DATA SHEET

74HC4052; 74HCT4052
Dual 4-channel analog multiplexer, demultiplexer

Product specification
Supersedes data of 1997 Aug 27

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Philips Semiconductors

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Dual 4-channel analog multiplexer, demultiplexer

74HC4052; 74HCT4052

FEATURES

- Wide analog input voltage range from –5 V to +5 V
- Low ON-resistance:
  - 80 Ω (typical) at $V_{CC} - V_{EE}$ = 4.5 V
  - 70 Ω (typical) at $V_{CC} - V_{EE}$ = 6.0 V
  - 60 Ω (typical) at $V_{CC} - V_{EE}$ = 9.0 V
- Logic level translation: to enable 5 V logic to communicate with ±5 V analog signals
- Typical “break before make” built in
- Complies with JEDEC standard no. 8-1 A
- ESD protection:
  - HBM EIA/JESD22-A114-A exceeds 2000 V
  - MM EIA/JESD22-A115-A exceeds 200 V.
- Specified from –40 to +85 °C and –40 to +125 °C.

APPLICATIONS

- Analog multiplexing and demultiplexing
- Digital multiplexing and demultiplexing
- Signal gating.

DESCRIPTION

The 74HC4052/74HCT4052 are high-speed Si-gate CMOS devices and are pin compatible with the HEF4052B. They are specified in compliance with JEDEC standard no. 7A.

The 74HC4052/74HCT4052 are dual 4-channel analog multiplexers or demultiplexers with common select logic. Each multiplexer has four independent inputs/outputs (pins nY0 to nY3) and a common input/output (pin nZ). The common channel select logics include two digital select inputs (pins S0 and S1) and an active LOW enable input (pin $\overline{E}$). When pin $\overline{E}$ = LOW, one of the four switches is selected (low-impedance ON-state) with pins S0 and S1. When pin $\overline{E}$ = HIGH, all switches are in the high-impedance OFF-state, independent of pins S0 and S1.

V_{CC} and GND are the supply voltage pins for the digital control inputs (pins S0, S1, and $\overline{E}$). The V_{CC} to GND ranges are 2.0 to 10.0 V for 74HC4052 and 4.5 to 5.5 V for 74HCT4052. The analog inputs/outputs (pins nY0 to nY3 and nZ) can swing between V_{CC} as a positive limit and V_{EE} as a negative limit. $V_{CC} - V_{EE}$ may not exceed 10.0 V.

For operation as a digital multiplexer/demultiplexer, V_{EE} is connected to GND (typically ground).

FUNCTION TABLE

INPUT[1]			CHANNEL BETWEEN
$\overline{E}$	S1	S0	
L	L	L	nY0 and nZ
L	L	H	nY1 and nZ
L	H	L	nY2 and nZ
L	H	H	nY3 and nZ
H	X	X	none

Note

1. H = HIGH voltage level
   L = LOW voltage level
   X = don’t care.

QUICK REFERENCE DATA

V_{EE} = GND = 0 V; T_{amb} = 25 °C; $t_r = t_f$ = 6 ns.

SYMBOL	PARAMETER	CONDITIONS	TYPICAL		UNIT
			74HC4052	74HCT4052	
t_{PZH}/t_{PZL}	turn-on time $\overline{E}$ or Sn to V_{os}	C_L = 15 pF; R_L = 1 kΩ; V_{CC} = 5 V	28	18	ns
t_{PHZ}/t_{PLZ}	turn-off time $\overline{E}$ or Sn to V_{os}	C_L = 15 pF; R_L = 1 kΩ; V_{CC} = 5 V	21	13	ns
C_I	input capacitance		3.5	3.5	pF
C_{PD}	power dissipation capacitance per switch	notes 1 and 2	57	57	pF
C_S	maximum switch capacitance	independent (Y)	5	5	pF
		common (Z)	12	12	pF

Notes

1. C_{PD} is used to determine the dynamic power dissipation (P_D in μW).
   $P_D = C_{PD} \times V_{CC}^2 \times f_i \times N + \Sigma[(C_L + C_S) \times V_{CC}^2 \times f_o]$ where:
   f_i = input frequency in MHz;
   f_o = output frequency in MHz;
   C_L = output load capacitance in pF;
   C_S = maximum switch capacitance in pF;
   V_{CC} = supply voltage in Volts;
   N = total load switching outputs;
   $\Sigma[(C_L + C_S) \times V_{CC}^2 \times f_o]$ = sum of the outputs.
2. For 74HC4052 the condition is V_I = GND to V_{CC}
   For 74HCT4052 the condition is V_I = GND to V_{CC} − 1.5 V.

ORDERING INFORMATION

TYPE NUMBER	PACKAGE				
	TEMPERATURE RANGE	PINS	PACKAGE	MATERIAL	CODE
74HC4052D	−40 to +125 °C	16	SO16	plastic	SOT109-3
74HCT4052D	−40 to +125 °C	16	SO16	plastic	SOT109-3
74HC4052DB	−40 to +125 °C	16	SSOP16	plastic	SOT338-1
74HCT4052DB	−40 to +125 °C	16	SSOP16	plastic	SOT338-1
74HC4052N	−40 to +125 °C	16	DIP16	plastic	SOT38-9
74HCT4052N	−40 to +125 °C	16	DIP16	plastic	SOT38-9
74HC4052PW	−40 to +125 °C	16	TSSOP16	plastic	SOT403-1
74HC4052BQ	−40 to +125 °C	16	DHVQFN16	plastic	SOT763-1
74HCT4052BQ	−40 to +125 °C	16	DHVQFN16	plastic	SOT763-1

PINNING

PIN	SYMBOL	DESCRIPTION
1	2Y0	independent input or output
2	2Y2	independent input or output
3	2Z	common input or output
4	2Y3	independent input or output
5	2Y1	independent input or output
6	$\overline{E}$	enable input (active LOW)
7	V_{EE}	negative supply voltage
8	GND	ground (0 V)
9	S1	select logic input
10	S0	select logic input
11	1Y3	independent input or output
12	1Y0	independent input or output
13	1Z	common input or output
14	1Y1	independent input or output
15	1Y2	independent input or output
16	V_{CC}	positive supply voltage

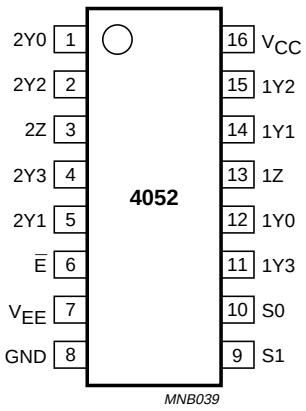
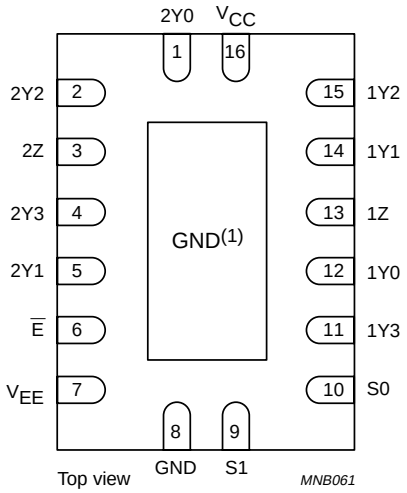


Fig.1 Pin configuration DIP16, SO16 and (T)SSOP16.



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

Fig.2 Pin configuration DHVQFN16.

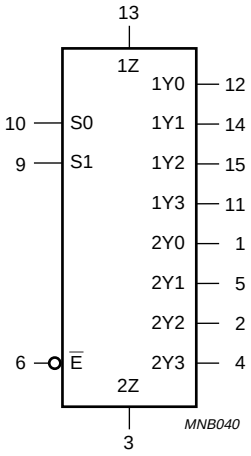


Fig.3 Logic symbol.

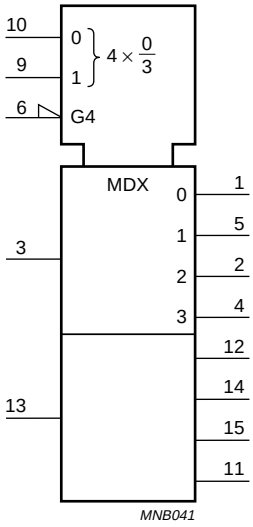


Fig.4 IEC logic symbol.

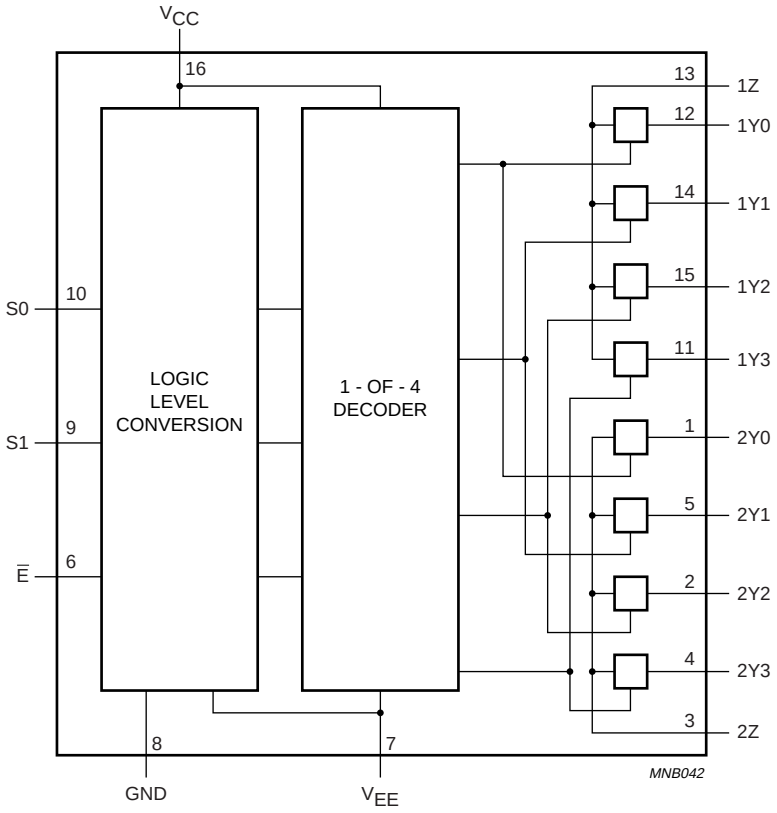


Fig.5 Functional diagram.

