

#### **General Description**

Maxim's redesigned DG441/DG442 analog switches now feature on-resistance matching (4 $\Omega$  max) between switches and guaranteed on-resistance flatness over the signal range (9 $\Omega$  max). These low on-resistance switches conduct equally well in either direction. They guarantee low charge injection (10pC max), low power consumption (1.65mW), and an ESD tolerance of 2000V minimum per Method 3015.7. The new design offers lower off-leakage current over temperature (less than 5nA at +85°C).

The DG441/DG442 are quad, single-pole/single-throw (SPST) analog switches. The DG441 has four normally closed switches, and the DG442 has four normally open switches. Switching times are less than 250ns for  $t_{ON}$  and less than 70ns for  $t_{OFF}$ . These devices operate from a single +10V to +30V supply, or bipolar  $\pm 4.5$ V to  $\pm 20$ V supplies. Maxim's improved DG441/DG442 continue to be fabricated with a 44V silicon-gate process.

#### \_Applications

Sample-and-Hold Circuits Communication Systems Test Equipment Battery-Operated Systems Heads-Up Displays Fax Machines PBX, PABX
Guidance and Control
Systems
Audio-Signal Routing
Military Radios
Modems

#### **New Features**

- ♦ Plug-In Upgrades for Industry-Standard DG441/DG442
- ♦ Improved rDS(ON) Match Between Channels(4Ωmax)
- ♦ Guaranteed rFLAT(ON) Over Signal Range (9Ωmax)
- ♦ Improved Charge Injection (10pC max)
- ♦ Improved Off-Leakage Current Over Temperature (<5nA at +85°C)</p>
- Withstand Electrostatic Discharge (2000V min) per Method 3015.7

#### **Existing Features**

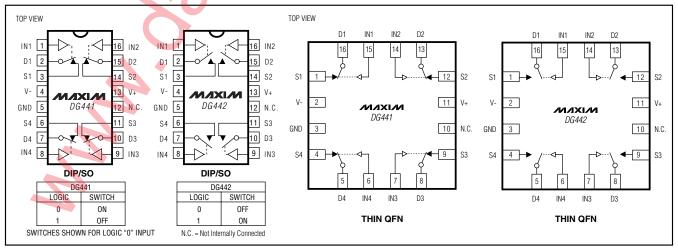
- ♦ Low rds(ON) (85Ω max)
- ♦ Single-Supply Operation +10V to +30V Bipolar-Supply Operation ±4.5V to ±20V
- Low Power Consumption (1.65mW max)
- Rail-to-Rail Signal Handling
- **♦ TTL/CMOS-Logic Compatible**

#### **Ordering Information**

PART	TEMP. RANGE	PIN-PACKAGE
DG441CJ	0°C to +70°C	16 Plastic DIP
DG441CY	0°C to +70°C	16 Narrow SO
DG441C/D	0°C to +70°C	Dice*
DG441DJ	-40°C to +85°C	16 Plastic DIP
DG441DY	-40°C to +85°C	16 Narrow SO
DG441DK	-40°C to +85°C	16 CERDIP
DG441ETE	-40°C to +85°C	16 Thin QFN (5mm x 5mm)

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

### Pin Configurations/Functional Diagrams/Truth Tables



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<sup>\*</sup>Contact factory for dice specifications.

<sup>\*\*</sup>Contact factory for availability and processing to MIL-STD-883B.

#### **ABSOLUTE MAXIMUM RATINGS**

Voltage Referenced to V-	Continuous Power Dissipation (T <sub>A</sub> = +70°C) Plastic DIP (derate 10.53mW/°C above +70°C)842mW Thin QFN (derate 33.3mW/°C above +70°C)2667mW
V <sub>L</sub> (GND - 0.3V) to (V+ + 0.3V)	Narrow SO (derate 8.70mW/°C above +70°C)696mW
Digital Inputs, $V_S$ , $V_D$ (Note 1)(V 2V) to (V+ + 2V) or 30mA	CERDIP (derate 10.00mW/°C above +70°C)800mW
(whichever occurs first)	Operating Temperature Ranges
Continuous Current (any terminal)30mA	DG441C/DG442C0°C to +70°C
Peak Current, S or D	DG441D, E/DG442D, E40°C to +85°C
(pulsed at 1ms, 10% duty-cycle max)100mA	DG441AK/DG442AK65°C to +150°C
	Storage Temperature Range65°C to +150°C
	Lead Temperature (soldering, 10s)+300°C

