

LTM4680  
High Efficiency, PolyPhase 120A  $\mu$ Module  
Regulator with Digital Power System Management

## DESCRIPTION

Demonstration circuit 2863A features the [LTM®4680](#), which is a dual 30A or single 60A  $\mu$ Module® regulator with a 4.5V to 16V input range. Two LTM4680  $\mu$ Module ICs are paralleled on this board to deliver 120A maximum load current. The output voltage is adjustable from 0.5V to 3.3V. Refer to the [LTM4680 data sheet](#) for more detailed information.

The DC2863A 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 LTM4680, download the GUI software LTpowerPlay® onto

your PC and use ADI I<sup>2</sup>C/SMBus/PMBus dongle [DC1613A](#) to connect to the board. LTpowerPlay allows the user to reconfigure the part on-the-fly and store the configuration in EEPROM, view telemetry of voltage, current, temperature and fault status.

## GUI Download

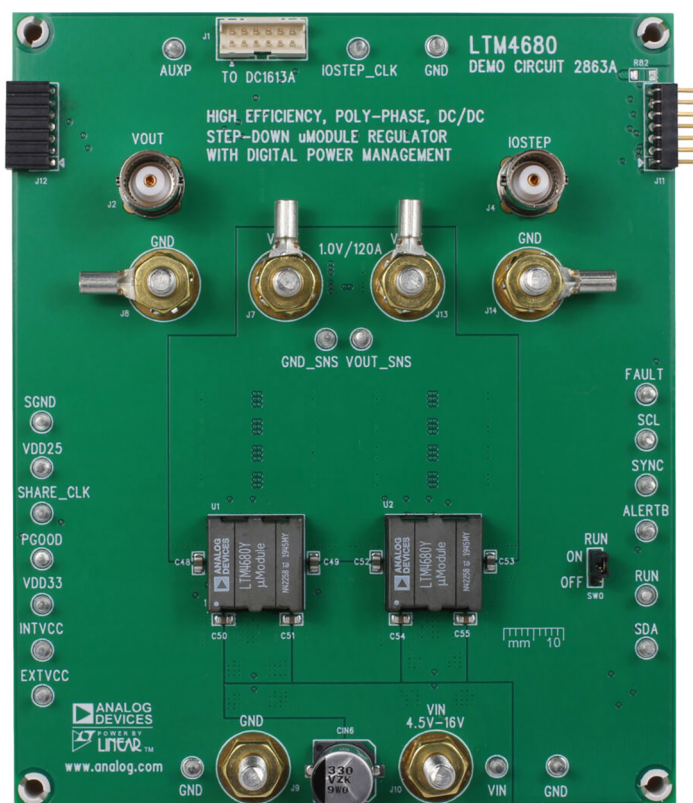
The software can be downloaded from [LTpowerPlay](#).

For more details and instructions on LTpowerPlay, Refer to the LTpowerPlay GUI for LTM4680 quick start guide.

**Design files for this circuit board are available.**

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## BOARD PHOTO



**Figure 1. LTM4680/DC2863A Demo Circuit**

# DEMO MANUAL DC2863A

## PERFORMANCE SUMMARY Specifications are at $T_A = 25^\circ\text{C}$

| PARAMETER                         | CONDITIONS                                                                    | MIN | TYP             | MAX | UNITS |
|-----------------------------------|-------------------------------------------------------------------------------|-----|-----------------|-----|-------|
| Input Voltage Range               |                                                                               | 4.5 |                 | 16  | V     |
| Output Voltage, $V_{OUT}$         | $V_{IN} = 4.5\text{V to }16\text{V}$ , $I_{OUT} = 0\text{A to }120\text{A}$   | 0.5 | 1               | 3.3 | V     |
| Maximum Output Current, $I_{OUT}$ | $V_{IN} = 4.5\text{V to }16\text{V}$ , $V_{OUT} = 0.5\text{V to }3.3\text{V}$ |     | 120             |     | A     |
| Typical Efficiency                | $V_{IN} = 12\text{V}$ , $V_{OUT} = 1.0\text{V}$ , $I_{OUT} = 120\text{A}$     |     | 87.2 (Figure 5) |     | %     |
| Default Switching Frequency       |                                                                               |     | 500             |     | kHz   |

## QUICK START PROCEDURE

Table 1. LTM4680 Demo Boards

| MAXIMUM OUTPUT CURRENT | NUMBER OF OUTPUTS | NUMBER OF LTM4680 $\mu$ Module REGULATORS ON THE BOARD | DEMO BOARD NUMBER       |
|------------------------|-------------------|--------------------------------------------------------|-------------------------|
| 30A/30A                | 2                 | 1                                                      | <a href="#">DC2844A</a> |
| 60A                    | 1                 | 1                                                      | <a href="#">DC2845A</a> |

Demonstration circuit 2863A is easy to set up to evaluate the performance of the LTM4680. See Figure 2 for the proper measurement equipment setup and follow the procedure below.

1. With power off, connect the input power supply to  $V_{IN}$  (4.5V to 16V) and GND (input return).
2. Connect the 1V output load between  $V_{OUT}$  and GND (Initial load: no load).
3. Connect the DVMs to the input and output. Set default jumper position:  
**JP1:**     RUN            ON
4. Turn on the input power supply and check for the proper output voltage.  $V_{OUT}$  should be within  $1.0\text{V} \pm 0.5\%$ .

5. Once the proper output voltage is established, adjust the load within the operating range and observe the output voltage regulation, ripple voltage and other parameters.
6. Connect the dongle and control the output voltages from the GUI. Refer to the LTpowerPlay GUI for the LTM4680 quick start guide for details.

NOTE: When measuring the output or input voltage ripple, do not use the long ground lead on the oscilloscope probe. See Figure 3 for the proper scope probe technique. Short, stiff leads need to 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.

