

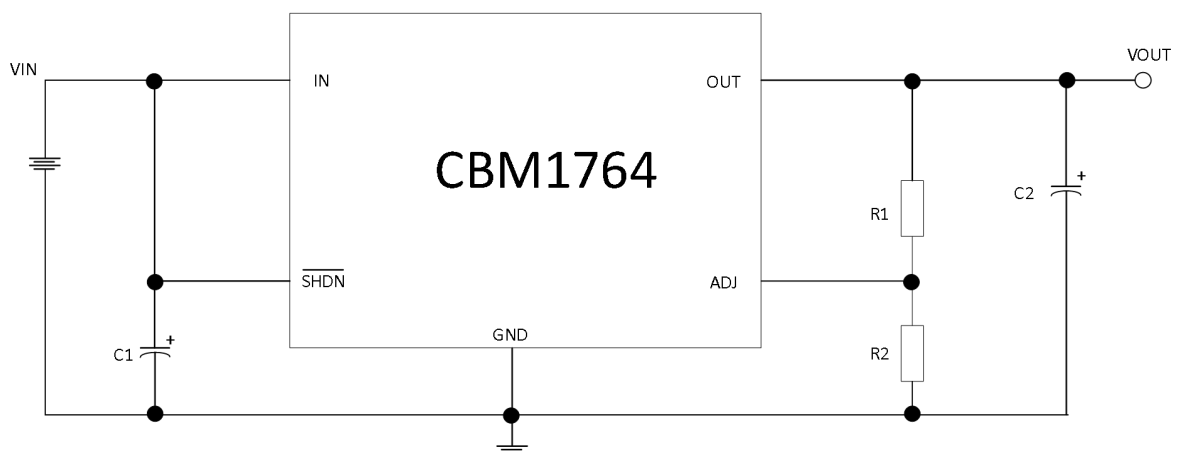
Features

- Optimized for Fast Transient Response
- Output Current: 3A
- Dropout Voltage: 340mV at 3A
- Low Noise: 40 μ V_{RMS} (10Hz to 100kHz)
- 1mA Quiescent Current
- Wide Input Voltage Range: 2.7V to 20V
- No Protection Diodes Needed
- Controlled Quiescent Current in Dropout
- Fixed Output Voltages: 1.5V, 1.8V, 2.5V, 3.3V
- Adjustable Output from 1.21V to 20V
- <1 μ A Quiescent Current in Shutdown
- Stable with 10 μ F Output Capacitor
- Reverse Battery Protection
- No Reverse Current
- Stable with Ceramic Capacitors

Applications

- Post Regulator for Switching Supplies
- 3.3V to 2.5V Logic Power Supply

Typical Application



C1=C2=10 μ F TANTALUM CERAMIC OR ALUMINUM ELECTROLYTIC

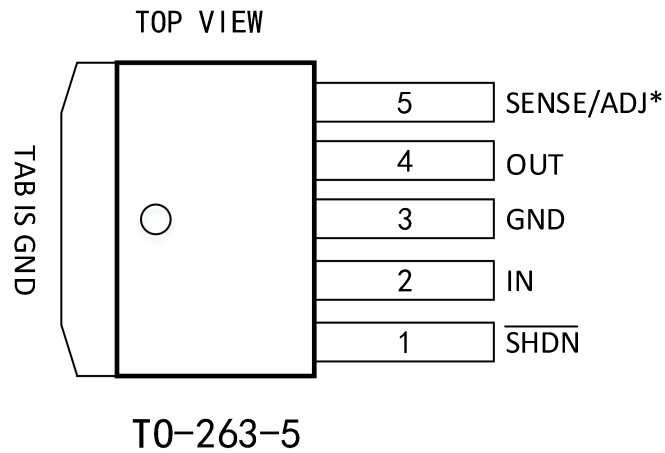
General Description

The CBM1764 is a low dropout regulator optimized for fast transient response. The device is capable of supplying 3A of output current with a dropout voltage of 340mV. Operating quiescent current is 1mA, dropping to $<1\mu\text{A}$ in shutdown. Quiescent current is well controlled; it does not rise in dropout as it does with many other regulators. In addition to fast transient response, the CBM1764 has very low output voltage noise which makes the device ideal for sensitive RF supply applications. Output voltage range is from 1.21V to 20V. The CBM1764 regulators are stable with output capacitors as low as $10\mu\text{F}$. Internal protection circuitry includes reverse battery protection, current limiting, thermal limiting and reverse current protection. The device is available in fixed output voltages of 1.5V, 1.8V, 2.5V, 3.3V and as an adjustable device with a 1.21V reference voltage. The CBM1764 regulators are available in 5-lead TO-220 and DD packages, and 16-lead FE packages.

