ACPL-32JT, ACPL-C87AT

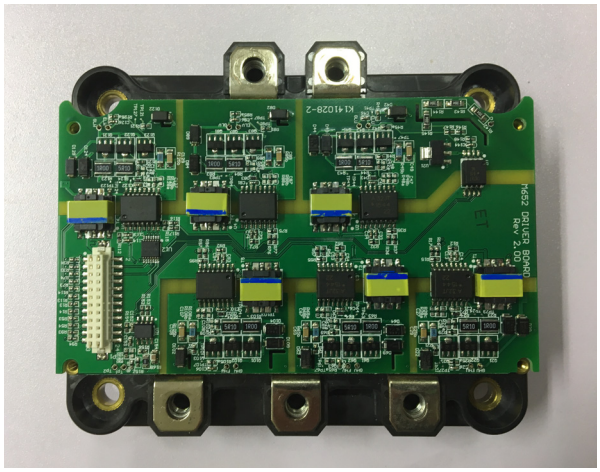
Evaluation Driver Board for Fuji M652 6-in-1 IGBT

User Guide

Introduction

This evaluation driver board is optimized for a Fuji M652 6-in-1 Integrated Gate Bipolar Transistor (IGBT) module rated at 650V, 600A. It features 6 x ACPL-32JT for IGBT gate driving and 1 x ACPL-C87AT for bus voltage sensing.

Figure 1 Evaluation Driver Board for Fuji M652 IGBT



Key Features

Gate Driver

The ACPL-32JT is an Automotive 2.5 Amp Gate Drive Optocoupler. It features an integrated flyback controller for isolated DC-DC converter, IGBT desaturation sensing, and protection with soft-shutdown.

Fault Detection and Protection

The power stage of a typical three-phase inverter is susceptible to destructive failures due to overcurrent and overvoltage conditions.

An ACPL-32JT monitors each IGBT for short circuit events by way of the collector voltage and triggers a local fault shutdown sequence when required. A small gate discharge device slowly reduces the short circuit collector current to prevent overvoltage damage. The IGBT is shut off before the dissipated energy can reach destructive levels.

Integrated Flyback Controller

Each ACPL-32JT has an integrated DC-DC flyback controller that is paired with a flyback transformer to provide a split rail Vcc2 voltage of +15V/–5V with up to 2W of isolated power for driving each IGBT. This distributed power supply architecture removes the need for a separate monolithic power supply.

Bus Voltage Sensing

The ACPL-C87AT is an automotive unity-gain isolated voltage sensor that utilizes superior optical coupling technology, with a sigma-delta analog-to-digital converter, chopper stabilized amplifiers, and a fully differential circuit topology to provide unequaled isolation-mode noise rejection, low offset, high gain accuracy, and stability.

An ACPL-C87AT is used with a resistor chain for bus voltage sensing.

Board Operation

Power Supply

The board accepts 8V to 18V applied across DC12 to GND1. The nominal voltage is 12V.

PWM Inputs

There are six Pulse Width Modulation (PWM) inputs for driving the IGBT module: PWMLW, PWMHW, PWMLV, PWMHV, PWMLU, PWMHU.

0V: Input Low

5V: Input High (max 5.5V)

Signals are referenced to GND1.

The input LEDs of the ACPL-32JT gate drivers are driven by an on-board current buffer.

Desat Fault Feedback

There are six Desat Fault feedback outputs, one for each IGBT: FLU, FHU, FLV, FHV, FLW, FHW.

When fault on gate driver secondary side is detected, Fault feedback is pulled Low.

Low: Desat Fault Detected

High (5V): No Fault

UVLO Feedback

There are six Under-Voltage Lock Out (UVLO) feedback outputs, one for each IGBT: ULU, UHU, ULV, UHV, ULW, UHW.

When undervoltage on gate driver secondary side is detected, UVLO feedback is pulled Low.

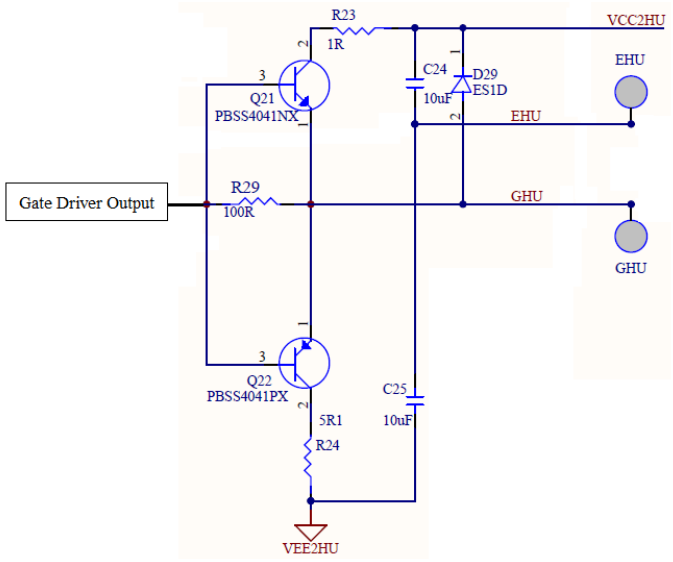
Low: Undervoltage Detected

High (5V): Voltage Normal

Board Design

Gate Driving

Figure 2 Gate Driving

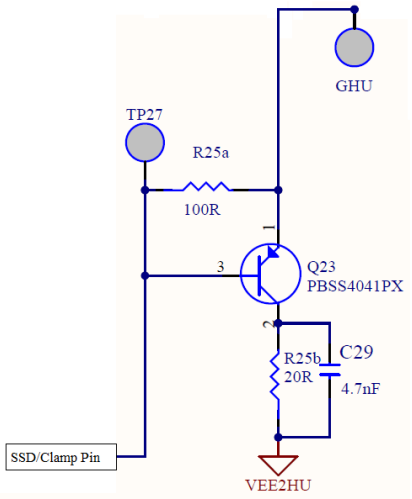


The Gate Driver output is connected to a push-pull buffer to drive the IGBT gate.

The strength of the turn-on and turn-off is controlled by Ron and Roff respectively (R23 and R24 in Figure 2).

Soft Shutdown

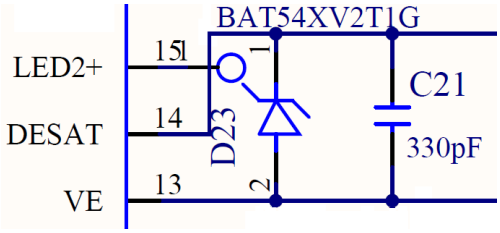
Figure 3 Soft Shutdown



The IGBT collector voltage is sensed by the ACPL-32JT gate drivers through the Desat pin. When desaturation events are detected, ACPL-32JT applies a soft shutdown to the IGBT gate to prevent damage. A PNP buffer transistor is used to customize the shutdown process. The shutdown strength is controlled by Rssd and Cssd.

