Power Management ICs for Mobile Phones

Power Management ICs for Battery Chargers

BD5650AFVM

No.10032EBT02

●Description

BD5650AFVM is small controller built in high accuracy reference voltage, constant voltage controlled amplifier and over current detection. BD5650AFVM functions as constant voltage control to realize stable power supply and abnormal (open-collector ON) output in case a controller continues to detect over current overtime. A time until driving is flexible depend on external capacitance.

●Features

1) Constant voltage control
2) Supply voltage range: 2.5V～18V
3) High accuracy reference voltage: 1.21V±1%
4) Current detected voltage: 73mV±5%(0～85℃)
5) Built-in over current detection with delay time
6) Small package: MSOP8

●Applications

It is suitable for secondary side controller in AC/DC adaptor to protect from over current.

●Absolute Maximum Ratings (Ta=25℃)

Parameter	Symbol	Ratings	Unit
Maximum supply Voltage	VMAX	-0.3 ～ 20	V
CP pin maximum voltage	VCPMAX	-0.3～7	V
Power Dissipation	Pd	587 *1	mW
Operating Temperature Range	Topr	-30 ～ +85	℃
Maximum Junction Temperature	Tjmax	150	℃
Storage Temperature Range	Tstg	-55 ～ +150	℃

*1 Pd derate at 4.7mW/℃ for temperature above Ta = 25℃ (When mounted on a PCB 70.0mm×70.0mm×1.6mm)

●Operating condition (Ta=0～+85℃)

Parameter	Symbol	Ratings	Unit
Supply voltage	VCC	2.5～18	V
CP pin operating voltage	VCP	0～5.5	V

●Electric Characteristics (Ta=25℃, Vcc=+5V)

Parameter	Symbol	Limits			Unit	Conditions
		MIN.	TYP.	MAX.		
【WHOLE DEVICE】						
Total Supply Current - not taking the output sinking current into account	ICC	-	0.6	1.2	mA	
【Voltage Control Loop】						
Transconduction Gain(VCT). Sink Current Only	GMV	1.0	4.5	-	mA/mV	
Voltage Control Loop Reference at 1.5mA sinking current	VREF	1.198	1.21	1.222	V	Ta=25℃
		1.186	1.21	1.234		0 < Ta < 85℃
【Current Detection】						
Current Detection Reference	VSE	69.4	73	76.6	mV	0 < Ta < 85℃
Current out of pin ICT	Ibi	2	5	9	μA	ICT=-0.1V
【Output Stage】						
Output Short Circuit Current, Output to VCC, Sink Current Only	IOS	11	25	50	mA	OUT=VCC, ICT=-0.2V VSE=0V
【Delay Time Setting】						
CP Charge Current	Ichg	612	665	718	nA	Set 4 second, when CP=2.2uF

This product is not designed to be radiation-resistant.

