

# Output voltage compensation DC/DC converter for USB Monolithic IC MM3630BR

## Outline

Output voltage compensation for USB power supply. Support it that the compensation the output voltage to descend by cable resistance and satisfies a USB standard. In addition, its feature of synchronous rectification reduces both the number of components used in the corresponding device and the mounting area. To prevent interfere with the AM-band, it is equipped with the variable function that operates according to an external resistor and the external synchronization for the switching frequency.

## Features

1. Absolute maximum rating : 40V
2. Input voltage range : 4.5 to 33V
3. Output voltage range : 3 to 7V
4. Reference voltage :  $0.8V \pm 1.5\%$
5. Output current : 1.5A
6. Switching frequency range : 200kHz to 1000kHz.  
Ext. SYNC or Set by resistor
7. Adjustable over current protection.
8. Package : SQFN-24

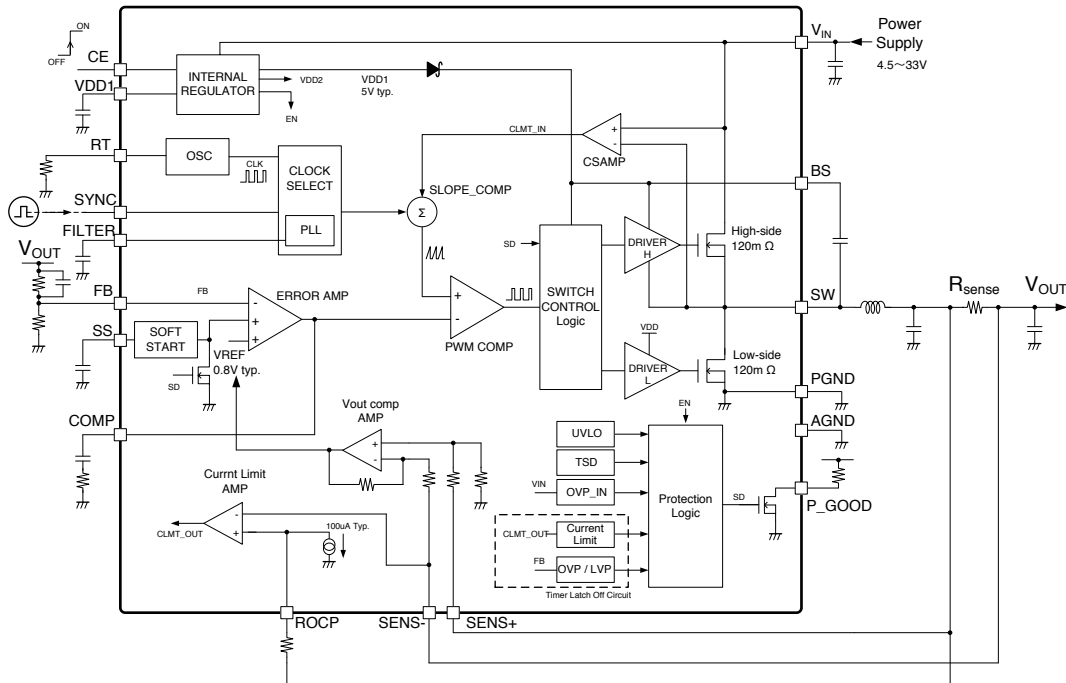
## Package

SQFN-24

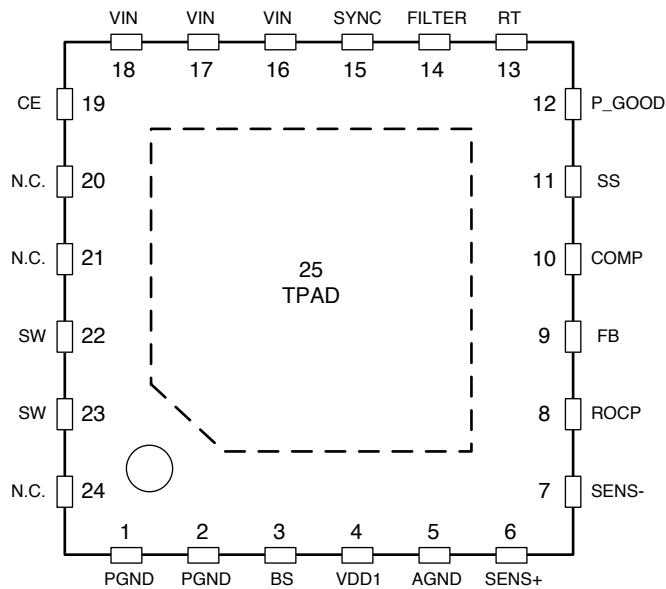
## Applications

1. Car Audio
2. Car Navigation
3. Connector Box

Block Diagram



Pin Assignment



**Pin Description**

Pin No.	Pin name	Pin description
1, 2	PGND	Ground pin.
3	BS	Bootstrap capacitor connection pin. The bootstrap capacitor 0.1 $\mu$ F is necessary between BS to SW to drive the high side switch.
4	VDD1	Internal linear regulator output pin.
5	AGND	Ground pin.
6	SENS+	Output voltage correction amplifier input plus pin. Corrects an output voltage drop for output impedance by adjusting an amplifier gain by resistance connected with. In not using RSENSE resistance (short circuit use), please connect with V <sub>OUT</sub> together with a SENS- pin.
7	SENS-	Output voltage correction amplifier input minus pin. Corrects an output voltage drop for output impedance by adjusting an amplifier gain by resistance connected with. In not using RSENSE resistance (short circuit use), please connect with V <sub>OUT</sub> together with a SENS+ pin.
8	ROCP	Current Limit detection value setting pin. An CurrentLimit detection level is decided by resistance linked to a Rocp pin, and output voltage compensation resistance. In not using a ROCP pin, please connect to GND.
