24V, 2A, 500kHz, ACOT™ Step-Down Converter in 8 Pin TSOT-23

General Description

The RT6215A/B is a simple, easy-to-use, 2A synchronous step-down DC-DC converter with an input supply voltage range of 4.5V to 24V. The device build-in an accurate 0.791V reference voltage and integrates low $R_{DS(ON)}$ power MOSFETs to achieve high efficiency in a SOT23-8 package.

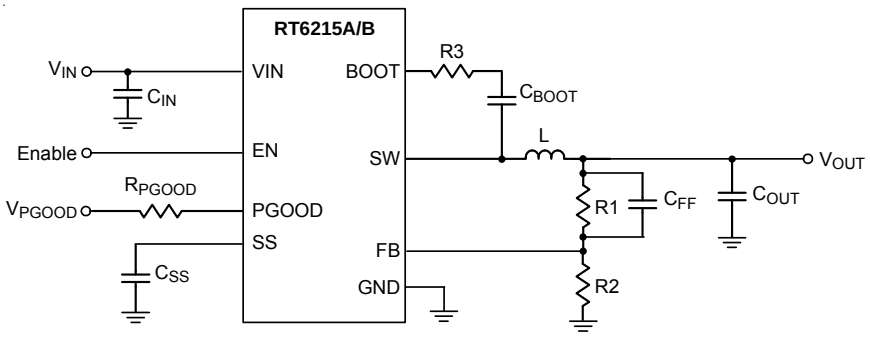
The RT6215A/B adopts Advanced Constant On-Time (ACOT™) control architecture to provide an ultrafast transient response with few external components and to operate in nearly constant switching frequency over the line, load, and output voltage range. The RT6215A operates in automatic PSM that maintains high efficiency during light load operation. The RT6215B operates in Forced PWM that helps meet tight voltage regulation accuracy requirements.

The RT6215A/B senses both FETs current for a robust over-current protection. It features cycle-by-cycle current limit protection and prevent the device from the catastrophic damage in output short circuit, over current or inductor saturation. An externally adjustable soft-start function prevents inrush current during start-up. The device also includes input under-voltage lockout, output under-voltage protection, and over-temperature protection (thermal shutdown) to provide safe and smooth operation in all operating conditions. The RT6215A/B is offered in a TSOT-23-8(FC) package.

Features

- **2A Converter With Built-In 100mΩ/85mΩ Low $R_{DS(ON)}$ Power FETs**
- **Input Supply Voltage Range : 4.5V to 24V**
- **Output Voltage Range : 0.791V to 5V**
- **Advanced Constant On-Time (ACOT™) Control**
- **Ultrafast Transient Response**
- **No Needs For External Compensations**
- **Optimized for Low-ESR Ceramic Output Capacitors**
- **0.791V ±1.5% High-Accuracy Feedback Reference Voltage**
- **Low Quiescent Current (170μA typ.)**
- **Both HS/LS FETs Protection for Robust Over-Current Protection**
- **Optional for Operation Modes :**
  - **Power Saving Mode (PSM) at Light Load (RT6215A)**
  - **Forced PWM Mode (RT6215B)**
- **Light-load V_{OUT} Ripple Reduction Technology in PSM**
- **Fixed Switching Frequency : 500kHz**
- **Externally Adjustable Soft-Start**
- **Monotonic Start-Up for Pre-Biased Output**
- **Input Under-Voltage Lockout (UVLO)**
- **Output Under-Voltage Protection (UVP) with Hiccup Mode**
- **Power Good Indication**
- **Enable Control**
- **Available In TSOT-23-8 (FC) Package**

Simplified Application Circuit



Ordering Information

RT6215A/B □□□

- Package Type
  J8F : TSOT-23-8 (FC)
- Lead Plating System
  G : Green (Halogen Free and Pb Free)
- UVP Option
  H : Hiccup
- PSM/PWM
  A : PSM/PWM
  B : Force-PWM

Note :

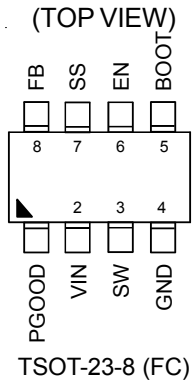
Richtek products are :

- RoHS compliant and compatible with the current requirements of IPC/JEDEC J-STD-020.
- Suitable for use in SnPb or Pb-free soldering processes.

Applications

- Set Top Box
- Portable TV
- Access Point Router
- DSL Modem
- LCD TV

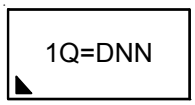
Pin Configuration



TSOT-23-8 (FC)

