



**THE DATASHEET OF
M74HC4538RM13TR**





M74HC4538

DUAL RETRIGGERABLE MONOSTABLE MULTIVIBRATOR

- HIGH SPEED :
 $t_{PD} = 25 \text{ ns}$ (TYP.) at $V_{CC} = 6V$
- LOW POWER DISSIPATION:
 STAND BY STATE :
 $I_{CC} = 4\mu A$ (MAX.) at $T_A = 25^\circ C$
 ACTIVE STATE :
 $I_{CC} = 200\mu A$ (TYP.) at $V_{CC} = 6V$
- HIGH NOISE IMMUNITY:
 $V_{NIH} = V_{NIL} = 28\% V_{CC}$ (MIN.)
- SYMMETRICAL OUTPUT IMPEDANCE:
 $|I_{OH}| = I_{OL} = 4mA$ (MIN)
- BALANCED PROPAGATION DELAYS:
 $t_{PLH} \cong t_{PHL}$
- WIDE OPERATING VOLTAGE RANGE:
 V_{CC} (OPR) = 2V to 6V
- WIDE OUTPUT PULSE WIDTH RANGE :
 $t_{WOUT} = 120 \text{ ns} \sim 60 \text{ s}$ OVER AT $V_{CC} = 4.5 \text{ V}$
- PIN AND FUNCTION COMPATIBLE WITH
 74 SERIES 4538



ORDER CODES

PACKAGE	TUBE	T & R
DIP	M74HC4538B1R	
SOP	M74HC4538M1R	M74HC4538RM13TR
TSSOP		M74HC4538TTR

retriggerable. That is, they may be triggered repeatedly while their outputs are generating a pulse and the pulse will be extended. Pulse width stability over a wide range of temperature and supply is achieved using linear CMOS techniques.

The output pulse equation is simply :
 $PW = 0.7 (R)(C)$ where PW is in seconds, R in Ohms and C is in Farads.

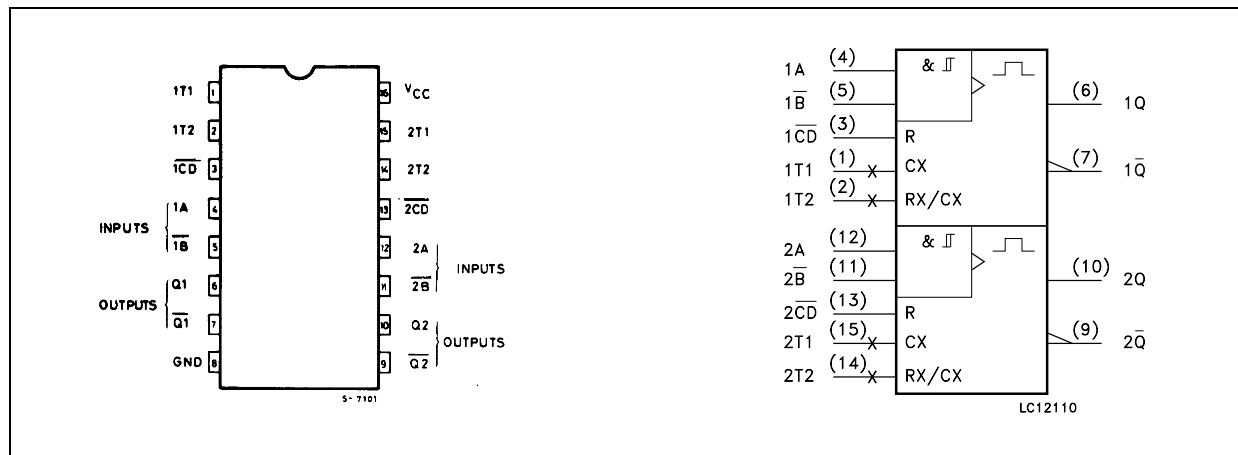
All inputs are equipped with protection circuits against static discharge and transient excess voltage.

DESCRIPTION

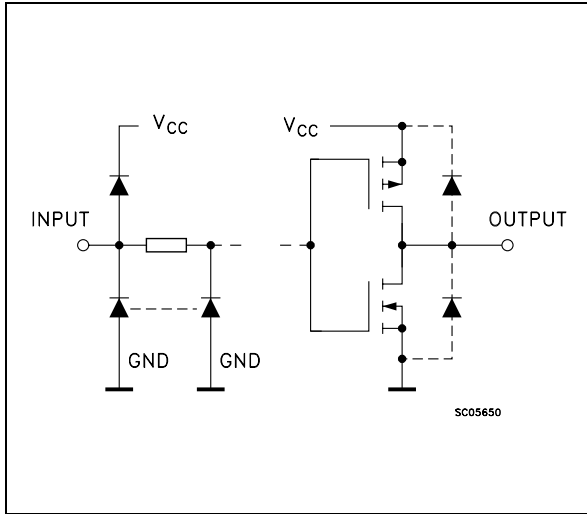
The M74HC4538 is an high speed CMOS MONOSTABLE MULTIVIBRATOR fabricated with silicon gate C²MOS technology.

