CAPTRON Electronic GmbH
Johann-G.-Gutenberg-Str.7
82140 Olching, Germany
www.captron.com

smartLED Software Development Kit

Product: SEH100, SEH200, SEH201 & smartLED SDK Documentation

Release

Function	Department	Name	Date
Author	Software Development	Artan Jakaj	15.03.2023

History

Date	Description	Author	Version
15.03.2023	First draft release of the documentation	AJ	1.0
23.06.2023	Added commands for SMC control	MLE	1.1
06.09.2023	Added information about fallback functionality	MLE	
13.09.2023	Added assign process description	MLE	
17.01.2024	Added more descriptions for SMC, examples, common settings	MLE	1.2

Applicable Documents/Data

Nr	Title	Description	Version
[1]	MQTT Communication protocol		

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Johann-G.-Gutenberg-Str.7
82140 Olching, Germany
www.captron.com

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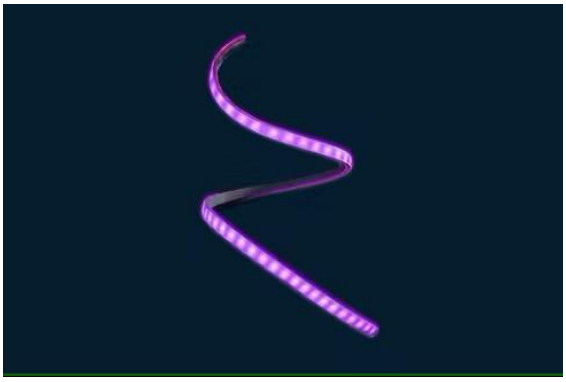
1 Introduction

The CAPTRON Pick-by-Light order picking solution is designed for medium-sized manufacturing companies and covers all relevant functions of a distributed WMS. The modular and open system links hardware with software solutions. It can be easily integrated into an existing software architecture and easily expanded – for easy digitization of material flows in production and intralogistics.

The hardware part of the solution consists of the following components:

- **smartLED**: robust, flexible and versatile Pick-by-Light LED stripes, which can be applied in simply way on a lot of surfaces (more information: [smartLED | CAPTRON Solutions (captron-solutions.com)]



- **LEDhub**: the functional interface to the IP network (more information: [LEDhub | CAPTRON Solutions (captron-solutions.com)]

smarLED SDK Documentation is a developer guide, which demonstrates how to control the smartLED Strips with the LEDhub using the MQTT communication protocol.
The business applications can implement the MQTT protocol and publish messages to the LEDhub.

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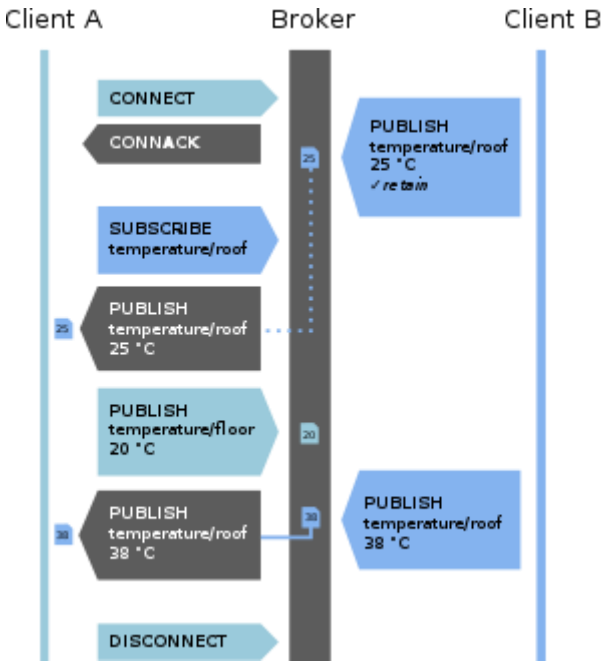
2 Short notes about the MQTT Protocol

MQTT stands for Message Queuing Telemetry Transport. It is a lightweight messaging protocol that is designed to provide efficient, reliable communication between devices in IoT (Internet of Things) and other resource-constrained environments.

