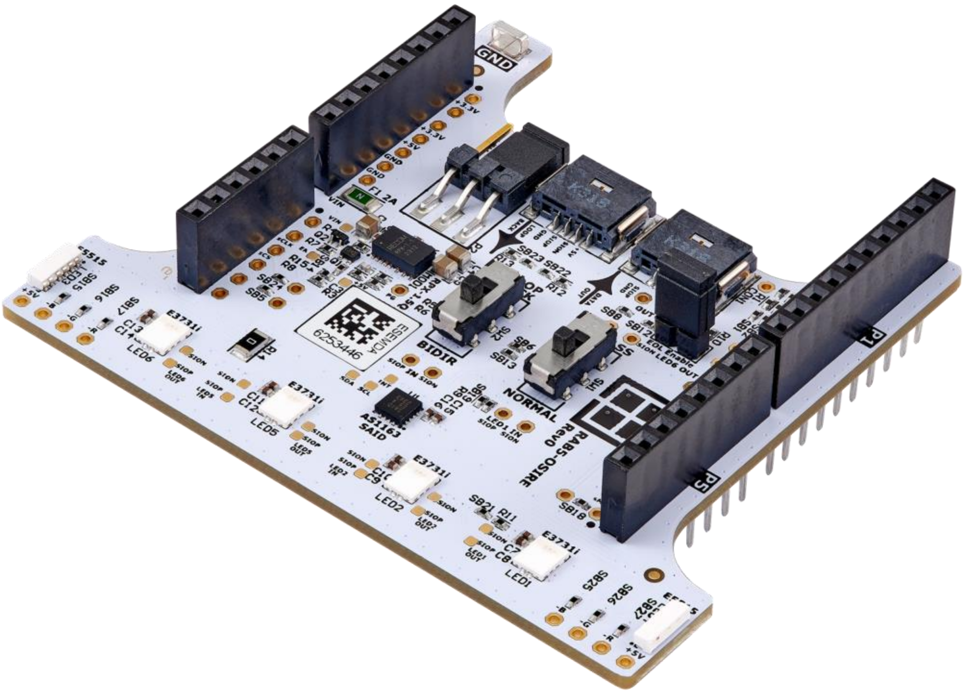
RAB5 – OSIRE User Manual



Versions

Version	Date	Rationale
0.1	March 20, 2024	First draft. Author: GDR
1.0	July 31, 2024	Getting started added. Authors: GDR, KOA

Legal disclaimer

The evaluation board is for testing purposes only and, because it has limited functions and limited resilience, is not suitable for permanent use under real conditions. If the evaluation board is nevertheless used under real conditions, this is done at one's responsibility; any liability of Rutronik is insofar excluded.

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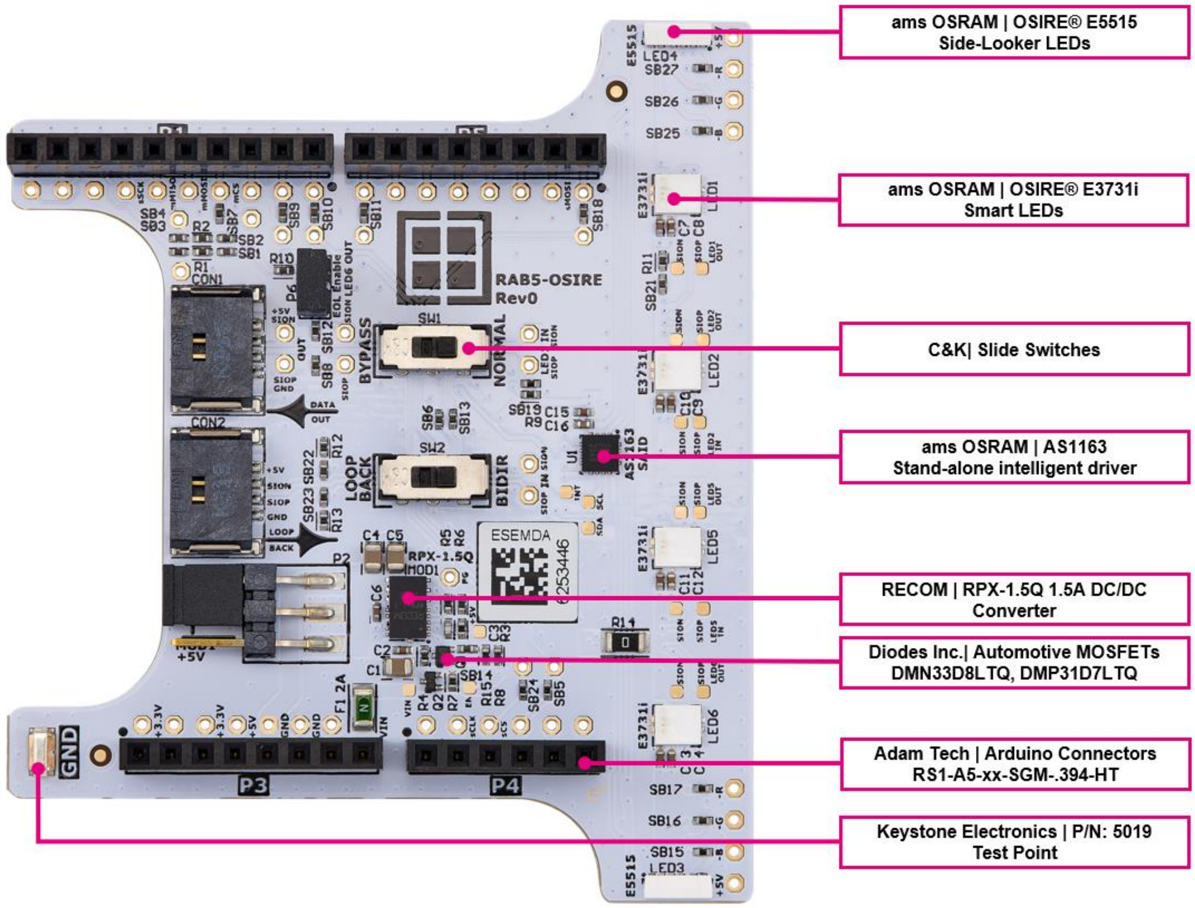
RAB5 Overview

Features

- **OSIRE® E3731i** – ams OSRAM Automotive smart RGB LEDs. Check OSIRE overview chapter to learn more.
- **OSIRE® E5515 –** ams OSRAM Automotive side-looker RGB LEDs.
- **AS1163** – ams OSRAM Stand-alone intelligent driver. Check Features of AS1163 chapter to learn more.
- **RPX-1.5Q** – RECOM Automotive DC/DC 1.5 Amp Converter.
- **DMN33D8LTQ, DMP31D7LTQ** – Diodes Inc. Automotive MOSFETs.
- **Arduino Connectors** – Adam Tech RS1-A5-**xx**-SGM-.394-HT[1].
- **JS202011JCQN** – C&K Switches slide switch.
- **Passive components –** passive components from Samsung EM, ASJ and Yageo.

