Improved Quad SPST CMOS Analog Switches

DESCRIPTION

The DG441B, DG442B are monolithic quad analog switches designed to provide high speed, low error switching of analog and audio signals. The DG441B, DG442B are upgrades to the original DG441, DG442.

Combing low on-resistance (45 Ω, typ.) with high speed (t_{ON} 120 ns, typ.), the DG441B, DG442B are ideally suited for Data Acquisition, Communication Systems, Automatic Test Equipment, or Medical Instrumentation. Charge injection has been minimized on the drain for use in sample-and-hold circuits.

The DG441B, DG442B are built using Vishay Siliconix's high-voltage silicon-gate process. An epitaxial layer prevents latchup.

When on, each switch conducts equally well in both directions and blocks input voltages to the supply levels when off.

FEATURES

- Low On-Resistance: 45 Ω
- Low Power Consumption: 1 mW
- Fast Switching Action - t_{ON}: 120 ns
- Low Charge Injection - Q: - 1 pC
- TTL/CMOS-Compatible Logic
- Single Supply Capability
- Material categorization: For definitions of compliance please see www.vishay.com/doc?99912

BENEFITS

- Less Signal Errors and Distortion
- Reduced Power Supply Requirements
- Faster Throughput
- Reduced Pedestal Errors
- Simple Interfacing

APPLICATIONS

- Audio Switching
- Data Acquisition
- Sample-and-Hold Circuits
- Communication Systems
- Automatic Test Equipment
- Medical Instruments

RoHS COMPLIANT

HALOGEN FREE

FUNCTIONAL BLOCK DIAGRAM AND PIN CONFIGURATION

DG441B
Dual-In-Line and SOIC

Top View

DG441B
QFN16 (4 x 4 mm)

Top View
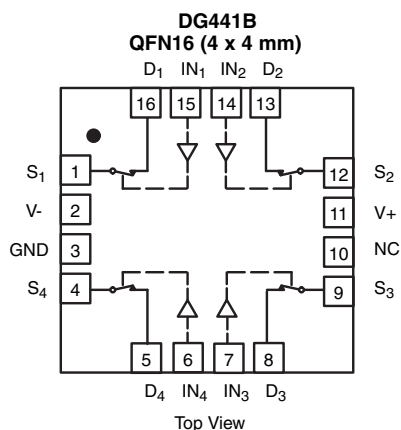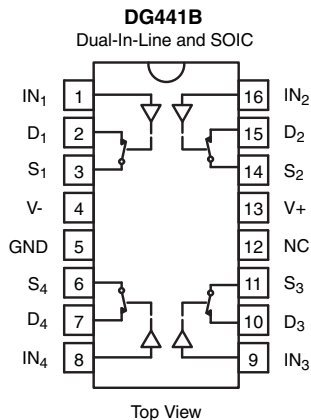
TRUTH TABLE

Logic	DG441B	DG442B
0	ON	OFF
1	OFF	ON

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

ORDERING INFORMATION

Temp Range	Package	Part Number
- 40 °C to 85 °C	16-pin Plastic DIP	DG441BDJ
		DG441BDJ-E3
		DG442BDJ
		DG442BDJ-E3
	16-pin Narrow SOIC	DG441BDY-E3
		DG441BDY-T1-E3
		DG442BDY-E3
		DG442BDY-T1-E3
	16 pin QFN 4 x 4 mm (Variation 1)	DG441BDN-T1-E4
		DG442BDN-T1-E4

ABSOLUTE MAXIMUM RATINGS (T_A = 25 °C, unless otherwise noted)

Parameter		Symbol	Limit	Unit
V+ to V-			44	V
GND to V-			25	
Digital Inputs[a], V_S, V_D			(V-) - 2 to (V+) + 2 or 30 mA, whichever occurs first	
Continuous Current (Any Terminal)			30	mA
Current, S or D (Pulsed at 1 ms, 10 % duty cycle)			100	
Storage Temperature			- 65 to 125	°C
Power Dissipation (Package)[b]	16-pin Plastic DIP[c]		470	mW
	16-pin Narrow Body SOIC[d]		900	
	QFN-16[d]		850	

Notes:
a. Signals on S_X, D_X, or IN_X 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 12 mW/°C above 75 °C.

