LT3748
100V Isolated Flyback Converter

DESCRIPTION

Demonstration circuit 1745A is an isolated flyback converter featuring the LT3748 controller for high input voltage applications. It is designed for a 15V output at up to 3A from a 100V to 400V DC input. The part senses the isolated output voltage from the third winding of the flyback transformer during the off time of the power switch. No opto-coupler or signal transformer is required for regulation. A minimum load of approximately 150mA is required on the output of the circuit to maintain regulation.

Optionally, the demo circuit can be powered from a universal offline input (85V~265V, 50/60Hz) using the AC input terminals. Provisions for an EMI filter and surge protection are provided in the demo circuit. The EMI filter is designed to meet the EN55022 Class B standard. The table below summarizes the performance.

The demo circuit can be easily modified for applications requiring different output voltages/currents from either an AC or DC input. Some pre-designed EFD25, EF16, and EF25 transformers from vendors such as Würth Electronics, Sumida, Pulse Engineering and Coilcraft can be assembled on the board. Some of these transformers are listed in Table 1.

The LT3748 is a high input voltage isolated flyback controller that eliminates the need for an optocoupler and secondary-side reference voltage, all while maintaining isolation between the primary and secondary-side with only one part, the transformer, having to cross the isolation barrier. The LT3748 is well suited for a wide variety of industrial, automotive, medical, telecom, datacom applications, where regulated isolated output is required.

The LT3748 datasheet gives a complete description of the part, operation and application information. The datasheet should be read in conjunction with this quick start guide for Demonstration Circuit 1745A before powering the demo circuit.

Design files for this circuit board are available at http://www.linear.com/demo

PERFORMANCE SUMMARY (T_A = 25°C)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Minimum Input DC Voltage	I_{OUT} = 3A		100		V
Maximum Input DC Voltage	I_{OUT} = 3A		400		V
Typical Start-Up DC Input Voltage Set by UVLO			70		V
Typical Shutdown DC Input Voltage Set by UVLO			60		V
Minimum Input AC Voltage	Line Frequency, 50Hz/60Hz		85		VAC (RMS)
Maximum Input AC Voltage	Line Frequency, 50Hz/60Hz		265		VAC (RMS)
Output Voltage, V_{OUT}	V_{IN} = 100V ~ 400V (DC), I_{OUT} = 150mA ~ 3A		15 ±5%		V
Output Current, I_{OUT}	V_{IN} = 100V ~ 400V (DC)		3		A
Minimum Load Current with Regulated Output, I_{MIN}			150		mA
Typical Efficiency with DC INPUT	V_{IN} = 100V ~ 400V (DC), I_{OUT} = 3A		87		%
Typical Efficiency with AC INPUT	V_{IN} = 85V ~ 265V (AC), I_{OUT} = 3A		84		%
Maximum Ripple Voltage, V_{P-P}	V_{IN} = 400V (DC), I_{OUT} = 3A		750		mV
Maximum Switching Frequency at Full Load	V_{IN} = 400V (DC), I_{OUT} = 3A		155		kHz
Minimum Switching Frequency at Full Load	V_{IN} = 100V (DC), I_{OUT} = 3A		55		kHz

PERFORMANCE SUMMARY

Table 1. Pre-Designed Transformers for High Voltage Applications with LT3748

TRANSFORMER PART NUMBER	MAGNETIC CORE	L_{PRI} (µH)	L_{LEAK} (nH)	N_{PSA} (N_P:N_S:N_A)	R_{PRI} (mΩ)	R_{SEC} (mΩ)	TARGET APPLICATION		PEAK CURRENT I_{SAT} (A)
							INPUT (V)	OUTPUT	
750311715	EFD25	280	4000	10:1:1	300	20	60 ~ 600	15V/2A	2.5
750311771	EFD25	500	5000	6:1:1	450	15	100 ~ 400	15V/3A	2.5
10393-T029	EFD25	400	6500	7:1:1	300	15	100 ~ 400	12V/3.5A	2.2
750311715	EFD25	280	4000	10:1:1	300	20	60 ~ 600	15V/2A	2.5
750811048	EE16	1500	14000	4.4:1:0.5	2900	210	120 ~ 375	30V/0.3A	0.65
750811050	EE16	1500	30000	4:1:0.3	4900	550	100 ~ 400	48V/0.2A	0.65
7508110117	EE16	650	20000	9:1:2.45	2400	65	100 ~ 400	5V/2A	0.88
7508110313	EE16	1400	30000	6:1:1	4900	185	100 ~ 400	15V/0.6A	0.54

