

# DATA SHEET

## **74AVC16245**

**16-bit transceiver with direction pin;  
3-state (3.6 V tolerant)**

Product specification  
Supersedes data of 1998 Dec 11  
File under Integrated Circuits, IC24

1999 Nov 15

# 16-bit transceiver with direction pin; 3-state (3.6 V tolerant)

## 74AVC16245

### FEATURES

- Wide supply voltage range from 1.2 to 3.6 V
- Complies with JEDEC standard no. 8-1A/5/7
- CMOS low power consumption
- Input/output tolerant up to 3.6 V
- Dynamic Controlled Output (DCO) circuit dynamically changes output impedance, resulting in noise reduction without speed degradation
- Low inductance multiple power and ground pins for minimum noise and ground bounce
- Power off disables outputs, permitting live insertion.

### DESCRIPTION

The 74AVC16245 is a 16-bit transceiver featuring non-inverting 3-state bus compatible outputs in both send and receive directions.

The 74AVC16245 features two output enable inputs ( $\overline{nOE}$ ) for easy cascading and two send/receive inputs ( $nDIR$ ) for direction control. Input  $\overline{nOE}$  controls the outputs so that the buses are effectively isolated. This device can be used as two 8-bit transceivers or one 16-bit transceiver.

This product is designed to have an extremely fast propagation delay and a minimum amount of power consumption.

To ensure the high-impedance output state during power-up or power-down, input  $\overline{nOE}$  should be tied to  $V_{CC}$  through a pull-up resistor (live insertion).

A DCO circuitry is implemented to support termination line drive during transient (see Figs 1 and 2).

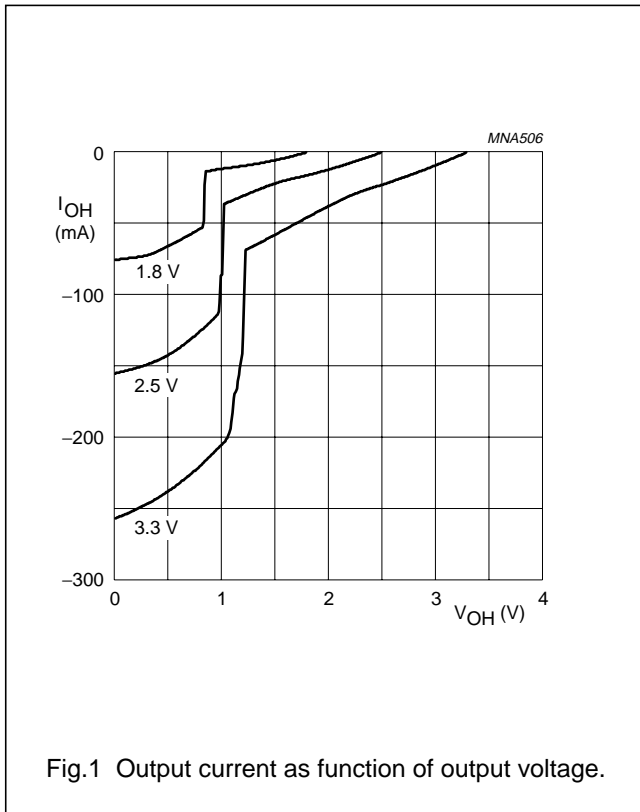


Fig.1 Output current as function of output voltage.

