74HC4060; 74HCT4060

14-stage binary ripple counter with oscillator

Rev. 03 — 14 July 2008 Product data sheet

1. General description

The 74HC4060; 74HCT4060 are high-speed Si-gate CMOS device and is pin compatible with the HEF4060.

The 74HC4060; 74HCT4060 are 14-stage ripple-carry counter/dividers and oscillators with three oscillator terminals (RS, RTC and CTC), ten buffered outputs (Q3 to Q9 and Q11 to Q13) and an overriding asynchronous master reset (MR). The oscillator configuration allows design of either RC or crystal oscillator circuits. The oscillator may be replaced by an external clock signal at input RS. In this case keep the other oscillator pins (RTC and CTC) floating. The counter advances on the negative-going transition of RS. A HIGH level on MR resets the counter (Q3 to Q9 and Q11 to Q13 = LOW), independent of other input conditions. In the HCT version, the MR input is TTL compatible, but the RS input has CMOS input switching levels and can be driven by a TTL output by using a pull-up resistor to V_{CC}.

2. Features

- All active components on chip
- RC or crystal oscillator configuration
- Complies with JEDEC standard no. 7 A
- ESD protection:
  - HBM JESD22-A114E exceeds 2000 V
  - MM JESD22-A115-A exceeds 200 V
- Multiple package options
- Specified from –40 °C to +85 °C and from –40 °C to +125 °C

3. Applications

- Control counters
- Timers
- Frequency dividers
- Time-delay circuits

4. Ordering information

Table 1. Ordering information

Type number	Package			
	Temperature range	Name	Description	Version
74HC4060N	–40 °C to +125 °C	DIP16	plastic dual in-line package; 16 leads (300 mil)	SOT38-4
74HCT4060N				
74HC4060D	–40 °C to +125 °C	SO16	plastic small outline package; 16 leads; body width 3.9 mm	SOT109-1
74HCT4060D				
74HC4060DB	–40 °C to +125 °C	SSOP16	plastic shrink small outline package; 16 leads; body width 5.3 mm	SOT338-1
74HCT4060DB				
74HC4060PW	–40 °C to +125 °C	TSSOP16	plastic thin shrink small outline package; 16 leads; body width 4.4 mm	SOT403-1
74HC4060BQ	–40 °C to +125 °C	DHVQFN16	plastic dual in-line compatible thermal-enhanced very thin quad flat package; no leads; 16 terminals; body 2.5 × 3.5 × 0.85 mm	SOT763-1
74HCT4060BQ				

