EVAL-LT8419-BZ

LTC7871 High-Power, Polyphase, Bidirectional Supply/Charger with LT8419 GaN Driver

General Description

The EVAL-LT8419-BZ is a high-power, high-efficiency, six-phase bidirectional converter featuring the LTC7871 controller and LT8419 GaN drivers. Each phase uses an LT8419 half-bridge driver to drive EPC2361 GaN FETs, with the gate driver placed close to the FETs and driven by PWM signals from the LTC7871. The V_{HIGH} and V_{LOW} terminals serve as either inputs or outputs, depending on the direction of power flow. In buck mode, which is selected by SW1, the board converts 30V to 70V at VHIGH to a regulated 12V output at V_{LOW}. In boost mode, it converts 10V to 14V at V_{LOW} to a regulated 48V output at V_{HIGH}.

The maximum V_{LOW} current is 200A in either direction, limited by the selected inductors. Maximum output power is 2.4kW in buck mode across the specified input range, and 2.4kW in boost mode when V_{LOW} is 12V. External airflow is required for operation at maximum power.

Inductor current in each phase is sensed through a low 1mΩ resistor using a highly accurate AC/DC current-sensing architecture with low power dissipation. The LTC7871 constant-current loop provides DC current limiting for current flowing into or out of the V_{LOW} terminal, depending on the state of the BUCK pin. This current limit is programmable through the SETCUR pin and can be monitored at the IMON pin.

The EVAL-LT8419-BZ includes a SPI-compatible serial port. With a DC2026C (Linduino® One) demo board and QuikEval™ software on a host computer, the user can:

- Margin the regulated V_{LOW} or V_{HIGH} up or down.
- Margin the DC current limit up or down with the SETCUR pin.
- Adjust the frequency spread and modulation rate of the spread spectrum circuit when spread spectrum is enabled.
- Monitor the operational status and faults of the LTC7871.

Additional features of the EVAL-LT8419-BZ include:

- Pin selectable light load operating modes.
  - Buck: FCM, pulse-skipping, and Burst Mode® operation
  - Boost: FCM and pulse-skipping
- SYNC and CLKOUT pins
- Optional jumper to enable spread-spectrum modulation
- RUN, FAULT, PGOOD, and PWNEN pins
- BUCK pin to externally control the direction of power flow
- Footprint for an optional heatsink

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Performance Summary

(Specifications are at T_A = 25°C.)

PAREMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Buck Mode						
Input Voltage	V_{HIGH}		30	48	70	V
Output Voltage	V_{LOW}			12		V
Output Current	I_{LOW}	V_{HIGH} = 48V			200	A
Switching Frequency	f_{SW}			350		kHz
Efficiency	η	V_{HIGH} = 48V I_{LOW} = 200A 400LFM Airflow		97.1		%
Boost Mode						
Input Voltage	V_{LOW}		10	12	14	V
Output Voltage	V_{HIGH}			48		V
Output Current	I_{HIGH}	V_{LOW} = 12V			48	A
Switching Frequency	f_{SW}			350		kHz
Efficiency	η	V_{LOW} = 12V I_{HIGH} = 48A 400LFM Airflow		96.2		%

Quick Start Procedure

Constant Voltage (CV) Buck Mode

1. See the connection diagram shown in *Figure 1*.
2. Place SW1 in the BUCK position.
3. Connect the input supply to V_{HIGH} and the load to V_{LOW}.
4. Connect the voltmeters to monitor V_{HIGH} and V_{LOW} and the ammeters to monitor I_{HIGH} and I_{LOW}.
5. Turn on the V_{HIGH} supply. With no load, slowly increase the V_{HIGH} supply until V_{HIGH} reaches 30V. At this point, 12V appears on V_{LOW}. The regulation limits are shown in the *Performance Summary* table.
6. Next, increase V_{HIGH} to 48V. Recheck the regulation.
7. Apply a load up to 200A across V_{LOW}. Recheck the regulation.
8. After the basic performance has been verified, the other aspects of performance can be measured and observed.