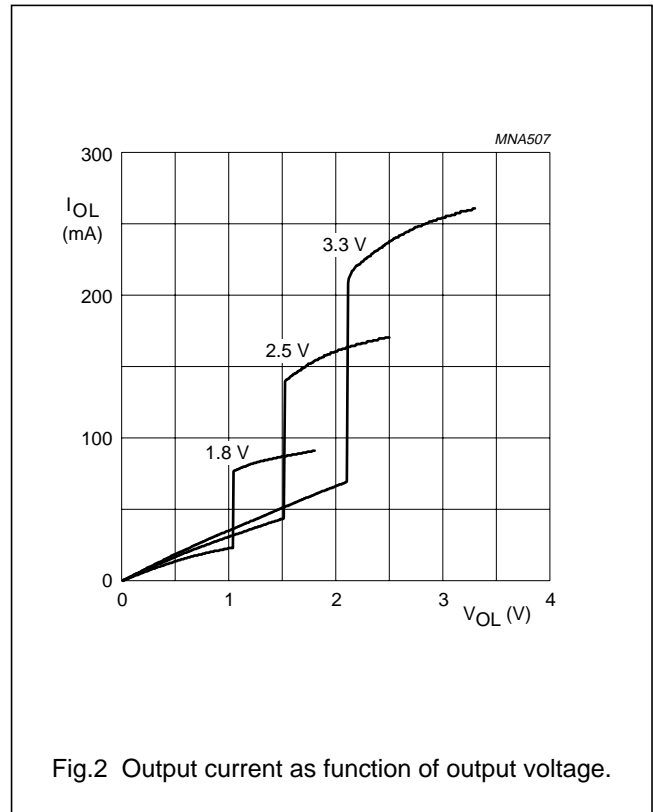


Fig.2 Output current as function of output voltage.

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**QUICK REFERENCE DATA**GND = 0 V;  $T_{amb} = 25\text{ }^{\circ}\text{C}$ ;  $t_r = t_f \leq 2.0\text{ ns}$ ;  $C_L = 30\text{ pF}$ .

SYMBOL	PARAMETER	CONDITIONS	TYP.	UNIT
$t_{PHL}/t_{PLH}$	propagation delay $nA_n$ to $nB_n$ ; $nB_n$ to $nA_n$	$V_{CC} = 1.2\text{ V}$	2.8	ns
		$V_{CC} = 1.5\text{ V}$	1.8	ns
		$V_{CC} = 1.8\text{ V}$	1.8	ns
		$V_{CC} = 2.5\text{ V}$	1.3	ns
		$V_{CC} = 3.3\text{ V}$	1.1	ns
$C_I$	input capacitance		5.0	pF
$C_{PD}$	power dissipation capacitance per buffer	notes 1 and 2		
		outputs enabled	42	pF
		outputs disabled	2	pF

**Notes**

- $C_{PD}$  is used to determine the dynamic power dissipation ( $P_D$  in  $\mu\text{W}$ ).

$$P_D = C_{PD} \times V_{CC}^2 \times f_i + \sum (C_L \times V_{CC}^2 \times f_o)$$
 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 Volts;

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

- The condition is  $V_I = \text{GND}$  to  $V_{CC}$ .

**FUNCTION TABLE**

See note 1.

INPUTS		INPUTS/OUTPUTS	
$\overline{nOE}$	$nDIR$	$nA_n$	$nB_n$
L	L	A = B	inputs
L	H	inputs	B = A
H	X	Z	Z

**Note**

- H = HIGH voltage level;  
L = LOW voltage level;  
X = don't care;  
Z = high-impedance OFF-state.

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**ORDERING INFORMATION**

TYPE NUMBER	PACKAGE				
	TEMPERATURE RANGE	PINS	PACKAGE	MATERIAL	CODE
74AVC16245DGG	-40 to +85 °C	48	TSSOP	plastic	SOT362-1

**PINNING**

PIN	SYMBOL	DESCRIPTION
1	1DIR	direction control
2, 3, 5, 6, 8, 9, 11 and 12	1B <sub>0</sub> to 1B <sub>7</sub>	data inputs/outputs
4, 10, 15, 21, 28, 34, 39 and 45	GND	ground (0 V)
7, 18, 31 and 42	V <sub>CC</sub>	DC supply voltage
13, 14, 16, 17, 19, 20, 22 and 23	2B <sub>0</sub> to 2B <sub>7</sub>	data inputs/outputs
24	2DIR	direction control
25	2 $\overline{\text{OE}}$	output enable input (active LOW)
26, 27, 29, 30, 32, 33, 35 and 36	2A <sub>7</sub> to 2A <sub>0</sub>	data inputs/outputs
37, 38, 40, 41, 43, 44, 46 and 47	1A <sub>7</sub> to 1A <sub>0</sub>	data inputs/outputs
48	1 $\overline{\text{OE}}$	output enable input (active LOW)

