System power supply for car stereos
BA3915B

The BA3915B is an one-chip power supply IC for use in car audio systems. The IC has seven output systems : one 5V output (V_{DD}), four 8.5V outputs (COM, FM, AM, AR), and two high-side switch outputs (ANT, AMP). The 5V outputs operate all the time if only the BCAD input is provided. The other outputs operate with BACKUP and ACC inputs, and their ON / OFF is controlled by the STANDBY and MODE inputs.

●Applications

Car audio systems

●Features

1) ACC and BACKUP voltages are monitored, compared with the internally set values; one-shot pulses are output to MUTE, which synchronizes with the rising and falling of the STANDBY input.
2) ACC voltage is monitored, compared with the internally set value, and the result is output to ACCB.
3) All outputs use a PNP transistor with low saturation voltage.
4) Output current limit circuit prevents damage to the IC due to short-circuiting.
5) Overvoltage protection circuit provides protection against surges from the ACC or BACKUP input.
6) Compact 16-pin POWER package allows large power dissipation.

●Absolute maximum ratings (Ta = 25°C)

Parameter	Symbol	Limits	Unit
Power supply voltage	BACKUP/ACC	24	V
Power dissipation	Pd	3400	mW
Operating temperature	Topr	−30～+85	℃
Storage temperature	Tstg	−55～+150	℃
Peak applied voltage	BACKUP/BCAP/ACC Peak	50*1	V

*1 tr ≧ 1 ms, applied time is less than 200 ms.

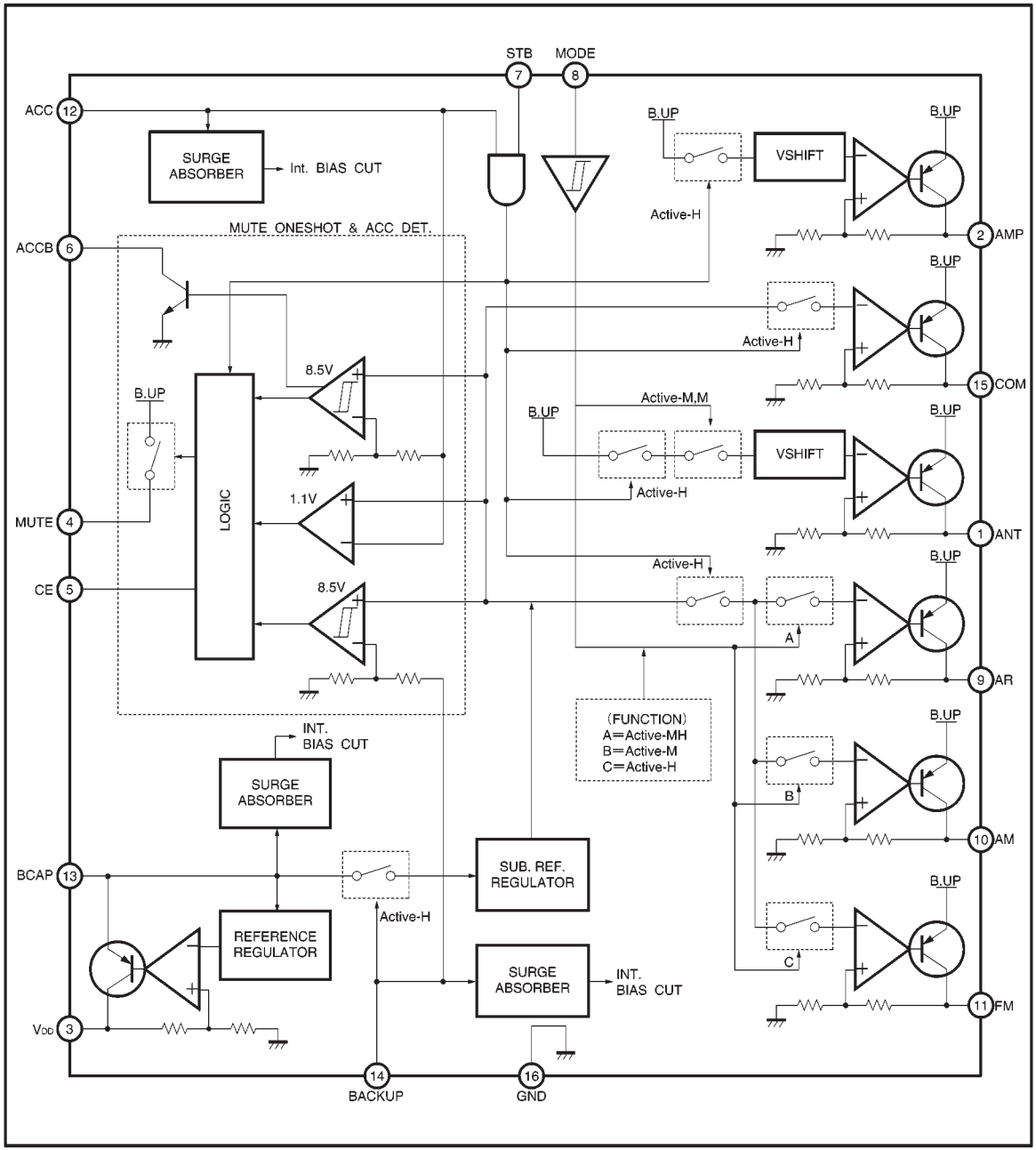
●Recommended operating conditions (Ta = 25°C)

Parameter	Symbol	Min.	Typ.	Max.	Unit
Recommended power supply voltage	BACKUP/BCAP/ACC	10	13.2	16	V
Operable voltage	BACKUP/BCAP/ACC	9.6	13.2	24	V
MUTE section operating voltage	BACKUP	4.0	—	—	V

Note: Not intended to ensure electrical characteristics (in particular, during a voltage drop)

Note: When the BACKUP input voltage becomes less than about 3 V, all the outputs except V_{DD} are shut down together with the logic bias voltage.

