LTC7890
High Frequency, Dual Output, Synchronous Buck Converter Using GaN FETs

DESCRIPTION

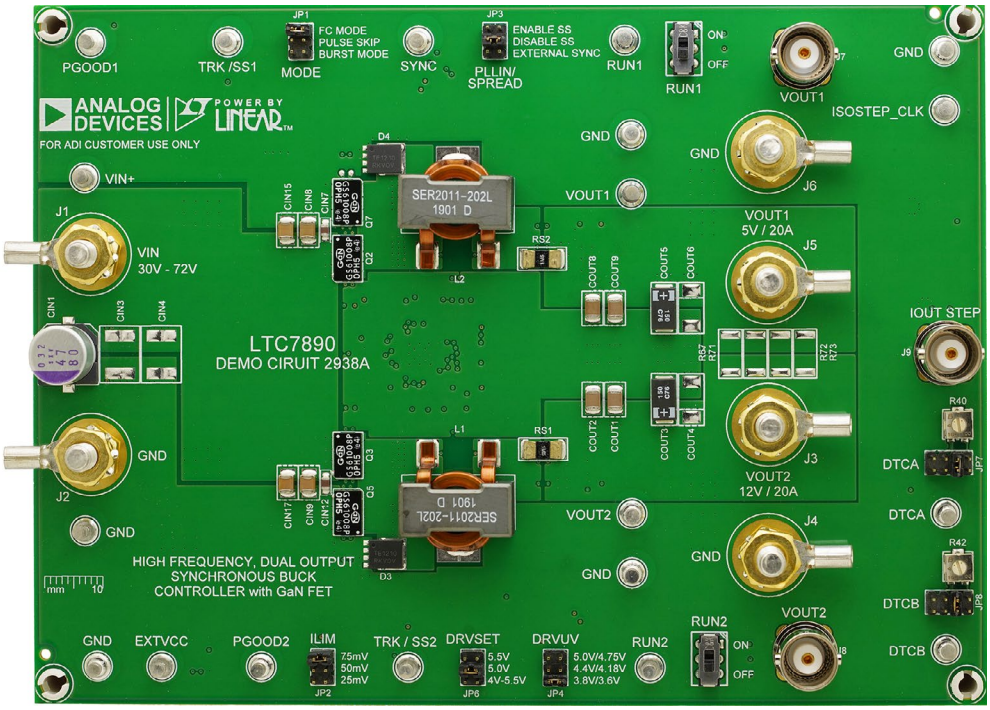
Demonstration circuit 2938A is a dual output nonisolated synchronous step-down converter that drives all N-channel gallium nitride (GaN) FET power stages. DC2938A features the LTC®7890, a low quiescent current high frequency (programmable fixed frequency from 100kHz up to 3MHz) dual step-down DC/DC synchronous controller, with dedicated driver feature for GaN FET housed in a small 6mm × 6mm QFN package.

The DC2938A operates over an input voltage range from 30V to 72V, while the LTC7890 can operate up to 100V. The DC2938A demo board produces two outputs: 5V and 12V with up to 20A output, respectively. DC2938A is configured with a sense resistor for current sensing. A mode selector allows the DC2938A to operate in forced continuous operation, pulse-skipping or Burst Mode® operation during light loads. DTCA and DTCB selector provides easy adjustment of the dead time to improve efficiency or to tailor the application. DRVSET and DRVUV selector offers option to choose drive voltage from 4V to 5.5V to optimize performance.

The $EXTV_{CC}$ pin permits the LTC7890 to be powered from the output of the switching regulator or other available source, reducing power dissipation, and improving efficiency. Please refer to the LTC7890 data sheet for a complete description of the part operation and application information.

Design files for this circuit board are available.

