



# SSL21082/SSL21084

Mains dimmable LED controller IC

Rev. 5.1 — 8 January 2013

Product data sheet

## 1. General description

---

The SSL21082 and SSL21084 are high-voltage Integrated Circuits (IC) for driving retrofit LED lamps in general lighting applications. They enable the implementation of a very compact low-cost system solution. The IC's have an integrated internal HV switch and work as Boundary Conduction Mode (BCM) buck converter.

The SSL21082 and SSL21084 are supplied by a start-up bleeder resistor, a  $dV/dt$  supply using capacitive coupling from the drain or any other auxiliary supply. The IC supply current is low. An internal clamp limits the supply voltage.

They have accurate output current control and can be operated using Pulse-Width Modulation (PWM) dimming. In addition, several protection features are available such as easy external temperature feedback.

The main benefits of this IC include:

- Small Printed-Circuit Board (PCB) footprint and compact solution
- High efficiency (up to 90 %) for non-dimmable high power factor solutions
- High power factor ( $>0.9$ )
- Ease of integration and many protection features
- Low electronic Bill Of Material (BOM)
- Mains phase-cut dimmable using external components
- Highly flexible IC for use in buck, buck/boost and flyback modes
- Single inductor used for non-isolated configurations because of internal demagnetization detection and  $dV/dt$  supply

The IC range is designed to start-up directly from the HV supply using an internal high-voltage current source. An internal clamp limits the supply voltage.



## 2. Features and benefits

---

- LED controller IC for driving strings of LEDs or high-voltage LED modules from a rectified mains supply
- Power-efficient boundary conduction mode operation with:
  - ◆ No reverse recovery losses in freewheel diode
  - ◆ Zero-Current Switching (ZCS) for switch turn-on
  - ◆ Zero-voltage or valley switching for switch turn-off
  - ◆ Minimal required inductance value and size
- Fast transient response through cycle-by-cycle current control:
  - ◆ No overshoot or undershoot in the LED current
- Simple high input power factor solution (>0.9)
- Internal Protection features:
  - ◆ UnderVoltage LockOut (UVLO)
  - ◆ Leading-Edge Blanking (LEB)
  - ◆ OverCurrent Protection (OCP)
  - ◆ Short-winding protection (SWP); SSL21082T/SSL21084T only
  - ◆ Internal OverTemperature Protection (OTP)
  - ◆ Brownout protection
- Mains phase cut dimmable LED driver solution:
  - ◆ Supports both leading-edge and trailing-edge dimmers
  - ◆ Easy external temperature protection with a single NTC
  - ◆ Open output protection using external components
  - ◆ Compatible with wall switches with built-in indication light during standby
- IC lifetime easily matches or surpasses LED lamp lifetime
- Input current distributed evenly over the phase, reducing required output capacitor size and bleeder dissipation

## 3. Applications

---

The SSL21082 and SSL21084 are intended for mains dimmable compact LED lamps for single mains input voltages. Mains input voltages include 100 V (AC), 120 V (AC) and 230 V (AC).

## 4. Quick reference data

**Table 1. Quick reference data**

| Symbol      | Parameter                        | Conditions   | Min   | Typ  | Max  | Unit     |
|-------------|----------------------------------|--|-------|------|------|----------|
| $V_{CC}$    | supply voltage                   | operating range                                    | [1] 8 | -    | 16   | V        |
| $R_{DSon}$  | drain-source on-state resistance | SSL21082T and SSL21082AT;<br>$T_j = 25\text{ °C}$  | 2.05  | 2.3  | 2.55 | $\Omega$ |
|             |                                  | SSL21082T and SSL21082AT;<br>$T_j = 125\text{ °C}$ | 3.05  | 3.45 | 3.85 | $\Omega$ |
|             |                                  | SSL21084T and SSL21084AT;<br>$T_j = 25\text{ °C}$  | 4     | 5    | 6    | $\Omega$ |
|             |                                  | SSL21084T and SSL21084AT;<br>$T_j = 125\text{ °C}$ | 6     | 7.5  | 9    | $\Omega$ |
| $I_{DRAIN}$ | current on pin DRAIN             | SSL21082T and SSL21082AT                           | -2    | -    | +2   | A        |
|             |                                  | SSL21084T and SSL21084AT                           | -1    | -    | 1    | A        |
| $V_{DRAIN}$ | voltage on pin DRAIN             | SSL21082T and SSL21082AT                           | -0.4  | -    | 300  | V        |
|             |                                  | SSL21084T and SSL21084AT                           | -0.4  | -    | 600  | V        |
| $f_{conv}$  | conversion frequency             |  | -     | 100  | -    | kHz      |

[1] An internal clamp sets the supply voltage. The current into the VCC pin must not exceed the maximum  $I_{DD}$  value (see [Table 4](#)).

## 5. Ordering information

**Table 2. Ordering information**

| Type number | Package |   | Version   |
|-------------|---------|---|-----------|
|             | Name    | Description   |           |
| SSL21082T   | SO12    | plastic small package outline body; 12 leads; body width 3.9 mm | SOT1196-1 |
| SSL21082AT  |         |   |           |
| SSL21084T   |         |   |           |
| SSL21084AT  |         |   |           |