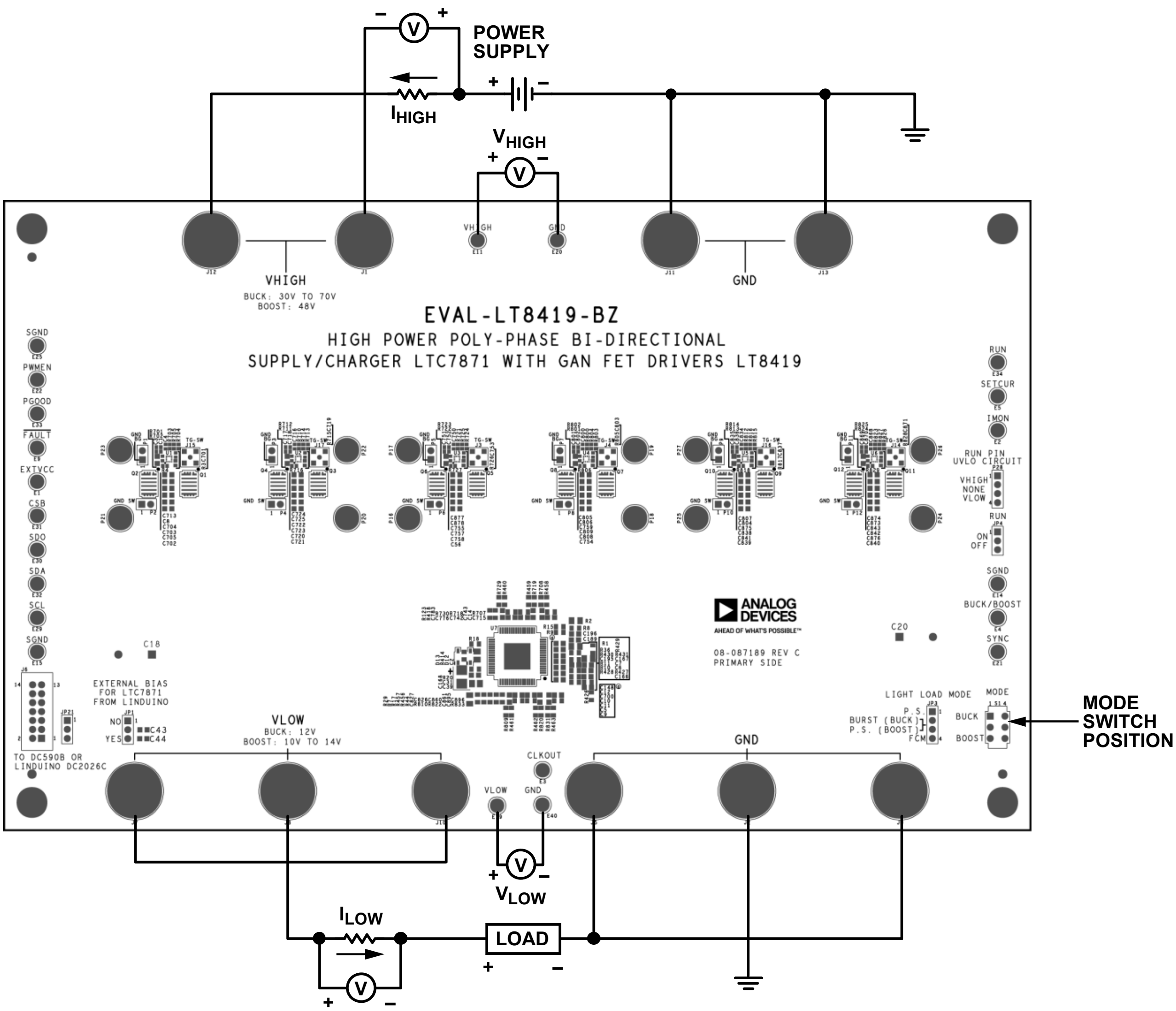

Figure 1. Proper Measurement Equipment Setup for Buck Mode

Constant Voltage (CV) Boost Mode

1. See the connection diagram in *[Figure 2](#)*.
2. Place SW1 in the BOOST position.
3. Connect the input supply to V_{LOW} and the load to V_{HIGH}.
4. Connect the voltmeters to monitor V_{LOW} and V_{HIGH} and the ammeters to monitor I_{LOW} and I_{HIGH}.
5. Turn on the V_{LOW} supply. With no load, slowly increase the V_{LOW} supply until V_{LOW} reaches 10V. At this point, 48V appears on the output. The regulation limits are shown in the *Performance Summary* table.
6. Next, increase V_{LOW} to 12V. Recheck the regulation.
7. Apply a load up to 48A across V_{HIGH}. Recheck the regulation.
8. After the basic performance has been verified, the other aspects of performance can be measured and observed.

Note: When measuring the output voltage or input voltage ripple, ensure that the measurement is taken directly across an output or input capacitor. Do not use the long ground lead on the oscilloscope probe.

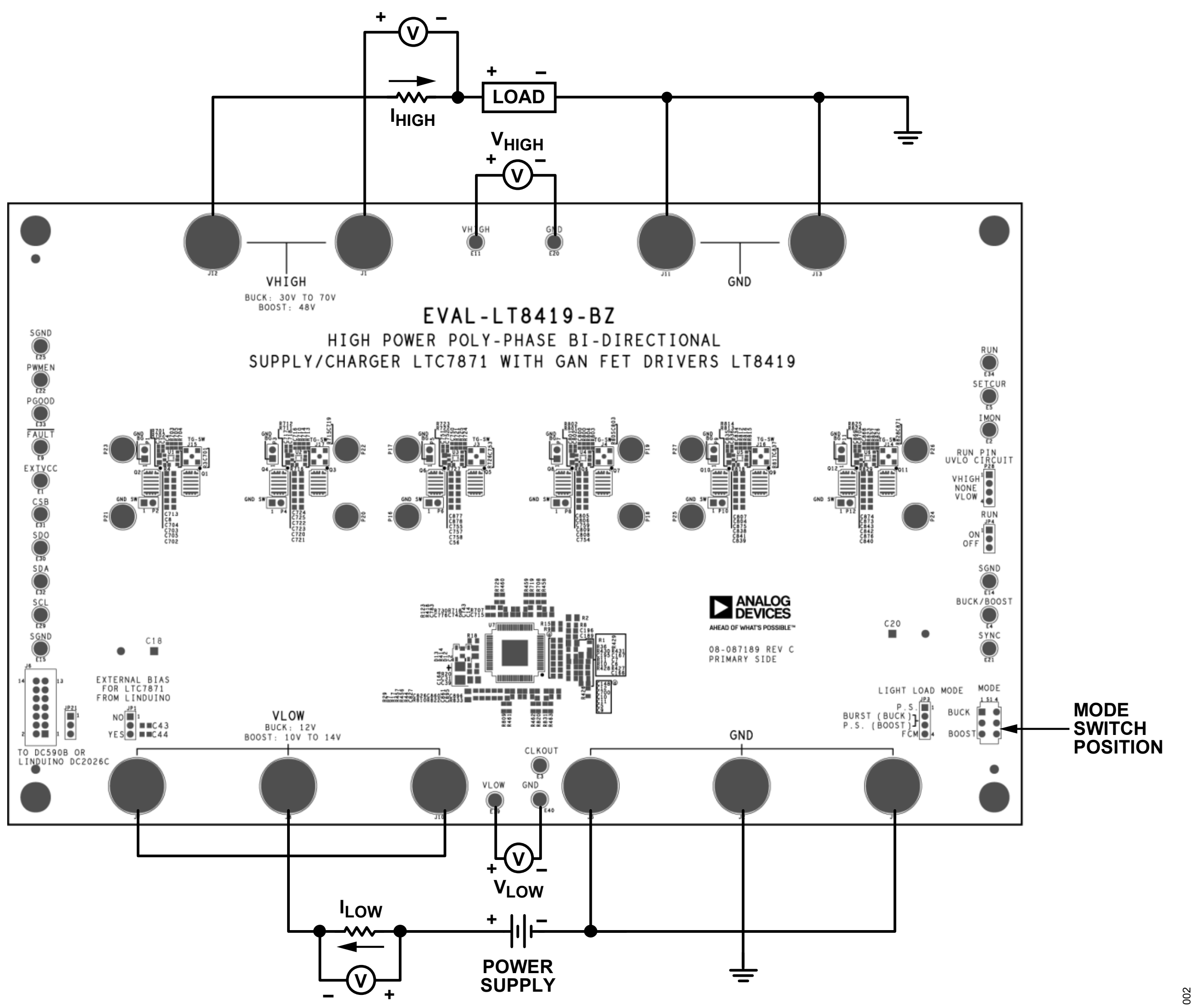

Figure 2. Proper Measurement Equipment Setup for Boost Mode

Constant-Current (CC) Mode

The EVAL-LT8419-BZ can operate as a constant current source when operating either as a buck or a boost:

