RVP010 Micro-power Transformer Drivers for Isolated Power Supplies

2.8-6VIN/24V/1A LDMOS

FEATURES

- Push-pull Topology
- Highly Integration with Simple Peripheral Circuitry
- Built-in 24V/0.1Ω LDMOS
- 1.7A Current limit
- Wide Input Voltage Range: 2.8-6V
- Two Selectable Switch Frequencies
- EN Pin for On/Off Control
- Short-circuit Protection, Thermal Shutdown, and Self-recovery
- Ambient Temperature: -40°C~+125°C

APPLICATIONS

- Isolated Power Supplies for CAN, RS-485, RS-232, SPI, I2C, etc.
- Process Control
- Precision/Medical Instrument
- Distributed/Radio/Telecom Power Supplies
- Low-noise Isolated USB Power Supplies
- Low-noise Filament Power Supplies
- IGBT Gate Drive Power Supplies

DESCRIPTION

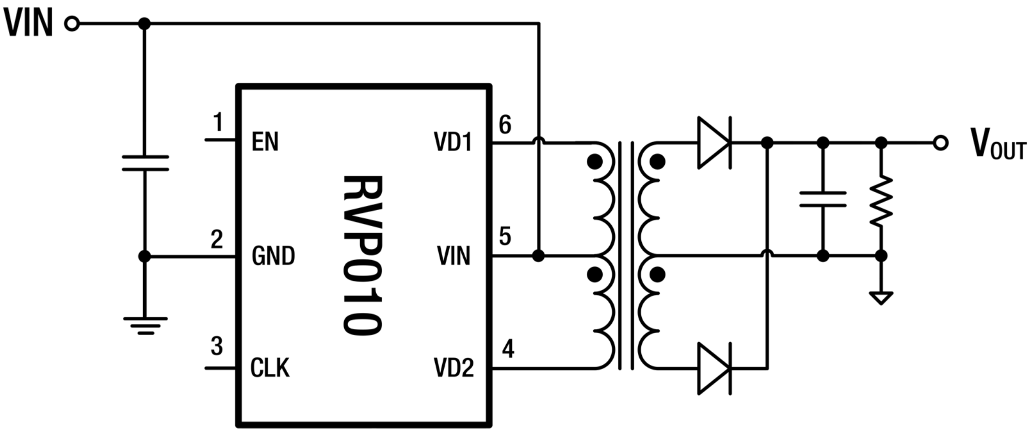
The RVP010 is a push-pull transformer driver specifically designed for small form factor, low standby power isolated micro power supplies. It requires only a simple peripheral configuration, including input and output filter capacitors, an isolation transformer, and a rectifier circuit, to achieve an isolated power supply with a 3.3V or 5V input, an output voltage ranging from 3.3V to 24V, and output power between 1W and 3W.

The RVP010 integrates an internal oscillator that generates a pair of high-precision complementary signals to drive two N-channel switches. Its symmetrical internal architecture ensures excellent balance between the two power switches, minimizing magnetic bias during operation. The chip includes an enable pin (EN) and supports two selectable operating frequencies, which can be chosen by either floating or grounding the CLK pin. A high-precision dead-time control circuit is also integrated to prevent simultaneous conduction of the two power switches under all operating conditions.

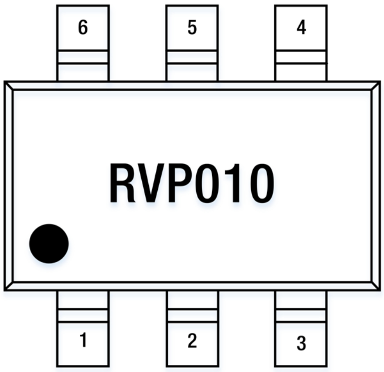
Device Information

Part Number	Package	Size	SPQ
RVP010	SOT23-6	3.0 mm x 3.02 mm	3000

SIMPLIFIED SCHEMATIC



PIN CONFIGURATION AND FUNCTIONS



NAME	No.	TYPE	DESCRIPTION
EN	1	I	A low level on the EN pin turns the device off. Leaving the EN pin floating or keeping it at a high level turns the device on.
GND	2	P	Logic circuit grounding and analog circuit grounding.
CLK	3	I	This pin functions as the operating frequency selector. Leaving this pin floating selects the low frequency of 217kHz. Connecting this pin to GND selects the high frequency of 390kHz.
VD2	4	O	Transformer drive output 2.
VIN	5	P	This is the device supply pin. It should be bypassed to GND with a 1 µF capacitor mounted as close as possible to the device.
VD1	6	O	Transformer drive output 1.

TECHNICAL SPECIFICATIONS

Absolute Maximum Ratings

		MIN	MAX	UNIT
VIN Input Voltage	V_{IN}	-0.3	10	V
LDMOS Drain Voltage	VD1 , VD2	-1	24	
	VD1, VD2 (transient 50ns)	-2		
LDMOS Peak Current	$I_{(VD1)Pk}$, $I_{(VD2)Pk}$		2.2	A
EN/CLK Pin Voltage	EN, CLK	-0.3	6.6	V
Maximum Junction Temperature	T_{JMAX}		150	°C
Storage Temperature Range	T_{STG}	-55	150	°C

Stress exceeding the absolute maximum rated value may cause permanent damage to the device. These are only stress ratings and do not imply that the device operates beyond the recommended operating conditions under these or any other conditions. Long term exposure to absolute maximum rated conditions may affect the reliability of the device. All voltages are related to grounding. The current is positive input and negative output.

ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human Body Model (HBM), VD1 and VD2 to GND	±8000	V
		Other pins per ESDA/JEDEC JS-001-2017; (Zap 1 pulse, Interval: ≥0.1 s)	±2000	V
		Charged Device Model (CDM), per ESDA/JEDEC JS-002-2014	±1000	V

Thermal Resistance

Packaging	θ_{JA}	Ψ_{JT}	UNIT
SOT23-6	143	17.37	°C/W

Note: Measured on a test board with 1oz copper (7.62cm × 11.43cm).

Recommended Operatings Conditions

		MIN	TYP	MAX	UNIT
VIN Input Voltage	V_{IN}	2.8		6.0	V
LDMOS Drain Voltage	I_{VD1}, I_{VD2}			1.0	A
Ambient Temperature	T_A	-40		125	°C

Electrical Characteristics

Unless otherwise noted, all values are measured at ambient temperature T=25°C and with CLK floating.

