74HC4060-Q100; 74HCT4060-Q100

14-stage binary ripple counter with oscillator

Rev. 3 — 8 May 2020 Product data sheet

1. General description

The 74HC4060-Q100; 74HCT4060-Q100 is a 14-stage ripple-carry counter/divider and oscillator with three oscillator terminals (RS, RTC and CTC), ten buffered parallel 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 oscillator pins (RTC and CTC) floating. The counter advances on the HIGH-to-LOW transition of RS. A HIGH level on MR clears all counter stages and forces all outputs LOW, independent of the other input conditions. Inputs include clamp diodes. This enables the use of current limiting resistors to interface inputs to voltages in excess of V_{CC}.

This product has been qualified to the Automotive Electronics Council (AEC) standard Q100 (Grade 1) and is suitable for use in automotive applications.

2. Features and benefits

- Automotive product qualification in accordance with AEC-Q100 (Grade 1)
  - Specified from -40 °C to +85 °C and from -40 °C to +125 °C
- All active components on chip
- RC or crystal oscillator configuration
- Complies with JEDEC standard no. 7 A
- Input levels:
  - For 74HC4060-Q100: CMOS level
  - For 74HCT4060-Q100: TTL level
- ESD protection:
  - MIL-STD-883, method 3015 exceeds 2000 V
  - HBM JESD22-A114F exceeds 2000 V
  - MM JESD22-A115-A exceeds 200 V (C = 200 pF, R = 0 Ω)
- Multiple package options
- DHVQFN package with Side-Wettable Flanks enabling Automatic Optical Inspection (AOI) of solder joints

3. Applications

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

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4. Ordering information

Table 1. Ordering information

Type number	Package			
	Temperature range	Name	Description	Version
74HC4060D-Q100	-40 °C to +125 °C	SO16	plastic small outline package; 16 leads; body width 3.9 mm	SOT109-1
74HCT4060D-Q100				
74HC4060DB-Q100	-40 °C to +125 °C	SSOP16	plastic shrink small outline package; 16 leads; body width 5.3 mm	SOT338-1
74HC4060PW-Q100	-40 °C to +125 °C	TSSOP16	plastic thin shrink small outline package; 16 leads; body width 4.4 mm	SOT403-1
74HC4060BQ-Q100	-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-Q100				