9. For buck operation, set up the EVAL-LT8419-BZ as shown in *Figure 1*. For boost operation, set up the EVAL-LT8419-BZ as shown in *Figure 2*. The load needs to have a constant voltage mode.
10. If the converter is set up as a buck, set the CV load at 10V or less. If the converter is set up as a boost, set the CV at 40V or less.
11. Connect a bench voltage source to the SETCUR pin as shown in *Figure 3*, which can be either a DC voltage or the output of a pulse generator.
12. Monitor SETCUR, IMON, and I_{LOW} or I_{HIGH} while adjusting the SETCUR voltage.

For buck to boost or boost to buck transition testing, set up the EVAL-LT8419-BZ as shown in *Figure 4*.

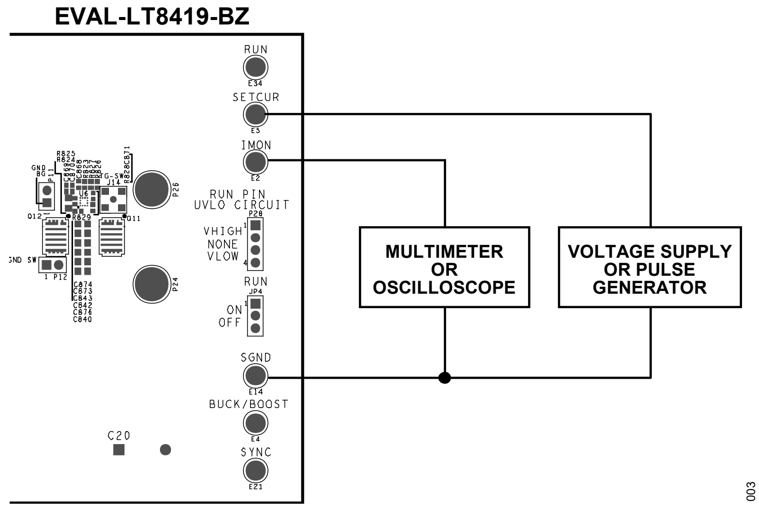

Figure 3. Using SETCUR Pin to Control Load Current

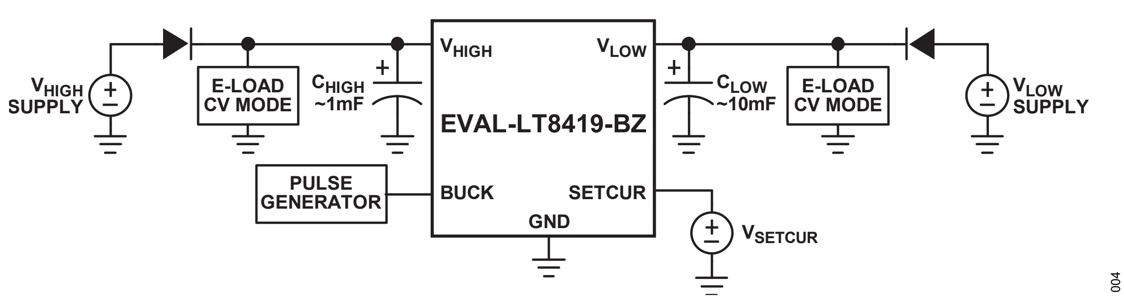

Figure 4. Typical Setup for the Buck/Boost Transition Test

External Bulk Capacitance

Additional bulk capacitance may be required across the input for either power flow direction, especially if operating at or near full load with supply cables longer than 2ft. Depending on the supply cable inductance, when operating as a boost, an extra 10mF of bulk capacitance across V_{LOW} may be required. When operating as a buck, an extra 1mF of bulk capacitance across V_{HIGH} may be required. For buck/boost transition testing, add this extra capacitance across both inputs. Typical choices for the external capacitance are either aluminum electrolytic or supercapacitors with a sufficient voltage rating.

Thermal Consideration

At room ambient temperature, 400LFM of airflow is recommended for continuous full-load operation in either direction. All efficiency curves and thermal images shown in the demo manual were captured under this airflow condition using an adjustable external fan.

To further improve thermal performance, the EVAL-LT8419-BZ includes three optional footprints for the board-mounted 567-45AB heatsink. These heatsinks are installed at P18–P27 on the top layer, directly above the GaN FETs for phases 1 and 2, phases 3 and 4, and phases 5 and 6. TG-A6200-20-20-0.5 thermal pads are placed between the heatsinks and the GaN FETs to enhance heat dissipation.

SPI Interface

To control or monitor the EVAL-LT8419-BZ from the QuikEval software on a host computer, follow these steps:

13. See *Figure 5*.
14. If QuikEval is already installed, download the latest software by selecting **Tools** > **Update Program**. If QuikEval is not installed, click *QuikEval Software Installer*.
15. Connect J6 of the EVAL-LT8419-BZ to a DC2026C with a 14-pin ribbon cable.
16. Connect the DC2026C to the host computer with a USB cable.
17. Refer to the demo manual of the DC2026C for further details.
18. Apply a voltage within the specified input range to either V_{HIGH} or V_{LOW}, depending on the direction of power flow.
19. Start QuikEval on the host computer.
20. Use QuikEval to monitor and control the LTC7871. The LTC7871 QuikEval GUI is shown in *Figure 6*. The dashboard is on the left, and an optional design tool is on the right.
    a. To read the status, press either the **Read Once** button or the **Read Continuously** button on the dashboard.
    b. QuikEval can margin V_{LOW}, V_{HIGH}, and the DC I_{LOW} current limit up or down by writing to the register which controls the current source digital-to-analog converter (I_{DAC}) for the V_{FBLOW}, V_{FBHIGH}, or SETCUR pins. To use this feature, make sure the **Read Continuously** button is not enabled; this button is grey when not enabled.
    c. An optional design tool can be enabled from the **File** menu. It calculates the required I_{DAC} value to margin the V_{LOW}, V_{HIGH}, or DC I_{LOW} current limit to a given value. To use this tool, enter the values for the feedback divider or SETCUR resistor and then enter the value for the desired V_{LOW}, V_{HIGH}, or $I_{L(MAX)}$, which is the DC I_{LOW} current limit. The design tool then provides the calculated I_{DAC} value. To update the LTC7871's registers, enter the calculated I_{DAC} values in the dashboard and then press the respective **Update** button.

