HARRIS SEMICONDUCTOR

DG200, DG201

December 1993

CMOS Dual/Quad SPST Analog Switches

Features

- Switches Greater than $28V_{P-P}$ Signals with ±15 Supplies
- Break-Before-Make Switching t_{OFF} 250ns, t_{ON} 700ns Typical
- TTL, DTL, CMOS, PMOS Compatible
- Non-Latching with Supply Turn-Off
- Complete Monolithic Construction
- Industry Standard (DG200, DG201)

Applications

- Data Acquisition
- Sample and Hold Circuits
- Operational Amplifier Gain Switching Networks

Description

The DG200 and DG201 solid state analog gates are designed using an improved, high voltage CMOS monolithic technology. They provide ease-of-use and performance advantages not previously available from solid state switches. Destructive latch-up of solid state analog gates has been eliminated by Harris's CMOS technology.

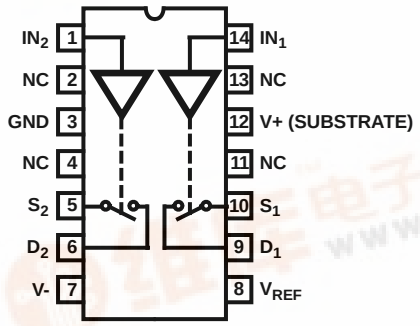
The DG200 and DG201 are completely specification and pinout compatible with the industry standard devices.

Ordering Information

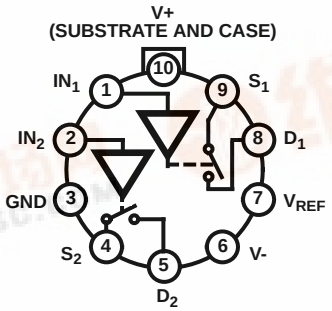
PART NUMBER	TEMPERATURE	PACKAGE
DG200AA	-55°C to +125°C	10 Pin Metal Can
DG200AK	-55°C to +125°C	14 Lead Ceramic DIP
DG200BA	-25°C to +85°C	10 Pin Metal Can
DG200BK	-25°C to +85°C	14 Lead Ceramic DIP
DG200CJ	0°C to +70°C	14 Lead Plastic DIP
DG200AA/883B	-55°C to +125°C	10 Pin Metal Can
DG200AK/883B	-55°C to +125°C	14 Lead Ceramic DIP
DG201AK	-55°C to +125°C	16 Lead Ceramic DIP
DG201BK	-25°C to +85°C	16 Lead Ceramic DIP
DG201CJ	0°C to +70°C	16 Lead Plastic DIP
DG201AK/883B	-55°C to +125°C	16 Lead Ceramic DIP

