

**OBSOLETE PRODUCT  
NO RECOMMENDED REPLACEMENT  
Call Central Applications 1-800-442-7747  
or email: centapp@harris.com**

April 1999

## QUAD Varafet Analog Switch

### Features

- $r_{DS(ON)}$  (Typ) ..... 35Ω
- $I_{D(OFF)}$  (Typ) ..... 10pA
- Switching Times ( $R_L = 1k\Omega$ )
  - $t_{ON}$  ..... 25ns
  - $t_{OFF}$  ..... 75ns
- Built-In Overvoltage Protection ..... ±25V
- Charge Injection Error (Typ) into 0.01μF Capacitor .. 3mV
- $C_{ISS}$  (Typ) ..... <1pF
- Can Be Used for Hybrid Construction

### Part Number Information

PART NUMBER	TEMP. RANGE (°C)	PACKAGE
IH401A	-55 to 125	16 Ld CERDIP

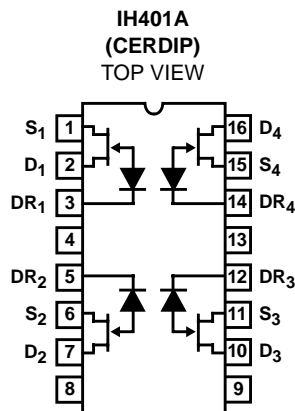
### Description

The IH401A is made up of 4 monolithically constructed combinations of varactor type diode and a N-Channel JFET. The JFET itself is very similar to the popular 2N4391, and the driver diode is specially designed, such that its capacitance is a strong function of the voltage across it. The driver diode is electrically in series with the gate of the N-Channel FET and simulates a back-to-back diode structure. This structure is needed to prevent forward biasing the source-to-gate or drain-to-gate junctions of the JFET when used in switching applications.

Previous applications of JFETs required the addition of diodes, in series with the gate, and then perhaps a gate-to-source referral resistor or a capacitor in parallel with the diode; therefore, at least 3 components were required to perform the switch function. The IH401A does this same job in one component (with a great deal better performance characteristics).

Like a standard JFET, the practically perform a solid state switch function translator should be added to drive the diode. This translator takes the TTL levels and converts them to voltages required to drive the diode/FET system (typically a 0V to -15V translation and a 3V to +15V shift). With ±15V power supplies, the IH401A will typically switch 22V<sub>p-p</sub> at any frequency from DC to 20MHz, with less than 50Ω  $r_{DS(ON)}$ .

### Pinout



# IH401A

## Absolute Maximum Ratings

Supply Voltage  
 $V_S$  to  $V_D$  ..... 35V  
 $V_G$  to  $V_S, V_D$  ..... 35V

## Thermal Information

Maximum Junction Temperature (Ceramic Package) ..... 175°C  
 Storage Temperature Range ..... -65°C to 150°C  
 Lead Temperature (Soldering, 10s) ..... 300°C

## Operating Conditions

Temperature Range ..... 55°C to 125°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 At 25°C/125°C