5. Functional diagram

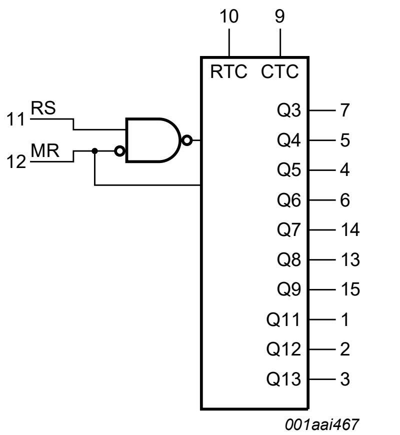


Fig. 1. Logic symbol

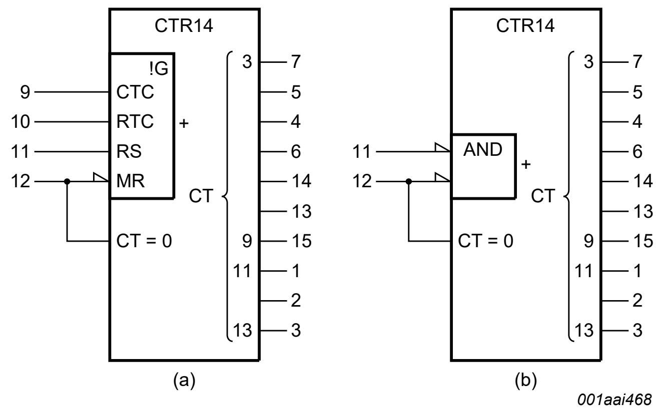


Fig. 2. IEC logic symbol

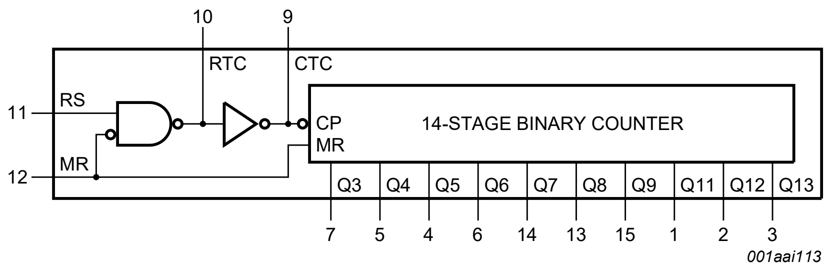


Fig. 3. Functional diagram

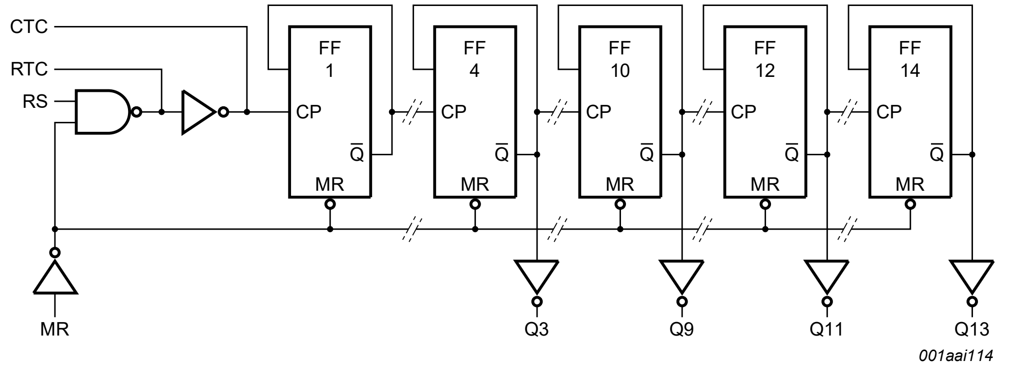


Fig. 4. Logic diagram

6. Pinning information

6.1. Pinning

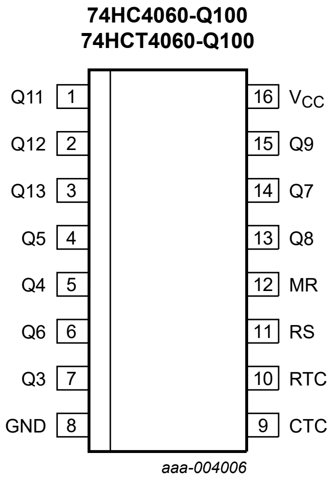
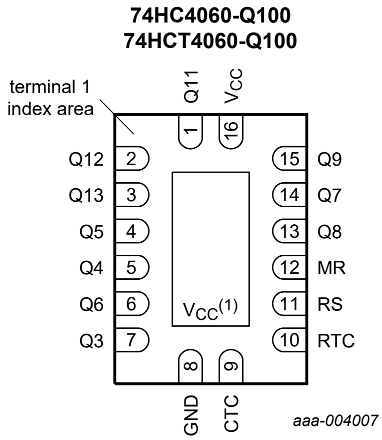


Fig. 5. Pin configuration SOT109-1 (SO16), SOT338-1 (SSOP16) and SOT403-1 (TSSOP16)



Transparent top view

(1) This is not a supply pin. There is no electrical or mechanical requirement to solder the pad. In case soldered, the solder land should remain floating or connected to V_{CC}

Fig. 6. Pin configuration SOT763-1 (DHVQFN16)

6.2. Pin description

Table 2. Pin description

Symbol	Pin	Description
Q11, Q12, Q13	1, 2, 3	counter output
Q3, Q4, Q5, Q6, Q7, Q8, Q9	7, 5, 4, 6, 14, 13, 15	counter output
GND	8	ground (0 V)
CTC	9	external capacitor connection
RTC	10	external resistor connection
RS	11	clock input /oscillator pin
MR	12	master reset input (active HIGH)
V_{CC}	16	supply voltage

