

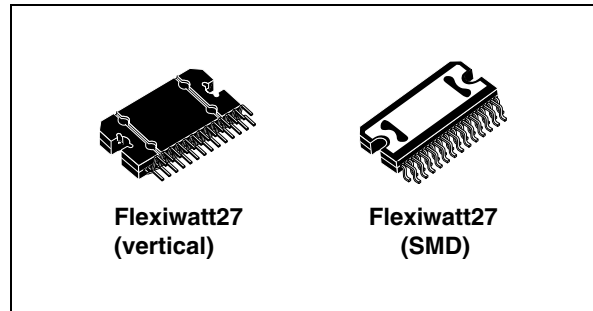
## Multifunction voltage regulator for car radio

### Features

- L5958 six outputs:
  - 8.5 V @ 200 mA
  - 5.0 V @ 300 mA
  - 3.3 V @ 250 mA
  - 1.8 V @ 350 mA
  - 3.3 V @ 100 mA standby
  - 1.8 V @ 100 mA standby
- 2 A high side driver
- Reset function
- VDD core reset function
- Battery audio warning
- Battery can warning
- Ignition comparator
- Load dump protection
- Thermal shutdown
- Overcurrent limitation
- All pin ESD protected

### Description

The L5958 includes 6 linear voltage regulators and a 2 A power switch, working down to 4.5 V battery level. All the voltage regulators can be switched off through the three enable pins.



The two 3.3 V (REG5) and 1.8 V (REG6) stand-by regulators can reach a quasi-zero current consumption when switched off.

The device is equipped with two different reset buffers to control the operating voltages: the reset which checks the two stand-by outputs, 3.3V and 1.8 V, and the VDD core reset which checks the linear switched outputs, 3.3 V and 1.8 V. It is also equipped with two different battery voltage warnings, provided by the Hold CAN and the Hold audio detectors, with the possibility to program the lower threshold through an external resistance.

The ignition buffer completes the device.

A backup function is available through two pins which needs to be connected to two independent capacitors: one for the 3.3 V and 1.8 V linear switched outputs and one for the 3.3 V and 1.8 V standby outputs.

**Table 1. Device summary**

| Order code | Package                | Packing       |
|------------|------------------------|---------------|
| L5958      | Flexiwatt27 (vertical) | Tube          |
| L5958SM    | Flexiwatt27 (SMD)      | Tube          |
| L5958SMTR  | Flexiwatt27 (SMD)      | Tape and reel |

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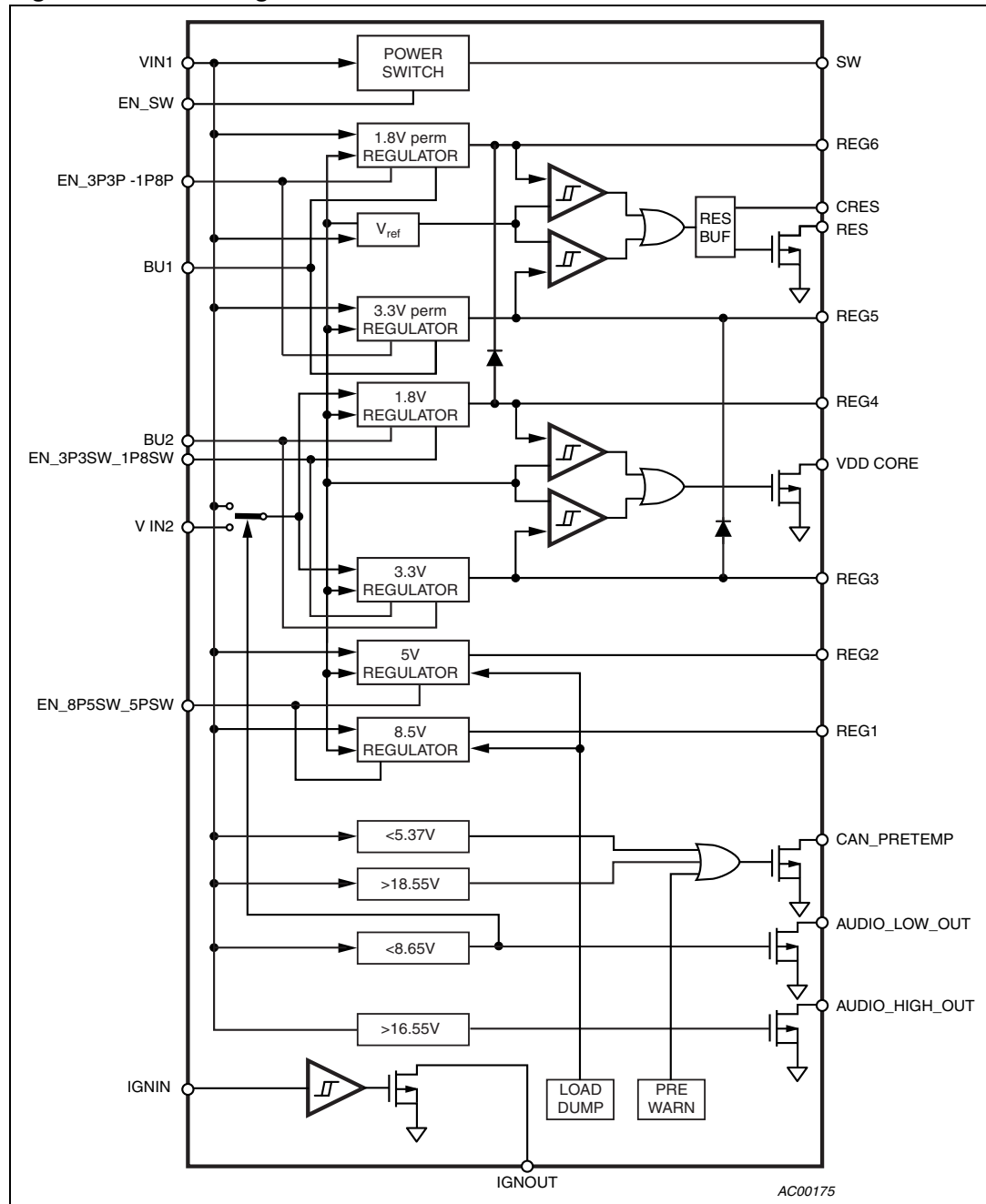
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# 1 Block diagram

Figure 1. Block diagram



## 2 Pin description

Figure 2. Flexiwatt27 (SMD and vertical) pin connection (top view)

