

# MASS FLOW METERS

## DIMENSIONS (not including fittings)

GM1	Models up to 15 sL/min: 3"W x 5 1/2"H x 1"D
GM3/GM4	30 to 100 sL/min models: 3 5/8"W x 6"H x 1 1/4"D
GM5	200 sL/min models: 12"W x 9"H x 2 1/2"D
GM6	500 sL/min models: 12"W x 10"H x 3 1/2"D
GM7	1000 sL/min models: 12"W x 11 1/2"H x 5"D

MODEL	FLOW RATE [std liters/min]	MAXIMUM PRESSURE DROP		
		[mm H <sub>2</sub> O]	[psid]	[mbar]
GM1	up to 10	25	0.04	2.5
GM3	20	300	0.44	30
	30	800	1.18	81
	40	1480	2.18	150
	50	2200	3.23	223
GM4	60	3100	4.56	314
	80	4422	6.5	448
	100	5500	8.08	557
GM5	200	272	4.0	28
GM6	500	340	5.0	34
GM7	1000	612	9.0	62

## \*SPECIFICATIONS

<b>ACCURACY:</b>	<b>GM 1, 3 and 4:</b> ±1.0% of full scale. <b>GM 5, 6 and 7:</b> ±1.5% of full scale. OPTIONAL ENHANCED ACCURACY: ±1.0% of full scale.
<b>CALIBRATIONS:</b>	Performed at standard conditions [14.7 psia (101.4 kPa) and 70 °F (21.1 °C)] unless otherwise requested.
<b>REPEATABILITY:</b>	±0.25% of full scale.
<b>RESPONSE TIME:</b>	Generally 2 seconds to within ±2% of actual flow rate over 25 to 100% of full scale.
<b>TEMPERATURE COEFFICIENT:</b>	0.15% of full scale / °C.
<b>PRESSURE COEFFICIENT:</b>	0.01% of full scale / psi (0.07 bar).
<b>MAXIMUM PRESSURE DROP:</b>	See Table 3.
<b>GAS and AMBIENT TEMP.:</b>	32 °F to 122 °F (0 °C to 50 °C). 14 °F to 122 °F (-10 °C to 50 °C) - Dry gases only.
<b>OUTPUT SIGNALS:</b>	Linear 0-5 Vdc. 1000 ohms min. load impedance and 4-20 mA 0-500 Ohms loop resistance.
<b>TRANSDUCER INPUT POWER:</b>	Universal +12 to +26 VDC, 200 mA maximum.
<b>TIME CONSTANT:</b>	800 ms.
<b>GAS PRESSURE:</b>	1000 psig (70 bars) maximum GM 1, 3, 4. 20 psig (1.4 bars) optimum. 500 psig (34.5 bars) GM 5, 6, 7. 20 psig (1.4 bars) optimum.
<b>** MATERIALS IN FLUID CONTACT:</b>	<b>a.</b> Aluminum models GM Series: anodized aluminum, 316 stainless steel, brass and FKMO-rings. <b>b.</b> Stainless steel models GM1S, 3S,4S, 5S, 67S and 7S: 316 stainless steel and FKM O-rings. Optional O-rings: Buna®, EPR and Kalrez®.
<b>ATTITUDE SENSITIVITY:</b>	No greater than +15 degree rotation from horizontal to vertical; standard calibration is in horizontal position.
<b>CONNECTIONS:</b>	<b>GM 1:</b> 1/4" compression fittings. <i>Optional:</i> 6mm, 3/8" and 1/8" compression fittings or 1/4" VCR®. <b>GM 3:</b> 1/4" compression fittings. <i>Optional:</i> 6mm and 3/8" compression fittings or 1/4" VCR®. <b>GM 4:</b> 3/8" compression fittings. <b>GM 5:</b> 3/8" compression fittings. <b>GM 6:</b> 1/2" compression fittings. <b>GM 7:</b> 3/4" FNPT fittings or 3/4" compression fittings.
<b>LEAK INTEGRITY:</b>	1 x 10 <sup>-9</sup> sL/sec of helium maximum to the outside environment.
<b>CE COMPLIANT:</b>	EN 55011 class 1, class B; EN50082-1.