9	FB	Output voltage feedback pin. Output voltage is set by adjusting the resistor between V <sub>OUT</sub> , FB and GND.
10	COMP	Phase compensation pin. Error amplifier output pin. Connect to phase compensation componets to thin pin.
11	SS	Soft-start time adjustable pin.
12	P_GOOD	Reset output pin. Open drain reset output pin. L signal is outputted when the abnormal operation is detected.
13	RT	External frequency setting pin.
14	FILTER	The phase-locked loop's low pass filter pin. In not using an external synchronization function, please connect to GND.
15	SYNC	External synchro pin. The switching frequency is synchronized with sync pin input pulse signal. In not using an external synchronization function, please connect to GND.
16, 17, 18	VIN	Power supply pin. Input power supply voltage 4.5-33V. Input capacitor must be used to the ceramic capacitor.
19	CE	Chip enable pin. Pull above 2.0V to enable, pull below 0.6V to disable. Please avoid use in the state that is floating.
20, 21, 24	N.C.	No connect pin.
22, 23	SW	Inductor connection pin. Output pin to inductor.
25	TPAD	Thermal pad Thermal pad must be connected to ground to use the best electrical characteristics.

**Absolute Maximum Ratings** (Except where noted otherwise Ta=25°C)

Item	Symbol	Ratings	Units
VIN Supply Voltage	V <sub>INMAX</sub>	-0.3~+40	V
SW Pin Voltage	V <sub>SWMAX</sub>	-0.3~V <sub>IN</sub> +0.3	V
BS Pin Voltage	V <sub>BSMAX</sub>	V <sub>SW</sub> -0.3~V <sub>SW</sub> +5.5	V
FB Pin Voltage	V <sub>FBMAX</sub>	-0.3~+5.5	V
CE Pin Voltage	V <sub>CEMAX</sub>	-0.3~+40	V
SS Pin Voltage	V <sub>SSMAX</sub>	-0.3~+5.5	V
COMP Pin Voltage	V <sub>COMPMAX</sub>	-0.3~+5.5	V
VDD1 Pin Voltage	V <sub>VDDMAX</sub>	-0.3~+5.5	V
SYNC Pin Voltage	V <sub>SYNCMAX</sub>	-0.3~+5.5	V
RT Pin Voltage	V <sub>RTMAX</sub>	-0.3~+5.5	V
FILTER Pin Voltage	V <sub>FILTERMAX</sub>	-0.3~+5.5	V
ROCP Pin Voltage	V <sub>ROCPMAX</sub>	-0.3~+12	V
SENS+ Pin Voltage	V <sub>SENS+MAX</sub>	-0.3~+12	V
SENS- Pin Voltage	V <sub>SENS-MAX</sub>	-0.3~+12	V
P_GOOD Pin Voltage	V <sub>PGOODMAX</sub>	-0.3~+5.5	V
AGND-PGND Pin Voltage	V <sub>GNDMAX</sub>	-0.3~+0.3	V
Storage Temperature	T <sub>stg</sub>	-55~+150	°C
Power dissipation (Note1)	P <sub>d</sub>	2.37	W

Note1 : Using JEDEC standard 4layers board.

