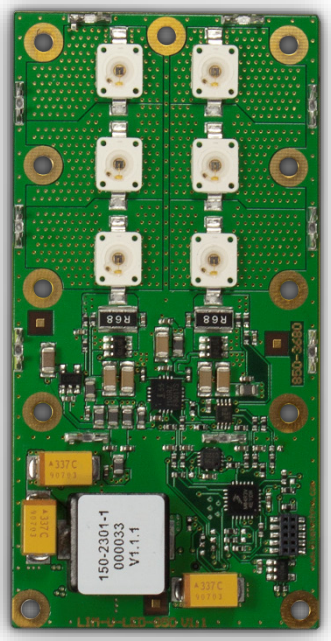
BLUETECHNIX
Embedding Ideas

LIM-U–LED-850 6



Hardware User Manual

Version 2.5

Contact

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Information

For further information on technology, delivery terms and conditions and prices please contact Bluetechnix (http://www.bluetechnix.com).

Warning

Due to technical requirements components may contain dangerous substances.

1 General Information

This guide applies to the LIM^{u} – LED-850 flash module from Bluetechnix GmbH. Follow this guide chapter by chapter to set up and understand your product.

The document applies to the X-Grade product.

1.1 Symbols Used

This guide makes use of a few symbols and conventions:

Warning

Indicates a situation which, if not avoided, could result in minor or moderate injury and/or property damage or damage to the device.

Caution

Indicates a situation which, if not avoided, may result in minor damage to the device, in malfunction of the device or in data loss.

Note

Notes provide information on special issues related to the device or provide information that will make operation of the device easier.

Procedures

A procedure always starts with a headline

1. The number indicates the step number of a certain procedure you are expected to follow. Steps are numbered sequentially.

This sign ➤ indicates an expected result of your action.

References

This symbol indicates a cross reference to a different chapter of this manual or to an external document.

1.2 Certification

X-Grade Version

X-Grade version of the products are not intended for sale and have therefore no certifications. The user is responsible for a correct usage in order with federal laws.

2 Introduction

2.1 Overview

The LIM^{u} – LED-850 is a high-power IR-flash with 6 IR-LEDs for the Bluetechnix Modular ToF KIT. The wide input voltage range, the possibility to assemble lenses for different fields of view and the option to assemble only the half of the LEDs makes the module ideal for a large variety of applications.

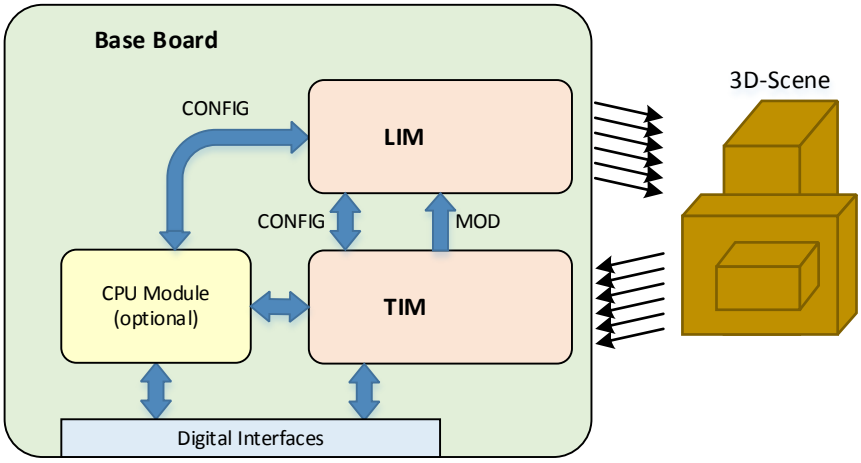

Figure 2-1: Bluetechnix ToF 3D Sensor System

2.2 Key Features

- Size: 80 x 40mm
- 3 or 6 High Power IR-Emitter
- Maximum peak optical output power: 10W (or 5W with 3 LEDs)
- Opening Angle: 120° (without lens)
- Plastic lenses for different opening angles available (30°, 60°, 110°)
- 12V-30V LED supply, 3V3 logic supply
- EMI-shield-clips

2.3 Applications

- 3D ToF Sensors
- IR Flash applications

3 General Description

3.1 Functional Description

The following image shows the block diagram of the LIM^{u} – LED-850.