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Pin Configuration



Pin Assignment

Num	Symbol	Description
1	$\overline{\text{SHDN}}$	Turn off the control signal, and the low level is effective.
2	IN	Voltage input.
3	GND	Ground pin.
4	OUT	Voltage output
5	SENSE/ADJ*	The fixed output voltage type is the output feedback signal sense, and the adjustable output voltage type is the resistance partial voltage feedback signal adj.

Note: the bottom pad of To-263-5 package is connected with pin 3, which is GND signal.

Electrical Characteristics

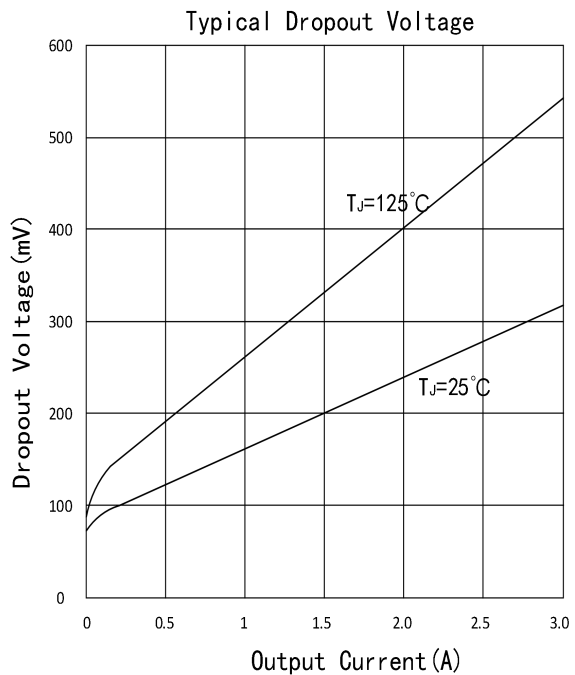
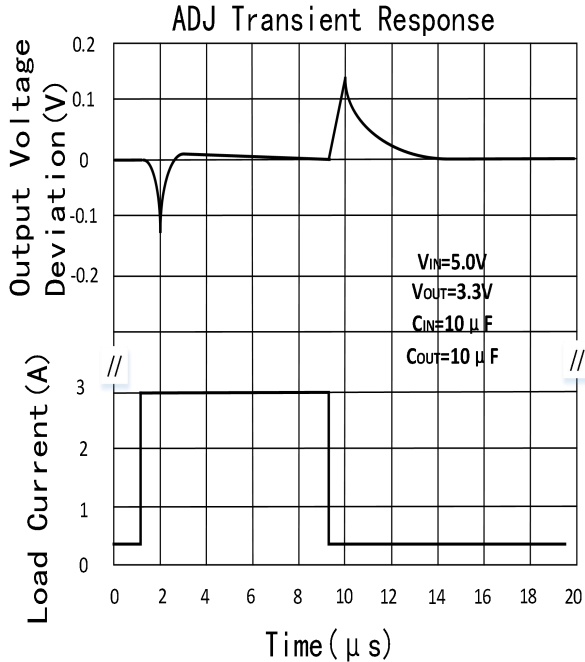
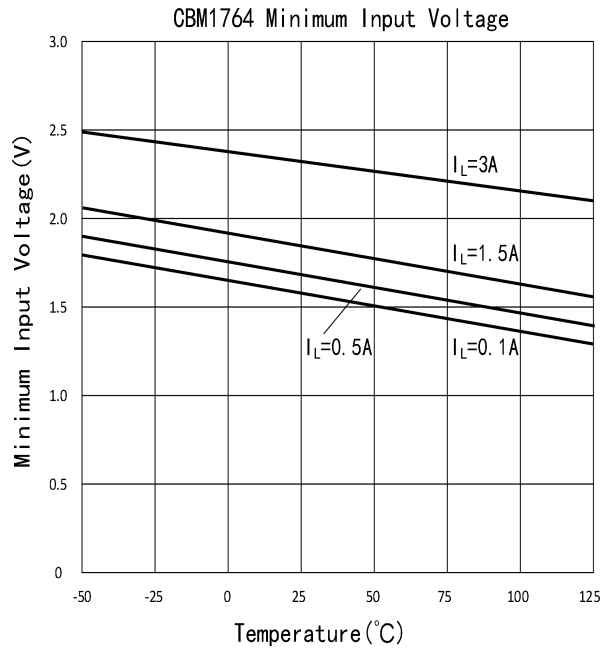
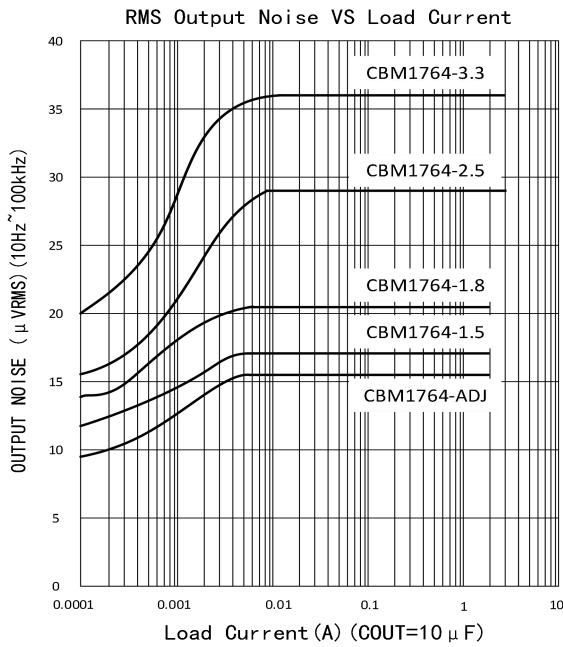
The • denotes specifications which apply over the full operating temperature range, otherwise specifications are $T_A = 25^\circ\text{C}$.

