IS32LT3146 40V/450mA, STANDALONE 6-CHANNEL LINEAR LED DRIVER WITH THERMAL SHUNT EVALUATION BOARD GUIDE

DESCRIPTION

The IS32LT3146 device is a six-channel linear LED driver with a power resistor to shunt the power dissipation to optimize the thermal stress on the device. It supports both sequential turn on mode and traditional blink mode for turn signal light application. A logic level at the SEQEN pin is used to switch between these two modes. The startup delay time and channel to channel internal delay time of the sequential turn on are fully programmable by external resistors, and microcontroller is not required. The sequential turn on mode is able to implement multiple devices synchronization operation to realize more than 6 LED strings sequential turn on. A single resistor from the SEQMODE pin to GND selects sequential turn on styles: one channel by one channel, two channels by two channels, three channels by three channels or all channels simultaneous on.

For added system reliability, the IS32LT3146 integrates fault detection circuitry for LED open/short circuit, single LED short circuit, thermal roll-off and thermal shutdown conditions. The FAULTB pin is dedicated for fault conditions reporting.

The IS32LT3146 device is available in the eTSSOP-20 package with exposed pad for enhanced thermal dissipation.
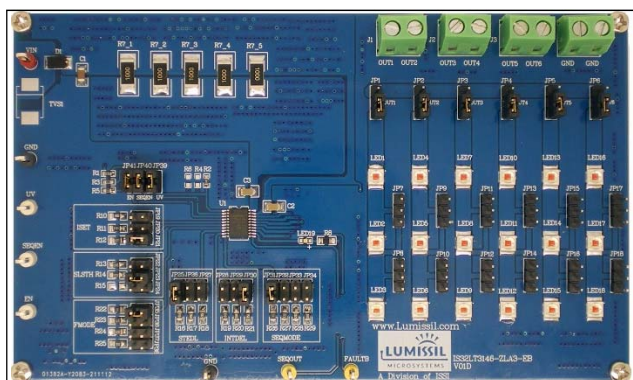
QUICK START

Figure 1: Photo of IS32LT3146 Evaluation Board

FEATURES

- Wide input voltage range: 5V~40V
- Thermal shunt resistor to optimize the device thermal stress
- Programmable sequential turn on of each channel
  - ±5% timer accuracy
  - Timing programmable by external resistors
  - Stand-alone sequential turn on timing for multiple devices operation (no signal wire connection among the devices)
  - Synchronized sequential turn on timing for multiple devices operation
  - Sequential turn on style selectable: one by one, two by two, three by three or all simultaneous on
  - Single pin to select between sequential turn on mode or traditional blink mode
- 6-CH current source driver
- Parallel outputs for higher current using multiple channels of a single IC or multiple ICs
- Adjustable constant output current set by a single 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 fail all fail" or "one fail other on"
  - Single LED shorted - 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

RECOMMENDED EQUIPMENT

- 12V, 1A DC power supply or 12V Battery

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
IS32LT3146-ZLA3-EB	-40°C to +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 IS32LT3146 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 BCM power supply to the GND terminal of the evaluation board and the VCC of the BCM 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.
   Note: to implement continuous sequential turn on display, please use a BCM with turn light blink signal to power supply the evaluation board.

2) The jumper JP41 is used to enable/shutdown the device. The JP41 default is closed to enable the device. Open JP41 forces the device into the shutdown mode with an ultralow standby current.

3) The jumper JP40 is used to select display mode, sequential turn on mode or traditional blink mode. The jumper JP40 default is closed to enable sequential turn on mode. Opening JP40 will enable traditional blink mode.

4) The jumper JP39 is used to enable/disable the LED string open and single LED short fault detection. Closing JP39 enables both fault detections when VINA>9V (programmable by the resistor divider, R1 and R2). Opening JP39 will disable both fault detections.

5) The jumpers JP19~JP21 are used to set the output current. Default JP21 is closed to set the output current to 75mA (Typ.); only JP19 is closed set the output current to 26mA (Typ.); only JP20 is closed sets the output current to 51mA (Typ.).

6) The jumpers JP22~JP24 are used to set single LED short detect threshold. Default JP23 is closed to set the detect threshold to 4.5V (Typ.); only JP22 is closed to set the detect threshold to 2.88V (Typ.). Closing JP24 will disable single LED short detection.

