Evaluating the LTC3888/LTC3888-1, 8-Phase, Single Output Synchronous Buck Converter with Power System Management

FEATURES

- Input voltage range: 7 V to 14 V
- Output voltage V_{OUT}: 0.3 V to 1.8 V, 1 V (default)
- Max output current: 400 A
- Number of phases: 8
- Current sense
- Temperature monitor
- PM bus compliant with digital power system management

EVALUATION BOARD KIT CONTENTS

- DC2888A-A/DC2888A-B evaluation board

EQUIPMENT NEEDED

- DC power supplies
- Multimeters for voltage and current measurements
- Electronic load or resistive loads
- DC1613A (USB to I^2C/PMBUS dongle)
- Oscilloscope
- Function generator or alternative digital driver

GRAPHICAL USER INTERFACE (GUI) DOWNLOAD

Download the software from:

https://www.analog.com/en/design-center/ltpower-play.html.

For more details and instructions of LTpowerPlay, see LTPowerplay Quick Start Procedure.

GENERAL DESCRIPTION

Demonstration circuit DC2888A-A/DC2888A-B is an 8-phase single-output, high efficiency, high density, synchronous buck converter with 7 V to 14 V input range. The output can supply up to 400 A maximum load current. The demo board showcases one LTC3888/LTC3888-1 working with eight LTC7051. The LTC3888/LTC3888-1 is a PMBus-compliant dual loop 8-phase step-down DC/DC controller with digital power system management. LTC7051 is an integrated smart power stage with current sense and temperature monitor. Refer to the LTC3888/LTC3888-1 and LTC7051 data sheets for detailed information.

DC2888A-A/DC2888A-B powers up to default settings and produces power based on configuration resistors without the need for any serial bus communication. This allows easy evaluation of the DC/DC converter. To fully explore the extensive power system management features of the part, download the GUI software LTpowerPlay™ on your PC and use Analog Devices' I^2C/SMBus/PMBus dongle DC1613A to connect to the board. LTpowerPlay allows to reconfigure the part on the fly and store the configuration in electrically erasable programmable read-only memory (EEPROM), and view the telemetry of voltage, current, temperature, and fault status.

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EVALUATION BOARD PHOTOGRAPH

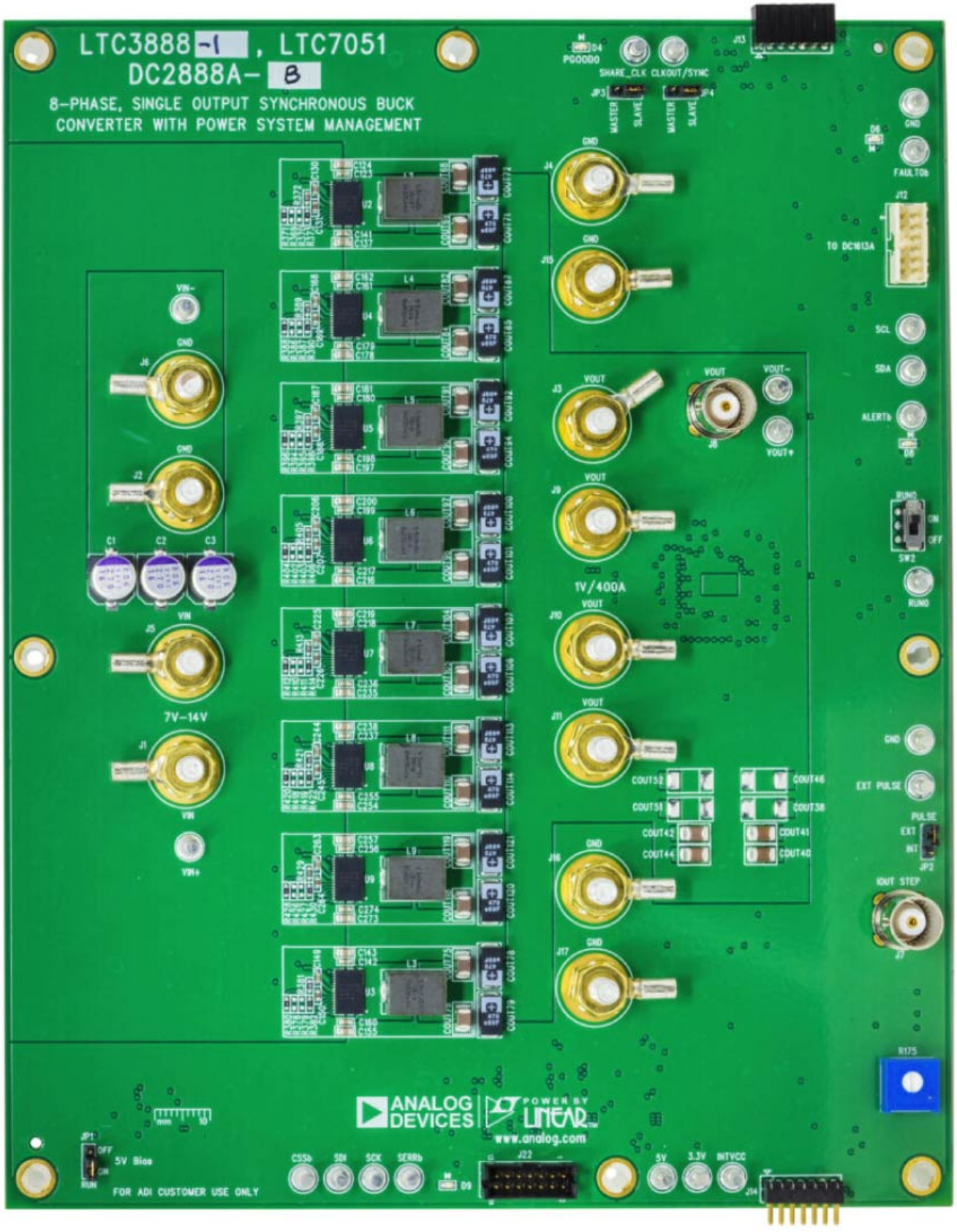

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Figure 1. 8-Phase Single-Output LTC3888-1 and LTC7051/DC2888A-B Demo Circuit

EVALUATION BOARD PHOTOGRAPH

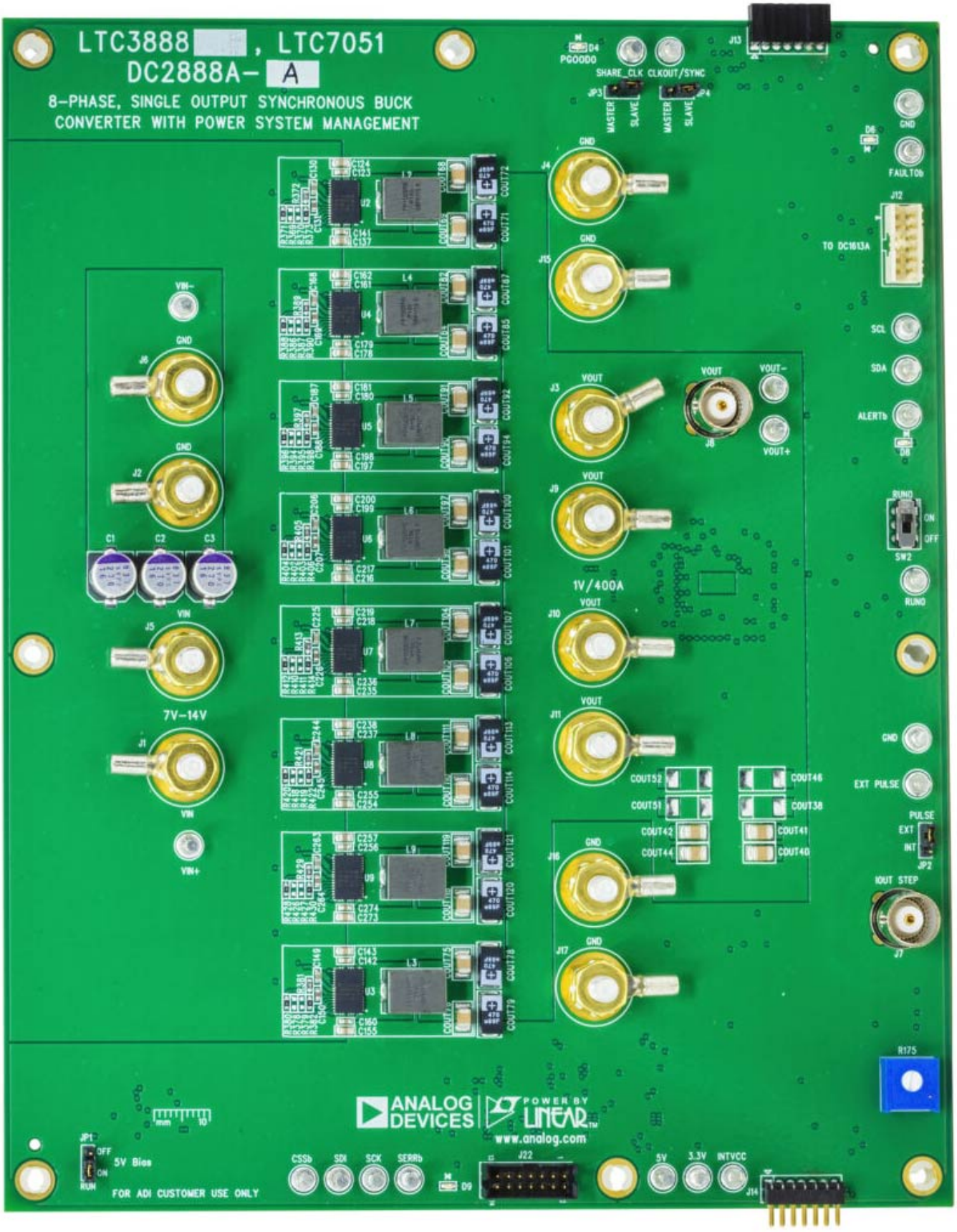


Figure 2. 8-Phase Single-Output LTC3888 and LTC7051/DC2888A-A Demo Circuit

PERFORMANCE SUMMARY

T_A = 25°C, unless otherwise specified.

Table 1. Performance Summary

Parameter	Test Conditions/Comments	Value
Input Voltage Range, V_{IN}		7 V to 14 V
Output Voltage, V_{OUT}	V_{IN} = 7 V to 14 V, I_{OUT} = 0 A to 40 A	0.3 V to 1.8 V, default: 1.0 V
Maximum Output Current, I_{OUT}	V_{IN} = 7 V to 14 V, V_{OUT} = 0.3 V to 1.8 V	400 A
Typical Efficiency	V_{IN} = 12 V, V_{OUT} = 1.0 V, I_{OUT} = 400 A	90.9%
Default Switching Frequency		500 kHz

QUICK START PROCEDURE

Demonstration circuit DC2888A-A/DC2888A-B is easy to set up to evaluate the performances of the LTC3888/LTC3888-1 and LTC7051. See Figure 3 for the proper measurement equipment setup and follow this procedure.

1. With power off, connect the input power supply (7 V to 14 V) to V_{IN} (J1, J5) and GND (J2, J6).
2. Connect the 1.0 V output load (initial load: no load) between V_{OUT} (J3, J9, J10, J11) and GND (J4, J15, J16, J17).
3. Set default jumper position:
   - JP1: ON
   - JP2: EXT
   - JP3: SLAVE
   - JP4: SLAVE
   - SW2: ON
4. Turn on the input power supply and check for the proper output voltage. V_{OUT} should be 1.0 V ±0.5%.
5. Once the proper output voltage is established, adjust the loads within the operating range and observe the output voltage regulation, ripple voltage, and other parameters.
6. Connect the dongle and control the output voltage from the GUI. See LTPowerplay Quick Start Procedure for details.

Note:

1. When measuring the efficiency, it is recommended to monitor the V_{IN}, V_{OUT} at the locations close to the power stage. Here is one example:

(1) Monitor V_{IN} across C218.

(2) Monitor V_{OUT} across COUT104.

2. When measuring the output or input voltage ripple, do not use the long ground lead on the oscilloscope probe. See Figure 4 for the proper scope probe technique. Short, stiff leads must be soldered to the (+) and (−) terminals of an output capacitor. The probe's ground ring needs to touch the (−) lead and the probe tip needs to touch the (+) lead.