Component placement



[1] Adam Tech - RS1-A5-06-SGM-.394-HT, RS1-A5-08-SGM-.394-HT and RS1-A5-10-SGM-.394-HT

Hardware

Fuses

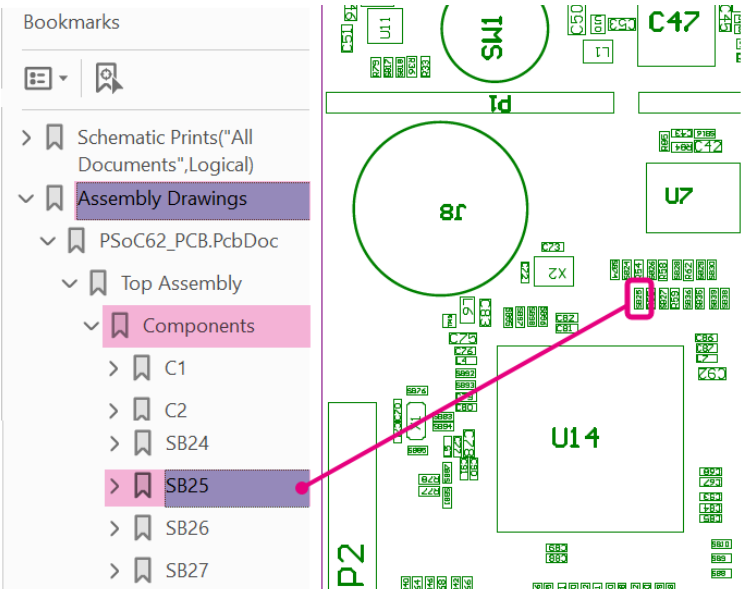
The RAB5-OSIRE board has only one 2A fast-acting fuse F1 in a 1206 package; Part No: CC12H2A-TR „Eaton“.

Solder bridges

Designator	Circuit	Default
SB1	I2C SCL pull-up resistor to +5V.	Closed
SB2	I2C SDA pull-up resistor to +5V.	Closed
SB3	I2C SCL with P1 pin 10.	Closed
SB4	I2C SDA with P1 pin 9.	Closed
SB5	sSPI[2] CS signal to P4 pin 4.	Closed
SB6	SIOP input signal to SW1 and LED1.	Closed
SB7	SIOP input signal to P1 pin 4.	Closed
SB8	LED6 SIOP output signal to CON1.	Closed
SB9	U1 Interrupt signal to P1 pin 2.	Closed
SB10	sSPI CS signal from P1 pin 1.	Closed
SB11	MOD1 Power Supply EN signal from P5 pin 8.	Closed
SB12	LED6 SION output signal to CON1.	Closed
SB13	SION input signal to SW1 and LED1.	Closed
SB14	MOD1 Enable pull-up resistor.	Closed
SB15	LED3 B- connection with U1.	Closed
SB16	LED3 G- connection with U1.	Closed
SB17	LED3 R- connection with U1.	Closed
SB18	SIOP input signal to sSPI MOSI from P5 pin 1.	Closed
SB19	LED1 SIOP input pull-up resistor.	Closed
SB21	LED1 SION input pull-down resistor.	Closed
SB22	Loop-back SION pull-up resistor.	Closed
SB23	Loop-back SIOP pull-down resistor.	Closed
SB24	SION input signal to sSPI_CLK from P4 pin3.	Closed
SB25	LED4 B- connection with U1.	Closed
SB26	LED4 G- connection with U1.	Closed
SB27	LED4 R- connection with U1.	Closed

The locations of the solder bridges can be found in the 3D model and assembly drawings of RAB5-OSIRE.

[2] sSPI – Slave SPI signal from the controller (RDK4) board.



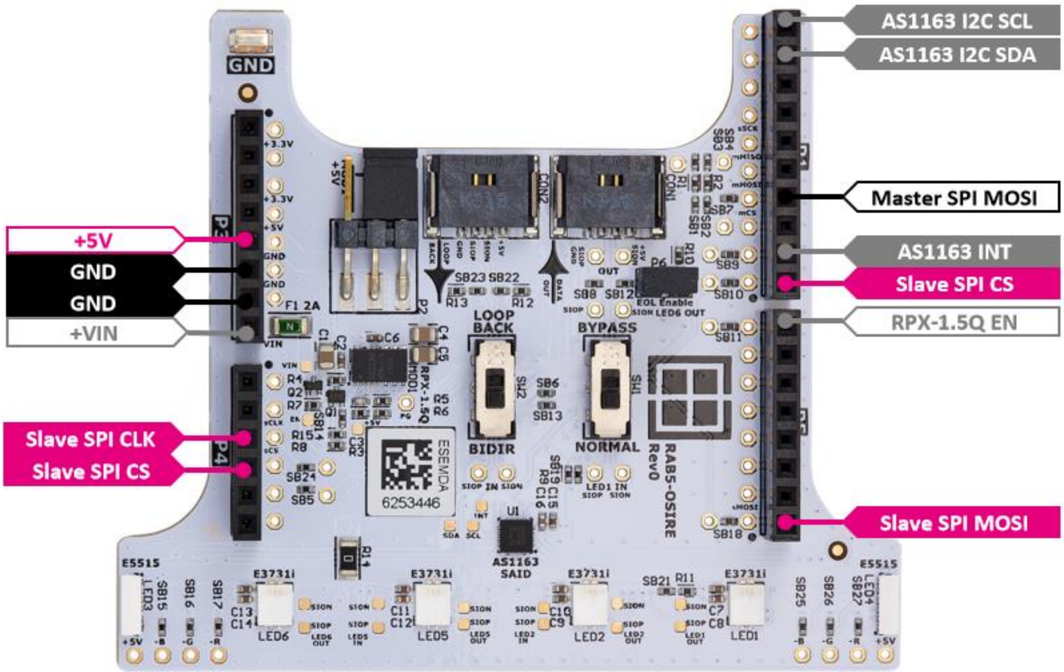
How to find a component on the layout

Changing the fuses or solder bridges

The SMD „[Chipping Tool - Tweezers](#)“ is recommended for use for SMD solder bridges or fuse soldering on the RAB5-OSIRE development board.

Board pinout

The voltage level of SPI and I2C interfaces is TTL 5V. The power supply input +VIN cannot exceed +20V.



Power supply options

The OSIRE LEDs including the SAID AS1163 can consume up to 50 mA per single LED channel. Depending on the system built by a user, the current consumption might be too large for some platforms to handle. If used with RDK4 Rev2, the proposed power supply options are given below:

1. RDK4 SBC LDO VCC2 power supply. The current is limited to 100mA. The USB-C should be plugged constantly to supply the main MCU with power. The 12V power supply is recommended to be connected to the J1 and J4 BATERRY terminals.
2. RDK4 USB-C power supply. This option requires the solder bridges SB54 [closed] and SB55 [opened] to be soldered before the RAB5-OSIRE can be powered through the ARDUINO Header +5V pin from USB-C directly. The current will be limited by the USB-C protection IC to the 400mA.
3. RAB5-OSIRE RECOM Power Supply RPX-1.5Q. This option will allow the current supply for LED devices up to 1.5A. The +9…+20V power may be provided from J1 and J4 BATERRY terminals on the RDK4 board or fed directly into the VIN Arduino Header pin. The MCU power supply can be provided from the USB-C socket or with additional wiring from the RAB5-OSIRE board to the RDK4 MCU CURRENT Port/Jumper.
4. External +5V power supply. This option will supply much larger currents for the internal and external LED devices. Use the P2 terminal without the jumper to connect the external power supply to the pin2 and GND on Arduino Header P3. The MCU power supply can be provided from the USB-C socket or with additional wiring from the RAB5-OSIRE board to the RDK4 MCU CURRENT Port/Jumper.