Each multivibrator features both a negative A, and a positive B, edge triggered input, either of which can be used as an inhibit input. Also included is a clear input that when taken low resets the one shot. The monostable multivibrator are

PIN CONNECTION AND IEC LOGIC SYMBOLS



INPUT AND OUTPUT EQUIVALENT CIRCUIT



PIN DESCRIPTION

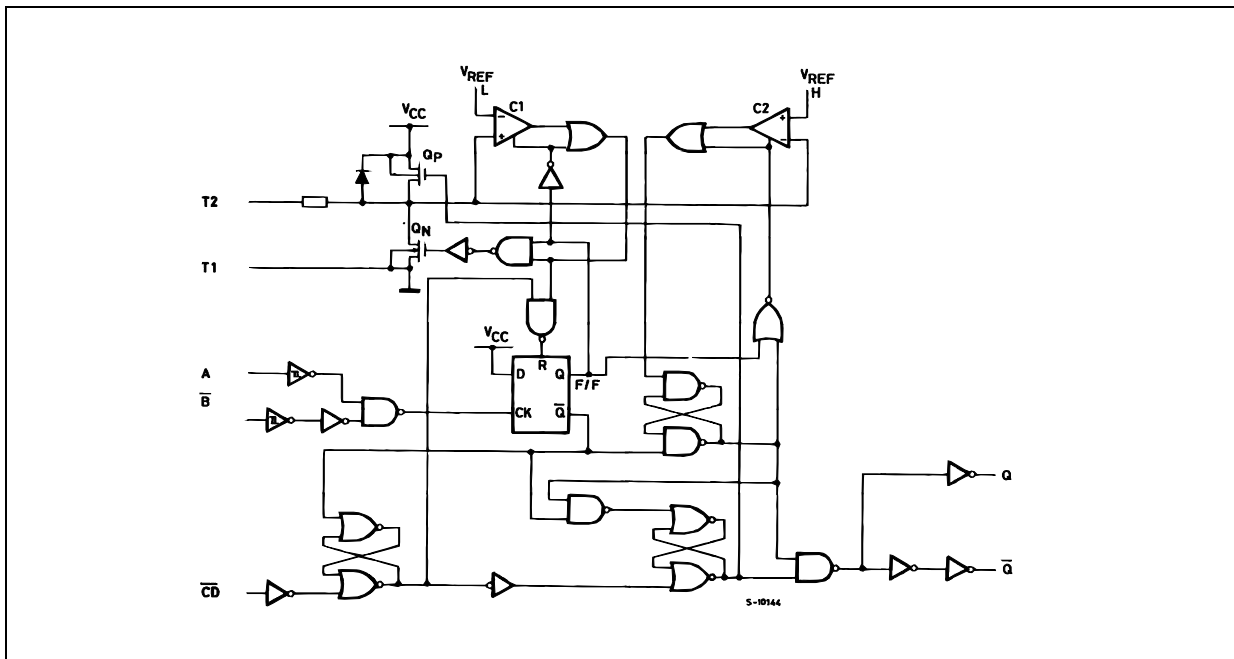
PIN No	SYMBOL	NAME AND FUNCTION
1, 15	1T1, 2T1	External Capacitor Connections
2, 14	1T2, 2T2	External Resistor/Capacitor Connections
3, 13	$\overline{1CD}, \overline{2CD}$	Direct Reset Inputs (Active Low)
4, 12	1A, 2A	Trigger Inputs (LOW to HIGH, Edge-Triggered)
5, 11	$\overline{1B}, \overline{2B}$	Trigger Inputs (HIGH to LOW, Edge Triggered)
6, 10	Q1, Q2	Pulse Outputs
7, 9	$\overline{Q1}, \overline{Q2}$	Complementary Pulse Outputs
8	GND	Ground (0V)
16	Vcc	Positive Supply Voltage

TRUTH TABLE

INPUTS			OUTPUTS		NOTE
A	\overline{B}	\overline{CD}	Q	\overline{Q}	
	H	H			OUTPUT ENABLE
X	L	H	L	H	INHIBIT
H	X	H	L	H	INHIBIT
L		H			OUTPUT ENABLE
X	X	L	L	H	INHIBIT

