Infineon

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Bridge driver IC / TLE7189F

Evaluation Board TLE7189F

Application Note

Rev. 1.0, 2010-07-12

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 TLE7189F.

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 TLE7189F 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 TLE7189F 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 TLE7189F contains one 3-Phase N-Channel MOSFET Driver IC TLE7189F, 6 N-Channel Power MOSFETs (configured as 3 half bridges), one 1mOhm current sense shunt per phase, and auxiliary components like a 5V Vreg to enable the operation with a minimum of external equipment.

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 TLE7189F as well as the Evaluation Board TLE7189F 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 … 45 V (limited by the auxiliary 5 V linear regulator).

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 TLE7189F 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 TLE7189F is located in the center of the board. The P-VQFN-48 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 1mohm shunt for load current measurement
- 1 1000uF electrolytic capacitor
- 1 X µF ceramic capacitor
- and a snubber per MOSFET

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 only on the first layer of the PCB avoiding additional ohmic parasitics by vias. The vias in the design are for cooling purposes.
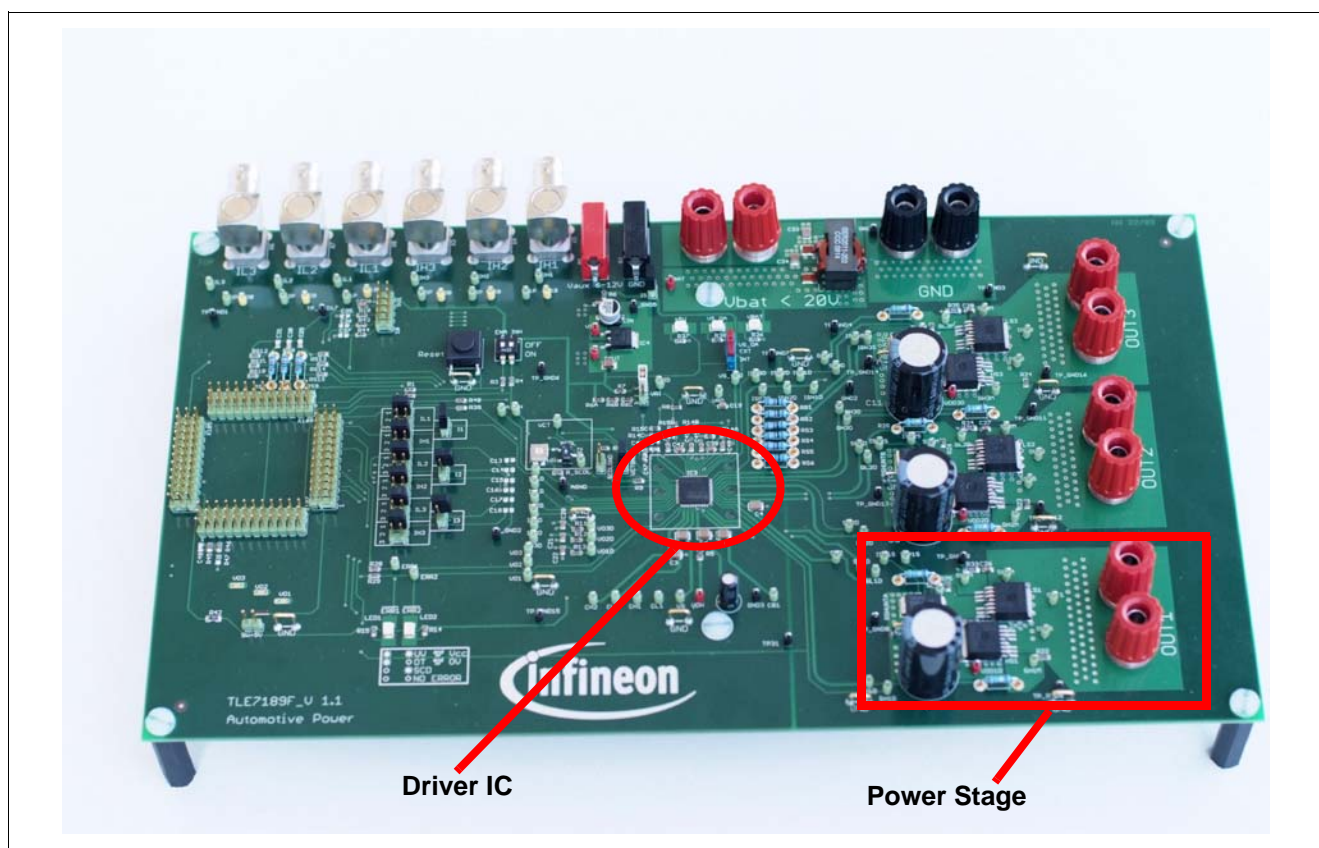

Driver IC

Power Stage

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)
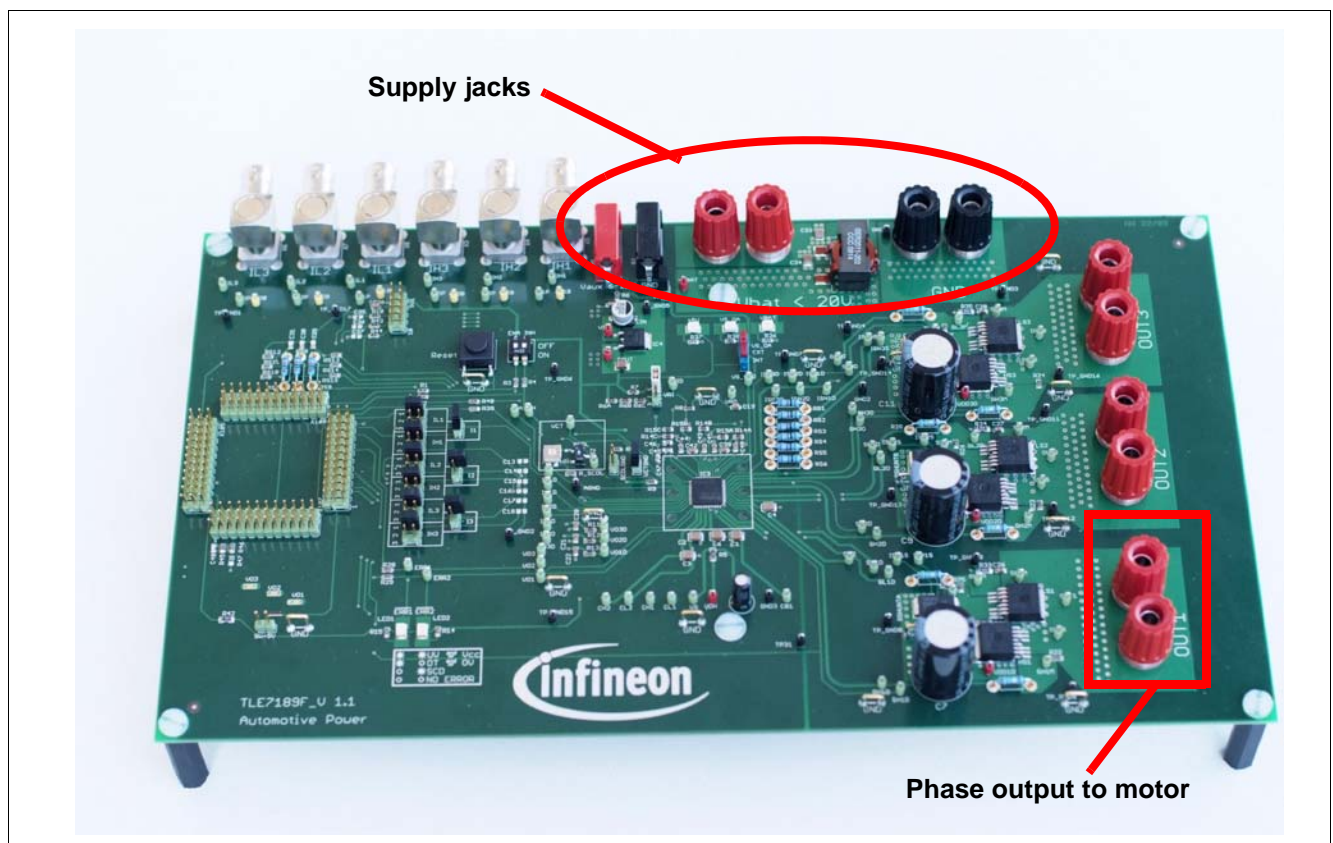

