Introduction to Simulation Model - Infineon Designer

SPIDER+ LED 12V TLE75602-ESH

About this document

Scope and purpose

This document outlines the main features of SPIDER+ TLE75602-ESH by means of its digital twin, referred to as simulation model, in typical application setups aiming to be an easy, time efficient and cost reduction solution for exploring device capabilities and integration in complex applications.

Information covered in this document does not substitute datasheet content and shall be regarded as complementary to it. For a more precise description of the device and its features, please consult the datasheet.

Intended audience

This application note along with the simulation model itself offers an interactive solution targeted for anybody who aims to explore the functionality and “what if” scenarios for TLE75602-ESH device.

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1 SPIDER+ LED 12V TLE75602-ESH

The TLE75602-ESH is a 2 channel low-side and 6 configurable channel Smart SPI Switch in PG-TSDSO-24 package providing embedded protective functions. It is specially designed to control relays and LEDs in automotive and industrial applications. A serial peripheral interface (SPI) is utilized for control and diagnosis of the loads as well as of the device. For direct control and PWM there are two input pins available connected to two outputs by default. Additional or different outputs can be controlled by the same input pins (programmable via SPI).

The available online circuits are listed below:

- 12V Automotive – LED – Relay – Motor Control – Smart Switch SPI Driver IC TLE75602-ESH (SPIDER+ LED) – Resistive and Inductive Loads with PWM Mode
- 12V Automotive – LED – Relay – Motor Control – Smart Switch SPI Driver IC TLE75602-ESH (SPIDER+ LED) – Capacitive Load with Bulb Inrush Mode
- 12V Automotive – LED – Relay – Motor Control – Smart Switch SPI Driver IC TLE75602-ESH (SPIDER+ LED) – Open Load at ON Diagnosis

Click here to open the circuits.

2 Simulation model features

- Perform transient simulations: observe and analyze transient device response to different stimuli. The number of stimuli and probes is unlimited.
- Measure the device electrical parameters in typical conditions with increased precision at small resolution (e.g. 100 ns/1 µV/1 µA).
- Integrate the simulation model in complex applications and explore new possibilities.
- Explore main features of the real device (for more details consult the datasheet): shortest time to obtain results, zero error cost (no harm to physical components), can be done by anyone (engineers, students, etc.):
    - Power stage
    - Inductive output clamping
    - Switching channels in parallel
    - Overload detection and protection
    - Overtemperature detection and protection (transient thermal model for 2s2p PCB JEDEC standard)
    - Overtemperature and overload protection in limp home mode (restart timer)
    - Reverse polarity protection for low-side channels
    - Output status monitor (Open load detection in off-state diagnosis)
    - Bulb inrush mode
    - Open load detection in on-state for high-side channels
    - PWM generators
- Simulation model does not cover all features of the real device in order to keep the usability and simulation speed in a reasonable range:
    - SPI protocol
    - ReverSave
    - Current consumption of the IC not considered (no realistic power efficiency calculation possible)
    - No ESD, EMC, AC, DC and Monte Carlo analysis simulation capability
    - Possible convergence issues for using DC sources, steep ramps or high frequency sources within the setup.

Details on the implementation

SPI registers controlling different features have been emulated with either voltage sources available as virtual pins on the symbol or global parameters available in the PARAMETERS: section on the test bench.

The binary value associated to each SPI register is given directly in decimal. For an easy configuration, tables with coding convention are available on the test bench.

To activate or deactivate the thermal behavior, change the value of THERMAL_MODEL parameter:

- THERMAL_MODEL=1: P=1W; T=85°C; PCB type: 2s2p
- THERMAL_MODEL=0: Self-heating deactivated ($T_J = T_{AMB}$)

The ambient temperature of the entire chip can be set by connecting a voltage source to TAMB input pin. Junction temperature (T_J) is always T_{AMB} + temperature due to self-heating of the device considering the main source power dissipation (power device). The convention is 1 V=1°C.

