EVAL-LTC7899-AZ

High Voltage Synchronous Negative to Positive Converter

General Description

The evaluation circuit EVAL-LTC7899-AZ features the *LTC®7899*: a 140V Low I_Q, synchronous, negative input to positive output controller with programmable 5V to 10V gate drive. Split gate drivers allow for easily adjustable turn-on and turn-off of FETs. User adjustable adaptive and set dead time control modes are available for optimal gate timing. Additionally, the IC features low I_Q, up to 2.5MHz programmable/synchronizable switching frequency, spread spectrum, in a small 28-lead (4mm x 5mm) QFN package. These features allow for a wide variety of applications including industrial, military, and telecommunications systems.

The EVAL-LTC7899-AZ operates from a -32V to -54V input voltage range and generates a positive 48V output, up to 8.8A load current. The EVAL-LTC7899-AZ is set to a 150kHz switching frequency, which results in up to 97.3% peak efficiency.

The LTC7899 supports a wide input and output voltage range ($|V_{IN^-}|+V_{OUT}$) up to 135V. The evaluation circuit has been designed with 120V FETs, various FETs of similar footprint can be substituted to fit a wide array of applications.

The EVAL-LTC7899-AZ provides a high-performance, cost-effective solution for generating a positive 48V output from a negative input. The LTC7899 data sheet gives a complete description of this part, its operation, and application information. The data sheet must be read in conjunction with this user guide for EVAL-LTC7899-AZ.

Design files for this circuit board are available at *www.analog.com*.

Performance Summary (T_A = 25°C)

PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
Input Voltage Range, V_{IN^-}			-54		-32	V
Output Voltage, V_{OUT}	V_{IN^-} = -32V to -54V		47.27	48.24	49.20	V
Maximum Load Current	See *Figure 8*, Maximum component temperature <100°C	V_{IN^-} = -32V			7	A
		V_{IN^-} = -48V			8.5	A
		V_{IN^-} = -54V			8.8	A
Output Voltage Ripple (Peak-to-Peak)	V_{IN^-} = -48V, I_{OUT} = 8.5A			350		mV_{P-P}
Run Rising Threshold				-29.7		V
Run Falling Threshold				-27.2		V
Switching Frequency	JP3 = Disable SS (SSFM Off)			150		kHz
	JP3 = Enable SS (SSFM On)		150		180	kHz
Typical Efficiency	V_{IN^-} = -48V, I_{OUT} = 8.5A			97.1		%
	V_{IN^-} = -32V, I_{OUT} = 7A			96.9		%

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Quick Start Procedure

The evaluation circuit EVAL-LTC7899-AZ is easy to set up to evaluate the performance of the LTC7899. For a proper measurement equipment setup, see *Figure 1* and follow the procedure below.

1. Set the input power supply to a voltage between -32V and -54V. Disable the power supply.

   NOTE: Make sure that the input voltage V_{IN}- does not exceed -54V.

2. Connect the positive terminal of the power supply to the GND jack at the input and the negative terminal to the V_{IN}- jack on the input.
3. Connect the load (< 8.8A) between V_{OUT} and GND.
4. Verify that the RUN jumper (JP2) is in the ON position.
5. Turn the input power supply on and adjust the input voltage to -32V.
6. Verify that the output voltage is 48V on the voltmeter connected to V_{OUT}. If there is no output, temporarily disconnect the load to make sure that the load is not set too high.
7. Once the proper output voltage is established, adjust the load and observe the output voltage regulation, ripple voltage, efficiency, and other parameters.

   NOTE: When measuring the input or output voltage ripple, care must be taken to minimize the length of the oscilloscope probe's ground lead. Measure the input or output voltage ripple by connecting the probe tip directly across the V_{OUT} and GND terminals. Preferably across the input or output capacitors. Use only one ground point, and make sure the input supply, load, and optional function generator are floating.

The EVAL-LTC7899-AZ is a fully assembled and tested board that demonstrates the performance of the LTC7899. The evaluation circuit is designed to deliver a positive 48V output at load current up to 8.8A from a -32V to -54V input supply, see *Figure 8* for a maximum output current vs. input voltage plot. The board is programmed with a switching frequency of 150kHz.