## MASS FLOW METERS

A low cost solution to thermal mass flow metering for gases is presented by Dakota's mass flow meter line.

The mass flow meter design combines the convenience and accuracy of conventional mass flow devices with low costs previously unattainable.

Each of these meters incorporate an advanced straight tube sensor in conjunction with flow passage elements constructed of aluminum and brass for non-corrosive gases or 316 stainless steel for corrosive applications.

## GENERAL DESCRIPTION

Compact, self contained Mass Flow Meters are designed to read flow rates of gases. The rugged design coupled with instrumentation grade accuracy provides versatile and economical means of flow control.

Aluminum or stainless steel models with readout options of either engineering units (standard) or 0 to 100 percent displays are available.

The mechanical layout of the design includes an LCD readout built into the top of the transducer. This readout module is tiltable over 90 degrees to provide optimal reading comfort. It is connected to the transducer by a standard modular plug, and is also readily removable for remote reading installations. Transducers without LCD readout are offered for OEM applications.

Mass flow meters are available with flow ranges from 10 sccm to 1000 sL/min N<sub>2</sub>. Gases are connected by means of 1/4", 3/8", 1/2" compression fittings and 3/4" FNPT fittings. Optional fittings are available. These controllers may be used as bench top units or mounted by means of screws in the base.

*\* The selection of materials of construction, is the responsibility of the customer. The company accepts no liability.*

## Aluminum and Stainless Mass Flow Meters



### DESIGN FEATURES

- ✓ Rigid metallic construction.
- ✓ Maximum pressure of 1000 psig (70 bars) for GM1, GM3, GM4 models. 500 psig for GM5, GM6 and GM7.
- ✓ Leak integrity  $1 \times 10^{-9}$  of helium.
- ✓ NIST traceable certification.
- ✓ Built-in tiltable LCD readout.
- ✓ 0-5 Vdc and 4-20 mA signals.
- ✓ Circuit protection.
- ✓ Can be used as a portable device.
- ✓ Engineering units or 0 to 100% displays.
- ✓ Totalizer option.