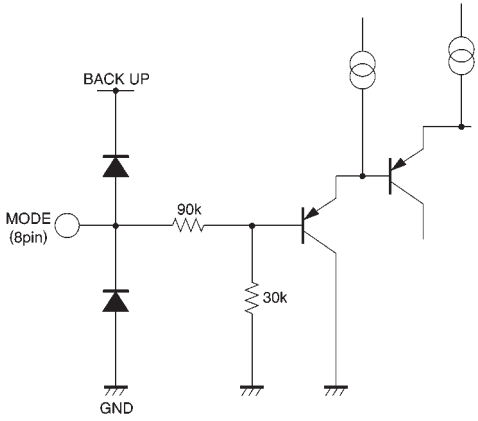
●Block diagram

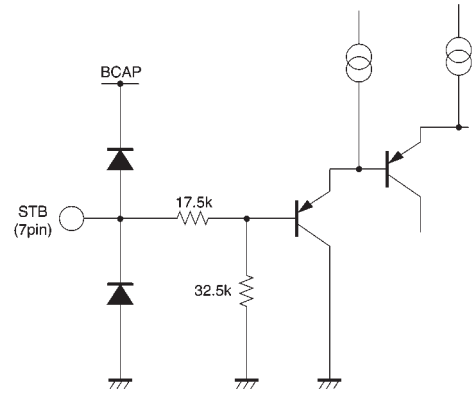


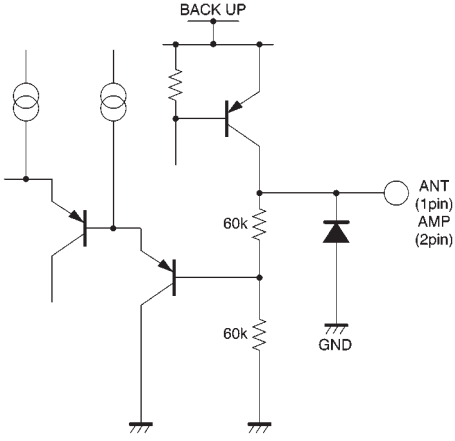
●Pin descriptions (Ta = 25°C, BACKUP / ACC = 13.2V)

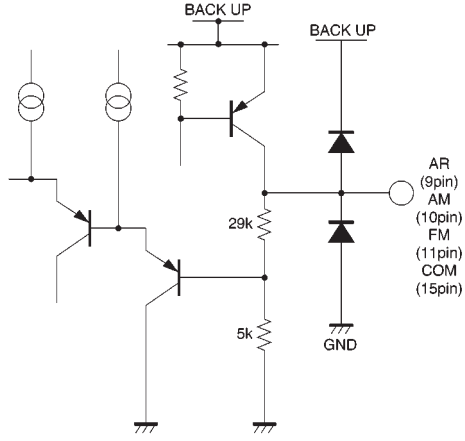
Pin No.	Pin name	Function
1	ANT	12.6V power supply output pin for antenna drive
2	AMP	12.6V power supply output pin for amplifiers
3	V_{DD}	5.0V power supply output pin for microcontroller; always output when BACKUP input is provided
4	MUTE	One-shot pulse output
5	CE	Capacitor connection pin for one-shot pulse time constant (TM) setting
6	ACCB	NPN transistor open collector output; ON when ACC is 8.5 V (typical) or more
7	STANDBY	Only V_{DD} is output when LOW; COM, FM, AM, AR, ANT, and AMP can be output when HIGH
8	MODE	3-mode input controls ON/OFF of FM, AM, AR, ANT, and AMP outputs
9	AR	8.5V power supply output pin for AR
10	AM	8.5V power supply output pin for AM tuner
11	FM	8.5V power supply output pin for FM tuner
12	ACC	Accessory power supply connection
13	BCAP	Capacitor connection pin for V_{DD} backup
14	BACKUP	Backup power supply connection
15	COM	8.5V power supply output pin for COMMON
16	GND	Ground

