DESCRIPTION

Demonstration circuit 1185 is a dual phase/dual output synchronous buck converter featuring the LTC3850EUF. The demo board comes in two versions. The output voltages for version -A are 2.0V/10A and 1.8V/10A and the output voltages for version -B are 1.5V/15A and 1.2V/15A. The input voltage range is 6.5V to 14V for both versions. For applications that have a 5V +/- 0.5V input, the board has an optional resistor to tie the INTVCC pin to the VIN pin.

The demo board uses a high density, two sided drop-in layout. The power components, excluding the bulk output and input capacitors, fit within a 1.35" X 0.75" area on the top layer. The control circuit resides in a 0.60" X 0.75" area on the bottom layer. The package style for the LTC3850EUF is a 4mm X 4mm 28-lead QFN with an exposed ground pad.

The main features of the board include an internal 5V linear regulator for bias, RUN pins for each output, an EXTVCC pin and a PGOOD signal. The board can be configured for either CCM (original setting), Burst Mode, or pulse skip operation with the MODE jumper. The board also has optional resistors for single output / dual phase operation, rail tracking, DCR sensing and synchronization to an external clock.

Design files for this circuit board are available. Call the LTC factory.

Table 1. Performance Summary (T_A = 25°C)

PARAMETER	CONDITION	VALUE
Minimum Input Voltage		6.5V
Maximum Input Voltage		14V
Version -A		
Output Voltage V_{OUT1}	I_{OUT1} = 0A to 10A	2.0V ±2%
Output Voltage V_{OUT2}	I_{OUT2} = 0A to 10A	1.8V ±2%
Nominal Switching Frequency		500kHz
Full Load Efficiency	V_{OUT1} = 2.0V, I_{OUT1} = 10A , V_{IN} = 12V	88.0%
(see Figure 3 for efficiency curves)	V_{OUT2} = 1.8V, I_{OUT2} = 10A , V_{IN} = 12V	87.0%
Version -B		
Output Voltage V_{OUT1}	I_{OUT1} = 0A to 15A	1.5V ±2%
Output Voltage V_{OUT2}	I_{OUT2} = 0A to 15A	1.2V ±2%
Nominal Switching Frequency		400kHz
Full Load Efficiency	V_{OUT1} = 1.5V, I_{OUT1} = 15A , V_{IN} = 12V	87.4%
(see Figure 4 for efficiency curves)	V_{OUT2} = 1.2V, I_{OUT2} = 15A , V_{IN} = 12V	85.3%

QUICK START PROCEDURE

Demonstration circuit 1185 is easy to set up to evaluate the performance of the LTC3850EUF. Refer to Figure 1 for the proper measurement equipment setup and follow the procedure below:

NOTE: When measuring the output or input voltage ripple, care must be taken to avoid a long ground lead on the oscilloscope probe. See Figure 2 for the proper scope probe technique. Short, stiff leads need to be soldered to the (+) and (-) terminals of an output capacitor. The probe's ground ring needs to touch the (-) lead and the probe tip needs to touch the (+) lead.

Place jumpers in the following positions:

JP1	**RUN1**	**ON**
JP2	**RUN2**	**ON**
JP3	**MODE**	**CCM**

With power off, connect the input power supply to VIN and GND.

Turn on the power at the input.

NOTE: Make sure that the input voltage does not exceed 15V.

Check for the proper output voltages.
Version –A:
Vout1 = 1.960V to 2.040V
Vout2 = 1.764V to 1.836V

Version –B:
Vout1 = 1.470V to 1.530V
Vout2 = 1.176V to 1.224V

Once the proper output voltages are established, adjust the loads within the operating range and observe the output voltage regulation, ripple voltage, efficiency and other parameters.

NOTE: Do not apply load across the VOSn+ and VOSn- turrets. These turrets are only intended to Kelvin sense the output voltage across COUT1 and COUT4. Heavy load currents may damage the output voltage sense traces.