Pinouts

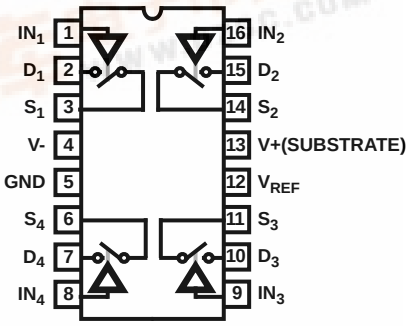
DG200 (CDIP, PDIP) TOP VIEW



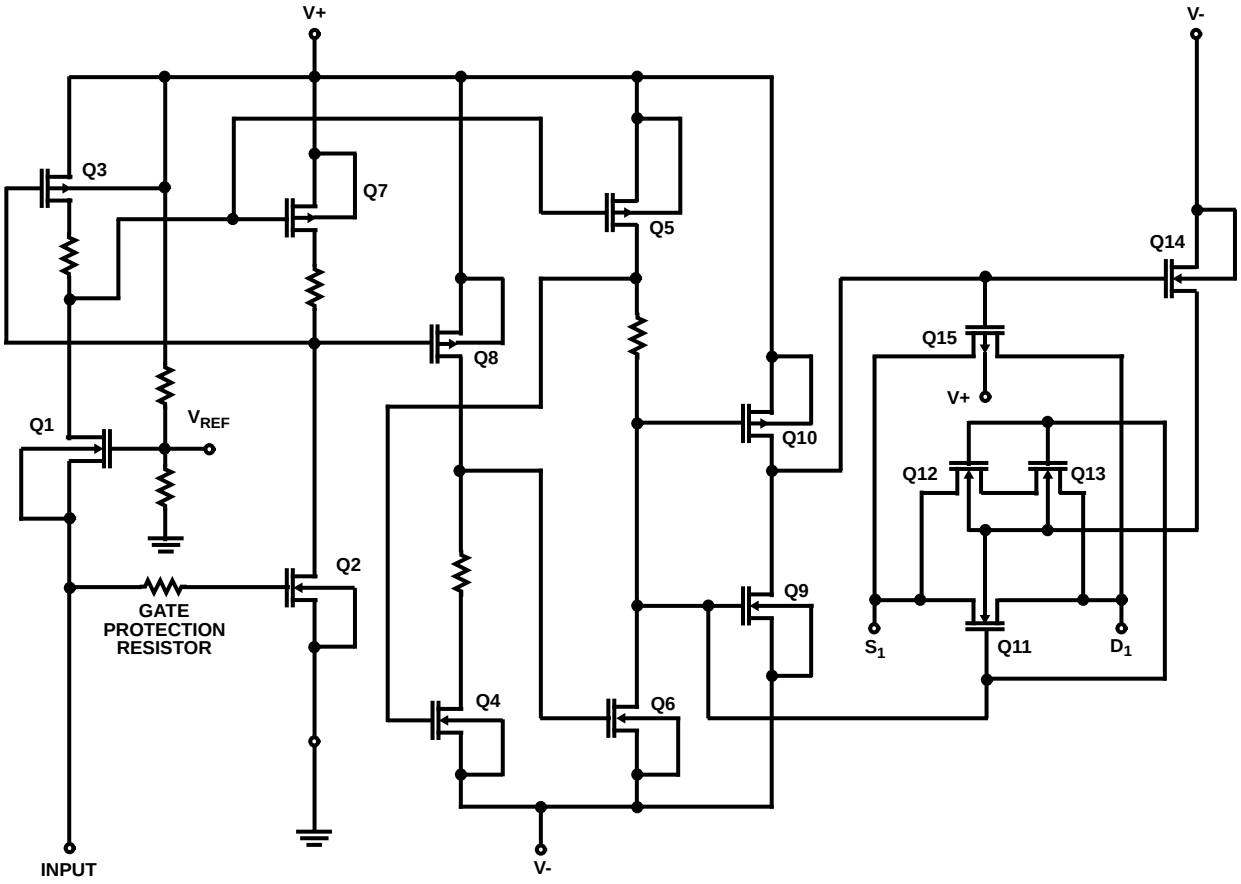
DG200 (TO-100 METAL CAN) TOP VIEW



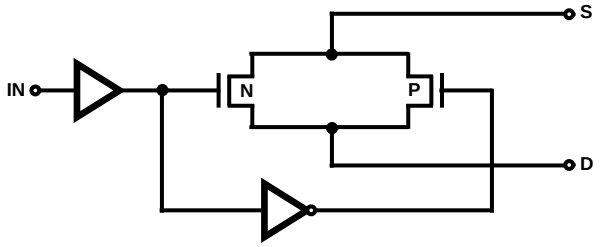
DG201 (CDIP, PDIP) TOP VIEW



Schematic Diagram ($^1/_2$ DG200, $^1/_4$ DG201)



Functional Diagram



DG200, DG201 SWITCH CELL

Specifications DG200

Absolute Maximum Ratings

V+, V- . . . . . <36V
V+ - V_D . . . . . <30V
V_D - V- . . . . . <30V
V_D - V_S . . . . . <28V
V_{IN} - GND . . . . . <20V
Storage Temperature Range . . . . . -65°C to +150°C
Lead Temperature (Soldering 10s) . . . . . +300°C

Thermal Information

Thermal Resistance	θ_{JA}	θ_{JC}
Ceramic DIP Package	95°C/W	24°C/W
Plastic DIP Package	100°C/W	-
Metal Can Package	136°C/W	65°C/W