PARAMETER	CONDITION	Temperature (°C)	CBM1764			
			MIN	TYP	MAX	UNIT
Minimum input voltage	$I_{LOAD}=0.5A$			1.7		V
	$I_{LOAD}=1.5A$			1.9		V
	$I_{LOAD}=3A$	•		2.3	2.7	V
Output voltage	(CBM1764-1.5) $V_{IN}=2.21V, I_{LOAD}=1mA$ $2.7V < V_{IN} < 20V, 1mA < I_{LOAD} < 3A$		1.477	1.500	1.523	V
		•	1.447	1.500	1.545	V
	(CBM1764-1.8) $V_{IN}=2.3V, I_{LOAD}=1mA$ $2.8V < V_{IN} < 20V, 1mA < I_{LOAD} < 3A$		1.773	1.800	1.827	V
		•	1.737	1.800	1.854	V
	(CBM1764-2.5) $V_{IN}=3V, I_{LOAD}=1mA$ $3.5V < V_{IN} < 20V, 1mA < I_{LOAD} < 3A$		2.462	2.500	2.538	V
		•	2.412	2.500	2.575	V
	(CBM1764-3.3) $V_{IN}=3.8V, I_{LOAD}=1mA$ $4.3V < V_{IN} < 20V, 1mA < I_{LOAD} < 3A$		3.250	3.300	3.350	V
	•	3.183	3.300	3.400	V	
(CBM1764-ADJ) $V_{IN}=2.21V, I_{LOAD}=1mA$ $2.7V < V_{IN} < 20V, 1mA < I_{LOAD} < 3A$			1.192	1.210	1.228	V
	•		1.168	1.210	1.246	V
Line Regulation	(CBM1764-1.5) $\Delta V_{IN} = 2.21V$ to $20V$, $I_{LOAD} = 1mA$	•		2.5	10	mV
	(CBM1764-1.8) $\Delta V_{IN} = 2.3V$ to $20V$, $I_{LOAD} = 1mA$	•		3	10	mV
	(CBM1764-2.5) $\Delta V_{IN} = 3V$ to $20V$, $I_{LOAD} = 1mA$	•		4	10	mV
	(CBM1764-3.3) $\Delta V_{IN} = 3.8V$ to $20V, I_{LOAD} = 1mA$	•		4.5	10	mV
	(CBM1764-ADJ) $\Delta V_{IN} = 2.21V$ to $20V, I_{LOAD} = 1mA$	•		2	10	mV
(CBM1764-1.5) $V_{IN} = 2.7V, \Delta I_{LOAD} = 1mA$ to $V_{IN} = 2.7V, \Delta I_{LOAD} = 1mA$ to $3A$				3	7	mV
	•				23	

