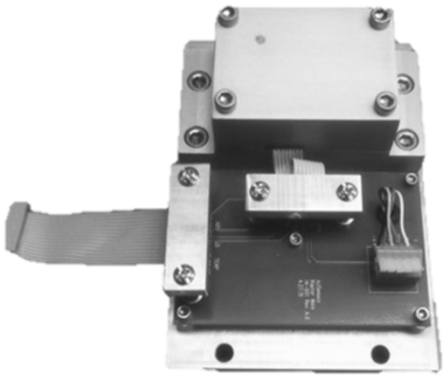
Mass Flow Meter
Manifold Mount

AMF100



- -40°C - 85°C Operating Temperature Range
- Absolute and Differential Pressure Sensors
- Temperature Sensor
- 1ms Response Time
- Digital Output – SPI
- Calibrated Pressure and Temperature Outputs
- ± 0.15% Total Error Band
- Media – Harsh Liquid, Air, & Gas

DESCRIPTION

The AMF100 is a flow meter designed for harsh environments. The AMF100 incorporates an absolute pressure transducer, a differential transducer, and a temperature sensor. The absolute and differential sensors are media isolated and the temperature sensor is encapsulated in a 316 stainless steel housing. There are 3 embedded microprocessors, one for each sensor that store the correction coefficients.

All units are 100% tested and calibrated over the operating pressure and temperature ranges. The SPI digital output is half duplex to simplify the operation of the device.

APPLICATIONS

- Mil/Aero
- Industrial Automation
- HVAC
- Automotive Engine
- Compressor
- Pneumatic

Maximum Environmental Ratings

Operating Temperature ……. -40°C to 85°C
Storage Temperature Range ……. -55°C to 125°C

Proof pressure ……..……... 3x full scale pressure
Burst pressure ……..……... 5x full scale pressure

Application Information

Package

The AMF100 is a retrofit for an existing product and utilizes the same x/y footprint. The overall height is slightly taller. The base and sensor housing are clear anodized 6061 aluminum. The temperature probe is 316 stainless as are the pressure sensor elements.

Stability

The MEMs pressure sensor elements have excellent long term stability. To remove residual post assembly stress, the units are burned in for 2 weeks.

Pressure ports

Manifold Mount.

Media

The AMF100 is tolerant to most media including oil, air, gas, some corrosive media, and salt water.

Wetted parts

The wetted surfaces are composed of 316L stainless steel and clear anodized 6061 aluminum.

Pressure Range

The standard pressure range is 25 PSI absolute and 10 PSI differentially.

Connectors

A 3M connector is used to provide power to the part and connect the digital lines to the 3 microprocessors.

Ordering Guide

AMF100 Digital Output Operational Characteristics

V_+ = 5V, V_- = 0V, Temperature = 25°C

PARAMETER	SYMBOL	Min	Typ	Max	UNITS
Supply Voltage	V_{DD}	2.7	5	5.5	V
Operating Temperature	T_S	-40		85	°C
Supply Current	I_{DD}		3		mA
Accuracy					
Total Error Band		-.15		.15	%Full Scan
Non-Linearity (Note 1)		-.1		.1	%Full Scan
Temperature Error (Null and Span) (Note 2)		-1	.5	1	C
Response Time	t_R	1	2	20	ms
Analog-to-Digital					
Resolution – Absolute Pressure	ADC		.0015		PSI
Resolution –Differential Pressure	ADC		.00016		PSI
Temperature Resolution			0.1		°C
SPI Interface					
Input Low Level	V_{in_low}	0		.2	Vdd
Input High Level	V_{in_high}	.8		1	Vdd
Output Low Level	V_{o_low}			.1	Vdd
Load Capacitance @SDA	Csda @400khz			200	pF
Pull-Up Resistor	R_{I2C_PU}	500			Ω
Input Capacitance (each pin)	C_{I2C_In}			10	pF

Notes: 1) Defined as best straight line 2) Measured from 25°C to 85°C.

