

Quad Bilateral Switch

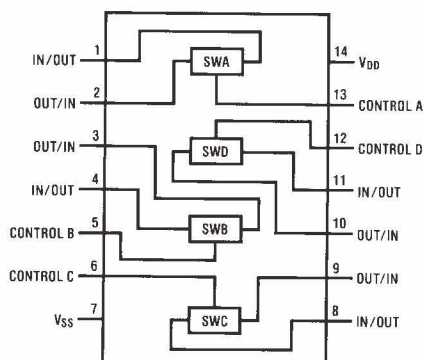
■ DESCRIPTION

The TK4016 is a quad bilateral switch intended for the transmission or multiplexing of analog or digital signals. Each of the four independent bilateral switches has a single control signal input, can convert analog-to-digital or digital-to-analog.

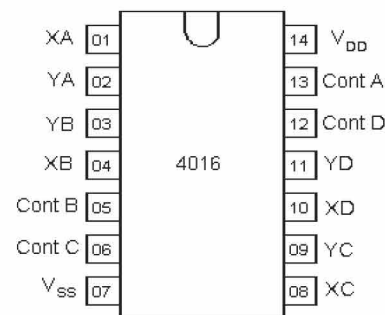
■ FEATURES

- Wide supply voltage range: 3V to 15V
- Maximum input current of 1 μ A at 18 V over full package-temperature range; 100 nA at 18 V and 25°C
- High-voltage type of 20V rating
- "ON" resistance for 15V operation: 400 Ω (typ.)
- Matched "ON" resistance over 15V signal input: $\Delta R_{ON} = 10 \Omega$ (typ.)
- High degree of linearity:
0.4% distortion (typ.) @ $f_{IS} = 1 \text{ kHz}$, $V_{IS} = 5V_{p-p}$
 $V_{DD} - V_{SS} = 10V$, $R_L = 10 \text{ k}\Omega$
- Extremely low "OFF" switch leakage:
0.1 nA (typ.) @ $V_{DD} - V_{SS} = 10V$, $T_A = 25^\circ \text{C}$
- Extremely high control input impedance: 10^{12} (typ.)
- Low crosstalk between switches:
-50 dB (typ.) @ $f_{IS} = 0.9 \text{ MHz}$, $R_L = 1 \text{ k}\Omega$
- Frequency response, switch "ON": 40 MHz (typ.)
- $T_A = -40^\circ$ to 125°C for all packages

■ LOGIC DIAGRAM



■ PIN ASSIGNMENT



■ FUNCTION TABLE

INPUT of Control	Analog Switch Mode
L	Close
H	Open

■ Ordering information

Part Number	Package	Packing	Operating Temperature	Standard Package
TK4016BM	SOIC-14	Reel	-40°C ~ 125°C	2500
TK4016BP	TSSOP-14	Reel	-40°C ~ 125°C	2500
TK4016BE	DIP-14	Tube	-40°C ~ 125°C	1000

■ MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_{CC}	DC Supply Voltage (Referenced to GND)	-0.5 to +18V	V
V_{IN}	DC Input Voltage (Referenced to GND)	-0.5 to V_{DD} 0.5	V
V_{OUT}	DC Output Voltage (Referenced to GND)	-0.5 to V_{DD} 0.5	V
I_{IN}	DC Input Current, per Pin	± 10	mA
P_D	Power Dissipation in Plastic DIP+ SOIC Package+	700 500	mW
P_D	Power Dissipation per Output Transistor	100	mW
Tstg	Storage Temperature	-55 to 150	°C
T_L	Lead Temperature, 1 mm from Case for 10 Seconds (Plastic DIP or SOIC Package)	260	°C

■ RECOMMENDED OPERATING CONDITIONS

Symbol	Parameter	Min	Max	Unit
V_{CC}	DC Supply Voltage (Referenced to GND)	3	15	V
V_{IN}, V_{OUT}	DC Input Voltage, Output Voltage (Referenced to GND)	0	V_{DD}	V
T_A	Operating Temperature, All Package Types	-40	125	°C

■ DC Electrical Characteristics (Note 2)