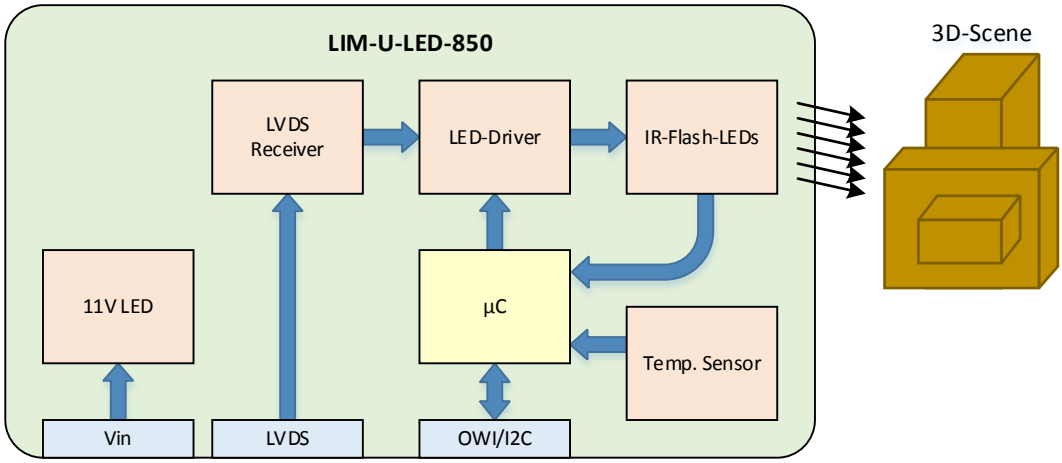

Figure 3-1 Hardware Architecture

3.2 Components

3.2.1 Power Supply

The input-voltage for the LEDs is variable from 12V to 30V. An additional 3V3 power supply for the onboard logic is required.

3.2.2 IR-Flash LED

Six LEDs are placed on the board, three LEDs in two strings. Two different types of LEDs can be assembled: SFH4235 or SFH4236.

The SFH4236 has a radiation angle of 40°. These LEDs are not used for standard products, but a custom assembling can be offered upon request.

The SFH4235 are default mounted option on the LIMs. They have a radiation angle of 120°, but exchangeable plastic lenses give the opportunity to adapt the module for the proper application.

Name	Angle	profile	Assembling	Order number (RS)
FL-42	20°	lambert	Clip-on	720-8927
FL-54	125°	butterfly	Twist-on	720-8958
FL-63S	30°	lambert	Twist-on	720-8936
FL-66S	60°	lambert	Twist-on	720-8939
FL-68D	60°, 120°	oval	Twist-on	720-8949
FL-68S	120°, 60°	oval	Twist-on	720-8945
FL-69S	140°	spot	Twist-on	720-8942
FL-70	110°	spot	Twist-on	720-8933
FL-82	135°x80°x70°	batwing	Twist-on	720-8951
FL-90	15°	lambert	Clip-on	720-8923

Table 3.1: Available Lenses for the SFH4235

3.2.3 Continuous current and over temperature protection

To prevent overheating, and the LEDs from constant lighting in case of a false input signal, there are two independent protection mechanisms:

- Temperature monitoring
- LED-current monitoring

Both protections are realized with a customized MKL04Z8VFK4 microcontroller from Freescale. Refer to the **ToF Safety Chip** manual for further information.

3.2.3.1 Continuous current protection

The LED current monitoring is realized by measuring the LP-filtered switching-signal of the LEDs. Each String will be individually monitored.

3.2.3.2 Over temperature protection

The temperature sensor ADT7408CCPZ from Analog Devices is used to monitor the PCB Temperature. The sensor is connected via I²C to the ToF Safety Chip.

The temperature levels for enabling the optional fan and for turning of the LED supply can be configured on the fly.

3.3 Interfaces

The 20 pole connector on the bottom side of the PCB is not only used to power the module, but has also several communication signals: a One-Wire-Interface, a Two-Wire-Interface (I²C) and the light modulation signals (MOD+ and MOD-).

3.3.1 Modulation interface

The modulation interface is a differential LVDS signal. The signal is used to turn on/off the LEDs.

Note:

Keep the connection between the TIM and LIM as short as possible.
If multiple LIMs are connected to one TIM then the modulation signals to each LIM must be length matched.
The MOD signals must be routed with a differential impedance of 100 Ohm.

3.3.2 One Wire Interface (OWI)

The One-Wire-Interface can be used to monitor the current PCB temperature and for the LIM module configuration. Refer to the ToF Safety Chip datasheet for information about the protocol.

3.3.3 I²C

The I²C compatible Two-Wire-Interface is also routed to the ToF Safety Chip and can be used as alternative to the OWI.

3.3.4 PWM

The PWM signal is a standard 3.3V TTL Signal and can be used to drive a fan for active cooling. The signal knows three states: off, on and 8Hz switching with 50% duty-cycle.

Note:

The PWM signal cannot drive a fan directly. Make sure that the fan is driven by an external N-channel MOSFET.

