Seeed Studio BeagleBone® Green Eco

User Guide

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1. Seeed Studio BeagleBone® Green Eco Overview

1.1 Introduction

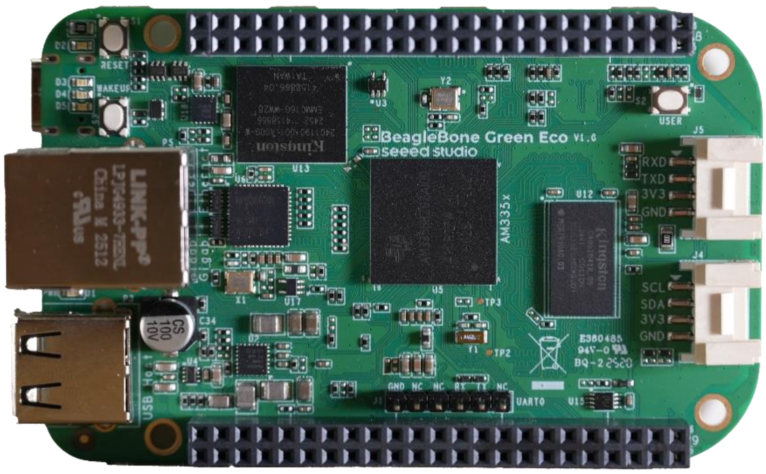


Figure 1-1. Seeed Studio BeagleBone® Green Eco

Seeed Studio BeagleBone® Green Eco is an industrial-grade open-source hardware development platform which is powered by the AM335x ARM Cortex-A8 processor. This incorporates high-quality components that support wider temperature ranges, enhanced power stability, and improved signal integrity suitable for commercial and light industrial applications. This board is part of Seeed Studio BeagleBone Green family, developed in partnership with BeagleBoard.org. It is based on the BeagleBone Black's schematic design and software.

With 16GB of onboard eMMC storage, Seeed Studio BeagleBone® Green Eco provides developers with enough space for operating systems, applications, and data storage. The platform features a high-performance Gigabit Ethernet connection, delivering high bandwidth for networking applications that require substantial data throughput or responsive device communication.

With a USB Type-C port, it offers improved durability and simplified cable management while maintaining the ability to power and program the board through a single connection. The familiar BeagleBoard.org® BeagleBone® form factor is preserved, including the two Grove connectors that simplify sensor integration and make the platform immediately accessible to developers of all experience levels.

On the software side, the Seeed Studio BeagleBone® Green is one of the BeagleBoard Compatible® boards, and it comes pre-installed with the Debian software designated by the

BeagleBoard.org® Foundation. This robust software foundation provides developers with well-established tools, libraries, and resources that significantly streamline the development process across diverse applications.

Applications:

- Commercial automation projects leveraging the industrial-grade components and extensive I/O capabilities
- Data acquisition systems utilizing the various input interfaces and high-speed networking
- IoT gateways benefiting from the expanded storage and reliable connectivity options
- Embedded control systems taking advantage of the AM335x processor's real-time processing capabilities
- Educational and prototyping environments where the combination of industrial compatibility, extensive documentation, and software support accelerates development from concept to commercial application

1.2 Kit Contents

This package includes:

- Seeed Studio BeagleBone® Green Eco * 1
- USB Type-C Cable * 1
- User Guide * 1

1.3 Hardware Specification

Seeed Studio BeagleBone® Green Eco is built around Texas Instruments' AM335x ARM Cortex-A8 processor, providing a robust foundation for diverse embedded applications. Below is the functional block diagram illustrating the primary components and interconnections that make up the hardware architecture of the board. This diagram shows how the AM335x SoC interfaces with memory, storage, peripherals, and various I/O options.

Figure 1-2. Functional Block Diagram of Seeed Studio BeagleBone® Green Eco

The comprehensive hardware specification table provides detailed information about key components and capabilities of Seeed Studio BeagleBone® Green Eco. This industrial-grade development platform offers significant processing power, generous memory, extensive I/O options, and modern connectivity features suitable for commercial and educational applications.

Table 1-1. Seeed Studio BeagleBone® Green Eco specification

Category	***Item***	*Specification*
Processor	Core	TI AM335x 1GHz ARM® Cortex-A8
	Accelerators	NEON floating-point unit & 3D graphics accelerator
Memory	RAM	512MB DDR3L, 800MHz
	Flash Storage	16GB eMMC
	EEPRPM	32Kbit
	External Storage	microSD card slot, supports up to 32GB
Power	Power Management	TI TPS6521403 PMIC
	Voltage Regulators	TI TPS62A01DRL (3.3V Buck converter) TPS2117DRL (Power Mux)
	Input Voltage	5V DC (via USB Type-C&Cape headers)
	Operating Current	Max 614mA
Interfaces	USB	1x USB 2.0 Host Type-A port for connecting peripherals (keyboard, mouse, WiFi adapter, etc.) 1x USB 2.0 Type-C for power and device communication
	Network	Gigabit Ethernet (10/100/1000Mbps)
	Expansion Headers	4x UART, 2x I2C, 1x SPI, 13x GPIO
	Grove	1x I2C, 1x UART
	Buttons	1x Reset button, 1x Wake up button, 1x User button
	Indicators	1x power LED, 4x user-programmable LEDs
Physical	Dimensions	86.4mm x 53.3mm x 18mm
	Weight	39.3g
	Operating Temperature	-40~85℃

2. Hardware

Seeed Studio BeagleBone® Green Eco incorporates a high-performance, low-power system architecture based on the AM335x system-on-chip (SoC). This section presents detailed specifications of all hardware subsystems, including processor specifications, memory configuration, power management circuitry, and interface peripherals. The technical parameters documented herein establish operating conditions, electrical characteristics, and functional capabilities of the device.

