DESCRIPTION

Demonstration circuit 776 is a 36V-72Vin, forward converter featuring the LTC3705 and LTC3706. This circuit was designed specifically to attain a high step-down ratio power supply in one stage in order to efficiently power 1.5V loads from a typical telecom input voltage range. Isolation voltage is 1500VDC. This circuit features secondary-side control of the supply without the need of an optocoupler, self-starting architecture, input undervoltage lockout, and output overvoltage protection.

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		36V
Maximum Input Voltage		72V
Output Voltage V_{OUT}	V_{IN} = 36V to 72V, I_{OUT} = 0A to 45A, 400LFM	1.5V ± 1%
Maximum Output Current	400LFM	45A
	200LFM	40A
Typical Output Ripple V_{OUT}	V_{IN} = 48V, I_{OUT} = 30A (20MHz BW)	$30mV_{P-P}$
Output Regulation	Line	±0.01%
	Load	±0.18%
Dynamic Response	Peak Deviation	65mV
	Load Step of 20A to 40A (1A/us min)	
	Settling Time (to within 15mV of set point)	50us
Nominal Switching Frequency		215kHz
Efficiency	V_{IN} = 48V, I_{OUT} = 45A, 400LFM	84.75% Typical
On/Off Control	Logic Low Voltage-Off	1V MAX
	Logic High Voltage-On	2.5V MIN
Isolation Voltage	Basic Insulation	1500VDC

OPERATING PRINCIPLES

The LTC3706 controller is used on the secondary and the LTC3705 driver with self-starting capability is used on the primary. When an input voltage is applied, the LTC3705 begins a controlled soft-start of the output voltage. As this voltage begins to rise, the LTC3706 secondary controller is quickly powered up via T1, D3, and Q13. The LTC3706 then assumes control of the output voltage by sending encoded

PWM gate pulses to the LTC3705 primary driver via the small signal transformer, T3. The LTC3705 then operates as a simple driver receiving both input signals and bias power through T3.

The transition from primary to secondary control occurs seamlessly at a fraction of the output voltage. From that point on, operation and design simplifies to that of a simple buck converter. Secondary sensing eliminates delays, tames large-signal overshoot and reduces output capacitance. This, while utilizing off-the-shelf magnetics and attaining high efficiency.

For large values of input inductance, a 100V, 47uF electrolytic capacitor can be added across the input terminals to damp the input filter and provide adequate stability. See Linear Technology Application Note AN19 for a discussion on input filter stability analysis. A recommended part is the Sanyo 100MV39AX.

QUICK START PROCEDURE

Demonstration circuit 776 is easy to set up to evaluate the performance of the LTC3705 and LTC3706. 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 output (or input) voltage ripple by touching the probe tip and probe ground directly across the +Vout and –Vout (or +Vin and –Vin) terminals. See Figure 2 for proper scope probe technique.

1. Set an input power supply that is capable of 36V to 72V to a voltage of 36V. Then turn off the supply.
2. With power off, connect the supply to the input terminals +Vin and –Vin.
   a. Input voltages lower than 36V can keep the converter from turning on due to the undervoltage lockout feature of the LTC3705.
   b. If efficiency measurements are desired, an ammeter capable of measuring 3Adc can be put in series with the input supply in order to measure the DC776A's input current.
   c. A voltmeter with a capability of measuring at least 72V can be placed across the input terminals in order to get an accurate input voltage measurement.
3. Turn on the power at the input.

   NOTE: Make sure that the input voltage never exceeds 72V.
4. Check for the proper output voltage of 1.5V ± 1%. Turn off the power at the input.
5. Once the proper output voltages are established, connect a variable load capable of sinking 50A at 1.5V to the output terminals +Vout and –Vout. Set the current for 0A.
   a. If efficiency measurements are desired, an ammeter or a resistor shunt that is capable of handling 50Adc can be put in series with the output load in order to measure the DC776A's output current.
   b. A voltmeter with a capability of measuring at least 2V can be placed across the output terminals in order to get an accurate output voltage measurement.
6. Turn on the power at the input.

   NOTE: 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 again established, adjust the load within the operating range and observe the output voltage regulation, ripple voltage, efficiency and other desired parameters.