Figure 2   Evaluation board TLE7189F - supply

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 IL_1, IH_1 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.
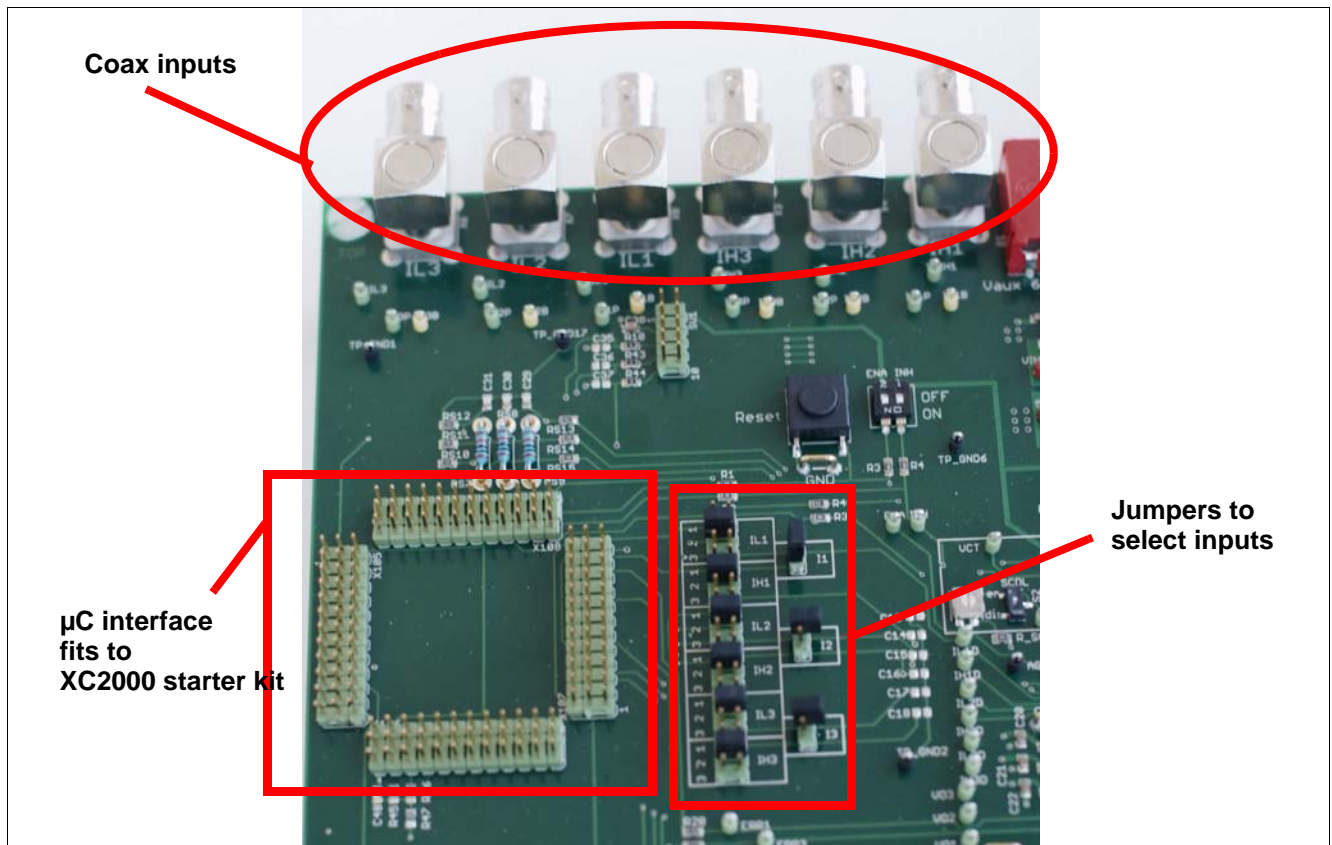

Figure 3   Input interfaces

3.1.5 Board internal input signals

The board is designed to operate with and without µC.

If the board is operated without µC.

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

See **Figure 4**.

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).

Please set the ENA to "ON" to provide a high signal to the driver IC.

Please see as well the schematics.

3.1.5.3   VCT Signal

The VCT signal allows to test the VCC-Check of the driver even the VSOA pin is supply by correct 5V.

To operate the driver normally it is necessary to pull VCT to GND, otherwise the driver will show an VCT error.

If you do not use a µC, you can connect VCT to GND by setting the Jumper "VCTGND§". It is located close to the driver IC on its left side.

3.1.5.4   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 switches, jumpers and a potentiometer.

The SCDL switch allows to switch the SCDL input between 5V (deactivation of the SCDL feature) and the potentiometer. Please compare with the schematics.

The potentiometer allows the trimming of the Signal between 0,7V and 2,5V.

The SCDLGND Jumper allows to set the SCDL input to 0V. This is triggering the test feature for the short circuit detection of the driver.

In Normal operation, this jumper has to be open.

3.1.5.5   Reset

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

3.1.5.6   VRI

The pin VRI allows to set the zero current equivalent output voltage at the OpAmp output. The voltage levels supported by the board are 2,5V and 1,65V. The level is selected by the jumper VRI.

3.1.5.7   VSOA

The TLE7189F has 3 integrated OpAmps for current measurement. These three OpAmps are supplied at the VSOA pin of driver IC. This supply pin us used additionally for the so called VCC check of the driver.

In normal conditions VSOA has to be supplied by 5V. The VS_OA switch on the board switches the VSOA pin of the driver between Vaux and 5V.

Under normal conditions the VSOA is connected to 5V - means the switch is on position "EXT".

