

# ISL73846MEV1Z

## Push-Pull Converter Evaluation Board

### Description

The ISL73846MEV1Z is an evaluation platform for a radiation-tolerant push-pull power supply, built around the ISL73846M PWM controller. It converts a nominal 28V input (20V-36V range) to a regulated 12V output, capable of delivering up to 12A continuous load current, and is optimized for space and high-reliability applications.

The design features synchronous rectification on the secondary side to improve efficiency and thermal performance. It operates at 200kHz per switch (effective 400kHz at the output filter), maintains  $\pm 2\%$  output voltage regulation, and supports  $\pm 4\%$  output voltage deviation during 0A to 12A load transients.

The included ISLFBKISOEV1Z feedback daughterboard enables signal-level isolation for both the output voltage feedback and synchronous rectifier PWM signals, while still allowing for accurate regulation during steady-state and fault detection.

Together, the ISL73846MEV1Z and ISLFBKISOEV1Z offer a comprehensive platform to evaluate the performance, control flexibility, and robustness of the ISL73846M in demanding isolated power supply applications.

### Features

- Synchronous push-pull converter
- Current-mode control
- Regulated isolated output
- Resistor programmable deadtime

### Specifications

- VIN range: 20V to 36V (nominal 28V)
- VDD\_EXT range: 5V to 19V
- $V_{OUT} = 12V \pm 2\%$
- $I_{OUT} = 12A$  max (continuous, OCP level is 22A peak)
- Output voltage deviation from steady state value for 12A load transient less than  $\pm 4\%$ .

Switching frequency = 200kHz per switch, 400kHz effective at output inductor and capacitors (ripple).

### Contents

- ISL73846MEV1Z board
- ISLFBKISOEV1Z daughterboard

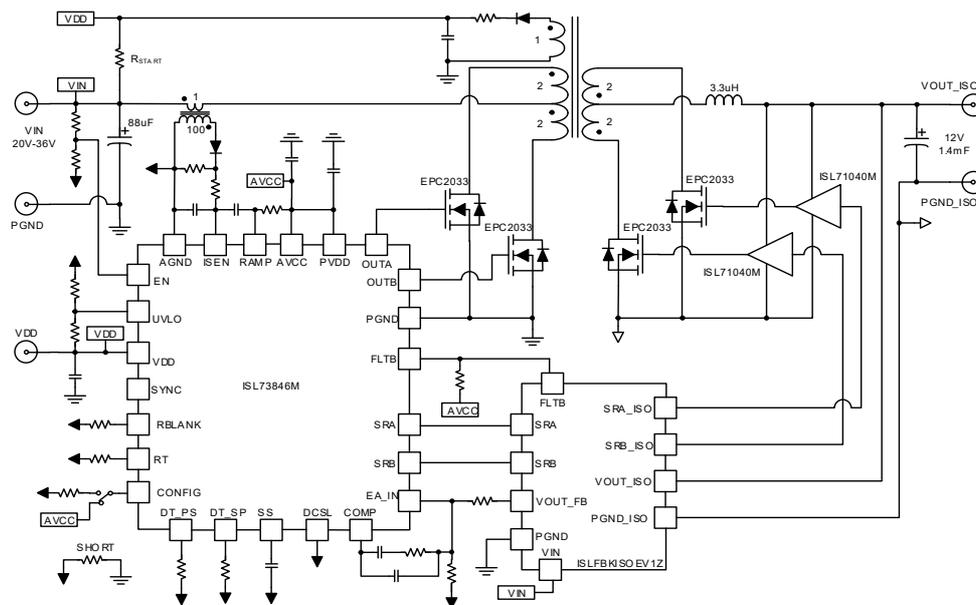


Figure 1. Board Block Diagram

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# 1. Functional Description

ISL73846MEV1Z features a single ISL73846M general-purpose PWM controller in a 50% duty ratio limited configuration. ISL73846M has integrated low-side drivers (OUTA/OUTB), which are used to directly drive the primary side switches (EPC2033 GaN FETs) of the converter. The secondary side synchronous rectifiers (EPC2033 GaN FETs) are driven by ISL71040MRTZ low-side drivers with SRA/SRB control signals generated by the ISL73846M controller. Deadtime between OUTx and SRx outputs of the controller are resistor programmable.

The PWM oscillator frequency is set to 400 kHz, and the DC SL pin is pulled to ground. This allows 50% duty ratio limited PWM outputs with alternate PWM pulses coming out of OUTA or OUTB. Switching frequency of each switch is 200kHz. Center-tapped synchronous rectifier configuration on the secondary side steps down the voltage across the inductor and doubles the switching frequency (effective 400kHz switching across output inductor L1, output capacitors and input capacitors).

Because the push-pull converter topology can provide an isolated output, the output voltage feedback on the secondary side of the transformer (T1) to the controller on the primary side must be galvanically isolated. Also, synchronous rectifier drive signals generated by the controller must be isolated to be used by the ISL71040M drivers on the secondary side. The ISLFBKISOEV1Z daughterboard provides these two functions. The ISLFBKISOEV1Z daughterboard has a housekeeping flyback converter providing continuous power to circuits required for feedback isolation and GMR-based digital isolators (ISL71710M). On the secondary side of the daughterboard, output voltage is converted to PWM with the help of one ISL7119 comparator. This PWM signal is communicated through the digital isolator to the primary side of the daughterboard and then filtered to be used by the error amplifier of the ISL73846M controller for voltage regulation.

Because ISL73846M has an op-amp error amplifier (as opposed to a transconductance error amplifier), it is not capable of transient OV fault detection. For this purpose, an external OV protection circuit is implemented on the feedback isolator daughterboard, which pulls down FLTB of the controller and forces hiccup whenever output voltage increases above 13.2V.

For current mode control, the pulsed input current is sensed with a current sense transformer (placed at the primary side center-tap of T1). Slope compensation is provided with a resistor from AVCC of the ISL73846M device and a capacitor from the ISEN pin to the RAMP pin to match the downslope of the inductor current referred to the primary side.

## 1.1 Push-Pull Converter Design with ISL73846M Controller

Given the input and output voltage specification of the push-pull converter ( $V_{IN} = 28V$  nominal,  $V_{OUT} = 12V$ ), a transformer ratio of 1:1 ( $G_{main} = 1$ , parameter used later) is deemed ideal. The push-pull converter topology also requires a center-tapped primary winding. A center-tapped secondary winding is also used in this application as it leads to reduced output inductor size, compared to a current doubler secondary rectifier configuration without center-tapped secondary windings. For this purpose, a custom planar transformer (ZF2931-AL) with 75 $\mu$ H magnetizing inductance (measured between pins 2 and 5 with 4 and 3 shorted and all other windings open) was developed. The leakage inductance of the transformer is 150nH (max, measured between pins 2 and 5 with 3 and 4 shorted and all other windings shorted).

Typically, the primary-side switches in a push-pull converter are expected to twice block the input voltage of the converter. Because the input voltage can be as high as 36V for a nominal 28V rail, the switches are expected to block 72V ideally. However, the leakage inductance of the main transformer can cause the drain-to-source voltage of the primary GaN FETs to spike much higher than 72V. GaN FETs with 150V breakdown ratings are chosen for this purpose. RCD clamps are also implemented on each primary side GaN FET to limit inductive voltage spikes on the drain of the GaN FETs.

Synchronous rectification can significantly improve efficiency in isolated converter topologies, and the ISL73846M controller can generate outputs to control synchronous rectifiers. Because the main transformer winding ratio is 1:1, the synchronous rectifiers are expected to block 72V when the input voltage is 36V. The same EPC2033 GaN FETs are chosen for the synchronous rectifier switches. In isolated topologies with synchronous rectifiers, output inductor current can be negative (for example, at steady state no load or during a load step-down transient).

Because there is no path for negative currents to flow through the synchronous rectifiers or primary side switches when they are off (during deadtime at no load condition or if the controller shuts down when the inductor current is negative), large negative currents can cause large drain-to-source voltage spikes on the synchronous rectifiers. To mitigate this, another RCD clamp circuit is implemented at the LX node of the converter (see schematics), allowing negative inductor current to flow into the clamp capacitor and discharge into the output capacitors.

A switching frequency of 400kHz (effective across the output LC filter) is chosen to optimize the converter efficiency because higher switching frequencies lead to additional switching and core losses. To program this switching frequency R36 = 5.9kΩ was chosen. 200ns of blanking time is required to ensure that switching transients are ignored before the PWM comparator resets the output. A 3.3kΩ resistor from the RBLANK pin to ground programs a minimum on/off time to 300ns. Blanking time is approximately 60ns lower than minimum on/off time.

