

# 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<sup>®</sup>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, 5A. Additional input bulk capacitance may be needed, subject to the source impedance.

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 part has integrated input current, input voltage, output current and output voltage feedback loops and is capable of bi-directional operation. The operating mode of the controller is determined through the MODE pin (jumper JP1). The MODE pin can select among discontinuous mode, forced continuous mode and Burst Mode<sup>®</sup> operation.

The CLKOUT output and the SYNC input can be used to synchronize switching between two or more DC1924A circuits.

To supply the LT8705 chip from an external voltage supply ( $> 6.4V$ ) through the EXTVCC terminal, cut the trace as marked on the board.

The input range of the demo circuit is up to 80V, therefore, the demo circuit utilizes 100V MOSFETs. The typical efficiency is about 97% from a 36V input to 48V, 5A load, using the stock inductor. At the output power level

of 100W, even one percent of efficiency improvement is a big advantage in minimizing temperature rise. If an efficiency measurement is needed in an application, the output voltage must be measured at the output capacitors instead of at the load. This prevents cable loss from being counted as a loss of the board.

Modifications can be made to DC1924A in order to increase the efficiency even higher: 1) Replacing the inductor with a physically bigger one, e.g. SER2918H-223 from Coilcraft, and 2) If the input and/or output voltage level is at a lower level, replacing MOSFETs with low voltage ones, e.g. Si7892BDP from Vishay, may also help.

The LT8705 data sheet gives a complete description of the part, operation and application information. The data sheet must be read in conjunction with this quick start guide for demo circuit 1924A. The LT8705EUHE 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 performance. See the data sheet section Circuit Board Layout Checklist.

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

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## PERFORMANCE SUMMARY

Specifications are at  $T_A = 25^\circ C$

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
$V_{IN}$	Input Supply Range		36		80	V
$V_{OUT}$	Output Voltage			48		V
$I_{OUT}$	Maximum Output Current			5		A
$F_{SW}$	Switching Frequency			200		kHz
EFF	Efficiency at DC	$V_{IN} = 36V, I_{OUT} = 5A$ $V_{IN} = 48V, I_{OUT} = 5A$ $V_{IN} = 72V, I_{OUT} = 5A$		97.4 97 97.4		% % %

## DESCRIPTION

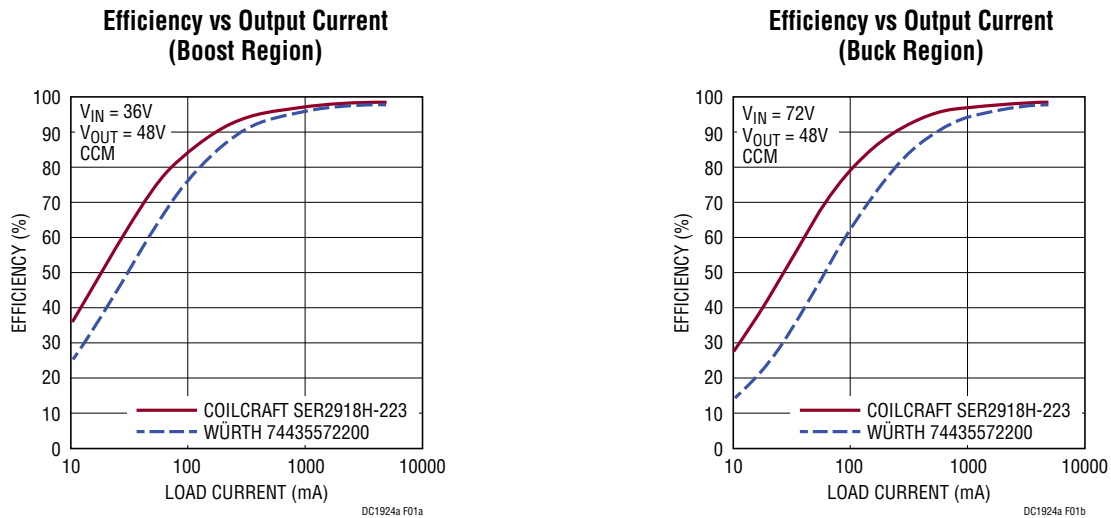


Figure 1. LT8705 Demo Board Efficiency

**Note:** The demo circuit uses the Würth inductor. See the front page and the Typical Performance Characteristics

section of LT8705 data sheet for more curves from this demo circuit using the Coilcraft inductor.

## QUICK START PROCEDURE

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. Use short and thick wire for input and output power connections.

To measure input/output voltage ripple, care must be taken to avoid a long ground lead on the oscilloscope probe. Remove the oscilloscope probe end cap and ground lead and set the bandwidth limit on the oscilloscope. Measure the input/output voltage ripple by touching the probe tip directly across input/output capacitor terminals, connecting the probe ground terminal to the board's GND plane. See Figure 3 for proper voltage ripple measurement technique.

