

# System power supply for car stereos

## BA3915B

The BA3915B is a one-chip power supply IC for use in car audio systems. The IC has seven output systems : one 5V output (VDD), 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	°C
Storage temperature	Tstg	-55~150	°C
Peak applied voltage	BACKUP/BCAP/ACC Peak	50*1	V

\*1 tr ≥ 1 msec, applied time is less than 200 msec

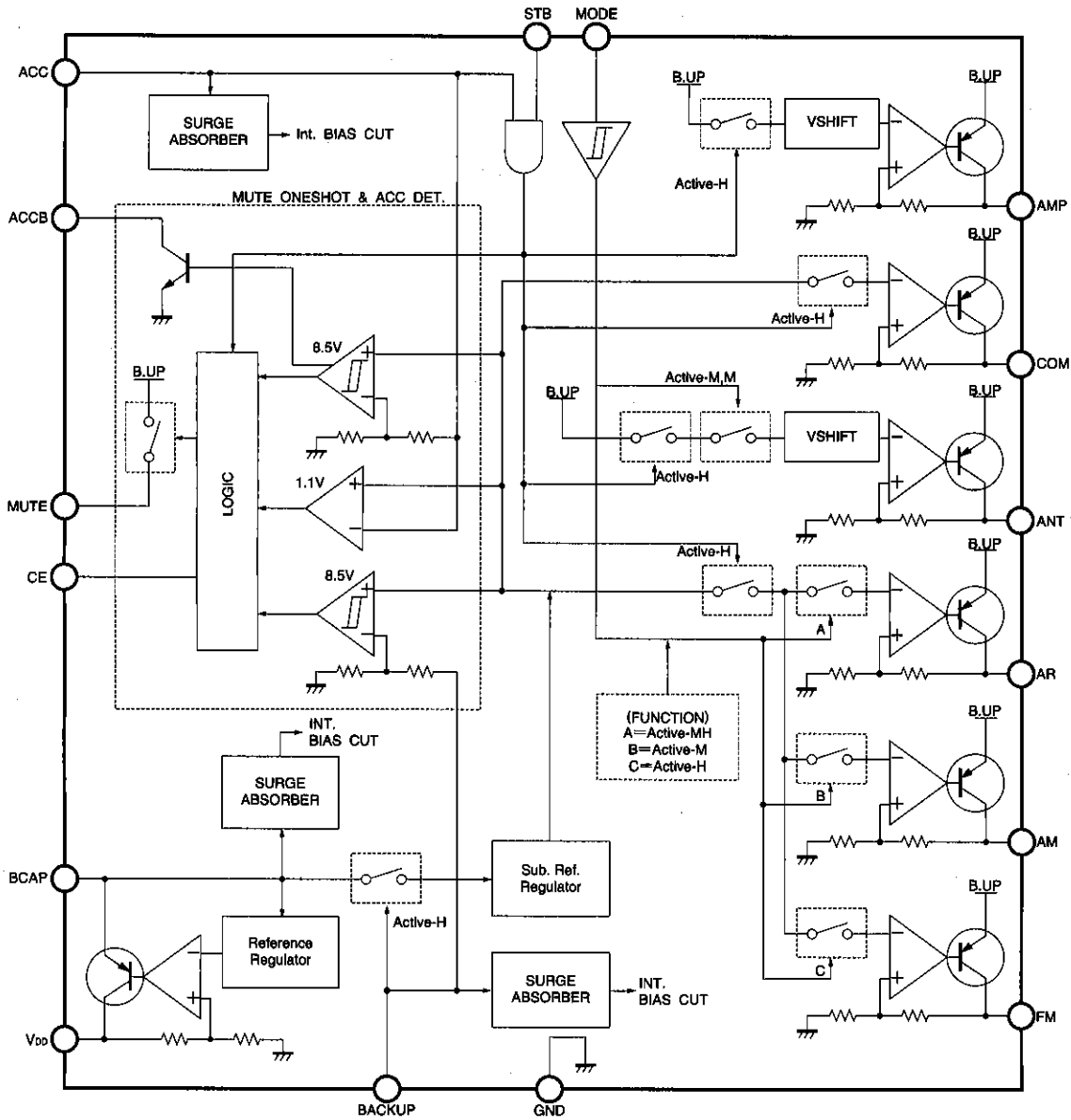
### ●Recommended operating conditions (Ta=25°C)

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 VDD are shut down together with the logic bias voltage.

