EVAL-LTC7897-AZ

Wide Input and Output Voltage Synchronous Buck Controller

General Description

The evaluation circuit EVAL-LTC7897-AZ features the LTC®7897: a 140V Low I_Q Synchronous Buck 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 smart 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, and a small 28-lead (4mm x 5mm) QFN package. These features allow for a wide variety of applications including industrial, military, medical, and telecommunications systems.

The EVAL-LTC7897-AZ operates from a 16V to 100V input voltage range and generates a 12V, 20A output (see Figure 8). The LTC7897 has a precision voltage reference providing an output voltage with 2% tolerance over the full operating conditions. The EVAL-LTC7897-AZ is set to a 200kHz switching frequency, which results in a small and efficient circuit. The converter achieves over 93% efficiency with a 20A load at full operating V_{IN} and peak efficiency over 96%.

The LTC7897 supports output voltages from 0.8V to 135V. The evaluation circuit has been designed with 150V FETs. Various FETs of similar footprint can be substituted to fit a wide array of applications.

The EVAL-LTC7897-AZ provides a high-performance, cost-effective solution for generating a 12V output. The LTC7897 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-LTC7897-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	Non-destructive	0		135	V
Output Voltage	V_{IN} = 16V to 135V	11.76	12	12.24	V
Maximum Load Current	V_{IN} = 16V to 100V, Airflow (see Figure 8)			20	A
	V_{IN} = 16V to 75V, No Airflow, Maximum board temperature < 100°C			20	A
Output Voltage Ripple (Peak-to-Peak)	V_{IN} = 48V, I_{OUT} = 20A		85		mV_{P-P}
Run Rising Threshold			15.6		V
Run Falling Threshold			14		V
Switching Frequency	JP1 = Disable SS (SSFM Off)		200		kHz
	JP1 = Enable SS (SSFM On)	200		240	kHz
Typical Efficiency	V_{IN} = 48V, I_{OUT} = 20A		95		%
	V_{IN} = 100V, I_{OUT} = 20A		93		%

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Quick Start Procedure

The evaluation circuit EVAL-LTC7897-AZ is easy to set up to evaluate the performance of the LTC7897. For a proper measurement equipment setup, see *Figure 1* and follow the procedure below.

1. Set the input power supply to a voltage between 16V and 135V. Disable the power supply.

   NOTE: Make sure that the input voltage V_{IN} does not exceed 135V.
2. Connect the positive terminal of the power supply to V_{IN} and the negative terminal to GND.
3. Connect the load (< 20A) between V_{OUT} and GND.
4. Verify that the RUN switch (SW1) is set to the ON position.
5. Turn the input power supply on and adjust the input voltage to 48V.
6. Verify that the output voltage is 12V 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_{IN} or V_{OUT} and GND terminals. Preferably across the input or output capacitors.

The EVAL-LTC7897-AZ is a fully assembled and tested board that demonstrates the performance of the LTC7897. The evaluation circuit is designed to deliver 12V output at load current up to 20A from a 16V to 135V input supply. The board is programmed with a switching frequency of 200kHz.

Adjusting the Output Voltage

The LTC7897 supports an adjustable output voltage range from 0.8V to 135V. To change the output voltage from the programmed 12V, change R7 and R8. Refer to the Setting the Output Voltage section on the data sheet for how to calculate the V_{FB} resistor divider 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 200kHz is chosen for 12V output and a wide input voltage range. R13 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 LTC7897 data sheet for details.

RUN Control (RUN, SW1)

The RUN turret of the evaluation circuit receives an external on/off signal for the controller. The EVAL-LTC7897-AZ includes a resistive voltage divider (R6 and R56) connected between the V_{IN} and GND pins to turn on the device at the required input voltage. Turn the switch (SW1) to the ON position to connect the RUN pin to the center of this resistor divider. The EVAL-LTC7897-AZ is designed to turn on the LTC7897 around 15.6V. This threshold can be easily adjusted by changing R6 and R56. Turn SW1 to the off position to disable the controller. See *Table 3* to configure SW1.

TRACK and Soft-Start Input (TRACK/SS)

The LTC7897's TRACK/SS pin can be used to program an external soft-start function or to allow V_{OUT} to track another supply during startup. The adjustable soft-start function is used to limit the inrush current during startup. The soft-start time is adjusted by C4. An external supply can be connected to the TRACK/SS turret to make the startup of the V_{OUT} track an external supply. Typically, this requires connecting to the TRACK/SS turret through an external resistor divider from the external supply to GND. Refer to the Soft-Start and Tracking section on the data sheet.

