OptConnect ema[™] ema:Play User Guide

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1. Introduction

1.1 Scope

The OptConnect ema:Play Evaluation Kit is a hardware platform designed and optimized for evaluating OptConnect ema[™] modems. ema:Play provides easy access to the features of OptConnect ema[™] modems, and acts as a launching point for translation into custom IoT/M2M applications using OptConnect ema[™]. This document serves as a guide and point of reference for using ema:Play correctly and efficiently.

1.2 Contact Information

For more information regarding OptConnect ema[™] contact OptConnect Sales at 1.877.678.3343 ext. 2020 during normal business hours. For technical support contact OptConnect Customer Care Center at 1.877.678-3343 ext. 2021 from 8 am till 9 pm MST Monday through Saturday.

1.3 Orderable Part Numbers

| Orderable Device | Primary Module Firmware Revision | Operating Temperature | LTE Bands | 3G UMTS | Network | Region |
|---------------------|---|--------------------------|-----------------------------|------------|------------------|---------------|
| EMA-L4-1-XX-A-A | 20.00.505 | -40 to +85°C | FDD B2, B4, B5, B12, B13 | B2, B5 | AT&T, Verizon | North America |
| EMA-L4-1-US-B-A | 20.00.005 | -40 to +85°C | FDD B2, B4, B5, B12, B13 | B2, B5 | AT&T, Verizon | United States |
| EMA-L4-1-XX-A-A-000 | 20.00.506 | -40 to +85°C | FDD B2, B4, B5, B12, B13 | B2, B5 | AT&T, Verizon | North America |
| EMA-L4-1-US-B-A-000 | 20.00.006 | -40 to +85°C | FDD B2, B4, B5, B12, B13 | B2, B5 | AT&T, Verizon | United States |

Unless instructed otherwise EMA-L4-1-XX... will utilize AT&T as the primary carrier and Verizon as the secondary carrier. Unless instructed otherwise, EMA-L4-1-US... will utilize Verizon as the primary carrier and AT&T as the secondary carrier.

| Orderable Device | Description | Operating Temperature | Region |
|---------------------|---|--------------------------|---------------|
| EMA-ZZ-1-XX-Z-B | ema:Play Evaluation Kit, OptConnect ema™ evaluation platform | -40 to +85°C | North America |
| EMA-L4-1-XX-A-B | ema:Play Evaluation Kit, OptConnect ema™ evaluation platform, EMA-L4-1-XX ema modem included | -40 to +85°C | North America |
| EMA-L4-1-US-B-B | ema:Play Evaluation Kit, OptConnect ema™ evaluation platform, ema EMA-L4-1-US ema modem included | -40 to +85°C | United States |



1.4 Additional Resources

OptConnect ema[™] is supported by a full range of documentation, including User Guides and Application Notes as well as related code samples. The latest versions of these resources can be found at **http://optconnect.com/ema**. Suggested prerequisites for this document are the following:

- OptConnect ema™ Hardware Guide
- OptConnect ema[™] Getting Started
- OptConnect ema[™] emaLink AT Command Manual

1.5 Activation

If ema is not activated/registered upon receipt, please visit **https://summit.optconnect.com/ema** to activate/register ema. Once activated, ema:Play includes a free trial period that will last for three months, with 1 GB of data being available per month. Please contact OptConnect (see section 1.2) for further questions and requests in regard to the trial period.

2. Overview

2.1 Contents

The ema:Play Evaluation Kit is shipped as a ready to use, "all-in-one" platform for evaluating OptConnect ema[™] modems for IoT/M2M applications. The contents of the kit are listed below.

- 1. ema:Play Evaluation Kit with/without ema installed (see section 1.3 for device p/n's)
- 2. OptConnect Gemini MIMO Antenna
- 3. 5VDC Power Supply
- 4. 2 x USB cables

2.2 Features

- On-Board Microcontroller Unit (MCU)
 - Microchip ATSAME51J20A.
 - 120MHz Core Processor
 - o 1 MB Flash, 256 KB Ram
 - On Board programmer/debugger
 - JLink OB Technology
 - Cortex SWD Connector for external programmers/debuggers
 - Debug Port
 - UART to USB access
 - External Header access
 - Voltage Monitors
 - Input Voltage
 - ema Voltage
- Configurable Power Supply
 - Wide input voltage range 4.5V 30V
 - External power input terminal for other sources (Battery, benchtop, etc.)
 - Standard barrel connector input
 - USB power input (excludes powering ema)



- ema load switch for low power applications
- Configurable ema Communication Interfaces
 - Modem UART interface access
 - RS485/422 full-Duplex
 - RS485 half-Duplex with Auto Direction Control
 - On-Board MCU
 - External header access
 - Serial 2 USB (S2USB) for computer terminal access
 - o emaLink interface access
 - On-Board MCU
 - External header access
 - o ema USB interface
 - Screw terminal block access for wire to board
 - Shrouded connector access for board to board
- Built in sensors and feedback
 - Temperature and humidity
 - Light/photo
 - o 2 user push buttons
 - LED cellular signal array (Blue)
 - 2 x LEDs (Red)
- User Application Headers
 - Input/Output Application Header
 - Access to On-Board MCU
 - 1 x i2c
 - 1 x CAN bus
 - 4 x UART
 - 1 x Analog to Digital (ADC)
 - 1 x Digital to Analog (DAC)
 - 6 x General Purpose Input Output (GPIO)
 - Access to ema communication interfaces
 - Modem UART
 - emaLink
 - Power Application Header
 - ema power control
 - 3.3V power control
 - ema IOVREF control
 - ema Reset Request control
 - ema On/Off control
 - 3.3V, 4.0V for external usage
- Easy grab test points for measurements
- Efficient design
 - Cost and availability optimized
- Antenna adaptors built in
 - U.FL to SMA for both main and diversity
- Electrical design CAD available for reference



3. Hardware

Section 3 outlines the hardware of ema:Play from a user perspective. *Figures 1-3* can be used as quick reference guides for navigating the various components and features of ema:Play. The hardware is designed for flexibility and configurability to support different user IoT/M2M applications and integration architectures, and to also serve as a reference for custom hardware designs integrating ema.

3.1 At a Glance



Figure 1





Figure 2



3.2 System Architecture



Figure 3

3.3 Power

ema:Play can be powered through multiple connectors and/or ports. Furthermore, depending on which connector/port is powering ema:Play, will also determine which sub systems of the hardware are powered. There are various feedback LED's that are provided to let the user know which sub systems are currently powered. In addition to power input configurations, ema:Play also offers power output for applications requiring off board power:

Table 1 summarizes the power input architecture and configurations.

Table 2 summarizes related power control signals.



| Description | Voltage (ref) | Sources | Inputs Ports (ref) | Outputs Ports (ref) | Systems Powered | Feedback (ref) |
|----------------------------------|---|---|---|--|----------------------------|------------------------------------|
| Main Power Input | Min 4.5V (VIN) Max 30V (VIN) Min 6.75W | External Source | Barrel Connector (J9) External VIN (J2/J1) | Test Hook (J9+) Test Hook (ExtVIN, VIN) | 4V, 4VMOD(ema), 3.3V | 4V (D5) 4VMOD (D6) 3.3V (D7) |
| S2USB USB | 5V (5V_S2USB) | External USB Port | S2USB Port (J10) | Test Hook (5vS2USB) | 3.3V, S2USB | 3.3V (D7) S2USB (D9) |
| JLink USB | 5V (5V_USBJL) | External USB Port | JLink USB Port (J13) | Test Point (TP76) | 3.3V, JLink | 3.3V(D7) JLink (D28) |
| Main Regulator (U5) Output | 4V (4V0) Max 3A | Main Power Input | na | Test Hook (4V0) Pwr App Hdr (J4.1) | 4V, 4VMOD(ema), 3.3V | 4V (D5) 4VMOD (D6) 3.3V (D7) |
| Load Switch (U6) Output | 4V (4VMOD) Max 2A | 4V (4V0) | na | Test Hook (4VMOD1, 4VMOD2) Pwr App Hdr (J4.7) | 4VMOD(ema) | 4VMOD (D6) |
| MCU & Interface Power (U7) | 3.3V (3V3) Max 1A | 4V (4V0) 5V (5V_S2USB) 5V (5V_USBJL) | na | Test Hook (3.3V) Pwr App Hdr (J4.3) IO App Hdr (J5.12) | 3.3V | 3.3V (D7) |
| ema IOVREF | Min 1.8V (IO_VREF) *Max 5.5V (IO_VREF) | 3.3V (3V3) External via Pwr App Hdr (J4.9) | Pwr App Hdr (J4.9) | Test Hook (VIOREF1, VIOREF2) | ema IO interface | na |

* Onboard MCU (U16) must be held in reset if IOVREF is supplied as >4.1V

| Description | Signal (ref) | Systems Disabled | Notes | |
|----------------------------------|--------------------------|---------------------|--|--|
| ema Power disable | 4VMOD_DIS (J4.2) | ema Power | This signal can be driven high to disable ema's power for power sensitive applications | |
| MCU & interface Power disable | 3V3_DIS (J4.4) | 3.3V Power rail | This signal can be driven high to disable the entire 3.3V power rail. Typically, this would be used if an external host embedded system is interfacing to ema using the Application headers | |
| Onboard IOVREF disable | OB_uP_IOVREF_DIS (J5.28) | Onboard 3.3V IOVREF | This signal can be used to set ema's IOVREF level from an external source | |

Table 2



3.4 Communications

ema:Play provides several useful and common communication interfaces for sending and receiving data to and from ema. Additionally, standard interfaces are offered to communicate directly with the Onboard MCU (U16) for further flexibility. Refer to the following tables for identifying which interface will work best for the application:

Table 3 summarizes the ema Modem, emaLink, and USB Interface configurations.

Table 4 summarizes the Onboard MCU (U16) interface configurations.

| ema Interface | ema:Play Interface | Access Port (ref) | Configuration Switches (ref) | Use Case Example |
|-----------------------------|-----------------------------|--|---------------------------------------|---|
| | S2USB Standard Comm Port | S2USB USB Port (J10) | Dipswitch (SW2) | This interface can be used to access the ema Modem UART from a computer terminal program and manually send AT commands |
| | RS232 | Wire to Board Terminal (J2.3-J2.6) Board to Board Terminal (J1.3-J1.6) | Dipswitch (SW2) Slide Switch (SW4) | This interface can be used to access the ema Modem UART using RS232 from an external device, to send AT commands |
| ema Modem UART Interface | RS422/RS485-4 | Wire to Board Terminal (J2.3-J2.6) Board to Board Terminal (J1.3-J1.6) | Dipswitch (SW2) Slide Switch (SW4) | This interface can be used to access the ema Modem UART using RS422/RS485 full duplex from an external device, to send AT commands |
| | RS485-2 | Wire to Board Terminal (J2.3, J2.4) Board to Board Terminal (J1.3, J1.4) | Dipswitch (SW2) Slide Switch (SW4) | This interface can be used to access the ema Modem UART using RS485 half-duplex from an external device, to send AT commands |
| | Onboard MCU (U16) | Onboard MCU (U16.44, U16.45) | Dipswitch (SW2) | This interface can be used by the Onboard MCU (U16) to access the ema Modem UART to send AT commands |
| | External Device | IO App Hdr (J5.17-J5.20) | Dipswitch (SW2) | This interface can be used by an external embedded device to access the ema Modem UART to send AT commands |
| emalink Interface | Onboard MCU (U16) | Onboard MCU (U16.35, U16.36) | Dipswitch (SW3) | This interface can be used by the Onboard MCU (U16) to access the emaLink interface for ema management features |
| | External Device | IO App Hdr (J5.15, J5.16) | Dipswitch (SW3) | This interface can be used by an external embedded device to access the emaLink interface for ema management features |



| Onboard MCU (U16) Interface | ema:Play Interface | Access Port (ref) | Configuration Switches (ref) | Use Case Examples |
|-----------------------------------|-----------------------------|--|---------------------------------|---|
| | RS232 | Wire to Board Terminal (J2.3-J2.6) Board to Board Terminal (J1.3-J1.6) | Slide Switch (SW4) | This interface can be used to access the Onboard MCU (U16) using RS232 from an external device |
| | RS422/RS485-4 | Wire to Board Terminal (J2.3-J2.6) Board to Board Terminal (J1.3-J1.6) | Slide Switch (SW4) | This interface can be used to access the Onboard MCU (U16) using RS422/RS485 full duplex from an external device |
| UART | RS485-2 | Wire to Board Terminal (J2.3, J2.4) Board to Board Terminal (J1.3, J1.4) | Slide Switch (SW4) | This interface can be used to access the Onboard MCU (U16) using RS485 half-duplex from an external device |
| | External Device | IO App Hdr (J5.21-J5.24) | | This interface can be used to access the Onboard MCU (U16) using an external embedded device using UART |
| | S2USB Enhanced Comm Port | S2USB USB Port (J10) | | This interface can be used as a debug/console input/output port for the Onboard MCU (U16) |
| i2c | External Device | IO App Hdr (J5.13, J5.14) | | This interface can be used to interface to the Onboard MCU (U16) using an external device over i2c |
| CAN | External Device | IO App Hdr (J5.25, J5.26) | | This interface can be used to access the Onboard MCU (U16) using an external CAN transceiver |
| GPIO | External Device | IO App Hdr (J5.2-J5.7) | | This interface can be used to interface to the Onboard MCU (U16) using GPIO and/or peripherals supported by the MCU. |

Table 4

ema:Play has built in configuration switches to allow the user to easily select which communication interface to use in their application. Alternatively, the Onboard MCU (U16) can be used to control the communication interface selection via custom firmware. The architecture is such that the ema Modem UART signals and the emaLink interface signals can be directed according to *Table 5* using dipswitches (SW2, SW3), and the slide switch (SW4).



Table 5 summarizes how to configure the ema:Play hardware for the desired ema interface. Alternatively, the switch settings are also labeled on the ema:Play PCB silkscreen for quick reference.

| Desired ema Interface | Desired ema:Play Interface | Access Port (ref) | Switch Configuration |
|-----------------------------|----------------------------------|--|------------------------------------|
| | S2USB Standard Comm Port | S2USB USB Port (J10) | Dipswitch (SW2): |
| | RS232 | Wire to Board Terminal (J2.3-J2.6) Board to Board Terminal (J1.3-J1.6) | Dipswitch (SW2) Slide Switch (SW4) |
| ema Modem UART Interface | RS422/RS485-4 | Wire to Board Terminal (J2.3-J2.6) Board to Board Terminal (J1.3-J1.6) | Dipswitch (SW2) Slide Switch (SW4) |
| | RS485-2 | Wire to Board Terminal (J2.3, J2.4) Board to Board Terminal (J1.3, J1.4) | Dipswitch (SW2) Slide Switch (SW4) |
| | Onboard MCU (U16) | Onboard MCU (U16.44, U16.45) | Dipswitch (SW2) |



| | External Device | IO App Hdr (J5.17-J5.20) | Dipswitch (SW2) |
|-------------------|----------------------|---------------------------------|-----------------|
| | Onboard MCU (U16) | Onboard MCU (U16.35, U16.36) | Dipswitch (SW3) |
| emaLink Interface | External Device | IO App Hdr (J5.15, J5.16) | Dipswitch (SW3) |
| ema USB | ema USB Port | ema USB Port (J6) | |

3.5 Onboard MCU (U16)

ema:Play provides an onboard MCU (U16) to allow users to develop their own custom IoT/M2M applications using ema. There are various sensors, peripherals, and LED's integrated into the ema:Play hardware that can be accessed by U16. Please visit the following website for more information regarding the onboard MCU (U16):

https://www.microchip.com/wwwproducts/en/ATSAME51J20A

Table 6 summarizes the various sensors and peripherals available to U16 for customization.

| Sensor/Peripheral | Interface to U16 |
|----------------------|------------------|
| (ref) | (ref) |
| Temperature/Humidity | i2c |
| (U1) | (U16.29, U16.30) |
| Photo/Light | A/D |
| (Q2) | (U16.61) |
| Main Voltage Monitor | A/D |
| (VIN_MON) | (U16.63) |
| ema Voltage Monitor | A/D |
| (MOD_V_MON) | (U16.62) |



| External A/D Monitor | A/D |
|--|---|
| (OB_uP_AIN) | (U16.64) |
| External High Accuracy Crystal | XIN/XOUT |
| (XTAL1) | (U16.31, U16.32) |
| Push Buttons | Digital Input |
| (SW7, SW8) | (U16.19, U16.20) |
| Manual Reset | Digital Input |
| (SW5, SW6) | (U16.52) |
| External D/A Output | Digital Output |
| (OB_uP_DAC) | (U16.3) |
| GPIO | GPIO |
| (PA06-PA08, PB06-PB07) | (U16.15, U16.16, U16.9, U16.10, U16.17) |
| User LEDs (BLU_LED0-BLU_LED3, RED_LED0-RED_LED1) | GPIO (U16.23-U16.28) |

3.6 Onboard Programmer/Debugger

ema:Play provides an onboard Segger JLink In Circuit Programmer/Debugger (ICP/D) USB port (J13) for loading firmware into the onboard MCU (U16) for custom applications. This ICP/D also functions as a debugger for development and evaluation purposes. This allows the user to eliminate purchasing an external ICP/D to use with the onboard MCU (U16). Additionally, a Cortex Single Wire Debug (SWD) Connector (J11) is provided for use with any compatible external ARM Cortex ICP/D. For more information regarding the onboard Segger JLink ICP/D, please visit this website:

https://www.segger.com/products/debug-probes/j-link/models/j-link-ob/

3.7 User Application Headers and Connectors

ema:Play provides a wire to board screw terminal connector (J2) and a board to board shrouded connector (J1) to interface to external devices and allow them direct access to ema, or the onboard MCU (U16). Also provided are a power application header (J4) and an IO application header (J5), for ultimate flexibility when developing custom applications for ema.