Adjusting the Output Voltage

The LTC7899 supports an adjustable output voltage range from 1.2V to ($|V_{IN}^-|+V_{OUT}$) ≤ 135V. To change the output voltage from the programmed 48V, change R19 and R17. Refer to the *Setting the Output Voltage* section in the data sheet for how to calculate the V_{FBA} and V_{FBB} resistor values for the desired output voltage. Output capacitors and other components will also need to be changed to meet the desired output voltage.

Setting the Switching Frequency

Selecting the switching frequency is a trade-off between efficiency and component size. For optimal performance, a switching frequency of 150kHz is chosen for a 48V output and a -32V to -54V input voltage range. R37 programs the desired switching frequency. The switching frequency is set using the FREQ and PLLIN/SPREAD pins. Refer to the *Setting the Operating Frequency* section in the LTC7899 data sheet for details.

RUN Control (RUN, JP2)

The RUN turret of the evaluation circuit receives an external on/off signal for the controller. The EVAL-LTC7899-AZ includes a resistive voltage divider (R9 and R12) connected between the V_{IN}- and GND to turn on the device at the required input voltage. Placing the RUN jumper (JP2) to the ON position to connect the RUN pin to the center of this resistor divider. The EVAL-LTC7899-AZ is designed to turn on the LTC7899 around -29.7V. This threshold can be easily adjusted by changing R9 and R12. Placing the RUN jumper (JP2) to the OFF position to disable the controller. See *Table 2* to configure JP2.

Soft-Start (SS)

The LTC7899's SS pin can program an external soft-start function to allow V_{OUT} to ramp up slowly. The adjustable soft-start function is used to limit the inrush current during startup. The soft-start time is adjusted by changing the value of C17. Refer to the *Soft-Start* section in the data sheet.

Mode Selection (MODE, JP1)

The EVAL-LTC7899-AZ provides a jumper (JP1) to allow the LTC7899 to operate in either forced continuous, pulse skipping, or burst modes at lighter loads. Refer to the LTC7899 data sheet for more details on the modes of operation. *Table 1* shows the mode selection JP1 settings that can be used to configure the desired mode of operation.

Spread Spectrum, Phase-Locked Loop, and External Frequency Synchronization (PLLIN/SPREAD, JP3)

The LTC7899 features spread-spectrum mode operation to improve EMI. This mode varies the switching frequency within the typical boundaries of the frequency set by the FREQ pin and +20%. Spread-spectrum operation is enabled by tying the PLLIN/SPREAD pin to $INTV_{CC}$. The EVAL-LTC7899-AZ includes a jumper (JP3) to conveniently enable or disable the spread-spectrum operation. See *Table 3* to configure JP3.

The LTC7899 also features a phase-locked loop to synchronize the internal oscillator to an external clock source. The EVAL-LTC7899-AZ provides SYNC and V_{IN}- turrets to connect an external clock source to synchronize with the device switching. Keep the jumper (JP3) in the SYNC position when the external clock signal is applied. For more details about external clock synchronization, refer to the LTC7899 data sheet.

Clock Output (CLKOUT)

The EVAL-LTC7899-AZ provides CLKOUT and V_{IN}- turrets to use in multiphase operation. The LTC7899 features an output clock signal that can be connected to the PLLIN of a second LTC7899 chip for multiphase operation. For more details about multiphase operation, refer to the LTC7899 data sheet.

Open-Drain PGOOD Output (PGOOD)

The EVAL-LTC7899-AZ provides a PGOOD turret to monitor the status of the PGOOD output. PGOOD is high when V_{FBB} voltage is within ±10% of the 1.2V reference. PGOOD is pulled low when V_{FBB} voltage is not within 1.2V ±10% or the RUN pin is low (shutdown). The voltage on the PGOOD pin should not exceed 6V.

$EXTV_{CC}$ Linear Regulator

The $EXTV_{CC}$ pin allows DRV_{CC} to be derived from a high efficiency external source (up to 30V max). On EVAL-LTC7899-AZ, the $EXTV_{CC}$ pin is not used and is connected to $INTV_{CC}$. To use $EXTV_{CC}$, remove R36 and add a 0Ω resistor on R21, then connect the external source across the $EXTV_{CC}$ and V_{IN}- turrets.

Thermal Performance

The LTC7899 features excellent thermal performance due to the high efficiency of the synchronous negative to positive controller circuitry. The component temperatures of EVAL-LTC7899-AZ with a typical -48V input and 8.5A load are shown in *Figure 7*. The six-layer PCB layout features solid copper planes that provide adequate heat spreading across the whole board. For additional information on the maximum load current for a given input voltage, see *Figure 8*.