PARAMETER	SYMBOL	TEST CONDITIONS	MIN	TYP	MAX	UNITS
Switch "ON" Resistance	$r_{DS(ON)}$	$V_{DRIVE} = 15V,$ $V_{DRAIN} = -10V,$ $I_D = 10mA$	-	35	50	$\Omega$
Pinch-Off Voltage	$V_P$	$I_D = 1nA, V_{DS} = 10V$	2	4	5	V
Switch "OFF" Current or "OFF" Leakage	$I_{D(OFF)}$	$V_{DRIVE} = -15V,$ $V_{SOURCE} = -10V,$ $V_{DRAIN} = +10V$	-	10	$\pm 500$	pA
Switch "OFF" Leakage at 125°C	$I_{D(OFF)}$	$V_{DRIVE} = -15V,$ $V_{SOURCE} = -10V,$ $V_{DRAIN} = +10V$	-	0.25	50	nA
Switch "OFF" Current	$I_{S(OFF)}$	$V_{DRIVE} = -15V,$ $V_{DRAIN} = -10V,$ $V_{SOURCE} = +10V$	-	10	$\pm 500$	pA
Switch "OFF" Leakage at 125°C	$I_{S(OFF)}$	$V_{DRIVE} = -15V,$ $V_{SOURCE} = -10V,$ $V_{DRAIN} = +10V$	-	0.3	50	nA
Switch Leakage When Turned "ON"	$I_{D(ON)} =$ $I_{S(ON)}$	$V_D = V_S = -10V,$ $V_{DRIVE} = +15V$	-	0.02	$\pm 2$	nA
AC Input Voltage Range without Distortion	$V_{ANALOG}$	See Figure 2	20	22	-	$V_{P-P}$
Charge Injection Amplitude	$V_{INJECT}$	See Figure 3	-	3	-	mV <sub>P-P</sub>
Diode Reverse Breakdown Voltage. This Correlates to Overvoltage Protection	$BV_{DIODE}$	$V_D = V_S = -V,$ $I_{DRIVE} = 1\mu A,$ $DRIVE = 0V$	-30	-45	-	V
Gate to Source or Gate to Drain Reverse Breakdown Voltage	$BV_{GSS}$	$V_{DRIVE} = -V,$ $V_D = V_S = 0V,$ $DRIVE = 1\mu A$	30	41	-	V
Maximum Current Switch can Deliver (Pulsed)	$I_{DSS}$	$V_{DRIVE} = 15V,$ $V_S = 0V,$ $D = +10V$	35	55	-	mA
Switch "ON" Time (Note 1)	$t_{ON}$	See Figure 1	-	50	-	ns
Switch "OFF" Time (Note 1)	$t_{OFF}$	See Figure 1	-	150	-	ns

### NOTE:

1. Driving waveform must be >100ns rise and fall time.

**Test Circuits**

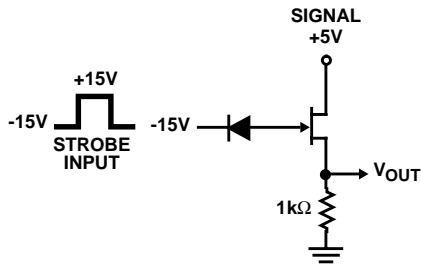


FIGURE 1. SWITCHING TIME TEST CIRCUIT AND WAVEFORMS

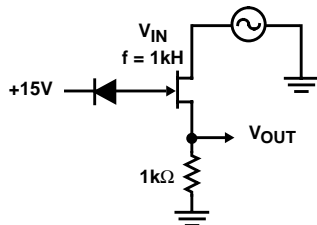


FIGURE 2. ANALOG INPUT VOLTAGE RANGE TEST CIRCUIT

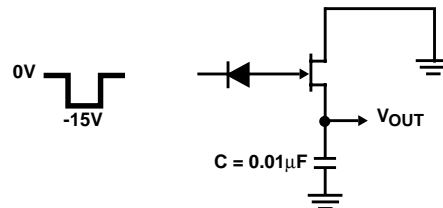


FIGURE 3. CHARGE INJECTION TEST CIRCUIT

**Applications**

**IH401A Family**

In general, the IH401A family can be used in any application formally using a JFET/isolation diode combination (2N4391 or similar). Like standard FET circuits, the IH401A requires a translator for normal analog switch function. The translator is used to boost the TTL input signals to the  $\pm 15V$  analog supply levels which allow the IH401A to handle  $\pm 10V$  analog signals. A typical simple PNP translator is shown in Figure 4.

A translator which overcomes the problems of the simple PNP stage is the Harris IH6201 (See Note). This translator driving an IH401A varafet produces the following typical features:

- $t_{ON}$  time of approx. 200ns
- $t_{OFF}$  time of approx. 80ns
- TTL compatible strobing levels of  $0.4V \overset{2.4V}{\square}$
- $I_{D(ON)} + I_{S(ON)}$  typically 20pA up to  $\pm 10V$  analog signals
- $I_{D(OFF)}$  or  $I_{S(OFF)}$  typically 20pA
- Quiescent current drain of approx. 100nA in either "ON" or "OFF" case