1. With power off, connect the input power supply to  $V_{IN}$  and GND.
2. Connect the  $\overline{SHDN}$  terminal to ground with a clip-on lead to disable the board.

3. Apply 36V to the input. Source must have greater than 10A capability.
4. Remove the clip-on lead from  $\overline{SHDN}$  to enable the board. Note that the demo circuit will be enabled at  $V_{IN} > 5.6V$ , when  $V_{IN}$  is rising.
5. When measuring input/output voltages, measure at the input/output terminals of the board.
6. Turn on the power at the input.
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.
8. Carefully evaluate other design parameters as needed.

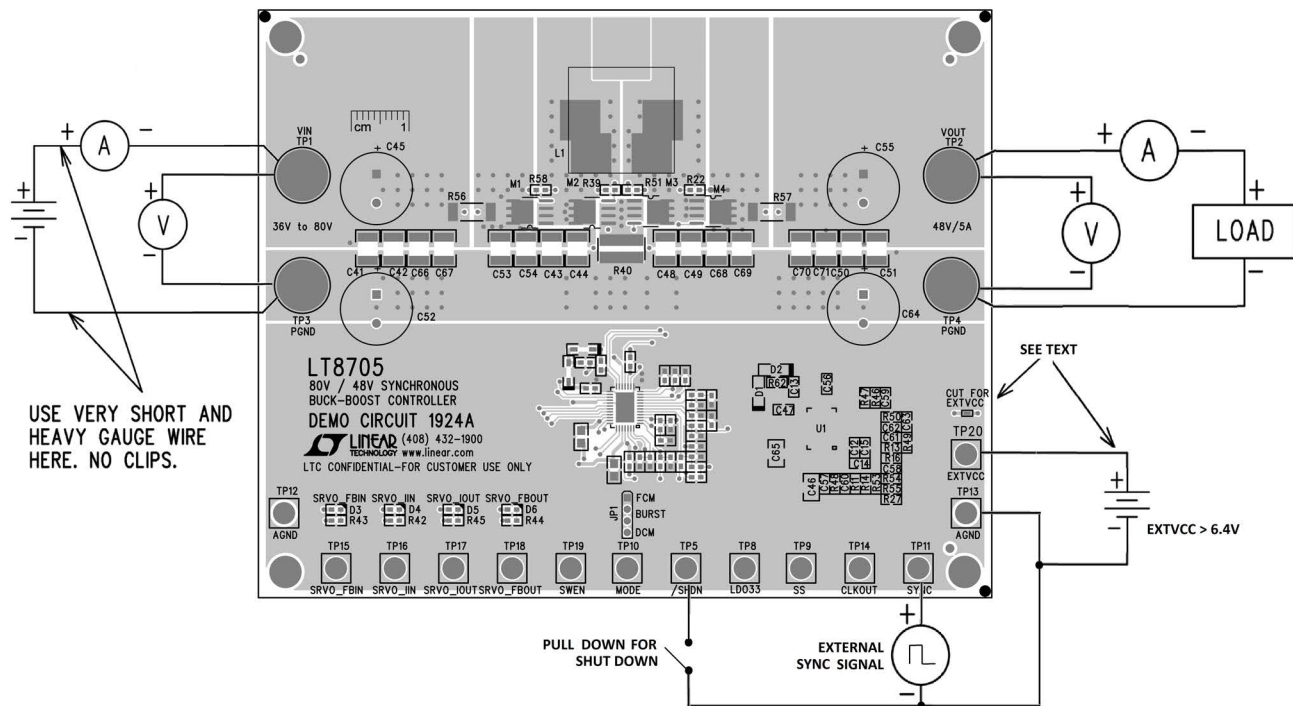
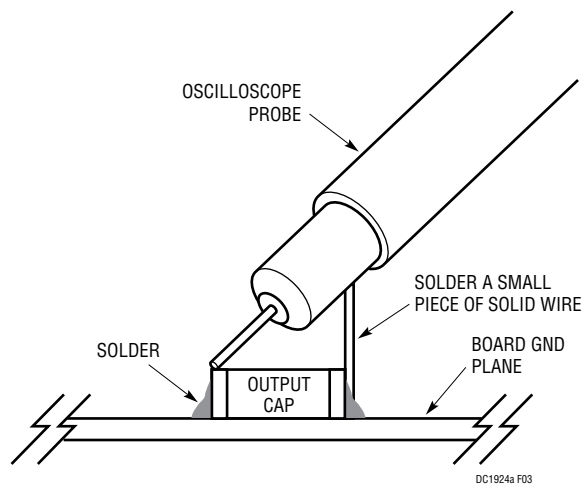