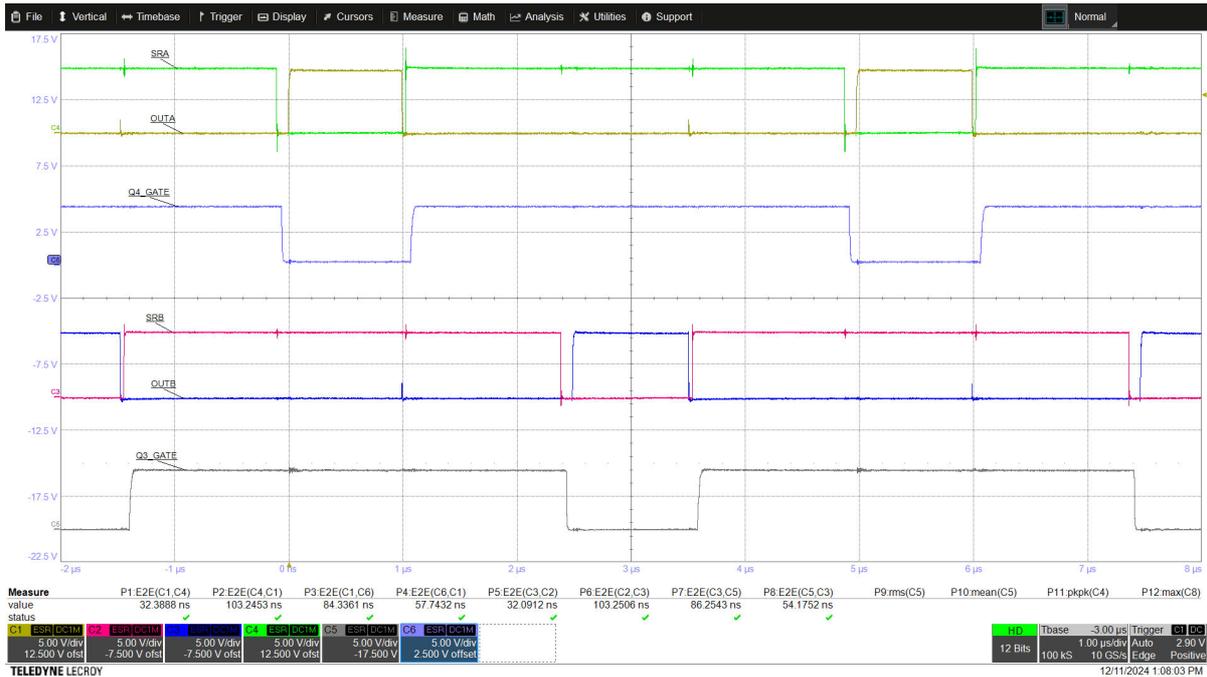


Figure 2. PWM Outputs of ISL73846M and Synchronous Rectifier Gate Drive Signal, Measured Effective Deadtime

OUTx falling to SRx rising deadtime is programmed to 30ns and SRx falling to OUTx rising deadtime is programmed to 100ns. The primary switches are directly driven by the ISL73846M controller, while the synchronous rectifiers are driven by the SRx outputs through digital isolators and additional low side drivers. Unequal deadtimes are programmed to compensate for the additional delay in the synchronous rectifier driving path. Figure 2 shows the controller outputs, the gate driver outputs, and the effective deadtimes. The deadtimes are programmed by selecting R39 (60.4kΩ) and R40 (10kΩ) from the DT\_SP and DT\_PS pins of the controller.

The output inductor L1 (3.3μH) is selected so that nominally (VIN = 28V) inductor current ripple is 40% of full load current (12A). The isolated feedback generator (ISLFBKISOEV1Z) circuit generates a 1.7MHz PWM output with 4V average when VOUT\_ISO is 12V. To filter this PWM output from the isolated feedback circuit, two poles at 40kHz are placed in the compensation network. This is necessary to attenuate the ripple on the COMP output enough to ensure jitter on the OUTx outputs is below 50ns. To make the output stable, the converter bandwidth is set at 3.5kHz.

To ensure output voltage overshoot and undershoot during a 0A-12A load transient is below 360mV (3% of 12V) and set a 3.5kHz converter bandwidth, output capacitance of 1.4mF is required.

Current sensing on the primary side is done using a 1:100 (G<sub>SNS</sub> = 0.01, parameter used later) transformer and a 2.8Ω terminating resistor (RSENSE, R18 in schematics). At 12A output current (full load), the sensed voltage at the terminating resistor would be 336mV. For a 3% overshoot/undershoot during a full load transient, the PWM

output of the feedback isolator should show a 120mV overshoot/undershoot. To match the sensed current, the gain of the error amplifier must be set to be 2.8 or higher. The PWM filter on the isolated feedback generation board and error amplifier components (R41, C21, R42, C9) on the eval board are designed to set two poles at 40kHz, an integrator with a zero set at 500Hz and a gain of 2.8.

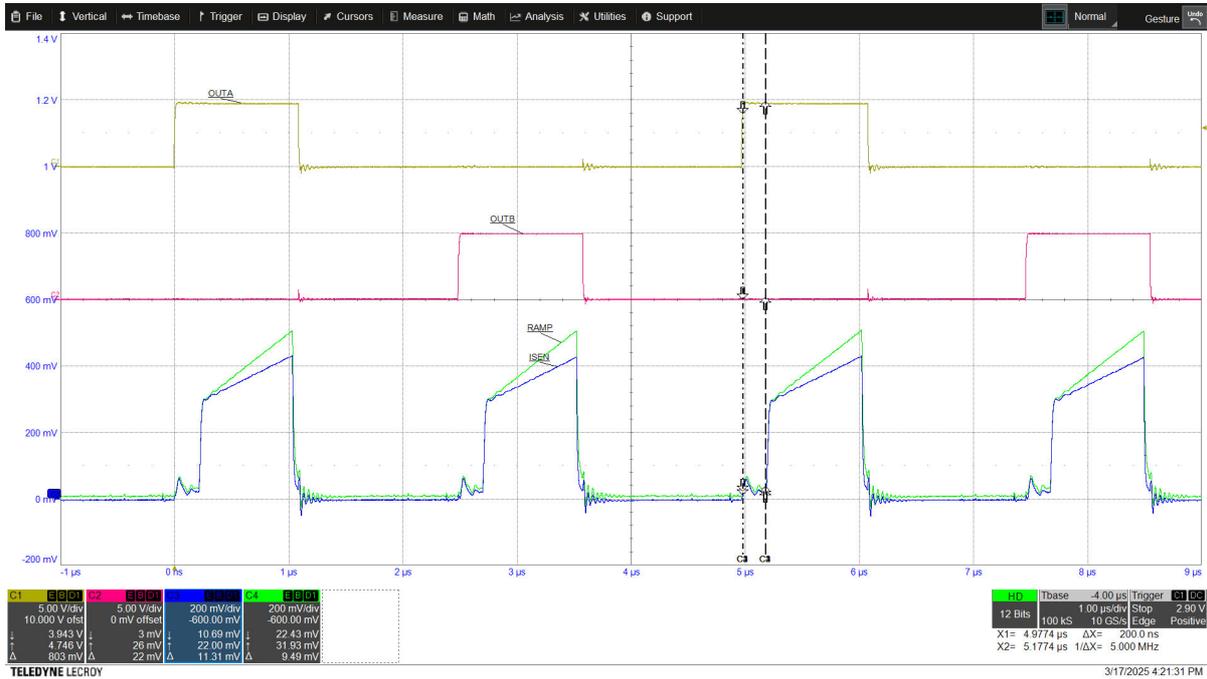


Figure 3. PWM Outputs of ISL73846M, Current Sense and Slope Compensated Current Sense Inputs, Measured Effective Blanking Time = 200ns

Because the duty ratio of the application is close to 50% (higher than 50% at the lowest input voltage which is 20V), slope compensation is required to mitigate sub-harmonic oscillations. A resistor from AVCC, R8 and a capacitor C21 are used to generate a slope compensated current sense signal. R8 and C21 are chosen such that the slope of the compensated current sense signal on the RAMP pin matches  $\frac{V_{IN}}{L_1} \times R_{SENSE} \times \frac{G_{sns}}{G_{main}}$ . A current sense filter capacitor C5 was not necessary as the current sense input to the controller was verified to be free from high frequency noise. Figure 3 shows the PWM outputs and voltages at the ISEN and RAMP pins. The cursors show approximately a 200ns delay between the rising edge of OUTA and the rising edge of ISEN/RAMP voltage. It was verified that 200ns is enough blanking time for the current sense waveforms to be free of switching transients.

The EN pin of the controller is programmed by resistors R3 and R4 such that the converter turns on at  $V_{IN} = 19V$  and turns off at  $V_{IN} = 17V$ . The controller sinks  $6\mu A$  from the EN pin when it is not enabled. The EN threshold is 2V. The EN Hysteresis is programmed by R3 and the  $6\mu A$  current ( $332k\Omega \times 6\mu A = 2V$ ). And the EN turn off threshold level (17V) is programmed by the R3/R4 ratio.

The UVLO pin of the controller can be directly connected to VDD if external VDD is used. If VDD is powered by the AUX winding of the transformer (offline startup) then UVLO must be programmed by a resistor divider from VDD (R10 and R11). If UVLO pin voltage is below the threshold (1.23V), the controller is in a low power state, drawing less than  $100\mu A$  of current. A startup resistor R44 is used to slowly charge up the VDD rail from  $V_{IN}$ . When VDD reaches 10V, the UVLO threshold is met, the controller starts up and the OUTx outputs start switching. When switching starts, the AUX winding output powers up and the operating current of the controller is supplied by the AUX winding. If VDD voltage falls below 8V after switching starts, UVLO pin voltage falls below threshold, and the converter shuts down and enters a low power state.  $44\mu F$  of capacitance on the VDD rail is required to ensure that VDD does not fall below the 8V UVLO falling threshold. The UVLO pin sources  $5\mu A$  of current when

UVLO threshold is met. The upper resistor (R10) and the 5 $\mu$ A hysteresis current programs 2V UVLO hysteresis. The R10 and R11 resistor divider ratio programs the UVLO turn on threshold.

## 1.2 Feedback Isolation

To maintain galvanic isolation between the primary and secondary sides of the converter, output voltage feedback and the synchronous rectifier control signals must be isolated. This is achieved with the ISLFBKISOEV1Z daughterboard. The daughterboard converts the output voltage of the converter, VOUT\_ISO, to a pulse width modulated signal by using a hysteretic comparator (U5 on ISLFBKISOEV1Z schematics) on the secondary side. This signal is then passed through the isolation barrier with the help of an ISL71710 (GMR based) digital isolator. The average value of the PWM signal, VOUT\_PWM, is 4V when output voltage is 12V and 500mV when the output voltage is 0V. The PWM output is then filtered with an RC filter (R14, C43 on ISLFBKISOEV1Z schematics). Figure 4 and Figure 5 show the PWM output of the digital isolator and the filtered version of the signal on the controller side, VOUT, and the behavior of the filtered feedback signal at startup.

