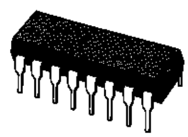
SGS-THOMSON MICROELECTRONICS

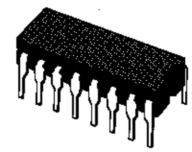
M54HC4538
M74HC4538

DUAL RETRIGGERABLE MONOSTABLE MULTIVIBRATOR

- HIGH SPEED
  t_{PD} = 25 ns (TYP.) AT V_{CC} = 5 V
- LOW POWER DISSIPATION
  STANDBY STATE I_{CC} = 4 μA (MAX.) AT T_A = 25 °C
  ACTIVE STATE I_{CC} = 200 μA (TYP.) AT V_{CC} = 5 V
- HIGH NOISE IMMUNITY
  V_{NIH} = V_{NIL} = 28 % V_{CC} (MIN.)
- OUTPUT DRIVE CAPABILITY
  10 LSTTL LOADS
- BALANCED PROPAGATION DELAYS
  t_{PLH} = t_{PHL}
- WIDE OUTPUT PULSE WIDTH RANGE
  t_{WOUT} = 120 ns ~ 60 s OVER AT V_{CC} = 4.5 V
- OUTPUT PULSE WIDTH INDEPENDENT FROM TRIGGER INPUT PULSE WIDTH
- PIN AND FUNCTION COMPATIBLE WITH 4538B

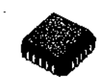


B1R
(Plastic Package)



F1R
(Ceramic Package)

M1R
(Micro Package)



C1R
(Chip Carrier)

ORDER CODES :

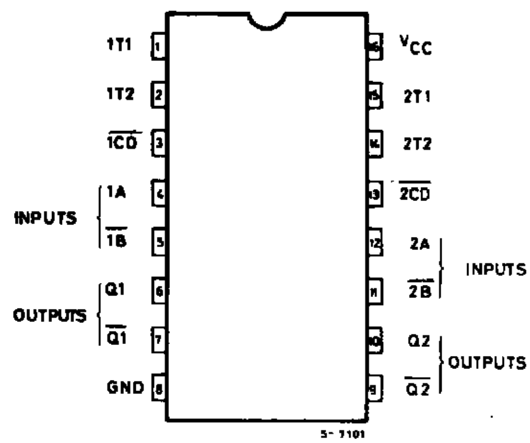
M54HC4538F1R M74HC4538M1R
M74HC4538B1R M74HC4538C1R

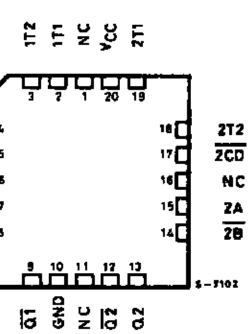
DESCRIPTION

The M54/74HC4538 is a high speed CMOS DUAL MONOSTABLE MULTIVIBRATOR fabricated in silicon gate C^2MOS technology. It has the same high speed performance of LSTTL combined with true CMOS low power consumption. 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 multivibrators are retriggerable. That is, they may be triggered reapeatedly 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.