● Block diagram



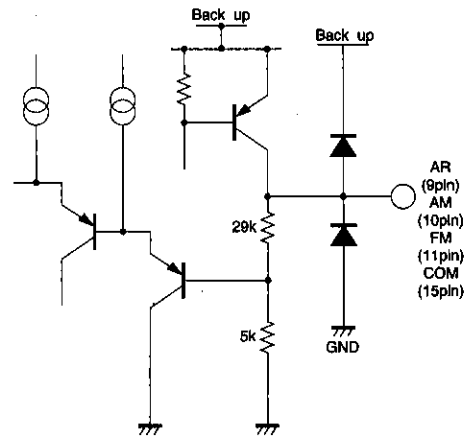
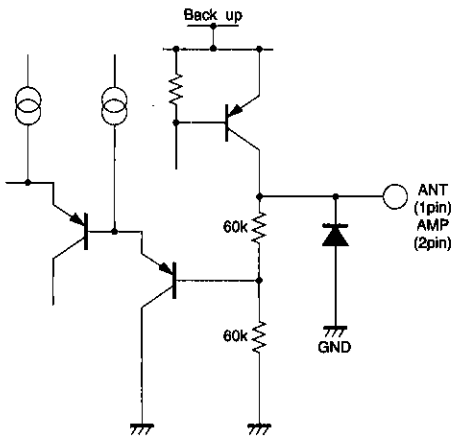
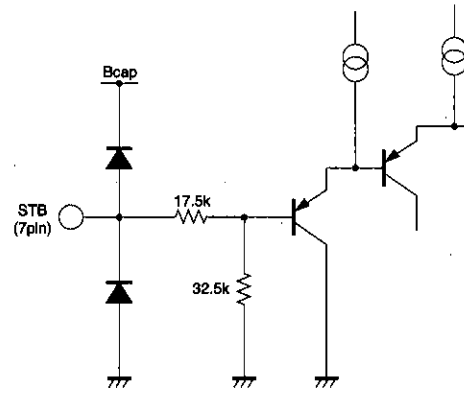
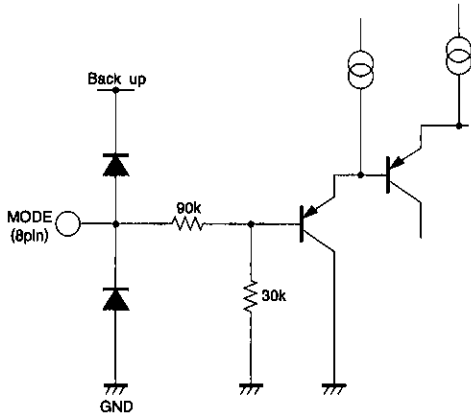
(FUNCTION)  
 A=Active-MH  
 B=Active-M  
 C=Active-H

BA3900/10 Series  
 System Power Supply

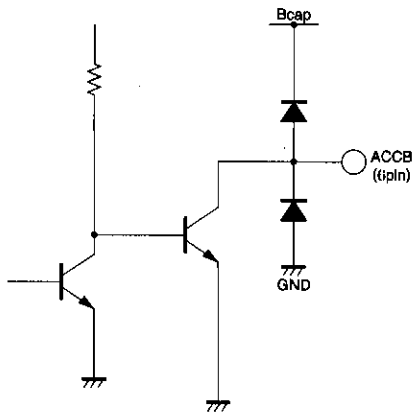
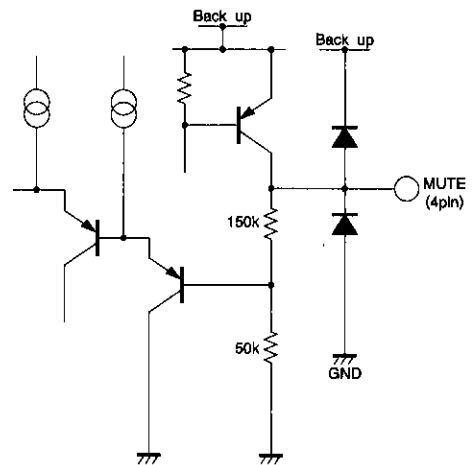
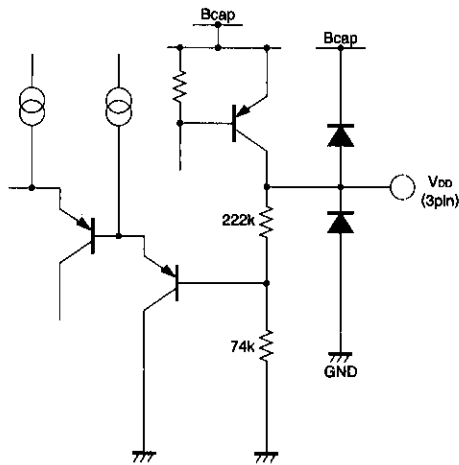
●Pin description (Ta=25°C, BACKUP/ACC=13.2V)

