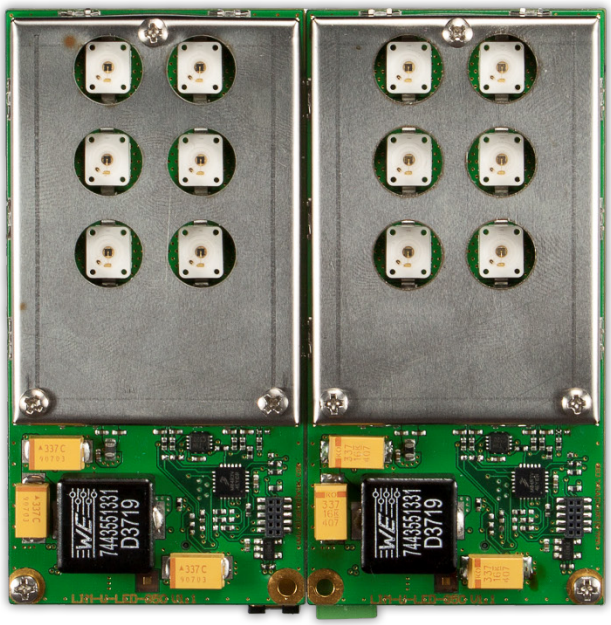
BLUETECHNIX
Embedding Ideas

ToF-Flash V2



Hardware User Manual

Version 2.1

Contact

Bluetechnix

Waidhausenstraße 3/19

A-1140 Vienna

AUSTRIA

office@bluetechnix.com

http://www.bluetechnix.com

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Warning

Due to technical requirements components may contain dangerous substances.

1 Introduction

1.1 Overview

The ToF-Flash is a high-power IR-flash module for ToF-sensors like the Argos-3D-P100, or the Sentis-ToF-M100. The ToF-Flash is powered over a standard 2 pole terminal connector and receives a synchronization signal via a 4 pole Interface connector.

1.2 Key Features

- Light enhancement for all Bluetechnix ToF camera Products.
- Optical Output Power: 10W
- Opening Angle: 100°
- Plastic lenses for different opening angles available

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2 System Architecture

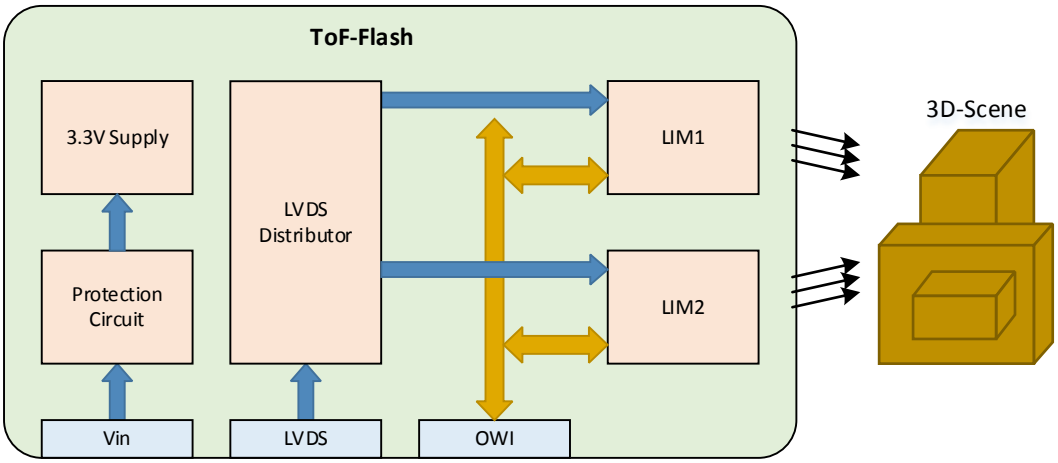

Figure 2-1: Hardware Architecture

2.1 Components

2.1.1 Power Supply

The input-voltage is variable from 12V to 30V.

The circuit is protected against over- and under-voltage as well as overcurrent by a LT4356IDE. The protected input voltage is connected directly to the LIM LED supply voltage, which is specified for the same input voltage.

The 3.3V rail for the LIMs and the on-board LVDS clock distributor is generated by a low current buck regulator. The calculated current is quite low and its maximum can be assumed as 250mA. Nonetheless, a LDO would generate a maximum power loss of 4W on an input voltage of 30V.

The LT3470A Is a good solution, as it needs only small PCB area, and has a good performance over the whole input voltage range.

