1. General Description

The WD20027 is a high-efficiency synchronous buck converter that can operate over a wide input voltage range of 2.5V to 5.5V and can deliver up to 2A of output current. It integrates the main switch and synchronous switch inside and has extremely low on-resistance to reduce conduction loss. The switching frequency is 1.5MHz, which can reduce the size of the external inductor and output capacitor and reduce the output voltage ripple.

The WD20027 is available in SOT23-5L / SOT23-6L / DFN1.6×1.6-6L package.

2. Features

- 2.5V~5.5V input voltage range
- 35uA ultra-low quiescent current
- Internal soft-start
- Input overvoltage protection (OVP)
- Short circuit protection hiccup mode
- Internal integrated low $R_{DS(ON)}$ switch
- 1.5MHz switching frequency minimizes external components
- 100% duty cycle supports input and output low dropout operation
- RoHS compliant and halogen free

3. Applications

- Set-top box, security camera
- Mobile phones, handheld game consoles, media players
- Electric toys, meters, etc.

4. Typical Application

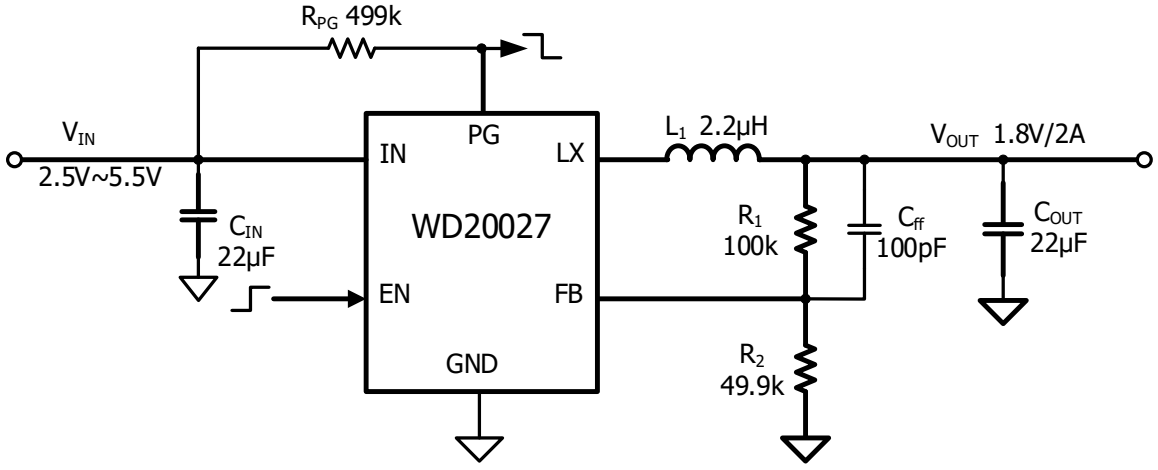


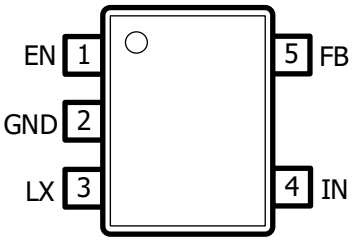
Figure 1 Simplified Schematic

Note: Power Good feature is only available in WD20027MFR

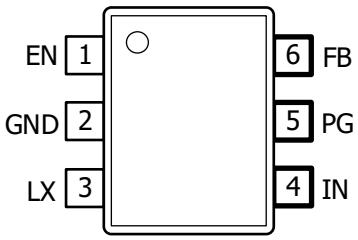
5. Pin Configuration

(Top View)

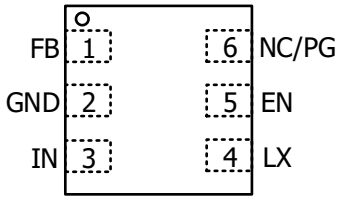
SOT23-5



SOT23-6



DFN1.6x1.6-6



6. Pin Description

PIN NUMBER			PIN NAME	PIN FUNCTION
SOT23-5	SOT23-6	DFN1.6*1.6-6		
1	1	5	EN	Enable signal input pin, the chip works when input high level, do not leave the pin floating.
2	2	2	GND	Ground pin.
3	3	4	LX	Switching node pin. This pin should be connected with the inductor.
4	4	3	IN	Power input pin. Use a ceramic decoupling capacitor of at least 22uF to connect this pin to ground.
/	5	6	NC/PG	Power Good Indicator pin. Low if output voltage < 90% of the regulation voltage, high otherwise.
5	6	1	FB	Feedback pin. Connect this pin to the center point of the output divider resistor to set the output voltage.

7. Absolute Maximum Ratings

Over operating free-air temperature range (unless otherwise noted)[1]

PARAMETER		RATING	UNIT
IN Pin Voltage Range to GND		-0.3~6.5	V
LX Pin Voltage Range to GND		-0.3~6.5	V
EN, FB, PG Voltage		-0.3~6.5	V
Storage Junction Temperature		-55~150	°C
Operating Temperature Range		-40~85	°C
Dynamic Vin and SW Voltage		-1.2V for 70ns to 8.5V for 70ns	
Thermal Resistance, Junction to Ambient	SOT23-5/6L	150	°C /W
	DFN1.6*1.6-6L	140	°C /W
Thermal Resistance, Junction to Case	SOT23-5/6L	70	°C /W
	DFN1.6*1.6-6L	65	°C /W
ESD	HBM	2	kV
	CDM	1	kV

Note1: Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under Recommended Operating Conditions. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

8. Electrical Characteristics

(V_{IN} = V_{EN} = 5V, V_{OUT} = 1.8V, C_{IN} = C_{OUT} = 22μF, L_1 = 2.2μH, T_A = 25°C, unless otherwise noted)

