USER MANUAL

ICLEDFEATHERWING

150015

VERSION 1.0

JUNE 10, 2024

WÜRTH ELEKTRONIK MORE THAN YOU EXPECT

****

MUST READ

Check for firmware updates

Before using the product make sure you use the most recent firmware version, data sheet and user manual. This is especially important for ICLED products that were not purchased directly from Würth Elektronik eiSos. A firmware update on these respective products may be required.

We strongly recommend to include in the customer system design, the possibility for a firmware update of the product.

CAUTIONS AND WARNING

This product is highly sensitive to electrostatic discharge (ESD). As such, always use proper ESD precaution when handling. Failing to fallow the aforementioned recommendations can result in severe damage to the part.

The IC LED FeatherWing can get hot during operation. Please avoid touching the surfaces of the board while it is in use, and wait approximately one minute after turning off the power supply before handling it

Warning against optical radiation:View the FeatherWing from a safe distance and use adequate protection as needed.

Revision history

Manual version	HW version	Notes	Date
1.0	3.0	Initial version	June 2024

Abbreviations

Abbreviation	Name	Description
CISPR	Comité International Spécial des Perturbations Radioélectriques	International Special Committee on Radio
EV	Evaluation	
ESD	Electro Static Discharge	
EMC	Electro Magnetic Compatibility	
GND	Ground	
HIGH	High signal level	
IC	Integrated Circuit	
IDE	Integrated development environment	
IEC	International Electrotechnical Commission	
IEEE	Institute for electrical and electronic engineers	
JTAG	Joint Test Action Group	
LED	Light Emitting Diode	
Li-Po	Lithium-Polymer	
LOW	Low signal level	
PC	Personal Computer	
PCB	Printed Circuit Board	
PWM	Pulse Width Modulation	
USB	Universal Serial Bus	
VDD	Positive supply voltage	
VSS	Negative supply voltage	

Contents

1 General description

1.1 Introduction

The Würth Elektronik eiSos ICLEDFeatherWing is a development board fully compatible to the popular Adafruit Feather line of development boards. It extends the Feathers with a small 7x15 Würth Elektronik eiSos IC-LED Display, which is controlled by just 1 GPIO pin of feather micro-controller. The published libraries and example-code make it easy to build up a prototype and kick-start the application development.

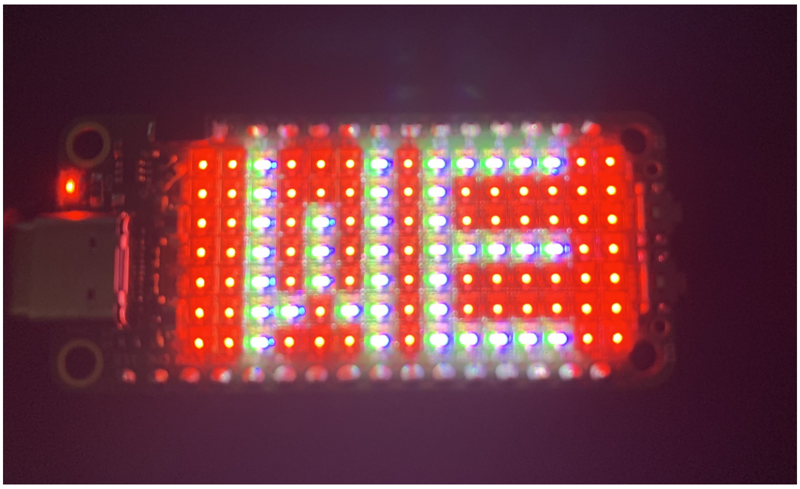

Figure 1: IC-LED Featherwing

1.2 Contents

Description	Quantity
WE ICLEDFeatherWing	1
ESD Foam	1
Packaging: ESD safe bag	1

Table 1: Contents article numbers

Remove the ESD foam before using the FeatherWing to prevent any potential short circuits. Additionally, use the board on a non-conductive surface under laboratory conditions to ensure proper functionality.

2 Functional description

The ICLEDFeatherWing was designed with rapid prototyping in mind. Being fully compatible with the Adafruit ecosystem, this FeatherWing allows the user the flexibility to choose the preferred host microcontroller. The inherent modularity of the ecosystem allows the FeatherWing to be easily integrated into any project.
The next sections provide a brief introduction to Adafruit's Feather ecosystem and details on the Würth Elektronik eiSos ICLEDs.

2.1 Adafruit Feather

The Adafruit Feather ecosystem consists of two types of boards apart from a host of accessories:

- **Feather:** Adafruit Feathers are a complete line of development boards from Adafruit that are standalone and stackable. They can be powered either over the on-board micro-USB plugs or using a Li-Po battery. Feathers are portable, flexible and light as their namesake.
- **FeatherWing:** FeatherWings are stackable boards that when used along with a Feather add a certain functionality to the system.

The Feather system with more than 50+ Wings, several different types of accessories and arduino/circuit python based code support provides a perfect ecosystem for rapid prototyping. Please refer to adafruit.com/feather for more details on the Adafruit Feather ecosystem.

2.2 ICLEDFeatherwing (1312020030000)

Key features

The Würth Elektronik eiSos ICLEDFeatherWing contains 105 IC LEDs in a 7x15 display shape with a pitch of 2.38 mm. It can be controlled by any adafruit feather micro-controller board and is powered by USB-C (5 V @ 3 A) or LiPoly battery. The display is controlled by only 1 pin while a second GPIO-pin is used to trigger an interrupt by pushing the "Prog"-button on featherwing. Internal Level-shifter makes logic-levels lower than 3.3 V possible and with that usage of other micro-controllers than adafruit feathers. Table 2 shows the key characteristics and figure 2 the wavelength spectrum of this featherwing.

Properties	Value	Unit
Supply voltage	3.3 - 5	V
Logic level high In (min)	1.65 - 3.6	V
Logic level high In (R5 switched)	2.7 - V_{dd}	V
Logic level high Out	0.9 * V_{dd}	V
Power intake (USB-C) max	15	W
Power Consumption max	8	W
Power Consumption max (limitation)	2.5	W
Power Consumption typ.	1.5	W
Emitting power density max	16 000	cd/m^2
Emitting power density (limitation)	10 000	cd/m^2
Peak wavelength Red	630	nn
Peak wavelength Green	520	nn
Peak wavelength Blue	465	nn
Sleep current	90	mA
Frame rate max.	150	Hz

Table 2: Basic characteristics

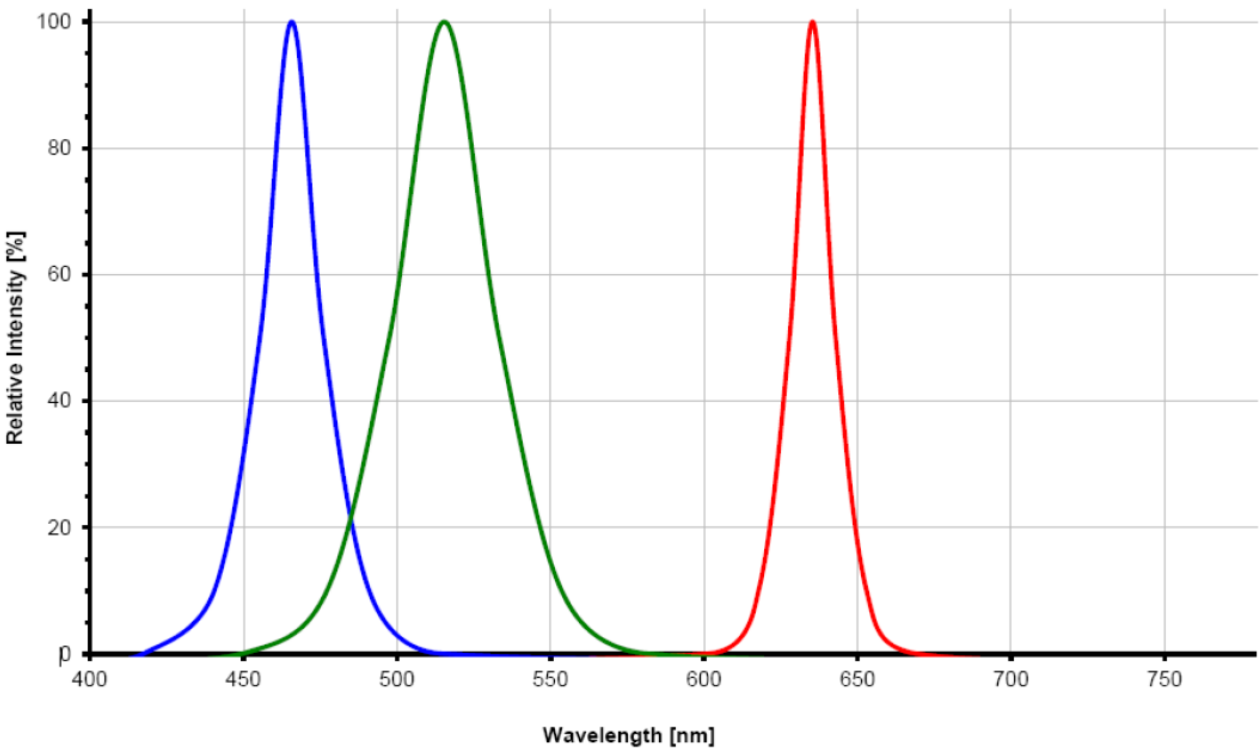

Figure 2: Wavelength spectrum

IC LEDs

The Würth Elektronik eiSos IC LEDs are compact RGB-LEDs with an 8-Bit PWM for each color. This allows 16.777.216 different color mixing values controlled by a single wire. Every ICLED has an integrated signal reshaping, which guarantees optimal signal-shape for all LEDs in row.

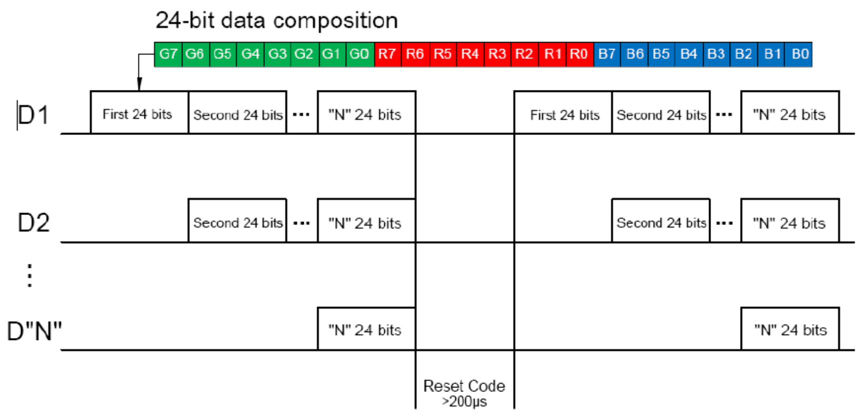

Figure 3: Data transmission method

IC LEDs are driven by a single data line. The data transmission method (as shown in figure 3) begins with the first ICLEDin the sequence, which reads the initial 24 bits from the data stream. This ICLEDthen regenerates and forwards the remaining bits to the subsequent ICLEDin the chain. A unique end-of-data signal, characterized by a low signal level lasting more than 200 μs on the data line, signifies the end of the data packet. Upon detecting this signal, the first ICLEDprepares to interpret the next sequence of 24 bits as the starting point for a new transmission cycle.