QUICK START PROCEDURE

IMPORTANT NOTE TO CUSTOMERS

HIGH VOLTAGES ARE PRESENTED ON THE DEMO CIRCUIT, AND CAN LEAD TO LETHAL INJURIES TO HUMAN BODY. ONLY QUALIFIED PERSONEL SHOULD OPERATE IT. IT IS STRONGLY RECOMMENDED TO USE SAFETY GLASSES AND AN ISOLATION TRANSFORMER.

Demonstration Circuit 1745A can be set up to evaluate the performance of the LT3748 with high input voltages.

NOTE. IMPROPER COMPONENTS REPLACEMENT ON THE DEMO CIRCUIT CAN CAUSE PERFORMANCE DETERIORATIONS, CIRCUIT MALFUNCTION, PROPERTY DAMAGE, AND EVEN LIFE-THREATHENING INJURIES. CONTACT LINEAR TECHNOLOGY APPLICATIONS ENGINEERS FOR PROPER COMPONENT REPLACEMENT.

A) HIGH DC VOLTAGE APPLICATIONS

Refer to Figure 1 for proper measurement equipment setup for DC inputs applications. It is suggested that the DC power supply be connected to the VIN and GND ports on the upper left of the demo circuit. Follow the procedure below.

1. With power off, connect the DC input power supply to VIN and GND on the board (Refer to Figure 1).

   NOTE. MAKE SURE THAT PROPER INPUT PORTS ARE USED. For DC INPUT, USE V_{IN} AND GND PORTS ON THE UPPER LEFT SIDE OF THE DEMO CIRCUIT.

   NOTE. Make sure to use DC power supply with right voltage and current capability and current limit function.

2. Connect the load to the terminals V_{OUT}^+ and V_{OUT}^- on the output terminals of the board. Apply 150mA load to the output.

3. Turn on the power at the input. Increase the input voltage to minimum as specified in Performance Summary Table (which is 100V for DC input).

   NOTE. Make sure that the input voltage does not exceed the maximum voltage specified in Performance Summary Table (which is 400V for DC input). Exceed this limit might damage the demo circuit.

4. Check for the proper output voltages. The output should be regulated at 15V (±5%).

   NOTE. If there is no output, temporarily disconnect the power supply. Make sure that the load is connected with correct polarity. Make sure to connect the power source to the correct input ports. If the output voltage is out

Figure 1. Demo Board Setup

QUICK START PROCEDURE

of spec, make sure minimum load current is applied to the output, the load is not set too high, and the current of power supply is below current limit.

5. Once the proper output voltage is established, adjust the input and load within the operating range and observe the output voltage regulation, ripple voltage, efficiency and other parameters.

   NOTE. When measuring the output voltage ripples, care must be taken to avoid a long ground lead on the oscilloscope probe. Measure the output voltage ripple by touching the probe tip directly across the V_{OUT}^+ and V_{OUT}^- terminals. See Figure 3 for proper scope probe technique.

Typical operation waveforms, regulation and efficiency curves are shown in Figures 4, 5 and 6.

B) HIGH AC VOLTAGE APPLICATIONS

Optionally, this demo circuit 1745A can be used for off-line applications with universal ac inputs (85V ~ 265V). Refer to Figure 2 for proper measurement equipment setup. Follow the procedure below.

1. With power off, connect the AC power supply to the AC input connector on the board (Refer to Figure 2).

   NOTE. Make sure that ONLY AC input ports are used. For AC input, use Line and NEUT ports on the lower left side of the board. Connect AC voltages to DC input port will damage the demo circuit.

2. Connect the load to the terminals V_{OUT}^+ and V_{OUT}^- on the board. Apply 150mA load to the output terminals.

3. Turn on the power at the input. Increase the input voltage to minimum as specified in Performance Summary Table (which is $85V_{RMS}$ for AC input).

