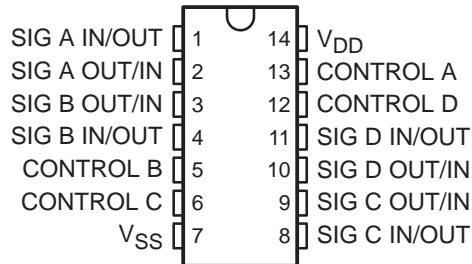


- 15-V Digital or  $\pm 7.5$ -V Peak-to-Peak Switching
- 125- $\Omega$  Typical On-State Resistance for 15-V Operation
- Switch On-State Resistance Matched to Within 5  $\Omega$  Over 15-V Signal-Input Range
- On-State Resistance Flat Over Full Peak-to-Peak Signal Range
- High On/Off Output-Voltage Ratio: 80 dB Typical at  $f_{IS} = 10$  kHz,  $R_L = 1$  k $\Omega$
- High Degree of Linearity: <0.5% Distortion Typical at  $f_{IS} = 1$  kHz,  $V_{IS} = 5$  V p-p,  $V_{DD} - V_{SS} \geq 10$  V,  $R_L = 10$  k $\Omega$
- Extremely Low Off-State Switch Leakage, Resulting in Very Low Offset Current and High Effective Off-State Resistance: 10 pA Typical at  $V_{DD} - V_{SS} = 10$  V,  $T_A = 25^\circ\text{C}$
- Extremely High Control Input Impedance (Control Circuit Isolated From Signal Circuit):  $10^{12}$   $\Omega$  Typical
- Low Crosstalk Between Switches: -50 dB Typical at  $f_{IS} = 8$  MHz,  $R_L = 1$  k $\Omega$
- Matched Control-Input to Signal-Output Capacitance: Reduces Output Signal Transients
- Frequency Response, Switch On = 40 MHz Typical
- 100% Tested for Quiescent Current at 20 V
- 5-V, 10-V, and 15-V Parametric Ratings
- Meets All Requirements of JEDEC Tentative Standard No. 13-B, *Standard Specifications for Description of "B" Series CMOS Devices*
- Applications:
  - Analog Signal Switching/Multiplexing: Signal Gating, Modulator, Squelch Control, Demodulator, Chopper, Commutating Switch
  - Digital Signal Switching/Multiplexing
  - Transmission-Gate Logic Implementation
  - Analog-to-Digital and Digital-to-Analog Conversion
  - Digital Control of Frequency, Impedance, Phase, and Analog-Signal Gain

E, F, M, NS, OR PW PACKAGE  
(TOP VIEW)



## description/ordering information

The CD4066B is a quad bilateral switch intended for the transmission or multiplexing of analog or digital signals. It is pin-for-pin compatible with the CD4016B, but exhibits a much lower on-state resistance. In addition, the on-state resistance is relatively constant over the full signal-input range.

The CD4066B consists of four bilateral switches, each with independent controls. Both the p and the n devices in a given switch are biased on or off simultaneously by the control signal. As shown in Figure 1, the well of the n-channel device on each switch is tied to either the input (when the switch is on) or to  $V_{SS}$  (when the switch is off). This configuration eliminates the variation of the switch-transistor threshold voltage with input signal and, thus, keeps the on-state resistance low over the full operating-signal range.

The advantages over single-channel switches include peak input-signal voltage swings equal to the full supply voltage and more constant on-state impedance over the input-signal range. However, for sample-and-hold applications, the CD4016B is recommended.



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.

 **TEXAS  
INSTRUMENTS**

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# CD4066B CMOS QUAD BILATERAL SWITCH

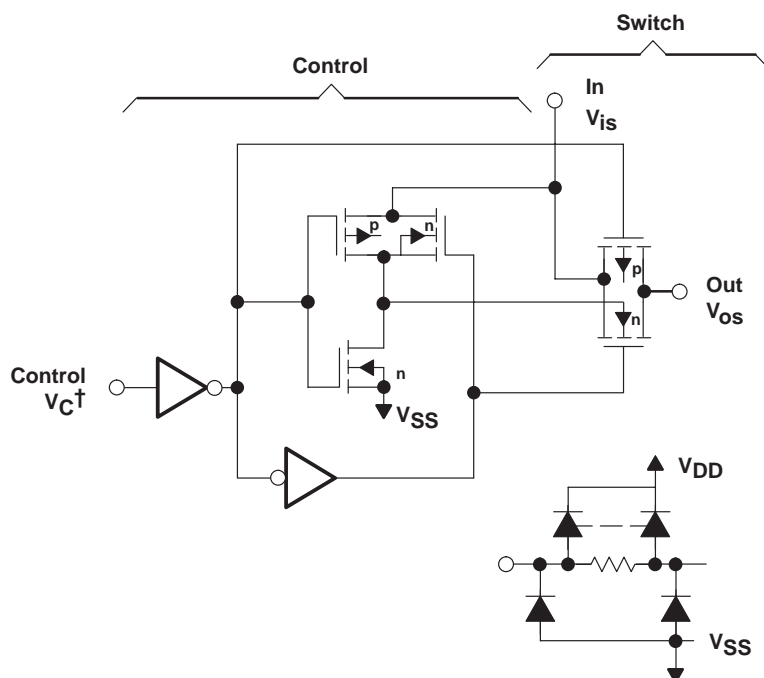
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## description/ordering information (continued)

