GENERAL DESCRIPTION

The IS32LT3147 is a six-channel linear LED driver supporting a thermal shunt resistor for power dissipation to minimize the device thermal stress. Each channel has its own individual PWM control input. For added system reliability, the IS32LT3147 integrates fault detection circuitry for LED open/short circuit, single LED short circuit, thermal roll-off and thermal shutdown conditions. The FAULTB is a bi-directional open drain pin for reporting fault conditions and receiving system fault signal inputs. The FMODE pin configures the type of response to a fault signal, either “One Fail Other On” or “One Fail All Fail”.

The IS32LT3147 device is available in an eTSSOP-20 package with exposed pad for enhanced thermal dissipation.

FEATURES

- Wide input voltage range: 5V~40V
- Thermal shunt resistor to optimize the device thermal stress
- 6-CH current source driver
- Parallel outputs for higher current using multiple channels of a single IC or multiple ICs
- Individual PWM dimming to each channel
- Adjustable constant output current set by reference resistor
  - Max. current: 75mA per channel
  - Max. current: 450mA in Parallel Operation
- Low headroom voltage
  - Max. headroom: 500mV at 25mA per channel
  - Max. headroom: 900mV at 75mA per channel
- Robust fault protection with reporting:
  - Fault modes selectable: “one fails all fail” or “one fails other on”
  - Single LED short - single resistor to set the detection threshold
  - LED string open/short
  - Current setting pin (ISET) open/short
  - Thermal shutdown
  - External UVLO setting for single LED short and LED string open detection
  - FAULTB pin for failure reporting, allowing parallel bus connection
- Current slew rate control to optimize EMI performance
- Thermal roll-off – over junction temperature current derating
- Operating junction temperature range -40°C to 150°C
- AEC-Q100 Qualified

QUICK START

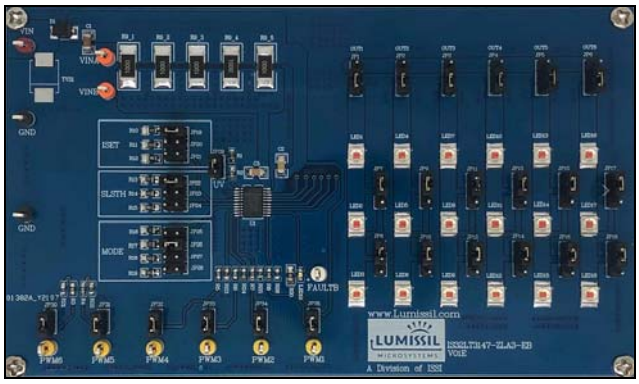

Figure 1: IS32LT3147 Demo Board Photo

RECOMMENDED EQUIPMENT

- 12V, 1A DC power supply

ABSOLUTE MAXIMUM RATINGS

- ≤ 40V power supply

Caution: Do not exceed the conditions listed above, otherwise the board will be damaged.

ORDERING INFORMATION

Part No.	Temperature Range	Package
IS32LT3147-ZLA3-EB	-40°C ~ +125°C (Automotive)	eTSSOP-20, Lead-free

Table 1: Ordering Information

For pricing, delivery, and ordering information, please contact Lumissil’s analog marketing team at analog@Lumissil.com or (408) 969-6600.

PROCEDURE

The IS32LT3147 evaluation board is fully assembled and tested. Follow the steps listed below to verify board operation.

Caution: Do not turn on the power supply until all connections are completed.

1. Connect the GND of the power supply to the GND terminal of the evaluation board and the VCC of the power supply to the VIN terminal of the evaluation board. Default VINA and VINB connect 20Ω (five 100Ω resistors in parallel) shunt resistor to derate the power dissipation on the driver.
2. Output Current Setting
   Output current can be adjusted by R10/R11/R12 resistors using Table 2 jumper settings.

Jumper	Setting	Output Current of Each Channel
JP19	Closed	74.9mA (Typ.)
JP20	Closed	51mA (Typ.)
JP21	Closed	25.8mA (Typ.)

Table 2: Output Current Setting

3. Single LED Short Detect Setting
   Single LED short detect voltage can be adjusted by R13/R14/R15 resistors using Table 3 jumper settings.

