Never stop thinking

Bridge driver IC / TLE7185-1E

Evaluation Board TLE7185-1E

Application Note

Rev. 1.0, 2010-09-25

Automotive Power

1 Abstract

Note: The following information is given as a hint for the implementation of the device only and shall not be regarded as a description or warranty of a certain functionality, condition or quality of the device.

This Application Note is intended to provide useful information about the evaluation board for the bridge driver IC TLE7185-1E.

It should help the user to set up the board and to get it run easily.

It is assumed that the user knows the data sheet of the driver IC TLE7185-1E and its functions.

The application note is not meant to explain the functions of the driver IC.

The evaluation board is designed to facilitate first application tests with the bridge driver IC. It should help to get familiar with the features of the device and to gain experience with “usual” signal shapes on the board while driving simple loads or motors.

The evaluation board can be ordered via the usual sales channels of Infineon Technologies.

This application note will describe the components of the evaluation board.

A guidance for a first setup is given as well as detailed information about circuitry and layout.

2 Introduction

Typical applications for the bridge driver IC TLE7185-1E are automotive 3-phase motor drives such as electrical power steering or fan and pump applications or any other 3-phase motor application in the 12V power net.

Please study the datasheet of the device before you read this application note.

The Evaluation Board TLE7185-1E contains one 3-Phase N-Channel MOSFET Driver IC TLE7185-1E, 6 N-Channel Power MOSFETs (configured as 3 half bridges with one common shunt in GND path), and auxiliary components like a 5V Vreg to enable the operation with a minimum of external equipment.

For customers who want to measure the current an external OpAmp is installed on the board.

In addition, the Evaluation Board provides LEDs that indicate status info as well as jumpers and adjustable resistors to offer flexibility during the evaluation.

The Driver IC TLE7185-1E as well as the Evaluation Board TLE7185-1E is designed for 12 V automotive systems. The voltage limit on the supply connector Vbat is -0.3 … 40 V (limited by the MOSFETs). The Driver IC itself, the capacitors are rated at 45 V and 50 V, respectively. The voltage limit on the Vaux terminal is -0.3 … 32 V.

Due to the intrinsic body diodes of the Power MOSFETs, the Evaluation board is not reverse battery protected. Reverse battery will result in excessive currents through the body diodes of the Power MOSFETs. However, the TLE7185-1E is protected by resistor R5 = 10 on its VS pin.

The load current is limited by power dissipation and the associated temperature rise of the components and the PCB. Hence, the loaded current limit is higher when the ambient temperature is lower and/or with airflow across the PCB.

3 Board description

In this chapter the components of the board are described.

3.1 Set up the board for tests

3.1.1 Bridge driver and power stages

The TLE7185-1E is located in the center of the board. The PG-DSO36 package of the driver IC provides an exposed pad which is soldered to the PCB. To improve the heat transfer into the PCB thermal vias are used. The exposed pad is connected to the device GND.

The power stages consist out of 3 half-bridges at the right side of the board.

The main components of each power stage are:

- 1 high side MOSFET IPB180N04S4-00 with 1mOhm
- 1 low side MOSFET IPB180N04S4-00 with 1mOhm
- 1 1000uF electrolytic capacitor
- 1 X µF ceramic capacitor
- and a snubber per MOSFET

In the GND path there is a shared 1mohm shunt.

The layout of each half bridge is optimized to have low stray inductance. Therefore all components are located close to each other. The load current is guided mainly on the first layer of the PCB avoiding additional ohmic parasitics by vias. The common shunt led to a star configuration of the output stages as it is part of each phase. The vias in the design are for cooling purposes.

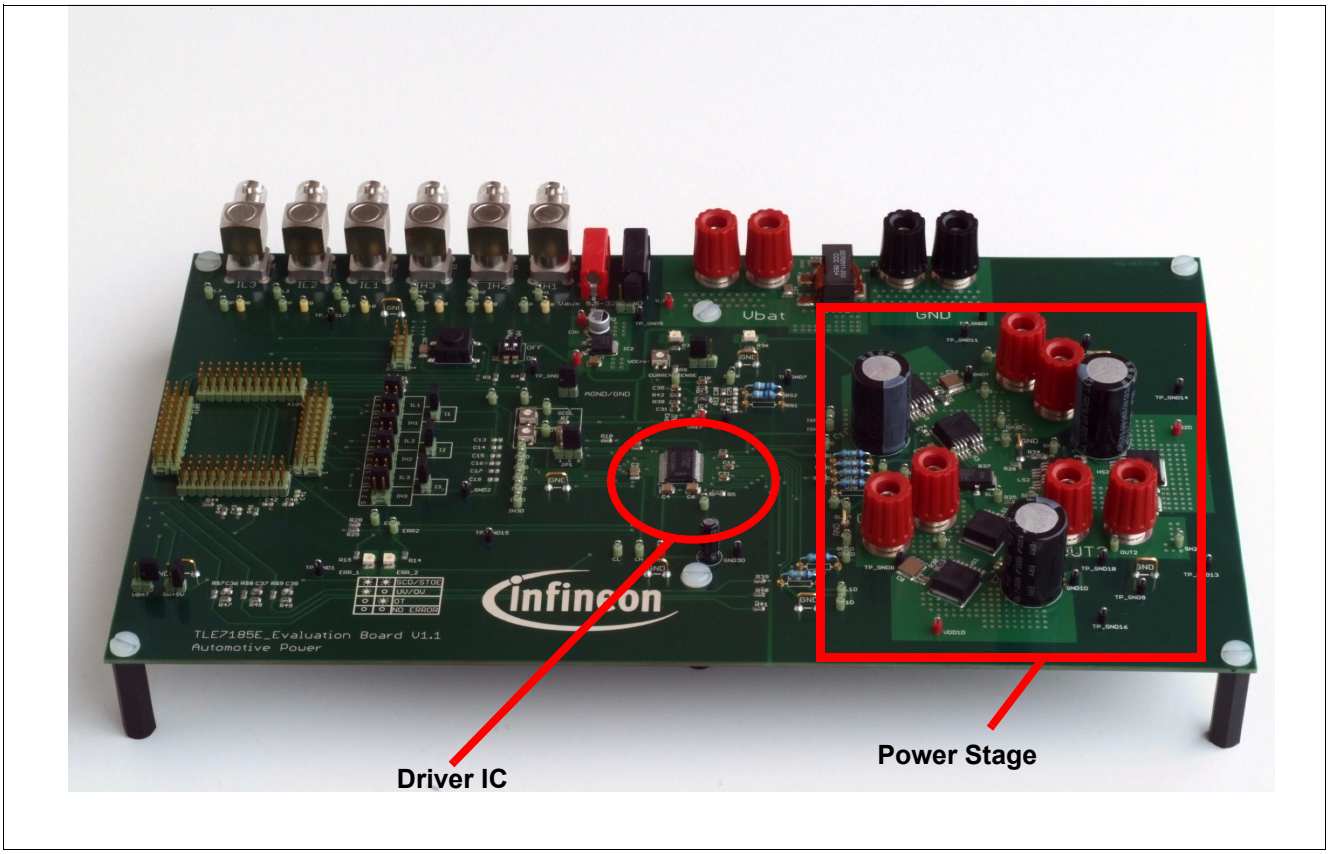

Figure 1 Figure Example

3.1.2 Power supply

The main supply for the board and the load (= motor) is connected to the “Vbat” and “GND” connectors at the bottom of the board.

If the supply for the power bridge should be separated from the logic supply, the Jumper “I5” has to be opened and the logic supply is connected separately to the “Vaux” and the corresponding “GND” connector.

Both GND jacks of the supply and the Vaux GND are connected internally.

3.1.3 Connection to load

The board offers the 3 phase outputs of the B6-Bridge on the right hand side of the board. This offers several options to connect loads. Some examples are given here:

- 3-phase Motor connected to Out1, Out2 and Out3
- DC-Brush motor connected to Out 1 and GND
- DC-brush motor connected to Out 1 and Vbat
- DC-brush motor connected to Out 2 and Out 3
- Resistor and inductor connected to Out 2 and GND
- ...

Both the supply jacks and the Output jacks are available 2 time to allow to connect multiple cables for loads with higher current.

The board is thermally limited. Please take care that the components are not overheated (shunt resistor, MOSFETs, DC-Link capacitors)