2.1.2 LVDS Clock Distributor

To maintain a good signal quality, the SY89832U LVDS clock distributor splits up the single input signal to two modulation signals for each LIM.

2.1.3 LIM

Two LIM-U-LED-850 modules can be connected to the ToF-Flasher V2.

2.2 Interfaces

2.2.1 Power Connector

A two pole terminal connector allows powering the Hardware. The used part is a 691322110002 from Würth Electronic. The mating screw-terminal connector is 691361100002.

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Pin	Name	Description
1	V_{IN}	Positive Power Supply
2	GND	Power Ground

Table 2-1: Power Connector Description

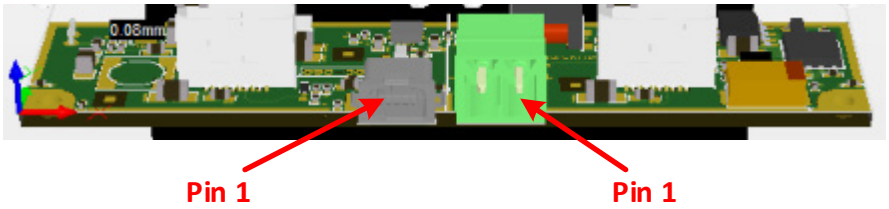

Figure 2-2: ToF-Flash Connectors

2.2.2 Mod Light Connector

The Argos-P100 LED Mod Light Interface delivers the LVDS modulation signal and has an additional one wire interface pin (OWI) which is connected to both oft the OWI interfaces of the LIM modules. This signal pin accepts 3.3V TTL voltage levels. The used connector is a MQ172X-4PA from Hirose; the mating part is MQ172X-4SA-CV, available at mouser or Digy-Key.

Pin	Name	Description
1	OWI	One wire interface
2	MOD_N	Inverting LVDS input of the modulation signal
3	MOD_P	Non-inverting LVDS input of the modulation signal
4	GND	Signal ground

Table 2-2: Modulation Connector Interface Description

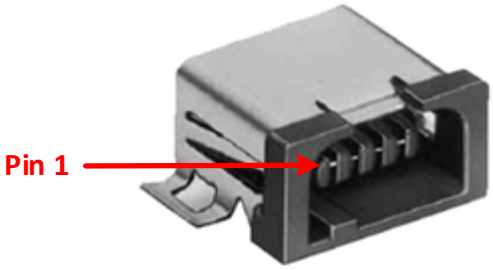

Figure 2-3: Mod Light Interface

2.3 Application Range

2.3.1 IR-LED

The twelve LEDs (six for each LIM) are sufficient for a view range of approximately 10m (strong dependent on the reflectivity of the target) with a viewing angle of 90°.

2.3.2 Temperature Range

Industrial temperature grade: -40°C to +55C°.

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The maximum ambient temperature is strongly dependent on the application. If only short integration times (lower range) and low frame-rates are needed, or a high sophisticated cooling system is applied, higher ambient temperatures are possible.

2.4 Electrical Specifications

2.4.1 Operating Conditions

Symbol	Parameter	Min	Typical	Max	Unit
V_{IN}	LED supply voltage	12	12/24	30	V
P_{LED}	Power consumption during ToF integration [1)]			61.5	W
V_{CC}	Logic supply voltage	3.0	3.3	3.6	V
I_{IN}	Supply current			4.17[2)]	A
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 pin	-100		100	mA
T_{OP}	Operating temperature on PCB	-40		85	°C
φ_{AMB}	Relative ambient humidity (non condensing)	10		90	%
FITP[3)]	Frame-rate integration time product			10	

Table 2.3: Electrical characteristics

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

Note 2) Limited by the on-board protection circuit.

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 without appropriate cooling! An operation without appropriate cooling may cause permanent damage to the device.

2.4.2 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_{IN}	LED supply voltage	-30	30	V
V_{IO}	Input or output voltage	-0.3	3.6	V
T_{AMB}	Ambient temperature	-40	85	°C
T_{STO}	Storage temperature	-55	125	°C
φ_{AMB}	Relative ambient humidity (non-condensing)	0	90	%

Table 2.4: Absolute maximum ratings

2.4.3 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:

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

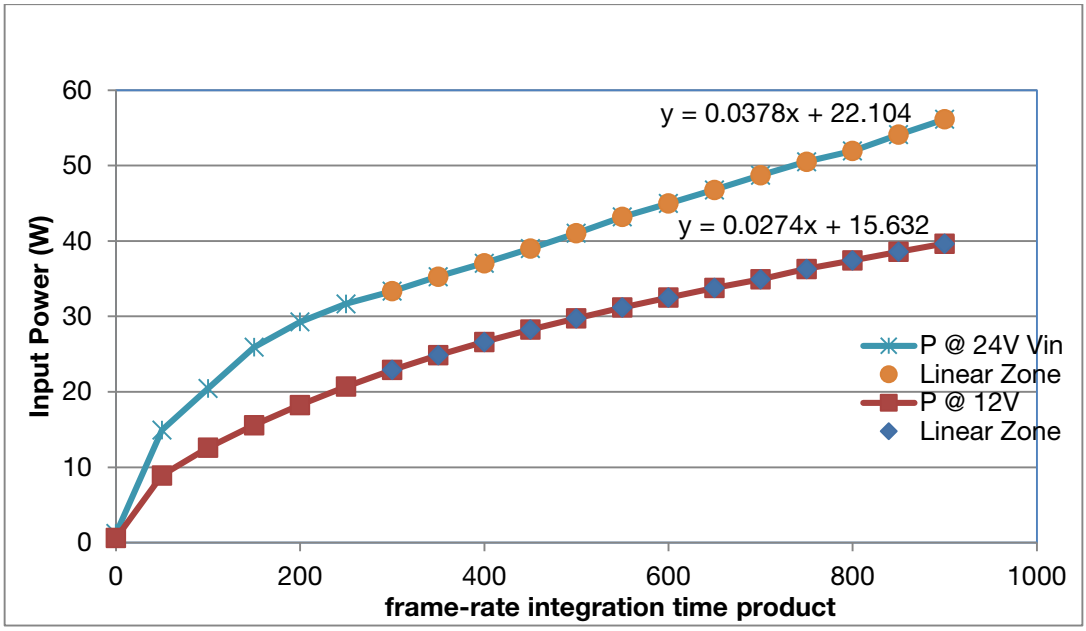

Figure 2-4: Input power depending on frame-rate integration time product

2.4.4 Electrical Power Considerations

The supply voltage range is 12V to 30V, the maximum input power can be assumed as 60W. The maximum input current is ca. 5A @ 12V input voltage.

The current protection as well as the over and under voltage protection is realized with LT4356.

Part	Current	Power
LVDS Splitter	75 mA	248 mW
LIM @ 3.3V	2x 50 mA	330 mW
	Sum: 175 mA	**578 mW**

Table 2-5: 3.3V Domain Power Estimation

Part	Curent	Power
LIM 1	3 x 1.2A	30 W
LIM 2	3 x 1.2A	30 W
FAN	0.1A	1 W
	Sum:	**61 W peak power**

Table 2-6: 11V Domain Power Estimation

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A peak power consumption of approximately 61.5 W is expected.

2.5 Mechanical Requirements

2.5.1 Outline

80 x 80 mm.

The total height mainly depends on the cooling. It can be also up to 80mm.

2.5.2 LED Placement

If the ToF-Flash Module will be embedded into an enclosure, care must be taken to not shadow the light cone of the LEDs. The following drawing shows the calculation model.

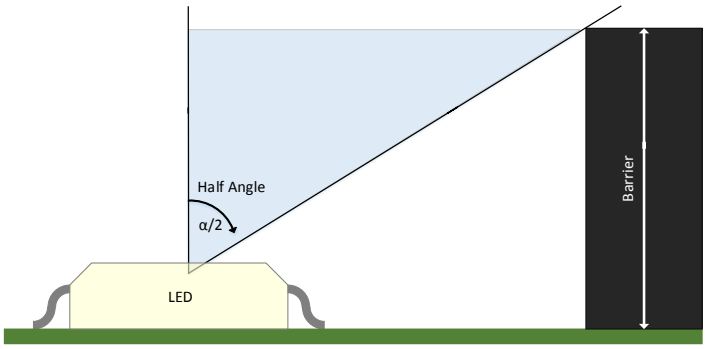

Figure 2-5: LED distance to barrier calculation model

The light cone origin is located 2mm above the PCB surface.

For the exact LED position can be taken from the LIM specification. The two LIMs are located right next to each other.