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP.	MAX	UNIT
V_{IN}	Input Voltage Range	-	2.5		5.5	V
V_{UVLO}	Input UVLO threshold	V_{IN} rising		2.3	2.45	V
V_{HYS}	UVLO Hysteresis			0.18		V
OVP	V_{IN} OVP Threshold	V_{IN} rising		6.2		V
I_Q	Quiescent Current	I_{OUT}=0, V_{FB}=V_{REF}*105%		35	65	μA
I_{SHDN}	Shutdown Current	V_{EN}=0V		0.1	1.0	μA
V_{REF}	Feedback Reference Voltage		0.588	0.600	0.612	V
$R_{DS(ON),P}$	PFET RON[1]			115		mΩ
$R_{DS(ON),N}$	NFET RON[1]			60		mΩ
I_{LIM}	PFET Current Limit			3.2		A
R_{Dis}	LX Discharge Resistance	V_{EN}=0V		50		Ω
V_{ENH}	EN rising threshold	-	1.5			V
V_{ENL}	EN falling threshold	-			0.4	V
I_{EN_LK}	EN Leakage Current			0.01	1.0	μA
V_{PG_TH}	Power Good Threshold	PG low，FB falling WD20027MFR		90		%
		PG high，FB rising WD20027MFR		90		%
I_{PG_SINK}	Power Good Sink Current	WD20027MFR			2	mA
F_{OSC}	Oscillator Frequency	I_{OUT}=1A		1.5		MHz
		V_{OUT}=0V		400		kHz
t_{ON_MIN}	Min ON Time[1]			60		ns

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP.	MAX	UNIT
D_{MAX}	Max Duty Cycle				100	%
T_{SS}	Soft Start Time			500		μs
T_{SD}	Thermal Shutdown Temperature			175		°C
T_{HYS}	Thermal Shutdown Hysteresis			35		°C

Note1: Design by guarantee.

9. Typical Performance Characteristics

(V_{IN} = V_{EN} = 5V, V_{OUT} = 1.8V, C_{IN} = C_{OUT} = 22μF, L_1 = 2.2μH, T_A = 25°C, unless otherwise noted)