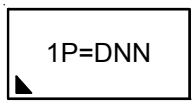
Marking Information

RT6215AHGJ8F



1Q= : Product Code
DNN : Date Code

RT6215BHGJ8F

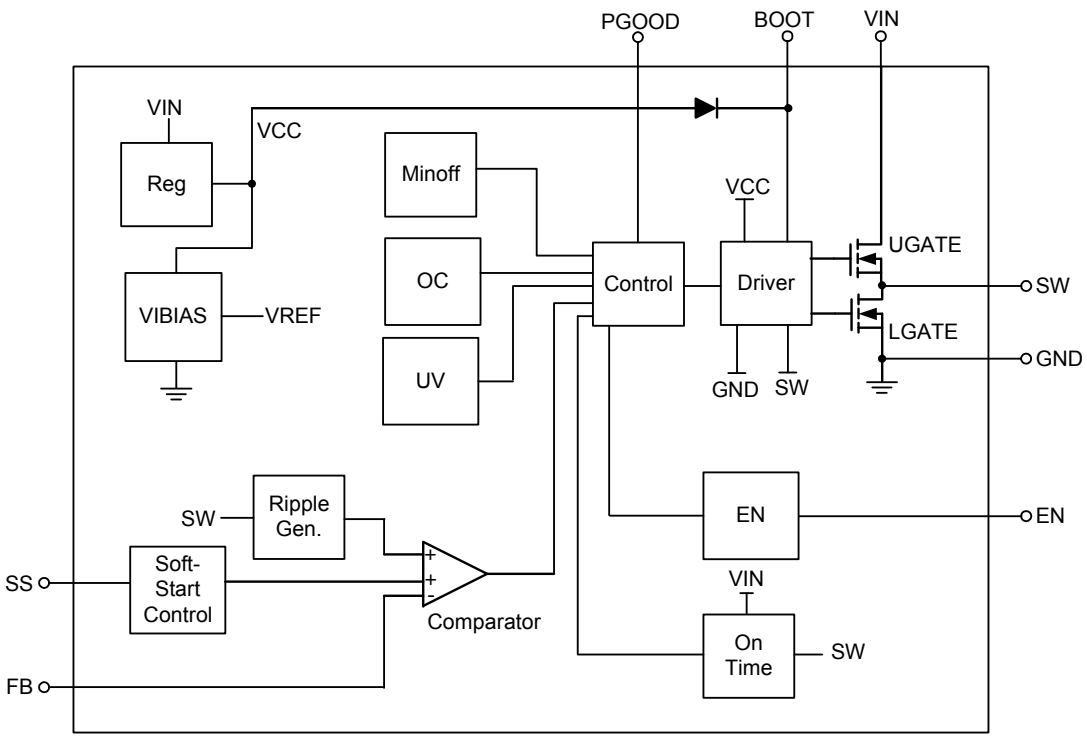


1P= : Product Code
DNN : Date Code

Functional Pin Description

Pin No.	Pin Name	Pin Function
1	PGOOD	Power good indicator. Open drain output.
2	VIN	Input voltage. Support 4.5V to 24V input voltage. Must bypass with a suitable large ceramic capacitor at this pin.
3	SW	Switch node. Connected to external L-C filter.
4	GND	System ground.
5	BOOT	Bootstrap supply for high side gate driver. Connect a 0.1μF ceramic capacitor between the BOOT and SW pins.
6	EN	Buck enable. High = Enable.
7	SS	Soft-start control pin. Connect a capacitor between the SS pin and ground to set the soft-start time. Suggested capacitor value is $C_{SS} \geqq 2.8nF$.
8	FB	Feedback input. The pin is used to set the output voltage of the converter to regulate to the desired via a resistive divider.

Functional Block Diagram



Operation

Input Under-Voltage Lockout

If the input voltage exceeds the under voltage lockout (UVLO) rising threshold voltage (V_{UVLO}), the converter resets and prepares the PWM for operation. If the input voltage falls below the UVLO falling threshold voltage ($V_{UVLO} - \Delta V_{UVLO}$) during normal operation, the device stops switching. The UVLO rising and falling threshold voltage includes a hysteresis to prevent noise caused reset.

Chip Enable

The EN pin is the chip enable input. Pulling the EN pin low (<1.1V) will shutdown the device. During shutdown mode, the quiescent current of the RT6215A/B drops to lower than 10μA. Driving the EN pin high (>1.6V) will turn on the device.

Over Current Protection

The RT6215A/B provides cycle-by-cycle valley current limit which measures the inductor current through the synchronous rectifier during the off-time while the inductor current ramps down. The current is determined by measuring the voltage between Source and Drain of the synchronous rectifier and apply temperature compensation for greater accuracy. If the current exceeds the current limit, the on-time one-shot is inhibited until it drops below the current limit level. If the output current exceeds the available inductor current, the output voltage will drop. If it drops below the output under-voltage protection level (see next section) the IC will stop switching to avoid excessive heat.

Output Under-Voltage Protection with Hiccup Mode

The RT6215A/B provides under voltage protection (UVP) with Hiccup Mode. When the FB voltage drops below half of the feedback threshold voltage, V_{FB}, the UVP function will be triggered and the IC will shut down for a period of time and then recover automatically. The Hiccup Mode of UVP can reduce input current in short circuit conditions and power dissipation. And then resume normal operation when the overload or short circuit is removed.

Over-Temperature Protection

The RT6215A/B includes an over-temperature protection (OTP) to prevent the chip from operating at excessively high temperatures. The chip will shut down the switching operation when the junction temperature exceeds 160°C. Once the junction temperature cools down by approximately 25°C, the IC will resume normal operation.

Soft-Start Function

The RT6215A/B provides adjustable soft-start function. The soft-start function is used to prevent large inrush current while converter is being powered-up. The soft-start timing can be programmed by the external capacitor C_{SS} between SS and GND. An internal current source I_{SS} (4μA) charges an external capacitor to build a soft-start ramp voltage. The V_{FB} voltage will track the internal ramp voltage during soft-start interval. The typical soft-start time is calculated as follows :

Soft-Start time $t_{SS} = C_{SS} \times 0.791 / 4\mu A$

Power Good Indicator

The power good indicator is an open-drain output and requires a pull up resistor. When the output voltage is lower than 90% of its set voltage, PGOOD will be pulled low. It is held low until the output voltage returns to within the allowed tolerances once more. During soft-start, PGOOD is actively held low and only allowed to transition high after soft-start is over and the output voltage has reached 95% of its setting voltage.