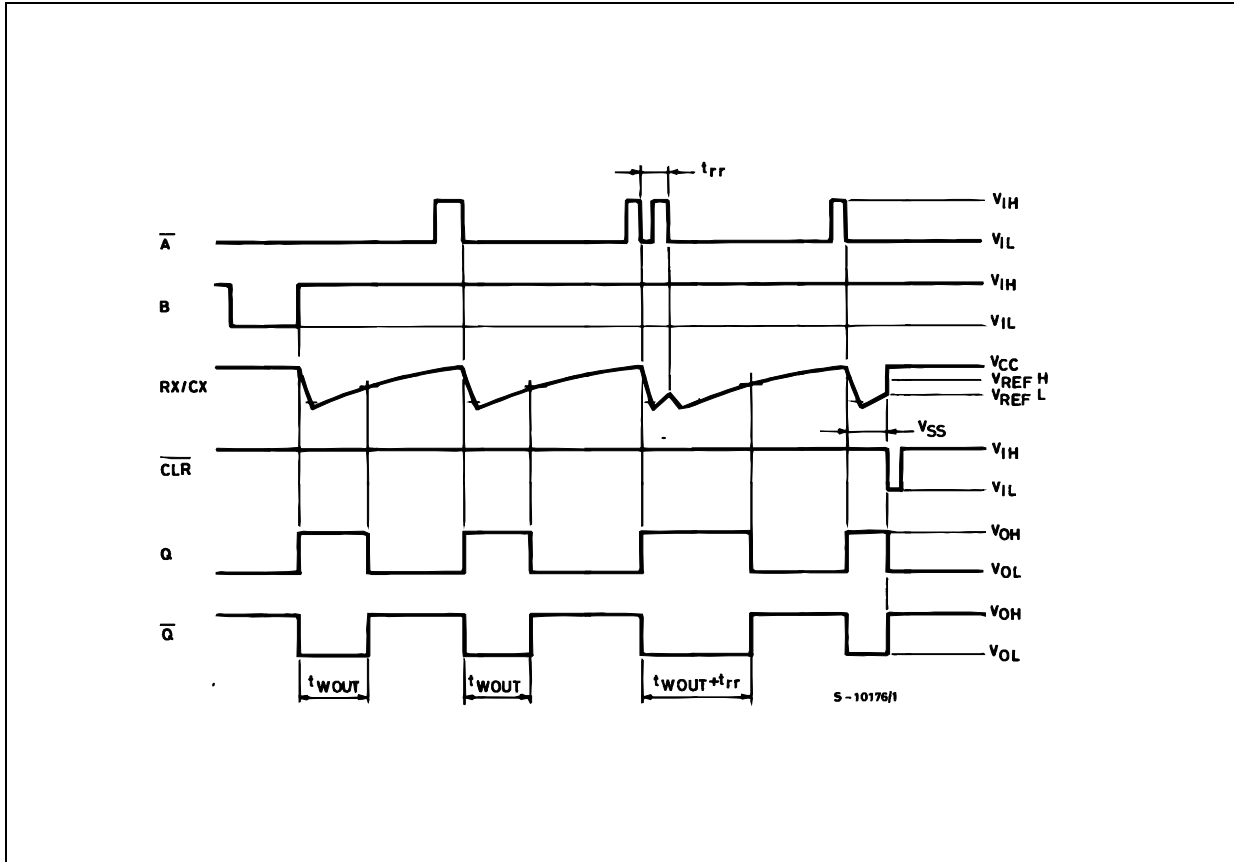
X : Don't Care

SYSTEM DIAGRAM

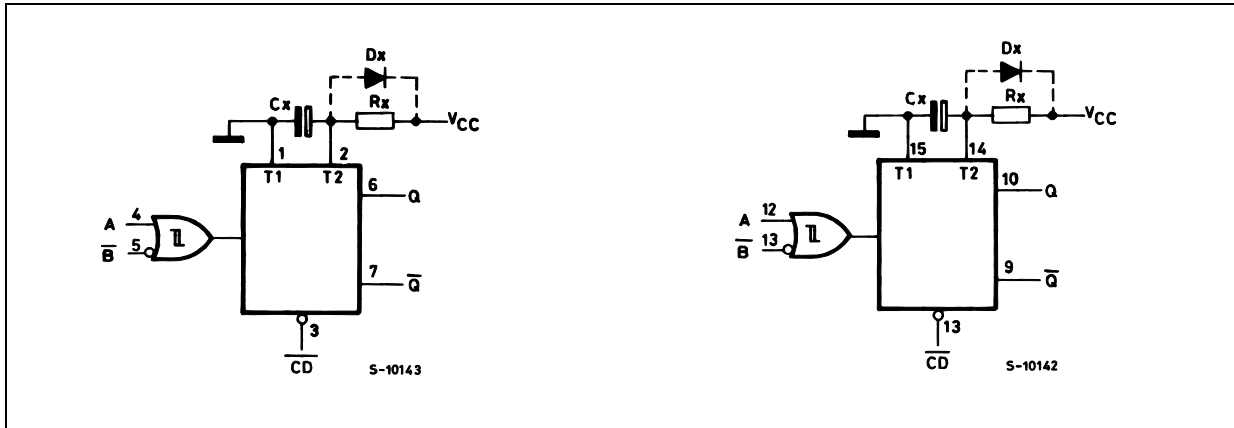


This logic diagram has not be used to estimate propagation delays

TIMING CHART



BLOCK DIAGRAM



- (1) C_x, R_x, D_x are external components.
- (2) D_x is a clamping diode.

