

## Low-Power, High-Speed CMOS Analog Switches

### DESCRIPTION

The DG401B, DG403B, DG405B monolithic analog switches are replacements for the popular DG401/403/405 analog switches and provide improved performance, combining high speed ( $t_{ON}$ : 100 ns, typ) with low power consumption make the DG401B series ideal for portable and battery powered applications.

Built on the Vishay Siliconix proprietary high-voltage silicon-gate process to achieve high voltage rating and superior switch on/off performance, break-before-make is guaranteed for the SPDT configurations.

Each switch conducts equally well in both directions when on, and blocks up to 30 V peak-to-peak when off. On-resistance is very flat over the full  $\pm 15$  V analog range. The DG401B has two independent SPST switches. The DG403B has four SPST switches in NO/NC combinations. The DG405B has four switches in two SPST pairs (see Functional Block Diagrams and Pin Configurations on pages 1 and 2.)

The DG401B, DG403B, DG405B is available in both 16-pin plastic dip and 16-pin SOIC packages.

As a committed partner to the community and the environment, Vishay Siliconix manufactures this product with the lead (Pb)-free device terminations. For analog switching products manufactured with 100 % matte tin device terminations, the lead (Pb)-free “-E3” suffix is being used as a designator.

### FEATURES

- 44 V supply max rating
- $\pm 15$  V analog signal range
- On-resistance -  $R_{DS(on)}$ : 23  $\Omega$
- Low leakage -  $I_{D(on)}$ : 40 pA
- Fast switching -  $t_{ON}$ : 100 ns
- Upgrade to DG401B, DG403B, DG405B
- TTL, CMOS compatible
- Single supply capability

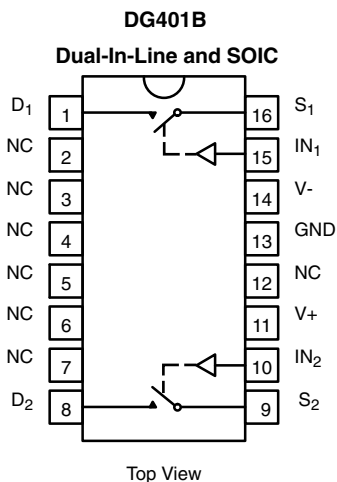
### BENEFITS

- Wide dynamic range
- Break-before-make switching action (DG403B only)
- Simple interfacing

### APPLICATIONS

- Audio and video switching
- Sample-and-hold circuits
- Test equipment
- PBX, PABX

### FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION

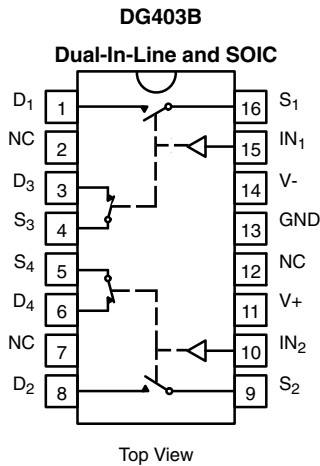


Two SPST Switches per Package

| TRUTH TABLE |        |
|-------------|--------|
| Logic       | Switch |
| 0           | OFF    |
| 1           | ON     |

Logic "0"  $\leq 0.8$  V  
Logic "1"  $\geq 2.4$  V

## FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION



Four SPST Switches in Two Pairs per Package

| TRUTH TABLE |                                   |                                   |
|-------------|-----------------------------------|-----------------------------------|
| Logic       | SW <sub>1</sub> , SW <sub>2</sub> | SW <sub>3</sub> , SW <sub>4</sub> |
| 0           | OFF                               | ON                                |
| 1           | ON                                | OFF                               |

Logic "0" ≤ 0.8 V

Logic "1" ≥ 2.4 V



Four SPST Switches in Two Pairs per Package

| TRUTH TABLE |        |
|-------------|--------|
| Logic       | Switch |
| 0           | OFF    |
| 1           | ON     |

Logic "0" ≤ 0.8 V

Logic "1" ≥ 2.4 V

### ORDERING INFORMATION

| Standard Commercial Part Number | Lead (Pb)-free Commercial Part Number | Package                               | Temperature Range |
|---------------------------------|---------------------------------------|---------------------------------------|-------------------|
| DG401BDJ                        | DG401BDJ-E3                           | 16-Pin Plastic Dip                    | - 40 to 85 °C     |
| DG403BDJ                        | DG403BDJ-E3                           |                                       |                   |
| DG405BDJ                        | DG405BDJ-E3                           |                                       |                   |
| DG401BDY                        | DG401BDY-E3                           | 16-Pin Narrow SOIC                    |                   |
| DG403BDY                        | DG403BDY-E3                           |                                       |                   |
| DG405BDY                        | DG405BDY-E3                           |                                       |                   |
| DG401BDY-T1                     | DG401BDY-T1-E3                        | 16-Pin Narrow SOIC With Tape and Reel |                   |
| DG403BDY-T1                     | DG403BDY-T1-E3                        |                                       |                   |
| DG405BDY-T1                     | DG405BDY-T1-E3                        |                                       |                   |



| ABSOLUTE MAXIMUM RATINGS                                      |                                 |                                                               |      |
|---------------------------------------------------------------|---------------------------------|---------------------------------------------------------------|------|
| Parameter                                                     | Symbol                          | Limit                                                         | Unit |
| V+ to V-                                                      |                                 | 44                                                            | V    |
| GND to V-                                                     |                                 | 25                                                            |      |
| Digital Inputs <sup>a</sup> , V <sub>S</sub> , V <sub>D</sub> |                                 | (V-) - 0.3 V to (V+) + 0.3 V or 30 mA, whichever occurs first |      |
| Current (Any Terminal) Continuous                             |                                 | 30                                                            | mA   |
| Current, S or D (Pulsed 1 ms 10 % duty)                       |                                 | 100                                                           |      |
| Storage Temperature                                           | (DJ, DY Suffix)                 | - 65 to 125                                                   | °C   |
| Power Dissipation (Package) <sup>b</sup>                      | 16-Pin Plastic DIP <sup>c</sup> | 450                                                           | mW   |
|                                                               | 16-Pin SOIC <sup>d</sup>        | 600                                                           |      |

