

## Evaluation Board for the **ADP1853** Step-Down DC-to-DC Controller

### FEATURES

- Input voltage range: 9 V to 15 V**
- Output voltage: 3.3 V**
- Output current: up to 20 A**
- Switching frequency: 300 kHz**
- Operates in PWM or PSM**
- Designed for evaluation of the **ADP1853** functionality**
- Flexible and easy to re-configure and modify**

### EVALUATION BOARD DESCRIPTION

This document describes the design, operation, and test results of the **ADP1853-EVALZ**. The input voltage range for this evaluation board is 9 V to 15 V, and the regulated output voltage  $V_{OUT}$  is set to 3.3 V with the maximum output current up to 20 A. The switching frequency ( $f_{SW}$ ) of 300 kHz is set to achieve high efficiency.

### ADP1853 DEVICE DESCRIPTION

The **ADP1853** is a step-down switching controller with integrated drivers for N-channel synchronous power MOSFETs. The switching frequency of the **ADP1853** can be synchronized to an external clock signal applied to the SYNC input. The **ADP1853** has a clock output, CLKOUT, which can be used for synchronizing other controllers. The CLKOUT frequency is the same as the switching and it is 180° out of phase.

In addition, the boost diode is integrated into the **ADP1853**, thus lowering the overall system cost and component count. The **ADP1853** can be set to operate in pulse skip, high efficiency mode (PSM) under light load, or in PWM continuous conduction mode.

The **ADP1853** includes externally adjustable soft start, output overvoltage protection, externally programmable current limit, power good, tracking function, and a programmable oscillator frequency that ranges from 200 kHz to 1.5 MHz. The **ADP1853** has the reference voltage accuracy of  $\pm 1\%$  from  $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$  junction temperature. This controller can be powered from a 2.75 V to 20 V supply and is available in a 20-lead 4 mm  $\times$  4 mm LFCSP package.

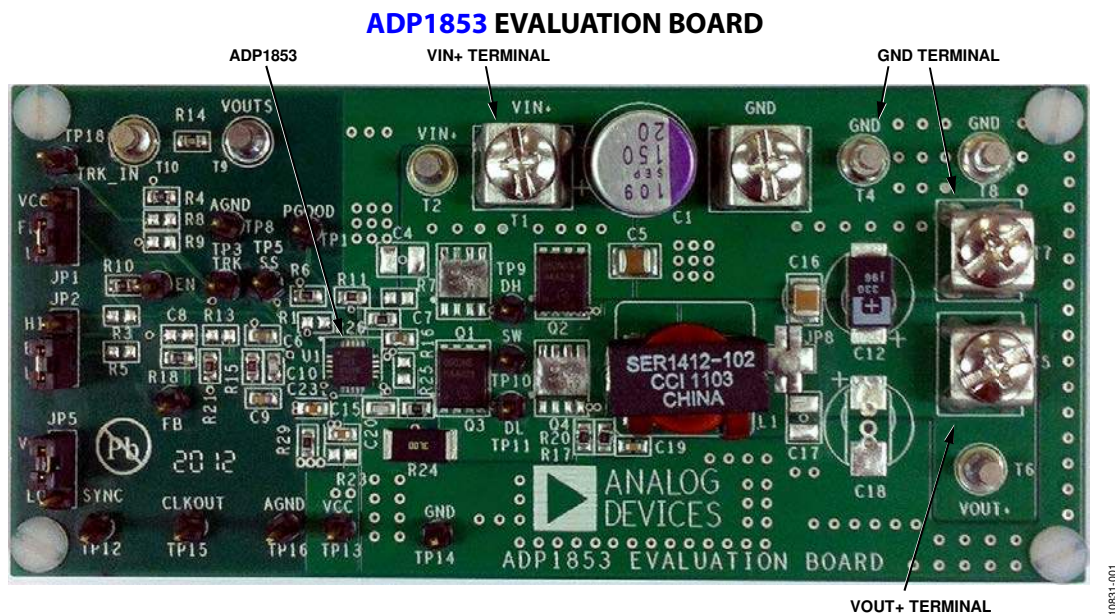


Figure 1.

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**REVISION HISTORY**

6/12—Revision 0: Initial Version

## COMPONENT DESIGN

### ADIsimPower DESIGN TOOL

The ADP1853 is supported by the ADIsimPower™ design tool set. ADIsimPower is a collection of tools that produce complete power designs optimized to a specific design goal. The tools allow the user to generate a full schematic, bill of materials, and calculate performance in minutes. ADIsimPower can optimize designs for cost, area, efficiency, and parts count while taking into consideration the operating conditions and limitations of the IC and all real external components. The ADIsimPower tool can be found at [www.analog.com/ADIsimPower](http://www.analog.com/ADIsimPower) and the user can request an unpopulated board through the tool.