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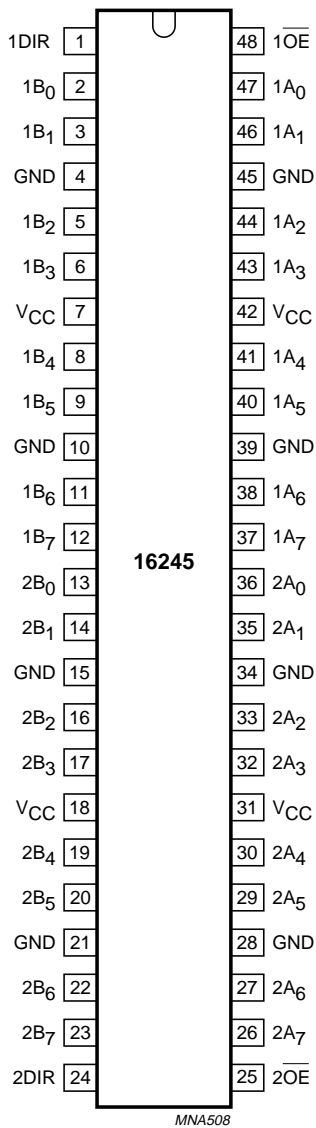


Fig.3 Pin configuration.

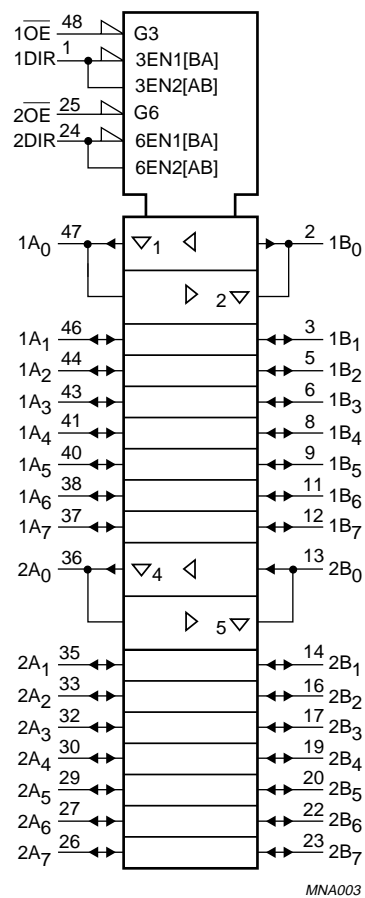


Fig.4 IEEE/IEC logic symbol.

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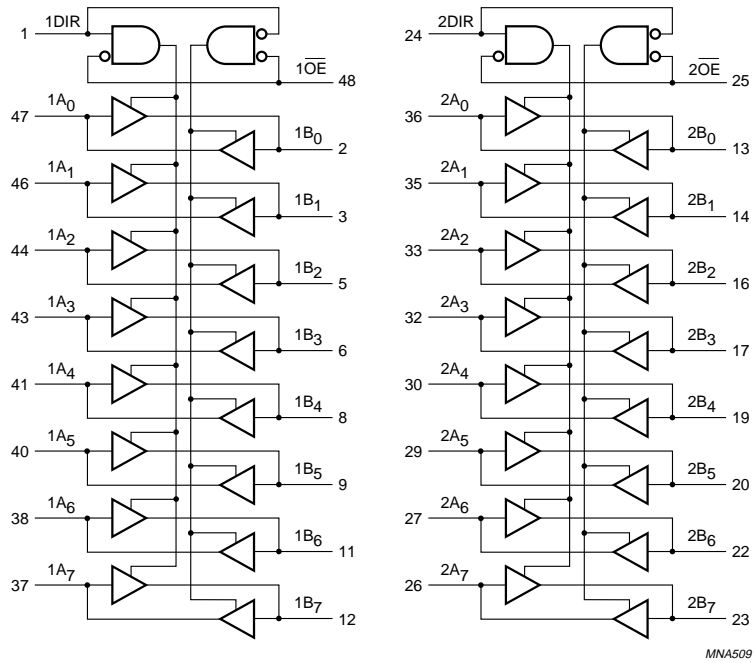


Fig.5 Logic symbol.

