

BREVET DE TECHNICIEN SUPÉRIEUR

SYSTÈMES ÉLECTRONIQUES

SESSION 2007

Épreuve : ÉLECTRONIQUE

DOSSIER DOCUMENTATION TECHNIQUE

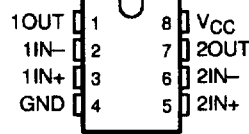
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| SESSION 2007- | CODE : SEE4 EL |
| B.T.S. SYSTÈMES ÉLECTRONIQUES | |
| ÉPREUVE : ÉLECTRONIQUE | |
| Durée : 4 Heures | Coefficient : 4 |

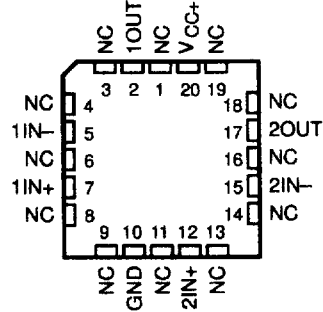
**LM158, LM158A, LM258, LM258A
LM358, LM358A, LM2904, LM2904Q
DUAL OPERATIONAL AMPLIFIERS**
SLOS068D – JUNE 1976 – REVISED SEPTEMBER 2001

- **Wide Range of Supply Voltages:**
 - Single Supply . . . 3 V to 30 V
(LM2904 and LM2904Q . . . 3 V to 26 V) or
 - Dual Supplies
- **Low Supply-Current Drain Independent of Supply Voltage . . . 0.7 mA Typ**
- **Common-Mode Input Voltage Range Includes Ground, Allowing Direct Sensing Near Ground**
- **Low Input Bias and Offset Parameters:**
 - Input Offset Voltage . . . 3 mV Typ
A Versions . . . 2 mV Typ
 - Input Offset Current . . . 2 nA Typ
 - Input Bias Current . . . 20 nA Typ
A Versions . . . 15 nA Typ
- **Differential Input Voltage Range Equal to Maximum-Rated Supply Voltage . . . ± 32 V (LM2904 and LM2904Q . . . ± 26 V)**
- **Open-Loop Differential Voltage Amplification . . . 100 V/mV Typ**
- **Internal Frequency Compensation**

**D, JG, P, OR PW PACKAGE
(TOP VIEW)**



**LM158, LM158A . . . FK PACKAGE
(TOP VIEW)**



NC – No internal connection

description

These devices consist of two independent, high-gain, frequency-compensated operational amplifiers designed to operate from a single supply over a wide range of voltages. Operation from split supplies also is possible if the difference between the two supplies is 3 V to 30 V (3 V to 26 V for the LM2904 and LM2904Q), and V_{CC} is at least 1.5 V more positive than the input common-mode voltage. The low supply-current drain is independent of the magnitude of the supply voltage.

Applications include transducer amplifiers, dc amplification blocks, and all the conventional operational amplifier circuits that now can be more easily implemented in single-supply-voltage systems. For example, these devices can be operated directly from the standard 5-V supply used in digital systems and easily provide the required interface electronics without additional ± 5 -V supplies.

The LM2904Q is manufactured to demanding automotive requirements.

The LM158 and LM158A are characterized for operation over the full military temperature range of -55°C to 125°C . The LM258 and LM258A are characterized for operation from -25°C to 85°C , the LM358 and LM358A from 0°C to 70°C , and the LM2904 and LM2904Q from -40°C to 125°C .

logic diagram (each amplifier)



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

PRODUCTION DATA Information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.



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On products compliant to MIL-PRF-38535, all parameters are tested unless otherwise noted. On all other products, production processing does not necessarily include testing of all parameters.