SYMBOL	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
INPUT PIN VIN						
V_{IN}	Input voltage range		2.8		6.0	V
$V_{IN (ON)}$	Start Up Voltage	EN floating, V_{IN} rising	2.65	2.8	2.95	V
$V_{IN (HYS)}$	Hysteresis voltage	EN floating, V_{IN} falling		0.6		V
I_Q	VIN quiescent current	VD1/VD2 floating		0.64	1.4	mA
$I_{VIN (EN)}$	VIN current after EN disabled	EN=0		5.2	7.0	µA
ENABLE PIN EN						
$V_{IN (ON)}$	Enable pin EN start up voltage	V_{EN} Voltage rising		1.8		V
$V_{EN (OFF)}$	EN enable shut down voltage	V_{EN} Voltage falling		0.8		V
$I_{EN (HYS)}$	EN enable shut down hysteresis			1.0		V
OUTPUT PIN VD1 / VD2						
DMM	VD1/VD2 pulse width mismatch ratio			0%		
$R_{DS(ON)}$	LDMOS on-resistance	VIN=4.5V, $I_{DS1/ IDS2}$=1A		90	135	mΩ
		VIN=3.0V, $I_{DS1/ IDS2}$=1A		108	162	
V_{SLEW}	Voltage slew rate	VD1/VD2 are connected respectively with 50Ω to VIN		135		V/us
t_{BBM}	Interval between VD1 and VD2 (Break-before-make time)	VD1/VD2 are respectively connected with 50Ω to VIN		175		ns
I_{LIM0}	Initial value of Current Clamp Limit	VD1, VD2, VIN short connect, Testing I_{VIN}		0.5		A
I_{LIM1}	Current clamp limits steady-state values			1.7		A
t_{SS}	Soft-start time			3.0		mS
Frequency of CLK at high level						
f_{SW1}	Frequency of CLK at high level	CLK floating	183	217	247	kHz
f_{SW2}	Frequency of the CLK at low level	CLK connected to GND	365	390	475	kHz
THERMAL SHUT DOWN PROTECTION						
T_{SHDN}	Thermal shut down threshold		146	162	178	°C
$T_{SHDN (HYS)}$	Thermal shut down hysteresis			18		°C

Typical Characteristics

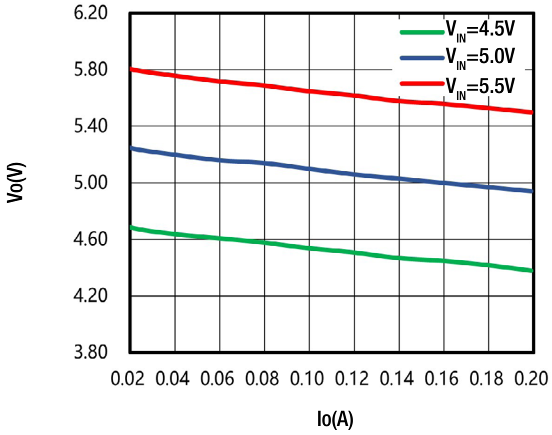


Fig. 1 Output Voltage vs Load Current
(RVP010, 5V to 5V/1W)

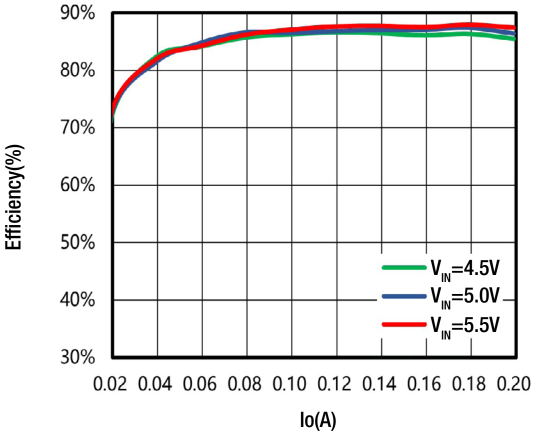


Fig. 2 Efficiency vs Load Current
(RVP010, 5V to 5V/1W)

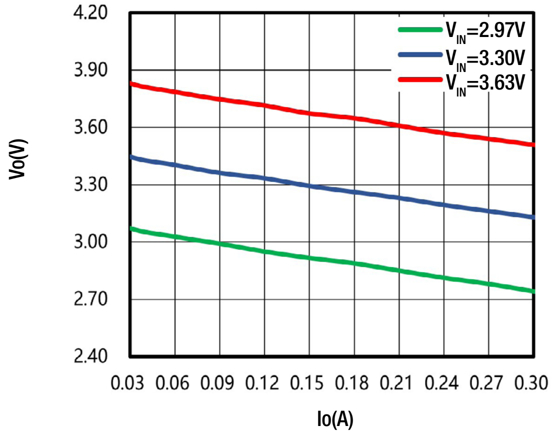


Fig. 3 Output Voltage vs Load Current
(RVP010, 3.3V to 3.3V/1W)

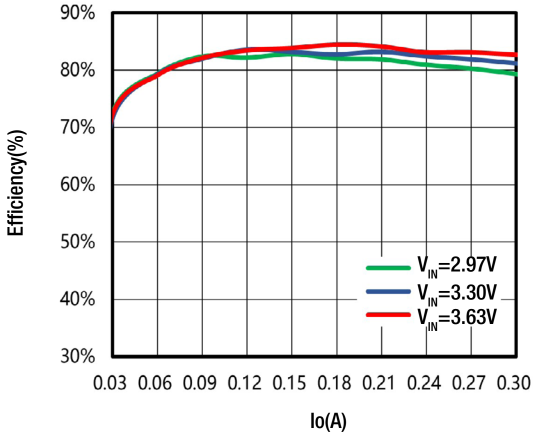


Fig. 4 Efficiency vs Load Current
(RVP010, 3.3V to 3.3V/1W)

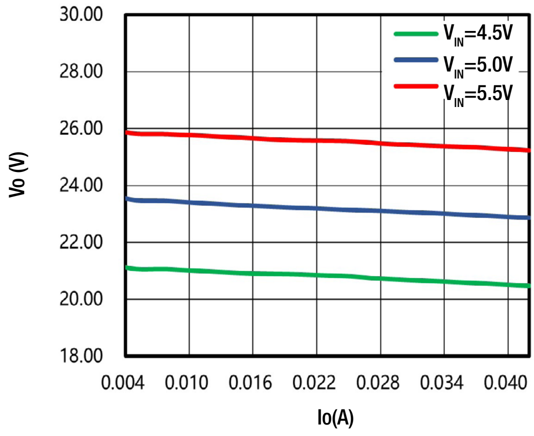


Fig. 5 Output Voltage vs Load Current
(RVP010, 5V to 24V/1W)

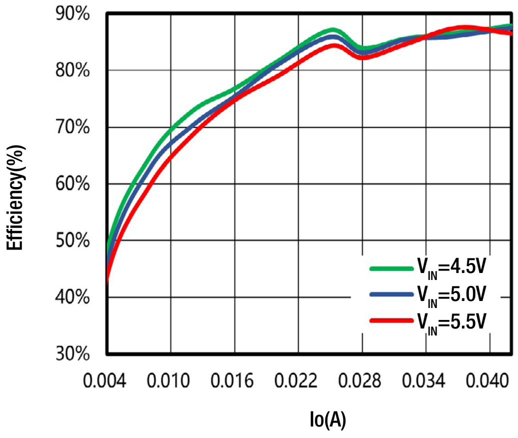


Fig. 6 Efficiency vs Load Current
(RVP010, 5V to 24V/1W)