Notes:

- a. Signals on S<sub>X</sub>, D<sub>X</sub>, or I<sub>NX</sub> exceeding V+ or V- will be clamped by internal diodes. Limit forward diode current to maximum current ratings.
- b. All leads welded or soldered to PC board.
- c. Derate 6 mW/°C above 75 °C.
- d. Derate 7.6 mW/°C above 75 °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 in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

| SPECIFICATIONS <sup>a</sup>           |                                     |                                                                                                           |                    |                            |                   |                   |      |
|---------------------------------------|-------------------------------------|-----------------------------------------------------------------------------------------------------------|--------------------|----------------------------|-------------------|-------------------|------|
| Parameter                             | Symbol                              | Test Conditions Unless Specified<br>V+ = 15 V, V- = - 15 V<br>V <sub>IN</sub> = 2.4 V, 0.8 V <sup>f</sup> | Temp. <sup>b</sup> | Limits<br>- 40 °C to 85 °C |                   |                   | Unit |
|                                       |                                     |                                                                                                           |                    | Min. <sup>d</sup>          | Typ. <sup>c</sup> | Max. <sup>d</sup> |      |
| <b>Analog Switch</b>                  |                                     |                                                                                                           |                    |                            |                   |                   |      |
| Analog Signal Range <sup>e</sup>      | V <sub>ANALOG</sub>                 |                                                                                                           | Full               | -15                        |                   | 15                | V    |
| Drain-Source On-Resistance            | R <sub>DS(on)</sub>                 | I <sub>S</sub> = - 10 mA, V <sub>D</sub> = ± 10 V<br>V+ = 13.5 V, V- = - 13.5 V                           | Room<br>Full       |                            | 23                | 45<br>55          | Ω    |
| Δ Drain-Source On-Resistance          | ΔR <sub>DS(on)</sub>                | I <sub>S</sub> = - 10 mA, V <sub>D</sub> = ± 5 V, 0 V<br>V+ = 16.5 V, V- = - 16.5 V                       | Room<br>Full       |                            | 0.72              | 3<br>5            |      |
| Switch Off Leakage Current            | I <sub>S(off)</sub>                 | V+ = 16.5, V- = - 16.5 V<br>V <sub>D</sub> = ± 15.5 V, V <sub>S</sub> = ± 15.5 V                          | Room<br>Hot        | - 0.5<br>- 5               | - 0.01            | 0.5<br>5          | nA   |
|                                       | I <sub>D(off)</sub>                 |                                                                                                           | Room<br>Hot        | - 0.5<br>- 5               | - 0.01            | 0.5<br>5          |      |
| Channel On Leakage Current            | I <sub>D(on)</sub>                  | V+ = 16.5 V, V- = - 16.5 V<br>V <sub>S</sub> = V <sub>D</sub> = ± 15.5 V                                  | Room<br>Hot        | - 1<br>- 10                | - 0.04            | 1<br>10           |      |
| <b>Digital Control</b>                |                                     |                                                                                                           |                    |                            |                   |                   |      |
| Input Current V <sub>IN</sub> Low     | I <sub>IL</sub>                     | V <sub>IN</sub> under test = 0.8 V, all other = 2.4 V                                                     | Full               | - 1                        | 0.005             | 1                 | μA   |
| Input Current V <sub>IN</sub> High    | I <sub>IH</sub>                     | V <sub>IN</sub> under test = 2.4 V, all other = 0.8 V                                                     | Full               | - 1                        | 0.005             | 1                 |      |
| <b>Dynamic Characteristics</b>        |                                     |                                                                                                           |                    |                            |                   |                   |      |
| Turn-On Time                          | t <sub>ON</sub>                     | R <sub>L</sub> = 300 Ω, C <sub>L</sub> = 35 pF<br>see figure 2                                            | Room               |                            | 100               | 150               | ns   |
| Turn-Off Time                         | t <sub>OFF</sub>                    |                                                                                                           | Room               |                            | 60                | 100               |      |
| Break-Before-Make Time Delay (DG403B) | t <sub>D</sub>                      | R <sub>L</sub> = 300 Ω, C <sub>L</sub> = 35 pF                                                            | Room               | 5                          | 12                |                   |      |
| Charge Injection                      | Q                                   | C <sub>L</sub> = 10 000 pF, V <sub>gen</sub> = 0 V, R <sub>gen</sub> = 0 Ω                                | Room               |                            | 60                |                   | pC   |
| Off Isolation Reject Ratio            | OIRR                                | R <sub>L</sub> = 100 Ω, C <sub>L</sub> = 5 pF, f = 1 MHz                                                  | Room               |                            | - 81.7            |                   | dB   |
| Channel-to-Channel Crosstalk          | X <sub>TALK</sub>                   |                                                                                                           | Room               |                            | - 94.8            |                   |      |
| Source Off Capacitance                | C <sub>S(off)</sub>                 | f = 1 MHz, V <sub>S</sub> = 0 V                                                                           | Room               |                            | 12                |                   | pF   |
| Drain Off Capacitance                 | C <sub>D(off)</sub>                 |                                                                                                           | Room               |                            | 12                |                   |      |
| Channel On Capacitance                | C <sub>D</sub> , C <sub>S(on)</sub> |                                                                                                           | Room               |                            | 39                |                   |      |

