

# Datasheet

60 Series SOM

*Version 1.0*

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## REVISION HISTORY

| Version | Date        | Notes           | Contributors | Approver  |
|---------|-------------|-----------------|--------------|-----------|
| 1.0     | 13 Nov 2018 | Initial Version | Andrew Chen  | Jay White |
|         |             |                 |              |           |
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## 1 SCOPE

This document describes key hardware aspects of the Laird 60 Series system on module (SOM). This document is intended to assist device manufacturers and related parties with the integration of this radio into their host devices. Data in this document is drawn from many sources and includes information found in the Laird 60-SIPT, Marvell 88W8997/88PG823, and Atmel/Microchip ATSAMA5D3X.

**Note that the information in this document is subject to change.** Please contact Laird to obtain the most recent version of this document.

## 2 INTRODUCTION

### 2.1 General Description

The Laird 60 Series SOM wireless bridge module is a wireless communications subsystem that may be integrated into a variety of host devices via many available electronic and logical interfaces. The SOM provides complete enterprise-class Wi-Fi connectivity with an integrated TCP/IP stack. It also provides full support for 2x2 MIMO 802.11 a/b/g/n/ac WLAN plus Bluetooth 4.2 dual mode dual-mode air standards with a fully integrated security supplicant providing 802.11i/WPA2 Enterprise authentication, data encryption, and BT protocol stacks.

The 60 SOM has a wide variety of interfaces including RMII, RGMII, serial UART, Hi-Speed USB, SPI, SDIO, TTL RGB, PCM, and I2C. The wireless bridge may be configured, monitored, and managed via a Command Line Interface (CLI) over an available dedicated console port, via a web interface over a wireless or Ethernet interface, or via a remote SDK interface over wireless or Ethernet.

The 60 SOM incorporates the [Laird 60-SIPT](#) Wi-Fi SiP module which uses Marvell 88W8997/88PG823. The product also features a Cortex A5 processor running at 536 MHz and a MCP memory with 1 Gb 32-bits of Lower Power DDR (LPDDR) memory, and 2 Gb 8-bits of SLC NAND flash storage. Several GPIO lines are available for data acquisition and similar applications. The platform should support the Linux OS version 3.0.x to current highest LTS version. A software developer's kit (SDK) with Application Programming Interfaces (API) and software tools are available for the development of custom software applications on the device.



### 2.2 Features and Functionality

The 60 SOM is based on the ATSAMA5D36 processor from Atmel/Microchip. This processor offers several interfaces, some of which are multiplexed and not available simultaneously. The module has the following features:

- ATSAMA5D34 single ARM Cortex-A5 core operating at speeds up to 536 MHz:
  - 32-Kb L1 instruction cache
  - 32-Kbyte data cache, 32-Kbyte instruction cache, Virtual Memory System Architecture (VMSA)
  - 160-Kbyte internal ROM single-cycle access at system speed.
  - One 128-Kbyte internal SRAM, single-cycle access at system speed
  - Very slow clock operating mode, software programmable power optimization capabilities
- Security:
  - TRNG: True random number generator
  - AES: 256-bit, 192-bit, 128-bit key algorithm, compliant with FIPS PUB 197 Specifications
  - TDES: Two-key or three-key algorithms, compliant with FIPS PUB 46-3 Specifications
  - Atmel/Microchip secure boot solution
- Memory:
  - 1 Gb, 32-bits of Lower Power DDR (LPDDR) memory
  - 2 Gb, 8-bits of SLC NAND flash memory
- 2X2 IEEE 802.11 a/b/g/n/ac WLAN interface
- Bluetooth version 4.2 dual-mode
- Support interface:
  - 24-bits TTL RGB bus for TFT LCD display
  - X1 MMC/SD/SDIO card port

- X3 HS/FS/LS USB Ports with: X1 USB device port. X2 USB host ports.
- X1 10/100/1000 Mbps reduced Gigabit media independent interface (RGMII)
- X1 10/100 Mbps reduced media-independent interface (RMII)
- X1 CAN bus, fully compliant with CAN 2.0 Part A and 2.0 Part B
- X3 UARTs
- X1 DBGU for debug purpose
- X2 Master/Slave serial peripheral interfaces
- X1 Synchronous serial controllers
- X2 Two-wire interface up to 400 Kbit/s supporting I2C Protocol and SMBUS
- ADC and GPIOs

- Ultra-miniature low profile SMT module (30 x 30 x 2.8 mm) based on 188 pads 2 row LGA package

The 60 SOM provides the following two U. FL type antenna connectors that provide two streams MIMO operation to reach the maximum data rate:

- Main/ANT0 antenna – Wi-Fi only
- Auxiliary/ANT1 – Wi-Fi and Bluetooth

Bluetooth signals can only be presented at the auxiliary/ANT1. Supported host device antenna types include dipole and monopole antennas.

Regulatory operational requirements are included in this document and may be incorporated into the operating manual of any device into which the 60 SOM is installed. The 60 SOM is designed for installation into mobile devices which typically operate at distances greater than 20 cm from the human body and portable devices which typically operate at distances less than 20 cm from the human body. See [Documentation Requirements](#) for more information.

The 60 Series SOM modules include two product SKUs which have different supported software features. Please check Laird sales/FAE for further information. Order information is listed below:

| Part Number | Description                                                      |
|-------------|------------------------------------------------------------------|
| 453-00003   | 60 Series SOM                                                    |
| 455-00003   | Development board for the 60 Series SOM                          |
| 455-00004   | LCD Touchscreen for the 60 Series SOM development board (add-on) |

**CAUTION:** The 60 Series SOM only allows one time reflow during the SMT assembly process. Applying more than one time reflow during this process will damage the module.



### 3 PIN DEFINITIONS AND SIGNAL DESCRIPTIONS

|              |     |                  |
|--------------|-----|------------------|
| <b>Note:</b> | PWR | Power Input      |
|              | I/O | Input and output |
|              | I   | Input            |
|              | O   | Output           |
|              | PU  | Pull-up          |
|              | PD  | Pull-down        |

**Table 1: 60 SOM pin definitions**

| Pin # | Name    | Type | Pins map to CPU | Voltage Ref. | DVK Function                            | If Not Used |
|-------|---------|------|-----------------|--------------|-----------------------------------------|-------------|
| G1    | GND     | -    | -               | -            | Ground                                  | GND         |
| A1    | VCC3_3  | PWR  | -               | -            | DC 3.3V input for the module            | --          |
| A2    | GND     | -    | -               | -            | Ground                                  | GND         |
| A3    | G_125CK | I    | PB18            | VDDIOP1      | RGMII 125 MHz input clock               | NC          |
| A4    | G_RXCK  | I    | PB11            | VDDIOP1      | RGMII Receive clock                     | NC          |
| A5    | G_RXER  | I    | PB13            | VDDIOP1      | RGMII Receive error                     | NC          |
| A6    | GND     | -    | -               | -            | Ground                                  | GND         |
| A7    | G_RX3   | I    | PB7             | VDDIOP1      | RGMII Receive data                      | NC          |
| A8    | G_MDIO  | I/O  | PB17            | VDDIOP1      | RGMII Management data Input/Output      | NC          |
| A9    | G_RX1   | I    | PB5             | VDDIOP1      | RGMII Receive data                      | NC          |
| A10   | G_RX0   | I    | PB4             | VDDIOP1      | RGMII Receive data                      | NC          |
| A11   | G_RX2   | I    | PB6             | VDDIOP1      | RGMII Receive data                      | NC          |
| A12   | GND     | -    | -               | -            | Ground                                  | GND         |
| A13   | GND     | -    | -               | -            | Ground                                  | GND         |
| A14   | G_TXCK  | O    | PB8             | VDDIOP1      | RGMII Transmit clock or Reference clock | NC          |
| A15   | G_TXEN  | O    | PB9             | VDDIOP1      | RGMII Transmit Enable                   | NC          |
| A16   | GND     | -    | -               | -            | Ground                                  | GND         |
| A17   | G_TX2   | O    | PB2             | VDDIOP1      | RGMII Transmit data                     | NC          |
| A18   | G_TX3   | O    | PB3             | VDDIOP1      | RGMII Transmit data                     | NC          |
| A19   | G_TX0   | O    | PB0             | VDDIOP1      | RGMII Transmit data                     | NC          |
| A20   | G_TX1   | O    | PB1             | VDDIOP1      | RGMII Transmit data                     | NC          |
| A21   | G_MDC   | O    | PB16            | VDDIOP1      | RGMII Management data clock             | NC          |
| A22   | GND     | -    | -               | -            | Ground                                  | GND         |
| A23   | GND     | -    | -               | -            | Ground                                  | GND         |
| A24   | TW_CLK  | I/O  | PA31            | VDDIOP0      | Two-wire Serial clock                   | NC          |
| A25   | TW_D    | I/O  | PA30            | VDDIOP0      | Two-wire Serial data                    | NC          |
| A26   | GND     | -    | -               | -            | Ground                                  | GND         |

| Pin # | Name             | Type | Pins map to CPU | Voltage Ref. | DVK Function                                                                    | If Not Used |
|-------|------------------|------|-----------------|--------------|---------------------------------------------------------------------------------|-------------|
| A27   | ADTRG            | I    | PD19            | VDDIOP1      | ADC Trigger                                                                     | NC          |
| A28   | AD3              | I    | PD23            | VCC3_3       | Touchscreen Analog-to-Digital Converter – ADC Lower Right touch panel           | NC          |
| A29   | AD4              | I    | PD24            | VCC3_3       | Touchscreen Analog-to-Digital Converter – ADC Panel Input                       | NC          |
| A30   | AD0              | I    | PD20            | VCC3_3       | Touchscreen Analog-to-Digital Converter – ADC Upper-left touch panel            | NC          |
| A31   | AD5              | I    | PD25            | VCC3_3       | Analog Input                                                                    | NC          |
| A32   | AD1              | I    | PD21            | VCC3_3       | Touchscreen Analog-to-Digital Converter – ADC Upper-right touch panel           | NC          |
| A33   | AD2              | I    | PD22            | VCC3_3       | Touchscreen Analog-to-Digital Converter – ADC Lower-left touch panel            | NC          |
| A34   | GND              | -    | -               | -            | Ground                                                                          | GND         |
| A35   | FIQ              | I/PU | PC31            | VDDIOP0      | Fast Interrupt<br>Default: Interrupt signal from Audio Codec chip.              | NC          |
| A36   | GND              | -    | -               | -            | Ground                                                                          | GND         |
| A37   | VDDIOP1          | PWR  | -               | -            | I/O Port 1 Reference Voltage; 1.8V or 3.3V                                      | --          |
| A38   | URXD0            | I    | PC29            | VDDIOP0      | UART0 Receive data                                                              | NC          |
| A39   | UTXD0            | O    | PC30            | VDDIOP0      | UART0 Transmit data                                                             | NC          |
| A40   | GND              | -    | -               | -            | Ground                                                                          | GND         |
| A41   | TK0              | I/O  | PC16            | VDDIOP0      | Synchronous Serial Controller (SSC) Transmit clock                              | NC          |
| A42   | TD0              | O    | PC18            | VDDIOP0      | Synchronous Serial Controller (SSC) Transmit data                               | NC          |
| A43   | PCK2             | O    | PC15            | VDDIOP0      | Programmable Clock Output;<br>Default: Master clock for Audio CODEC             | NC          |
| A44   | RF0              | I/O  | PC20            | VDDIOP0      | Synchronous Serial Controller (SSC) Receive Frame Sync                          | NC          |
| A45   | TF0              | I/O  | PC17            | VDDIOP0      | Synchronous Serial Controller (SSC) Transmit Frame Sync                         | NC          |
| A46   | RD0              | I    | PC21            | VDDIOP0      | Synchronous Serial Controller (SSC) Receive data                                | NC          |
| A47   | RK0              | I/O  | PC19            | VDDIOP0      | Synchronous Serial Controller (SSC) Receive clock                               | NC          |
| G2    | GND              | -    | -               | -            | Ground                                                                          | GND         |
| B1    | VCC3_3           | PWR  | -               | -            | DC 3.3V input for the module                                                    | --          |
| B2    | GND              | -    | -               | -            | Ground                                                                          | GND         |
| B3    | GPIO<br>Default: | I    | PC14            | VDDIOP0      | Device USB Bus Power Sense<br><b>H</b> – USB device port is plugged into a host | 10k;PL      |

| Pin #      | Name                             | Type | Pins map to CPU                                | Voltage Ref. | DVK Function                                                 | If Not Used |
|------------|----------------------------------|------|------------------------------------------------|--------------|--------------------------------------------------------------|-------------|
| VBUS_SENSE |                                  |      | L – USB device port is NOT plugged into a host |              |                                                              |             |
| B4         | E_TXEN                           | O    | PC4                                            | VDDIOP0      | RMII Transmit Enable                                         | NC          |
| B5         | GPIO<br>Default: E_INT           | I    | PC10                                           | VDDIOP0      | RMII Interrupt Input from Ethernet PHY                       | NC          |
| B6         | E_RXD1                           | I    | PC3                                            | VDDIOP0      | RMII Receive data                                            | NC          |
| B7         | E_MDIO                           | I/O  | PC9                                            | VDDIOP0      | RMII Management Data Input/Output                            | NC          |
| B8         | E_RXD0                           | I    | PC2                                            | VDDIOP0      | RMII Receive data                                            | NC          |
| B9         | E_RXER                           | I    | PC6                                            | VDDIOP0      | RMII Receive error                                           | NC          |
| B10        | E_CRSDV                          | I    | PC5                                            | VDDIOP0      | RMII Carrier Sense/Data Valid                                | NC          |
| B11        | E_MDC                            | O    | PC8                                            | VDDIOP0      | RMII Management Data clock                                   | NC          |
| B12        | E_TXD1                           | O    | PC1                                            | VDDIOP0      | RMII Transmit data                                           | NC          |
| B13        | E_TXD0                           | O    | PC0                                            | VDDIOP0      | RMII Transmit data                                           | NC          |
| B14        | GND                              | -    | -                                              | -            | Ground                                                       | GND         |
| B15        | E_REFCK                          | I    | PC7                                            | VDDIOP0      | RMII Transmit Clock or Reference clock                       | NC          |
| B16        | GND                              | -    | -                                              | -            | Ground                                                       | GND         |
| B17        | SPI1_CLK                         | I/O  | PC24                                           | VDDIOP0      | SPI1 Serial clock                                            | NC          |
| B18        | GND                              | -    | -                                              | -            | Ground                                                       | GND         |
| B19        | SPI1_MISO                        | I/O  | PC22                                           | VDDIOP0      | SPI1 Master In Slave Out                                     | NC          |
| B20        | SPI1_MOSI                        | I/O  | PC23                                           | VDDIOP0      | SPI1 Master Out Slave In                                     | NC          |
| B21        | SPI1_NPCS2<br>Default:<br>TW_CK1 | I/O  | PC27                                           | VDDIOP0      | SPI1 Peripheral Chip Select<br>TW_CK1: Two-wire Serial clock | NC          |
| B22        | GND                              | -    | -                                              | -            | Ground                                                       | GND         |
| B23        | LCD_DAT4                         | O    | PA4                                            | VDDIOP0      | LCD Controller (LCDC) data bus                               | NC          |
| B24        | LCD_DAT2                         | O    | PA2                                            | VDDIOP0      | LCD Controller (LCDC) data bus                               | NC          |
| B25        | LCD_DAT14                        | O    | PA14                                           | VDDIOP0      | LCD Controller (LCDC) data bus                               | NC          |
| B26        | LCD_PWM                          | O    | PA24                                           | VDDIOP0      | LCDPWM for LCD Panel Contrast Control                        | NC          |
| B27        | LCD_DAT10                        | O    | PA10                                           | VDDIOP0      | LCD Controller (LCDC) data bus                               | NC          |
| B28        | LCD_DAT0                         | O    | PA0                                            | VDDIOP0      | LCD Controller (LCDC) data bus                               | NC          |
| B29        | LCD_DAT12                        | O    | PA12                                           | VDDIOP0      | LCD Controller (LCDC) data bus                               | NC          |
| B30        | GND                              | -    | -                                              | -            | Ground                                                       | GND         |
| B31        | LCD_PCK                          | O    | PA28                                           | VDDIOP0      | LCD Controller (LCDC) LCD pixel clock                        | NC          |
| B32        | GND                              | -    | -                                              | -            | Ground                                                       | GND         |
| B33        | LCD_DAT22                        | O    | PA22                                           | VDDIOP0      | LCD Controller (LCDC) data bus                               | NC          |
| B34        | LCD_DAT20                        | O    | PA20                                           | VDDIOP0      | LCD Controller (LCDC) data bus                               | NC          |
| B35        | LCD_DAT8                         | O    | PA8                                            | VDDIOP0      | LCD Controller (LCDC) data bus                               | NC          |