Pressure Sensor Digital Interface – SPI

SPI is available only as half duplex (read-only from the AMF100). The factory default is negative edge detect with a clock frequency of 4 MHz.

PARAMETER	SYMBOL	MIN	TYP	MAX	UNITS
SCLK clock frequency (4MHz clock)	f_{SCL}	50		800	kHz
SCLK clock frequency (1MHz clock)	f_{SCL}	50		200	kHz
SS drop to first clock edge	t_{HDSS}	2.5			µs
Minimum SCLK clock low width	t_{LOW}	0.6			µs[1]
Minimum SCLK clock high width	t_{HIGH}	0.6			µs[1]
Clock edge to data transition	t_{CLKD}	0		0.1	µs
Rise of SS relative to last clock edge	t_{SUSS}	0.1			µs
Bus free time between rise and fall of SS	t_{BUS}	2			µs

[1] *Combined low and high widths must equal or exceed minimum SCLK period.*

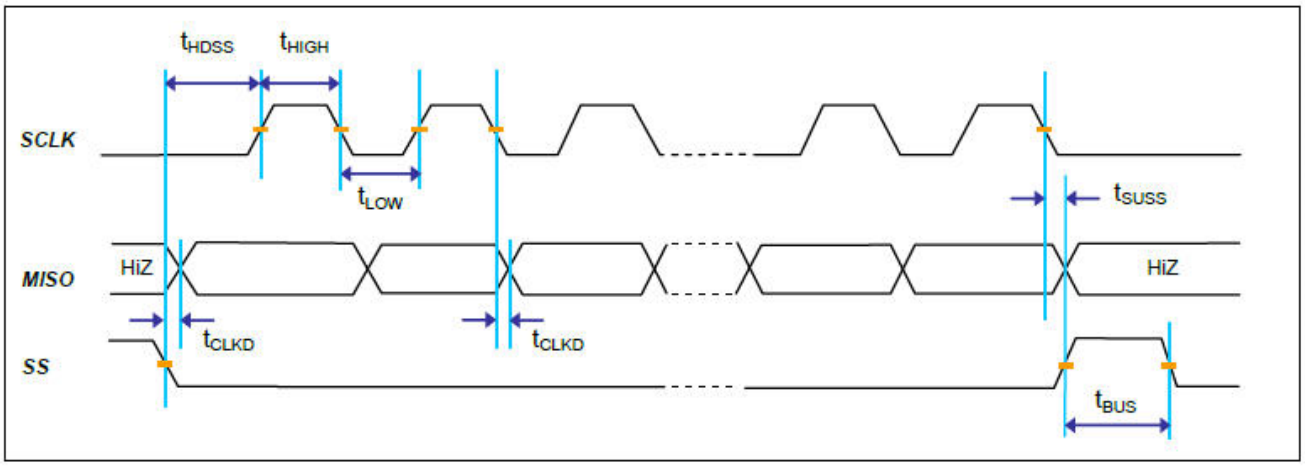


Figure 2

Pressure Sensor SPI Read Operations

For simplifying explanations and illustrations, only falling edge SPI polarity will be discussed in the following sections. The SPI interface will have data change after the falling edge of SCLK. The master should sample MISO on the rise of SCLK. The entire output packet is 4 bytes (32 bits). The high bridge data byte comes first, followed by the low bridge data byte. Then 11 bits of corrected temperature (T[10:0]) are sent: first the T[10:3] byte and then the {T[2:0],xxxxx} byte. The last 5 bits of the final byte are undetermined and should be masked off in the application. If the user only requires the corrected bridge value, the read can be terminated after the 2nd byte. If the corrected temperature is also required but only at an 8-bit resolution, the read can be terminated after the 3rd byte is read.

