DATA SHEET

TJA1050

High speed CAN transceiver

Preliminary specification
File under Integrated Circuits, IC18

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FEATURES

- Fully compatible with the *"ISO 11898"* standard
- High speed (up to 1 Mbaud)
- Transmit Data (TXD) dominant time-out function
- Bus lines protected against transients in an automotive environment
- Silent mode in which the transmitter is disabled
- Differential receiver with wide common-mode range for high ElectroMagnetic Immunity (EMI)
- Input levels compatible with 3.3 V devices
- Thermally protected
- Short-circuit proof to battery and ground
- An unpowered node does not disturb the bus lines
- At least 110 nodes can be connected.

GENERAL DESCRIPTION

The TJA1050 is the interface between the CAN protocol controller and the physical bus. The device provides differential transmit capability to the bus and differential receive capability to the CAN controller.

The TJA1050 is the successor to the PCA82C250 high speed CAN transceiver. The most important improvements are:

- Much lower ElectroMagnetic Emission (EME) due to optimal matching of the CANH and CANL output signals
- Improved behaviour in case of an unpowered node.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{CC}	supply voltage		4.75	5.25	V
V_{CANH}	DC voltage at CANH	0 < V_{CC} < 5.25 V; no time limit	–27	+40	V
V_{CANL}	DC voltage at CANL				
$V_{i(dif)(bus)}$	differential bus input voltage	dominant	1.5	3	V
$t_{PD(TXD-RXD)}$	propagation delay TXD to RXD; see Fig.4	V_S = 0 V	–	250	ns
T_{amb}	operating ambient temperature		–40	+125	°C

ORDERING INFORMATION

TYPE NUMBER	PACKAGE		
	NAME	DESCRIPTION	VERSION
TJA1050T	SO8	plastic small outline package; 8 leads; body width 3.9 mm	SOT96-1
TJA1050U	–	bare die	–

BLOCK DIAGRAM

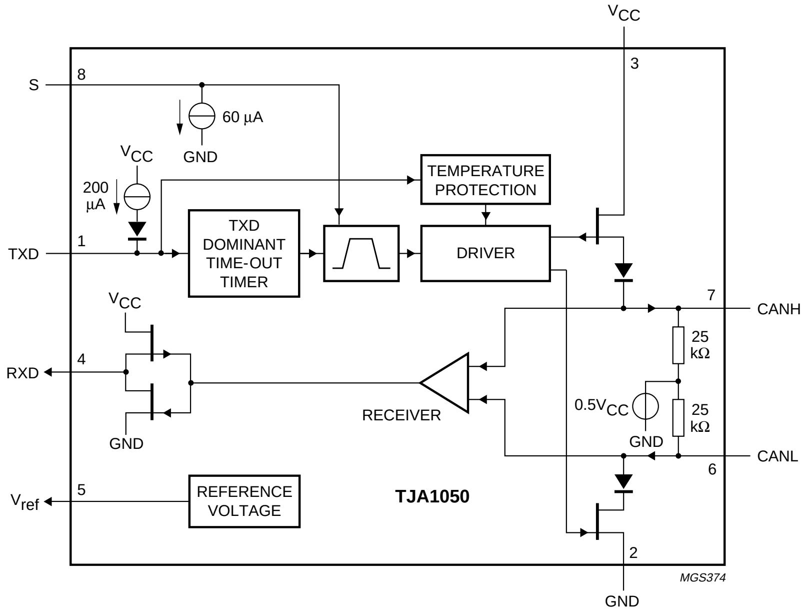


Fig.1 Block diagram.

PINNING

SYMBOL	PIN	DESCRIPTION
TXD	1	transmit data input; reads in data from the CAN controller to the bus line drivers
GND	2	ground
V_{CC}	3	supply voltage
RXD	4	receive data output; reads out data from the bus lines to the CAN controller
V_{ref}	5	reference voltage output
CANL	6	LOW-level CAN bus line
CANH	7	HIGH-level CAN bus line
S	8	select input for high speed mode/silent mode

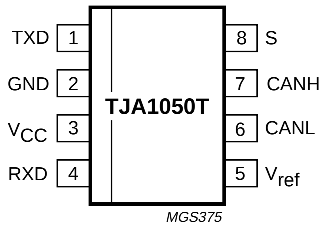


Fig.2 Pin configuration.