Jumper	Setting	Single LED Short Detect Voltage
JP22	Closed	Disabled
JP23	Closed	2.88V (Typ.)
JP24	Closed	4.5V (Typ.)

Table 3: Single LED Short Detect Voltage Setting

4. Fault Actions Setting
   Fault actions can be programmed by R16/R17/R18/R19 resistors using Table 4 jumper settings. See Table 7/8 for more fault action detail.

Jumper Setting	Fault Actions	Single LED Short
JP25 Closed	One Fail All Fail Mode	Retry Current in Faulty Channel
JP26 Closed		Latched Off Device
JP27 Closed	One Fail Other On Mode	Retry Current in Faulty Channel
JP28 Closed		Fully On

Table 4: Fault Actions Setting

5. Fault UVLO Enable/Disable
   The UV pin with a resistor divider from VINA is to program an undervoltage-lockout threshold for LED string open and single LED shorted fault detections. This helps to prevent false fault detection due to the insufficient power supply voltage, such as caused by a power rail transient. The UV pin voltage must be higher than V_{UVTH} to enable fault detection and lower than (V_{UVTH}-V_{UVTH_HY}) to disable. The jumper JP29 is used to enable/disable fault UVLO function.

Jumper	Setting	Fault UVLO
JP29	Closed	9.67V (Typ.)
	Open	Disabled

Table 5: Fault UVLO Setting

6. Output Enable/Disable
   The OUT6~OUT1 output are respectively enabled/disabled by the jumper JP30~JP35 using Table 6 jumper settings.

Jumper	Setting	OUTx
JP30~JP35	Closed	Enabled
	Open	Disabled

Table 6: Output Enabled/Disabled Setting

7. PWM Dimming
   Open the jumpers JP30~JP35 and applying external PWM signal on the PWM1~PWM6 terminals can individually modulate the LED brightness of each channel by the PWM duty cycle.
   Note: If JP30~JP35 are not opened, the external PWM source may be damaged by a high voltage.
8. Fault Reporting
   The fault protections include LED string open/shorted, single LED shorted, ISET pin open/shorted, thermal roll off (not reported) and thermal shutdown. The FAULTB pin will go low when the device detects a fault condition. When FAULTB pin goes low, LED19 will light up. Once the fault condition is removed, the FAULTB pin goes back to high impedance and LED19 will be turned off. (In the “one fails all fail and latched off” mode, fault state needs power cycle to reset) Refer to the Table 7/8 for more details.
   Note: R20 and LED19 are not necessary for actual application.
9. On Board LED Strings Setting
   There are 6 on board LED strings, one for each OUTx channel. The jumpers JP1~JP6 are used to connect the IS32LT3147 outputs to the onboard LED strings (LED1~LED18). Connecting JP1~JP6 to downside pin will enable the corresponding LED string. Connecting JP1~JP6 to upper side pin will disable the corresponding LED string.
   Each LED string can be adjusted from 1 to 3 LEDs by jumpers, JP7/JP8 for OUT1, JP9/JP10 for OUT2, JP11/JP12 for OUT3, JP13/JP14 for OUT4, JP15/JP16 for OUT5, JP17/JP18 for OUT6. Connect to upper side to enable and downside to disable the corresponding LEDs.
10. Turn on the power supply and LED string lights up.

If the OUTx strings fail to light up, check the power connections and status of the fault LED19.

11. Test points for PWMx (input), FAULTB (input/output), VINA, VINB are available for external monitoring and control.

EVALUATION BOARD OPERATION

OUTPUT CURRENT SETTING

The regulated LED current (up to 75mA) per channel is set by a resistor (R_{ISET}) from ISET pin to GND. The programming resistor is computed using the following Equation:

$$R_{ISET} = \frac{V_{ISET}}{I_{OUT}} \times 404 \qquad (1)$$

(6.2kΩ ≤ R_{ISET} ≤ 46.5kΩ) and V_{ISET} = 1.15V (Typ.). Where, R_{ISET} is in Ω and I_{OUT} is the desired current of each channel in Amps.

It is recommended that R_{ISET} be a 1% accuracy resistor with good temperature characteristics to ensure a stable output current. The R_{ISET} resistor must be placed as close as possible to the ISET pin on PCB layout to avoid noise interference and ground bounce.