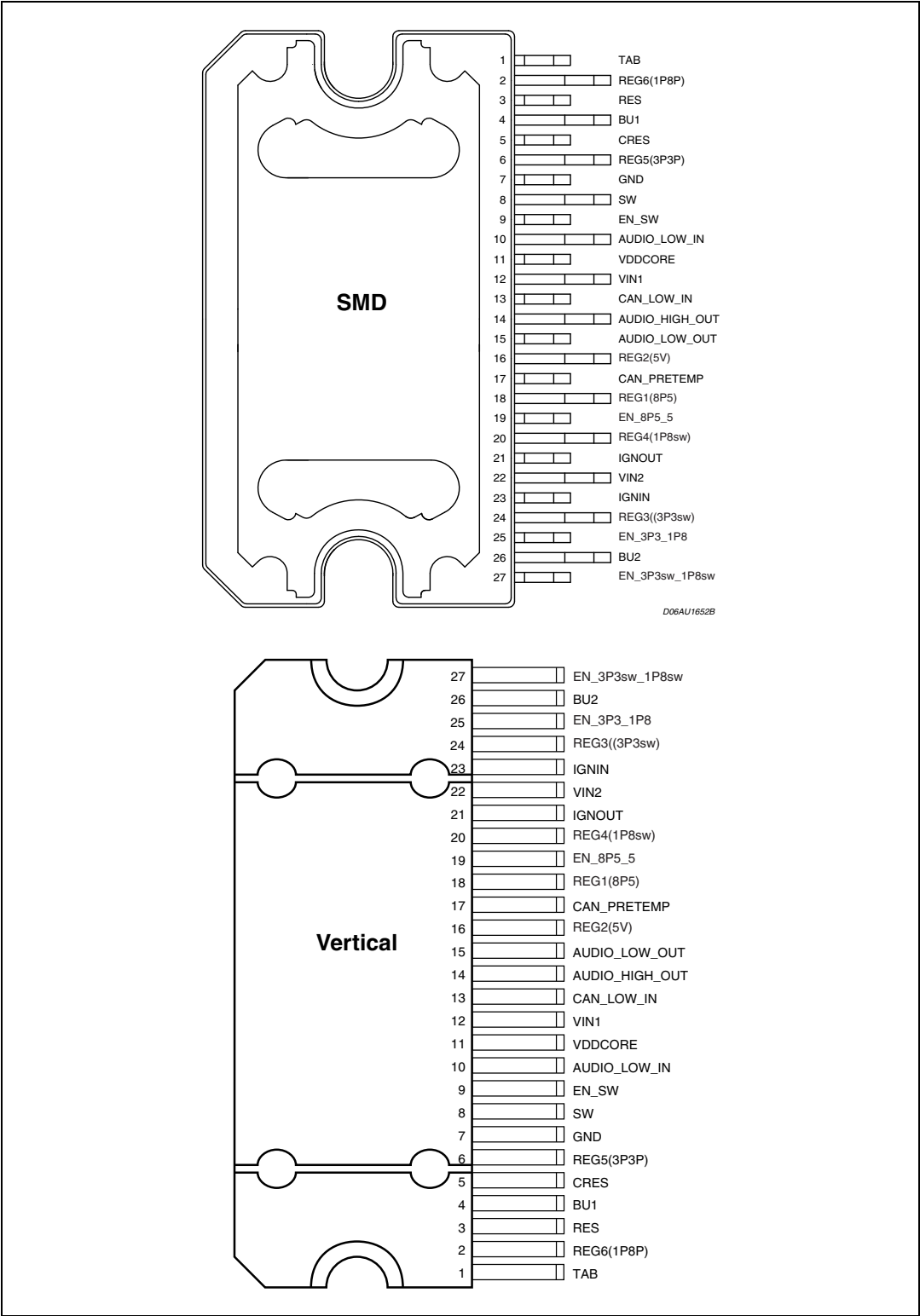


Table 2. Pin description

| Pin N# | Pin name       | Function                                                                                                                                            | Type |
|--------|----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|------|
| 1      | TAB            |                                                                                                                                                     |      |
| 2      | REG6(1P8P)     | Output of Reg6 (1.8 V/100 mA)                                                                                                                       | O    |
| 3      | RES            | Reset signal for MCU application                                                                                                                    | O    |
| 4      | BU1            | Connect to a reserve capacitor. When battery is removed suddenly, the energy stored in this capacitor can still supply reg5 and reg6 for some time. | I/O  |
| 5      | CRES           | Connect a capacitor to delay reset signal                                                                                                           | O    |
| 6      | REG5(3P3P)     | Output of Reg5 (3.3 V/100 mA)                                                                                                                       | O    |
| 7      | GND            | Power supply ground                                                                                                                                 | S    |
| 8      | SW             | Output of power switch                                                                                                                              | O    |
| 9      | EN_SW          | Enable signal for SW                                                                                                                                | I    |
| 10     | AUDIO_LOW_IN   | Hold Audio Low threshold adjustment                                                                                                                 | I    |
| 11     | VDDCORE        | Warn signal to 3.3 Vsw or 1.8Vsw                                                                                                                    | O    |
| 12     | VIN1           | Power supply for Reg1,Reg2,Reg5,Reg6 and SW                                                                                                         | S    |
| 13     | CAN_LOW_IN     | Hold CAN Low threshold adjustment                                                                                                                   | I    |
| 14     | AUDIO_HIGH_OUT | Hold Audio High signal for MCU application                                                                                                          | O    |
| 15     | AUDIO_LOW_OUT  | Hold Audio Low signal for MCU application                                                                                                           | O    |
| 16     | REG2(5V)       | Output of Reg2                                                                                                                                      | O    |
| 17     | CAN_PRETEMP    | Hold can low signal or hold can high signal with load dump detection or pretemp warning                                                             | O    |
| 18     | REG1(8P5)      | Output of Reg1                                                                                                                                      | O    |
| 19     | EN_8P5_5       | Enable signal for 5 V and 8.5 V                                                                                                                     | I    |
| 20     | REG4(1P8sw)    | Output of Reg4 (1.8 V/350 mA)                                                                                                                       | O    |
| 21     | IGNOUT         | Ignition signal output                                                                                                                              | O    |
| 22     | VIN2           | Power supply for Reg3 and Reg4                                                                                                                      | S    |
| 23     | IGNIN          | Ignition signal input                                                                                                                               | I    |
| 24     | REG3((3P3sw)   | Output of Reg3 (3.3 V / 250 mA)                                                                                                                     | O    |
| 25     | EN_3P3_1P8     | Enable signal for 3.3 Vperm and 1.8 Vperm. A resistor of 1 k $\Omega$ in series to this control pin is suggested.                                   | I    |
| 26     | BU2            | Connect to a reserve capacitor. When battery is removed suddenly, the energy stored in this capacitor can still supply reg3 and reg4 for some time. | I/O  |
| 27     | EN_3P3sw_1P8sw | Enable signal for 3.3 V and 1.8 V                                                                                                                   | I    |

## 3 Electrical specifications

### 3.1 Absolute maximum ratings

**Table 3. Absolute maximum ratings**

| Symbol       | Parameter                                                                                          | Value              | Unit |
|--------------|----------------------------------------------------------------------------------------------------|--------------------|------|
| $V_{SDC}$    | DC operating supply voltage                                                                        | 30                 | V    |
| $V_{STR}$    | Transient supply voltage                                                                           | 50                 | V    |
| $I_O$        | Output current                                                                                     | internally limited |      |
| $T_{op}$     | Operating temperature range                                                                        | -40 to 105         | °C   |
| $T_{stg}$    | Storage temperature                                                                                | -55 to 150         | °C   |
| $T_j$        | Junction temperature                                                                               | -55 to 150         | °C   |
| $V_{pinMIN}$ | Minimum pin voltage (EN_SW, AUDIO_LOW_IN, CAN_LOW_IN, EN_8P5_5, IGNIN, EN_3P3_1P8, EN_3P3sw_1P8sw) | -0.3               | V    |

### 3.2 Thermal data

**Table 4. Thermal data**

| Symbol           | Parameter                           | Value    | Unit |
|------------------|-------------------------------------|----------|------|
| $R_{th\ j-case}$ | Thermal resistance junction-to-case | Max. 1.0 | °C/W |