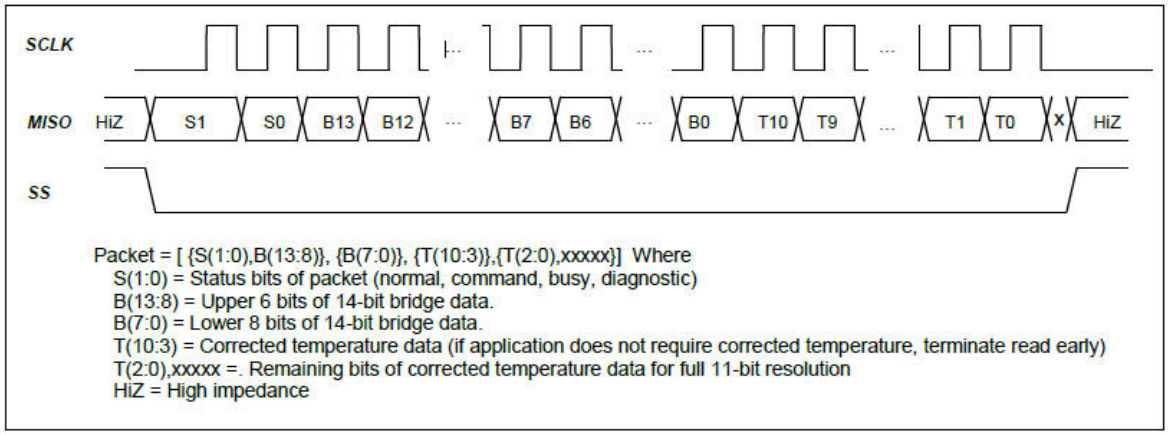
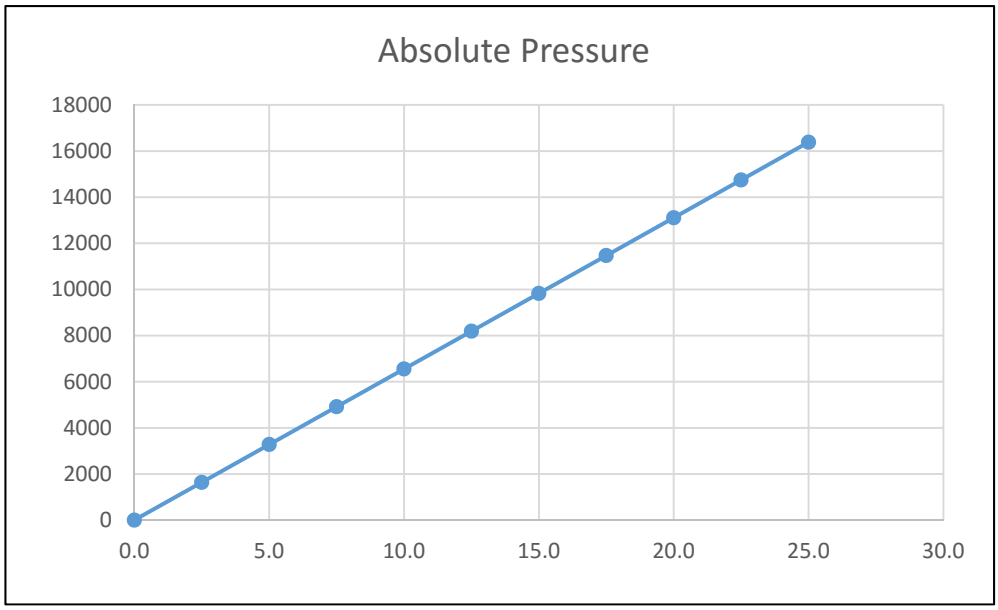


