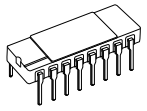
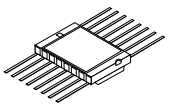
M54HC191

RAD-HARD 4 BIT SYNCHRONOUS UP/DOWN COUNTERS

- HIGH SPEED:
  f_{MAX} = 61 MHz (TYP.) at V_{CC} = 6V
- LOW POWER DISSIPATION:
  I_{CC} =4µA(MAX.) at T_A=25°C
- 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
- PIN AND FUNCTION COMPATIBLE WITH 54 SERIES 191
- SPACE GRADE-1: ESA SCC QUALIFIED
- 50 krad QUALIFIED, 100 krad AVAILABLE ON REQUEST
- NO SEL UNDER HIGH LET HEAVY IONS IRRADIATION
- DEVICE FULLY COMPLIANT WITH SCC-9204-066



DILC-16



FPC-16

ORDER CODES

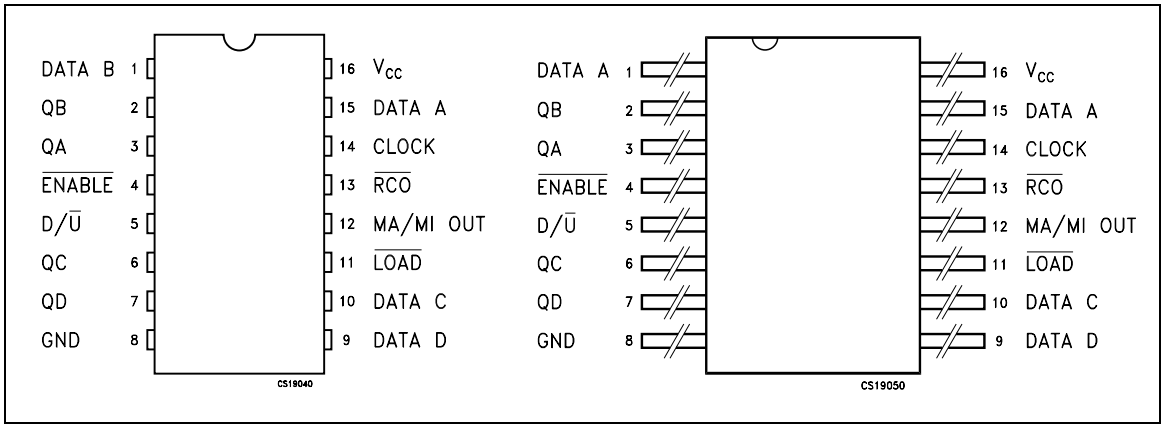
PACKAGE	FM	EM
DILC	M54HC191D	M54HC191D1
FPC	M54HC191K	M54HC191K1

DESCRIPTION

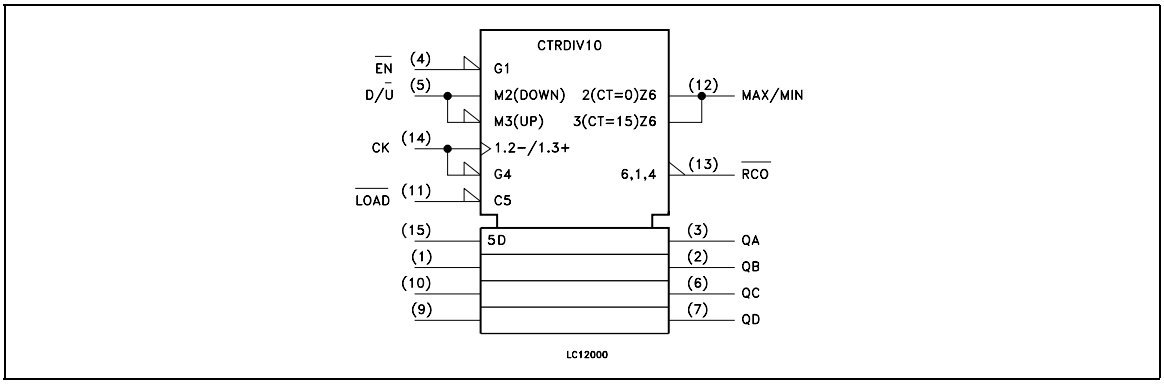
The M54HC191 is an high speed CMOS 4-BIT SYNCHRONOUS UP/DOWN COUNTER fabricated with silicon gate C^2MOS technology.
State changes of the counter are synchronous with the LOW-to-HIGH transition of the Clock Pulse Input.