Parameter, Units	Symbol	Conditions, Units				Limits					
						-55°C		125°C		25°C	
		V_{IL} , V	V_{IH} , V	I_O , mA	V_{DD} , V	Min	Max	Min	Max	Min	Max
Low Level Input Voltage, V	V_{ILC}		-	-	5.0	-	0.9	-	0.4	-	0.7
			-	-	10	-	0.9	-	0.4	-	0.7
			-	-	15	-	0.9	-	0.4	-	0.7
High Level Input Voltage, V	V_{IHC}		-	-	5.0	3.5	-	3.5	-	3.5	-
			-	-	10	7	-	7	-	7	-
			-	-	15	11	-	11	-	11	-
Switch Output Voltage, V	V_{OS}	$V_{IS}=0$ B		0.25	5.0	0.4	-	-	-	-	-
				0.14	5.0	-	-	0.4	-	-	-
				0.2	5.0	-	-	-	-	0.4	-
				0.62	10	0.5	-	-	-	-	-
				0.36	10	-	-	0.5	-	-	-
				0.5	10	-	-	-	-	0.5	-
				1.8	15	1.5	-	-	-	-	-
				1.1	15	-	-	1.5	-	-	-
				1.5	15	-	-	-	-	1.5	-
		$V_{IS}=5.0$ V		-0.25	5.0	4.6	-	-	-	-	-
				-0.14	5.0	-	-	4.6	-	-	-
				-0.2	5.0	-	-	-	-	4.6	-
		$V_{IS}=10$ V		-0.62	10	9.5	-	-	-	-	-
				-0.36	10	-	-	9.5	-	-	-
				-0.5	10	-	-	-	-	9.5	-
		$V_{IS}=15$ V		-1.8	15	13.5	-	-	-	-	-
				-1.1	15	-	-	13.5	-	-	-
				-1.5	15	-	-	-	-	13.5	-

■ DC Electrical Characteristics (continue)

Parameter, Units	Symbol	Conditions, Units				Limits					
						-55°C		125°C		25°C	
		V_{IL} , V	V_{IH} , V	I_O , mA	V_{DD} , V	Min	Max	Min	Max	Min	Max
Input/Output Overshoot Voltage Amplitude, mV	$V_{A/O}$	$V_C=10\text{ V}$, $R_L=10\text{ k}\Omega$, $t_{LH}=t_{HL}\leq 20\text{ nsec}$			10	-	-	-	-	50*	
Quiescent Device Current, μA	I_{DD}		-	-	5.0	-	0.25	-	7.5	-	0.25
			-	-	10	-	0.5	-	15	-	0.5
			-	-	15	-	1.0	-	30	-	1.0
			-	-	20	-	5.0	-	150	-	5.0
Input/Output Leakage, μA	$I_{L/O}$	0	18	-	18	-	± 0.1	-	± 1.0	-	± 0.1
Low Level Input Current, μA	I_{IL}	0	-	-	18	-	-0.1	-	-1.0	-	-0.1
High Level Input Current, μA	I_{IH}		18	-	18	-	0.1	-	1.0	-	0.1

Note 3: If the switch input is held at V_{DD} , V_{IHC} is the control input level that will cause the switch output to meet the standard "B" series V_{OH} and I_{OH} output levels. If the analog switch input is connected to V_{SS} , V_{IHC} is the control input level — which allows the switch to sink standard "B" series $|I_{OH}|$, high level current, and still maintain a $V_{OL} \leq$ "B" series.

■ AC Electrical Characteristics (Note 4)
 $T_A = 25^{\circ}\text{C}$, $t_r = t_f = 20\text{ ns}$ and $V_{SS} = 0\text{V}$ unless otherwise specified

Parameter, Units	Symbol	Conditions,				Limits					
		Units				-55°C		+125°C		+25°C	
		V _{IL} , V	V _{IH} , V	I _O , mA	V _{DD} , V						
Propagation Delay Time Control Input to Signal Output Logical Level to High Impedance (Propagation Delay Time Control Input to Signal Output High Impedance to Logical Level), nsec	t _{PHZ} (t _{PZH}) t _{PLZ} (t _{PZL})	t _{LH} =t _{HL} ≤20 nsec, C _L =50 pF R _L =1 kOhm			5.0	-	70	-	140	-	70
					10	-	40	-	80	-	40
					15	-	30	-	60	-	30
Capacitance, pF - Signal Input - Signal Output	C _{IS} C _{OS}	V _C =V _{SS} =-5V			5.0	-	-	-	-	4*	
- Feedthrough Capacitance	C _{IOS}					-	-	-	-	0.2*	
- Control Input Capacitance	C _{IN}				5.0	-	-	-	-		7.5

* Typical value

Note 4: AC Parameters are guaranteed by DC correlated testing.