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## RECOMMENDED OPERATING CONDITIONS

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
$V_{CC}$	DC supply voltage	according JEDEC low-voltage standards	1.65 2.3 3.0	1.95 2.7 3.6	V V V
		low-voltage applications	1.2	3.6	V
$V_I$	DC input voltage		0	3.6	V
$V_O$	DC output voltage	3-state	0	3.6	V
		HIGH or LOW state	0	$V_{CC}$	V
$T_{amb}$	operating ambient temperature	in free air	-40	+85	°C
$t_r, t_f$	input rise and fall times	$V_{CC} = 1.65$ to $2.3$ V	0	30	ns/V
		$V_{CC} = 2.3$ to $3.0$ V	0	20	ns/V
		$V_{CC} = 3.0$ to $3.6$ V	0	10	ns/V

## LIMITING VALUES

In accordance with the Absolute Maximum Rating System (IEC 134); voltages are referenced to GND (ground = 0 V).

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
$V_{CC}$	DC supply voltage		-0.5	+4.6	V
$I_{IK}$	DC input diode current	$V_I < 0$ V	-	-50	mA
$V_I$	DC input voltage	for inputs; note 1	-0.5	+4.6	V
$I_{OK}$	DC output diode current	$V_O > V_{CC}$ or $V_O < 0$ V	-	±50	mA
$V_O$	DC output voltage	HIGH or LOW state; note 1	-0.5	$V_{CC} + 0.5$	V
		3-state; note 1	-0.5	+4.6	V
$I_O$	DC output source or sink current	$V_O = 0$ V to $V_{CC}$	-	±50	mA
$I_{CC}, I_{GND}$	DC $V_{CC}$ or GND current		-	±100	mA
$T_{stg}$	storage temperature		-65	+150	°C
$P_{tot}$	power dissipation per package	temperature range from -40 to +85 °C; note 2	-	500	mW

## Notes

1. The input and output voltage ratings may be exceeded if the input and output current ratings are observed.
2. Above 60 °C the value of  $P_D$  derates linearly with 5.5 mW/K.

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## DC CHARACTERISTICS

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

SYMBOL	PARAMETER	TEST CONDITIONS		$T_{amb} = -40 \text{ to } +85 \text{ } ^\circ\text{C}$			UNIT
		OTHER	$V_{CC}$ (V)	MIN.	TYP. <sup>(1)</sup>	MAX.	
$V_{IH}$	HIGH-level input voltage		1.2	$V_{CC}$	–	–	V
			1.65 to 1.95	$0.65V_{CC}$	0.9	–	V
			2.3 to 2.7	1.7	1.2	–	V
			3.0 to 3.6	2.0	1.5	–	V
$V_{IL}$	LOW-level input voltage		1.2	–	–	GND	V
			1.65 to 1.95	–	0.9	$0.35V_{CC}$	V
			2.3 to 2.7	–	1.2	0.7	V
			3.0 to 3.6	–	1.5	0.8	V
$V_{OH}$	HIGH-level output voltage	$V_I = V_{IH}$ or $V_{IL}$	1.65 to 3.6	$V_{CC} - 0.20$	$V_{CC}$	–	V
		$I_O = -100 \mu\text{A}$	1.65	$V_{CC} - 0.45$	$V_{CC} - 0.10$	–	V
		$I_O = -4 \text{ mA}$	2.3	$V_{CC} - 0.55$	$V_{CC} - 0.28$	–	V
		$I_O = -8 \text{ mA}$	3.0	$V_{CC} - 0.70$	$V_{CC} - 0.32$	–	V
$V_{OL}$	LOW-level output voltage	$V_I = V_{IH}$ or $V_{IL}$	1.65 to 3.6	–	GND	0.20	V
		$I_O = 100 \mu\text{A}$	1.65	–	0.10	0.45	V
		$I_O = 4 \text{ mA}$	2.3	–	0.26	0.55	V
		$I_O = 8 \text{ mA}$	3.0	–	0.36	0.70	V
$I_I$	input leakage current per pin	$V_I = V_{CC}$ or GND	1.65 to 3.6	–	0.1	2.5	$\mu\text{A}$
$I_{off}$	power off leakage current	$V_I$ or $V_O = 3.6$	0	–	0.1	$\pm 10$	$\mu\text{A}$
$I_{IHZ}/I_{ILZ}$	input current for common I/O pins	$V_I = V_{CC}$ or GND	1.65 to 3.6	–	0.1	12.5	$\mu\text{A}$
$I_{OZ}$	3-state output OFF-state current	$V_I = V_{IH}$ or $V_{IL}$ ; $V_O = V_{CC}$ or GND	1.65 to 2.7	–	0.1	5	$\mu\text{A}$
			3.0 to 3.6	–	0.1	10	$\mu\text{A}$
$I_{CC}$	quiescent supply current	$V_I = V_{CC}$ or GND; $I_O = 0$	1.65 to 2.7	–	0.1	20	$\mu\text{A}$
			3.0 to 3.6	–	0.2	40	$\mu\text{A}$