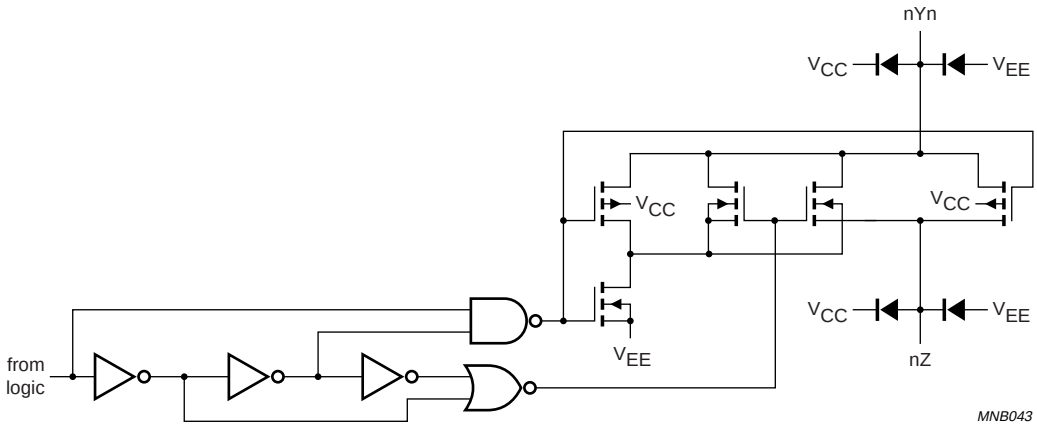


Fig.6 Schematic diagram (one switch).

LIMITING VALUES

In accordance with the Absolute Maximum Rating System (IEC 60134); voltages are referenced to V_{EE} = GND (ground = 0 V); note 1.

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{CC}	supply voltage		–0.5	+11.0	V
I_{IK}	input diode current	$V_I < –0.5$ V or $V_I > V_{CC} + 0.5$ V	–	±20	mA
I_{SK}	switch diode current	$V_S < –0.5$ V or $V_S > V_{CC} + 0.5$ V	–	±20	mA
I_S	switch current	$–0.5 \text{ V} < V_S < V_{CC} + 0.5$ V	–	±25	mA
I_{EE}	V_{EE} current		–	±20	mA
I_{CC}; I_{GND}	V_{CC} or GND current		–	±50	mA
T_{stg}	storage temperature		–65	+150	°C
P_{tot}	power dissipation	T_{amb} = –40 to +125 °C; note	–	500	mW
P_S	power dissipation per switch		–	100	mW

Notes

1. To avoid drawing V_{CC} current out of pins nZ, when switch current flows in pins nYn, the voltage drop across the bidirectional switch must not exceed 0.4 V. If the switch current flows into pins nZ, no V_{CC} current will flow out of pins nYn. In this case there is no limit for the voltage drop across the switch, but the voltages at pins nYn and nZ may not exceed V_{CC} or V_{EE}.
2. For DIP16 packages: above 70 °C derate linearly with 12 mW/K.

   For SO16 packages: above 70 °C derate linearly with 8 mW/K.

   For SSOP16 and TSSOP16 packages: above 60 °C derate linearly with 5.5 mW/K.

   For DHVQFN16 packages: above 60 °C derate linearly with 4.5 mW/K.

RECOMMENDED OPERATING CONDITIONS

SYMBOL	PARAMETER	CONDITIONS	74HC4052			74HCT4052			UNIT
			MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
V_{CC}	supply voltage	see Figs 7 and 8							
		V_{CC} – GND	2.0	5.0	10.0	4.5	5.0	5.5	V
		V_{CC} – V_{EE}	2.0	5.0	10.0	2.0	5.0	10.0	V
V_I	input voltage		GND	–	V_{CC}	GND	–	V_{CC}	V
V_S	switch voltage		V_{EE}	–	V_{CC}	V_{EE}	–	V_{CC}	V
T_{amb}	operating ambient temperature	see DC and AC characteristics per device	–40	+25	+85	–40	+25	+85	°C
			–40	–	+125	–40	–	+125	°C
t_r, t_f	input rise and fall times	V_{CC} = 2.0 V	–	6.0	1000	–	6.0	500	ns
		V_{CC} = 4.5 V	–	6.0	500	–	6.0	500	ns
		V_{CC} = 6.0 V	–	6.0	400	–	6.0	500	ns
		V_{CC} = 10.0 V	–	6.0	250	–	6.0	500	ns

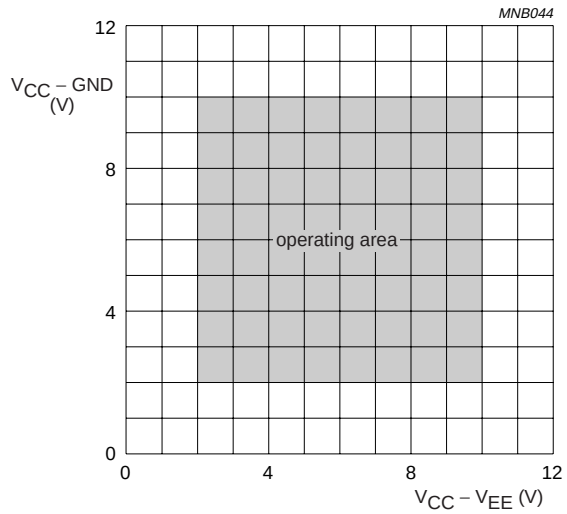


Fig.7 Guaranteed operating area as a function of the supply voltages for 74HC4052.

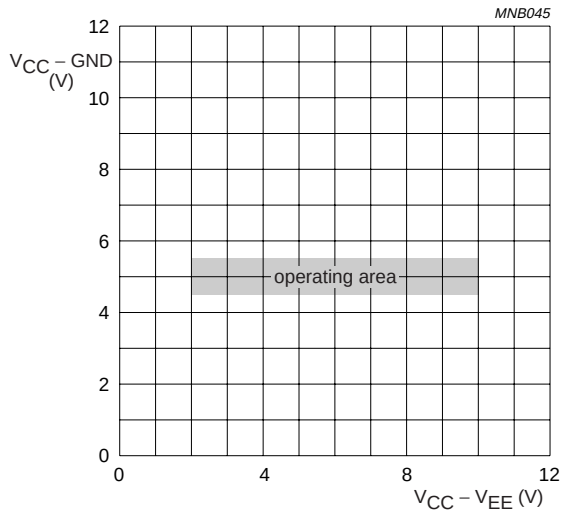


Fig.8 Guaranteed operating area as a function of the supply voltages for 74HCT4052.

DC CHARACTERISTICS

Family 74HC4052

V_{is} is the input voltage at pins nYn or nZ, whichever is assigned as an input; V_{os} is the output voltage at pins nZ or nYn, whichever is assigned as an output; voltages are referenced to GND (ground = 0 V).

SYMBOL	PARAMETER	TEST CONDITIONS			MIN.	TYP.	MAX.	UNIT
		OTHER	V_{CC} (V)	V_{EE} (V)				
T_{amb} = −40 to +85 °C; note 1								
V_{IH}	HIGH-level input voltage		2.0	–	1.5	1.2	–	V
			4.5	–	3.15	2.4	–	V
			6.0	–	4.2	3.2	–	V
			9.0	–	6.3	4.7	–	V
V_{IL}	LOW-level input voltage		2.0	–	–	0.8	0.5	V
			4.5	–	–	2.1	1.35	V
			6.0	–	–	2.8	1.8	V
			9.0	–	–	4.3	2.7	V
I_{LI}	input leakage current	V_I = V_{CC} or GND	6.0	0	–	–	±1.0	μA
			10.0	0	–	–	±2.0	μA
$I_{S(OFF)}$	analog switch OFF-state current	V_I = V_{IH} or V_{IL}; $\|V_S\|$ = V_{CC} − V_{EE}; see Fig.9						
		per channel	10.0	0	–	–	±1.0	μA
		all channels	10.0	0	–	–	±2.0	μA
$I_{S(ON)}$	analog switch ON-state current	V_I = V_{IH} or V_{IL}; $\|V_S\|$ = V_{CC} − V_{EE}; see Fig.10	10.0	0	–	–	±2.0	μA
I_{CC}	quiescent supply current	V_I = V_{CC} or GND; V_{is} = V_{EE} or V_{CC}; V_{os} = V_{CC} or V_{EE}	6.0	0	–	–	80.0	μA
			10.0	0	–	–	160.0	μA