FUNCTIONAL DESCRIPTION

The TJA1050 is the interface between the CAN protocol controller and the physical bus. It is primarily intended for high speed automotive applications using baud rates from 40 kbaud up to 1 Mbaud. It provides differential transmit capability to the bus and differential receiver capability to the CAN protocol controller. It is fully compatible to the *“ISO 11898”* standard.

A current-limiting circuit protects the transmitter output stage from damage caused by accidental short-circuit to either positive or negative battery voltage, although power dissipation increases during this fault condition.

A thermal protection circuit protects the IC from damage by switching off the transmitter if the junction temperature exceeds a value of approximately 165 °C. Because the transmitter dissipates most of the power, the power dissipation and temperature of the IC is reduced. All other IC functions continue to operate. The transmitter off-state resets when TXD goes HIGH. The thermal protection circuit is particularly needed when a bus line short-circuits.

The CANH and CANL lines are protected from automotive electrical transients (according to *“ISO 7637”*; see Fig.6) and are also protected from Electro-Static-Discharge (ESD) of up to 4 kV from the human body.

Control line S (pin 8) allows two operating modes to be selected; high speed mode or silent mode.

High speed mode is the normal operating mode and is selected by connecting pin S to ground. It is the default mode if pin S is unconnected.

In the silent mode, the transmitter is disabled. All other IC functions continue to operate. The silent mode is selected by connecting pin S to V_{CC}.

A ‘TXD Dominant Time-out’ timer circuit prevents the bus lines being driven to a permanent dominant state (blocking all network communication) if TXD is forced permanently LOW by a hardware and/or software application failure. The timer is triggered by a negative edge on TXD. If the duration of the LOW-level on TXD exceeds the internal timer value, the transmitter is disabled, driving the bus into a recessive state. The timer is reset by a positive edge on TXD.

Table 1 Function table of the CAN transceiver
(X = don’t care)

V_{CC}	TXD	S	CANH	CANL	BUS STATE	RXD
4.75 to 5.25 V	0	0 (or floating)	HIGH	LOW	dominant	0
4.75 to 5.25 V	X	1	$0.5 \times V_{CC}$	$0.5 \times V_{CC}$	recessive	1
4.75 to 5.25 V	1 (or floating)	X	$0.5 \times V_{CC}$	$0.5 \times V_{CC}$	recessive	1
<2 V (not powered)	X	X	$0 V < CANH < V_{CC}$	$0 V < CANL < V_{CC}$	recessive	X
$2 V < V_{CC} < 4.75 V$	>2 V	X	$0 V < CANH < V_{CC}$	$0 V < CANL < V_{CC}$	recessive	X

LIMITING VALUES

In accordance with the Absolute Maximum Rating System (IEC 134). All voltages are referenced to GND (pin 2). Positive currents flow into the IC.

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{CC}	supply voltage		–0.3	+5.25	V
V_{CANL}, V_{CANH}	DC voltage at CANL and CANH	$0 < V_{CC} < 5.25$ V; no time limit	–27	+40	V
V_{TXD}, V_{RXD}, V_{ref} and V_S	DC voltage at TXD, RXD, V_{ref} and S		–0.3	V_{CC} + 0.3	V
$V_{trt(CANH)}$, $V_{trt(CANL)}$	transient voltage at CANH and CANL	time limit is 1 μs	–55	+55	V
		note 1	–200	+200	V
V_{esd}	electrostatic discharge at CANH; CANL	note 3	–4	+4	kV
	electrostatic discharge at TXD; V_{CC}; RXD; V_{ref} and S	note 3	–2	+2	kV
	electrostatic discharge at all pins	note 4	–200	+200	V
T_{stg}	storage temperature		–55	+150	°C
T_{amb}	operating ambient temperature		–40	+125	°C
T_j	junction temperature	note 2	–40	+150	°C

Notes

1. The waveforms of the applied transients shall be in accordance with *“ISO 7637 part 1”*, test pulses 1, 2, 3a and 3b, (see Fig.6).
2. In accordance with *“IEC 747-1”*. An alternative definition of T_j is: $T_j = T_{amb} + P \times R_{th(j-a)}$, where $R_{th(j-a)}$ is a fixed value to be used for the calculation of T_j. The rating for T_j limits the allowable combinations of power dissipation (P) and ambient temperature (T_{amb}).
3. Human body model; C = 100 pF R = 1.5 kΩ.
4. Machine model; C = 200 pF R = 25 Ω.