| Pin # | Name                               | Type | Pins map to CPU | Voltage Ref. | DVK Function                                                                                      | If Not Used |
|-------|------------------------------------|------|-----------------|--------------|---------------------------------------------------------------------------------------------------|-------------|
| B36   | LCD_VSYNC                          | O    | PA26            | VDDIOP0      | LCD Controller (LCDC) LCD vertical synchronization                                                | NC          |
| B37   | LCD_DAT3                           | O    | PA3             | VDDIOP0      | LCD Controller (LCDC) data bus                                                                    | NC          |
| B38   | LCD_HSYNC                          | O    | PA27            | VDDIOP0      | LCD Controller (LCDC) LCD horizontal synchronization                                              | NC          |
| B39   | LCD_DAT16                          | O    | PA16            | VDDIOP0      | LCD Controller (LCDC) data bus                                                                    | NC          |
| B40   | LCD_DAT6                           | O    | PA6             | VDDIOP0      | LCD Controller (LCDC) data bus                                                                    | NC          |
| B41   | LCD_DAT1                           | O    | PA1             | VDDIOP0      | LCD Controller (LCDC) data bus                                                                    | NC          |
| B42   | LCD_DISP                           | O    | PA25            | VDDIOP0      | LCD Controller (LCDC) LCD Display ON/OFF                                                          | NC          |
| B43   | LCD_DAT18                          | O    | PA18            | VDDIOP0      | LCD Controller (LCDC) data bus                                                                    | NC          |
| B44   | LCD_DAT15                          | O    | PA15            | VDDIOP0      | LCD Controller (LCDC) data bus                                                                    | NC          |
| B45   | LCD_DAT13                          | O    | PA13            | VDDIOP0      | LCD Controller (LCDC) data bus                                                                    | NC          |
| B46   | LCD_DAT17                          | O    | PA17            | VDDIOP0      | LCD Controller (LCDC) data bus                                                                    | NC          |
| B47   | LCD_DEN                            | O    | PA29            | VDDIOP0      | LCD Controller (LCDC) LCD data enable                                                             | NC          |
| G3    | GND                                | -    | -               | -            | Ground                                                                                            | GND         |
| C1    | LCD_DAT19                          | O    | PA19            | VDDIOP0      | LCD Controller (LCDC) data bus                                                                    | NC          |
| C2    | LCD_DAT23                          | O    | PA23            | VDDIOP0      | LCD Controller (LCDC) data bus                                                                    | NC          |
| C3    | LCD_DAT21                          | O    | PA21            | VDDIOP0      | LCD Controller (LCDC) data bus                                                                    | NC          |
| C4    | GND                                | -    | -               | -            | Ground                                                                                            | GND         |
| C5    | SPI1_NPCS3<br>Default:<br>TW_IRQ1  | I/O  | PC28            | VDDIOP0      | SPI1 Peripheral Chip Select<br>TW_IRQ1: Two-wire interrupt<br>Touch screen change Interrupt (I/P) | NC          |
| C6    | SPI1_NPCS1<br>Default:<br>TW_D1    | I/O  | PC26            | VDDIOP0      | SPI1 Peripheral Chip Select<br>TW_D1: Two-wire serial data                                        | NC          |
| C7    | SPI1_NPCS0<br>Default:<br>LCD_Mode | O    | PC25            | VDDIOP0      | SPI1 Peripheral Chip Select<br>LCD_Mode Select: <b>H</b> – DE mode;<br><b>L</b> – HSD/VSD mode    | NC          |
| C8    | LCD_DAT7                           | O    | PA7             | VDDIOP0      | LCD Controller (LCDC) data bus                                                                    | NC          |
| C9    | LCD_DAT9                           | O    | PA9             | VDDIOP0      | LCD Controller (LCDC) data bus                                                                    | NC          |
| C10   | LCD_DAT5                           | O    | PA5             | VDDIOP0      | LCD Controller (LCDC) data bus                                                                    | NC          |
| C11   | LCD_DAT11                          | O    | PA11            | VDDIOP0      | LCD Controller (LCDC) data bus                                                                    | NC          |
| C12   | GND                                | -    | -               | -            | Ground                                                                                            | GND         |
| C13   | GND                                | -    | -               | -            | Ground                                                                                            | GND         |
| C14   | GND                                | -    | -               | -            | Ground                                                                                            | GND         |
| C15   | WIFI_3V3                           | PWR  |                 |              | 3.3V Power Supply for Wi-Fi SIP on the module                                                     | --          |
| C16   | LTE_SIN                            | I    | -               | VDDIOP1      | LTE Coex. Signal Input                                                                            | NC          |

| Pin # | Name                                 | Type | Pins<br>map to<br>CPU | Voltage<br>Ref. | DVK Function                                                                                                      | If Not<br>Used |
|-------|--------------------------------------|------|-----------------------|-----------------|-------------------------------------------------------------------------------------------------------------------|----------------|
| C17   | LTE_SOUT                             | O    | -                     | VDDIOP1         | LTE Coex. Signal Output                                                                                           | NC             |
| C18   | GND                                  | -    | -                     | -               | Ground                                                                                                            | GND            |
| C19   | GPIO<br>Default:<br>eMMC_Disable     | I/O  | PE30                  | 1.8V            | GPIO:<br>eMMC Card slot Power Supply Control<br>O/P: Low to disable the eMMC power                                | NC             |
| C20   | IRQ<br>Default:<br>eMMC_CD           | I/O  | PE31                  | 1.8V            | IRQ<br>eMMC Card Card Detect<br>I/P: Low Active.<br>L – detect SDIO card inserted                                 | 10K;PU         |
| C21   | GND                                  | -    | -                     | -               | Ground                                                                                                            | GND            |
| C22   | GND                                  | -    | -                     | -               | Ground                                                                                                            | GND            |
| C23   | VDDIOP1                              | PWR  | -                     | -               | I/O Port 1 Reference Voltage; 1.8V or 3.3V                                                                        | --             |
| C24   | SPI0_MISO                            | I/O  | PD10                  | VDDIOP1         | SPI0 Master In Slave Out                                                                                          | NC             |
| C25   | GND                                  | -    | -                     | -               | Ground                                                                                                            | GND            |
| C26   | SPI0_CLK                             | I/O  | PD12                  | VDDIOP1         | SPI0 serial clock                                                                                                 | NC             |
| C27   | GND                                  | -    | -                     | -               | Ground                                                                                                            | GND            |
| C28   | SPI0_MOSI                            | I/O  | PD11                  | VDDIOP1         | SPI0 Master Out Slave In                                                                                          | NC             |
| C29   | SPI0_NPCS0                           | O    | PD13                  | VDDIOP1         | SPI0 Peripheral Chip Select                                                                                       | NC             |
| C30   | GND                                  | -    | -                     | -               | Ground                                                                                                            | GND            |
| C31   | GND                                  | -    | -                     | -               | Ground                                                                                                            | GND            |
| C32   | GND                                  | -    | -                     | -               | Ground                                                                                                            | GND            |
| C33   | GND                                  | -    | -                     | -               | Ground                                                                                                            | GND            |
| C34   | RXD_2                                | I    | PE25                  | 1.8V            | USART2 Receive data                                                                                               | NC             |
| C35   | GND                                  | -    | -                     | -               | Ground                                                                                                            | GND            |
| C36   | GPIO/SCK_2<br>Default:<br>INTn_IO_Ex | I/O  | PE20                  | 1.8V            | General purpose I/O/USART2 Serial clock<br>Default: Interrupt signal from I/O expander chip.<br>I/P; “Low” active | NC             |
| C37   | RTS_2                                | O    | PE24                  | 1.8V            | USART2 Request-to-Send                                                                                            | NC             |
| C38   | CTS_2                                | I    | PE23                  | 1.8V            | USART2 Clear-to-Send                                                                                              | NC             |
| C39   | TXD_2                                | O    | PE26                  | 1.8V            | USART2 Transmit data                                                                                              | NC             |
| C40   | GND                                  | -    | -                     | -               | Ground                                                                                                            | GND            |
| C41   | GND                                  | -    | -                     | -               | Ground                                                                                                            | GND            |
| C42   | BT_PCM_IN                            | I    | -                     | VDDIOP1         | Bluetooth PCM Input                                                                                               | NC             |
| C43   | BT_PCM_SYNC                          | I/O  | -                     | VDDIOP1         | Bluetooth PCM Sync                                                                                                | NC             |
| C44   | BT_PCM_OUT                           | O    | -                     | VDDIOP1         | Bluetooth PCM Output                                                                                              | NC             |
| C45   | BT_PCM_CLK                           | I/O  | -                     | VDDIOP1         | Bluetooth PCM Clock                                                                                               | NC             |
| C46   | GND                                  | -    | -                     | -               | Ground                                                                                                            | GND            |

| Pin # | Name                               | Type | Pins map to CPU | Voltage Ref. | DVK Function                                                                                        | If Not Used |
|-------|------------------------------------|------|-----------------|--------------|-----------------------------------------------------------------------------------------------------|-------------|
| C47   | RXD_3                              | I    | PE18            | 1.8V         | USART3 Receive data                                                                                 | NC          |
| G4    | GND                                | -    | -               | -            | Ground                                                                                              | GND         |
| D1    | CTS_3                              | I    | PE16            | 1.8V         | USART3 Clear-to-Send                                                                                | NC          |
| D2    | GPIO SCK_3                         | I/O  | PE15            | 1.8V         | General purpose I/O<br>USART3 Serial clock                                                          | NC          |
| D3    | TXD_3                              | O    | PE19            | 1.8V         | USART3 Transmit data                                                                                | NC          |
| D4    | RTS_3                              | O    | PE17            | 1.8V         | USART3 Request-to-Send                                                                              | NC          |
| D5    | GND                                | -    | -               | -            | Ground                                                                                              | GND         |
| D6    | GPIO/SCK_1<br>Default:<br>GETH_INT | I/O  | PB25            | VDDIOP1      | General purpose I/O; USART1 Serial clock<br>GETN_INT: Interrupt input from RGMII PHY;<br>Low active | 4.7K;PU     |
| D7    | RTS_1                              | O    | PB27            | VDDIOP1      | USART1 Request-to-Send                                                                              | NC          |
| D8    | RXD_1                              | I    | PB28            | VDDIOP1      | USART1 Receive data                                                                                 | NC          |
| D9    | CTS_1                              | I    | PB26            | VDDIOP1      | USART1 Clear-to-Send                                                                                | NC          |
| D10   | TXD_1                              | O    | PB29            | VDDIOP1      | USART1 Transmit data                                                                                | NC          |
| D11   | SHDN                               | O    | SHDN            | VDD_BU       | Shutdown Control;<br>Use to turn off the external PMU for VCC3_3<br>O/P;Low Active                  | NC          |
| D12   | GND                                | -    | -               | -            | Ground                                                                                              | GND         |
| D13   | GND                                | -    | -               | -            | Ground                                                                                              | GND         |
| D14   | HHSDPC                             | A    | HHSDPC          | -            | USB Host Port C High Speed Data +                                                                   | NC          |
| D15   | HHSDMC                             | A    | HHSDM<br>C      | -            | USB Host Port C High Speed Data -                                                                   | NC          |
| D16   | GND                                | -    | -               | -            | Ground                                                                                              | GND         |
| D17   | GND                                | -    | -               | -            | Ground                                                                                              | GND         |
| D18   | HHSDPB                             | A    | HHSDPB          | -            | USB Host Port B High Speed Data +                                                                   | NC          |
| D19   | HHSDMB                             | A    | HHSDM<br>B      | -            | USB Host Port B High Speed Data -                                                                   | NC          |
| D20   | GND                                | -    | -               | -            | Ground                                                                                              | GND         |
| C21   | HSDMA                              |      | HSDMA           |              | USB Device Port A High-Speed Data -                                                                 | NC          |
| C22   | HSDPA                              |      | HSDPA           |              | USB Device Port A High-Speed Data +                                                                 | NC          |
| D23   | GND                                | -    | -               | -            | Ground                                                                                              | GND         |
| D24   | VDD_BU                             | PWR  | -               | -            | Module Backup Power for RTC mode<br>Note: VDD_BU need to be same Voltage level as<br>VDDIOP1        | --          |
| D25   | WKUP                               | I/PU | WKUP            | VDD_BU       | Wake-Up: Wake up Module from RTC Mode.<br>I/P;Low Active.<br>Has 100K pull-up in the module design  | NC          |

| Pin #  | Name    | Type | Pins map to CPU | Voltage Ref. | DVK Function                                                                                                                                                                                          | If Not Used |
|--------|---------|------|-----------------|--------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|
| D26    | BMS     | I/PU | BMS             | VDDIOP0      | Boot Mode Select.<br>Has 10K pull-up in the SOM module design<br>NC: Normal Boot from NandFlash on the module<br>GND: Boot from External Memory                                                       | NC          |
| D27    | NRST    | I    | NRST            | VDDIOP0      | Microcontroller Reset; Low Active<br>10K pulled-up is needed<br>Put the 10K $\Omega$ pulled-up resistor close to this pin.<br>And keep the trace as short as possible and avoid noise and ESD source. | 10K PU      |
| D28    | GND     | -    | -               | -            | Ground                                                                                                                                                                                                | GND         |
| D29    | D_TXD   | O    | PB31            | VDDIOP1      | Debug UART Transmit data                                                                                                                                                                              | NC          |
| D30    | D_RXD   | I    | PB30            | VDDIOP1      | Debug UART Receive data                                                                                                                                                                               | NC          |
| D31    | CAN_RX1 | I    | PB14            | VDDIOP1      | CAN input                                                                                                                                                                                             | NC          |
| D32    | GND     | -    | -               | -            | Ground                                                                                                                                                                                                | GND         |
| D33    | CAN_TX1 | O    | PB16            | VDDIOP1      | CAN output                                                                                                                                                                                            | NC          |
| D34    | GND     | -    | -               | -            | Ground                                                                                                                                                                                                | GND         |
| D35    | MC_DA3  | I/O  | PD4             | VDDIOP1      | High Speed Multimedia Card data                                                                                                                                                                       | NC          |
| D36    | MC_DA5  | I/O  | PD6             | VDDIOP1      | High Speed Multimedia Card data                                                                                                                                                                       | NC          |
| D37    | MC_DA1  | I/O  | PD2             | VDDIOP1      | High Speed Multimedia Card data                                                                                                                                                                       | NC          |
| D38    | MC_DA7  | I/O  | PD8             | VDDIOP1      | High Speed Multimedia Card data                                                                                                                                                                       | NC          |
| D39    | MC_DA4  | I/O  | PD5             | VDDIOP1      | High Speed Multimedia Card data                                                                                                                                                                       | NC          |
| D40    | MC_CDA  | I/O  | PD0             | VDDIOP1      | High Speed Multimedia Card Command                                                                                                                                                                    | NC          |
| D41    | MC_DA6  | I/O  | PD7             | VDDIOP1      | High Speed Multimedia Card data                                                                                                                                                                       | NC          |
| D42    | GND     | -    | -               | -            | Ground                                                                                                                                                                                                | GND         |
| D43    | MC_DA0  | I/O  | PD1             | VDDIOP1      | High Speed Multimedia Card data                                                                                                                                                                       | NC          |
| D44    | MC_CLK  | I/O  | PD9             | VDDIOP1      | High Speed Multimedia Card clock                                                                                                                                                                      | NC          |
| D45    | MC_DA2  | I/O  | PD3             | VDDIOP1      | High Speed Multimedia Card data                                                                                                                                                                       | NC          |
| D46    | GND     | -    | -               | -            | Ground                                                                                                                                                                                                | GND         |
| D47    | VDDIOP0 | PWR  | -               | -            | I/O Port 0 Reference Voltage; 1.8V or 3.3V                                                                                                                                                            | --          |
| G5-G13 | GND     | -    | -               | -            | Ground                                                                                                                                                                                                | GND         |

