# 200 kPa On-Chip Temperature Compensated & Calibrated Pressure Sensors

**MPX2200 SERIES**

**0 to 200 kPa (0 to 29 psi)
40 mV FULL SCALE SPAN
(TYPICAL)**

The MPX2200 series device is a silicon piezoresistive pressure sensor providing a highly accurate and linear voltage output — directly proportional to the applied pressure. The sensor is a single monolithic silicon diaphragm with the strain gauge and a thin–film resistor network integrated on–chip. The chip is laser trimmed for precise span and offset calibration and temperature compensation. They are designed for use in applications such as pump/motor controllers, robotics, level indicators, medical diagnostics, pressure switching, barometers, altimeters, etc.

**Features**

- Temperature Compensated Over 0°C to +85°C
- ±0.25% Linearity (MPX2200D)
- Easy–to–Use Chip Carrier Package Options
- Available in Absolute, Differential and Gauge Configurations

**Application Examples**

- Pump/Motor Controllers
- Robotics
- Level Indicators
- Medical Diagnostics
- Pressure Switching
- Barometers
- Altimeters

Figure 1 illustrates a block diagram of the internal circuitry on the stand–alone pressure sensor chip.

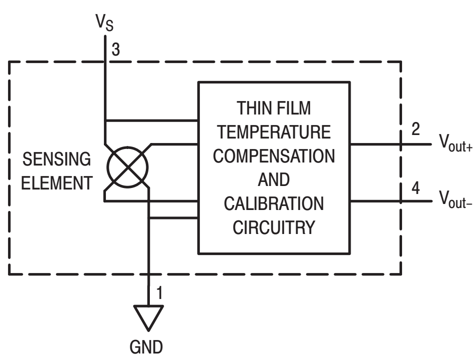



**Figure 1. Temperature Compensated Pressure Sensor Schematic**

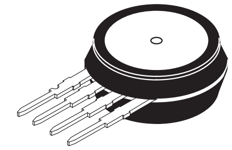
**VOLTAGE OUTPUT versus APPLIED DIFFERENTIAL PRESSURE**

The differential voltage output of the sensor is directly proportional to the differential pressure applied.

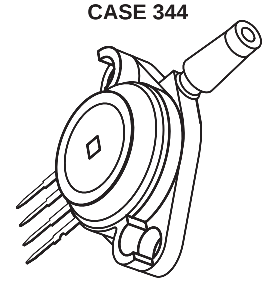
The absolute sensor has a built–in reference vacuum. The output voltage will decrease as vacuum, relative to ambient, is drawn on the pressure (P1) side.

The output voltage of the differential or gauge sensor increases with increasing pressure applied to the pressure (P1) side relative to the vacuum (P2) side. Similarly, output voltage increases as increasing vacuum is applied to the vacuum (P2) side relative to the pressure (P1) side.

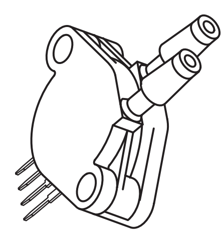
**UNIBODY PACKAGE**



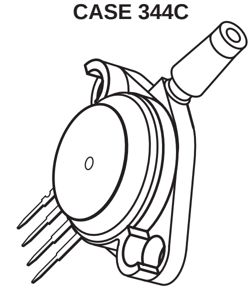
**MPX2200A/D
CASE 344**



**MPX2200AP/GP
CASE 344B**



**MPX2200DP
CASE 344C**



**MPX2200GVP
CASE 344D**

| PIN NUMBER | | | |
|---|---|---|---|
| 1 | Gnd | 3 | $V_S$ |
| 2 | $+V_{out}$ | 4 | $-V_{out}$ |

NOTE: Pin 1 is noted by the notch in the lead.

REV 9

## MAXIMUM RATINGS(NOTE)

| Rating | Symbol | Value | Unit |
|---|---|---|---|
| Maximum Pressure (P1 > P2) | $P_{max}$ | 800 | kPa |
| Storage Temperature | $T_{stg}$ | –40 to +125 | °C |
| Operating Temperature | $T_A$ | –40 to +125 | °C |

NOTE: Exposure beyond the specified limits may cause permanent damage or degradation to the device.