**Flow rates are unaffected  
by temperature  
and pressure variations  
within stated limitations.**

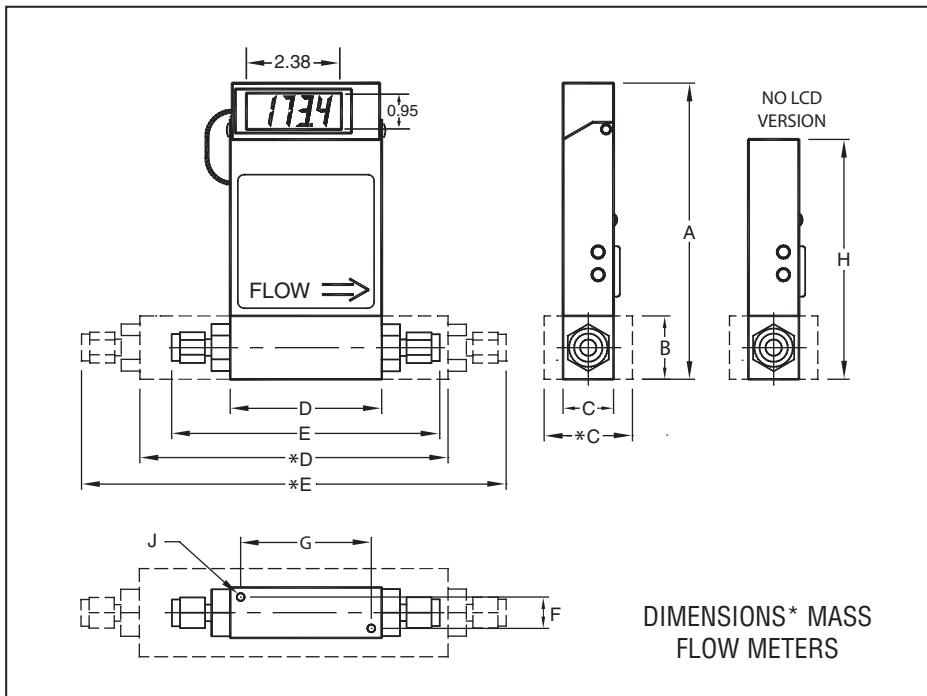
### PRINCIPLES OF OPERATION

Metered gases are divided into two laminar flow paths, one through the primary flow conduit, and the other through a capillary sensor tube. Both flow conduits are designed to ensure laminar flows and therefore the ratio of their flow rates is constant.

Two precision temperature sensing windings on the sensor tube are heated, and when flow takes place, gas carries heat from the upstream to the downstream windings. The resultant temperature differential is proportional to the change in resistance of the sensor windings.

**Output signals of 0 to 5Vdc and 4 to 20mA are generated indicating mass molecular based flow rates of the metered gas.**

Flow rates are unaffected by temperature and pressure variations within stated limitations.



MODEL	CONNECTION Compression Fitting (except model GM7)	DIMENSION (INCH)								
		LCD VERSION							NO LCD	MOUNTING HOLE
		A	B	C	D	E	F	G		
GM1	1/4" Tube O Diameter	5.72	1.00	1.13	3.00	5.02	0.69	2.69	4.61	6-32
				*C	*D	*E				
GM3	1/4" Tube O Diameter	6.10	1.37	1.25	4.13	6.15	0.69	2.69	4.99	6-32
GM4	3/8" Tube O Diameter	6.10	1.37	1.25	4.13	6.27	0.69	2.69	4.99	6-32
GM5	3/8" Tube O Diameter	6.73	2.00	1.75	6.69	8.83	0.99	4.69	5.62	10-24
GM6	1/2" Tube O Diameter	7.64	3.00	3.00	7.25	9.67	2.250	6.750	6.53	1/4-20
GM7	3/4" NPT Female	8.66	4.00	4.00	7.30	-	3.000	6.800	7.55	1/4-20

# MASS FLOW CONTROLLERS

## MASS FLOW CONTROLLERS

Thermal Mass Flow Controllers are designed to indicate and control set flow rates of gases.

The mass flow controller combines the characteristics, and accuracy of conventional mass flow devices into a unique compact design at low costs previously unattainable.

Each of these controllers incorporates an advanced straight tube sensor in conjunction with flow passage elements constructed of aluminum and brass for non-corrosive gases or 316 stainless steel for corrosive applications. Zero and span adjustments are accessible from the outside of transmitters.



### \*SPECIFICATIONS

ACCURACY:	ACCURACY %FS			OPTIONAL ENHANCED ACCURACY %FS			
	MODEL:	GC1, 3, 4	GC5, 6, 7	MODEL:	GC5, 6, 7		
FLOW RANGE:	0-100%	20-100%	0-20%	FLOW RANGE:	20-100%	0-20%	
ACCURACY:	±1.0%	±1.5%	±3%	ACCURACY:	±1%	±1.0%	REF DATA with ±1%

**CALIBRATIONS:** Performed at standard conditions [14.7 psia (101.4 kPa) and 70 °F (21.1°C)] unless otherwise requested.

