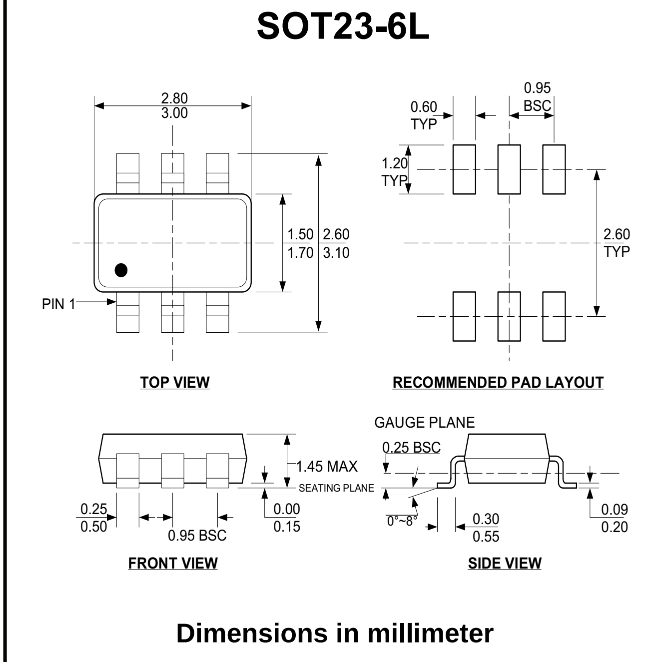
GX8610

60V/1.0A 2MHz 0.8VFB Asynchronous DCM Converter



General Description

The GX8610 is a low EMI signature, asynchronous, step-down, switch-mode converter with internal power MOSFETs.It offers a very compact solution to provide 1.0A continuous current over a wide input supply range, with excellent load and line regulation. GX8610 achieves low EMI signature with well controlled switching edges. Fault condition protection includes programmable-output over-voltage protection, Constant on time Mode, and thermal shutdown.GX8610 requires a minimal number of readily available standard external components. It is available in SOT23-6 package.

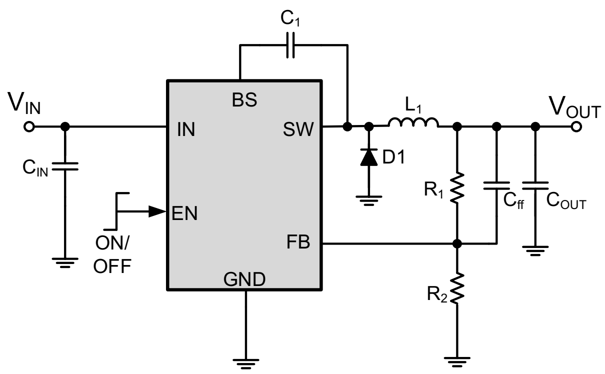
Features

- Wide 8.5V to 60V Operating Input Range
- 1.0A Continuous Output Current
- 2MHz Switching Frequency
- Short Protection with Hiccup-Mode
- Built-in Over Current Limit
- Low Nosie& Low EMI Signature
- Integrated internal Soft-Start
- 600mΩ Low RDS(ON) Internal MOSFETs
- Output Adjustable from 0.8V
- 98% Duty cycle max
- Thermal Shutdown
- Current Mode
- MSL3 Package Level

Applications

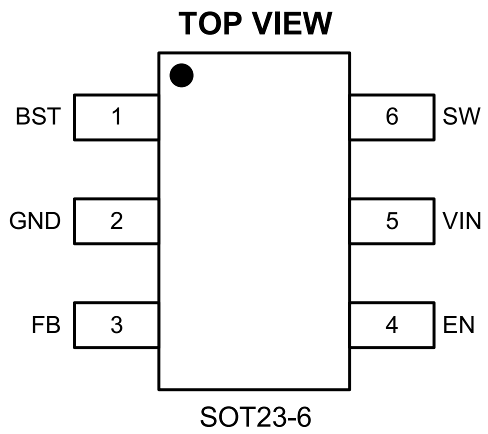
- Automotive Entertainment
- Wireless and DSL Modems
- Computer Entertainment
- IoT Applications
- Digital Still and Video Cameras
- GPS & E-Bike & E-motors

