

# QUICK START GUIDE FOR DEMONSTRATION CIRCUIT 610

## DUAL OUTPUT ISOLATED POWER SUPPLY

### LT3804, LT3781, and LTC1693-1

## DESCRIPTION

Demonstration circuit 610 is a dual output high efficiency isolated DC/DC power supply with 36V to 72V input range. It has two outputs: 3.3V at 15A max and 1.8V at 15A max. The LT3804, a secondary side dual output controller, is used to tightly regulate both outputs. True differential Kelvin sensing is used for each

output feedback amplifier to achieve high regulation accuracy. The complete design is mounted within a standard half brick PCB area with about half inch height.

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

**Table 1. Performance Summary ( $T_A = 25^\circ\text{C}$ )**

PARAMETER	CONDITION	VALUE
Minimum Input Voltage		36V
Maximum Input Voltage		72V
$V_{OUT1}$	$V_{IN} = 36\text{V to } 72\text{V}$ , $I_{OUT1} = 0\text{A to } 15\text{A}$ , $I_{OUT2} = 0\text{A to } 15\text{A}$	3.31V $\pm 2\%$
$V_{OUT2}$	$V_{IN} = 36\text{V to } 72\text{V}$ , $I_{OUT1} = 0\text{A to } 15\text{A}$ , $I_{OUT2} = 0\text{A to } 15\text{A}$	1.81V $\pm 2\%$
Typical Output Ripple $V_{OUT1}$	$V_{IN} = 48\text{V}$ , $I_{OUT1} = 15\text{A}$ (20MHz BW)	30mV <sub>P-P</sub>
Typical Output Ripple $V_{OUT2}$	$V_{IN} = 48\text{V}$ , $I_{OUT2} = 15\text{A}$ (20MHz BW)	15mV <sub>P-P</sub>
Output Regulation	Line	$\pm 0.1\%$
	Load	$\pm 0.2\%$
Nominal Switching Frequency		230kHz
Efficiency	$V_{IN} = 48\text{V}$ , $I_{OUT1} = I_{OUT2} = 15\text{A}$	85% Typical
	$V_{IN} = 48\text{V}$ , $I_{OUT1} = I_{OUT2} = 15\text{A}$ . With output current sense resistor R55=R49=0 ohm	87% Typical
Power Good (high)	Normal operation ( $V_{OUT1} = 3.3\text{V}$ and $V_{OUT2} = 1.8\text{V}$ )	9.3V Typical
On/Off Control	Logic Low Voltage-Off	0.6V MAX
	Logic High Voltage-On	1V MIN
Isolation Voltage	Basic Insulation	1500VDC

## OPERATING PRINCIPLES

Demonstration circuit 610 features the LT3804, LT3781 and LTC1693-1 controllers. The basic power stage topology is a two-switch forward converter with synchronous rectification. The primary side controller uses an LT3781, a current mode two-switch forward controller with built-in MOSFET drivers. On the secondary side, the LT3804 is used to provide the voltage feedback for the 3.3V output (Vo1). The output from the built-in opto-coupler driver is fed into an opto-coupler (MOC207) and then transferred to LT3781 on the primary side to complete the 3.3V regulation. An LTC1693-1 high speed dual N-channel MOSFET driver provides the gate driving for the synchronous MOSFETs at the 3.3V output stage. The LTC1693-1 driver's input signals come from SG and BG outputs of the LT3781 through two small gate drive transformers (T2 and T3).

The LT3804 also precisely regulates the 1.8V output (Vo2) by further reducing and controlling the duty cycle of the switching waveform from the power transformer (T1) secondary winding. In fact, the 1.8V circuit is a special synchronous buck converter whose input is a pulsed waveform instead of a DC voltage.

True differential remote sensing is provided for both outputs to achieve high regulation accuracies. Power good indicator PGOOD, will be high only if both outputs are within +/-10% of their nominal values.

The LT3804 provides output current limit function for both 1.8V and 3.3V outputs. The current limits for 3.3V and 1.8V outputs are estimated to be 50mV/R55 and 50mV/R49, respectively.

A planar transformer PA0191 by Pulse Engineering is employed as the power transformer in this design. This transformer is constructed on a PQ20 core with nine turns of primary windings, two turns of secondary windings and seven turns of auxiliary windings for the LT3781 bias supply. Si7892DP MOSFETs are selected for the secondary side due to their low Rds (on), 30V V<sub>DSS</sub> rating and the compact and thermally enhanced Power-Pak SO-8 package.

The switching frequency of the circuit is about 230KHz. 1500V input to output isolation is provided. Additional features of this design include primary side on/off control, input over voltage protection, under voltage lockout, soft start and board over temperature shutdown.

Without airflow, the hottest spot on the demo board has a temperature rise about 75°C at 48Vin and full loads. Airflow is required at heavy load with elevated temperature operation.

## QUICK START PROCEDURE

Demonstration circuit 610 is easy to set up to evaluate the performance of the LT3804, LT3781, and LTC1693-1. Refer to Figure 1 for proper measurement equipment setup and follow the procedure below:

**NOTE:** When measuring the input or output voltage ripple, care must be taken to avoid a long ground lead on the oscilloscope probe. Measure the input or output voltage ripple by touching the probe tip directly across the Vin or Vout and GND terminals. See Figure 2 for proper scope probe technique.