### Note

1. All typical values are measured at  $T_{amb} = 25 \text{ } ^\circ\text{C}$ .



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AC CHARACTERISTICS

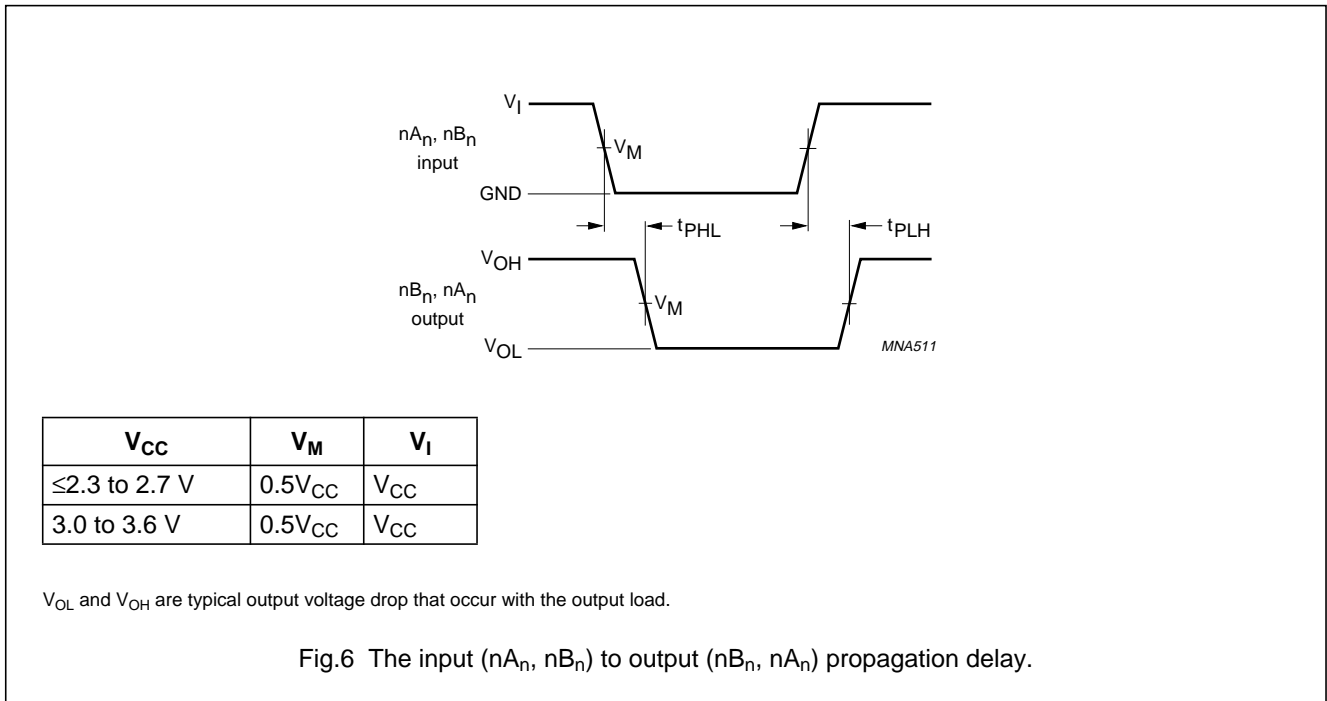
GND = 0 V;  $t_r = t_f \leq 2.0$  ns;  $C_L = 30$  pF.