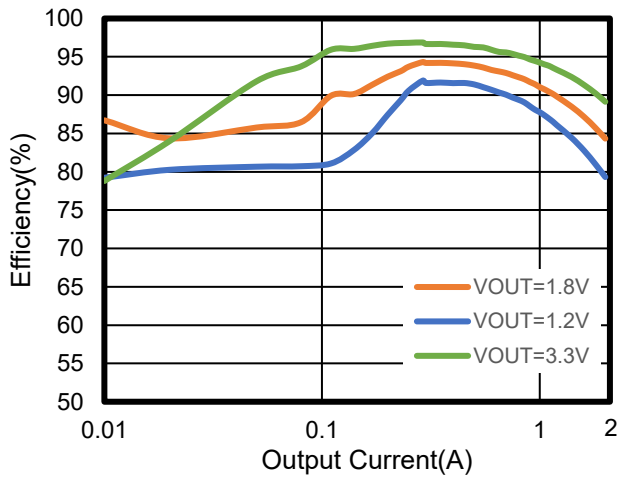


Figure 2 Efficiency vs. Output Current

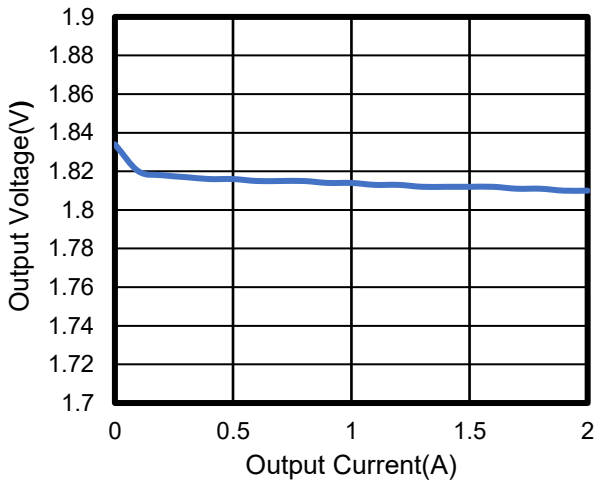


Figure 3 Output Voltage vs. Output Current

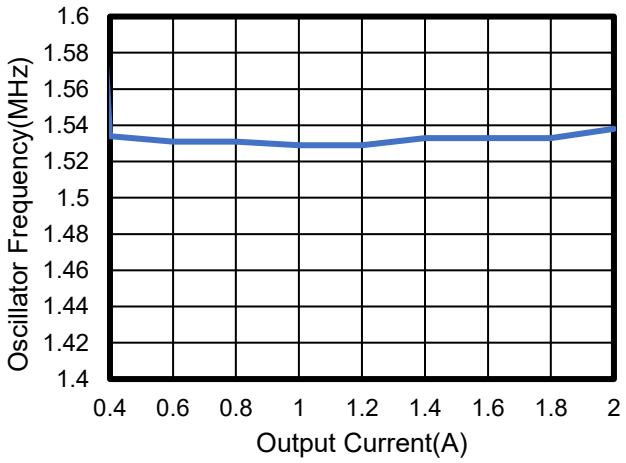


Figure 4 Oscillator Frequency vs. Output Current

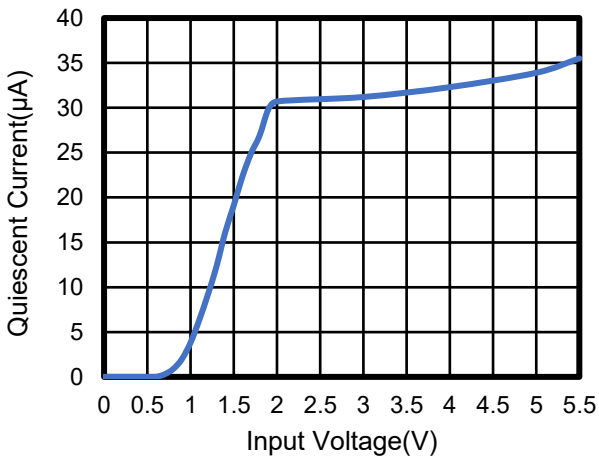


Figure 5 Quiescent Current vs. Input Voltage

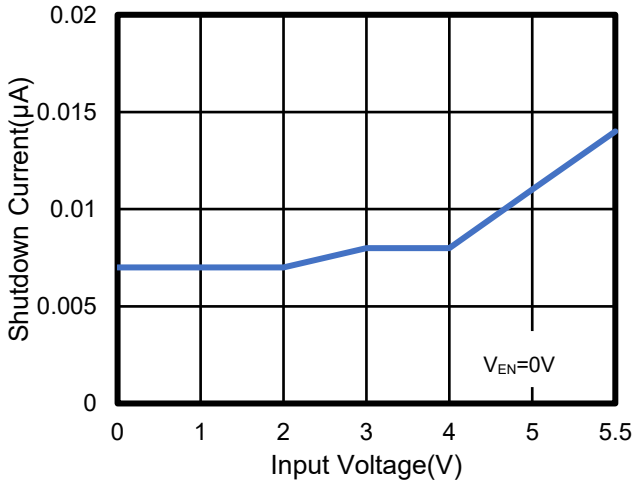


Figure 6 Shutdown Current vs. Input Voltage

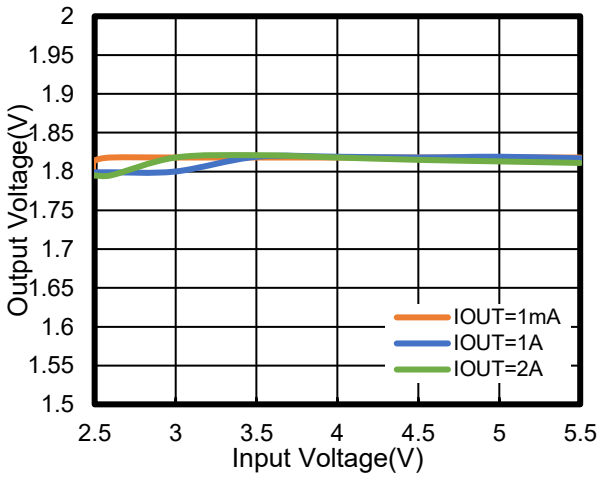


Figure 7 Output Voltage vs. Input Voltage

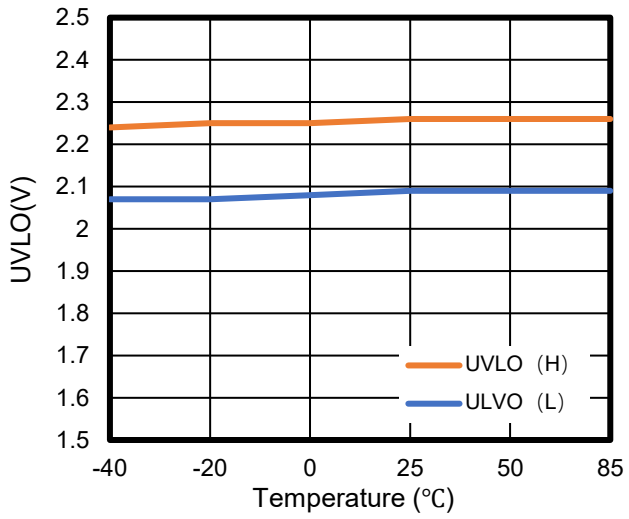


Figure 8 UVLO vs. Temperature

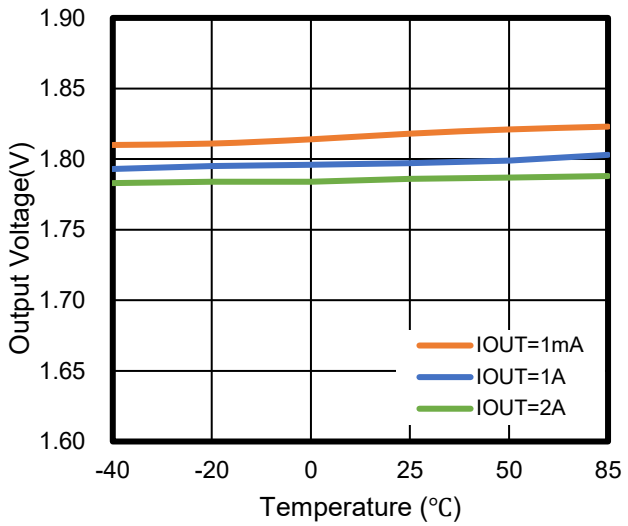


Figure 9 Output Voltage vs. Temperature

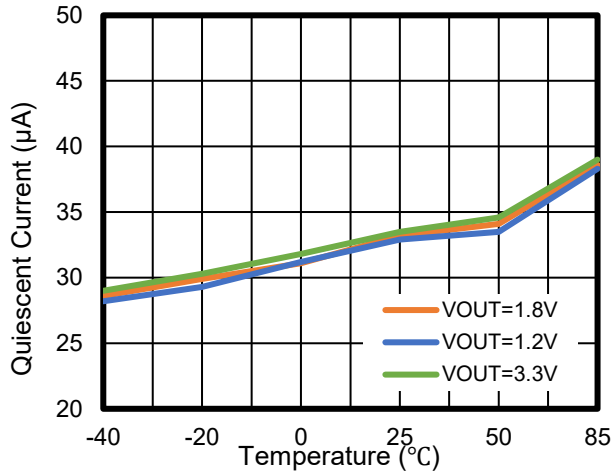


Figure 10 Quiescent Current vs. Temperature

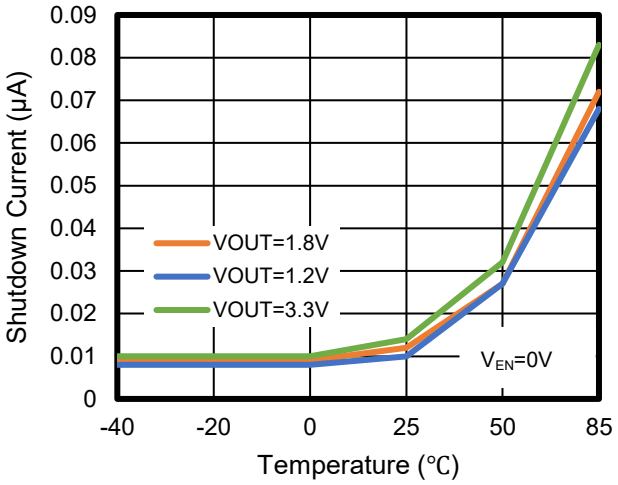


Figure 11 Shutdown Current vs. Temperature

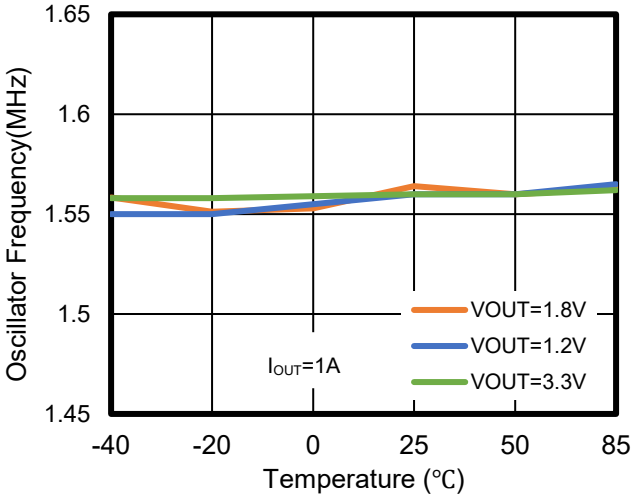


Figure 12 Oscillator Frequency vs. Temperature

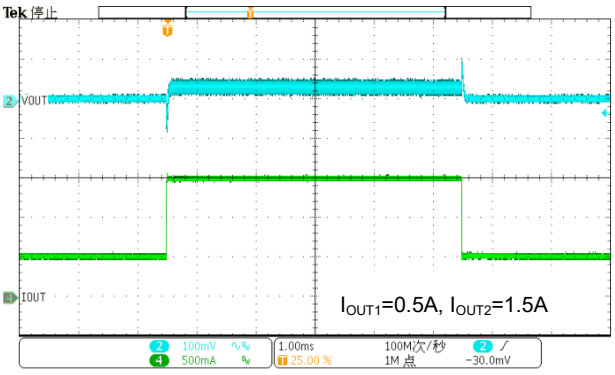


Figure 13 Load Transient