SYMBOL	PARAMETER	TEST CONDITIONS			MIN.	TYP.	MAX.	UNIT
		OTHER	V_{CC} (V)	V_{EE} (V)				
T_{amb} = −40 to +125 °C								
V_{IH}	HIGH-level input voltage		2.0	–	1.5	–	–	V
			4.5	–	3.15	–	–	V
			6.0	–	4.2	–	–	V
			9.0	–	6.3	–	–	V
V_{IL}	LOW-level input voltage		2.0	–	–	–	0.5	V
			4.5	–	–	–	1.35	V
			6.0	–	–	–	1.8	V
			9.0	–	–	–	2.7	V
I_{LI}	input leakage current	V_I = V_{CC} or GND	6.0	0	–	–	±1.0	μA
			10.0	0	–	–	±2.0	μA
$I_{S(OFF)}$	analog switch OFF-state current	V_I = V_{IH} or V_{IL}; $\|V_S\|$ = V_{CC} − V_{EE}; see Fig.9						
		per channel	10.0	0	–	–	±1.0	μA
		all channels	10.0	0	–	–	±2.0	μA
$I_{S(ON)}$	analog switch ON-state current	V_I = V_{IH} or V_{IL}; $\|V_S\|$ = V_{CC} − V_{EE}; see Fig.10	10.0	0	–	–	±2.0	μA
I_{CC}	quiescent supply current	V_I = V_{CC} or GND; V_{is} = V_{EE} or V_{CC}; V_{os} = V_{CC} or V_{EE}	6.0	0	–	–	160	μA
			10.0	0	–	–	320.0	μA

Note

1. All typical values are measured at T_{amb} = 25 °C.

Family 74HCT4052

V_{is} is the input voltage at pins nYn or nZ, whichever is assigned as an input; V_{os} is the output voltage at pins nZ or nYn, whichever is assigned as an output; voltages are referenced to GND (ground = 0 V).

SYMBOL	PARAMETER	TEST CONDITIONS			MIN.	TYP.	MAX.	UNIT
		OTHER	V_{CC} (V)	V_{EE} (V)				
T_{amb} = −40 to +85 °C; note 1								
V_{IH}	HIGH-level input voltage		4.5 to 5.5	–	2.0	1.6	–	V
V_{IL}	LOW-level input voltage		4.5 to 5.5	–	–	1.2	0.8	V
I_{LI}	input leakage current	$V_I = V_{CC}$ or GND	5.5	0	–	–	±1.0	μA
$I_{S(OFF)}$	analog switch OFF-state current	$V_I = V_{IH}$ or V_{IL}; $\lvert V_S \rvert = V_{CC} - V_{EE}$; see Fig.9						
		per channel	10.0	0	–	–	±1.0	μA
		all channels	10.0	0	–	–	±2.0	μA
$I_{S(ON)}$	analog switch ON-state current	$V_I = V_{IH}$ or V_{IL}; $\lvert V_S \rvert = V_{CC} - V_{EE}$; see Fig.10	10.0	0	–	–	±2.0	μA
I_{CC}	quiescent supply current	$V_I = V_{CC}$ or GND; $V_{is} = V_{EE}$ or V_{CC}; $V_{os} = V_{CC}$ or V_{EE}	5.5	0	–	–	80.0	μA
			5.0	–5.0	–	–	160.0	μA
ΔI_{CC}	additional quiescent supply current per input	$V_I = V_{CC} - 2.1$ V; other inputs at V_{CC} or GND	4.5 to 5.5	0	–	45	202.5	μA
T_{amb} = −40 to +125 °C								
V_{IH}	HIGH-level input voltage		4.5 to 5.5	–	2.0	–	–	V
V_{IL}	LOW-level input voltage		4.5 to 5.5	–	–	–	0.8	V
I_{LI}	input leakage current	$V_I = V_{CC}$ or GND	5.5	0	–	–	±1.0	μA
$I_{S(OFF)}$	analog switch OFF-state current	$V_I = V_{IH}$ or V_{IL}; $\lvert V_S \rvert = V_{CC} - V_{EE}$; see Fig.9						
		per channel	10.0	0	–	–	±1.0	μA
		all channels	10.0	0	–	–	±2.0	μA
$I_{S(ON)}$	analog switch ON-state current	$V_I = V_{IH}$ or V_{IL}; $\lvert V_S \rvert = V_{CC} - V_{EE}$; see Fig.10	10.0	0	–	–	±2.0	μA
I_{CC}	quiescent supply current	$V_I = V_{CC}$ or GND; $V_{is} = V_{EE}$ or V_{CC}; $V_{os} = V_{CC}$ or V_{EE}	5.5	0	–	–	160.0	μA
			5.0	–5.0	–	–	320.0	μA
ΔI_{CC}	additional quiescent supply current per input	$V_I = V_{CC} - 2.1$ V; other inputs at V_{CC} or GND	4.5 to 5.5	0	–	–	220.5	μA

Note

1. All typical values are measured at T_{amb} = 25 °C.

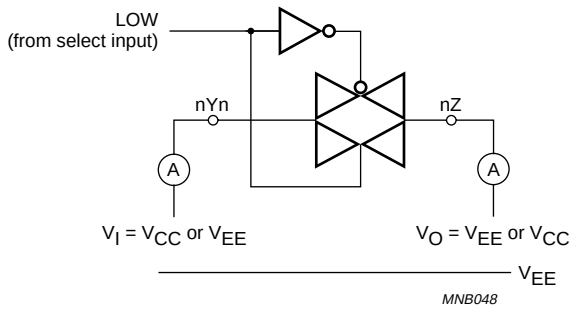


Fig.9 Test circuit for measuring OFF-state current.

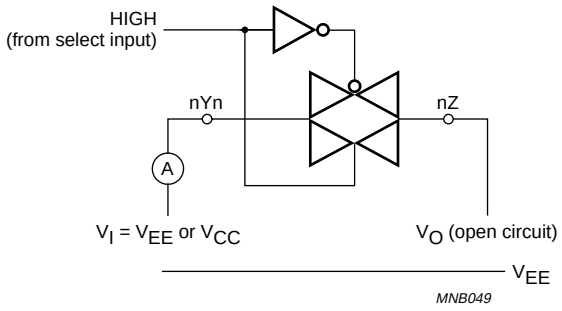


Fig.10 Test circuit for measuring ON-state current.

Resistance R_{ON} for 74HC4052 and 74HCT4052

V_{is} is the input voltage at pins nYn or nZ, whichever is assigned as an input; see notes 1 and 2; see Fig.11.

SYMBOL	PARAMETER	TEST CONDITIONS				MIN.	TYP.	MAX.	UNIT
		OTHER	V_{CC} (V)	V_{EE} (V)	I_S (μA)				
T_{amb} = −40 to +85 °C; note 3									
$R_{ON(peak)}$	ON-resistance (peak)	V_{is} = V_{CC} to V_{EE}; V_I = V_{IH} or V_{IL}	2.0	0	100	–	–	–	Ω
			4.5	0	1000	–	100	225	Ω
			6.0	0	1000	–	90	200	Ω
			4.5	–4.5	1000	–	70	165	Ω
$R_{ON(rail)}$	ON-resistance (rail)	V_{is} = V_{EE}; V_I = V_{IH} or V_{IL}	2.0	0	100	–	150	–	Ω
			4.5	0	1000	–	80	175	Ω
			6.0	0	1000	–	70	150	Ω
			4.5	–4.5	1000	–	60	130	Ω
		V_{is} = V_{CC}; V_I = V_{IH} or V_{IL}	2.0	0	100	–	150	–	Ω
			4.5	0	1000	–	90	200	Ω
			6.0	0	1000	–	80	175	Ω
			4.5	–4.5	1000	–	65	150	Ω
ΔR_{ON}	maximum ON-resistance difference between any two channels	V_{is} = V_{CC} to V_{EE}; V_I = V_{IH} or V_{IL}	2.0	0	–	–	–	–	Ω
			4.5	0	–	–	9	–	Ω
			6.0	0	–	–	8	–	Ω
			4.5	–4.5	–	–	6	–	Ω
T_{amb} = −40 to +125 °C									
$R_{ON(peak)}$	ON-resistance (peak)	V_{is} = V_{CC} to V_{EE}; V_I = V_{IH} or V_{IL}	2.0	0	100	–	–	–	Ω
			4.5	0	1000	–	–	270	Ω
			6.0	0	1000	–	–	240	Ω
			4.5	–4.5	1000	–	–	195	Ω
$R_{ON(rail)}$	ON-resistance (rail)	V_{is} = V_{EE}; V_I = V_{IH} or V_{IL}	2.0	0	100	–	–	–	Ω
			4.5	0	1000	–	–	210	Ω
			6.0	0	1000	–	–	180	Ω
			4.5	–4.5	1000	–	–	160	Ω
		V_{is} = V_{CC}; V_I = V_{IH} or V_{IL}	2.0	0	100	–	–	–	Ω
			4.5	0	1000	–	–	240	Ω
			6.0	0	1000	–	–	210	Ω
			4.5	–4.5	1000	–	–	180	Ω

Notes

1. For 74HC4052: V_{CC} – GND or V_{CC} – V_{EE} = 2.0, 4.5, 6.0 and 9.0 V; for 74HCT4052: V_{CC} – GND = 4.5 and 5.5 V, V_{CC} – V_{EE} = 2.0, 4.5, 6.0 and 9.0 V.
2. When supply voltages (V_{CC} – V_{EE}) near 2.0 V the analog switch ON-resistance becomes extremely non-linear. When using a supply of 2 V, it is recommended to use these devices only for transmitting digital signals.
3. All typical values are measured at T_{amb} = 25 °C.