3. When doing the load transient test, it is recommended to use a function generator to generate a pulse (~3% duty cycle with 10 Hz ~ 100 Hz frequency). Then apply this pulse to the EXT PULSE (E9) and GND (E10) turrets. The dynamic load circuit works well to achieve the desired load transient by adjusting the amplitude, rising edge, and falling edge of the pulse. Here are examples:

(1) Set the amplitude of the pulse as 3.18 V for a 0 A to 50 A load transient test with 5 mΩ I_{OUT} sensing resistor

(2) Set the amplitude of the pulse as 3.66 V for a 0 A to 100 A load transient test with 5 mΩ I_{OUT} sensing resistor

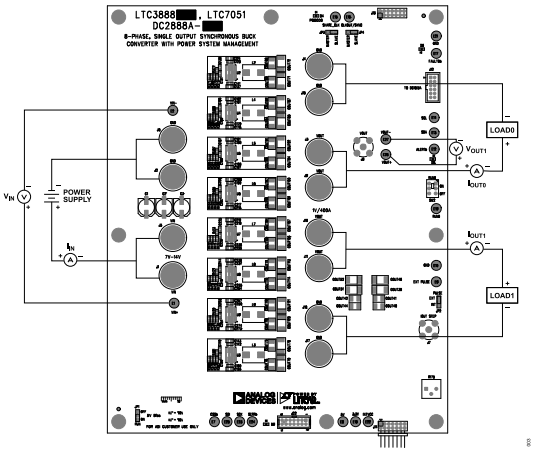


Figure 3. DC2888A-B Measurement Equipment Setup

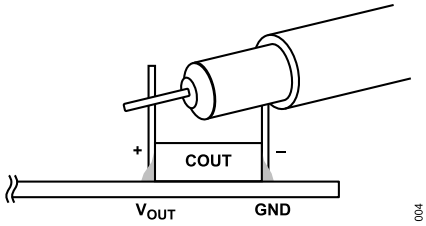


Figure 4. Measuring Output Voltage Ripple

CONNECTING A PC TO DC2888A-A/DC2888A-B

Use a PC to reconfigure the power management features of the LTC3888/LTC3888-1 such as: nominal V_{OUT}, margin set points, overvoltage (OV)/undervoltage (UV) limits, current fault limits, temperature fault limits, sequencing parameters, fault log, fault responses, and other functionality. The DC1613A dongle may be plugged when V_{IN} is present.

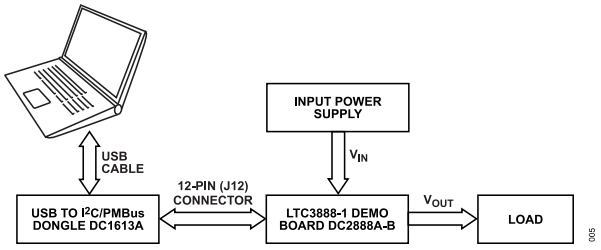


Figure 5. Demo Setup with PC

QUICK START PROCEDURE

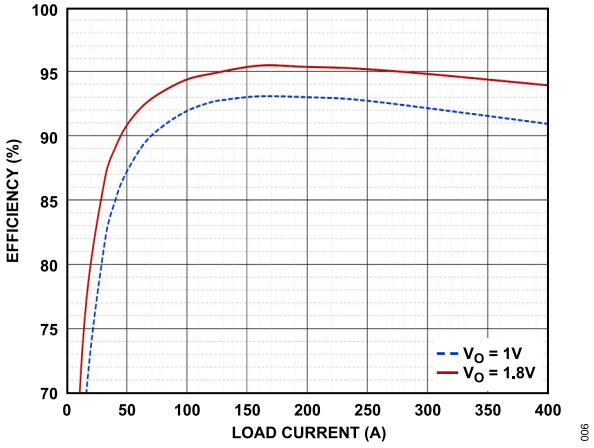


Figure 6. Efficiency vs. Load Current at fs = 500 kHz

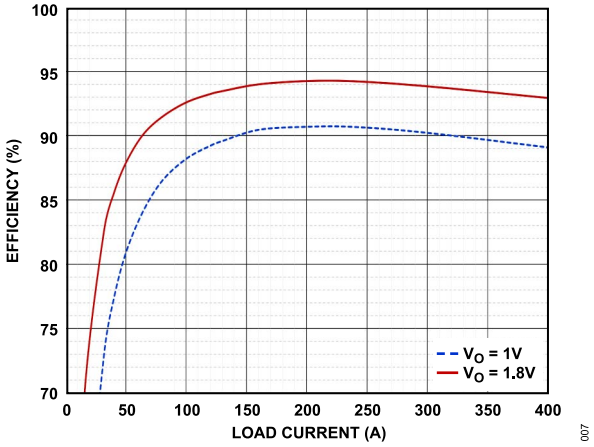


Figure 7. Efficiency vs. Load Current at fs = 1 MHz

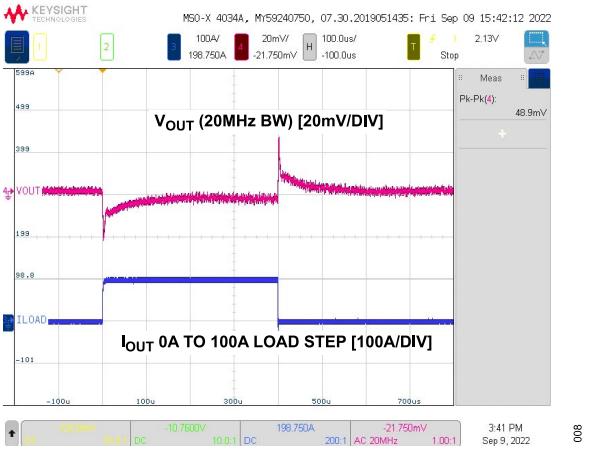


Figure 8. 0 A to 100 A Load Transient Response at V_{IN} = 12 V, V_{OUT} = 1.0 V, fs = 500 kHz

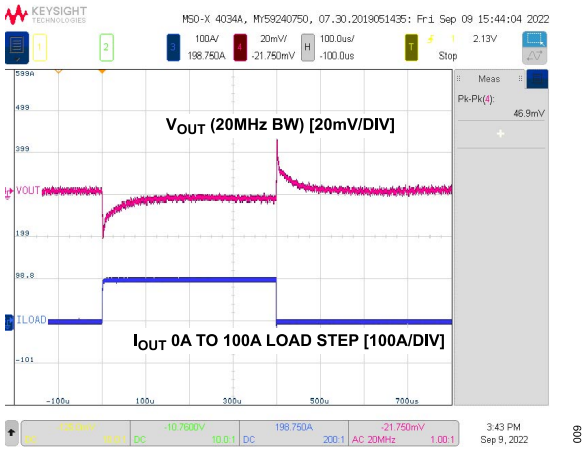


Figure 9. 0 A to 100 A Load Transient Response at V_{IN} = 12 V, V_{OUT} = 1.0 V, fs = 1 MHz

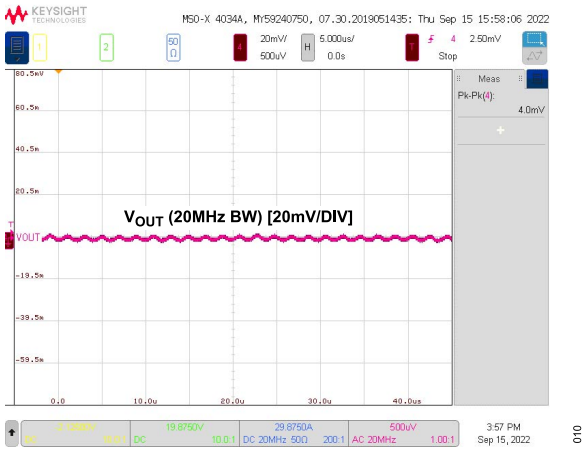


Figure 10. V_{OUT} Voltage Ripple at V_{IN} = 12 V, V_{OUT} = 1.0 V, I_{OUT} = 400 A, fs = 500 kHz

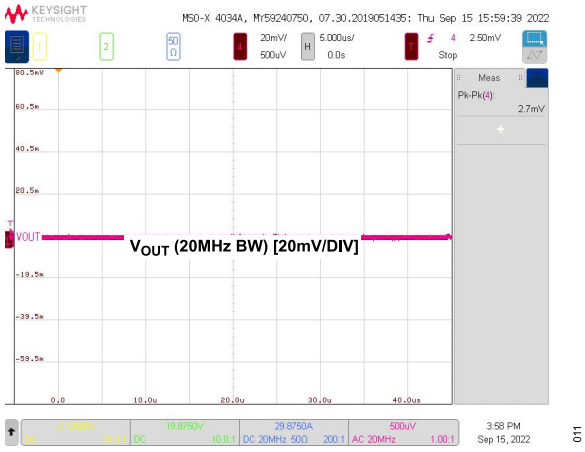


Figure 11. V_{OUT} Voltage Ripple at V_{IN} = 12 V, V_{OUT} = 1.0 V, I_{OUT} = 400 A, fs = 1 MHz

QUICK START PROCEDURE

Note: The default switching frequency of the board is 500 kHz. To change the switching frequency, connect the board to a PC and change the switching frequency on the LTPowerplay Software GUI with V_{IN} powered on and SW2 set to OFF. To have the optimized control at 1 MHz, set g_m to 4.35 mS for DC2888A-B and to 5.04 ms for DC2888A-A, and R_{ITH} to 11 kΩ on the LTpowerPlay Software GUI.

The options of 10 A/phase, 20 A/phase, and 30 A/phase steps of load emulation function of the LTC3888/LTC3888-1 are designed based on the assumption that current sensing gain IOUT_CAL_GAIN is equal to 5 mV/A. On this board, IOUT_CAL_GAIN is equal to 3 mV/A. So, the load step options are 16.67 A/phase, 33.33 A/phase, and 50 A/phase.

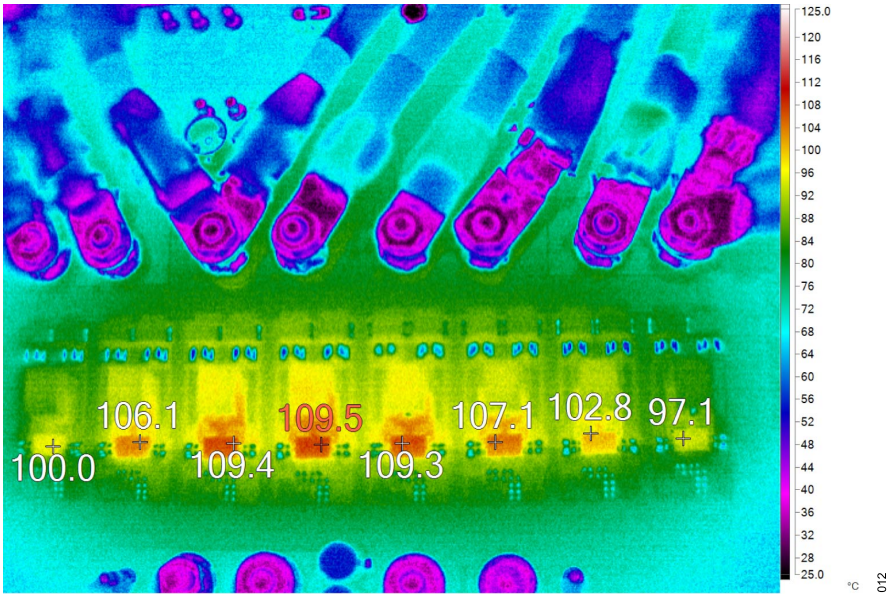


Figure 12. Thermal at V_{IN} = 12 V, V_{OUT} = 1.0 V, I_{OUT} = 400 A, fs = 500 kHz = 23°C, No Airflow

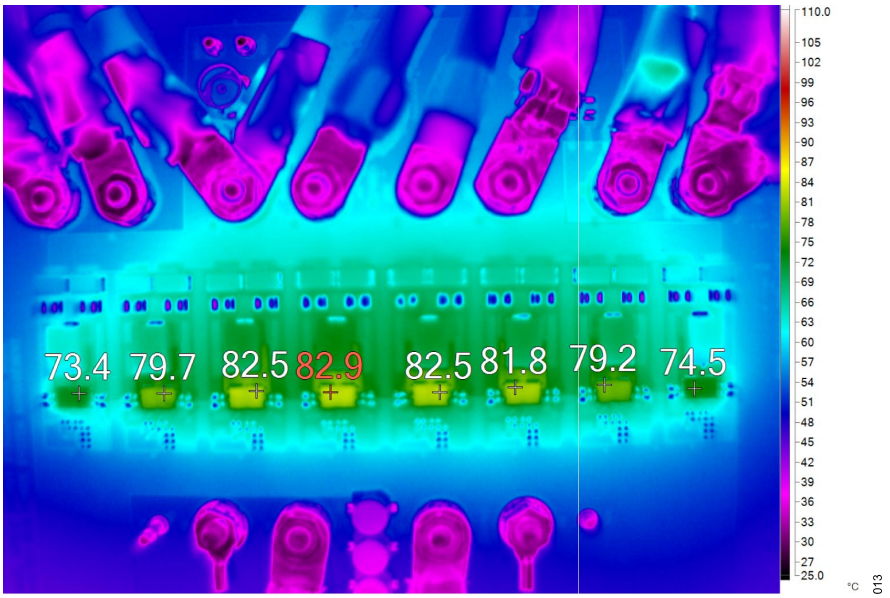


Figure 13. Thermal at V_{IN} = 12 V, V_{OUT} = 1.0 V, I_{OUT} = 400 A, fs = 500 kHz, T_A = 23°C, 200 FPM Airflow

LTPOWERPLAY SOFTWARE GUI

LTpowerPlay is a powerful Windows-based development environment that supports Analog Devices' power system management ICs and µModules, including LTM4675, LTM4676, LTM4677, LTM4678, LTM4680, LTM4700, LTC3880, LTC3882, LTC3883, LTC3884, and LTC3888. The software supports a variety of different tasks. Use LTpowerPlay to evaluate Analog Devices ICs by connecting to a demo board system. LTpowerPlay can also be used in an offline mode (with no hardware present) to build a multichip configuration file that can be saved and reloaded at a later time. LTpowerPlay provides unprecedented diagnostic and debug features. It becomes a valuable diagnostic tool during board bring-up to program or tweak the power management scheme in a system, or to diagnose power issues when bringing up rails. LTpowerPlay utilizes the DC1613A USB-to-I²C/SMBus/PMBus controller to communicate with one of many potential targets, including LTM4675, LTM4676, LTM4677, LTM4678, LTM4680, LTM4700, LTC3880, LTC3882, LTC3883, LTC3884, and LTC3888 demo systems, or a customer board. The software also provides an automatic update feature to keep the software current with the latest set of device drivers and documentation.