**Note 1:** Signals on S, D, or IN exceeding V+ or V- are clamped by internal diodes. Limit forward current to maximum current ratings. 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—Dual Supplies**

(V+ = 15V, V- = -15V, GND = 0V,  $V_{INH}$  = 2.4V,  $V_{INL}$  = 0.8V,  $T_A$  =  $T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS		MIN	TYP (Note 2)	MAX	UNITS		
SWITCH									
Analog-Signal Range	Vanalog	(Note 3)			-15		15	V	
Drain-Source On-Resistance		V+ = 13.5V, V- = -13.5V, Is = -10mA, VD = 8.5V or -8.5V	T <sub>A</sub> = +25°C			50	85	Ω	
Dialii-Source Off-Hesistance	rDS(ON)		TA = TMIN to TMAX				100		
On-Resistance Match	Arparoni	V+ = 15V, V- = -15V, VD = ±10V.	T <sub>A</sub> = +25°	C			4	•	
Between Channels (Note 4)	Δr <sub>DS</sub> (ON)	$I_{S} = \pm 10V,$ $I_{S} = -10mA$	TA = TMIN	to T <sub>MAX</sub>			5	Ω	
On-Resistance Flatness	KEL AT(ON)	V+ = 15V, V- = -15V, V <sub>D</sub> = 5V or -5V,	T <sub>A</sub> = +25°	С			9		
(Note 4)	rFLAT(ON)	VD = 5V  or  -5V, $IS = -10mA$	TA = TMIN	to T <sub>MAX</sub>			15	Ω	
Source Off-Leakage Current (Note 5)	I <sub>S(OFF)</sub>	$V+ = 16.5V, V- = -16.5V, V_D = \mp 15.5V, V_S = \pm 15.5V$	T <sub>A</sub> = +25°	С	-0.50	0.01	0.50		
				C, D	-5		5	nA	
			$T_A = T_{MAX}$	А	-20		20		
D : 0"1 1 0 1		$V+ = 16.5V, V- = -16.5V, V_D = \mp 15.5V, V_S = \pm 15.5V$	$T_A = +25^{\circ}$	C	0.50	0.01	0.50		
Drain Off-Leakage Current (Note 5)	ID(OFF)		$T_A = T_{MAX}$ $C, D$ $A$	C, D	-5		5	nA	
(				-20		20	1		
	akage Current ID(ON) V+ = 16.5V, V- = -		T <sub>A</sub> = +25°	C	-0.50	0.08	0.50		
Drain On-Leakage Current (Note 5)	or	$V_D = \pm 15.5V,$ $V_S = \pm 15.5V$	$T_A = T_{MAX}$ $C, D$ $A$	C, D	-10		10	nA	
(	IS(ON)			А	-20		20		
DIGITAL	·		·	·					
Input Current with Input Voltage High	linh	V <sub>IN</sub> = 2.4V		-500	0.01	500	nA		
Input Current with Input Voltage Low	l <sub>INL</sub>	$V_{IN} = 0.8V$		-500	0.01	500	nA		

# **ELECTRICAL CHARACTERISTICS—Dual Supplies (continued)** $(V+ = 15V, V- = -15V, GND = 0V, V_{INH} = 2.4V, V_{INL} = 0.8V, T_A = T_{MIN} \text{ to } T_{MAX}, \text{ unless otherwise noted.})$