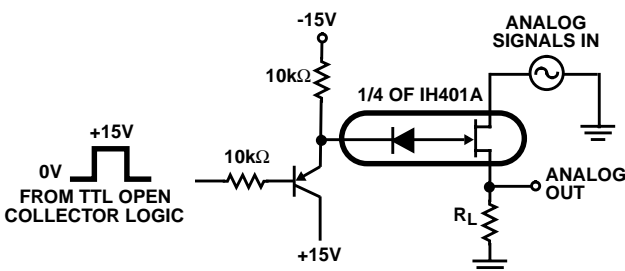


FIGURE 4. TYPICAL SIMPLE PNP TRANSLATOR

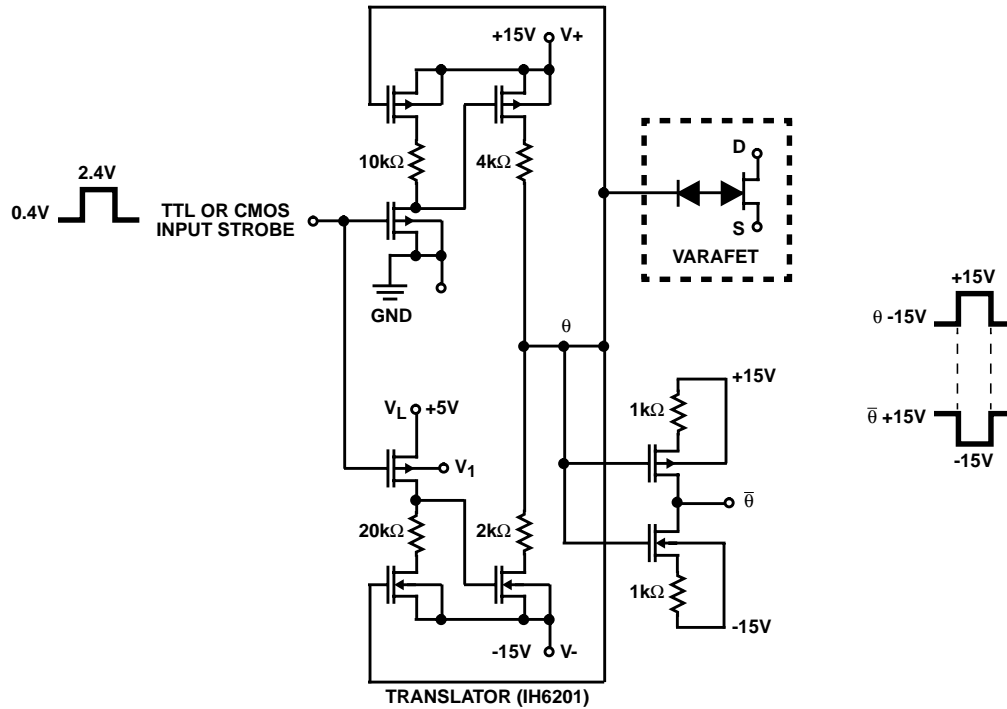
Although this simple PNP circuit represents a minimum of components, it requires open collector TTL input and  $t_{OFF}$  is limited by the collector load resistor (approximately  $1.5\mu s$  for  $10k\Omega$ ). Improved switching speed can be obtained by increasing the complexity of the translator stage.

NOTE: The IH6201 is a dual translator (two independent translators per package) constructed from monolithic CMOS technology. The schematic of one-half IH6201, driving one-fourth of an IH401A, is shown in Figure 5.

A very useful feature of this system is that one-half of an IH6201 and one-half of an IH401A can combine to make a SPDT switch, or an IH6201 plus an IH401A can make a dual SPDT analog switch. (See Figure 8)

# IH401A

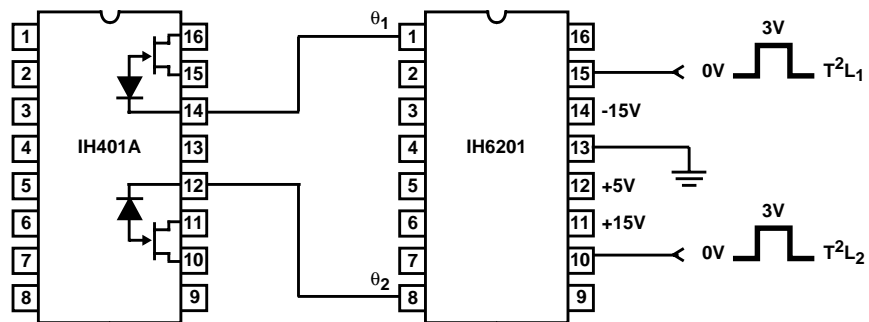
## Typical Application Schematic $(\frac{1}{2}$ of IH401A, Driving $\frac{1}{4}$ of an IH401A)