For information about selecting power components and calculating component values, see also the ADP1853 data sheet.

### INDUCTOR SELECTION

The selected inductor is a Coilcraft SER1412-102ME with 1  $\mu$ H inductance, and 32 A saturation current. This shielded inductor with a flat wire windings core provides exceptionally low DCR of 1.3 m $\Omega$  (typical).

### INPUT CAPACITORS

Because of the low ESR and high input current rating of a multi-layer ceramic capacitor (MLCC), a 10  $\mu$ F MLCC is selected as the input capacitor close to the high-side power MOSFET. In addition, a 150  $\mu$ F bulk OS-CON™ capacitor (aluminum solid capacitor with conductive polymer) from Sanyo is chosen for filtering out any unwanted low frequency noise from the input power supply.

### OUTPUT CAPACITORS

A combination of a 330  $\mu$ F POSCAP™ polymer capacitor and a 22  $\mu$ F MLCC is selected for the output rail. Polymer capacitors have low ESR and high current ripple rating. Connecting polymer capacitors and MLCCs in parallel is very effective in reducing voltage ripple.

### MOSFET SELECTION

For low output or low duty cycle, select a high-side MOSFET with fast rise and fall times and with low input capacitance to minimize charging and switching power loss. As for the synchronous rectifier (low-side MOSFET), select a MOSFET with low  $R_{DS(on)}$  because it conducts current most of the time during the switching cycle and contributes larger portion in the conductive losses than the high-side MOSFET. For the high-side MOSFET, the BSC052N03LS from Infineon in the PG-TDSON-8 package is selected. This part has low input capacitance (770 pF typical) and fast transition times (typical turn-on delay is 2.4 ns). For the low-side MOSFET, the BSC090NS from Infineon, with the  $R_{DS(on)}$  of 3.5 m $\Omega$  (maximum at  $V_{GS}$  of 4.5 V) is selected.

TEST RESULTS

$T_A = 25^\circ\text{C}$ .

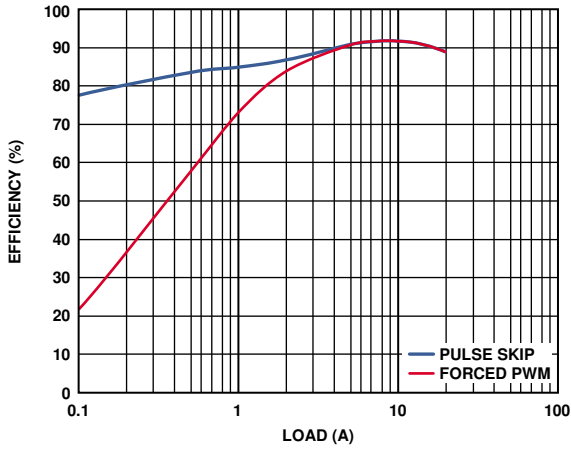


Figure 2. Efficiency,  $V_{IN} = 12\text{ V}$ ,  $V_{OUT} = 3.3\text{ V}$ ,  $f_{OSC} = 300\text{ kHz}$

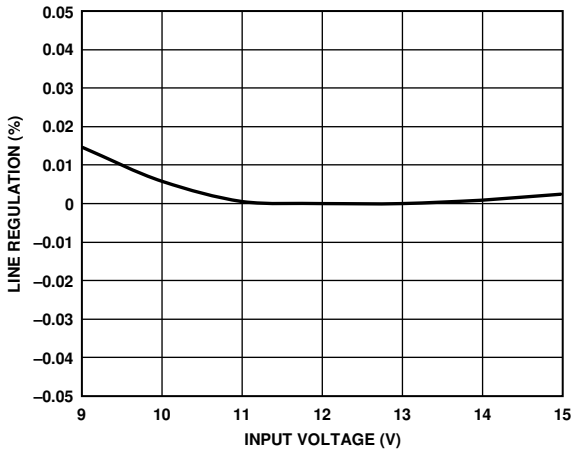


Figure 3. Line Regulation,  $V_{OUT} = 3.3\text{ V}$ ,  $f_{SW} = 300\text{ kHz}$ , 20 A Load

