

High Efficiency 1.0MHz 1.2A Synchronous Step Up Converter

1 Features

- 0.9V to 5.5V Input Voltage Range
- 0.5V Accurate Reference Voltage
- Adjustable Output Voltage up to 5.5V
- Internal 1.2A Switch Current Limit
- Integrated 600mΩ PMOS R_{DS_ON} and 300mΩ NMOS R_{DS_ON}
- 1.0MHz Fixed Switching Frequency
- Load Disconnected During Shutdown
- Input Under Voltage Lockout
- Thermal Shutdown Protection
- Available in SOT23-6 Package
- RoHS Compliant and Halogen-Free

2 Applications

- Single or Dual cell Alkaline
- 1 Cell Li-Ion or Li-Primary
- Personal Medical Products
- Handheld Instrument

3 Description

The GD30DC2101 is a high efficiency, current mode, synchronous boost converter which could operate from single-cell, dual-cell Alkaline battery or one-cell Li-Ion or Li-polymer battery. Possible output currents depends on the input-to-output voltage ratio. The converter output voltage can be adjusted to 5.5V by an external resistor divider. In light load, the GD30DC2101 enters into the power-save mode to maintain high efficiency.

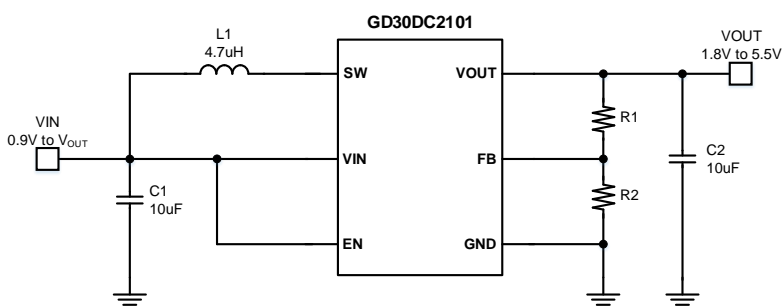
The GD30DC2101 integrated a 300mΩ N-channel MOSFET switch and 600mΩ P-channel synchronous rectifier. No external Schottky diode is required. The device is available in SOT23-6 package.

Device Information¹

PART NUMBER	PACKAGE	BODY SIZE (NOM)
GD30DC2101	SOT23-6	2.90mm x 2.90mm

1. For packaging details, see [Package Information](#) section.

Simplified Application Schematic



3.3V Output Efficiency

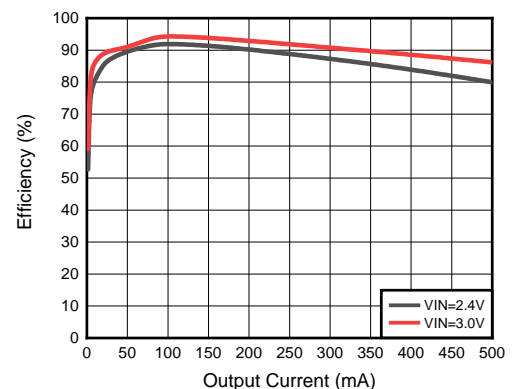
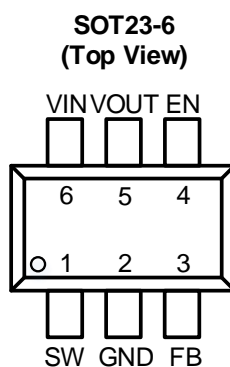


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4 Device Overview

4.1 Pinout and Pin Assignment



4.2 Pin Description

PIN NUMBER		PIN TYPE ¹	FUNCTION
NAME	SOT23-5		
SW	1	I	Boost and rectifying switch input.
GND	2	G	Ground pin connection for logic and power.
FB	3	I	Voltage feedback for programming the output voltage.
EN	4	I	Enable input (VIN enabled, GND disabled).
VOUT	5	O	Boost converter output.
VIN	6	I	Supply voltage.

1. I = Input, O = Output, G = Ground.

5 Parameter Information

5.1 Absolute Maximum Ratings

Exceeding the operating temperature range(unless otherwise noted)¹

SYMBOL	PARAMETER	MIN	MAX	UNIT
V _{IN}	Input voltage	−0.3	6.0	V
V _{SW}	Switching node voltage (SW)	−0.3	6.0	V
V _{IO}	I/O pin voltage (EN, FB)	−0.3	6.0	V
T _J	Operating junction temperature	−40	150	°C
T _{stg}	Storage temperature	−55	150	°C
P _{max}	SOT23-5/6 Maximum power dissipation @ T _A =+25°C		0.4	W

1. The maximum ratings are the limits to which the device can be subjected without permanently damaging the device. Note that the device is not guaranteed to operate properly at the maximum ratings. Exposure to the absolute maximum rating conditions for extended periods may affect device reliability.

5.2 Recommended Operation Conditions

SYMBOL ^{1,2}	PARAMETER	MIN	TYP	MAX	UNIT
V _{IN}	Input supply voltage range	0.9		5.5	V
V _{OUT}	Output voltage range	1.8		5.5	V
T _J	Operating junction temperature	−40		125	°C

1. The device is not guaranteed to function outside of its operating conditions.
2. Refer to the [Application Information](#) section for further information.