For technical questions, contact: pmostechsupport@vishay.com

Document Number: 72625
S13-1284-Rev. C, 27-May-13

SPECIFICATIONS[a] (for dual supplies)

Parameter	Symbol	Test Conditions Unless Otherwise Specified V+ = 15 V, V- = - 15 V V_L = 5 V, V_{IN} = 2.4 V, 0.8 V[e]	Temp.[b]	Min.[d]	Typ.[c]	Max.[d]	Unit
Analog Switch							
Analog Signal Range[e]	V_{ANALOG}		Full	- 15		15	V
Drain-Source On-Resistance	$R_{DS(on)}$	I_S = 1 mA, V_D = ± 10 V	Room Full		45	80 95	Ω
On-Resistance Match Between Channels[e]	$\Delta R_{DS(on)}$	I_S = 1 mA, V_D = ± 10 V	Room Full		2	4 5	
Switch Off Leakage Current	$I_{S(off)}$	V_D = ± 14 V, V_S = ± 14 V	Room Full	- 0.5 - 5	± 0.01	0.5 5	nA
	$I_{D(off)}$		Room Full	- 0.5 - 5	± 0.01	0.5 5	
Channel On Leakage Current	$I_{D(on)}$	$V_S = V_D$ = ± 14 V	Room Full	- 0.5 - 10	± 0.02	0.5 10	
Digital Control							
Input Voltage Low	V_{INL}		Full			0.8	V
Input Voltage High	V_{INH}		Full	2.4			
Input Current V_{IN} Low	I_{INL}	V_{IN} under test = 0.8 V All Other = 2.4 V	Full	- 1	- 0.01	1	µA
Input Current V_{IN} High	I_{INH}	V_{IN} under test = 2.4 V All Other = 0.8 V	Full	- 1	0.01	1	
Dynamic Characteristics							
Turn-On Time	t_{ON}	R_L = 1 kΩ, C_L = 35 pF	Room		120	220	ns
Turn-Off Time	t_{OFF}	V_S = 10 V, See Figure 2	Room		65	120	
Charge Injection[e]	Q	C_L = 1 nF, V_S = 0 V V_{gen} = 0 V, R_{gen} = 0 Ω	Room		- 1		pC
Off Isolation[e]	OIRR	R_L = 50 Ω , C_L = 15 pF	Room		- 90		dB
Crosstalk (Channel-to-Channel)	X_{TALK}	V_S = 1 V_{RMS}, f = 100 kHz	Room		- 95		
SourceOff Capacitance[e]	$C_{S(off)}$	f = 1 MHz	Room		4		pF
Drain Off Capacitance[e]	$C_{D(off)}$		Room		4		
Channel On Capacitance[e]	$C_{D(on)}$	$V_S = V_D$ = 0 V, f = 1 MHz	Room		16		
Power Supplies							
Positive Supply Current	I+	V+ = 16.5 V, V- = - 16.5 V V_{IN} = 0 or 5 V	Room Full			1 5	µA
Negative Supply Current	I-		Room Full	- 1 - 5			

SPECIFICATIONS (for single supply)

Parameter	Symbol	Test Conditions Unless Otherwise Specified V+ = 12 V, V- = 0 V V_{IN} = 2.4 V, 0.8 V[e]	Temp.[b]	Limits - 40 °C to 85 °C			Unit
				Min.[d]	Typ.[c]	Max.[d]	
Analog Switch							
Analog Signal Range[e]	V_{ANALOG}		Full	0		12	V
Drain-Source On-Resistance	$R_{DS(on)}$	I_S = 1 mA, V_D = 3 V, 8 V	Room Full		90	160 200	Ω
Dynamic Characteristics							
Turn-On Time	t_{ON}	R_L = 1 kΩ, C_L = 35 pF, V_S = 8 V	Room		120	300	ns
Turn-Off Time	t_{OFF}	See Figure 2	Room		60	200	
Charge Injection	Q	C_L = 1 nF, V_{gen} = 6 V, R_{gen} = 0 Ω	Room		4		pC
Power Supplies							
Positive Supply Current	I+	V_{IN} = 0 V or 5 V	Room Full			1 5	μA
Negative Supply Current	I-		Room Full	- 1 - 5			

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_{IN} = input voltage to perform proper function.