The data transmission protocol is designed with a specific order: it reads the most significant bit (MSB) first. This begins with the 8-bit pulse-width modulation (PWM) code for the green LED component. This is followed in sequence by the PWM codes for the red and blue LED components, respectively. This method ensures a structured and efficient way to control the color and brightness of each ICLEDindividually.

3 Hardware description

This sections contains a detailed description of the hardware features of the ICLEDFeatherWing.

3.1 Connectors

This section explains all connectors of the ICLEDFeatherWing.

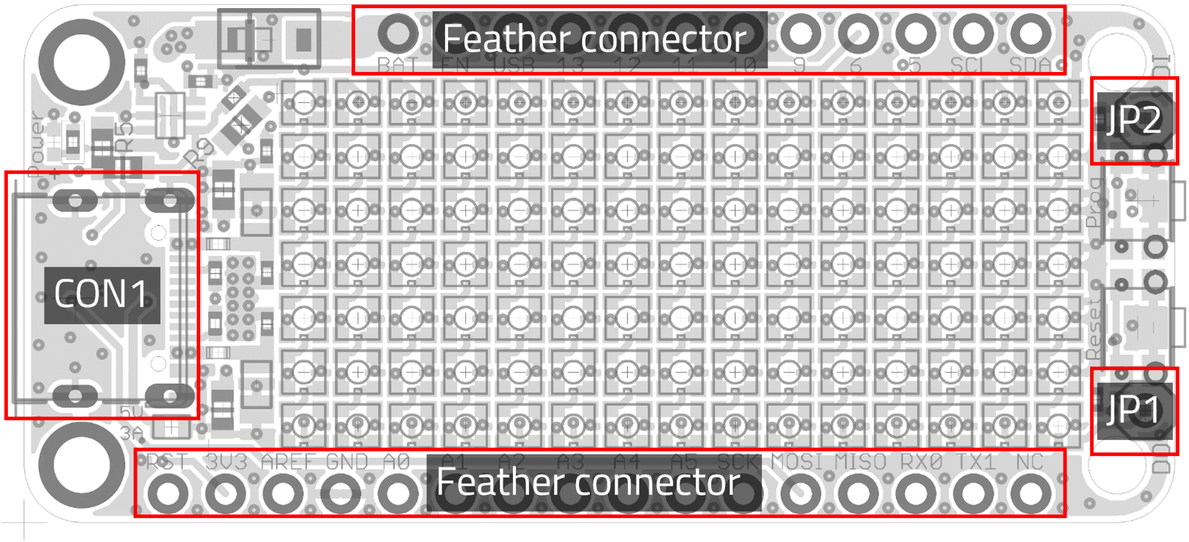

Figure 4: ICLEDFeatherWing connnectors (top view)

Pin header	Function	WE- article number
Feather connector	Connection to Feather M0 or other FeatherWings	*61301211121 | 61301611121*
CON1	USB-C connector for VDD bus supply	*629722000214*

Table 3: Default assembled connectors and pin headers

3.1.1 Feather connector

This is the standard set of connectors that is used across the Feather ecosystem. The table below describes the functions of each of the 28 pins as applicable to this FeatherWing.

Pin Number	Pin name	Function
1	$\overline{RST}$	$\overline{Reset}$
2	3V3	3.3V reference level
3	AREF	Not connected
4	GND	Ground
5	A0	Not connected
6	A1	Not connected
7	A2	Not connected
8	A3	Not connected
9	A4	Not connected
10	A5	Not connected
11	SCK	Not connected
12	MOSI	(Optional) DI via R10
13	MISO	Not connected
14	U0RX	Not connected
15	U0TX	Not connected
16	NC	Not connected
17	SDA	Not connected
18	SCL	Not connected
19	5	S2
20	6	DI via R9
21	9	Not connected
22	U1TX	Not connected
23	U1RX	Not connected
24	12	(Optional) DI via R4
25	13	Not connected
26	5V	(Optional) USB power via R8
27	EN	Not connected
28	VBAT	Battery Power via D2

Table 4: Feather connector part 2

3.1.2 CON1

Connector CON1 is a USB-C connector designed for connecting to a power source (e.g. PC) using a standard USB-C cable. It is strongly advised against using a USB-Type-A to USB-Type-C adapter. The 5.1 kΩ resistors placed on the CC-lines will handle out up to 3 A from power source. However, the actual maximum current delivered will depend on what the power source can safely provide.

CON1	Function
-	USB-C connector for VDD bus supply

Table 5: USB-C connector

3.1.3 JP1

Connector JP1 is an optional standard 2.54 mm pinheader, which is not mounted by default. It can be used to combine multiple ICLEDFeatherWings or with other ICLEDscreens. JP1 is directly connected to the DOUT Pin of ICLED105.

JP1	Function
1	Data Out of last IC LED

Table 6: Data Out connector

3.1.4 JP2

Connector JP2 is an optional standard 2.54 mm pinheader, which is not mounted by default. It can be used to combine multiple ICLEDFeatherWings or with other ICLEDscreens. JP2 is connected to DIN Pin of ICLED1 via U1 and R5 or optional directly to DIN of ICLED1 via R3.

JP2	Function
1	Data In of Level-Shifter (U1)

Table 7: Data In connector

By switching boards in series it is important to remove R5 and replace the 0 Ω resistor for R3, on every board except the first one. First board will output data on 5 V logic level. If input signal level is higher than 3.6 V, there is a risk of damaging the level-shifter.

3.1.5 DIN Pin

The Data In (DIN) Pin is Pin 20 (GPIO 6) by default. It can be changed by removing R9 from board. If a 0 Ω resistor is placed for R4, pin 24 (GPIO 12) is the new DIN pin. By soldering a 0 Ω resistor for R10 it is also possible to use pin 12 (MOSI) for data input. Instead of soldering a 0 Ω resistor, it is also an option to short-circuit pads with solder. If needed, JP2 can be used as data input pin.
DIN is connected to level-shifter (U1) via R5 by default. If R5 is removed and a 0Ω resistor is placed for R3, DIN is directly connected to DIN pin of LED1. This is highly recommended, if input logic level is higher than 3.6 V, to avoid damaging U1. Please remind, that the maximum input voltage level is 5.5 V for ICLEDFeatherWing.
Input reference level for U1 is 3V3. By supplying 3V3 pin with input logic voltage, any logic level between 1.65 V and 3.6 V can be shifted to 5 V.

3.2 Push buttons

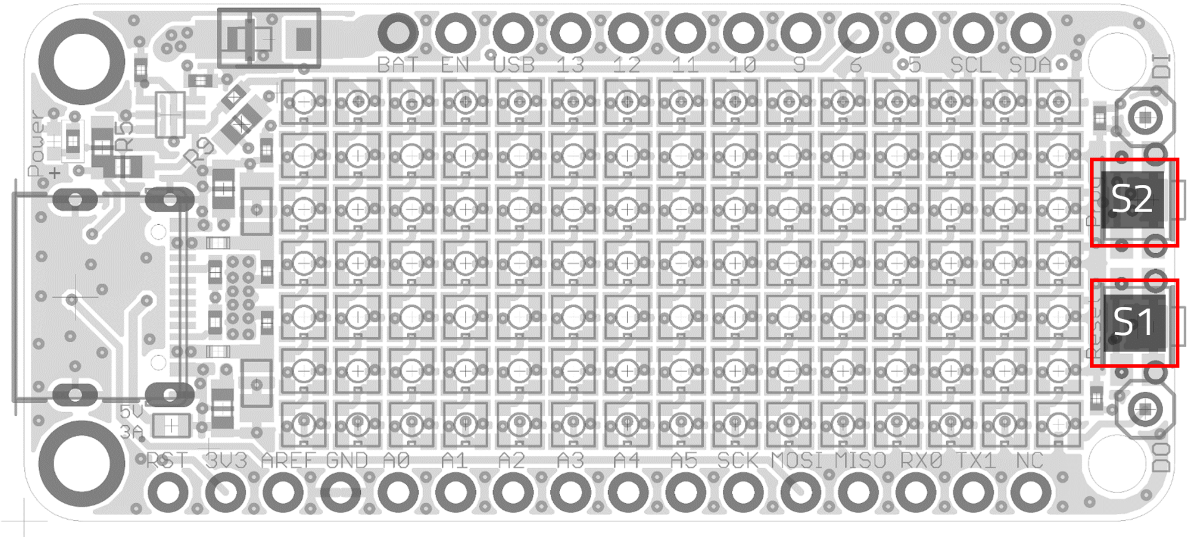

Figure 5: ICLEDFeatherWing push buttons (top view)

3.2.1 S1

This push button is connected to the /RESET pin of the Feather connector. Pressing this button resets m0.

3.2.2 S2

This push button is connected to Pin 5 of the Feather connector. Pressing this button pulls pin 5 to signal low. It is recommended to set this pin as an input with internal pull-up by software. It is recommended to use this pin for interrupt functions for example to change displayed data.

3.3 Power supply

The ICLEDFeatherWing is powered with 5 V by USB-C or with 3.7 V by battery connected to Feather M0. It is highly not recommended to use an USB-Type-A to USB-Type-C adapter. The 5.1 kΩ resistors placed on the CC-lines will handle out up to 3 A from power source. However, the actual maximum current delivered will depend on what the power source can safely provide. It can also be powered by the Feather M0 Board with USB-Type-B via charging IC of the Feather M0. In this case, board is powered with 4.2 V and current is limited to max. 100 mA. If battery is connected, it can buffer higher currents fo a while.
By soldering a 0 Ω resistor on R8 it is possible to connect VDD nodes of ICLEDFeatherWing and Feather M0 board. In this case ICLEDFeatherWing can be powered from the M0 USB-connection, or the M0 can be powered from USB-C-Connector connection of ICLEDFeather-Wing. Please remind limited maximum current consumption of USB-Type-B. For this reason it is recommended to power Feather-stack from USB-C of ICLEDFeatherWing.

If the FeatherWing is power sourced, the power LED (D1) lights up.
The 3V3 pin is only the reference-level for U1. It should be supplied with logic level high (between 1.65 V and 3.6 V) if used. It will be supplied by M0/M4 3.3 V power-rail if connected. For more information see chapter 3.1.5.

If R8 is soldered, it is highly not recommended to connect USB-C plug of ICLEDFeatherWing and USB-B plug of Feather M0 to PC at same time. The USB-standard specifies a voltage between 4.45 V and 5.25 V. This can result in an short-circuit of 0.8 V between USB-connectors, as there is no Schottky-diode between them.

3.4 Fuses and temperature safety

To prevent board from overheating, there is a PWM limit of 210 included in the WE-ICLED library uploaded on Github. All 3 color coordinates of a LED are summed up and if they are above 210, they will be reduced step by step. The R:G:B color mixing ratio will be kept the same but the intensity will be reduced. When writing own code, please keep in mind that the board will heat up, if all ICLEDs are operated at full power. For this reason F1 & F2 will shut down VDD, if board gets too hot. The cutoff temperature depends on the current floating trough them. For more details see datasheets of F1 and F2 (part number can be found in BOM on section 3.7)

It is possible, but not recommended to short-circuit F1 and F2. In this case all LEDs can be used on full power without restrictions, but board will heat up uncontrolled. Please keep this in mind and be careful, when doing this. On full power, the ICLEDFeatherWing can reach more than 150° C.