**Recommended Operating Conditions**

Item	Symbol	Ratings	Units
Operating Ambient Temperature	T <sub>OPR</sub>	-40~+85	°C
Operating Voltage1	V <sub>OP1</sub>	4.5~33	V
Output Voltage Setting Range	V <sub>OUT</sub>	3~7	V

**Electrical Characteristics**

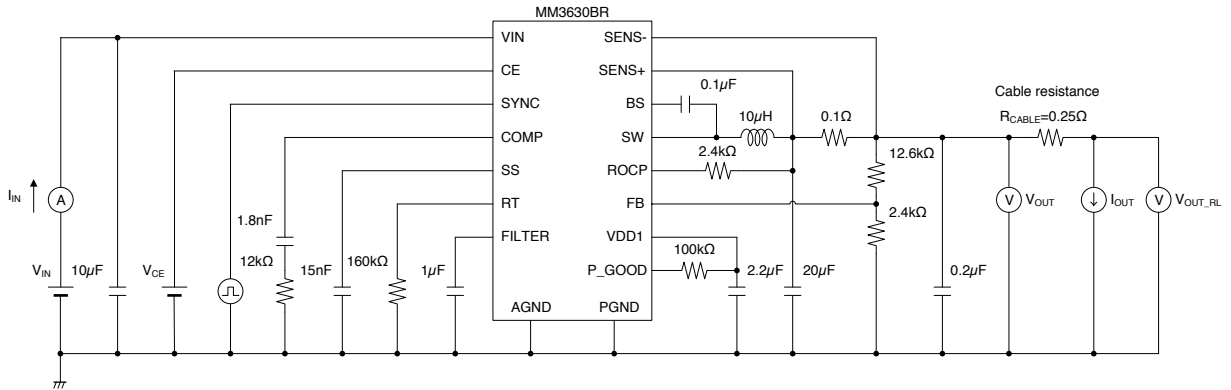
(Except where noted otherwise Ta=25°C, VIN=12V, VCE=3V)