Desat Blanking

Figure 4 Desat Blanking

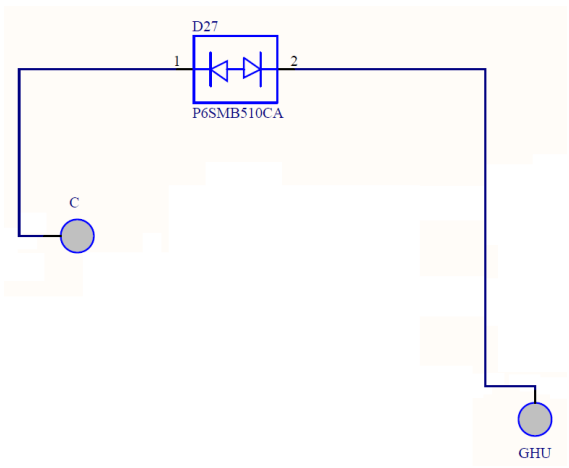


The total blanking time is calculated in terms of internal blanking time tDESAT(BLANKING) (0.6 µs typ), external capacitance CBLANK (330 pF), FAULT threshold voltage VDESAT (7V typ), and DESAT charge current ICHG (0.9 mA typ) as follows:

$$tBLANK = tDESAT(BLANKING) + (CBLANK \times VDESAT/ICHG)$$
$$= 0.6\ \mu s + (330\ pF \times 7V/0.9\ mA)$$
$$\sim 3.2\ \mu s$$

Active Clamp

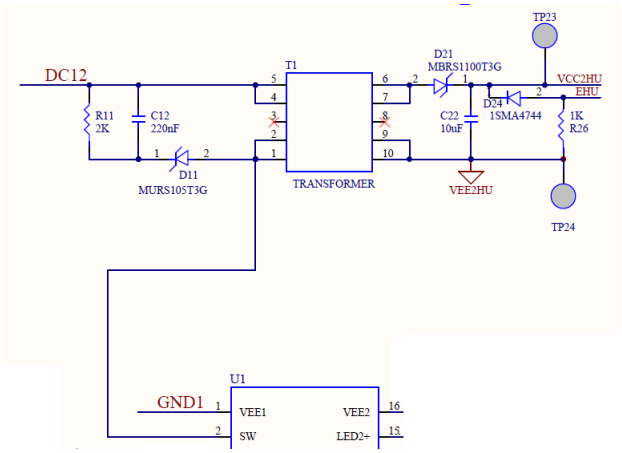
Figure 5 Active Clamp



A Transient Voltage Suppressor (TVS) rated at 510V is placed between the Gate and Collector of the IGBT to provide active clamp protection. Vce of the IGBT is clamped and protected by the TVS.

DC/DC Converter

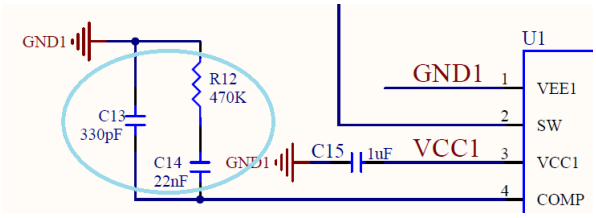
Figure 6 DC/DC Converter



Each ACPL-32JT Gate Driver integrates a DC/DC converter that provides distributed power to the secondary side.

For DC12 = 8V to 18V, this circuit nominally supports a secondary-side load of up to 60 mA (including Icc2 of ACPL-32JT) at the regulated VCC2 voltage.

Figure 7 Compensation Network



The compensation network is referenced to a nominal transformer of Lp = 60 µH, Ls = 260 µH.

Bus Voltage Sensing

Bus voltage is sensed through a precision resistor chain. ACPL-C87AT optically isolates the signal for transmission to a microcontroller (output Voltage Sense Output (VSO) on P1 header).

The Bus Voltage Sense Ratio may be calculated as follows:

$$\text{Bus Voltage Sense Ratio} = \frac{R146 + R147}{R142 + R143 + R144 + R145 + R146 + R147}$$

$$= \frac{2k + 2k}{200k + 200k + 200k + 200k + 2k + 2k}$$

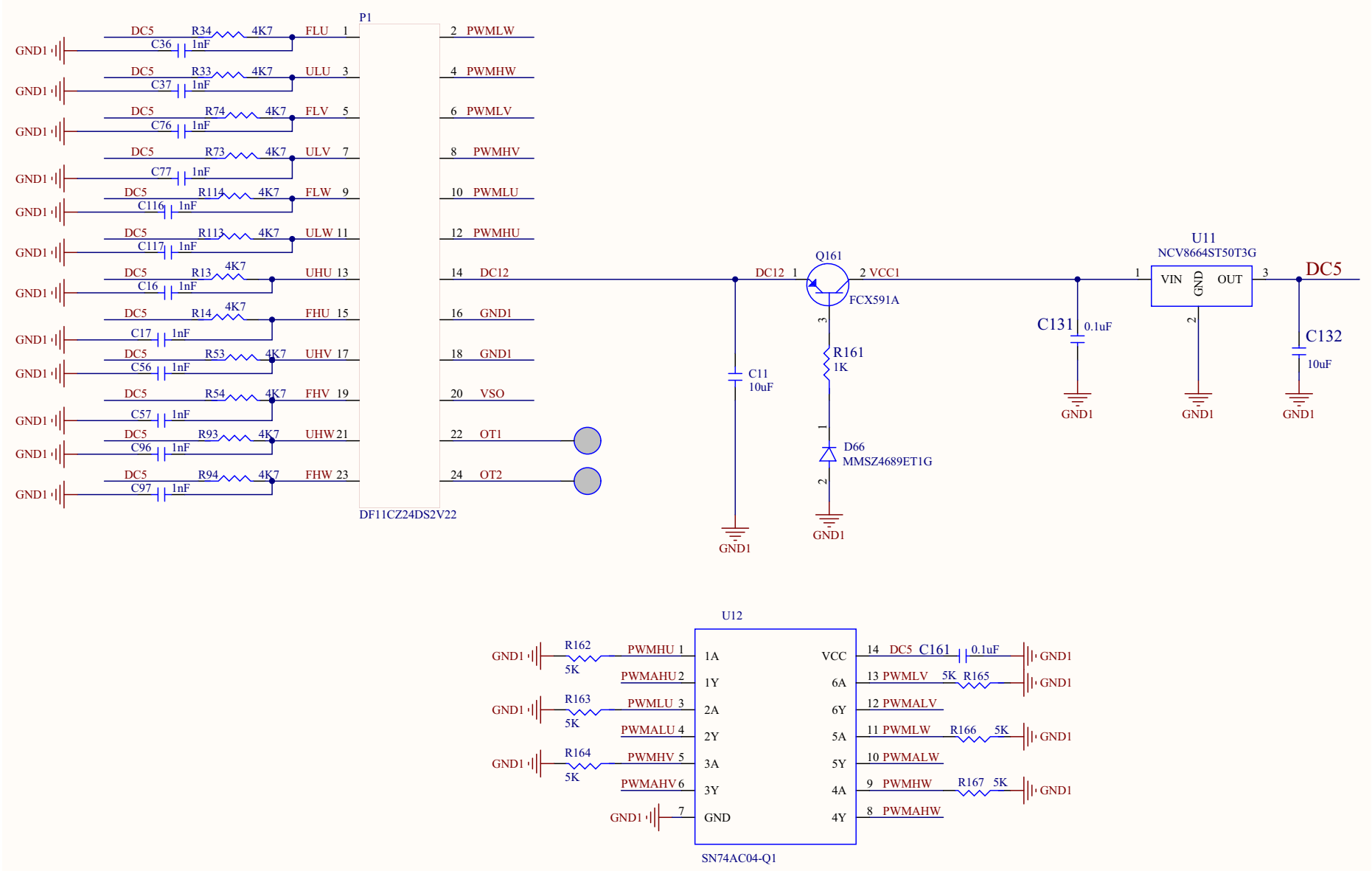
$$= 4.975 \text{ mV/V}$$

Connection Interface (Connector Header P1)