Figure 2. Proper Measurement Equipment Setup

## QUICK START PROCEDURE



**Figure 3. Proper Output Voltage Ripple Measurement Technique**

## PARTS LIST

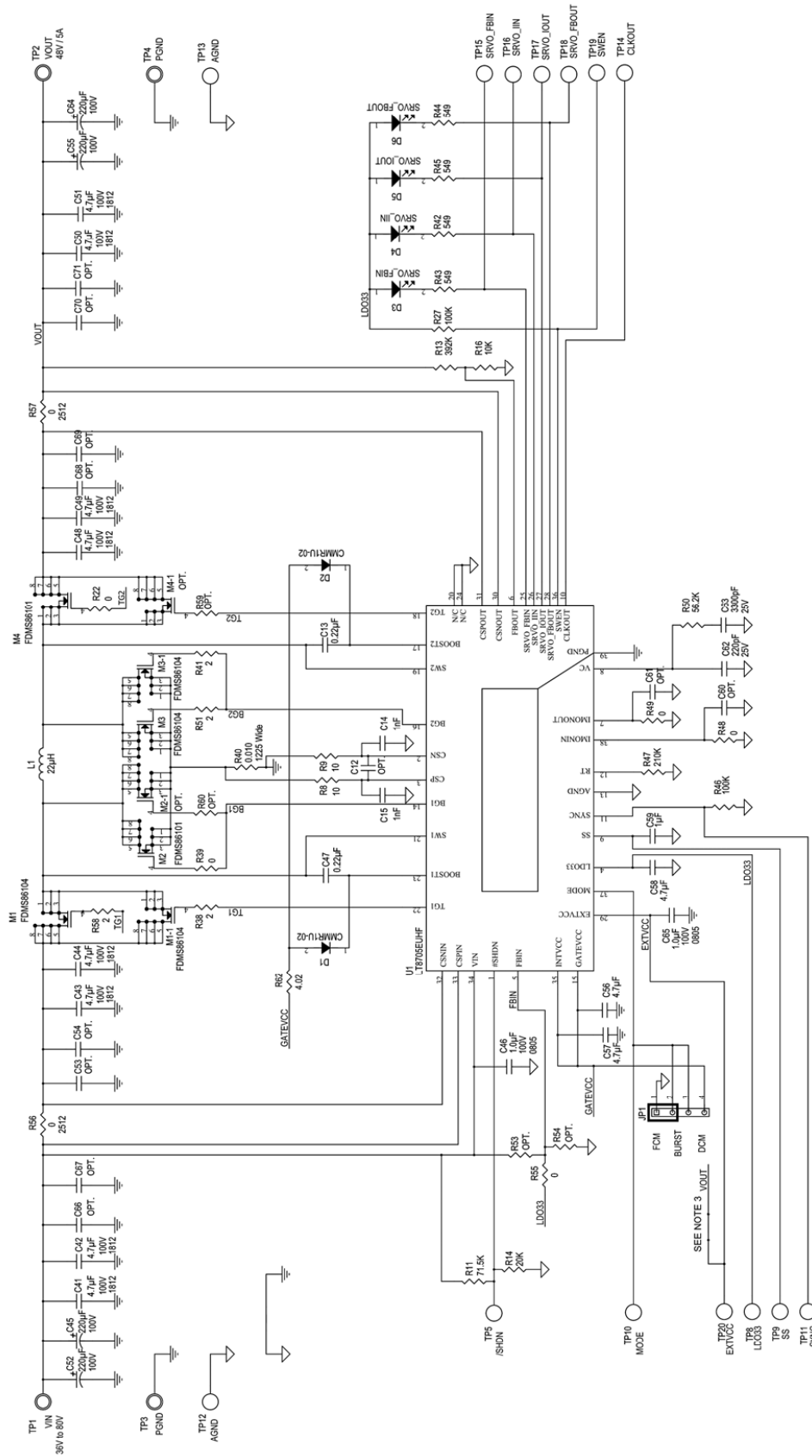
ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
<b>Required Circuit Components</b>				
1	2	C13, C47	CAP CERM 0.22 $\mu$ F 10% 16V X5R 0603	TAIYO YUDEN EMK107BJ224KA-T
2	2	C14, C15	CAP CER 1000pF 16V 20% X7R 0603	AVX CORPORATION 0603YC102MAT4A
3	8	C41, C42, C43, C44, C48, C49, C50, C51	CAP CER 4.7 $\mu$ F 100V X7S 1812	TDK, C4532X7S2A475M
4	4	C45, C52, C55, C64	CAP ALUM 220 $\mu$ F 100V 20% RADIAL	UCC, EKZ-E101ETD221MK25S
5	2	C46, C65	CAP CER 1 $\mu$ F 100V X7S 0805	TDK, C2012X7S2A105K
6	3	C56, C57, C58	CAP CER 4.7 $\mu$ F 16V 10% X5R 0603	TAIYO YUDEN, EMK107ABJ475KA-T
7	1	C59	CAP CER 1 $\mu$ F 16V 10% X7R 0603	TDK, C1608X7R1C105K
8	1	C62	CAP CER 220pF 25V 5% NPO 0603	NIC, NMC0603NPO221J50TRPF
9	1	C63	CAP CER 3300pF 25V 5% NPO 0603	KEMET C0603C332J3GAC
10	2	D1, D2	RECTIFIERS ULTRA FAST RECTIFIER SINGLE	CENTRAL SEMI CMMR1U-02 TR
11	4	D3, D4, D5, D6	LED SMARTLED GREEN 570NM 0603	LG L29K-G2J1-24-Z
12	1	L1	INDUCTOR POWER 22 $\mu$ H 11A SMD	WÜRTH ELECTRONICS 74435572200
13	4	M1, M3, M1-1, M3-1	MOSFET N-CH 100V 7A POWER56	FAIRCHILD SEMICONDUCTOR FDMS86104
14	2	M2, M4	MOSFET N-CH 100V 12.4A POWER56	FAIRCHILD SEMICONDUCTOR FDMS86101
15	2	R8, R9	RES 10 $\Omega$ 1/10W 1% 0603 SMD	VISHAY CRCW060310R0FKEA
16	1	R62	RES 4.02 $\Omega$ 1/10W 1% 0603 SMD	VISHAY CRCW06034R02FNEA
17	1	R11	RES 71.5k $\Omega$ 1/10W 1% 0603 SMD	PANASONIC ERJ-3EKF7152V
18	1	R13	RES 392k $\Omega$ 1/10W 0.1% 0603 SMD	VISHAY MCT06030D3923BP100
19	1	R14	RES 20k $\Omega$ 1/10W 1% 0603 SMD	VISHAY CRCW060320K0FKEA
20	1	R16	RES 10k $\Omega$ 1/10W 0.1% 0603 SMD	PANASONIC ERA-3AEB103V
21	2	R27, R46	RES 100k $\Omega$ 1/10W 1% 0603 SMD	VISHAY CRCW0603100KFKEA
22	4	R38, R41, R51, R58	RES 2 $\Omega$ 1/10W 1% 0603 SMD	VISHAY CRCW06032R00FKEA
23	1	R40	RES 0.01 $\Omega$ 3W 2512 5% SMD	TT ELECTRONICS LRF3W-R01JW
24	4	R42, R43, R44, R45	RES 549 $\Omega$ 1/10W 1% 0603 SMD	VISHAY CRCW0603549RFKEA
25	1	R47	RES 210k $\Omega$ 1/10W 1% 0603 SMD	VISHAY CRCW0603210KFKEA
26	1	R50	RES 56.2k $\Omega$ 1/10W 1% 0603 SMD	VISHAY CRCW060356K2FKEA
27	1	U1	LT8705 SYNCHRONOUS 4 SWITCH BUCK-BOOST DC/DC CONTROLLER	LT8705EUHF