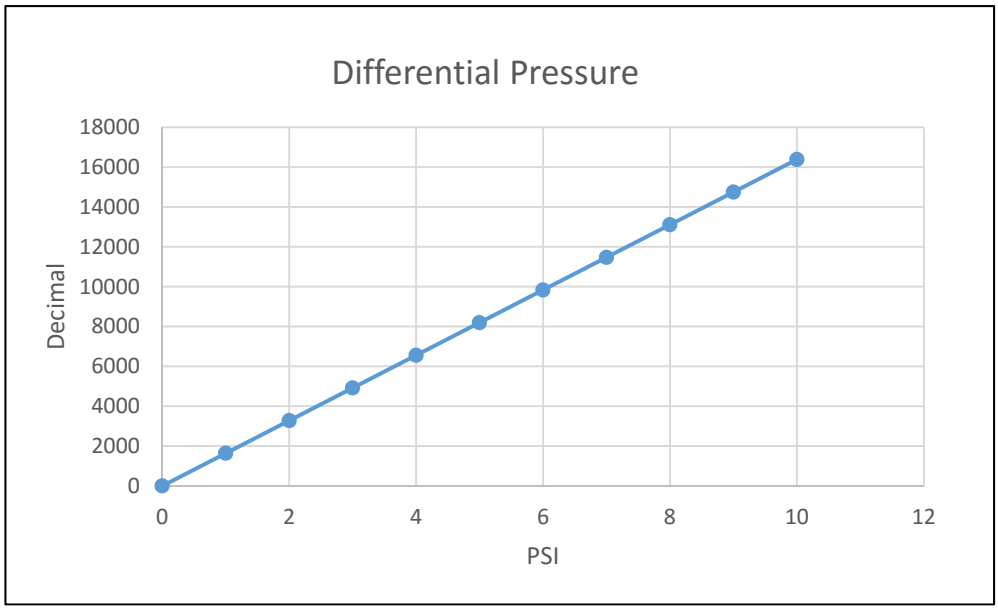
Figure 3

Sensor Outputs



PSIA	% Output	Decimal	Hex
0.0	0	0	0
2.5	10	1638	666
5.0	20	3277	CCD
7.5	30	4915	1333
10.0	40	6553	1999
12.5	50	8192	2000
15.0	60	9830	2666
17.5	70	11468	2CCC
20.0	80	13106	3332
22.5	90	14745	3999
25.0	100	16383	3FFF

Sensor Outputs



PSID	% Output	Decimal	Hex
0	0	0	0
1	10	1638	666
2	20	3277	CCD
3	30	4915	1333
4	40	6553	1999
5	50	8192	2000
6	60	9830	2666
7	70	11468	2CCC
8	80	13106	3332
9	90	14745	3999
10	100	16383	3FFF

Temperature Sensor Digital Interface – SPI

Figure 4 shows the timing diagram for a serial read from the temperature probe. The CS line enables the SCLK input. Thirteen bits of data plus a sign bit are transferred during a read operation. Read operations occur during streams of 16 clock pulses. The first 2 bits out are leading zeros and the next 14 bits contain the temperature data. If CS remains low and 16 more SCLK cycles are applied, the temp probe loops around and outputs the two leading zeros plus the 14 bits of data that are in the temperature value register. When CS returns high, the DOUT line goes into three-state. Data is clocked out onto the DOUT line on the falling edge of SCLK.