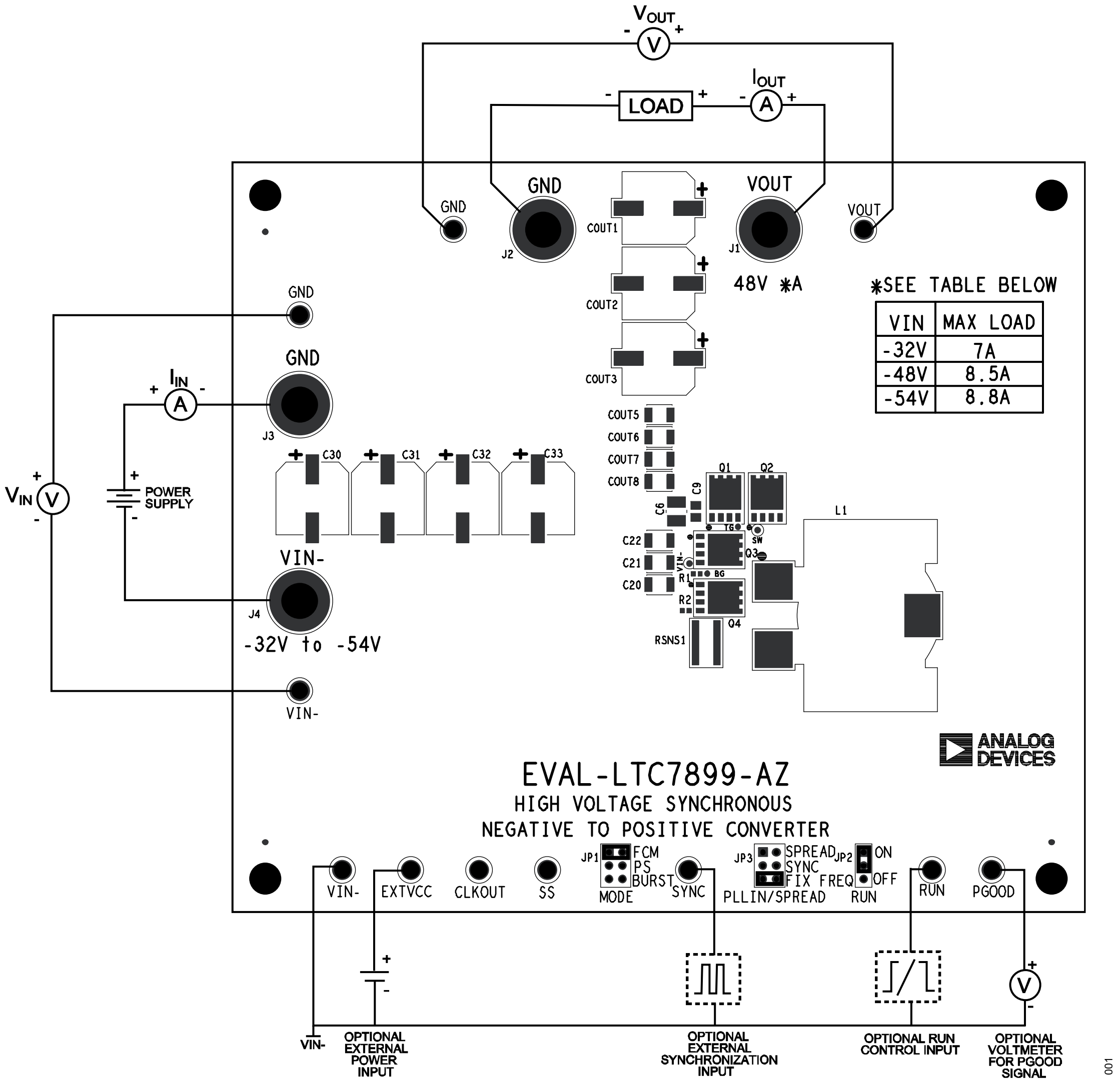


Figure 1. EVAL-LTC7899-AZ Board Connections

Table 1. MODE Switch (JP1) Settings

SHUNT POSITION	MODE PIN	LIGHT LOAD BEHAVIOR
1-2* (FCM)	Connected to $INTV_{CC}$	Forced continuous mode
3-4 (PS)	Connected to $INTV_{CC}$ with a 100kΩ	Pulse-skipping mode
5-6 (BURST)	Connected to V_{IN}-	Burst mode

