User's Manual

# ISL78264EVAL1Z

## User's Manual: Evaluation Board

## Automotive

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# ISL78264EVAL1Z

Evaluation Board

The ISL78264EVAL1Z board demonstrates the two-channel synchronous buck converter operation of the ISL78264 in which the converters have 180 phase shift to minimize input capacitor stress. It illustrates the high efficiency of synchronous buck operation and all the features of the IC including overcurrent protection, overvoltage and undervoltage protection, and power-good indication for each channel.

## Key Features

- $V_{IN}$ operating range: 3.75V to 42V
- Selectable Forced PWM or ECM Mode with Iq = 6µA (one channel)
- Programmable switching frequency: 200kHz to 2.2MHz
- Dropout mode for high duty-cycle operation
- 20ns on-times for low duty-cycle operation
- External synchronization
- Programmable spread spectrum clocking
- 180° phase shift between channels
- 2A Sourcing/3A sinking MOSFET drivers
- Boot UVLO and programmable boot refresh time
- Extensive protection mechanisms for OV/UV/OC/OT
- Monitor test points for key signals

## Specifications

This board is configured and optimized for the following operating conditions. See "Operating Range" on page 4 for more detailed descriptions.

- VIN_TYP = 12-14V
- VIN_MAX = 42V (typical)
- VOUT1 = 5V (up to 10A)
- VOUT2 = 3.3V (up to 10A)
- $f_{SW}$ = 2.2MHz

## Ordering Information

| Part Number | Description |
|---|---|
| ISL78264EVAL1Z | ISL78264 evaluation board |

## Related Literature

For a full list of related documents, visit our website:

- ISL78264 device page

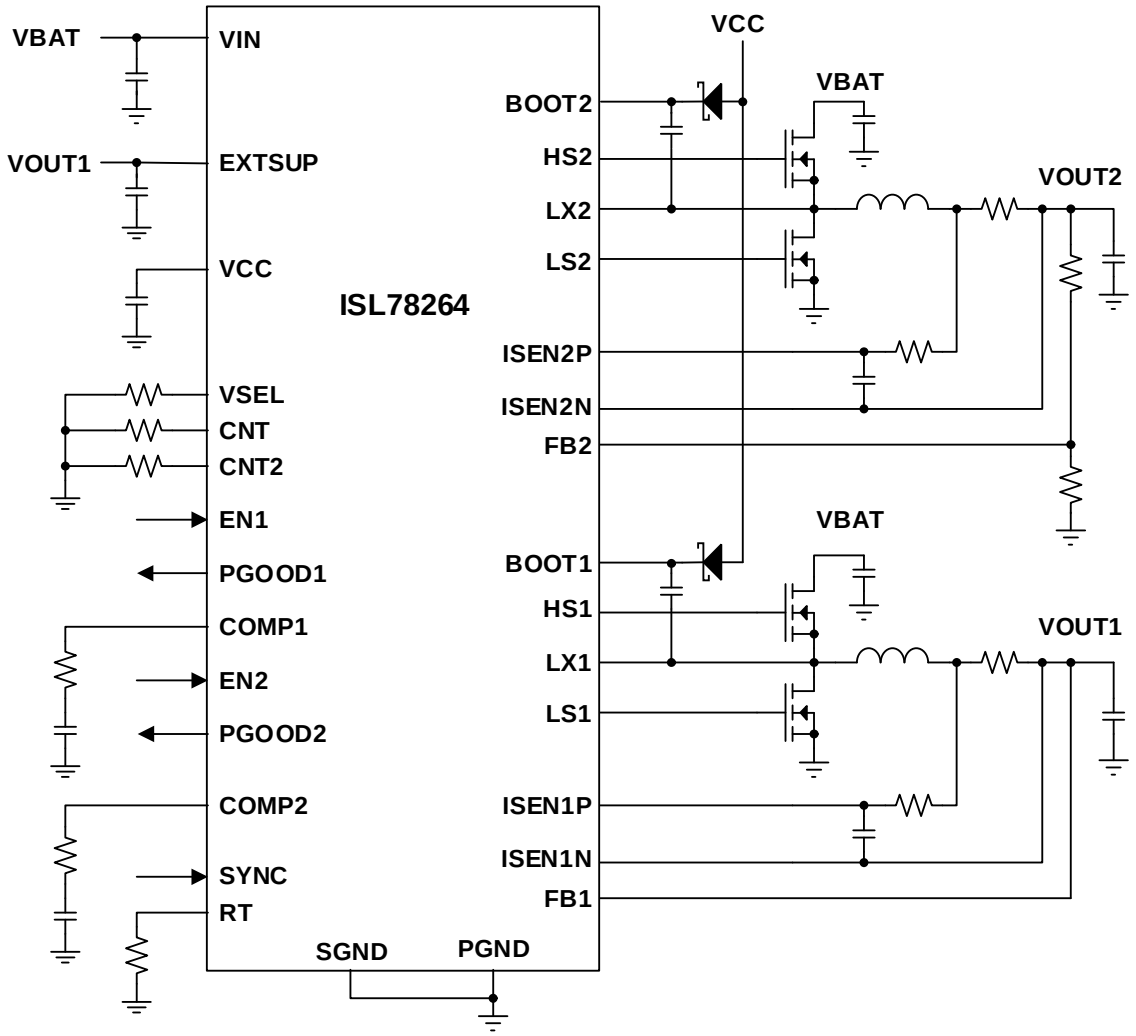


**Figure 1. ISL78264EVAL1Z Block Diagram**

# 1. Functional Description

The ISL78264EVAL1Z evaluation board photos are shown in Figures 2 and 3. The board supports a quick evaluation of various features of the ISL78264 while demonstrating a power solution providing two rail voltages with very high efficiency over a wide load range. The ISL78264EVAL1Z demonstrates the feature set of the ISL78264 supporting automotive applications powered from a car battery.

