# Mercury System

# SB120



Neopixel Board - Product Datasheet

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|--------|------------------|
| Date | 31/03/2018 |
| Status | Released |

| Revision History | | | |
|---|---|---|---|
| Version | Date | Author | Changes |
| 1.0 | 31/03/2018 | Francesco Ficili | Initial Release. |
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# SUMMARY

# 1. Introduction

The Mercury System (MS in short) is a modular system for the development of connectivity and IoT applications. The system uses various type of electronic boards (logic unit, modems, slave board equipped with sensors and actuators, power boards...) and a complete SW framework to allow the realization of complex applications. Scalability, ease of use and modularity are key factors and are granted by the use of a heterogeneous set of components that allow to assemble the system like a construction made with LEGO© bricks.

The board set which composes the system is made up by the following "families":

- **Base Board (BB):** It's the "brain" of the system and contains the main logic unit as well as different communication buses and connector to interfaces the slaves. It also contains a simple power supply system and a recharge unit for a single LiPo cell (it can satisfy the power requirements of simpler systems). It can exist in different variants, depending on the employed microcontroller unit.
- **Modem Board (MB):** this one is the board that allow network connectivity. It can exist in different variant, depending on the network interface (GSM/GPRS, Wi-Fi, BT, Radio…). It's interfaced to the Base Board with a dedicated serial line.
- **Power Board (PB):** it's the board that allow to satisfy the particular power requirement of the system, when it's necessary. They can be vary depending on the particular power requirement to satisfy (high power, solar harvesting, piezo harvesting, etc.).
- **Slave Board (SB):** these are the system's peripherals, and they vary depending on the specific mounted sensor or actuator. Typical examples are SB with relay, temperature sensors, RGB LED controller, servo controller, accelerometer, etc. They communicate with the BB with I2C or UART and a dedicated command set.
- **Expansion Board (EB):** these are the board that allow planar connection of Mercury boards. There are variants which can contains Displays, battery socket, etc.
- **Brain-Less Board (BL):** these are the controller-less boards. They in general contain really simple sensor or actuators that don't need the bus interface. There are meant as an alternative to slave boards for cost-sensitive applications.

Slave Boards and Modem Board are provided pre-programmed with a FW which implements a dedicated command set for a high-level management of the boards, while the Base Boards are provided with a SW framework which provides all the low-level services (operative system, device drivers, system services, etc.), leaving to the user only the development of application level logic. Moreover, the Base Board comes with an USB bootloader, so it can be programmed without the need of a flashing device.
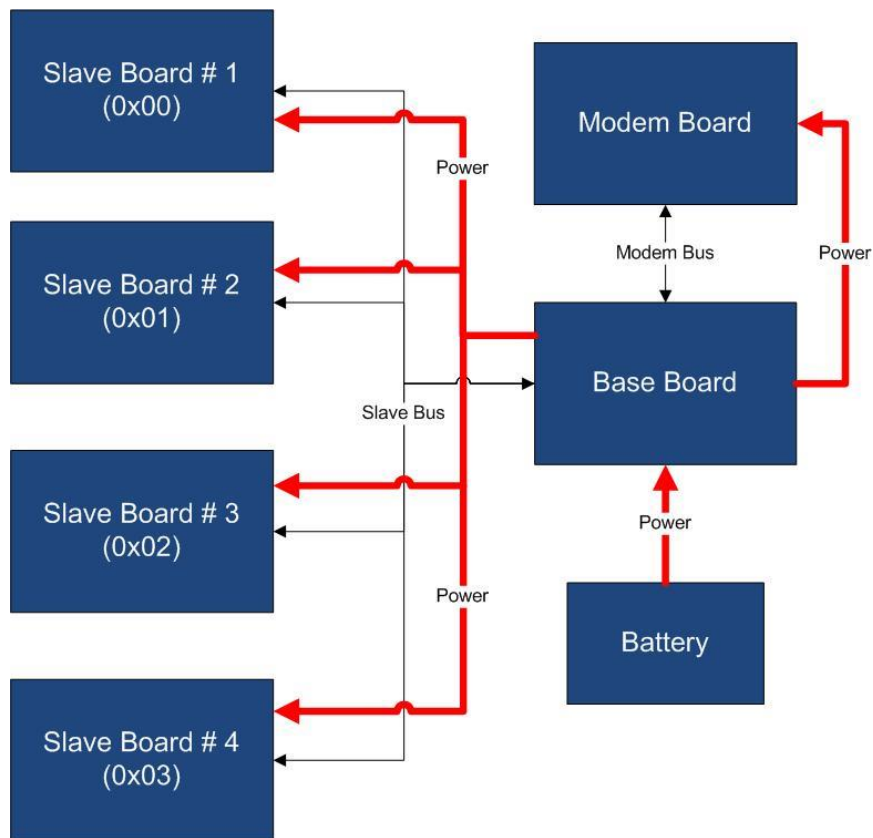
Figure 1 shows a typical system connection:



*Figure 1 - Typical System Connection*

Examples of application fields of MS are:

- Home automation System,
- IoT applications,
- Connectivity Applications,
- Monitoring and control Systems,
- Remote Control,
- Industrial Process control,
- Robotics applications,
- Test benches,
- Etc…

## 2. Block Diagram

The SB120 is a 3-channel Neopixel board, able to interface Neopixel LEDs strips or rings. Figure 2 shows the SB120 block diagram. The heart of the system is a PIC16F1829 8-bit RISC microcontroller, produced by Microchip Technology Inc.
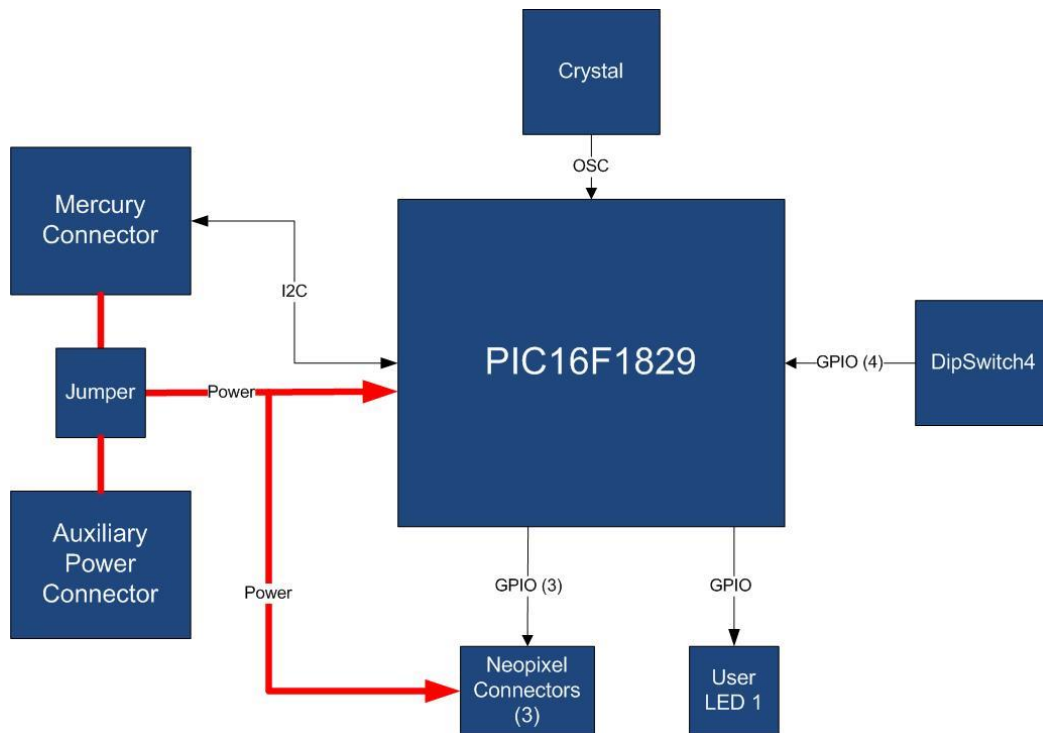


*Figure 2 - Block Diagram*

The main characteristics of the employed MCU are resumed in Table 1:

*Table 1 - MCU characteristics*

| Parameter Name | Description |
|---|---|
| Program Memory Type | Flash |
| Program Memory (KB) | 14 |
| CPU Speed (MIPS) | 8 |
| RAM Bytes | 1,024 |
| Data EEPROM (bytes) | 256 |
| Digital Communication Peripherals | 1-UART, 1-A/E/USART, 1-SPI, 1-I2C1-MSSP(SPI/I2C) |
| Capture/Compare/PWM Peripherals | 2 CCP, 2 ECCP |
| Timers | 4 x 8-bit, 1 x 16-bit |
| ADC | 12 ch, 10-bit |
| Comparators | 2 |
| Temperature Range (C) | -40 to 125 |
| Operating Voltage Range (V) | 1.8 to 5.5 |

| | |
|---|---|
| Pin Count | 20 |
| XLP | Yes |

The SB120 is connected to a Mercury System Base Board by means of I2C bus. The address of the board could be dynamically set by means of a 4 positions dip switch, allowing up to 15 address values (address 0x00 is reserved for I2C general call broadcast addressing scheme). The Neopixel channels could be supplied by means of VddBat from Mercury System network or by means of an external power source (a jumper and a proper screw-terminal connector are provided for this purpose).