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.
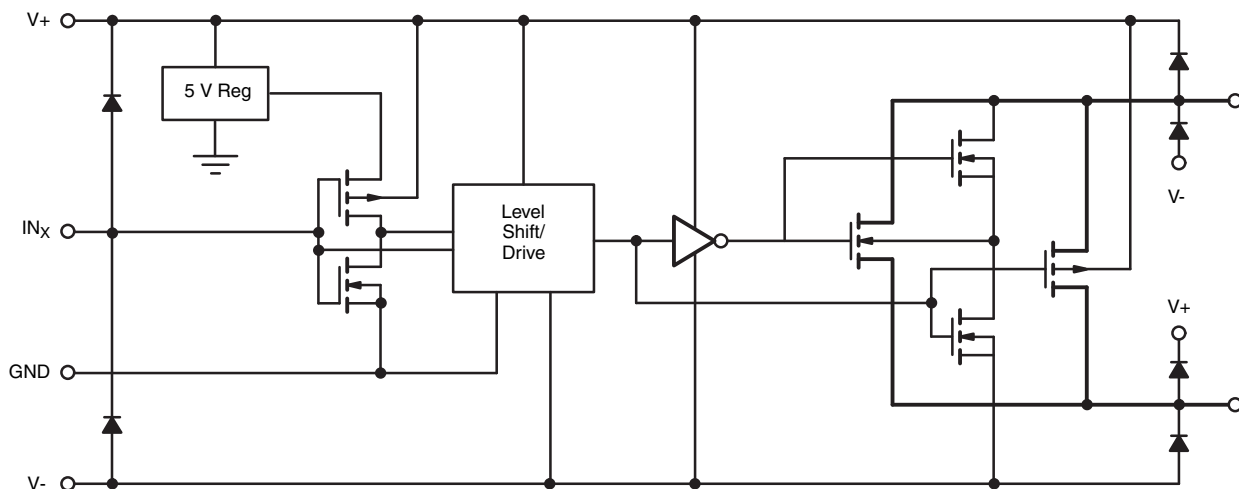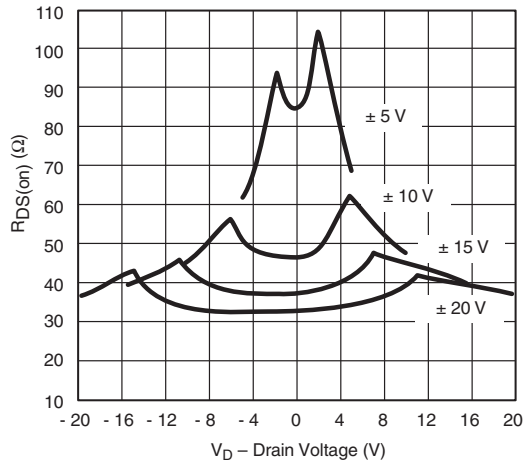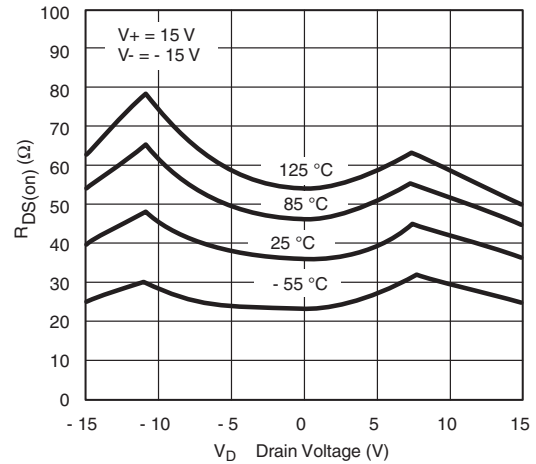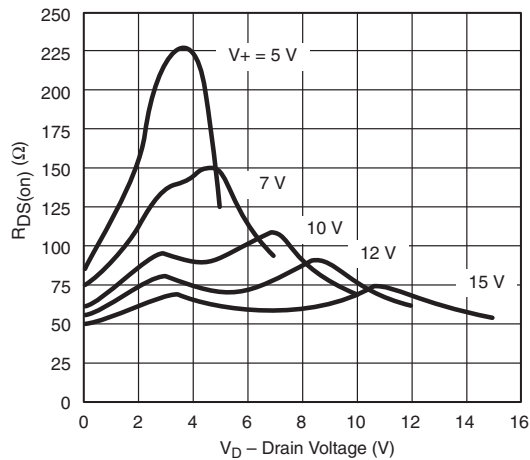
SCHEMATIC DIAGRAM (typical channel)

