

# 74HC4060-Q100; 74HCT4060-Q100

14-stage binary ripple counter with oscillator

Rev. 2 — 10 April 2013

Product data sheet

## 1. General description

The 74HC4060-Q100; 74HCT4060-Q100 are high-speed Si-gate CMOS devices that comply with JEDEC standard no. 7A. They are pin compatible with Low-power Schottky TTL (LSTTL).

The 74HC4060-Q100; 74HCT4060-Q100 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  $V_{CC}$ .

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  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$  and from  $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$
- All active components on chip
- RC or crystal oscillator configuration
- ESD protection:
  - ◆ MIL-STD-883, method 3015 exceeds 2000 V
  - ◆ HBM JESD22-A114F exceeds 2000 V
  - ◆ MM JESD22-A115-A exceeds 200 V ( $C = 200 \text{ pF}$ ,  $R = 0 \Omega$ )
- Multiple package options

## 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
74HCT4060DB-Q100				
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

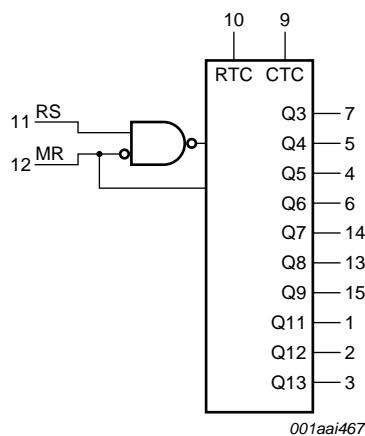


Fig 1. Logic symbol

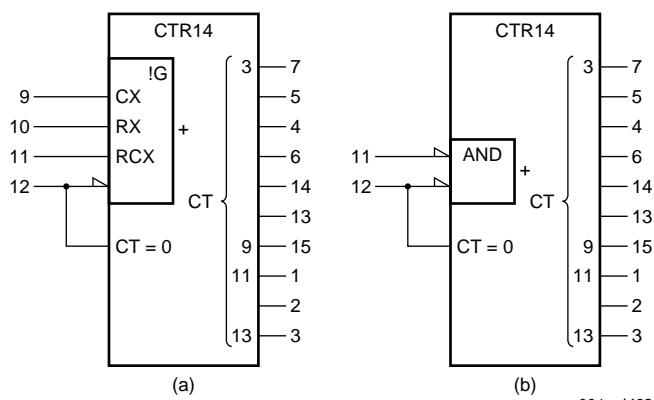


Fig 2. IEC logic symbol

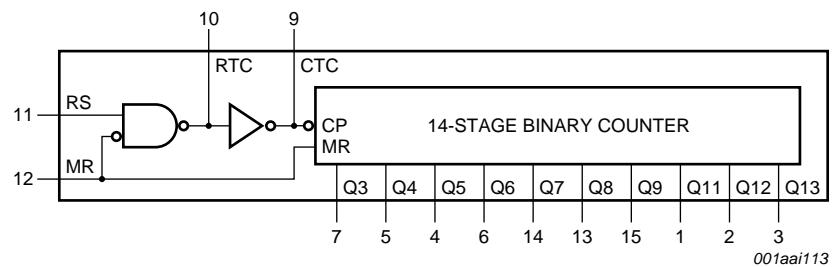


Fig 3. Functional diagram

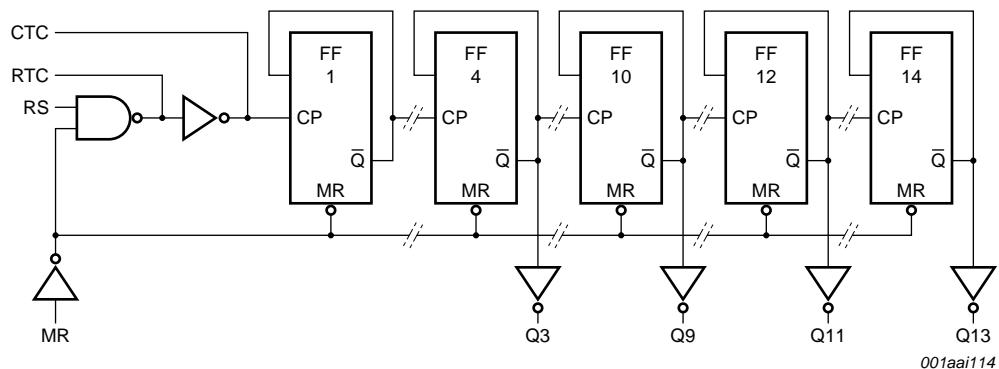


Fig 4. Logic diagram

## 6. Pinning information

### 6.1 Pinning

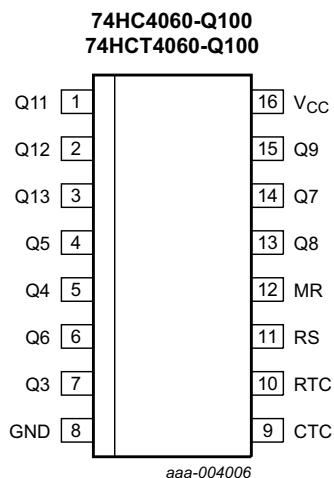


Fig 5. Pin configuration SO16 and (T)SSOP16

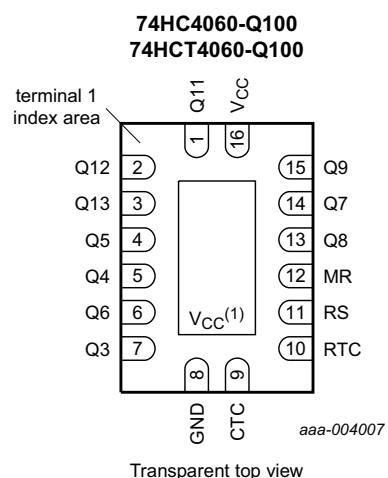


Fig 6. Pin configuration DHVQFN16

(1) The die substrate is attached to this pad using conductive die attach material. It cannot be used as supply pin or input.