**REPEATABILITY:** ±0.25% of full scale.

**RESPONSE TIME:** Generally 2 seconds to within ±2% of actual flow rate over 25 to 100% of full scale.

**TEMPERATURE COEFFICIENT:** 0.15% of full scale / °C.

**PRESSURE COEFFICIENT:** 0.01% of full scale / psi (0.07 bar).

**PRESSURE DROP:** See Table above.

**OPTIMUM GAS PRESSURE:** 25 psig (1.73 bars).

**MAX. GAS PRESSURE:** 1000 psig (70 bars) maximum GC1, 3, 4. 500 psig (34.5 bars) GC5, 6, 7.

**TURN DOWN RATIO:** 40:1.

**MAX. DIFF. PRESSURE:** 50 psi for GC1/3/5/6 and 7 (3.4 bars), 40 psi for 47 (2.7 bars).

**GAS and AMBIENT TEMP:** 32 °F to 122 °F (0 °C to 50 °C). 14 °F to 122 °F (-10 °C to 50 °C) - Dry gases only.

**\*\*MATERIALS FLUID CONTACT:**

- Aluminum models GC Series: anodized aluminum, 316 stainless steel, brass and FKM O-rings.
- Stainless steel models GC1S, 3S, 4S, 5S, 6S and 7S: 316 stainless steel and FKM O-rings.  
Optional O-rings: Buna®, EPR and Kalrez®.

**ATTITUDE SENSITIVITY:** No greater than ±15 degree rotation from horizontal to vertical; standard calibration is in horizontal position.

**OUTPUT SIGNALS:** Linear 0-5 Vdc. (1000 ohms min. load impedance); 4-20 mA (0-500 ohms loop resistance) Max noise ±20mV.

**COMMAND SIGNALS:** Analog 0-5 Vdc or 4-20 mA for remote set point mode; NPN compatible purge /valve off.

**CONNECTIONS:**

- GC1:** 1/4" compression fittings. *Optional:* 6mm, 3/8" and 1/8" compression fittings or 1/4" VCR®.
- GC3:** 1/4" compression fittings. *Optional:* 6mm and 3/8" compression fittings or 1/4" VCR®.
- GC4:** 3/8" compression fittings.
- GC5:** 3/8" compression fittings.
- GC6:** 1/2" compression fittings.
- GC7:** 3/4" FNPT fittings. *Optional:* 3/4" compression fittings.

**LEAK INTEGRITY:** 1 x 10<sup>-9</sup> sml/sec of helium maximum to the outside environment.

**TRANSDUCER INPUT POWER:**

- GC1, 3 and 4: Universal +12 Vdc to 26 Vdc, 650 mA maximum.
- GC5, 6 and 7: +12 Vdc, 800 mA; +24 Vdc, 650 mA optional.

**CIRCUIT PROTECTION:** Circuit boards have built-in polarity reversal protection. Resettable fuses provide power input protection.

**DISPLAY:** 3-1/2 digit LCD, 0.5" high characters.

**CE COMPLIANT:** EN 55011 class 1, class B; EN50082-1.

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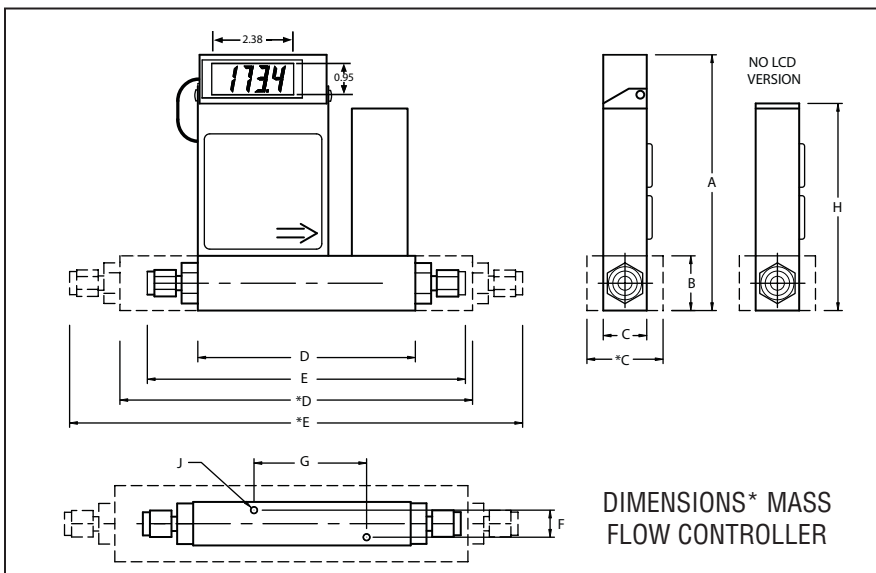
## Aluminum and Stainless Mass Flow Controllers



