SHOCK TUBE LAB

PURPOSE: The purpose is to measure the Mach Number and Pressure Ratio for a Shock Wave travelling down a Shock Tube and to compare the measurements with theoretical values based on Normal Shock Wave Theory.

SETUP: The Shock Tube consists of a driver section and a test section. The test section has 2 pressure sensors: these are wired to an oscilloscope.

PROCEDURE: Install a paper or mylar diaphragm in the flange which joins the two sections of the tube. Fire the tube and record pressure sensor data on the oscilloscope. Use these measurements to estimate the Mach Number and Pressure Ratio. Compare the measurements with theoretical values. Repeat the experiment for weak and strong shocks.

SHOCK WAVE THEORY

High speed gas dynamics theory shows that for a normal shock wave the pressure ratio across the shock is related to the Mach Number by the equation:

$$P_H/P_L = 1 + 2k/(k+1)\ (M_L M_L - 1)$$

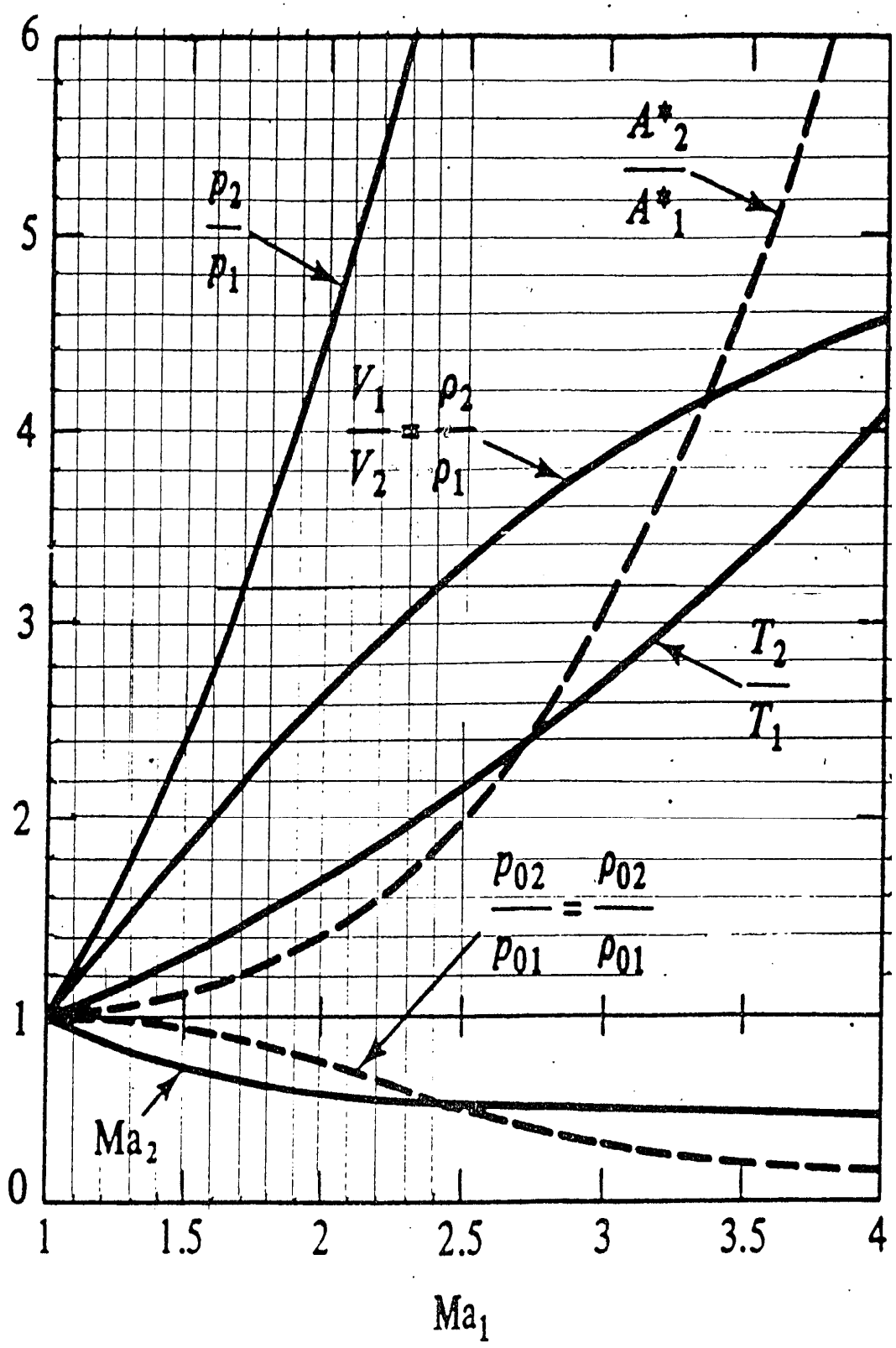
where M_L is the Mach Number of the shock wave, P_H is the pressure downstream of the shock and P_L is the pressure upstream of the shock.