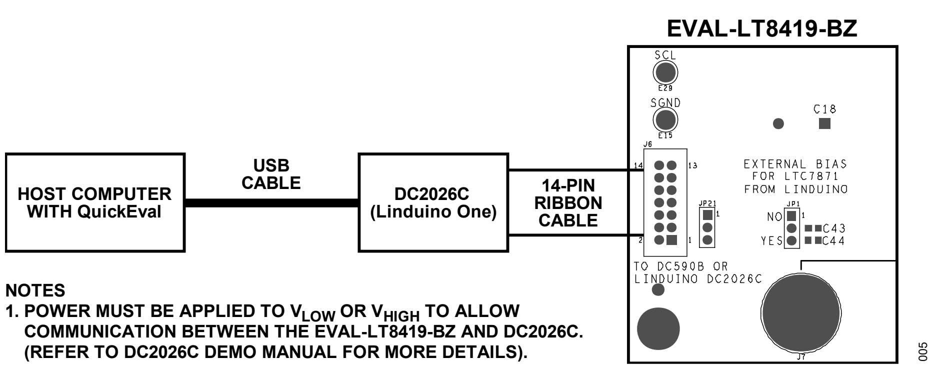

Figure 5. SPI Communication Setup to a Host Computer

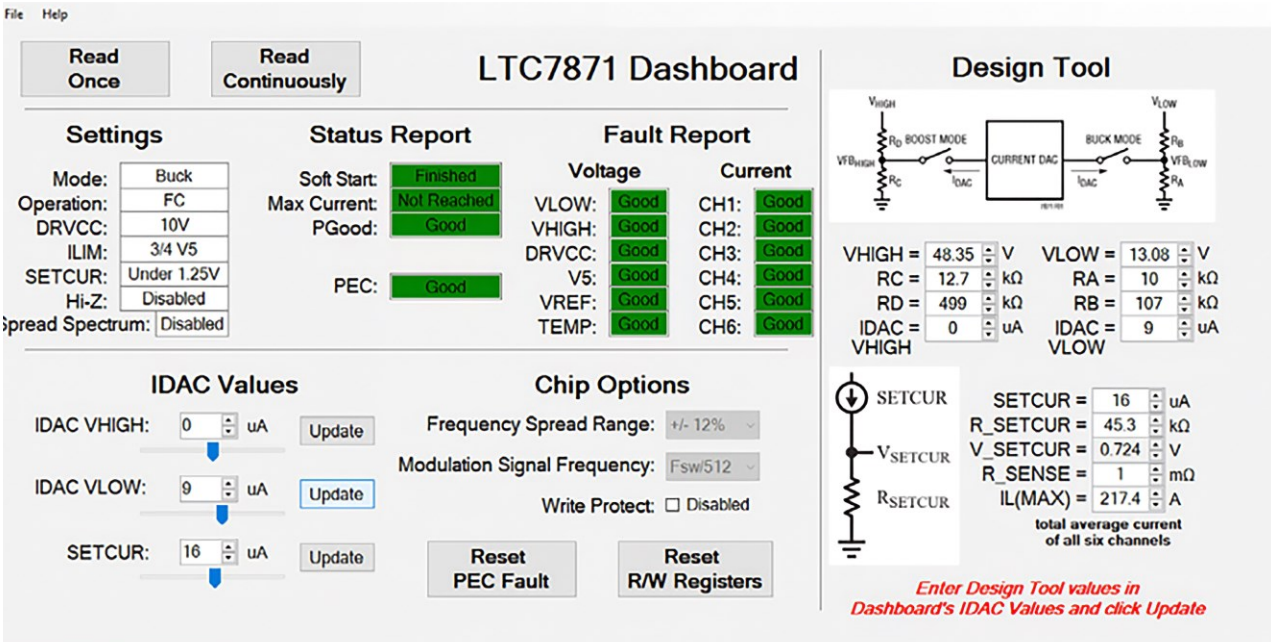

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Figure 6. Graphic User Interface (GUI) Is Available in QuikEval Software

Performance

Buck Mode

(T_A = +25°C and 400LFM airflow, unless otherwise noted. All test results below are taken in buck mode.)