Absolute Maximum Ratings (Note 1)

- Supply Input Voltage and EN Voltage, VIN, EN ---------- –0.3V to 28V
- Switch Voltage, SW ---------- –0.3V to 28V
  SW (t ≤ 10ns) ---------- –5V to 30V
- BOOT to SW, V_{BOOT} – V_{SW} ---------- –0.3V to 6V
- BOOT Voltage ---------- –0.3V to 32V
- Other Pins ---------- –0.3V to 6V
- Power Dissipation, P_D @ T_A = 25°C
  TSOT-23-8 (FC) ---------- 1.428W
- Package Thermal Resistance (Note 2)
  TSOT-23-8 (FC), θ_{JA} ---------- 70°C/W
  TSOT-23-8 (FC), θ_{JC} ---------- 15°C/W
- Junction Temperature ---------- 150°C
- Lead Temperature (Soldering, 10 sec.) ---------- 260°C
- Storage Temperature Range ---------- –65°C to 150°C
- ESD Susceptibility (Note 3)
  HBM (Human Body Model) ---------- 2kV

Recommended Operating Conditions (Note 4)

- Supply Input Voltage ---------- 4.5V to 24V
- Junction Temperature Range ---------- –40°C to 125°C
- Ambient Temperature Range ---------- –40°C to 85°C

Electrical Characteristics

(V_{IN} = 12V, T_A = 25°C, unless otherwise specified)

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Supply Voltage						
VIN Supply Input Operating Voltage	V_{IN}		4.5	--	24	V
VIN Under-Voltage Lockout Threshold	V_{UVLO}	V_{IN} Rising	3.9	4.1	4.3	V
VIN Under-Voltage Lockout Threshold-Hysteresis	ΔV_{UVLO}		--	550	--	mV
Supply Current						
Supply Current (Shutdown)	I_{SHDN}	V_{EN} = 0V	--	--	10	μA
Supply Current (Quiescent)	I_Q	V_{EN} = 2V, V_{FB} = 1V	--	170	270	μA
Soft-Start						
Soft-Start Charge Current	I_{SS}		--	4	--	μA
Enable Voltage						
EN Rising Threshold	V_{ENH}		1.2	1.4	1.6	V
EN Falling Threshold	V_{ENL}		1.1	1.25	1.4	V
Feedback Voltage						
Feedback Threshold Voltage	V_{FB}		779	791	803	mV

Parameter	Symbol	Test Conditions	Min	Typ	Max	Unit
Internal MOSFET						
High-Side Switch-On Resistance	$R_{DS(ON)\_H}$	$V_{BOOT}-V_{SW}$ = 4.8V	--	100	--	mΩ
Low-Side Switch-On Resistance	$R_{DS(ON)\_L}$		--	85	--	mΩ
Current Limit						
Low-Side Switch Valley Current Limit	I_{LIM_L}		2.2	2.7	--	A
High-Side Switch Peak Current Limit	I_{LIM_H}		--	5.5	--	A
Switching Frequency						
Switching Frequency	f_{SW}		--	500	--	kHz
On-Time Timer Control						
Maximum Duty Cycle	D_{MAX}		--	90	--	%
Minimum On-Time	$t_{ON(MIN)}$		--	60	--	ns
Thermal Shutdown						
Thermal Shutdown	T_{SD}		--	160	--	°C
Thermal Hysteresis	ΔT_{SD}		--	25	--	°C
Output Under Voltage Protections						
UVP Trip Threshold		UVP detected	--	50	--	%
		Hysteresis	--	10	--	%
Power Good						
Power Good Threshold	V_{PGOOD}	V_{FB} Rising threshold, PGOOD from low to high	--	95	--	%
		V_{FB} Falling hysteresis, PGOOD from high to low	--	5	--	%
		V_{FB} Rising threshold, PGOOD from high to low	--	115	--	%
		V_{FB} Falling hysteresis, PGOOD from low to high	--	5	--	%

Note 1. Stresses beyond those listed "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions may affect device reliability.

Note 2. θ_{JA} is measured under natural convection (still air) at T_A = 25°C with the component mounted on a high effective-thermal-conductivity four-layer test board on a JEDEC 51-7 thermal measurement standard. The first layer is filled with copper. θ_{JC} is measured at the lead of the package.

Note 3. Devices are ESD sensitive. Handling precaution is recommended.

Note 4. The device is not guaranteed to function outside its operating conditions.

Typical Application Circuit

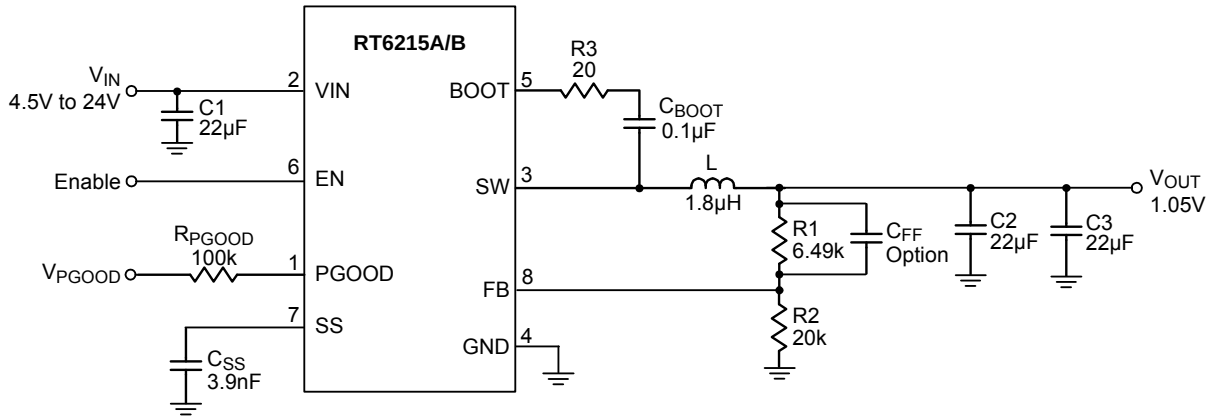


Table 1. Suggested Component Values

V_{OUT} (V)	R1 (kΩ)	R2 (kΩ)	L (µH)	C_{OUT} (µF)	C_{FF} (pF)
1.05	6.49	20	1.8	44	--
1.2	10.5	20	2.2	44	--
1.8	25.5	20	3.6	44	--
2.5	43.2	20	4.7	44	22 to 68
3.3	63.4	20	4.7	44	22 to 68
5	107	20	6.8	44	22 to 68