Operating Temperature Range
"A" Suffix . . . . . -55°C to +125°C
"B" Suffix . . . . . -25°C to +85°C
"C" Suffix . . . . . 0°C to +70°C

CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

Electrical Specifications (T_A = +25°C, V+ = +15V, V- = -15V)

PARAMETER	TEST CONDITIONS	MILITARY			COMMERCIAL / INDUSTRIAL			UNITS
		-55°C	+25°C	+125°C	0°C TO -25°C	+25°C	+70°C TO +85°C	
Input Logic Current, $I_{IN(ON)}$	V_{IN} = 0.8V (Notes 2, 3)	±10	±1	±10	-	±10	±10	µA
Input Logic Current, $I_{N(OFF)}$	V_{IN} = 2.4V (Notes 2, 3)	±10	±1	±10	-	±10	±10	µA
Drain-Source On Resistance, $r_{DS(ON)}$	I_S = 10mA, V_{ANALOG} = ±10V	70	70	100	80	80	100	Ω
Channel-to-Channel $r_{DS(ON)}$ Match, $r_{DS(ON)}$		-	25 (Typ)	-	-	30 (Typ)	-	Ω
Minimum Analog Signal Handling Capability, V_{ANALOG}		-	±15V	-	-	±15V	-	V
Switch OFF Leakage Current, $I_{D(OFF)}$	V_{ANALOG} = -14V to +14V	-	±2	100	-	±5	100	nA
Switch OFF Leakage Current, $I_{S(OFF)}$	V_{ANALOG} = -14V to +14V	-	±2	100	-	±5	100	nA
Switch ON Leakage Current, $I_{D(ON)}$ + $I_{S(ON)}$	V_D = V_S = -14V to +14V	-	±2	200	-	±10	200	nA
Switch "ON" Time (Note 1), t_{ON}	R_L = 1kΩ, V_{ANALOG} = -10V to +10V (Figure 5)	-	1.0	-	-	1.0	-	µs
Switch "OFF" Time, t_{OFF}	R_L = 1kΩ, V_{ANALOG} = -10V to +10V (Figure 5)	-	0.5	-	-	0.5	-	µs
Charge Injection, $Q_{(INJ.)}$	Figure 6	-	15 (Typ)	-	-	20 (Typ)	-	mV
Minimum Off Isolation Rejection Ratio, OIRR	f = 1MHz, R_L = 100Ω, C_L ≤ 5pF (Figure 7, Note 1)	-	54 (Typ)	-	-	50 (Typ)	-	dB
+Power Supply Quiescent Current, I_{V1}	V_{IN} = 0V or V_{IN} = 5V	1000	1000	2000	1000	1000	2000	µA
-Power Supply Quiescent Current, I_{V2}		1000	1000	2000	1000	1000	2000	µA
Minimum Channel to Channel Cross Coupling Rejection Ratio, CCRR	One Channel Off	-	54 (Typ)	-	-	50 (Typ)	-	dB

NOTES:

1. Pull Down Resistor must be ≤ 2kΩ.
2. Typical values are for design aid only, not guaranteed and not subject to production testing.
3. All channels are turned off by high "1" logic inputs and all channels are turned on by low "0" inputs; however 0.8V to 2.4V describes the minimum range for switching properly. Peak input current required for transition is typically -120µA.

Specifications DG201

Absolute Maximum Ratings

V+ to V- . . . . . <36V
V+ to V_D . . . . . <30V
V_D to V- . . . . . <30V
V_D to V_S . . . . . <28V
V_{REF} to V- . . . . . <33V
V_{REF} to V_{IN} . . . . . <30V
V_{REF} to GND . . . . . <20V
V_{IN} to GND . . . . . <20V
Current (Any Terminal) . . . . . <30mA
Storage Temperature Range . . . . . -65°C to +150°C
Lead Temperature (Soldering 10s) . . . . . +300°C

Thermal Information

Thermal Resistance	θ_{JA}	θ_{JC}
Ceramic DIP Package	80°C/W	24°C/W
Plastic DIP Package	145°C/W	-

Operating Temperature Range
"A" Suffix . . . . . -55°C to +125°C
"B" Suffix . . . . . -25°C to +85°C
"C" Suffix . . . . . 0°C to +70°C

CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

Electrical Specifications (T_A = +25°C, V+ = +15V, V- = -15V)

PARAMETER	TEST CONDITIONS	MILITARY			COMMERCIAL / INDUSTRIAL			UNITS
		-55°C	+25°C	+125°C	0°C TO -25°C	+25°C	+70°C TO +85°C	
Input Logic Current, $I_{IN(ON)}$	V_{IN} = 0.8V (Note 1)	10	±1	10	±1	±1	10	µA
Input Logic Current, $I_{N(OFF)}$	V_{IN} = 2.4V (Note 1)	10	±1	10	±1	±1	10	µA
Drain-Source On Resistance, $r_{DS(ON)}$	I_S = 10mA, V_{ANALOG} = ±10V	80	80	125	100	100	125	Ω
Channel-to-Channel $r_{DS(ON)}$ Match, $r_{DS(ON)}$		-	25 (Typ)	-	-	30 (Typ)	-	Ω
Minimum Analog Signal Handling Capability, V_{ANALOG}		-	±15 (Typ)	-	-	±15 (Typ)	-	V
Switch OFF Leakage Current, $I_{D(OFF)}$	V_{ANALOG} = -14V to +14V	-	±1	100	-	±5	100	nA
Switch OFF Leakage Current, $I_{S(OFF)}$	V_{ANALOG} = -14V to +14V	-	±1	100	-	±5	100	nA
Switch ON Leakage Current, $I_{D(ON)} + I_{S(ON)}$	$V_D = V_S$ = -14V to +14V	-	±2	200	-	±5	200	nA
Switch "ON" Time (Note 2), t_{ON}	R_L = 1kΩ, V_{ANALOG} = -10V to +10V (Figure 5)	-	1.0	-	-	1.0	-	µs
Switch "OFF" Time (Note 2), t_{OFF}	R_L = 1kΩ, V_{ANALOG} = -10V to +10V (Figure 5)	-	0.5	-	-	0.5	-	µs
Charge Injection, $Q_{(INJ.)}$	Figure 6	-	15 (Typ)	-	-	20 (Typ)	-	mV
Minimum Off Isolation Rejection Ratio, OIRR	f = 1MHz, R_L = 100Ω, $C_L \leq$ 5pF, (Figure 7)	-	54 (Typ)	-	-	50 (Typ)	-	dB
+Power Supply Quiescent Current, $I+_Q$	V_{IN} = 0V or V_{IN} = 5V	2000	1000	2000	2000	1000	2000	µA
-Power Supply Quiescent Current, $I-_Q$		2000	1000	2000	2000	1000	2000	µA
Minimum Channel to Channel Cross Coupling Rejection Ratio, CCRR	One Channel Off	-	54 (Typ)	-	-	50 (Typ)	-	dB

NOTES:

1. Typical values are for design aid only, not guaranteed and not subject to production testing.
2. All channels are turned off by high "1" logic inputs and all channels are turned on by low "0" inputs; however 0.8V to 2.4V describes the minimum range for switching properly. Peak input current required for transition is typically -120µA.