## QUICK START PROCEDURE

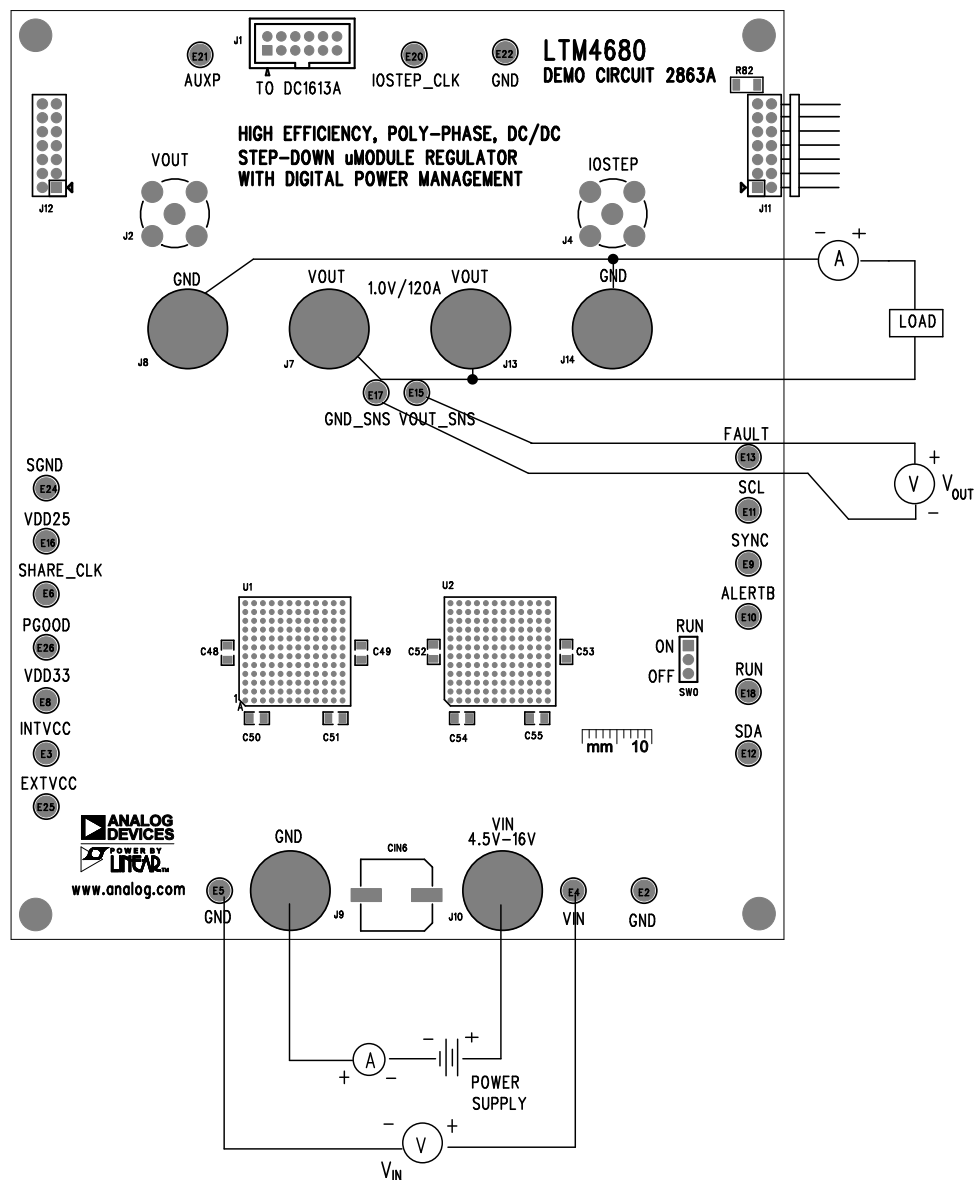


Figure 2. Proper Measurement Equipment Setup

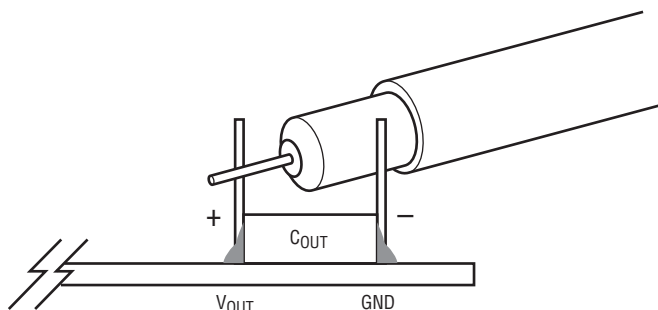


Figure 3. Measuring Output Voltage Ripple

## QUICK START PROCEDURE

### Connecting a PC to DC2863A

Use a PC to reconfigure the power management features of the LTM4680, such as nominal  $V_{OUT}$ , margin set points,

OV/UV limits, temperature fault limits, sequencing parameters, the fault log, fault responses, GPIOs and other functionalities. The DC1613A dongle may be plugged in when  $V_{IN}$  is present.

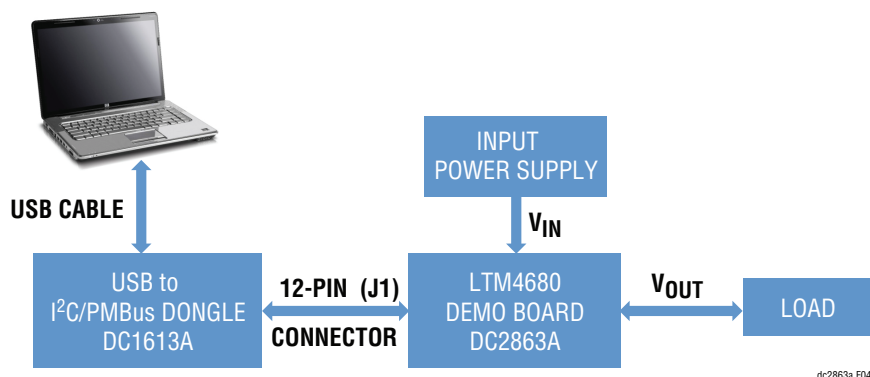


Figure 4. Demo Setup with PC

## TYPICAL PERFORMANCE CHARACTERISTICS

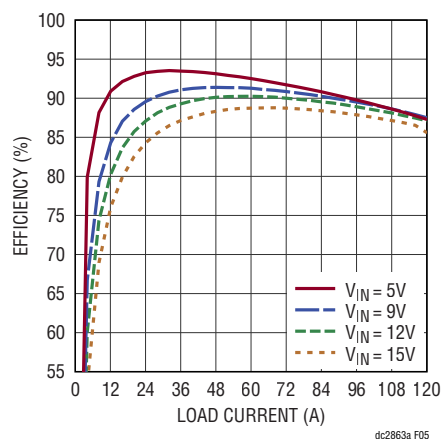


Figure 5. Efficiency vs Load Current,  $V_{OUT} = 1V$ ,  $f_{SW} = 500kHz$

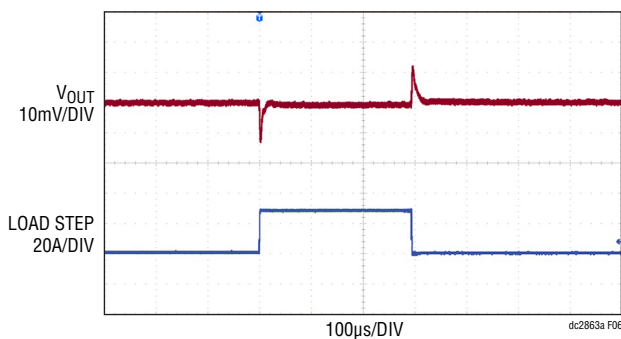


Figure 6.  $V_{OUT}$  Load Transient Response at  $V_{IN} = 12V$ ,  $V_{OUT} = 1V$