5.3 Electrical Sensitivity

SYMBOL	CONDITIONS	VALUE	UNIT
V _{ESD(HBM)}	Human-body model (HBM), ANSI/ESDA/JEDEC JS-001-2017 ¹	±2000	V
V _{ESD(CDM)}	Charge-device model (CDM), ANSI/ESDA/JEDEC JS-002-2022 ²	±200	V

1. JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
2. JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

5.4 Thermal Resistance

SYMBOL ¹	CONDITIONS	PACKAGE	VALUE	UNIT
Θ_{JA}	Natural convection, 2S2P PCB	SOT23-6	117.71	°C/W
Θ_{JB}	Cold plate, 2S2P PCB	SOT23-6	59.55	°C/W
Θ_{JC}	Cold plate, 2S2P PCB	SOT23-6	34.00	°C/W
Ψ_{JB}	Natural convection, 2S2P PCB	SOT23-6	59.46	°C/W
Ψ_{JT}	Natural convection, 2S2P PCB	SOT23-6	2.27	°C/W

1. Thermal characteristics are based on simulation, and meet JEDEC document JESD51-7.

5.5 Electrical Characteristics

$V_{IN} = V_{EN} = 5V$, $T_J = 25^{\circ}C$, unless otherwise noted.

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT
POWER SUPPLY						
V _{IN_STP}	Start-up voltage	V _{OUT} = 3.3V, R _{LOAD} = 3.3kΩ	0.85	0.9		V
I _{Q1}	Quiescent current	V _{IN} = V _{EN} = 1.2V, V _{FB} = 0.6V		0.1	1	μA
I _{SHDN}	Shutdown current	V _{EN} = 0V		0.2	1	μA
ENABLE						
V _{EN_RISE}	Rising enable threshold	V _{IN} ≤ 1.5V	0.8 x V _{IN}		V	
		1.5V ≤ V _{IN} ≤ 5.5V	1.2			
V _{EN_FALL}	Falling enable threshold	V _{IN} ≤ 1.5V	0.2 x V _{IN}			
		1.5V ≤ V _{IN} ≤ 5.5V	0.3			
I _{EN}	Enable input current			0.1		μA
VOLTAGE REFERENCE						
V _{FB}	Feedback voltage		0.49	0.5	0.51	V
I _{FB}	Feedback leakage current				0.1	μA
INTEGRATED POWER MOSFETS						
R _{DS(on)_N}	Switch NMOS on resistance			300		mΩ
R _{DS(on)_P}	Rectifier PMOS on resistance			600		mΩ
SWITCHING REGULATOR						
F _{SW}	Switching frequency			1.0		MHz
OUTPUT CHARACTERISTIC						
V _{OUT}	Output voltage range		1.8		5.5	V
I _{Q2}	V _{OUT} quiescent current	V _{OUT} = 3.3V		2.5	5	μA
CURRENT LIMIT						
I _{LIM}	Switch current limit			1.2		A
THERMAL SHUTDOWNM						
T _{TSD}	Thermal shutdown temperature			155		°C
T _{HYS}	Thermal shutdown hysteresis			20		°C

5.6 Typical Characteristics

$T_A = -40^{\circ}\text{C}$ to 125°C , unless otherwise noted.