### ORDERING INFORMATION

TA	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
-55°C to 125°C	CDIP – F	Tube of 25	CD4066BF3A	CD4066BF3A
	PDIP – E	Tube of 25	CD4066BE	CD4066BE
	SOIC – M	Tube of 50	CD4066BM	CD4066BM
		Reel of 2500	CD4066BM96	
		Reel of 250	CD4066BMT	
	SOP – NS	Reel of 2000	CD4066BNSR	CD4066B
	TSSOP – PW	Tube of 90	CD4066BPW	CM066B
		Reel of 2000	CD4066BPWR	

† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at [www.ti.com/sc/package](http://www.ti.com/sc/package).



† All control inputs are protected by the CMOS protection network.

NOTES: A. All p substrates are connected to  $V_{DD}$ .

B. Normal operation control-line biasing: switch on (logic 1),  $V_C = V_{DD}$ ; switch off (logic 0),  $V_C = V_{SS}$

C. Signal-level range:  $V_{SS} \leq V_{is} \leq V_{DD}$

92CS-29113

Figure 1. Schematic Diagram of One-of-Four Identical Switches and Associated Control Circuitry

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

DC supply-voltage range, $V_{DD}$ (voltages referenced to $V_{SS}$ terminal)	–0.5 V to 20 V
Input voltage range, $V_{is}$ (all inputs)	–0.5 V to $V_{DD} + 0.5$ V
DC input current, $I_{IN}$ (any one input)	±10 mA
Package thermal impedance, $\theta_{JA}$ (see Note 1): E package	80°C/W
M package	86°C/W
NS package	76°C/W
PW package	113°C/W
 Lead temperature (during soldering):	
At distance $1/16 \pm 1/32$ inch ( $1,59 \pm 0,79$ mm) from case for 10 s max	265°C
Storage temperature range, $T_{stg}$	–65°C 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.

NOTE 1: The package thermal impedance is calculated in accordance with JESD 51-7.

**recommended operating conditions**

	MIN	MAX	UNIT
$V_{DD}$ Supply voltage	3	18	V
$T_A$ Operating free-air temperature	–55	125	°C

# CD4066B CMOS QUAD BILATERAL SWITCH

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## electrical characteristics

PARAMETER	TEST CONDITIONS	LIMITS AT INDICATED TEMPERATURES								UNIT
		V <sub>IN</sub> (V)	V <sub>DD</sub> (V)	-55°C	-40°C	85°C	125°C	25°C		
								TYP	MAX	
I <sub>DD</sub> Quiescent device current		0, 5	5	0.25	0.25	7.5	7.5	0.01	0.25	μA
		0, 10	10	0.5	0.5	15	15	0.01	0.5	
		0, 15	15	1	1	30	30	0.01	1	
		0, 20	20	5	5	150	150	0.02	5	
<b>Signal Inputs (V<sub>is</sub>) and Outputs (V<sub>os</sub>)</b>										
r <sub>on</sub> On-state resistance (max)	V <sub>C</sub> = V <sub>DD</sub> , R <sub>L</sub> = 10 kΩ returned to $\frac{(V_{DD} - V_{SS})}{2}$ , V <sub>is</sub> = V <sub>SS</sub> to V <sub>DD</sub>	5		800	850	1200	1300	470	1050	Ω
		10		310	330	500	550	180	400	
		15		200	210	300	320	125	240	
Δr <sub>on</sub> On-state resistance difference between any two switches	R <sub>L</sub> = 10 kΩ, V <sub>C</sub> = V <sub>DD</sub>	5						15		Ω
		10						10		
		15						5		
THD Total harmonic distortion	V <sub>C</sub> = V <sub>DD</sub> = 5 V, V <sub>SS</sub> = -5 V, V <sub>is(p-p)</sub> = 5 V (sine wave centered on 0 V), R <sub>L</sub> = 10 kΩ, f <sub>is</sub> = 1-kHz sine wave							0.4		%
-3-dB cutoff frequency (switch on)	V <sub>C</sub> = V <sub>DD</sub> = 5 V, V <sub>SS</sub> = -5 V, V <sub>is(p-p)</sub> = 5 V (sine wave centered on 0 V), R <sub>L</sub> = 1 kΩ							40		MHz
-50-dB feedthrough frequency (switch off)	V <sub>C</sub> = V <sub>SS</sub> = -5 V, V <sub>is(p-p)</sub> = 5 V (sine wave centered on 0 V), R <sub>L</sub> = 1 kΩ							1		MHz
I <sub>is</sub> Input/output leakage current (switch off) (max)	V <sub>C</sub> = 0 V, V <sub>is</sub> = 18 V, V <sub>os</sub> = 0 V; and V <sub>C</sub> = 0 V, V <sub>is</sub> = 0 V, V <sub>os</sub> = 18 V	18		±0.1	±0.1	±1	±1	±10 <sup>-5</sup>	±0.1	μA
-50-dB crosstalk frequency	V <sub>C</sub> (A) = V <sub>DD</sub> = 5 V, V <sub>C</sub> (B) = V <sub>SS</sub> = -5 V, V <sub>is</sub> (A) = 5 V <sub>p-p</sub> , 50-Ω source, R <sub>L</sub> = 1 kΩ							8		MHz
t <sub>pd</sub> Propagation delay (signal input to signal output)	R <sub>L</sub> = 200 kΩ, V <sub>C</sub> = V <sub>DD</sub> , V <sub>SS</sub> = GND, C <sub>L</sub> = 50 pF, V <sub>is</sub> = 10 V (square wave centered on 5 V), t <sub>r</sub> , t <sub>f</sub> = 20 ns	5						20	40	ns
		10						10	20	
		15							7	
C <sub>is</sub> Input capacitance	V <sub>DD</sub> = 5 V, V <sub>C</sub> = V <sub>SS</sub> = -5 V							8		pF
C <sub>os</sub> Output capacitance	V <sub>DD</sub> = 5 V, V <sub>C</sub> = V <sub>SS</sub> = -5 V							8		pF
C <sub>ios</sub> Feedthrough	V <sub>DD</sub> = 5 V, V <sub>C</sub> = V <sub>SS</sub> = -5 V							0.5		pF