**Default position*

Table 2. RUN Jumper (JP2) Settings

SHUNT POSITION	RUN PIN	CONTROLLER
1-2* (ON)	Connected to the center node of the resistor-divider R9 and R12	Programmed to startup at the desired input voltage level
2-3 (OFF)	Connected to V_{IN}-	Disabled

**Default position*

Table 3. PLLIN/SPREAD Selection Jumper (JP3) Settings

SHUNT POSITION	PLLIN/SPREAD PIN	SWITCHING FREQUENCY
1-2 (SPREAD)	Connected to $INTV_{CC}$	Spread spectrum
3-4 (SYNC)	Connected to the center node of R39 and C16	Set by external SYNC input
5-6* (FIXED FREQ)	Connected to V_{IN}-	Fixed frequency set by R37

**Default position*

Performance

(V_{IN^-} = -48V, V_{OUT} = 48V, I_{OUT} = 8.5A, f_{SW} = 150kHz, MODE = FCM, T_A = +25°C, unless otherwise noted.)

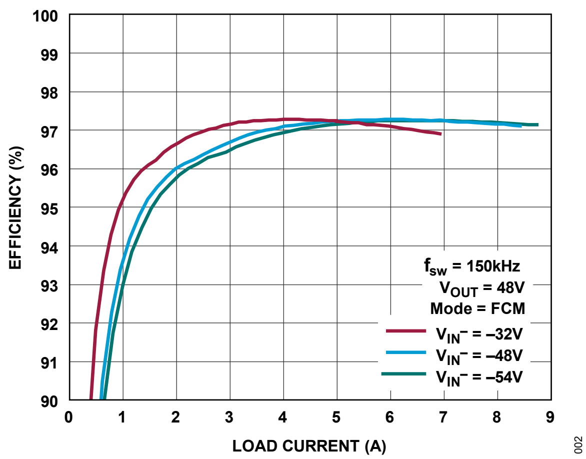


Figure 2. Efficiency vs. Load Current. At V_{IN^-} = -48V, EVAL-LTC7899-AZ performs with an efficiency of over 97% with 48V output and 8.5A load.

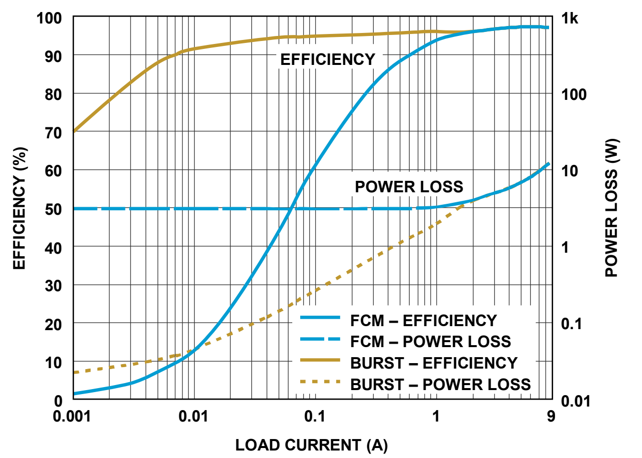


Figure 3. Efficiency and Power Loss vs. Load Current at V_{IN^-} = -48V. At low load, burst mode significantly improves power loss compared to FCM.

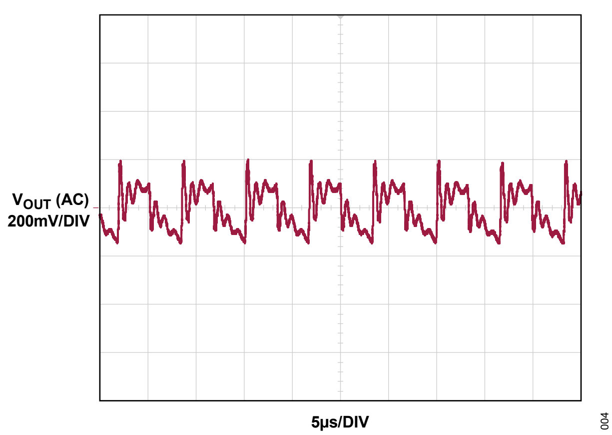


Figure 4. Output Voltage Ripple at V_{IN^-} = -48V and I_{OUT} = 8.5A. EVAL-LTC7899-AZ has small output voltage ripple with small output capacitors.

