

High Efficiency Fast Response, 8A, 24V Input Synchronous Buck Converter

General Description

The SY83088A is a high efficiency synchronous buck converter operating over a wide input voltage range of 4V to 24V and capable of delivering up to 8A current. It integrates low $R_{DS(ON)}$ top and bottom MOSFETs to minimize the conduction loss. It operates at a pseudo-constant frequency of 600kHz, to enable the use of small size inductor and capacitors. The SY83088A also integrates a bypass switch which allows the VCC to be powered by external 3.3V power supply, further reduce the power consumption of the entire system.

Silergy's constant on-time and ripple-based control strategy supports high input/output voltage ratios (low duty cycles), and fast transient response while maintaining a near constant operating frequency over line, load and output voltage ranges. This control method provides stable operation without complex compensation, including when using low ESR output ceramic capacitors.

The SY83088A provides cycle-by-cycle current limit, input under voltage lockout, internal soft-start, output under voltage protection, over voltage protection and over temperature protection, to guarantee safe operation in all operating conditions.

Features

- Low $R_{DS(ON)}$ for Internal MOSFETs: 20mΩ Top, 10mΩ Bottom
- Wide Input Voltage Range: 4V ~ 24V
- Adjustable Output Voltage: 0.6V ~ 12.5V
- Large Duty Cycle On-Time Stretch
- 8A Continuous Output Current Capability
- 600kHz Pseudo-Constant Frequency
- $\pm 1\%$ Internal Reference Voltage
- Internal 1ms Soft-Start Limits the Inrush Current
- Constant On-Time and Ripple-Based Control to Achieve Fast Transient Responses
- Integrated 1.5Ω Bypass Switch
- PFM/FCCM Selectable Light Load Operation Mode
- Power Good Indicator
- Output Auto-Discharge Function
- Programmable Valley Current Limit Threshold by ILMT Pin
- Cycle-by-Cycle Valley and Peak Current Limit Protection
- Hic-Cup Mode Output Under Voltage Protection
- Auto-Recovery Mode Output Over Voltage Protection
- Auto-Recovery Mode Over Temperature Protection
- Input Under Voltage Lockout (UVLO)
- RoHS Compliant and Halogen Free
- Compact Package: QFN2.5x2.5-16

Applications

- LCD-TV/Net-TV/3D-TV
- Set Top Box
- Notebook
- High Power AP

Typical Application

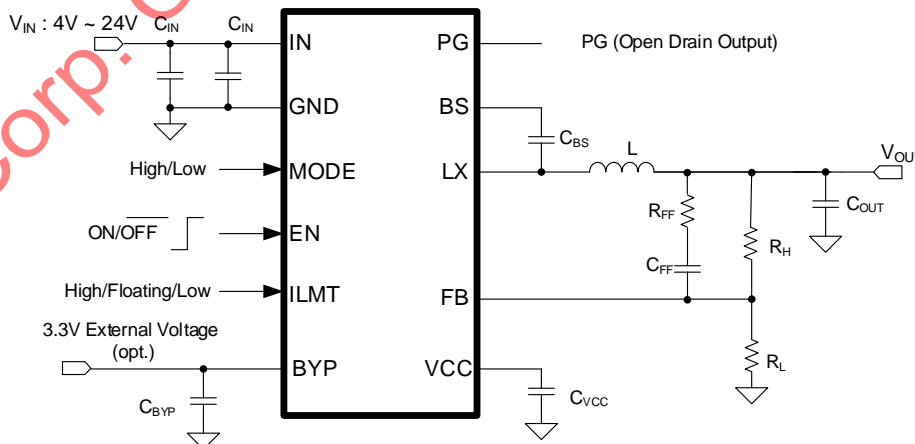


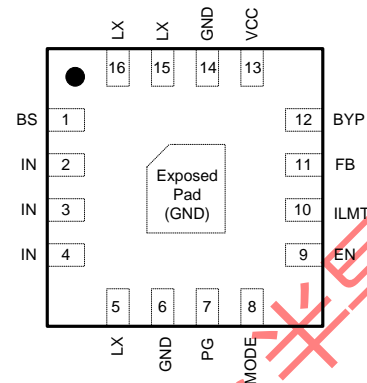
Figure 1. Schematic Diagram

Ordering Information

| Ordering Number | Package type | Top Mark |
|-----------------|--|----------|
| SY83088ARHC | QFN2.5x2.5-16 RoHS Compliant and Halogen Free | GBBxyz |

x = year code, y = week code, z = lot number code

Pinout (top view)