Note 5: These devices should not be connected to circuits with the power "ON".

Note 6: In all cases, there is approximately 5 pF of probe and jig capacitance on the output; however, this capacitance is included in C_L wherever it is specified.

Note 7: V_{IS} is the voltage at the in/out pin and V_{OS} is the voltage at the out/in pin. V_C is the voltage at the control input.

AC Electrical Characteristics (continue)

$T_A = 25^{\circ}\text{C}$, $t_r = t_f = 20\text{ ns}$ and $V_{SS} = 0\text{V}$ unless otherwise specified

Parameter, Units	Symbol	Conditions,				Limits					
		Units				-55°C		+125°C		+25°C	
		V_{IL} , V	V_{IH} , V	I_O , mA	V_{DD} , V	Min	Max	Min	Max	Min	Max
Harmonic Factor, %	Kh	$V_C=5\text{ V}$, $V_{SS}=-5\text{ V}$, $V_{IS}=5\text{ V}$, $R_L=10\text{ k}\Omega$, $f_{IS}=1\text{ kHz}$			5.0	-	-	-	-	0.4*	
Frequency Response – Switch “ON” (Frequency at -3dB), MHz	BW	$V_C=5\text{ V}$, $V_{SS}=-5\text{ V}$, $V_{IS}=5\text{ V}$, $R_L=1\text{ k}\Omega$, $C_L=50\text{ pF}$, $t_{LH}=t_{HL}\leq 20\text{ nsec}$ (Figure 4)			5.0	-	-	-	-	40*	
Frequency Response – Switch “OFF” (Frequency at -50dB), MHz	f_1	$V_C=5\text{ V}$, $V_{SS}=-5\text{ V}$, $V_{IS}=5\text{ V}$, $R_L=1\text{ k}\Omega$, $C_L=50\text{ pF}$, $t_{LH}=t_{HL}\leq 20\text{ nsec}$ (Figure 4)			5.0	-	-	-	-	1.25*	
Crosstalk Between Any Two Swithes (Frequency at -50dB), MHz	f_2	(Figure 5)			5.0	-	-	-	-	0.9*	
Switching Frequency, MHz	f_S	$V_C=10\text{ V}$, $V_{SS}=\text{GND}$, $V_{IS}=10\text{ V}$, $R_L=1\text{ k}\Omega$, $C_L=50\text{ pF}$, $t_{LH}=t_{HL}\leq 20\text{ nsec}$ $V_{OS}=1/2\text{ }V_{OS}$ under frequency 1 kHz			10	-	-	-	-	10*	
Propagation Delay Time Signal Input to Signal Output, nsec	t_{PHL} (t_{PLH})	$t_{LH}=t_{HL}\leq 20\text{ nsec}$, $C_L=50\text{ pF}$			5.0	-	70	-	200	-	100
		$R_L=200\text{ k}\Omega$			10	-	40	-	80	-	40
					15	-	30	-	60	-	30

* Typical value

Note 4: AC Parameters are guaranteed by DC correlated testing.

Note 5: These devices should not be connected to circuits with the power “ON”.

Note 6: In all cases, there is approximately 5 pF of probe and jig capacitance on the output; however, this capacitance is included in C_L wherever it is specified.

Note 7: V_{IS} is the voltage at the in/out pin and V_{OS} is the voltage at the out/in pin. V_C is the voltage at the control input.