   NOTE. Make sure that the input voltage does not exceed the maximum voltage specified in Table on Performance Summary (which is $265V_{RMS}$ for AC input).

4. Check for the proper output voltages. The output should be regulated at 15V (±5%).

   NOTE. If there is no output, temporarily disconnect the power supply. Make sure that the load is connected with correct polarity. Make sure you connect the power source to the correct input ports. If the output voltage is out of spec, make sure minimum load current is applied to the output, the load is not set too high, and the current of power supply is below current limit.

5. Once the proper output voltage is established, adjust the input and load within the operating range and observe the output voltage regulation, ripple voltage, efficiency and other parameters.

   NOTE. When measuring the output voltage ripples, care must be taken to avoid a long ground lead on the oscilloscope probe. Measure the output voltage ripple by touching the probe tip directly across the V_{OUT}^+ and V_{OUT}^- terminals. See Figure 3 for proper scope probe technique.

   NOTE. When doing the short-circuit test, make sure to short the output with very short wires to exclude any parasitic inductance of the short-circuit.

QUICK START PROCEDURE

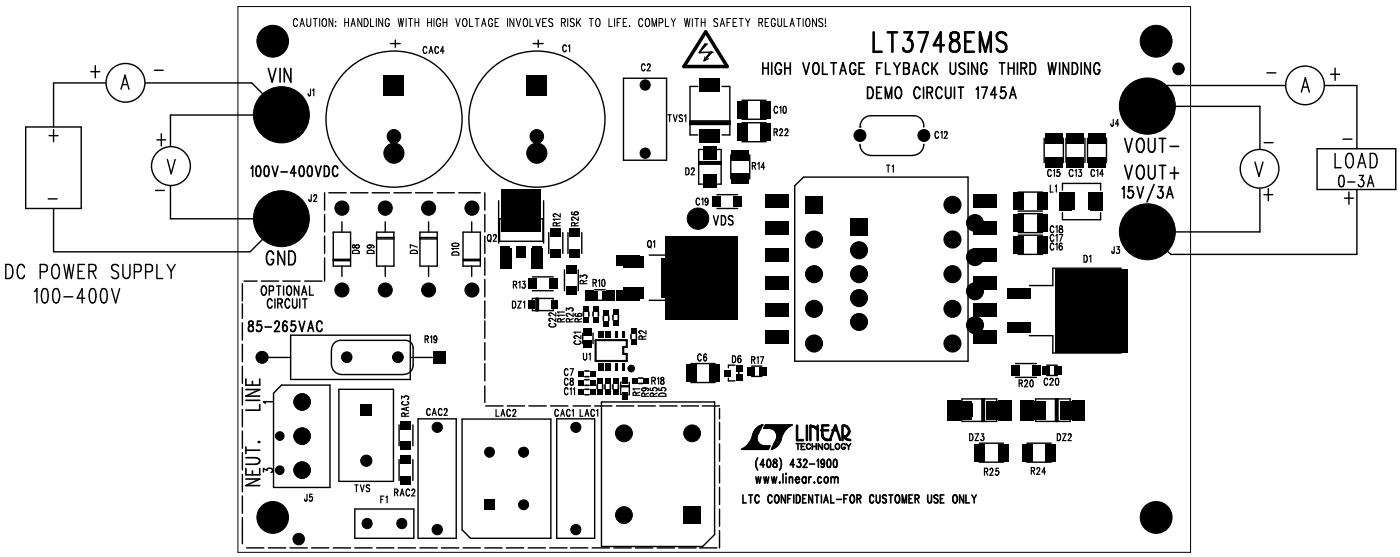


Figure 1. Proper Measurement Equipment Setup for DC Input

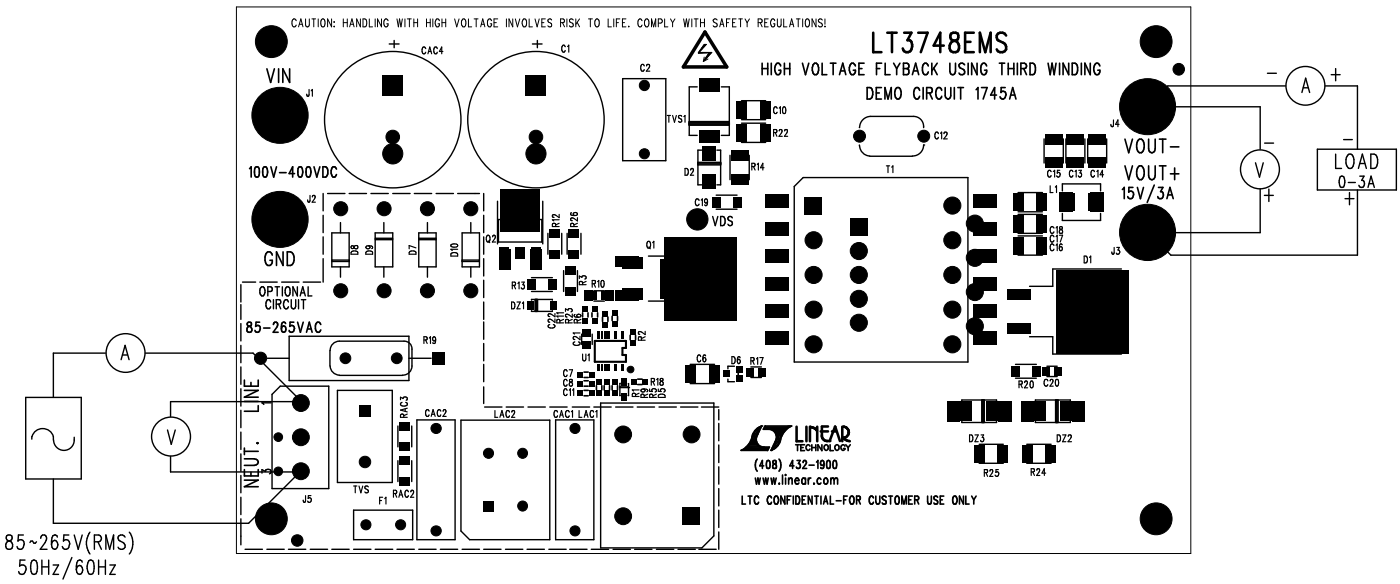


Figure 2. Proper Measurement Equipment Setup for AC Input

QUICK START PROCEDURE

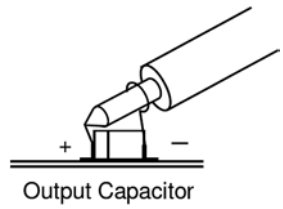


Figure 3. Proper Scope Probe Placement for Measuring Output Ripple

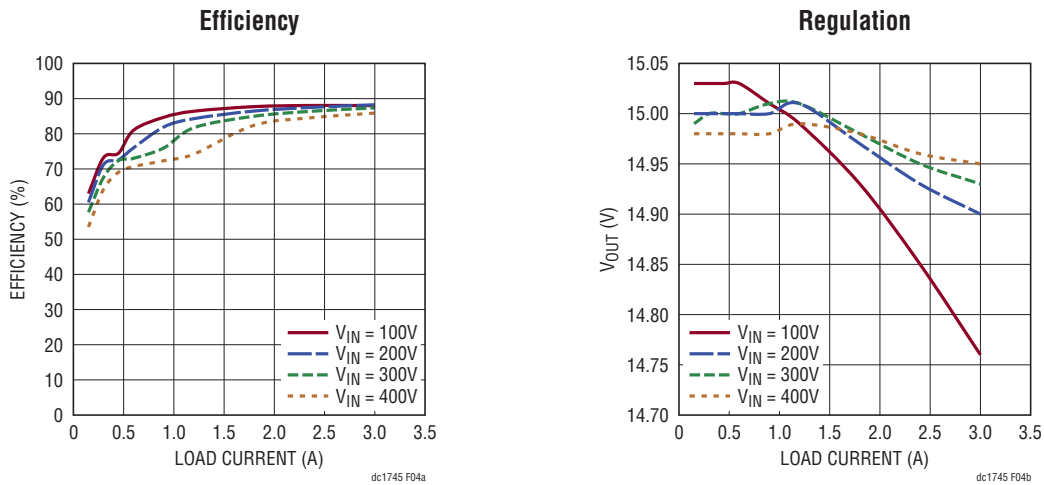
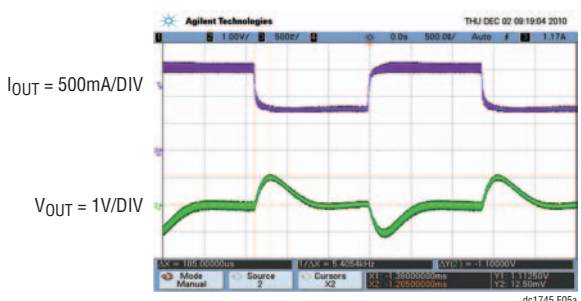