Download the LTpowerPlay software from:

http://www.analog.com/ltpowerplay.

To access technical support documents for Analog Devices' digital power system management products, visit the LTpowerPlay help menu.

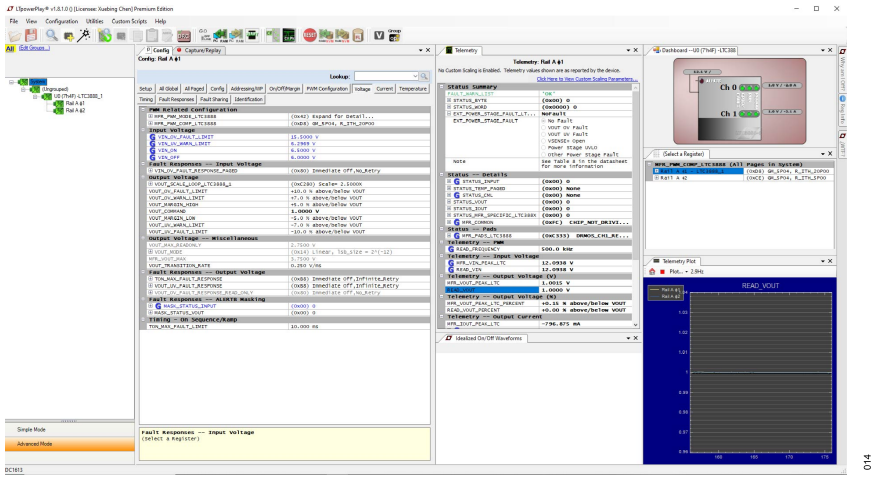


Figure 14. LTpowerPlay Main Interface (DC2888A-B)

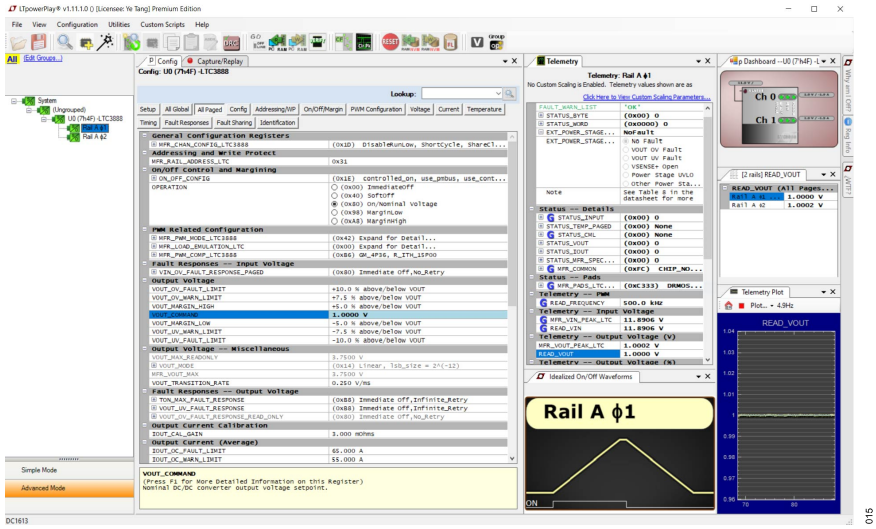


Figure 15. LTpowerPlay Main Interface (DC2888A-A)

LTPOWERPLAY QUICK START PROCEDURE

The following procedure describes how to use LTpowerPlay to monitor and change the settings of LTC3888/LTC3888-1.

1.Download and install the LTPowerPlay GUI:

http://www.analog.com/ltpowerplay

2. Launch the LTpowerPlay GUI.

a. The GUI should automatically identify the DC2888A-A/DC2888A-B. The system tree on the left hand side should look like this:

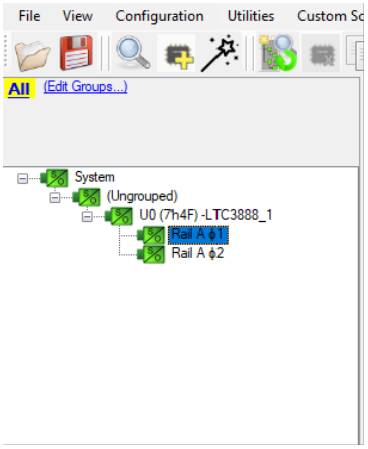


Figure 16. System Tree (DC2888A-B)

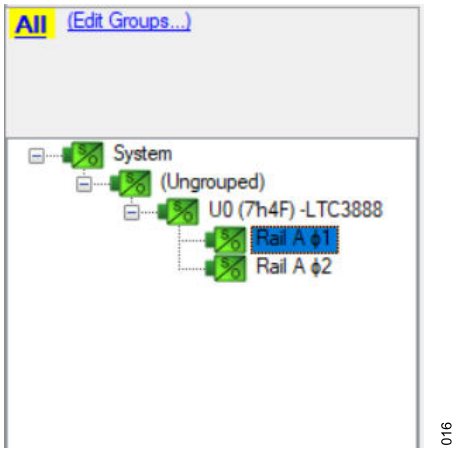


Figure 17. System Tree (DC2888A-A)

b. A green message box shows for a few seconds in the lower left-hand corner, confirming that LTC3888-1 is communicating:

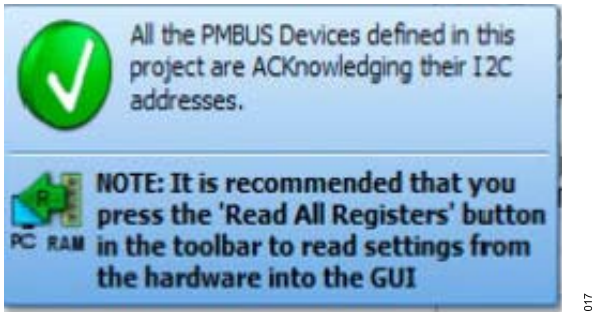


Figure 18. Message Box

c. In the Toolbar, click “R” (RAM to PC) to read the RAM from the LTC3888-1. This reads the configuration from the RAM of LTC3888-1 and loads it into the GUI.

Figure 19. Click "R" to Read RAM

d. To change the output voltage to a different value, like 1.5 V, in the "Voltage" tab, type 1.5 in the VOUT_COMMAND box, like this:

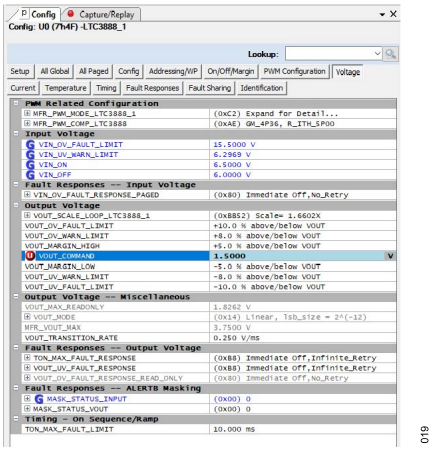


Figure 20. VOUT_COMMAND Box (DC2888A-B)

LTPOWERPLAY QUICK START PROCEDURE

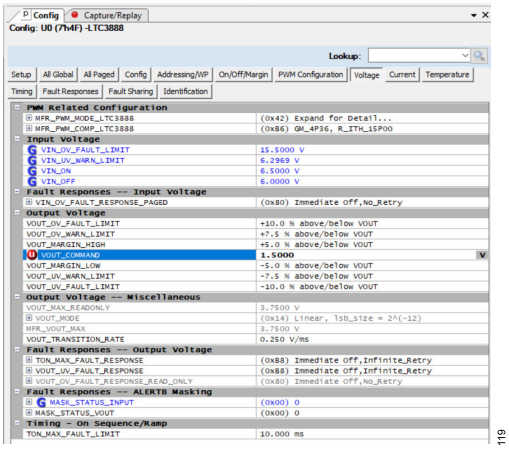


Figure 21. VOUT_COMMAND Box (DC2888A-A)

Then, click “W” (PC to RAM) to write these register values to LTC3888-1. After finishing this step, the output voltage changes to 1.5 V.

Figure 22. Click "W" to Write Register Values

If the write is successful, the following message pops up:

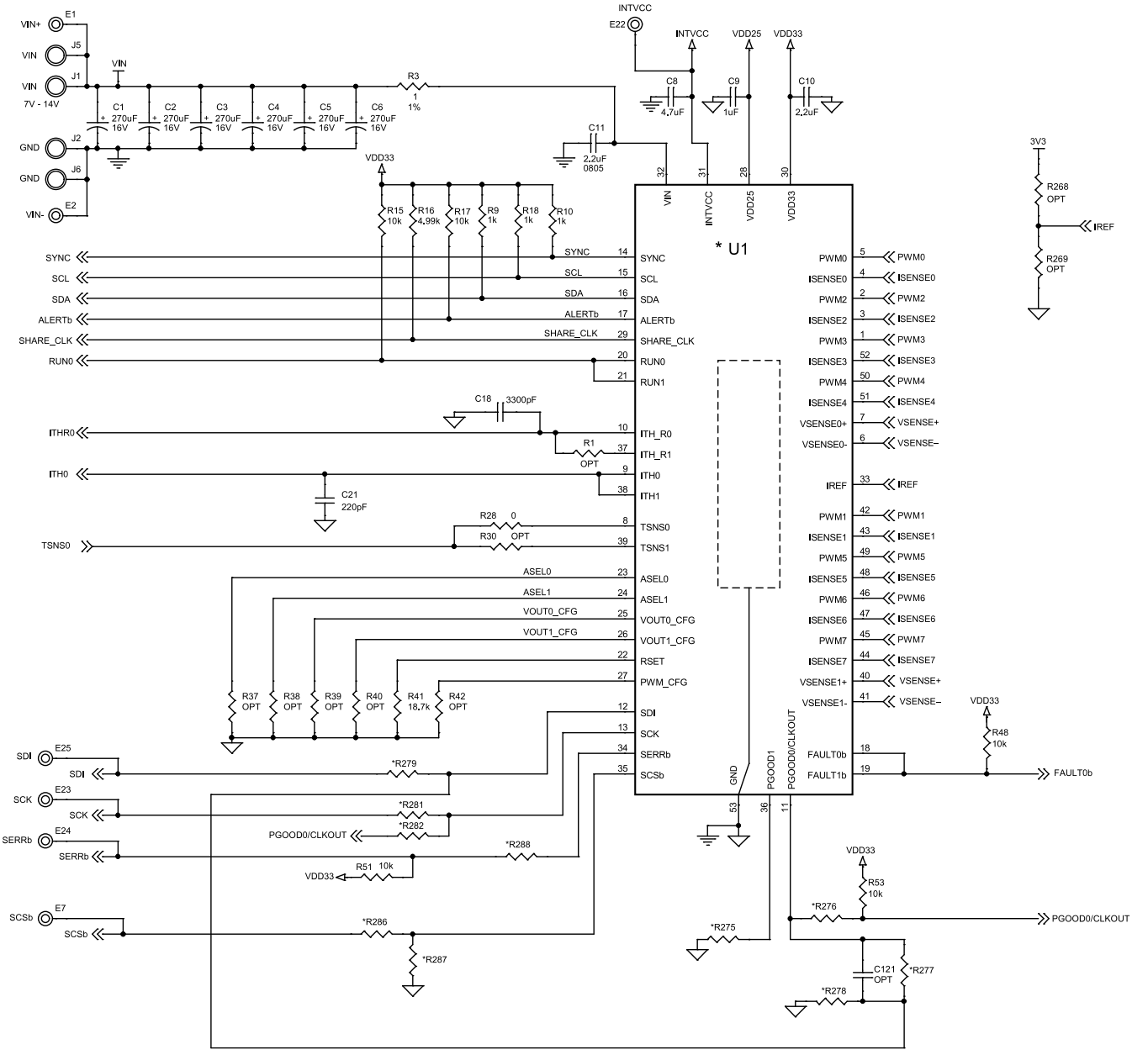
Figure 23. Message for Successful Write

e. Save the changes into the non-volatile memory (NVM). In the tool bar, click “RAM to NVM” button, as following:

Figure 24. RAM to NVM

f. Save the demo board configuration to a (*.proj) file. Click "Save" and save the file. Name it as desired.