3 Model performance

3.1 Switching resistive/inductive loads and LEDs in PWM mode – transient

This test bench is configured to switch resistive and inductive loads and LEDs in PWM mode using the PWM engine embedded in the device.

- Channel 0 is configured to switch with a frequency of 100 Hz and a duty cycle of 25% (low-side switch)
- Channel 2 is configured to switch with a frequency of 400 Hz and a duty cycle of 50% (configured as a high-side switch)
- Channel 3 drives a relay (configured as low-side switch)

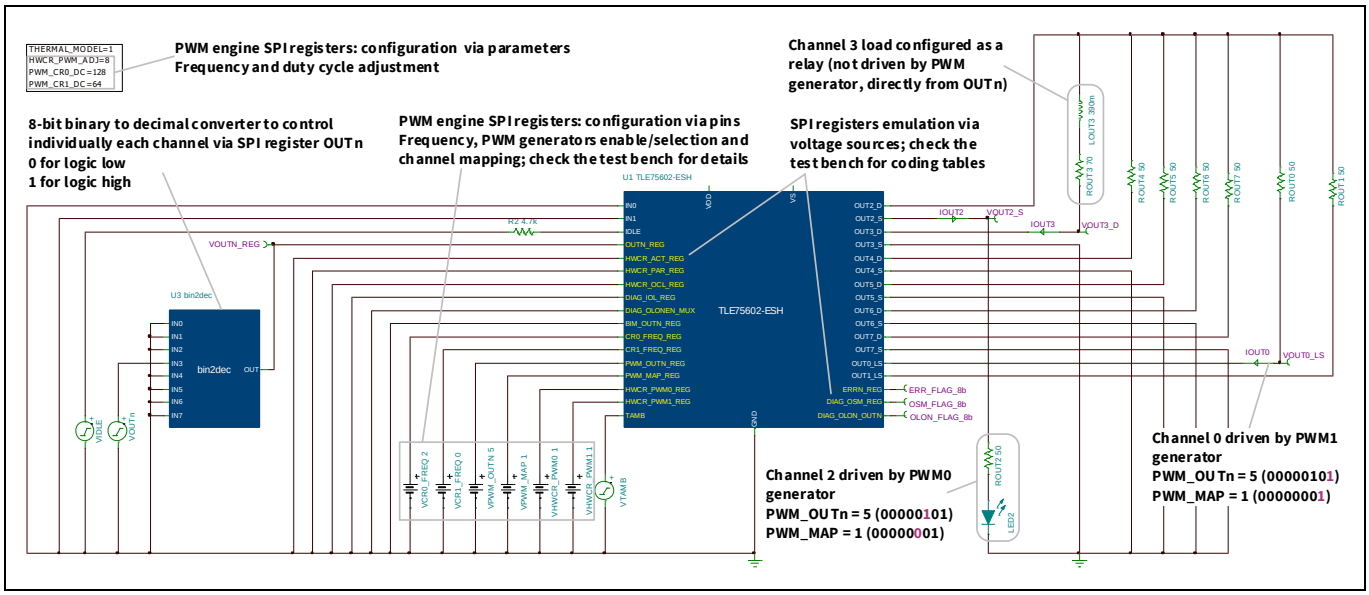

Figure 1 Test setup for PWM mode [click to open]