3.5 Schematics

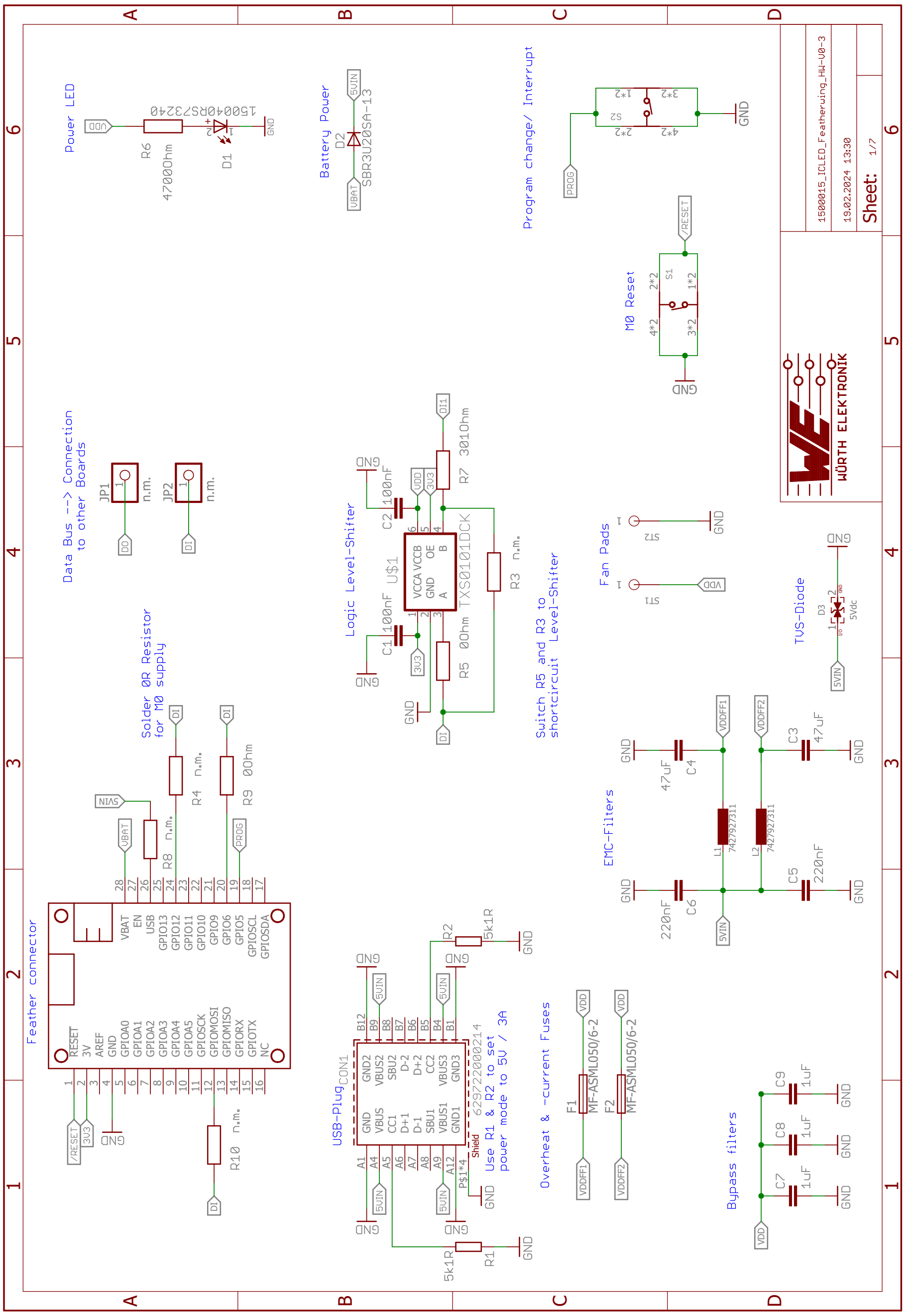

Figure 6: Schematics Sheet 1

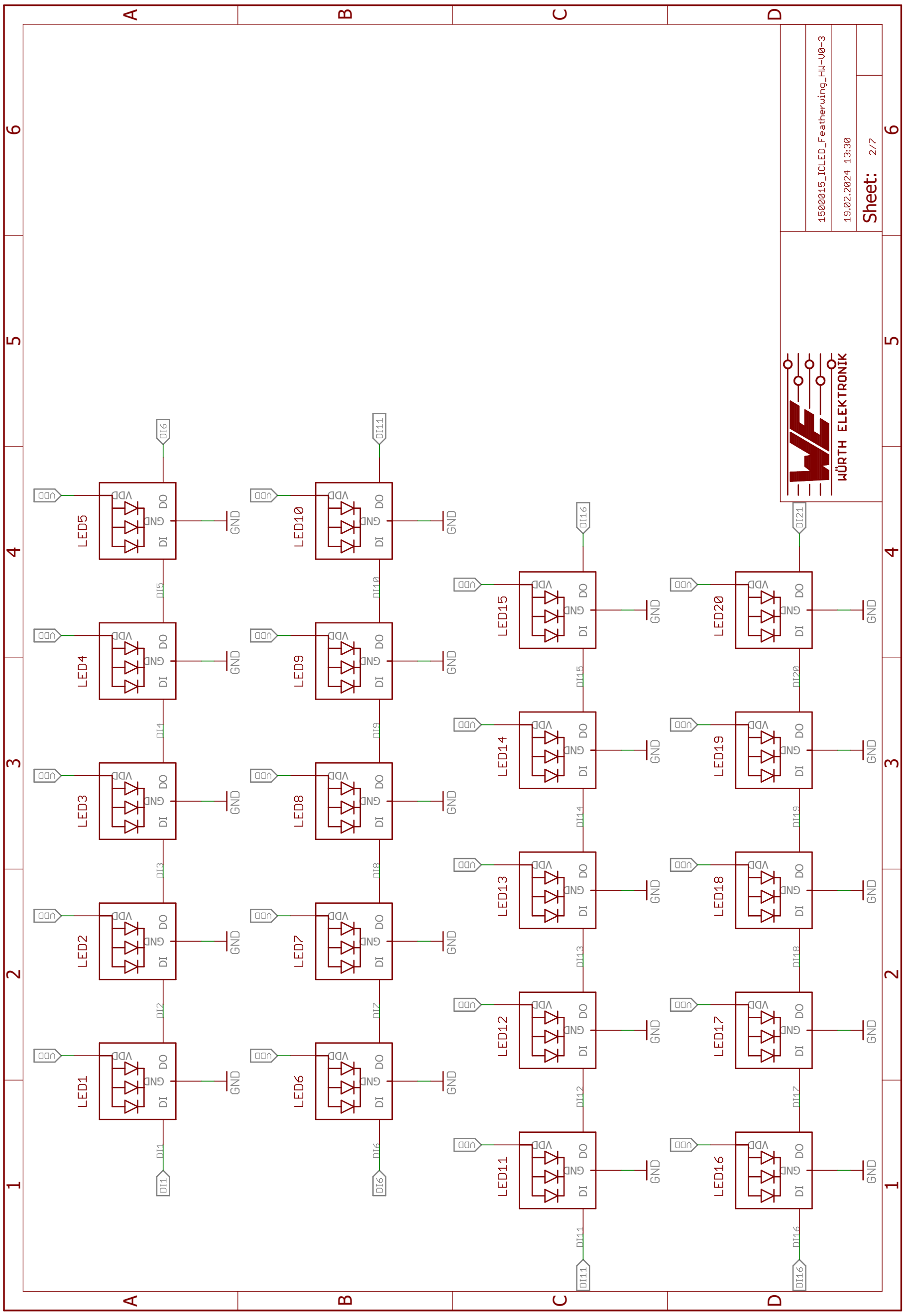

Figure 7: Schematics Sheet 2

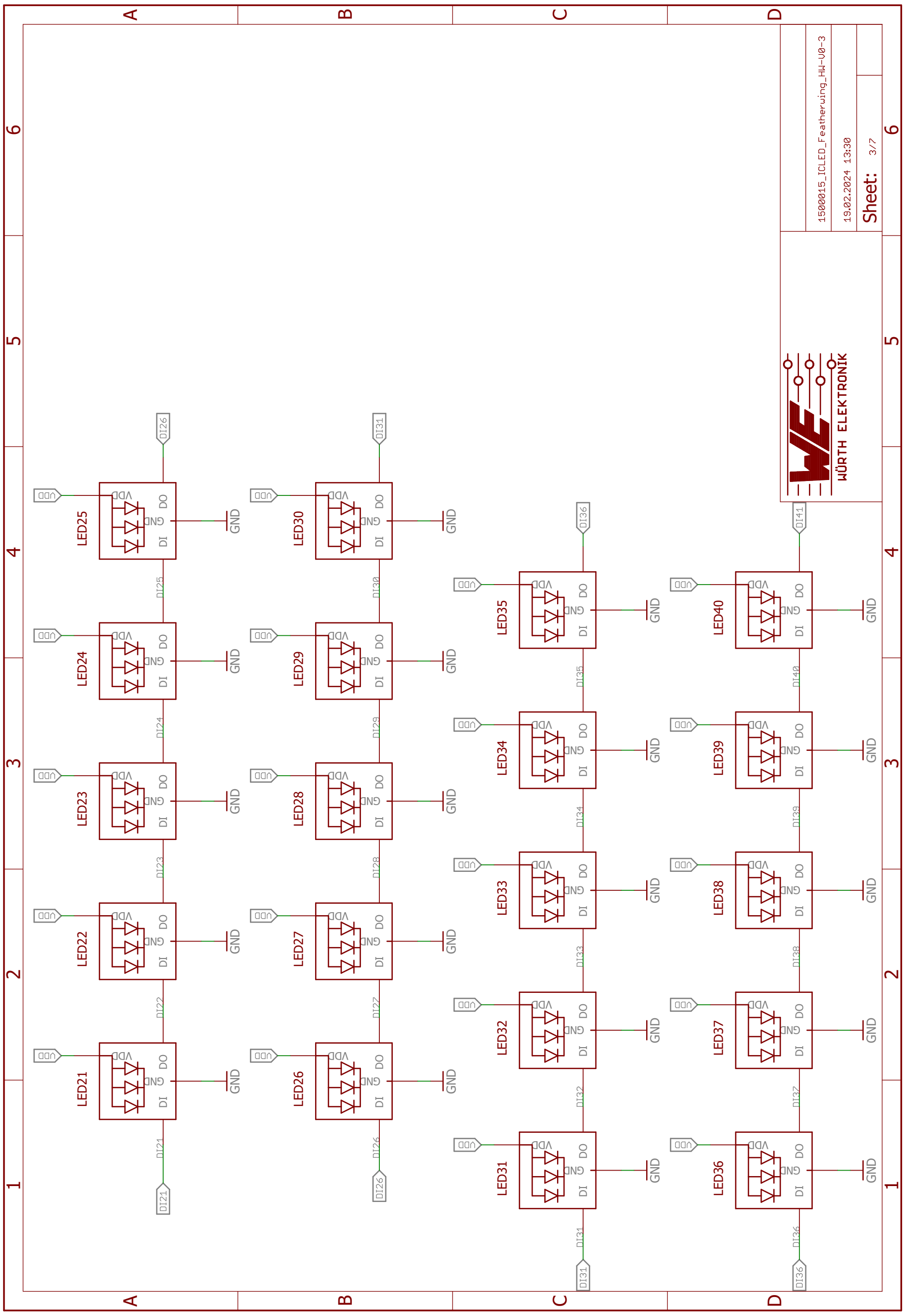

Figure 8: Schematics Sheet 3

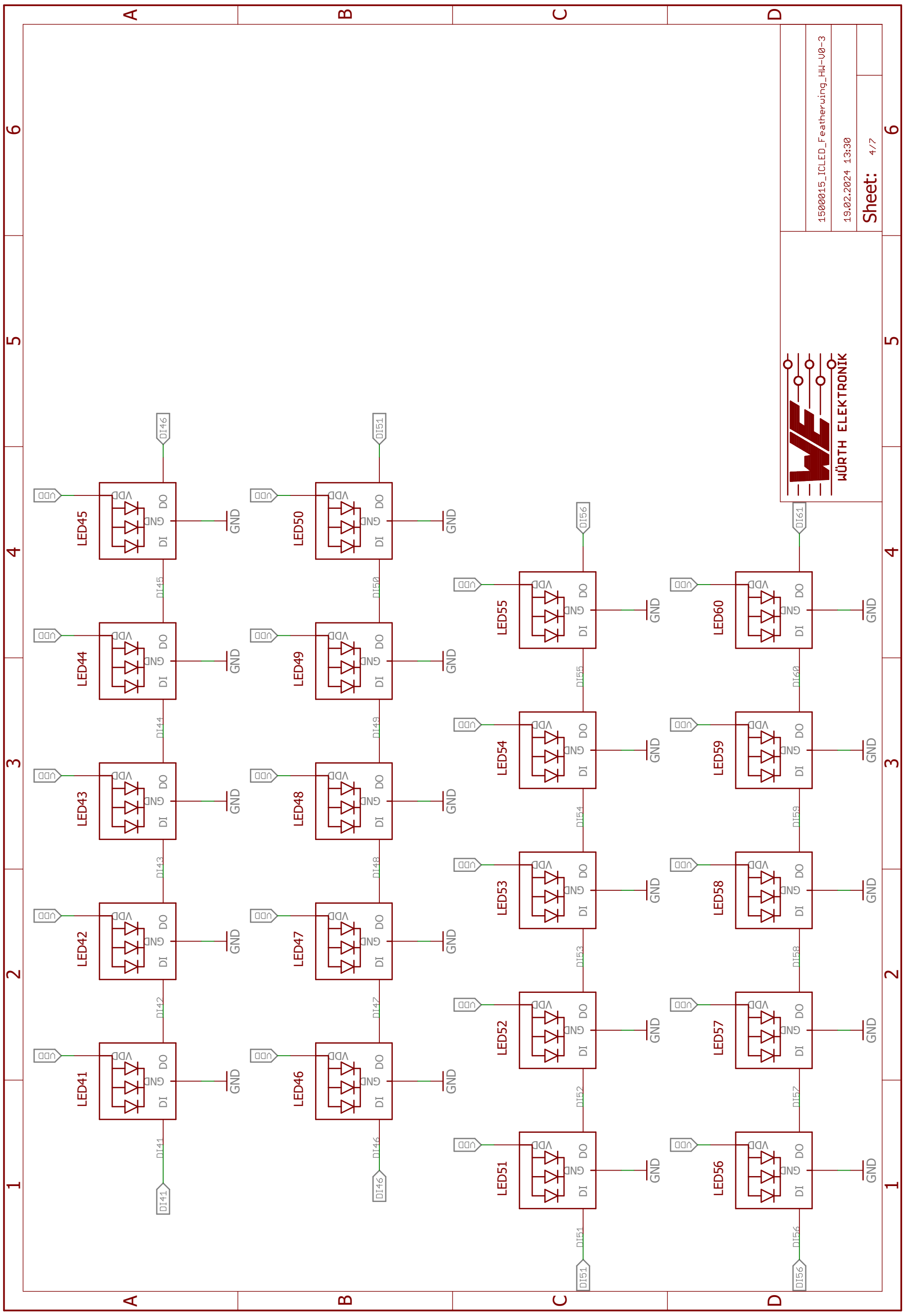