Simplified Application Circuit



Basic Application Circuit

Pin Description



Pin Description

Pin	Name	Function
1	BST	Bootstrap. A capacitor connected between SW and BS pins is required to form a floating supply across the high-side switch driver.
2	GND	Ground Pin
3	FB	Adjustable Version Feedback input. Connect FB to the center point of the external resistor divider
4	EN	Drive this pin to a logic-high to enable the IC. Drive to a logic-low to disable the IC and enter micro-power shutdown mode.
5	VIN	Power Supply Pin
6	SW	Switching Pin

Specifications

Absolute Maximum Ratings [1] [2]

Item	Min	Max	Unit
V_{IN} voltage	-0.3	60	V
EN voltage	-0.3	6.5	V
SW voltage	-0.3(-5V<10nS)	V_{IN}+0.5V(+115V<10nS)	V
BST voltage		Vsw+5	V
FB voltage	–0.3	6.0	V
Power dissipation		0.75	W
Operating junction temperature, TJ	-40	150	°C
Storage temperature, T_{stg}	–65	150	°C
Lead Temperature (Soldering, 10sec.)		260	°C

Note (1): Exceeding these ratings may damage the device.

Note (2): The device is not guaranteed to function outside of its operating conditions.

Recommended Operating Conditions

Item	Min	Max	Unit
Operating junction temperature [1]	–40	125	°C
Operating temperature range	-40	85	°C
Input voltage	8.5	60	V
Output voltage	1.0	30	V
Output current(12V)	0	1.0	A
Output current(5V)	0	1.0	A
Output current(Peak<100mS)	0	1.5	A

Note (1): All limits specified at room temperature (T_A = 25°C) unless otherwise specified. All room temperature limits are 100% production tested. All limits at temperature extremes are ensured through correlation using standard Statistical Quality Control (SQC) methods. All limits are used to calculate Average Outgoing Quality Level (AOQL).

Thermal Information

Item	Description	SOT23-6	Unit
$R_{\theta JA}$	Junction-to-ambient thermal resistance [1][2]	170	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	130	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	46	°C/W

Note (1): The package thermal impedance is calculated in accordance to JESD 51-7.

Note (2): Thermal Resistances were simulated on a 4-layer, JEDEC board

Electrical Characteristics (1) (2)

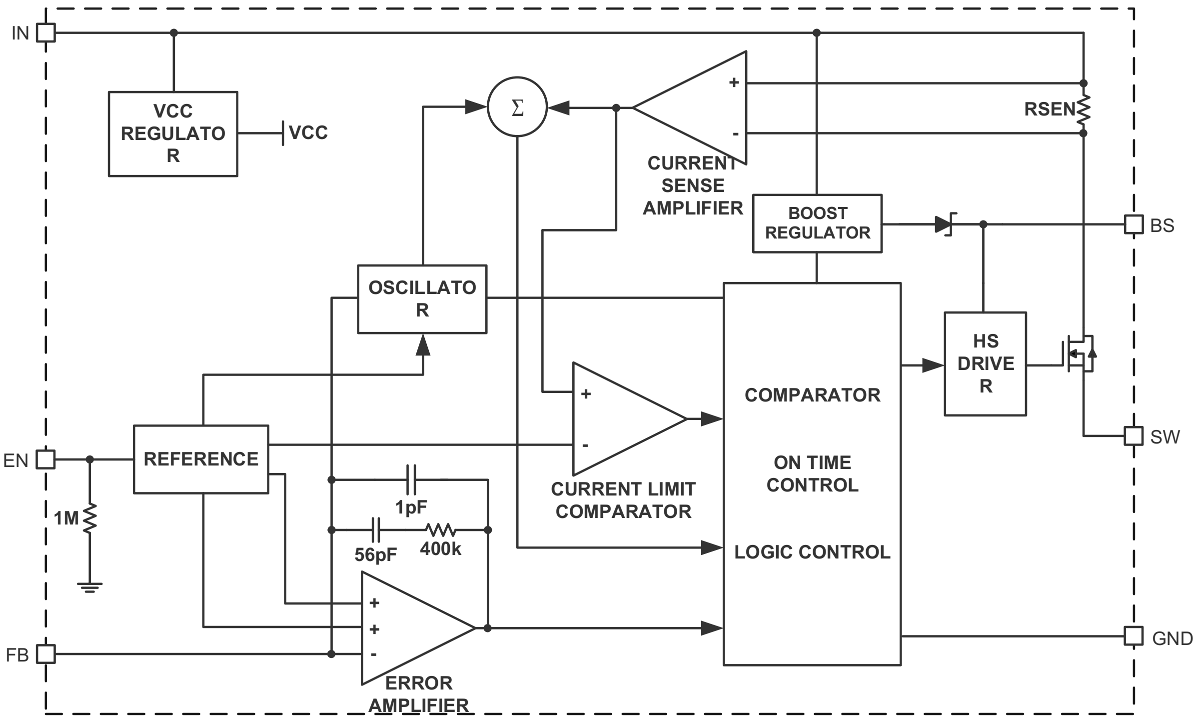
(GX8610)V_{IN}=48V, T_A=25°C, unless otherwise specified.