Figure 4. Typical Curves of Efficiency and Regulations

QUICK START PROCEDURE



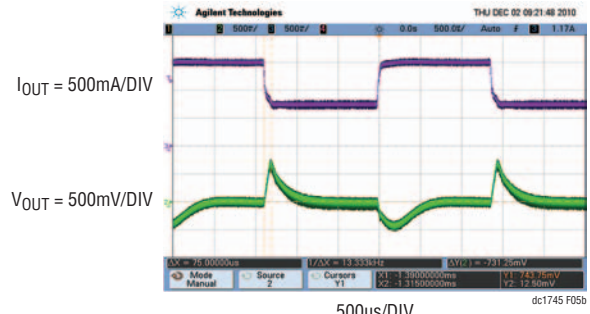
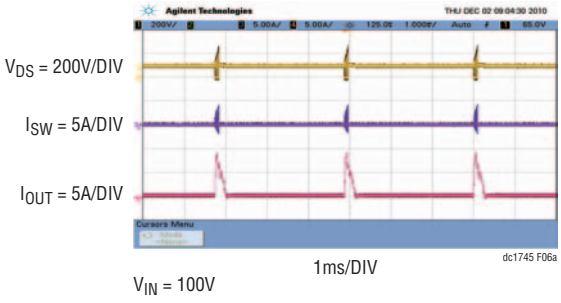