### DESIGN FEATURES

- ✓ Rigid metallic construction.
- ✓ Maximum pressure of 1000 psig (70 bars)  
GC1, GC3, GC4. 500 psig (34.5 bars)  
for GC5, GC6 and GC7.
- ✓ Leak integrity  $1 \times 10^{-9}$  smL/sec of helium.
- ✓ NIST traceable certification.
- ✓ Built-in tiltable LCD readout.
- ✓ Local or remote setpoint control.
- ✓ 0-5 Vdc and 4-20 mA signals.
- ✓ Circuit protection.
- ✓ Totalizer option.

MODEL	CONNECTION Compression Fitting (except model GC7)	DIMENSION (INCH)								
		LCD VERSION							NO LCD	MOUNTING HOLE
		A	B	C	D	E	F	G		
GC1	1/4" Tube O Diameter	5.72	1.00	1.00	4.27	6.29	0.69	2.68	4.61	6-32
				*C	*D	*E				
GC3	1/4" Tube O Diameter	6.10	1.37	1.25	5.19	7.21	0.69	2.69	4.99	6-32
GC4	3/8" Tube O Diameter	6.10	1.37	1.25	5.19	7.33	0.69	2.69	4.99	6-32
GC5	3/8" Tube O Diameter	6.73	2.00	1.75	10.2	12.3	1.39	4.69	5.62	10-24
GC6	1/2" Tube O Diameter	7.55	3.00	3.00	10.24	12.4	2.5	6.80	6.53	1/4-20
GC7	3/4" NPT Female	8.66	4.00	4.00	10.5	—	3.0	6.80	7.55	1/4-20



### GENERAL DESCRIPTION

Compact, self contained mass flow controllers are designed to indicate and control flow rates of gases. The rugged design coupled with instrumentation grade accuracy provides versatile and economical means of flow control. Aluminum or stainless steel models with readout options of either engineering units (standard) or 0 to 100 percent displays are available.

The built-in electromagnetic valve allows the flow to be set to any desired flow rate within the range of the particular model. The valve is normally closed as a safety feature to ensure that gas flow is shut off in case of a power outage. Setpoints are controlled either locally or remotely.

The LCD readout built into the top of the transducer is tiltable over 90 degrees to provide optimal reading comfort. It is connected to the transducer by a standard modular plug, and is readily removable for remote reading installations. Transducers without LCD readout are offered for OEM applications.

The combined gas streams flow through a proportionating electromagnetic valve with an appropriately selected orifice. The closed loop control circuit continuously monitors the mass flow output and maintains it at the set flow rate.

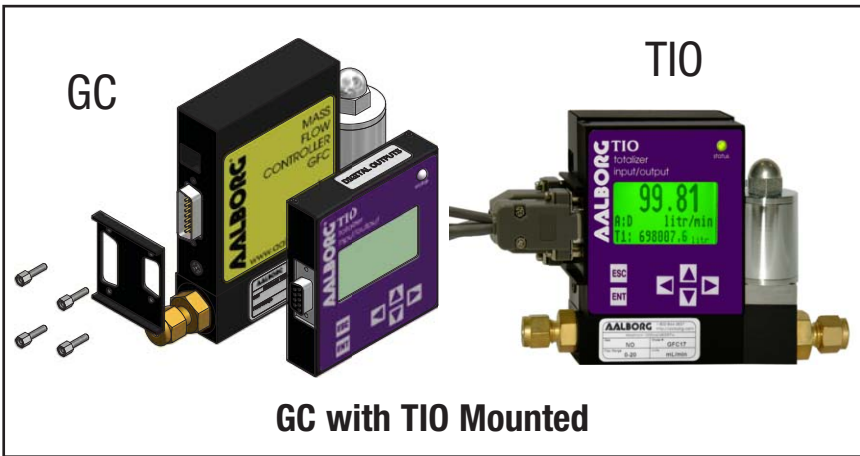
Flow rates are unaffected by temperature and pressure variations within stated limitations.