## 4 POWER CONSIDERATION

### 4.1 Power Supply

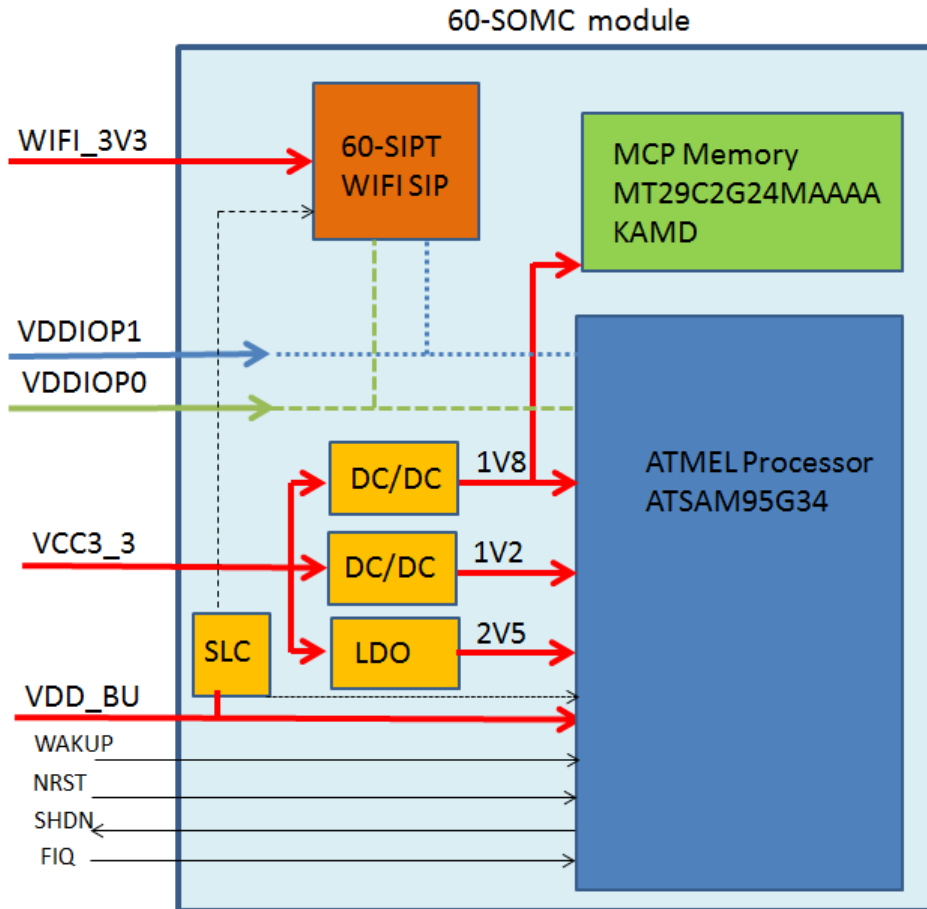


Figure 2: 60 SOM module power supply

The 60 SOM requires a primary power supply input from regulated 3.3V voltage. There are three main power rails for the module:

- WiFi\_3V3 – Mainly used for the 60-SIPT Wi-Fi/BT SIP on the 60 SOM.
- VCC3\_3 – Provides the input power for the processor and memory on the 60 SOM. Several DC/DC regulators and LDO generate required voltages and power on sequence (POS) timing for the processor.
- VDD\_BU – Provides the backup power to the Atmel/Microchip processor on the 60 SOM. It also powers the slow clock oscillator (32.768 KHz) that provides slow clock to both the Atmel/Microchip processor and the 60-SIPT when the 60 SOM is in deep sleep mode.

The VDDIOP0 and VDDIOP1 are the Peripheral I/O's DC Supply Voltage which could be set to 1.8V or 3.3V according to the application required. Due to the VDDIOP1 defined the slow clock signal level of the 60-SIPT as well, always keep the VDD\_BU and VDDIOP1 at the same voltage.

## 4.2 Power on Sequence

When the power supply is connected to the 60 SOM, most of the power on sequence are designed and performed inside the 60 SOM. No specific order and timing required for the VDD\_BU, VDDIOP0, VDDIOP1, WIFI\_3V3, and VCC3\_3. However, minimum of 5 ms ( $t_1$ ) is needed for the reset (NRST) to power up.

Table 2: Power on sequence

| Symbol | Parameter               | Conditions                                     | Min | Max | Unit |
|--------|-------------------------|------------------------------------------------|-----|-----|------|
| $t_1$  | Reset Delay at Power-Up | From the Group established supply to NRST high | 5   | -   | ms   |

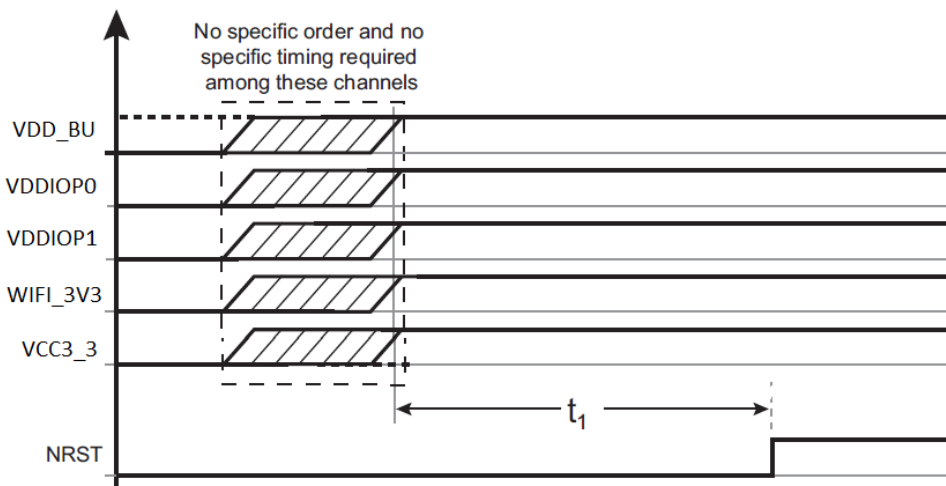


Figure 3: Power on sequence

## 4.3 Power Down Sequence

Table 3 provides the 60 SOM power-down sequence that starts by asserting the NRST line to 0. Once NRST is asserted, the supply inputs can be immediately shut down without any specific timing or order. Do not shut down VDD\_BU if the application uses a backup battery on this supply input.

Table 3: Power down sequence

| Symbol      | Parameter                 | Conditions                                 | Min | Max | Unit |
|-------------|---------------------------|--------------------------------------------|-----|-----|------|
| $t_{RSTPD}$ | Reset Delay at Power-Down | From NRST low to the group supply turn-off | 0   | -   | ms   |

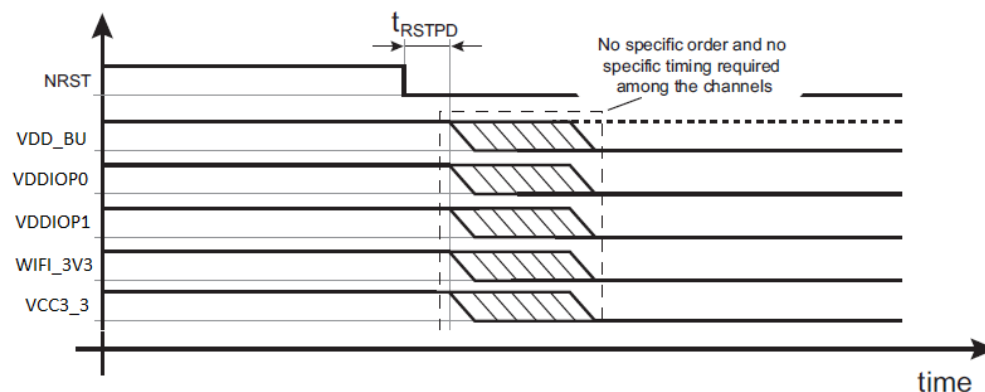


Figure 4: Power down sequence

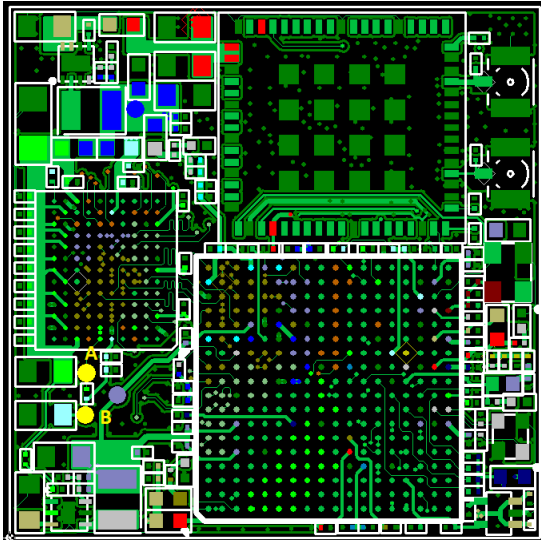
## 5 BOOTING

You can choose to boot from an external NOR Flash memory using the BMS pin. The sampling of the BMS pin is done by hardware at reset and the result is available in the BMS bit of the SFR\_EBICFG register.

By default, the BMS signal is tied to high (VDDIOP0); the BMS bit is read at 1.

The ROM code standard sequence is executed, basic chip initialization and attempt to retrieve a valid code from external non-volatile memories (NVM).

Shorting points A and B together bypasses the onboard NANDFlash on the 60 SOM and forces the module into ROM boot status. This allows you to program the NANDFlash through Atmel SAM-BA program.



**Figure 5: Shorting points A and B**

If the BMS signal is tied to low, the BMS bit is read at 0.

The ROM code allows execution of the code contained in the memory connected to Chip Select 0 of the External Bus Interface.

## 6 WIRELESS INTERFACE

The Laird 60 Series SOM combines a wireless local area network (WLAN) and dual-mode Bluetooth (BT) solution to support IEEE 802.11 a/b/g/n/ac 2X2 MIMO WLAN standards and BT 4.2 with the integration of WLAN/BT and Low Energy (BLE) technology.

The following sections include specifications for the wireless interfaces available on the 60 SOM.

### 6.1 WLAN 802.11a/b/g/n/ac

The 2.4 GHz band on the 60 SOM supports 20 MHz bandwidths and the 5 GHz band supports 20/40/80 MHz bandwidths.

The following sections specify the performance of the WLAN IEEE 802.11a/b/g/n/ac interface on the 60 SOM module.

#### 6.1.1 WLAN RF Channels and Regulatory Domains

The 60 SOM supports the following channels and regulatory domains.

**Table 4: Supported WLAN RF channels and regulatory domains**

| Feature                                   | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|-------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Regulatory Domain Support</b>          | FCC (Americas, Parts of Asia, and Middle East)<br>ETSI (Europe, Middle East, Africa, and Parts of Asia)<br>IC (Industry Canada)<br>MIC (Japan) (formerly TELEC) – Option<br>KC (Korea) (formerly KCC) – Option                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>2.4 GHz Frequency Bands</b>            | <b>ETSI</b> – 2.4 GHz to 2.483 GHz <b>FCC</b> – 2.4 GHz to 2.473 GHz<br><b>MIC</b> – 2.4 GHz to 2.495 GHz <b>KC</b> – 2.4 GHz to 2.483 GHz                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>2.4 GHz Operating Channels (Wi-Fi)</b> | <b>ETSI</b> – 13 (3 non-overlapping) <b>FCC</b> – 11 (3 non-overlapping)<br><b>MIC</b> – 14 (4 non-overlapping) <b>KC</b> – 13 (3 non-overlapping)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>5 GHz Frequency Bands</b>              | <b>ETSI</b><br>5.15 GHz to 5.35 GHz (Ch 36/40/44/48/52/56/60/64)<br>5.47 GHz to 5.725 GHz (Ch 100/104/108/112/116/120/124/128/132/136/140/144)<br><b>FCC</b><br>5.15 GHz to 5.35 GHz (Ch 36/40/44/48/52/56/60/64)<br>5.47 GHz to 5.725 GHz (Ch 100/104/108/112/116/120/124/128/132/136/140/144)<br>5.725 GHz to 5.825 GHz (Ch 149/153/157/161/165)<br><b>MIC (Japan)</b><br>5.15 GHz to 5.35 GHz (Ch 36/40/44/48/52/56/60/64)<br>5.47 GHz to 5.725 GHz (Ch 100/104/108/112/116/120/124/128/132/136/140/144)<br><b>KC</b><br>5.15 GHz to 5.35 GHz (Ch 36/40/44/48/52/56/60/64)<br>5.47 GHz to 5.725 GHz (Ch 100/104/108/112/116/120/124)<br>5.725 GHz to 5.825 GHz (Ch 149/153/157/161/165) |
| <b>5 GHz Operating Channels (Wi-Fi)</b>   | <b>ETSI</b> – 19 non-overlapping <b>FCC</b> – 24 non-overlapping<br><b>MIC (Japan)</b> – 19 non-overlapping <b>KC</b> – 20 non-overlapping                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |

## 6.1.2 WLAN Modulation and Data Rate

| Feature                    |         | Description                                                                                                                                                                                                                         |               |                 |            |        |        |       |        |     |        |       |
|----------------------------|---------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------|-----------------|------------|--------|--------|-------|--------|-----|--------|-------|
| Wi-Fi Standards            |         | IEEE 802.11a, 802.11b, 802.11d, 802.11e, 802.11g, 802.11h, 802.11i, 802.11n, 802.11r, 802.11ac, 802.11w, 802.11k, 802.11v                                                                                                           |               |                 |            |        |        |       |        |     |        |       |
| Supported Wi-Fi Data Rates |         | Support 802.11 ac/a/b/g/n 2X2 MIMO<br>802.11b (DSSS, CCK) 1, 2, 5.5, 11 Mbps<br>802.11a/g (OFDM) 6, 9, 12, 18, 24, 36, 48, 54 Mbps<br>802.11n (OFDM, HT20/HT40, MCS 0-15)<br>802.11ac (OFDM, HT20, MCS0-8; OFDM HT40/HT80, MCS 0-9) |               |                 |            |        |        |       |        |     |        |       |
| Modulation                 |         | BPSK, QPSK, CCK, 16-QAM, 64-QAM, and 256-QAM. Details in the following table:                                                                                                                                                       |               |                 |            |        |        |       |        |     |        |       |
| 802.11ac                   | 802.11n | HT MCS Index                                                                                                                                                                                                                        | VHT MCS Index | Spatial Streams | Modulation | Coding | 20 MHz |       | 40 MHz |     | 80 MHz |       |
|                            |         |                                                                                                                                                                                                                                     |               |                 |            |        | No SGI | SGI   | No SGI | SGI | No SGI | SGI   |
|                            |         | 0                                                                                                                                                                                                                                   | 0             | 1               | BPSK       | 1/2    | 6.5    | 7.2   | 13.5   | 15  | 29.3   | 32.5  |
|                            |         | 1                                                                                                                                                                                                                                   | 1             | 1               | QPSK       | 1/2    | 13     | 14.4  | 27     | 30  | 58.5   | 65    |
|                            |         | 2                                                                                                                                                                                                                                   | 2             | 1               | QPSK       | 3/4    | 19.5   | 21.7  | 40.5   | 45  | 87.8   | 97.5  |
|                            |         | 3                                                                                                                                                                                                                                   | 3             | 1               | 16-QAM     | 1/2    | 26     | 28.9  | 54     | 60  | 117    | 130   |
|                            |         | 4                                                                                                                                                                                                                                   | 4             | 1               | 16-QAM     | 3/4    | 39     | 43.3  | 81     | 90  | 175.5  | 195   |
|                            |         | 5                                                                                                                                                                                                                                   | 5             | 1               | 64-QAM     | 2/3    | 52     | 57.8  | 108    | 120 | 234    | 260   |
|                            |         | 6                                                                                                                                                                                                                                   | 6             | 1               | 64-QAM     | 3/4    | 58.5   | 65    | 121.5  | 135 | 263.3  | 292.5 |
|                            |         | 7                                                                                                                                                                                                                                   | 7             | 1               | 64-QAM     | 5/6    | 65     | 72.2  | 135    | 150 | 292.5  | 325   |
|                            |         |                                                                                                                                                                                                                                     | 8             | 1               | 256-QAM    | 3/4    | 78     | 86.7  | 162    | 180 | 351    | 390   |
|                            |         |                                                                                                                                                                                                                                     | 9             | 1               | 256-QAM    | 5/6    | N/A    | N/A   | 180    | 200 | 390    | 433.3 |
|                            |         | 8                                                                                                                                                                                                                                   | 0             | 2               | BPSK       | 1/2    | 13     | 14.4  | 27     | 30  | 58.5   | 65    |
|                            |         | 9                                                                                                                                                                                                                                   | 1             | 2               | QPSK       | 1/2    | 26     | 28.9  | 54     | 60  | 117    | 130   |
|                            |         | 10                                                                                                                                                                                                                                  | 2             | 2               | QPSK       | 3/4    | 39     | 43.3  | 81     | 90  | 175.5  | 195   |
|                            |         | 11                                                                                                                                                                                                                                  | 3             | 2               | 16-QAM     | 1/2    | 52     | 57.8  | 108    | 120 | 234    | 260   |
|                            |         | 12                                                                                                                                                                                                                                  | 4             | 2               | 16-QAM     | 3/4    | 78     | 86.7  | 162    | 180 | 351    | 390   |
|                            |         | 13                                                                                                                                                                                                                                  | 5             | 2               | 64-QAM     | 2/3    | 104    | 115.6 | 216    | 240 | 468    | 520   |
|                            |         | 14                                                                                                                                                                                                                                  | 6             | 2               | 64-QAM     | 3/4    | 117    | 130.3 | 243    | 270 | 526.5  | 585   |
|                            |         | 15                                                                                                                                                                                                                                  | 7             | 2               | 64-QAM     | 5/6    | 130    | 144.4 | 270    | 300 | 585    | 650   |
|                            |         |                                                                                                                                                                                                                                     | 8             | 2               | 256-QAM    | 3/4    | 156    | 173.3 | 324    | 360 | 702    | 180   |
|                            |         |                                                                                                                                                                                                                                     | 9             | 2               | 256-QAM    | 5/6    | N/A    | N/A   | 360    | 400 | 780    | 866.7 |