### 3.3 Electrical characteristics

$V_S = 14.4\text{ V}$ ;  $T_{amb} = 25\text{ °C}$ ; unless otherwise specified

**Table 5. Electrical characteristics**

| Symbol                | Parameter               | Test condition                            | Min. | Typ.          | Max. | Unit |
|-----------------------|-------------------------|-------------------------------------------|------|---------------|------|------|
| <b>Input supplies</b> |                         |                                           |      |               |      |      |
| $V_{in1}$             | Input supply voltage 1  | Operating                                 | 9    | -             | 18   | V    |
| $V_{in2}$             | Input supply voltage 2  | Operating                                 | 4.5  | -             | 18   | V    |
| $V_{in1}$             | Input supply voltage 1  | Reverse polarity                          | -    | not operating |      | -    |
| $V_{in2}$             | Input supply voltage 2  | Reverse polarity                          | -    | not operating |      | -    |
| $I_q$                 | Total quiescent current | Standby (-40 °C to 85 °C)<br>Perm reg on  | -    | 50            | 100  | μA   |
|                       |                         | Standby (25 °C) Perm reg off              | -    | 4             | 10   | μA   |
|                       |                         | Standby (-40 °C to 85 °C)<br>Perm reg off | -    | 4             | 30   | μA   |

Table 5. Electrical characteristics (continued)

| Symbol                 | Parameter                       | Test condition                                                             | Min. | Typ. | Max. | Unit |
|------------------------|---------------------------------|----------------------------------------------------------------------------|------|------|------|------|
| Load dump<br>$V_{in1}$ | Battery over voltage            | $V_{in1}$                                                                  | 24   | 26   | 28   | V    |
| Load dump<br>$V_{in2}$ | Battery over voltage            | $V_{in2}$                                                                  | 24   | 26   | 28   | V    |
| <b>Regulator 1</b>     |                                 |                                                                            |      |      |      |      |
| $V_o$ (8.5sw)          | Output voltage 8.5V             | -                                                                          | 8.0  | 8.5  | 8.9  | V    |
| $\Delta V$             | Line regulation                 | $I = 20\text{ mA}$ ; $9\text{ V} < V_s < 18\text{ V}$                      | -    | -    | 50   | mV   |
| $\Delta V_i$           | Load regulation                 | $I_{reg1} = 1\text{ to }20\text{ mA}$                                      | -    | -    | 100  | mV   |
| PSRR                   | Supply voltage ripple rejection | $f = 1\text{ kHz}$ ; $V_{in1} = 1.5\text{ Vpp}$ ;<br>$I_o = 200\text{ mA}$ | 45   | -    | -    | dB   |
| $V_{drop}$             | Drop out voltage                | $I_{reg1} = 200\text{ mA}^{(1)}$                                           | -    | -    | 0.35 | V    |
| $I_m$                  | Current limit                   | $R_{short} = 0.5\ \Omega$                                                  | 0.3  | -    | 0.6  | A    |
| <b>Regulator 2</b>     |                                 |                                                                            |      |      |      |      |
| $V_o$ (5Vsw)           | Output voltage 5V               | -                                                                          | 4.75 | 5    | 5.25 | V    |
| $\Delta V$             | Line regulation                 | $I = 300\text{ mA}$ ; $9\text{ V} < V_s < 18\text{ V}$                     | -    | -    | 50   | mV   |
| $\Delta V_i$           | Load regulation                 | $I_{reg2} = 1\text{ to }300\text{ mA}$                                     | -    | -    | 100  | mV   |
| PSRR                   | Supply voltage ripple rejection | $f = 1\text{ kHz}$ ; $V_{in1} = 1.5\text{ Vpp}$ ;<br>$I_o = 300\text{ mA}$ | 50   | -    | -    | dB   |
| $V_{drop}$             | Drop out voltage                | $I_{reg2} = 300\text{ mA}^{(1)}$                                           | -    | -    | 0.45 | V    |
| $I_m$                  | Current limit                   | $R_{short} = 0.5\ \Omega$                                                  | 400  | -    | 800  | mA   |
| <b>Regulator 3</b>     |                                 |                                                                            |      |      |      |      |
| $V_o$ (3.3sw)          | Output voltage 3.3V             | -                                                                          | 3.15 | 3.30 | 3.45 | V    |
| $\Delta V$             | Line regulation                 | $I = 250\text{ mA}$ ; $4.5\text{ V} < V_s < 18\text{ V}$                   | -    | -    | 50   | mV   |
| $\Delta V_i$           | Load regulation                 | $I_{reg3} = 1\text{ to }250\text{ mA}$                                     | -    | -    | 100  | mV   |
| PSRR                   | Supply voltage ripple rejection | $f = 1\text{ kHz}$ ; $V_{in1} = 1.5\text{ Vpp}$ ;<br>$I_o = 250\text{ mA}$ | 50   | -    | -    | dB   |
| $V_{drop}$             | Drop out voltage                | $I_{reg3} = 250\text{ mA}^{(1)}$                                           | -    | -    | 0.75 | V    |
| $I_m$                  | Current limit                   | $R_{short} = 0.5\ \Omega$                                                  | 400  | -    | 800  | mA   |
| <b>Regulator 4</b>     |                                 |                                                                            |      |      |      |      |
| $V_o$ (1.8sw)          | Output voltage 1.8V             | -                                                                          | 1.73 | 1.80 | 1.90 | V    |
| $\Delta V$             | Line regulation                 | $I = 350\text{ mA}$ ; $4.5\text{ V} < V_s < 18\text{ V}$                   | -    | -    | 50   | mV   |
| $\Delta V_i$           | Load regulation                 | $I_{reg4} = 1\text{ to }350\text{ mA}$                                     | -    | -    | 100  | mV   |
| PSRR                   | Supply voltage ripple rejection | $f = 1\text{ kHz}$ ; $V_{in1} = 1.5\text{ Vpp}$ ;<br>$I_o = 350\text{ mA}$ | 50   | -    | -    | dB   |
| $V_{drop}$             | Drop out voltage                | $I_{reg4} = 350\text{ mA}^{(1)}$                                           | -    | -    | 2.2  | V    |
| $I_m$                  | Current limit                   | $R_{short} = 0.5\ \Omega$                                                  | 430  | -    | 800  | mA   |

Table 5. Electrical characteristics (continued)