Load Regulation	(CBM1764-1.8) $V_{IN} = 2.7V, \Delta I_{LOAD} = 1mA$ to 3A, $V_{IN} = 2.8V, \Delta I_{LOAD} = 1mA$ to 3A	•		1.5	8	mV
	(CBM1764-2.5) $V_{IN} = 3.5V, \Delta I_{LOAD} = 1mA$ to 3A, $V_{IN} = 3.5V, \Delta I_{LOAD} = 1mA$ to 3A	•		4	25	mV
	(CBM1764-2.5) $V_{IN} = 3.5V, \Delta I_{LOAD} = 1mA$ to 3A, $V_{IN} = 3.5V, \Delta I_{LOAD} = 1mA$ to 3A	•		4	10	mV
	(CBM1764-3.3) $V_{IN} = 4.3V, \Delta I_{LOAD} = 1mA$ to 3A, $V_{IN} = 4.3V, \Delta I_{LOAD} = 1mA$ to 3A	•		4	30	mV
	(CBM1764-3.3) $V_{IN} = 4.3V, \Delta I_{LOAD} = 1mA$ to 3A, $V_{IN} = 4.3V, \Delta I_{LOAD} = 1mA$ to 3A	•		4	12	mV
	(CBM1764-3.3) $V_{IN} = 4.3V, \Delta I_{LOAD} = 1mA$ to 3A, $V_{IN} = 4.3V, \Delta I_{LOAD} = 1mA$ to 3A	•		4	40	mV
Dropout Voltage $V_{IN} = V_{OUT}(NOMINAL)$	$I_{LOAD} = 1mA$	•		0.02	5	mV
	$I_{LOAD} = 100mA$	•		2	20	mV
	$I_{LOAD} = 500mA$	•		0.02	0.05	V
	$I_{LOAD} = 500mA$	•		0.07	0.10	V
	$I_{LOAD} = 1.5A$	•		0.14	0.13	V
	$I_{LOAD} = 1.5A$	•		0.14	0.18	V
GND Pin Current $V_{IN} = V_{OUT}(NOMINAL) + 1V$	$I_{LOAD} = 0mA$	•		0.25	0.20	V
	$I_{LOAD} = 1mA$	•		0.25	0.27	V
	$I_{LOAD} = 100mA$	•		0.25	0.33	V
	$I_{LOAD} = 100mA$	•		0.25	0.40	V
	$I_{LOAD} = 500mA$	•		0.37	0.45	V
	$I_{LOAD} = 500mA$	•		0.37	0.66	V
Output Voltage Noise	$C_{OUT} = 10\mu F, I_{LOAD} = 3A, BW = 10Hz$ to 10	•		1	1.5	mA
	$C_{OUT} = 10\mu F, I_{LOAD} = 3A, BW = 10Hz$ to 10	•		1.1	1.6	mA
	$C_{OUT} = 10\mu F, I_{LOAD} = 3A, BW = 10Hz$ to 10	•		3.1	5	mA
	$C_{OUT} = 10\mu F, I_{LOAD} = 3A, BW = 10Hz$ to 10	•		8	18	mA
	$C_{OUT} = 10\mu F, I_{LOAD} = 3A, BW = 10Hz$ to 10	•		40	75	mA
	$C_{OUT} = 10\mu F, I_{LOAD} = 3A, BW = 10Hz$ to 10	•		57	200	mA
ADJ Pin Bias Current				40		μV_{RMS}
Shutdown Threshold	$V_{OUT} = Off$ to On	•		3	10	μA
	$V_{OUT} = On$ to Off	•	0.25	0.55	2	V
SHDN Pin Current	$V_{SHDN} = 0V$			0.01	1	μA
	$V_{SHDN} = 20V$			12	30	μA
Quiescent Current in Shutdown	$V_{IN} = 6V, V_{SHDN} = 0V$			0.1	1	μA

