LTC7891 High Frequency Step-Down Supply with GaN FETs

DESCRIPTION

Demonstration circuit 2995A is a buck regulator featuring the LTC®7891. The DC2995A operates from a 36V to 72V input voltage range and generates a 12V, 20A output. The LTC7891 has a precision voltage reference which can generate an output voltage with 2% tolerance over the full operating conditions. The 500kHz switching frequency operation results in a small and efficient circuit. The converter achieves over 96% efficiency with 20A load.

The demonstration circuit can be easily modified to regulate output voltages from 0.8V to 60V.

The DC2995A provides a high performance cost-effective solution for generating a 12V output. The LTC7891 data sheet gives a complete description of this part, its operation and application information and must be read in conjunction with this demo manual.

Design files for this circuit board are available.

PERFORMANCE SUMMARY Specifications are at $T_A = 25°C$

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Minimum Input Voltage	I_{OUT} = 0A to 20A		36		V
Maximum Input Voltage	I_{OUT} = 0A to 20A		72		V
Output Voltage	V_{IN} = 36V to 72V		12 ±2%		V
Output Voltage Ripple	V_{IN} = 48V, I_{OUT} = 20A		300		mV_{P-P}
Nominal Switching Frequency			500		kHz

QUICK START PROCEDURE

Demonstration circuit 2995A is easy to set up to evaluate the performance of the LTC7891. For proper measurement equipment setup refer to Figure 1 and follow the procedure below.

NOTE: When measuring the input or output voltage ripple, care must be taken to minimize the length of oscilloscope probe ground lead. Measure the input or output voltage ripple by connecting the probe tip directly across the VIN or VOUT and GND terminals as shown in Figure 2.

1. With power off, connect the input power supply to VIN and GND.
2. Keep the load set to 0A or disconnected.
3. Turn the input power source on and slowly increase the input voltage.

   NOTE: Make sure that the input voltage V_{IN} does not exceed 72V.
4. Set the input voltage to 48V and check for the proper output voltage of 12V. If there is no output, temporarily disconnect the load to make sure that the load is not set too high.
5. Once the proper output voltage is established, adjust the load, and observe the output voltage regulation, ripple voltage, efficiency, and other parameters.

