

## General-Purpose CMOS Analog Switches

### General Description

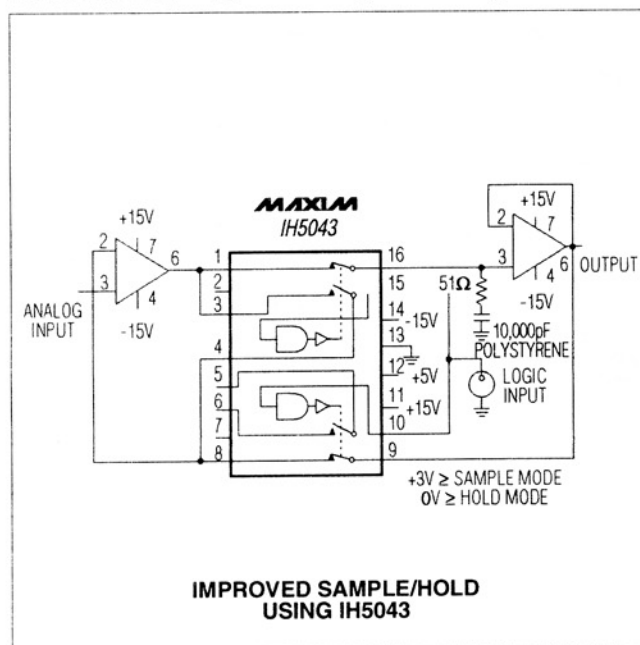
The IH5040 family consists of seven CMOS analog switches that are intended for general-purpose applications. These switches are latch-up proof, break-before-make single, dual, and quad versions of the popular switch formats SPST, SPDT, DPST, and 4PST. Key features of the family include a low, 1nA leakage 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  $\pm 4.5\text{V}$  to  $\pm 18\text{V}$ , and will switch input signals that include the supplies.

### Applications

PBX, PABX  
Guidance and Control Systems  
Test Equipment  
Sample-and-Holds  
Military Radios

### Typical Operating Circuit



### Features

- ◆ Improved Second Source
- ◆ Guaranteed  $\pm 4.5\text{V}$  to  $\pm 18\text{V}$  Operation
- ◆ Input Voltage Range Includes Supplies
- ◆ Latchup-Proof Construction
- ◆ TTL/CMOS Logic Compatible
- ◆  $>1\mu\text{A}$  Quiescent Current
- ◆ Monolithic, Low-Power CMOS Design

### Ordering Information

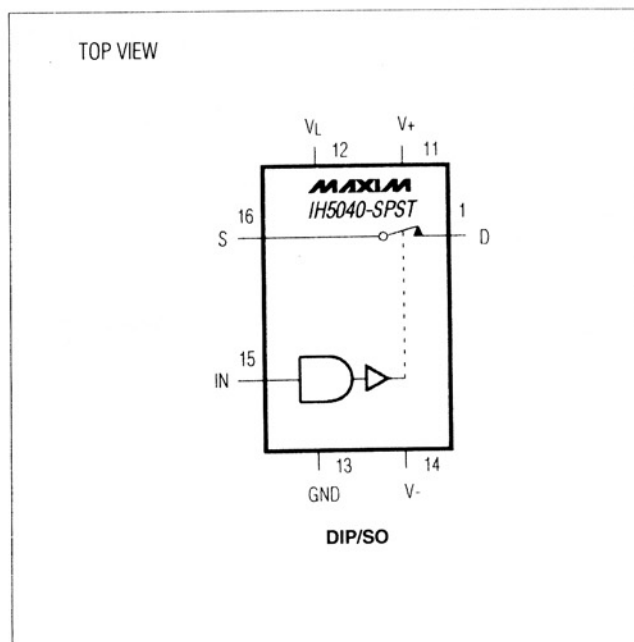
| PART                             | TEMP. RANGE     | PIN-PACKAGE    |
|----------------------------------|-----------------|----------------|
| SINGLE POLE, SINGLE THROW (SPST) |                 |                |
| IH5040CPE                        | 0°C to +70°C    | 16 Plastic DIP |
| IH5040CWE                        | 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.