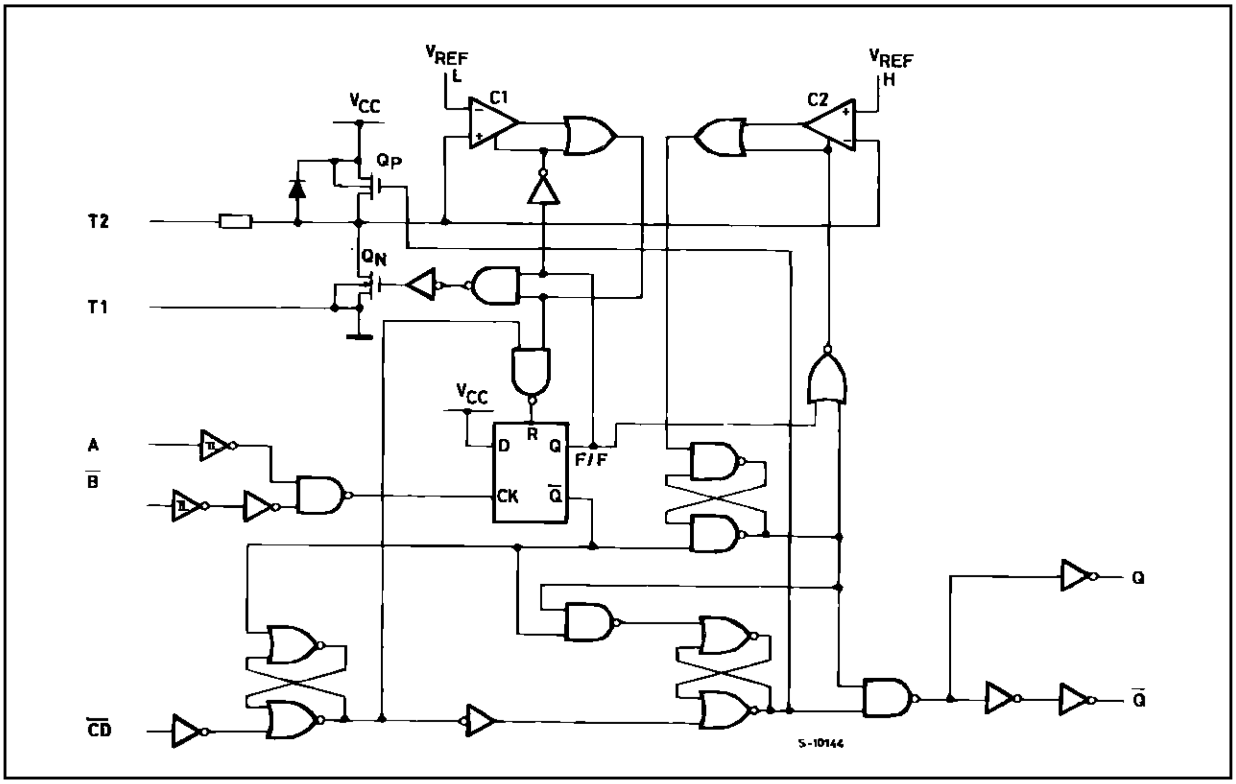
PIN CONNECTIONS (top view)