An asynchronous parallel load input overrides counting and loads the data present on the DATA inputs into the flip-flops, which makes it possible to use the circuits as programmable counters. A count enable input serves as the carry/borrow input in multi-stage counters. Control input, Down/Up, determines whether a circuit counts up or down. A MAX/MIN output and a Ripple Clock output provide overflow/underflow indication and make possible a variety of methods for generating carry/borrow signals in multi-stage counter applications.
All inputs are equipped with protection circuits against static discharge and transient excess voltage.

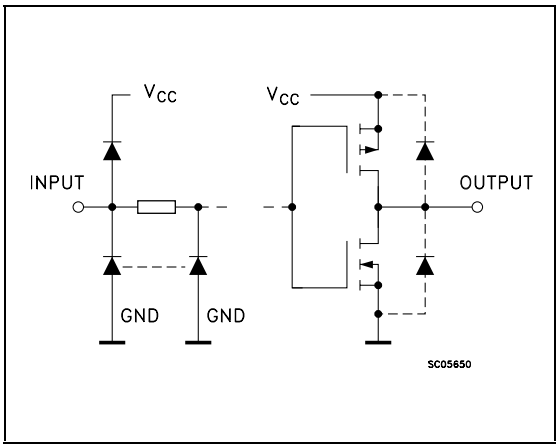
PIN CONNECTION



IEC LOGIC SYMBOLS



INPUT AND OUTPUT EQUIVALENT CIRCUIT



PIN DESCRIPTION

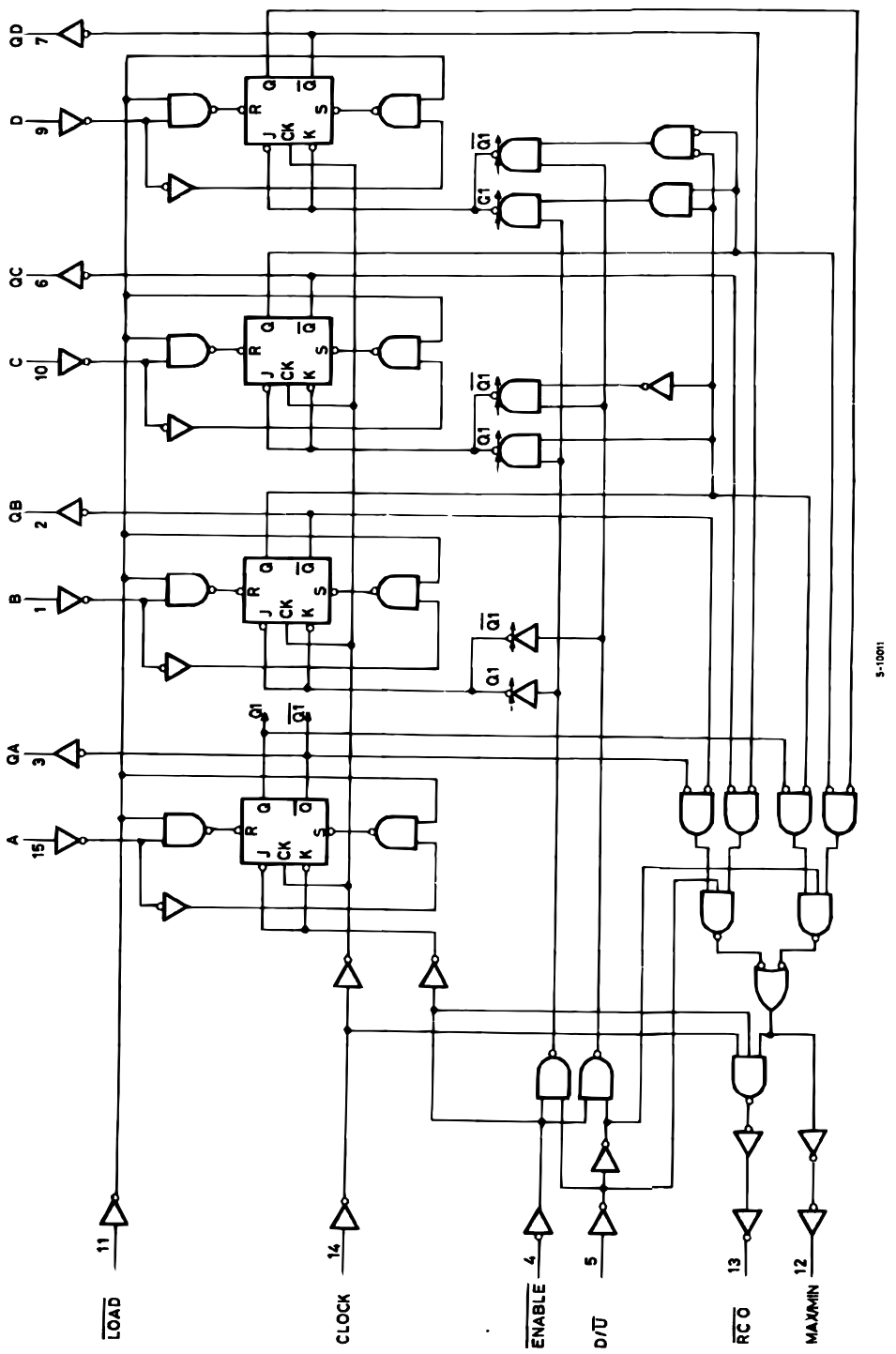
PIN N°	SYMBOL	NAME AND FUNCTION
3, 2, 6, 7	QA to QD	Flip-Flop Outputs
4	$\overline{\text{ENABLE}}$	Count Enable Input (Active LOW)
5	D/$\overline{\text{U}}$	Parallel Data Input
11	LOAD	Load Input (Active LOW)
12	MA/MI OUT	Terminal Count Output
13	$\overline{\text{RCO}}$	Ripple Clock Output (Active LOW)
14	CLOCK	Clock Input (LOW to HIGH, edge triggered)
15, 1, 10, 9	DA to DD	Data Inputs
8	GND	Ground (0V)
16	V_{CC}	Positive Supply Voltage

