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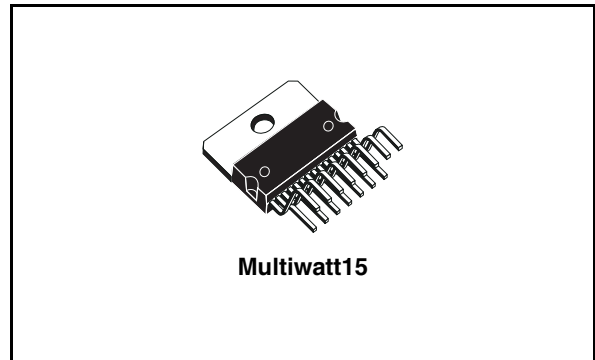
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## Multifunction voltage regulator for car radio

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### Features

- Four outputs
  - 8.5V @ 200mA (V8P5)
  - 8/10V @ 1000mA selectable 10V or 8V (V810)
  - 3.3V @ 100mA permanent (VSTBY)
  - 3.3V @ 800mA (VREGSW)
- Two protected high side driver (HSD1, HSD2)
- Reset function
- Battery voltage (under/over) warning output
- Load dump protection
- Independent thermal shutdown on all regulators and HSDs
- Overcurrent limitation
- Storage CAP output (STCAP)
- Small CAP required by stability of regulators
- All pins ESD protected



### Description

The L5959 contains a four voltage regulator and two protected HSDs. HSDs are protected against loss of ground and loss of battery.

The IC includes a monitoring circuit for detection.

The IC features a very low quiescent current in stand-by and independent thermal shutdown.