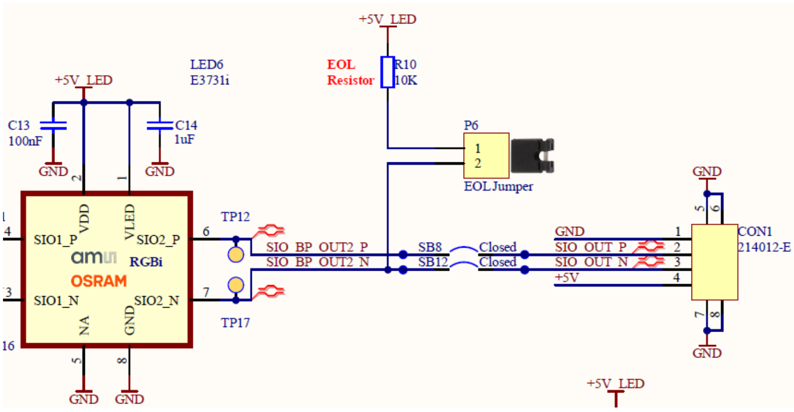
Hardware configuration

The RAB5-OSIRE board is configurable and flexible to adapt to any platform that uses a +5V voltage level for signals. Some configuration methods require soldering skills, for example, if the SBxx need to be changed or wires from Arduino Holes and Arduino Headers need to be rerouted. Switching the switch or replacing the jumpers might be enough though.

EOL – End-of-Line P6 jumper

The P6 jumper is placed by default. The EOL R10 10K termination resistor is connected to the LED6 SIO2_N output and is detectable as the last device on the SIO [Serial I/O] communication line.

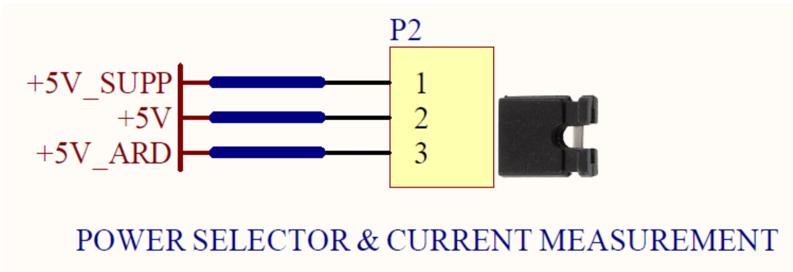
Remove this jumper if you need to extend the SIO chain by connecting additional OSP devices.



Power selector and current measurement port P2

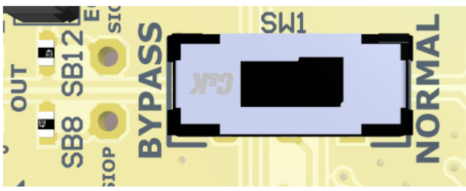
By default, P2 pins 2 and 3 are shorted with a jumper, therefore, the board is powered from the Arduino Header +5V power input. Changing the jumper position to pins 1 and 2 would power up the board from the RECOM power supply MOD1. Please note that the MOD1 onboard power supply needs an external +9V…+20V power source to be connected to the Arduino Header P3 pin8 [VBAT] firstly[3].

The port P2 pin 1 [+5V_SUPP] may also be used to supply power from external power sources and measure the power consumption of the system the user might have built. The jumper is removed from P2 in case of external power measurements need to be done.



LED chain bypass switch SW1

The switch SW1 is switched from the “NORMAL” to the “BYPASS” position if communication with the onboard devices needs to be bypassed. It is necessary to remove the SB8 and SB12 solder bridges before using the external devices or the communications will be interfered with the LED6 – it is the last device in the RAB5-OSIRE LED chain. Please note that the first device on the SIO line must also have 10K pull-up and pull-down resistors connected.



[3] If the RDK4 kit is used, it will be enough to apply power to the BATTERY terminals J1 and J4.

Loop-back mode switch SW2

The SW2 switch selects the topology of the externally connected OSP devices between the Bidirectional "BIDIR" and the Loop-Back "LOOP BACK" modes.

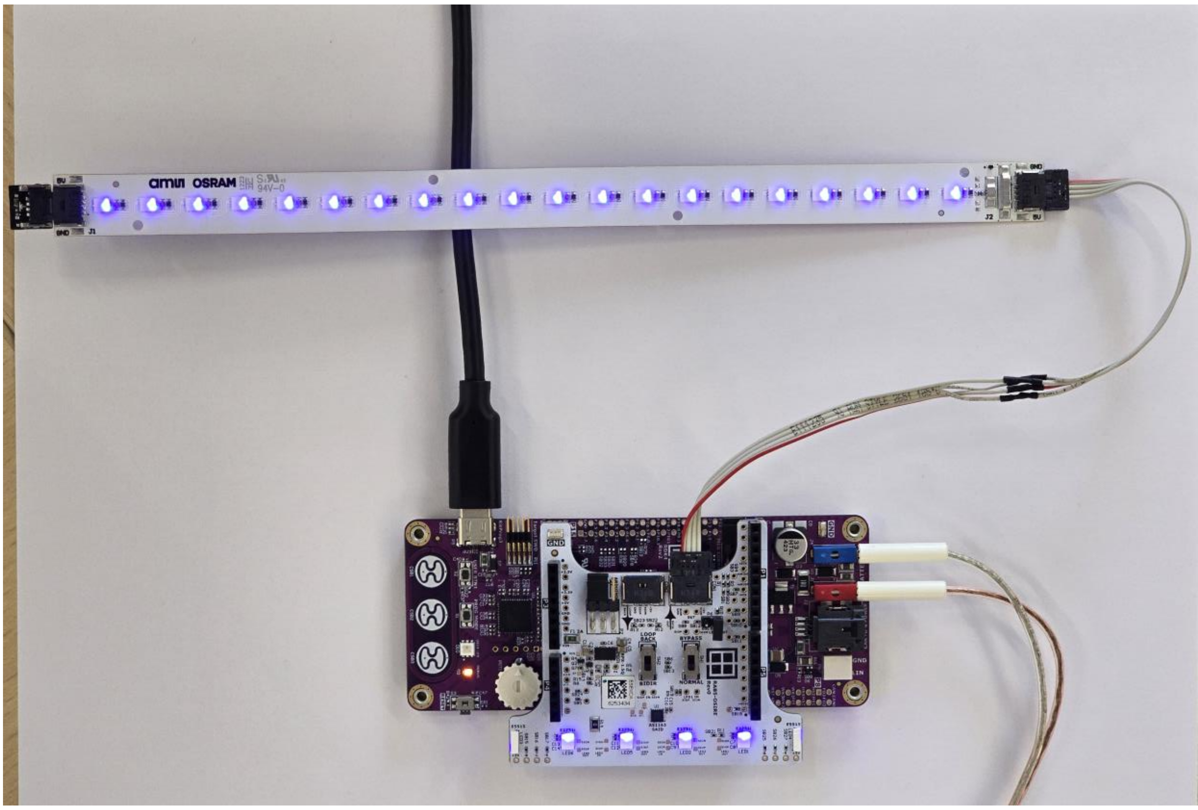
In the case of the Bidirectional configuration, the connector CON1 is used only. Otherwise, if Loop-Back mode is engaged – the connectors CON1 and CON2 are used.

Using ams OSRAM LED stripes

The LED stripes LEDATV3196 can be obtained from RUTRONIK2 in limited quantities. Each LES stripe has 20 OSIRE® E3731i LEDs onboard. The cable and EOL resistor board are included.

Please note that a single LED stripe may consume up to 3A and the onboard power supply RPX-1.5Q can provide up to 1.5A. If you need to go up to the maximum possible brightness using an LED Stripe, please consider power supply option 4 in paragraph "Power supply options".