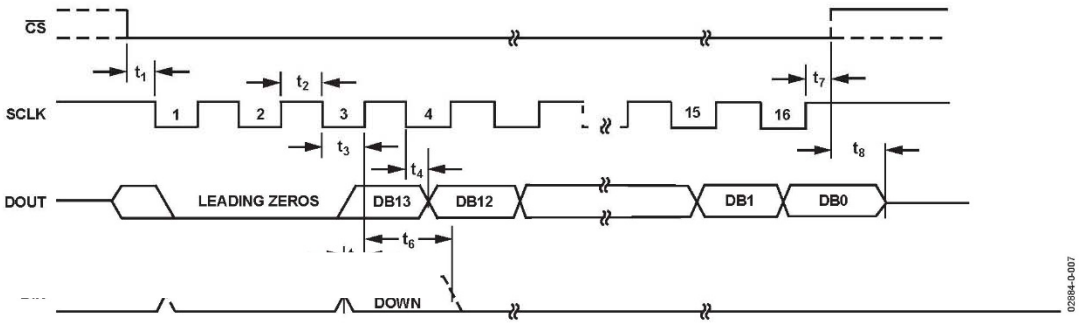


Figure 4

Temperature Sensor Digital Interface – SPI

Temperature Conversion Equations

Positive Temperature = ADC Code(d)/32

Negative Temperature = (ADC Code(d)[1] – 16384)/32

Negative Temperature = (ADC Code(d)[2] – 8192)/32

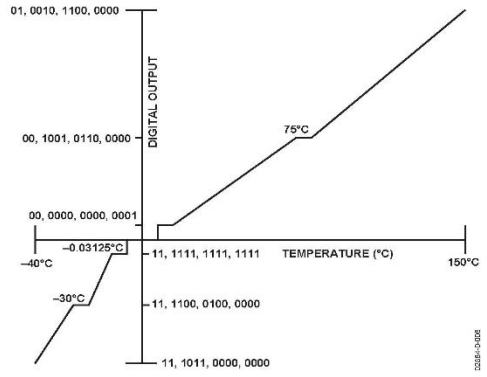
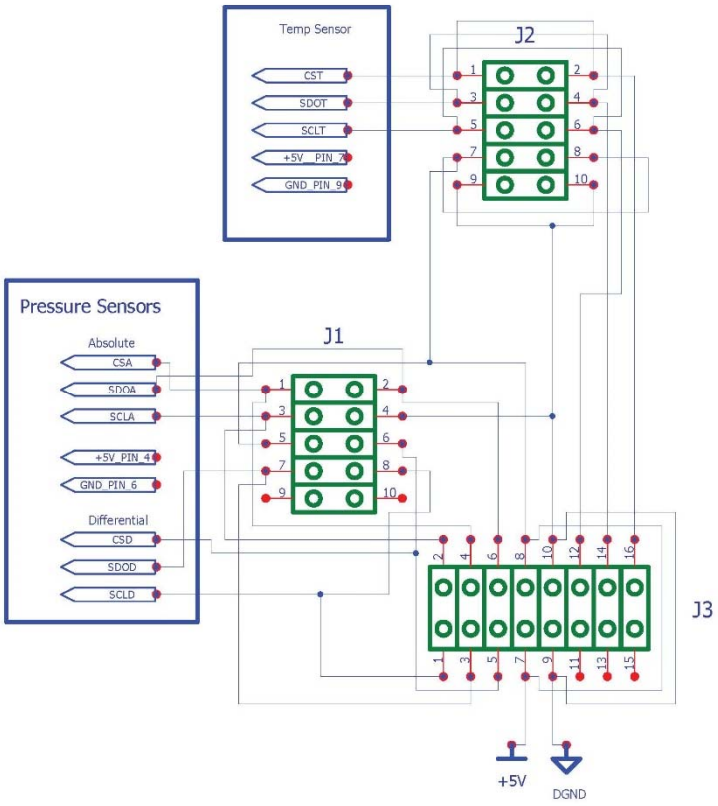


Figure 13. Temperature-to-Digital Transfer Function

[1] ADC code uses all 14 bits of the data byte, including the sign bit.
[2] DB13 (the sign bit) is removed from the ADC code.

Temperature	Digital Output DB13 … DB0
–40°C	11, 1011 0000 0000
–30°C	11, 1100 0100 0000
–25°C	11, 1100 1110 0000
–10°C	11, 1110 1100 0000
–0.03125°C	11, 1111 1111 1111
0°C	00, 0000 0000 0000
+0.03125°C	00, 0000 0000 0001
+10°C	00, 0001 0100 0000
+25°C	00, 0011 0010 0000
+50°C	00, 0110 0100 0000
+75°C	00, 1001 0110 0000
+100°C	00, 1100 1000 0000
+125°C	00, 1111 1010 0000
+150°C	01, 0010 1100 0000

