HI-201HS

High Speed Quad SPST CMOS Analog Switch

Features

- Fast Switching Times ..... t_{ON} = 30ns, t_{OFF} = 40ns
- Low "ON" Resistance 30Ω
- Pin Compatible with Standard HI-201
- Wide Analog Voltage Range (±15V Supplies) .. ±15V
- Low Charge Injection (±15V Supplies) 10pC
- TTL Compatible
- Symmetrical Switching Analog Current Range 80mA

Applications

- High Speed Multiplexing
- High Frequency Analog Switching
- Sample and Hold Circuits
- Digital Filters
- Operational Amplifier Gain Switching Networks
- Integrator Reset Circuits

Description

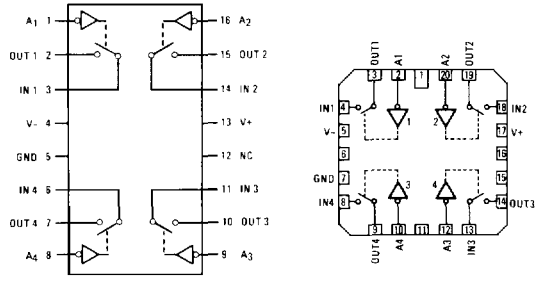
The HI-201HS is a monolithic CMOS Analog Switch featuring very fast switching speeds and low ON resistance. This integrated circuit consists of four independently selectable SPST switches and is pin compatible with the industry standard HI-201 switch.

Fabricated using silicon-gate technology and the Harris Dielectric Isolation process, this TTL compatible device offers improved performance over previously available CMOS analog switches. Featuring maximum switching times of 50ns, low ON resistance of 50Ω maximum, and a wide analog signal range, the HI-201HS is designed for any application where improved switching performance, particularly switching speed, is required. (A more detailed discussion on the design and application of the HI-201HS can be found in Application Note 543).

The HI-201HS is available in a 16 pin Ceramic DIP package. The HI-201HS-2 is specified over the temperature range from -55°C to +125°C and the HI-201HS-5 version from 0°C to +75°C. HI-201HS-4 is also offered from -25°C to +85°C.

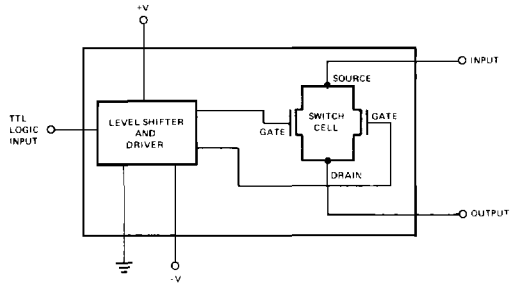
Pinout

TOP VIEW



LOGIC	SWITCH
0	ON
1	OFF

Functional Diagram



CAUTION: These devices are sensitive to electrostatic discharge. Proper I.C. handling procedures should be followed.

Absolute Maximum Ratings

Supply Voltage (Between Pins 4 and 13) 36V
Digital Input Voltage (Pins 1, 8, 9, 16) ..... $+V_{SUPPLY}$ +4V
$-V_{SUPPLY}$ -4V
Analog Input Voltage (One Switch) ..... $+V_{SUPPLY}$ +2.0V
Pins 2, 3, 6, 7, 10, 11, 14, 15 $-V_{SUPPLY}$ -2.0V
Analog Current — Continuous Peak 30mA, 80mA
Total Power Dissipation (Note 2) 750mW
Maximum Junction Temperature ..... +175°C

Operating Temperature Range

HI-201HS-2 ..... -55°C to +125°C
HI-201HS-4 ..... -25°C to +85°C
HI-201HS-5 ..... 0°C to +75°C
Storage Temperature ..... -65°C to +150°C

Electrical Specifications

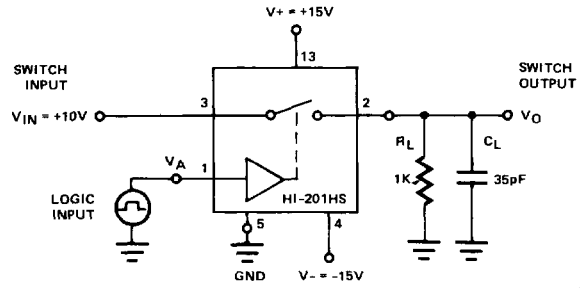
Unless Otherwise Specified: Supplies = +15V, -15V; V_{AH} (Logic Level High) = 3.0V, V_{AL} (Logic Level Low) = +0.8V, GND = 0V