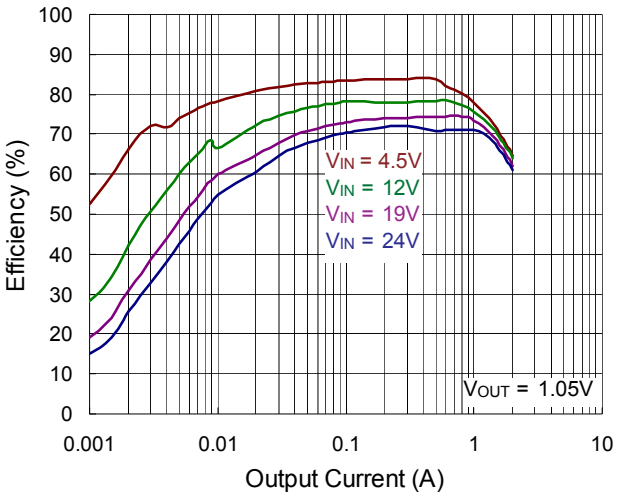
Note :

(1) All the input and output capacitors are the suggested values, referring to the effective capacitances, subject to any de-rating effect, like a DC bias.

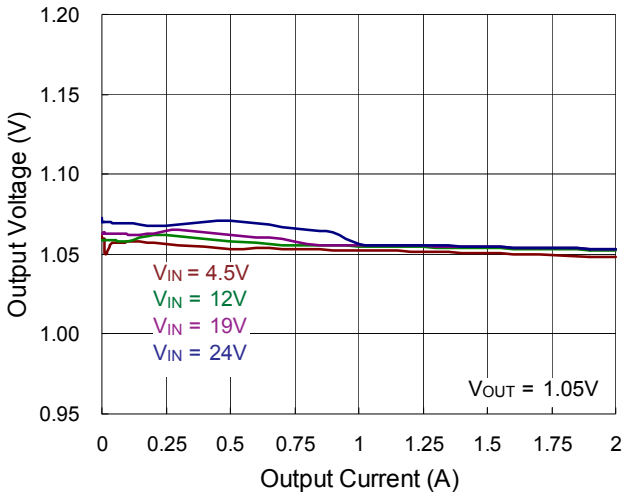
(2) For low output voltage application, it can optimize the load transient response of the device by adding feedforward capacitor (C_{FF}, 22pF to 68pF).