## 1.1 Recommended Equipment

- VBAT ($V_{IN}$ supply): 50V power supply with 20A source current capability
- Output Loads: Two loads capable of >10A
- Digital Multimeters (DMM) and/or oscilloscope to monitor various voltages

## 1.2 Operating Range

- Enable operation
  - S1 and S2 control EN1 and EN2 for Converter 1 and Converter 2, respectively.
  - EN1 has a 100kΩ resistor to VIN to allow auto-start of Channel 1 when VIN is applied.
  - EN2 has a 10kΩ pull-up resistor to VCC, requiring $V_{CC}$ to be present for Channel 2 to be enabled.
  - The converters are allowed to start when the input voltage ($V_{IN}$), rises above 5.65V (typical).
- VIN_MIN = 6V or lower
  - The board shuts down when $V_{CC}$ falls below 4V (typical)
- VIN_TYP = 12V
- VIN_MAX = 42V (typical)
- IOUT_MAX = 10A
- $f_{SW}$ = 2.2MHz as selected with R16 = 6.81kΩ
- The board is set in ECM mode by default with J10 (FCCM) open, which allows R46 (100kΩ) to pull the SYNC pin low.
- The board is set to connect 5V output of Channel 1 to EXTSUP (U1-20) with a jumper shorting Pins 2-3 of J15 to provide an efficient 5V source for control and gate drive power
- Switches S3 and S4 allow setting the operating configurations as detailed in the datasheet
  - S3 should have position 8 **ON** to connect VSEL (U1-3) to R31 (75kΩ) to ground to select Converter 1 as 5V fixed voltage
  - S3 should have position 3 **ON** to connect VSEL (U1-1) to R26 (54.9kΩ) to ground to select Boot refresh time of 300ns
  - S4 should have position 3 **ON** to connect VSEL (U1-3) to R34 (14.7kΩ) to ground to select minimum dead time and Spread Spectrum **OFF**

## 1.3 External Connections and Setup Before Start-Up

1. Connect the $V_{IN}$ power supply between VBAT (J1) and GND (J2). Before typical start-up, set the $V_{IN}$ power supply voltage to 12V. The power supply output should remain off before start-up.
2. For initial startup position S1 and S2 in **OFF** position.
3. Connect separate electronic loads between VOUT1 (J6) and GND (J5), and VOUT2 (J3) and GND (J4). Set the electronic load to 0A for the first start-up. The load should remain off before start-up.
4. Place the DMMs or oscilloscope appropriately where the signals are to be measured.
5. Switch S1 to **ON** position to enable VOUT1.
6. Switch S2 to **ON** position to enable VOUT2.