PARAMETER	TEMP	HI-201HS-2 MIN	HI-201HS-2 TYP	HI-201HS-2 MAX	HI-201HS-5/-4 MIN	HI-201HS-5/-4 TYP	HI-201HS-5/-4 MAX	UNITS
ANALOG SWITCH CHARACTERISTICS								
V_S, Analog Signal Range	Full	-15	-	+15	-15	-	+15	V
R_{ON}, On Resistance (Note 3)	+25°C	-	30	50	-	30	50	Ω
	Full	-	-	75	-	-	75	Ω
R_{ON} Match	+25°C	-	3	-	-	3	-	%
$I_{S(OFF)}$, Off Input Leakage Current	+25°C	-	0.3	1	-	0.3	1	nA
	Full	-	-	100	-	-	50	nA
$I_{D(OFF)}$, Off Output Leakage Current	+25°C	-	0.3	1	-	0.3	1	nA
	Full	-	-	100	-	-	50	nA
$I_{D(ON)}$, On Leakage Current	+25°C	-	0.1	1	-	0.1	1	nA
	Full	-	-	100	-	-	50	nA
DIGITAL INPUT CHARACTERISTICS								
V_{AL}, Input Low Threshold	Full	-	-	0.8	-	-	0.8	V
V_{AH}, Input High Threshold	+25°C	2.0	-	-	2.0	-	-	V
	Full	2.4	-	-	2.4	-	-	V
I_{AL}, Input Leakage Current (Low)	+25°C	-	200	-	-	200	-	µA
	Full	-	-	-500	-	-	-500	µA
I_{AH}, Input Leakage Current (High)	+25°C	-	20	-	-	20	-	µA
	Full	-	-	+40	-	-	+40	µA
SWITCHING CHARACTERISTICS								
t_{ON}, Switch On Time (Note 4)	+25°C	-	30	50	-	30	50	ns
t_{OFF1}, Switch Off Time (Note 4)	+25°C	-	40	50	-	40	50	ns
t_{OFF2}, Switch Off Time (Note 4)	+25°C	-	150	-	-	150	-	ns
Output Settling Time 0.1%	+25°C	-	180	-	-	180	-	ns
"Off Isolation" (Note 5)	+25°C	-	72	-	-	72	-	dB
Crosstalk (Note 6)	+25°C	-	86	-	-	86	-	dB
Charge Injection (Note 7)	+25°C	-	10	-	-	10	-	pC
$C_{S(OFF)}$, Input Switch Capacitance	+25°C	-	10	-	-	10	-	pF
$C_{D(OFF)}$, Output Switch Capacitance	+25°C	-	10	-	-	10	-	pF
$C_{D(ON)}$, Output Switch Capacitance	+25°C	-	30	-	-	30	-	pF
C_A, Digital Input Capacitance	+25°C	-	18	-	-	18	-	pF
$C_{DS(OFF)}$, Drain-To-Source Capacitance	+25°C	-	0.5	-	-	0.5	-	pF
POWER REQUIREMENTS (Note 8)								
P_D, Power Dissipation	+25°C	-	120	-	-	120	-	mW
	Full	-	-	240	-	-	240	mW
I^+, Current (Pin 13)	+25°C	-	4.5	-	-	4.5	-	mA
	Full	-	-	10.0	-	-	10.0	mA
I^-, Current (Pin 4)	+25°C	-	3.5	-	-	3.5	-	mA
	Full	-	-	6	-	-	6	mA

NOTES:
1. Absolute maximum ratings are limiting values, applied individually, beyond which the serviceability of the circuit may be impaired. Functional operability under any of these conditions is not necessarily implied.
2. Derate 8mW/°C above T_A = +75°C, $\theta_{ja} \approx 100°C/W$, $\theta_{jc} = 32°C/W$.
3. $V_{OUT} = \pm 10V$, $I_{OUT} = 1mA$.
4. $R_L = 1k\Omega$, $C_L = 35pF$, $V_{IN} = +10V$, $V_A = +3V$. (See Switching Waveforms).
5. $V_A = 3V$, $R_L = 1k\Omega$, $C_L = 10pF$, $V_{IN} = 3V_{RMS}$, f = 100kHz.
6. $V_A = 3V$, $R_L = 1k\Omega$, $V_{IN} = 3V_{RMS}$, f = 100kHz.
7. $C_L = 1000pF$, $V_{IN} = 0V$, $R_{IN} = 0\Omega$, $\Delta Q = C_L \times \Delta V_O$.
8. $V_A = 3V$ or $V_A = 0$ for all switches.
9. $V_A = 4V$.