PARAMETER	SYMBOL	CONDITIONS			TYP (Note 2)	MAX	UNITS
SUPPLY							
Power-Supply Range	V+, V-			±4.5		±20.0	V
Positive Supply Current	l+	All channels on or off, V+ = 16.5V, V- = -16.5V, V <sub>IN</sub> = 0V or 5V			15	100	μA
Nogative Supply Current	I-	All channels on or off, $T_A = +25^{\circ}C$		-1	-0.0001	1	
Negative Supply Current	-	V+ = 16.5V, V- = -16.5V, V <sub>IN</sub> = 0V or 5V	T <sub>A</sub> = T <sub>MIN</sub> to T <sub>MAX</sub>	-5		5	μΑ
Ground Current	IGND	All channels on or off, V+ = 16.5V, V- = -16.5V, V <sub>IN</sub> = 0V or 5V		-100	-15		μΑ
DYNAMIC							
Turn-On Time	ton	$V_S = \pm 10V$ , $R_L = 1k\Omega$ , Figure 2	T <sub>A</sub> = +25°C		150	250	ns
T O# Ti		DG441, $V_D = \pm 10V$ , Figure 2	T <sub>A</sub> = +25°C		90	120	no
Turn-Off Time	toff	DG442, $V_D = \pm 10V$ , Figure 2 $T_A = +25$ °C			110	170	- ns
Charge Injection (Note 3)	Q	$C_L = 1nF, V_{GEN} = 0V,$ $R_{GEN} = 0\Omega, Figure 3$	T <sub>A</sub> = +25°C		5	10	рС
Off-Isolation Rejection Ratio (Note 6)	OIRR	$R_L = 50\Omega$ , $C_L = 5pF$ , $f = 1MHz$ , Figure 4	T <sub>A</sub> = +25°C		60		dB
Crosstalk (Note 7)		$R_L = 50\Omega$ , $C_L = 5pF$ , $f = 1MHz$ , Figure 5 $T_A = +25^{\circ}C$			-100		dB
Source Off-Capacitance	Cs(OFF)	f = 1MHz, Figure 6	T <sub>A</sub> = +25°C		4		рF
Drain Off-Capacitance	C <sub>D</sub> (OFF)	f = 1MHz, Figure 6	T <sub>A</sub> = +25°C		4		рF
Drain On-Capacitance	C <sub>D(ON)</sub>	f = 1MHz, Figure 6	T <sub>A</sub> = +25°C		16		рF

#### **ELECTRICAL CHARACTERISTICS—Single Supply**

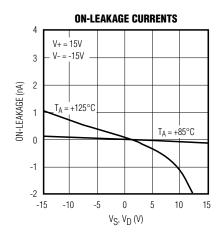
 $(V+ = 12V, V- = 0V, GND = 0V, V_{INH} = 2.4V, V_{INL} = 0.8V, T_A = T_{MIN}$  to  $T_{MAX}$ , unless otherwise noted.)

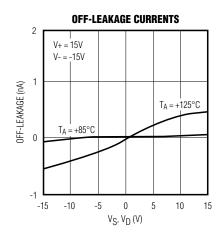
PARAMETER	SYMBOL	CONDITIONS		MIN	TYP (Note 2)	MAX	UNITS
SWITCH							
Analog Signal Range	Vanalog	(Note 3)	(Note 3)			12	V
Drain-Source	rDS(ON)	V+ = 10.8V, V <sub>D</sub> = 3V, 8V, I <sub>S</sub> = 1.0mA	T <sub>A</sub> = +25°C		100	160	Ω
On-Resistance	103(011)		$T_A = T_{MIN}$ to $T_{MAX}$			200	
SUPPLY							
Power-Supply Range	V+			10		30	V
Positive Supply Current	I+	All channels on or off, V <sub>IN</sub> = 0V or 5V			15	100	μΑ
Negative Supply Current	I-	All channels on or off,	T <sub>A</sub> = +25°C	-1	-0.0001	1	μΑ
Negative Supply Current	-	VIN = 0V  or  5V	$T_A = T_{MIN}$ to $T_{MAX}$	-5		5	
Ground Current	IGND	All channels on or off, V <sub>IN</sub> = 0V or 5V		-100	-15		μΑ
DYNAMIC							
Turn-On Time	ton	V <sub>S</sub> = 8V, Figure 2	T <sub>A</sub> = +25°C		300	400	ns
Turn-Off Time	toff	Vs = 8V, Figure 2	T <sub>A</sub> = +25°C		60	200	ns
Charge Injection (Note 3)	Q	$C_L = 1nF, V_{GEN} = 0V$	T <sub>A</sub> = +25°C		5	10	рС

