LTC7801EUFD
High Input Voltage Synchronous Buck Converter

DESCRIPTION

Demonstration circuit 2641A is a single output synchronous buck converter featuring the LTC7801EUFD in the 24-lead QFN package. The input voltage range is from 16V to 100V and the output is 12V/10A. The DC2641A is configured with a sense resistor for overcurrent protection. Inductor DCR current sensing is optional.

The board has a lot of features including an optional onboard NMOS LDO for DRVCC, a switch-mode power supply for $EXTV_{CC}$, jumper selectable 100% duty cycle operation in dropout, a mode selector pin that allows the converter to run in CCM, pulse-skip, adjustable burst clamp or default Burst Mode® operation, a PGOOD output voltage monitor and PLLIN for PolyPhase® operation.

The LTC7801 data sheet gives a complete description of the part, operation and application information and must be read in conjunction with this demo manual for DC2641A.

Design files for this circuit board are available at http://www.linear.com/demo/DC2641A

PERFORMANCE SUMMARY

Specifications are at T_A = 25°C

PARAMETER	CONDITIONS	VALUE
Input Voltage Range		16V ~ 100V
Output Voltage V_{OUT}	V_{IN} = 16~100V, I_{OUT} = 0~10A, JP4: FCM	12V ± 2% (11.76V ~ 12.24V)
Maximum Output Current $I_{OUT,MAX}$	V_{IN} = 16~100V	10A
Default Operating Frequency (Typical)		150kHz
External Clock Sync. Frequency Range		75kHz – 850kHz
Typical Full Load Efficiency (See Figure 4)	V_{IN} = 48V, V_{OUT} = 12V, I_{OUT} = 10A, f_{SW} = 150 kHz	95.3%

QUICK START PROCEDURE

Demonstration circuit DC2641A is easy to set up to evaluate the performance of the LTC7801EUFD. 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 V_{IN} or V_{OUT} and GND terminals or directly across relevant capacitor. See Figure 2 for proper scope probe technique.

1. Place jumpers in the following positions:

   JP1 ON

   JP4 FCM

   JP5 ON

   JP8 OFF

2. With power off, connect the input power supply to V_{IN} and GND.

3. Turn on the power at the input.

   NOTE: Make sure that the input voltage is higher than 16V and does not exceed 100V.

4. Check the output voltage. The output voltage should be between 11.76V and 12.24V.

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

   NOTE: If there is no output, temporarily disconnect the load to make sure that the load is not set too high.