SINGLE OUTPUT / DUAL PHASE OPERATION

A single output / dual phase converter may be preferred for high output current applications. The benefits of single output / dual phase operation is lower ripple current through the input and output capacitors, improved load step response and simplified thermal design. To implement single output / dual phase operation, make the following modifications:

1. Tie VOUT1 to VOUT2 by tying together the exposed copper pads near J3 and J5 at the edge of the board. Use a piece of heavy copper foil.
2. Tie ITH1 to ITH2 by stuffing 0Ω at R49.
3. Tie VFB1 to VFB2 by stuffing 0Ω at R50.
4. Tie TRK/SS1 to TRK/SS2 by stuffing 0Ω at R52.
5. Tie RUN1 to RUN2 by stuffing 0Ω at R55.
6. Remove the redundant ITH compensation network and VFB divider.

RAIL TRACKING

Demonstration circuit 1185 is setup for independent turn-on of VOUT1 and VOUT2. The ramp-rate for VOUT1 is determined by the TRK/SS1 cap at C2 and the ramp-rate for VOUT2 is determined by the TRK/SS2 cap at C47. The turn-on of one rail will not affect the other for the original demo board.

This board can be modified on the bench to allow VOUT1 to track an external signal. It can also be modified to allow VOUT2 to track VOUT1 or to allow VOUT2 to track an external signal. Tables 2 and 3 cover the rail tracking options for each rail, with the –B version used as an example.

Table 1. V_{OUT1} Tracking Options for a 1.5V Output.

	TRACK1 DIVIDER		TRK/SS1 CAP
CONFIGURATION	**R3**	**R2**	**C2**
Soft Start Without Tracking (original board)	0 Ω	Not stuffed	0.1uF
External Coincident Tracking	17.8kΩ	20.0kΩ	Not Stuffed

Table 2. V_{OUT2} Tracking Options for a 1.2V Output.

	TRACK2 DIVIDER			TRK/SS2 CAP
CONFIGURATION	**R36**	**R34**	**R37**	**C47**
Soft Start Without Tracking (original board)	0 Ω	Not stuffed	Not stuffed	0.1uF
Coincident Tracking to V_{OUT1} (1.5V)	0 Ω	10.0kΩ	20.0kΩ	Not Stuffed
External Coincident Tracking	10.0kΩ	Not stuffed	20.0kΩ	Not Stuffed

INDUCTOR DCR SENSING

Demonstration circuit 1185 provides an optional circuit for DCR sensing. DCR sensing uses the DCR of the inductor to sense the inductor current instead of discrete sense resistors. The advantages of DCR sensing are lower cost, reduced board space and higher efficiency, but the disadvantage is a less accurate current limit. If DCR sensing is used, be sure to select an inductor current with a sufficiently high saturation current or use an iron powder type. Tables 3 and 4 show an example of how to modify the DC1185 for DCR sensing using these parameters:

V_{OUT1} = 2.0V / 10A

V_{OUT2} = 1.8V / 10A

V_{IN} = 6.5V to 14V

Fsw = 500kHz, typical

L1,2 = Toko FDU0650-R56M=P3

(0.56uH, DCR = 2.45mΩ typ, 3.2mΩ max)

ILIM = FLOATING (R42,R44 = OPEN)

Table 3. V_{OUT1} Configured as a 2.0V/10A Converter Using DCR Sensing and Discrete Sense Resistors

			RSENSE FILTER RESISTORS	SENSE FIILTER CAP	DCR FILTER/DIVIDER RESISTORS		SENSE1- TO L1- JUMPER
					TOP	BOTTOM	
CONFIGURATION	**RS1**	**L1**	**R29,R30**	**C14**	**R45**	**R47**	**R61**
DCR Sensing	Short with Cu strip or very short & thick piece of wire	Toko FDU0650-R56M=P3	Open	0.1uF	2.37kΩ	6.49kΩ	0 Ω
Discrete RSENSE (original board)	3mΩ 2010 pkg	Toko FDU0650-R56M=P3	100Ω	1nF	Open	Open	Open

Table 4. V_{OUT2} Configured as a 1.8V/10A Converter Using DCR Sensing and Discrete Sense Resistors

