Sensata MATHSCON-6 24v AC or DC Powered Dual Input Mathematical Isolating Signal Converter User Manual

MATHESON-6
24V AC or DC POWERED
DUAL INPUT MATHEMATICAL
ISOLATING SIGNAL CONVERTER
User Manual

Contents

INTRODUCTION

1.1 Hardware Features

The MATHSCON isolating signal converter can be user configured to carry out a wide range of mathematical functions on two isolated input channels. One input is a universal current, voltage, thermocouple, or RTD input

and the other can be either voltage or current.
Each channel can be multiplied by a factor or linearised and then any of the following functions can be performed on these input channels Addition, Subtraction, Multiplication, Division, Square Root, High Signal Select, Low Signal Select, Absolute Difference.
The unit produces an isolated, scalable current or voltage output corresponding to the result of the required function.
The unit can be powered by any DC voltage between 16 and 36Vdc or AC voltage between 16 and 32Vac. The instrument is packaged in a compact 17.5mm wide enclosure which can be mounted on a standard TS35 DIN rail.

1.2 Isolation Details

The MATHSCON has full 3 port isolation of 1000V between the Input Stage, Output Stage, and Power Supply for functional reasons.

UNPACKING

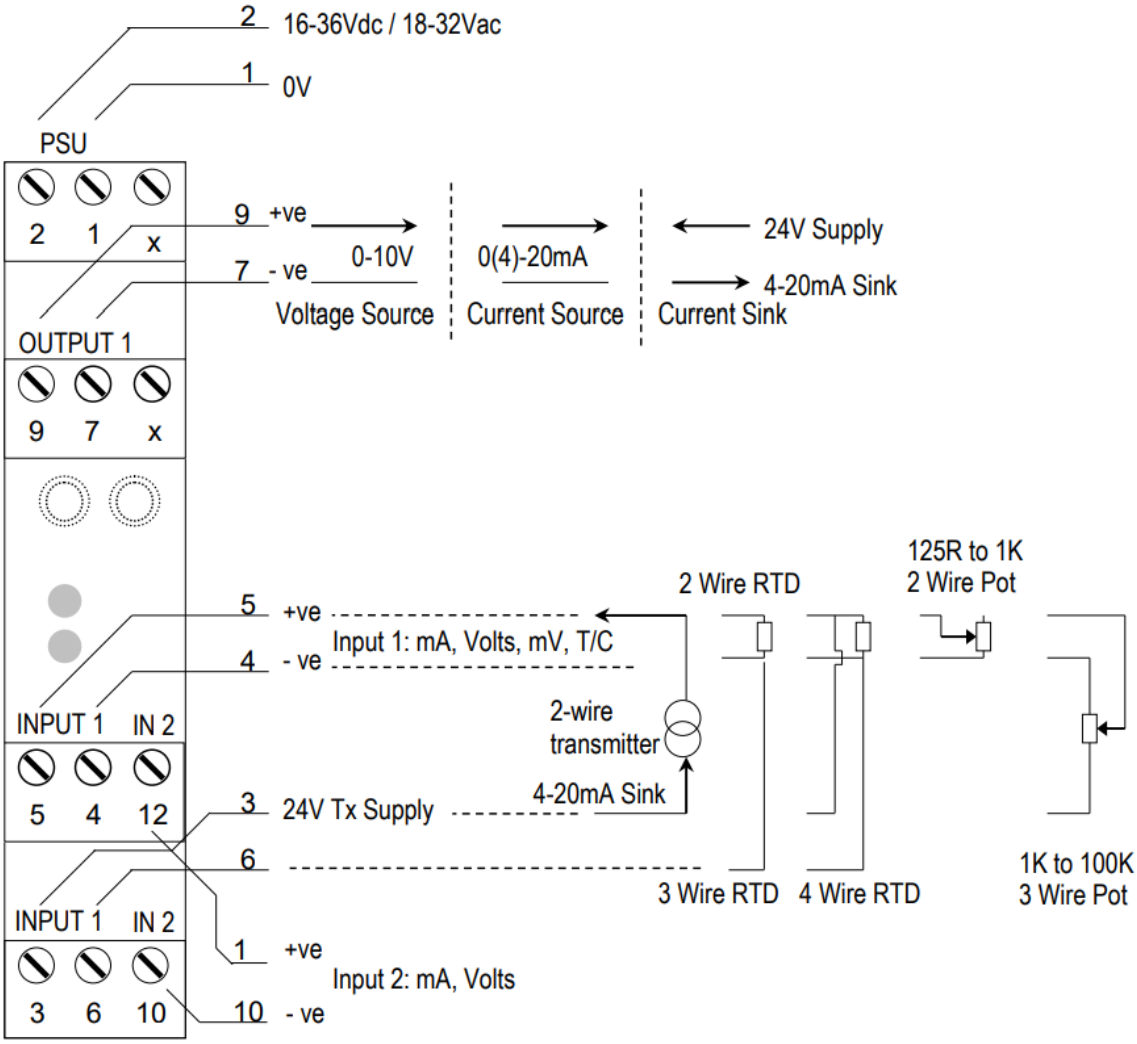
The instrument should be carefully inspected for signs of damage that may have occurred in transit. In the unlikely case that damage has been sustained, DO NOT use the instrument, but please retain all packaging for our inspection and contact your supplier immediately.
The instrument comes with the following items as standard:

1 MATHSCON-6 Isolating Mathematical Signal Converter
1 MATHSCON-6 User Manual

If the instrument has been factory configured the input and output details will be listed on the Serial number label on the side of the unit. If this label is blank then the unit will be set to its default configuration which is 4-20mA on both inputs and 420mA source output, scaled as (A+B)/2.
If re-configuration is required, please refer to sections 4 and 5 of this manual.

CONNECTIONS

The MATHSCON is housed in a compact DIN rail mounting enclosure, with 12 terminals, arranged in 4 rows of 3 terminals. Two rows are at the top of the front panel and 2 rows are at the bottom. All the sensor input terminals are on the bottom rows and the power supply and analog outputs are on the top terminals.
The diagram below shows how to connect all the different input, output, and power supply types.



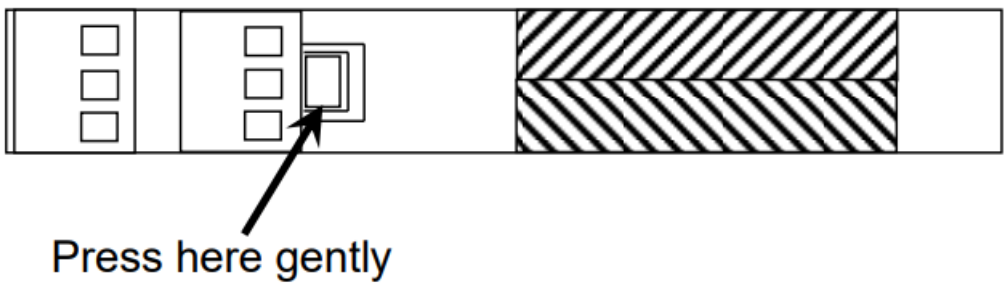
CONFIGURING THE MATHSCON

⚠WARNING!

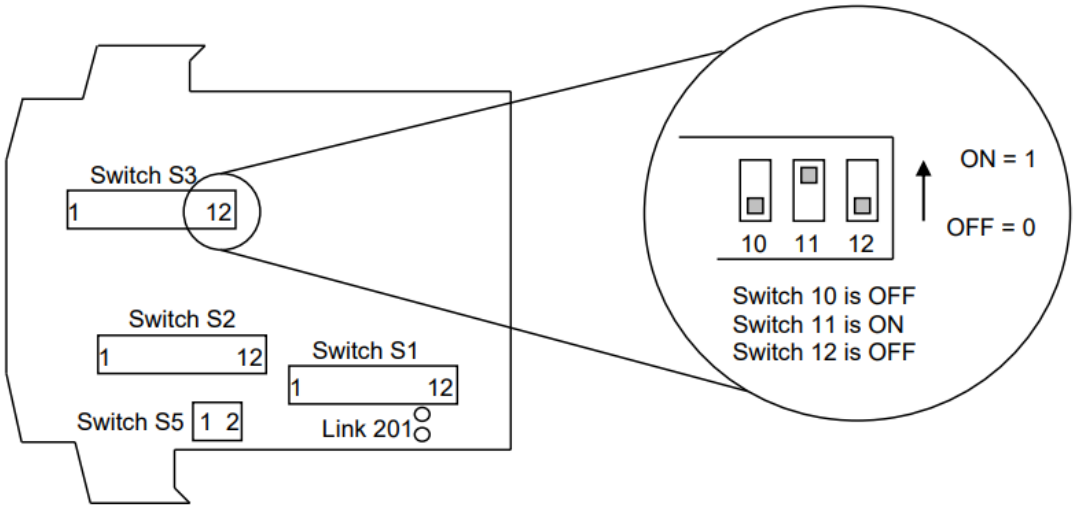
DO NOT OPEN THE UNIT OR ADJUST SWITCHES WITH THE POWER SUPPLY, INPUT, OR OUTPUT CONNECTED