2.1 Board Overview

Seeed Studio BeagleBone® Green Eco implements a compact form factor layout with integrated components as depicted in the following diagrams. Key functional blocks are identified in Figures 2-1 and 2-2, illustrating top and bottom PCB views respectively.

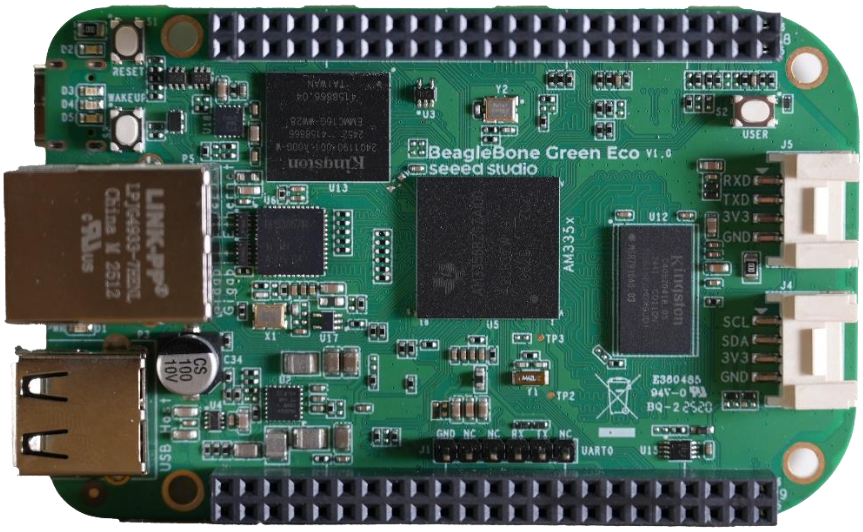


Figure 2-1. Seeed Studio BeagleBone® Green Eco

2.2 Key Features

Seeed Studio BeagleBone® Green Eco offers an optimized design approach while maintaining full compatibility with the BeagleBoard.org® BeagleBone® ecosystem. Utilizing industrial-grade components, increased storage capacity, faster networking, and modern connectivity options, it delivers reliable performance for both development projects and production deployments. The 4-layer PCB design provides a reference implementation that balances signal integrity and manufacturing requirements while maintaining essential functionality. This engineering approach, combined with an efficient power management system, ensures dependable operation across diverse applications. The familiar expansion interfaces preserve compatibility with existing hardware and software solutions, facilitating seamless integration between platforms without requiring significant redesign of peripheral hardware or application code.

2.2.1 Processor

Seeed Studio BeagleBone® Green Eco integrates the Texas Instruments AM335x 1GHz ARM® Cortex-A8 processor that combines computational processing, graphics acceleration, and real-time control functionality within a single SoC. The architecture implements ARMv7-A with NEON™ SIMD engine and VFPv3 floating-point unit for efficient execution of complex computational tasks, while maintaining power efficiency for embedded applications.

A distinctive feature is the Programmable Real-time Unit Subsystem and Industrial Communication Subsystem (PRU-ICSS), comprising dual 32-bit RISC cores operating independently from the main ARM processor. These PRUs enable deterministic real-time control with sub-microsecond response times and implementation of specialized industrial communication protocols. The AM335x supports high-level operating systems including Linux and real-time operating systems through TI's Processor SDK and development environments.

- AM335x 1GHz ARM® Cortex-A8 processor, 15.0mm x 15.0mm, NFBGA (324)
- NEON™ SIMD coprocessor and VFPv3 floating-point unit for accelerated media and signal processing
- PowerVR SGX™ Graphics Accelerator supporting OpenGL ES 2.0
- Dual 32-bit PRU-ICSS for real-time industrial communications and control
- Support for industrial interfaces including EtherCAT, PROFINET, and PROFIBUS

2.2.2 Memory and Storage

Seeed Studio BeagleBone® Green Eco includes:

- 1x 512MB (4Gb) DDR3L RAM (Kingston D2516ECMDXGJDI-U) with 16-bit interface
- 1x 16GB eMMC onboard flash storage (Kingston EMMC16G-WW28) with MMC1 8-bit interface
- 1x 32Kbit EEPROM (FMD FT24C32A-ELRT) connected via I2C0
- MicroSD card slot with MMC0 4-bit interface for expandable storage

2.2.3 Interfaces and Peripherals

Seeed Studio BeagleBone® Green Eco supports:

- Gigabit Ethernet connectivity
- USB Host port for connecting external devices
- USB 2.0 Type-C port for power and communications
- 1x USB 2.0 Host Interface, Type-A

2.2.4 Expansion Connectors / Headers to Support Application Specific Capes

- 2.5.9.1 Grove I2C Interface (J4)
- 1x 6-pins UART0 headers
- Two Grove connectors (One I2C and One UART) for easy connection to the Grove ecosystem of sensors and actuators

2.3 Power Requirements

Seeed Studio BeagleBone® Green Eco powered through its USB Type-C connector or the P9 expansion header which serves as both a power input and communications interface. The board requires a 5V power supply.