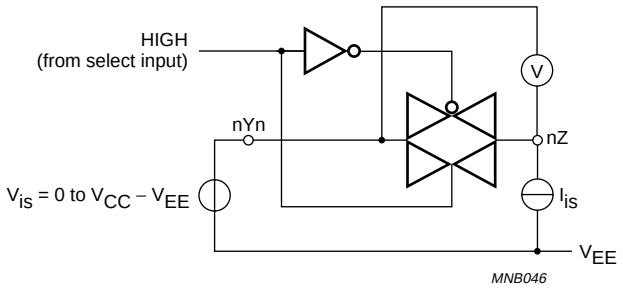
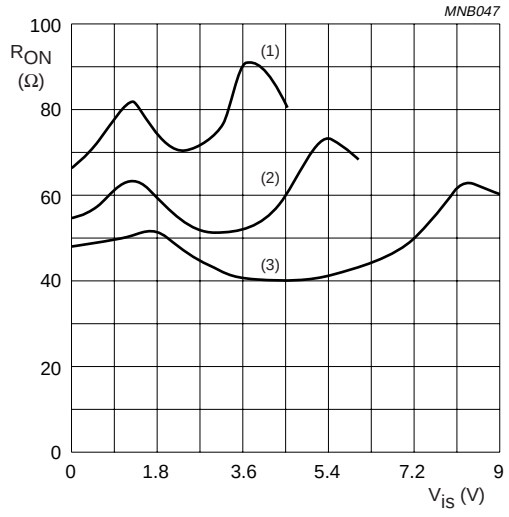


Fig.11 Test circuit for measuring R_{ON}.



V_{is} = 0 to $V_{CC} - V_{EE}$
(1) V_{CC} = 4.5 V
(2) V_{CC} = 6 V
(3) V_{CC} = 9 V

Fig.12 Typical R_{ON} as a function of input voltage V_{is}.

AC CHARACTERISTICS

Type 74HC4052

GND = 0 V; $t_r = t_f$ = 6 ns; C_L = 50 pF.

SYMBOL	PARAMETER	TEST CONDITIONS			MIN.	TYP.	MAX.	UNIT
		OTHER	V_{CC} (V)	V_{EE} (V)				
T_{amb} = −40 to +85 °C; note 1								
t_{PHL}/t_{PLH}	propagation delay V_{is} to V_{os}	R_L = ∞; see Fig.19	2.0	0	–	14	75	ns
			4.5	0	–	5	15	ns
			6.0	0	–	4	13	ns
			4.5	–4.5	–	4	10	ns
t_{PZH}/t_{PZL}	turn-on time $\overline{E}$, Sn to V_{os}	R_L = ∞; see Figs 20, 22 and 21	2.0	0	–	105	405	ns
			4.5	0	–	38	81	ns
			6.0	0	–	30	69	ns
			4.5	–4.5	–	26	58	ns
t_{PHZ}/t_{PLZ}	turn-off time $\overline{E}$, Sn to V_{os}	R_L = 1 kΩ; see Figs 20, 22 and 21	2.0	0	–	74	315	ns
			4.5	0	–	27	63	ns
			6.0	0	–	22	54	ns
			4.5	–4.5	–	22	48	ns
T_{amb} = −40 to +125 °C								
t_{PHL}/t_{PLH}	propagation delay V_{is} to V_{os}	R_L = ∞; see Fig.19	2.0	0	–	–	90	ns
			4.5	0	–	–	18	ns
			6.0	0	–	–	15	ns
			4.5	–4.5	–	–	12	ns
t_{PZH}/t_{PZL}	turn-on time $\overline{E}$, Sn to V_{os}	R_L = ∞; see Figs 20, 22 and 21	2.0	0	–	–	490	ns
			4.5	0	–	–	98	ns
			6.0	0	–	–	83	ns
			4.5	–4.5	–	–	69	ns
t_{PHZ}/t_{PLZ}	turn-off time $\overline{E}$, Sn to V_{os}	R_L = 1 kΩ; see Figs 20, 22 and 21	2.0	0	–	–	375	ns
			4.5	0	–	–	75	ns
			6.0	0	–	–	64	ns
			4.5	–4.5	–	–	57	ns

Note

1. All typical values are measured at T_{amb} = 25 °C.

Type 74HCT4052

GND = 0 V; $t_r = t_f$ = 6 ns; C_L = 50 pF.

SYMBOL	PARAMETER	TEST CONDITIONS			MIN.	TYP.	MAX.	UNIT
		OTHER	V_{CC} (V)	V_{EE} (V)				
T_{amb} = −40 to +85 °C; note 1								
t_{PHL}/t_{PLH}	propagation delay V_{is} to V_{os}	R_L = ∞; see Fig.19	4.5	0	–	5	15	ns
			4.5	–4.5	–	4	10	ns
t_{PZH}/t_{PZL}	turn-on time $\overline{E}$, Sn to V_{os}	R_L = 1 kΩ; see Figs 20, 22 and 21	4.5	0	–	41	88	ns
			4.5	–4.5	–	28	60	ns
t_{PHZ} t_{PLZ}	turn-off time $\overline{E}$, Sn to V_{os}	R_L = 1 kΩ; see Figs 20, 22 and 21	4.5	0	–	26	63	ns
			4.5	–4.5	–	21	48	ns
T_{amb} = −40 to +125 °C								
t_{PHL}/t_{PLH}	propagation delay V_{is} to V_{os}	R_L = ∞; see Fig.19	4.5	0	–	–	18	ns
			4.5	–4.5	–	–	12	ns
t_{PZH}/t_{PZL}	turn-on time $\overline{E}$, Sn to V_{os}	R_L = 1 kΩ; see Figs 20, 22 and 21	4.5	0	–	–	105	ns
			4.5	–4.5	–	–	72	ns
t_{PHZ}/t_{PLZ}	turn-off time $\overline{E}$, Sn to V_{os}	R_L = 1 kΩ; see Figs 20, 22 and 21	4.5	0	–	–	75	ns
			4.5	–4.5	–	–	57	ns

Note

1. All typical values are measured at T_{amb} = 25 °C.

Type 74HC4052 and 74HCT4052

Recommended conditions and typical values; GND = 0 V; T_{amb} = 25 °C; C_L = 50 pF. V_{is} is the input voltage at pins nYn or nZ, whichever is assigned as an input. V_{os} is the output voltage at pins nYn or nZ, whichever is assigned as an output.

SYMBOL	PARAMETER	TEST CONDITIONS				TYP.	UNIT
		OTHER	$V_{is(p-p)}$ (V)	V_{CC} (V)	V_{EE} (V)		
d_{sin}	sine-wave distortion	f = 1 kHz; R_L = 10 kΩ; see Fig.13	4.0	2.25	–2.25	0.04	%
			8.0	4.5	–4.5	0.02	%
		f = 10 kHz; R_L = 10 kΩ; see Fig.13	4.0	2.25	–2.25	0.12	%
			8.0	4.5	–4.5	0.06	%
$\alpha_{OFF(feedthr)}$	switch OFF signal feed-through	R_L = 600 Ω; f = 1 MHz; see Figs 14 and 15	note 1	2.25	–2.25	–50	dB
				4.5	–4.5	–50	dB
$\alpha_{ct(s)}$	crosstalk between two switches/multiplexers	R_L = 600 Ω; f = 1 MHz; see Fig.16	note 1	2.25	–2.25	–60	dB
				4.5	–4.5	–60	dB
$V_{ct(p-p)}$	crosstalk voltage between control and any switch (peak-to-peak value)	R_L = 600 Ω; f = 1 MHz; $\overline{E}$ or Sn, square-wave between V_{CC} and GND, $t_r = t_f$ = 6 ns; see Fig.17	–	4.5	0	110	mV
				4.5	–4.5	220	mV
f_{max}	minimum frequency response (–3dB)	R_L = 50 Ω; see Figs 13 and 18	note 2	2.25	–2.25	170	MHz
				4.5	–4.5	180	MHz
C_S	maximum switch capacitance	independent (Y)	–	–	–	5	pF
		common (Z)	–	–	–	12	pF

Notes

1. Adjust input voltage V_{is} to 0 dBm level (0 dBm = 1 mW into 600 Ω).
2. Adjust input voltage V_{is} to 0 dBm level at V_{os} for 1 MHz (0 dBm = 1 mW into 50 Ω).

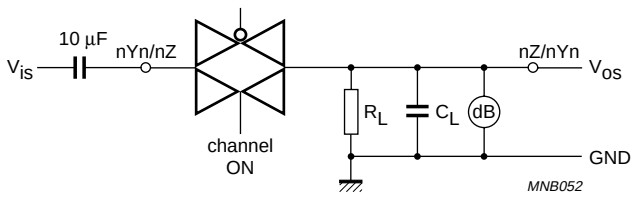


Fig.13 Test circuit for measuring sine-wave distortion and minimum frequency response.