SCHEMATIC DIAGRAMS



VERSION	U1	R279	R277	R278	R276	R275	R286	R287	R288	R281	R282
–A	LTC3888IUHG	0	OPT	OPT	0	OPT	0	OPT	0	0	OPT
–B	LTC3888IUHG-1	OPT	31.6K	21K	OPT	0	OPT	0	OPT	OPT	0

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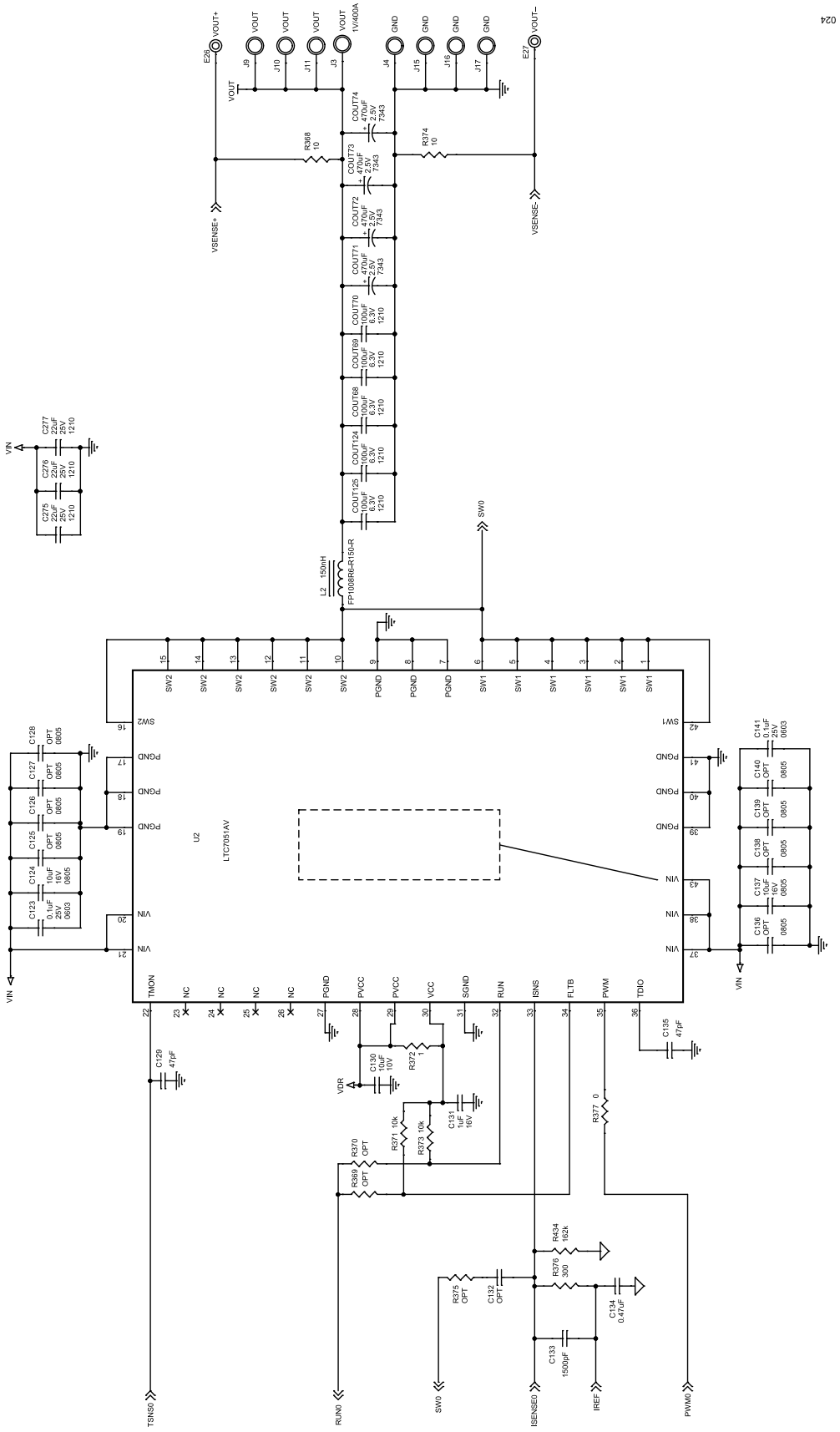
SCHEMATIC DIAGRAMS



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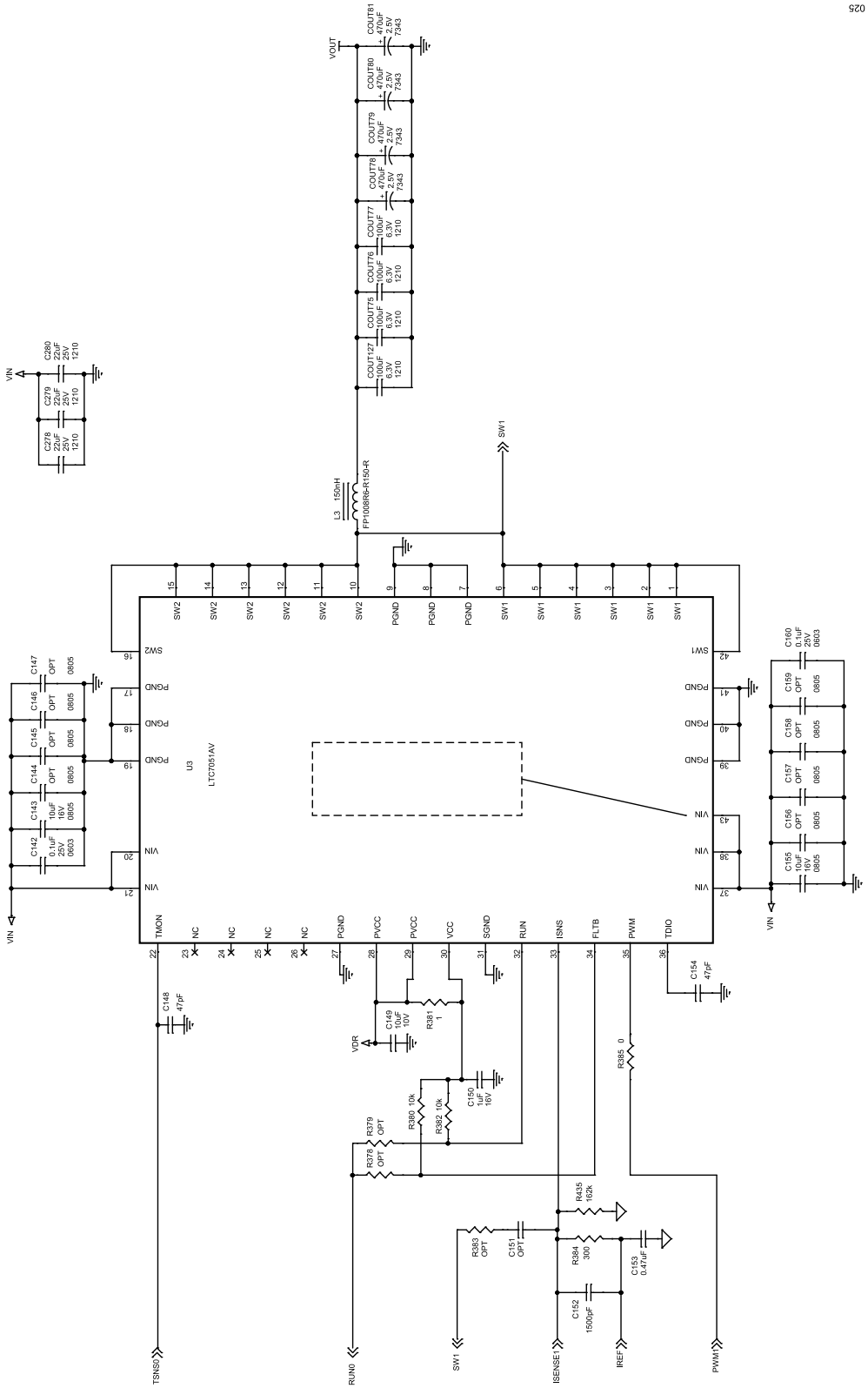

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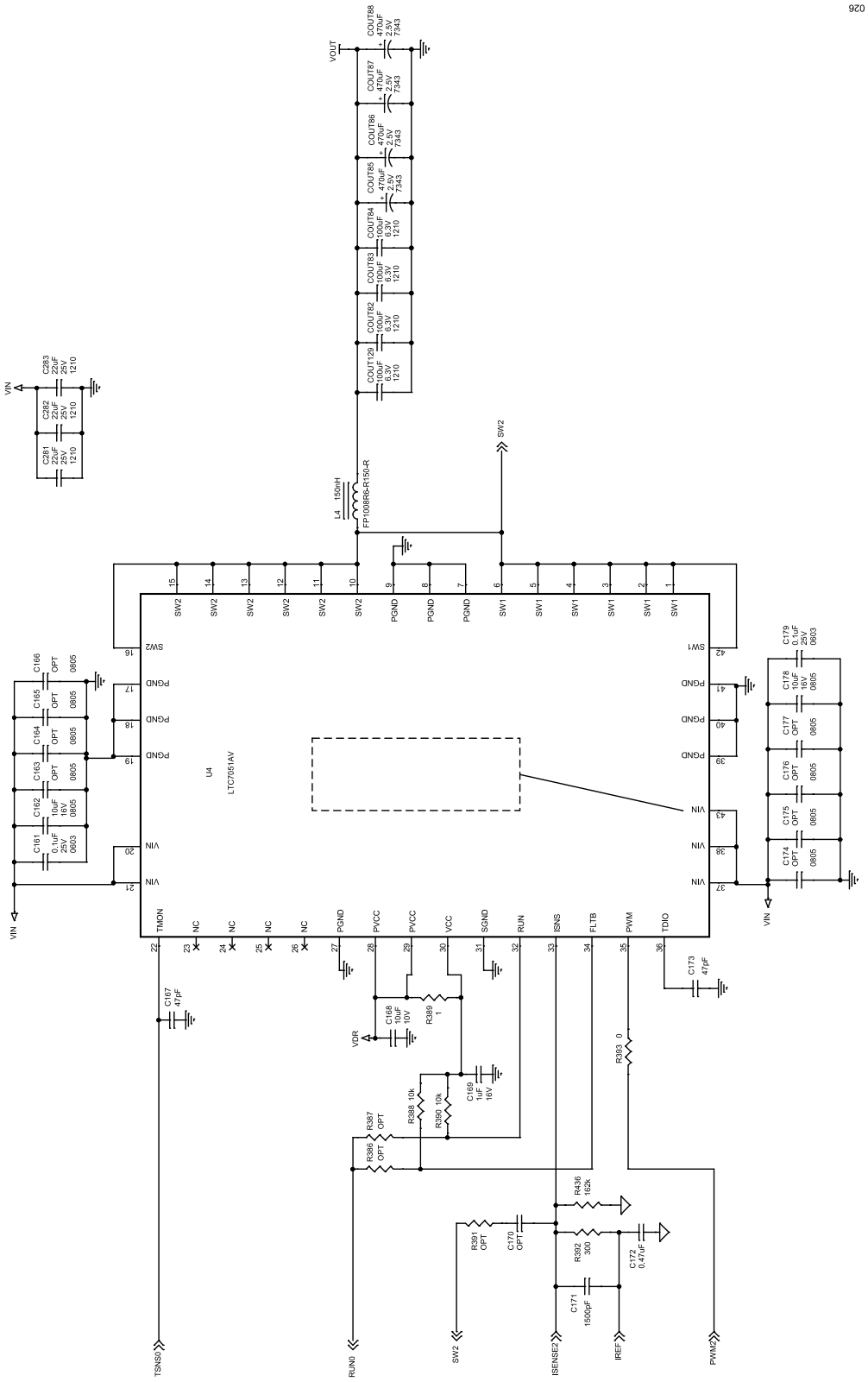