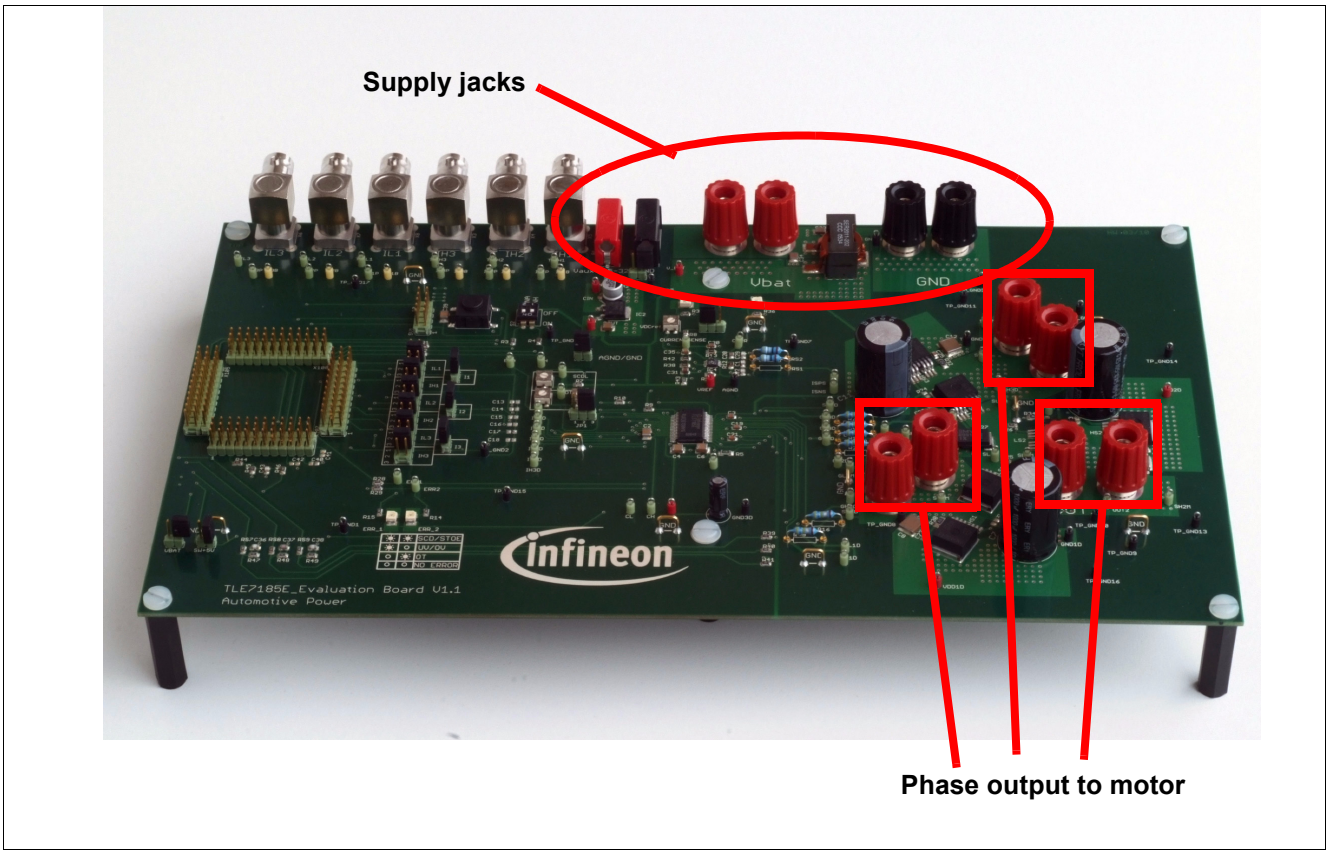

Figure 2 Evaluation board TLE7189F - supply

Note:

3.1.4 Input or control signals

There are mainly 2 ways to feed the PWM input signals for the driver IC to the board.

The first way is to use the Coax inputs at the top of the board. Simply connects these inputs to your pattern generator.

A second way to feed input signals into the board is to use the µC interface. It is designed to have access to all necessary signals and is optimized with its pinning for the usage in combination with a XC2000 starter kit.

If other controllers are used, an adapter PCB might be necessary.

The selection of the input source is done by the Jumpers next to the µC interface. They are named IL1, IH1 and so on. Please see the schematics to check the right position of these jumpers.

In addition the jumpers I1, I2 and I3 allow to use the same input signal for the highside and the lowside input of the same half-bridge. In this case the dead time is controlled by the bridge driver itself.

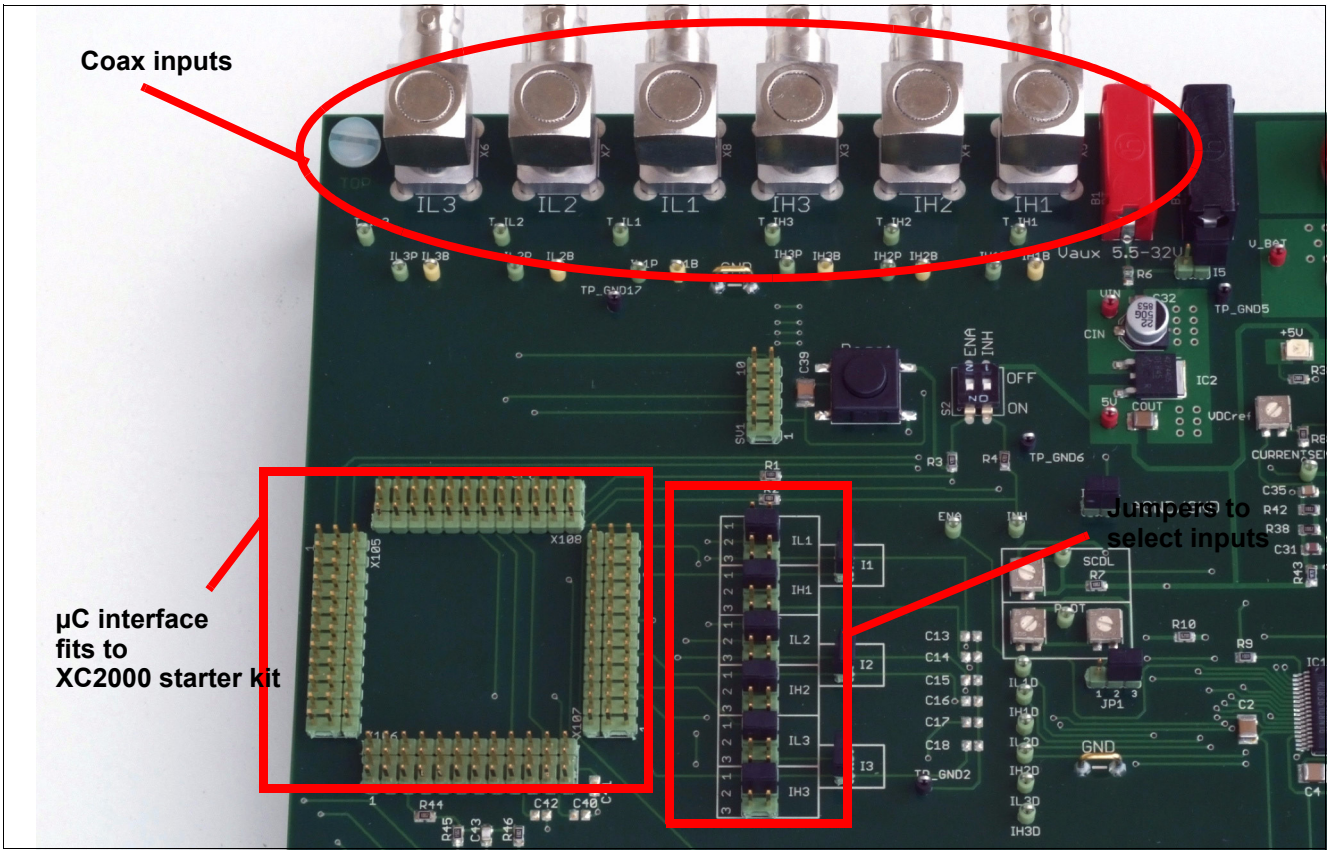

Figure 3 Input interfaces

3.1.5 Board internal input signals

The board is designed to operate with and without µC.

To simplify the use of the board without µC some signals can be set by jumpers and switches.

See **Figure 5**.

3.1.5.1 INH-Signal

The INH signal is the main “ON” and “OFF” switch of the driver. It has to be high to operate the driver IC.

If no INH signal is provided by the µC interface, the signal can be set by the INH switch (dual switch, below IH2 coax connector).

Please set the INH to “ON” to provide a high signal to the driver IC.

Please see as well the schematics.

3.1.5.2 ENA-Signal

The ENA signal can reset the driver IC by setting it to “low”. For normal operation the ENA signal has to be high.

If no ENA signal is provided by the µC interface, the signal can be set by the ENA switch (dual switch, below IH2 coax connector).

Set the ENA to “ON” to provide a high signal to the driver IC.

3.1.5.3 SCDL Signal

The SCDL Pin of the driver is used to set the short circuit detection level of the driver IC. The board allows to set the voltage applied to the pin with the help of a potentiometer.

The potentiometer allows the trimming of the Signal between 0,3V and 2,5V.

3.1.5.4 Reset

The board allows to reset the driver manually by the RESET button. This button overwrites signals coming from the µC interface.

3.1.5.5 Dead time settings

The pin DT of the driver allows to set the internal dead time generator between 0.14us and 4us. To chose the minimum dead time, set jumper 1 to position 1-2. The maximum dead time is chosen when the jumper is left open. In position 2-3, the dead time can be varied by the two potentiometers.

3.1.5.6 Reference voltage for the OpAmp

The on board current sense circuit shown in **Figure 4** allows the current measurement in both directions. An reference voltage is applied to the reference buffer to provide a voltage signal VREF with low impedance. If no current is flowing over the shunt, the main OpAmp will provide VREF as output.

Please put jumper JP2 in position “2-3” to 2.5V for VREF. If another VREF voltage is needed, put JP2 in position “1-2” and use the VDCref potentiometer to set VREF.

3.1.5.7 AGND/GND jumper

This jumper connects the AGND and GND signal on the board. Please remove this jumper to separate these two signals.