The board utilizes the TPS65214 Power Management IC (PMIC), an industrial-grade solution engineered for exceptional efficiency and reliability. This advanced PMIC delivers comprehensive power management through a single, highly integrated device, complementing the board's industrial operating temperature range of -40°C to +85°C.

2.3.1 Integrated Power Architecture

At the heart of the TPS65214 are three high-performance buck converters designed to deliver clean, stable power with minimal losses. The primary converter supplies up to 2A with precision voltage control from 0.6V to 3.4V, while two additional 1A converters provide flexible power options for various system components. This configuration enables Seeed Studio BeagleBone® Green Eco to efficiently power core processors, memory, and peripheral systems from a single source.

These converters feature an intelligent power management system that automatically transitions between forced-PWM mode for noise-sensitive applications and pulse-frequency-modulation (PFM) for light-load efficiency. Operating at a 2.3MHz switching frequency, the converters maintain stable output while requiring minimal external components - typically just a 470nH inductor and output capacitance starting at just 10μF.

For analog and sensitive components, the PMIC includes two low-dropout regulators offering 300mA and 500mA capacity with voltage ranges from 0.6V to 3.3V. These regulators can be configured either as traditional LDOs for minimal noise or as load switches for maximum efficiency, providing the flexibility to optimize between performance and power consumption based on application requirements.

2.3.2 Advanced Power Management Features

The TPS65214 incorporates a sophisticated system management architecture that enhances both reliability and flexibility. The programmable power sequencing controller allows complete customization of startup and shutdown sequences with eight configurable time slots and durations ranging from 0ms to 10ms. This precise control ensures proper initialization of complex systems and prevents problems associated with improper power sequencing.

The device's comprehensive protection system continuously monitors for undervoltage, overcurrent, and short-circuit conditions across all power rails. Thermal protection with multiple threshold levels prevents damage during extreme operating conditions. When potential issues are detected, the configurable fault response system can either trigger immediate shutdown, notify the host processor, or take pre-programmed corrective actions.

System designers benefit from a flexible I2C interface that provides complete control over all power parameters. The interface supports standard, fast, and fast-plus modes, enabling integration with virtually any host processor. Dynamic voltage scaling allows real-time adjustment of output voltages during operation, enabling sophisticated power optimization strategies that significantly extend battery life in portable applications.

Multi-function pins provide additional flexibility, allowing the PMIC to be configured for various system architectures. These include configurable GPIO pins that can sequence external power devices, push button input for system control, and reset/interrupt outputs for processor coordination.

The TPS65214's non-volatile memory configuration ensures that system parameters are preserved across power cycles, while the ability to program custom settings provides flexibility for diverse application requirements. This combination of advanced features and robust design makes Seeed Studio BeagleBone® Green Eco's power system exceptionally capable, reliable, and efficient across a wide range of operating conditions.

2.4 Header Pin Definition

Expansion headers provide extensive I/O capabilities.

2.4.1 Cape Expansion Headers

Each digital I/O pin has 8 different modes that can be selected, including GPIO.

P9

DGND	1	2	DGND
VDD_3V3B	3	4	VDD_3V3
VDD_5V	5	6	VDD_5V
SYS_5V	7	8	SYS_5V
PWR_BUT	9	10	SYS_RESETn
UART4_RXD	11	12	GPIO1_28
UART4_TXD	13	14	EHRPWM1A
GPIO1_16	15	16	EHRPWM1B
I2C1_SCL	17	18	I2C1_SDA
I2C2_SCL	19	20	I2C2_SDA
UART2_TXD	21	22	UART2_RXD
GPIO1_17	23	24	UART1_TXD
GPIO3_21	25	26	UART1_RXD
GPIO3_19	27	28	SPI1_CS0
SPI1_D0	29	30	SPI1_D1
SPI1_SCLK	31	32	VDD_ADC
AIN4	33	34	GNDA_ADC
AIN6	35	36	AIN5
AIN2	37	38	AIN3
AIN0	39	40	AIN1
CLKOUT2	41	42	GPIO0_7
DGND	43	44	GPIO0_8
DGND	45	46	GPIO0_9

LEGEND
POWER/GROUND/RESET
AVAILABLE DIGITAL
AVAILABLE PWM
SHARED I2C BUS
RECONFIGURABLE DIGITAL
ANALOG INPUTS (1.8V)

P8

DGND	1	2	DGND
MMC1_DAT6	3	4	MMC1_DAT7
MMC1_DAT2	5	6	MMC1_DAT3
TIMER4	7	8	TIMER7
TIMER5	9	10	TIMER6
GPIO1_13	11	12	GPIO1_12
EHRPWM2B	13	14	GPIO1_26
GPIO1_15	15	16	GPIO1_14
GPIO1_27	17	18	GPIO2_1
EHRPWM2A	19	20	MMC1_CMD
MMC1_CLK	21	22	MMC1_DAT5
MMC1_DAT4	23	24	MMC1_DAT1
MMC1_DAT0	25	26	GPIO1_29
LCD_VSYNC	27	28	LCD_PCLK
LCD_HSYNC	29	30	LCD_DE
LCD_DATA14	31	32	LCD_DATA15
LCD_DATA13	33	34	LCD_DATA11
LCD_DATA12	35	36	LCD_DATA10
LCD_DATA8	37	38	LCD_DATA9
LCD_DATA6	39	40	LCD_DATA7
LCD_DATA4	41	42	LCD_DATA5
LCD_DATA2	43	44	LCD_DATA3
LCD_DATA0	45	46	LCD_DATA1

Figure 2-2. Expansion Header Pinout Diagram

2.4.2 65 Possible Digital I/Os

In GPIO mode, each digital I/O can produce interrupts.

