI400PR/2/S	SI400PR/5/S	SI400PR/10/S	SI400PR/20/S	SI400PR10/2/S
Spring Push Axial Cable Feather Touch		SI400T/2/S	SI400T/5/S	SI400T/10/S	SI400T/20/S	SI400T10/2S
Spring Push Radial Cable Feather Touch		SI400TR/2/S	SI400TR/5/S	SI400TR/10/S	SI400TR/20/S	SI400TR10/2S
Pneumatic Axial Cable		SI400P/2/P	SI400P/5/P	SI400P/10/P	SI400P/20/P	SI400P10/2S
Pneumatic Radial Cable		SI400PR/2/P	SI400PR/5/P	SI400PR/10/P	SI400PR/20/P	SI400PR10/2/P
Pneumatic Axial Cable Feather Touch		SI400T/2/P	SI400T/5/P	SI400T/10/P	SI400T/20/P	SI400T10/2S
Pneumatic Radial Cable Feather Touch		SI400TR/2/P	SI400TR/5/P	SI400TR/10/P	SI400TR/20/P	SI400TR10/2S

Measurement Performance						
Measurement Range	1	2	5	10	20	2
Accuracy (% of Reading) (Note 1)	0.2	0.2	0.15	0.15	0.15	0.2
Repeatability (worst case) µm (Note 2)	0.15	0.15	0.15	0.15	0.15	0.15
Repeatability (typical) µm (Note 3)	0.05	0.05	0.05	0.07	0.07	0.05
Resolution (µm)	0.01	0.01	0.05	0.05	0.1	0.01
Pre Travel (mm)	0.15	0.15	0.15	0.15	0.15	0.15
Post Travel (mm)	0.35	0.85	0.85	0.85	0.85	8.85
Tip Force (N) at Middle of Range ±20%						
Spring Push	0.7	0.7	0.7	0.7	0.7	0.7
Spring Push Feather Touch	0.3	0.3	0.3	0.3	0.3	0.3
Pneumatic at 0.4 bar	N/A	0.7	0.7	0.7	0.7	0.7
Pneumatic at 1 bar	N/A	2.6	2.6	2.6	2.6	2.6
Pneumatic Feather Touch ±30% at 0.3 bar	N/A	0.18	0.18	0.18	0.18	0.18
Pneumatic Feather Touch ±30% at 1 bar	N/A	1.1	1.1	1.1	1.1	1.1
Pneumatic Jet	N/A	0.85	0.85	0.85	0.85	0.85
Temperature Coefficient %FS/ºC	0.01	0.01	0.01	0.01	0.01	0.01

Environmental	
Sealing for Probe	IP65 with gaiter or IP50 without gaiter
Sealing for Probe Interface Electronics	Top and Front: IP41, Rear: IP20, In line connector: IP67
Storage Temperature (ºC)	-20 to +70
Probe Operating Temperature with Gaiter (ºC)	+5 to +80
Probe Operating Temperature without Gaiter (ºC)	-10 to +80
Electronics Operating Temperature (ºC)	0 to 60
EMC Emissions	EN61000-6-3 and EN61326
EMC Immunity	EN61000-6-2 and EN61326
Power	18 to 32 VDC @ 0.07A typical

Material	
Probe Body	Stainless Steel
Probe Tip (options)	Nylon, Ruby, Silicon Nitride, Tugsten Carbide
Gaiter (standard)	Fluoroelastomer
Cable	PUR
Electronics Module	ABS

Electronics Interface (Orbit ACS)	
Alarm Outputs - selectable High, OK, Low	3 outputs either NPN, PNP, logic Programable Active Hi or Lo
Discrete Inputs - user selectable	4 inputs user configurable eg. Print, Zero, Preset
Update Rate for I/O discretes (ms)	5
Bandwidth of Electronics (Hz) - user selectable	460, 230, 115, 58, 29, 14, 7,4
Communications Interface Protocol	MODBUS (RTU or ASCII) or Solartron Serial Formats
Communications Interface Hardware	RS485 or RS232 (User selectable) Up to 115,200 Baud
Update Rate for Serial Data (ms)	25

Note 1: Accuracy 0.1 µm or % reading whichever greater

Note 2: Obtained by repeated operation against a carbide target with side load applied to the bearing using max-min

Note 3: Obtained by repeated operation against a carbide target standard deviation from average (68%)

For specifications of other Gauging and Displacement Transducers, Orbit® LT, or Orbit® LTH, please refer to their respective datasheets.