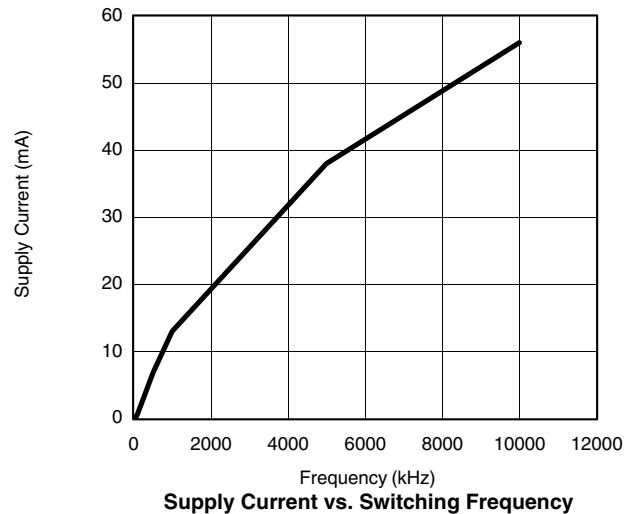
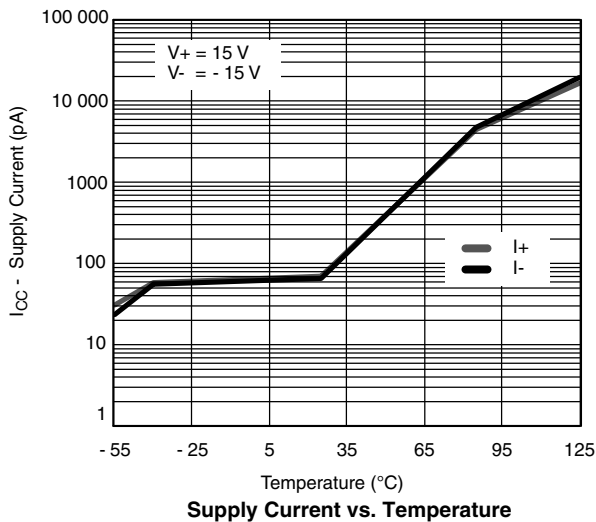


| SPECIFICATIONS <sup>a</sup> |                  |                                                                                                                                      |                       |                            |                   |                   |      |
|-----------------------------|------------------|--------------------------------------------------------------------------------------------------------------------------------------|-----------------------|----------------------------|-------------------|-------------------|------|
| Parameter                   | Symbol           | Test Conditions<br>Unless Specified<br>V <sub>+</sub> = 15 V, V <sub>-</sub> = - 15 V<br>V <sub>IN</sub> = 2.4 V, 0.8 V <sup>f</sup> | Temp.<br><sub>b</sub> | Limits<br>- 40 °C to 85 °C |                   |                   | Unit |
|                             |                  |                                                                                                                                      |                       | Min. <sup>d</sup>          | Typ. <sup>c</sup> | Max. <sup>d</sup> |      |
| <b>Power Supplies</b>       |                  |                                                                                                                                      |                       |                            |                   |                   |      |
| Positive Supply Current     | I <sub>+</sub>   | V <sub>+</sub> = 16.5 V, V <sub>-</sub> = - 16.5 V<br>V <sub>IN</sub> = 0 or 5 V                                                     | Room Full             |                            | 0.250             | 0.5               | mA   |
| Negative Supply Current     | I <sub>-</sub>   |                                                                                                                                      | Room Full             | - 0.5<br>- 1               | 0.25              |                   |      |
| Ground Current              | I <sub>GND</sub> |                                                                                                                                      | Room Full             | - 0.5<br>- 1               | 0.25              |                   |      |

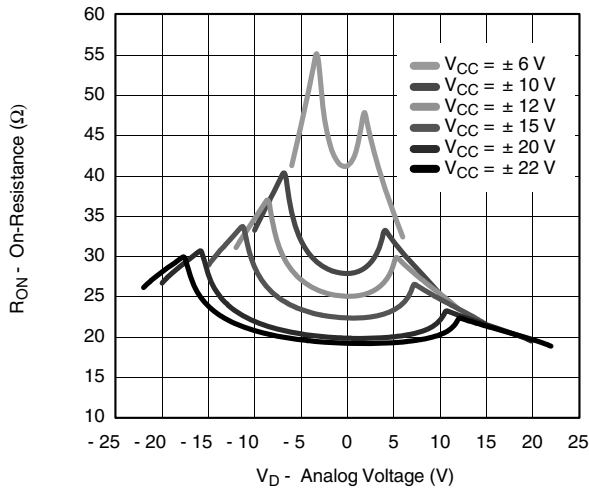
Notes:

- a. Refer to PROCESS OPTION FLOWCHART.
- b. Room = 25 °C, Full = as determined by the operating temperature suffix.
- c. Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.
- d. The algebraic convention whereby the most negative value is a minimum and the most positive a maximum, is used in this data sheet.
- e. Guaranteed by design, not subject to production test.
- f. V<sub>IN</sub> = input voltage to perform proper function.

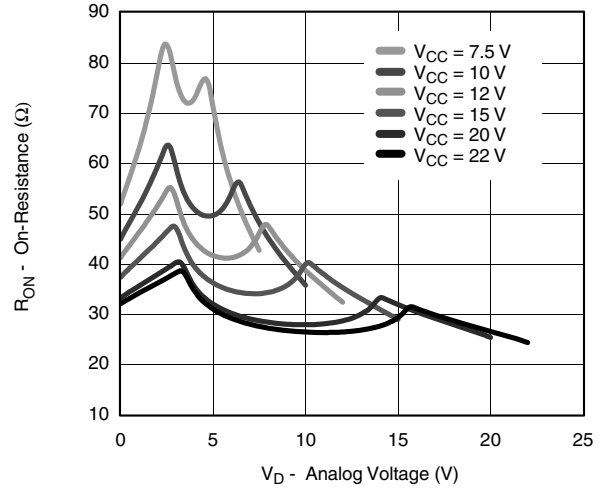
## TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



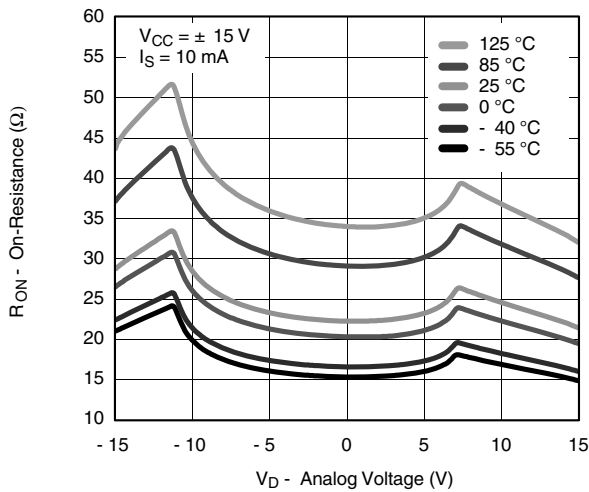
## TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