Pin Description

| Pin No | Pin Name | Pin Description |
|-----------|----------|---|
| 1 | BS | Bootstrap pin. Supply top MOSFET gate driver. Connect a 0.1μF ceramic capacitor between the BS pin and the LX pin. |
| 2, 3, 4 | IN | Input pin. Decouple this pin to the GND with at least a 10μF ceramic capacitor. A 0.1μF ceramic capacitor placed in parallel is recommended to reduce high frequency noise. |
| 5, 15, 16 | LX | Inductor pin. Connect this pin to the switching node of the inductor. |
| 6, 14, EP | GND | Ground pin. |
| 7 | PG | Power good indicator pin. PG pin should be connected to V _{IN} or another voltage source through a resistor (e.g., 10kΩ ~ 100kΩ). This pin becomes high when the output voltage is within 90% to 120% of regulated value under normal operation. |
| 8 | MODE | Light load operation mode selection pin. Pull this pin low for PFM operation and pull this pin high for FCCM operation. Do not leave this pin floating. |
| 9 | EN | Enable control pin of the device. Pull high to turn on. Pull low to turn off. Do not leave this pin floating. |
| 10 | ILMT | Valley current limit threshold selection pin. See Table1 to find more details. |
| 11 | FB | Output feedback pin. Connect this pin to the center point of the output resistor divider as shown in Figure 1. $V_{OUT} = 0.6 \times (1 + R_H/R_L)$. |
| 12 | BYP | External 3.3V bypass power supply input pin. Decouple this pin to ground with a 1μF ceramic capacitor. Make one good RC filter for BYP input if the 3.3V external power ripple is large. Leave this pin floating or connect this pin to the ground if it is not used. |
| 13 | VCC | Internal 3.3V LDO output pin. Power supply for internal analog circuits. Decouple this pin to GND with at least a 2.2μF ceramic capacitor. |

Block Diagram

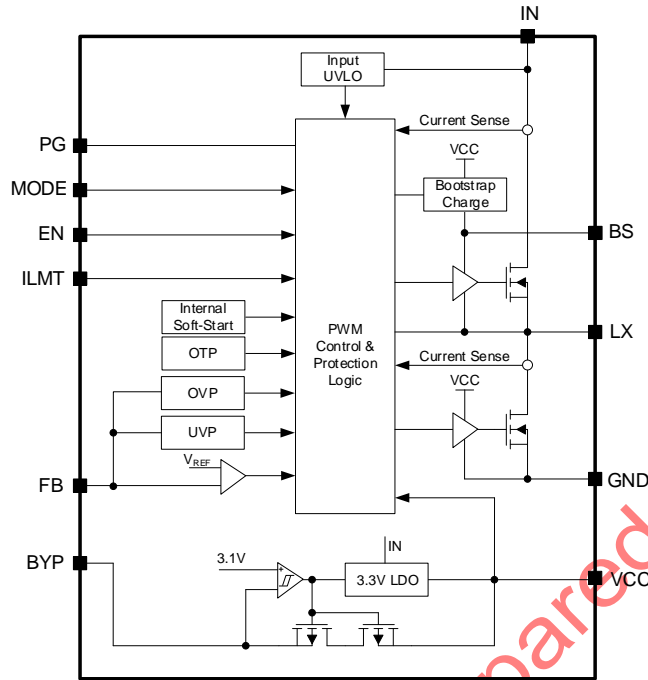


Figure3. Block Diagram

Absolute Maximum Ratings

| Parameter (Note1) | Min | Max | Unit |
|------------------------------------|---------|----------|------|
| IN | -0.3 | 26 | V |
| IN-LX, LX, PG, EN, MODE | -0.3 | IN + 0.3 | |
| BS-LX, ILMT, VCC | -0.3 | 4 | |
| FB, BYP | -0.3 | 6 | |
| LX, 10ns Duration | GND - 5 | IN + 3 | |
| LX, 20ns Duration | GND - 1 | IN + 2 | |
| Junction Temperature, Operating | -40 | 150 | °C |
| Lead Temperature (Soldering, 10s.) | | 260 | |
| Storage Temperature | -65 | 150 | |