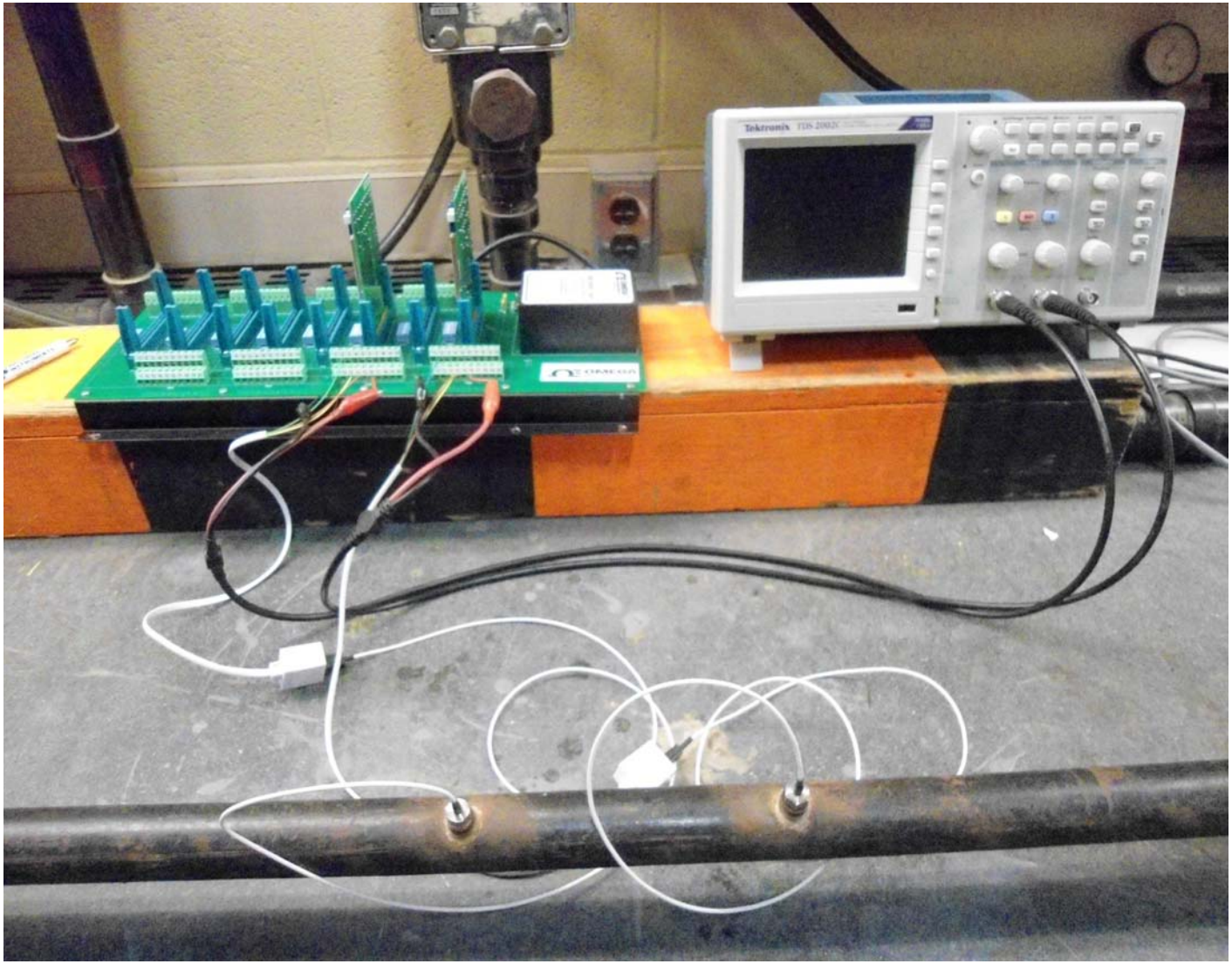
SHOCK WAVE MEASUREMENTS

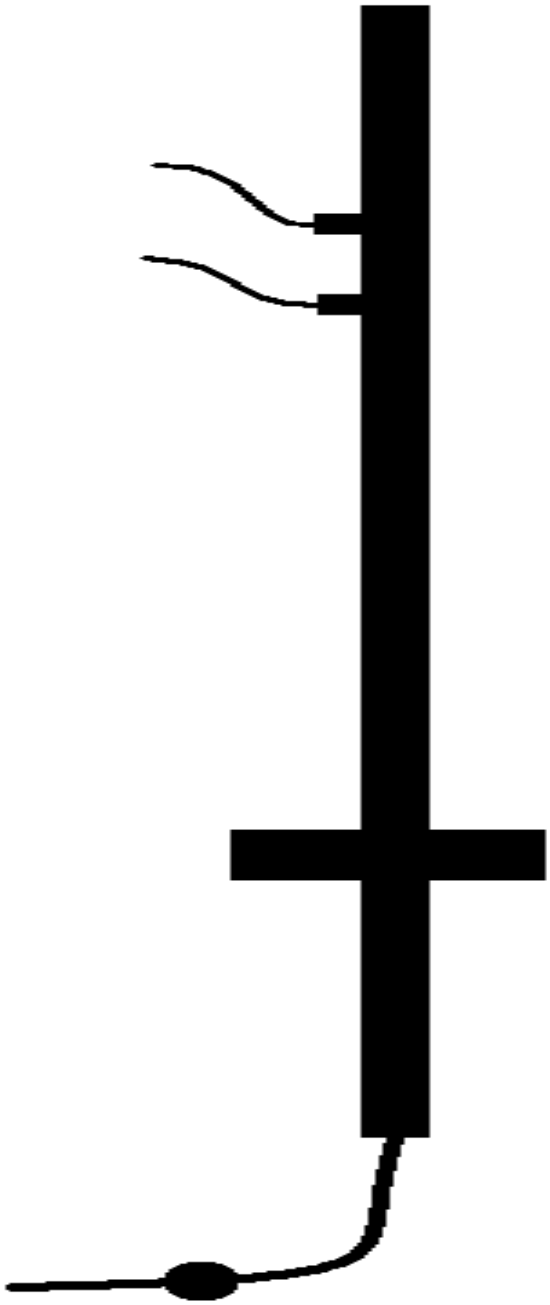
The pressure rise across the shock is given by each pressure sensor. The pressure ratio is:

$$P_H = P_L + \Delta P \qquad P_H/P_L = 1 + \Delta P/P_L$$

The Mach Number is: $M = U/a$. In this equation, U is the shock speed and a is the speed of sound. The shock speed is the distance between sensors divided by time between sensors: $U = \Delta x/\Delta t$. The shock moves into atmospheric air with sound speed $\sqrt{[kRT]} = 343$ m/s.