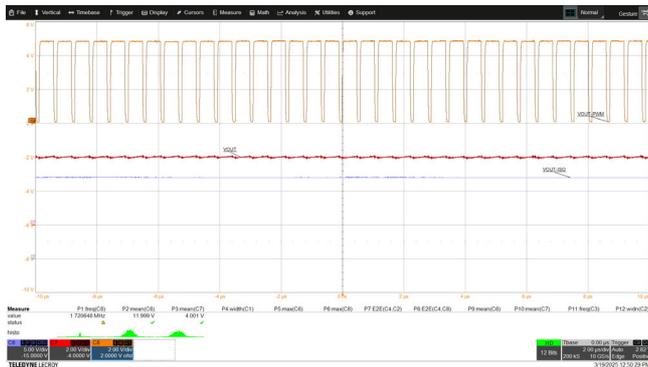


Figure 4. PWM and filtered version of isolated feedback (VOUT\_ISO = 12V)



Figure 5. Startup Response of Feedback Isolator Output (VOUT\_ISO is Ramped Up to 12V)

The synchronous rectifier driving PWM signals are similarly passed to the secondary side from the primary through two ISL71710M digital isolators. Additionally, a comparator is placed on the daughter card that pulls down FLT\_B when the output of the isolated feedback generator exceeds 4.5V (fast overvoltage protection) and puts the controller into hiccup mode. To power the circuits on the ISLFBKISOEV1Z, a housekeeping flyback is implemented using an ISL71041 controller. This generates  $\pm$ 9V output rails on the secondary side of the isolator and an 8V rail on the primary side (used for closed loop regulation of the flyback converter). Two ISL71090 5V reference ICs were used on the primary and secondary sides of the board to generate accurate 5V supplies required.

## 1.3 Operational Characteristics

The ISL73846MEV1Z push-pull converter is designed to operate from a 28V nominal input (VIN). The controller can be supplied from the VDD\_EXT plug. VDD\_EXT can range from 5V to 19V, which is the maximum operating voltage of the ISL73846M controller. Alternatively, the controller can also get its supply from the aux-winding of the main transformer. In this case stand-by current (to charge up VDD rail before the controller starts switching) is provided by a resistor (R44) from VIN. The following are the Jumper configurations for these two power-up methods:

- VDD\_SEL jumper shorted between position 1 and 2, UVLO\_SEL jumper shorted: controller powers up from VDD\_EXT plug.
- VDD\_SEL jumper shorted between position 2 and 3, UVLO\_SEL jumper open: aux winding of main transformer supplies operating current of controller.

When powered up, the converter regulates VOUT\_ISO to 12V. An electronic load can be used to test loaded operation and transient response of the converter. The maximum continuous load that the converter can support throughout its VIN range (20V – 36V) is 12A. A resistor divider from VIN is tied to the EN pin of the controller,

which programs the controller to turn on when VIN is above 19V. When enabled, the controller turns off when VIN falls below 17V. Operating the converter at VIN less than 20V is not recommended as it might not be able to startup at full load without going into overcurrent protection mode.

The ISL73846MEV1Z board offers two overcurrent protection modes that are programmable by the CONFIG jumper:

- CONFIG jumper shorted – The CONFIG pin is connected to AVCC. The controller immediately goes into hiccup if OCP (sensed current is above 22A) is detected in 4 out of previous 8 switching periods of either OUTA or OUTB.
- CONFIG jumper open – The CONFIG pin is connected to ground with a 113kΩ resistor. In this mode, the controller limits the inductor current in a pulse-by-pulse manner when load is increased above 22A. As a result, the output voltage falls. When the EA\_IN pin voltage falls below the undervoltage detection threshold, the controller goes into hiccup mode. Because the error amplifier of the ISL73846M is an operational amplifier (Op amp), EA\_IN does not necessarily follow VOUT, if the output of the Op amp is not saturated.

The programmed OCP mode is only detected when the controller powers up. To change the OCP mode of the controller, power cycling VDD of the controller is necessary after changing the CONFIG pin connection.

### 1.4 Setup and Configuration

Complete the following steps to power up the ISL73846MEV1Z evaluation board.

1. Ensure VDD and VIN are supplied to the board, VDD\_SEL and UVLO\_SEL jumpers are connected as discussed in the previous subsection.
2. Ensure CONFIG jumper is connected or open depending on required OCP mode.
3. Connect an electronic load or a multimeter to VOUT of the board (to monitor output voltage).
4. Ensure that the ISLFBKISOEV1Z daughter card is connected properly. (If not connected, the controller always detects output voltage as zero, output voltage keeps building up over multiple hiccup cycles if no load is applied. This might cause serious damage to the output capacitors and the eval board).
5. Set the electronic load to a value between 0A and 12A. Set the current limit of VIN supply to 9A or higher.
6. Turn on VIN and VDD supplies and monitor any probe points on oscilloscope as required. Output voltage observed should be within 2% of 12V. VDD\_EXT supply current should be less than 10mA at steady state.

## 2. Board Design

### 2.1 ISL73846MEV1Z Board

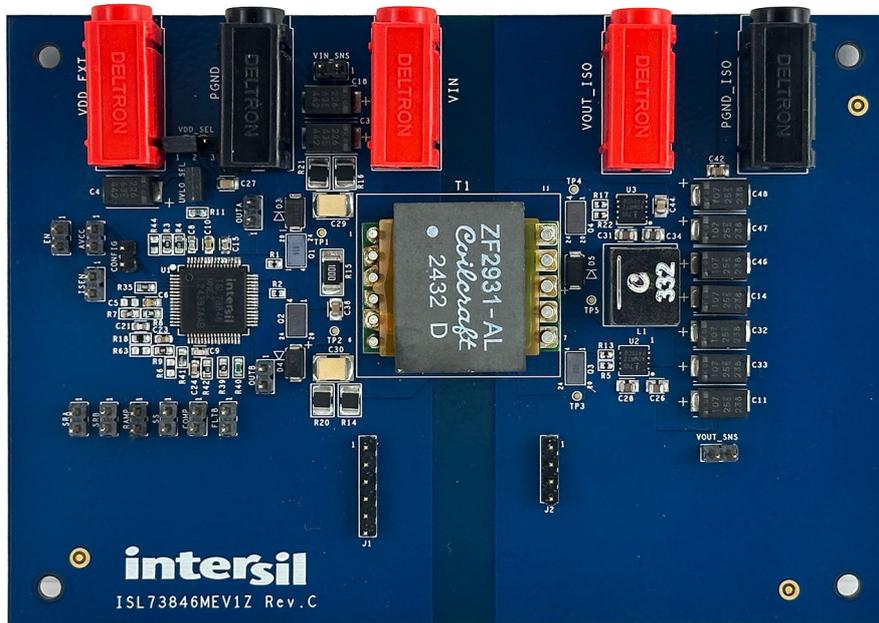


Figure 6. ISL73846MEV1Z Evaluation Board (Top)

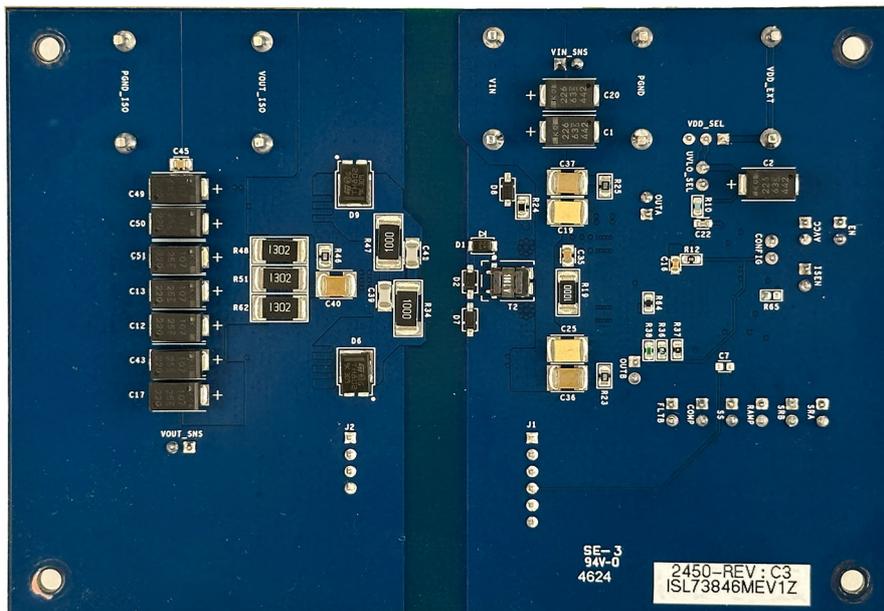


Figure 7. ISL73846MEV1Z Evaluation Board (Bottom)

#### 2.1.1 Layout Guidelines

The push-pull converter topology uses two low-side switches on the primary side that can be driven directly with the low-side gate drivers in the ISL73846M controller. The PGND pin of the controller serves as the gate drive current return path. The PVDD pin of the controller is the supply of the gate drivers. Place low parasitic ceramic capacitors close to the PVDD pin to ensure proper decoupling of the gate drive currents. This evaluation board also supplies PVDD from AVCC of the chip because the average gate driver current required to drive EPC2033 GaNFETs at 200 kHz is lower than 5mA. A 10Ω resistor is also placed between AVCC and PVDD to ensure proper