MATHESON is an extremely versatile device that can support many different types of input. The unit is configured by turning the power off, selecting the internal switch settings required, and turning the power back on.

To open the MATHSCON, 2 catches just below the outer terminal blocks must be pushed in gently, one at a time. The front of the case can then be pulled, and the unit will come out of the box.



There are 4 switch banks, S1, S2, S3, S5, and one link 201 as shown below:



Switch S1 and S2 configures input 1 type, S1, and S5 configure input 2 types, and S3 configures the output type and function. Link 201 should be fitted for a 3-wire potentiometer on input 1. The switch settings are explained in the next few pages. The diagrams refer to switch positions 0 and 1, with 0 being OFF and 1 being ON.
This is illustrated in the picture above.

4.1 Voltage Input

Select the range from the table below and set Switch S1 to the required values. Note that Input 2 can be independently selected to be Voltage or Current for all types of Input 1 range and type.

Voltage Range	**Switch S1**										
Input 1	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	
0-1V	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**1**	**0**	**0**	
0-2V	0	0	0	1						0	
0-4V	0	0	1	0						0	
0-5V	**0**	**1**	**0**	**0**						**0**	
0-7.5V	1	0	0	0						0	
0-8V	0	0	1	1						0	
0-10V	**0**	**1**	**0**	**1**						**0**	
0-15V	1	0	0	1						0	
0-20V	0	1	1	0						0	
0-30V	1	0	1	0						0	
0-40V	0	1	1	1						0	
1-5V	**0**	**1**	**0**	**0**						**1**	
-5 to +5V	1	1	0	0						1	
-10 to +10V	**1**	**1**	**0**	**1**	**1**	**0**	**1**	**1**	**0**	**0**	
Input 2											**11** **12**
0-10V											**1** **0**
1-5V											**1** **1**

Then select the required setting from the table below for switches S2 and S5.

Input 1 Voltage Range	Switch S2											
	1	2	3	4	5	6	7	8	9	10	11	12
0-30V & 0-40V Ranges	0	0	1	1	0	0	1	1	0	0	0	0
All other Ranges Listed Above	0	0	1	0	1	0	1	0	0	0	0	0
Input 2 Voltage Range	**Switch S5**											
	1	**2**										
0-10V and 1-5V	0	0										

!WARNING!

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4.2 Current Input

Select the range from the table below and set Switch S1 to the required values. Note that Input 2 can be independently selected to be Voltage or Current for all types of Input 1 range and type.

mA Range	Switch S1											
Input 1	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**		
0-1mA	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**1**	**1**	**0**		
0-2mA	0	0	0	1						0		
0-4mA	0	0	1	0						0		
0-5mA	0	1	0	0						**0**		
0-8mA	0	0	1	1						0		
0-10mA	0	1	0	1						0		
0-15mA	1	0	0	1						**0**		
0-20mA	**0**	**1**	**1**	**0**						0		
0-30mA	1	0	1	0						0		
4-20mA	**0**	**1**	**1**	**0**						**1**		
4-40mA	0	1	1	1						1		
4-30mA	1	0	1	0						1		
-5 to +5mA	1	1	0	0						1		
-10 to +10mA	1	1	0	1	1	0	1	1	1	0		
Input 2											**11**	**12**
4-20mA											**0**	**0**
0-20mA											**0**	**1**

Then select the required setting from the table below for switches S2 and S5.