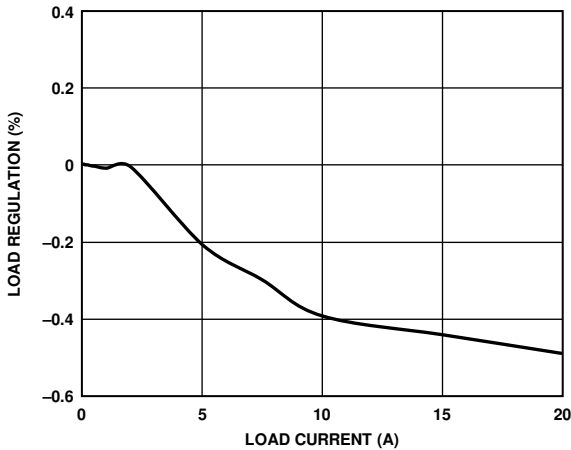


Figure 4. Load Regulation,  $V_{IN} = 12\text{ V}$ ,  $V_{OUT} = 3.3\text{ V}$ ,  $f_{SW} = 300\text{ kHz}$

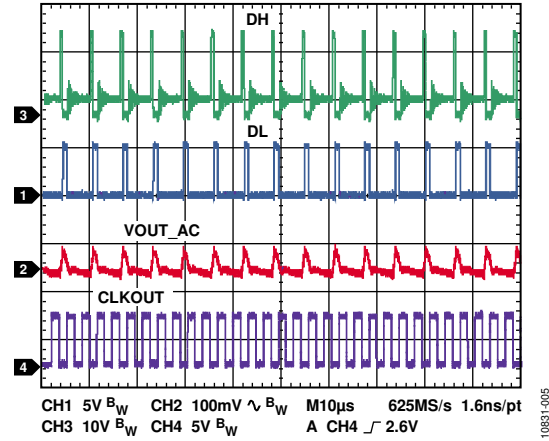


Figure 5. Switching Waveforms, Light Load of 0.5 A,  $f_{OSC} = 300\text{ kHz}$ , Pulse Skip Enabled, SYNC Low

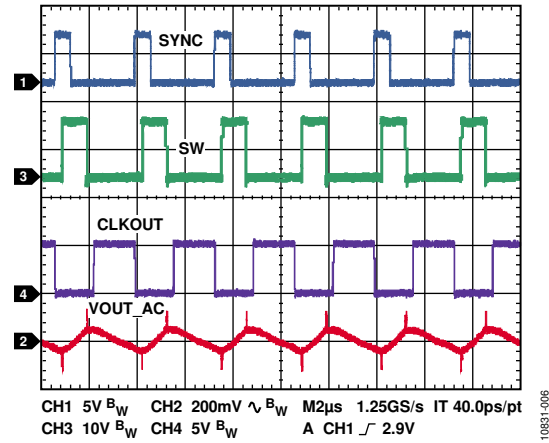


Figure 6. Switching Waveforms, 20 A Load,  $f_{SYNC} = 300\text{ kHz}$

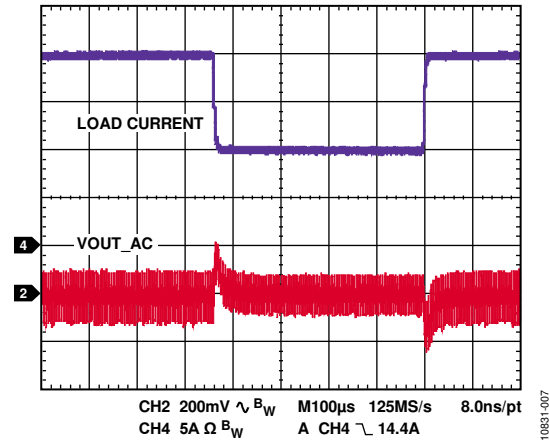


Figure 7.  $V_{OUT}$  Transient Response, 20 A to 10 A Load Step

## EVALUATION BOARD OPERATING INSTRUCTION

1. Connect Jumper JP2 (EN) with a shunt to the low position (disabled)
2. Connect Jumper JP1 (FRQ) with a shunt to the low position for 300 kHz operation.
3. Connect Jumper JP5 (SYNC) with a shunt to the high position for PWM operation or to the low position for pulse skip operation at light load.
4. Connect a power supply to the board input terminals VIN+ and GND and apply 12 V.
5. Connect Jumper JP2 (EN) to the high position to enable the [ADP1853](#).