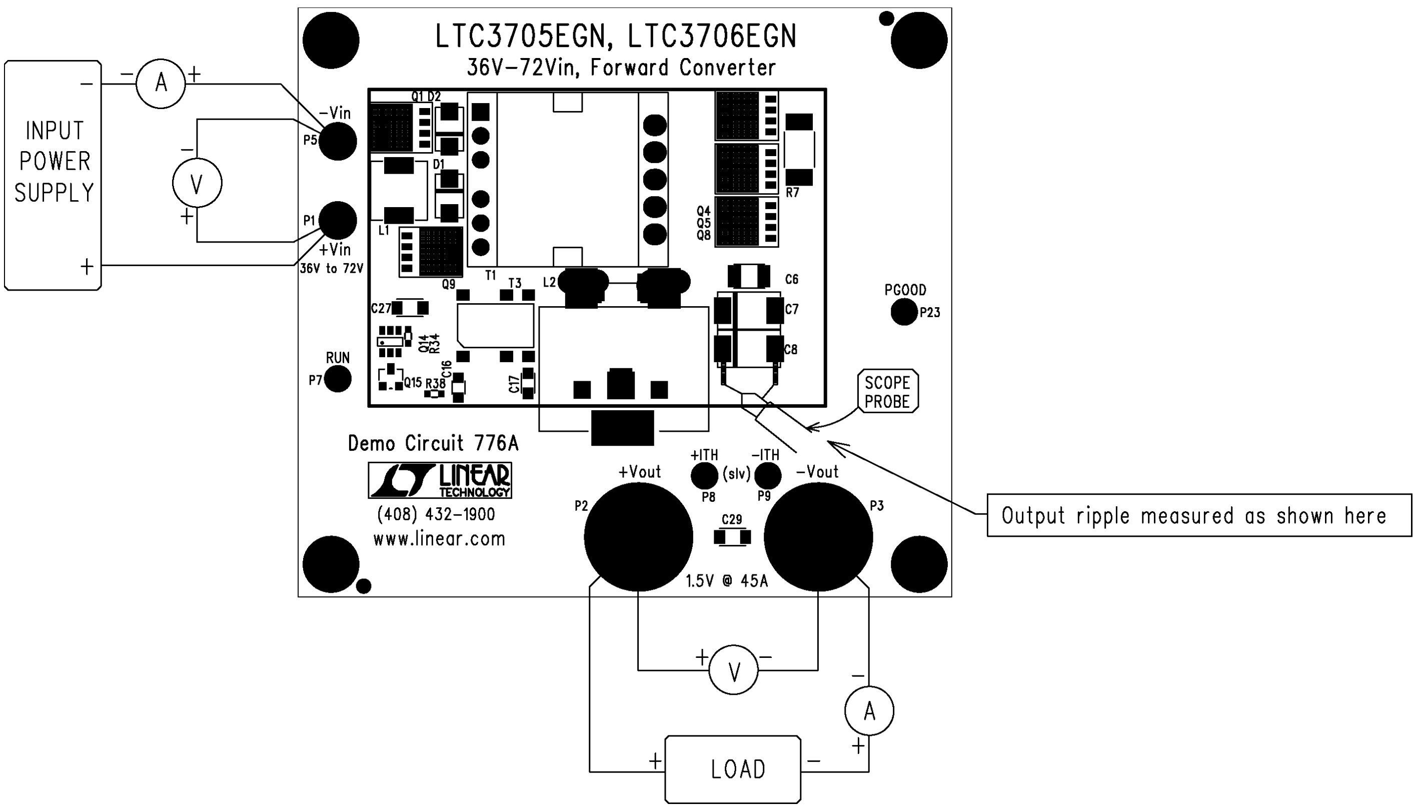


Figure 1. Proper Measurement Equipment Setup

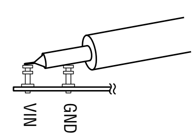


Figure 2. Measuring Input or Output Ripple

MEASURED DATA

Figures 3 through 13 are measured data for a typical DC776A.

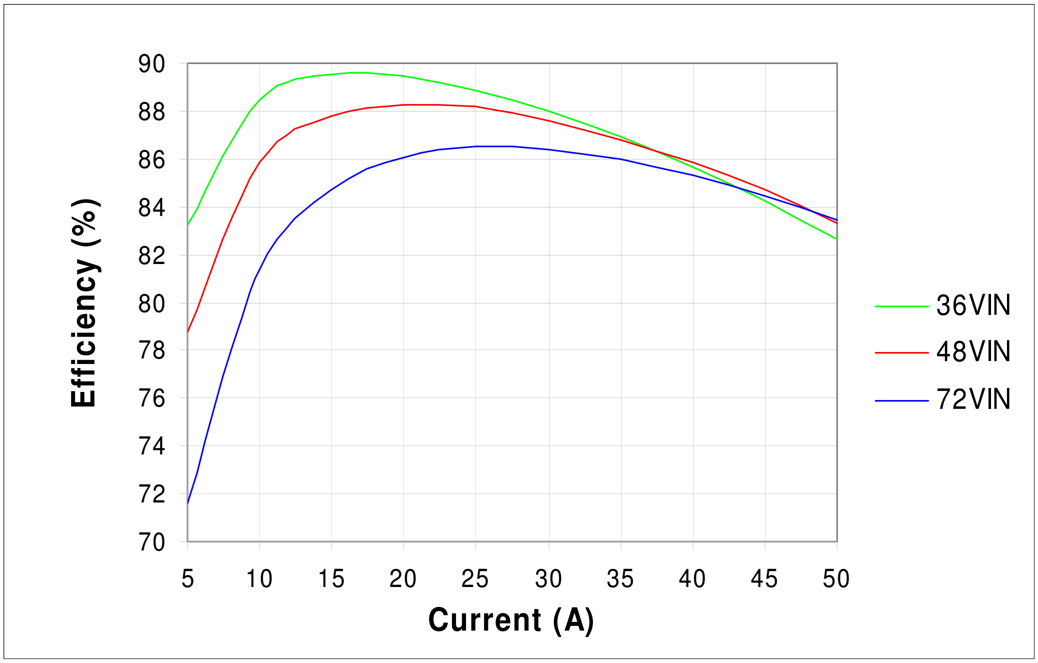


Figure 3. Efficiency (400LFM)

