TEA1761T

GreenChip™ Synchronous rectifier for flyback

Rev. 08 — January 26, 2006 Objective data sheet

1. General description

The TEA1761 is a member of the new generation of synchronous rectifier controller ICs for switched mode power supplies. Its high level of integration allows the design of a cost effective power supply with a very low number of external components.

The TEA1761 is a controller IC dedicated for synchronous rectification on the secondary side of discontinuous conduction mode and quasi resonant flyback converters. Besides electronics for synchronous rectification, also circuitry for output voltage and output current regulation is integrated.

The TEA1761 is fabricated in a Silicon On Insulator process. This Philips SOI process makes a wide voltage range possible.

2. Features

2.1 Distinctive features

- Wide supply voltage range(8.5 V to 38 V)
- High level of integration, resulting in a very low external component count
- Wide opto output voltage range (3.5V to 38V)
- Accurate internal voltage reference for voltage control (within 1%)
- High driver output voltage of 10V to drive all MOSFET brands to the lowest RdsOn

2.2 Green features

- Low current consumption
- High system efficiency from no load to full load

2.3 Protection features

- Under voltage protection
- Internal over temperature protection

3. Applications

The TEA1761 is intended for adapters. The device can also be used in all other discontinuous conduction mode and quasi resonant flyback systems that demand a high efficient and cost-effective solution.

PHILIPS

4. Ordering information

Table 1: Ordering information

Type number	Package		
	Name	**Description**	**Version**
TEA1761T	SO8	plastic small outline package; 8 leads; body width 3.9 mm	SOT96-1

5. Block diagram

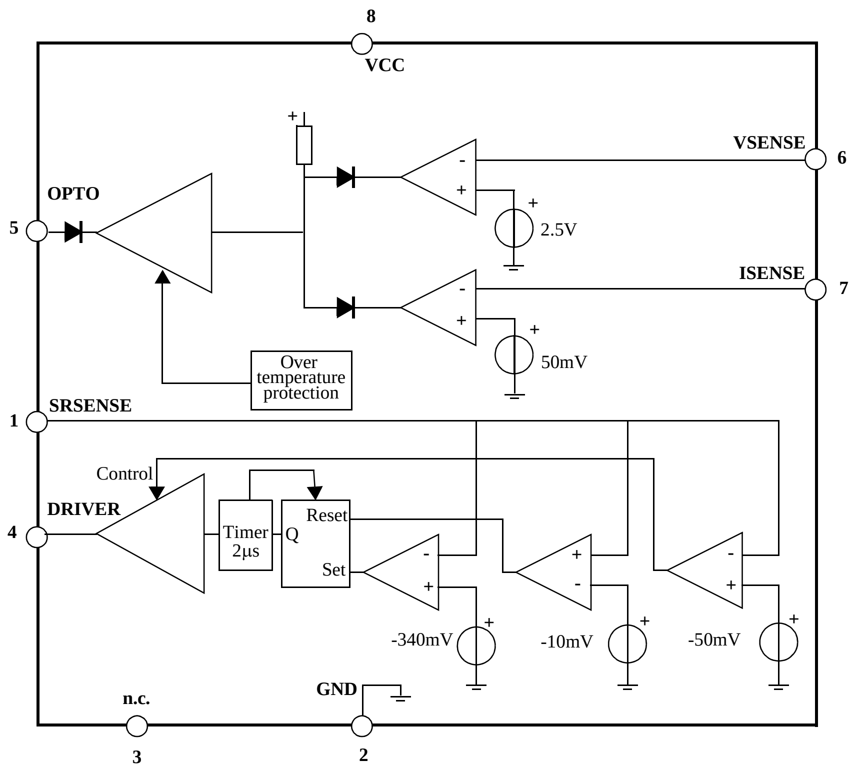


Fig 1. Block diagram.

6. Pinning information

6.1 Pinning

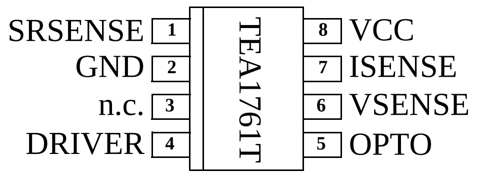


Fig 2. Pin configuration: TEA1761T (SOT96-1).

6.2 Pin description

Table 2: Pin description SO-14

Symbol	Pin	Description
SRSENSE	1	synchronous timing input
GND	2	ground
n.c.	3	not connected
DRIVER	4	driver output for SR MOSFET
OPTO	5	opto coupler driver output
VSENSE	6	sense input for voltage control
ISENSE	7	sense input for current control
VCC	8	supply voltage

7. Functional description

The TEA1761 is the controller for synchronous rectification to be used in discontinuous current mode and quasi resonant flyback converters. Besides control of the SR MOSFET, the TEA1761 contains the voltage reference and amplifiers to regulate and control the output voltage and current of the power supply.