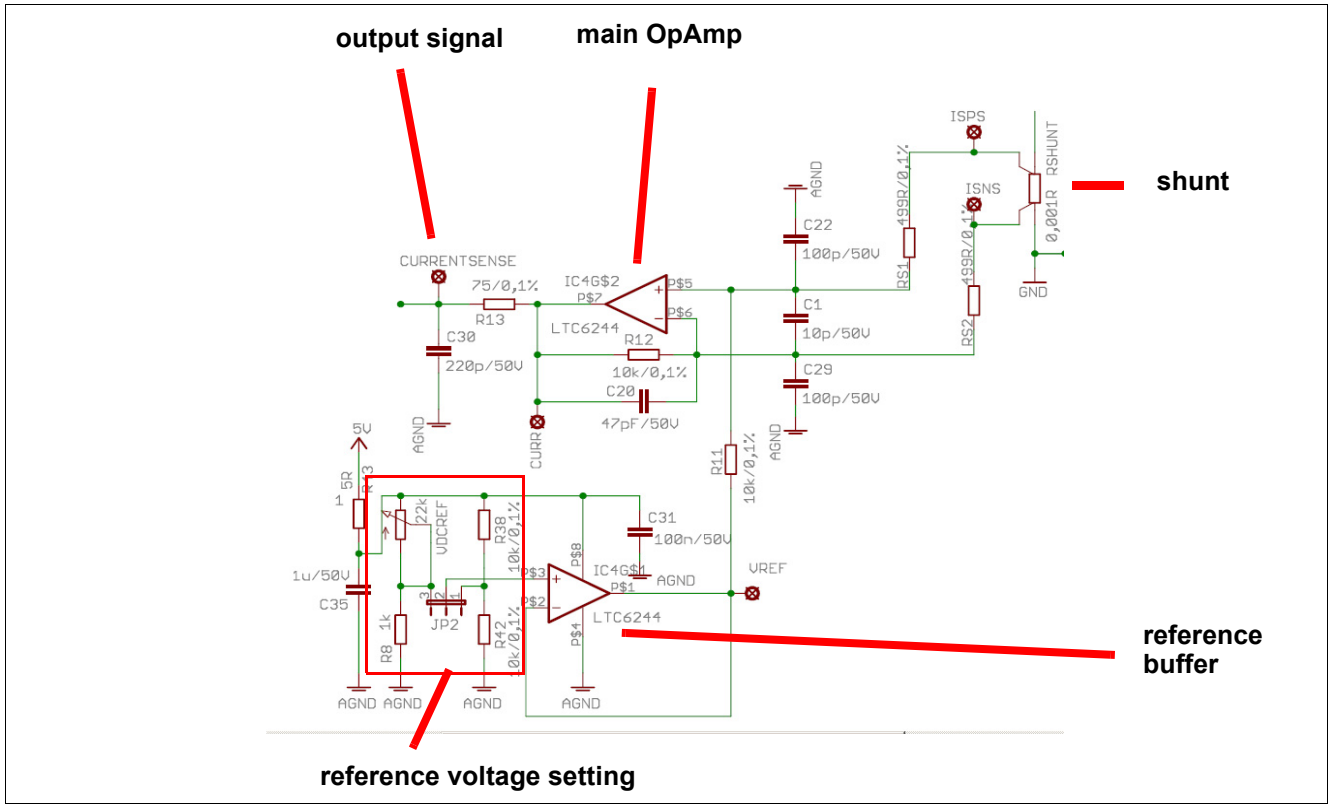

Figure 4 Current sense circuit

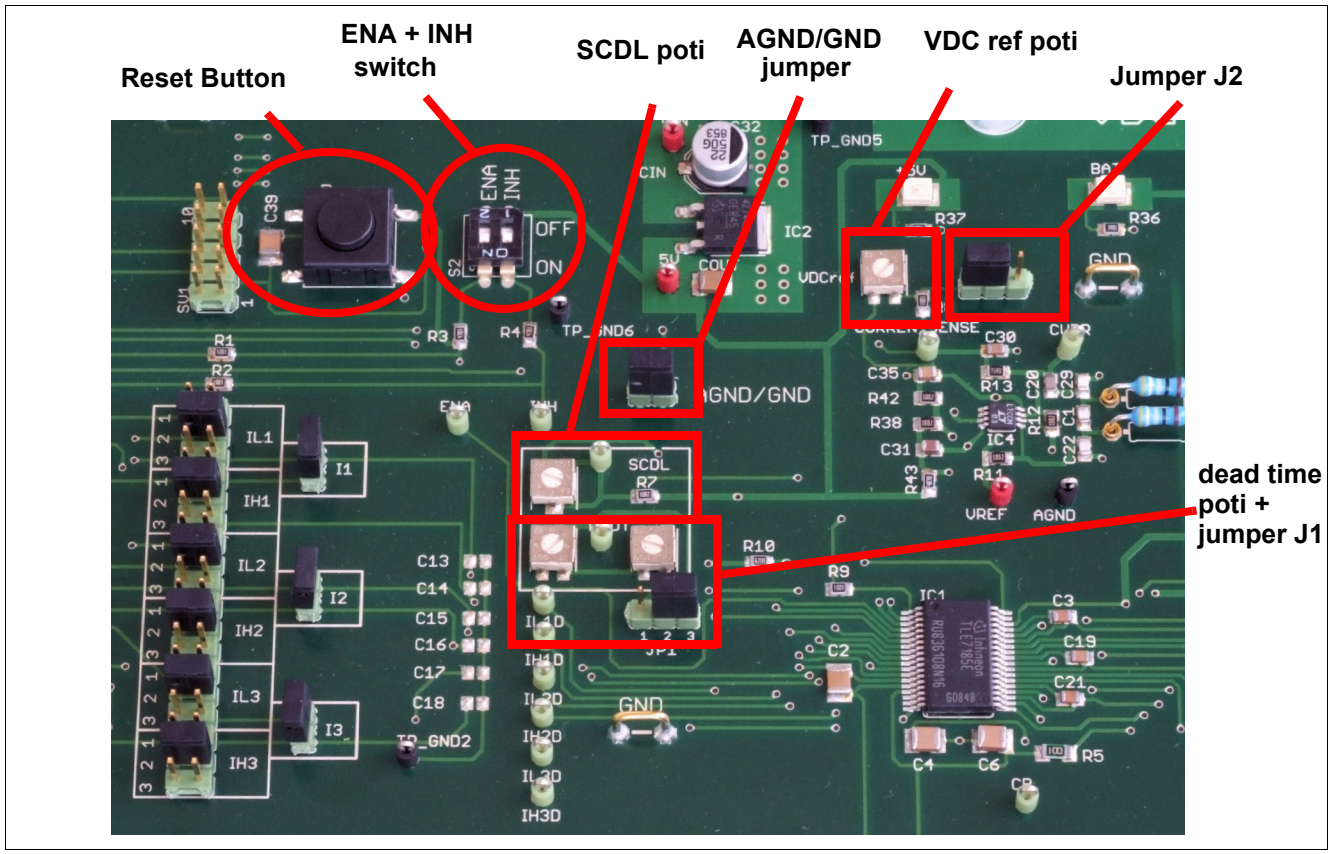

Figure 5 Board internal signals

3.2 Example for first tests

One of the easiest setup is to drive a DC-brush motor with a single phase.

This example chosen because only simple equipment is necessary.

For detailed description of the settings see **Chapter 3.1**

- Chose a DC-brush motor for 12V with a nominal current rating below 50A.
- Connect one terminal to OUT2 and the other one to VBAT.
- Chose a power supply which is strong enough to supply the motor and connect it to Vbat and GND. Keep the supply off in a first step.
- Close jumper I5
- Connect a 5V 20kHz 50% duty cycle signal to the coax input IL2
- Close jumper IL2 pin 3-4 to chose coax input
- Close jumper I2 to connect IH2 and IL2 input of driver. In this case the dead time of the driver will be used.
- Set ENA and INH to “on”
- Close jumper AGND/GND.
- Set SCDL value with the potentiometer to 0,9V (or chose your own value).
- Set VREF to 2.5V by connecting “12” in the Jumper JP2.
- Now you can switch on the power supply and set it 14V. In the upper middle area of the board there are 2 LEDs for the supervision of the supply state of the board. Both LED should be illuminated.

Normally the motor starts now start to run. If not press the Reset Button to remove any error.

The error state can be seen at the LEDs in the left bottom area of the board. A legend is printed on the board for easy interpretation of the signals.

3.2.1 First test results

In this chapter some typical oscilloscope plots are shown. They can be used for verification of the setup and debugging.

Please adjust the right dead type by using **Figure 8** and **Figure 9**.