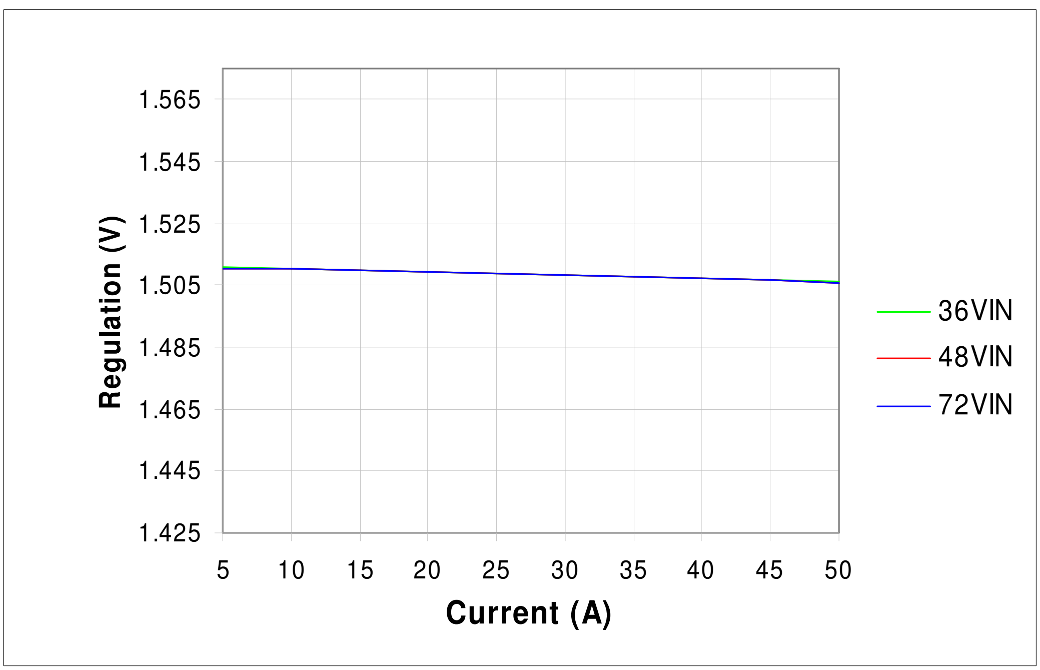


Figure 4. Regulation (400LFM)

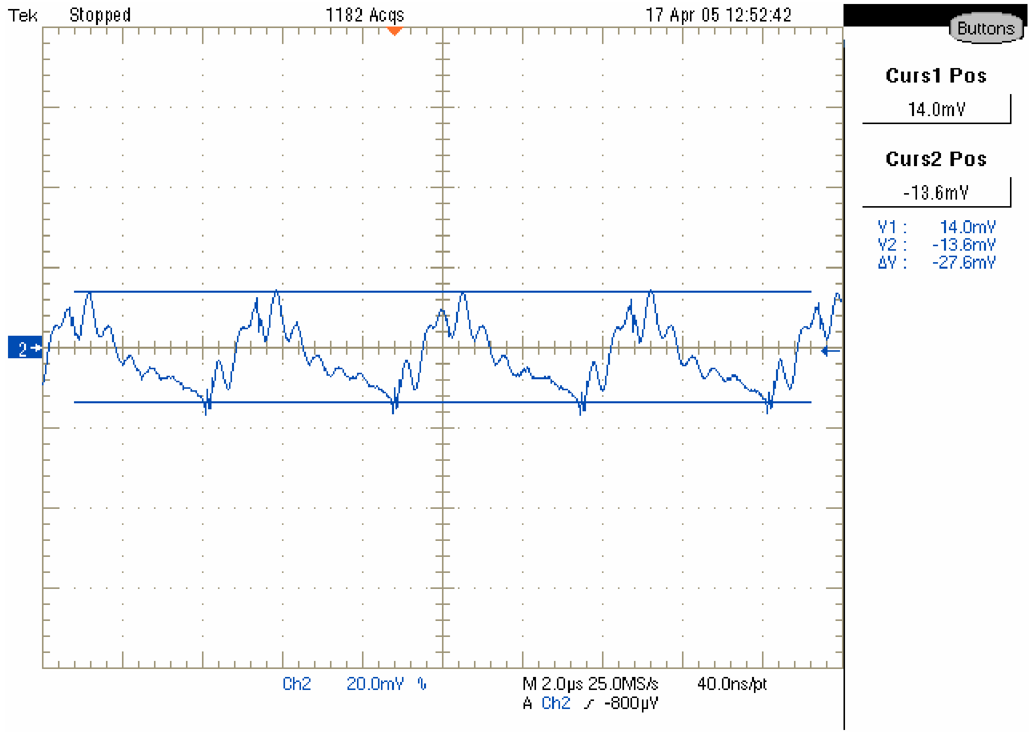


Figure 5. Output Voltage Ripple (72Vin and 50A)