BOARD PHOTO



PERFORMANCE SUMMARY

Specifications are at T_A = 25°C

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
V_{IN}	Input Supply Range	Continuous Operation, Free Air	30		72	V
V_{OUT1}	Output Voltage 1			5		V
V_{OUT2}	Output Voltage 2			12		V
I_{OUT1}	Output Current 1				20	A
I_{OUT2}	Output Current 2				20	A
P_{OUT}/P_{IN}	Efficiency, See Figure 3 and Figure 4 for More Information	V_{IN} = 48V, V_{OUT1} = 5V, I_{OUT1}= 20A		93.87		%
		V_{IN} = 48V, V_{OUT} = 12V, I_{OUT}= 20A		96.71		%

QUICK START PROCEDURE

Demonstration circuit 2938A is easy to set up to evaluate the performance of the LTC7890. Refer to Figure 1 for the proper measurement equipment setup and follow the procedure below.

1. With power off, connect the input power supply to V_{IN} (30V to 72V) and GND (input return).
2. Connect the output loads between V_{OUT1} and GND, V_{OUT2} and GND, respectively. (initial load: no load). Refer to Figure 1.

   NOTE: Please use J1 and J2 (not E3 and E4), J5 and J6 (not E6 and E8), and J3 and J4 (not E5 and E7) for input power supply, output load V_{OUT1} and V_{OUT2} connection.
3. Connect the DVMs to the input and outputs.
4. Check the default jumper/switch position: RUN1 and RUN2 are OFF.
5. Turn on the input power supply and adjust voltage to 48V.

   NOTE: Make sure that the input voltage does not exceed 72V.
6. Turn on the switches: RUN1: ON and RUN2: ON
7. Check for the proper output voltages from V_{OUT1} to GND and V_{OUT2} to GND.
8. Once the proper output voltage is established, adjust the loads within the operating range and measure the efficiency, output ripple voltage and other parameters.
9. After completing all tests, adjust the load to 0A, power off the input power supply.

NOTE: When measuring the 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 the relevant capacitor. See Figure 2 for the proper scope probe technique.

EXTERNAL $EXTV_{CC}$ OPTION

The $EXTV_{CC}$ pin of the LTC7890 on the DC2938A board can be utilized for better efficiency and better thermal performance. Please follow the below procedure if an external power supply is used to bias the LTC7890 $EXTV_{CC}$ pin (do not float this pin).

1. Open R59 and populate R61 with a 0Ω resistor.
2. Apply a DC voltage (recommend 6V to 13V) on $EXTV_{CC}$ and GND turret after the input voltage is established. Make sure $EXTV_{CC} < V_{IN}$.
3. Turn off the DC bias on the $EXTV_{CC}$ before powering off the input power supply.