4 Specifications

4.1 Electrical Specifications

4.1.1 Operating Conditions

Symbol	Parameter	Min	Typical	Max	Unit
V_{LED}	Input supply voltage	12		30	V
P_{LED}	Power consumption during ToF integration [1)]			35	W
V_{CC}	Logic supply voltage	3.0	3.3	3.6	V
I_{CC}	Logic supply input current	20	30	300[2)]	mA
V_{OH}	High level output voltage	2.8		3.3	V
V_{OL}	Low level output voltage	0		0.5	V
V_{IH}	High level input voltage	2.31			V
V_{IL}	Low level input voltage			1.15	V
I_O	Output current on IO pins	-100		100	mA
T_{OP}	Operating temperature on PCB	-20		70	°C
ϕ_{AMB}	Relative ambient humidity (non condensing)	10		90	%
FITP[3)]	Frame-rate integration time product			10	

Table 4.1: Electrical characteristics

Note 1) Average power for a ToF modulation signal with 50% duty cycle with 6 LEDs mounted.

Note 2) Depends on current consumption on the IO pins.

Note 3) The Frame-rate Integration time product indicates the power consumption based on integration time in milliseconds and frame-rate (FITP = 4 * t_i * fr). The maximum value is valid without cooling.

Warning

Do not operate this device with appropriate cooling! An operation without appropriate cooling may cause permanent damage to the device.

4.1.2 Absolute Maximum Ratings

Stressing the device above the rating listed in the absolute maximum ratings table may cause permanent damage to the device. These are stress ratings only. Operation of the device at these or any other conditions greater than those indicated in the operating sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Symbol	Parameter	Min	Max	Unit
V_{LED}	LED supply voltage	-0.3	30	V
V_{CC}	Logic supply voltage	-0.3	3.6	V
V_{IO}	Input or output voltage	-0.3	3.6	V
T_{AMB}	Ambient temperature	-20	70	°C
T_{STO}	Storage temperature	-55	125	°C
ϕ_{AMB}	Relative ambient humidity	0	90	%

Table 4.2: Absolute maximum ratings

4.1.3 Input current

The input current depends on the selected frame-rate (fps) and the integration time (t_{INT}). The following figure shows typical values. The values for the x axis shows the FITP which has been calculated with the following equation:

$$FITP = t_{INT}\ [ms] \cdot fps\ \left[\frac{1}{s}\right] \cdot 4$$

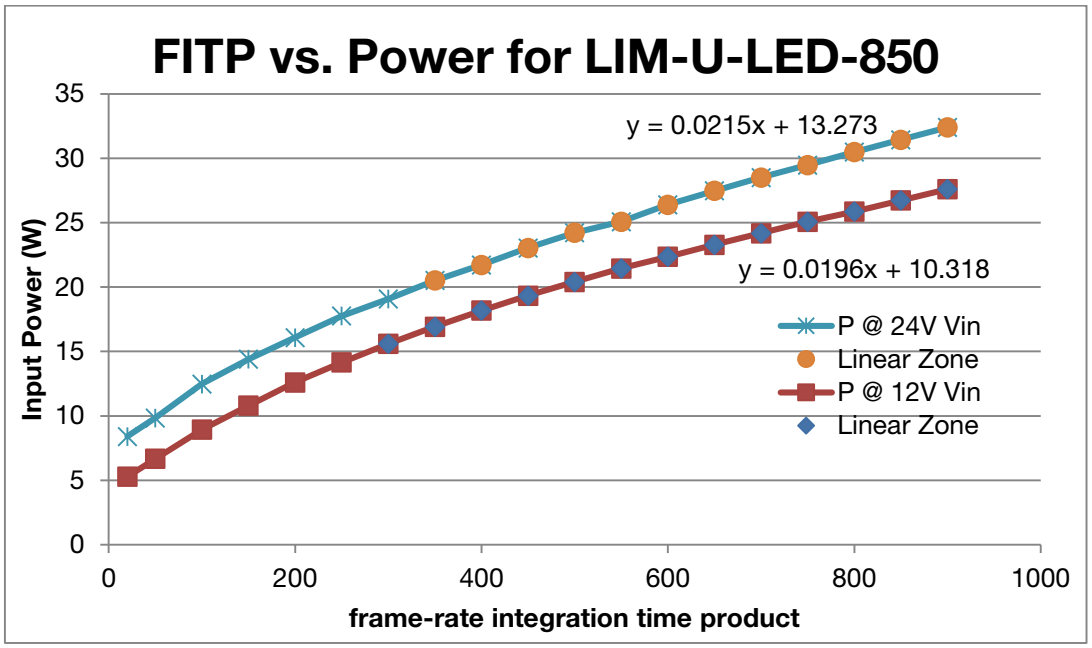

Figure 4-1: Input power depending on frame-rate integration time product

4.1.4 ESD Sensitivity

ESD (electrostatic discharge) sensitive device. Charged devices and circuit boards can discharge without detection. Although this product features patented or proprietary protection circuitry, damage may occur on devices subjected to high energy ESD. Therefore, proper ESD precautions should be taken to avoid performance degradation or loss of functionality.