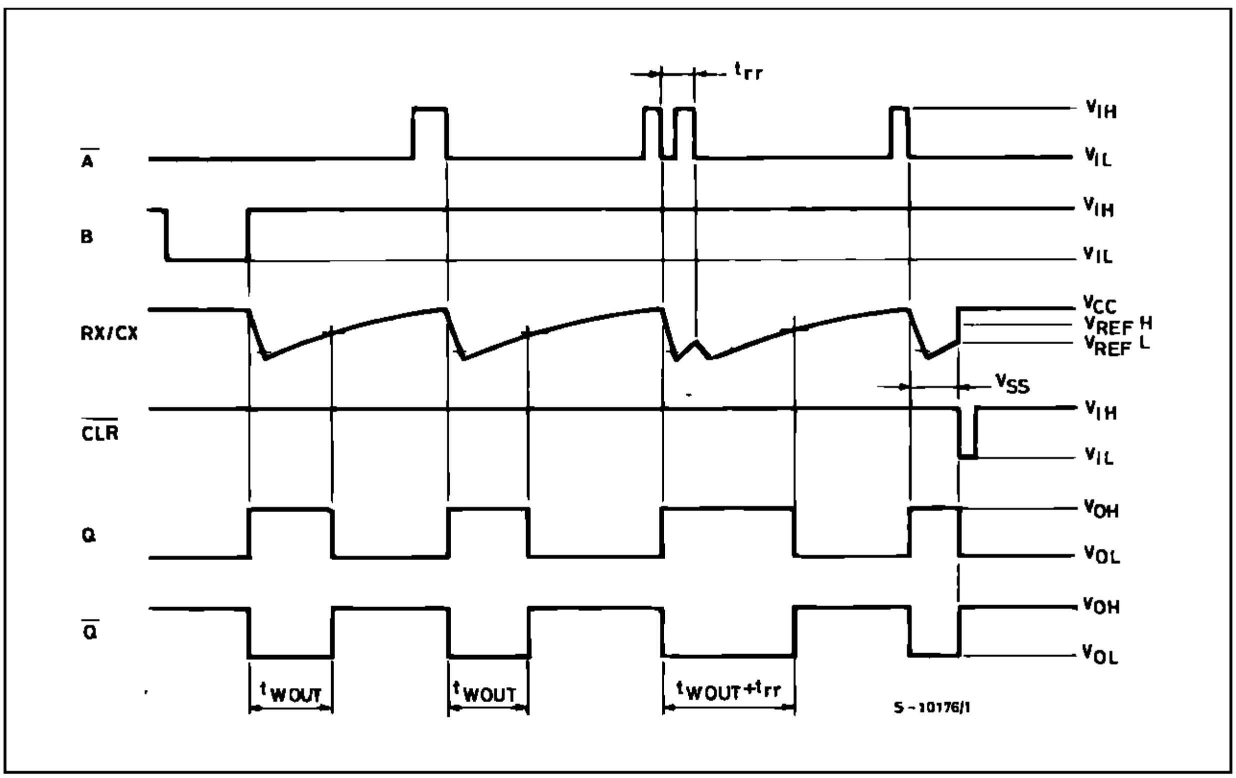


NC =
No Internal
Connection

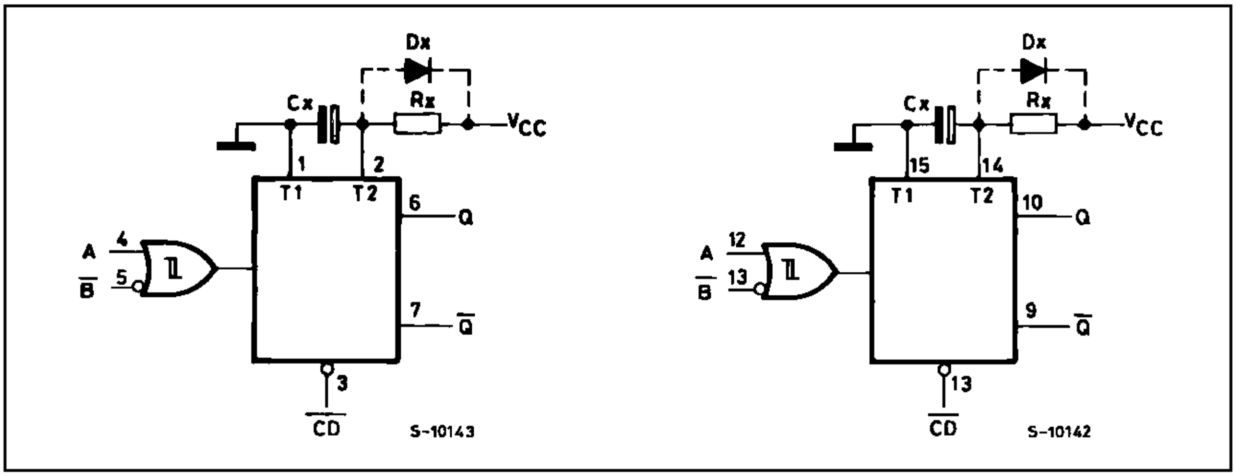
SYSTEM DIAGRAM



TIMING CHART



BLOCK DIAGRAM



Notes : 1. Cx, Rx, Dx are external components.
2. Dx is a clamping diode.
3. The external capacitor is charged to V_{CC} in the stand-by state, i.e. no trigger. When the supply voltage is turned off Cx is discharged mainly through an internal parasitic diode (see figures). If Cx is sufficiently large and V_{CC} decreases rapidy, 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 the I.C. is avoided. The maximum forward current of the parasitic diode is approximately 20 mA. In cases where Cx is large the time taken for the supply voltage to fall to 0.4 V_{CC} can be calculated as follows :
$t_f \geq (V_{CC} - 0.7) \cdot Cx/20\text{ mA}$
In cases where t_f is too short an external champing diode is required to protect the I.C. from the surge current.

FUNCTIONAL DESCRIPTION

STAND-BY STATE

The external capacitor, Cx, is fully charged to V_{CC} in the stand-by state. Hence, before triggering, transistor Qp and Qn (connected to the Rx/Cx 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 $\overline{B}$ has a falling edge ;

2 nd) $\overline{B}$ is "high" and A has a rising edge ;

After the multivibrator has been retriggered comparator C1 and C2 start operating and Qn is turned on. Cx then discharges through Qn. The voltage at the node Rx/Cx external falls.

When it reaches V_{REFL} the output of comparator C1 becomes low. This in turn resets the flip-flop and Qn is turned off.

At this point C1 stops functioning but C2 continues to operate. The voltage at R/C external begins to rise with a time constant set by the external components Rx, Cx.

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 C2 output goes low and G goes low. C2 stops operating. That means that after triggering when the voltage at R/C external returns to V_{REFH} the multivibrator has returned to its MONOSTABLE STATE. In the case where Rx • Cx 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 tw (out) is as follows :

$$t_{W(OUT)} = 0.72\ Cx \bullet Rx$$

RE-TRIGGER OPERATION

When a second trigger pulse follows the first its effect will depend on the state of the multivibrator. If the capacitor Cx is being charged the voltage level of Rx/Cx external falls to V_{REFL} again and Q remains high i.e. the retrigger pulse arrives in a time shorter than the period Rx • Cx 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, trr (Min.) depends on V_{CC} and Cx.