Ripple Rejection	$V_{IN} - V_{OUT} = 1.5V$ (Avg), $V_{RIPPLE} = 0.5VP-P$ $f_{RIPPLE} = 120Hz$, $I_{LOAD} = 1.5A$		55	63		dB
Current Limit	$V_{IN} = 7V$, $V_{OUT} = 0V$			5.2		A
Input Reverse Leakage Current	$V_{IN} = -20V$, $V_{OUT} = 0V$	•		1		mA
Reverse Output Current	(CBM1764-1.5) $V_{OUT} = 1.5V$, $V_{IN} < 1.5V$			900	1200	μA
	(CBM1764-1.8) $V_{OUT} = 1.8V$, $V_{IN} < 1.8V$			900	1200	μA
	(CBM1764-2.5) $V_{OUT} = 2.5V$, $V_{IN} < 2.5V$			900	1200	μA
	(CBM1764-3.3) $V_{OUT} = 3.3V$, $V_{IN} < 3.3V$			900	1200	μA
	(CBM1764-ADJ) $V_{OUT} = 1.21V$, $V_{IN} < 1.21V$			400	600	μA

Typical Characteristics



Port Characteristics

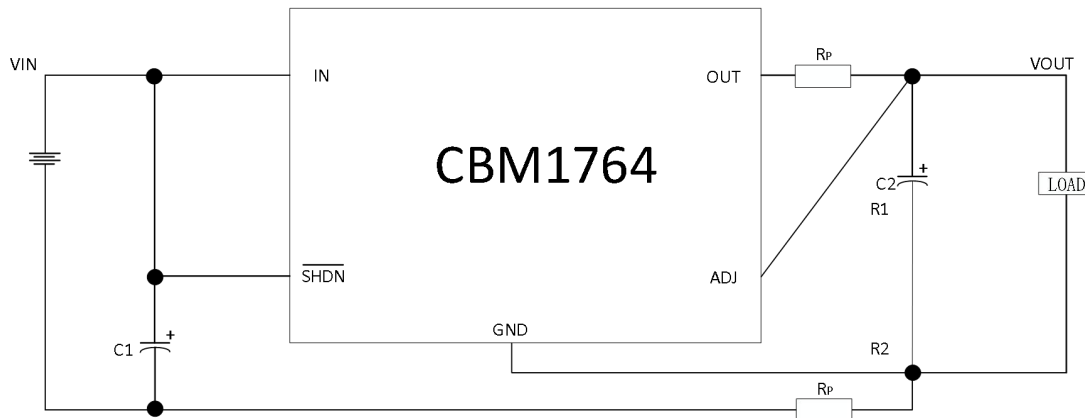
SHDN (pin 1): enable port. The enable port can control the CBM1764 regulator to enter the low power off state. When the enable is low, the output voltage will be turned off. The enable terminal can be driven by using 5V logic level or OC gate structure with pull-up resistance. The typical current of the enable port is about 12ua, so the OC gate structure needs to ensure a driving current of more than 20ua. If the enable function is not used, the enable terminal must be short circuited with the power supply; Once the enable port is suspended, the circuit will enter the micro power off state.

In (2 pins): power input terminal. Power input is provided to the device through this port. When the distance between the input port of the device and the filter capacitor of the power bus is greater than 6 inches, the bypass capacitor needs to be connected in parallel at this port. Generally speaking, the output impedance of the battery pack will increase with the increase of frequency, so a bypass capacitor should be added to the power supply circuit of the battery pack. The capacitance value is 1uF to 10uF. CBM1764DT regulator has the function of input reverse connection. When the battery is inserted reversely and the input voltage to ground is reversed, the regulator shows a state like a diode connected in series at its input. At this time, no reverse current flows into the regulator and no reverse voltage appears at the load end. The device will protect itself and the load network.

GND (3 feet): Ground.

Out (4 PINS): output terminal. The output terminal can provide a stable power supply for the load. The port requires a minimum capacitance of 10uF to prevent output oscillation. Larger output capacitance can limit the transient peak voltage of load transient response.

Sense (5 pin): output detection port. The fixed output version (such as 1.5V, 1.8V, 2.5V, 3.3V) circuit has this port. The port is directly connected to the reverse input of the internal error amplifier of the device. Where the port is short circuited with the out end of the device, the adjustment rate is the best and the voltage stabilizing accuracy is the highest. In application, the line loss resistor RP between the regulator and the load network will generate a voltage drop, leading to the drift of the voltage supply at the load side. For this phenomenon, the short contact between sense and out can be moved to the load end to eliminate the voltage drop problem (as shown in Figure 1). It should be noted that the voltage drop still exists, which is only converted into the input-output voltage difference of the device. The current of sense port is about 400ua.