### 6.2 Pin description

Table 2. Pin description

Symbol	Pin	Description
Q11 to Q13	1, 2, 3	counter output
Q3 to 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 <sub>CC</sub>	16	supply voltage

## 7. Functional description

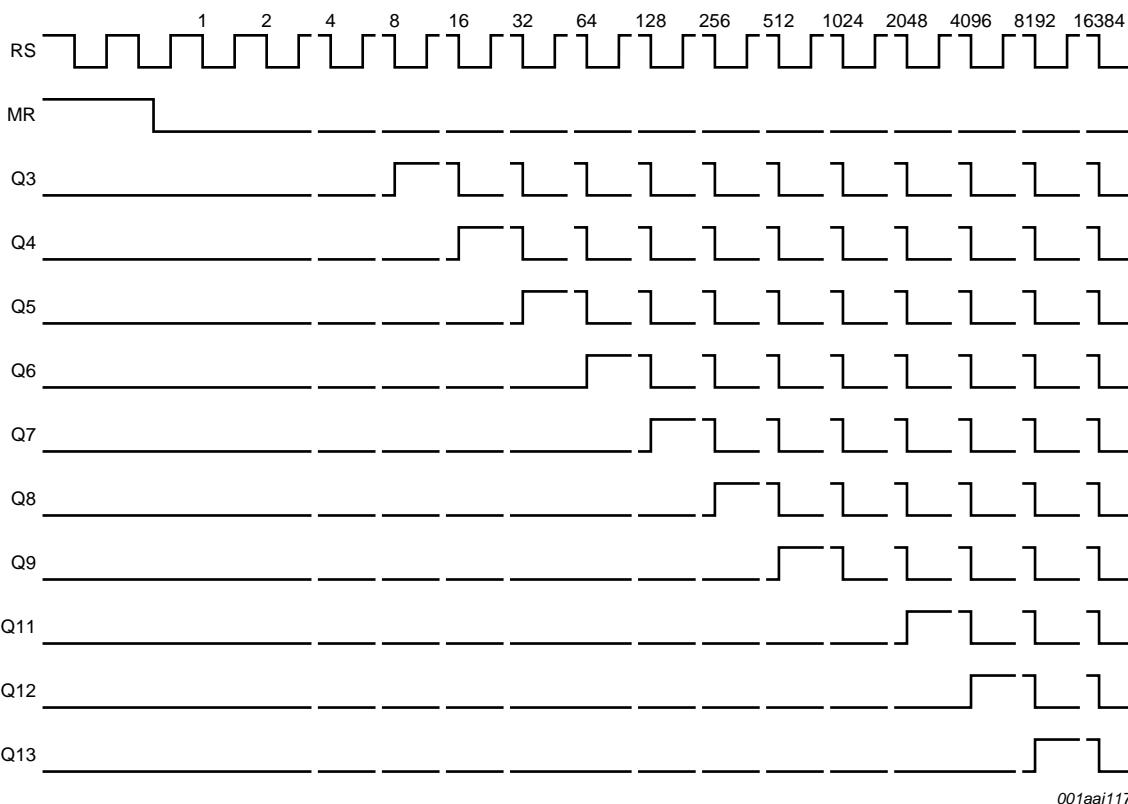


Fig 7. Timing diagram

## 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]	-	$\pm 20$ mA
$I_{OK}$	output clamping current	$V_O < -0.5$ V or $V_O > V_{CC} + 0.5$ V	[1]	-	$\pm 20$ mA
$I_O$	output current	$-0.5$ V < $V_O$ < $V_{CC} + 0.5$ V	-	$\pm 25$	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 <sub>tot</sub>	total power dissipation	T <sub>amb</sub> = -40 °C to +125 °C			
		SO16 package	[2]	-	500 mW
		(T)SSOP16 package	[3]	-	500 mW
		DHVQFN16 package	[4]	-	500 mW