Pin No.	Pin name	Function
1	ANT	12.6 V power supply output pin for antenna drive
2	AMP	12.6 V power supply output pin for amplifiers
3	V <sub>DD</sub>	5.0 V power supply output pin for microcontroller; always output when BACKUP input is provided
4	MUTE	One-shot pulse output pin
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 <sub>DD</sub> 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	8.5 V power supply output pin for AR
10	AM	8.5 V power supply output pin for AM tuner
11	FM	8.5 V power supply output pin for FM tuner
12	ACC	Accessory power supply connection pin
13	BCAP	Capacitor connection pin for V <sub>DD</sub> backup
14	BACKUP	Backup power supply connection pin
15	COM	8.5 V power supply output pin for COMMON
16	GND	Ground pin

● Input/output circuits



I/O equivalent circuits



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

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions	Measurement Circuit
BCAP circuit current 1	ICAP1	—	0.40	0.55	mA	BCAP=12.5V, BUP=0V	1
BACKUP standby circuit current	IBUP	—	0.18	0.20	mA	BUP=13.2V, BCAP=12.5V	1
BCAP circuit current 2	ICAP2	—	1.30	1.75	mA	BUP=13.2V, BCAP=12.5V	1
[VDD]							
Output voltage	VO1	4.75	5.00	5.25	V	IO1=80mA	1
Voltage variation	$\Delta V_{O11}$	—	100	300	mV	IO1=80mA	1
Load variation	VO11	—	50	170	mV	IO1 ; 0→80mA	1
Minimum I/O voltage differential	$\Delta V_{O12}$	—	0.4	0.7	V	IO1=80mA	1
Output current capacity	IO1	80	—	—	mA		1
Ripple rejection ratio	RR1	41	45	—	dB	f=100Hz, VRR=−10dBV	2
[COM]							
Output voltage	VO2	8.05	8.50	8.95	V	IO2=300mA	1
Voltage variation	$\Delta V_{O21}$	—	100	300	mV	IO2=300mA	1
Load variation	VO21	—	50	170	mV	IO2 ; 0→300mA	1
Minimum I/O voltage differential	$\Delta V_{O22}$	—	0.4	0.7	V	IO2=300mA	1
Output current capacity	IO2	300	—	—	mA		1
Ripple rejection ratio	RR2	41	45	—	dB	f=100Hz, VRR=−10dBV	2
[FM]							
Output voltage	VO3	8.05	8.50	8.95	V	IO3=300mA	1
Voltage variation	$\Delta V_{O31}$	—	100	300	mV	IO3=300mA	1
Load variation	VO31	—	50	170	mV	IO3 ; 0→300mA	1
Minimum I/O voltage differential	$\Delta V_{O32}$	—	0.4	0.7	mV	IO3=300mA	1
Output current capacity	IO3	300	—	—	mA		1
Ripple rejection ratio	RR3	41	45	—	dB	f=100Hz, VRR=−10dBV	2
[AM]							
Output voltage	VO4	8.05	8.50	8.95	V	IO4=200mA	1
Voltage variation	$\Delta V_{O41}$	—	100	300	mV	IO4=200mA	1
Load variation	VO41	—	50	170	mV	IO4 ; 0→200mA	1
Minimum I/O voltage differential	$\Delta V_{O42}$	—	0.4	0.7	V	IO4=200mA	1
Output current capacity	IO4	200	—	—	mA		1
Ripple rejection ratio	RR4	36	40	—	dB	f=100Hz, VRR=−10dBV	2
[ANT]							
Minimum I/O voltage differential	$\Delta V_{O52}$	—	0.6	1.1	V	IO5=250mA	1
Load variation	VO51	—	180	540	mV	IO5 ; 0→250mA	1
Output current capacity	IO5	250	—	—	mA		1
[AMP]							
Minimum I/O voltage differential	$\Delta V_{O62}$	—	0.6	1.1	V	IO6=100mA	1
Load variation	VO61	—	100	300	mV	IO6 ; 0→100mA	1
Output current capacity	IO6	100	—	—	mA		1