Performance Curves

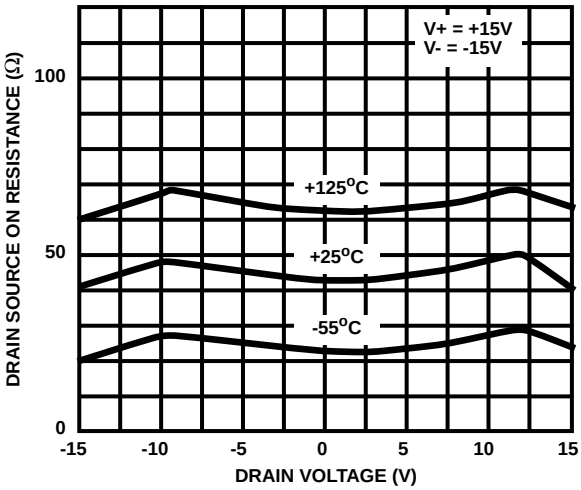


FIGURE 1. $R_{DS(ON)}$ vs V_D AND TEMPERATURE

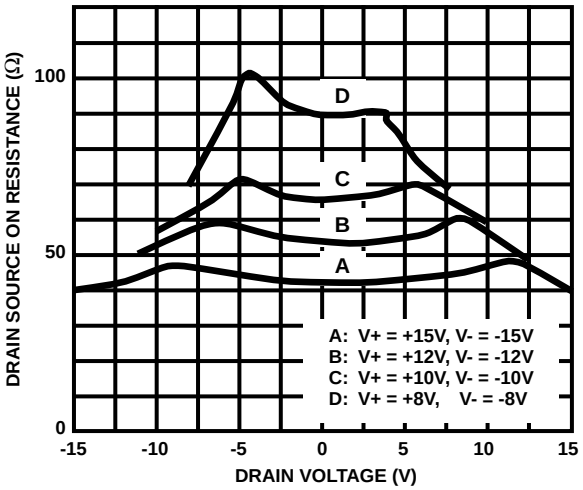


FIGURE 2. $r_{DS(ON)}$ vs V_D AND POWER SUPPLY VOLTAGE

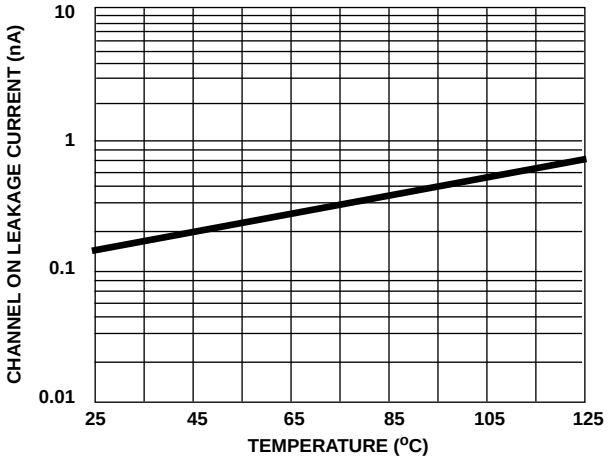


FIGURE 3. $I_{D(ON)}$ vs TEMPERATURE

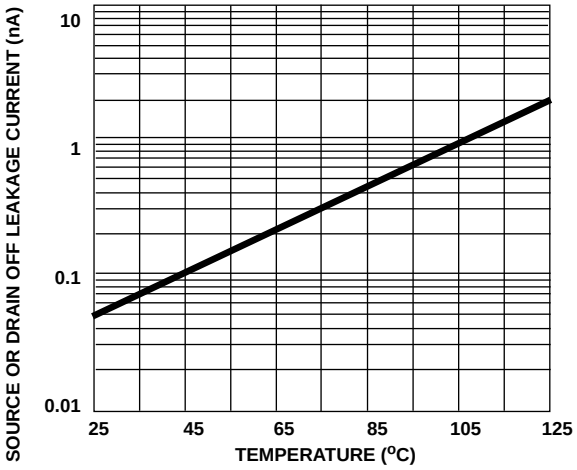


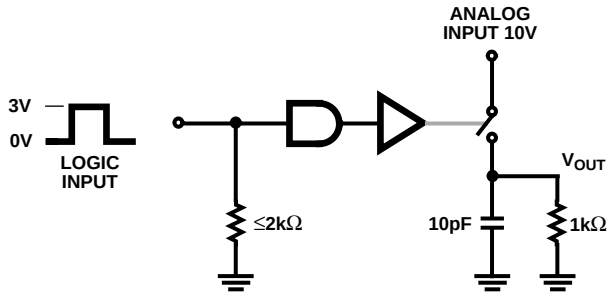
FIGURE 4. $I_{S(OFF)}$ OR $I_{D(OFF)}$ vs TEMPERATURE