Position of the VS_OA switch see **Figure 4**

Please use this switch only to test the VCC check when Vbat is below 18V. Otherwise the driver might be destroyed.
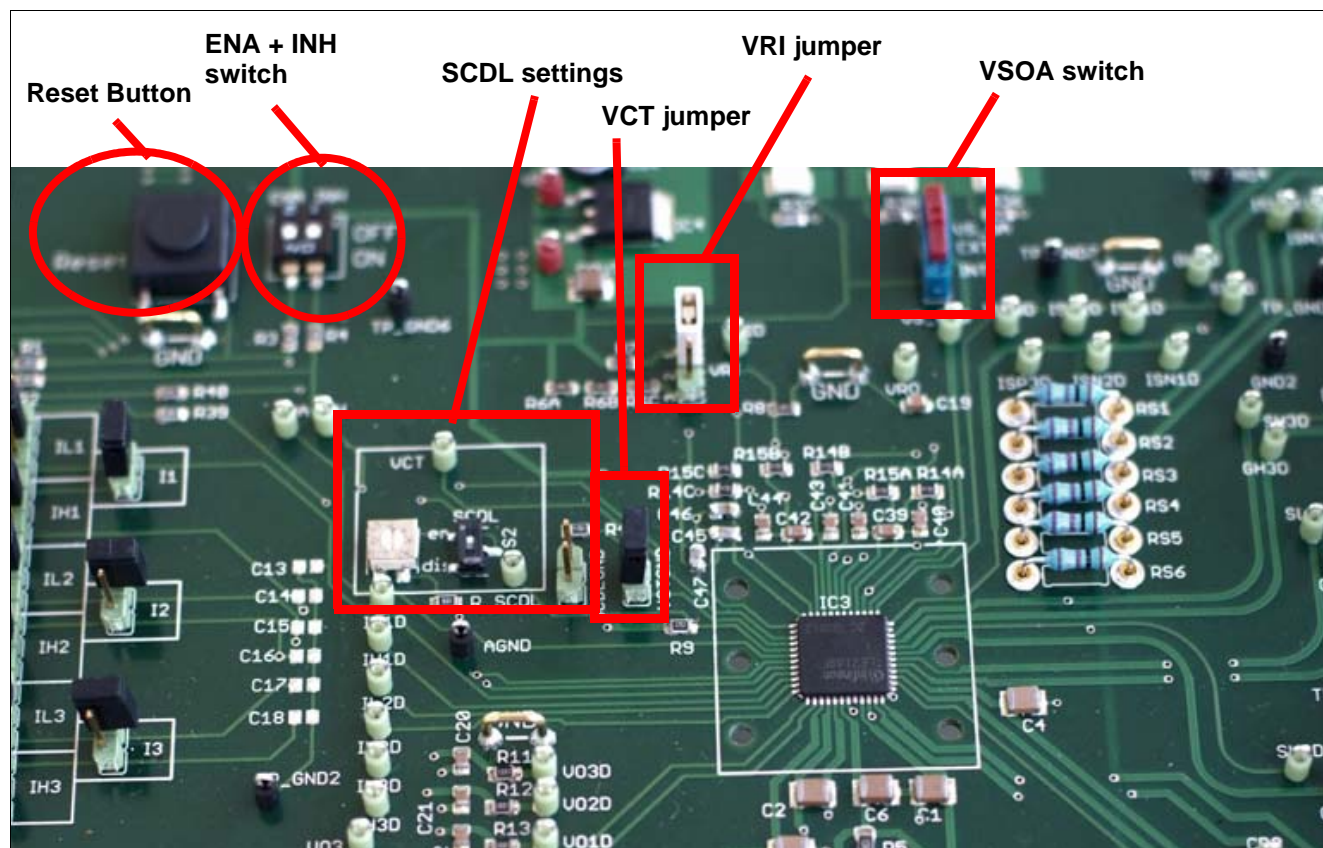
Figure 4   Board internal signals

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 OUT1 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 IL1
- Close jumper IL1 pin 3-4 to chose coax input
- Close jumper I1 to connect IH1 and IL1 input of driver. In this case the dead time of the driver will be used.
- Set ENA and INH to "on"
- Set jumper VCTGND to set the Vcc Check values for 5V supply at VSOA
- Set VSOA switch to "ext" to supply VSOA with 5V
- Set SCDL value with the potentiometer to 0,9V (or chose your own value). Make sure that the jumper SCDLGND is open and the switch SCDL is set to "en".

- Set VRI to 2.5V by connecting "12" in the Jumper VRI.
- Now you can switch on the power supply and set it 12V. In the upper middle area of the board there are 3 LEDs for the supervision of the supply state of the board. All of the 3 LED should be on.