QUICK START PROCEDURE

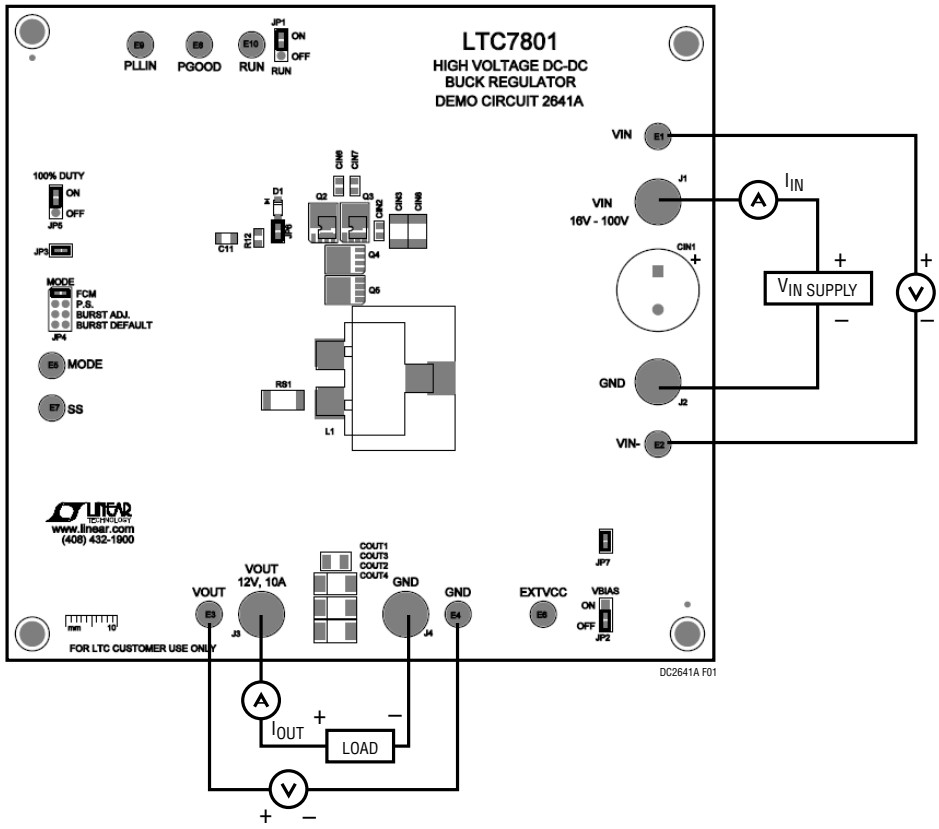


Figure 1. Proper Measurement Equipment Setup

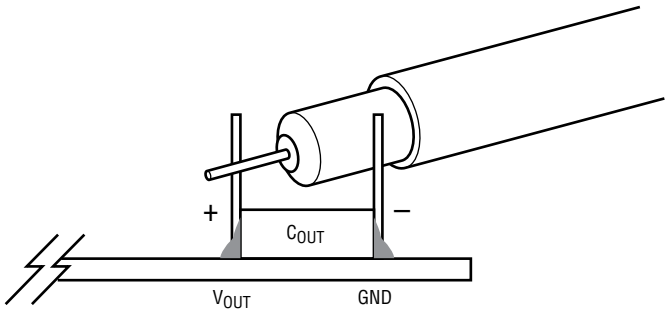


Figure 2. Measuring Input or Output Ripple Across Terminals or Directly Across Ceramic Capacitor

FREQUENCY SYNCHRONIZATION AND MODE SELECTION

Demonstration circuit 2641A's Mode selector allows the converter to run in forced continuous operation, pulse-skipping operation, Burst Mode or Burst mode with adjustable clamp level by changing the position of JP4. To synchronize the DC2641A to an external clock, apply the sync signal to the PLLIN turret. Depending upon the JP4 setting, the DC2641A will operate in different modes. See Table 1 for the detailed description.

100% DUTY

Demonstration circuit 2641A features 100% duty cycle operation in dropout. Set the JP5 to "ON" position to activate this feature. Set JP5 to "OFF" position disables the internal charge pump and enables boost refresh, allowing for 99% duty cycle operation in dropout.

OPTIONAL INDUCTOR DCR CURRENT SENSING

Demonstration circuit 2641A provides an optional circuit for Inductor DCR Current Sensing. Inductor DCR Current Sensing uses the DCR of the inductor to sense the inductor current instead of discrete sense resistors. The advantages of DCR sensing are lower cost, reduced board space and higher efficiency, but the disadvantage is a less accurate current limit. If DCR sensing is used, be sure to select an inductor current with a sufficiently high saturation current or use an iron powder type material.

Refer to Table 2 for Optional Inductor DCR Current Sensing setup and to the data sheet for more details.

Low Quiescent Current Applications and Measurement

The typical quiescent current (I_Q) of the LTC7801 controller is 40µA in sleep mode as specified in the LTC7801 data sheet. However, the input current of the DC2641A board can be higher than this value because of additional circuit outside of the IC. To reduce the total input current, large value FB divider resistors should be used. In addition, some jumpers and resistors should be configured accordingly. Refer to Table 3 for the low input quiescent current setup.