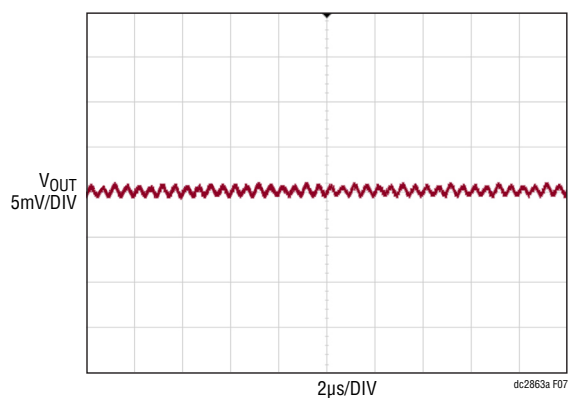
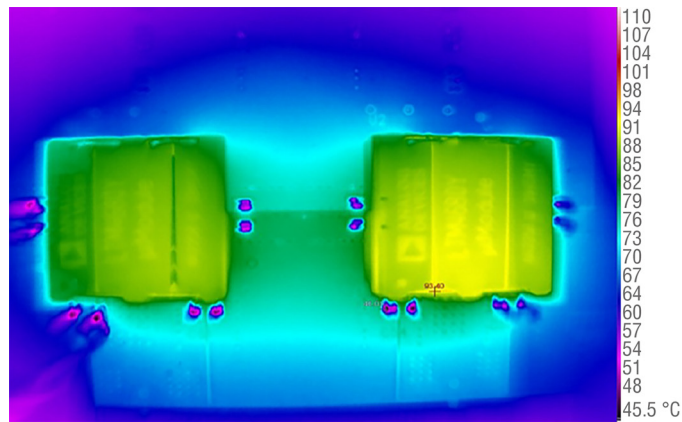
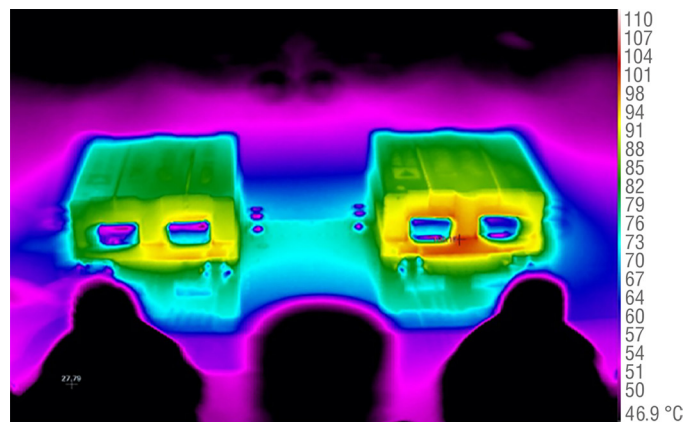


Figure 7.  $V_{OUT}$  Voltage Ripple at  $V_{IN} = 12V$ ,  $V_{OUT} = 1V$ ,  $I_{OUT} = 0A$

## TYPICAL PERFORMANCE CHARACTERISTICS



(a) Front View



(b) Side View

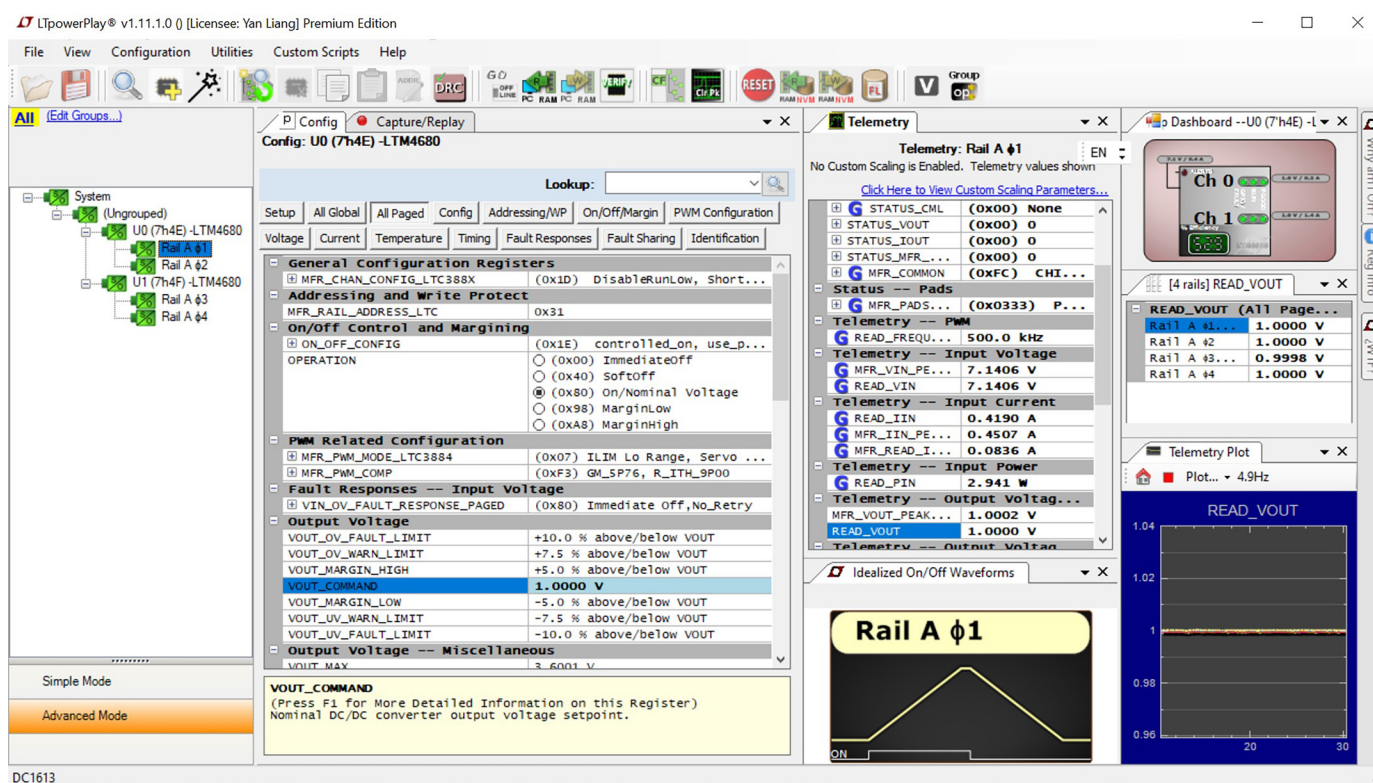
Figure 8. Thermal at  $V_{IN} = 12V$ ,  $V_{OUT} = 1V$ ,  $I_{OUT} = 120A$ ,  $T_A = 25^{\circ}C$ , No Airflow