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

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions	Measurement Circuit
<b>[AR]</b>							
Output voltage	V <sub>O7</sub>	8.05	8.50	8.95	V	I <sub>O7</sub> =200mA	1
Voltage variation	ΔV <sub>O71</sub>	—	100	300	mV	I <sub>O7</sub> =200mA	1
Load variation	V <sub>O71</sub>	—	50	170	mV	I <sub>O7</sub> ; 0→200mA	1
Minimum I/O voltage differential	ΔV <sub>O72</sub>	—	0.4	0.7	V	I <sub>O7</sub> =200mA	1
Output current capacity	I <sub>O7</sub>	200	—	—	mA		1
Ripple rejection ratio	RR7	41	45	—	dB	f=100Hz, V <sub>RR</sub> =-10dBV	2
<b>[MUTE]</b>							
Output voltage	V <sub>O8</sub>	4.3	4.9	5.5	V	I <sub>O8</sub> =10mA	3
Pulse CE output current	I <sub>TM</sub>	0.6	1.0	1.4	μA	I <sub>O8</sub> =10mA	3
Pulse threshold voltage	V <sub>TM</sub>	0.9	1.0	1.1	V	I <sub>O8</sub> =10mA	3
Pulse width	TM	—	0.1	—	SEC	CE=0.1 μF	3
<b>(ACC)</b>							
Output A rising threshold	V <sub>TAR1</sub>	1.0	1.1	1.2	V	TM is counted from ACC = V <sub>TAR2</sub>	3
Pulse A rising threshold	V <sub>TAR2</sub>	8.0	8.5	9.0	V		3
Output A falling threshold	V <sub>TAF1</sub>	8.0	8.5	9.0	V		3
Pulse A falling threshold	V <sub>TAF2</sub>	1.0	1.1	1.2	V		3
<b>(BACKUP)</b>							
Output B rising threshold	V <sub>TBR1</sub>	4.7	5.0	5.3	V		3
Pulse B rising threshold	V <sub>TBR2</sub>	8.0	8.5	9.0	V		3
Output B falling threshold	V <sub>TBF1</sub>	8.0	8.5	9.0	V		3
Pulse B falling threshold	V <sub>TBF2</sub>	4.7	5.0	5.3	V		3
<b>(STANDBY)</b>							
Output S rising threshold	V <sub>TSR1</sub>	1.6	1.9	2.2	V		3
Pulse S rising threshold	V <sub>TSR2</sub>	2.6	2.9	3.2	V		3
Output S falling threshold	V <sub>TSF1</sub>	2.6	2.9	3.2	V		3
Pulse S falling threshold	V <sub>TSF2</sub>	1.6	1.9	2.2	V		3
<b>[MODE]</b>							
OFF mode threshold	V <sub>TR1</sub>	—	—	1.1	V	OFF MODE	1
AM ON threshold	V <sub>TR2</sub>	1.25	1.5	1.75	V	AM MODE WITH ANT, AMP & AR	1
FM ON threshold	V <sub>TR3</sub>	2.5	3.0	3.5	V	FM MODE WITH ANT, AMP & AR	1
AM hysteresis width	V <sub>AHY</sub>	0.1	0.2	0.3	V	AM MODE WITH ANT, AMP & AR	1
FM hysteresis width	V <sub>FHY</sub>	0.1	0.2	0.3	V	FM MODE WITH ANT, AMP & AR	1
Input current	I <sub>MO</sub>	15	40	65	μA	MODE=5V	1
<b>[STANDBY]</b>							
Standby voltage	V <sub>SB1</sub>	—	—	2.4	V		1
Active voltage	V <sub>SB2</sub>	3.2	—	—	V		1
Input current	V <sub>STB</sub>	75	100	125	μA	STANDBY=5V	1
<b>[ACCB]</b>							
Detected voltage	V <sub>DET</sub>	8.0	8.5	9.0	V	Same as V <sub>TAF</sub>	1
Output saturation voltage when ON	V <sub>SAT1</sub>	—	0.5	0.9	V	ACC=13.2V I <sub>O9</sub> =2mA	1

