DATA SHEET

UBA2007
Charge switch

Product specification

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Philips
Semiconductors

PHILIPS

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1 FEATURES

- Very low ohmic charge switch (0.25 Ω) with soft switching and adjustable current limitation
- Very low ohmic reverse switch (0.25 Ω) with built-in current limitation
- 130 mA pre-charge current
- Battery overvoltage and undervoltage protection
- Charger overvoltage protection of up to +20 V and reverse polarity protection down to −20 V
- On-chip thermal protection
- Charger detection
- Built-in current sensing
- Small 3 × 3 mm HVSON10 package with excellent thermal properties
- The UBA2007 is qualified according to the IEC 61000-4-2 standard for ESD performance.

2 APPLICATIONS

- Charging circuits.

3 GENERAL DESCRIPTION

The UBA2007 is an intelligent charge switch IC for pulse mode charging applications. With its integrated low ohmic power switch it is designed for charging of 1-cell Li-Ion or 3-cell NiMH batteries in either a pre-charge or fast charge mode. The reverse mode of the UBA2007 allows the supply of accessories connected to the charger pin. Several integrated safety mechanisms such as current limitation, overvoltage protection, thermal protection and ESD guarantee fail-safe operation.

4 ORDERING INFORMATION

TYPE NUMBER	PACKAGE		
	NAME	DESCRIPTION	VERSION
UBA2007TK/N2	HVSON10	plastic thermal enhanced very thin small outline package; no leads; 10 terminals; body 3 × 3 × 0.85 mm	SOT650-1

5 BLOCK DIAGRAM

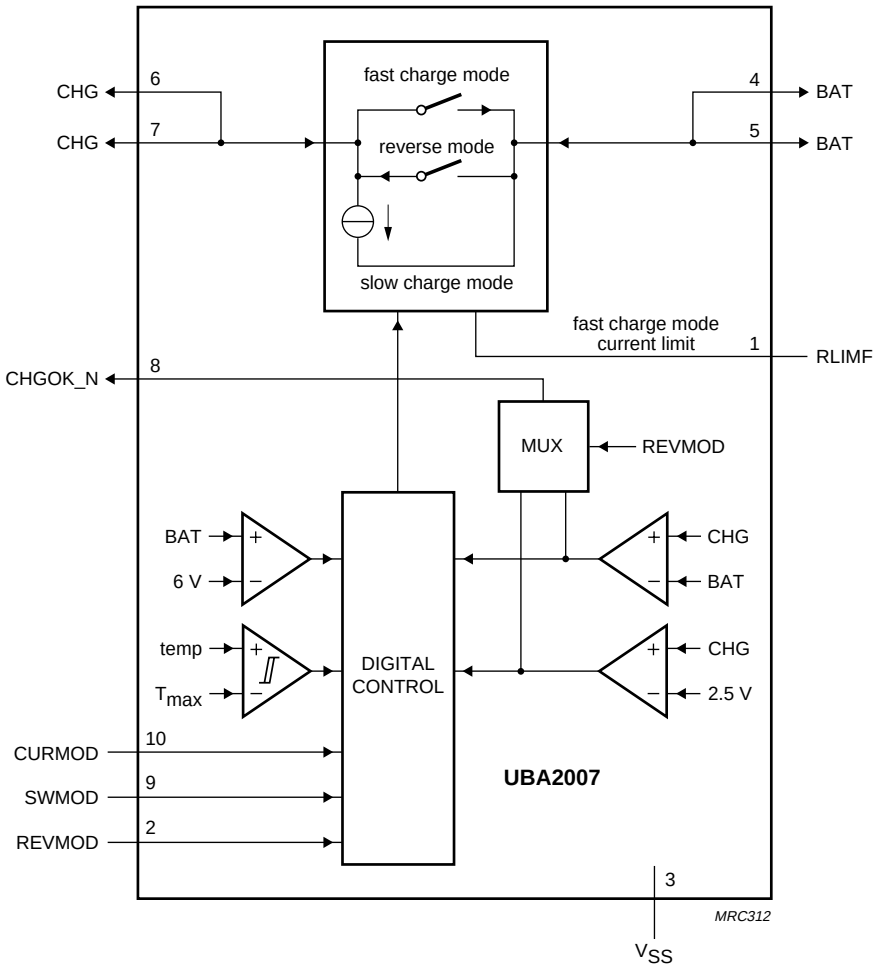
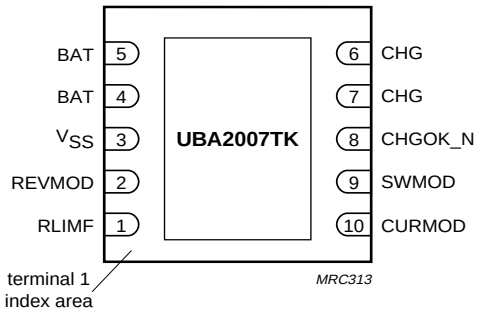


Fig.1 Block diagram.