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.
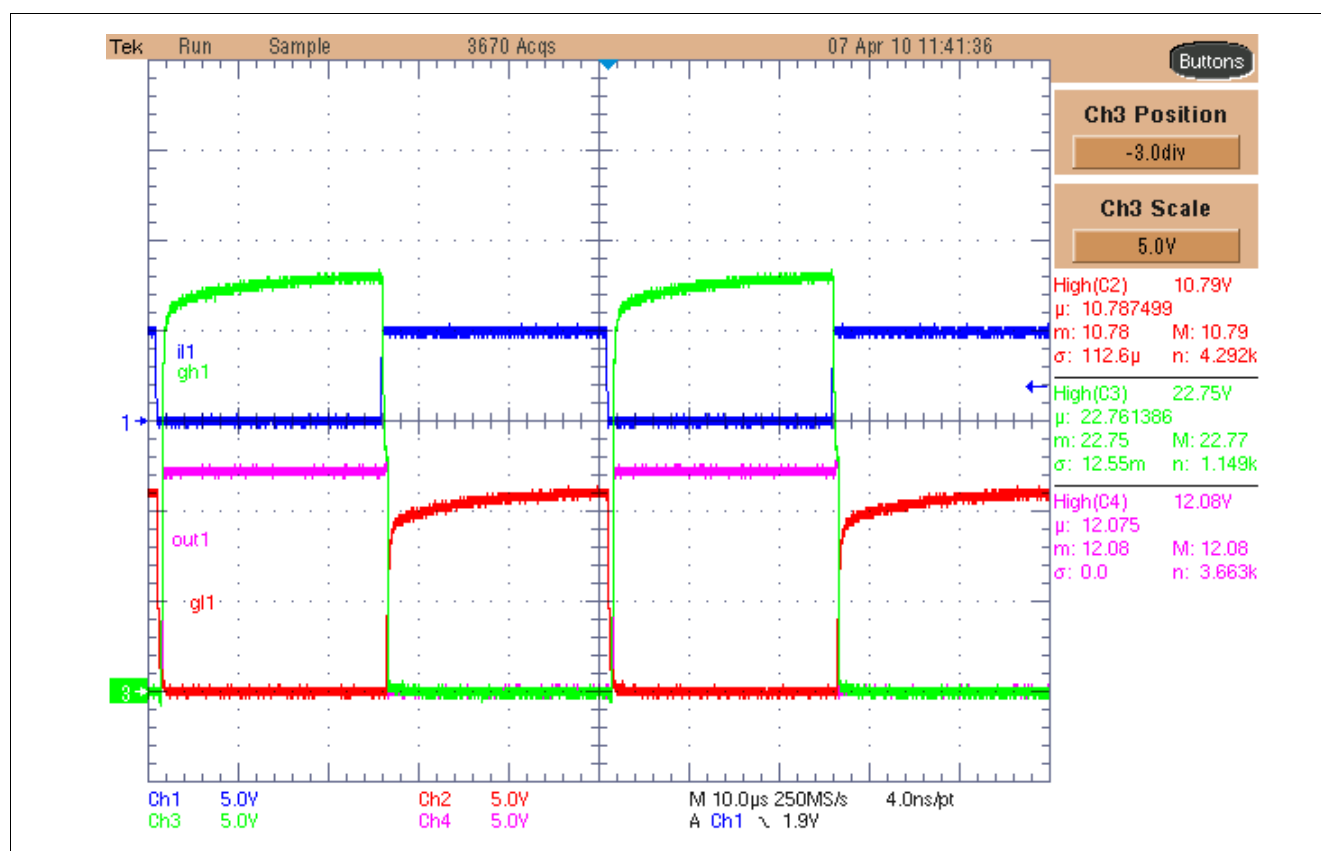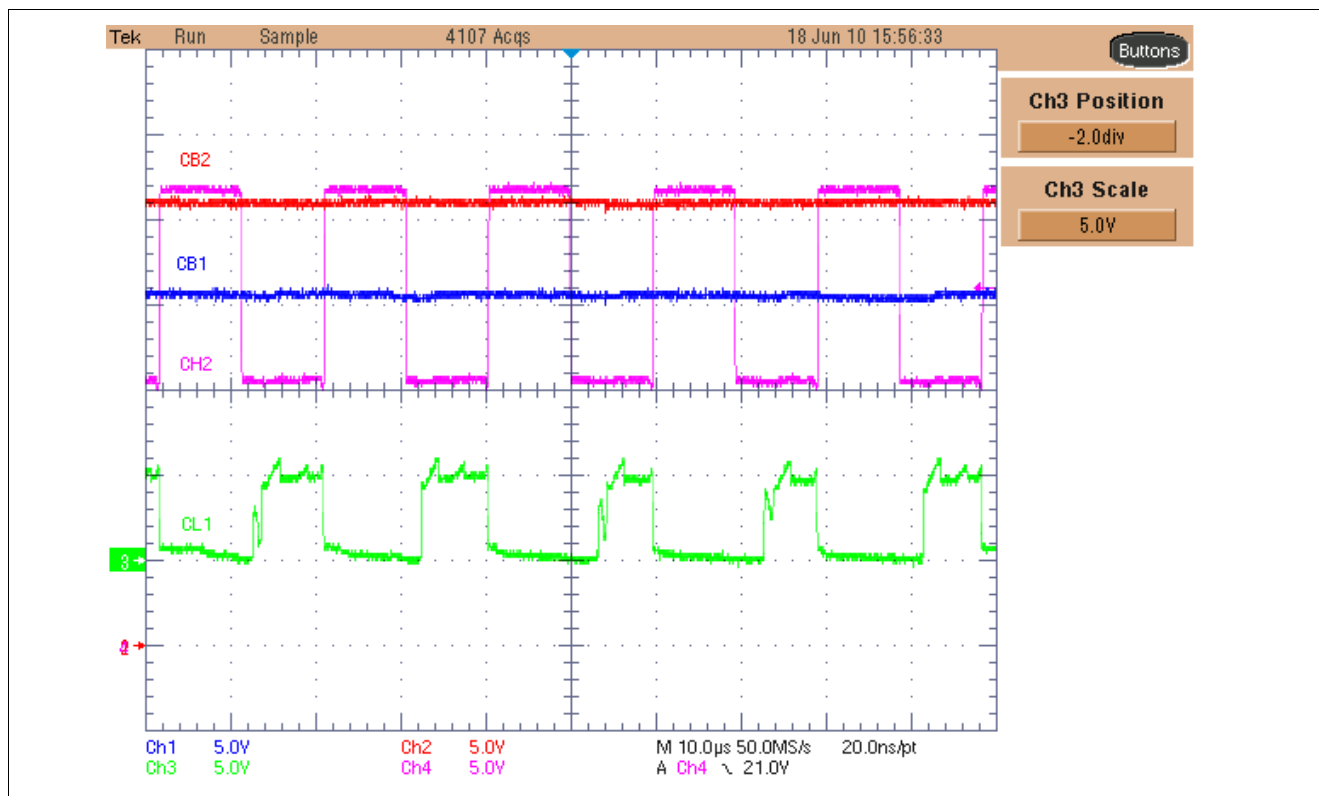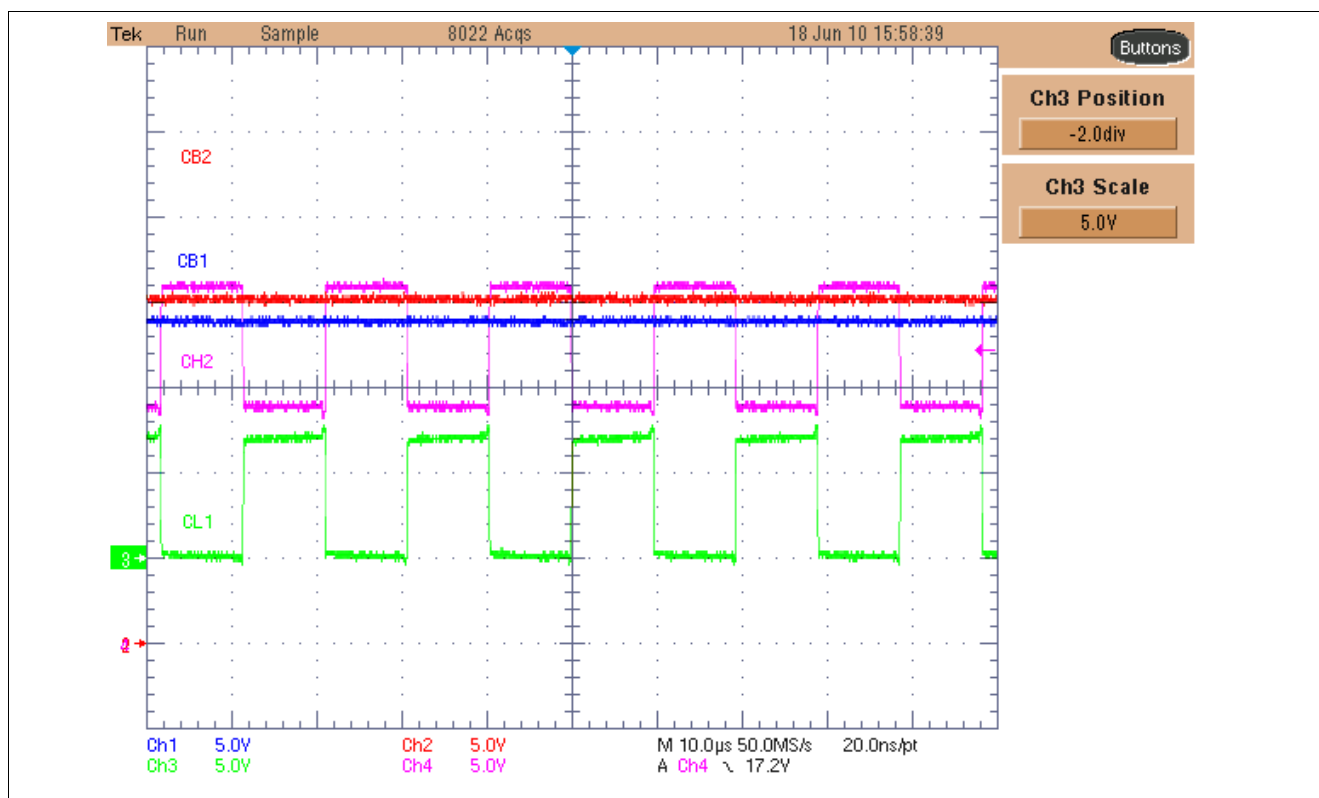