# 2. PCB Layout Guidelines

## 2.1 ISL78264EVAL1Z Evaluation Board

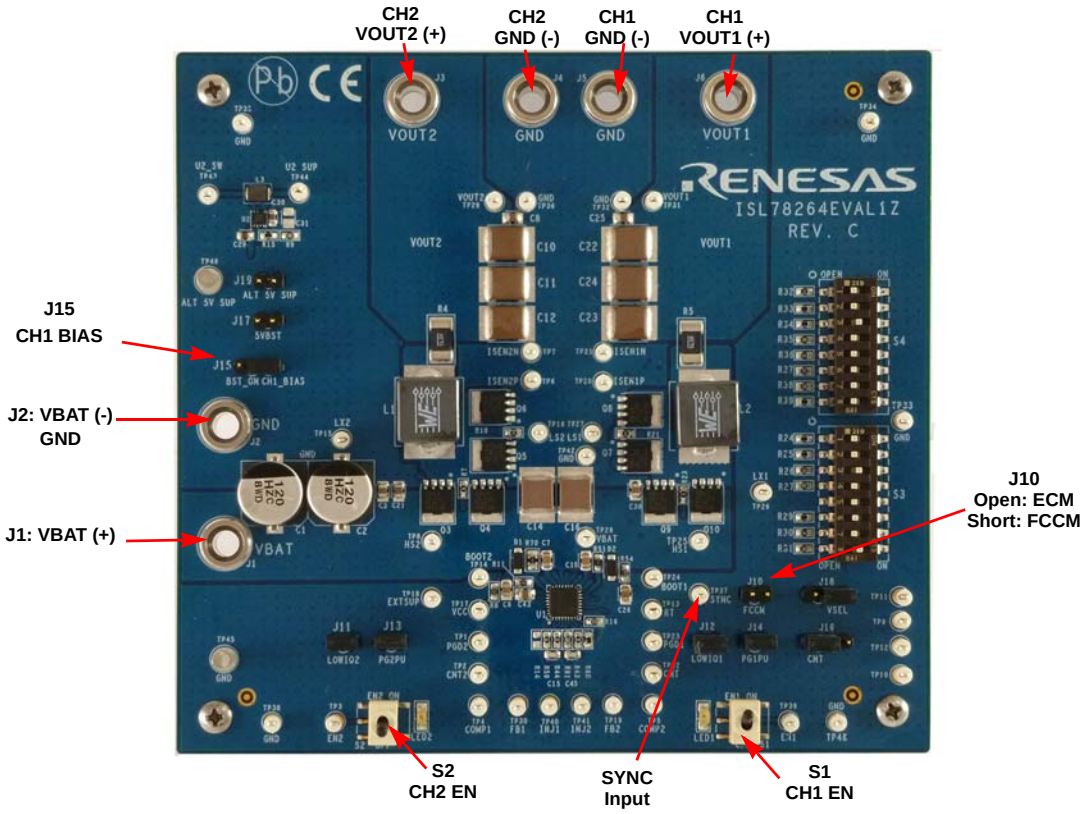


**Figure 2. ISL78264EVAL1Z Evaluation Board (Top)**

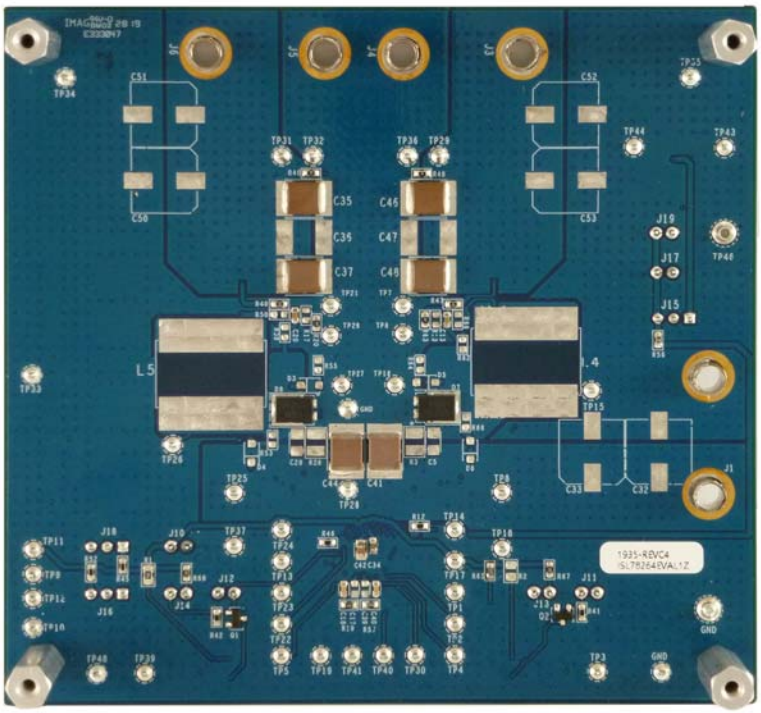

**Figure 3. ISL78264EVAL1Z Evaluation Board (Bottom)**

## 2.2 ISL7202xCSEHEVAL1Z Circuit Schematic

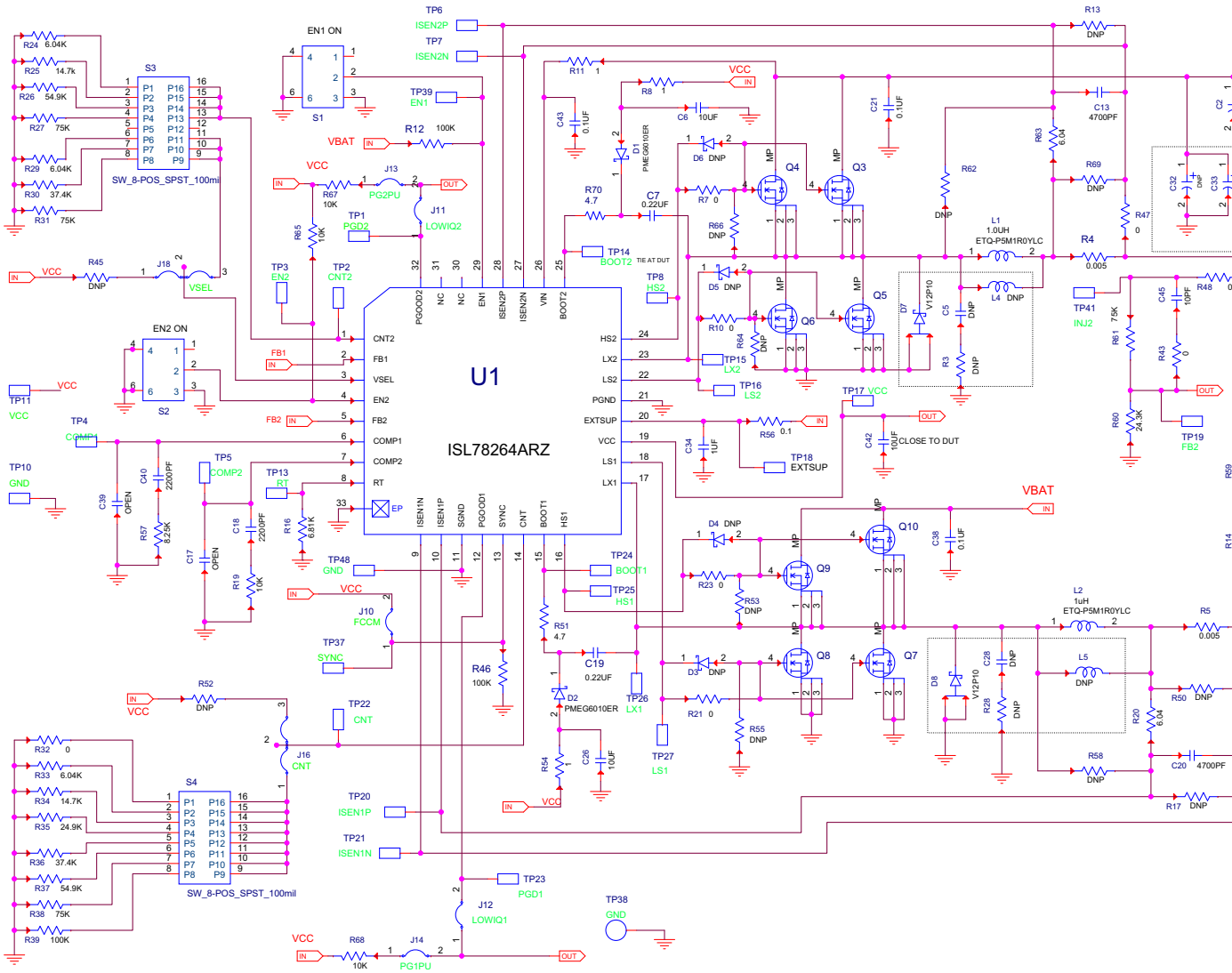


**Figure 4. Schematic - Page 1 of 2**

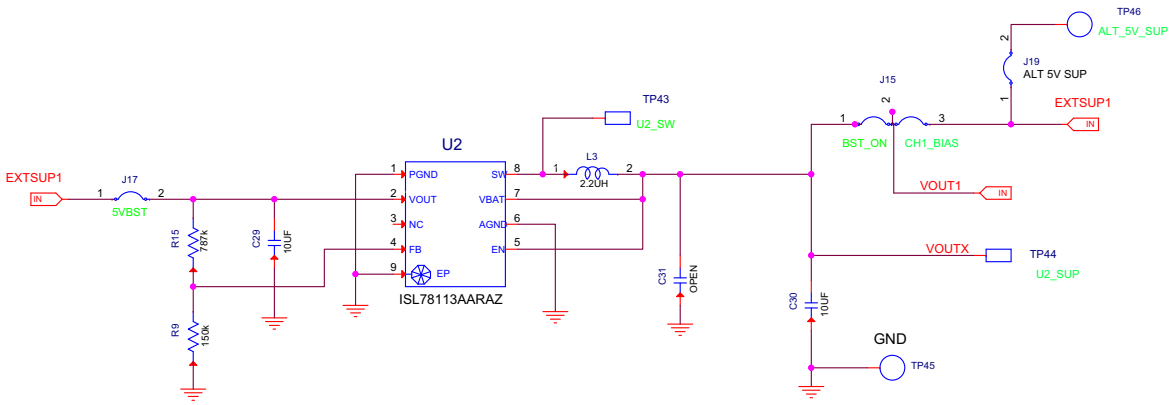


**Figure 5. Schematic - Page 2 of 2**

**Table 1. Connector/Monitor Pin Descriptions**

| Connector/ Test Point | Signal Name | Description |
|---|---|---|
| J1 | VBAT | VIN supply connection for positive input. |
| J2 | GND | VIN supply GND connection. |
| J3 | VOUT2 | VOUT2 connection to load. |
| J4 | GND | VOUT2 GND connection to load. |
| J5 | GND | VOUT1 GND connection to load. |
| J6 | VOUT1 | VOUT1 connection to load. |
| J10 | FCCM | Jumper open to allow ECM operation; install to force FCCM. |
| J11 | LOWIQ2 | Jumper normally installed for PGOOD2; open to measure low $I_Q$. |
| J12 | LOWIQ1 | Jumper normally installed for PGOOD1; open to measure low $I_Q$. |
| J13 | PG2PU | Jumper normally installed for PGOOD2; open to measure low $I_Q$. |
| J14 | PG1PU | Jumper normally installed for PGOOD1; open to measure low $I_Q$. |
| J15 | BST_ON/CH1_BIAS | Jumper normally connects VOUT1 to EXTSUP1. |
| J16 | CNT | Jumper installed to connect S4 and CNT configuration resistor. |
| J17 | 5VBST | Jumper normally open; can be used to connect U2-2 to EXTSUP1. |
| J18 | VSEL | Jumper installed to connect S3 and VSEL configuration resistor. |
| J19 | ALT_5V_SUP | Jumper normally open; can be installed to use alternate bias supply. |
| TP1 | PGD2 | Test point to monitor PGOOD2 on pin U1-32. |
| TP2 | CNT2 | Test point to monitor CNT2 on pin U1-14. |
| TP3 | EN2 | Test point to monitor EN2 on pin U1-4. |
| TP4 | COMP1 | Test point to monitor COMP1 on pin U1-6. |
| TP5 | COMP2 | Test point to monitor COMP2 on pin U1-7. |
| TP6 | ISEN2P | Test point to monitor ISEN2P on pin U1-28. |