### 6.1.3 WLAN Security

| Feature  | Description                                            |
|----------|--------------------------------------------------------|
| Security | <b>Standards</b>                                       |
|          | Wireless Equivalent Privacy (WEP)                      |
|          | Wi-Fi Protected Access (WPA)                           |
|          | IEEE 802.11i (WPA2)                                    |
|          | <b>Encryption</b>                                      |
|          | Wireless Equivalent Privacy (WEP, RC4 Algorithm)       |
|          | Temporal Key Integrity Protocol (TKIP, RC4 Algorithm)  |
|          | Advanced Encryption Standard (AES, Rijndael Algorithm) |
|          | Encryption Key Provisioning                            |
|          | Static (40-bit and 128-bit lengths)                    |
|          | Pre-Shared (PSK)                                       |
|          | <b>Dynamic</b>                                         |
|          | 802.1X Extensible Authentication Protocol Types        |
|          | EAP-FAST                                               |
|          | PEAP-MSCHAPv2                                          |
|          | EAP-TLS                                                |
|          | PEAP-TLS                                               |
|          | EAP-TTLS                                               |
|          | LEAP                                                   |
|          | PEAP-GTC                                               |

### 6.1.4 WLAN TX Power and RX Sensitivity

| Feature                                                                                                                                                                                                                               | Description                               |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------|
| <b>Transmit Power</b>                                                                                                                                                                                                                 | <b>802.11a</b>                            |
|                                                                                                                                                                                                                                       | 6 Mbps                                    |
|                                                                                                                                                                                                                                       | 18 dBm (63 mW)                            |
|                                                                                                                                                                                                                                       | 54 Mbps                                   |
|                                                                                                                                                                                                                                       | 16 dBm (40 mW)                            |
|                                                                                                                                                                                                                                       | <b>802.11b</b>                            |
|                                                                                                                                                                                                                                       | 1 Mbps                                    |
|                                                                                                                                                                                                                                       | 18 dBm (63 mW)                            |
|                                                                                                                                                                                                                                       | 11 Mbps                                   |
|                                                                                                                                                                                                                                       | 18 dBm (63 mW)                            |
| <i>Note: Transmit power on each channel varies according to individual country regulations. All values are nominal with +/-2 dBm tolerance at room temperature. Tolerance could be up to +/-2.5 dBm across operating temperature.</i> | <b>802.11g</b>                            |
|                                                                                                                                                                                                                                       | 6 Mbps                                    |
|                                                                                                                                                                                                                                       | 18 dBm (63 mW)                            |
|                                                                                                                                                                                                                                       | 54 Mbps                                   |
|                                                                                                                                                                                                                                       | 16 dBm (40 mW)                            |
|                                                                                                                                                                                                                                       | <b>802.11n (2.4/5 GHz)</b>                |
|                                                                                                                                                                                                                                       | 6.5 Mbps (MCS0-5/MCS8-13; HT20)           |
|                                                                                                                                                                                                                                       | 18 dBm (63 mW)                            |
|                                                                                                                                                                                                                                       | 65 Mbps (MCS6-7/MCS14-15; HT20)           |
|                                                                                                                                                                                                                                       | 16 dBm (40 mW)                            |
| <i>Note:</i><br>HT20 – 20 MHz-wide channels<br>HT40 – 40 Mhz-wide channels<br>HT80 – 80 MHz-wide channels                                                                                                                             | 13.5Mbps (MCS0-5/MCS8-13; HT40)           |
|                                                                                                                                                                                                                                       | 16 dBm (40 mW)                            |
|                                                                                                                                                                                                                                       | 135Mbps (MCS6-7/MCS14-15; HT40)           |
|                                                                                                                                                                                                                                       | 14 dBm (25 mW)                            |
|                                                                                                                                                                                                                                       | <b>802.11ac (5 GHz)</b>                   |
|                                                                                                                                                                                                                                       | 6.5/13 Mbps (MCS0-6; Ntst=1,2; HT20)      |
|                                                                                                                                                                                                                                       | 18 dBm (63 mW)                            |
|                                                                                                                                                                                                                                       | 78/156 Mbps (MCS7-8; Ntst=1,2; HT20)      |
|                                                                                                                                                                                                                                       | 16 dBm (40 mW)                            |
|                                                                                                                                                                                                                                       | 13.5/27Mbps (MCS0-6; Ntst=1,2; HT40)      |
|                                                                                                                                                                                                                                       | 16 dBm (40 mW)                            |
|                                                                                                                                                                                                                                       | 180/360Mbps (MCS7-9; Ntst=1,2; HT40)      |
|                                                                                                                                                                                                                                       | 12 dBm (25 mW)                            |
|                                                                                                                                                                                                                                       | 29.3/58.5 Mbps (MCS0-5; Ntst=1,2; HT80)   |
|                                                                                                                                                                                                                                       | 14 dBm (25 mW)                            |
|                                                                                                                                                                                                                                       | 263.3/526.5 Mbps (MCS6-8; Ntst=1,2; HT80) |
|                                                                                                                                                                                                                                       | 12 dBm (15.8 mW)                          |
|                                                                                                                                                                                                                                       | 390/780 Mbps (MCS9; Ntst=1,2; HT80)       |
|                                                                                                                                                                                                                                       | 10 dBm (10 mW)                            |

| Feature                                                                                                         | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|-----------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Typical Receiver Sensitivity</b><br>(PER <= 10%)                                                             | <b>802.11a:</b><br>6 Mbps -90 dBm<br>54 Mbps -74 dBm                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Note:</b> All values nominal, +/-3 dBm.<br>Sensitivity on CH13/CH155 (WLAN); CH78 (BT) decodes up to 4-6 dB. | <b>802.11b:</b><br>1 Mbps -95 dBm<br>11 Mbps -90 dBm (PER<8%)<br><b>802.11g:</b><br>6 Mbps -91 dBm<br>54 Mbps -75 dBm<br><b>802.11n (2.4 GHz)</b><br>6.5 Mbps (MCS0; HT20) -91 dBm<br>65 Mbps (MCS7; HT20) -73 dBm<br>13.5Mbps (MCS0; HT40) -85 dBm<br>135Mbps (MCS7; HT40) -70 dBm<br><b>802.11n (5 GHz)</b><br>6.5 Mbps (MCS0; HT20) -89 dBm<br>65 Mbps (MCS7; HT20) -70 dBm<br>13.5Mbps (MCS0; HT40) -86 dBm<br>135Mbps (MCS7; HT40) -69 dBm<br><b>802.11ac (5 GHz)</b><br>6.5 Mbps (MCS0; HT20) -89 dBm<br>78 Mbps (MCS8; HT20) -67 dBm<br>13.5 Mbps (MCS0; HT40) -86 dBm<br>180 Mbps (MCS9; HT40) -63 dBm<br>29.3 Mbps (MCS0; HT80) -81 dBm<br>390/780 Mbps (MCS9; HT80) -55 dBm |

## 6.2 Bluetooth

The 60 Series SOM includes a fully-integrated Bluetooth baseband/radio. Several features and functions are listed in [Table 5](#).

**Table 5: Bluetooth functions**

| Feature                             | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|-------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Bluetooth Interface</b>          | <ul style="list-style-type: none"> <li>Voice interface:               <ul style="list-style-type: none"> <li>Hardware support for continual PCM data transmission/reception without processor overhead</li> <li>Standard PCM clock rates from 64 kHz to 2.048 MHz with multi-slot handshake and synchronization</li> <li>A-law, U-law, and linear voice PCM encoding/decoding</li> </ul> </li> <li>High-speed UART interface</li> </ul>                                                                                                                                                                                                                                                        |
| <b>Bluetooth Core Functionality</b> | <ul style="list-style-type: none"> <li>Bluetooth 4.2</li> <li>Bluetooth Class 2/Bluetooth class 1</li> <li>WLAN and Bluetooth share same LNA and antenna</li> <li>Digital audio interfaces with PCM/TDM interface for voice application</li> <li>Baseband and radio BDR and EDR package type: 1 Mbps, 2 Mbps, 3 Mbps</li> <li>Fully functional Bluetooth baseband: AFH, forward error correction, header error control, access code correction, CRC, encryption bit stream generation, and whitening</li> <li>Adaptive Frequency Hopping (AFH) using Packet Error Rate (PER)</li> <li>Interlaced scan for faster connection setup</li> <li>Simultaneous active ACL connection setup</li> </ul> |

| Feature                | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                        | <ul style="list-style-type: none"> <li>Automatic ACL package type selection</li> <li>Full master and slave piconet support</li> <li>Scatter net support</li> <li>SCO/eSCO links with hardware accelerated audio signal processing and hardware supported PPEC algorithm for speech quality improvement</li> <li>All standard SCO/eSCO voice coding</li> <li>All standard pairing, authentication, link key, and encryption operations</li> <li>Encryption (AES) support</li> </ul> |
| BLE Core Functionality | <ul style="list-style-type: none"> <li>Advertiser, scanner, initiator, master, and slave roles support (connects up to 16 links)</li> <li>WLAN/Bluetooth coexistence (BCA) protocol support</li> <li>Shared RF with BDR/EDR</li> <li>Encryption (AES) support</li> <li>Intelligent Adaptive Frequency Hopping (AFH)</li> <li>LE privacy 1.2</li> <li>LE secure connection</li> <li>LE data length extension</li> <li>LE advertising length extension</li> <li>2vMbps LE</li> </ul> |

## 6.2.1 Bluetooth Specification

| Feature                                                                                                                                                                                                                               | Description                                                                                                                                                                                                    |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Bluetooth Media                                                                                                                                                                                                                       | Frequency Hopping Spread Spectrum (FHSS)                                                                                                                                                                       |
| Bluetooth Standards                                                                                                                                                                                                                   | Bluetooth version 2.1 with Enhanced Data Rate<br>Bluetooth 4.2 (Bluetooth Low Energy or BLE)                                                                                                                   |
| Supported Bluetooth Data Rates                                                                                                                                                                                                        | 1, 2, 3 Mbps                                                                                                                                                                                                   |
| Bluetooth Modulation                                                                                                                                                                                                                  | GFSK@ 1 Mbps<br>Pi/4-DQPSK@ 2 Mbps<br>8-DPSK@ 3 Mbps                                                                                                                                                           |
| Regulatory Domain Support                                                                                                                                                                                                             | FCC (Americas, Parts of Asia, and Middle East)<br>ETSI (Europe, Middle East, Africa, and Parts of Asia)<br>IC (Industry Canada)<br>MIC (Japan) (formerly TELEC) – Option<br>KC (Korea) (formerly KCC) – Option |
| 2.4 GHz Frequency Bands                                                                                                                                                                                                               | 2.4 GHz to 2.483 GHz                                                                                                                                                                                           |
| Transmit Power                                                                                                                                                                                                                        | <b>Bluetooth</b><br>1 Mbps (1DH5) 10 dBm (12.5 mW)<br>2 Mbps 7 dBm (6.3 mW)<br>3 Mbps 7 dBm (6.3 mW)<br>BLE (1 Mbps) 7 dBm (6.3 mW)                                                                            |
| <b>Note:</b> Transmit power on each channel varies according to individual country regulations. All values are nominal with +/-2 dBm tolerance at room temperature. Tolerance could be up to +/-2.5 dBm across operating temperature. |                                                                                                                                                                                                                |
| Typical Receiver Sensitivity (PER <= 10%)                                                                                                                                                                                             | <b>Bluetooth:</b><br>1 Mbps (1DH5) -95 dBm<br>2 Mbps (2DH5) -94 dBm                                                                                                                                            |

| Feature                                                                    | Description           |
|----------------------------------------------------------------------------|-----------------------|
| <b>Note:</b> All values nominal, +/-3 dBm.                                 | 3 Mbps (3DH5) -88 dBm |
| <b>Note:</b> Sensitivity on CH13 (WLAN)/CH78 (BT) will decade up to 4-6dB. | BLE -95 dBm           |