**Table 1. Jumper Description**

| Jumper | Description | Default Factory Setting | Function  |
|--------|-------------|-------------------------|---|
| JP1    | FRQ         | Low                     | Connect shunt low for 300 kHz or high for 600 kHz switching frequency operation. The <a href="#">ADP1853-EVALZ</a> is configured for operation at 300 kHz. Connect JP1 low. |
| JP2    | EN          | Low                     | Connect shunt high to enable the <a href="#">ADP1853</a> or low to disable it.  |
| JP5    | SYNC        | Low                     | Connect shunt high for PWM or low for pulse skip operation. For synchronization, remove the shunt from JP5 and apply an external clock to the TP12 SYNC.                    |

**Table 2. Performance Summary (T<sub>A</sub> = 25°C)**

| Parameter   | Condition                    |
|---|------------------------------|
| V <sub>IN</sub>                                   | 9 V to 15 V                  |
| f <sub>SW</sub>                                   | Switching frequency, 300 kHz |
| V <sub>OUT</sub>                                  | 3.3 V                        |
| I <sub>OUT</sub>                                  | 0 A to 20 A                  |
| V <sub>OUT</sub> Ripple, DC Load                  | 90 mV at 20 A load           |
| V <sub>OUT</sub> Deviation upon Step Load Release | 5% with 10 A step load       |

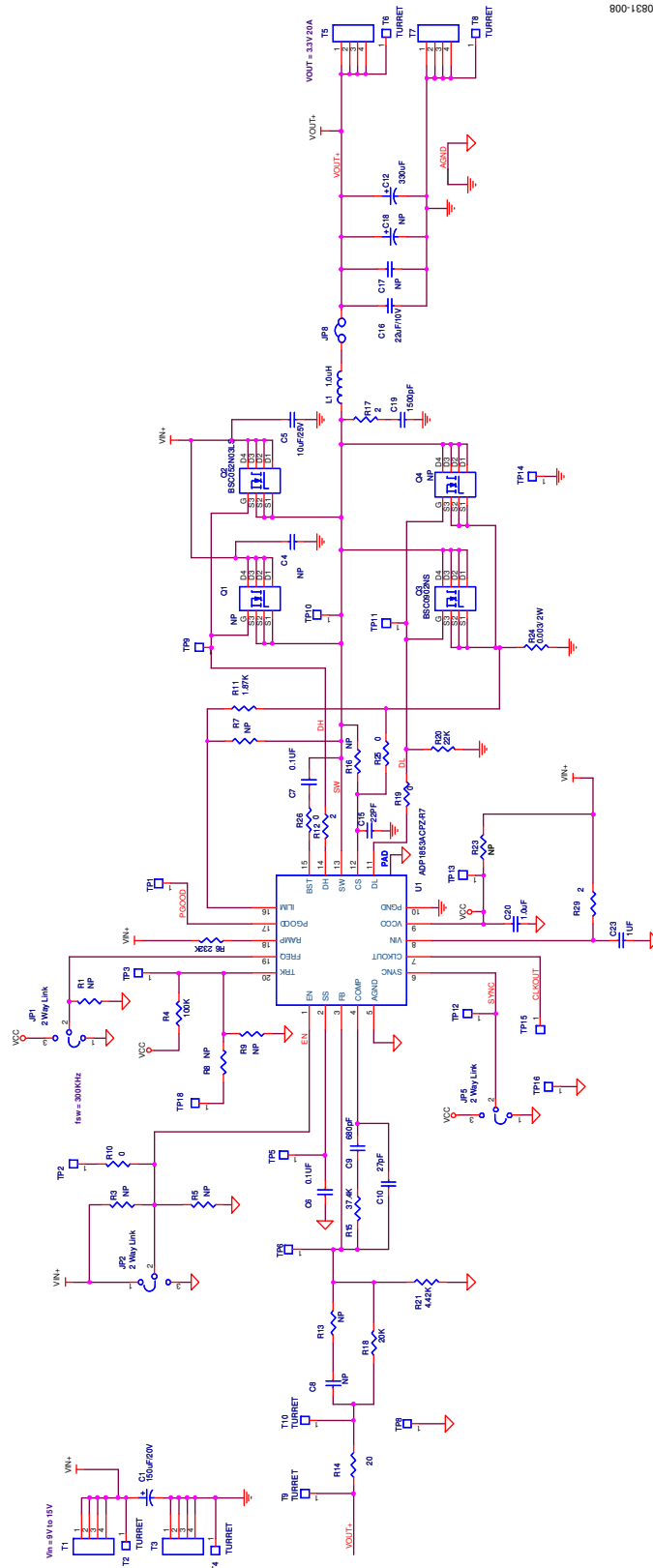
**OTHER INFORMATION ABOUT THE EVALUATION BOARD PCB LAYOUT**

As seen in Figure 1, the layout of this evaluation board is not optimized for the smallest PCB area. It is laid out in such a way that any of the components can be desoldered and replaced easily with different components by using a hand soldering iron so that the user can modify the existing design without acquiring a new PCB layout. The physical size of the compensation components is 0603, which is selected for its ease of hand soldering when reworking the board is needed. The size of these components can be smaller in an actual design. Note that there are extra place holders for the output filter capacitors, high-side and low-side MOSFETs, and the input ceramic decoupling capacitor. The user can remove, add, or change any of these

