National Semiconductor

June 1986

DS7800/DS8800 Dual Voltage Level Translator

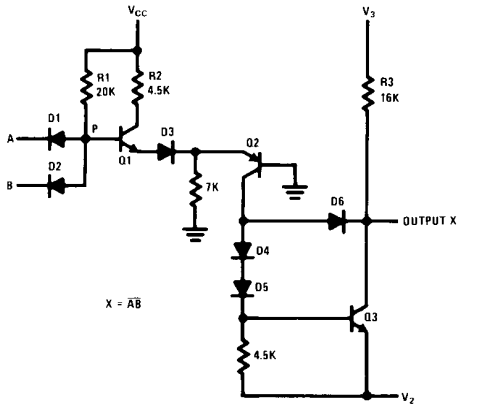
General Description

The DS7800/DS8800 are dual voltage translators designed for interfacing between conventional TTL or LS voltage levels and those levels associated with high impedance junction or MOS REF-type devices. The design allows the user a wide latitude in his selection of power supply voltages, thus providing custom control of the output swing. The translator is especially useful in analog switching; and since low power dissipation occurs in the ''off'' state, minimum system power is required.

Features

- 31 volt (max) output swing
- 1 mW power dissipation in normal state
- Standard 5V power supply
- Temperature range:
  - DS7800 −55°C to +125°C
  - DS8800 0°C to +70°C
- Compatible with all MOS devices

Schematic and Connection Diagrams



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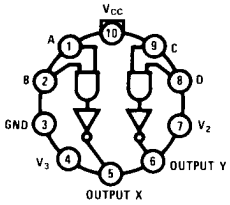
Metal Can Package



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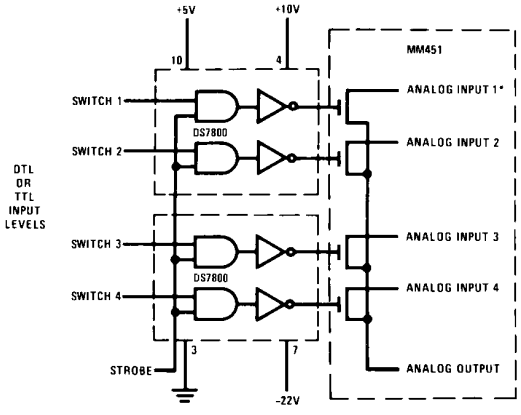
Top View
Order Number DS7800H or DS8800H
See NS Package Number H10C

Typical Applications

4-Channel Analog Switch



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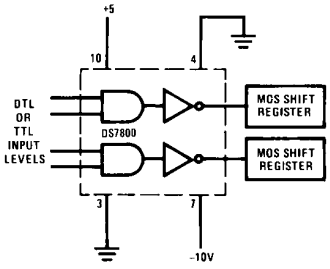
*Analog signals within the range of +8V to −8V.

Bipolar to MOS Interfacing



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Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

V_{CC} Supply Voltage	7.0V
V2 Supply Voltage	−30V
V3 Supply Voltage	30V
V3−V2 Voltage Differential	40V
Input Voltage	5.5V
Storage Temperature	−65°C to +150°C
Lead Temperature (Soldering, 4 seconds)	260°C
Maximum Power Dissipation* at 25°C	
Metal Can (TO-5) Package	690 mW

*Derate metal can package 4.6 mW/°C above 25°C.

Operating Conditions

	Min	Max	Units
Supply Voltage, V_{CC}			
DS7800	4.5	5.5	V
DS8800	4.75	5.25	V
Temperature (T_A)			
DS7800	−55	+125	°C
DS8800	0	+70	°C

Electrical Characteristics (Notes 2 and 3)