Figure 5. Transient with 0.75A to 1.5A at 100V and 400V Input



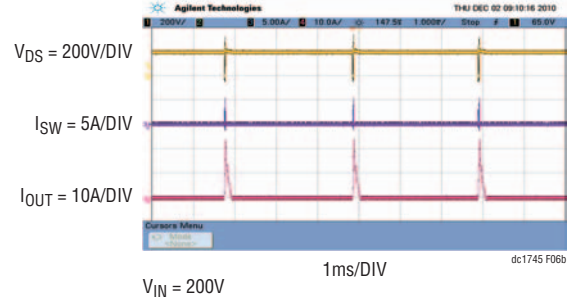


Figure 6. Typical Waveforms for Short Circuit Conditions

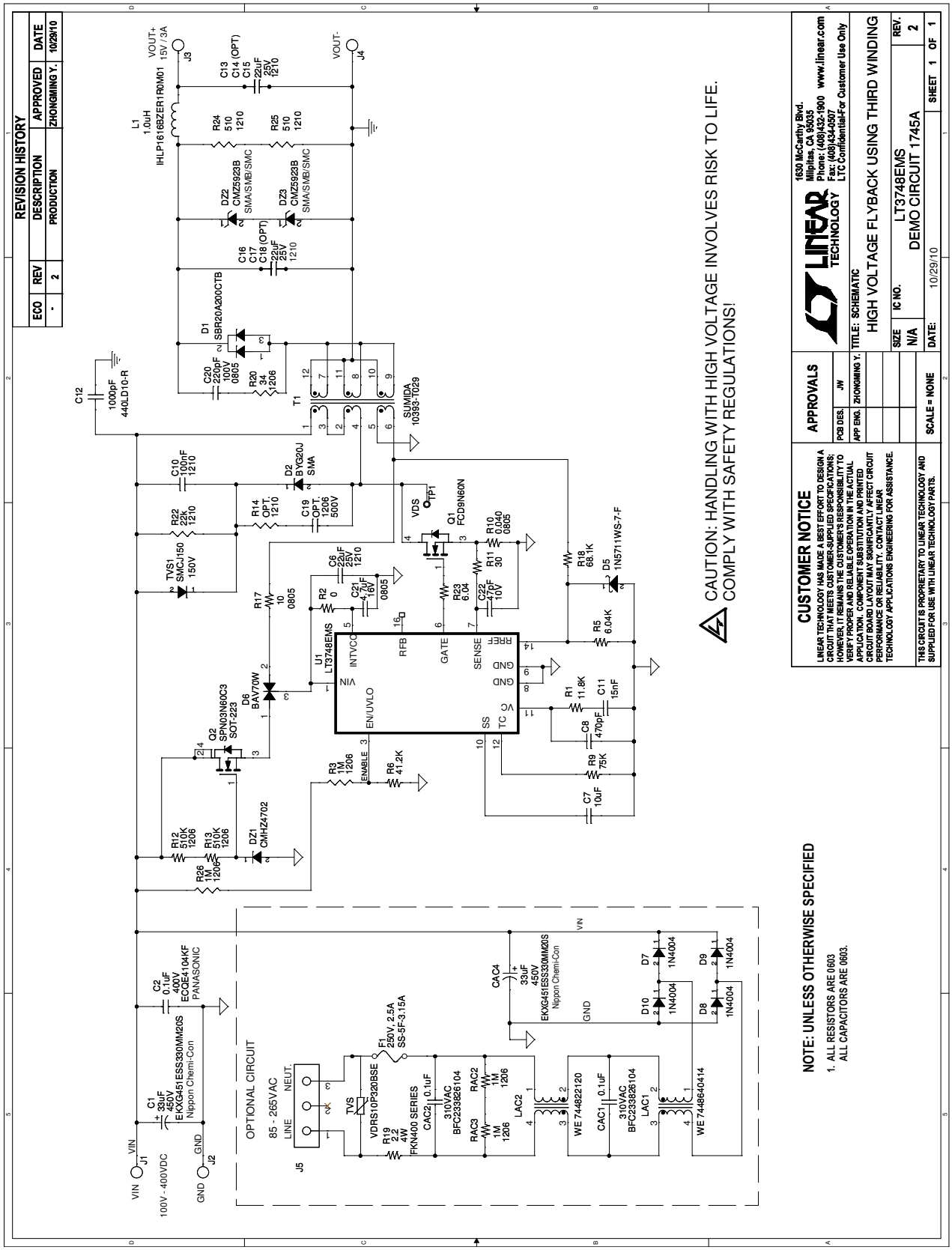
PARTS LIST

QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components			
2	CAC1,CAC2	Capacitor, 0.1µF, 250V/275VAC ECQ-UL, 20%	Panasonic, ECQU2A104ML
2	C1,CAC4	Capacitor, 33µF, 450V, Size 18mm × 20mm, 20%	Nippon Chemi-Con, EKXG451ESS330MM20S
1	C2	Capacitor, FILM, 0.1µF, 400VDC, 10%	Panasonic, ECQE4104KF
7	C6,C15-C17	Capacitor, X5R, 22µF, 25V, 20%, 1210	AVX, 12103D226MAT2A
1	C7	Capacitor, X5R, 10µF, 6.3V, 20%, 0603	TDK, C1608X5ROJ106M
1	C8	Capacitor, C0G, 470pF, 50V, 10%, 0603	AVX, 06035A471KAT2A
1	C10	Capacitor, X7R, 0.1µF, 200V, 10%, 1210	AVX, 12102C104KAT2A
1	C11	Capacitor, X7R, 15nF, 25V, 10%, 0603	AVX, 06033A153KAT2A
1	C12	Capacitor, 1000pF, 400VAC	Vishay, 440LD10-R
1	C20	Capacitor, NPO, 220pF, 100V, 10%, 0805	AVX, 08051A221KAT2A
1	C21	Capacitor, X7R, 4.7µF, 16V, 20%, 0805	AVX, 0805YC475MAT2A
1	C22	Capacitor, C0G, 47pF, 50V, 10%, 0603	AVX, 06035A470KAT2A
1	DZ1	Zener Diode, 15V, SOD-123	Central Semi., CMHZ4702
2	DZ2,DZ3	Zener Diode, 8.2V, SMA (SMB, SMC)	Central Semi., CMZ5923B
1	D1	Super Barrier Rec., 20A, 200V, SBR	Diodes, SBR20A200CTB
1	D2	Ultrafast Avalanche Rec., BYG20J, SMA	Vishay, BYG20J
1	D5	Schottky Barrier Rec., 1N5711WS, SOD-323	Diodes, 1N5711WS-7-F
1	D6	Dual SW Diode, BAV70W, SOT-323	Diodes, BAV70W-7-F
4	D7,D8,D9,D10	Diode Rec.,1N4004, DO-41	Diodes, 1N4004-T
1	F1	Fuse, 250V, 2.5A	Cooper Busmann, SS-5F-3.15A
1	LAC1	Current-Compensated Chock	Wurth, 7448640414
1	LAC2	Common Mode Chock	Wurth, 744822120
1	L1	Inductor, 1µH	Vishay, IHLP1616BZER1ROM11
1	Q1	N-CH MOSFET, 600V, 9A, DPAK/D-2-PAK	Fairchild, FCD9N60NTM