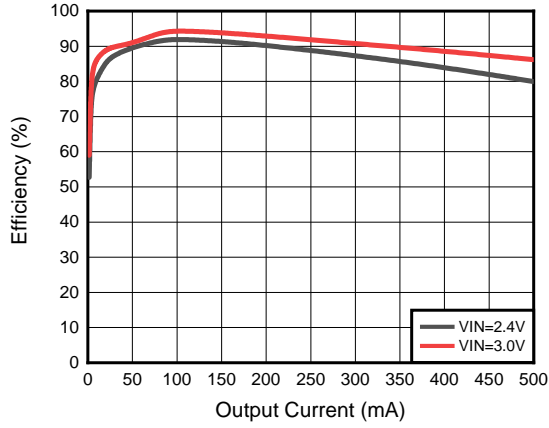


Figure 1. Efficiency vs. Output Current, $V_{OUT} = 3.3\text{V}$

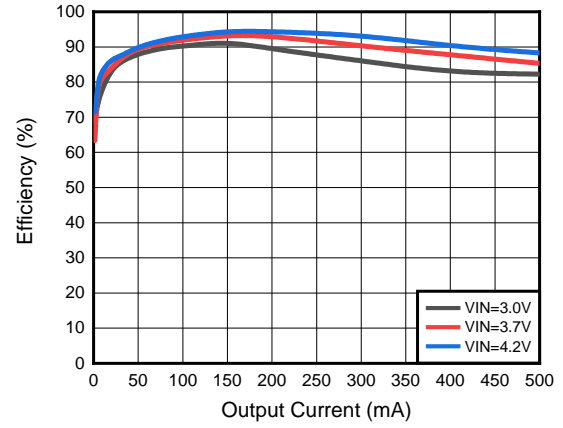


Figure 2. Efficiency vs. Output Current, $V_{OUT} = 5.0\text{V}$

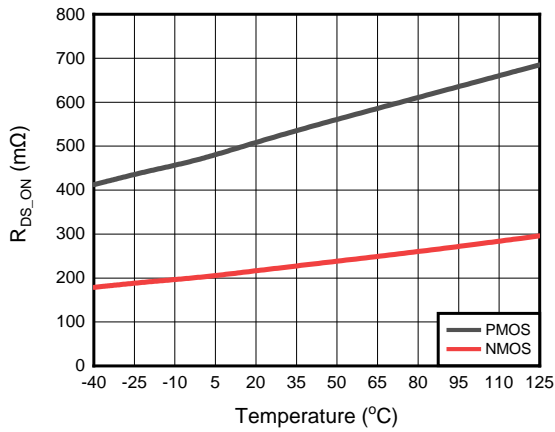


Figure 3. MOSFET ON Resistance vs. Temperature

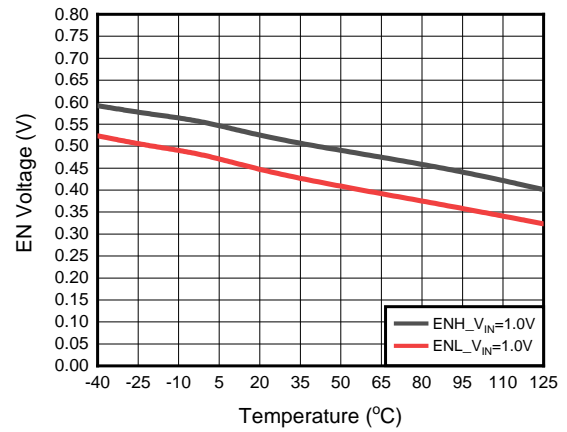


Figure 4. EN Voltage vs. Temperature, $V_{IN} = 1\text{V}$

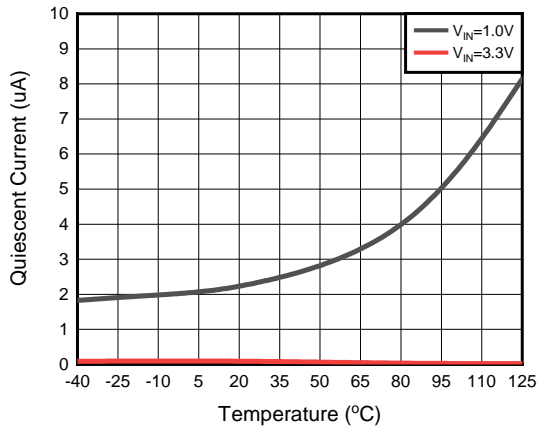


Figure 5. Quiescent Current vs. Temperature

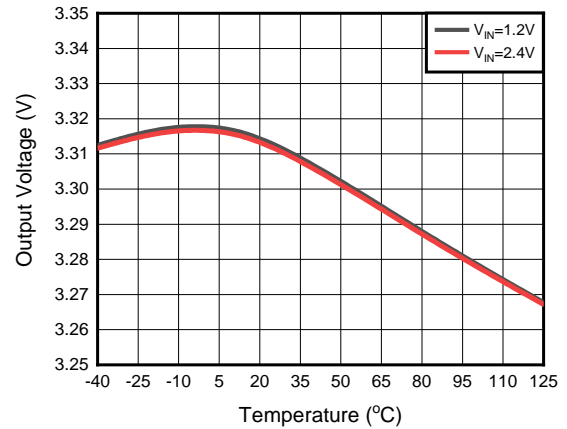


Figure 6. V_{OUT} vs. Temperature, $I_{Load} = 10\text{mA}$

6 Functional Description

6.1 Block Diagram

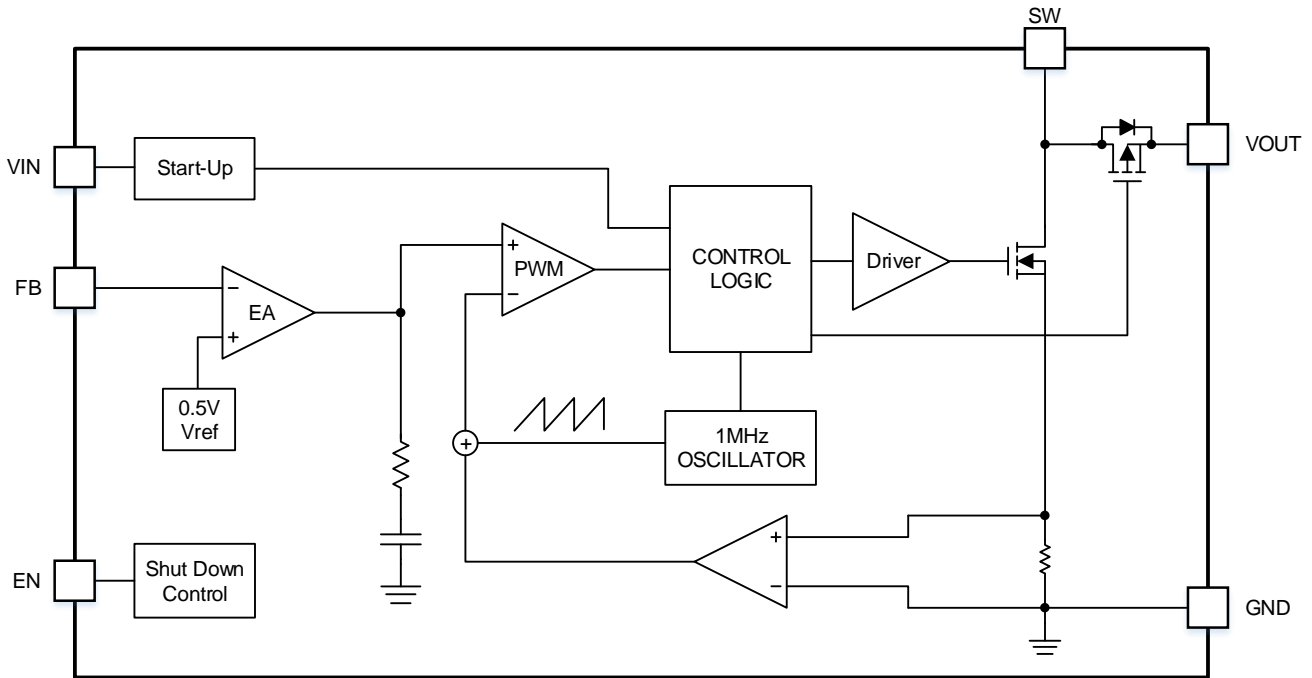


Figure 7. GD30DC2101 Functional Block Diagram

6.2 Operation

The GD30DC2101 is a current mode step-up boost converter with 1MHz operation frequency. The input voltage range is 0.9V to 5.5V and the output voltage up to 5.5V. The GD30DC2101 automatically transits from PWM to power save mode during light load condition which can maintain a high efficiency. To achieve high efficiency the power stage is realized as a synchronous boost topology. For the power switching two actively controlled low $R_{DS(ON)}$ power MOSFETs are implemented.

