19-0907; Rev 1; 7/92

MAXIM

# General-Purpose CMOS Analog Switches



## General Description

The IH5040 family consists of seven CMOS analog switches that are intended for general-purpose applications. These switches are latch-up proof, break-before-make single, dual, and quad versions of the popular switch formats SPST, SPDT, DPST, and 4PST. Key features of the family include a low, 1nA leakage current and a quiescent current of less than 1µA.

Maxim's IH5040 family has faster switching times than the original manufacturer's devices. All devices are bidirectional and maintain almost constant on resistance throughout their operating range. These switches are guaranteed to operate from ±4.5V to ±18V, and will switch input signals that include the supplies.

## Applications

PBX, PABX

Guidance and Control Systems

Test Equipment

Sample-and-Holds

Military Radios

## Features

- ♦ **Improved Second Source**
- ♦ **Guaranteed ±4.5V to ±18V Operation**
- ♦ **Input Voltage Range Includes Supplies**
- ♦ **Latchup-Proof Construction**
- ♦ **TTL/CMOS Logic Compatible**
- ♦ **>1µA Quiescent Current**
- ♦ **Monolithic, Low-Power CMOS Design**

## Ordering Information

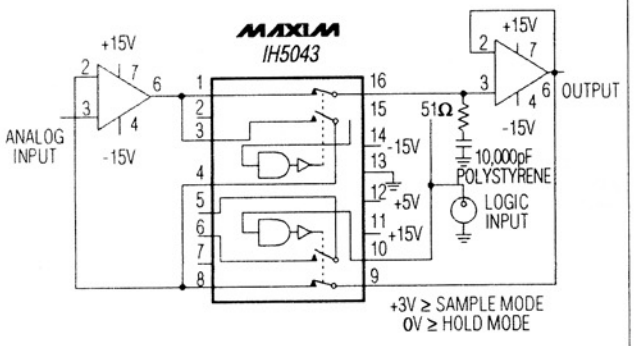
| PART | TEMP. RANGE | PIN-PACKAGE |
|---|---|---|
| **SINGLE POLE, SINGLE THROW (SPST)** | | |
| IH5040CPE | 0°C to +70°C | 16 Plastic DIP |
| IH5040CWE | 0°C to +70°C | 16 Wide SO |
| IH5040 CJE | 0°C to +70°C | 16 CERDIP |
| IH5040C/D | 0°C to +70°C | Dice* |
| IH5040MJE | -55°C to +125°C | 16 CERDIP** |

***Ordering Information continued at end of data sheet.***

* *Contact factory for dice specifications.*

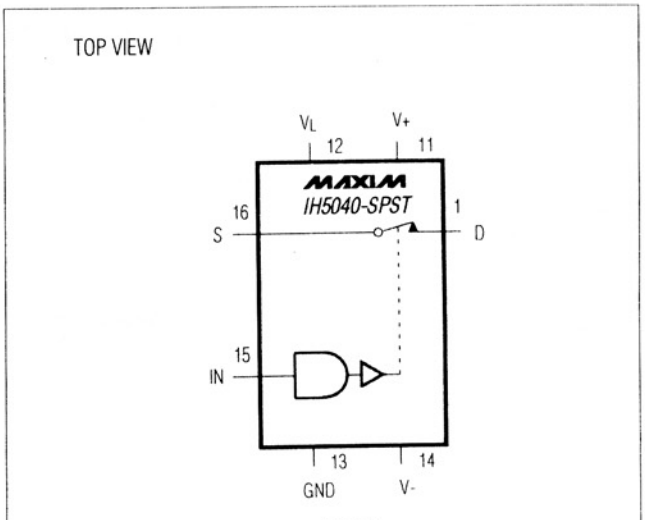
** *Contact factory for availability and processing to MIL-STD-883.*

## Typical Operating Circuit




**IMPROVED SAMPLE/HOLD USING IH5043**

## Pin Configurations & Switching-State Diagrams






***For pricing, delivery, and ordering information, please contact Maxim/Dallas Direct! at 1-888-629-4642, or visit Maxim's website at www.maxim-ic.com.***