The external capacitor is charged to V_{CC} in the stand-by-state, i.e. no trigger. When the supply voltage is turned off C_x is discharged mainly through an internal parasitic diode (see figures). If C_x is sufficiently large and V_{CC} decreases rapidly, there will be some possibility of damaging the I.C. with a surge current or latch-up. If the voltage supply filter capacitor is large enough and V_{CC} decrease slowly, the surge current is automatically limited and damage to the I.C. is avoided. The maximum forward current of the parasitic diode is approximately 20 mA. In cases where C_x is large the time taken for the supply voltage to fall to 0.4 V_{CC} can be calculated as follows :

$$t_f \geq (V_{CC} - 0.7) \times C_x / 20\text{mA}$$

In cases where t_f is too short an external clamping diode is required to protect the I.C. from the surge current.

FUNCTIONAL DESCRIPTION**STAND-BY STATE**

The external capacitor, C_x , is fully charged to V_{CC} in the stand-by state. Hence, before triggering, transistor Q_p and Q_n (connected to the R_x/C_x node) are both turned-off. The two comparators that control the timing and the two reference voltage sources stop operating. The total supply current is therefore only leakage current.

TRIGGER OPERATION

Triggering occurs when :

1 st) A is "LOW" and \bar{B} has a falling edge;

2 nd) \bar{B} is "HIGH" and A has a rising edge;

After the multivibrator has been retriggered comparator C_1 and C_2 start operating and Q_n is turned on. C_x then discharges through Q_n . The voltage at the node R_x/C_x external falls.

When it reaches V_{REFL} the output of comparator C_1 becomes low. This in turn reset the flip-flop and Q_n is turned off.

At this point C_1 stops functioning but C_2 continues to operate.

The voltage at R/C external begins to rise with a time constant set by the external components R_x , C_x .

Triggering the multivibrator causes Q to go high after internal delay due to the flip-flop and the gate. Q remains high until the voltage at R/C external rises again to V_{REFH} . At this point C_2 output goes low and G goes low. C_2 stop

operating. That means that after triggering when the voltage R/C external returns to V_{REFH} the multivibrator has returned to its MONOSTABLE STATE. In the case where $R_x \cdot C_x$ are large enough and the discharge time of the capacitor and the delay time in the I.C. can be ignored, the width of the output pulse t_w (out) is as follows :

$$t_{w(OUT)} = 0.72 C_x \cdot R_x$$

RE - TRIGGERED OPERATION

When a second triggered pulse follows the first its effect will depend on the state of the multivibrator. If the capacitor C_x is being charged the voltage level of R_x/C_x external falls to V_{REFL} again and Q remains High i.e. the retrigger pulse arrives in a time shorter than the period $R_x \cdot C_x$ seconds, the capacitor charging time constant. If the second trigger pulse is very close to the initial trigger pulse it is ineffective ; i.e. the second trigger must arrive in the capacitor discharge cycle to be ineffective; Hence the minimum time for a second trigger to be effective, t_{rr} (MIN.) depends on V_{CC} and C_x

RESET OPERATION

\overline{CD} is normally high. If \overline{CD} is low, the trigger is not effective because Q output goes low and trigger control flip-flop is reset.

Also transistor Q_p is turned on and C_x is charged quickly to V_{CC} . This means if \overline{CD} input goes low the IC becomes waiting state both in operating and non operating state.

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_{CC}	Supply Voltage	-0.5 to +7	V
V_I	DC Input Voltage	-0.5 to $V_{CC} + 0.5$	V
V_O	DC Output Voltage	-0.5 to $V_{CC} + 0.5$	V
I_{IK}	DC Input Diode Current	± 20	mA
I_{OK}	DC Output Diode Current	± 20	mA
I_O	DC Output Current	± 25	mA
I_{CC} or I_{GND}	DC V_{CC} or Ground Current	± 50	mA
P_D	Power Dissipation	500(*)	mW
T_{stg}	Storage Temperature	-65 to +150	°C
T_L	Lead Temperature (10 sec)	300	°C

Absolute Maximum Ratings are those values beyond which damage to the device may occur. Functional operation under these conditions is not implied

(*) 500mW at 65 °C; derate to 300mW by 10mW/°C from 65°C to 85°C

RECOMMENDED OPERATING CONDITIONS

Symbol	Parameter	Value	Unit	
V_{CC}	Supply Voltage	2 to 6	V	
V_I	Input Voltage	0 to V_{CC}	V	
V_O	Output Voltage	0 to V_{CC}	V	
T_{op}	Operating Temperature	-55 to 125	°C	
t_r, t_f	Input Rise and Fall Time (CD only)	$V_{CC} = 2.0V$	0 to 1000	ns
		$V_{CC} = 4.5V$	0 to 500	ns
		$V_{CC} = 6.0V$	0 to 400	ns
C_x	External Capacitor	NO LIMITATION	pF	
R_x	External Resistor	$V_{CC} < 3V$	5K to 1M	Ω
		$V_{CC} \geq 3V$	1K to 1M	