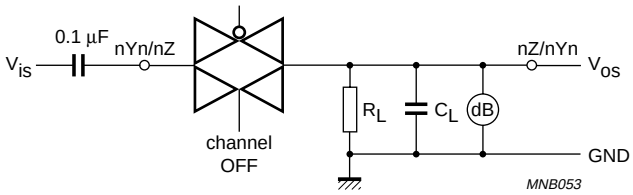
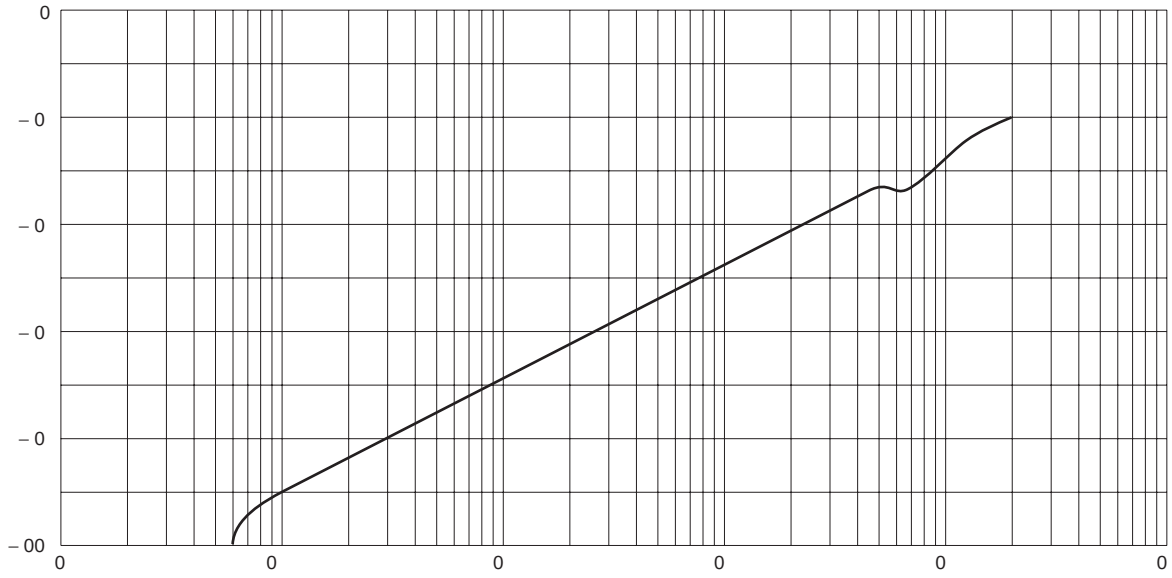
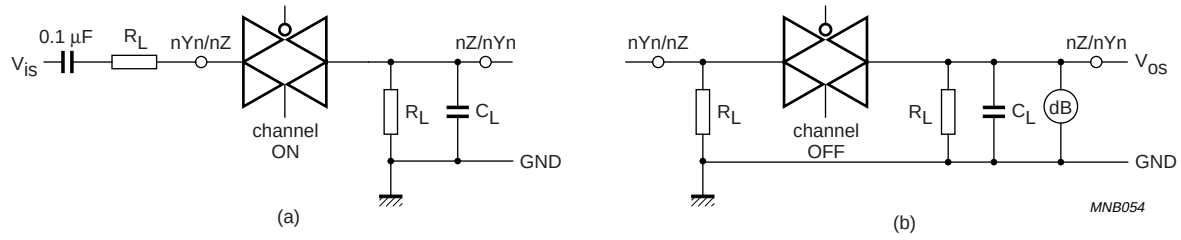


Fig.14 Test circuit for measuring switch OFF signal feed-through.



Test conditions: V_{CC} = 4.5 V; GND = 0 V; V_{EE} = –4.5 V; R_L = 50 Ω; R_{source} = 1 kΩ.

Fig.15 Typical switch OFF signal feed-through as a function of frequency.



(a) channel ON condition.

(b) channel OFF condition.

Fig.16 Test circuits for measuring crosstalk between any two switches/multiplexers.

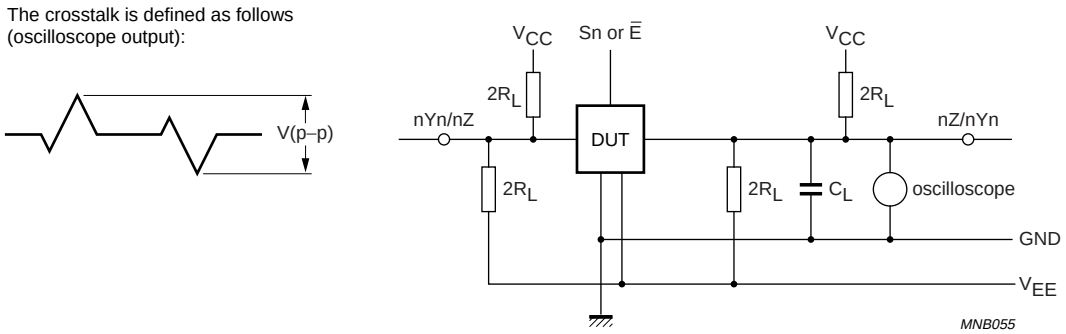
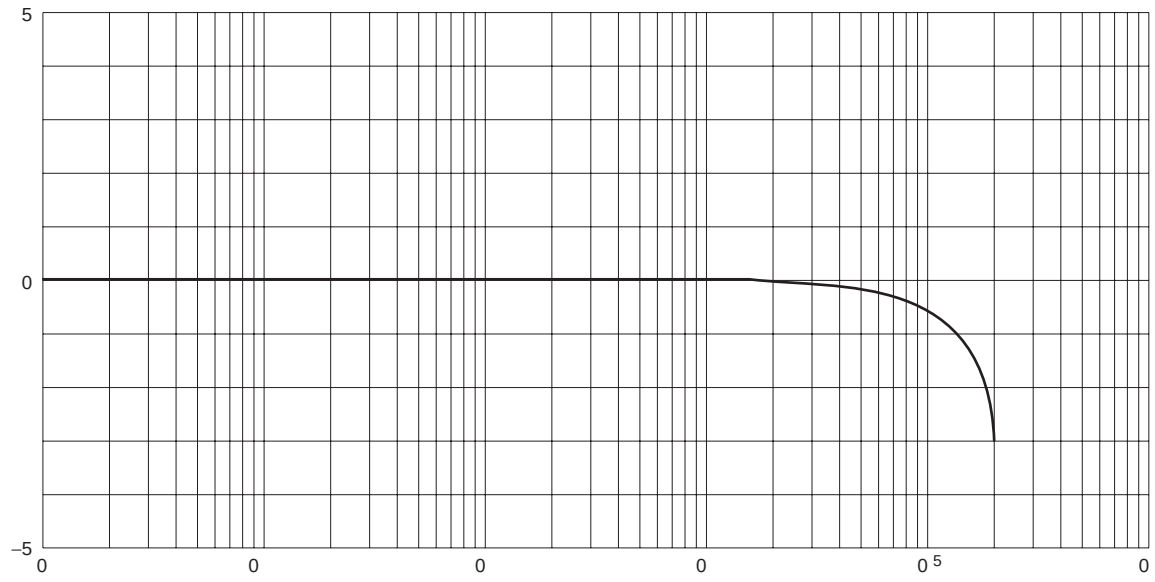


Fig.17 Test circuit for measuring crosstalk between control and any switch.



Test conditions: V_{CC} = 4.5 V; GND = 0 V; V_{EE} = –4.5 V; R_L = 50 Ω; R_{source} = 1 kΩ.

Fig.18 Typical frequency response.

AC WAVEFORMS

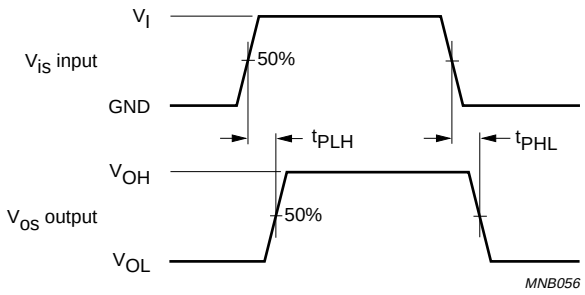
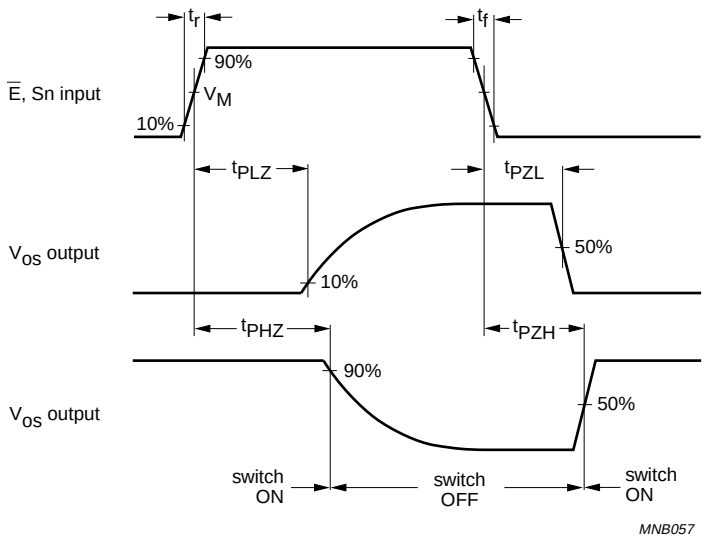
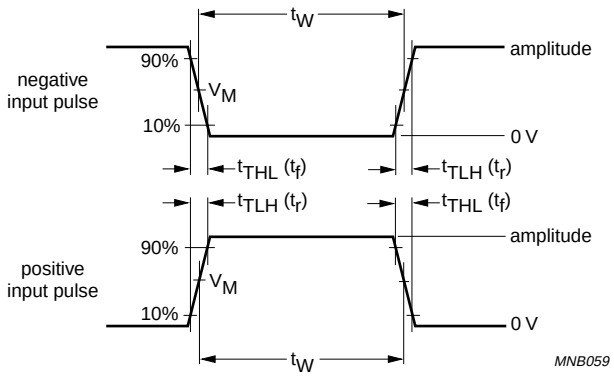


Fig.19 Waveforms showing the input (V_{is}) to output (V_{os}) propagation delays.