6. Block diagram

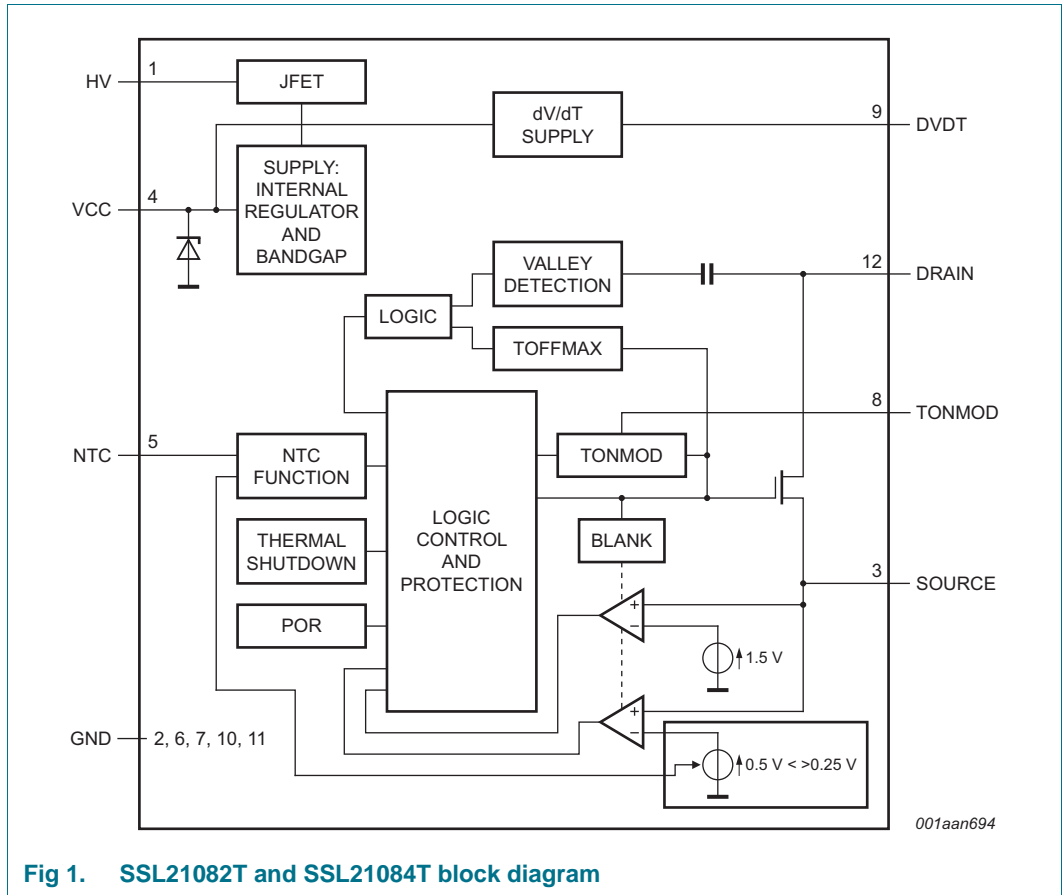


Fig 1. SSL21082T and SSL21084T block diagram

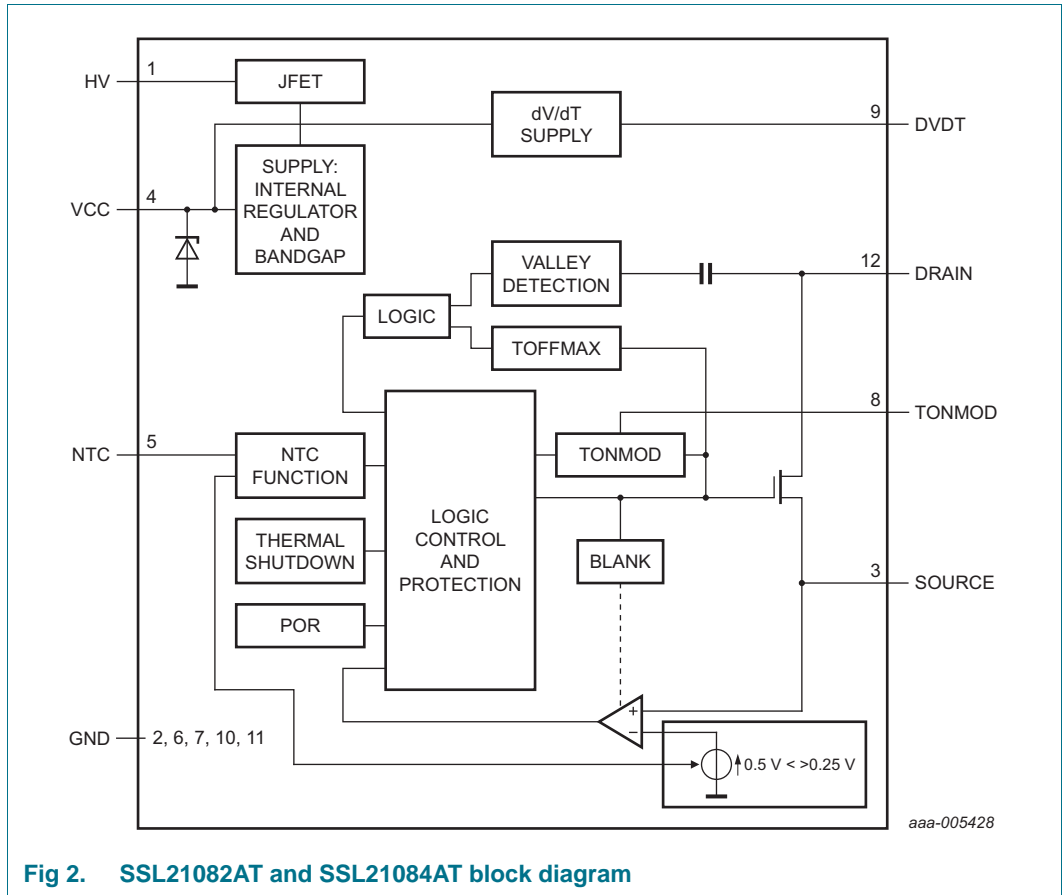
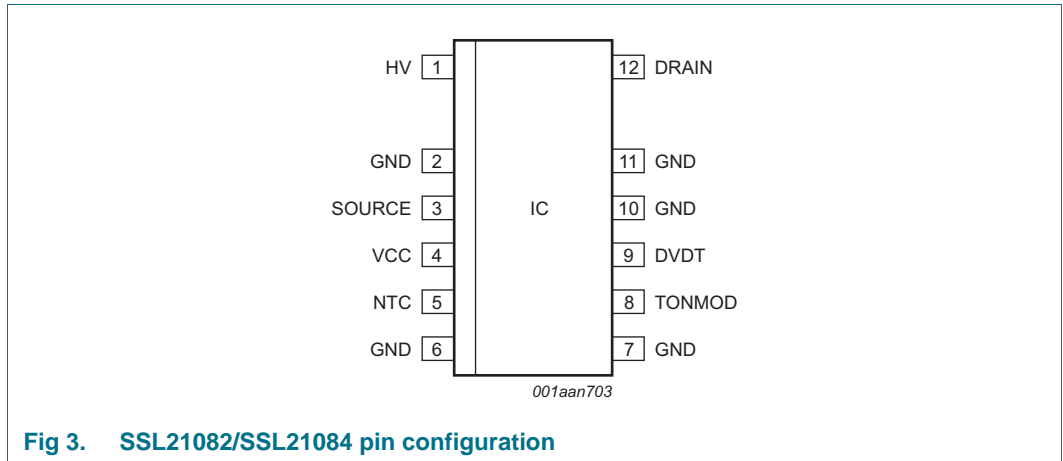


Fig 2. SSL21082AT and SSL21084AT block diagram

## 7. Pinning information

### 7.1 Pinning



### 7.2 Pin description

**Table 3. Pin description**

| Symbol | Pin             | Description                  |
|--------|-----------------|------------------------------|
| HV     | 1               | high-voltage supply pin      |
| GND    | 2, 6, 7, 10, 11 | ground                       |
| SOURCE | 3               | low-side external switch     |
| VCC    | 4               | supply voltage               |
| NTC    | 5               | temperature protection input |
| TONMOD | 8               | on time modulation input     |
| DVDT   | 9               | AC supply pin                |
| DRAIN  | 12              | high-side external switch    |

## 8. Functional description

### 8.1 Introduction

The SSL21082 and SSL21084 are controller IC solutions for small form factor mains phase-cut dimmable LED lamps in isolated and non-isolated applications.

### 8.2 Converter operation

The converter in the SSL21082 and SSL21084 is a Boundary Conduction Mode (BCM), peak current controlled system. See [Figure 4](#) for the basic application diagram. See [Figure 5](#) for relevant the waveforms.

This converter type operates at the boundary between continuous and discontinuous mode. Energy is stored in inductor L each period that the switch is on. The inductor current  $I_L$  is zero when the MOSFET is switched on. The amplitude of the current build-up in L is proportional to the voltage drop over the inductor and the time that the MOSFET switch is on. When the MOSFET is switched off, the energy in the inductor is released towards the output. The current then falls at a rate proportional to the value of  $V_O$ . The LED current  $I_{LED}$  depends on the peak current through the inductor (SSL21082/SSL21084 controlled) and on the dimmer angle while it is optimized for a high-power factor. A new cycle is started once the inductor current  $I_L$  is zero. This quasi-resonant operation results in higher efficiency.

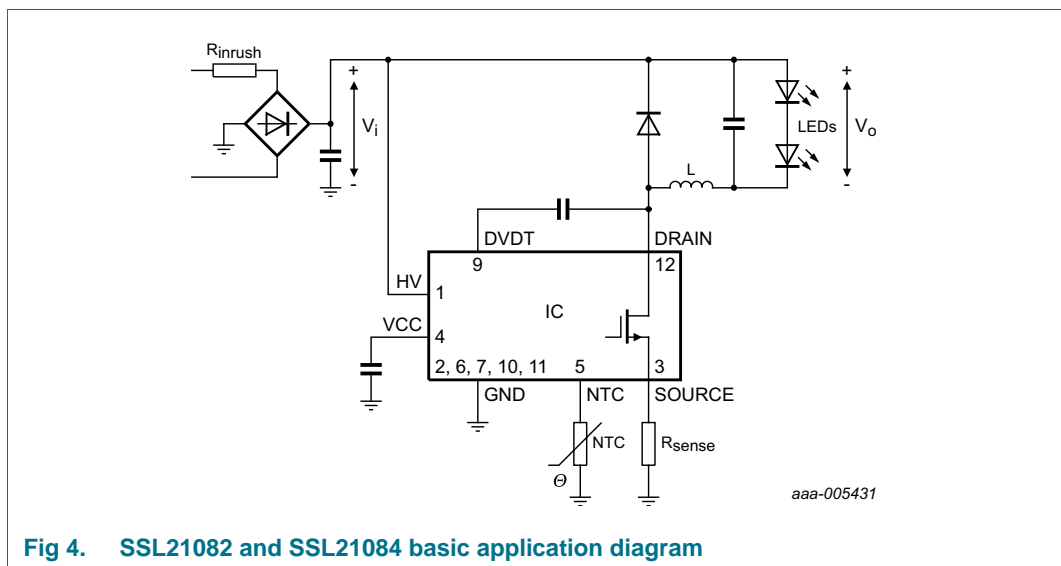


Fig 4. SSL21082 and SSL21084 basic application diagram

### 8.3 Valley detection

A new cycle is started when the primary switch is switched on (see Figure 5). In the following sections, “on” represents the conductive state and off the non-conductive state.

Following time  $t_1$ , when the peak current is detected on the SOURCE pin, the switch is turned off and the secondary stroke starts at  $t_2$ . When the secondary stroke is completed with the coil current at  $t_3$  equaling zero, the drain voltage starts to oscillate at approximately the  $V_i - V_O$  level. The peak to peak amplitude equals  $2 \times V_O$ . In tapped buck topology, this amplitude is multiplied by the ratio of the windings.