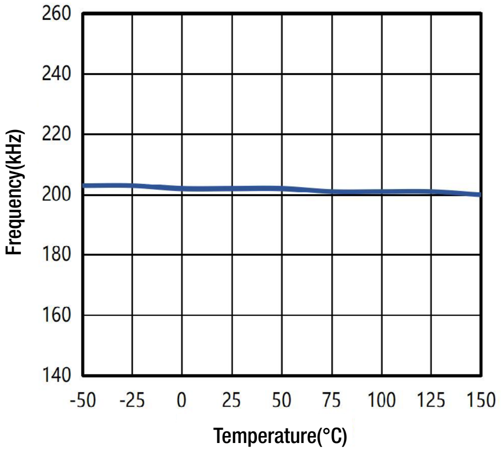


Fig. 7 Frequency (CLK floating) vs Junction Temperature

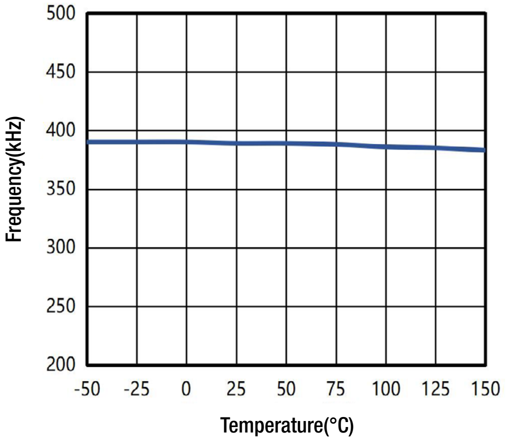


Fig. 8 Frequency (CLK Grounded) vs Junction Temperature

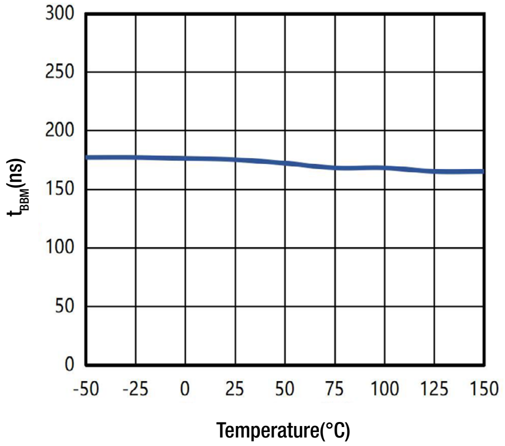


Fig. 9 Dead-time (CLK floating) vs Junction Temperature

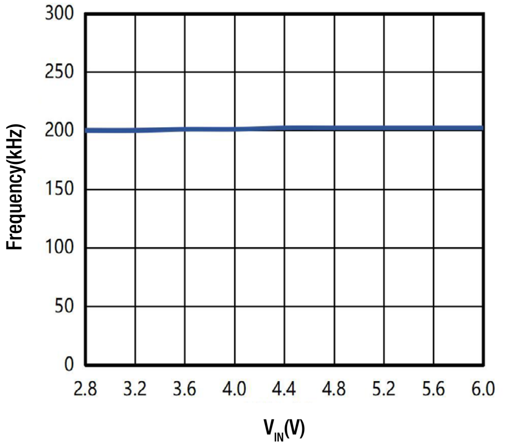


Fig. 10 Frequency (CLK floating) vs Input Voltage

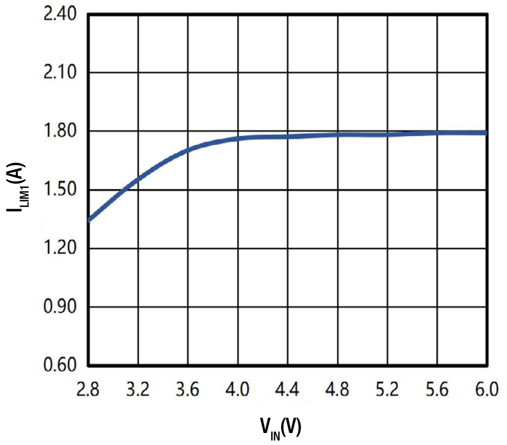


Fig. 11 Clamp Current (CLK floating) vs Input Voltage

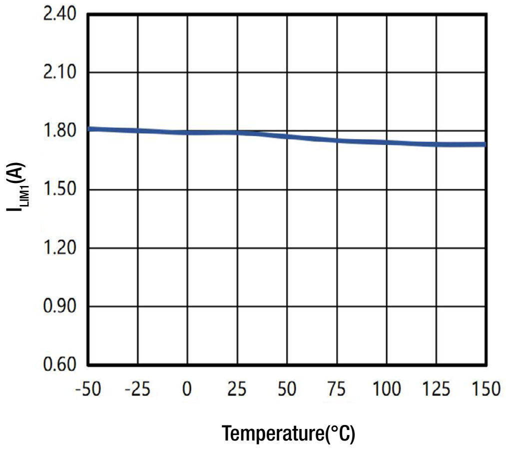


Fig. 12 Clamp Current vs Junction Temperature

PARAMETER MEASUREMENT INFORMATION

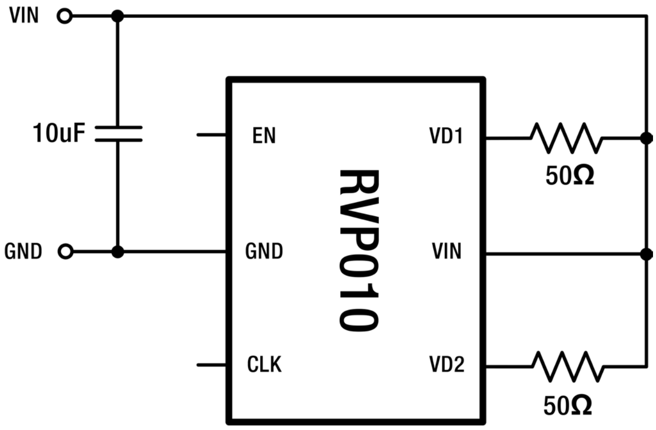


Fig. 13 Measurement Circuit f_{SWO}/ V_{SLEW}/ t_{BBM}

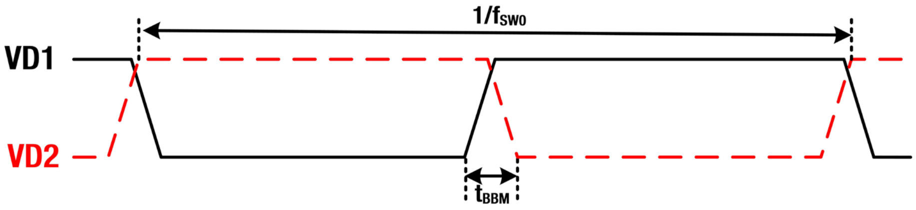


Fig. 14 Timing Diagram for VD1 and VD2

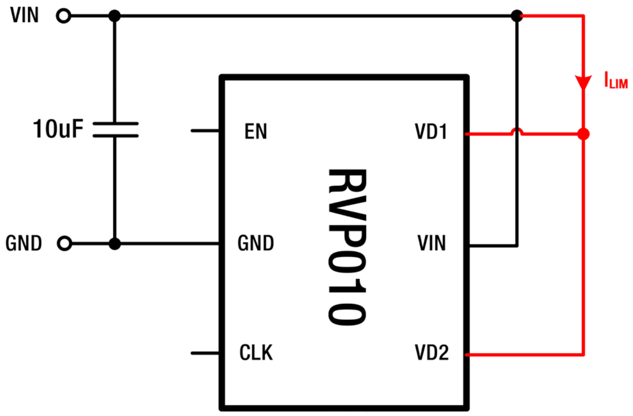


Fig. 15 I_{LIM} Measurement Circuit

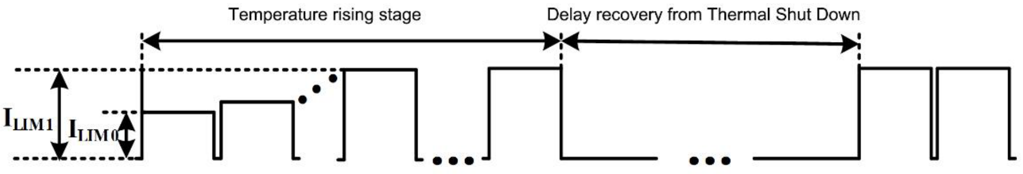


Fig. 16 Timing Diagram for I_{LIM}

FUNCTIONS AND PRINCIPLES

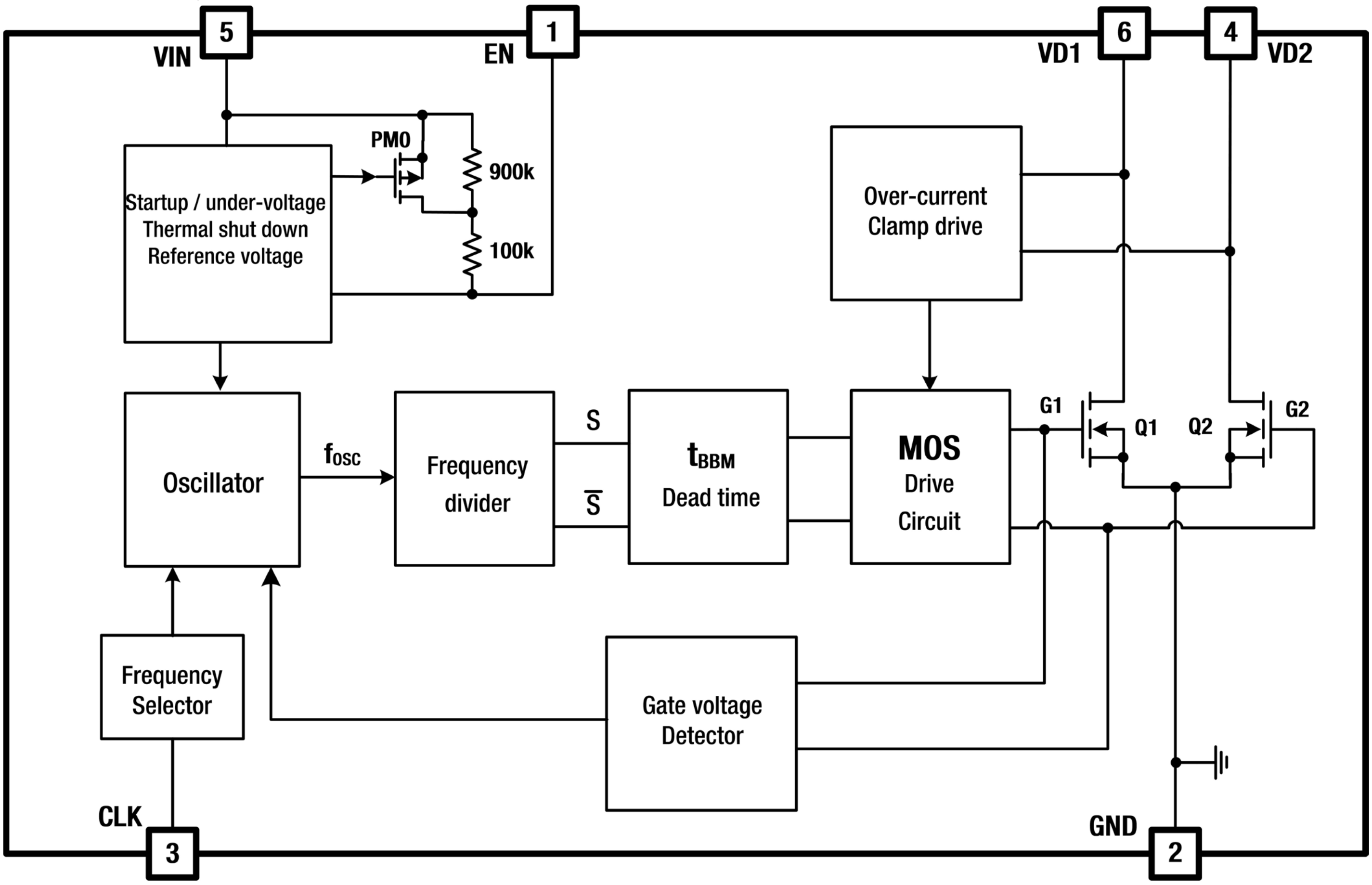
Overview

RVP010–Integrated Push-Pull Controller with Internal Power Switches: RVP010 is a highly integrated Push-Pull controller tailored for isolated DC-DC switching power supply applications. It incorporates a matched pair of low-resistance 0.1Ω nLDMOS power switches, optimized for input voltage ranges from 2.8V to 6V.