Typical Operating Characteristics

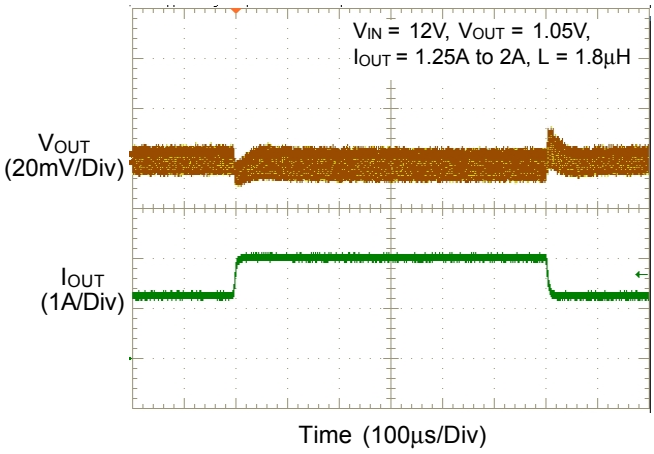
Efficiency vs. Output Current



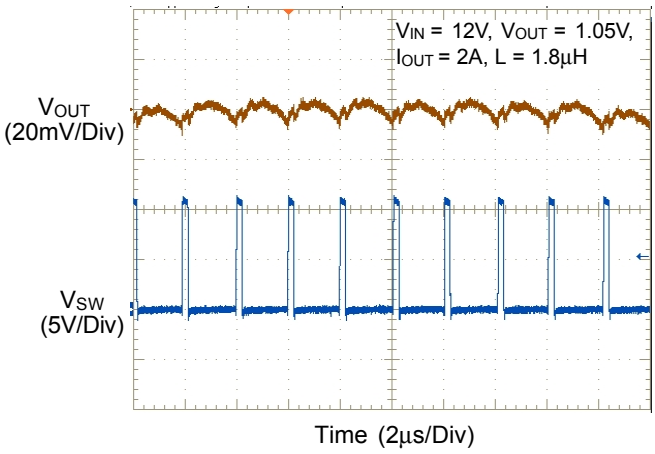
Output Voltage vs. Output Current



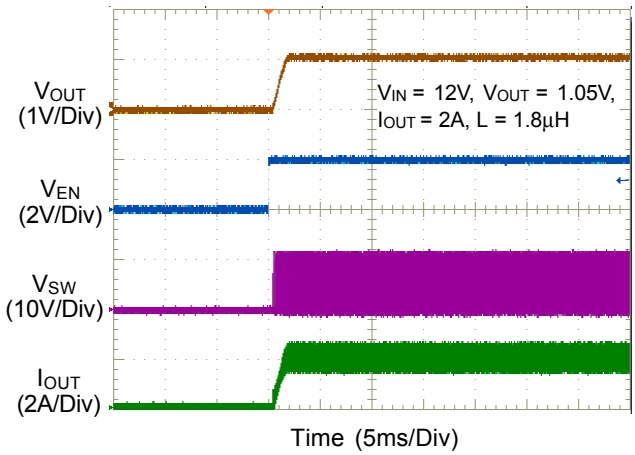
Load Transient Response



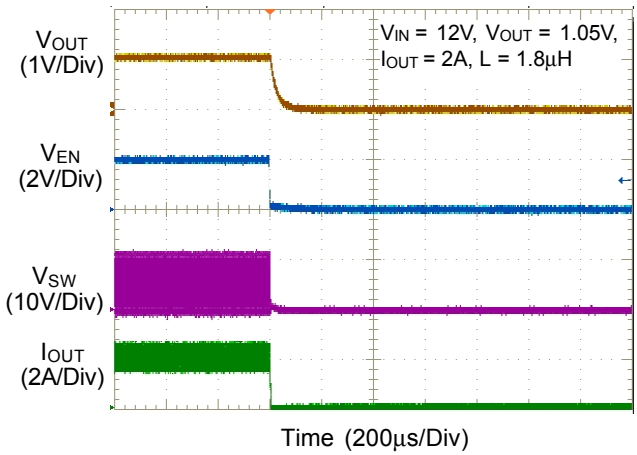
Output Ripple Voltage



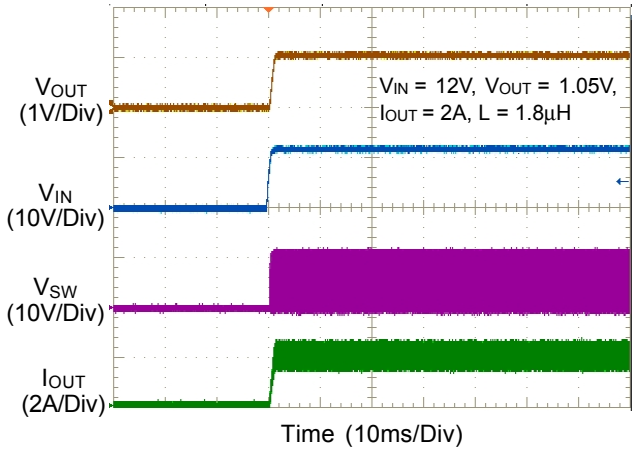
Power On from EN



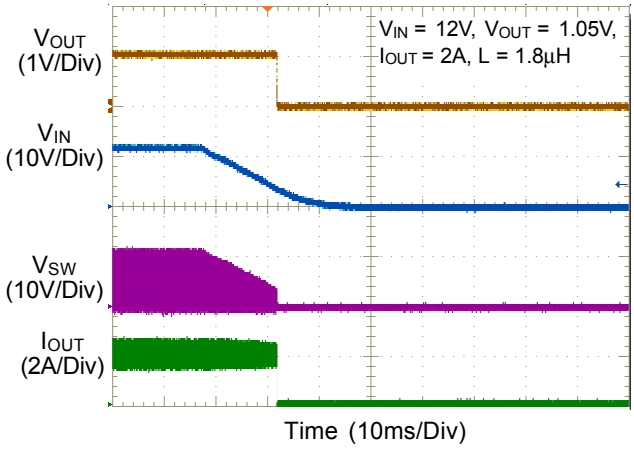
Power Off from EN



Power On from VIN



Power Off from VIN



Application Information

Inductor Selection

The consideration of inductor selection includes inductance, RMS current rating and, saturation current rating. The inductance selection is generally flexible and is optimized for the low cost, low physical size, and high system performance.

Choosing lower inductance to reduce physical size and cost, and it is useful to improve the transient response. However, it causes the higher inductor peak current and output ripple voltage to decrease system efficiency. Conversely, higher inductance increase system efficiency, but the physical size of inductor will become larger and transient response will be slow because more transient time is required to change current (up or down) by inductor. A good compromise between size, efficiency, and transient response is to set a inductor ripple current (ΔI_L) about 20% to 50% of the desired full output load current.

Calculate the approximate inductance by the input voltage, output voltage, switching frequency (f_{SW}), maximum rated output current ($I_{OUT(MAX)}$) and inductor ripple current (ΔI_L).

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

Once the inductance is chosen, the inductor ripple current (ΔI_L) and peak inductor current can be calculated.

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

$$I_{L(PEAK)} = I_{OUT(MAX)} + \frac{1}{2}\Delta I_L$$

$$I_{L(VALLY)} = I_{OUT(MAX)} - \frac{1}{2}\Delta I_L$$

The typical operating circuit design for the RT6215A/B, the output voltage is 1.05V, maximum rated output current is 2A, input voltage is 12V, and inductor ripple current is 1A which is 50% of the maximum rated output current, the calculated inductance value is :

$$L = \frac{1.05 \times (12 - 1.05)}{12 \times 500 \times 10^3 \times 1} = 1.92\mu H$$

The inductor ripple current set at 1A and so we select 1.8µH inductance. The actual inductor ripple current and required peak current is shown as below :

$$\Delta I_L = \frac{1.05 \times (12 - 1.05)}{12 \times 500 \times 10^3 \times 1.8 \times 10^{-6}} = 1.06A$$

$$I_{L(PEAK)} = I_{OUT(MAX)} + \frac{1}{2}\Delta I_L = 2 + \frac{1.06}{2} = 2.53A$$

Inductor saturation current should be chosen over IC's current limit.

Input Capacitor Selection

The input filter capacitors are needed to smooth out the RMS input ripple current drawn from the input power source and ripple voltage seen at the input of the converter. The voltage rating of the input filter capacitors must be greater than the maximum input voltage. It's also important to consider the ripple current capabilities of capacitors.

The RMS input ripple current (I_{RMS}) is a function of the input voltage (V_{IN}), output voltage (V_{OUT}), and rated output current (I_{OUT}) :

$$I_{RMS} = I_{OUT} \times \frac{V_{OUT}}{V_{IN}} \times \sqrt{\frac{V_{IN}}{V_{OUT}} - 1}$$

The maximum RMS input ripple current occurs at maximum output load and it needs to be concerned about the ripple current capabilities of capacitors at maximum output load.

Ceramic capacitors are most often used because of their low cost, small size, high RMS current ratings, and robust surge current capabilities. It should pay attention that value of capacitors change as temperature, bias voltage, and operating frequency change. For example the capacitance value of a capacitor decreases as the dc bias across the capacitor increases.

