

GENERAL DESCRIPTION

The SGM41603 is an efficient 2:1 bidirectional switched-capacitor converter with integrated power switches. It can deliver 10A in forward direction (2:1 voltage divider) and 5A in the reverse direction (1:2 voltage doubler). This device allows using a 2S Li+ power source as a 1S Li+ solution by inserting it between the 2S battery pack and charger output, and saves the existing 1S power architecture that is powered from the same battery.

This 2-phase high switching frequency (1.5MHz, MAX) and inductor-less topology allow low profile design with small footprint. The high switching frequency also reduces the size and quantity of the required capacitors. Safe operation is assured by over-voltage, under-voltage, over-current and thermal protections. Interference is also minimized by the built-in frequency dithering option. This device can achieve 98.5% efficiency which is the highest in its class. Thermal management of such a low loss device is simple, which makes it an ideal choice for industrial, consumer, and medical applications.

The I²C interface allows flexible parameter settings including OCP, OVLO, switching frequency thresholds and soft-start currents and durations. The SGM41603 is available in a Green WLCSP-2.85×2.59-42B package.

APPLICATIONS

Smartphones, Tablets, Ultrabooks
 Chromebooks, DSLR and Mirrorless Cameras
 Power Banks, 2S Li+ Battery Applications
 Smartphone Direct Charging, Portable Printers
 Portable Gaming Devices, Two-Way Radios

FEATURES

- **Bidirectional Switched Capacitor Converter**
 - ♦ Forward Direction 2:1 Conversion, Reverse Direction 1:2 Conversion
- **2-Phase Interleaved Operation (90° or 180°)**
- **8 Integrated N-Type MOSFET Switches**
- **10A Output Current Capability**
- **98.5% Peak Efficiency**
- **Low I_Q Current: 40μA Forward Operating**
- **6.7μA Shutdown Current**
- **I²C Interface with Interrupt Signaling**
- **Adjustable Soft-Start Current and Timeout**
- **0.25MHz to 1.5MHz Adjustable Switching Frequency**
- **Low EMI with Switching Frequency Dithering**
- **Enable Input**
- **Out-of-Audio Option at Light Load**
- **Power Good Output**
- **Programmable V1X & V2X Over-Voltage Lockout**
- **Separate OCP Adjustment for Each Direction**
- **Thermal Alarm and Protection**
- **Available in a Green WLCSP-2.85×2.59-42B Package**

TYPICAL APPLICATION

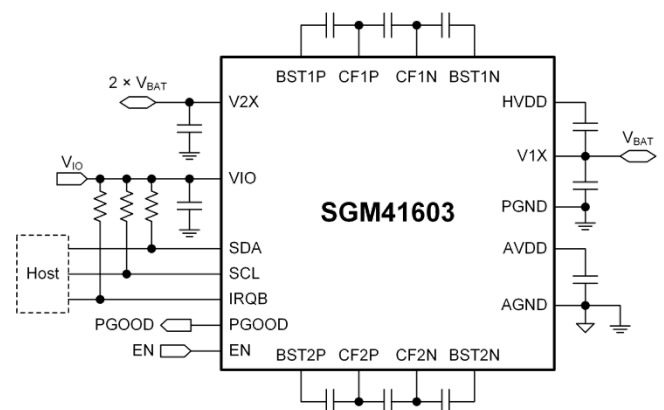


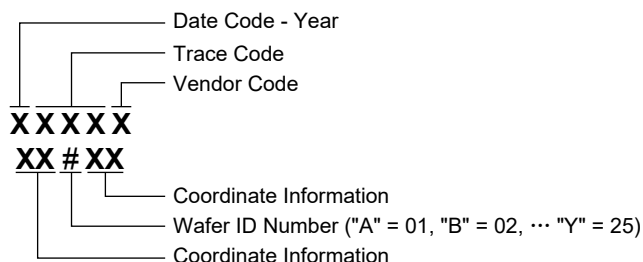
Figure 1. Typical Application Circuit

PACKAGE/ORDERING INFORMATION

| MODEL | PACKAGE DESCRIPTION | SPECIFIED TEMPERATURE RANGE | ORDERING NUMBER | PACKAGE MARKING | PACKING OPTION |
|----------|---------------------|-----------------------------|-----------------|------------------------|---------------------|
| SGM41603 | WLCSP-2.85×2.59-42B | -40°C to +85°C | SGM41603YG/TR | 064 XXXXXX XX#XX | Tape and Reel, 5000 |