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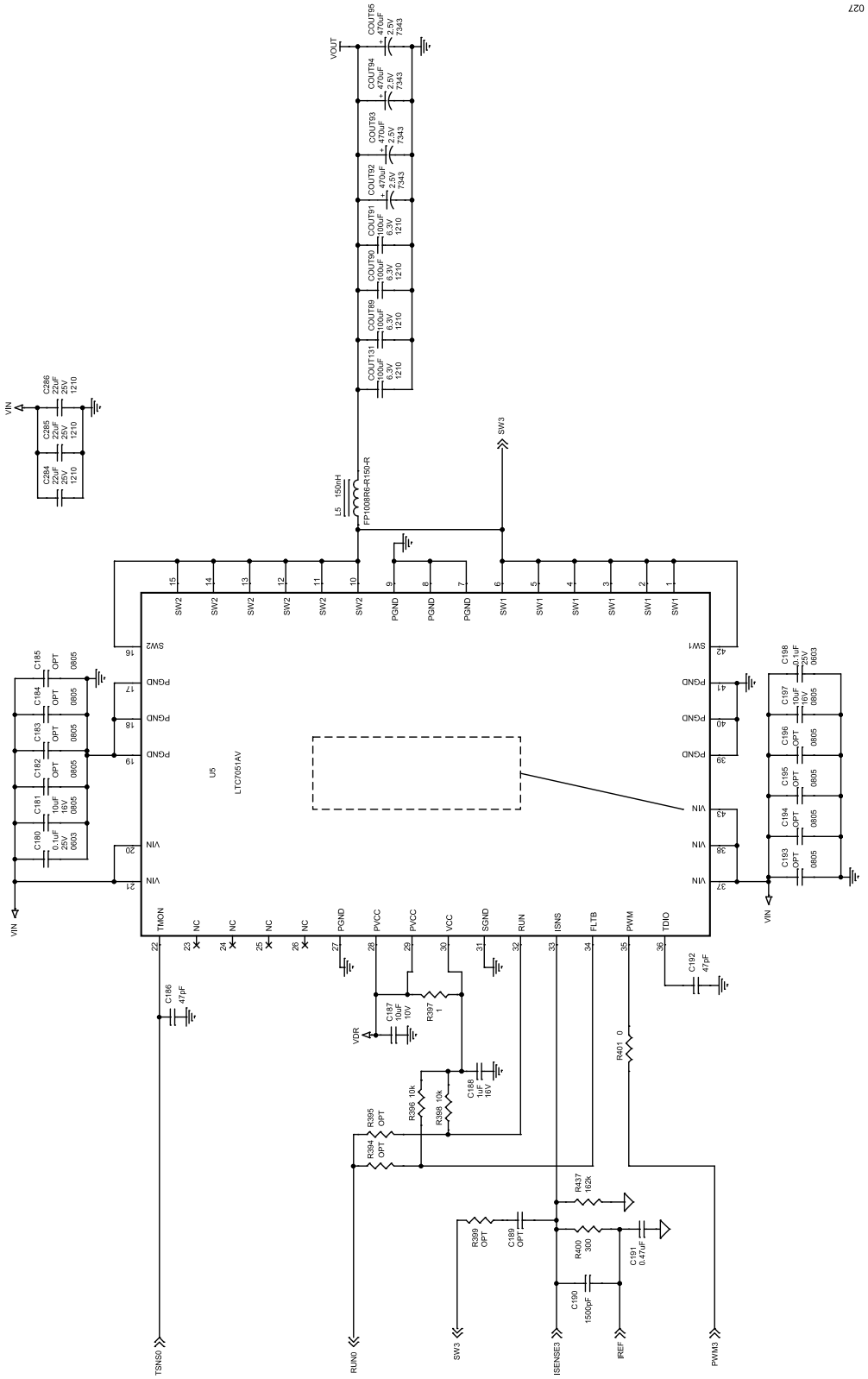

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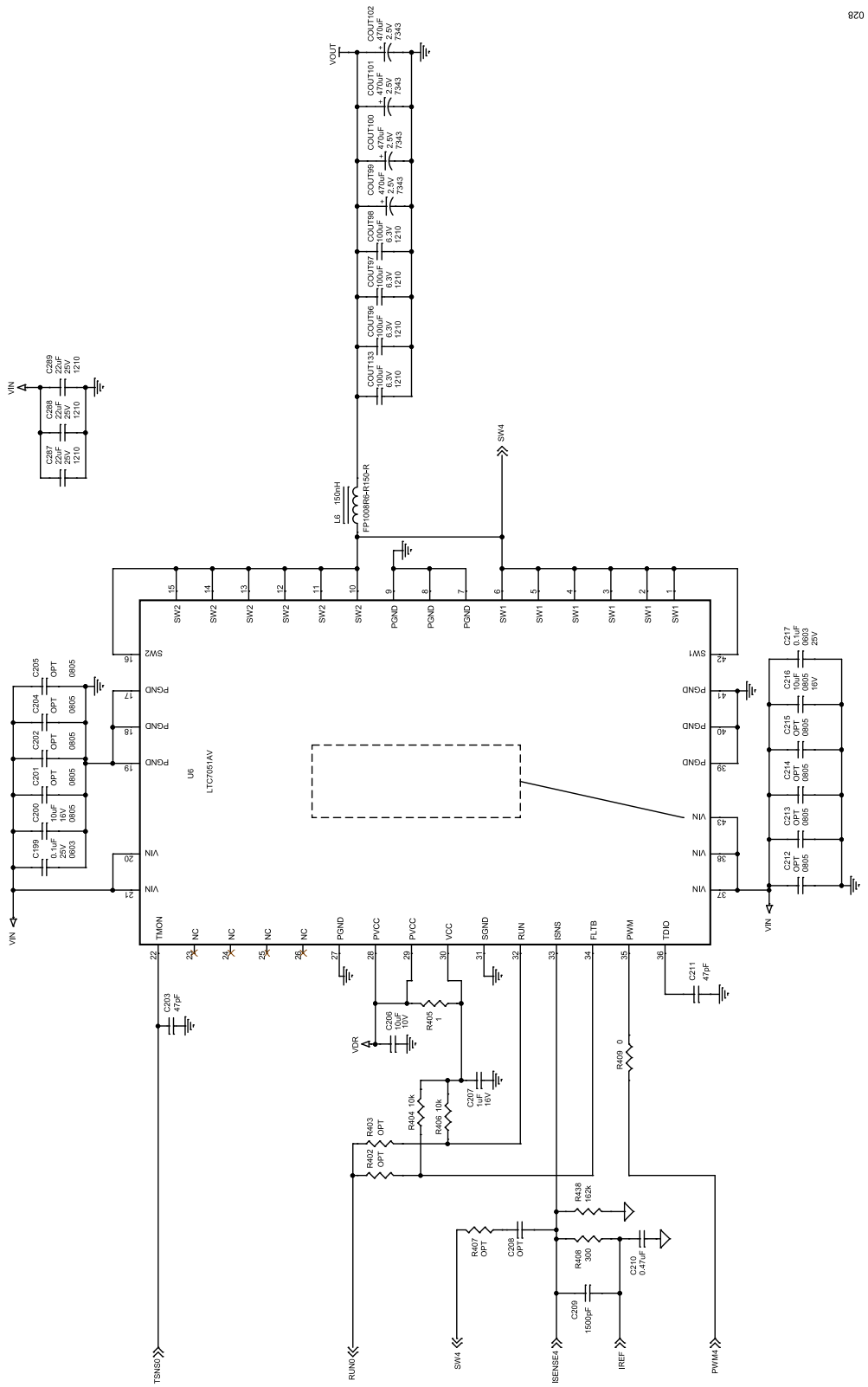

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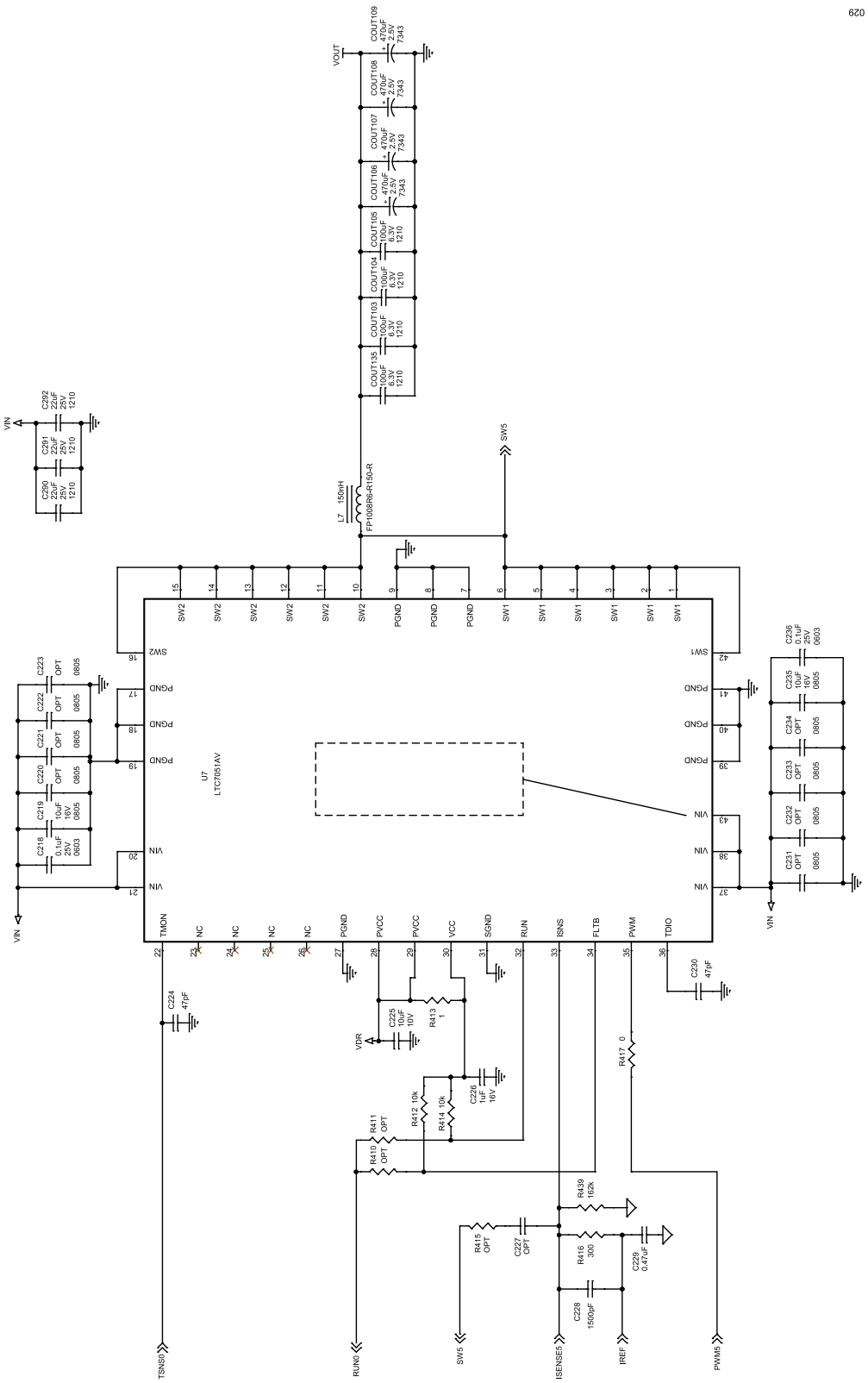