Figure 1.

TYPICAL CHARACTERISTICS (T_A = 25 °C, unless otherwise noted)
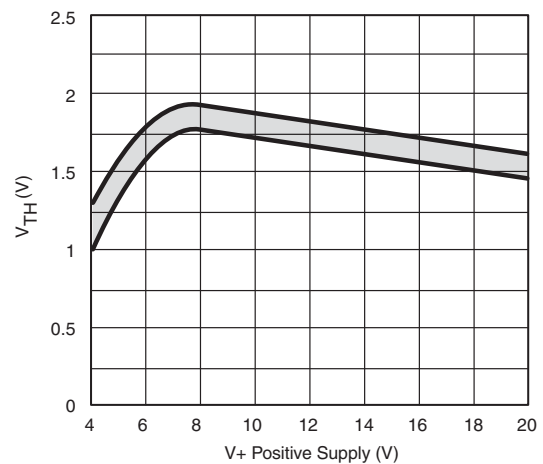

$R_{DS(on)}$ vs. V_D and Power Supply Voltages

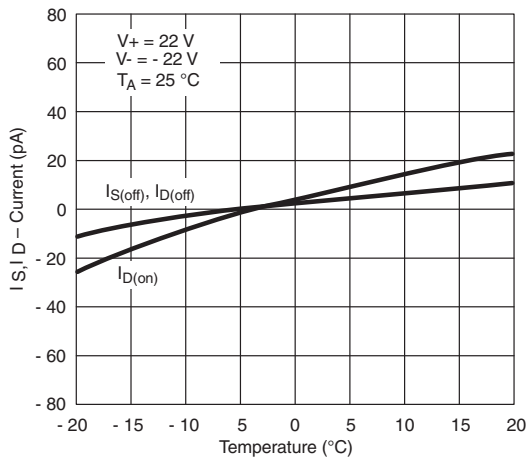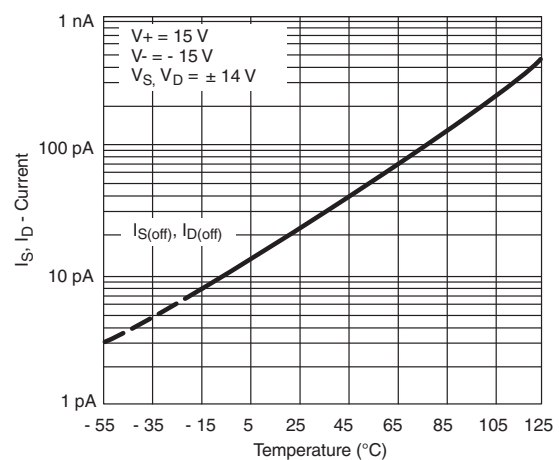**$R_{DS(on)}$ vs. V_D and Temperature**

$R_{DS(on)}$ vs. V_D and Single Power Supply Voltages
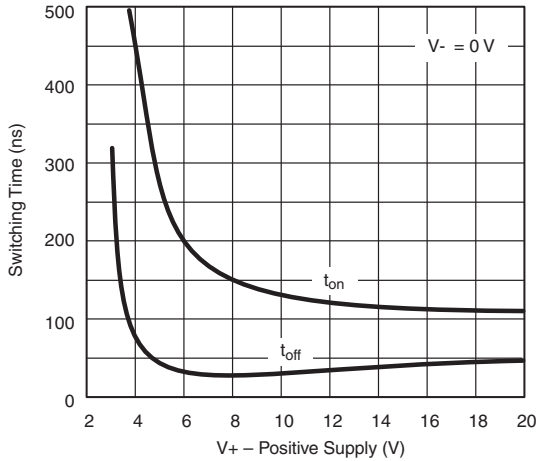