## 7 MODULE SPECIFICATION

| Feature                                    | Description                                                                                                                                           |
|--------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Physical Interface</b>                  | Two-row LGA SMD type with 1.0 mm pin pitch                                                                                                            |
| <b>Ethernet Interface</b>                  | X1, 10/100 Mbps Reduced Media Independent Interface (RMII)<br>X1, 10/100/1000 Mbps Reduced Gigabit Media Independent Interface (RGMII)                |
| <b>Asynchronous Serial Port Interfaces</b> | X3, Four-wire UART with hardware handshaking (up to 921,600 baud)<br><b>Note:</b> UART2/UART3 are for 1.8V only.                                      |
| <b>SPI Interface</b>                       | X2, master and slave modes supported with multiple chip select pins                                                                                   |
| <b>CAN bus</b>                             | X1, CAN bus, fully compliant with CAN 2.0 Part A and 2.0 Part B                                                                                       |
| <b>USB Interfaces</b>                      | X1, USB device port with high speed/full speed/low speed data rates<br>X2, USB host ports with high speed/full speed/low speed data rates             |
| <b>SD/eMMC interface</b>                   | X1, High-speed multimedia card data                                                                                                                   |
| <b>Two Wire Interface</b>                  | X1, Two-wire I2C<br>The other two-wire interface is multiplexed with SPI bus                                                                          |
| <b>Debug Interface</b>                     | X1, Two-wire UART (console) for debug purpose                                                                                                         |
| <b>Digital GPIO</b>                        | X6, Digital General Purpose I/O (GPIO)                                                                                                                |
| <b>Analog-to-Digital Converter – ADC</b>   | X6, Analog-to-Digital converter for touch panel                                                                                                       |
| <b>Audio interface</b>                     | X1, Synchronous Serial Controller (SSC)                                                                                                               |
| <b>Video interface</b>                     | X1, 24-bits TTL RGB LCD display interface                                                                                                             |
| <b>PCM interface</b>                       | 13-bit or 16-bit linear, 8-bit $\mu$ -law or A-law companded sample formats for Bluetooth                                                             |
| <b>Antenna Interface</b>                   | Two Hirose U.FL connectors for Wi-Fi (Main/AUX) and BT (AUX only) separately, 50 ohm                                                                  |
| <b>Wi-Fi Interface</b>                     | Marvell 88W8997 2x2 802.11a/b/g/n/ac on 20/40/80 MHz bandwidth                                                                                        |
| <b>Bluetooth Interface</b>                 | Marvell 88W8997 Bluetooth 4.2 dual-mode (EDR+BLE)                                                                                                     |
| <b>Processor Chip Set</b>                  | Atmel 536 MHz ARM 9, P/N ATSAMA5D34A                                                                                                                  |
| <b>Operating System</b>                    | Embedded Linux, 4.1 kernel                                                                                                                            |
| <b>Memory</b>                              | 128 MB (1 Gb) LPDDR                                                                                                                                   |
| <b>Storage</b>                             | 256 MB (2Gb) SLC NAND flash                                                                                                                           |
| <b>Input Voltage Requirements</b>          | VDD_BU;VDDIOP0; VDDIOP1: 3.3V+/-10% or 1.8V+/-0.15V<br>VCC3_3;WIFI_3V3: 3.3V+/-10%<br><br><b>Note:</b> Keep regulated voltage ripple less than 30 mV. |
| <b>Operating Temperature</b>               | -30° to +85°C (-22°F to 185°F)                                                                                                                        |
| <b>Operating Humidity</b>                  | 10 to 90% (non-condensing)                                                                                                                            |

| Feature                         | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |          |               |         |          |          |      |          |  |
|---------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|---------------|---------|----------|----------|------|----------|--|
| Storage Temperature             | -40° to 85°C (-40° to 185°F)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |          |               |         |          |          |      |          |  |
| Storage Humidity                | 10 to 90% (non-condensing)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |          |               |         |          |          |      |          |  |
| Maximum Electrostatic Discharge | Conductive 8KV; Air coupled 12 KV follow EN61000-4-2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |          |               |         |          |          |      |          |  |
| Size                            | 30 mm (length) x 30 mm (width) x 2.8 mm (thickness)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |          |               |         |          |          |      |          |  |
| Weight                          | 5.0 g                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |          |               |         |          |          |      |          |  |
| Operating Systems Supported     | Linux 3.x to 4.9.x kernel                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |          |               |         |          |          |      |          |  |
| Security                        | <p><b>Standards</b></p> <p>Wireless Equivalent Privacy (WEP)<br/>Wi-Fi Protected Access (WPA)<br/>IEEE 802.11i (WPA2)</p> <p><b>Encryption</b></p> <p>Wireless Equivalent Privacy (WEP, RC4 Algorithm)<br/>Temporal Key Integrity Protocol (TKIP, RC4 Algorithm)<br/>Advanced Encryption Standard (AES, Rijndael Algorithm)<br/>Encryption Key Provisioning<br/>Static (40-bit and 128-bit lengths)<br/>Pre-Shared (PSK)</p> <p><b>Dynamic</b></p> <p>802.1X Extensible Authentication Protocol Types</p> <table> <tr> <td>EAP-FAST</td><td>PEAP-MSCHAPv2</td></tr> <tr> <td>EAP-TLS</td><td>PEAP-TLS</td></tr> <tr> <td>EAP-TTLS</td><td>LEAP</td></tr> <tr> <td>PEAP-GTC</td><td></td></tr> </table> | EAP-FAST | PEAP-MSCHAPv2 | EAP-TLS | PEAP-TLS | EAP-TTLS | LEAP | PEAP-GTC |  |
| EAP-FAST                        | PEAP-MSCHAPv2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |          |               |         |          |          |      |          |  |
| EAP-TLS                         | PEAP-TLS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |          |               |         |          |          |      |          |  |
| EAP-TTLS                        | LEAP                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |          |               |         |          |          |      |          |  |
| PEAP-GTC                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |          |               |         |          |          |      |          |  |
| Compliance                      | <p><b>ETSI Regulatory Domain</b></p> <p>EN 300 328 v 2.1.1<br/>EN 301 489-1<br/>EN 301 489-17<br/>EN 301 893<br/>EN 60950-1<br/>EU 2002/95/EC (RoHS)</p> <p><b>FCC Regulatory Domain</b></p> <p>FCC 15.247 DTS – 802.11b/g (Wi-Fi) – 2.4 GHz<br/>FCC 15.407 UNII – 802.11a (Wi-Fi) – 5 GHz<br/>FCC 15.247 DSS – BT 2.1</p> <p><b>Industry Canada</b></p> <p>RSS-247 – 802.11a/b/g/n (Wi-Fi) – 2.4 GHz, 5.8 GHz, 5.2 GHz, and 5.4 GHz<br/>RSS-247 – BT 2.1</p>                                                                                                                                                                                                                                          |          |               |         |          |          |      |          |  |

| Feature                                                        | Description                                                                                                                                                                                                                                                                                                                                                                                             |
|----------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Certifications                                                 | <b>Wi-Fi Alliance</b><br>802.11a, 802.11b, 802.11g , 802.11n, 802.11ac<br>WPA Enterprise<br>WPA2 Enterprise<br>Bluetooth® SIG Qualification    |
| Warranty                                                       | Three Year Warranty                                                                                                                                                                                                                                                                                                                                                                                     |
| <i>All specifications are subject to change without notice</i> |                                                                                                                                                                                                                                                                                                                                                                                                         |

## 8 ELECTRICAL CHARACTERISTICS

### 8.1 Absolute Maximum Ratings

Table 6 summarizes the absolute maximum ratings and Table 7 lists the recommended operating conditions for the 60 SOM. Absolute maximum ratings are those values beyond which damage to the device can occur. Functional operation under these conditions, or at any other condition beyond those indicated in the operational sections of this document, is not recommended.

**Note:** Maximum rating for signals follows the supply domain of the signals.

Table 6: Absolute maximum ratings

| Symbol (Domain)       | Parameter                                                                            | Max Rating             | Unit |
|-----------------------|--------------------------------------------------------------------------------------|------------------------|------|
| VCC3_3                | DC 3.3V input for the module                                                         | 4.0                    | V    |
| WIFI_3V3              | 3.3V Power Supply for Wi-Fi SIP on the module (for 1.8V system)<br>(for 3.3V system) | 4.0                    | V    |
| VDD_BU                | Backup Power for RTC mode                                                            | 4.0                    | V    |
| VDDIOP0               | I/O configuration power supply (for 1.8V system)                                     | 2.2                    | V    |
| VDDIOP1               | (for 3.3V system)                                                                    | 4.0                    | V    |
| Storage               | Storage Temperature                                                                  | -40 to +85             | °C   |
| Voltage on Input Pins | With respect to Ground                                                               | VDDIO+0.3<br>(4.0 max) | V    |
| ANT0; ANT1            | Maximum RF input (reference to 50-Ω input)                                           | +10                    | dBm  |

### 8.2 Recommended Operating Conditions

Table 7: Recommended operating conditions

| Symbol (Domain)          | Parameter                                 | Min      | Typ     | Max      | Unit |
|--------------------------|-------------------------------------------|----------|---------|----------|------|
| VCC3_3; WIFI_3V3         | External 3.3V power supply                | 3.0      | 3.30    | 3.6      | V    |
| VDD_BU; VDDIOP0; VDDIOP1 | Backup and I/O configuration power supply | 1.65/3.0 | 1.8/3.3 | 1.95/3.6 | V    |
| T-ambient                | Ambient temperature                       | -30      | 25      | 85       | °C   |

### 8.3 DC Electrical Characteristics

Table 8 lists the general DC electrical characteristics over recommended operating conditions (unless otherwise specified).

**Table 8: General DC electrical characteristics**

| Symbol           | Parameter                    | Conditions            | Min        | Typ        | Max        | Unit |
|------------------|------------------------------|-----------------------|------------|------------|------------|------|
| VIL              | Input Low-level Voltage      | VDDIOPx in 3.3V range | -0.3       | -          | 0.8        | V    |
|                  |                              | VDDIOPx in 1.8V range | -0.3       | -          | 0.54       |      |
| VIH              | Input High-level Voltage     | VDDIOPx in 3.3V range | 2.4        | -          | 3.6        | V    |
|                  |                              | VDDIOPx in 1.8V range | 1.26       | -          | 2.1        |      |
| V <sub>hys</sub> | Schmitt trigger Hysteresis   | VDDIOPx in 3.3V range | 0.34       | -          | -          | V    |
|                  |                              | VDDIOPx in 1.8V range | 0.21       | -          | -          |      |
| VOL              | Output Low-level Voltage     | IO Max                | -          | -          | 0.4        | V    |
| VOH              | Output High-level Voltage    | IO Max                | VDDIOP-0.4 | -          | -          | V    |
| RPULL            | Pull-up/Pull-down Resistance | VDDIOPx in 3.3V range | 45         | 70         | 130        | kΩ   |
|                  |                              | VDDIOPx in 1.8V range | 100        | 160        | 310        |      |
| IO               | Output Current               | VDDIOPx in 3.3V range | 8          | 26         | 38         | mA   |
|                  |                              |                       | (LO_DRIVE) | (ME_DRIVE) | (HI_DRIVE) |      |
|                  |                              | VDDIOPx in 1.8V range | 5          | 16         | 22         |      |
|                  |                              |                       | (LO_DRIVE) | (ME_DRIVE) | (HI_DRIVE) |      |
| RS               | Series Resistor              | SCK_1/GETH_INT;       | 3          | 6          | 7          | Ω    |
|                  |                              |                       | (LO_DRIVE) | (ME_DRIVE) | (HI_DRIVE) |      |
|                  |                              | VBUS_SENSE            | -          | 30         | -          |      |
|                  |                              | SCK_1/GETH_INT        | -          | 13         | -          |      |

## 8.4 Power Consumption

Table 9 and Table 10 show the power consumption of the 60 SOM when transmitting in 2.4 GHz and 5 GHz modes.

**Table 9: WLAN transmitter characteristics for 2.4 GHz per chain operation**

| Freq.     | Mode/Rate (Mbps) | Output Power Per Chain (dBm) | Typical Current Consumption Single Chain (mA) <sup>8</sup> | Max. Current Consumption Single Chain (mA) <sup>8</sup> |
|-----------|------------------|------------------------------|------------------------------------------------------------|---------------------------------------------------------|
| 2417 MHz  | 1 Mbps           | 18 dBm                       | 550                                                        | 1050                                                    |
|           | 54 Mbps          | 16 dBm                       | 450                                                        | 820                                                     |
|           | HT20 MCS7        | 16 dBm                       | 450                                                        | 820                                                     |
| 2442 MHz  | 1 Mbps           | 18 dBm                       | 550                                                        | 1050                                                    |
|           | 54 Mbps          | 16 dBm                       | 460                                                        | 820                                                     |
|           | HT20 MCS7        | 16 dBm                       | 350                                                        | 820                                                     |
| 2467n MHz | 1 Mbps           | 18 dBm                       | 550                                                        | 1050                                                    |
|           | 54 Mbps          | 16 dBm                       | 450                                                        | 820                                                     |
|           | HT20 MCS7        | 16 dBm                       | 450                                                        | 820                                                     |

Table 10: WLAN current consumption on 5 GHz

| Freq.    | Mode/Rate [Mbps] | Output Power Per Chain [dBm] | Typical Current Consumption Single Chain (mA) | Typical Current Consumption Dual Chain (mA) |
|----------|------------------|------------------------------|-----------------------------------------------|---------------------------------------------|
| 5200 MHz | 6 Mbps           | 18 dBm                       | 580                                           | 1100                                        |
|          | 54 Mbps          | 16 dBm                       | 520                                           | 970                                         |
|          | HT20 MCS0        | 18 dBm                       | 580                                           | 1100                                        |
|          | HT20 MCS7        | 16 dBm                       | 520                                           | 970                                         |
| 5190 MHz | HT40 MCS7        | 14 dBm                       | 450                                           | 820                                         |
| 5600 MHz | 6 Mbps           | 18 dBm                       | 600                                           | 1200                                        |
|          | 54 Mbps          | 16 dBm                       | 530                                           | 970                                         |
|          | HT20 MCS0        | 18 dBm                       | 600                                           | 1200                                        |
|          | HT20 MCS7        | 16 dBm                       | 530                                           | 970                                         |
| 5510 MHz | HT40 MCS7        | 14 dBm                       | 460                                           | 830                                         |
| 5825 MHz | 6 Mbps           | 18 dBm                       | 590                                           | 1150                                        |
|          | 54 Mbps          | 16 dBm                       | 520                                           | 980                                         |
|          | HT20 MCS0        | 18 dBm                       | 600                                           | 1150                                        |
|          | HT20 MCS7        | 16 dBm                       | 510                                           | 1020                                        |
| 5795 MHz | HT40 MCS7        | 14 dBm                       | 450                                           | 850                                         |

**Note:** Final TX power values on each channel are limited by the regulatory certification test limit.

## 9 INTERFACE SPECIFICATIONS

### 9.1 Ethernet

There are two Ethernet interfaces available on the 60 SOM that support RMII (10/100) and RGMII (10/100/1000) to comply with IEEE Standard 802.3.

### 9.2 Display Interface LCD

The LCD interface on 60 SOM transfers the LCD image data to an LCD display module. The LCD is programmable on a per overlay basis and supports different LCD resolutions, window sizes, image formats, and pixel depths. The following is a list of features:

- Dual AHB master interface
- Supports Single Scan Active TFT display
- Supports 12-, 16-, 18-, and 24-bit output mode through the spatial dithering unit
- Supports asynchronous output mode (at synthesis time)
- 1, 2, 4, 8 bits per pixel (palletized)
- 12, 16, 18, 19, 24, 25, and 32 bits per pixel (non-palletized)
- Supports one base layer (background)
- Supports two overlay layer windows
- Supports one high end overlay (HEO) window
- Supports one hardware cursor, fixed or free size
- Hardware cursor fixed size on the following patterns: 32 x 32, 64 x 64, and 128 x 128
- Little Endian Memory Organization

- Programmable timing engine, with integer clock divider
- Programmable polarity for data, line synchro and frame synchro
- Display size up to 2048 x 2048 or up to 720 p in video format
- Color lookup table with up to 256 entries and predefined 8-bit Alpha
- Programmable negative and positive row striding for all layers
- Programmable negative and positive pixel striding for all overlay1, overlay2, and HEO Layers
- High-end overlay supports 4:2:0 planar mode and semi-planar mode
- High-end overlay supports 4:2:2 planar mode, semi-planar mode and packed
- High-end overlay includes chroma upsampling unit
- Horizontal and vertical rescaling unit with edge interpolation and independent non-integer ratio
- Hidden layer removal supported
- Integrates fully-programmable color space conversion
- Overlay1, Overlay2, and high-end Overlay Integrate Rotation Engine: 90, 180, 270
- Blender function supports arbitrary 8-bit alpha value and chroma keying
- DMA user interface uses linked list structure and add-to-queue structure

Table 11 shows the I/O lines description of the LCD bus.

**Table 11: I/O lines description**

| Name          | Description                                          | Type   |
|---------------|------------------------------------------------------|--------|
| LCD_PWM       | Contrast control signal using pulse width modulation | Output |
| LCD_HSYNC     | Horizontal synchronization pulse                     | Output |
| LCD_VSYNC     | Vertical synchronization pulse                       | Output |
| LCD_DAT[23:0] | LCD 24-bit data bus                                  | Output |
| LCD_DEN       | Data enable                                          | Output |
| LCD_DISP      | Display enable signal                                | Output |
| LCD_PCLK      | Pixel clock                                          | Output |

### 9.3 Audio Interface (Synchronous Serial Controller)

The Synchronous Serial Controller (SSC) provides a synchronous communication link with external devices. It supports many serial synchronous communication protocols generally used in audio and telecom applications such as I2S, Short Frame Sync, and Long Frame Sync.

The SSC contains an independent receiver and transmitter and a common clock divider. Both the receiver and the transmitter interface with three signals:

- TD/RD signal for data
- TK/RK signal for the clock
- TF/RF signal for the Frame Sync.

The transfers can be programmed to start automatically or on different events detected on the Frame Sync signal.