Table 1. Mode Selection and Synchronized Operation Options

CONFIGURATION	JP4	MODE WITH SYNC. SIGNAL APPLIED TO PLLIN
Forced Continuous Operation	FCM	FCM
Pulse-Skipping Operation	P.S.	P.S.
Burst Mode Operation with Adjustable Clamp Level	Burst ADJ.	FCM
Burst Mode Operation with Default Clamp	Burst Default	FCM

Table 2. Optional Inductor DCR Current Sensing

CONFIGURATION	RS1	R24	R28	C16	R37	R38	R39	R40
Current Sense Resistor (Default)	Ref. Sch.	Ref. Sch.	Ref. Sch.	OPEN	OPEN	OPEN	OPEN	OPEN
Inductor DCR Current Sensing	0Ω Copper	OPEN	OPEN	Calculated Value from Data Sheet			0Ω	0Ω

Table 3. Low Input Quiescent Current Configuration

REFERENCE DESIGNATOR	R1	R2	R23	JP3	JP4	JP5	JP8
Function	OVLO		PGOOD	$INTV_{CC}$ Jumper	MODE Selector	100% DUTY	BIAS supply
Stuffing Option	OPEN	0Ω	OPEN	OPEN	BURST ADJ. or BURST DEFAULT	OFF	OFF

$EXTV_{CC}$ BIAS SUPPLY

By default, the DC2641A $EXTV_{CC}$ turret is tied to the 12V V_{OUT}.

To power the $EXTV_{CC}$ from on-board bias supply:

1. Leave the JP7 OPEN. This step disconnects the $EXTV_{CC}$ from V_{OUT}.
2. Keep the JP8 at the "ON" position. The on-board BIAS supply output voltage is 12V.

Alternatively, $EXTV_{CC}$ can also be powered by an external power supply:

1. Leave the JP7 OPEN.
2. Keep the JP8 at the "OFF" position.
3. Apply a DC voltage (<14V) between the $EXTV_{CC}$ and GND turret, after the input voltage is established. Ensure that $EXTV_{CC} \leq V_{IN}$.

