74HC590

8-bit binary counter with output register; 3-state

Rev. 4 — 14 March 2022 Product data sheet

1. General description

The 74HC590 is an 8-bit binary counter with a storage register and 3-state outputs. The storage register has parallel (Q0 to Q7) outputs. The binary counter features master reset counter ($\overline{MRC}$) and count enable ($\overline{CE}$) inputs. The counter and storage register have separate positive edge triggered clock (CPC and CPR) inputs. If both clocks are connected together, the counter state is always one count ahead of the register. Internal circuitry prevents clocking from the clock enable. A ripple carry output ($\overline{RCO}$) is provided for cascading. Cascading is accomplished by connecting $\overline{RCO}$ of the first stage to $\overline{CE}$ of the second stage. Cascading for larger count chains can be accomplished by connecting $\overline{RCO}$ of each stage to the counter clock (CPC) input of the following stage. Inputs include clamp diodes. This enables the use of current limiting resistors to interface inputs to voltages in excess of V_{CC}.

2. Features and benefits

- Wide supply voltage range from 2.0 V to 6.0 V
- CMOS low power dissipation
- High noise immunity
- Latch-up performance exceeds 100 mA per JESD 78 Class II Level B
- Complies with JEDEC standards:
  - JESD8C (2.7 V to 3.6 V)
  - JESD7A (2.0 V to 6.0 V)
- CMOS input levels
- Counter and register have independent clock inputs
- Counter has master reset
- Multiple package options
- ESD protection:
  - HBM JESD22-A114F exceeds 2000 V
  - MM JESD22-A115-A exceeds 200 V
  - CDM JESD22-C101C exceeds 1000 V
- Specified from -40 °C to +85 °C and from -40 °C to +125 °C

3. Ordering information

Table 1. Ordering information

Type number	Package			
	Temperature range	Name	Description	Version
74HC590D	-40 °C to +125 °C	SO16	plastic small outline package; 16 leads; body width 3.9 mm	SOT109-1
74HC590PW	-40 °C to +125 °C	TSSOP16	plastic thin shrink small outline package; 16 leads; body width 4.4 mm	SOT403-1
74HC590BQ	-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