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

[2] P<sub>tot</sub> derates linearly with 8 mW/K above 70 °C.[3] P<sub>tot</sub> derates linearly with 5.5 mW/K above 60 °C.[4] P<sub>tot</sub> 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-Q100			74HCT4060-Q100			Unit
			Min	Typ	Max	Min	Typ	Max	
V <sub>CC</sub>	supply voltage		2.0	5.0	6.0	4.5	5.0	5.5	V
V <sub>I</sub>	input voltage		0	-	V <sub>CC</sub>	0	-	V <sub>CC</sub>	V
V <sub>O</sub>	output voltage		0	-	V <sub>CC</sub>	0	-	V <sub>CC</sub>	V
T <sub>amb</sub>	ambient temperature		-40	-	+125	-40	-	+125	°C
Δt/ΔV	input transition rise and fall rate	V <sub>CC</sub> = 2.0 V	-	-	625	-	-	-	ns/V
		V <sub>CC</sub> = 4.5 V	-	1.67	139	-	1.67	139	ns/V
		V <sub>CC</sub> = 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	
<b>74HC4060-Q100</b>										
V <sub>IH</sub>	HIGH-level input voltage	MR input								
		V <sub>CC</sub> = 2.0 V	1.5	1.3	-	1.5	-	1.5	-	V
		V <sub>CC</sub> = 4.5 V	3.15	2.4	-	3.15	-	3.15	-	V
		V <sub>CC</sub> = 6.0 V	4.2	3.1	-	4.2	-	4.2	-	V
		RS input								
		V <sub>CC</sub> = 2.0 V	1.7	-	-	1.7	-	1.7	-	V
		V <sub>CC</sub> = 4.5 V	3.6	-	-	3.6	-	3.6	-	V
		V <sub>CC</sub> = 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 <sub>IL</sub>	LOW-level input voltage	MR input								
		V <sub>CC</sub> = 2.0 V	-	0.8	0.5	-	0.5	-	0.5	V
		V <sub>CC</sub> = 4.5 V	-	2.1	1.35	-	1.35	-	1.35	V
		V <sub>CC</sub> = 6.0 V	-	2.8	1.8	-	1.8	-	1.8	V
		RS input								
		V <sub>CC</sub> = 2.0 V	-	-	0.3	-	0.3	-	0.3	V
		V <sub>CC</sub> = 4.5 V	-	-	0.9	-	0.9	-	0.9	V
		V <sub>CC</sub> = 6.0 V	-	-	1.2	-	1.2	-	1.2	V
V <sub>OH</sub>	HIGH-level output voltage	RTC output; RS = MR = GND								
		I <sub>O</sub> = −20 μA; V <sub>CC</sub> = 2.0 V	1.9	2.0	-	1.9	-	1.9	-	V
		I <sub>O</sub> = −20 μA; V <sub>CC</sub> = 4.5 V	4.4	4.5	-	4.4	-	4.4	-	V
		I <sub>O</sub> = −20 μA; V <sub>CC</sub> = 6.0 V	5.9	6.0	-	5.9	-	5.9	-	V
		I <sub>O</sub> = −2.6 mA; V <sub>CC</sub> = 4.5 V	3.98	-	-	3.84	-	3.7	-	V
		I <sub>O</sub> = −3.3 mA; V <sub>CC</sub> = 6.0 V	5.48	-	-	5.34	-	5.2	-	V
		RTC output; RS = MR = V <sub>CC</sub>								
		I <sub>O</sub> = −20 μA; V <sub>CC</sub> = 2.0 V	1.9	2.0	-	1.9	-	1.9	-	V
		I <sub>O</sub> = −20 μA; V <sub>CC</sub> = 4.5 V	4.4	4.5	-	4.4	-	4.4	-	V
		I <sub>O</sub> = −20 μA; V <sub>CC</sub> = 6.0 V	5.9	6.0	-	5.9	-	5.9	-	V
		I <sub>O</sub> = −0.65 mA; V <sub>CC</sub> = 4.5 V	3.98	-	-	3.84	-	3.7	-	V
		I <sub>O</sub> = −0.85 mA; V <sub>CC</sub> = 6.0 V	5.48	-	-	5.34	-	5.2	-	V
		CTC output; RS = V <sub>IH</sub> ; MR = V <sub>IL</sub>								
		I <sub>O</sub> = −3.2 mA; V <sub>CC</sub> = 4.5 V	3.98	-	-	3.84	-	3.7	-	V
		I <sub>O</sub> = −4.2 mA; V <sub>CC</sub> = 6.0 V	5.48	-	-	5.34	-	5.2	-	V
		V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; except RTC output								
		I <sub>O</sub> = −20 μA; V <sub>CC</sub> = 2.0 V	1.9	2.0	-	1.9	-	1.9	-	V
		I <sub>O</sub> = −20 μA; V <sub>CC</sub> = 4.5 V	4.4	4.5	-	4.4	-	4.4	-	V
		I <sub>O</sub> = −20 μA; V <sub>CC</sub> = 6.0 V	5.9	6.0	-	5.9	-	5.9	-	V
		V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; except RTC and CTC outputs								
		I <sub>O</sub> = −4.0 mA; V <sub>CC</sub> = 4.5 V	3.98	-	-	3.84	-	3.7	-	V
		I <sub>O</sub> = −5.2 mA; V <sub>CC</sub> = 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 <sub>OL</sub>	LOW-level output voltage	RTC output; RS = V <sub>CC</sub> ; MR = GND									
		I <sub>O</sub> = 20 µA; V <sub>CC</sub> = 2.0 V	-	0	0.1	-	0.1	-	0.1	V	
		I <sub>O</sub> = 20 µA; V <sub>CC</sub> = 4.5 V	-	0	0.1	-	0.1	-	0.1	V	
		I <sub>O</sub> = 20 µA; V <sub>CC</sub> = 6.0 V	-	0	0.1	-	0.1	-	0.1	V	
		I <sub>O</sub> = 2.6 mA; V <sub>CC</sub> = 4.5 V	-	-	0.26	-	0.33	-	0.4	V	
		I <sub>O</sub> = 3.3 mA; V <sub>CC</sub> = 6.0 V	-	-	0.26	-	0.33	-	0.4	V	
	CTC output; RS = V <sub>IL</sub> ; MR = V <sub>IH</sub>	V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; except RTC output									
		I <sub>O</sub> = 3.2 mA; V <sub>CC</sub> = 4.5 V	-	-	0.26	-	0.33	-	0.4	V	
		I <sub>O</sub> = 4.2 mA; V <sub>CC</sub> = 6.0 V	-	-	0.26	-	0.33	-	0.4	V	
		V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; except RTC and CTC outputs									
		I <sub>O</sub> = 4.0 mA; V <sub>CC</sub> = 4.5 V	-	-	0.26	-	0.33	-	0.4	V	
		I <sub>O</sub> = 5.2 mA; V <sub>CC</sub> = 6.0 V	-	-	0.26	-	0.33	-	0.4	V	
I <sub>I</sub>	input leakage current	V <sub>I</sub> = V <sub>CC</sub> or GND; V <sub>CC</sub> = 6.0 V	-	-	±0.1	-	±1.0	-	±1.0	µA	
I <sub>CC</sub>	supply current	V <sub>I</sub> = V <sub>CC</sub> or GND; I <sub>O</sub> = 0 A; V <sub>CC</sub> = 6.0 V	-	-	8.0	-	80	-	160	µA	
C <sub>I</sub>	input capacitance		-	3.5	-	-	-	-	-	pF	
<b>74HCT4060-Q100</b>											
V <sub>IH</sub>	HIGH-level input voltage	MR input; V <sub>CC</sub> = 4.5 V to 5.5 V	[1]	2.0	-	-	2.0	-	2.0	-	V
V <sub>IL</sub>	LOW-level input voltage	MR input; V <sub>CC</sub> = 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 <sub>OH</sub>	HIGH-level output voltage	RTC output; RS = MR = V <sub>CC</sub>								
		I <sub>O</sub> = −20 µA; V <sub>CC</sub> = 4.5 V	4.4	4.5	−	4.4	−	4.4	−	V
		I <sub>O</sub> = −0.65 mA; V <sub>CC</sub> = 4.5 V	3.98	−	−	3.84	−	3.7	−	V
		RTC output; RS = MR = GND								
		I <sub>O</sub> = −20 µA; V <sub>CC</sub> = 4.5 V	4.4	4.5	−	4.4	−	4.4	−	V
		I <sub>O</sub> = −2.6 mA; V <sub>CC</sub> = 4.5 V	3.98	−	−	3.84	−	3.7	−	V
		CTC output; RS = V <sub>IH</sub> ; MR = V <sub>IL</sub>								
		I <sub>O</sub> = −3.2 mA; V <sub>CC</sub> = 4.5 V	3.98	−	−	3.84	−	3.7	−	V
		V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; except RTC output								
		I <sub>O</sub> = −20 µA; V <sub>CC</sub> = 4.5 V	4.4	4.5	−	4.4	−	4.4	−	V
V <sub>OL</sub>	LOW-level output voltage	V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; except RTC and CTC outputs								
		I <sub>O</sub> = −4.0 mA; V <sub>CC</sub> = 4.5 V	3.98	−	−	3.84	−	3.7	−	V
		RTC output; RS = V <sub>CC</sub> ; MR = GND								
		I <sub>O</sub> = 20 µA; V <sub>CC</sub> = 4.5 V	−	0	0.1	−	0.1	−	0.1	V
		I <sub>O</sub> = 2.6 mA; V <sub>CC</sub> = 4.5 V	−	−	0.26	−	0.33	−	0.4	V
		CTC output; RS = V <sub>IL</sub> ; MR = V <sub>IH</sub>								
		I <sub>O</sub> = 3.2 mA; V <sub>CC</sub> = 4.5 V	−	−	0.26	−	0.33	−	0.4	V
		V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; except RTC output								
		I <sub>O</sub> = 20 µA; V <sub>CC</sub> = 4.5 V	−	0	0.1	−	0.1	−	0.1	V
		V <sub>I</sub> = V <sub>IH</sub> or V <sub>IL</sub> ; except RTC and CTC outputs								
I <sub>I</sub>	input leakage current	I <sub>O</sub> = 4.0 mA; V <sub>CC</sub> = 4.5 V	−	−	0.26	−	0.33	−	0.4	V
		V <sub>I</sub> = V <sub>CC</sub> or GND; V <sub>CC</sub> = 5.5 V	−	−	±0.1	−	±1.0	−	±1.0	µA
I <sub>CC</sub>	supply current	V <sub>I</sub> = V <sub>CC</sub> or GND; V <sub>CC</sub> = 5.5 V; I <sub>O</sub> = 0 A	−	−	8.0	−	80	−	160	µA
ΔI <sub>CC</sub>	additional supply current	per input pin; V <sub>I</sub> = V <sub>CC</sub> − 2.1 V; other inputs at V <sub>CC</sub> or GND; V <sub>CC</sub> = 4.5 V to 5.5 V; I <sub>O</sub> = 0 A	−	40	144	−	180	−	196	µA
C <sub>I</sub>	input capacitance		−	3.5	−	−	−	−	−	pF

[1] For HCT4060-Q100, only input MR (pin 12) has TTL input switching levels.