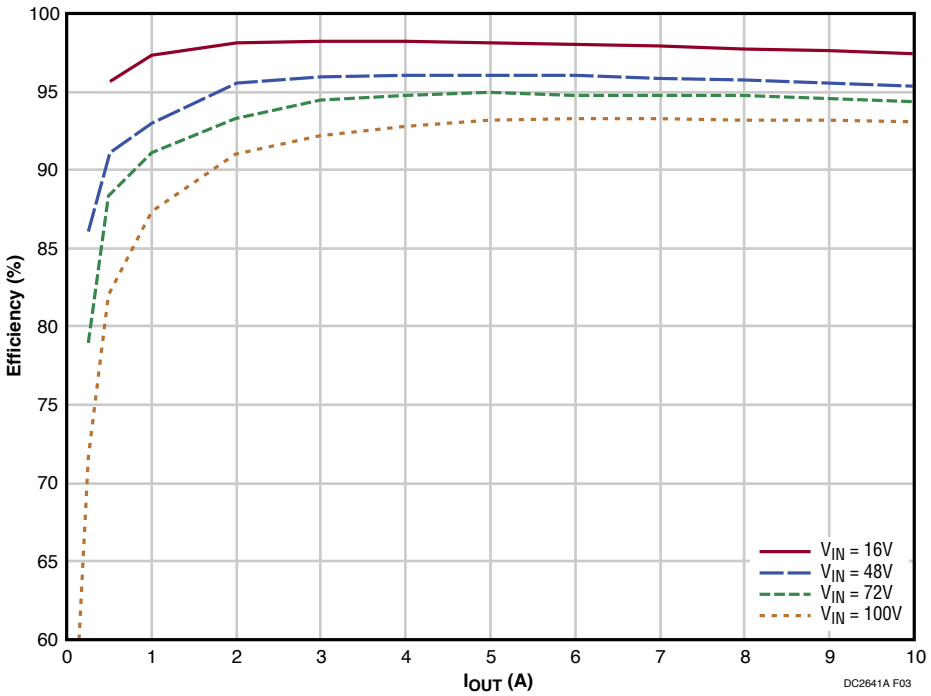


Figure 3. DC2641A V_{OUT} Typical Efficiency vs Load Current

EXTV$_{CC}$ BIAS SUPPLY

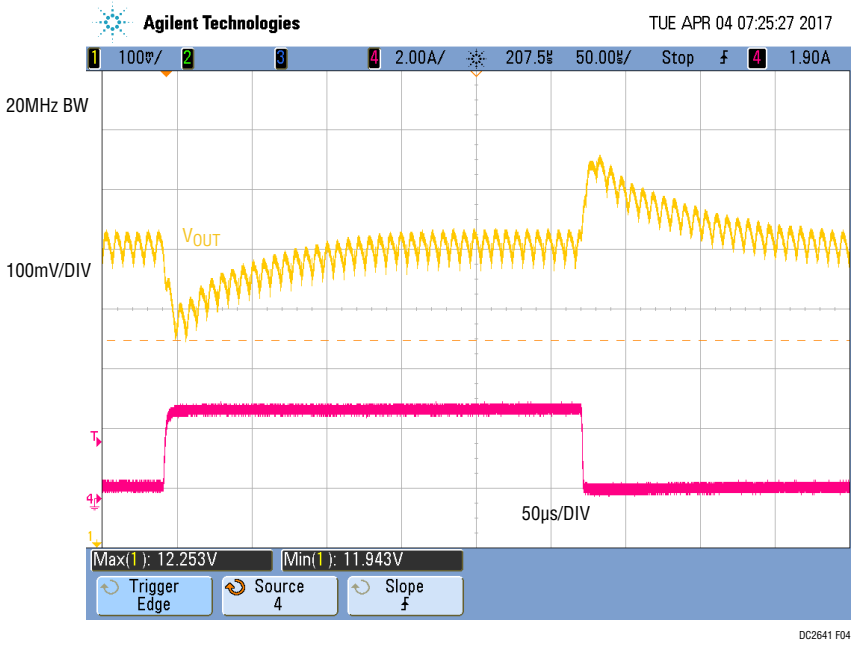


Figure 4. DC2641A V_{OUT} 0~2.5A Load Transient at V_{IN} = 48V

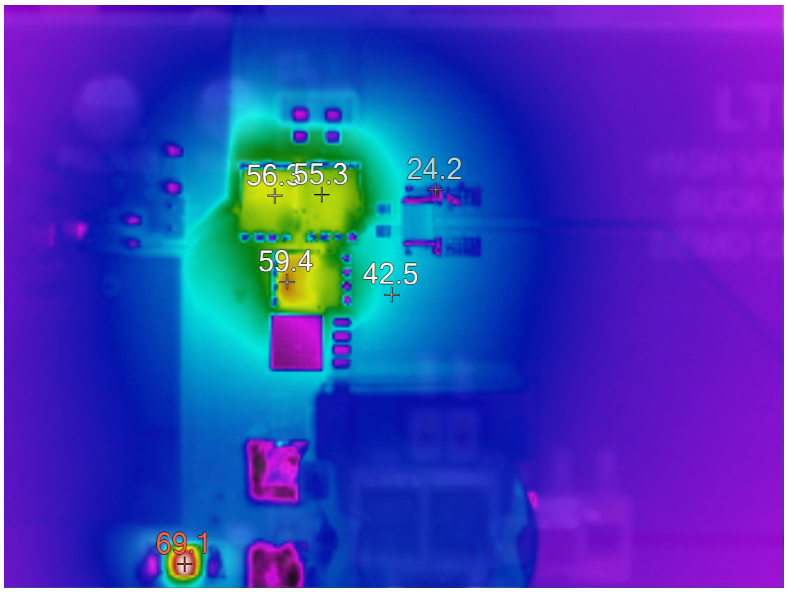


Figure 5. Thermal Image V_{IN} 48V, V_O 12V at 10A No Air Flow, T_A = 25°C

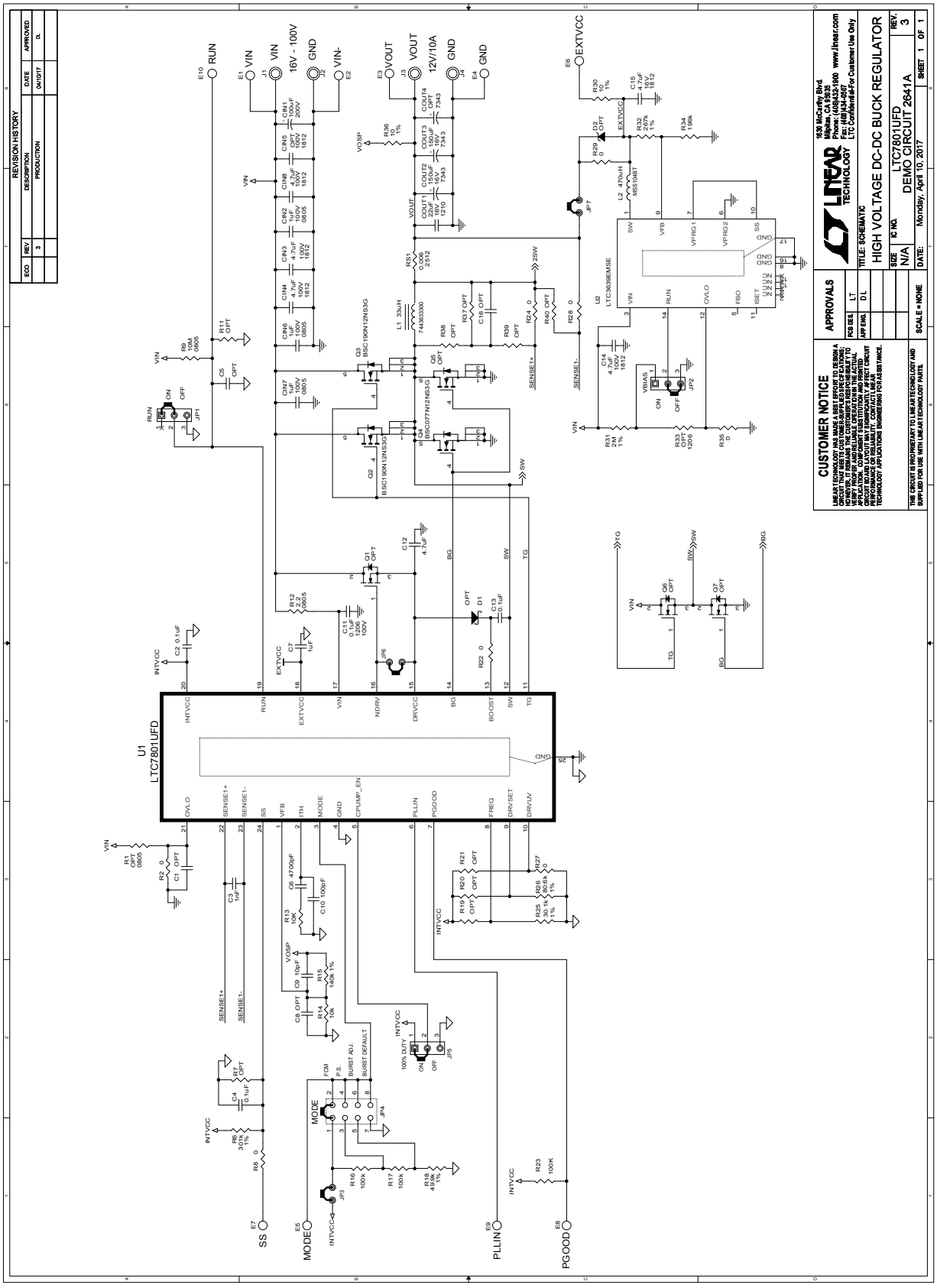
PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	1	CIN1	CAP., 100µF, ELECT, 200V, 20%, 16×20mm, THT, NRB-XS Series	NIC NRB-XS101M200V16x20TBF
2	5	CIN3, CIN4, CIN8, C14, C15	CAP., 2.2µF, X7R, 100V, 10%, 1812	TDK, C4532X7R2A225K230KA
3	3	CIN2, CIN6, CIN7	CAP, 1µF, X7R, 10V, 10%, 0805	AVX 0805ZC105KAT2A
4	1	COUT1	CAP, 22µF, X7R, 16V, 10%, 1210	TDK, C3225X7R1C226K250AC
5	2	COUT2, COUT3	CAP., 150µF, TANT, 16V, 20%, 7343, D-CASE	AVX TPSD157M016R0125
6	3	C2, C4, C13	CAP, 0.1µF, X7R, 25V, 10%, 0603	AVX, 06033C104KAT2A
7	1	C3	CAP, 1000pF, X7R, 50V, 10%, 0603	AVX 06035C102KAT2A