MARKING INFORMATION

NOTE: XXXXX = Date Code, Trace Code and Vendor Code. XX#XX = Coordinate Information and Wafer ID Number.



Green (RoHS & HSF): SG Micro Corp defines "Green" to mean Pb-Free (RoHS compatible) and free of halogen substances. If you have additional comments or questions, please contact your SGMICRO representative directly.

ABSOLUTE MAXIMUM RATINGS

| | |
|--|------------------------------------|
| V2X to PGND | -0.3V to 16V |
| BSTxP to PGND | -0.3V to 16V |
| BSTxN to PGND | -0.3V to 8V |
| BSTxP to CFxP | -0.3V to 6V |
| BSTxN to CFxN | -0.3V to 6V |
| CFxP to PGND | -0.3V to (V _{V1X} + 6V) |
| CFxN, V1X to PGND | -0.3V to 6V |
| PGND to AGND | -0.3V to 0.3V |
| HVDD to AGND | -0.3V to (V _{V1X} + 6V) |
| AVDD, NC, IRQB, VIO to AGND | -0.3V to 6V |
| EN to AGND | -0.3V to 16V |
| SDA, SCL to AGND | -0.3V to (V _{VIO} + 0.3V) |
| PGOOD to AGND | -0.3V to 2.0V |
| V1X Continuous RMS Current (From V2X to V1X) | 10A |
| Package Thermal Resistance | |
| WLCSP-2.85×2.59-42B, θ_{JA} | 62°C/W |
| WLCSP-2.85×2.59-42B, θ_{JB} | 15.5°C/W |
| WLCSP-2.85×2.59-42B, θ_{JC} | 25.6°C/W |
| Junction Temperature | +150°C |
| Storage Temperature Range | -65°C to +150°C |
| Lead Temperature (Soldering, 10s) | +260°C |
| ESD Susceptibility | |
| HBM | 2000V |
| CDM | 1000V |

RECOMMENDED OPERATING CONDITIONS

| | |
|---|--------------|
| V2X | 5V to 11V |
| V1X | 2.8V to 5.5V |
| I _{V1X} (Voltage Divider Mode) | 0A to 10A |
| I _{V2X} (Voltage Doubler Mode) | 0A to 5A |

| | |
|--------------------------------|-----------------|
| (BST1P - CF1P), (BST1N - CF1N) | 0V to 5V |
| (CF1P - V1X), CF1N | 0V to 5.5V |
| (BST2P - CF2P), (BST2N - CF2N) | 0V to 5V |
| (CF2P - V1X), CF2N | 0V to 5.5V |
| AVDD, (HVDD - V1X), VIO, EN | 0V to 5V |
| PGOOD | 0V to 1.8V |
| SDA, SCL, IRQB | 0V to 5V |
| Junction Temperature Range | -40°C to +125°C |

OVERSTRESS CAUTION

Stresses beyond those listed in Absolute Maximum Ratings may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect reliability. Functional operation of the device at any conditions beyond those indicated in the Recommended Operating Conditions section is not implied.