**electrical characteristics (continued)**

CHARACTERISTIC	TEST CONDITIONS	V <sub>DD</sub> (V)	LIMITS AT INDICATED TEMPERATURES						UNIT
			-55°C	-40°C	85°C	125°C	25°C		
							TYP	MAX	
<b>Control (V<sub>C</sub>)</b>									
V <sub>I(LC)</sub> Control input, low voltage (max)	I <sub>IS</sub>   < 10 μA, V <sub>IS</sub> = V <sub>SS</sub> , V <sub>OS</sub> = V <sub>DD</sub> , and V <sub>IS</sub> = V <sub>DD</sub> , V <sub>OS</sub> = V <sub>SS</sub>	5	1	1	1	1	1	V	
		10	2	2	2	2	2		
		15	2	2	2	2	2		
V <sub>I(HC)</sub> Control input, high voltage	See Figure 6	5	3.5 (MIN)						V
		10	7 (MIN)						
		15	11 (MIN)						
I <sub>IN</sub> Input current (max)	V <sub>IS</sub> ≤ V <sub>DD</sub> , V <sub>DD</sub> - V <sub>SS</sub> = 18 V, V <sub>CC</sub> ≤ V <sub>DD</sub> - V <sub>SS</sub>	18	±0.1	±0.1	±1	±1	±10 <sup>-5</sup>	±0.1	μA
Crosstalk (control input to signal output)	V <sub>C</sub> = 10 V (square wave), t <sub>r</sub> , t <sub>f</sub> = 20 ns, R <sub>L</sub> = 10 kΩ	10					50		mV
Turn-on and turn-off propagation delay	V <sub>IN</sub> = V <sub>DD</sub> , t <sub>r</sub> , t <sub>f</sub> = 20 ns, C <sub>L</sub> = 50 pF, R <sub>L</sub> = 1 kΩ	5					35	70	ns
		10					20	40	
		15					15	30	
Maximum control input repetition rate	V <sub>IS</sub> = V <sub>DD</sub> , V <sub>SS</sub> = GND, R <sub>L</sub> = 1 kΩ to GND, C <sub>L</sub> = 50 pF, V <sub>C</sub> = 10 V (square wave centered on 5 V), t <sub>r</sub> , t <sub>f</sub> = 20 ns, V <sub>OS</sub> = 1/2 V <sub>OS</sub> at 1 kHz	5					6		MHz
		10					9		
		15					9.5		
C <sub>I</sub> Input capacitance							5	7.5	pF

**switching characteristics**

V <sub>DD</sub> (V)	SWITCH INPUT						SWITCH OUTPUT, V <sub>OS</sub> (V)	
	V <sub>IS</sub> (V)	I <sub>IS</sub> (mA)					MIN	MAX
		-55°C	-40°C	25°C	85°C	125°C		
5	0	0.64	0.61	0.51	0.42	0.36	0.4	
5	5	-0.64	-0.61	-0.51	-0.42	-0.36	4.6	
10	0	1.6	1.5	1.3	1.1	0.9	0.5	
10	10	-1.6	-1.5	-1.3	-1.1	-0.9	9.5	
15	0	4.2	4	3.4	2.8	2.4	1.5	
15	15	-4.2	-4	-3.4	-2.8	-2.4	13.5	