The wire to board screw terminal connector (J2) and the board to board shrouded connector (J1) are electrically connected in parallel and can be used to allow external devices with common interfaces (RS232, RS422, RS485) to directly access ema and the onboard MCU (U16). Flow control (CTS/RTS) is also provided at these connectors where applicable. Reference section 3.4 for further details on these interfaces.

Table 7 summarizes the signals relative to J2 and J1



| J2/J1 Pin Number | J2/J1 Signal Name | Usage Example |
|------------------|-------------------|--|
| 1 | EXT_VIN | This signal can be used to supply 4.5V-30V to power the ema:Play/ema platform |
| 2 | DGND | Connect this to the external devices' system Ground/return |
| 3 | 232TX/A | (RS232) Connect this to the external devices' RX signal (RS422/485-2/4) Connect this to the external devices' TXD+ signal |
| 4 | 232RX/B | (RS232) Connect this to the external devices' TX signal (RS422/485-2/4) Connect this to the external devices' TXD- signal |
| 5 | 232RTS/Y | (RS232) Connect this to the external devices' CTS signal (RS422/485-4) Connect this to the external devices' RXD+ signal |
| 6 | 232CTS/Z | (RS232) Connect this to the external devices' RTS signal (RS422/485-4) Connect this to the external devices' RXD- signal |
| 7 | EMA_RNG | This signal can be monitored by an external device. It is programmable in ema via an AT command |
| 8 | EMA_STS | This signal can be monitored by an external device. It will go high (IO_VREF) when ema's communication interfaces become ready |

The power application header (J4) can be used to control various power functions on ema:Play as well as ema.

Table 8 summarizes the signals relative to J4.

| J4 Pin Number | J4 Signal Name | Usage Example |
|---------------|----------------|---|
| 1 | 4V0 | This signal can be used to power external devices (4V @ 1.25A max) |
| 2 | 4VMOD_DIS | This signal can be used by an external device to remove power from ema. Drive high (max 5.5V) to disable ema power via load switch (U6). |
| 3 | 3V3 | This signal can be used to power external devices (3.3V @ .75A max) |
| 4 | 3V3_DIS | This signal can be used by an external device to disable the onboard 3.3V power rail. Drive high (max 5.5V) to disable the 3.3V power rail. |
| 5 | DGND | Connect this to the external devices' system Ground/return |
| 6 | MODEM_RESET | This signal can be used by an external device to request an ema reset in the event that ema becomes unresponsive. Drive high (max 5.5V) for a minimum of 1 seconds, then release. |



| 7 | 4VMOD | This signal can be used to power external devices that may require the ability to have power removed by the load switch (U6). (4V $@$ 1.25A max) |
|----|---------------|--|
| 8 | MODEM_ON_OFF | This signal can be used to request ema to turn ON or OFF. Drive high (max 5.5V) to request ema to turn ON. Drive low to request ema to turn OFF. |
| 9 | MODEM_IO_VREF | This signal can be used by an external source to set ema's IO voltage levels (1.8V-5.5V) |
| 10 | Unused | Unused |

The IO application header (J5) can be used to control, monitor, and interface with various signals and systems throughout the ema:Play hardware, as well as ema.

Table 9 summarizes the signals relative to J5.

| J5 Pin Number | J4 Signal Name | Usage Example |
|----------------|---------------------------------------|---|
| 1, 10, 27 | DGND | Connect this to the external devices' system Ground/return |
| 2, 3, 4, 5, 6 | PA08, PB07, PB06, PA07 PA06 | These signals connect directly to the onboard MCU's (U16) GPIO's and can be used according to the limitations of U16 |
| 7 | OB_uP_RESET | This signal can be used by an external device to force a hardware reset of the onboard MCU (U16) |
| 8 | MOD_DTR | This signal can be used by an external device to assert the Data Terminal Ready (DTR) signal for ema |
| 9 | OB_uP_AIN | This signal can be used by an external device to input an analog voltage (max 3.3V) for reading by the onboard MCU (U16) |
| 11 | OB_uP_DAC | This signal can be used by the onboard MCU (U16) to generate analog voltage (max 3.3V) for use by an external device |
| 13, 14 | OB_uP_SCL, OB_uP_SDA | These signals can be used to connect external i2c devices for use by the onboard MCU (U16) |
| 15, 16 | EXT_EMA_RX, EXT_EMA_TX | These signals can be used by an external device to communicate directly over the emaLink interface. See section 3.4. |
| 17, 18, 19, 20 | EXT_RTS, EXT_CTS, EXT_RX, EXT_TX | These signals can be used by an external device to communicate directly over the ema Modem UART interface. See section 3.4. |
| 21, 22 | OB_uP_APP_HDR_RX, OB_uP_APP_HDR_TX | These signals can be used by an external device to communicate directly with the onboard MCU (U16) |
| 23, 24 | OB_uP_DBG_RX, OB_uP_DBG_TX | These signals can be used by the onboard MCU (U16) to send and receive debug/console messages over UART. |
| 25, 26 | CAN/RX, CAN/TX | These signals can be used by the onboard MCU (U16) to interface to a CAN transceiver for communications |



| 28 OB_uP_IOV | REF_DIS | This signal can be used by an external device to disable the onboard 3.3V IO_VREF. Drive high (max 5.5V). |
|--------------|---------|---|
|--------------|---------|---|

3.8 Antennas

ema:Play provides two U.FL to SMA antenna adaptor cables. The external antennas should be connected at the SMA ends of the adaptor cables (primary-J3, diveristy-J12). The U.FL ends of these adaptors should be carefully connected to ema after it has been seated correctly in the modem socket (J7/J8).

Table 10 lists recommended antennas for use with ema:Play

| Туре | Manufacturer | Part Number |
|----------------------------------|--------------|-------------------|
| External Cellular Antenna | Taoglas | TG.30.8113 |
| External Cellular Antenna | Taoglas | GSA.8841.A.105111 |
| External Cellular MIMO Antenna * | 2J | <u>2J7724Ma</u> |

Table 10

* Available from OptConnect

3.9 Mechanical

3.9.1 Dimensions

Width = 3.250 inches, 82.55 mm

Length = 3.330 inches, 84.58 mm

Max height, ema seated, not including standoffs = .5825 inches, 14.8 mm Max height, ema seated, including standoffs = .8770 inches, 22.3 mm





The PCB assembly for ema:Play includes a 40 mil(.0400 inches) clearance area along both short sides(x) of the PCB assembly along the edge. This allows the PCB assembly to slide into an enclosure that is suitable for the slide mounting method.

4. Software

Section 4 outlines the software architecture and framework that is compatible with ema:Play. The methods and techniques outlined in this section represent different ways to develop software for ema:Play and ema, and are by no means the only methods and techniques that can be used.

There are four main methods for interfacing software with ema using ema:Play.

 Develop software that runs on ema:Play onboard MCU (U16). This method closely follows the procedure outlined in section 4.1, and involves a technical understanding and knowledge of writing code for embedded systems. Typically, this method will involve a Real Time Operating System (RTOS) runtime environment, such as freeRTOS or similar, and will use the U16 UARTs to access ema, along with any other desired features that ema:Play offers. See section 3.5. Reference section 5.4.1 for ema:Play configuration to support this method.

- 2. Develop software that runs external to ema:Play on a host platform that has a standard serial COMM interface. This method requires that ema:Play be connected to the host platform using the S2USB USB interface (J10). The most common host platform in this scenario is a standard computer with a terminal program. This method grants access to ema via its Modem UART interface. Reference OptConnect ema™ Getting Started with ema and OptConnect ema™ Application Note 001: HTTP Using Socket Dials for guidance on this method. Reference section 5.4.2 for ema:Play configuration to support this method.
- 3. Develop software that runs external to ema:Play on a host platform that can access ema using USB drivers. USB drivers are available for download at **http://optconnect.com/ema**. This method involves writing software at a higher application level, with easy access to the hardware's USB drivers. The interface to ema via ema:Play would occur at the ema USB port (J6). Reference *OptConnect ema™ Application Note 002: Windows Networking Guide* for guidance on this method. Reference section 5.4.3 for ema:Play configuration to support this method.
- 4. Develop software that runs external to ema:Play on a different embedded development kit or custom piece of embedded hardware or machine. ema can be accessed via ema:Play at the user Application Headers (J4, J5). Additionally, built in features of ema:Play can also be accessed using this method. See section 3.5 and 3.7. Reference section 5.4.4 and 5.4.5 for ema:Play configuration to support this method.

4.1 Native Development Environment

4.1.1 Overview

ema:Play has an onboard MCU (U16) that is provided for custom user applications utilizing ema as the cellular connection. This section demonstrates how to use *Atmel Studio 7* to get up and running, developing code quickly on ema:Play. The hardware for ema:Play is setup for flexibility relative to the development environment, and *Atmel Studio 7* was chosen due to its simplicity and availability. Additionally, more in-depth documentation about *Atmel Studio 7* is available than this User Guide provides. To reduce development time, and spend more time developing the application versus the driver and register initialization code, Microchip offers the *Atmel | Start* tool. The samples used in ema:Play have been developed using this tool. For more information regarding *Atmel | Start*, visit https://start.atmel.com/.

Any development environment that supports the onboard MCU (U16, Microchip <u>ATSAME51J20A</u>) and a Segger JLink In Circuit Programmer/Debugger (ICP/D), or the ARM Cortex SWD Debug Connector (J11) interface can be used. Reference section 3.6 for more details on the ICP/D.

4.1.2 Setup and Building

1. Download and install Atmel Studio 7: Go to the following website for the download link:

https://www.microchip.com/mplab/avr-support/atmel-studio-7

Make sure to select the following options during the installation. See Figure 4.

1**Opt**Conr



| Atmel Studio 🗕 × | Atmel Studio × |
|---------------------|---|
| Atmel Studio 7.0 | Atmel Studio 7.0 |
| Select Architecture | Select extensions |
| AVR 8-bit MCU | Atmel Software Framework and Example Projects |
| AVR 32-bit MCU | |
| SMART ARM MCU | |
| Back Next Cancel | Back Next Cancel |
| Figure 4 | |

The installation will take several minutes to complete.

- Obtain the latest GettingStartedWithemaVx.x.zip firmware package: Go to http://optconnect.com/emaPlay, or reach out to an OptConnect representative to obtain the file. Reference section 1.2 for more information.
- 3. **Launch Atmel Studio 7:** Once the software is launched the landing page should look similar to *Figure 5.*

| Start Page - AtmelStudio | Taule Window Main | Standard Mode Cuick Launch (Ctrl+Q) | P = 8 × |
|---|---|-------------------------------------|----------------------------------|
| | 1000 million gen - Debug Browser ア ※ 二 ア ※ 二 ア | - 🖓 🖋 🕼 📾 - 🖕 전 관 표 한 및 한 | 1 % 61 61 61 72 % <mark>-</mark> |
| Start Page @ X | | ATMEL STUDIO Z | ion Explorer 🔹 🤑 🗙 |
| Start New Example Project Open Project Recent | Discover Atmel Studio Getting started with Atmel Studio Getting started with AKR development Open Atmel Start Configurator Download Atmel Studio Extensions | | |
| | Download documentation | | |
| Keep page open after project load Show page on startup | | | |
| Output Ready | | | |



4. **Open the project:** Open the *GettingStartedWithemaVx.x* sample project by clicking on the "Open Project" link or selecting "File", then "Project/Solution" and navigating to the location of the *GettingStartedWithema.atsln* file that was obtained in step 2. Once the project has been opened, the screen should look similar to *Figure 6*.



| Notes and a second seco | Cuick Jaunch (Otla O) |
|--|--|
| Co estingstateSWithema - Atmessizatio | |
| Die Den Ben de 11 - 12 - 12 - 12 - 12 - 12 - 12 - 12 | · · · · · · · · · · · · · · · · · · · |
| Mu n = → II ► 🐼 🛊 ? * k T Hex 75 🗿 * . () () () () () () () () () (| |
| | Solution Explorer Solution Explorer Solution CertifyStanderSolution Solution CertifyStanderSolution Solution CertifyStanderSolution Solution CertifyStanderSolution Solution CertifyStanderSolution Solution CertifyStanderSolution Solution Solution |
| Error lat | - # × |
| Entre Solution * 🗸 V Entre 🔥 unamings V unessages jours + interimisense * | Bealest File Line |
| Usergeon * | Project File Line |
| Error Lai Brailepoins Codput | |
| Ready | 4 |
| Figure 6 | |

5. **Investigate the** *Atmel* | *Start* **Setup:** On the right side of the screen, navigate to the "Solution Explorer", and click on the "Reconfigure Atmel Start Project" button as shown in *Figure 7*.

| SettingStartedWithema - AtmetStudio Advanced Mode 🔻 🛛 | Quick Launch (Ctr | 1+Q) P | - • × |
|--|--|---|---|
| pire par pew voossa Aer project guns genog poos genoom pep | 74 U 24 U | 1 3 3 5 5 5 | 1 21 28 |
| MI 🖞 = -> II -> | | | |
| | Solution Explore Search Reconf Search Reconf Solution | er Composition of the second | v v v v v v v v v v v v v v v v v v v |
| Fron List | | Search Error List | • # × |
| Description * | Project | File | Line |
| | | | |
| Error List direktpoints Output | | | |
| Ready | | | |

Figure 7

This will load the *Atmel* | *Start* tool setup relative to this project. This tool can be used to quickly configure the drivers and middleware for the onboard MCU (U16). For this project, the following peripherals have already been configured. Reference *Figure 8*.

| ADC_0 | Analog to digital converter driver used to convert voltages. |
|--------------------|--|
| EMAPLAY_DEBUG_UART | UART communications between U16 and the S2USB enhanced |
| | COMM port (J10), used for console debug I/O. |
| I2C_0 | i2c communications between U16 and the onboard |
| | temperature/humidity sensor (U1). |
| EMA_MGMT_UART | UART communications between U16 and emaLink. |
| EMA_MODEM_UART | UART communications between U16 and the ema Modem UART. |
| | |



TIMER_0

Timer driver used to create a periodic time-based interrupt for U16.

| Atmel START 👻 🗙 | | Solution Explorer 🔹 🖣 🗙 |
|---|-----------------------|---|
| Atmel START atsames1j20a | What's New Help | ○ ○ 益 ○ · ● 協 ▶ (参) Σ Search Solution Explorer (Ctrl+;) |
| MY SOFTWARE COMPONENTS | (?) | Solution 'GettingStartedWithema' (1 project) |
| Application Add software component Middleware Driver System driver | Show system drivers C | |
| C ADC.0 C EMAPLAY. DEBUG.UART C EMA_MGMT.UART C EMA_MODEM.UART C | TIMER_0 | <pre>>examples >hpl >hpl >ff >OppConnect <atmel_start.c hhatmel_start.ch hhatmel_start.pic.b</atmel_start.c </pre> |
| GCLK CMCC MCLK OSC32KCTRL OSCCTRL RAMECC DMAC O | PORT | c driver_initc h driver_inith c mainc |
| GETTINGSTARTEDWITHEMA | \otimes | |
| GENERAL | | |
| | * | |
| GENERATE PROJECT | | |

Figure 8

The "Add software component" button can be used to add various drivers and middleware as needed.