# LTPowerPlay SOFTWARE GUI

LTpowerPlay is a powerful Windows-based development environment that supports Analog Devices power system management ICs and  $\mu$ Module ICs, including LTM4675, LTM4676A, LTM4677, LTM4678, LTM4680, LTM4686, LTM4700, LTC<sup>®</sup>3880, LTC3882, LTC3883, LTC3884 and LTC3887. The software supports a variety of different tasks. You can use LTpowerPlay to evaluate Analog Devices ICs by connecting to a demo board system. LTpowerPlay can also be used offline (with no hardware present) to build a multichip configuration file that can be saved and reloaded later. 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-SMBus controller to communicate with one of many potential targets, including LTM4675, LTM4676A, LTM4677, LTM4678, LTM4680, LTM4686, LTM4700, LTC3880, LTC3882, LTC3883, LTC3884 and LTC3887's demo system, 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. The LTpowerPlay software can be downloaded from [LTpowerPlay](#).

To access technical support documents for Analog Digital Power Products, visit the LTpowerPlay Help menu. Online help is also available through the LTpowerPlay.

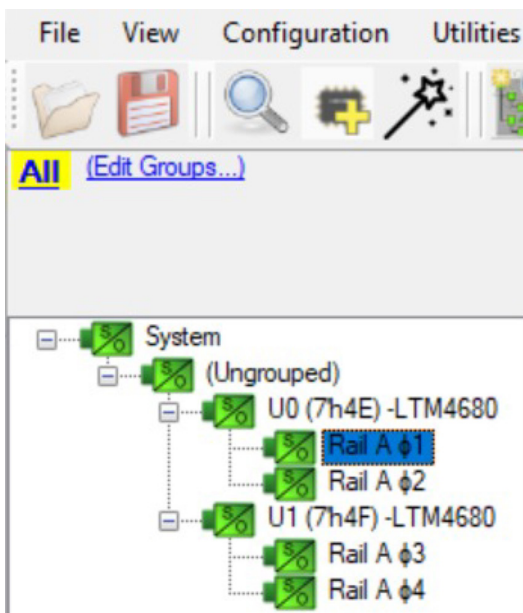


**Figure 9. LTpowerPlay Main Interface**

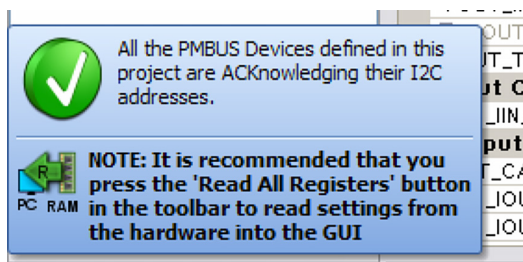
## LTpowerPlay QUICK START PROCEDURE

The following procedure describes how to use LTpowerPlay to monitor and change the settings of LTM4680.

1. Download and install the [LTpowerPlay](#) GUI.
2. Launch the LTpowerPlay GUI.
  - a. The GUI should automatically identify the DC2863A. The system tree on the left hand side should look like this:



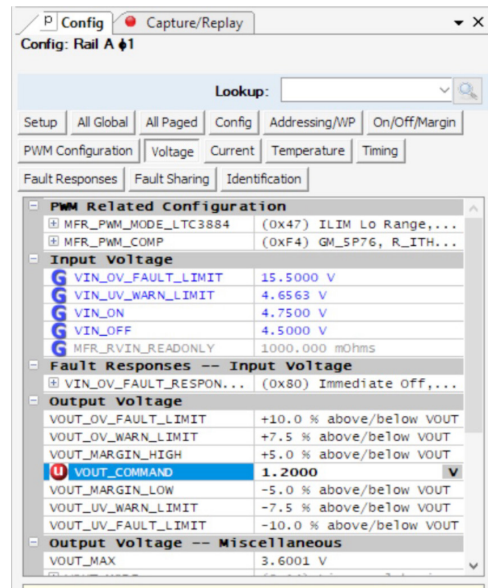
- b. A green message box shows for a few seconds in the lower left hand corner, confirming that LTM4680 is communicating:



- c. In the Toolbar, click the “R” (RAM to PC) icon to read the RAM from the LTM4680. This reads the configuration from the RAM of LTM4680 and loads it into the GUI.



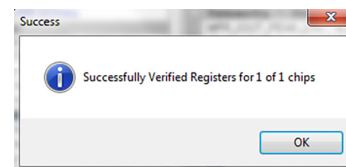
- d. If you want to change the output voltage to a different value, like 1.2V. In the Config tab, type in 1.2 in the VOUT\_COMMAND box, like this:



- e. Then, click the “W” (PC to RAM) icon to write these register values to the LTM4680. After finishing this step, you will see the output voltage will change to 1.2V.



- f. If the write is successful, you will see the following message:



- g. You can save the changes into the NVM. In the toolbar, click the “RAM to NVM” button:



- h. Save the demo board configuration to a (\*.proj) file. Click the Save icon and save the file. Name it whatever you want.