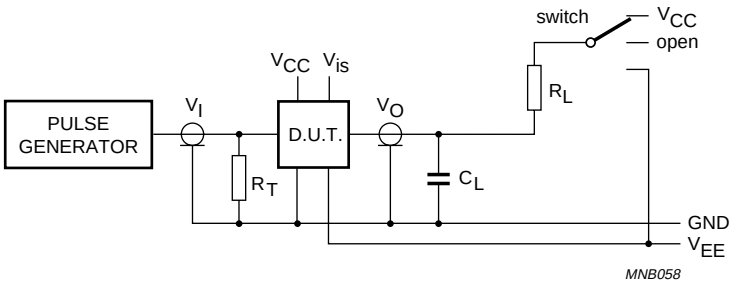
For 74HC4052: V_M = 50%; V_I = GND to V_{CC}.
For 74HCT4052: V_M = 1.3 V; V_I = GND to 3 V.

Fig.20 Waveforms showing the turn-on and turn-off times.



FAMILY	AMPLITUDE	V_M	t_r and t_f	
			f_{max}; PULSE WIDTH	OTHER
74HC4052	V_{CC}	50%	<2 ns	6 ns
74HCT4052	3.0 V	1.3 V	<2 ns	6 ns

Fig.21 Input pulse definitions.



TEST	SWITCH	V_{is}
t_{PZH}	V_{EE}	V_{CC}
t_{PZL}	V_{CC}	V_{EE}
t_{PHZ}	V_{EE}	V_{CC}
t_{PLZ}	V_{CC}	V_{EE}
other	open	pulse

Definitions for test circuit:

R_L = load resistance

C_L = load capacitance including jig and probe capacitance.

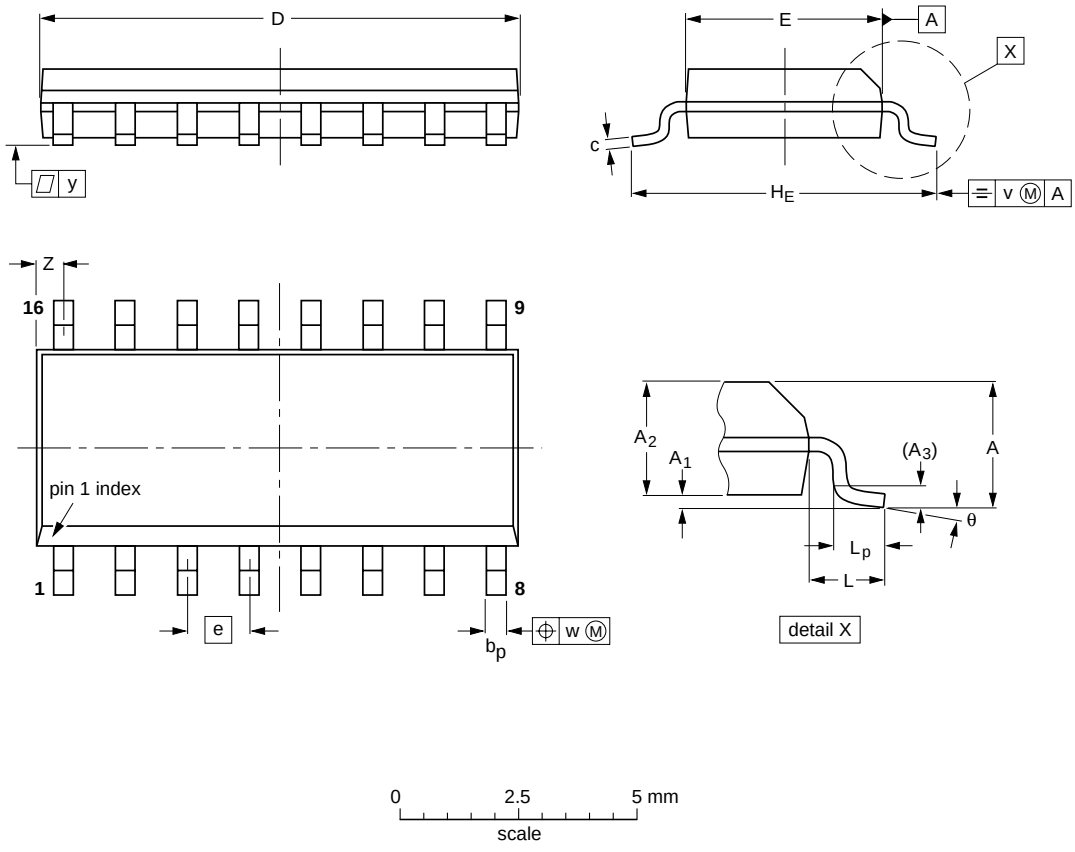
R_T = termination resistance should be equal to the output impedance Z_O of the pulse generator.

$t_r = t_f$ = 6 ns; when measuring f_{max}, there is no constraint to t_r and t_f with 50% duty factor.

Fig.22 Test circuit for measuring AC performance.

PACKAGE OUTLINES

SO16: plastic small outline package; 16 leads; body width 3.9 mm; body thickness 1.47 mm **SOT109-3**



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

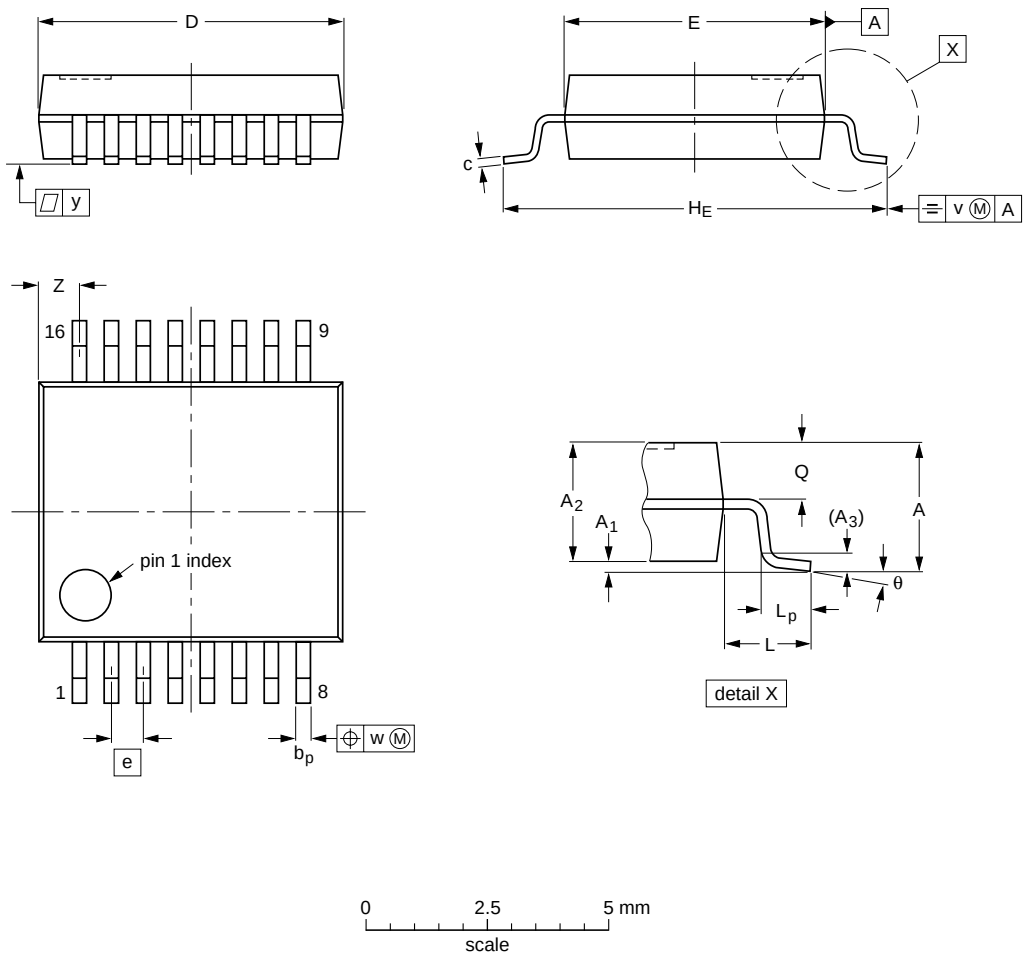
UNIT	A max.	A_1	A_2	A_3	b_p	c	$D^{(1)}$	$E^{(1)}$	e	H_E	L	L_p	v	w	y	$Z^{(1)}$	θ
mm	1.75	0.25 0.10	1.55 1.40	0.25	0.49 0.36	0.25 0.19	10.0 9.8	4.0 3.8	1.27	6.2 5.8	1.05	1.0 0.4	0.25	0.25	0.1	0.7 0.3	8^o 0^o
inches	0.069	0.010 0.004	0.061 0.055	0.01	0.019 0.014	0.0100 0.0075	0.39 0.38	0.16 0.15	0.05	0.244 0.228	0.041	0.039 0.016	0.01	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			
SOT109-3		MS-012AC				~~98-12-23~~ 03-02-19