6. **Investigate the PINMUX Configurator in Atmel | Start:** On the left side of the screen, click on the button labeled "Go to PINMUX Configurator" as shown in *Figure 9*.

| Atmel START | e X | - | Solution Explorer 🔹 🖣 🗙 |
|---------------|---|-----------------------|---|
| | Atmel START atsame51j20a | What's New Help | 이 이 삶 '이 - 라 땀 수 (왕 D Search Solution Explorer (Ctrl+;) 우 - |
| | MY SOFTWARE COMPONENTS | (?) | Solution 'GettingStartedWithema' (1 project) |
| DASHBOARD | Application Middleware Add software component System driver | Show system drivers C | |
| Go to PINMUX | Configurator (shortout p) | TIMER_0 | <pre>p acamples p and p and p and p and p acconnect c atmel_start.c h atmel_start.h b atmel_start.h</pre> |
| | GCLK () CMCC () MCLK () OSC32KCTRL () OSCCTRL () | PORT | c driver_init.c h driver_init.h c main.c |
| | RАМЕСС Ф. DMAC Ф. | | |
| | GETTINGSTARTEDWITHEMA | \otimes | |
| | GENERAL | | |
| | Rename component | | |
| | GENERATE PROJECT | | |

Figure 9

This will pull up the PINMUX Configurator where the ema:Play user can change the pin settings on U16. Note that the column labeled "User Label" is the reference that can be seen in the API calls from the source code. See *Figure 10. Atmel* | *Start* API documentation can be found here: http://ww1.microchip.com/downloads/en/DeviceDoc/50002633A.pdf .



| At | tmel | START A | TSAME51J20 | DA | | | | What's New Help | ○ ○ ☆ [†] ⊙ + Ø @ ♪ - 3 |
|------|-------------|-----------------|--------------|--------|---|--------------|--|----------------------|---|
| PIN | имих с | ONFIGURAT | OR | 10.0 M | | | | ? | Solution 'GettingStartedWithema' (1 p |
| 2 | | Pin | n Board Mode | Mode | Show labels v 🕀 Zoom in 🕞 Zoom out 🛛 Auto fit v | Output Files | | | |
| # | Pad | User label 个 | Header | Label | | | 1.1.1 | | Libraries |
| 38 | PA19 | ema_rng | | | Digital input | P/38 | a chuir an c | | App Support Config |
| 37 | PA18 | ema_sts | | | Digital input | P/37 | | | Device_Startup |
| 6 | PB05 | iovref_dis | | | Digital out | P/6 | | | P a examples |
| 39 | PB16 | mod4V_dis | | | Digital out | P/39 | | | P i hai |
| 5 | PB04 | n_photosense_en | | | Digital out | P/5 | | 44 (Vinis) 47 (HS | Þ 🧰 hri |
| 18 | PA09 | n_sht30_res | | | Digital out | P/18 | AND DESCRIPTION OF A DE | es (Pezt | D OptConnect |
|) 15 | PA06 | pa06_user_din0 | | | Digital input | P/15 | | 43 7624 | c atmel_start.c |
| 16 | PA07 | pa07_user_din1 | | | Digital input | | | Міскоснір | h atmel_start_pins.h |
| 9 | PB06 | pb06_user_dout0 | | | Digital out | P/9 | ATSAME51J20A | arta read | c driver_init.c |
| 10 | PB07 | pb07_user_dout1 | | | Digital out | P/10 | معر المعرف ال معرف المعرف ا | bi Pitra reality_da | h driver_init.h |
| 27 | PB14 | red_led0 | | | Digital out | P/27 | TQFP | 24 2018 area_reg | Cintante |
| 28 | PB15 | red_led1 | | | Digital out | P/28 | Inco MARK 10 | 26 20077 PM12 | |
| 19 | PA10 | sw0_read | | | Digital input | P/19 | pdg_mm_pdg_ | 94 WEDE | |
| 20 | PA11 | sw1_read | | | Digital input | | | | |
| E N | lo software | components | | | | | | | |
| 1 | PA00 | | | | | | | | |
| 2 | PA01 | | | | | | and the second s | | |
| ~ | 17901 | | | | | • | 111 | | - |



7. Investigate the main.c source file: In the "Solution Explorer" under the folder "GettingStartedWithema", locate the main.c file and open it. It can be observed that the "User Label" references are used in the API calls in the int main(void) function. This is a simple demonstration of the correlation between the *Atmel* | *Start* tool and the source code references. Reference *Figure 11*.

| main.c | * X Atmel START | - | Solution Explorer | |
|----------|--|-------------|-----------------------------------|----------------|
| → mai | ngpio_set_pin_level | Ç Go | 0 0 🟠 To - 🗗 🔞 🖌 🗕 | (1) |
| | // init the debug input/output | ÷ | Search Solution Explorer (Ctrl+:) | - م |
| P | witder DEBUG | ^ | | -1.44 |
| | unt32_t dg_timer; | | Solution Gettingstartedwithem | a' (1 project) |
| | emarlay_d_init(&dog_rx_d, dog_d_rx_durr, sizeo(dog_d_rx_durr)); | | Gettingstartedwithema | |
| | emeriay_u_init(addg_ux_q, ddg_ux_ddin | | Dependencies | |
| | embray_unic_ecopy action as_post_art): usart async enable(&emarkay_obje usrt): | | D Output Files | |
| | emaplay dbg uarts send ("\r\n\r\nema:Play \"Getting Started with ema demo\" FW Version: ". sizeof("\r\n\r\nema:Play \"Getting Started with ema demo\" FW Versio | on: | P 🔛 Libraries | |
| | emaPlay_dbg_uart_send(DATE, sizeof(DATE), 20, 0); | | App Support | |
| | emaPlay_dbg_uart_send("\r\n'?' for menu\r\n", sizeof("\r\n'?' for menu\r\n"), 20, 0); | | P G Config | |
| | <pre>dbg_timer = TIME_ELAPSED_ms(0);</pre> | | Device_startup | |
| | #endif | | P a examples | |
| | | - 11 | P i hai | |
| | //init adc | - 11 | P i npi | |
| | adc_sync_enable_channel(&ADC_0, 0); | - 11 | P i hri | |
| | | - 11 | P OptConnect | |
| | // init i/c for sht30 sensor | - 11 | c atmel_start.c | |
| | izc_m_sync_set_slavedur(alzt, oxoods, izc_m_stven); | - 11 | h atmel_start.h | |
| | iic_m_sync_enable(with), | - 51 | h atmel_start_pins.h | |
| | // turn on the photo detector | | c driver_init.c | |
| | gpio set pin level(n photosense en, false); | | h driver_init.h | |
| | | | C main.c | |
| | // read chip uniue serial number | | | |
| | <pre>emaPlay_get_chip_SN(emaPlay.sn);</pre> | | | |
| | | | | |
| | // init timers | | | |
| | <pre>system_task_exec_timer = TIME_ELAPSED_ms(0);</pre> | | | |
| | system_adc_scan_timer = IIME_bLAPSbU_ms(0); | | | |
| | system_env_read_timer = lint_tLAr>tu_ms(0); | | | |
| | // main application loop | | | |
| | while (1) { | | | |
| | | | | |
| | // handle any asynch URCs from the ema mgmt UART, this must be called frequently and periodically | Ŧ | | |
| 100 % | | F | | |
| | | | | |

Figure 11

8. **Build the project:** Click "Build", then "Build Solution", or simply press F7 to compile the source code and build the project. The "Output" window can be observed for any errors. There should not be any errors if using the provided project. Reference *Figure 12*.



| mainc 4 × Atmel START | - | Solution Explorer | - ù × |
|--|---------------|---------------------------------------|------------------------|
| | ▼ | ○ ○ ☆ '⊙ - ฮ 🖗 | ی 🛃 💻 🖋 |
| a #ifdef DEBUG | - | Search Solution Explorer (Ct | rl+;) ••• |
| uint32_t dbg_timer; | 1 | Solution 'GettingStarte | dWithema' (1 project 🔿 |
| <pre>emaPlay_q_init(&dbg_rx_q, dbg_q_rx_buff, sizeof(dbg_q_rx_buff));</pre> | | A GettingStartedWit | thema |
| emarlay_q_init(adog_tx_q, aog_q_tx_ourr, sizeor(aog_q_tx_ourr)); amaplay_ust_satus(& amaplay_dubug_ust_kamaplay_dbg_ust_in_(usart_ch_t)amaplay_dbg_ty_ch_(usart_ch_t)amaplay_dbg_ry_ch_); | | Dependencies | |
| usart async enable(& email a debug uart): usart async enable(& email a debug uart): | | Output Files | |
| emaPlay_dbg_uart_send("\r\n\r\nema:Play \"Getting Started with ema demo\" FW Version: ", sizeof("\r\n\r\nema:Play \"Getting Started with ema demo\" F | W Version: | Libraries | |
| <pre>emaPlay_dbg_uart_send(DATE, sizeof(DATE), 20, 0);</pre> | | 🗀 App Support | |
| <pre>emaPlay_dbg_uart_send("\r\n'?' for menu\r\n", sizeof("\r\n'?' for menu\r\n"), 20, 0);</pre> | | 🔹 🕨 🚞 Config | |
| <pre>dbg_timer = TIME_ELAPSED_ms(0);</pre> | | Device_Startup | |
| #endlT | | examples | |
| //init adc | | 🕨 🛄 hal | |
| adc sync enable channel(&ADC 0, 0); | | Þ 🧰 hpl | |
| | | P 🛄 hri | |
| // init i2c for sht30 sensor | | P OptConnect | |
| <pre>i2c_m_sync_set_slaveaddr(&I2C, 0x0045, I2C_M_SEVEN);</pre> | | c atmel_start.c | |
| <pre>i2c_m_sync_enable(&I2C);</pre> | | h atmel_start.h | |
| 100 % * 4 |) F | ■ atmet start bins | n |
| Output | | | → - |
| Show output from: Build • 😒 🖕 🖕 🖉 | | | |
| Task "RunOutputFileVerifyTask" | | | A |
| Program Memory Usage : 54824 bytes 5.2 % Full | | | |
| Data Memory Usage : 833/5 bytes 30.8 % Full | | | |
| Done building target "CoreBuild" in project "GettingStartedWithema.coroi". | | | |
| Target "PostBuildEvent" skipped, due to false condition; ('\$(PostBuildEvent)' !- '') was evaluated as ('' !- ''). | | | |
| Target "Build" in file "C:\Program Files (x86)\Atmel\Studio\7.0\Vs\Avr.common.targets" from project "C:\Project\ema\Engineering\dev kit\design\ema_dk_a_a\FW\pre release\GettingS | tartedWithema | \GettingStartedWithema\Get | tingStartedWithem |
| Done building target "Build" in project "GettingStartedWithema.cproj". | | | |
| Done building project "Gettingstartedwithema.cproj". | | | |
| Build succeeded. | | | |
| Rebuild All: 1 succeeded, 0 failed, 0 skipped | | | |
| | | | |
| 4 | | | |
| Figure 12 | | | |
| rigure 12 | | | |

4.1.3 Sample Program/Debug Session

This section continues from section 4.1.2 and demonstrates how to program the firmware into the ema:Play onboard MCU (U16). *Atmel Studio 7* can also be used to step through code in a debug capacity.

1. **Connect ema:Play JLink ICP/D to computer:** Locate the onboard JLink Programmer/Debugger port (J13) and connect it to the computer running *Atmel Studio 7*. Right click on the "GettingStartedWithema" project folder and select "Properties". The project properties window appears. On the left side, click on the "Tool" tab, then select the J-Link programmer/debugger from the list as shown in *Figure 13*.

| GettingStartedWithen | na* 19 X main.c Atmel START ASF Wizard 🔹 | Solution Explorer | - + × |
|--|---|---|----------|
| Build Build Events | Configuration: N/A V Platform: N/A V | © © ☆ io - ☞ ি / - 3 Search Solution Explorer (Ctrl+;) | ک |
| Toolchain Device Tool Packs Advanced | Selected debugger/programmer J-Link * 760115005 v Interface: SWD v Ilink Control Panel <u>J-Link * 760115005 v Interface: SWD v Ilink Control Panel</u> <u>J-Link * 760115005 v Interface: SWD v Ilink Control Panel</u> <u>J-Link * 760115005 v Interface: SWD v Ilink Control Panel</u> <u>J-Link * 760115005 v Interface: SWD v Ilink Control Panel</u> <u>J-Link * 760115005 v Interface: SWD v Ilink Control Panel</u> <u>J-Link * 760115005 v Interface: SWD v Ilink Control Panel</u> <u>J-Link * 760115005 v Interface: SWD v Ilink Control Panel</u> <u>J-Link * 760115005 v Interface: SWD v Ilink Control Panel</u> <u>J-Link * 760115005 v Interface: SWD v Ilink Control Panel</u> <u>J-Link * 760115005 v Interface: SWD v Ilink Control Panel</u> <u>J-Link * 760115005 v Interface: SWD v Ilink Control Panel</u> <u>J-Link * 760115005 v Interface: SWD v Ilink Control Panel</u> <u>J-Link * 760115005 v Interface: SWD v Ilink Control Panel</u> <u>J-Link * 760115005 v Interface: SWD v Ilink Control Panel</u> <u>J-Link * 760115005 v Interface: SWD v Ilink Control Panel</u> <u>J-Link * 760115005 v Interface: SWD v Ilink Control Panel</u> <u>J-Link * 760115005 v Ilink * 760115005 v Ilink * 760100000000000000000000000000000000000</u> | GettingStartedWithema GettingStartedWithema GettingStartedWithema GettingStartedWithema GettingStartedWithema Getting GettingStartedWithema Getting Getting Getting GettingStartedWithema GettingStartedWit | 4 |
| | Overvide Vector Table Offset Register exception_table ØC cache all flash memory except Image: Cache all flash memory except ØU Use flashloader applet 0x20000000 | Properties | - # × |

Figure 13

Note that if an external programmer/debugger were to be used, it would show up in this list as well.



2. Program the firmware: Click the "Tools" dropdown menu and select "Device Programming". Confirm that the "Tool" is the J-Link, and the "Device" is the ATSAME51J20A as shown in *Figure* 16. Click "Apply". Click the Blue JLink Control Utility Icon to launch the J-Link Control Panel. Confirm that the "Device" is set to ATSAME51J19* as shown in *Figure* 14. If it's not set to this, click on the "Settings" tab, and select the correct device next to the check box "Override device selection" as shown in *Figure* 15.



Figure 14

Figure 15

* There is an identified issue with *Atmel Studio 7* that does not allow the ATSAME51J20A to be used by the JLink Utility

Close the JLink Control Utility and Click "Read". The "Device Signature" and "Target Voltage" will be read from the onboard MCU (U16) as shown in *Figure 16*.



| J-Link (760115005) - Device Pr | rogramming | | | ? × | |
|---|--------------------------|----------------------------------|---------------------------|---------------------------------|--|
| Tool Device J-Link Y ATSAME51J20A | Interface SWD × Apply | Device signature 0x61810004 Read | Target Voltage 3.3 V Read | ۵ 🛃 | |
| Interface settings Tool information Device information Memories Fuses Security | -SWD Clock | not exceed target CPU speed | I * 10. | 4 MHz Reset to default clock | |
| | | | | | |
| Reading device IDOK | | | | | |
| ▼ Reading device IDO | к | | | | |
| | | | | Close | |

Figure 16

On the left side, click the tab labeled "Memories". Next, click the "Program" button. *Atmel Studio* 7 will use the onboard JLink programmer to program the firmware into the ema:Play onboard MCU (U16) program flash. Once complete, ema:Play Blue LEDs signal array (D14-D17) should continue to scroll. Reference *Figure 17*.

| J-Link (760115040) - Devi | ce Programming | | | ? × |
|--|---|--------------------------------|-------------------------------------|------------|
| Tool Device J-Link V ATSAME51J | Interface 20A • SWD • Apply | Device signature 0x61810004 Re | Target Voltage ad 3.3 V Read 🐼 📘 |] |
| Interface settings Tool information | Device Erase Chip ~ Erase now | 1 | | |
| Device information | Flash (1024 KB) C:\Project\ema\Engineering) | \dev kit\design\ema_dk_a | a_a\FW\pre release\GettingStarted | Withema\ ~ |
| Fuses Security | Erase Flash before progra Advanced | amming | Program Verify | Read |
| | User Page (512 bytes) Erase User Page before p Advanced | rogramming | Program Verify | ۲ Read |
| | | | | |
| rasıng device OK rogramming FlashOK erifying FlashOK | | | | |
| Verifying FlashO | к | | | |
| | | | | Close |

Figure 17



5. Reference

OptConnect provides several reference documents relative to ema:Play and ema that designers and developers should review carefully and use as needed to help with custom hardware and software. Schematics, PCB Layout, and sample code projects can be requested. Refer to section 1.2, or visit **http://optconnect.com/ema** for the latest versions of these documents and projects. The following sections include copies of ema:Play design files for quick reference and further design considerations.