# DEMO MANUAL DC1924A

## PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
<b>Additional Circuit Components</b>				
1	0	C12, C60, C61	CAP 0603 OPTION	CAP 0603 OPTION
2	8	C53, C54, C66, C67, C68, C69, C70, C71	CAP 1812 OPTION	CAP 1812 OPTION
3	0	M2-1, M4-1	MOSFET POWER56 OPTION	MOSFET POWER56 OPTION
4	0	R53, R59, R60	RES 0603 OPTION	RES 0603 OPTION
5	0	R54	RES 0603 OPTION	RES 0603 OPTION
6	5	R22, R39, R48, R49, R55	RES 0Ω 1/10W 0603 SMD	VISHAY, CRCW06030000Z0EA
7	2	R56, R57	RES 0Ω 1.5W 2512 SMD	VISHAY DALE CRCW25120000Z0EGHP
<b>Hardware</b>				
1	1	JP1	CONN HEADER 4POS 2MM VERT T/H	SAMTEC TMM-104-02-L-S
2	4	MH1, MH2, MH3, MH4	SPACER STACKING #4 SCREW NYLON	KEYSTONE ELECTRONICS 8833
3	1	SHUNT1	CONN SHUNT 2MM 2POS	SAMTEC 2SN-BK-G
4	4	TP1, TP2, TP3, TP4	JACK NON-INSULATED 0.218"	KEYSTONE 575-4
5	14	TP5, TP8, TP9, TP10, TP11, TP12, TP13, TP14, TP15, TP16, TP17, TP18, TP19, TP20	TERM SOLDER TURRET 0.156" 0.066"L	MILL-MAX 2308-2-00-44-00-00-07-0

**SCHEMATIC DIAGRAM**



# DEMO MANUAL DC1924A

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This notice contains important safety information about temperatures and voltages. For further safety concerns, please contact a LTC application engineer.

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