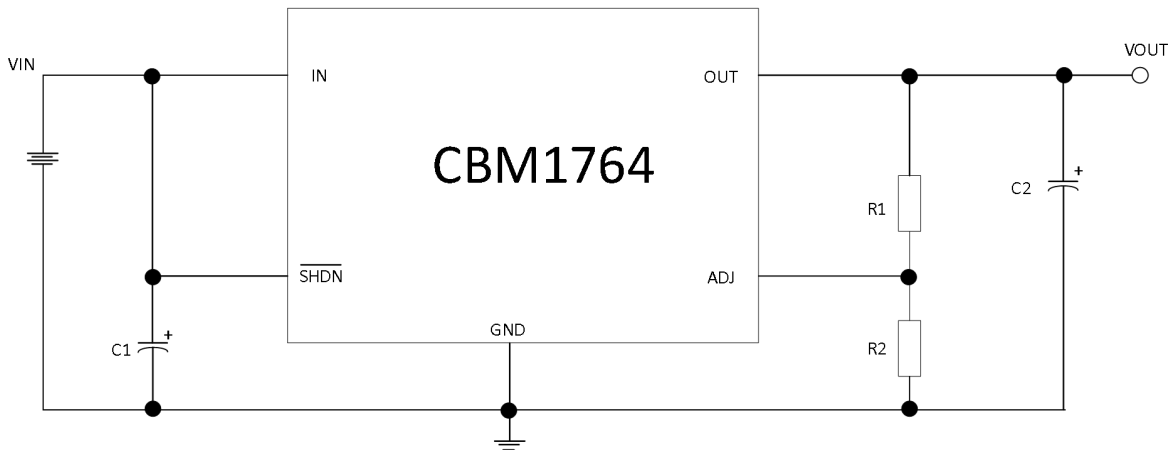
Adj (5 pins): adjustable end. The adjustable output version of the product has this port, and the adj end is directly connected to the reverse input port of the internal operational amplifier. The internal embedded voltage of this port is $\pm 7V$. The bias current of the port is about $3\mu A$, and the current direction is flowing into the device. The adj terminal voltage is about $1.2V$, and the output voltage adjustment range is $1.2V$ to $20V$.

Application Information

CBM1764 series is a $3A$ low dropout linear regulator with fast transient response. The circuit can provide $3A$ load capacity, and the differential pressure is $340mV$. The quiescent current during operation is about $1mA$, and the quiescent current drops below $1\mu A$ in the off state. This circuit combines several protection characteristics to make it better used in battery system. When the reverse input or reverse output voltage is connected, the protective device will not be damaged. In battery backup applications, when the input voltage of the backup battery is pulled down to the ground, the output will be blocked. At this time, the circuit behaves like a diode connected in series with the output, and prevents the inflow of reverse current.

Adjustable application

The output voltage adjustment range of the adjustable version is $1.2V$ to $20V$. The output voltage can be set by adjusting the ratio of two external resistors, as shown in Figure 2. The current of $R1$ is equal to $1.2V/R1$, and the current of $R2$ is equal to $R1$ current plus adj terminal bias current. At $25^\circ C$, the adj bias current is about $3\mu A$ and flows into the adj port through resistor $R2$. The output voltage can be calculated using the formula in Figure 2. The value of $R1$ should be less than $4.17k$, which can minimize the error caused by adj terminal current to output voltage. Note that in the off state, the output voltage is turned off, and there is no current on the voltage dividing resistance.



$C1=C2=10\mu\text{F}$ TANTALUM CERAMIC OR ALUMINUM ELECTROLYTIC

$$V_{\text{OUT}} = 1.2\text{V}(1+R1/R2) + (I_{\text{ADJ}})(R1)$$

$$\text{ADJ} = 1.2\text{V}$$

$$I_{\text{ADJ}} = 3\mu\text{A} @25^\circ\text{C}$$

Fig. 2 adjustable application circuit diagram

For the adjustable version of the circuit, the output terminal can be connected with the adj port to obtain an output voltage of 1.2V. Devices with an output voltage greater than 1.2V will vary in equal proportion according to the ratio of output voltage to 1.2V ($V_{\text{out}} / 1.2\text{V}$). For example, for a 1.2V output circuit, if the load adjustment rate is - 3mV when the output current is 1mA to 3a, then when the output is set to 5V, the load adjustment rate under the same conditions is: $(5\text{V} / 1.2\text{V}) * (3\text{mV}) = 12.5\text{mV}$.