TRUTH TABLE

INPUTS				OUTPUTS				FUNCTION
$\overline{\text{LOAD}}$	$\overline{\text{ENABLE}}$	D/$\overline{\text{U}}$	CLOCK	QA	QB	QC	QD	
L	X	X	X	a	b	c	d	PRESET DATA
H	L	L	⎍	UP COUNT				UP COUNT
H	L	H	⎍	DOWN COUNT				DOWN COUNT
H	H	X	⎍	NO CHANGE				NO COUNT
H	X	X	⎎	NO CHANGE				NO COUNT

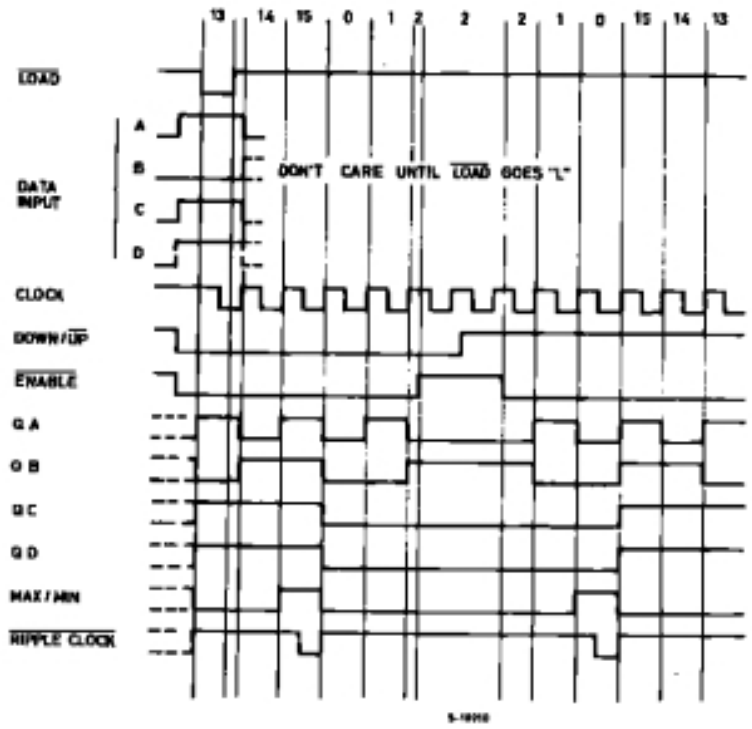
X : Don't Care
a - d: The level of steady state inputs a through d respectively

LOGIC DIAGRAM



This logic diagram has not be used to estimate propagation delays

TIMING CHART



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	300	mW
T_{stg}	Storage Temperature	-65 to +150	°C
T_L	Lead Temperature (10 sec)	265	°C

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

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	V_{CC} = 2.0V	0 to 1000	ns
		V_{CC} = 4.5V	0 to 500	ns
		V_{CC} = 6.0V	0 to 400	ns

DC SPECIFICATIONS

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.	
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 µA	1.9	2.0		1.9		1.9		V
		4.5	I_O=-20 µA	4.4	4.5		4.4		4.4		
		6.0	I_O=-20 µA	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 µA		0.0	0.1		0.1		0.1	V
		4.5	I_O=20 µA		0.0	0.1		0.1		0.1	
		6.0	I_O=20 µA		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_{CC}	Quiescent Supply Current	6.0	V_I = V_{CC} or GND			4		40		80	µA