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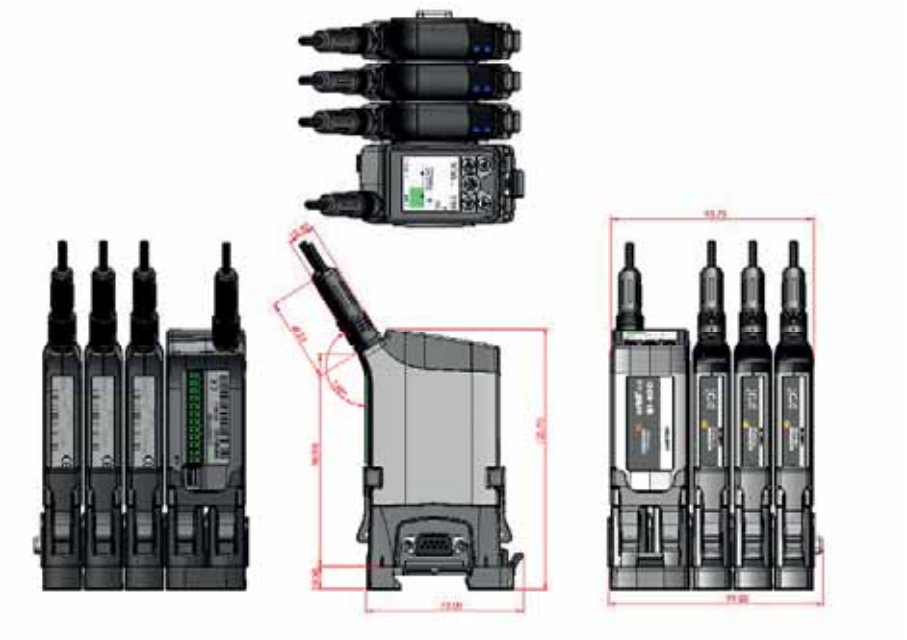
Instrument Functionality	
Measurement	
Measurement SI400	A, MAXA-MINA, B, MAXB-MINB, C, MAXC-MINC, D, MAXD-MIND,
Measurement Types	Track. Peak+, Peak -
Measurement Modes	Absolute, Zero (tare), Preset
Measurement Units	mm, inches, mils
Display	
Analogue SI400	Four Bars representing reading showing limits
Digital SI400	Four Digital up to 5 decimal places mm (6 for inches)
Keypad	
Type	Sealed Membrane

For Gauging probes, SI100 and SI200 can also be ordered with no plug for higher accuracy, or inline plug along cable
- Specs are for standard, plugged, gauging probes only. Specs will vary with other sensors. If considering another sensor, contact your local Solartron representative for details.
- Standard cable length is 2 meters. Special cable lengths can be ordered.

Drawing



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ABSOLUTE TTL MODULE

user leaflet

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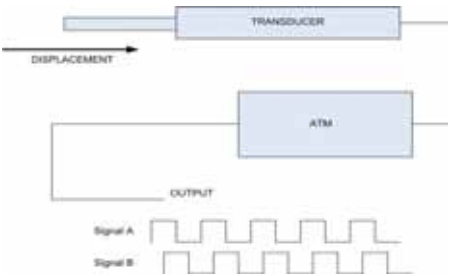
Product Description

Introduction

The Solartron ATM transducer comprises a sensor and conditioning electronics which provides an RS422 level square wave output. Each output pulse represents a discrete incremental displacement.



This type of square wave output, often called TTL can be read by many basic counter cards and instruments.

The major difference between the ATM and conventional incremental sensors which provide outputs of this type is that the ATM is an absolute sensor and therefore cannot lose its position even if it is moved quickly. Incremental sensors will miss count if moved too quickly, which means they need a reference signal at a known position to re-datum. The ATM does not need this and does not provide a reference signal.