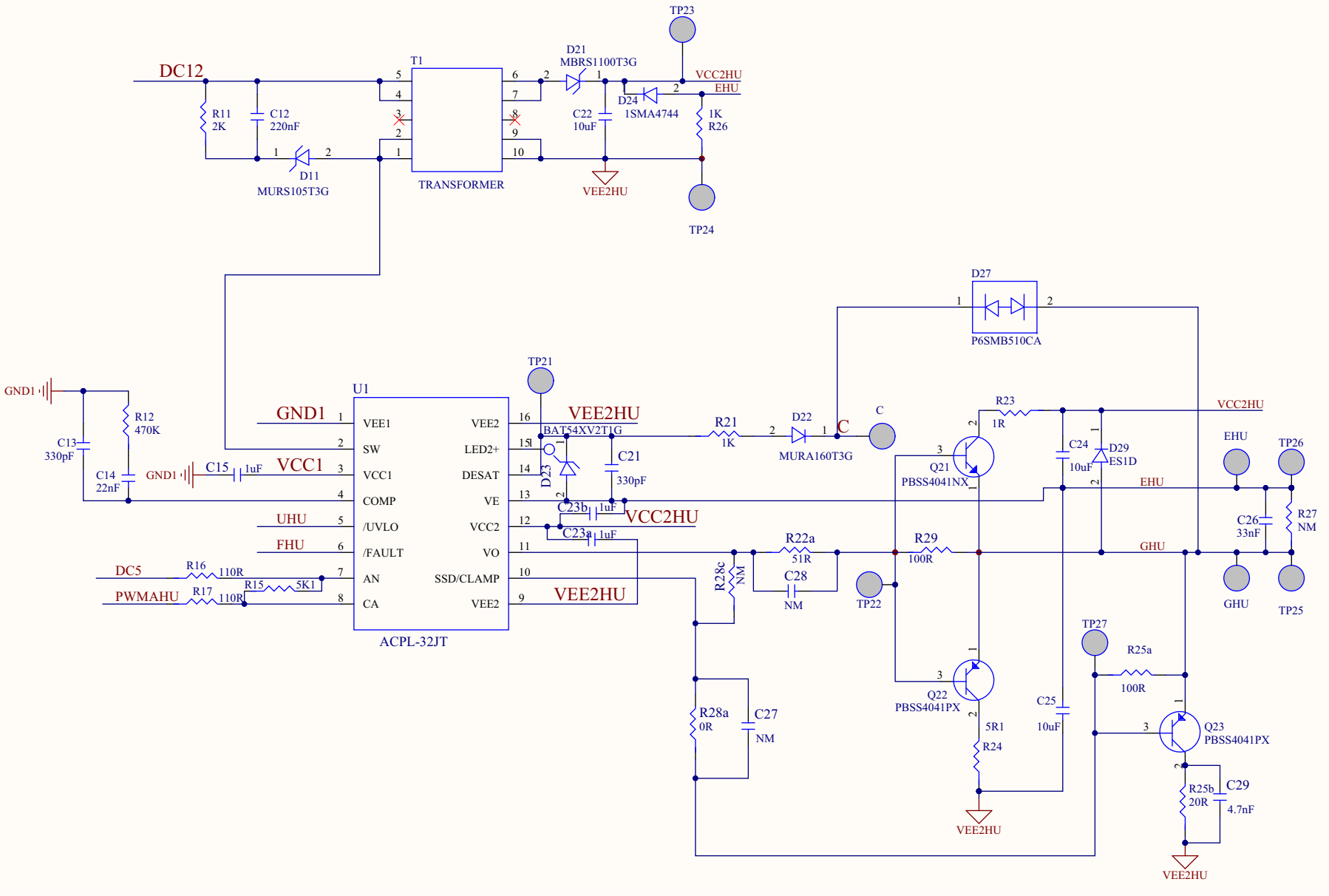
Pin	Name	Type	LEVEL	Item	Logic
1	FLU	OUT	TTL	Fault Feedback for U-bottom	L: Fault
3	ULU	OUT	TTL	Under-Voltage Lock Out Feedback for U-bottom	L: Under-Voltage Lock Out
5	FLV	OUT	TTL	Fault Feedback for V-bottom	L: Fault
7	ULV	OUT	TTL	Under-Voltage Lock Out Feedback for V-bottom	L: Under-Voltage Lock Out
9	FLW	OUT	TTL	Fault Feedback for W-bottom	L: Fault
11	ULW	OUT	TTL	Under-Voltage Lock Out Feedback for W-bottom	L: Under-Voltage Lock Out
13	UHU	OUT	TTL	Under-Voltage Lock Out Feedback for U-top	L: Under-Voltage Lock Out
15	FHU	OUT	TTL	Fault Feedback for U-top	L: Fault
17	UHV	OUT	TTL	Under-Voltage Lock Out Feedback for V-top	L: Under-Voltage Lock Out
19	FHV	OUT	TTL	Fault Feedback for V-top	L: Fault
21	UHW	OUT	TTL	Under-Voltage Lock Out Feedback for W-top	L: Under-Voltage Lock Out
23	FHW	OUT	TTL	Fault Feedback for W-top	L: Fault
2	PWMLW	IN	TTL	PWM input for W-bottom	H: Led on, L: Led off
4	PWMHW	IN	TTL	PWM input for W-top	H: Led on, L: Led off
6	PWMLV	IN	TTL	PWM input for V-bottom	H: Led on, L: Led off
8	PWMHV	IN	TTL	PWM input for V-top	H: Led on, L: Led off
10	PWMLU	IN	TTL	PWM input for U-bottom	H: Led on, L: Led off
12	PWMHU	IN	TTL	PWM input for U-top	H: Led on, L: Led off
14	DC12	Power	8V to 18V	DC power supply	—
16	GND1	Ground	Ground	Low Voltage Side Ground	—
18	GND1	Ground	Ground	Low Voltage Side Ground	—
20	VSO	OUT	Analog (0 to 2V)	Bus Voltage Sensor Output	Analog (0 to 2V)
22	OT1	OUT	—	Connection to IGBT NTC Thermistor Pin T1	—
24	OT2	OUT	—	Connection to IGBT NTC Thermistor Pin T2	—