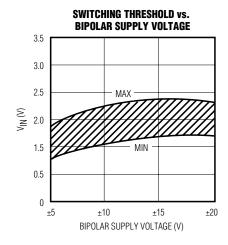
- **Note 2:** Typical values are for **design aid only,** are not guaranteed, and are not subject to production testing. The algebraic convention, where the most negative value is a minimum and the most positive value a maximum, is used in this data sheet.
- Note 3: Guaranteed by design.
- **Note 4:** On-resistance match between channels and flatness is guaranteed only with bipolar-supply operation. Flatness is defined as the difference between the maximum and the minimum value of on-resistance as measured at the extremes of the specified analog range.
- Note 5: Leakage parameters Is(OFF), ID(OFF), and ID(ON) are 100% tested at the maximum rated hot temperature and guaranteed by correlation at +25°C.
- **Note 6:** Off-Isolation Rejection Ratio = 20log (V<sub>D</sub>/V<sub>S</sub>), V<sub>D</sub> = output, V<sub>S</sub> = input to off switch.
- Note 7: Between any two switches.

#### **Typical Operating Characteristics**

 $(T_A = +25^{\circ}C, \text{ unless otherwise noted.})$ 

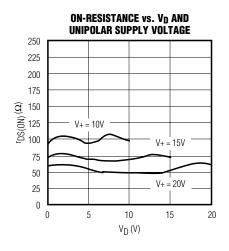


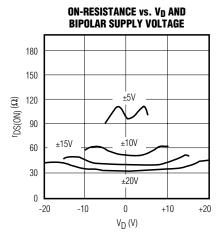


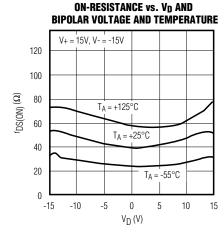


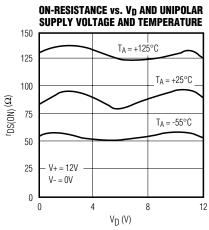
#### **Typical Operating Characteristics (continued)**

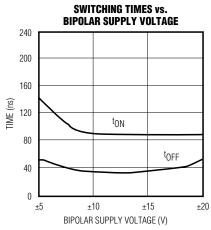
 $(T_A = +25^{\circ}C, \text{ unless otherwise noted.})$ 

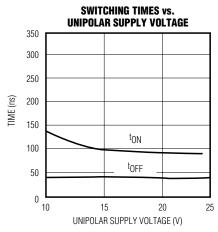


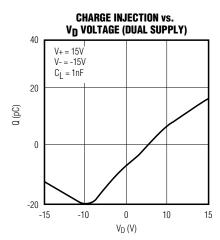


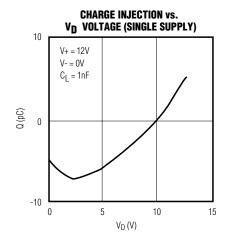












#### **Pin Description**

F	PIN	NAME	FUNCTION
DIP/SO	QFN	NAIVIE	FUNCTION
1, 16, 9, 8	15, 14, 7, 6	IN1-IN4	Input
2, 15, 10, 7	16, 13, 8, 5	D1-D4	Analog Switch Drain Terminal
3, 14, 11, 6	1, 12, 9, 4	S1–S4	Analog Switch Source Terminal
4	2	V-	Negative-Supply Voltage Input
5	3	GND	Ground
12	10	N.C.	Not Internally Connected
13	11	V+	Positive-Supply Voltage Input—Connected to Substrate
_	EP	PAD	Exposed Pad. Connect PAD to V+.

#### \_Applications Information

#### Operation with Supply Voltages Other Than ±15V

Using supply voltages other than ±15V reduces the analog signal range. The DG441/DG442 switches operate with ±4.5V to ±20V bipolar supplies or with a +10V to +30V single supply; connect V- to 0V when operating with a single supply. Also, all device types can operate with unbalanced supplies such as +24V and -5V. The *Typical Operating Characteristics* graphs show typical on-resistance with ±20V, ±15V, ±10V, and ±5V supplies. (Switching times increase by a factor of two or more for operation at ±5V.)