Mode Selection (MODE, JP2)

The EVAL-LTC7897-AZ provides a jumper (JP2) to allow the LTC7897 to operate in either forced continuous, pulse skipping, or burst modes at lighter loads. Refer to the LTC7897 data sheet for more details on the modes of operation. *Table 2* shows the mode selection JP2 settings that can be used to configure the desired mode of operation.

Spread Spectrum, Phase-Locked Loop, and External Frequency Synchronization (PLLIN/SPREAD, JP1)

The LTC7897 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-LTC7897-AZ includes a jumper (JP1) to conveniently enable or disable the spread-spectrum operation. See *Table 1* to configure JP1.

The LTC7897 also features a phase-locked loop to synchronize the internal oscillator to an external clock source. The EVAL-LTC7897-AZ provides a SYNC turret to connect an external clock source to synchronize with the device switching. Keep the jumper (JP1) in the EXT position when the external clock signal is applied. For more details about external clock synchronization, refer to the LTC7897 data sheet.

Open-Drain PGOOD Output (PGOOD)

The EVAL-LTC7897-AZ provides a PGOOD turret to monitor the status of the PGOOD output. PGOOD is high when V_{FB} voltage is within ±10% of the 0.8V reference. PGOOD is pulled low when V_{FB} voltage is not within 0.8V ± 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-LTC7897-AZ, the $EXTV_{CC}$ pin is connected to V_{OUT}. The included high efficiency LTC3639 step-down regulator can also be used to supply $EXTV_{CC}$, accommodating a wide range of output voltages.

Thermal Performance

The LTC7897 features excellent thermal performance due to the high efficiency of the synchronous step-down controller circuitry. The component temperatures of EVAL-LTC7897-AZ with a typical 48V input and 20A load are shown in *Figure 7*. The six-layer PCB layout features solid copper planes that provide adequate heat spreading across the whole board.

The board can operate with an input voltage up to 135V at 20A without forced air under transient conditions. For continuous operation with an input voltage above 75V, forced airflow is required to keep the maximum temperature of the board under 100°C at room temperature (T_A = 25˚C). For additional information on operating conditions, see *Figure 8*.