# CD4066B CMOS QUAD BILATERAL SWITCH

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## TYPICAL CHARACTERISTICS

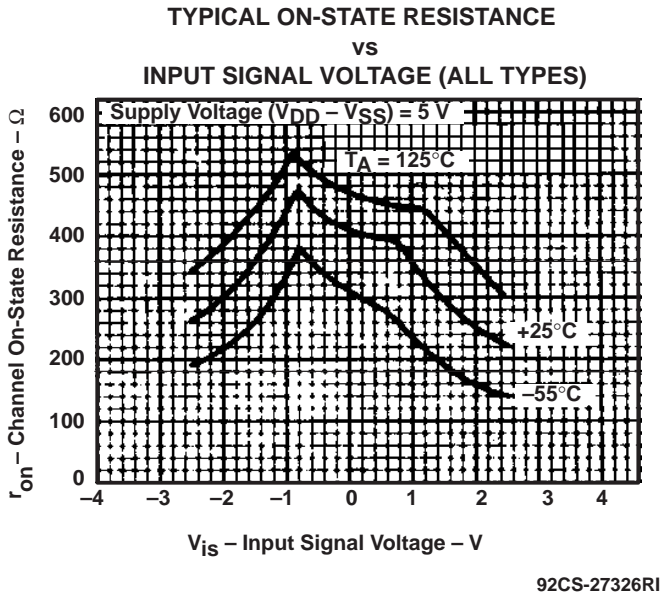


Figure 2

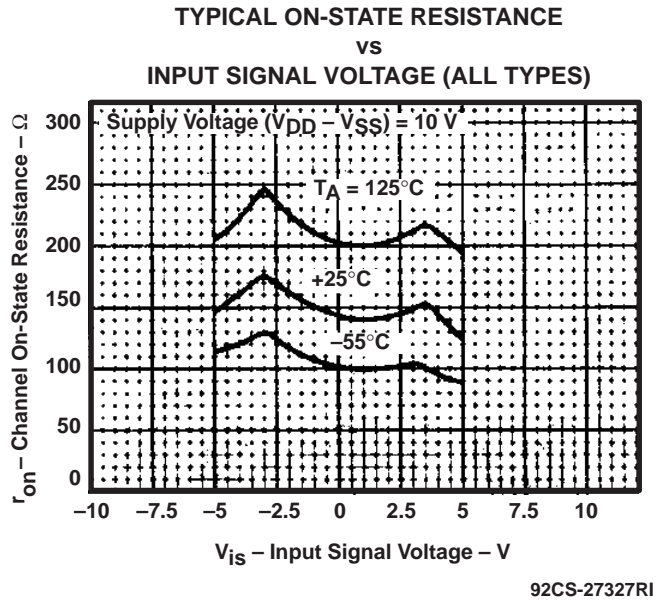


Figure 3

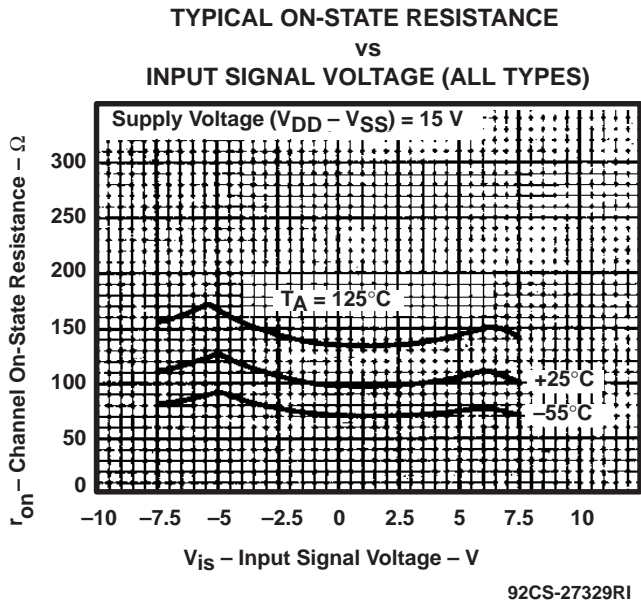


Figure 4

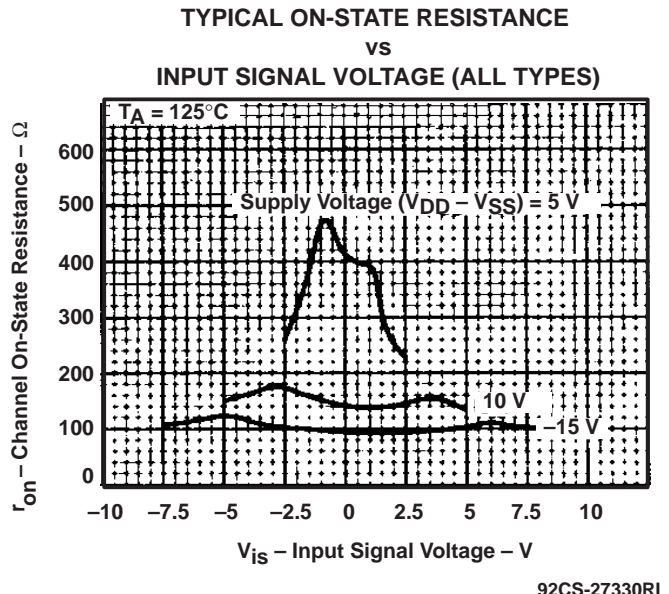
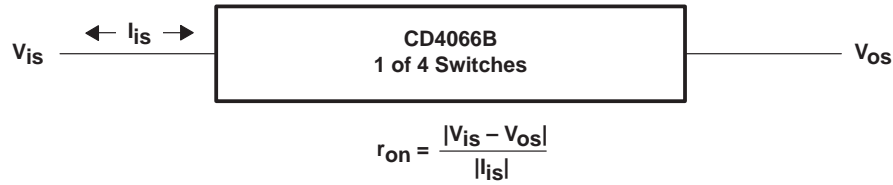