5 Connector Description

5.1 LIM Connector

The following table shows the pin-out of the 20-pin LIM connector:

Pin #	Type	Signal name	Description
1	PWR	V_{IN}	Input Supply Voltage
2	PWR	GND	Power Ground
3	PWR	V_{IN}	Input Supply Voltage
4	PWR	GND	Power Ground
5	PWR	V_{IN}	Input Supply Voltage
6	PWR	GND	Power Ground
7	PWR	V_{IN}	Input Supply Voltage
8	PWR	GND	Power Ground
9	PWR	V_{IN}	Input Supply Voltage
10	PWR	GND	Power Ground
11	-	NC	Not Connected
12	O	PWM	Fan Driver Signal
13	IO	OWI	One-Wire-Interface
14	PWR	GND	Signal Ground
15	I	MOD-	Negative Differential Modulation Signal
16	PWR	3V3	3.3V Logic Supply Voltage
17	I	MOD+	Positive Differential Modulation Signal
18	IO	SDA	I²C Serial Data IO
19	-	NC	Not Connected
20	I	SCL	I²C Serial Clock Input

Table 5.1 Pin-out of the LIM connector

The mating Connector is a 20pin LSS connector from SAMTEC. To achieve different stacking heights following connectors can be used:

Part Number	Stacking Height
LSS-110-01-F-DV-A	9 mm
LSS-110-02-F-DV-A	12 mm
LSS-110-03-F-DV-A	10 mm

Table 5.2: Mating Connectors

As this are hermaphrodite connectors, please be aware that the pin numbering refers to the connector mounted on the LIM module (Figure 6-2). The connector on the baseboard must be rotated by 180°. See Figure 6-2 for the connector orientation.

6 Mechanical Outline

All Dimensions in the drawings below are given in Millimeters.