7) The jumpers JP25~JP27 are used to set startup delay time for sequential turn on mode. Default JP25 is closed set the delay time to 50ms (Typ.); only JP26 is closed set the delay time to 250ms (Typ.); only JP27 is closed set the delay time to 500ms (Typ.).

8) The jumpers JP28~JP30 are used to set interval delay time for sequential turn on mode. Default JP30 is closed to set the delay time to 100ms (Typ.); only JP28 is closed to set the delay time to 10ms (Typ.); only close JP29 set the delay time to 50ms (Typ.).

9) The jumpers JP31~JP34 are used to set display style of the sequential turn on mode. Default JP31 is closed to set one by one style; only JP32 is closed set two by two style; only JP33 is closed set three by three style; only JP34 is closed set all simultaneous on style.

10) The jumpers JP35~JP38 are used to program the fault actions. Please refer to Tables 2 and 3 for a detailed fault response listing.

Jumper	Fault Actions	Single LED Short
JP35 closed	One Fail All Fail Mode	Retry Current in Faulty Channel
JP36 closed		Latched Off Device
JP37 closed	One Fail Other On Mode	Retry Current in Faulty Channel
JP38 closed		Fully On

11) The jumper JP1~JP6 are used to connect the IS32LT3146 outputs to the onboard LED strings (LED1~LED18). Connecting JP1~JP6 to downside pin will enable the corresponding channel. Connecting JP1~JP6 to upper side pin will disable the corresponding channel. Open JP1~JP6 to disable the onboard LED string and use the green terminal blocks to connect external LED strings.
   Note: Connecting external LED strings without removing JP1~JP6 jumpers' header will drive both onboard and external LED strings in parallel resulting in lower current drive to the LED string.

12) There are six onboard LED strings which can be adjusted from 1 to 3 LEDs by jumpers, JP7~JP18. Connecting to upper side or open the jumper enables the corresponding LED. Connecting to downside disables the corresponding LED.

13) R8 and LED19 are used for the fault reporting indicator LED which will turn on during a fault detection.

Note: This circuit is not necessary in the actual application.

14) Turn on the power supply to light up the LEDs.
15) Test points for UV, EN, SEQEN (input), SEQOUT, FAULTB (output), are available for external monitoring and control.

JUMPER SETTING TABLE

Table 1   Jumper Setting Table

Jumper	Function	Setting
JP1~JP6	Power to the onboard LED strings or external LED strings	Close upper side pin: connect output to VINB to disable the corresponding channel. Close downside pin: connect output to onboard LED string Open: connect the external LED strings to J1~J4 blocks
J1,J2,J3,J4	External LED string connector	J1: connect external LED strings to OUT1, OUT2 J2: connect external LED strings to OUT3, OUT4 J3: connect external LED strings to OUT5, OUT6 J4: GND
JP7~JP18	LED string configuration	Close upper side pin or open: enable the corresponding LED Close downside pin: disable the corresponding LED.
JP19~JP21	Output current setting	Close jumper JP19 only: set output current to 26mA (Typ.) Close jumper JP20 only: set output current to 51mA (Typ.) Close jumper JP21 only: set output current to 75mA (Typ.)
JP22~JP24	Single LED short detection threshold setting	Close jumper JP22 only: set voltage threshold to 2.88V (Typ.) Close jumper JP23 only: set voltage threshold to 4.5V (Typ.) Close jumper JP24 only: disable the single LED short detection
JP25~JP27	Startup delay time setting for sequential turn on mode	Close jumper JP25 only: set delay time to 50ms (Typ.) Close jumper JP26 only: set delay time to 250ms (Typ.) Close jumper JP27 only: set delay time to 500ms (Typ.)
JP28~JP30	Interval delay time setting for sequential turn on mode	Close jumper JP28 only: set delay time to 10ms (Typ.) Close jumper JP29 only: set delay time to 50ms (Typ.) Close jumper JP30 only: set delay time to 100ms (Typ.)
JP31~JP34	Display style setting for sequential turn on mode	Close jumper JP31 only: set one by one style Close jumper JP32 only: set two by two style Close jumper JP33 only: set three by three style Close jumper JP34 only: set all simultaneous on style
JP35~JP38	Fault action mode setting	Close jumper JP35 only: set "One Fail All Fail" fault action with single LED short retry current Close jumper JP36 only: set "One Fail All Fail" fault action with single LED short latch off Close jumper JP37 only: set "One Fail Other On" fault action with single LED short retry current Close jumper JP38 only: set "One Fail Other On" fault action with single LED short fully on
JP39	UV setting	Close jumper JP39: set fault UVLO threshold to 9.0V (Typ.) Open jumper JP39: disable LED string open and single LED short fault detection
JP40	Display mode setting	Close jumper JP40: enable sequential turn on mode Open jumper JP40: enable traditional blink mode
JP41	EN setting	Close jumper JP41: enable the outputs Open jumper JP41: disable the outputs