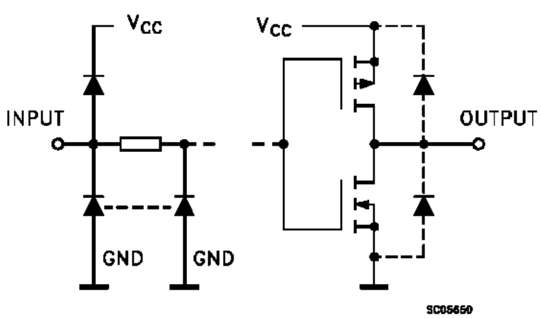
FUNCTIONAL DESCRIPTION (continued)

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 Op is turned on and Cx is charged quicky to V_{CC}. This means if $\overline{CD}$ input goes low, the IC becomes waiting state both in operating and non operating state.

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

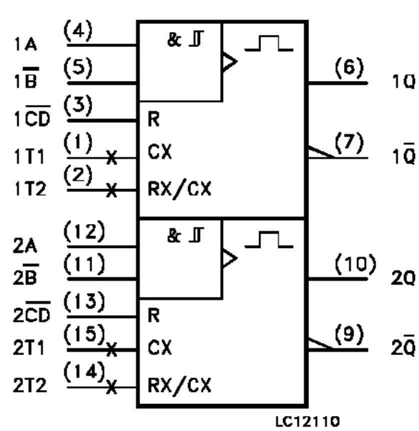
INPUT AND OUTPUT EQUIVALENT CIRCUIT



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	1$\overline{B}$, 2$\overline{B}$	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	V_{CC}	Positive Supply Voltage

IEC LOGIC SYMBOL



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 Source Sink Current Per Output Pin	± 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	^oC
T_L	Lead Temperature (10 sec)	300	^oC

Absolute Maximum Ratings are those values beyond which damage to the device may occur. Functional operation under these condition is not implied.
(*) 500 mW: ≅ 65 ^oC derate to 300 mW by 10mW/^oC: 65 ^oC to 85 ^oC

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: **M54HC** Series **M74HC** Series		-55 to +125 -40 to +85	^oC ^oC
t_r, t_f	Input Rise and Fall Time ($\overline{CLR}$ only)	V_{CC} = 2 V	0 to 1000	ns
		V_{CC} = 4.5 V	0 to 500	
		V_{CC} = 6 V	0 to 400	
C_X	External Capacitor		NO LIMITATION (*)	
R_X	External Resistor	$V_{CC} \leq 3$ V	5K to 1M (*)	Ω
		$V_{CC} > 3$ V	1K to 1M (*)	

(*) The maximum allowable values of Cx and Rx are a function of leakage of capacitor Cx, the leakage of device and leakage due to the board layout and surface resistance. Susceptibility to externally induced noise may occur for Rx > 1MΩ

DC SPECIFICATIONS

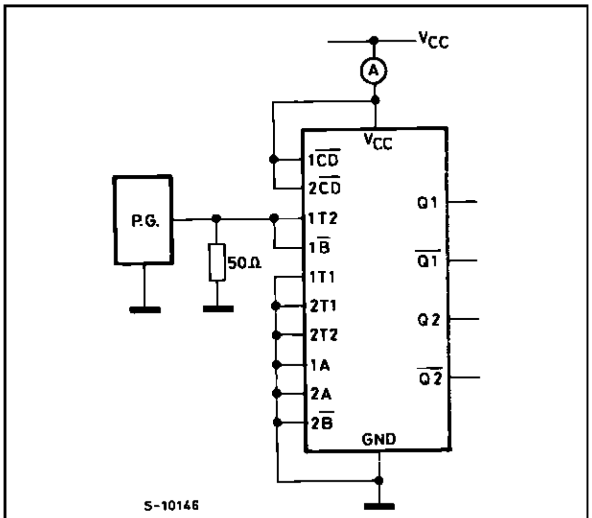
Symbol	Parameter	Test Conditions			Value							Unit
		V_{CC} (V)			T_A = 25 °C 54HC and 74HC			-40 to 85 °C 74HC		-55 to 125 °C 54HC		
					Min.	Typ.	Max.	Min.	Max.	Min.	Max.	
V_{IH}	High Level Input Voltage	2.0			1.5			1.5		1.5		V
		4.5			3.15			3.15		3.15		
		6.0			4.2			4.2		4.2		
V_{IL}	Low Level 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	V_I = V_{IH} or V_{IL}	I_O=-20 µA	1.9	2.0		1.9		1.9		V
		4.5			4.4	4.5		4.4		4.4		
		6.0			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	V_I = V_{IH} or V_{IL}	I_O= 20 µA		0.0	0.1		0.1		0.1	V
		4.5				0.0	0.1		0.1		0.1	
		6.0				0.0	0.1		0.1		0.1	
		4.5		I_O= 4.0 mA		0.17	0.26		0.37		0.40	
		6.0		I_O= 5.2 mA		0.18	0.26		0.37		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 Rext/Cext				±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 pins 2, 14 V_I = V_{CC}/2			40	120		160			µA
		4.5				0.2	0.3		0.4			mA
		6.0				0.3	0.6		0.8			mA