## 11. Dynamic characteristics

**Table 6. Dynamic characteristics**

*GND = 0 V;  $C_L = 50 \text{ pF}$  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	
<b>74HC4060-Q100</b>										
$t_{pd}$	propagation delay	RS to Q3; see <a href="#">Figure 8</a> [1]								
		$V_{CC} = 2.0 \text{ V}$	-	99	300	-	375	-	450	ns
		$V_{CC} = 4.5 \text{ V}$	-	36	60	-	75	-	90	ns
		$V_{CC} = 5.0 \text{ V}; C_L = 15 \text{ pF}$	-	31	-	-	-	-	-	ns
		$V_{CC} = 6.0 \text{ V}$	-	29	51	-	64	-	77	ns
	Qn to Qn+1; see <a href="#">Figure 9</a> [2]	Qn to Qn+1; see <a href="#">Figure 9</a> [2]								
		$V_{CC} = 2.0 \text{ V}$	-	22	80	-	100	-	120	ns
		$V_{CC} = 4.5 \text{ V}$	-	8	16	-	20	-	24	ns
		$V_{CC} = 5.0 \text{ V}; C_L = 15 \text{ pF}$	-	6	-	-	-	-	-	ns
		$V_{CC} = 6.0 \text{ V}$	-	6	14	-	17	-	20	ns
$t_{PHL}$	HIGH to LOW propagation delay	MR to Qn; see <a href="#">Figure 10</a>								
		$V_{CC} = 2.0 \text{ V}$	-	55	175	-	220	-	265	ns
		$V_{CC} = 4.5 \text{ V}$	-	20	35	-	44	-	53	ns
		$V_{CC} = 5.0 \text{ V}; C_L = 15 \text{ pF}$	-	17	-	-	-	-	-	ns
		$V_{CC} = 6.0 \text{ V}$	-	16	30	-	37	-	45	ns
$t_t$	transition time	Qn; see <a href="#">Figure 8</a> [3]								
		$V_{CC} = 2.0 \text{ V}$	-	19	75	-	95	-	110	ns
		$V_{CC} = 4.5 \text{ V}$	-	7	15	-	19	-	22	ns
		$V_{CC} = 6.0 \text{ V}$	-	6	13	-	16	-	19	ns
		RS (HIGH or LOW); see <a href="#">Figure 8</a>								
$t_w$	pulse width	$V_{CC} = 2.0 \text{ V}$	80	17	-	100	-	120	-	ns
		$V_{CC} = 4.5 \text{ V}$	16	6	-	20	-	24	-	ns
		$V_{CC} = 6.0 \text{ V}$	14	5	-	17	-	20	-	ns
		MR (HIGH); see <a href="#">Figure 10</a>								
		$V_{CC} = 2.0 \text{ V}$	80	25	-	100	-	120	-	ns
	recovery time	$V_{CC} = 4.5 \text{ V}$	16	9	-	20	-	24	-	ns
		$V_{CC} = 6.0 \text{ V}$	14	7	-	17	-	20	-	ns
		MR to RS; see <a href="#">Figure 10</a>								
		$V_{CC} = 2.0 \text{ V}$	100	28	-	125	-	150	-	ns
		$V_{CC} = 4.5 \text{ V}$	20	10	-	25	-	30	-	ns
		$V_{CC} = 6.0 \text{ V}$	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 <a href="#">Figure 8</a>								
		$V_{CC} = 2.0$ 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
$C_{PD}$	power dissipation capacitance	$V_I = \text{GND to } V_{CC}$ ; $V_{CC} = 5$ V; $f_i = 1$ MHz	[4]	-	40	-	-	-	-	pF
<b>74HCT4060-Q100</b>										
$t_{pd}$	propagation delay	RS to Q3; see <a href="#">Figure 8</a>	[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 <a href="#">Figure 9</a>	[2]							
$t_{PHL}$	HIGH to LOW propagation delay	MR to Qn; see <a href="#">Figure 10</a>								
		$V_{CC} = 4.5$ V	-	21	44	-	55	-	66	ns
$t_t$	transition time	Qn; see <a href="#">Figure 8</a>	[3]							
		$V_{CC} = 4.5$ V	-	7	15	-	19	-	22	ns
$t_w$	pulse width	RS (HIGH or LOW); see <a href="#">Figure 8</a>								
		$V_{CC} = 4.5$ V	16	6	-	20	-	24	-	ns
		MR (HIGH); see <a href="#">Figure 10</a>								
		$V_{CC} = 4.5$ V	16	6	-	20	-	24	-	ns
$t_{rec}$	recovery time	MR to RS; see <a href="#">Figure 10</a>								
		$V_{CC} = 4.5$ V	26	13	-	33	-	39	-	ns
$f_{max}$	maximum frequency	RS; see <a href="#">Figure 8</a>								
		$V_{CC} = 4.5$ 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;  $C_L = 50 \text{ pF}$  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	$V_I = \text{GND to } V_{CC} - 1.5 \text{ V};$ [4] $V_{CC} = 5 \text{ V}; f_i = 1 \text{ MHz}$	-	40	-	-	-	-	-	pF

[1]  $t_{pd}$  is the same as  $t_{PHL}$  and  $t_{PLH}$ .[2]  $Q_{n+1}$  is the next  $Q_n$  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  $\mu\text{W}$ ):

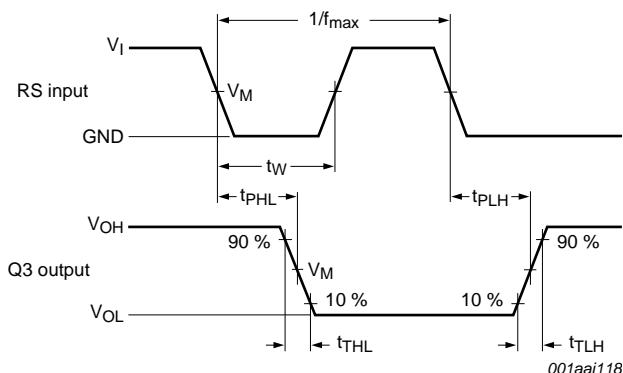
$$P_D = C_{PD} \times V_{CC}^2 \times f_i \times N + \sum(C_L \times V_{CC}^2 \times f_o) \text{ where:}$$