To ensure safe operation under high load conditions, the RVP010 features built-in current clamping, which actively limits the peak current through the internal switches. This not only safeguards the device itself but also protects external components from excessive current stress. The device supports dual operating frequencies, selectable via the CLK pin. Floating or grounding this pin allows the user to configure the switching frequency as required. A built-in dead time (t_{BBM}) between the drive signals ensures non-overlapping switching of the internal MOSFETs, effectively preventing cross-conduction and minimizing drain-source voltage spikes during transitions. This contributes to significantly reduced switching losses.

RVP010 features an enable control via the EN pin. When EN is driven high-or left unconnected due to its internal pull-up-the device operates normally. Pulling the EN pin low disables the device and places it into an ultra-low power standby mode, making it ideal for power consumption sensitive applications.

Functional Block Diagram



Application Information

Push-pull Drive Sequence

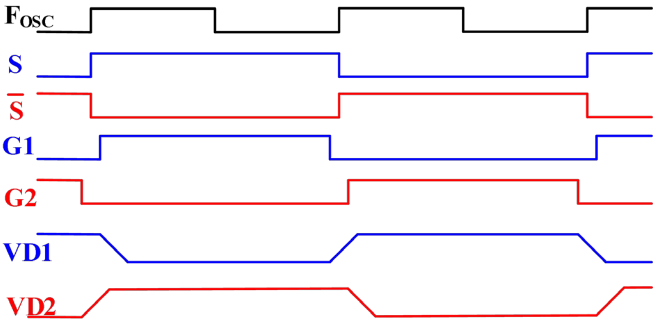


Fig. 17 Push-pull Drive Sequence and Output Signal Waveforms

As shown in Figure 17, the output signals from G1 and G2 serve as the gate drive signals for the output LDMOS transistors Q1 and Q2. These signals have identical high-level pulse widths. Between the high-level signals, a synchronized low-level interval exists-this is the break-before-make time t_{BBM}. The t_{BBM} interval prevents simultaneous conduction of Q1 and Q2, avoiding short circuits between the two LDMOS channels, reducing the drain voltage at turn-on, and consequently minimizing switching losses.