**Table 1. Device summary**

Order code	Package	Packing
L5959	Multiwatt15	Tube

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# 1 Block diagram

Figure 1. Block diagram

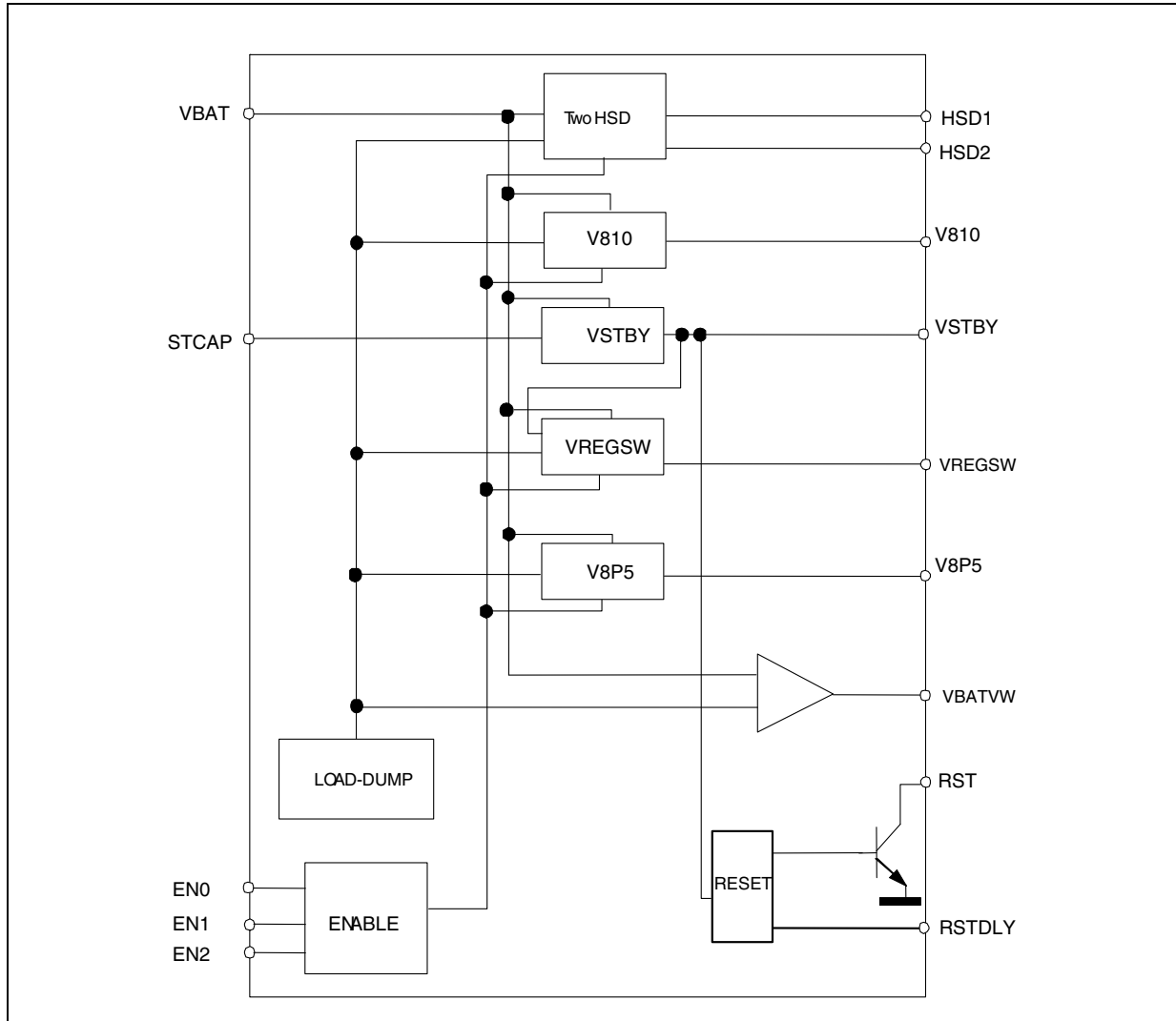


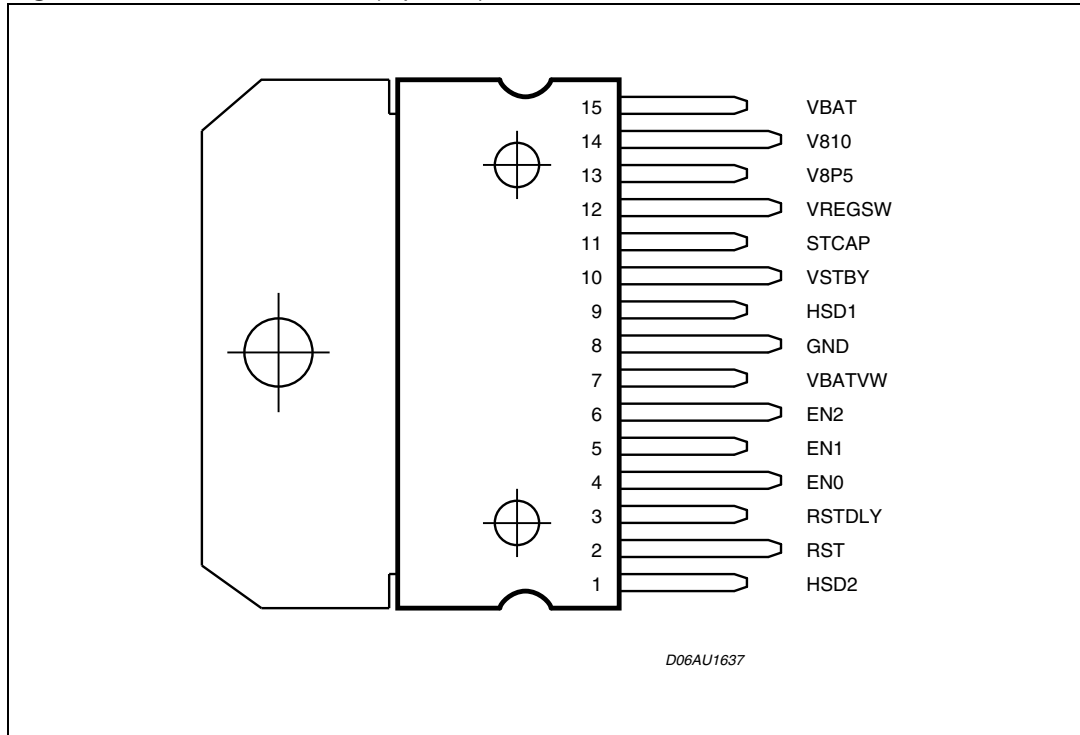
Table 2. Enable logic

EN2	EN1	EN0	VREGSW	V8P5	HSD1	V810 (8V)	V810 (10V)	HSD2
0	0	0	Off	Off	Off	Off	Off	Off
0	0	1	On	On	On	Off	On	On
0	1	0	On	Off	Off	Off	Off	Off
0	1	1	On	On	On	Off	Off	On
1	0	0	On	On	On	Off	Off	Off
1	0	1	On	On	On	Off	On	Off
1	1	0	On	On	On	On	Off	Off
1	1	1	On	On	On	On	Off	On

## 2 Pins description

### 2.1 Pins connection

Figure 2. Pins connection (top view)





## 3 Electrical specification

### 3.1 Absolute maximum ratings

Table 3. Absolute maximum ratings

Symbol	Parameter	Value	Unit
$V_{BATDC}$	DC operating supply voltage	30	V
$V_{BATTR}$	Transient supply voltage	50	V
$I_O$	Output current	internally limited	
$R_{ESR}$	Output capacitor series eq. resistance (MAX.)	0.5	$\Omega$
$T_{op}$	Operating temperature range	-40 to 105	$^{\circ}C$
$T_{stg}$	Storage temperature	-55 to 150	$^{\circ}C$
$T_j$	Junction temperature	-55 to 150	$^{\circ}C$
$P_d$	Power dissipation $T_{case} = 85^{\circ}C$	43	W

### 3.2 Thermal data

Table 4. Thermal data

Symbol	Parameter	Multiwatt	Unit
$R_{th\ j-case}$	Thermal resistance junction to case max.	1.8	$^{\circ}C/W$

### 3.3 Electrical characteristics

Table 5. Electrical characteristics

( $V_S = 14.4V$ ;  $T_{amb} = 25^{\circ}C$ ; unless otherwise specified)

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
<b>INPUT SUPPLIES</b>						
$V_{bat}$	Input supply	Operating	9		18	V
$V_{STCAP}$	Input supply voltage 2	Operating	6		18	V
$V_{bat}$	Battery voltage	Reverse polarity		non operating		
$V_{STCAP}$	Input supply voltage 2	Reverse polarity		non operating		
$I_q$	Total quiescent current	EN0 = EN1 = EN2 = 0 V; VBAT = 14 V; $I_{VSTBY} = 100\ \mu A$		55	75	$\mu A$
$V_{OV}$	VBAT Over-voltage shutdown	Verify all outputs except VSTBY disabled and VBATVW* asserted low (VBAT Rising)	24	27	30	V
$V_{HYSOV}$	Hysteresis of over-voltage shutdown		200	750	1500	mV



**Table 5. Electrical characteristics (continued)**  
 ( $V_S = 14.4V$ ;  $T_{amb} = 25^{\circ}C$ ; unless otherwise specified)