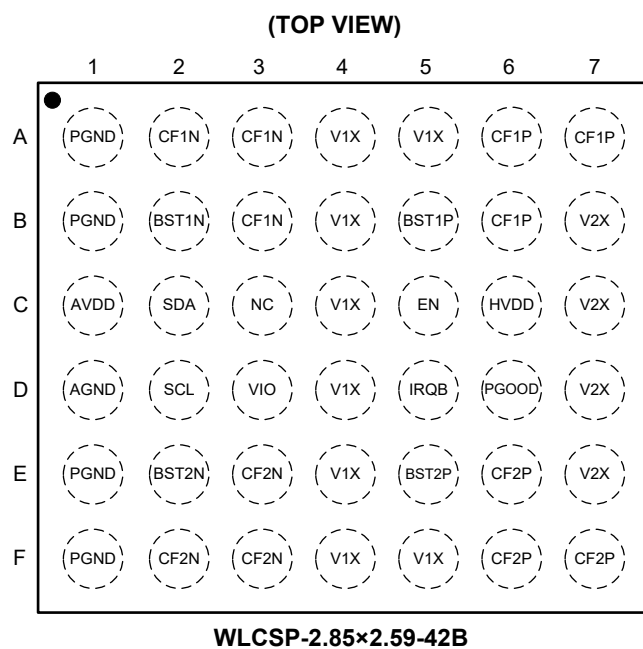
ESD SENSITIVITY CAUTION

This integrated circuit can be damaged if ESD protections are not considered carefully. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because even small parametric changes could cause the device not to meet the published specifications.

DISCLAIMER

SG Micro Corp reserves the right to make any change in circuit design, or specifications without prior notice.

PIN CONFIGURATION



PIN DESCRIPTION

| PIN | NAME | TYPE ⁽¹⁾ | FUNCTION |
|--------------------------------|-------|---------------------|--|
| A1, B1, E1, F1 | PGND | P | Power Ground. |
| A2, A3, B3 | CF1N | P | Flying Cap Phase 1 Negative Node. Connect at least two parallel 47μF capacitors between CF1P and CF1N pins as close as possible to these pins. |
| A4, A5, B4, C4, D4, E4, F4, F5 | V1X | P | Lower Voltage (1X) Power Port. It is an input in forward mode and an output in reverse mode. A 22μF capacitor is recommended between V1X and PGND. |
| A6, A7, B6 | CF1P | P | Flying Cap Phase 1 Positive Node. Connect at least two parallel 47μF capacitors between CF1P and CF1N pins as close as possible to these pins. |
| B2 | BST1N | P | Bootstrap Capacitor Connection for Q _{CL1} Gate Driver Supply. Place a 47nF or larger ceramic capacitor between this pin and CF1N. |
| B5 | BST1P | P | Bootstrap Capacitor Connection for Q _{CH1} Gate Driver Supply. Place a 47nF or larger ceramic capacitor between this pin and CF1P. |
| B7, C7, D7, E7 | V2X | P | Higher Voltage (2X) Power Port. It is an input in forward and an output in reverse direction. A 22μF capacitor is recommended between V2X and PGND. |
| C1 | AVDD | AO | 5V LDO Output. Decouple AVDD to AGND with at least 1μF high quality ceramic capacitor (X5R or better). Do not connect any external load to AVDD. |
| C2 | SDA | DIO | I ² C Interface Data Line. |
| C3 | NC | – | No Connection. Leave this pin open. |
| C5 | EN | DI | Active High Device Enable Input. |
| C6 | HVDD | AO | (V _{V1X} + 5V) LDO Output. Decouple HVDD to V1X with at least 1μF high quality ceramic capacitor (X5R or better). Do not connect any external load to HVDD. |
| D1 | AGND | P | Analog Ground. |
| D2 | SCL | DI | I ² C Interface Clock Line. |
| D3 | VIO | P | Input Voltage Supply for I/O Circuits. Bypass this pin to AGND with at least 1μF high quality ceramic capacitor (X5R or better). |
| D5 | IRQB | DO | Open-Drain Active Low Interrupt Output. Pull it up with a 100kΩ resistor to VIO. A low on IRQB indicates a fault condition. |
| D6 | PGOOD | DO | Power Good Output. |
| E2 | BST2N | P | Bootstrap Capacitor Connection for Q _{CL2} Gate Driver Supply. Place a 47nF or larger ceramic capacitor between this pin and CF2N. |
| E3, F2, F3 | CF2N | P | Flying Cap Phase 2 Negative Node. Connect at least two parallel 47μF capacitors between CF2P and CF2N pins as close as possible to these pins. |
| E5 | BST2P | P | Bootstrap Capacitor Connection for Q _{CH2} Gate Driver Supply. Place a 47nF or larger ceramic capacitor between this pin and CF2P. |
| E6, F6, F7 | CF2P | P | Flying Cap Phase 2 Positive Node. Connect at least two parallel 47μF capacitors between CF2P and CF2N pins as close as possible to these pins. |

