MODELS
092, 594, 6633A

BAROMETRIC PRESSURE SENSOR
OPERATION MANUAL

Met One Instruments, Inc
Corporate Sales & Service: 1600 NW Washington Blvd. Grants Pass, OR 97526
Tel (541) 471-7111 Fax (541) 471-7116
www.metone.com - service@metone.com

1.0 INTRODUCTION

The Model 092 Barometric Pressure Sensor is designed to measure ambient atmospheric pressure and provide serial digital outputs and analog outputs all from the same sensor module. Pressure is sensed using a board mounted digital pressure sensor. An on board CPU scales pressure measurement and performs communications.

The Model 092 is simple to set up and use. The analog output voltage and pressure range limits are set with DIP switches. The DIP-switches allow quick configuration without requiring a laptop or data-logger for communication. Refer to Table 5-2 for switch settings.

Model 6633A is a special version with 4-20 mA output. It incorporates an additional circuit board to translate the 0-1 V sensor signal to 4-20 mA. Refer to Figure 3.6 for connection information.

Model 594 is identical to Model 092, but is configured with unique DIP-switch settings for compatibility with the Auto-ID feature on AutoMet data loggers. The range is 20-32 in.Hg and the analog output is 0-1 V. In addition, an Auto-ID output is provided to allow the data logger to automatically identify the sensor and scale the measurements. Refer to Table 5-2 for switch settings. Refer to Figure 3.2 for connection information.

Additional parameters may be configured with terminal connections (see section 10). The terminal connection accommodates standard RS-232 and RS-485. The SDI-12 interface parameters may be configured using an SDI-12 master in the transparent mode. Consult the manual for your particular data logger for additional information.

1.1 General Specifications:

Operational

Range:	600-1100 mbar (17.72-32.48 in Hg)*
Resolution:	0.1 mbar (.003 Hg)
Temp. Operating Range:	-40 to +55°C
Temp. Compensated Range:	-40 to 55°C
Accuracy:	±0.35 mbar @ 25°C
	±0.75 mbar @ 0 to55°C
	±1.5 mbar @ -40°C
Long Term Stability:	±1 mbar in 12 months

*Analog Output Range is user-selectable with DIP switches:
See Table 5-2 for switch settings and pressure conversions.
Factory default range: 800-1100 mbar.
Digital Output is fixed: 600-1100 mbar.

Analog Output Voltage - User selectable. See Table 5-1 for switch settings.

0 –1VDC
0 – 2VDC
0 – 2.5VDC
0 – 5VDC (Factory default)

Digital Outputs

RS-232
RS-485
SDI-12 (Default address = 0)

Communications Protocol

Terminal mode and for RS-232 and RS485
SDI-12

Serial Settings

Baud options = 1200, 2400, 4800, 9600, 19.2k
8 data bits, no parity, and 1 stop bit.
Default baud rate = 19.2k

Power

6-16 VDC, 10 ma @ 12VDC

Connections

Screw terminals on circuit board

Size

Polycarbonate Enclosure
120 x 80 x 55 mm 4.72 x 3.14 x 2.16 inches

CE Certification

See Appendix D

2.0 INSTALLATION

The sensor is designed for indoor or outdoor use. Refer to figures 3.1 thru 3.5 for wiring instructions depending on the intended use.

2.1 Mounting for outdoor use:
When designated for outdoor use, the unit is supplied with a solar shield and U-bolts. The sensor is provided attached to the solar shield. Install the solar shield with the U-bolts provided on any vertical pipe up to 2" IPS. Install the sensor so that it's facing a northerly direction so that the solar shield protects the sensor enclosure from direct sunlight.

2.1 Mounting for indoor use:
For indoor mounting to a flat surface, mounting holes 1.97 x 4.25. Cover must be temporally removed to access mounting holes.

Note: The pressure sensor element is light sensitive, for accuracy in the measurement; do not operate the 092 with the top cover off.

3.0 INPUT/OUTPUT CONNECTIONS

See Figure 3.1 for Analog wiring.
See Figure 3.2 for 594 (AutoMet auto-ID) wiring.
See Figure 3.3 for RS232 wiring.
See Figure 3.4 for RS485 wiring.
See Figure 3.5 for SDI-12 wiring.
See Figure 3.6 for 6633A (4-20 mA Output) wiring.