6 PINNING

SYMBOL	PIN	DESCRIPTION
RLIMF	1	FAST CHARGE mode current limiting resistor; output current source
REVMOD	2	REVERSE mode control; see Table 1 for operating modes; digital input
V_{SS}	3	ground
BAT	4	battery pin; power input/output
BAT	5	battery pin; power input/output
CHG	6	charger input/REVERSE mode output; power input/output
CHG	7	charger input/REVERSE mode output; power input/output
CHGOK_N	8	charger detection output; if REVMOD is LOW, the output is in high-impedance state when $V_{CHG} < 2.5$ V; if REVMOD is HIGH the output is in high-impedance state when $V_{CHG} < V_{BAT}$; open drain output
SWMOD	9	PWM mode input; see Table 1 for operating modes; digital input 160 kΩ pull-down
CURMOD	10	charge mode input; see Table 1 for operating modes; digital input 160 kΩ pull-down



This diagram is a bottom view

For mechanical specification of HVSON10 package, see Chapter 12.

Fig.2 Pin configuration.

7 FUNCTIONAL DESCRIPTION

7.1 Control

The functionality of the UBA2007 is determined by the state of the three digital control signals and the status of the protection circuits as shown in Table 1. The digital control signals CURMOD and SWMOD have an internal pull-down resistor to define the state of the input pins when the controlling circuit is not operational.

Table 1 UBA2007 operation state as function of the digital control signals; note 1

CUR MOD	SW MOD	REV MOD	HIGH TEMP	HIGH BAT	CHGOK_N	V_{BAT} > 3.1 V	MODE	FUNCTION	CURRENT DIRECTION(2)
X	X	X	yes	X	X	X	SHUTDOWN	switch high ohmic	none
X	X	X	X	yes	X	X	SHUTDOWN	switch high ohmic	none
X	X	L	no	no	H	X	OFF	switch high ohmic	none
L	L	L	no	no	X	X	OFF	switch high ohmic	none
H	L	L	no	no	L	X	SLOW CHARGE	current source	charger to battery
L	H	L	no	no	L	X	FAST CHARGE	switch low ohmic	charger to battery
H	H	L	no	no	L	X	SLOW and FAST CHARGE	switch low ohmic	charger to battery
L	L	H	no	no	X	yes	REVERSE	switch low ohmic	battery to charger
L	L	H	no	no	X	no	SHUTDOWN	switch high ohmic	none
H	L	H	no	no	L	X	REVERSE and SLOW CHARGE	current source	charger to battery
H	L	H	no	no	H	yes	REVERSE and SLOW CHARGE	switch low ohmic	battery to charger
H	L	H	no	no	H	no	REVERSE and SLOW CHARGE	switch high ohmic	none
L	H	H	no	no	L	X	REVERSE and FAST CHARGE	switch low ohmic	charger to battery
L	H	H	no	no	H	yes	REVERSE and FAST CHARGE	switch low ohmic	battery to charger
L	H	H	no	no	H	no	REVERSE and FAST CHARGE	switch high ohmic	none

CUR MOD	SW MOD	REV MOD	HIGH TEMP	HIGH BAT	CHGOK_N	V_{BAT} > 3.1 V	MODE	FUNCTION	CURRENT DIRECTION(2)
H	H	H	no	no	L	X	REVERSE and SLOW and FAST CHARGE	switch low ohmic	charger to battery
H	H	H	no	no	H	yes	REVERSE and SLOW and FAST CHARGE	switch low ohmic	battery to charger
H	H	H	no	no	H	no	REVERSE and SLOW and FAST CHARGE	switch high ohmic	none

Notes

1. X = don't care;
   L = LOW voltage level;
   H = HIGH voltage level.
2. Currents in the other direction are blocked.

7.2 OFF mode

In the OFF mode the current path between charger and battery is fully switched off. In addition all internal circuitry is switched off. The battery is not loaded by the UBA2007 in this situation.