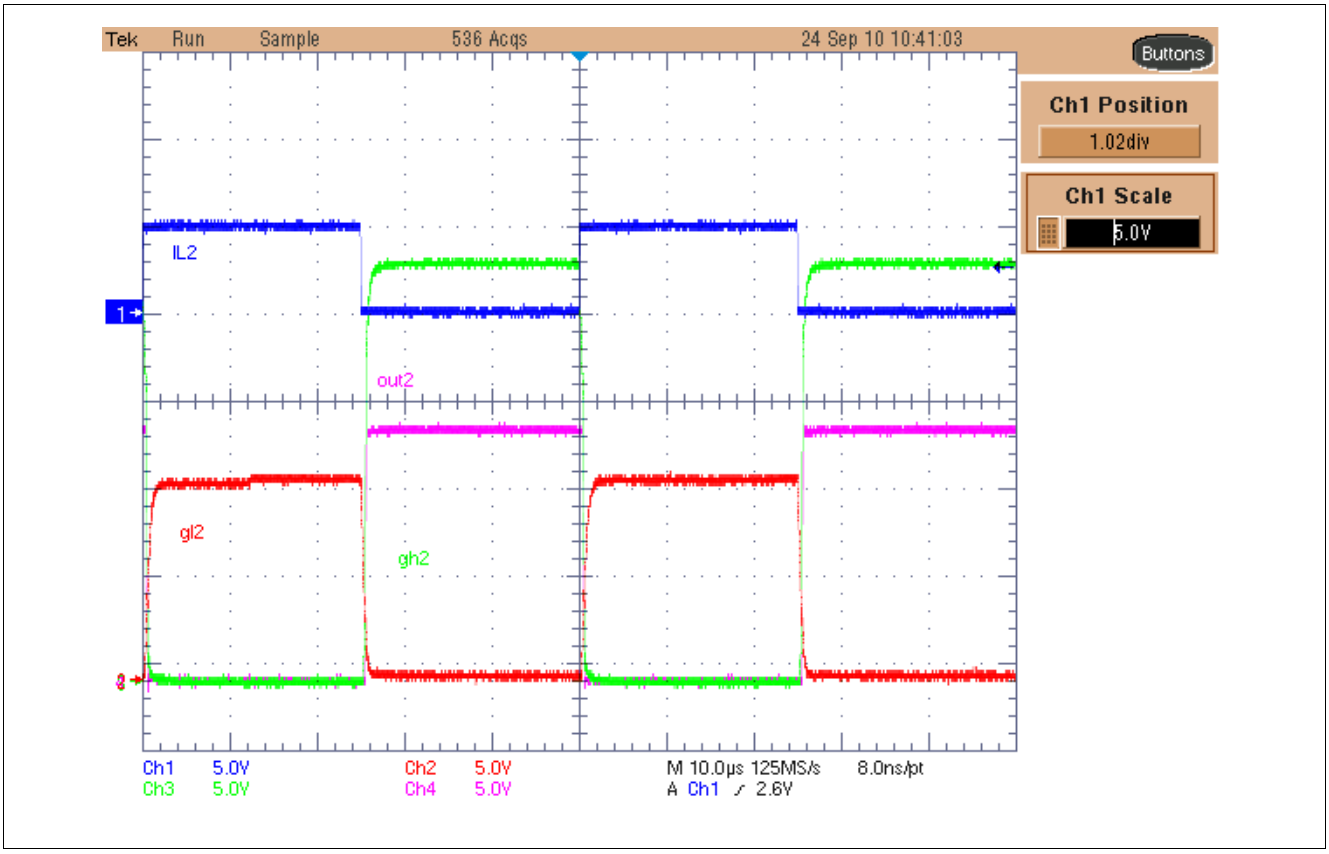

Figure 6 Output signals at OUT1

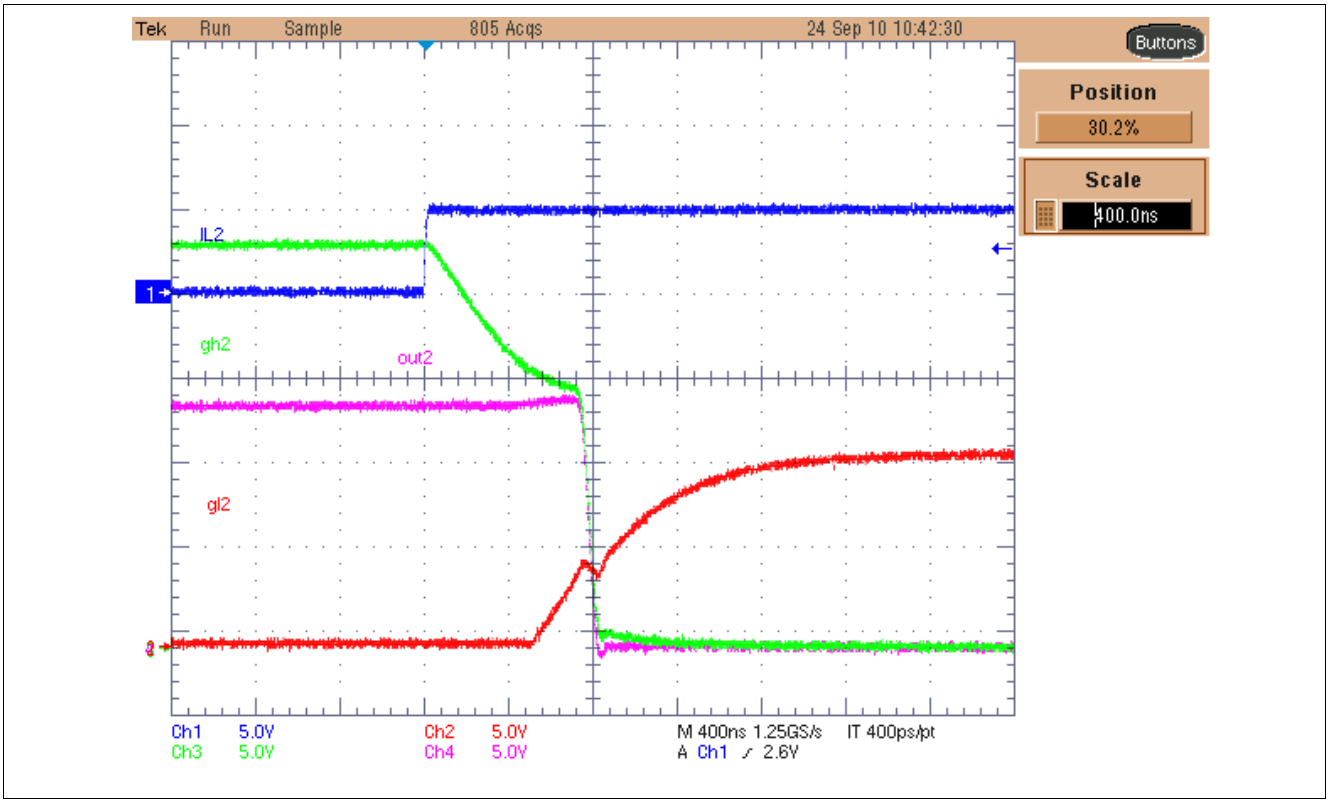

Figure 7 Output signals at OUT1 - Zoom with right setting of dead time

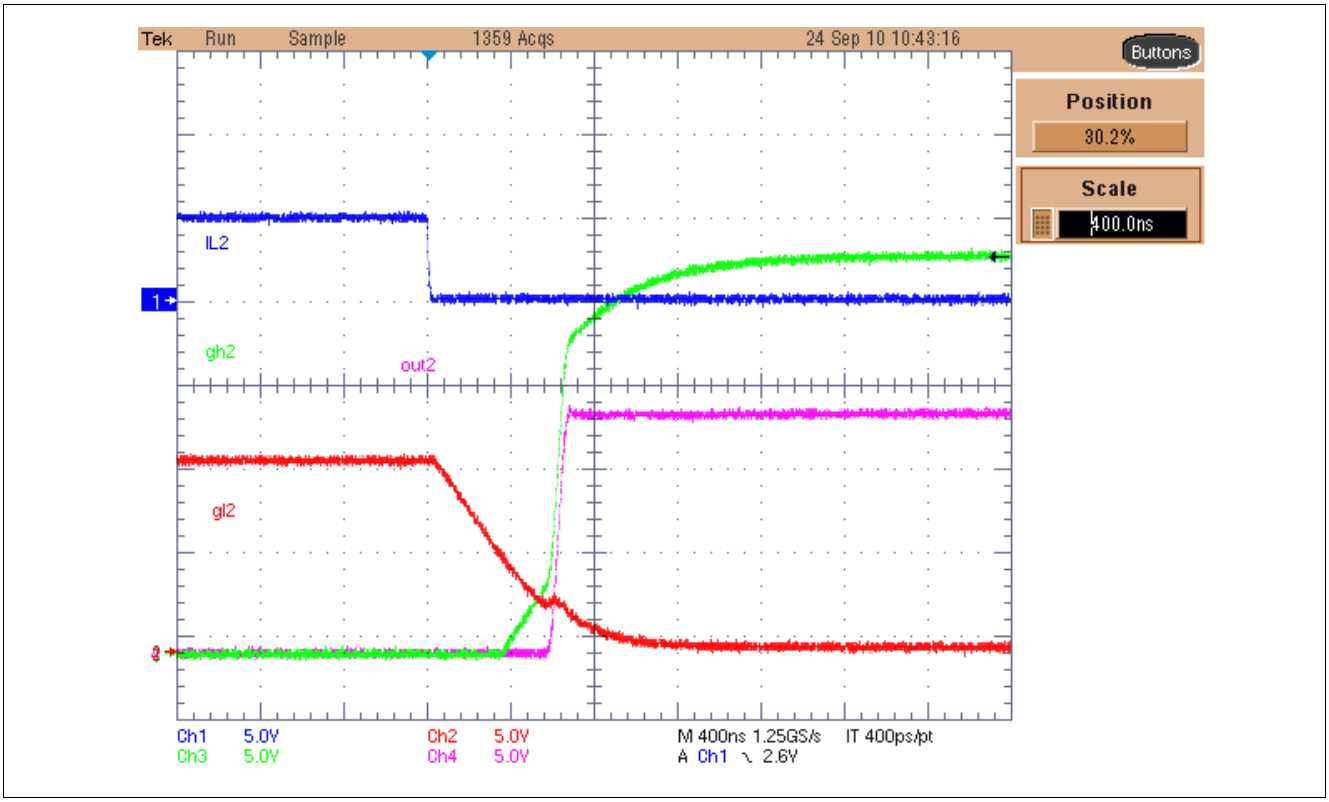

Figure 8 Output signals at OUT1 - Zoom with right setting of dead time