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 (CLOCK - Q)	2.0			92	180		225		270	ns
		4.5			23	36		45		54	
		6.0			20	31		38		46	
t_{PLH} t_{PHL}	Propagation Delay Time (CLOCK - $\overline{RCO}$)	2.0			39	120		150		180	ns
		4.5			13	24		30		36	
		6.0			11	20		26		31	
t_{PLH} t_{PHL}	Propagation Delay Time (CLOCK - MAX/MIN)	2.0			120	240		300		360	ns
		4.5			30	48		60		72	
		6.0			26	41		51		61	
t_{PLH} t_{PHL}	Propagation Delay Time (LOAD - Q)	2.0			108	205		255		310	ns
		4.5			27	41		51		61	
		6.0			23	35		43		53	
t_{PLH} t_{PHL}	Propagation Delay Time (DATA - Q)	2.0			84	175		220		265	ns
		4.5			21	35		44		53	
		6.0			18	30		37		45	
t_{PLH} t_{PHL}	Propagation Delay Time (ENABLE - RCO)	2.0			39	105		130		160	ns
		4.5			13	21		26		32	
		6.0			11	18		22		27	
t_{PLH} t_{PHL}	Propagation Delay Time (D/U - RCO)	2.0			63	180		225		270	ns
		4.5			21	36		45		54	
		6.0			18	31		38		46	
t_{PLH} t_{PHL}	Propagation Delay Time (D/U - MAX/MIN)	2.0			64	160		200		240	ns
		4.5			18	32		40		48	
		6.0			15	27		34		41	
f_{MAX}	Maximum Clock Frequency	2.0		6.2	9		4		3.4		MHz
		4.5		31	37		20		17		
		6.0		37	44		24		20		
$t_{W(H)}$ $t_{W(L)}$	Minimum Pulse Width (CLOCK)	2.0			40	100		125		150	ns
		4.5			10	20		25		30	
		6.0			9	17		21		26	
$t_{W(L)}$	Minimum Pulse Width (LOAD)	2.0			36	75		95		110	ns
		4.5			9	15		19		22	
		6.0			8	13		16		19	
t_s	Minimum Set-up Time (SI, PI - CK)	2.0			80	175		220		265	ns
		4.5			20	35		44		53	
		6.0			17	30		37		45	
t_s	Minimum Set-up Time (S0, S1 - CK)	2.0			16	50		60		75	ns
		4.5			4	10		12		15	
		6.0			3	9		11		13	
t_h	Minimum Hold Time	2.0				0		0		0	ns
		4.5				0		0		0	
		6.0				0		0		0	

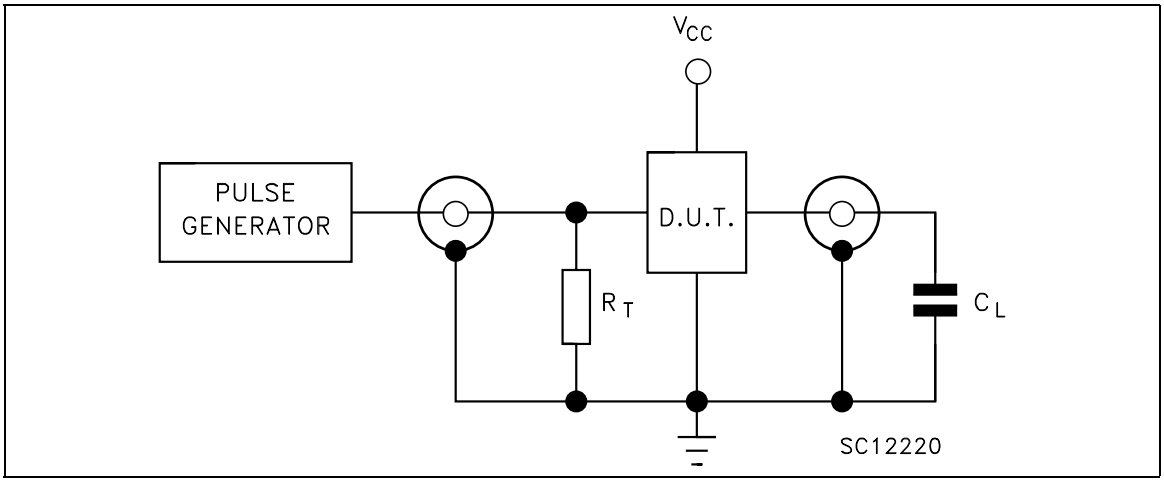
Symbol	Parameter	Test Condition		Value							Unit
		V_{CC} (V)		T_A = 25°C			-40 to 85°C		-55 to 125°C		
				Min.	Typ.	Max.	Min.	Max.	Min.	Max.	
t_{REM}	Minimum Removal Time (CLEAR)	2.0			12	50		60		65	ns
		4.5			3	10		12		15	
		6.0			3	9		11		13	