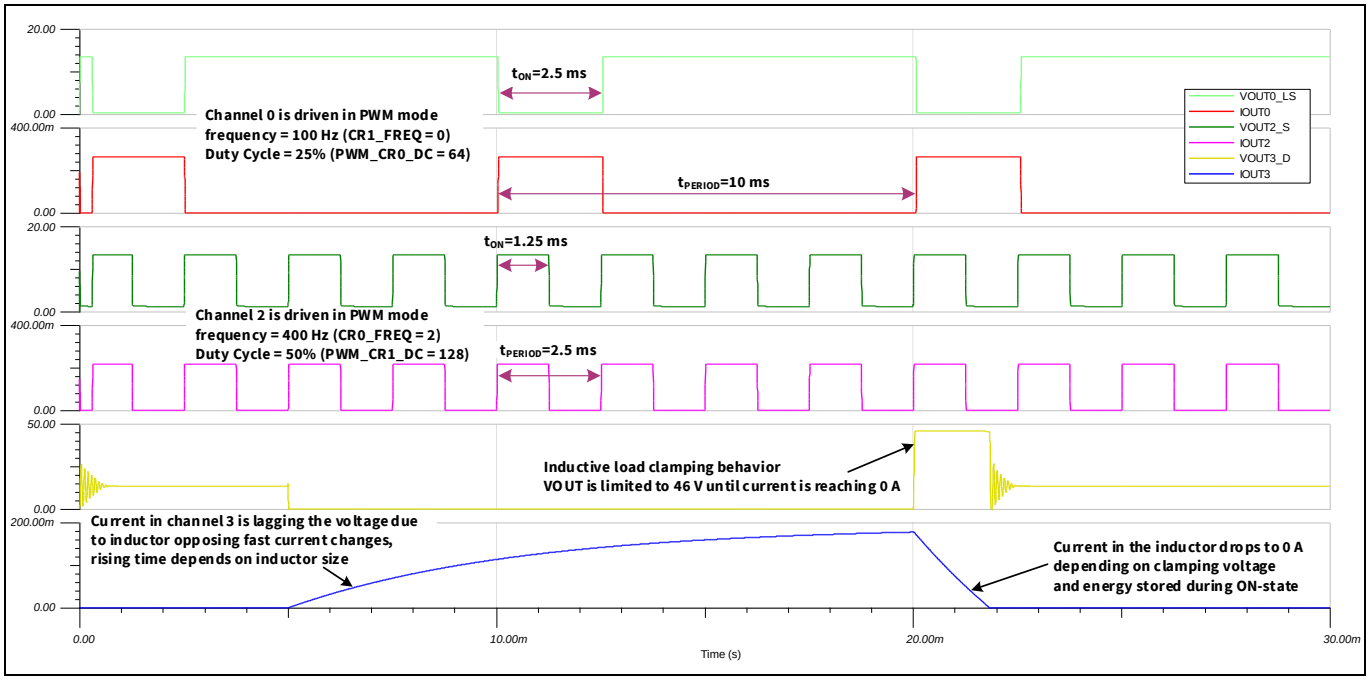

Figure 2 Simulation results

3.2 Switching capacitive loads using Bulb Inrush Mode feature – transient

This test bench is configured to switch capacitive loads. The feature shows the concept of charging capacitive loads using the retry mechanism.

For a proper dimensioning, please check against real measurements.

- Channel 2 is configured to switch a capacitive load including ESR and wire inductance.