4.0 USER DEFINED OPTIONS

None

5.0 USER INTERFACE

SW1-Analog Output Voltage Switch Settings

Range	SW1-1	SW1-2
0-1 V	On	On
0-2 V	On	Off
0-2.5 V	Off	On
0-5 V	Off	Off

Table 5-1

SW2 – Analog Output Pressure Range Switch Settings

RANGE SELECTION						SWITCH SETTINGS			
LOWER mbar	UPPER mbar	LOWER mm Hg	UPPER mm Hg	LOWER in Hg	UPPER in Hg	SW2-1	SW2-2	SW2-3	SW2-4
600	800	450	600	17.72	23.62	ON	ON	ON	ON
600	900	450	675	17.72	26.58	OFF	ON	ON	ON
600	1000	450	750	17.72	29.53	ON	OFF	ON	ON
600	1100	450	825	17.72	32.48	OFF	OFF	ON	ON
700	800	525	600	20.67	23.62	ON	ON	OFF	ON
700	900	525	675	20.67	26.58	OFF	ON	OFF	ON
700	1000	525	750	20.67	29.53	ON	OFF	OFF	ON
700	1100	525	825	20.67	32.48	OFF	OFF	OFF	ON
677.1	1083.6	508.0	812.8	20.00	32.00	ON	ON	ON	OFF
800	900	600	675	23.62	26.58	OFF	ON	ON	OFF
800	1000	600	750	23.62	29.53	ON	OFF	ON	OFF
800	1100	600	825	23.62	32.48	OFF	OFF	ON	OFF
						ON	ON	OFF	OFF
						OFF	ON	OFF	OFF
900	1000	675	750	26.58	29.53	ON	OFF	OFF	OFF
900	1100	675	825	26.58	32.48	OFF	OFF	OFF	OFF

Table 5-2

The two SW2 switch combinations shown with no pressure values are invalid settings. If the switches are set to either of these combinations, the analog output will default to the full range of 600-1100 mbar.

SW2 switch settings shown in Gray highlight will put the sensor into Model 594 (AutoMet plug & play) mode. In this mode, the analog output is fixed at 0-1V, and the SW1 switches are disabled. The sensor Auto-ID voltage is provided on the Aux Out terminal (terminal 10).

6.0 THEORY OF OPERATION

The 092 Barometric Pressure Sensor utilizes a piezoresistive pressure sensor module. This module contains an analog to digital converter, a temperature sensor, and non-volatile memory for storage of calibration coefficients. The pressure sensor module communicates with a highly integrated, mixed-signal microcontroller via a 3-wire serial peripheral interface (SPI).

The microcontroller contains two UARTS. One is connected to the RS-232 and RS-485 interfaces, while the second performs SDI-12 communications. The two serial ports function independently for the most part. The exception is the selection of pressure units which is common to both ports. It is possible to utilize the RS-232/485 port in interval or polled mode while an SDI-12 data recorder polls the sensor for data.

The microcontroller also contains a 12-bit digital to analog converter (DAC) for the sensor's analog output. The DAC is connected to a programmable gain amplifier stage. The gain of the output amplifier is set with dip switches (SW1). This allows the selection of 0-1, 0-2, 0-2.5, or 0-5 Volts for the analog output.

At startup the microcontroller reads the calibration coefficients from the pressure sensor module and compares them to values stored in its own non-volatile memory during factory calibration. An error message is displayed on the RS-232/485 port if the values do not match, indicating that one of the non-volatile memory sources may be corrupt or the sensor module may be malfunctioning.

The microcontroller polls the pressure sensor module once per second for the barometric pressure and ambient temperature. The raw readings are temperature corrected by the microcontroller. Then, second and third order temperature corrections are applied to the pressure reading. Finally, an individual factory determined calibration coefficient is applied and the pressure value is stored for output.

The microcontroller reads the state of the pressure range dip switches (SW2) once per second to determine the scaling of the analog output range. The pressure value is checked for under-range and over-range conditions and sent to the DAC for output. An under-range condition will produce an output of zero volts, while an over-range condition will set the analog output to the full-scale voltage as determined by the setting of the output range dip switches (SW1). Please note that analog output accuracy and resolution will be optimized by selecting the narrowest pressure range that will be encountered at the location where the sensor will be used.

The SW2 pressure range dip switch settings do not affect the range of the serial output. The serial message may deviate to values outside of the range of 600 to 1100 millibars if the sensor is subjected to ambient pressures outside of this range. Pressure conditions in the range of 10 to 10,000 millibars will not harm the sensor, but the measurement accuracy is not guaranteed beyond the range of 600 to 1100 millibars.

All input and output lines are protected from static surge damage by Transzorbs and current limiting resistors.

7.0 CALIBRATION

Calibration is performed against a NIST traceable standard. The calibration coefficients are stored in non-volatile memory at the factory. No user calibration is available. The sensor must be returned to Met One Instruments if periodic calibration is desired.

8.0 MAINTENANCE

Periodic cleaning of the sintered filter on the bottom of the unit may be required in dusty conditions. Remove the filter from the bottom of the unit and clean with distilled water.