Mass flow controllers are available with flow ranges from 10 sccm to 1000 sL/min N<sub>2</sub>. Gases are connected by means of 1/4", 3/8", or optional 1/8" compression fittings and 3/4" FNPT fittings. Optional fittings are available. These controllers may be used as bench top units or mounted by means of screws in the base. Transducer power supply ports are fuse and polarity protected.

MODEL	FLOW RATE [std liters/min]	MAXIMUM PRESSURE DROP	
		[psid]	[mbar]
GC1	up to 10	1.06	0.075
GC3	20	2.00	0.138
	30	3.5	0.241
	40	5.5	.379
GC4	50	8	.551
	100	18.9	1.302
GC5	200	10	690
GC6	500	12	827
GC7	1000	15	1034



**GM with TIO Mounted**



**GC with TIO Mounted**

## Applications

For flow meters and controllers with analog 0-5 (5-10) (0-10)Vdc, 4-20mA input output interface, where flow indications / control and totalizers or alarm functions are required. Also when re-transmission of the flow rate and/or totalizer functions via optically-isolated pulse output or serial communication is desired. Local or programmable set point control for flow controllers (no host PC presence required). Activation of user-supplied equipment via programmable optically-isolated digital outputs when flow alarms or totalizers events are active.

## Display

The graphical LCD display has large 13mm (0.51") digits for flow rate and 5.5mm (0.21") for total and can be set by user to simultaneously show different combination of the flow parameters: flow rate, totalizers, flow alarms, and diagnostic events . All configuration parameter settings are easily accessed via a simple user-interface menu driven by a 6 button key-pad which can be password-protected.

## DESIGN FEATURES

- ✓ Displays instantaneous, total and accumulated flow rates.
- ✓ Built-in Flow Linearizer (10 point linearization of the flow curve).
- ✓ Up to 47 different volumetric and mass flow engineering units.
- ✓ Large 13mm (0.51") digits for flow rate and 5.5mm (0.21") for Total.
- ✓ Digital RS-232 or RS-485 interface (multi-drop capability of up to 64 devices.)
- ✓ Compact design for unit mount, panel mount, wall mount or field mount applications.
- ✓ User-programmable, optically-isolated pulse output.
- ✓ Two programmable, optically-isolated, digital outputs.
- ✓ Flow controllers, set point command control via local LCD or digital interface.
- ✓ Programmable set point table with ramping up/down capability up to 16 steps.
- ✓ Free Configuration and Monitoring Utility software.

## Programmable Pulse Output

The programmable flow pulse output is operating independently from totalizers and based on configuration settings can provide pulse frequency proportional to instantaneous fluid flow rate.

The LCD/keypad and digital communication interface commands are provided to:

- ✓ Enable/Disable Pulse Output.
- ✓ Configure Pulse Output start flow rate (in % of full scale).
- ✓ Configure the Unit/Pulse value (in current volumetric or mass flow units).
- ✓ Configure Pulse Active On Time (10 - 6550 ms).

## Signal Input and Signal Output

- ✓ 0-5 Vdc (Input/Output)
- ✓ 5-10 Vdc (Output only)
- ✓ 0-10 Vdc (Input/Output)
- ✓ 4-20 mA (Input/Output)

For flow meters and / or flow controllers, TIO provides jumpers selectable for 0-5 Vdc or 4-20 mA analog set point control signals. The flow rate set point can be adjusted locally via key-pad, remotely via host PC using digital communication interface, or programmed in advance using built-in 16 steps batch table with ramping up/down support.

## Digital Communication

All process data and settings can be read and modified manually via local LCD Key-pad or through the digital RS-232 or RS-485 communication interface. Proprietary ASCII software interface command set and free Communication Utility software are provided.