QUICK START PROCEDURE

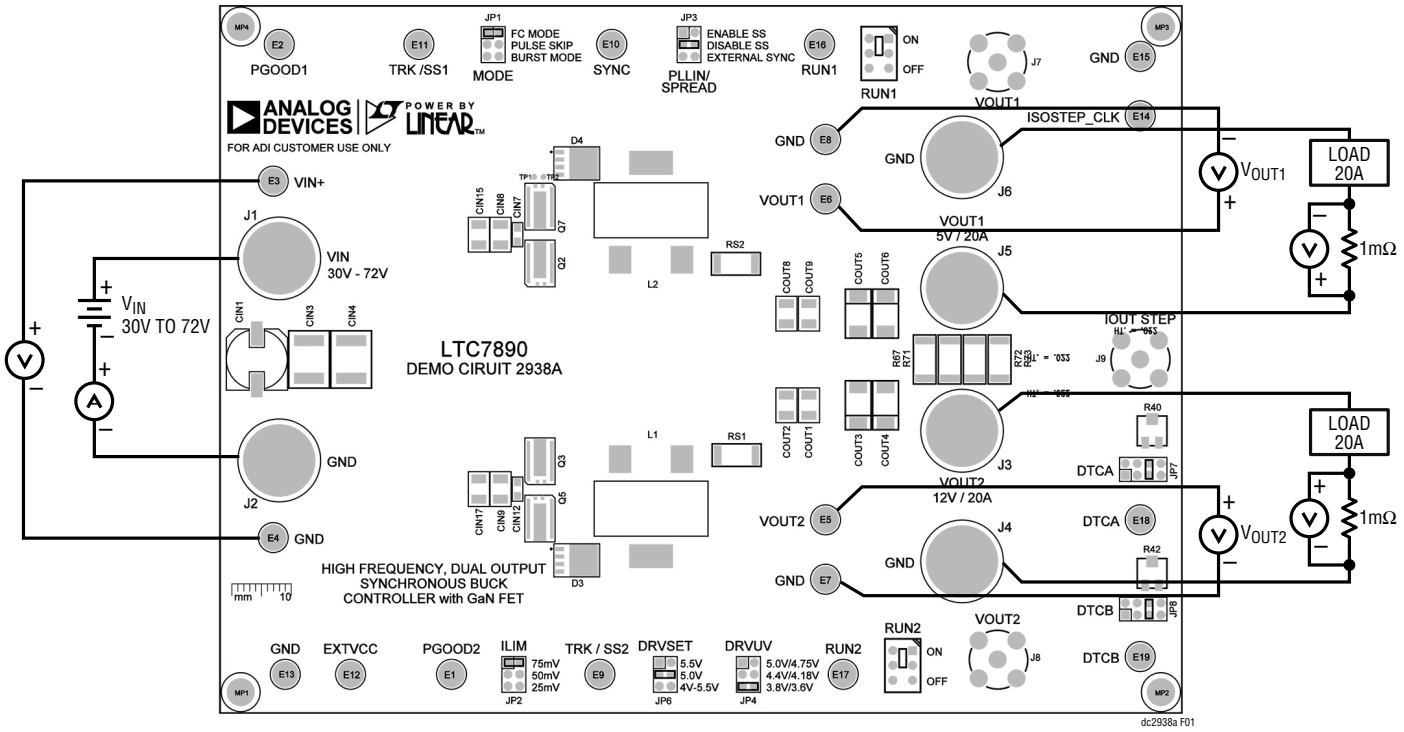


Figure 1. Test Setup Drawing for DC2938A

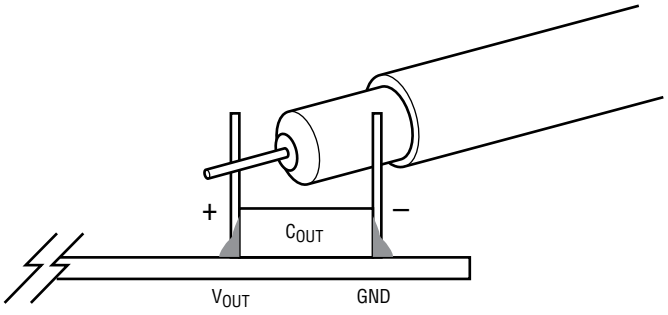


Figure 2. Proper Measurement Equipment Setup

TYPICAL TEST RESULTS

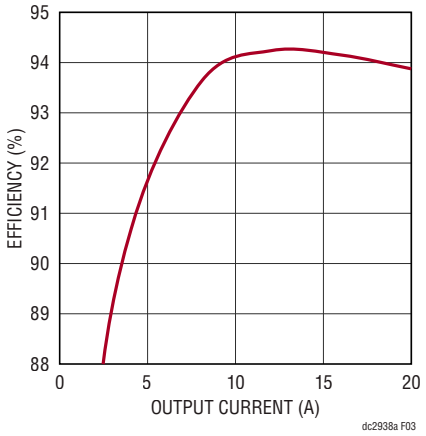


Figure 3. Measured Efficiency (V_{IN} = 48V, V_{OUT} = 5V, f_{SW} = 500kHz)