Pin Description

DG200 (14 LEAD DIP)		
PIN	**SYMBOL**	**DESCRIPTION**
1	IN_2	Logic control for switch 2
2	NC	No Connection
3	GND	Ground Terminal (Logic Common)
4	NC	No Connection
5	S_2	Source (input) terminal for switch 2
6	D_2	Drain (output) terminal for switch 2
7	V-	Negative power supply terminal
8	V_{REF}	Logic reference voltage
9	D_1	Drain (output) terminal for switch 1
10	S_1	Source (input) terminal for switch 1
11	NC	No Connection
12	V+	Positive power supply terminal (substrate)
13	NC	No Connection
14	IN_1	Source (input) terminal for switch 1

DG201 (16 LEAD DIP)		
PIN	**SYMBOL**	**DESCRIPTION**
1	IN_1	Logic control for switch 1
2	D_1	Drain (output) terminal for switch 1
3	S_1	Source (input) terminal for switch 1
4	V-	Negative power supply terminal
5	GND	Ground terminal (Logic Common)
6	S_4	Source (input) terminal for switch 4
7	D_4	Drain (output) terminal for switch 4
8	IN_4	Logic control for switch 4
9	IN_3	Logic control for switch 3
10	D_3	Drain (output) terminal for switch 3
11	S_3	Source (input) terminal for switch 3
12	V_{REF}	Logic reference voltage
13	V+	Positive power supply terminal (substrate)
14	S_2	Source (input) terminal for switch 2
15	D_2	Drain (output) terminal for switch 2
16	IN_2	Logic control for switch 2

Test Circuits



NOTE: All channels are turned off by high "1" logic inputs and all channels are turned on by low "0" inputs; however 0.8V to 2.4V describes the minimum range for switching properly. Peak input current required for transition is typically -120µA.

FIGURE 5.

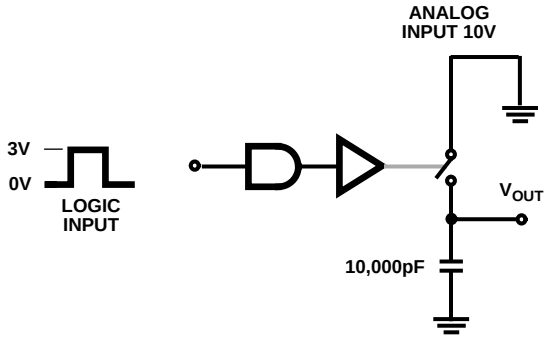
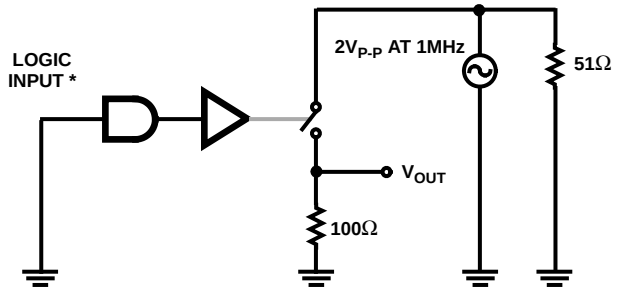


FIGURE 6.



* Pull Down Resistor must be ≤ 2kΩ.

FIGURE 7.

Typical Applications

Using the V_{REF} Terminal

The DG200 and DG201 have an internal voltage divider setting the TTL threshold on the input control lines for V+ equal to +15V. The schematic shown in Figure 8 with nominal resistor values, gives approximately 2.4V on the V_{REF} pin. As the TTL input signal goes from +0.8V to +2.4V, Q1 and Q2 switch states to turn the switch ON and OFF.

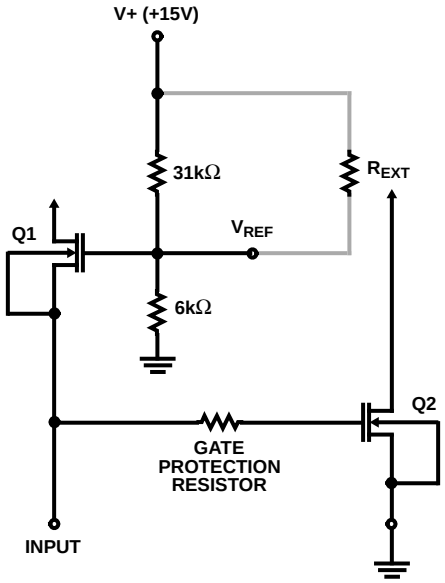


FIGURE 8.