5.1 Schematics



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OptConnect











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| 1 ema_dk_a_a PCBA BC | 0M rev 1 | 4/19/2019 | | | | | | | | | |
|---|-------------------|--|--|---------------------------------|-------------------------|-----------------------|---------------------------------|---------------------------------|------------|-------------------------|------------------------|
| 3 Designator Va | lue Populati n | Description | Footprint | Mfgr 1 | Mfgr 1phn | Supplier 1 | Supplier Part Number 1 | DigiReel ph | Quantity S | upplier Unit Price 1 | Supplier Subtotal 1 |
| 3.3V, 5%S2USB, 5%USBMOD, ExtVIN, 4 J9+, VIN, VIOHEF2 | | PC TEST POINT MINATURE RED | THRU, TEST LOOP, RED | Keystone Electronics | 5000 | Digi-key | 36-5000-ND | | ~ | 0.35 | 2.45 |
| 5 4V0, 4VM0D1, 4VM0D2, VI0REF1 | | PC TEST POINT MINIATURE BLUE | THRU, TEST LOOP, BLU | Keystone Electronics | 5117 | Digi-key | 36-5117-ND | | 4 | 0.35 | 14 |
| C1, C2, C3, C5, C5, C7, C8, C11, C16, C19, C21, C23, C24, C26, C27, C28, C29, C30, C31, C32, C34, C35, C37, C46, C46, C47, C48, C43, C52, C33, C57, C58, | | | | | | | | | | | |
| 6 C61, C62, C64, C65, C70, C71, C72, C73 . 1u 7 C4 | | CAP CER 0.1UF 50V X7R 0603 | CAP0603IPCMED | Yageo | CC0600KRX7H9BB104 | Digi-key | 3TI-1344-1-ND | 311-1344-6-ND | 47 | 0.084 | 3.528 |
| 8 C9 C10 C20 C43 C46 10 | 5 4 | CAP CER MUCH NV VAN KIN | | Camericon Elandro-Manhania | CLIMICACIONINIMIE | Dici-ken | 1276.2876.1AID | 1976-2876-6-MD | - 4 | 0.65 | 9C1 |
| 9 C12. C13. C17 221 | | CAP CER 22UF 10V X7B 1206 | CAPIZIOPOWED | Samsung Electro-Mechanie | CL31B226KPHNFNE | Diai-keu | 1276-3145-1-ND | 1276-3145-6-ND | 0 | 0.63 | 189 |
| 10 C14, C54 1pF | | CAP CER 1PF 50V COGINPO 0603 | CAP0603PCMED | Samsung Electro-Mechanie | CL10C010CB8NNNC | Digi-key | 1276-1293-1-ND | 1276-1293-6-ND | ~ | 0.1 | 0.2 |
| 11 CI5 27 | Ŀ | CAP CER 2700PF 50V X7R 0603 | CAP0603PCMED | Samsung Electro-Mechanie | CL108272KB8NNNC | Digi-key | 1276-2022-1-ND | 1276-2022-6-ND | - | 0.1 | 0.1 |
| 12 C18, C22, C44, C59, C63 1uF | | CAP CER 1UF 16V X7R 0603 | CAP0603PCMED | Samsung Electro-Mechanie | CL10B105MCBNNWC | Digi-key | 1276-6524-1-ND | 1276-6524-6-ND | ß | 0.1 | 0.5 |
| 13 C36, C60 4.7 | 4 | CAP CER 4.7UF 16V X7R 0805 | CAP0805PCMED | Samsung Electro-Mechanid | CL21B475KOFNNNE | Digi-key | 1276-2873-1-ND | 1276-2873-6-ND | ~ | 0.34 | 0.68 |
| 14 D1, D3, D27 | + | DIODE AFRAY SCHOTTKY 20V 3HUSON | 3-PowerUDFN | Nexperia USA Inc | PMEG2020CPA,115 | Digi-key | 1727-5194-1-ND | 1727-5194-6-ND | ~ | 0.56 | 1.68 |
| 15 D2, D8, D25 | + | TVS DIODE 5.5V SOT143 | SOT-143, TO-253-4, TO-253AA | Diodes Inc | DRTR5V0U2SR-7 | Digi-key | DRTR5V0U2SR-7DICT-ND | DRTR5V0U2SR-7DIDKR-ND | m | 0.33 | 11 |
| 15 D4, D25 17 D5 D5 D3 D3 | + | DICIDE SCHUTTRY 30V 3A SCIOI28 | 500-128 remai ED | Nexperia USA Inc. Visotuista | PME 63030EP,T5 | Digi-key Diai-bari | 1/27-5324-1-ND 764-4004.1A/D | 1/27-5324-6-ND 764.1174-6-ND | N 14 | 0.49 | 1 96 |
| 18 Dit Dit Dit Dit Dit D21 D22 | + | NUCLE SCHOTTRY 30V MMAS SOT23 | 0000440 SOT.22.3 TO.236.3 SO.59 | Trobiba Sami | TRATEASIM | Dici-keu | TRATEASI MCT.MD | TRATEASI MDKRAD | 10 | 03 | 154 |
| 19 Dtd. D15. D16. D17 | | LED BLUE CLEAR CHP SVD | 0003LED | Kindhricht | APT 1928CBC/D | Dici-keu | 754-1434-1-ND | 754-1434-6-ND | 1 | 0.49 | 196 |
| 20 D18, D19 Re | - | LED RED CLEAR CHP SMD | 0603LED | Kinabricht | APT1508EC | Diai-kev | 754-1117-1-ND | DV-9-2117-9-22 | ~ | 0.37 | 0.74 |
| 21 D23 | | LED CRANGE CLEAR CHP SMD | 0603LED | Kingbright | APT1608SECK | Digi-key | 754-1120-1-ND | 754-1120-6-ND | - | 0.43 | 0.43 |
| 22 D24 | | TVS DIDDE 26V 40V U-DFN2020-2 | 2-UDFN, U-DFN2020-2 | Diodes Inc | D26V0H1U2UP20-7 | Digi-key | D26V0H1U2UP20-7DICT-ND | D26V0H1U2LP20-7DIDKP-ND | - | 0.43 | 0.43 |
| 23 FB1, FB2, FB3, FB4 | | FERRITE BEAD 120 CHM 0603 1LN | 0603X055M | Pulse Electronics | PE-0603PFB121ST | Digi-key | 553-2387-1-ND | 553-2387-6-ND | 4 | 0.1 | 0.4 |
| 24 GND1 GND2 | | PC TEST POINT MINIATURE GREEN | THRU, TEST LOOP, GRN | Keystone Electronics | 5116 | Digi-key | 36-5116-ND | | 2 | 0.35 | 0.7 |
| 25 J1 | | CONN HEADER VERT \$POS 2MM | THRU, 1x8, 2MM | Molex | 0532530870 | Digi-key | QN-2026M/M | | - | 0.37 | 0.37 |
| 26 J2 | | TERM BLK \$POS SIDE ENT 3.5MM PCB | THRU, 198, TERM, 3.5MM | On Share Technology | OSTTE080161 | Digi-key | ED2641-ND | | - | 173 | 173 |
| 27 J3, J12 | | CONN, RF, SMA TO U.FL, ADAPTOR, PCB MOUN | ITHRU, RFSMARA-7053 | Roho Communication | RFSMARA-7053-DOWN | Roho Communication | RFSMARA-7053-DOWN | | 2 | | |
| 28 J4 | + | CONN HEADER VERT 10POS 2.54MM | THPU, 2X5, 2.54MM | Amphenol ICC | 77313-118-10LF | Digi-key | 609-4437-ND | | - | 0.54 | 0.54 |
| 29 J5 | + | CONN HEADER VERT 28POS 2.54MM | THFU, 2X14, 254MM | Sullins Connector | PREC040AAN-RC | Digi-key | S2012EC-14-ND | | - | 023 | 0.53 |
| 30 J6, J10, J13 | | CONN RCPT MINI USB 85POS SMD RA | SMD, USB | Amphenol ICC | 10033526-N3212MLF | Digi-key | 609-4701-1-ND | 008-4701-6-ND | m | | |
| 31 J7, J8 | | CONN RECEPT 2MM SINGLE STR 10PDS | THRU, 1X10, 2MM | Sullins Connector Solutions | NPPN1018FCN-RC | Digi-key | S5751-10-ND | | 2 | 0.98 | 1.96 |
| 32 J9 | | CONN PWR JACK 25%55MM SOLDER | POWER JACK THRU HOLE | CUI Inc | P.J-102A | Digi-key | CP-102A-ND | | - | 0.64 | 0.64 |
| 33 Jtt | | CONN HEADER VERT 10POS 127MM | THRU, 2x5, 127MM | Wurth Electronics Inc. | 62201021121 | Digi-key | 732-5374-ND | | - | 14 | 14 |
| 34 L1 4.7 | F | FIXED IND 4.7UH 4.5A 27.6 MCHM | SMD, INDUCTOR | Murata | 1255AY-4R7M=P3 | Digi-key | 490-10812-1MD | 490-10812-6-ND | - | 0.48 | 0.48 |
| 35 L2 10. | Ŧ | FIXED IND 10UH 112A 335 MDHM | SMD-1212, INDUCTOR | Murata | LQH3NP2100MGRL | Digi-key | 490-15956-1-ND | 490-15956-6-ND | - | 0.44 | 0.44 |
| 36 01.03 | + | MOSFET P-CH 50V 130MA SOT23-3 | SOT-23-3, TO-236-3, SC-59 | Diodes Inc | BSS84-7-F | Digi-key | BSS84-FDICT-ND | BSS84-FDIDKR-ND | ~ | 0.27 | 0.54 |
| 3/ UZ | - | PHUTUTHANSISTURFLAT CLEAR 1206 | CAPTZIUIPCMED | Everlight Electronics Co | PT15-21UTH8 | Digi-key | UN1-1361-190 | 1080-1380-6-ND | - | 5 | 0 10 |
| 36 (44, 45, 45, 44, 47, 48, 412, A13, A14, A15, | - | MUSFET N-CH 20V 220MA SUT-23 | 501-23-3 ,10-236-3, 50-59 | UN Semi | FDV30IN | Digi-key | FDV30INCT-ND | FDV30INDKHND | | 8 | 2.92 |
| R16, F17, F18, F19, F22, F28, F31, F33, 39 F34, F35, F51, F53, F50, F61, F68, F76 10K | | FES SMD 10K CHM 1/2 110W 0603 | RESOB03IPCMED | Yageo | AC0603FR-0710KL | Digi-key | 311-10.0KHRCT-ND | 311-10.0KHFDKF-ND | 55 | 0.024 | 0.6 |
| R2, F54, F55, F56, F57, F69, F70, R71, A0 B72 B73, B74 B83 | | DEC CAND 0 THAN 1 MADED WINA 1000 | DC COCOSID-LAED | Verses | DC0603 (D-0700) | Not be | 2810 0CDCT.MD | | \$ | 1000 | 0 26.0 |
| 41 P65 2.2 | × | PES SMD 22K CHM 12: 110W 0603 | PESOBO3IPCMED | Yaceo | PC0603FB+072K2L | Diai-keu | 311-2 20KHRCT-ND | 311-2.20KHRDKR-ND | 10 | 0 | 0.9 |
| 42 R6 R10 20k | | FES SMD 20K DHM 1% 710W 0603 | RE S0603IPCMED | Yageo | FIC0603FFI-0720KL | Digi-key | 311-20.0KHPICT-ND | 311-20.0KHPDKP-ND | 2 | 6 | 0.2 |
| 43 F8 | | PES 0 OHM JUMPER \$2W 1210 | 1210X07M | Stackpole Electronics | FIMCF1210ZT0FI00 | Digi-key | FMCF12102T0F00CT-ND | FMCF12102T0F000KF-ND | - | 0.12 | 0.12 |
| 44 R20 50 | × | PES SMD 150K CHM 1% 110W 0603 | PE S0603IPCMED | Yageo | RC0603FR-07150KL | Digi-key | 311-150KHRCT-ND | 311-TSOKHPDKR-ND | - | 0.1 | 0.1 |
| 45 R21 200 | × | PES SMD 200K CHM 1% 710W 0603 | RES0603IPCMED | Yageo | RC0603FR-07200KL | Digi-key | 311-200KHPCT-ND | 311-200KHFDKR-ND | - | 0.1 | 0 |
| 46 R23 | × | PES SMD 96.3K CHM 1% 110W 0603 | HE S0603IPCMED | Yageo | PC0603FFI-0795K3L | Digi-key | 311-95.3KHRCT-ND | 311-95.3KHRDKR-ND | - | 5 | 0 |
| 47 H24 118 | ~ ; | FES SMD 118K CHM 1% 110W 0603 | RESOBCIPCMED | Yageo | PICO603FR-07118KL | Digi-key | 311-TBKHPICT-ND | 311-TIBKHPDKP-ND | + | 5 3 | 5 |
| 40 P26 P27 245 | 4 . | PEC SMD RIAN UTM 14, FUW 0000 DEC SMD 24K FUAA 147 310 U 0000 | PE-SUBORTUMED | V ageo | DEDOUTT-U/ IDN4L | District Contract | 211-DUMPETAD | 311-D.4MITEUNTINU | | 5 5 | 5 |
| 50 R29 R30 R81 220 | | RES SMD 220 CHM 12, 10W 0603 | PESDE03IPCMED | Yaceo | PEOBO3FB-07220FL | Dici-keu | 311-220HBCT-MD | 311-220HEDKE-ND | 1 4 | 5 | 0.4 |
| 51 R32, R36, R65, R67, R82 27 | | PES SMD 127 CHM 1% 110W 0603 | PES0603IPCMED | Yaqao | PC0603FB-07127FL | Diai-kev | 311-127HBCT-ND | 311-127HEDKB-ND | 6 | 10 | 0.5 |
| 52 R37, R38, R42, R44, R58, R59 4.7 | × | PES SMD 4.7K CHM 1% 110W 0603 | RESOB03IPCMED | Yageo | PC0603FP-074K7L | Digi-key | 311-4, 70KHPICT-ND | 311-4.70KHRDKR-ND | 9 | 0.1 | 0.6 |
| 53 R39, R40, R43, R46 3K | | PES SMD 3K CHM 1% #10W 0603 | HE S0603IPCMED | Yageo | AC0603FR-073KL | Digi-key | 311-3.00KHRCT-ND | 311-3.00KHRDKR-ND | 4 | 0.1 | 0.4 |
| 5.4 R45, R78 3.3 | × | PES SMD 3.3K CHM 1% 110W 0603 | RES0603IPCMED | Yageo | RC0603FR-073K3P | Digi-key | YAG1300CT-ND | YAG1300DKR-ND | 2 | 6 | 0.2 |
| 55 R52 330 | _ | RES SMD 330 CHM 1% 1/0W 0803 | RES0603IPCMED | Yageo | RC0603FR-07330R | Digi-key | 311-330HPCT-ND | 311-330HFDKF-ND | - | 0.1 | 0 |
| 56 B74, B75 15 | _ | FIES SMD 15K CHM 12 1/0W 0603 | RESOBCIPCMED | Yageo | RC0603FR+071K5L | Digi-key | 311-150KHRCT-ND | 311-150KHEDKR-ND | 2 7 | 10 | 0.2 |
| 5/ HES count quife | _ | PC TEST FUINI MINALUPE WHILE CONTRUME OPECT MINAL BV | THRU, TEST LUURY, WHI ION: 11 SAN 3 DIG NO SETTCH | Keystone Electronics | 5002 rec: mithuiA | Digi-key Northau | 36-5002-NU ECO 1076,6,MD | | | 1.20 | 0.15 |
| 20 2WL5W2 | + | SWITCH UP STOL MUMB 8Y | SMU J-LERU, ITUS UN SEITUR SUN STIT WINE 2 POS DIP SWITCH | Nidec Lopal | UPD-UIUZMB 148 DUICT | Ug-key Not-bau | DDJ-IS/0-D-NU | | 40 | UB | 101 |
| 33 3WC, 2WC | _ | DWITCH DELECTIVE OF DELEMENT OF THE COL | | | 1 DW2-017 | ng-key | C1202monwo | - | 4 | 20 | - |