4. Functional diagram

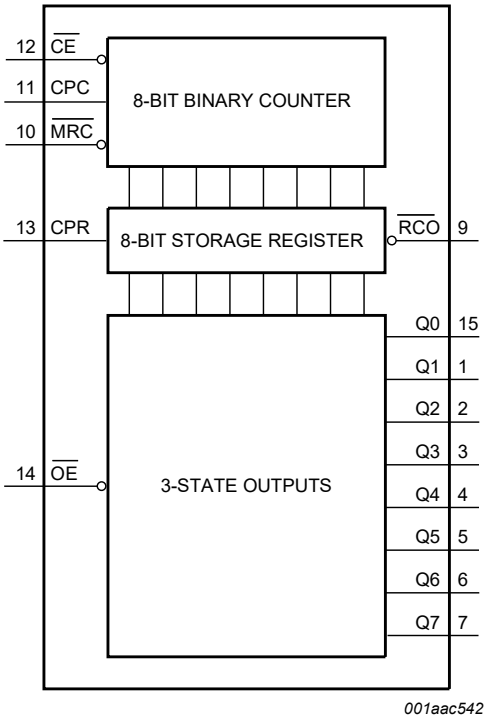

Fig. 1. Functional diagram

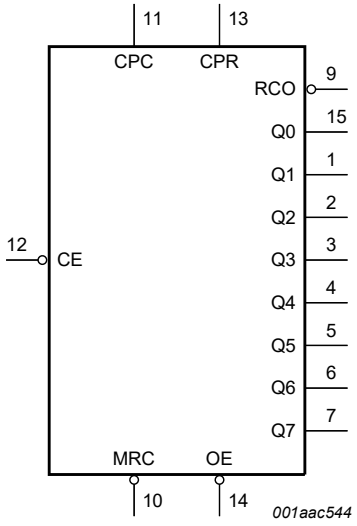

Fig. 2. Logic symbol

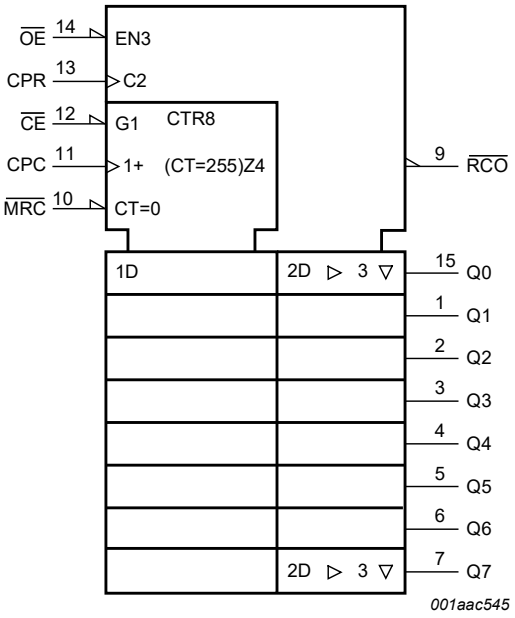

Fig. 3. IEC logic symbol

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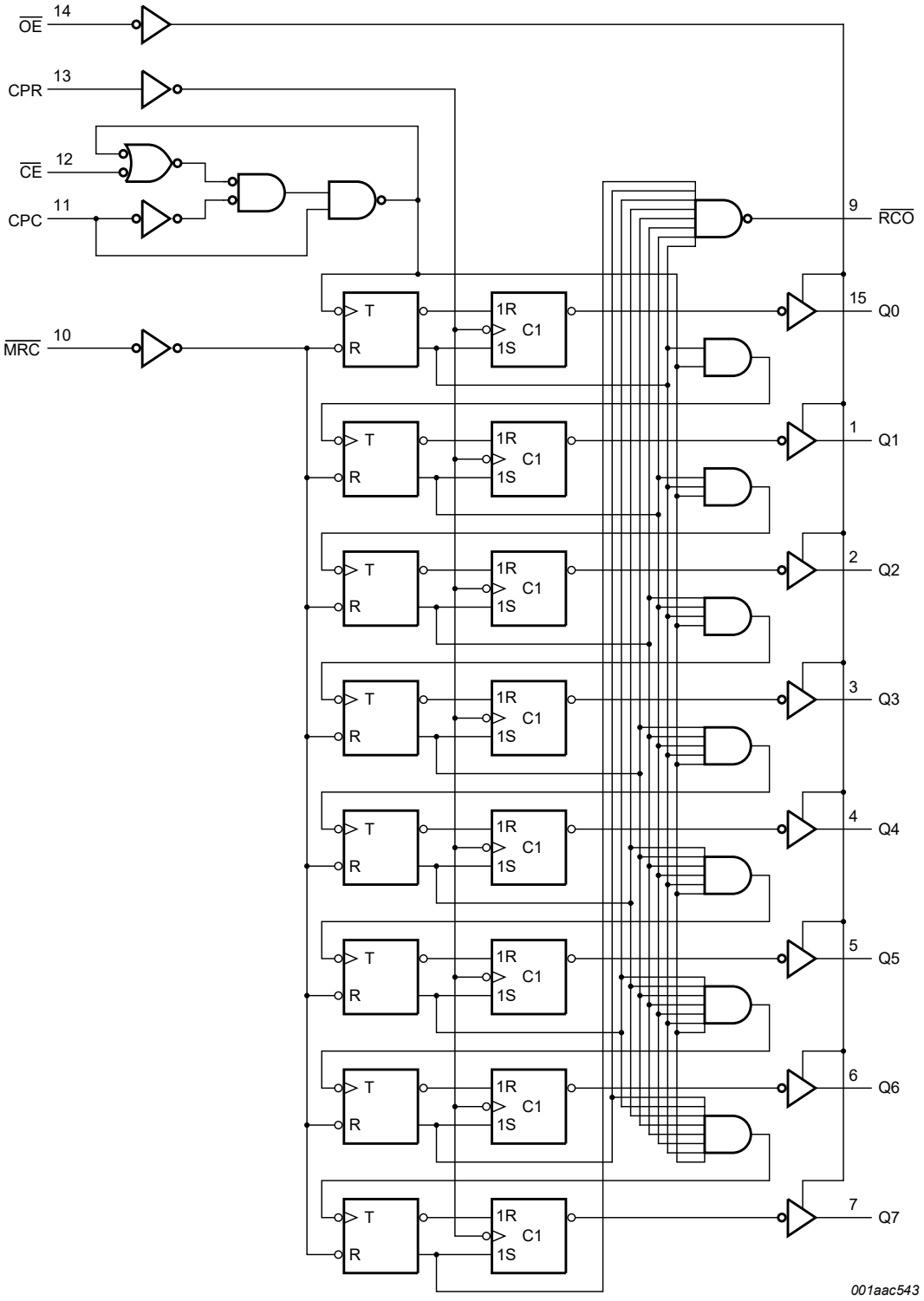

Fig. 4. Logic diagram

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5. Pinning information

5.1. Pinning

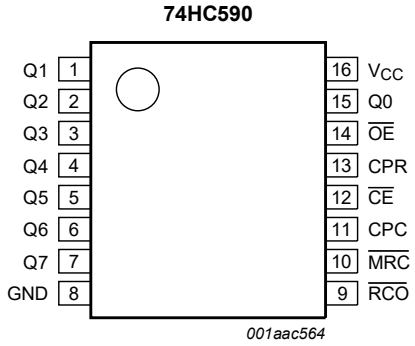
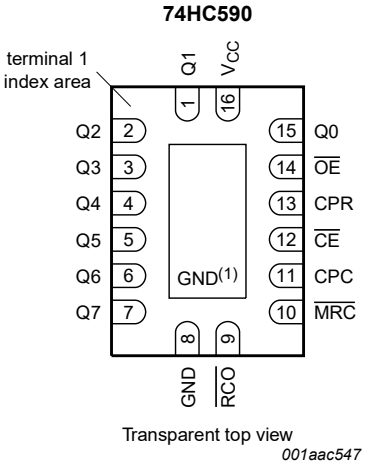