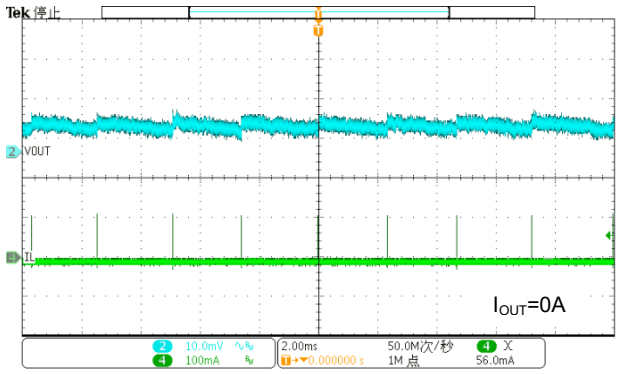


Figure 14 Output Ripple

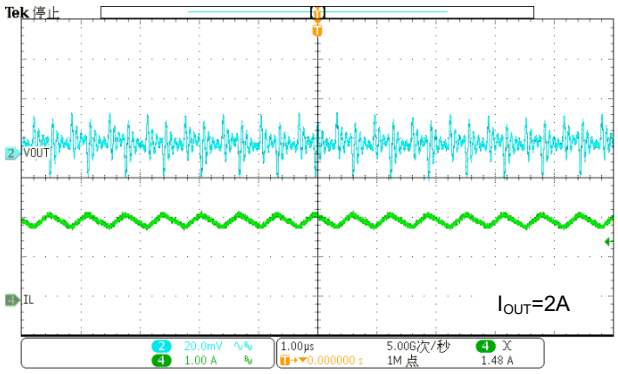


Figure 15 Output Ripple

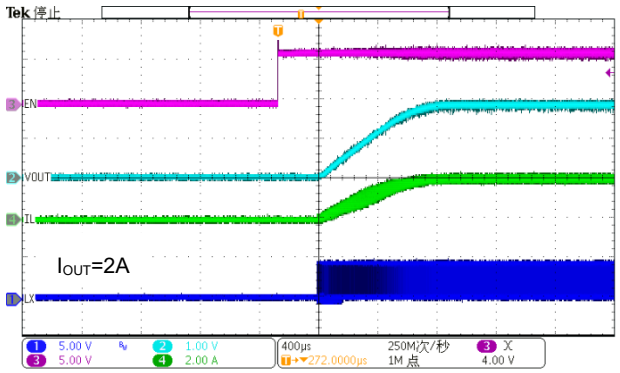


Figure 16 Startup from Enable

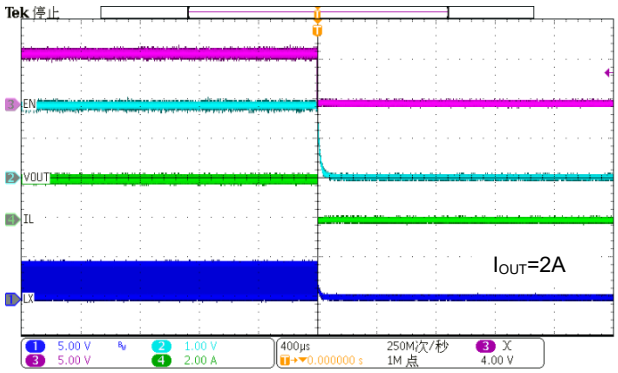


Figure 17 Shutdown from Enable

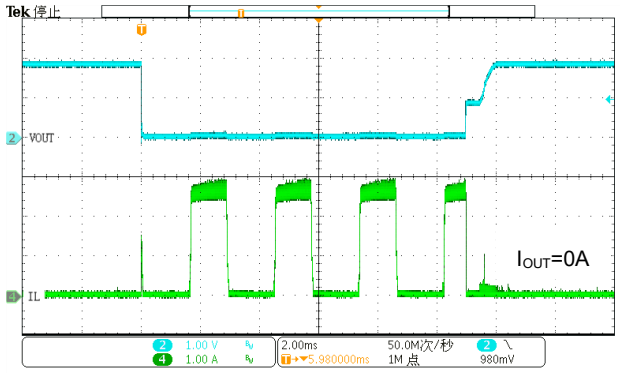


Figure 18 Short Circuit Protection and Recovery

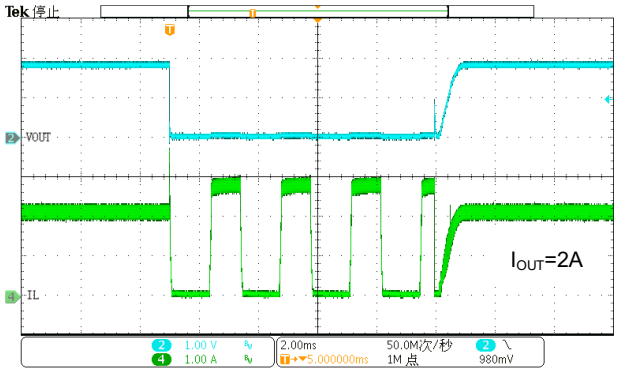
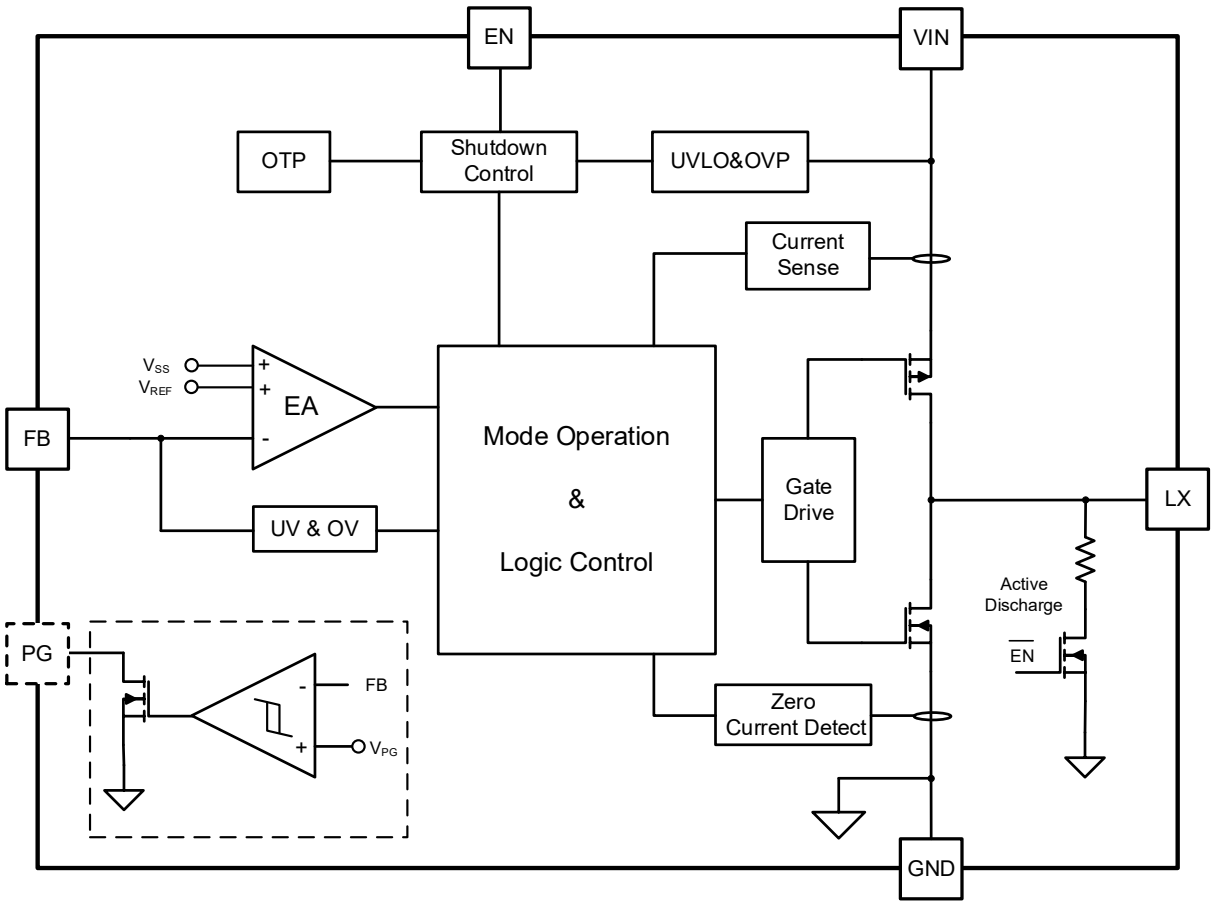


Figure19 Short Circuit Protection and Recovery

10. Function Description

10.1 Block Diagram



Note: Power Good feature is only available in WD20027MFR

10.2 V_{IN}-UVLO

The chip has an under-voltage lockout function, which ensures that the chip will not start until the input voltage reach the specified voltage, and a hysteresis function is set for UVLO to ensure that noise on the power supply does not cause system failure.

10.3 EN

When the input voltage is greater than the under-voltage lockout (UVLO) threshold (typically 2.3V), the chip can be enabled by pulling EN higher than 1.5V. Pulling it down to ground disables the chip. When the chip is disabled, it goes into output discharge mode automatically. Its internal discharge MOSFET provides a resistive discharge path for the output capacitor. EN can be directly connected with V_{IN} for default enable-on, and floating EN is not permitted.

10.4 Soft Start

During the power-up of the chip, the output voltage rises from zero to the regulated level. Due to the effect of negative feedback, the duty cycle of the PWM control signal of the power MOSFET changes from the maximum value and gradually decreases until the circuit is stable. Due to the existence of output filter

capacitors in the circuit, it is easy to generate inrush current when charging the capacitors. At this time, a large current will flow through the power MOSFET, which is easy to cause the system fail. Therefore, there is a soft start function built in the chip, and the output voltage gradually increases from 0V to the regulated level during power-on, reducing the input inrush current.