| Symbol                                                          | Parameter                       | Test condition                                                       | Min. | Typ. | Max.  | Unit          |
|-----------------------------------------------------------------|---------------------------------|----------------------------------------------------------------------|------|------|-------|---------------|
| <b>Regulator 5</b>                                              |                                 |                                                                      |      |      |       |               |
| $V_{O(3.3perm)}$                                                | Output voltage 3.3 V            | -                                                                    | 3.15 | 3.30 | 3.45  | V             |
| $\Delta V$                                                      | Line regulation                 | $I = 100 \text{ mA}; 9 \text{ V} < V_S < 18 \text{ V}$               | -    | -    | 50    | mV            |
| $\Delta V_i$                                                    | Load regulation                 | $I_{reg4} = 1 \text{ to } 100 \text{ mA}$                            | -    | -    | 100   | mV            |
| PSRR                                                            | Supply voltage ripple rejection | $f = 1 \text{ kHz}; V_{in1} = 1.5 \text{ Vpp}; I_o = 100 \text{ mA}$ | 50   | -    | -     | dB            |
| $V_{drop}$                                                      | Drop out voltage                | $I_{reg4} = 100 \text{ mA}^{(1)}$                                    | -    | -    | 0.7   | V             |
| $I_m$                                                           | Current limit                   | $R_{short} = 0.5 \Omega$                                             | 150  | -    | 300   | mA            |
| <b>Regulator 6</b>                                              |                                 |                                                                      |      |      |       |               |
| $V_{O(1.8perm)}$                                                | Output voltage 1.8V             | -                                                                    | 1.73 | 1.80 | 1.90  | V             |
| $\Delta V$                                                      | Line regulation                 | $I = 100 \text{ mA}; 9 \text{ V} < V_S < 18 \text{ V}$               | -    | -    | 50    | mV            |
| $\Delta V_i$                                                    | Load regulation                 | $I_{reg4} = 1 \text{ to } 100 \text{ mA}$                            | -    | -    | 100   | mV            |
| PSRR                                                            | Supply voltage ripple rejection | $f = 1 \text{ kHz}; V_{in1} = 1.5 \text{ Vpp}; I_o = 100 \text{ mA}$ | 50   | -    | -     | dB            |
| $V_{drop}$                                                      | Drop out voltage                | $I_{reg4} = 100 \text{ mA}^{(1)}$                                    | -    | -    | 2.2   | V             |
| $I_m$                                                           | Current limit                   | $R_{short} = 0.5 \Omega$                                             | 150  | -    | 300   | mA            |
| <b>Power switch</b>                                             |                                 |                                                                      |      |      |       |               |
| $V_{dropSW}$                                                    | Drop voltage power switch       | $I_{dcSW} = 1.8 \text{ A max.}$                                      | -    | -    | 0.5   | V             |
| $I_{pSW1}$                                                      | Peak current power switch       | Peak time < 10 ms                                                    | 2    | -    | 3.5   | A             |
| $I_{pSW2}$                                                      | Peak current power switch       | Peak time > 40 ms                                                    | 0.9  | -    | 2     | A             |
| SWDEL                                                           | Delay Protection                | -                                                                    | 10   | -    | 40    | ms            |
| <b>Reset buffer (open drain RESET for permanent regulators)</b> |                                 |                                                                      |      |      |       |               |
| $RES_{reg5}$                                                    | RES threshold voltage for reg5  | $V_{reg5} = 3.3 \text{ V}$                                           | 3.00 | 3.15 | 3.25  | V             |
| $V_{hys\_reg5}$                                                 | hysteresis of reset for reg5    |                                                                      | 10   | 50   | 100   | mV            |
| $RES_{reg6}$                                                    | RES threshold voltage for reg6  | $V_{reg6} = 1.8 \text{ V}$                                           | 1.67 | -    | 1.833 | V             |
| $V_{hys\_reg6}$                                                 | Hysteresis of reset for reg6    |                                                                      | 10   | 20   | 40    | mV            |
| $V_{ol}$                                                        | Low level                       | $I_{SINK(RES)} = 1 \text{ mA}$                                       | -    | 0.3  | 0.5   | V             |
| $I_{LSink(RES)}$                                                | Low level sink current          | Reset = 5 V                                                          | 15   | 20   | 24    | mA            |
| RES delay                                                       | $C_{res} = 47\text{nF}$         |                                                                      | 20   | 42   | 70    | ms            |
| $\Delta T_{RES}$                                                | Reset rise and fall time        | $R = 10 \text{ k}\Omega \text{ \& } C = 15 \text{ pF}$               | -    | -    | 50    | $\mu\text{s}$ |
| $I_{Charge}$                                                    | Charge current                  | $C_{RES} = 0 \text{ V}$                                              | 1    | 2    | 3     | $\mu\text{A}$ |
| $I_{Discharge}$                                                 | Discharge current               | $C_{RES} = 5 \text{ V}$                                              | 0.5  | -    | 3     | mA            |

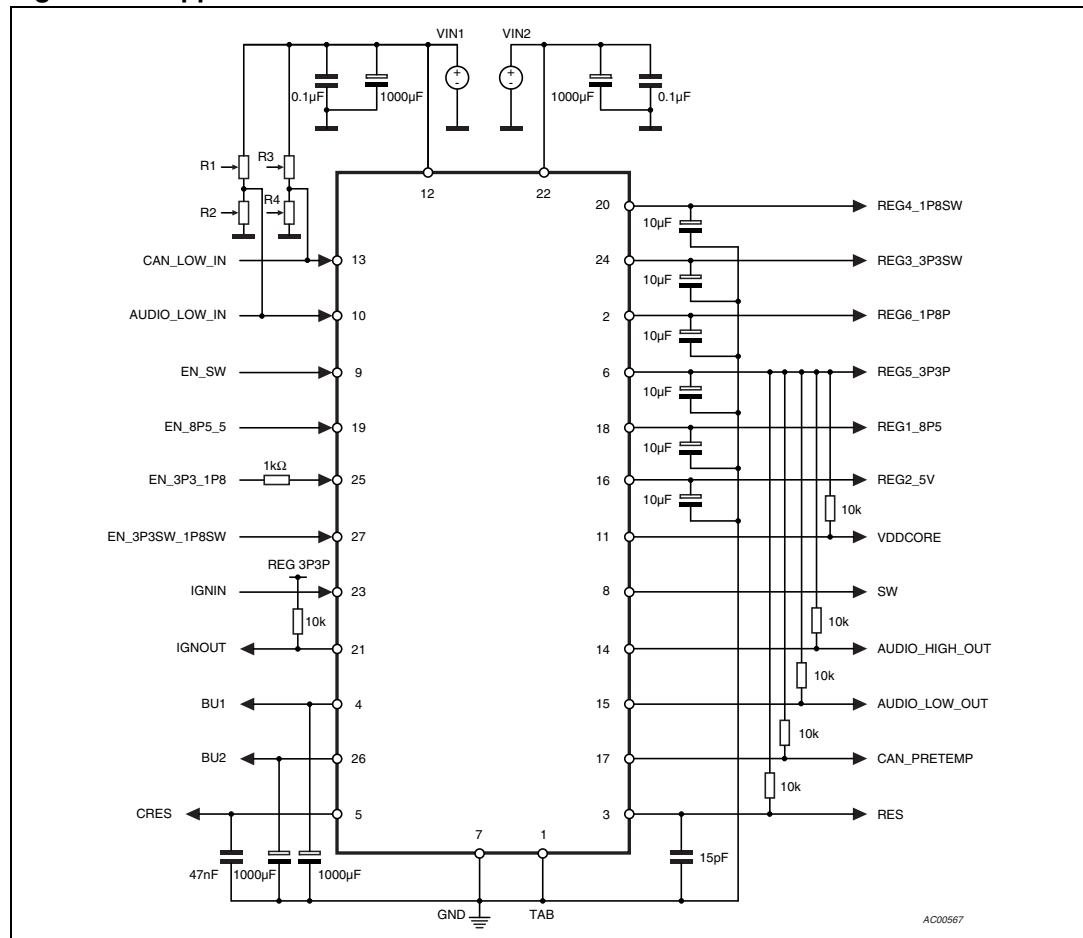
Table 5. Electrical characteristics (continued)