5.2 Bill of Materials (BOM)

COptConnect MANAGED WIRELESS SOLUTIONS

| | | | | | | | | | | | 1 |
|---|---------|-------------------------------------|--|--------------------------|-------------------------------|-------------------|-------------------------------|--------------------------|----|-------|-------|
| 60 SW4 | SP3T | SWITCH SLIDE SP3T 100MA 12V | SMD, GULL WING, SW, SP3T | Nidec Copal | CSS-1310TB | Digi-key | 563-1095-1-ND | 563-1095-6-ND | - | 0.63 | 0.63 |
| 61 SW6, SW7, SW8 | _ | SWITCH TACTILE SPST-ND 0.05A t2V | SMD, TACT SW, SPST | C&K | PTS6455L50SMTR92 LFS | Digi-key | CKN9069CT-ND | CKN9088DKR-ND | 0 | 0.16 | 0.48 |
| 62 UT | | SENSOR HUMD/TEMP 5V I2C 3% SMD | 8-DFN, 8-VFDFN EXPOSED PAD | Sensition AG | SHT30-DIS-B | Digi-key | 1649-1009-1-ND | 1649-1009-6-ND | - | 3.93 | 3.93 |
| 63 U2, U3, U4 | | IC MULTIPLEXER DUAL 4X116TSSDP | 16-TSSDP | Texas Instruments | SN74LV4052APWR | Digi-key | 296-3831-1-ND | 296-3831-6-ND | ~ | 0.48 | 1,44 |
| 64 U5 | | IC REG BUCK ADJ 3A SYNC 850P | 8-SOIC (0.154", 3.90mm Width) Exposed Pa | Richtek USA Inc | RT2862AGSP | Digi-key | 1028-1372-1-ND | D28-1372-6-ND | - | 2.17 | 2.17 |
| 65 U6 | | IC SW DISTRIBUTION ADJ SOT23-6 | SOT-23-6, IPCMED | Microchip | MIC2007YM6-TR | Digi-key | 576-1460-1-ND | 576-1460-6-ND | - | 0.48 | 0.48 |
| 66 U7 | | IC REG LINEAR 3.3V 1A SOT23-5 | SOT-23-5, SC-74A, SOT-753 | Texas Instruments | TLV75733PDBVR | Digi-key | 296-50414-1-ND | 296-50414-6-ND | - | 0.88 | 0.88 |
| 67 U8 | | IC SGL USB-DL UART BRIDGE 24GFN | 24-CFN, 24-WFCFN Exposed Pad | Silicon Labs | CP2105-F01-GMR | Digi-key | CP2105-F01-GMRCT-ND | CP2105-F01-GMRDKR-ND | - | 1.56 | 1.56 |
| 68 U9 | | IC TXFK FS232 ESD TRUE 20TSSOP | 20-TSSDP (0.173", 4.40mm Width) | MadLinear Inc | SP322EUEY-LTR | Digi-key | 1016-1795-1-ND | 1016-1735-6-ND | - | 1.92 | 1.92 |
| 69 UID, UT2, UT5 | | IC SWITCH DUAL SPST US8 | 8-VFSCP(230MM) | ON Semi | FSA1259AK8X | Digi-key | FSA1259AK8XCT-ND | FSA1259AK8XDKR-ND | ~ | 0.7 | 21 |
| 70 UTI | | IC TXFX FS422485 20MEPS 10MSDP | 10-MSOP, 10-TFSOP | Renesas | ISL3176EIUZ | Digi-key | ISL3176EIUZ-ND | ISL3176EIUZ-TDKR-ND | - | | |
| 71 U13 | | IC GATE NAND SCHMITT 4CH 14TSSOP | M-TSSOP | CN Semi | MC74HC132ADTG | Digi-key | MC74HC132ADTGOS-ND | MC74HC132ADTR2GOSDKR-ND | - | 0.38 | 0.38 |
| 72 U14 | | IC TXFX FS422485 20MBPS 8MSOP | 8-MSOP, 8-TSSOP | Renesas | ISL3778EIUZ | Digi-key | ISL3178EIUZ-ND | | - | | |
| 73 U16 | | IC MCU 328IT 1MB FLASH 64TCFP | 64-TQFP(10X10MM) | Microchip | ATSAME51J20A-AU | Digi-key | ATSAME51120A-AU-ND | ATSAME51J20A-AUT-DKR-ND | - | 5.4 | 5.4 |
| 74 UT7 | | IC REG LINE AR 3.3V 250MA SOT23-3 | SOT-23-3 , TO-236-3, SC-59 | Diodes Inc | AP2138N-3.3TFIG1 | Digi-key | AP2138N-3.3THG1DICT-ND | AP2138N-3.3TFIG1DIDKR-ND | - | 0.35 | 0.35 |
| 75 U18 | | IC MCU 32BIT 128KB FLASH 48LQFP | 48-LGFPIPCMED | STMicroelectronics | STM32F072CBT6 | Digi-key | 497-14645-ND | | - | 3.56 | 3.56 |
| 76 | | | | | | | | | | | |
| 77 Other | | | | | | | | | | | |
| 78 PCB | | PCB, ema: Play eval kit, ema_dk_a_a | | OptConnect | dk_a | Advanced Circuits | | | - | 13.62 | 13.62 |
| 79 STANDOFFS | | FIDUND STANDOFF #4-40 ALUM 38" | | Keystone Electronics | 2026 | Digi-key | 36-2026-ND | | 4 | 0.22 | 0.88 |
| 80 SCREWS | | MACHINE SCREW PAN PHILLIPS 4-40 | | Keystone Electronics | 0066 | Digi-key | 36-9900-ND | | 4 | 0.04 | 0.16 |
| 81 FIEMWARE1 | | Fw, UB, JUNK OB | | Segger | J-Link-OB-STM32F072- 128KB | Segger | J-Link-OB-STM32F072- 128KB | | - | 10 | 13 |
| 82 FIRMWARE2 | | FW, UTB, ema: Play App Code | | OptConnect | ema dk fw 1 | OptConnect | ema_dk_fw_1 | | - | | |
| | | - | | | | | | | - | _ | |
| 00 Not Fopulated | | | | | | | | | | | |
| 89 C38, C39, C40, C41 | ЧЧ | CAP CER 0.1UF 50V X7R 0603 | CAP0603IPCMED | Yageo | CC0603KFX7F9BB104 | Digi-key | 311-1344-1-ND | 3th-1344-6-ND | 4 | 0.12 | 0.48 |
| 90 C50, C51 | OpF NP | CAP CER 10PF 25V X7R 0603 | CAP0603PCMED | AVX Corp | 06033C100KAT2A | Digi-key | 478-11366-1-ND | 478-11366-6-ND | 2 | 0.27 | 0.54 |
| 91 C56, C68, C69 1 | 00uF NP | CAP CER 100UF 10V X5R 1210 | CAP1210IPCLARGE | Taiyo Yuden | LMK325BJ107MM-T | Digi-key | 587-1965-1-ND | 587-1965-6-ND | 3 | 136 | 4.08 |
| 92 C66 4 | 17uF NP | C.A.P. C.E.H. 4, 7U/F 16V X7H 0805 | CAP0805PCMED | Samsung Electro-Mechanic | CL21B475KOFNINE | Digi-key | 1276-2873-1-ND | 1276-2873-6-ND | - | 0.34 | 0.34 |
| 93 C67 2 | CINF NP | CAP CER 2700PF 50V X7R 0503 | CAP0603IPCMED | Samsung Electro-Mechanic | CL10B272KB8NNNC | Digi-key | 1276-2022-1-ND | 1276-2022-6-ND | - | 0.1 | 0.1 |
| 94 ema | đ | EMA | EMA OUTLINE | OptConnect | EMA-DXXX-L4-A | | | | - | | |
| 95 J14 | đ | CABLE ADAPTER 6 POS | TAG CONNECT, PROG | Tag-Connect LLC | TC2030-IDC | Digi-key | TC2030-IDC-ND | | - | 43.71 | 43.71 |
| 96 F13 | đ | RES SMD 0 CHM JUMPER 110W 0603 | RESOB03IPCMED | Yageo | RC0603UR-070FL | Digi-key | 311-0.0GPICT-ND | 311-0.0GRDKR-ND | - | 0.1 | 0.1 |
| 97 R41 | 20 NP | PES SMD 120 CHM 1% 710W 0603 | RESOB03IPCMED | Yageo | RC0603FR-07120FL | Digi-key | 311-120HPCT-ND | 311-120HPDKR-ND | - | 0.1 | 0.1 |
| 98 R77 | M ND | PES SMD 10K OHM 1% 110W 0603 | RE S0603IPCMED | Yageo | RC0603FR-0710KL | Digi-key | 311-10.0KHPCT-ND | 311-10.0KHRDKR-ND | - | 0.1 | 1.0 |
| TP1, TP2, TP2, TP3, TP12, TP15, TP26, TP28, TP30, TP31, TP34, TP35, TP36, TP37, TP38, TP41, TP42, TP42, TP44, TP56, TP65, TP61, TP72, 99 TP73, TP74, TP75, TP76 | d | TEST POINT | TEST POINT, 4MM | | | Diai keu | | | 53 | | |
| 100 XTAL1 1 | 2MHz NP | CRYSTAL 12MH2 10PF SMD | 4-SMD, ND LEAD | ECS Inc. | ECS-120-10-33B-CKM-TR | Digi-key | XC2426CT-ND | XC2426DKR-ND | - | 0.59 | 0.59 |
| | | | | | | | | | | | |





5.3 Assembly Reference





5.4 Sample ema:Play configurations

Sections 5.4.1 – 5.4.5 demonstrate how to configure the ema:Play dipswitches (SW2-SW4) for the most common use cases. A snippet of the used ema:Play hardware components is provided as well for reference.

Note: If the on-board MCU (U16) is not required for use, it should be held in reset using SW5.

5.4.1 On-board MCU control (default)

In this configuration, the on-board MCU (U16) is running an application and using ema as the cellular internet connection. Both the Modem UART and emaLink interfaces are connected directly to the MCU as shown below. AT commands are used to control ema.



5.4.2 External S2USB control

In this configuration, an external host such as a Windows or Linux environment controls ema through use of ema:Play's S2USB port (J10). This configuration can also be used to manually send AT commands via a Terminal program. The Modem UART interface (standard COM port, 115200,8,N,1) can be accessed directly using this method. Additionally, and with the help of two short jumpers, the emaLink interface (enhanced COM port, 19200,8,N,1) can also be accessed through the S2USB port (J10). Reference *Figure 22* for how to connect the jumper wires. AT commands are used to control ema.







Figure 22

5.4.3 External USB control

In this configuration, an external USB host driver controls ema through use of ema's direct USB interface via ema:Play's USB port (J6). This configuration requires the host system to support ema USB host drivers. These drivers are available from OptConnect. Refer to section 1.2 for the best way to obtain these drivers.





5.4.4 External MCU control

In this configuration, an external MCU is running an application and using ema as the cellular internet connection. Both the Modem UART and emaLink interfaces are connected directly to the external MCU via ema:Play's IO Application Header (J5). AT commands are used to control ema.



5.4.5 External RS232/RS485/RS422 control

In this configuration, an external host device that supports RS232/RS485/RS422 can be used to access ema's Modem UART interface via ema:Play's screw terminal block (J2) or shrouded connector (J1). This configuration is useful in industrial and commercial applications where the desired host system is a machine, PLC or similar. If the interface used is selected to be RS485/RS422 then the host system can be located long distances from ema and ema:Play. Auto-direction control is built into ema:Play so there is no need to control the ema:Play driver enable (DE) signal when using RS485. This configuration does not allow access to the emaLink interface. AT commands are used to control ema.





5.5 Sample Project – Getting Started with ema

5.5.1 Overview

This section aims to provide an overview and detailed description of the *Getting Started with ema* sample project. Go to **http://optconnect.com/emaPlay**, or reach out to an OptConnect representative to obtain the latest project package. Reference section 1.2 for more information. Additionally, this section will instruct the user on how to configure the ema:Play hardware to support the project. The overall goal of this sample project is to demonstrate a simple IoT application, where the ema:Play is using ema as its cellular internet connection, to send and receive ema:Play telemetry data to an IoT cloud platform. OptConnect partner's with Banyan Hills Technologies, and leverages their award-winning Canopy IoT Platform (https://banyanhills.com/canopy-iot-platform/). This sample project integrates Canopy's endpoint agent (Leaf) to provide the link between the ema:Play hardware and the Canopy IoT Platform. Autonomously, ema will also be managing the cellular connection. The OptConnect Summit portal (https://summit.optconnect.com/login) can be used to track ema's management activities.

5.5.2 Features Supported/Demonstrated

- ema startup and initialization, recovery, and shutdown
- ema microFOTA
- ema Board Notify
- ema Glimpse
- ema Board ID
- Temperature, Humidity, Light, and Voltage sensing
- 4 user digital outputs (2 LED, 2 GPIO)
- 3 user inputs (1 ADC, 2 digital)
- Banyan Hills Canopy Dashboard
- Device to cloud communications
- Cloud to device communications
- HTTPS POST
- JSON messaging

5.5.3 Hardware Configuration

The ema:Play hardware must be configured properly to accommodate this sample project. The hardware should be configured to the default configuration as shown in section 5.4.1. Additionally, verify the following settings are as follows:

- MCU reset released (SW5 set to OFF)
- ema cellular module OFF/released (SW1 set to OFF)
- Power applied through barrel connector (J9) or EXT_VIN (J1.1, J2.1)



5.5.4 Software Project Hierarchy

The sample project main application has the following folder and file hierarchy:

| 4 | 🗁 OptConnect | |
|---|---|--|
| | ema c oc_ema_modem_at.c b oc_ema_modem_at.h | ema AT cmd drivers ema Modem AT cmd driver |
| | c oc_emaLink_at.c c oc_emaLink_at.h | ema emaLink cmd driver |
| | emaPlay emaPlay.c emaPlay.h | ema:Play functionality ema:Play used functions |
| | h emaPlay_config.h c queue.c h queue.h | ema:Play configuration options queue/fifo functionality |
| | Leaf oc_leaf.c oc_leaf.h | Banyan Hills Leaf agent functionality Leaf driver |
| | c atmel_start.c atmel_start.h | Atmel START generated |
| | atmel_start_pins.h driver_init.c | Atmel START driver init |
| | h driver_init.h c main.c | Main application |

5.5.5 Software Configuration

The sample project has several build time options that can be modified for different functionality of the project. The options are editable in *emaPlay_config.h*. The project must be re-built if changing these options. See below snippet for configurable options and description:

| #define ENABLE_LEAF_NOOP | 1 | <pre>// 1 = send leaf noop to get data from the server synchronously(higher system latency) // 0 = use ema Board Notify to get data from the server asynchronously(not supported)</pre> |
|---|---------|---|
| #define LEAF ATTEMPTS | 1 | // number of attempts for a leaf query(if a failure occurs) |
| #define DIN_D_TIME | 2000 | // ms. Digital input debounce time |
| #ifdef DEBUG | | |
| <pre>// function specific console debug</pre> | control | |
| #define DBG_MODEM_AT | 0 | // console output of ema Modem UART interface traffic |
| #define DBG_MODEM_AT_HEX | 0 | // console output of ema Modem UART interface traffic in hex format |
| #define DBG_EMA_LINK_AT | 0 | // console output of ema Management UART interface traffic |
| #define DBG EMA LINK AT HEX | 0 | // console output of ema Management UART interface traffic in hex format |
| #define DBG EMA LINK URC | 0 | // console output of ema URCs |
| #define DBG_EMA_LINK_URC_HEX | 0 | // console output of ema URC hex format |
| #define DBG_APPLICATION | 1 | // console output of ema main application debug messsages |
| #endif | | |
| // functionality | | |
| #define OPT_RECOVER_EMA | 1 | // 1 = forces the code to recover ema if any errors are encountered. |
| | | // 0 = stops on an error |
| #define OPT_AUTO_START | 0 | // 1 = force the code to automatically start the demo without user interaction |
| | | // O = user must press and hold sw7 for 2 seconds or 's' in the terminal to start the demo |
| <pre>#define OPT_PERIODIC_STATISTIC seconds).</pre> | 0 | <pre>// 1 = Periodic Mode => sends the statistic(temp, hum, adc, etc) data to the cloud periodically(~30</pre> |
| | | // WARNING, Periodic Mode consumes a lot more cellular data. |
| | | // 0 = Delta Mode => sends the statistic data when a change of defined deltas(below) occurs |
| #if OPT PERIODIC STATISTIC == 0 | | |
| #define TEMP DELTA | .5f | // change in deg F |
| #define R HUM DELTA | 2 | // change in rel hum % |
| #define EMA V DELTA | .1f | // change in ema voltage |
| #define SYS V DELTA | .5F | // change in sys voltage |
| #define SIG Q DELTA | 1 | // change in sig q or "bars" |
| #define LIGHT DELTA | 75 | // change in light adc % |
| #define USER ADC DELTA | 75 | // change in user adc % |
| #endif | | |
| | | |



Console debug input and output is provided through the use of ema:Play's S2USB port (J10). This will help the user understand how the project is executing in real time and provides verbose debug messaging as per the enabled console outputs. See "function specific console debug control" in file emaPlay_config.h. The COM port settings for the console debug interface are **115200,8,N,1**. The COM port will enumerate with the computer as an Enhanced COM Port (COMxxx):

Ports (COM & LPT)

Silicon Labs Dual CP2105 USB to UART Bridge: Enhanced COM Port (COM111)

Silicon Labs Dual CP2105 USB to UART Bridge: Standard COM Port (COM110)

Pressing '?' in the console will list the currently active console Cmds as shown:

| - | | | - Cmd Menu | | |
|---|----|---|------------------|--------|------|
| , | ď | | ema:Play and ema | status | data |
| , | s' | = | Start/Stop demo | | |

Current console Cmd descriptions:

'd' = ema:Play and ema status data. This cmd will list the status of all relevant data to the project:

Example:

| ema status | |
|-----------------|---|
| uptime: | 155 |
| pri. carrier: | AT&T |
| act. carrier: | AT&T |
| cell fw ver: | 20.00.505 |
| failover: | Disabled |
| failover time: | 0 |
| context ID: | 1 |
| context status: | 1 |
| acc tech: | E-UTRAN |
| reg status: | 1 |
| calc sig q: | 2 |
| mobile ip: | 10.175.46.154 |
| board ID: | emaPlay-4056B76938433753202020374D2702FF-ema-n1e00d800010 |
| ema fw ver: | v1.1.0-0-g06d50ee BUILD=dev A |
| sn: | ema-n1e00d800010 |
| ema_model: | EMA-L4-1-XX-A-A |
| OC Services: | Connected |
| | |
| emaPlay stat | |
| temp: | 21.3f |
| rel hum: | 30.8% |
| light ADC: | 68 (12 bit) |
| ema V: | 0.00 |
| sys V: | 5.20 |
| user ADC: | 1903 (12 bit) |
| sw 1 state: | |
| sw 2 state: | |
| din 1 state: | 1 |
| din 2 state: | |
| led 1 duty | |
| led 1 period | |
| led 2 duty | |
| lea z perioa | 9 (ms) 9 (|
| dout 1 duty | |
| dout 1 period | |
| dout 2 auty | |
| aout z perioa | U \NS7 4056 876 938433753309030374N37037FP |
| leaf init: | 10505707504557552020205745270211 |
| auto vehoote | |
| manual weboots | |
| manual rebuuts | |

's' = Start/Stop demo. This cmd will start and stop (graceful ema shutdown) the demo project.