6.2.1 Under Voltage Lockout

To avoid mis-operation of the device at an insufficient supply voltage, implement under voltage locking to shutdown the device when the voltage is below the V_{HYS} hysteresis of the V_{UVLO} .

6.2.2 Current Limit

The GD30DC2101 has a typical 1.2A switch current limit, once the inductor exceeds the current limit, the internal switch turns off immediately and enter hiccup mode. The switch current limit prevents the device from high inductor current and drawing excessive current from a battery or input voltage rail. Excessive current might occur with a heavy load or shorted output circuit condition.

6.2.3 Thermal Shutdown

The internal thermal shutdown circuitry forces the device to stop switching if the junction temperature exceeds 155°C(typical), both the high-side and low-side FETs are turned off. Once the device temperature falls below the threshold with hysteresis 20°C (typical), the device returns to normal operation automatically.

6.3 Device Mode Description

6.3.1 Device Enable

The device is enabled when EN is set high and shut down when EN is low. During shutdown, the converter stops switching and all internal control circuitry is turned off. In this case the input voltage is connected to the output through the back-gate diode of the rectifying MOSFET. This means that there always will be voltage at the output which can be as high as the input voltage or lower depending on the load.

7 Application Information

The GD30DC2101 is intended for systems powered by a single cell battery to up to double Alkaline cells with a typical terminal voltage between 0.9V and 5.5V. It can also be used in systems powered by one-cell Li-Ion or Li-Polymer batteries with a typical voltage between 2.5V and 4.2V. Additionally, any other voltage source with a typical output voltage between 0.9V and 5.5V can be used with the GD30DC2101.

7.1 Typical Application Circuit

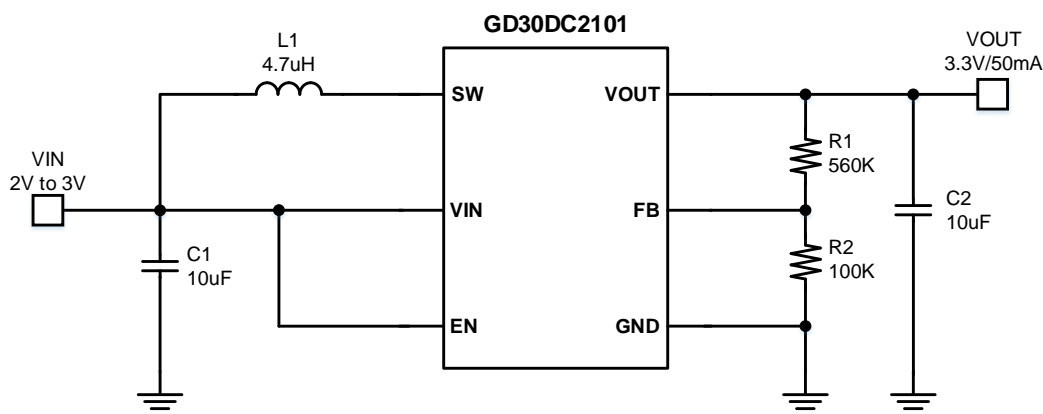


Figure 8. 3.3V Output Voltage Reference Design

7.2 Design Example

In this example, the input voltage range is from 2V to 3V for one-cell coin cell battery input design, use the parameters in [Table 1](#).

Table 1. Design Parameters

PARAMETER	EXAMPLE VALUE
Input Voltage	2V to 3V
Output Voltage	3.3V
Output Current	50mA

[Table 2](#) lists the components used for the example.

Table 2. Design Example Component^{1,2}

COMPONENT	DESCRIPTION
C1,C2	10uF, Ceramic Capacitor, 10V, X5R, size 0603
L1	4.7uH, Power Inductor
R1,R2	Divider resistor, 1%, size 0603

1. The components used in these design cases do not belong to GD products, GD does not warrant its accuracy or completeness. GD's customers need to test and verify whether the selected components meet their intended use to ensure stable system operation.
2. Refer to [Detailed Design Description](#) section for guidance on component selection and calculation equations.

7.3 Detailed Design Description

7.3.1 Output Voltage Setting

An external resistor divider is used to set output voltage according to Equation(1). By selecting R1 and R2, the output voltage is programmed to the desired value. When the output voltage is regulated, the typical voltage reference at the FB pin is 0.5V.

To ensure system performance, choose the value of R2 carefully. Since a large R2 make FB sensitive to noise and a small R2 increase power loss. So the value of 100KΩ is recommended. It can achieves a balance between system stability and low current consumption.

$$V_{OUT} = 0.5V \times \left(1 + \frac{R_1}{R_2}\right) \quad (1)$$

The feedback circuit is shown in Figure 9.

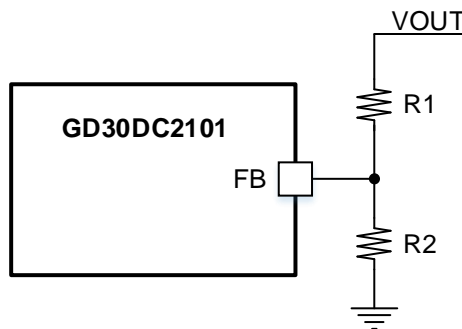


Figure 9. Feedback resistor divider

7.3.2 Inductor Selection

A boost converter normally requires two main passive components for storing energy during the conversion. A boost inductor is required and a storage capacitor at the output. To select the boost inductor, it is recommended to keep the possible peak inductor current below the current limit threshold of the power switch in the chosen configuration.