Input 1 mA Range	Switch S2 1	2	3	4	5	6	7	8	9	10	11	12
Using Internal 24V Tx Supply for 4 to 20mA transmitter	1	1	0	1	0	0	1	0	0	0	1	0
All other Ranges Listed Above	1	1	0	0	1	0	1	0	0	0	0	0

Input 2 mA Range	Switch S5 1	2
4-20mA and 0-20mA	1	1

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4.3 Millivolt (mV) Input

To set input 1 as an mV input type select the range from the table below and set Switch S1 to the required values.

mV Range Input 1	Switch S1 1	2	3	4	5	6	7	8	9	10	11	12
0-25mV	0	0	0	0	1	1	1	1	0	0		
0-50mV	0	0	0	1								
0-100mV	**0**	**0**	**1**	**0**								
0-125mV	0	1	0	0								
0-150mV	1	0	0	0								
0-200mV	**0**	**0**	**1**	**1**								
0-250mV	0	1	0	1								
0-300mV	1	0	0	1								
0-500mV	**0**	**1**	**1**	**0**								
0-600mV	1	0	1	0								
0-1000mV	0	1	1	1								
0-1200mV	1	0	1	1								
-125 to +125mV	1	1	0	0								
-125 to +1000mV	1	1	1	1	1	1	1	1	0	0		

And then select the required setting from the table below for switch S2.

Input 1	Switch S2											
mV Range	1	2	3	4	5	6	7	8	9	10	11	12
All Ranges												
Listed Above	0	1	0	0	1	0	1	0	0	0	0	0

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4.4 Potentiometer Input

To set input 1 as a potentiometer select the range from the table below and set Switch S1 to the required values.

Potentiometer Range Input 1	**Switch S1**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
2 Wire 0-125R	0	0	0	0	0	1	1	1	0	1		
2 Wire 0-250R	0	0	0	1								
2 Wire 0-500R	**0**	**0**	**1**	**0**								
2 Wire 0-625R	0	1	0	0								
2 Wire 0-750R	1	0	0	0								
2 Wire 0-1K	**0**	**0**	**1**	**1**	0	1	1	1	0	1		
3 Wire from 0-1K to 0-100K	**0**	**0**	**0**	**0**	**1**	**1**	**1**	**1**	**1**	**0**		

Then select the required setting from the table below for switch S2.

Potentiometer Input	**Switch S2**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
2 Wire Potentiometer	0	1	0	0	1	0	0	0	0	0	0	1
3 Wire Potentiometer	**also fit link 201 (see page 5 for details)** 0	0	1	1	0	0	1	0	0	0	1	0

⚠**!WARNING!**

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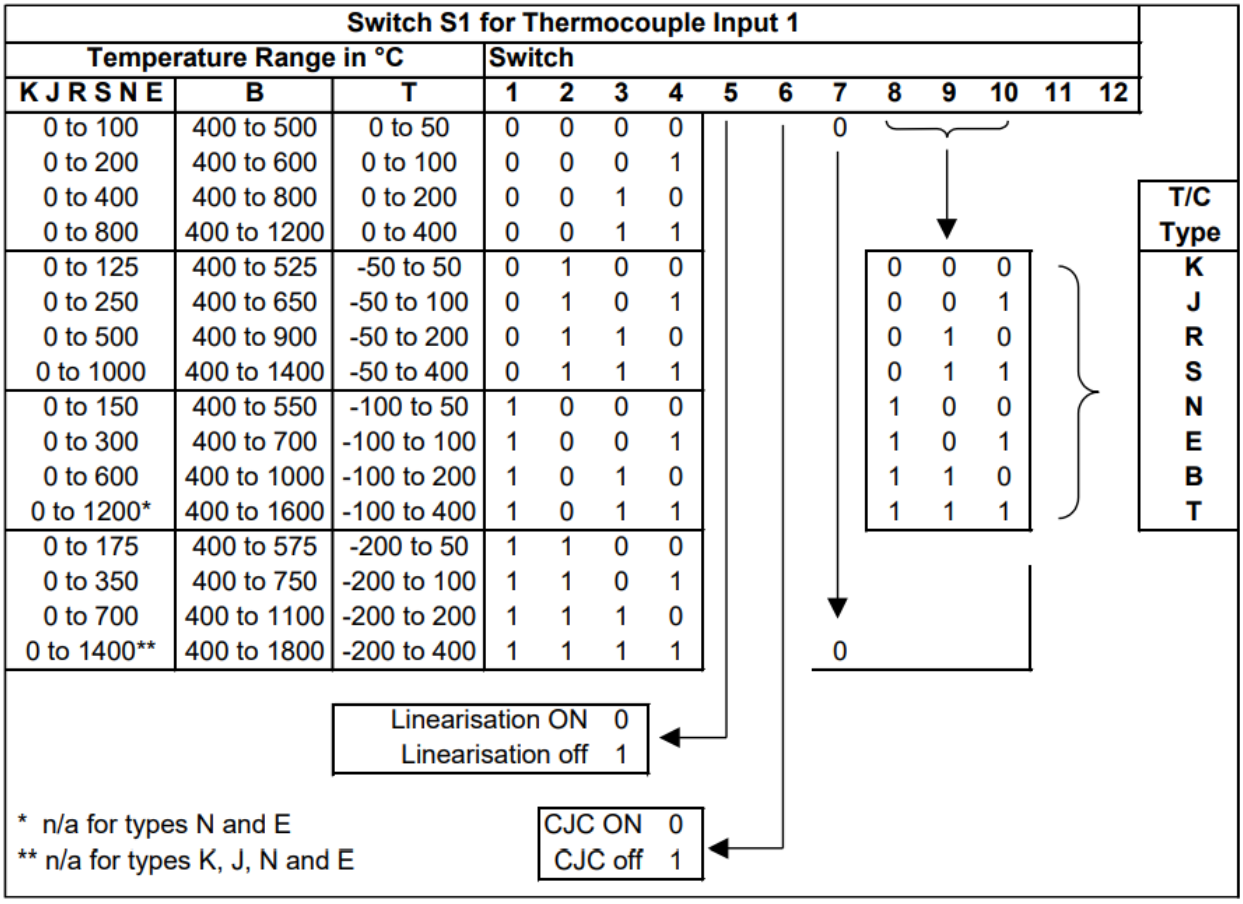
4.5 Thermocouple Input