## OPERATING CHARACTERISTICS ($V_S$ = 10 Vdc, $T_A$ = 25°C unless otherwise noted, P1 > P2)

| Characteristics | | Symbol | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Pressure Range(1) | | $P_{OP}$ | 0 | — | 200 | kPa |
| Supply Voltage | | $V_S$ | — | 10 | 16 | Vdc |
| Supply Current | | $I_o$ | — | 6.0 | — | mAdc |
| Full Scale Span(3) | | $V_{FSS}$ | 38.5 | 40 | 41.5 | mV |
| Offset(4) | | $V_{off}$ | –1.0 | — | 1.0 | mV |
| Sensitivity | | ΔV/ΔP | — | 0.2 | — | mV/kPa |
| Linearity(5) | MPX2200D Series<br>MPX2200A Series | — | –0.25<br>–1.0 | —<br>— | 0.25<br>1.0 | $\%V_{FSS}$ |
| Pressure Hysteresis(5) (0 to 200 kPa) | | — | — | ±0.1 | — | $\%V_{FSS}$ |
| Temperature Hysteresis(5) (–40°C to +125°C) | | — | — | ±0.5 | — | $\%V_{FSS}$ |
| Temperature Effect on Full Scale Span(5) | | $TCV_{FSS}$ | –1.0 | — | 1.0 | $\%V_{FSS}$ |
| Temperature Effect on Offset(5) | | $TCV_{off}$ | –1.0 | — | 1.0 | mV |
| Input Impedance | | $Z_{in}$ | 1300 | — | 2500 | Ω |
| Output Impedance | | $Z_{out}$ | 1400 | — | 3000 | Ω |
| Response Time(6) (10% to 90%) | | $t_R$ | — | 1.0 | — | ms |
| Warm–Up | | — | — | 20 | — | ms |
| Offset Stability(7) | | — | — | ±0.5 | — | $\%V_{FSS}$ |

NOTES:
1. 1.0 kPa (kiloPascal) equals 0.145 psi.
2. Device is ratiometric within this specified excitation range. Operating the device above the specified excitation range may induce additional error due to device self–heating.
3. Full Scale Span ($V_{FSS}$) is defined as the algebraic difference between the output voltage at full rated pressure and the output voltage at the minimum rated pressure.
4. Offset ($V_{off}$) is defined as the output voltage at the minimum rated pressure.
5. Accuracy (error budget) consists of the following:
   - Linearity: Output deviation from a straight line relationship with pressure, using end point method, over the specified pressure range.
   - Temperature Hysteresis: Output deviation at any temperature within the operating temperature range, after the temperature is cycled to and from the minimum or maximum operating temperature points, with zero differential pressure applied.
   - Pressure Hysteresis: Output deviation at any pressure within the specified range, when this pressure is cycled to and from the minimum or maximum rated pressure, at 25°C.
   - TcSpan: Output deviation at full rated pressure over the temperature range of 0 to 85°C, relative to 25°C.
   - TcOffset: Output deviation with minimum rated pressure applied, over the temperature range of 0 to 85°C, relative to 25°C.
6. Response Time is defined as the time for the incremental change in the output to go from 10% to 90% of its final value when subjected to a specified step change in pressure.
7. Offset stability is the product's output deviation when subjected to 1000 hours of Pulsed Pressure, Temperature Cycling with Bias Test.

**LINEARITY**

Linearity refers to how well a transducer's output follows the equation: $V_{out} = V_{off}$ + sensitivity x P over the operating pressure range. There are two basic methods for calculating nonlinearity: (1) end point straight line fit (see Figure 2) or (2) a least squares best line fit. While a least squares fit gives the "best case" linearity error (lower numerical value), the calculations required are burdensome.

Conversely, an end point fit will give the "worst case" error (often more desirable in error budget calculations) and the calculations are more straightforward for the user. Motorola's specified pressure sensor linearities are based on the end point straight line method measured at the midrange pressure.