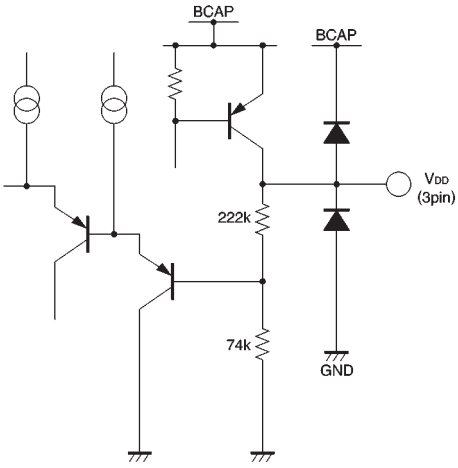
●Input / output circuits

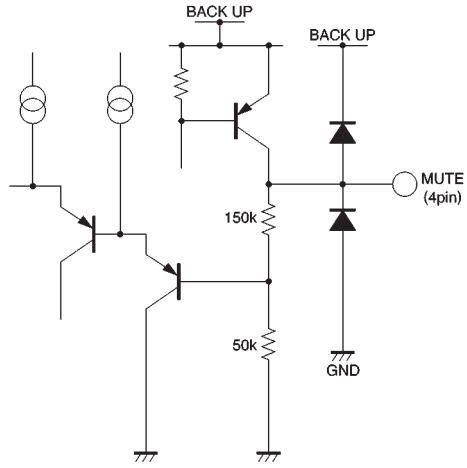


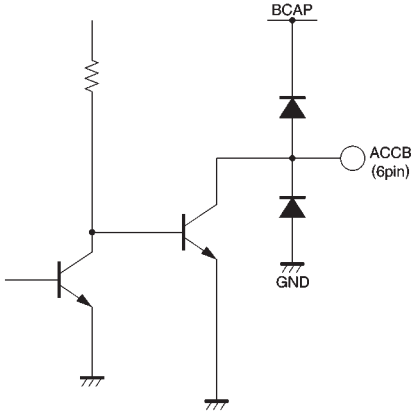







BCAP
BCAP
VDD
(3pin)
222k
74k
GND


BACK UP
BACK UP
MUTE
(4pin)
150k
50k
GND


BCAP
ACCB
(6pin)
GND

●Electrical characteristics (unless otherwise noted, Ta = 25°C, BACKUP / ACC = 13.2V)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions	Measurement circuit
BCAP supply current 1	I_{CAP1}	—	0.40	0.55	mA	BCAP=12.5V, BUP=0V	Fig.1
BACKUP standby supply current	I_{BUP}	—	0.18	0.20	mA	BUP=13.2V, BCAP=12.5V	Fig.1
BCAP supply current 2	I_{CAP2}	—	1.30	1.75	mA	BUP=13.2V, BCAP=12.5V	Fig.1
〈V_{DD}〉							
Output voltage	V_{O1}	4.75	5.00	5.25	V	I_{O1}=80mA	Fig.1
Voltage regulation	ΔV_{O11}	—	100	300	mV	I_{O1}=80mA	Fig.1
Load regulation	V_{O11}	—	50	170	mV	I_{O1}=0→80mA	Fig.1
Minimum I/O voltage differential	ΔV_{O12}	—	0.4	0.7	V	I_{O1}=80mA	Fig.1
Output current capacity	I_{O1}	80	—	—	mA		Fig.1
Ripple rejection ratio	RR1	41	45	—	dB	f=100Hz, V_{RR}=−10dBV	Fig.2
〈COM〉							
Output voltage	V_{O2}	8.05	8.50	8.95	V	I_{O2}=300mA	Fig.1
Voltage regulation	ΔV_{O21}	—	100	300	mV	I_{O2}=300mA	Fig.1
Load regulation	V_{O21}	—	50	170	mV	I_{O2}=0→300mA	Fig.1
Minimum I/O voltage differential	ΔV_{O22}	—	0.4	0.7	V	I_{O2}=300mA	Fig.1
Output current capacity	I_{O2}	300	—	—	mA		Fig.1
Ripple rejection ratio	RR2	41	45	—	dB	f=100Hz, V_{RR}=−10dBV	Fig.2
〈FM〉							
Output voltage	V_{O3}	8.05	8.50	8.95	V	I_{O3}=300mA	Fig.1
Voltage regulation	ΔV_{O31}	—	100	300	mV	I_{O3}=300mA	Fig.1
Load regulation	V_{O31}	—	50	170	mV	I_{O3}=0→300mA	Fig.1
Minimum I/O voltage differential	ΔV_{O32}	—	0.4	0.7	mV	I_{O3}=300mA	Fig.1
Output current capacity	I_{O3}	300	—	—	mA		Fig.1
Ripple rejection ratio	RR3	41	45	—	dB	f=100Hz, V_{RR}=−10dBV	Fig.2
〈AM〉							
Output voltage	V_{O4}	8.05	8.50	8.95	V	I_{O4}=200mA	Fig.1
Voltage regulation	ΔV_{O41}	—	100	300	mV	I_{O4}=200mA	Fig.1
Load regulation	V_{O41}	—	50	170	mV	I_{O4}=0→200mA	Fig.1
Minimum I/O voltage differential	ΔV_{O42}	—	0.4	0.7	V	I_{O4}=200mA	Fig.1
Output current capacity	I_{O4}	200	—	—	mA		Fig.1
Ripple rejection ratio	RR4	36	40	—	dB	f=100Hz, V_{RR}=−10dBV	Fig.2
〈ANT〉							
Minimum I/O voltage differential	ΔV_{O52}	—	0.6	1.1	V	I_{O5}=250mA	Fig.1
Load regulation	V_{O51}	—	180	540	mV	I_{O5}=0→250mA	Fig.1
Output current capacity	I_{O5}	250	—	—	mA		Fig.1
〈AMP〉							
Minimum I/O voltage differential	ΔV_{O62}	—	0.6	1.1	V	I_{O6}=100mA	Fig.1
Load regulation	V_{O61}	—	100	300	mV	I_{O6}=0→100mA	Fig.1
Output current capacity	I_{O6}	100	—	—	mA		Fig.1

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions	Measurement circuit
〈AR〉							
Output voltage	V_{O7}	8.05	8.50	8.95	V	I_{O7}=200mA	Fig.1
Voltage regulation	ΔV_{O71}	—	100	300	mV	I_{O7}=200mA	Fig.1
Load regulation	V_{O71}	—	50	170	mV	I_{O7}=0→200mA	Fig.1
Minimum I/O voltage differential	ΔV_{O72}	—	0.4	0.7	V	I_{O7}=200mA	Fig.1
Output current capacity	I_{O7}	200	—	—	mA		Fig.1
Ripple rejection ratio	RR7	41	45	—	dB	f=100Hz, V_{RR}=−10dBV	Fig.2
〈MUTE〉							
Output voltage	V_{O8}	4.3	4.9	5.5	V	I_{O8}=10mA	Fig.3
Pulse CE output current	I_{TM}	0.6	1.0	1.4	μA	I_{O8}=10mA	Fig.3
Pulse threshold voltage	V_{TM}	0.9	1.0	1.1	V	I_{O8}=10mA	Fig.3
Pulse width	TM	—	0.1	—	SEC	CE=0.1 μF	Fig.3
〈ACC〉							
Output A rising threshold	V_{TAR1}	1.0	1.1	1.2	V	TM is counted from ACC = V_{TAR2}	Fig.3
Pulse A rising threshold	V_{TAR2}	8.0	8.5	9.0	V		Fig.3
Output A falling threshold	V_{TAF1}	8.0	8.5	9.0	V		Fig.3
Pulse A falling threshold	V_{TAF2}	1.0	1.1	1.2	V		Fig.3
〈BACKUP〉							
Output B rising threshold	V_{TBR1}	4.7	5.0	5.3	V		Fig.3
Pulse B rising threshold	V_{TBR2}	8.0	8.5	9.0	V		Fig.3
Output B falling threshold	V_{TBF1}	8.0	8.5	9.0	V		Fig.3
Pulse B falling threshold	V_{TBF2}	4.7	5.0	5.3	V		Fig.3
〈STANDBY〉							
Output S rising threshold	V_{TSR1}	1.6	1.9	2.2	V		Fig.3
Pulse S rising threshold	V_{TSR2}	2.6	2.9	3.2	V		Fig.3
Output S falling threshold	V_{TSF1}	2.6	2.9	3.2	V		Fig.3
Pulse S falling threshold	V_{TSF2}	1.6	1.9	2.2	V		Fig.3
〈MODE〉							
OFF MODE threshold	V_{TR1}	—	—	1.1	V	OFF MODE	Fig.1
AM ON threshold	V_{TR2}	1.25	1.5	1.75	V	AM MODE WITH ANT, AMP & AR	Fig.1
FM ON threshold	V_{TR3}	2.5	3.0	3.5	V	FM MODE WITH ANT, AMP & AR	Fig.1
AM hysteresis width	V_{AHY}	0.1	0.2	0.3	V	AM MODE WITH ANT, AMP & AR	Fig.1
FM hysteresis width	V_{FHY}	0.1	0.2	0.3	V	FM MODE WITH ANT, AMP & AR	Fig.1
Input current	I_{MO}	15	40	65	μA	MODE=5V	Fig.1
〈STANDBY〉							
Standby level	V_{SB1}	—	—	2.4	V		Fig.1
Active level	V_{SB2}	3.2	—	—	V		Fig.1
Input current	V_{STB}	75	100	125	μA	STANDBY=5V	Fig.1
〈ACCB〉							
Detected voltage	V_{DET}	8.0	8.5	9.0	V	Same as V_{TAF}	Fig.1
Output saturation voltage when ON	V_{SAT1}	—	0.5	0.9	V	ACC=13.2V Io9=2mA	Fig.1