6
5
4
3
2
1
0
1
1.5
2
2.5
3
3.5
4
Ma_1
$\frac{p_2}{p_1}$
$\frac{A^*_2}{A^*_1}$
$\frac{V_1}{V_2} = \frac{\rho_2}{\rho_1}$
$\frac{T_2}{T_1}$
$\frac{p_{02}}{p_{01}} = \frac{\rho_{02}}{\rho_{01}}$
Ma_2


Tektronix



SHOCK TUBE DATA SHEET

RUN	ΔP VOLTS	Δt SECONDS	M	P_H/P_L

SAMPLE CALCULATIONS

MACH NUMBER

$U = \Delta x/\Delta t$

$a = \sqrt{[kRT]}$

$M = U/a$

PRESSURE RATIO

$\Delta P(BAR) = \Delta P(VOLTS)/CF$

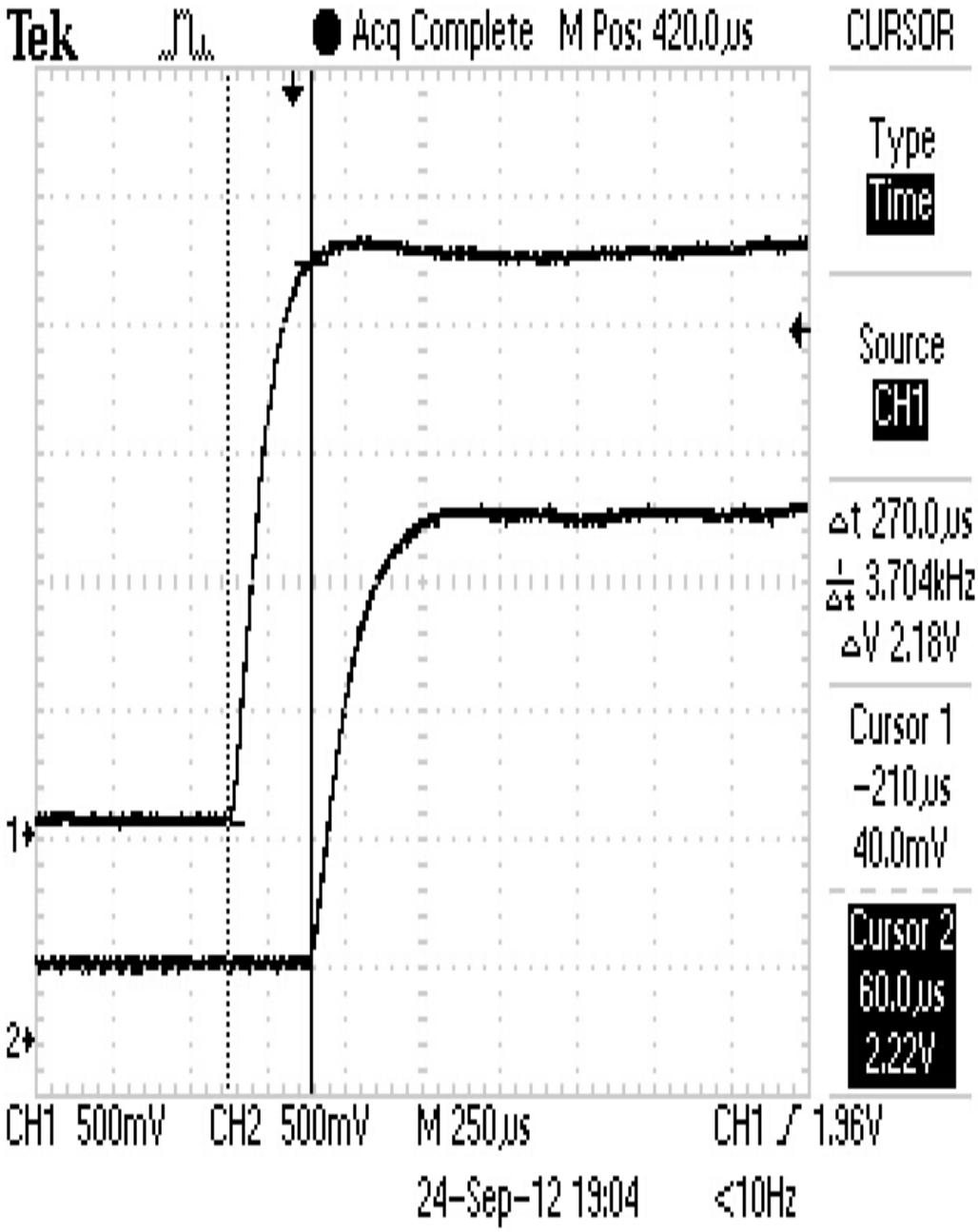
$P_H/P_L = 1 + \Delta P(BAR)$

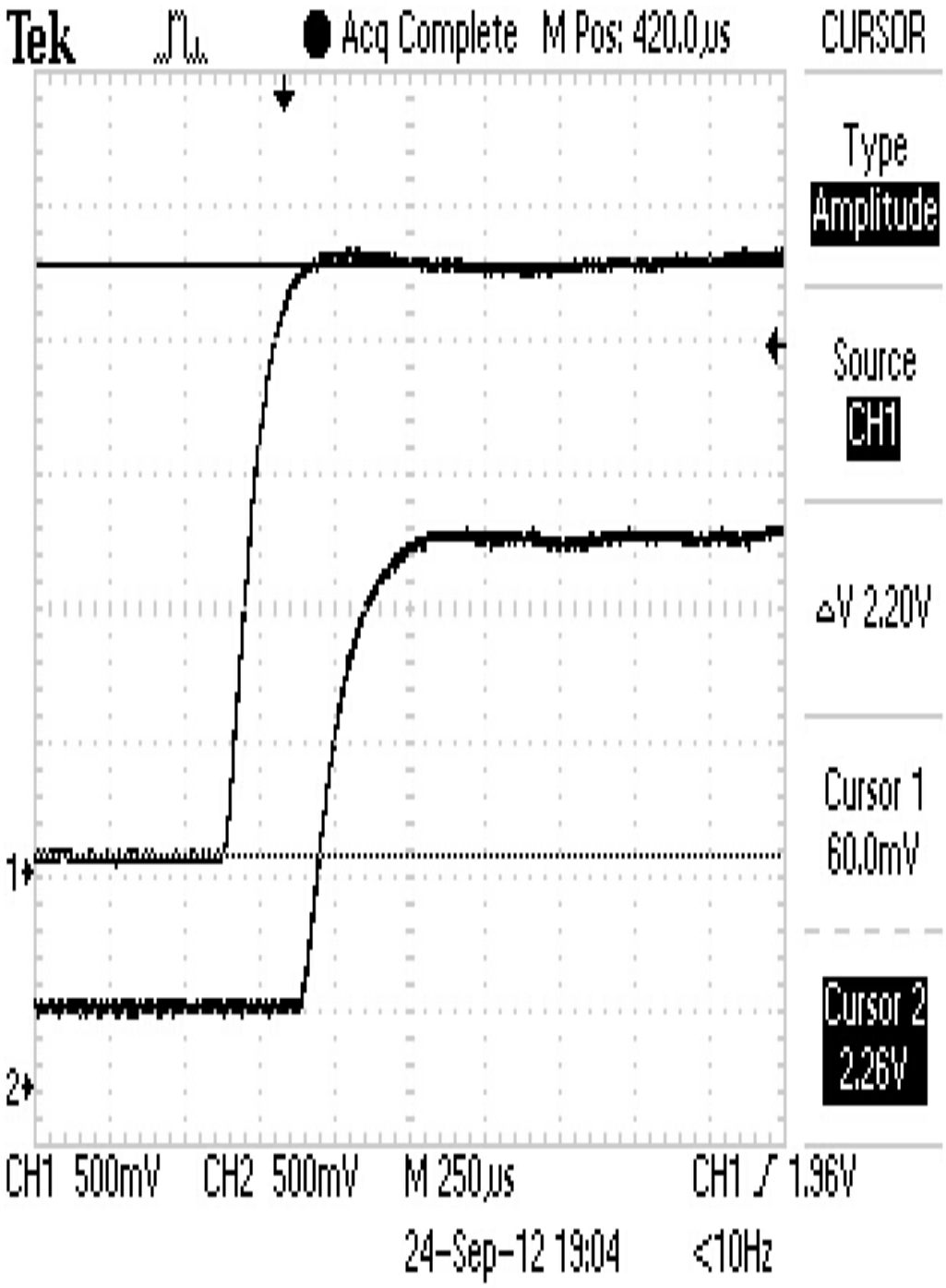
PRESSURE SENSORS

SPACING $\Delta x = 0.15m$

CF#1 2.46 [VOLTS/BAR]

CF#2 1.95 [VOLTS/BAR]


Tek