5. Functional diagram

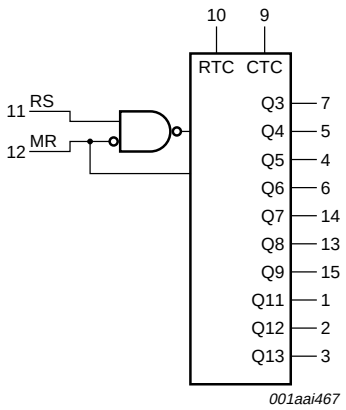


Fig 1. Logic symbol

7. Functional description

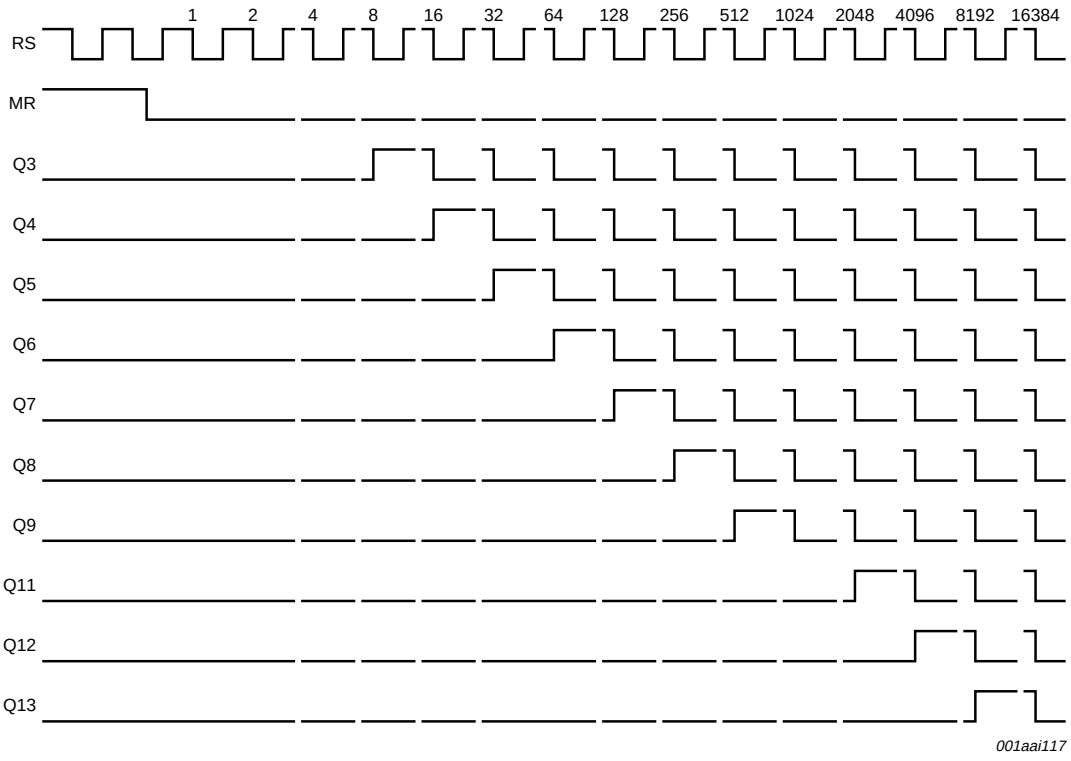


Fig 7. Timing diagram

8. Limiting values

Table 3. Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134). Voltages are referenced to GND (ground = 0 V).

Symbol	Parameter	Conditions		Min	Max	Unit
V_{CC}	supply voltage			–0.5	+7	V
I_{IK}	input clamping current	$V_I < –0.5$ V or $V_I > V_{CC} + 0.5$ V	[1]	-	±20	mA
I_{OK}	output clamping current	$V_O < –0.5$ V or $V_O > V_{CC} + 0.5$ V	[1]	-	±20	mA
I_O	output current	$–0.5 \text{ V} < V_O < V_{CC} + 0.5$ V		-	±25	mA
I_{CC}	supply current			-	50	mA
I_{GND}	ground current			–50	-	mA
T_{stg}	storage temperature			–65	+150	°C

Table 3. Limiting values *...continued*

In accordance with the Absolute Maximum Rating System (IEC 60134). Voltages are referenced to GND (ground = 0 V).

Symbol	Parameter	Conditions		Min	Max	Unit
P_{tot}	total power dissipation	T_{amb} = –40 °C to +125 °C				
		DIP16 package	[2]	-	750	mW
		SO16 package	[3]	-	500	mW
		(T)SSOP16 package	[4]	-	500	mW
		DHVQFN16 package	[5]	-	500	mW

[1] The input and output voltage ratings may be exceeded if the input and output current ratings are observed.

[2] P_{tot} derates linearly with 12 mW/K above 70 °C.

[3] P_{tot} derates linearly with 8 mW/K above 70 °C.

[4] P_{tot} derates linearly with 5.5 mW/K above 60 °C.

[5] P_{tot} derates linearly with 4.5 mW/K above 60 °C.

9. Recommended operating conditions

Table 4. Recommended operating conditions

Voltages are referenced to GND (ground = 0 V)

Symbol	Parameter	Conditions	74HC4060			74HCT4060			Unit
			Min	Typ	Max	Min	Typ	Max	
V_{CC}	supply voltage		2.0	5.0	6.0	4.5	5.0	5.5	V
V_I	input voltage		0	-	V_{CC}	0	-	V_{CC}	V
V_O	output voltage		0	-	V_{CC}	0	-	V_{CC}	V
T_{amb}	ambient temperature		–40	-	+125	–40	-	+125	°C
$\Delta t/\Delta V$	input transition rise and fall rate	V_{CC} = 2.0 V	-	-	625	-	-	-	ns/V
		V_{CC} = 4.5 V	-	1.67	139	-	1.67	139	ns/V
		V_{CC} = 6.0 V	-	-	83	-	-	-	ns/V

10. Static characteristics

Table 5. Static characteristics

At recommended operating conditions; voltages are referenced to GND (ground = 0 V).

