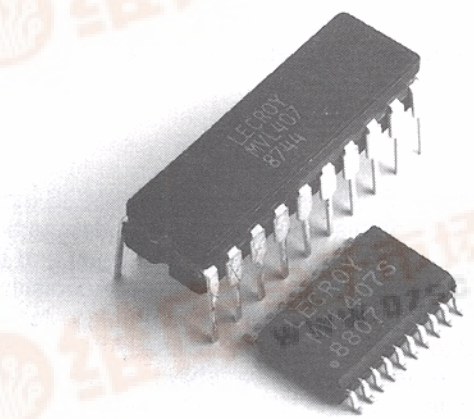
MVL407, MVL407S
Monolithic Voltage Comparator

MVL407 4-CHANNEL VOLTAGE COMPARATOR
MVL407S 4-CHANNEL VOLTAGE COMPARATOR



- 400 MHz Operation
- 3.5 nsec Propagation Delay
- Built-in 4.8 mV Hysteresis
- 50 Ω Line Drive Capability
- 4 Comparators/Device
- 100 mW/Channel Typical Power Dissipation
- Complementary ECL Outputs
- Available in 20-Pin DIP or SOIC Packages
- Low Cost

ULTRA-FAST COMPARATOR FOR DISCRIMINATORS, TDCS AND WIRE CHAMBER FRONT-ENDS

The Model MVL407 and the Model MVL407S are quad voltage comparators designed for applications requiring ultra-high speed and accurate timing. The devices are manufactured using a high speed bipolar process which results in an extremely short (3.5 nsec) propagation delay with operation at speeds in excess of 400 MHz. The comparators are available in two types of package; a standard 20-pin DIP (MVL407), or a surface-mount version in a SOIC (Small Outline IC) package (MVL407S). Unpackaged die are also available (MVL407D).

The MVL407 incorporates a unique hysteresis feature for exceptionally clean operation. When the comparator changes state, an internal differential input offset of about 4.8 mV is generated. This positive feedback drives the device quickly through its switching region, greatly reducing the possibility of oscillation or output chatter with small or slowly changing inputs. The propagation delay is typically 3.5 nsec and changes by only 100 psec across a 5 to 100 mV overdrive range. This very low delay variation makes these comparators extremely useful in critical timing applications.

Each channel provides differential inputs and complementary outputs compatible with the ECL logic family. The outputs can drive 50 Ω loads or 100 Ω twisted pair. (External pull-down resistors are required.)

For evaluation and prototyping, the Model MVL407PK is recommended. It consists of a single MVL407 mounted on a printed circuit

SPECIFICATIONS

MVL407, MVL407S

MAXIMUM RATING	Symbol	Parameter	Min	Typ	Max	Units	Comments
	V_{CC}	Positive Supply Voltage		+5.00	+6.00	V	
	V_{EE}	Negative Supply Voltage		-5.20	-6.00	V	
		Input Voltage			±4.00	V	
		Differential Input Voltage			±4.00	V	
		Output Current		30.00		mA	Per output pin
		Power Dissipation		800.00		mW	
	T	Operating Temperature	-20.00	25.00	+70.00	° C	