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



DIMENSIONS (mm are the original dimensions)

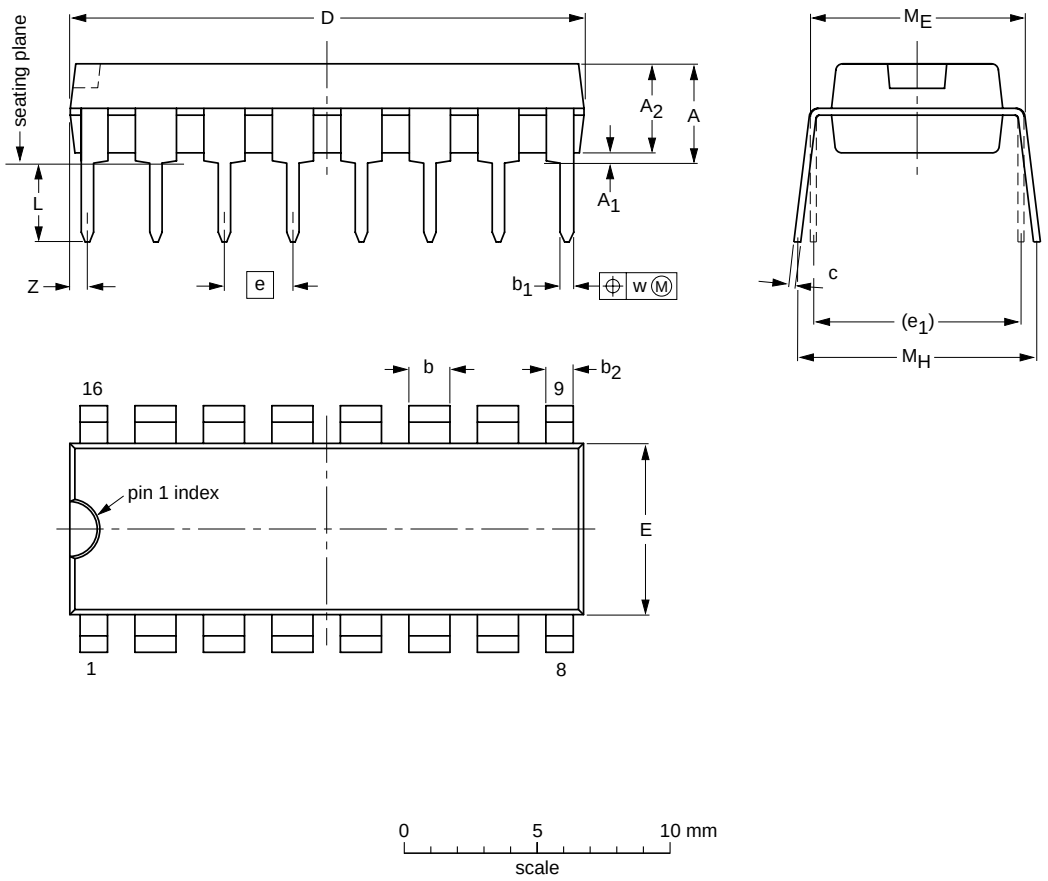
UNIT	A max.	A_1	A_2	A_3	b_p	c	D (1)	E (1)	e	H_E	L	L_p	Q	v	w	y	Z (1)	θ
mm	2	0.21 0.05	1.80 1.65	0.25	0.38 0.25	0.20 0.09	6.4 6.0	5.4 5.2	0.65	7.9 7.6	1.25	1.03 0.63	0.9 0.7	0.2	0.13	0.1	1.00 0.55	8^o 0^o

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

DIP16: plastic dual in-line package; 16 leads (300 mil) **SOT38-9**



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

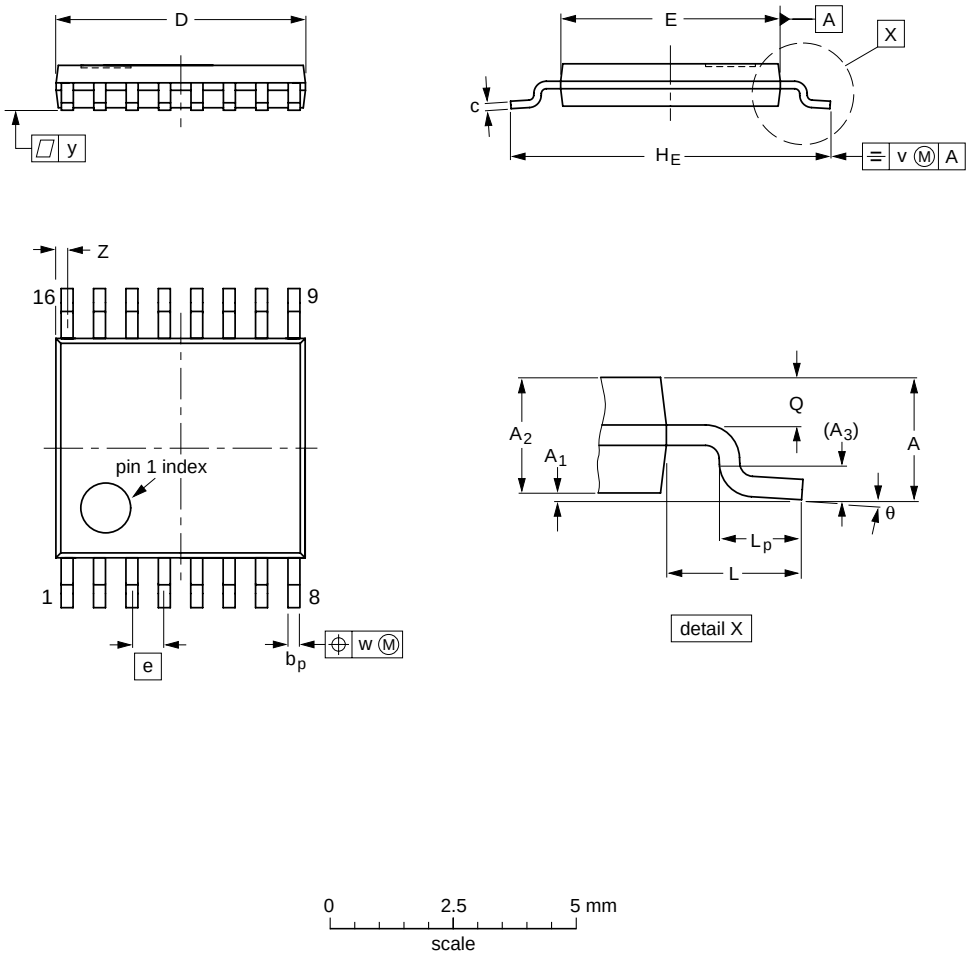
UNIT	A max.	A_1 min.	A_2 max.	b	b_1	b_2	c	D (1)	E (1)	e	e_1	L	M_E	M_H	w	Z (1) max.
mm	4.32	0.38	3.56	1.65 1.40	0.51 0.41	1.14 0.76	0.36 0.20	19.3 18.8	6.45 6.24	2.54	7.62	3.81 2.92	8.23 7.62	9.40 8.38	0.254	0.76
inches	0.17	0.015	0.14	0.065 0.055	0.020 0.016	0.045 0.030	0.014 0.008	0.76 0.74	0.254 0.246	0.1	0.3	0.150 0.115	0.324 0.300	0.37 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	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT38-9						~~97-07-24~~ 03-03-12

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



DIMENSIONS (mm are the original dimensions)