●Measurement circuit diagram

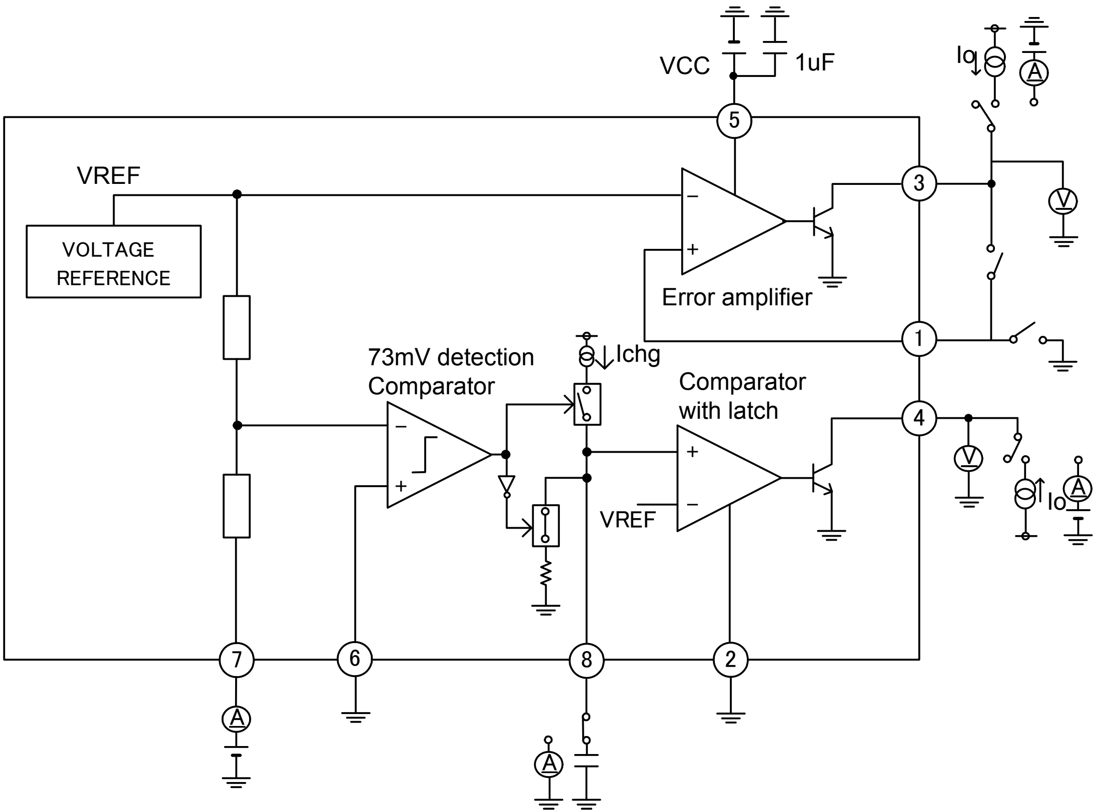


Fig.1

●Reference data

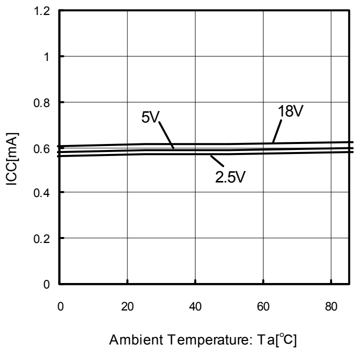


Fig.2 Circuit current vs temp.

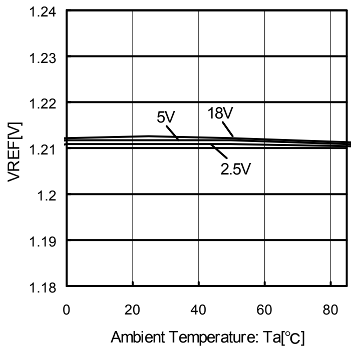


Fig.3 Voltage controlled reference voltage vs temp.

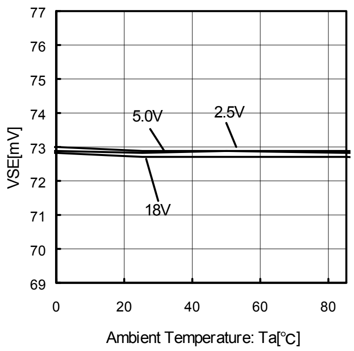


Fig.4 Over-current detected voltage vs temp.

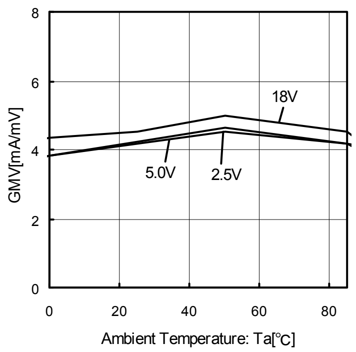


Fig.5 Voltage controlled amplifier:GM vs temp.

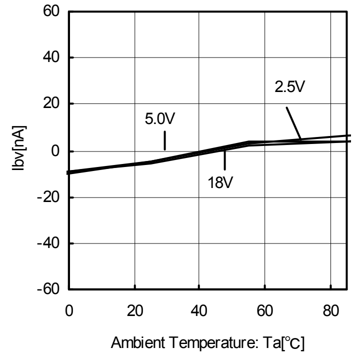


Fig.6 VCT pin input bias current vs temp.

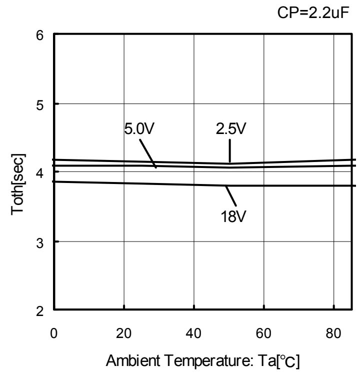


Fig.7 Delay time vs temp.

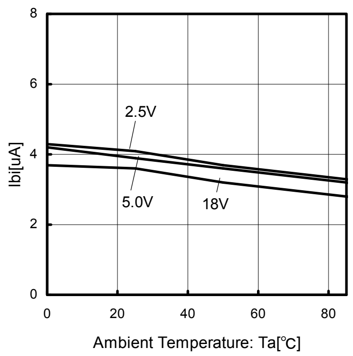


Fig.8 ICT pin output current vs temp.