ELECTRICAL CHARACTERISTICS	Symbol	Parameter	Min	Typ	Max	Units	Comments
	I_{OS}	Input offset current	-0.50	±0.05	+0.50	µA	See Fig. 1
	$\Delta I_{OS}/\Delta T$	Avg. Temp. Const. of I_{OS}	-1.50	±0.50	+1.50	nA/°C	
	I_B	Input bias current	3.50	5.00	7.00	µA	See Fig. 1
	$\Delta I_B/\Delta T$	Avg. Temp. Const. of I_B	-40.00	-20.00	0	nA/°C	See Fig. 11
	R_{in}	Input resistance	20.00	30.00	—	KΩ	
	C_{in}	Input capacitance	1.20	1.60	2.10	pF	
	V_{cm}	Input voltage range	-2.00	—	1.70	V	See Figs. 2, 14
	V_{T+}	Threshold for OUT ⌐	-1.00	+2.40	+5.00	mV	
	V_{T-}	Threshold for OUT ¬	-6.00	-2.40	0	mV	See Fig. 4,
	$\Delta V_{T\pm}/\Delta T$	Avg. Temp. Const. of $V_{T\pm}$	-10.00	±5.00	10.00	µV/°C	Note 4
	V_H	Hysteresis voltage	4.60	4.80	5.00	mV	
	V_{OL}	Output low level	-1.85	-1.71	-1.63	V	See Fig. 3
	V_{OH}	Output high level	-0.96	-0.84	-0.80	V	R_T = 510 Ω, V_T = -5.2 V
	$\Delta V_{OH}/\Delta T$	Avg. Temp. Const. of V_{OH}	—	1.50	—	mV/°C	
	$\Delta V_{OL}/\Delta T$	Avg. Temp. Const. of V_{OL}	—	0.60	—	mV/°C	
	I+	Positive supply current	—	40.00	50.00	mA	4 channels without
	I-	Negative supply current	—	37.00	47.00	mA	output pulldown
	PD	Power dissipation	—	392.00	494.00	mW	resistors, See Fig. 1

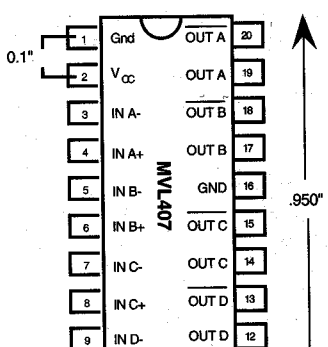
SWITCHING CHARACTERISTICS	Symbol	Parameter	Min	Typ	Max	Units	Comments
	t_{pd}	Propagation delay	3.00	3.50	4.00	nsec	50 mV overdrive, Notes 2, 4; See Fig. 3, R_T = 510 Ω, V_T = -5.2 V
	$\Delta t_{pd}/\Delta T$	Avg. Temp. Const. of prop. delay	—	2.00	—	psec/°C	0 to 70°C
	t_r, t_f	Transition time	0.80	1.20	1.40	nsec	R_T = 50 Ω, V_T = -2 V, Fig. 3
	t_r, t_f	Transition time	0.50	0.85	1.20	nsec	R_T = 510 Ω, V_T = -5.2 V, Fig. 3
	DPR	Double pulse resolution	—	2.00	—	nsec	Notes 3, 4
	f_{max}	Max. toggle frequency	—	400.00	—	MHz	
	T_{min}	Min. input width	—	1.00	—	nsec	

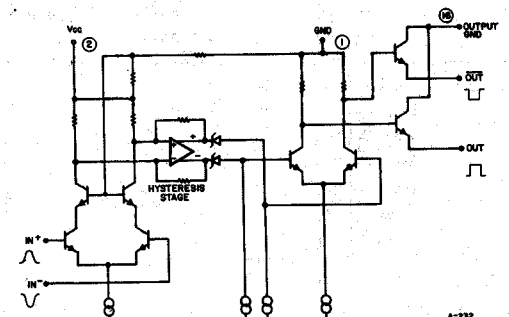
INTERCHANNEL MATCHING*	Symbol	Parameter	Min	Typ	Max	Units	Comments
	ΔV_H	Hysteresis	—	±0.25	—	mV	
	$\Delta V_{T\pm}$	Threshold voltage	—	±1.25	—	mV	
	ΔI_{OS}	Input offset current	—	±50.00	—	nA	
	Δt_{pd}	Propagation delay	—	±125.00	—	psec	
		Cross talk - any channel	—	—	—	dB	Unobservable, Note 1

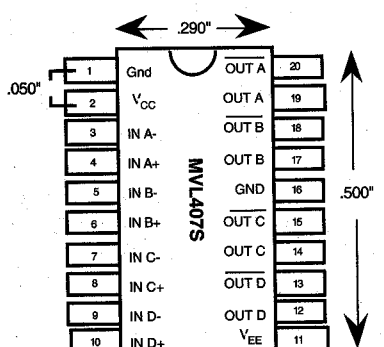
*Interchannel matching refers to the variation between the channels on any single chip.

