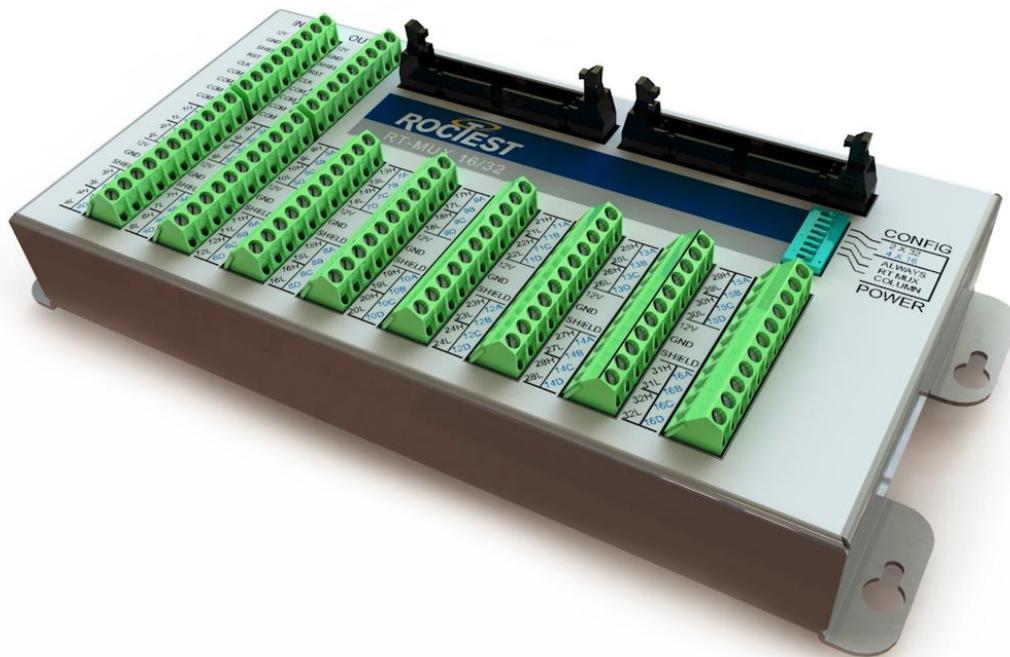




# INSTRUCTION MANUAL

## RELAY MULTIPLEXER

Model : RT-MUX 16/32



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This product should be installed and operated only by qualified personnel. Its misuse is potentially dangerous. The Company makes no warranty as to the information furnished in this manual and assumes no liability for damages resulting from the installation or use of this product. The information herein is subject to change without notification.

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E10378-170620



## TABLE OF CONTENTS

<b>1</b>	<b>PRODUCT DESCRIPTION .....</b>	<b>2</b>
1.1	MULTIPLEXED INPUT CHANNELS .....	2
1.2	DAISY CHAIN FEATURE .....	2
1.3	POWER SOURCE OUTPUTS .....	2
1.4	SURGE PROTECTIONS .....	2
1.5	MANUAL SWITCHING PORTS .....	2
1.6	RT-MUX HOUSING.....	3
1.7	COMPATIBILITY.....	3
<b>2</b>	<b>MULTIPLEXER LAYOUT .....</b>	<b>3</b>
<b>3</b>	<b>TERMINALS DESCRIPTIONS .....</b>	<b>4</b>
3.1	INPUT CONTROL TERMINALS .....	4
3.2	OUTPUT CONTROL TERMINALS.....	5
3.3	INPUT TERMINALS.....	5
3.4	OUTPUT TERMINALS .....	5
3.5	SHIELD TERMINALS.....	6
3.6	POWER OUTPUT TERMINALS .....	6
3.7	SENSOR CONNECTIONS.....	7
<b>4</b>	<b>OPERATING MODES .....</b>	<b>8</b>
4.1	SC-MODE (STANDARD OPERATION).....	8
4.2	CH-MODE (GO TO CHANNEL) .....	9
4.3	OPERATIONNAL CRITERIA.....	10
4.4	DATALOGGER PROGRAMMING EXAMPLE.....	10
4.5	THERMOCOUPLE MEASUREMENT.....	11
4.6	SENSOR TYPES .....	11
<b>5</b>	<b>RT-MUX ENCLOSURES.....</b>	<b>11</b>
5.1	RT-MUX ENCLOSURE.....	12
5.2	RT-MUX ENCLOSURE WITH MANUAL SWITCH PANEL .....	12
<b>6</b>	<b>RT-MUX SPECIFICATIONS .....</b>	<b>13</b>

## TABLE OF FIGURES

Figure 1:	RT-MUX 16/32 FRONT PANEL .....	3
Figure 2:	OUTPUT TERMINALS vs CHANNEL NUMBER .....	6
Figure 3:	TWO-CONDUCTOR SENSOR CONNECTIONS (2x32) .....	7
Figure 4:	FOUR-CONDUCTOR SENSOR CONNECTIONS (4x16) .....	7
Figure 5:	SC-MODE RESET & CLOCK TIMINGS .....	8
Figure 6:	CH-MODE RESET & CLOCK TIMINGS .....	9
Figure 7:	STANDARD ENCLOSURE .....	12
Figure 8:	RT-MUX WITH MANUAL SWITCHING PANEL ENCLOSURE .....	12
Figure 9:	RT-MUX DIMENSIONS .....	14