Figure 5   Output signals at OUT1

Figure 6   Signals at the charge pump with Vs=12V

If the supply voltage is reduced to 7.5V, the signals at the charge pump change:
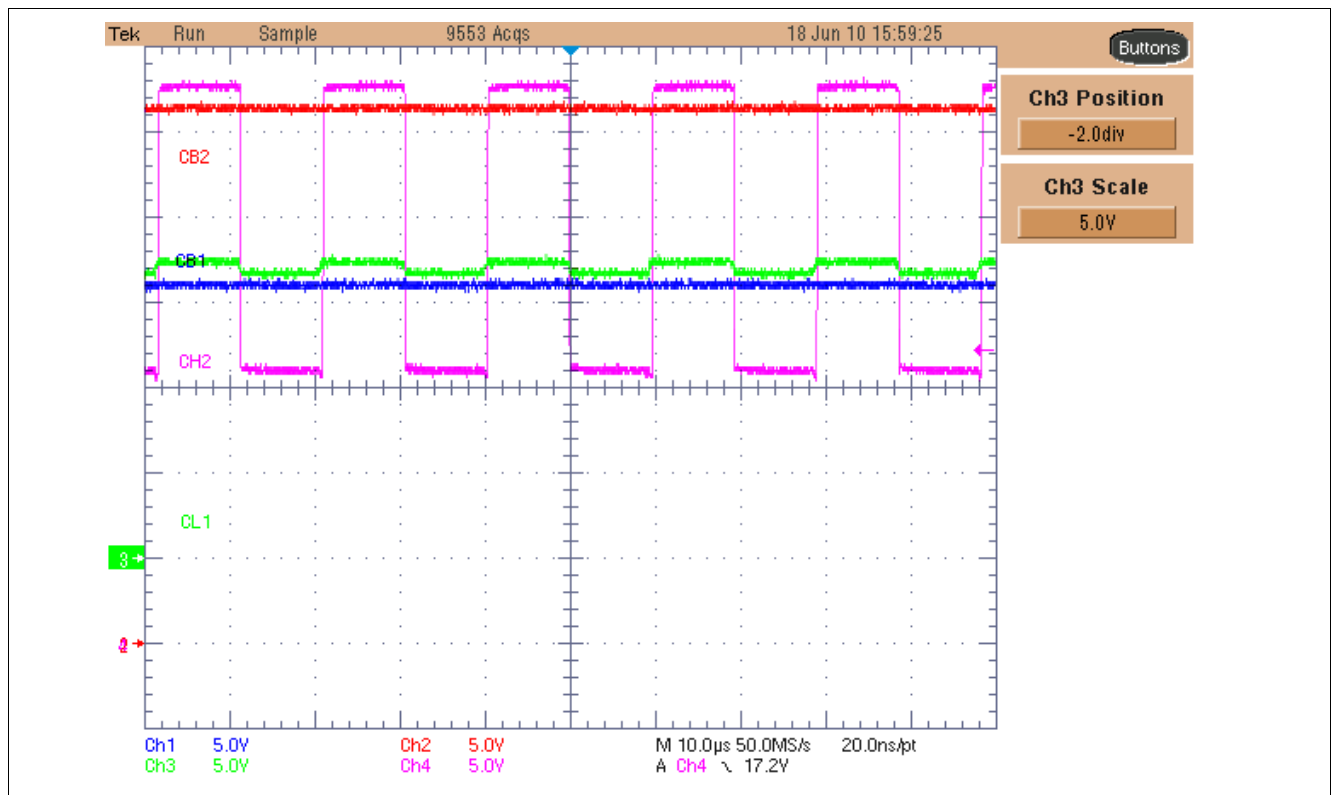

Figure 7   Signals at the charge pump with Vs=7.5V
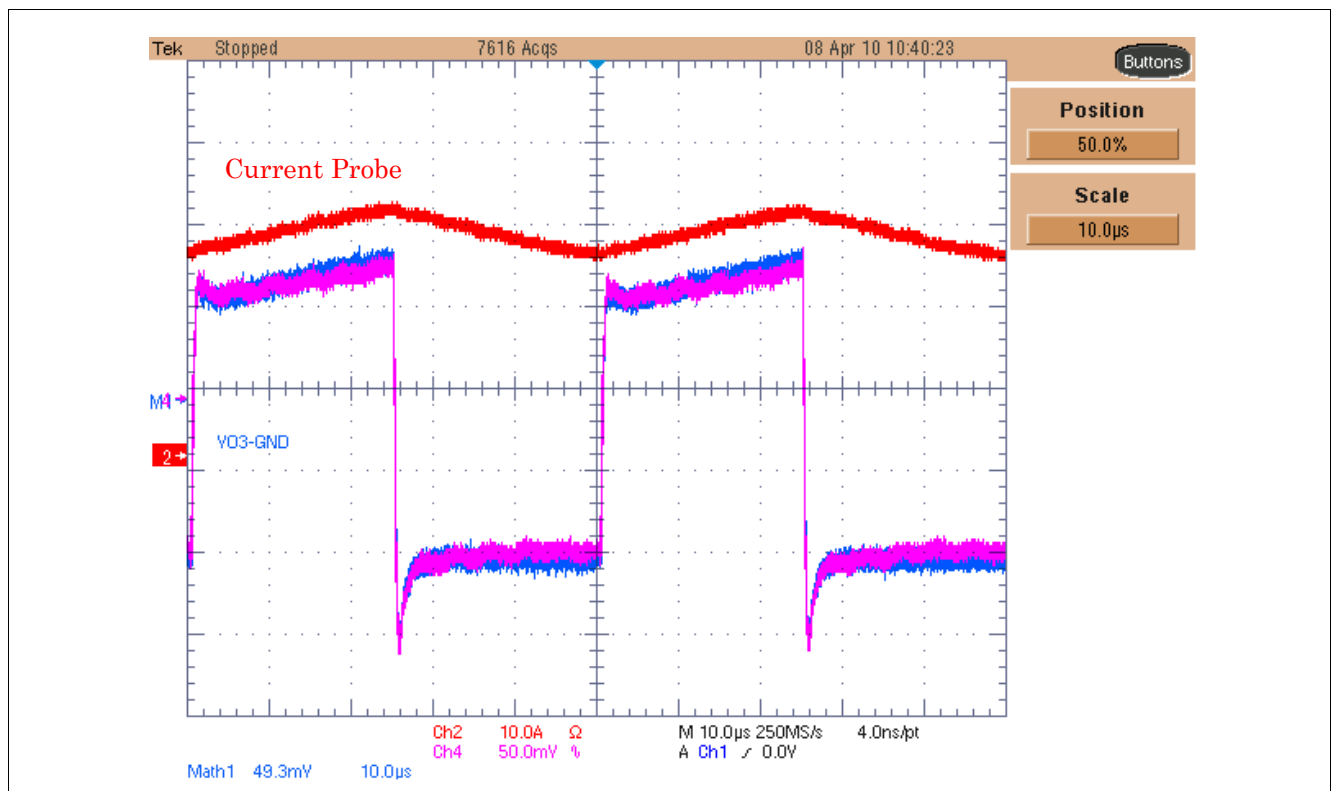
Figure 8   Signals at the charge pump with Vs=17V