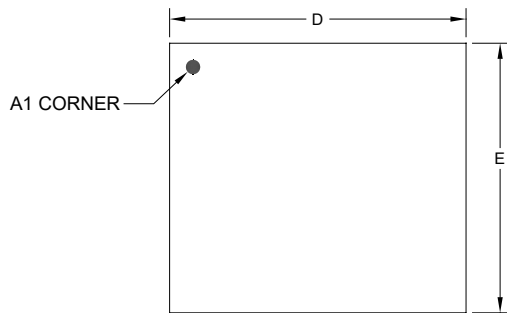
NOTE:

1. P = Power, AI = Analog Input, AO = Analog Output, AIO = Analog Input/Output, DI = Digital Input, DO = Digital Output, DIO = Digital Input/Output.

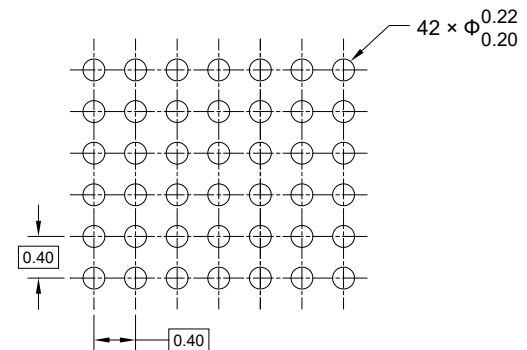
PACKAGE INFORMATION

PACKAGE OUTLINE DIMENSIONS

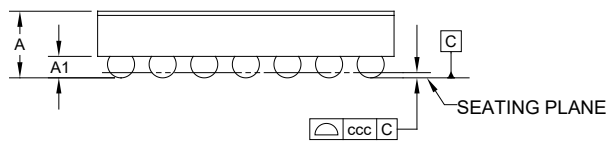
WLCSP-2.85×2.59-42B



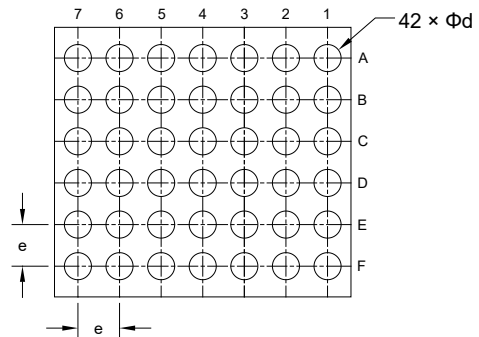
TOP VIEW



RECOMMENDED LAND PATTERN (Unit: mm)



SIDE VIEW



BOTTOM VIEW

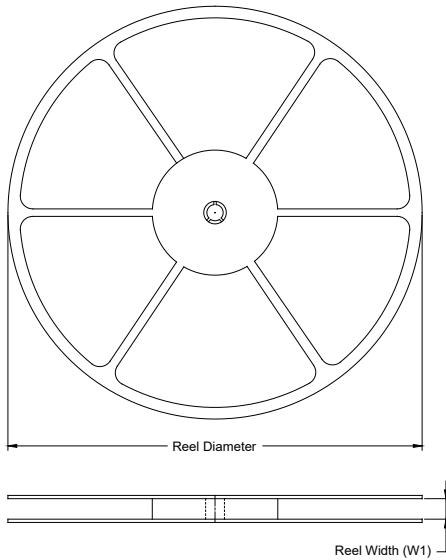
| Symbol | Dimensions In Millimeters | | |
|--------|---------------------------|-------|-------|
| | MIN | NOM | MAX |
| A | 0.602 | 0.640 | 0.678 |
| A1 | 0.186 | 0.206 | 0.226 |
| D | 2.823 | 2.853 | 2.883 |
| E | 2.563 | 2.593 | 2.623 |
| d | 0.240 | 0.260 | 0.280 |
| e | 0.400 BSC | | |
| ccc | - | 0.050 | - |

NOTE: This drawing is subject to change without notice.

