LT8705
80V V_{IN} and V_{OUT} Synchronous 4-Switch Buck-Boost DC/DC Controller

DESCRIPTION

Demonstration circuit 1924A is a high performance buck-boost converter featuring the LT®8705 that can operate from input voltages above, below or equal to the output voltage. The demo board input range is 36V to 80V. The output is optimized for 48V at 5A, with the output current limit set at 7A. (The circuit will operate with lower input voltage than 36V if load current is reduced).

The controller has integrated input current, input voltage, output current and output voltage regulators. The one regulator that wants to decrease current gets control over the compensation pin VC. The inductor current is controlled by the VC signal that is fed into a current comparator together with a ramp compensation signal.

While the current mode control limits the inductor current both in normal and in reverse direction, these current limits have some variation as input voltage changes. The input and output current regulators offer more accurate current limits.

The input voltage regulator is typically used in applications with solar panels or other high impedance power sources, and will reduce the current if the input voltage drops below the set point.

The operating mode of the controller is determined through the MODE pin (jumper JP1) and can be set to discontinuous mode, forced continuous mode and Burst Mode® operation.

The LT8705 is capable of bidirectional operation when operating in forced continuous mode. Additional circuitry may be needed depending on the application.

The CLKOUT output and the SYNC input can be used to synchronize two DC1924A circuits with 180 degree phase shift.

By feeding the LT8705 from a separate low voltage supply, the power dissipation can be reduced. To supply the LT8705 chip from an external voltage supply (> 6.4V), cut the trace as marked on the board to disconnect the EXTVCC pin from V_{OUT}. The LT8705 will start when voltage is applied at the input (VIN pin), and when it is running it will draw current from the EXTVCC pin if the voltage is > 6.4V.

Typical efficiency with 5A load is above 97% across a 36V to 72V input range using the supplied inductor. Lower core loss can be achieved by using a ferrite core inductor.

The LT8705 data sheet gives a complete description of the part, operation and application information. The data sheet should be read in conjunction with this quick start guide for demo circuit 1924A. The input voltage range of the LT8705 itself is 2.8V (need EXTVCC > 6.4V) to 80V and the output range is 1.3V to 80V.

The LT8705EUHF is assembled in a 38-Lead (5mm × 7mm) plastic QFN package with a thermal pad underneath the chip. Proper board layout is essential for maximum thermal and electrical performance. See the data sheet section Circuit Board Layout Checklist.

Design files for this circuit board are available at http://www.linear.com/demo/DC1924A

PERFORMANCE SUMMARY

Specifications are at T_A = 25°C

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V_{IN}	Input Supply Range	Note: Output Power Is Limited When V_{IN} < 30V	36	48	80	V
V_{OUT}	Output Voltage			48		V
I_{IN}	Maximum Load Current			5		A
I_{OUT}	Output Current Limit			7		A
f_{SW}	Switching Frequency			200		kHz
EFF	Efficiency at DC Input	V_{IN} = 36V, V_{OUT} = 48V, I_{OUT} = 5A V_{IN} = 48V, V_{OUT} = 48V, I_{OUT} = 5A V_{IN} = 72V, V_{OUT} = 48V, I_{OUT} = 5A		97.5 97.2 97.5		% % %

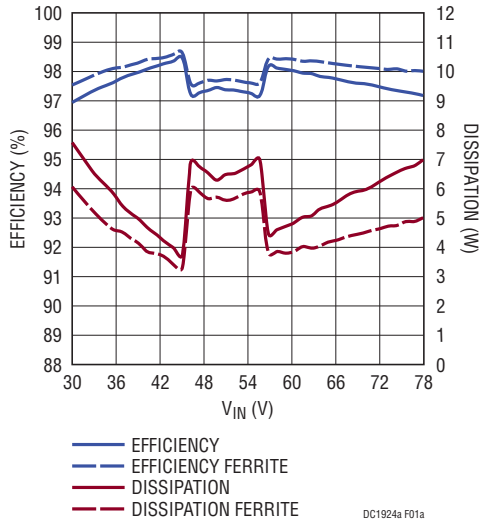


Figure 1a. Efficiency and Power Loss as Function of Input Voltage at 5A Load. Dotted Lines Show Increased Efficiency When the Inductor Is Replaced by a Ferrite Core Inductor (Coiltronics SER2918H-223KL)