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

Symbol	Parameter	Test Conditions			Value							Unit
		V_{CC} (V)			T_A = 25 °C 54HC and 74HC			-40 to 85 °C 74HC		-55 to 125 °C 54HC		
					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 ($\overline{CD}$ - 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	C_X = 0	R_X = 5KΩ		540	1200		1500		1800	ns
		4.5		R_X = 1KΩ		180	250		320		375	
		6.0		R_X = 1KΩ		150	200		260		320	
		2.0	C_X = 0.01 µF R_X = 10KΩ		70	83	96	70	96	70	96	µs
		4.5			69	77	85	69	85	69	85	
		6.0			69	77	85	69	85	69	85	
		2.0	C_X = 0.1 µF R_X = 10KΩ		0.67	0.75	0.83	0.67	0.83	0.67	0.9	ms
		4.5			0.67	0.73	0.77	0.67	0.77	0.67	0.8	
		6.0			0.67	0.73	0.77	0.67	0.77	0.67	0.8	
Δt_{WOUT}	Output Pulse Width Error Between Circuits (In same pack)					±1						%
$t_{W(H)}$ $t_{W(L)}$	Minimum Pulse Width (CLOCK)	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 (CLEAR)	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_s	Minimum Retrigger Time	2.0	C_X = 0.1 µF R_X = 1KΩ			380					6	ns
		4.5				92						
		6.0				72						
		2.0	C_X = 0.01 µF R_X = 1KΩ			6						µs
		4.5				1.4						
		6.0				1.2						
C_{IN}	Input Capacitance					5	10		10		10	pF
C_{PD} (*)	Power Dissipation Capacitance					70						pF

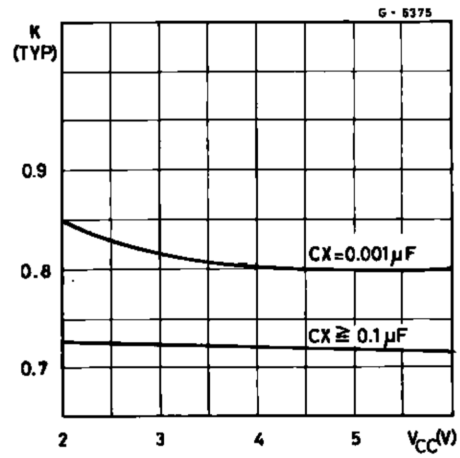
(*) C_{PD} is defined as the value of the IC's internal equivalent capacitance which is calculated from the operating current consumption without load. (Refer to Test Circuit). Average operting current can be obtained by the following equation. $I_{CC}(opr) = C_{PD} \bullet V_{CC} \bullet f_{IN} + I_{CC}'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

TEST CIRCUIT I_{CC} (Opr.)

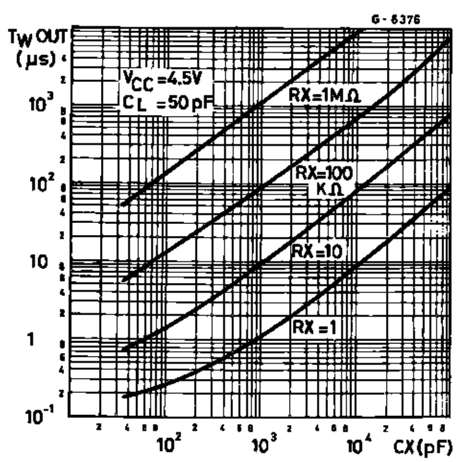


INPUT WAVEFORM IS THE SAME AS THAT IN CASE OF SWITCHING CHARACTERISTICS TEST.

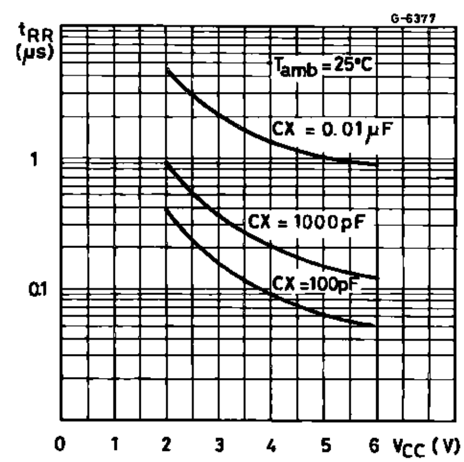
Output Pulse Width Constant K = Supply Voltage.