Circuit Schematic

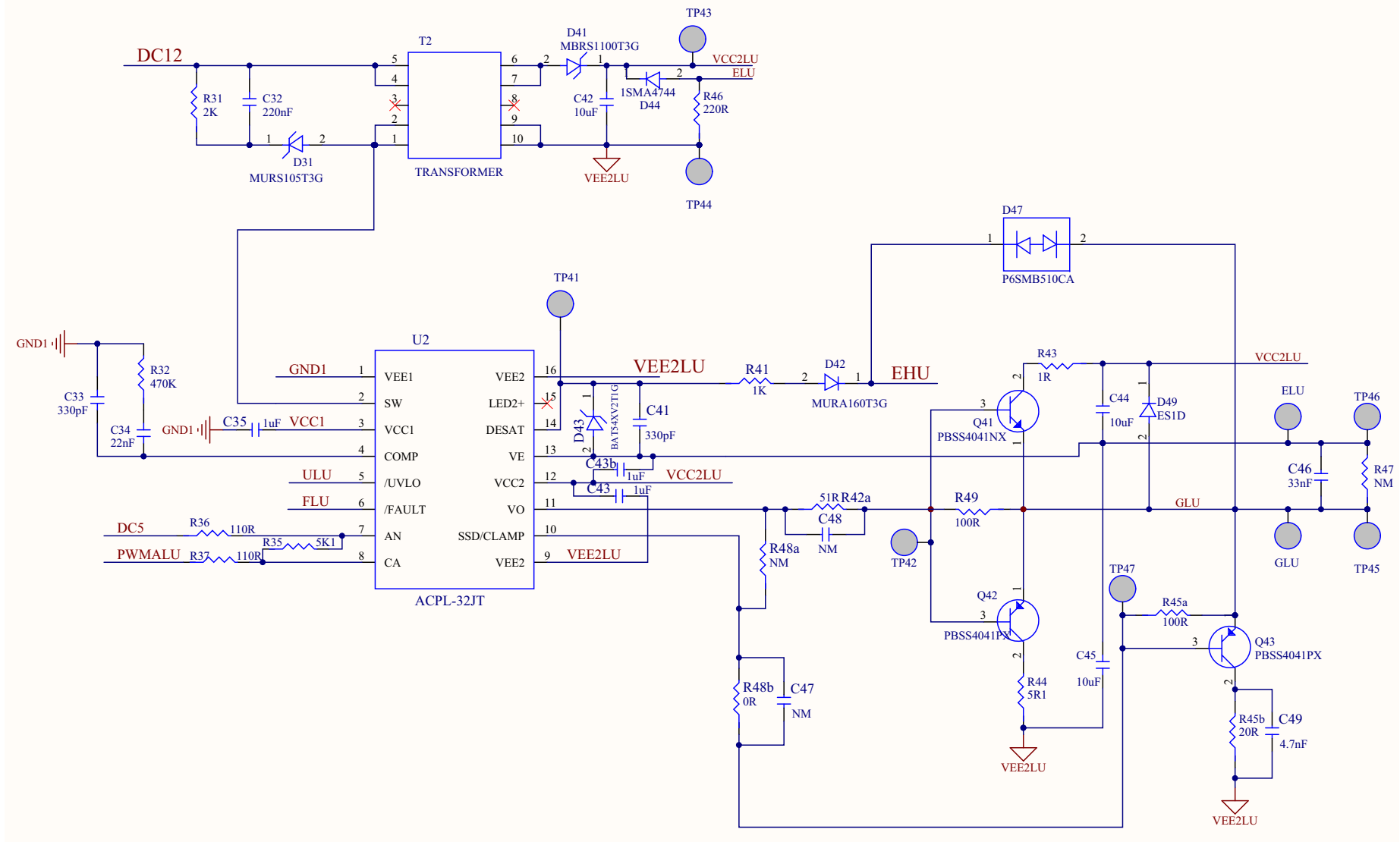
M652 Driver Board



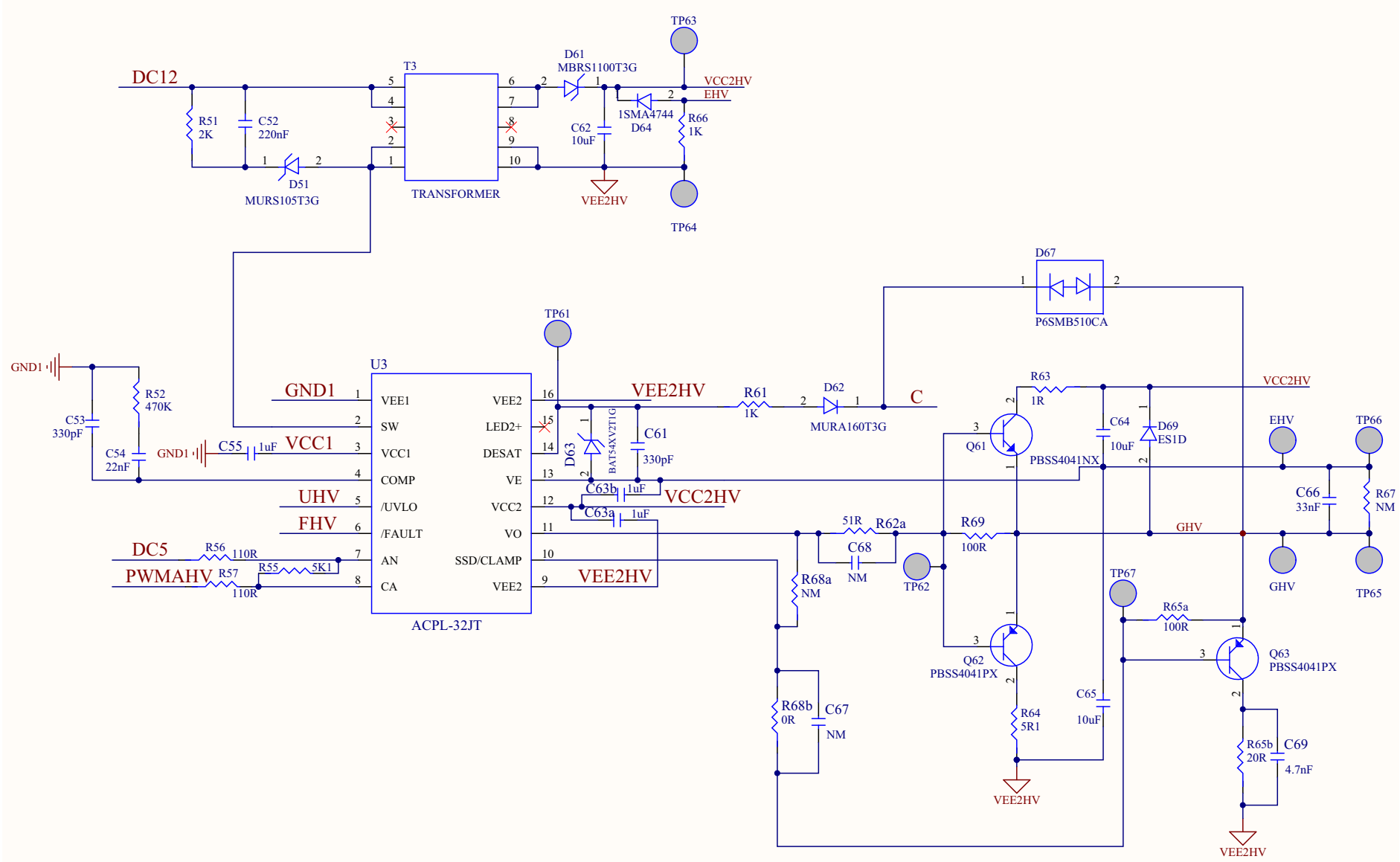
M652 Driver Board: U-Top



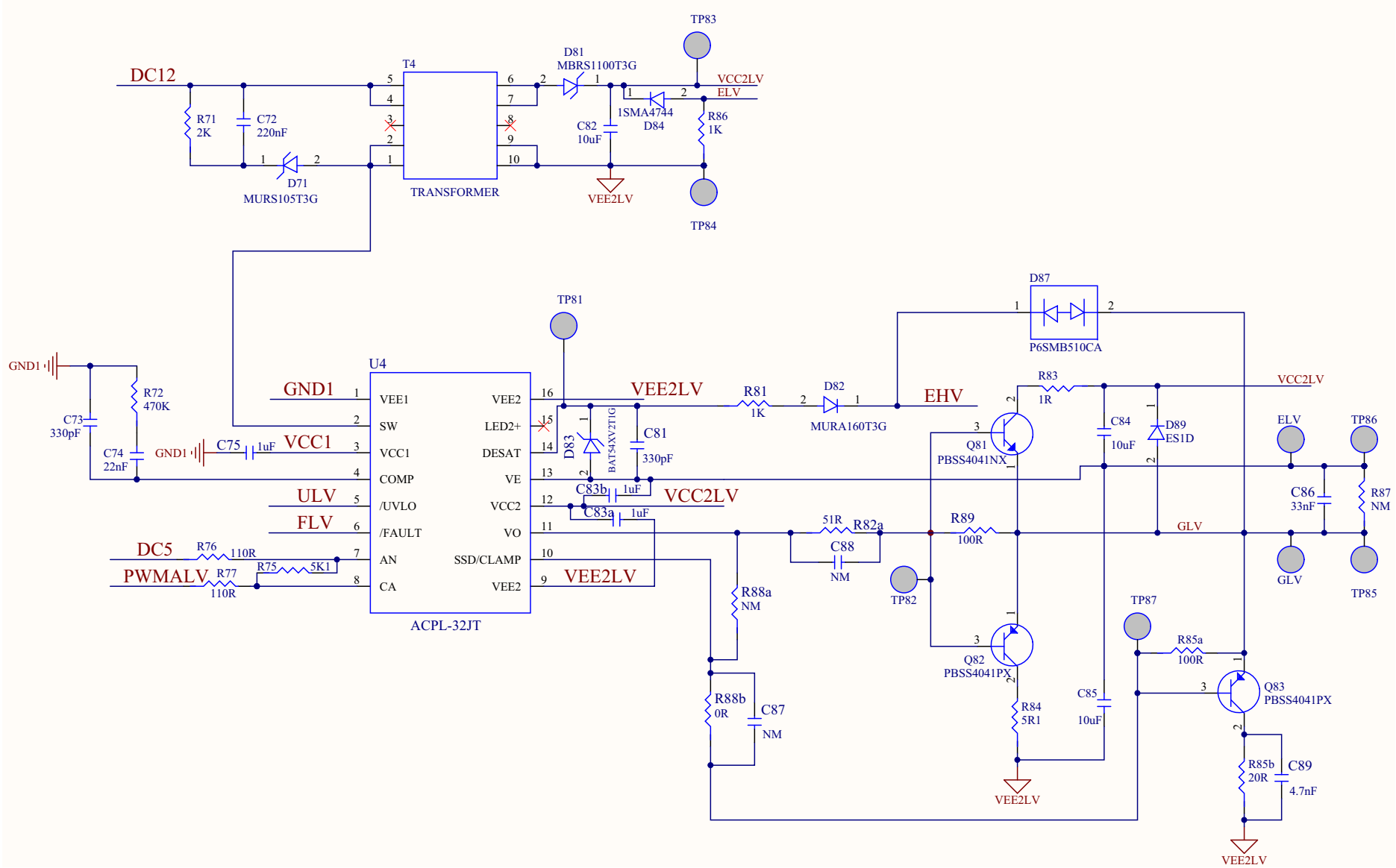