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
$V_{UV}$	VBAT Under-voltage warning	Verify VBATVW* asserted low (VBAT Falling)	7	7.4	7.8	V
$V_{HYSUV}$	Hysteresis of under-voltage warning		70	300	500	mV
<b>VSTBY</b>						
$V_o$ (VSTBY)	Output voltage of VSTBY		3.14	3.3	3.46	V
$\Delta V$	Line regulation	$V_{BAT} = 6$ to $18V$ ; $I = 100mA$	-10	0	+10	mV
$\Delta V_i$	Load regulation	$I_{VSTBY} = 0.5$ to $100$ mA	-40	-5	+10	mV
$V_{over}$	Over shoot	$I_{VSTBY} = 100$ to $0.5$ mA, $C_o = 1\mu F$		2.5	6	%
PSRR	Supply voltage ripple rejection	$I_{VSTBY} = 50$ mA; $f_o = 20$ to $1$ kHz; $V_{BAT} = 14 V_{dc}, 1.0 V_{ac(pp)}$	50	70		dB
		$I_{VSTBY} = 50$ mA; $f_o = 20$ to $20$ kHz; $V_{BAT} = 14 V_{dc}, 1.0 V_{ac(pp)}$	45	55		dB
$V_N$	Output noise	Weighted filter $f_o = 20$ Hz to $20$ kHz $I_{VSTBY} = 5$ mA		85	200	$\mu V$
$V_{drop}$	Drop out voltage	$I_{VSTBY} = 100mA^{(1)}$			2.6	V
	Drop out voltage	$I_{VSTBY} = 5$ mA			2.3	V
$I_m$	Current limit	$R_{short} = 0\Omega$	150	200	300	mA
$TS_{EN}$	VSTBY thermal shutdown	$I_{VSTBY} = 500 \mu A$ ; Increase $T_a$ until VSTBY disabled	150		190	$^{\circ}C$
<b>VREGSW</b>						
$V_o$ (VREGSW)	Output voltage 3.3V		3.14	3.3	3.46	V
$V_{TRK}$	VREGSW output tracking voltage on VSTBY	$I_{VSTBY} = 50$ mA $I_{VREGSW} = 0.5$ to $800$ mA Measure VSTBY – VREGSW	-40		40	mV
		$I_{VSTBY} = 0.5$ mA to $100$ mA $I_{VREGSW} = 0.5$ to $800$ mA Measure VSTBY – VREGSW	-50		50	mV
$\Delta V$	Line regulation	$V_{in1} = 9$ to $18V$ ; $I = 800mA$	-40	10	40	mV
$\Delta V_i$	Load regulation	$I_{VREGSW} = 1$ to $800mA$	-50	-15	10	mV

**Table 5. Electrical characteristics (continued)** $(V_S = 14.4V; T_{amb} = 25^{\circ}C; \text{ unless otherwise specified})$ 

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
PSRR	Supply voltage ripple rejection	$I_{VREGSW} = 400 \text{ mA};$ $f_o = 20 \text{ to } 1 \text{ kHz};$ $V_{BAT} = 14 V_{dc}, 1.0 V_{ac(pp)}$	50	70		dB
		$I_{VREGSW} = 400 \text{ mA};$ $f_o = 20 \text{ to } 20 \text{ kHz};$ $V_{BAT} = 14 V_{dc}, 1.0 V_{ac(pp)}$	45	55		dB
$V_N$	Output noise	Weighted filter $f_o = 20 \text{ Hz to } 20 \text{ kHz}$ $I_{VREGSW} = 5 \text{ mA}$		85	200	$\mu\text{V}$
$V_{drop}$	Drop out voltage	$I_{VREGSW} = 800 \text{ mA}$			2.6	V
$V_{drop}$	Drop out voltage	$I_{VREGSW} = 5 \text{ mA}$			2.3	V
$I_m$	Current limit	$R_{short} = 0\Omega$	1	1.5	2.5	A
$TS_{EN}$	VREGSW thermal shutdown	$I_{VREGSW} = 500 \mu\text{A};$ Increase $T_a$ until VREGSW disabled	150		190	$^{\circ}\text{C}$
$t_{don}$	Turn-on delay;	$I_{vregsw} = 5 \text{ mA}$	10	45	110	$\mu\text{s}$
$t_{doff}$	Turn-off delay,	$I_{VREGSW} = 700 \text{ mA}$		45	110	$\mu\text{s}$
<b>V8P5</b> ( $V_{BAT} = 9.5V \text{ to } 18V$ )						
$V_o$ (V8P5)	Output voltage 8.5V		8.3	8.5	8.7	V
$\Delta V$	Line regulation	$V_{BAT} = 9.5 \text{ to } 18V; I = 200 \text{ mA}$	-50	3.0	50	mV
$\Delta V_i$	Load regulation	$I_{V8P5} = 1 \text{ to } 200 \text{ mA}$	-30	3	20	mV
PSRR	Supply voltage ripple rejection	$I_{V8P5} = 100 \text{ mA};$ $f_o = 20 \text{ to } 1 \text{ kHz};$ $V_{BAT} = 14 V_{dc}, 1.0 V_{ac(pp)}$	50	60		dB
		$I_{V8P5} = 100 \text{ mA};$ $f_o = 20 \text{ to } 20 \text{ kHz};$ $V_{BAT} = 14 V_{dc}, 1.0 V_{ac(pp)}$	35	40		dB
$V_N$	Output noise	Weighted filter $f_o = 20 \text{ Hz to } 20 \text{ kHz}$ $I_{V8P5} = 5 \text{ mA}$		190	450	$\mu\text{V}$
$V_{drop}$	Drop out voltage	$I_{V8P5} = 200 \text{ mA}$		0.45	0.9	V
$I_m$	Current limit	$R_{short} = 0\Omega$	275	450	700	mA
$TS_{EN}$	V8P5 thermal shutdown	$I_{V8P5} = 500 \mu\text{A};$ Increase $T_a$ until V8P5 disabled	150		190	$^{\circ}\text{C}$
$t_{don}$	Turn-on delay;	$I_{V8P5} = 5 \text{ mA}$	10	45	110	$\mu\text{s}$
$t_{doff}$	Turn-off delay,	$I_{V8P5} = 200 \text{ mA}$		45	110	$\mu\text{s}$
<b>V810 (8V)</b> ( $V_{BAT} = 9.2V \text{ to } 18V$ )						
$V_o$ (V810)	Output voltage 8.0V		7.6	8.0	8.4	V
$\Delta V$	Line regulation	$V_{BAT} = 9.2 \text{ to } 18V;$ $I = 1000 \text{ mA}$	-50	3	50	mV