P9			
DGND	1	2	DGND
VDD_3V3	3	4	VDD_3V3
VDD_5V	5	6	VDD_5V
SYS_5V	7	8	SYS_5V
PWR_BUT	9	10	SYS_RESETN
GPIO0_30	11	12	GPIO1_28
GPIO0_31	13	14	GPIO1_18
GPIO1_16 GPIO2_0	15	16	GPIO1_19
GPIO0_5	17	18	GPIO0_4
GPIO0_13	19	20	GPIO0_12
GPIO0_3	21	22	GPIO0_2
GPIO1_17	23	24	GPIO0__15
GPIO3_21	25	26	GPIO0_14
GPIO3_19	27	28	GPIO3_17
GPIO3_15	29	30	GPIO3_16
GPIO3_14	31	32	VDD_ADC
AIN4	33	34	GNDA_ADC
AIN6	35	36	AIN5
AIN2	37	38	AIN3
AIN0	39	40	AIN1
GPIO0_20 GPIO3_20	41	42	GPIO0_7 GPIO3_18
DGND	43	44	DGND
DGND	45	46	DGND

P8			
DGND	1	2	DGND
GPIO1_6	3	4	GPIO1_7
GPIO1_2	5	6	GPIO1_3
GPIO2_2	7	8	GPIO2_3
GPIO2_5	9	10	GPIO2_4
GPIO1_13	11	12	GPIO1_12
GPIO0_23	13	14	GPIO0_26
GPIO1_15	15	16	GPIO1_14
GPIO0_27	17	18	GPIO2_1
GPIO0_22	19	20	GPIO1_31
GPIO1_31	21	22	GPIO1_5
GPIO1_4	23	24	GPIO1_1
GPIO1_0	25	26	GPIO1_29
GPIO2_22	27	28	GPIO2_24
GPIO2_23	29	30	GPIO2_25
GPIO0_10	31	32	GPIO0_11
GPIO0_9	33	34	GPIO2_17
GPIO0_8	35	36	GPIO2_16
GPIO2_14	37	38	GPIO2_15
GPIO2_12	39	40	GPIO2_13
GPIO2_10	41	42	GPIO2_11
GPIO2_8	43	44	GPIO2_9
GPIO2_6	45	46	GPIO2_7

Figure 2-3. 65 Possible Digital I/O Pinout Diagram

2.4.3 PWMs and Timers

Up to 8 digital I/O pins can be configured with pulse-width modulators (PWM) to produce signals to control motors or create pseudo analog voltage levels, without taking up any extra CPU cycles.

P9			
DGND	1	2	DGND
VDD_3V3	3	4	VDD_3V3
VDD_5V	5	6	VDD_5V
SYS_5V	7	8	SYS_5V
PWR_BUT	9	10	SYS_RESETn
UART4_RXD	11	12	GPIO1_28
UART4_TXD	13	14	EHRPWM1A
GPIO1_16	15	16	EHRPWM1B
I2C1_SCL	17	18	I2C1_SDA
I2C2_SCL	19	20	I2C2_SDA
UART2_TXD	21	22	UART2_RXD
GPIO1_17	23	24	UART1_TXD
GPIO3_21	25	26	UART1_RXD
GPIO3_19	27	28	SPI1_CS0
SPI1_D0	29	30	SPI1_D1
SPI1_SCLK	31	32	VDD_ADC
AIN4	33	34	GNDA_ADC
AIN6	35	36	AIN5
AIN2	37	38	AIN3
AIN0	39	40	AIN1
GPIO_20	41	42	GPIO0_7
DGND	43	44	GPIO0_8
DGND	45	46	GPIO0_9

P8			
DGND	1	2	DGND
GPIO1_6	3	4	GPIO1_7
GPIO1_2	5	6	GPIO1_3
TIMER4	7	8	TIMER7
TIMER5	9	10	TIMER6
GPIO1_13	11	12	GPIO1_12
EHRPWM2B	13	14	GPIO0_26
GPIO1_15	15	16	GPIO1_14
GPIO0_27	17	18	GPIO2_1
EHRPWM2A	19	20	GPIO1_31
GPIO1_31	21	22	GPIO1_5
GPIO1_4	23	24	GPIO1_1
GPIO1_0	25	26	GPIO1_29
GPIO2_22	27	28	GPIO2_24
GPIO2_23	29	30	GPIO2_25
GPIO0_10	31	32	GPIO0_11
GPIO0_9	33	34	GPIO2_17
GPIO0_8	35	36	GPIO2_16
GPIO2_14	37	38	GPIO2_15
GPIO2_12	39	40	GPIO2_13
GPIO2_10	41	42	GPIO2_11
GPIO2_8	43	44	GPIO2_9
GPIO2_6	45	46	GPIO2_7

Figure 2-4. PWMs and Timers Pinout Diagram

2.4.4 Analog Inputs

Make sure you don't input more than 1.8V to the analog input pins. This is a single 12-bit analog-to-digital converter with 8 channels, 7 of which are made available on the headers.