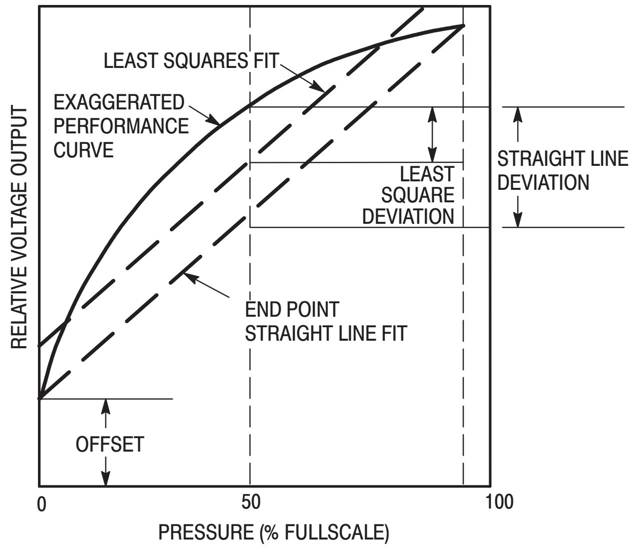



**Figure 2. Linearity Specification Comparison**

## ON–CHIP TEMPERATURE COMPENSATION and CALIBRATION

Figure 3 shows the output characteristics of the MPX2200 series at 25°C. The output is directly proportional to the differential pressure and is essentially a straight line.

The effects of temperature on Full Scale Span and Offset are very small and are shown under Operating Characteristics.

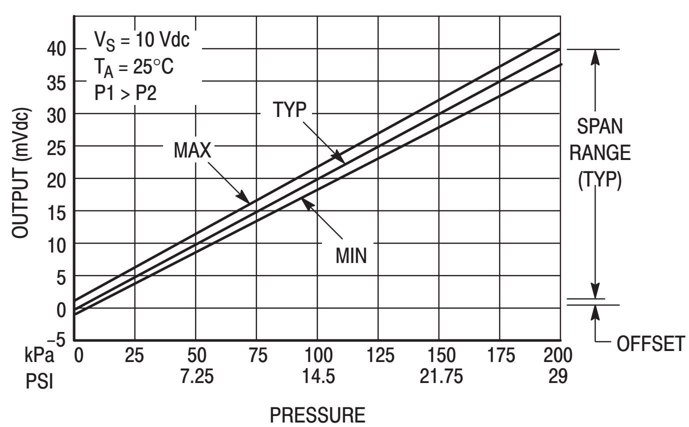



**Figure 3. Output versus Pressure Differential**

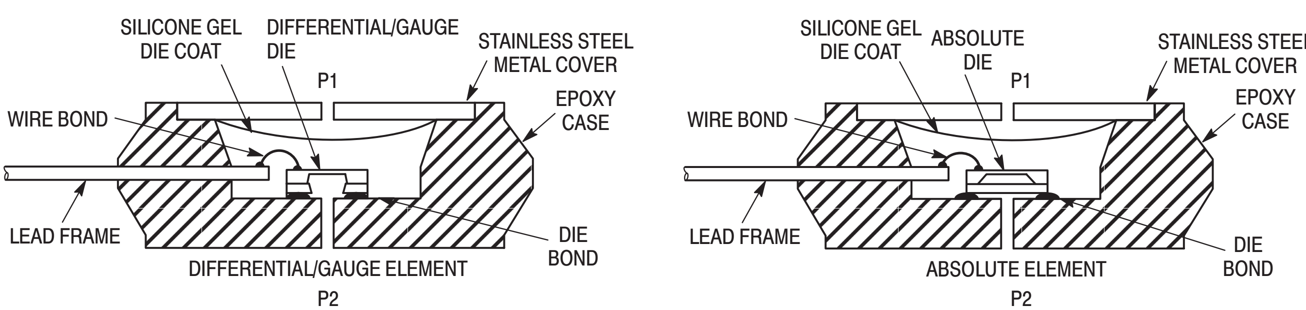



**Figure 4. Cross–Sectional Diagrams (Not to Scale)**

Figure 4 illustrates an absolute sensing die (right) and the differential or gauge die in the basic chip carrier (Case 344). A silicone gel isolates the die surface and wire bonds from the environment, while allowing the pressure signal to be transmitted to the silicon diaphragm.

The MPX2200 series pressure sensor operating characteristics and internal reliability and qualification tests are based on use of dry air as the pressure media. Media other than dry air may have adverse effects on sensor performance and long term reliability. Contact the factory for information regarding media compatibility in your application.

## PRESSURE (P1)/VACUUM (P2) SIDE IDENTIFICATION TABLE

Motorola designates the two sides of the pressure sensor as the Pressure (P1) side and the Vacuum (P2) side. The Pressure (P1) side is the side containing the silicone gel which isolates the die from the environment. The differential or gauge sensor is designed to operate with positive differential pressure applied, P1 > P2. The absolute sensor is designed for vacuum applied to P1 side.