The device is protected from an output overcurrent condition caused by the R_{ISET} resistor. The output channel current is limited to an I_{OUT_L} value of 120mA (Typ.) should the ISET pin be shorted or if a low value resistor is connected to the ISET pin.

Unused channel(s) must have its corresponding PWM pin connected to GND to disable it and its corresponding OUTx pin connected to the VINB pin to avoid a false fault detection.

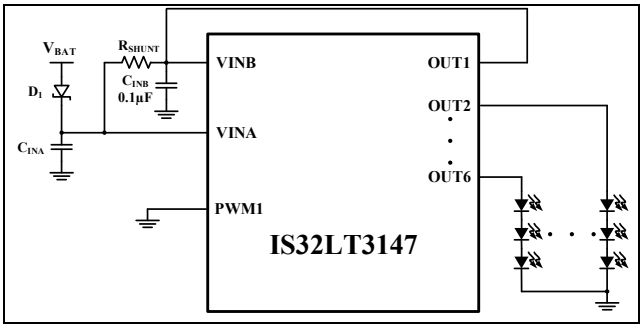

Figure 2 OUT1 Unused Example

SINGLE LED SHORT DETECTION

The IS32LT3147 supports single LED short detection which is implemented by detecting the OUTx pins voltage. The detection is enabled/disabled by UV pin as well to prevent insufficient power supply VINA falsely triggering. The detection voltage is set by a resistor R_{SLSTH} connected from SLSTH pin to GND:

$$R_{SLSTH} = \frac{V_{SLSTH}}{3 \times I_{SLSTH}} \qquad (2)$$

Where V_{SLSTH} is desired single LED short detection voltage in Volt. The maximum V_{SLSTH} should not be set above 8.5V.

It is recommended that R_{SLSTH} be 1% accuracy resistor with good temperature characterization. The V_{SLSTH} should be properly chosen within:

$$N \times V_{f\_MIN} > V_{SLSTH} > (N-1) \times V_{f\_MAX} \qquad (3)$$

Where N is the number of LEDs used in the strings, V_{f_MAX} and V_{f_MIN} is the maximum and minimum forward voltage of LED used.

Table 7 "One Fail All Fail" Mode Fault Actions

R_{FMODE} = 0Ω or 27kΩ (ONE-FAIL-ALL-FAIL)					
UV Pin	**Fault Type**	**Fault Condition**	**Output State**	**FAULTB Pin (with Input Function)**	**Recovery**
V_{UV}<(V_{UVTH}-V_{UVTH_HY})	LED string open	Disabled			
	LED string short	V_{OUTx}<V_{SCV}	Faulty channel outputs I_{RTR} for recovery detection and other channels off	Pull low (If the FAULTB pins of multiple devices are tied together, all other devices will be off)	V_{OUTx}> (V_{SCV}+V_{SCV_HY})
	Single LED short	Disabled			
	ISET open	ISET pin to GND resistance> R_{ISET_OC}	All channels off	Pull low (If the FAULTB pins of multiple devices are tied together, all other devices will be off)	ISET pin to GND resistance resumes to normal range
	ISET short	ISET pin to GND resistance< R_{ISET_SC}	All channels off		ISET pin to GND resistance resumes to normal range
	Thermal shutdown	T_J>T_{SD}	All channels off		T_J<(T_{SD}-T_{SDHY})
	Thermal roll-off	T_J>T_{RO}	Output current of all channels linearly decreases toward zero following T_J increasing	High impedance (If the FAULTB pins of multiple devices are tied together, all other devices will be on)	T_J<T_{RO}
V_{UV}>V_{UVTH}	LED string open	(V_{INB}-V_{OUTx})<V_{OCV}	Faulty channel outputs I_{RTR} for recovery detection and other channels off	Pull low (If the FAULTB pins of multiple devices are tied together, all other devices will be off)	(V_{INB}-V_{OUTx})> (V_{OCV}+V_{OCV_HY})
	LED string short	V_{OUTx}<V_{SCV}	Faulty channel outputs I_{RTR} for recovery detection and other channels off		V_{OUTx}> (V_{SCV}+V_{SCV_HY})
	Single LED short	V_{OUTx}<V_{SLSTH}	R_{FMODE} = 0Ω: Faulty channel outputs I_{RTR} for recovery detection and other channels off		V_{OUTx}> (V_{SLSTH}+ V_{SLSTH_HY})
			R_{FMODE} = 27kΩ: All channels latched off		Power cycle
	ISET open	ISET pin to GND resistance> R_{ISET_OC}	All channels off		ISET pin to GND resistance resumes to normal range
	ISET short	ISET pin to GND resistance< R_{ISET_SC}	All channels off		ISET pin to GND resistance resumes to normal range
	Thermal shutdown	T_J>T_{SD}	All channels off		T_J<(T_{SD}-T_{SDHY})
	Thermal roll-off	T_J>T_{RO}	Output current of all channels linearly decreases toward zero following T_J increasing	High impedance (If the FAULTB pins of multiple devices are tied together, all other devices will be on)	T_J<T_{RO}