The OFF mode is entered if:

- SWMOD, CURMOD and REVMOD are LOW.
- REVMOD is LOW and CHGOK_N is HIGH.

7.3 SHUTDOWN mode

The SHUTDOWN mode corresponds to switching off the charging path between the pins BAT and CHG. The circuit will enter the SHUTDOWN mode in the following cases:

- Overvoltage detected on pin BAT
- Undervoltage detected on pin BAT while in REVERSE mode
- Overheat detected on the die.

In the case of overvoltage shutdown, the state is latched internally and can be reset only by disconnecting the charger wall plug.

7.4 SLOW CHARGE mode

In the SLOW CHARGE mode a constant current is applied to the battery. SLOW CHARGE mode is entered when the SWMOD and REVMOD input pins are made LOW, pin CURMOD is HIGH, the charger input voltage is at least 2.5 V and $V_{CHG} > V_{BAT}$.

The SLOW CHARGE mode is stopped when the voltage on the BAT pin increases above the maximum battery voltage or when a too high die temperature occurs.

7.5 FAST CHARGE mode

In the FAST CHARGE mode the switch (see Fig.1) is turned on slowly by the internal circuitry. The FAST CHARGE mode is entered when the SWMOD input signal is HIGH.

The current through the switch is monitored by the current limiting circuit. When this current exceeds the predefined current limit, it is kept constant by reducing the drive voltage of the switch.

The current limit is adjustable, from 50 mA to 2 A, through an external resistor connected to the RLIMF pin. The voltage on RLIMF is proportional to the current flowing through the switch (see Section 11.3).

The FAST CHARGE mode is stopped when the voltage on the BAT pin increases above the maximum battery voltage or when a too high die temperature occurs.

Attention: RLIMF cannot trim the current limit while in SLOW CHARGE or REVERSE modes.

Remark: The dissipation inside the UBA2007 will increase strongly when the current limitation is activated, this might lead to activation of the thermal protection.

7.6 REVERSE mode

The REVERSE mode switch is activated when the REVMOD input is pulled HIGH.

The current through the REVERSE mode switch is monitored by the current limiting circuit. This current limiting circuit reduces the drive voltage for the REVERSE mode switch when the current exceeds the set current limit resulting in a constant current behaviour of the REVERSE mode switch.

When V_{BAT} < 2.7 V the REVERSE mode is automatically disabled and the UBA2007 returns to SHUTDOWN mode (see Fig.3).

Remark: The dissipation inside the UBA2007 will increase strongly when the current limitation is activated, this might lead to activation of the thermal protection.

7.7 REVERSE and SLOW CHARGE mode

The REVERSE and SLOW CHARGE mode corresponds to the SLOW CHARGE mode if a charger is connected to pin CHG. When no charger is present, this mode is equivalent to the REVERSE mode.

7.8 REVERSE and FAST CHARGE mode

The REVERSE and FAST CHARGE mode corresponds to the FAST CHARGE mode if a charger is connected to pin CHG. When no charger is present, this mode is equivalent to the REVERSE mode. When the current flows from the charger to the battery, the current limit can be adjusted from 50 mA to 2 A, using the external resistor R_{RLIMF}.

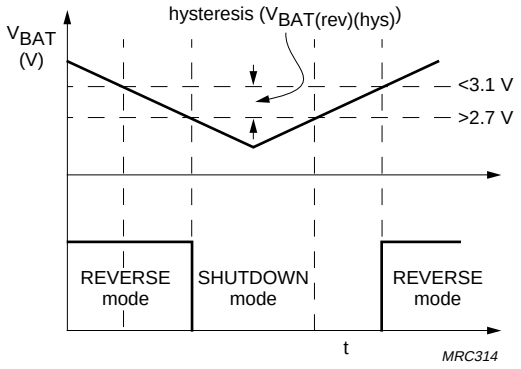


Fig.3 Reverse mode behaviour as a function of V_{BAT}.

8 LIMITING VALUES

In accordance with the Absolute Maximum Rating System (IEC 60134).