| TP7 | ISEN2N | Test point to monitor ISEN2N on pin U1-27. |
| TP8 | HS2 | Test point to monitor HS2 on pin U1-24. |
| TP10 | GND | |
| TP11 | VCC | Test point to monitor $V_{CC}$. |
| TP13 | RT | Test point to monitor RT on pin U1-8. |
| TP14 | BOOT2 | Test point to monitor BOOT2 on pin U1-25. |
| TP15 | LX2 | Test point to monitor BOOT2 on pin U1-23. |
| TP16 | LS2 | Test point to monitor LS2 on pin U1-22. |
| TP17 | VCC | Test point to monitor Vcc on pin U1-19. |
| TP18 | EXTSUP | Test point to monitor EXTSUP on pin U1-20. |
| TP19 | FB2 | Test point to monitor FB2 on pin U1-5. |
| TP20 | ISEN1P | Test point to monitor ISEN1P on pin U1-10. |
| TP21 | ISEN1N | Test point to monitor ISEN1N on pin U1-9. |
| TP22 | CNT | Test point to monitor CNT on pin U1-14. |
| TP23 | PGD1 | Test point to monitor PGOOD1 on pin U1-12. |
| TP24 | BOOT1 | Test point to monitor BOOT1 on pin U1-15. |
| TP25 | HS1 | Test point to monitor HS1 on pin U1-16. |
| TP26 | LX1 | Test point to monitor LX1 on pin U1-19. |
| TP27 | LS1 | Test point to monitor LS1 on pin U1-18 |

**Table 1. Connector/Monitor Pin Descriptions (Continued)**

| Connector/ Test Point | Signal Name | Description |
|---|---|---|
| TP28 | VBAT | Test point to monitor VBAT supply voltage. |
| TP29 | VOUT2 | Test point to monitor VOUT2 voltage. |
| TP30 | FB1 | Test point to monitor FB1 on pin U1-2. |
| TP32 | VOUT1 | Test point to monitor VOUT1 voltage. |
| TP10, TP33, TP34, TP35, TP36, TP38, TP42, TP45, TP48 | GND | Test point to connect to GND. |
| TP37 | SYNC | Test point to monitor SYNC pin U1-13. |
| TP39 | EN1 | Test point to monitor EN1 pin U1-29. |
| TP40 | INJ1 | Test point to inject signal for Channel 1 control loop evaluation. |
| TP41 | INJ2 | Test point to inject signal for Channel 2 control loop evaluation. |
| TP43 | U2_SW | Test point to monitor voltage on pin U2-8. |
| TP44 | U2_SUP | Test point to monitor voltage on pin U2-7. |
| TP46 | ALT_5V_SUP | Test point to monitor voltage on J19-2. |