Parameter	Conditions	Min.	Typ.	Max.	Unit
Input Voltage Range		8.5		60	V
Quiescent current into VIN pin	V_{EN} = 5.0V, V_{IN} = 48V		180	300	µA
Shutdown current into VIN pin	V_{EN} = 0V, V_{IN} = 48V			3	µA
Regulated Feedback Voltage	V_{IN}=48V, T_A=25°C	790	800	810	mV
Output Voltage Line Regulation	V_{IN} = 4.5V to 100V, Out=5.0V			1	%
Output Voltage Load Regulation	V_{IN} =48V, Out=5.0V, ΔV_{LOAD}(0-1.5A)			1	%
Oscillation Frequency1	V_{IN} =48V, Out=5V, Iload=1A		2000		KHz
High-Side Switch On-Resistance	I_{SW}= 1000mA		600		mΩ
High-Side Switch Current Limit	V_{IN}= 48V, FB=90%		2.0		A
V_{IN} Under-Voltage Lockout Threshold			8.0		V
V_{IN} Under-Voltage Lockout Threshold-Hysteresis			300		mV
EN Rising Threshold		1.5			V
EN Falling Threshold				0.4	V
EN Threshold Hysteresis			200		mV
EN Leakage Current				5.0	µA
SW Leakage Current	V_{EN}=0V, V_{IN}=Vsw=48V			2.0	µA
Soft Start		1	1.8	3	mS
Thermal Shutdown			160		℃
Thermal Hysteresis			30		℃

Note (1): MOSFET on-resistance specifications are guaranteed by correlation to wafer level measurements.

Note (2): Thermal shutdown specifications are guaranteed by correlation to the design and characteristics analysis.

Functional Block Diagram



Block Diagram

Functions Description

Internal Regulator

The GX8610 is a COT mode step down DC/DC converter that provides excellent transient response with no extra external compensation components. This device contains an internal, low resistance, high voltage power MOSFET, and operates at a high 2MHz operating frequency to ensure a compact, high efficiency design with excellent AC and DC performance.

Error Amplifier

The error amplifier compares the FB pin voltage with the internal FB reference (VFB) and outputs a current proportional to the difference between the two. This output current is then used to charge or discharge the internal compensation network, which is used to control the power MOSFET current. The optimized internal compensation network minimizes the external component counts and simplifies the control loop design.

Under-Voltage Lockout (UVLO)

Under-voltage lockout (UVLO) protects the chip from operating at an insufficient supply voltage. UVLO protection monitors the internal regulator voltage. When the voltage is lower than UVLO threshold voltage, the device is shut off. When the voltage is higher than UVLO threshold voltage, the device is enabled again.

Thermal Shutdown

Thermal shutdown prevents the chip from operating at exceedingly high temperatures. When the silicon die temperature exceeds 160°C, it shuts down the whole chip. When the temperature falls below its lower threshold (Typ. 160°C) the chip is enabled again.

Internal Soft-Start

The soft-start is implemented to prevent the converter output voltage from overshooting during startup. When the chip starts, the internal circuitry generates a soft-start voltage (SS) ramping up from 0V to 0.8V. When it is lower than the internal reference (REF), SS overrides REF so the error amplifier uses SS as the reference. When SS is higher than REF, REF regains control. The SS time is internally max to 3.0ms.