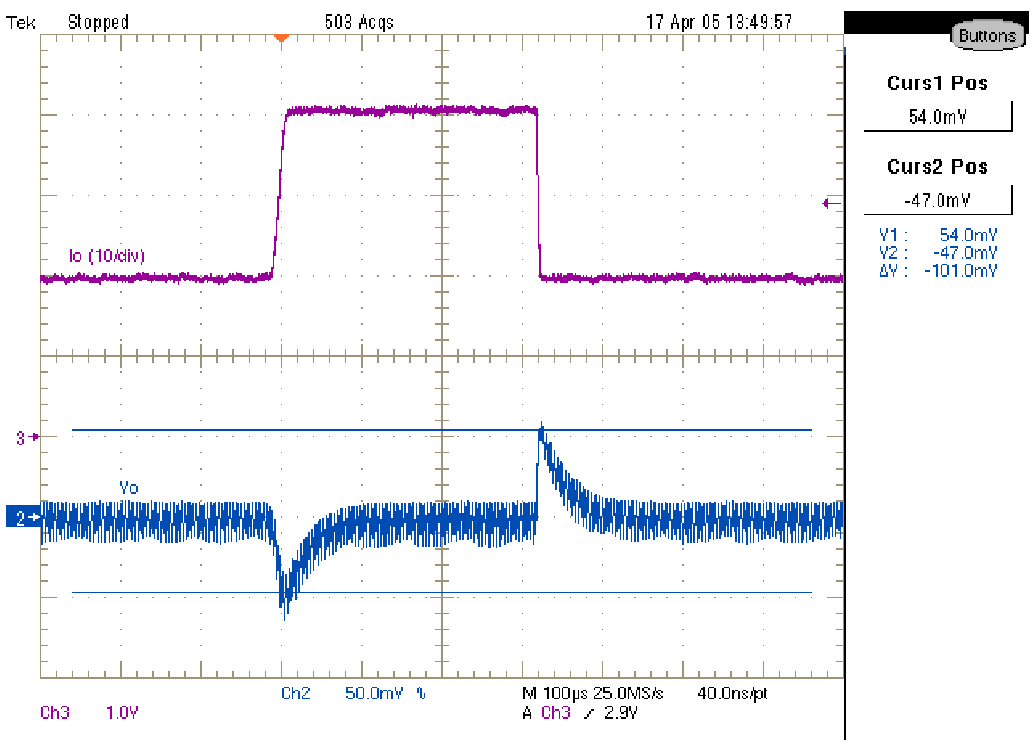


Figure 6. Load Transient Response (>1A/us)

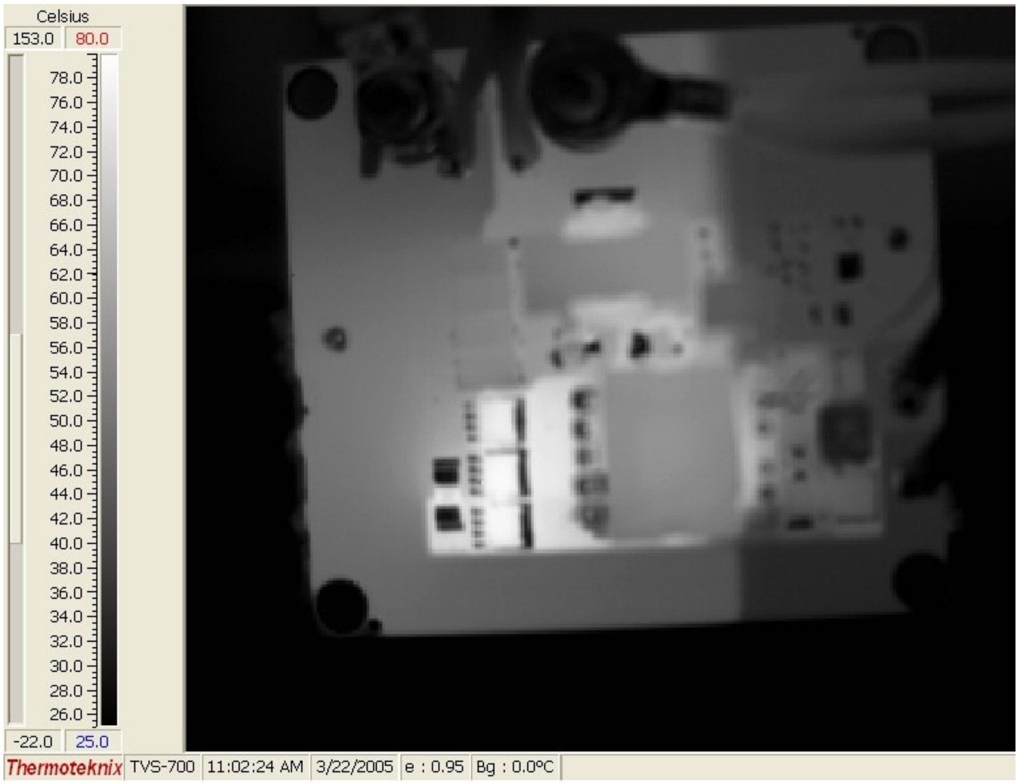


Figure 7. Temp Data (48Vin, 45A, 400LFM – front)