●Measurement circuits

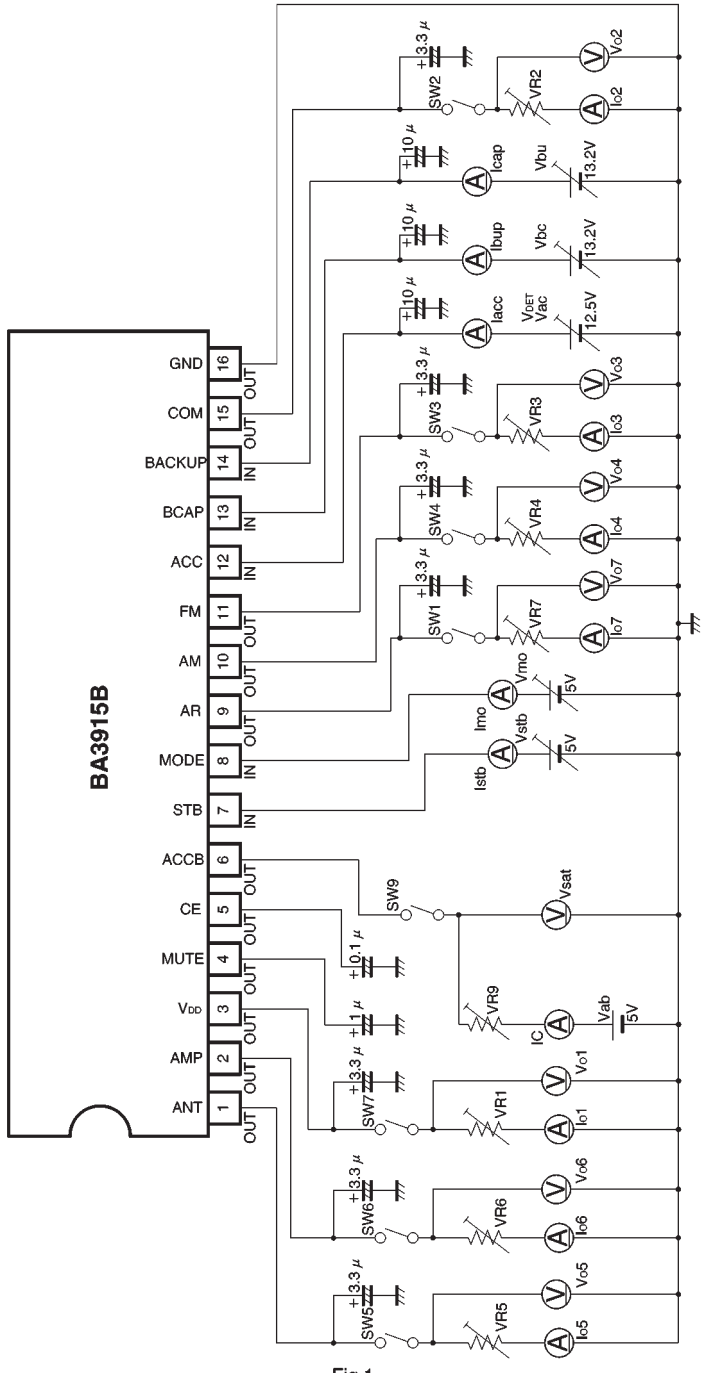


Fig.1

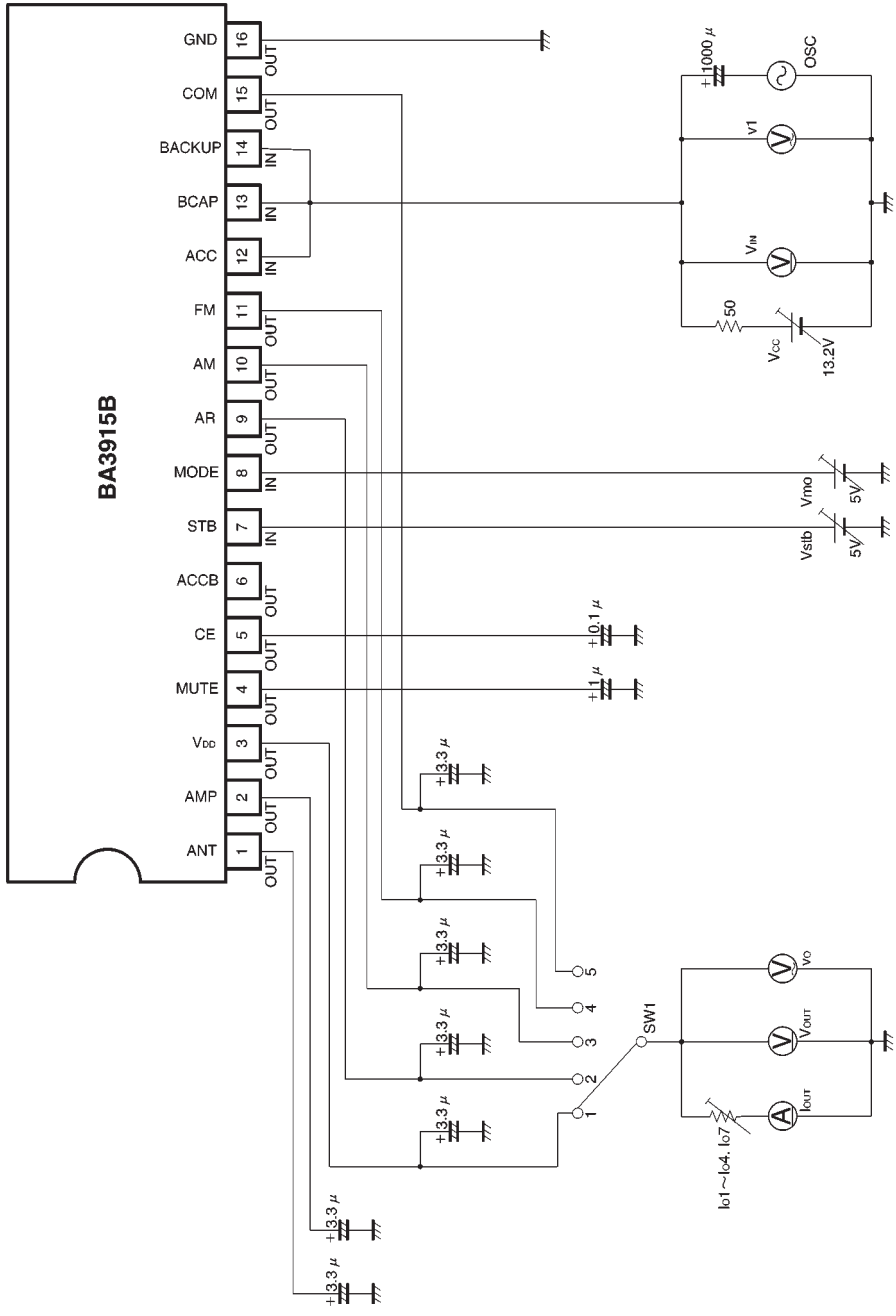

BA3915B
GND 16 OUT
COM 15 OUT
BACKUP 14 IN
BCAP 13 IN
ACC 12 IN
FM 11 OUT
AM 10 OUT
AR 9 OUT
MODE 8 IN
STB 7 IN
ACCB 6 OUT