			RSENSE FILTER RESISTORS	SENSE FIILTER CAP	DCR FILTER/DIVIDER RESISTORS		SENSE1- TO L1- JUMPER
					TOP	BOTTOM	
CONFIGURATION	**RS2**	**L2**	**R39,R40**	**C15**	**R51**	**R53**	**R62**
DCR Sensing	Short with Cu strip or very short & thick piece of wire	Toko FDU0650-R56M=P3	Open	0.1uF	2.37kΩ	6.49kΩ	0 Ω
Discrete RSENSE (original board)	3mΩ 2010 pkg	Toko FDU0650-R56M=P3	100Ω	1nF	Open	Open	Open

SYNCHRONIZATION TO AN EXTERNAL CLOCK

The LTC3850 uses a phase lock loop which forces its internal clock to be synchronized to an external clock. Once synchronized, the rising edge of the top FET gate is aligned to the rising edge of the external clock. The external clock signal needs to be applied to the LTC3850's MODE pin which is tied to the turret labeled SYNC. The internal phase lock loop is stabilized by a network on the FREQ pin of the LTC3850. To setup the DC1185 for synchronization to an external clock, follow the steps below.

1. Remove R7.
2. Stuff 10kΩ at R8.
3. Stuff 10nF at R10.
4. Leave 1nF at C12.
5. Float the MODE pin by placing the MODE jumper in the BM position.
6. Apply the external clock from the turret labeled SYNC to GND.