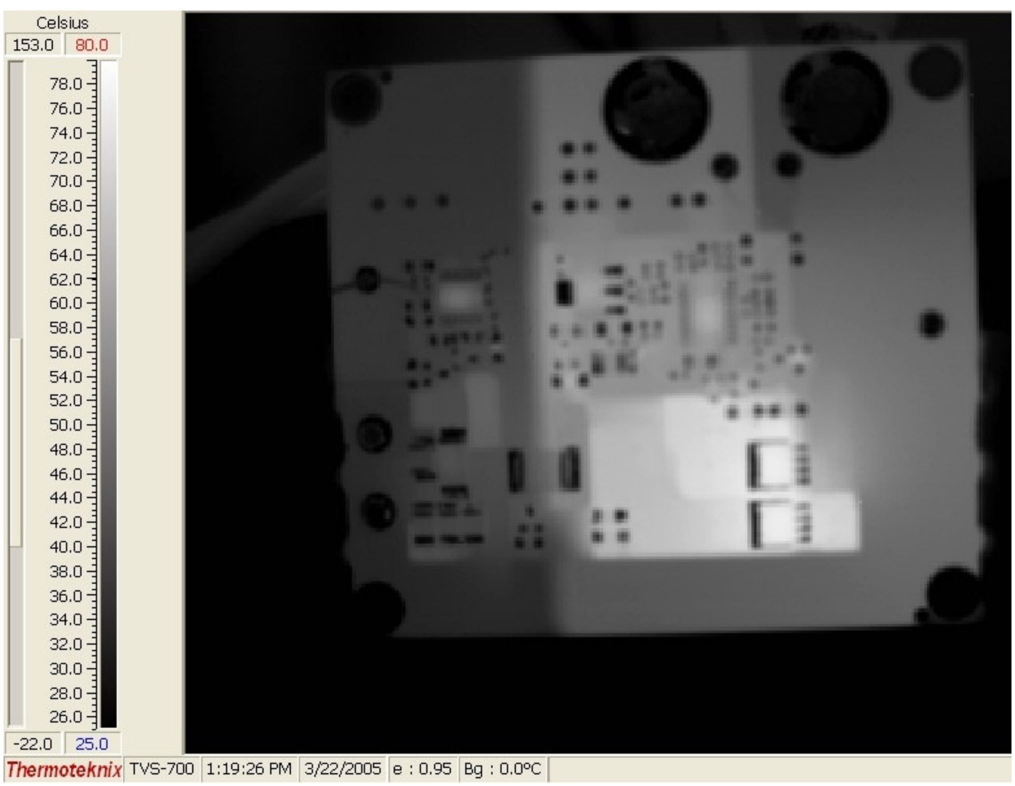


Figure 8. Temp Data (48Vin, 45A, 400LFM – back)