P9			
DGND	1	2	DGND
VDD_3V3	3	4	VDD_3V3
VDD_5V	5	6	VDD_5V
SYS_5V	7	8	SYS_5V
PWR_BUT	9	10	SYS_RESETn
UART4_RXD	11	12	GPIO1_28
UART4_TXD	13	14	EHRPWM1A
GPIO1_16	15	16	EHRPWM1B
I2C1_SCL	17	18	I2C1_SDA
I2C2_SCL	19	20	I2C2_SDA
UART2_TXD	21	22	UART2_RXD
GPIO1_17	23	24	UART1_TXD
GPIO3_21	25	26	UART1_RXD
GPIO3_19	27	28	SPI1_CS0
SPI1_D0	29	30	SPI1_D1
SPI1_SCLK	31	32	VDD_ADC
AIN4	33	34	GNDA_ADC
AIN6	35	36	AIN5
AIN2	37	38	AIN3
AIN0	39	40	AIN1
GPIO_20	41	42	GPIO0_7
DGND	43	44	GPIO0_8
DGND	45	46	GPIO0_9

P8			
DGND	1	2	DGND
MMC1_DAT6	3	4	MMC1_DAT7
MMC1_DAT2	5	6	MMC1_DAT3
TIMER4	7	8	TIMER7
TIMER5	9	10	TIMER6
GPIO1_13	11	12	GPIO1_12
EHRPWM2B	13	14	GPIO1_26
GPIO1_15	15	16	GPIO1_14
GPIO1_27	17	18	GPIO2_1
EHRPWM2A	19	20	MMC1_CMD
MMC1_CLK	21	22	MMC1_DAT5
MMC1_DAT4	23	24	MMC1_DAT1
MMC1_DAT0	25	26	GPIO1_29
LCD_VSYNC	27	28	LCD_PCLK
LCD_HSYNC	29	30	LCD_DE
LCD_DATA14	31	32	LCD_DATA15
LCD_DATA13	33	34	LCD_DATA11
LCD_DATA12	35	36	LCD_DATA10
LCD_DATA8	37	38	LCD_DATA9
LCD_DATA6	39	40	LCD_DATA7
LCD_DATA4	41	42	LCD_DATA5
LCD_DATA2	43	44	LCD_DATA3
LCD_DATA0	45	46	LCD_DATA1

Figure 2-5. Analog Inputs Pinout Diagram

2.4.5 UART

There is a dedicated header for getting to the UART0 pins and connecting a debug cable. Five additional serial ports are brought to the expansion headers, but one of them only has a single direction to the headers.

P9			
DGND	1	2	DGND
VDD_3V3	3	4	VDD_3V3
VDD_5V	5	6	VDD_5V
SYS_5V	7	8	SYS_5V
PWR_BUT	9	10	SYS_RESETn
UART4_RXD	11	12	GPIO1_28
UART4_TXD	13	14	EHRPWM1A
GPIO1_16	15	16	EHRPWM1B
I2C1_SCL	17	18	I2C1_SDA
I2C2_SCL	19	20	I2C2_SDA
UART2_TXD	21	22	UART2_RXD
GPIO1_17	23	24	UART1_TXD
GPIO3_21	25	26	UART1_RXD
GPIO3_19	27	28	SPI1_CS0
SPI1_D0	29	30	SPI1_D1
SPI1_SCLK	31	32	VDD_ADC
AIN4	33	34	GNDA_ADC
AIN6	35	36	AIN5
AIN2	37	38	AIN3
AIN0	39	40	AIN1
GPIO_20	41	42	GPIO0_7
DGND	43	44	GPIO0_8
DGND	45	46	GPIO0_9

P8			
DGND	1	2	DGND
MMC1_DAT6	3	4	MMC1_DAT7
MMC1_DAT2	5	6	MMC1_DAT3
TIMER4	7	8	TIMER7
TIMER5	9	10	TIMER6
GPIO1_13	11	12	GPIO1_12
EHRPWM2B	13	14	GPIO1_26
GPIO1_15	15	16	GPIO1_14
GPIO1_27	17	18	GPIO2_1
EHRPWM2A	19	20	MMC1_CMD
MMC1_CLK	21	22	MMC1_DAT5
MMC1_DAT4	23	24	MMC1_DAT1
MMC1_DAT0	25	26	GPIO1_29
LCD_VSYNC	27	28	LCD_PCLK
LCD_HSYNC	29	30	LCD_DE
LCD_DATA14	31	32	LCD_DATA15
LCD_DATA13	33	34	LCD_DATA11
LCD_DATA12	35	36	LCD_DATA10
LCD_DATA8	37	38	LCD_DATA9
LCD_DATA6	39	40	LCD_DATA7
LCD_DATA4	41	42	LCD_DATA5
LCD_DATA2	43	44	LCD_DATA3
LCD_DATA0	45	46	LCD_DATA1

Figure 2-6. UART Pinout Diagram

2.4.6 I2C

The first I2C bus is utilized for reading EEPROMS on cape add-on boards and can't be used for other digital I/O operations without interfering with that function can still use it to add other I2C devices at available addresses. The second I2C bus is available for you to configure and use.