Table 2 Fault Action Description for “One Fail All Fail”

<table>
<tr><th colspan="7">R_{FMODE} = 0Ω or 27kΩ (ONE-FAIL-ALL-FAIL)</th></tr>
<tr><th>UV Pin</th><th>Fault Type</th><th>Fault Condition</th><th colspan="2">Output State</th><th>FAULTB Pin (with Input Function)</th><th>Recovery</th></tr>
<tr><td rowspan="7">$V_{UV}<(V_{UVTH}-V_{UVTH\_HY})$</td><td>LED string open</td><td colspan="5">Disabled</td></tr>
<tr><td>LED string short</td><td>$V_{OUTx}<V_{SCV}$</td><td colspan="2">Faulty channel outputs I_{RTR} for recovery detection and other channels off</td><td>Pull low
(If the FAULTB pins of multiple devices are tied together, all other devices will be off)</td><td>$V_{OUTx}>(V_{SCV}+V_{SCV\_HY})$</td></tr>
<tr><td>Single LED short</td><td colspan="5">Disabled</td></tr>
<tr><td>ISET open</td><td>ISET pin to GND resistance> R_{ISET_OC}</td><td colspan="2">All channels off</td><td rowspan="3">Pull low
(If the FAULTB pins of multiple devices are tied together, all other devices will be off)</td><td>ISET pin to GND resistance resumes to normal range</td></tr>
<tr><td>ISET short</td><td>ISET pin to GND resistance< R_{ISET_SC}</td><td colspan="2">All channels off</td><td>ISET pin to GND resistance resumes to normal range</td></tr>
<tr><td>Thermal shutdown</td><td>$T_J>T_{SD}$</td><td colspan="2">All channels off</td><td>$T_J<(T_{SD}-T_{SDHY})$</td></tr>
<tr><td>Thermal roll-off</td><td>$T_J>T_{RO}$</td><td colspan="2">Output current of all channels linearly decreases toward zero following T_J increasing</td><td>High impedance
(If the FAULTB pins of multiple devices are tied together, all other devices will be on)</td><td>$T_J<T_{RO}$</td></tr>
<tr><td rowspan="8">$V_{UV}>V_{UVTH}$</td><td>LED string open</td><td>$(V_{INB}-V_{OUTx})<V_{OCV}$</td><td colspan="2">Faulty channel outputs I_{RTR} for recovery detection and other channels off</td><td rowspan="7">Pull low
(If the FAULTB pins of multiple devices are tied together, all other devices will be off)</td><td>$(V_{INB}-V_{OUTx})>(V_{OCV}+V_{OCV\_HY})$</td></tr>
<tr><td>LED string short</td><td>$V_{OUTx}<V_{SCV}$</td><td colspan="2">Faulty channel outputs I_{RTR} for recovery detection and other channels off</td><td>$V_{OUTx}>(V_{SCV}+V_{SCV\_HY})$</td></tr>
<tr><td rowspan="2">Single LED short</td><td rowspan="2">$V_{OUTx}<V_{SLSTH}$</td><td>R_{FMODE} = 0Ω</td><td>Faulty channel outputs I_{RTR} for recovery detection and other channels off</td><td>$V_{OUTx}>(V_{SLSTH}+V_{SLSTH\_HY})$</td></tr>
<tr><td>R_{FMODE} = 27kΩ</td><td>All channels latched off</td><td>Power cycle</td></tr>
<tr><td>ISET open</td><td>ISET pin to GND resistance> R_{ISET_OC}</td><td colspan="2">All channels off</td><td>ISET pin to GND resistance resumes to normal range</td></tr>
<tr><td>ISET short</td><td>ISET pin to GND resistance< R_{ISET_SC}</td><td colspan="2">All channels off</td><td>ISET pin to GND resistance resumes to normal range</td></tr>
<tr><td>Thermal shutdown</td><td>$T_J>T_{SD}$</td><td colspan="2">All channels off</td><td>$T_J<(T_{SD}-T_{SDHY})$</td></tr>
<tr><td>Thermal roll-off</td><td>$T_J>T_{RO}$</td><td colspan="2">Output current of all channels linearly decreases toward zero following T_J increasing</td><td>High impedance
(If the FAULTB pins of multiple devices are tied together, all other devices will be on)</td><td>$T_J<T_{RO}$</td></tr>
</table>