Select the range from the table below and set Switch S1 to the required values.



Then select the required setting from the table below for switch S2.

Input 1 Thermocouple	Switch S2											
	1	2	3	4	5	6	7	8	9	10	11	12
All Ranges	0	1	0	0	1	1	1	0	0	0	0	0

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4.6 RTD Input

Select the range from the table below and set Switch S1 to the required values.

Range in °C	Switch S1											
	1	2	3	4	5	6	7	8	9	10	11	12
0 to 100	0	0	0	0			1	0	0			
0 to 200	0	0	0	1								
0 to 400	0	0	1	0								
0 to 800	0	0	1	1								
-50 to 50	0	1	0	0								
-50 to 150	0	1	0	1								
-50 to 250	0	1	1	0								
-50 to 350	0	1	1	1								
-100 to 50	1	0	0	0								
-100 to 100	1	0	0	1								
-100 to 200	1	0	1	0								
-100 to 400	1	0	1	1								
-200 to 200	1	1	0	0								
-200 to 400	1	1	0	1								
-200 to 600	1	1	1	0								
-200 to 800	1	1	1	1			1	0	0			

RTD linearisation ON	0
RTD linearisation off	1

PT100	0
PT1000	1

RTD 2 or 4 wire	0
RTD 3 wire	1

And then select the required setting from the table below for switch S2.

Input 1 RTD	Switch S2											
	1	2	3	4	5	6	7	8	9	10	11	12
2 Wire RTD	0	1	0	0	1	0	0	0	0	0	0	1
3 Wire RTD	0	1	0	0	0	0	0	0	1	0	0	1
4 Wire RTD	0	1	0	0	0	0	0	0	0	1	0	0