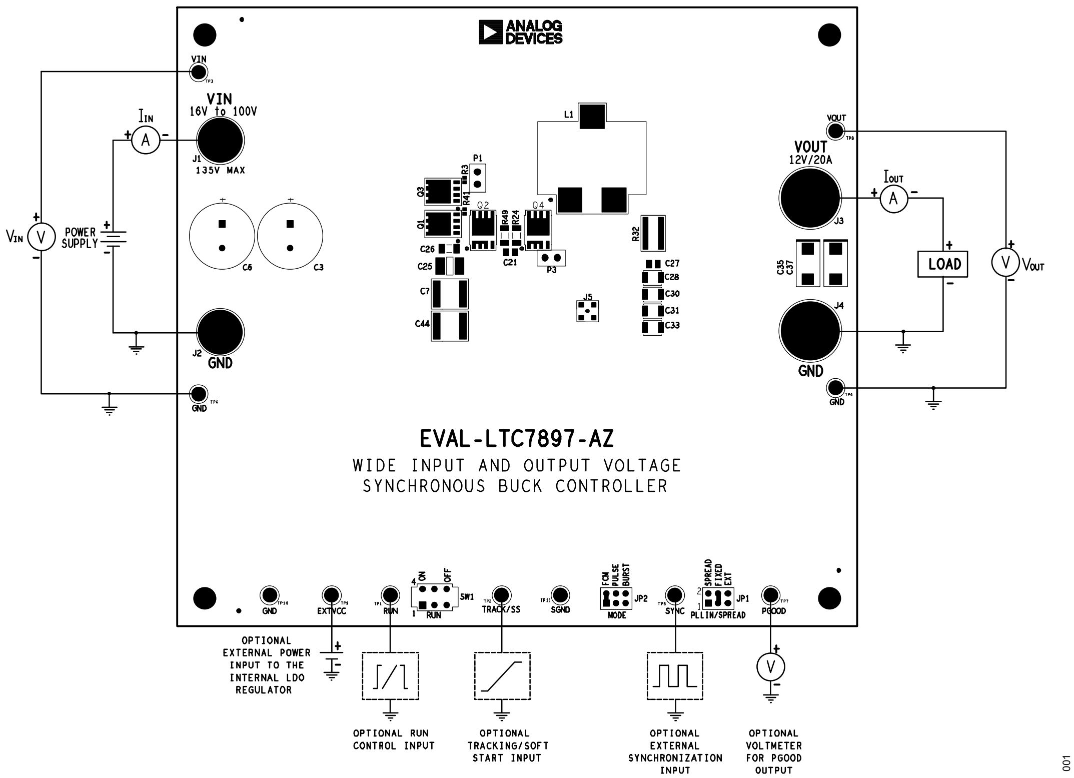


Figure 1. EVAL-LTC7897-AZ Board Connections

Table 1. PLLIN/SPREAD Selection Jumper (JP1) Settings

SHUNT POSITION	MODE PIN	MODE
1-2	Connected to $INTV_{CC}$	Spread spectrum
3-4*	Connected to GND	Fixed frequency
5-6	Connected to the center node of R49 and C16	External SYNC input

*Default position

Table 2. MODE Jumper (JP2) Settings

SHUNT POSITION	PLLIN/SPREAD PIN	DESCRIPTION
1-2*	Connected to $INTV_{CC}$	Forced continuous mode of operation
3-4	Connected to $INTV_{CC}$ with a 100kΩ	Pulse skipping mode of operation
5-6	Connected to GND	Burst mode of operation

*Default position

Table 3. RUN Switch (SW1) Settings

SWITCH POSITION	RUN PIN	CONTROLLER
ON*	Connected to the center node of the resistor-divider R6 and R56	Programmed to startup at the desired input voltage level
OFF	Connected to GND	Disabled

*Default position

Performance

(V_{IN} = 48V, V_{OUT} = 12V, I_{OUT} = 20A, f_{SW} = 200kHz, MODE = FCM, T_A = +25°C, unless otherwise noted.)

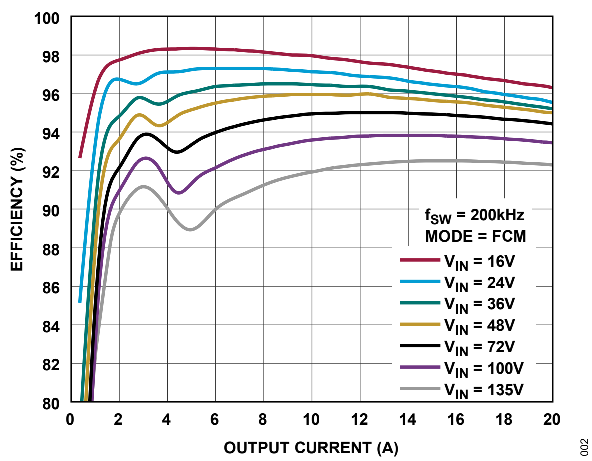


Figure 2. Efficiency vs. Load Current. At V_{IN} = 48V, EVAL-LTC7897-AZ performs with an efficiency of over 95% with 12V output and 20A load.

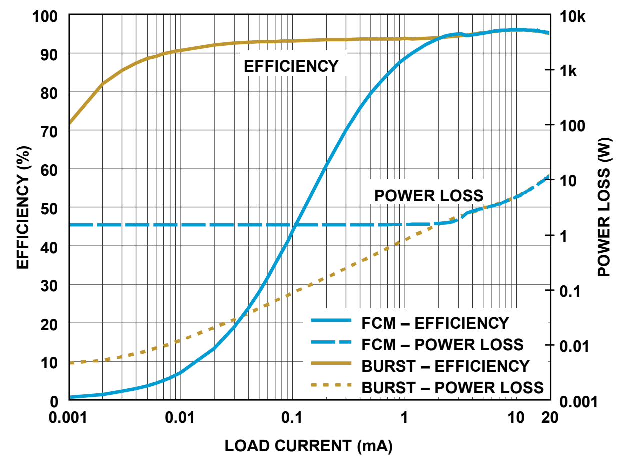


Figure 3. Efficiency and Power Loss vs. Load Current at V_{IN} = 48V. At low load, burst mode significantly improves power loss compared to FCM.