MQTT follows a publish/subscribe model, where publishers send messages to a broker that acts as an intermediary, and subscribers receive those messages from the broker. This allows for efficient distribution of messages to multiple recipients, without requiring each device to maintain a direct connection to every other device.

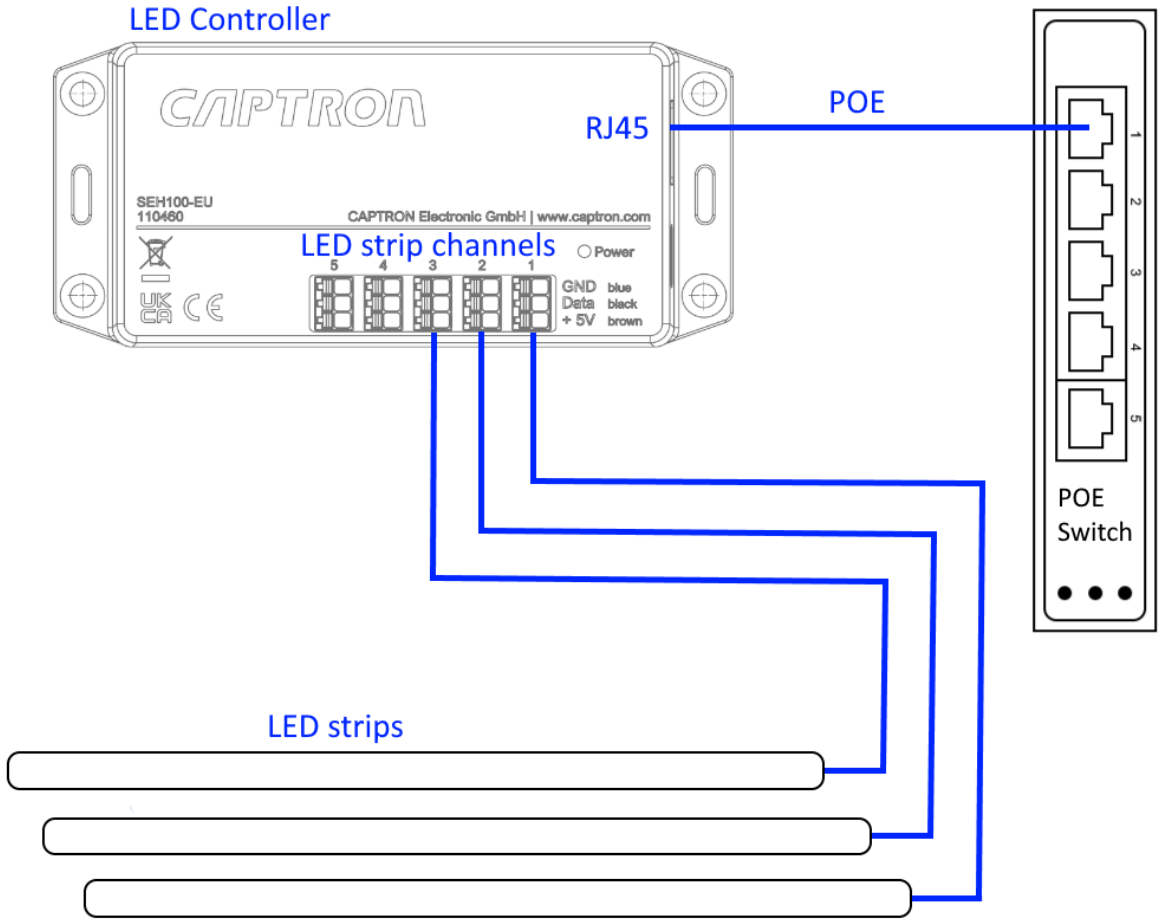
MQTT is designed to be highly scalable, flexible, and easy to implement on a wide range of devices, from simple microcontrollers to powerful servers. It is widely used in IoT applications, where devices need to communicate with each other over constrained networks and with limited processing power and memory resources.