Symbol	Parameter	Conditions	25 °C			–40 °C to +85 °C		–40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
74HC4060										
V_{IH}	HIGH-level input voltage	MR input								
		V_{CC} = 2.0 V	1.5	1.3	-	1.5	-	1.5	-	V
		V_{CC} = 4.5 V	3.15	2.4	-	3.15	-	3.15	-	V
		V_{CC} = 6.0 V	4.2	3.1	-	4.2	-	4.2	-	V
		RS input								
		V_{CC} = 2.0 V	1.7	-	-	1.7	-	1.7	-	V
		V_{CC} = 4.5 V	3.6	-	-	3.6	-	3.6	-	V
		V_{CC} = 6.0 V	4.8	-	-	4.8	-	4.8	-	V

Table 5. Static characteristics *…continued*

At recommended operating conditions; voltages are referenced to GND (ground = 0 V).

Symbol	Parameter	Conditions	25 °C			–40 °C to +85 °C		–40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
V_{IL}	LOW-level input voltage	MR input								
		V_{CC} = 2.0 V	-	0.8	0.5	-	0.5	-	0.5	V
		V_{CC} = 4.5 V	-	2.1	1.35	-	1.35	-	1.35	V
		V_{CC} = 6.0 V	-	2.8	1.8	-	1.8	-	1.8	V
		RS input								
		V_{CC} = 2.0 V	-	-	0.3	-	0.3	-	0.3	V
		V_{CC} = 4.5 V	-	-	0.9	-	0.9	-	0.9	V
		V_{CC} = 6.0 V	-	-	1.2	-	1.2	-	1.2	V
V_{OH}	HIGH-level output voltage	RTC output; RS = MR = GND								
		I_O = –20 µA; V_{CC} = 2.0 V	1.9	2.0	-	1.9	-	1.9	-	V
		I_O = –20 µA; V_{CC} = 4.5 V	4.4	4.5	-	4.4	-	4.4	-	V
		I_O = –20 µA; V_{CC} = 6.0 V	5.9	6.0	-	5.9	-	5.9	-	V
		I_O = –2.6 mA; V_{CC} = 4.5 V	3.98	-	-	3.84	-	3.7	-	V
		I_O = –3.3 mA; V_{CC} = 6.0 V	5.48	-	-	5.34	-	5.2	-	V
		RTC output; RS = MR = V_{CC}								
		I_O = –20 µA; V_{CC} = 2.0 V	1.9	2.0	-	1.9	-	1.9	-	V
		I_O = –20 µA; V_{CC} = 4.5 V	4.4	4.5	-	4.4	-	4.4	-	V
		I_O = –20 µA; V_{CC} = 6.0 V	5.9	6.0	-	5.9	-	5.9	-	V
		I_O = –0.65 mA; V_{CC} = 4.5 V	3.98	-	-	3.84	-	3.7	-	V
		I_O = –0.85 mA; V_{CC} = 6.0 V	5.48	-	-	5.34	-	5.2	-	V
		CTC output; RS = V_{IH}; MR = V_{IL}								
		I_O = –3.2 mA; V_{CC} = 4.5 V	3.98	-	-	3.84	-	3.7	-	V
		I_O = –4.2 mA; V_{CC} = 6.0 V	5.48	-	-	5.34	-	5.2	-	V
		V_I = V_{IH} or V_{IL}; except RTC output								
		I_O = –20 µA; V_{CC} = 2.0 V	1.9	2.0	-	1.9	-	1.9	-	V
		I_O = –20 µA; V_{CC} = 4.5 V	4.4	4.5	-	4.4	-	4.4	-	V
		I_O = –20 µA; V_{CC} = 6.0 V	5.9	6.0	-	5.9	-	5.9	-	V
		V_I = V_{IH} or V_{IL}; except RTC and CTC outputs								
		I_O = –4.0 mA; V_{CC} = 4.5 V	3.98	-	-	3.84	-	3.7	-	V
		I_O = –5.2 mA; V_{CC} = 6.0 V	5.48	-	-	5.34	-	5.2	-	V

Table 5. Static characteristics *…continued*

At recommended operating conditions; voltages are referenced to GND (ground = 0 V).