The Pressure (P1) side may be identified by using the table below:

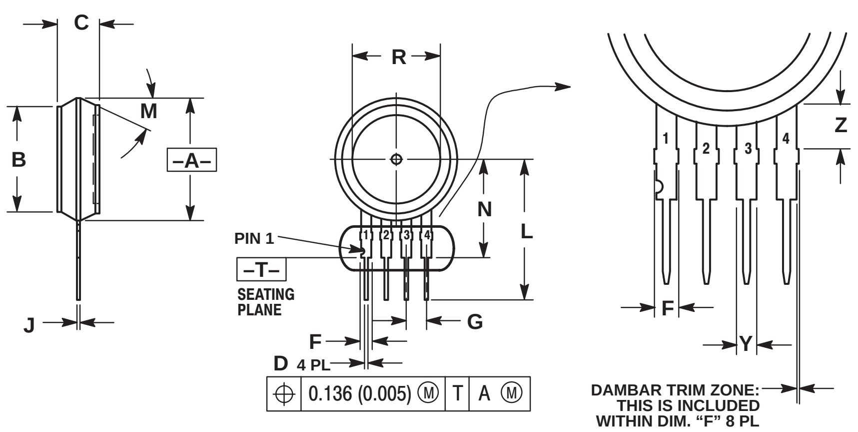
| Part Number | | Case Type | Pressure (P1) Side Identifier |
|---|---|---|---|
| MPX2200A | MPX2200D | 344 | Stainless Steel Cap |
| MPX2200DP | | 344C | Side with Part Marking |
| MPX2200AP | MPX2200GP | 344B | Side with Port Attached |
| MPX2200GVP | | 344D | Stainless Steel Cap |

## ORDERING INFORMATION

MPX2200 series pressure sensors are available in absolute, differential and gauge configurations. Devices are available in the basic element package or with pressure port fittings which provide printed circuit board mounting ease and barbed hose pressure connections.

| Device Type | Options | Case Type | MPX Series | |
|---|---|---|---|---|
| | | | Order Number | Device Marking |
| Basic Element | Absolute, Differential | 344 | MPX2200A<br>MPX2200D | MPX2200A<br>MPX2200D |
| Ported Elements | Differential | 344C | MPX2200DP | MPX2200DP |
| | Absolute, Gauge | 344B | MPX2200AP<br>MPX2200GP | MPX2200AP<br>MPX2200GP |
| | Gauge, Vacuum | 344D | MPX2200GVP | MPX2200GVP |

## PACKAGE DIMENSIONS




NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION –A– IS INCLUSIVE OF THE MOLD STOP RING. MOLD STOP RING NOT TO EXCEED 16.00 (0.630).

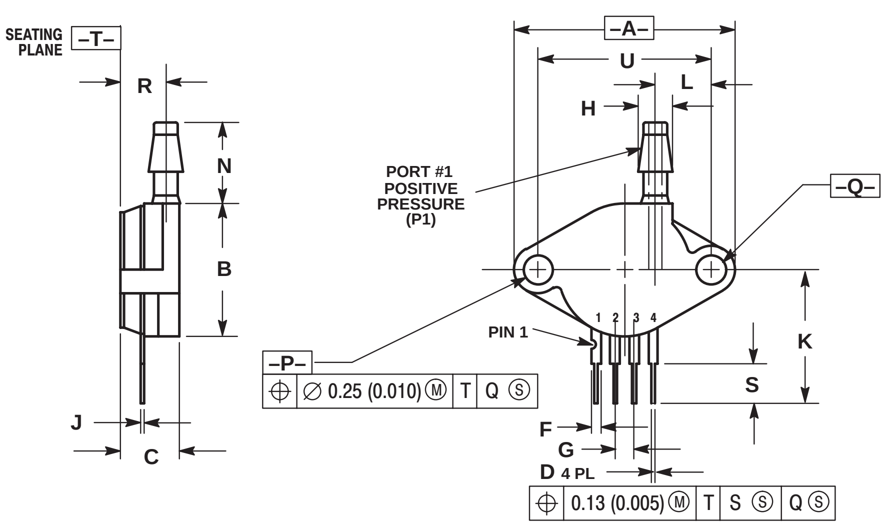
| | INCHES | | MILLIMETERS | |
|---|---|---|---|---|
| DIM | MIN | MAX | MIN | MAX |
| A | 0.595 | 0.630 | 15.11 | 16.00 |
| B | 0.514 | 0.534 | 13.06 | 13.56 |
| C | 0.200 | 0.220 | 5.08 | 5.59 |
| D | 0.016 | 0.020 | 0.41 | 0.51 |
| F | 0.048 | 0.064 | 1.22 | 1.63 |
| G | 0.100 BSC | | 2.54 BSC | |
| J | 0.014 | 0.016 | 0.36 | 0.40 |
| L | 0.695 | 0.725 | 17.65 | 18.42 |
| M | 30° NOM | | 30° NOM | |
| N | 0.475 | 0.495 | 12.07 | 12.57 |
| R | 0.430 | 0.450 | 10.92 | 11.43 |
| Y | 0.048 | 0.052 | 1.22 | 1.32 |
| Z | 0.106 | 0.118 | 2.68 | 3.00 |