The Maximum allowable values of C_x and R_x are a function of leakage of capacitor C_x , the leakage of device and leakage due to the board layout and surface resistance. Susceptibility to externally induced noise may occur for $R_x > 1M\Omega$

DC SPECIFICATIONS

Symbol	Parameter	Test Condition		Value						Unit	
		V_{CC} (V)		$T_A = 25^\circ C$			-40 to 85°C		-55 to 125°C		
				Min.	Typ.	Max.	Min.	Max.	Min.		Max.
V_{IH}	High Level Input Voltage	2.0		1.5			1.5		1.5		V
		4.5		3.15			3.15		3.15		
		6.0		4.2			4.2		4.2		
V_{IL}	Low Level Input Voltage	2.0				0.5		0.5		0.5	V
		4.5				1.35		1.35		1.35	
		6.0				1.8		1.8		1.8	
V_{OH}	High Level Output Voltage	2.0	$I_O = -20 \mu A$	1.9	2.0		1.9		1.9		V
		4.5	$I_O = -20 \mu A$	4.4	4.5		4.4		4.4		
		6.0	$I_O = -20 \mu A$	5.9	6.0		5.9		5.9		
		4.5	$I_O = -4.0 mA$	4.18	4.31		4.13		4.10		
		6.0	$I_O = -5.2 mA$	5.68	5.8		5.63		5.60		
V_{OL}	Low Level Output Voltage	2.0	$I_O = 20 \mu A$		0.0	0.1		0.1		0.1	V
		4.5	$I_O = 20 \mu A$		0.0	0.1		0.1		0.1	
		6.0	$I_O = 20 \mu A$		0.0	0.1		0.1		0.1	
		4.5	$I_O = 4.0 mA$		0.17	0.26		0.33		0.40	
		6.0	$I_O = 5.2 mA$		0.18	0.26		0.33		0.40	
I_I	Input Leakage Current	6.0	$V_I = V_{CC}$ or GND			± 0.1		± 1		± 1	μA
I_I	Input Leakage Current	6.0	$V_I = V_{CC}$ or GND R_{ext}/C_{ext}			± 0.1		± 1		± 1	μA
I_{CC}	Quiescent Supply Current	6.0	$V_I = V_{CC}$ or GND			4		40		80	μA
I_{CC}	Quiescent Supply Current	2.0	$V_I = V_{CC}$ or GND		40	120		160		200	μA
		4.5	Pin 2 or 14		0.2	0.3		0.4		0.6	mA
		6.0	$V_{IN} = V_{CC}/2$		0.3	0.6		0.8		1.0	mA

AC ELECTRICAL CHARACTERISTICS (C_L = 50 pF, Input t_r = t_f = 6ns)