Fig. 5. Pin configuration SOT109-1 (SO16) and SOT403-1 (TSSOP16)



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

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

5.2. Pin description

Table 2. Pin description

Symbol	Pin	Description
Q0, Q1, Q2, Q3, Q4, Q5, Q6, Q7	15, 1, 2, 3, 4, 5, 6, 7	parallel data output
GND	8	ground (0 V)
$\overline{RCO}$	9	ripple carry output (active LOW)
$\overline{MRC}$	10	master reset counter input (active LOW)
CPC	11	counter clock input (active HIGH)
$\overline{CE}$	12	count enable input (active LOW)
CPR	13	register clock input (active HIGH)
$\overline{OE}$	14	output enable input (active LOW)
V_{CC}	16	supply voltage

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6. Functional description

Table 3. Function table

H = HIGH voltage level; L = LOW voltage level; X = don't care; ↑ = LOW-to-HIGH transition; ↓ = HIGH-to-LOW transition.
$\overline{RCO}$ = $\overline{Q0' \cdot Q1' \cdot Q2' \cdot Q3' \cdot Q4' \cdot Q5' \cdot Q6' \cdot Q7'}$ (Q0' to Q7' are internal outputs of the counter).

Inputs					Description
$\overline{OE}$	CPR	$\overline{MRC}$	$\overline{CE}$	CPC	
H	X	X	X	X	Q outputs disable
L	X	X	X	X	Q outputs enable
X	↑	X	X	X	counter data stored into register
X	↓	X	X	X	register stage is not changed
X	X	L	X	X	counter clear
X	X	H	L	↑	advance one count
X	X	H	L	↓	no count
X	X	H	H	X	no count

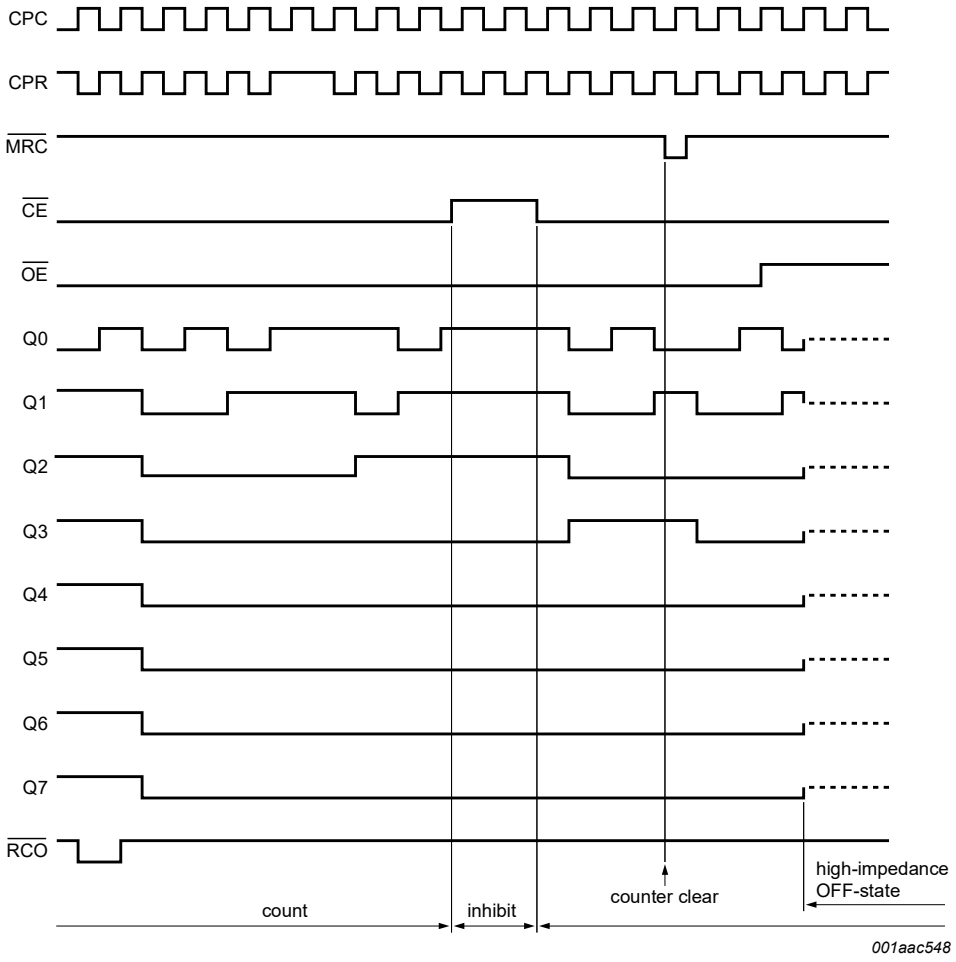

Fig. 7. Typical timing sequence

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7. Limiting values

Table 4. 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	+7.0	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	$V_O = -0.5$ V to $V_{CC} + 0.5$ V				
		$\overline{RCO}$ standard output		-	±25	mA
		Qn bus driver output		-	±35	mA
I_{CC}	supply current			-	70	mA
I_{GND}	ground current			-70	-	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 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.