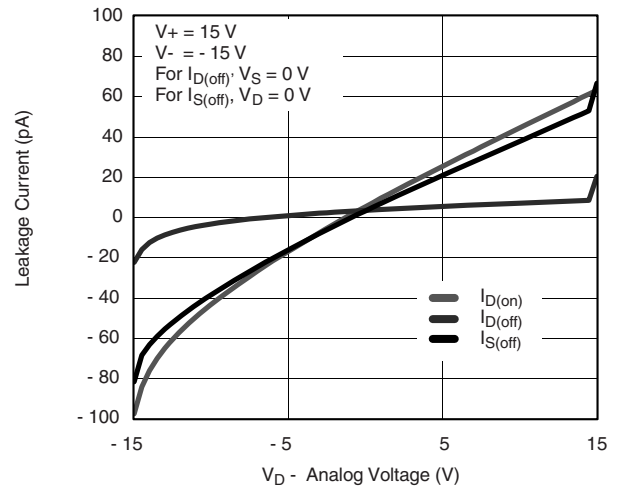
**$R_{ON}$  vs. Analog Voltage and Supply Voltage**



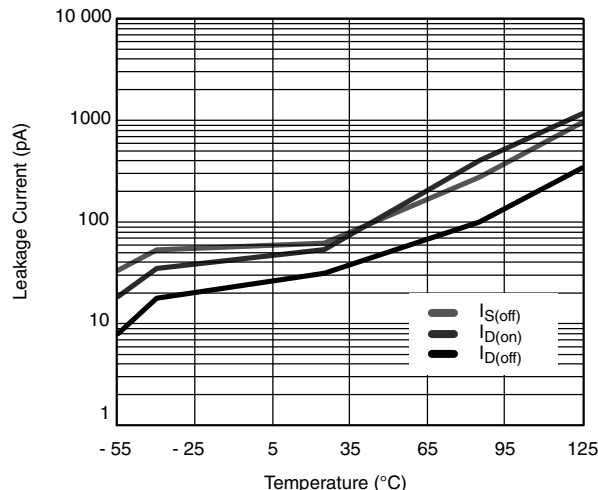
**$R_{ON}$  vs. Analog Voltage and Single Supply Voltage**



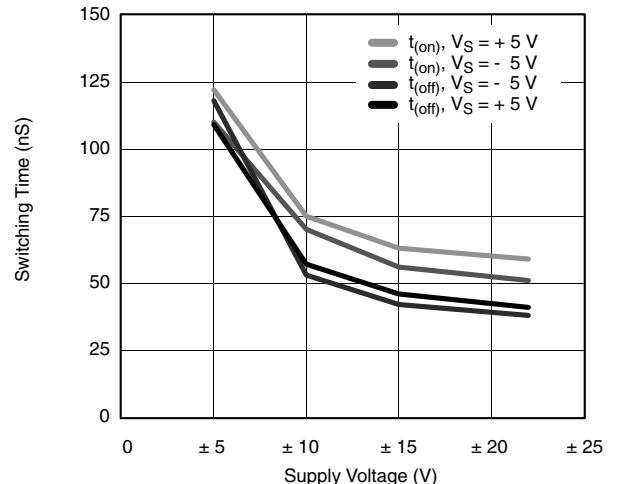
**$R_{ON}$  vs. Analog Voltage and Temperature**



**Leakage Current vs. Analog Voltage**

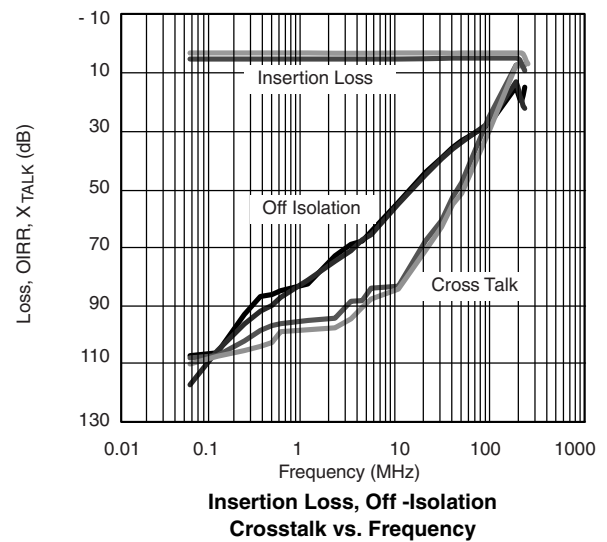
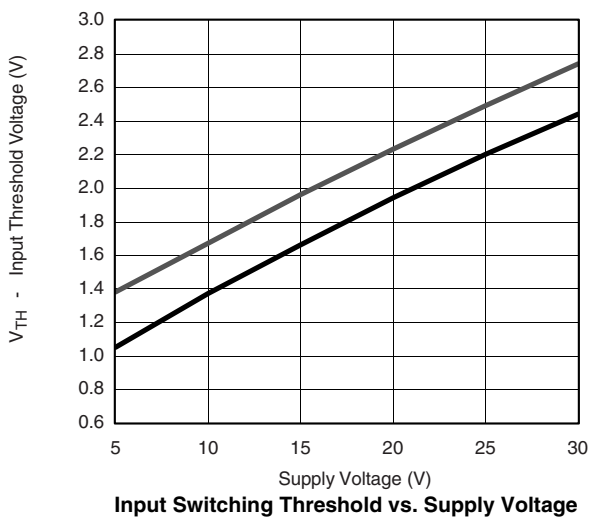
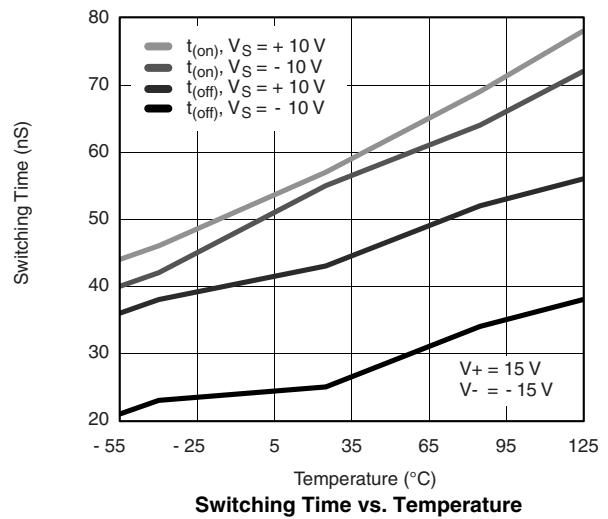
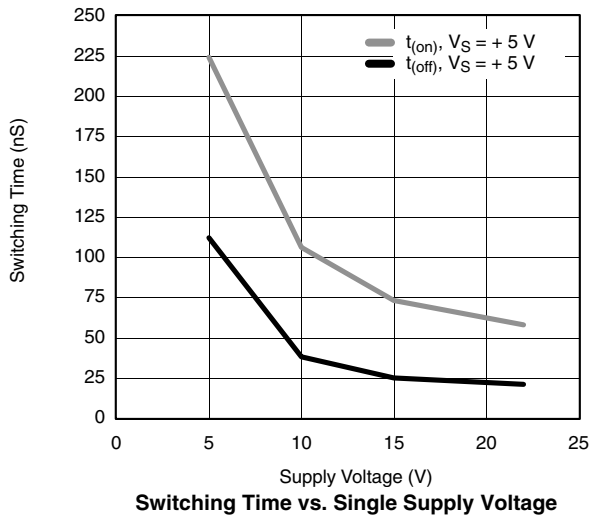