Acq Complete M Pos: 420.0µs
CURSOR
Type
Time
Source
CH1
Δt 270.0µs
1/Δt 3.704kHz
ΔV 2.18V
Cursor 1
−210µs
40.0mV
Cursor 2
60.0µs
2.22V
1
2
CH1 500mV
CH2 500mV
M 250µs
CH1 ⁄ 1.96V
24-Sep-12 19:04
<10Hz


Tek
Acq Complete M Pos: 420.0µs
CURSOR
Type
Amplitude
Source
CH1
ΔV 2.20V
Cursor 1
60.0mV
Cursor 2
2.26V
1
2
CH1 500mV CH2 500mV M 250µs CH1 ƒ 1.96V
24-Sep-12 19:04 <10Hz

EPX Series

- Stainless Steel Pressure Sensor
- Flush Diaphragm
- Small threads
- Suitable for general applications
- Broad frequency range

DESCRIPTION

The EPX is a miniature threaded pressure sensor with stainless steel flush diaphragm compatible with general media. Threads M5x0.8 or 10-32 UNF are available with built-in O-ring seal for an easy installation. The EPX is offered in many pressure ranges from 0.35 to 350 bar (5 to 5000 psi) with gage, sealed gage, or absolute pressure reference. Non standard excitation, compensated temperatures, cable and thread lengths are available as options.

FEATURES

- Small Threads M5x0.8 or 10-32 UNF
- Ranges from 0.35 to 350 bar (5 to 5,000 psi)
- Stainless Steel Construction
- Useful frequency up to 90kHz
- CE approved

APPLICATIONS

- General testing
- Automotive, marine and flight testing
- Space flight and experimentation