MQTT



3 Hardware assembling

The cable connections between all parts of the system are presented on the schema below



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4 Local MQTT communication

To start communicating with the LEDhub in a local environment a mqtt server is necessary. For example eclipse-mosquitto in a docker environment can be used. To provide address and login information the CAPTRON onboard system can be used as well as the integrated setup page. For the onboard system you will need the unique-id printed on the device. Please make sure that the device can reach this server: *iot-ogc-prod-northeurope.azure-devices.net* on tcp-port 8883. More information concerning the setup page you find in the chapter “web setup”.

4.1 Definitions

- {product} is the name of the product. e.g. "SEH100" or "SEH200" in case of python head with SMC connection
- {device-id} is the unique name of the device and consists of a randomly generated word combination like "GroovySquareTongue" or "TinyHappyGroup"
  This id is used to create the topics. The id is printed on the device.
- {Content definition} is the part of the topic after the {device-id}. e.g. "/Pub/MAM"

4.2 Device information

Topic	`captron.com/{product}/nd/{device-id}/Pub/MAM`
Device Pub/Sub	Publish

Message Payload Data	<pre>{
	"Content": "{Content definition}",
	"BoardName": "lucky_python",
	"Manufacturer": "CAPTRON",
	"Model": "PYTHON-Head",
	"ProductCode": "123456789",
	"SoftwareVersion"; "v0.0.1"
	}</pre>

Explanation	The device broadcasts data which is generic and individual to a device and the configuration which is given to the device during the onboarding process also all methods which can be called

Topic	`captron.com/{product}/nd/{device-id}/Get/MAM`
Device Pub/Sub	Subscribe
Message Payload Data	n.a.
Explanation	Request device information Replies on corresponding "Pub"-topic

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4.3 Configuration

4.3.1 MQTT

Topic	captron.com/{product}/nd/{device-id}/Set/Config/MQTT
Device Pub/Sub	Subscribe

Message Payload Data	{
	"Content": "{Content definition}",
	"Vendor": "captron",
	"Port": 1883,
	"MQTTServer": "update.oneGrid.captron.com",
	"MQTTUsername": "Captron2022",
	"MQTTPassword": "qwxYT321!",
	"Encryption": false
	}

Explanation	Provide connection information specific to the owner of the application such as server config. If no login credentials are needed you can use null as the value of mqtt username and mqtt password. This message is used while automatic onboarding process. Be aware that after a power cycle the device will ask this information from the onboarding system.

4.3.2 LED strip

Topic	captron.com/{product}/nd/{device-id}/Set/Config/LedStrip
Device Pub/Sub	Subscribe

Message Payload Data	{
	"Content": "{Content definition}",
	"Demo": false,
	"LED_STRIP_1":{
	"Length": "42"
	},
	"LED_STRIP_2":{
	"Length": "42"
	},
	etc...
	}

Explanation	Use case specific configuration of led stripes (e.g. length as count of leds), For FW v0.2.10 and higher: this message is NOT mandatory anymore. The default used is 180 LEDs per stripe. Bool "Demo" enables/disables the demo mode. If enabled: plays different colors and effects on output 1 and 2, this setting is persistent saved in memory - if you enable the demo mode it is also activated after a powercycle

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4.4 Activate LED strip

Topic	`captron.com/{product}/nd/{device-id}/Set/Data/LedStrip`
Device Pub/Sub	Subscribe
Message Payload Data	

```
{
    "Content": "{Content definition}",
    "LED_STRIP_1": {
        "Active": true,
        "Segments": [
            {
                "StartLED": 0,
                "StopLED": 30,
                "Speed": 190,
                "Effect": 1,
                "Colors": [
                    {
                        "R": 0,
                        "G": 150,
                        "B": 0
                    },
                    {
                        "R": 0,
                        "G": 150,
                        "B": 0
                    }
                ]
            }
        ]
    }
}
```