Thermal Information

| Parameter (Note2) | Typ | Unit |
|--|-----|------|
| θ_{JA} Junction-to-Ambient Thermal Resistance | 33 | °C/W |
| θ_{JC} Junction-to-Case Thermal Resistance | 5.5 | |
| P_D Power Dissipation $T_A = 25^\circ\text{C}$ | 3 | W |

Recommended Operating Conditions

| Parameter (Note3) | Min | Max | Unit |
|---------------------------|-----|------|------|
| Input Voltage | 4 | 24 | V |
| Output Voltage | 0.6 | 12.5 | |
| Continuous Output Current | | 8 | A |
| Ambient Temperature | -40 | 85 | °C |
| Junction Temperature | -40 | 125 | |

Electrical Characteristics

 (V_{IN} = 12V, C_{OUT} = 66μF, C_{FF} = 220pF, R_{FF} = 1kΩ, T_J = 25°C, I_{OUT} = 1A unless otherwise specified (note4))

| Parameter | | Symbol | Test Conditions | Min | Typ | Max | Unit |
|---|---------------------------------------|-------------------------|--|-------|-------|-----------------|-------------------|
| Input | Voltage Range | V _{IN} | | 4 | | 24 | V |
| | UVLO Rising Threshold | V _{IN,UVLO} | V _{IN} rising | | | 3.9 | |
| | UVLO Hysteresis | V _{IN,HYS} | | | 0.3 | | |
| | Quiescent Current | I _Q | PFM, EN = High, V _{OUT} = V _{SET} × 105% | | 160 | | μA |
| | Shutdown Current | I _{SHDN} | EN = Low | | 4 | -9 | |
| Output | Voltage Range | V _{OUT} | | 0.6 | | 12.5 | V |
| | Feedback Reference Voltage | V _{REF} | | 0.594 | 0.600 | 0.606 | |
| | FB Input Current | I _{FB} | V _{FB} = 1V | -50 | | 50 | nA |
| | Discharge Current | I _{DIS} | V _{OUT} = 5V | | 100 | | mA |
| | Soft-Start Time | t _{SS} | V _{FB} from 0% to 100% V _{REF} (Note5) | | 1 | | ms |
| | OVP Threshold | V _{OVP} | V _{FB} rising | 115 | 120 | 125 | %V _{REF} |
| | OVP Hysteresis | V _{OVP,HYS} | | | 5 | | |
| | OVP Delay Time | t _{OVP,DLY} | (Note5) | | 30 | | μs |
| | UVP Threshold | V _{UVP} | V _{FB} falling | 55 | 60 | 65 | %V _{REF} |
| | UVP Delay Time | t _{UVP,DLY} | (Note5) | | 200 | | μs |
| MOSFETs | Top MOSFET R _{DS(ON)} | R _{DS(ON),TOP} | | | 20 | | mΩ |
| | Bottom MOSFET R _{DS(ON)} | R _{DS(ON),BOT} | | | 10 | | |
| | Top MOSFET Current Limit Threshold | I _{LMT,TOP} | | | 22 | | A |
| | Bottom MOSFET Current Limit Threshold | I _{LMT,BOT} | ILMT = Low | 8 | | | |
| | | | ILMT = Floating | 12 | | | |
| Bottom MOSFET Reverse Current Limit Threshold | I _{LMT,RVS} | FCCM mode | 3 | 4.8 | | | |
| Enable (EN) | Input Voltage High | V _{EN,H} | | 1 | | | V |
| | Input Voltage Low | V _{EN,L} | | | | 0.4 | |
| | Input Current | I _{EN} | V _{EN} = 3.3V | | | 1 | μA |
| | De-Glitch Time | t _{EN,DG} | (Note5) | | 40 | | μs |
| MODE | Voltage for PFM Mode | V _{MODE,PFM} | | 0 | | 0.4 | V |
| | Voltage for FCCM Mode | V _{MODE,FCCM} | | 1 | | V _{IN} | |
| | Input Current | I _{MODE} | V _{MODE} = 3.3V | | | 1 | μA |
| ILMT | Input Voltage High | V _{ILMT,H} | (Note5) | 2.5 | | | V |
| | Input Voltage Low | V _{ILMT,L} | (Note5) | | | 0.4 | |
| Frequency | Switching Frequency | f _{SW} | V _{OUT} = 5V, CCM | 510 | 600 | 690 | kHz |
| | Minimum On-Time | t _{ON,MIN} | | | 50 | | ns |
| | Minimum Off-Time | t _{OFF,MIN} | | | 150 | | |