THERMAL CHARACTERISTICS

According to IEC 747-1.

SYMBOL	PARAMETER	CONDITIONS	VALUE	UNIT
$R_{th(j-a)}$	thermal resistance from junction to ambient; TJA1050T(SO8)	in free air	160	K/W

QUALITY SPECIFICATION

Quality specification *“SNW-FQ-611 part D”* is applicable.

CHARACTERISTICS

V_{CC} = 4.75 to 5.25 V; T_{amb} = –40 to +125 °C; R_L = 60 Ω unless specified otherwise; all voltages are referenced to GND (pin 2); positive currents flow into the IC; all parameters are guaranteed over the ambient temperature range by design, but only 100% tested at T_{amb} = 25 °C unless specified otherwise.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
Supply (V_{CC})						
I_{CC}	supply current	dominant; V_{TXD} = 0 V	tbf	–	75	mA
		recessive; $V_{TXD} = V_{CC}$	tbf	–	13	mA
Transmitter data input (TXD)						
V_{IH}	HIGH-level input voltage	output recessive	2.0	–	V_{CC} + 0.3	V
V_{IL}	LOW-level input voltage	output dominant	–0.3	–	+0.8	V
I_{IH}	HIGH-level input current	$V_{TXD} = V_{CC}$	–30	0	+30	μA
I_{IL}	LOW-level input current	V_{TXD} = 0 V	–100	–200	–300	μA
$C_{i(TXD)}$	TXD input capacitance	not tested	–	–	tbf	pF
Mode select input (S)						
V_{IH}	HIGH-level input voltage	silent mode	2.0	–	V_{CC} + 0.3	V
V_{IL}	LOW-level input voltage	high speed mode	–0.3	–	+0.8	V
I_{IH}	HIGH-level input current	$V_S = V_{CC}$	30	60	100	μA
I_{IL}	LOW-level input current	V_S = 0 V	–30	0	+30	μA
Receiver data output (RXD)						
I_{OH}	HIGH-level output current	V_{RXD} = 0.7 V_{CC}	tbf	tbf	tbf	mA
I_{OL}	LOW-level output current	V_{RXD} = 0.45 V	2	8.5	20	mA
V_{ref}						
V_{ref}	reference output voltage	–50 μA < I_{Vref} < 50 μA	0.45V_{CC}	0.5V_{CC}	0.55V_{CC}	V
Bus lines (CANH; CANL)						
$V_{CANH(reces)}$; $V_{CANL(reces)}$	recessive bus voltage	$V_{TXD} = V_{CC}$; no load	2.0	–	3.0	V
$I_{o(CANH)(reces)}$; $I_{o(CANL)(reces)}$	recessive output current	–27 V < V_{CANH}, V_{CANL} < 32 V; 0 V < V_{CC} < 5.25 V	–2.5	–	+2.5	mA
$V_{o(CANH)}$	CANH dominant output voltage	V_{TXD} = 0 V	2.8	–	4.5	V
$V_{o(CANL)}$	CANL dominant output voltage		0.5	–	2.0	V
$V_{i(dif)(bus)}$	differential bus input voltage ($V_{CANH} - V_{CANL}$)	V_{TXD} = 0 V; 42.5 < R_L < 60 Ω (dominant)	1.5	–	3.0	V
		$V_{TXD} = V_{CC}$; no load (recessive)	–500	–	+50	mV
$I_{o(sc)(CANH)}$	CANH short-circuit output current	V_{CANH} = 0 V; V_{TXD} = 0 V	–35	–	–95	mA
$I_{o(sc)(CANL)}$	CANL short-circuit output current	V_{CANL} = 36 V; V_{TXD} = 0 V	35	–	150	mA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$V_{dif(th)}$	differential receiver threshold voltage	–12 V < $V_{CANH,}$ V_{CANL} < 12 V; see Fig.5	0.5	0.7	0.9	V
$V_{i(dif)(hys)}$	differential receiver input voltage hysteresis	see Fig.5	100	–	200	mV
$R_{i(cm)(CANH)}$; $R_{i(cm)(CANL)}$	CANH; CANL common mode input resistance		10	25	50	kΩ
$R_{i(cm)(m)}$	matching between CANH and CANL common mode input resistance	$V_{CANH} = V_{CANL}$	–3	–	+3	%
$R_{i(dif)}$	differential input resistance		20	50	100	kΩ
$C_{i(CANH)}$; $C_{i(CANL)}$	CANH; CANL input capacitance	$V_{TXD} = V_{CC}$; not tested	–	–	20	pF
$C_{i(dif)}$	differential input capacitance		–	–	10	pF
$I_{LI(CANH)}$; $I_{LI(CANL)}$	CANH; CANL input leakage current	V_{CC} = 0 V; $V_{CANH} = V_{CANL}$ = 5 V	–	–	500	µA
Thermal shutdown						
$T_{j(sd)}$	shutdown junction temperature		155	165	180	°C
Timing characteristics (see Figs 3 and 4)						
$t_{d(TXD-BUSon)}$	delay TXD to bus active	V_S = 0 V	tbf	tbf	150	ns
$t_{d(TXD-BUSoff)}$	delay TXD to bus inactive					
$t_{d(BUSon-RXD)}$	delay bus active to RXD		tbf	tbf	100	ns
$t_{d(BUSoff-RXD)}$	delay bus inactive to RXD					