Figure 5

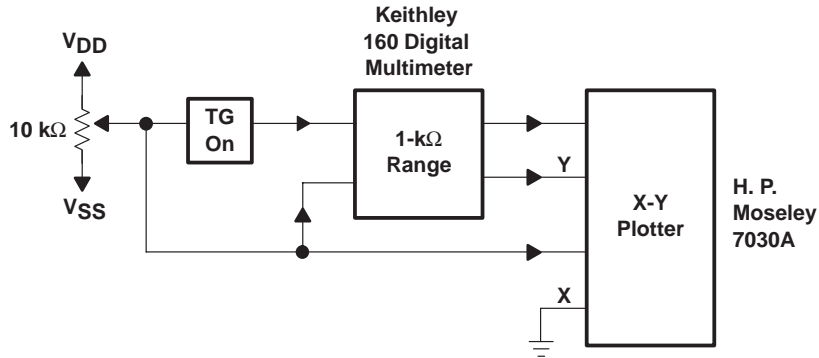


TYPICAL CHARACTERISTICS



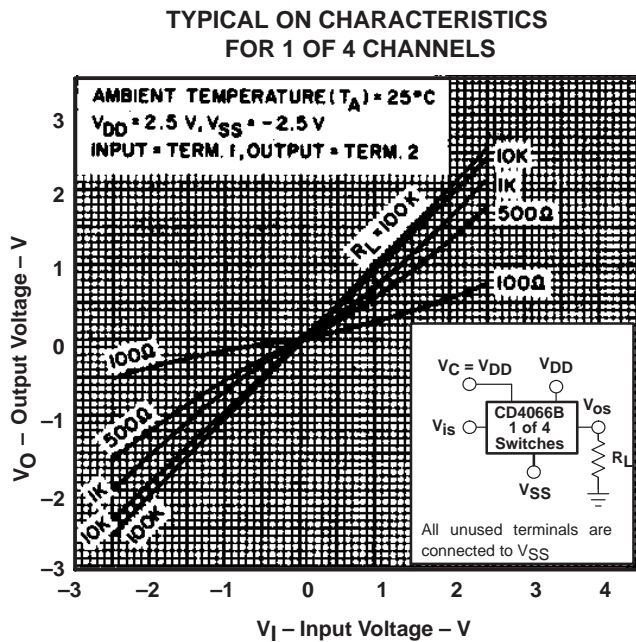
92CS-30966

Figure 6. Determination of  $r_{on}$  as a Test Condition for Control-Input High-Voltage ( $V_{IHC}$ ) Specification

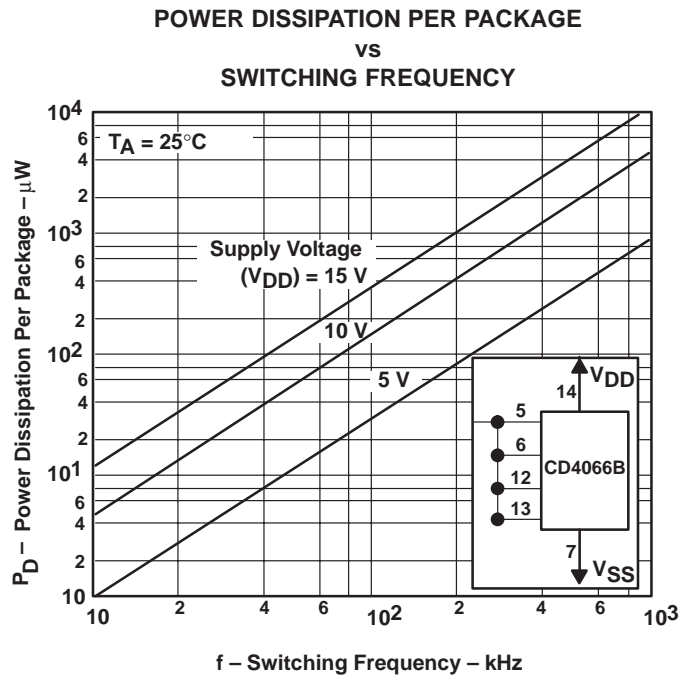


92CS-22716

Figure 7. Channel On-State Resistance Measurement Circuit



92CS-30919

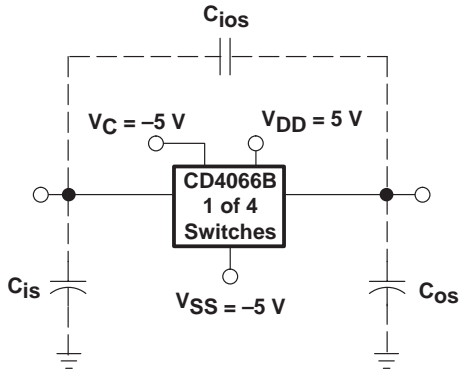


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# CD4066B CMOS QUAD BILATERAL SWITCH

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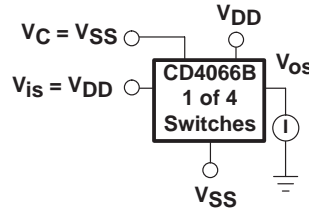
## TYPICAL CHARACTERISTICS



92CS-30921

Measured on Boonton capacitance bridge, model 75a (1 MHz); test-fixture capacitance nulled out.