Test Circuit

SWITCHING TEST CIRCUIT (t_{ON}, t_{OFF1}, t_{OFF2})

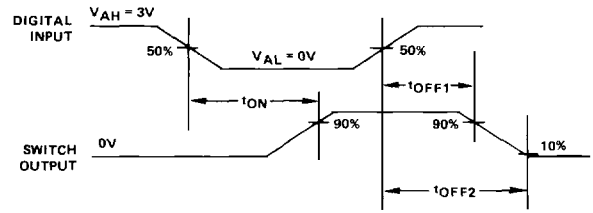


$$V_O = V_{IN} \frac{R_L}{R_L + R_{ON}}$$

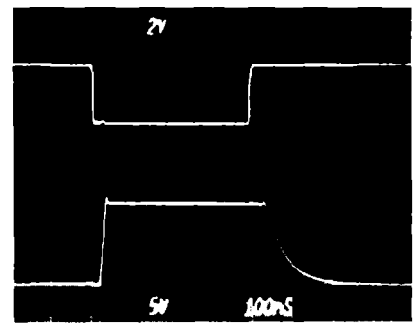
C_L INCLUDES $C_{FIXTURE} + C_{PROBE}$

Switching Waveforms

LOGIC "0" = SWITCH ON



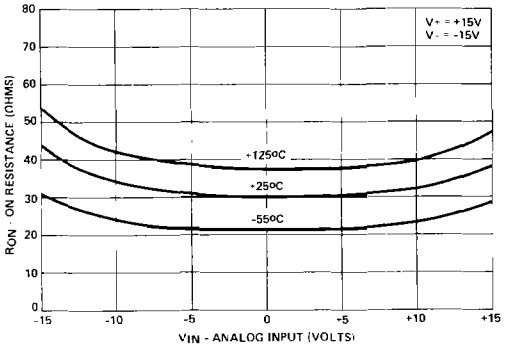
t_{ON}, t_{OFF}(TTL INPUT)
V_{AH} = +3.0V



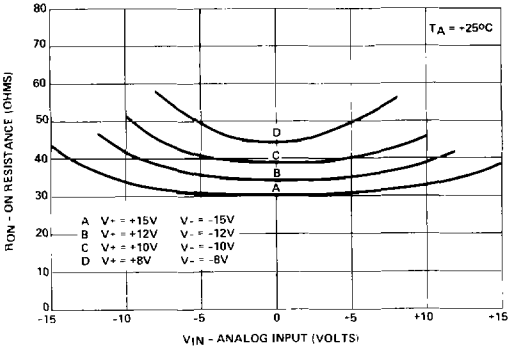
TOP: TTL Input (2V/Div.)
BOTTOM: Output (5V/Div.) HORIZONTAL: 100ns/Div.

Typical Performance Curves

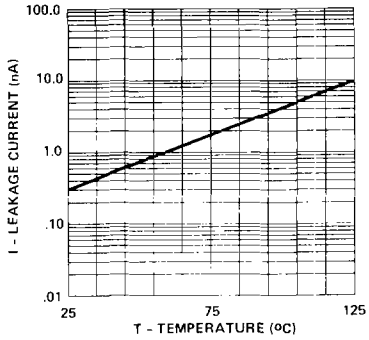
"ON" RESISTANCE vs. ANALOG SIGNAL LEVEL AND TEMPERATURE



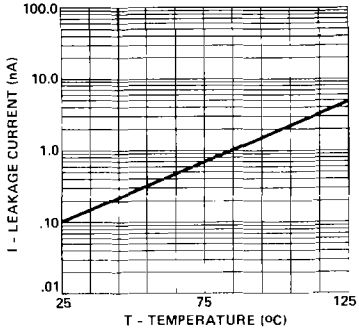
"ON" RESISTANCE vs. ANALOG SIGNAL LEVEL AND POWER SUPPLY VOLTAGE



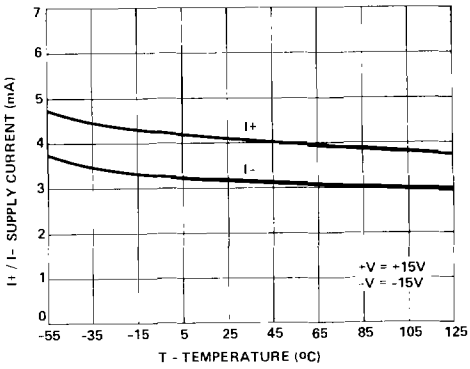
$I_{S(OFF)}$ OR $I_{D(OFF)}$ vs. TEMPERATURE*



