

Introduction

As electric vehicles (EVs) become increasingly prevalent, the traction inverter system plays a critical role in maintaining the overall reliability and robustness of EV powertrains. A traction inverter system typically consists of a motor, power switches (IGBTs or SiC devices), gate drivers, an isolated bias supply, and a microcontroller unit (MCU). Both positive and negative bias voltages are required to properly drive IGBT and SiC gate drivers. There are multiple isolated bias supply architectures, including fully distributed, semi-distributed, and centralized configurations, as described in the [Isolated Bias Power Supply Architecture for HEV and EV Traction Inverters](#) technical white paper. In a centralized architecture, a single controller is sufficient to manage the entire bias supply system, and the flyback topology is widely adopted for cost-effectiveness, galvanic isolation capability, and circuit simplicity. This application brief presents a centralized bias supply architecture along with a detailed schematic implementing the LM51551-Q1 and clarify correct UVLO bias power sequence is also a key design consideration.

Bias Supply

1. Traction inverter bias supply architecture

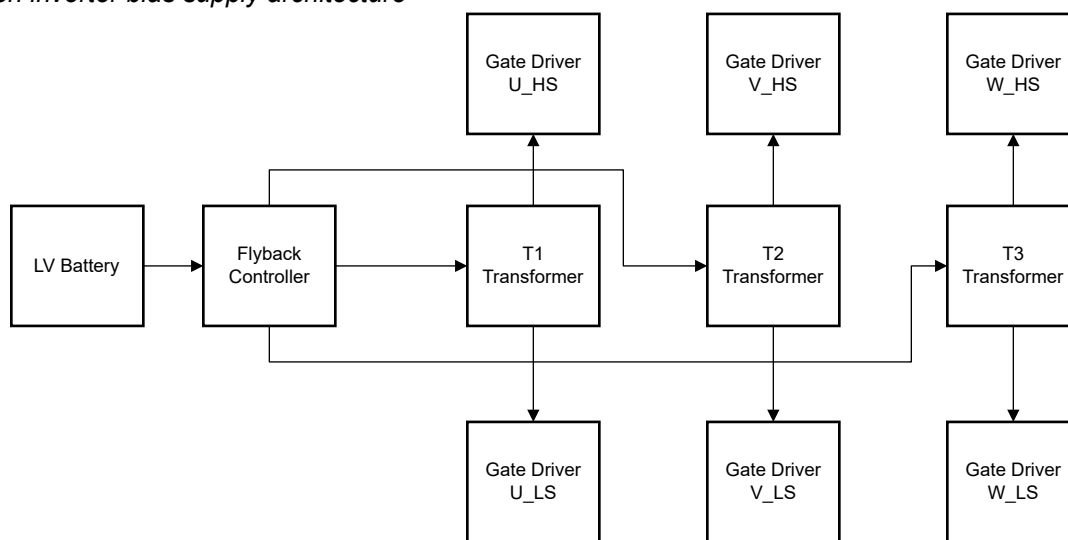


Figure 1. Bias Supply System Block Diagram

Figure 1 shows a centralized bias supply architecture. The flyback converter draws power from the low-voltage battery. The LM51551-Q1 controls the primary-side MOSFET switch to generate high-frequency voltage pulses on the transformer primary winding. Three isolated transformers are dedicated to the gate drivers of the U, V, and W motor phases. Each transformer provides two independently isolated positive and negative output rails to supply the high-side and low-side gate drivers separately.

2. Bias supply schematic

The typical design is as shown in [Figure 2](#):