CE 5 OUT
MUTE 4 OUT
VDD 3 OUT
AMP 2 OUT
ANT 1 OUT
+1000 μ
OSC
V1
VIN
50
VCC
13.2V
Vmo
5V
Vstb
5V
+0.1 μ
+1 μ
+3.3 μ
SW1
VO
VOUT
IOUT
Io1~Io4. Io7

Fig.2

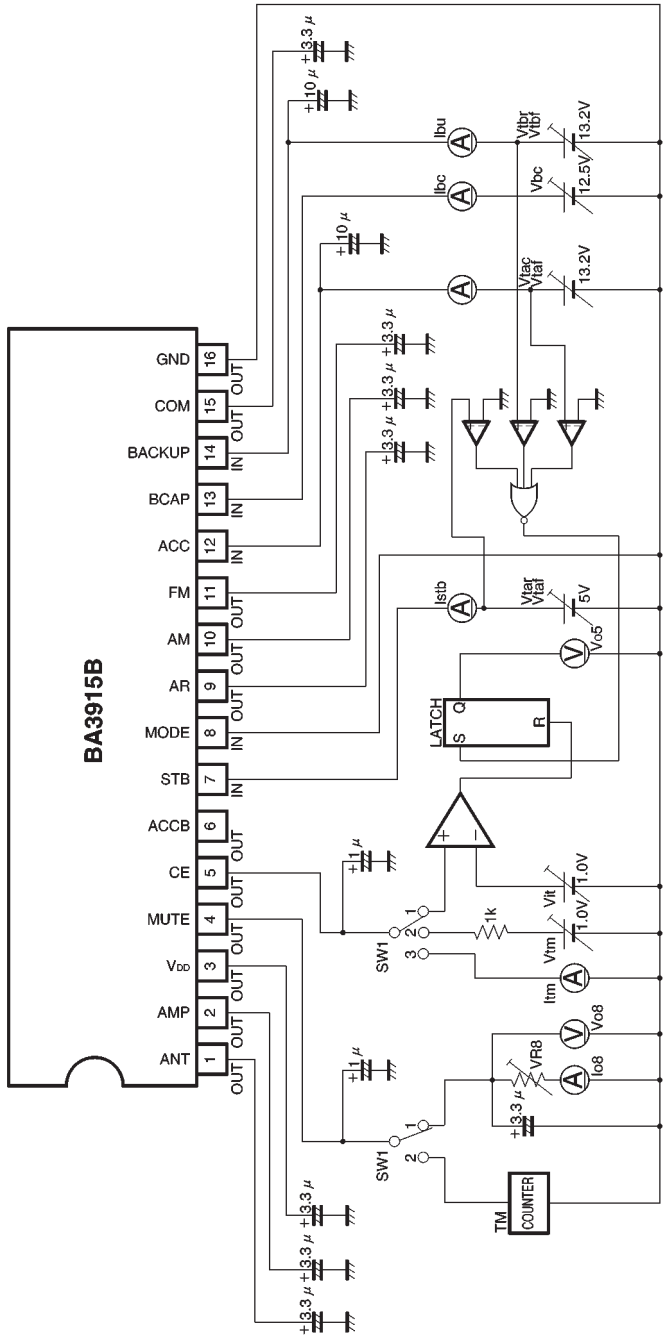
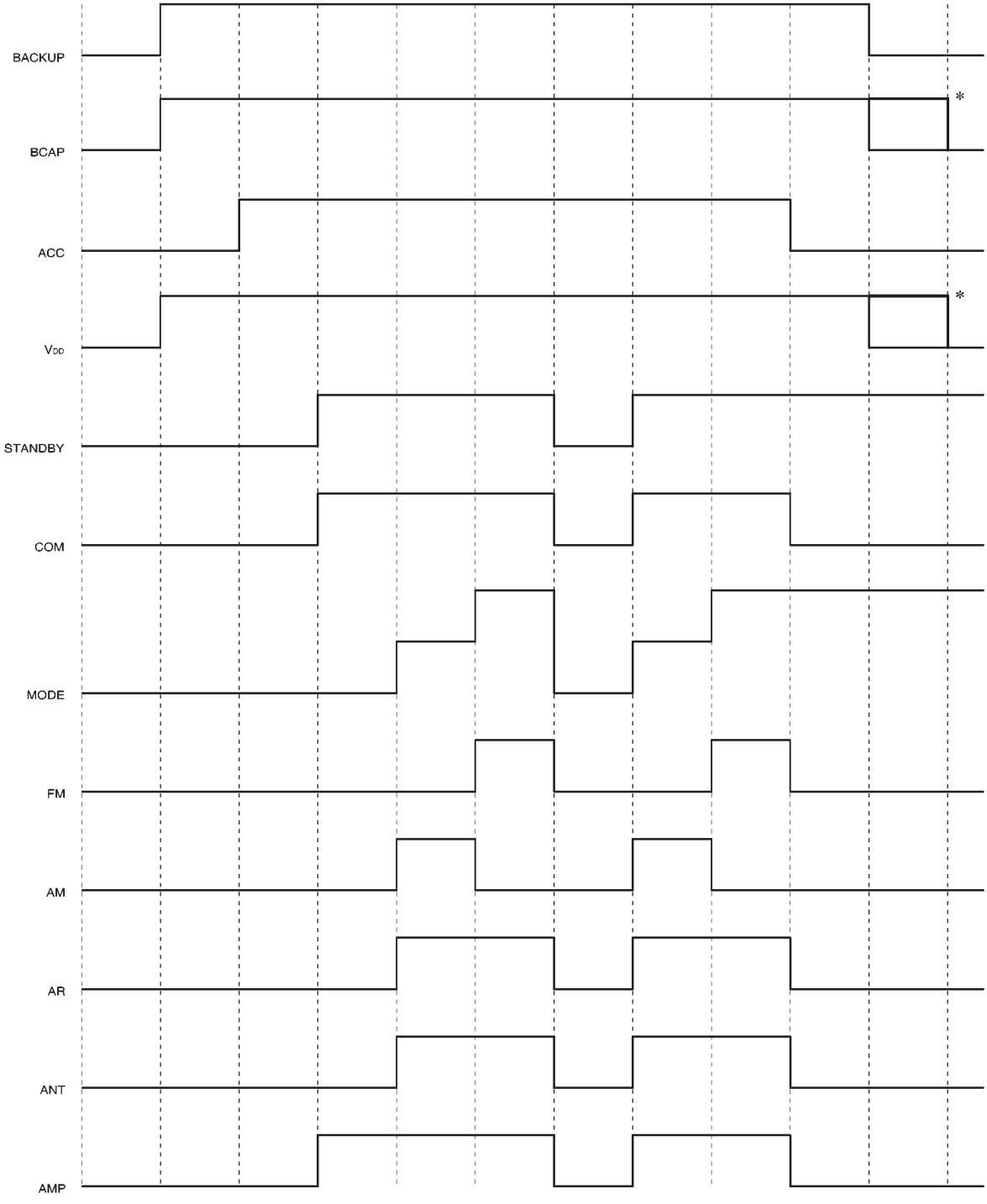