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{CHG}	charger input voltage		–20	+20	V
V_{BAT}, V_{RLIMF}	battery input voltage and voltage on pin RLIMF		–0.5	+6	V
$I_{BAT(max)}$, $I_{CHG(max)}$	maximum current through pins BAT and CHG		–	2.5	A
V_{CURMOD}, V_{SWMOD}, V_{REVMOD}, V_{CHGOK_N}	voltage on pins CURMOD, SWMOD, REVMOD and CHGOK_N		–0.5	+5	V
I_I	input current at any input		–10	+10	mA
I_O	output current at any output		–10	+10	mA
T_{amb}	ambient temperature		–40	+85	°C
T_{stg}	storage temperature		–55	+150	°C
V_{esd}	electrostatic discharge voltage	JEDEC standard class 2; all pins			
		HBM; note 1	–	±2500	V
		MM; note 2	–	±200	V
		IEC 61000-4-2 standard; pins BAT and CHG			
		CD (LVL2); note 3	–	±4000	V
		AD (LVL3); note 4	–	±8000	V

Notes

1. Human Body Model: equivalent to discharging a 100 pF capacitor via a 1.5 kΩ resistor.
2. Machine model: equivalent to discharging a 200 pF capacitor via a 0 Ω resistor.
3. Contact Discharge (Level 2): equivalent to discharging, through contact, a 150 pF capacitor via a 330 Ω resistor.
4. Air Discharge (Level 3): equivalent to discharging, through the air, a 150 pF capacitor via a 330 Ω resistor.

9 THERMAL CHARACTERISTICS

SYMBOL	PARAMETER	CONDITIONS	VALUE	UNIT
$R_{th(j-c)}$	thermal resistance from junction to case	note 1	22[2]	K/W

Notes

1. HVSON10 is mounted to a water-cooled heatsink with the topside of the package. Package is mounted to a 4-layer printed-circuit board and exposed to still air.
2. For a typical printed-circuit board of a handset the total thermal resistance will be higher. For correct operation up to 85 °C ambient temperature the total thermal resistance must not exceed 100 K/W.

10 CHARACTERISTICS

V_{SS} = 0 V; T_{amb} = –40 to +85 °C; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.(1)	MAX.	UNIT
Charge switch						
V_{CHG}	charger input voltage	note 2	–20	–	+20	V
V_{BAT}	battery input voltage	note 3	0	–	6.0	V
I_{BAT}	current through pin BAT	OFF mode; V_{BAT} = 5 V; V_{CHG} = 0 V	–	5	10	µA
		SHUTDOWN after overheat	–	15	30	µA
		SHUTDOWN after overvoltage	–	–	1	mA
		SHUTDOWN after undervoltage	–	–	20	µA
		SLOW CHARGE mode; V_{BAT} = 5 V; V_{CHG} = floating	–	5	10	µA
		REVERSE mode; I_{CHG} = 0 A; V_{BAT} > 3.1 V	–	90	150	µA
I_{CHG}	current through pin CHG	OFF mode and SHUTDOWN mode; V_{CHG} = 2.5 V to 10.5 V; V_{BAT} = 0 V to 5.7 V	–	–	400	µA
		OFF mode and SHUTDOWN mode; V_{CHG} = 12 V to 20 V; V_{BAT} = 0 V to 5.7 V	–	–	5	mA
		FAST CHARGE mode; I_{BAT} = 0 A; V_{CHG} = 3.6 V	–	–	140	µA
$I_{CHG(det)}$	minimum charge current detection	REVMOD = HIGH; $I_{CHG} \rightarrow$ BAT; note 4	–	0.1	4	mA
$V_{CHG(det)}$	minimum charge voltage detection	REVMOD = LOW; note 3	1.1	2	2.5	V
$I_{CHG(slow)}$	slow charge current	V_{CHG} > V_{BAT} + 1 V				
		V_{CHG} = 2.5 V to 7 V	120	145	180	mA
		V_{CHG} = 7 V to 20 V	90	140	190	mA
$I_{CHG(fast)(lim)}$	current limit of the fast charge current	CURMOD = HIGH; SWMOD = LOW; $I_{CHG(fast)}$ = 50 mA to 2 A	–30	–	+10	%
		SWMOD = HIGH; $V_{CHG-BAT}$ > 400 mV; R_{RLIMF} = 680 Ω; note 5	0.58	0.73	0.88	A
$V_{RLIMF(acc)}$	absolute accuracy of voltage sensed on pin RLIMF	$I_{CHG(fast)}$ = 1.25 A; notes 6 and 7	–10	–	+30	%
$V_{RLIMF(lin)}$	linearity of voltage sensed on pin RLIMF	$I_{CHG(fast)}$ = 1.25 A; notes 6 and 7	–10	–	+10	%
$I_{lim(rev)}$	current limit REVERSE mode	note 8	450	700	950	mA
$V_{BAT(rev)}$	minimum battery voltage for REVERSE mode activation	including hysteresis	2.7	–	3.1	V
$V_{BAT(rev)(hys)}$	$V_{BAT(rev)}$ hysteresis		–	200	–	mV