## 1 PRODUCT DESCRIPTION

The RT-MUX 16/32 is a compact relay multiplexer designed to switch low level analog signals; its principal function is to increase the number of channels that can be measured by a datalogger system. The RT-MUX 16/32 electromechanical relays are sequentially activated by the datalogger's digital output ports; these ports are controlled by the datalogger's program. When an input channel on the RT-MUX is activated, the sensor's wires connected to that input channel are routed by the relays to the multiplexer's common outputs. These common outputs are then wired to a measuring channel on the datalogger allowing a single datalogger channel to measure several sensors.

### 1.1 MULTIPLEXED INPUT CHANNELS

The RT-MUX can multiplex up to thirty-two sensors (2 conductors) or sixteen sensors (4 conductors) however, using two RT-MUXs in parallel, up to six or eight conductor sensors can be multiplexed.

### 1.2 DAISY CHAIN FEATURE

To simplify and minimize wiring between a datalogger and several multiplexers, the RT-MUX can be daisy chained. This unique feature requires only two digital output ports from a datalogger to control a chain of multiplexers, thus reducing the wiring cost.

### 1.3 POWER SOURCE OUTPUTS

The RT-MUX comes with eight 12 VDC Output Power Source terminals. Sensors that require power can be connected to these terminals. The mini slide switches located on the RT-MUX's front panel are used to select between different power modes.

### 1.4 SURGE PROTECTIONS

The RT-MUX modular design offers the possibility to add surge protections against lightning or EMI/RFI on every input channel.

The **Standard** RT-MUX model provides reverse protection on the 12 Volts power terminals and basic surge protections on the Clock and Reset input/output terminals using Transient Voltage Suppressors (TVS1500W).

The **Protected** RT-MUX model provides additional protection on all signal input terminals using Transient Voltage Suppressors (TVS1500W).

The **Fully Protected** RT-MUX model provides a 6 elements protection scheme on all signal input terminals using a combination of Transient Voltage Suppressors (TVS 36V 1500W), Gas Discharge Tubes (230V 5kA 1pF) and 10 $\mu$ H inductors to limit inrush surge current.

### 1.5 MANUAL SWITCHING PORTS

All RT-MUX models are equipped with two Latch Ribbon-cable connectors; these two connectors are used with Roctest's Manual Switching Panel to provide manual measuring capability between a portable readout device and the sensors connected to the input terminals. The RT-MUX and the Switching Panel are mounted inside the same enclosure. See Figure 8.

## 1.6 RT-MUX HOUSING

The RT-MUX circuits are housed in a 16 gauge (0.0598 inches) steel case for maximum protection. The case comes with four mounting tabs to mount the RT-MUX on a backplane panel inside a NEMA enclosure; the RT-MUX can also be mounted on a DIN rail with optimal DIN rail accessories.

## 1.7 COMPATIBILITY

The RT-MUX is compatible with Campbell Scientific datalogger series: CR300, CR6 CR800, CR850, CR1000, CR3000, CR5000 and older dataloggers such as; CR10, CR10X, CR21X and CR23X. The RT-MUX is also compatible with the AVW200 and AVW206 vibrating wire interfaces. In addition, the RT-MUX supports Campbell Scientific's AM16/32B multiplexer Mode A and Mode B.

The RT-MUX should be compatible with any datalogger that has at least two controllable digital output ports, where the pulse's width and delay can be controlled.



**Figure 1: RT-MUX 16/32 FRONT PANEL**

## 2 MULTIPLEXER LAYOUT

The multiplexer front panel is divided into four sections:

- The Input/Output Control Terminals
- The Input Terminals and 12VDC Output Power Source Terminals
- The mini Slide Switches
- The Latch Ribbon-cable Connectors

The two Control Terminals located on the upper left side are used for power, control signals and sensors' return signals.

The Input Terminals located on the lower section from left to right are used to connect the sensors. The 12VDC Output Power Source Terminals located in the middle of the Input Terminals are used to supply power required by some transducers.

The mini Slide Switches located on the upper right side are used to set the multiplexer's operating mode.

The two latch ribbon-cable connectors located in the upper middle section are used to connect the optional manual switching panel.

### 3 TERMINALS DESCRIPTIONS

The RT-MUX's terminal blocks are organized in two rows; the top row terminals (two columns) are used for the input/output control signals, the bottom row terminals (ten columns) are used for the sensor inputs and 12VDC Output Power. All terminals are angled to facilitate wire connections. Each terminal allows connection of two conductors but is not recommended.