# General-Purpose CMOS Analog Switches

## ABSOLUTE MAXIMUM RATINGS

V+ to V- ..... 44V
V+ to $V_D$ ..... 30V
$V_D$ to V- ..... 30V
$V_D$ to $V_S$ ..... ±22V
$V_L$ to V- ..... 33V
$V_L$ to $V_{IN}$ ..... 30V
$V_L$ to GND ..... 20V
$V_{IN}$ to GND ..... 20V
Digital Inputs ..... (V+ + 0.3V) to (V+ - 44V)
$V_S$ or $V_D$ (Note 1) ..... -0.3V to (V+ + 0.3V)
Current (any terminal) ..... 30mA

Continuous Power Dissipation ($T_A$ = +70°C)
Plastic DIP (derate 10.53mW/°C above +70°C) ..... 842mW
Wide SO (derate 9.52mW/°C above +70°C) ..... 762mW
CERDIP (derate 10.00mW/°C above +70°C) ..... 800mW
TO-100 (derate 6.67mW/°C above +70°C) ..... 533mW
Operating Temperature Ranges:
IH504_C__ ..... 0°C to +70°C
IH504_M__ ..... -55°C to +125°C
Storage Temperature Range ..... -65°C to +150°C
Lead Temperature (soldering, 10sec) ..... +300°C

**Note 1:** Signals on S, D, and digital inputs that exceed V- or V+ will be clamped by internal diodes. Limit forward diode current to 30mA maximum.

*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 in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.*

## ELECTRICAL CHARACTERISTICS

(V+ = 15V, V- = -15V, $V_L$ = 5V, $T_A$ = +25°C, unless otherwise noted.)

| PARAMETER | SYMBOL | CONDITIONS | | IH504_M | | | IH504_C | | | UNITS |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| Input Logic Current | $I_{IN(ON)}$ | $V_{IN}$ = 2.4V | $T_A$ = +25°C | -1 | | 1 | -1 | | 1 | µA |
| | | | $T_A$ = $T_{MAX}$ | -10 | | 10 | -10 | | 10 | |
| | $I_{IN(OFF)}$ | $V_{IN}$ = 0.8V | $T_A$ = +25°C | -1 | | 1 | -1 | | 1 | |
| | | | $T_A$ = $T_{MAX}$ | -10 | | 10 | -10 | | 10 | |
| Input Logic Low | $V_{IL}$ | $T_A$ = $T_{MIN}$ to $T_{MAX}$ | | | | 0.8 | | | 0.8 | V |
| Input Logic High | $V_{IH}$ | $T_A$ = $T_{MIN}$ to $T_{MAX}$ | | 2.4 | | | 2.4 | | | V |
| Drain-Source On Resistance | $r_{DS(ON)}$ | $I_S$ = 10mA, $V_{ANALOG}$ = -10V to 10V | $T_A$ = +25°C | | | 75 | | | 80 | Ω |
| | | | $T_A$ = $T_{MAX}$ | | | 150 | | | 130 | |
| Channel-to-Channel $r_{DS(ON)}$ Match | $\Delta r_{DS(ON)}$ | | | | 3 | | | 5 | | Ω |
| Minimum Analog-Signal Handling Capability | $V_{ANALOG}$ | | | -15 | | 15 | -15 | | 15 | V |
| Switch-Off Leakage Current | $I_D/I_{S(OFF)}$ | $V_{ANALOG}$ = -10V to 10V | $T_A$ = +25°C | -1 | | 1 | -5 | | 5 | nA |
| | | | $T_A$ = $T_{MAX}$ | -100 | | 100 | -100 | | 100 | |

## ELECTRICAL CHARACTERISTICS (continued)

(V+ = 15V, V- = -15V, $V_L$ = 5V, $T_A$ = +25°C, unless otherwise noted.)