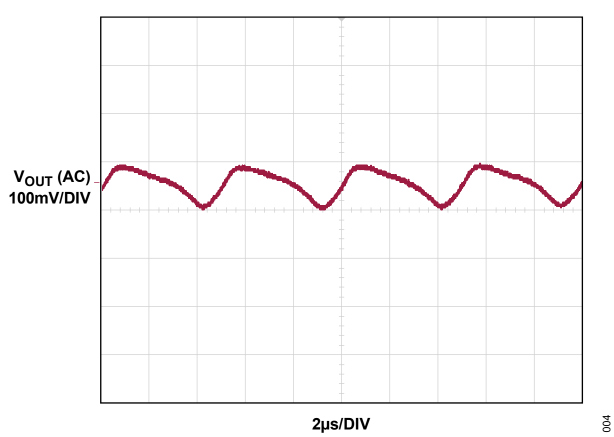


Figure 4. Output Voltage Ripple at V_{IN} = 48V and I_{OUT} = 20A. EVAL-LTC7897-AZ has small output voltage ripple with a small output capacitors.

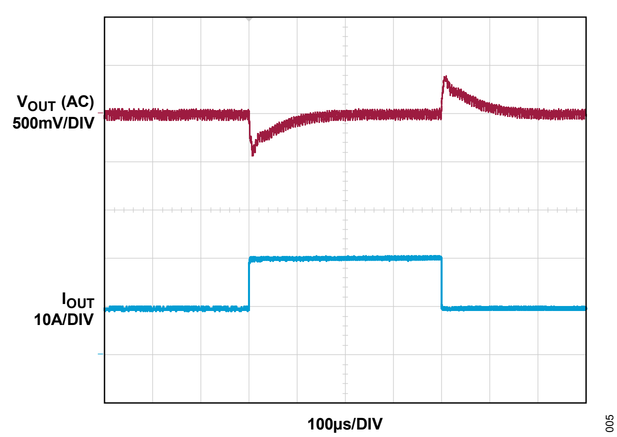


Figure 5. Load Step Response at V_{IN} = 48V. EVAL-LTC7897-AZ has good load step response with a small output capacitors.

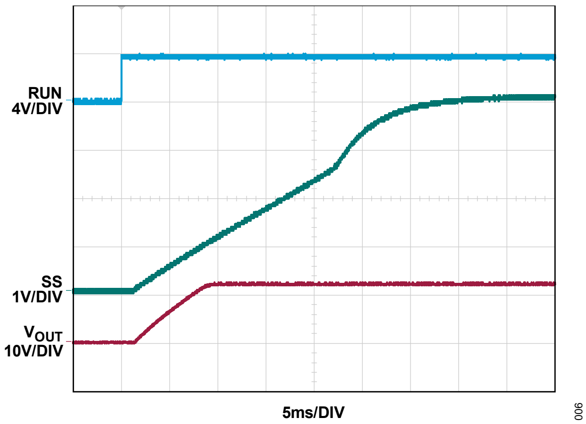


Figure 6. Soft-Start Behavior. EVAL-LTC7897-AZ ramps the output slowly at startup without output voltage overshoot.

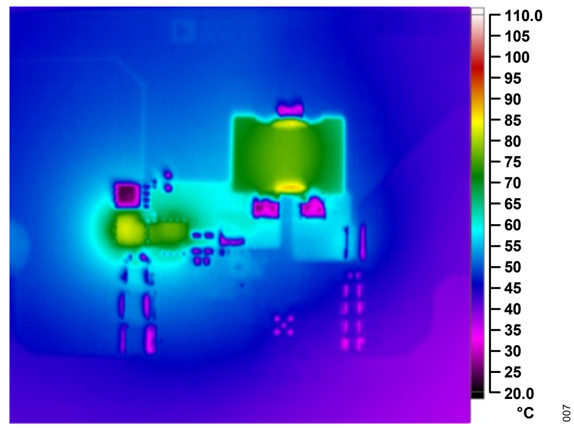


Figure 7. Thermal Performance with 48V Input, 12V Output, and 20A Load. No airflow. The hottest component on EVAL-LTC7897-AZ stays under 100°C (T_A = 25°C).