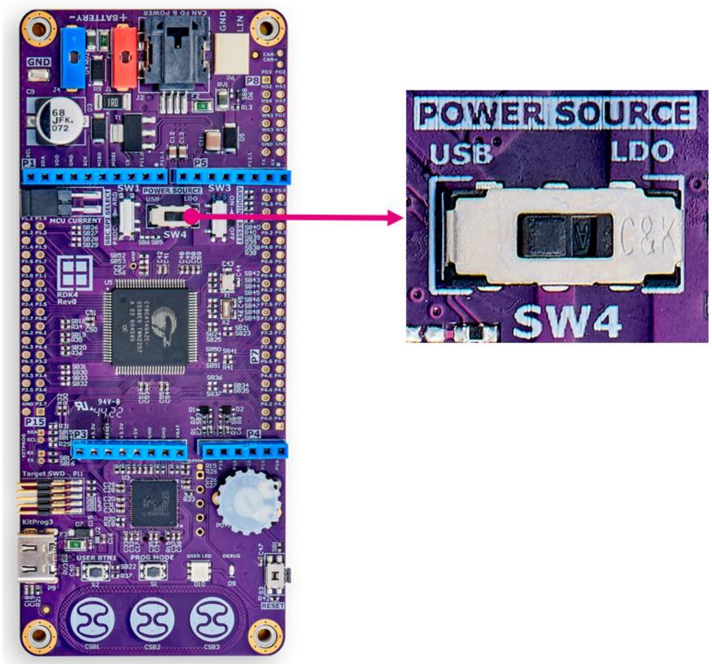
The simplest configuration is to use the RAB5-OSIRE LEDs and SAID together with an external LED Stripe(s). Connect the stripe to the CON1 and remove the EOL Enable jumper from the P6. Switch the P2 to the +5V Module (internal RPX-1.5Q power supply) and connect the 12V power supply to the J1 and J4 sockets as it is shown in a photo below.



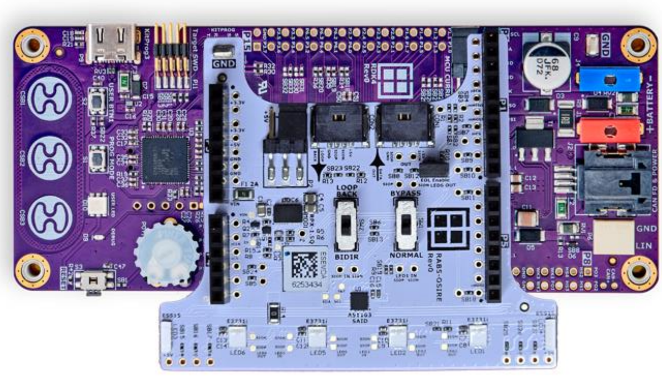
Software and firmware

Getting started

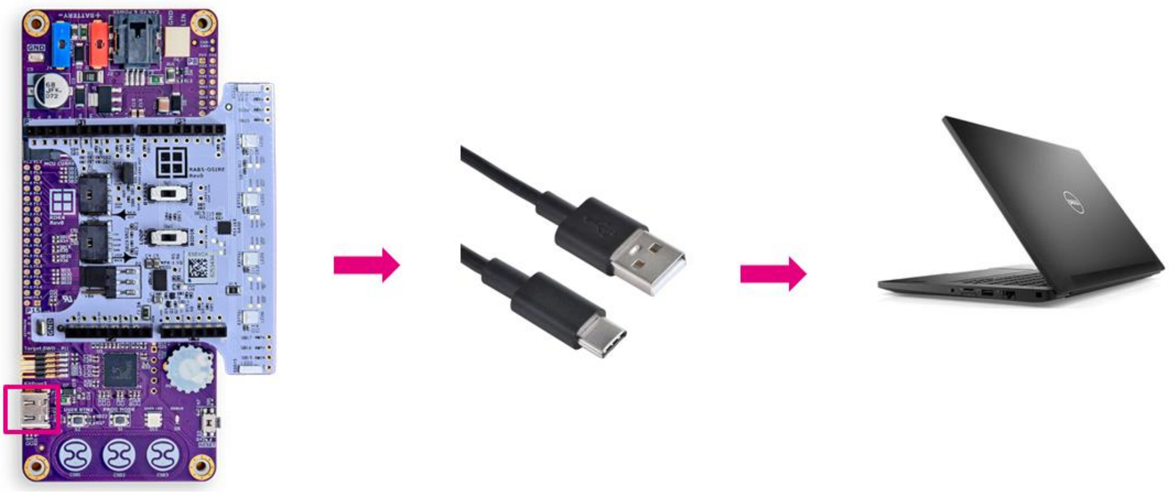
1. Register or/and login to the Infineon website, press on **myInfineon** tab. https://www.infineon.com
2. Download and install the latest ModusToolbox™ software.
3. Download the ams OSRAM GUI software from here: https://github.com/RutronikSystemSolutions/RAB5-OSIRE_Documents_and_GUI
4. [Optional] Get in touch with solutions@rutronik.com to get the ams OSRAM GUI software and the source code for the colour correction algorithms.
5. Check if a SW4 is in the **USB** position.



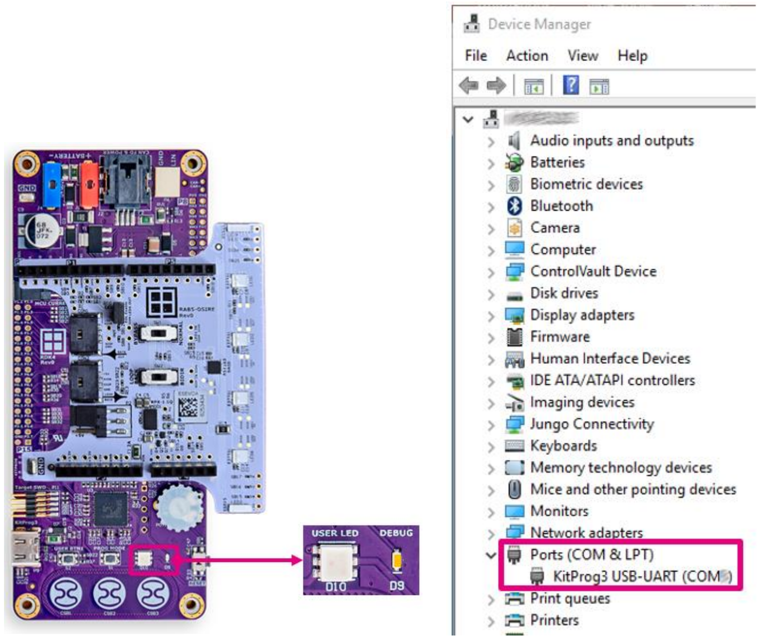
6. Mount the RAB5-OSIRE adapter board on the RDK4 Rev2 development kit.



7. Connect a USB-C socket with a marking **KitProg3** of RDK4 with your PC using USB Type-C cable.

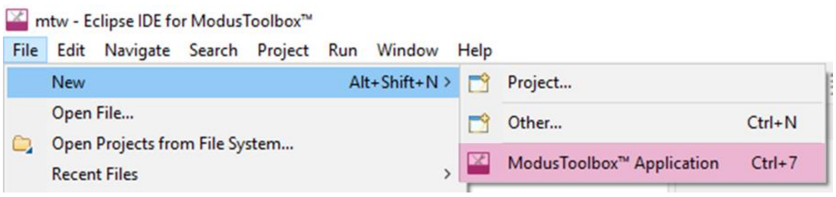


8. Check if the RDK4 is ready: yellow **DEBUG** LED must shine constantly, **KitProg3** must be seen in the **Device Manager** window.