8. Recommended operating conditions

Table 5. Recommended operating conditions

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

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9. Static characteristics

Table 6. 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	
V_{IH}	HIGH-level input voltage	V_{CC} = 2.0 V	1.5	1.2	-	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	3.2	-	4.2	-	4.2	-	V
V_{IL}	LOW-level input voltage	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
V_{OH}	HIGH-level output voltage	V_I = V_{IH} or V_{IL}								
		all outputs								
		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
		$\overline{RCO}$ standard output								
		I_O = -4 mA; V_{CC} = 4.5 V	4.18	4.31	-	4.13	-	4.1	-	V
		I_O = -5.2 mA; V_{CC} = 6.0 V	5.68	5.80	-	5.63	-	5.6	-	V
		Qn bus driver output								
		I_O = -6.0 mA; V_{CC} = 4.5 V	4.18	4.31	-	4.13	-	4.1	-	V
		I_O = -7.8 mA; V_{CC} = 6.0 V	5.68	5.80	-	5.63	-	5.6	-	V
V_{OL}	LOW-level output voltage	V_I = V_{IH} or V_{IL}								
		all outputs								
		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
		$\overline{RCO}$ standard output								
		I_O = 4 mA; V_{CC} = 4.5 V	-	0.17	0.26	-	0.33	-	0.4	V
		I_O = 5.2 mA; V_{CC} = 6.0 V	-	0.18	0.26	-	0.33	-	0.4	V
		Qn bus driver output								
		I_O = 6.0 mA; V_{CC} = 4.5 V	-	0.17	0.26	-	0.33	-	0.4	V
		I_O = 7.8 mA; V_{CC} = 6.0 V	-	0.18	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_{OZ}	OFF-state output current	V_I = V_{IH} or V_{IL}; V_O = V_{CC} or GND; V_{CC} = 6.0 V	-	-	±0.5	-	±5.0	-	±10	μA
I_{CC}	supply current	V_I = V_{CC} or GND; I_O = 0 A; V_{CC} = 6.0 V	-	-	4.0	-	40	-	80	μA
C_I	input capacitance		-	3.5	-	-	-	-	-	pF

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10. Dynamic characteristics

Table 7. Dynamic characteristics

GND (ground = 0 V); for test circuit see Fig. 14.

Symbol	Parameter	Conditions	25 °C			-40 °C to +85 °C		-40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
t_{pd}	propagation delay	CPC to $\overline{RCO}$; see Fig. 8 [1]								
		V_{CC} = 2.0 V	-	52	150	-	190	-	230	ns
		V_{CC} = 4.5 V	-	19	30	-	38	-	45	ns
		V_{CC} = 6.0 V	-	15	26	-	33	-	40	ns
		CPR to Qn; see Fig. 9								
		V_{CC} = 2.0 V	-	50	140	-	175	-	210	ns
		V_{CC} = 4.5 V	-	17	28	-	35	-	42	ns
		V_{CC} = 6.0 V	-	14	24	-	30	-	36	ns
t_{PLH}	LOW to HIGH propagation delay	$\overline{MRC}$ to $\overline{RCO}$; see Fig. 10								
		V_{CC} = 2.0 V	-	53	130	-	165	-	200	ns
		V_{CC} = 4.5 V	-	18	26	-	33	-	40	ns
		V_{CC} = 6.0 V	-	14	22	-	28	-	34	ns
t_{en}	enable time	$\overline{OE}$ to Qn; see Fig. 11 [2]								
		V_{CC} = 2.0 V	-	28	105	-	130	-	160	ns
		V_{CC} = 4.5 V	-	13	21	-	26	-	32	ns
		V_{CC} = 6.0 V	-	11	18	-	22	-	27	ns
t_{dis}	disable time	$\overline{OE}$ to Qn; see Fig. 11 [3]								
		V_{CC} = 2.0 V	-	28	105	-	130	-	160	ns
		V_{CC} = 4.5 V	-	13	21	-	26	-	32	ns
		V_{CC} = 6.0 V	-	11	18	-	22	-	27	ns
t_W	pulse width	CPC and CPR; HIGH or LOW; see Fig. 8 and Fig. 9								
		V_{CC} = 2.0 V	100	24	-	125	-	145	-	ns
		V_{CC} = 4.5 V	20	9	-	25	-	29	-	ns
		V_{CC} = 6.0 V	17	8	-	21	-	25	-	ns
		$\overline{MRC}$; LOW; see Fig. 10								
		V_{CC} = 2.0 V	75	28	-	95	-	110	-	ns
		V_{CC} = 4.5 V	15	8	-	19	-	22	-	ns
		V_{CC} = 6.0 V	13	6	-	16	-	19	-	ns
t_{su}	set-up time	CPC to CPR; see Fig. 13								
		V_{CC} = 2.0 V	100	46	-	125	-	150	-	ns
		V_{CC} = 4.5 V	20	14	-	25	-	30	-	ns
		V_{CC} = 6.0 V	17	10	-	21	-	26	-	ns
		$\overline{CE}$ to CPC; see Fig. 12								
		V_{CC} = 2.0 V	100	44	-	125	-	150	-	ns
		V_{CC} = 4.5 V	20	11	-	25	-	30	-	ns
		V_{CC} = 6.0 V	17	9	-	21	-	26	-	ns