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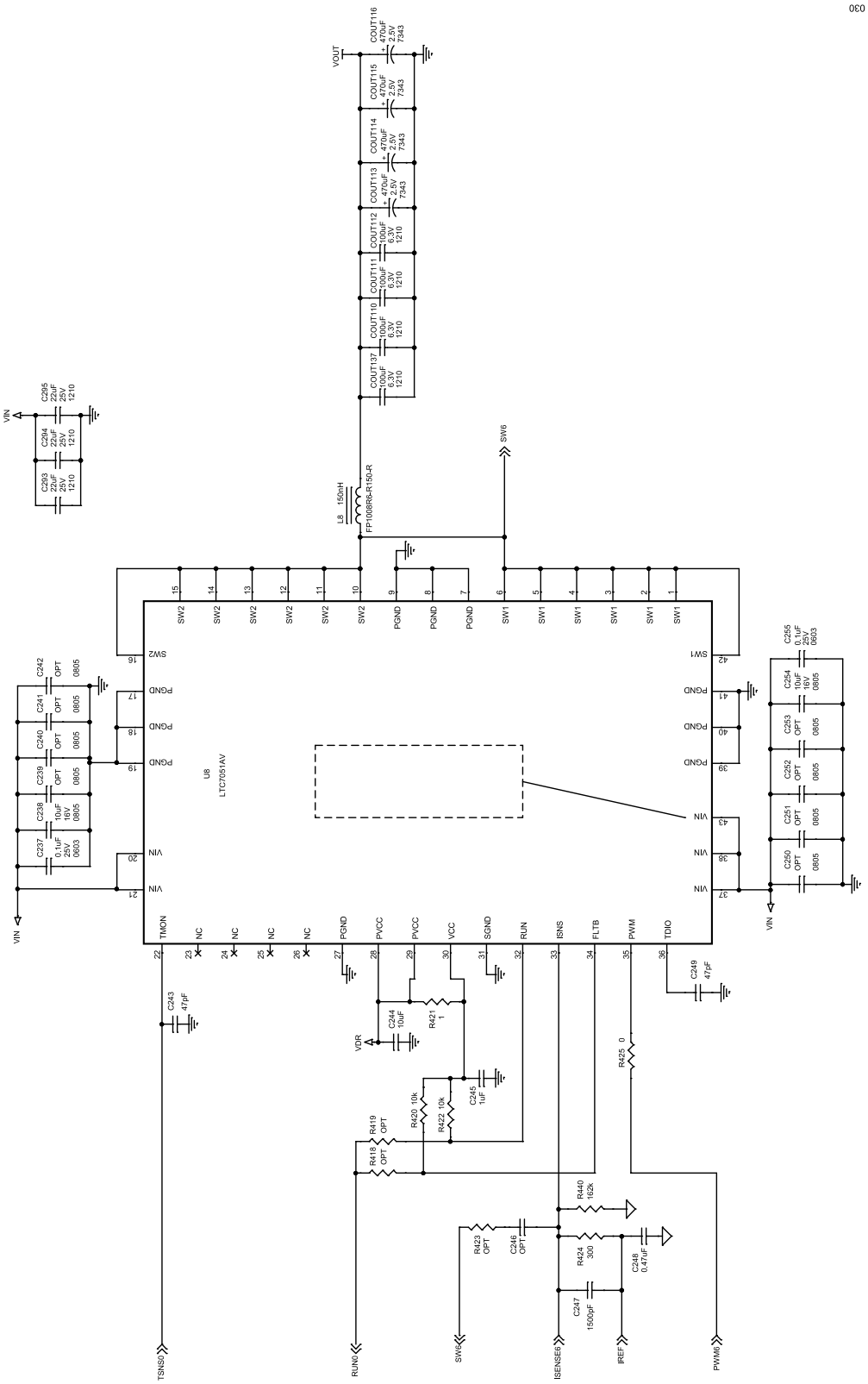

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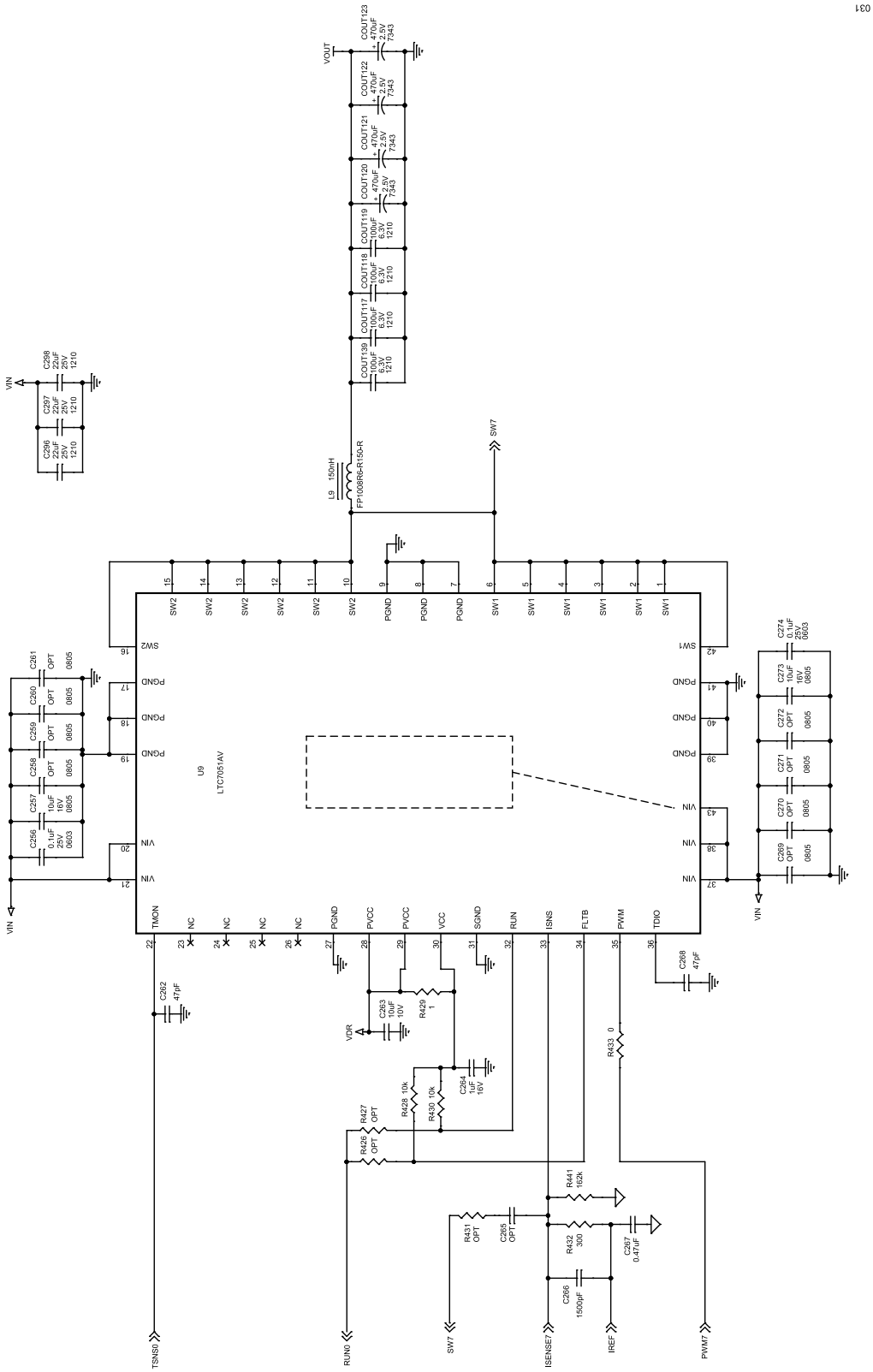

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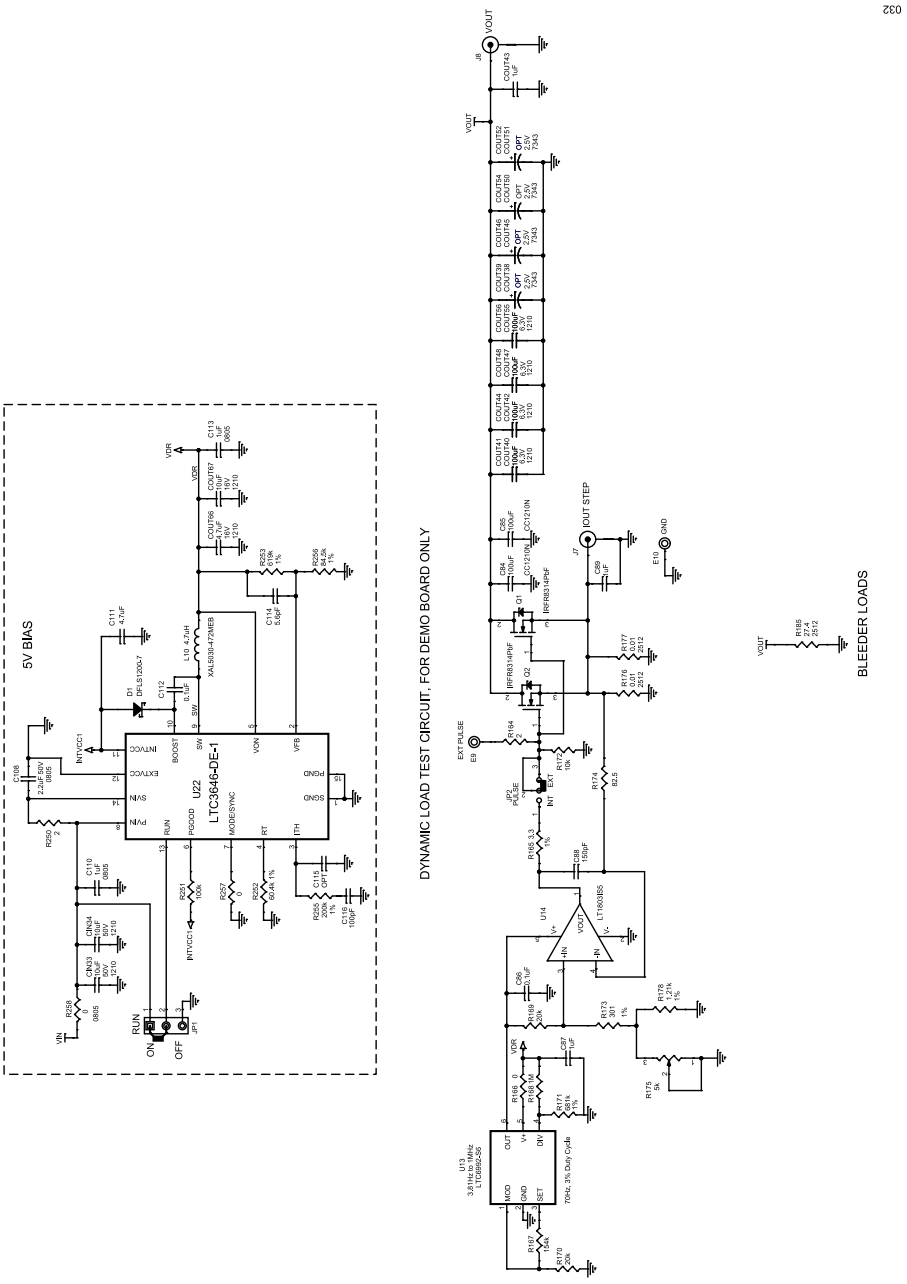

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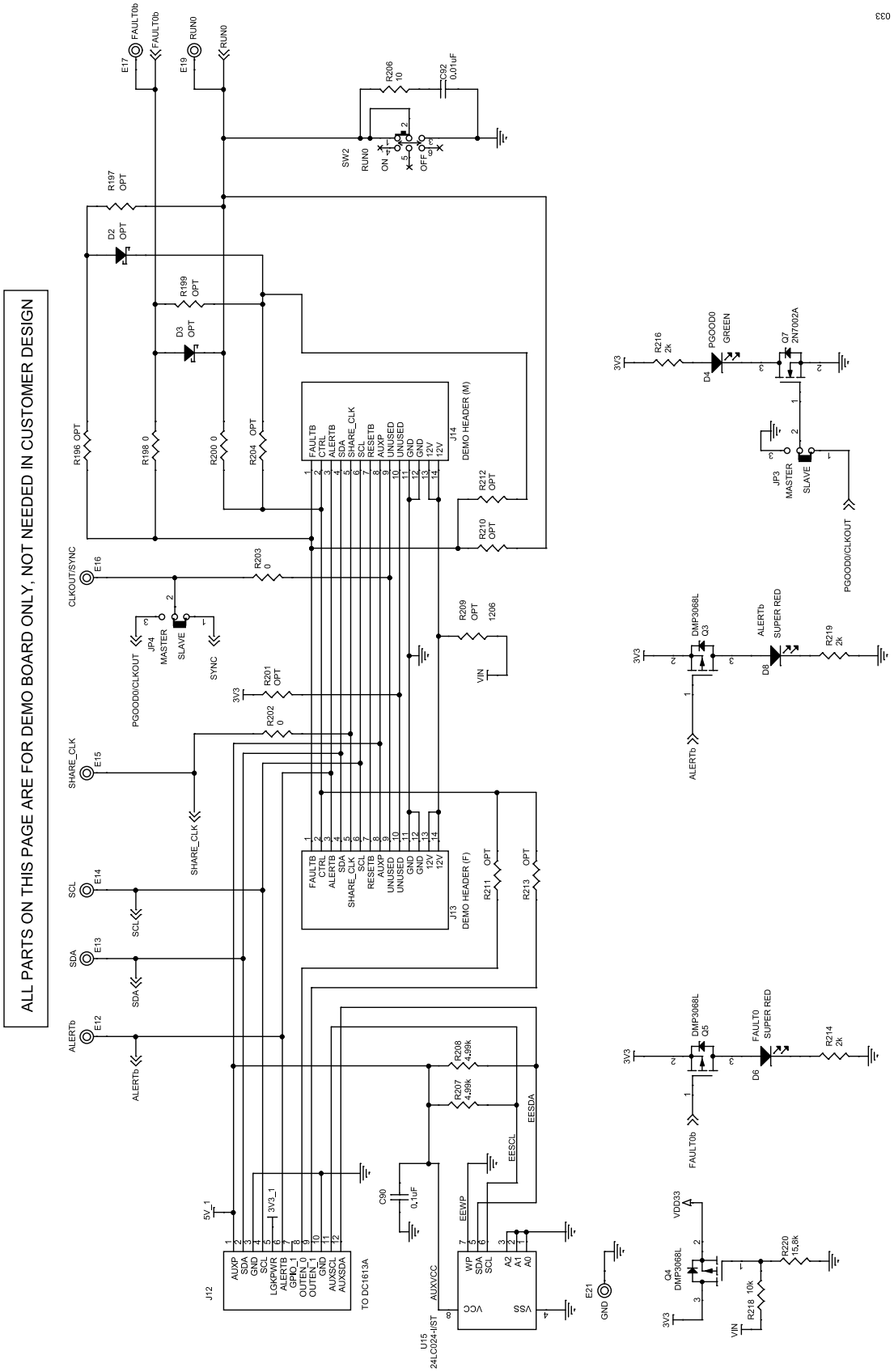