A special feature, called valley detection is an integrated part of the SSL21082 and SSL21084 circuitry. Dedicated built-in circuitry connected to the DRAIN pin, senses when the voltage on the drain of the switch reaches its lowest value. The next cycle is then started at  $t_{00}$  and as a result the capacitive switching losses are reduced. A valley is detected and accepted when both the frequency of the oscillations and the voltage swing are within the range specified ( $f_{ring}$  and  $\Delta V_{vrec(min)}$ ) for detection.  $\Delta V_{vrec(min)}$  is the voltage differential between the HV (pin) in and the DRAIN pin. If a valid valley is not detected, the secondary stroke is continued until the maximum off-time ( $t_{off(high)}$ ) is reached, then the next cycle is started.

A series resistance can be included at the drain sensing pin for flyback mode to remove the high-frequency ringing caused by the transformer leakage inductance.

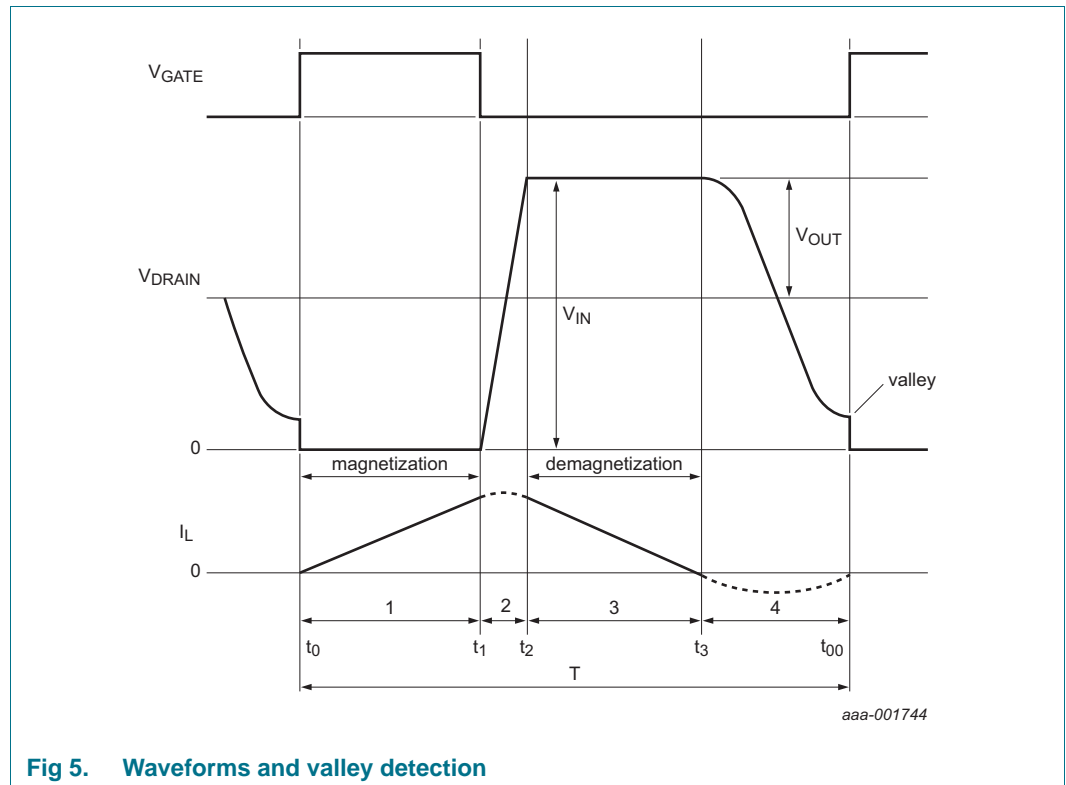


Fig 5. Waveforms and valley detection



## 8.4 Protective features

The IC has the following protective features:

- UnderVoltage LockOut (UVLO)
- Leading-Edge Blanking (LEB)
- OverCurrent Protection (OCP)
- Internal OverTemperature Protection (OTP)
- Brownout protection
- Short-winding protection (SWP): T versions only
- LED overtemperature control and protection
- An optional output OverVoltage Protection circuit is implemented using external components and the NTC pin.

The internal OTP and LED over temperature protections are safe-restart protections. The IC halts, causing  $V_{CC}$  to fall below  $V_{CC(stop)}$  and triggers a start-up. When  $V_{CC}$  drops lower than  $V_{CC(rst)}$ , the IC resets the latch protection mode. If  $V_{CC}$  drops below  $V_{CC(stop)}$ , the IC halts. Switching starts only when no fault condition exists.

### 8.4.1 UnderVoltage LockOut (UVLO)

When the voltage on the VCC pin  $< V_{CC(stop)}$ , the IC stops switching. An attempt is then made to restart by supplying  $V_{CC}$  from the HV pin voltage.

### 8.4.2 Leading-Edge Blanking (LEB)

To prevent false detection of the short-winding or overcurrent, a blanking time following switch-on is implemented. When the MOSFET switch turns on there can be a short current spike due to capacitive discharge of voltage over the drain and source. During the LEB time ( $t_{leb}$ ), the spike is disregarded.

### 8.4.3 OverCurrent Protection (OCP)

The SSL21082 and SSL21084 contains a highly accurate peak current detector. It triggers when the voltage on the SOURCE pin reaches the peak level  $V_{th(ocp)SOURCE}$ . The current through the switch is sensed using a resistor connected to the SOURCE pin. The sense circuit is activated following LEB time  $t_{leb}$ . As the LED current is half the peak current (by design), it automatically provides protection for maximum LED current during operation. There is a propagation delay  $t_{d(ocp-swoff)}$  between overcurrent detection and the actual closure of the switch. Due to the delay, the actual peak current is slightly higher than the OCP level set by the resistor in series to the SOURCE pin.

### 8.4.4 OverTemperature Protection (OTP)

When the internal OTP function is triggered at a certain IC temperature ( $T_{th(act)otp}$ ), the converter stops operating. The OTP safe-restart protection and the IC restarts again with switching resuming when the IC temperature drops below  $T_{th(rel)otp}$ .

### 8.4.5 Brownout protection

Brownout protection is designed to limit the lamp power when the input voltage drops close to the output voltage level. Since the input power must remain constant, the input current would otherwise increase to a level that is too large for the input circuitry. In the SSL21082 and SSL21084, there is a maximum limit on the on-time of switch  $t_{on(high)}$ .

In buck mode, the rate of current rise in the coil during the on-phase is proportional to the difference between input voltage and output voltage. Therefore, the peak current cannot be reached before  $t_{on(high)}$  and as a result the average output current to the LEDs is reduced.

#### 8.4.6 $t_{on}$ control

The  $t_{on(high)}$  can be lowered by connecting a capacitor to the TONMOD pin. The external capacitor is charged during the primary stroke with  $I_{TONMOD}$ . If the  $V_{TONMOD}$  level is reached before the  $t_{on(high)}$  time, the switch is turned off and the secondary stroke starts. When a capacitor is not connected to the pin,  $V_{TONMOD}$  is reached quickly. Shorter than the minimum limit of 1  $\mu$ s. In this case or when the TONMOD pin is grounded, the internal time constant,  $t_{on(high)}$  determines the maximum on-time. This function is used to control the converter operation over the mains cycle which enables the design of a mains dimmable driver.

#### 8.4.7 Short-winding protection

This protection activates when there is a steep rising current on the SOURCE pin. This current occurs when there is very small or an inductor is not present between the input voltage and DRAIN pin. When the voltage on the SOURCE pin is > 1.5 V after the Leading-edge blanking time, the latched protection is triggered.

This feature is only available with the SSL21082T and SSL21084T versions.

### 8.5 VCC supply

The SSL21082 and SSL21084 can be supplied using three methods:

- Under normal operation, the voltage swing on the DVDT pin is internally rectified to provide current on the VCC pin
- At start-up, there is an internal current source connected to the HV pin. The current source provides internal power until either the  $dV/dt$  supply or an external current on the VCC pin provides the supply.
- Using an auxiliary winding, the voltage can be rectified and connected to the VCC pin.

The IC starts up when the voltage at the VCC pin is higher than  $V_{CC(startup)}$ . The IC locks out (stops switching) when the voltage on the VCC pin is lower than  $V_{CC(stop)}$ . The hysteresis between the start and stop levels allows the IC to be supplied by a buffer capacitor until the external supply is stable. The SSL21082 and SSL21084 have an internal  $V_{CC}$  clamp, which is an internal active Zener (or shunt regulator). This internal active Zener limits the voltage on the supply VCC pin to the maximum value of  $V_{CC}$ . If the maximum current of the supply minus the current consumption of the IC (determined by the load on the gate drivers), is lower than the maximum value of  $I_{DD}$ , an external Zener diode is not needed in the supply circuit.