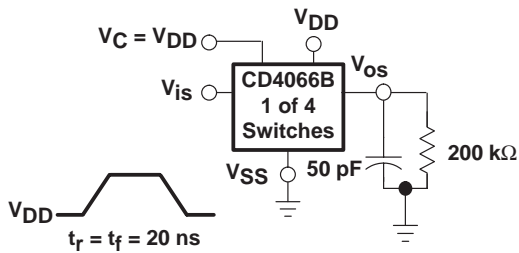
**Figure 10. Typical On Characteristics for One of Four Channels**



92CS-30922

All unused terminals are connected to V<sub>SS</sub>.

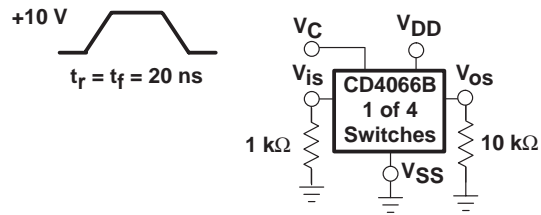
**Figure 11. Off-Switch Input or Output Leakage**



92CS-30923

All unused terminals are connected to V<sub>SS</sub>.

**Figure 12. Propagation Delay Time Signal Input (V<sub>iss</sub>) to Signal Output (V<sub>oss</sub>)**



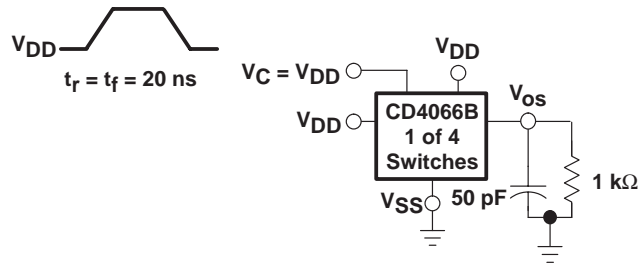
92CS-30924

All unused terminals are connected to V<sub>SS</sub>.

**Figure 13. Crosstalk-Control Input to Signal Output**



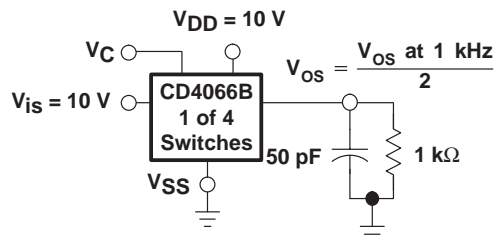
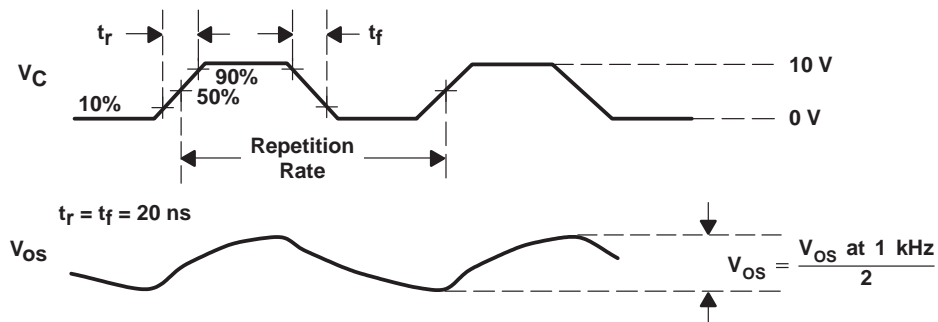
TYPICAL CHARACTERISTICS



- NOTES: A. All unused terminals are connected to  $V_{SS}$ .  
B. Delay is measured at  $V_{os}$  level of +10% from ground (turn-on) or on-state output level (turn-off).

92CS-30925

Figure 14. Propagation Delay,  $t_{PLH}$ ,  $t_{PHL}$  Control-Signal Output



All unused terminals are connected to  $V_{SS}$ .