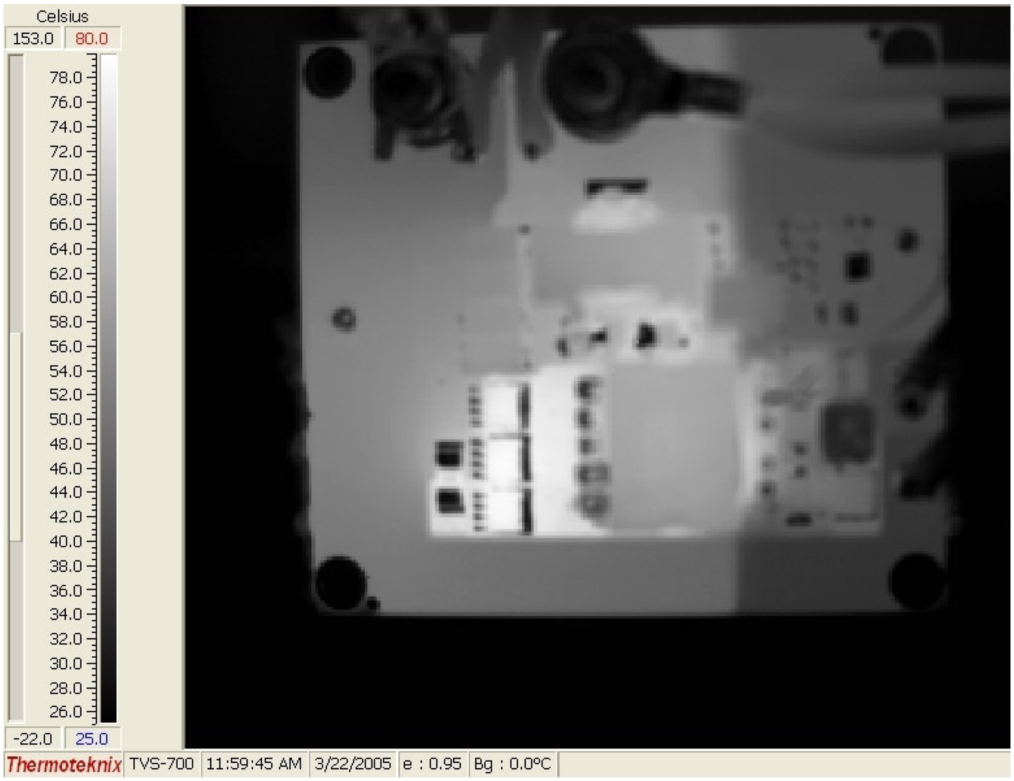


Figure 9. Temp Data (48Vin, 40A, 200LFM – front)

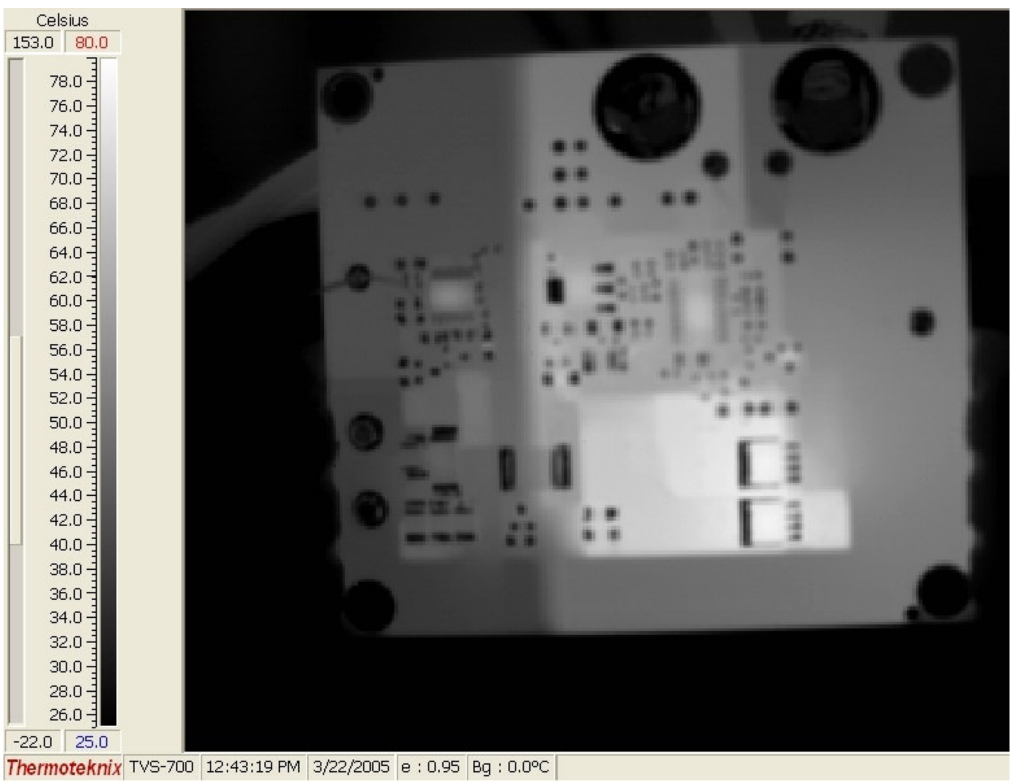


Figure 10. Temp Data (48Vin, 40A, 200LFM – back)