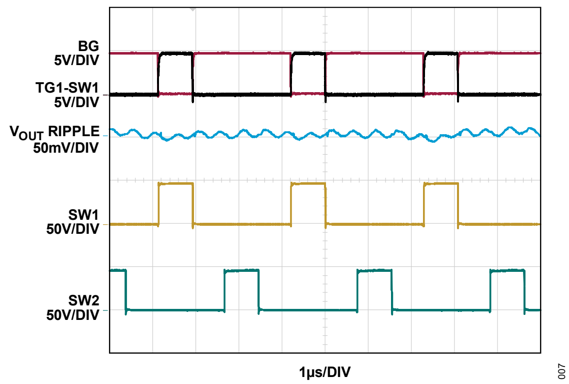


Figure 7. Waveforms at V_{HIGH} = 48V, V_{LOW} = 12V, I_{LOW} = 200A

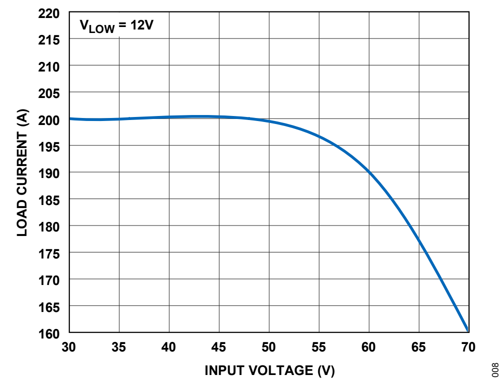


Figure 8. Maximum Load Current at V_{LOW} = 12V

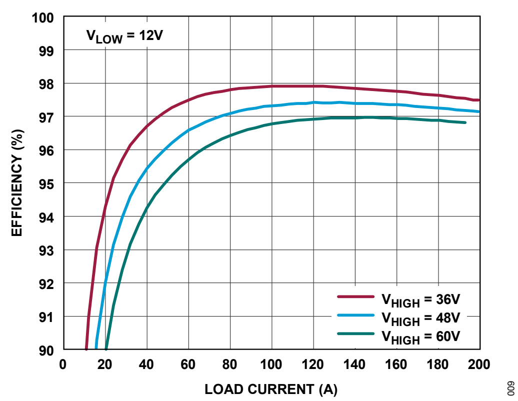


Figure 9. Efficiency at V_{LOW} = 12V

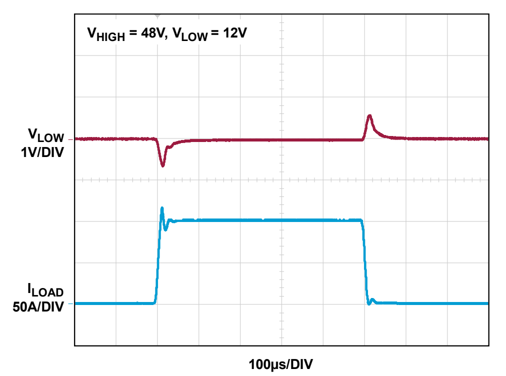


Figure 10. Load Transient at V_{HIGH} = 48V, V_{LOW} = 12V

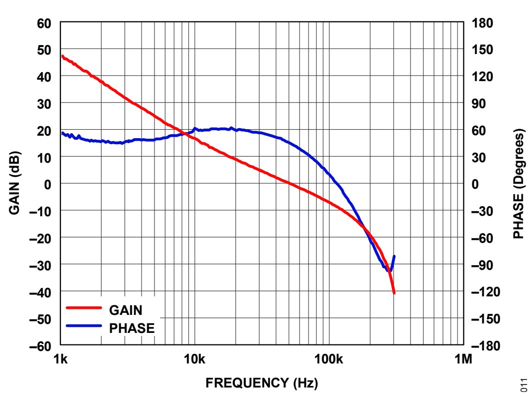


Figure 11. Bode Plot at V_{HIGH} = 48V, V_{LOW} = 12V, I_{OUT} = 200A f_C = 50kHz, PM = 45°, GM = 9dB

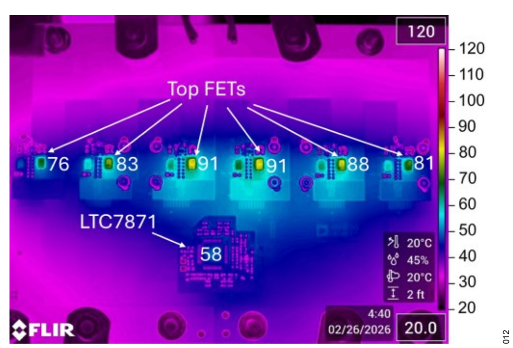


Figure 12. Thermal Image at V_{HIGH} = 48V, V_{LOW} = 12V, I_{OUT} = 200A

Boost Mode

(T_A = +25°C and 400LFM airflow, unless otherwise noted. All test results below are taken in boost mode.)