power components, including the inductor, to achieve a particular design objective. The track function, where TRK is pulled up to VCCO through a 100 k $\Omega$  resistor (R4), is not used on this evaluation board. If a tracking function is needed, the user can remove the resistor, R4, and place a resistor divider (R8/R9) to configure the desired tracking function. To study the precision enable function, remove the shunt for JP2 and apply an external voltage to TP2 EN. To program higher UVLO threshold, place the required resistor divider (R3/R5).

See Figure 8, the evaluation board schematic, for more information.

# EVALUATION BOARD SCHEMATICS AND ARTWORK



800-1C801

Figure 8. Evaluation Board Schematic

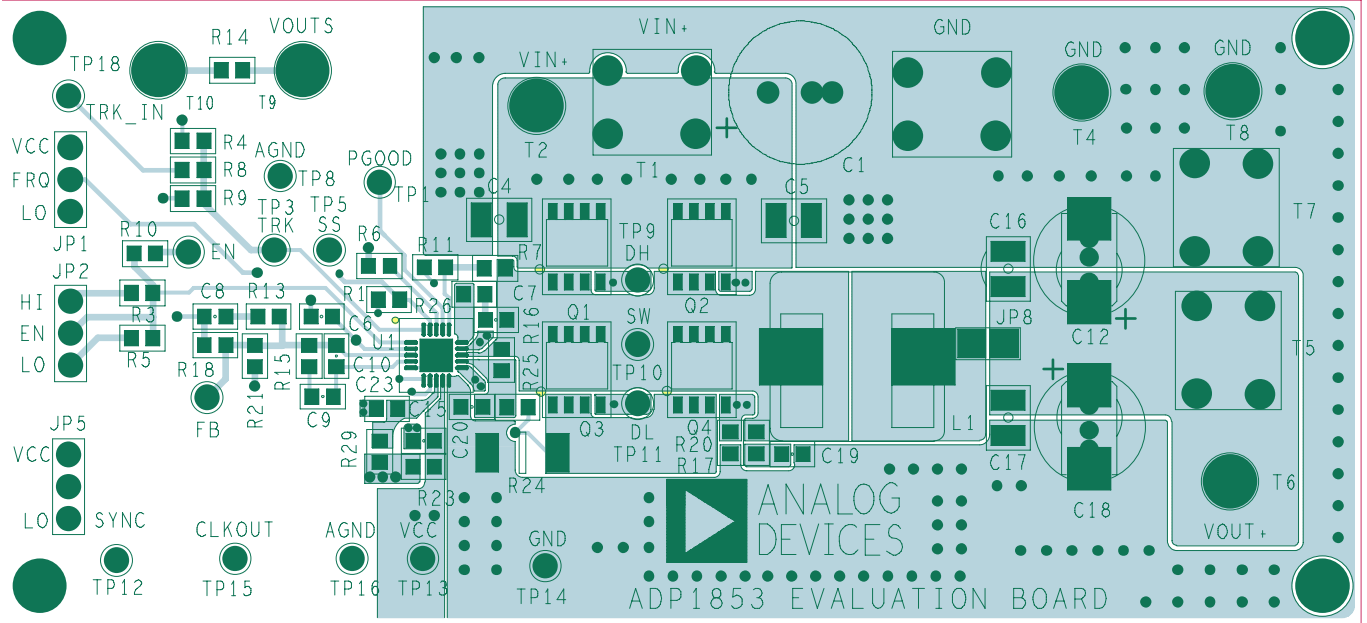


Figure 9. Top Layer with Silkscreen

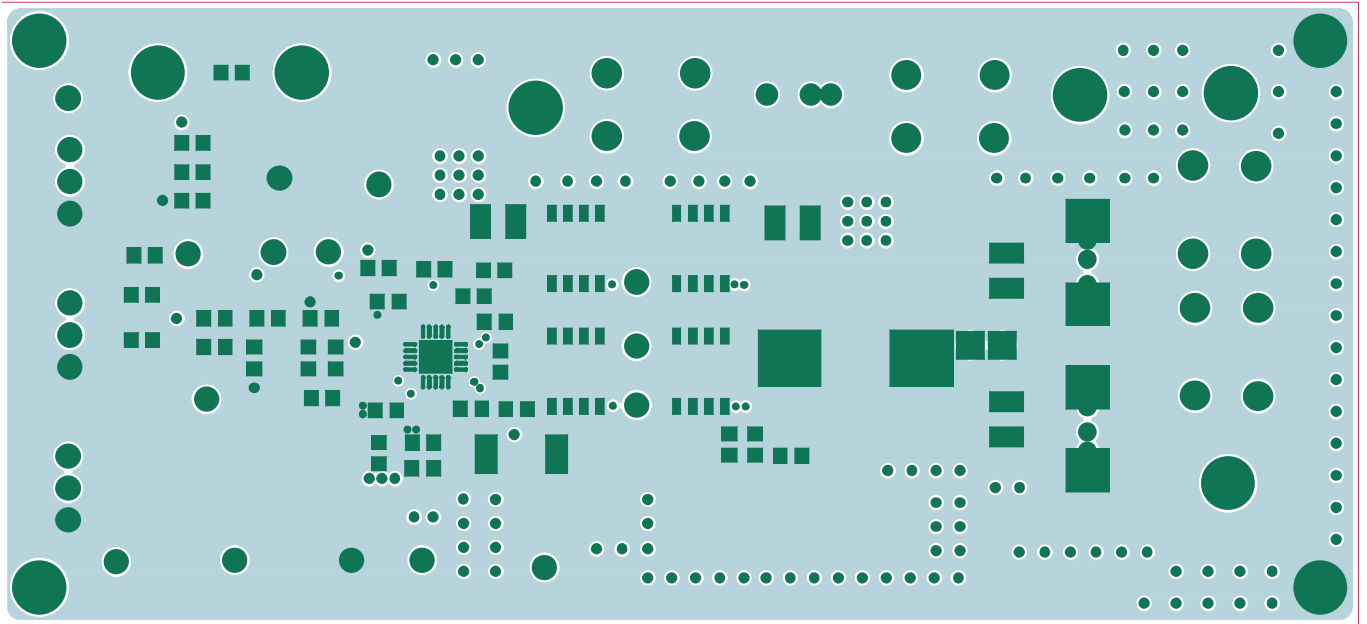


Figure 10. Second Layer (AGND Plane)