Return of the sensor to Met One Instruments for a yearly recalibration is recommended.

9.0 CONTROL AND COMMUNICATION

Operational parameters of the 092 are set with board mounted DIP switches and by using one of the serial communications protocols. These protocols include; SDI-12 and simple two character terminal commands via RS-232 or RS-485.

10.0 TERMINAL MODE

The terminal emulator supports using a VT-100 terminal. Sending three (3) carriage returns within two seconds starts the terminal service. Terminal mode begins by displaying the Model Number, Date Code, Serial Number, and Firmware Version:
i.e. 092-YY-SSSSS-CCC-VV.V
where: YY is the Year of manufacture
SSSSS is the Serial Number
CCC is the Calibration Tracking Code
VV.V is the Firmware Version

Note: Pressure measurements are suspended while the terminal service is active. SDI-12 polls will return the last pressure value measured before terminal service was entered.

Command	Description
DR	Display range switch setting for analog output. Command: DR<cr>
HE	Display the Help menu Command: HE<cr> HE = This Help menu DR = Display Range Switch setting for Analog Output. LB = Toggle Verbose Label mode. Use with MicroMet or CR-10X logger. LC = Display Last Calibration information PU = Set Pressure Units QU = Quit command mode and save any changes SB = Set Baud rate. ST = Set Serial Trigger Address (RS-485 Only) VN = Display Firmware Version Number
LB	Verbose Control of RS-232/485 Parameter Labels for Data loggers Command: LBx<cr> Where x is: 1 = Enable Labels (default) 0 = Suppress Labels
LC	Display the last calibration information table. Command: LC<cr> Returns the serial number and date of last calibration.
OI	Select Output Interval Command: OIx<cr> Where x is: 0 = Serial Trigger. Address must be set with ST command. 1 = 1 second 2 = 5 seconds 3 = 10 seconds 4 = 15 seconds 5 = 30 seconds 6 = 60 seconds

Command	Description
PU	Pressure Units Sets the Engineering Units for Pressure Command: PUx<cr> Where x is: 0 = Millibars (default) 1 = Hectopascals 2 = Inches of Mercury 3 = Millimeters of Mercury 4 = Kilopascals
QU	Quit Save changes and exit Command or Terminal mode. Command: QU<cr> Not supported by SDI-12
SB	Serial Baud Rate Command: SBx<cr> Where x is: 1 = 1200 Baud 2 = 2400 Baud 3 = 4800 Baud 4 = 9600 Baud 5 = 19200 Baud (default)
ST	Serial Trigger (RS-485 Only) Set the string used in Rs-485 mode to serve as a trigger for the unit's send data command. Command: STx<cr> Where 'x' is the serial trigger string. The 'x' character can be anything from one to six characters, but cannot be three "!" in row.
VN	Version Number Returns the firmware version number Command: VN<cr>

11.0 SDI-12 SERVICE

NAME	SDI-12 COMMAND	SENSOR RESPONSE
Address Query	?!	a<CR><LF> Where a = address
Acknowledge Active	a!	a<CR><LF> Where a = address
Send Identification	aI!	a13Climo 092 1.0 0Axxxxx<CR><LF> Where a=address and xxxxx = S/N
Change Address	aAb!	b<CR><LF> Where b = new address
Start Measurement	aM!	a0001<CR><LF> Where a = address
Start Measurement with CRC	aMC!	a0001<CR><LF> Where a = address
Send Data.	aD0!	a+1013.0<CR><LF> Where a = address
Start Concurrent Measurement	aC!	a00001<CR><LF> Where a = address
Start Concurrent Measurement with CRC	aCC!	a00001<CR><LF> Where a = address
Continuous Measurements	aR0!	a+xxxx.x<CR><LF> Where a = address and xxxx.x = data
Continuous Measurements with CRC	aRC0!	a+xxxx.x{crc}<CR><LF> Where a = address, xxxx.x = data and {crc} = CRC
* Display Last Calibration	aXLC!	aXLCyymmdd<CR><LF> Where yymmdd is date of last calibration
* Set Pressure Units	aXPUf!	aXPUf<CR><LF> Where f is: 0 for Millibars (default), or 1 for Hectopascals, or 2 for Inches of Mercury, or 3 for Millimeters of Mercury, or 4 for Kilopascals
* Display Version Number.	aXVN!	aXVNxx.x<CR><LF> Where a = address and xx.x = firmware version

* Extended SDI-12 commands not available with all data loggers.