Table 3   Fault Action Description for 'One Fail Other On'

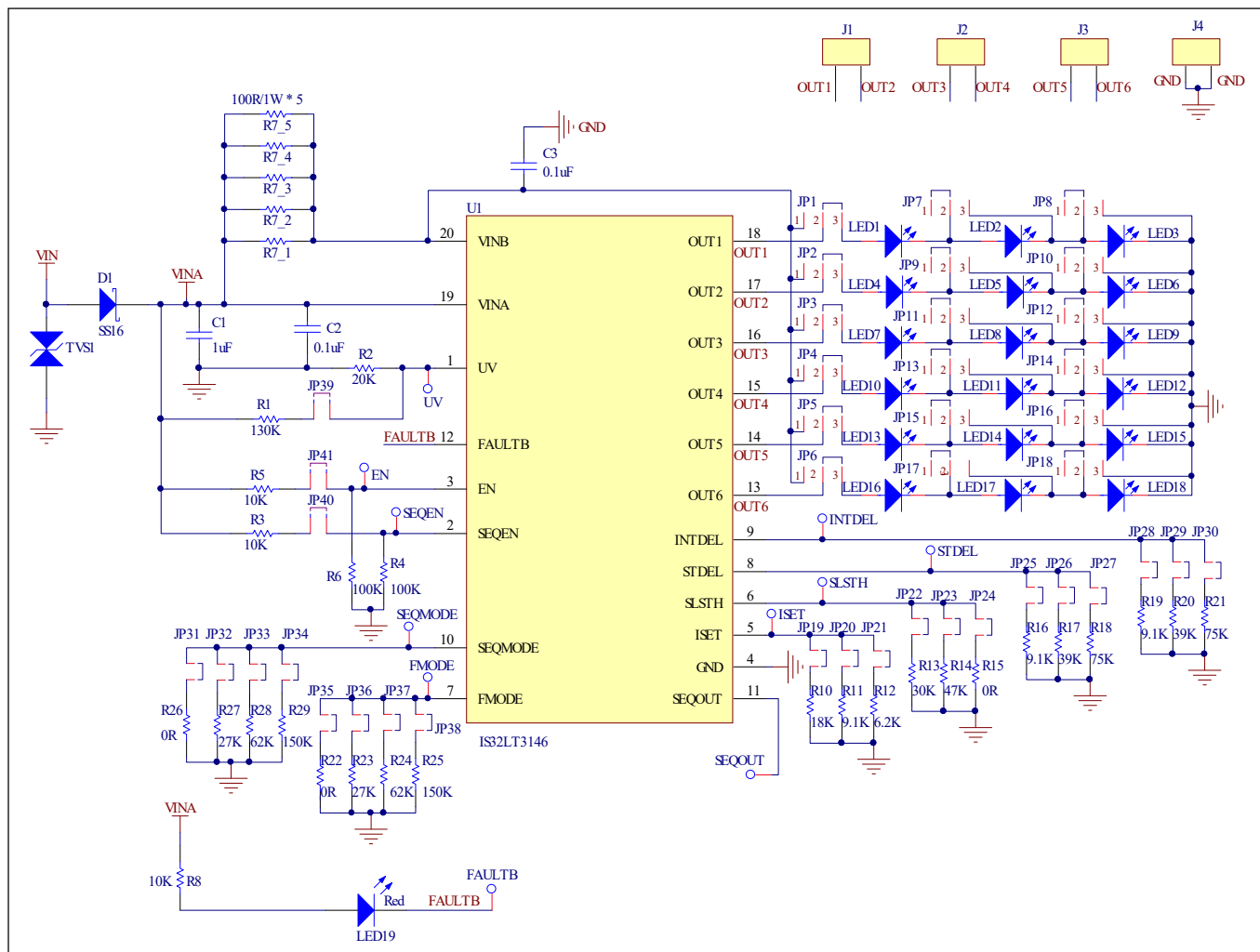| UV Pin	Fault Type	Fault Condition	Output State	FAULTB Pin (without Input Function)	Recovery
			R_{FMODE} = 62kΩ or 150kΩ (ONE-FAIL-OTHER-ON)		
$V_{UV} < (V_{UVTH} - V_{UVTH\_HY})$	LED string open	Disabled			
	LED string short	$V_{OUTx} < V_{SCV}$	Faulty channel outputs I_{RTR} for recovery detection 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 / R_{FMODE} = 150kΩ: All channels on		$V_{OUTx} > (V_{SLSTH} + V_{SLSTH\_HY})$
	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)	$T_J < T_{RO}$