The t_{BBM} in the RVP010 is fixed and independent of the CLK signal. It is generated only after the gate voltage of Q1 and Q2 is fully discharged during shutdown. This ensures that t_{BBM} is not affected by variations in thermal characteristics or drive delays, maintaining consistent operation across the entire input voltage range.

Current Clamp Drive Mode

Excessive current through the LDMOS may occur during converter startup, an output short circuit, or transformer magnetic saturation. In such cases, the gate drive voltage of LDMOS transistors Q1 and Q2 is reduced to limit the current to the predefined Current Clamp Limit. This control mechanism ensures that the LDMOS operates within its safe operating area, while also protecting the transformer and output rectifier diode from high inrush current. As a result, the overall reliability and robustness of the converter are significantly improved.

Delay Recovery from Thermal Shutdown Protection Mode

When the internal temperature of the device exceeds a predefined threshold, it enters Thermal Shutdown Protection mode, during which all LDMOS are disabled. To resume normal operation and re-enable the LDMOS drive, two conditions must be met: (1) the internal temperature must fall below the Thermal Shutdown Recovery Threshold, and (2) a mandatory cooldown period must elapse.

Upon restarting from Thermal Shutdown Protection, the internal temperature is typically closer to the ambient temperature. This results in a larger temperature margin before reaching the shutdown threshold again, allowing for a longer LDMOS drive period. This behavior is particularly beneficial under heavy capacitive loads, as it helps prevent abnormal startup conditions when large output capacitance is present.

Output Short-Circuit Protection

RVP010 implements Output Short Circuit Protection through the combined mechanisms of Current Clamp Drive Mode and Delayed Recovery from Thermal Shutdown Protection. When a short circuit occurs at the output of the push-pull converter, the transformer's primary winding becomes clamped. In this condition, most of the input voltage (V_{IN}) drops across the N-channel LDMOS Q1 or Q2, while the voltage across the transformer is minimal.

Upon detecting excessive current through the LDMOS, the device enters Current Clamp Drive Mode, limiting the current to a safe level. As a result of sustained high current, the LDMOS generates heat, causing the device temperature to gradually rise until it reaches the Thermal Shutdown threshold. The device then enters Delayed Recovery mode, during which LDMOS is disabled.

The rate of temperature rise depends on the ambient temperature and input voltage. Lower ambient temperatures or input voltages slow the thermal buildup, extending the time before shutdown and providing greater tolerance for large capacitive loads. Even under high-temperature conditions, the Delayed Recovery mechanism helps optimize startup behavior and enhance capacitive load handling.

General Operation Mode

During startup, the voltage across the converter's output capacitor is low, resulting in a high current through the LDMOS. In this stage, the device operates in Current Clamp Drive Mode to limit the current and ensure safe operation. As the output voltage approaches its rated value, the current through the LDMOS decreases. The device then increases the gate drive voltage to minimize the internal on-resistance $R_{DS(on)}$, thereby improving efficiency and reducing conduction losses.

Enable Shutdown Mode

To achieve ultra-low standby power consumption, the RVP010 includes an enable control pin (EN). When the EN voltage falls below 0.8V, the device enters shutdown mode. When the voltage rises above 1.8V, normal operation resumes.

Internally, the EN pin is connected to two series pull-up resistors: a 900kΩ resistor and a 100kΩ resistor. During normal high-level operation, the 900kΩ resistor is bypassed by the P-channel MOSFET (PM0), resulting in an effective pull-up resistance of 100kΩ. This configuration enhances noise immunity and ensures stable operation. When the EN pin is pulled low to shut down the device, PM0 is turned off, resulting in an effective pull-up resistance of 1MΩ. This significantly reduces the shutdown current, contributing to the device's ultra-low standby power consumption.

Frequency Selection

The RVP010 offers two selectable operating frequencies: 217kHz and 390kHz. When the CLK pin is left floating, the device operates at the lower frequency of 217kHz. When the CLK pin is connected to GND, the higher frequency of 390kHz is selected. This allows users to choose between two distinct switching frequencies without requiring any external components.

Working Principle of a Push-Pull Converter

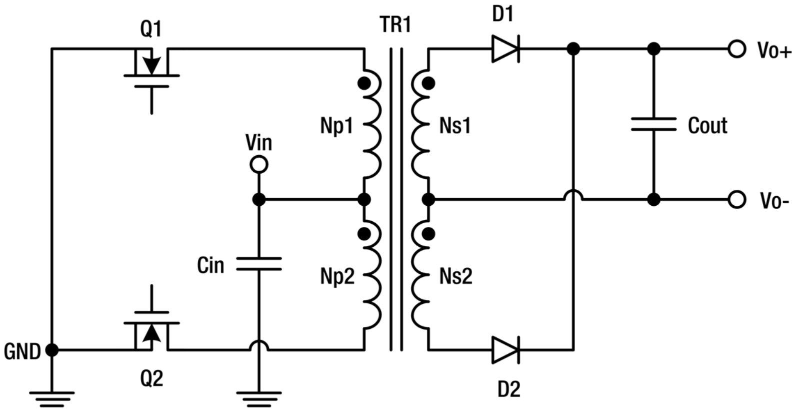


Fig. 18 Schematic Diagram of a Push-Pull Converter

As shown in Figure 18, the push-pull converter primarily consists of switching MOSFET Q1 and Q2, an isolated center-tap transformer TR1, a full-wave rectifier circuit formed by diodes D1 and D2, and input/output filter capacitors. During operation, Q1 and Q2 alternate switching, generating AC voltages of opposite phases across the primary windings Np1 and Np2 of transformer TR1. These voltages are coupled through the transformer to the secondary side, where they are rectified by D1 and D2 into a DC voltage. The output voltage, determined by the transformer's turns ratio, is then smoothed by the output capacitor Cout to provide a relatively stable DC output.

Because the push-pull converter transfers energy to the secondary side with a duty cycle close to 100%, it achieves high conversion efficiency and favorable dynamic response. Theoretically, only a small output capacitor is needed to maintain a low output voltage ripple. However, to prevent simultaneous conduction of Q1 and Q2-which could cause a short circuit across the transformer's primary-the controller introduces a break-before-make interval between the switching of the two MOSFET. During this interval, no energy is delivered from the transformer, and the load is momentarily powered by the output capacitor. As a result, a certain amount of output voltage ripple is introduced, depending on load conditions and the size of Cout.