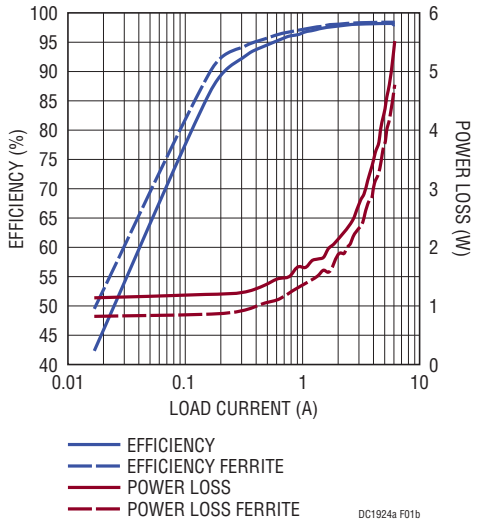


Figure 1b. Efficiency and Power Loss in CCM Buck Mode. V_{IN} = 56V. Dotted Lines Show Increased Efficiency When the Inductor Is Replaced by a Ferrite Core Inductor (Coiltronics SER2918H-223KL)

QUICK START PROCEDURE

1. Demonstration circuit 1924A is easy to set up to evaluate the performance of the LT8705. Refer to Figure 2 for proper measurement equipment setup and follow the procedure below.
2. With power off, connect the input power supply to V_{IN} (TP1) and GND (TP3).
3. Connect the SHDN terminal to ground with a clip-on lead to disable the board.
4. Apply 48V to the input. The power source must have greater than 12A capability if you want to evaluate the board with full load over the input range.
5. Remove the clip-on lead from SHDN to enable the board.
6. Note that the demo circuit will be enabled at $V_{IN} > 5.6V$, when V_{IN} is rising. If operation at very low input voltage is not wanted, increase the value of R11 to set the undervoltage shutdown at the wanted level.
7. Once the proper output voltage is established, adjust the load and the input voltage within the operating range and observe the output voltage regulation, ripple voltage and efficiency and other parameters as needed. When measuring input/output voltages, measure at the input/output terminals of the board to avoid measurement error caused by voltage drops in cables.
8. To measure input/output voltage ripple, avoid a long ground lead on the oscilloscope probe, as it may pick up switching noise. A commonly accepted method is to remove the oscilloscope probe end cap and ground lead and set the 20MHz bandwidth limit on the oscilloscope. Measure the input/output voltage ripple by touching the probe tip directly to the positive terminal of the input or output capacitor. Connect the probe ground terminal to the board's GND plane near the capacitor with a very short wire.