Figure 2: IS32LT3146 Application Schematic

IS32LT3146 40V/450mA, STANDALONE 6-CHANNEL LINEAR LED DRIVER WITH THERMAL SHUNT EVALUATION BOARD GUIDE

BILL OF MATERIALS

Name	Symbol	Description	Qty	Supplier	Part No.
LED Driver	U1	6CH Constant current LED driver	1	ISSI	IS32LT3146
Capacitor	C1	CAP,1µF,50V, ±10%, SMD	1	Yageo	AC1206KRX7R9BB105
Capacitor	C2, C3	CAP,100nF,50V, ±10%, SMD	2	Yageo	AC1206KRX7R9BB104
Resistor	R7_1~R7_5	RES,100R,2512, ±5%,1W, SMD	5	Yageo	AC2512JR-07100RL
Resistor	R1	RES,130k, 0603, ±1%, SMD	1	Yageo	AC0603FR-07130KL
Resistor	R2	RES,20k, 0603,±1%,SMD	1	Yageo	AC0603FR-0720KL
Resistor	R3,R5	RES,10k, 0603,±5%,SMD	2	Yageo	AC0603JR-0710KL
Resistor	R4,R6	RES,100k, 0603,±5%,SMD	2	Yageo	AC0603JR-07100KL
Resistor	R8	RES,10k, 0805,±5%,SMD	1	Yageo	AC0805JR-0710KL
Resistor	R10	RES,18k, 0805,±1%,SMD	1	Yageo	AC0805FR-0718KL
Resistor	R11	RES,9.1k, 0805,±1%,SMD	1	Yageo	AC0805FR-079K1L
Resistor	R12	RES,6.2k, 0805,±1%,SMD	1	Yageo	AC0805FR-076K2L
Resistor	R13	RES,30k, 0805,±1%,SMD	1	Yageo	AC0805FR-0730KL
Resistor	R14	RES,47k, 0805,±1%,SMD	1	Yageo	AC0805FR-0747KL
Resistor	R15	RES,0R, 0805,±5%,SMD	1	Yageo	AC0805JR-070RL
Resistor	R16,R19	RES,9.1k, 0805,±1%,SMD	2	Yageo	AC0805FR-079K1L
Resistor	R17,R20	RES,39k, 0805,±1%,SMD	2	Yageo	AC0805FR-0739KL
Resistor	R18,R21	RES,75k, 0805,±1%,SMD	2	Yageo	AC0805FR-0775KL
Resistor	R22,R26	RES,0R, 0805,±5%,SMD	2	Yageo	AC0805JR-070RL
Resistor	R23,R27	RES,27k, 0805,±5%,SMD	2	Yageo	AC0805JR-0727KL
Resistor	R24,R28	RES,62k, 0805,±5%,SMD	2	Yageo	AC0805JR-0762KL
Resistor	R25,R29	RES,150k, 0805,±5%,SMD	2	Yageo	AC0805JR-07150KL
Schottky	D1	SS16,1A,60V,SMB	1	ONsemi	NRVBSS16T3G
LED	LED1~LED18	Yellow LED,1W,V_F=2.0V	18		
LED	LED19	Red LED ,20mA, V_F=1.8V	1		
Headers	JP1~JP18	3 pin headers	18		
Headers	JP19~JP41	2 pin headers	23		
Green Terminal blocks	J1~J4	Ext terminal blocks	4		