#### 8.5.1 VCC regulator

During supply dips, the input voltage can drop too low to supply the required IC current. Under these conditions, if the VCC voltage drops lower than  $V_{CC(swon)reg}$  level, a second regulator is started. Its function is to fill in the required supply current which the external supply does not deliver. It prevents the IC going into UVLO. When the VCC voltage is higher than  $V_{CC(swon)reg}$  level, the regulator is turned off.

### 8.6 DVDT pin supply (dV/dt)

The DVDT pin is connected to an internal single-sided rectification stage. When an alternating voltage with sufficient amplitude is supplied to this pin, the IC can be powered without another external power connection. This solution provides a compact effective solution without introducing high-power losses and without the need for an additional inductor winding.

### 8.7 NTC functionality and PWM dimming

The NTC pin can be used as a control method for LED thermal protection.

Alternatively, the pin can be used as an input to disable/enable light output using a digital signal (PWM dimming). The pin has an internal current source which generates a current  $I_{offset(NTC)}$ . An NTC resistor, for monitoring the LED temperature, can be directly connected to the NTC pin. Depending on the resistance value and the corresponding NTC pin voltage, the converter reacts as shown in [Figure 6](#)

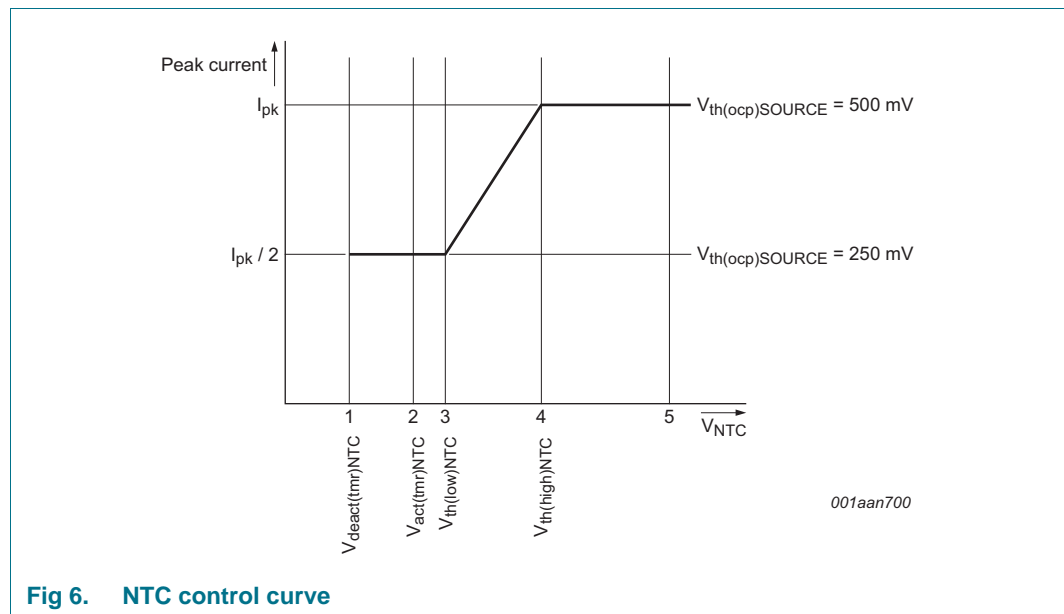


Fig 6. NTC control curve

When the voltage on the NTC pin is higher than  $V_{th(high)NTC}$ , see [Figure 6\(4\)](#), the converter delivers nominal output current. When the voltage is lower than this level, the peak current is gradually reduced until  $V_{th(low)NTC}$  is reached, see [Figure 6\(3\)](#). The peak current is now half the peak current of nominal operation. When  $V_{act(tmr)NTC}$  is passed, see [Figure 6\(2\)](#), a timer starts to run which distinguishes between the following situations:

- If the low-level  $V_{deact(tmr)NTC}$  is not reached within time  $t_{to(deact)NTC}$  [Figure 6\(1\)](#), LED overtemperature is detected. The IC stops switching and attempts to restart from the HV pin voltage. Restart takes place when the voltage on NTC pin is higher than  $V_{th(high)NTC}$ , see [Figure 6\(4\)](#). It is assumed that the reduction in peak current did not result in a lower NTC temperature and LED OTP is activated.
- If the low-level  $V_{deact(tmr)NTC}$  is reached within the time  $t_{to(deact)NTC}$  [Figure 6\(1\)](#), it is assumed the pin is pulled down externally. The restart function is not triggered. Instead, the output current is reduced to zero. PWM dimming can be implemented this way. The output current rises again when the voltage is higher than  $V_{deact(tmr)NTC}$ .

### 8.7.1 Soft-start function

The NTC pin can be used to make a soft start function. During switch-on, the level on the NTC pin is low. By connecting a capacitor (in parallel with the NTC resistor), a time constant can be defined. The time constant causes the level on the NTC pin to increase slowly. When passing level  $V_{th(low)NTC}$  [Figure 6\(3\)](#), the convertor starts with half of the maximum current. The output current slowly increases to maximum when  $V_{th(high)NTC}$  [Figure 6\(4\)](#) is reached.

## 8.8 Mains dimmer compatibility

The SSL21082/SSL21084 provides mains dimmer compatibility using dynamic  $t_{on}$  control. This control is used to shape an input current waveform to provide the most effective current to load the dimmer over most of the mains cycle. In the dimmed position, the output current is controlled both by the conductive phase of the dimmer and the slope current control of the TONMOD function. An additional advantage of this method is a high-power factor.

The additional dimming range is achieved by modulating the charge current of the capacitor connected to the TONMOD pin.

## 8.9 Heat sink

In SSL21082/SSL21084 applications, the PCB copper acts as the heat sink. The IC has thermal leads (GND pins 2, 6, 10 and 11) for enhanced heat transfer from die to the PCB copper heat sink. The thermal lead connection can drastically reduce thermal resistance. [Equation 1](#) shows the relationship between the maximum allowable power dissipation and the thermal resistance from junction to ambient.

$$R_{th(j-a)} = \frac{(T_{j(max)} - T_{amb})}{P} \quad (1)$$

Where:

$R_{th(j-a)}$  = thermal resistance from junction to ambient

$T_{j(max)}$  = maximum junction temperature

$T_{amb}$  = ambient temperature

P = Power dissipation

## 9. Limiting values

**Table 4. Limiting values**

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

| Symbol                         | Parameter                       | Conditions                                     | Min      | Max  | Unit |
|--------------------------------|---------------------------------|--|----------|------|------|
| <b>General</b>                 |                                 |  |          |      |      |
| SR                             | slew rate                       | on pin DRAIN                                   | -5       | +5   | V/ns |
| P <sub>tot</sub>               | total power dissipation         | SO12 package                                   | -        | 1    | W    |
| T <sub>amb</sub>               | ambient temperature             |  | -40      | +125 | °C   |
| T <sub>j</sub>                 | junction temperature            |  | -40      | +150 | °C   |
| T <sub>stg</sub>               | storage temperature             |  | -55      | +150 | °C   |
| <b>Voltages</b>                |                                 |  |          |      |      |
| V <sub>CC</sub>                | supply voltage                  | continuous                                     | [1] -0.4 | +20  | V    |
| V <sub>DRAIN</sub>             | voltage on pin DRAIN            | SSL21082                                       | -0.4     | +300 | V    |
|                                |                                 | SSL21084                                       | -0.4     | +600 |      |
| V <sub>HV</sub>                | voltage on pin HV               | current limited                                | -0.4     | +600 | V    |
| V <sub>SOURCE</sub>            | voltage on pin SOURCE           | current limited                                | -0.4     | +5.2 | V    |
| V <sub>NTC</sub>               | voltage on pin NTC              | current limited                                | -0.4     | +5.2 | V    |
| V <sub>TONMOD</sub>            | voltage on pin TONMOD           | current limited                                | -0.4     | +5.2 | V    |
| <b>Currents</b>                |                                 |  |          |      |      |
| I <sub>DD</sub>                | supply current                  | on pin VCC                                     | [2] -    | 20   | mA   |
| I <sub>DRAIN</sub>             | current on pin DRAIN            | SSL21082                                       | -2       | +2   | mA   |
|                                |                                 | SSL21084                                       | -1       | +2   | mA   |
| I <sub>SOURCE</sub>            | current on pin SOURCE           | SSL21082                                       | -2       | +2   | mA   |
|                                |                                 | SSL21084                                       | -1       | +1   | mA   |
| I <sub>DVTD</sub>              | current on pin DVDT             | duration 20 μs maximum                         | -        | 1.3  | mA   |
| <b>Electrostatic discharge</b> |                                 |  |          |      |      |
| V <sub>ESD</sub>               | electrostatic discharge voltage | human body model; all pins except DRAIN and HV | [3] -2   | +2   | kV   |
|                                |                                 | human body model; DRAIN and HV                 | -1       | +1   | kV   |
|                                |                                 | charged device                                 | [4] -500 | +500 | V    |

[1] The current into the VCC pin must not exceed the maximum I<sub>DD</sub> value.