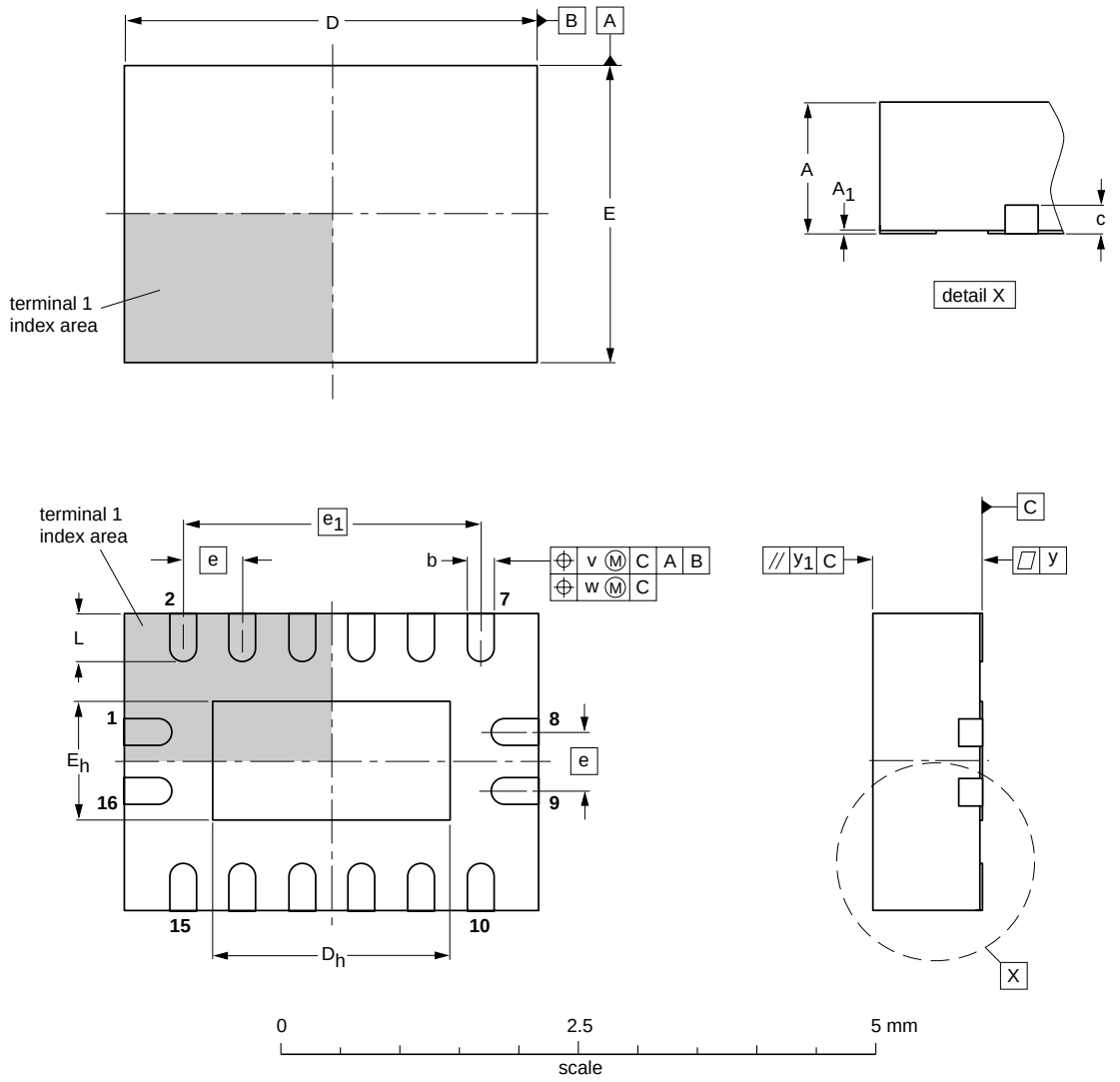
UNIT	A max.	A_1	A_2	A_3	b_p	c	D (1)	E (2)	e	H_E	L	L_p	Q	v	w	y	Z (1)	θ
mm	1.1	0.15 0.05	0.95 0.80	0.25	0.30 0.19	0.2 0.1	5.1 4.9	4.5 4.3	0.65	6.6 6.2	1	0.75 0.50	0.4 0.3	0.2	0.13	0.1	0.40 0.06	8^o 0^o

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

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

SOLDERING

Introduction to soldering surface mount packages

This text gives a very brief insight to a complex technology. A more in-depth account of soldering ICs can be found in our *"Data Handbook IC26; Integrated Circuit Packages"* (document order number 9398 652 90011).

There is no soldering method that is ideal for all surface mount IC packages. Wave soldering can still be used for certain surface mount ICs, but it is not suitable for fine pitch SMDs. In these situations reflow soldering is recommended.

Reflow soldering

Reflow soldering requires solder paste (a suspension of fine solder particles, flux and binding agent) to be applied to the printed-circuit board by screen printing, stencilling or pressure-syringe dispensing before package placement. Driven by legislation and environmental forces the worldwide use of lead-free solder pastes is increasing.

Several methods exist for reflowing; for example, convection or convection/infrared heating in a conveyor type oven. Throughput times (preheating, soldering and cooling) vary between 100 and 200 seconds depending on heating method.

Typical reflow peak temperatures range from 215 to 270 °C depending on solder paste material. The top-surface temperature of the packages should preferably be kept:

- below 220 °C (SnPb process) or below 245 °C (Pb-free process)
  - for all the BGA packages
  - for packages with a thickness ≥ 2.5 mm
  - for packages with a thickness < 2.5 mm and a volume ≥ 350 mm^3 so called thick/large packages.
- below 235 °C (SnPb process) or below 260 °C (Pb-free process) for packages with a thickness < 2.5 mm and a volume < 350 mm^3 so called small/thin packages.

Moisture sensitivity precautions, as indicated on packing, must be respected at all times.

Wave soldering

Conventional single wave soldering is not recommended for surface mount devices (SMDs) or printed-circuit boards with a high component density, as solder bridging and non-wetting can present major problems.

To overcome these problems the double-wave soldering method was specifically developed.

If wave soldering is used the following conditions must be observed for optimal results:

- Use a double-wave soldering method comprising a turbulent wave with high upward pressure followed by a smooth laminar wave.
- For packages with leads on two sides and a pitch (e):
  - larger than or equal to 1.27 mm, the footprint longitudinal axis is **preferred** to be parallel to the transport direction of the printed-circuit board;
  - smaller than 1.27 mm, the footprint longitudinal axis **must** be parallel to the transport direction of the printed-circuit board.

  The footprint must incorporate solder thieves at the downstream end.
- For packages with leads on four sides, the footprint must be placed at a 45° angle to the transport direction of the printed-circuit board. The footprint must incorporate solder thieves downstream and at the side corners.

During placement and before soldering, the package must be fixed with a droplet of adhesive. The adhesive can be applied by screen printing, pin transfer or syringe dispensing. The package can be soldered after the adhesive is cured.

Typical dwell time of the leads in the wave ranges from 3 to 4 seconds at 250 °C or 265 °C, depending on solder material applied, SnPb or Pb-free respectively.

A mildly-activated flux will eliminate the need for removal of corrosive residues in most applications.

Manual soldering

Fix the component by first soldering two diagonally-opposite end leads. Use a low voltage (24 V or less) soldering iron applied to the flat part of the lead. Contact time must be limited to 10 seconds at up to 300 °C.

When using a dedicated tool, all other leads can be soldered in one operation within 2 to 5 seconds between 270 and 320 °C.

Suitability of surface mount IC packages for wave and reflow soldering methods

PACKAGE[1]	SOLDERING METHOD	
	WAVE	REFLOW[2]
BGA, LBGA, LFBGA, SQFP, TFBGA, VFBGA	not suitable	suitable
DHVQFN, HBCC, HBGA, HLQFP, HSQFP, HSOP, HTQFP, HTSSOP, HVQFN, HVSON, SMS	not suitable[3]	suitable
PLCC[4], SO, SOJ	suitable	suitable
LQFP, QFP, TQFP	not recommended[4][5]	suitable
SSOP, TSSOP, VSO, VSSOP	not recommended[6]	suitable

Notes

1. For more detailed information on the BGA packages refer to the *"(LF)BGA Application Note*" (AN01026); order a copy from your Philips Semiconductors sales office.
2. All surface mount (SMD) packages are moisture sensitive. Depending upon the moisture content, the maximum temperature (with respect to time) and body size of the package, there is a risk that internal or external package cracks may occur due to vaporization of the moisture in them (the so called popcorn effect). For details, refer to the Drypack information in the *"Data Handbook IC26; Integrated Circuit Packages; Section: Packing Methods"*.
3. These packages are not suitable for wave soldering. On versions with the heatsink on the bottom side, the solder cannot penetrate between the printed-circuit board and the heatsink. On versions with the heatsink on the top side, the solder might be deposited on the heatsink surface.
4. If wave soldering is considered, then the package must be placed at a 45° angle to the solder wave direction. The package footprint must incorporate solder thieves downstream and at the side corners.
5. Wave soldering is suitable for LQFP, TQFP and QFP packages with a pitch (e) larger than 0.8 mm; it is definitely not suitable for packages with a pitch (e) equal to or smaller than 0.65 mm.
6. Wave soldering is suitable for SSOP, TSSOP, VSO and VSSOP packages with a pitch (e) equal to or larger than 0.65 mm; it is definitely not suitable for packages with a pitch (e) equal to or smaller than 0.5 mm.

DATA SHEET STATUS

LEVEL	DATA SHEET STATUS(1)	PRODUCT STATUS(2)(3)	DEFINITION
I	Objective data	Development	This data sheet contains data from the objective specification for product development. Philips Semiconductors reserves the right to change the specification in any manner without notice.
II	Preliminary data	Qualification	This data sheet contains data from the preliminary specification. Supplementary data will be published at a later date. Philips Semiconductors reserves the right to change the specification without notice, in order to improve the design and supply the best possible product.
III	Product data	Production	This data sheet contains data from the product specification. Philips Semiconductors reserves the right to make changes at any time in order to improve the design, manufacturing and supply. Relevant changes will be communicated via a Customer Product/Process Change Notification (CPCN).

Notes

1. Please consult the most recently issued data sheet before initiating or completing a design.
2. The product status of the device(s) described in this data sheet may have changed since this data sheet was published. The latest information is available on the Internet at URL http://www.semiconductors.philips.com.
3. For data sheets describing multiple type numbers, the highest-level product status determines the data sheet status.

DEFINITIONS

Short-form specification — The data in a short-form specification is extracted from a full data sheet with the same type number and title. For detailed information see the relevant data sheet or data handbook.

Limiting values definition — Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 60134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.

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