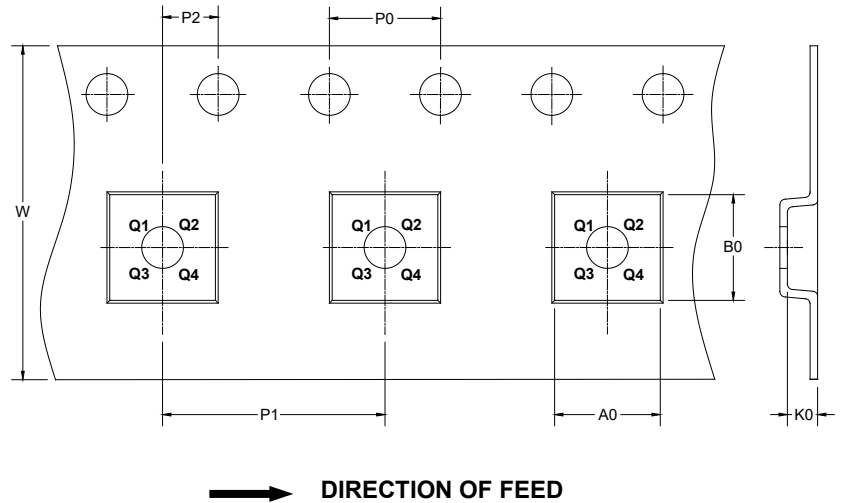
PACKAGE INFORMATION

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



NOTE: The picture is only for reference. Please make the object as the standard.

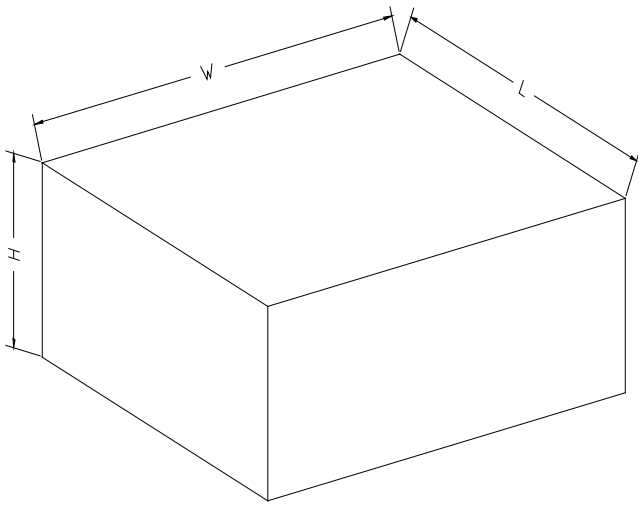
KEY PARAMETER LIST OF TAPE AND REEL

| Package Type | Reel Diameter | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P0 (mm) | P1 (mm) | P2 (mm) | W (mm) | Pin1 Quadrant |
|---------------------|---------------|--------------------|---------|---------|---------|---------|---------|---------|--------|---------------|
| WLCSP-2.85×2.59-42B | 13" | 12.4 | 2.70 | 3.00 | 0.80 | 4.0 | 8.0 | 2.0 | 12.0 | Q2 |

DD0001

PACKAGE INFORMATION

CARTON BOX DIMENSIONS



NOTE: The picture is only for reference. Please make the object as the standard.

KEY PARAMETER LIST OF CARTON BOX

| Reel Type | Length (mm) | Width (mm) | Height (mm) | Pizza/Carton |
|-----------|-------------|------------|-------------|--------------|
| 13" | 386 | 280 | 370 | 5 |

DD0002