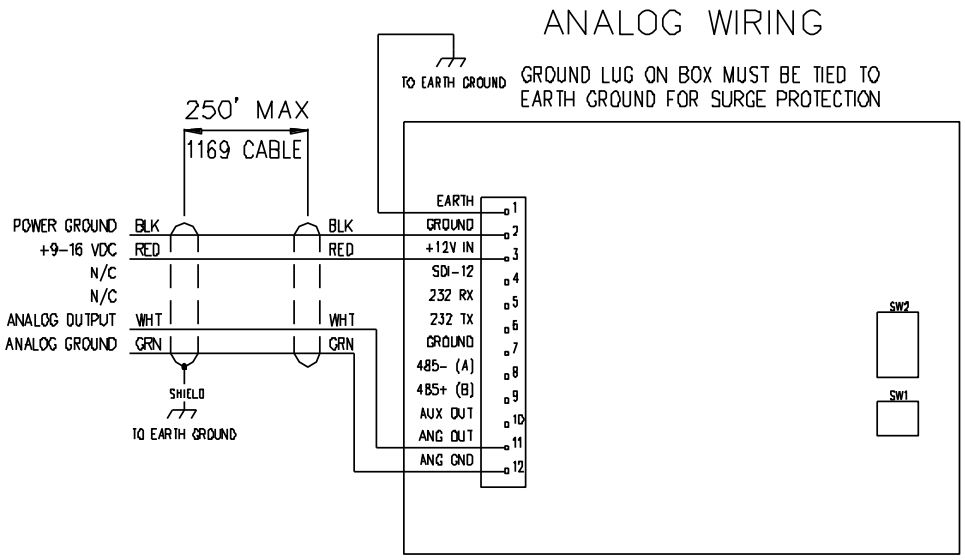


Figure 3.1 – Analog Wiring

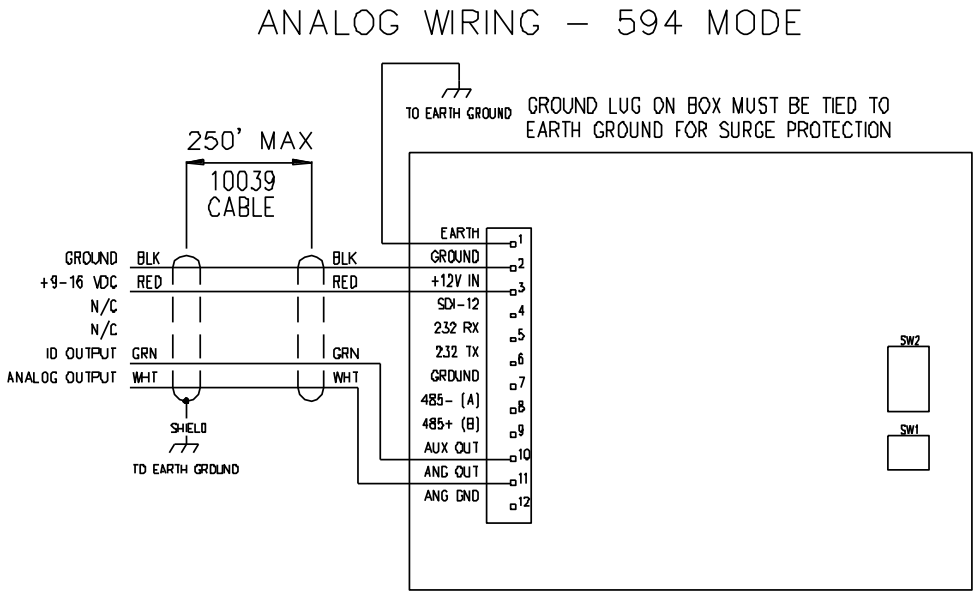


Figure 3.2 – Analog Wiring (594 Mode)