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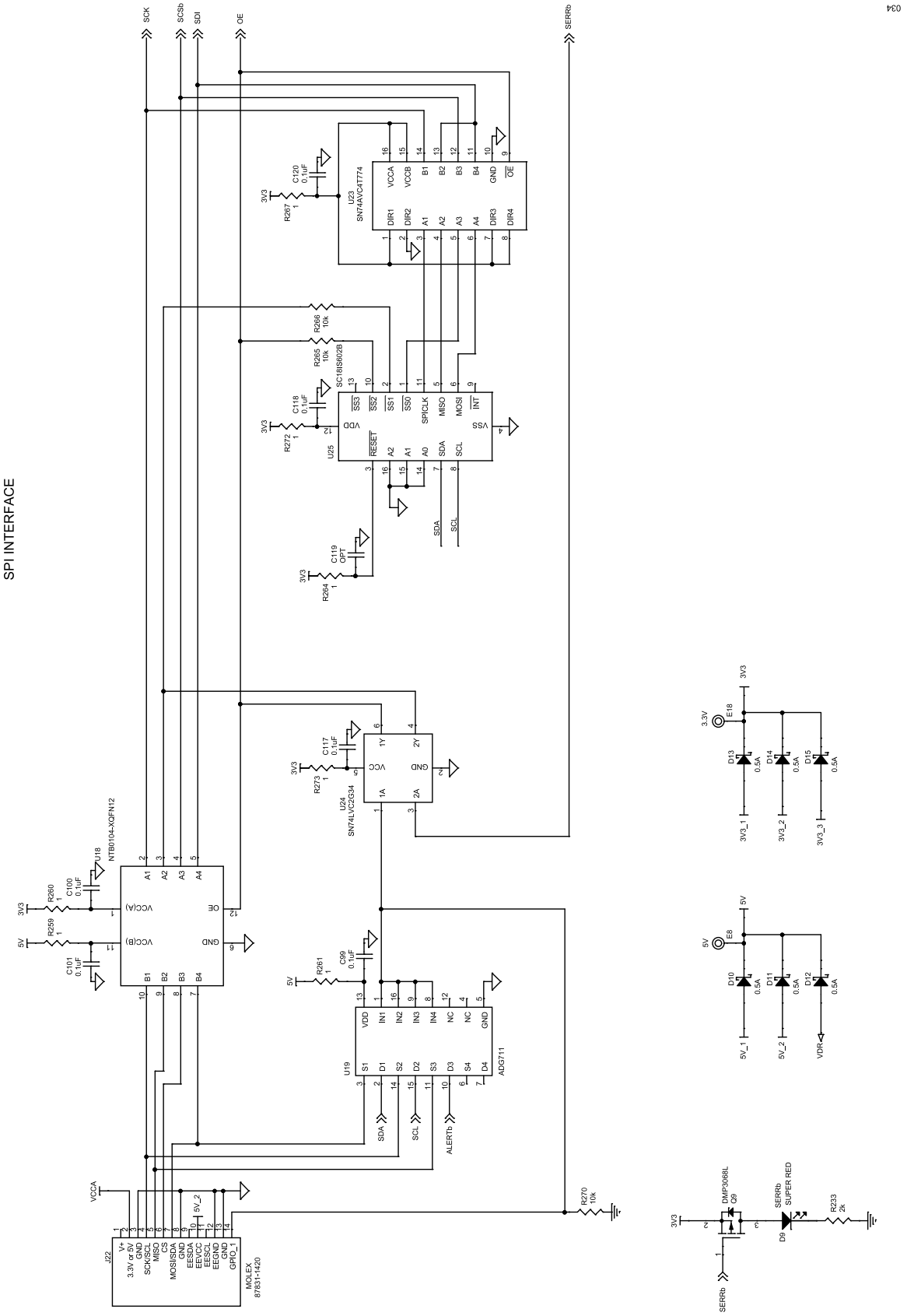

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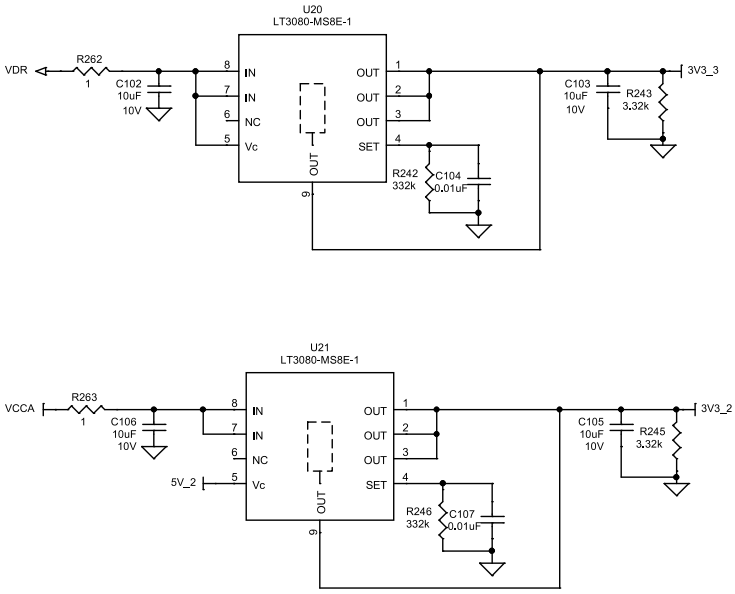

PCA ADDITIONAL PARTS

MP9	STANDOFF,NYLON,SNAP-ON,0.50"
MP10	STANDOFF,NYLON,SNAP-ON,0.50"
MP11	STANDOFF,NYLON,SNAP-ON,0.50"
MP12	STANDOFF,NYLON,SNAP-ON,0.50"
MP13	STANDOFF,NYLON,SNAP-ON,0.50"
MP14	STANDOFF,NYLON,SNAP-ON,0.50"
MP15	STANDOFF,NYLON,SNAP-ON,0.50"
MP16	STANDOFF,NYLON,SNAP-ON,0.50"
LB1	BOARD S/N LABEL 895-0154
STNCL1	TOOL, STENCIL, 700-DC2888A REV03
PCB1	PCB, DC2888A REV03

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ORDERING INFORMATION

BILL OF MATERIALS

Table 2. Required Circuit Components

Item	Qty.	Reference	Description	Suggested Manufacturer, P/N
1	6	C1 to C6	Capacitor, 270 µF, aluminium-polymer, OS-CON, 16 V, 20%, radial, surface mount device, 8 mm x 11.9 mm, E12, SVPC series	Panasonic, 16SVPC270M
2	1	C8	Capacitor, 4.7 µF, X5R, 16 V, 20%, 0603	Murata, GRM188R61C475MAAJD
3	11	C9, C87, C131, C150, C169, C188, C207, C226, C245, C264, COUT43	Capacitor, 1 µF, X7R, 16 V, 20%, 0603	AVX, 0603YC105MAT2A
4	1	C10	Capacitor, 2.2 µF, X5R, 16 V, 20%, 0603	AVX, 0603YD225MAT2A
5	2	C11, C108	Capacitor, 2.2 µF, X7R, 50 V, 10%, 0805	AVX, 08055C225KAT2A
6	1	C18	Capacitor, 3300 pF, X7R, 50 V, 10%, 0603	Wurth Elektronik, 885012206086
7	1	C21	Capacitor, 220 pF, X7R, 50 V, 10%, 0603	AVX, 06035C221KAT2A
8	43	C84, C85, COUT40 to COUT42, COUT44, COUT47, COUT48, COUT55, COUT56, COUT68 to COUT70, COUT75 to COUT77, COUT82 to COUT84, COUT89 to COUT91, COUT96 to COUT98, COUT103 to COUT105, COUT110 to COUT112, COUT117 to COUT119, COUT124, COUT125, COUT127, COUT129, COUT131, COUT133, COUT135, COUT137, COUT139	Capacitor, 100 µF, X5R, 6.3 V, 20%, 1210	AVX, 12106D107MAT2A
9	8	C86, C99 to C101, C112, C117, C118, C120	Capacitor, 0.1 µF, X7R, 16 V, 10%, 0603	AVX, 0603YC104KAT2A
10	1	C88	Capacitor, 150 pF, X7R, 50 V, 10%, 0603	AVX, 06035C151KAT2A
11	1	C89	Capacitor, 1 µF, X5R, 50 V, 10%, 0603	AVX, 06035D105KAT2A
12	1	C90	Capacitor, 0.1 µF, X7R, 50 V, 10%, 0603	AVX, 06035C104KAT2A
13	3	C92, C104, C107	Capacitor, 0.01 µF, C0G, 25 V, 5%, 0603	Kemet, C0603C103J3GACTU
14	12	C102, C103, C105, C106, C130, C149, C168, C187, C206, C225, C244, C263	Capacitor, 10 µF, X5R, 10 V, 10%, 0603	AVX, 0603ZD106KAT2A
15	2	C110, C113	Capacitor, 1 µF, X7R, 50 V, 10%, 0805	Taiyo Yuden, UMK212B7105KG-T
16	1	C111	Capacitor, 4.7 µF, X5R, 10 V, 10%, 0603	AVX, 0603ZD475KAT2A
17	1	C114	Capacitor, 5.6 pF, C0G/NP0, 50 V, +/−0.25 pF, 0603	AVX, 06035A5R6CAT2A
18	1	C116	Capacitor, 100 pF, X7R, 25 V, 5%, 0603	AVX, 06033C101JAT2A
19	16	C123, C141, C142, C160, C161, C179, C180, C198, C199, C217, C218, C236, C237, C255, C256, C274	Capacitor, 0.1 µF, X7R, 25 V, 10%, 0603	AVX, 06033C104KAT2A
20	16	C124, C137, C143, C155, C162, C178, C181, C197, C200, C216, C219, C235, C238, C254, C257, C273	Capacitor, 10 µF, X7R, 16 V, 10%, 0805	Taiyo Yuden, EMK212BB7106MG-T
21	16	C129, C135, C148, C154, C167, C173, C186, C192, C203, C211, C224, C230, C243, C249, C262, C268	Capacitor, 47 pF, C0G, 50 V, 5%, 0603	Vishay, VJ0603A470JXAAC
22	8	C133, C152, C171, C190, C209, C228, C247, C266	Capacitor, 1500 pF, X7R, 25 V, 10%, 0603	AVX, 06033C152KAT2A

ORDERING INFORMATION

Table 2. Required Circuit Components (Continued)