## PARTS LIST

| ITEM                                            | QTY | REFERENCE                                                                    | PART DESCRIPTION                                           | MANUFACTURER/PART NUMBER      |
|-------------------------------------------------|-----|------------------------------------------------------------------------------|------------------------------------------------------------|-------------------------------|
| <b>Required Circuit Components</b>              |     |                                                                              |                                                            |                               |
| 1                                               | 14  | COUT1-COUT3, COUT6-COUT8, COUT18, COUT19, COUT26, COUT27, C34, C35, C45, C46 | CAP, 100µF, X5R, 6.3V, 20%, 1210                           | AVX, 12106D107MAT2A           |
| 2                                               | 2   | CIN1, CIN6                                                                   | CAP, 330µF, ALUM POLY HYB, 35V, 20%, RADIAL, SMD, AEC-Q200 | PANASONIC, EEH-ZK1V331P       |
| 3                                               | 8   | CIN2-CIN5, CIN7-CIN10                                                        | CAP, 22µF, X5R, 35V, 20%, 1210                             | TAIYO YUDEN, GMK325BJ226MM-P  |
| 4                                               | 12  | COUT9-COUT16, COUT21-COUT24                                                  | CAP, 470µF, TANT, POSCAP, 4V, 20%, 7343, 10mΩ, TPF         | PANASONIC, 4TPF470ML          |
| 5                                               | 1   | C14                                                                          | CAP, 1000pF, X7R, 50V, 5%, 0603                            | AVX, 06035C102JAT2A           |
| 6                                               | 1   | C15                                                                          | CAP, 22pF, C0G/NP0, 25V, 5%, 0603                          | AVX, 06033A220JAT2A           |
| 7                                               | 2   | C30, C39                                                                     | CAP, 4.7µF, X5R, 6.3V, 10%, 0603                           | AVX, 06036D475KAT2A           |
| 8                                               | 2   | C33, C38                                                                     | CAP, 2.2µF, X5R, 6.3V, 10%, 0603                           | AVX, 06036D225KAT2A           |
| 9                                               | 4   | C48, C49, C52, C53                                                           | CAP, 47µF, X5R, 6.3V, 20%, 0805                            | MURATA, GRM21BR60J476ME15L    |
| 10                                              | 4   | C50, C51, C54, C55                                                           | CAP, 10µF, X5R, 25V, 10%, 0805                             | MURATA, GRM21BR61E106KA73L    |
| 11                                              | 12  | R10-R15, R18, R24, R52, R77, R94, R125                                       | RES., 10k, 1%, 1/10W, 0603, AEC-Q200                       | VISHAY, CRCW060310K0FKEA      |
| 12                                              | 3   | R25, R32, R70                                                                | RES., 10Ω, 1%, 1/10W, 0603                                 | VISHAY, CRCW060310R0FKEA      |
| 13                                              | 1   | R26                                                                          | RES., 22.6k, 1%, 1/10W, 0603, AEC-Q200                     | VISHAY, CRCW060322K6FKEA      |
| 14                                              | 1   | R126                                                                         | RES., 32.4k, 1%, 1/10W, 0603, AEC-Q200                     | VISHAY, CRCW060332K4FKEA      |
| 15                                              | 1   | R127                                                                         | RES., 1.65k, 1%, 1/10W, 0603, AEC-Q200                     | VISHAY, CRCW06031K65FKEA      |
| 16                                              | 2   | U1, U2                                                                       | IC., DUAL 30A OR SINGLE 60A µModule REG, BGA-144           | ANALOG DEVICES, LTM4680EY#PBF |
| <b>Additional Demo Board Circuit Components</b> |     |                                                                              |                                                            |                               |
| 1                                               | 2   | Q1, Q20                                                                      | XSTR., MOSFET, N-CH, 40V, 14A, DPAK (TO-252)               | VISHAY, SUD50N04-8M8P-4GE3    |
| 2                                               | 1   | Q19                                                                          | XSTR., MOSFET, P-CH, 20V, 5.9A, SOT-23-3 (TO-236-3)        | VISHAY, Si2365EDS-T1-GE3      |
| 3                                               | 10  | R9, R63, R65, R66, R91, R92, R106, R112, R113, R122                          | RES., 0Ω, 1/10W, 0603, AEC-Q200                            | VISHAY, CRCW06030000Z0EA      |
| 4                                               | 3   | C21, C24, C47                                                                | CAP, 1µF, X5R, 25V, 10%, 0603                              | AVX, 06033D105KAT2A           |
| 5                                               | 1   | C23                                                                          | CAP, 1µF, X7R, 25V, 10%, 0805                              | AVX, 08053C105KAT2A           |
| 6                                               | 1   | C26                                                                          | CAP, 0.1µF, X5R, 16V, 10%, 0603                            | AVX, 0603YD104KAT2A           |
| 7                                               | 1   | C28                                                                          | CAP, 0.01µF, X7R, 25V, 5%, 0603                            | AVX, 06033C103JAT2A           |
| 8                                               | 2   | R53, R132                                                                    | RES., 0.01Ω, 1%, 1/2W, 2010, METAL, SENSE, AEC-Q200        | VISHAY, WSL2010R0100FEA       |
| 9                                               | 2   | R72, R73                                                                     | RES., 4.99k, 1%, 1/10W, 0603, AEC-Q200                     | VISHAY, CRCW06034K99FKEA      |
| 10                                              | 1   | R78                                                                          | RES., 15.8k, 1%, 1/10W, 0603, AEC-Q200                     | VISHAY, CRCW060315K8FKEA      |
| 11                                              | 2   | R90, R109                                                                    | RES., 0.002Ω, 1%, 2W, 2512, METAL, SENSE, AEC-Q200         | BOURNS, CRE2512-FZ-R002E-2    |
| 12                                              | 4   | R104, R105, R108, R123                                                       | RES., OPTION, 0805                                         |                               |
| 13                                              | 0   | COUT4, COUT5, COUT17, COUT25                                                 | CAP, OPTION, 7343                                          |                               |
| 14                                              | 0   | C16, C17, C29, C31, C32, C36, C37, C40, C41, C43, C44                        | CAP, OPTION, 0603                                          |                               |
| 15                                              | 0   | D2                                                                           | DIODE, OPTION, SOD-323                                     |                               |