**Leakage Current vs. Temperature**



**Switching Time vs. Supply Voltage**

## TYPICAL CHARACTERISTICS (25 °C, unless otherwise noted)



## SCHEMATIC DIAGRAM (Typical Channel)

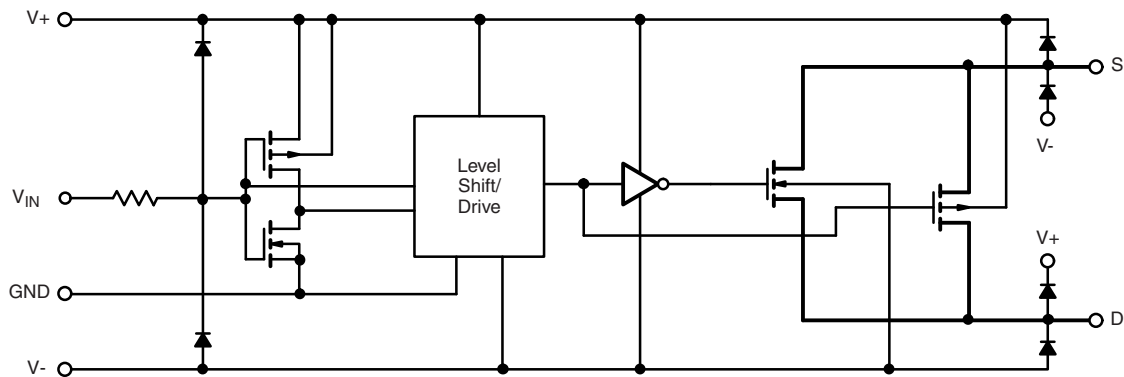
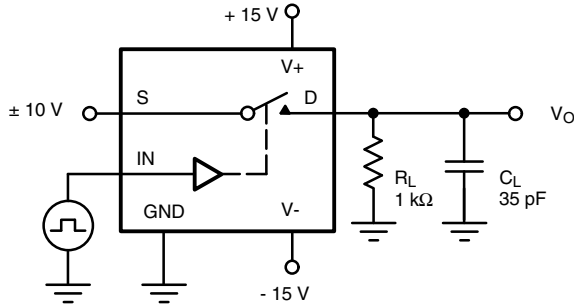


Figure 1.

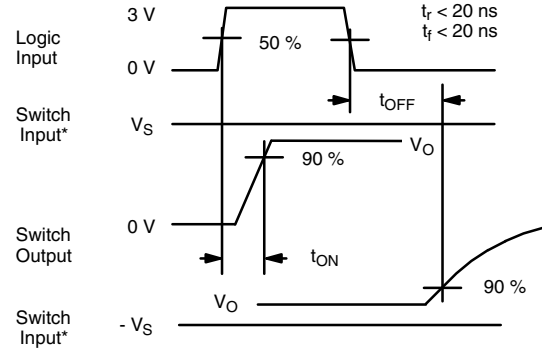
## TEST CIRCUITS

$V_O$  is the steady state output with the switch on. Feedthrough via switch capacitance may result in spikes at the leading and trailing edge of the output waveform.



$C_L$  (includes fixture and stray capacitance)

$$V_O = V_S \frac{R_L}{R_L + R_{DS(on)}}$$



\*  $V_S = 10\text{ V}$  for  $t_{ON}$ ,  $V_S = -10\text{ V}$  for  $t_{OFF}$

Note: Logic input waveform is inverted for switches that have the opposite logic sense control

Figure 2. Switching Time



$C_L$  (includes fixture and stray capacitance)