The second parameter for choosing the inductor is the desired current ripple in the inductor. Normally, it is advisable to work with a ripple of less than 20% of the average inductor current. A smaller ripple reduces the magnetic hysteresis losses in the inductor, as well as output voltage ripple and EMI. But in the same way, regulation time at load changes rises. In addition, a larger inductor increases the total system cost. With those parameters, the value of the inductor is given by:

$$L = \frac{V_{IN} \times (V_{OUT} - V_{IN})}{\Delta I_L \times f \times V_{OUT}} \quad (2)$$

Parameter f is the switching frequency and ΔI_L is the ripple current in the inductor, i.e, 20% x I_L . With this calculated value and currents, it is possible to choose a suitable inductor. Care must be taken that load transients and losses in the circuit can lead to higher currents. Also, the losses in the inductor caused by magnetic hysteresis losses and copper losses are a major parameter for total circuit efficiency.

7.3.3 Input Capacitor Selection

To minimize the potential noise problem, place a typical X5R or better grade ceramic capacitor close to the VIN and GND pins, minimize the loop area formed by CIN, and VIN/GND pins. In this case a 10uF or larger low ESR ceramic capacitors is recommended.

7.3.4 Output Capacitor Selection

The output capacitor is selected to handle the output ripple noise requirements. Both steady state ripple and transient requirements must be taken into consideration when selecting this capacitor. The GD30DC2101 is not sensitive to the ESR in terms of stability. For the best performance, such as to minimize output voltage ripple, it is recommended to use X5R or better grade ceramic capacitor and a 10uF or larger low ESR ceramic capacitors.

7.4 Power Dissipation

For DC/DC, there is still some power deposited on the chip and converted into heat, in spite of switch mode power supplies have considerably higher efficiency when compared to linear regulators. The device power dissipation includes conduction loss, switching loss, gate charge loss and quiescent current losses. The maximum allowable continuous power dissipation at any ambient temperature is calculated by [Equation\(3\)](#):

$$P_{D(MAX)} = \frac{T_{J(MAX)} - T_A}{\theta_{JA}} \quad (3)$$

Where $T_{J(MAX)}$ is the maximum junction temperature, T_A is the ambient temperature and θ_{JA} is the junction to ambient thermal resistance. Once exceeding the maximum allowable power, The device enters thermal shutdown to avoid permanent damage.

7.5 Typical Application Curves

$C_{IN} = C_{OUT} = 10\mu F$, $L = 4.7\mu H$, $T_A = 25^\circ C$, unless otherwise noted.