Symbol	Parameter	Conditions		Min	Typ (Note 6)	Max	Units
V_{IH}	Logical "1" Input Voltage	V_{CC} = Min		2.0			V
V_{IL}	Logical "0" Input Voltage	V_{CC} = Min				0.8	V
I_{IH}	Logical "1" Input Current	V_{CC} = Max	V_{IN} = 2.4V			5	μA
			V_{IN} = 5.5V			1	mA
I_{IL}	Logical "0" Input Current	V_{CC} = Max, V_{IN} = 0.4V			−0.2	−0.4	mA
I_{OL}	Output Sink Current	V_{CC} = Min, V_{IN} = 2V,	DS7800	1.6			mA
		V3 Open	DS8800	2.3			mA
I_{OH}	Output Leakage Voltage	V_{CC} = Max, V_{IN} = 0.8V (Notes 4 and 7)				10	μA
R_O	Output Collector Resistor	T_A = 25°C		11.5	16.0	20.0	kΩ
V_{OL}	Logical "0" Output Voltage	V_{CC} = Min, V_{IN} = 2.0V (Note 7)				V_2 + 2.0	V
$I_{CC(MAX)}$	Power Supply Current Output "ON" Per Gate	V_{CC} = Max, V_{IN} = 4.5V (Note 5)			0.85	1.6	mA
$I_{CC(MIN)}$	Power Supply Current Output "OFF" Per Gate	V_{CC} = Max, V_{IN} = 0V (Note 5)			0.22	0.41	mA

Switching Characteristics T_A = 25°C, nominal power supplies unless otherwise noted

Symbol	Parameter	Conditions	Min	Typ	Max	Units
t_{pd0}	Transition Time to Logical "0" Output	T_A = 25°C, C = 15 pF (Note 8)	25	70	125	ns
t_{pd1}	Transition Time to Logical "1" Output	T_A = 25°C, C = 15 pF (Note 9)	25	62	125	ns

Note 1: "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. Except for "Operating Temperature Range" they are not meant to imply that the devices should be operated at these limits. The table of "Electrical Characteristics" provides conditions for actual device operation.

Note 2: Unless otherwise specified min/max limits apply across the −55°C to +125°C temperature range for the DS7800 and across the 0°C to +70°C range for the DS8800.

Note 3: All currents into device pins shown as positive, out of device pins as negative, all voltages referenced to ground unless otherwise noted. All values shown as max or min on absolute value basis.

Note 4: Current measured is drawn from V_3 supply.

Note 5: Current measured is drawn from V_{CC} supply.

Note 6: All typical values are measured at T_A = 25°C with V_{CC} = 5.0V, V_2 = −22V, V_3 = +8V.

Note 7: Specification applies for all allowable values of V_2 and V_3.

Note 8: Measured from 1.5V on input to 50% level on output.

Note 9: Measured from 1.5V on input to logic "0" voltage, plus 1V.

Theory of Operation

The two input diodes perform the AND function on TTL input voltage levels. When at least one input voltage is a logical ''0'', current from V_{CC} (nominally 5.0V) passes through R_1 and out the input(s) which is at the low voltage. Other than small leakage currents, this current drawn from V_{CC} through the 20 kΩ resistor is the only source of power dissipation in the logical ''1'' output state.

When both inputs are at logical ''1'' levels, current passes through R_1 and diverts to transistor Q_1, turning it on and thus pulling current through R_2. Current is then supplied to the PNP transistor, Q_2. The voltage losses caused by current through Q_1, D_3, and Q_2 necessitate that node P reach a voltage sufficient to overcome these losses before current begins to flow. To achieve this voltage at node P, the inputs must be raised to a voltage level which is one diode potential lower than node P. Since these levels are exactly the same as those experienced with conventional TTL, the interfacing with these types of circuits is achieved.

Transistor Q_2 provides ''constant current switching'' to the output due to the common base connection of Q_2. When at least one input is at the logical ''0'' level, no current is delivered to Q_2; so that its collector supplies essentially zero current to the output stage. But when both inputs are raised to a logical ''1'' level current is supplied to Q_2.