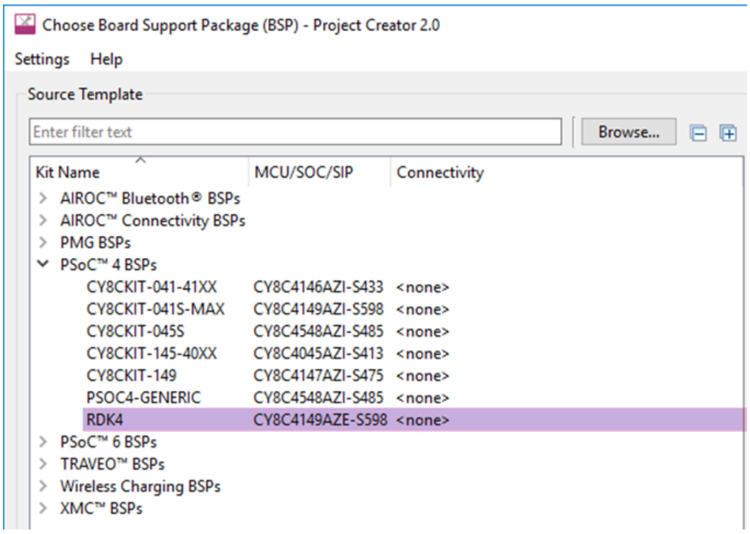


Running a RAB5-OSIRE code example

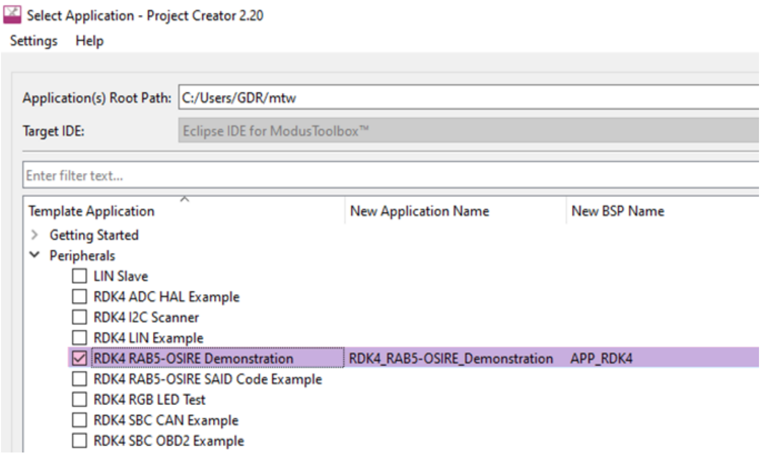
1. Run **File - New - ModusToolbox™ Application.**



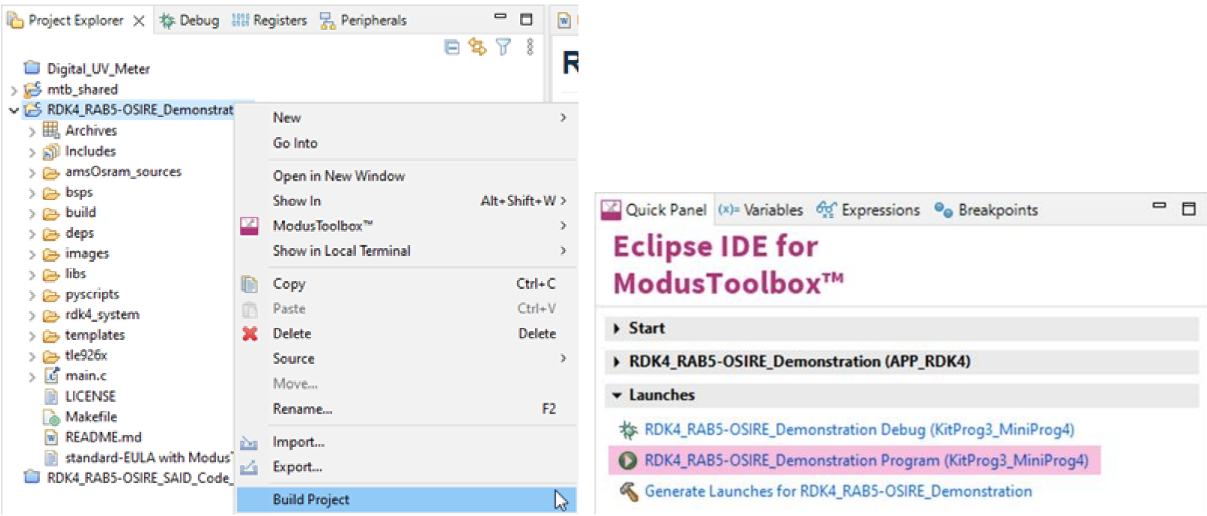
2. Select **RDK4** BSP (PSoC™ 4 BSPs list). Press on **Next**.



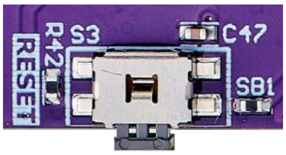
3. Select **RDK4_RAB5-OSIRE_Demonstration** in **Peripherals** category. Press **Create**.



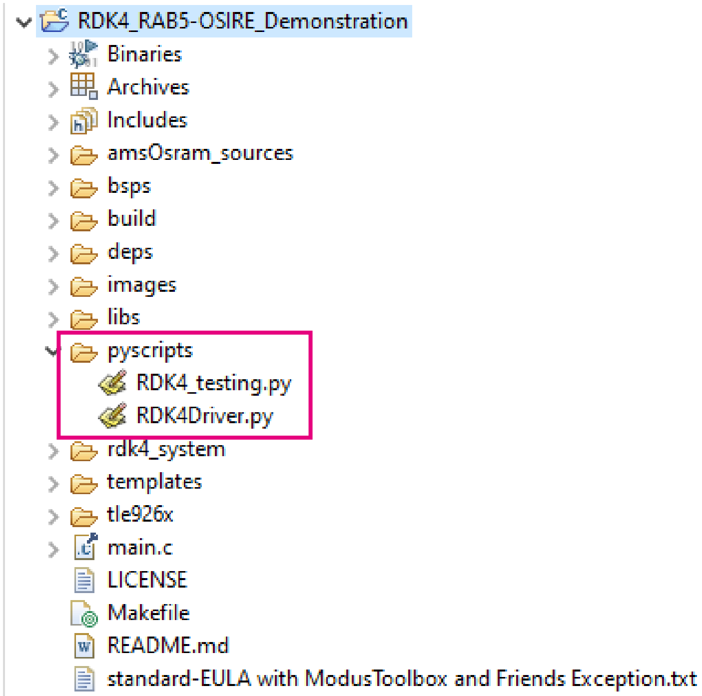
4. **Build** and **Program** the created project.