8	1	C6	CAP, 4700pF, X7R, 50V, 10%, 0603	AVX 06035C472KAT2A
9	1	C7	CAP, 1µF, X7R, 16V, 20%, 0603	TDK, C1608X7R1C105M080AC
10	1	C9	CAP, 10pF, X7R, 50V, 10%, 0603	AVX 06035C100KAT2A
11	1	C10	CAP., 100pF, C0G, 50V, 5%, 0603	AVX 06035A101JAT2A
12	1	C11	CAP, 0.1µF, X7R, 100V, 10%, 1206	AVX 12061C104KAT2A
13	1	C12	CAP, 4.7µF, X5R, 16V, 20%, 0603	TDK C1608X5R1C475M080AC
14	1	L1	IND., 33µH, PWR, 15%, 12A, 11.4mΩ, 2013	WURTH ELEKTRONIK 7443633300
15	1	L2	IND., 470µH, PWR, 10%, 0.72A, 886mΩ, 10.0×10.2×4.8mm, MSS1048T Series, AEC-Q200	COILCRAFT MSS1048T-474KLB
16	2	Q2, Q3	XSTR., PWR MOSFET, N-CH, 120V, 44A, PG-TDSON-8, SuperSO8	INFINEON BSC190N12NS3 G
17	1	Q4	XSTR., PWR MOSFET, N-CH, 120V, 98A, PG-TDSON-8, SuperSO8	INFINEON BSC077N12NS3 G
18	1	RS1	RES, 0.006Ω, 1%, 2W, 2512, HIGH PWR, SENSE, AEC-Q200	VISHAY WSL25126L000FEA18
19	1	R6	RES., 301kΩ, 1%, 1/10W, 0603	VISHAY CRCW0603301KFKEA
20	1	R9	RES., 10MΩ, 5%, 1/8W, 0805, AEC-Q200	VISHAY CRCW080510M0JNEA