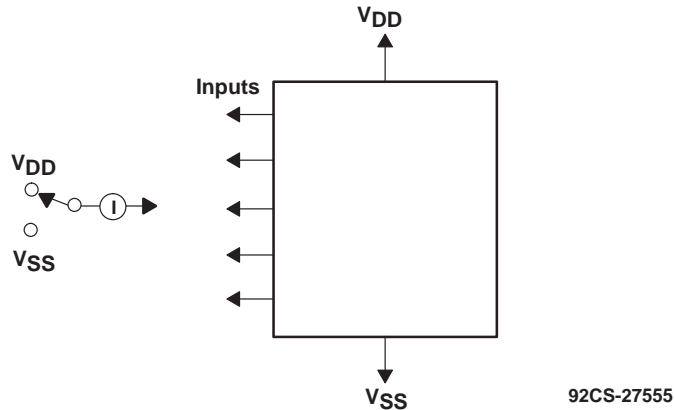
92CS-30925

Figure 15. Maximum Allowable Control-Input Repetition Rate

# CD4066B CMOS QUAD BILATERAL SWITCH

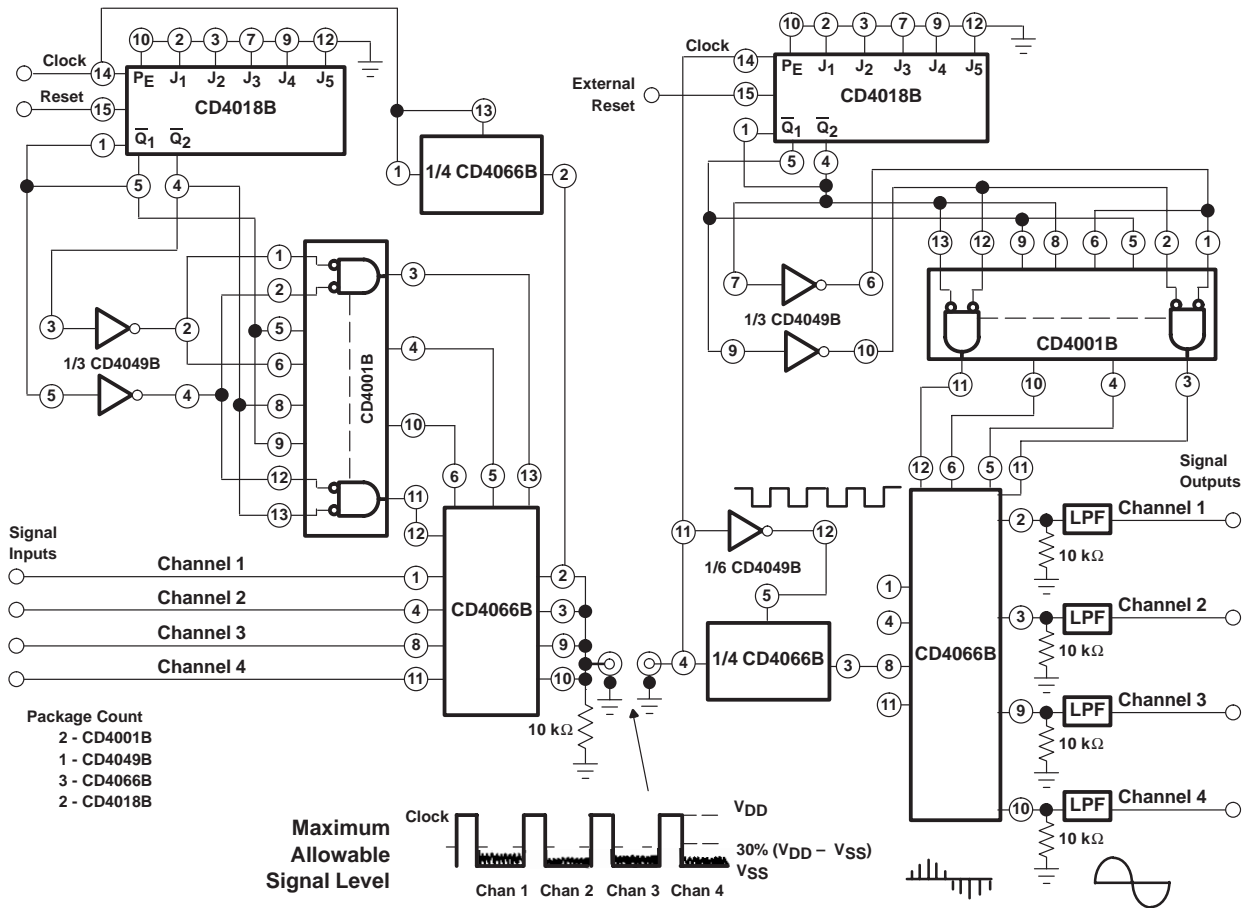
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## TYPICAL CHARACTERISTICS



Measure inputs sequentially to both  $V_{DD}$  and  $V_{SS}$ . Connect all unused inputs to either  $V_{DD}$  or  $V_{SS}$ . Measure control inputs only.