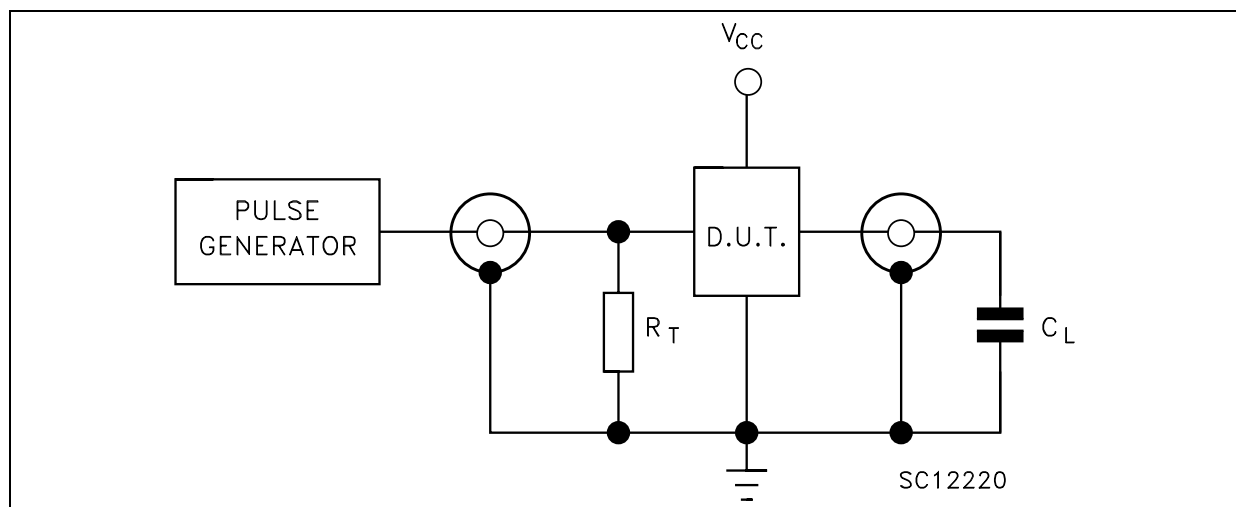
Symbol	Parameter	Test Condition		Value						Unit			
		V _{CC} (V)		T _A = 25°C			-40 to 85°C		-55 to 125°C				
				Min.	Typ.	Max.	Min.	Max.	Min.		Max.		
t _{TLH} t _{THL}	Output Transition Time	2.0			30	75		95		110	ns		
		4.5			8	15		19		22			
		6.0			7	13		16		19			
t _{PLH} t _{PHL}	Propagation Delay Time (A, \overline{B} - Q, \overline{Q})	2.0			120	250		315		375	ns		
		4.5			30	50		63		75			
		6.0			25	43		54		64			
t _{PLH} t _{PHL}	Propagation Delay Time (CD - Q, \overline{Q})	2.0			100	195		245		295	ns		
		4.5			25	39		49		59			
		6.0			20	33		42		50			
t _{WOUT}	Output Pulse Width	2.0	Cx=0	Rx = 5KΩ		540	1200		1500		1800	ns	
				Rx = 1KΩ		180	250		320		375		
				Rx = 1KΩ		150	200		260		320		
		2.0	Cx = 0.01μF Rx = 10KΩ		70	83	96	70	96	70	96	μs	
					69	77	85	69	85	69	85		
					69	77	85	69	85	69	85		
		2.0	Cx = 0.1μF Rx = 10KΩ		0.67	0.75	0.83	0.67	0.83	0.67	0.9	ms	
					0.67	0.73	0.77	0.67	0.77	0.67	0.8		
					0.67	0.73	0.77	0.67	0.77	0.67	0.8		
		Δt _{WOUT}	Output Pulse Width Error Between Circuits in Same Package				±1						%
		t _{W(H)} t _{W(L)}	Minimum Pulse Width (A, \overline{B})	2.0			30	75		95		110	ns
				4.5			8	15		19		22	
6.0					7	13		16		19			
t _{W(L)}	Minimum Pulse Width (CD)	2.0			30	75		95		110	ns		
		4.5			8	15		19		22			
		6.0			7	13		16		19			
t _{REM}	Minimum Clear Removal Time	2.0			0	15		15		20	ns		
		4.5			0	5		5		7			
		6.0			0	5		5					
t _{rr}	Minimum Retrigger Time	2.0	Cx = 0.1 μF Rx = 1KΩ		380						ns		
					92								
					72								
		2.0	Cx = 0.01μF Rx = 1KΩ		6							μs	
					1.4								
					1.2								

CAPACITIVE CHARACTERISTICS

Symbol	Parameter	Test Condition		Value						Unit	
		V _{CC} (V)		T _A = 25°C			-40 to 85°C		-55 to 125°C		
				Min.	Typ.	Max.	Min.	Max.	Min.		Max.
C _{IN}	Input Capacitance	5.0			5	10		10		10	pF
C _{PD}	Power Dissipation Capacitance (note 1)	5.0			70						pF