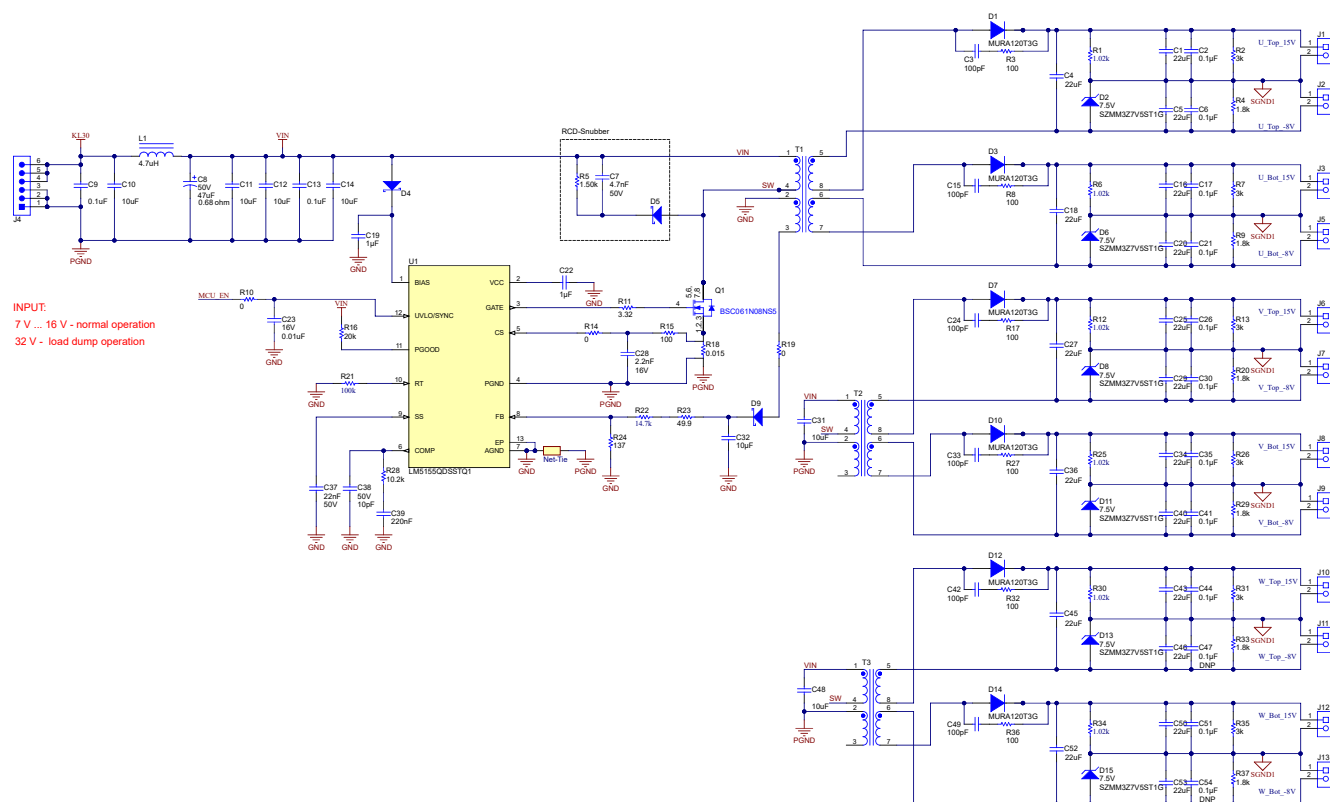


Figure 2. Typical Bias Supply Schematic

3. Bias and UVLO power-up and power-down sequencing considerations

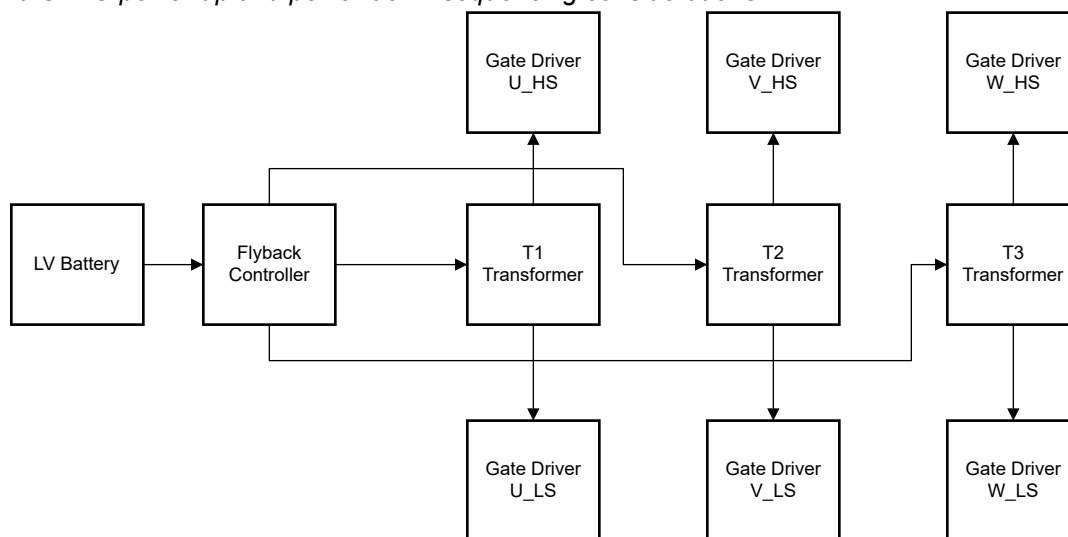


Figure 3. Block Diagram of UVLO

In this centralized architecture, a single controller governs the entire bias supply. Considering functional safety and energy saving, the bias supply must be properly enabled and disabled in a controller manner. The LM51551-Q1 integrates an input voltage undervoltage lockout (UVLO) function. The UVLO pin provides a flexible interface with the MCU, allowing the system to enable or disable the flyback converter based on system-level requirements. When the MCU enables or disables the LM51551-Q1 through the UVLO pin, all pin voltages must remain within the specified absolute maximum ratings throughout the switching transitions.

Table 1. Absolute Maximum Rating of Bias and UVLO

	MIN (V)	MAX (V)
BIAS to AGND	-0.3	50
UVLO to AGND	-0/3	VBIAS+0.3

Considering the voltage stress on bias and UVLO, [Figure 4](#) and [Figure 5](#) refer to power-on and power-off sequencing respectively.

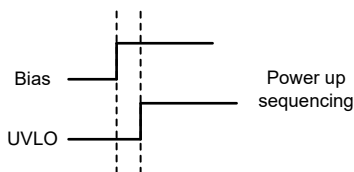


Figure 4. Power-Up Sequencing

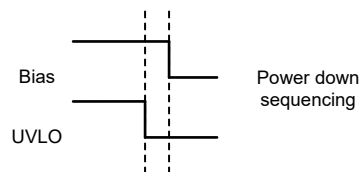


Figure 5. Power-Down Sequencing

Summary

Among the various isolated bias supply architectures fully distributed, semi-distributed, and centralized, the centralized architecture offers the most cost-effective design for traction inverter applications. This application note presents a centralized bias supply architecture along with a detailed schematic implementing the LM51551-Q1. When designing with the LM51551-Q1, follow the specified power-up and power-down sequencing for both the BIAS and UVLO pins to provide reliable operation and compliance with absolute maximum ratings.

References

In addition to this document, see the following references at ti.com.

1. Texas Instruments, [LM51551-Q1 2.2MHz Wide Input Nonsynchronous Boost, SEPIC, Flyback Controller](#), datasheet
2. Texas Instruments, [How to Design an Isolated Flyback Using LM5155](#), application note
3. Texas Instruments, [Isolated Bias Power Supply Architecture for HEV and EV Traction Inverters](#), technical white paper

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