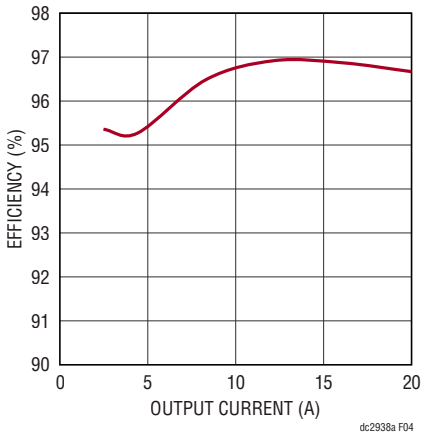
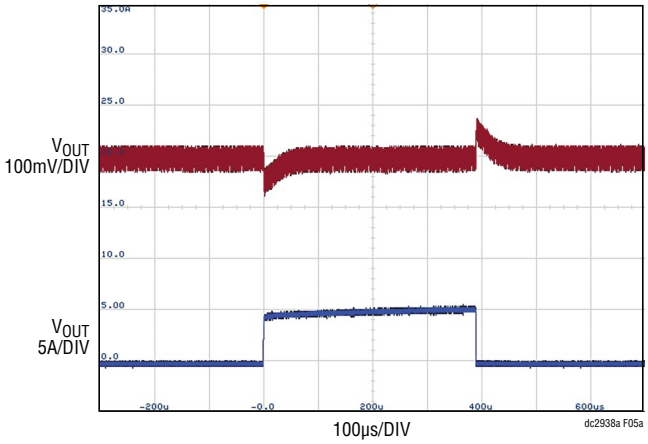


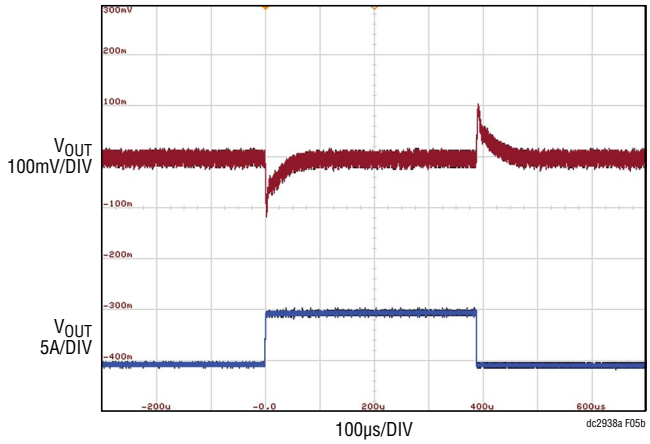
Figure 4. Measured Efficiency (V_{IN} = 48V, V_{OUT} = 12V, f_{SW} = 500kHz)

TYPICAL TEST RESULTS



V_{IN} = 48V, V_{OUT} = 5V, 10A–15A–10A LOAD

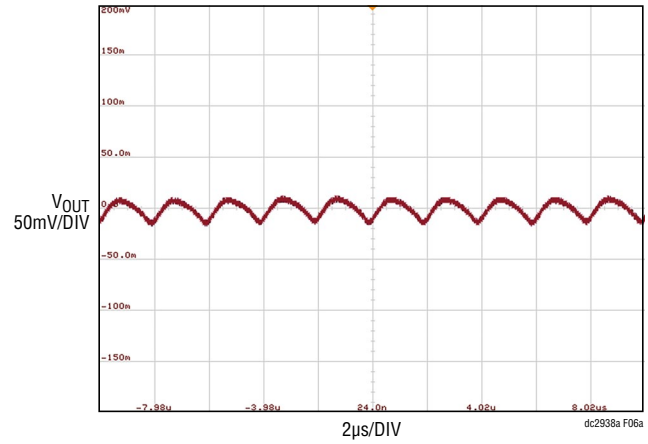
(a)