QUICK START PROCEDURE

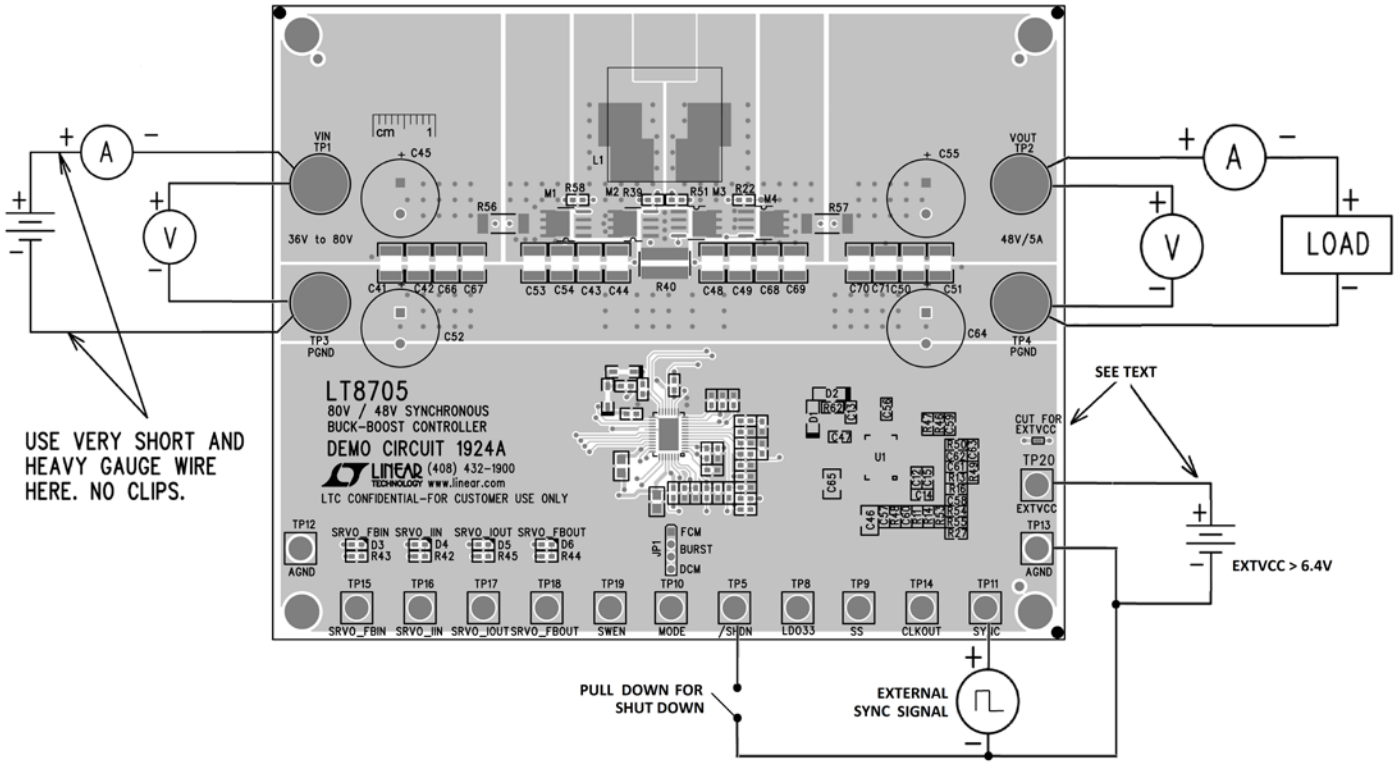


Figure 2. Test Setup

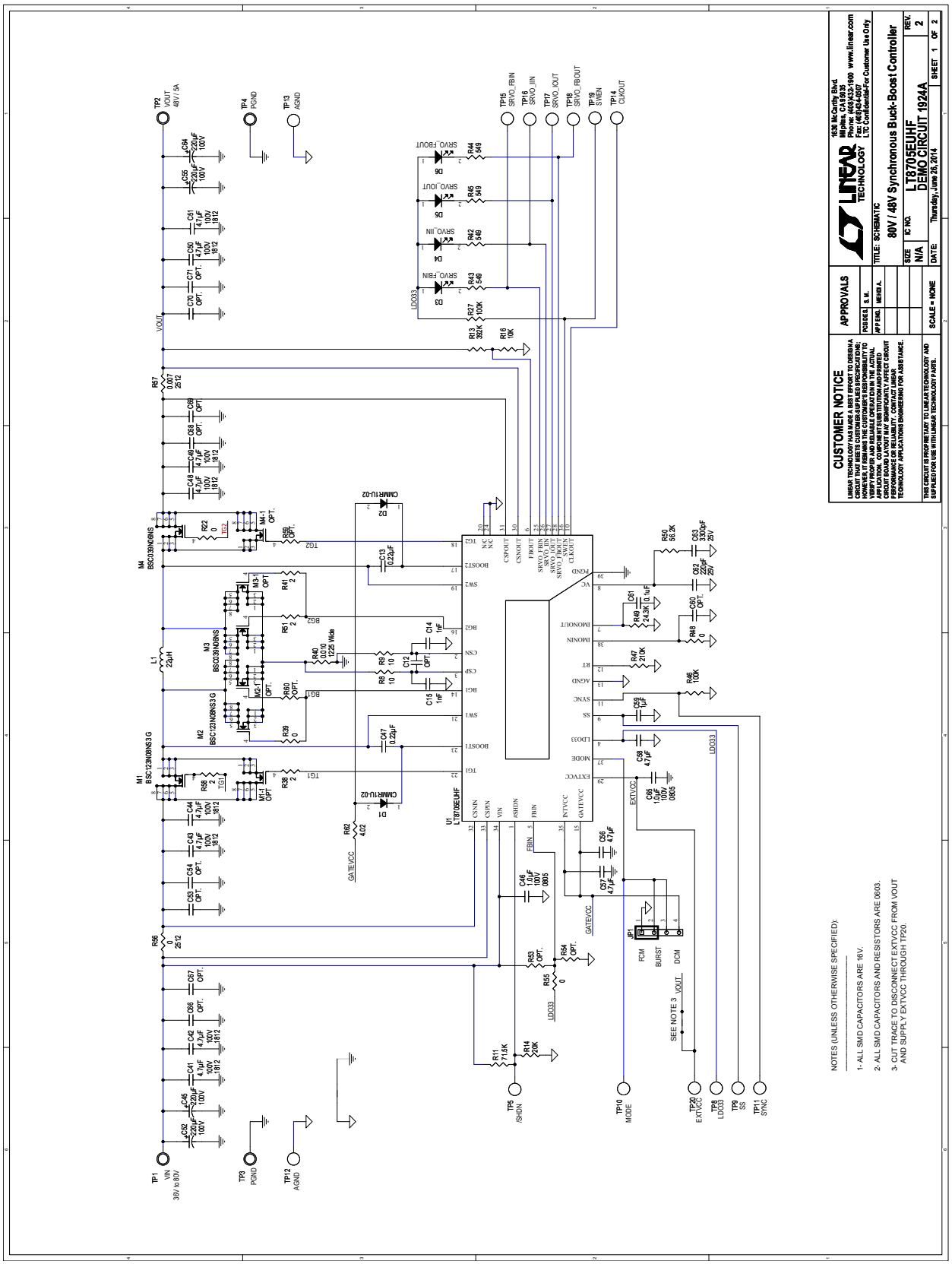
PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	2	C13, C47	CAP CERM 0.22µF 10% 16V X5R 0603	TAIYO YUDEN EMK107BJ224KA-T
2	2	C14, C15	CAP CER 1000pF 16V 20% X7R 0603	AVX CORPORATION 0603YC102MAT4A
3	8	C41-C44, C48, C49-C51	CAP CER 4.7µF 100V X7S 1812	TDK C4532X7S2A475M
4	2	C46, C65	CAP CER 1.0µF 100V X7S 0805	TDK C2012X7S2A105K
5	4	C45, C52, C55, C64	CAP ALUM 220µF 100V 20% RADIAL	UCC EKY-101ELL221MK25S
6	3	C56, C57, C58	CAP CER 4.7µF 16V 10% X5R 0603	TAIYO YUDEN, EMK107ABJ475KA-T
7	1	C59	CAP CER 1µF 16V 10% X7R 0603	TDK C1608X7R1C105K
8	1	C61	CAP CER 100nF 16V 10% X7R 0603	TDK C1608X7R1C104K
9	1	C62	CAP CER 220pF 25V 5% NP0 0603	NIC NMC0603NPO221J50TRPF
10	1	C63	CAP CER 3300pF 25V 5% NP0 0603	KEMET C0603C332J3GAC
11	2	D1, D2	RECTIFIERS ULTRA FAST RECTIFIER SINGLE	CENTRAL SEMI CMMR1U-02 TR
12	4	D3, D4, D5, D6	LED SMARTLED GREEN 570NM 0603	LG L29K-G2J1-24-Z
13	1	L1	INDUCTOR POWER 22µH 11.0A SMD	WÜRTH ELECTRONICS 74435572200