21	1	R12	RES., 2.2Ω, 5%, 1/8W, 0805, AEC-Q200	VISHAY CRCW08052R20JNEA
22	2	R13, R14	RES., 10kΩ, 5%, 1/10W, 0603, AEC-Q200	VISHAY CRCW060310K0JNEA
23	1	R15	RES., 140kΩ, 1%, 1/10W, 0603, AEC-Q200	VISHAY CRCW0603140KFKEA
24	3	R16, R17, R23	RES., 100kΩ, 1%, 1/10W, 0603	VISHAY CRCW0603100KFKEA
25	1	R18	RES., 49.9kΩ, 1%, 1/10W, 0603	VISHAY CRCW060349K9FKEA
26	1	R25	RES., 30.1kΩ, 1%, 1/10W, 0603, AEC-Q200	VISHAY CRCW060330K1FKEA
27	1	R26	RES., 80.6kΩ, 1%, 1/10W, 0603	VISHAY CRCW060380K6FKEA
28	2	R30, R36	RES., 10Ω, 1%, 1/10W, 0603	VISHAY CRCW060310R0FKEA
29	1	R31	RES., 2MΩ, 1%, 1/10W, 0603, AEC-Q200	VISHAY CRCW06032M00FKEA
30	1	R32	RES., 267kΩ, 1%, 1/10W, 0603	VISHAY CRCW0603267KFKEA
31	1	R34	RES., 196kΩ, 1%, 1/10W 0603	VISHAY CRCW0603196KFKEA
32	1	U1	IC, HIGH VOLTAGE DC/DC BUCK REG., QFN-24 (4mm×5mm)	LINEAR TECH. LTC7801UFD#PBF
33	1	U2	IC, SYNCHRONOUS STEP DOWN REGULATOR, 150V, 100mA, MSOP-16	LINEAR TECH LTC3639EMSE#PBF