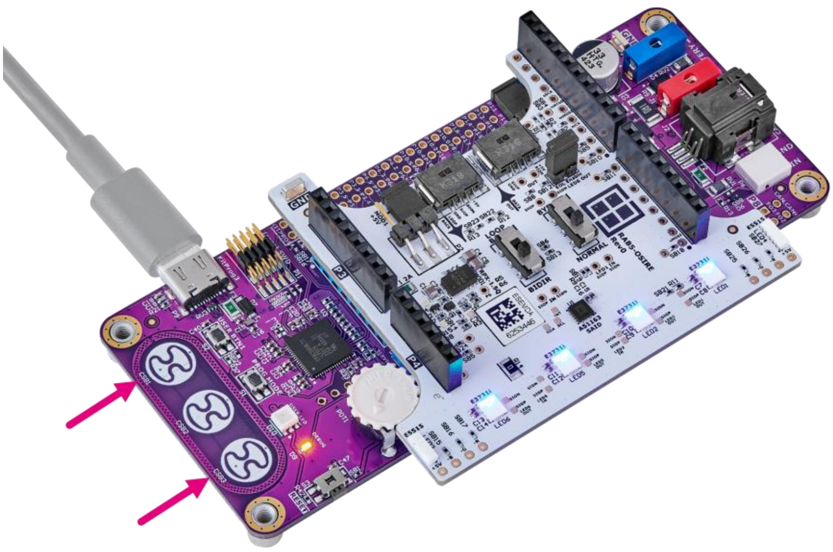
5. Press **RESET** button on the RDK4 board.



The Python script for the test and the driver can be found in the demo project:



By default, the „Minimal RGB“ demo mode is always engaged from the startup. Touch the CSB1 once and you will get into „Color Correction“ mode.



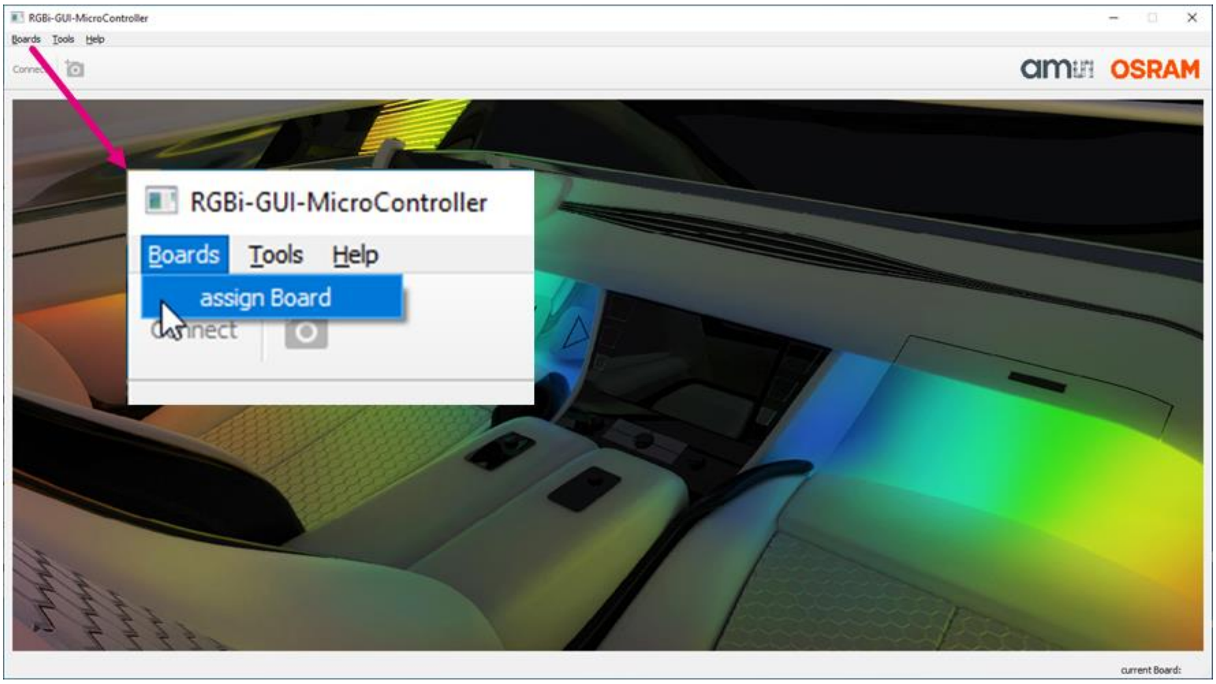
The USER LED on the RDK4 will start blinking in YELLOW. From this point, the user needs to decide whether to read all the OTP memory from every OSIRE LED and store it in the microcontroller memory. If you are running this demo for the first time, this is necessary. So, to do that please touch the CSB3 button gently and wait until the USER LED starts blinking in GREEN. Touch the CSB1 now and the demo will start. If the memory has been saved previously, you only need to keep pressing the CSB1 and you will get to this mode anyway.

If you further touch the CSB1, you will get into the „Running Lights“ mode. You will see how the LEDs are changing the colours sequentially for every LED, they are updated once per 10 milliseconds. This demo mode is more impressive with a larger number of LEDs (the external LED stripe should be used).

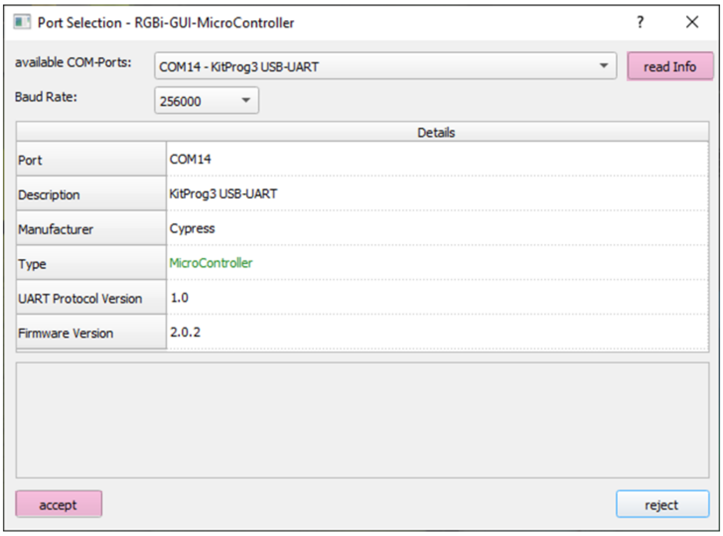
Touching and holding the CSB1 will get you back to the „Minimal RGB“ demo.

ams OSRAM RGBi-MCU-GUI Software

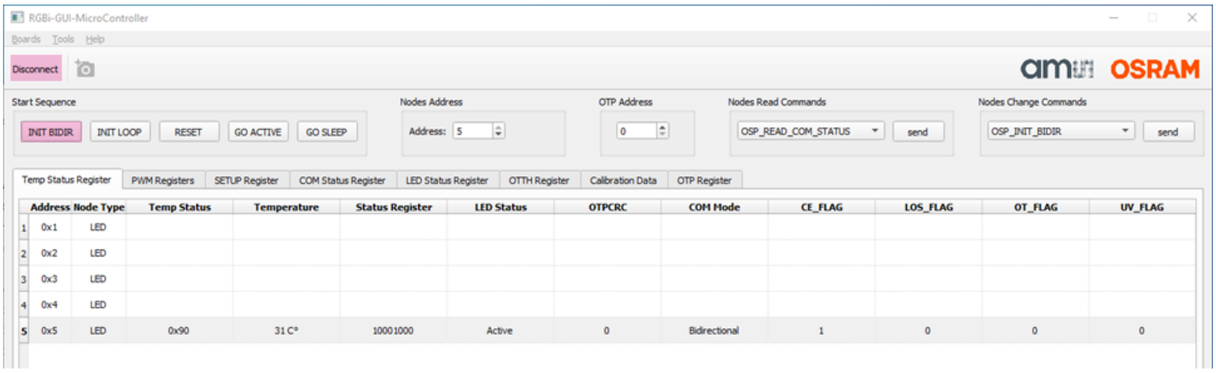
1. Follow the steps of Getting started and Running a RAB5-OSIRE code example chapters.
2. Run **ams OSRAM RGBi-GUI-MicroController** software and press **Assign board.**



3. Select the **COM Port** where the RDK4 KitProg3 is connected, press **Read info** and **Accept**.



4. Press on the **Connect** button.



Always start working with LEDs from the INIT_DIR command. If you need to set all the LEDs at once, please set the address to 0 – it is the broadcasting address.