Figure 9: Schematics Sheet 4

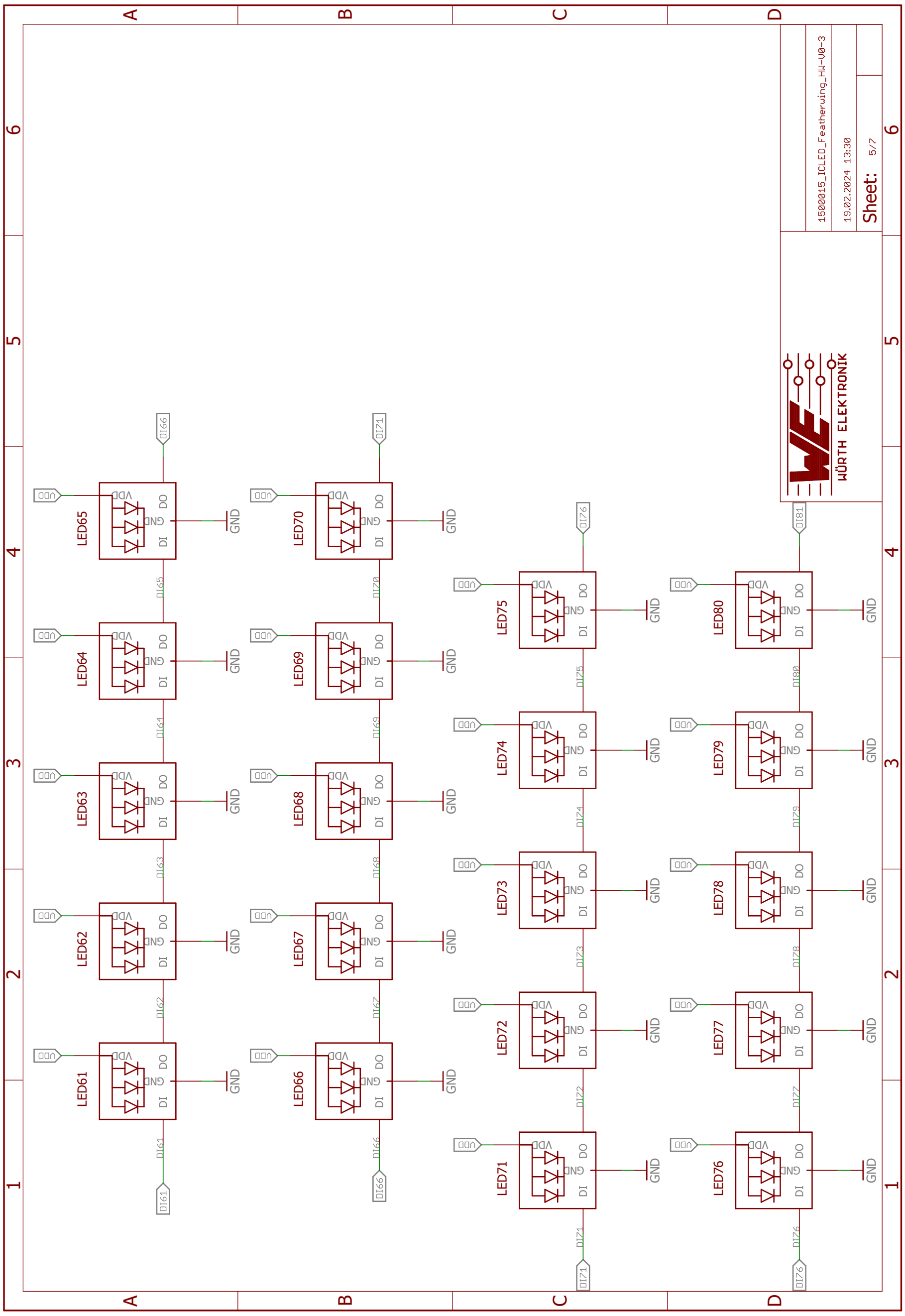

Figure 10: Schematics Sheet 5

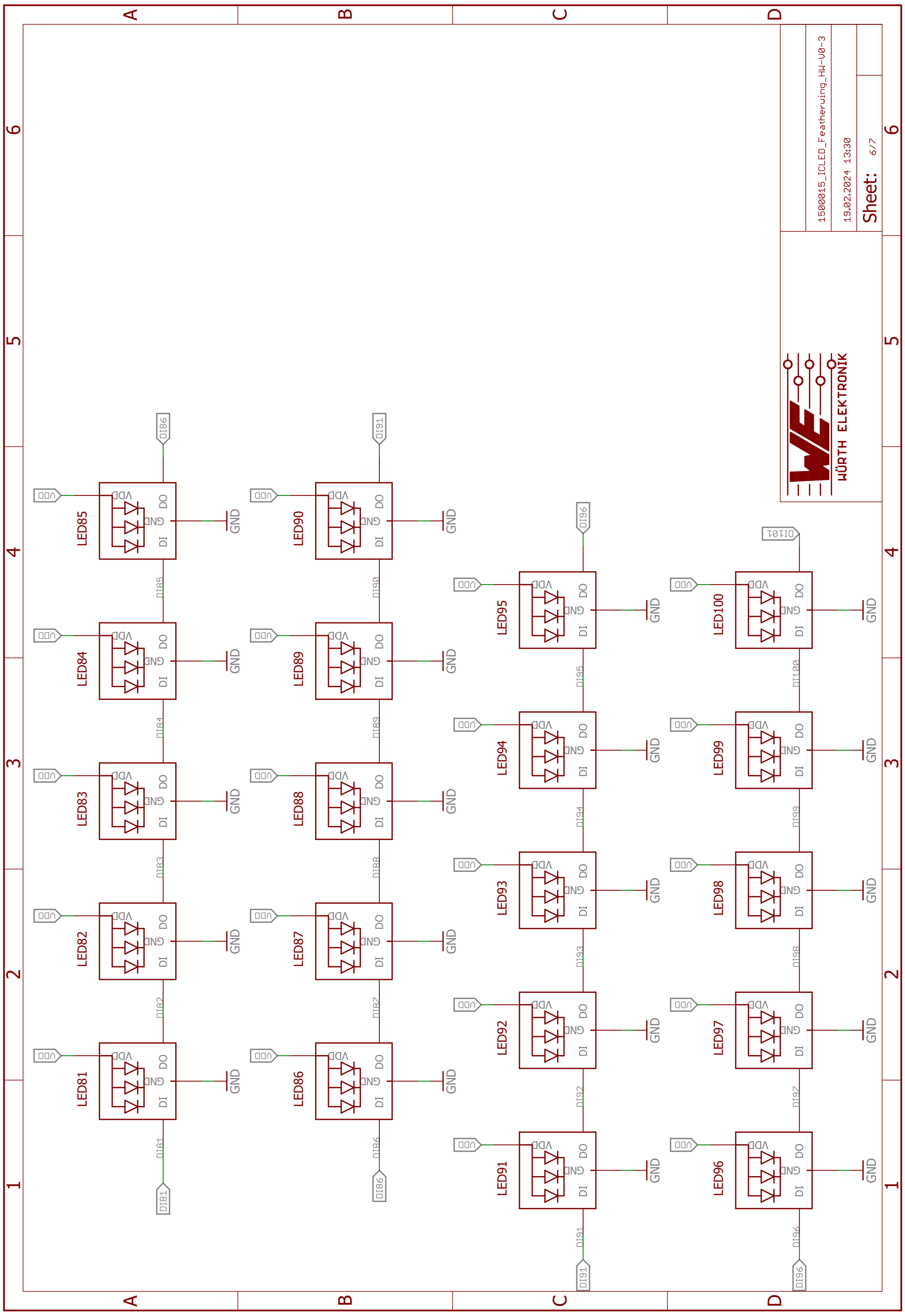

Figure 11: Schematics Sheet 6

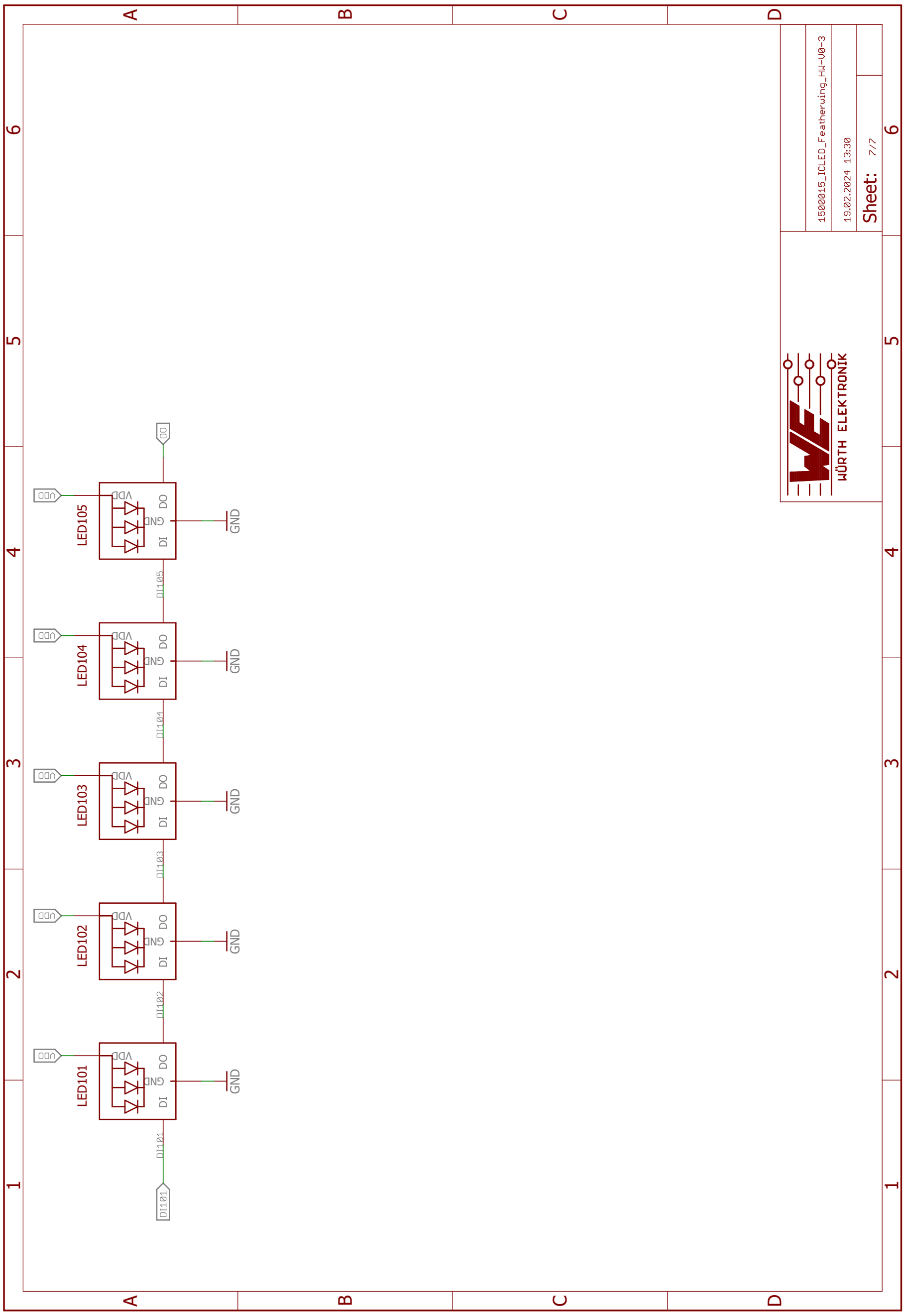

Figure 12: Schematics Sheet 7

3.6 Layout