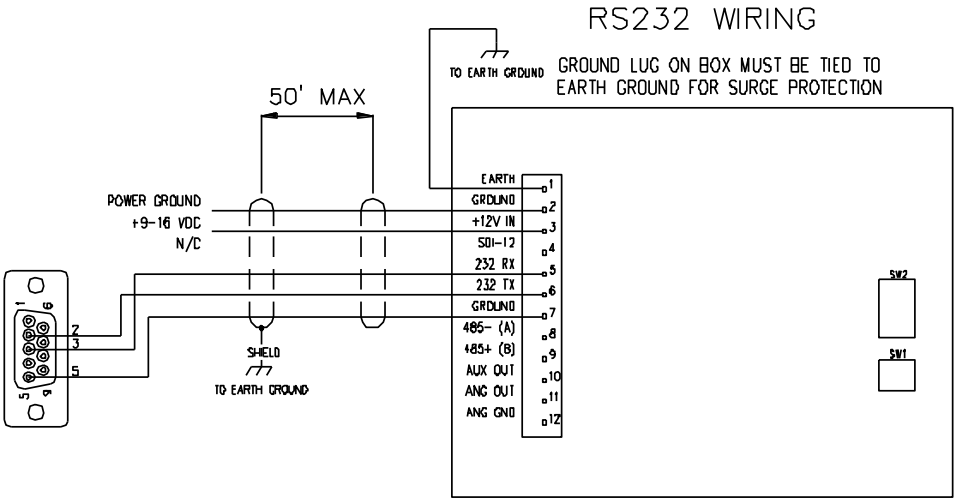


Figure 3.3 – RS232 Wiring

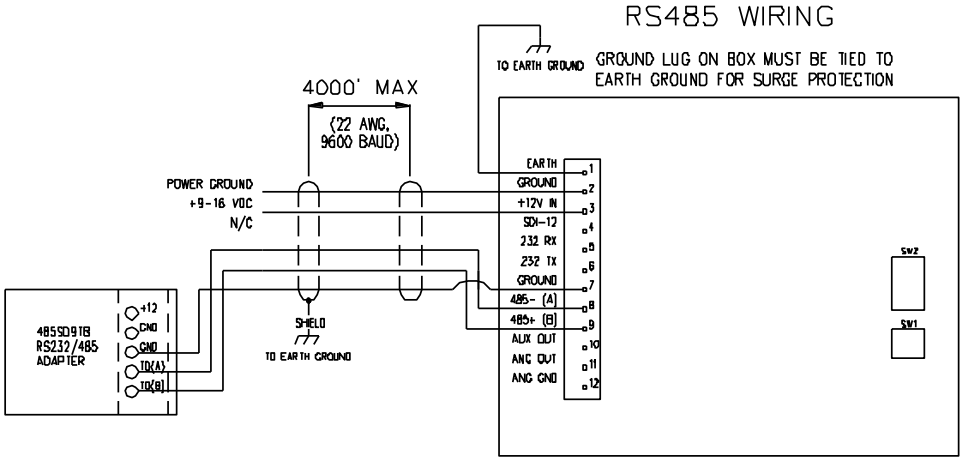


Figure 3.4 – RS485 Wiring

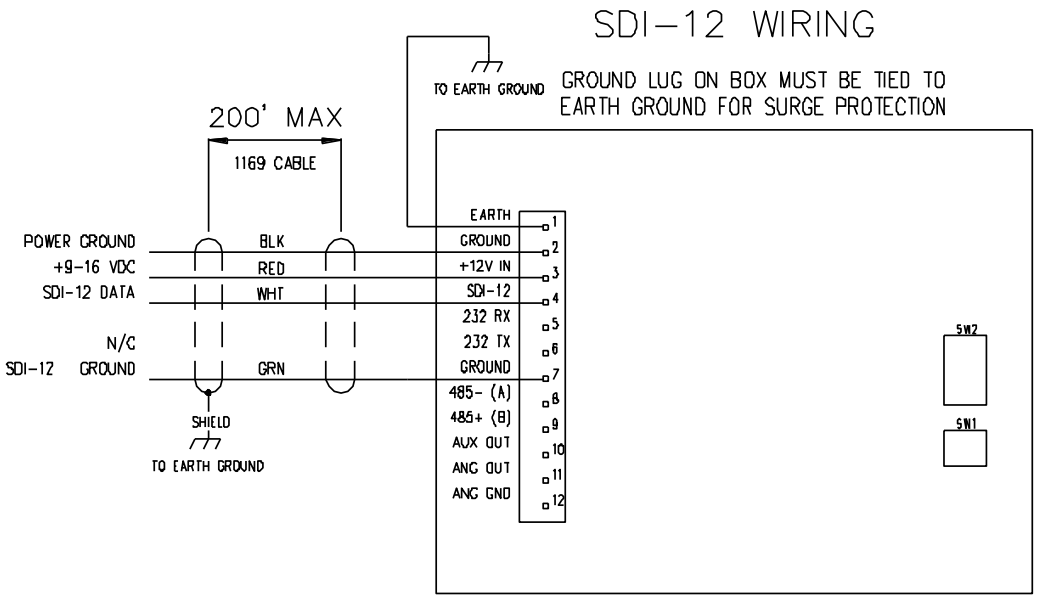


Figure 3.5 – SDI-12 Wiring

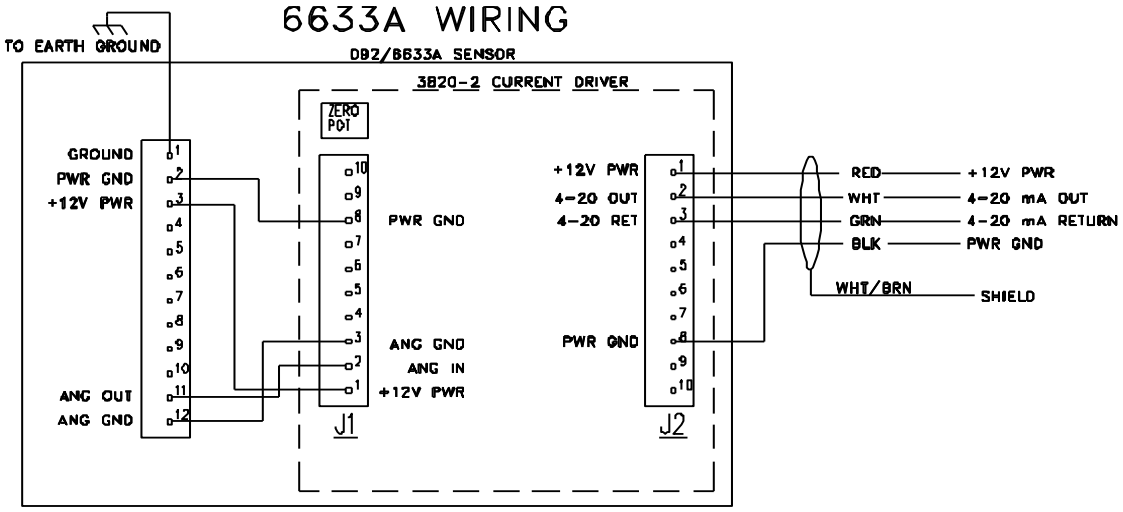


Figure 3.6 – 6633A Wiring

Appendix A

ABSOLUTE BAROMETRIC PRESSURE CORRECTION TO MEAN SEA LEVEL PRESSURE

Based on the ICAO standard Atmosphere

Elevation	Sea Level Correction Factor		
(feet)	in Hg	mm Hg	mbar
0	0.000	0.00	0.00
10	0.011	0.27	0.37
20	0.022	0.55	0.73
30	0.032	0.82	1.10
40	0.043	1.10	1.46
50	0.054	1.37	1.83
60	0.065	1.65	2.20
70	0.076	1.92	2.56
80	0.086	2.19	2.93
90	0.097	2.47	3.29
100	0.108	2.74	3.66
200	0.216	5.48	7.30
300	0.323	8.20	10.94
400	0.430	10.92	14.56
500	0.537	13.63	18.17
600	0.643	16.33	21.78
700	0.749	19.03	25.37
800	0.855	21.72	28.95
900	0.960	24.39	32.52
1000	1.066	27.07	36.08
2000	2.100	53.35	71.12
3000	3.105	78.86	105.13
4000	4.079	103.62	138.15
5000	5.025	127.64	170.18
6000	5.943	150.95	201.26
7000	6.833	173.56	231.40
8000	7.696	195.49	260.63
9000	8.533	216.74	288.97
10000	9.344	237.35	316.44
11000	10.130	257.31	343.05
12000	10.892	276.66	368.84

Add the correction to the absolute pressure reading to calculate Mean Sea Level Pressure. Subtract the correction from 1013.3 mbar (or 760.0 mm Hg, or 29.93 in Hg) to calculate the average Absolute Pressure at any elevation.