STYLE 1:
PIN 1. GROUND
2. + OUTPUT
3. + SUPPLY
4. – OUTPUT

STYLE 2:
PIN 1. $V_{CC}$
2. – SUPPLY
3. + SUPPLY
4. GROUND

STYLE 3:
PIN 1. GND
2. –VOUT
3. VS
4. +VOUT

**CASE 344–15**
**ISSUE Z**



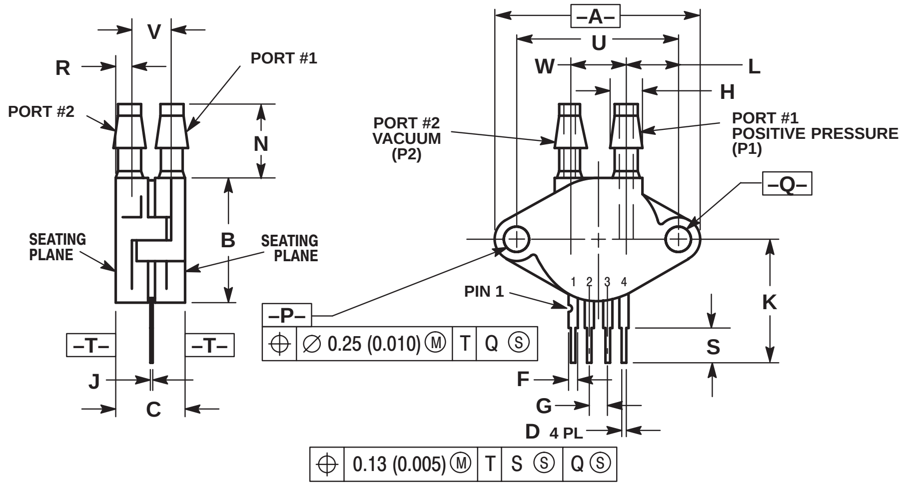

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1982.
2. CONTROLLING DIMENSION: INCH.

| | INCHES | | MILLIMETERS | |
|---|---|---|---|---|
| DIM | MIN | MAX | MIN | MAX |
| A | 1.145 | 1.175 | 29.08 | 29.85 |
| B | 0.685 | 0.715 | 17.40 | 18.16 |
| C | 0.305 | 0.325 | 7.75 | 8.26 |
| D | 0.016 | 0.020 | 0.41 | 0.51 |
| F | 0.048 | 0.064 | 1.22 | 1.63 |
| G | 0.100 BSC | | 2.54 BSC | |
| H | 0.182 | 0.194 | 4.62 | 4.93 |
| J | 0.014 | 0.016 | 0.36 | 0.41 |
| K | 0.695 | 0.725 | 17.65 | 18.42 |
| L | 0.290 | 0.300 | 7.37 | 7.62 |
| N | 0.420 | 0.440 | 10.67 | 11.18 |
| P | 0.153 | 0.159 | 3.89 | 4.04 |
| Q | 0.153 | 0.159 | 3.89 | 4.04 |
| R | 0.230 | 0.250 | 5.84 | 6.35 |
| S | 0.220 | 0.240 | 5.59 | 6.10 |
| U | 0.910 BSC | | 23.11 BSC | |