#### 3.1 INPUT CONTROL TERMINALS

- 12V** This is the multiplexer's main 12VDC power source. This voltage does not need to be regulated because the RT-MUX has its own built-in voltage regulator, however, the voltage must be between 10 and 16 VDC. When active, the RT-MUX draws approximately 25 mA (RST signal= 5VDC with one channel active). When in standby, the RT-MUX draws approximately 20 $\mu$ A (RST signal= 0VDC).
- GND** This is the multiplexer's power supply ground and it also serves as a reference for the control signals. It must be connected to the datalogger's power ground reference at all times, even if an independent local 12VDC power supply is used to power the multiplexer(s). This ground is not directly linked to the channel shielding; it is linked by a Transient Voltage Suppressor (TVS).
- RST** This control signal is used to activate or deactivate the RT-MUX multiplexer. In addition, each activation/deactivate cycle resets the multiplexer's to its initial state (RESET). A voltage between 3.5 VDC and 5 VDC applied to this terminal activates the multiplexer, a voltage below 0.9VDC deactivate the multiplexer and puts it on standby or low power mode.
- CLK** This control signal is referred to as the "clock" and is used to sequentially select the input channels and routed them to the multiplexer's common output. The "clock" signals are pulses generated by the datalogger's digital output ports. Transition changes are made on the rising edges of the pulse signal from low <0.9 VDC to 3.5 VDC < high < 5 VDC.
- COMs** Usually signals on these input terminals originate from the proceeding multiplexer in a daisy chain configuration.. The inputs COM H, L, or COM A, B, C and D are connected to the COMs output terminals.

## 3.2 OUTPUT CONTROL TERMINALS

- 12V** This terminal is directly connected to the 12V input terminal.
- GND** This terminal is directly connected to the GND input terminal.
- RST** This output control signal is used to activate or deactivate the next multiplexer in a daisy chained configuration. When the multiplexer's last channel is released, this terminal outputs a voltage signal of 5 VDC to activate the next multiplexer in the chain if a daisy chained configuration is used. Each activation/deactivate cycle resets the multiplexer's to its initial state (RESET).
- CLK** This output control signal is buffered from the CLK signal input, it is used to apply the "clock" signal to the next multiplexer and reduces the load on the datalogger's digital output ports. The same electrical property applies; transition changes are made on the rising edges of the pulse signal from low <0.9 VDC to 3.5 VDC < high < 5 VDC.
- COMs** These terminals are directly connected to the COM input terminals. The COM output terminals COM H, L, or COM A, B, C D are connected to the datalogger's terminals or to the COM input terminals of the next multiplexer in a daisy chain configuration.

## 3.3 INPUT TERMINALS

These input terminals are used for sensors or transducers connections. The input terminals are labeled accordingly, based on two-conductor sensors or four-conductor sensors.

### **Two-conductor Sensors: 1H, 1L to 32H, 32L**

When connecting two-conductor sensors, the input terminals labeled; 1H, 1L to 32H, 32L are used to make the connections, a maximum of thirty-two sensors can be connected. The common output terminals will then be COM H and COM L. The mini slide switch is set to 2 x 32 positions.

### **Four-conductor Sensors: 1A, 1B, 1C, 1D to 16A, 16B, 16C 16L**

When connecting four-conductor sensors, the input terminals labeled; 1A, 1B, 1C, 1D to 16A, 16B, 16C 16L are used to make the connections a maximum of sixteen sensors can be connected. The common output terminals are then COMA, COMB, COMC and COMD. The mini slide switch is set to 4 x 16 positions.

## 3.4 OUTPUT TERMINALS

### **COM HL, COM ABCD**

The COM terminals are the sensors' common output signal, and are typically routed to the datalogger's input terminals. In some cases, the COM outputs are routed to a specific interface to precondition the sensor signal before the datalogger makes the measurement; example when using the AVW200 Vibrating Wire interface. Depending on the multiplexer's configuration, COM HL or COM ABCD is used. The following figure shows which input signals are found on the COM terminals during the "clock" sequence.

32 CH. (CIk)	COMH	COML		16 CH. (CIk)	COMA	COMB	COMC	COMD
1	1H	1L		1	1A	1B	1C	1D
2	2H	2L		2	2A	2B	2C	2D
3	3H	3L		3	3A	3B	3C	3D
4	4H	4L		4	4A	4B	4C	4D
.	.	.		.	.	.	.	.
.	.	.		.	.	.	.	.
30	30H	30L		14	14A	14B	14C	14D
31	31H	31L		15	15A	15B	15C	15D
32	32H	32L		16	16A	16B	16C	16D

**Figure 2: OUTPUT TERMINALS vs CHANNEL NUMBER**

### 3.5 SHIELD TERMINALS

#### SHIELDS

This is the electrostatic shielding used to restrict electric noises on the input signals and also provide electric protections. All input terminals labeled SHIELD are internally connected together. For maximum electrostatic protection, the sensor cable's drain wire or shield must be connected to these terminals. The common signal cable's shield is connected to the datalogger, and from there, connected to the earth ground.

### 3.6 POWER OUTPUT TERMINALS

Some sensors have built-in conditioning circuit that needs power to function properly. These sensors may be located in areas where connecting them to a local power source could be impractical and unreliable. A few examples of such sensors:

- Tiltmeter
- Barometer
- LVDT
- 4-20 mA Transducer

The RT-MUX comes with eight 12 VDC Power Source Outputs. The terminals are located in the middle of each input terminal row. They provide unregulated 12 VDC power sources with a maximum current of 250 mA each; however, the maximum current if all eight Power Source Outputs are used is 1 Amp.