Item	Symbol	Measurement conditions	Min.	Typ.	Max.	Units
Operating Voltage 2	V <sub>OP2</sub>	V <sub>OUT</sub> =5V, I <sub>OUT</sub> =2.5A R <sub>T</sub> =160kΩ, R <sub>sense</sub> =0Ω	7		18	V
Supply Current	I <sub>S1</sub>	V <sub>CE</sub> =3V, V <sub>FB</sub> =0.9V No swithing		1.5	3	mA
Shutdown Current	I <sub>S2</sub>	V <sub>CE</sub> =0V, V <sub>IN</sub> =33V		0.01	1	μA
Feedback Voltage	V <sub>FB</sub>	V <sub>COMP</sub> =V <sub>FB</sub> , I <sub>OUT</sub> =0A	0.788	0.800	0.812	V
Output Voltage Compensation Coefficient	K <sub>C</sub>	V <sub>SENS+</sub> -V <sub>SENS-</sub> =0.05V, 0.3V	0.392	0.412	0.432	
Error Amplifier Transconductance	G <sub>EA</sub>	ΔI <sub>COMP</sub> =±10μA, V <sub>COMP</sub> =1V		100		μA/V
High-side Switch On-resistance (Note2)	R <sub>ONH</sub>	V <sub>GS</sub> =4.5V		120		mΩ
Low-side Switch On-resistance (Note2)	R <sub>ONL</sub>	V <sub>GS</sub> =4.5V		120		mΩ
High-side Switch Leakage Current	I <sub>LEAKH</sub>	V <sub>CE</sub> =0V, V <sub>SW</sub> =0V		0.01	1	μA
Low-side Switch Leakage Current	I <sub>LEAKL</sub>	V <sub>CE</sub> =0V, V <sub>BS</sub> =12V, V <sub>SW</sub> =12V		0.01	1	μA
Low Output Voltage Protection	V <sub>LVP</sub>	V <sub>FB</sub> =high to low, V <sub>COMP</sub> =1V	0.3	0.4	0.5	V
Over Output Voltage Protection	V <sub>OVV</sub>	V <sub>FB</sub> =low to high, V <sub>COMP</sub> =1V	110	120	130	%
Latch Delay Time	t <sub>LATCH</sub>		0.7	1.0	1.3	ms
Oscillation Frequency	f <sub>SW</sub>	V <sub>FB</sub> =0.7V, R <sub>T</sub> =160kΩ, SYNC=open	450	500	550	kHz
Oscillation Frequency Range	f <sub>RANGE</sub>		200		1000	kHz
Minimum Off Time	t <sub>MIN</sub>	V <sub>FB</sub> =0.7V			240	ns
Minimum On Time	t <sub>ONMIN</sub>				240	ns
UVLO Wake up Voltage	V <sub>UVLO</sub>	V <sub>DD1</sub> =low to high	4.0	4.2	4.5	V
UVLO Hysteresis Voltage	ΔV <sub>UVLO</sub>	V <sub>DD1</sub> =high to low		0.2		V
Over Input Voltage Protection	V <sub>OVV<sub>IN</sub></sub>	V <sub>IN</sub> =low to high	33.5	36.5	39.5	V
OVLO Hysteresis Voltage	ΔV <sub>OVV<sub>IN</sub></sub>	V <sub>IN</sub> =high to low		0.9		V
Soft Start Time	T <sub>SS</sub>	C <sub>SS</sub> =15000pF, V <sub>CE</sub> >V <sub>CET</sub> to time that V <sub>OUT</sub> is up to reach 95% of the normal value.		6		ms
CE Pin Threshold Voltage	V <sub>CET</sub>		0.6		2	V
Thermal Shutdown (Note2)	TSD			170		°C
Thermal Shutdown Hystersis (Note2)	ΔTSD			30		°C
ROCP Pin Input Current	I <sub>ROCP</sub>	V <sub>ROCP</sub> =5V	95	100	105	μA
Output Current Limit Offset Voltage	V <sub>OFFSET</sub>	V <sub>SENS-</sub> - V <sub>ROCP</sub>	-5.0		+5.0	mV
SYNC High Voltage	V <sub>SYNCH</sub>	V <sub>SYNC</sub> =0V to 5V	2.0			V
SYNC Low Voltage	V <sub>SYNCL</sub>	V <sub>SYNC</sub> =5V to 0V			0.4	V
SYNC Input Current	I <sub>SYNC</sub>	V <sub>SYNC</sub> =3V	0.06	0.12	0.24	mA

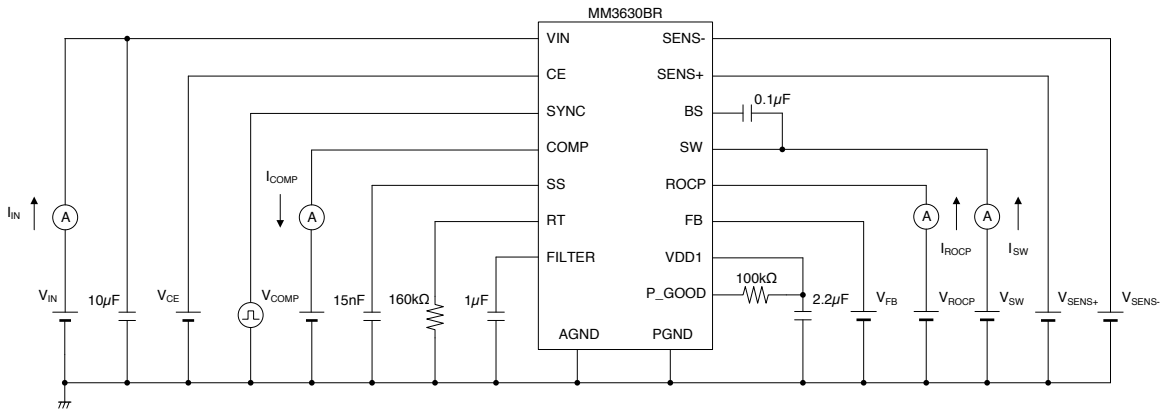
Note2 : Guaranteed by design, not tested.