7. Functional description

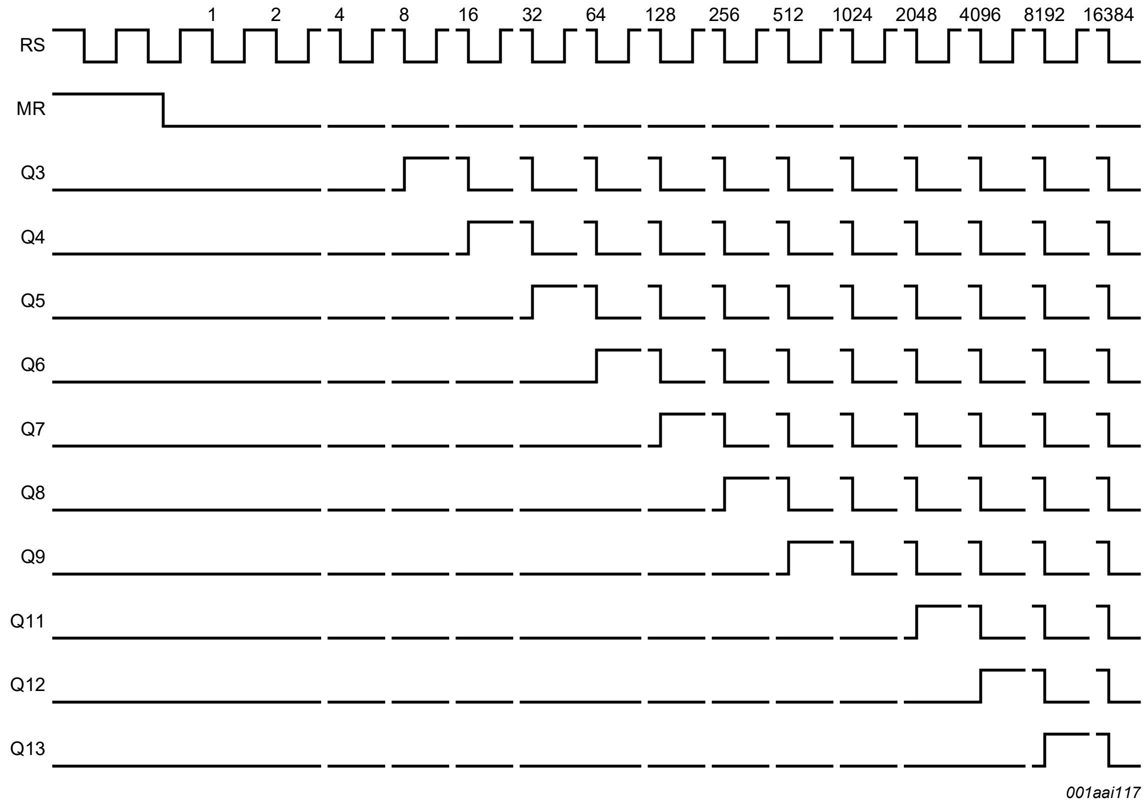


Fig. 7. Timing diagram

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 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
P_{tot}	total power dissipation	T_{amb} = -40 °C to +125 °C [2]	-	500	mW

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

[2] For SOT109-1 (SO16) package: P_{tot} derates linearly with 12.4 mW/K above 110 °C.
For SOT338-1 (SSOP16) package: P_{tot} derates linearly with 8.5 mW/K above 91 °C.
For SOT403-1 (TSSOP16) package: P_{tot} derates linearly with 8.5 mW/K above 91 °C.
For SOT763-1 (DHVQFN16) package: P_{tot} derates linearly with 11.2 mW/K above 106 °C.

9. Recommended operating conditions

Table 4. Recommended operating conditions

Voltages are referenced to GND (ground = 0 V)

Symbol	Parameter	Conditions	74HC4060-Q100			74HCT4060-Q100			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-Q100										
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
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

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 = 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
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

Symbol	Parameter	Conditions	25 °C			-40 °C to +85 °C		-40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
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-Q100										
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
		RS input; $V_{CC} = 4.5$ V	3.6	-	-	3.6	-	3.6	-	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
		RS input; $V_{CC} = 4.5$ V	-	-	0.9	-	0.9	-	0.9	V
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

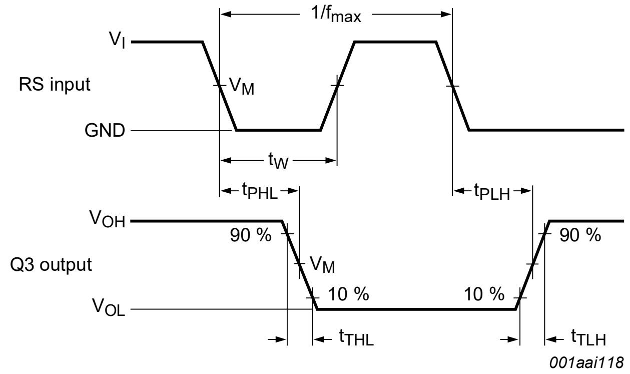
GND = 0 V; C_L = 50 pF unless otherwise specified; for test circuit see Fig. 11.

Symbol	Parameter	Conditions	25 °C			-40 °C to +85 °C		-40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
74HC4060-Q100										
t_{pd}	propagation delay	RS to Q3; see Fig. 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 Fig. 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 Fig. 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 Fig. 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 Fig. 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 Fig. 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 Fig. 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

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 Fig. 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-Q100										
t_{pd}	propagation delay	RS to Q3; see Fig. 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 Fig. 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 Fig. 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 Fig. 8 [3]								
		V_{CC} = 4.5 V	-	7	15	-	19	-	22	ns
t_W	pulse width	RS (HIGH or LOW); see Fig. 8								
		V_{CC} = 4.5 V	16	6	-	20	-	24	-	ns
		MR (HIGH); see Fig. 10								
		V_{CC} = 4.5 V	16	6	-	20	-	24	-	ns
t_{rec}	recovery time	MR to RS; see Fig. 10								
		V_{CC} = 4.5 V	26	13	-	33	-	39	-	ns
f_{max}	maximum frequency	RS; see Fig. 8								
		V_{CC} = 4.5 V	30	80	-	24	-	20	-	MHz
		V_{CC} = 5.0 V; C_L = 15 pF	-	88	-	-	-	-	-	MHz
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.

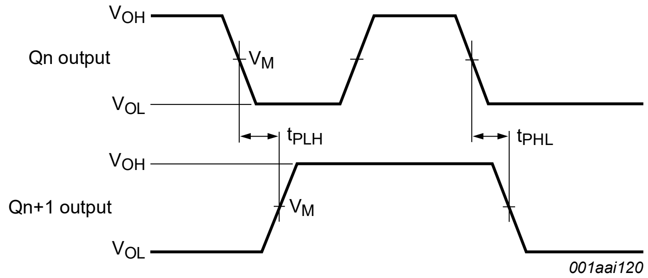
11.1. Waveforms and test circuit



Measurement points are given in Table 7.