LM158, LM158A, LM258, LM258A
LM358, LM358A, LM2904, LM2904Q
DUAL OPERATIONAL AMPLIFIERS
SLOS068D – JUNE 1976 – REVISED SEPTEMBER 2001

absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

| | | LM158, LM158A LM258, LM258A LM358, LM358A | LM2904 LM2904Q | UNIT |
|---|---------------------|---|-------------------|------|
| Supply voltage, V_{CC} (see Note 1) | | 32 | 26 | V |
| Differential input voltage, V_{ID} (see Note 2) | | ±32 | ±26 | V |
| Input voltage, V_I (either input) | | -0.3 to 32 | -0.3 to 26 | V |
| Duration of output short circuit (one amplifier) to ground at (or below) 25°C free-air temperature ($V_{CC} \leq 15$ V) (see Note 3) | | Unlimited | Unlimited | |
| Package thermal impedance, θ_{JA} (see Note 4) | D package | 97 | 97 | °C |
| | P package | 85 | 85 | |
| | PW package | 149 | 149 | |
| Continuous total power dissipation | | See Dissipation Rating Table | | |
| Operating free-air temperature range, T_A | LM158, LM158A | -55 to 125 | | °C |
| | LM258, LM258A | -25 to 85 | | |
| | LM358, LM358A | 0 to 70 | | |
| | LM2904, LM2904Q | | -40 to 125 | |
| Case temperature for 60 seconds | FK package | 260 | | °C |
| Lead temperature 1,6 mm (1/16 inch) from case for 60 seconds | JG package | 300 | 300 | °C |
| Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds | D, P, or PW package | 260 | 260 | °C |
| Storage temperature range, T_{stg} | | -65 to 150 | -65 to 150 | °C |

† Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

- NOTES: 1. All voltage values, except differential voltages and V_{CC} specified for measurement of I_{OS} , are with respect to the network ground terminal.
2. Differential voltages are at $IN+$ with respect to $IN-$.
3. Short circuits from outputs to V_{CC} can cause excessive heating and eventual destruction.
4. The package thermal impedance is calculated in accordance with JESD 51-7.

DISSIPATION RATING TABLE

| PACKAGE | $T_A \leq 25^\circ\text{C}$ POWER RATING | DERATING FACTOR ABOVE $T_A = 25^\circ\text{C}$ | $T_A = 70^\circ\text{C}$ POWER RATING | $T_A = 85^\circ\text{C}$ POWER RATING | $T_A = 125^\circ\text{C}$ POWER RATING |
|---------|---|---|--|--|---|
| FK | 1375 mW | 11.0 mW/°C | 880 mW | 715 mW | 275 mW |
| JG | 1050 mW | 8.4 mW/°C | 672 mW | 546 mW | 210 mW |



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**LM158, LM158A, LM258, LM258A
LM358, LM358A, LM2904, LM2904Q
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electrical characteristics at specified free-air temperature, $V_{CC} = 5\text{ V}$ (unless otherwise noted)