| Parameter | | Symbol | Test Conditions | Min | Typ | Max | Unit |
|-----------------|------------------------|-----------------------------|-----------------------------|------|------|------|--------------|
| Power Good (PG) | Rising Threshold | $V_{PG,R}$ | V_{FB} rising (good) | 87 | 90 | 93 | % V_{REF} |
| | Falling Threshold | $V_{PG,F}$ | V_{FB} falling (not good) | 80 | 83 | 86 | |
| | Delay Time | $t_{PG,R}$ | Low to high (Note5) | | 200 | | μ s |
| | | $t_{PG,F}$ | High to low (Note5) | | 30 | | |
| | | $t_{PG,OFF}$ | IC shuts down (Note5) | | | 0.5 | |
| Low Voltage | $V_{PG,LOW}$ | $V_{FB} = 0V, I_{PG} = 5mA$ | | | 0.45 | V | |
| VCC | Output Voltage | V_{CC} | VCC adds 1mA load | 3.15 | 3.3 | 3.45 | V |
| BYP | $R_{DS(ON)}$ | $R_{DS(ON),BYP}$ | | | 1.5 | | Ω |
| | Turn On Voltage | V_{BYP} | | 2.97 | 3.1 | | V |
| | Turn On Hysteresis | $V_{BYP,HYS}$ | | | 0.2 | | V |
| | OVP Voltage | $V_{BYP,OVP}$ | | | 120 | | % V_{CC} |
| OTP | Temperature | T_{OTP} | T_J rising (Note5) | | 150 | | $^{\circ}$ C |
| | Temperature Hysteresis | T_{HYS} | T_J falling (Note5) | | 15 | | |

Note 1: Stresses beyond the “Absolute Maximum Ratings” may cause permanent damage to the device. These are stress ratings only. Functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability

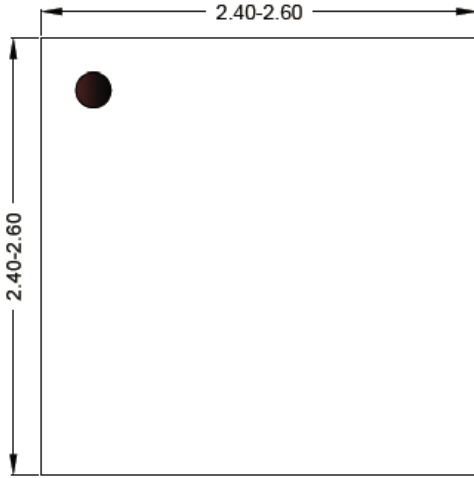
Note 2: Package thermal resistance is measured in the natural convection at $T_A = 25^{\circ}$ C on a 8.5cm \times 8.5cm size, four-layer Silergy Evaluation Board with 2-oz copper.

Note 3: The device is not guaranteed to function outside its operating conditions.

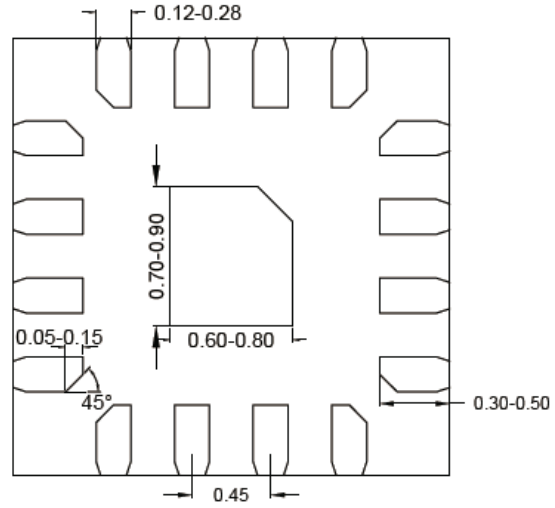
Note 4: Unless otherwise stated, limits are 100% production tested under pulsed load conditions such that $T_A \cong T_J = 25^{\circ}$ C. Limits over the operating temperature range (See recommended operating conditions) and relevant voltage range(s) are guaranteed by design, test, or statistical correlation.

Note 5: Guaranteed by design.