**Table 5. Electrical characteristics (continued)**  
 ( $V_S = 14.4V$ ;  $T_{amb} = 25^\circ C$ ; unless otherwise specified)

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
$\Delta V_i$	Load regulation	$I_{V810} = 0.5$ to $1000$ mA	-100	-20	10	mV
PSRR	Supply voltage ripple rejection	$I_{V810} = 500$ mA; $f_o = 20$ to $1$ kHz; $V_{BAT} = 14 V_{dc}$ , $1.0 V_{ac(pp)}$	50	55		dB
		$I_{V810} = 500$ mA; $f_o = 20$ to $20$ kHz; $V_{BAT} = 14 V_{dc}$ , $1.0 V_{ac(pp)}$	30	35		dB
$V_N$	Output noise	Weighted filter $f_o = 20$ Hz to $20$ kHz $I_{V810} = 5$ mA		175	450	$\mu V$
Vdrop	Drop out voltage	$I_{V810}(8V) = 1000mA$ <sup>(1)</sup>		0.45	0.9	V
$I_m$	Current limit	$R_{short} = 0\Omega$	1.5	2.3	3.5	A
TS <sub>EN</sub>	V810(8V) thermal shutdown	$I_{V810(8V)} = 500 \mu A$ ; Increase $T_a$ until V810(8V) disabled	150		190	$^\circ C$
$t_{don}$	Turn-on delay;	$I_{V810(8V)} = 5mA$	10	45	110	$\mu s$
$t_{doff}$	Turn-off delay,	$I_{V810(8V)} = 1000$ mA		45	110	$\mu s$
<b>V810 (10V)</b> ( $V_{BAT}=11.2V$ to $18$ V)						
$V_o$ (V810)	Output Voltage 10.0V		9.5	10.0	10.5	V
$\Delta V$	Line regulation	$V_{BAT} = 11.2$ to $18V$ ; $I = 1000mA$	-50	2.5	50	mV
$\Delta V_i$	Load regulation	$I_{V810} = 0.5$ to $1000$ mA	-100	-25	10	mV
PSRR	Supply voltage ripple rejection	$I_{V810} = 500$ mA; $f_o = 20$ to $1$ kHz; $V_{BAT} = 14 V_{dc}$ , $1.0 V_{ac(pp)}$	50	55		dB
		$I_{V810} = 500$ mA; $f_o = 20$ to $20$ kHz; $V_{BAT} = 14 V_{dc}$ , $1.0 V_{ac(pp)}$	30	35		dB
$V_N$	Output noise	Weighted filter $f_o = 20$ Hz to $20$ kHz $I_{V810} = 5$ mA		175	450	$\mu V$
Vdrop	Drop out voltage	$I_{V810}(10V) = 1000mA$ <sup>(1)</sup>		0.4	0.9	V
$I_m$	Current limit	$R_{short} = 0\Omega$	1.5	2.3	3.5	A
TS <sub>EN</sub>	V810(10V) thermal shutdown	$I_{V810(8V)} = 500 \mu A$ ; Increase $T_a$ until V810(10V) disabled	150		190	$^\circ C$
$t_{don}$	Turn-on delay;	$I_{V810(8V)} = 5mA$	10	45	110	$\mu s$
$t_{doff}$	Turn-off delay,	$I_{V810(8V)} = 1000$ mA		45	110	$\mu s$
<b>HIGH SIDE DRIVER1</b>						
VdropSW	Drop voltage HDS1	$I_{dc} = 100mA$		0.25	0.6	V
		$I_{dc} = 200mA$ , $t=5S$		0.50	1.2	V

**Table 5. Electrical characteristics (continued)**  
 ( $V_S = 14.4V$ ;  $T_{amb} = 25^\circ C$ ; unless otherwise specified)