7.1 Start-up and undervoltage lock out

The IC will activate the synchronous rectifier circuitry and the voltage/current sense circuitry as soon as the voltage on the VCC pin is above 8.6V (typ.). As soon as the voltage drops below 8.1V (typ.), the SR driver output is actively kept low and the opto driver output is disabled.

7.2 Synchronous rectification

After a negative voltage (-340mV typ.) is sensed on the SRSENSE pin, the driver output voltage is made high and the external MOSFET is switched on. As soon as the SRSense voltage rises to -50mV, the driver output voltage is regulated to maintain the -50mV on the SRSense pin. As soon as the SRSENSE voltage is above -12mV, the driver output is pulled to ground. After switch-on of the SR MOSFET, the input signal on the SRSENSE pin is blanked for 2usec (typ.). This will eliminate false switch-off due to high frequency ringing at the start of the secondary stroke.

Because the driver output voltage is reduced as soon as the voltage on the SRSENSE pin is -50mV, the external power switch can be switched off fast when the current through the switch reaches zero. With this zero-current switch off, no separate standby mode is needed to maintain high efficiency during no-load operation. The zero current is sensed by sensing a -12mV level on the SRSENSE pin. see Figure 3.

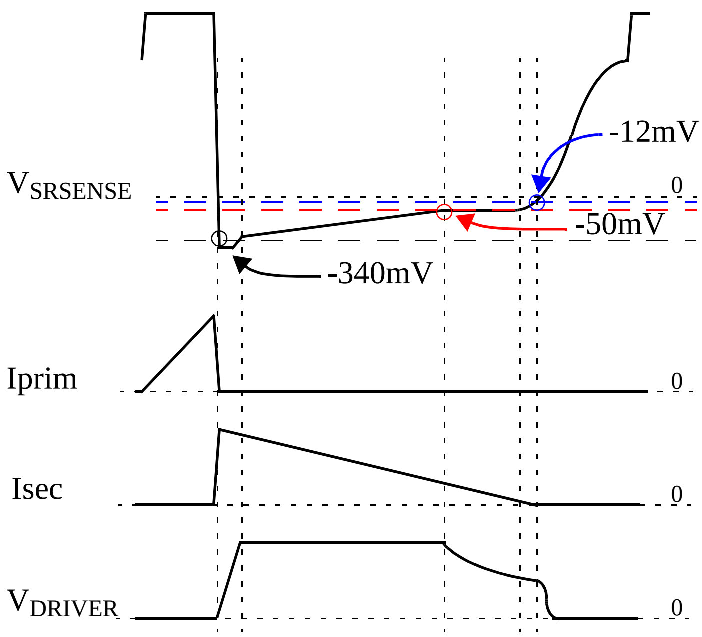


Fig 3. Synchronous rectification signals

If the secondary stroke of the flyback converter is shorter than 2usec (typ.), the driver output is disabled. This will guarantee stable operation for very low duty cycles.

7.3 SMPS output voltage and current regulation

The output voltage of the flyback SMPS can be controlled by sensing the output voltage via the VSENSE pin. The feedback loop via the primary controller can regulate the output voltage of the switched mode power supply by regulating the voltage on the VSENSE pin to 2.5V.

Also the output current of the flyback SMPS can be controlled or limited. The voltage on the ISENSE pin is regulated or limited to 50mV above the voltage on pin GND.

7.4 Opto output

The opto output has a open drain output configuration. The maximum sink current is internally limited to 5mA (typ.). The output is linear controlled via the VSENSE and ISENSE input pins. An over temperature situation will switch the opto output to its maximum sink current.

During start-up (V_{CC}<$V_{CC,start}$) and under voltage lock-out the output is disabled.

7.5 Supply management

All (internal) reference voltages are derived from a temperature compensated, on-chip band gap circuit. The reference voltage is trimmed to an accuracy within 1%.

7.6 OverTemperature Protection (OTP)

The IC provides an accurate internal over temperature protection of 150deg.C. (typ.). The IC will maximize current of pin OptoProt as soon as the internal temperature limit is reached. The opto signal can be used on the primary side of the flyback controller to activate the SMPS protection or limit the output power. As soon as the over temperature condition is solved, normal operation will resume.