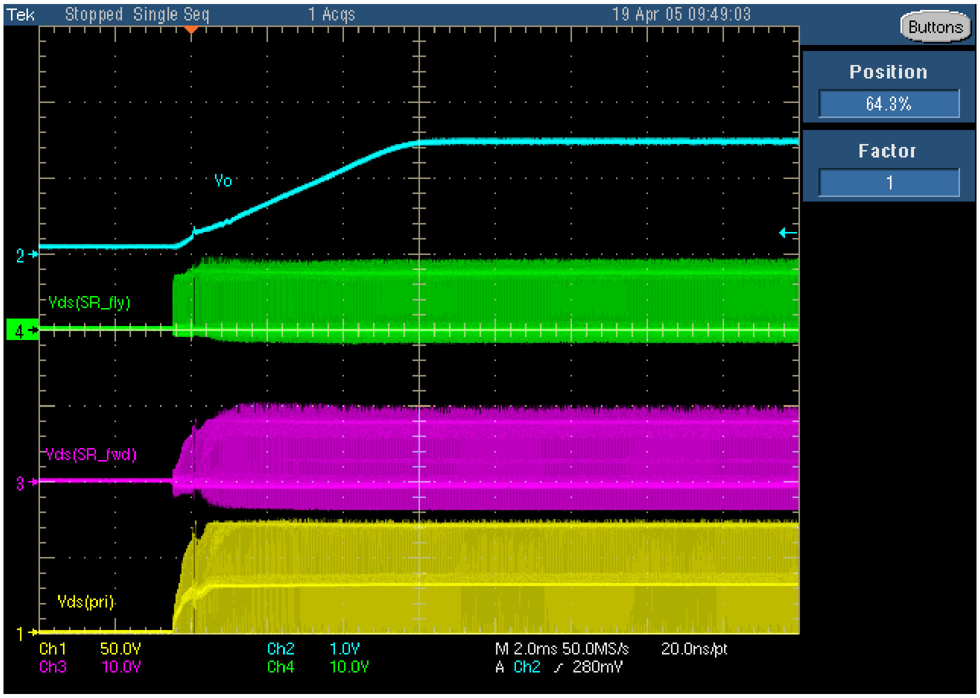


Figure 11. Turn-on Waveforms (72Vin and 50A)

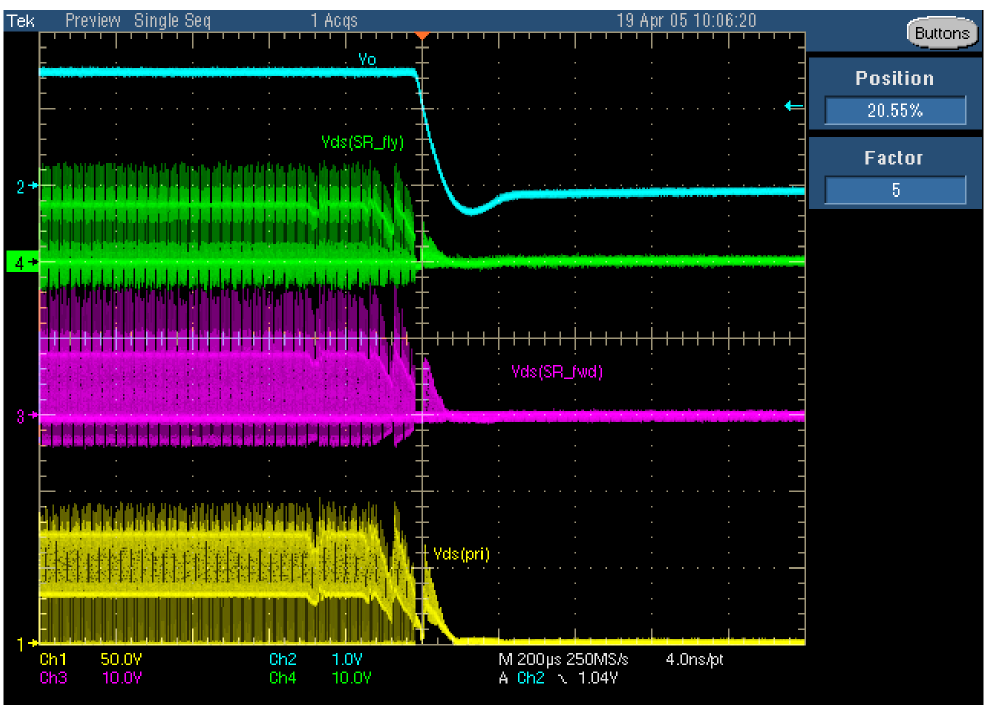


Figure 12. Turn-off Waveforms (72Vin and 50A)