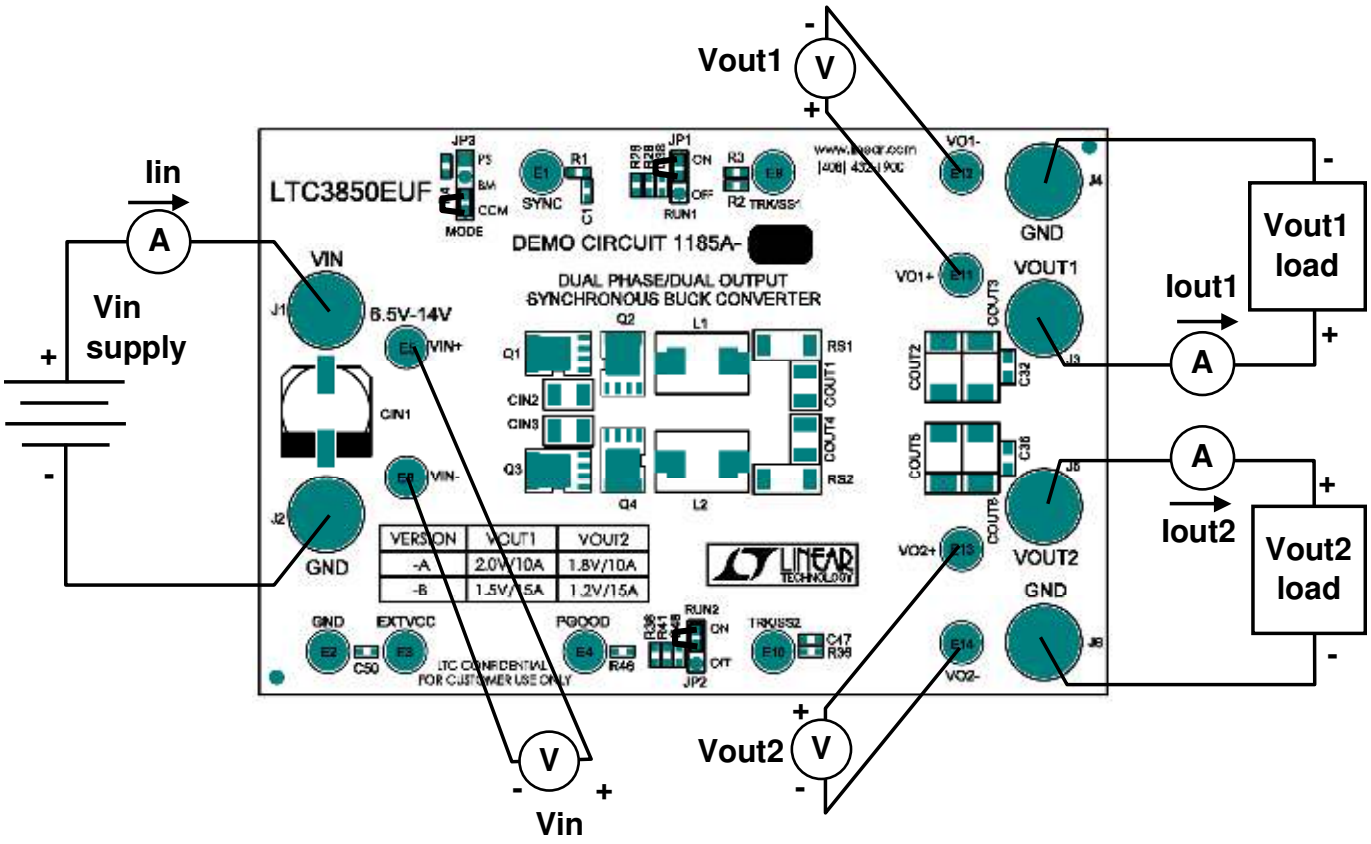


Figure 1. Proper Measurement Equipment Setup

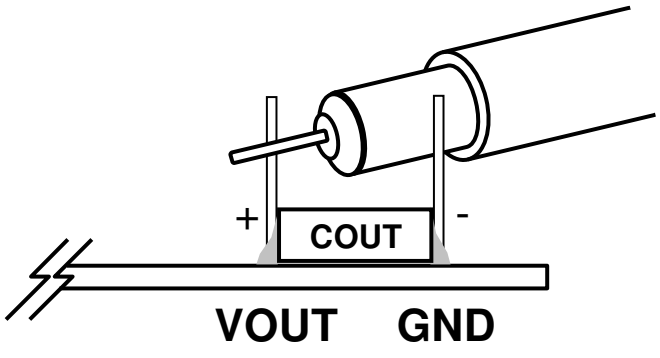