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.(1)	MAX.	UNIT
$V_{CHG-BAT(fast)}$	voltage between pins CHG and BAT in FAST CHARGE mode	I_{CHG} = 0.9 A	–	0.22	0.36	V
$V_{BAT-CHG(rev)}$	voltage between pins BAT and CHG in REVERSE mode	I_{BAT} = 0.4 A; V_{BAT} = 3.6 V	0.1	0.2	0.25	V
$I_{rev(slow)}$	reverse current in SLOW CHARGE mode	CURMOD = HIGH; SWMOD = LOW; V_{CHG} = 0 V	–	–	5	µA
$I_{rev(fast)}$	reverse current in FAST CHARGE mode	SWMOD = HIGH; V_{CHG} = 0 V	–	–	5	µA
$I_{rev(rev)}$	reverse current in REVERSE mode	CURMOD = LOW; SWMOD = LOW; REVMOD = HIGH; V_{BAT} = 0 V	–	–	5	µA
$\Delta I/\Delta t_{on(fast)}$	soft switching on in FAST CHARGE mode	I_{CHG} ramps up from 0 A to 2 A; note 9	0.2	–	3	A/ms
$\Delta I/\Delta t_{off(fast)}$	switching off in FAST CHARGE mode	I_{CHG} ramps down from 2 A to 0 A; note 9	20	–	80	A/ms
$\Delta I/\Delta t_{on(rev)}$	soft switching speed in REVERSE mode	V_{BAT} > 3.2 V, I_{CHG} ramps up from 0 A to 0.4 A; note 9	0.5	–	5	A/ms
$\Delta I/\Delta t_{off(rev)}$	switching off in REVERSE mode	V_{BAT} > 3.2 V, I_{CHG} ramps down from 0.4 A to 0 A; note 9	10	40	80	A/ms
E_{max}	maximum energy dissipation capability of the CHG pin	note 10 during fast switch off; note 11 during smooth switch off	 – –	 – –	 1 2	 mJ mJ
P_{tot}	total power dissipation	note 12	–	–	600	mW
$V_{BAT(max)}$	detection threshold to disable charging	notes 8 and 13	5.3	5.5	5.7	V
CHGOK_N output						
I_{OL}	maximum output current		–	–	500	µA
V_{OL}	maximum output voltage	with output current = I_{OL}	–	–	200	mV
I_{LOZ}	leakage current in high-impedance state	V_O = 5 V	–	–	1	µA
Control inputs: pins CURMOD, SWMOD and REVMOD						
V_{IH}	HIGH-level input voltage		1.4	–	5	V
V_{IL}	LOW-level input voltage		0	–	0.4	V
CONTROL INPUTS: PINS CURMOD AND SWMOD						
R_{pd}	pull-down resistor		100	200	300	kΩ
CONTROL INPUT: PIN REVMOD						
I_{IL}	LOW-level input current	V_{IN} = 0 V	–	–	1	µA