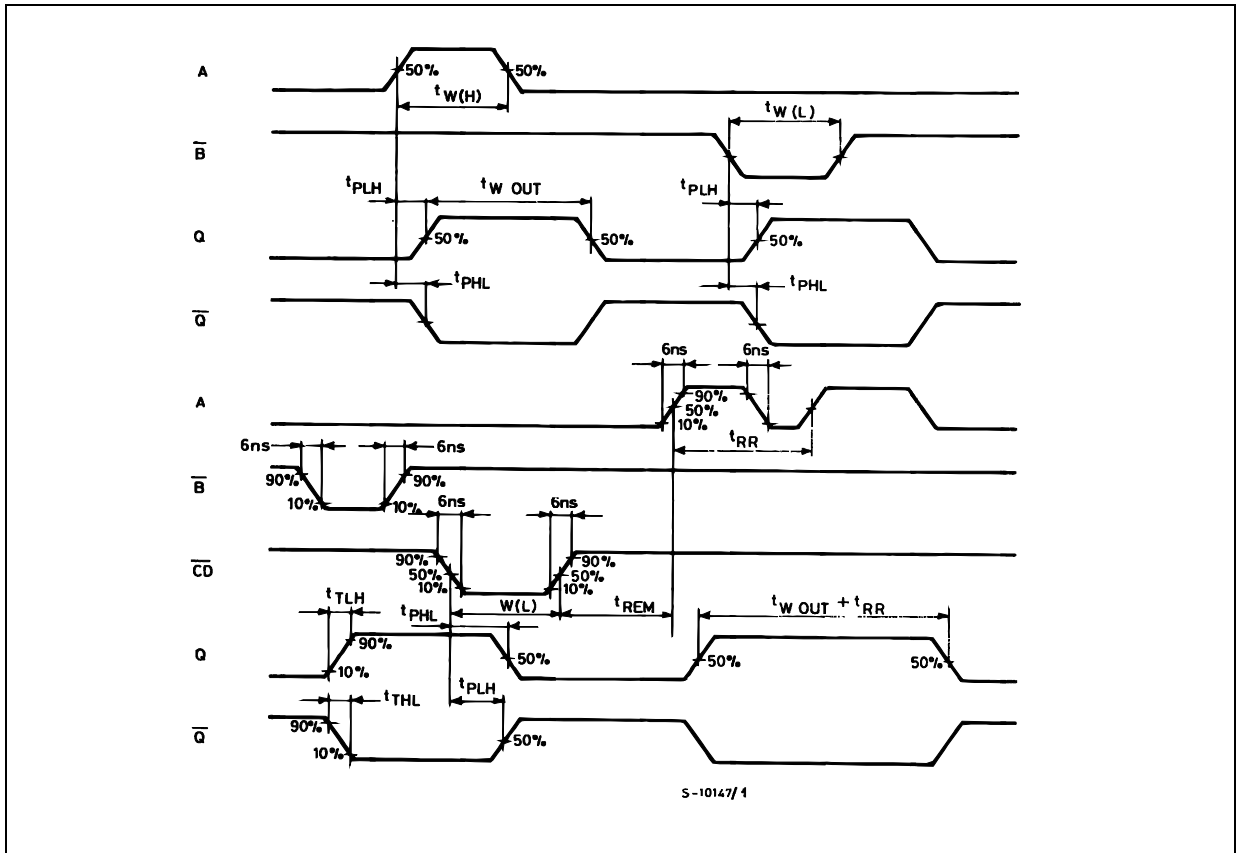
1) C_{PD} is defined as the value of the IC's internal equivalent capacitance which is calculated from the operating current consumption without load. (Refer to Test Circuit). Average operating current can be obtained by the following equation. $I_{CC(opr)} = C_{PD} \times V_{CC} \times f_{IN} + I_{CC}' \text{ Duty}/100 + I_c/2(\text{per monostable})$ (I_{CC}' : Active Supply current) (Duty : %)

TEST CIRCUIT



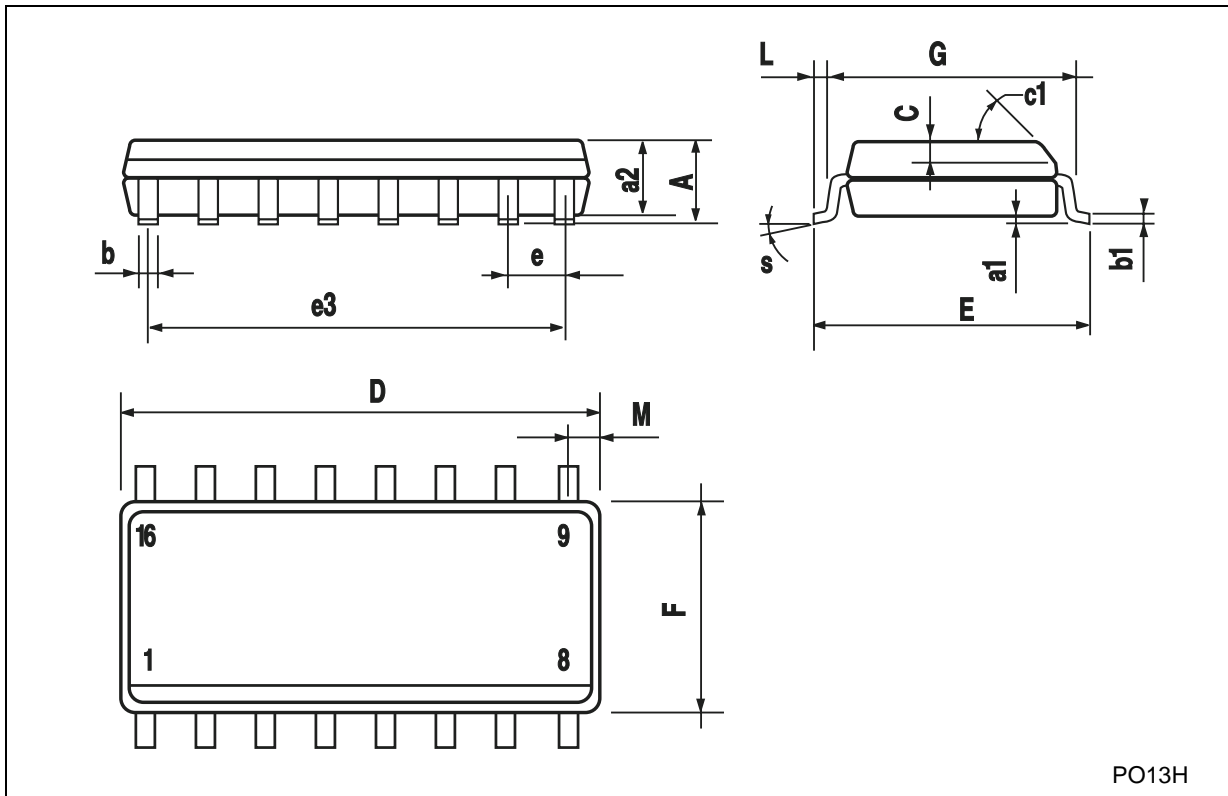
C_L = 50pF or equivalent (includes jig and probe capacitance)
R_T = Z_{OUT} of pulse generator (typically 50Ω)