Startup and Shutdown

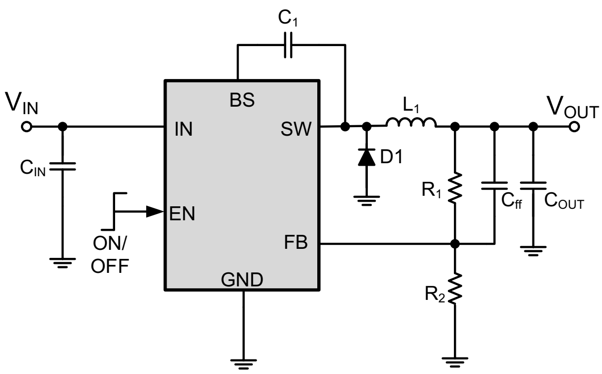
If both V_{IN} and EN are higher than their appropriate thresholds, the chip starts. The reference block starts first, generating stable reference voltage and currents, and then the internal regulator is enabled. The regulator provides stable supply for the remaining circuitries. Three events can shut down the chip: EN low, V_{IN} low and thermal shutdown. In the shutdown procedure, the signaling path is first blocked to avoid any fault triggering. The comp voltage and the internal supply rail are then pulled down. The floating driver is not subject to this shutdown command.

Applications Information

Setting the Output Voltage

GX8610 require an input capacitor, an output capacitor and an inductor. These components are critical to the performance of the device. GX8610 are internally compensated and do not require external components to achieve stable operation. The output voltage can be programmed by resistor divider.

$$V_{OUT} = V_{FB} \times \frac{R1 + R2}{R2}$$



V_{OUT}(V)	R1(KΩ)	R2(KΩ)	L1(µH)	D1	C_{IN}(µF)	C_{OUT}(µF)	C_{FF}
12	144 1%	10 1%	33uH 2A	SS310	4.7uF *2	22+22uF	10pF
5	54 1%	10 1%	33uH 2A	SS310	4.7uF *2	22+22uF	47pF

Selecting the Inductor

The recommended inductor values are shown in the Application Diagram. It is important to guarantee the inductor core does not saturate during any foreseeable operational situation. The inductor should be rated to handle the peak load current plus the ripple current: Care should be taken when reviewing the different saturation current ratings that are specified by different manufacturers. Saturation current ratings are typically specified at 25°C, so ratings at maximum ambient temperature of the application should be requested from the manufacturer.

$$L = \frac{V_{OUT} \times (V_{IN} - V_{OUT})}{V_{IN} \times \Delta I_L \times F_{OSC}}$$

Where ΔIL is the inductor ripple current. Choose inductor ripple current to be approximately 30% if the maximum load current. The maximum inductor peak current is:

$$I_{L(MAX)} = I_{LOAD} + \frac{\Delta I_L}{2}$$

Under light load conditions below 100mA, larger inductance is recommended for improved efficiency.

Selecting the Output Capacitor

Special attention should be paid when selecting these components. The DC bias of these capacitors can result in a capacitance value that falls below the minimum value given in the recommended capacitor specifications table. The ceramic capacitor's actual capacitance can vary with temperature. The capacitor type X7R, which operates over a temperature range of −55°C to +125°C, will only vary the capacitance to within ±15%. The capacitor type X5R has a similar tolerance over a reduced temperature range of −55°C to +85°C. Many large value ceramic capacitors, larger than 1uF are manufactured with Z5U or Y5V temperature characteristics. Their capacitance can drop by more than 50% as the temperature varies from 25°C to 85°C. Therefore X5R or X7R is recommended over Z5U and Y5V in applications where the ambient temperature will change significantly above or below 25°C. Tantalum capacitors are less desirable than ceramic for use as output capacitors because they are more expensive when comparing equivalent capacitance and voltage ratings in the 0.47uF to 44uF range. Another important consideration is that tantalum capacitors have higher ESR values than equivalent size ceramics. This means that while it may be possible to find a tantalum capacitor with an ESR value within the stable range, it would have to be larger in capacitance (which means bigger and more costly) than a ceramic capacitor with the same ESR value. It should also be noted that the ESR of a typical tantalum will increase about 2:1 as the temperature goes from 25°C down to −40°C, so some guard band must be allowed.

PC Board Layout Example & Guidelines

The PCB layout is an important step to maintain the high performance of the GX8610 device.

Efficient layout of the switching power supplies is critical for stable operation. For the high frequency switching converter, poor layout design may cause poor line or load regulation and stable issues. For best results, refer to below figure and follow the guidelines below and take figures as the reference.

- The high current paths (GND, VIN and SW) should be placed very close to the device with short, direct and wide traces.
- Place the input capacitor as close to VIN and GND as possible.
- Place the VCC bypass capacitor as close to VCC as possible.
- Keep the switching node (such as SW) far away from the Vout sense network.
- Add a grid of thermal vias under the exposed pad to improve thermal conductivity.