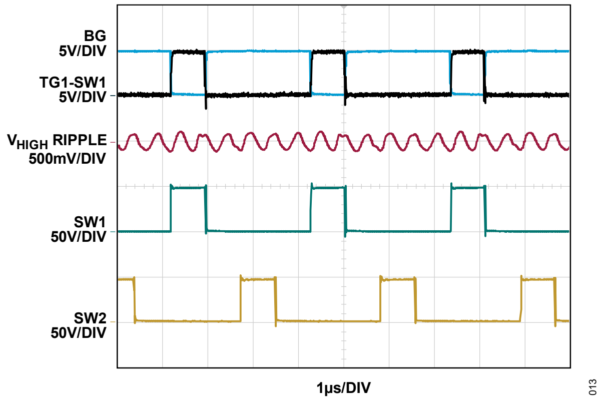


Figure 13. Waveforms at V_{LOW} = 12V, V_{HIGH} = 48V, I_{HIGH} = 40A

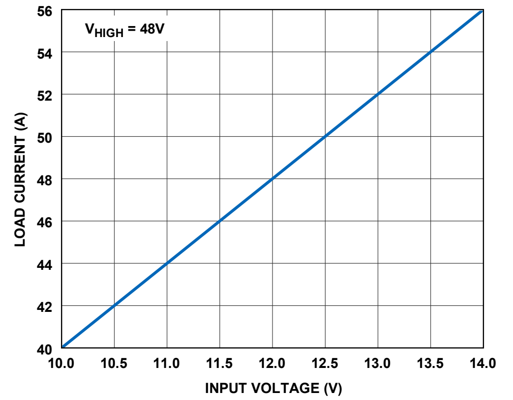


Figure 14. Maximum Load Current at V_{HIGH} = 48V

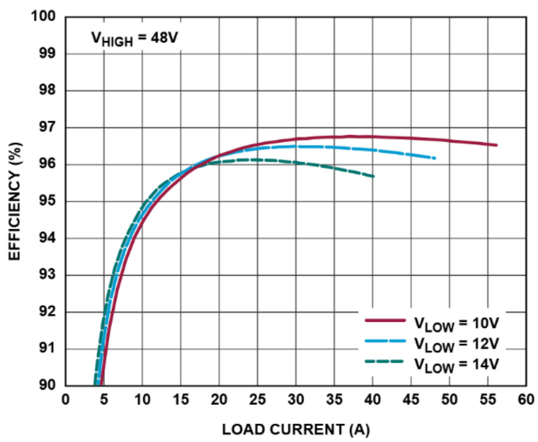


Figure 15. Efficiency at V_{HIGH} = 48V

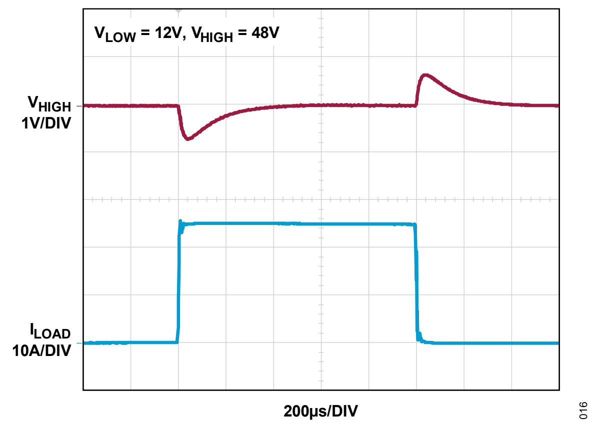


Figure 16. Load Transient at V_{LOW} = 12V, V_{HIGH} = 48V

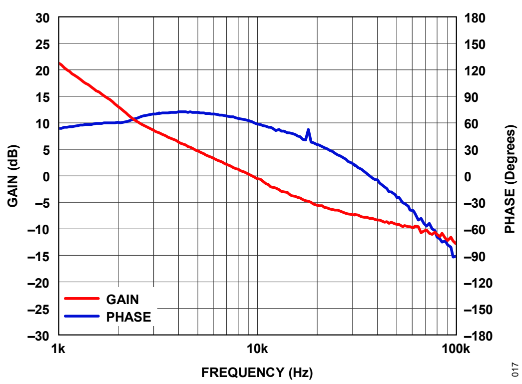


Figure 17. Bode Plot at V_{LOW} = 12V, V_{HIGH} = 48V, I_{OUT} = 40A f_C = 9.3kHz, PM = 62°, GM = 8dB

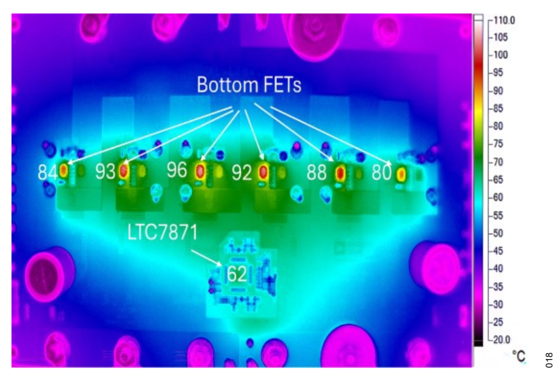


Figure 18. Thermal Image at V_{LOW} = 12V, V_{HIGH} = 48V, I_{OUT} = 48A

Schematics

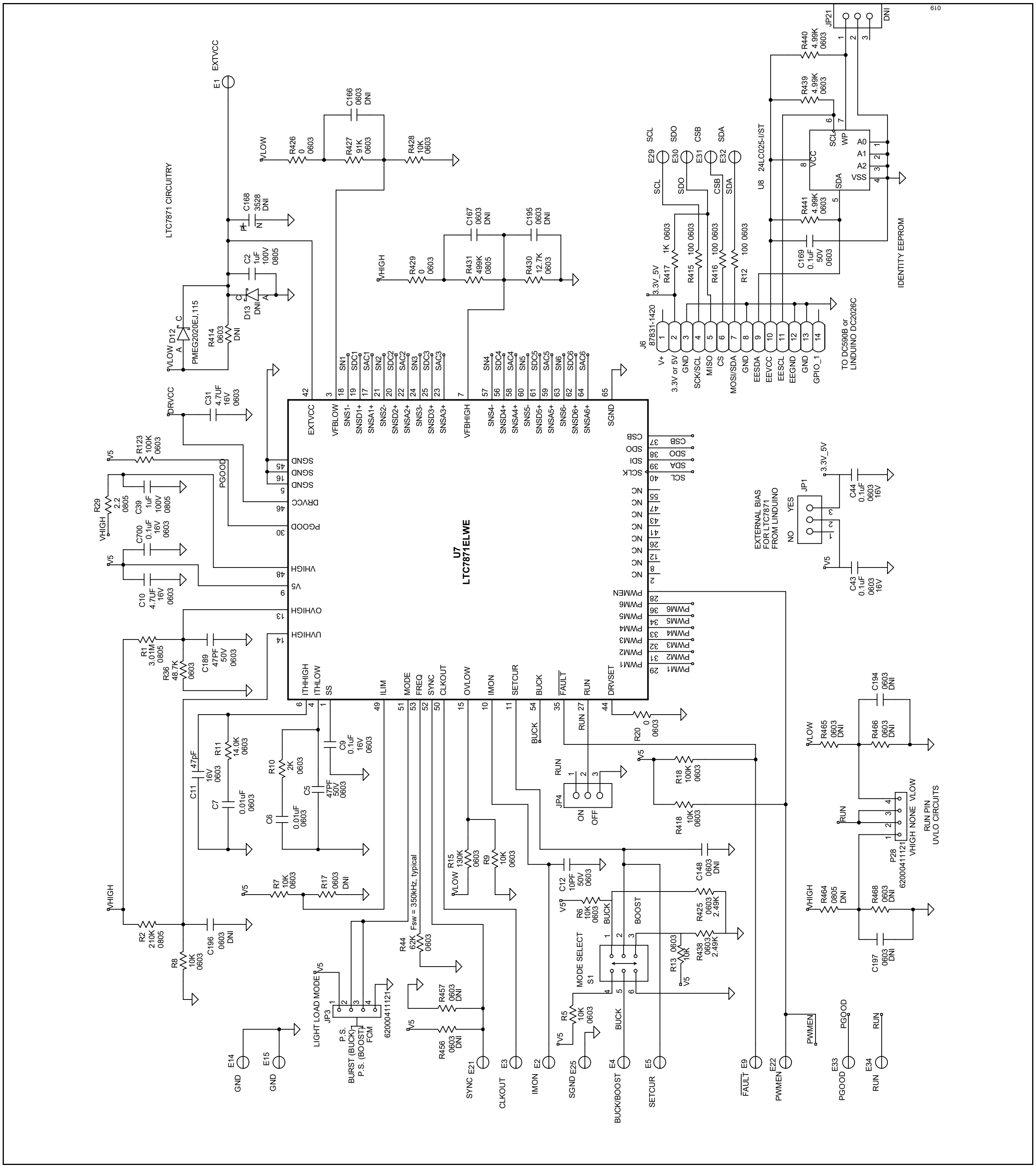


Figure 19. EVAL-LT8419-BZ Schematic—LTC7871 Controller

Schematics (continued)