SYMBOL	PARAMETER	TEST CONDITIONS		$T_{amb} = -40$ to $+85$ °C			UNIT
		WAVEFORMS	$V_{CC}$ (V)	MIN.	TYP. <sup>(1)</sup>	MAX.	
$t_{PHL}/t_{PLH}$	propagation delay $nA_n$ to $nB_n$ ; $nB_n$ to $nA_n$	see Figs 6 and 8	1.2	–	2.8	–	ns
			1.40 to 1.60	–	1.8	–	ns
			1.65 to 1.95	0.7	1.8	3.0	ns
			2.3 to 2.7	0.6	1.3	1.9	ns
			3.0 to 3.6	0.5	1.1	1.7	ns
$t_{PZH}/t_{PZL}$	3-state output enable time $nOE$ to $nA_n$ ; $nOE$ to $nB_n$	see Figs 7 and 8	1.2	–	5.9	–	ns
			1.40 to 1.60	–	3.9	–	ns
			1.65 to 1.95	1.4	3.3	6.5	ns
			2.3 to 2.7	1.0	2.4	4.5	ns
			3.0 to 3.6	0.7	2.0	3.7	ns
$t_{PHZ}/t_{PLZ}$	3-state output disable time $nOE$ to $nA_n$ ; $nOE$ to $nB_n$	see Figs 7 and 8	1.2	–	6.9	–	ns
			1.40 to 1.60	–	4.8	–	ns
			1.65 to 1.95	2.2	3.7	6.0	ns
			2.3 to 2.7	1.1	2.0	4.2	ns
			3.0 to 3.6	1.2	2.2	3.7	ns

Note

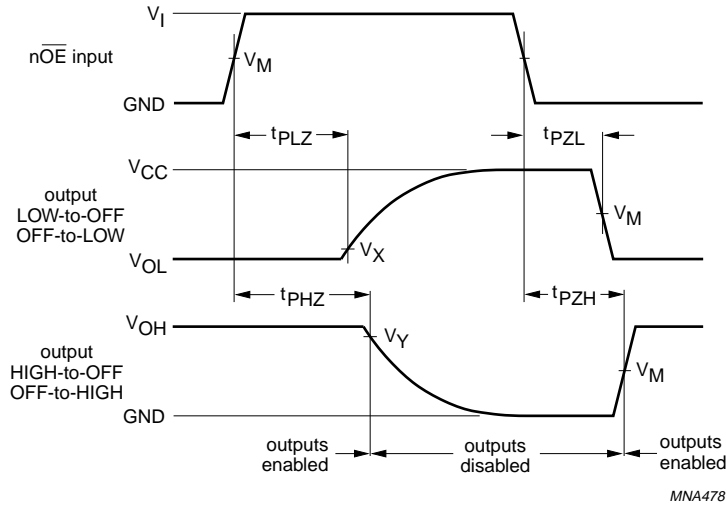
1. All typical values are measured at  $T_{amb} = 25$  °C and at  $V_{CC} = 1.2$  V, 1.5 V, 1.8 V, 2.5 V or 3.3 V.

AC WAVEFORMS



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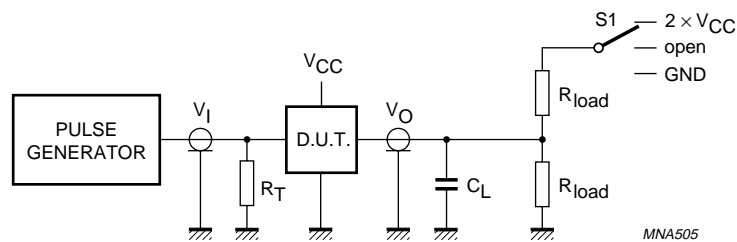


MNA478

V <sub>CC</sub>	V <sub>M</sub>	V <sub>X</sub>	V <sub>Y</sub>	V <sub>I</sub>
≤2.3 to 2.7 V	0.5V <sub>CC</sub>	V <sub>OL</sub> + 0.15 V	V <sub>OH</sub> - 0.15 V	V <sub>CC</sub>
3.0 to 3.6 V	0.5V <sub>CC</sub>	V <sub>OL</sub> + 0.3 V	V <sub>OH</sub> - 0.3 V	V <sub>CC</sub>

V<sub>OL</sub> and V<sub>OH</sub> are typical output voltage drop that occur with the output load.