Notes:

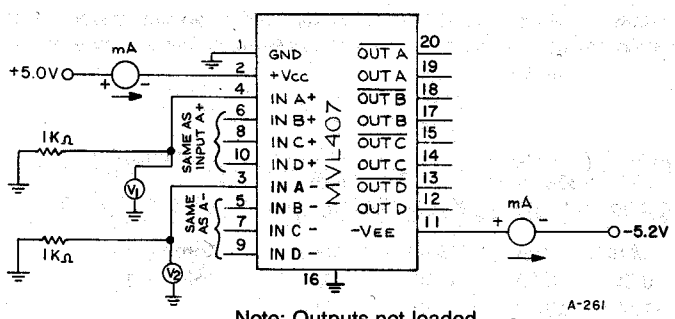
1. Cross talk is measured at a threshold of 2 mV.
2. Propagation delays are defined as the delay between a positive going input and an output transition of either polarity. The input overdrive is 50 mV with the threshold set at 0 mV.
3. Double pulse resolution is defined as the minimum pulse pair spacing at which the MVL407 responds to the second pulse of the pair. The output levels of the second pulse must cross V_{OH} and V_{OL}. See Figure 5.
4. See Application Hints.
5. Characteristics measured at V_{CC} = +5.0 V, V_{EE} = -5.2 V and T = 25°C.







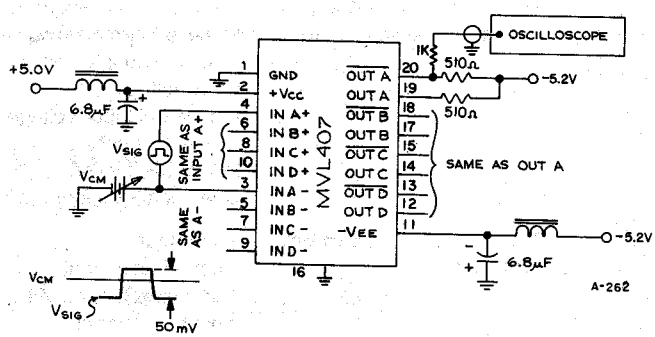
COMP & CHAMBER



Note: Outputs not loaded.

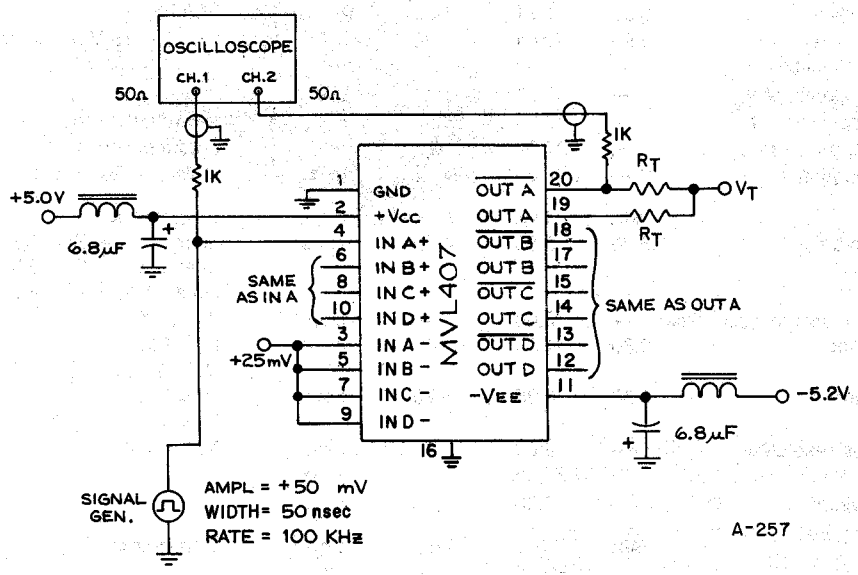
$$I_B = \frac{1}{2}\,\frac{V_1 + V_2}{1\ K\Omega} \qquad I_{OS} = \frac{V_1 - V_2}{1\ K\Omega}$$

Figure 1



V_{CM} is varied from −2.0 V to +1.7 V. Over this range output should not be affected by V_{CM}.