P9			
DGND	1	2	DGND
VDD_3V3B	3	4	VDD_3V3
VDD_5V	5	6	VDD_5V
SYS_5V	7	8	SYS_5V
PWR_BUT	9	10	SYS_RESETn
UART4_RXD	11	12	GPIO1_28
UART4_TXD	13	14	EHRPWM1A
GPIO1_16	15	16	EHRPWM1B
I2C1_SCL	17	18	I2C1_SDA
I2C2_SCL	19	20	I2C2_SDA
UART2_TXD	21	22	UART2_RXD
GPIO1_17	23	24	UART1_TXD
GPIO3_21	25	26	UART1_RXD
GPIO3_19	27	28	SPI1_CS0
SPI1_D0	29	30	SPI1_D1
SPI1_SCLK	31	32	VDD_ADC
AIN4	33	34	GNDA_ADC
AIN6	35	36	AIN5
AIN2	37	38	AIN3
AIN0	39	40	AIN1
CLKOUT2	41	42	GPIO0_7
DGND	43	44	GPIO0_8
DGND	45	46	GPIO0_9

P8			
DGND	1	2	DGND
MMC1_DAT6	3	4	MMC1_DAT7
MMC1_DAT2	5	6	MMC1_DAT3
TIMER4	7	8	TIMER7
TIMER5	9	10	TIMER6
GPIO1_13	11	12	GPIO1_12
EHRPWM2B	13	14	GPIO1_26
GPIO1_15	15	16	GPIO1_14
GPIO1_27	17	18	GPIO2_1
EHRPWM2A	19	20	MMC1_CMD
MMC1_CLK	21	22	MMC1_DAT5
MMC1_DAT4	23	24	MMC1_DAT1
MMC1_DAT0	25	26	GPIO1_29
LCD_VSYNC	27	28	LCD_PCLK
LCD_HSYNC	29	30	LCD_DE
LCD_DATA14	31	32	LCD_DATA15
LCD_DATA13	33	34	LCD_DATA11
LCD_DATA12	35	36	LCD_DATA10
LCD_DATA8	37	38	LCD_DATA9
LCD_DATA6	39	40	LCD_DATA7
LCD_DATA4	41	42	LCD_DATA5
LCD_DATA2	43	44	LCD_DATA3
LCD_DATA0	45	46	LCD_DATA1

Figure 2-7. I2C Pinout Diagram

2.4.7 SPI

For shifting out data fast, you might consider using one of the SPI ports.

P9			
DGND	1	2	DGND
VDD_3V3B	3	4	VDD_3V3
VDD_5V	5	6	VDD_5V
SYS_5V	7	8	SYS_5V
PWR_BUT	9	10	SYS_RESETn
UART4_RXD	11	12	GPIO1_28
UART4_TXD	13	14	EHRPWM1A
GPIO1_16	15	16	EHRPWM1B
I2C1_SCL	17	18	I2C1_SDA
I2C2_SCL	19	20	I2C2_SDA
UART2_TXD	21	22	UART2_RXD
GPIO1_17	23	24	UART1_TXD
GPIO3_21	25	26	UART1_RXD
GPIO3_19	27	28	SPI1_CS0
SPI1_D0	29	30	SPI1_D1
SPI1_SCLK	31	32	VDD_ADC
AIN4	33	34	GNDA_ADC
AIN6	35	36	AIN5
AIN2	37	38	AIN3
AIN0	39	40	AIN1
CLKOUT2	41	42	GPIO0_7
DGND	43	44	GPIO0_8
DGND	45	46	GPIO0_9

P8			
DGND	1	2	DGND
MMC1_DAT6	3	4	MMC1_DAT7
MMC1_DAT2	5	6	MMC1_DAT3
TIMER4	7	8	TIMER7
TIMER5	9	10	TIMER6
GPIO1_13	11	12	GPIO1_12
EHRPWM2B	13	14	GPIO1_26
GPIO1_15	15	16	GPIO1_14
GPIO1_27	17	18	GPIO2_1
EHRPWM2A	19	20	MMC1_CMD
MMC1_CLK	21	22	MMC1_DAT5
MMC1_DAT4	23	24	MMC1_DAT1
MMC1_DAT0	25	26	GPIO1_29
LCD_VSYNC	27	28	LCD_PCLK
LCD_HSYNC	29	30	LCD_DE
LCD_DATA14	31	32	LCD_DATA15
LCD_DATA13	33	34	LCD_DATA11
LCD_DATA12	35	36	LCD_DATA10
LCD_DATA8	37	38	LCD_DATA9
LCD_DATA6	39	40	LCD_DATA7
LCD_DATA4	41	42	LCD_DATA5
LCD_DATA2	43	44	LCD_DATA3
LCD_DATA0	45	46	LCD_DATA1

Figure 2-8. SPI Pinout Diagram

2.5 Detailed Hardware Design

The following sections provide an overview of the different interfaces and circuits on Seeed Studio BeagleBone® Green Eco. Table 2-1 shows the interface mapping for Seeed Studio BeagleBone® Green Eco.

2.5.1 USB Interface

2.5.1.1 USB 2.0 Type-A Interface

Seeed Studio BeagleBone® Green Eco features a USB 2.0 Type-A Host port that allows connection of various USB peripherals. USB 2.0 Data lines DP and DM from the Type-A connector are connected to the USB1 interface of the AM335x SoC to provide USB high-speed/full-speed communication. The port supports data rates up to 480Mbps.

The Type-A connector can provide 5V power to connected USB devices. A current-limiting circuit protects the board from excessive current draw from peripherals.

2.5.1.2 USB 2.0 Type-C Interface

Seeed Studio BeagleBone® Green Eco employs a USB 2.0 Type-C connector that serves dual purposes as both a data communication interface and the primary power input for the board. The USB Type-C port is connected to the USB0 interface of the AM335x SoC.