TEST AND APPLICATION INFORMATION

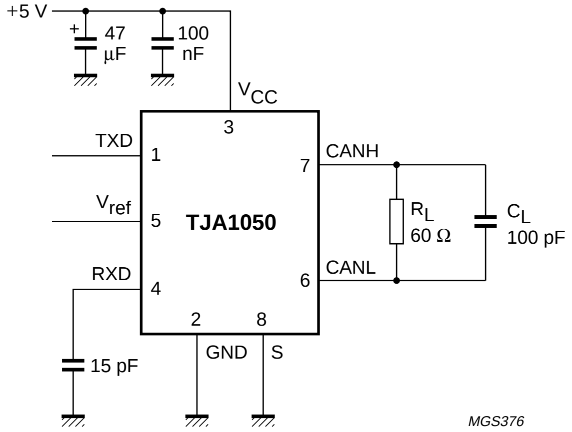
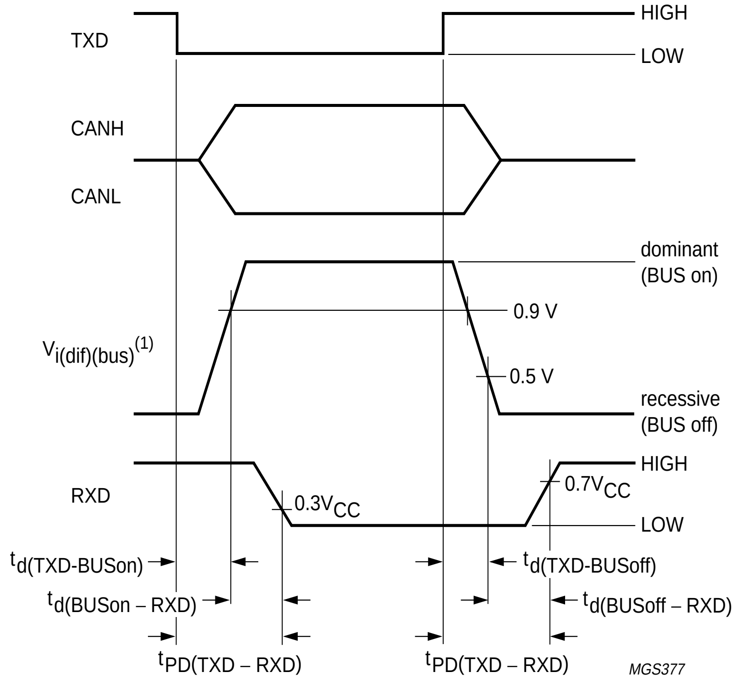


Fig.3 Test circuit for timing characteristics.