● Measurement circuit

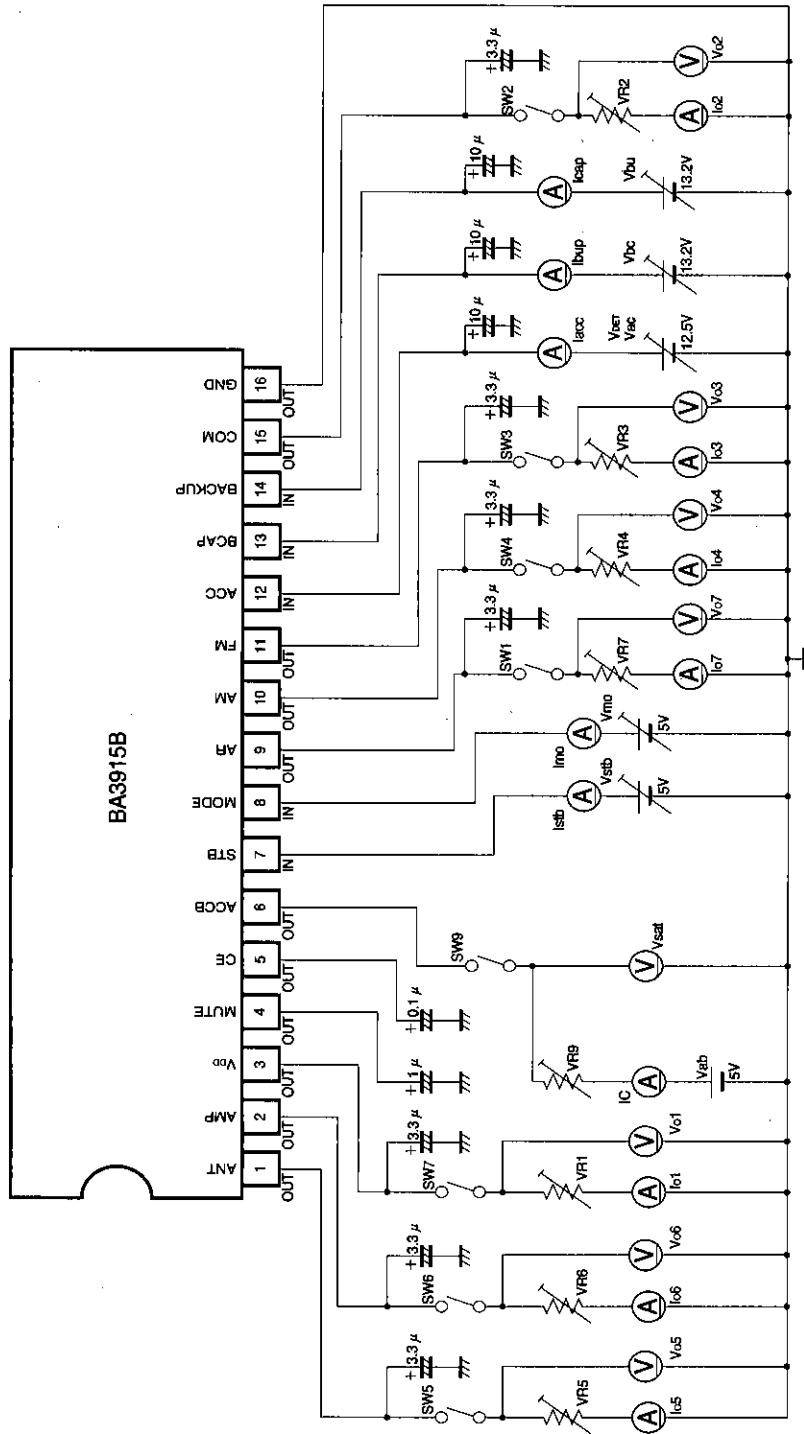


Fig.1



● Measurement circuit