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			112						pF

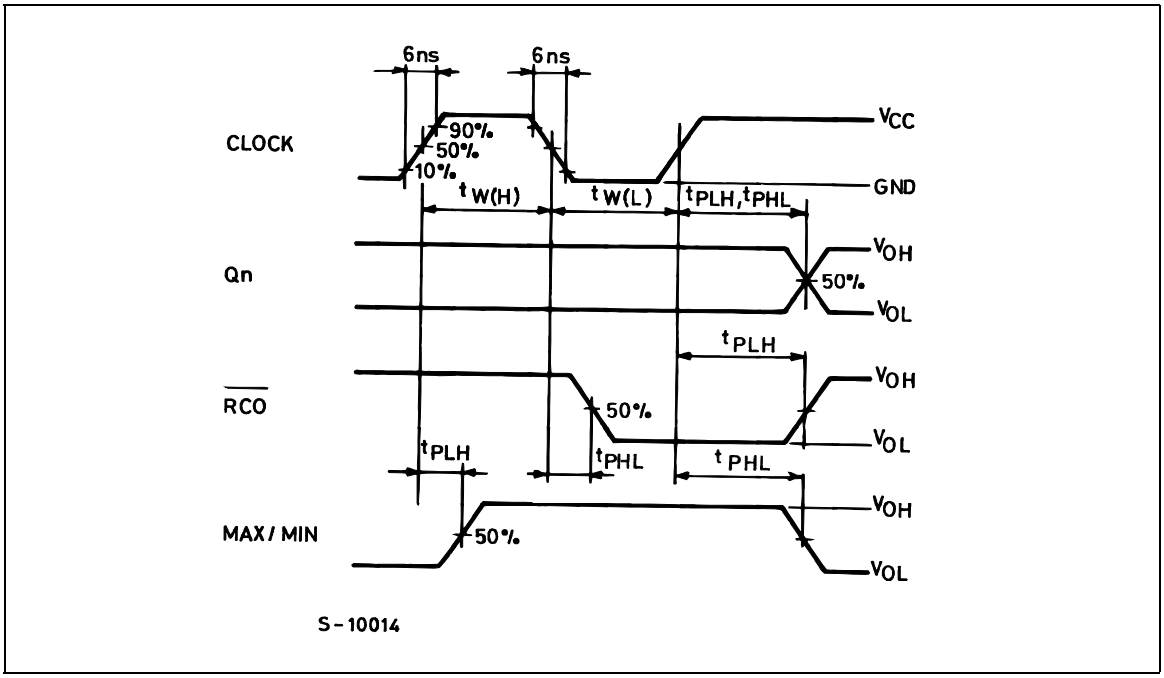
1) C_{PD} is defined as the value of the IC's internal equivalent capacitance which is calculated from the operating current consumption without load. (Refer to Test Circuit). Average operating current can be obtained by the following equation. $I_{CC(opr)} = C_{PD} \times V_{CC} \times f_{IN} + I_{CC}$