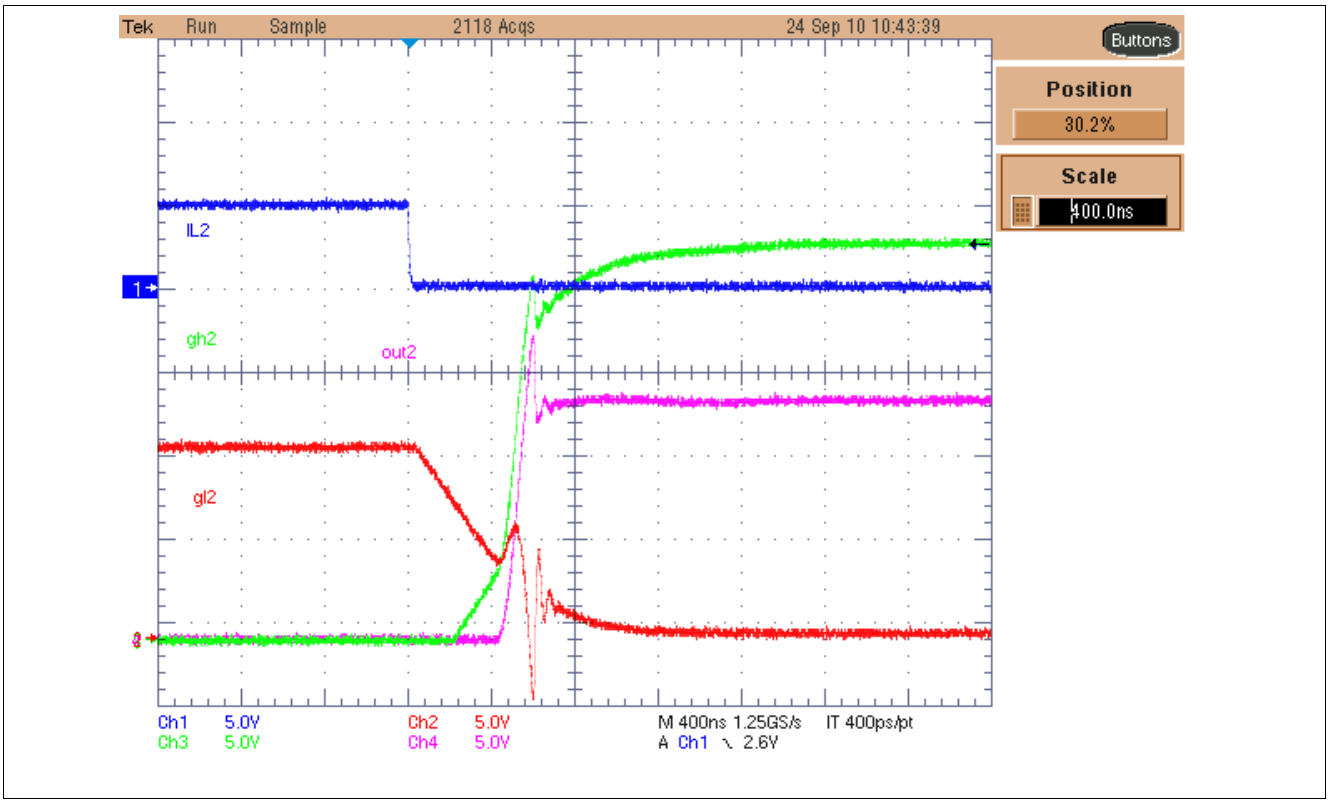

Figure 9 Output signals at OUT1 - Zoom with too short setting of dead time

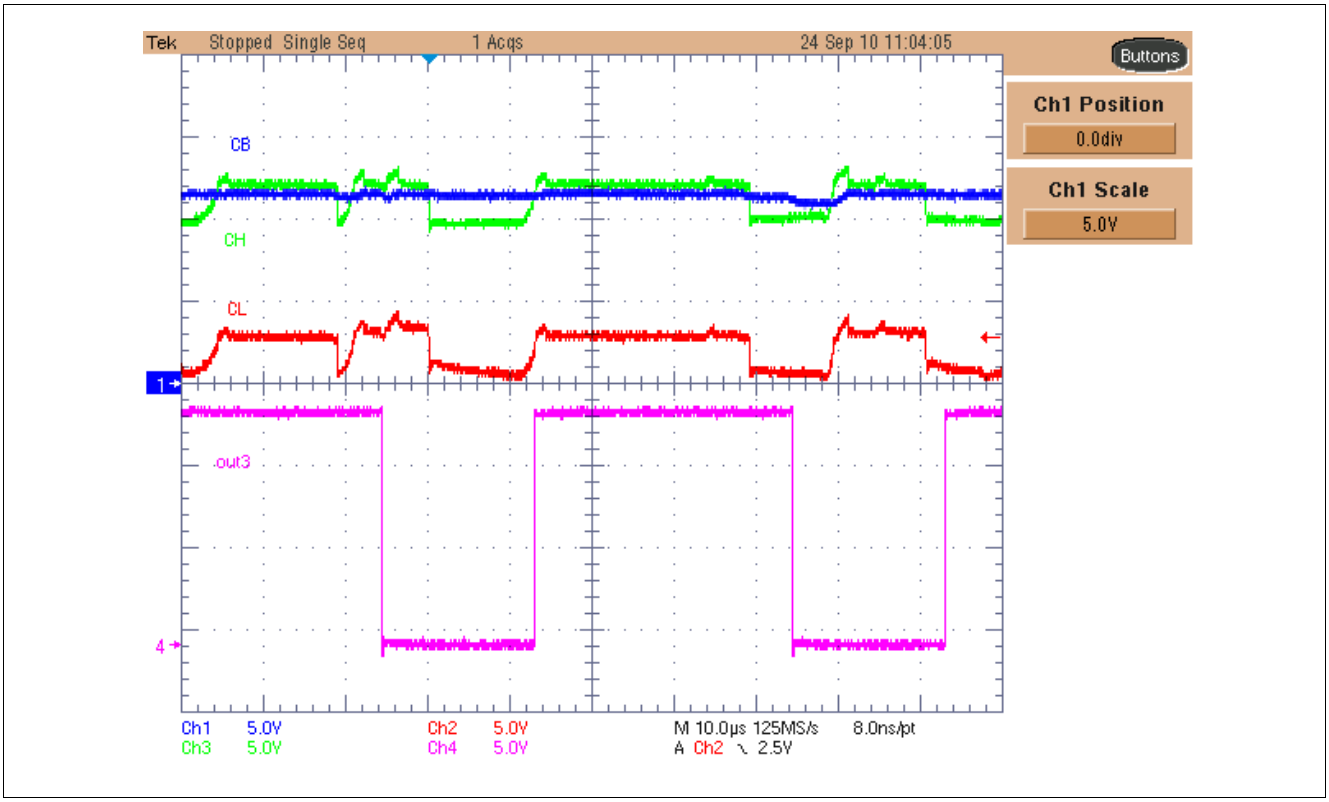

Figure 10 Signals at the charge pump with Vs=13.8V

If the supply voltage is reduced to 5.5V, the signals at the charge pump change:

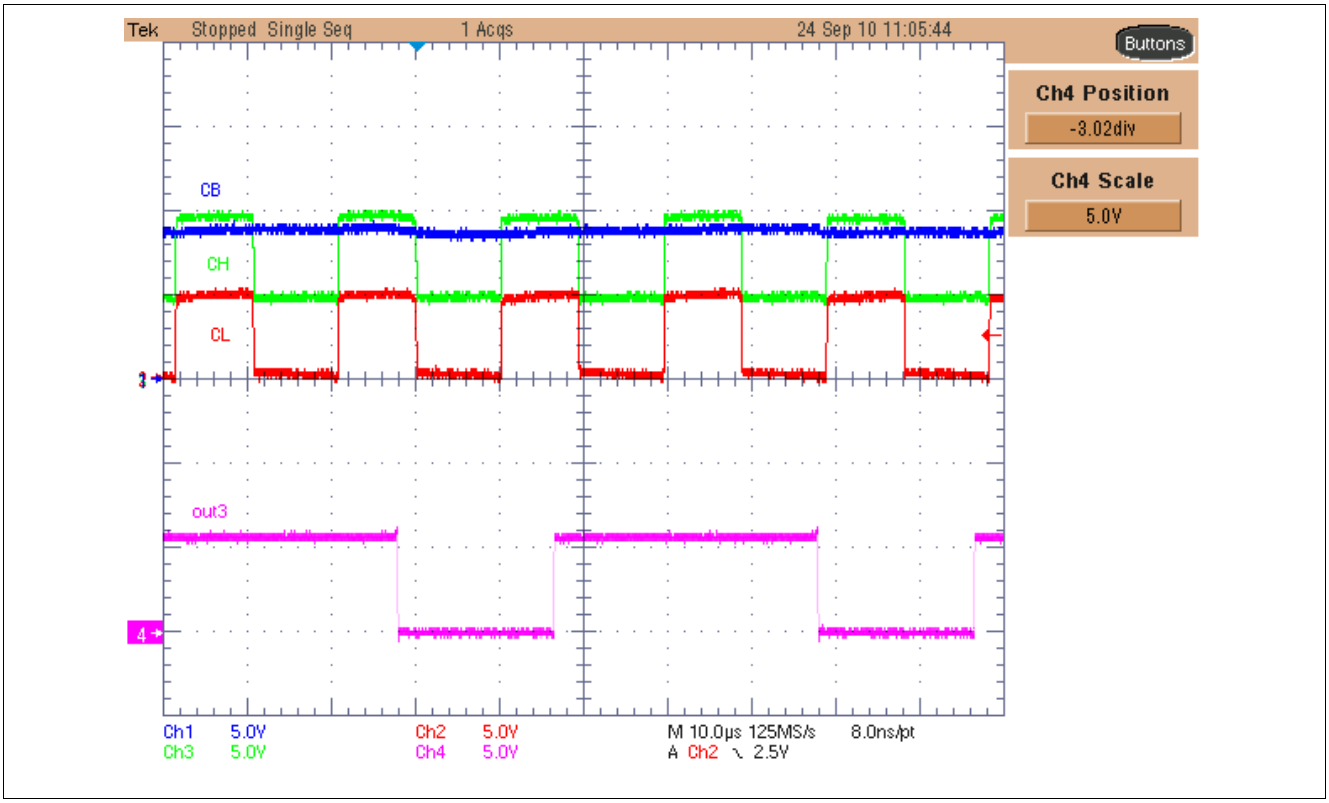

Figure 11 Signals at the charge pump with Vs=7.5V

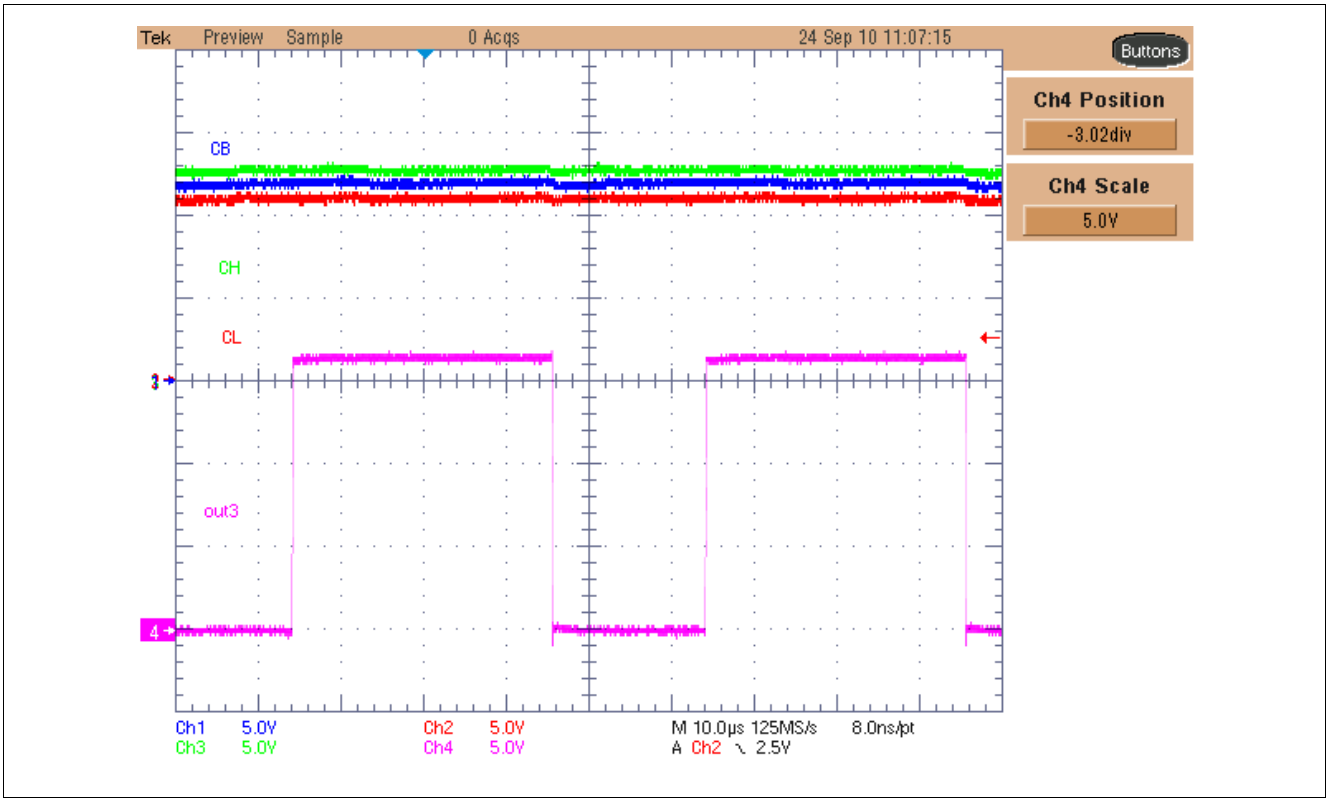

Figure 12 Signals at the charge pump with Vs=16V

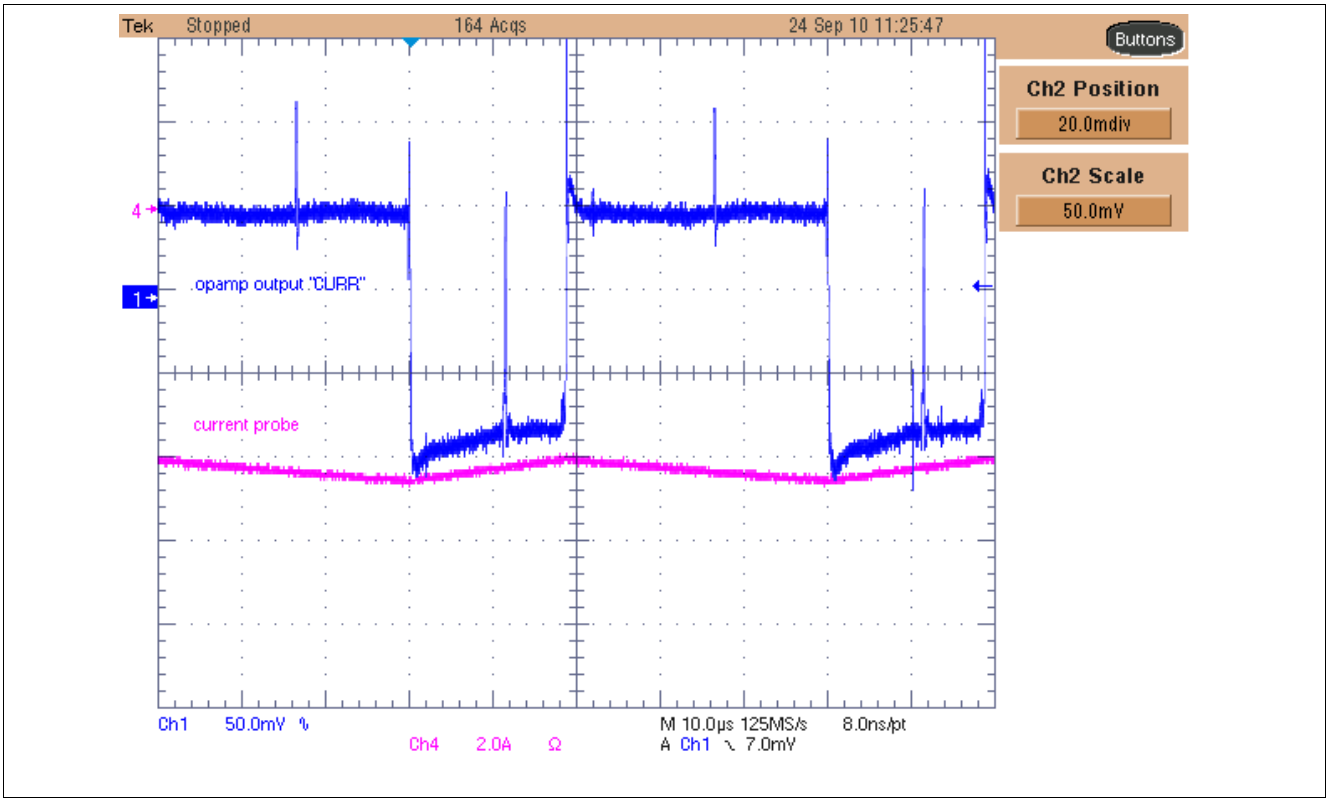

Figure 13 Output signals at VO1 compared with a current probe measurement at the motor