However, take care when these capacitors are used at the input of circuits supplied by a wall adapter or other supply connected through long and thin wires. Current surges through the inductive wires can induce ringing at the IC's power input which could potentially cause large, damaging voltage spikes at VIN pin. If this phenomenon is observed, some bulk input capacitance may be required. Ceramic capacitors can be placed in parallel with other types such as tantalum, electrolytic, or polymer to reduce voltage ringing and overshoot.

Choose capacitors rated at higher temperatures than required. Several ceramic capacitors may be paralleled to meet the RMS current, size, and height requirements of the application. The typical operating circuit use 10μF and one 0.1μF low ESR ceramic capacitors on the input.

Output Capacitor Selection

The RT6215A/B is optimized for output terminal with ceramic capacitors application and best performance will be obtained using them. The total output capacitance value is usually determined by the desired output ripple voltage level and transient response requirements for sag which is undershoot on positive load steps and soar which is overshoot on negative load steps.

Output Ripple Voltage

Output ripple voltage at the switching frequency is caused by the inductor current ripple and its effect on the output capacitor's ESR and stored charge. These two ripple components are called ESR ripple and capacitive ripple.

Since ceramic capacitors have extremely low ESR and relatively little capacitance, both components are similar in amplitude and both should be considered if ripple is critical.

$$V_{RIPPLE} = V_{RIPPLE(ESR)} + V_{RIPPLE(C)}$$

$$V_{RIPPLE(ESR)} = \Delta I_L \times R_{ESR}$$

$$V_{RIPPLE(C)} = \frac{\Delta I_L}{8 \times C_{OUT} \times f_{SW}}$$

The typical operating circuit design for the RT6215A/B, the output voltage is 1.05V, inductor ripple current is 1.06A, and using 2 pieces of 22μF output capacitor with about 5mΩ ESR, the output voltage ripple components are :

$$V_{RIPPLE(ESR)} = \Delta I_L \times R_{ESR} = 1.06A \times 5m\Omega = 5.3mV$$

$$V_{RIPPLE(C)} = \frac{\Delta I_L}{8 \times C_{OUT} \times f_{SW}} = \frac{1.06A}{8 \times 44\mu F \times 500kHz} = 6.02mV$$

$$V_{RIPPLE} = V_{RIPPLE(ESR)} + V_{RIPPLE(C)} = 11.32mV$$

Output Transient Undershoot and Overshoot

In addition to output ripple voltage at the switching frequency, the output capacitor and its ESR also affect the voltage sag (undershoot) and soar (overshoot) when the load steps up and down abruptly. The ACOT™ transient response is very quick and output transients are usually small. However, the combination of small ceramic output capacitors (with little capacitance), low output voltages (with little stored charge in the output capacitors), and low duty cycle applications (which require high inductance to get reasonable ripple currents with high input voltages) increases the size of voltage variations in response to very quick load changes. Typically, load changes occur slowly with respect to the IC's switching frequency.

But some modern digital loads can exhibit nearly instantaneous load changes and the following section shows how to calculate the worst-case voltage swings in response to very fast load steps.

The output voltage transient undershoot and overshoot each have two components : the voltage steps caused by the output capacitor's ESR, and the voltage sag and soar due to the finite output capacitance and the inductor current slew rate. Use the following formulas to check if the ESR is low enough (typically not a problem with ceramic capacitors) and the output capacitance is large enough to prevent excessive sag and soar on very fast load step edges, with the chosen inductor value.

The amplitude of the ESR step up or down is a function of the load step and the ESR of the output capacitor :

$$V_{ESR\_STEP} = \Delta I_{OUT} \times R_{ESR}$$

The amplitude of the capacitive sag is a function of the load step, the output capacitor value, the inductor value,

the input-to-output voltage differential, and the maximum duty cycle. The maximum duty cycle during a fast transient is a function of the on-time and the minimum off-time since the ACOT™ control scheme will ramp the current using on-times spaced apart with minimum off-times, which is as fast as allowed. Calculate the approximate on-time (neglecting parasitic) and maximum duty cycle for a given input and output voltage as :

$$t_{ON} = \frac{V_{OUT}}{V_{IN} \times f_{SW}} \text{ and } D_{MAX} = \frac{t_{ON}}{t_{ON} + t_{OFF(MIN)}}$$

The actual on-time will be slightly longer as the IC compensates for voltage drops in the circuit, but we can neglect both of these since the on-time increase compensates for the voltage losses. Calculate the output voltage sag as :

$$V_{SAG} = \frac{L \times (\Delta I_{OUT})^2}{2 \times C_{OUT} \times (V_{IN(MIN)} \times D_{MAX} - V_{OUT})}$$

The amplitude of the capacitive soar is a function of the load step, the output capacitor value, the inductor value and the output voltage :

$$V_{SOAR} = \frac{L \times (\Delta I_{OUT})^2}{2 \times C_{OUT} \times V_{OUT}}$$

Feed-Forward Capacitor (C_{FF})

The RT6215A/B is optimized for ceramic output capacitors and for low duty cycle applications. However for high-output voltages, with high feedback attenuation, the circuit's transient response can be slowed. In high-output voltage circuits transient response is improved by adding a small "feedforward" capacitor (C_{FF}) across the upper FB divider resistor (Figure 1), to speed up the transient response without affecting the steady-state stability of the circuit. Choose a suitable capacitor value that following suggested component BOM.

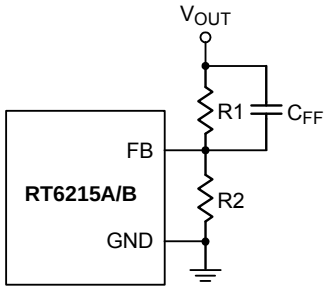


Figure 1. C_{FF} Capacitor Setting

Chip Enable Operation

For automatic start-up the high-voltage EN pin can be connected to VIN, through a 100kΩ resistor. Its large hysteresis band makes EN useful for simple delay and timing circuits. EN can be externally pulled to VIN by adding a resistor-capacitor delay (R_{EN} and C_{EN} in Figure 2). Calculate the delay time using EN's internal threshold where switching operation begins.