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

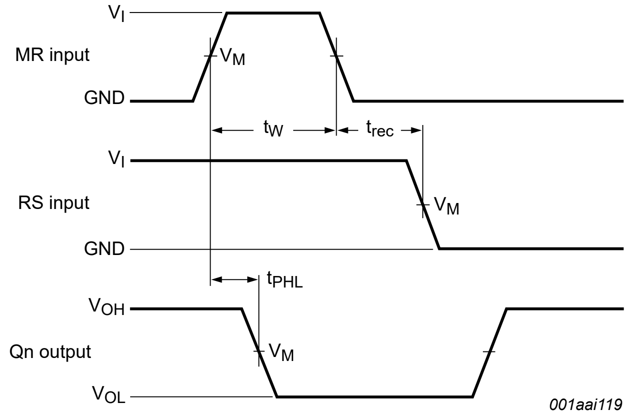
Fig. 8. Waveforms showing the clock (RS) to output (Q3) propagation delays, the clock pulse width, the output transition times and the maximum clock frequency



Measurement points are given in Table 7.

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

Fig. 9. Waveforms showing the output Qn to output Qn+1 propagation delays



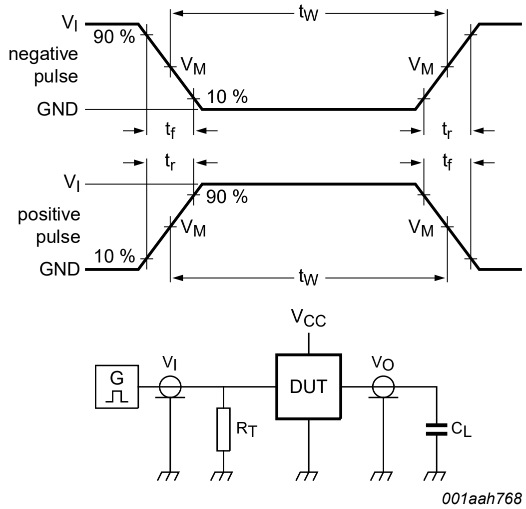
Measurement points are given in Table 7.

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

Fig. 10. Waveforms showing the master reset (MR) pulse width, the master reset to output (Qn) propagation delays and the master reset to clock (RS) recovery time

Table 7. Measurement points

Type	Input	Output
	V_M	V_M
74HC4060-Q100	0.5 × V_{CC}	0.5 × V_{CC}
74HCT4060-Q100	1.3 V	1.3 V



Test data is given in Table 8.

Definitions test circuit:

R_T = Termination resistance should be equal to output impedance Z_o of the pulse generator.

C_L = Load capacitance including jig and probe capacitance.

Fig. 11. Test circuit for measuring switching times

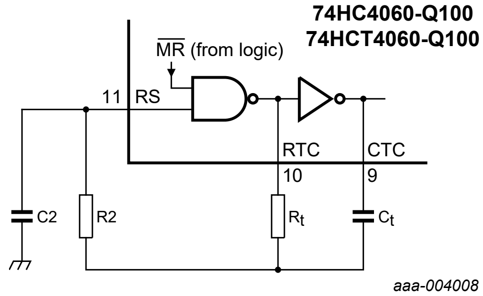
Table 8. Test data

Type	Input		Load
	V_I	t_r, t_f	C_L
74HC4060-Q100	V_{CC}	6 ns	15 pF, 50 pF
74HCT4060-Q100	3 V	6 ns	15 pF, 50 pF

12. RC oscillator

12.1. Timing component limitations

The oscillator frequency is mainly determined by R_tC_t, provided R2 ≈ $2R_t$ and R2C2 << R_tC_t. The function of R2 is to minimize the influence of the forward voltage across the input protection diodes on the frequency. The stray capacitance C2 should be kept as small as possible. In consideration of accuracy, C_t must be larger than the inherent stray capacitance. R_t must be larger than the ON resistance in series with it, which typically is 280 Ω at V_{CC} = 2.0 V, 130 Ω at V_{CC} = 4.5 V and 100 Ω at V_{CC} = 6.0 V.



Typical formula for oscillator frequency: $f_{osc} = \frac{1}{2.5 \times R_t \times C_t}$

Fig. 12. Example of a RC oscillator

The recommended values for these components to maintain agreement with the typical oscillation formula are:

C_t > 50 pF, up to any practical value and 10 kΩ < R_t < 1 MΩ.
In order to avoid start-up problems, $R_t \geq$ 1 kΩ.

12.2. Typical crystal oscillator circuit

In Fig. 13, R2 is the power limiting resistor. For starting and maintaining oscillation a minimum transconductance is necessary, so R2 should not be too large. A practical value for R2 is 2.2 kΩ.