Table 2 resumes the SB120 board main characteristics:

*Table 2 – Board Characteristics*

| Parameter | Description | Notes |
|---|---|---|
| Board Type | Slave Board (SB) | |
| Supported Bus | I2C | |
| Addressing | Dip Switch 4 | |
| Peripheral Description | 3 Neopixel Channels | |

# 3. Hardware

This section goes deeper in the HW details of SB120. Figure 3 depicts the most important components of the board:
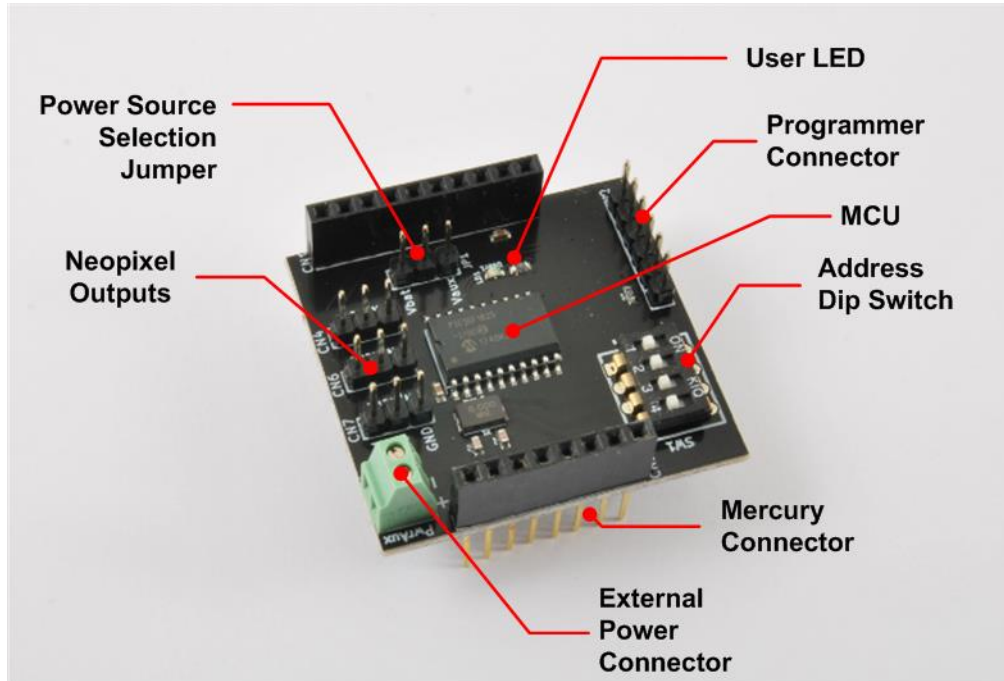


*Figure 3 - Hardware Highlight*

Table 3 provides a description of board's main components:

*Table 3 – Hardware characteristics*

| Parameter Name | Description |
| --- | --- |
| User LED | Board User LED, by default it's configured as heartbeat LED (periodic pulses). |
| Neopixel Outputs | Neopixel channels connectors. |
| Mercury Connector | Mercury connector used to interface the board with the others MS boards. |
| Address Dip Switch | Dip Switch to set the address of the board within the Mercury System. |
| MCU | PIC16F1829 main controller board. |
| Programmer Connector | PicKit 3 Microchip Programmer/debugger connector. It is directly connected to the MCU debug port, in order to allow advanced debugging and programming features, if needed. |
| Power Source Sel. Jumper | Jumper to select between internal (VddBat) and externally provided power source for Neopixel Channels. |
| External Power Connector | Screw-terminal connector for external power source. |

# 4. Pinouts

This section highlights the pinouts of SB120 connectors.

## Mercury Connector

The Mercury Connector is the connector which interfaces the SB120 with the rest of Mercury System. The connector's pinout is depicted in Figure 4 and Table 4 explains the meaning of each single pin (NC stands for "Not Connected").