Explanation

Light UP LED`s

- use the Active-flag for switching the strip on or off
- Effects
  - 1: FX_MODE_STATIC
  - 2: FX_MODE_BLINK
  - 3: FX_MODE_FLASH
  - 4: FX_MODE_LEADING_LINES
  - 5: FX_MODE_LEADING_LINES_REVERSE
  - 6: FX_MODE_MULTIPICKER
  - 200: FX_MODE_CUSTOM_KNIGHT_RIDER
- Speed from 1 (slow) to 250 (fast)
- Multiple Colors apply only for some effects like the FX_MODE_MULTIPICKER.
  In that case colors change between the RGB-values specified in the colors-array.
  For all other effect only the first color in the array applies.
- 6 segments with different colors/effects can be set. Depending on the maximum mqtt message size also more segments can be set. The mqtt message size must be below 4k.
- This command can be ignored if a power limit is reached. In this case an error message will be logged to inform the user.

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82140 Olching, Germany
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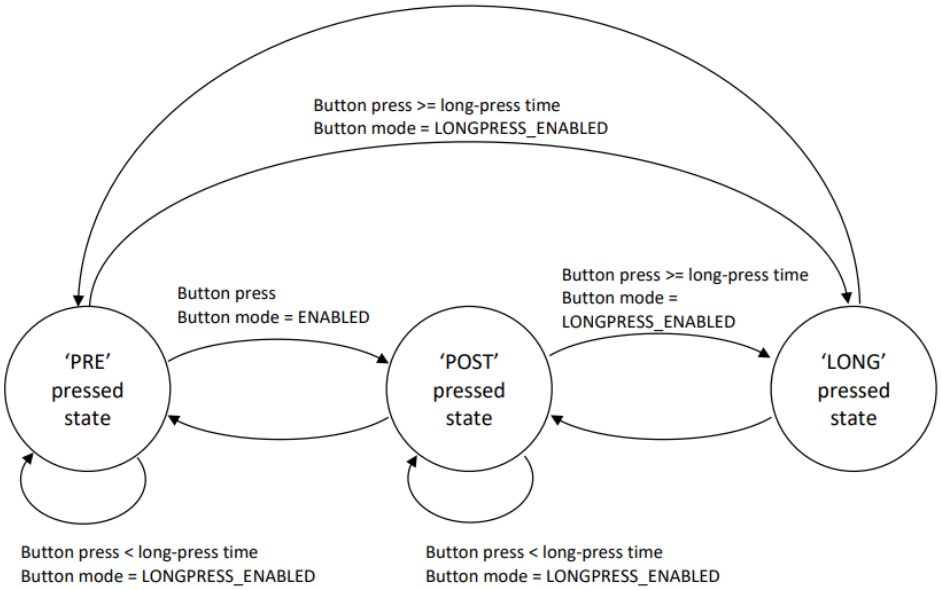
4.5 Control of SMC buttons (SEH200 devices)

4.5.1 State machine

SMC buttons start in PRE-state. When touching the button it will change to POST-state (when enabled via command). Bringing the state back to PRE is only possible through command. Different color settings for PRE- and POST-state are possible.



4.5.2 Topics and Definitions

Topic	`captron.com/{product}/nd/{device-id}/Set/Data/Smc`
Device Pub/Sub	Subscribe

Message Payload Data	<pre>{
	"Content": "{Content definition}",
	"Address": "{Button address, "HUB" or "ALL_SENSORS"}",
	"CommandType": "{Command Type}",
	"Offset": "{Offset}",
	"Payload": "{Payload}"
	}</pre>

Explanation	Control SMC buttons connected to SEH200. Implemented in FW V0.2.5

Commands to SMC	Address: Button address or "ALL_SENSORS"
	• **Setting LED ring and display**
	  • Command Type: "SET_PARAMETER"
	  • Offset: "PRE_BUTTON_MODE" and "POST_BUTTON_MODE"
	  • Payload: "{ENABLED or DISABLED}/{quantity}/{LED ring color}/{LED ring effect}/{Display text}"
	• **Setting button rotation (*)**
	  • Command Type: "SET_PARAMETER"
	  • Offset: "BUTTON_ROTATE"
	  • Payload: "BUTTON_ROTATION_NORMAL" or "BUTTON_ROTATION_UPSIDEDOWN"
	* Older firmware version do not apply this setting after powercycle. In this case it is needed to send this command after each powercycle of the SMC button.