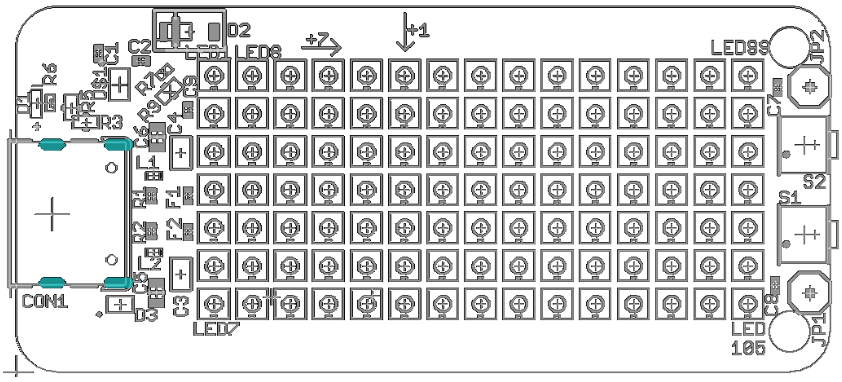

Figure 13: Assembly diagram TOP

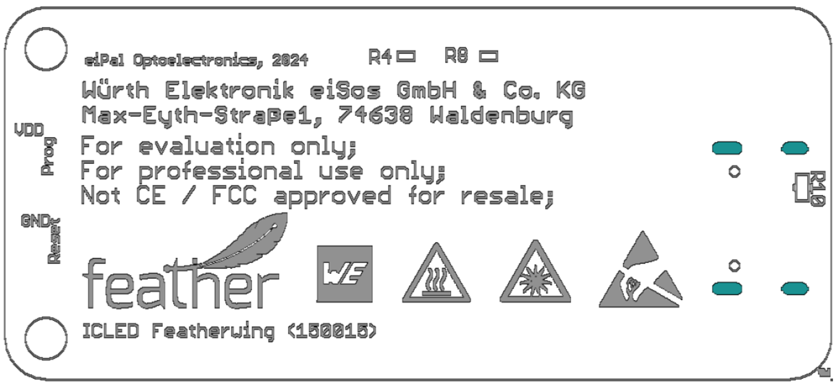

Figure 14: Assembly diagram BOTTOM

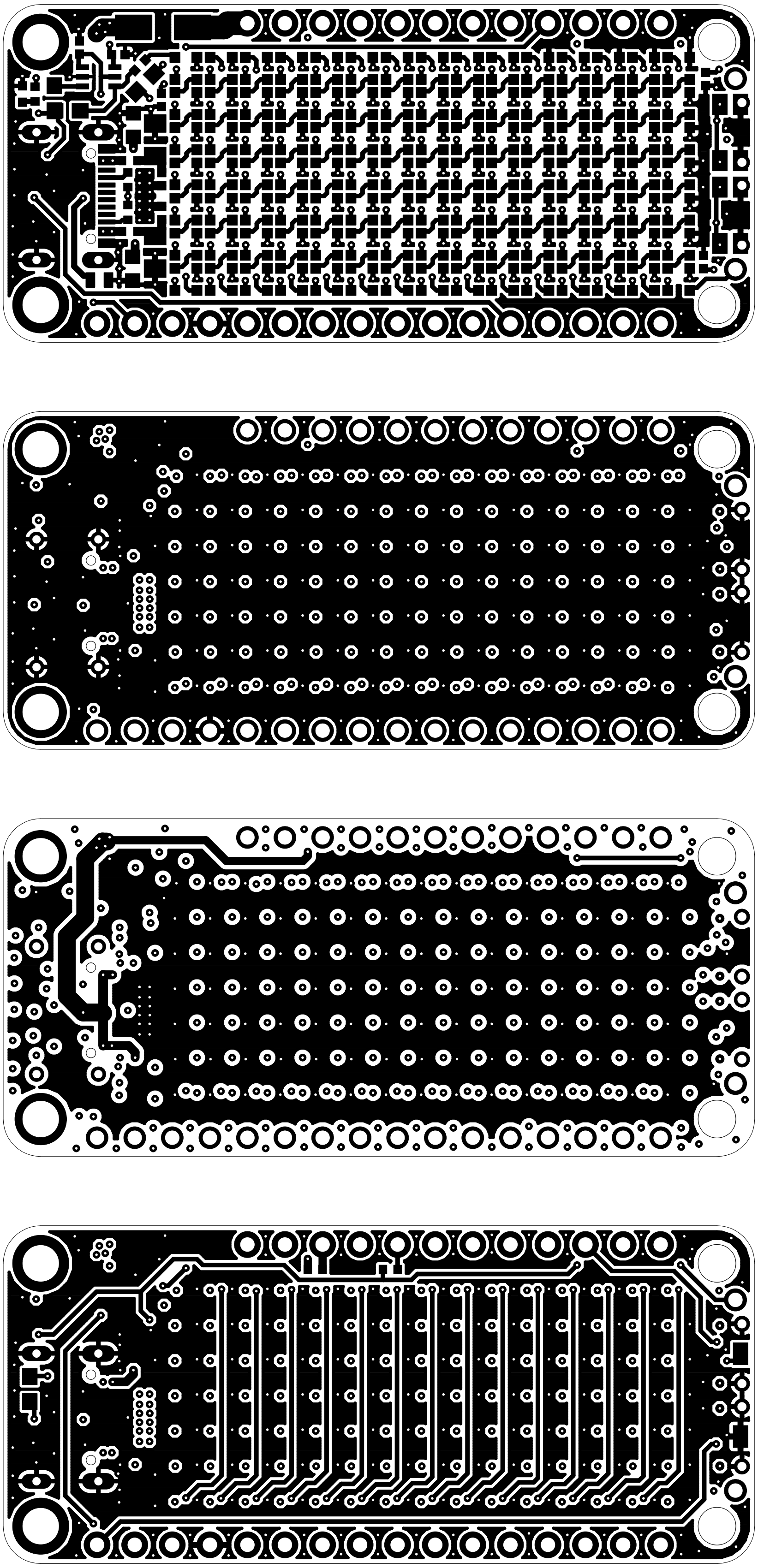

Figure 15: Top layer (upper), layer 2 (second), layer 15 (third), bottom layer (bottom)