Figure 2



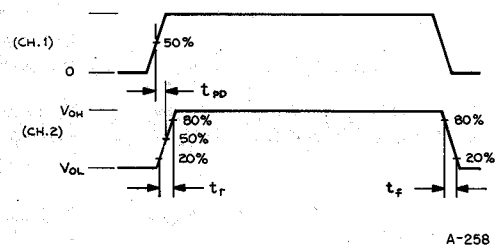
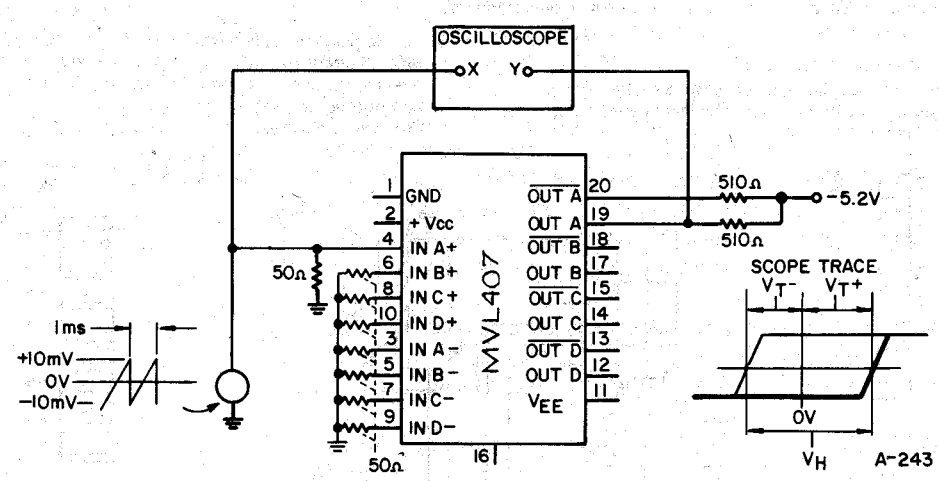


Figure 3



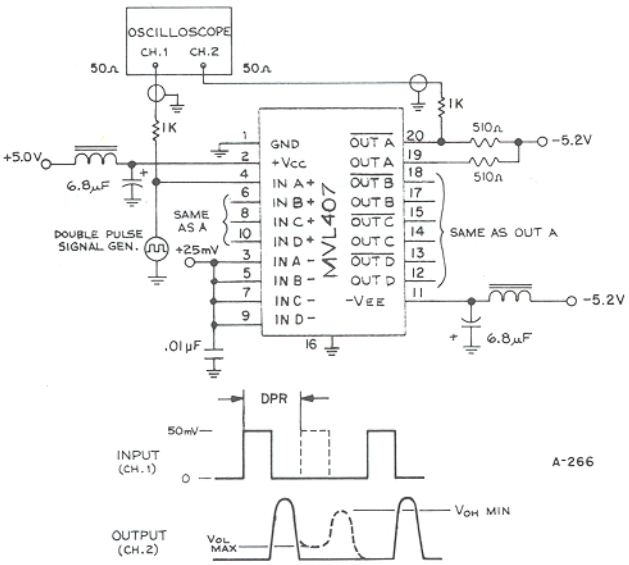
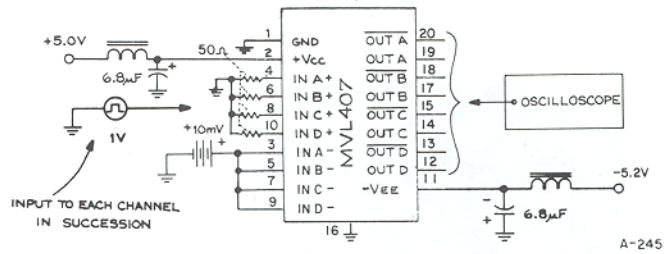


Figure 5



Drive one channel only. If any other channel triggers, cross talk spec is not met.