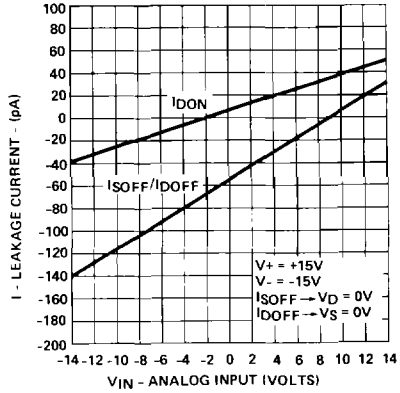
$I_{D(ON)}$ vs. TEMPERATURE*



SUPPLY CURRENT vs. TEMPERATURE



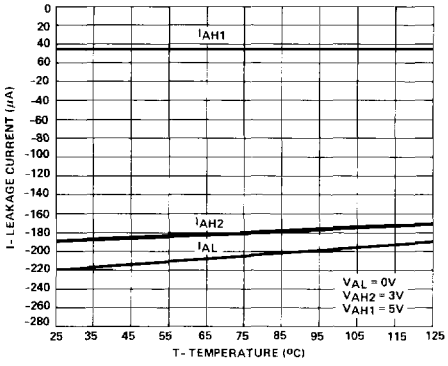
LEAKAGE CURRENT vs. ANALOG INPUT VOLTAGE



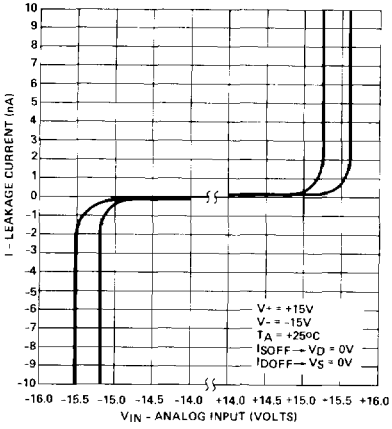
* THEORETICALLY, LEAKAGE CURRENT WILL CONTINUE TO DECREASE BELOW +25°C. BUT DUE TO ENVIRONMENTAL CONDITIONS, LEAKAGE MEASUREMENTS BELOW THIS TEMPERATURE ARE NOT REPRESENTATIVE OF ACTUAL SWITCH PERFORMANCE.

Typical Performance Curves (Continued)

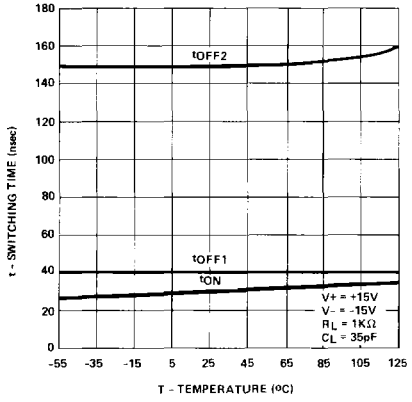
DIGITAL INPUT LEAKAGE CURRENT vs. TEMPERATURE*



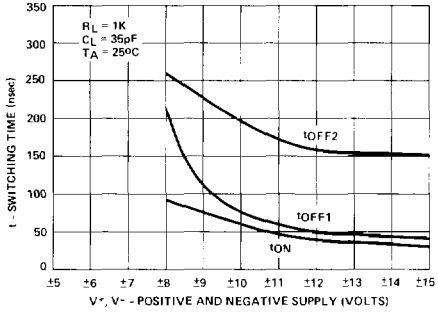
LEAKAGE CURRENT vs. ANALOG INPUT VOLTAGE
(V_{IN} > +14V, V_{IN} < -14V)