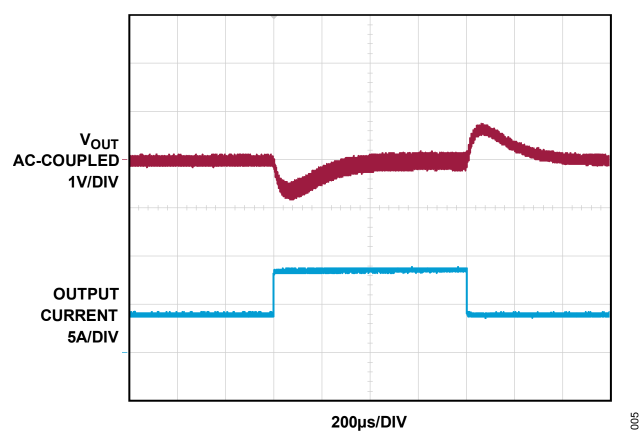


Figure 5. Load Step Response at V_{IN^-} = -48V. EVAL-LTC7899-AZ has good load step response with small output capacitors.

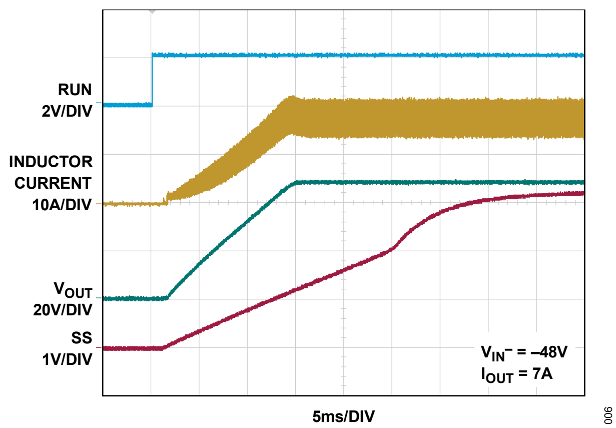


Figure 6. Soft-Start Behavior. EVAL-LTC7899-AZ ramps the output slowly at startup without output voltage overshoot.

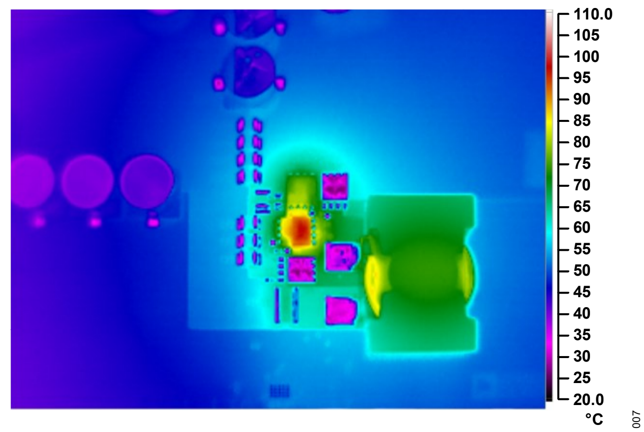


Figure 7. Thermal Performance with -48V Input, 48V Output, and 8.5A Load. No airflow. The hottest component on EVAL-LTC7899-AZ stays under 100°C (T_A = 25°C).