| PARAMETER | SYMBOL | CONDITIONS | | IH504_M | | | IH504_C | | | UNITS |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| Switch-On Leakage Current | $I_{D(ON)}$ | $V_D$ = $V_S$ = -10V to 10V | $T_A$ = +25°C | -2 | | 2 | -10 | | 10 | nA |
| | | | $T_A$ = $T_{MAX}$ | -200 | | 200 | -100 | | 100 | |
| Switch-On Time | $t_{ON}$ | Figure 1 | | | | 400 | | | 400 | ns |
| Switch-Off Time | $t_{OFF}$ | Figure 1 | | | | 200 | | | 200 | ns |
| Charge Injection | $Q_{(INJ)}$ | Figure 2 (Note 2) | | | 15 | | | 20 | | mV |
| Minimum Off-Isolation Rejection Ratio | OIRR | Figure 3, $C_L$ < 5pF | | | 54 | | | 50 | | dB |
| V+ Quiescent Current | I+Q | $V_{IN}$ = 0V and 5V | $T_A$ = +25°C | | | 1 | | | 10 | µA |
| | | | $T_A$ = $T_{MAX}$ | | | 10 | | | 100 | |
| V- Quiescent Current | I-Q | $V_{IN}$ = 0V and 5V | $T_A$ = +25°C | -1 | | | -10 | | | µA |
| | | | $T_A$ = $T_{MAX}$ | -10 | | | -100 | | | |
| $V_L$ Quiescent Current | $I_{LQ}$ | $V_{IN}$ = 0V and 5V | $T_A$ = +25°C | | | 1 | | | 10 | µA |
| | | | $T_A$ = $T_{MAX}$ | | | 10 | | | 100 | |
| Ground Quiescent Current | $I_{GND}$ | $V_{IN}$ = 0V and 5V | $T_A$ = +25°C | -1 | | | -10 | | | µA |
| | | | $T_A$ = $T_{MAX}$ | -10 | | | -100 | | | |
| Minimum Channel-to-Channel Cross-Coupling Rejection Ratio | CCRR | One channel off (Note 2) | | | 54 | | | 50 | | dB |
| Power-Supply Range for Continuous Operation | $V_{OP}$ | (Notes 2, 3) | | ±4.5 | | ±18 | ±4.5 | | ±18 | V |

**Note 2:** Not production tested.
**Note 3:** Electrical characteristics, such as on resistance, will change when power supplies other than ±15V are used.

## Test Circuits

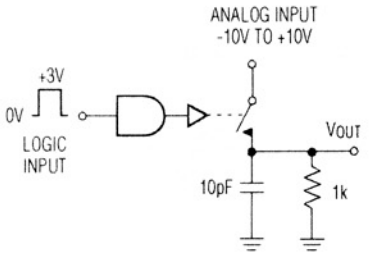



*Figure 1. Switching Time*

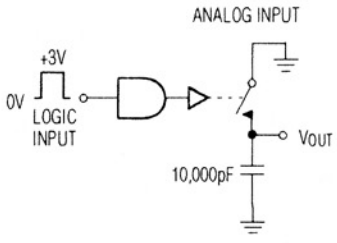



*Figure 2. Charge Injection*

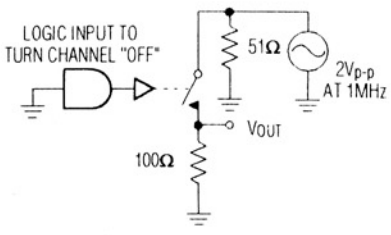
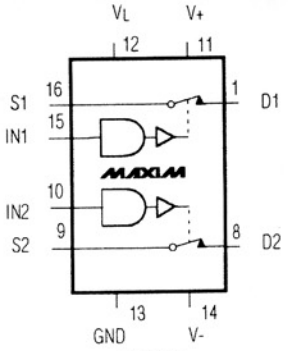



*Figure 3. Off-Isolation Rejection Ratio*

# General-Purpose CMOS Analog Switches

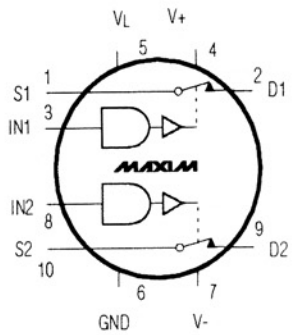
## Pin Configurations & Switching-State Diagrams (continued)