5.5.6 Software Architecture & Description

The *Getting Started with ema* sample project is architected in such a way to demonstrate how easy it is to collect local sensor/IO information and act upon it. The Canopy IoT platform allows IoT campaigns to be created that can automate tasks. For example, if Digital Input 1 goes high, then turn ON LED 1. This sample project processes the following input and outputs, that can be used with the Canopy IoT Campaigns. Reference section 5.5.10 for further information and usage example of the Canopy IoT dashboard.

| Input/Type | Output/Type |
|--|--|
| Temperature/sensor | LED 1/red LED (D18) |
| Relative Humidity/sensor | LED 2/red LED (D19) |
| Light Intensity/sensor | Digital Output 1/IO app header pin (J5.4) |
| System Voltage/analog | Digital Output 2/IO app header pin (J5.3) |
| ema Voltage/analog | Signal Quality/LED bar graph/State (D14 – D17) |
| User ADC/analog | |
| Push Button 1/switch (SW7) | |
| Push Button 2/switch (SW8) | |
| Digital Input 1/IO app header pin (J5.6) | |
| Digital Input 2/IO app header pin (J5.5) | |

| D14 – D17 LED State | Description |
|-------------------------|---|
| Scrolling left to right | Idle, waiting for user input (hold SW7 for 2 seconds) |
| D14 Flashing | Searching for cellular network, and/or acquiring signal |
| All Flashing | An error has occurred |
| 1 – 4 LEDs ON solid | Indicating current signal quality |

D14 – D17 LED State Reference Table



The runtime environment is bare metal to demonstrate that the most resource constrained designs can work easily with ema. A simplified flow chart of the software is shown.





This various software components or functions that are used in this sample project are detailed below:

emaPlay_mgmt_URC_handler(): This function is called as frequently as possible. It handles any asynchronous ema URC's that have been received over the emaLink interface. The data is written to a FIFO queue(*mgmt_uart_async_rx_q*) at the interrupt level during the receive data callback function (*emaPlay_mgmt_rx_cb*). The entire URC verbose message is retrieved. The function

emaPlay_mgmt_process_URC() will process the URC according to the requirements of the application. *emaPlay_system_task()*: This function is the main state machine that handles the control of ema, as well as transacting any relevant data to and from the IoT cloud platform. Once the demo is started, the state machine powers on ema and the cellular module, checks network status, checks/starts the data session, initializes the Leaf agent, then enters a normal operations state. User events and periodic/delta statistic messages will create and build JSON messages to be sent to the cloud.

emaPlay_scan_analog_inputs(): This function scans and debounces the system's analog inputs. *emaPlay_read_temp_humidiity()*: This function communicates over i2c to a temperature/humidity sensor and converts the data into degrees F and relative humidity %.

emaPlay_check_events(): This function processes any of the digital events that can take place from either the push buttons or the user digital inputs. The low-level reading and debouncing of the actual MCU pin(s) occurs on a timer interrupt.

dbg_task(): This function handles any queued console debug output as well as reading any console input.



5.5.7 Console Debug Output Sample

172789 175137

| ema:Play "Getting Started with ema demo" PW Version: May 11 2020 '?' for menu |
|---|
| 761 mS: ema power detected 861 mS: Press and hold SW7 for 2 seconds to start |
| 11202 mS: Initializing ema, applying power. Waiting 14211 mS: ema Board ID set: emaPlay-4056B76938433753202020374D2702FF-ema-n1e00d800010 14211 mS: ema Powered ON. Turning module ON. Waiting 2855m mS: Module ON and ready |
| 29858 mS: Checking network status, searching 41708 mS: Registered on the AT&T network 41708 mS: Checking data session 41754 mS: No session, statting session |
| 41897 mS: Data session active 41915 mS: Starting Leaf 41954 mS: Leaf Started 42015 mS: Delta change detected |
| 42553 mS: No session, starting session 44298 mS: Building Leaf Statistic message 44398 mS: Sending Leaf message 46852 mS: Leaf guery success |
| 57057 mS: Building Leaf Noop message 57157 mS: Sending Leaf message 59434 mS: Leaf query success 61939 mS: Periodic network status check |
| 69641 mS: Building Leaf Noop message 69741 mS: Sending Leaf message 72177 mS: Leaf query success 81989 mS: Periodic network status check |
| 82990 mS: Building Leaf Noop message 83090 mS: Sending Leaf message 85422 mS: Leaf query success 86603 mS: Event detected |
| 86703 mS: Building Leaf Event message 86803 mS: Sending Leaf message 89345 mS: Leaf query success |
| 142182 mS: Periodic network status check 147192 mS: Building Leaf Noop message 147292 mS: Sending Leaf message 149762 mS: Leaf query success |
| 149869 mS: Board Notification: control,4,500,1000 159969 mS: Building Leaf Noop message 160069 mS: Sending Leaf message 162467 mS: Leaf query success |
| 162473 mS: Periodic network status check 172689 mS: Building Leaf Noop message 172789 mS: Sending Leaf message 175137 mS: Leaf query success |



| 1261471 mS | |
|------------------|--|
| ema status | 125 |
| uptime: | |
| pri. carrier: | |
| act. carrier: | |
| cell fw ver: | 20.00.505 |
| failover | Disabled |
| failover time: | |
| context ID: | |
| context status: | |
| acc tech: | E-01RAN |
| reg status | |
| calc sig q: | |
| mobile ip: | 10.175.46.154 |
| board ID: | emar1ay-405bB7b938433753202020374D2702FF-ema-n1e00d800010 |
| ema fw ver: | v1.1.0-0-g0bd50ee BUILD=dev H |
| sn: | |
| ema model: | EUH-L4-1-XX-H-H |
| OG Services: | Gonnected |
| emaPlay stat | |
| temp: | 70_8f |
| rel hum: | 30.6% |
| light ADC: | 73 (12 bit) |
| ema V: | 4.00 |
| sys V: | 5.10 |
| user ADC: | 1897 (12 bit) |
| sw 1 state: | |
| sw 2 state: | 8 |
| din 1 state: | 1 |
| din 2 state: | 1 |
| led 1 duty | Ø (mS) |
| led 1 period | Ø (mS) |
| led 2 duty | Ø (mS) |
| led 2 period | Ø (mS) |
| dout 1 duty | Ø (mS) |
| dout 1 period | Ø (mS) |
| dout 2 duty | Ø (mS) |
| dout 2 period | U (mS) |
| sn: | 4056B76938433753202020374D2702FF |
| leaf init: | 1 |
| auto reboots | |
| manual repoots | U Contraction of the second seco |
| | |
| 1264867 mS: Peri | iodic network status check |
| 1267973 mS: Buil | lding Leaf Noop message |
| 1268073 mS: Send | ling Leaf message |
| 1270603 mS: Leaf | query success |
| 1271703 mS: Grad | erully shutting down ema |
| 1272707 m5: Modu | the turned orr, removing power |
| 1273307 M&: POWE | er removed, going late |
| IZIJIUI Ma- Pres | ss and note swy for 2 seconds to start |

The console output shown above is typical to what would be seen when running this sample project for a short period of time. Each console line starts with a timestamp(mS) since the code execution started.

The first message outputted is the welcome message that includes the "*Project Name*" FW Version: Mo Day Year, followed by an input tip; '?' for menu. Reference the below table for line by line description.

| Timestamp(mS) | Description |
|---------------|---|
| 761 | ema:Play has detected that power for ema is available. |
| 861 | The user is instructed to hold SW7 to start the demo. |
| 11202 | After holding SW7, ema:Play is applying power to ema and waiting for the appropriate URC. |
| 14211 | URC detected, ema:Play has set its Board ID via ema to be reported to Summit. |
| 14211 | ema:Play detected ema is powered on, and is now powering on the cellular module and waiting for the appropriate URCs. |
| 29858 | URCs detected. Cellular module is now powered on and ready. |
| 29858 | ema:Play is now checking the carrier network status for registration. |
| 41708 | ema has been registered on the AT&T network and obtained adequate signal. |
| 41708 | ema:Play is now checking for an active data connection. |
| 41754 | No data session active, ema:Play is activating the data session. |
| 41897 | The data session is now active. |
| 41915 | ema:Play is starting the Leaf agent. |
| 41954 | The Leaf agent is ready. |



| 42015 44298 44398 | ema:Play has detected a change in telemetry data ema:Play is building the Leaf statistic message. ema:Play is sending the Leaf statistic message via HTTPS. |
|---------------------------------|---|
| 57157 61939 | ema:Play is checking for data from the Canopy/Leaf servers. ema:Play is periodically checking the carrier network status using OptConnect Glimpse. |
| 86603 86703 86803 | ema:Play detected an event (button pressed). ema:Play is building the Leaf event message. ema:Play is sending the Leaf event message via HTTPS. |
| 142182 | ema:Play is periodically checking the carrier network status using OptConnect Glimpse. |
| | |
| 149869 | ema:Play received a Board Notify message from the cloud, with LED control data. |
| 1261471 | ema:Play outputted status data, as a result of the user inputting the 'd' cmd. |
| 1271703 | The user has instructed ema:Play to gracefully shutdown ema by pressing and Holding SW7. ema:Play is waiting for the appropriate URCs |
| 1272702 | ema:Play has gracefully shutdown ema's cellular module. |
| 1273307 | ema:Play has removed power from ema. |
| 1273407 | ema:Play is idle and waiting for the user to (re)start the demo. |



5.5.8 OptConnect Summit Portal

5.5.8.1 Overview

The OptConnect Summit portal is an online tool that allows users to manage and monitor their entire fleet of OptConnect cellular devices. This section describes how to use the Summit portal for basic ema monitoring and management. This section assumes that the users' Summit account has been setup successfully, and the user can login to the Summit portal. For questions regarding Summit account creation and login credentials, refer to section 1.2.

5.5.8.2 Login and Find ema

- 1. Confirm that ema:Play and ema are powered ON, and allow ema up to 30 seconds to establish a connection to OptConnect services.
- 2. Navigate to **https://summit.optconnect.com/login** and login to the portal. The landing page should look similar to *Figure 23*. All of the OptConnect cellular devices associated with this account will be quantified by the categories shown.



Figure 23

3. Click the "CURRENTLY ONLINE" button. The view will switch and list all OptConnect cellular devices associated with this account that are currently online. Locate the ema in question by serial number. Click on the serial number to monitor ema as shown in *Figure 24*.



| | 100 | Acm | e Company-OC | | | | | | Q 💼 🚍 menu |
|---|----------------------------|---------|---------------|---|------|---|-------------------------|---------|--|
| The devices for the last check-in range s | selected are listed below. | | | | | | | | × |
| View Devices by Equipment | Type | known | evices | | | | | | |
| 10 v rows per page | | | | | | | Search/I | Filter: | |
| YOUR DEVICE ID | SERIAL 🔶 | STATUS | LAST CHECK-IN | ¢ | TYPE | ¢ | IP | ¢ | DESCRIPTION \$ |
| Sunset Gazette -7AKIT012 | 323280179 | 0-2 Hrs | | | | | | | Sam's Sandwich Shop - Kaysville UT |
| ATM TID | 854117 | 0-2 Hrs | | | | | 10.175.34.74 (M2) | | Hindenburger Broiled Burgers - Kaysville UT |
| TID123 | 967257 | 0-2 Hrs | | | | | 10.175.0.22 (M2M | | Zeppelin Sub Shop - Kaysville UT |
| POS.A74.1165 | 70B3D5D3B4D7 | 0-2 Hrs | | | | | 10.145.188.117 (M2M) | | Freddy's Convenience Mart - Little Rock AR |
| | ema-n1e00d800010 | 0-2 Hrs | | | | | 10.175.46.154 | | OC Engineering #10 |
| US-UT-KAY-0104 | 70B3D5D3B7C5 | 0-2 Hrs | | | | | 10.145.220.92 (M2M) | | Diffuse Drug Store - Kaysville UT |
| Review Times - 145927 | 70B3D5D3BB04 | 0-2 Hrs | | | | | 10475013 (M2M | Ĩ | Husk Gas Station - Beeville TX |
| | SU381900034 | 0-2 Hrs | | | | | 100.73.69.114 (M2M) | | |
| Kiosk 12345 | 345800405 | 0-2 Hrs | | | | | 10175.44.39 (M2) | | Freddy's Convenience Mart - Highland UT |
| Showing 1 to 9 of 9 entries | | | | | | | First | ← P | revious <u>1</u> Next → Last |

Figure 24

5.5.8.3 Device Attributes and Location

1. The "DEVICE ATTRIBUTES" section can be used to investigate ema's Board ID, IP address, Last check-in, etc. Certain fields (Device ID, and Description) can also be edited accordingly. Reference *Figure 25*. Note the board ID that was set by ema:Play in the sample log in section 5.5.7.

| | SN: ema-n1e00d800010 | | |
|-------------------|---|------------------------|---------------------|
| 55.6 | Participation of the second | | |
| DEVICE ATTRIBUTES | | | |
| YOUR DEVICE ID | Add Device ID | STATIC IP | |
| DESCRIPTION | OC Engineering #10 | CHECK-IN (HRS:MIN AGO) | Over 7 days 7+ Days |
| BOARD ID | emaPlay-8E1CBC8638433753202020374C2E02FF-ema-n1e00d800010 | LAST CHECK-IN | 10/22/2019 13:53 |
| SERIAL NUMBER | ema-n1e00d800010 | MODEL | EMA-L4-1-US-B-A |
| Edit Device ID | Edit Description Support Detail | | |

Figure 25

2. The "APPROXIMATE DEVICE LOCATION" section can be used to view ema's location. Reference *Figure 26*.





Figure 26

5.5.8.4 Events, Usage and Analytics

1. The "EMA EVENTS" section can be used to closely monitor ema's behavior over time. Reference *Figure 27.*

| EMA EVENT | | | | | | | | | | | | | | | | | | | | | |
|-------------------|----------|--|-------|-------|------|-------|------------|--------|---------|------------------|------|-----|-------|-------|---|--------|----|--|--|---|--|
| | | | | | | | | er | na Ev | /ents | | | | | | | | | | Ξ | |
| 2 Dec | | | | | | | | | | | | | | | | | | | | | |
| 1 Dec | | | | | | | | | | | | | | | | | | | | | |
| 30 Nov | | | | | | | | | | | | | | | | | | | | | |
| D afe D 29 Nov | | | | | | | | | | | | | | | | | | | | | |
| 28 Nov | | | | | | | | | | | | | | | | | | | | | |
| 27 Nov | | | | | | | | | | | | | | | | | | | | | |
| 26 Nov | | | | | | | | | | | | | | | | | | | | | |
| 12:0 | 00:00 AM | | 6:00: | 00 AM | | | | | | 12:00:00 Time | PM | | | | e | :00:00 | РМ | | | | |
| | | | | • | Chec | k-ins | ♦ (| Cell C | onnecti | on obta | ined | V P | owere | ed on | | | | | | | |

Figure 27

2. The "DATA USAGE HISTORY" and "SIGNAL ANALYTICS" sections can be used to monitor ema's usage and signal data. Reference *Figure 28*.





Figure 28

5.5.9 Board Notify via Summit API

5.5.9.1 Overview

The OptConnect Summit portal exposes the Summit Application Programming Interface (API) that can be accessed by any internet connected device. Any user application that wishes to use the Summit API must meet the following pre-requisites:

- Has a valid Summit account and login credentials
- Has the Summit API access enabled for the account

Refer to section 1.2 for information on contacting OptConnect for troubleshooting Summit API access.

The Summit API allows applications to access information and data relevant to the users Summit account and associated devices. Reference the Summit API Docs webpage at **https://docs.optconnect.com/documentation**

This section demonstrates ema's Board Notify feature using ema:Play. Board Notify is a powerful but simple feature that allows any internet connected device to send small chunks of data to ema using the Summit API secure channel. This allows the user's host application utilizing ema to remain mostly idle, and not have to periodically send data out or poll for data from the server. This inherently will save on data usage and power consumption. The Board Notify feature is initiated from the Summit API and is presented to the user application and hardware via the emaLink interface as a URC. Reference the *OptConnect ema™ emaLink AT Command Manual* for further information on URC's

Confirm ema:Play is powered on and configured as shown in section 5.5.3.



5.5.9.2 Create a New API Application in Summit

1. Navigate to **https://summit.optconnect.com/login** and login to the portal. In the top right area of the screen, click on the "MENU" button. In the menu, click on "Manage API Apps" as shown in *Figure 29*.