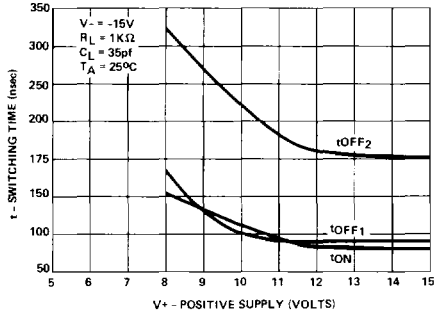
SWITCHING TIME vs. TEMPERATURE



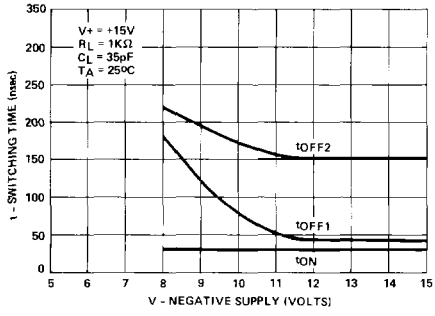
SWITCHING TIME vs. POSITIVE AND NEGATIVE SUPPLY VOLTAGE



SWITCHING TIME vs. POSITIVE SUPPLY VOLTAGE



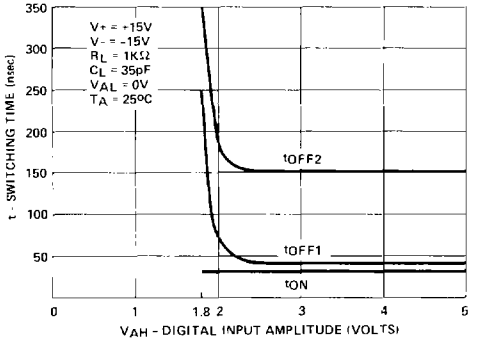
SWITCHING TIME vs. NEGATIVE SUPPLY VOLTAGE



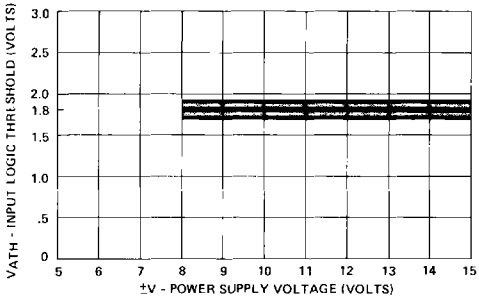
* THEORETICALLY, LEAKAGE CURRENT WILL CONTINUE TO DECREASE BELOW +25°C. BUT DUE TO ENVIRONMENTAL CONDITIONS, LEAKAGE MEASUREMENTS BELOW THIS TEMPERATURE ARE NOT REPRESENTATIVE OF ACTUAL SWITCH PERFORMANCE.

Typical Performance Curves (Continued)

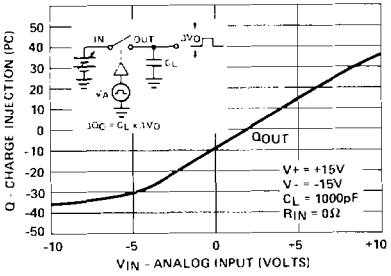
SWITCHING TIME vs. INPUT LOGIC AMPLITUDE