4 Schematics and Layout

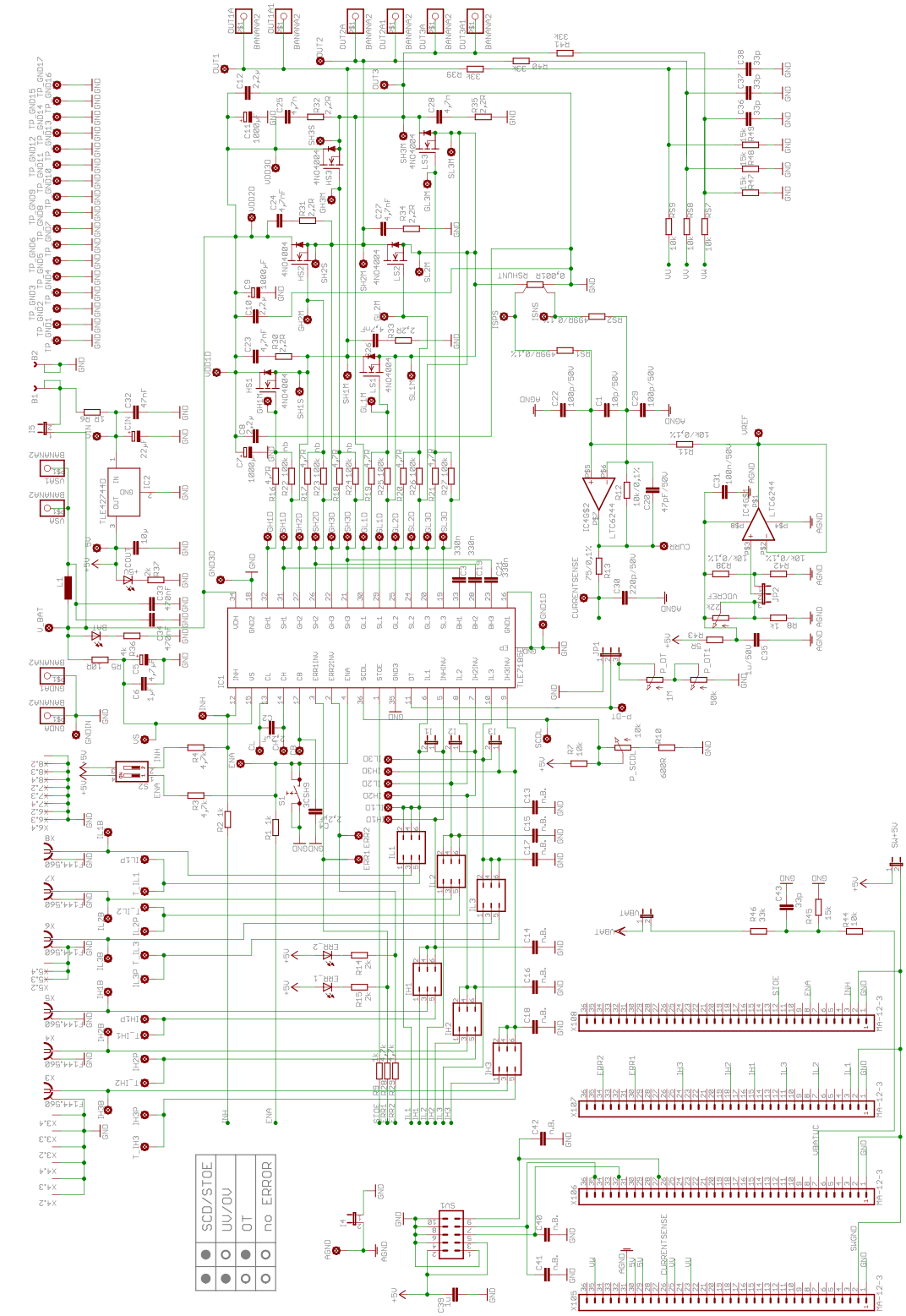

Figure 14 Figure Example

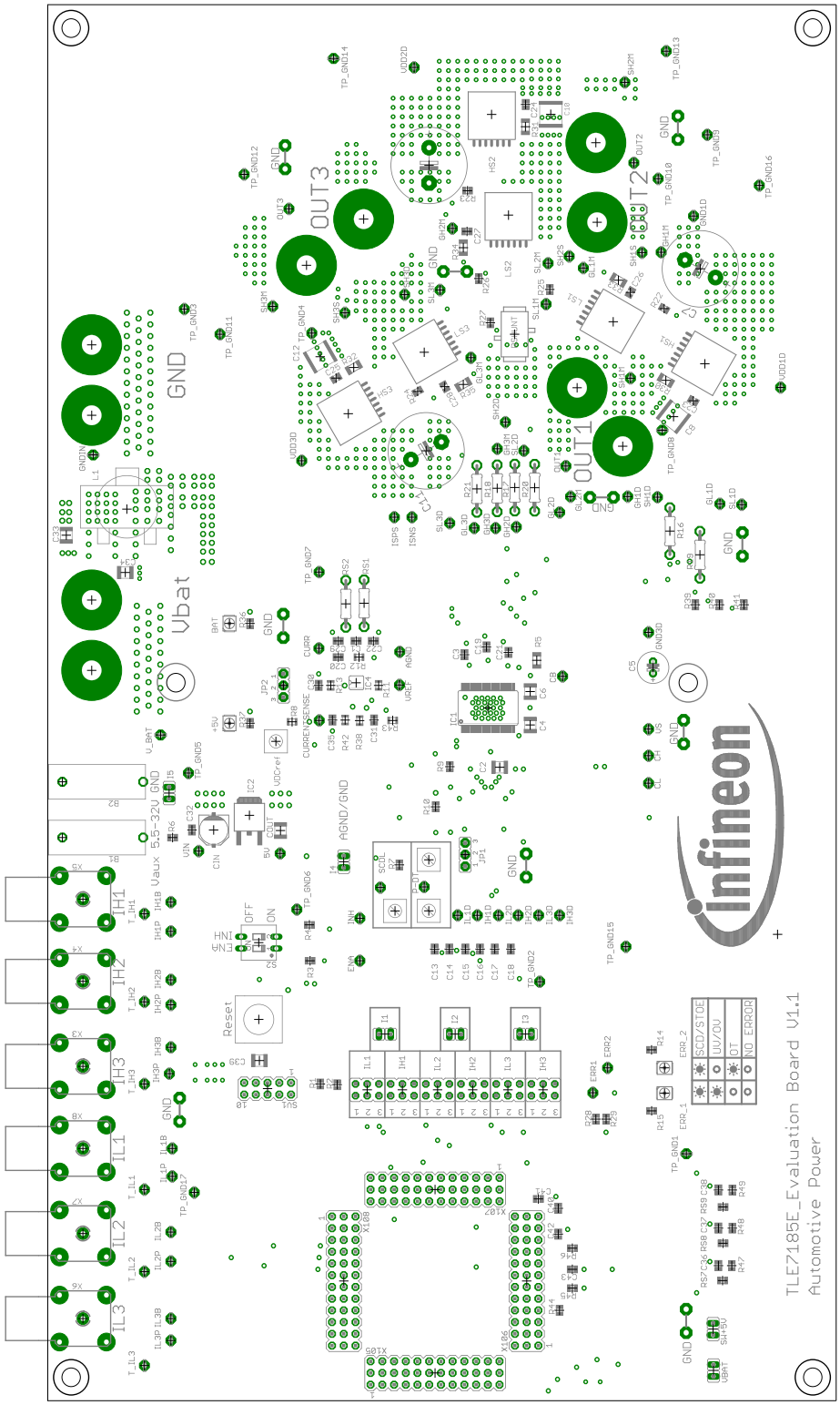

Figure 15 Placing of components

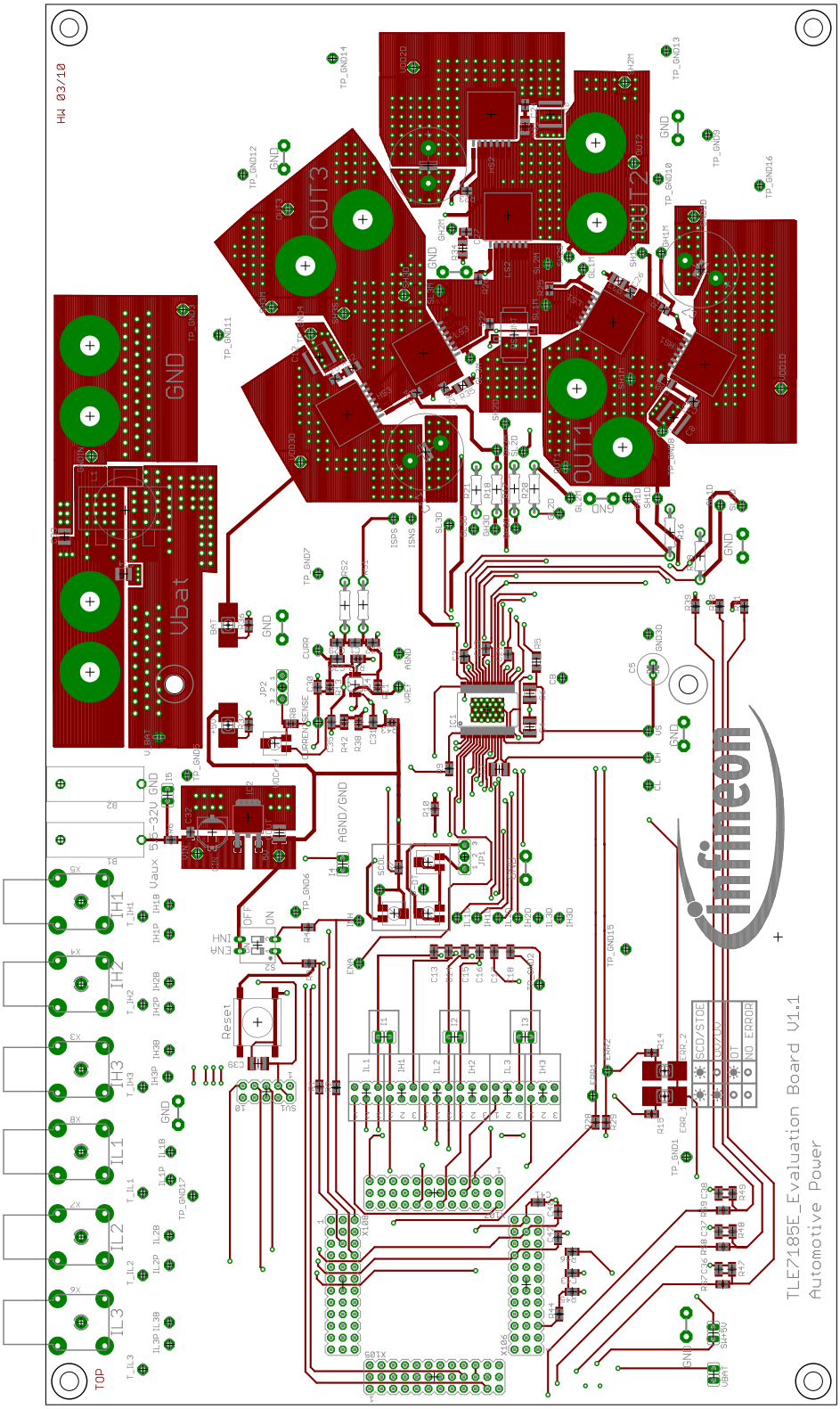

Figure 16 Top level metallization

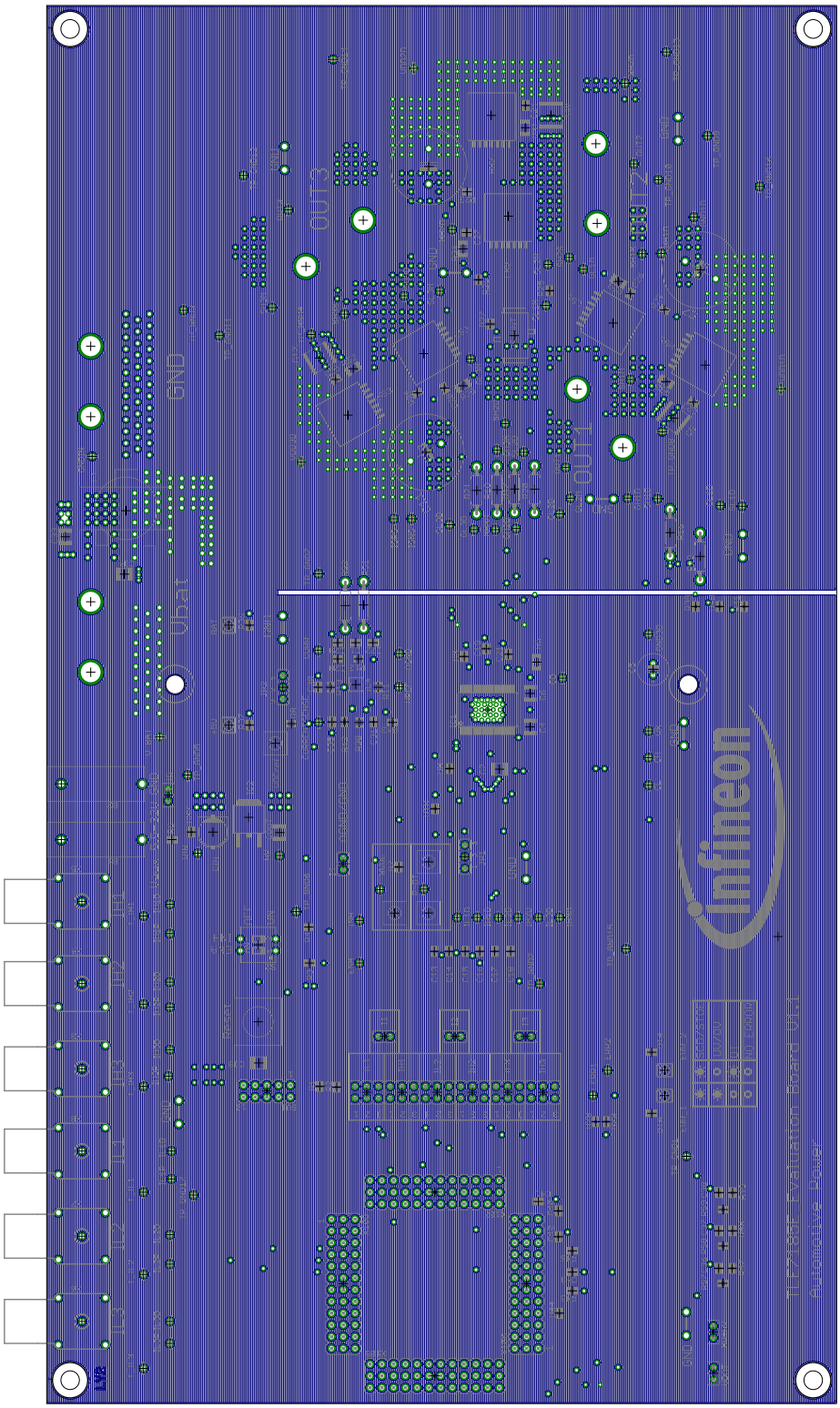

Figure 17 2nd layer metallization