Table 8 "One Fail Other On" Mode Fault Actions

R_{FMODE} = 62kΩ or 150kΩ (ONE-FAIL-OTHER-ON)					
UV Pin	**Fault Type**	**Fault Condition**	**Output State**	**FAULTB Pin (without Input Function)**	**Recovery**
V_{UV}<(V_{UVTH}-V_{UVTH_HY})	LED string open	Disabled			
	LED string short	V_{OUTx}<V_{SCV}	Faulty channel outputs I_{RTR} for recovery detection and other channels on	Pull low (If the FAULTB pins of multiple devices are tied together, all other devices will be on)	V_{OUTx}> (V_{SCV}+V_{SCV_HY})
	Single LED short	Disabled			
	ISET open	ISET pin to GND resistance> R_{ISET_OC}	All channels off	Pull low (If the FAULTB pins of multiple devices are tied together, all other devices will be on)	ISET pin to GND resistance resumes to normal range
	ISET short	ISET pin to GND resistance< R_{ISET_SC}	All channels off		ISET pin to GND resistance resumes to normal range
	Thermal shutdown	T_J>T_{SD}	All channels off		T_J<(T_{SD}-T_{SDHY})
	Thermal roll-off	T_J>T_{RO}	Output current of all channels linearly decreases toward zero following T_J increasing	High impedance (If the FAULTB pins of multiple devices are tied together, all other devices will be on)	T_J<T_{RO}
V_{UV}>V_{UVTH}	LED string open	(V_{INB}-V_{OUTx})<V_{OCV}	Faulty channel outputs I_{RTR} for recovery detection and other channels on	Pull low (If the FAULTB pins of multiple devices are tied together, all other devices will be on)	(V_{INB}-V_{OUTx})> (V_{OCV}+V_{OCV_HY})
	LED string short	V_{OUTx}<V_{SCV}	Faulty channel outputs I_{RTR} for recovery detection and other channels on		V_{OUTx}> (V_{SCV}+V_{SCV_HY})
	Single LED short	V_{OUTx}<V_{SLSTH}	R_{FMODE} = 62kΩ: Faulty channel outputs I_{RTR} for recovery detection and other channels on		V_{OUTx}> (V_{SLSTH}+ V_{SLSTH_HY})
			R_{FMODE} = 150kΩ: All channels on		
	ISET open	ISET pin to GND resistance> R_{ISET_OC}	All channels off		ISET pin to GND resistance resumes to normal range
	ISET short	ISET pin to GND resistance< R_{ISET_SC}	All channels off		ISET pin to GND resistance resumes to normal range
	Thermal shutdown	T_J>T_{SD}	All channels off		T_J<(T_{SD}-T_{SDHY})
	Thermal roll-off	T_J>T_{RO}	Output current of all channels linearly decreases toward zero following T_J increasing	High impedance (If the FAULTB pins of multiple devices are tied together, all other devices will be on)	T_J<T_{RO}