SWITCHING CHARACTERISTICS TEST WAVEFORM (f=1MHz; 50% duty cycle)



SO-16 MECHANICAL DATA

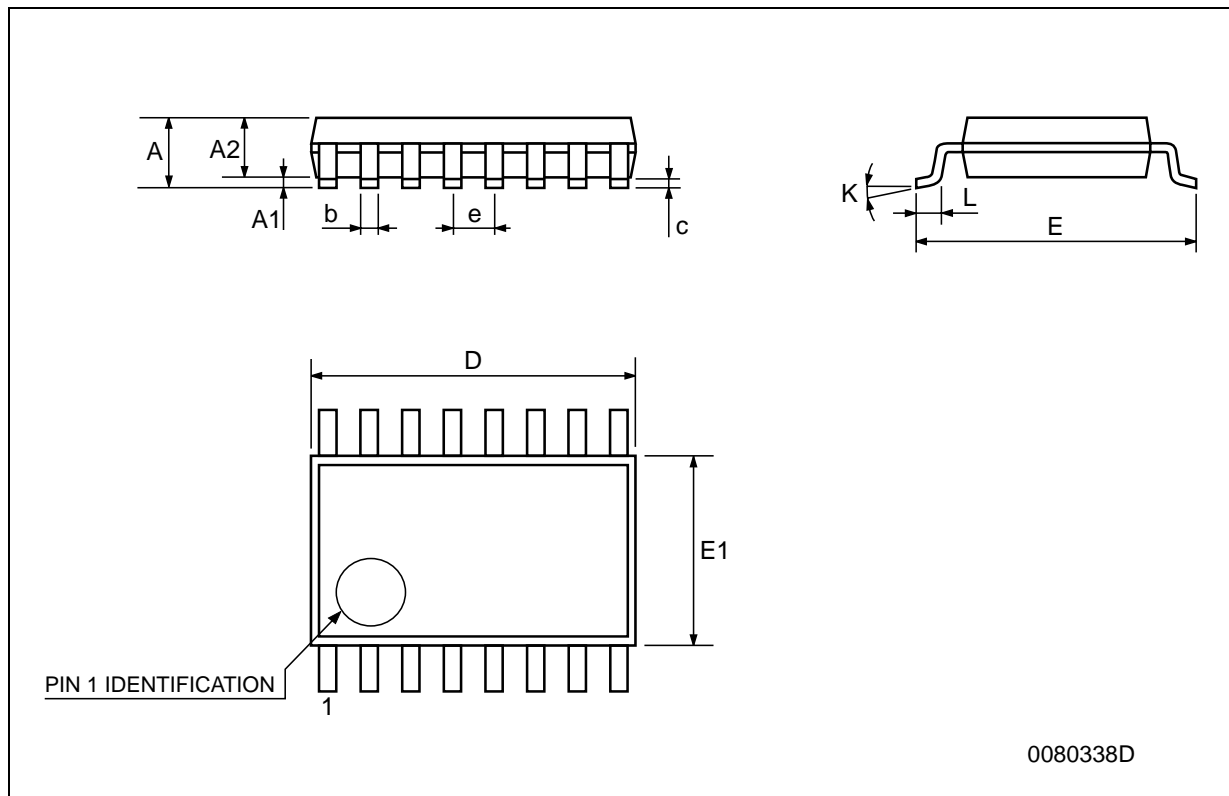
DIM.	mm.			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A			1.75			0.068
a1	0.1		0.2	0.003		0.007
a2			1.65			0.064
b	0.35		0.46	0.013		0.018
b1	0.19		0.25	0.007		0.010
C		0.5			0.019	
c1	45° (typ.)					
D	9.8		10	0.385		0.393
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		8.89			0.350	
F	3.8		4.0	0.149		0.157
G	4.6		5.3	0.181		0.208
L	0.5		1.27	0.019		0.050
M			0.62			0.024
S	8° (max.)					



PO13H

TSSOP16 MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A			1.2			0.047
A1	0.05		0.15	0.002	0.004	0.006
A2	0.8	1	1.05	0.031	0.039	0.041
b	0.19		0.30	0.007		0.012
c	0.09		0.20	0.004		0.0089
D	4.9	5	5.1	0.193	0.197	0.201
E	6.2	6.4	6.6	0.244	0.252	0.260
E1	4.3	4.4	4.48	0.169	0.173	0.176
e		0.65 BSC			0.0256 BSC	
K	0°		8°	0°		8°
L	0.45	0.60	0.75	0.018	0.024	0.030



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