Item	Qty.	Reference	Description	Suggested Manufacturer, P/N
23	8	C134, C153, C172, C191, C210, C229, C248, C267	Capacitor, 0.47 µF, X7R, 16 V, 10%, 0603	Kemet, C0603C474K4RACTU
24	24	C275 to C298	Capacitor, 22 µF, X7R, 25 V, 10%, 1210, no substitutes allowed	Murata, GRM32ER71E226KE15L
25	2	CIN33, CIN34	Capacitor, 10 µF, X7R, 50 V, 10%, 1210, no substitutes allowed	Murata, GRM32ER71H106KA12L
26	1	COUT66	Capacitor, 4.7 µF, X5R, 16 V, 20%, 1210	AVX, 1210YD475MAT2A
27	1	COUT67	Capacitor, 10 µF, X7R, 16 V, 10%, 1210	AVX, 1210YC106KAT2A
28	32	COUT71 to COUT74, COUT78 to COUT81, COUT85 to COUT88, COUT92 to COUT95, COUT99 to COUT102, COUT106 to COUT109, COUT113 to COUT116, COUT120 to COUT123	Capacitor , 470 µF, tantalum-polymer, POSCAP, 2.5 V, 20%, 7343, TPF series	Panasonic, ETPF470M5H
29	1	D1	Diode, Schottky, 200 V, 1 A, PowerDI-123, AEC-Q101	Diodes Inc., DFLS1200-7
30	1	D4	Light-emitting diode (LED), green, water clear, 0603	Wurth Elektronik, 150060GS75000
31	3	D6, D8, D9	Light-emitting diode (LED), super red, water clear, 0603	Wurth Elektronik, 150060SS75000
32	6	D10 to D15	Diode, Schottky, 20 V, 0.5 A, SOD-882, leadless	Nexperia, PMEG2005AEL, 315
33	8	L2 to L9	Inductor, 150 nH, power, shielded, 10%, 74 A, 0.18 mΩ, 10.8 mm × 8 mm	Eaton, FP1008R6-R150-R
34	1	L10	Inductor, 4.7 µH, power, 20%, 5.9 A, 40 mΩ, 5.48 mm x 5.28 mm, surface mount device, XAL5030, AEC-Q200	Coilcraft, XAL5030-472MEB
35	2	Q1, Q2	XSTR., MOSFET, N-CH, 30 V, 90 A, DPAK	Infineon, IRFR8314TRPBF
36	4	Q3 to Q5, Q9	XSTR., MOSFET, P-CH, 30 V, 3.3 A, SOT-23-3	Diodes Inc., DMP3068L-13
37	1	Q7	XSTR., MOSFET, N-CH, 60 V, 220 mA, SOT23-3, AEC-Q101	Diodes Inc., 2N7002A-13
38	16	R3, R259 to R261, R264, R267, R272, R273, R372, R381, R389, R397, R405, R413, R421, R429	Resistor, 1 Ω, 1%, 1W/10W, 0603	Yageo, RC0603FR-071RL
39	3	R9, R10, R18	Resistor, 1 kΩ, 1%, 1W/10W, 0603, AEC-Q200	Vishay, CRCW06031K00FKEA
40	26	R15, R17, R48, R51, R53, R172, R218, R265, R266, R270, R371, R373, R380, R382, R388, R390, R396, R398, R404, R406, R412, R414, R420, R422, R428, R430	Resistor, 10 kΩ, 1%, 1W/10W, 0603, AEC-Q200	Vishay, CRCW060310K0FKEA
41	3	R16, R207, R208	Resistor, 4.99 kΩ, 1%, 1W/10W, 0603	Panasonic, ERJ3EKF4991V
42	1	R41	Resistor, 18.7 kΩ, 1%, 1W/10W, 0603, AEC-Q200	NIC, NRC06F1872TRF
43	2	R164, R250	Resistor, 2 Ω, 1%, 1W/10W, 0603, AEC-Q200	Vishay, CRCW06032R00FKEA
44	1	R165	Resistor, 3.3 Ω, 1%, 1W/10W, 0603, AEC-Q200	Vishay, CRCW06033R30FKEA
45	1	R166	Resistor, 0 Ω, 1W/10W, 0603, AEC-Q200	Vishay, CRCW06030000Z0EA
46	1	R167	Resistor, 154 kΩ, 1%, 1W/10W, 0603, AEC-Q200	NIC, NRC06F1543TRF
47	1	R168	Resistor, 1 MΩ, 1%, 1W/10W, 0603, AEC-Q200	NIC, NRC06F1004TRF
48	2	R169, R170	Resistor, 20 kΩ, 1%, 1W/10W, 0603	NIC, NRC06F2002TRF
49	1	R171	Resistor, 681 kΩ, 1%, 1W/10W, 0603, AEC-Q200	NIC, NRC06F6813TRF
50	1	R173	Resistor, 301 Ω, 1%, 1W/10W, 0603, AEC-Q200	Panasonic, ERJ3EKF3010V
51	1	R174	Resistor, 82.5 Ω, 1%, 1W/10W, 0603, AEC-Q200	NIC, NRC06F82R5TRF
52	1	R175	Resistor, 5 kΩ, 10%, 1W/2W, through-hole technology (THT) 3/8" square, 1-turn, top adjustment, trimpot	Bourns, 3386P-1-502LF
53	2	R176, R177	Resistor, 0.01 Ω, 1%, 1W, 2512, power, metal, sense, AEC-Q200	Vishay, WSL2512R0100FEA

ORDERING INFORMATION

Table 2. Required Circuit Components (Continued)

Item	Qty.	Reference	Description	Suggested Manufacturer, P/N
54	1	R178	Resistor, 1.21 kΩ, 1%, 1W/10W, 0603	Panasonic, ERJ3EKF1211V
55	1	R185	Resistor, 27.4 Ω, 1%, 1W, 2512, AEC-Q200	Panasonic, ERJ1TNF27R4U
56	3	R206, R368, R374	Resistor, 10 Ω, 1%, 1W/10W, 0603	Vishay, CRCW060310R0FKEA
57	4	R214, R216, R219, R233	Resistor, 2 kΩ, 1%, 1W/10W, 0603	NIC, NRC06F2001TRF
58	1	R220	Resistor, 15.8 kΩ, 1%, 1W/10W, 0603, AEC-Q200	NIC, NRC06F1582TRF
59	2	R242, R246	Resistor, 332 kΩ, 1%, 1W/10W, 0603, AEC-Q200	NIC, NRC06F3323TRF
60	2	R243, R245	Resistor, 3.32 kΩ, 1%, 1W/10W, 0603, AEC-Q200	Panasonic, ERJ3EKF3321V
61	1	R251	Resistor, 100 kΩ, 1%, 1W/10W, 0603	Stackpole Electronics Inc., RMCF0603FG100K
62	1	R252	Resistor, 60.4 kΩ, 1%, 1W/10W, 0603, AEC-Q200	Vishay, CRCW060360K4FKEA
63	1	R253	Resistor, 619 kΩ, 1%, 1W/10W, 0603, AEC-Q200	NIC, NRC06F6193TRF
64	1	R255	Resistor, 200 kΩ, 1%, 1W/10W, 0603	NIC, NRC06F2003TRF
65	1	R256	Resistor, 84.5 kΩ, 1%, 1W/10W, 0603, AEC-Q200	NIC, NRC06F8452TRF
66	2	R262, R263	Resistor, 1 Ω, 5%, 1/8W, 0805, AEC-Q200	Panasonic, ERJ6GEYJ1R0V
67	8	R376, R384, R392, R400, R408, R416, R424, R432	Resistor, 300 Ω, 1%, 1W/10W, 0603, AEC-Q200	Panasonic, ERJ-3EKF3000V
68	8	R434 to R441	Resistor, 162 kΩ, 1%, 1W/10W, 0603	NIC, NRC06F1623TRF
69	1	SW2	Switch, slide, double-pole double-throw (DPDT), 0.3 A, 6 V DC, plated through hole (PTH)	C&K, JS202011CQN
70	1	U1	IC, 8-phase, dual output synch. buck converter, QFN-52 (UHG)	Analog Devices, LTC3888 (DC2888A-A) LTC3888IUHG-1 (DC2888A-B)
71	8	U2-U9	IC, monolithic driver and halfbridge, LQFN-42	Analog Devices, LTC7051AV#PBF
72	1	U13	IC, OSC., TimerBlox: voltage-controlled pulse-width modulation (PWM), 3.81 Hz to 1 MHz, 5 pF, 90 ppm, TSOT23-6	Analog Devices, LTC6992IS6-1#TRMPBF
73	1	U14	IC, single R to R in/out operational amplifier, TSOT23-5, 100 V/us, 85 MHz	Analog Devices, LT1803IS5#TRMPBF
74	1	U15	IC, electrically erasable programmable read-only memory (EEPROM), I^2C, TSSOP-8, 2 Kb (256 x 8), 400 kHz	Microchip, 24LC024-I/ST
75	1	U18	IC, translating transceiver, XQFN-12	NXP, NTB0104GU12, 115
76	1	U19	IC, translating transceiver, 16-pin TSSOP	Analog Devices, ADG711BRUZ#PBF
77	2	U20, U21	IC, 1.1 A adjustment single resistor low dropout (LDO), MSOP-8	Analog Devices, LT3080EMS8E-1#PBF
78	1	U22	IC, 1A sync. step-down converter, DFN-14	Analog Devices, LTC3646EDE-1#PBF
79	1	U23	IC, 4-bit dual-supply BUS XCVR, TSSOP-16	Texas Instruments, SN74AVC4T774PW
80	1	U24	IC, dual buffer gate, non-invert, SC70-6	Texas Instruments, SN74LVC2G34DCKR
81	1	U25	IC, bridge serial peripheral interface (SPI)/I^2C, 16-pin, TSSOP	NXP, SC18IS602BIPW/S8HP

Table 3. Additional Demo Board Circuit Components

Item	Qty	Reference	Description	Suggested ManµFacturer, P/N
1	0	C115, C119, C121, C132, C151, C170, C189, C208, C227, C246, C265	Capacitor, option, 0603	
2	0	C125 to C128, C136, C138 to C140, C144 to C147, C156 to C159, C163 to C166, C174 to	Capacitor, option, 0805	

NOTES

Table 3. Additional Demo Board Circuit Components (Continued)

Item	Qty	Reference	Description	Suggested ManµFacturer, P/N
		C177, C182 to 185, C193 to C196, C201, C202, C204, C205, C212 to C215, C220 to C223, C231 to C234, C239 to C242, C250 to C253, C258 to 261, C269 to C272		
3	0	COUT38, COUT39, COUT45, COUT46, COUT50-COUT52, COUT54	Capacitor, option, 7343	
4	0	D2, D3	Diode, option, SOD-323	
5	0	R1, R30, R37-R40, R42, R196, R197, R199, R201, R204, R210-R213, R268, R269, R275, R281, R287, R369, R370, R375, R378, R379, R383, R386, R387, R391, R394, R395, R399, R402, R403, R407, R410, R411, R415, R418, R419, R423, R426, R427, R431	Resistor, option, 0603	
6	19	R28, R198, R200, R202, R203, R257, R276, R279, R282, R286, R288, R377, R385, R393, R401, R409, R417, R425, R433	Resistor, 0 Ω, 1W/10W, 0603, AEC-Q200	Vishay, CRCW06030000Z0EA
7	0	R209	Resistor, option, 1206	
8	1	R258	Resistor, 0 Ω, 1W/8W, 0805	Vishay, CRCW08050000Z0EA
9	1	R277	Resistor, 31.6 kΩ, 1%, 1W/10W, 0603, AEC-Q200	Vishay, CRCW060331K6FKEA
10	1	R278	Resistor, 21 kΩ, 1%, 1W/10W, 0603	Vishay, CRCW060321K0FKEA

Table 4. Hardware

ITEM	QTY	REFERENCE	DESCRIPTION	SUGGESTED MANµFACTURER, P/N
1	21	E1, E2, E7 to E10, E12 to E19, E21 to E27	Test point, turret, 0.094" MTG. hole, PCB 0.062" THK	Mill-Max, 2501-2-00-80-00-00-07-0
2	12	J1 to J6, J9 to J11, J15 to J17	Evaluation board STUD hardware set, #10-32	Analog Devices, 720-0010
3	2	J7, J8	Connector, RF, BNC, RCPT, Jack, 5-pin, straight tip (ST), through-hole technology (THT), 50 Ω	Amphenol RF, 112404
4	1	J12	Connector, high dynamic range (HDR), shrouded, male, 2 x 6, 2 mm, vertical, ST, THT	Amphenol, 98414-G06-12ULF
5	1	J13	Connector, HDR, female, 2 x 7, 2 mm, R/A THT	Sullins Connector Solutions, NPPN072FJFN-RC
6	1	J14	Connector, HDR, male, 2 x 7, 2 mm, R/A THT	Molex, 0877601416
7	1	J22	Connector, HDR, shrouded, plug, male, 2 x 7, 2 mm, vertical, ST, THT, keyed	Molex, 87831-1420
8	4	JP1 to JP4	Connector, HDR, male, 1 x 3, 2 mm, vertical, ST, THT, no substitutes allowed	Samtec, TMM-103-02-L-S
9	8	MP9 to MP16	Standoff, nylon, snap-on, 0.50"	Wurth Elektronik, 702935000
10	4	XJP1, XJP2, XJP4, XJP5	Connector, shunt, female, 2-position, 2 mm	Samtec, 2SN-BK-G

NOTES

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.