BILL OF MATERIALS

Name	Symbol	Description	Qty	Supplier	Part No.
LED Driver	U1	Constant current LED driver	1	Lumissil	IS32LT3147
	TVS1	Not installed			
Capacitor	C2,C3	CAP,100nF,50V,±10%,SMD	2	TDK	CGA5L2C0G1H104J160AE
Capacitor	C1	CAP,4.7μF,50V,±10%,SMD	1	TDK	CGA5L3X7R1H475M160AE
Resistor	R9_1~R9_5	RES,100R,2512, ±5%,1W, SMD	5	Yageo	AC2512JR-07100RL
Resistor	R2,R3,R4,R5, R6,R7,R8	RES,10k,0603,±5%,SMD	7	Yageo	AC0603JR-07110KL
Resistor	R1	RES,68k,0603,±1%,SMD	1	Yageo	AC0603FR-0768KL
Resistor	R21,R22,R23, R24,R25,R26	RES,100k,0603,±5%,SMD	6	Yageo	AC0603JR-07100KL
Resistor	R13,R16	RES,0R,0805,±1%,SMD	2	Yageo	RC0805JR-070RL
Resistor	R20	RES,5.1k,0805,±5%,SMD	1	Yageo	AC0805JR-07100KL
Resistor	R10	RES,6.2k,0805,±1%,SMD	1	Yageo	AC0805FR-076K2L
Resistor	R11	RES,9.1k,0805,±1%,SMD	1	Yageo	AC0805FR-079K1L
Resistor	R12	RES,18k,0805,±1%,SMD	1	Yageo	AC0805FR-0718KL
Resistor	R17	RES,27k,0805,±1%,SMD	1	Yageo	AC0805FR-0727KL
Resistor	R14	RES,30k,0805,±1%,SMD	1	Yageo	AC0805FR-0730KL
Resistor	R15	RES,47k,0805,±1%,SMD	1	Yageo	AC0805FR-0747KL
Resistor	R18	RES,62k,0805,±1%,SMD	1	Yageo	AC0805FR-0762KL
Resistor	R19	RES,150k,0805,±1%,SMD	1	Yageo	AC0805FR-07150KL
Diode	D1	SS26,1A,60V,SMA	1	Vishay	SS16HE3_B/I
LED	LED1~LED18	Yellow LED,0.5W	18	Everlight	ELSW-F91Y3-0LPNM-BA3A5
LED	LED19	Red LED,0603,V_F=2V	1	Rohm	SML-D14VWT86AAS
Header	JP1~JP18	3 pin headers	18		
Header	JP19~JP35	2 pin headers	17		
Test point	PWM1,PWM2,PWM3,PWM4,PWM5,PWM6,VINA, VINB,FAULTB, VIN,GND	1 pin test point	12		

Bill of materials, refer to Figure 3 below.