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Symbol	Parameter	Conditions	25 °C			-40 °C to +85 °C		-40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
t_h	hold time	$\overline{CE}$ to CPC; see Fig. 12								
		V_{CC} = 2.0 V	0	-	-	0	-	0	-	ns
		V_{CC} = 4.5 V	0	-	-	0	-	0	-	ns
		V_{CC} = 6.0 V	0	-	-	0	-	0	-	ns
t_{rec}	recovery time	$\overline{MRC}$ to CPC; see Fig. 10								
		V_{CC} = 2.0 V	75	28	-	95	-	110	-	ns
		V_{CC} = 4.5 V	15	7	-	19	-	22	-	ns
		V_{CC} = 6.0 V	13	6	-	16	-	19	-	ns
f_{max}	maximum frequency	CPC or CPR; see Fig. 8 and Fig. 9								
		V_{CC} = 2.0 V	6.6	16	-	5.2	-	4.4	-	MHz
		V_{CC} = 4.5 V	33	52	-	26	-	22	-	MHz
		V_{CC} = 6.0 V	39	61	-	31	-	26	-	MHz
C_{PD}	power dissipation capacitance	V_I = GND to V_{CC} [4]	-	44	-	-	-	-	-	pF

[1] t_{pd} is the same as t_{PHL} and t_{PLH}.
[2] t_{en} is the same as t_{PZH} and t_{PZL}.
[3] t_{dis} is the same as t_{PLZ} and t_{PHZ}.
[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.

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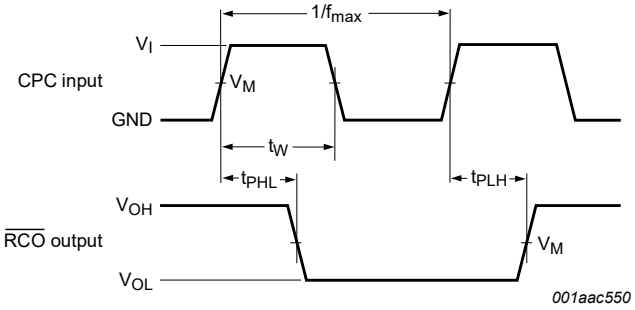
10.1. Waveforms and test circuit



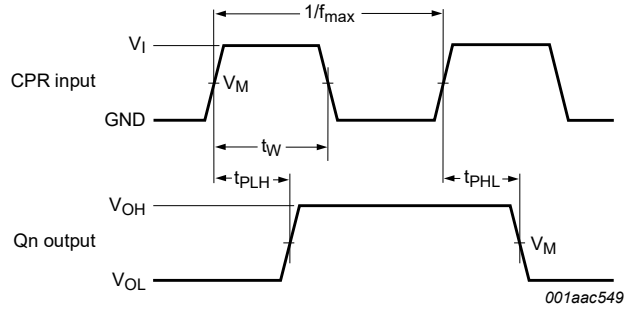
Measurement points are given in Table 8.

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

Fig. 8. Waveforms showing the propagation delays from the counter clock input (CPC) to ripple carry ($\overline{RCO}$) output and the CPC pulse width

Table 8. Measurement points

Input		Output
V_I	V_M	V_M
V_{CC}	$0.5V_{CC}$	$0.5V_{CC}$



Measurement points are given in Table 8.