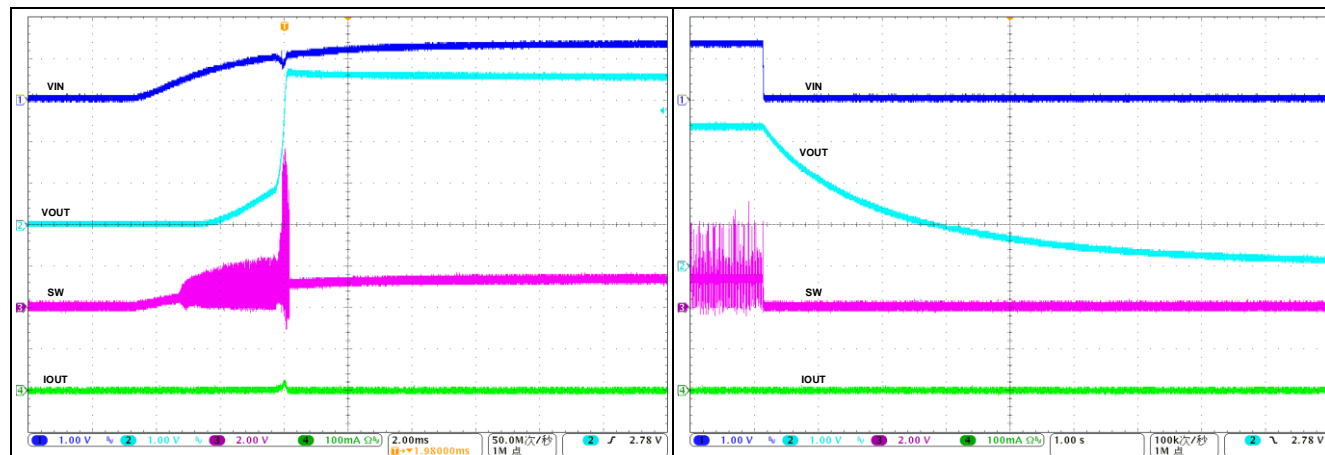


Figure 10. Startup from VIN

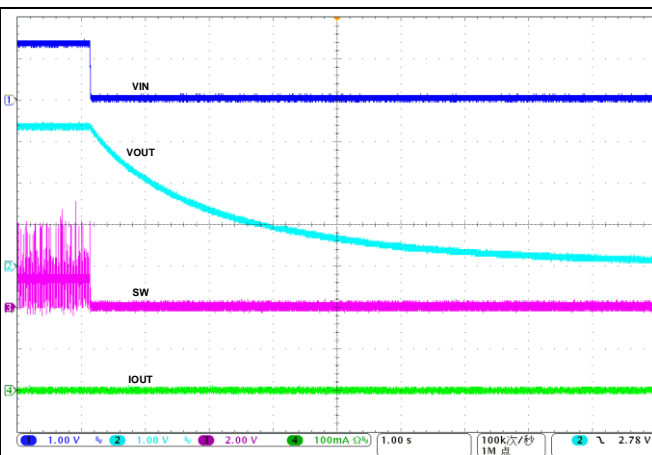


Figure 11. Shutdown from VIN

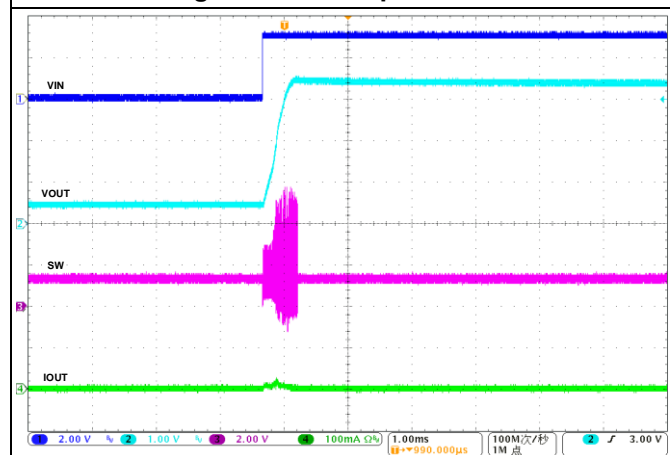


Figure 12. Startup from EN

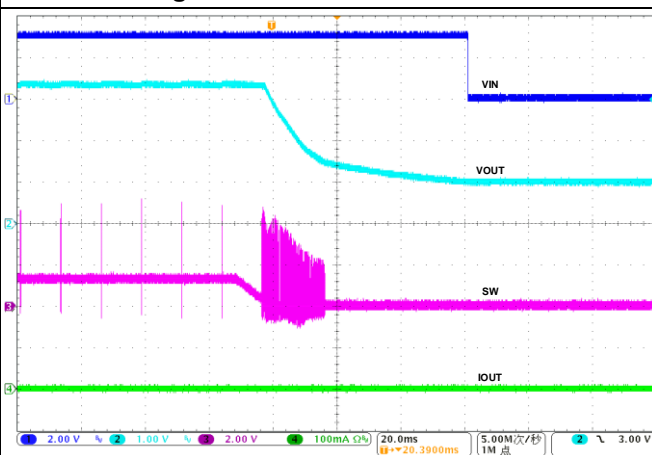


Figure 13. Shutdown from EN

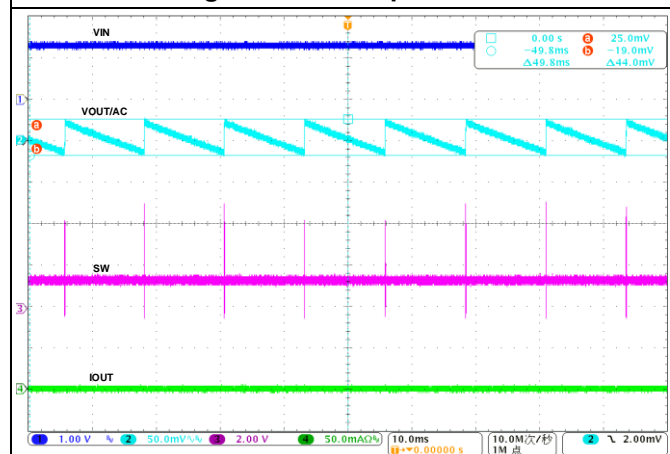


Figure 14. Output Ripple without Load

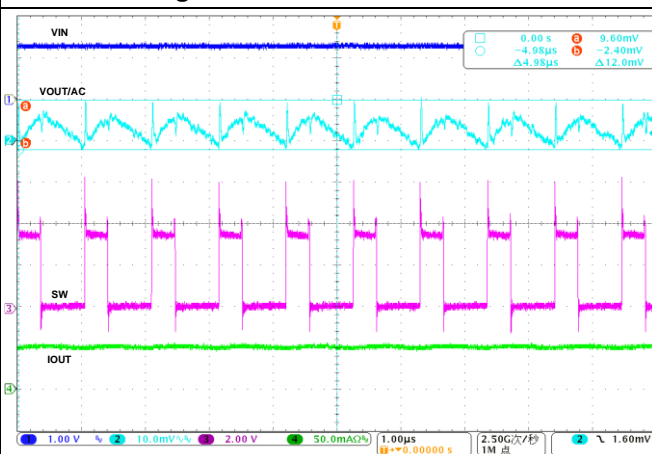
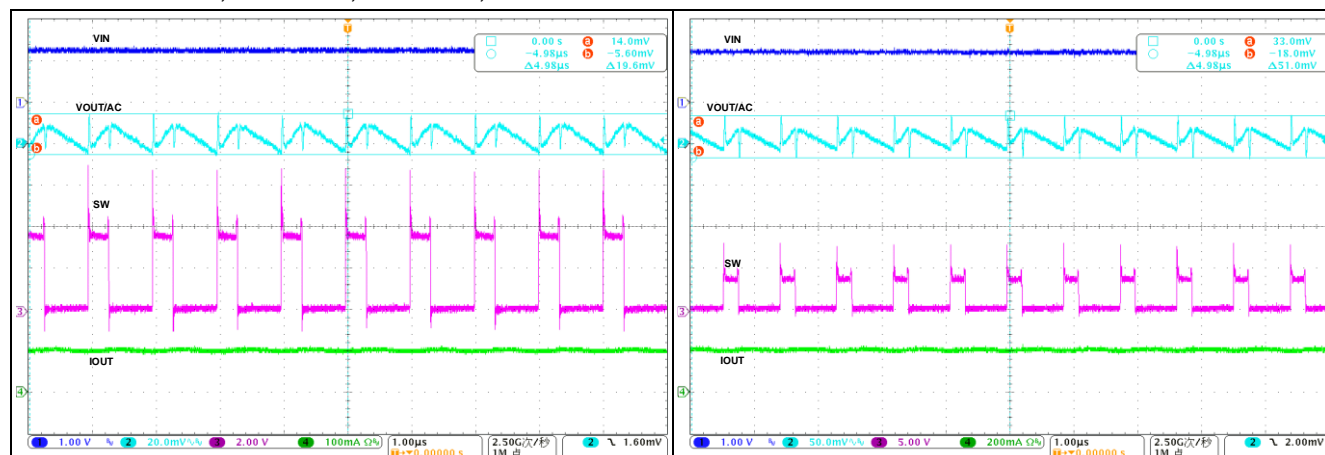


Figure 15. Output Ripple with 50mA Load

Typical Application Curves (continued)

$C_{IN} = C_{OUT} = 10\mu F$, $L = 4.7\mu H$, $T_A = 25^\circ C$, unless otherwise noted.