Safety

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 the maximum ratings as specified in this document

This equipment operates below the SELV and is therefore outside the scope of the Low Voltage Directive

Service and Repair

	No user serviceable parts. Return to supplier for repair

Operation

Output Signals Provided

The ATM provides four output signals in the form of square waves. These are Signals A and B. Signal B is phase shifted 90 degrees to Signal A. For each signal A and B the inverse signal is also transmitted.

The Signal A and the inverse signal A is often called a Differential Signal A and the Signal B and the inverse signal B a Differential Signal B.

Signal A is commonly referred to as the IN PHASE Signal and Signal B as the QUADRATURE Signal, where quadrature indicates a 90 degree phase shift with respect to the in phase signal.

Operation

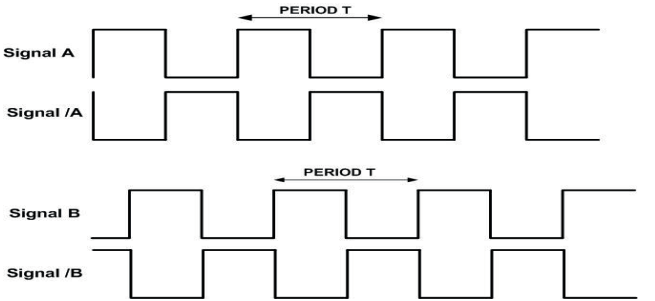


Figure 2: Output Signal Waveforms

The period of Signal A and Signal B is the same and therefore the Output Signal Frequency of A and B is:-

Output Signal Frequency = 1/PERIOD = 1/T

Resolution

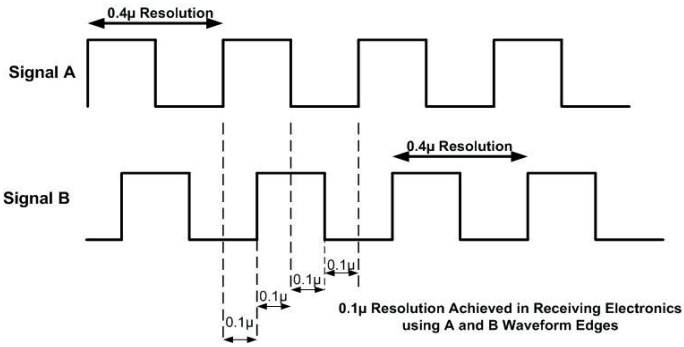


Figure 3: X4 Interpolation (performed in Receiving Electronics)

In figure 2 the period T of the signal corresponds to the resolution of the ATM. The ATM can be factory set to a specified resolution. These are 0.1 µm, 0.2 µm and 0.5 µm. **The resolution assumes x4 interpolation in the receiving electronics. (see opposite Fig 3).**

The period T of the separate A and B signals is therefore 0.4 µm, 0.8 µm, 2 µm.