Figure 6

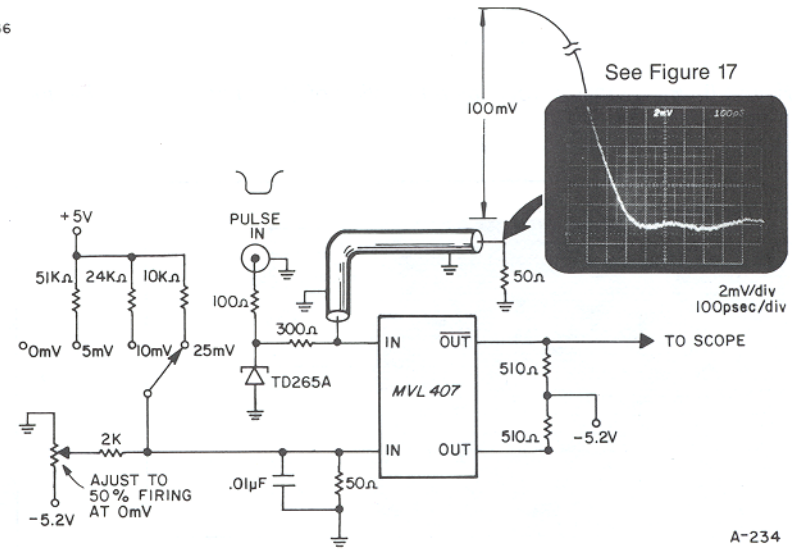


Figure 7

APPLICATION HINTS

Interconnection Techniques

To achieve optimum performance, high speed circuits require some special layout precautions. For a good low inductance ground current return path, a ground plane must be used. The input impedance should be as low as is practical and lead lengths should be as short as possible. The MVL407 should be soldered into the printed circuit board instead of using a socket. To minimize ringing, output lead lengths of 2 cm or less are recommended. If longer lengths are required, use a microstrip transmission line, miniature coaxial cable, or twisted pair. Reflections will occur unless the line is properly terminated. Termination resistors typically go to -2.0 V. Low impedance lines are better for driving capacitive loads. Supply voltages should be well decoupled with good RF capacitors connected to the ground plane as close to the MVL407 supply pins as practical.

Propagation Delay Measurement

The ability of a voltage comparator to perform an accurate timing function is determined by the constancy of its propagation delay with overdrive. Because the input rise time and the comparator's slew time add in quadrature to produce the observed propagation delay, it is necessary to employ a very fast input pulse to accurately measure propagation delay variances of the device. A slow input would give optimistically low results. See Figures 8, 9, & 14.

In order to produce a sufficiently fast and clean input pulse, a tunnel diode based pulse generator was employed. It produced a very clean pulse with a rise time (10% to 90%) of approximately 0.1 nsec. See Figures 7 and 17.

Double Pulse Resolution Measurement

full amplitude output. The delay of the second pulse was reduced until a degradation of output amplitude was noted. The closest spacing of the input pulse pair which will produce a second pulse of full output amplitude is considered to be the DPR (Figure 5).

Hysteresis

The MVL407 incorporates about 4.8 mV of internal hysteresis, and therefore has two thresholds separated by about 4.8 mV. One threshold (V_{T+}) applies for input signals that cause a low-to-high transition on the normally low output (e.g., a positive-going signal applied to the IN^+ output, or a negative-going signal applied to the IN^- input). The other (V_{T-}) applies for input signals that cause a high-to-low transition on the normally low output. The hysteresis voltage (V_H) is the difference between these two thresholds. V_{T+}, V_{T-} and V_H are measured as shown in Figure 4.