TEST CIRCUIT

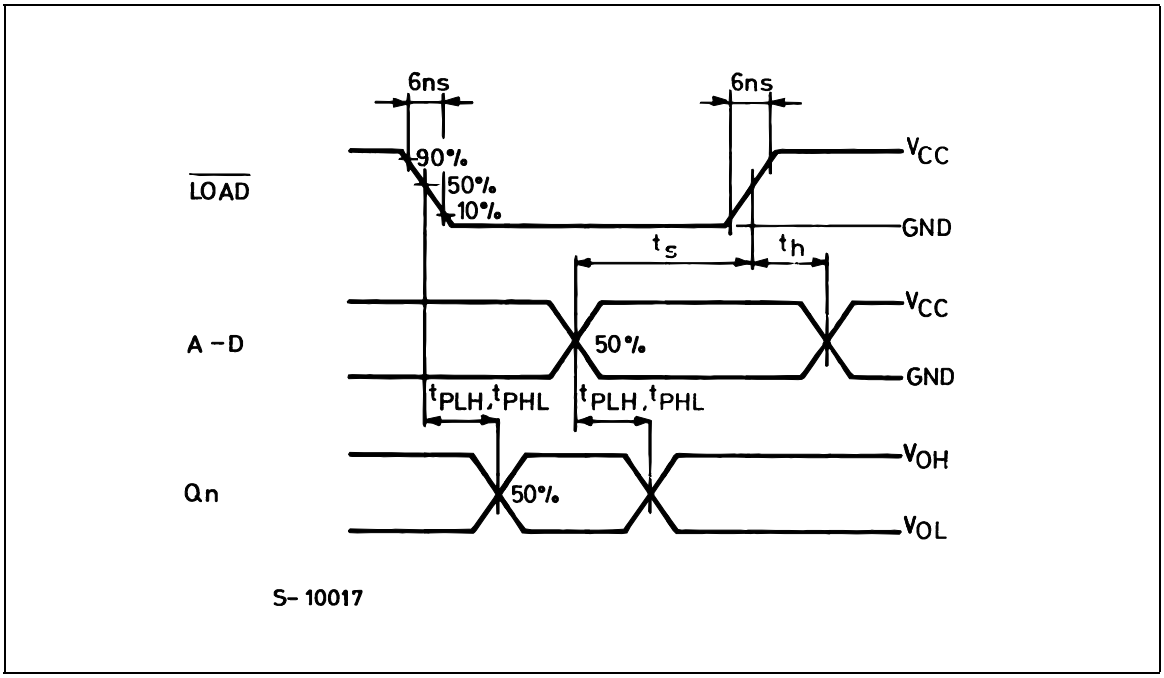


C_L = 50pF or equivalent (includes jig and probe capacitance)
$R_T = Z_{OUT}$ of pulse generator (typically 50Ω)

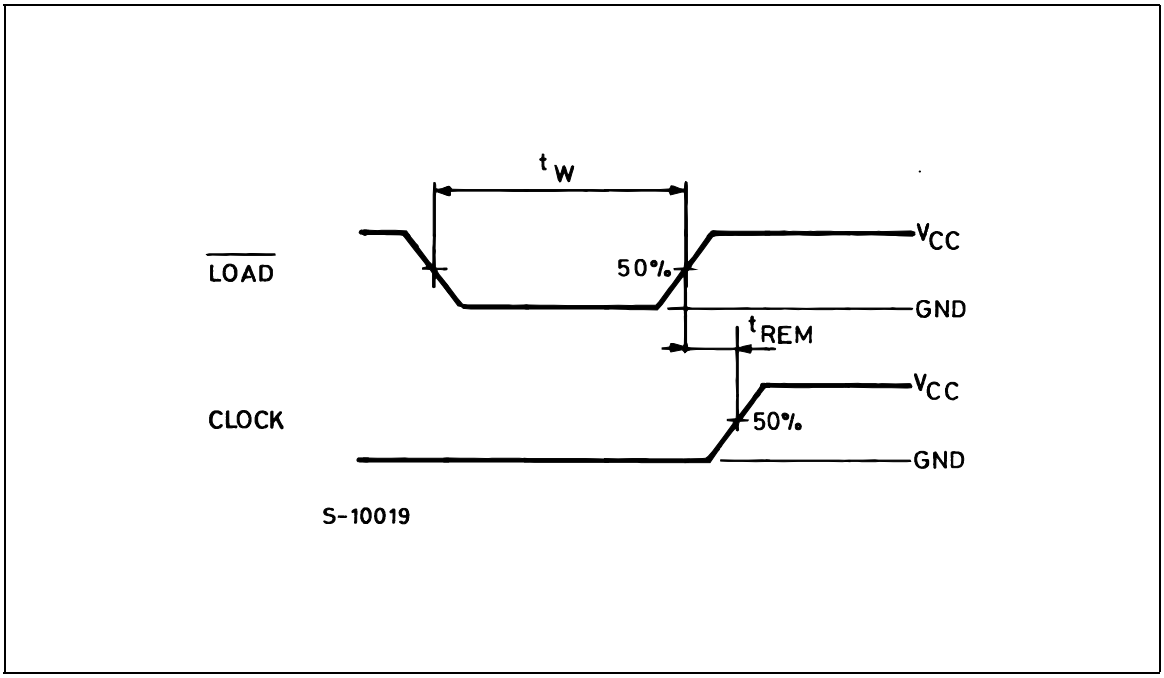
WAVEFORM 1: PROPAGATION DELAY TIME, MINIMUM PULSE WIDTH (CLOCK)(f=1MHz; 50% duty cycle)