(1) $V_{i(dif)(bus)} = V_{CANH} - V_{CANL}$

Fig.4 Timing diagram for AC characteristics.

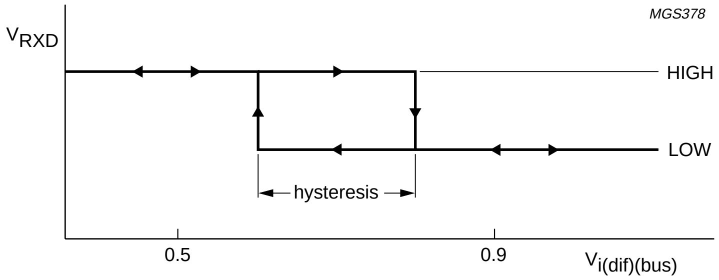
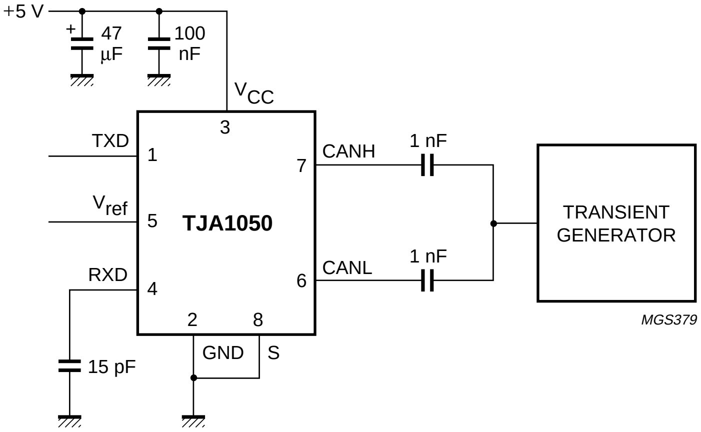


Fig.5 Hysteresis of the receiver.



The waveforms of the applied transients shall be in accordance with *“ISO 7637 part 1”*, test pulses 1, 2, 3a and 3b.

Fig.6 Test circuit for automotive transients.

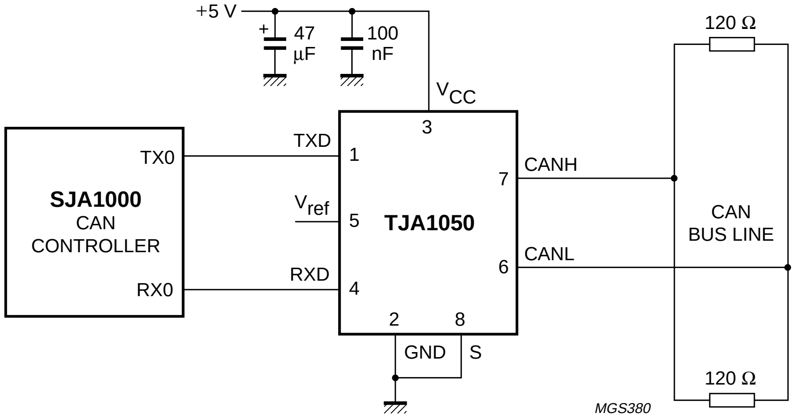


Fig.7 Application information.

BONDING PAD LOCATIONS FOR TJA1050U

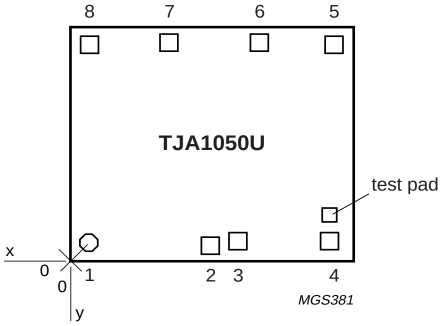


Fig.8 Bonding pad locations.