Input Switching Threshold vs. Supply Voltage
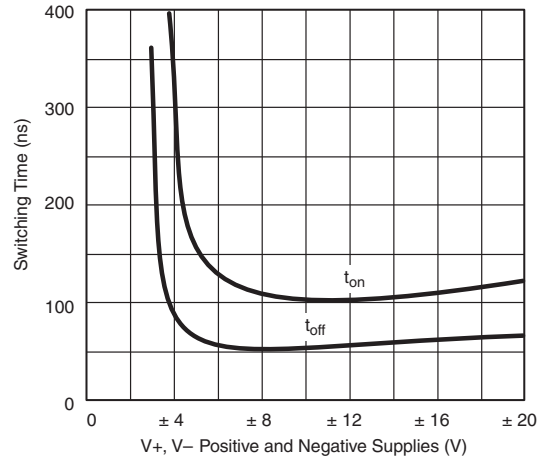

Leakage Currents vs. Analog Voltage
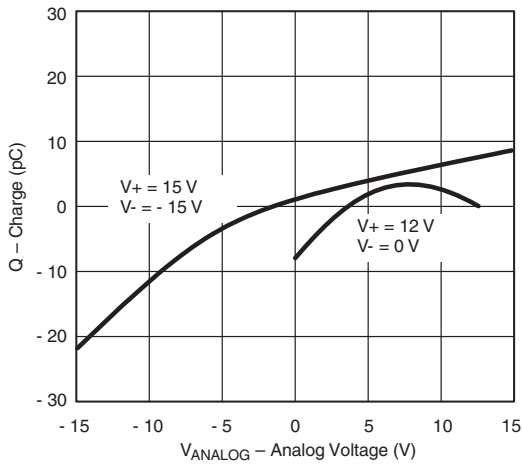

Leakage Currents vs. Temperature

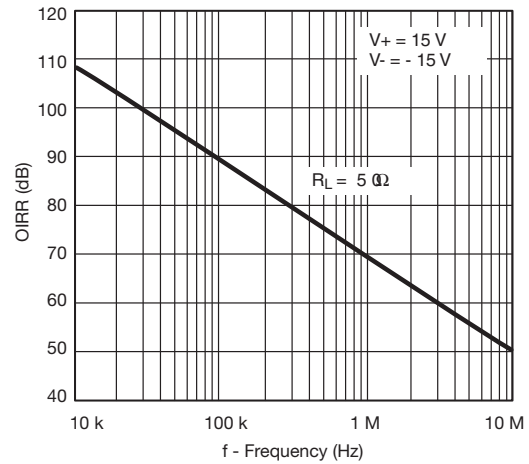## TYPICAL CHARACTERISTICS (T_A = 25 °C, unless otherwise noted)
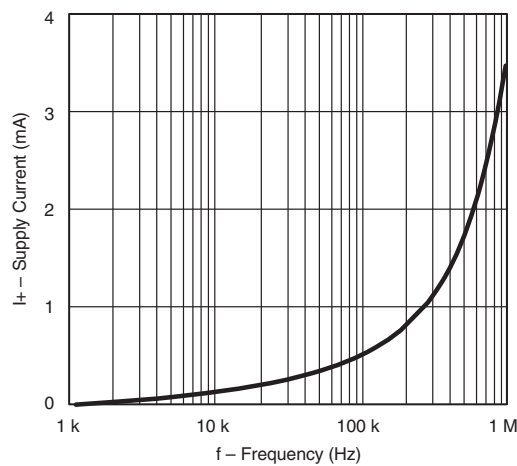
Switching Time vs. Single Supply Voltage