The Power Source Outputs can operate in three different modes:

- ALWAYS
- RT-MUX
- COLUMN

The RT-MUX must be powered when the Power Source Outputs are in use. The different operating modes are selected using the mini slide switches.

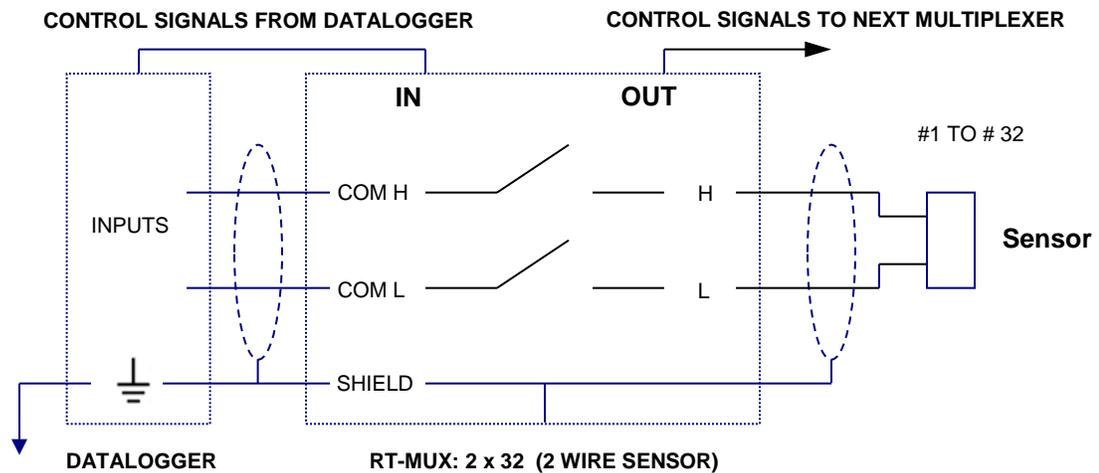
**ALWAYS mode:** In this mode all the Power Source Outputs are continuously powered even if the RXT-MUX is not activated by the RST control signal.

**RT-MUX mode:** In this mode all the Power Source Outputs are powered only when the RT-MUX is activated by the RST control signal.

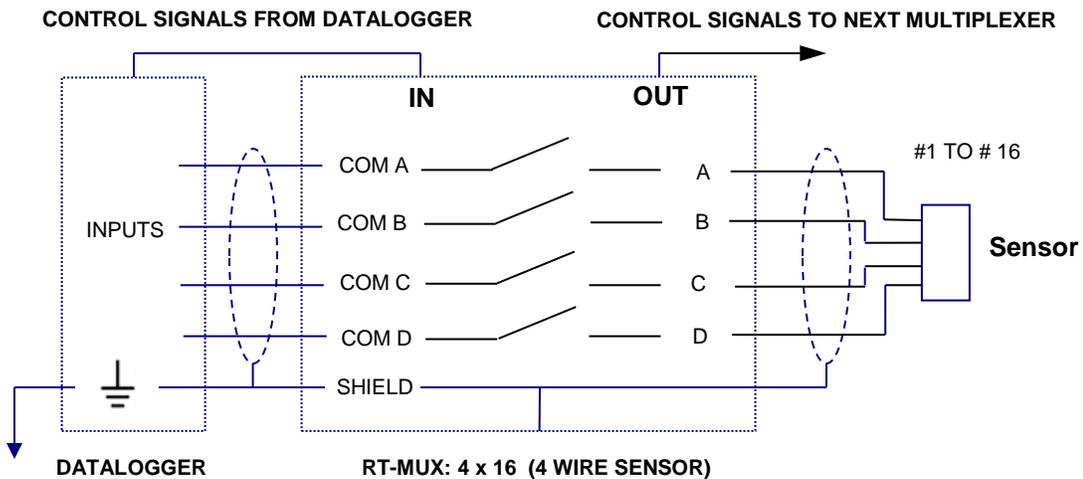
**COLUMN mode:** In this mode only one of the eight Power Source Outputs is powered at a time. When the datalogger activates the RST signal and sends the first CLK signal, the Power Source Output located in the first “column” is powered. Power is maintained until all channels in this first “column” are released or deselected.

### 3.7 SENSOR CONNECTIONS

Typical sensor connections to the RT-MUX and a datalogger system:



**Figure 3: TWO-CONDUCTOR SENSOR CONNECTIONS (2x32)**



**Figure 4: FOUR-CONDUCTOR SENSOR CONNECTIONS (4x16)**

## 4 OPERATING MODES

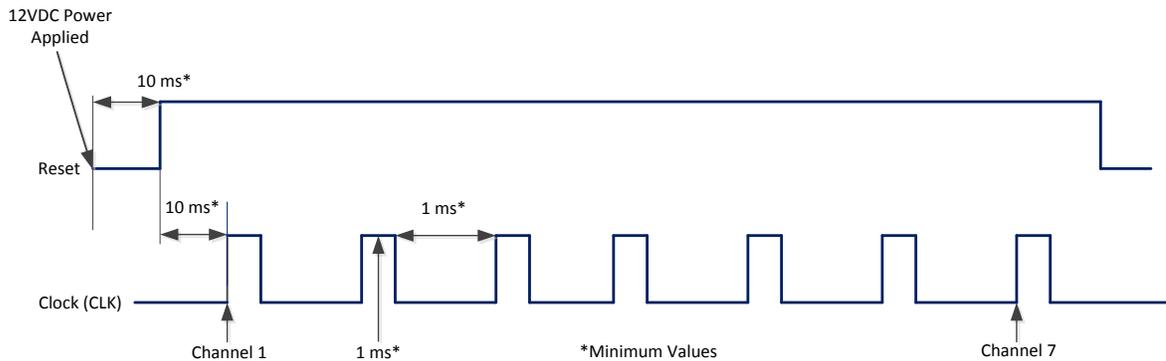
The RT-MUX has two operating modes; the standard mode (SC) and the go-to channel mode (CH). In the SC mode, the multiplexer channels are activated in sequence (scan) starting from the first channel and ending with the last channel. Most application uses the SC standard mode.

In the CH mode or go-to mode, the multiplexer goes directly to a specific channel skipping all preceding channels. Note: the CH mode cannot be used when multiplexers are daisy chained.

For the RT-MUX to function correctly in both modes, a datalogger must have at least two programmable digital output ports (level 0-5V). These two modes are controlled by the datalogger's program only, and not by the front panel mini switches.

In typical applications, the main 12 Volts power source for the RT-MUX is not switched OFF by the datalogger; it is kept always ON. Maintaining the power ON is perfectly acceptable since the multiplexer draws only 20  $\mu$ A in standby mode; when not enabled and no relays active. However, if for some reasons an application requires that the main 12 Volts power source be switched OFF, a minimum delay of 10 milliseconds must be inserted in the datalogger's programming code. The delay is inserted after the activation of the 12 Volts power source and before activating the multiplexer's RST signal, failing to do so will cause the multiplexer to go out of sync with the "clock" signal. See Figure 5.

### 4.1 SC-MODE (STANDARD OPERATION)



**Figure 5: SC-MODE RESET & CLOCK TIMINGS**

Controlling the RT-MUX in SC-MODE with a datalogger is fairly simple, provided that all voltages and timings are respected. Use the mini slide switch to select between 2x32 or 4x16 positions. See Figure 5.

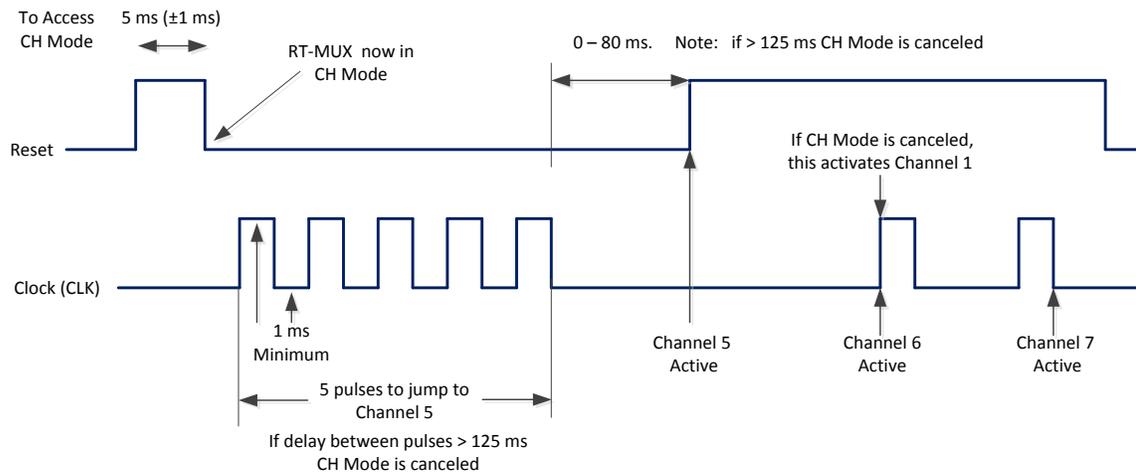
1. The datalogger activates the RST Input terminal using one control port
2. A delay of 10 milliseconds is inserted
3. The datalogger sends a pulse to CLK Input terminal using a second control port
4. A delay of 20 milliseconds for relay contact to close is inserted
5. Channel 1 is activated and measurement can begin:

**(1H, 1L) → COM H, COM L → DATALOGGER**

**(1A, 1B, 1C, 1D) → COMA, COMB, COMC, COMD → DATALOGGER**

6. Repeat steps 3, to 5 until all desired channels are measured
7. The datalogger deactivates the RST Input terminal, resetting the multiplexer to its initial state

## 4.2 CH-MODE (GO TO CHANNEL)



**Figure 6: CH-MODE RESET & CLOCK TIMINGS**

Controlling the RT-MUX in CH-MODE requires some special timing sequences from the datalogger's digital output ports. See Figure 6