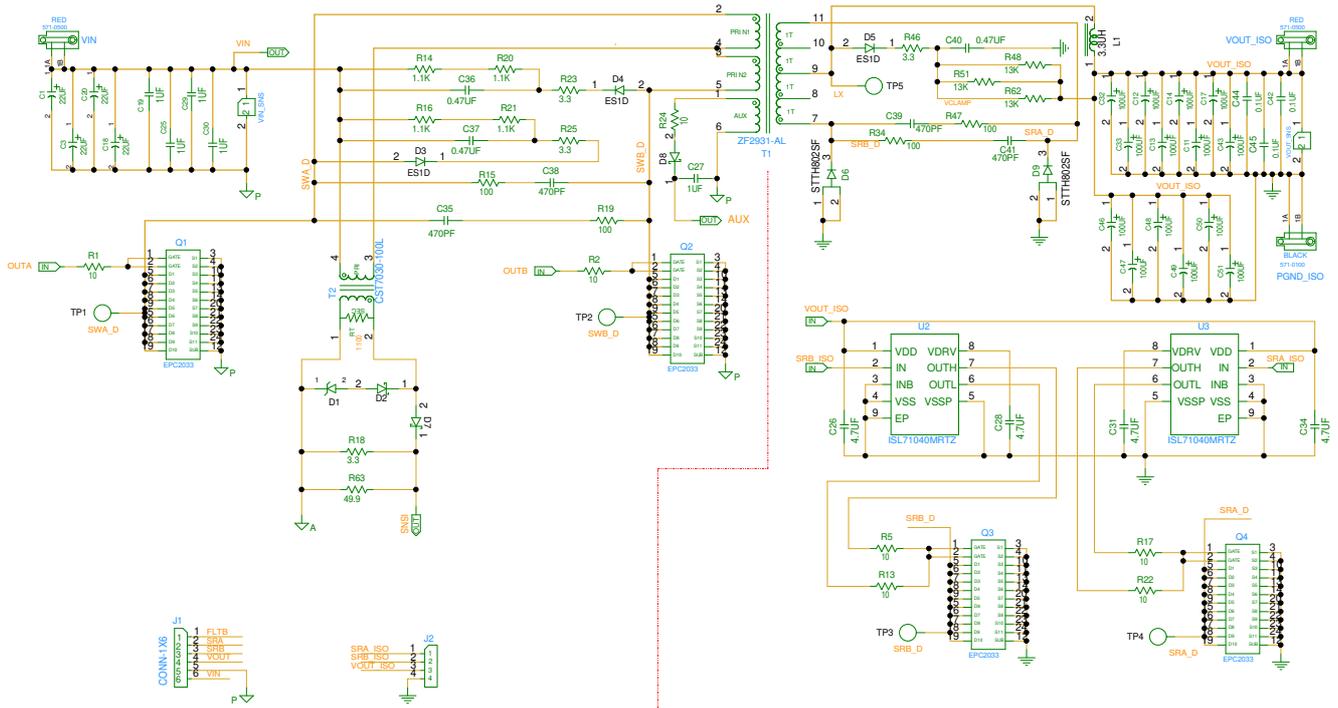


Figure 9. ISL73846MEV1Z Schematic Page 2

### 2.1.3 Bill of Materials

Qty	Reference Designator	Description	Manufacturer	Manufacturer Part Number
1	C24	CAP, SMD, 0603, 0.015µF, 25V, 10%, X7R, ROHS	KYOCERA	KGM15AR71E153KT-T
1	C23	CAP, SMD, 0603, 0.33µF, 16V, 10%, X7R, ROHS	YAGEO	CC0603KRX7R7BB334-T
1	C21	CAP, SMD, 0603, 1000pF, 25V, 10%, C0G/NP0, ROHS	KYOCERA	KGM15ACG1E102KT-T
2	C8, C22	CAP, SMD, 0603, 100pF, 100V, 10%, C0G/NP0, ROHS	TDK	C1608C0G2A101K080AA-T
3	C42, C44, C45	CAP, SMD, 0805, 0.1µF, 25V, 10%, X7R, ROHS	KYOCERA	KGM21NR71E104KT-T
1	C27	CAP, SMD, 0805, 1µF, 50V, 10%, X7R, ROHS	YAGEO	CC0805KKX7R9BB105-T
2	C35, C38	CAP, SMD, 0805, 470pF, 200V, 10%, X7R, ROHS	KEMET	C0805C471K2RAC7800-T
3	C36, C37, C40	CAP, SMD, 1812, 0.47µF, 200V, 10%, X7R, ROHS	KEMET	C1812C474K2RAC7800-T
4	C19, C25, C29, C30	CAP, SMD, 1812, 1µF, 100V, 10%, X7R, ROHS	Vishay	VJ1812Y105KBBAT4X-T
4	C6, C10, C15, C16	CAP, SMD, 0603, 1µF, 25V, 10%, X7R, ROHS	MURATA	GCM188R71E105KA64D-T
4	C26, C28, C31, C34	CAP, SMD, 0805, 4.7µF, 25V, 10%, X7R, ROHS	KEMET	C0805C475K3RACAUTO-T
2	C39, C41	CAP, SMD, 1206, 470pF, 200V, 10%, C0G/NP0, ROHS	KYOCERA	KAM31BCG2D471KT-T
14	C11-C14, C17, C32, C33, C43, C46-C51	CAP-TANT, SMD, 7.3×4.3mm, 100µF, 25V, 20%, ROHS	KEMET	T521X107M025ATE030-T
6	C1-C4, C18, C20	CAP-TANT, SMD, 7.3×4.3mm, 22µF, 63V, 20%, ROHS	KEMET	T521X226M063ATE075-T
1	L1	COIL-PWR IND, SMD, 3.3µH, 20%, 27.4A, ROHS	COILCRAFT	XAL1010-332MED-T
3	D3-D5	DIODE-RECTIFIER, SMD, 2P, SMA, 200V, 1A, ROHS	DIODES Inc.	ES1D-13-F-T
2	D6, D9	DIODE-RECTIFIER, SMD, TO-277A, 200V, 8A, ROHS	STM	STTH802SF-T
3	D2, D7, D8	DIODE-SCHOTTKY, SMD, SOD-123, 100V, 0.15A, ROHS	Vishay	BAT46W-E3-08-T

Qty	Reference Designator	Description	Manufacturer	Manufacturer Part Number
1	D1	DIODE-ZENER, 5.1V, 800mW, SMD, DO-219AB, ROHS	Vishay	BZD27B5V1P-M3-08-T
1	C9	CAP, SMD, 0603, 200pF, 50V, 10%, NP0, ROHS	Vishay	VJ0603D201KXAAJ-T
2	U2, U3	IC- GaNFET DRIVER, 8PTDFN, 4x4, ROHS	RENESAS	ISL71040MRTZ
4	Q1-Q4	IC-GaN FET, SMD, DIE, N-CHAN, 150V, 48A, ROHS	EPC	EPC2033-T
1	U1	IC-RH, DUAL OUTPUT PWM CONTROLLER, 30K, 19V, 1.5A, ROHS	RENESAS	ISL73846M30NEZ
1	R7	RES, SMD, 0603, 100Ω, 1/10W, 1%, TKF, ROHS	YAGEO	RC0603FR-07100RL-T
1	R35	RES, SMD, 0603, 113K, 1/10W, 0.1%, TNF, ROHS	YAGEO	RT0603BRD07113KL-T
1	R8	RES, SMD, 0603, 49.9K, 1/10W, 1%, TKF, ROHS	YAGEO	RC0603FR-0749K9L-T
1	R36	RES, SMD, 0603, 5.9K, 1/10, 1%, TKF, ROHS	YAGEO	RC0603FR-075K9L-T
2	R34, R47	RES, SMD, 2512, 100Ω, 2W, 1%, TF, ROHS	TE Conn.	CRGP2512F100R-T
6	R1, R2, R5, R13, R17, R22	RES, SMD, 0402, 2Ω, 1/10W, 1%, TF, ROHS	YAGEO	RC0402FR-072RL-T
1	R64	RES, SMD, 0603, 0Ω, TKF, ROHS	Vishay	RCS06030000Z0EC-T
1	R9	RES, SMD, 0603, 1.24K, 1/10W, 1%, TF, ROHS	Stackpole	RMCF0603FT1K24-T
2	R38, R40	RES, SMD, 0603, 10K, 1/10W, 0.1%, TNF, ROHS	Vishay	TNPW060310K0BEEA-T
1	R12	RES, SMD, 0603, 10Ω, 1/10W, 1%, TKF, ROHS	Stackpole	RMCF0603FT10R0-T
1	R42	RES, SMD, 0603, 20.5K, 1/10W, 1%, TF, ROHS	Stackpole	RMCF0603FT20K5-T
1	R37	RES, SMD, 0603, 3.3K, 1/10W, 1%, TKF, ROHS	Rohm Semi.	KTR03EZPF3301-T
1	R18	RES, SMD, 0603, 2.8Ω, 1/10W, 1%, TKF, ROHS	Vishay	CRCW06032R80FKEA-T
1	R3	RES, SMD, 0603, 332K, 1/10W, 1%, TKF, ROHS	Stackpole	RMCF0603FT332K-T
1	R10	RES, SMD, 0603, 402K, 1/10W, 1%, TKF, ROHS	KOA Speer	RK73H1JTDD4023F-T
1	R4	RES, SMD, 0603, 44.2K, 1/10W, 1%, TKF, ROHS	Stackpole	RMCF0603FT44K2-T
1	R41	RES, SMD, 0603, 5.62K, 1/10W, 1%, TKF, ROHS	Stackpole	RMCF0603FT5K62-T
1	R39	RES, SMD, 0603, 60.4K, 1/10W, 1%, TKF, ROHS	Stackpole	RMCF0603FT60K4-T
1	R24	RES, SMD, 0805, 10Ω, 1/2W, 1%, TKF, ROHS	Panasonic	ERJ-P6WF10R0V-T
3	R23, R25, R46	RES, SMD, 0805, 1Ω, 1/8W, 1%, TKF, ROHS	Stackpole	RMCF0805FT1R00-T
4	R14, R16, R20, R21	RES, SMD, 1210, 1.1k, 1/2W, 1%, TKF, ROHS	Vishay	CRCW12101K10FKEA-T
2	R15, R19	RES, SMD, 2010, 100Ω, 1W, 1%, TKF, ROHS	Stackpole	RMCP2010FT100R-T
3	R48, R51, R62	RES, SMD, 2512, 13K, 3W, 1%, TKF, ROHS	TE Conn.	352213KFT-T
1	R11	RES, SMD, 56K, 1/10W, 1%, TKF, ROHS	KOA Speer	RK73H1JTDD5602F-T
1	T2	TRANSFORMER-CURRSSENS, 1:100 TURNS, 20A, ROHS	Coilcraft	CST7030-100LC
1	T1	TRANSFORMER, CUSTOM, ROHS, 2:2:4CT, 150μH, ROHS	Coilcraft	ZF2931-AL
1	R44	DO NOT POPULATE	-	-
3	R6, R63, R65	DO NOT POPULATE	-	-
2	C5, C7	DO NOT POPULATE	-	-
2	CONFIG, UVLO_SEL	CONN-HEADER, 1x2, RETENTIVE, 2.54mm, ROHS	Amphenol	69190-202HLF
1	VDD_SEL	CONN-HEADER, 1x3, BRKAWY 1x36, 2.54mm, ROHS	Amphenol	68000-236-1X3
1	J2	CONN-HEADER, 1x4, BRKAWY 1x36, 2.54mm, ROHS	Amphenol	68000-236-1X4
1	J1	CONN-HEADER, 1x6, BRKAWY 1x36, 2.54mm, ROHS	Amphenol	68000-236-1X6