NOTE: Each transistor output has a  $\theta$  and output.  $\bar{\theta}$  is just the inverse of  $\theta$ , i.e., ( $\bar{\theta}$  output is 180 degrees out of phase with respect to  $\theta$  output).

FIGURE 5. IH6201 DRIVING AN IH401A

## Switching Information



NOTE: Either switch is turned on when strobe input goes high.

FIGURE 6. DUAL SPST ANALOG SWITCH

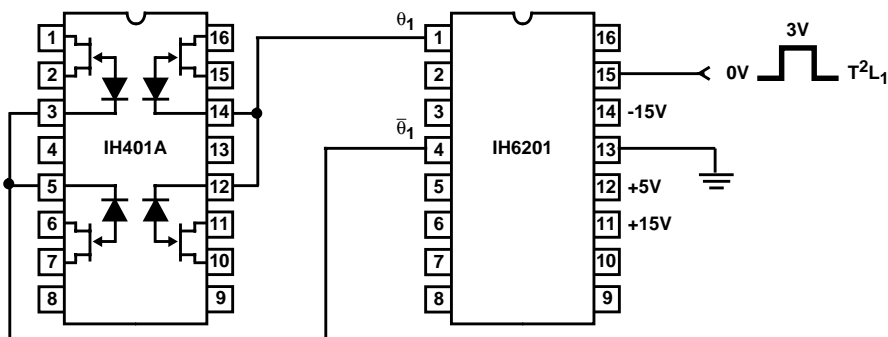


FIGURE 7. DPDT ANALOG SWITCH

# IH401A

## Switching Information (Continued)

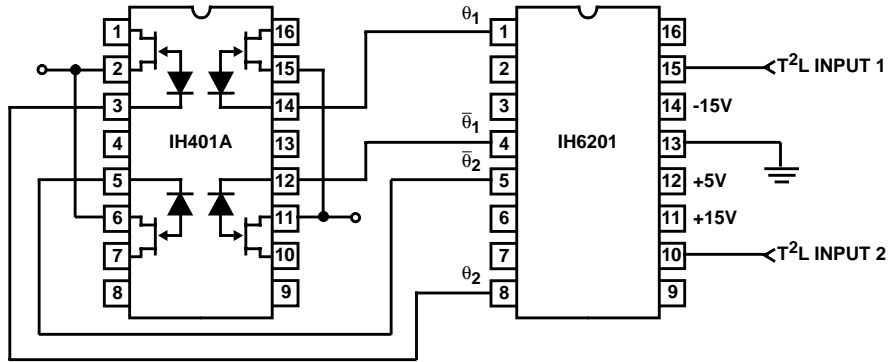


FIGURE 8. DUAL SPDT ANALOG SWITCH

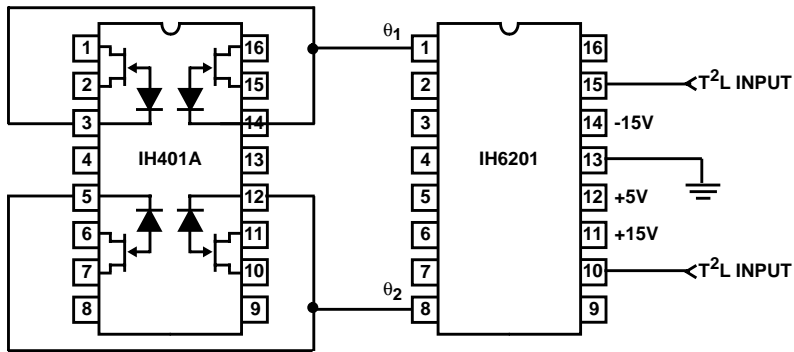


FIGURE 9. DUAL DPST ANALOG SWITCH