Firmware examples

All these examples can be found on [GitHub] and are available directly from Project Creator in ModusToolbox™ IDE.

RDK4_REV2_OSIRE_DEMO	This ModusToolbox™ application enables the RDK4 development kit and RAB5-OSIRE adapter board to be used with ams OSRAM RGBi-GUI-MicroController software
RDK4_RAB5-OSIRE_SAID	This ModusToolbox™ code example is for SAID AS1163 testing and development.

Production data

Schematics

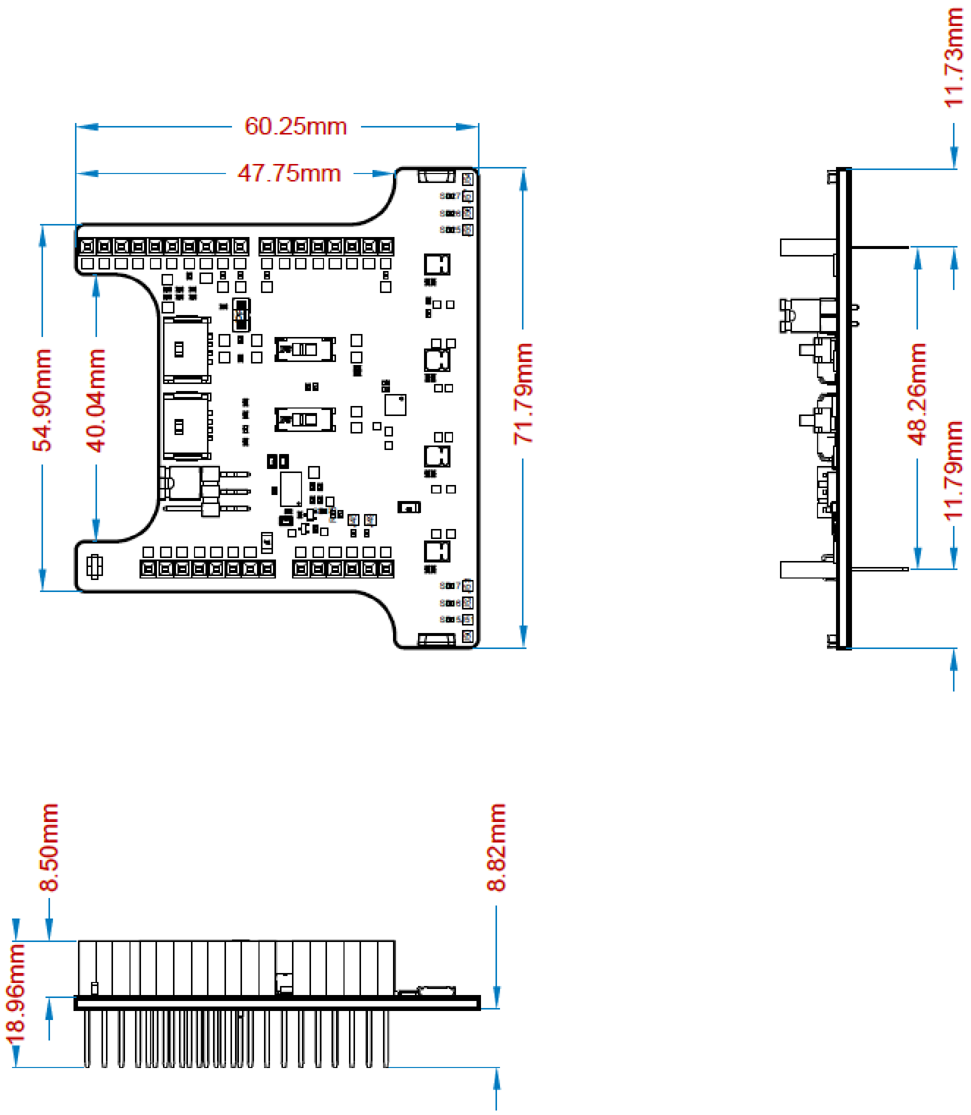
You'll find the schematics of RAB5-OSIRE here.

BOM

You'll find the BOM for RAB5-OSIRE here.

Mechanical layout

You'll find the Drawing for RAB5-OSIRE here.



OSIRE overview

Introduction

OSIRE ® E3731i is an intelligent RGB device (RGBi) designed for use in highly dynamic cases that require fast color changes and accurate color reproduction. The main application area is car interior lighting.

Figure 2. OSIRE ® E3731i

Features and operation of OSIRE ® E3731i

Key features

- Daisy chaining of up to 1000 units.
- Completely open protocol, no license costs.
- High brightness over full gamut in a day and night dimming modes.
- High color setpoint accuracy over full gamut.
- Integrated temperature sensor and optical measurement data.
- Integrated LED driver.

Design

A typical application includes up to 1000 LEDs arranged on one or multiple PCBs. An external MCU addresses and controls each device in a daisy chain architecture via an open system protocol. The open protocol allows the microcontroller to read back the calibration data, temperature and status of the LED. It also allows to read back a temperature value to optimize this color algorithm.

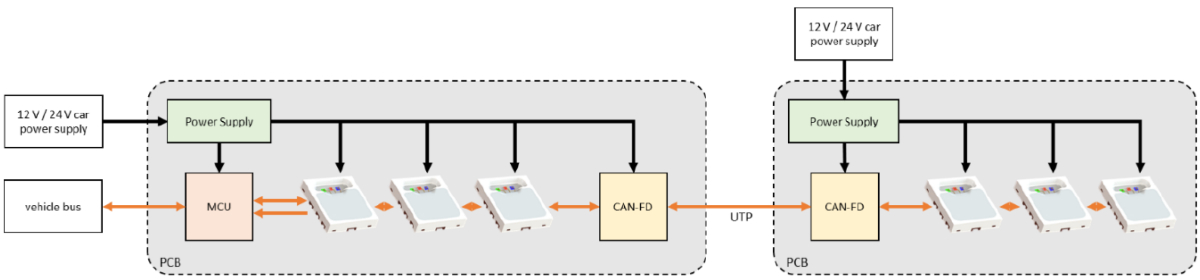


Figure 3. Application design

The first device in a daisy chain communicates with the master MCU via a dedicated single-ended interface.

It’s allowed to extend the daisy chain over multiple PCBs in a point-to-point fashion using the physical layer of CAN-FD.

Color mixing and calibration

Providing and maintaining LED light of a specific color shade is a complex task, as many factors affect the final result. These include both physical factors (current, temperature, aging) and design factors (chip position, angle, area, application material). To solve the problem, it is necessary to compensate for the influence of factors by calibrating the LEDs.

LED colors can be represented in a color space using the CIE (1931) x, y chromaticity diagram. Each hue is defined by a point (x, y) on a two-dimensional chromaticity graph. CIE x, y chromaticity diagrams are the basis for binning.