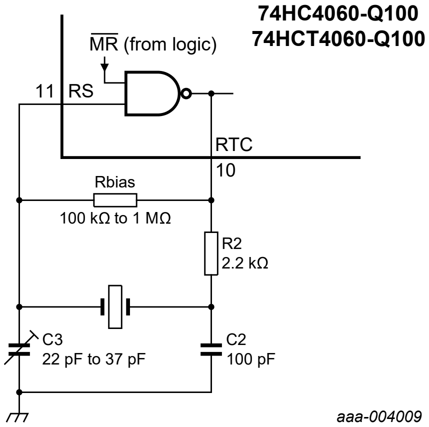
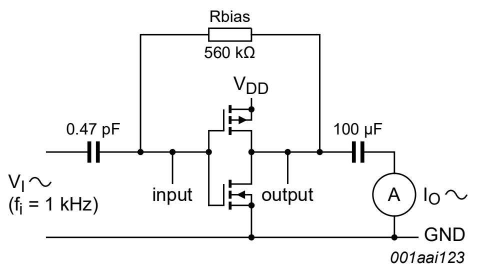
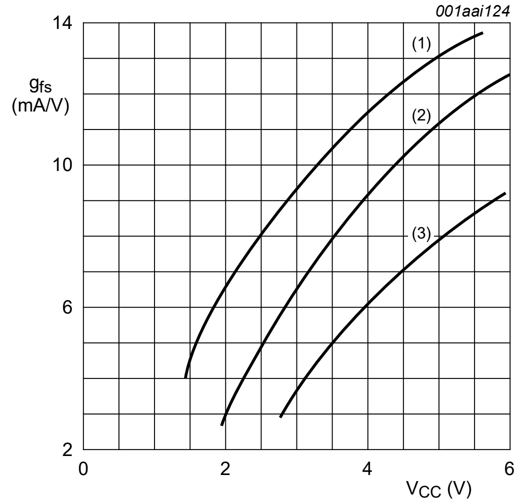


Fig. 13. External component connection for a crystal oscillator



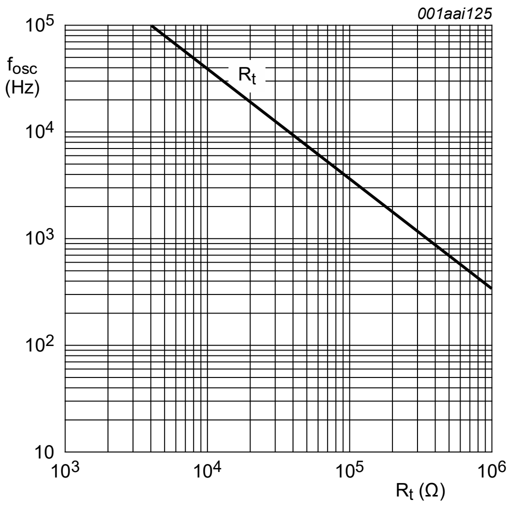
$g_{fs} = \Delta I_O / \Delta V_I$ at V_O is constant; MR = LOW.
See also Fig. 15.

Fig. 14. Test set-up for measuring forward transconductance



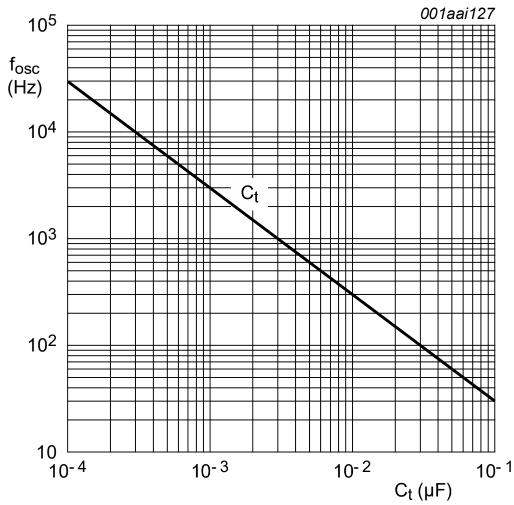
(1) Maximum.
(2) Typical.
(3) Minimum.
T_{amb} = 25 °C.

Fig. 15. Typical forward transconductance as function of the supply voltage



V_{CC} = 2.0 V to 6.0 V; T_{amb} = 25 °C.
For R_t curve: C_t = 1 nF; R2 = 2 × R_t.