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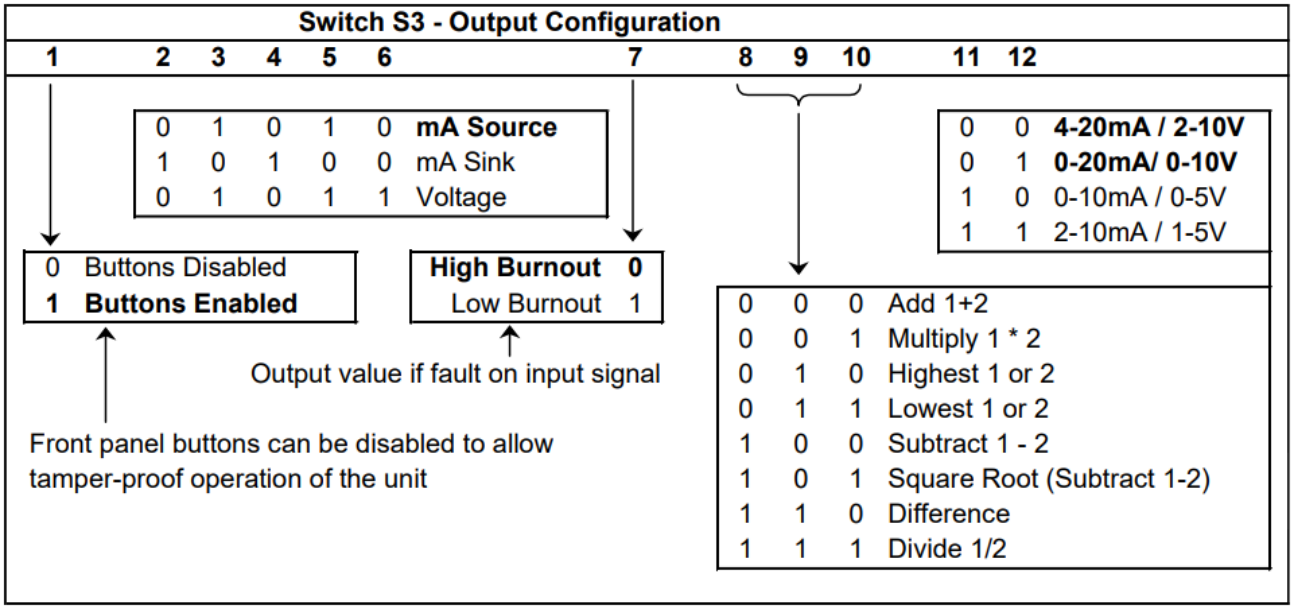
4.7 Output Configuration

Output type and maths operation is selected with Switch S3.



Switch S3 Examples												
	1	2	3	4	5	6	7	8	9	10	11	12
4-20mA Source	1	0	1	0	1	0	0	0	0	0	0	0
0-20mA Source	1	0	1	0	1	0	0	0	0	0	0	1
0-10V	1	0	1	0	1	1	0	0	0	0	0	1
4-20mA Sink	1	1	0	1	0	0	0	0	0	0	0	0
All these examples have the Add 1+2 maths function and High Burnout												

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CALIBRATING THE MATHSCON

When the unit is shipped the MATHSCON will be calibrated for the input and output types and ranges noted on the side label. If this label is blank, then the unit will be calibrated for 4-20mA on input 1 and input 2 and 4-20mA source output. The maths function will be Add 1+2, with scaling equivalent to Input 1 0-50%, Input 2 0-50%, output 0-100%.
The MATHSCON is programmed and calibrated using a multimeter and one or preferably two input sources. The led on the front panel is used to indicate if the unit is in run mode (green) or one of the four programming modes (red or amber).

5.1 Run Mode

In run mode the LED is green and the MATHSCON is working normally. Modes are selected by pressing either the up or down button on the front panel. After each press, the green LED will flash between 1 and 4 times to indicate which programming mode it will next enter (1 flash is mode 1, 2 flashes mode 2, etc.). To enter a programming mode both buttons must be simultaneously pushed and released.

5.2 Mode 1: Basic Calibration of Output

The output must be calibrated to the output range selected with Switch S3. For example, if the output range selected is 4-20 mA :

- In run, mode choose mode 1 (1 flash of the green led)
- Push and release both buttons on the front panel, LED will flash once and then go red
- Adjust output to 20 mA using the up and down buttons on the front panel
- Push and release both buttons, LED will go amber
- Adjust output to be 4 mA
- Push and release both buttons, and the LED will go green, it is in run mode again

5.3 Mode 2: Basic Calibration of Inputs 1 and 2
The inputs must be calibrated to the two input ranges selected with switches S1, S2, and S5. Four values are learned in this order: Input 1 Span then Zero, Input 2 Span then Zero. For example, if Input 1 is 0-10V and Input 2 is 4-20mA.

- In the run, mode choose mode 2 (2 flashes of the green LED)
- Push and release both buttons, LED will flash twice and then go red
- Inject 10V into input 1. The output will take a few seconds to stabilize as the input value is averaged to ensure an accurate reading is taken.
- Wait until the output is stable then push the up button to confirm the value.
- Push and release both buttons, the LED will go amber
- Inject 0V into input 1
- Wait until the output is stable then push the up button to confirm the value
- Push and release both buttons, the LED will go red
- Inject 20mA into input 2
- Wait until the output is stable then push the up button to confirm the value
- Push and release both buttons, the LED will go amber
- Inject 4mA into input 2
- Wait until the output is stable then push the up button to confirm the value
- Push and release both buttons, and the LED will go green, and it is in run mode again

Note: if the up button is not pressed and released, the input value won't be learned.