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	• **Setting longpress time (**)**
	  • Command Type: "SET_PARAMETER"
	  • Offset: "LONGPRESS_TIME"
	  • Payload: "{Milliseconds divided by 10, max 2.55 seconds}"
	** needs min. Firmware V5.3.9 on the SMC button.
	• **Assign button address**
	  • Command Type: "SET_STATUS"
	  • Offset: "ADDRESS_TO_BE_ASSIGNED"
	  • Payload: "{Number to assign}"
	• **Additional Commands: Switch between Pre/Post, Reboot etc.**
	  • Command Type: "SET_STATUS"
	  • Offset: "SPECIAL_COMMANDS"
	  • Payload:
	  • "PRE_PRESSED_STATE" - set to pre state
	  • "POST_PRESSED_STATE" - set to post state
	  • "REBOOT" - restart button
	  • "SHOW_CURRENT_ADDRESS" - show button address
	  • "LONG_PRESSED_STATE" - set to longpress state (needs min. SEH Firmware V0.2.27-3)
	Detailed information on commands or assign procedure see the next chapters.

Command for polling function	Address: "HUB" • Command Type: "SET_PARAMETER" • Payload: polling addresses, ("/" as separator), up to 6 addresses possible e.g. "1002/1003/1004" "0000" for switching polling off
Response	• when polling to certain button address is active • response when button was touched on topic "Pub/Data/Smc": Address: touched button Command Type: "SET_STATUS" Payload: "POST_PRESSED_STATE"

4.5.2.1 Setting LED ring and display

Message Payload Data	
	{
	"Content": "{Content definition}",
	"Address": "{Button address, "HUB" or "ALL_SENSORS"}",
	"CommandType": "SET_PARAMETER",
	"Offset": "{"PRE_BUTTON_MODE" or "POST_BUTTON_MODE"}",
	"Payload": "{"ENABLED" or "DISABLED" or "LONGPRESS_ENABLED"}/{Quantity}/
	{LED ring color}/{LED ring effect}/{Display text}"
	}

Explanation	{"ENABLED" or "DISABLED" or "LONGPRESS_ENABLED"}: • ENABLED: button can be confirmed, LED ring and display can be controlled • DISABLED: button can NOT be confirmed, LED ring and display can be controlled • LONGPRESS_ENABLED: button goes to Longpres-state after keeping the touch for a certain time (default 2 seconds), settings for LED ring and display can be controlled using the POST_BUTTON_MODE offset {Quantity}: number from 1 to 9999, number will be automatically aligned in the middle of the display {LED ring color}: • COLRED • COLOFF • COLGREEN • COLBLUE • COLYELLOW • COLMAGENTA • COLCYAN • COLWHITE

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{LED ring effect}:

- SOLID_RING
- FLASH_RING
- CONFIRM
- POINT_ANIMATED_CLOCK
- CIRCLE_ANIMATED_CLOCK
- SOLID_ARROW_UP
- SOLID_ARROW_DOWN
- SOLID_ARROW_LEFT
- SOLID_ARROW_RIGHT
- FLASH_ARROW_UP
- FLASH_ARROW_DOWN
- FLASH_ARROW_LEFT
- FLASH_ARROW_RIGHT
- ANIMATED_ARROW_UP
- ANIMATED_ARROW_DOWN
- ANIMATED_ARROW_LEFT
- ANIMATED_ARROW_RIGHT
- SOLID_ARROW_UP_LEFT (*)
- SOLID_ARROW_UP_RIGHT (*)
- SOLID_ARROW_DOWN_LEFT (*)
- SOLID_ARROW_DOWN_RIGHT (*)
- FLASH_ARROW_UP_LEFT (*)
- FLASH_ARROW_UP_RIGHT (*)
- FLASH_ARROW_DOWN_LEFT (*)
- FLASH_ARROW_DOWN_RIGHT (*)

* needs min. Firmware V5.3.7 on the SMC

{Display text}:

- max. 4 characters
- some characters can not be displayed due to 7-segment restrictions

Displayable characters are written in green.