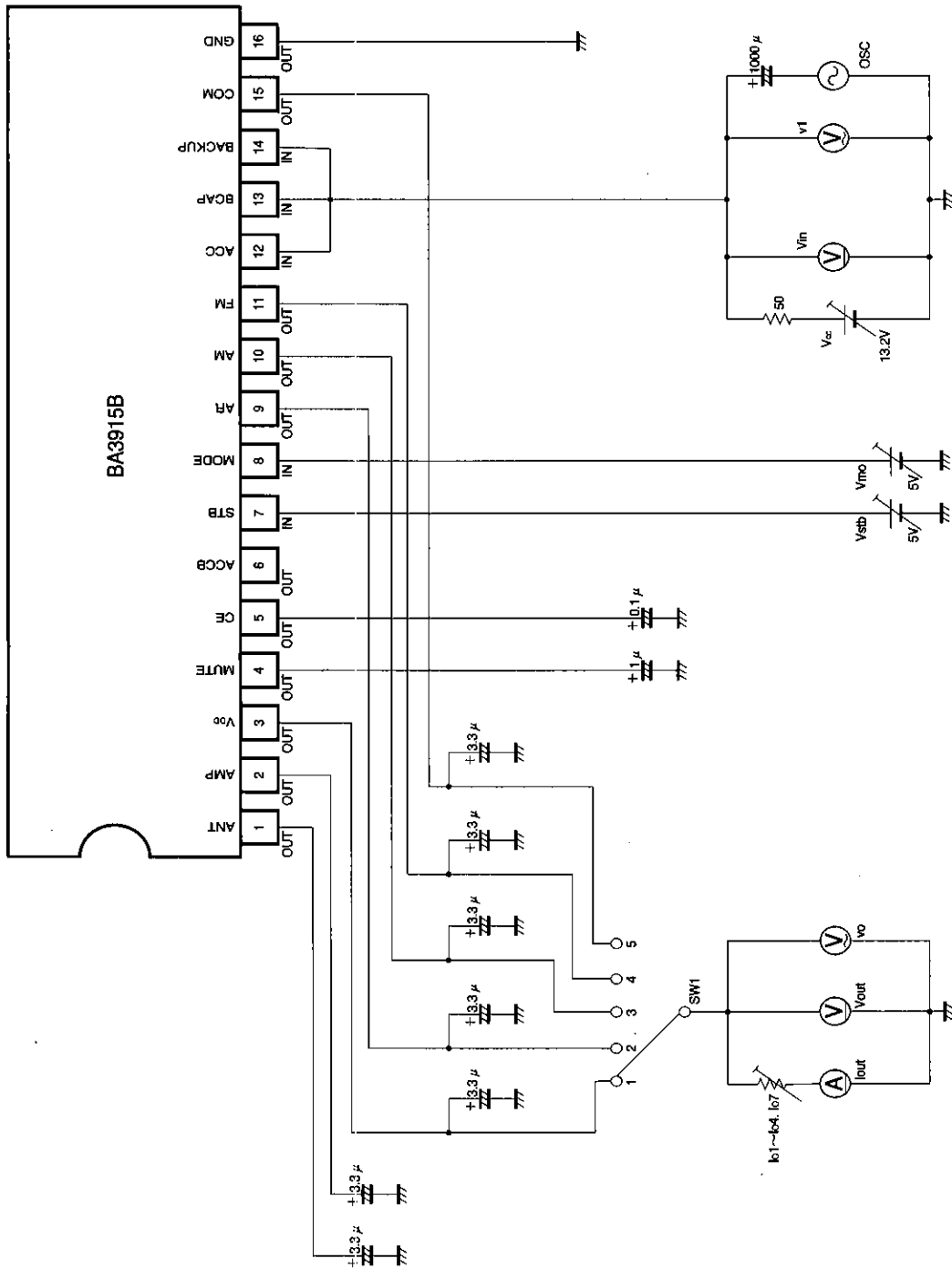
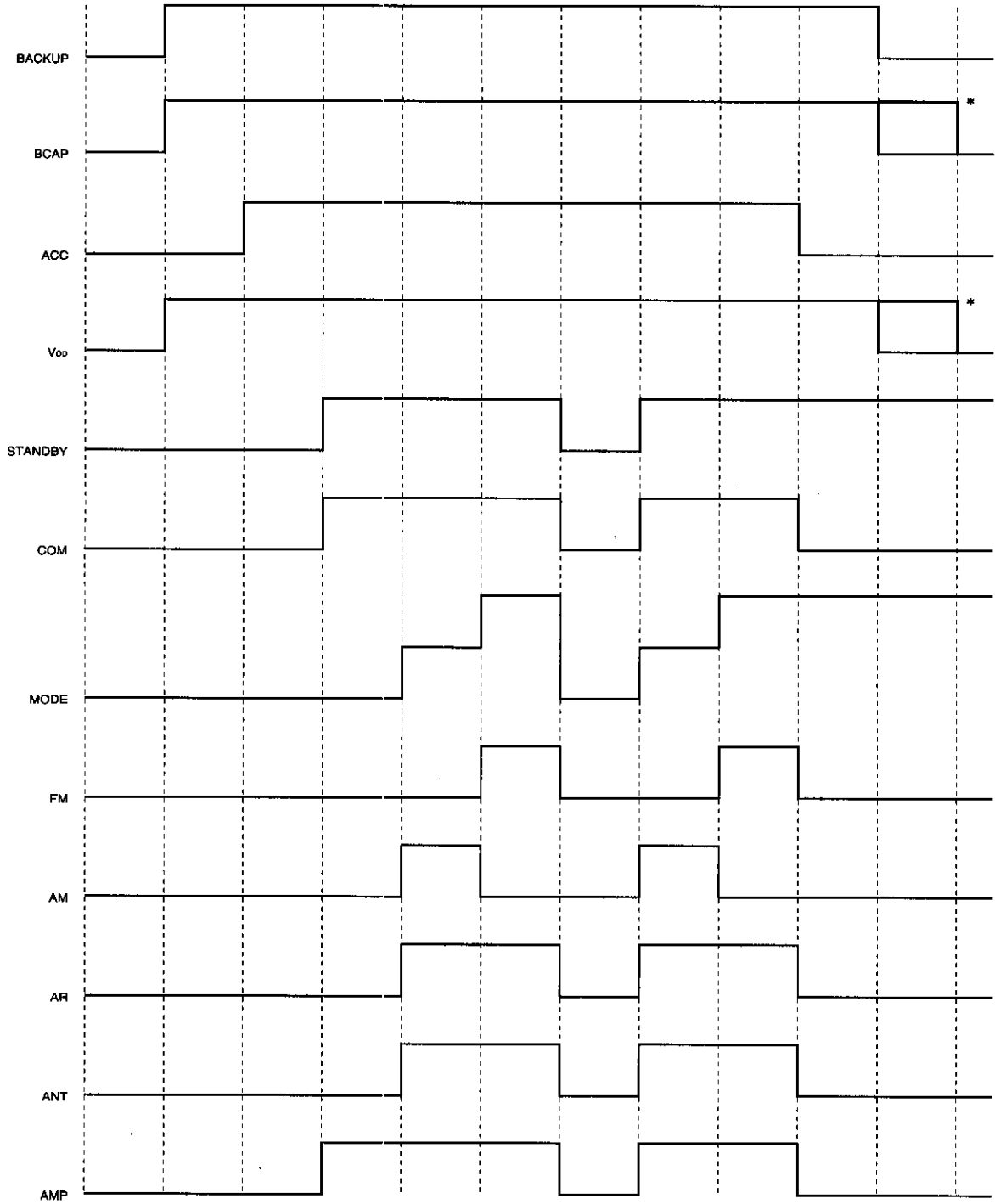