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
$I_{STG}$	HSD1 short to ground current	VHSD1=0V	240	300	400	mA
$I_{STB}$	HSD1 short to $V_{BAT}$ current	VHSD1=VBAT		2	10	mA
$\Delta I_{Q(VBAT)}$	HSD1 bias current change	$I_{HSD1} = 0$ to 100 mA; Measure change in VBAT current		0.15	10	mA
$TS_{EN}$	HSD1 thermal shutdown	$I_{HSD1} = 500 \mu A$ ; Increase $T_a$ until HSD1 disabled	150		190	$^\circ C$
$t_{don}$	Turn-on delay;	$I_{HSD1} = 10mA$	10	50	110	$\mu s$
$t_{doff}$	Turn-off delay,	$I_{HSD1} = 100 mA$		70	110	$\mu s$
$t_r$	Rise time	10% to 90%, $I_{HSD1} = 10mA$		35	75	$\mu s$
<b>HIGH SIDE DRIVER2</b>						
$V_{dropSW}$	Drop voltage HDS2	$I_{dc} = 300mA$		0.2	0.6	V
		$I_{dc} = 450mA, t=5S$		0.3	1.2	V
$I_{STG}$	HSD2 short to ground current	VHSD2=0V	0.55	0.75	1	A
$I_{STB}$	HSD2 short to $V_{BAT}$ current	VHSD2=VBAT		3.5	10	mA
$\Delta I_{Q(VBAT)}$	HSD2 bias current change	$I_{HSD2} = 0$ to 300 mA; Measure change in VBAT current		0.15	10	mA
$TS_{EN}$	HSD2 thermal shutdown	$I_{HSD2} = 500 \mu A$ ; Increase $T_a$ until HSD2 disabled	150		190	$^\circ C$
$t_{don}$	Turn-on delay;	$I_{HSD2} = 10mA$	10	45	110	$\mu s$
$t_{doff}$	Turn-off delay,	$I_{HSD2} = 300 mA$		70	110	$\mu s$
$t_r$	Rise time	10% to 90%, $I_{HSD2} = 10mA$		30	75	$\mu s$
<b>RST (open collector output)</b>						
$V_{TH}$	VSTBY reset threshold	Force VSTBY low until RST* asserted	0.93 * VSTBY	0.95 * VSTBY	0.97 * VSTBY	V
$V_{HYS}$	Hysteresis of reset on rising VSTBY		10	50	200	mV
$t_{rRST}$	Rise time	10% to 90%, $R_{RST} = 47 k\Omega$ , $C_{RST} = 50 pF$		20	30	$\mu s$
$t_{fRST}$	Fall time	90% to 10%, $R_{RST} = 47 k\Omega$ , $C_{RST} = 50 pF$		300	1000	ns
$V_{IH\_RSTDLY}$	RSTDLY input voltage threshold	Verify RST is de asserted	2.5	2.75	3.5	V
$I_{SRC}$	RSTDLY current	RSTDLY = 0 VDC	6	8.5	12	$\mu A$

**Table 5. Electrical characteristics (continued)** $(V_S = 14.4V; T_{amb} = 25^{\circ}C; \text{ unless otherwise specified})$ 

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
$t_{por}$	RST POR delay time	$C_{RSTDLY} = 0.1 \mu F$	20	30	50	ms
$T_{glitch}$	Glitch rejection filter time		5	12.5	20	$\mu s$
<b>ENABLE INPUT (VREGSW, V8P5, V810, HSD1, HSD2)</b>						
$V_{IH}$	Threshold recognized as high level				2.0	V
$V_{IL}$	Threshold recognized as low level		0.8			V
$V_{HYSEN}$	Hysteresis of enable		0.15	0.35		V
$I_{LKGEN}$	Enable input pull-down current	$V_{EN} = V_{IL(min)}$ to VSTBY	10	30	50	$\mu A$

1. Drop condition means that the supply voltage drop down to 100 mV from the regulated output and the regulator is sourcing its maximal load.
2. Stability Request is design info, not tested.