3.7 Bill of material

Part	Value	Pack	Manufacturer	NR
CON1	WR-COM	SMT	Würth Elektronik eiSos	629722000214
C1	100 nF	0402	Würth Elektronik eiSos	885012205037
C2	100 nF	0402	Würth Elektronik eiSos	885012205037
C3	47 μF	0805	Würth Elektronik eiSos	885012107006
C4	47 μF	0805	Würth Elektronik eiSos	88501210700
C5	220 nF	0603	Würth Elektronik eiSos	885012206125
C6	220 nF	0603	Würth Elektronik eiSos	885012206125
C7	1 μF	0402	Würth Elektronik eiSos	885012105012
C8	1 μF	0402	Würth Elektronik eiSos	885012105012
C9	1 μF	0402	Würth Elektronik eiSos	885012105012
D1	WL-SMCC	0402	Würth Elektronik eiSos	150040RS73240
D2	SBR3U20SA-13	SMT	Diodes inc	SBR3U20SA-13
D3	WE-TVS	SMT	Würth Elektronik eiSos	824032815
F1	MF-ASML050/6-2	0402	Bourns	MF-ASML050/6-2
F2	MF-ASML050/6-2	0402	Bourns	MF-ASML050/6-2
JP1	n.m.	THT	Würth Elektronik eiSos	61300111121
JP2	n.m.	THT	Würth Elektronik eiSos	61300111121
L1	WE-CBF	0402	Würth Elektronik eiSos	7427927311
L2	WE-CBF	0402	Würth Elektronik eiSos	7427927311
ICLED1	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED2	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED3	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED4	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED5	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED6	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED7	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED8	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED9	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED10	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED11	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED12	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED13	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000

Table 8: Bill of materials part 1

Part	Value	Pack	Manufacturer	NR
ICLED14	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED15	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED16	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED17	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED18	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED19	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED20	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED21	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED22	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED23	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED24	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED25	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED26	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED27	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED28	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED29	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED30	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED31	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED32	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
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ICLED34	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED35	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED36	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
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ICLED45	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED46	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED47	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED48	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED49	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED50	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000

Table 9: Bill of materials part 2

Part	Value	Pack	Manufacturer	NR
ICLED51	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED52	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED53	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED54	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED55	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED56	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED57	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED58	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED59	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED60	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED61	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED62	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED63	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED64	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED65	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED66	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED67	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED68	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED69	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED70	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED71	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED72	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED73	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
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ICLED75	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED76	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED77	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED78	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED79	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED80	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED81	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED82	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED83	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED84	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED85	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED86	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED87	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000

Table 10: Bill of materials part 3

Part	Value	Pack	Manufacturer	NR
ICLED88	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED89	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED90	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED91	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED92	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED93	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED94	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED95	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED96	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED97	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED98	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED99	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED100	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED101	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED102	WL-ICLE	2020	Würth Elektronik eiSos	1312020030000
ICLED103	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED104	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
ICLED105	WL-ICLED	2020	Würth Elektronik eiSos	1312020030000
R1	5,1 kΩ	0402	Yageo	RC0402FR-075K1L
R2	5,1 kΩ	0402	Yageo	RC0402FR-075K1L
R3	n.m.	0603	Würth Elektronik eiSos	560112116001
R4	n.m.	0402	Würth Elektronik eiSos	560112110001
R5	0 Ω	0603	Würth Elektronik eiSos	560112116001
R6	4,7 kΩ	0402	Würth Elektronik eiSos	560112110245
R7	330 Ω	0402	Würth Elektronik eiSos	560112110231
R8	n.m.	0402	Würth Elektronik eiSos	560112110001
R9	0 Ω	0603	Würth Elektronik eiSos	560112116001
R10	n.m.	0603	Würth Elektronik eiSos	560112116001
S1	WS-TASU	SMT	Würth Elektronik eiSos	434331013822
S2	WS-TASU	SMT	Würth Elektronik eiSos	434331013822
U1	TXS0101DCK	SMT	Texas Instruments	TXS0101DCK

Table 11: Bill of materials part 4

4 Software description

Würth Elektronik eiSos provides a software development kit (SDK) with examples to support all the WE FeatherWings. Here are the salient features of the WE FeatherWing SDK.

- The SDK is open-source and well documented.
- It uses popular open-source tool chain including an IDE.
- The examples are written in Arduino-styled C/C++ for quick prototyping.
- Development platform independent (Windows, Linux or MAC).
- Modular structure of the software stack makes it easy to integrate into any project.

The SDK can be accessed on Github at github.com/WurthElektronik/FeatherWings.

4.1 Software architecture

The WE FeatherWing SDK is built up in a modular way using a set of open-source tools to enable complete flexibility for the user.
The figure 16 shows the architecture of the WE FeatherWing SDK.

- **PlatformIO:** is a cross-platform, cross-architecture, multiple framework professional tool for embedded software development. It provides the tool chain necessary for the software development including building, debugging, code-upload and many more. PlatformIO works well on all the modern operating systems and supports a host of development boards including the Feathers from Adafruit. Further details about PlatformIO can be found under platformio.org
- **Platform interface:** This layer provides abstraction to the peripheral drivers for the platform being used. Currently, this SDK implements an abstraction to the Arduino peripheral drivers for the Feather M0 express platform.
- **WE SDK:** This is a layer of C++ drivers for the ICLEDFeatherWingfrom Würth Elektronik eiSos which implement all the necessary functions to utilize full feature set of the ICLED-module offered.

  More details on the SDK and dowloads under: github.com/WurthElektronik/FeatherWings.
- **Board files:** This layer provides abstraction at a board level and provides functions to configure and control individual FeatherWings from WE.
- **User application:** The SDK currently implements a quick start example for each of the FeatherWings.

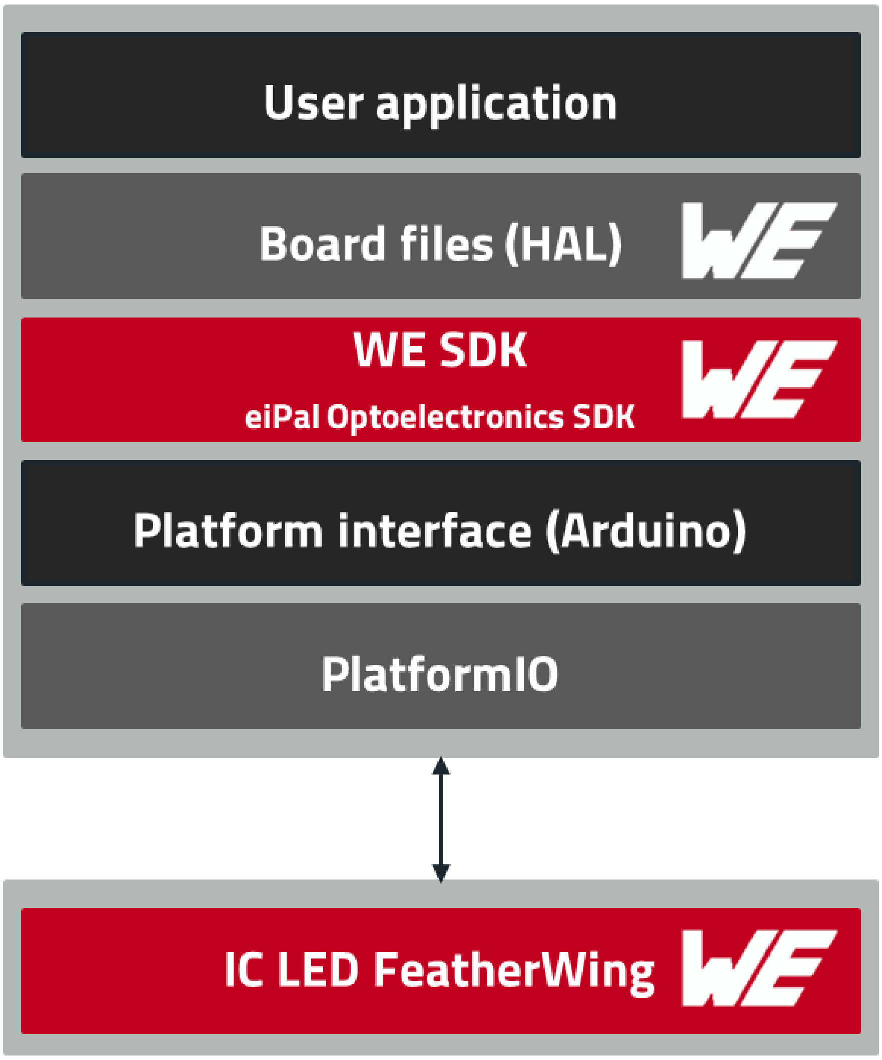

Figure 16: Software architecture

4.2 Installing the tools

4.2.1 IDE

Although, platformIO provides a versatile command line interface for development, the SDK provides quick start projects for the Visual Studio Code. This popular IDE makes for better code organization as well as code editing. Visual Studio Code is available on all modern operating systems. Support for extensions, built-in Git and a versatile code editor make it a well rounded tool for embedded software development. Please refer to code.visualstudio.com for more details on Visual Studio Code.

4.2.2 Installation steps

- Install Visual Studio Code on the platform of your choice following the instructions under code.visualstudio.com/docs
- Follow the instructions under platformio.org/install/ide?install=vscode to install PlatformIO IDE extension.

4.3 Hardware setup

The quick start examples in the SDK are written to be run on Adafruit's Feather M0 express. The hardware setup is as simple as stacking up the FeatherWing on top of the M0 Feather and powering up the board.

4.4 Running the quick start example

1. Clone or download the WE FeatherWing SDK from Github.
   github.com/WurthElektronik/FeatherWings
2. Open the workspace of interest with the filename <FeatherWing>.code-workspace in Visual Studio code.
3. Build and upload the code from the PlatformIO tab as shown in the below Figure
4. After successful upload, click on Monitor to view the debug logs in the serial terminal (See figure 17).