Code	...0	...1	...2	...3	...4	...5	...6	...7	...8	...9	...A	...B	...C	...D	...E	...F
3...	0	1	2	3	4	5	6	7	8	9	:	;	<	=[18]	>	?
4...	@[19]	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
5...	P	Q	R	S	T	U	V	W	X	Y	Z	[	\	]	^	_
6...	`	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
7...	p	q	r	s	t	u	v	w	x	y	z	{	|	}	~	DEL
8...	Bits 0 to 6 of ASCII code control segments a to g.															

[18] Displayed as '_' character.
[19] Used as 'space' character.

- use "@" as space character
- examples: "@Go@", "donE"

If both {Quantity} and {Display text} is defined {Quantity} will be used. When {Display text} is used no automatically alignment is done on the display. The user needs to take care about it. E.g. to show a left-aligned number {Display text} can be set to "42@@" or for a right-aligned number "@@42". If {Quantity} is used the alignment is done automatically.

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4.5.2.2 Examples

Sending to SMC button with address "1000"	Setting LED ring color to green (flashing) + Displaying a quantity of "42": `{ "Content": "/Set/Data/Smc", "Address": "1000", "CommandType": "SET_PARAMETER", "Offset": "PRE_BUTTON_MODE", "Payload": "ENABLED/42/COLGREEN/FLASH_RING" }`
	Setting LED ring color to blue + Displaying "donE" in post-pressed/longpress-state: `{ "Content": "/Set/Data/Smc", "Address": "1000", "CommandType": "SET_PARAMETER", "Offset": "POST_BUTTON_MODE", "Payload": "ENABLED//COLBLUE/SOLID_RING/donE" }`
	Switch button to pre-pressed-state: `{ "Content": "/Set/Data/Smc", "Address": "1000", "CommandType": "SET_STATUS", "Offset": "SPECIAL_COMMANDS", "Payload": "PRE_PRESSED_STATE" }`
	Setting longpress time to 1 second: `{ "Content": "/Set/Data/Smc", "Address": "1000", "CommandType": "SET_PARAMETER", "Offset": "LONGPRESS_TIME", "Payload": "100" }`
Sending to all connected SMC buttons	Switch buttons to pre-pressed-state: `{ "Content": "/Set/Data/Smc", "Address": "ALL_SENSORS", "CommandType": "SET_STATUS", "Offset": "SPECIAL_COMMANDS", "Payload": "PRE_PRESSED_STATE" }`

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4.5.3 Assign procedure

Each connected SMC needs a unique address to be able to communicate. The addressing starts with address 1000. Four steps are needed to assign an address to a certain button:

- Send a message to show an effect e.g.:

```
{
  "Address": "ALL_SENSORS",
  "CommandType": "SET_PARAMETER",
  "Offset": "PRE_BUTTON_MODE",
  "Payload": "ENABLED//COLCYAN/CIRCLE_ANIMATED_CLOCK/@@@@"
}
```

- Set all SMCs to PRE-state:

```
{
  "Address": "ALL_SENSORS",
  "CommandType": "SET_STATUS",
  "Offset": "SPECIAL_COMMANDS",
  "Payload": "PRE_PRESSED_STATE"
}
```

- Send assign message with the address to be used:

```
{
  "Address": "ALL_SENSORS",
  "CommandType": "SET_STATUS",
  "Offset": "ADDRESS_TO_BE_ASSIGNED",
  "Payload": "1000"
}
```

- Confirm the SMC to be assigned by touching it.