*Table 4 - Mercury Connector Pinout*

| Pin Name | Pin Number | Description |
|---|---|---|
| VddBat | CN1 – 1 CN2 – 2 | This pin is connected to the main power source. |
| VddMcu | CN1 – 2 | This pin is connected to MCU regulated positive voltage reference (3,3V). |
| GND | CN1 – 3 CN2 – 1 | This pin is connected to the board reference voltage. |
| SDA | CN2 – 7 | This pin is connected to I2C SDA line (Data Line). |
| SCL | CN2 – 8 | This pin is connected to I2C SCL line (Clock Line). |
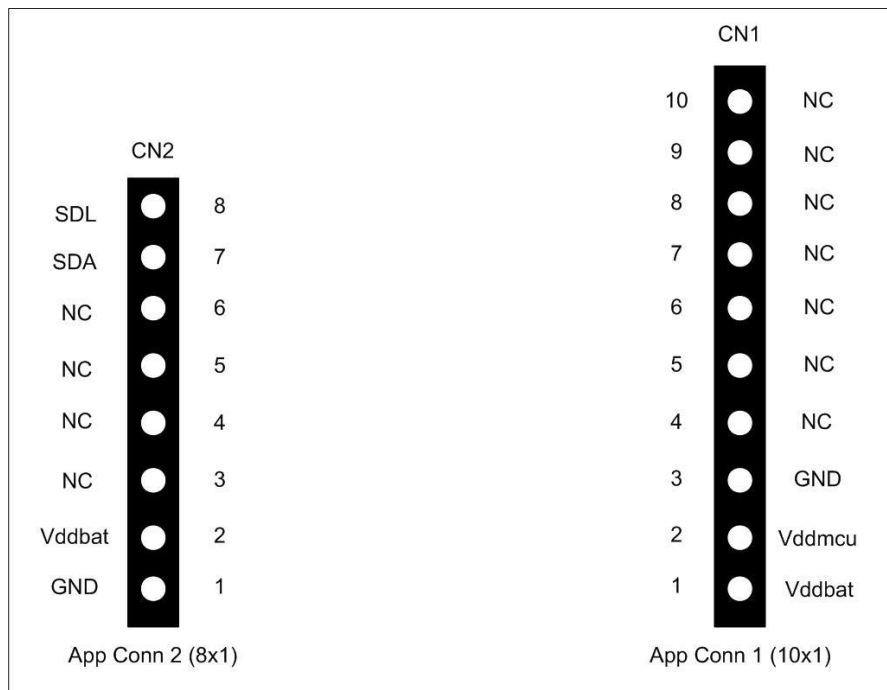


TOP VIEW

*Figure 4 - SB120 Mercury Connector Pinout*

## Programmer Connector

The Programmer Connector is the connector which allows to re-program the SB120 using Microchip Technology ICSP (In-Circuit Serial Programming) interface. The connector's pinout is depicted in Figure 5 and Table 5 explains the meaning of each single pin (NC stands for "Not Connected").

*Table 5 - Programmer Connector Pinout*

| Pin Name | Pin Number | Description |
|----------|------------|-------------|
| MCLR | CN3 – 1 | Microcontroller Master Clear (RESET) pin. |
| Vdd | CN3 – 2 | Positive power supply reference. |
| GND | CN3 – 3 | Power ground. |
| PGD | CN3 – 4 | Program Data pin. |
| PGC | CN3 – 5 | Program Clock pin. |
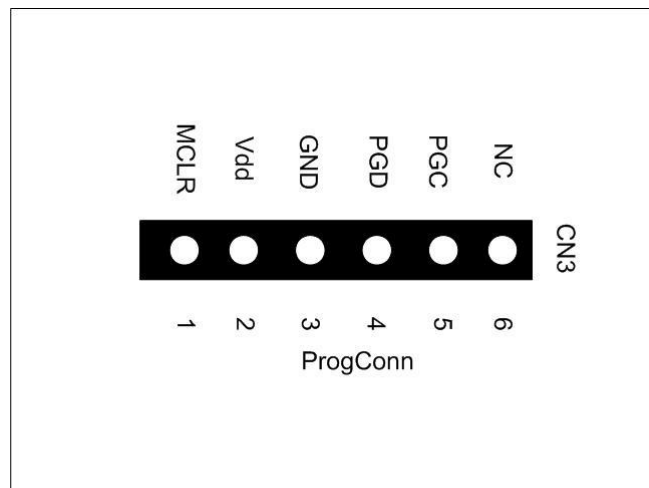


*Figure 5 - SB120 Programmer Connector Pinout*

## Neopixel Channels Connectors

The Neopixel Connectors interface the SB120 to Neopixel's strips or rings. The connector's pinout is depicted in Figure 6 and Table 6 explains the meaning of each single pin.