| Symbol                                                                | Parameter                      | Test condition                            | Min. | Typ.   | Max.  | Unit |
|-----------------------------------------------------------------------|--------------------------------|-------------------------------------------|------|--------|-------|------|
| <b>VDD_CORE_VAL buffer (open drain RESET for switched regulators)</b> |                                |                                           |      |        |       |      |
| RES <sub>reg3</sub>                                                   | RES threshold voltage for reg3 | V <sub>reg3</sub> = 3.3 V                 | 3.00 | 3.15   | 3.25  | V    |
| V <sub>hys_reg3</sub>                                                 | Hysteresis of reset for reg3   | -                                         | 10   | 50     | 100   | mV   |
| RES <sub>reg4</sub>                                                   | RES threshold voltage for reg4 | V <sub>reg4</sub> = 1.8 V                 | 1.67 | -      | 1.833 | V    |
| V <sub>hys_reg4</sub>                                                 | Hysteresis of reset for reg4   | -                                         | 10   | 20     | 40    | mV   |
| V <sub>ol</sub>                                                       | Low level                      | I <sub>SINK(RES)</sub> = 1 mA             | -    | 0.3    | 0.5   | V    |
| <b>Hold CAN signal (open drain for VIN1 battery warning 1)</b>        |                                |                                           |      |        |       |      |
| Hold1_high                                                            | Hold high threshold            | -                                         | 17   | -      | 20    | V    |
| V <sub>HYS</sub>                                                      | Hysteresis high TH.            | -                                         | 150  | 400    | 600   | mV   |
| Hold1_low                                                             | Hold low threshold             | -                                         | 5    | -      | 6     | V    |
| V <sub>HYS</sub>                                                      | Hysteresis low TH.             | -                                         | 200  | 400    | 600   | mV   |
| V <sub>ol</sub>                                                       | Low level                      | I <sub>SINK(RES)</sub> = 1 mA             | -    | 0.3    | 0.5   | V    |
| V <sub>REF</sub>                                                      | Reference voltage              | -                                         | -    | 1.2565 | -     | V    |
| <b>Hold audio signal (open drain for VIN1 battery warning 2)</b>      |                                |                                           |      |        |       |      |
| Hold2_high                                                            | Hold high threshold            | -                                         | 15.2 | -      | 17.8  | V    |
| V <sub>HYS</sub>                                                      | Hysteresis high TH.            | -                                         | 150  | 400    | 600   | mV   |
| Hold2_low                                                             | Hold low threshold             | -                                         | 7.8  | -      | 9.2   | V    |
| V <sub>HYS</sub>                                                      | Hysteresis low TH.             | -                                         | 200  | 400    | 600   | mV   |
| V <sub>ol</sub>                                                       | Low level                      | I <sub>SINK(RES)</sub> = 1 mA             | -    | 0.3    | 0.5   | V    |
| V <sub>REF</sub>                                                      | Reference voltage              | -                                         | -    | 1.2565 | -     | V    |
| <b>Ignition buffer (open drain)</b>                                   |                                |                                           |      |        |       |      |
| IGN <sub>IN</sub>                                                     | I <sub>GNout</sub> falling     | -                                         | 1.03 | 1.17   | 1.28  | V    |
| V <sub>hys(IGNout)</sub>                                              | Hysteresis of ignition buffer  | -                                         | 30   | 50     | 100   | mV   |
| V <sub>ol</sub>                                                       | Low level                      | I <sub>Lsink (IGNout)</sub> = 1 mA        | -    | 0.3    | 0.5   | V    |
| IGN <sub>RISE</sub>                                                   | Rising time                    | C = 15 pF                                 | -    | -      | 10    | μs   |
| IGN <sub>FALL</sub>                                                   | Fall time                      | C = 15 pF                                 | -    | -      | 10    | μs   |
| I <sub>CLAMP</sub>                                                    | Input clamp current            | V <sub>CC</sub> < V <sub>IGN</sub> < 50 V | -    | -      | 2     | mA   |
| IGN <sub>IN</sub>                                                     | Input voltage                  | Operative                                 | 0    | -      | 50    | V    |
| <b>Enable input (regulators 1,2,3,4,5,6 and power switch)</b>         |                                |                                           |      |        |       |      |
| V <sub>TH</sub>                                                       | Voltage threshold              | -                                         | 1.3  | -      | 2.3   | V    |
| EN <sub>IN(reg1,2,3,4 power switch)</sub>                             | Input voltage                  | Operative                                 | 0    | -      | 5     | V    |
| EN <sub>IN(reg5,6)</sub>                                              | Input voltage                  | Operative                                 | 0    | -      | 24    | V    |

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 current

### 3.4 Application diagram

Figure 3. Application circuit



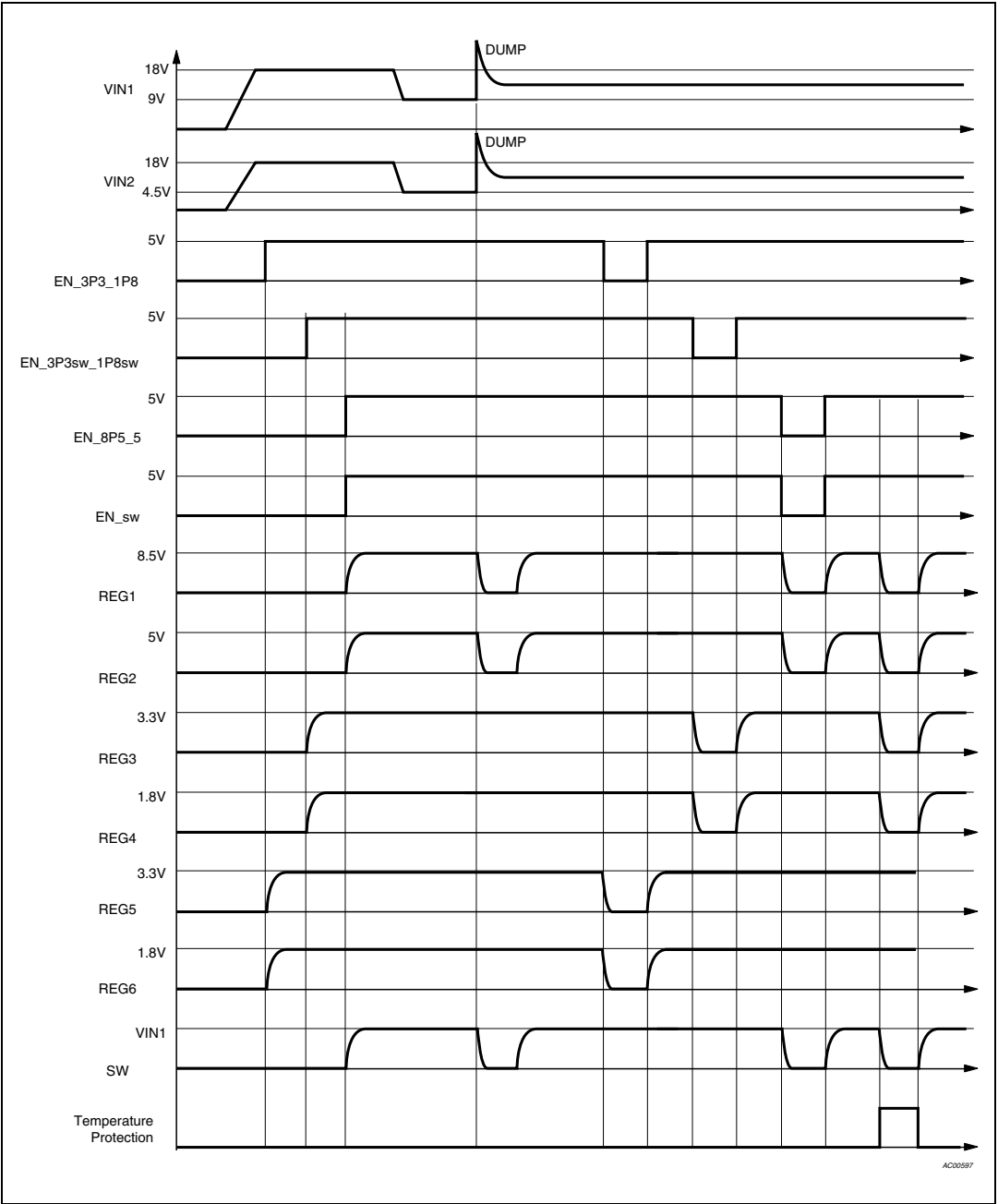
Recommended output filtering capacitors for all the regulators: C range = 5 µF to 100 µF, ESR range = 50 mΩ to 10 Ω (T= -40 °C to +85 °C)