Qty	Reference Designator	Description	Manufacturer	Manufacturer Part Number
13	AVCC, COMP, EN, FLTB, ISEN, OUTA, OUTB, RAMP, SRA, SRB, SS, VIN_SNS, VOUT_SNS	CONN-HEADER, 1x2, 2.54mm PITCH, 5.5x3.3mm, ROHS	3M	961102-6404-AR
2	PGND, PGND_ISO	CONN-PLUG, TH, 4mm INSUL.SOCKET, BLK, R/A, ROHS	Deltron	571-0100
3	VDD_EXT, VIN, VOUT_ISO	CONN-PLUG, TH, 4mm INSUL.SOCKET, RED, R/A, ROHS	Deltron	571-0500

### 2.1.4 Board Layout

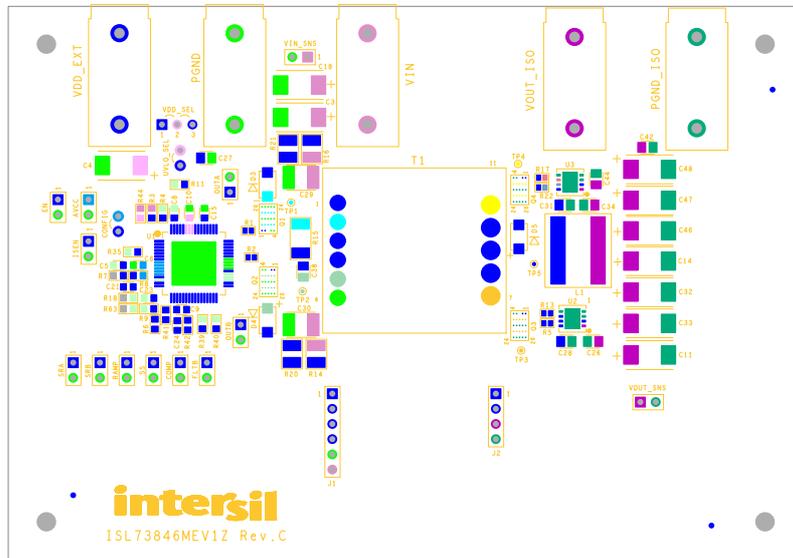


Figure 10. Silkscreen Top

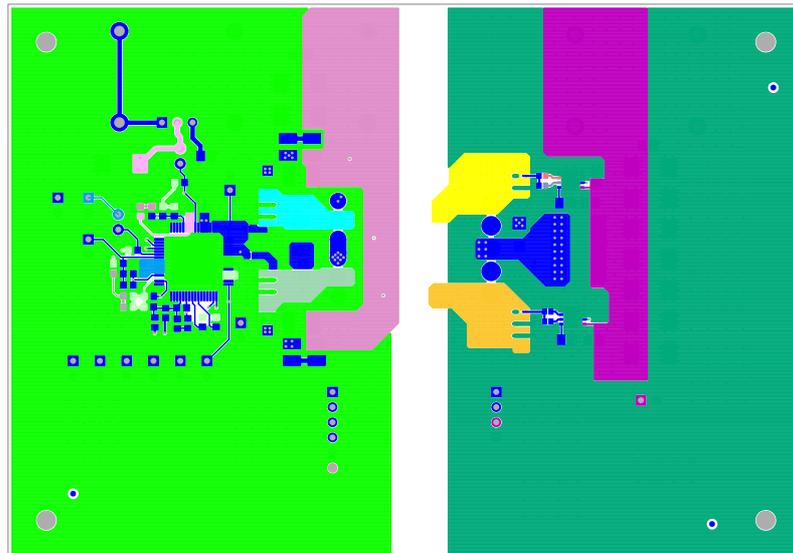


Figure 11. Top Layer

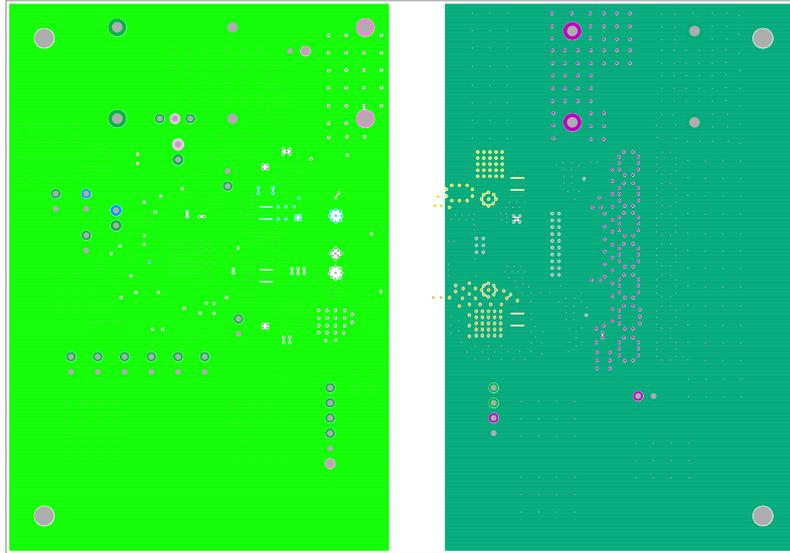


Figure 12. Layer 2

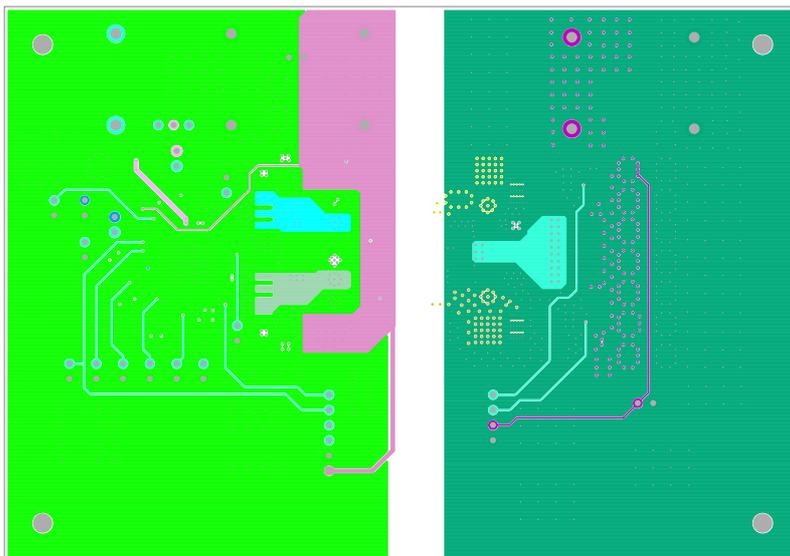


Figure 13. Layer 3

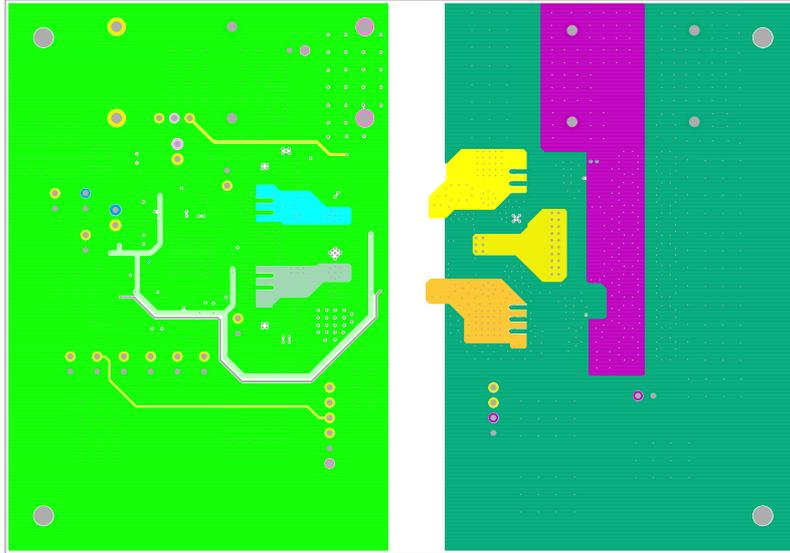


Figure 14. Layer 4

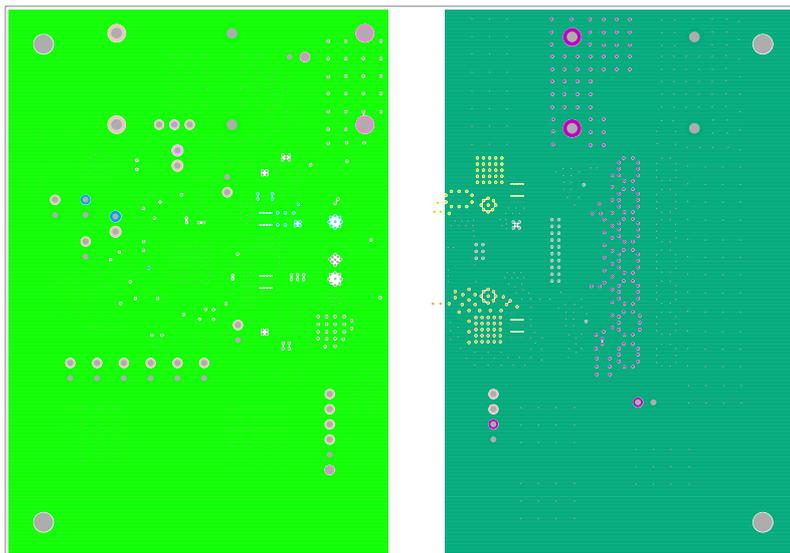


Figure 15. Layer 5

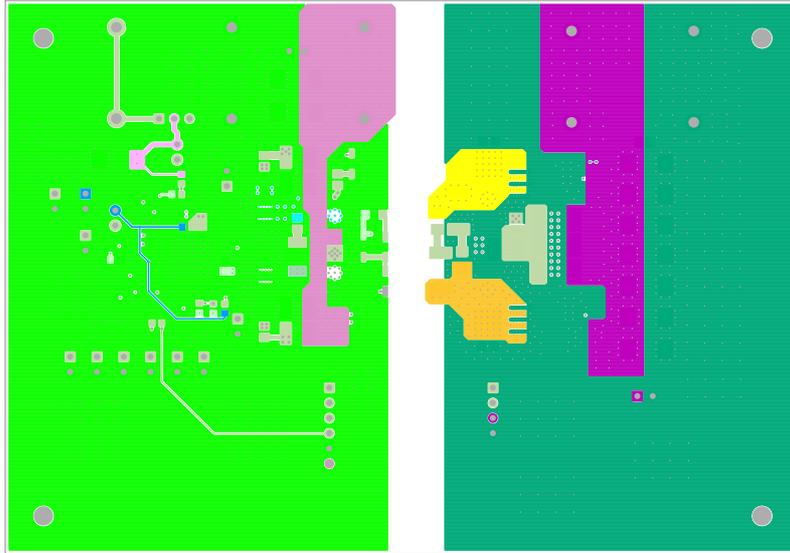


Figure 16. Bottom Layer

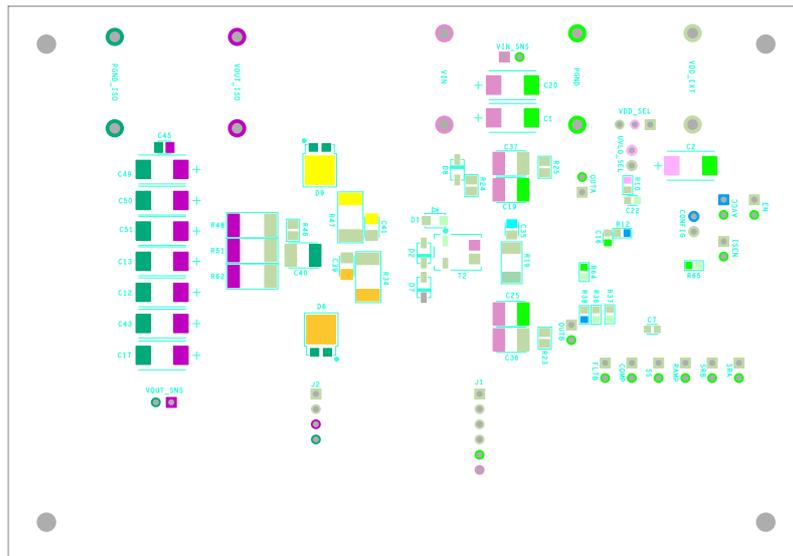


Figure 17. Silkscreen Bottom



## 2.2.1 Schematic Diagrams

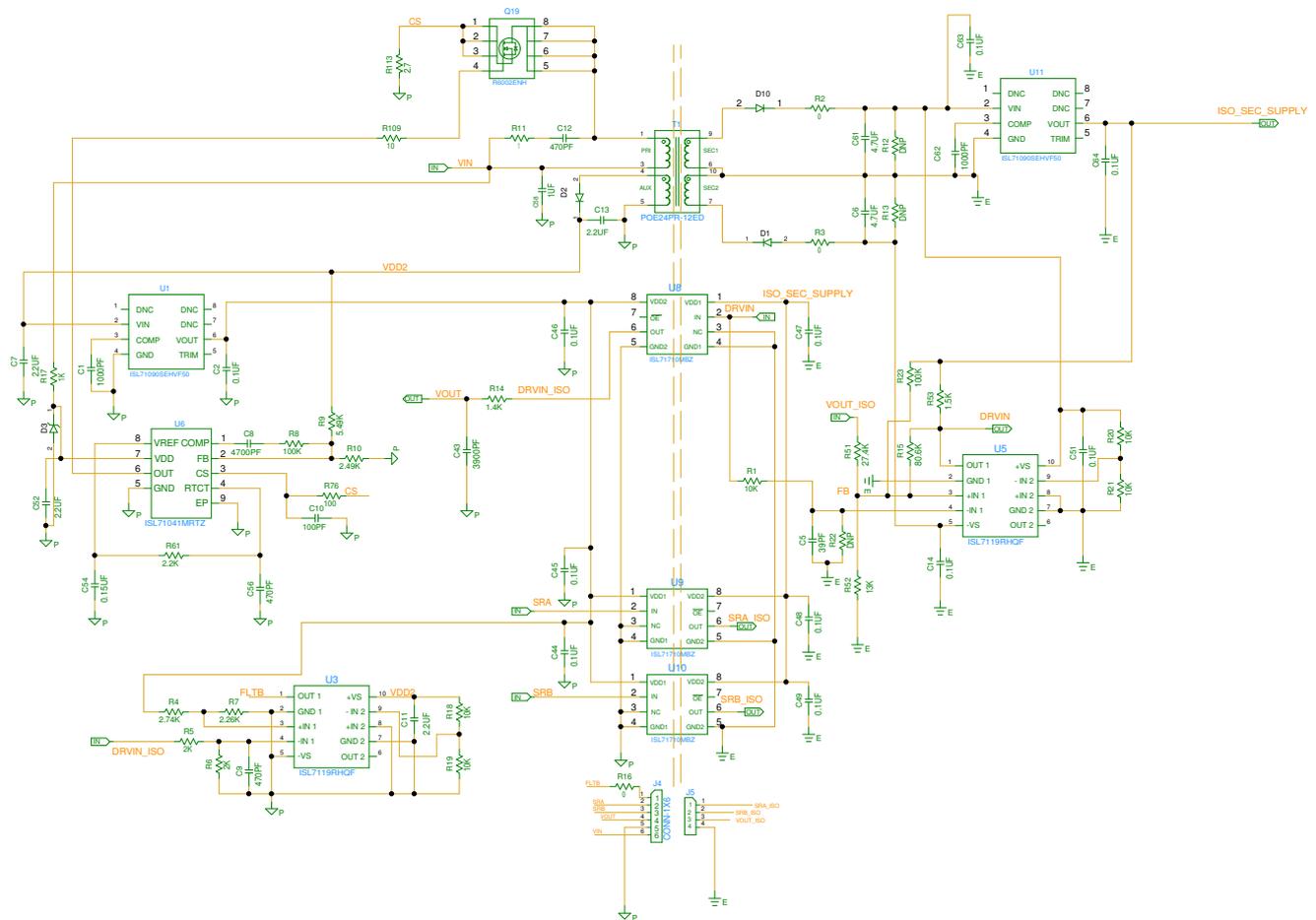