**IH5041 Dual SPST**



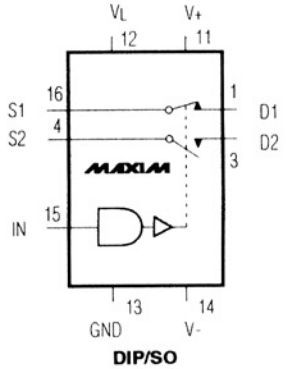

DIP/SO

**IH5041 Dual SPST**



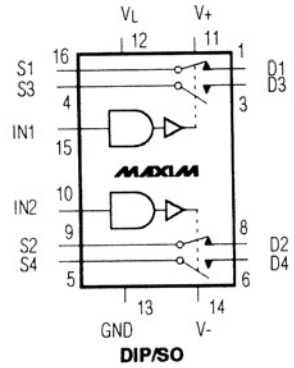

TO-100

**IH5042 Dual SPDT**



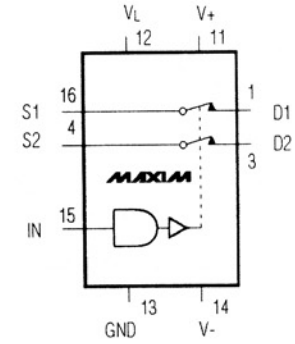

DIP/SO

**IH5043 Dual SPDT**



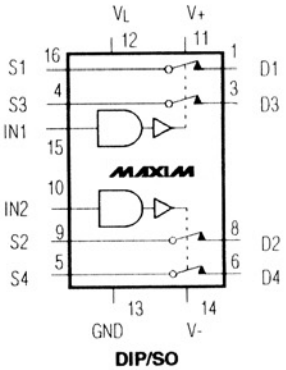

DIP/SO

**IH5044 DPST**



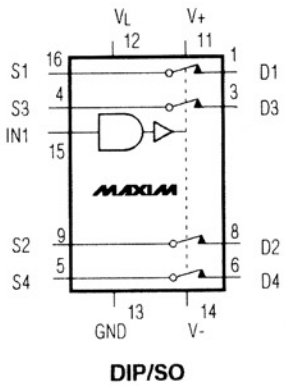

DIP/SO

**IH5045 Dual DPST**




DIP/SO

**IH5047 4PST**



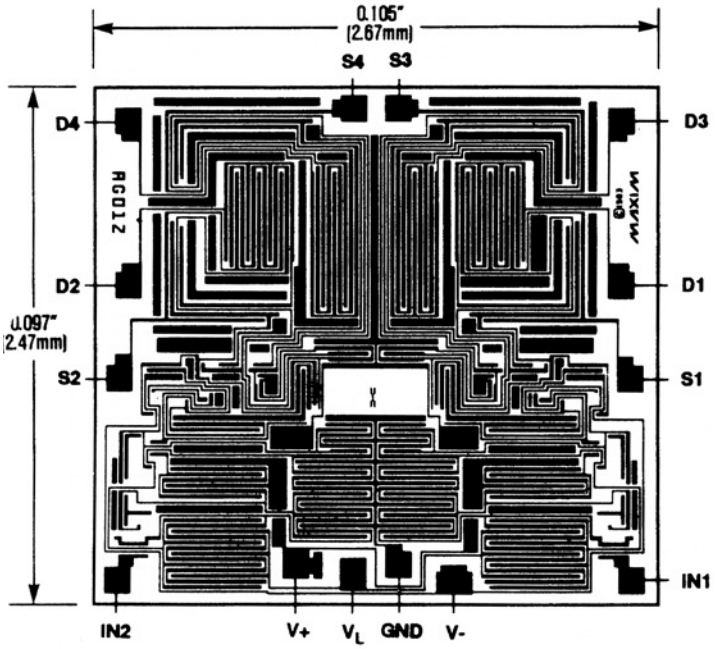

DIP/SO

**Table 1. Using the IH5040 Family with Only Two Supplies**

| SUPPLY VOLTAGES (V) | MINIMUM LOGIC I/P FOR "1" STATE (V) |
|---|---|
| ±15 | 12.6 |
| ±12 | 9.6 |
| ±10 | 7.6 |
| ±5 | 2.6 |