[2] An internal clamp sets the supply voltage.

[3] Human body model: equivalent to discharging a 100 pF capacitor through a 1.5 kΩ series resistor.

[4] Charged device model: equivalent to charging the IC up to 1 kV and the subsequent discharging of each pin down to 0 V over a 1 Ω resistor.

## 10. Thermal characteristics

**Table 5. Thermal characteristics**

| Symbol         | Parameter                                   | Conditions   | Typ | Unit |
|----------------|---|--|-----|------|
| $R_{th(j-a)}$  | thermal resistance from junction to ambient | in free air; PCB: 2 cm × 3 cm; 2-layer; 35 μm Cu per layer               | 121 | K/W  |
|                |   | in free air; PCB: JEDEC 2s2p   | 53  | K/W  |
| $\Psi_{j-top}$ | thermal resistance from junction to top     | top package temperature measured at the warmest point on top of the case | 3.4 | K/W  |

## 11. Characteristics

**Table 6. Characteristics**

| Symbol                 | Parameter  | Conditions  | Min                 | Typ  | Max  | Unit |
|------------------------|--|---|---------------------|------|------|------|
| $f_{conv}$             | conversion frequency   |   | -                   | 100  | -    | kHz  |
| <b>High-voltage</b>    |  |   |                     |      |      |      |
| $I_{leak(DRAIN)}$      | leakage current on pin DRAIN                                   | SSL21082; $V_{DRAIN} = 300$ V   | -                   | -    | 10   | μA   |
|                        |  | SSL21084; $V_{DRAIN} = 600$ V   | -                   | -    | 10   | μA   |
| $I_{leak(HV)}$         | leakage current on pin HV                                      | SSL21082; $V_{HV} = 300$ V  | -                   | -    | 30   | μA   |
|                        |  | SSL21084; $V_{HV} = 600$ V  | -                   | -    | 30   | μA   |
| <b>Supply</b>          |  |   |                     |      |      |      |
| $V_{CC}$               | supply voltage   | operating range   | <a href="#">1</a> 8 | -    | 16   | V    |
| $V_{CC(startup)}$      | start-up supply voltage  |   | 11                  | 12   | 13   | V    |
| $V_{CC(stop)}$         | stop supply voltage  |   | 8                   | 9    | 10   | V    |
| $V_{CC(hys)}$          | hysteresis of supply voltage                                   | between $V_{CC(startup)}$ and $V_{CC(stop)}$                                | 2                   | -    | 4.5  | V    |
| $V_{CC(rst)}$          | reset supply voltage   |   | 4.5                 | 5    | 5.5  | V    |
| $V_{CC(swon)reg}$      | regulator switch-on supply voltage                             |   | 8.75                | 9.25 | 9.75 | V    |
| $V_{CC(swoff)reg}$     | regulator switch-off supply voltage                            |   | 9.5                 | 10   | 10.5 | V    |
| $V_{CC(reg)hys}$       | regulator supply voltage hysteresis                            | $V_{CC(swoff)reg} - V_{CC(swon)reg}$  | 0.3                 | -    | -    | V    |
| $V_{CC(regswon-stop)}$ | supply voltage difference between regulator switch-on and stop | $V_{CC(swon)reg} - V_{CC(stop)}$  | 0.3                 | -    | -    | V    |
| <b>Consumption</b>     |  |   |                     |      |      |      |
| $I_{stb(HV)}$          | standby current on pin HV                                      | during start-up or in protection;<br>$V_{HV} = 100$ V                       | 300                 | 350  | 400  | μA   |
| $I_{CC(INT)}$          | internal supply current  | normal operation  | -                   | 1.3  | -    | mA   |
| <b>Capability</b>      |  |   |                     |      |      |      |
| $I_{sup(high)HV}$      | high supply current on pin HV                                  | Standby: $V_{HV} = 40$ V;<br>$V_{CC} < V_{CC(stop)}$                        | 1                   | 1.3  | 1.6  | mA   |
|                        |  | Regulator on: $V_{HV} = 40$ V;<br>$V_{CC} < V_{CC(swon)reg}$ after start-up | 2                   | 2.3  | 2.6  | mA   |

Table 6. Characteristics ...continued

| Symbol                       | Parameter  | Conditions   | Min                   | Typ  | Max   | Unit             |
|------------------------------|--|--|-----------------------|------|-------|------------------|
| <b>Current and SWP</b>       |  |  |                       |      |       |                  |
| $V_{th(ocp)SOURCE}$          | overcurrent protection threshold voltage on pin SOURCE   | $\Delta V/\Delta t = 0.1 \text{ V}/\mu\text{s}$                                | 480                   | 500  | 520   | mV               |
|                              |  | $\Delta V/\Delta t = 0.1 \text{ V}/\mu\text{s}; V_{NTC} = 0.325 \text{ V}$     | 230                   | 250  | 270   | mV               |
| $t_{d(ocp-swoff)}$           | delay time from overcurrent protection to switch-off     | $\Delta V/\Delta t = 0.1 \text{ V}/\mu\text{s}$                                | -                     | 75   | 100   | ns               |
| $t_{leb}$                    | leading edge blanking time                               | overcurrent protection   | 260                   | 300  | 340   | ns               |
| $\Delta t_{leb}$             | leading edge blanking time difference                    | between $t_{leb}$ for OCP and SWP  | 30                    | 50   | -     | ns               |
| $V_{th(SWP)SOURCE}$          | short-winding protection threshold voltage on pin SOURCE | SSL21082T/SSL21084T only   | 1.4                   | 1.5  | 1.6   | V                |
| <b>Valley detection</b>      |  |  |                       |      |       |                  |
| $(\Delta V/\Delta t)_{vrec}$ | valley recognition voltage change with time              | on pin DRAIN   | -30                   | -20  | -10   | V/ $\mu\text{s}$ |
| $f_{ring}$                   | ringing frequency  |  | <a href="#">2</a> 200 | 550  | 1000  | kHz              |
| $\Delta V_{vrec(min)}$       | minimum valley recognition voltage difference            | voltage drop on pin DRAIN  | 15                    | 20   | 25    | V                |
| $t_{d(vrec-swon)}$           | valley recognition to switch on delay time               |  | -                     | 100  | -     | ns               |
| <b>Brownout detection</b>    |  |  |                       |      |       |                  |
| $V_{th(TONMOD)}$             | threshold voltage on pin TONMOD                          |  | 3.75                  | 4    | 4.25  | V                |
| $I_{offset(TONMOD)}$         | offset current on pin TONMOD                             |  | -37                   | -43  | -48   | $\mu\text{A}$    |
| $t_{on(high)}$               | high on-time   |  | 12.5                  | 15   | 17.5  | $\mu\text{s}$    |
| <b>MOSFET output stage</b>   |  |  |                       |      |       |                  |
| $V_{BR(DRAIN)}$              | breakdown voltage on pin DRAIN                           | SSL21082; $T_j > 0 \text{ }^\circ\text{C}$                                     | 300                   | -    | -     | V                |
|                              |  | SSL21084; $T_j > 0 \text{ }^\circ\text{C}$                                     | 600                   | -    | -     | V                |
| $R_{DSon}$                   | drain-source on-state resistance                         | SSL21082; $T_j = 25 \text{ }^\circ\text{C}$                                    | 2.05                  | 2.3  | 2.55  | $\Omega$         |
|                              |  | SSL21082; $T_j = 125 \text{ }^\circ\text{C}$                                   | 3.05                  | 3.45 | 3.85  | $\Omega$         |
|                              |  | SSL21084; $T_j = 25 \text{ }^\circ\text{C}$                                    | 4                     | 5    | 6     | $\Omega$         |
|                              |  | SSL21084; $T_j = 125 \text{ }^\circ\text{C}$                                   | 6                     | 7.5  | 9     | $\Omega$         |
| $(dV/dt)_f(DRAIN)$           | fall rate of change of voltage on pin DRAIN              | SSL21082; $C_{DRAIN} = 150 \text{ pF}$ ,<br>$R_{SOURCE} = 2.2 \text{ } \Omega$ | -                     | 1.2  | -     | V/ns             |
|                              |  | SSL21084; $C_{DRAIN} = 75 \text{ pF}$ ,<br>$R_{SOURCE} = 2.2 \text{ } \Omega$  | <a href="#">2</a> -   | 1.5  | -     | V/ns             |
| <b>NTC functionality</b>     |  |  |                       |      |       |                  |
| $V_{th(high)NTC}$            | high threshold voltage on pin NTC                        |  | 0.47                  | 0.5  | 0.53  | V                |
| $V_{th(low)NTC}$             | low threshold voltage on pin NTC                         |  | 0.325                 | 0.35 | 0.375 | V                |
| $V_{act(tmr)NTC}$            | timer activation voltage on pin NTC                      |  | 0.26                  | 0.3  | 0.325 | V                |
| $V_{deact(tmr)NTC}$          | timer deactivation voltage on pin NTC                    |  | 0.17                  | 0.2  | 0.23  | V                |
| $t_{to(deact)NTC}$           | deactivation time-out time on pin NTC                    |  | 33                    | 46   | 59    | $\mu\text{s}$    |
| $I_{offset(NTC)}$            | offset current on pin NTC                                |  | -                     | -47  | -     | $\mu\text{A}$    |