V_{IN} = 48V, V_{OUT} = 12V, 10A–15A–10A LOAD

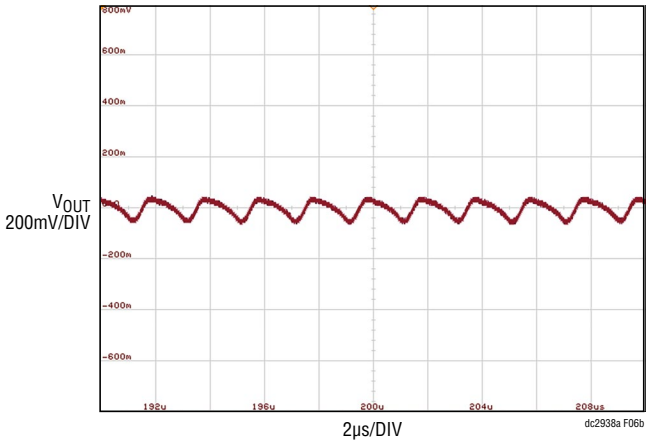
(b)

Figure 5. Measured Output Voltage vs Load Current



V_{IN} = 48V, V_{OUT} = 5V, I_{OUT} = 20A

(a)

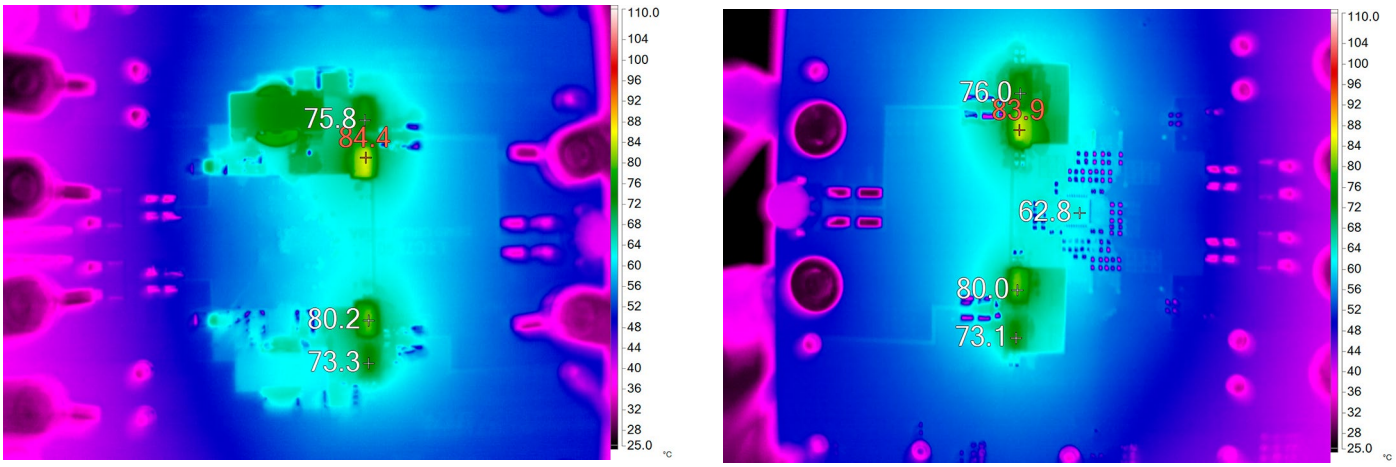


V_{IN} = 48V, V_{OUT} = 12V, I_{OUT} = 20A

(b)

Figure 6. Measured Output Voltage Ripple (20MHz BW, CCM)

TYPICAL TEST RESULTS



(a) Front View **(b) Back View**

Figure 7. Thermal at V_{IN} = 48V, V_{OUT1} = 5V, I_{OUT1} = 20A, V_{OUT2} =12V, I_{OUT} = 20A