7.7 Driver

The driver circuit to the gate of the external power MOSFET has a source capability of typically 380 mA and a sink capability of typically 2.2 A. This permits fast turn-on and turn-off of the power MOSFET for efficient operation. The output voltage of the driver is limited to 10V (typ.). This high output voltage will drive all MOSFET brands to the minimum on-state resistance.

During start-up conditions (V_{CC}<$V_{CC,start}$) and under voltage lock-out the driver output voltage is actively pulled low.

8. Limiting values

Table 3: Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134). All voltages are measured with respect to ground (pin 2); positive currents flow into the chip. The voltage ratings are valid provided other ratings are not violated; current ratings are valid provided the other ratings are not violated.

Symbol	Parameter	Conditions	Min	Max	Unit
Voltages					
V_{VCC}	supply voltage	continuous	–0.4	+38	V
V_{OPTO}	voltage on pin OPTO	continuous	–0.4	+38	V
$V_{SRSENSE}$	voltage on pin SRSENSE	continuos	-	+120	V
V_{VSENSE}	voltage on pin VSENSE	continuous	–0.4	+5	V
V_{ISENSE}	voltage on pin ISENSE		–0.4	+5	V
Currents					
I_{OPTO}	OPTO pin current		-	+12	mA
I_{DRIVER}	DRIVER pin current	d < 10 %	–0.8	+3	A
$I_{SRSENSE}$	SRSense pin current		–3		mA
General					
P_{tot}	total power dissipation	T_{amb} < 80 °C	-	0.45	W

Table 3: Limiting values *…continued*

In accordance with the Absolute Maximum Rating System (IEC 60134). All voltages are measured with respect to ground (pin 2); positive currents flow into the chip. The voltage ratings are valid provided other ratings are not violated; current ratings are valid provided the other ratings are not violated.

Symbol	Parameter	Conditions		Min	Max	Unit
T_{stg}	storage temperature			–55	+150	°C
T_j	junction temperature			–20	+150	°C
ESD						
V_{ESD}	electrostatic discharge voltage	class 1				
	human body model	pins 2 to 8	[1]	-	2000	V
		pin 1	[1]	-	1500	V
	machine model		[2]	-	200	V

[1] Equivalent to discharging a 100 pF capacitor through a 1.5 kΩ series resistor.

[2] Equivalent to discharging a 200 pF capacitor through a 0.75 μH coil and a 10 Ω resistor.

9. Thermal characteristics

Table 4: Thermal characteristics

Symbol	Parameter	Conditions	Typ	Unit
$R_{th(j-a)}$	thermal resistance from junction to ambient	in free air	150	K/W

10. Characteristics

Table 5: Characteristics

T_{amb} = 25 °C; V_{CC} = 20 V; all voltages are measured with respect to ground (pin 2); currents are positive when flowing into the IC; unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
Supply voltage management (pin V_{CC})						
V_{start}	start-up voltage		8.35	8.6	8.85	V
$V_{CC,hyst}$	hysteresis on V_{start}			0.5		V
V_{hys}	hysteresis V_{start}-V_{UVLO}		0.42	0.52	0.62	V
I_{oper}	supply current at V_{CC}<V_{start}	V_{CC}=8V	0.85	1	1.2	mA
I_{oper}	supply current under normal operation	no load on pin DRIVER	-	1.23	-	mA
Synchronous rectification sense input (pin SRSENSE)						
$V_{th(Driver)}$	Driver activation level		–370	–340	–310	mV
$V_{reg(Driver)}$	Driver regulation level		–60	–50	–40	mV
$V_{off(Driver)}$	Driver deactivation level			–12		mV
t_{delay}	delay driver activation		-	350	-	ns
t_{timer}	blanking time and minimum SR active time		1.5	2	2.5	μs
Driver (pin DRIVER)						
I_{source}	source current	V_{CC} > 9.5 V; V_{DRIVER} = 2 V	–0.42	–0.38	–0.35	A