| PARAMETER | TEST CONDITIONS† | T_A ‡ | LM158 LM258 | | | LM358 | | | UNIT |
|--|---|------------|-------------------|------|-------------------|-------|------------------------------|-----|------|
| | | | MIN | TYP§ | MAX | MIN | TYP§ | MAX | |
| V_{IO} Input offset voltage | $V_{CC} = 5\text{ V to MAX}$, $V_{IC} = V_{ICR(\text{min})}$, $V_O = 1.4\text{ V}$ | 25°C | 3 5 | | 3 7 | | mV | | |
| | | Full range | 7 | | 9 | | | | |
| $\alpha_{V_{IO}}$ Average temperature coefficient of input offset voltage | | Full range | 7 | | 7 | | $\mu\text{V}/^\circ\text{C}$ | | |
| I_{IO} Input offset current | $V_O = 1.4\text{ V}$ | 25°C | 2 30 | | 2 50 | | nA | | |
| | | Full range | 100 | | 150 | | | | |
| $\alpha_{I_{IO}}$ Average temperature coefficient of input offset current | | Full range | 10 | | 10 | | $\text{pA}/^\circ\text{C}$ | | |
| I_{IB} Input bias current | $V_O = 1.4\text{ V}$ | 25°C | -20 -150 | | -20 -250 | | nA | | |
| | | Full range | -300 | | -500 | | | | |
| V_{ICR} Common-mode input voltage range | $V_{CC} = 5\text{ V to MAX}$ | 25°C | 0 to $V_{CC}-1.5$ | | 0 to $V_{CC}-1.5$ | | V | | |
| | | Full range | 0 to $V_{CC}-2$ | | 0 to $V_{CC}-2$ | | | | |
| V_{OH} High-level output voltage | $R_L \geq 2\text{ k}\Omega$ $R_L \geq 10\text{ k}\Omega$ $V_{CC} = \text{MAX}$ | 25°C | $V_{CC}-1.5$ | | $V_{CC}-1.5$ | | V | | |
| | | 25°C | $V_{CC}-1.5$ | | $V_{CC}-1.5$ | | | | |
| | | Full range | 26 | | 26 | | | | |
| | | Full range | 27 28 | | 27 28 | | | | |
| V_{OL} Low-level output voltage | $R_L \leq 10\text{ k}\Omega$ | Full range | 5 20 | | 5 20 | | mV | | |
| A_{VD} Large-signal differential voltage amplification | $V_{CC} = 15\text{ V}$, $V_O = 1\text{ V to }11\text{ V}$, $R_L \geq 2\text{ k}\Omega$ | 25°C | 50 100 | | 25 100 | | V/mV | | |
| | | Full range | 25 | | 15 | | | | |
| CMRR Common-mode rejection ratio | $V_{CC} = 5\text{ V to MAX}$, $V_{IC} = V_{ICR(\text{min})}$ | 25°C | 70 80 | | 65 80 | | dB | | |
| k_{SVR} Supply-voltage rejection ratio ($\Delta V_{DD}/\Delta V_{IO}$) | $V_{CC} = 5\text{ V to MAX}$ | 25°C | 65 100 | | 65 100 | | dB | | |
| V_{O1}/V_{O2} Crosstalk attenuation | $f = 1\text{ kHz to }20\text{ kHz}$ | 25°C | 120 | | 120 | | dB | | |
| I_O Output current | $V_{CC} = 15\text{ V}$, $V_{ID} = 1\text{ V}$, $V_O = 0$ $V_{CC} = 15\text{ V}$, $V_{ID} = -1\text{ V}$, $V_O = 15\text{ V}$ $V_{ID} = -1\text{ V}$, $V_O = 200\text{ mV}$ | 25°C | -20 -30 | | -20 -30 | | mA | | |
| | | Full range | -10 | | -10 | | | | |
| | | 25°C | 10 20 | | 10 20 | | | | |
| | | Full range | 5 | | 5 | | | | |
| I_{OS} Short-circuit output current | V_{CC} at 5 V, GND at -5 V, $V_O = 0$ | 25°C | $\pm 40 \pm 60$ | | $\pm 40 \pm 60$ | | mA | | |
| I_{CC} Supply current (two amplifiers) | $V_O = 2.5\text{ V}$, No load | Full range | 0.7 1.2 | | 0.7 1.2 | | mA | | |
| | $V_{CC} = \text{MAX}$, $V_O = 0.5\text{ V}$, No load | Full range | 1 2 | | 1 2 | | | | |

† All characteristics are measured under open-loop conditions with zero common-mode input voltage, unless otherwise specified. MAX V_{CC} for testing purposes is 26 V for LM 2904 and 30 V for others.

‡ Full range is -55°C to 125°C for LM158, -25°C to 85°C for LM258, 0°C to 70°C for LM358, and -40°C to 125°C for LM2904 and LM2904Q.

§ All typical values are at $T_A = 25^\circ\text{C}$.



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**LM158, LM158A, LM258, LM258A
LM358, LM358A, LM2904, LM2904Q
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electrical characteristics at specified free-air temperature, $V_{CC} = 5\text{ V}$ (unless otherwise noted)