M652 Driver Board: U-Bottom



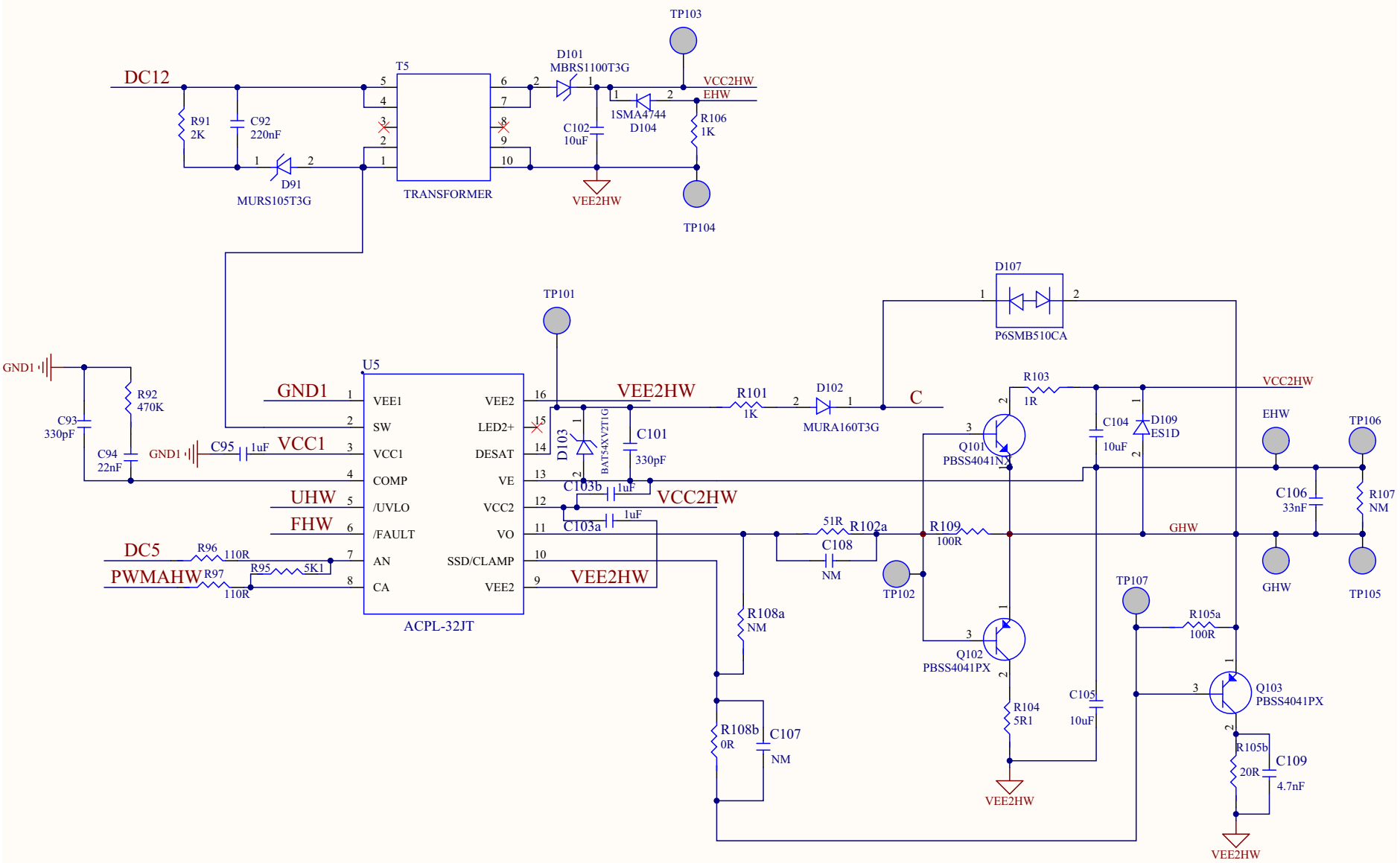
M652 Driver Board: V-Top



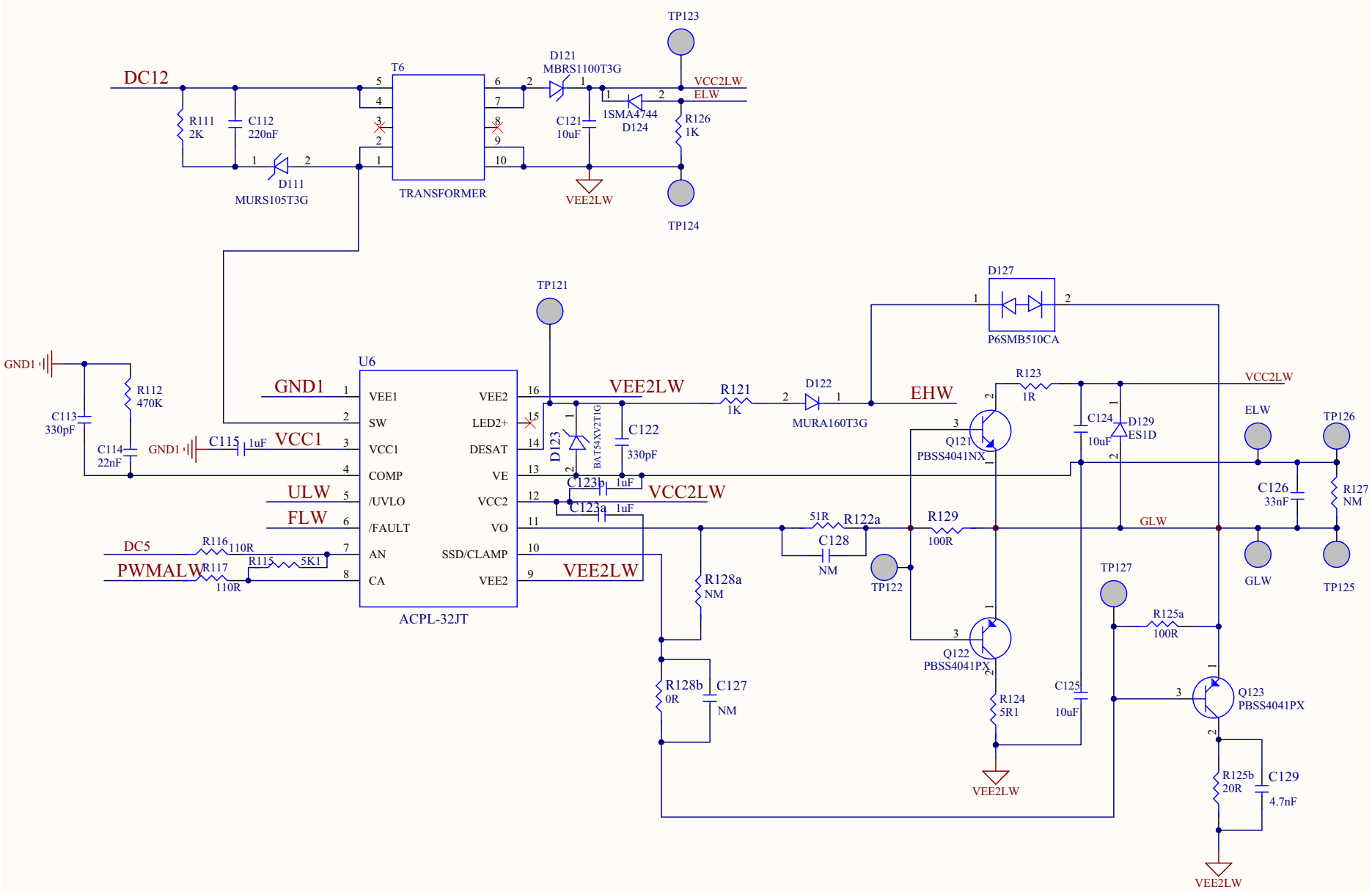