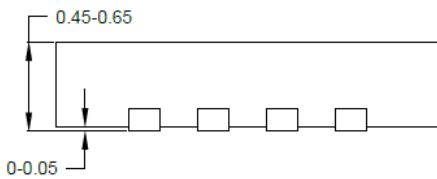
QFN2.5x2.5-16 Package Outline Drawing



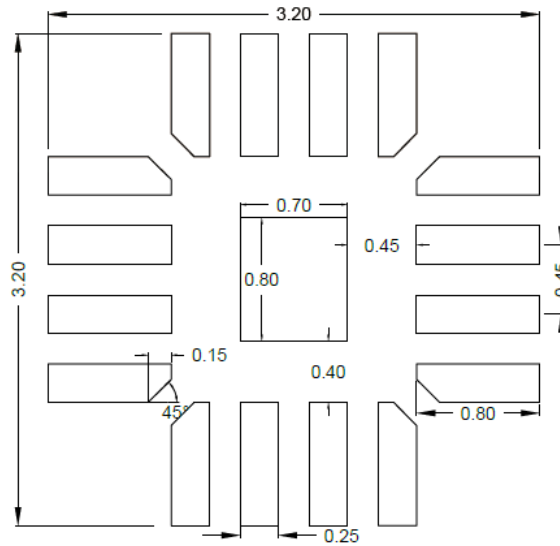
Top view



Bottom view



Side view

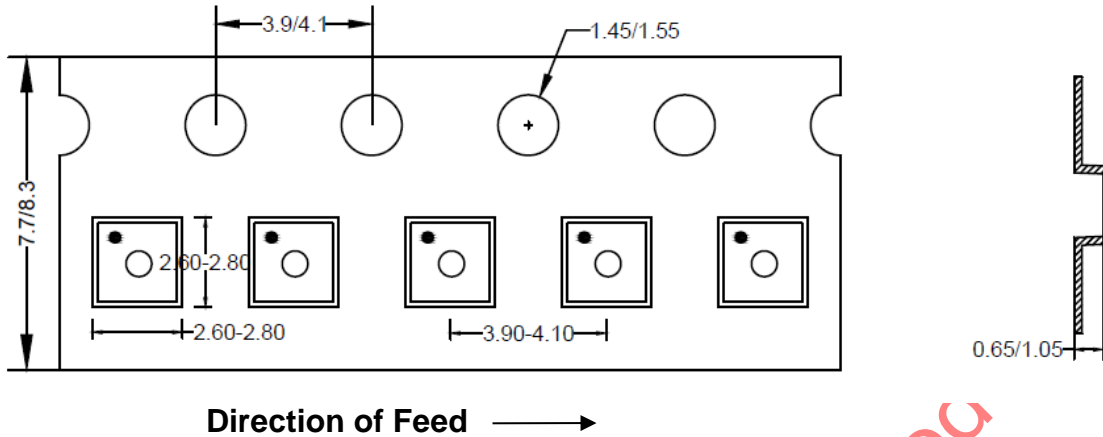


**Recommended PCB layout
(Reference only)**

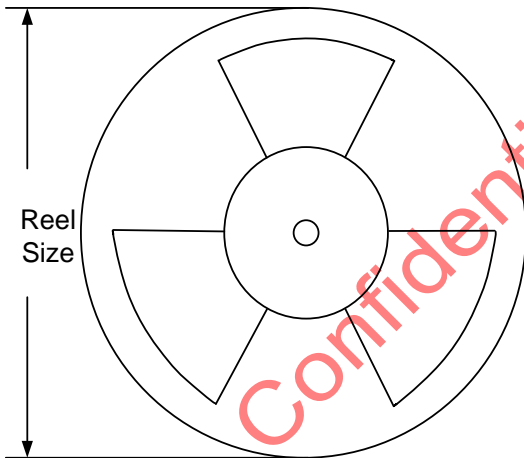
Notes: All dimension in millimeter and exclude mold flash & metal burr.

Tape and Reel Information

1. Tape Dimensions and Pin1 Orientation
QFN2.5x2.5



2. Reel Dimensions



| Package types | Tape width (mm) | Pocket pitch(mm) | Reel size (Inch) | Trailer length(mm) | Leader length (mm) | Qty per reel |
|---------------|-----------------|------------------|------------------|--------------------|--------------------|--------------|
| QFN2.5x2.5 | 8 | 4 | 7" | 400 | 160 | 3000 |

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