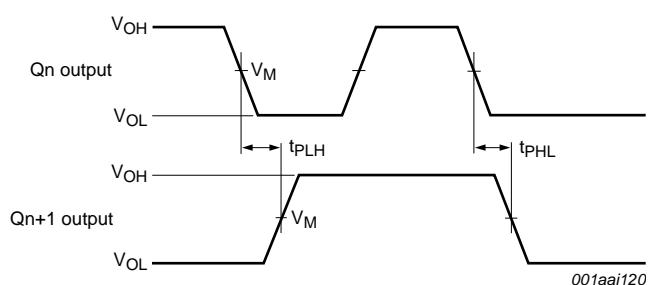
 $f_i$  = input frequency in MHz; $f_o$  = output frequency in MHz; $C_L$  = output load capacitance in pF; $V_{CC}$  = supply voltage in V;

N = number of inputs switching;

 $\sum(C_L \times V_{CC}^2 \times f_o)$  = sum of outputs.

## 12. Waveforms

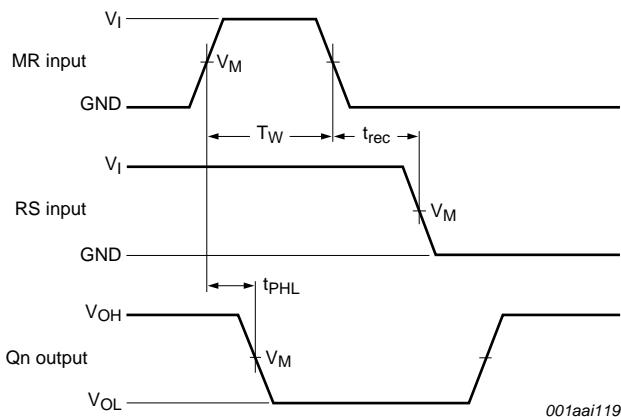
Measurement points are given in [Table 7](#). $V_{OL}$  and  $V_{OH}$  are typical voltage output levels that occur with the output load.**Fig 8. Waveforms showing the clock (RS) to output (Q3) propagation delays, the clock pulse width, the output transition times and the maximum clock frequency**



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  $Q_n$  to output  $Q_{n+1}$  propagation delays



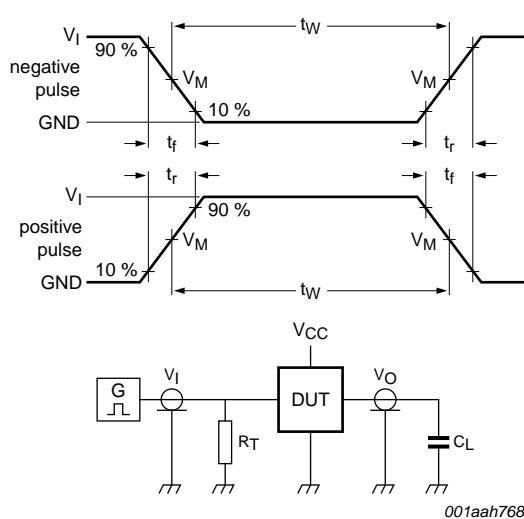
Measurement points are given in [Table 7](#).

$V_{OL}$  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	$0.5 \times V_{CC}$	$0.5 \times V_{CC}$
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**

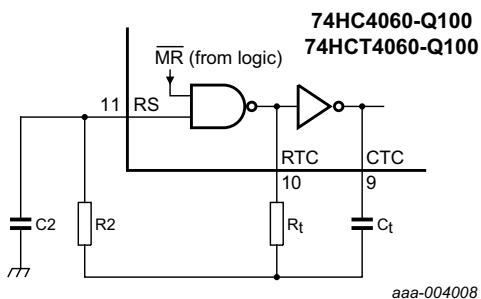
**Table 8. Test data**

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

## 13. RC oscillator

## 13.1 Timing component limitations

The oscillator frequency is mainly determined by  $R_t C_t$ , provided  $R2 \approx 2R_t$  and  $R2C2 \ll R_t C_t$ . 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  $280 \Omega$  at  $V_{CC} = 2.0$  V,  $130 \Omega$  at  $V_{CC} = 4.5$  V and  $100 \Omega$  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 an RC oscillator

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

$C_t > 50 \text{ pF}$ , up to any practical value and  $10 \text{ k}\Omega < R_t < 1 \text{ M}\Omega$ .

In order to avoid start-up problems,  $R_t \geq 1 \text{ k}\Omega$ .

## 13.2 Typical crystal oscillator circuit

In [Figure 13](#),  $R_2$  is the power limiting resistor. For starting and maintaining oscillation, a minimum transconductance is necessary, so  $R_2$  must not be too large. A practical value for  $R_2$  is  $2.2\text{ k}\Omega$ .

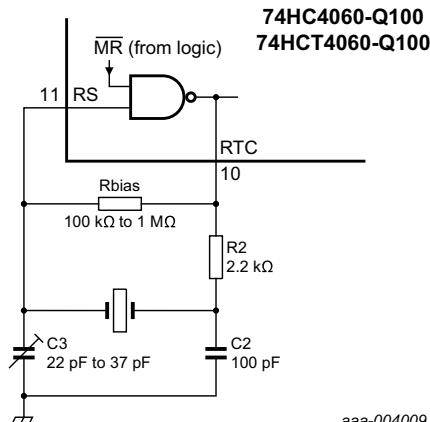
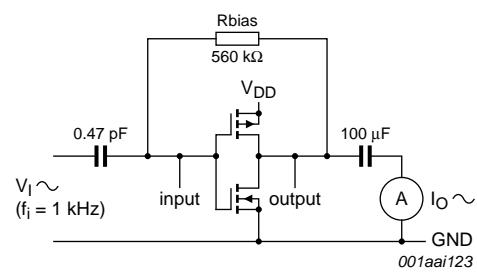


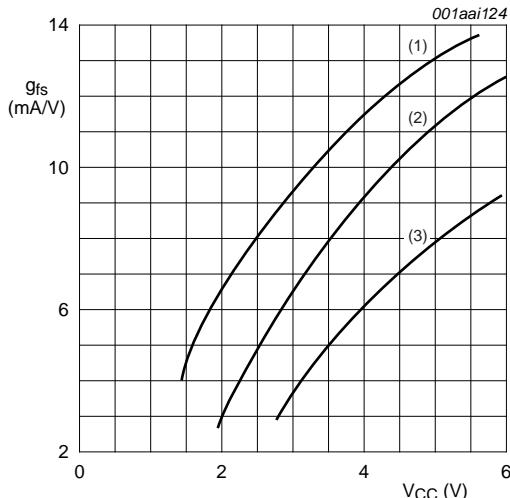
Fig 13. External component connection for a crystal oscillator



$g_{fs} = \Delta I_O / \Delta V_I$  at  $V_O$  is constant;  $MR = \text{LOW}$ .