6.1 Top View

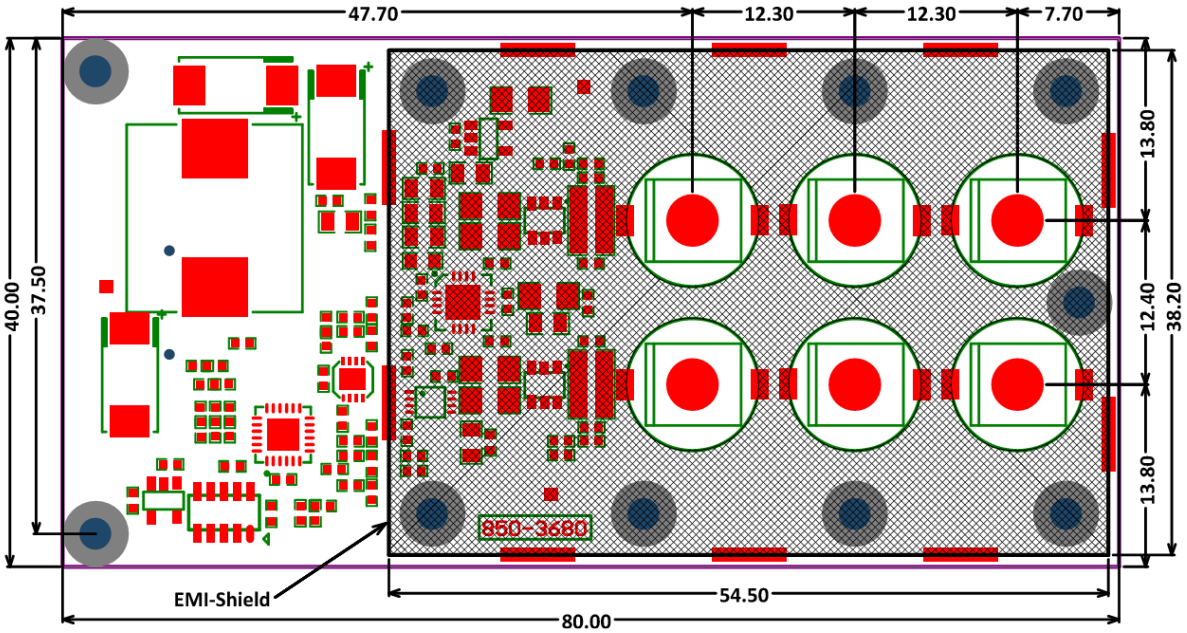

Figure 6-1: Top side Dimensions

6.2 Bottom View

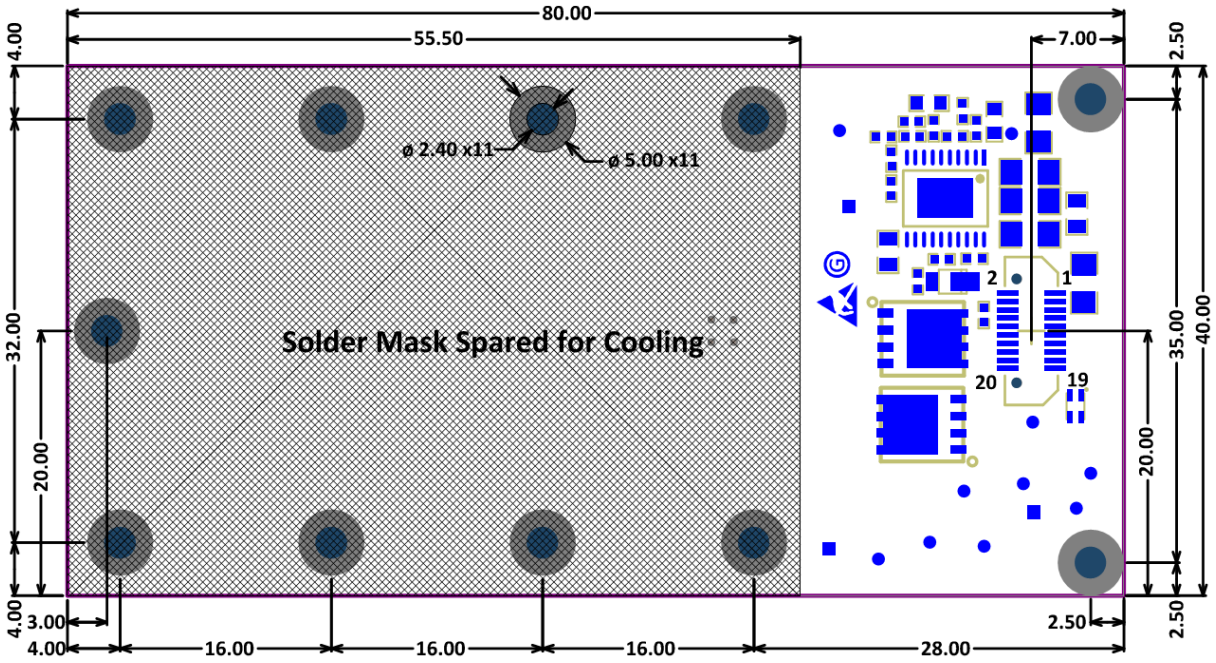

Figure 6-2: Bottom Side Components (bottom view)