**Note: the CH mode cannot be used when multiplexers are daisy chained.**

1. The datalogger first activates the RST Input terminal for a period of 5 milliseconds  $\pm 1$  millisecond
2. The datalogger deactivates the RST Input terminal
3. A small delay of 1 millisecond is inserted
4. The datalogger sends to the CLK Input terminal a number of pulses corresponding to the desired channel position. Note: Insert a 1 millisecond delay between pulses
5. A small delay of 1 millisecond is inserted
6. The datalogger activates again the RST Input terminal. Note that the RST signal must be activated within 80 milliseconds of the last CLK pulse, if the time between the last CLK pulse and the activation of the RST signal is longer than 80 milliseconds, the RT-MUX will revert to SC-MODE
7. A delay of 20 milliseconds for relay contact to close is inserted
8. Channel 5 is activated and measurement can begin, as shown in figure 6 above

**(5H, 5L) → COM H, COM L → DATALOGGER**

**(5A, 5B, 5C, 5D) → COMA, COMB, COMC, COMD → DATALOGGER**

9. Following channels are activated when the datalogger sends new pulses to CLK Input terminal
10. Repeat step 7 to 9 until all desired channels are measured
11. The datalogger deactivates the RST Input terminal, resetting the multiplexer to its initial state

### 4.3 OPERATIONNAL CRITERIA

The RT-MUX is not designed to multiplex high power signals. Power currents exceeding 30 mA will degrade relay contacts and affect future performances of the multiplexer. If such currents are multiplexed, the channel should never be used thereafter to carry signals for which variations of contact resistance could cause reading errors.

- **Power consumption of the RT-MUX:**

In two-conductor mode (2x32) or four-conductor mode (4x16) current drain is approximately <25 mA.

- **Activation of the RT-MUX (RST-IN):**

It must be activated (3.3 VDC ~ 8 VDC) at the beginning of the sequence and deactivated (<0.9 VDC) at the end of the sequence.

- A delay of 10 milliseconds between the activation (RST) and the first rise of the clock (CLK) is required.

- **Channel selection (CLK):**

A rise (1.5 VDC ~ 5 VDC) sequentially selects the input channels.

- Clock pulse minimum width: 1 millisecond (minimum delay between a rise and a fall of the signal).

- **Activation of the next RT-MUX in a Daisy Chain configuration (RST-OUT):**

This output signal is activated when the multiplexer's last channel is released, the RST-OUT is raised to 5 V Volts to activate the next multiplexer in the chain.

### 4.4 DATALOGGER PROGRAMMING EXAMPLE

The following CR6 programming example measures sixteen EM5 vibrating wire sensors every 5 minutes

```
' C3    Multiplexer Reset (RST)
' C4    Multiplexer Clock (CLK)
' U9    RT-MUX COM-A (VW Coil +)
' U10   RT-MUX COM-B (VW Coil -)
' U11   RT-MUX COM-C (VW Th +)
' U12   RT-MUX COM-D (VW Th -)

Const AT3 = 0.0014051      'Steinhart-Hart Coefficients: 3K Thermistor
Const BT3 = 0.0002369
Const CT3 = 0.0000001019

Public VWBuf(16,6)        'VW Buffer

BeginProg
  Scan (300,Sec,3,0)
  PortSet(C3,1)           'Enable RT-MUX
  Delay(0,10,mSec)
  For LC = 1 To 16       '16 Vibrating Wires & Temperatures
    PulsePort(C4,10000)
    VibratingWire (VWBuf(LC,1),1,U9,500,1100,1,0.01,"VWDiag",60,AT3,BT3,CT3)
  Next LC
  PortSet(C3,0)          'Disable RT-MUX
NextScan
EndProg
```

## 4.5 THERMOCOUPLE MEASUREMENT

When thermocouples are measured, an error is introduced at the contact of the thermocouple and the multiplexer's input terminals. This error can be corrected by using an external reference (other than the thermocouple). Knowledge of the thermocouple's temperature and the effect of variations on the readings can allow corrections to be made.

## 4.6 SENSOR TYPES

Sensor types can be divided into three broad categories.

- The **first** category consists of all Wheatstone bridge sensors (e.g. load cell, strain gauge, pressure cell). This type of sensor generally has four conductors (+ Power, - Power, + Signal, - Signal), however in some case the sensor may have up to six conductors. The two additional conductors are used to compensate wire resistances in which long wire length can influence the measurements. In cases where more than four-conductor sensors must be used, two RT-MUXs connected in parallel will increase the number of inputs terminal to eight. Note: For two RT-MUXs to work in parallel, they must be configured identically in four-conductor mode using the mini slide switches.
- The **second** category consists of all vibrating wire sensors. This type of sensor has two conductors to measure the vibrating wire frequency (coil) and, in some cases, two other conductors to measure the thermistor's resistance (e.g. PWS Piezometer). The RT-MUX can be used in a two-conductor or in a four-conductor configuration accordingly.
- The **third** category regroups all other types of signals: variable resistances (e.g. two- or three-conductor thermistors, two-, three- or four-conductor potentiometers), variable DC voltages (one or two conductors), variable DC currents (e.g. 4 to 20 mA, two or four conductors), variable frequencies (two conductors).