See also [Figure 15](#).

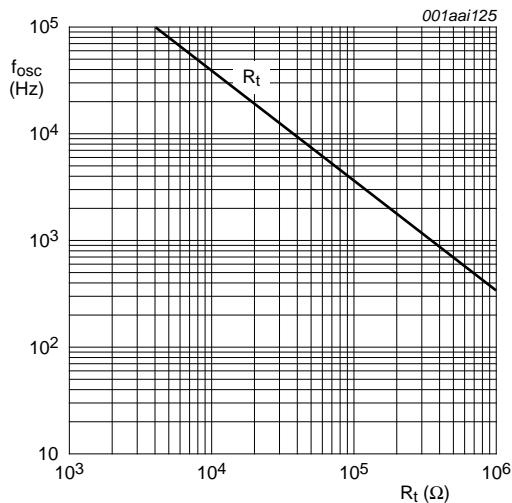
Fig 14. Test set-up for measuring forward transconductance



$T_{amb} = 25^\circ\text{C}$ .

- (1) Maximum.
- (2) Typical.
- (3) Minimum.

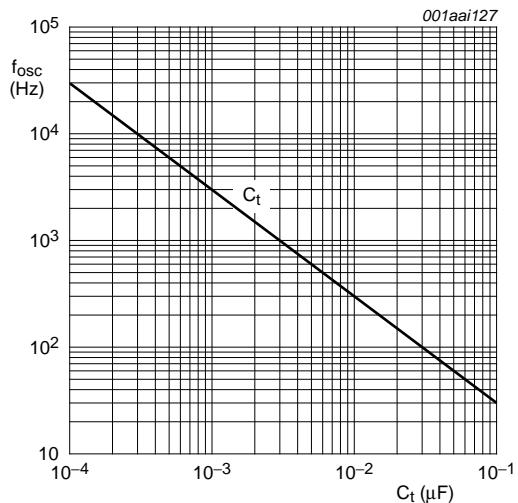
Fig 15. Typical forward transconductance as function of the supply voltage



$V_{CC}$  = 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.

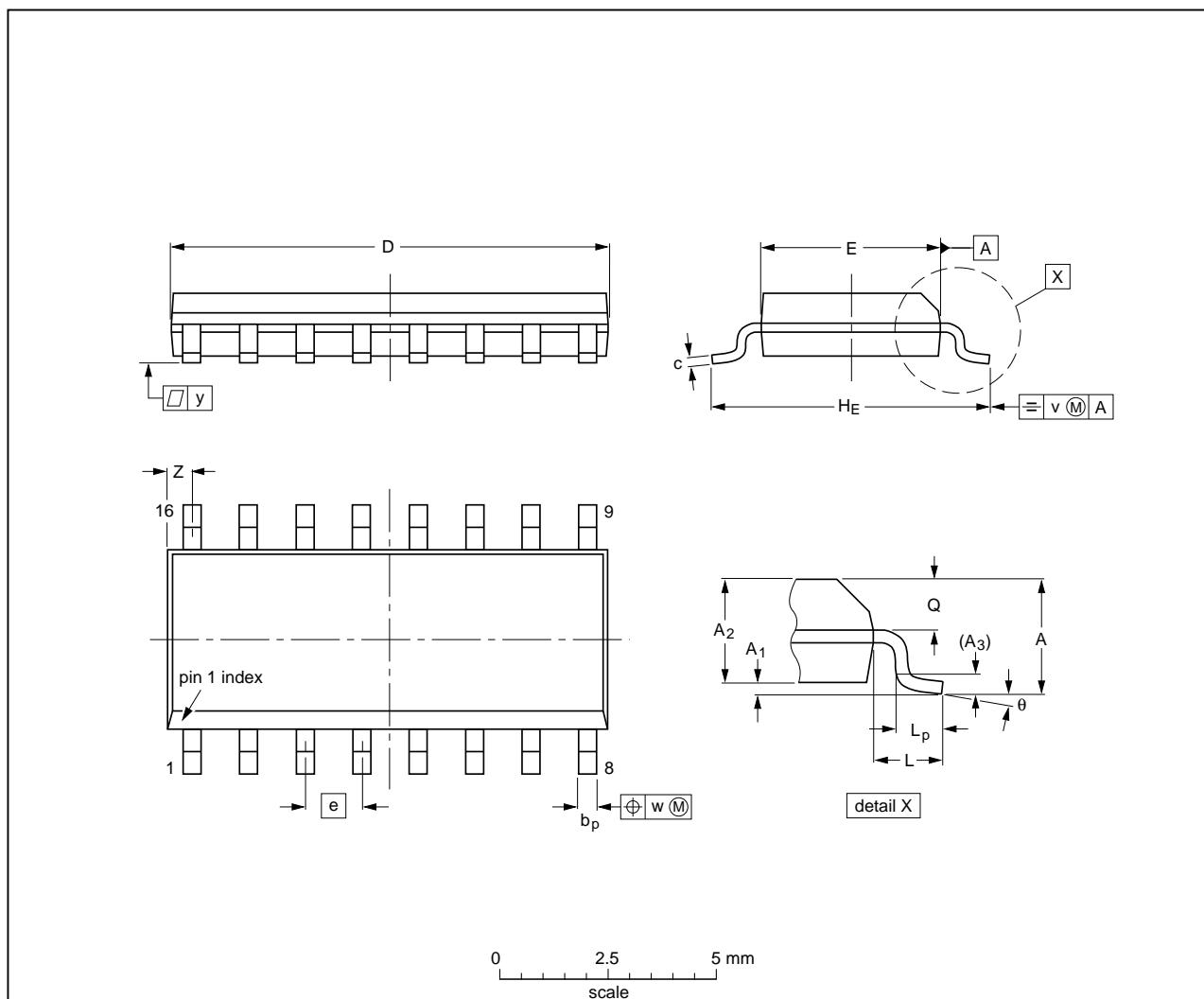
For  $C_t$  curve:  $R_t$  = 100 kΩ;  $R2$  = 200 kΩ.