Figure 29

2. Click on the "New API Application" button as shown in Figure 30.

| ion |
|------|
| ve |
| idit |
| ve |
| dit |
| |

3. The "Create New Summit API Application" page will load. Enter a Name and Description for this API application. Select the appropriate Application Roles and Account Access settings for this API Application, then click "Create" as shown in *Figure 31*.

Figure 30

|--|--|

| API Appl | ica | tion Mana | igen | nent | | | | |
|---------------------|----------|--|-------|------|--|--|--|--|
| Create New Summit A | PI App | lication | | | | | | |
| | | | | | | | | |
| Name * | ema: | Play Board Notify | | | | | | |
| Description * | Used | Used to test Board Notify | | | | | | |
| Application Roles | | | | | | | | |
| Read Data | • | Write Data | Ø | | | | | |
| Device Read Access | 2 | Device Actions | 2 | | | | | |
| OptReboot | 2 | | | | | | | |
| | | | | | | | | |
| Acme Company-OC | Ø | Looney Tunes-OC | Ø | | | | | |
| Create | b | | Reset | | | | | |
| | | Optioned | | | | | | |
| | | orth Kays Drive #110 Kaysville, UT • at 1.877.678.3343 or by Email. Lic | | | | | | |

Figure 31

4. Once the "Create" button is clicked, a window will pop up asking to copy the App Secret. Copy the App Secret and save it in a secure location for later use. Close the App Secret pop up page. The "Application Details" page should now be displayed as shown in *Figure 32*. Note the Account ID and the Application ID for later use.

| | | Q II | E MENU | | |
|---|------------------|--|--------|--|---|
| | API A | oplication Manageme | ent | | |
| | Application Deta | | | | |
| | Name: | ema:Play Board Notify | | | |
| A DECEMBER OF THE OWNER OWNER OF THE OWNER OWNE | Description: | Used to test Board Notify | | | |
| All | Account ID: | | | | |
| | Application ID: | 4075 | | | |
| | Status: | Active | | | k |
| Sector Sector | Created: | 20 Jan 2020 | | | |
| | Roles: | Read Data, Write Data, Device Read Access, De Actions, OptReboot | evice | | |
| the Southern of the | Clients: | Acme Company-OC, Looney Tunes-OC | | | |
| | | Edit Reset App Secret | | | |
| A CONTRACTOR OF THE OWNER OWNER OF THE OWNER OWNE | | Opt | | | |
| | | iptConnect at 498 North Kays Drive #110 Kaysville, UT 84037. ntact Customer Care at 1.877.678.3343 or by Email. License | | | |



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5. At this point, the API Application has been created for the user's Summit Account. Additionally, the App Secret, Account ID, and Application ID should all be noted and saved for the next section.

5.5.9.3 Authenticate User Application with Summit API

- Navigate to https://docs.optconnect.com/documentation. OptConnect provides an interactive Summit Developers online tool that can be used to test any Summit API. In order to initiate the Board Notify feature and access the Summit API Application that was created in the previous section, follow the steps below.
- Any application with access to the internet can use the Summit API. The application must authenticate with the Summit API using the Account ID, Application ID, and APP Secret. On the Summit Developers landing page, scroll down and click on the "POST" button next to the Authentication endpoint "/accounts/login/app_secret" as shown in *Figure 33*.

| Authenticatio | n v |
|-----------------------------|--|
| POST /acco | ants/login/app_secret Log in as a Summit API Application API application to receive temporary credentials for use when calling the API. These credentials will expire 60 minutes le. |
| Parameters | Try it out |
| Name | Description |
| ApplicationCreden (body) | tials * reports Example Value Model f "accountId": 0, "applicationId": 0, "accruit": "string" Parameter content type application/json |
| Responses | Response content type application/json |
| Code | Description |
| 200 | 200 response Example Value Model { "apiKey": "string", |
| 401 | Unauthorized |



 Click the "Try it out" button on the right side to make the tool interactive. Retrieve and enter the Account ID, Application ID, and App Secret directly into the JSON structure. Click the blue "Execute" button to make the request. A successful request will return an API Key and an SDK Token (JSON Web Token), which should be saved and used in subsequent Summit API calls. Reference *Figure 34*.



| Name | Description | |
|---|--|---|
| ApplicationCredentials * requ | ured Summit API application credentials used to log in as an a | application |
| (body) | Example Value Model | |
| | "accountlo: 1, "application1d": 4075, "secret": "w | |
| | | 11 |
| | Cancel | |
| | Parameter content type | |
| | application/json ~ | |
| | | |
| | Execute | Clear |
| - T | | , |
| Responses | Respon | se content type application/json v |
| Curl | | |
| curl -X POST "https://ap "content-type: applicati \"wnqmpgAfVIu5ACyG2egaHIv | i.optconnect.com/summit/beta/accounts/login/app_secr on/json" -d "{ \"accountId\": 1, \"applicationId\" vf#CH?J+Wu0Yw#Yc8ZlsHckYc9FS#8u@HcYV22jftZNN8Pbx\"}" | et" -H "accept: application/json" -H : 4075, \"secret\": |
| Server response | | |
| Code D | etails | |
| 200 R | esponse body | |
| | <pre>{ "apiKey": "p6uVjzhTQ2ctgIxYibtJ7yUlBts0TYp32trBcgj "token": "eyhbGci0jJUzIlNiJ9.eyJpc3Hi0jJPcHRDb25uZWN0IiwiZX bmhxVnFUbGdBN1pnIwiaWF0JjoxNTcSHjESHTc2LCJzdWI0iiwiZX LKJjo0HDcLDchHBsBMH0GlvbJVbV6VZjbpItAwdFJVM9v4C Y2UgQNH0aW9ucyIsIkRldmlj2SB5ZWFKIEFjY2VzcyJdLCJjdXN0 Lm46Iq6mDFaW_DNB0c47dbT7s78px8" }</pre> | 5", hwljoxNTcSNjIzMTc2LCJqdGki0iISNXhQV3VDOUJK MDcIIwiYNHjbSVudElXIjoxLCJhcHBsaWNHdGlvbk IsIldy3XFLERhdGFLCSZWrbLERhdEFLCZEXZp b2llcklkcyIGWzE2NDksHzYwNV1s.jyHt69hJz2pNw |
| R | esponse headers | |
| | content-length: 469 content-type: application/json | |

Figure 34



5.5.9.4 Send Data to ema Using Board Notify

 Scroll down on the Summit Developers page to the Summit API Endpoint labeled "/devices/ema/boardnotify/serial/{serial}" and click the "Post" button. Next, click the "Try it out" button to make the tool interactive. Enter the ema Serial Number (found on the ema label), the API Key (from above), and the SDK Token (from above). Reference *Figure 35*.

| POST /devices/ema/boardnotify/serial/{serial} Send a board notify command to an ema device | | | | | | |
|--|---|----|--------|--|--|--|
| Using the serial number of a | an ema device, send a board notify command | | | | | |
| Parameters | | | Cancel | | | |
| Name | Description | | | | | |
| serial * ^{required} string (path) | serial number of device ema-n1e00d800010 | | | | | |
| <pre>x-api-key * required string (header)</pre> | x-api-key p6uVjzhTQ2ctglxYibtJ7yU1Bts0TYp32trBcgj5 | Ν | | | | |
| Authorization * ^{required} string (header) | SDK Token Header eyJhbGciOiJIUz11NiJ9.eyJpc3MiOiJPcHRDb25uZV | 42 | | | | |
| Figure 35 | | | | | | |

2. The ema:Play demonstration project will process pre-configured (reference section 5.5.6) command data adhering to the following protocol:

| Cmd/Control | States | Command | Parameters (idx, duty(ms), period(ms)) |
|------------------|----------------|-------------------|--|
| LED 1 | Duty On/period | "control" | "4","duty(0-65535)","period(0-65535)" |
| LED 2 | Duty On/period | "control" | "5","duty(0-65535)","period(0-65535)" |
| Digital Output 1 | Duty On/period | "control" | "6","duty(0-65535)","period(0-65535)" |
| Digital Output 2 | Duty On/period | "control" | "7","duty(0-65535)","period(0-65535)" |
| Reboot ema | | "reboot_ema" | |
| Reboot ema:Play | | "reboot_ema_play" | |

In this example, this Summit API endpoint is used to instruct the ema:Play red LED (D18) to flash with a duty cycle of 500 ms and a period of 1000 ms. Enter the command data as shown in *Figure 36* and click on the blue "Execute" button. Within a few seconds the query should respond and the ema:Play red LED (D18) should start flashing. The ema:Play debug console can also be monitored to view the Board Notify data that was received by ema:Play as shown in *Figure 37*.



| BoardNotifyRequest * requir | ^{red} Board notify request | | |
|--|--|---|---|
| (body) | Example Value Model | | |
| | { "cmd": "control,4,500,1000" } | | |
| | Cancel Parameter content type application/json | | |
| | | | |
| | Execute | C | lear |
| | - | | |
| Responses | | Response content type | application/json ~ |
| Curl curl - X POST "https://a application/json" - H "; application/json" - H "; pljostrisigent pljvasvdCislyEstricitor vec200cbaryevNls wec200cbaryevNls vec200cbaryev | pi optconnect.com/summit/beta/device x-api-key: pEuVjshTQ2ctgIxYibtJ7yUBB popioj JPCHEDD23uZVNBTimIZXhwjoxIT 10517PCHEDD23uZVNBTimIZXhwjoxIT 10517PDC11wiTXNjSYUdELL5jouCcNbd d651LCJ3ZWFKTERbdG51LCJEZXZPYUgQNNB d651LCJ3ZWFKTERbdG51LCJEZXZPYUgQNNB a | a/ema/boardnotify/serial/ema- ts0TYp32trBcgjg",-H, "Authori sSNjTeHTC2LCngd6ki0iTSNNhQYSV HBaaNMhd6iv6kltj3DNSCLC3heH M9GucyIaIRRIdmljZSBSZWFRIEFJY a" -H "content-type: applica | nle00d800010" -H "accept: zation: DOUJKbahx/MrUbGdBNlpnIimiaW BaaWhdGlvDlJv6Vzfjblt9md 2VzcyJdLCJjdXN0b2llcklkcyJ6 tion/json" -d "{ \"cmd\": |
| Server response | | | |
| Code t | Details | | |
| 200 | Response body | | |
| | <pre>{ "responseEpochSeconds": 157962073 }</pre> | 7 | |
| F | Response headers | | |
| | content-length: 35 content-type: application/json | | |

Figure 36

| 359826 mS: | Periodic network status | check |
|------------|--------------------------|-----------------|
| 379876 mS: | Periodic network status | check |
| 399930 mS: | Periodic network status | check |
| 419980 mS: | Periodic network status | check |
| 440032 mS: | Periodic network status | check |
| 460082 mS: | Periodic network status | check |
| 480142 mS: | Periodic network status | check |
| 500194 mS: | Periodic network status | check |
| 520246 mS: | Periodic network status | check |
| 540298 mS: | Periodic network status | check |
| 560352 mS: | Periodic network status | check |
| 562608 mS: | Board Notification: cont | tro1,4,500,1000 |
| 580408 mS: | Periodic network status | check |
| 592360 mS: | Delta change detected | |
| 592560 mS: | Building Leaf Statistic | message |
| 592660 mS: | Sending Leaf message | |
| 595124 mS: | Leaf query success | |
| 600430 mS: | Periodic network status | check |
| 620484 mS: | Periodic network status | check |
| 640540 mS: | Periodic network status | check |
| 660596 mS: | Periodic network status | check |
| 680650 mS: | Periodic network status | check |
| 700706 mS: | Periodic network status | check |
| 720758 mS: | Periodic network status | check |
| 740814 mS: | Periodic network status | check |
| 760870 mS: | Periodic network status | check |
| 780922 mS: | Periodic network status | check |
| 800972 mS: | Periodic network status | check |
| 821022 mS: | Periodic network status | check |
| 841072 mS: | Periodic network status | check |
| 861128 mS: | Periodic network status | check |
| 881178 mS: | Periodic network status | check |

Figure 37

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5.5.10 Banyan Hills Canopy IoT[™] Platform 5.5.10.1 Overview

Every purchase of an OptConnect ema:Play Evaluation Kit includes a trial of Banyan Hills Canopy[™] enterprise IoT platform. Its real-time dashboard, advanced features and configurable KPIs give you complete visibility into your network of data. Manage the overall health of your devices, address service issues before problems arise and delight customers with entirely new experiences. Canopy[™] is coupled with Banyan Hills Leaf Agent, running on ema:Play's demonstration project, and using ema as the internet connection. This allows for a simple device to cloud round trip relationship utilizing ema:Play's onboard sensors, digital inputs, and digital outputs.

Canopy[™] includes the very powerful IoT Campaigns feature which allows for custom automation tasks that can be setup and controlled from the Canopy[™] dashboard. Furthermore, the ema:Play demonstration project is running the Leaf agent which connects the ema:Play endpoint hardware to the Canopy[™] dashboard. The following section will briefly outline the Canopy[™] dashboard relative to ema:Play and demonstrate a simple IoT Campaign to automate a task.

This section assumes that the users' Canopy account has been setup successfully, and the user can login to the Canopy dashboard. For questions regarding Canopy account creation and login credentials, refer to section 1.2. For questions about Canopy and how best to use it, contact **info@banyanhills.com** or go to **https://banyanhills.com**.

5.5.10.2 Login and Find ema:Play

- 1. Confirm that ema:Play and ema are powered ON, and ema:Play is configured according to section 5.5.3. Allow ema up to 30 seconds to establish a connection to the Canopy servers.
- Navigate to https://portal.my-canopy.com and login to the portal. The landing page should look similar to *Figure 38*. All of the ema:Play devices associated with this account that have connected to the servers will be listed under the "Operations" tab. Note: The ema:Play devices are listed by the inserted ema's serial number.

| Canopy | | | | | OptConr | nect - <u>Allien Volg</u> t - | 🕆 Marketplace | 0 |
|--------------------|----------------------|-----------------------------|---------------------|----------------|---------------|-------------------------------|----------------|---|
| | Ct Op | berations Locations Devices | O IoT Campaigns | | | | | |
| ү ⊚ ⊗ ⊞ 📿 03:20 РМ | ∑ 💿 🖗 🗇 🖽 📿 03:20 РМ | | | | | | ~ | |
| Summary | | | | | | | | ^ |
| Device Id | Temperature | Humidity | Light | System Voltage | Ema Voltage | Analog Input | Signal Quality | y |
| ema-b39622ea000b | ∦ 72.0 ∗⊧ | ♦ 30% | ○ 72 | 5 .2 | \$ 4.0 | ∕ 1,896 | .1 2 | |
| ema-n1e00d800010 | ∦ : 73.3 r⊧ | ♦ 30% | <mark>(</mark>) 81 | 5 .2 | \$ 4.0 | ∕ 1,898 | .1 2 | |

Figure 38

ema:Play's real time telemetry data can be viewed and monitored on this page.



5.5.10.3 Device Operations and Leaf Messaging

A useful tool that can be accessed from the Canopy dashboard is the JSON structure Leaf messaging data that is being sent over the cellular connection from the ema:Play hardware. To access this information, follow these steps:

1. Click on the associated ema serial number to go to the "Devices" tab as shown in Figures 39 & 40.

| | s Operation | Locations Devices | loT Campaigns | | | | |
|---------------------|---|---------------------------------------|---------------------------|----------------|------------------|--------------|--------------------------|
| ∑ ۞ ♡ ⊞ C 03:44 PM | | | | | | 2 | 020-05-04 - 2020-05-11 🗸 |
| Summary | | | | | | | ^ |
| Device Id | Temperature | Humidity | Light | System Voltage | Ema Voltage | Analog Input | Signal Quality |
| ema-b39622ea000b | ∦ 72.0 י⊧ | ♦ 30% | ? 72 | 5 .2 | 4 .0 | ∕ 1,896 | . 11 ² |
| : ema-n1e00d8000010 | JE 72.8 1F | d 29% | © 101 | 5 .2 | 4 .0 | ∕ 1,896 | .1 2 |
| | G Operatio | ns Locations Devices | QQ IoT Campaigns | | | | |
| Actions ^ | GENERAL INFO | LOCATIONS COMF | ponents events | | | 20 | 20-05-04 - 2020-05-11 ✓ |
| KPI Settings | Device Info Location House of Matt Device Id ema-he00d800010 Name ema-he00d800010 Status Serial Number Last Boot | Time Zone Time Zone Offset | Network IP Address | | Versions Leaf | | |

2. Click on the "Events" sub tab as shown in *Figure 40*. This will load and list all Leaf messages that are being transacted between the ema:Play hardware and the Canopy dashboard. *Figure 41* (below) illustrates what this sould look like. This information can be used for debugging purpose

(below) illustrates what this could look like. This information can be used for debugging purposes to gain insight on the raw data that is flowing.