### Pin Configurations & Switching-State Diagrams



# General-Purpose CMOS Analog Switches

## ABSOLUTE MAXIMUM RATINGS

|                                           |                      |
|-------------------------------------------|----------------------|
| V+ to V-                                  | 44V                  |
| V+ to V <sub>D</sub>                      | 30V                  |
| V <sub>D</sub> to V-                      | 30V                  |
| V <sub>D</sub> to V <sub>S</sub>          | ±22V                 |
| V <sub>L</sub> to V-                      | 33V                  |
| V <sub>L</sub> to V <sub>IN</sub>         | 30V                  |
| V <sub>L</sub> to GND                     | 20V                  |
| V <sub>IN</sub> to GND                    | 20V                  |
| Digital Inputs (V+ + 0.3V) to (V+ - 44V)  |                      |
| V <sub>S</sub> or V <sub>D</sub> (Note 1) | -0.3V to (V+ + 0.3V) |
| Current (any terminal)                    | 30mA                 |

|                                                       |                 |
|-------------------------------------------------------|-----------------|
| Continuous Power Dissipation (T <sub>A</sub> = +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<sub>L</sub> = 5V, T<sub>A</sub> = +25°C, unless otherwise noted.)

| PARAMETER                                       | SYMBOL                              | CONDITIONS                                                     |                                   | IH504_M                     |     |     | IH504_C                     |     |     | UNITS |
|-------------------------------------------------|-------------------------------------|----------------------------------------------------------------|-----------------------------------|-----------------------------|-----|-----|-----------------------------|-----|-----|-------|
|                                                 |                                     |                                                                |                                   | MIN                         | TYP | MAX | MIN                         | TYP | MAX |       |
| Input Logic Current                             | I <sub>IN(ON)</sub>                 | V <sub>IN</sub> = 2.4V                                         | T <sub>A</sub> = +25°C            | -1                          |     | 1   | -1                          |     | 1   | μA    |
|                                                 |                                     |                                                                | T <sub>A</sub> = T <sub>MAX</sub> | -10                         |     | 10  | -10                         |     | 10  |       |
|                                                 | I <sub>IN(OFF)</sub>                | V <sub>IN</sub> = 0.8V                                         | T <sub>A</sub> = +25°C            | -1                          |     | 1   | -1                          |     | 1   |       |
|                                                 |                                     |                                                                | T <sub>A</sub> = T <sub>MAX</sub> | -10                         |     | 10  | -10                         |     | 10  |       |
| Input Logic Low                                 | V <sub>IL</sub>                     | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>          |                                   | 0.8                         |     |     | 0.8                         |     |     | V     |
| Input Logic High                                | V <sub>IH</sub>                     | T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>          |                                   | 2.4                         |     |     | 2.4                         |     |     | V     |
| Drain-Source On Resistance                      | r <sub>DS(ON)</sub>                 | I <sub>S</sub> = 10mA,<br>V <sub>ANALOG</sub> =<br>-10V to 10V | T <sub>A</sub> = +25°C            | 75                          |     |     | 80                          |     |     | Ω     |
|                                                 |                                     |                                                                | T <sub>A</sub> = T <sub>MAX</sub> | 150                         |     |     | 130                         |     |     |       |
| Channel-to-Channel<br>r <sub>DS(ON)</sub> Match | Δr <sub>DS(ON)</sub>                |                                                                |                                   | 3                           |     |     | 5                           |     |     | Ω     |
| Minimum Analog-Signal<br>Handling Capability    | V <sub>ANALOG</sub>                 |                                                                |                                   | -15                      15 |     |     | -15                      15 |     |     | V     |
| Switch-Off Leakage Current                      | I <sub>D</sub> /I <sub>S(OFF)</sub> | V <sub>ANALOG</sub> =<br>-10V to 10V                           | T <sub>A</sub> = +25°C            | -1                          |     | 1   | -5                          |     | 5   | nA    |
|                                                 |                                     |                                                                | T <sub>A</sub> = T <sub>MAX</sub> | -100                        |     | 100 | -100                        |     | 100 |       |