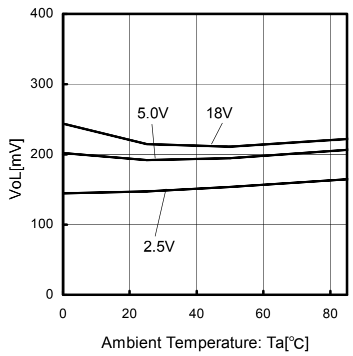


Fig.9 10mA sinking output voltage vs temp.

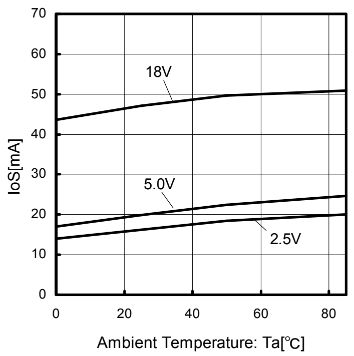


Fig.10 Output short-circuit current vs temp.

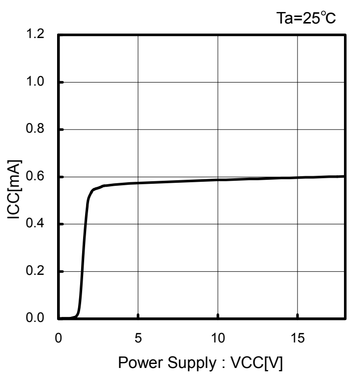


Fig.11 Circuit current vs VCC

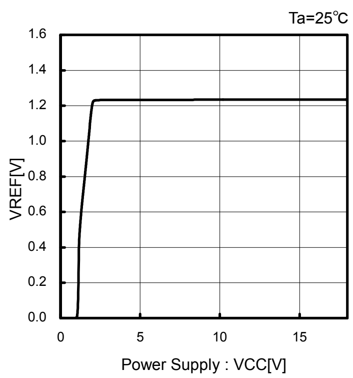


Fig.12 Voltage controlled reference voltage vs VCC

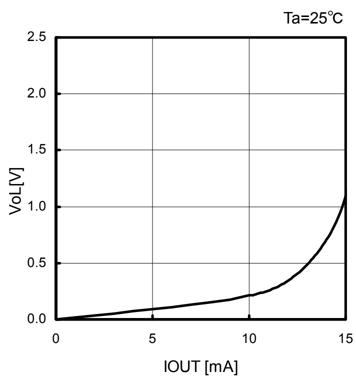


Fig.13 Sinking output voltage vs IOUT

● Block Diagram

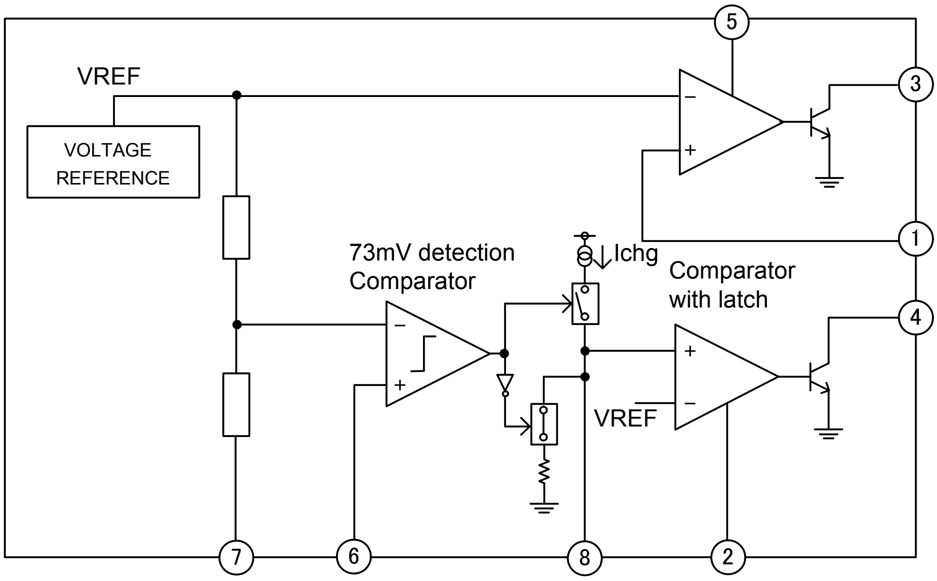


Fig.14

● Pin Description

PIN No.	PIN NAME	FUNCTION
1	VCT	Input Pin of the Voltage Control Loop
2	GND	Ground Line. 0V Reference For All Voltages
3	OUT	Output Pin. Sinking Current Only
4	OCP	Output Pin for Over Current Detection. After delay time, sinking current.
5	VCC	Positive Power Supply Line
6	VSE	Input Pin of the Current Detection(+). Normally short to GND.
7	ICT	Input Pin of the Current Detection(-). Detected at -73mV.
8	CP	Set delay time by capacitor.