Fig.2



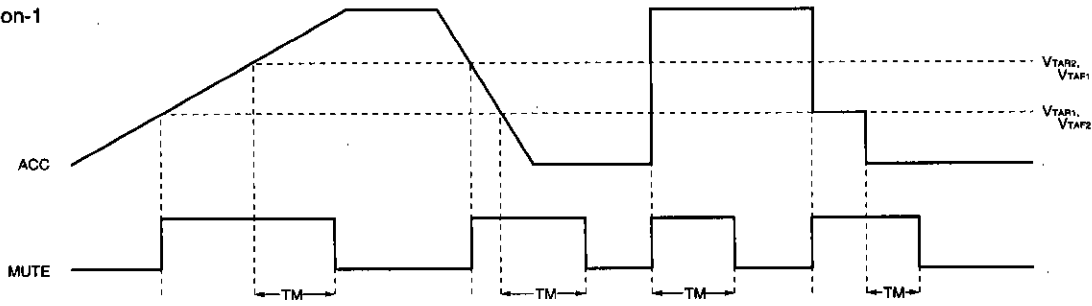
● Input/output timing chart



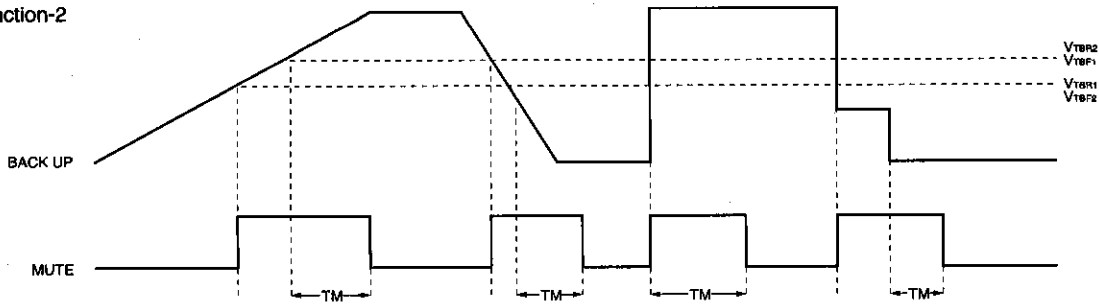
\* ... When an external capacitor is connected