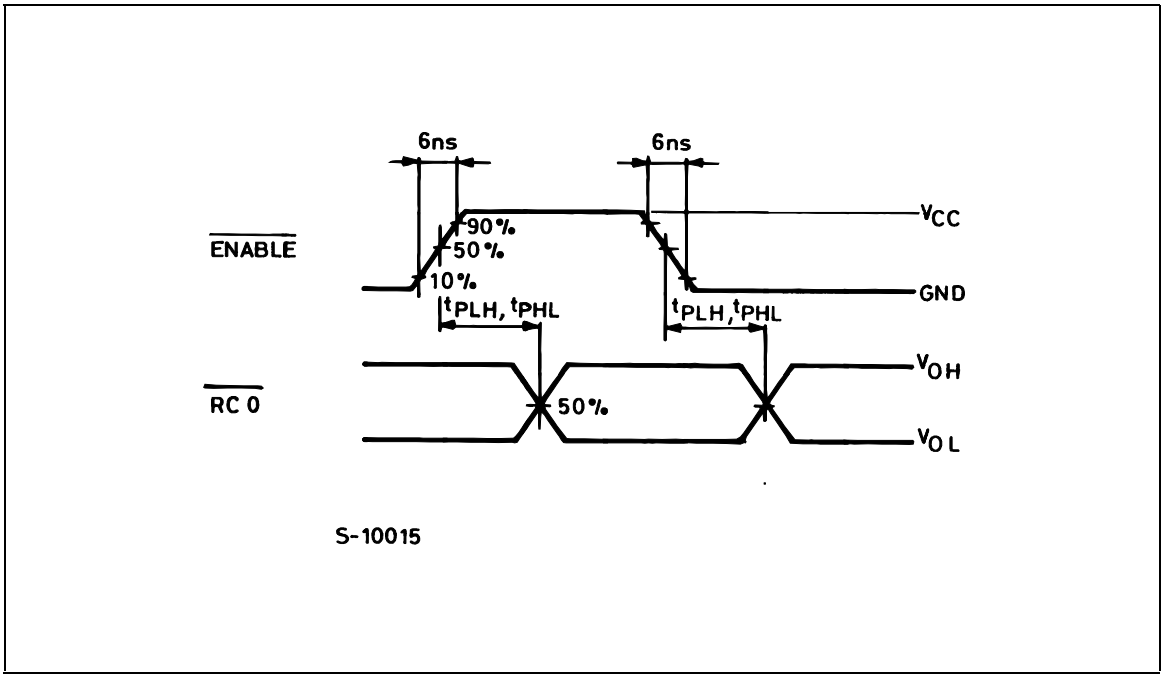
WAVEFORM 2: PROPAGATION DELAY TIME, SETUP AND HOLD TIME (A-D TO $\overline{\text{LOAD}}$) (f=1MHz; 50% duty cycle)



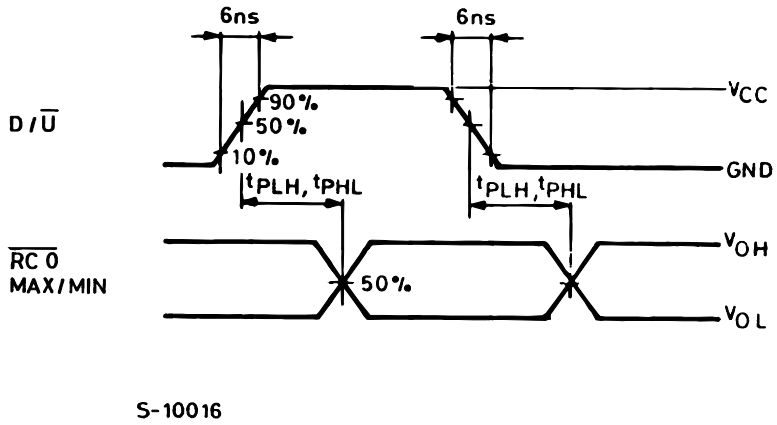
WAVEFORM 3: MINIMUM PULSE WIDTH ($\overline{\text{LOAD}}$) AND REMOVAL TIME ($\overline{\text{LOAD}}$ TO CLOCK) (f=1MHz; 50% duty cycle)



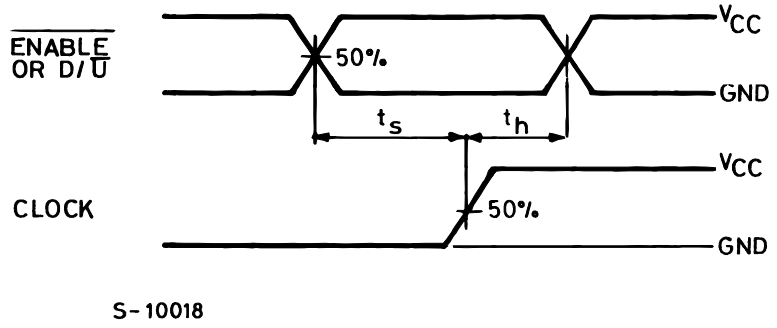
WAVEFORM 4: PROPAGATION DELAY TIME (f=1MHz; 50% duty cycle)



WAVEFORM 5: PROPAGATION DELAY TIME (f=1MHz; 50% duty cycle)