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## ELECTRICAL CHARACTERISTICS (continued)

( $V_+ = 15V$ ,  $V_- = -15V$ ,  $V_L = 5V$ ,  $T_A = +25^\circ C$ , unless otherwise noted.)

| PARAMETER                                                 | SYMBOL | CONDITIONS               |            | IH504_M |      |     | IH504_C |     |      | UNITS |   |
|-----------------------------------------------------------|--------|--------------------------|------------|---------|------|-----|---------|-----|------|-------|---|
|                                                           |        |                          |            | MIN     | TYP  | MAX | MIN     | TYP | MAX  |       |   |
| Switch-On Leakage Current                                 | ID(ON) | VD = VS =<br>-10V to 10V | TA = +25°C | -2      |      | 2   | -10     |     | 10   | nA    |   |
|                                                           |        |                          | TA = TMAX  | -200    |      | 200 | -100    |     | 100  |       |   |
| Switch-On Time                                            | ton    | Figure 1                 |            |         |      | 400 |         |     | 400  | ns    |   |
| Switch-Off Time                                           | toff   | Figure 1                 |            |         |      | 200 |         |     | 200  | ns    |   |
| Charge Injection                                          | Q(INJ) | Figure 2 (Note 2)        |            |         |      | 15  |         |     | 20   | mV    |   |
| Minimum Off-Isolation Rejection Ratio                     | OIRR   | Figure 3, CL < 5pF       |            |         |      | 54  |         |     | 50   | dB    |   |
| V+ Quiescent Current                                      | I+Q    | VIN = 0V<br>and 5V       | TA = +25°C |         |      | 1   |         |     | 10   | μA    |   |
|                                                           |        |                          | TA = TMAX  |         |      | 10  |         | 100 |      |       |   |
| V- Quiescent Current                                      | I-Q    | VIN = 0V<br>and 5V       | TA = +25°C | -1      |      |     | -10     |     |      | μA    |   |
|                                                           |        |                          | TA = TMAX  | -10     |      |     | -100    |     |      |       |   |
| VL Quiescent Current                                      | ILQ    | VIN = 0V<br>and 5V       | TA = +25°C |         |      | 1   |         |     | 10   | μA    |   |
|                                                           |        |                          | TA = TMAX  |         |      | 10  |         | 100 |      |       |   |
| Ground Quiescent Current                                  | IGND   | VIN = 0V<br>and 5V       | TA = +25°C | -1      |      |     | -10     |     |      | μA    |   |
|                                                           |        |                          | TA = TMAX  | -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               | VOP    | (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  $\pm 15V$  are used.

## Test Circuits

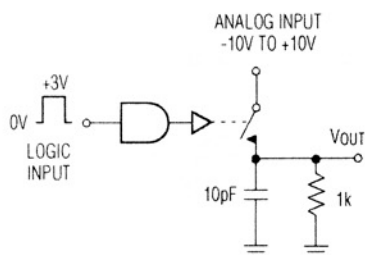


Figure 1. Switching Time

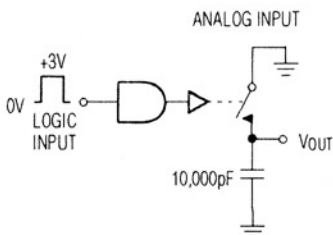


Figure 2. Charge Injection

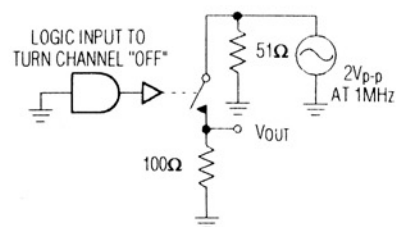
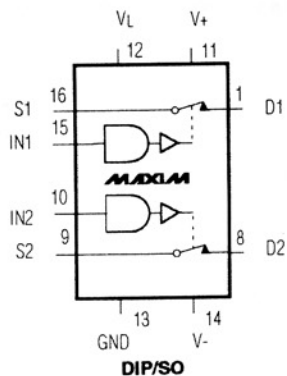