1	Q2	Power Transistor, SPN03N60C3, SOT-223	Infineon, SPN03N60C3
2	RAC2,RAC3	Resistor, Chip, 1M, 5%, 1206	Vishay, CRCW12061M00JNEA
1	R1	Resistor, Chip, 11.8k, 1%, 0603	Vishay, CRCW060311K8FKEA
1	R2	Resistor, Chip, 0Ω, 0603	Vishay, CRCW06030000Z0EA
1	R3	Resistor, Chip, 1000k, 5%, 1206	Vishay, CRCW12061M00JNEA
1	R5	Resistor, Chip, 6.04k, 1%, 0603	NIC, NRC06F6041TRF
1	R6	Resistor, Chip, 41.2k, 1%, 0603	Vishay, CRCW0603348KFKEA
1	R9	Resistor, Chip, 75k, 5%, 0603	Vishay, CRCW060375K0JKEA
1	R10	Resistor, Chip, 0.04Ω, 1% 0805 (1206)	Vishay, WSL0805R0400FEA
1	R11	Resistor, Chip, 30Ω, 1%, 0603	Vishay, CRCW060330R0FKEA
2	R12,R13	Resistor, Chip, 510k, 5%, 1206	Vishay, CRCW1206510KJKEA
1	R17	Resistor, Chip, 10Ω, 5%, 0805	NIC, NRC10J100TRF
1	R18	Resistor, Chip, 68.1k, 1%, 0603	Yageo, RC0603FR-0768K1L

PARTS LIST

QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
1	R19	Resistor, 2.2Ω, 4W, 15%	Murata, NTPA2R2LDNB0
1	R20	Resistor, Chip, 34.0, 1%, 1206	Vishay, CRCW120634R0FKEA
1	R22	Resistor, Chip, 22k, 5%, 1210	Yageo, RC1210JR-0722KL
1	R23	Resistor, Chip, 6.04, 1%, 0603	Yageo, RC0603FR-076R04L
2	R24,R25	Resistor, Chip, 510, 5%, 1210	NIC, NRC25J511TRF
1	TVS	VDR Metal Oxide Varistor	Vishay, VDRS10P320BSE
1	TVS1	TVS, 150V, SMCJ150, SMC	Diodes, SMCJ150A-13-F
1	T1	Transformer, CEFD2513B TYPE	Sumida, 10393-T029
1	U1	IC LT3748, MSOP-16	Linear Technology, LT3748#TRPBF
Additional Demo Board Circuit Components			
0	R14	Resistor, 1210 (OPT)	Option
0	C19 (OPT)	Capacitor, 1206 (OPT)	Option
0	C14, C18 (OPT)	Capacitor, 1210	Option
Hardware/Components (For Demo Board Only)			
4	STAND-OFF	Stand-Off, Nylon 0.25", Snap On	Keystone, 8831
4	J1,J2,J3,J4	Jack, Banana	Keystone, 575-4
1	J5	Terminal Block, PCB Mount, 282836-3	Tyco, 282836-3

SCHEMATIC DIAGRAM



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