Direction of Count Pulses

For an inward displacement Signal A leads Signal B,

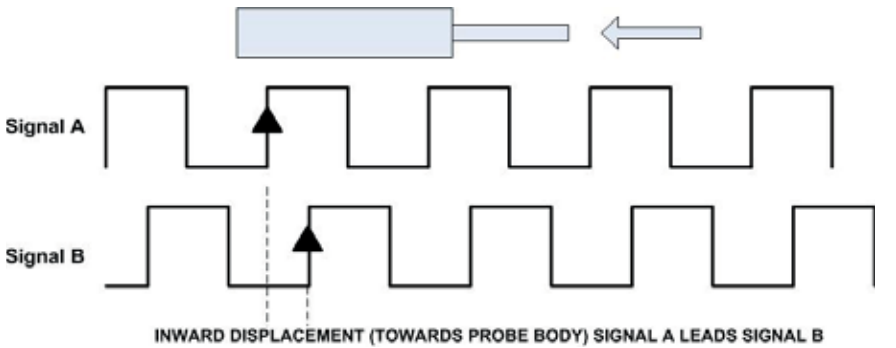


Fig 4a

Direction of Count Pulses

For an outward displacement Signal B leads Signal A

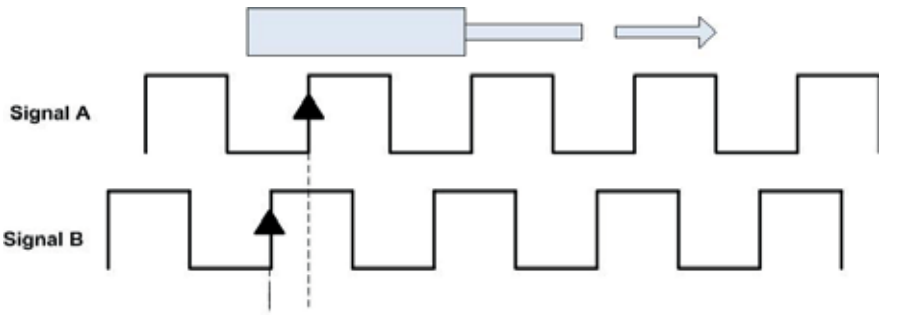


Fig 4b

Transmission of Count Pulses and Receiver Requirements

Number of Pulses sent

The ATM will send the exact number of pulses corresponding to the displacement moved. This will depend on the resolution set.

Number of A and B Pulses = Displacement (µm) / Selected resolution x 4.

E.g. Selected Resolution = 0.1 µm. Displacement =1.5 mm

Number of A and B Pulses = (1.5*1000) / (0.1 X 4) = 3750 pulses.

The receiving electronics must be able to count x4 the Number of pulse edges to correctly count the pulses. (See Fig 3).

Frequency of Pulses

Three factors affect the output frequency of Signals A and B from the ATM, these are:

- Maximum Output Signal Frequency, which is factory set. The ATM will never transmit at a higher frequency than this setting.
- The ATM resolution.
- The speed at which the probe is moved.

The output frequency of Signals A and B is calculated from the equation.

$$\text{Output frequency} = \frac{\text{Rate of change of Displacement (mm/sec)} * 1000}{\text{ATM Resolution} \times 4}$$

Frequency of Pulses

Three factors affect the output frequency of Signals A and B from the ATM, these are:

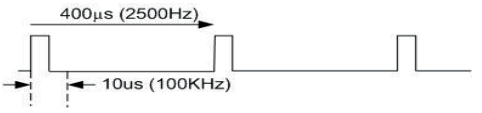
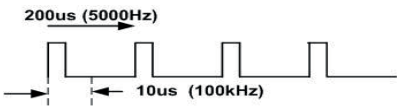
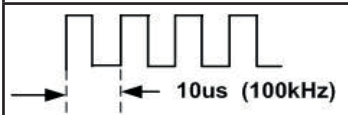
Table 1 below shows the relationship between Rate of change of Displacement (how fast the probe is moving) and the Output frequency for an ATM with a factory set resolution of 0.1 µm and a factory set maximum Output Frequency of 100 kHz.

Rate of Change of displacement	ATM Resolution	Output Frequency	
mm/sec	µm	Hz	
1	0.1	2500	
2	0.1	5000	
5	0.1	12500	
10	0.1	25000	
20	0.1	50000	
50	0.1	100000	Output Frequency Limited by maximum Output Signal Frequency
100	0.1	100000	

Table 1: Rate of Change of Displacement and Output Frequency

Frequency of Pulses

Example: Output Waveforms. (ATM set to 0.1 µm resolution, Max Output Frequency = 100 kHz)

	Probe moving at 1 mm/sec, therefore 2500 A pulses per second.
	Probe moving at 2 mm/sec, therefore 5000 A pulses per second.
	Probe moving at 50 mm/sec, therefore limited to Maximum Output frequency (100 kHz)

Frequency of Pulses

ATM system Lag

Once the probe is moving sufficiently fast that its Output Signal Frequency is limited by the factory set Maximum Output Signal Frequency then lag will be introduced into the measurement. This must be considered if the ATM is being used in a control application.