**Table 12: SSC I/O lines description**

| Name | Description               | Type         |
|------|---------------------------|--------------|
| RF   | Receiver Frame Synchro    | Input/Output |
| RK   | Receiver Clock            | Input/Output |
| RD   | Receiver Data             | Input        |
| TF   | Transmitter Frame Synchro | Input/Output |
| TK   | Transmitter Clock         | Input/Output |
| TD   | Transmitter Data          | Output       |

Typical application block diagram of SSC bus is shown in Figure 6.

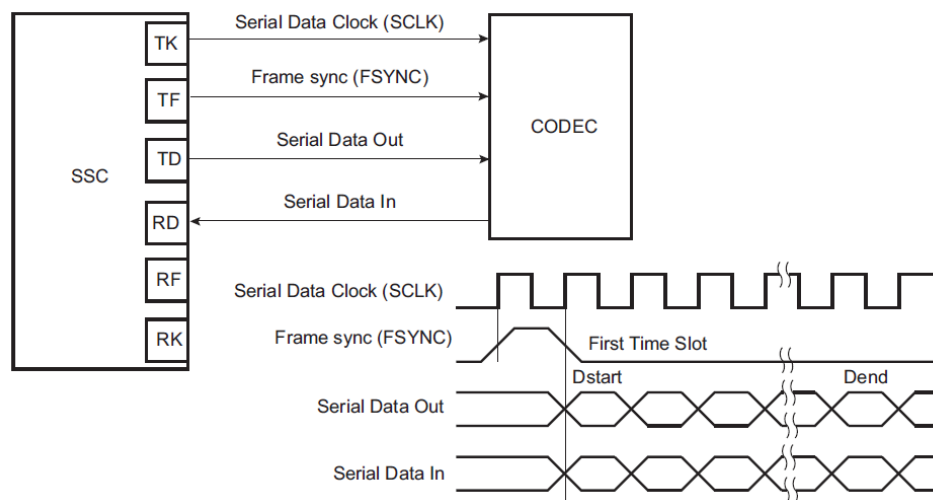


Figure 6: Typical application block diagram of SSC bus

## 9.4 High Speed Multimedia Card Interface

The high-speed Multimedia Card Interface (HSMCI) supports the MultiMedia Card (MMC) Specification V4.3, the SD memory card specification V2.0, and the SDIO V2.0 specification.

The SD memory card communication is based on a nine-pin interface (clock, command, four data, and three power lines) and the high-speed MMC on a seven-pin interface (clock, command, one data, three power lines, and one reserved for future use). The SD memory card interface also supports high-speed MMC operations. The main differences between SD and high-speed MultiMedia cards are the initialization process and the bus topology.

Table 13: HSMCI I/O lines description

| Name        | Description      | Type      | Comments                                            |
|-------------|------------------|-----------|-----------------------------------------------------|
| MCCDA       | Command/Response | I/O/PP/OD | CMD of an MMC or SDCard/SDIO                        |
| MCCK        | Clock            | I/O       | CLK of an MMC or SD Card/SDIO                       |
| MCDA0–MCDA7 | Data 0..7        | I/O/PP    | DAT[0..7] of an MMC<br>DAT[0..3] of an SD Card/SDIO |

## 9.5 Serial Peripheral Interface (SPI)

The SPI system consists of two data lines and two control lines:

- Master Out/Slave In (SPI\_MOSI) – This data line supplies the output data from the master shifted into the input(s) of the slave(s).
- Master In/Slave Out (SPI\_MISO) – This data line supplies the output data from a slave to the input of the master. There may be no more than one slave transmitting data during any particular transfer.
- Serial Clock (SPI\_CLK)—This control line is driven by the master and regulates the flow of the data bits. The master can transmit data at a variety of baud rates; there is one SPI\_CLK pulse for each bit that is transmitted.
- Slave Select (SPI\_NPCS)—This control line allows slaves to be turned on and off by hardware.

Table 14: SPI I/O lines descriptions

| Name      | Description         | Type   |        |
|-----------|---------------------|--------|--------|
|           |                     | Master | Slave  |
| SPIx_MISO | Master in/Slave out | Input  | Output |
| SPIx_MOSI | Master out/Slave in | Output | Input  |

| Name           | Description                         | Type   |        |
|----------------|-------------------------------------|--------|--------|
|                |                                     | Master | Slave  |
| SPIx_CLK       | Serial clock                        | Output | Input  |
| SPIx_NPCS[1-3] | Peripheral chip selects             | Output | Unused |
| SPI1_NPCS0     | Peripheral chip select/slave select | Output | Input  |

Typical application block diagram of SPI bus is shown in Figure 7.

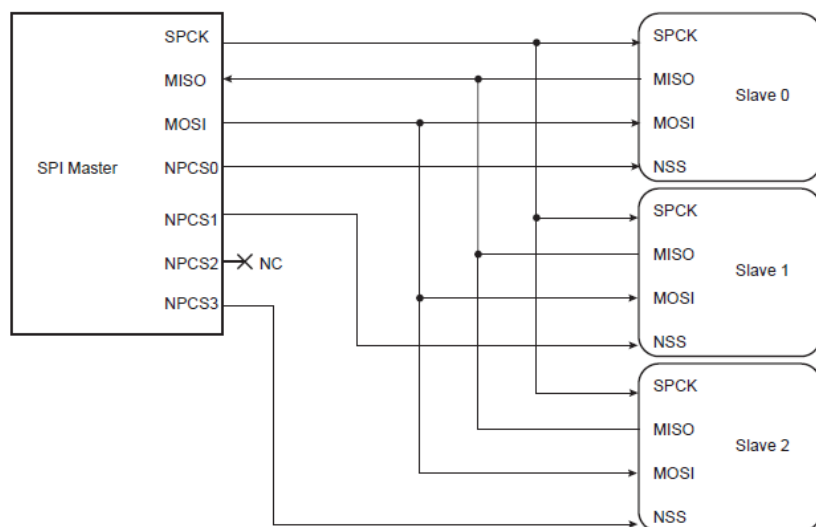


Figure 7: Typical application block diagram of SPI bus

## 9.6 Can Bus Interface

The CAN bus offers optimized features to support the Time Triggered Communication (TTC) protocol.

- Fully compliant with CAN 2.0 Part A and 2.0 Part B
- Bit rates up to one Mbit/second
- Eight object-oriented mailboxes with the following properties:
  - CAN Specification 2.0 Part A or 2.0 Part B programmable for each message
  - Object configurable in receive (with overwrite or not) or transmit modes
  - Independent 29-bit identifier and mask defined for each mailbox
  - 32-bit access to data registers for each mailbox data object
  - Uses a 16-bit timestamp on receive and transmit messages
  - Hardware concatenation of ID masked bitfields to speed up family ID processing
- 16-bit internal timer for timestamping and network synchronization
- Programmable reception buffer length up to eight mailbox objects
- Priority management between transmission mailboxes
- Autobaud and listening mode
- Low-power mode and programmable wake-up on bus activity or by the application
- Data, remote, error and overload frame handling
- Register write protection

Table 15: Can bus interface I/O lines description

| Name    | Description              | Type   |
|---------|--------------------------|--------|
| CAN_TX1 | CAN Receive Serial Data  | Input  |
| CAN_RX1 | CAN Transmit Serial Data | Output |

## 9.7 Two-wire Interface (TWI)

The Atmel/Microchip two-wire interface (TWI) interconnects components on a unique two-wire bus. It is made up of one clock line and one data line with speeds of up to 400 Kbits per second, based on a byte-oriented transfer format. It can be used with any Atmel/Microchip two-wire interface bus Serial EEPROM and I<sup>2</sup>C compatible device such as a Real Time Clock (RTC), dot matrix/graphic LCD controllers, and temperature sensor. The TWI is programmable as a master or a slave with sequential or single-byte access. Multiple master capability is supported.

Table 16 lists the compatibility level of the Atmel/Microchip two-wire Interface in Master mode and a full I<sup>2</sup>C compatible device.

**Table 16: Atmel/Microchip TWI compatibility with I<sup>2</sup>C standard**

| I <sup>2</sup> C Standard                     | Atmel/Microchip TWI |
|-----------------------------------------------|---------------------|
| Standard mode speed (100 kHz)                 | Supported           |
| Fast mode speed (400 kHz)                     | Supported           |
| 7- or 10-bit slave addressing                 | Supported           |
| START byte(1)                                 | Not Supported       |
| Repeated start (Sr) condition                 | Supported           |
| ACK and NACK management                       | Supported           |
| Slope control and input filtering (fast mode) | Not Supported       |
| Clock stretching/synchronization              | Supported           |
| Multi Master Capability                       | Supported           |

**Note 1:** START + b000000001 + Ack + Sr

**Table 17: TWI I/O lines description**

| Name   | Description                                                     | Type         |
|--------|-----------------------------------------------------------------|--------------|
| TW_D   | Two-wire Serial Data (drives external serial data line – SDA)   | Input/Output |
| TW_CLK | Two-wire Serial Clock (drives external serial clock line – SCL) | Input/Output |

## 9.8 Analog-to-Digital Converter (ADC)

There are six analog input channels available on the 60 SOM. The analog power supply (VDDANA) and the reference voltage (ADVREF) are set to 3.3V on the module. Analog inputs between these voltages (3.3V) convert to values based on a linear conversion. Software trigger, external trigger on rising edge of the ADTRG pin or internal triggers from Timer Counter output(s) are configurable.

**Table 18: ADC I/O lines description**

| Name  | Description                                     | Type   |
|-------|-------------------------------------------------|--------|
| AD0   | Analog input channels (Upper-left touch panel)  | Analog |
| AD1   | Analog input channels (Upper-right touch panel) | Analog |
| AD2   | Analog input channels (Lower-left touch panel)  | Analog |
| AD3   | Analog input channels (Lower-right touch panel) | Analog |
| AD4   | Analog input channels (Panel input)             | Analog |
| AD5   | Analog input channels                           | Analog |
| ADTRG | External trigger                                | Input  |

## 10 MECHANICAL SPECIFICATIONS

The 60 Series SOM measures 30 x 30 x 2.8 mm. Detail drawings are shown in Figure 8.

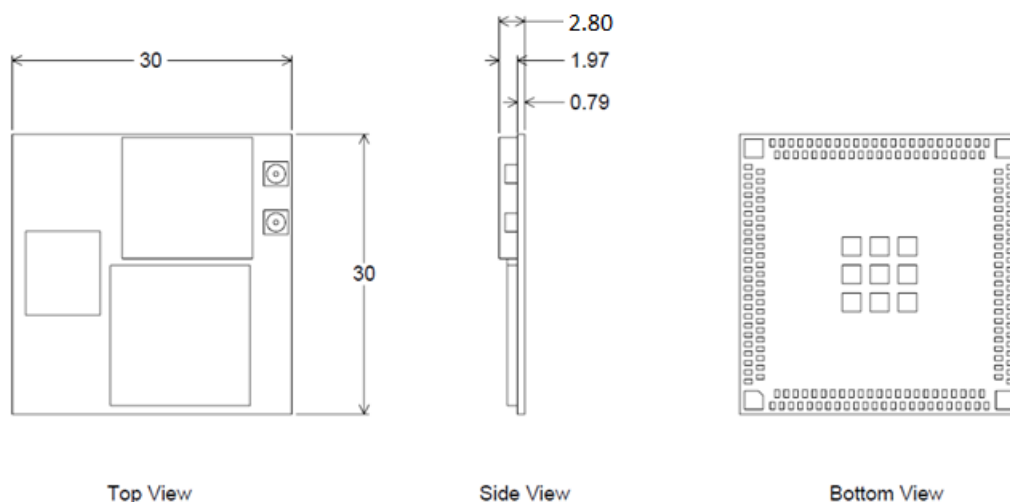


Figure 8: Module dimension of 60 SOM

**Note:** The Wi-Fi MAC address is located on the product label. The last digit of the Wi-Fi MAC address is assigned to end with either 0, 4, 8, or C. The BT MAC address is the Wi-Fi MAC address plus 3.

The 10/100 Ethernet LAN MAC (ELAN) address is also shown in the label on the 60 SOM. The other 10/100/1000 Giga-bits Ethernet LAN MAC address is the 10/100 Ethernet LAN MAC address plus 1.

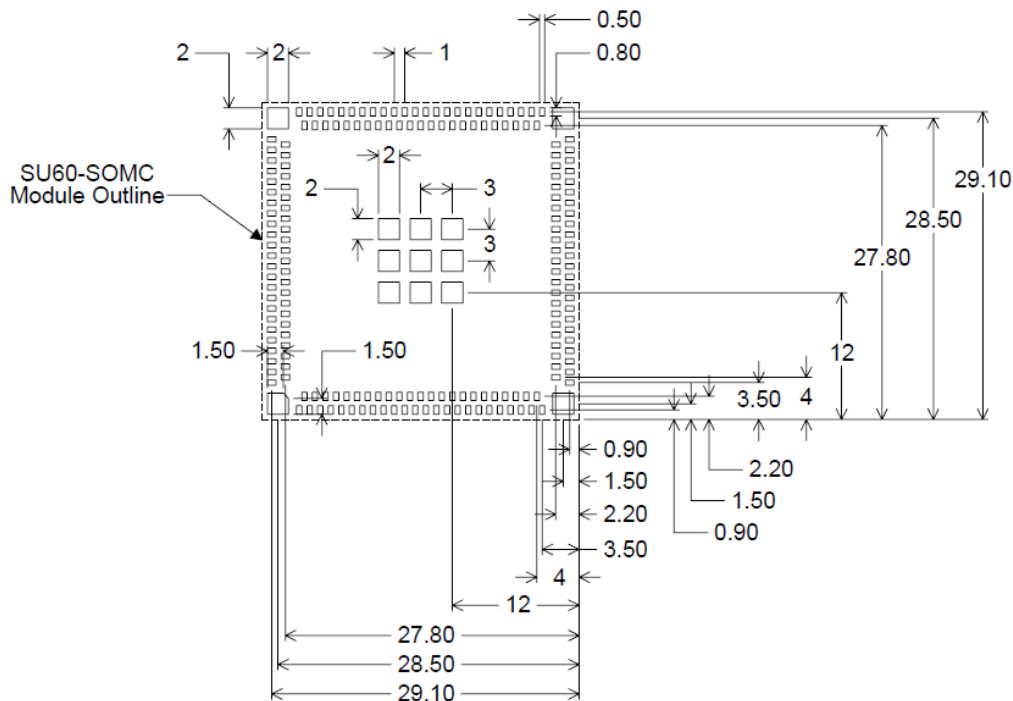


Figure 9: Mechanical drawing

Recommended landing pad for the 60 SOM. More ground via and the use of 1-oz copper is recommended in our design to get better thermal dissipation.

**Note:** The stencil thickness should be  $\geq 0.1$  mm and adjust the opening size/ratio and the SMT reflow thermal profile accordingly to minimize the void (less than 30% according to IPC standard) in the landing pad as possible.

## 11 ASSEMBLY INSTRUCTIONS

### 11.1 Required Storage Conditions

#### 11.1.1 Prior to Opening the Dry Packing

The following are required storage conditions **prior** to opening the dry packing:

- Normal temperature: 5~40°C
- Normal humidity: 80% (Relative humidity) or less
- Storage period: One year or less

**Note:** Humidity refers to *relative humidity*.

#### 11.1.2 After Opening the Dry Packing

The following are required storage conditions **after** opening the dry packing (to prevent moisture absorption):

- Storage conditions for one-time soldering:
  - Temperature: 5~25°C
  - Humidity: 60% or less
  - Period: 72 hours or less after opening
- Storage conditions for two-time soldering

Storage conditions following opening and prior to performing the 1<sup>st</sup> reflow:

- Temperature: 5~25°C
- Humidity: 60% or less
- Period: 48 hours or less after opening

**Note:** This module only allows one time reflow process. Applying more than one time reflow will cause damage.

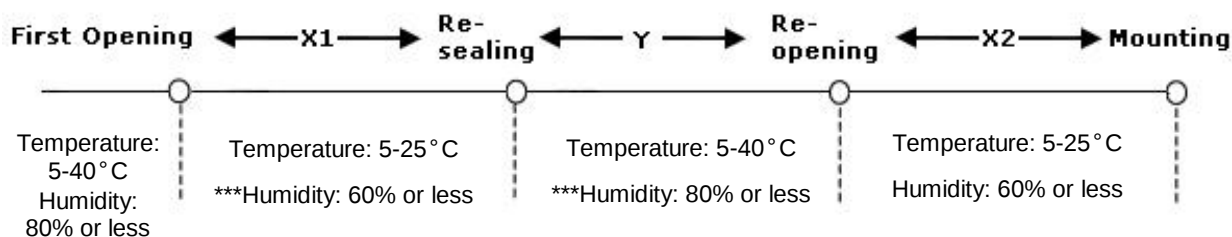
#### 11.1.3 Temporary Storage Requirements after Opening

The following are temporary storage requirements after opening:

- Put the device back to dry packing immediately when it is not used.
- Use a dry box or place desiccant (with a blue humidity indicator) with the devices and perform dry packing again using heat-sealing.