Switching Times vs. Power Supply Voltage

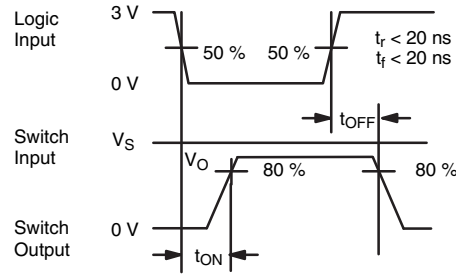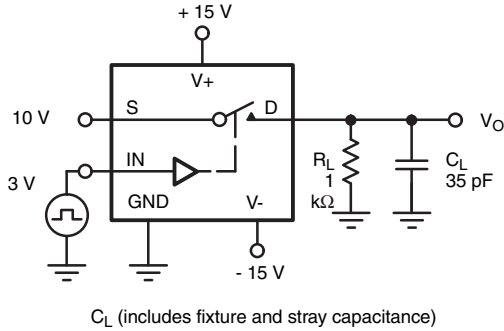**Q_S, Q_D - Charge Injection vs. Analog Voltage**

Off Isolation vs. Frequency

Supply Current vs. Switching Frequency

TEST CIRCUITS

C_L (includes fixture and stray capacitance)

Figure 2. Switching Time

Note: Logic input waveform is inverted for DG442.
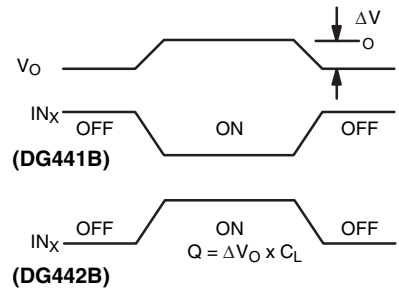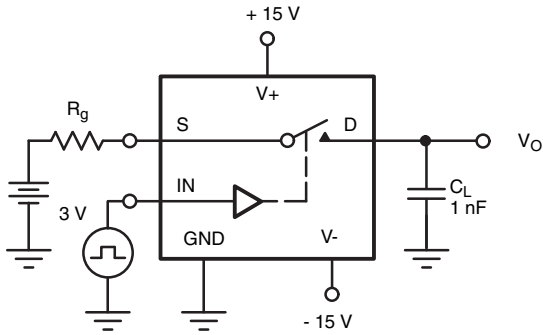
Figure 3. Charge Injection

$Q = \Delta V_O \times C_L$

C = 1 mF tantalum in parallel with 0.01 mF ceramic

X_{TALK} Isolation = $20 \log \left| \dfrac{V_S}{V_O} \right|$
C = RF bypass
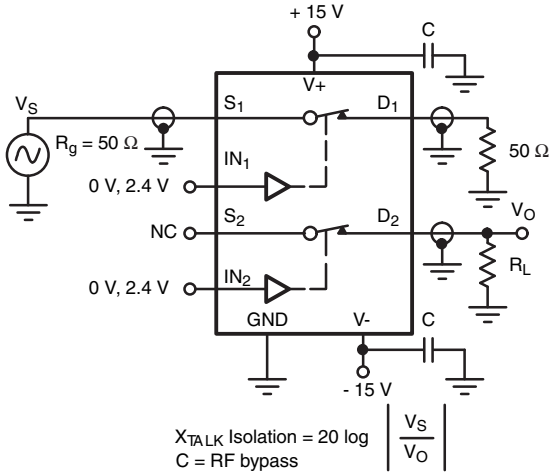
Figure 4. Crosstalk

Off Isolation = $20 \log \left| \dfrac{V_S}{V_O} \right|$
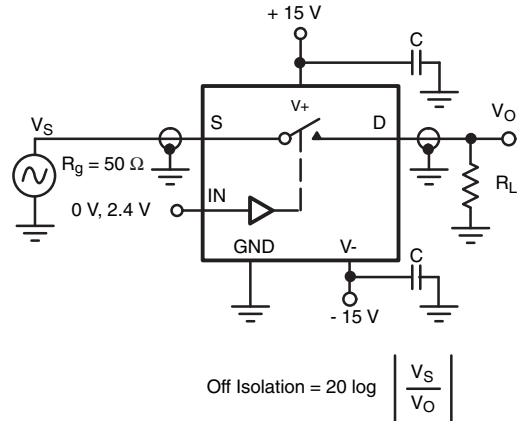
Figure 5. Off Isolation
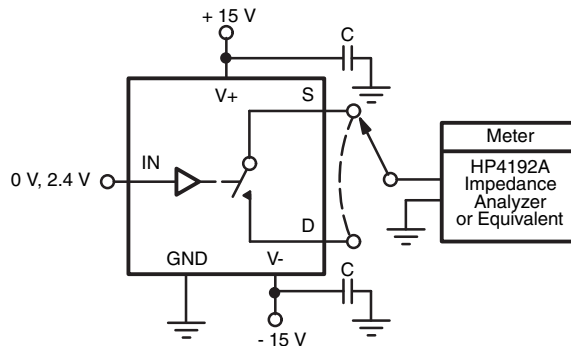
Figure 6. Source/Drain Capacitances