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

Fig. 9. Waveforms showing the propagation delays from the register clock input (CPR) to output (Qn) and the register clock pulse width

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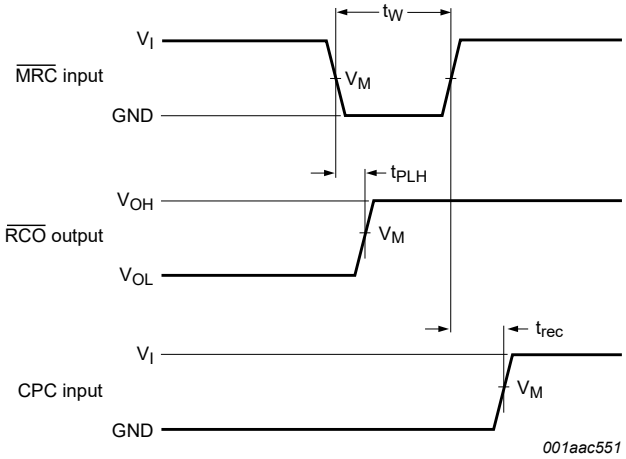
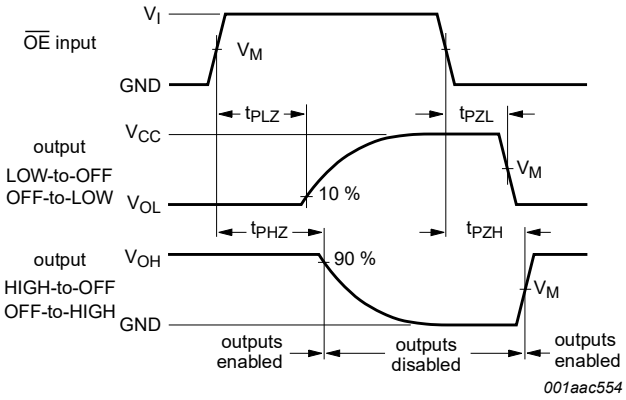


Measurement points are given in Table 8.

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

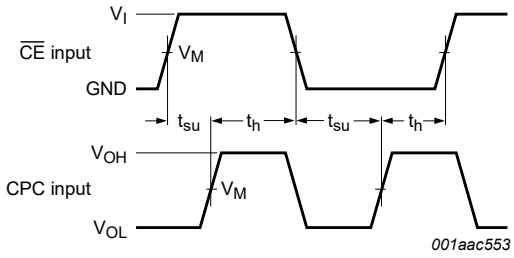
Fig. 10. Waveforms showing the propagation delays from the master reset counter input ($\overline{MRC}$) to output ($\overline{RCO}$), the $\overline{MRC}$ pulse width and recovery time



Measurement points are given in Table 8.

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

Fig. 11. Waveforms showing the 3-state enable and disable times



Measurement points are given in Table 8.

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

Fig. 12. Waveforms showing the set-up and hold times for the count enable input ($\overline{CE}$) to the counter clock input (CPC)

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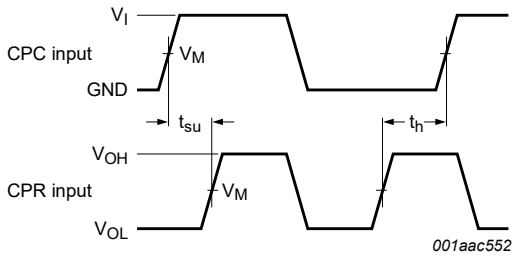
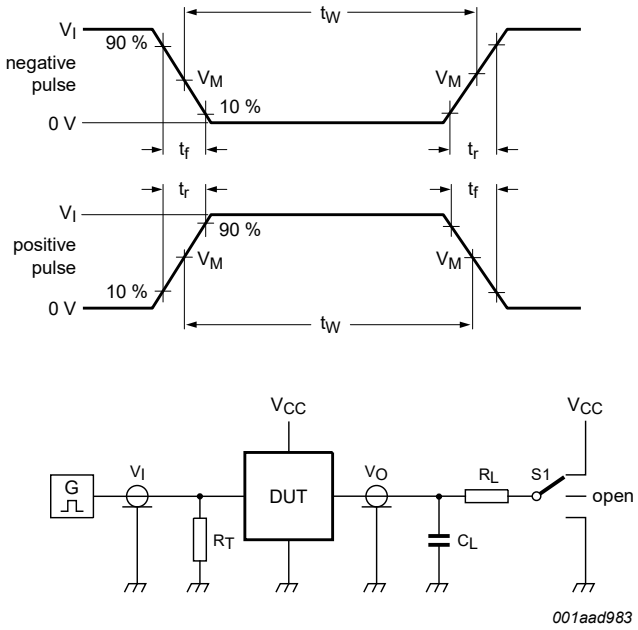


Measurement points are given in Table 8.

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

Fig. 13. Waveforms showing the set-up and hold times for the counter clock input (CPC) to the register clock input (CPR)



Test data is given in Table 9.

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;

R_L = Load resistance;

S1 = Test selection switch.