Table 5: Characteristics *…continued*

T_{amb} = 25 °C; V_{CC} = 20 V; all voltages are measured with respect to ground (pin 2); currents are positive when flowing into the IC; unless otherwise specified.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
I_{sink}	sink current	V_{CC} > 9.5 V;				
		V_{DRIVER} = 2 V	-	0.5	-	A
		V_{DRIVER} = 9.5 V	2.0	2.2	2.4	A
$V_{o(max)}$	maximum output voltage	V_{CC} > 12 V	-	10	12	V
Opto output (pin OPTO)						
$I_{opto(max)}$	maximum opto output current	U_{OPTO}>5V	4.25	5	12	mA
$U_{opto(min)}$	minimum opto output voltage	I_{OPTO}=4mA	-	-	3.5	V
Voltage sense (pin VSENSE)						
$V_{sense(reg)}$	Vsense regulation level		2.475	2.5	2.525	V
I_{Vsense}	Input current Vsense pin	Vsense=2.5V	-200	0	200	nA
S_{VSENSE}	Transconductance V_{VSENSE} to I_{OPTO}		-	40	-	A/V
G_{BW}	Unity gain bandwidth	R_{load}=1kohm	1			MHz
Current sense (pin ISENSE)						
$V_{Isense(reg)}$	Isense pin regulation level		46	50	54	mV
$I_{Isense(reg)}$	Input current Vsense pin	V_{Isense}=50mV	-200	0	200	nA
S_{ISENSE}	Transconductance V_{ISENSE} to I_{OPTO}		-	15	-	A/V
G_{BW}	Unity gain bandwidth	R_{load}=1kohm	1	-	-	MHz
Temperature protection						
$T_{prot(max)}$	maximum temperature protection level		144	150	156	°C
$T_{prot(hyst)}$	hysteresis for the temperature protection level		-	12	-	°C

11. Application information

A switched mode power supply with the TEA1761 consists of a primary side discontinuous conduction mode flyback controller, a transformer, and an output stage with a feedback circuit. In the output stage a MOSFET (Qsec) is used for low conduction losses. The MOSFET is controlled by the TEA1761. The output voltage and/or current is also controlled by the TEA1761 via the opto coupler connection to the primary side. See Figure 4

The output voltage is set by resistors Rfb1 and Rfb2. The output current is controlled by the resistor Risense. The timing for the synchronous rectifier switch is derived from the voltage sensed on the SRSENSE pin. The resistor in the SRSENSE connection is needed to protect the TEA1761 from excessive voltages. The SRSense resistor should typically be 1kohm. Higher values might impair correct timing, lower values may not provide sufficient protection.