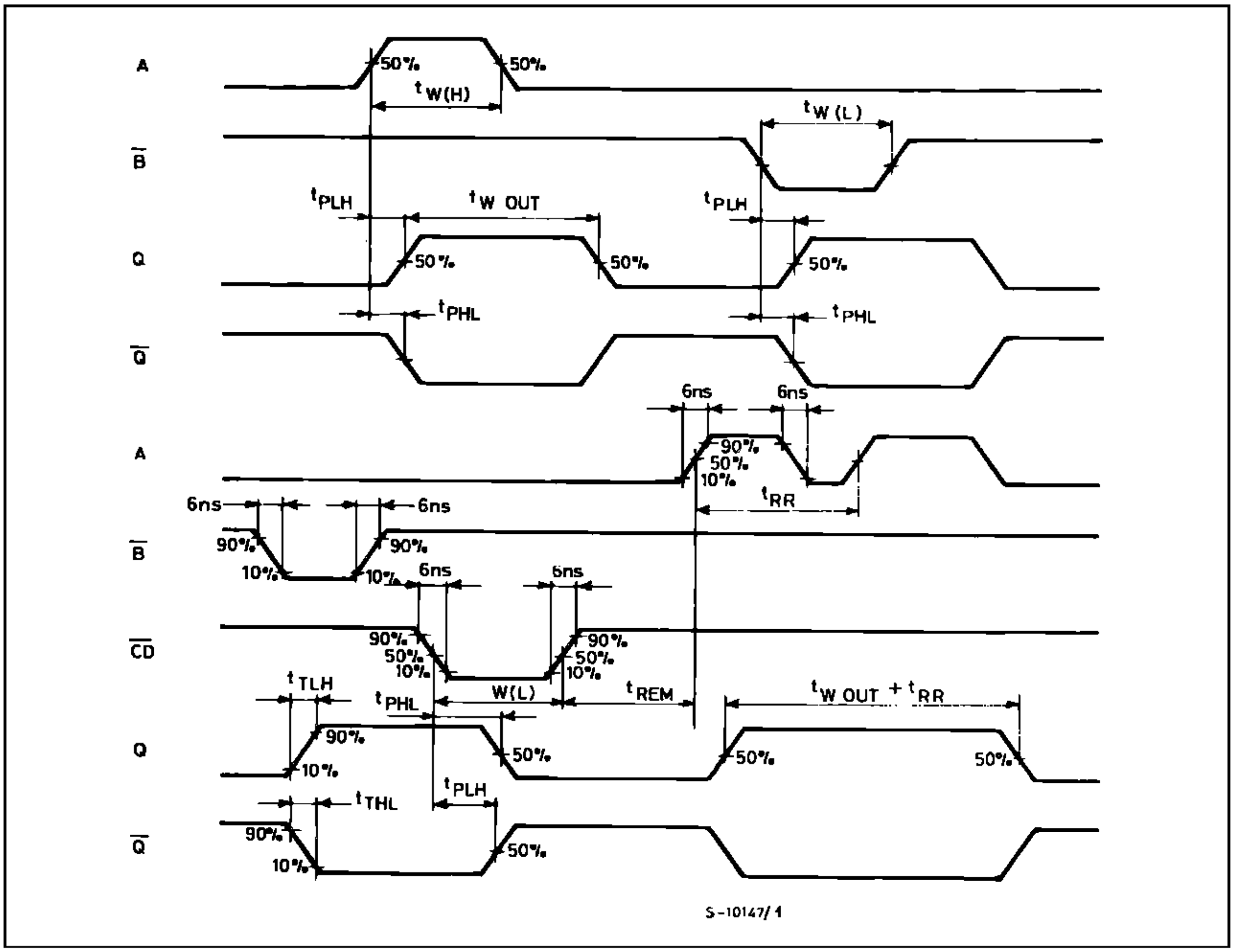
t_{WOUT} - Cx Characteristics (Typ).



t_{rr} - V_{CC} Characteristics (Typ).