Fig. 14. Test circuit for measuring switching times

Table 9. Test data

Supply voltage	Input		Load		Switch position		
V_{CC}	V_I	t_r, t_f	C_L	R_L	t_{PHL}, t_{PLH}	t_{PZH}, t_{PHZ}	t_{PZL}, t_{PLZ}
2.0 V to 6.0 V	V_{CC}	6 ns	50 pF	1 kΩ	open	GND	V_{CC}

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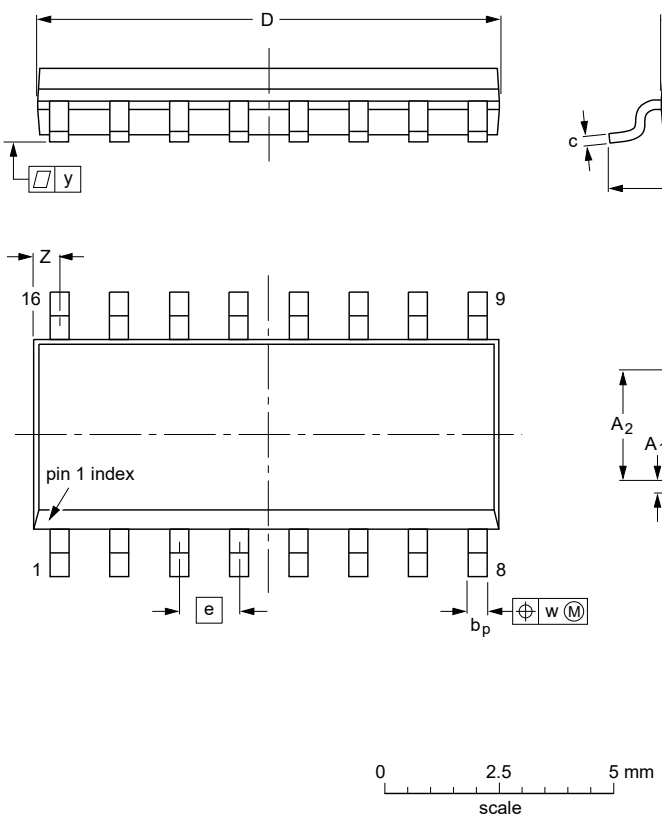
11. Package outline

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. 15. Package outline SOT109-1 (SO16)

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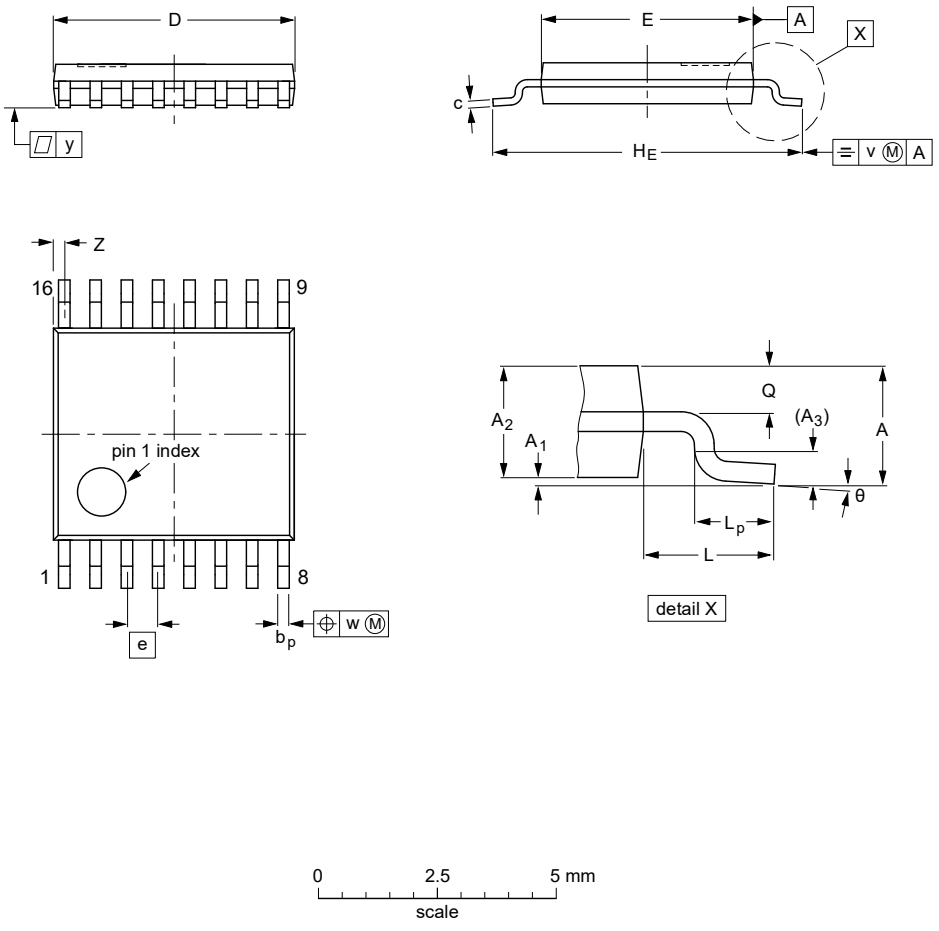
TSSOP16: plastic thin shrink small outline package; 16 leads; body width 4.4 mm **SOT403-1**



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. 16. Package outline SOT403-1 (TSSOP16)