Figure 2. Measuring Output Voltage Ripple

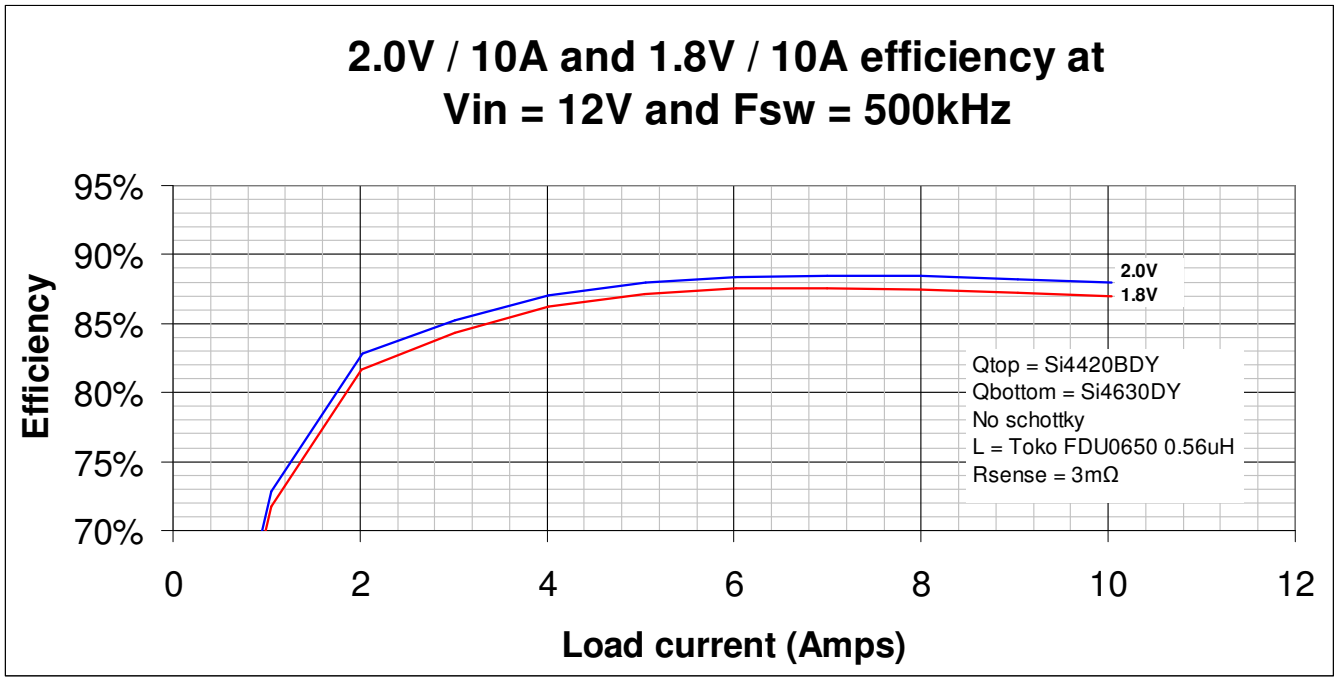


Figure 3. Efficiency Curves for the DC1185A-A.