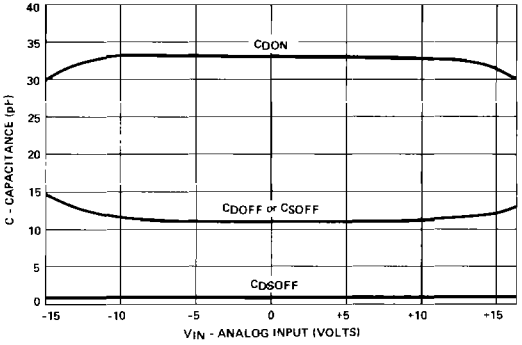
INPUT SWITCHING THRESHOLD vs. POSITIVE AND NEGATIVE SUPPLY VOLTAGES



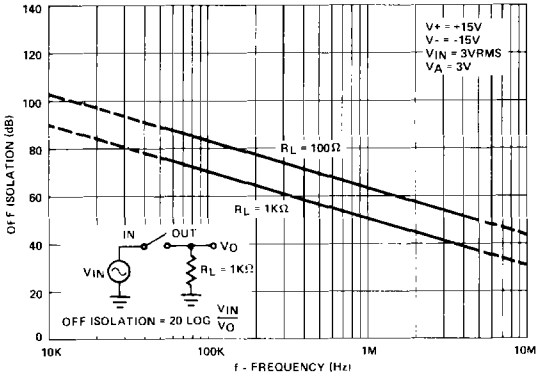
CHARGE INJECTION vs. ANALOG INPUT



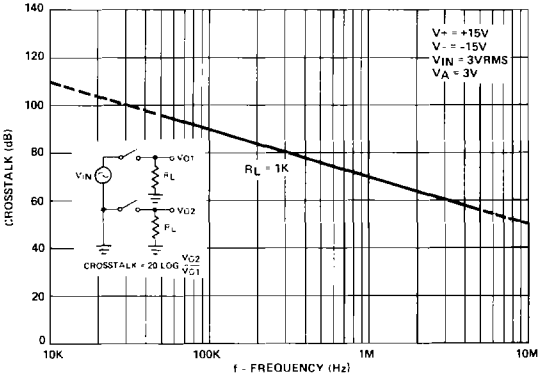
CAPACITANCE vs. ANALOG INPUT



OFF ISOLATION vs. FREQUENCY



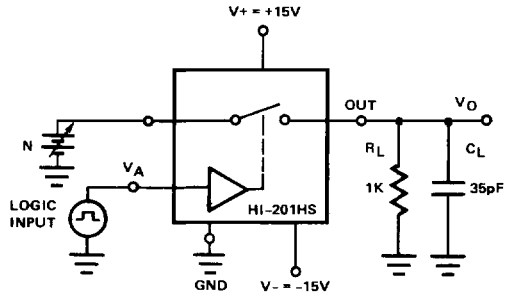
CROSSTALK vs. FREQUENCY



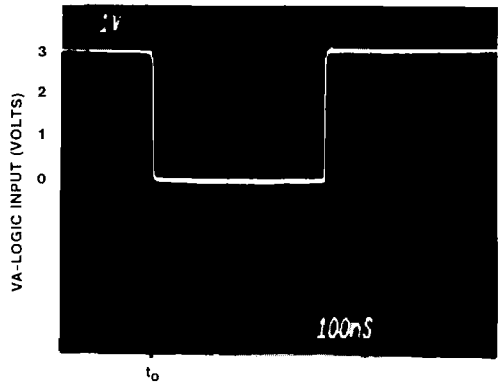
Switching Characteristics

SWITCHING CHARACTERISTICS vs. INPUT VOLTAGE

Typical delay, t_{ON}, t_{OFF}, settling time and switching transients in this circuit.