● Package Dimensions

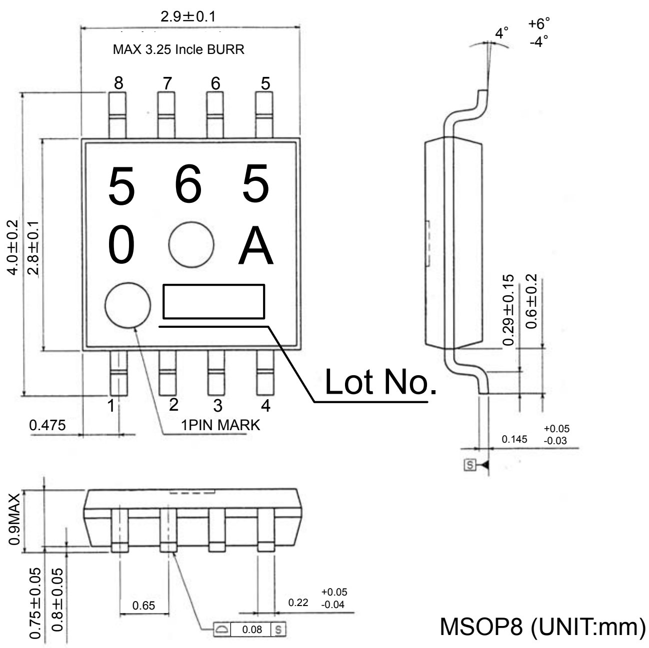


Fig.15

●Typical application

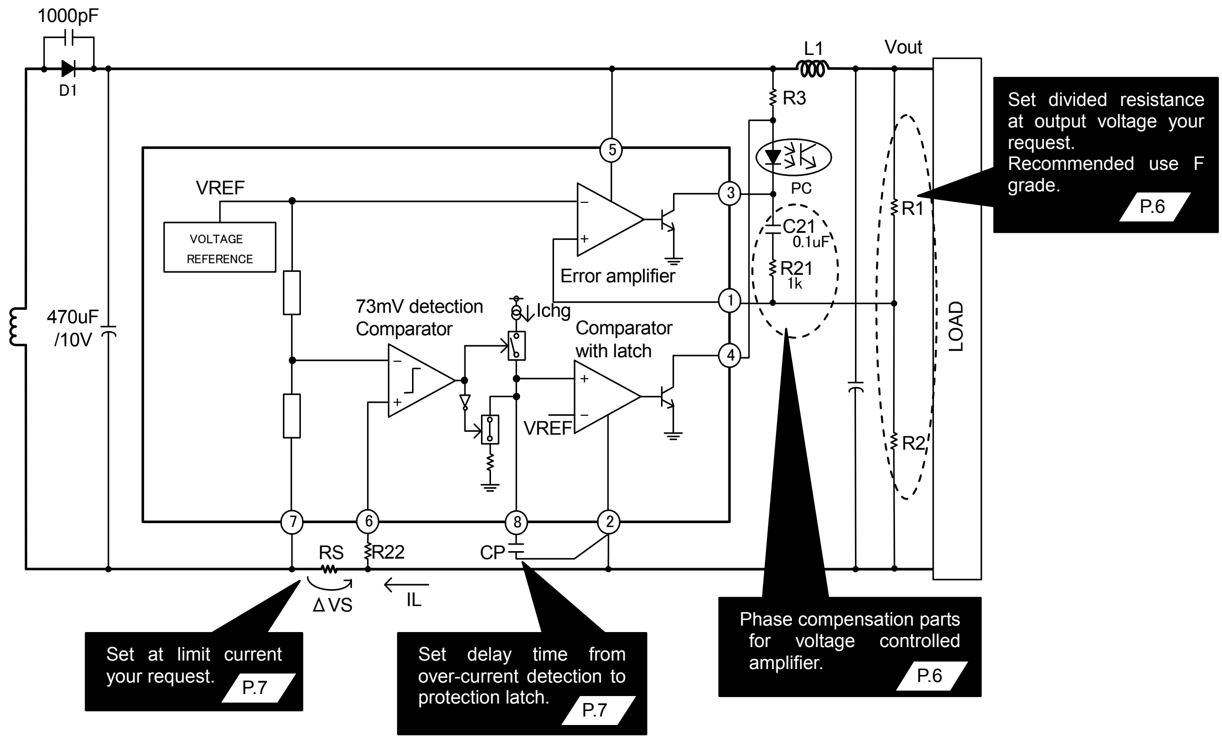


Fig.16

VOUT = VREF × (R1+R2) / R2 [V]