Figure 3. Off-Isolation Rejection Ratio

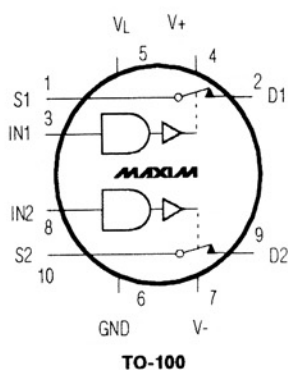
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## Pin Configurations & Switching-State Diagrams (continued)

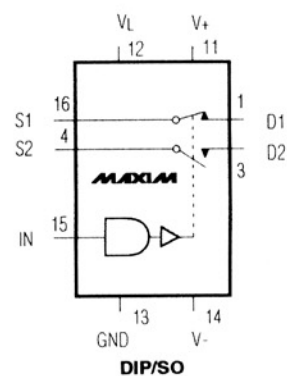
IH5041 Dual SPST



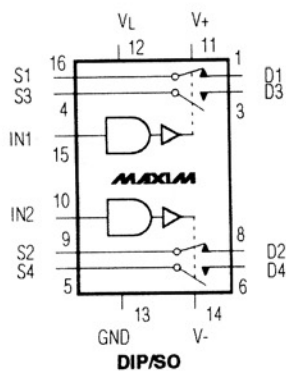
IH5041 Dual SPST



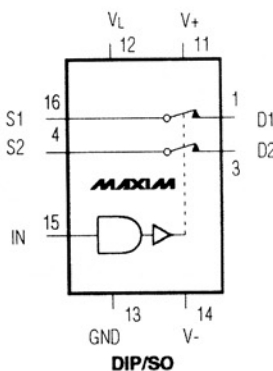
IH5042 Dual SPDT



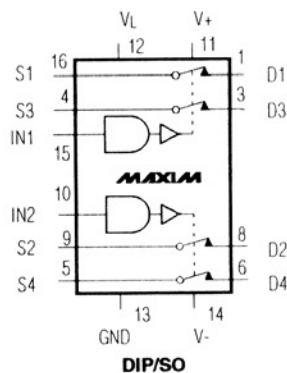
IH5043 Dual SPDT



IH5044 DPST



IH5045 Dual DPST



IH5047 4PST

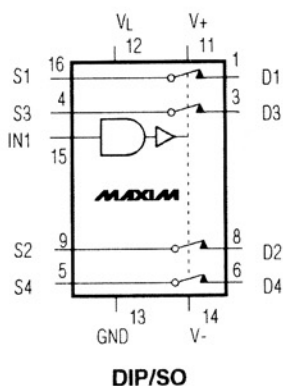


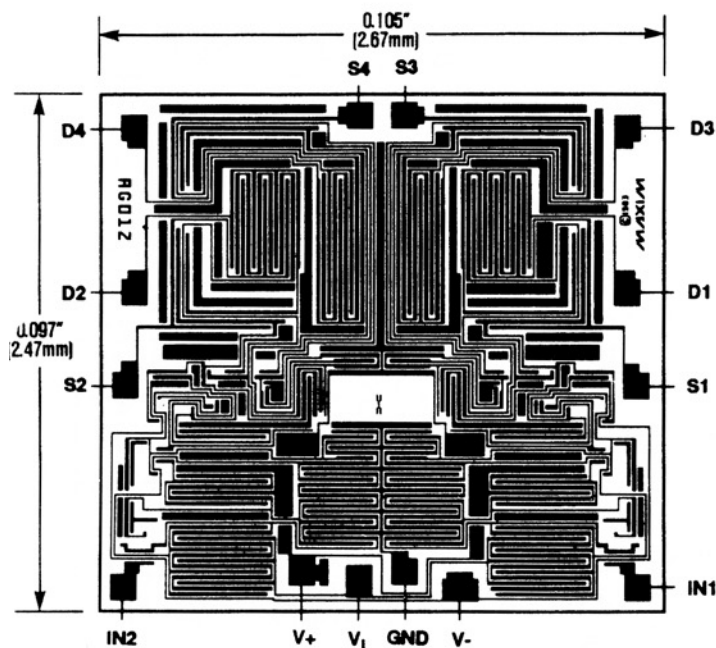
Table 1. Using the IH5040 Family with Only Two Supplies

| 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            |
|----------------------------------------------------|-----------------|------------------------|
| <b>DUAL, SINGLE POLE, SINGLE THROW (DUAL SPST)</b> |                 |                        |
| 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 <sup>†</sup> |
| 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 <sup>†</sup> |
| <b>SINGLE POLE, DOUBLE THROW (SPDT)</b>            |                 |                        |
| 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**            |
| <b>DUAL, SINGLE POLE, DOUBLE THROW (DUAL SPDT)</b> |                 |                        |
| 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**            |
| <b>DOUBLE POLE, SINGLE THROW (DPST)</b>            |                 |                        |
| 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**            |
| <b>DUAL, DOUBLE POLE, SINGLE THROW (DUAL DPST)</b> |                 |                        |
| 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**            |
| <b>QUAD POLE, SINGLE THROW (4PST)</b>              |                 |                        |
| 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.