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

## 14. 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 <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	b <sub>p</sub>	c	D <sup>(1)</sup>	E <sup>(1)</sup>	e	H <sub>E</sub>	L	L <sub>p</sub>	Q	v	w	y	Z <sup>(1)</sup>	θ
mm	1.75 0.10	0.25 0.36	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 0.004	0.010 0.049	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	0°

### 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

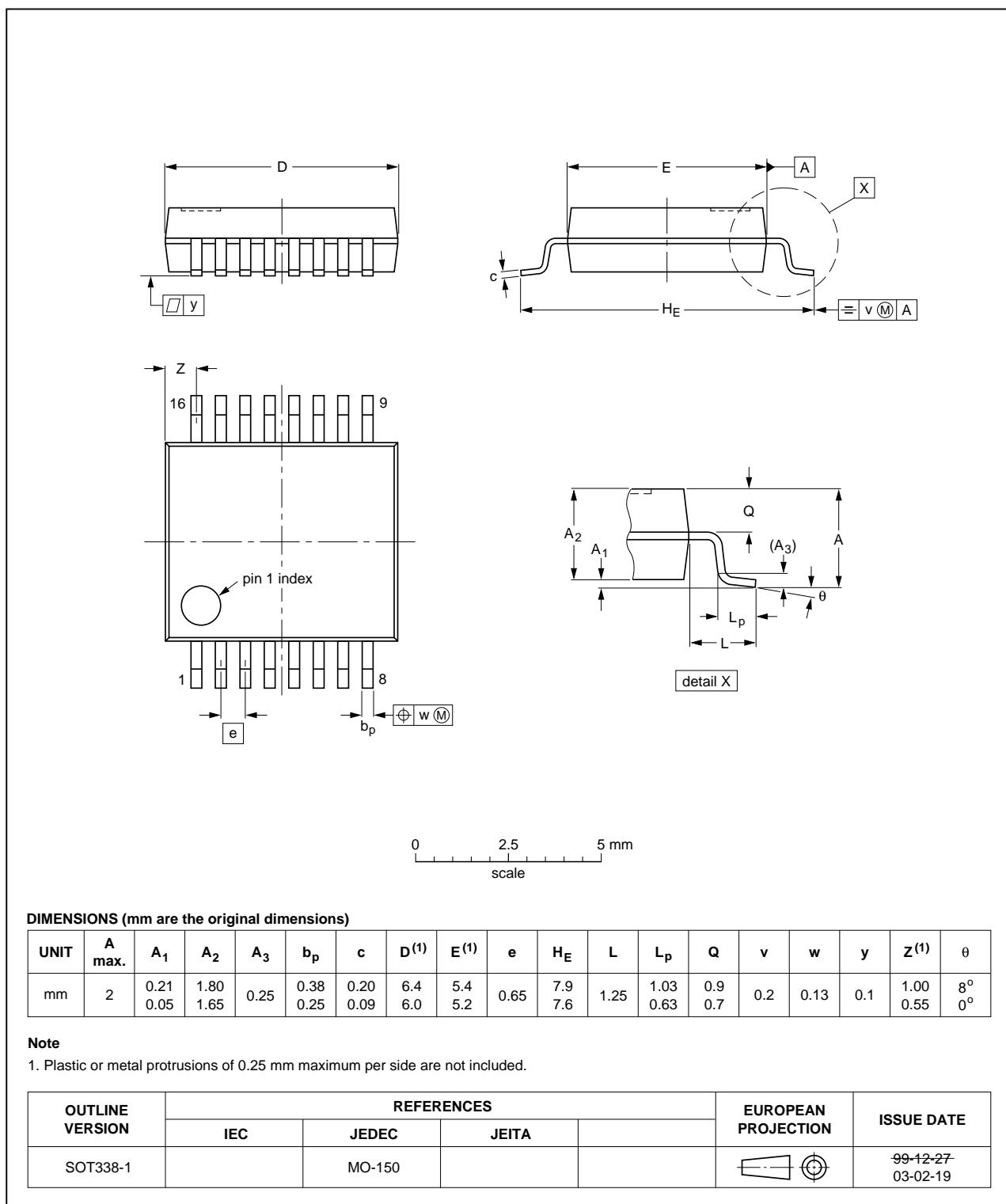


Fig 19. Package outline SOT338-1 (SSOP16)

TSSOP16: plastic thin shrink small outline package; 16 leads; body width 4.4 mm

SOT403-1

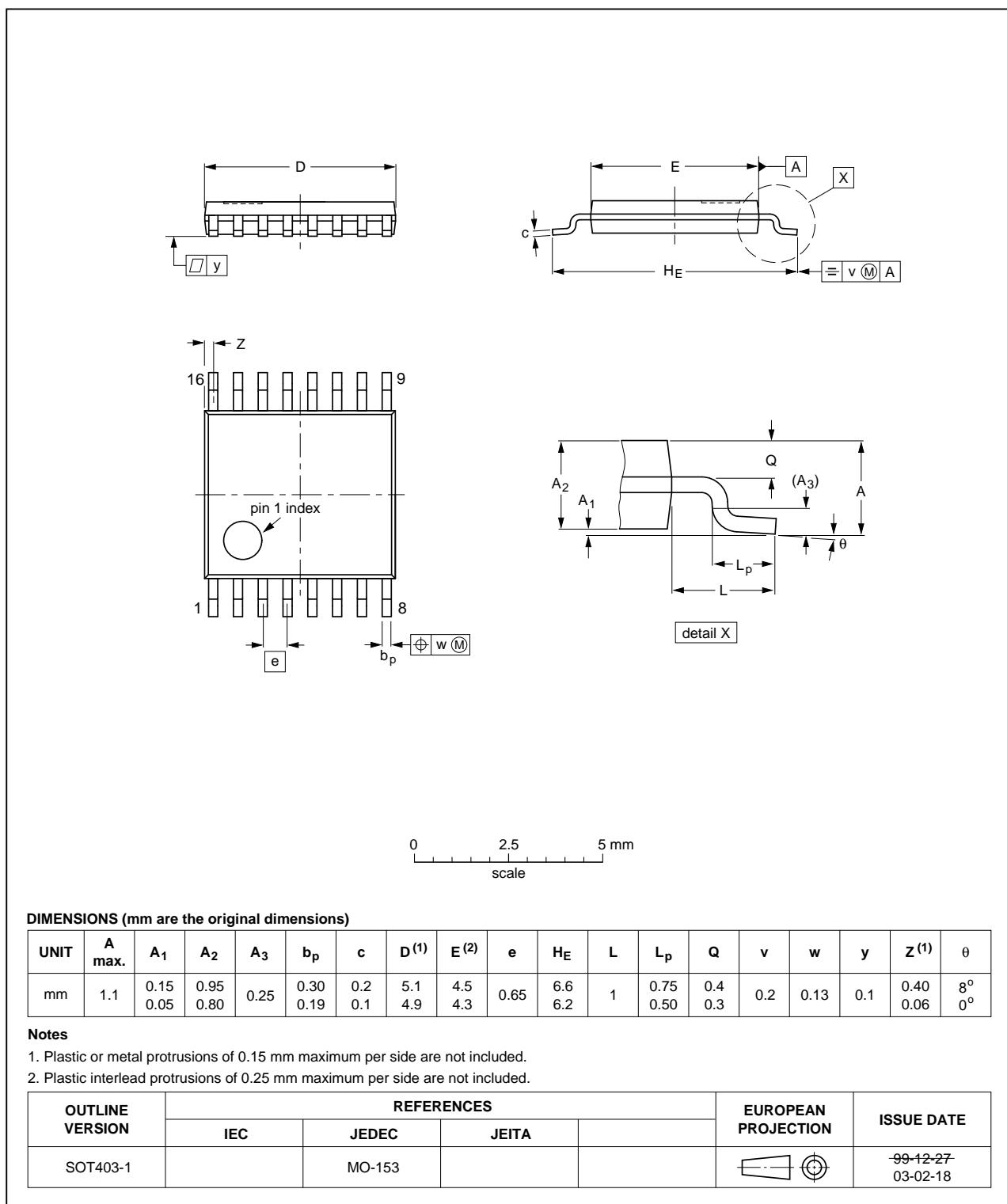


Fig 20. Package outline SOT403-1 (TSSOP16)