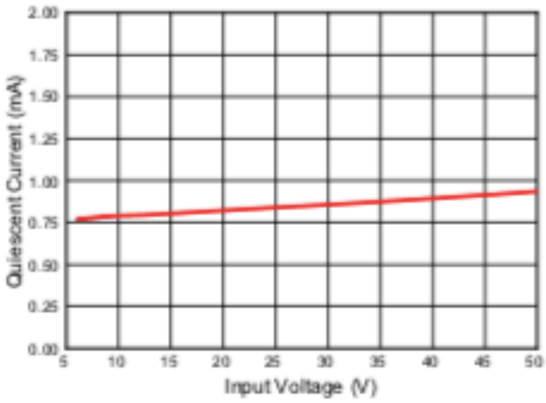
Typical Performance Characteristics

Note (1): Performance waveforms are tested on the evaluation board.

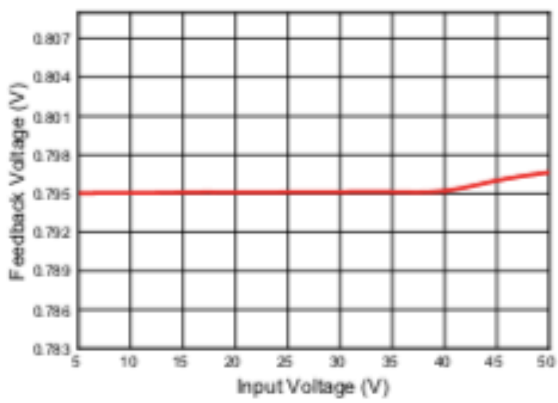
Note (2): C1=C2=22uF+0.1uF, C3=0.1uF, C4=33pF, L=47uH, D=SS16

VIN = 12V, VOUT=3.3V, TA = +25°C, unless otherwise noted.

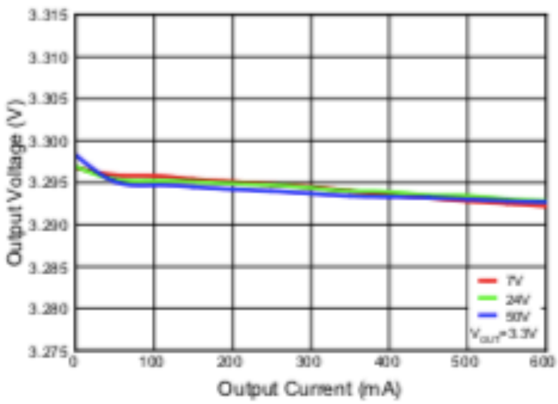
(1) Quiescent Current VS Input Voltage



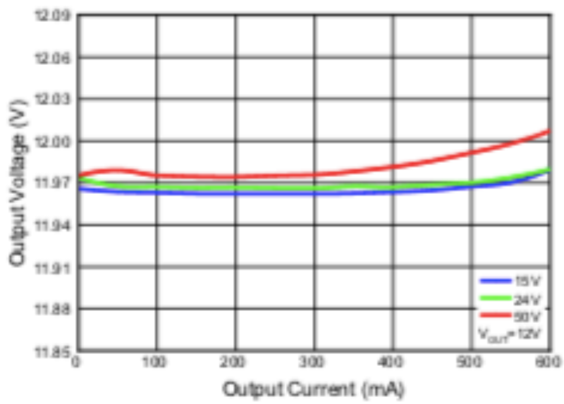
(2) Feedback Voltage VS Input Voltage



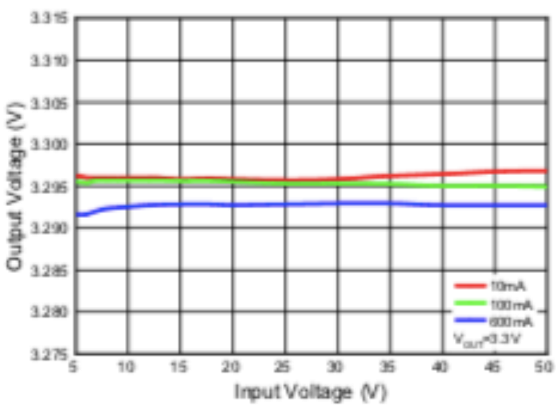
(3) Output Voltage VS Output Current (V_{OUT}=3.3V)



(4) Output Voltage VS Output Current (V_{OUT}=12V)



(5) Output Voltage VS Input Voltage (V_{OUT}=3.3V)



(6) Output Voltage VS Input Voltage (V_{OUT}=12V)