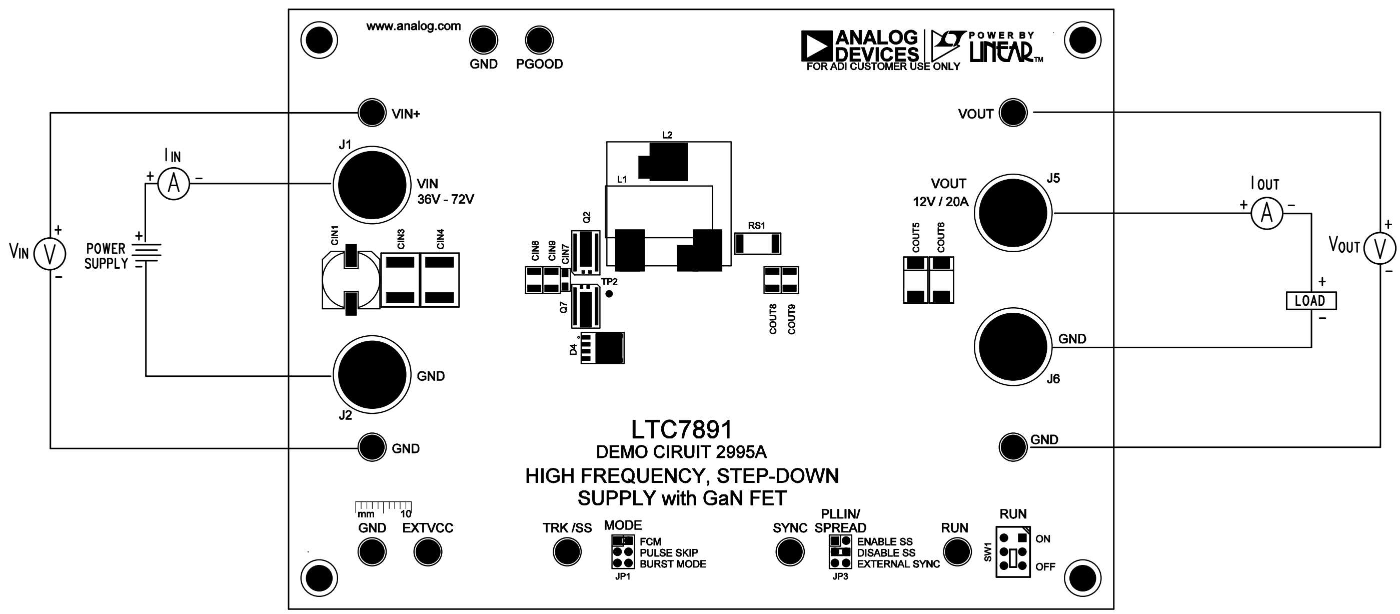


Figure 1. Proper Measurement Equipment Setup

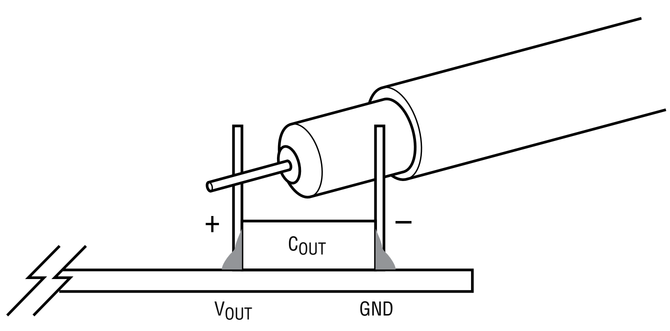


Figure 2. Measuring Input or Output Ripple

QUICK START PROCEDURE

Changing the Output Voltage

To change the output voltage from the programmed 12V, change the voltage setting resistors connected to LTC7891 FB pin (see Schematic Diagram section). Also, change all the power components required to meet the desired output voltage.

Converter Efficiency and Output Current

Typical performance of DC2995A is shown in Figure 3. The efficiency is high even at light loads thanks to Burst Mode® operation.

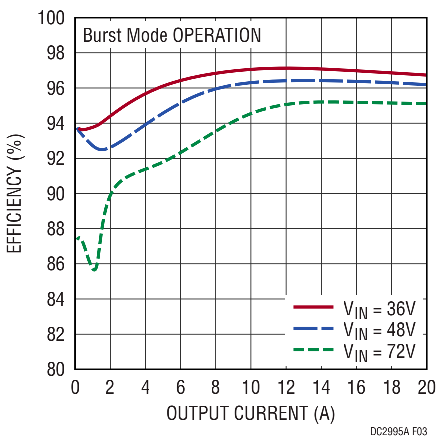


Figure 3. The 12V Output Efficiency is 96.1% with 20A Load

Output Load Step Response

The load step response of DC2995A is dependent on the amount and type of output caps used. For higher load steps more output capacitance can be added to keep the voltage transients at the desired level. The 10A load step transients with 48V input are shown in Figure 4. Other types of low ESR and high value capacitors can be used if space is available to reduce load transients to desired level.

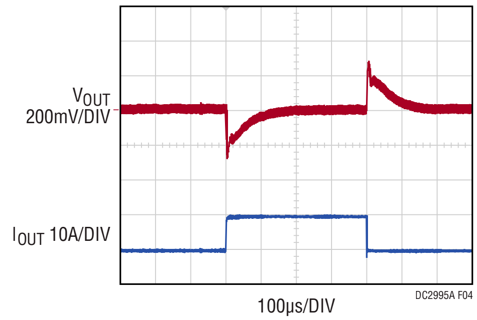


Figure 4. The LTC7891 Has Good Load Step Response with Small Output Capacitors

Start-Up and Soft-Start Function

The DC2995A features a soft-start circuit that ramps the output voltage up in monotonic fashion as shown in Figure 5. The soft-start circuit also prevents output voltage overshoot when output voltage ramp reaches regulation.