**Table 6.** Characteristics ...continued

| Symbol                        | Parameter  | Conditions | Min | Typ | Max | Unit |
|-------------------------------|--|------------|-----|-----|-----|------|
| <b>Temperature protection</b> |  |            |     |     |     |      |
| $T_{th(Act)otp}$              | overtemperature protection<br>activation threshold temperature |            | 160 | 170 | 180 | °C   |
| $T_{th(rel)otp}$              | overtemperature protection<br>release threshold temperature    |            | 90  | 100 | 110 | °C   |

[1] An internal clamp sets the supply voltage. The current into the VCC pin must not exceed the maximum  $I_{DD}$  value (see [Table 4](#)).

[2] This parameter is not tested during production, by design it is guaranteed

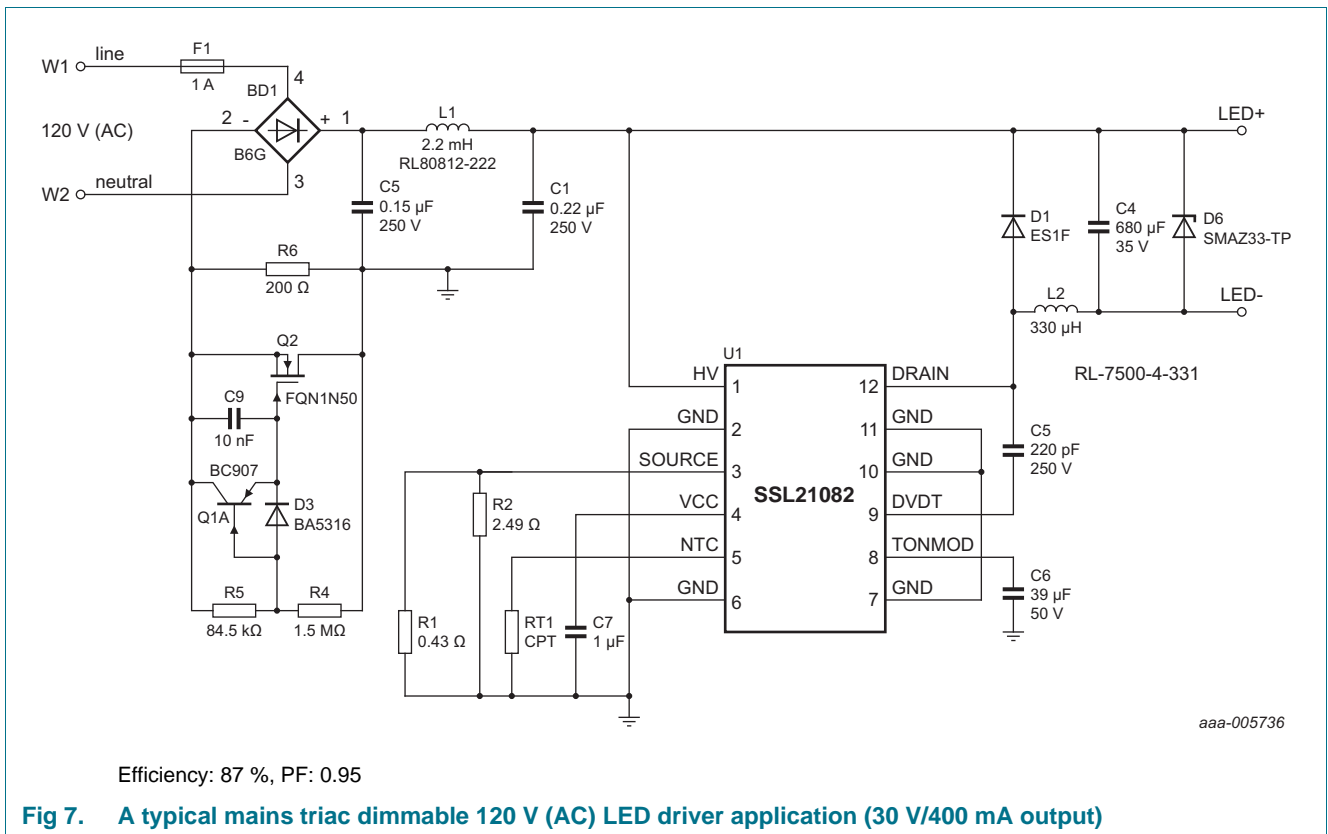


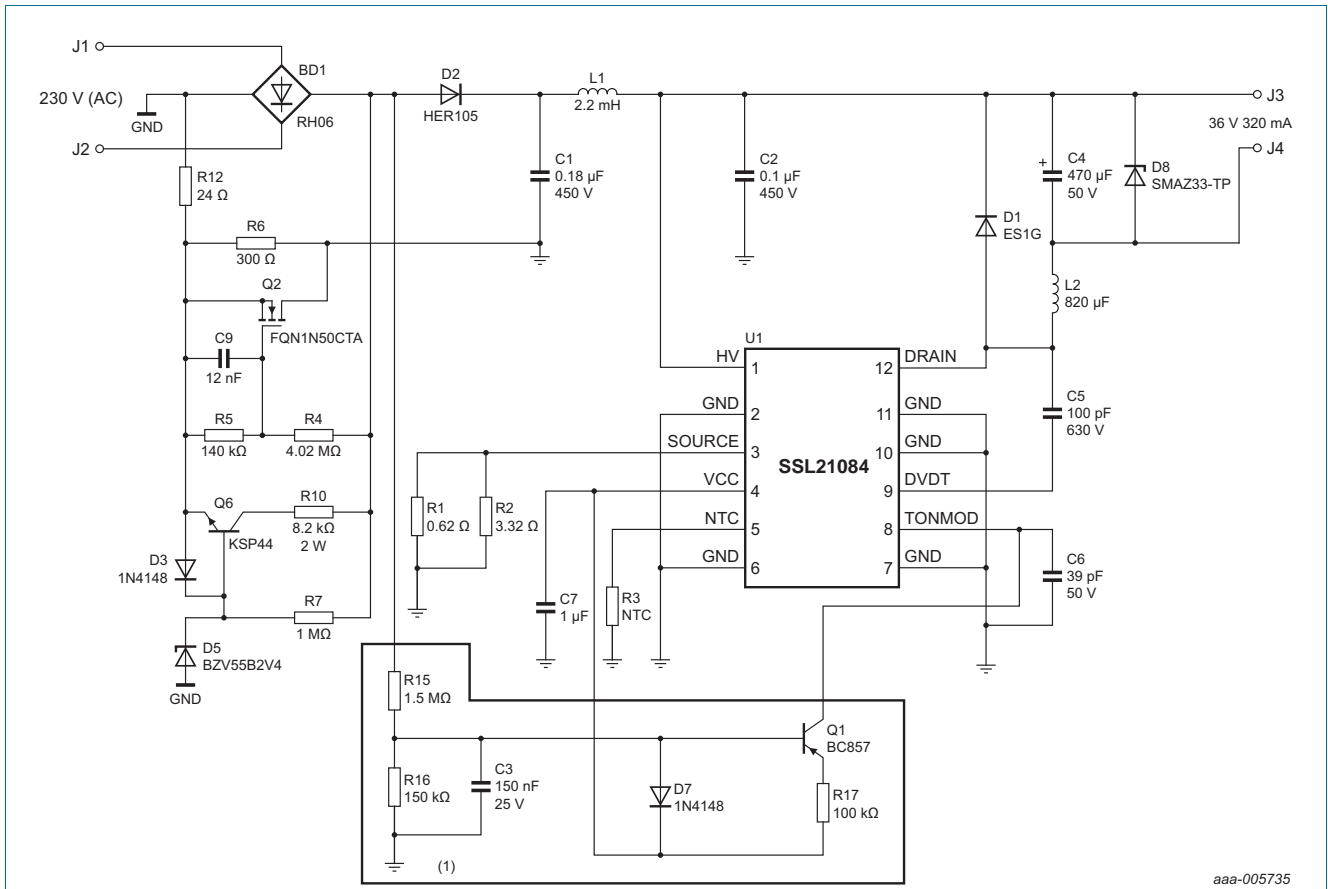
## 12. Application information

An LED driver with the SSL21082 and SSL21084 can be a buck, tapped buck or flyback converter operating in BCM (see Figure 8). The tapped buck option offers the advantage of larger duty factor and less peak current through the MOSFET switch, resulting in higher efficiency and higher converter ratio. The recommended voltage swing on the DRAIN pin is limited by the  $\Delta V_{vrec(min)}$  parameter. With a tapped buck configuration, this limitation is overcome enabling lower output voltages.