# General-Purpose CMOS Analog Switches

## Chip Topography



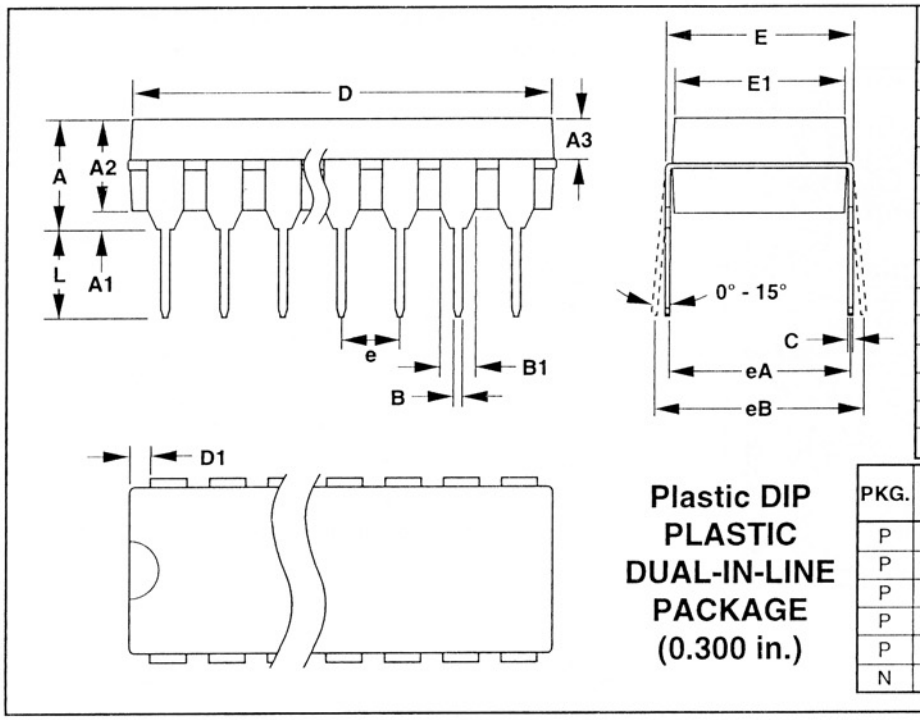

## Ordering Information (continued)

| PART | TEMP. RANGE | PIN-PACKAGE |
|---|---|---|
| **DUAL, SINGLE POLE, SINGLE THROW (DUAL SPST)** | | |
| IH5041CPE | 0°C to +70°C | 16 Plastic DIP |
| IH5041CWE | 0°C to +70°C | 16 Wide SO |
| IH5041CJE | 0°C to +70°C | 16 CERDIP |
| IH5041CTW | 0°C to +70°C | 16 TO-100† |
| IH5041C/D | 0°C to +70°C | Dice* |
| IH5041MJE | -55°C to +125°C | 16 CERDIP** |
| IH5041MTW | -55°C to +125°C | 16 TO-100† |
| **SINGLE POLE, DOUBLE THROW (SPDT)** | | |
| IH5042CPE | 0°C to +70°C | 16 Plastic DIP |
| IH5042CWE | 0°C to +70°C | 16 Wide SO |
| IH5042CJE | 0°C to +70°C | 16 CERDIP |
| IH5042C/D | 0°C to +70°C | Dice* |
| IH5042MJE | -55°C to +125°C | 16 CERDIP** |
| **DUAL, SINGLE POLE, DOUBLE THROW (DUAL SPDT)** | | |
| IH5043CPE | 0°C to +70°C | 16 Plastic DIP |
| IH5043CWE | 0°C to +70°C | 16 Wide SO |
| IH5043CJE | 0°C to +70°C | 16 CERDIP |
| IH5043C/D | 0°C to +70°C | Dice* |
| IH5043MJE | -55°C to +125°C | 16 CERDIP** |
| **DOUBLE POLE, SINGLE THROW (DPST)** | | |
| IH5044CPE | 0°C to +70°C | 16 Plastic DIP |
| IH5044CWE | 0°C to +70°C | 16 Wide SO |
| IH5044CJE | 0°C to +70°C | 16 CERDIP |
| IH5044C/D | 0°C to +70°C | Dice* |
| IH5044MJE | -55°C to +125°C | 16 CERDIP** |
| **DUAL, DOUBLE POLE, SINGLE THROW (DUAL DPST)** | | |
| IH5045CPE | 0°C to +70°C | 16 Plastic DIP |
| IH5045CWE | 0°C to +70°C | 16 Wide SO |
| IH5045CJE | 0°C to +70°C | 16 CERDIP |
| IH5045C/D | 0°C to +70°C | Dice* |
| IH5045MJE | -55°C to +125°C | 16 CERDIP** |
| **QUAD POLE, SINGLE THROW (4PST)** | | |
| IH5047CPE | 0°C to +70°C | 16 Plastic DIP |
| IH5047CWE | 0°C to +70°C | 16 Wide SO |
| IH5047CJE | 0°C to +70°C | 16 CERDIP |
| IH5047C/D | 0°C to +70°C | Dice* |
| IH5047MJE | -55°C to +125°C | 16 CERDIP** |