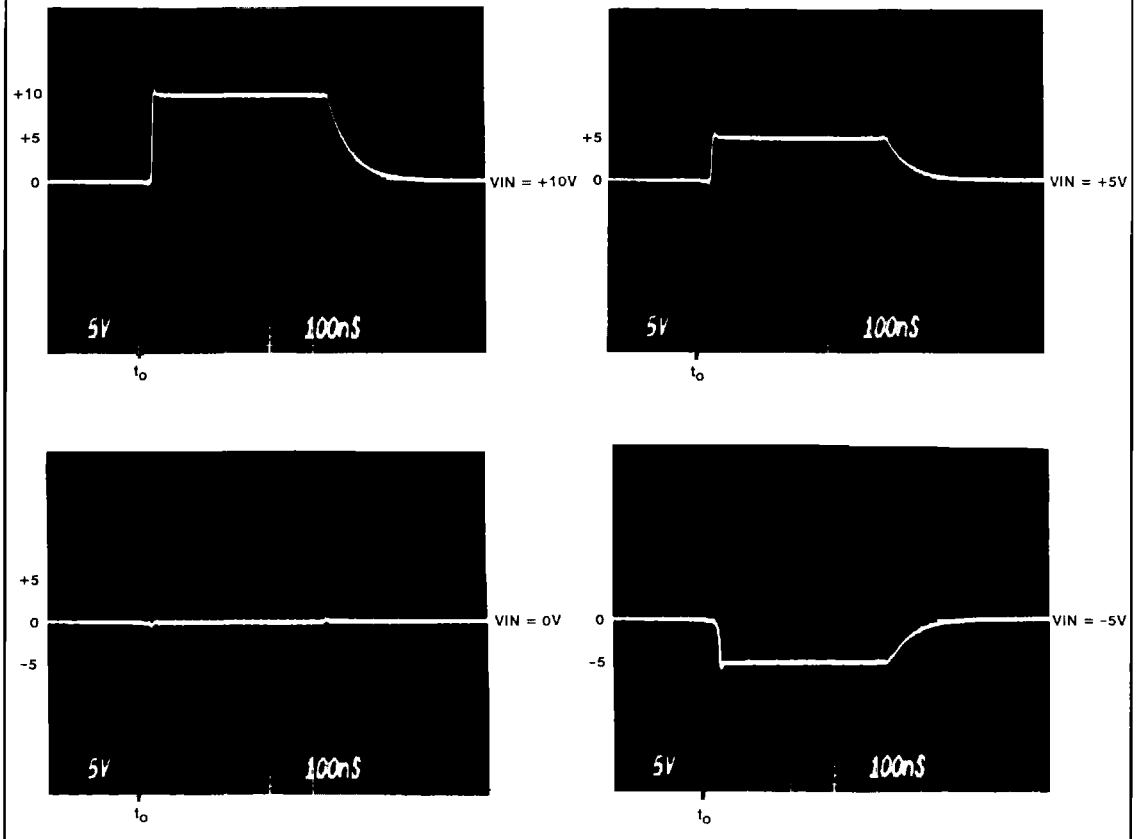


LOGIC INPUT



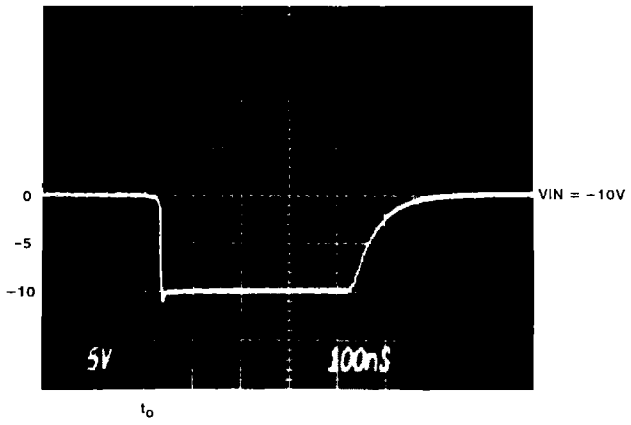
If R_L or C_L is increased, there will be corresponding increases in rise and/or fall RC times.

V_O - OUTPUT SWITCHING WAVEFORMS



Switching Characteristics (Continued)

V_O - OUTPUT SWITCHING WAVEFORMS



Application Information

LOGIC COMPATIBILITY

The HI-201HS is TTL compatible. Its logic inputs (Pins 1, 8, 9, 16) are designed to react to digital inputs which exceed a fixed, internally generated TTL switching threshold. The HI-201HS can also be driven with CMOS logic (0-15V), although the switch performance with CMOS logic will be inferior to that with TTL logic (0-5V).

The logic input design of the HI-201HS is largely responsible for its fast switching speed. It is a design which features a unique input stage consisting of complementary vertical PNP and NPN bipolar transistors. This design differs from that of the standard HI-201 product where the logic inputs are MOS transistors.

Although the new logic design enhances the switching speed performance, it also increases the logic input leakage currents. Therefore, the HI-201HS will exhibit larger digital input leakage currents in comparison to the standard HI-201 product.

CHARGE INJECTION

Charge injection is the charge transferred, through the internal gate-to-channel capacitances, from the digital logic input to the analog output. To optimize charge injection performance for the HI-201HS, it is advisable to provide a TTL logic input with fast rise and fall times.

If the power supplies are reduced from ±15V, charge injection will become increasingly dependent upon the digital input frequency. Increased logic input frequency will result in larger output error due to charge injection.

POWER SUPPLY CONSIDERATIONS

The electrical characteristics specified in this data sheet are guaranteed for power supplies $\pm V_S = \pm 15V$. Power supply voltages less than ±15V will result in reduced switch performance. The following information is intended as a design aid only:

POWER SUPPLY VOLTAGES	SWITCH PERFORMANCE
$\pm 12 < \pm V_S \pm 15V$	Minimal Variation
$\pm V_S < \pm 12V$	Parametric Variation becomes Increasingly Large (Increased ON Resistance, Longer Switching Times).
$\pm V_S < \pm 10V$	Not Recommended.
$\pm V_S > \pm 16V$	Not Recommended.

SINGLE SUPPLY

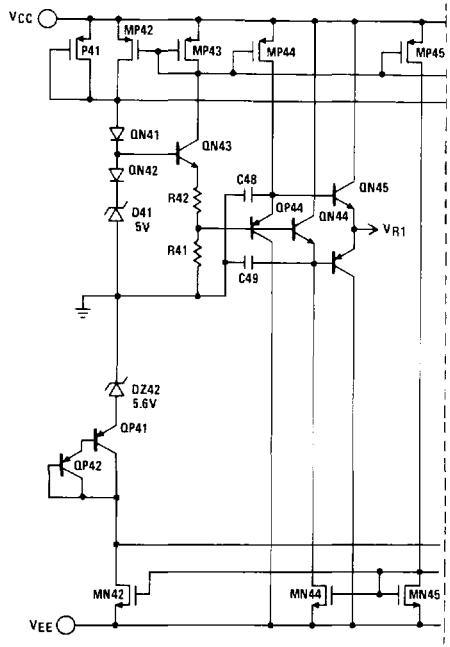
The switch operation of the HI-201HS is dependent upon an internally generated switching threshold voltage optimized for ±15V power supplies. The HI-201HS does not provide the necessary internal switching threshold in a single supply system. Therefore, if single supply operation is required, the HI-300 series of switches is recommended. The HI-300 series will remain operational to a minimum +5V single supply.