| PARAMETER | TEST CONDITIONS† | T_A ‡ | LM2904 LM2904Q | | | UNIT |
|--|---|------------|-------------------|------|-----------|------------------------------|
| | | | MIN | TYP§ | MAX | |
| V_{IO} Input offset voltage | $V_{CC} = 5\text{ V to MAX,}$ $V_{IC} = V_{ICR(min)}, V_O = 1.4\text{ V}$ | 25°C | 3 | | 7 | mV |
| | | Full range | | | 10 | |
| $\alpha_{V_{IO}}$ Average temperature coefficient of input offset voltage | | Full range | 7 | | | $\mu\text{V}/^\circ\text{C}$ |
| I_{IO} Input offset current | $V_O = 1.4\text{ V}$ | 25°C | 2 | 50 | | nA |
| | | Full range | 300 | | | |
| $\alpha_{I_{IO}}$ Average temperature coefficient of input offset current | | Full range | 10 | | | $\text{pA}/^\circ\text{C}$ |
| I_{IB} Input bias current | $V_O = 1.4\text{ V}$ | 25°C | -20 | -250 | | nA |
| | | Full range | -500 | | | |
| V_{ICR} Common-mode input voltage range | $V_{CC} = 5\text{ V to MAX}$ | 25°C | 0 to $V_{CC}-1.5$ | | V | |
| | | Full range | 0 to $V_{CC}-2$ | | | |
| V_{OH} High-level output voltage | $R_L \geq 2\text{ k}\Omega$ | 25°C | | | V | |
| | | 25°C | $V_{CC}-1.5$ | | | |
| | | Full range | 26 | | | |
| | | Full range | 23 | 24 | | |
| V_{OL} Low-level output voltage | $R_L \leq 10\text{ k}\Omega$ | Full range | 5 | | 20 | mV |
| | | 25°C | 25 | 100 | | V/mV |
| A_{VD} Large-signal differential voltage amplification | $V_{CC} = 15\text{ V, } V_O = 1\text{ V to } 11\text{ V,}$ $R_L \geq 2\text{ k}\Omega$ | Full range | 15 | | | |
| $CMRR$ Common-mode rejection ratio | $V_{CC} = 5\text{ V to MAX,}$ $V_{IC} = V_{ICR(min)}$ | 25°C | 50 | 80 | | dB |
| KS_{VR} Supply-voltage rejection ratio ($\Delta V_{DD}/\Delta V_{IO}$) | $V_{CC} = 5\text{ V to MAX}$ | 25°C | 65 | 100 | | dB |
| V_{O1}/V_{O2} Crosstalk attenuation | $f = 1\text{ kHz to } 20\text{ kHz}$ | 25°C | 120 | | dB | |
| I_O Output current | $V_{CC} = 15\text{ V, } V_{ID} = 1\text{ V, } V_O = 0$ | 25°C | -20 | -30 | | mA |
| | | Full range | -10 | | | |
| | $V_{CC} = 15\text{ V, } V_{ID} = -1\text{ V, } V_O = 15\text{ V}$ | 25°C | 10 | 20 | | |
| | | Full range | 5 | | | |
| I_{OS} Short-circuit output current | V_{CC} at 5 V, GND at -5 V, $V_O = 0$ | 25°C | ± 140 | | ± 160 | mA |
| | | Full range | 0.7 | | 1.2 | |
| I_{CC} Supply current (two amplifiers) | $V_O = 2.5\text{ V,}$ No load | Full range | 1 | | 2 | mA |
| | | Full range | | | | |
| | $V_{CC} = \text{MAX, } V_O = 0.5\text{ V,}$ No load | Full range | | | | |

† All characteristics are measured under open-loop conditions with zero common-mode input voltage, unless otherwise specified. MAX V_{CC} for testing purposes is 26 V for LM 2904 and 30 V for others.

‡ Full range is -55°C to 125°C for LM158, -25°C to 85°C for LM258, 0°C to 70°C for LM358, and -40°C to 125°C for LM2904 and LM2904Q.

§ All typical values are at $T_A = 25^\circ\text{C}$.



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CD4051BC • CD4052BC • CD4053BC

Single 8-Channel Analog Multiplexer/Demultiplexer • Dual 4-Channel Analog Multiplexer/Demultiplexer • Triple 2-Channel Analog Multiplexer/Demultiplexer

General Description

The CD4051BC, CD4052BC, and CD4053BC analog multiplexers/demultiplexers are digitally controlled analog switches having low "ON" impedance and very low "OFF" leakage currents. Control of analog signals up to 15V_{p-p} can be achieved by digital signal amplitudes of 3–15V. For example, if V_{DD} = 5V, V_{SS} = 0V and V_{EE} = -5V, analog signals from -5V to +5V can be controlled by digital inputs of 0–5V. The multiplexer circuits dissipate extremely low quiescent power over the full V_{DD}-V_{SS} and V_{DD}-V_{EE} supply voltage ranges, independent of the logic state of the control signals. When a logical "1" is present at the inhibit input terminal all channels are "OFF".