## 2.3 Bill of Materials

| Reference Designator | Description | Manufacturer | Manufacturer Part |
|---|---|---|---|
| | PWB-PCB, ISL78264EVAL1Z, REVC, ROHS | Imagineering | ISL78264EVAL1ZREVCPCB |
| C34 | CAP, SMD, 0603, 1.0µF, 16V, 10%, X7R, ROHS | TDK | C1608X7R1C105K |
| C3, C8, C21, C25, C38, C43 | CAP-AEC-Q200, SMD, 0805, 0.1µF, 100V, 10%, X7R, ROHS | TDK | CGA4J2X7R2A104K125AA |
| C14, C16, C41, C44 | CAP-AEC-Q200, SMD, 2220, 4.7µF, 100V, 10%, X7R, ROHS | TDK | CGA9N2X7R2A475K230KA |
| C10, C11, C12, C22, C23, C24, C35, C37, C46, C48 | CAP-AEC-Q200, SMD, 2220, 47µF, 16V, 20%, X7R, ROHS | TDK | CGA9N3X7R1C476M230KB |
| C6, C26, C42 | CAP-AEC-Q200, SMD, 0805, 10µF, 10V, 10%, X7R, ROHS | Murata | GCJ21BR71A106KE01L |
| C13, C20 | CAP-AEC-Q200, SMD, 0603, 4700pF, 100V, 10%, X7R, ROHS | Murata | GCM188R72A472KA37D |
| C15, C45 | CAP, SMD, 0603, 10pF, 50V, 10%, NP0, ROHS | Venkel | C0603COG500-100KDE |
| C29, C30 | CAP, SMD, 0603, 10µF, 16V, 10%, X5R, ROHS | Murata | GRM188R61C106KAALD |
| C18, C40 | CAP, SMD, 0603, 2200pF, 100V, 10%, X7R, ROHS | Venkel | C0603X7R101-222KNE |
| C17, C39 | CAP, SMD, 0603, DNP-PLACE HOLDER, ROHS | | |
| C7, C19, | CAP, SMD, 0805, 0.22µF, 100V, 10%, X7R, ROHS | Kemet | C0805C224K1RACAUTO |
| L1, L2 | COIL-PWR INDUCTOR, SMD, 10.9x10, 0, 1µH, 20A, 20%, 2.65mΩ, ROHS | Wurth Elektronik | 7443330100 |
| C1, C2 | CAP-AEC-Q200, SMD, 10.3mm, 120µF, 50V, 20%, 28mΩ, ROHS | Panasonic | EEH-ZC1H121P |
| L3 | COIL-INDUCTOR, SMD, 1210, 2.2µH, 30%, 1.85A, 76.8mΩ, WW, ROHS | Murata | LQH32PN2R2NNCL |
| TP45, TP46 | CONN-TURRET, TERMINAL POST, TH, ROHS | Keystone | 1514-2 |
| TP1-TP8, TP10, TP11, TP13-TP44, TP48 | CONN-MINI TEST POINT, VERTICAL, WHITE, ROHS | Keystone | 5002 |
| J1, J2, J3, J4, J5, J6 | CONN-JACK, MINI BANANA, 0.175 PLUG, NICKEL/BRASS, ROHS | Keystone | 575-4 |
| J10, J11, J12, J13, J14, J17, J19 | CONN-HEADER, 1x2, BRKAWY 1x36, 2.54mm, ROHS | BERG/FCI | 68000-236HLF |