6.3 Side View

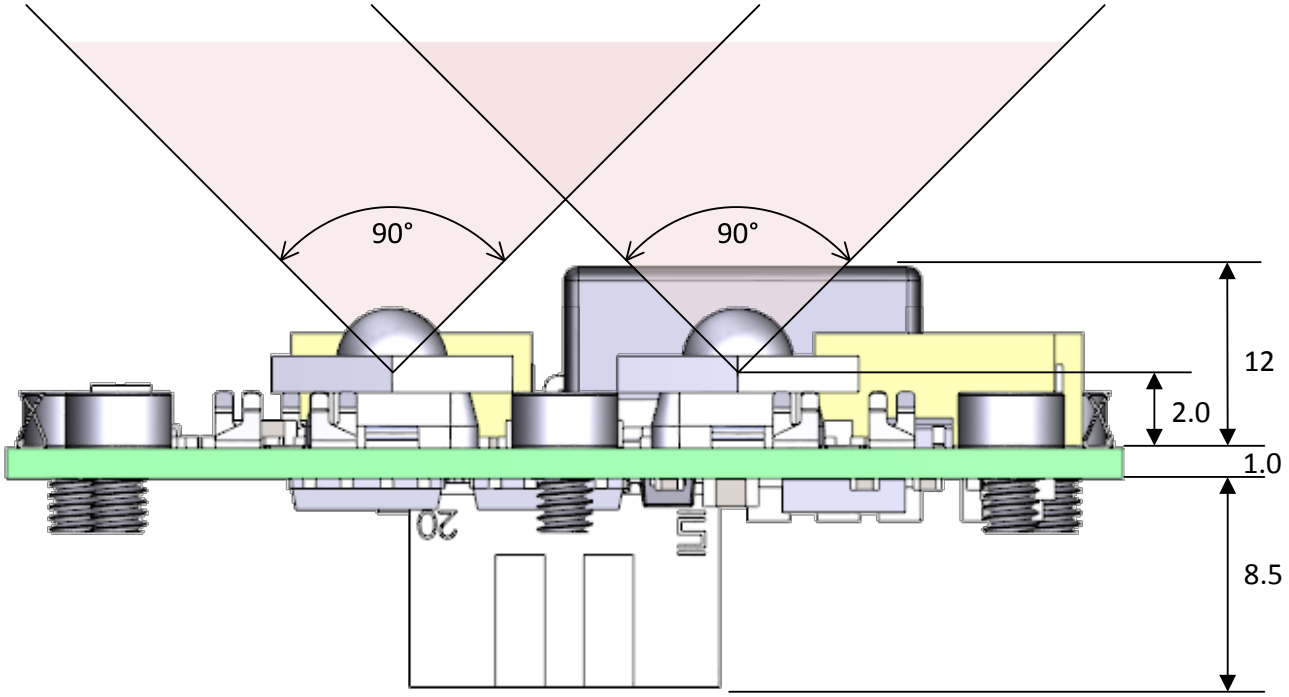

Figure 6-3: Side View with 90° Light cone

7 Assembly recommendations

For a good thermal performance, the LIMs should be mounted to an electrical conductive cooling plate (e.g. alum) by using 6 screws.

For better EMI performance an EMI-shield can be assembled afterwards with 3 screws. Together the EMI-shield and the cooling plate form a faraday-cage, which suppresses the high frequency radiation from the LEDs.

The following figures, taken from the ToF-Flash assembling guide, shows the mounting of the shielding.