The detection voltage thresholds (for both the battery warning 1 and 2) can be changed lower with external resistors, as following:

$$V_{TH1}(\text{hold\_can}) = 1.25V (R3 + R4) / R4$$

$$V_{TH2}(\text{hold\_audio}) = 1.25V (R1 + R2) / R2$$

Figure 4. Regulator and power switch diagram



3.5 Timing diagrams

Figure 5. Timing chart  $V_{batt}$  detection

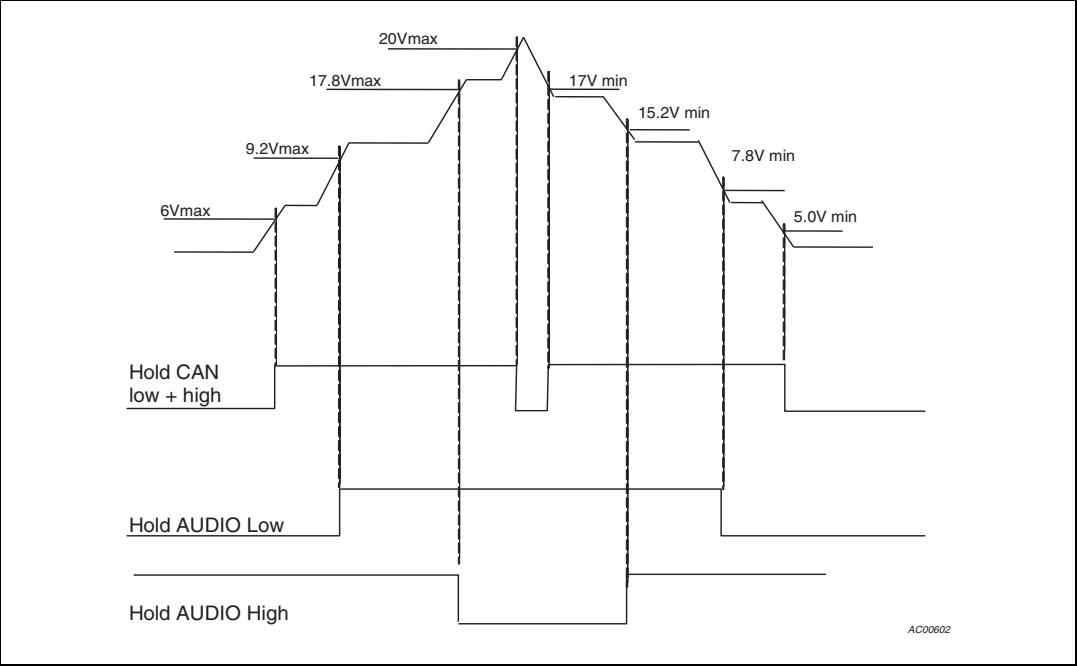


Figure 6. Timing chart 1.8 Vperm/3.3 Vperm and 1.8V sw/3.3 Vsw