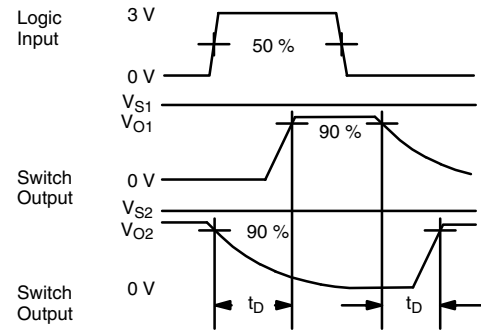


Figure 3. Break-Before-Make

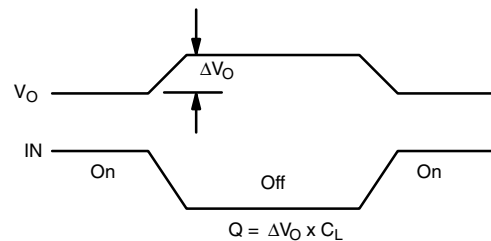
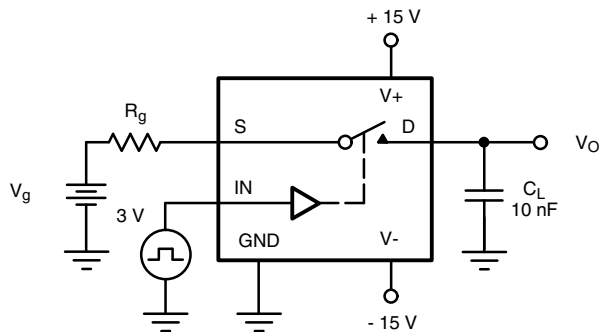
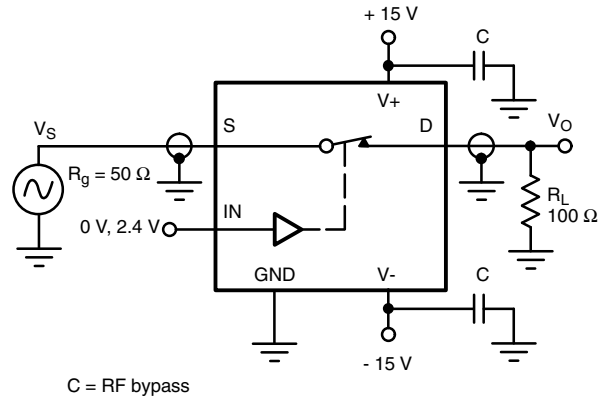


Figure 4. Charge Injection

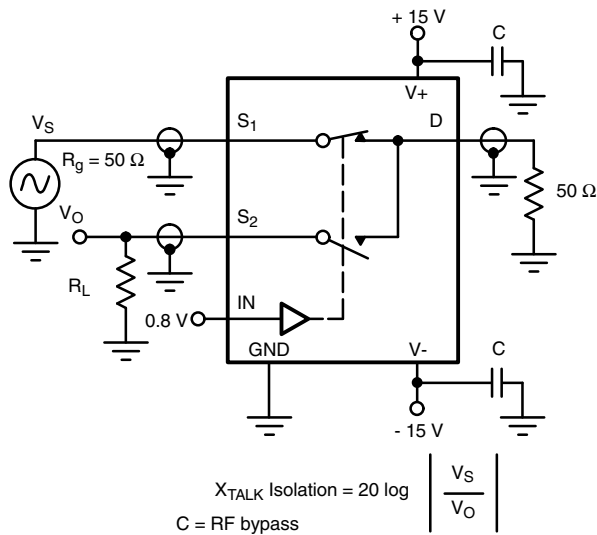
### TEST CIRCUITS



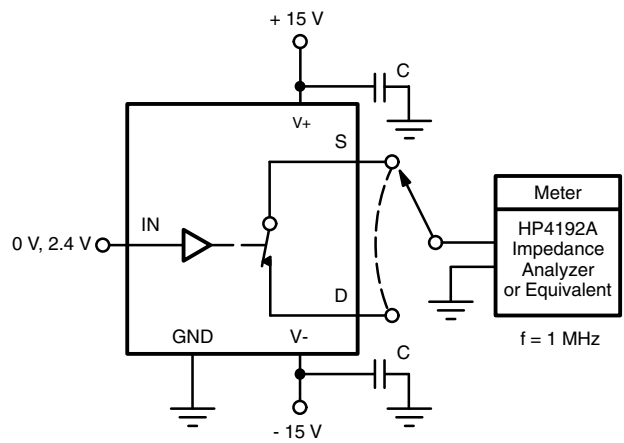
**Figure 5. Off Isolation**



**Figure 6. Insertion Loss**



**Figure 7. Crosstalk**



**Figure 8. Capacitances**



## APPLICATIONS

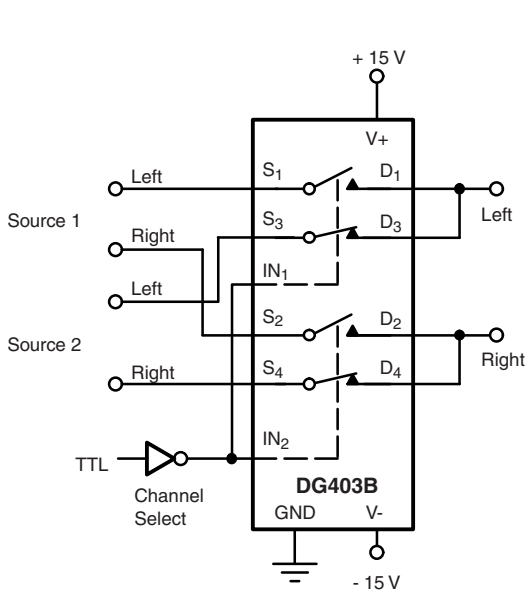


Figure 9. Stereo Source Selector

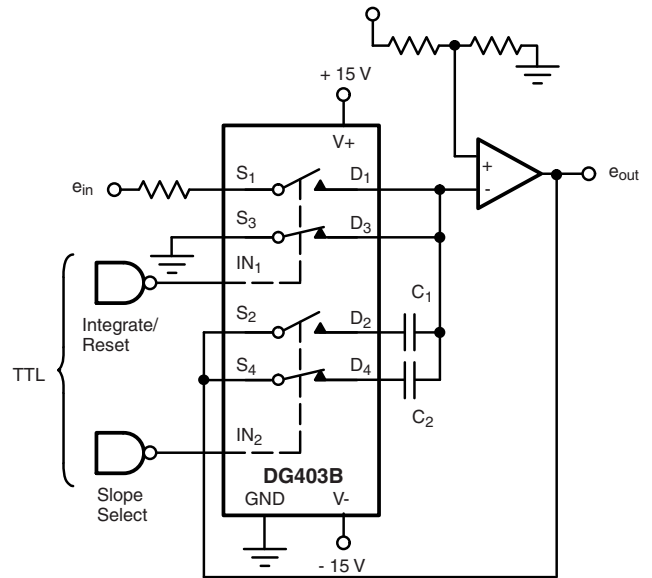


Figure 10. Dual Slope Integrator

### Dual Slope Integrators

The DG403B is well suited to configure a selectable slope integrator. One control signal selects the timing capacitor  $C_1$  or  $C_2$ . Another one selects  $e_{in}$  or discharges the capacitor in preparation for the next integration cycle.

