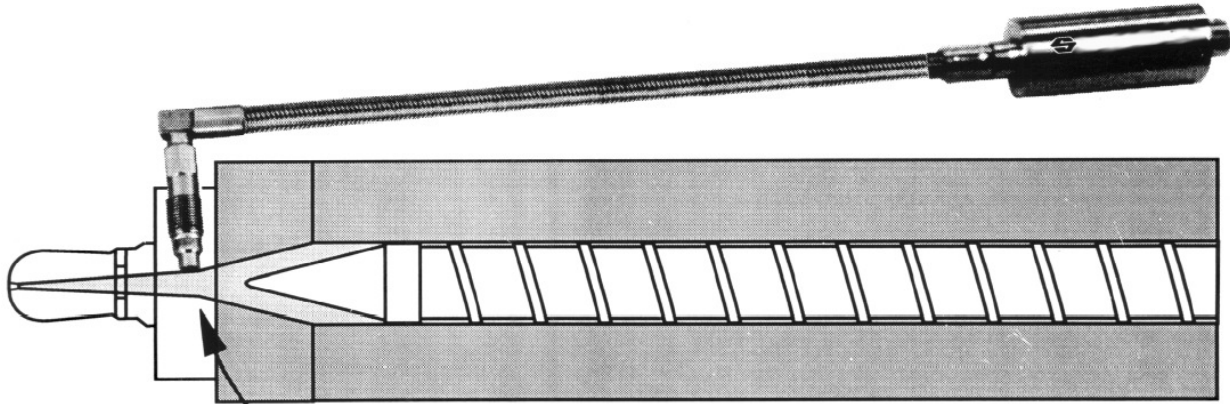




**Sensonetics, Inc**

## **NOZZLE PRESSURE & TEMPERATURE TRANSDUCER**



- Measures both temperature and pressure
- Sapphire Diaphragm
- Fast Response Time <100 microsecond
- Infinite Cycle Life @ rates FSPR
- Abrasion Proof Diaphragm
- No Harmful Mercury, NaK or Push Rods
- No Signal Decay
- No Hysteresis

### **APPLICATIONS**

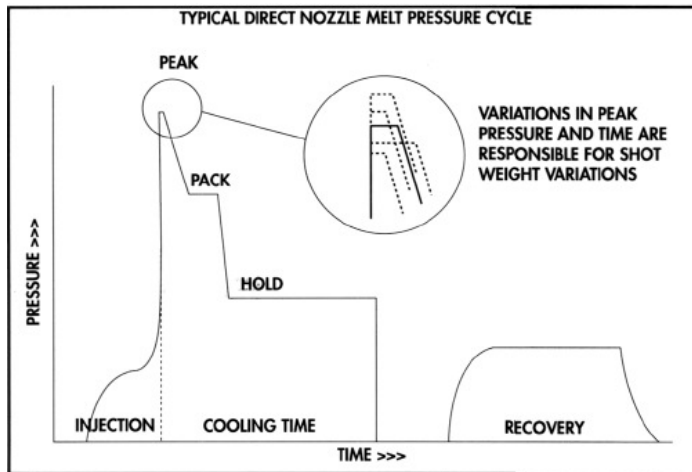
- Blow molding
- Co injection molding
- Injection Molding
- Gas assist molding
- LIM
- RIM
- Structural Foam
- Thermo set Injection Molding

## PROCESS IMPROVEMENT MADE EASY WITH NOZZLE MELT PRESSURE CONTROL

The principal benefit of nozzle melt pressure control is improved shot weight uniformity. The causes of shot weight variability include:

Lack of precise, peak pressure, time control and repeatability.

Variability in melt viscosity or melt temperature from shot to shot. Recognizing that melt viscosity is a function of shear stress, it is the uniformity of viscosity from shot to shot that is important, not variability within the cycle.