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

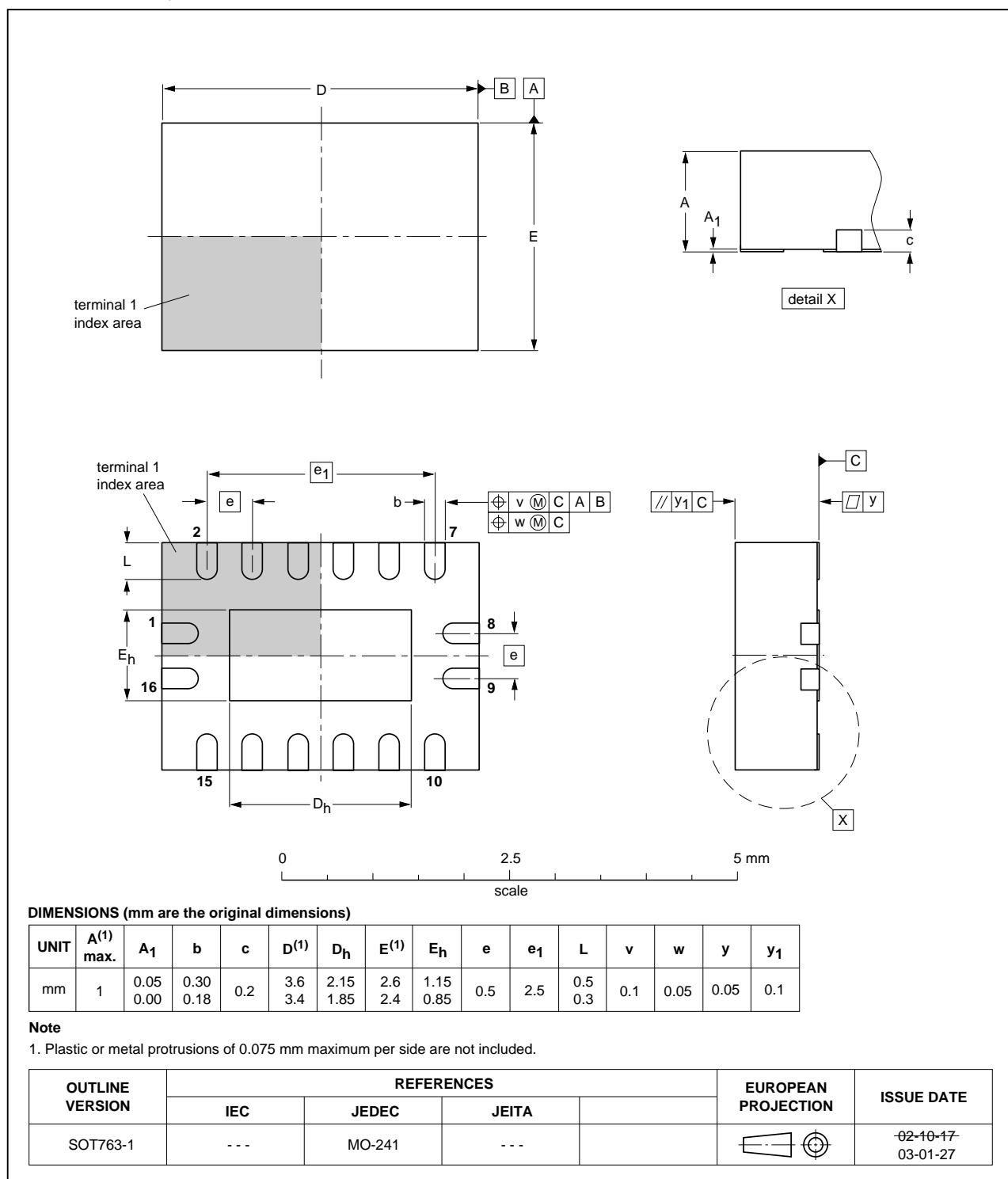


Fig 21. Package outline SOT763-1 (DHVQFN16)

## 15. Abbreviations

**Table 9. Abbreviations**

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

## 16. Revision history

**Table 10. Revision history**

Document ID	Release date	Data sheet status	Change notice	Supersedes
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	-	-

## 17. Legal information

### 17.1 Data sheet status

Document status <sup>[1][2]</sup>	Product status <sup>[3]</sup>	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 URL <http://www.nexperia.com>.

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## 19. Contents

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<b>1</b>	<b>General description</b> .....	<b>1</b>
<b>2</b>	<b>Features and benefits</b> .....	<b>1</b>
<b>3</b>	<b>Applications</b> .....	<b>1</b>
<b>4</b>	<b>Ordering information</b> .....	<b>2</b>
<b>5</b>	<b>Functional diagram</b> .....	<b>2</b>
<b>6</b>	<b>Pinning information</b> .....	<b>4</b>
6.1	Pinning .....	4
6.2	Pin description .....	4
<b>7</b>	<b>Functional description</b> .....	<b>5</b>
<b>8</b>	<b>Limiting values</b> .....	<b>5</b>
<b>9</b>	<b>Recommended operating conditions</b> .....	<b>6</b>
<b>10</b>	<b>Static characteristics</b> .....	<b>6</b>
<b>11</b>	<b>Dynamic characteristics</b> .....	<b>10</b>
<b>12</b>	<b>Waveforms</b> .....	<b>12</b>
<b>13</b>	<b>RC oscillator</b> .....	<b>15</b>
13.1	Timing component limitations .....	15
13.2	Typical crystal oscillator circuit .....	15
<b>14</b>	<b>Package outline</b> .....	<b>18</b>
<b>15</b>	<b>Abbreviations</b> .....	<b>22</b>
<b>16</b>	<b>Revision history</b> .....	<b>22</b>
<b>17</b>	<b>Legal information</b> .....	<b>23</b>
17.1	Data sheet status .....	23
17.2	Definitions.....	23
17.3	Disclaimers.....	23
17.4	Trademarks.....	24
<b>18</b>	<b>Contact information</b> .....	<b>24</b>
<b>19</b>	<b>Contents</b> .....	<b>25</b>

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