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APPLICATIONS
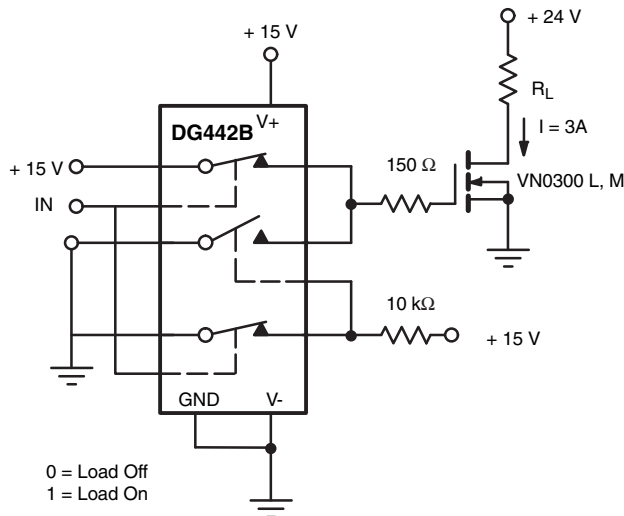
Figure 7. Power MOSFET Driver
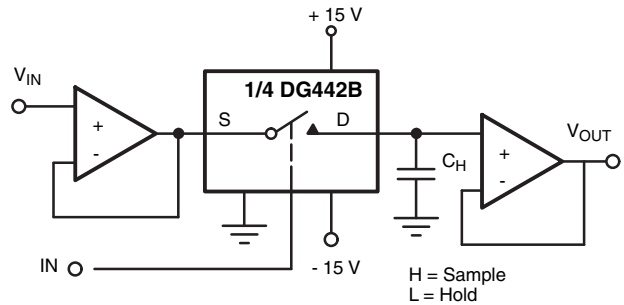
H = Sample
L = Hold

Figure 8. Open Loop Sample-and-Hold
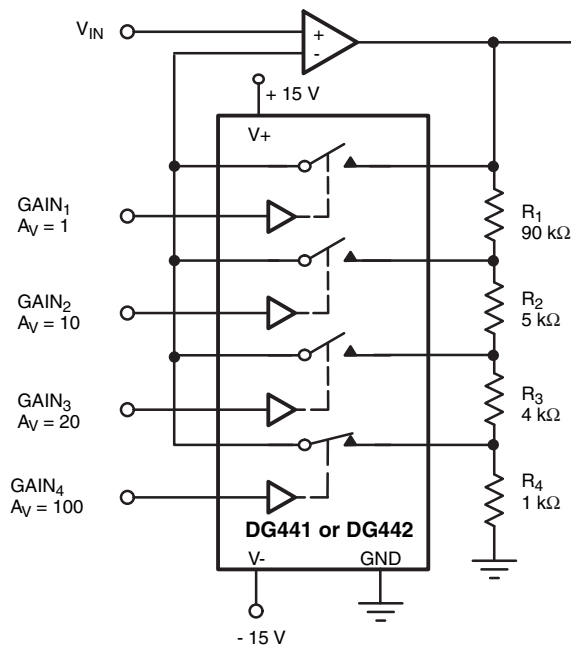
Gain error is determined only by the resistor tolerance. Op amp offset and CMRR will limit accuracy of circuit.