Sensonetix' Nozzle Pressure Transducer uses the same Silicon-on-Sapphire sensing diaphragm which has proven itself in melt extrusion applications. The sensing diaphragm is manufactured from sapphire, a single-crystal aluminum oxide which is the hardest of the metal oxide crystals and is chemically inert. Sapphire is ideally suited to the nozzle melt transducer application. It has a modulus of elasticity 30% higher than stainless steel and is 5 times more abrasion resistant than tungsten carbide. In fact, the only material that can scratch it is diamond. The high modulus of elasticity combined with the high gage factor of the piezoresistive strain gages results in virtually infinite fatigue (cycle) life. Single-crystal piezoresistive strain gages are epitaxially grown on the sapphire force collection diaphragm, forming a homogeneous, single-crystal, radiation-hardened structure. Unlike stainless steel, this structure has virtually no hysteresis and provides excellent repeatability and long-term stability. It can be exposed directly to process media and can withstand operating temperatures up to 700°F. An optional silicon on-diaphragm RTD is available, providing excellent temperature measurements (+/-0.5°F) of the melt isolated from the transducer mounting-well.

### NOZZLE MELT PRESSURE AND TEMPERATURE

PRESSURE and TEMPERATURE are the two most important measurable process variables in injection molding. It is essential to measure these parameters in the nozzle as near to the mold as possible. Until now, nozzle measurement was impractical due to wear out from abrasion and fatigue plus slow response time of available sensors.

**Sensonetix'** patented Silicon-on-Sapphire Nozzle Pressure Transducers provide direct measurement with faster than 500 microsecond response time. The sapphire diaphragm has infinite fatigue (cycle) life and will not wear out in abrasive melt applications. The on-diaphragm temperature sensor provides an accurate measurement of injection melt temperature because of turbulent flow in the nozzle. The

piezoresistive strain gages allow dynamic as well as steady-state pressures to be accurately measured without signal decay.

1. Operating pressures to 10,000 PSI, temperatures to 500 deg F, packages available up to 700°F.
2. Fast response time between 100 and 500 micro-seconds.
3. Infinite fatigue life at rated full scale pressure; the high gage factor and high modulus of elasticity of the sapphire diaphragm allows transducer to operate at less than 10% of the proportional limit.
4. Piezoresistive strain gages - Virtually no hysteresis; dynamic as well as steady-state pressures are measured.
5. Patented sapphire diaphragm, second in hardness to diamond, provides extreme resistance to wear and attack by abrasive fillers, blowing agents, or chemical and conductive additives.
6. Optional on-diaphragm Silicon RTD melt temperature sensor provides direct measurement of nozzle melt temperature.
7. Compact design fits most machine nozzle cones.
8. Environmentally safe; contains no hazardous chemical fills such as NaK and Mercury.
9. Available in mill volt, 0-5 and 0-10 VDC and 4-20mA outputs. Compatible with industry standards for data loggers, PLC's, PID controllers, and indicators.

Whether it is to improve injection process control, more accurately control the injection fill, pack, and hold pressures, or for accurate analysis data, Sensonetics Nozzle melt pressure transducers are superior to all other types.

#### **NOZZLE PRESSURE VS. HYDRAULIC PRESSURE TRANSDUCERS**

The advantages of using Sensonetics Nozzle Pressure Transducers to control peak pressures in open or closed-loop control instead of hydraulic pressure transducers is as follows: measurement errors relating to variations in hydraulic oil viscosity, cylinder and screw friction, screw shear variations, and plastic composition are eliminated. The nozzle pressure measurement has 20 to 200 times better resolution, thus allowing much better control. Hydraulic transducers infer melt pressure while Sensonetics nozzle transducers measure it directly.

Ssonetics nozzle pressure transducer's fast response ensures greater repeatability and accurate reproduction transfer of injection peak, pack, and hold pressures. This is especially important for faster cycling machines. The results: fewer short shots, fewer flash parts, faster setup times, fewer process control adjustments, and less scrap.