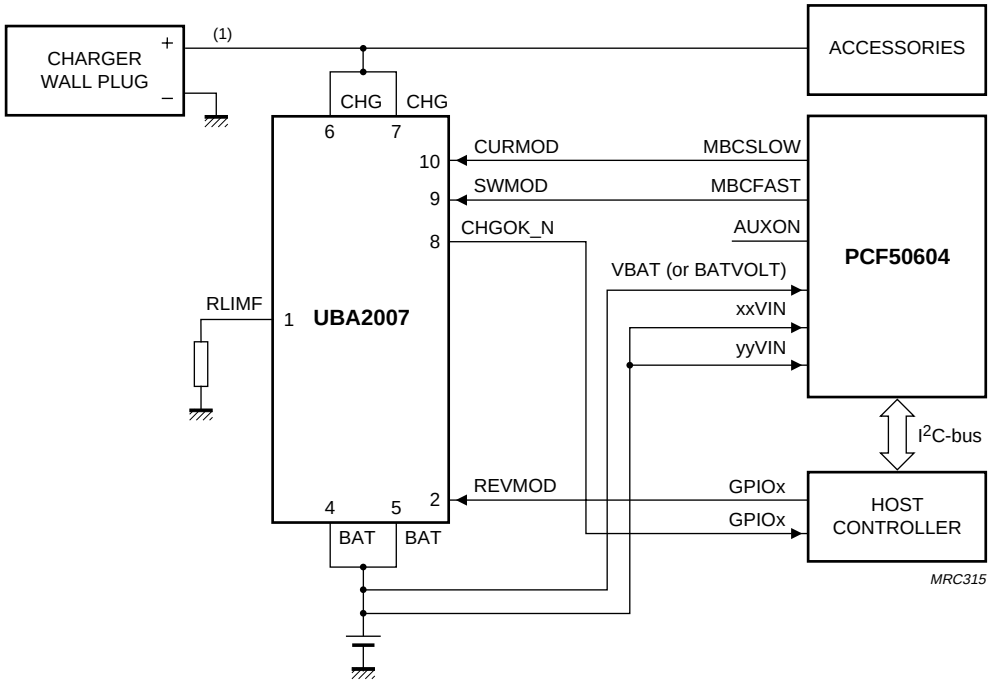
SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.(1)	MAX.	UNIT
Temperature high sensor						
T_{max}	maximum die temperature		135	150	165	°C
T_{hys}	hysteresis temperature		15	20	25	°C

Notes

1. Values are specified at T_{amb} = 25 °C, V_{CHG} = 6 V, V_{BAT} = 3.6 V, unless specified differently. They are validated by product characterization based on measurements on sample basis.
2. If V_{CHG} < 0 V (OFF mode) it is guaranteed that the battery stays completely protected and the discharge current is maximum 10 μA.
3. For proper operation V_{CHG} > 2.5 V or V_{BAT} > 2.5 V.
4. When I_{CHG} = 0 A and REVMOD = HIGH then CHGOK_N = HIGH.
5. R_{RLIMF} can be approximated with this equation: $R_{RLIMF} = \frac{500}{I_{CHG(fast)(lim)}}$.
6. V_{RLIMF} can be approximated with this equation: $V_{RLIMF} = \frac{I_{CHG} \times R_{RLIMF}}{1000}$.
7. Test is done for 3 currents: 50 mA, 450 mA and 900 mA.
8. Contact Philips Semiconductors if a different value is required.
9. Values are measured between 10 % and 90 %.
10. The voltage peak due to inductive flyback is clamped internally at 30 V. This will not damage the IC when the dissipated energy does not exceed the specified value.
11. Fast switch off occurs for overvoltage condition on pin BAT.
12. For a typical printed-circuit board of a handset with a total (printed-circuit board + package) thermal resistance of 100 K/W and 85 °C ambient temperature.
13. To reset the overvoltage protection state it is required to unplug the charger wall plug (V_{CHG} < 2.5 V).

11 APPLICATION INFORMATION

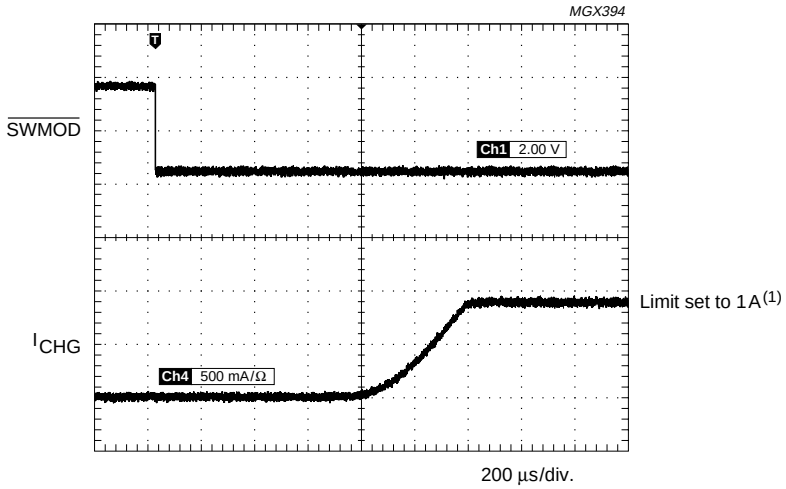
11.1 Application diagram



An external capacitor can be added on V_{CHG} (typically 10 nF) to prevent any oscillation of the pre-charge current. This applies only when using a linear charger.