*Table 6 - Neopixel Connectors pinout*

| Pin Name | Pin Number | Description |
|----------|------------|-------------|
| GND | CN7, 6, 4 – 1 | Power ground. |
| Sig | CN7, 6, 4 – 2 | Neopixel signal. |
| Vdd | CN7, 6, 4 – 3 | Positive power supply voltage. |
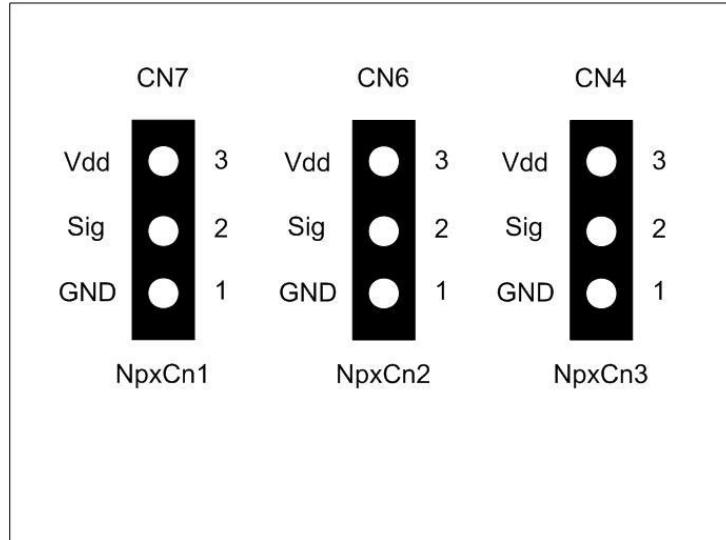
Figure 6 - SB120 Neopixel Connectors pinout

# 5. Command Set

## Specific Command Set

The SB120 board supports both the MS Generic Command Set (see document MS_GenericCommandSet) and a set of specific commands (also called Specific Command Set).

Table 7 lists the SB120 Specific Command Set:

*Table 7 - Command Set*

| Code | Cmd Name | Parameters | Description |
|------|----------|------------|-------------|
| 0x50 | CH1 Write Pixel | PixelSts (1 byte) | Write CH1 Neopixels basing on pixel number and pixel color set (1 = ON, 0 = OFF). |
| 0x51 | CH1 Set Pixel Color | Green (1 byte) Red (1 byte) Blue (1 byte) | Set primary tri-color for CH1 (in order, green-red-blue). |
| 0x52 | CH1 Set Pixel Number | Pixel Number (1 byte) | Set the Neopixel LED number for CH1 (max = 100). |
| 0x53 | CH2 Write Pixel | PixelSts (1 byte) | Write CH2 Neopixels basing on pixel number and pixel color set (1 = ON, 0 = OFF). |
| 0x54 | CH2 Set Pixel Color | Green (1 byte) Red (1 byte) Blue (1 byte) | Set primary tri-color for CH2 (in order, green-red-blue). |
| 0x55 | CH2 Set Pixel Number | Pixel Number (1 byte) | Set the Neopixel LED number for CH2 (max = 100). |
| 0x56 | CH3 Write Pixel | PixelSts (1 byte) | Write CH3 Neopixels basing on pixel number and pixel color set (1 = ON, 0 = OFF). |
| 0x57 | CH3 Set Pixel Color | Green (1 byte) Red (1 byte) Blue (1 byte) | Set primary tri-color for CH3 (in order, green-red-blue). |
| 0x58 | CH3 Set Pixel Number | Pixel Number (1 byte) | Set the Neopixel LED number for CH3 (max = 100). |

## Examples

Some examples of Specific Command Set usage are listed below:

1) Set full Green for CH1 Neopixels: **[0x51] [0xFF] [0x00] [0x00]**
2) Set full Red for CH1 Neopixels: **[0x51] [0x00] [0xFF] [0x00]**
3) Set full Blue for CH1 Neopixels: **[0x51] [0x00] [0x00] [0xFF]**
4) Set CH1 Neopixel number to 10: **[0x52] [0x0A]**
5) Set CH2 Neopixel number to 5: **[0x55] [0x05]**
6) Turn on CH1 Neopixels: **[0x50] [0x01]**
7) Turn off CH1 Neopixels: **[0x50] [0x00]**

**Note**: all Neopixel channels start from no color (0x00,0x00,0x00) and Neopixel number equal to 1, so the user has to adjust color scheme and LEDs number for each channel after startup.

# 6. Technical Specifications

Table 8 resumes the board technical specifications:

*Table 8 - Board Technical Specifications*

| Parameter | Max | Typ | Min | Unit | Notes |
|-----------|-----|-----|-----|------|-------|
| Supply Voltage | 3.6 | 3.3 | 2.0 | V | |
| Current Cons. (Normal) | | 10 | | uA | |
| Current Cons. (Peak) | | 1 | | mA | |
| Current Cons. (Low Power) | | 100 | | nA | |
| Startup Time | | 100 | | mS | |