Note: All messages transacted between ema:Play and Canopy are in JSON format.



| | t Operations Loc | ations Devices IoT Can | npaigns | | |
|------------------|-----------------------|------------------------|-------------------------|--|--|
| Actions ~ | ema-n1e00d8000 | 10 | | | 2020-05-05 - 2020-05-12 💙 |
| KPI Settings 🗸 🗸 | GENERAL INFO LOCA | TIONS COMPONENTS | EVENTS | | |
| Notes + ^ | C Refresh Date | | | | |
| | C Reliesh Data | | | | 📓 Export To Excel |
| | Event Type 🗸 Sub Type | Event Date Time V | Process Date Time 🗸 🗸 | Event Details | ~ |
| | event ema:Play | 2020-05-12 10:32:50 AM | 2020-05-12 10:32:50 AM | type: "ema/Canopy Demo" events: {"sw1_state":0,"sw2_state":1,"din1 | 1_state":1,"din2_state":1} |
| | statistic ema:Play | 2020-05-12 10:32:45 AM | 2020-05-12 10:32:45 AM | type: 'ema/Canopy Demo' statistics: ('env_temp':72.2;'sig_qual':2;'user_adc':1894;'ema_volts':4;'env_light':62 | 2,"sys_volts":5.1,"env_humidity":30.4} |
| | statistic ema:Play | 2020-05-12 10:32:33 AM | 2020-05-12 10:32:33 AM | type: "ema/Canopy Demo" statistics: ("env_temp":72.2;"sig_qual":2;"user_ade":1901;"ema_volts":4;"env_light":82 | 2,"sys_volts":5.2,"env_humidity":32.4} |
| | statistic ema:Play | 2020-05-12 10:32:30 AM | 2020-05-12 10:32:30 AM | type: "ema/Canopy Demo" statistics: ("env_temp":72.2;"sig_qual":2;"user_ado":1909;"ema_volts":4;"env_Light":2(| D,*sys_volts*:5.2,*env_humidity*:32.4} |

Figure 41

It can be observed from *figure 41* that an *event* type message was received on 5/12/2020 at 10:32:50 AM. The JSON data shows that the event that triggered this message was "*sw2_state*":1. This indicates that a button(ref des SW8) was pressed and released on the ema:Play hardware. Furthermore, *statistic* type messages have also been received updating the KPI state of the telemetry data that can be viewed on the "Operations" tab.

5.5.10.4 Control Actions

The ema:Play demonstration project combined with the Leaf agent is pre-programmed to handle and process commands from the Canopy servers. These are known as *Actions*. The following steps will demonstrate how easy it is to command ema:Play to control an output.

1. From the "Devices" tab, expand the "Actions" section which is located towards the upper left of the page as shown in *Figure 42*.

| | Ope | erations Location | s Devices IoT Camp | D D paigns | | |
|--|----------------|-------------------|------------------------|-------------------------|---|-----------------------------------|
| Actions 🖓 🔨 | ema-n1e00 | 0d800010 | | | | 2020-05-05 - 2020-05-12 🗸 |
| ema:Play Actions Control Output Reboot ema | GENERAL INFO | LOCATIONS | S COMPONENTS | EVENTS | | |
| Reboot ema:Play | 🕃 Refresh Data | | | | | 🔀 Export To Excel |
| KPI Settings \checkmark | Event Type 🛛 🗸 | Sub Type 🛛 🗸 | Event Date Time 🗸 | Process Date Time 🛛 🗸 | Event Details | ~ |
| Notes + ^ | event | ema:Play | 2020-05-12 10:32:50 AM | 2020-05-12 10:32:50 AM | type: "ema/Canopy Demo" events: {"sw1_state":0,"sw2_state":1,"din1_state | te":1,"din2_state":1} |
| | statistic | ema:Play | 2020-05-12 10:32:45 AM | 2020-05-12 10:32:45 AM | type: "ema/Canopy Demo" statistics: ("env_temp":72.2;"sig_qual":2;"user_adc":1894;"ema_volts":4;"env_light":62;"sys | :_volts":5.1,"env_humidity":30.4} |
| | statistic | ema:Play | 2020-05-12 10:32:33 AM | 2020-05-12 10:32:33 AM | type: "ema/Canopy Demo" statistics: ("env_temp":72.2;"sig_qual":2;"user_adc":1901;"ema_volts":4;"env_light":82;"sys | _volts":5.2,"env_humidity":32.4} |
| Figure 42 | statistic | ema:Play | 2020-05-12 10:32:30 AM | 2020-05-12 10:32:30 AM | type: "ema/Canopy Demo" statistics: | |



 Click on the "Control Output" button to open the Control Output window. Select "LED 1" from the Output drop down, enter **500** for Duty, and enter **1000** for Period as shown in *Figure 43*. This will command ema:Play to control it's LED 1 (ref des D18) to flash at a frequency of ~2 Hz.

| | t e | erations Le | Control Output | | × | | |
|---|----------------|-------------|-------------------------|-------------------------|--|-------------------------------------|---|
| Actions ^ | ema-n1e00 |)d800 | Output * | | | | 2020-05-05 - 2020-05-12 🗸 |
| ema:Play Actions Control Output Reboot ema Reboot ema:Play | GENERAL INFO | LOC | Duty (0-65535) * | | | | |
| | | | Period (0-65535) * | | | | Export To Excel |
| KPI Settings V | Event Type 🗸 🗸 | Sub Type | | | | | ~ |
| Notes + ^ | event | ema:Play | | | Control Output | ts: {"sw1_state":0,"sw2_state":1,"d | in1_state":1,"din2_state":1) |
| | statistic | ema:Play | 2020-05-12 10:32:45 AM | 2020-05-12 10:32:45 AM | statistics: {"env_temp":72.2,"sig_qual":2,"user_a | adc":1894,"ema_volts":4,"env_light" | 62,"sys_volts":5.1,"env_humidity":30.4} |
| | ataliatia | | 2020 05 12 10 22 22 444 | 2020.05.12.10.22.22.414 | type: "ema/Canopy Demo" | | |
| | statistic | ema.Play | 2020-03-12 10:32:33 AM | 2020-03-12 10:32:33 AM | statistics: {"env_temp":72.2,"sig_qual":2,"user_a | adc":1901,"ema_volts":4,"env_light" | 82,"sys_volts":5.2,"env_humidity":32.4) |
| | | | | | type: "ema/Canopy Demo" | | |
| | statistic | ema:Play | 2020-05-12 10:32:30 AM | 2020-05-12 10:32:30 AM | statistics: | | |

Figure 43

3. Click the "Control Output" button to close this window. Click the "Control Output" confirmation button to send the command as shown in *Figure 44*.

| | ons | Op | Derations Lo | Control Output | | × | | |
|--|-----|----------------|--------------|--------------------------|------------------------|--|--------------------------------------|--|
| Actions | ` | ema-n1e0 | 0d800 | Are you sure you want to | perform Control Outpu | t on ema-n1e00d800010? | | 2020-05-05 - 2020-05-12 💙 |
| ema:Play Actions Control Output Reboot ema | | GENERAL INFO | LOC | | | Control Output | | |
| Reboot ema:Play | | | | Period (0-65535) * | | | | 🛙 Export To Excel |
| KPI Settings | 1 | Event Type 🗸 🗸 | Sub Type | | | | | ~ |
| Notes + ^ | ` | event | ema:Play | | | | ts: {"sw1_state":0,"sw2_state":1,"d | in1_state":1,"din2_state":1) |
| | | statistic | ema:Play | 2020-05-12 10:32:45 AM | 2020-05-12 10:32:45 AM | Control Output statistics: {"env_temp":72.2;"sig_qual":2;"user_ | .adc":1894,"ema_volts":4,"env_light" | :62,"sys_volts":5.1,"env_humidity":30.4) |
| | | statistic | ema:Play | 2020-05-12 10:32:33 AM | 2020-05-12 10:32:33 AM | type: "ema/Canopy Demo" statistics: ("env_temp":72.2,"sig_qual":2,"user_ | .adc":1901/fema_volts":4,"env_light" | :82,"sys_volts":5.2,"env_humidity":32.4) |
| | | statistic | ema:Play | 2020-05-12 10:32:30 AM | 2020-05-12 10:32:30 AM | type: "ema/Canopy Demo" statistics: | | |

Figure 44

At this point the Canopy servers will post the command data for retrieval by the next ema:Play Leaf request. This can take up to 10 seconds. Observe on the ema:Play hardware that the RED LED D18 is flashing.



5.5.10.5 Automation using IoT Campaigns

The Canopy dashboard is displaying ema:Play's real time telemetry data and can control ema:Play's outputs, as the previous 3 sections have demonstrated. Now, it's time to tie it all togethers using IoT Campaigns. IoT Campaigns are a simple way to automate tasks using the Canopy dashboard, without having to make any changes at the endpoint hardware, ema:Play. This section will demonstrate how to setup and use IoT Campaigns. To do this we will use ema:Play's built-in light sensor, push button, and one of the two controllable LED's to simulate a security application. The high-level goal is to toggle an output when light intensity goes above a certain threshold, and to be able to press a button to disable the output. Reference section 5.5.6 for the available input and outputs of the ema:Play hardware. The scenario for this demonstration is outlined below:



1. From the Canopy dashboard, navigate to the "IoT Campaigns" page as shown in *Figure 45*.

| Image: Connect wireless solutions Image: Connect wireless solutions Image: Connect wireless solutions Image: Connect wireless solutions Image: Connect wireless solutions Image: Connect wireless solutions Image: Connect wireless wireless Image: Connect wireless Image: Connect wireless solutions Image: Connect wireless Image: Connect wireless Image: Connect wireless Image: Connect wireless Image: Connect wireless Image: Connect wireless Image: Connect wireless Image: Connect wireless Image: Connect wireless Image: Connect wireless Image: Connect wireless Image: Connect wireless Image: Connect wireless Image: Connect wireless Image: Connect wireless Image: Connect wireless Image: Connect wireless Image: Connect wireless Image: Connect wireless Image: Connect wireless Image: Connect wireless Image: Connect wireless Image: Connect wireless Image: Connect wireless Image: Connect wireless Image: Connect wireless Image: Connect wireless Image: Connect wireless Image: Connect wireless Image: Connect wireless Image: Connect wireless Image: Connect wireless Image: Connect wireless Image: Connect wireless Image: Connect wireless Image: Conn | | | | | | | | | |
|--|------------------|--------------|------------------|----------------|---------------|--------------|----------------|--|--|
| ∇ Φ 𝔅 <t< td=""></t<> | | | | | | | | | |
| Summary | Summary | | | | | | | | |
| Device Id | Temperature | Humidity | Light | System Voltage | Ema Voltage | Analog Input | Signal Quality | | |
| ema-b39622ea000b | ₽ 72.0 י⊧ | ≜ 30% | [] 72 | 5 .2 | \$ 4.0 | ∕ 1,896 | . 11 2 | | |
| ema-n1e00d800010 | ₿ 72.7 ·F | ≜ 30% | [] 64 | 5 .2 | \$ 4.0 | ∕1,893 | . 11 2 | | |
| CTESTPROD | J: | \ -% | Ô- | 5 - | 5 - | ∕ | atl= | | |
| Figure AF | | | | | | | | | |





 On the right side of the screen click the "Add New" button to create a new IoT Campaign. Enter Intruder – Flash Light Detected in the Name Field and Alarm Trigger in the Description Field and click "Add" as shown in *Figure 46*.

| OCanopy | | | OptConnect 👻 | 요 Matt Voigt - | 🖀 Marketplace | 0 |
|---------|--------------|--------------------------------------|--------------|---------------------------|---------------|---|
| | Operations L | Add New X | | | | |
| | | Name Intruder - Flash Light Detected | | | | |
| | | Description Alarm Triggel | | | | |
| | | Add | | | | |
| | | | | | | |
| | | | | | | |

Figure 46

3. The IoT Campaign canvas page will load and should look similar to *Figure 47*. The canvas is where the logic for the **Intruder – Flash Light Detected** IoT Campaign can be designed. The left side of the screen includes the modules that can be dragged onto the canvas and interconnected with other modules.

Figure 47



4. Design the IoT Campaign according to *Figure 48*, making sure to click on each module and set the appropriate fields to the correct Organization, Device, etc. Click on "Start Campaign" as shown.



Figure 48

5. Repeat steps 2 – 4 above to create another IoT Campaign named **Disarm System** with description **Disable Alarm**. Use *Figure 49* as reference for the logic. Start the Campaign and return to the "IoT Campaigns" page.

| | Operations Locations Devices IoT Campaigns | | |
|-------------------------|--|---------------------------------------|--------|
| Disarm System | | Saved a minute ago Start Campaign | Exit |
| Q Search | · · · · · · · · · · · · · · · · · · · | · · · · · · · · · · · · · · · · · · · | |
| Events ^ | Organization: Banyan > OptConnect | | |
| | | | |
| Timer Stop Leaf Event | toad Device | | |
| | | | Merce |
| KPI Status Set Variable | 🛔 Set Variable 🖀 | btn1 == 0 | |
| | Name: btn1 Value: data.events.sw1_state | • • • • • • • • • • • • • • | |
| Branches ^ | | btn1 == 1 | |
| -c -c -c | | Control Output | s stop |
| | | Duty: 0 Period: 0 | |
| Split Or And | | | |

Figure 49

6. The two campaigns that were just created should be listed as shown in *Figure 50*. They should show *Active* in the "Status" column.

| | Operations | | E Cooo | | | |
|------------------------|---------------------|-----------------|--------------------------------|----------|------------------|-----------|
| All Filters My Filters | IoT Campaigns | | | | | 🕞 Expo |
| | Organization | ∨ Name | ~ Description | ✓ Status | ✓ Last Deploymen | t 🗸 Tasks |
| Description | Banyan > OptConnect | Intruder - Flas | h Light Detected Alarm Trigger | Active | 2020-05-12 | Ø |
| Statue | Banyan > OptConnect | Disarm System | n Disable Alarm | Active | 2020-05-12 | Ø |

Figure 50

o

7. Navigate back to the "Operations" page and observe the real time ema: Play "Light" column for the device in question as shown in Figure 51.

| | t Operation | Locations Devices | loT Campaigns | | | | |
|------------------|------------------------------|-------------------|--------------------------|----------------|-------------|--------------|-----------------------|
| ∑ ۞ C 02:08 PM | | | | | | 2020 | -05-05 - 2020-05-12 🗸 |
| Summary | | | | | | | ^ |
| Device Id | Temperature | Humidity | Light | System Voltage | Ema Voltage | Analog Input | Signal Quality |
| ema-b39622ea000b | ∦ 72.0 [.] ⊧ | d 30% | ○ 72 | 5.2 | 4 .0 | ∕ 1,896 | .1 2 |
| ema-n1e00d800010 | ∦ 73.7 _" ⊧ | d 31% | ⊘ 64 ₺ | 5.2 | 4 .0 | ∕ 1,894 | .1 2 |
| CTESTPROD | ! | & -% | Q- | 7 - | * - | ∿ | all- |



9. According to the logic of the IoT Campaign Intruder – Flash Light Detected, when this value goes above 1000, the LED 1 (ref des D18) should begin to flash at a frequency of ~2 Hz. Use a light source and shine it at the light detector (Q2) on ema:Play, while observing the "Light" column on the "Operations" page for the appropriate device. Confirm that within 10 seconds of the value crossing the threshold (1000), LED 1 begins to Flash. Reference Figures 51 & 52.

| | Dpera | tions Locations Devices | CC IoT Campaigns | |
|------------------|------------------|-------------------------|---------------------|---------------|
| ү © 🕅 С 02:09 РМ | | | | |
| Summary | | | | |
| Device Id | Temperature | Humidity | Light | Sys |
| ema-b39622ea000b | ∦ 72.0 -⊧ | (€) 30% | ? 72 | \$ 5.2 |
| ema-n1e00d800010 | 🚦 74.0 -r | 👌 30% | ♀3,928 む | \$ 5.2 |
| : OCTESTPROD | 1 - | d % | Q- | 5 |
| Figure 51 | | | | |



Figure 52

10. The alarm has been triggered. It turns out it was a false alarm, so now it's time to disable the alarm. Use the second IoT Campaign Disarm System to disable the alarm and stop LED 1 from flashing. According to the logic of this IoT Campaign, press SW 1 (ref des SW7) on ema:Play to stop the LED from flashing. Allow 10 seconds for the LED to stop flashing.

CON



5.5.10.6 Summary

The demonstration above may not seem all that useful in a real-world application, but it could easily be adjusted using the IoT Campaign canvas and logic to monitor and react to any of ema:Play's preprogrammed input and outputs. Reference section 5.5.6 for a complete list of these. For example, ema:Play could be placed inside of a piece of equipment, provide the internet connection via ema, and monitor the temperature. Using Canopy and IoT Campaigns, if the temperature crossed a threshold, an email could be sent to an authority to take corrective action. All of this would require no technical work and demonstrates how ema:Play, coupled with Canopy provides a full soup-to-nuts IoT experience.



6. Revision History

| Revision | Date | Description | Author |
|----------|-----------|-----------------|--------|
| 1.0 | 5/14/2020 | Initial Release | MSV |