Bill of materials, refer to Figure 2 above.
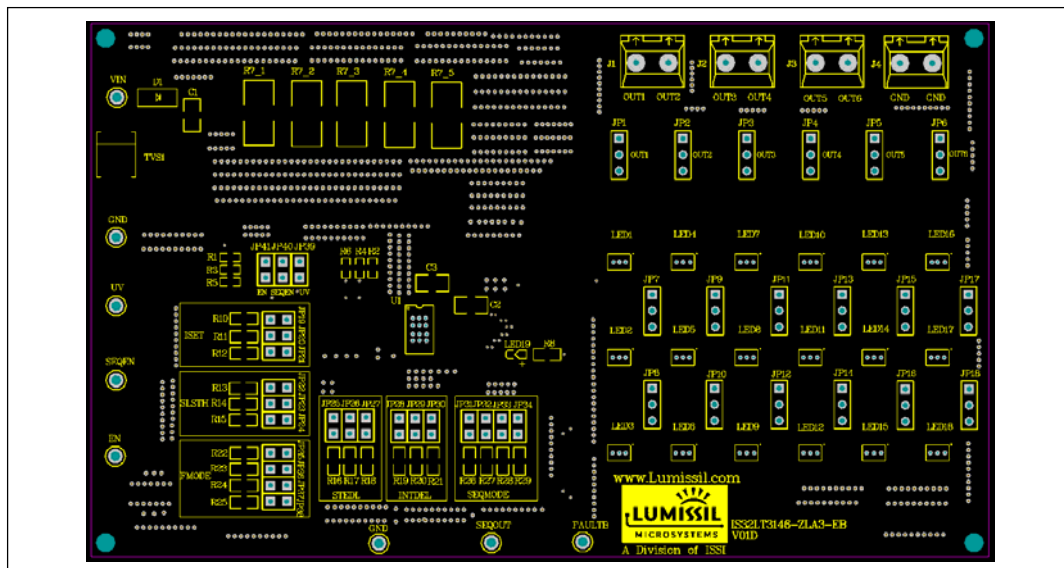
PCB LAYOUT