Fig.4 UBA2007 in combination with the PCF50604 PMU.

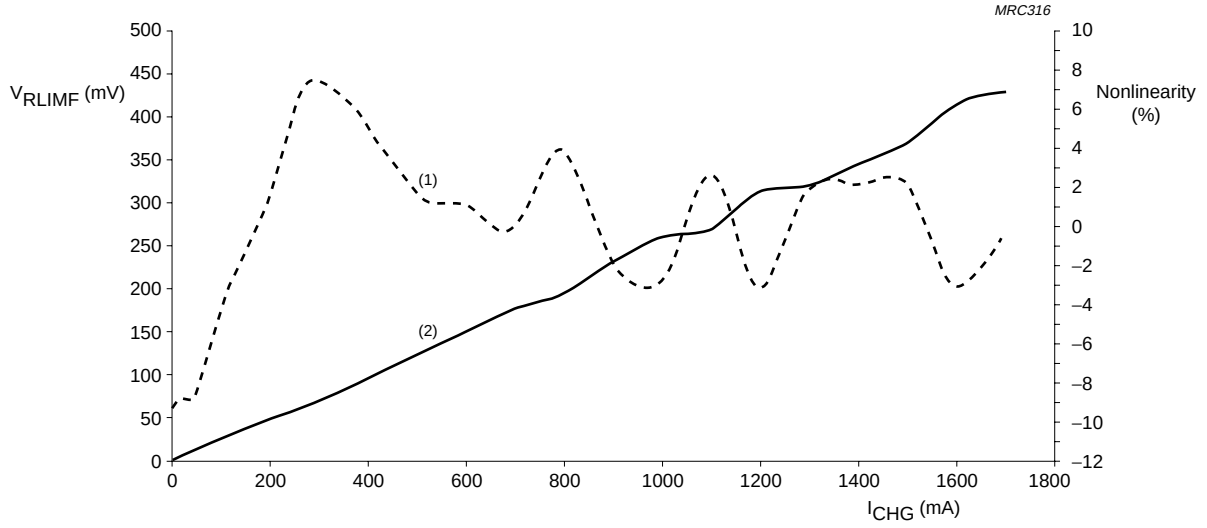
11.2 Soft switching



(1) Limit is set by selecting R_{RLIMF}

Fig.5 Soft switching sequence (CURMOD = LOW).

11.3 Current measurement possibility



(1) Non linearity in %.

(2) V_{RLIMF} as function of I_{CHG}; R_{RLIMF} = 250 Ω.

Fig.6 Linear behaviour.