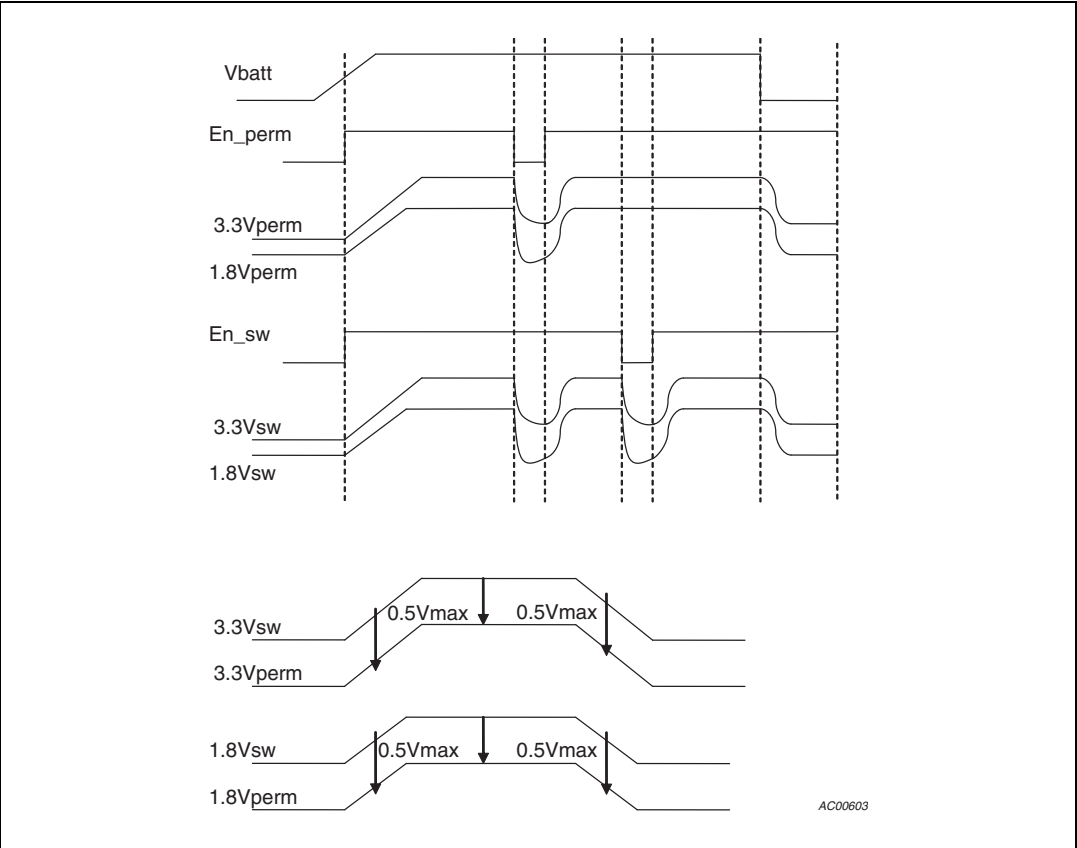


Figure 7. Reset and BU1 backup diagram

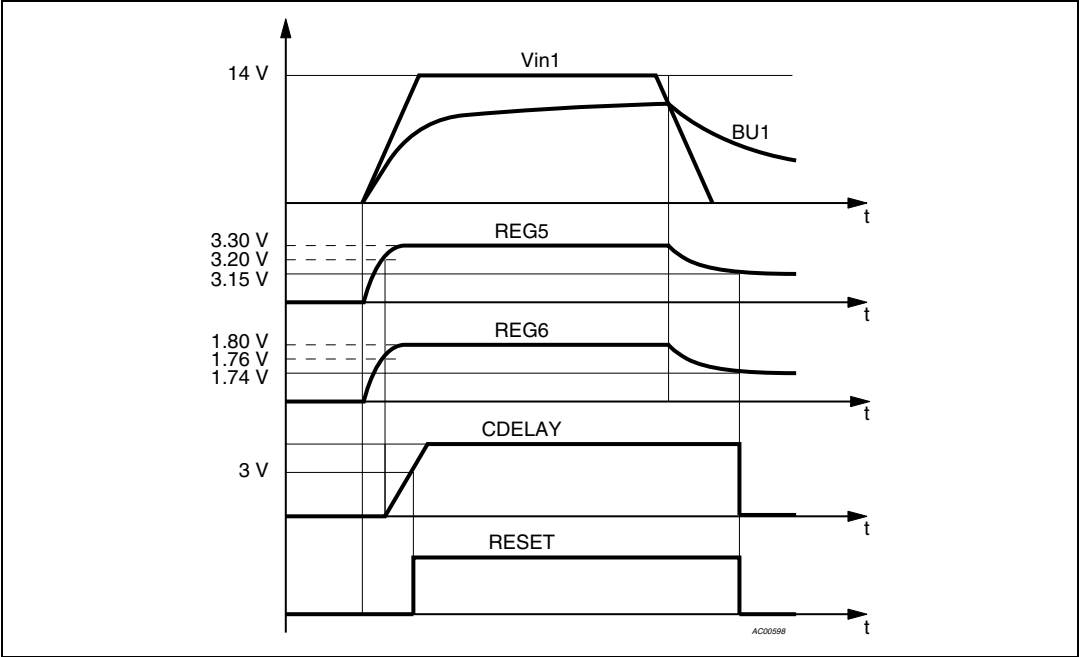


Figure 8. BU2 backup diagram

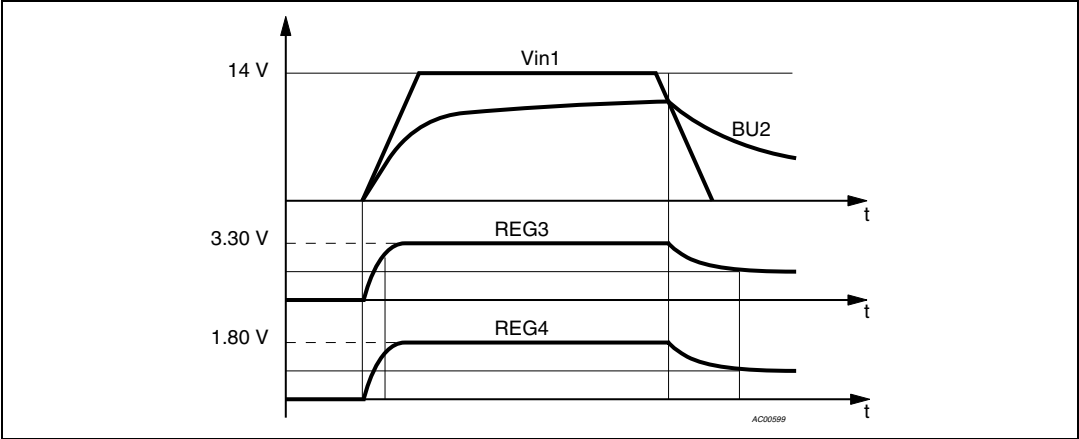
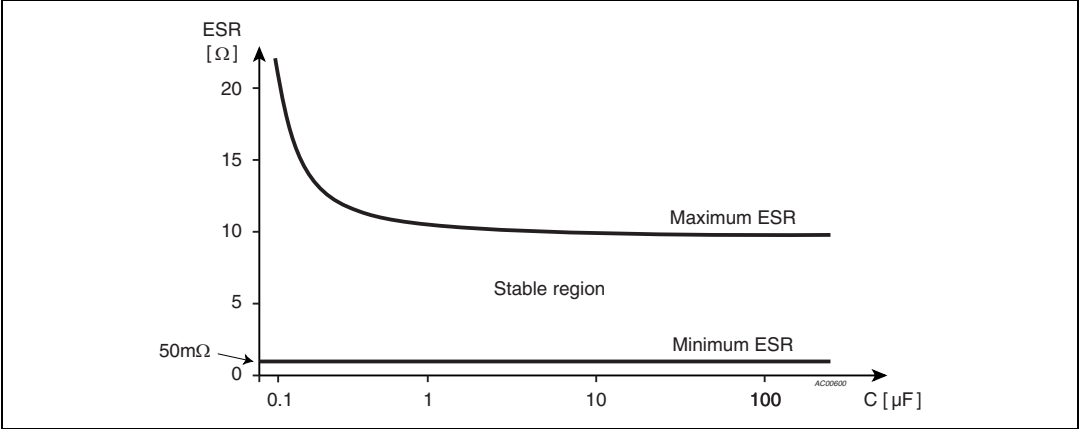
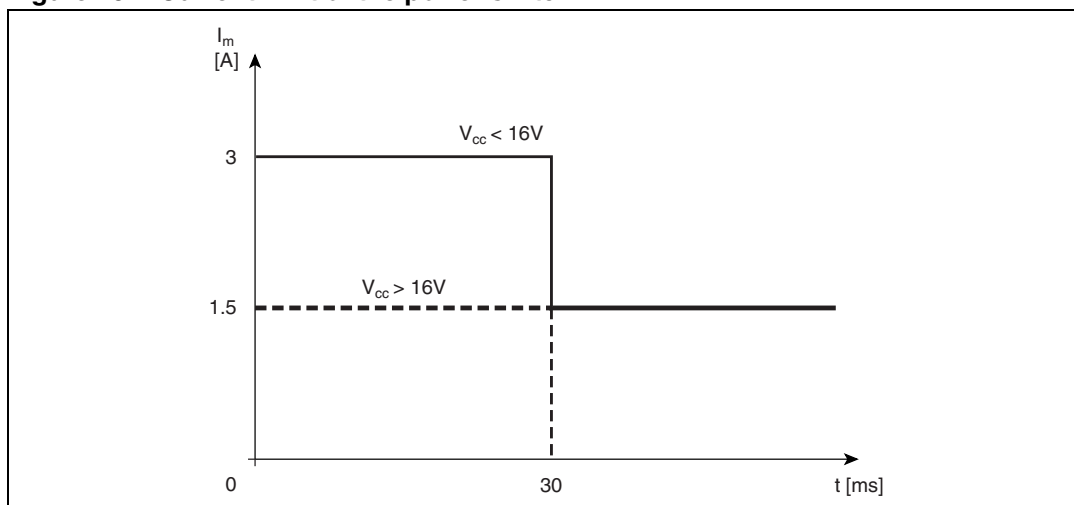


Figure 9. Maximum ESR for stability (valid for all the regulator outputs)



**Figure 10. Current limit of the power switch**

## 4 Package information

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com).