CURRENT LIMIT : IL = VSE / RS [A]

Recommended part list

Symbol	Products	Recommended value
C0	UD Series (Nichikon)	220 ～ 1000 μF
C1	UD Series (Nichikon)	100 ～ 680 μF
C21	MCH182CN104 (Rohm)	0.1 μF
CP	-	(Tolerence B)
R1	MCR03 (Rohm)	160k (Tolerence F)
R2	MCR03 (Rohm)	51k (Tolerence F)
R3	MCR03 (Rohm)	470
R21	MCR03 (Rohm)	1k
R22	MCR03 (Rohm)	470
RS	MCR25 (Rohm)	0.3 (Tolerence F)
D1	SB240	-
PC	PC17K1DD (KODENSHI)	-

Caution in use

We are convinced that an example above application circuit is no problem, but you should sufficiently evaluate the characteristics for your application. You need to decide external values sufficiently considering static characteristics, transient characteristics and IC’s unevenness to keep working application margin when you use in change external circuit value. You need to evaluate when you decide external value, since the frequency response in overall system is affected in particular from not IC only but characteristics of optocoupler and primary side control IC.

●Explanation for circuit working

1. Constant voltage control

(1-1) Output voltage

Voltage feedback system is composited from error amplifier, resistance R1 / R2 and optocoupler connected to OUT terminal.

Output voltage “VOUT” is defined by expression (1).

$$VOUT = VREF \times (R1+R2)/R2 \quad (1)$$

VOUT is free setting from R1 / R2, but a potential of OUT terminal is not over VCC.

In addition, it is recommended that resistance R1 / R2 has high impedance not to have heavy load at output. But an input bias current is 50nA(typ.) in VCT terminal, you need to select a resistance value that flow over 10uA not to influence the ratio of resistance in (1).

We show a reference value below.

When R1=160kΩ, R2=51kΩ, Vout=5.00V

(1-2) Frequency response of error amplifier

In BD5650AFVM, shunt regulation executes constant voltage control. Monitoring an alteration of output voltage in VCT terminal, through error amplifier, finally respond as sink current in OUT terminal. A frequency response of transconductance, a change at output current against an change at input voltage, is shown in Fig.17. In case that frequency is higher over 200kHz, a response of GAIN is lower, error amplifier is losing its function little by little.

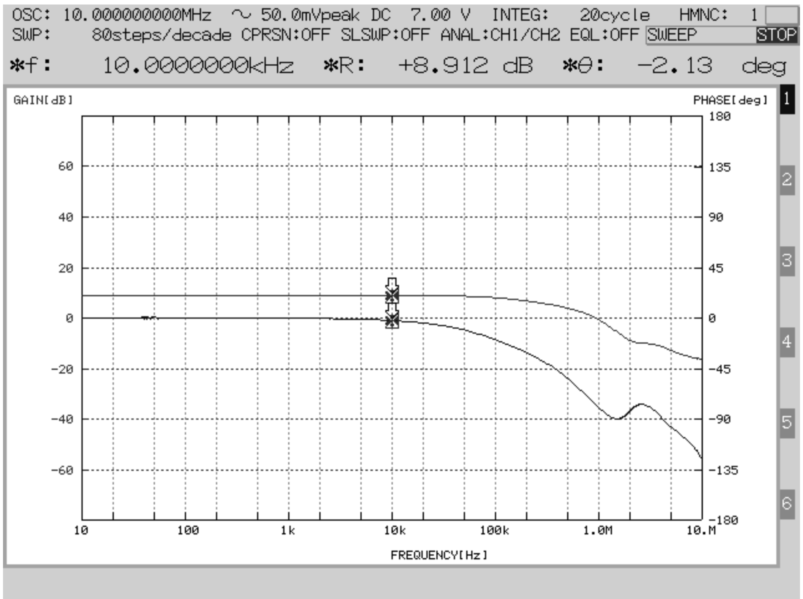


Fig.17

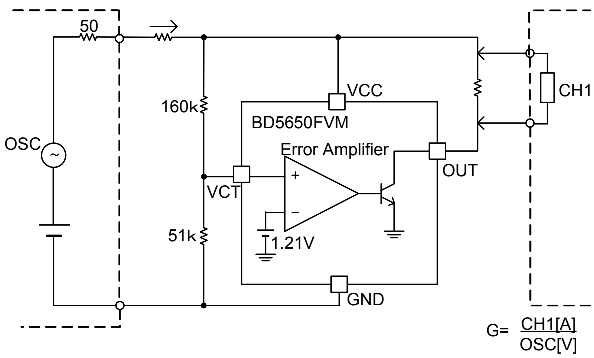


Fig.18

It is needed that your application circuit connects external capacitance and resistance between OUT terminal and VCT terminal for phase compensation regarding constant voltage control. But you need to decide external values sufficiently considering static characteristics, transient characteristics and IC’s unevenness to keep working application margin.