## 4 Timing diagrams

Figure 3. Timing diagram of regulators and HSD

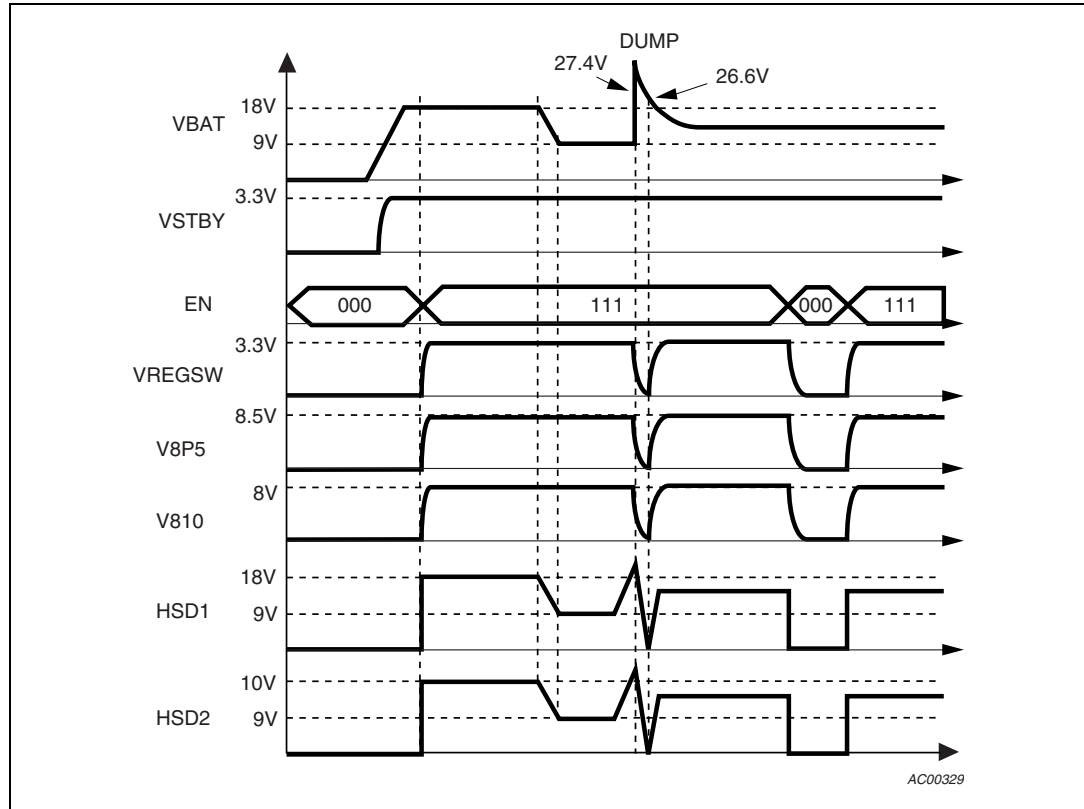


Figure 4. STCAP and RST diagram

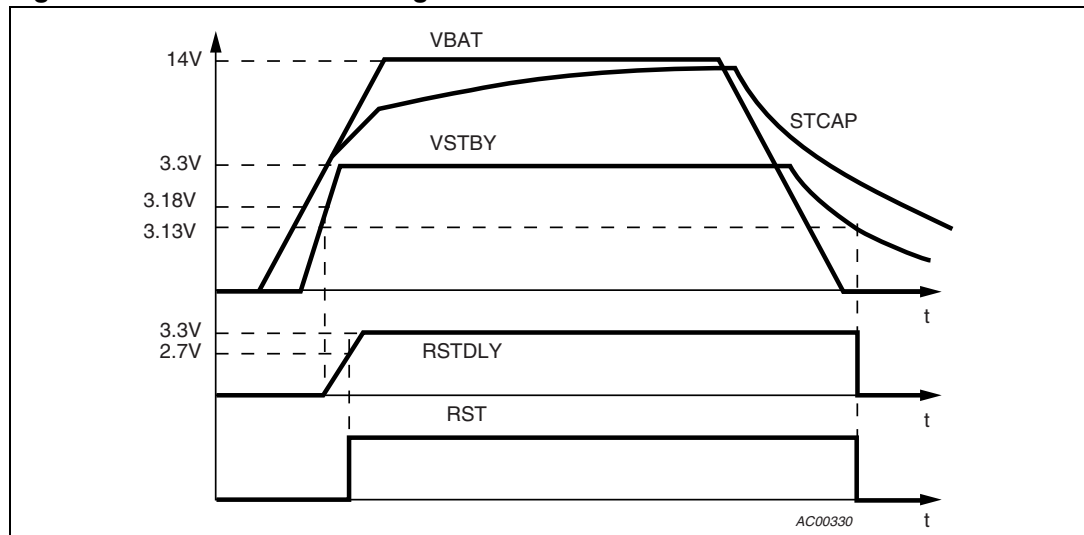


Figure 5. VBATVW (over/under voltage warning)