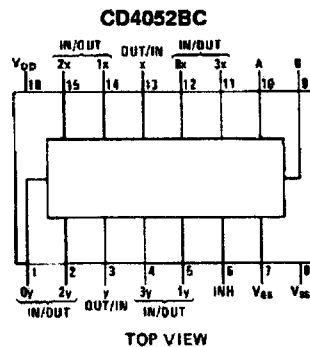
CD4051BC is a single 8-channel multiplexer having three binary control inputs, A, B, and C, and an inhibit input. The three binary signals select 1 of 8 channels to be turned "ON" and connect the input to the output.

CD4052BC is a differential 4-channel multiplexer having two binary control inputs, A and B, and an inhibit input. The two binary input signals select 1 or 4 pairs of channels to be turned on and connect the differential analog inputs to the differential outputs.

CD4053BC is a triple 2-channel multiplexer having three separate digital control inputs, A, B, and C, and an inhibit input. Each control input selects one of a pair of channels which are connected in a single-pole double-throw configuration.

Features

- Wide range of digital and analog signal levels: digital 3 – 15V, analog to 15V_{p-p}
- Low "ON" resistance: 80Ω (typ.) over entire 15V_{p-p} signal-input range for V_{DD} - V_{EE} = 15V
- High "OFF" resistance: channel leakage of ±10 pA (typ.) at V_{DD} - V_{EE} = 10V
- Logic level conversion for digital addressing signals of 3 – 15V (V_{DD} - V_{SS} = 3 – 15V) to switch analog signals to 15 V_{p-p} (V_{DD} - V_{EE} = 15V)
- Matched switch characteristics: ΔR_{ON} = 5Ω (typ.) for V_{DD} - V_{EE} = 15V
- Very low quiescent power dissipation under all digital-control input and supply conditions: 1 μW (typ.) at V_{DD} - V_{SS} = V_{DD} - V_{EE} = 10V
- Binary address decoding on chip



Truth Table

| INPUT STATES | | | | "ON" CHANNELS | | |
|--------------|---|---|---|---------------|---------|------------|
| INHIBIT | C | B | A | CD4051B | CD4052B | CD4053B |
| 0 | 0 | 0 | 0 | 0 | 0X, 0Y | cx, bx, ax |
| 0 | 0 | 0 | 1 | 1 | 1X, 1Y | cx, bx, ay |
| 0 | 0 | 1 | 0 | 2 | 2X, 2Y | cx, by, ax |
| 0 | 0 | 1 | 1 | 3 | 3X, 3Y | cx, by, ay |
| 0 | 1 | 0 | 0 | 4 | | cy, bx, ax |
| 0 | 1 | 0 | 1 | 5 | | cy, bx, ay |
| 0 | 1 | 1 | 0 | 6 | | cy, by, ax |
| 0 | 1 | 1 | 1 | 7 | | cy, by, ay |
| 1 | * | * | * | NONE | NONE | NONE |

*Don't Care condition.



CMOS Dual 8-Bit Buffered Multiplying DAC

AD7528

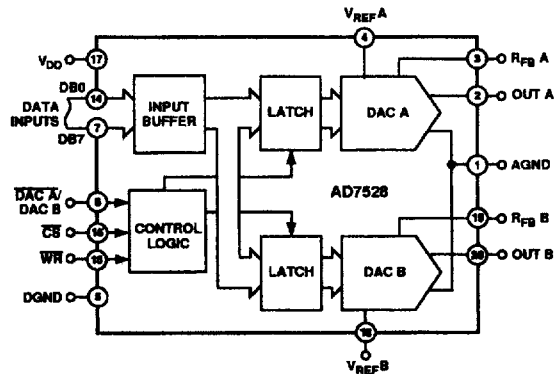
FEATURES

- On-Chip Latches for Both DACs
- +5 V to +15 V Operation
- DACs Matched to 1%
- Four Quadrant Multiplication
- TTL/CMOS Compatible
- Latch Free (Protection Schottkys not Required)