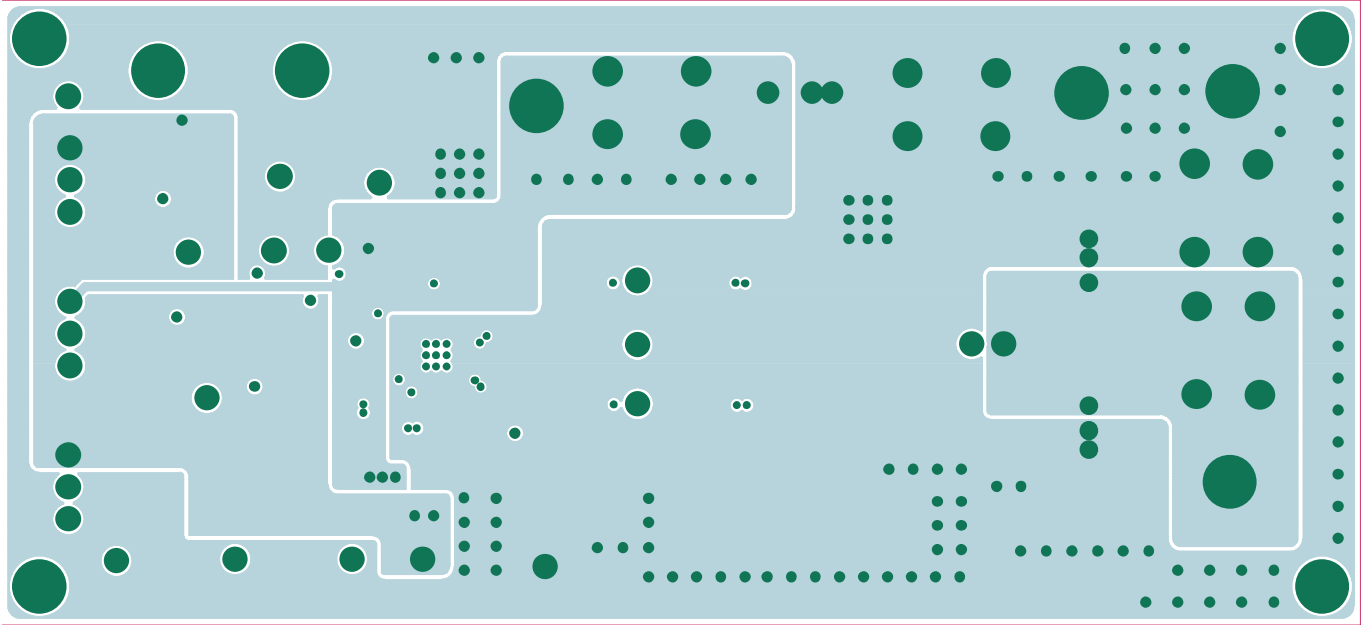


Figure 11. Third Layer ( $V_{IN}$ ,  $V_{CC0}$ ,  $V_{OUT}$ , and PGND)

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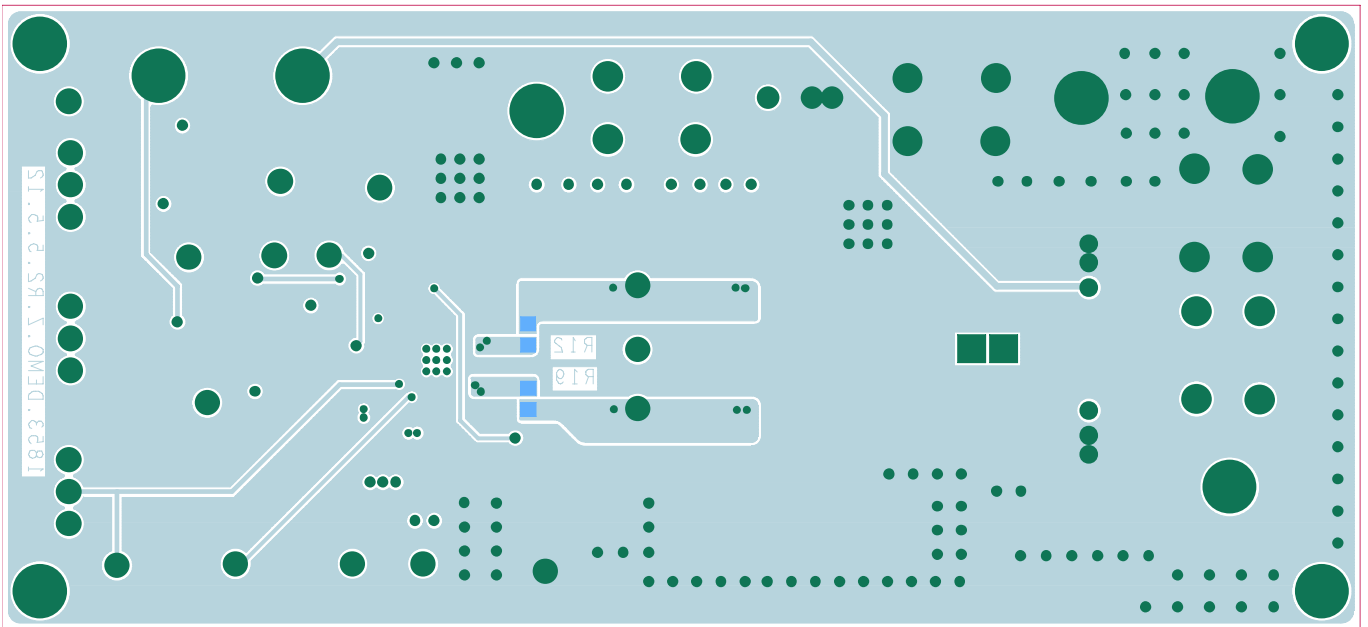


Figure 12. Bottom Layer

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## ORDERING INFORMATION

## BILL OF MATERIALS

Table 3.