Output Capacitance and stability

The internal structure of this product is a feedback circuit. Like many feedback circuits, frequency compensation can ensure the stability of the circuit output. For CBM1764, frequency compensation includes internal negative feedback compensation design and external output capacitance. The size, type and equivalent ESR of the output capacitor will affect the stability of the product.

In addition to stability, the output capacitance also affects the high frequency transient response performance. The loop of the regulator has a limited bandwidth. For the transient response of high-frequency load, the recovery of transient phenomenon is affected by the output capacitance and the bandwidth of the regulator. The CBM1764 is designed to be easy to use while accepting a wide range of diverse output capacitors. However, the output capacitance

affects the frequency compensation of the device, and the better frequency stability may need to introduce ESR, especially for ceramic capacitors.

For ease of use, low ESR polymer tantalum capacitor is a good choice for transient response and stability. The inherent ESR of these capacitors can improve the stability of the circuit. The ESR of ceramic capacitor is very small, which is also a good choice in some cases. Placing a small series resistance element can achieve the purpose of optimizing stability and minimizing ringing. In any case, when the maximum ESR reaches $3\ \Omega$, it is necessary to ensure a minimum output capacitance of 10uF.

Overload Recovery

Similar to most linear power supplies and regulators, CBM1764 series products have safe working area protection. The safe working area protection reduces the output current when the differential pressure increases, so that the internal output power tube can work safely within the whole range of input and output differential pressure. When the power supply is just started, with the increase of input voltage, the output voltage increases with the input voltage. At this time, it can work under heavy load. When the input-output voltage difference decreases, it can provide large output current. However, when the input voltage continues to rise, the output voltage is small, and the voltage difference continues to increase, exceeding the threshold, the input voltage will be pulled down and turned off and enter the safety zone protection until the input voltage returns to the normal threshold again.

Output Voltage Noise

CBM1764 voltage regulator series has good noise characteristics in 10Hz to 100kHz working frequency band and full load working conditions. The typical value of output voltage noise is $50\text{nv} \sqrt{\text{Hz}}$. When the output voltage increases, the output noise will increase. The effective value of 3.3V fixed output voltage noise is about $40\ \mu\text{VRMS}$.

Thermal stress analysis:

The power supply capacity of the circuit is limited by the maximum junction temperature ($125\ ^\circ\text{C}$), and its power dissipation consists of two parts:

1. The product of output current and input-output voltage difference $I_{\text{OUT}} * (V_{\text{IN}} - V_{\text{OUT}})$;
2. Product of ground terminal current and input voltage $I_{\text{gnd}} * V_{\text{in}}$. The power dissipation capacity of the circuit is equal to the sum of the above two parts.

CBM1764 series products have internal thermal protection design to protect devices in case of output overload. Keep the device working normally, and the maximum junction temperature shall not exceed 125 °C. It is important to carefully consider all factors affecting the thermal resistance of the junction to the environment. At the same time, the influence of other heat sources near the device should also be considered.

For surface mount devices, heat sinks can transfer heat to board level or copper wires. Surface tiled heat sinks and gold plated vias can be used to conduct heat generated by power devices. The junction to ambient thermal resistance of to-263 package is 23 °C / W.