Figure 9   Output signals at VO1 compared with a current probe measurement at the motor
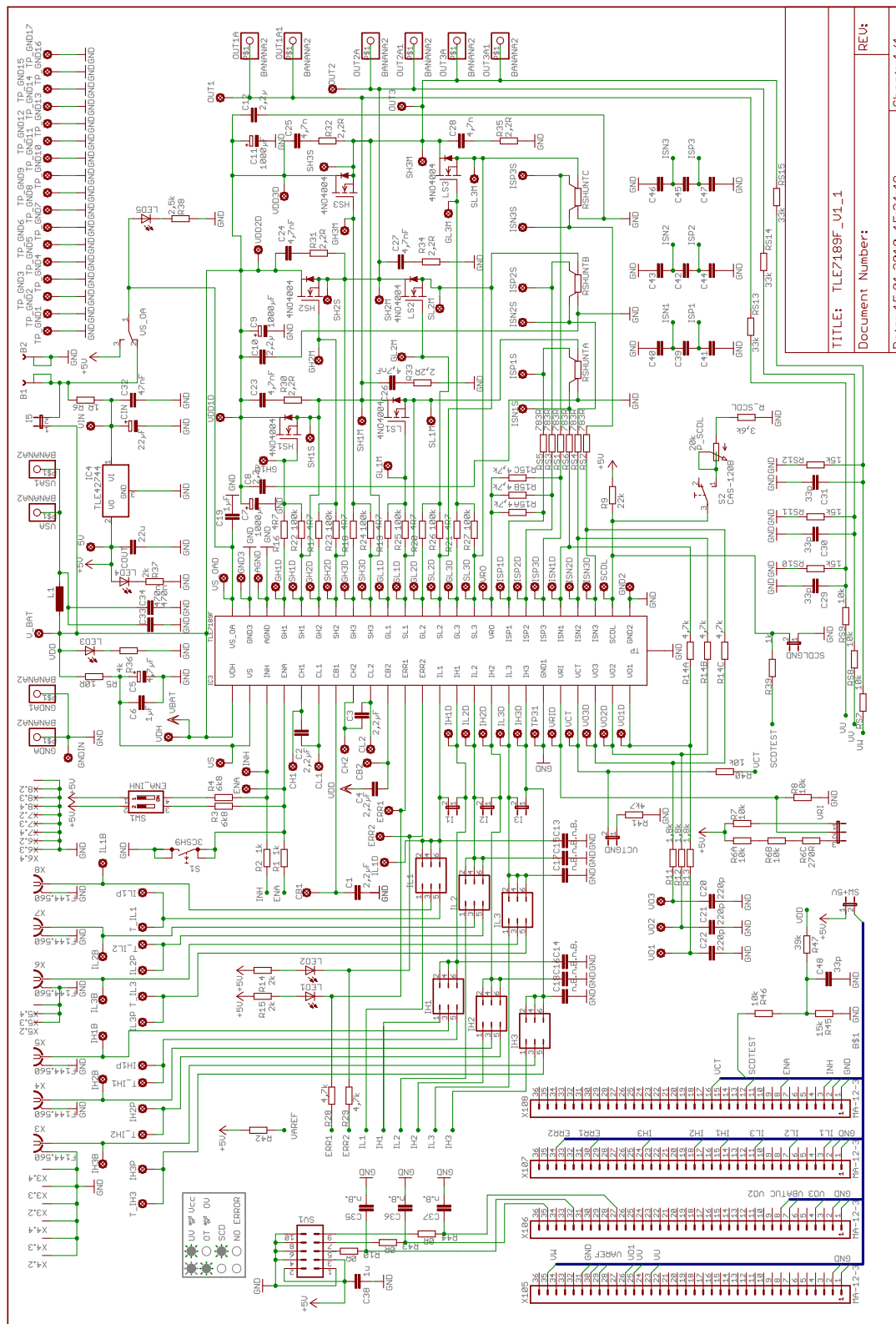
4 Schematics and Layout

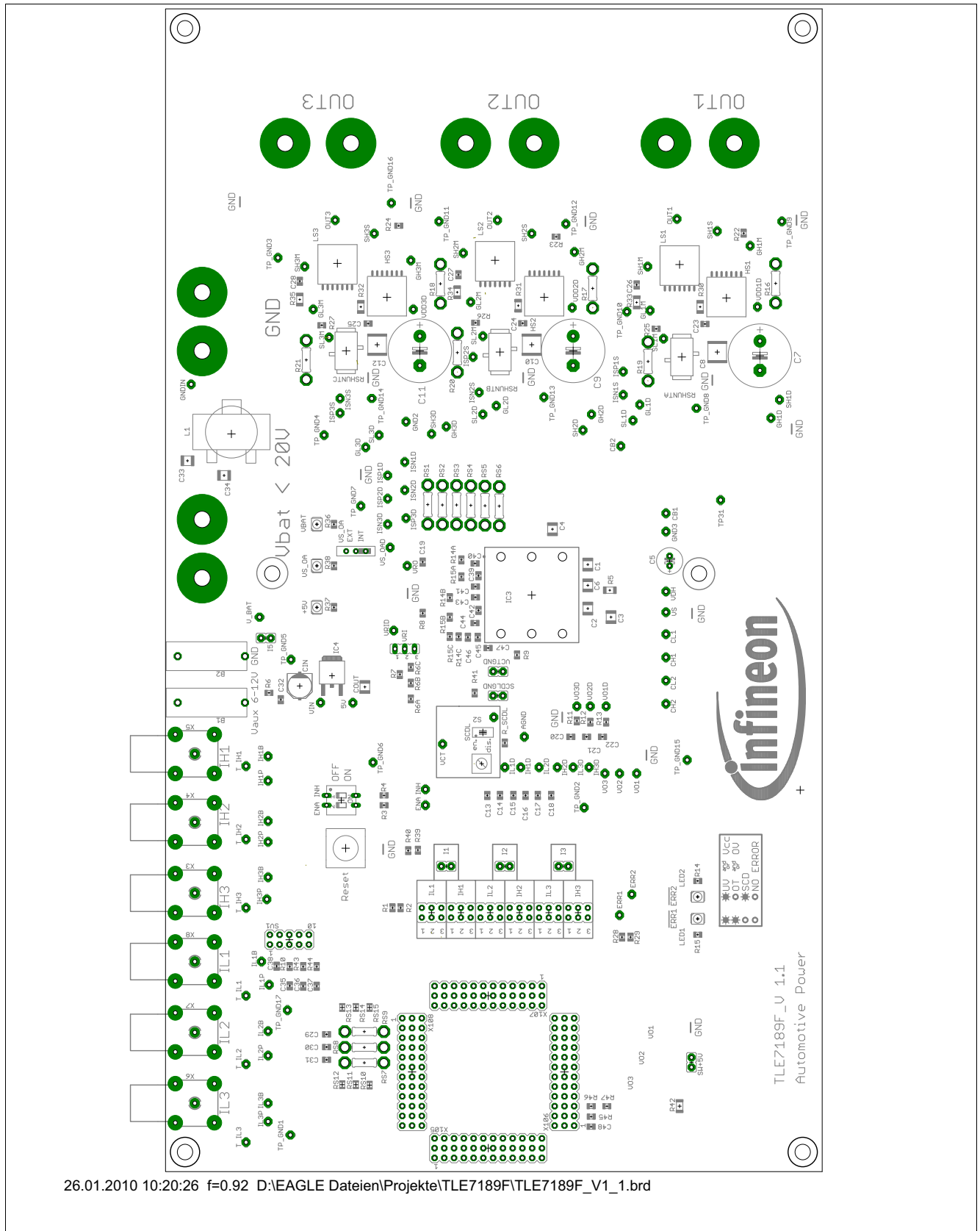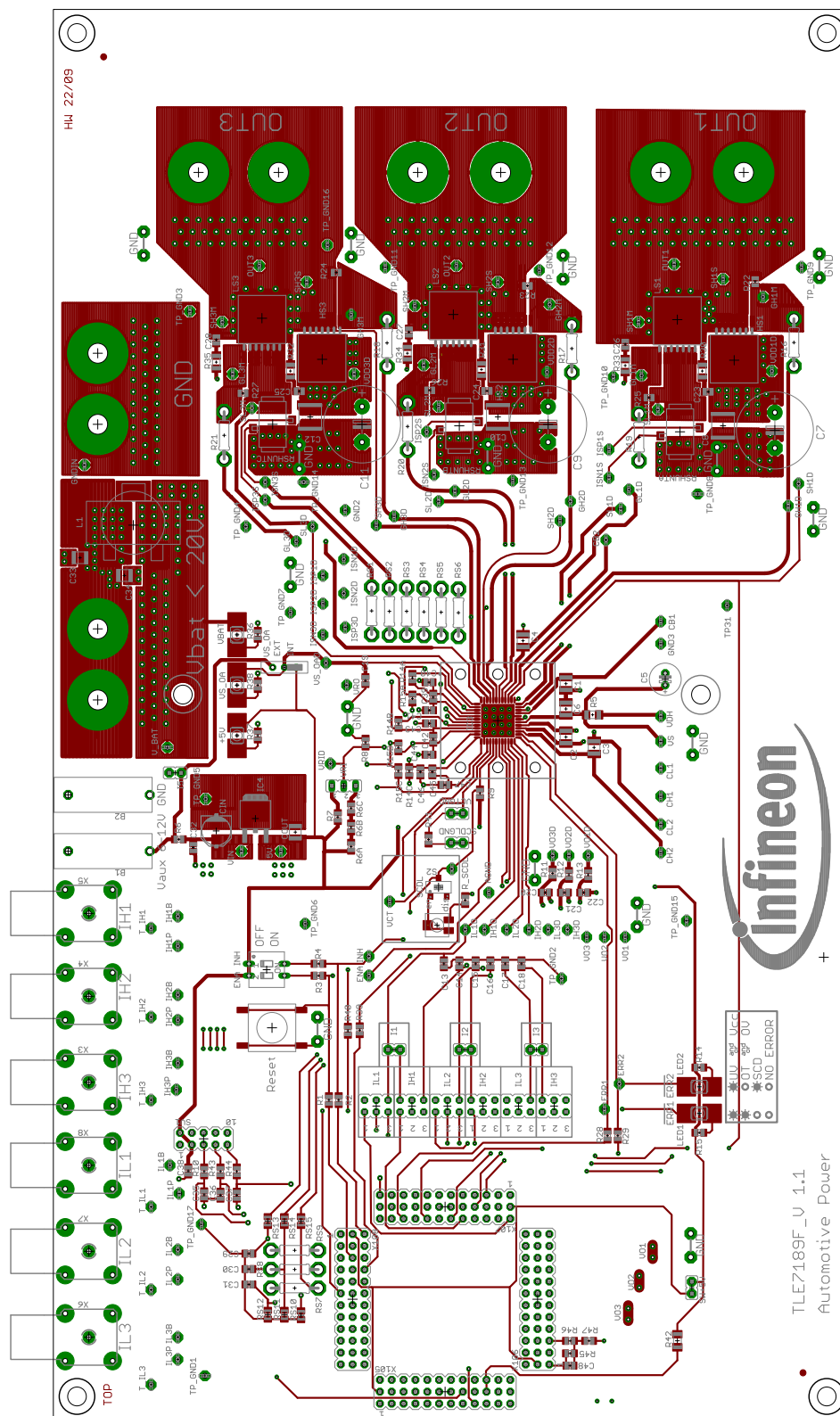**Figure 10   Figure Example**