An external MOSFET can be added to implement digital control of EN when no system voltage above 2V is available (Figure 3). In this case, a 100kΩ pull-up resistor, R_{EN}, is connected between VIN and the EN pin. MOSFET Q1 will be under logic control to pull down the EN pin. To prevent enabling circuit when V_{IN} is smaller than the V_{OUT} target value or some other desired voltage level, a resistive voltage divider can be placed between the input voltage and ground and connected to EN to create an additional input under voltage lockout threshold (Figure 4).

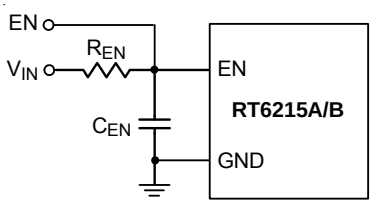


Figure 2. External Timing Control

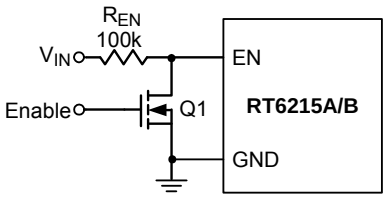


Figure 3. Digital Enable Control Circuit

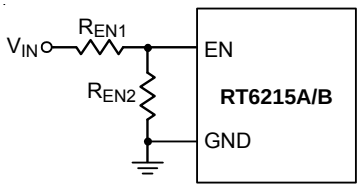


Figure 4. Resistor Divider for Lockout Threshold Setting

Output Voltage Setting

Set the desired output voltage using a resistive divider from the output to ground with the midpoint connected to FB. The output voltage is set according to the following equation :

$$V_{OUT} = 0.791V \times (1 + \frac{R1}{R2})$$

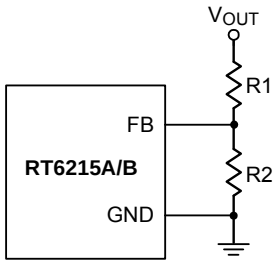


Figure 5. Output Voltage Setting

Place the FB resistors within 5mm of the FB pin. Choose R2 between 10kΩ and 100kΩ to minimize power consumption without excessive noise pick-up and calculate R1 as follows :

$$R1 = \frac{R2 \times (V_{OUT} - V_{FB})}{V_{FB}}$$

For output voltage accuracy, use divider resistors with 1% or better tolerance.

External Bootstrap Diode

Connect a 0.1μF low ESR ceramic capacitor between the BOOT and SW pins. This capacitor provides the gate driver voltage for the high-side MOSFET. It is recommended to add an external bootstrap diode between an external 5V and BOOT pin for efficiency improvement when input voltage is lower than 5.5V. The bootstrap diode can be a low cost one such as IN4148 or BAT54. The external 5V can be a 5V fixed input from system or a 5V output of the RT6215A/B Note that the external boot voltage must be lower than 5.5V.

External BOOT Capacitor Series Resistance

The internal power MOSFET switch gate driver is optimized to turn the switch on fast enough for low power loss and good efficiency, but also slow enough to reduce EMI. Switch turn-on is when most EMI occurs since V_{SW} rises rapidly. During switch turn-off, SW is discharged relatively slowly by the inductor current during the dead time between high-side and low-side switch on-times. In some cases it is desirable to reduce EMI further, at the expense of some additional power dissipation. The switch turn-on can be slowed by placing a small (<47Ω) resistance between BOOT and the external bootstrap capacitor. This will slow the high-side switch turn-on and V_{SW}'s rise. To remove the resistor from the capacitor charging path (avoiding poor enhancement due to undercharging the BOOT capacitor), use the external diode shown in Figure 6 to charge the BOOT capacitor and place the resistance between BOOT and the capacitor/diode connection.

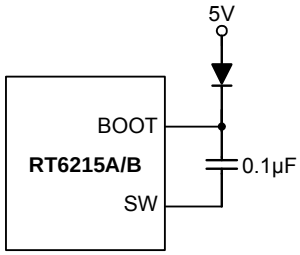


Figure 6. External Bootstrap Diode

Under Voltage Protection

The RT6215A/B provides under-voltage protection (UVP) with hiccup mode. When the FB voltage drops below 50% of the feedback threshold voltage, V_{FB}, the UVP function will be triggered to shut down switching operation. If the UVP condition remains for a period, the RT6215A/B will automatically attempt to restart. When the UVP condition is removed, the converter will resume normal operation.

Over Temperature Protection

The RT6215A/B features an Over Temperature Protection (OTP) circuitry to prevent from overheating due to excessive power dissipation. The OTP will shut down switching operation when junction temperature exceeds 160°C. Once the junction temperature cools down by approximately 25°C, the converter will resume operation. To maintain continuous operation, the maximum junction temperature should be lower than 125°C.

Soft-Start Function

The RT6215A/B provides adjustable soft-start function. The soft-start function is used to prevent large inrush current while converter is being powered-up. The soft-start

timing can be programmed by the external capacitor C_{SS} between SS and GND. An internal current source I_{SS} (4μA) charges an external capacitor to build a soft-start ramp voltage. The V_{FB} voltage will track the internal ramp voltage during soft-start interval. The typical soft-start time is calculated as follows :

Soft-Start time t_{SS} = C_{SS} x 0.791 / 4μA

Power Good Indicator

The power good indicator is an open-drain output and requires a pull up resistor. When the output voltage is lower than 90% of its set voltage, PGOOD will be pulled low. It is held low until the output voltage returns to within the allowed tolerances once more. During soft-start, PGOOD is actively held low and only allowed to transition high after soft-start is over and the output voltage has reached 95% of its setting voltage.