Elevation	Sea Level Correction Factor		
(meters)	in.Hg	mm Hg	mbar
0	0.000	0.00	0.00
10	0.035	0.90	1.20
20	0.071	1.80	2.40
30	0.106	2.70	3.60
40	0.142	3.60	4.80
50	0.177	4.49	5.99
60	0.212	5.39	7.19
70	0.247	6.29	8.38
80	0.283	7.18	9.57
90	0.318	8.07	10.77
100	0.353	8.97	11.96
200	0.703	17.85	23.80
300	1.049	26.65	35.52
400	1.392	35.36	47.14
500	1.732	43.99	58.64
600	2.068	52.53	70.03
700	2.401	60.99	81.31
800	2.731	69.37	92.49
900	3.058	77.67	103.55
1000	3.381	85.89	114.51
2000	6.446	163.74	218.30
3000	9.218	234.14	312.17
4000	11.719	297.66	396.85

Add the correction to the absolute pressure reading to calculate Mean Sea Level Pressure. Subtract the correction from 1013.3 mbar (or 760.0 mm Hg, or 29.93 in Hg) to calculate the average Absolute Pressure at any elevation.

Appendix B

Site Elevation vs. Sensor Range

When using analog signals, it is recommended to keep the sensor's pressure range to a minimum in order to achieve optimum signal resolution. This is not a consideration when using digital signals – digital signals are always at full range (800-1100 mbar) and full resolution. The 092 sensor ranges can be customer-selected to accommodate installation at any elevation from below sea level to approximately 12000 feet.