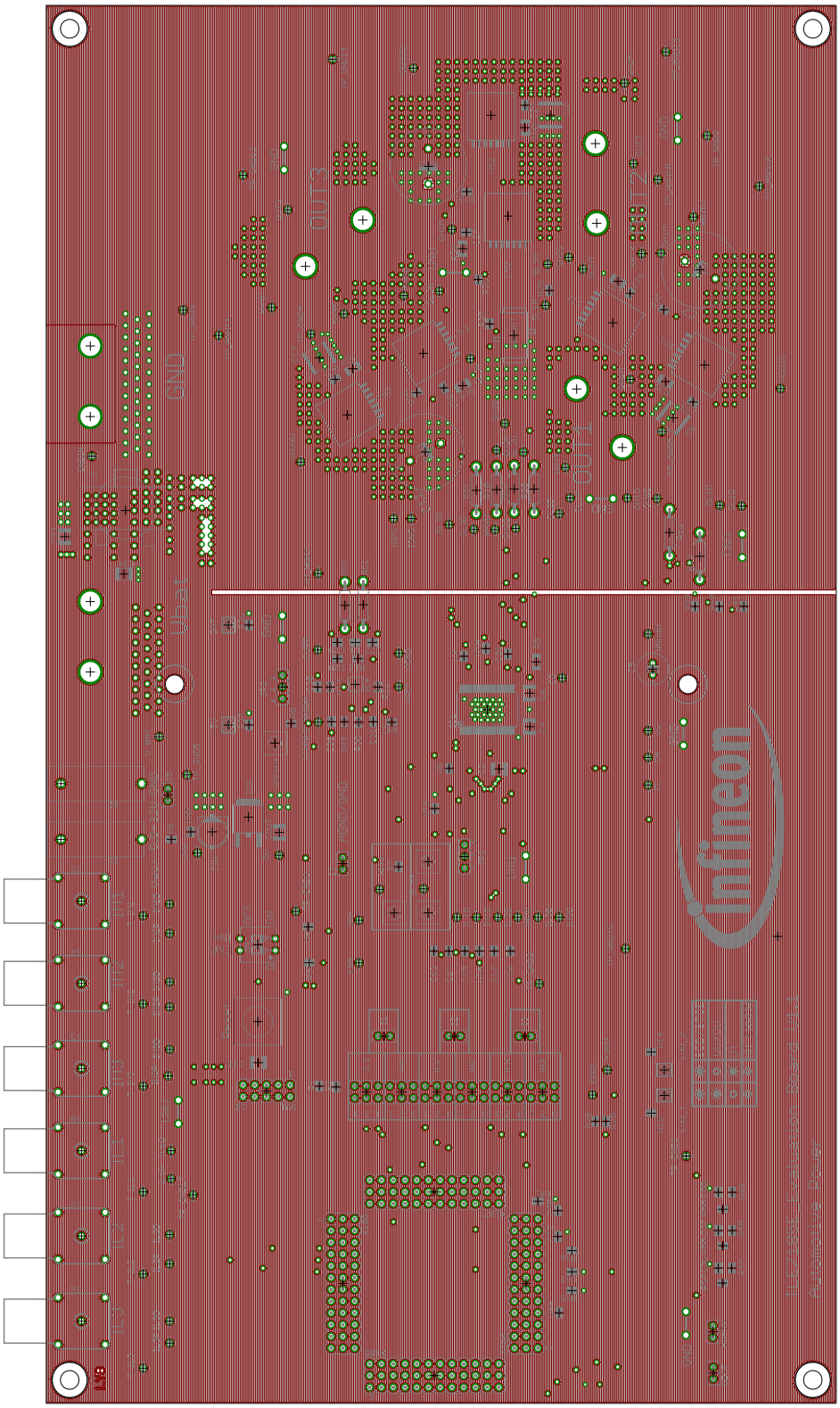

Figure 18 3rd layer metallization

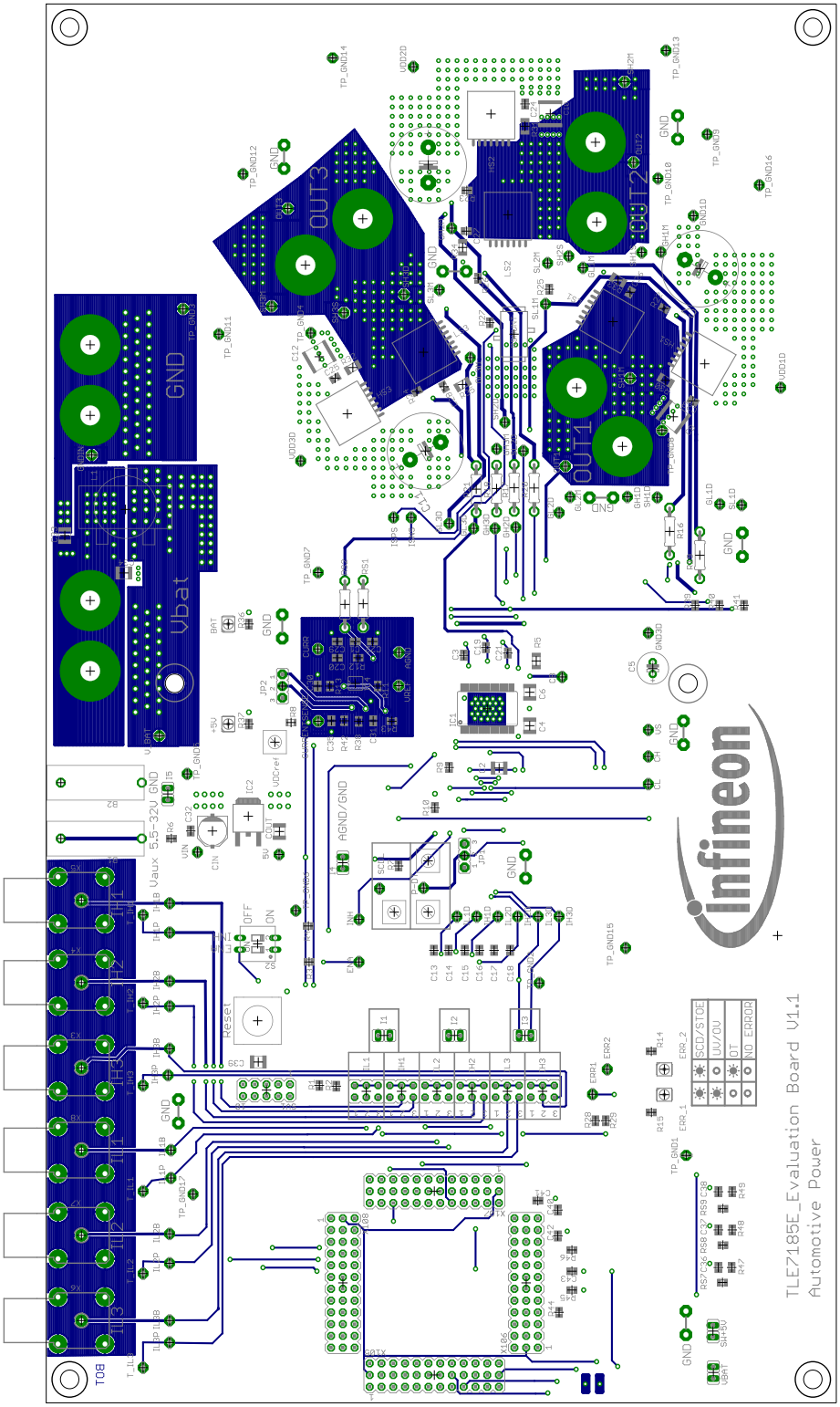

Figure 19 Bottom layer metallization

5 Revision History

TLE7185-1E

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Page	Subjects (major changes since last revision)

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