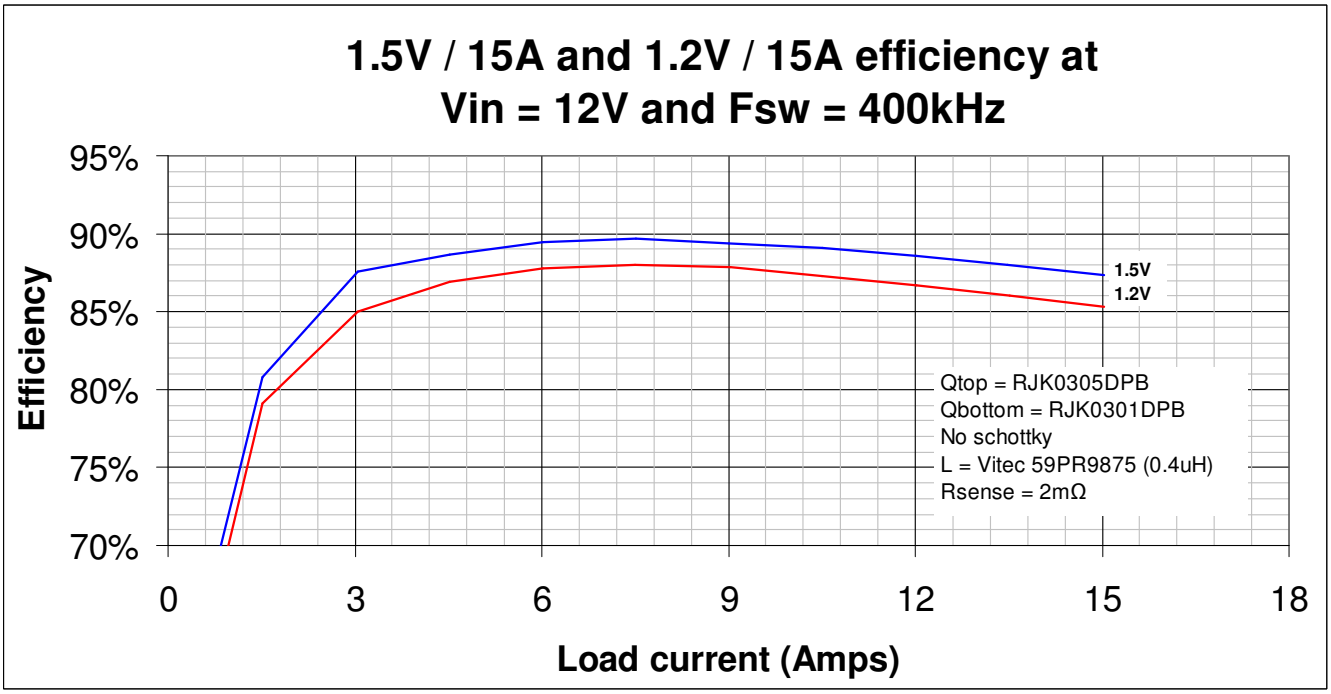
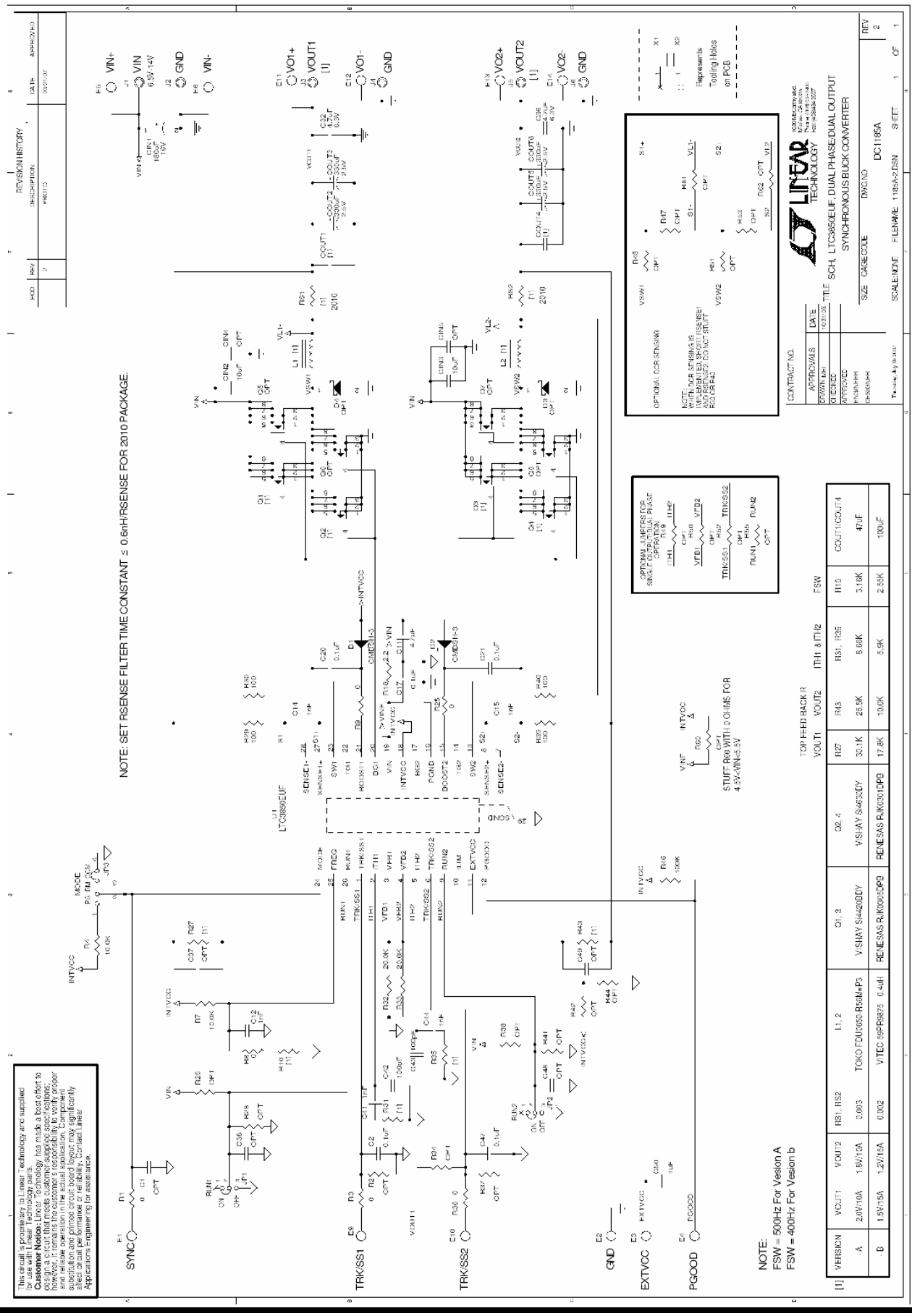


Figure 4. Efficiency Curves for the DC1185A-B.



[1] VERSION	VOUT1	VOUT2	RS1, RS2	L1, 2	Q1, 3	Q2, 4	R27	R43	R31, R35	R10	COUT1/COUT4
A	2.0V/10A	1.8V/10A	0.003	TOKO FDU3050-R5M=P3	VISHAY Si4420BDY	VISHAY Si4430DY	30.1K	25.5K	5.66K	3.16K	47uF
B	1.5V/15A	1.2V/15A	0.002	VITEC 59PR5875 0.4uH	RENESAS RJK0305DPB	RENESAS RJK0301DPB	17.8K	10.0K	5.9K	2.55K	100uF