The following indicate the required storage period, temperature, and humidity for this temporary storage:

##### Storage temperature and humidity



\*\*\* - External atmosphere temperature and humidity of the dry packing

#### Storage period

- X1+X2 – Refer to [After Opening the Dry Packing](#) storage requirements. Keep is X1+X2 within 72 hours.
- Y – Two weeks or less

## 11.2 Baking Conditions

Baking conditions and processes for the 60 SOM follow the J-STD-033 standard which includes the following:

- The calculated shelf life in a sealed bag is 12 months at <40°C and <80% relative humidity.
- Once the packaging is opened, the 60 SOM must be mounted (according to **MSL4/Moisture Sensitivity Level 4**) within 72 hours at <30°C and <60% relative humidity according to IPC/JEDEC J-STD -033C.
- If the 60 SOM is not mounted within 72 hours or if, when the packaging is opened, the humidity indicator card displays >10% humidity, then the product must be baked for 48 hours at 125°C (±5°C).

## 11.3 Surface Mount Conditions

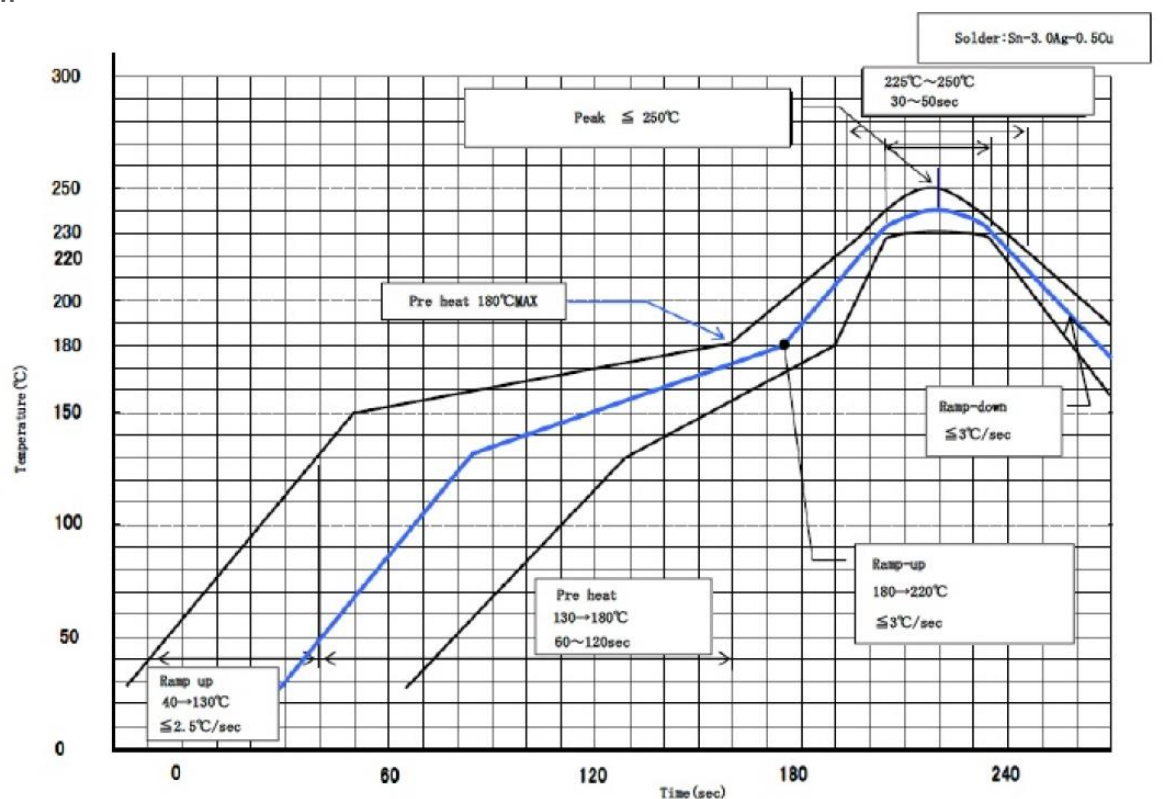
The following soldering conditions are recommended to ensure device quality. You must adjust for your platform PCB size, thickness of stencil, and the solder paste you use to get optimized solder quality.

### 11.3.1 Soldering

Convection reflows or IR/Convection reflow (one-time soldering or two-time soldering in air or nitrogen environment)

- Measuring point – IC package surface
- Temperature profile:

Pin



Ramp-up : 40 - 130 deg. Less than 2.5 deg./sec

Pre heat : 130 - 180 deg. 60 - 120 sec , 180 deg. MAX

Ramp-up : 180 - 220 deg. Less than 3 deg./sec

Peak Temperature : MAX 250 deg.

225 deg. ~ 250 deg. , 30 ~ 50 sec

Ramp-down : Less than 3 deg./sec

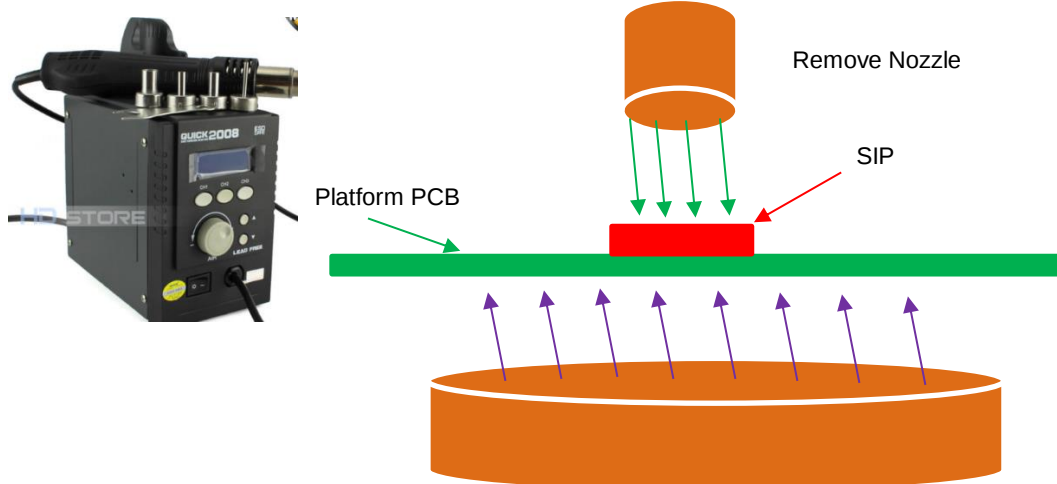
**Figure 10: Temperature profile for reference only, customer need to adjust this for their assembly condition**

### 11.3.2 Cautions on Removing the 60 SOM from the Platform for RMA

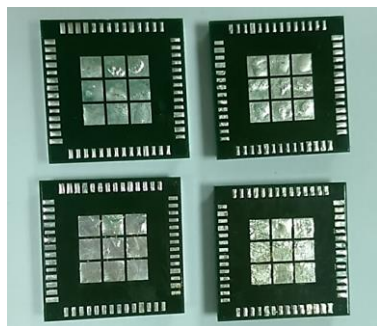
- Bake the platform before removing the Wi-Fi/BT SIP from the platform. Reference baking conditions.
- Remove the Wi-Fi/BT SIP by using a hot air gun. This process should be carried out by a skilled technician.

Suggestion conditions:

- One-side component platform:
  - Set the hot plate at 280°C.
  - Put the platform on the hot plate for 8~10 seconds.
  - Remove the SIP from platform.
- Two-side components platform:
  - Use two hot air guns
  - On the bottom side, use a pre-heated nozzle (temperature setting of 200~250°C) at a suitable distance from the platform PCB.
  - On the top side, apply a remove nozzle (temperature setting of 330°C). Heat the SIP until it can be removed from platform PCB.

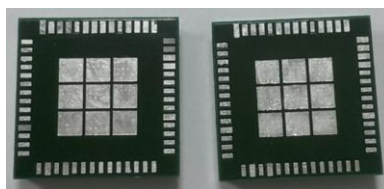


- Remove the residue solder under the bottom side of 60 SOM.



(Not accepted for RMA)

**With residue solder on the bottom**



(Accepted for RMA analysis)

**Without residue solder on the bottom**

- Remove and clean the residue flux is needed.

### 11.3.3 Precautions for Use

- Opening/handling/removing must be done on an anti-ESD treated workbench. All workers must also have undergone anti-ESD treatment.

The devices should be mounted within one year of the date of delivery.

## 12 REGULATORY

### 12.1 Certified Antennas

| Model                                 | Type            | Connector | 2400~2483.5MHz                                                                               |
|---------------------------------------|-----------------|-----------|----------------------------------------------------------------------------------------------|
|                                       |                 |           | 5150~5250MHz 5250~5350MHz<br>5470~5725MHz 5725~5850MHz                                       |
| Laird/NanoBlade-IP04                  | PCB Dipole      | IPEX U.FL | 2 dBi (2.4-2.5 GHz), 3.9 dBi (5.15-5.35 GHz),<br>4 dBi (5.6 GHz)                             |
| Laird/MAF95310 Mini NanoBlade Flex    | PCB Dipole      | IPEX U.FL | 2.79 dBi @ 2.4 GHz, 3.38 dBi @ 5 GHz                                                         |
| Ethertronics/WLAN_1000146             | Magnetic Dipole | IPEX U.FL | 2.5 dBi (2.390-2.490), 3.5 dBi (4.900-5.100),<br>3.5 dBi (5.150-5.350), 3.5 dBi (5.70-5.900) |
| LSR/FlexPIFA 001-0016                 | PIFA            | IPEX U.FL | 2.5 dBi @ 2.4 GHz, 3 dBi @ 5GHz                                                              |
| LSR/001-0009                          | Dipole          | IPEX U.FL | 2 dBi @ 2.4 GHz, 2 dBi @ 5GHz                                                                |
| FlexMIMO Antenna<br>EFD2455A3S-10MHF1 | PIFA            | IPEX U.FL | 2dBi@2.4GHz, 3dBi@5GHz                                                                       |
| LSR/001-0009 w/filter                 | Dipole          | IPEX U.FL | 2 dBi @ 2.4 GHz, 2 dBi @ 5GHz                                                                |

### 12.2 FCC and IC

| Model  | US/FCC       | CANADA/IC      |
|--------|--------------|----------------|
| 60 SOM | SQG-SU60SOMC | 3147A-SU60SOMC |

The 60 SOM is designed to pass certification with the antenna listed below. The required antenna impedance is 50 ohms.

| Model                                 | Type            | Connector | Peak gain ( dBi ) |               |               |               |               |
|---------------------------------------|-----------------|-----------|-------------------|---------------|---------------|---------------|---------------|
|                                       |                 |           | 2400~2483.5 MHz   | 5150~5250 MHz | 5250~5350 MHz | 5470~5725 MHz | 5725~5850 MHz |
| Laird/NanoBlade-IP04                  | PCB Dipole      | IPEX U.FL | 2.0 dBi           | 3.9 dBi       | 3.9 dBi       | 4.0 dBi       |               |
| Laird/MAF95310<br>Mini NanoBlade Flex | PCB Dipole      | IPEX U.FL | 2.79 dB           | 3.38 dBi      |               |               |               |
| Ethertronics/WLAN_1000146             | Magnetic Dipole | IPEX U.FL | 2.5 dBi           | 3.5 dBi       |               |               |               |
| LSR/FlexPIFA 001-0016                 | PIFA            | IPEX U.FL | 2.5 dBi           | 3.0 dBi       |               |               |               |
| LSR/001-0009                          | Dipole          | IPEX U.FL | 2.0 dBi           | 2.0 dBi       |               |               |               |
| FlexMIMO Antenna<br>EFD2455A3S-10MHF1 | PIFA            | IPEX U.FL | 2.5 dBi           | 3.0dBi        |               |               |               |
| LSR/001-0009 w/filter                 | Dipole          | IPEX U.FL | 2.0dBi            | 2.0 dBi       |               |               |               |

## 12.2.1 FCC

### **Federal Communication Commission Interference Statement**

This equipment was tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

### **FCC Caution**

Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

### **Important Note**

#### **Radiation Exposure Statement**

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with a minimum distance of 20 centimeters between the radiator and your body.

This transmitter must not be co-located or operated in conjunction with any other antenna or transmitter.

Country Code selection feature to be disabled for products marketed to the US/CANADA.

**This device is intended only for OEM integrators under the following conditions:**

1. The antenna must be installed such that 20 centimeters is maintained between the antenna and users, and
2. The transmitter module may not be co-located with any other transmitter or antenna,
3. For all products market in US, OEM must limit the operation channels in CH1 to CH11 for 2.4G band by supplied firmware programming tool. OEM shall not supply any tool or info to the end-user regarding to Regulatory Domain change.

If the conditions above are met, further transmitter test are not required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed.

### **Important Note**

In the event that these conditions cannot be met (for example, certain laptop configurations or co-location with another transmitter), then the FCC authorization is no longer considered valid and the FCC ID cannot be used on the final product. In these circumstances, the OEM integrator is responsible for re-evaluating the end product (including the transmitter) and obtaining a separate FCC authorization.

### **End Product Labeling**

This transmitter module is authorized only for use in a device where the antenna may be installed such that 20 cm may be maintained between the antenna and users. The final end product must be labeled in a visible area with the following:

**Contains FCC ID: SQG-SU60SOMC.**

### **Manual Information to the End User**

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module.

The end user manual shall include all required regulatory information/warning as show in this manual.

## 12.2.2 Industry Canada

### Industry Canada Statement

This device contains licence-exempt transmitter(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada's licence-exempt RSS(s). Operation is subject to the following two conditions:

- This device may not cause interference; and
- This device must accept any interference, including interference that may cause undesired operation of the device.

*Cet appareil contient des émetteurs / récepteurs exempts de licence qui sont conformes au (x) RSS (s) exemptés de licence d'Innovation, Sciences et Développement économique Canada. L'opération est soumise aux deux conditions suivantes:*

- *Cet appareil ne doit pas causer d'interférences*
- *Cet appareil doit accepter toute interférence, y compris les interférences pouvant provoquer un fonctionnement indésirable de l'appareil*

This radio transmitter (IC: 3147A-SU60SOMC) has been approved by Industry Canada to operate with the antenna types listed below with the maximum permissible gain indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

*Le présent émetteur radio (IC: 3147A-SU60SOMC) a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés ci dessous et ayant un gain admissible maximal. Les types d'antenne non inclus dans cette liste, et dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur.*

### Antenna Information

| Model                                         | Type            | Connector | Peak gain (dBi) |               |               |               |               |
|-----------------------------------------------|-----------------|-----------|-----------------|---------------|---------------|---------------|---------------|
|                                               |                 |           | 2400~2483.5 MHz | 5150~5250 MHz | 5250~5350 MHz | 5470~5725 MHz | 5725~5850 MHz |
| Laird/NanoBlade-IP04                          | PCB Dipole      | IPEX U.FL | 2.0 dBi         | 3.9 dBi       | 3.9 dBi       | 4.0 dBi       |               |
| Laird/MAF95310 Mini NanoBlade Flex            | PCB Dipole      | IPEX U.FL | 2.79 dB         | 3.38 dBi      |               |               |               |
| Ethertronics/WLAN_1000146                     | Magnetic Dipole | IPEX U.FL | 2.5 dBi         | 3.5 dBi       |               |               |               |
| LSR/FlexPIFA 001-0016                         | PIFA            | IPEX U.FL | 2.5 dBi         | 3.0 dBi       |               |               |               |
| LSR/001-0009                                  | Dipole          | IPEX U.FL | 2.0 dBi         | 2.0 dBi       |               |               |               |
| Laird MIMO FlexPIFA Antenna EFD2455A3S-10MHF1 | PIFA            | IPEX U.FL | 2.5 dBi         | 3.0 dBi       |               |               |               |
| LSR/001-0009 w/filter                         | Dipole          | IPEX U.F  | 2.0 dBi         | 2.0 dBi       |               |               |               |

#### Caution:

- The device for operation in the band 5150–5250 MHz is only for indoor use to reduce the potential for harmful interference to co-channel mobile satellite systems;
- for devices with detachable antenna(s), the maximum antenna gain permitted for devices in the bands 5250-5350 MHz and 5470-5725 MHz shall be such that the equipment still complies with the e.i.r.p. limit;
- for devices with detachable antenna(s), the maximum antenna gain permitted for devices in the band 5725-5850 MHz shall be such that the equipment still complies with the e.i.r.p. limits specified for point-to-point and non-point-to-point operation as appropriate; and

Operations in the 5.25-5.35GHz band are restricted to indoor usage only.