BA3915B
GND 16 OUT
COM 15 OUT
BACKUP 14 IN
BCAP 13 IN
ACC 12 IN
FM 11 OUT
AM 10 OUT
AR 9 OUT
MODE 8 IN
STB 7 IN
ACCB 6 OUT
CE 5 OUT
MUTE 4 OUT
VDD 3 OUT
AMP 2 OUT
ANT 1 OUT
+3.3 μ
+10 μ
+1 μ
Ibu
Ibc
Istb
Itm
Io8
Vbu
Vbf
Vbc
Vtaf
Vtm
Vlt
Vo5
Vo8
13.2V
12.5V
5V
1.0V
1k
VR8
SW1
LATCH
S Q R
COUNTER
TM

Fig.3

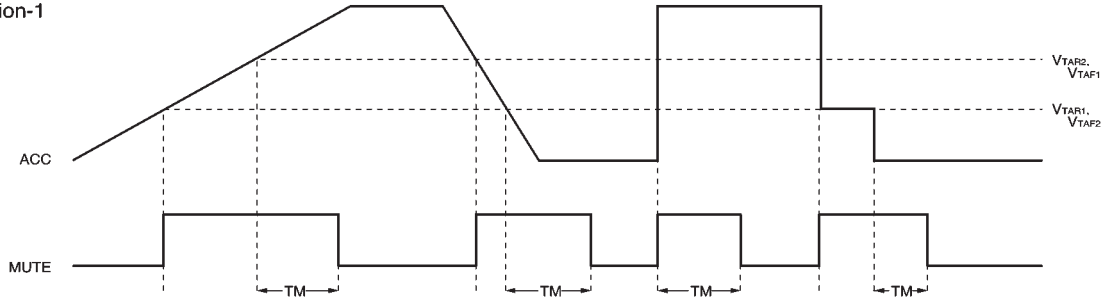
●Input / output timing chart



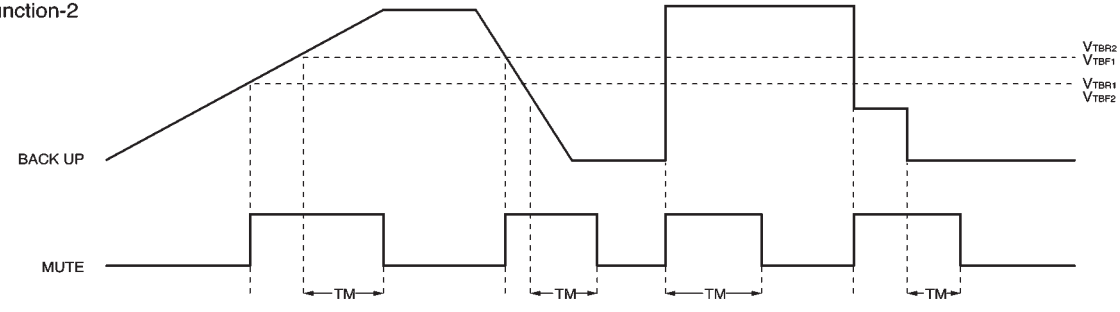
* ··· When an external capacitor is connected