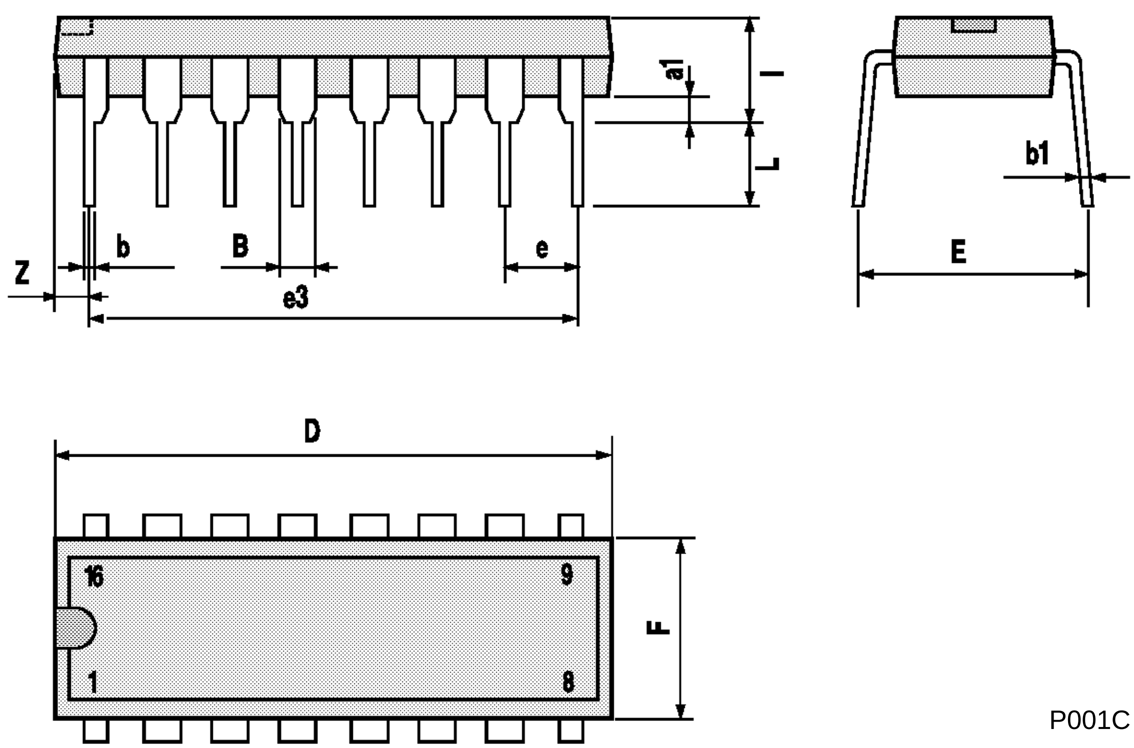


SWITCHING CHARACTERISTICS TEST WAVEFORM



Plastic DIP16 (0.25) MECHANICAL DATA

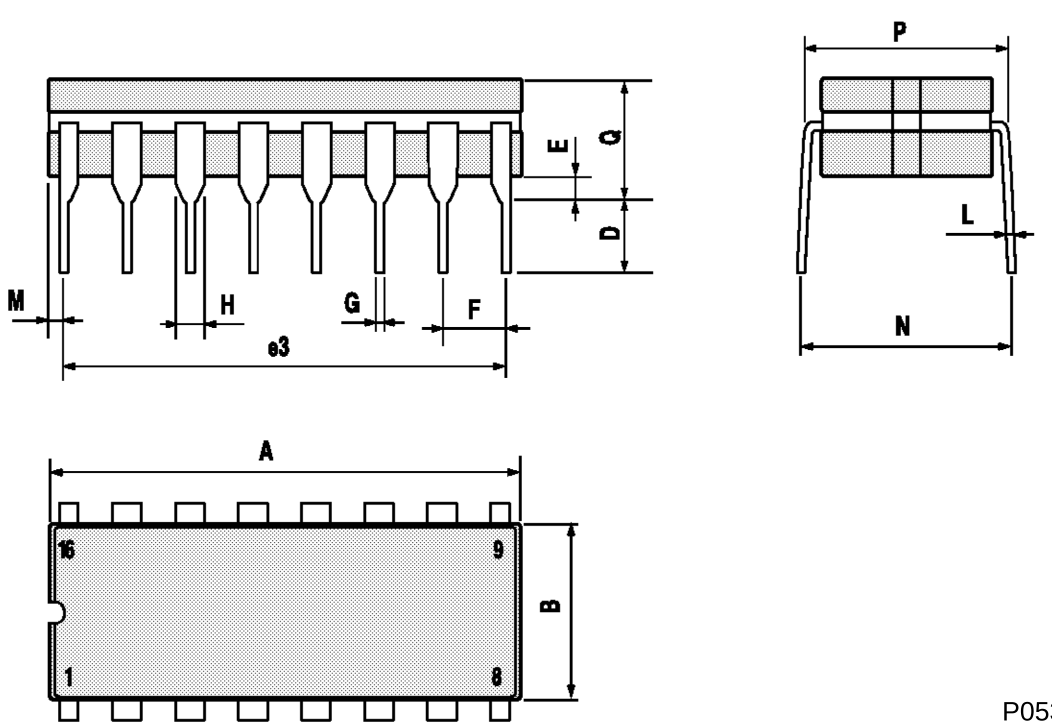
DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
a1	0.51			0.020		
B	0.77		1.65	0.030		0.065
b		0.5			0.020	
b1		0.25			0.010	
D			20			0.787
E		8.5			0.335	
e		2.54			0.100	
e3		17.78			0.700	
F			7.1			0.280
I			5.1			0.201
L		3.3			0.130	
Z			1.27			0.050