Figure 16. Input Leakage-Current Test Circuit



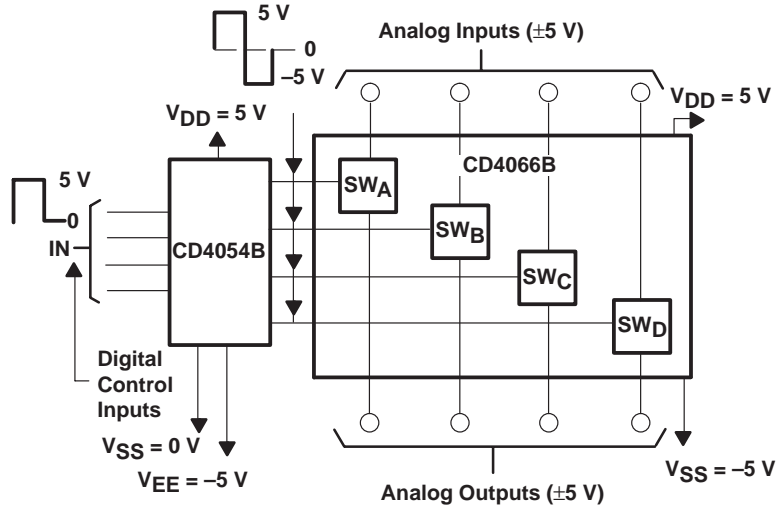
92CM-30928

Figure 17. Four-Channel PAM Multiplex System Diagram



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TYPICAL CHARACTERISTICS



92CS-30927

Figure 18. Bidirectional Signal Transmission Via Digital Control Logic

# CD4066B

## CMOS QUAD BILATERAL SWITCH

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### APPLICATION INFORMATION

In applications that employ separate power sources to drive  $V_{DD}$  and the signal inputs, the  $V_{DD}$  current capability should exceed  $V_{DD}/R_L$  ( $R_L$  = effective external load of the four CD4066B bilateral switches). This provision avoids any permanent current flow or clamp action on the  $V_{DD}$  supply when power is applied or removed from the CD4066B.

In certain applications, the external load-resistor current can include both  $V_{DD}$  and signal-line components. To avoid drawing  $V_{DD}$  current when switch current flows into terminals 1, 4, 8, or 11, the voltage drop across the bidirectional switch must not exceed 0.8 V (calculated from  $r_{on}$  values shown).

No  $V_{DD}$  current will flow through  $R_L$  if the switch current flows into terminals 2, 3, 9, or 10.



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PACKAGING INFORMATION

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
CD4066BE	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
CD4066BEE4	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
CD4066BF	ACTIVE	CDIP	J	14	1	TBD	Call TI	Level-NC-NC-NC
CD4066BF3A	ACTIVE	CDIP	J	14	1	TBD	Call TI	Level-NC-NC-NC
CD4066BM	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
CD4066BM96	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
CD4066BM96E4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
CD4066BME4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
CD4066BMT	ACTIVE	SOIC	D	14	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
CD4066BMTE4	ACTIVE	SOIC	D	14	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
CD4066BNSR	ACTIVE	SO	NS	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
CD4066BNSRE4	ACTIVE	SO	NS	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
CD4066BPW	ACTIVE	TSSOP	PW	14	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
CD4066BPWG4	ACTIVE	TSSOP	PW	14	90	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
CD4066BPWR	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
CD4066BPWRG4	ACTIVE	TSSOP	PW	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
JM38510/05852BCA	ACTIVE	CDIP	J	14	1	TBD	Call TI	Level-NC-NC-NC

<sup>(1)</sup> The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

<sup>(2)</sup> Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS) or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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J (R-GDIP-T\*\*)

14 LEADS SHOWN

CERAMIC DUAL IN-LINE PACKAGE



DIM \ PINS **	14	16	18	20
A	0.300 (7,62) BSC	0.300 (7,62) BSC	0.300 (7,62) BSC	0.300 (7,62) BSC
B MAX	0.785 (19,94)	.840 (21,34)	0.960 (24,38)	1.060 (26,92)
B MIN	—	—	—	—
C MAX	0.300 (7,62)	0.300 (7,62)	0.310 (7,87)	0.300 (7,62)
C MIN	0.245 (6,22)	0.245 (6,22)	0.220 (5,59)	0.245 (6,22)



4040083/F 03/03

- NOTES:
- All linear dimensions are in inches (millimeters).
  - This drawing is subject to change without notice.
  - This package is hermetically sealed with a ceramic lid using glass frit.
  - Index point is provided on cap for terminal identification only on press ceramic glass frit seal only.
  - Falls within MIL STD 1835 GDIP1-T14, GDIP1-T16, GDIP1-T18 and GDIP1-T20.

N (R-PDIP-T\*\*)

PLASTIC DUAL-IN-LINE PACKAGE

16 PINS SHOWN



- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - $\triangle C$  Falls within JEDEC MS-001, except 18 and 20 pin minimum body length (Dim A).
  - $\triangle D$  The 20 pin end lead shoulder width is a vendor option, either half or full width.



D (R-PDSO-G14)

PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
  - B. This drawing is subject to change without notice.
  - C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
  - D. Falls within JEDEC MS-012 variation AB.

# MECHANICAL DATA

NS (R-PDSO-G\*\*)

PLASTIC SMALL-OUTLINE PACKAGE

14-PINS SHOWN



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15.

PW (R-PDSO-G\*\*)

PLASTIC SMALL-OUTLINE PACKAGE

14 PINS SHOWN



4040064/F 01/97

- NOTES: A. All linear dimensions are in millimeters.  
 B. This drawing is subject to change without notice.  
 C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.  
 D. Falls within JEDEC MO-153

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