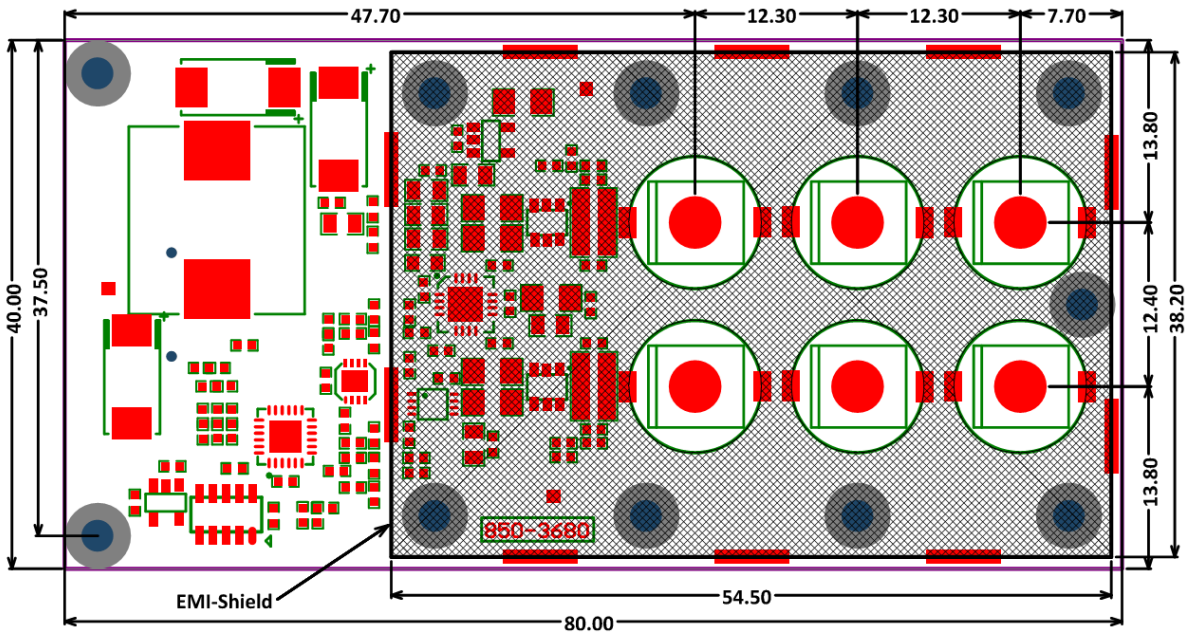

Figure 2-6: LED placement on the LIM module

2.5.3 Cooling

Calculation considerations:

- The LEDs have an efficiency of at least 21%, i.e. the thermal power can be calculated as follows:
  $P_{LED} = I_{RMS} * V_f * 0.79 = 1.2A * 3.2V * 0.79 = 3W$
- Only the most power consuming parts are taken in consideration. Compare to this parts, the rest can be neglected. This Parts are:
  - 12 LEDs (3W each)
  - 4 LED series resistors (0.98W each)
  - 4 half bridge FETs (0.4W each)
  - 2 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 20ms).

The following drawing shows the used model for temperature calculations.

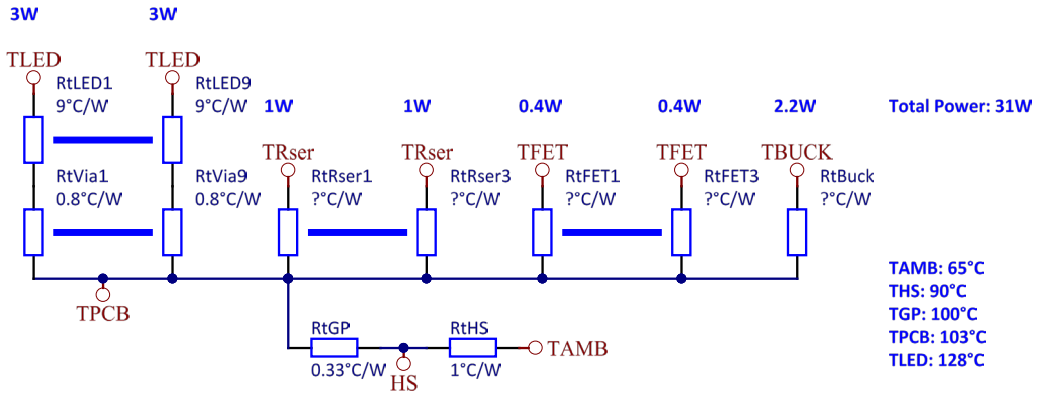

Figure 2-7: Thermal Power Calculation Model

Following heat spreaders fit to the design:

Name	R_T [K/W @ lfm]	L x b x h	Hersteller	Bestellnummer (Disti)	Preis
517-95AB	2 @ 300	61 x 58 x 24	WAKEFIELD SOLUTIONS	1838853 (Farnell)	4.8
241214B91200G	1 @ 200	61 x 58 x 36	AAVID THERMALLOY	1436803 (Farnell)	9.2
241204B92200G	3 @ 300	61 x 58 x 36	AAVID THERMALLOY	1703176 (Farnell)	5.2

Table 2-7: Applicable Heat Spreader

Following Cooling Fans could be used: MB60251V2-0000-A99 (25mm), MB60201V2-0000-A99 (20mm).
This fan complies following certifications and safety guidance:

Figure 2-8: fan certification and safety

2.5.4 Gap Pad

Berquist Gap Pad 2500S20.

2.5.5 Mounting

The ToF-Flash module is itself a modular system. The fixed parts are the ToF-.Flash adapter, and the two LIM-U-LED-850 modules. Other parts (mainly for cooling) may alter for different application.

2.5.6 ToF-Flash Adapter

This chapter describes the ToF-Flash adapter dimensions, for the LIM dimensions refer to the LIM-U-LED-850 Hardware User Manual.

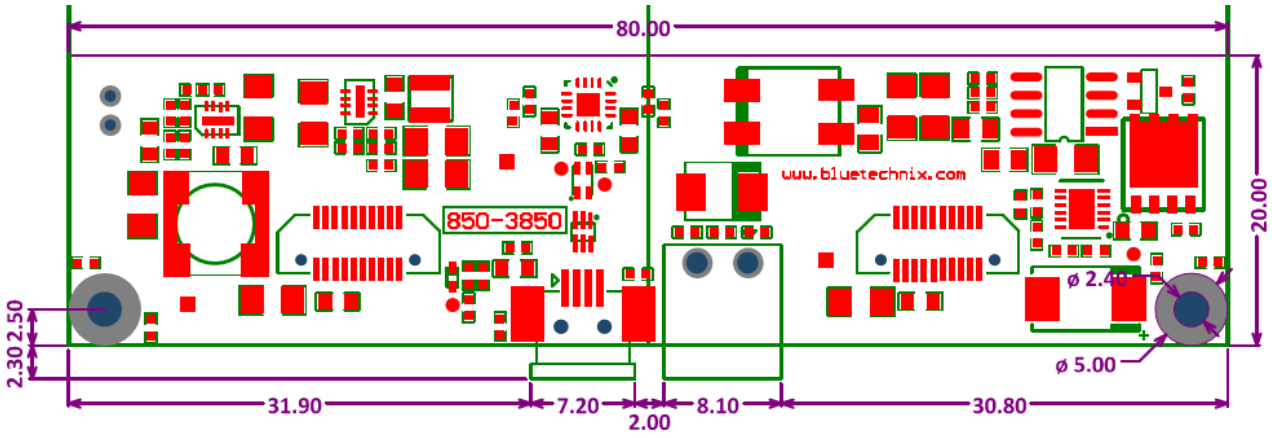

Figure 2-9: Adapter PCB Top Dimensions

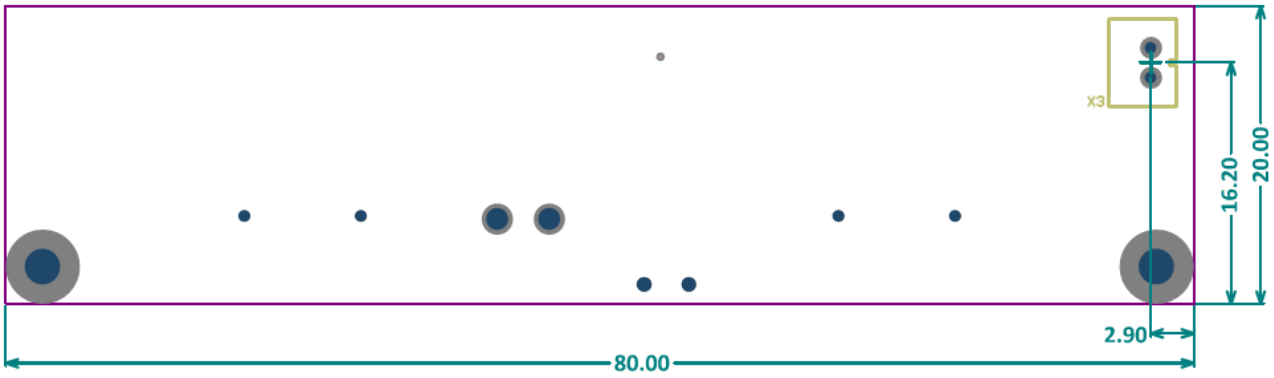

Figure 2-10: Adapter PCB Bottom Side Dimensions

2.5.7 Cooling Plate

For a stand-alone variant of the ToF-Flasher, a cooling plate is needed for assembling the two LIMs to the heat spreader.