Measuring Circuit

TEST CIRCUIT1

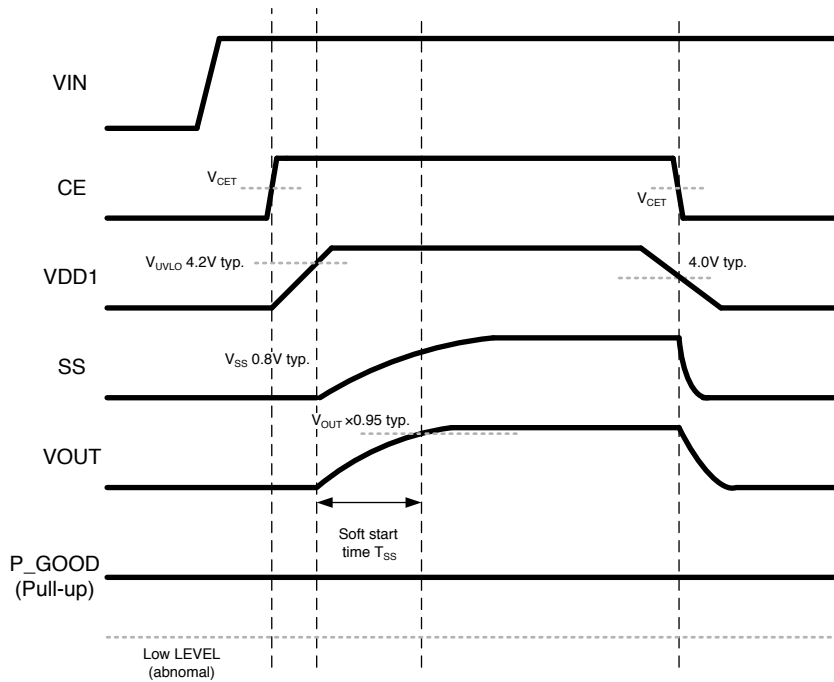


TEST CIRCUIT2



## Timing Chart

### (1) Start-up/ Shut-down

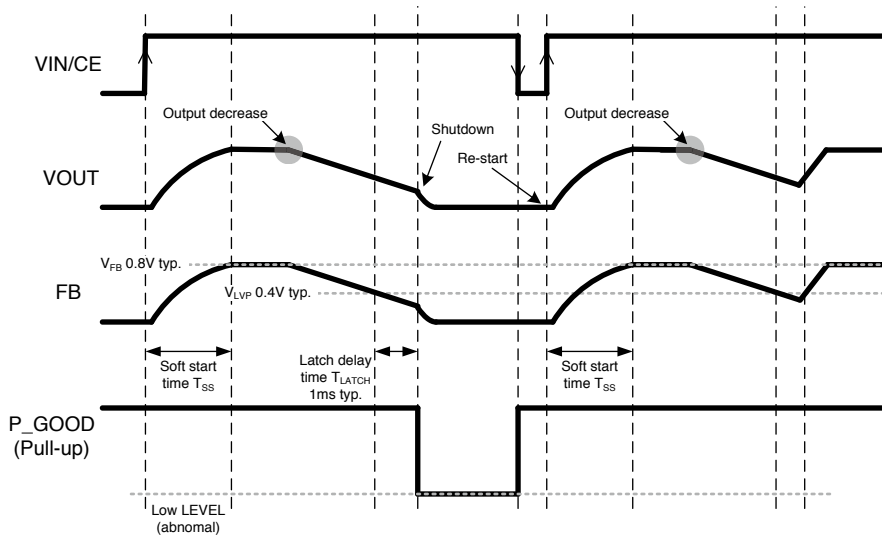


Start-up condition is  $V_{CE} > V_{CET}$  and  $V_{DD1} > V_{UVLO}$ .

Shut-down condition is  $V_{CE} < V_{CET}$  and  $V_{DD1} < V_{UVLO}$ .

Soft start time  $V_{SS}$  is from  $V_{CE} > V_{CET}$  to time that  $V_{OUT}$  is up to reach 95% of the normal value.