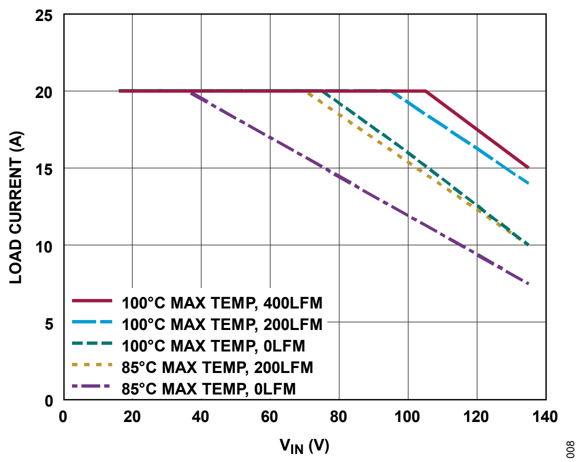
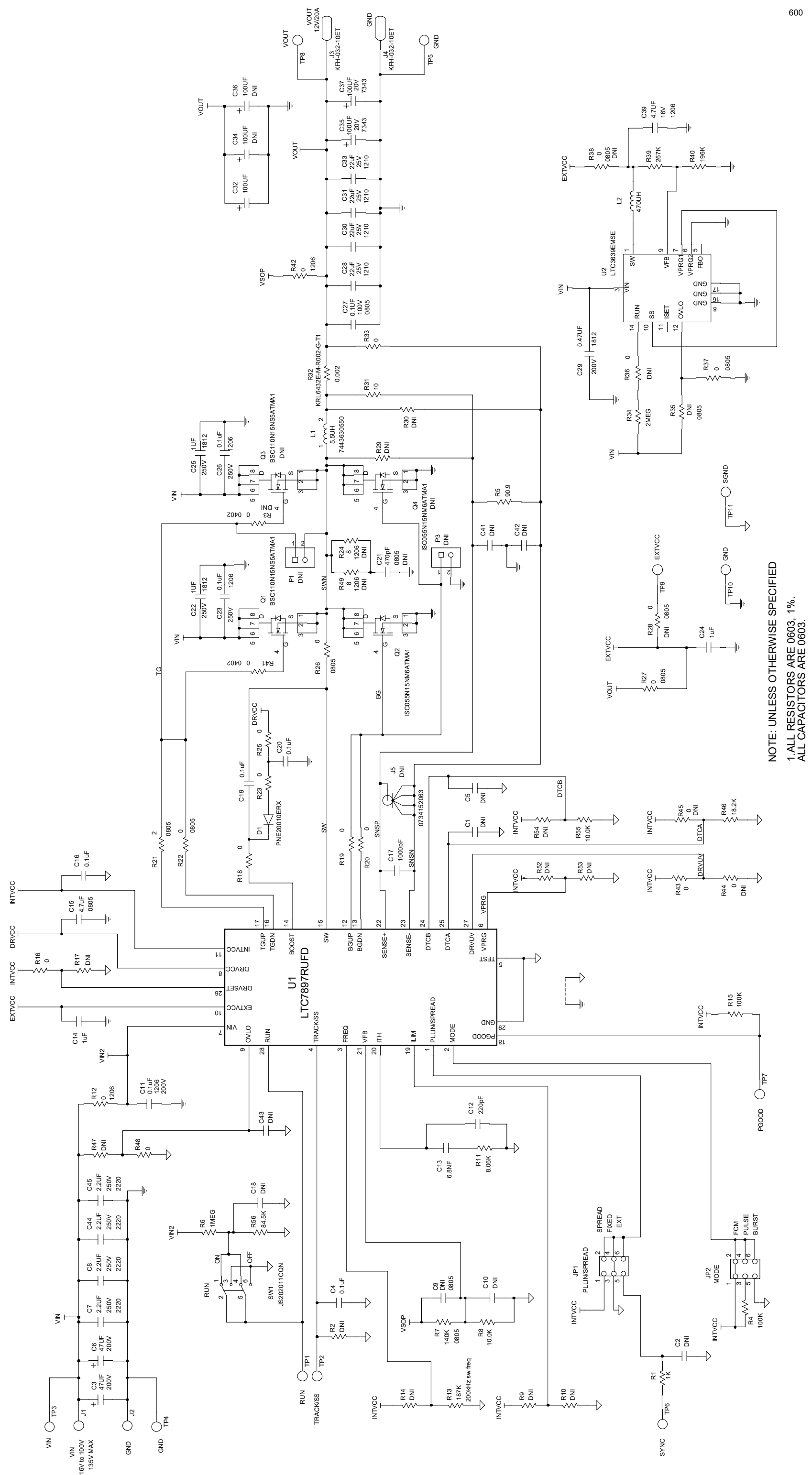


Figure 8. Load Current Derating. Maximum Output Current vs. V_{IN} to maintain board temperatures below 85°C and 100°C with and without airflow (T_A = 25˚C).

Schematic


600
U1
LTC7897RUFD
NOTE: UNLESS OTHERWISE SPECIFIED
1.ALL RESISTORS ARE 0603, 1%.
ALL CAPACITORS ARE 0603.
VIN
16V to 100V
135V MAX
VOUT
12V/20A

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	2/25	Initial release	—

Notes