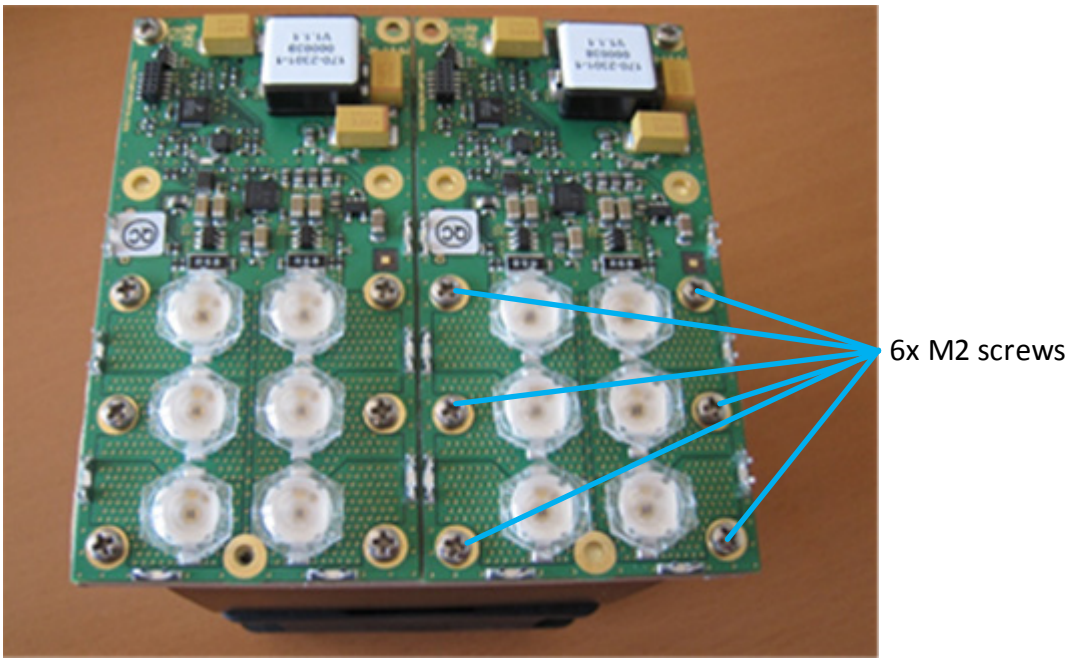

Figure 7-1: Cooling plate mounting

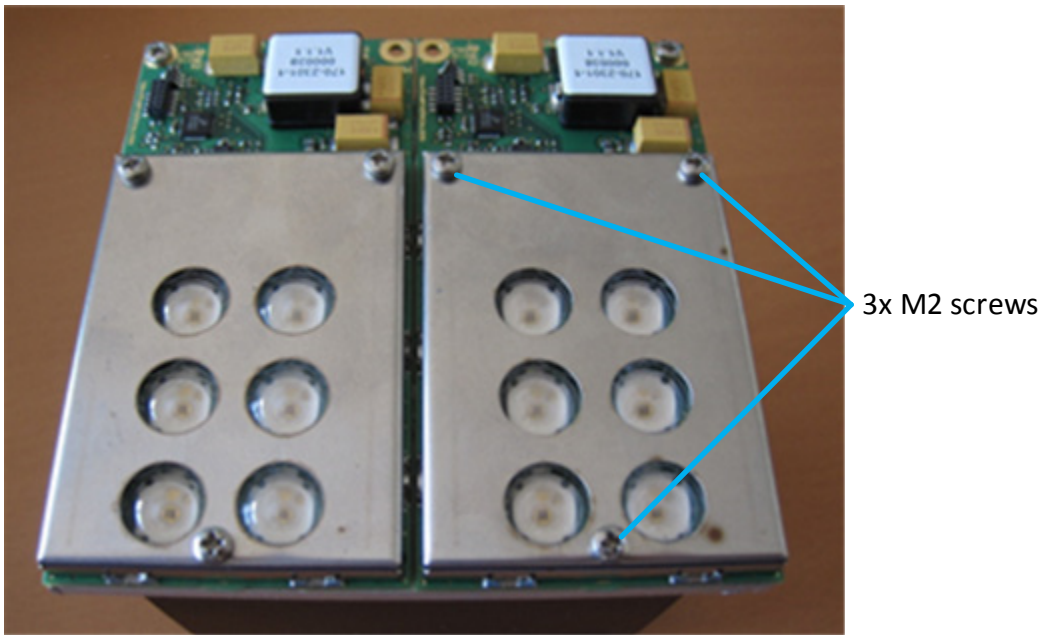

Figure 7-2: EMI-shield mounting

Bluetechnix provides two shields for different applications:

1. 4 mm shield height for LEDs with lenses (90°, 60° and 30° viewing angle)
2. 2 mm shield height for LEDs without lenses (120° viewing angle)

Figure 7-3: EMI-shield 4 mm

8 Cooling

8.1 Power Calculations

As the LED forward voltage and the mean current are known, the electrical LED power can be calculated easily:

$$P_{LED} = I_{MEAN} * U_f = 0.9A * 3.2V = 2.88W \quad [1]$$

The LEDs have an efficiency of at least 21%, i.e. 79% of the electrical power will be converted in thermal power:

$$P_{TH} = P_{LED} * 0.21 = 2.28W \quad [2]$$

$$P_{OPT} = P_{LED} * 0.79 = 0.6W \quad [3]$$

Only the most power consuming parts are taken in consideration. Compare to this parts, the rest can be neglected. This Parts are:

- 6 LEDs (2.28W each)
- 2 LED series resistors (0.9W each)
- 2 half bridge FETs (0.4W each)
- Buck Converter (including all Parts: 2.2W)

The worst-case relation between integration-time and read-out-time is 93% (achievable with an integration time of 26ms and a frame-rate of 9 fps).

Equation [4] shows the maximum dissipation power.

$$P_{DISS} = 6 * P_{TH} + 2* (P_{RSER} + P_{FET}) = 16.3W \quad [4]$$

8.2 Temperature Calculations

Knowing the power dissipation and the thermal resistance of the LED and the PCB vias, the estimated led junction temperature can be calculated.

Referring to the LED datasheet, a maximum operating temperature of 125°C is allowed. The thermal resistance from the LED-die to the PCB-pad is given as 9 K/W. The thermal resistance from the LED-pads to the bottom side of the pcb is approximately 1.5 K/W. Therefore a maximum PCB temperature can be calculated:

$$T_{PCB} = T_{LED} - P_{DISS} * (R_{TLED} + R_{TPCB}) \quad [5]$$
$$= 125\ °C - 2.9W * (9\ K/W + 1.5\ K/W) = 94.5\ °C$$

To have a good margin and to increase the LED lifetime, the ToF Security Chip turns the LED power supply off, when the measured PCB temperature exceeds 80°C. This value can be changed in the register settings of the safety chip.

The following drawing shows the used model for temperature calculations.