5.4 Mode 3: Advanced Scaling
If the input ranges are weighted differently (e.g., Input 1: 5-80%, Input 2: 18-65%), scaling must be applied to each input before the maths operation is applied. Four scaling values must be programmed to achieve this (e.g., a value represents 5, another 80, then 18 and 65). The scaling values are programmed into the MATHSCON by adjusting the output to proportionately represent the weighting of

$$ScalingVal = \frac{\{x*(OutputSpan - OutputZero)\}}{Biggest} + OutputZero$$

Where x is the Yovalue to be represented (eg 5,80,18 or 65 in the example), Biggest is the biggest of the 4 %values (80), OutputZero and OutputSpan are the values calibrated in Mode 1, for example, 4 -20mA the two inputs.
This equation allows us to calculate four scaling values:
Input 1: 5-80% is 5 mA to 20 mA

Input 2: 18-65% is 7.6 mA to 17 mA
The four scaling values are learned in this order: Input 1 Span (20 mA) then Zero (5 mA), Input 2 Span (17 mA) then Zero (7.6 mA).

- In run, mode choose mode 3 (3 flashes of the green led)
- Push and release both buttons, the LED will flash 3 times and then go red
- Adjust output to 20 mA using the up and down buttons on the front panel
- Push and release both buttons, the LED will go amber
- Adjust output to be 5 mA
- Push and release both buttons, the LED will go red
- Adjust output to be 17 mA
- Push and release both buttons, the LED will go amber
- Adjust output to be 7.6 mA
- Push and release both buttons, and the led will go green, and it is in run mode again

5.5 Mode 4: Calibrate MATHSCON Output
The MATHSCON must be taught what the output should be for two different sets of input values, ideally at either end of the output scale. The best results are obtained with two input sources, but it is usually possible to do this calibration with only one. If one of the inputs is not connected, the value of that input will default to the %value of its zero point, so if the input is scaled from 0% and multiplication is carried out, the result will always be zero, regardless of the value on the other input. Similarly, for a “lowest” maths operation, two input sources are required to set up an output value that is not zero.
The two points are learned in this order: Output Span point then Zero point.
E.g.: Input 1 is 0-10V and Input 2 is 4-20 mA
Input 1 is scaled 5-80% and Input 2 is scaled 18-65%
Output is 4-20mA, maths operation is Add, Output is scaled 23% to 145%
If 2 input sources are available :

- In the run, mode choose mode 4 (4 flashes of the green led)
- Push and release both buttons, the LED will flash 4 times and then go red
- Inject 10V into input 1, 20 mA into input 2
- Adjust output to 20 mA using the up and down buttons on the front panel
- Push and release both buttons, the LED will go amber
- Inject 0V into input 1 and 4 mA into input 2
- Adjust output to be 4 mA
- Push and release both buttons, and the LED will go green, and it is in run mode again

If 1 input source is available (say 0-10V), calculate what the output should be with one input at full scale, the other at zero Output span point = ((80+18)-23)/(145-23)*(20-16)+4=13.836 mA

- In the run, mode choose mode 4 (4 flashes of the green led)
- Push and release both buttons, the LED will flash 4 times and then go red
- Inject 10V into input 1, leave input 2 disconnected
- Adjust output to 13.836 mA using the up and down buttons on the front panel
- Push and release both buttons, the LED will go amber
- Inject 0V into input 1 and leave input 2 disconnected
- Adjust output to be 4 mA
- Push and release both buttons, and the LED will go green, it is in run mode again

If an input is not connected, the input value that the output uses will correspond to the value learned in Mode 2 when the zero-scale input was learned. In other words, the input is clipped at the bottom end. Inputs are not clipped at the top end, however.

5.6 Reset the Calibration Values

To reset the Mode 4 output calibration, change one of switches 11 or 12 and power on, and off then change the switch back again.

To reset the Mode 3 maths scaling, change one of switches 8, 9, or 10 and power on, off then change the switch back again.