2. Over current detection

BD5650AFVM has a function regarding over current detection. When over current your set limit freely flow during a continuous time you also set capacitance in CP terminal, open collector in OCP terminal is driving (ON). Once turned to ON, its state keep(latch) in internal. When you want to release latch state, you need that CP terminal fall to GND, or, VCC voltage apply lower under about 1V.

An application circuit in Fig.16 has a function that adaptor output stop due to stop feedback to primary side.

(2-1) Limit current

Overcurrent detection is composited from detection comparator, sensing resistance RS.

Limit current “IL” is defined by expression (2).

$$IL = VSE / RS \qquad (2)$$

IL means Limit current, VSE means current detected voltage(73mV: a potential difference from ICT toVSE).

We show a reference value below.

When IL=1A, RS=73mΩ

You need to decide RS value sufficiently considering maximum load current IL,max in application.

$$Pl=VSE \times IL,max \qquad (3)$$

For example, when IL,max set to 2A, the maximum power loss “Pl.max” is 200mW in RS resistance. Since BD5650AFVM itself can’t limit IL,max, considering a characteristics on module, you need to select resistance includes enough margin for power loss. But for mostly small power adaptor, selecting 1/4 watt or 1/2 watt resistance is sufficiently suitable.

(2-2) CP charge

A delay time from a occur of over current to turn ON in OCP terminal is below expression (4).

$$Toth=CP \times VREF/Ichg \qquad (4)$$

Timing chart when over current detection is shown in Fig.19.