■ AC Test Circuits and Switching Time Waveforms

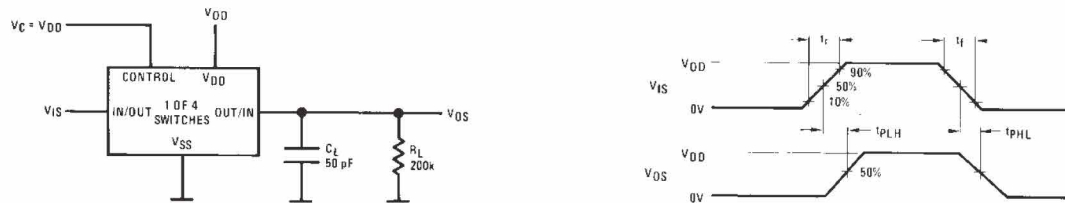


FIGURE 1. t_{PLH} , t_{PLH} Propagation Delay Time Control to Signal Output

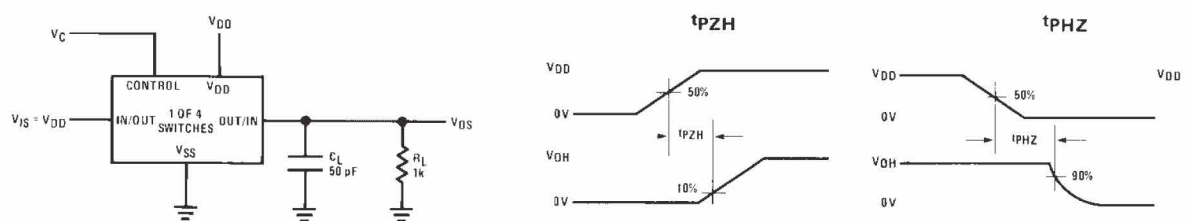


FIGURE 2. t_{PZH} , t_{PHZ} Propagation Delay Time Control to Signal Output

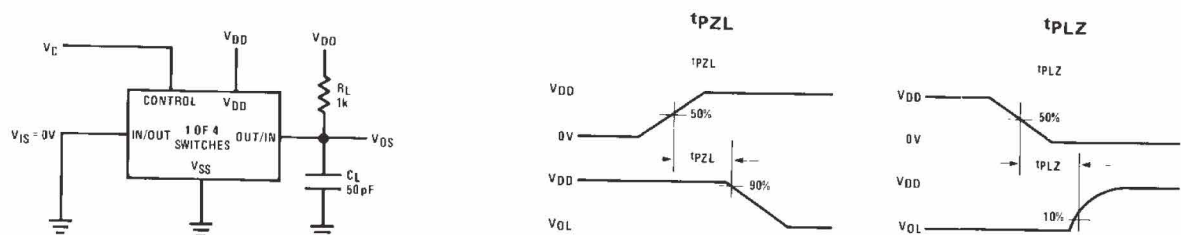


FIGURE 3. t_{PZH} , t_{PHZ} Propagation Delay Time Control to Signal Output

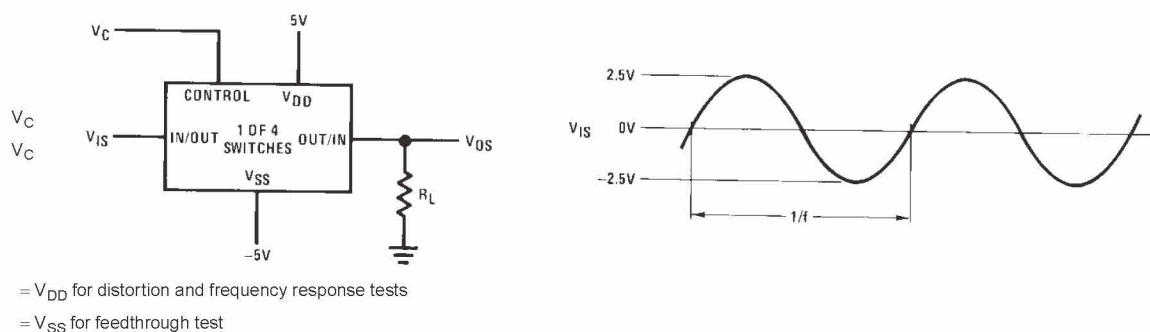


FIGURE 4. Sine Wave Distortion, Frequency Response and Feedthrough

■ AC Test Circuits and Switching Time Waveforms (Continued)