### Band-Pass Switched Capacitor Filter

Single-pole double-throw switches are a common element for switched capacitor networks and filters. The fast switching times and low leakage of the DG403B allow for higher clock rates and consequently higher filter operating frequencies.

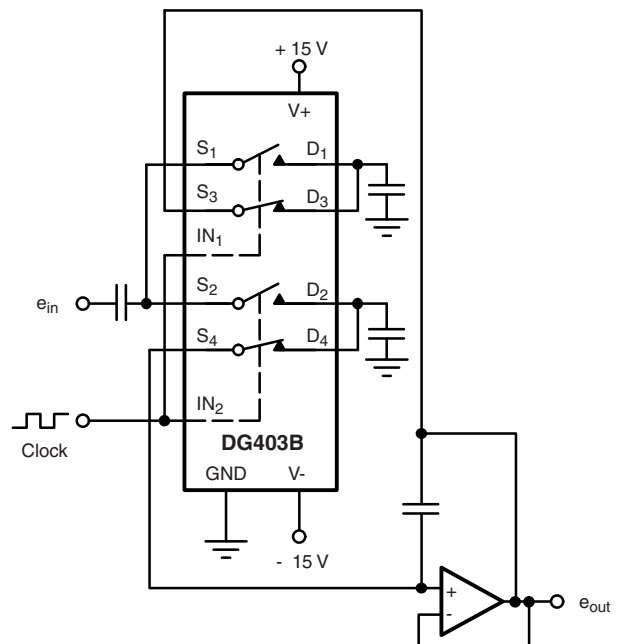


Figure 11. Band-Pass Switched Capacitor Filter

## APPLICATIONS

### Peak Detector

$A_3$  acting as a comparator provides the logic drive for operating  $SW_1$ . The output of  $A_2$  is fed back to  $A_3$  and compared to the analog input  $e_{in}$ . If  $e_{in} > e_{out}$  the output of  $A_3$  is high keeping  $SW_1$  closed. This allows  $C_1$  to charge up to

the analog input voltage. When  $e_{in}$  goes below  $e_{out}$   $A_3$  goes negative, turning  $SW_1$  off. The system will therefore store the most positive analog input experienced.

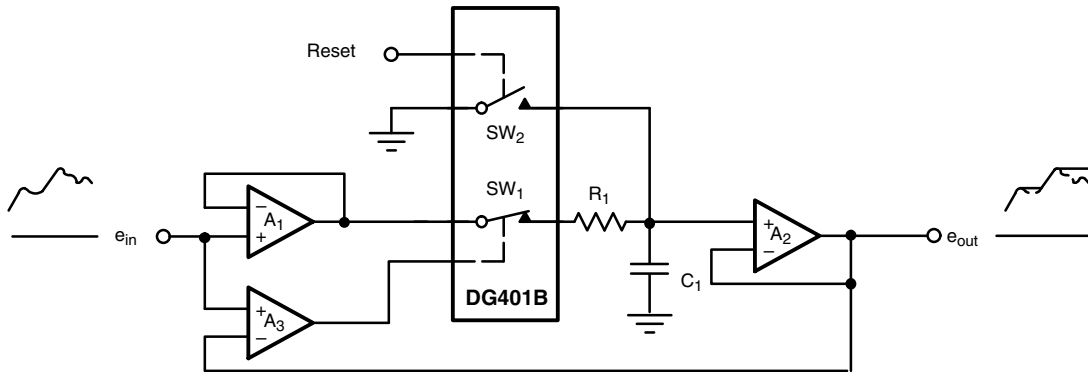


Figure 12. Positive Peak Detector



**SOIC (NARROW): 16-LEAD**  
JEDEC Part Number: MS-012

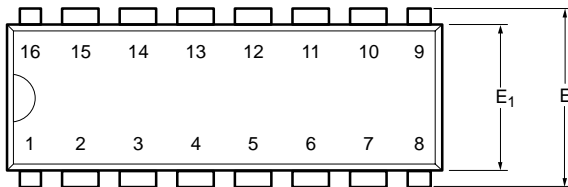


| Dim            | MILLIMETERS |       | INCHES    |       |
|----------------|-------------|-------|-----------|-------|
|                | Min         | Max   | Min       | Max   |
| A              | 1.35        | 1.75  | 0.053     | 0.069 |
| A <sub>1</sub> | 0.10        | 0.20  | 0.004     | 0.008 |
| B              | 0.38        | 0.51  | 0.015     | 0.020 |
| C              | 0.18        | 0.23  | 0.007     | 0.009 |
| D              | 9.80        | 10.00 | 0.385     | 0.393 |
| E              | 3.80        | 4.00  | 0.149     | 0.157 |
| e              | 1.27 BSC    |       | 0.050 BSC |       |
| H              | 5.80        | 6.20  | 0.228     | 0.244 |
| L              | 0.50        | 0.93  | 0.020     | 0.037 |
| ∅              | 0°          | 8°    | 0°        | 8°    |