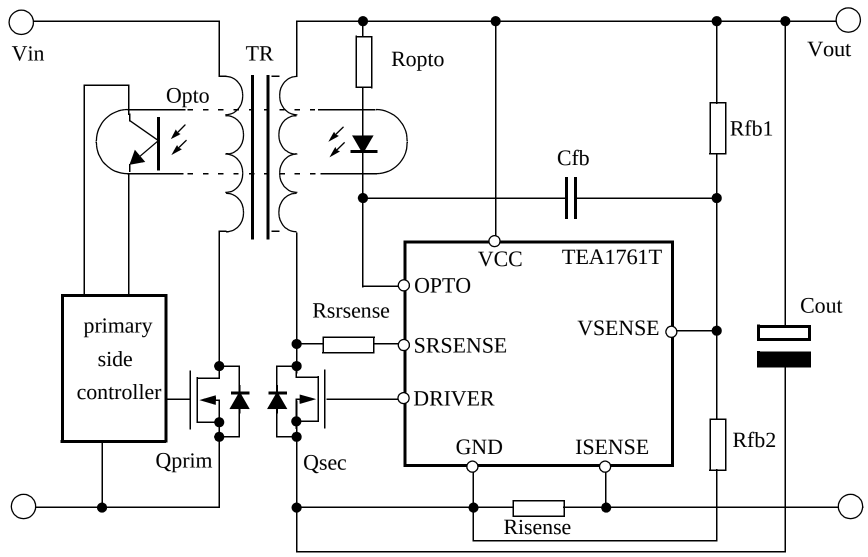


Fig 4. Application example TEA1761T

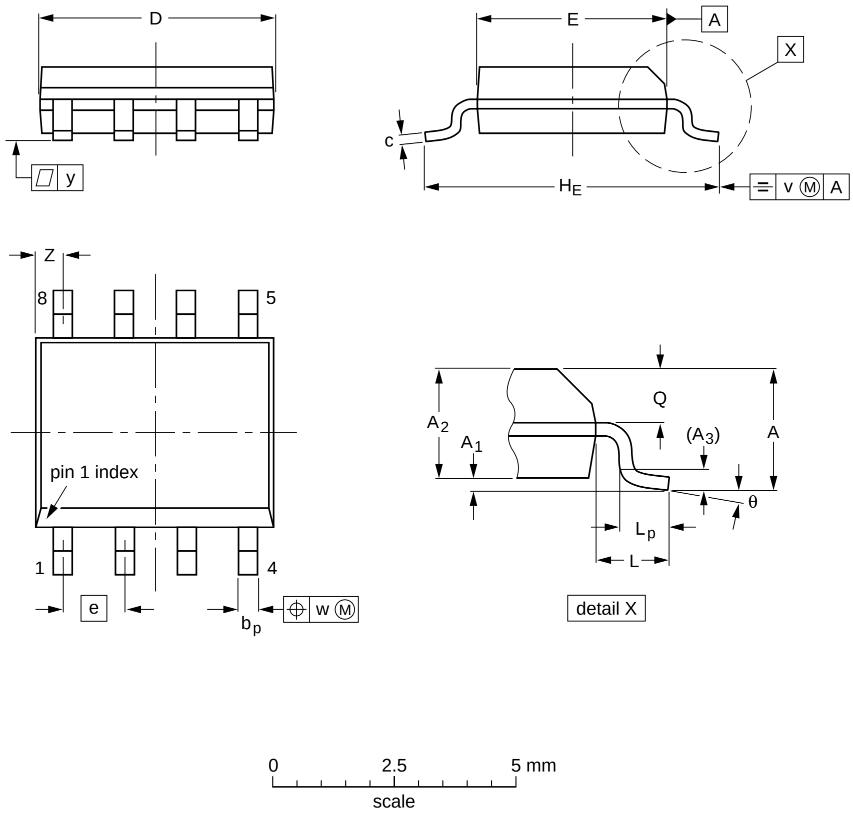
12. Test information

12.1 Quality information

The *General Quality Specification for Integrated Circuits, SNW-FQ-611* is applicable.

13. 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^o 0^o
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	0.05	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 (0.006 inch) maximum per side are not included.
2. 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			
SOT96-1	076E03	MS-012				~~99-12-27~~ 03-02-18

Fig 5. Package outline.

14. Soldering

14.1 Introduction

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 IC packages. Wave soldering is often preferred when through-hole and surface mount components are mixed on one printed-circuit board. 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. Driven by legislation and environmental forces the worldwide use of lead-free solder pastes is increasing.

14.2 Through-hole mount packages

14.2.1 Soldering by dipping or by solder wave

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.

The total contact time of successive solder waves must not exceed 5 seconds.

The device may be mounted up to the seating plane, but the temperature of the plastic body must not exceed the specified maximum storage temperature ($T_{stg(max)}$). If the printed-circuit board has been pre-heated, forced cooling may be necessary immediately after soldering to keep the temperature within the permissible limit.

14.2.2 Manual soldering

Apply the soldering iron (24 V or less) to the lead(s) of the package, either below the seating plane or not more than 2 mm above it. If the temperature of the soldering iron bit is less than 300 °C it may remain in contact for up to 10 seconds. If the bit temperature is between 300 and 400 °C, contact may be up to 5 seconds.

14.3 Surface mount packages

14.3.1 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, 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 225 °C (SnPb process) or below 245 °C (Pb-free process)
  - for all the BGA and SSOP-T 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 240 °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.

14.3.2 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.

14.3.3 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.

14.4 Package related soldering information

Table 6: Suitability of IC packages for wave, reflow and dipping soldering methods

Mounting	Package [1]	Soldering method		
		Wave	Reflow [2]	Dipping
Through-hole mount	DBS, DIP, HDIP, RDBS, SDIP, SIL	suitable [3]	–	suitable
Through-hole-surface mount	PMFP [4]	not suitable	not suitable	–
Surface mount	BGA, LBGA, LFBGA, SQFP, SSOP-T [5], TFBGA, VFBGA	not suitable	suitable	–
	DHVQFN, HBCC, HBGA, HLQFP, HSQFP, HSOP, HTQFP, HTSSOP, HVQFN, HVSON, SMS	not suitable [6]	suitable	–
	PLCC [7], SO, SOJ	suitable	suitable	–
	LQFP, QFP, TQFP	not recommended [7] [8]	suitable	–
	SSOP, TSSOP, VSO, VSSOP	not recommended [9]	suitable	–

[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] For SDIP packages, the longitudinal axis must be parallel to the transport direction of the printed-circuit board.

[4] Hot bar soldering or manual soldering is suitable for PMFP packages.

[5] These transparent plastic packages are extremely sensitive to reflow soldering conditions and must on no account be processed through more than one soldering cycle or subjected to infrared reflow soldering with peak temperature exceeding 217 °C ± 10 °C measured in the atmosphere of the reflow oven. The package body peak temperature must be kept as low as possible.

[6] 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.

[7] 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.

[8] Wave soldering is suitable for LQFP, QFP and TQFP 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.

[9] Wave soldering is 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.

15. Revision history

Table 7: Revision history

Document ID	Release date	Data sheet status	Change notice	Order number	Supersedes
TEA1761_1	not released	Objective data	-	-	-

16. 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.
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[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.

17. 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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21. Contents

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