Figure 3: Board Component Placement - Top Layer
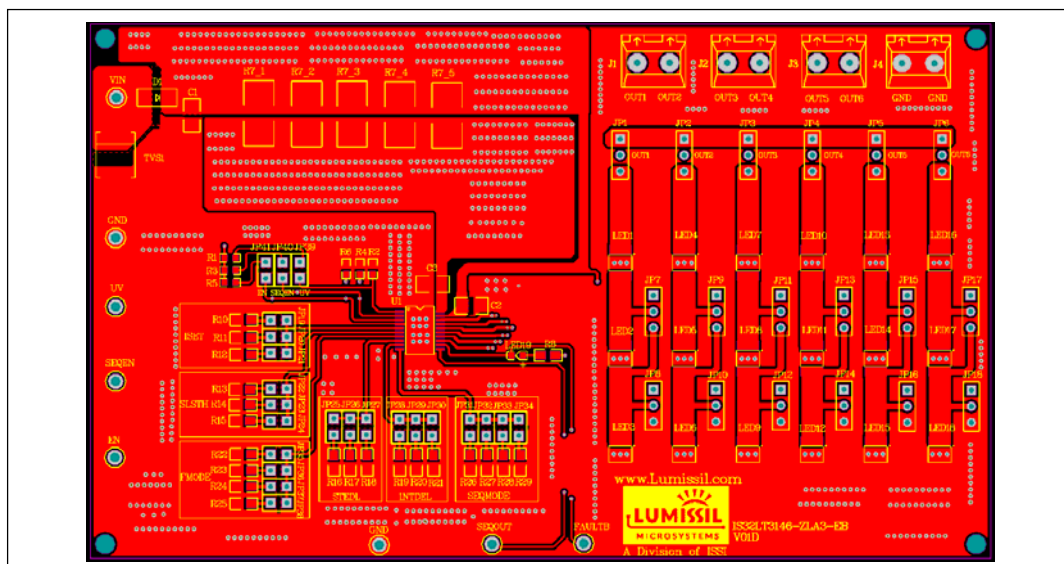
Figure 4: Board PCB Layout - Top Layer
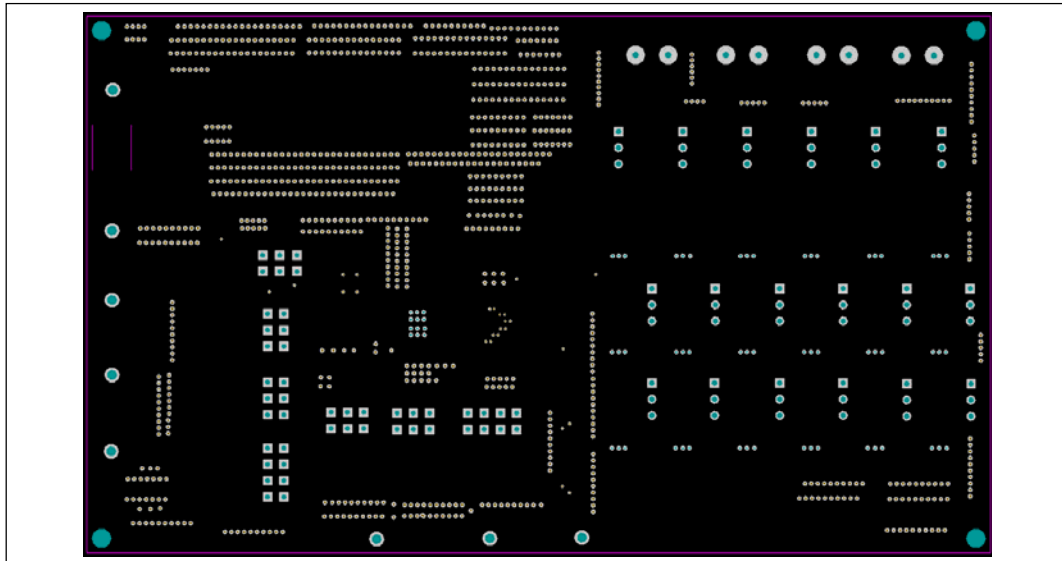
Figure 5: Board Component Placement - Bottom Layer
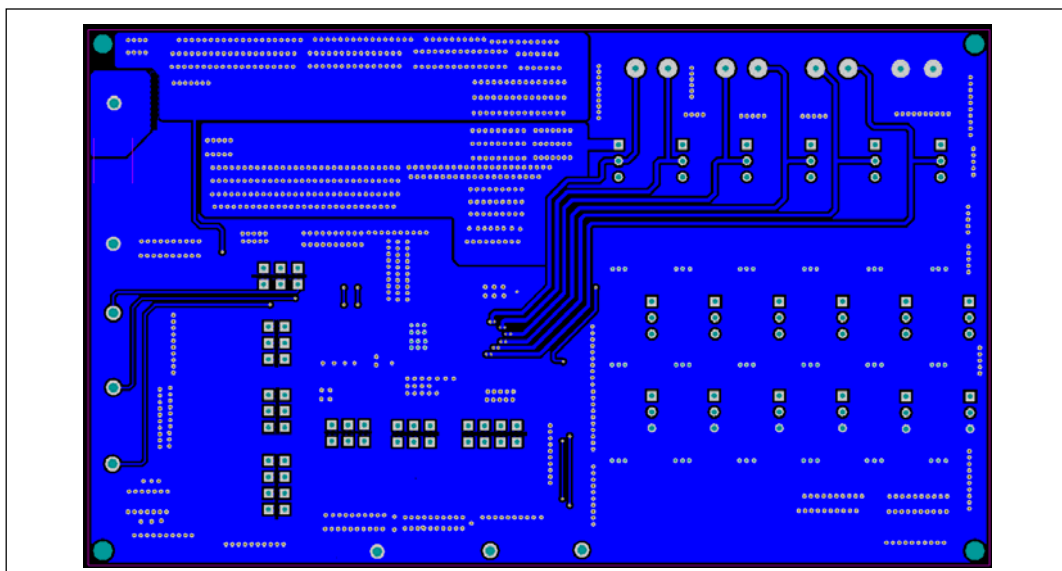
Figure 6: Board PCB Layout-Bottom Layer

A Division of ISSI

REVISION HISTORY

Revision	Detail Information	Data
A	Initial Release	2022.03.04