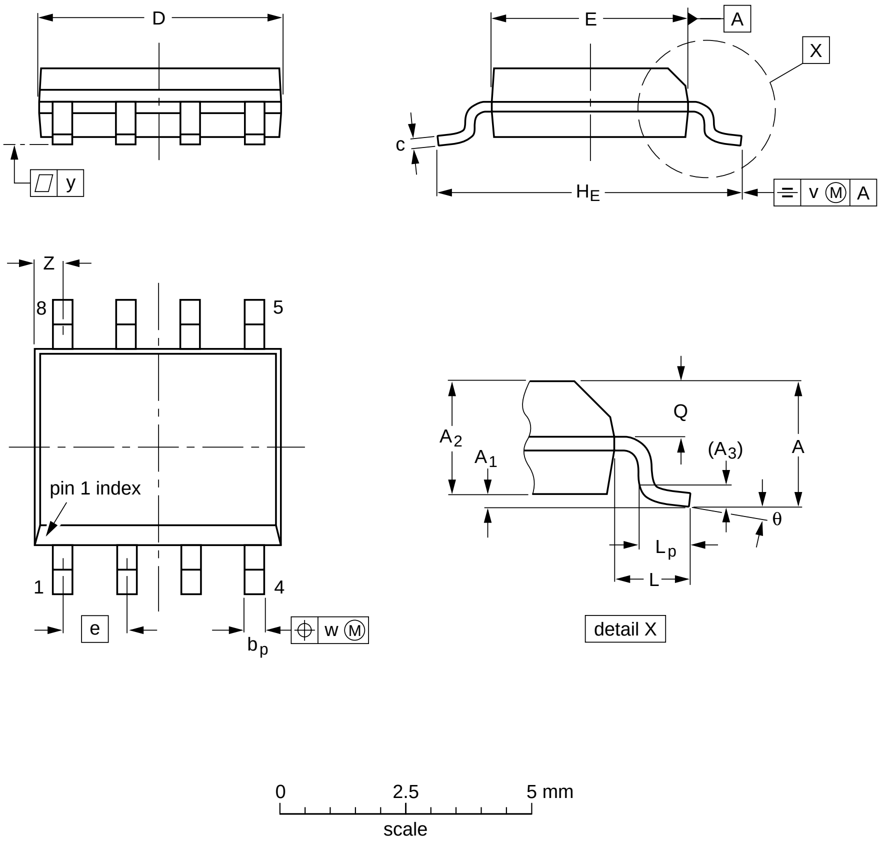
Table 2 Bonding pad locations

All x/y coordinates represent the position of the centre of each pad (in µm) with respect to x/y = 0 of the die (see Fig.8).

SYMBOL	PAD	COORDINATES	
		x	y
TXD	1	103	103
GND	2	740.5	85
V_{CC}	3	886.5	111
RXD	4	1371.5	111
V_{ref}	5	1394	1094
CANL	6	1006	1111
CANH	7	542.5	1111
S	8	103	1097

PACKAGE OUTLINE

SO8: plastic small outline package; 8 leads; body width 3.9 mm SOT96-1



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

UNIT	A max.	A_1	A_2	A_3	b_p	c	$D^{(1)}$	$E^{(2)}$	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	5.0 4.8	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	0.20 0.19	0.16 0.15	0.050	0.244 0.228	0.041	0.039 0.016	0.028 0.024	0.01	0.01	0.004	0.028 0.012	

Notes

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

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT96-1	076E03S	MS-012AA				~~95-02-04~~ 97-05-22

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 preferable 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.

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

PACKAGE	SOLDERING METHOD	
	WAVE	**REFLOW**(1)
BGA, SQFP	not suitable	suitable
HLQFP, HSQFP, HSOP, HTSSOP, SMS	not suitable(2)	suitable
PLCC(3), SO, SOJ	suitable	suitable
LQFP, QFP, TQFP	not recommended(3)(4)	suitable
SSOP, TSSOP, VSO	not recommended(5)	suitable

Notes

1. 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”*.
2. 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).
3. 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.
4. 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.
5. 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.	

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