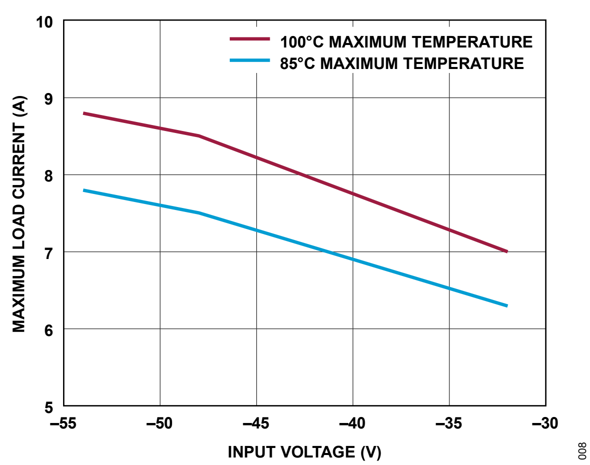
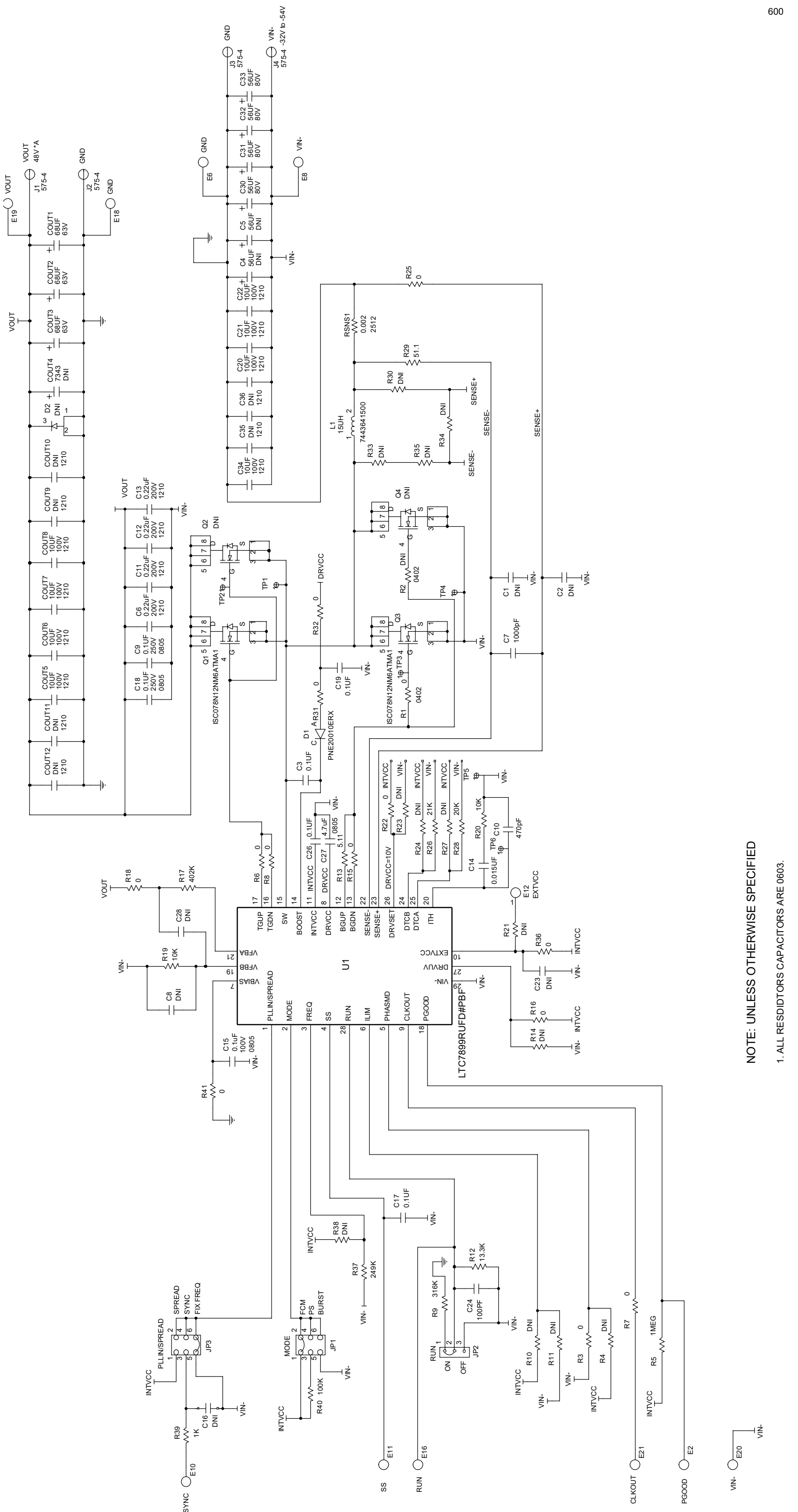


Figure 8. Load Current Derating. Maximum Output Current vs. V_{IN} to maintain board temperatures below 85°C and 100°C (T_A = 25°C).

Schematic


NOTE: UNLESS OTHERWISE SPECIFIED
1. ALL RESDIDTORS CAPACITORS ARE 0603.
LTC7899RUFD#PBF
U1

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	06/25	Initial release	—

Notes