1. With power off, connect the input power supply to +Vin (36V-72V) and -Vin (input return).
2. The on/off control pin should be left open for normal operation. (Connecting the on/off pin to the -Vin will turn off the converter.)
3. Connect the 3.3V load (Load 1 in Figure 1) between +Vo1 and Vo RTN; connect the 1.8V load (Load 2 in Figure 1) between +Vo2 and Vo RTN. (Initial loads: no load.)

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4. Connect remote sense pins to loads: Vo1s+ to load 1+; Vo1s- to load 1-; Vo2s+ to load 2+; Vo2s- to load 2- (see Figure 1).

Note: If remote sense function is not used, then connect Vo1s- and Vo2s- to Vo RTN; connect Vo1s+ to +Vo1; and connect Vo2s+ to +Vo2.

5. Connect the DVMs to the input and outputs.

6. Turn on the input power supply and check for the proper output voltages. Vo1 should be 3.31V+/-2%. Vo2 should be 1.81V+/-2%.

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

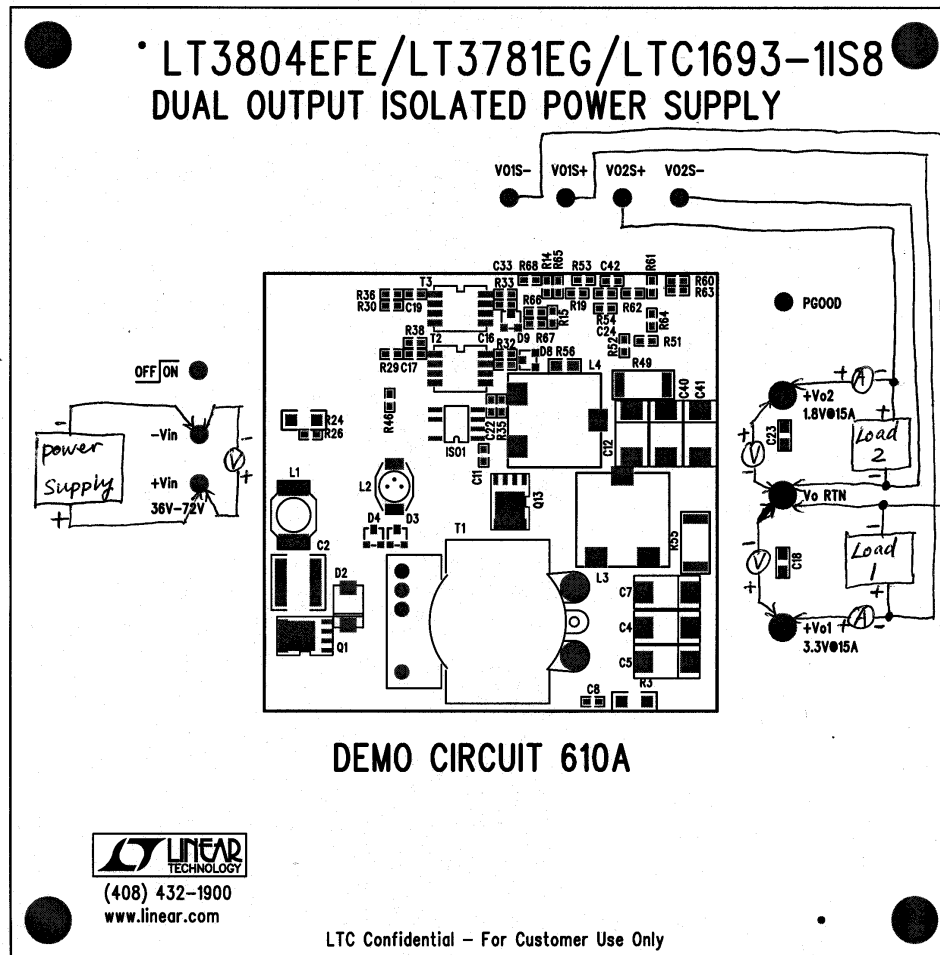


Figure 1. Proper Measurement Equipment Setup

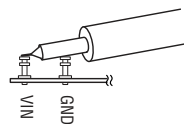
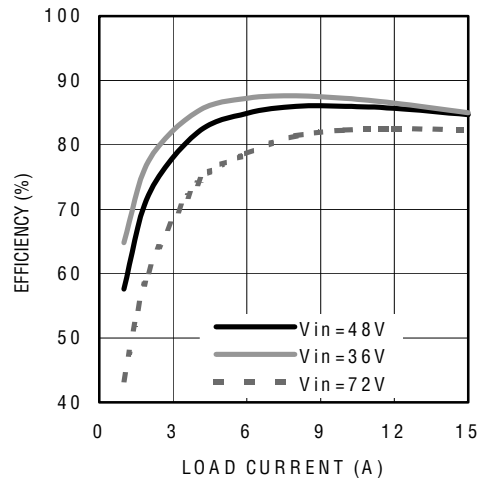


Figure 2. Measuring Input or Output Ripple



**Figure 3. Efficiency vs load current ( $I_{o1}=I_{o2}$ )**