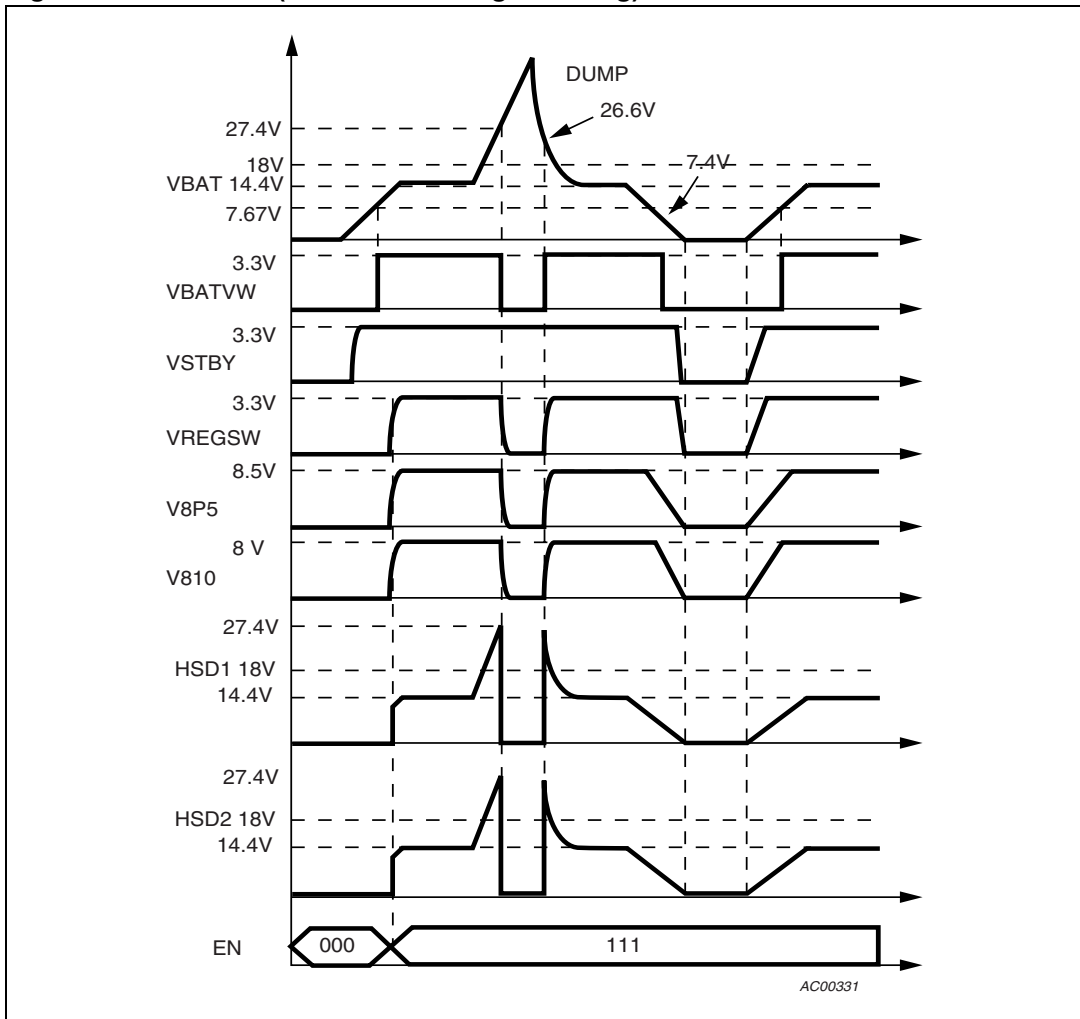
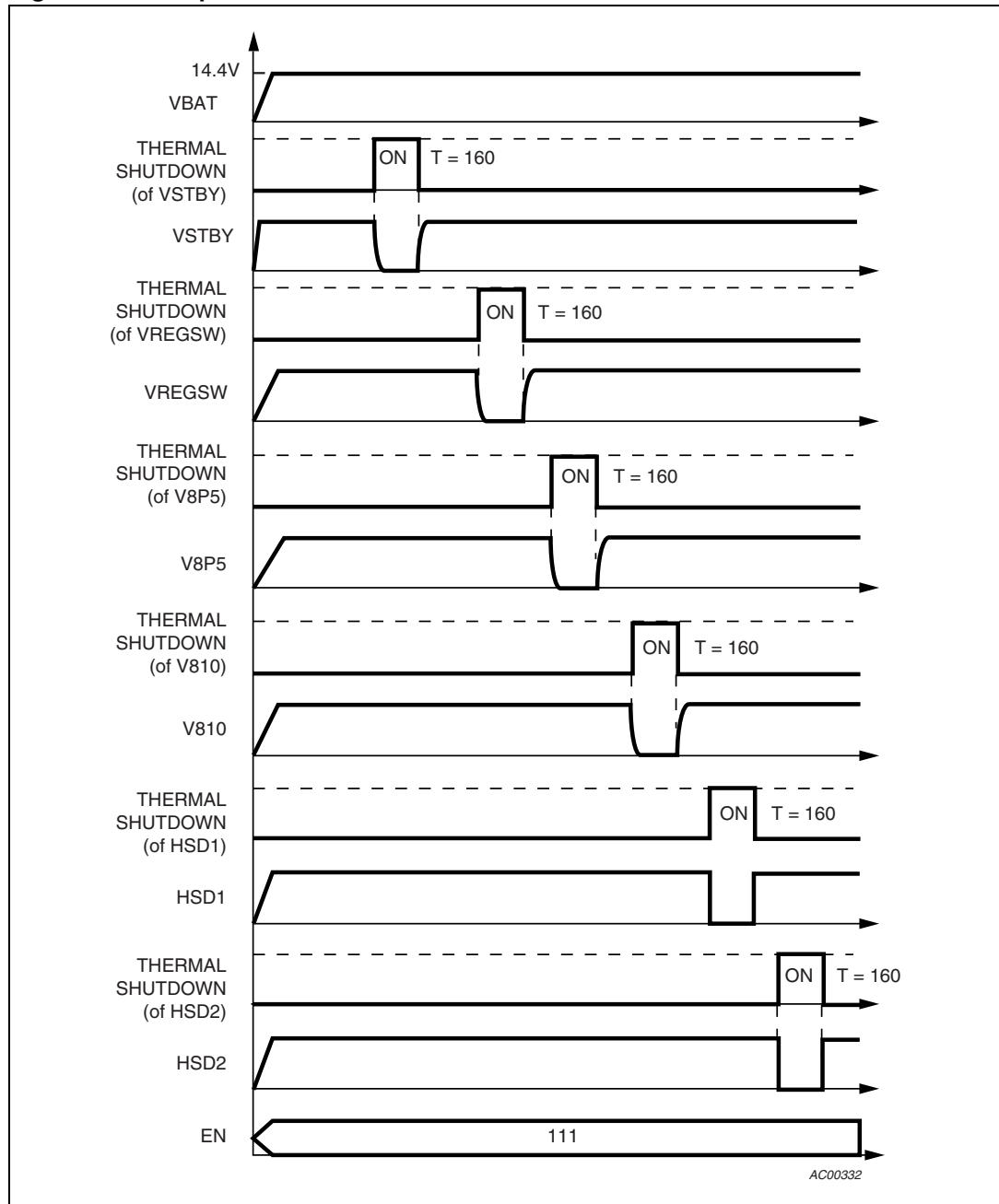
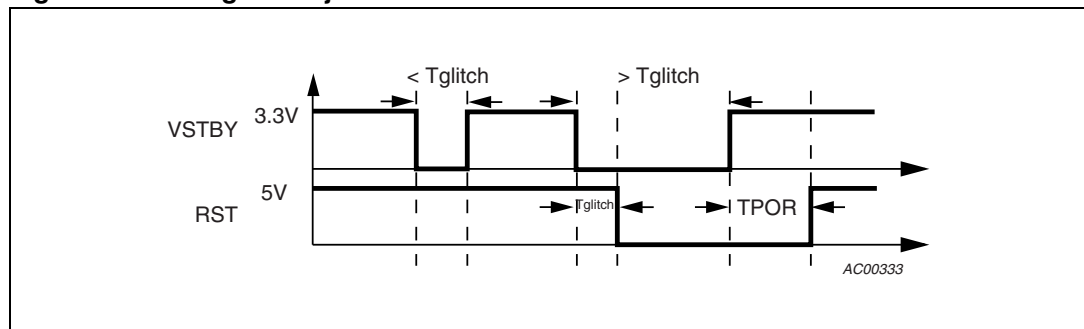