Symbol	Parameter	Conditions		25 °C			–40 °C to +85 °C		–40 °C to +125 °C		Unit
				Min	Typ	Max	Min	Max	Min	Max	
V_{OL}	LOW-level output voltage	RTC output; RS = V_{CC}; MR = GND									
		I_O = 20 µA; V_{CC} = 2.0 V		-	0	0.1	-	0.1	-	0.1	V
		I_O = 20 µA; V_{CC} = 4.5 V		-	0	0.1	-	0.1	-	0.1	V
		I_O = 20 µA; V_{CC} = 6.0 V		-	0	0.1	-	0.1	-	0.1	V
		I_O = 2.6 mA; V_{CC} = 4.5 V		-	-	0.26	-	0.33	-	0.4	V
		I_O = 3.3 mA; V_{CC} = 6.0 V		-	-	0.26	-	0.33	-	0.4	V
		CTC output; RS = V_{IL}; MR = V_{IH}									
		I_O = 3.2 mA; V_{CC} = 4.5 V		-	-	0.26	-	0.33	-	0.4	V
		I_O = 4.2 mA; V_{CC} = 6.0 V		-	-	0.26	-	0.33	-	0.4	V
		V_I = V_{IH} or V_{IL}; except RTC output									
		I_O = 20 µA; V_{CC} = 2.0 V		-	0	0.1	-	0.1	-	0.1	V
		I_O = 20 µA; V_{CC} = 4.5 V		-	0	0.1	-	0.1	-	0.1	V
		I_O = 20 µA; V_{CC} = 6.0 V		-	0	0.1	-	0.1	-	0.1	V
		V_I = V_{IH} or V_{IL}; except RTC and CTC outputs									
		I_O = 4.0 mA; V_{CC} = 4.5 V		-	-	0.26	-	0.33	-	0.4	V
		I_O = 5.2 mA; V_{CC} = 6.0 V		-	-	0.26	-	0.33	-	0.4	V
I_I	input leakage current	V_I = V_{CC} or GND; V_{CC} = 6.0 V		-	-	±0.1	-	±1.0	-	±1.0	µA
I_{CC}	supply current	V_I = V_{CC} or GND; I_O = 0 A; V_{CC} = 6.0 V		-	-	8.0	-	80	-	160	µA
C_I	input capacitance			-	3.5	-	-	-	-	-	pF
74HCT4060											
V_{IH}	HIGH-level input voltage	MR input; V_{CC} = 4.5 V to 5.5 V	[1]	2.0	-	-	2.0	-	2.0	-	V
V_{IL}	LOW-level input voltage	MR input; V_{CC} = 4.5 V to 5.5 V	[1]	-	-	0.8	-	0.8	-	0.8	V

Table 5. Static characteristics *…continued*

At recommended operating conditions; voltages are referenced to GND (ground = 0 V).