STYLE 1:
PIN 1. GROUND
2. + OUTPUT
3. + SUPPLY
4. – OUTPUT

**CASE 344B–01**
**ISSUE B**

## PACKAGE DIMENSIONS — CONTINUED

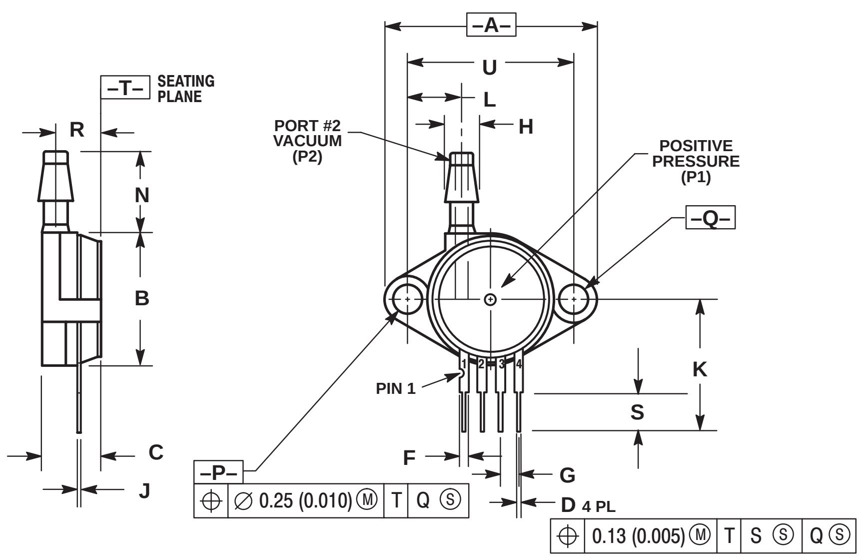



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

| DIM | INCHES MIN | INCHES MAX | MILLIMETERS MIN | MILLIMETERS MAX |
|---|---|---|---|---|
| A | 1.145 | 1.175 | 29.08 | 29.85 |
| B | 0.685 | 0.715 | 17.40 | 18.16 |
| C | 0.405 | 0.435 | 10.29 | 11.05 |
| D | 0.016 | 0.020 | 0.41 | 0.51 |
| F | 0.048 | 0.064 | 1.22 | 1.63 |
| G | 0.100 BSC | | 2.54 BSC | |
| H | 0.182 | 0.194 | 4.62 | 4.93 |
| J | 0.014 | 0.016 | 0.36 | 0.41 |
| K | 0.695 | 0.725 | 17.65 | 18.42 |
| L | 0.290 | 0.300 | 7.37 | 7.62 |
| N | 0.420 | 0.440 | 10.67 | 11.18 |
| P | 0.153 | 0.159 | 3.89 | 4.04 |
| Q | 0.153 | 0.159 | 3.89 | 4.04 |
| R | 0.063 | 0.083 | 1.60 | 2.11 |
| S | 0.220 | 0.240 | 5.59 | 6.10 |
| U | 0.910 BSC | | 23.11 BSC | |
| V | 0.248 | 0.278 | 6.30 | 7.06 |
| W | 0.310 | 0.330 | 7.87 | 8.38 |

STYLE 1:
PIN 1. GROUND
2. + OUTPUT
3. + SUPPLY
4. – OUTPUT

**CASE 344C–01**
**ISSUE B**




NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1982.
2. CONTROLLING DIMENSION: INCH.

| DIM | INCHES MIN | INCHES MAX | MILLIMETERS MIN | MILLIMETERS MAX |
|---|---|---|---|---|
| A | 1.145 | 1.175 | 29.08 | 29.85 |
| B | 0.685 | 0.715 | 17.40 | 18.16 |
| C | 0.305 | 0.325 | 7.75 | 8.26 |
| D | 0.016 | 0.020 | 0.41 | 0.51 |
| F | 0.048 | 0.064 | 1.22 | 1.63 |
| G | 0.100 BSC | | 2.54 BSC | |
| H | 0.182 | 0.194 | 4.62 | 4.93 |
| J | 0.014 | 0.016 | 0.36 | 0.41 |
| K | 0.695 | 0.725 | 17.65 | 18.42 |
| L | 0.290 | 0.300 | 7.37 | 7.62 |
| N | 0.420 | 0.440 | 10.67 | 11.18 |
| P | 0.153 | 0.159 | 3.89 | 4.04 |
| Q | 0.153 | 0.158 | 3.89 | 4.04 |
| R | 0.230 | 0.250 | 5.84 | 6.35 |
| S | 0.220 | 0.240 | 5.59 | 6.10 |
| U | 0.910 BSC | | 23.11 BSC | |

STYLE 1:
PIN 1. GROUND
2. + OUTPUT
3. + SUPPLY
4. – OUTPUT

**CASE 344D–01**
**ISSUE B**

# NOTES

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