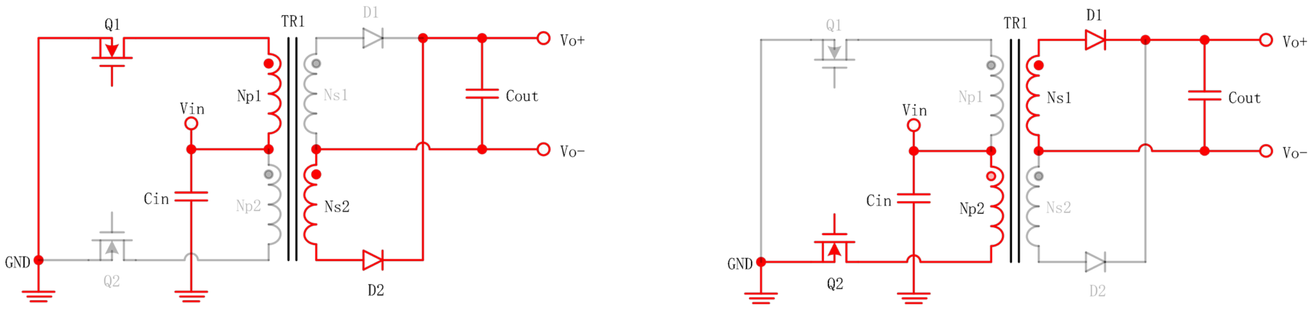


Fig. 19 Switching Cycles of a Push-Pull Converter

Figure 19 shows the equivalent schematic diagram illustrating the operating principle of the push-pull converter. Switches Q1 and Q2 operate alternately with an approximate 50% duty cycle. When Q1 is conducting, the input voltage (Vin) drives current from the un-dotted terminal of the primary winding Np1, through the upper half of the transformer's primary, and exits via the dotted terminal of Np1 through switch Q1 to ground. During this time, energy is transferred to the secondary side via transformer TR1.

According to Faraday's Law of Induction, when Q1 conducts, the output current flows from the un-dotted terminal of the secondary winding Ns2, through rectifier diode D2, to the output port Vo+. After passing through the load, it returns to the dotted terminal of Ns2 via Vo–. The operation during Q2 conduction is functionally identical and is not detailed here for brevity.

While the converter is operating, each winding of the transformer-Np1, Np2, Ns1, and Ns2-experiences a corresponding induced voltage. The amplitude of this induced voltage is directly proportional to the transformer's turns ratio, and the polarities follow the "same polarity at the same end" rule.

Assuming ideal components (i.e., neglecting parasitic elements, and assuming ideal switches Q1/Q2 and diodes D1/D2), it can be derived that the voltage stress across each switch (Q1 or Q2) is approximately twice the input voltage (2×Vin), and the reverse voltage across each rectifier diode (D1 or D2) is approximately twice the output voltage (2×Vo) during operation of the push-pull converter.

Core Magnetization

For proper operation, the push-pull transformer must satisfy the principle of volt-second balance. This means that the voltage-time (volt-second) product applied to the transformer during the magnetization (excitation) phase must equal the volt-second product during the demagnetization phase. Failure to maintain this balance can lead to core saturation, potentially causing excessive current, reduced efficiency, or circuit malfunction.

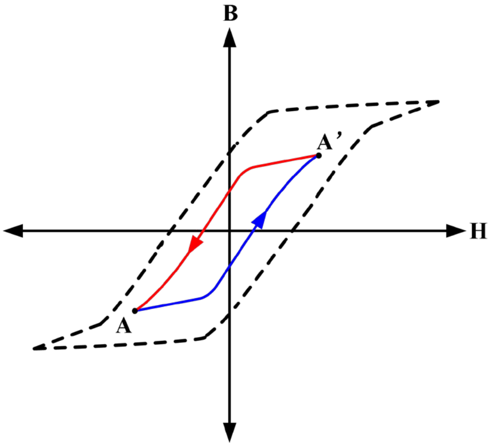


Fig. 20 Core Magnetization Curve of a Push-Pull Transformer

Figure 20 illustrates the magnetization curve of a push-pull converter, where B represents magnetic flux density and H denotes magnetic field strength. When switch Q1 conducts, the transformer enters the excitation phase, during which magnetic flux increases and shifts from point A to A' on the B-H curve. Conversely, when switch Q2 conducts, the transformer enters the demagnetization phase, during which the magnetic flux decreases and returns from A' to A, reducing the flux density. At the end of Q2's conduction period, the flux density reaches its negative maximum.

The peak magnetic flux density (B) is primarily determined by the product of the primary winding voltage (Vp) and the switch-on time (Ton)-commonly referred to as the volt-second product (Vp×Ton). For stable transformer operation, the push-pull converter must satisfy the volt-second balance principle, meaning the volt-second product during the excitation phase must equal that during demagnetization. If this balance is not maintained, the magnetic flux density experiences a cumulative offset from the B-H curve origin with each switching cycle, gradually driving the core toward saturation and leading to abnormal circuit behavior.

In practical implementations, especially with MOSFETs used as the main switching devices, perfect symmetry between the on-times of Q1 and Q2 cannot be guaranteed. This slight mismatch results in unequal volt-second products and causes magnetic bias. Magnetic bias increases the current flowing through the corresponding circuit path, introducing additional losses in the affected MOSFET and contributing to thermal rise.

However, due to the positive temperature coefficient of the MOSFET's on-resistance ($R_{DS(on)}$), as temperature increases, the voltage drop across the conducting MOSFET rises. This, in turn, reduces the effective voltage (Vp) across the transformer's primary winding during conduction, leading to an automatic deviation correction. This self-balancing effect helps mitigate long-term magnetic bias and enhances the overall reliability and thermal stability of the converter.

TYPICAL APPLICATION

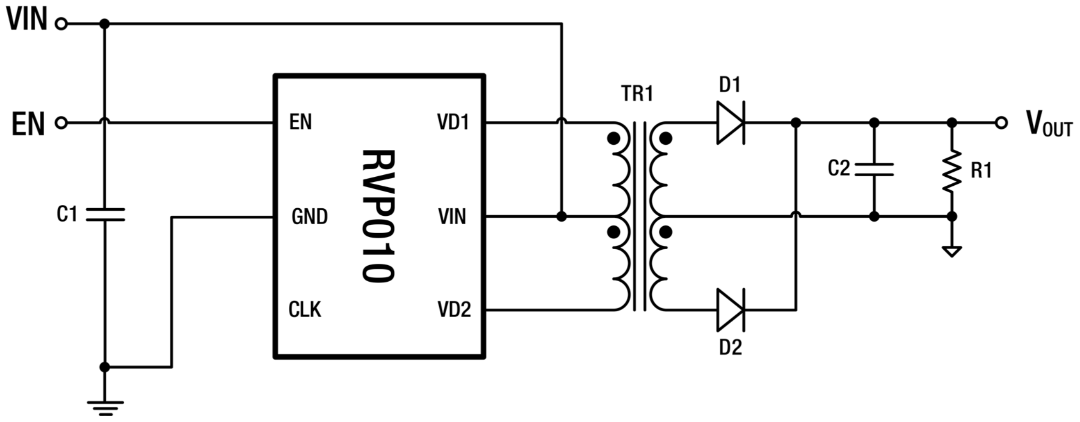


Fig. 21 Typical Application Schematic

Design Requirements

The following are typical applications based on the input voltage of 5V±10%, the isolated non-regulated 5V output, and the maximum output power of 1W. The relevant technical parameters of the power supply are shown in the table below:

Input and Output Parameters

TECHNICAL SPECIFICATION	MIN	TYP	MAX	UNIT
Input Voltage	4.5	5.0	5.5	V
Output Voltage	---	5.0	---	V
Output Current	---	0.2	---	A
Output Ripple + Noise	---	50	100	mV
Voltage Regulation Rate	---	---	1.5	%
Load Regulation Rate	---	---	10	%
Efficiency	---	85	---	%
Reliability Requirements				
Output Short Circuit Protection	Continuous, self-recovery			
Operating Temperature	-40	---	85	°C
Isolation Voltage	1500	---	---	VDC

Input Capacitor Selection

As shown in Figure 21, the input capacitor C1 serves the functions of energy storage, filtering, and decoupling. For improved high-frequency performance, an additional 0.1μF ceramic decoupling capacitor may be connected in parallel between VIN and GND. This decoupling capacitor should be placed as close to the device as possible to minimize parasitic inductance and enhance noise suppression.

During operation, capacitor C1 supplies transient current to the push-pull converter, helping to stabilize input voltage and reduce ripple. To achieve low input voltage ripple, a capacitance value between 1μF and 10μF is recommended. The capacitor's voltage rating must exceed the maximum input voltage, with adequate de-rating to ensure long-term reliability.

A surface-mount ceramic capacitor with low ESR and stable temperature characteristics (e.g., X7R or C0G dielectric) is preferred. For optimal filtering and noise performance, place C1 as close as possible to the VIN and GND pins of the device. Additionally, the power traces connected to the capacitor should be wide and short to minimize voltage spikes caused by AC current flowing through PCB trace inductance during switching operation.

Output Rectifier Diode Selection

For the output rectifier circuit of the push-pull converter, Schottky diodes are recommended due to their low forward voltage drop and short reverse recovery time, which contribute to improved load regulation and higher overall conversion efficiency. The recommended topology uses a full-wave rectifier configuration. In this structure, each rectifier diode is subjected to a reverse voltage that can reach up to twice the output voltage. Therefore, the reverse voltage rating of the selected Schottky diode must be greater than 2× the maximum output voltage, taking into account the worst-case conditions (i.e., highest input voltage and lightest load). Adequate voltage derating should also be applied to ensure long-term reliability. The diode must also be rated for the full operating temperature range of the application. Special attention must be paid to the reverse leakage current, which increases significantly at elevated temperatures. When operating near the maximum rated temperature, it's critical to derate the diode based on its reverse leakage and thermal characteristics. Refer to the diode manufacturer's temperature derating curves for detailed guidance.

To ensure stable and safe operation under all conditions—including output short circuits—the diode must also be capable of handling the maximum current that may flow during fault events. When the RVP010 detects an output short circuit, it automatically enters Output Short Circuit Protection Mode and switches to Current Clamp Drive Mode, limiting the current through the MOSFET to the Current Clamp Limit (typically 1.7 A). At this point, the maximum operating current of the output rectifier diode can be derived from the transformer's turns ratio, calculated using the following formula:

$$I_{D-MAX} = \frac{N_P}{N_S} \times I_{LIM-MAX}$$

Where N_P and N_S represent the number of turns of the primary and secondary windings of the push-pull transformer, respectively, and $I_{LIM-MAX}$ is the device's maximum current clamp limit.

In Output Short Circuit Protection Mode, the RVP010 first switches to Current Clamp Drive Mode. As power dissipation increases, the device eventually enters Thermal Shutdown Protection Mode. During the period between entering Auto Recovery and reaching thermal shutdown, the output rectifier diode is subjected to its maximum operating current. Therefore, when selecting the diode, it is also critical to ensure that its Forward Surge Current Peak (I_{FSM}) rating meets the application's requirements.

In this application example, the RB160M-30 Schottky diode is selected. At an operating temperature of 75°C, this diode features a forward voltage drop of approximately 280mV@0.2A, and a reverse leakage current of about 90µA@15V. It also offers a peak forward surge current (I_{FSM}) of 30A.

For applications with higher operating temperature requirements, alternative Schottky diodes with lower reverse leakage current at elevated temperatures should be considered. Always consult the diode's datasheet and temperature derating curves to ensure reliable operation under all expected conditions.

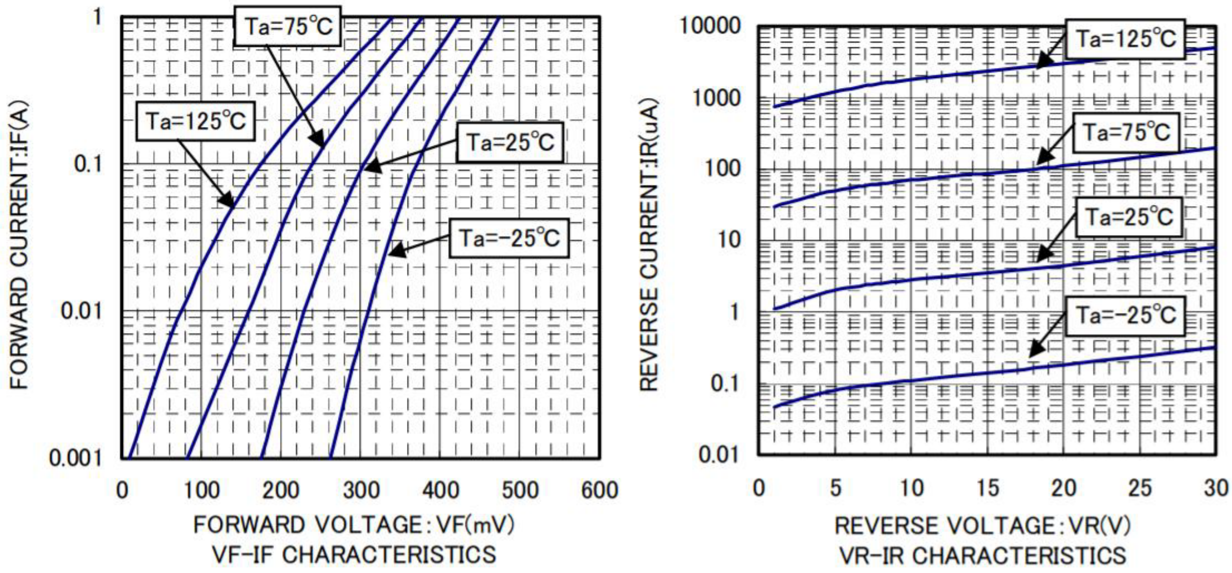


Fig. 22 Operating Characteristics of Schottky Diode RB160M-30

Output Capacitor Selection

Although the push-pull converter can theoretically transfer energy to the secondary side with a 100% duty cycle, a break-before-make time is required between the switching of MOSFETs Q1 and Q2 to ensure reliable operation. This BBM interval prevents both switches from conducting simultaneously, which could otherwise result in a short circuit across the transformer's primary winding. During this interval, when neither switch is conducting, the transformer temporarily stops delivering energy to the output. Consequently, the output filter capacitor (C3) supplies the load, leading to a momentary voltage ripple. The magnitude of this ripple depends on the load current and the capacitance value. To minimize output voltage ripple and enhance transient response, a low-ESR ceramic capacitor is recommended for the output filter. In practical applications, a capacitor in the range of 4.7µF to 10µF is typically suitable for C2, offering effective filtering and contributing to the overall stability and performance of the converter.