When RUN pin is enabled, the output voltage will start ramping up after 1ms delay that is required for $INTV_{CC}$ pin to reach the internal UVLO level.

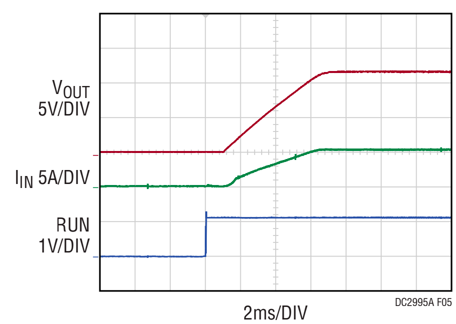


Figure 5. The DC2995A Ramps the Output Slowly at Start-Up without Output Voltage Overshoot

QUICK START PROCEDURE

Thermal Performance

The LTC7891 features excellent thermal performance due to high efficiency of synchronous buck circuit. The temperature rises of LTC7891 with 48V input and 20A load is shown in Figure 6.

The six-layer PCB layout features solid copper planes that provide heat spreading across the whole board.

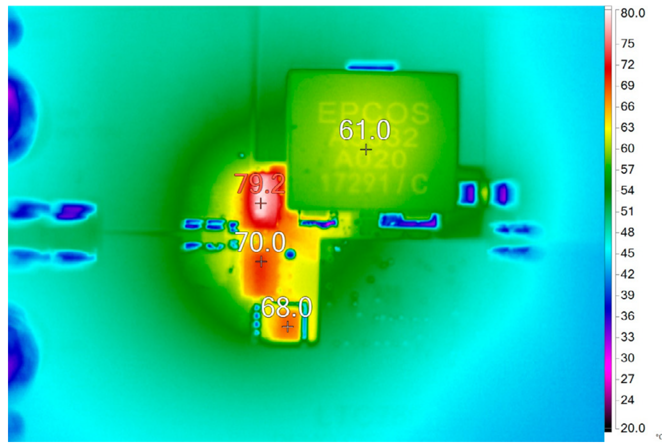


Figure 6. The LTC7891 Has Only 54.2°C Temperature Rise with 48V Input, 12V Output and 20A Load. (T_A = 25°C, No Cooling Fan)