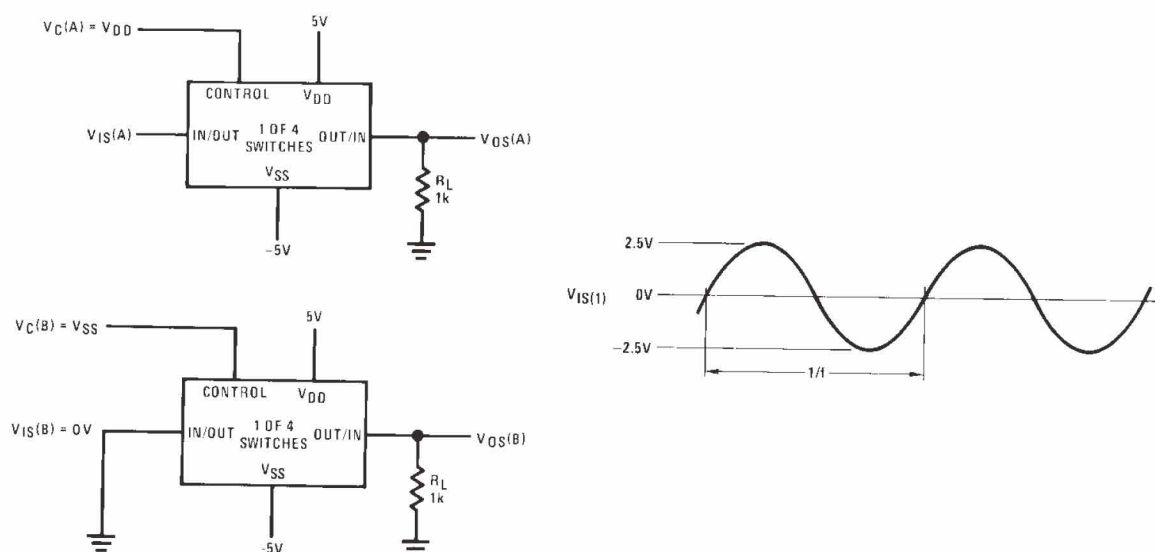


FIGURE 5. Crosstalk Between Any Two Switches

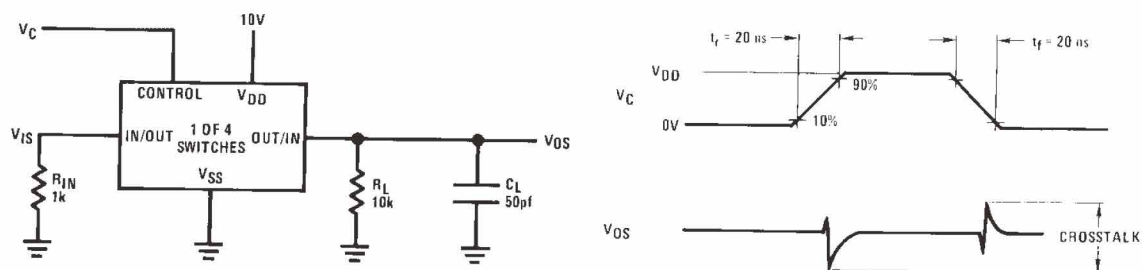


FIGURE 6. Crosstalk — Control to Input Signal Output

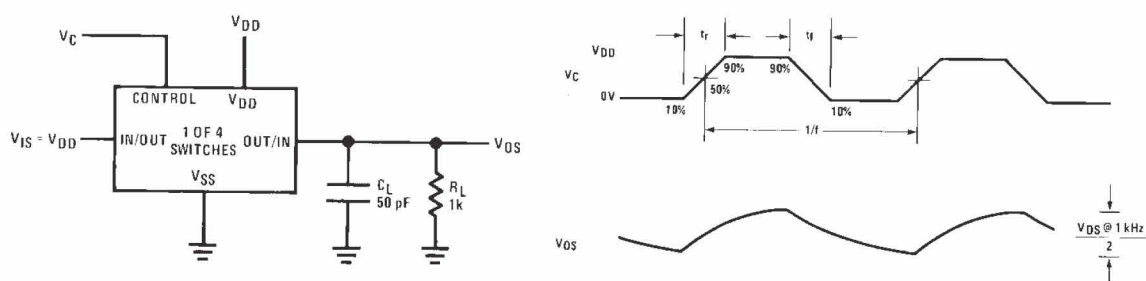
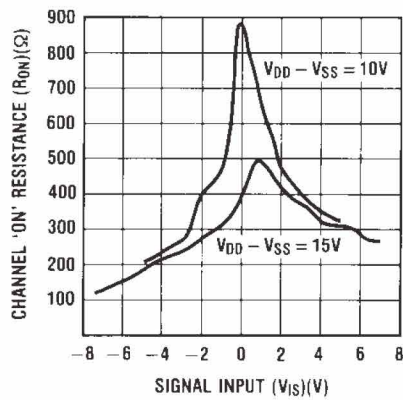


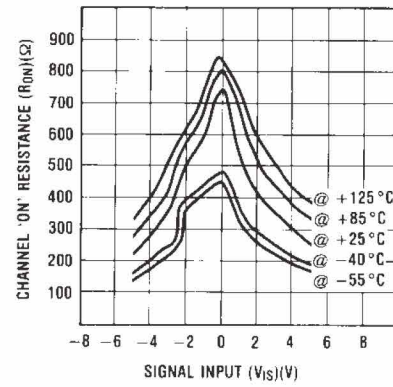