OM2 SERIES MODULAR SIGNAL CONDITIONING SYSTEM
1/4, 1/2, FULL BRIDGE, 1 TO 8 CHANNELS

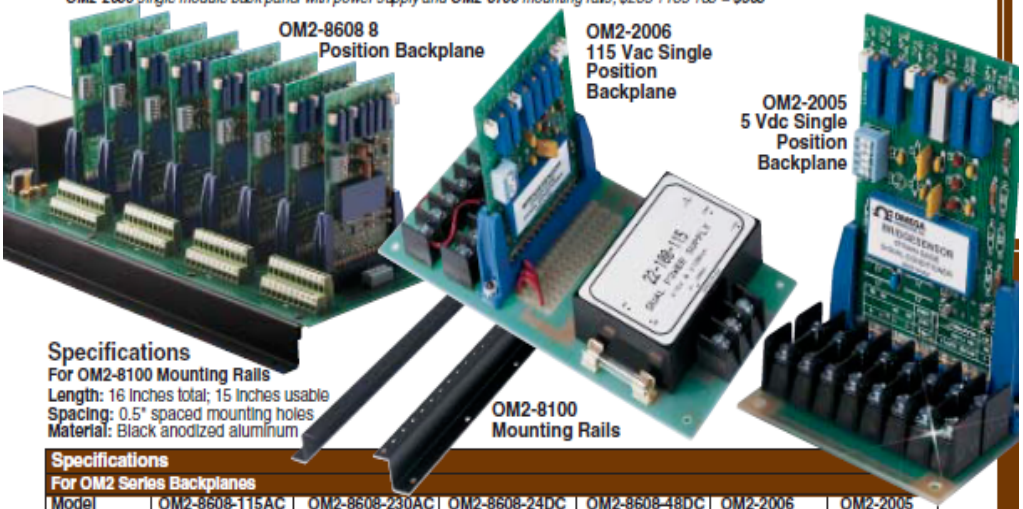
To Order *(Specify Model Number)*			
Model No.	**Price**	**Gain Range***	**Description**
OM2-162	$285	2 to 5000	Signal conditioning module for ½ and full strain bridge circuits
OM2-163	280	10 to 1000	Signal conditioning module for ¼, ½ or full strain bridge circuits or transducers with open collector output

Accessories

Model No.	Price	Description
OM2-8608-115AC	$440	115 Vac powered backplane for 8 OM2 signal conditioning modules with power supply and mounting rails included
OM2-8608-230AC	440	230 Vac powered backplane for 8 OM2 signal conditioning modules with power supply and mounting rails included
OM2-8608-24DC	440	DC powered backplane for 8 OM2 signal conditioning modules with power supply and mounting rails included; 10 to 36 Vdc power
OM2-8608-48DC	440	DC powered backplane for 8 OM2 signal conditioning modules with power supply and mounting rails included; 24 to 72 Vdc power
OM2-2006	185	115 Vac powered backplane for one OM2 signal conditioning module with power supply (mounting rails not included) (not compatible with OM2-161)
OM2-2005	40	5 Vdc powered backplane for one OM2 signal conditioning module (screw terminals only) (not compatible with OM2-161)
OM2-8100	35	Two 16" mounting rails (2 rails already included with OM2-8608)

** 10 V Maximum. Comes with complete operator's manual.*

Ordering Example: *Complete system including* ***OM2-162*** *signal conditioning module for ½ and full-bridge strain gage measurement,* ***OM2-2006*** *single module back panel with power supply and* ***OM2-8100*** *mounting rails, $285 +185 +35 =* ***$505***



Specifications
For OM2-8100 Mounting Rails
Length: 16 inches total; 15 inches usable
Spacing: 0.5" spaced mounting holes
Material: Black anodized aluminum

Specifications For OM2 Series Backplanes						
Model	OM2-8608-115AC	OM2-8608-230AC	OM2-8608-24DC	OM2-8608-48DC	OM2-2006	OM2-2005
Input Range	115 Vac ±10 V	230 Vac ±10 V	10-36 Vdc	24-72 Vdc	115 Vac ±10 V	5 Vdc
Frequency	50/60 Hz	50/60 Hz	N/A	N/A	50/60 Hz	N/A
Temperature	0-55°C 32-131°F	0-55°C 32-131°F	0-55°C 32-131°F	0-55°C 32-131°F	0-55°C 32-131°F	0-55°C 32-131°F
Size	6.25 x 16.5" (159 x 419 mm)	6.25 x 16.5" (159 x 419 mm)	6.25 x 16.5" (159 x 419 mm)	6.25 x 16.5" (159 x 419 mm)	3.5 x 6.9" (89 x 175 mm)	2.75 x 3.25" (70 x 83 mm)
Weight	3 lb, 3 oz (1.43 kg)	3 lb, 3 oz (1.43 kg)	1 lb, 6 oz (.62 kg)	1 lb, 6 oz (.62 kg)	15 oz (425 g)	4 oz (113 g)