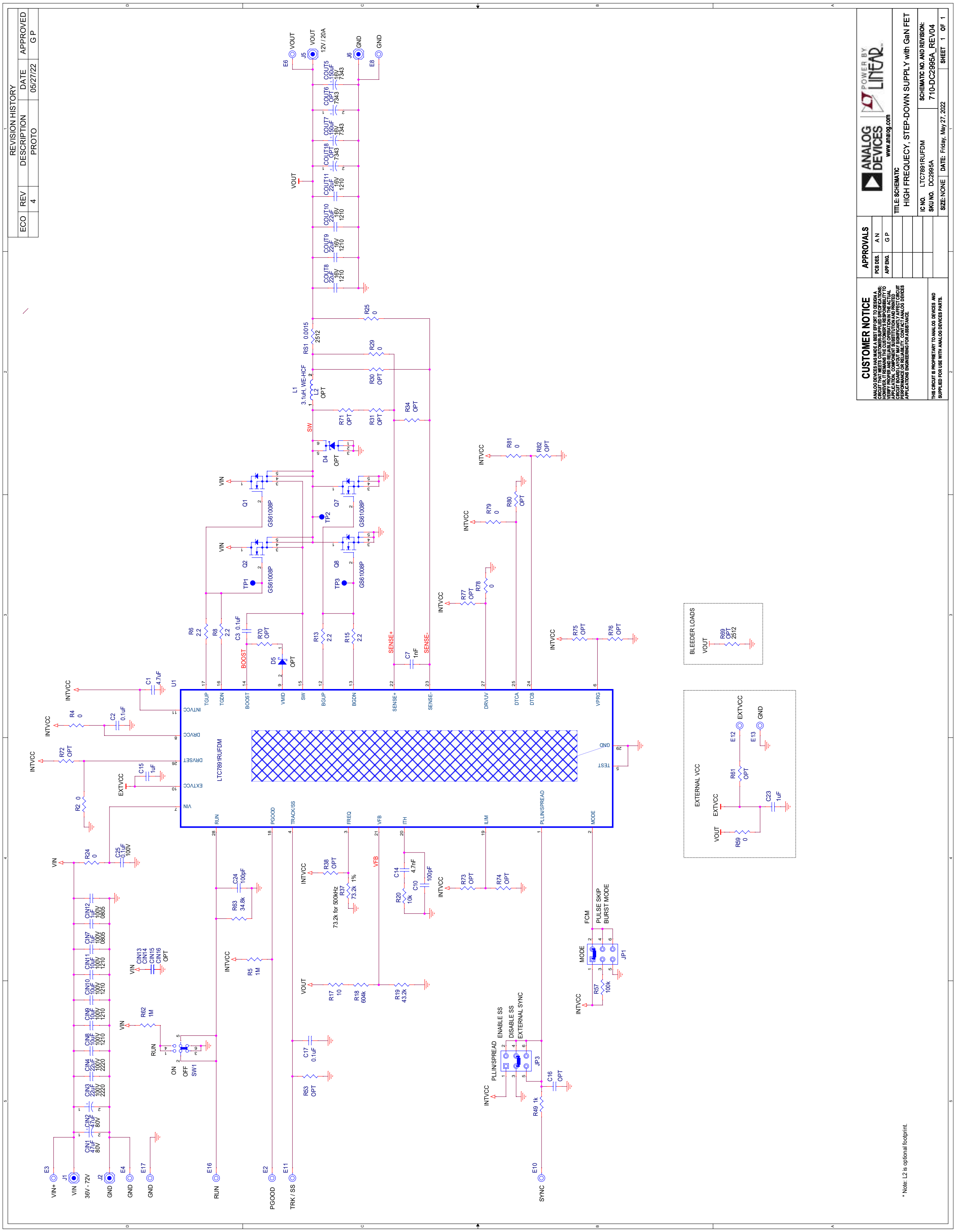
PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Required Circuit Components				
1	1	C1	CAP., 4.7µF, X5R, 25V, 10%, 0603	MURATA, GRM188R61E475KE11D
2	3	C2, C3, C17	CAP., 0.1µF, X7R, 25V, 10%, 0603	AVX, 06033C104KAT2A
3	1	C7	CAP., 1000pF, X7R, 25V, 10%, 0603	AVX, 06033C102KAT2A
4	2	C10, C24	CAP., 100pF, C0G, 25V, 10%, 0603	AVX, 06033A101KAT2A
5	1	C14	CAP., 4700pF, C0G/NP0, 50V, 5%, 0603	AVX, 06035A472JAT2A
6	1	C15	CAP., 1µF, X5R, 50V, 10%, 0603, AEC-Q200	MURATA, GRT188R61H105KE13D
7	1	C23	CAP., 1µF, X7R, 25V, 10%, 0603, AEC-Q200	MURATA, GCM188R71E105KA64D
8	1	C25	CAP., 0.1µF, X7R, 100V, 10%, 0603	AVX, 06031C104KAT2A
9	2	CIN1, CIN2	CAP., 47µF, ALUM. POLY. HYB., 80V, 20%, 10mm × 10.2mm SMD, RADIAL, AEC-Q200	PANASONIC, EEHZC1K470P
10	2	CIN3, CIN4	CAP., 22µF, X7S, 100V, 20%, 2220, STACKED	TDK, CKG57NX7S2A226M500JH
11	2	CIN7, CIN12	CAP., 1µF, X7S, 100V, 10%, 0805, SOFT TERM.	MURATA, GRJ21BC72A105KE11L
12	4	CIN8-CIN11	CAP., 10µF, X7S, 100V, 10%, 1210	MURATA, GRM32EC72A106KE05L
13	2	COUT5, COUT7	CAP., 150µF, TANT., 16V, 20%, 7343	PANASONIC, 16TQC150MYF
14	4	COUT8-COUT11	CAP., 22µF, X7R, 16V, 10%, 1210	MURATA, GRM32ER71C226KEA8L
15	1	L1	IND., 3.1µH, WE-HCF, PWR, 15%, 16A, 2.09mΩ, 2013	WURTH ELEKTRONIK, 7443630310
16	4	Q1, Q2, Q7, Q8	XSTR., MOSFET, N-CH, E-Mode, 100V, 90A, GaNPX-4, BOTTOM-SIDE COOLED	GAN SYSTEMS INC., GS61008P-MR
17	9	R2, R4, R24, R25, R29, R59, R78, R79, R81	RES., 0Ω, 1/10W, 0603, AEC-Q200	VISHAY, CRCW06030000Z0EA
18	2	R5, R62	RES., 1M, 1%, 1/10W, 0603, AEC-Q200	VISHAY, CRCW06031M00FKEA
19	4	R6, R8, R13, R15	RES., 2.2Ω, 5%, 1/10W, 0603, AEC-Q200	PANASONIC, ERJ3GEYJ2R2V
20	1	R17	RES., 10Ω, 1%, 1/10W, 0603	VISHAY, CRCW060310R0FKEA
21	1	R18	RES., 604k, 1%, 1/10W, 0603, AEC-Q200	VISHAY, CRCW0603604KFKEA
22	1	R19	RES., 43.2k, 1%, 1/10W, 0603, AEC-Q200	PANASONIC, ERJ3EKF4322V
23	1	R20	RES., 10k, 1%, 1/10W, 0603, AEC-Q200	VISHAY, CRCW060310K0FKEA
24	1	R37	RES., 73.2k, 1%, 1/10W, 0603	NIC, NRC06F7322TRF
25	1	R49	RES., 1k, 1%, 1/10W, 0603	VISHAY, CRCW06031K00FKEA
26	1	R57	RES., 100k, 1%, 1/10W, 0603, AEC-Q200	VISHAY, CRCW0603100KFKEA
27	1	R63	RES., 34.8k, 1%, 1/10W, 0603	VISHAY, CRCW060334K8FKEA
28	1	RS1	RES., 0.0015Ω, 1%, 3W, 2512, METAL, SENSE, AEC-Q200	VISHAY, WSLP25121L500FEA
29	1	U1	IC, STEP-DOWN CONTROLLER FOR GaN FETs, QFN-28	ANALOG DEVICES, LTC7891RUFDM#PBF