FIGURE 7. Maximum Control Input Frequency

■ Typical Performance Characteristics

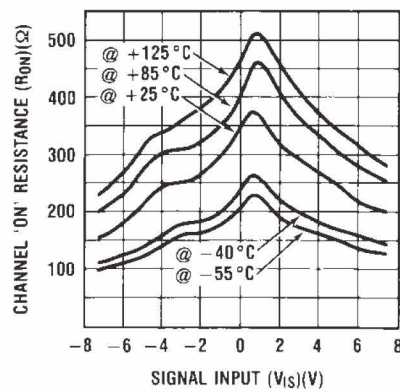
'ON' Resistance vs. Signal Voltage $T_A = 25^\circ\text{C}$



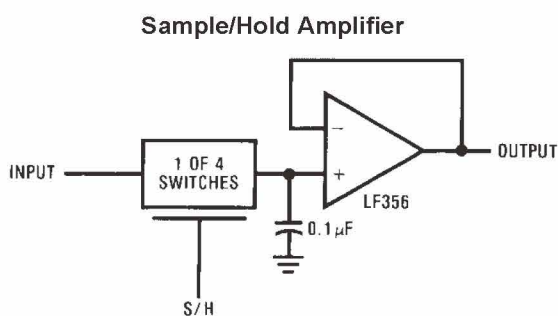
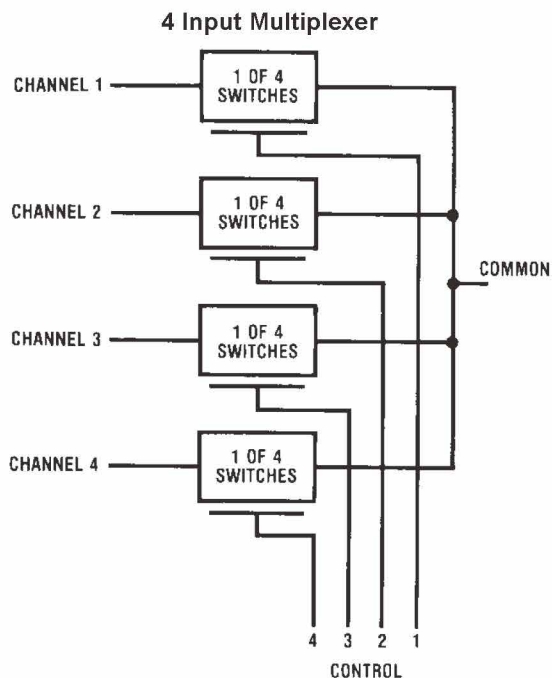
'ON' Resistance Temperature Variation for $V_{DD} - V_{SS} = 10\text{V}$