If the power supply voltage is less than +15V, then a resistor must be added between V+ and the V_{REF} pin, to restore +2.4V at V_{REF}. The table shows the value of this resistor for various supply voltages, to maintain TTL compatibility. If CMOS logic levels on a +5V supply are being used, the threshold shifts are less critical, but a separate column of suitable values is given in the table. For logic swings of -5V to + 5V, no resistor is needed.

In general, the "low" logic level should be <0.8V to prevent Q1 and Q2 from both being ON together (this will cause incorrect switch function).

TABLE 1.

V+ SUPPLY (V)	TTL RESISTOR (kΩ)	CMOS RESISTOR (kΩ)
+15	-	-
+12	100	-
+10	51	-
+9	(34)	34
+8	(27)	27
+7	18	18

Metallization Topology

DIE DIMENSIONS:
74 x 77 x 14 ± 1mils

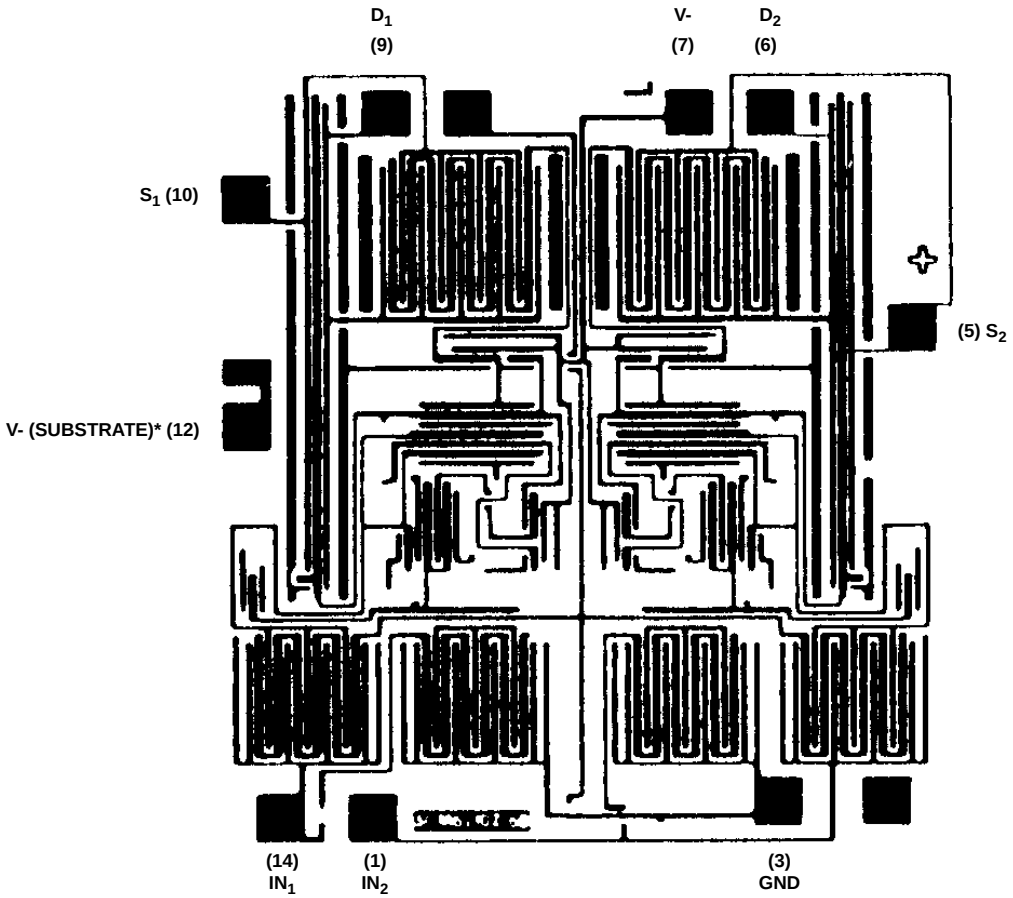
METALLIZATION:
Type: Al
Thickness: 10kÅ ± 1kÅ