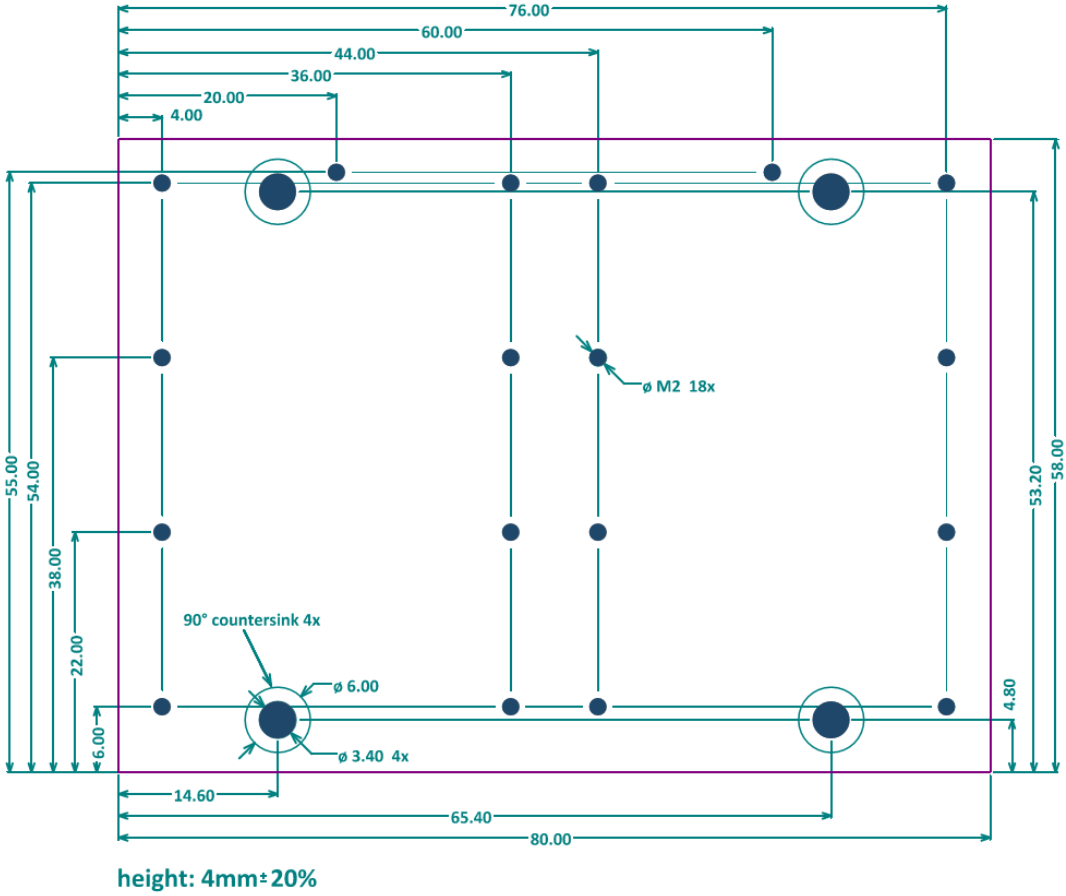

Figure 2-11: Cooling Plate Dimensions

2.6 Environmental requirements

2.6.1 Temperature

-20°C to +55°C.

2.6.2 Humidity

10% to 90% non-condensing.

2.6.3 G-force, vibration

The ToF-Flasher module is designed for stationary operation. For rough environments, additional measurements must be ordered.

2.7 EMC and safety requirements

The product should fulfill all requirements for CE conformity declaration as specified in 2004/108/EG.

EMV: EN55022, Class A; EN55024

Eye Safety: EN 62471

3 Document Revision History

Version	Date	Author	Description
1	2014 07 23	DST	Adaptions for Hardware Revision V2.0
2	2014 07 25	MHO	Added FITP vs. Power diagram

Table 3-1: Revision history

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4 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 4-1: List of abbreviations

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