Airflow	Heat Sink	Ambient (°C)
Natural Convection	None	25

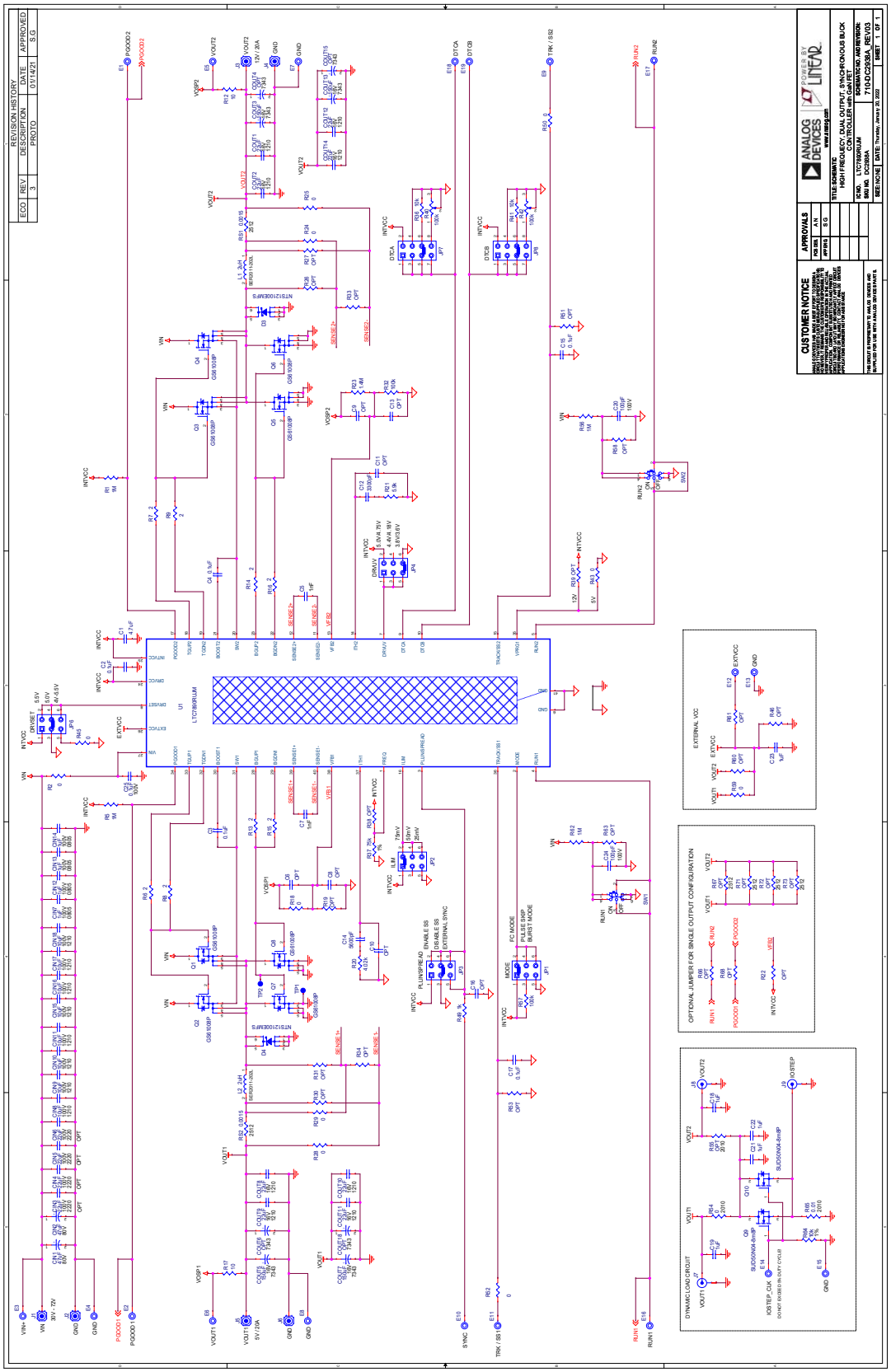
PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	1	C1	CAP., 4.7µF, X5R, 25V, 10%, 0603, NO SUBS. ALLOWED	MURATA, GRM188R61E475KE11D
2	5	C2, C3, C4, C15, C17	CAP., 0.1µF, X7R, 25V, 10%, 0603	AVX, 06033C104KAT2A
3	2	C5, C7	CAP., 1000pF, X7R, 25V, 10%, 0603	AVX, 06033C102KAT2A
4	1	C12	CAP., 3300pF, X7R, 50V, 10%, 0603	WURTH ELEKTRONIK, 885012206086
5	1	C14	CAP., 5600pF, C0G, 50V, 5%, 0603	KEMET, C0603C562J5GACTU
6	3	C18, C19, C23	CAP., 1µF, X7R, 25V, 10%, 0603, AEC-Q200	MURATA, GCM188R71E105KA64D
7	2	C20, C24	CAP., 100pF, C0G, 100V, 5%, 0603	MURATA, GRM1885C2A101JA01D
8	2	C21, C22	CAP., 1µF, X7R, 25V, 10%, 0805	AVX, 08053C105KAT2A
9	1	C25	CAP., 0.1µF, X7R, 100V, 10%, 0603	AVX, 06031C104KAT2A
10	2	CIN1, CIN2	CAP., 47µF, ALUM POLY, OS-CON, 80V, 20%, 10mm ×12.6mm, F12, SMD, RADIAL	PANASONIC, 80SXV47M
11	4	CIN7, CIN12, CIN13, CIN14	CAP., 1µF, X7S, 100V, 10%, 0805, SOFT TERM.	MURATA, GRJ21BC72A105KE11L
12	8	CIN8, CIN9, CIN10, CIN11, CIN15, CIN16, CIN17, CIN18	CAP., 10µF, X7S, 100V, 10%, 1210	MURATA, GRM32EC72A106KE05L
13	8	COUT1, COUT2, COUT8, COUT9, COUT10, COUT11, COUT12, COUT14	CAP., 22µF, X7R, 16V, 10%, 1210	MURATA, GRM32ER71C226KEA8L
14	4	COUT3, COUT5, COUT7, COUT13	CAP., 150µF, TANT, POSCAP, 16V, 20%, 7343, 50mΩ, TQC	PANASONIC, 16TQC150MYF
15	2	D3, D4	DIODE, SCHOTTKY, 100V, 12A, SO-8FL, AEC-101	ON SEMICONDUCTOR, NTS12100EMFST1G