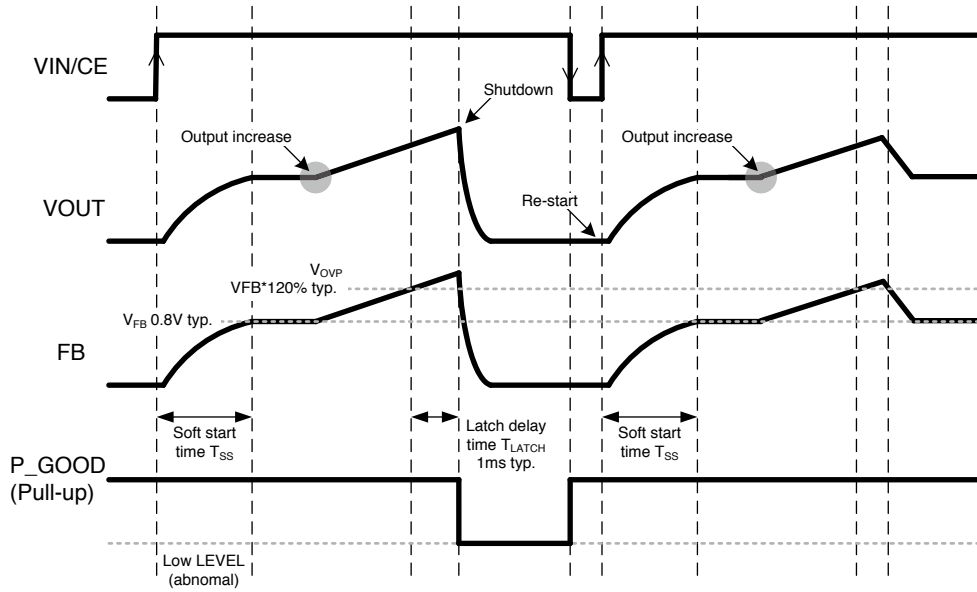
### (2) Low output voltage protection



When LVP are detected exceeding latch delay time  $T_{LATCH}$ , IC is shutdown,  $P\_GOOD$  is L-Output.

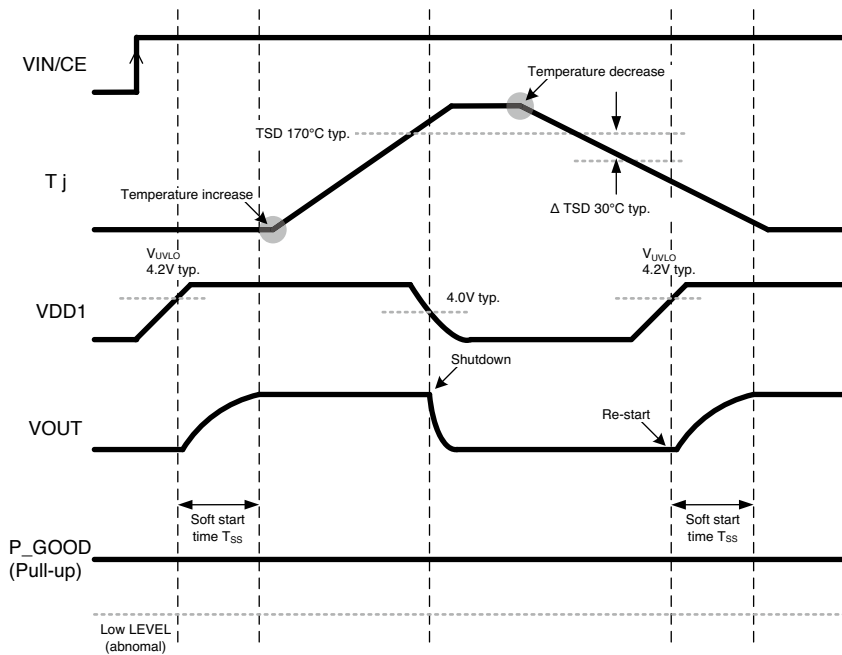
The IC is re-start by turning on  $VIN/CE$  pin.

(3) Over output voltage protection



When OVP are detected exceeding latch delay time T<sub>LATCH</sub>, IC is shutdown, P\_GOOD is L-Output. The IC is re-start by turning on VIN/CE pin.