Figure 20. ISLFBKISOEV1Z Schematic

## 2.2.2 Bill of Materials

Qty	Ref Des	Description	Manufacturer	Part Number
1	PCB	PWB-PCB, ISLFBKISOEV1Z, REV B, ROHS	Imagineering	ISLFBKISOEV1ZREVBPCB
2	C1, C62	CAP, SMD, 0402, 1000pF, 25V, 10%, X7R, ROHS	Kyocera	KGM05AR71H102JH-T
1	C10	CAP, SMD, 0603, 100pF, 100V, 1%, C0G/NP0, ROHS	Kemet	C0603C101F1GACTU-T
1	C12	CAP, SMD, 1206, 470pF, 100V, 10%, COG, ROHS	YAGEO	CC1206KRNPO0BN471-T
11	C2, C63, C64, C14, C44, C45, C46, C47, C48, C49, C51	CAP-AEC-Q200, SMD, 0603, 0.1µF, 50V, 10%, X7R, ROHS	Murata	GCJ188R71H104KA12D-T
1	C43	CAP, SMD, 0603, 3900pF, 50V, 10%, X7R, ROHS	KEMET	C0603C392K5RACTU-T
1	C5	CAP, SMD, 0603, 39pF, 50V, 10%, C0G/NP0, X7R, ROHS	Kemet	C0603C390K5GACTU-T
1	C54	CAP-AEC-Q200, SMD, 0603, 0.15µF, 25V, 10%, X7R, ROHS	TDK	CGA3E2X7R1E154K080AA-T
1	C58	CAP, SMD, 1812, 1µF, 100V, 10%, X7R, ROHS	Vishay	VJ1812Y105KBBAT4X-T
2	C6, C61	CAP, SMD, 0603, 4.7µF, 35V, 10%, X5R, ROHS	Murata	GRM188R6YA475KE15D-T
4	C7, C11, C13, C52	CAP, SMD, 0603, 2.2µF, 25V, 10%, X7S, ROHS	Murata	GRM188C71E225KE11D-T