'ON' Resistance Temperature Variation for $V_{DD} - V_{SS} = 15\text{V}$



■ Typical Applications

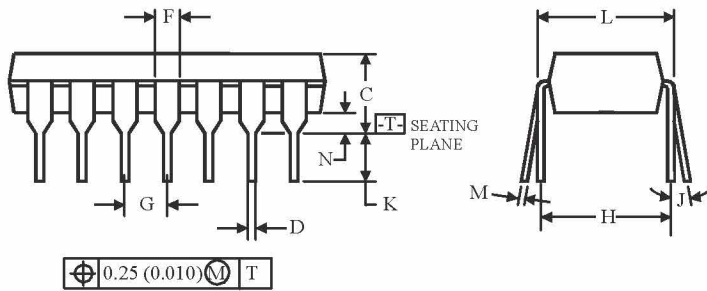
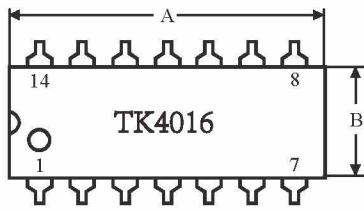


Special Considerations

The TK4016 is composed of 4, two-transistor analog switches. These switches do not have any linearization or compensation circuitry for " R_{ON} " as do the IW4066B's. Because of this, the special operating considerations for the IW4066B do not apply to the TK4016, but at low supply voltages, $\leq 5V$, the TK4016's on resistance becomes

non-linear. It is recommended that at 5V, voltages on the in/out pins be maintained within about 1V of either V_{DD} or V_{SS} ; and that at 3V the voltages on the in/out pins should be at V_{DD} or V_{SS} for reliable operation.

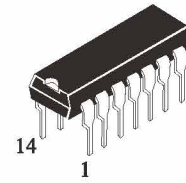
N SUFFIX PLASTIC DIP



$\oplus 0.25 (0.010) \text{ (M) T}$

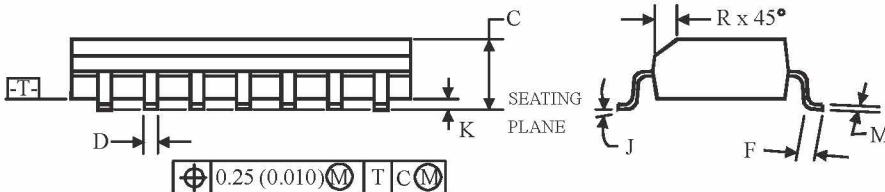
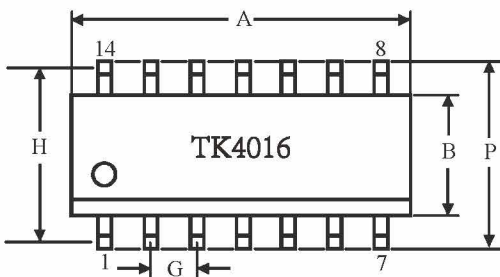
NOTES:

1. Dimensions "A", "B" do not include mold flash or protrusions. Maximum mold flash or protrusions 0.25 mm (0.010) per side.



Symbol	Dimensions, mm	
	MIN	MAX
A	18.67	19.69
B	6.10	7.11
C		5.33
D	0.36	0.56
F	1.14	1.78
G	2.54	
H	7.62	
J	0°	10°
K	2.92	3.81
L	7.62	8.26
M	0.20	0.36
N	0.38	

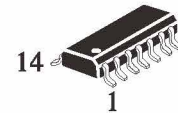
D SUFFIX SOIC



$\oplus 0.25 (0.010) \text{ (M) T C (M)}$

NOTES:

1. Dimensions A and B do not include mold flash or protrusion.
2. Maximum mold flash or protrusion 0.15 mm (0.006) per side for A; for B - 0.25 mm (0.010) per side.



Symbol.	Dimensions, mm	
	MIN	MAX
A	8.55	8.75
B	3.80	4.00
C	1.35	1.75
D	0.33	0.51
F	0.40	1.27
G	1.27	
H	5.72	
J	0°	8°
K	0.10	0.25
M	0.19	0.25
P	5.80	6.20
R	0.25	0.50