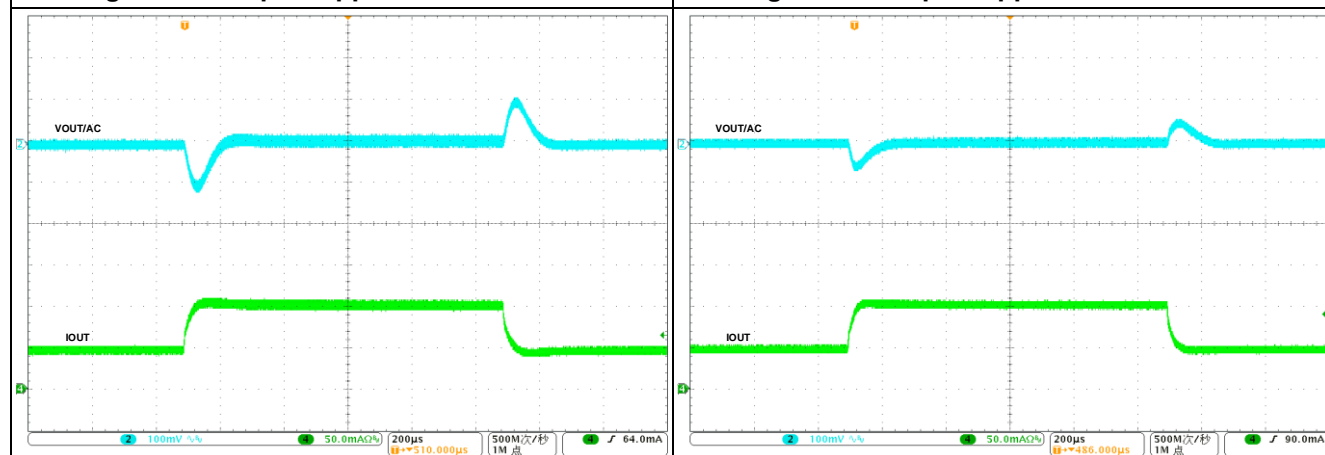


$V_{IN} = 1.2V$, $V_{OUT} = 3.3V$, $I_{OUT} = 100mA$

Figure 16. Output Ripple with 100mA Load

$V_{IN} = 1.2V$, $V_{OUT} = 3.3V$, $I_{OUT} = 200mA$

Figure 17. Output Ripple with 200mA Load



$V_{IN} = 1.2V$, $V_{OUT} = 3.3V$

Figure 18. Load Transient Response

$V_{IN} = 2.4V$, $V_{OUT} = 3.3V$

Figure 19. Load Transient Response

8 Layout Guidelines and Example

As for all switching power supplies, the layout is an important step in the design, especially at high-peak currents and high switching frequencies. If the layout is not carefully done, the regulator could show stability problems as well as EMI problems. Therefore, use wide and short traces for the main current path and for the power ground tracks. The input capacitor, output capacitor, and the inductor should be placed as close as possible to the IC. Use a common ground node for power ground and a different one for control ground to minimize the effects of ground noise. Connect these ground nodes at any place close to the ground pin of the IC.

The feedback divider should be placed as close as possible to the ground pin of the IC. To lay out the control ground, it is recommended to use short traces as well, separated from the power ground traces. This avoids ground shift problems, which can occur due to superimposition of power ground current and control ground current.

For best results, follow the layout example below.