With SW$_4$ Closed

$$\frac{V_{OUT}}{V_{IN}} = \frac{R_1 + R_2 + R_3 + R_4}{R_4} = 100$$

Figure 9. Precision-Weighted Resistor Programmable-Gain Amplifier

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S13-1284-Rev. C, 27-May-13

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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$_1$	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

All Leads	
0.101 mm	
0.004 IN	

PDIP: 16-LEAD

Dim	MILLIMETERS		INCHES	
	Min	Max	Min	Max
A	3.81	5.08	0.150	0.200
A_1	0.38	1.27	0.015	0.050
B	0.38	0.51	0.015	0.020
B_1	0.89	1.65	0.035	0.065
C	0.20	0.30	0.008	0.012
D	18.93	21.33	0.745	0.840
E	7.62	8.26	0.300	0.325
E_1	5.59	7.11	0.220	0.280
e_1	2.29	2.79	0.090	0.110
e_A	7.37	7.87	0.290	0.310
L	2.79	3.81	0.110	0.150
Q_1	1.27	2.03	0.050	0.080
S	0.38	1.52	.015	0.060

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

QFN 4x4-16L Case Outline

TOP VIEW

BOTTOM VIEW

SIDE VIEW

DIM	VARIATION 1						VARIATION 2					
	MILLIMETERS[1]			INCHES			MILLIMETERS[1]			INCHES		
	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.	MIN.	NOM.	MAX.
A	0.75	0.85	0.95	0.029	0.033	0.037	0.75	0.85	0.95	0.029	0.033	0.037
A1	0	-	0.05	0	-	0.002	0	-	0.05	0	-	0.002
A3	0.20 ref.			0.008 ref.			0.20 ref.			0.008 ref.		
b	0.25	0.30	0.35	0.010	0.012	0.014	0.25	0.30	0.35	0.010	0.012	0.014
D	4.00 BSC			0.157 BSC			4.00 BSC			0.157 BSC		
D2	2.0	2.1	2.2	0.079	0.083	0.087	2.5	2.6	2.7	0.098	0.102	0.106
e	0.65 BSC			0.026 BSC			0.65 BSC			0.026 BSC		
E	4.00 BSC			0.157 BSC			4.00 BSC			0.157 BSC		
E2	2.0	2.1	2.2	0.079	0.083	0.087	2.5	2.6	2.7	0.098	0.102	0.106
K	0.20 min.			0.008 min.			0.20 min.			0.008 min.		
L	0.5	0.6	0.7	0.020	0.024	0.028	0.3	0.4	0.5	0.012	0.016	0.020
N[3]	16			16			16			16		
Nd[3]	4			4			4			4		
Ne[3]	4			4			4			4		

Notes

[1] Use millimeters as the primary measurement.

[2] Dimensioning and tolerances conform to ASME Y14.5M. - 1994.

[3] N is the number of terminals. Nd and Ne is the number of terminals in each D and E site respectively.

[4] Dimensions b applies to plated terminal and is measured between 0.15 mm and 0.30 mm from terminal tip.

[5] The pin 1 identifier must be existed on the top surface of the package by using identification mark or other feature of package body.

[6] Package warpage max. 0.05 mm.

ECN: S13-0893-Rev. B, 22-Apr-13
DWG: 5890

For technical questions, contact: powerictechsupport@vishay.com

RECOMMENDED MINIMUM PADS FOR SO-16

Recommended Minimum Pads
Dimensions in Inches/(mm)

Return to Index

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PI5A4157ZUEX PI5A3166TAEX FSA634UCX TC4066BP(N,F) DG302BDJ-E3 PI5A100QEX HV2605FG-G HV2301FG-G

RS2117YUTQK10 RS2118YUTQK10 RS2227XUTQK10 ADG452BRZ-REEL7 MAX4066ESD+ MAX391CPE+ MAX4730EXT+T

MAX314CPE+ BU4066BCFV-E2 MAX313CPE+ BU4S66G2-TR NLAS3158MNR2G NLASB3157MTR2G TS3A4751PWR

NLAS4157DFT2G NLAS4599DFT2G NLASB3157DFT2G NLAST4599DFT2G NLAST4599DTT1G DG300BDJ-E3 DG2503DB-T2-GE1

DG2502DB-T2-GE1 TC4W53FU(TE12L,F) 74HC2G66DC.125 ADG619BRMZ-REEL ADG1611BRUZ-REEL7 LTC201ACN#PBF