Atmospheric pressure will decrease with increasing elevation at the rate of approximately 1% per 80 meters elevation. The tables in Appendix A can be used to correct absolute pressure (provided by the 092 sensor) to mean sea level pressure (MSLP). At any elevation, weather causes the atmospheric pressure to vary above and below the average. The sensor should be set to an appropriate range so that it can report any expected atmospheric pressure at a given elevation.

Mean sea level pressure (MSLP) is 1013mbar (hPa). Maximum and minimum pressures are considered to be as follows:
Maximum MSLP = 1070mbar.
Minimum MSLP = 940 mbar (non-hurricane)
Minimum MSLP = 880 mbar (hurricane)

The amount of deviation from average pressure also decreases with increasing elevation. Consequently, the elevation affects both the average pressure and the pressure deviation due to weather activity.

The following formulas can be used to calculate maximum and minimum expected absolute pressures at any elevation:
Maximum expected pressure = P_A * (1070/1013)
Minimum expected (non-hurricane) pressure = P_A * (940/1013)
Minimum expected (hurricane) pressure = P_A * (880/1013)

where: P_A = average absolute pressure at a specific elevation, computed from table in Appendix A.

These formulas and derivatives were used to compute the recommended sensor ranges for specific elevations in the tables below.

Recommended pressure ranges for given elevations above sea level

Elevation	Non-Hurricane Recommended Range
0 to 1200 ft.	900 to 1100 mbar
1200 to 1900 ft.	800 to 1100 mbar
1900 to 4400 ft.	800 to 1000 mbar
4400 to 6200 ft.	700 to 1000 mbar
6200 to 8000 ft.	700 to 900 mbar
8000 to 12000 ft.	600 to 800 mbar

Elevation	Hurricane Zone Recommended Range
0 to 1900 ft.	800 to 1100 mbar
1900 to 2600 ft.	800 to 1000 mbar
2600 to 6200 ft.	700 to 1000 mbar
6200 ±50 ft.	700 to 900 mbar
6200 to 7800 ft.	600 to 900 mbar
7800 to 10200 ft.	600 to 800 mbar

Practical elevation ranges for each 200-300 mbar sensor range

Pressure Range	Non-Hurricane Elevation	Hurricane Zone Elevation
900 to 1100 mbar	-750 to 1200 ft.	-750 to –600 ft.
800 to 1100 mbar	-750 to 4400 ft.	-750 to 2600 ft.
800 to 1000 mbar	1900 to 4400 ft.	1900 to 2600 ft.
700 to 1000 mbar	1900 to 8000 ft.	1900 to 6200 ft.
700 to 900 mbar	6200 to 8000 ft.	6200 ±50 ft.
600 to 900 mbar	6200 to 12000 ft.	6200 to 10200 ft
600 to 800 mbar	7800 to 12000 ft.	7800 to 10200 ft.

Appendix C

Units Conversion

One Atmosphere

1 atm	1013.3 mbar
	1013.3 hPa
	760.00 mm Hg
	760.00 Torr
	29.921 in Hg
	14.696 psia