The USB Type-C port functions as a USB device (peripheral) interface, allowing Seeed Studio BeagleBone® Green Eco to connect to a host computer for programming, debugging, and serial console access. This connection also provides 5V power to the board.

USB 2.0 Data lines DP and DM from the Type-C connector are equipped with common mode chokes for EMI/EMC reduction and ESD protection components to dissipate any transient voltages. The USB_5V power from this connector is routed through the TPS2117DRL power multiplexer IC, which selects between power sources when multiple sources are connected.

2.5.2 Ethernet Interface

Seeed Studio BeagleBone® Green Eco provides a 10/100/1000 Mbps Ethernet interface for network connectivity, terminated with an RJ45 connector. This interface allows direct connection to local networks through standard Ethernet cables.

The Ethernet port features integrated link and activity indicator LEDs - a green LED showing established link status and a yellow LED indicating active network traffic. These visual indicators help users quickly determine network connection status.

The interface supports standard network protocols and services, including DHCP for automatic IP address acquisition and static IP configuration. The board's Ethernet implementation is compatible with common networking tools and utilities found in Linux distributions.

For developers, the Ethernet interface can be accessed through standard Linux networking commands and APIs. The processor's Common Platform Ethernet Switch (CPSW) subsystem provides efficient packet processing, enabling reliable network performance for various applications.

The Ethernet port supports Wake-on-LAN functionality, allowing remote power management when properly configured in the operating system. This feature can be useful for headless applications where remote access is needed without physical interaction.

When connecting to networks, standard CAT5e or better Ethernet cables are recommended for optimal performance, particularly when utilizing the gigabit capabilities of the interface.

2.5.3 Power Supply Interface

Seeed Studio BeagleBone® Green Eco features a flexible power management architecture centered on the TPS65214 PMIC. The board is powered through the USB Type-C connector using a standard 5V USB power adapter or host computer.

The core power management is handled by the TPS65214 PMIC (specifically the PTPS6521403VAFR variant in a QFN-24 package), which generates multiple regulated voltage rails required by the AM335x processor. Buck1 (2A capacity) supplies 1.1V for the processor core (VDD_MPU), Buck2 (1A capacity) provides 1.1V for digital logic (VDD_CORE), and Buck3 (1A capacity) delivers 1.5V for DDR memory (VDDS_DDR).

Two integrated LDOs complement the switching regulators: LDO1 (300mA) supplies 1.8V for the various analog domains, while LDO2 (500mA) is dedicated to powering the VDDS pins.

The power design includes comprehensive protection features integrated within the

TPS65214, including overcurrent protection, thermal shutdown, and short-circuit protection to ensure reliable operation in various environments.

For RTC functionality, the board supports "RTC, No RTC Only Mode," which is the default configuration. The configuration is implemented through resistors R175 and R4 as indicated in the design notes, with specific caution against installing both resistors simultaneously to prevent potential damage to the AM335x processor.

2.5.4 DDR3L SDRAM Interface

Seeed Studio BeagleBone® Green Eco incorporates 512MB of DDR3L SDRAM (Kingston D2516ECMDXGJDI-U), providing the main system memory for applications and operating system functions. The memory communicates with the AM335x processor through a 16-bit data bus operating at speeds up to 800 MT/s.

DDR3L technology operates at 1.35V (compared to 1.5V for standard DDR3), improving energy efficiency while maintaining performance. This makes the board suitable for both battery-powered and continuously-powered applications.

The memory interface includes data lines (D0-D15), address lines (A0-A15), bank address lines (BA0-BA2), and control signals (CLK, CKE, CS, RAS, CAS, WE) connected directly to the processor. The interface also features differential data strobe signals (DQS0/DQS0N and DQS1/DQS1N) to ensure accurate data transfer timing, particularly at high speeds.

For system development and debugging, all memory address and data lines are accessible through test points on the board. During normal operation, the memory automatically enters self-refresh mode when the system enters low-power states, helping to conserve energy while preserving data.

The DDR3L memory is completely managed by the AM335x processor, and developers typically don't need to interact with it directly as the operating system and software development tools handle memory management automatically.

2.5.5 eMMC Flash Interface

Seeed Studio BeagleBone® Green Eco incorporates a 16GB Kingston EMMC16G-WW28 eMMC storage device, providing non-volatile memory for the operating system and user data. The eMMC connects to the AM335x processor through an 8-bit data bus and operates at speeds up to 52MHz in high-speed mode.

This embedded storage serves as the primary boot device and storage medium for the board, holding the operating system, application software, and user files. The eMMC interface uses a direct connection scheme with command, clock, and data lines routed to the processor with series resistors to control signal integrity at higher transfer speeds.

The eMMC storage is powered by the 3.3V supply rail and includes a comprehensive decoupling capacitor network to ensure stable operation during intensive read/write operations. A hardware reset signal allows the processor to initialize the eMMC device during boot sequences, with a pull-up resistor maintaining a known state during power-up.

The eMMC appears to the operating system as a standard block storage device, similar to a hard drive or SSD. This enables developers to use standard file systems and storage access methods without specific knowledge of the underlying storage technology. For users requiring additional storage space, the board also supports microSD cards through a dedicated connector.

The use of eMMC technology provides several advantages over raw NAND flash, including built-in wear leveling, bad block management, and error correction, resulting in improved reliability and longer service life for the storage system.

2.5.6 Micro SD Card Slot Interface

Seeed Studio BeagleBone® Green Eco includes a standard micro SD card slot (P10), providing users with expandable storage options and an alternative boot source. The card slot supports SD and SDHC cards up to 32GB, with SDXC cards also compatible when appropriately formatted.