APPLICATIONS

- Digital Control of:
 - Gain/Attenuation
 - Filter Parameters
 - Stereo Audio Circuits
 - X-Y Graphics

FUNCTIONAL BLOCK DIAGRAM



GENERAL DESCRIPTION

The AD7528 is a monolithic dual 8-bit digital/analog converter featuring excellent DAC-to-DAC matching. It is available in skinny 0.3" wide 20-lead DIPs and in 20-lead surface mount packages.

Separate on-chip latches are provided for each DAC to allow easy microprocessor interface.

Data is transferred into either of the two DAC data latches via a common 8-bit TTL/CMOS compatible input port. Control input $\overline{\text{DAC A/DAC B}}$ determines which DAC is to be loaded. The AD7528's load cycle is similar to the write cycle of a random access memory and the device is bus compatible with most 8-bit microprocessors, including 6800, 8080, 8085, Z80.

The device operates from a +5 V to +15 V power supply, dissipating only 20 mW of power.

Both DACs offer excellent four quadrant multiplication characteristics with a separate reference input and feedback resistor for each DAC.

PRODUCT HIGHLIGHTS

- DAC-to-DAC matching:** since both of the AD7528 DACs are fabricated at the same time on the same chip, precise matching and tracking between DAC A and DAC B is inherent. The AD7528's matched CMOS DACs make a whole new range of applications circuits possible, particularly in the audio, graphics and process control areas.
- Small package size:** combining the inputs to the on-chip DAC latches into a common data bus and adding a $\overline{\text{DAC A/DAC B}}$ select line has allowed the AD7528 to be packaged in either a small 20-lead DIP, SOIC or PLCC.

REV. B

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ORDERING GUIDE¹

| Model ² | Temperature Ranges | Relative Accuracy | Gain Error | Package Options ³ |
|--------------------|--------------------|-------------------|------------|------------------------------|
| AD7528JN | -40°C to +85°C | ±1 LSB | ±4 LSB | N-20 |
| AD7528KN | -40°C to +85°C | ±1/2 LSB | ±2 LSB | N-20 |
| AD7528LN | -40°C to +85°C | ±1/2 LSB | ±1 LSB | N-20 |
| AD7528JP | -40°C to +85°C | ±1 LSB | ±4 LSB | P-20A |
| AD7528KP | -40°C to +85°C | ±1/2 LSB | ±2 LSB | P-20A |
| AD7528LP | -40°C to +85°C | ±1/2 LSB | ±1 LSB | P-20A |
| AD7528JR | -40°C to +85°C | ±1 LSB | ±4 LSB | R-20 |
| AD7528KR | -40°C to +85°C | ±1/2 LSB | ±2 LSB | R-20 |
| AD7528LR | -40°C to +85°C | ±1/2 LSB | ±1 LSB | R-20 |
| AD7528AQ | -40°C to +85°C | ±1 LSB | ±4 LSB | Q-20 |
| AD7528BQ | -40°C to +85°C | ±1/2 LSB | ±2 LSB | Q-20 |
| AD7528CQ | -40°C to +85°C | ±1/2 LSB | ±1 LSB | Q-20 |
| AD7528SQ | -55°C to +125°C | ±1 LSB | ±4 LSB | Q-20 |
| AD7528TQ | -55°C to +125°C | ±1/2 LSB | ±2 LSB | Q-20 |
| AD7528UQ | -55°C to +125°C | ±1/2 LSB | ±1 LSB | Q-20 |

NOTES

¹Analog Devices reserves the right to ship side-brazed ceramic in lieu of cerdip. Parts will be marked with cerdip designator "Q."

²Processing to MIL-STD-883C, Class B is available. To order, add suffix "/883B" to part number. For further information, see Analog Devices' 1990 Military Products Databook.

³N = Plastic DIP; P = Plastic Leaded Chip Carrier; Q = Cerdip; R = SOIC.

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