# DEMO MANUAL DC2863A

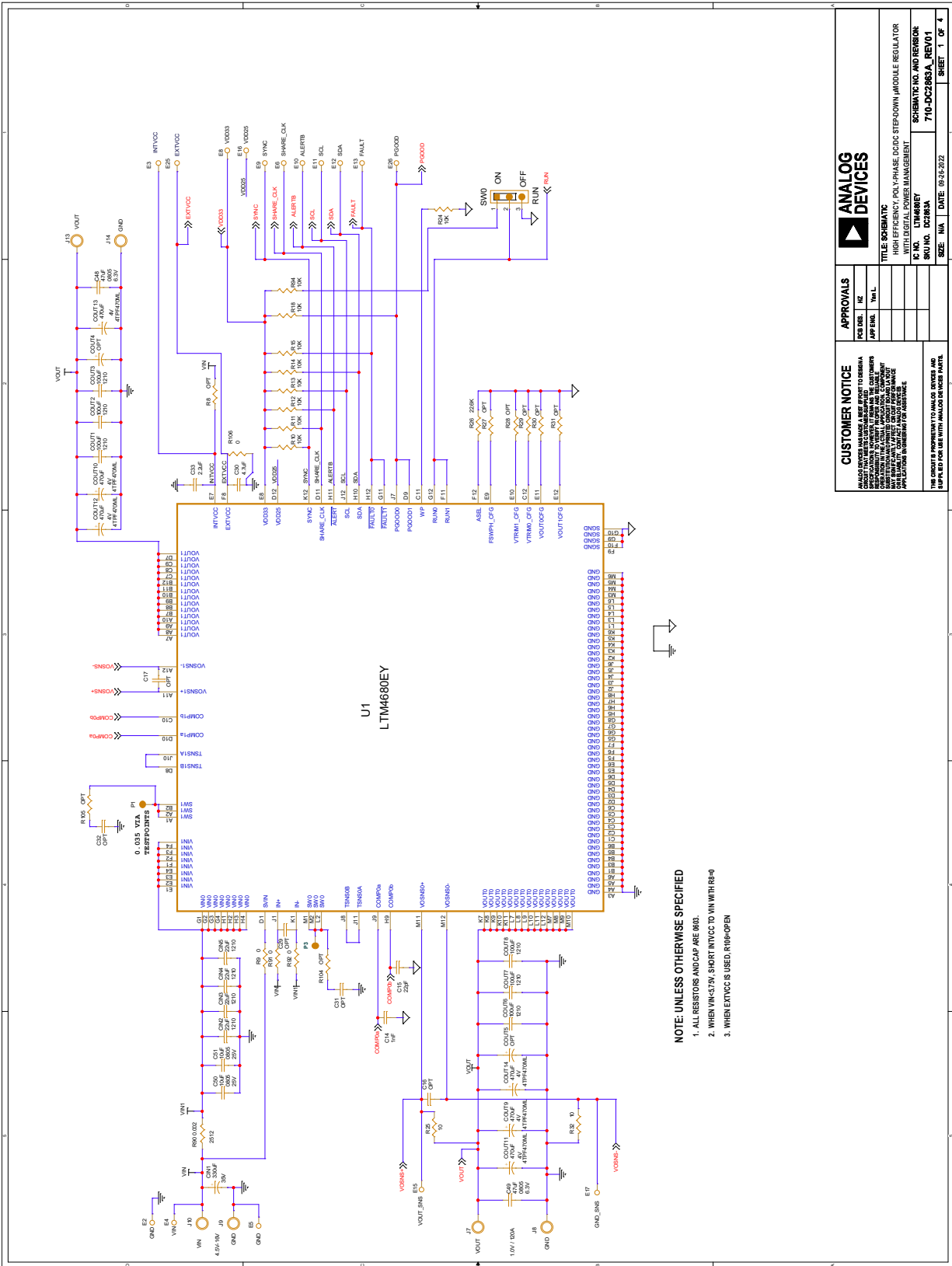
## PARTS LIST

| ITEM | QTY | REFERENCE                                                                | PART DESCRIPTION                                   | MANUFACTURER/PART NUMBER |
|------|-----|--------------------------------------------------------------------------|----------------------------------------------------|--------------------------|
| 16   | 0   | R8, R27-R31, R64, R67, R74, R75, R83, R107, R110, R128, R129, R130, R131 | RES., OPTION, 0603                                 |                          |
| 17   | 0   | R50                                                                      | RES., OPTION, 1210                                 |                          |
| 18   | 0   | R82                                                                      | RES., OPTION, 1206                                 |                          |
| 19   | 1   | U3                                                                       | IC, MEMORY, EEPROM, 2kb (256 × 8), TSSOP-8, 400kHz | MICROCHIP, 24LC025-I/ST  |