The micro SD interface connects to the AM335x processor through the MMC0 controller, utilizing a 4-bit data bus (SD_DAT0 through SD_DAT3) that allows for transfer rates up to 24MB/s. The interface includes command (SD_CMD) and clock (SD_CLK) lines required for SD protocol communication, with series resistors to maintain signal integrity.

A card detect switch (SD_CD) allows the system to sense when a card is inserted or removed, enabling hot-plug functionality. This detection mechanism permits the operating system to automatically mount or safely unmount the SD card when physical changes occur.

The SD card interface is powered by the 3.3V rail. Pull-up resistors on the data and command lines maintain proper signal levels according to the SD card specification.

For embedded applications, the micro SD slot provides several key advantages:

- Alternative boot source when the on-board eMMC needs reprogramming
- Easy data exchange between the BeagleBoard.org® and other systems
- Storage expansion for applications requiring additional space
- System recovery option in case of software corruption on the primary eMMC

To boot from the micro SD card rather than the on-board eMMC, users can press the BOOT button while applying power to the board, which forces the AM335x processor to prioritize the SD card in its boot sequence.

2.5.7 Grove Connector Interfaces

Seeed Studio BeagleBone® Green Eco features two Grove connectors (J4 and J5), strategically integrated to leverage Seeed Studio's extensive Grove ecosystem of sensors, actuators, and modules. These standardized 4-pin interfaces provide a plug-and-play solution for rapidly prototyping and developing embedded systems without complex wiring or soldering.

Figure 2-16. Seeed Studio's extensive Grove ecosystem

2.5.7.1 Grove I2C Interface (J4)

The J4 connector provides a dedicated I2C interface operating at 3.3V logic levels. This Grove port connects directly to the AM335x processor's I2C2 bus (I2C2_SCL and I2C2_SDA),with unpopulated footprints for optional 4.7k pull-up resistorsensuring reliable communication with a wide range of I2C modules.

This interface supports numerous Grove I2C modules from the Seeed ecosystem. Compatible devices include environmental sensors for measuring temperature, humidity, and pressure; motion and position sensors such as accelerometers and gyroscopes; display modules including OLED and LCD screens; and various interface adapters and port expanders. The standardized connection format eliminates the need for complex wiring or breadboards when prototyping with these components.

2.5.7.2 Grove UART Interface (J5)

The J5 connector provides a UART (Universal Asynchronous Receiver/Transmitter) interface, connecting to the AM335x processor's UART2 port. This Grove port enables easy integration with serial communication modules operating at 3.3V logic levels.

Common Grove UART modules compatible with this interface include wireless communication modules for Bluetooth, WiFi, and LoRa connectivity; GPS/GNSS receivers for location-based applications; RFID readers for identification and access control; and specialized sensor modules that utilize serial interfaces. This connectivity option extends the board's capabilities into numerous communication domains with minimal integration effort.

Supplementary Materials

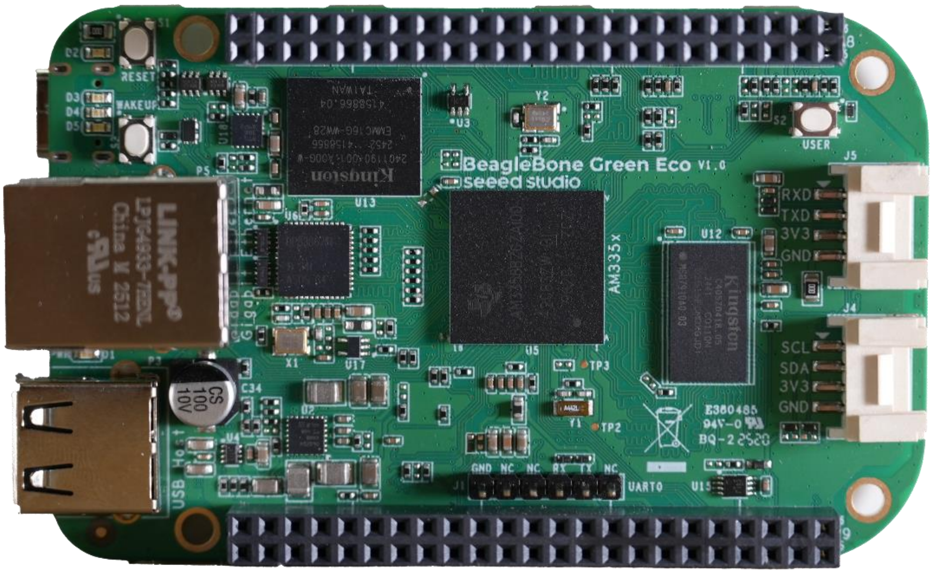
Known Hardware or Software Issues

Information not available at time of release.

Brand Uses approval

Seeed Studio BeagleBone® Green Eco board is a compatible board of the BeagleBoard.org BeagleBone that is **licensed by BeagleBoard.org® . See https://www.beagleboard.org/partner-program for more information.**

Board photos



Kit List

Seeed Studio BeagleBone® Green Eco x1

USB Type-C Cable x1

User Guide x1

Compliance

TBD

REACH/ROHS

TBD

EMC

TBD

Thermal image of board while running a standard Software use case

TBD

UL E-file number for this board

E469716

FCC Requirement

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

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

Note:

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.