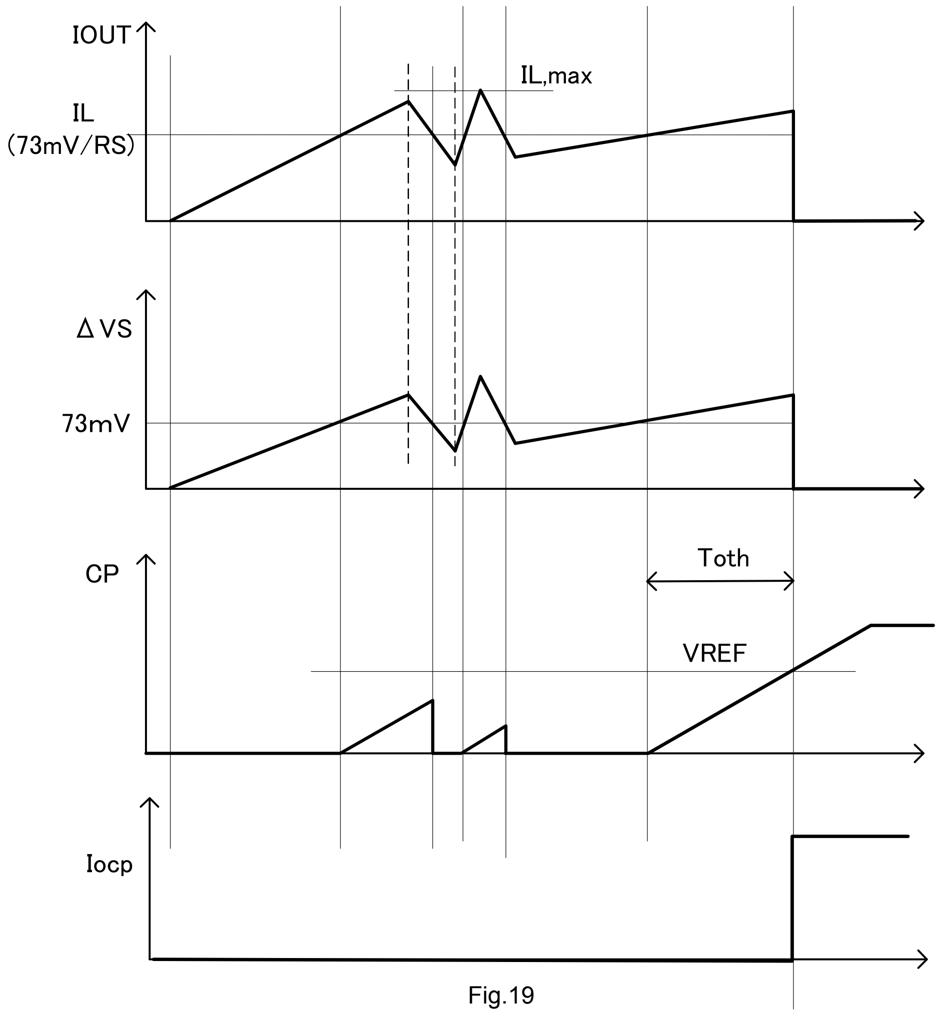


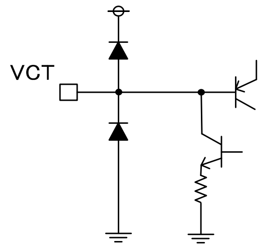
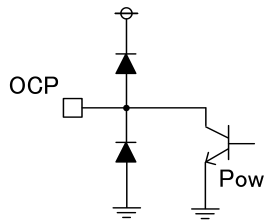
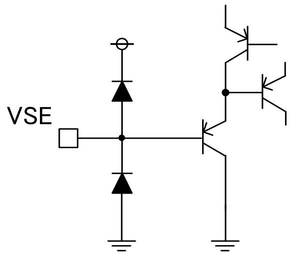
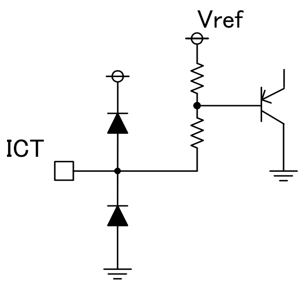
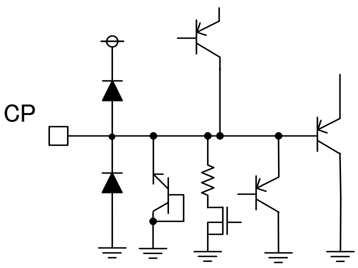
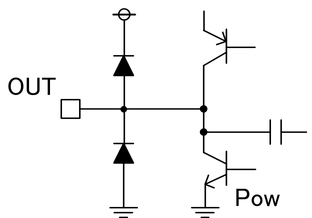
Fig.19

In case that over current reduces and ΔVS become under 73mV during CP charging, an electric charge in CP capacitance discharge and CP voltage returns to 0V. When over current detect for the second time, start to charge.
Its discharging velocity is shown in expression (8).

$$Vcp(t) = Vcp0 \cdot \exp\left(-\frac{t}{CP \cdot Rdis}\right) \qquad (8)$$

Vcp0 means CP terminal voltage at discharge start, and Rdis is internal discharge resistance:900Ω(typ.).
If you don't set up a delay time, you need that CP terminal is open or connects 10pF order of magnitude. In this case, when IC detects surge current in an instant, normal working stops by protection. Consequently, you need to use this mode considering a characteristics of module.
In addition, when you don't use a function that IC detects over current, you need to short ICT terminal to VSE terminal and pull down to GND by about 10kΩ in CP terminal.
Regarding board layout around CP capacitance, you pay attention that CP capacitance will not be in parallel with noisy parts and lines wherever possible, and place to short pattern line as possible.

●Internal equivalent circuit diagram

VCT(1PIN)	OCP(4PIN)	VSE(6PIN)
		
ICT(7PIN)	**CP(8PIN)**	**OUT(3PIN)**
		

●Operation Notes

1) Absolute maximum ratings
Use of the IC in excess of absolute maximum ratings such as the applied voltage or operating temperature range may result in IC deterioration or damage. Assumptions should not be made regarding the state of the IC (short mode or open mode) when such damage is suffered. A physical safety measure such as a fuse should be implemented when use of the IC in a special mode w here the absolute maximum ratings may be exceeded is anticipated.
2) GND potential
Ensure a minimum GND pin potential in all operating conditions. In addition, ensure that no pins other than the GND pin carry a voltage lower than or equal to the GND pin, including during actual transient phenomena. As an exception, the circuit design allows voltages up to -0.3 V to be applied to the ICT pin.
3) Setting of heat
Use a thermal design that allows for a sufficient margin in light of the power dissipation (Pd) in actual operating conditions.
4) Pin short and mistake fitting
Use caution when orienting and positioning the IC for mounting on printed circuit boards. Improper mounting may result in damage to the IC. Shorts between output pins or between output pins and the power supply and GND pin caused by the presence of a foreign object may result in damage to the IC.
5) Actions in strong magnetic field
Use caution when using the IC in the presence of a strong electromagnetic field as doing so may cause the IC to malfunction.
6) Mutual impedance
Power supply and ground wiring should reflect consideration of the need to lower mutual impedance and minimize ripple as much as possible (by making wiring as short and thick as possible or rejecting ripple by incorporating inductance and capacitance).
7) Regarding input pin of the IC
This IC is a monolithic IC which (as shown is Fig-1)has P^+ substrate and between the various pins. A P-N junction is formed from this P layer of each pin. For example, the relation between each potential is as follows,
   ○ (When GND > PinB and GND > PinA, the P-N junction operates as a parasitic diode.)
   ○ (When PinB > GND > PinA, the P-N junction operates as a parasitic transistor.)
Parasitic diodes can occur inevitably in the structure of the IC. The operation of parasitic diodes can result in mutual interference among circuits as well as operation faults and physical damage. Accordingly you must not use methods by which parasitic diodes operate, such as applying a voltage that is lower than the GND (P substrate) voltage to an input pin.
Although the circuit design allows voltages up to -0.3 V to be applied to the ICT pin, voltages lower than this may cause the behavior described above. Use caution when designing the circuit.