#### Avertissement:

- les dispositifs fonctionnant dans la bande de 5150 à 5250MHz sont réservés uniquement pour une utilisation à l'intérieur afin de réduire les risques de brouillage préjudiciable aux systèmes de satellites mobiles utilisant les mêmes canaux;

- (ii) pour les dispositifs munis d'antennes amovibles, le gain maximal d'antenne permis pour les dispositifs utilisant les bandes de 5250 à 5350MHz et de 5470 à 5725 MHz doit être conforme à la limite de la p.i.r.e;
- (iii) pour les dispositifs munis d'antennes amovibles, le gain maximal d'antenne permis (pour les dispositifs utilisant la bande de 5725 à 5850 MHz) doit être conforme à la limite de la p.i.r.e. spécifiée pour l'exploitation point à point et l'exploitation non point à point, selon le cas;

Les opérations dans la bande de 5.25-5.35GHz sont limités à un usage intérieur seulement.

### **Radiation Exposure Statement**

This equipment complies with Canada radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20 cm between the radiator and your body.

### **Déclaration d'exposition aux radiations**

Cet équipement est conforme Canada limites d'exposition aux radiations dans un environnement non contrôlé. Cet équipement doit être installé et utilisé à distance minimum de 20cm entre le radiateur et votre corps.

**This device is intended only for OEM integrators under the following condition:**

- The transmitter module may not be co-located with any other transmitter or antenna.

As long as the condition above is met, further transmitter test will not be required. However, the OEM integrator is still responsible for testing their end-product for any additional compliance requirements required with this module installed.

**Cet appareil est conçu uniquement pour les intégrateurs OEM dans les conditions suivantes:**

- Le module émetteur peut ne pas être coïmplanté avec un autre émetteur ou antenne.

Tant que les 1 condition ci-dessus sont remplies, des essais supplémentaires sur l'émetteur ne seront pas nécessaires. Toutefois, l'intégrateur OEM est toujours responsable des essais sur son produit final pour toutes exigences de conformité supplémentaires requis pour ce module installé.

#### **Important Note:**

In the event that these conditions cannot be met (for example certain laptop configurations or co-location with another transmitter), then the Canada authorization is no longer considered valid and the IC ID cannot be used on the final product. In these circumstances, the OEM integrator is responsible for re-evaluating the end product (including the transmitter) and obtaining a separate Canada authorization.

#### **Note Importante:**

Dans le cas où ces conditions ne peuvent être satisfaites (par exemple pour certaines configurations d'ordinateur portable ou de certaines co-localisation avec un autre émetteur), l'autorisation du Canada n'est plus considéré comme valide et l'ID IC ne peut pas être utilisé sur le produit final. Dans ces circonstances, l'intégrateur OEM sera chargé de réévaluer le produit final (y compris l'émetteur) et l'obtention d'une autorisation distincte au Canada.

### **End Product Labeling**

The final end product must be labeled in a visible area with the following: **Contains IC:** 3147A-SU60SOMC

### **Plaque signalétique du produit final**

Le produit final doit être étiqueté dans un endroit visible avec l'inscription suivante: **Contient des IC:** 3147A-SU60SOMC

### **Manual Information to the End User**

The OEM integrator has to be aware not to provide information to the end user regarding how to install or remove this RF module in the user's manual of the end product which integrates this module.

The end user manual shall include all required regulatory information/warning as show in this manual.

## Manuel d'information à l'utilisateur final

L'intégrateur OEM doit être conscient de ne pas fournir des informations à l'utilisateur final quant à la façon d'installer ou de supprimer ce module RF dans le manuel de l'utilisateur du produit final qui intègre ce module. Le manuel de l'utilisateur final doit inclure toutes les informations réglementaires requises et avertissements comme indiqué dans ce manuel.

## 12.3 European Union Regulatory

The 60 Series SOM has been tested for compliance with relevant standards for the EU market. 60 SOM module was tested with antennas listed below.

| Model                                      | Type            | Connector | 2400~2483.5MHz                                                                               |
|--------------------------------------------|-----------------|-----------|----------------------------------------------------------------------------------------------|
|                                            |                 |           | 5150~5250MHz 5250~5350MHz<br>5470~5725MHz 5725~5850MHz                                       |
| Laird/NanoBlade-IP04                       | PCB Dipole      | IPEX U.FL | 2 dBi (2.4-2.5 GHz), 3.9 dBi (5.15-5.35 GHz),<br>4 dBi (5.6 GHz)                             |
| Laird/MAF95310 Mini NanoBlade Flex         | PCB Dipole      | IPEX U.FL | 2.79 dBi @ 2.4 GHz, 3.38 dBi @ 5 GHz                                                         |
| Ethertronics/WLAN_1000146                  | Magnetic Dipole | IPEX U.FL | 2.5 dBi (2.390-2.490), 3.5 dBi (4.900-5.100),<br>3.5 dBi (5.150-5.350), 3.5 dBi (5.70-5.900) |
| LSR/FlexPIFA 001-0016                      | PIFA            | IPEX U.FL | 2.5 dBi @ 2.4GHz, 3 dBi @ 5GHz                                                               |
| LSR/001-0009                               | Dipole          | IPEX U.FL | 2 dBi @ 2.4 GHz, 2 dBi @ 5 GHz                                                               |
| MIMO FlexPIFA Antenna<br>EFD2455A3S-10MHF1 | PIFA            | IPEX U.FL | 2.5dBi@2.4GHz, 3dBi@5GHz                                                                     |
| LSR/001-0009 w/filter                      | Dipole          | IPEX U.FL | 2 dBi @2.4 GHz, 2 dBi @5GHz                                                                  |

The OEM should consult with a qualified test house before entering their device into an EU member country to make sure all regulatory requirements have been met for their complete device.

Reference the Declaration of Conformities listed below for a full list of the standards that the modules were tested to. Test reports are available upon request.

### 12.3.1 EU Declarations of Conformity

|                        |                                                                                                                                        |
|------------------------|----------------------------------------------------------------------------------------------------------------------------------------|
| Manufacturer:          | Laird                                                                                                                                  |
| Products:              | 60 SOM series                                                                                                                          |
| EU Directives:         | 1999/5/EC – R&TTE<br>2006/95/EC – Low Voltage directive (LVD)<br>2004/108/EC – Electromagnetic compatibility (EMC)<br>2014/30/EU – EMC |
| Conformity Assessment: | Annex IV                                                                                                                               |

#### Reference standards used for presumption of conformity:

| Article Number | Requirement                                                              | Reference standard(s)                    |
|----------------|--------------------------------------------------------------------------|------------------------------------------|
| 3.1a           | 2006/95/EC                                                               | EN 60950-                                |
|                | Low voltage equipment safety                                             | 1:2006+A11:2009+A1:2010+A12:2011+A2:2013 |
|                | 2006/95/EC<br>RF Exposure                                                | EN 62311:2008                            |
| 3.1b           | 2004/108/EC                                                              | EN 301 489-1 v1.9.2 (2011-09)            |
|                | Protection requirements with respect to<br>electromagnetic compatibility | EN 301 489-17 v2.2.1 (2012-09)           |
| 3.2            | 1999/5/EC                                                                | EN 300 328 v1.9.1 (2015-02)              |

Means of the efficient use of the radio  
frequency spectrum

EN 301 893 v1.8.1(2015-03)

**Declaration:**

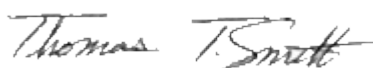
We, Laird, declare under our sole responsibility that the essential radio test suites have been carried out and that the above product to which this declaration relates is in conformity with all the applicable essential requirements of Article 3 of the EU Directive 1999/5/EC, when used for its intended purpose.

Place of Issue: Laird  
W66N220 Commerce Court, Cedarburg, WI 53012 USA  
tel: +1-262-375-4400 fax: +1-262-364-2649

Date of Issue: TBD

Name of Authorized Person: Thomas T Smith, Director of EMC Compliance

Signature of Authorized Person:



## 13 ORDERING INFORMATION

| Part Number | Description                                                      |
|-------------|------------------------------------------------------------------|
| 453-00003   | 60 Series SOM                                                    |
| 455-00003   | Development board for the 60 Series SOM                          |
| 455-00004   | LCD Touchscreen for the 60 Series SOM development board (add-on) |

### 13.1 General Comments

This is a preliminary datasheet. Please check with Laird for the latest information before commencing a design. If in doubt, ask.

|                                                                                                                  |                                                                                                                                                                                                                                      |
|------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  <b>Česky</b><br>[Czech]      | <i>[Jméno výrobce]</i> tímto prohlašuje, že tento <i>[typ zařízení]</i> je ve shodě se základními požadavky a dalšími příslušnými ustanoveními směrnice 1999/5/ES.                                                                   |
|  <b>Dansk</b><br>[Danish]     | Undertegnede <i>[fabrikantens navn]</i> erklærer herved, at følgende udstyr <i>[udstyrets typebetegnelse]</i> overholder de væsentlige krav og øvrige relevante krav i direktiv 1999/5/EF.                                           |
|  <b>Deutsch</b><br>[German]   | Hiermit erkläre <i>[Name des Herstellers]</i> , dass sich das Gerät <i>[Gerätetyp]</i> in Übereinstimmung mit den grundlegenden Anforderungen und den übrigen einschlägigen Bestimmungen der Richtlinie 1999/5/EG befindet.          |
|  <b>Eesti</b><br>[Estonian]   | Käesolevaga kinnitab <i>[tootja nimi = name of manufacturer]</i> seadme <i>[seadme tüüp = type of equipment]</i> vastavust direktiivi 1999/5/EÜ põhinõuetele ja nimetatud direktiivist tulenevatele teistele asjakohastele sätetele. |
|  <b>English</b>               | Hereby, <i>[name of manufacturer]</i> , declares that this <i>[type of equipment]</i> is in compliance with the essential requirements and other relevant provisions of Directive 1999/5/EC.                                         |
|  <b>Español</b><br>[Spanish]  | Por medio de la presente <i>[nombre del fabricante]</i> declara que el <i>[clase de equipo]</i> cumple con los requisitos esenciales y cualesquiera otras disposiciones aplicables o exigibles de la Directiva 1999/5/CE.            |
|  <b>Ελληνική</b><br>[Greek]   | ΜΕ ΤΗΝ ΠΑΡΟΥΣΑ <i>[name of manufacturer]</i> ΔΗΛΩΝΕΙ ΟΤΙ <i>[type of equipment]</i> ΣΥΜΜΟΡΦΩΝΕΤΑΙ ΠΡΟΣ ΤΙΣ ΟΥΣΙΩΔΕΙΣ ΑΠΑΙΤΗΣΕΙΣ ΚΑΙ ΤΙΣ ΛΟΙΠΕΣ ΣΧΕΤΙΚΕΣ ΔΙΑΤΑΞΕΙΣ ΤΗΣ ΟΔΗΓΙΑΣ 1999/5/ΕΚ.                                             |
|  <b>Français</b><br>[French]  | Par la présente <i>[nom du fabricant]</i> déclare que l'appareil <i>[type d'appareil]</i> est conforme aux exigences essentielles et aux autres dispositions pertinentes de la directive 1999/5/CE.                                  |
|  <b>Italiano</b><br>[Italian] | Con la presente <i>[nome del costruttore]</i> dichiara che questo <i>[tipo di apparecchio]</i> è conforme ai requisiti essenziali ed alle altre disposizioni pertinenti stabilite dalla direttiva 1999/5/CE.                         |

|                                  |                                                                                                                                                                                                                                          |
|----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Latviski</b><br>[Latvian]     | Aršo[ <i>name of manufacturer /izgatavotājanosaukums</i> ] deklarē, ka[ <i>type of equipment / iekārtas tips</i> ]atbilstDirektīvas 1999/5/EK būtiskajāmprasībām un citiemar to saistītajiemnoteikumiem.                                 |
| <b>Lietuvių</b><br>[Lithuanian]  | Šiuo [ <i>manufacturer name</i> ] deklaruoja, kad šis [ <i>equipment type</i> ] atitinka esminius reikalavimus ir kitas 1999/5/EB Direktyvos nuostatas.                                                                                  |
| <b>Nederlands</b><br>[Dutch]     | Hierbij verklaart [ <i>naam van de fabrikant</i> ] dat het toestel [ <i>type van toestel</i> ] in overeenstemming is met de essentiële eisen en de andere relevante bepalingen van richtlijn 1999/5/EG.                                  |
| <b>Malti</b><br>[Maltese]        | Hawnhekk, [ <i>isem tal-manifattur</i> ], jiddikjara li dan [ <i>il-mudel tal-prodott</i> ] jikkonforma mal-htigijiet essenzjali u ma provvedimenti oħrajn rilevanti li hemm fid-Dirrettiva 1999/5/EC.                                   |
| <b>Magyar</b><br>[Hungarian]     | Alulírott, [ <i>gyártó neve</i> ] nyilatkozom, hogy a [ <i>... típus</i> ]megfelel a vonatkozó alapvető követelményeknek és az 1999/5/EC irányelv egyéb előírásainak.                                                                    |
| <b>Polski</b><br>[Polish]        | Niniejszym [ <i>nazwa producenta</i> ] oświadczam, że [ <i>nazwa wyrobu</i> ] jest zgodny z zasadniczymi wymogami oraz pozostałymi stosownymi postanowieniami Dyrektywy 1999/5/EC.                                                       |
| <b>Português</b><br>[Portuguese] | [ <i>Nome do fabricante</i> ] declara que este [ <i>tipo de equipamento</i> ] está conforme com os requisitos essenciais e outras disposições da Directiva 1999/5/CE.                                                                    |
| <b>Slovensko</b><br>[Slovenian]  | [ <i>Ime proizvajalca</i> ] izjavlja, da je ta [ <i>tip opreme</i> ] v skladu z bistvenimi zahtevami in ostalimi relevantnimi določili direktive 1999/5/ES.                                                                              |
| <b>Slovensky</b><br>[Slovak]     | [ <i>Menovýrobcu</i> ]týmtovyhlasuje, že[ <i>typzariadenia</i> ]splňazákladnépožiadavky a všetkypríslušnéustanoveniaSmernice 1999/5/ES.                                                                                                  |
| <b>Suomi</b><br>[Finnish]        | [ <i>Valmistaja = manufacturer</i> ] vakuuttaa täten että [ <i>type of equipment = laitteen tyyppimerkintä</i> ] tyyppinen laite on direktiivin 1999/5/EY oleellisten vaatimusten ja sitä koskevien direktiivin muiden ehtojen mukainen. |
| <b>Svenska</b><br>[Swedish]      | Härmed intygar [ <i>företag</i> ] att denna [ <i>utrustningstyp</i> ] står i överensstämmelse med de väsentliga egenskapskrav och övriga relevanta bestämmelser som framgår av direktiv 1999/5/EG.                                       |

### 13.1.1 Labeling Requirements

The final end product must be labeled in a visible area with the following notice:



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