Switch performance will degrade as power supply voltage is reduced from optimum levels (±15V). So it is recommended that a single supply design be thoroughly evaluated to ensure that the switch will meet the requirements of the application.

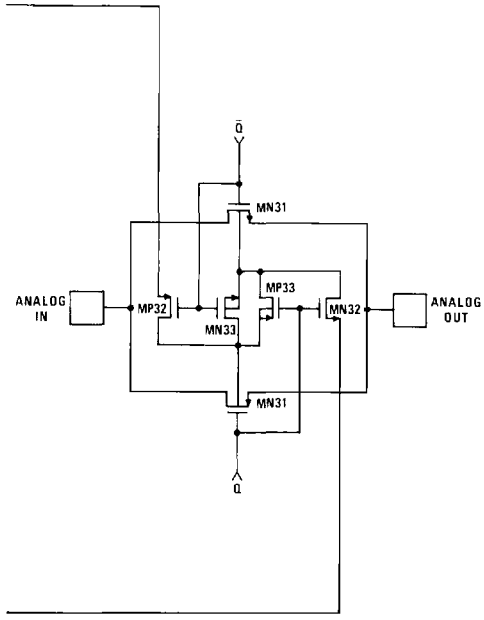
For Further Information See Application Notes 520, 521, 531, 532, 543 and 557 in Section 10 of Data Book.

Schematic Diagrams

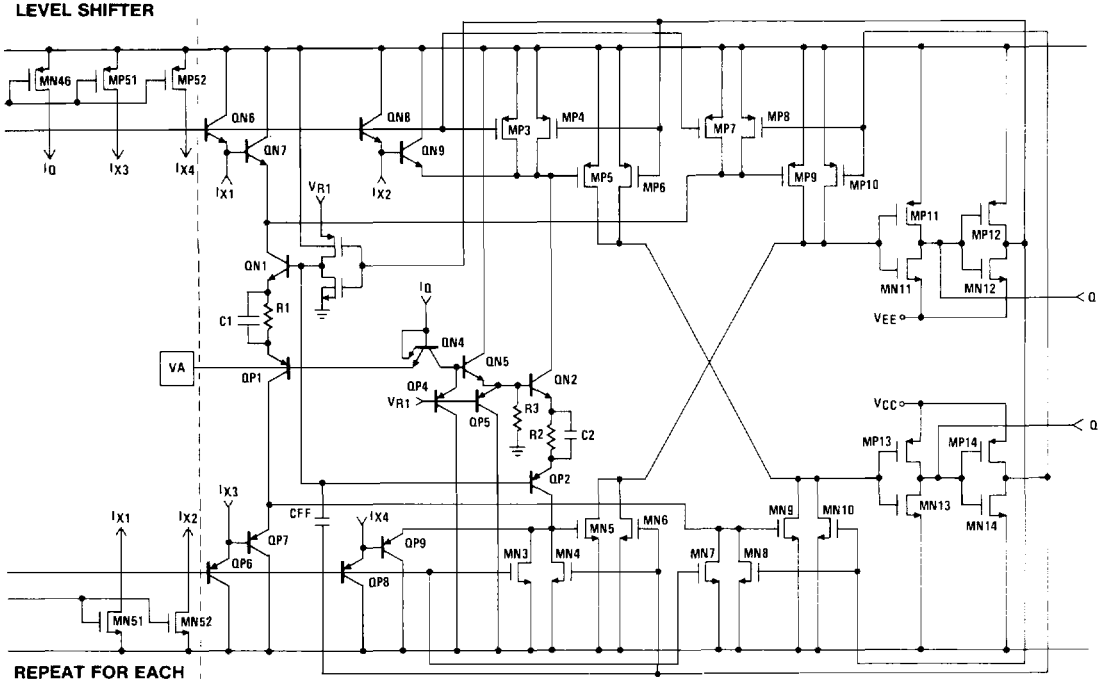
TTL/CMOS REFERENCE CIRCUIT



SWITCH CELL



DIGITAL INPUT AND LEVEL SHIFTER



REPEAT FOR EACH LEVEL SHIFTER