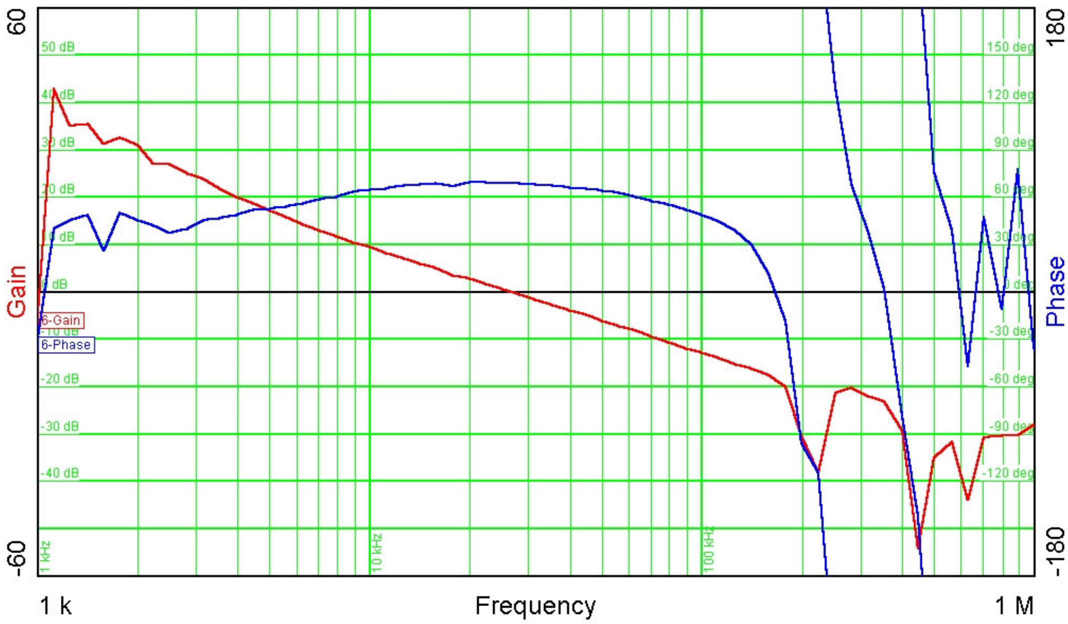
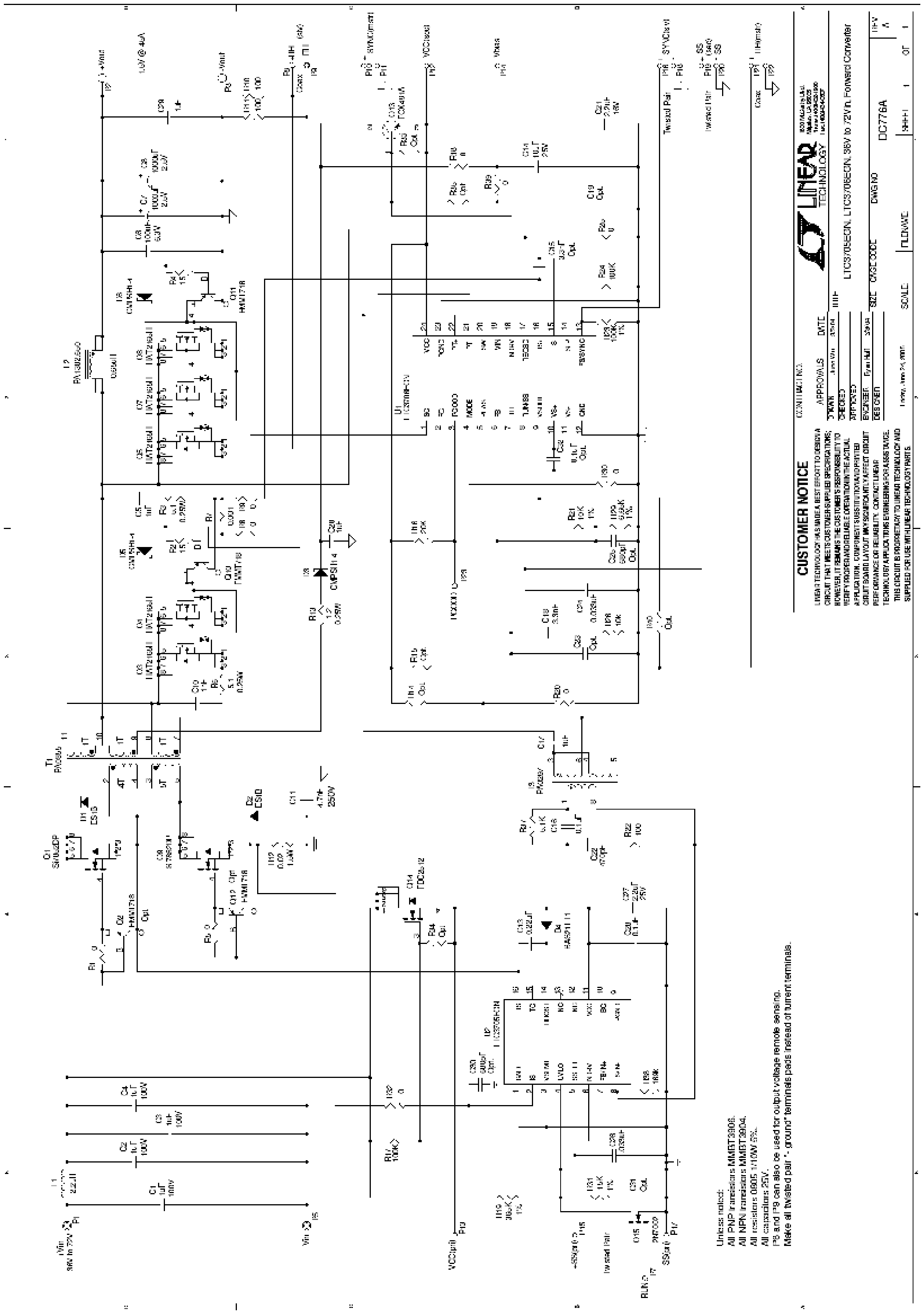


Figure 13. Control Loop Bode Plot (48Vin and 20A)


CUSTOMER NOTICE
LTC3705EGN, LTC3706EGN, 36V to 72Vin, Forward Converter
DC776A
Unless noted:
All PNP transistors MMBT3906.
All NPN transistors MMBT3904.
All resistors 0805 1/10W 5%.
All capacitors 25V.
P8 and P9 can also be used for output voltage remote sensing.
Make all twisted pair "-" ground terminals pads instead of turrent terminals.