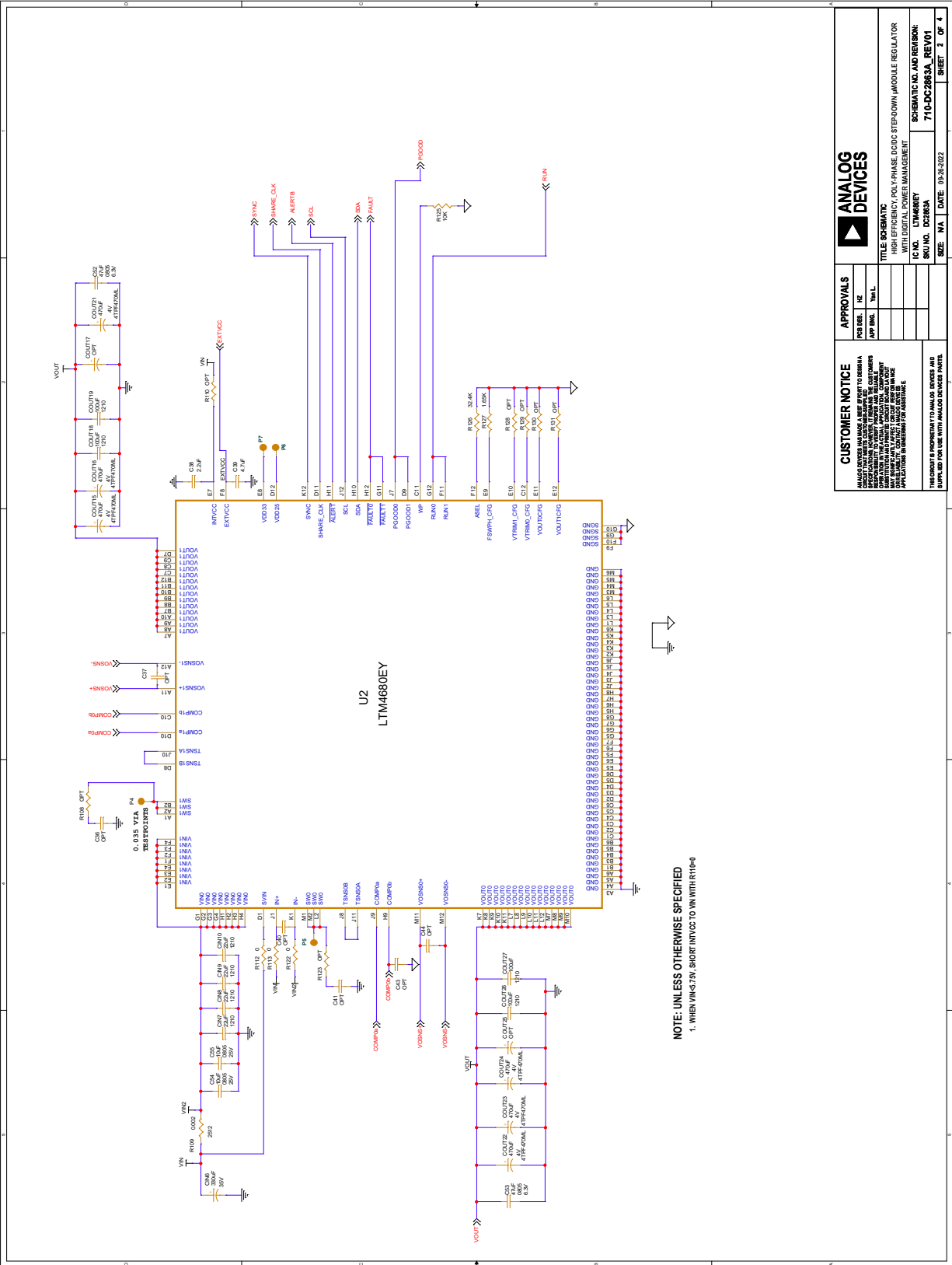
### Hardware: For Demo Board Only

|    |    |                                          |                                                       |                                             |
|----|----|------------------------------------------|-------------------------------------------------------|---------------------------------------------|
| 1  | 1  | SW0                                      | CONN., HDR, MALE, 1 × 3, 2mm, VERT, ST, THT           | SULLINS CONNECTOR SOLUTIONS, NRPN031PAEN-RC |
| 2  | 4  | J7-J10                                   | STUD, TEST PIN                                        | PEM, KFH-032-10                             |
| 3  | 8  | J7-J10 (×2)                              | NUT, BRASS 10-32                                      | ANY, #10-32M/S                              |
| 4  | 4  | J7-J10                                   | RING, LUG #10                                         | KEYSTONE, 8205                              |
| 5  | 4  | J7-J10                                   | WASHER, TIN PLATED BRASS                              | ANY, #10                                    |
| 6  | 1  | XJP1                                     | CONN., SHUNT, FEMALE, 2-POS, 2mm                      | SAMTEC, 2SN-BK-G                            |
| 7  | 2  | J2, J4                                   | CONN., RF BNC, RCPT, JACK, 5-PIN, ST, THT, 50Ω        | AMPHENOL RF, 112404                         |
| 8  | 1  | J1                                       | CONN., HDR, SHROUDED, MALE, 2 × 6, 2mm, VERT, ST, THT | AMPHENOL, 98414-G06-12ULF                   |
| 9  | 1  | J12                                      | CONN., HDR, FEMALE, 2 × 7, 2mm, R/A THT               | SULLINS CONNECTOR SOLUTIONS, NPPN072FJFN-RC |
| 10 | 1  | J11                                      | CONN., HDR, MALE, 2 × 7, 2mm, R/A THT                 | MOLEX, 0877601416                           |
| 11 | 21 | E2-E6, E8-E13, E15-E18, E20-E22, E24-E26 | TEST POINT, TURRET, 0.064" MTG. HOLE, PCB 0.062" THK  | MILL-MAX, 2308-2-00-80-00-00-07-0           |
| 12 | 4  | MH1-MH4                                  | STANDOFF, NYLON, SNAP-ON, 0.50"                       | KEYSTONE, 8833                              |

SCHEMATIC DIAGRAM



SCHEMATIC DIAGRAM



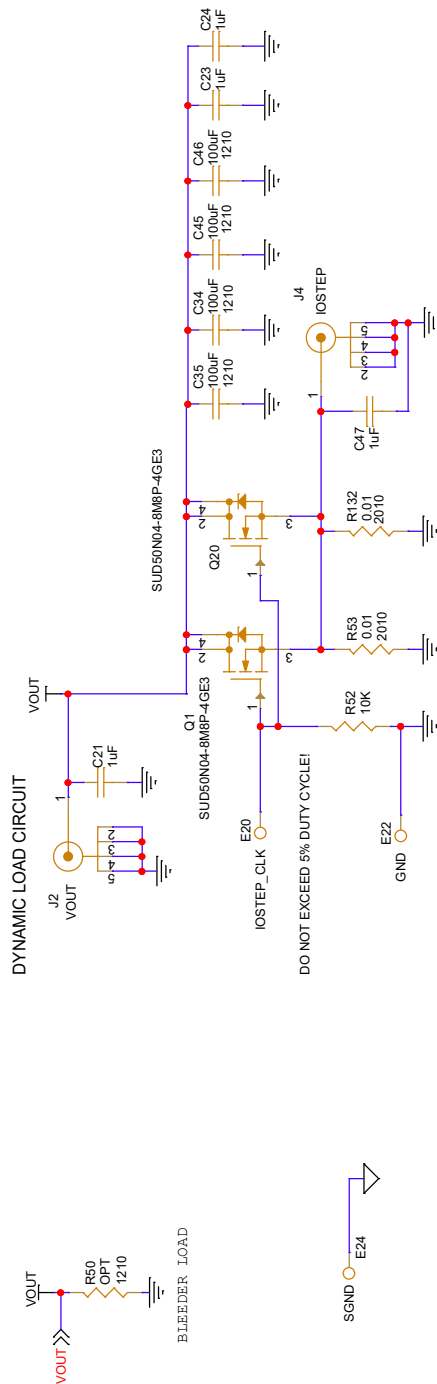
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|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|----------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------|
| CUSTOMER NOTICE                                                                                                                                                                                                                                                                                                                                                                                                                           |     |     |  ANALOG DEVICES |                                                                            |
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| THIS CIRCUIT IS PROPRIETARY TO ANALOG DEVICES AND IS SUPPLIED FOR YOUR USE WITH ANALOG DEVICES PARTS.                                                                                                                                                                                                                                                                                                                                     |     |     |                                                                                                    |                                                                            |
| FOR DES.                                                                                                                                                                                                                                                                                                                                                                                                                                  | REV | YML | TITLE: SCHEMATIC                                                                                   | POLY-PHASE, DC/DC STEP-DOWN MODULE REGULATOR WITH DIGITAL POWER MANAGEMENT |
| APP DRN                                                                                                                                                                                                                                                                                                                                                                                                                                   |     |     | IC NO.                                                                                             | UTM4899Y                                                                   |
|                                                                                                                                                                                                                                                                                                                                                                                                                                           |     |     | REV NO.                                                                                            | 710-DC2863A, REV01                                                         |
|                                                                                                                                                                                                                                                                                                                                                                                                                                           |     |     | SIZE                                                                                               | 1/8" DATE: 03-25-2022                                                      |
|                                                                                                                                                                                                                                                                                                                                                                                                                                           |     |     | SHEET 2 OF 3                                                                                       |                                                                            |

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THE CIRCUIT IS PROPRIETARY TO ANALOG DEVICES AND IS SUPPLIED FOR USE WITH ANALOG DEVICES PARTS.