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Additional Demo Board Circuit Components				
1	0	CIN5 (OPT)	CAP, OPT 1812	OPTION
2	0	COUT4 (OPT)	CAP, OPTION 7343	OPTION
3	0	C1, C5, C8, C16 (OPT)	CAP, OPTION 0603	OPTION
4	0	D1 (OPT)	DIODE, OPTION SOD-123	OPTION
5	0	D2 (OPT)	DIODE, OPTION SOD-323	OPTION
6	0	L4 (OPT)	IND., 22µH, PWR, 10%, 30A, 2.05mΩ, 27.9×19.8×15.36mm, SER2915H Series, AEC-Q200	COILCRAFT SER2915H-223KL OPTION
7	0	Q1, Q6, Q7 (OPT)	XSTR, OPTION TO252-3	OPTION
8	0	Q5 (OPT)	XSTR, OPTION LFPAK	OPTION
9	0	Q12, Q13 (OPT)	XSTR, OPT IN_PG_TS	OPTION
10	0	R1 (OPT)	RES, OPTION 0805	OPTION
11	8	R2, R8, R22, R24, R27, R28, R29, R35	RES, 0Ω 1/10W 0603	VISHAY CRCW06030000Z0EA
12	0	R7, R11, R19, R20, R21, R37, R38, R39, R40(OPT)	RES, OPTION 0603	OPTION
13	0	R33 (OPT)	RES, OPTION 1206	OPTION
Additional				
1	10	E1-E10	TEST POINT, TURRET, 0.094", MTG. HOLE	MILL-MAX 2501-2-00-80-00-00-07-0
2	3	JP1, JP2, JP5	CONN., HDR, MALE, 1×3, 2mm, THT, STR	WURTH ELEKTRONIK, 62000311121
3	3	JP3, JP6, JP7	CONN., HDR, MALE, 1×2, 2mm, THT, STR	WURTH ELEKTRONIK, 62000211121
4	1	JP4	CONN., HDR, MALE, 2×4, 2mm, THT, STR	WURTH ELEKTRONIK, 62000821121
5	4	J1, J2, J3, J4	CONN., BANANA JACK, FEMALE, THT, NON-INSULATED, SWAGE	KEYSTONE 575-4
6	7	XJP1, XJP2, XJP3, XJP4, XJP5, XJP6, XJP7	CONN., SHUNT, FEMALE, 2 POS, 2mm	WURTH ELEKTRONIK, 60800213421
7	4	MH1, MH2, MH3, MH4	STANDOFF, NYLON, SNAP-ON, 0.50"	WURTH ELEKTRONIK, 702935000

SCHEMATIC DIAGRAM



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