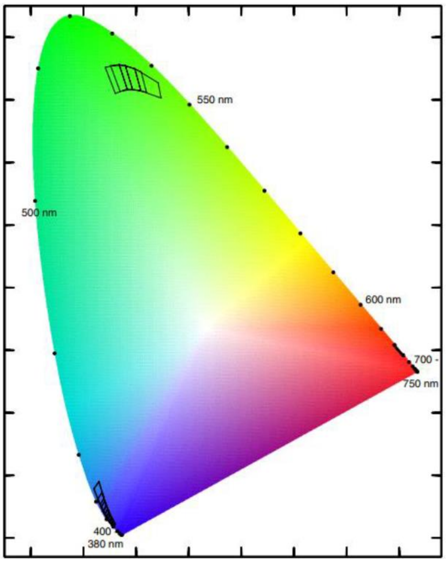


Figure 4. Chromaticity diagram

OSIRE® E3731i provides for every LED a built-in calibration data as well as a built-in temperature sensor in the IC. Together, this allows a highly accurate color control over the full color gamut and operating temperature range.

Calibration data (or optical data) describe an LED color radiation at the current moment of time. It is stored as encoded triplets of u’, v’, I_v for every LED. Here u’, v’ are color coordinates at chromaticity diagram, I_v is a current setting defining day or night dimming mode (50mA or 10mA). The encoded values are loaded to the MCU, and the physical color coordinates are calculated by it.

Any color within the accessible gamut for an RGB triplet can be realized by a linear combination of the individual spectra of three LEDs. Scaling of the intensity of the single LEDs is conveniently done by changing the effective duty cycle of the LEDs through the PWM (pulse-width modulation). The calculation of PWM duty cycles is given in the startup guide.

As temperature significantly affect the hue of LED, a temperature sensor is included for a full compensation of all three colors. It allows various ways to realize a highly accurate color control over the full color gamut and operating temperature range. The calculation method of temperature compensation is given in the startup guide.

Open system protocol

The communication in OSIRE ® E3731i is based on a dedicated master-slave serial bus protocol, called open system protocol (OSP). With OSP any appropriate microcontroller can be used without need to pay for a license.

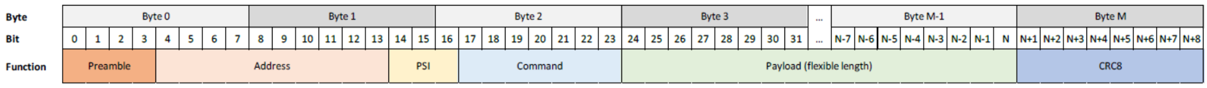


Figure 5. Message frame format

OSP allows bi directional, loop back, unicast and broadcast communications. Manchester code is used for a data transfer. Auto addressing of up to 1,000 devices is available.

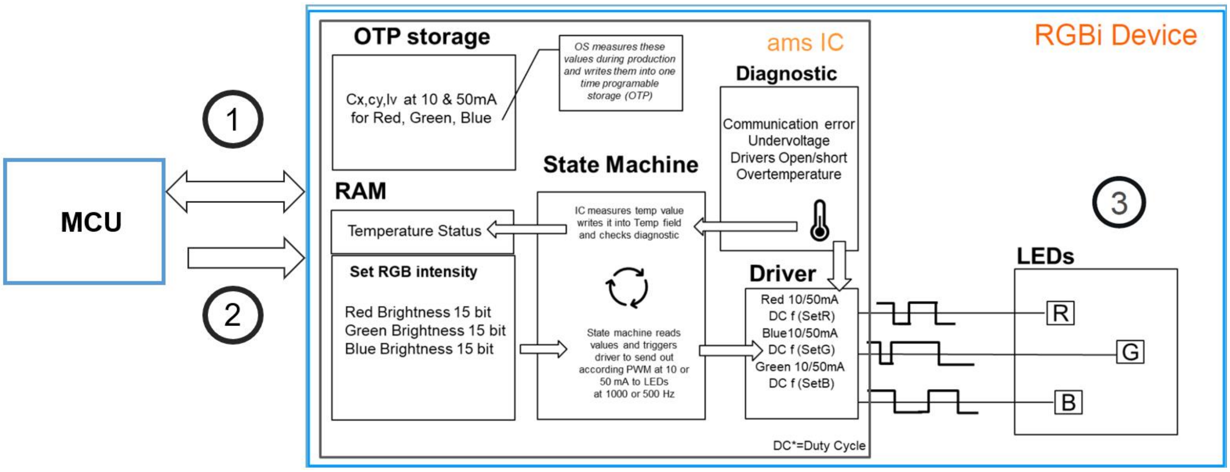


Figure 6. Flow of communication in OSP

To Figure 6. (1) Initialization. Auto-addressing of all RGBi devices in the chain. MCU reads the optical data of the three embedded R/G/B chips (cx, cy, Iv at 10mA and at 50mA) from each device.

(2): Color point request. MCU calculates color coordinates and sends R/G/B PWM values to the devices. MCU may request temperature from individual LEDs to consider temperature impact.

(3): Output. Each device drives the three chips according to request. Output kept until new request received.

Features of AS1163

AS 1163 (or SAID) by ams OSRAM is a module allowing to turn regular LEDs to intelligent ones. It drives nine LEDs organized in three channel triplets (RGB) with an independent PWM dimming dynamic range.

The communication protocol supported by AS1163 is fully compatible with OSIRE E3731i. AS1163 supports additional features such as I²C gateway, parallel connection, power-rail feedback and analogue readout.

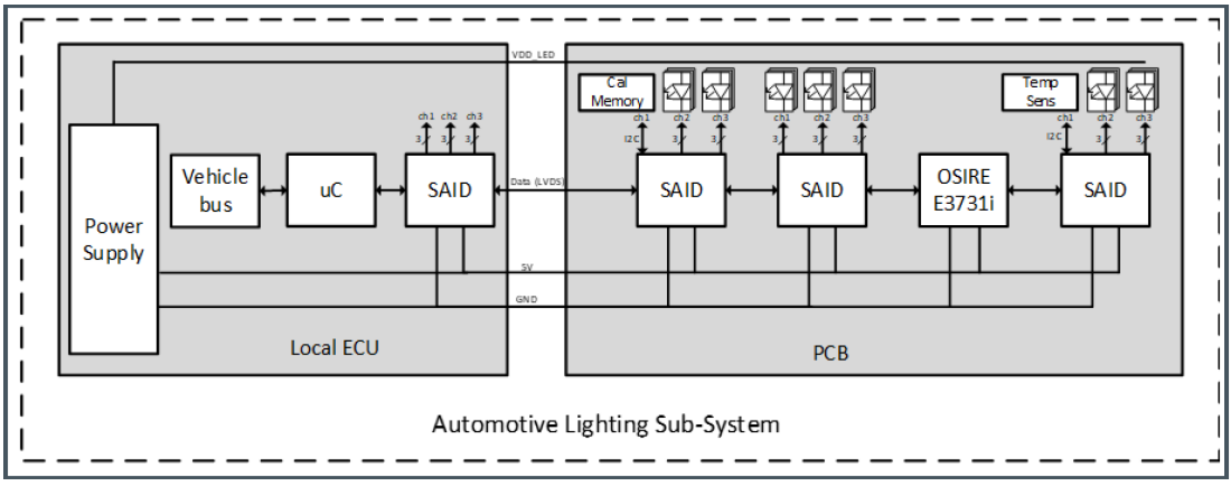


Figure 7. Example of AS1163 use case

At Figure 7 an LED stripe (designated as PCB) is connected to the electronic control unit of the car. The first and the last SAIDs of the PCB drive two LED triplets, the SAID in the middle drives three of them.

A memory connected to the first SAID stores calibration data for all LEDs on the PCB. A temperature sensor measures the temperature of one LED that is enough for this use case.