PARTS LIST

ITEM	QTY	REFERENCE	PART DESCRIPTION	MANUFACTURER/PART NUMBER
Additional Demo Board Circuit Components				
1	0	C16	CAP., OPTION, 0603	
2	0	CIN13-CIN16	CAP., 10µF, X7S, 100V, 10%, 1210	MURATA, GRM32EC72A106KE05L
3	0	COUT6, COUT18	CAP., OPTION, 7343	
4	0	D4	DIODE, SCHOTTKY, 100V, 12A, SO-8FL, AEC-101	ON SEMICONDUCTOR, NTS12100EMFST1G
5	0	D5	DIODE, SCHOTTKY BARRIER 100V 200mA SOD-323	ON SEMICONDUCTOR, NSR02100HT1G
6	0	R30, R31, R34, R38, R53, R61, R70-R77, R80, R82	RES., OPTION, 0603	
7	0	R69	RES., OPTION, 2512	
8	1	SW1	SWITCH SLIDE DPDT 300MA 6V THROUGH HOLE	C&K, JS202011CQN
9	4	J1, J2, J5, J6	EVAL BOARD STUD HARDWARE SET, #10-32	ANALOG DEVICES, 720-0010
10	0	L1	IND., OPTION, 3.6µH, PWR, SHIELDED, 20%, 30A, 1.82mΩ, 19.69mm × 19.56mm × 12.95mm, SER2013, AEC-Q200	COILCRAFT, SER2013-362MLB

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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