Fig.7 The 3-state enable and disable times.



MNA505

TEST	S1	V <sub>CC</sub>	V <sub>I</sub>	R <sub>load</sub>
t <sub>PLH</sub> /t <sub>PHL</sub>	open	<2.3 V	V <sub>CC</sub>	1000 Ω
t <sub>PLZ</sub> /t <sub>PZL</sub>	2 x V <sub>CC</sub>	2.3 to 2.7 V	V <sub>CC</sub>	500 Ω
t <sub>PHZ</sub> /t <sub>PZH</sub>	GND	3.0 to 3.6 V	V <sub>CC</sub>	500 Ω

Definitions for test circuit.

C<sub>L</sub> = load capacitance including jig and probe capacitance (See Chapter "AC characteristics").

R<sub>T</sub> = termination resistance should be equal to the output impedance Z<sub>o</sub> of the pulse generator.

Fig.8 Test circuitry for switching times.

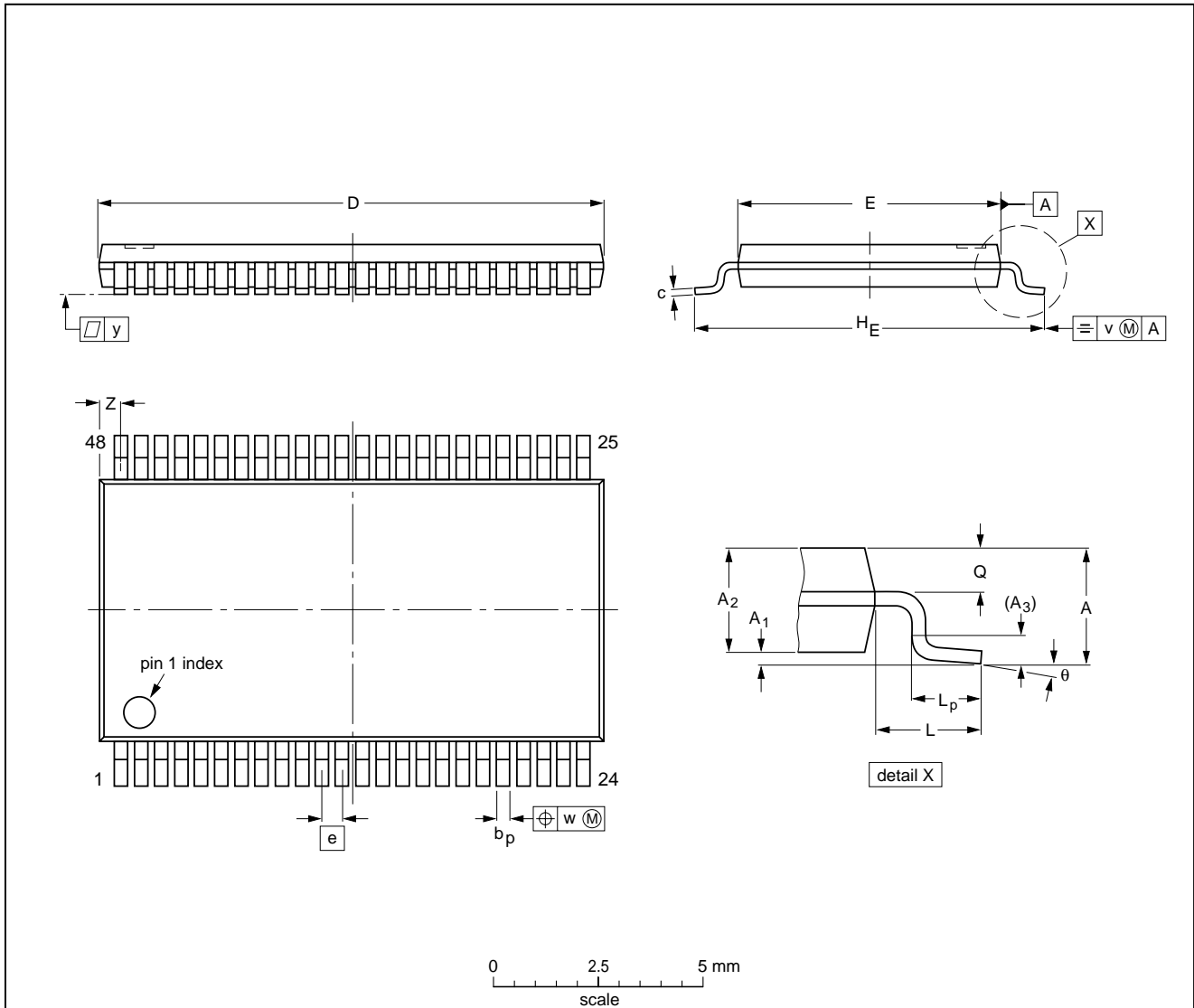
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PACKAGE OUTLINE