4.5.4 Reset Assign

Send these two messages to reset the assigned address to FFFE (default) on all connected SMCs:

```
{
  "Address": "ALL_SENSORS",
  "CommandType": "SET_PARAMETER",
  "Offset": "ADDRESS_BTN_LOW_BYTE",
  "Payload": "FFFE"
}
{
  "Address": "ALL_SENSORS",
  "CommandType": "SET_STATUS",
  "Offset": "SPECIAL_COMMANDS",
  "Payload": "REBOOT"
}
```

Also if accidently two SMCs have the same address assigned please first reset the assign for all connected SMCs and then start the assign procedure again with address 1000.

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82140 Olching, Germany
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4.6 Health, status and common settings

4.6.1 LED strip

Topic	captron.com/{product}/nd/{device-id}/Pub/Health/LedStrip
Device Pub/Sub	Publish

Message Payload Data	{
	"Content": "{Content definition}",
	"Firmware": "V0.1.0",
	"LED_STRIP_1": {
	"Configured": true,
	"Length": 42,
	"Active": true
	},
	"LED_STRIP_2": {
	"Configured": true,
	"Length": 42,
	"Active": false
	},
	"LED_STRIP_3": {
	"Configured": true,
	"Length": 42,
	"Active": false
	},
	"LED_STRIP_4": {
	"Configured": false,
	"Length": 0,
	"Active": false
	},
	"LED_STRIP_5": {
	"Configured": false,
	"Length": 0,
	"Active": false
	}
	}

Explanation	The health of a LED strip connected to the board. This message is published after powering on the device.

Topic	captron.com/{product}/nd/{device-id}/Get/Health/LedStrip
Device Pub/Sub	Subscribe
Message Payload Data	n.a.
Explanation	Request LED strip health and information . Replies on corresponding "Pub"-topic

4.6.2 System

Topic	captron.com/{product}/nd/{device-id}/Pub/Health/SysLog
Device Pub/Sub	Publish
Message Payload Data	event logging (info, warn, error etc.), version, uptime, ip address etc.
Explanation	The Syslog of a device. This message is published every 6h and also when LED strip health is requested. Also diagnosis messages (e.g. detected wiring errors, overloads etc.) are published on this topic.

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4.6.3 Common settings

Topic	captron.com/{product}/nd/{device-id}/Set/Config/Common
Device Pub/Sub	Subscribe

Message Payload Data	{
	"Content": "{Content definition}",
	"LogLevel": {1 to 6},
	"StartDiagnosis": true
	}

Explanation	LogLevel: setting the log level. the default setting is "3" - Warning. Different levels can be set: • 1 - Fatal • 2 - Error • 3 - Warning (default) • 4 - Notice (logs e.g. the response if an LED segment is activated) • 5 - Info • 6 - Trace Log messages with choosen and lower numbers (higher severity) are published on the syslog-topic. E.g. setting the log level to 4 will force the device to publish log messages with the rankings: Fatal, Error, Warning and Notice. The setting of the log level is not saved in flash - the device will always start with the default setting. StartDiagnosis (only for devices SEH101 and SEH201): starts diagnosis on output clamps. Check for e.g. wiring faults. Possible errors are published on the syslog-topic.

4.7 Firmware update

Topic	captron.com/{product}/nd/{device-id}/Call/FirmwareUpdate
Device Pub/Sub	Subscribe

Message Payload Data	{
	"Content": "{Content definition}",
	"Url": "update.oneGrid.captron.com/stable/firmware.bin"
	}

Explanation	Start the update process

4.8 Time distribution

Topic	captron.com/Time captron.com/{product}/nd/{device-id}/Set/Config/Time
Device Pub/Sub	Subscribe

Message Payload Data	{
	"Content": "{Content definition}",
	"DateTime": "%Y-%m-%d %H:%M:%S"
	}

Explanation	Distribute time to each device String with format "%Y-%m-%d %H:%M:%S", e.g. "2023-02-28T11:18:30"