| Reference Designator | Description | Manufacturer | Manufacturer Part |
|---|---|---|---|
| J15, J16, J18 | CONN-HEADER, 1x3, BREAKAWY 1x36, 2.54mm, ROHS | BERG/FCI | 68000-236HLF |
| J11, J12, J13, J14, J15-Pins 2-3, J16-Pins 1-2, J18-Pins 2-3 | CONN-JUMPER, SHORTING, 2PIN, BLACK, GOLD, ROHS | Sullins | SPC02SYAN |
| D1, D2 | DIODE-SCHOTTKY, SMD, 2P, SOD123W, 60V, 1A, Vf = 530mV at 1A, ROHS | Nexperia | PMEG6010ER, 115 |
| D7, D8 | DIODE-SCHOTTKY, SMD, TO-277A(SMPC), 100V, 12A, ROHS | Vishay | V12P10-M3/86A |
| LED1, LED2 | LED, SMD, 1206, GREEN, 75mW, 3mcd, 567nm, ROHS | Dialight | 597-3311-407NF |
| U2 | IC-SYNCRONOUS BOOST CONVERTER, 8P, DFN, ROHS | Renesas | ISL78113AARAZ |
| U1 | IC-DUAL BUCK CONTROLLER, 32P, WFQFN, 5x5, ROHS | Renesas | ISL78264ARZ |
| Q1, Q2 | TRANSISTOR, N-CHANNEL, 3LD, SOT-23, 60V, 115mA, ROHS | Diodes, Inc. | 2N7002-7-F |
| Q3-Q10 | TRANSISTOR-MOS, N-CHANNEL, SMD, 4P, LFPAK, 40V, 33A, 18.1mΩ, ROHS | NXP | BUK9Y21-40E, 115 |
| R20, R63 | RES-AEC-Q200, SMD, 0603, 6.04Ω, 1/10W, 1%, TF, ROHS | Vishay/Dale | CRCW06036R04FKEA |
| R56 | RES-AEC-Q200, SMD, 0603, 0.1Ω, 1/4W, 1%, TF, CURR.SENSE, ROHS | Panasonic | ERJ-3BSFR10V |
| R8, R11, R54 | RES, SMD, 0603, 1Ω, 1/10W, 1%, TF, ROHS | Panasonic | ERJ-3RQF1R0V |
| R51, R70 | RES, SMD, 0603, 4.7Ω, 1/10W, 1%, TF, ROHS | Venkel | CR0603-10W-4R70FT |
| R7, R10, R21, R23, R32, R40, R43, R44, R47, R48, R49, R59 | RES, SMD, 0603, 0Ω, 1/10W, TF, ROHS | Venkel | CR0603-10W-000T |
| R19, R65, R67, R68 | RES, SMD, 0603, 10k, 1/10W, 1%, TF, ROHS | Venkel | CR0603-10W-1002FT |
| R12, R39, R41, R42, R46 | RES, SMD, 0603, 100k, 1/10W, 1%, TF, ROHS | Venkel | CR0603-10W-1003FT |
| R25, R34 | RES, SMD, 0603, 14.7k, 1/10W, 1%, TF, ROHS | Venkel | CR0603-10W-1472FT |
| R9 | RES, SMD, 0603, 150k, 1/10W, 1%, TF, ROHS | Yageo | RC0603FR-07150KL |
| R60 | RES, SMD, 0603, 24.3k, 1/10W, 1%, TF, ROHS | Yageo | RC0603FR-0724K3L |
| R35 | RES, SMD, 0603, 24.9k, 1/10W, 1%, TF, ROHS | Panasonic | ERJ-3EKF2492V |
| R30, R36 | RES, SMD, 0603, 37.4k, 1/10W, 1%, TF, ROHS | Yageo | RC0603FR-0737K4L |
| R26, R37 | RES, SMD, 0603, 54.9k, 1/10W, 1%, TF, ROHS | Panasonic | ERJ-3EKF5492V |
| R24, R29, R33 | RES, SMD, 0603, 6.04k, 1/10W, 1%, TF, ROHS | Venkel | CR0603-10W-6041FT |
| R16 | RES, SMD, 0603, 6.81k, 1/10W, 1%, TF, ROHS | Yageo | RC0603FR-076K81L |
| R27, R31, R38, R61 | RES, SMD, 0603, 75k, 1/10W, 1%, TF, ROHS | Venkel | CR0603-10W-7502FT |
| R15 | RES, SMD, 0603, 787k, 1/10W, 1%, TF, ROHS | Yageo | RC0603FR-07787KL |
| R57 | RES, SMD, 0603, 8.25kΩm, 1/10W, 1%, TF, ROHS | Panasonic | ERJ-3EKF8251V |
| R13, R14, R17, R50, R53, R55, R58, R62, R64, R66, R69 | RES, SMD, 0603, DNP-PLACE HOLDER, ROHS | | |
| R1, R2 | RES, SMD, 0805, 750Ω, 1/8W, 1%, TF, ROHS | Panasonic | ERJ-6ENF7500V |
| R3, R28 | RES, SMD, 1210, DNP, DNP, DNP, TF, ROHS | | |
| R4, R5 | RES-AEC-Q200, SMD, 2512, 0.005Ω, 2W, 1%, CURR.SENSE, MF, ROHS | Vishay/Dale | WSL25125L000FEA18 |
| S3, S4 | SWITCH-SLIDE DIP, SMD, 8POS, SPST, 100mA, 12V, SEALED, ROHS | CTS Electronic Components | 219-8MSTR |
| S1, S2 | SWITCH-TOGGLE, SMD, 6PIN, SPDT, 2POS, ON-NONE-ON, ROHS | ITT Industries /C&K Division | GT11MSCBE |