P001C

Ceramic DIP16/1 MECHANICAL DATA

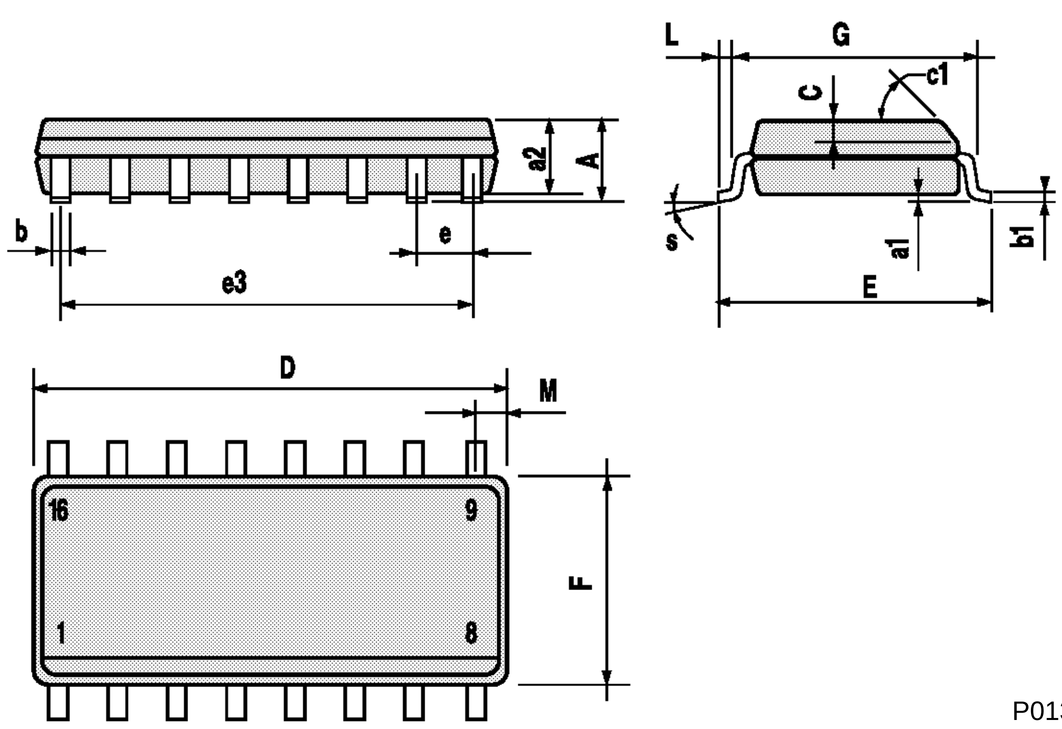
DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A			20			0.787
B			7			0.276
D		3.3			0.130	
E	0.38			0.015		
e3		17.78			0.700	
F	2.29		2.79	0.090		0.110
G	0.4		0.55	0.016		0.022
H	1.17		1.52	0.046		0.060
L	0.22		0.31	0.009		0.012
M	0.51		1.27	0.020		0.050
N			10.3			0.406
P	7.8		8.05	0.307		0.317
Q			5.08			0.200



P053D

SO16 (Narrow) MECHANICAL DATA

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A			1.75			0.068
a1	0.1		0.2	0.004		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.)					



P013H

PLCC20 MECHANICAL DATA

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	9.78		10.03	0.385		0.395
B	8.89		9.04	0.350		0.356
D	4.2		4.57	0.165		0.180
d1		2.54			0.100	
d2		0.56			0.022	
E	7.37		8.38	0.290		0.330
e		1.27			0.050	
e3		5.08			0.200	
F		0.38			0.015	
G			0.101			0.004
M		1.27			0.050	
M1		1.14			0.045