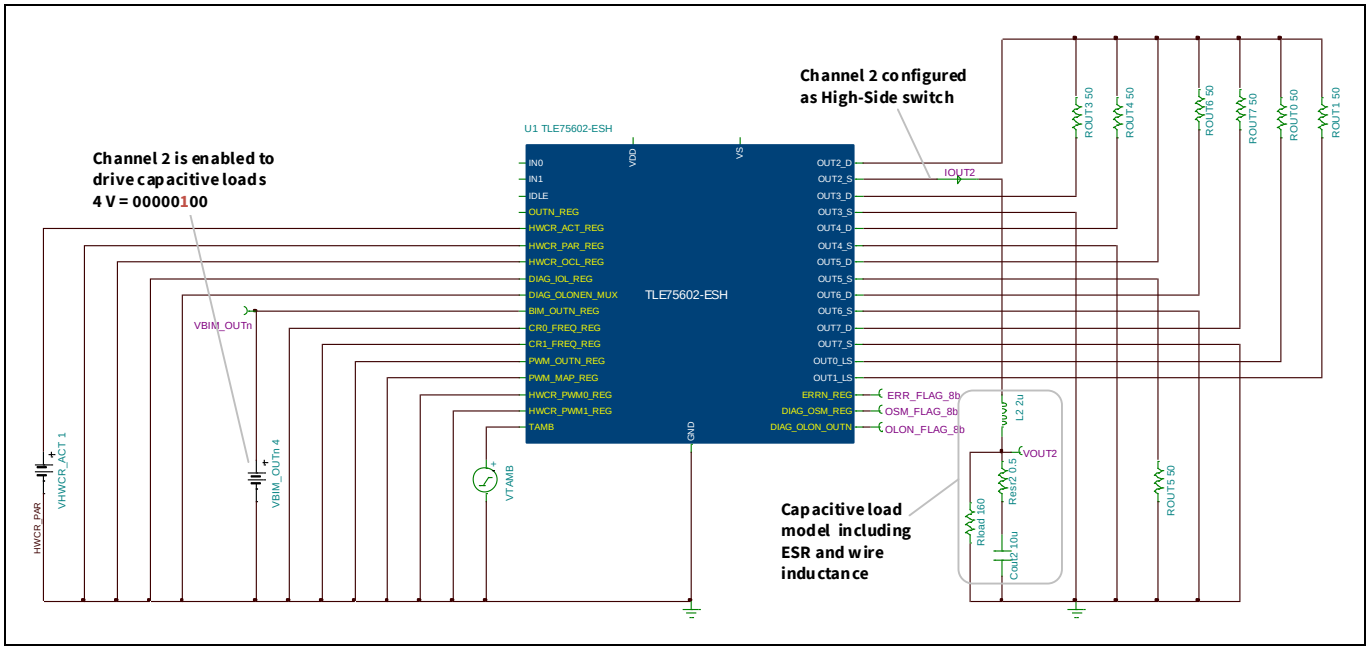

Figure 3 Test setup for BIM feature click to open

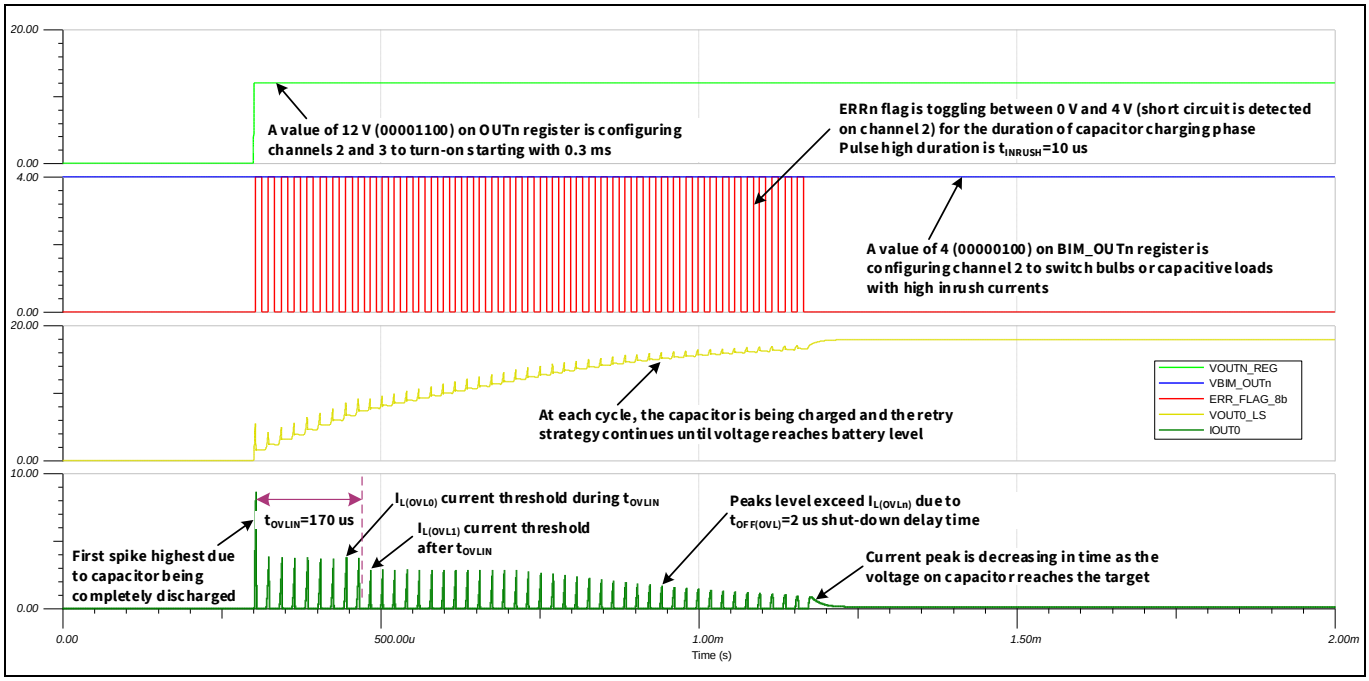

Figure 4 Simulation results

3.3 Open load detection at on-state – transient

This test bench is configured to detect open load at on-state for auto-configurable channels used as high-side switches.

- Channel 3 is configured as high-side switch (open load at on is detected)
- Channel 4 is configured as low-side switch (open load at on is not detected)
- The two channels are turned on after 1 ms and remain on. At the 3 ms timestamp an open load error is induced on channel 3 and at timestamp 5 ms an open load error is induced on channel 4. The error is detected on channel 3 but not on channel 4, since it is configured as a low-side switch.