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**Figure 11. Flexiwatt27 (vertical) mechanical data and package dimensions**

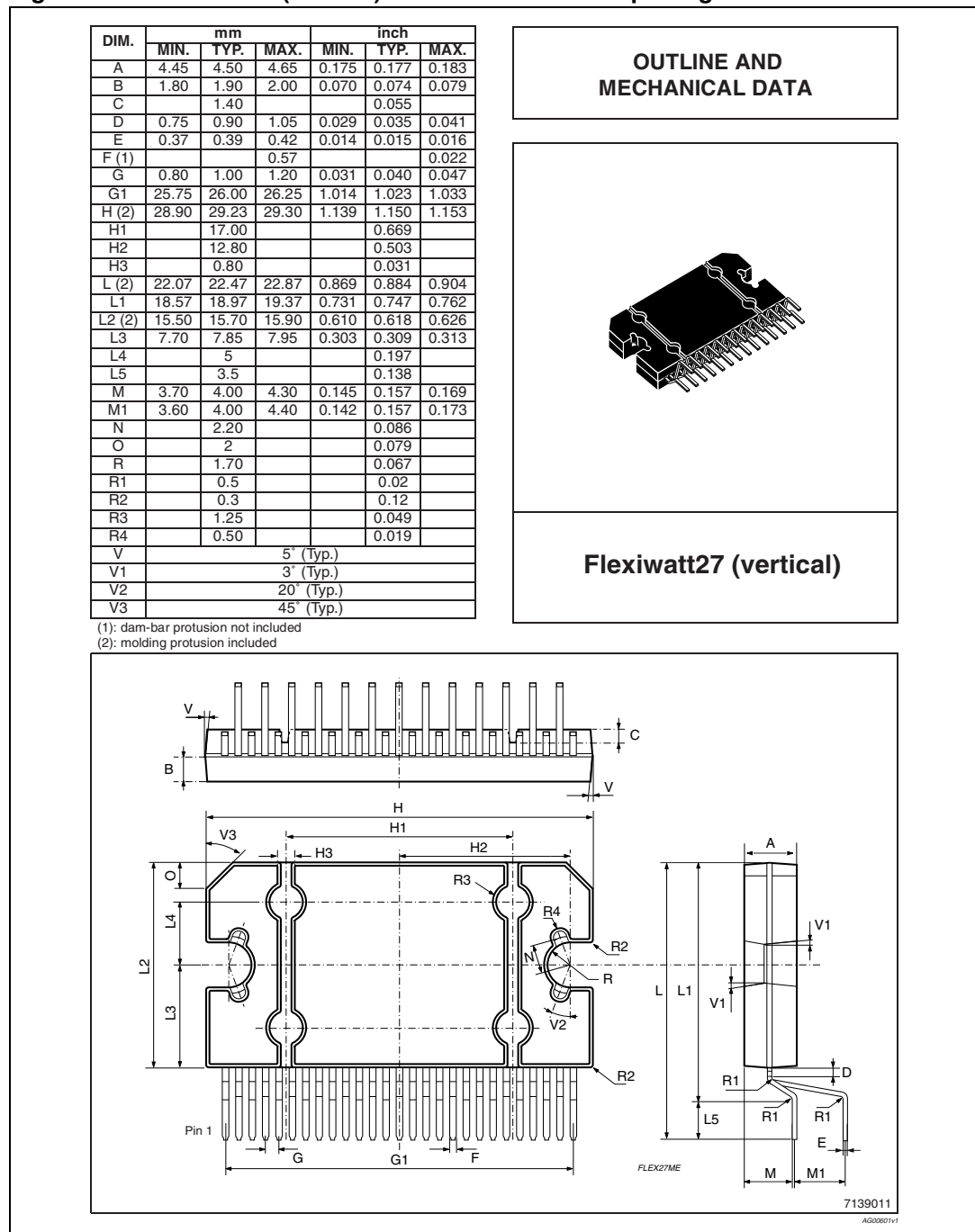
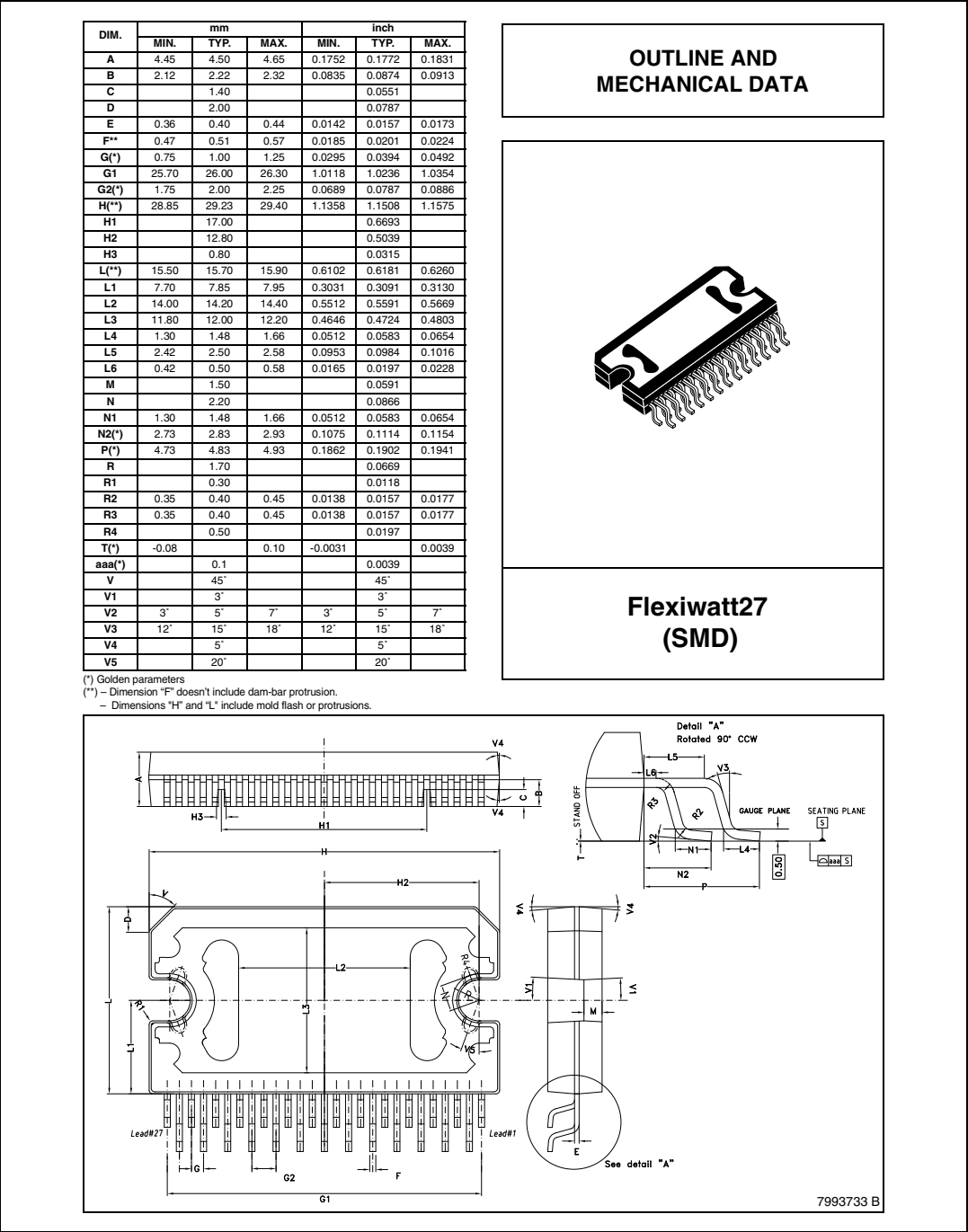


Figure 12. Flexiwatt27 (SMD) mechanical data and package dimensions



## 5 Revision history

**Table 6. Document revision history**

| Date        | Revision | Changes             |
|-------------|----------|---------------------|
| 12-Jul-2010 | 1        | Initial release.    |
| 18-Sep-2013 | 2        | Updated Disclaimer. |

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