10.5 PWM/PFM Mode

The PWM/PFM hybrid control method is to stabilize the output voltage by changing the width and pulse frequency of the square wave. At full load, PWM is used, which has relatively high efficiency and a wide range of duty cycles. The PFM mode is used to improve the efficiency at light load.

10.6 Feedback

The FB will be connected to the internal EA of the chip and compared with the internal reference voltage(0.6V). The result of the comparison will control the change of the duty cycle, so as to achieve the purpose of stabilizing the voltage.

10.7 Output Protection

The chip has a minimum 3.2A high-side switch peak current limit. When the high-side switch reaches its peak current limit, it remains in hiccup mode until the current drops. This prevents the inductor current from continuing to rise and damaging components.

The chip enters short-circuit protection mode when it reaches the peak current limit under short-circuit condition and attempts to recover with hiccup mode. In this process, the chip disables the output power stage, discharges the soft-start capacitor, and then attempts to soft start again automatically. If the short-circuit condition remains after the soft start ends, the chip repeats this cycle until the short-circuit disappears and the output rises back to the regulation level.

10.8 Power Good (only for WD20027MFR)

The chip has an open drain PG and requires an external pull-up resistor between 100kΩ~500kΩ for the power good. Note: Keep PG pull-up voltage is not more than V_{IN}. When V_{OUT} is within 90% -100% of the regulated level, V_{PG} is pulled up to high by the external resistor. If V_{OUT} exceeds the 90% -100% window, the internal MOSFET pulls PG to ground.

11. Application Information

11.1 Typical Application Circuit

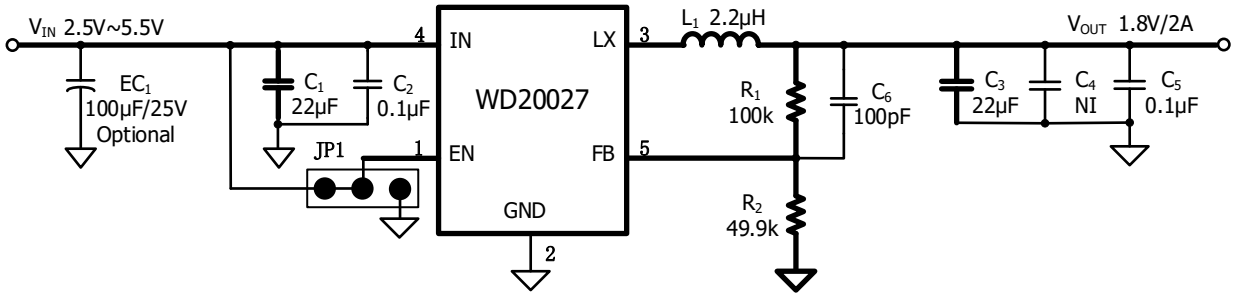


Figure 20 WD20027MER Typical Application Circuit

11.2 Setting the Output Voltage

The output voltage is set by an external resistor divider according to equation:

$$V_{OUT} = V_{FB} \times \left(1 + \frac{R_1}{R_2}\right) = 0.6V \times \left(1 + \frac{R_1}{R_2}\right)$$

There is no strict requirement for the feedback resistor. An R_1 value greater than 10kΩ is reasonable for most applications. R_2 must not be higher than 100kΩ to achieve high efficiency at light load while providing acceptable noise sensitivity.

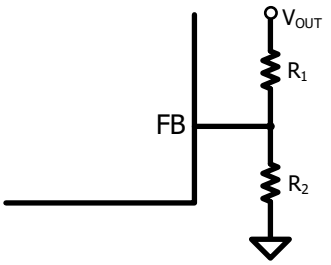


Figure 21 Feedback Network

Table1 shows a list of recommended component selections for common WD20027 output voltages.

Table 1. Recommended Component Selections

Output Voltage (V)	R_1 (kΩ)	R_2 (kΩ)	L_1 (μH)	C_1 (μF)	C_3 (μF)	C_6 (pF)
1.0	40.2	60.4	1.0	22	22	100
1.2	49.9	49.9	1.0	22	22	100
1.5	60.4	40.2	1.5	22	22	100

Output Voltage (V)	R_1 (kΩ)	R_2 (kΩ)	L_1 (μH)	C_1 (μF)	C_3 (μF)	C_6 (pF)
1.8	100	49.9	2.2	22	22	100
2.5	76.8	24	2.2	22	22	100
3.3	90.9	20	2.2	22	22	100
5.0	110	15	2.2	22	22	100

11.3 Selecting the Inductor

Most applications work best with a 1 - 2.2μH inductor. Select an inductor with a DC resistance less than 50mΩ to optimize efficiency. A high-frequency, switch-mode power supply with a magnetic device produces a strong electronic magnetic inference in the system. Any shield inductor, are ideal for applications as they can decrease the influence effectively.

For most designs, estimate the inductance value with equation:

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

Where ΔI_L is the inductor ripple current.

Choose an inductor current that is approximately 30% of the maximum load current. The inductor peak current can be calculated with equation in CCM:

$$I_{PEAK} = I_{OUT} + \frac{\Delta I_L}{2}$$

11.4 Selecting the Input Capacitor

A typical X5R or better grade ceramic capacitor with 10V rating and no less than 22μF capacitance is recommended. To minimize the potential noise problem, we place this ceramic capacitor really close to the V_{IN} and GND pins. Care should be taken to minimize the loop area formed by C_1, and IN/GND pins. An optional E-cap 100uF/25V EC1 should be used for hot-swap application when powered by external power supply with over 1000mm wires.

When using ceramic capacitors, ensure that they have enough capacitance to provide a sufficient charge to prevent an excessive voltage ripple at the input. The input voltage ripple caused by the capacitance can be estimated with equation:

$$\Delta V_{IN} = \frac{I_{OUT}}{f_s \times C_1} \times \frac{V_{OUT}}{V_{IN}} \times \left(1 - \frac{V_{OUT}}{V_{IN}}\right)$$

11.5 Selecting the Output Capacitor

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. Estimate the output voltage ripple with equation:

$$\Delta V_{OUT} = \frac{V_{OUT}}{f_s \times L_1} \times (1 - \frac{V_{OUT}}{V_{IN}}) \times (R_{ESR} + \frac{1}{8 \times f_s \times C_3})$$

Where L_1 is the inductor value, and R_{ESR} is the equivalent series resistance (ESR) value of the output capacitor.