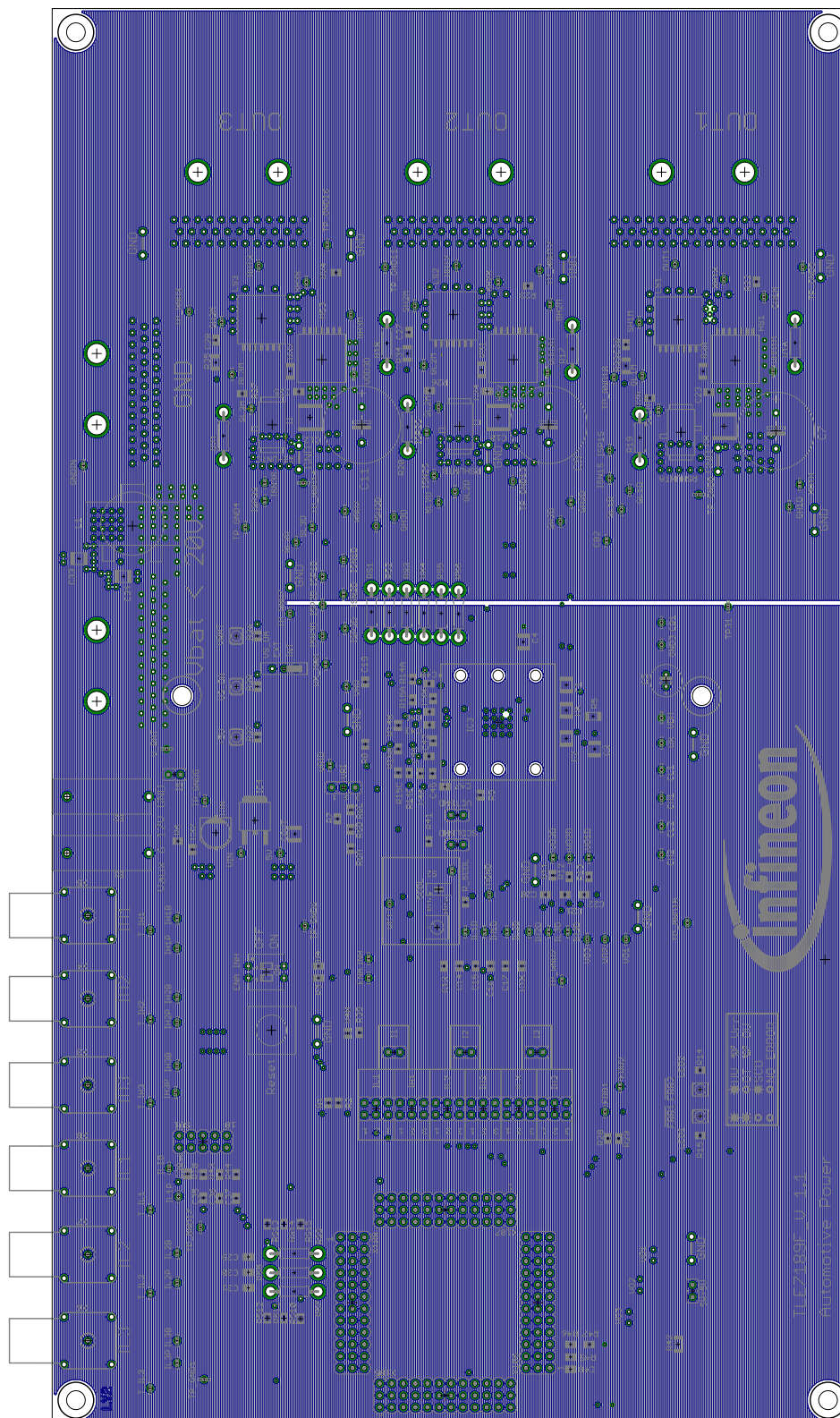**Figure 11   Placing of components**

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Figure 12   Top level metallization
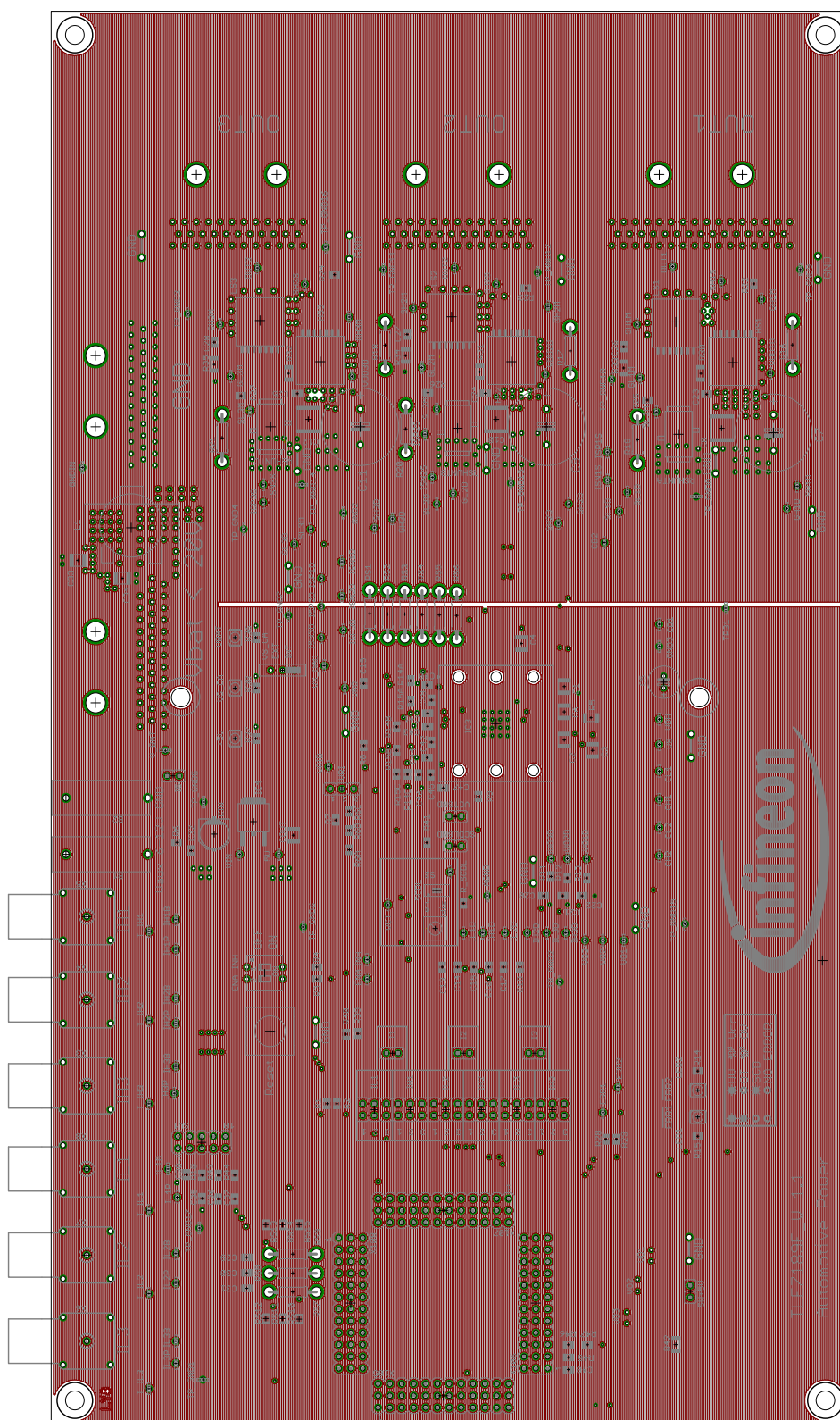
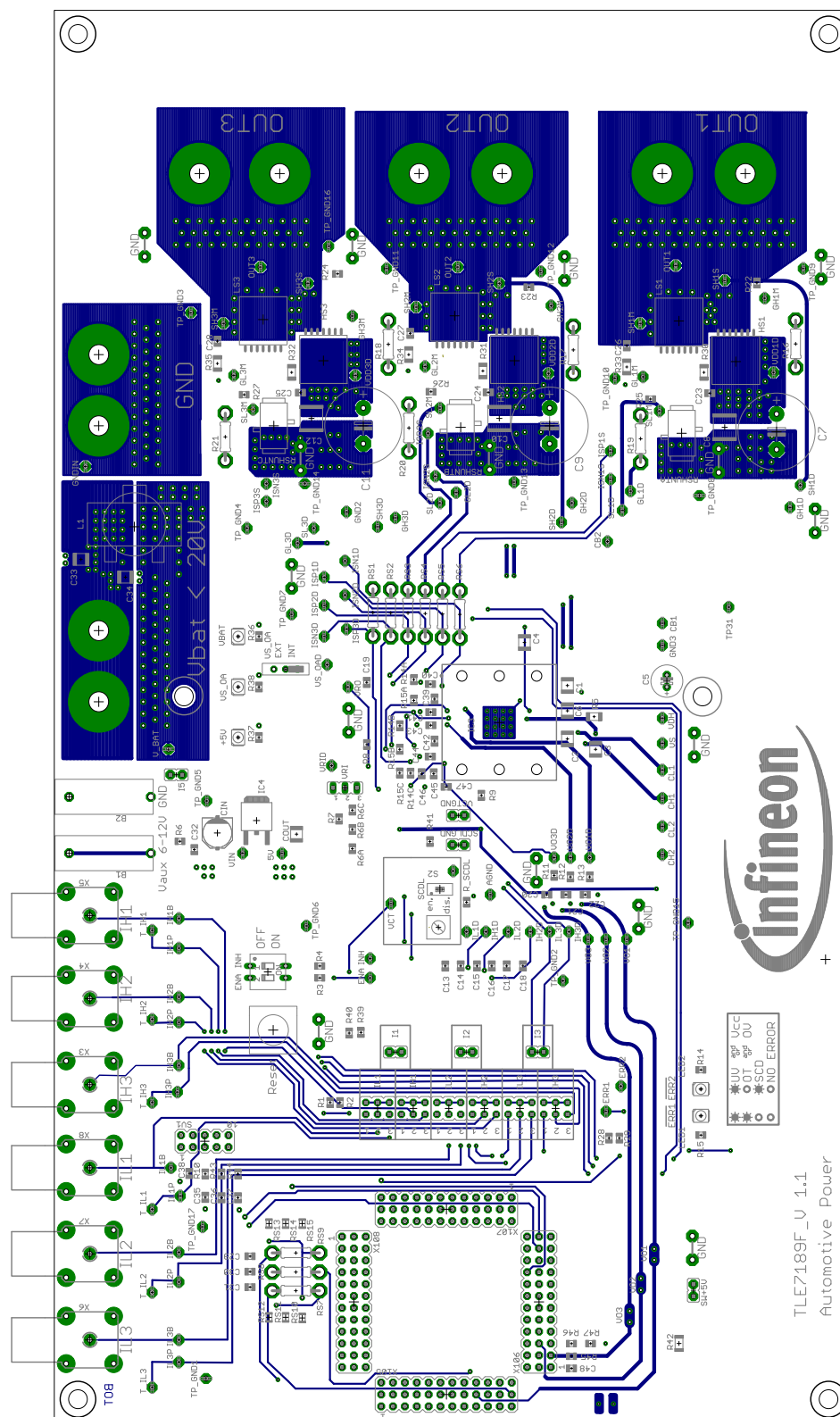26.01.2010 10:21:33 f=0.92 D:\EAGLE Dateien\Projekte\TLE7189F\TLE7189F_V1_1.brd

Figure 13   2nd layer metallization

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Figure 14   3rd layer metallization

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Figure 15   Bottom layer metallization

5 Revision History

TLE7189F

Revision History: Rev. 1.0, 2010-07-12

Previous Version(s):
Rev. none

Page	Subjects (major changes since last revision)

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