16	19	E1, E2, E3, E4, E5, E6, E7, E8, E9, E10, E11, E12, E13, E14, E15, E16, E17, E18, E19	TEST POINT, TURRET, 0.094" MTG. HOLE, PCB 0.062" THK	MILL-MAX, 2501-2-00-80-00-00-07-0
17	2	L1, L2	IND., 2µH, PWR, SHIELDED, 20%, 40A, 1.34mΩ, 19.69mm × 19.55mm × 10.67mm, SER2011, AEC-Q200	COILCRAFT, SER2011-202MLB
18	8	Q1, Q2, Q3, Q4, Q5, Q6, Q7, Q8	XSTR., MOSFET, N-CH, E-MODE, 100V, 90A, GaNPX-4, BOTTOM-SIDE COOLED	GAN SYSTEMS INC., GS61008P-E05-MR
19	2	Q9, Q10	XSTR., MOSFET, N-CH, 40V, 14A, DPAK (TO-252)	VISHAY, SUD50N04-8M8P-4GE3
20	4	R1, R5, R56, R62	RES., 1M, 1%, 1W/10W, 0603, AEC-Q200	VISHAY, CRCW06031M00FKEA
21	11	R2, R18, R24, R25, R28, R29, R43, R45, R50, R52, R59	RES., 0Ω, 1W/10W, 0603, AEC-Q200	VISHAY, CRCW06030000Z0EA
22	8	R6, R7, R8, R9, R13, R14, R15, R16	RES., 2Ω, 1%, 1W/10W, 0603, AEC-Q200	VISHAY, CRCW06032R00FKEA
23	2	R12, R17	RES., 10Ω, 1%, 1W/10W, 0603	VISHAY, CRCW060310R0FKEA
24	1	R20	RES., 4.02k, 1%, 1W/10W, 0603, AEC-Q200	PANASONIC, ERJ3EKF4021V
25	1	R21	RES., 5.9k, 1%, 1W/10W, 0603	PANASONIC, ERJ3EKF5901V
26	1	R23	RES., 1.4M, 1%, 1W/10W, 0603, AEC-Q200	VISHAY
27	2	R32, R57	RES., 100k, 1%, 1W/10W, 0603, AEC-Q200	VISHAY, CRCW0603100KFKEA
28	3	R36, R41, R64	RES., 10k, 1%, 1W/10W, 0603, AEC-Q200	VISHAY, CRCW060310K0FKEA
29	1	R37	RES., 75k, 1%, 1W/10W, 0603	PANASONIC, ERJ3EKF7502V
30	2	R40, R42	RES., 100k, 20%, 1W/4W, SMD 4mm SQ, 1-TURN, TOP ADJ., TRIMPOT	BOURNS, 3314J-1-104E
31	1	R49	RES., 1k, 1%, 1W/10W, 0603	VISHAY, CRCW06031K00FKEA