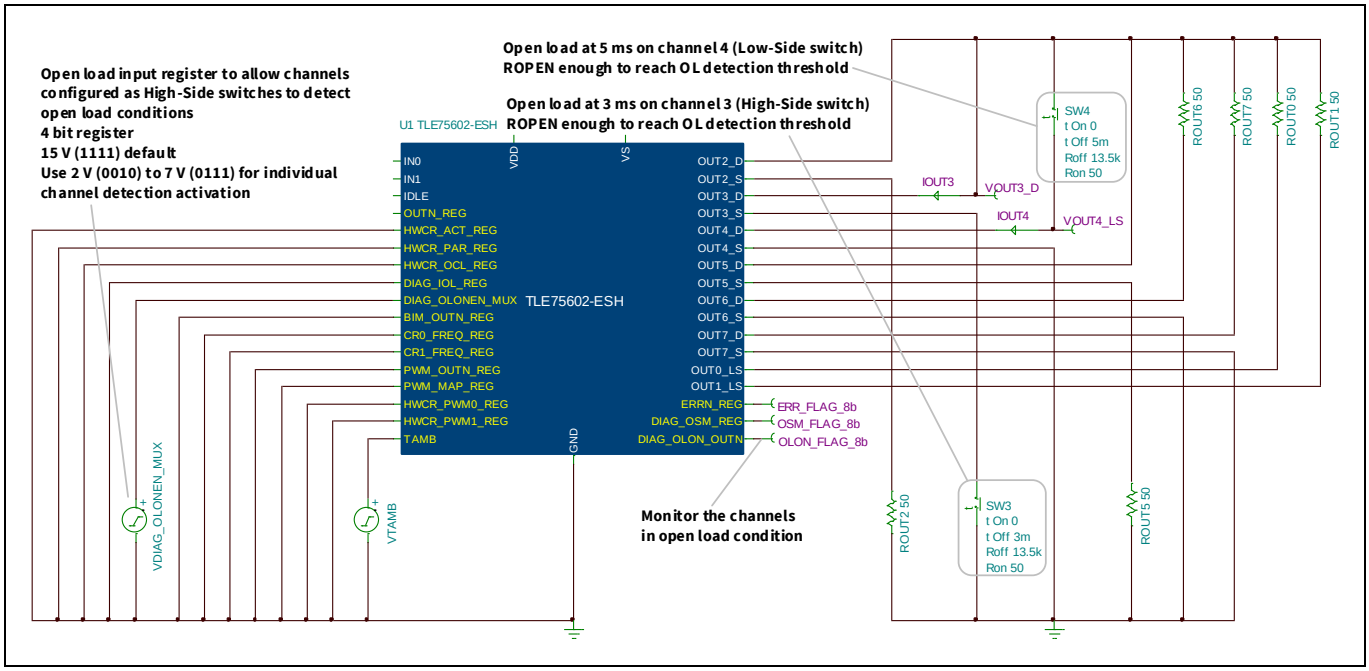

Figure 5 Test setup for open load detection at on-state click to open

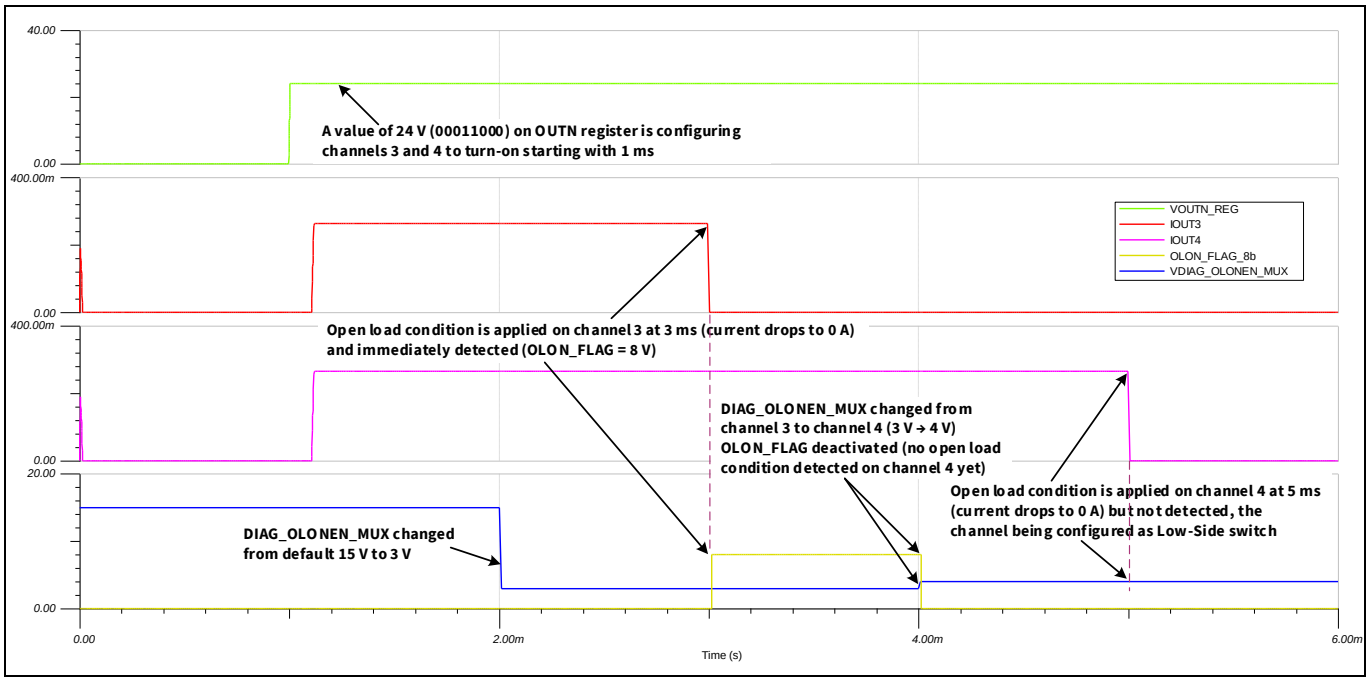

Figure 6 Simulation results

4 Revision history

Document version	Date of release	Description of changes
Rev.1.00	2020-07-03	Initial version created

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