INSTALLATION

The MATHSCON's input and output circuits are classed as Separated Extra Low Voltage (SELV). This means that they must not be externally connected to voltages exceeding 30V ac or 60V dc, nor do they generate voltages above these limits internally. Where a higher voltage input is required a specially designed DIVIDER unit can be used to condition the input signal before connection to the process input terminals.

The MATHSCON unit clips directly onto the 'Top Hat' (TS35) symmetrical DIN rail. Ideally, the mounting orientation should be vertical. Good airflow around the unit will maximize the reliability of the instrument.

The use of ferrules is recommended for wiring terminations.

Do not exceed the terminal torque rating of 0.4 Nm – use an appropriate screwdriver. The unit can be removed from the DIN rail by sliding a small screwdriver into the slot at the rear of the enclosure on the lower face and gently levering the metal clip, whilst lifting the unit from the rail.

TROUBLESHOOTING

The MATHSCON has some built-in self-diagnostic functions. If the LED on the front panel is flashing, then the fault can be found by counting the number of flashes between gaps and using the table below to locate the problem.

No of Flashes	Nature of Fault	Corrective Action
0 (Green On)	Unit Working – no suspected fa ult	Check Wiring and switch settings
2,3,8,9,10,11,12 green	Hardware Error, extreme noise, poor supply	Switch off the unit, check the switch settings, and wiring, a nd retry. If still faulty please contact the supplier
7 green	RTD / Thermocouple burnout	Repair RTD, T/C, or wiring
No LED	Power Failure	Check supply lines and voltage

7.1 Incorrect Reading

- Check that Unit is configured for the correct Sensor
- Check that Input Scaling is as required.
- Check that Linearisation has been set correctly.
- Check that Thermocouples have correct compensation cables and polarity.
- Check that RTD is set for the correct option 2, 3, or 4 Wire.
- Check that RTD leads are connected to appropriate terminal pins.

7.2 Sensor Failure

- Check that the sensor wiring is correct.
- Check Thermocouple polarity.
- Check that all RTD leads are connected to the correct terminals.
- Check that the MATHSCON is configured for the correct sensor.
- Check that the applied voltage is not out of range.
- Check that the applied current is not out of range.
- Check that the applied millivoltage is not out of range.

SPECIFICATIONS (@ 25°C)

Operating Temperature	0 to 55 °C
Operating Altitude	Sea Level to 2000m
Humidity	0-90% RH
Power Requirements DC Supply AC Supply	16 to 36Vdc 16 to 32Vac
Current Consumption	55mA @24VDC (20mA in & out) 85mA @24VDC (maximum load, tx supply) 200mA@16VDC (maximum load, tx supply) 260mA for 50ms on 24VDC power up
Transmitter Power Supply	22V to 29V @ up to 24mA Depending on the supply voltage and load
Calibration accuracy	±0.05% full scale
Linearity	±0.05% full scale
Temperature Stability	50ppm / °C
Input Impedance: Current Input Voltage Input Millivolt Input	 15 ohms 1 M ohm Greater Than 10 M ohm
Thermocouple Burn Out Current:	500nA Nominal
Cold junction compensation accuracy	±0.5°C over the operating range
Maximum Voltage Output	11.5 V into a minimum of 7Kohm
Maximum Current Output	23.0 mA into a maximum of 1Kohm
Time Response (90% of a step change):	50ms ± 10ms
The unit has full 3 port Isolation to 1kV between Power Supply, Input, and Output. The unit can also withstand transients of 2.5kV for 50 µsecs.	
Dimensions	114.5 mm x 99mm x 17.5mm (H x D x W)
Mounting	DIN Rail TS35
Connections	Screw Clamp with pressure plate
Conductor Size	0.5 to 4.0 mm
Insulation Stripping	12 mm
Maximum Terminal Torque	0.4 Nm
Weight	Approx. 106g
EMC	BS EN61326

AUG 2022
Sensata Technologies
220808

Documents / Resources

	**Sensata MATHSCON-6 24v AC or DC Powered Dual Input Mathematical Isolating Signal Converter** [pdf] User Manual MATHSCON-6 24v AC or DC Powered Dual Input Mathematical Isolating Signal Converter, MATHSCON-6, 24v AC or DC Powered Dual Input Mathematical Isolating Signal Converter, Mathematical Isolating Signal Converter, Isolating Signal Converter, Signal Converter, Converter