11.4 Drop voltage dependence

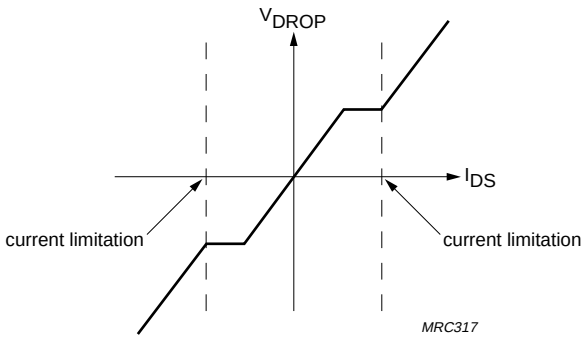
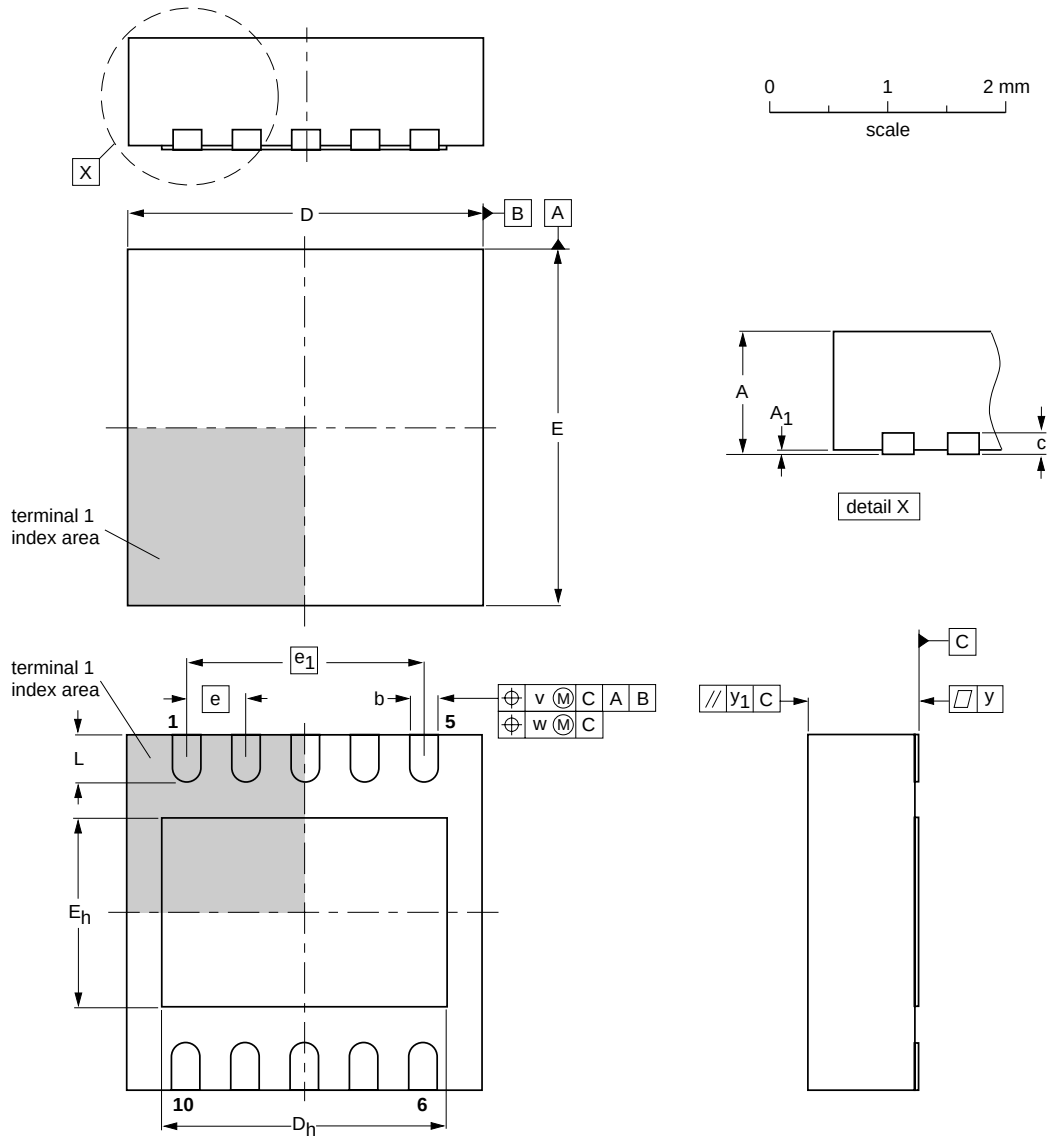


Fig.7 Dependence of drop voltage between pins CHG and BAT on charging current.

12 PACKAGE OUTLINE

HVSON10: plastic thermal enhanced very thin small outline package; no leads; 10 terminals; body 3 x 3 x 0.85 mm **SOT650-1**



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	3.1 2.9	2.55 2.15	3.1 2.9	1.75 1.45	0.5	2	0.55 0.30	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			
SOT650-1	- - -	MO-229	- - -			~~01-01-22~~ 02-02-08

13 SOLDERING

13.1 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.

13.2 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 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 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.

13.3 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.

13.4 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.

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

PACKAGE[1]	SOLDERING METHOD	
	WAVE	REFLOW[2]
BGA, LBGA, LFBGA, SQFP, SSOP-T[3], TFBGA, VFBGA	not suitable	suitable
DHVQFN, HBCC, HBGA, HLQFP, HSQFP, HSOP, HTQFP, HTSSOP, HVQFN, HVSON, SMS	not suitable[4]	suitable
PLCC[5], SO, SOJ	suitable	suitable
LQFP, QFP, TQFP	not recommended[5][6]	suitable
SSOP, TSSOP, VSO, VSSOP	not recommended[7]	suitable
PMFP[8]	not suitable	not 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 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.
4. 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.
5. 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.
6. 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.
7. 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.
8. Hot bar or manual soldering is suitable for PMFP packages.

14 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.

15 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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