Symbol	Parameter	Conditions	25 °C			–40 °C to +85 °C		–40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
V_{OH}	HIGH-level output voltage	RTC output; RS = MR = V_{CC}								
		I_O = –20 µA; V_{CC} = 4.5 V	4.4	4.5	-	4.4	-	4.4	-	V
		I_O = –0.65 mA; V_{CC} = 4.5 V	3.98	-	-	3.84	-	3.7	-	V
		RTC output; RS = MR = GND								
		I_O = –20 µA; V_{CC} = 4.5 V	4.4	4.5	-	4.4	-	4.4	-	V
		I_O = –2.6 mA; V_{CC} = 4.5 V	3.98	-	-	3.84	-	3.7	-	V
		CTC output; RS = V_{IH}; MR = V_{IL}								
		I_O = –3.2 mA; V_{CC} = 4.5 V	3.98	-	-	3.84	-	3.7	-	V
		V_I = V_{IH} or V_{IL}; except RTC output								
		I_O = –20 µA; V_{CC} = 4.5 V	4.4	4.5	-	4.4	-	4.4	-	V
		V_I = V_{IH} or V_{IL}; except RTC and CTC outputs								
		I_O = –4.0 mA; V_{CC} = 4.5 V	3.98	-	-	3.84	-	3.7	-	V
V_{OL}	LOW-level output voltage	RTC output; RS = V_{CC}; MR = GND								
		I_O = 20 µA; V_{CC} = 4.5 V	-	0	0.1	-	0.1	-	0.1	V
		I_O = 2.6 mA; V_{CC} = 4.5 V	-	-	0.26	-	0.33	-	0.4	V
		CTC output; RS = V_{IL}; MR = V_{IH}								
		I_O = 3.2 mA; V_{CC} = 4.5 V	-	-	0.26	-	0.33	-	0.4	V
		V_I = V_{IH} or V_{IL}; except RTC output								
		I_O = 20 µA; V_{CC} = 4.5 V	-	0	0.1	-	0.1	-	0.1	V
		V_I = V_{IH} or V_{IL}; except RTC and CTC outputs								
		I_O = 4.0 mA; V_{CC} = 4.5 V	-	-	0.26	-	0.33	-	0.4	V
I_I	input leakage current	V_I = V_{CC} or GND; V_{CC} = 5.5 V	-	-	±0.1	-	±1.0	-	±1.0	µA
I_{CC}	supply current	V_I = V_{CC} or GND; V_{CC} = 5.5 V; I_O = 0 A	-	-	8.0	-	80	-	160	µA
ΔI_{CC}	additional supply current	per input pin; V_I = V_{CC} – 2.1 V; other inputs at V_{CC} or GND; V_{CC} = 4.5 V to 5.5 V; I_O = 0 A	-	40	144	-	180	-	196	µA
C_I	input capacitance		-	3.5	-	-	-	-	-	pF

[1] For HCT4060, only input MR (pin 12) has TTL input switching levels.

11. Dynamic characteristics

Table 6. Dynamic characteristics

GND = 0 V; C_L = 50 pF unless otherwise specified; for test circuit see Figure 11.

Symbol	Parameter	Conditions	25 °C			–40 °C to +85 °C		–40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
74HC4060										
t_{pd}	propagation delay	RS to Q3; see Figure 8 [1]								
		V_{CC} = 2.0 V	-	99	300	-	375	-	450	ns
		V_{CC} = 4.5 V	-	36	60	-	75	-	90	ns
		V_{CC} = 5.0 V; C_L = 15 pF	-	31	-	-	-	-	-	ns
		V_{CC} = 6.0 V	-	29	51	-	64	-	77	ns
		Qn to Qn+1; see Figure 9 [2]								
		V_{CC} = 2.0 V	-	22	80	-	100	-	120	ns
		V_{CC} = 4.5 V	-	8	16	-	20	-	24	ns
		V_{CC} = 5.0 V; C_L = 15 pF	-	6	-	-	-	-	-	ns
		V_{CC} = 6.0 V	-	6	14	-	17	-	20	ns
t_{PHL}	HIGH to LOW propagation delay	MR to Qn; see Figure 10								
		V_{CC} = 2.0 V	-	55	175	-	220	-	265	ns
		V_{CC} = 4.5 V	-	20	35	-	44	-	53	ns
		V_{CC} = 5.0 V; C_L = 15 pF	-	17	-	-	-	-	-	ns
		V_{CC} = 6.0 V	-	16	30	-	37	-	45	ns
t_t	transition time	Qn; see Figure 8 [3]								
		V_{CC} = 2.0 V	-	19	75	-	95	-	110	ns
		V_{CC} = 4.5 V	-	7	15	-	19	-	22	ns
		V_{CC} = 6.0 V	-	6	13	-	16	-	19	ns
t_W	pulse width	RS (HIGH or LOW); see Figure 8								
		V_{CC} = 2.0 V	80	17	-	100	-	120	-	ns
		V_{CC} = 4.5 V	16	6	-	20	-	24	-	ns
		V_{CC} = 6.0 V	14	5	-	17	-	20	-	ns
		MR (HIGH); see Figure 10								
		V_{CC} = 2.0 V	80	25	-	100	-	120	-	ns
		V_{CC} = 4.5 V	16	9	-	20	-	24	-	ns
		V_{CC} = 6.0 V	14	7	-	17	-	20	-	ns
t_{rec}	recovery time	MR to RS; see Figure 10								
		V_{CC} = 2.0 V	100	28	-	125	-	150	-	ns
		V_{CC} = 4.5 V	20	10	-	25	-	30	-	ns
		V_{CC} = 6.0 V	17	8	-	21	-	26	-	ns

Table 6. Dynamic characteristics *...continued*

GND = 0 V; C_L = 50 pF unless otherwise specified; for test circuit see Figure 11.