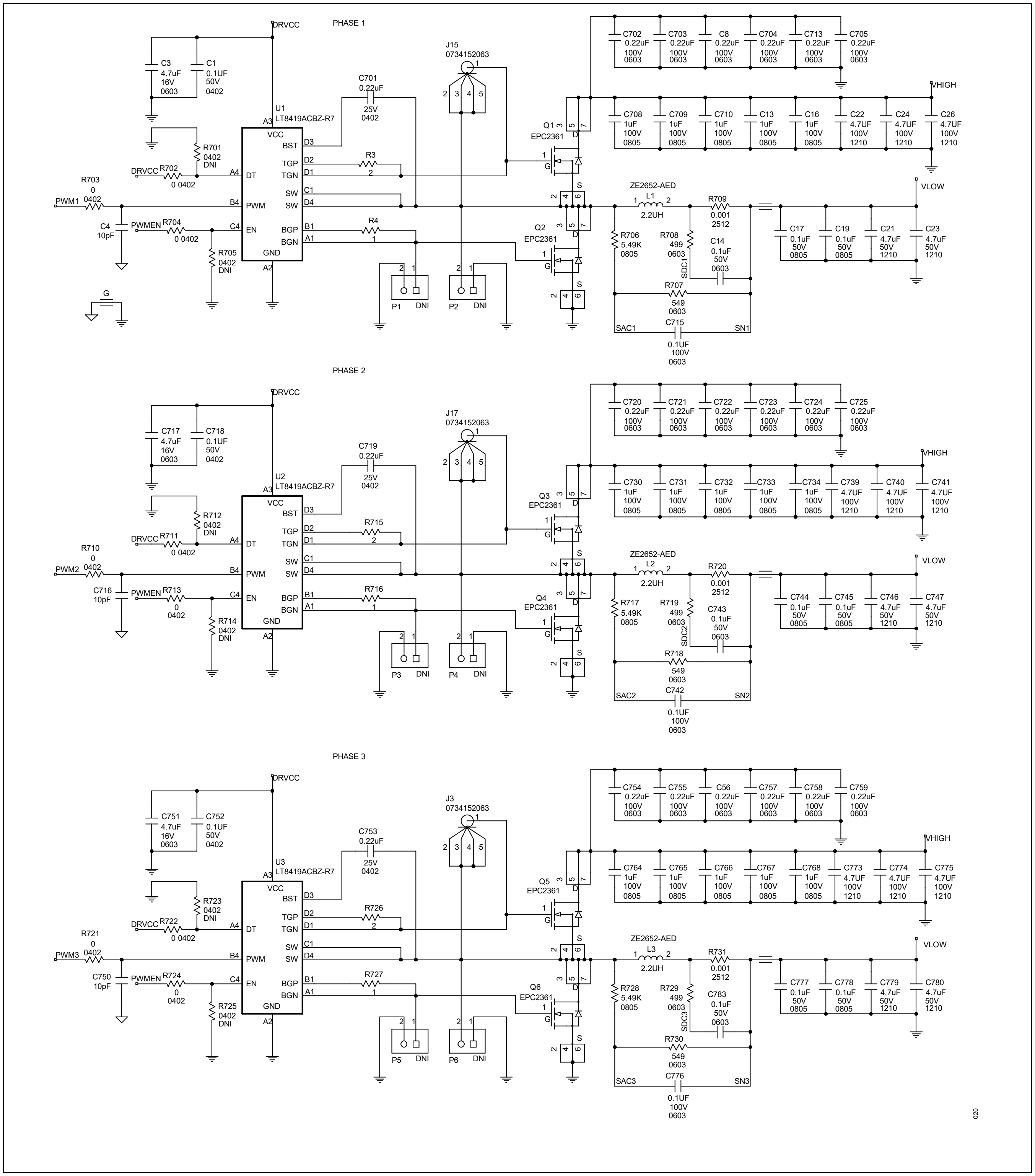


Figure 20. EVAL-LT8419-BZ Schematic—Power Phases 1, 2, and 3

Schematics (continued)