GLASSIVATION:
Type: SiO_2/Si_3N_4
SiO_2 Thickness: 7kÅ ± 1.4kÅ
Si_3N_4 Thickness: 8kÅ ± 1.2kÅ

WORST CASE CURRENT DENSITY:
1×10^5 A/cm^2

Metallization Mask Layout

DG200



*** Backside of Chip is V+**

Metallization Topology

DIE DIMENSIONS:
94 x 101 x 14 ± 1mils

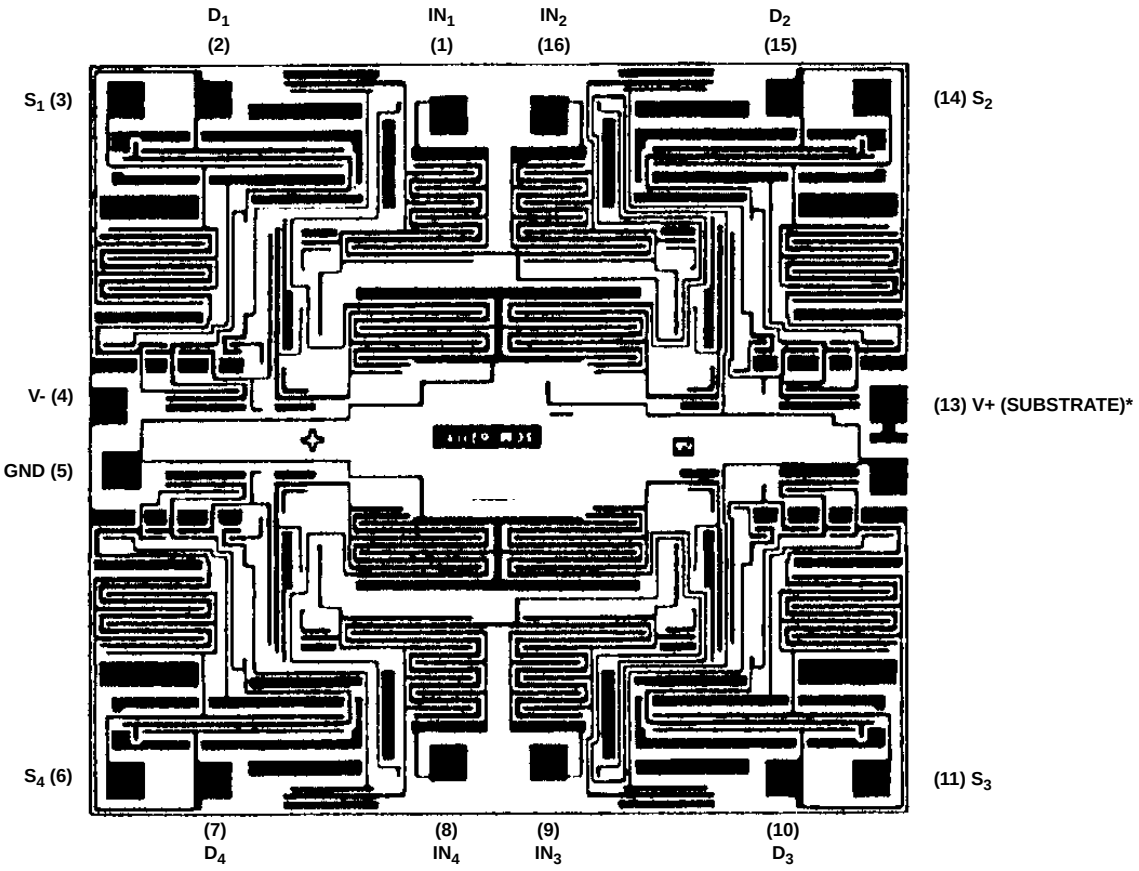
METALLIZATION:
Type: Al
Thickness: 10kÅ ± 1kÅ

GLASSIVATION:
Type: SiO_2/Si_3N_4
SiO_2 Thickness: 7kÅ ± 1.4kÅ
Si_3N_4 Thickness: 8kÅ ± 1.2kÅ

WORST CASE CURRENT DENSITY:
1×10^5 A/cm^2

Metallization Mask Layout

DG201



*** Backside of Chip is V+**