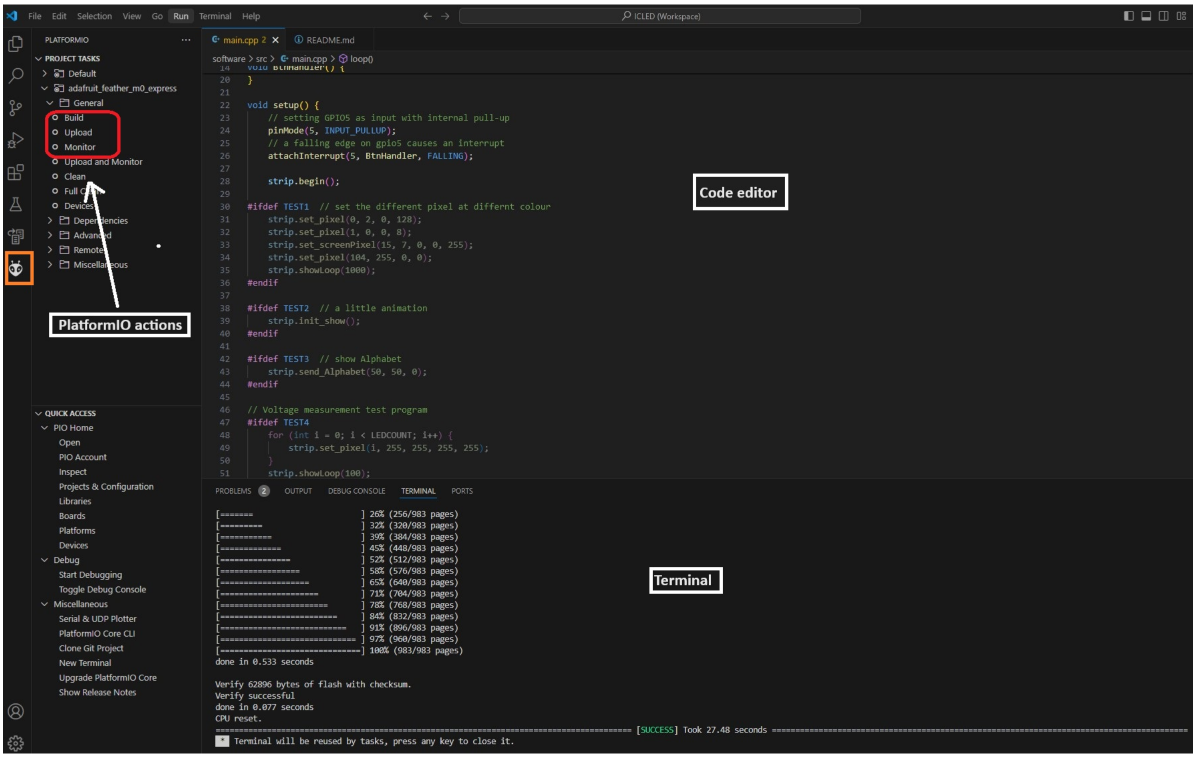

Figure 17: Running the quick start example

4.5 SDK description of functions and methods

The SDK for the ICLEDFeatherWingis built using a class-based architecture. This design encapsulates data and methods, which enhances code organization, reusability, and maintainability. Below is a brief description of some useful functions and methods implemented in the SDK:

4.5.1 Color setting of an ICLED by pixel number

Set a specific pixel to a desire color with given brightness

strip.set_pixel(uint16_t pixel, uint16_t G_H, uint8_t R_S, uint8_t B_V, uint8_t Bright)

- // pixel: IC LED number - 1 to set for specific color
- // G_H: G/H-coordinate of color
- // R_S: R/S-coordinate of color
- // B_V: B/V-coordinate of color
- // Bright: Brightness

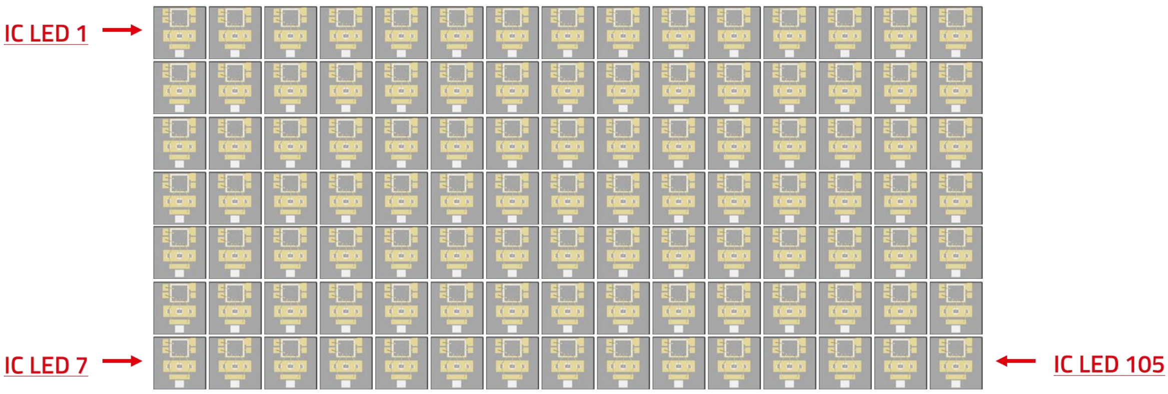

Figure 18: Schematic pin numbering of ICLED FeatherWing

Note: The IC LEDs are connected in a daisy chain. The numbering starts from ICLED1 at the top-left corner and progresses vertically down to ICLED7. ICLED8 is the LED right adjacent to ICLED1, and the sequence continues vertically again. This pattern repeats, ending with ICLED105 at the bottom-right corner as seen on figure 18.

4.5.2 Color setting of an ICLED by XY-coordinates

Set the specific pixel to given color with desired brightness by XY_Coordinates (rows and columns)

strip.set_screenPixel(uint8_t column, uint8_t row, uint16_t G_H, uint8_t R_S, uint8_t B_V, uint8_t Bright)

- // Column: IC LED's column
- // Row: IC LED's row

- // G_H: G/H-coordinate of color
- // R_S: R/S-coordinate of color
- // B_V: B/V-coordinate of color
- // Bright: Brightness

Note: The IC LEDs are arranged in a grid of 15 columns and 7 rows, as shown on figure 19.

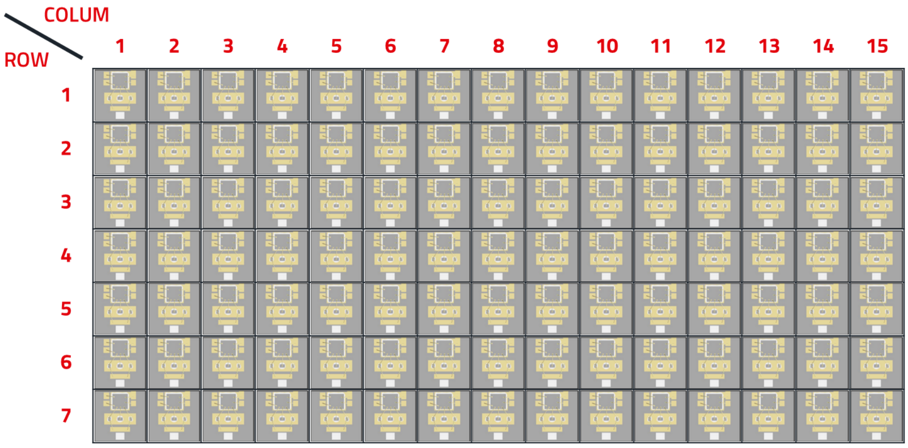

Figure 19: IC LED FeatherWing grid array

4.5.3 Color setting of all IC LEDs

Set all the pixels of ICLEDFeatherWingto a given colour and brightness.
strip.set_all(uint16_t G_H, uint8_t R_S, uint8_t B_V, uint8_t Bright)

- // G_H: G/H-coordinate of color
- // R_S: R/S-coordinate of color
- // B_V: B/V-coordinate of color
- // Bright: Brightness

4.5.4 Configuring ASCII symbols

Write a character symbol to the LED buffer (LEDBuf). Most ASCII-128 characters are supported, but not all.

strip.set_char(char c, uint16_t place, uint16_t G_H, uint8_t R_S, uint8_t B_V, uint8_t Bright)

- //c: ASCII character to write

- //place: Left boundry of symbol
- //G_H: G/H-coordinate of color
- //R_S: R/S-coordinate of color
- //B_V: B/V-coordinate of color
- //Bright: Brightness

4.5.5 Configuring a string

Write an entire string to the expanded LED buffer (LEDBuf).

strip.set_string(char c[], uint16_t place, uint16_t G_H, uint8_t R_S, uint8_t B_V, uint8_t Bright)

- //c: string to set in buffer
- //place: left boundary of string
- //G_H: G/H-coordinate of color
- //R_S: R/S-coordinate of color
- //B_V: B/V-coordinate of color
- //Bright: Brightness

4.5.6 Transferring data to IC LEDs

This function is called to transfer all the configured data to the IC LEDs. The delay parameter is particularly useful for creating animation effects, as it controls the speed of data transfer and can help achieve desired visual pacing.

strip.show(uint32_t del)

- //del: Delay time in ms

Note: The delay should be at least 5 ms, this is useful for slowing down animations.

4.5.7 Interrupt controlled data transfer to IC LEDs

Start transferring data to the IC LEDs on screen and continues until an interrupt occurs. In the SDK, this interrupt occurs when the S2 push button on the FeatherWing is pressed down.

strip.showLoop(uint32_t del)

- //del: Delay time in ms between two interrupts checks

4.5.8 Display scrolling text on screen

Start scrolling text from right to left for a specified number of times.
strip.showRun(uint32_t del, uint16_t end, uint16_t times)

- //del: Delay time in ms
- //end: End of last symbol in RAM
- //times: Amount of "times" the animation is repeated

4.5.9 Background color filling

Fill expanded LED buffer (LEDBuff) with a given color and brightness, making it useful for filling the background of text.

strip.fill(uint16_t G_H, uint8_t R_S, uint8_t B_V, uint8_t Bright)

- //G_H: G/H-coordinate of color
- //R_S: R/S-coordinate of color
- //B_V: B/V-coordinate of color
- //Bright: Brightness

4.5.10 Setting HSV mode

Change the color mode to HSV. Use methods as usual with HSV coordinates, and the library calculates the corresponding GRB values automatically.

strip.to_HSV()

4.5.11 Setting RGB mode

Change colour mode to GRB. Use methods with RGB coordinates.

strip.to_GRB()

4.5.12 Resetting LED buffer

Reset the information in the expanded buffer (LEDBuff) to zero. Use this function to reset the LED buffer, effectively removing all previously set colors and characters.

strip.clearChar()

5 Software Based Applications

The code includes several predefined functions to showcase the capabilities of the ICLED-FeatherWing.