#### **Overvoltage Protection**

Proper power-supply sequencing is recommended for all CMOS devices. Do not exceed the absolute maximum ratings because stresses beyond the listed ratings can cause permanent damage to the devices. Always sequence V+ on first, followed by V- and logic inputs. If power-supply sequencing is not possible, add two small, external signal diodes in series with supply pins for overvoltage protection (Figure 1). Adding external diodes reduces the analog-signal range to 1V below V+ and 1V above V-, but low switch resistance and low leakage characteristics are unaffected. Device operation is unchanged, and the difference between V+ and V- should not exceed +44V.

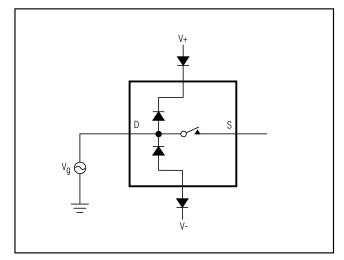


Figure 1. Overvoltage Protection Using External Blocking Diodes

#### **Timing Diagrams/Test Circuits**

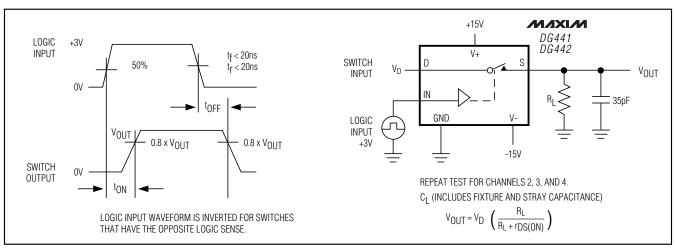


Figure 2. Switching Time

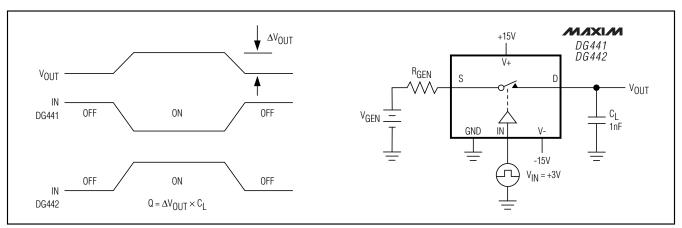


Figure 3. Charge Injection

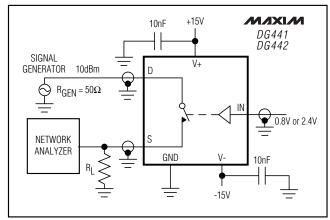


Figure 4. Off-Isolation Rejection Ratio

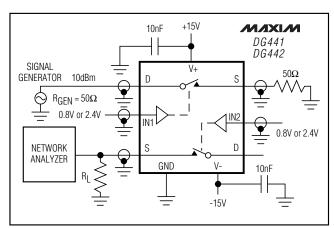


Figure 5. Crosstalk (repeat for channels 3 and 4)

# \_\_\_\_\_Timing Diagrams/ Test Circuits (continued)

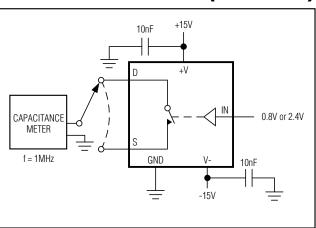


Figure 6. Source/Drain-On/Off Capacitance

#### \_Ordering Information (continued)

PART	TEMP. RANGE	PIN-PACKAGE
DG442AK	-55°C to +125°C	16 CERDIP**
DG442CJ	0°C to +70°C	16 Plastic DIP
DG442CY	0°C to +70°C	16 Narrow SO
DG442C/D	0°C to +70°C	Dice*
DG442DJ	-40°C to +85°C	16 Plastic DIP
DG442DY	-40°C to +85°C	16 Narrow SO
DG442DK	-40°C to +85°C	16 CERDIP
DG442ETE	-40°C to +85°C	16 Thin QFN (5mm x 5mm)
DG442AK	-55°C to +125°C	16 CERDIP**

<sup>\*</sup>Contact factory for dice specifications.

Maxim cannot assume responsibility for use of any circuitry other than circuitry entirely embodied in a Maxim product. No circuit patent licenses are implied. Maxim reserves the right to change the circuitry and specifications without notice at any time.

<sup>\*\*</sup>Contact factory for availability and processing to MIL-STD-883B.