## 2.4 Board Layout

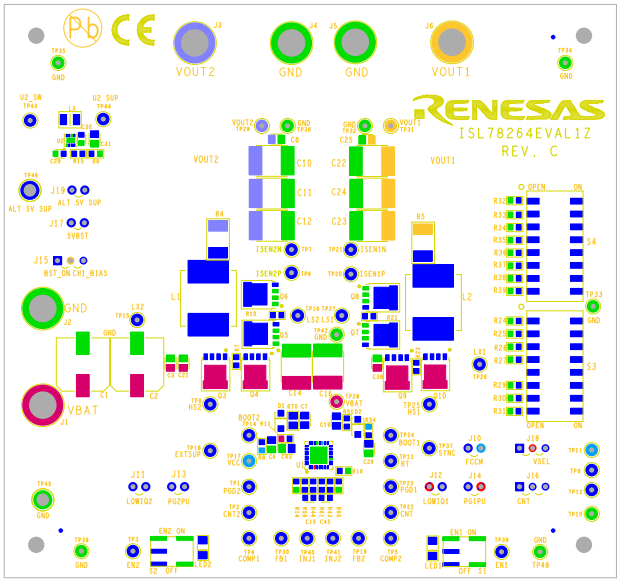


Figure 6. Silkscreen Top

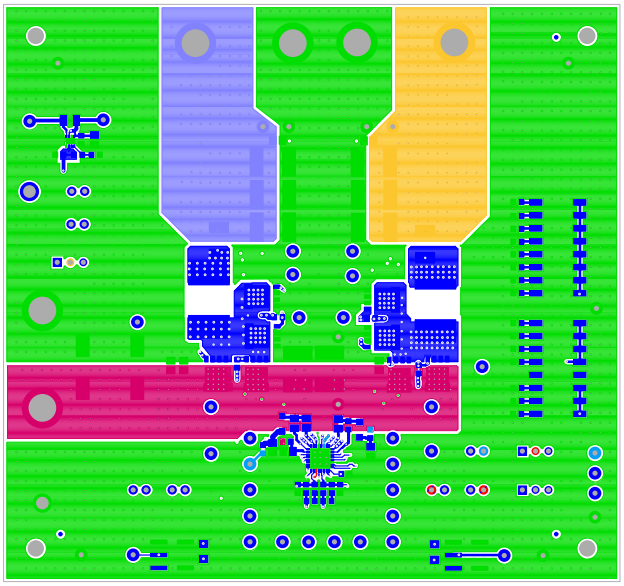

Figure 7. Layer 1

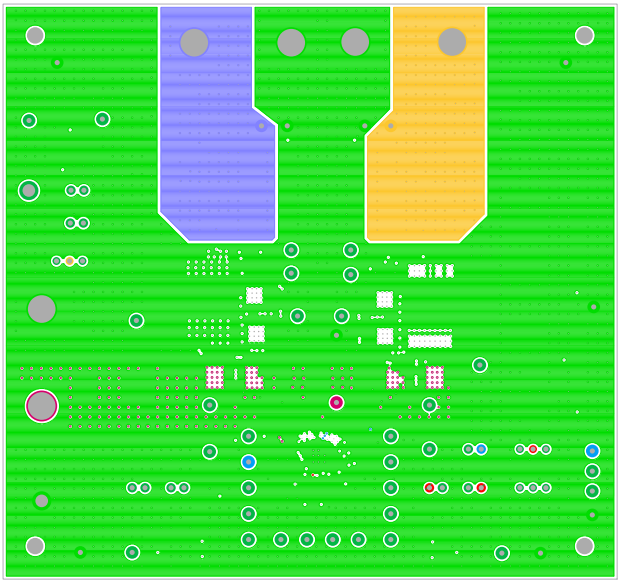

Figure 8. Layer 2

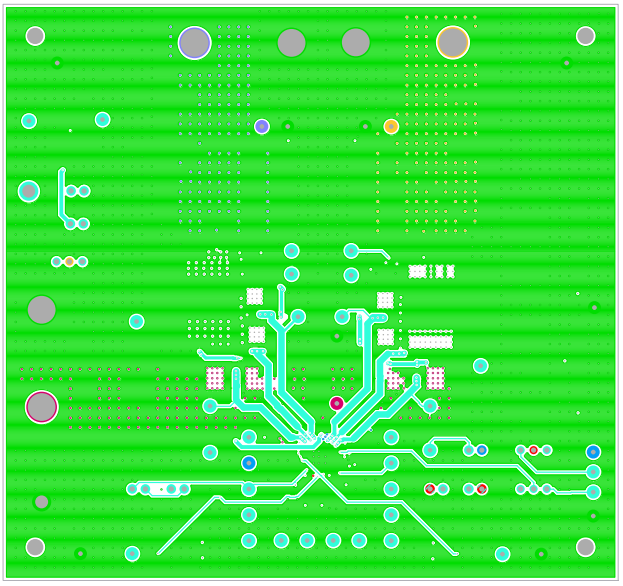

Figure 9. Layer 3

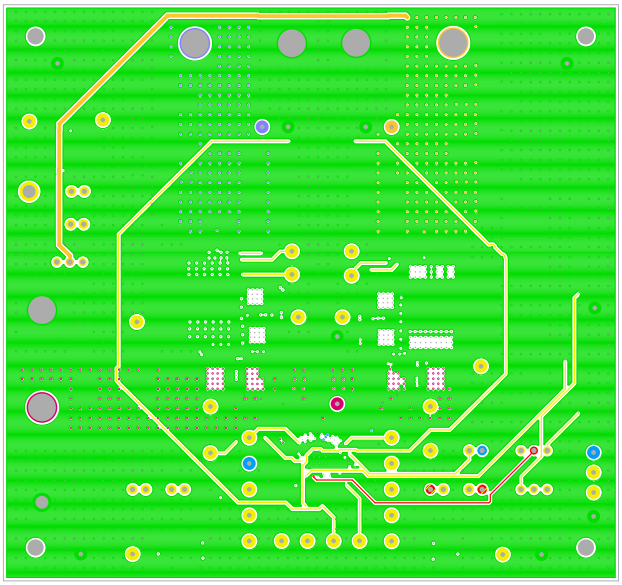

Figure 10. Layer 4

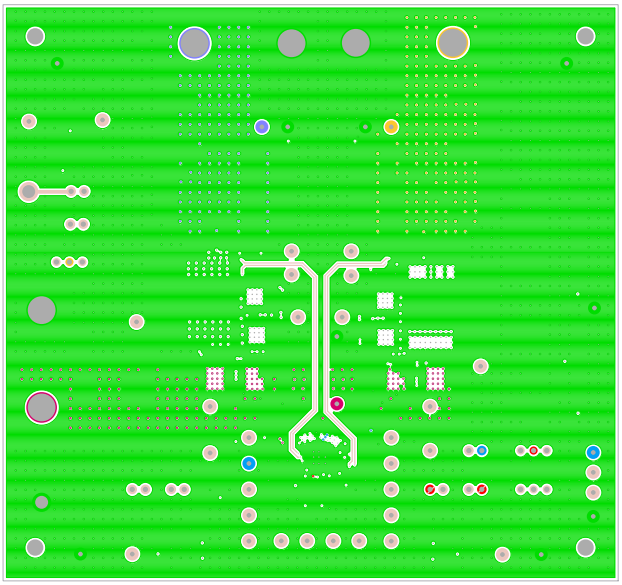

Figure 11. Layer 5

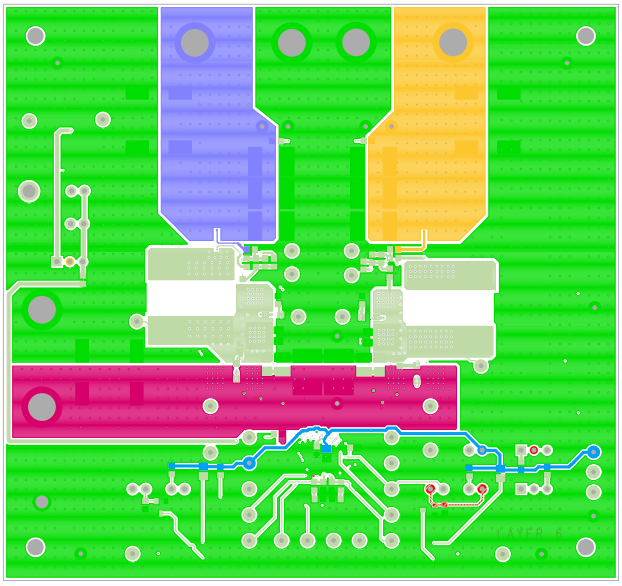

Figure 12. Layer 6

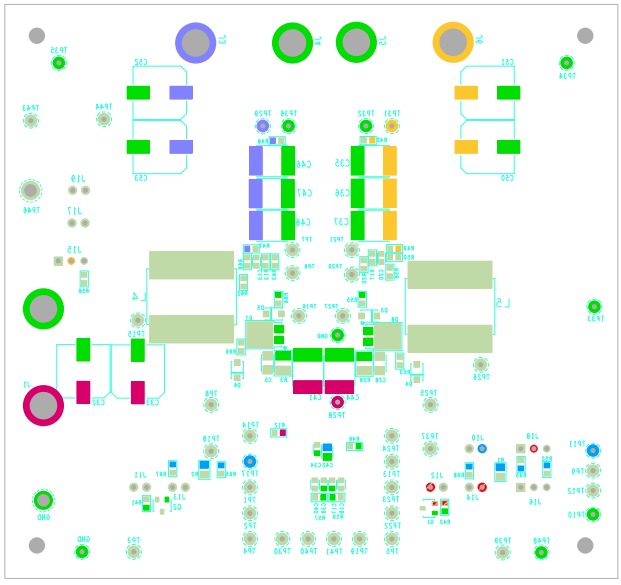

Figure 13. Silkscreen Bottom