M652 Driver Board: V-Bottom



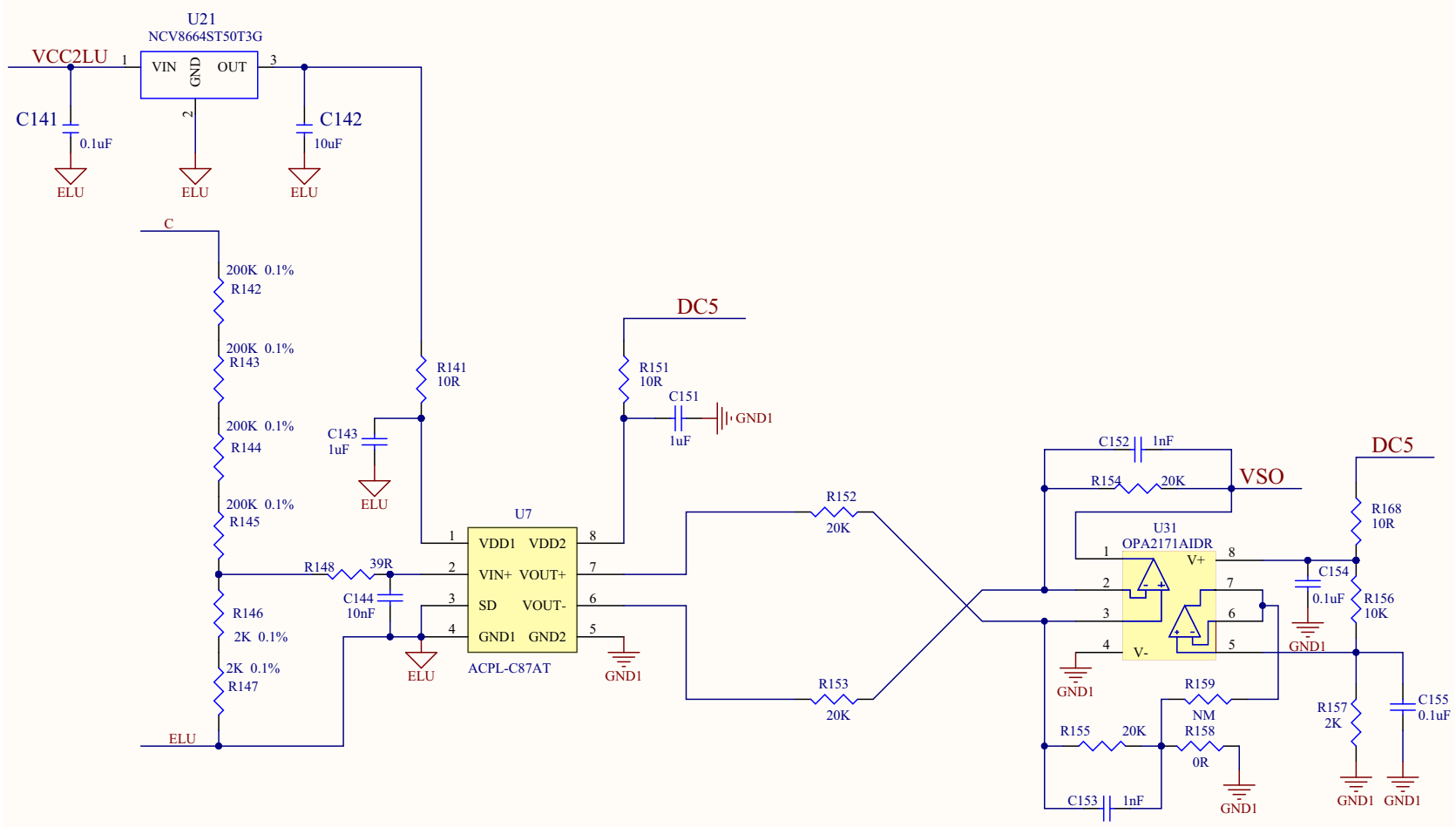
M652 Driver Board: W-Top



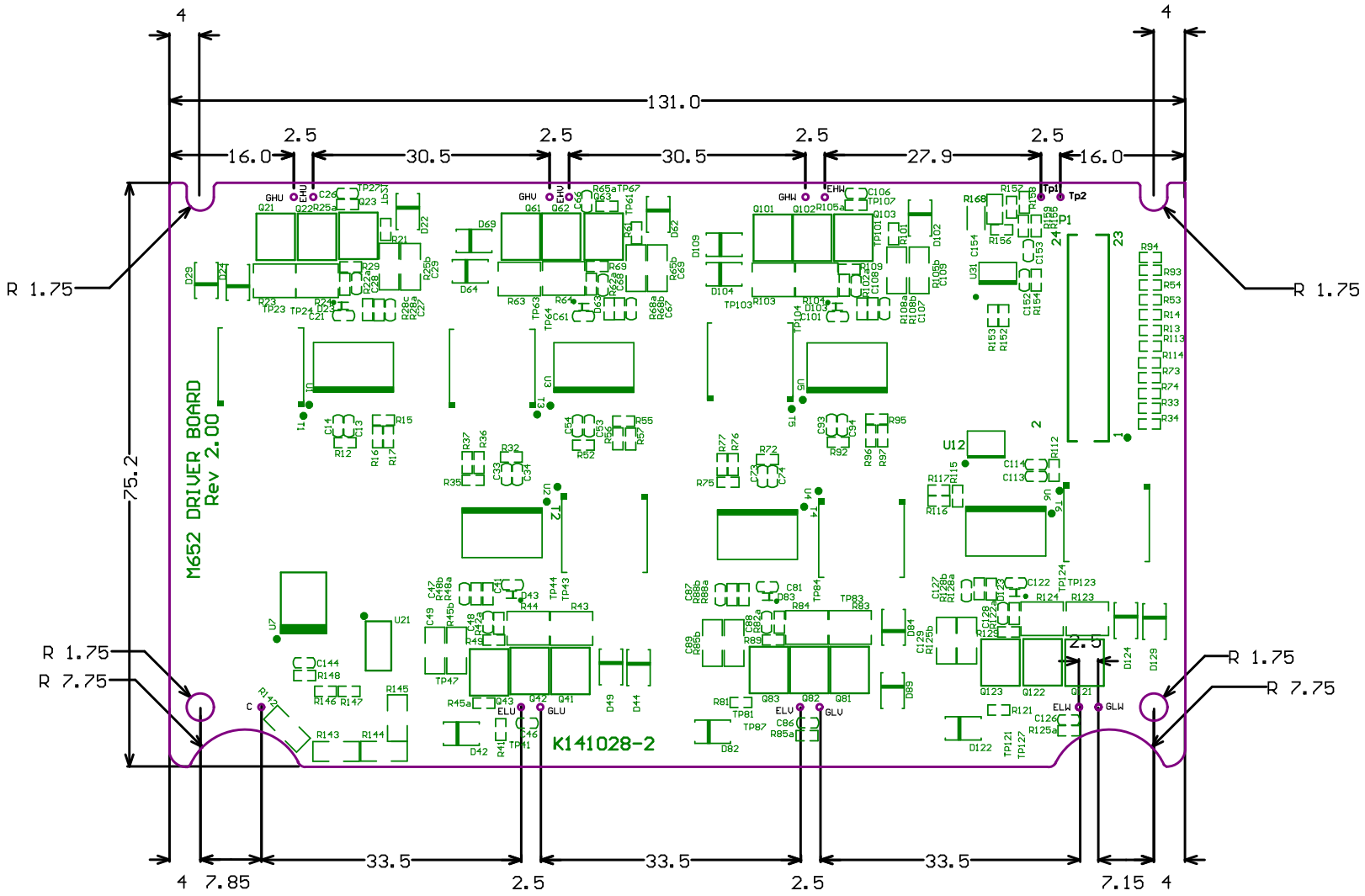
M652 Driver Board: W-Bottom