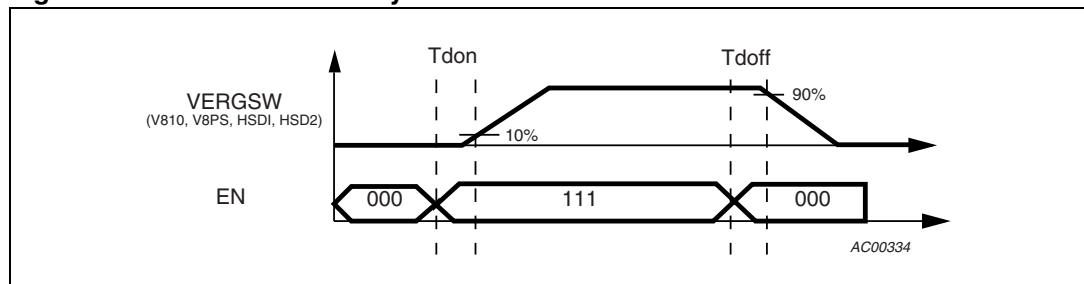
Figure 6. Independent thermal shutdown



**Figure 7. RST glitch rejection**



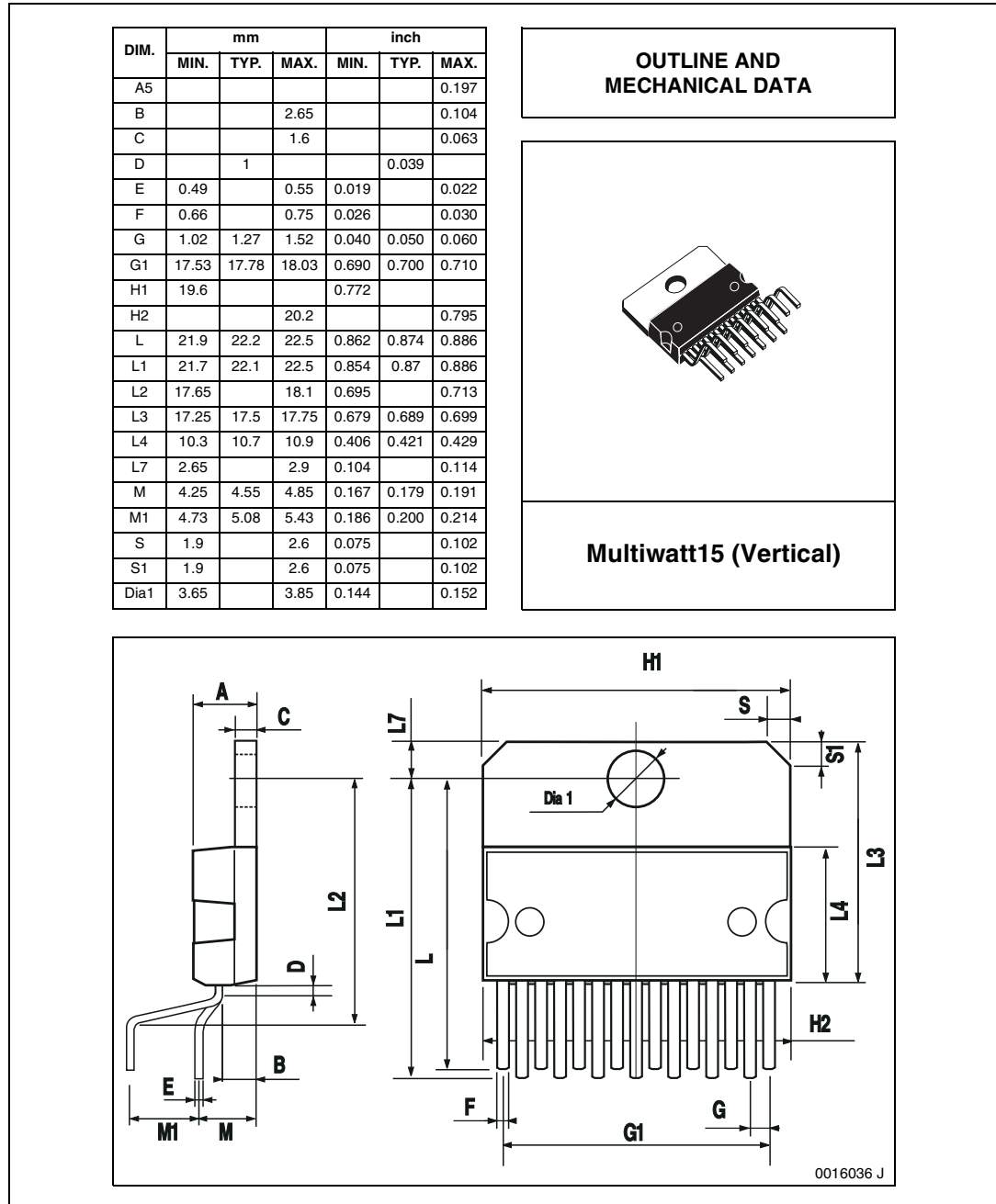
**Figure 8. Enable on/off delay**



# 5 Package information

In order to meet environmental requirements, ST offers these devices in ECOPACK<sup>®</sup> packages. These packages have a Lead-free second level interconnect. The category of second Level Interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an ST trademark. ECOPACK specifications are available at: [www.st.com](http://www.st.com).

**Figure 9. Multiwatt15 (vertical) mechanical data and package dimensions**



## 6 Revision history

**Table 6. Document revision history**

<b>Date</b>	<b>Revision</b>	<b>Changes</b>
26-Jun-2006	1	Initial release.
28-Aug-2007	2	Minor changes, improved quality of the drawings.
17-Sep-2013	3	Updated Disclaimer.

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