It is recommended for 230 V applications that a TVS is placed after the rectifier bridge to limit maximum voltage over the bus. In mains dimmable solutions, the bus voltage can become substantially higher than the nominal mains voltage without clamping because of line resonance and rectification. This can destroy the electrolytic capacitors, IC or MOSFET. Open string protection can be added using the auxiliary winding voltage to pull-down the NTC pin voltage. In addition, the TVS prevents voltage spikes due to for example lighting surges.

Further information can be found in the *SSL21082 and SSL21084 application note*.





aaa-005735

Efficiency: 86 %, PF: 0.91 .

(1) optional for deep dimming.

**Fig 8. A typical mains dimmable tapped 230 V (AC) LED driver application (36 V/320 mA output)**

13. Package outline

SO12: plastic small outline package; 12 leads; body width 3.9 mm

SOT1196-1

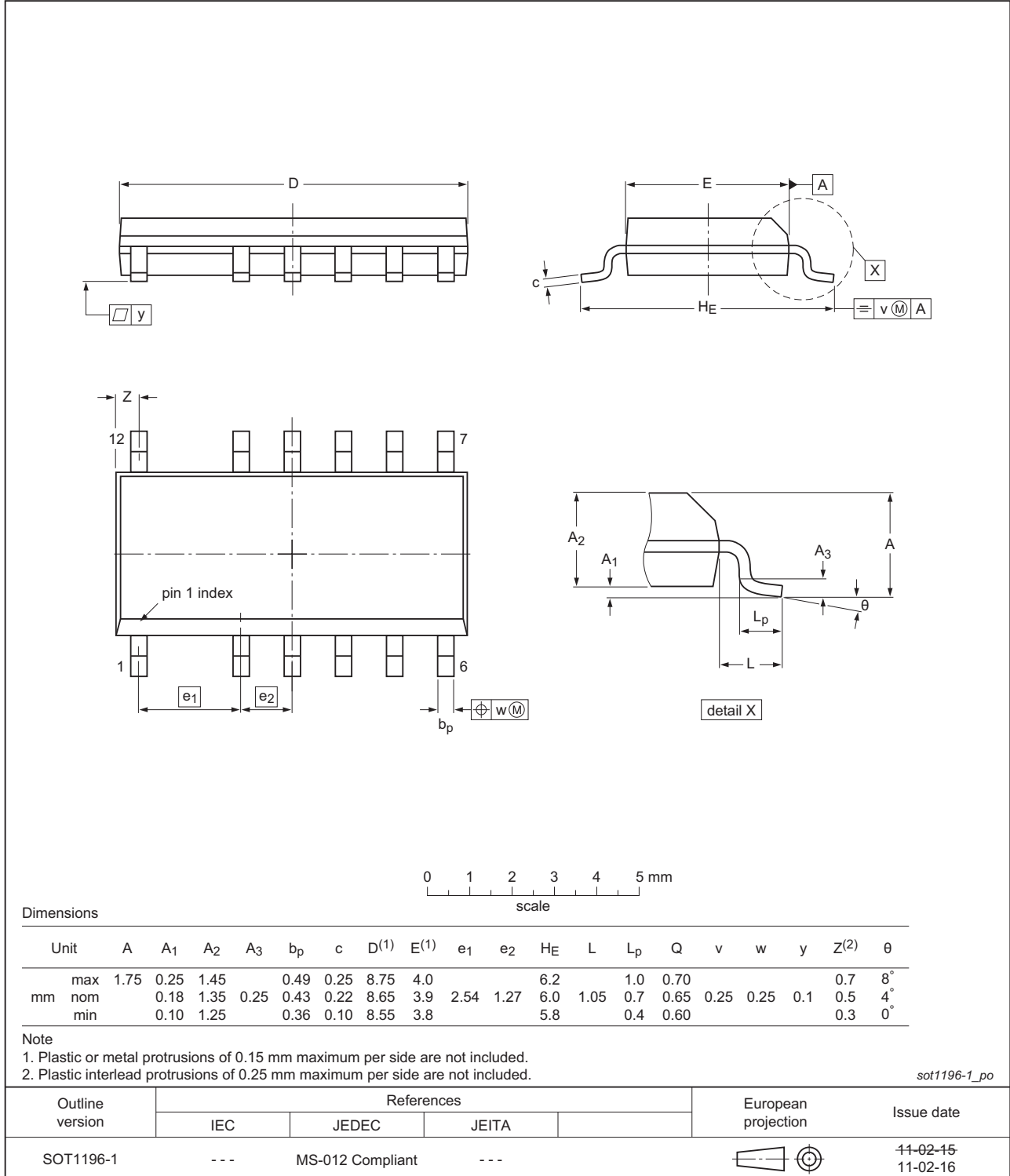


Fig 9. Package outline SOT1196-1 (SO12)

## 14. Abbreviations

Table 7. Abbreviations

| Acronym | Description                                       |
|---------|---|
| BCM     | Boundary Conduction Mode                          |
| LEB     | Leading-Edge Blanking                             |
| LED     | Light Emitting Diode                              |
| MOSFET  | Metal-Oxide Semiconductor Field-Effect Transistor |
| OCP     | OverCurrent Protection                            |
| OTP     | OverTemperature Protection                        |
| PCB     | Printed-Circuit Board                             |
| PWM     | Pulse-Width Modulation                            |
| TVS     | Transient Voltage Suppression                     |
| UVLO    | UnderVoltage LockOut                              |
| ZCS     | Zero-Current Switching                            |

## 15. Revision history

**Table 8. Revision history**

| Document ID              | Release date | Data sheet status  | Change notice | Supersedes               |
|--------------------------|--------------|--|---------------|--------------------------|
| SSL21082_SSL21084 v.5.1  | 20130108     | Product data sheet   | -             | SSL21082_SSL21084 v.5    |
| Modifications:           |              | <ul style="list-style-type: none"> <li>• <a href="#">Table 1 “Quick reference data”</a> has been updated.</li> <li>• <a href="#">Table 2 “Ordering information”</a> has been updated.</li> <li>• <a href="#">Figure 4 “SSL21082 and SSL21084 basic application diagram”</a> has been updated.</li> <li>• <a href="#">Table 4 “Limiting values”</a> has been updated.</li> <li>• <a href="#">Table 6 “Characteristics”</a> has been updated.</li> </ul> |               |                          |
| SSL21082_SSL21084 v.5    | 20121026     | Product data sheet   | -             | SSL2108_SER v.4          |
| SSL2108_SER v.4          | 20120508     | Product data sheet   | -             | SSL21081T_2T_3T_4T v.3.1 |
| SSL21081T_2T_3T_4T v.3.1 | 20120222     | Product data sheet   | -             | SSL21081T_2T_3T_4T v.3   |
| SSL21081T_2T_3T_4T v.3   | 20120214     | Product data sheet   | -             | SSL21081T_2T_3T_4T v.2   |
| SSL21081T_2T_3T_4T v.2   | 20111206     | Preliminary data sheet   | -             | SSL2108X v.1             |
| SSL2108X v.1             | 20110909     | Preliminary data sheet   | -             | -                        |

## 16. Legal information

### 16.1 Data sheet status

| Document status <sup>[1][2]</sup> | Product status <sup>[3]</sup> | Definition  |
|-----------------------------------|-------------------------------|---|
| Objective [short] data sheet      | Development                   | This document contains data from the objective specification for product development. |
| Preliminary [short] data sheet    | Qualification                 | This document contains data from the preliminary specification.                       |
| Product [short] data sheet        | Production                    | This document contains the product specification.                                     |

[1] Please consult the most recently issued document before initiating or completing a design.