#### **SENSONETICS VS. OTHER NOZZLE PRESSURE TRANSDUCERS**

Piezoelectric nozzle pressure transducers have a very fast response time, but only measure while the pressure is changing. When the pressure is held steady, the signal decays to zero, thus confusing the control system. This type of transducer also is susceptible to abrasion wear out of the diaphragm. Mercury or NaK-filled nozzle pressure transducers have relatively slow response times of 50 to 100 milliseconds, too slow for proper sensing of the peak transfer pressure. They also have very thin diaphragms which wear very quickly when exposed to abrasive melts. These transducers have a very

limited fatigue life if used at or near the rated pressure range. Typical life can be as little as 100,000 cycles. Sensonetics Silicon-on-Sapphire pressure transducers have been tested to more than 8 million cycles at FSPR, the equivalent of more than 2.5 years on a 9.5 second cycle. The Sensonetics Nozzle Pressure Transducer has a 100 to 500 microsecond response time, is abrasion proof, can measure dynamic as well as steady-state pressure, has virtually infinite fatigue life, and does not contain environmentally hazardous fills.

### **FIELD PROVEN IN PLASTIC EXTRUSION PROCESSES**

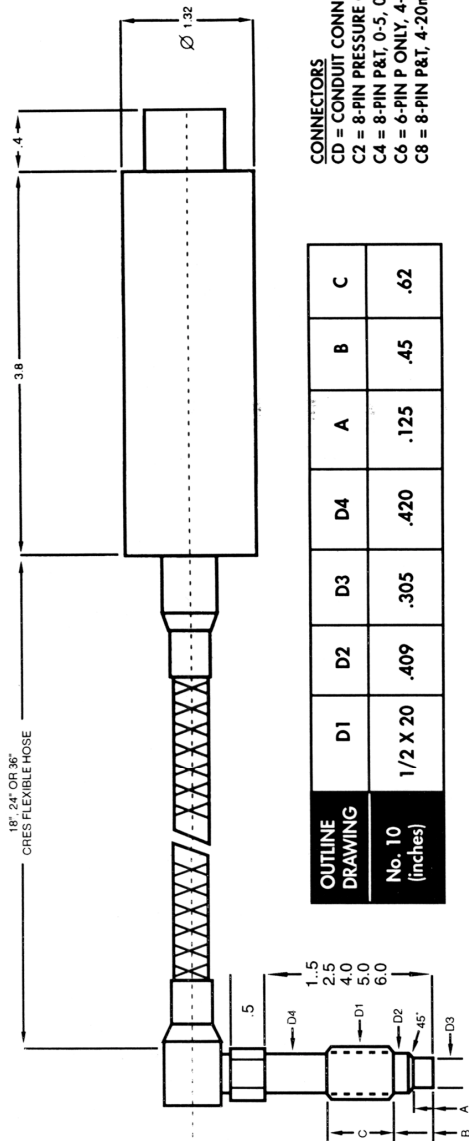
Sensonetics melt pressure/temperature transducers and transmitters are increasingly being used in extrusion applications and have been proven especially beneficial when tight control and quick response is required. In closed-loop pressure control such as critical catheter, fiber, or film production, they allow users to achieve exceptional dimensional control. In highly filled polymer melt extrusion applications, the Sensonetics melt pressure/temperature transducers have virtually unlimited wear life, thus eliminating costly down-time and replacement costs.

### **SYSTEM COMPATIBILITY**

Sensonetics offers all of the standard outputs such as mill volt, 0-5 and 0-10VDC, or 4-20mA, thus making them interface able with all popular injection molding control systems. In many instances, provisions already exist for nozzle melt pressure control.

### **APPLICATIONS**

**Sensonetics** Nozzle Pressure Transducers are suitable for molding the full range of elastomers, thermoplastics, engineered plastics, structural foams; thermo set polymers, silicones, and rubbers. Nozzle Pressure Transducers are available in pressure ranges from 500 to 10,000 PSI in a wide variety of configurations. Combined pressure and temperature models are available for use up to 700°F. These combined transducers are ideal for monitoring critical melt temperatures of rubber and thermo set compounds, thus preventing scorching and premature cross-linking.