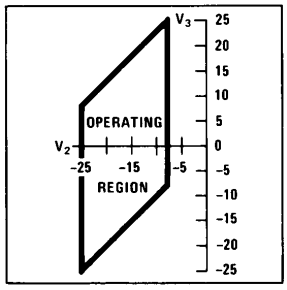
Selecting Power Supply Voltage

The graph shows the boundary conditions which must be used for proper operation of the unit. The range of operation for power supply V_2 is shown on the X axis. It must be between −25V and −8V. The allowable range for power supply V_3 is governed by supply V_2. With a value chosen for V_2, V_3 may be selected as any value along a vertical line passing through the V_2 value and terminated by the boundaries of the operating region. A voltage difference between power supplies of at least 5V should be maintained for adequate signal swing.

Since this current is relatively constant, the collector of Q_2 acts as a constant current source for the output stage. Logic inversion is performed since logical ''1'' input voltages cause current to be supplied to Q_2 and Q_3. And when Q_3 turns on the output voltage drops to the logical ''0'' level.

The reason for the PNP current source, Q_2, is so that the output stage can be driven from a high impedance. This allows voltage V_2 to be adjusted in accordance with the application. Negative voltages to −25V can be applied to V_2. Since the output will neither source nor sink large amounts of current, the output voltage range is almost exclusively dependent upon the values selected for V_2 and V_3.

Maximum leakage current through the output transistor Q_3 is specified at 10 μA under worst-case voltage between V_2 and V_3. This will result in a logical ''1'' output voltage which is 0.2V below V_3. Likewise the clamping action of diodes D_4, D_5, and D_6, prevents the logical ''0'' output voltage from falling lower than 2V above V_2, thus establishing the ouput voltage swing at typically 2 volts less than the voltage separation between V_2 and V_3.



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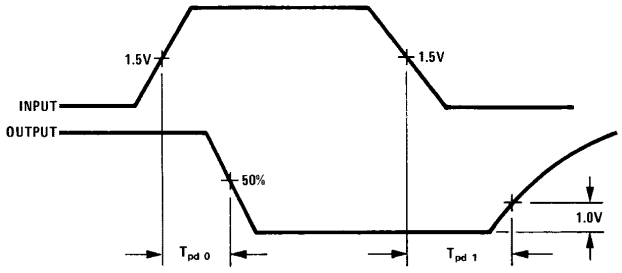
Switching Time Waveforms



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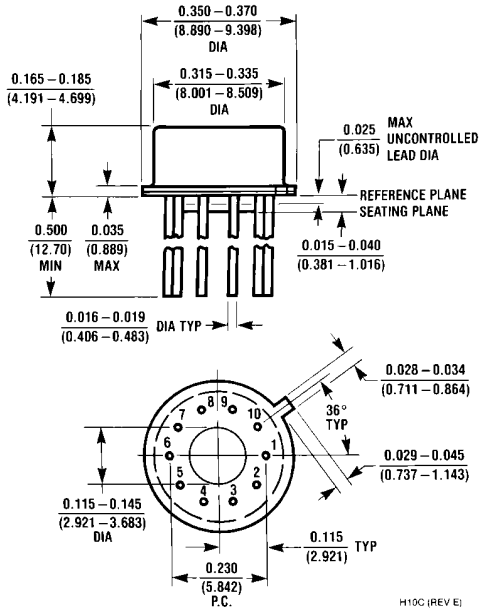
Physical Dimensions inches (millimeters)



Metal Can Package (H)
Order Number DS7800H or DS8800H
NS Package Number H10C

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National Semiconductor Corporation
1111 West Bardin Road
Arlington, TX 76017
Tel: 1(800) 272-9959
Fax: 1(800) 737-7018

National Semiconductor Europe
Fax: (+49) 0-180-530 85 86
Email: cnjwge@tevm2.nsc.com
Deutsch Tel: (+49) 0-180-530 85 85
English Tel: (+49) 0-180-532 78 32
Français Tel: (+49) 0-180-532 93 58
Italiano Tel: (+49) 0-180-534 16 80

National Semiconductor Hong Kong Ltd.
13th Floor, Straight Block,
Ocean Centre, 5 Canton Rd.
Tsimshatsui, Kowloon
Hong Kong
Tel: (852) 2737-1600
Fax: (852) 2736-9960

National Semiconductor Japan Ltd.
Tel: 81-043-299-2309
Fax: 81-043-299-2408

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