For the best performance, it is recommended to use X5R or better grade ceramic capacitor with 10V rating and no less than 22μF capacitance.

11.6 PCB Layout Guidelines

For 1.5MHz high-frequency switching converter, a poor layout design can result in poor line or load regulation and stability issues. For best performance, refer to Figure 20 and follow the guidelines below.

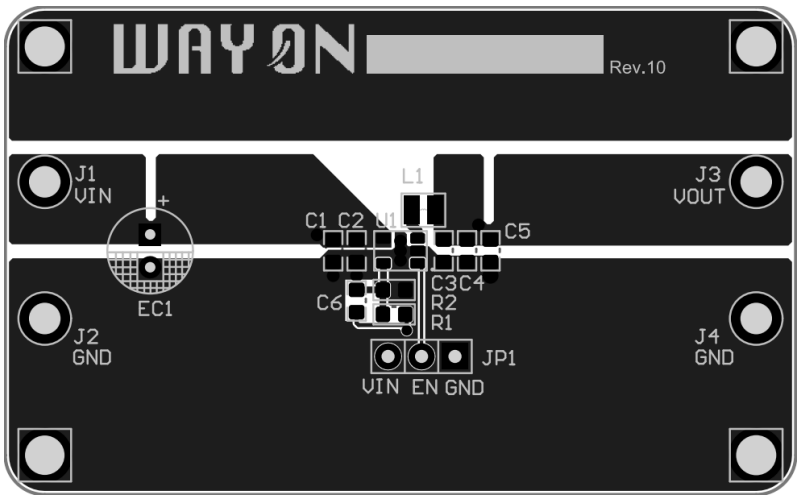


Figure 22 WD20027MER PCB Layout

1. Place the high-current paths (GND, IN and LX) very close to the device with short, direct, and wide traces.

2. Place the input capacitors C_1 and C_2 as close to IN and GND as possible.

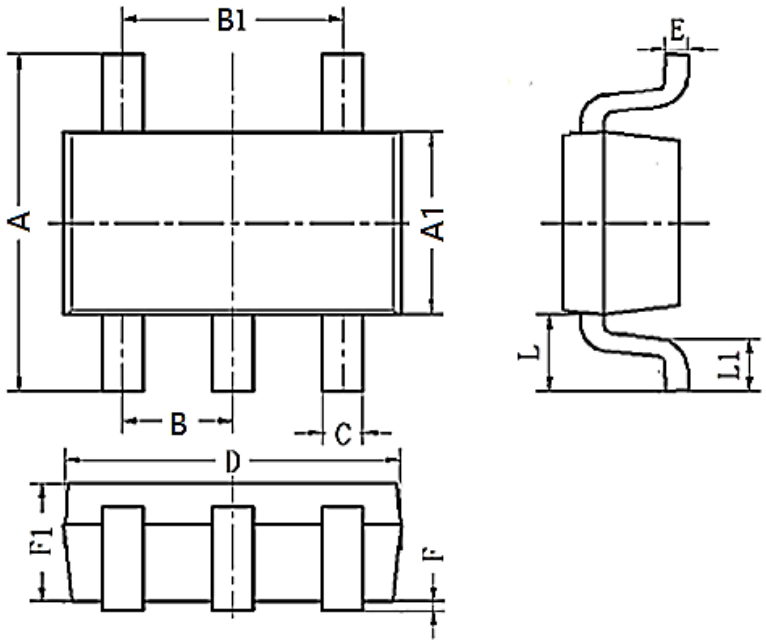
3. Place the external feedback resistors R_1 and R_2 next to FB.

4. Keep the switching node LX short and away from the feedback network.

5. Keep the V_{OUT} sense line as short as possible or away from the power inductor, especially the surrounding inductor.