The presence of this hysteresis helps assure that the outputs of the MVL407 are always in a defined state, even for small or very slowly changing inputs. Comparators without hysteresis show a pronounced tendency to oscillate when biased near threshold. In spite of its higher speed, the MVL407 gives

TYPICAL PERFORMANCE CURVES

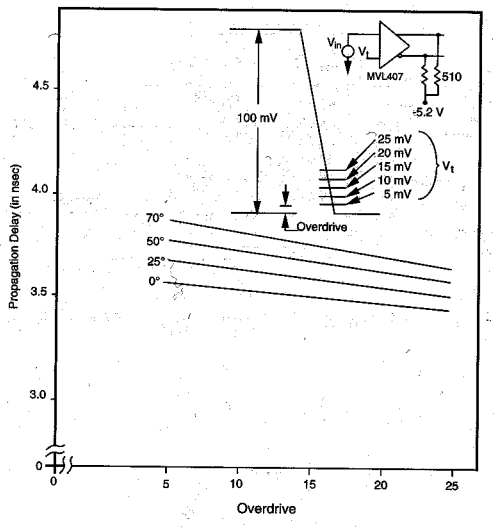


Figure 8: Propagation Delay as a Function of Overdrive

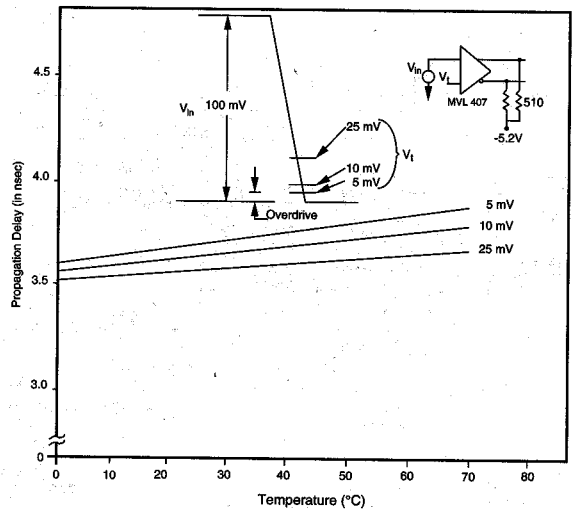


Figure 9: Propagation Delay as a Function of Temperature

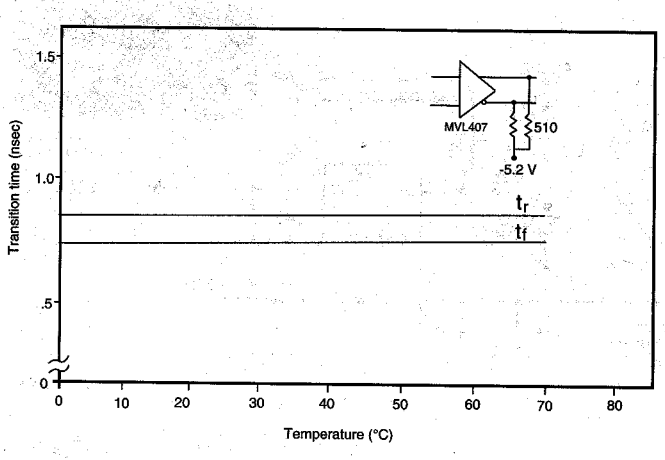


Figure 10: Output Rise and Fall Time as a Function of Temperature

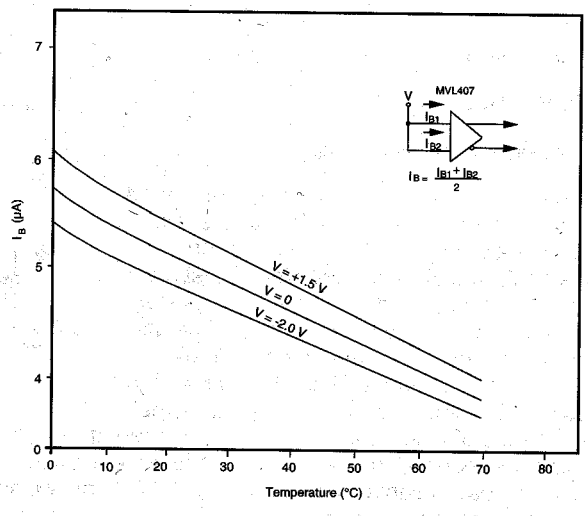
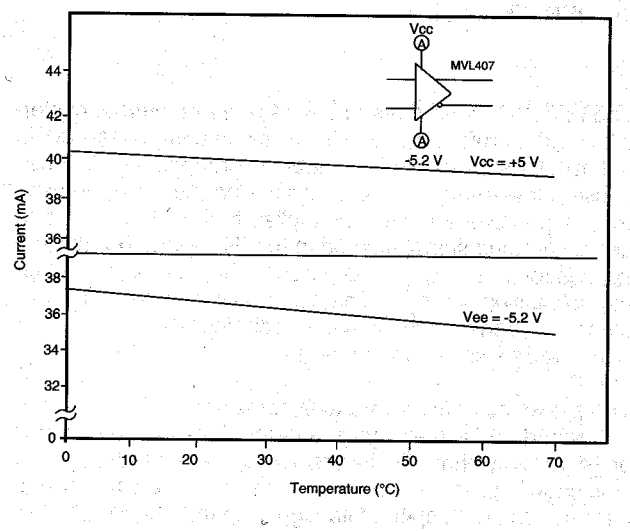
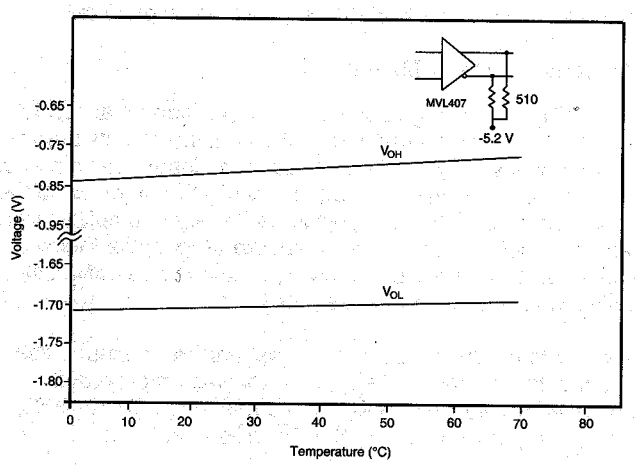