ECN: S-03946—Rev. F, 09-Jul-01  
DWG: 5300



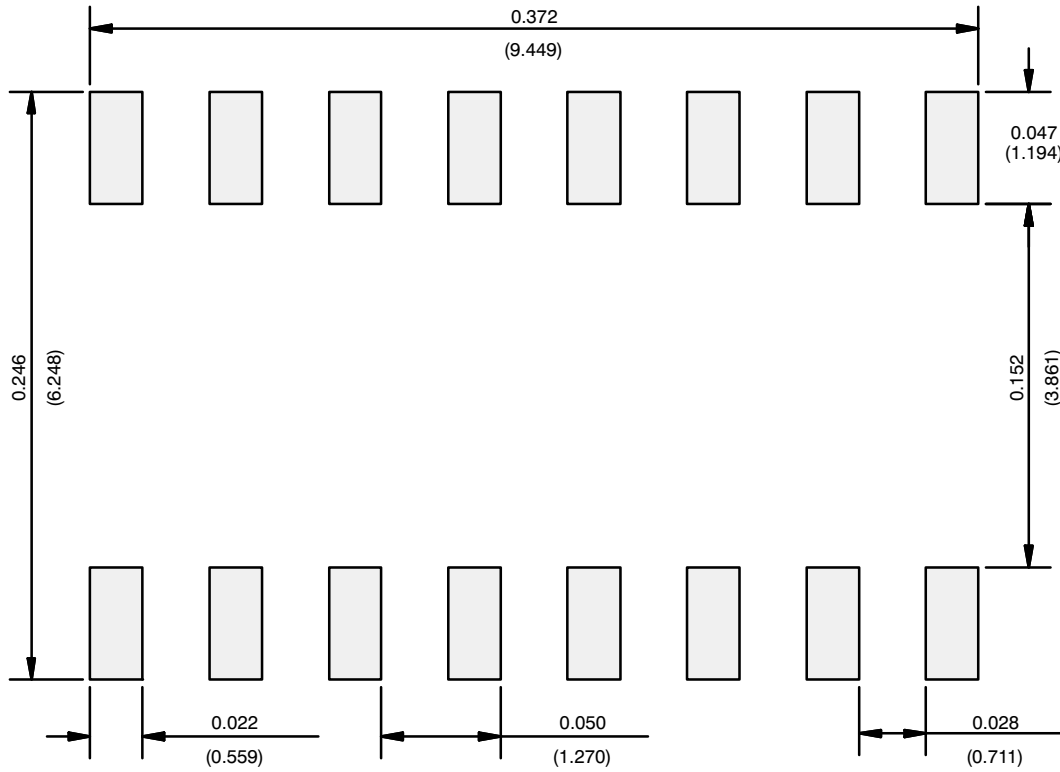
### PDIP: 16-LEAD



| Dim                  | MILLIMETERS |       | INCHES |       |
|----------------------|-------------|-------|--------|-------|
|                      | Min         | Max   | Min    | Max   |
| <b>A</b>             | 3.81        | 5.08  | 0.150  | 0.200 |
| <b>A<sub>1</sub></b> | 0.38        | 1.27  | 0.015  | 0.050 |
| <b>B</b>             | 0.38        | 0.51  | 0.015  | 0.020 |
| <b>B<sub>1</sub></b> | 0.89        | 1.65  | 0.035  | 0.065 |
| <b>C</b>             | 0.20        | 0.30  | 0.008  | 0.012 |
| <b>D</b>             | 18.93       | 21.33 | 0.745  | 0.840 |
| <b>E</b>             | 7.62        | 8.26  | 0.300  | 0.325 |
| <b>E<sub>1</sub></b> | 5.59        | 7.11  | 0.220  | 0.280 |
| <b>e<sub>1</sub></b> | 2.29        | 2.79  | 0.090  | 0.110 |
| <b>e<sub>A</sub></b> | 7.37        | 7.87  | 0.290  | 0.310 |
| <b>L</b>             | 2.79        | 3.81  | 0.110  | 0.150 |
| <b>Q<sub>1</sub></b> | 1.27        | 2.03  | 0.050  | 0.080 |
| <b>S</b>             | 0.38        | 1.52  | .015   | 0.060 |

ECN: S-03946—Rev. D, 09-Jul-01  
DWG: 5482

## RECOMMENDED MINIMUM PADS FOR SO-16



Recommended Minimum Pads  
Dimensions in Inches/(mm)

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## Material Category Policy

**Vishay Intertechnology, Inc. hereby certifies that all its products that are identified as RoHS-Compliant fulfill the definitions and restrictions defined under Directive 2011/65/EU of The European Parliament and of the Council of June 8, 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (EEE) - recast, unless otherwise specified as non-compliant.**

**Please note that some Vishay documentation may still make reference to RoHS Directive 2002/95/EC. We confirm that all the products identified as being compliant to Directive 2002/95/EC conform to Directive 2011/65/EU.**

**Vishay Intertechnology, Inc. hereby certifies that all its products that are identified as Halogen-Free follow Halogen-Free requirements as per JEDEC JS709A standards. Please note that some Vishay documentation may still make reference to the IEC 61249-2-21 definition. We confirm that all the products identified as being compliant to IEC 61249-2-21 conform to JEDEC JS709A standards.**

Компания «Life Electronics» занимается поставками электронных компонентов импортного и отечественного производства от производителей и со складов крупных дистрибьюторов Европы, Америки и Азии.

С конца 2013 года компания активно расширяет линейку поставок компонентов по направлению коаксиальный кабель, кварцевые генераторы и конденсаторы (керамические, пленочные, электролитические), за счёт заключения дистрибьюторских договоров

Мы предлагаем:

- Конкурентоспособные цены и скидки постоянным клиентам.
- Специальные условия для постоянных клиентов.
- Подбор аналогов.
- Поставку компонентов в любых объемах, удовлетворяющих вашим потребностям.
- Приемлемые сроки поставки, возможна ускоренная поставка.
- Доставку товара в любую точку России и стран СНГ.
- Комплексную поставку.
- Работу по проектам и поставку образцов.
- Формирование склада под заказчика.
- Сертификаты соответствия на поставляемую продукцию (по желанию клиента).
- Тестирование поставляемой продукции.
- Поставку компонентов, требующих военную и космическую приемку.
- Входной контроль качества.
- Наличие сертификата ISO.

В составе нашей компании организован Конструкторский отдел, призванный помогать разработчикам, и инженерам.

Конструкторский отдел помогает осуществить:

- Регистрацию проекта у производителя компонентов.
- Техническую поддержку проекта.
- Защиту от снятия компонента с производства.
- Оценку стоимости проекта по компонентам.
- Изготовление тестовой платы монтаж и пусконаладочные работы.



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