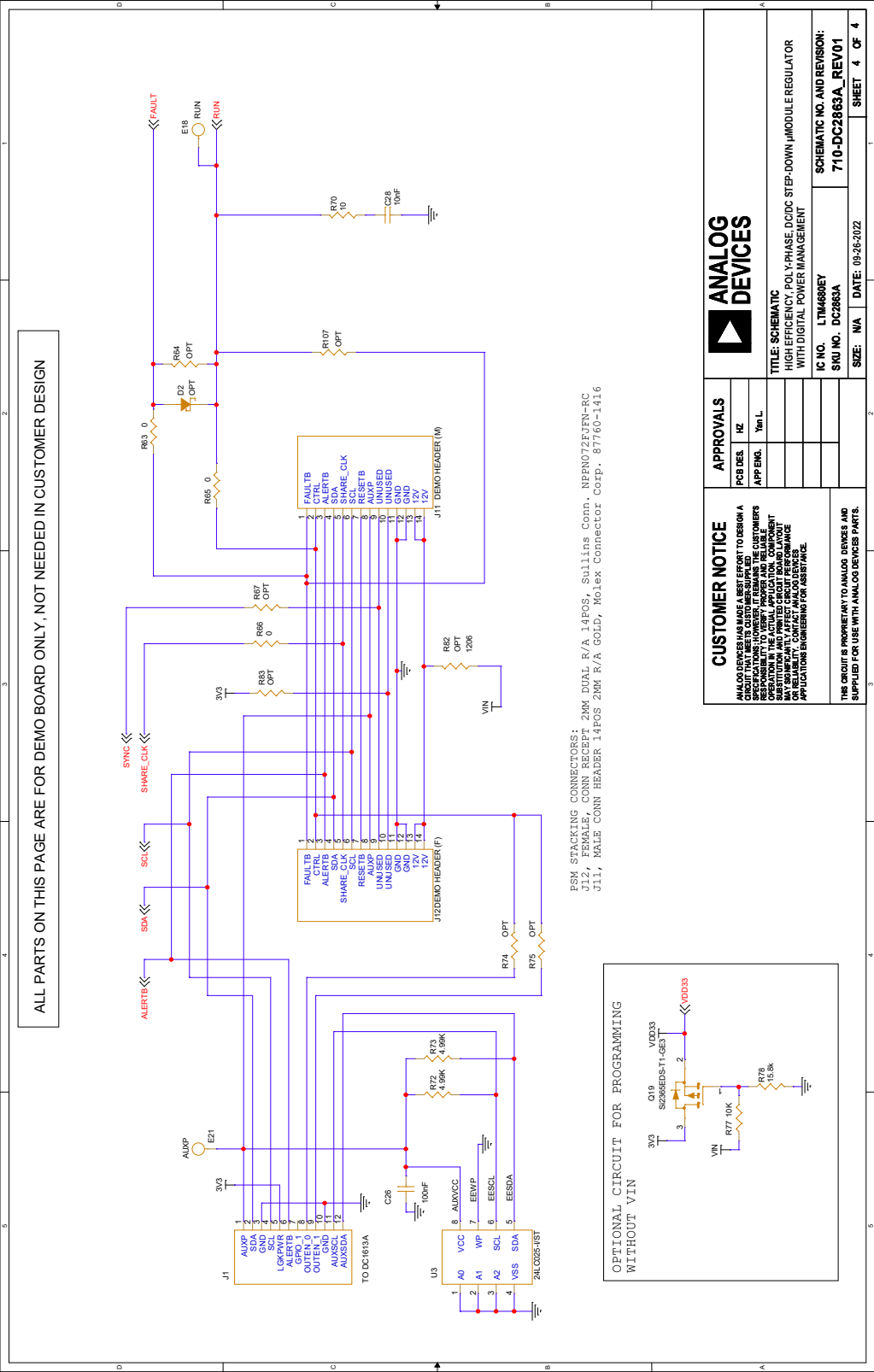
SCHEMATIC DIAGRAM

ALL PARTS ON THIS PAGE ARE FOR DEMO ONLY, NOT NEEDED IN CUSTOMER DESIGN



| CUSTOMER NOTICE                                                                                                                                                                                                                                                                                                                                                                                                      |  | APPROVALS                                                                                                           |        |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|---------------------------------------------------------------------------------------------------------------------|--------|
| ANALOG DEVICES                                                                                                                                                                                                                                                                                                                                                                                                       |  | PCB DES.                                                                                                            | HZ     |
|                                                                                                                                                                                                                                                                                                                                                                                                                      |  | APP ENG.                                                                                                            | Yan L. |
|                                                                                                                                                                                                                                                                                                                                                                                                                      |  |                                                                                                                     |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                      |  |                                                                                                                     |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                      |  |                                                                                                                     |        |
| THIS CIRCUIT IS PROPRIETARY TO ANALOG DEVICES AND SUPPLIED FOR USE WITH ANALOG DEVICES PARTS.                                                                                                                                                                                                                                                                                                                        |  | TITLE: SCHEMATIC<br>HIGH EFFICIENCY POLY-PHASE DC/DC STEP-DOWN $\mu$ MODULE REGULATOR WITH DIGITAL POWER MANAGEMENT |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                      |  |                                                                                                                     |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                      |  |                                                                                                                     |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                      |  |                                                                                                                     |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                      |  |                                                                                                                     |        |
| DO NOT EXCEED 5% DUTY CYCLE!                                                                                                                                                                                                                                                                                                                                                                                         |  | IC NO. LTM4680EY<br>SKU NO. DC2863A                                                                                 |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                      |  |                                                                                                                     |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                      |  |                                                                                                                     |        |
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| ANALOG DEVICES HAS MADE A BEST EFFORT TO DESIGN A CIRCUIT THAT MEETS CUSTOMER-SUPPLIED SPECIFICATIONS; HOWEVER, IT REMAINS THE CUSTOMER'S RESPONSIBILITY TO VERIFY PROPER AND RELIABLE OPERATION IN THEIR FINAL APPLICATION. ANY CHANGES, SUBSTITUTION AND PRINTED CIRCUIT BOARD LAYOUT MAY SIGNIFICANTLY AFFECT CIRCUIT PERFORMANCE OR RELIABILITY. CONTACT ANALOG DEVICES APPLICATIONS ENGINEERING FOR ASSISTANCE. |  | SCHEMATIC NO. AND REVISION:<br>710-DC2863A_REV01                                                                    |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                      |  |                                                                                                                     |        |
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|                                                                                                                                                                                                                                                                                                                                                                                                                      |  |                                                                                                                     |        |
| THIS CIRCUIT IS PROPRIETARY TO ANALOG DEVICES AND SUPPLIED FOR USE WITH ANALOG DEVICES PARTS.                                                                                                                                                                                                                                                                                                                        |  | SIZE: N/A<br>DATE: 09-26-2022                                                                                       |        |
|                                                                                                                                                                                                                                                                                                                                                                                                                      |  |                                                                                                                     |        |
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| DO NOT EXCEED 5% DUTY CYCLE!                                                                                                                                                                                                                                                                                                                                                                                         |  | SHEET 3 OF 4                                                                                                        |        |
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SCHEMATIC DIAGRAM



REVISION HISTORY

| REV | DATE  | DESCRIPTION      | PAGE NUMBER |
|-----|-------|------------------|-------------|
| A   | 03/24 | Initial Release. | —           |

**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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