SCHEMATIC

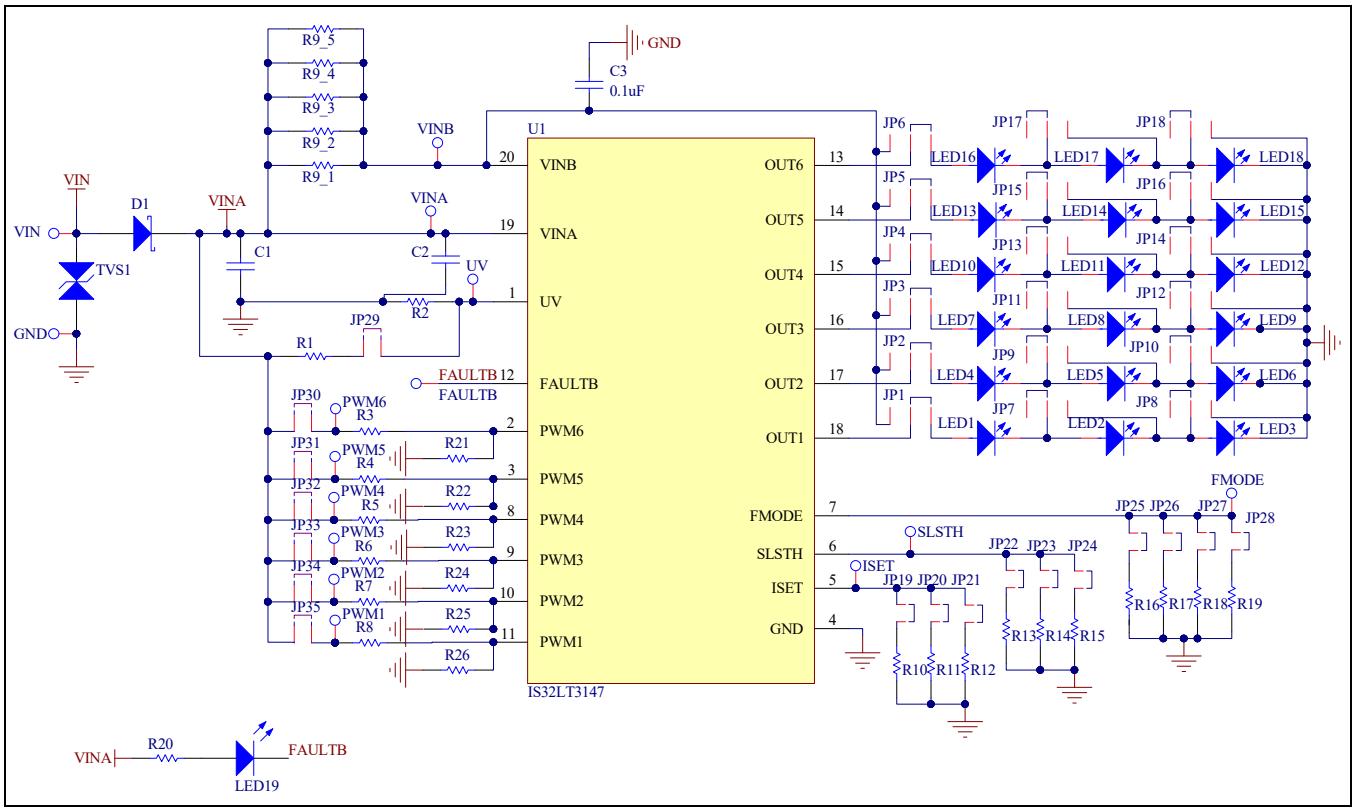

Figure 3: IS32LT3147 DEMO Board Schematic

PCB LAYOUT

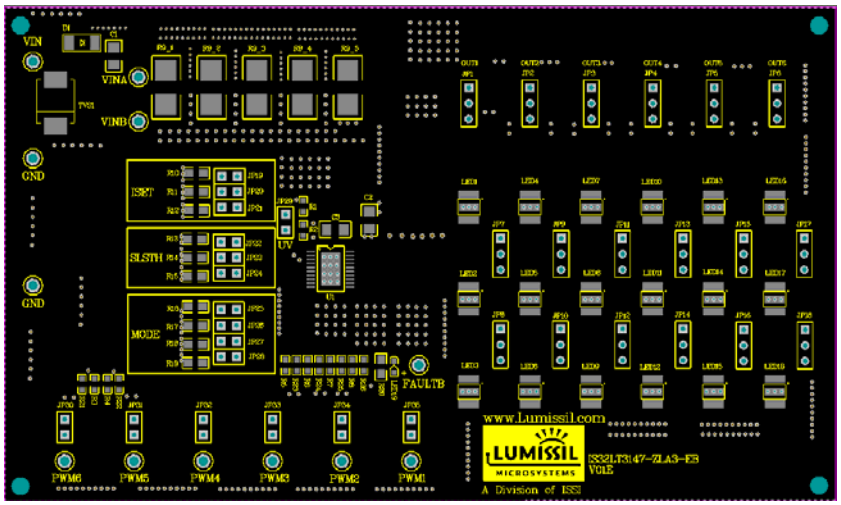

Figure 4: Board Component Placement Guide - Top Layer

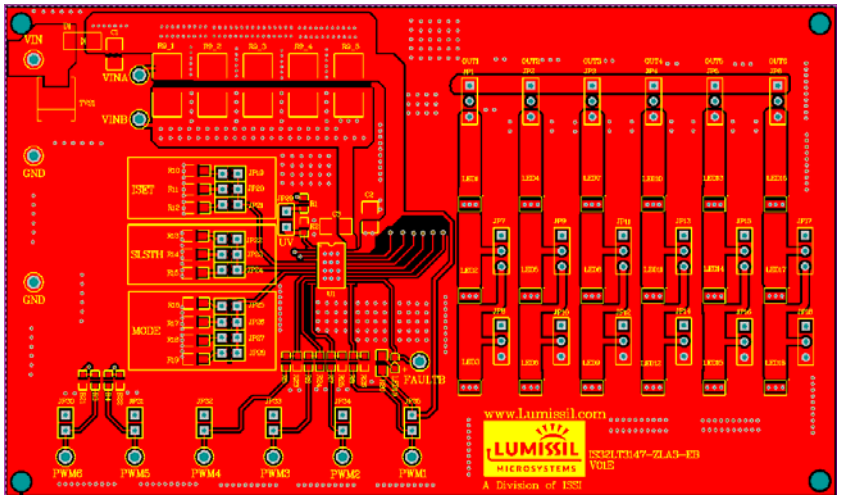

Figure 5: Board PCB Layout - Top Layer