* *Contact factory for dice specifications.*
** *Contact factory for availability and processing to MIL-STD-883.*
† *Contact factory for availability.*

## Package Information

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information .go to **www.maxim-ic.com/packages**.)

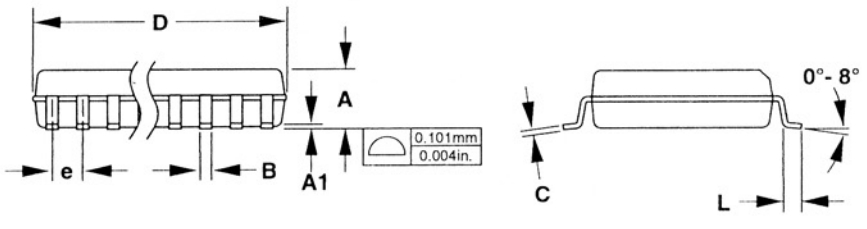


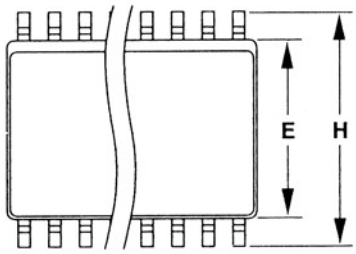

Plastic DIP
PLASTIC
DUAL-IN-LINE
PACKAGE
(0.300 in.)

| DIM | INCHES | | MILLIMETERS | |
|---|---|---|---|---|
| | MIN | MAX | MIN | MAX |
| A | – | 0.200 | – | 5.08 |
| A1 | 0.015 | – | 0.38 | – |
| A2 | 0.125 | 0.175 | 3.18 | 4.45 |
| A3 | 0.055 | 0.080 | 1.40 | 2.03 |
| B | 0.016 | 0.022 | 0.41 | 0.56 |
| B1 | 0.045 | 0.065 | 1.14 | 1.65 |
| C | 0.008 | 0.012 | 0.20 | 0.30 |
| D1 | 0.005 | 0.080 | 0.13 | 2.03 |
| E | 0.300 | 0.325 | 7.62 | 8.26 |
| E1 | 0.240 | 0.310 | 6.10 | 7.87 |
| e | 0.100 | – | 2.54 | – |
| eA | 0.300 | – | 7.62 | – |
| eB | – | 0.400 | – | 10.16 |
| L | 0.115 | 0.150 | 2.92 | 3.81 |

| PKG. | DIM | PINS | INCHES | | MILLIMETERS | |
|---|---|---|---|---|---|---|
| | | | MIN | MAX | MIN | MAX |
| P | D | 8 | 0.348 | 0.390 | 8.84 | 9.91 |
| P | D | 14 | 0.735 | 0.765 | 18.67 | 19.43 |
| P | D | 16 | 0.745 | 0.765 | 18.92 | 19.43 |
| P | D | 18 | 0.885 | 0.915 | 22.48 | 23.24 |
| P | D | 20 | 1.015 | 1.045 | 25.78 | 26.54 |
| N | D | 24 | 1.14 | 1.265 | 28.96 | 32.13 |

21-0043A




Wide SO
SMALL-OUTLINE
PACKAGE
(0.300 in.)