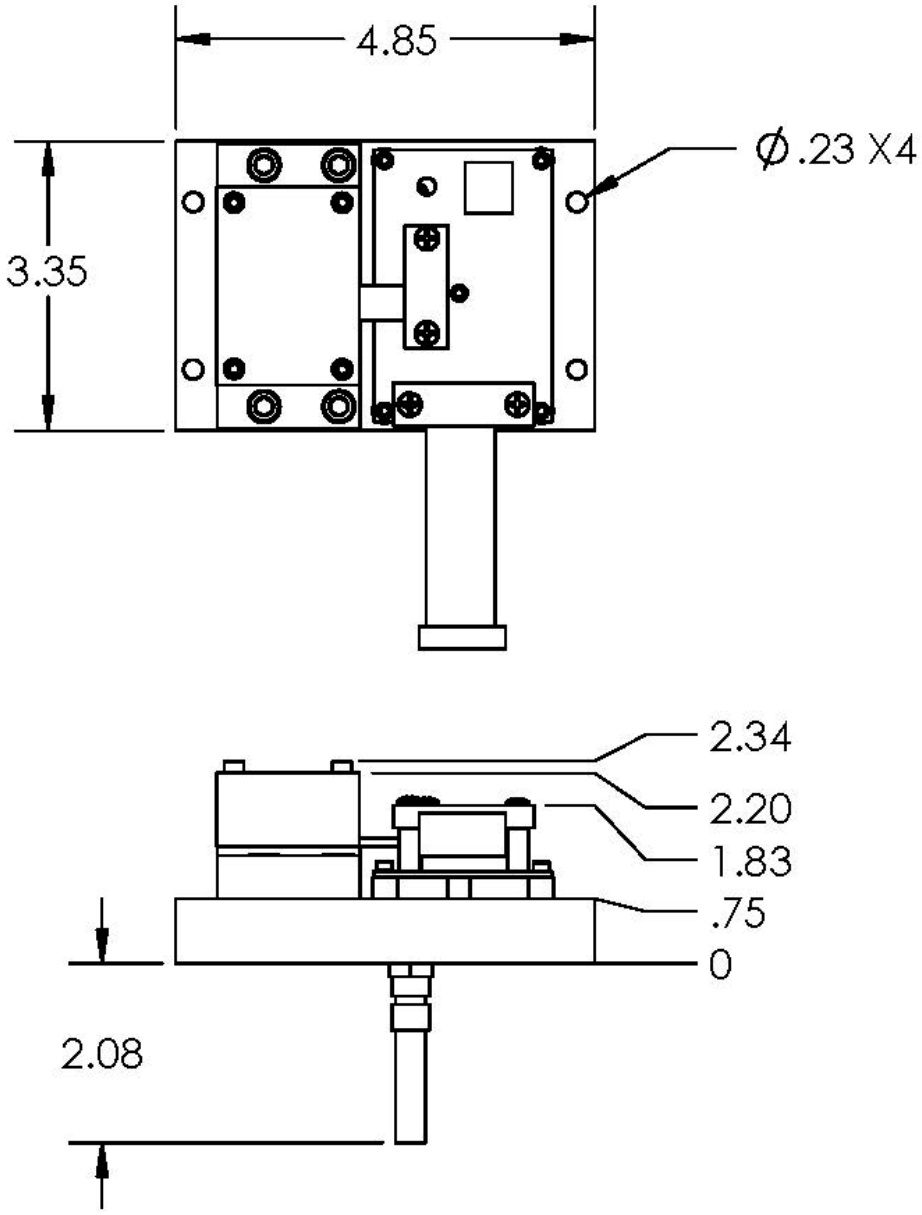
Main Board Schematic



Edge Connector

Edge Connector		
J3		
1	SCLD	Serial Clock Differential
2	SCLA	Serial Clock Absolute
3	SDOD	Serial Data Out Differential
4	CSA	Chip Select Absolute
5	CSD	Chip Select Differential
6	SDOA	Serial Data Out Absolute
7	+V	+5V
8	+V	+5V
9	DGND	DGND
10	DGND	DGND
11	NC	NC
12	SCLT	Serial Clock Temperature
13	NC	NC
14	SDOT	Serial Data Out Temperature
15	NC	NC
16	CST	Chip Select Temperature

Mechanical Dimensions (inches)



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