Inches of Mercury to Millibars or to Millimeters of Mercury

in Hg	mbar / 33.864
	mbar * 0.02953
	mm Hg / 25.400
	mm Hg * 0.03937

Millimeters of Mercury to Millibars or to Inches of Mercury

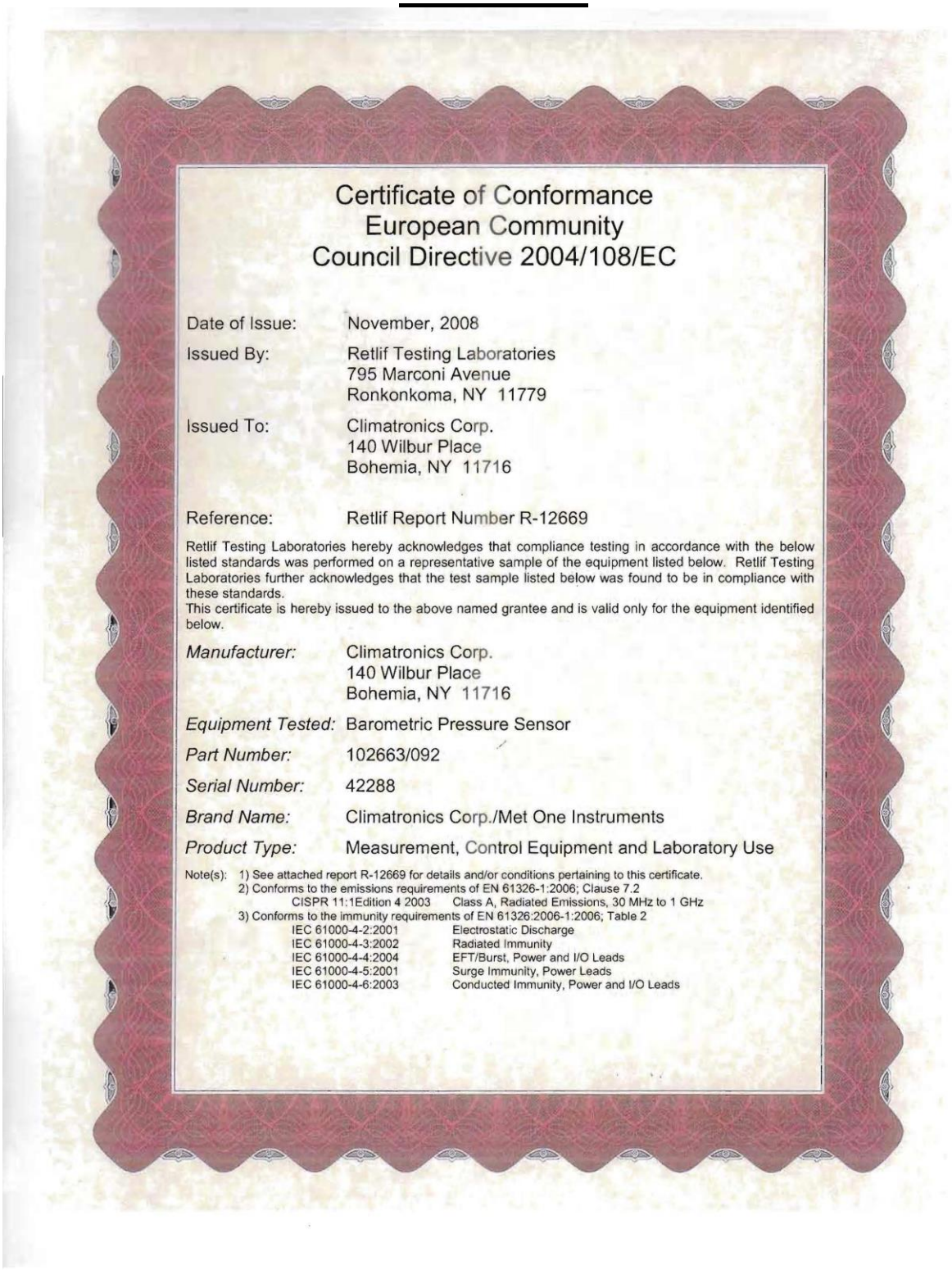
mm Hg	mbar / 1.3332
	mbar * 0.750064
	in Hg / 0.03937
	in Hg * 25.400

Millibars to Millimeters of Mercury or to Inches of Mercury

mbar	mm Hg / 0.750064
	mm Hg * 1.3332
	in Hg / 0.02953
	in Hg * 33.864

Appendix D

CE MARK



Certificate of Conformance
European Community
Council Directive 2004/108/EC

Date of Issue: November, 2008

Issued By: Retlif Testing Laboratories
795 Marconi Avenue
Ronkonkoma, NY 11779

Issued To: Climatronics Corp.
140 Wilbur Place
Bohemia, NY 11716

Reference: Retlif Report Number R-12669

Retlif Testing Laboratories hereby acknowledges that compliance testing in accordance with the below listed standards was performed on a representative sample of the equipment listed below. Retlif Testing Laboratories further acknowledges that the test sample listed below was found to be in compliance with these standards.
This certificate is hereby issued to the above named grantee and is valid only for the equipment identified below.

Manufacturer: Climatronics Corp.
140 Wilbur Place
Bohemia, NY 11716

Equipment Tested: Barometric Pressure Sensor

Part Number: 102663/092

Serial Number: 42288

Brand Name: Climatronics Corp./Met One Instruments

Product Type: Measurement, Control Equipment and Laboratory Use

Note(s): 1) See attached report R-12669 for details and/or conditions pertaining to this certificate.
2) Conforms to the emissions requirements of EN 61326-1:2006; Clause 7.2
CISPR 11:1Edition 4 2003 Class A, Radiated Emissions, 30 MHz to 1 GHz
3) Conforms to the immunity requirements of EN 61326:2006-1:2006; Table 2

IEC 61000-4-2:2001	Electrostatic Discharge
IEC 61000-4-3:2002	Radiated Immunity
IEC 61000-4-4:2004	EFT/Burst, Power and I/O Leads
IEC 61000-4-5:2001	Surge Immunity, Power Leads
IEC 61000-4-6:2003	Conducted Immunity, Power and I/O Leads