Symbol	Parameter	Conditions		25 °C			–40 °C to +85 °C		–40 °C to +125 °C		Unit
				Min	Typ	Max	Min	Max	Min	Max	
f_{max}	maximum frequency	RS; see Figure 8									
		V_{CC} = 2.0 V		6	26	-	4.8	-	4	-	MHz
		V_{CC} = 4.5 V		30	80	-	24	-	20	-	MHz
		V_{CC} = 5.0 V; C_L = 15 pF		-	87	-	-	-	-	-	MHz
		V_{CC} = 6.0 V		35	95	-	28	-	24	-	MHz
C_{PD}	power dissipation capacitance	V_I = GND to V_{CC}; V_{CC} = 5 V; f_i = 1 MHz	[4]	-	40	-	-	-	-	-	pF
74HCT4060											
t_{pd}	propagation delay	RS to Q3; see Figure 8	[1]								
		V_{CC} = 4.5 V		-	33	66	-	83	-	99	ns
		V_{CC} = 5.0 V; C_L = 15 pF		-	31	-	-	-	-	-	ns
		Qn to Qn+1; see Figure 9	[2]								
		V_{CC} = 4.5 V		-	8	16	-	20	-	24	ns
		V_{CC} = 5.0 V; C_L = 15 pF		-	6	-	-	-	-	-	ns
t_{PHL}	HIGH to LOW propagation delay	MR to Qn; see Figure 10									
		V_{CC} = 4.5 V		-	21	44	-	55	-	66	ns
		V_{CC} = 5.0 V; C_L = 15 pF		-	18	-	-	-	-	-	ns
t_t	transition time	Qn; see Figure 8	[3]								
		V_{CC} = 4.5 V		-	7	15	-	19	-	22	ns
t_W	pulse width	RS (HIGH or LOW); see Figure 8									
		V_{CC} = 4.5 V		16	6	-	20	-	24	-	ns
		MR (HIGH); see Figure 10									
		V_{CC} = 4.5 V		16	6	-	20	-	24	-	ns
t_{rec}	recovery time	MR to RS; see Figure 10									
		V_{CC} = 4.5 V		26	13	-	33	-	39	-	ns
f_{max}	maximum frequency	RS; see Figure 8									
		V_{CC} = 4.5 V		30	80	-	24	-	20	-	MHz
		V_{CC} = 5.0 V; C_L = 15 pF		-	88	-	-	-	-	-	MHz

Table 6. Dynamic characteristics *…continued*

GND = 0 V; C_L = 50 pF unless otherwise specified; for test circuit see Figure 11.

Symbol	Parameter	Conditions		25 °C			–40 °C to +85 °C		–40 °C to +125 °C		Unit
				Min	Typ	Max	Min	Max	Min	Max	
C_{PD}	power dissipation capacitance	V_I = GND to V_{CC} – 1.5 V; V_{CC} = 5 V; f_i = 1 MHz	[4]	-	40	-	-	-	-	-	pF

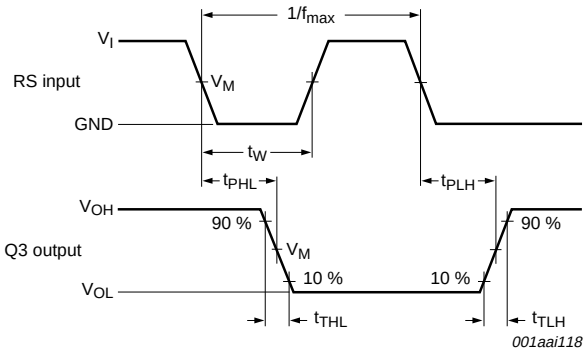
[1] t_{pd} is the same as t_{PHL} and t_{PLH}.

[2] Qn+1 is the next Qn output.

[3] t_t is the same as t_{THL} and t_{TLH}.