| Qty | Reference Designator  | Description  | Manufacturer               | Part No.           |
|-----|---|--|----------------------------|--------------------|
| 1   | C1  | OS-CON 150 $\mu$ F 20 V  | Sanyo                      | 20SEP150M          |
| 2   | C4  | Open   |                            |                    |
| 1   | C5  | Capacitor ceramic 10 $\mu$ F 25 V 10% X7R 1210   | Murata                     | GRM32DR71E106KA12  |
| 2   | C6, C7  | Capacitor ceramic 0.1 $\mu$ F 25 V 10% X7R 0603  | Murata                     | GRM188R71E104KA01D |
| 1   | C8  | Open   |                            |                    |
| 1   | C9  | Capacitor ceramic 680 pF X7R 0603  | Murata                     | GRM188R71H681KA01D |
| 1   | C10   | Capacitor ceramic 27 pF C0G/NP0 0603   | Murata                     | GRM1885C1H270JA01D |
| 1   | C12   | POSCAP 330 $\mu$ F 6.3 V 15 m $\Omega$   | Sanyo                      | 6TPE330MFL         |
| 1   | C15   | Capacitor ceramic 22 pF C0G/ NP0 0603  | Murata                     | GRM1885C1H220JA01D |
| 1   | C16   | Capacitor ceramic 22 $\mu$ F 10 V X5R 1210   | Murata                     | GRM32ER61A226KE20L |
| 1   | C17   | Open   |                            |                    |
| 1   | C18   | Open   |                            |                    |
| 1   | C19   | Capacitor ceramic 1500 pF X7R 0603   | Murata                     | GRM188R71H152KA01D |
| 2   | C20, C23  | Capacitor ceramic 1 $\mu$ F 25 V X7R 0603  | Murata                     | GRM188R71E105KA12D |
| 3   | JP1, JP2, JP5   | Jumper, Header 3, 0.100"   | Samtec                     | TSW-150-07-G-S     |
| 1   | JP8   | Solder bridge  |                            |                    |
| 1   | L1  | Inductor 1.0 $\mu$ H 1.3 m $\Omega$ , I <sub>SAT</sub> = 32 A, I <sub>RMS</sub> = 37 A | Coilcraft                  | SER1412-102ME      |
| 1   | Q1  | Open   |                            |                    |
| 1   | Q2  | N MOSFET, 30 V, 5.2 m $\Omega$   | Infineon                   | BSC052N03LS        |
| 1   | Q3  | N MOSFET, 30 V, 2.6 m $\Omega$   | Infineon                   | BSC0902NS          |
| 1   | Q4  | Open   |                            |                    |
| 9   | R1, R3, R5, R7, R8, R9,<br>R13, R16, R23  | Open   |                            |                    |
| 1   | R4  | Resistor 100 k $\Omega$ 1/10W 5% 0603  | Vishay                     | CRCW0603100KFKEA   |
| 1   | R6  | Resistor 232 k $\Omega$ 1%   | Vishay                     | CRCW0603232KFKEA   |
| 4   | R10, R19, R25, R26  | Resistor 0 $\Omega$  | Vishay                     | CRCW06030000Z0EA   |
| 1   | R11   | Resistor 1.87 k $\Omega$ 1%  | Vishay                     | CRCW06031K87FKEA   |
| 3   | R12, R17, R29   | Resistor 2.0 $\Omega$ 1%   | Vishay                     | CRCW0602R00FKEA    |
| 1   | R14   | Resistor 20 $\Omega$   | Vishay                     | CRCW060320R0FKEA   |
| 1   | R15   | Resistor 37.4 k $\Omega$ 1%  | Vishay                     | CRCW060337K4FKEA   |
| 1   | R18   | Resistor 20 k $\Omega$ 1%  | Vishay                     | CRCW060320K0FKEA   |
| 1   | R20   | Resistor 22 k $\Omega$ 1%  | Vishay                     | CRCW060322K0FKEA   |
| 1   | R21   | Resistor 4.42 k $\Omega$ 1%  | Vishay                     | CRCW06034K42FKEA   |
| 1   | R24   | Resistor.003 $\Omega$ 2 W 1% 2512 SMD  | ROHM                       | PMR100HZPFV3L00    |
| 15  | TP1, TP2, TP3, TP5, TP6, TP8,<br>TP9, TP10, TP11, TP12, TP13,<br>TP14, TP15, TP16, TP18 | Test points, header 0.100"   | Samtec                     | TSW-150-07-G-S     |
| 4   | T1, T3, T5, T7  | Terminal screw vertical PC MNT   | Keystone Electronics Corp. | 8191K-ND           |
| 6   | T2, T4, T6, T8, T9, T10   | TURRET170  | Keystone Electronics Corp. | 1502-1             |
| 1   | U1  | Device under test, 20LD LFCSP  | Analog Devices             | ADP1853ACPZ-R7     |
| 3   |   | Shunt  | Samtec                     | SNT-100-BK-G       |
| 4   |   | Standoff HEX .500/4 NYL  | Keystone Electronics Corp. | 1902C              |
| 4   |   | Screw NYL slot   | Richco                     | NSS-4-6-01         |

**NOTES**

## 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.

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