●MUTE timing chart

Function-1



Function-2



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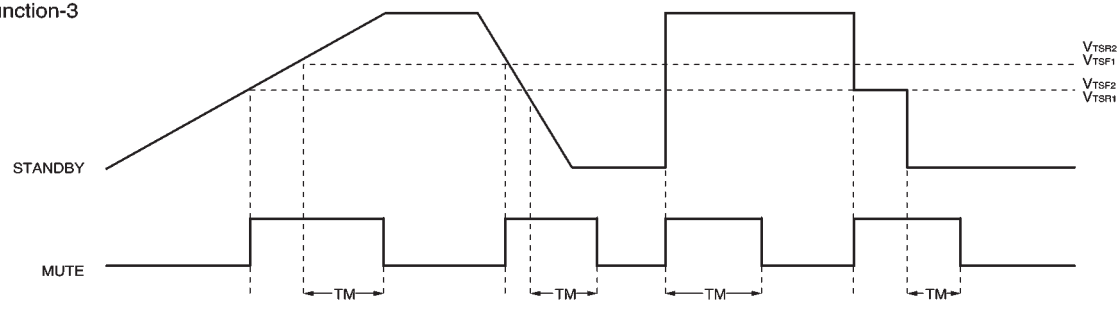
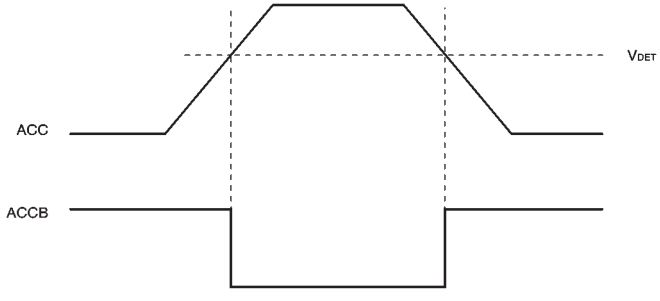
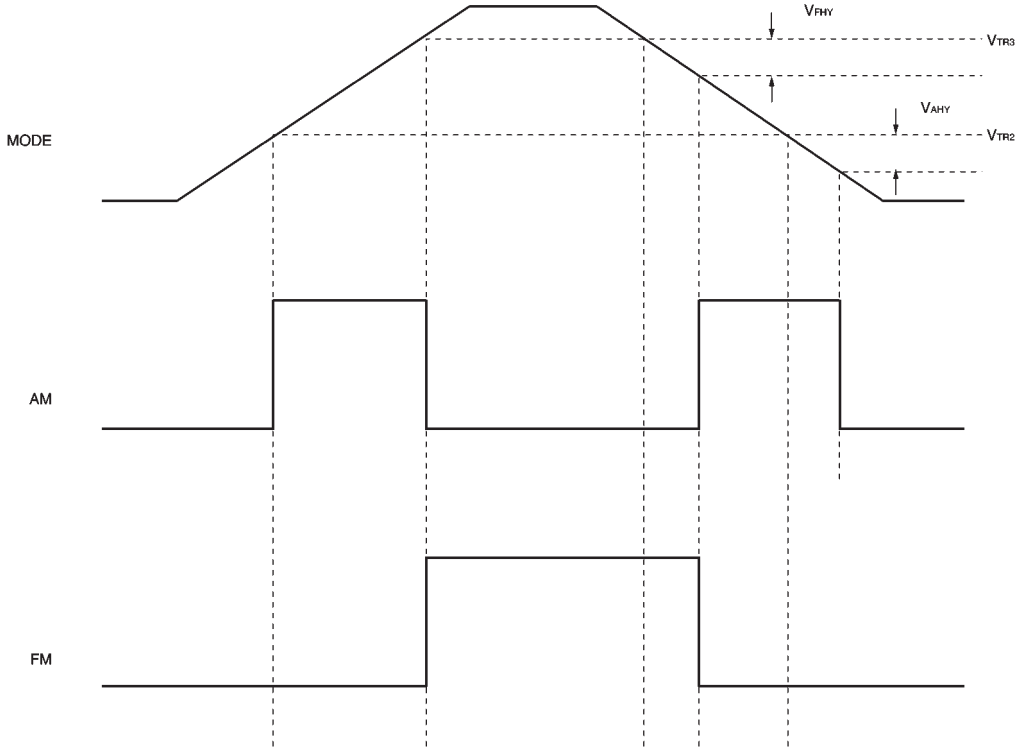


ACCB timing chart

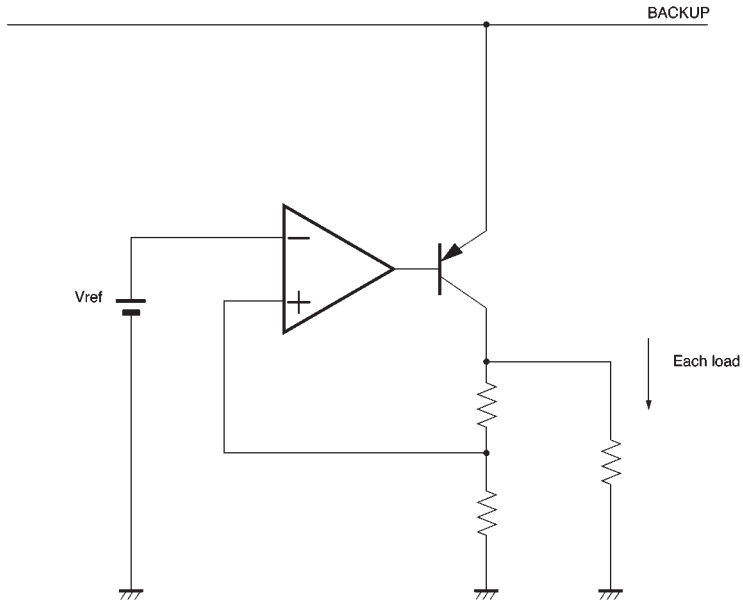


●AM / FM output timing chart



●Estimate of allowable power dissipation

Except under transitional conditions, the power dissipation of this IC is 3.4W per unit at 25°C. See Fig. 4 for heat reduction characteristics, including some cases where heat sinks are used.



A = maximum BACKUP voltage
B = maximum BCAP voltage
I_1 = maximum output current for V_{DD} (80mA)
I_2 = maximum output current for COM (300mA)
I_3 = maximum output current for FM (300mA)
I_4 = maximum output current for AM (200mA)
I_5 = maximum output current for AR (200mA)
I_6 = maximum output current for ANT (250mA)
I_7 = maximum output current for AMP (100mA)

- Power consumed by V_{DD} 5.0V $P_1 = (B - 5.0V) \times I_1 + (I_1 / 16 + I_1 / 10) \times B$
- Power consumed by COM 8.5V $P_2 = (A - 8.5V) \times I_2 + (I_2 / 60 + I_2 / 10) \times A$
- Power consumed by FM 8.5V $P_3 = (A - 8.5V) \times I_3 + (I_3 / 60 + I_3 / 10) \times A$
- Power consumed by AM 8.5V $P_4 = (A - 8.5V) \times I_4 + (I_4 / 40 + I_4 / 10) \times A$
- Power consumed by AR 8.5V $P_5 = (A - 8.5V) \times I_5 + (I_5 / 40 + I_5 / 10) \times A$
- Power consumed by ANT $P_6 = (0.6V) \times I_6 + (I_6 / 50 + I_6 / 10) \times A$
- Power consumed by AMP $P_7 = (0.6V) \times I_7 + (I_7 / 50 + I_7 / 10) \times A$
- Power consumed internally by each circuit $P_8 = A \times$ circuit current (about 10mA)

$P_{MAX} = P_1 + P_2 + (P_3 \text{ or } P_4, \text{whichever is larger}) + P_5 + P_6 + P_7 + P_8$

●Operation notes

(1) Although the quality of this IC is rigorously controlled, the IC may be destroyed when the supply voltage or the operating temperature exceeds their absolute maximum ratings. Because short mode or open mode cannot be specified when the IC is destroyed, be sure to take physical safety measures, such as fusing, if any of the absolute maximum ratings might be exceeded.