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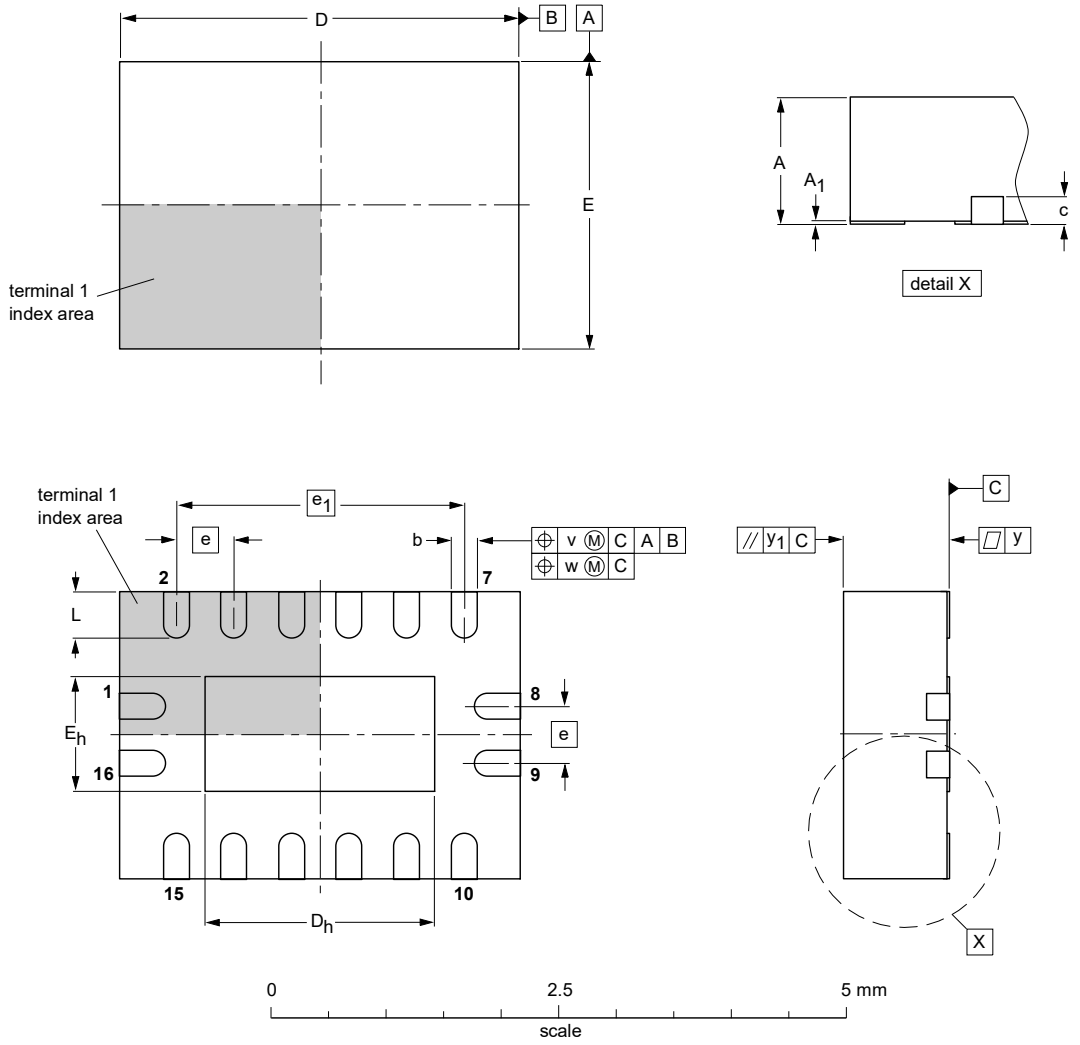
DHVQFN16: plastic dual in-line compatible thermal enhanced very thin quad flat package; no leads; 16 terminals; body 2.5 x 3.5 x 0.85 mm **SOT763-1**



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. 17. Package outline SOT763-1 (DHVQFN16)

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12. Abbreviations

Table 10. Abbreviations

Acronym	Description
CDM	Charged Device Model
CMOS	Complementary Metal-Oxide Semiconductor
DUT	Device Under Test
ESD	ElectroStatic Discharge
HBM	Human Body Model
MM	Machine Model

13. Revision history

Table 11. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
74HC590 v.4	20220314	Product data sheet	-	74HC590 v.3
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 2 updated. • ESD CDM value changed from 2000 V to 1000 V (errata). • Section 7: Derating values for P_{tot} total power dissipation updated.			
74HC590 v.3	20160224	Product data sheet	-	74HC590 v.2
Modifications:	• Type number 74HC590N (SOT38-4) removed.			
74HC590 v.2	20090428	Product data sheet	-	74HC590 v.1
Modifications:	• The format of this data sheet has been redesigned to comply with the new identity guidelines of NXP Semiconductors. • Legal texts have been adapted to the new company name where appropriate. • Quick reference data incorporated in to Section 9 and Section 10. • Added type number 74HC590N (DIP16 package)			
74HC590 v.1	20050330	Product data sheet	-	-

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14. 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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