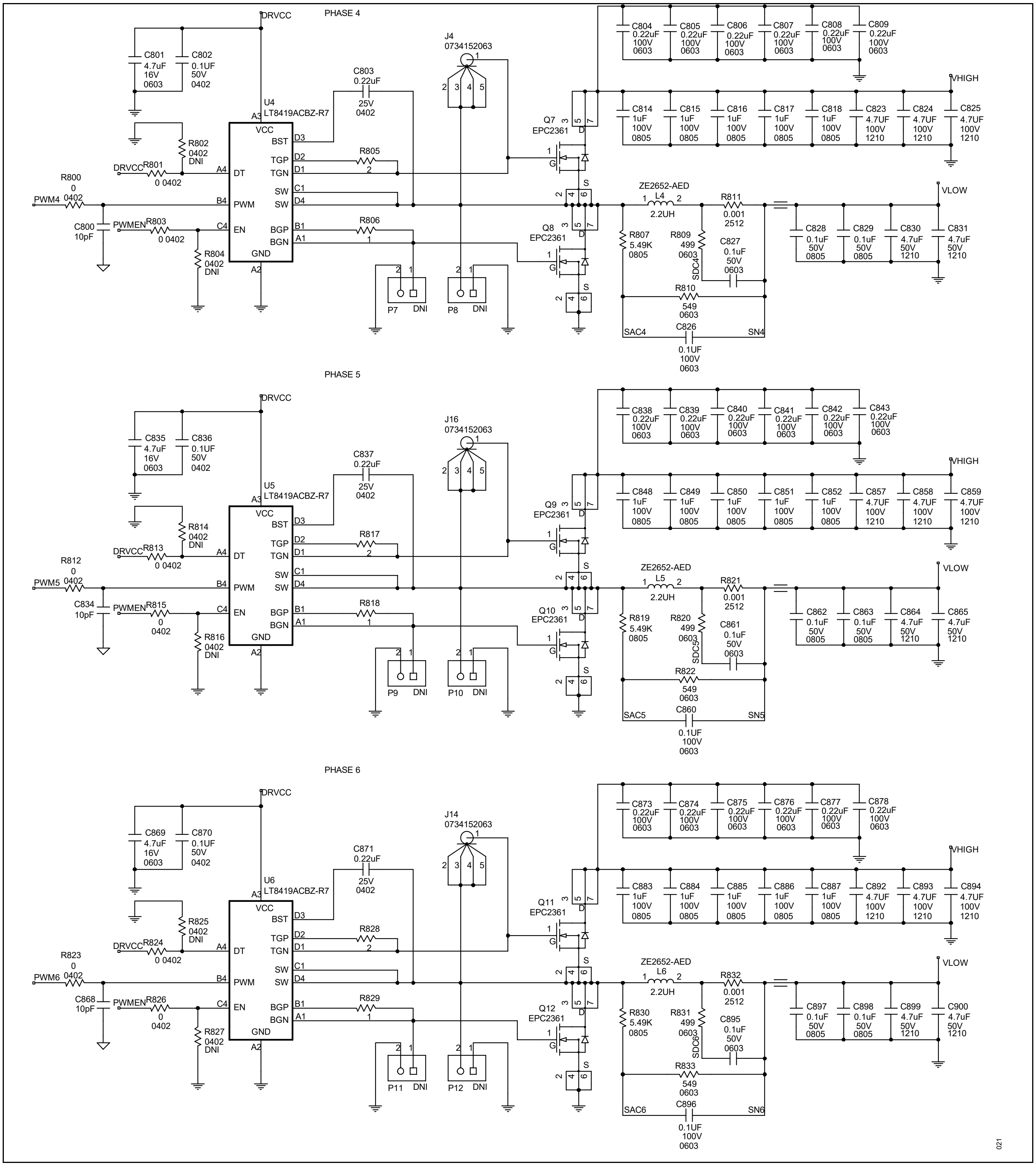
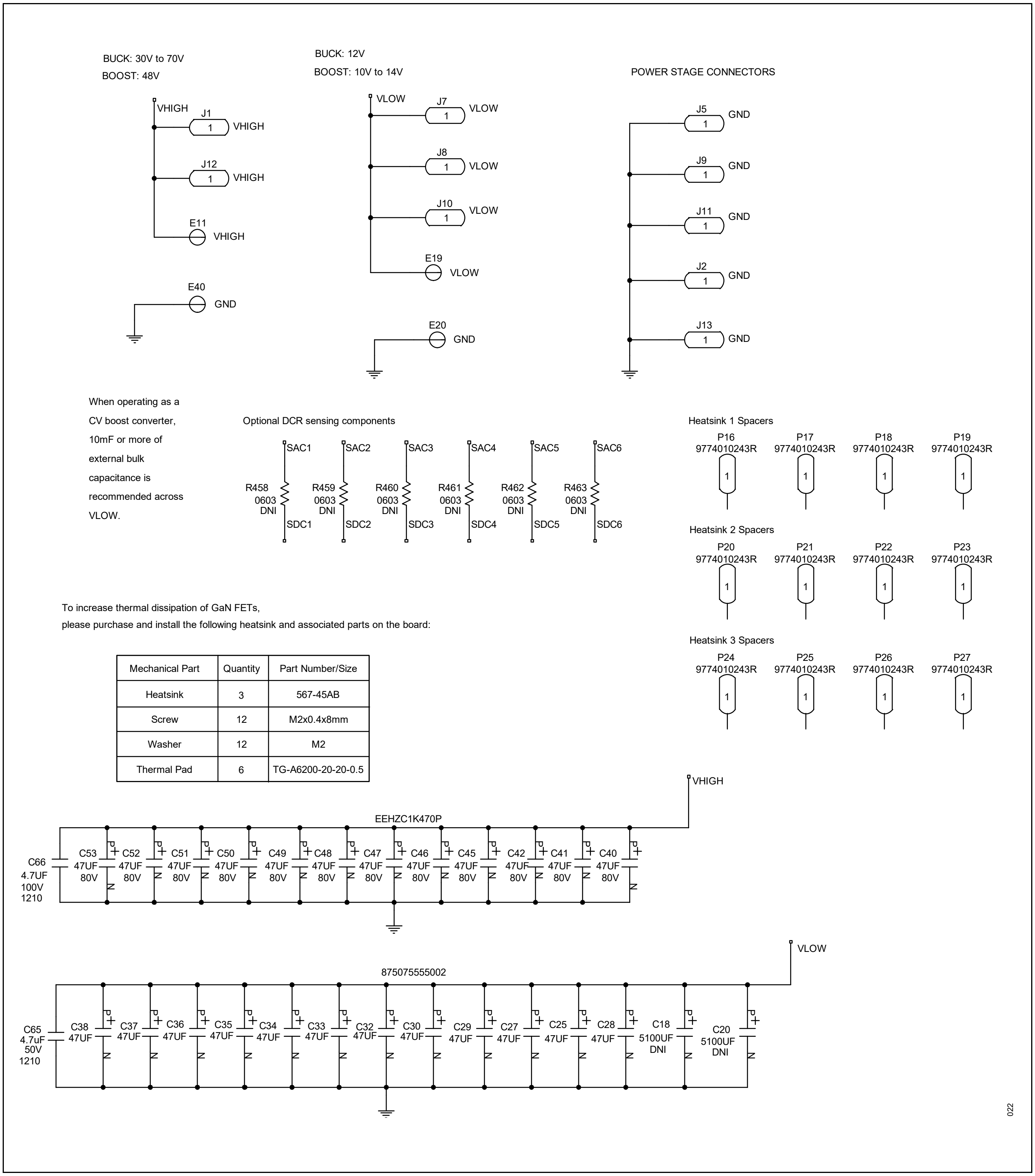


Figure 21. EVAL-LT8419-BZ Schematic—Power Phases 4, 5, and 6

Schematics (continued)



Mechanical Part	Quantity	Part Number/Size
Heatsink	3	567-45AB
Screw	12	M2x0.4x8mm
Washer	12	M2
Thermal Pad	6	TG-A6200-20-20-0.5

Figure 22. EVAL-LT8419-BZ Schematic—Power Stage Capacitors and Connectors

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	7/26	Initial release	—

Notes