14	2	M1, M2	MOSFET N-CH 80V 55A TDSON-8	INFINEON BSC123N08NS3 G
15	2	M3, M4	MOSFET N-CH 60V 19A TDSON-8	INFINEON BSC039N06NS
16	2	R8, R9	RES 10.0Ω 1/10W 1% 0603 SMD	VISHAY CRCW060310R0FKEA
17	1	R11	RES 71.5k 1/10W 1% 0603 SMD	PANASONIC ERJ-3EKF7152V
18	1	R13	RES 392k 1/10W 0.1% 0603 SMD	VISHAY MCT06030D3923BP100
19	1	R14	RES 20.0k 1/10W 1% 0603 SMD	VISHAY CRCW060320K0FKEA
20	1	R16	RES 10.0k 1/10W 0.1% 0603 SMD	PANASONIC ERA-3AEB103V
21	2	R27, R46	RES 100k 1/10W 1% 0603 SMD	VISHAY CRCW0603100KFKEA
22	4	R38, R41, R51, R58	RES 2.00Ω 1/10W 1% 0603 SMD	VISHAY CRCW06032R00FKEA
23	1	R40	RES 0.01Ω 3W 2512 5% SMD	TT ELECTRONICS LRF3WLF-01-R010-J
24	4	R42, R43, R44, R45	RES 549Ω 1/10W 1% 0603 SMD	VISHAY CRCW0603549RFKEA
25	1	R47	RES 210k 1/10W 1% 0603 SMD	VISHAY CRCW0603210KFKEA
26	1	R49	RES 24.3k 1/10W 1% 0603 SMD	VISHAY CRCW060324K3FKEA
27	1	R50	RES 56.2k 1/10W 1% 0603 SMD	VISHAY CRCW060356K2FKEA
28	1	R57	RES 0.007Ω 1W 1% 2512 SMD	VISHAY CRCW25127L000FEA
29	1	R62	RES 4.02Ω 1/10W 1% 0603 SMD	VISHAY CRCW06034R02FKEA
30	1	U1	LT8705 SYNCHRONOUS 4 SWITCH BUCK-BOOST DC/DC CONTROLLER	LINEAR TECH LT8705EUHF#PBF