[2] The term 'short data sheet' is explained in section "Definitions".

[3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the Internet at URL <http://www.nxp.com>.

### 16.2 Definitions

**Draft** — The document is a draft version only. The content is still under internal review and subject to formal approval, which may result in modifications or additions. NXP Semiconductors does not give any representations or warranties as to the accuracy or completeness of information included herein and shall have no liability for the consequences of use of such information.

**Short data sheet** — A short data sheet is an extract from a full data sheet with the same product type number(s) and title. A short data sheet is intended for quick reference only and should not be relied upon to contain detailed and full information. For detailed and full information see the relevant full data sheet, which is available on request via the local NXP Semiconductors sales office. In case of any inconsistency or conflict with the short data sheet, the full data sheet shall prevail.

**Product specification** — The information and data provided in a Product data sheet shall define the specification of the product as agreed between NXP Semiconductors and its customer, unless NXP Semiconductors and customer have explicitly agreed otherwise in writing. In no event however, shall an agreement be valid in which the NXP Semiconductors product is deemed to offer functions and qualities beyond those described in the Product data sheet.

### 16.3 Disclaimers

**Limited warranty and liability** — Information in this document is believed to be accurate and reliable. However, NXP Semiconductors does not give any representations or warranties, expressed or implied, as to the accuracy or completeness of such information and shall have no liability for the consequences of use of such information. NXP Semiconductors takes no responsibility for the content in this document if provided by an information source outside of NXP Semiconductors.

In no event shall NXP Semiconductors be liable for any indirect, incidental, punitive, special or consequential damages (including - without limitation - lost profits, lost savings, business interruption, costs related to the removal or replacement of any products or rework charges) whether or not such damages are based on tort (including negligence), warranty, breach of contract or any other legal theory.

Notwithstanding any damages that customer might incur for any reason whatsoever, NXP Semiconductors' aggregate and cumulative liability towards customer for the products described herein shall be limited in accordance with the *Terms and conditions of commercial sale* of NXP Semiconductors.

**Right to make changes** — NXP Semiconductors reserves the right to make changes to information published in this document, including without limitation specifications and product descriptions, at any time and without notice. This document supersedes and replaces all information supplied prior to the publication hereof.

**Suitability for use** — NXP Semiconductors products are not designed, authorized or warranted to be suitable for use in life support, life-critical or safety-critical systems or equipment, nor in applications where failure or malfunction of an NXP Semiconductors product can reasonably be expected to result in personal injury, death or severe property or environmental damage. NXP Semiconductors and its suppliers accept no liability for inclusion and/or use of NXP Semiconductors products in such equipment or applications and therefore such inclusion and/or use is at the customer's own risk.

**Applications** — Applications that are described herein for any of these products are for illustrative purposes only. NXP Semiconductors makes no representation or warranty that such applications will be suitable for the specified use without further testing or modification.

Customers are responsible for the design and operation of their applications and products using NXP Semiconductors products, and NXP Semiconductors accepts no liability for any assistance with applications or customer product design. It is customer's sole responsibility to determine whether the NXP Semiconductors product is suitable and fit for the customer's applications and products planned, as well as for the planned application and use of customer's third party customer(s). Customers should provide appropriate design and operating safeguards to minimize the risks associated with their applications and products.

NXP Semiconductors does not accept any liability related to any default, damage, costs or problem which is based on any weakness or default in the customer's applications or products, or the application or use by customer's third party customer(s). Customer is responsible for doing all necessary testing for the customer's applications and products using NXP Semiconductors products in order to avoid a default of the applications and the products or of the application or use by customer's third party customer(s). NXP does not accept any liability in this respect.

**Limiting values** — Stress above one or more limiting values (as defined in the Absolute Maximum Ratings System of IEC 60134) will cause permanent damage to the device. Limiting values are stress ratings only and (proper) operation of the device at these or any other conditions above those given in the Recommended operating conditions section (if present) or the Characteristics sections of this document is not warranted. Constant or repeated exposure to limiting values will permanently and irreversibly affect the quality and reliability of the device.

**Terms and conditions of commercial sale** — NXP Semiconductors products are sold subject to the general terms and conditions of commercial sale, as published at <http://www.nxp.com/profile/terms>, unless otherwise agreed in a valid written individual agreement. In case an individual agreement is concluded only the terms and conditions of the respective agreement shall apply. NXP Semiconductors hereby expressly objects to applying the customer's general terms and conditions with regard to the purchase of NXP Semiconductors products by customer.

**No offer to sell or license** — Nothing in this document may be interpreted or construed as an offer to sell products that is open for acceptance or the grant, conveyance or implication of any license under any copyrights, patents or other industrial or intellectual property rights.

**Export control** — This document as well as the item(s) described herein may be subject to export control regulations. Export might require a prior authorization from competent authorities.

**Quick reference data** — The Quick reference data is an extract of the product data given in the Limiting values and Characteristics sections of this document, and as such is not complete, exhaustive or legally binding.

**Non-automotive qualified products** — Unless this data sheet expressly states that this specific NXP Semiconductors product is automotive qualified, the product is not suitable for automotive use. It is neither qualified nor tested in accordance with automotive testing or application requirements. NXP Semiconductors accepts no liability for inclusion and/or use of non-automotive qualified products in automotive equipment or applications.

In the event that customer uses the product for design-in and use in automotive applications to automotive specifications and standards, customer (a) shall use the product without NXP Semiconductors' warranty of the product for such automotive applications, use and specifications, and (b)

whenever customer uses the product for automotive applications beyond NXP Semiconductors' specifications such use shall be solely at customer's own risk, and (c) customer fully indemnifies NXP Semiconductors for any liability, damages or failed product claims resulting from customer design and use of the product for automotive applications beyond NXP Semiconductors' standard warranty and NXP Semiconductors' product specifications.

**Translations** — A non-English (translated) version of a document is for reference only. The English version shall prevail in case of any discrepancy between the translated and English versions.

## 16.4 Trademarks

Notice: All referenced brands, product names, service names and trademarks are the property of their respective owners.

**GreenChip** — is a trademark of NXP B.V.

## 17. Contact information

For more information, please visit: <http://www.nxp.com>

For sales office addresses, please send an email to: [salesaddresses@nxp.com](mailto:salesaddresses@nxp.com)

18. Contents

1 General description . . . . . 1

2 Features and benefits . . . . . 2

3 Applications . . . . . 2

4 Quick reference data . . . . . 3

5 Ordering information . . . . . 3

6 Block diagram . . . . . 4

7 Pinning information . . . . . 6

7.1 Pinning . . . . . 6

7.2 Pin description . . . . . 6

8 Functional description . . . . . 7

8.1 Introduction . . . . . 7

8.2 Converter operation . . . . . 7

8.3 Valley detection . . . . . 8

8.4 Protective features . . . . . 9

8.4.1 UnderVoltage LockOut (UVLO) . . . . . 9

8.4.2 Leading-Edge Blanking (LEB) . . . . . 9

8.4.3 OverCurrent Protection (OCP) . . . . . 9

8.4.4 OverTemperature Protection (OTP) . . . . . 9

8.4.5 Brownout protection . . . . . 9

8.4.6  $t_{on}$  control . . . . . 10

8.4.7 Short-winding protection . . . . . 10

8.5 VCC supply . . . . . 10

8.5.1 VCC regulator . . . . . 10

8.6 DVDT pin supply (dV/dt) . . . . . 11

8.7 NTC functionality and PWM dimming . . . . . 11

8.7.1 Soft-start function . . . . . 12

8.8 Mains dimmer compatibility . . . . . 12

8.9 Heat sink . . . . . 12

9 Limiting values . . . . . 13

10 Thermal characteristics . . . . . 14

11 Characteristics . . . . . 14

12 Application information . . . . . 17

13 Package outline . . . . . 19

14 Abbreviations . . . . . 20

15 Revision history . . . . . 21

16 Legal information . . . . . 22

16.1 Data sheet status . . . . . 22

16.2 Definitions . . . . . 22

16.3 Disclaimers . . . . . 22

16.4 Trademarks . . . . . 23

17 Contact information . . . . . 23

18 Contents . . . . . 24

Please be aware that important notices concerning this document and the product(s) described herein, have been included in section 'Legal information'.

© NXP B.V. 2013. All rights reserved.

For more information, please visit: <http://www.nxp.com>  
 For sales office addresses, please send an email to: [salesaddresses@nxp.com](mailto:salesaddresses@nxp.com)

Date of release: 8 January 2013  
 Document identifier: SSL21082\_SSL21084