Protection Characteristics

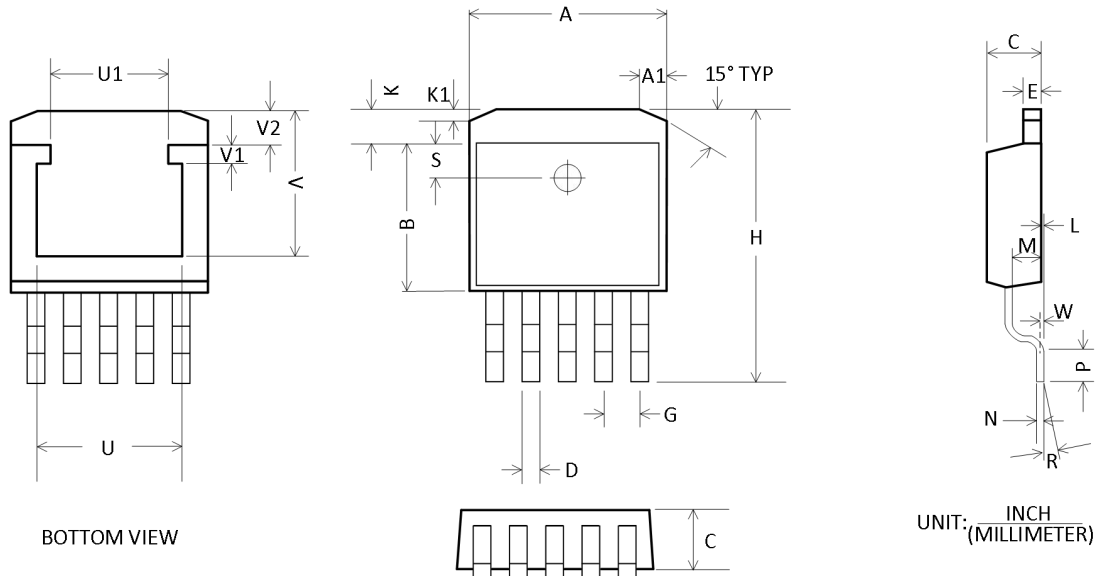
CBM1764 regulator integrates a variety of protection features, making it more ideal for battery system. In addition to the conventional protection characteristics of the single-chip regulator, such as current limit and thermal protection, the circuit also has the function of reverse input voltage protection, reverse output voltage protection, and reverse protection from output to input.

Over current protection and thermal protection are designed to protect the device from output overload. Under normal working conditions, the junction temperature shall not exceed 125 °C. The input of the circuit can withstand a reverse voltage of 20V. At this time, the current flowing into the device is limited within 1mA, and there will be no negative voltage at the output port. The circuit can protect itself and the load device. These protective structures can withstand the reverse connection problem of battery insertion.

When the output voltage of CBM1764 regulator is pulled down to the ground potential, the device will not be damaged. If the input port is suspended or grounded, the output can be pulled down to - 20V. For the fixed output version, the output terminal shows a large resistance, which can limit the inflow current to 900uA. For the adjustable version, the output is open and no current flows into the port. If the input is connected to a stable voltage source, the output will flow short-circuit current, and the thermal protection function will be started. In this state, the enable terminal will be pulled to the ground potential to turn off the output, and the short-circuit current will disappear.

Package Information

TO-263-5



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	9.78	10.54	.385	.415
B	8.38	8.64	.330	0.340
C	4.31	4.57	.170	.180
D	0.66	0.91	.026	.036
E	1.14	1.40	.045	.055
G	1.70ref		.067ref	
H	14.73	15.75	.580	.620
K	1.40	1.68	.055	.066
L	0.00	0.25	.000	.010
M	2.49	2.74	.098	.108
N	0.43	0.58	.017	.023
P	2.29	2.79	.090	.110
R	0°	8°	0°	8°
S	2.41	2.67	.095	.105
U	7.62ref		.30ref	

V	7.75ref		.305ref	
W	0.25		.010	
U1	6.52ref		.257ref	
V1	1.51ref		.059ref	
V2	1.64ref		.065ref	
A1	0.762	1.522	.030	.060
K1	0.277	0.557	.011	.022

Package/Ordering Information

PRODUCT	TEMPRANGE	PACKAGE	PAKEAGE MARKING	TRANSPOT MEDIA,QUANTILY
CBM1764DT-ADJ	-40°C~125°C	TO263-5	CBM1764DT-ADJ	Tape and Reel,800
CBM1764DT-1.5	-40°C~125°C	TO263-5	CBM1764DT-1.5	Tape and Reel,800
CBM1764DT-1.8	-40°C~125°C	TO263-5	CBM1764DT-1.8	Tape and Reel,800
CBM1764DT-2.5	-40°C~125°C	TO263-5	CBM1764DT-2.5	Tape and Reel,800
CBM1764DT-3.3	-40°C~125°C	TO263-5	CBM1764DT-3.3	Tape and Reel,800
CBM1764TS-ADJ	-40°C~125°C	TSSOP-16	1764A	Tape and Reel,800
CBM1764TS-1.5	-40°C~125°C	TSSOP-16	1764AC	Tape and Reel,800
CBM1764TS-1.8	-40°C~125°C	TSSOP-16	1764AD	Tape and Reel,800
CBM1764TS-2.5	-40°C~125°C	TSSOP-16	1764AE	Tape and Reel,800
CBM1764TS-3.3	-40°C~125°C	TSSOP-16	1764AF	Tape and Reel,800