Qty	Ref Des	Description	Manufacturer	Part Number
1	C8	CAP, SMD, 0603, 4700pF, 25V, 10%, X7R, ROHS	Kemet	C0603C472K3RAC7867-T
2	C9, C56	CAP, SMD, 0603, 470pF, 50V, 5%, C0G/NP0, ROHS	Murata	GRM1885C1H471JA01D-T
3	D1, D2, D10	DIODE-RECTIFIER, SMD, SOD-323, 2P, 100V, 250mA, ROHS	Diodes	1N4148WSF-7-T
1	D3	DIODE-ZENER, SMD, DO-219AB, 10V, 800mW, ROHS	Vishay	BZD27B10P-M3-08-T
1	J4	CONN-RECEPTACLE, FEMALE, TH, 1X6, 2.54mmPITCH, ROHS	Sullins	PPTC061LFBN-RC
1	J5	CONN-SOCKET, TH, 1X4, INSULATED, 2.54mm, ROHS	Sullins	PPTC041LFBN-RC
1	Q19	TRANSISTOR, SMD, 8SOP, MOSFET, N-CHANNEL, 600V, 1.7A, 2W, ROHS	Rohm	R6002ENHTB1-T
1	R1	RES-AEC-Q200, SMD, 0603, 10K, 1/10W, 1%, TKF, ROHS	Vishay	CRCW060310K0FKEB-T
1	R10	RES-AEC-Q200, SMD, 0603, 2.49K, 1/10W, 1%, TF, ROHS	Panasonic	ERJ-3EKF2491V-T
1	R109	RES-AEC-Q200, SMD, 0603, 10ohm, 1/10W, 1%, TKF, ROHS	Rohm	KTR03EZPF10R0-T
1	R11	RES, SMD, 0805, 1ohm, 1/8W, 1%, TF, ROHS	Panasonic	RC0805FR-071RL-T
1	R113	RES-AEC-Q200, SMD, 0805, 2.7ohm, 1/8W, 1%, TF, ROHS	Panasonic	RMCF0805FT2R70-T
3	R12, R13, R22	DO NOT POPULATE OR PURCHASE	Various	Generic
1	R14	RES-AEC-Q200, SMD, 0603, 1.4K, 1/10W, 1%, ROHS	Panasonic	ERJ-3EKF1401V-T
1	R15	RES-AEC-Q200, SMD, 0603, 80.6K, 1/10W, 1%, TF, ROHS	Panasonic	ERJ-3EKF8062V-T
1	R2, R3, R16	RES-AEC-Q200, SMD, 0603, 0ohm, 1/10W, TKF, ROHS	Panasonic	ERJ-3GEY0R00V-T
1	R17	RES-AEC-Q200, SMD, 0603, 1K, 1/10W, 1%, TF, ROHS	Panasonic	ERJ-3EKF1001V-T
4	R18, R19, R20, R21	RES-AEC-Q200, SMD, 0603, 10K, 1/10W, 1%, TKF, ROHS	Panasonic	ERJ-3EKF1002V-T
1	R23	RES-AEC-Q200, SMD, 0603, 100K, 1/10W, 1%, TKF, ROHS	Stackpole	RMCF0603FT100K-T
1	R4	RES-AEC-Q200, SMD, 0603, 2.747K, 1/10W, 0.1%, TNF, ROHS	Panasonic	ERA-3AEB2741V-T
2	R5, R6	RES-AEC-Q200, SMD, 0603, 2K, 1/10W, 1%, ROHS	Panasonic	ERJ-3EKF2001V-T
1	R51	RES-AEC-Q200, SMD, 0603, 27.4K, 1/10W, 1%, TF, ROHS	Panasonic	ERJ-3EKF2742V-T
1	R52	RES-AEC-Q200, SMD, 0603, 13K, 1/10W, 1%, ROHS	Panasonic	RMCF0603FT13K0-T
1	R53	RES-AEC-Q200, SMD, 0603, 1.5K, 1/10W, 0.1%, ROHS	Panasonic	ERA-3AEB152V-T
1	R61	RES-AEC-Q200, SMD, 0603, 2.2K, 1/10W, 0.1%, ROHS	Panasonic	ERA-3AEB222V-T
1	R7	RES-AEC-Q200, SMD, 0603, 2.26K, 1/10W, 1%, ROHS	Panasonic	ERJ-3EKF2261V-T
1	R76	RES-AEC-Q200, SMD, 0603, 100ohm, 1/10W, 1%, TF, ROHS	Panasonic	ERJ-3EKF1000V-T

Qty	Ref Des	Description	Manufacturer	Part Number
1	R8	RES-AEC-Q200, SMD, 0603, 100K, 1/10W, 0.1%, ROHS	Panasonic	ERA-3AEB104V-T
1	R9	RES, SMD, 0603, 5.49K, 1/16W, 1%, TF, ROHS	Panasonic	ERJ-3EKF5491V-T
1	T1	TRANSFORMER-FLYBACK, 24W, 12V, 1.0A, SMD, ROHS	CoilCraft	POE24PR-12ED-T
2	U1, U11	IC-RH, ULTRALOW NOISE, 5.0V, ROHS	Renesas	ISL71090SEHVF50
2	U3, U5	IC-RH HIGH SPEED DUAL VOLTAGE COMPARATOR, ROHS	Renesas	ISL7119RHQF
1	U6	IC-CURRENT MODE PWM, 50% DC, 7.0V UVLO, 8P, ROHS	Renesas	ISL71041MRTZ
3	U8, U9, U10	IC-DIGITAL ACTIVE ISOLATOR, SMD, 8P, SOICN, ROHS	Renesas	ISL71710MBZ
1	PLACE ASSY IN BAG	BAG, STATIC, 3X5, ZIP LOC, ROHS	ULINE	3X5-STATIC-BAG
1	AFFIX TO BOTTOM OF PCB	LABEL-DATE CODE=LINE 1:YRWK-REV#, LINE 2;BOM NAME	Renesas	LABEL-DATE CODE

### 2.2.3 Board Layout

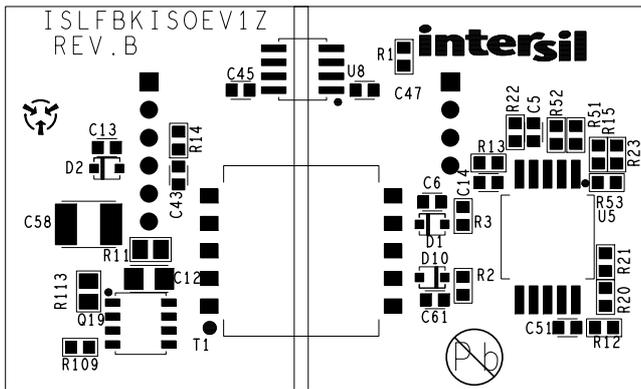


Figure 21. Silkscreen Top

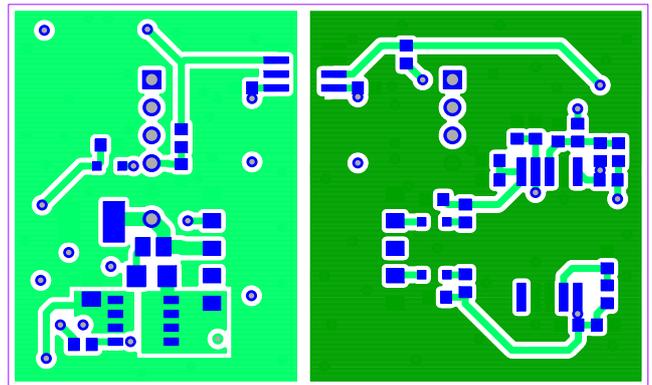


Figure 22. Top Layer

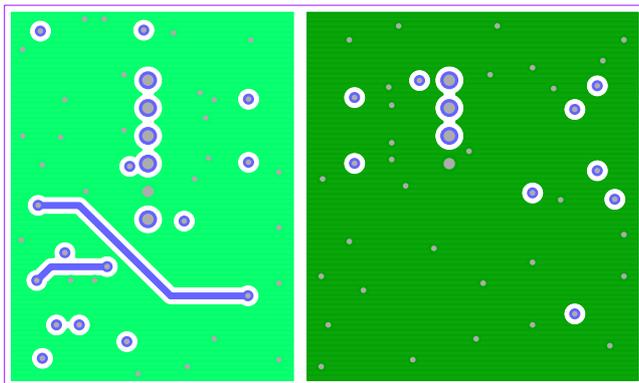


Figure 23. Layer 2

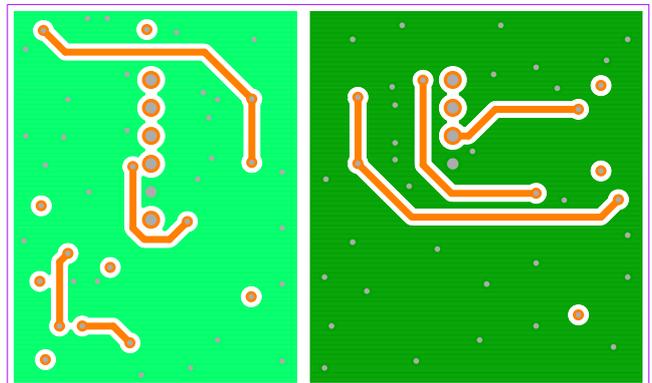


Figure 24. Layer 3

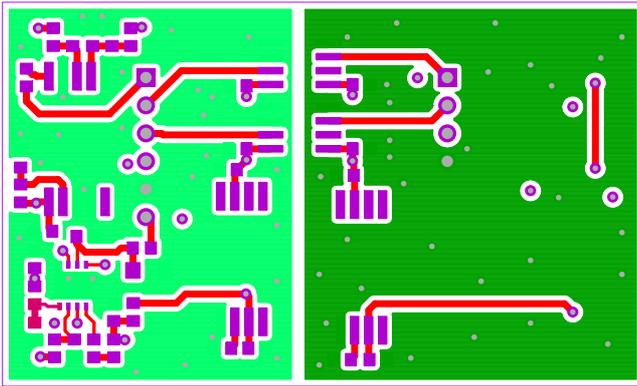


Figure 25. Bottom Layer

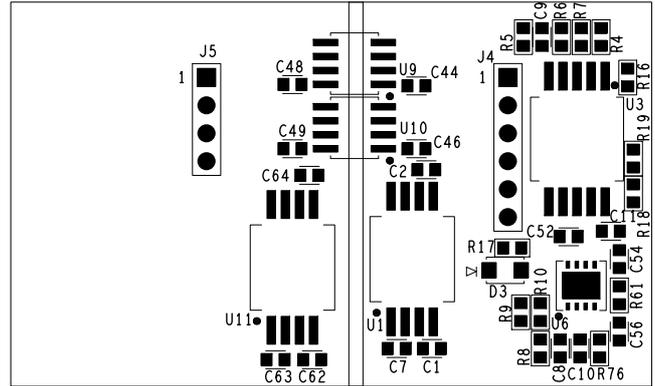


Figure 26. Silkscreen Bottom

### 3. Typical Performance Graphs

The following are the typical performance plots of the ISL73846MEV1Z push-pull converter evaluation board. For efficiency and load regulation plots, the controller is supplied from a 12V external power supply (VDD\_EXT). Input power includes power consumption of the controller and ISLFBKISOEV1Z daughter card. Typical steady state switching waveforms, soft-start, and overcurrent protection operation waveforms are shown in [Figure 27](#) to [Figure 36](#).