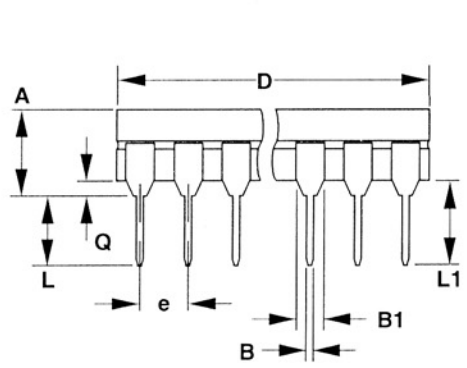
| DIM | INCHES | | MILLIMETERS | |
|---|---|---|---|---|
| | MIN | MAX | MIN | MAX |
| A | 0.093 | 0.104 | 2.35 | 2.65 |
| A1 | 0.004 | 0.012 | 0.10 | 0.30 |
| B | 0.014 | 0.019 | 0.35 | 0.49 |
| C | 0.009 | 0.013 | 0.23 | 0.32 |
| E | 0.291 | 0.299 | 7.40 | 7.60 |
| e | 0.050 | | 1.27 | |
| H | 0.394 | 0.419 | 10.00 | 10.65 |
| L | 0.016 | 0.050 | 0.40 | 1.27 |

| DIM | PINS | INCHES | | MILLIMETERS | |
|---|---|---|---|---|---|
| | | MIN | MAX | MIN | MAX |
| D | 16 | 0.398 | 0.413 | 10.10 | 10.50 |
| D | 18 | 0.447 | 0.463 | 11.35 | 11.75 |
| D | 20 | 0.496 | 0.512 | 12.60 | 13.00 |
| D | 24 | 0.598 | 0.614 | 15.20 | 15.60 |
| D | 28 | 0.697 | 0.713 | 17.70 | 18.10 |

21-0042A

## Package Information (continued)

(The package drawing(s) in this data sheet may not reflect the most current specifications. For the latest package outline information go to **www.maxim-ic.com/packages**.)




CERDIP
CERAMIC DUAL-IN-LINE
PACKAGE
(0.300 in.)

| DIM | INCHES | | MILLIMETERS | |
|---|---|---|---|---|
| | MIN | MAX | MIN | MAX |
| A | – | 0.200 | – | 5.08 |
| B | 0.014 | 0.023 | 0.36 | 0.58 |
| B1 | 0.038 | 0.065 | 0.97 | 1.65 |
| C | 0.008 | 0.015 | 0.20 | 0.38 |
| E | 0.220 | 0.310 | 5.59 | 7.87 |
| E1 | 0.290 | 0.320 | 7.37 | 8.13 |
| e | 0.100 | | 2.54 | |
| L | 0.125 | 0.200 | 3.18 | 5.08 |
| L1 | 0.150 | – | 3.81 | – |
| Q | 0.015 | 0.070 | 0.38 | 1.78 |
| S | – | 0.098 | – | 2.49 |
| S1 | 0.005 | – | 0.13 | – |

| DIM | PINS | INCHES | | MILLIMETERS | |
|---|---|---|---|---|---|
| | | MIN | MAX | MIN | MAX |
| D | 8 | – | 0.405 | – | 10.29 |
| D | 14 | – | 0.785 | – | 19.94 |
| D | 16 | – | 0.840 | – | 21.34 |
| D | 18 | – | 0.960 | – | 24.38 |
| D | 20 | – | 1.060 | – | 26.92 |
| D | 24 | – | 1.280 | – | 32.51 |

21-0045A

# General-Purpose CMOS Analog Switches

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