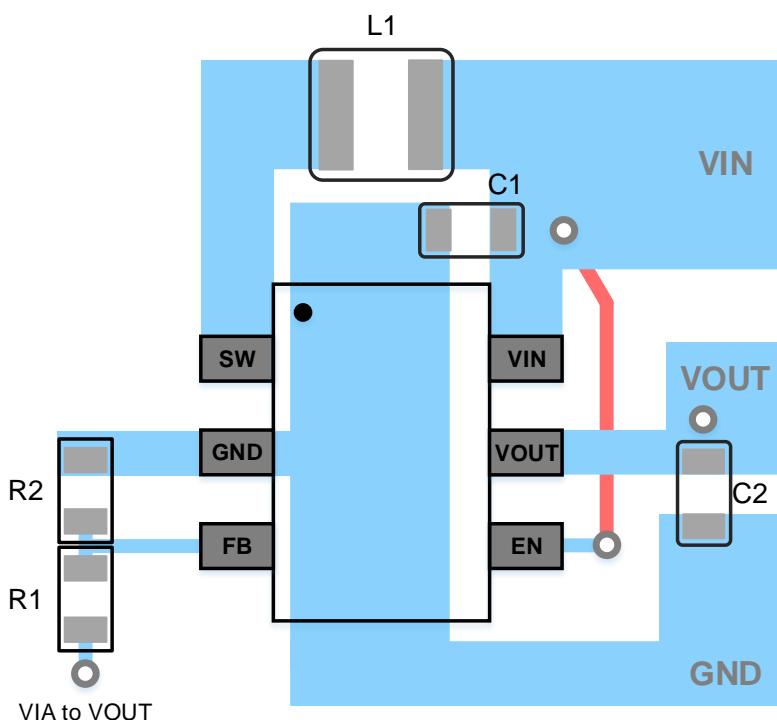
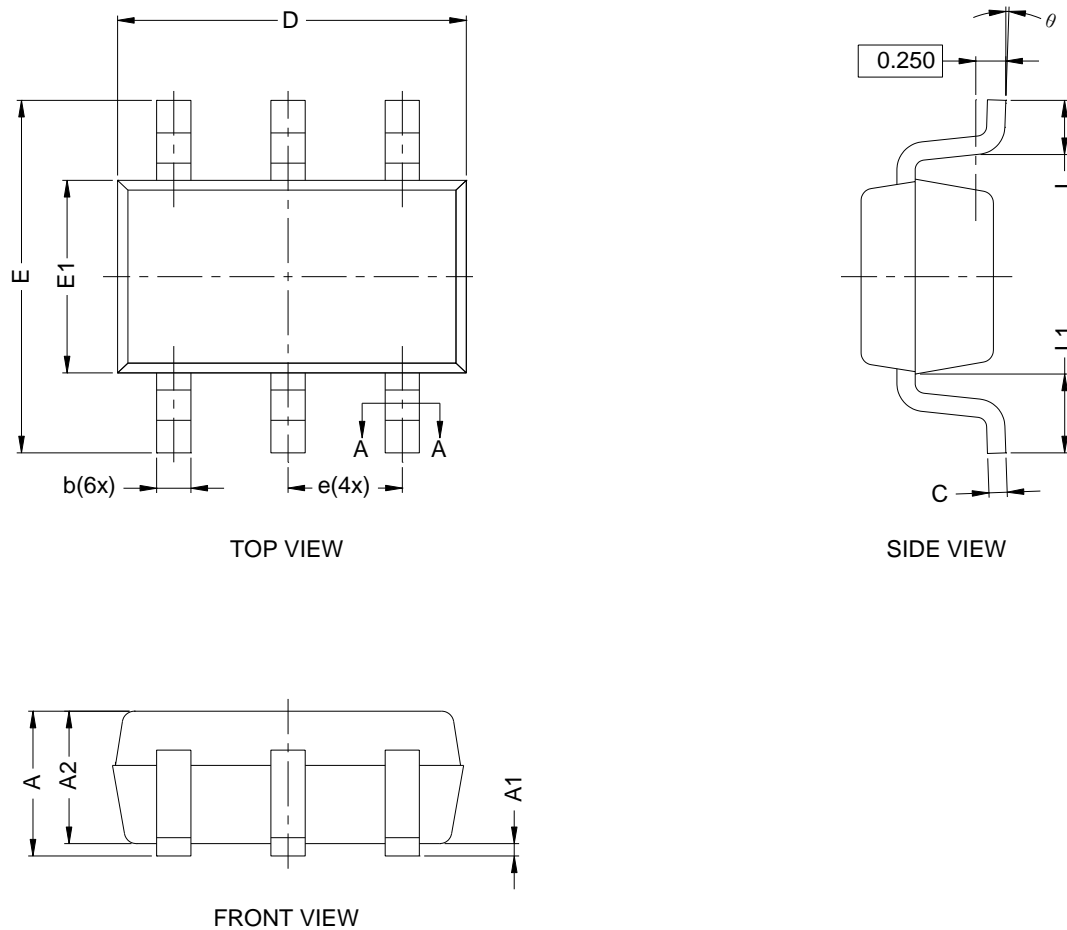


Figure 20. Typical GD30DC2101 Example Layout

9 Package Information

9.1 Outline Dimensions

SOT23-6 Package Outline



NOTES:

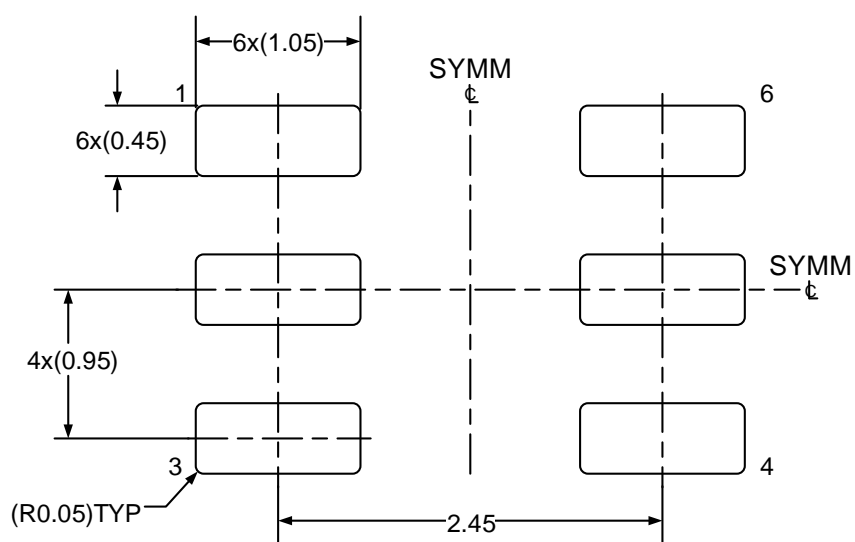
1. All dimensions are in millimeters.
2. Package dimensions does not include mold flash, protrusions, or gate burrs.
3. Refer to the [Table 3 SOT23-6 dimensions\(mm\)](#).

Table 3. SOT23-6 dimensions(mm)

SYMBOL	MIN	TYP	MAX
A			1.25
A1	0.03	0.08	0.15
A2	1.05	1.10	1.15
b	0.27		0.35
c	0.135		0.23
D	2.82	2.92	3.02
E	2.60	2.90	3.00
E1	1.50	1.62	1.70
e	0.95 BSC		
e1	1.90 BSC		
L	0.35	0.45	0.55
L1	0.49	0.64	0.79
θ	0°		8°

9.2 Recommended Land Pattern

SOT23-6 Land Pattern Example



NOTES: (continued)

1. Refer to the IPC-7351 can also help you complete the designs.
2. Exposed metal shown.
3. Drawing is 20X scale.

10 Ordering Information

Ordering Code	Package Type	ECO Plan	Packing Type	MOQ	OP Temp(°C)
GD30DC2101SSTR-I	SOT23-6	Green	Tape & Reel	3000	Industrial -40°C to +125°C

11 Revision History

REVISION NUMBER	DESCRIPTION	DATE
1.0	Initial release and device details	2024

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