[4] C_{PD} is used to determine the dynamic power dissipation (P_D in µW):
$P_D = C_{PD} \times V_{CC}^2 \times f_i \times N + \Sigma(C_L \times V_{CC}^2 \times f_o)$ where:
f_i = input frequency in MHz;
f_o = output frequency in MHz;
C_L = output load capacitance in pF;
V_{CC} = supply voltage in V;
N = number of inputs switching;
$\Sigma(C_L \times V_{CC}^2 \times f_o)$ = sum of outputs.

12. Waveforms



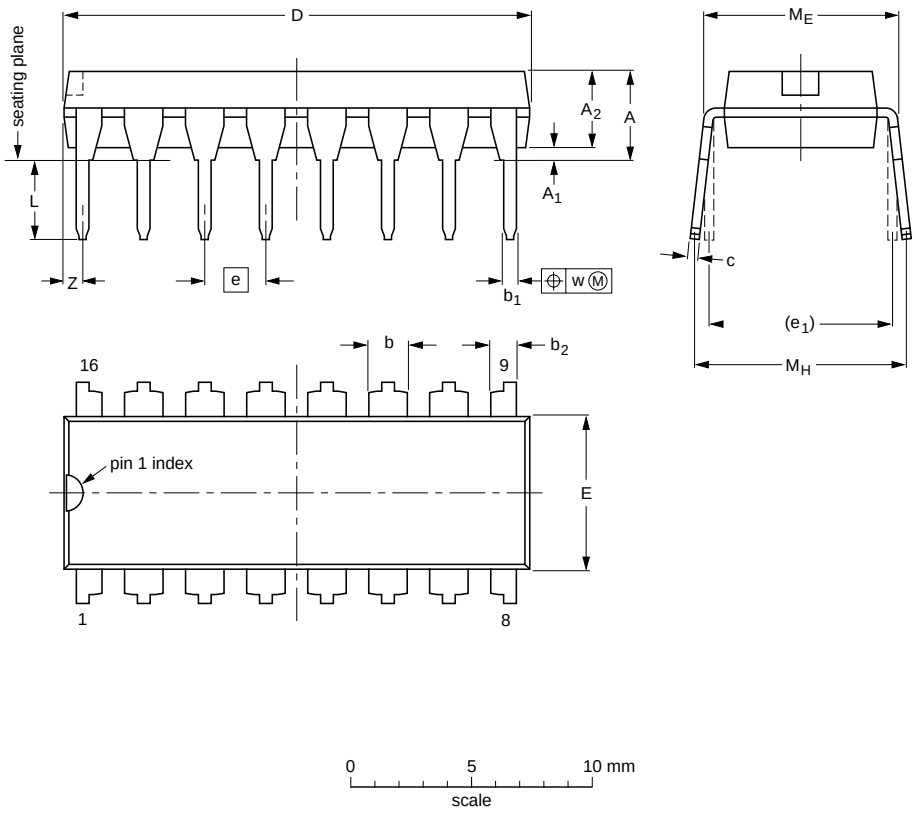
Measurement points are given in Table 7.

V_{OL} and V_{OH} are typical voltage output levels that occur with the output load.

Fig 8. Waveforms showing the clock (RS) to output (Q3) propagation delays, the clock pulse width, the output transition times and the maximum clock frequency

14. Package outline

DIP16: plastic dual in-line package; 16 leads (300 mil) **SOT38-4**



DIMENSIONS (inch dimensions are derived from the original mm dimensions)

UNIT	A max.	A_1 min.	A_2 max.	b	b_1	b_2	c	D (1)	E (1)	e	e_1	L	M_E	M_H	w	Z (1) max.
mm	4.2	0.51	3.2	1.73 1.30	0.53 0.38	1.25 0.85	0.36 0.23	19.50 18.55	6.48 6.20	2.54	7.62	3.60 3.05	8.25 7.80	10.0 8.3	0.254	0.76
inches	0.17	0.02	0.13	0.068 0.051	0.021 0.015	0.049 0.033	0.014 0.009	0.77 0.73	0.26 0.24	0.1	0.3	0.14 0.12	0.32 0.31	0.39 0.33	0.01	0.03

Note

1. Plastic or metal protrusions of 0.25 mm (0.01 inch) maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	
	IEC	JEDEC	JEITA			
SOT38-4						

Fig 18. Package outline SOT38-4 (DIP16)