## 5 RT-MUX ENCLOSURES

The RT-MUX can be used indoor without an enclosure under dry conditions; otherwise, an enclosure is required to protect the multiplexer's circuitry.

Two enclosure variants are available for the RT-MUX:

- The enclosure without the Manual Switching Panel. See Figure 7.
- The enclosure with the Manual Switching Panel. See Figure 8.

The enclosures are made of fiberglass reinforced polyester; a hinged cover with gasket allows easy access to the multiplexer's terminals / manual switching panel. The enclosures can be fitted with a common cable bushing or individual cable glands for each sensor. Both enclosures are wall mountable, an optional post mounting hardware kit is available.

The dimension for both enclosures is identical: Length: 14", Width: 12" Height: 4"

Other enclosure models are available from Roctest to meet specific data acquisition system and configuration, contact Roctest Sales Department for details

## 5.1 RT-MUX ENCLOSURE

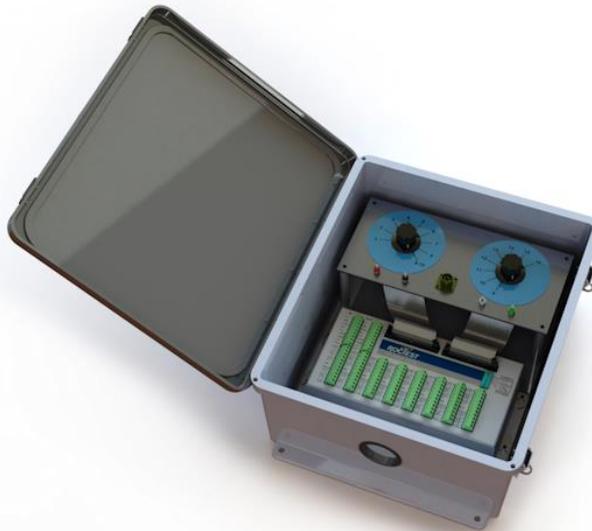
The following figure shows the RT-MUX mounted inside the standard enclosure. Two RT-MUXs can be mounted inside if the manual switching panel option is not used.



**Figure 7: STANDARD ENCLOSURE**

## 5.2 RT-MUX ENCLOSURE WITH MANUAL SWITCH PANEL

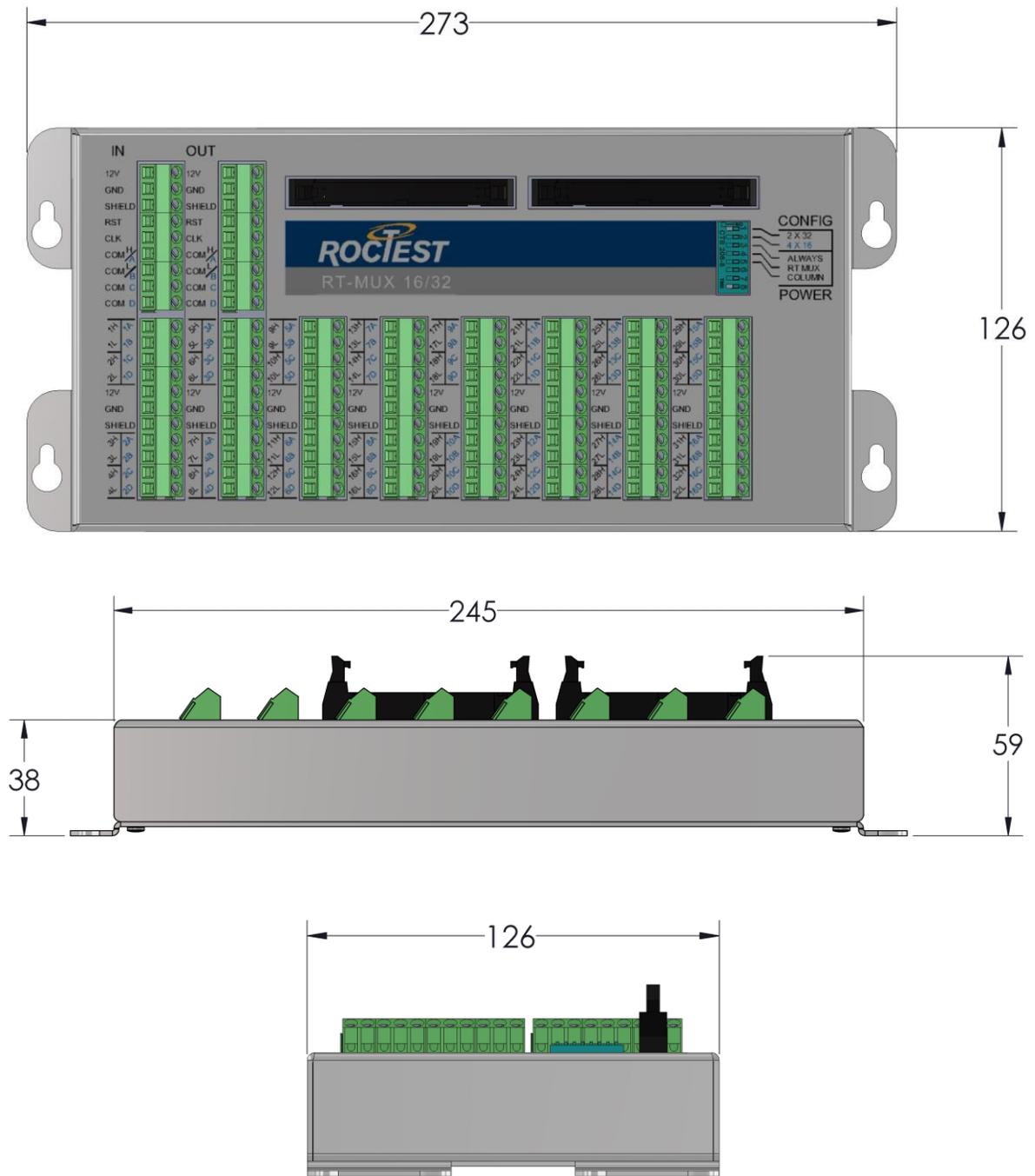
The following figure shows the RT-MUX with the Manual Switch Panel mounted inside the standard enclosure. Only one RT-MUX can be mounted inside the enclosure when the manual switching panel is installed.