# 3. Typical Performance Curves

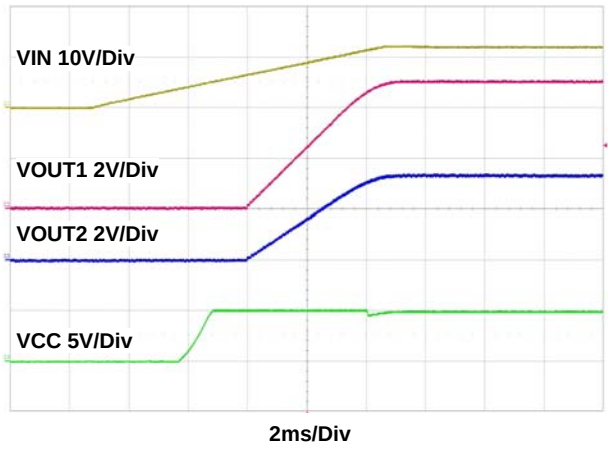


Figure 14. Buck 1/2 Start-Up with $V_{IN}$ Rising

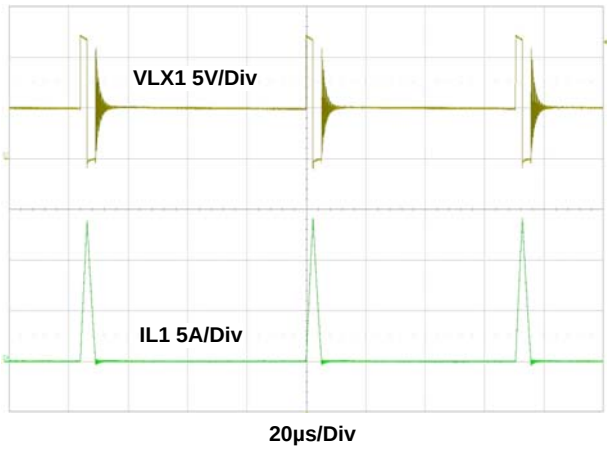


Figure 15. Steady State ECM Operation with IOUT1 = 0.5A

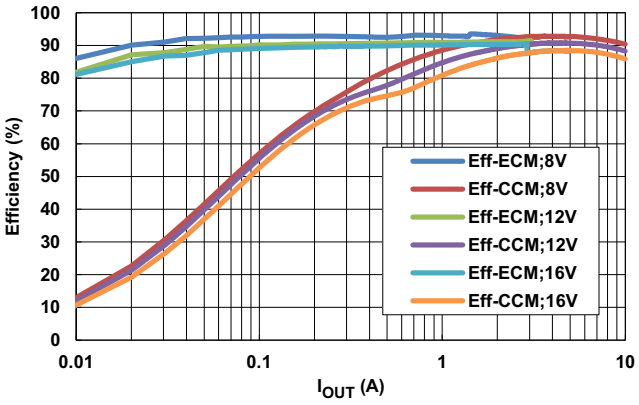


Figure 16. Buck 1 Efficiency VOUT1 = 5V

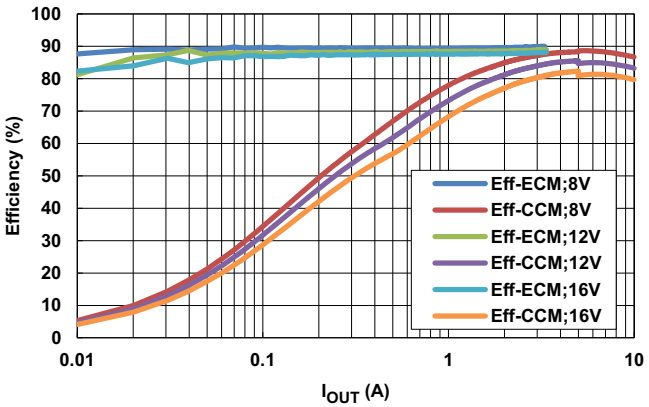


Figure 17. Buck 2 Efficiency VOUT2 = 3.3V

# 4. Revision History

| Rev. | Date | Description |
|---|---|---|
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