(2) Operating power supply voltage

When operating within the proper ranges of power supply voltage and ambient temperature, most circuit functions are guaranteed. Although the rated values of electrical characteristics cannot be absolutely guaranteed, characteristic values do not change drastically within the proper ranges.

(3) Power dissipation (Pd)

Refer to the power dissipation characteristics (Fig. 4) and the rough estimation of IC power dissipation given on a separate page. Make sure your design allows the maximum required power within the operating temperature range.

(4) Overvoltage protection circuit

The overvoltage protection circuit turns OFF all outputs when the potential difference between BACKUP (pin 14), BCAP (pin 13), or ACC (pin 12) and GND (pin 16) is more than about 26V at normal temperature. Make sure to use the IC within this voltage limit.

(5) Preventing oscillation at each output

To stop output oscillation, make sure to connect a capacitor having a capacitance of 10μF or greater between GND and each of the ANT (pin 1), AMP (pin 2), V_{DD} (pin 3), AM (pin 10), FM (pin 11), and COM (pin 15) output pins. We recommend using a tantalum electrolytic capacitor whose capacitance is unsusceptible to temperature.

(6) Overcurrent protection circuit

An overcurrent protection circuit is installed on the ANT (pin 1), AMP (pin 2), V_{DD} (pin 3), AM (pin 10), FM (pin 11), and COM (pin 15) outputs, based on the respective output current. This prevents IC destruction due to overcurrent, by limiting the current with a curve shape of "7" in the voltage-current graph. The IC is designed with margins so that current flow will be restricted and latching will be prevented even if a large current suddenly flows through a large capacitor. The circuit should be carefully set because output current is further restricted when output voltage is less than $1V_F$ (considered as short mode).

(7) Thermal protection circuit

A built-in thermal protection circuit prevents thermal damage to the IC. All outputs except V_{DD} are switched OFF when the circuit operates, and revert to the original state when the temperature drops to a certain level.

(8) BACKUP-ACC potential difference

If the BACKUP voltage exceeds the ACC voltage, a current flows through a protection diode connected internally between BACKUP and ACC. If the potential difference is more than $1V_F$, this diode is fully turned on.

(9) BCAP pin external diode

Voltage is supplied to BCAP from BACKUP through an external diode. The maximum current consumption is about 100mA. A reverse bias will be applied to the diode if the BACKUP pin becomes 0V. Select a diode that has sufficient electrical characteristics to cope with the above conditions.

(10) Grounding

Each ground trace must be adequately short from GND (pin 16). Make sure to arrange the ground traces in a pattern that prevents mutual interference.

(11) We recommend installing a bypass line in your application if there is a mode where potential difference between each output and input (V_{CC}) or GND is reversed from the normal state.

●Electrical characteristic curves

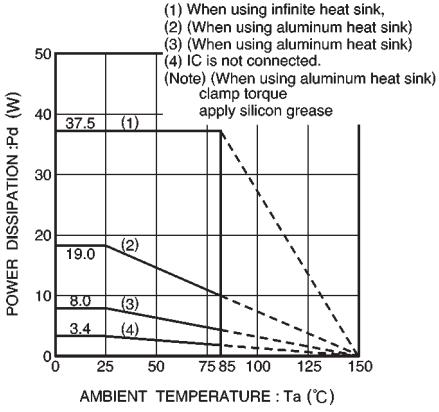


Fig.4 Termal derating curve

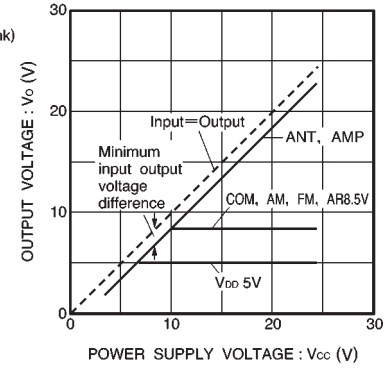


Fig.5 Output voltage vs. power supply voltage

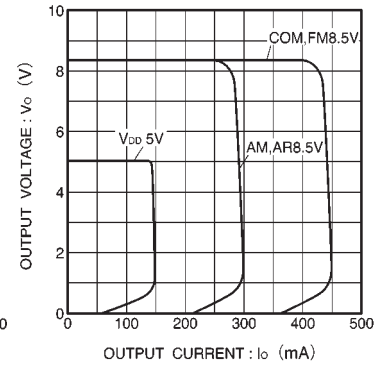


Fig.6 Output voltage vs. output current

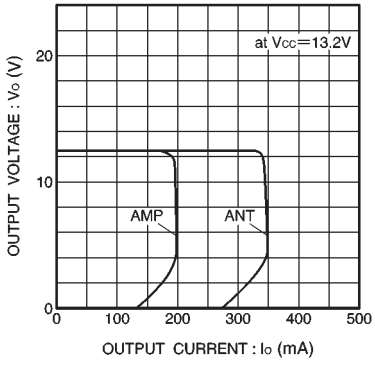


Fig.7 Output voltage vs. output current

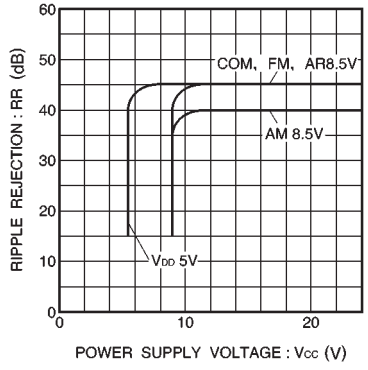


Fig.8 Ripple rejection ratio vs. power supply voltage

●External dimensions (Units: mm)