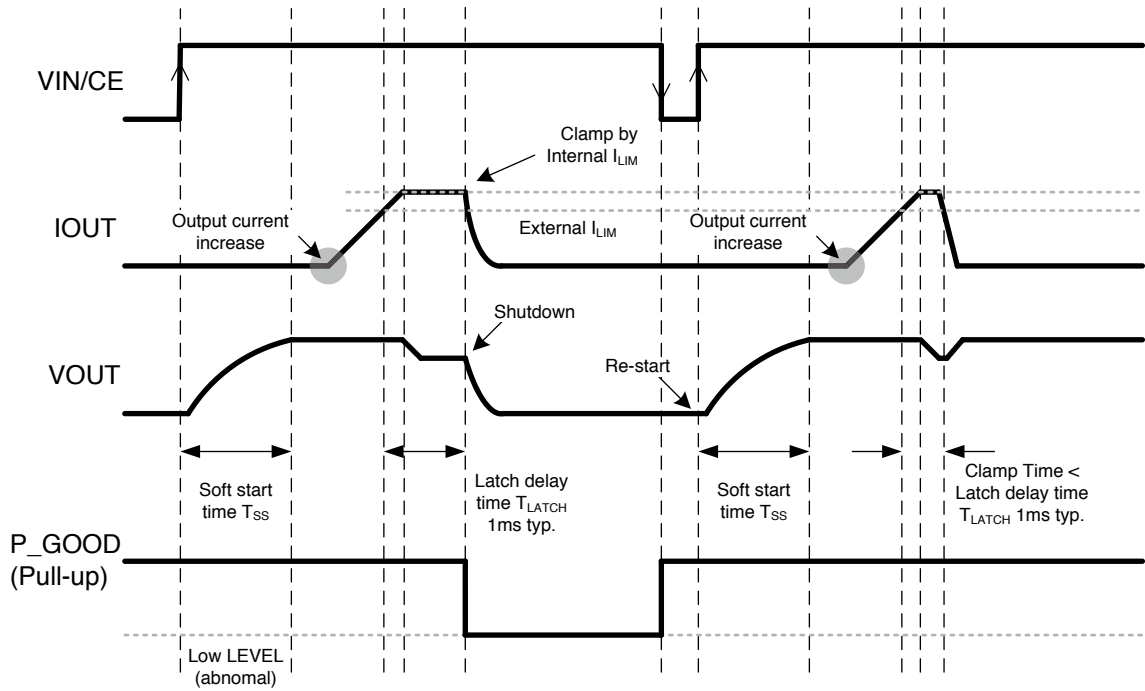
(4) Thermal shutdown function



When the junction temperature (T<sub>j</sub>) rises above 170 °C, VDD1 stops, and the IC shuts it down. When the junction temperature (T<sub>j</sub>) drops below 130 °C, IC will restart.

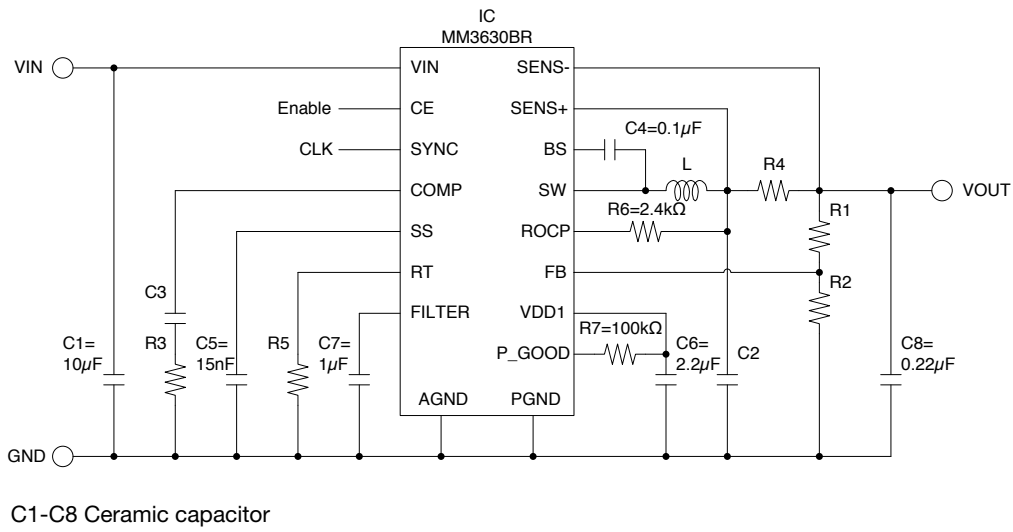


(5) Current limit function



When Current limit are detected exceeding latch delay time  $T_{LATCH}$ , IC is shutdown, P\_GOOD is L-Output. The IC is re-start by turning on VIN/CE pin.

Application Circuit



Recommended external parts value.

V <sub>OUT</sub> [V]	L [µH]	C2 [µF]	R1 [kΩ]	R2 [kΩ]	C3 [pF]	R3 [kΩ]	R5 [kΩ]
5.0	10	20	12.6	2.4	1800	12	160

· Notice

The output voltage is decided depending on the input voltage, Minimum on time, Maximum duty cycle. Please decide the output condition in consideration of the above-mentioned characteristic.

There is a possibility that operation becomes unstable when the current rating of the coil is exceeded. Please enlarge the current rating of the coil more than the output current.