Fig. 16. RC oscillator frequency as a function of R_t

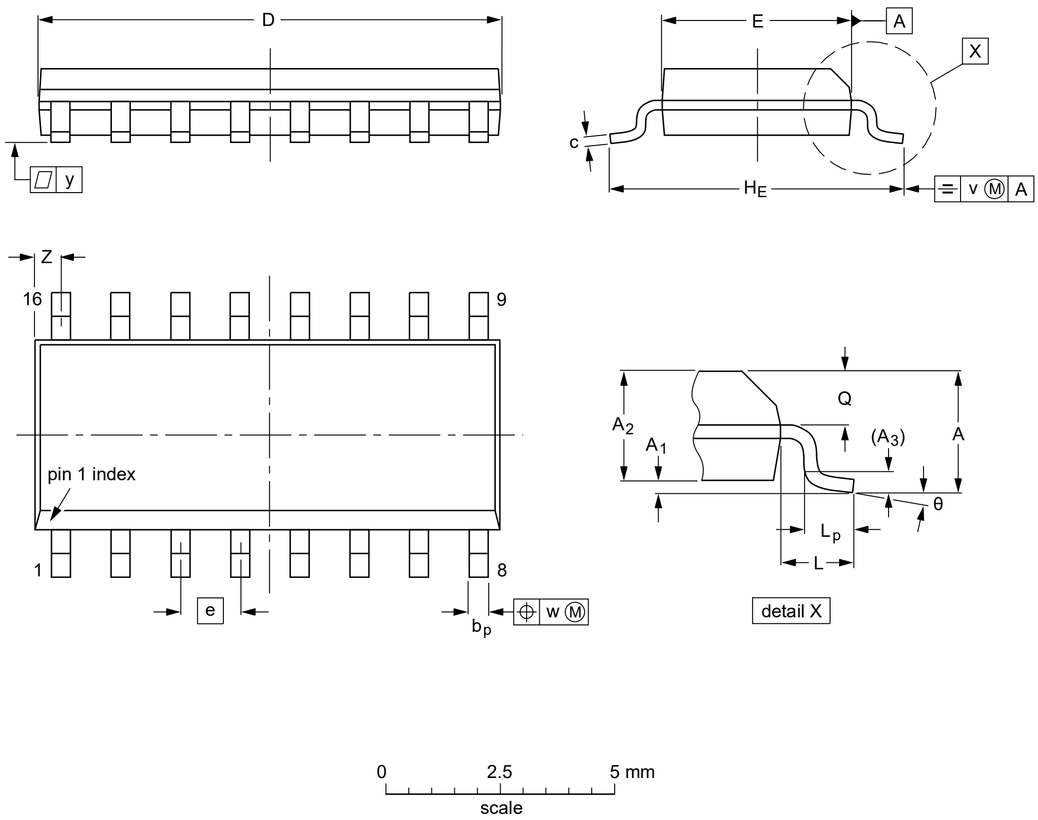


V_{CC} = 2.0 V to 6.0 V; T_{amb} = 25 °C.
For C_t curve: R_t = 100 kΩ; R2 = 200 kΩ.

Fig. 17. RC oscillator frequency as a function of C_t

13. Package outline

SO16: plastic small outline package; 16 leads; body width 3.9 mm **SOT109-1**



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

UNIT	A max.	A_1	A_2	A_3	b_p	c	$D^{(1)}$	$E^{(1)}$	e	H_E	L	L_p	Q	v	w	y	$Z^{(1)}$	θ
mm	1.75	0.25 0.10	1.45 1.25	0.25	0.49 0.36	0.25 0.19	10.0 9.8	4.0 3.8	1.27	6.2 5.8	1.05	1.0 0.4	0.7 0.6	0.25	0.25	0.1	0.7 0.3	8° 0°
inches	0.069	0.010 0.004	0.057 0.049	0.01	0.019 0.014	0.0100 0.0075	0.39 0.38	0.16 0.15	0.05	0.244 0.228	0.041	0.039 0.016	0.028 0.020	0.01	0.01	0.004	0.028 0.012	

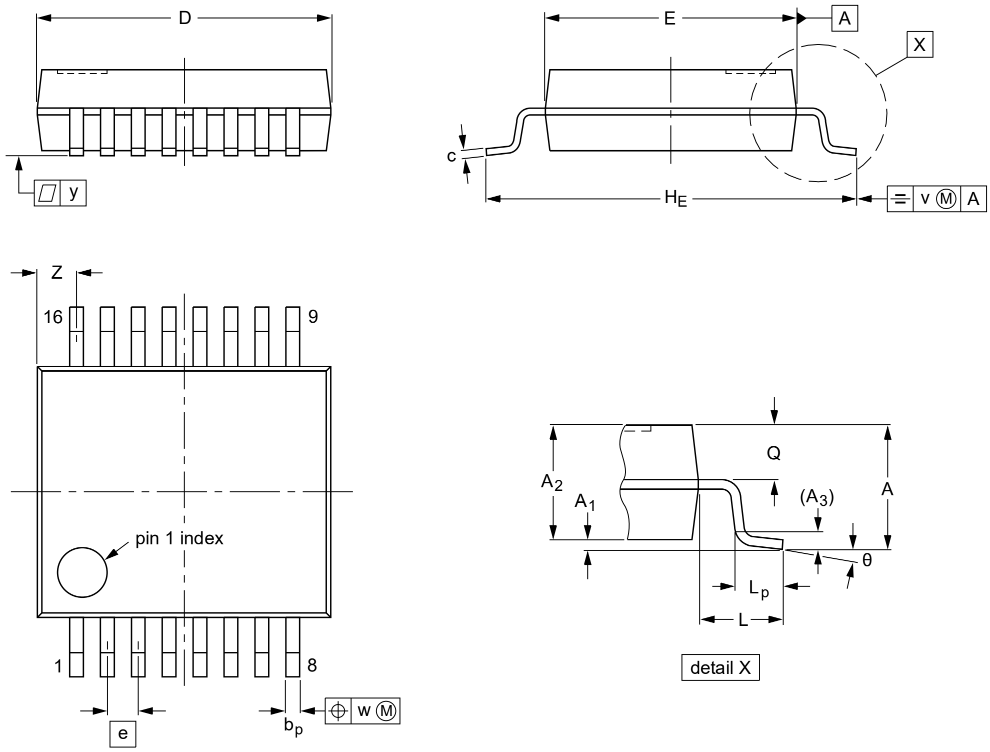
Note

1. Plastic or metal protrusions of 0.15 mm (0.006 inch) maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT109-1	076E07	MS-012				~~99-12-27~~ 03-02-19

Fig. 18. Package outline SOT109-1 (SO16)

SSOP16: plastic shrink small outline package; 16 leads; body width 5.3 mm **SOT338-1**



DIMENSIONS (mm are the original dimensions)