Push-Pull Transformer Selection

Estimation of the Turns Ratio of Primary and Secondary Windings

Assuming the output rectifier diode has been properly selected according to the design requirements, the forward conduction voltage drop V_F of the diode under maximum output load conditions can be determined. With this known value, the turns ratio of the push-pull transformer's primary to secondary windings can be estimated based on the input voltage at the primary side and the minimum required output voltage at the secondary side. This estimation ensures that the transformer delivers the necessary output voltage under worst-case conditions, accounting for voltage drops across the rectifier and any expected losses. Under nominal input voltage and full-load output, the input voltage across the primary winding of the push-pull transformer is:

$$V_P = V_{IN} - \frac{P_{O-MAX}}{\eta \times V_{IN}} \times R_{DS(ON)}$$

Where $P_{O\text{-}MAX}$ is the maximum output power of the push-pull converter, η represents the estimated efficiency of the converter under nominal input voltage and full load conditions, and $R_{DS(ON)}$ is the on-resistance of the internal N-channel MOSFETs integrated in the device.
Under full-load output, the minimum output voltage of the secondary winding is:

$$V_S = V_{O-MIN} + V_F$$

Where $V_{O\text{-}MIN}$ is the minimum allowable output voltage of the push-pull converter under full load conditions. To ensure that the converter meets its output voltage specifications during full load operation, $V_{O\text{-}MIN}$ can be estimated as 97% of the nominal output voltage, accounting for a typical tolerance of -3%. V_F represents the forward conduction voltage drop of the selected output rectifier diode under full load. These parameters are critical for accurately determining the required transformer turns ratio and ensuring proper voltage regulation at the output.
The formula for calculating the turns ratio of the primary and secondary windings can be derived from the above formula:

$$N_{PS} = \frac{V_{IN} - \dfrac{P_{O-MAX}}{\eta \times V_{IN}} \times R_{DS(ON)}}{V_{O-MIN} + V_F}$$

According to the input and output requirements of this application, assuming the push-pull converter has an efficiency of 85%, the turns ratio of the primary and secondary windings of the push-pull transformer can be estimated as:

$$N_{PS} = \frac{5V - \dfrac{1W}{0.85 \times 5V} \times (0.09\Omega)}{5V \times 0.97 + 0.34V} \approx 0.96$$

V-t Product Calculation for the Push-Pull Converter

To prevent transformer core saturation, the volt-second (V·t) product of the transformer must be greater than the maximum V·t product applied by the device during normal operation. In most isolated power supply designs, the input voltage range is selected from a relatively narrow band, typically specified as ±10% of the nominal input voltage. Therefore, the V·t product of the push-pull transformer should be calculated based on the upper limit of the input voltage range. At the same time, the switching frequency and its tolerance-as defined by the RVP010 device-must be considered to ensure that saturation does not occur under worst-case conditions. This worst-case scenario corresponds to the minimum operating frequency, which results in the longest switching period and, consequently, the highest applied V·t product.
The maximum V·t stress on the transformer's primary winding occurs when the device operates at the highest input voltage and the minimum switching frequency. Under these conditions, the V·t product is applied over half of the switching cycle, which corresponds to the conduction time of each switch in the push-pull topology. Therefore, this condition should be used as the basis for estimating the minimum required V·t rating of the transformer to ensure reliable and saturation-free operation.
Thus, the following calculation methods can be used as a reference for estimating the minimum volt-second product of the push-pull transformer:

$$V\mathrm{t}_{MIN} \geq V_{IN-MAX} \times \frac{T_{MAX}}{2} = \frac{V_{IN-MAX}}{2 \times f_{MIN}}$$

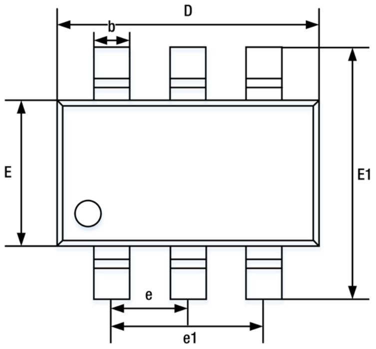
According to the design requirements of this application, it is assumed that the typical value of the set operating frequency is 217kHz, and the set minimum operating frequency is 183kHz.Under maximum input conditions, the volt-second product of the selected push-pull transformer shall meet:

$$Vt_{MIN} \geq \frac{5V \times 110\%}{2 \times 183kHz} \approx 15V\mu s$$

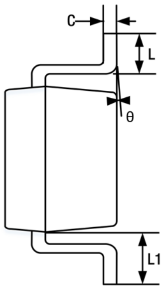
The selection of the push-pull transformer should be based on the appropriate volt-second product, the turns ratio of the primary and secondary windings, and actual application requirements. Additionally, the maximum output power, isolation voltage, and isolated distributed capacitance should also be considered as key selection criteria.

PACKAGING INFORMATION

SOT23-6

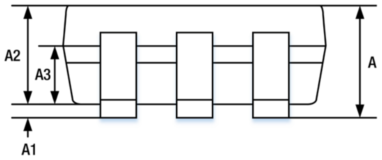


Package top view

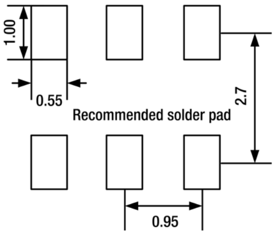


Package side view

DIMENSION TABLE			
SYMBOL	MILLIMETER		
	MINIMUM	NOMINAL	MAXIMUM
A	---	---	1.25
A1	0.04	---	0.12
A2	1.00	1.10	1.20
A3	0.60	0.65	0.70
b	0.33	---	0.50
C	0.14	---	0.20
D	2.82	2.92	3.02
E	1.50	1.60	1.70
E1	2.60	2.80	3.00
e	0.95 REF		
e1	1.90 REF		
L	0.35	0.45	0.60
L1	0.59 REF		
θ	0°	---	8°



Package front view



Recommended solder pad

ORDER INFORMATION

Device	Package Type	PIN	Packaging Method	QTY	Marking Code*	MSL
RVP010-PPN-R	SOT23-6	6	Tape and Reel	3000	RVP010	MSL-3
RVP010-PPN-CT	SOT23-6	6	Moisture Barrier Bag	10	RVP010	MSL-3

*Marking Code
RVP010——— Product Code