ATM Bandwidth

The ATM has a measurement bandwidth of 100 Hz. If it is used to measure signals with a frequency greater than 100 Hz then information about this signal will be lost.

Receiver Electronics

The receiver electronics must be able to handle signals up to 4 times the Maximum Output Signal frequency to ensure correct operation and not lose count.

ATM Maximum Output Signal Frequency	Minimum Frequency for Receiver
kHz	kHz
50	200
100	400
125	500
180	720
250	1000
360	1440
500	2000

Table 2: Receiver Electronics Input Frequency Requirements

Pre and Post Travel Positions

The ATM is set so that the probe has a pre and post travel region outside of the measurement range. If the probe is within the pre or post travel no signals are transmitted.

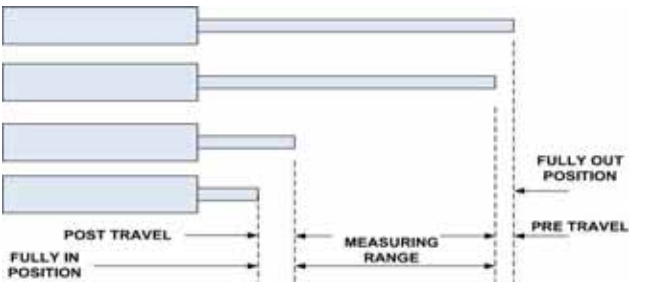


Figure 5: Pre and Post Travel

Absolute Mode and Incremental Mode

These options can be factory set.

In Absolute mode, on power on the ATM will read its absolute position and send pulses to the receiver corresponding to this position.

In incremental mode, on power on the ATM will treat this position as zero and will not send any pulses until it is moved.

Indication Lamps

The ATM has two indication lamps.

Condition	Blue LED	RED LED
Probe Moving (>10µm)	Flash	
Low Voltage warning (ATM still operates) **		Flash 20% On 80% Off
Low or High Voltage Error		Flash 80% On 20% Off
Hardware Error		On

** The ATM requires a +5 V ± 0.25 VDC Supply. If the voltage is outside of this range a warning is indicated, however the ATM will continue to operate. If the voltage is worse than 0.5 V out of range an error is indicated and the ATM stops transmitting signals.

Technical Data

Measurement Performance	
Transducer Range	0.5 mm to 150 mm depending on Probe Type fitted
Accuracy	Up to 0.15% reading depending on probe Type fitted
Resolution (x 4 interpolation)	0.1, 0.2 or 0.5 µm (factory set)
Repeatability	<0.15 µm depending on Probe Type Fitted
Electrical Performance	
Power	+5 V ± 0.25 VDC @ 100 mA
Output Signals (differential)	A and B, /A and /B (TTL / RS422)
Maximum Output Frequency	50, 100, 125, 250, 360, 500 kHz (factory set)
Bandwidth	100 Hz

Technical Data

Environmental	
Sealing	Transducer: typically IP65 depending on type. Electronics Module IP43
EMC	EN61000-6-3 Emissions EN61000-6-2 Susceptibility
Operating Temperature	0 ºC to 60 ºC
Storage Temperature	-20 ºC to 70 ºC
Air Supply (Pneumatic Probes)	Clean and Dry Air, maximum RH 60%, filtered to better than 5 µm (0.1 µm for specialist transducers with ultra low tip force). If unsure check with factory.
Operating Pressure (Pneumatic Probes)	Depends on Probe Type fitted. If unsure check with factory.

Electrical Connections

The ATM is normally supplied with 2 m of cable between the probe and the electronics module and 1 m between the electronics module and the connector or free wire end.

Signal	Description	Wire Ended	15 Way D Type (Heidenhain Pin Out)	15 Way D Type High Density
A	In Phase	Red	1	1
/A	In Phase Inverted	Pink	9	2
B	Quadrature	Yellow	3	3
/B	Quadrature Inverted	Green	11	4
Supply (+5 V ± 0.25 VDC)	Power Supply	Blue	4 & 12	13
Return (0V)	Return (0V)	Black	2 & 10	14