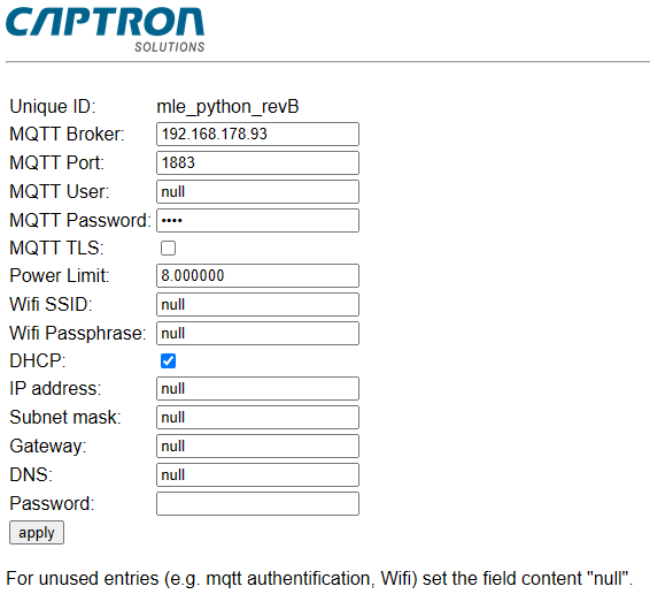
4.9 Status signalisation

At startup the device status is signaled by the connected LED stripes.
For helping while installation (mapping stripes to outputs) on each output another count of LEDs light up: one LED lights up on output 1, two LEDs light up on output 2 etc.
The signalisation colors will be shown until the first Set/Data-command.

Color	Status
Red	Ethernet/WiFi connection attempt, no Ethernet/WiFi connection
Yellow	mqtt connection attempt, no mqtt connection
Orange	Configuration requested, no Configuration
Cyan/Green-Blue	Connection established

4.10 Web Setup Page

As a possibility for an offline configuration the integrated setup page can be used. You can access it through any browser with typing in http:// followed by the IP of the device. As default the device will try to obtain its IP address through a DHCP server. In this server/router you can look up the assigned address. The web setup page is available from on Firmware Version V0.2.27-29.



To apply settings please type “pythonhead22” in the Password field (last line) and confirm the apply button.

4.10.1 Static IP setting

In case of static IP setting is needed (e.g. no DHCP server can be used), please fill at least the three fields: IP address, Subnet mask and Gateway. If there is no gateway, please nonetheless enter a valid address here (e.g. the devices address).
From on Firmware Version V0.2.27-57 the DNS field can be left “null”. The device will then omit trying to connect to our onboarding system.

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Johann-G.-Gutenberg-Str.7
82140 Olching, Germany
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4.11 Fallback Functionality

4.11.1 Priority

From Firmware Version V0.2.27-41 the ethernet port has priority over WiFi. If a connection through LAN can be established the WiFi setting will be ignored. If no ethernet connection can be established and no WiFi is configured, the device will try to connect to the fallback WiFi (EU variants only) – this will take up to 45 seconds.

4.11.2 Wifi fallback

In case that a configured Wifi network cannot be reached the device will try to access this hard-coded wifi:

- SSID "SEH_fallback_wifi"
- Passphrase "fallback_pw"

This fallback wifi network can be created e.g. with setting a hotspot on a mobile phone with the specific name and passphrase.

If the connection to the fallback wifi is established the device will connect to the onboarding-service and get the latest configuration. So, a faulty wifi configuration can be corrected this way.

The WiFi functionality is only available on EU-variants. On other variants like JP, CN or US the WiFi module is disabled.

4.11.3 Static IP fallback

In case that a device with static IP setting cannot access the network after about 45 seconds the device will fallback and try to get its network settings from a DHCP-server.

If the fallback was successful, the device will connect to the onboarding-service and get the latest configuration. A faulty IP setting can be corrected this way.

4.11.4 DHCP fallback (APIPA)

If the device is configured to get an address from a dhcp server and this server is not reachable the device will assign itself this network setting (within apipa range) after about 45 seconds:

- IP address: 169.254.101.201
- Subnet: 255.255.0.0

With a direct ethernet connection to a computer it can be reconfigured by using the websetup page. This fallback method is available from on firmware version V0.2.27-63.