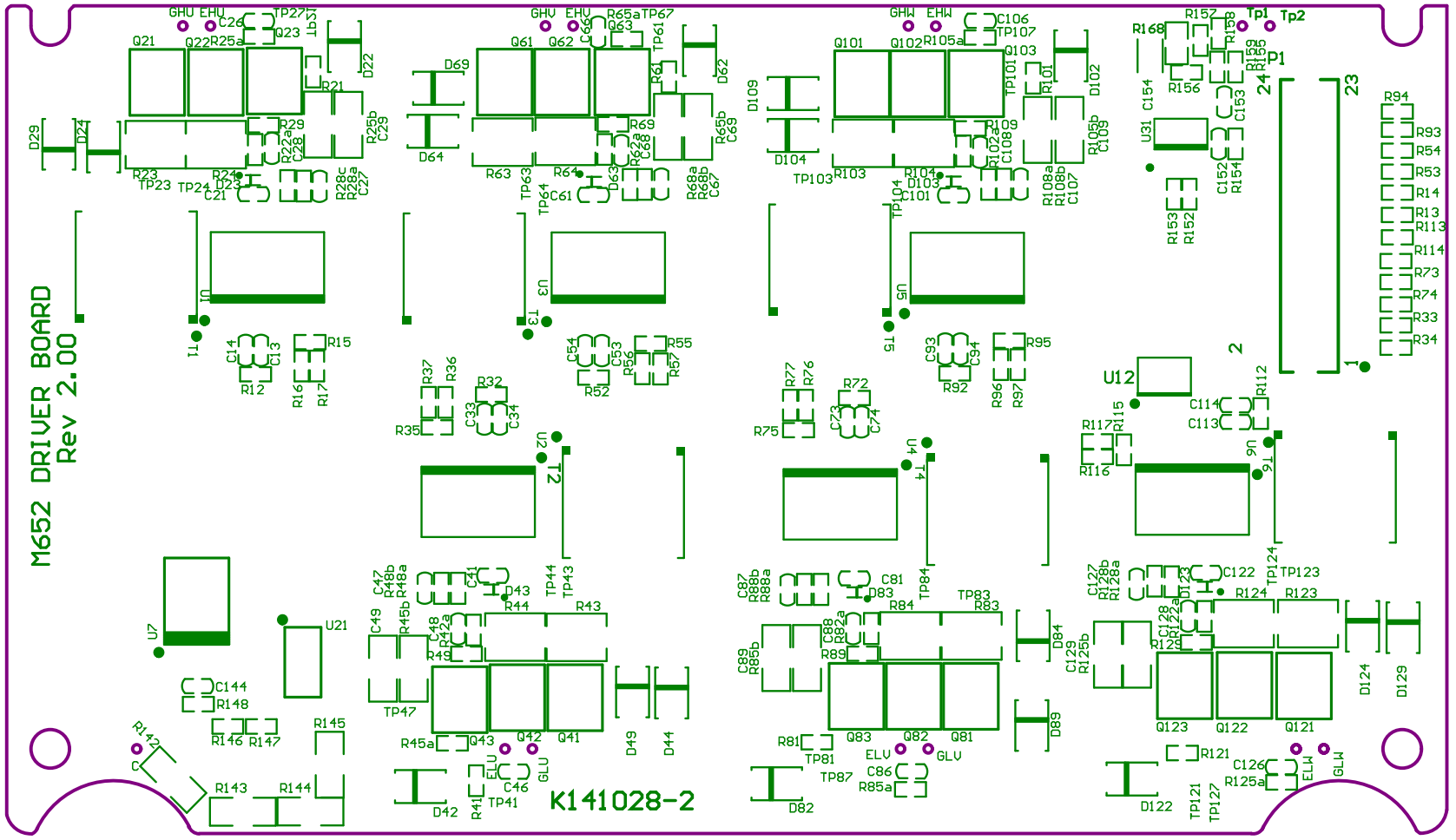
M652 Driver Board: Bus Voltage Sensing



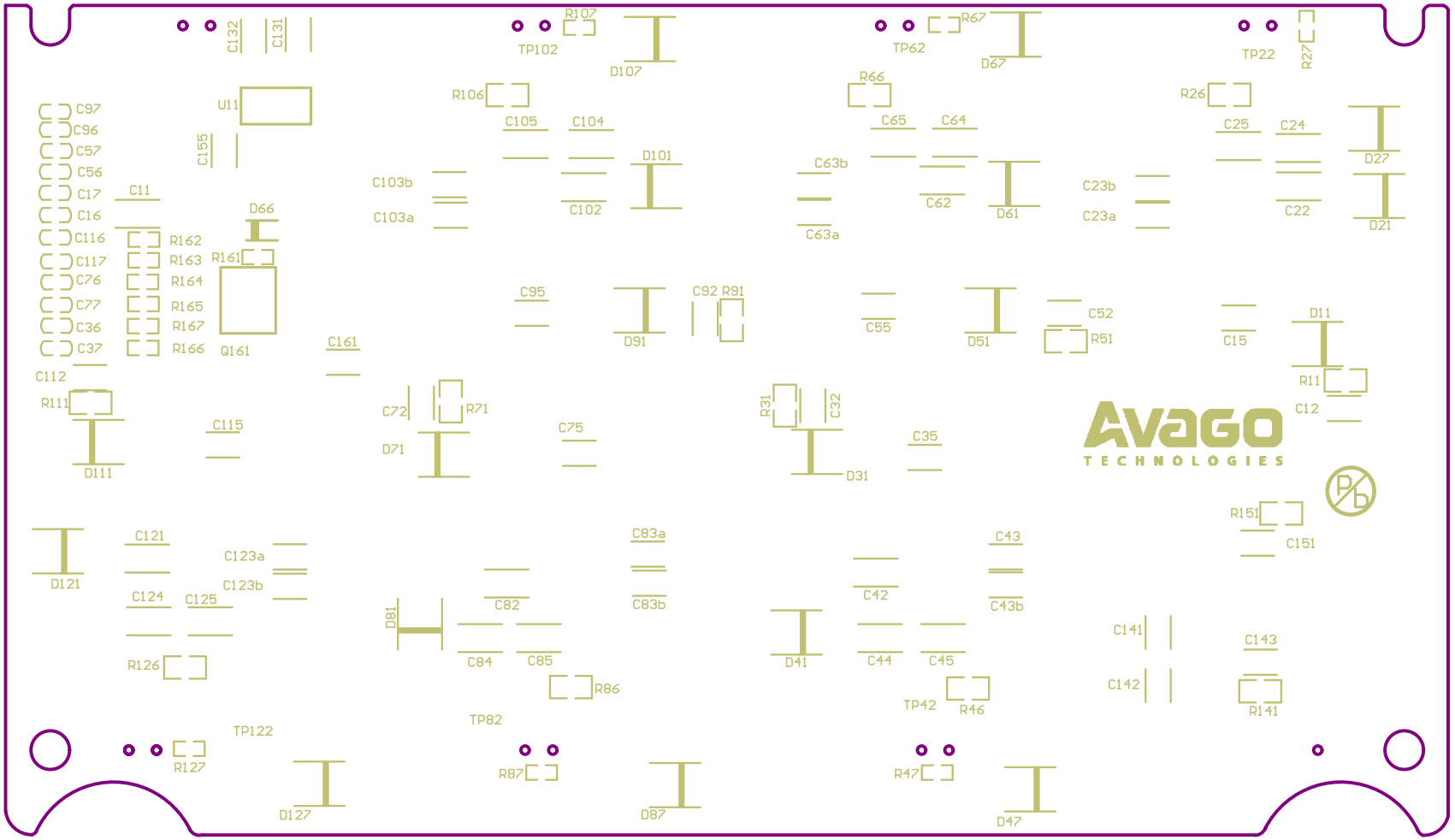
Board Dimensions



Component Location — Top



Component Location — Bottom



For product information and a complete list of distributors, please go to our web site: www.broadcom.com.

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