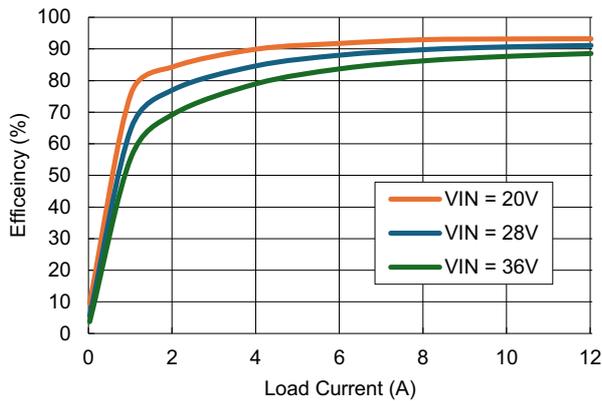


Figure 27. Efficiency

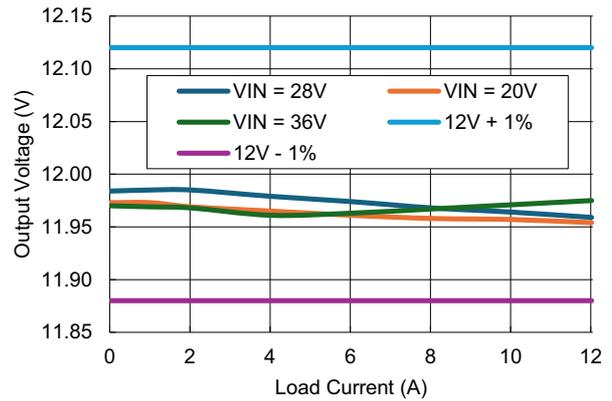


Figure 28. Load Regulation



Figure 29. 0A to 12A Load Step Response ( $V_{IN} = 28V$ )

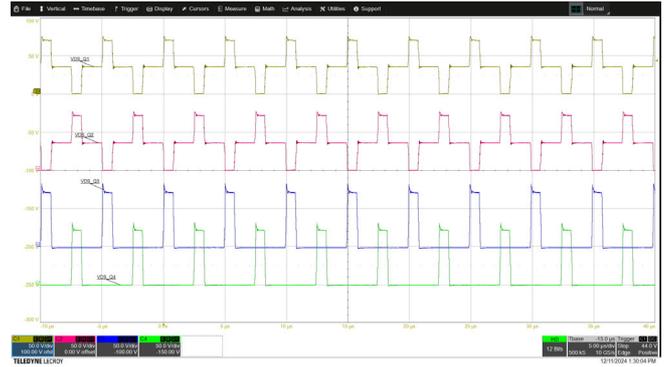


Figure 30. Drain-to-Source Voltages of GaNFETs,  $V_{IN} = 36V$ , 0A Load

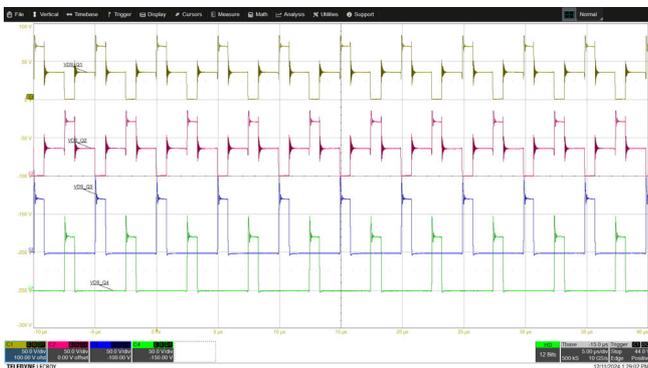


Figure 31. Drain-to-Source Voltages of GaNFETs,  $V_{IN} = 36V$ , 12A Load

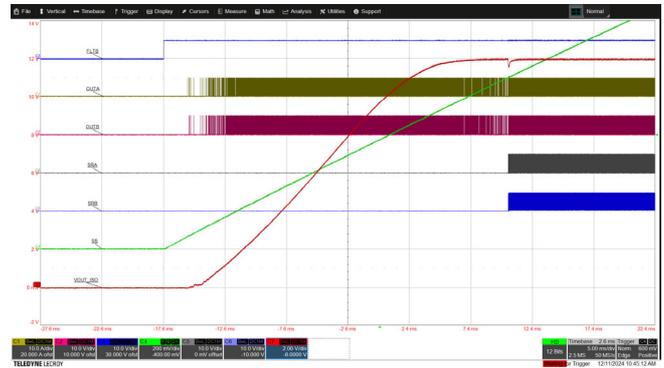


Figure 32. Soft Start ( $V_{IN}$  Ramp Up to 28V, 0A Load)



Figure 33. Soft Start ( $V_{IN}$  Ramp Up to 28V, 12A load)

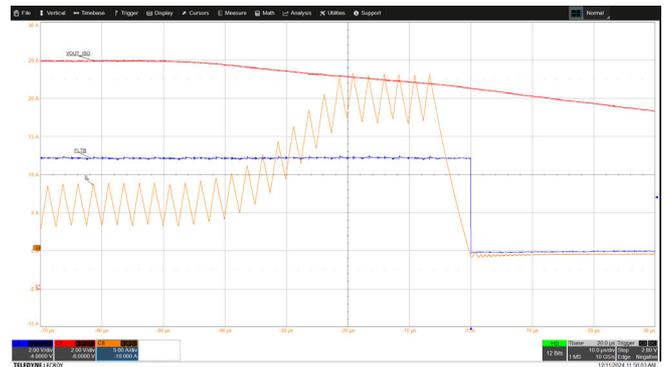


Figure 34. Overcurrent Protection (CONFIG Jumper Shorted,  $V_{IN} = 28V$ )



Figure 35. Overcurrent Protection (CONFIG Jumper Open,  $V_{IN} = 28V$ )

Note: Part shuts down when an undervoltage fault is detected at the EA\_IN pin.

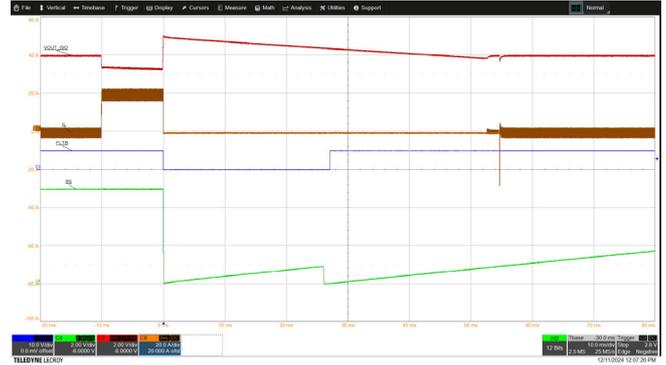


Figure 36. Overcurrent Protection (CONFIG Jumper Open)

Note: 19A load transient is applied and released after 10ms. The load release causes an overshoot on output voltage which is detected by the ISLFBKISOEV1Z board and causes the controller to go into hiccup.

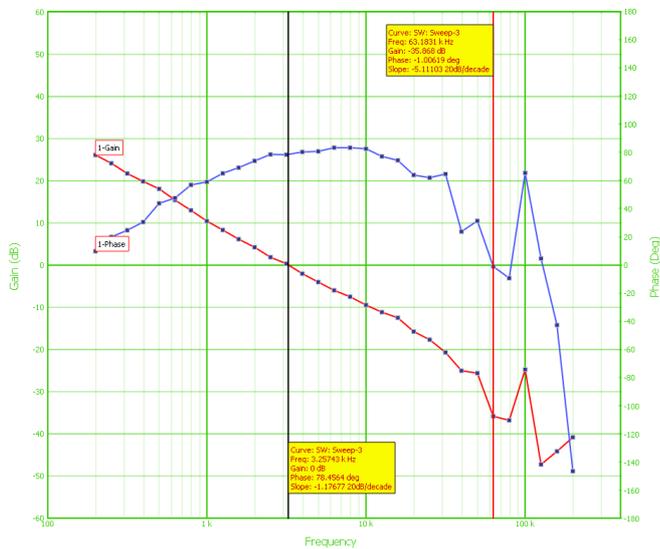


Figure 37. Loop Gain/Phase Characteristics at  $V_{IN} = 28V$ ,  $I_{OUT} = 6A$

## 4. Ordering Information

Part Number	Description
ISL73846MEV1Z	ISL73846M Push-Pull Converter Evaluation Board

## 5. Revision History

Revision	Date	Description
1.00	May 15, 2025	Initial release.

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