Thermal Considerations

The junction temperature should never exceed the absolute maximum junction temperature $T_{J(MAX)}$, listed under Absolute Maximum Ratings, to avoid permanent damage to the device. The maximum allowable power dissipation depends on the thermal resistance of the IC package, the PCB layout, the rate of surrounding airflow, and the difference between the junction and ambient temperatures. The maximum power dissipation can be calculated using the following formula :

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

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.

For continuous operation, the maximum operating junction temperature indicated under Recommended Operating Conditions is 125°C. The junction-to-ambient thermal resistance, θ_{JA}, is highly package dependent. For a TSOT-23-8 (FC) package, the thermal resistance, θ_{JA}, is 70°C/W on a standard JEDEC 51-7 high effective-thermal-conductivity four-layer test board. The maximum power dissipation at T_A = 25°C can be calculated as below :

$P_{D(MAX)}$ = (125°C – 25°C) / (70°C/W) = 1.428W for a TSOT-23-8 (FC) package.

The maximum power dissipation depends on the operating ambient temperature for the fixed $T_{J(MAX)}$ and the thermal resistance, θ_{JA}. The derating curves in Figure 7 allows the designer to see the effect of rising ambient temperature on the maximum power dissipation.

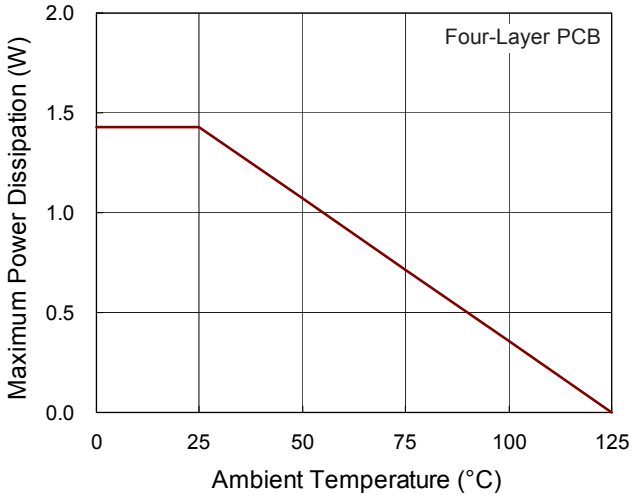


Figure 7. Derating Curve of Maximum Power Dissipation

Layout Considerations

For best performance of the RT6215A/B, the following layout guidelines must be strictly followed.

- Input capacitor must be placed as close to the IC as possible.
- SW should be connected to inductor by wide and short trace. Keep sensitive components away from this trace.
- Keep every trace connected to pin as wide as possible for improving thermal dissipation.
- The feedback components must be connected as close to the device as possible.
- Via can help to reduce power trace and improve thermal dissipation.

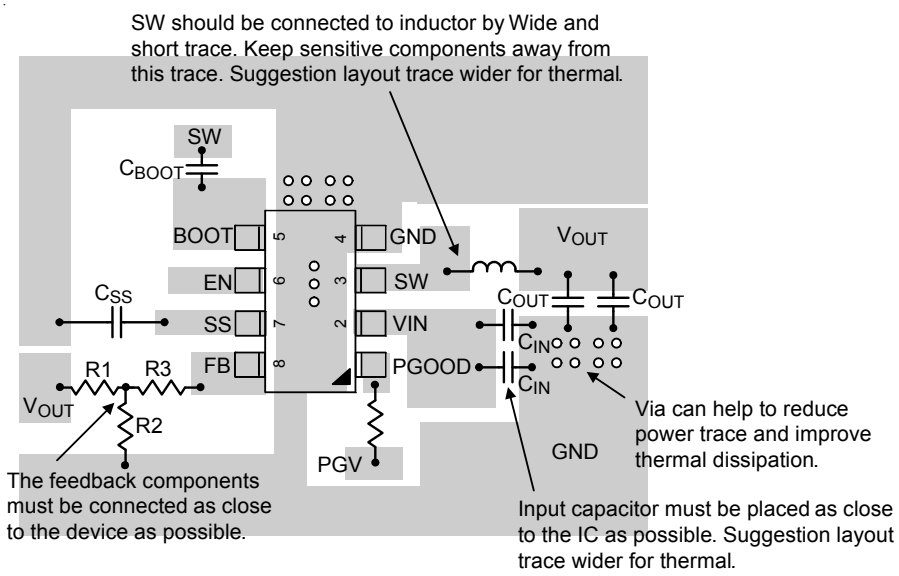
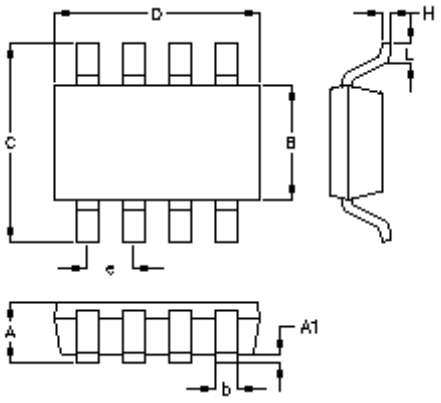


Figure 8. PCB Layout Guide

Outline Dimension



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min.	Max.	Min.	Max.
A	0.700	1.000	0.028	0.039
A1	0.000	0.100	0.000	0.004
B	1.397	1.803	0.055	0.071
b	0.220	0.380	0.009	0.015
C	2.591	3.000	0.102	0.118
D	2.692	3.099	0.106	0.122
e	0.585	0.715	0.023	0.028
H	0.080	0.254	0.003	0.010
L	0.300	0.610	0.012	0.024

TSOT-23-8 (FC) Surface Mount Package

Richtek Technology Corporation

14F, No. 8, Tai Yuen 1st Street, Chupei City

Hsinchu, Taiwan, R.O.C.

Tel: (8863)5526789

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