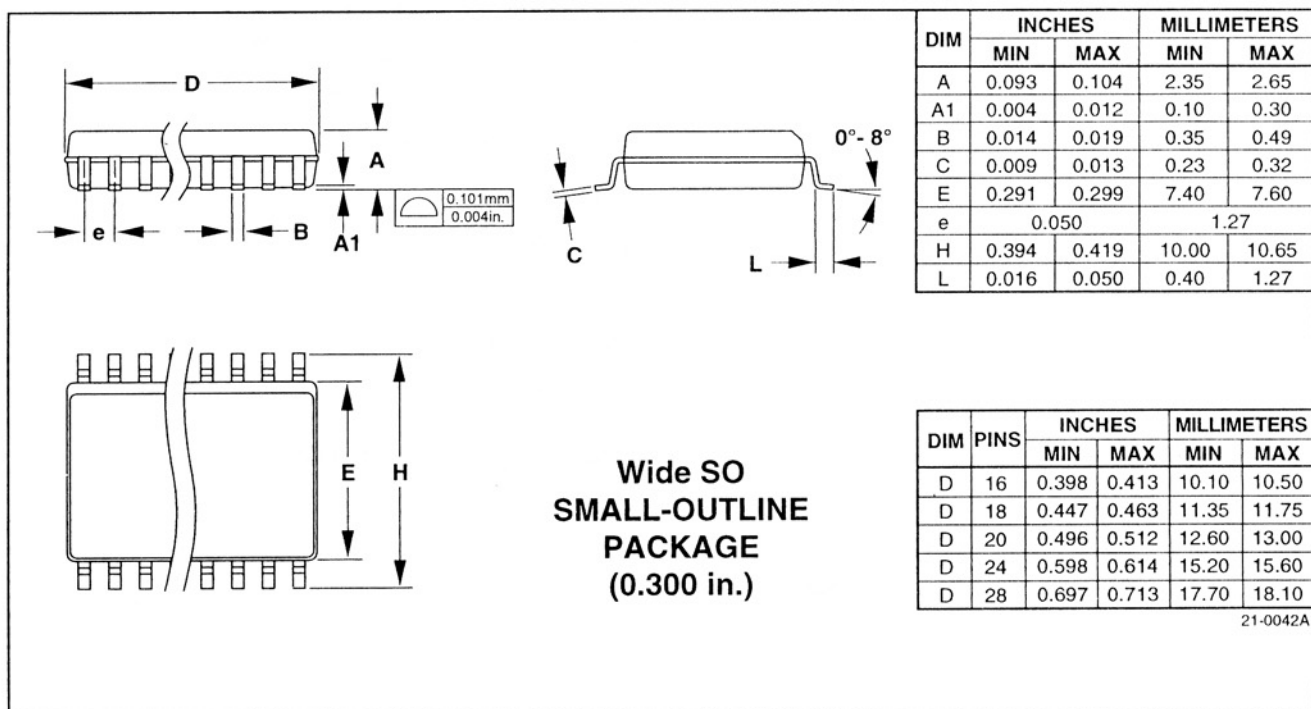
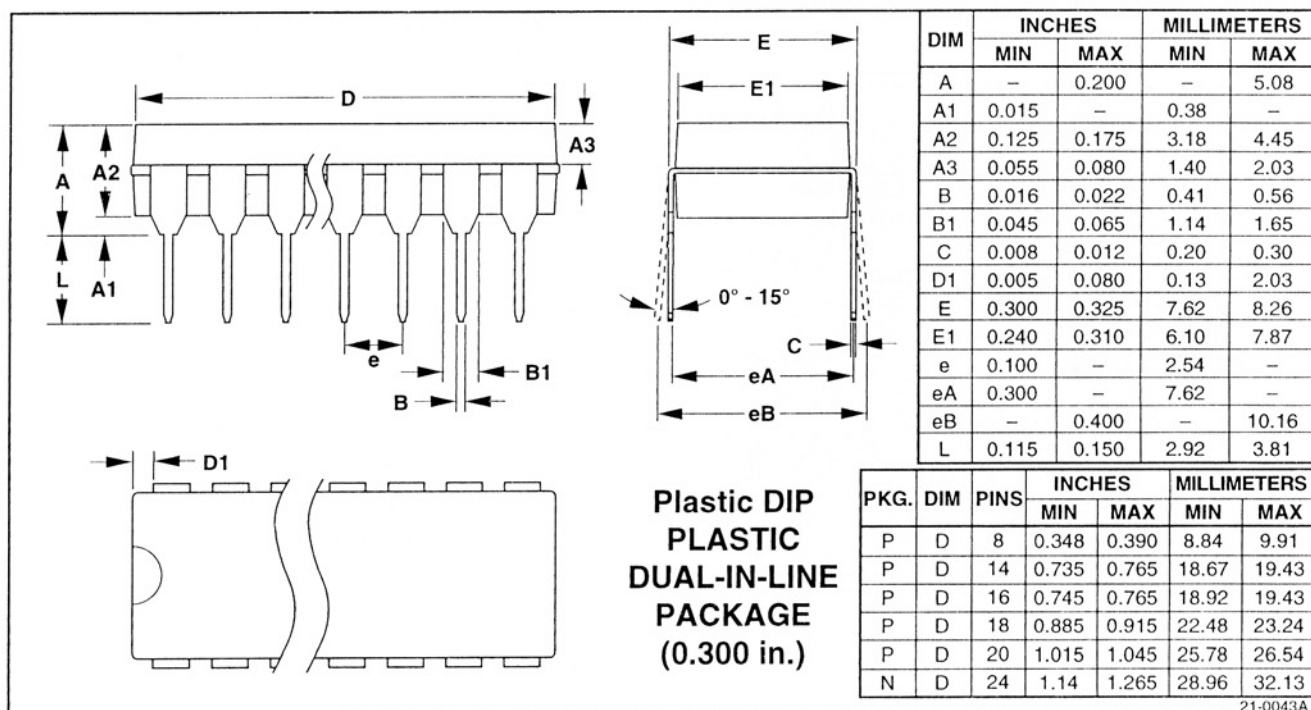
<sup>†</sup> Contact factory for availability.