5.1 Initializing sequence

The initializing sequence **init_show()** starts by displaying a single white pixel moving across the screen. Once it reaches the end, all pixels gradually brighten to white. Next, the **WE-logo** is shown, followed by the slogan **More than you expect** in scrolling text. This loop continues until interrupted.
Since the function uses hard-coded colors, it checks if the HSV color system is being used. If so, it switches to the GRB system and reverts back to HSV on interrupt. This is managed by the boolean variable hsv. The **WElogo()** method writes the WE logo at a specified start column in the buffer, allowing it to be reused by other functions or methods without hard-coding it again.
init_show()

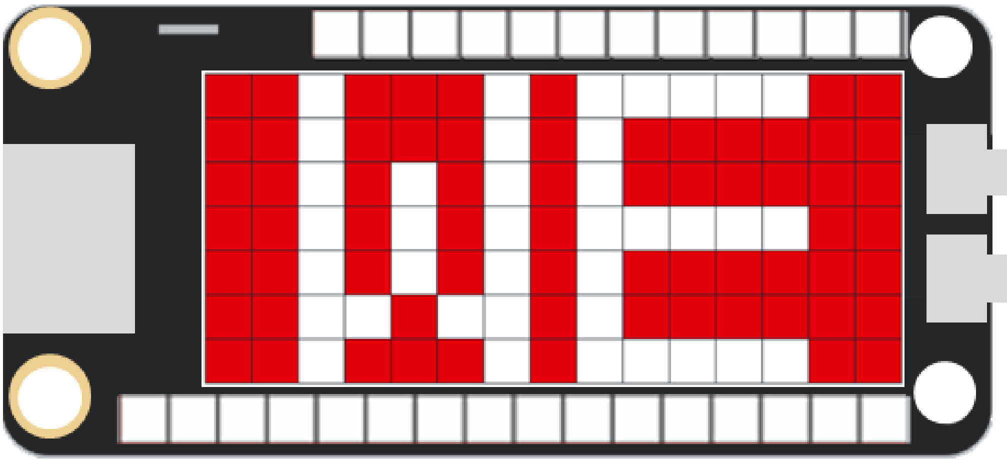

Figure 20: WE logo on ICLEDFeatherWing

5.2 Price tag

showPrice() writes a given string into buffer (by executing **set_string()**) and adds an euro Symbol on its end. When string and symbol are written, it checks the end column of the whole string. If it fits on one screen it executes **show()**, else it executes **showRun()**. This guarantees best display option for the price. Like the WE-logo before, the euro symbol is written by a new method **set_euro()**

showPrice(char c[], uint16_t place, uint16_t G_H, uint8_t R_S, uint8_t B_V, uint8_t Bright)
// Command to show a price tag on screen

- //c: string to set in buffer
- //place: left boundary of string

- //G_H: G/H-coordinate of color
- //R_S: R/S-coordinate of color
- //B_V: B/V-coordinate of color
- //Bright: Brightness

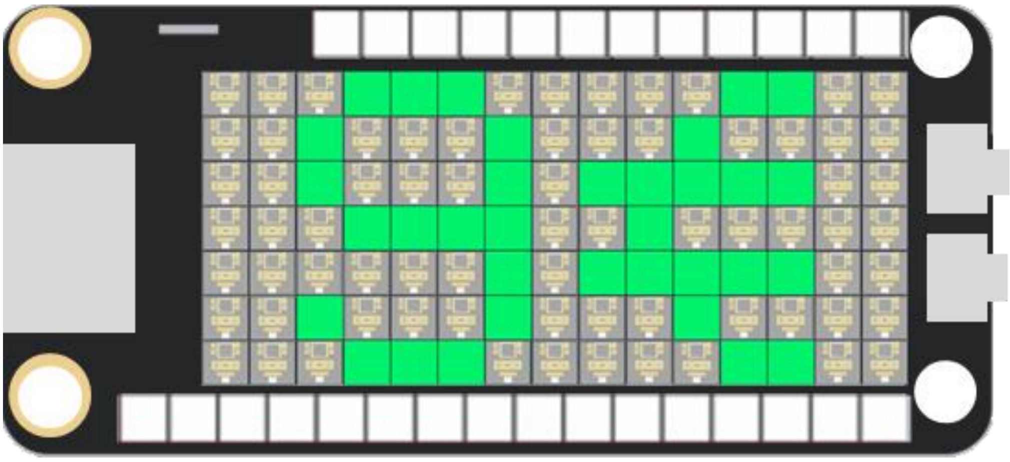

Figure 21: Price tag display

5.3 Emojis

set_emoji() places a chosen emoji at a specified column and with a chosen color.

set_emoji(uint8_t e, int32_t place, uint16_t G_H, uint8_t R_S, uint8_t B_V, uint8_t Bright)

- // e : number of emoji to write
- //place: left boundary of string
- //G_H: G/H-coordinate of color
- //R_S: R/S-coordinate of color
- //B_V: B/V-coordinate of color
- //Bright: Brightness

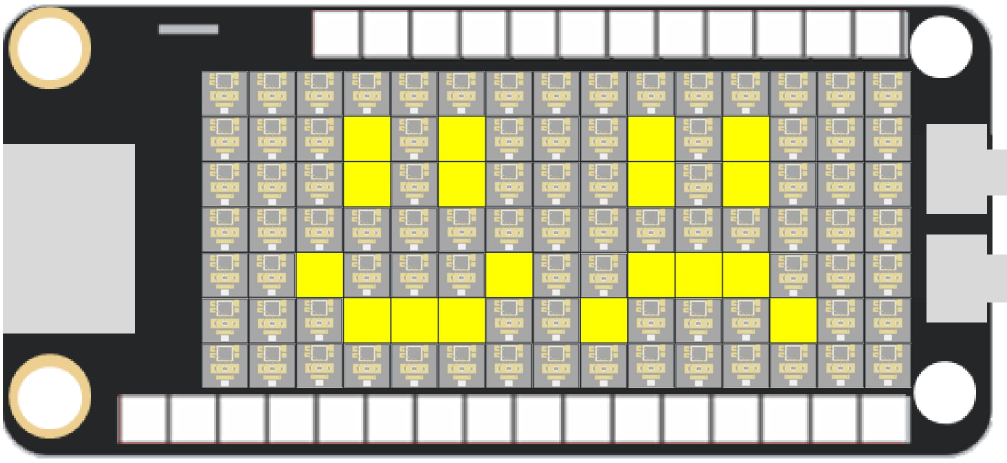

Figure 22: Emojis displayed on screen

5.4 Rainbow animation

The **showRainbow()** method displays a scrolling rainbow animation on screen, by transitioning seamlessly from red to green, then to blue, and back to red. The variable step size ensures that each color transition matches the display width, creating a visually appealing effect. By repeating the red-to-green transition and setting the end column of **showRunLoop()** one screen-width before the actual end column, the animation forms a continuous loop.
showRainbow(uint32_t del, uint8_t Bright)
// del : Delay time in ms (should be at least 5ms)
//Bright: brightness

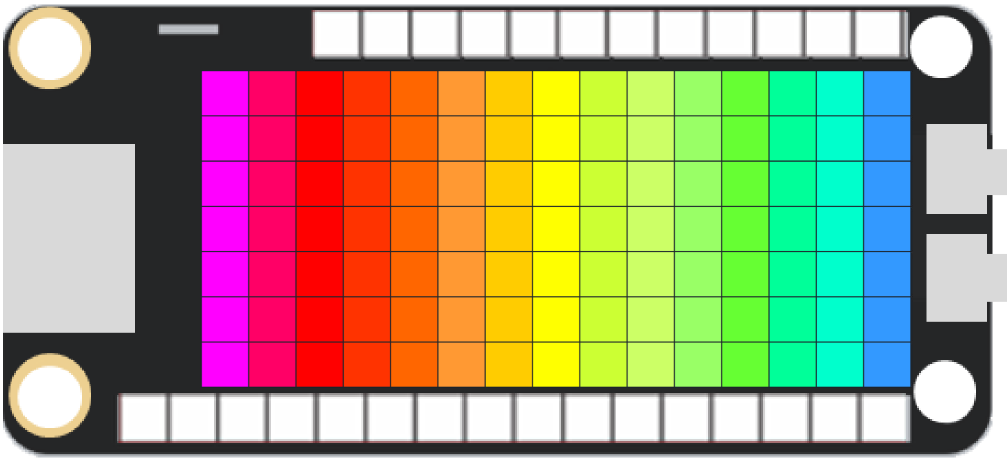

Figure 23: Scrolling rainbow animation on ICLEDFeatherWing

5.5 Application examples

Several example programs are included in the **main.cpp** file. Users can run these examples by defining the global test number value (**define TEST** from line 4) in the **main.cpp** file. The table below indicates the global test number, a short description of the application example, and the names of the required libraries.

Test number	Description
1	Initializing sequence
2	Set different pixels at different colour
3	Show alphabet
4	Display "Hello World!"
5	Display rainbow effect
6	Display prices
7	Show emojis
8	HSV and RGB color model test

Table 12: Application example definition according to TEST number

6 Regulatory compliance information

This evaluation board destined for professionals to be used solely at research and development facilities for such purposes. This board has been tested to satisfy general EMC requirements and to ensure the photobiological safety for the user. Following standards have been applied:

- CISPR32-FAR
- 61000-4-4 CDN coupling
- EN 55015_MAINS
- IEC 61000-4-3
- IEC 61000-4-6
- IEC 62471:2006
- EN 62471:2008

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You are responsible for using the WÃ¼rth Elektronik eiSos eiPal optoelectronics product with the incorporated Software in compliance with all applicable product liability and product safety laws. You acknowledge to minimize the risk of loss and harm to individuals and bear the risk for failure leading to personal injury or death due to your usage of the product with the incorporated Software.

Würth Elektronik eiSosâ products with the incorporated Software are not authorized for use in safety-critical applications, or where a failure of the product with the incorporated Software is reasonably expected to cause severe personal injury or death. Moreover, Würth Elektronik eiSosâ products with the incorporated Software are neither designed nor intended for use in areas such as military, aerospace, aviation, nuclear control, submarine, transportation (automotive control, train control, ship control), transportation signal, disaster prevention, medical, public information network etc. You shall inform Würth Elektronik eiSos about the intent of such usage before design-in stage.

In certain customer applications requiring a very high level of safety and in which the malfunction or failure of an electronic component could endanger human life or health, you must ensure to have all necessary expertise in the safety and regulatory ramifications of your applications. You acknowledge and agree that you are solely responsible for all legal, regulatory and safety-related requirements concerning your products and any use of Würth Elektronik eiSosâ products with the incorporated Software in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by Würth Elektronik eiSos. YOU SHALL INDEMNIFY WÜRTH ELEKTRONIK EISOS AGAINST ANY DAMAGES ARISING OUT OF THE USE OF WÜRTH ELEKTRONIK EISOS' PRODUCTS WITH THE INCORPORATED FIRMWARE IN SUCH SAFETY-CRITICAL APPLICATIONS.

9.3 Ownership

The incorporated Firmware created by Würth Elektronik eiSos is and will remain the exclusive property of Würth Elektronik eiSos.

9.4 Firmware update(s)

You have the opportunity to request the current and actual firmware for a bought Würth Elektronik eiSos eiPal optoelectronics product within the time of warranty. However, Würth Elektronik eiSos has no obligation to update a modules firmware in their production facilities, but can offer this as a service on request. The upload of firmware updates falls within your responsibility, e.g. via ACC or another software for firmware updates. Firmware updates will not be communicated automatically. It is within your responsibility to check the current version of a firmware in the latest version of the product manual on our website. The revision table in the product manual provides all necessary information about firmware updates. There is no right to be provided with binary files, so called "Firmware images", those could be flashed through JTAG, SWD, Spi-Bi-Wire, SPI or similar interfaces.

9.5 Disclaimer of warranty

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9.6 Limitation of liability

Any liability not expressly provided by Würth Elektronik eiSos shall be disclaimed.
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9.7 Applicable law and jurisdiction

Applicable law to this license terms shall be the laws of the Federal Republic of Germany. Any dispute, claim or controversy arising out of or relating to this license terms shall be resolved and finally settled by the court competent for the location of Würth Elektronik eiSos' registered office.

9.8 Severability clause

If any of these provisions shall be deemed invalid, void, or for any reason unenforceable, that provision shall be deemed severable and shall not affect the validity and enforceability of any remaining provisions. Any such provision shall be replaced with new valid provisions that most closely approximate the purpose of the terms. The above-mentioned provisions are also valid in the event that these terms are determined to contain gaps.

9.9 Miscellaneous

Würth Elektronik eiSos reserves the right at any time to change this terms at its own discretion. It is your responsibility to check for any updates. Your continued usage of the products with the incorporated Software will be deemed as the acceptance of the change.
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