**CONNECTORS**  
 CD = CONDUIT CONNECTION  
 C2 = 8-PIN PRESSURE ONLY, PCH • 12 • 8P  
 C4 = 8-PIN P&T, 0-5, 0-10V, PCH • 12 • 8P  
 C6 = 6-PIN P ONLY, 4-20mA, PTH • 10 • 6P  
 C8 = 8-PIN P&T, 4-20mA, PCH • 12 • 8P

|                        |          |      |      |      |      |     |     |
|------------------------|----------|------|------|------|------|-----|-----|
| <b>OUTLINE DRAWING</b> | D1       | D2   | D3   | D4   | A    | B   | C   |
|                        | 1/2 X 20 | .409 | .305 | .420 | .125 | .45 | .62 |
| <b>No. 10 (inches)</b> |          |      |      |      |      |     |     |

**PERFORMANCE CHARACTERISTICS**

|                    |   |
|--------------------|---|
| Pressure Ranges    | 0-150, 0-250, 0-500, 0-1000,<br>0-1500, 0-3000, 0-5000, 0-10000 |
| Combined Error     | Better than $\pm 0.5\%$ FSO                                     |
| Repeatability      | Better than $\pm 0.1\%$ FSO                                     |
| Resolution         | Infinite  |
| Frequency Response | Better than 10 KHz  |
| Maximum Pressure   | 2X full scale;  |

**ELECTRICAL CHARACTERISTICS**

|                   | SEN-40X                           | SEN-41X          | SEN-42X         | SEN-43X          |
|-------------------|-----------------------------------|------------------|-----------------|------------------|
| Output            | 0-33.3mV                          | 0-5VDC           | 4-20mA          | 0-10VDC          |
| Input Voltage     | 10VDC                             | 16-32VDC         | 14-30VDC        | 16-32VDC         |
| Load Resistance   | as req                            | 2000 OHMS<br>MIN | 800 OHMS<br>MAX | 2000 OHMS<br>MIN |
| Zero Adjust       | N/A                               | $\pm 10\%$ FS    | $\pm 10\%$ FS   | $\pm 10\%$ FS    |
| Span Adjust       | N/A                               | $\pm 10\%$ FS    | $\pm 10\%$ FS   | $\pm 10\%$ FS    |
| Shunt Calibration | 80%FSO $\pm 0.5\%$ for all models |                  |                 |                  |

**TEMPERATURE CHARACTERISTICS**

|                     |                      |
|---------------------|----------------------|
| Max Diaphragm Temp  | 750°F (400°C)        |
| Temperature effects |                      |
| Zero                | $\pm 0.01\%$ FSO/°F  |
| Span                | $\pm 0.005\%$ FSO/°F |

**CONNECTORS**

C1=Pressure, 6 pin  
 C2=Pressure, 8 pin  
 C4=Pressure & Temp., 8 pin  
 CD=Conduit  
 C6=P, 6-PIN-SEN421  
 C8=P+T, 8-PIN-SEN422

**TEMPERATURE SENSOR CHARACTERISTICS**

|             | SEN-402 | SEN-412       | SEN-422       | SEN-432       |
|-------------|---------|---------------|---------------|---------------|
| Output      | mVDC    | 0-5VDC        | 4-20mA        | 0-10VDC       |
| Input       | .01mA   | 16-32VDC      | 14-30VDC      | 16-32VDC      |
| Zero Adjust | N/A     | $\pm 10\%$ FS | $\pm 10\%$ FS | $\pm 10\%$ FS |
| Span Adjust | N/A     | $\pm 10\%$ FS | $\pm 10\%$ FS | $\pm 10\%$ FS |

**ORDERING INFORMATION**

SEN-432-5M-19R-1.5-36-C4

- MODEL
- PRESSURE
- BODY STYLE
- STEM LENGTH, INCHES
- FLEX, INCHES
- CONNECTOR

**RECOMMENDED ACCESSORIES**

CAX-20 = 20 ft. CONNECTOR/CABLE ASSEMBLY  
 X = SEE CONNECTOR NUMBER  
 MB-1 = MOUNTING BRACKET