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
32	1	R54	RES., 0Ω, 1W, 2010, HIGH PWR, PULSE PROOF, AEC-Q200	VISHAY, CRCW20100000Z0EFHP
33	1	R65	RES., 0.01Ω, 1%, 1W, 2010, PWR, METAL, SENSE, AEC-Q200	VISHAY, WSL2010R0100FEA18
34	2	RS1, RS2	RES., 0.0015Ω, 1%, 3W, 2512, METAL, SENSE, AEC-Q200	VISHAY, WSLP25121L500FEA
35	2	SW1, SW2	SWITCH, SLIDE, DPDT, 0.3A, 6VDC, PTH	C&K, JS202011CQN
36	1	U1	IC, BUCK CONTROLLER FOR GaN FETs, QFN-40	ANALOG DEVICES, LTC7890RUJM#TRPBF
Additional Demo Board Components				
1	0	C6, C8, C9, C10, C11, C13, C16	CAP., OPTION, 0603	
2	0	CIN3, CIN4, CIN5, CIN6	CAP., 22µF, X7S, 100V, 20%, 2220, STACKED	
3	0	COUT4, COUT6, COUT15, COUT18	CAP., OPTION, 7343	
4	0	R19, R22, R26, R27, R30, R31, R33, R34, R38, R39, R46, R51, R53, R58, R60, R61, R63, R66, R68	RES., OPTION, 0603	
5	0	R55	RES., OPTION, 2010	
6	0	R67, R71, R72, R73	RES., OPTION, 2512	
Hardware: For Demo Board Only				
1	6	J1, J2, J3, J4, J5, J6	EVAL BOARD STUD HARDWARE SET, #10-32	ANALOG DEVICES, 720-0010
2	3	J7, J8, J9	CONN., RF, BNC, RCPT, JACK, 5-PIN, ST, THT, 50Ω	AMPHENOL RF, 112404
3	5	JP1, JP2, JP3, JP4, JP6	CONN., HDR, MALE, 2×3, 2mm, VERT, ST, THT	WURTH ELEKTRONIK, 62000621121
4	2	JP7, JP8	CONN., HDR, MALE, 2×4, 2mm, VERT, ST, THT	WURTH ELEKTRONIK, 62000821121
5	4	MP1, MP2, MP3, MP4	STANDOFF, NYLON, SNAP-ON, 0.625" (5/8), 15.9mm	KEYSTONE, 8834
6	7	XJP1, XJP2, XJP3, XJP4, XJP6, XJP7, XJP8	CONN., SHUNT, FEMALE, 2-POS, 2mm	WURTH ELEKTRONIK, 60800213421

SCHEMATIC DIAGRAM



ESD Caution
ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

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