IH5040-IH5045/IH5047

# General-Purpose CMOS Analog Switches

## 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](http://www.maxim-ic.com/packages).)

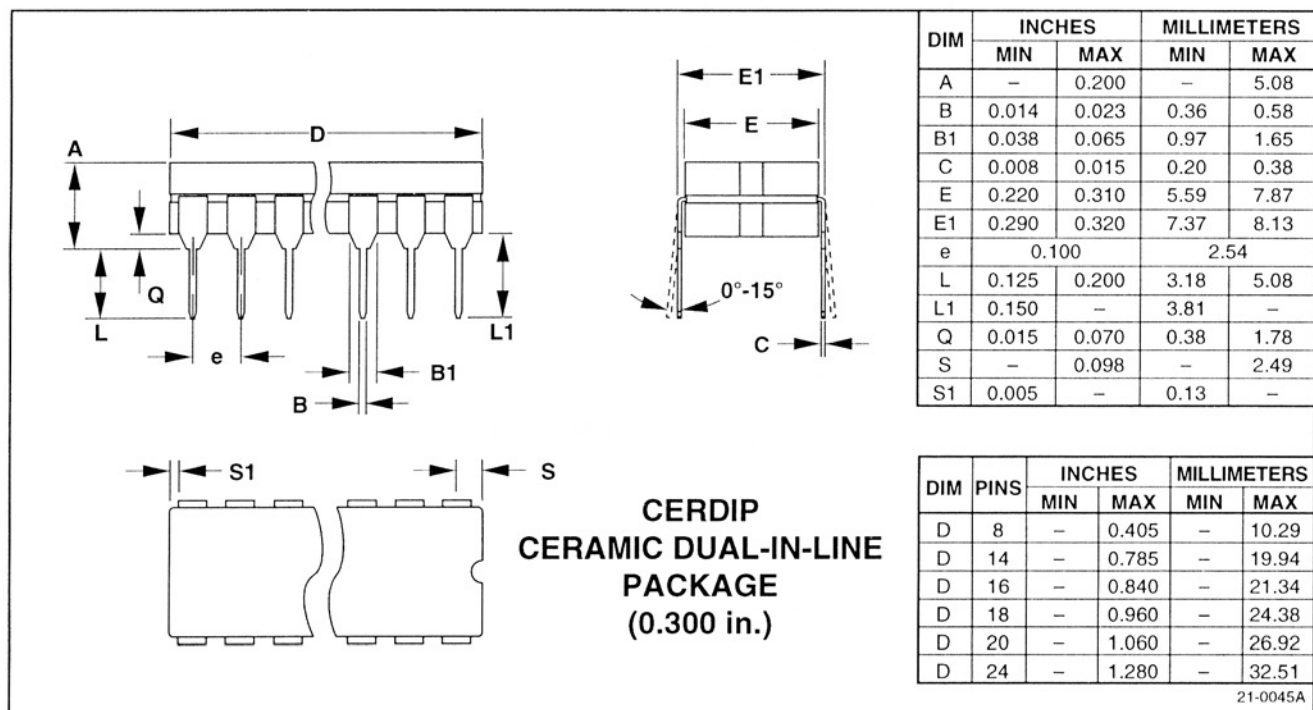


# General-Purpose CMOS Analog Switches

## 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](http://www.maxim-ic.com/packages).)

IH5040-IH5045/IH5047



## **General-Purpose CMOS Analog Switches**

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**8** \_\_\_\_\_ **Maxim Integrated Products, 120 San Gabriel Drive, Sunnyvale, CA 94086 (408) 737-7600**