TSSOP48: plastic thin shrink small outline package; 48 leads; body width 6.1 mm

SOT362-1



DIMENSIONS (mm are the original 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>(2)</sup>	e	H <sub>E</sub>	L	L <sub>p</sub>	Q	v	w	y	Z	θ
mm	1.2	0.15 0.05	1.05 0.85	0.25	0.28 0.17	0.2 0.1	12.6 12.4	6.2 6.0	0.5	8.3 7.9	1	0.8 0.4	0.50 0.35	0.25	0.08	0.1	0.8 0.4	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	EIAJ			
SOT362-1		MO-153ED				93-02-03 95-02-10

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### 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 is not always suitable for surface mount ICs, or for printed-circuit boards with high population densities. In these situations reflow soldering is often used.

#### 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.

Several methods exist for reflowing; for example, infrared/convection 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 250 °C. The top-surface temperature of the packages should preferably be kept below 230 °C.

#### 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 is 4 seconds at 250 °C.

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.

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

PACKAGE	SOLDERING METHOD	
	WAVE	REFLOW <sup>(1)</sup>
BGA, LFBGA, SQFP, TFBGA	not suitable	suitable
HBCC, HLQFP, HSQFP, HSOP, HTQFP, HTSSOP, SMS	not suitable <sup>(2)</sup>	suitable
PLCC <sup>(3)</sup> , SO, SOJ	suitable	suitable
LQFP, QFP, TQFP	not recommended <sup>(3)(4)</sup>	suitable
SSOP, TSSOP, VSO	not recommended <sup>(5)</sup>	suitable

### Notes

- 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".
- These packages are not suitable for wave soldering as a solder joint between the printed-circuit board and heatsink (at bottom version) can not be achieved, and as solder may stick to the heatsink (on top version).
- 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.
- Wave soldering is only suitable for LQFP, TQFP and QFP packages with a pitch (e) equal to or larger than 0.8 mm; it is definitely not suitable for packages with a pitch (e) equal to or smaller than 0.65 mm.
- Wave soldering is only suitable for SSOP and TSSOP 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.

### DEFINITIONS

Data sheet status	
Objective specification	This data sheet contains target or goal specifications for product development.
Preliminary specification	This data sheet contains preliminary data; supplementary data may be published later.
Product specification	This data sheet contains final product specifications.
Limiting values	
Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). 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.	
Application information	
Where application information is given, it is advisory and does not form part of the specification.	

### LIFE SUPPORT APPLICATIONS

These products are not designed for use in life support appliances, devices, or systems where malfunction of these products can reasonably be expected to result in personal injury. Philips customers using or selling these products for use in such applications do so at their own risk and agree to fully indemnify Philips for any damages resulting from such improper use or sale.

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**NOTES**

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**NOTES**

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