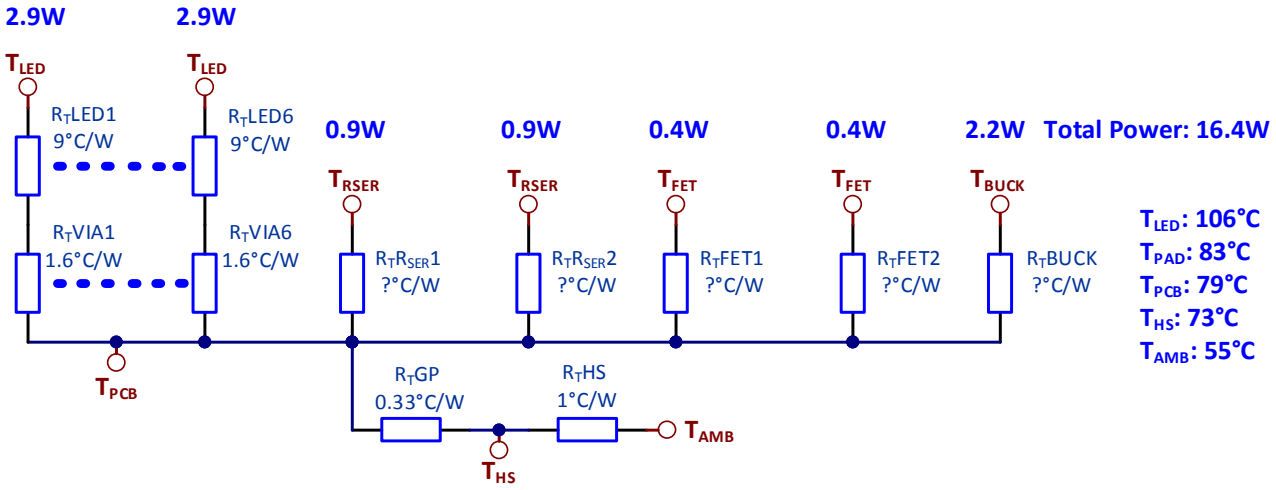

Figure 8-1: Thermal Power Calculation Model

For this calculation example a MW40-33 heat spreader from Malinco is mounted to the PCB with a GP2500S20 thermal gap pad from Bergquist.

The maximum LED temperature is 125°C, so in this configuration the LIM module could operate to fully load. If the maximum performance is not needed, smaller heat spreaders could be used, or higher ambient temperatures are possible.

Note:

The LED life time is connected to the junction temperature. A higher junction temperature may decrease the LED life time significantly.

9 Support

9.1 General Support

General support for products can be found at Bluetechnix' support site http://support.bluetechnix.at

10 Ordering Information

PON	Name	LED Amount	Light Cone Angle	Note
150-2301-2	LIM-U-LED-850 6 90	6	90°	
150-2302-2	LIM-U-LED-850 3 90	3	90°	MOQ 100 pcs.
150-2310-2	LIM-U-LED-850 6 30	6	30°	
150-2311-2	LIM-U-LED-850 6 60	6	60°	
150-2312-2	LIM-U-LED-850 6 120	6	120°	
150-2320-2	LIM-U-LED-850 3 30	3	30°	MOQ 100 pcs.
150-2321-2	LIM-U-LED-850 3 60	3	60°	MOQ 100 pcs.
150-2322-2	LIM-U-LED-850-3-120	3	120°	MOQ 100 pcs.

Table 10.1: Order Information

11 Product History

11.1 Version Information

11.1.1 LIM-U-LED-850

Version	Description
1.0.0	First release.
2.0.0	Enhanced support for I²C and One Wire Interface

Table 11.1: Overview LIM-U-LED-850 product changes

11.2 Anomalies

Version	Date	Description
V1.0	2014 03 06	No anomalies reported yet.
V2.0	2014 08 27	No anomalies reported yet.

Table 11.2 – Product anomalies

12 Document Revision History

Version	Date	Document Revision
1	2014 03 06	First release V1.0 of the Document
2	2014 07 25	Added FITP vs. Power diagram
3	2014 08 27	Changes for hardware revision V2.0 Description for available shielding
4	2014 09 19	Changes to operating conditions
5	2014 10 03	Updated PONs

Table 12.1: Revision history

13 List of Abbreviations

Abbreviation	Description
ADI	Analog Devices Inc.
AI	Analog Input
AMS	Asynchronous Memory Select
AO	Analog Output
CM	Core Module
DC	Direct Current
DSP	Digital Signal Processor
eCM	Enhanced Core Module
EBI	External Bus Interface
ESD	Electrostatic Discharge
GPIO	General Purpose Input Output
I	Input
I²C	Inter-Integrated Circuit
I/O	Input/Output
ISM	Image Sensor Module
LDO	Low Drop-Out regulator
MTBF	Mean Time Between Failure
NC	Not Connected
NFC	NAND Flash Controller
O	Output
OS	Operating System
PPI	Parallel Peripheral Interface
PWR	Power
RTOS	Real-Time Operating System
SADA	Stand Alone Debug Agent
SD	Secure Digital
SoC	System on Chip
SPI	Serial Peripheral Interface
SPM	Speech Processing Module
SPORT	Serial Port
TFT	Thin-Film Transistor
TISM	Tiny Image Sensor Module
TSC	Touch Screen Controller
UART	Universal Asynchronous Receiver Transmitter
USB	Universal Serial Bus
USBOTG	USB On The Go
ZIF	Zero Insertion Force

Table 13.1: List of abbreviations

A List of Figures and Tables

Figures

Tables