PARTS LIST

Additional Demo Board Circuit Components				
1	0	C12, C60	CAP 0603 OPTION	CAP 0603 OPTION
2	0	C53, C54, C66-C71	CAP 1812 OPTION	CAP 1812 OPTION
3	0	M1-1, M2-1, M3-1, M4-1	MOSFET POWER56 OPTION	MOSFET POWER56 OPTION
4	0	R53, R54, R59, R60	RES 0603 OPTION	RES 0603 OPTION
5	5	R22, R39, R48, R55	RES 0.0Ω 1/10W 0603 SMD	VISHAY CRCW06030000Z0EA
6	2	R56	RES 0.0Ω 1.5W 2512 SMD	VISHAY CRCW25120000Z0EG
Hardware: For Demo Board Only				
1	1	JP1	CONN HEADER 4POS 2MM VERT T/H	SAMTEC TMM-104-02-L-S
2	4	TP1, TP2, TP3, TP4	JACK NON-INSULATED 0.218"	KEYSTONE 575-4
3	14	TP5, TP8-TP20	TERM SOLDER TURRET 0.094	MILL-MAX 25012-00-80-00-00-07-0
4	1	SHUNT1	CONN SHUNT 2MM 2POS	SAMTEC 2SN-BK-G
5	4	MH1, MH2, MH3, MH4	SPACER STACKING #4 SCREW NYLON	KEYSTONE ELECTRONICS 8833
6	1		FAB, PRINTED CIRCUIT BOARD	DEMO CIRCUIT #1924A

SCHEMATIC DIAGRAM



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