## Totalizer input/output Flow Monitor/Controller

### Programmable Totalizers

TIO provides two independent programmable flow totalizers. Both totalizers are updated every 100 ms and can be set to activate different events. Main totalizer accumulated total is backed-up in EEPROM memory every second.

The LCD/keypad and digital communication interface commands are provided to:

- ✓ Enable/Disable totalizing the flow.
- ✓ Start the totalizer at a preset flow rate (in % of full scale).
- ✓ Assign action at a preset total volume (Event Volume).
- ✓ Configure power on delay (in seconds).
- ✓ Configure Auto Reset at preset volume.
- ✓ Configure Auto Reset delay (in seconds).
- ✓ Reset the totalizer to ZERO.

### Programmable Alarms

TIO provides the user with a flexible alarm/warning system that monitors the fluid flow for conditions that fall outside configurable limits as well as visual feedback for the user via the LCD or via an optically-isolated output. The flow alarm has several attributes which can be configured by the user via LCD/Keypad or digital communication interface:

- ✓ Enable/Disable flow alarm.
- ✓ Low flow alarm settings (in % of full scale).
- ✓ High flow alarm settings (in % of full scale).
- ✓ Flow alarm action delay.
- ✓ Flow alarm action latch mode.



#### \*SPECIFICATIONS

<b>ADC/DAC RESOLUTION:</b>	12 bit.
<b>ANALOG INPUTS:</b>	0-5 Vdc, 4-20 mA, 5-10 Vdc (jumper-selectable), 0-10 Vdc (special order).
<b>ANALOG OUTPUTS:</b>	0-5 Vdc, 4-20 mA (jumper-selectable).
<b>LCD:</b>	128x64 graphic LCD with instantaneous Flow reading and Total volume indication. Adjustable LCD contrast and back light.
<b>KEY-PAD:</b>	Local 6 tactical push buttons.
<b>PULSE OUTPUT:</b>	User-programmable, optically-isolated, with preset active low time interval (10 – 6550 ms).
<b>DIGITAL OUTPUT:</b>	Two programmable, optically-isolated, UCE @ 40Vdc, ICE @ 150 mA (Voltage Isolation: 250 Vrms).
<b>DIGITAL INTERFACE:</b>	RS-232 or RS-485 (multidrop capability up to 64 devices).
<b>PROTOCOL:</b>	Proprietary ASCII software interface command set.
<b>SPEED:</b>	1200 - 2400 - 4800 - 9600 -19200 – 38400 – 57600 – 115200 baud (user selectable).
<b>CONFIGURATION:</b>	<b>Stop bit:</b> 1 <b>Data bits:</b> 8 <b>Parity:</b> None <b>Flow Control:</b> None
<b>ADDRESSING:</b>	Maximum 255 addresses (for RS-485 option only).
<b>TYPE:</b>	RS232 or RS485 2-wire.
<b>POWER REQUIREMENTS:</b>	12 – 26 Vdc (up to 60 mA maximum).
<b>INTERFACE CONNECTORS:</b>	Process I/O signals and Digital RS-232/RS-485 interface – miniature 9 pin female D-SUB connector. Digital optically-isolated outputs: TERM BLOCK HEADER 4POS 3.5MM Male Pins, Shrouded.
<b>ENVIRONMENT:</b>	Installation Level II, Pollution Degree II, (Per IEC 664).
<b>ELECTROMAGNETIC COMPATIBILITY:</b>	Compliant ref. 89/336/EEC as amended. Emission Standard: EN 55011:1991, Group 1, Class A Immunity Standard: EN 55082- 1:1992
<b>OPERATING TEMPERATURE:</b>	-10 °C to +70 °C (14°F to +158 °F).
<b>DIMENSIONS:</b>	86.4 x 76.2 x 19.1 mm (3.4" x 3.0" x 0.75") - W x H x D.
<b>WEIGHT:</b>	Appr. 125g / 0.3 lbs.

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