Figure 11: Input Bias Current as a Function of Temperature





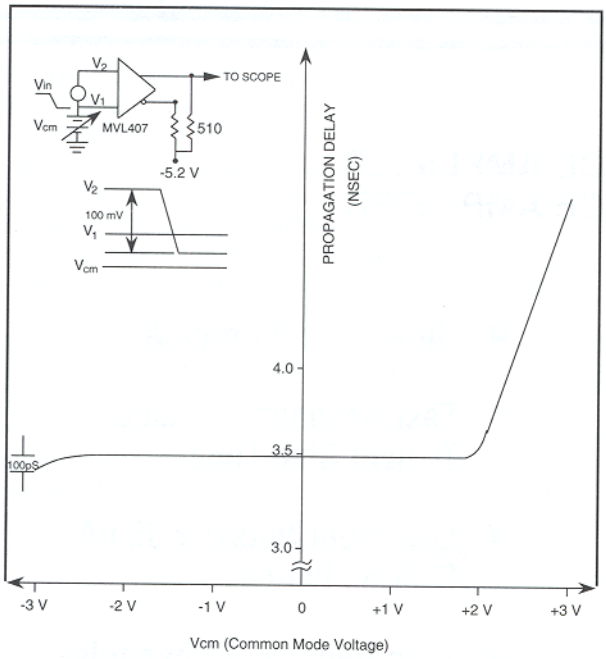
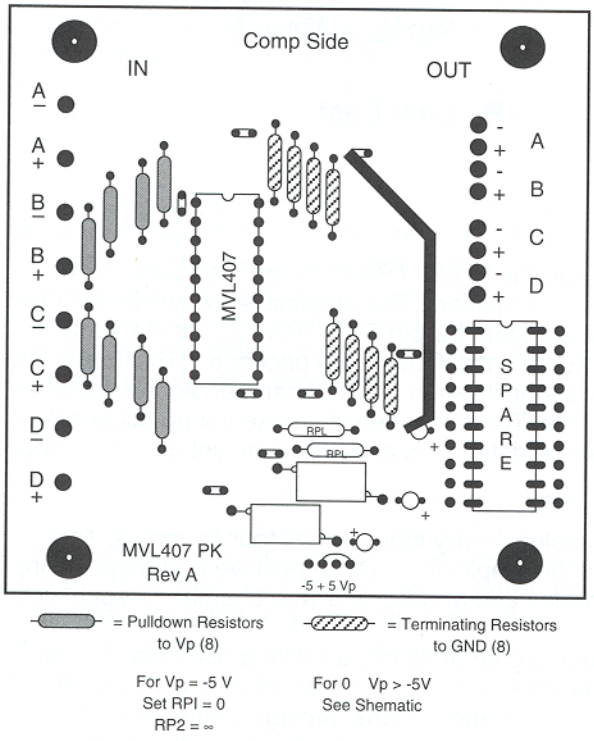


Figure 14: Propagation Delay as a Function of Common Mode Voltage



MVL407 PK Orientation Drawing

TYPICAL PERFORMANCE TRACES

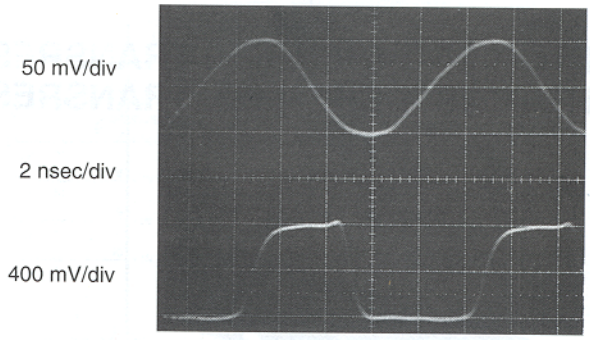


Figure 15: Response to 100 MHz sine wave.

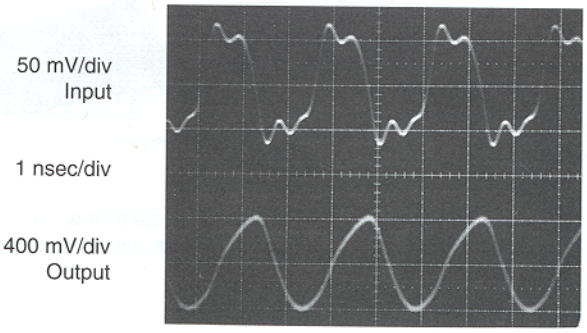


Figure 16: Response to 400 MHz input.

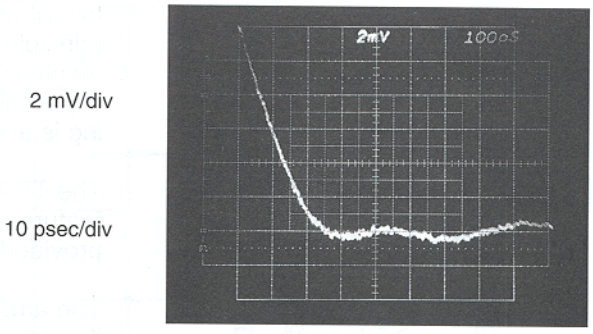


Figure 17: Fast timing pulse, see Figure 7.