UNIT	A max.	A_1	A_2	A_3	b_p	c	D [1]	E [1]	e	H_E	L	L_p	Q	v	w	y	Z [1]	θ
mm	2	0.21 0.05	1.80 1.65	0.25	0.38 0.25	0.20 0.09	6.4 6.0	5.4 5.2	0.65	7.9 7.6	1.25	1.03 0.63	0.9 0.7	0.2	0.13	0.1	1.00 0.55	8° 0°

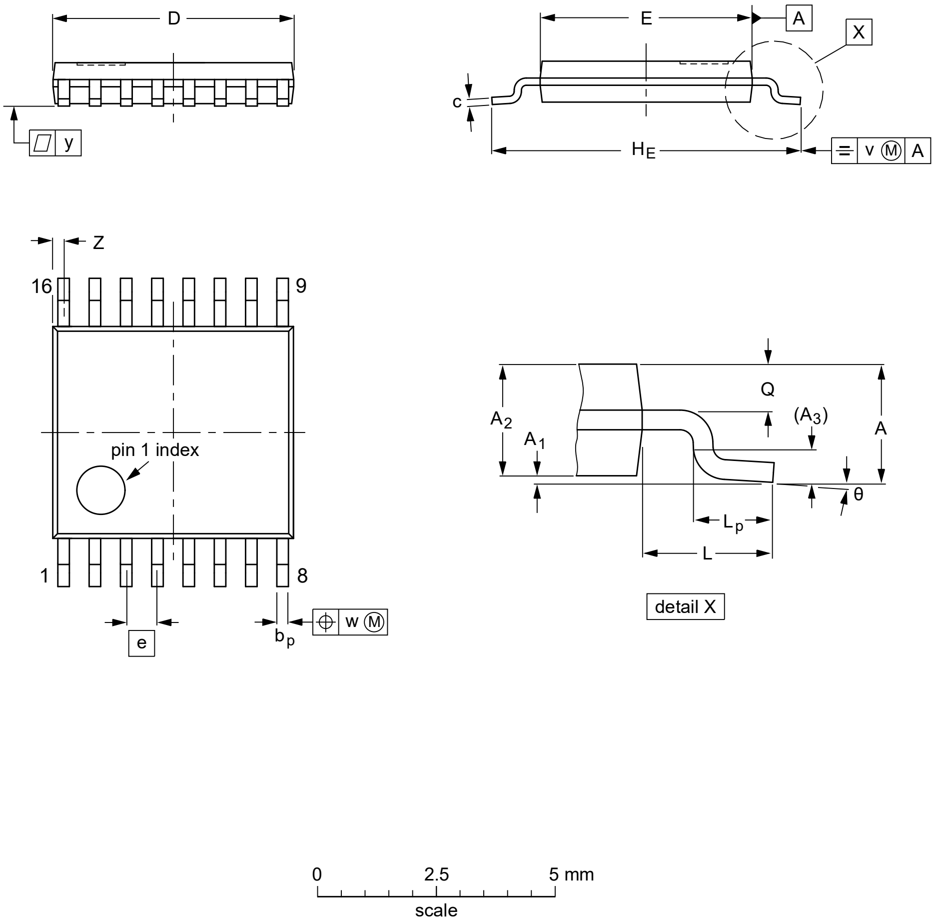
Note

1. Plastic or metal protrusions of 0.25 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT338-1		MO-150				~~99-12-27~~ 03-02-19

Fig. 19. Package outline SOT338-1 (SSOP16)

TSSOP16: plastic thin shrink small outline package; 16 leads; body width 4.4 mm **SOT403-1**



DIMENSIONS (mm are the original dimensions)

UNIT	A max.	A_1	A_2	A_3	b_p	c	D (1)	E (2)	e	H_E	L	L_p	Q	v	w	y	Z (1)	θ
mm	1.1	0.15 0.05	0.95 0.80	0.25	0.30 0.19	0.2 0.1	5.1 4.9	4.5 4.3	0.65	6.6 6.2	1	0.75 0.50	0.4 0.3	0.2	0.13	0.1	0.40 0.06	8° 0°