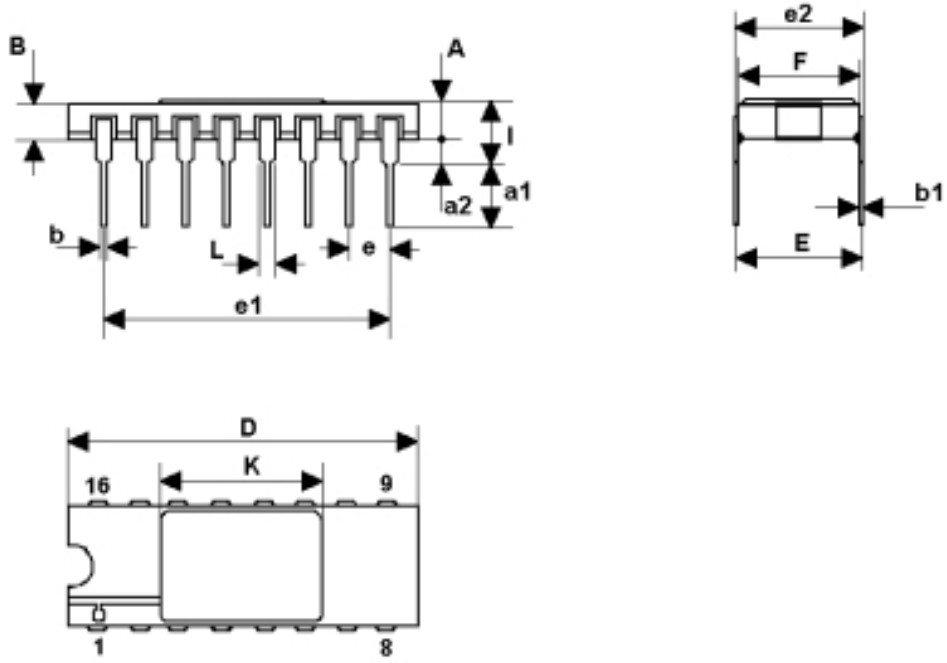


WAVEFORM 6: SETUP AND HOLD TIME (f=1MHz; 50% duty cycle)



DILC-16 MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A	2.1		2.71	0.083		0.107
a1	3.00		3.70	0.118		0.146
a2	0.63	0.88	1.14	0.025	0.035	0.045
B	1.82		2.39	0.072		0.094
b	0.40	0.45	0.50	0.016	0.018	0.020
b1	0.20	0.254	0.30	0.008	0.010	0.012
D	20.06	20.32	20.58	0.790	0.800	0.810
e	7.36	7.62	7.87	0.290	0.300	0.310
e1		2.54			0.100	
e2	17.65	17.78	17.90	0.695	0.700	0.705
e3	7.62	7.87	8.12	0.300	0.310	0.320
F	7.29	7.49	7.70	0.287	0.295	0.303
I			3.83			0.151
K	10.90		12.1	0.429		0.476
L	1.14		1.5	0.045		0.059



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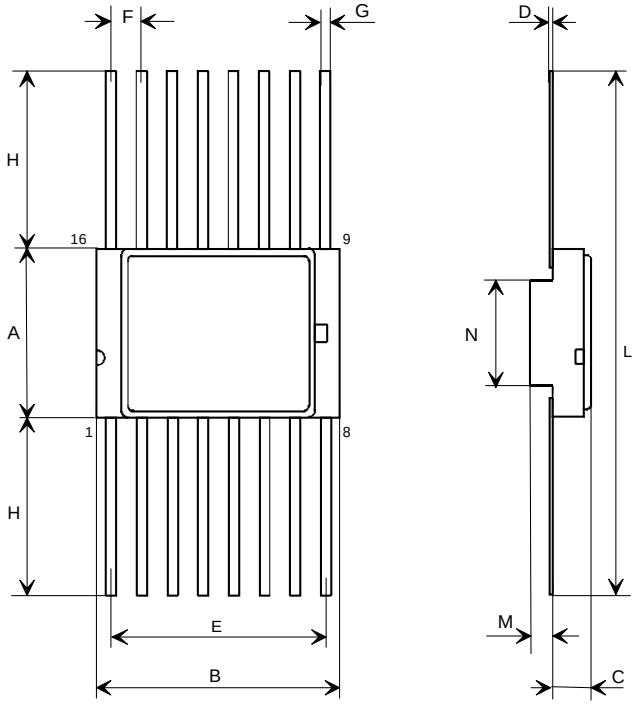
FPC-16 MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A	6.75	6.91	7.06	0.266	0.272	0.278
B	9.76	9.94	10.14	0.384	0.392	0.399
C	1.49		1.95	0.059		0.077
D	0.102	0.127	0.152	0.004	0.005	0.006
E	8.76	8.89	9.01	0.345	0.350	0.355
F		1.27			0.050	
G	0.38	0.43	0.48	0.015	0.017	0.019
H	6.0			0.237		
L	18.75		22.0	0.738		0.867
M	0.33	0.38	0.43	0.013	0.015	0.017
N		4.31			0.170	



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