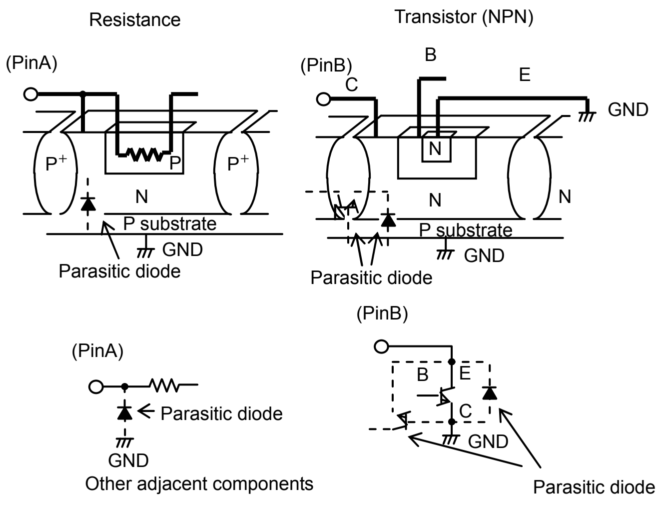
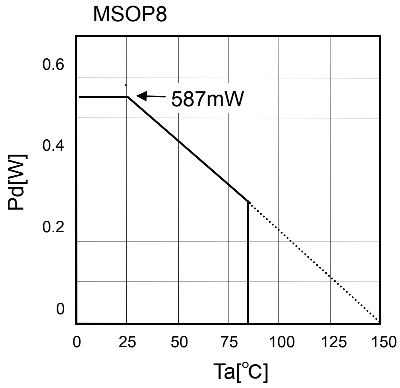


Fig.20 Simplified structure of a Bipolar IC

●Power Dissipation Reduction



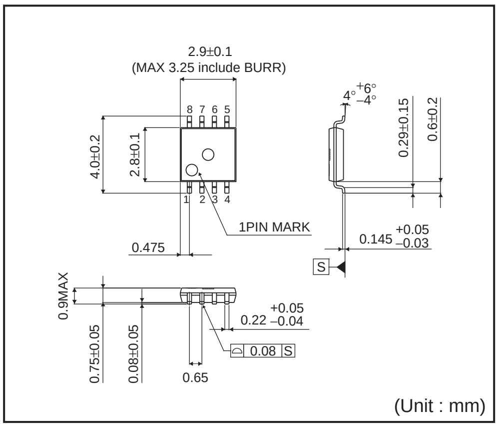
When mounted on a PCB
(70 mm × 70 mm × 1.6 mm, glass epoxy)

●Ordering Part Number

B	D	5	6	5	0	A	F	V	M	-	T	R

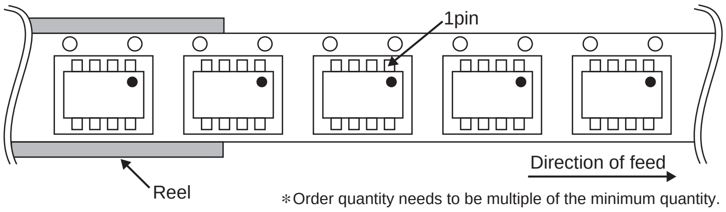
- BD: Part No.
- 5650A: Part No.
- FVM: Package, FVM: MSOP8
- TR: Packaging and forming specification, TR: Embossed tape and reel

MSOP8



<Tape and Reel information>

Tape	Embossed carrier tape
Quantity	3000pcs
Direction of feed	TR (The direction is the 1pin of product is at the upper right when you hold reel on the left hand and you pull out the tape on the right hand)



※Order quantity needs to be multiple of the minimum quantity.

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