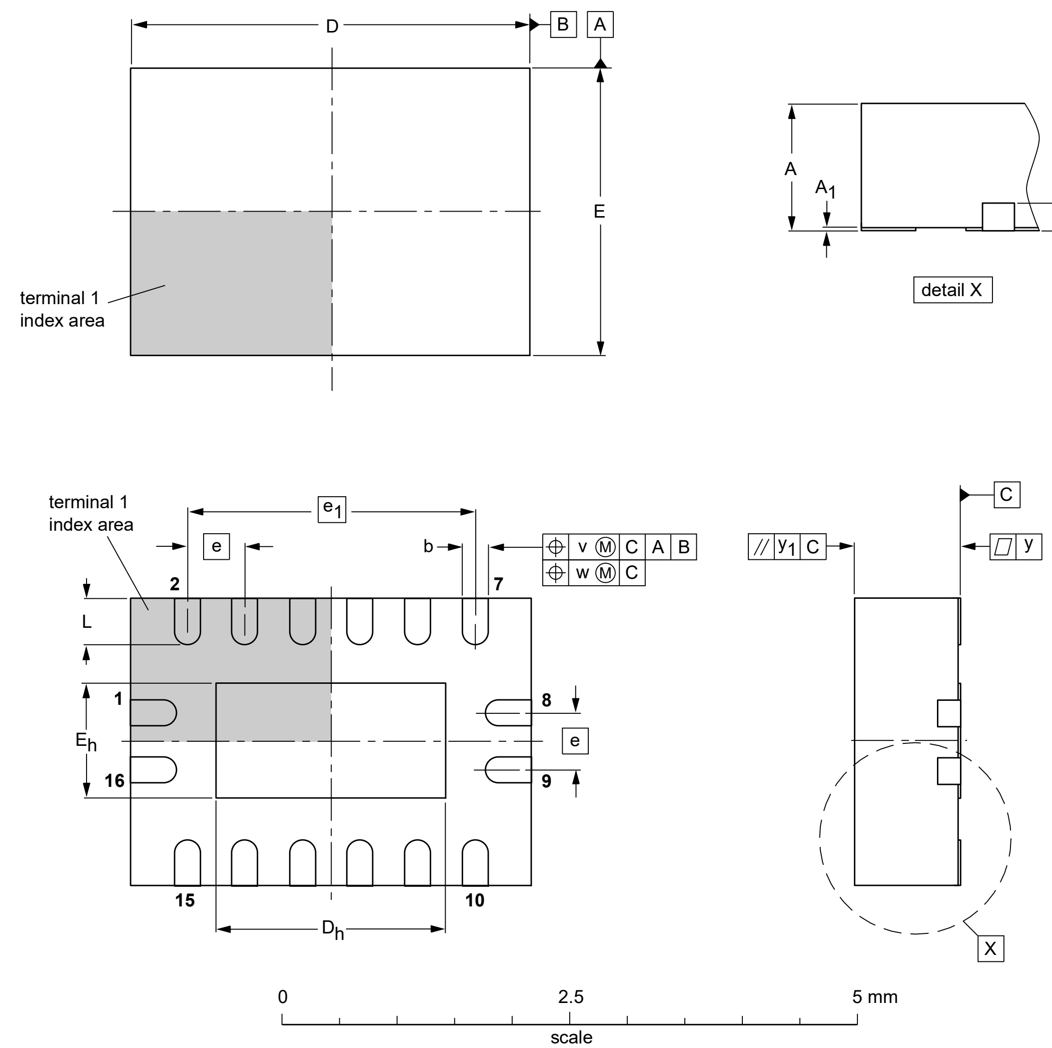
Notes

1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.
2. Plastic interlead protrusions of 0.25 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT403-1		MO-153				~~99-12-27~~ 03-02-18

Fig. 20. Package outline SOT403-1 (TSSOP16)

DHVQFN16: plastic dual in-line compatible thermal enhanced very thin quad flat package; no leads; 16 terminals; body 2.5 x 3.5 x 0.85 mm **SOT763-1**



DIMENSIONS (mm are the original dimensions)

UNIT	A(1) max.	A_1	b	c	D(1)	D_h	E(1)	E_h	e	e_1	L	v	w	y	y_1
mm	1	0.05 0.00	0.30 0.18	0.2	3.6 3.4	2.15 1.85	2.6 2.4	1.15 0.85	0.5	2.5	0.5 0.3	0.1	0.05	0.05	0.1

Note

1. Plastic or metal protrusions of 0.075 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT763-1	- - -	MO-241	- - -			~~02-10-17~~ 03-01-27

Fig. 21. Package outline SOT763-1 (DHVQFN16)

14. Abbreviations

Table 9. Abbreviations

Acronym	Description
CMOS	Complementary Metal-Oxide Semiconductor
DUT	Device Under Test
ESD	ElectroStatic Discharge
HBM	Human Body Model
MIL	Military
MM	Machine Model
TTL	Transistor-Transistor Logic

15. Revision history

Table 10. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
74HC_HCT4060_Q100 v.3	20200508	Product data sheet	-	74HC_HCT4060_Q100 v.2
Modifications:	• The format of this data sheet has been redesigned to comply with the identity guidelines of Nexperia. • Legal texts have been adapted to the new company name where appropriate. • Section 1 and Section 2 updated. • Fig. 2: Pinnames corrected. (errata) • Table 3: Derating values for P_{tot} total power dissipation updated. • Table 5: HIGH and LOW input levels added for 74HCT4060-Q100. (errata) • Type number 74HCT4060DB-Q100 (SSOP16/SOT338-1) removed.			
74HC_HCT4060_Q100 v.2	20130410	Product data sheet	-	74HC_HCT4060_Q100 v.1
Modifications:	• 74HC4060DB-Q100 and 74HCT4060DB-Q100 added.			
74HC_HCT4060_Q100 v.1	20120802	Product data sheet	-	-

16. Legal information

Data sheet status

Document status [1][2]	Product status [3]	Definition
Objective [short] data sheet	Development	This document contains data from the objective specification for product development.
Preliminary [short] data sheet	Qualification	This document contains data from the preliminary specification.
Product [short] data sheet	Production	This document contains the product specification.

[1] Please consult the most recently issued document before initiating or completing a design.
[2] The term 'short data sheet' is explained in section "Definitions".
[3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the internet at https://www.nexperia.com.

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Date of release: 8 May 2020

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