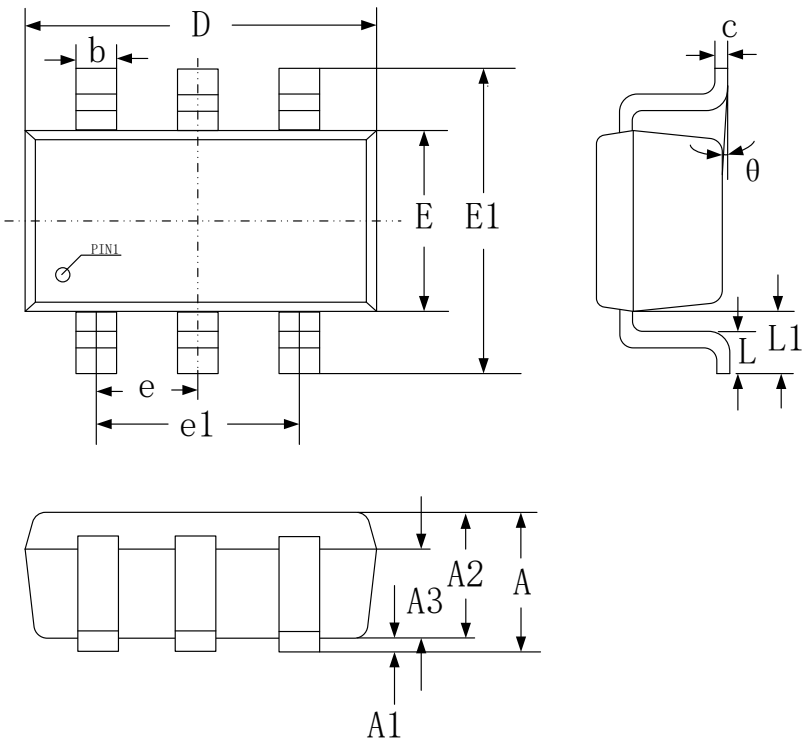
12. Package Information

SOT23-5



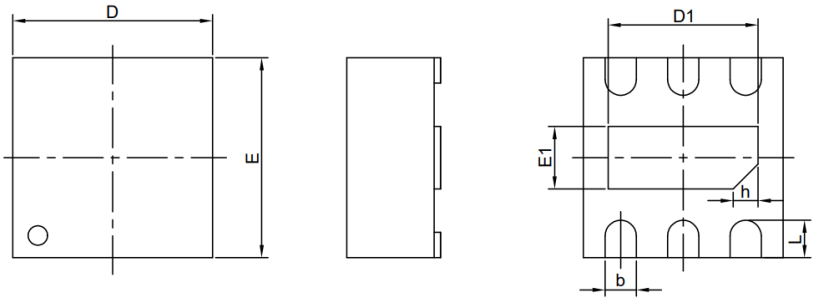
SYMBOL	DIMENSIONS IN MILLIMETERS		
	MIN	NOM	MAX
A	2.60	2.80	3.00
A1	1.50	1.60	1.70
B	0.85	0.95	1.05
B1	1.80	1.90	2.00
C	0.25	0.37	0.50
D	2.79	2.90	3.02
E	0.10	0.15	0.20
F	0.00	0.10	0.20
L	0.60REF		
L1	0.30	0.45	0.60
F1	0.85	1.10	1.30

SOT23-6

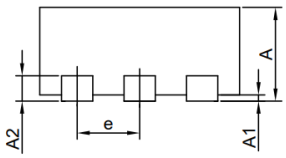


SYMBOL	DIMENSIONS IN MILLIMETERS		
	MIN	NOM	MAX
A	-	-	1.25
A1	0.00	-	0.15
A2	1.00	1.10	1.20
A3	0.575	0.65	0.725
b	0.325	-	0.5
c	0.1	-	0.2
D	2.82	2.92	3.02
E	1.50	1.60	1.70
E1	2.60	2.80	3.00
e	0.925	0.95	0.975
e1	1.90 BSC		
L1	0.59 REF		
L	0.35	0.45	0.60
θ	0°		8°

DFN1.6*1.6-6



Top View　　Side View　　Bottom View



Side View

SYMBOL	DIMENSIONS IN MILLIMETERS		
	MIN	NOM	MAX
A	0.70	0.75	0.80
A1	0.00	0.02	0.05
A2		0.203REF	
b	0.20	0.25	0.30
D	1.55	1.60	1.65
D1	0.95	-	1.25
E	1.55	1.60	1.65
E1	0.45	-	0.65
e		0.50BSC	
h	0.15	-	0.30
L	0.15	-	0.30

13. Ordering Information

PART NUMBER	POWER GOOD	PACKAGE	PACKING QUANTITY	MARKING
WD20027MER	N	SOT23-5L	3k/Reel	P26XX
WD20027MFR	Y	SOT23-6L	3k/Reel	P26PXX
WD20027FHR	N	DFN1.6*1.6-6L	3k/Reel	P26D XXXXX
WD20027FGR	Y	DFN1.6*1.6-6L	3k/Reel	P26D XXXXX

* XXXX is variable.

Contact Information
No.1001, Shiwan(7) Road, Pudong District, Shanghai, P.R.China.201207
Tel: 86-21-50310888 Fax: 86-21-50757680 Email: market@way-on.com
WAYON website: http://www.way-on.com
For additional information, please contact your local Sales Representative.
WAYON® is registered trademark of Wayon Corporation.

Specifications are subject to change without notice.
The device characteristics and parameters in this data sheet can and do vary in different applications and actual device performance may vary over time.
Users should verify actual device performance in their specific applications.

Product Specification Statement

- The product specification aims to provide users with a reference regarding various product parameters, performance, and usage. It presents certain aspects of the product's performance in graphical form and is intended solely for users to select product and make product comparisons, enabling users to better understand and evaluate the characteristics and advantages of the product. It does not constitute any commitment, warranty, or guarantee.
- The product parameters described in the product specification are numerical values, characteristics, and functions obtained through actual testing or theoretical calculations of the product in an independent or ideal state. Due to the complexity of product applications and variations in test conditions and equipment, there may be slight fluctuations in parameter test values. WAYON shall not guarantee that the actual performance of the product when installed in the customer's system or equipment will be entirely consistent with the product specification, especially concerning dynamic parameters. It is recommended that users consult with professionals for product selection and system design. Users should also thoroughly validate and assess whether the actual parameters and performance when installed in their respective systems or equipment meet their requirements or expectations. Additionally, users should exercise caution in verifying product compatibility issues, and WAYON assumes no responsibility for the application of the product.
- WAYON strives to provide accurate and up-to-date information to the best of our ability. However, due to technical, human, or other reasons, WAYON cannot guarantee that the information provided in the product specification is entirely accurate and error-free. WAYON shall not be held responsible for any losses or damages resulting from the use or reliance on any information in these product specifications. WAYON reserves the right to revise or update the product specification and the products at any time without prior notice, and the user's continued use of the product specification is considered an acceptance of these revisions and updates. Prior to purchasing and using the product, users should verify the above information with WAYON to ensure that the product specification is the most current, effective, and complete. If users are particularly concerned about product parameters, please consult WAYON in detail or request relevant product test reports. Any data not explicitly mentioned in the product specification shall be subject to separate agreement.
- Users are advised to pay attention to the parameter limit values specified in the product specification and maintain a certain margin in design or application to ensure that the product does not exceed the parameter limit values defined in the product specification. This precaution should be taken to avoid exceeding one or more of the limit values, which may result in permanent irreversible damage to the product, ultimately affecting the quality and reliability of the system or equipment.
- The design of the product is intended to meet civilian needs and is not guaranteed for use in harsh environments or precision equipment. It is not recommended for use in systems or equipment such as medical devices, aircraft, nuclear power, and similar systems, where failures in these systems or equipment could reasonably be expected to result in personal injury. WAYON shall assume no responsibility for any consequences resulting from such usage.
- Users should also comply with relevant laws, regulations, policies, and standards when using the product specification. Users are responsible for the risks and liabilities arising from the use of the product specification and must ensure that it is not used for illegal purposes. Additionally, users should respect the intellectual property rights related to the product specification and refrain from infringing upon any third-party legal rights. WAYON shall assume no responsibility for any disputes or controversies arising from the above-mentioned issues in any form.