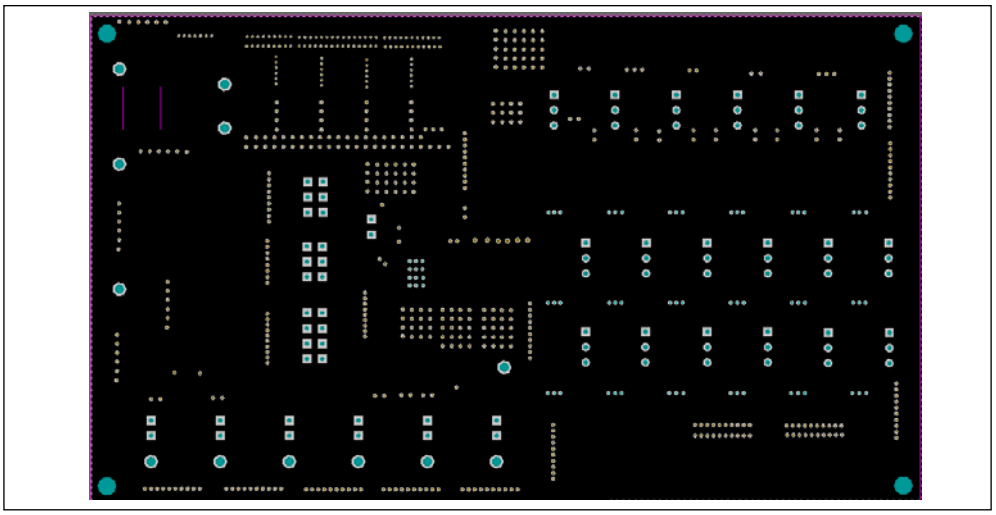

Figure 6: Board Component Placement Guide - Bottom Layer

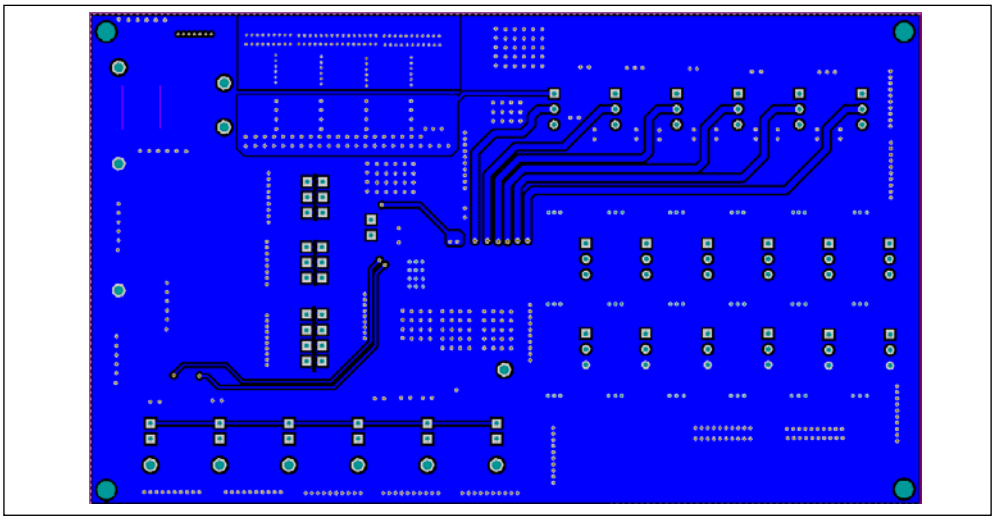

Figure 7: Board PCB Layout - Bottom Layer

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REVISION HISTORY

Revision	Detail Information	Date
A	Initial release.	2022.03.08