**Figure 8: RT-MUX WITH MANUAL SWITCHING PANEL ENCLOSURE**

## 6 RT-MUX SPECIFICATIONS

<b>Number of Channels:</b>	
<b>2 Wires Configuration (2x32):</b>	32 Channels
<b>4 Wires Configuration (4x16):</b>	16 Channels
<b>Power Supply Voltage (Nominal):</b> 12 VDC; Unregulated	
- Minimum Voltage	10 VDC
- Absolute Maximum Voltage:	16 VDC
<b>Current Consumption:</b>	
- Quiescent:	< 20 $\mu$ A
- Active (No relay active):	< 2 mA
- Active (2x32 or 4x16 Mode):	< 25 mA
<b>Control Signals:</b> Logic level 0 ~ 5 VDC	
- High:	Between 3.3 and 5.5 VDC
- Low:	Between 0 and 0.9 VDC
<b>Switching Current Capacity per Channel:</b>	
- Nominal (Resistive Load):	500 mA @ 30 VDC
- Absolute Maximum:	1 A
<b>Maximum Switching Voltage Per Channel:</b> 110 VDC	
<b>Maximum Wire Size (Terminal):</b> AWG #16	
<b>Contact Life:</b>	
- Mechanical:	$5 \times 10^7$
- Electrical:	$2 \times 10^5$
<b>Maximum Relay Actuation Time:</b> 50 ms	
<b>Electric Insulation:</b>	
- Coil-Contact:	1800 Vrms
- Contact-Contact:	750 Vrms
- Insulation Resistance	1000 M $\Omega$
<b>Operating Temperature:</b> -40°C à +70°C	
<b>Storage Temperature:</b> -40°C à +90°C	
<b>Humidity:</b> 0 – 95% RH Non-condensing	
<b>Weight:</b>	
- Basic Version:	≈ 860g
- Protected Version:	≈ 920g
<b>Dimensions:</b>	
- Length:	273 mm
- Width:	126 mm
- Height:	59 mm



**Figure 9: RT-MUX DIMENSIONS**

Note: Mounting tab hole diameters for 8-32 screw: 4.2 mm (0.1654)

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## **EC Declaration of Conformity**

**Roctest Limited**, located at 680 Birch Avenue, St-Lambert, QC, Canada J4P 2N3

We hereby declare that the devices described below are in conformity with the directives listed. In the event of unauthorized modification of any devices listed below, this declaration becomes invalid.

**Type: Signal Multiplexer**  
**Product Model: RT-MUX 16/32**

**Relevant EC Directives and Harmonized Standards:**

**2014/30/EU, Electromagnetic Compatibility directive.**

The product(s) to which this declaration relates is in conformity with the essential protection requirements of 2014/30/EU Electromagnetic Compatibility directive. The products are in conformity with the following standards and/or other normative documents:

EMC: Harmonized Standards: EN 61326-1:2013 Lab Equipment, EMC

EN55022/CISPR22 Radiated and Conducted Emission standard for residential, commercial and light-industrial environments

IEC61000-4-2:2008 Electrostatic discharge immunity test

IEC61000-4-3:2006 Radiated, radio-frequency, electromagnetic field immunity test

IEC61000-4-4:2012 Electrical fast transient/burst immunity test

IEC61000-4-5:2008 Surge immunity test

IEC61000-4-6: 2013 Immunity to conducted disturbances, induced by radio-frequency fields

IEC61000-4-11:2008 Voltage dips, short interruptions and voltage variations immunity tests

**2011/65/EU, the Restriction of Hazardous Substances Directive (RoHS)**

I hereby declare that the equipment named above has been designed to comply with the relevant sections of the above referenced specifications. The items comply with all applicable Essential Requirements of the Directives.



**Denis Levesque, Eng., MBA**  
**Director of Operations and Engineering**

**Date: May, 15, 2017**

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