●MUTE timing chart

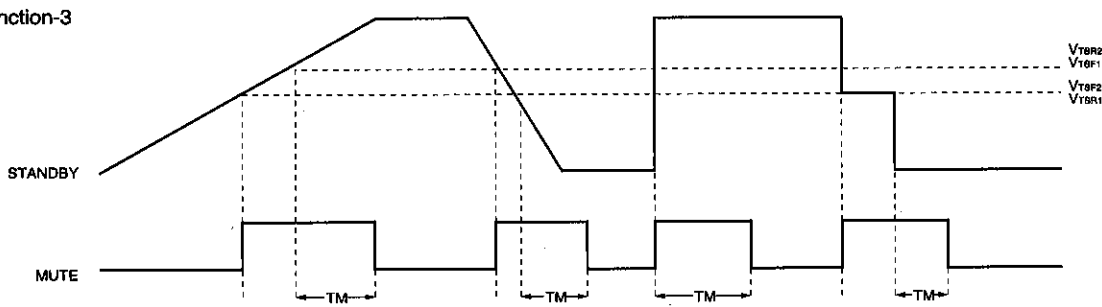
Function-1



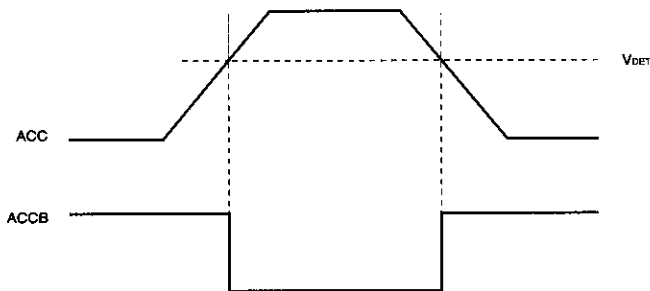
Function-2



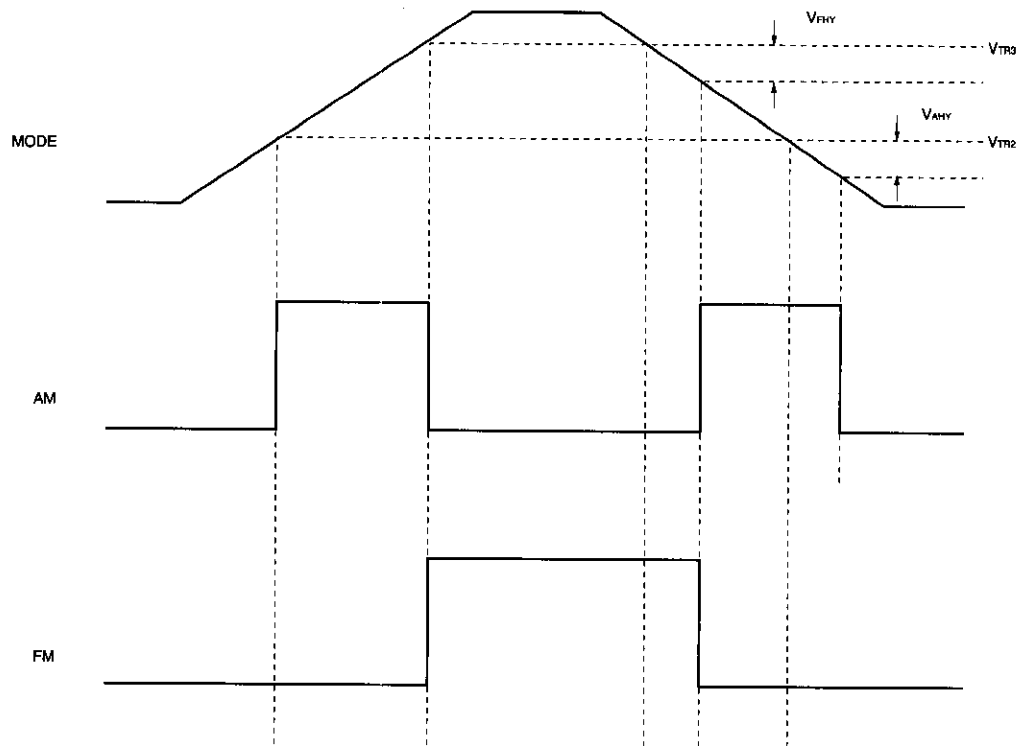
Function-3



ACCB timing chart

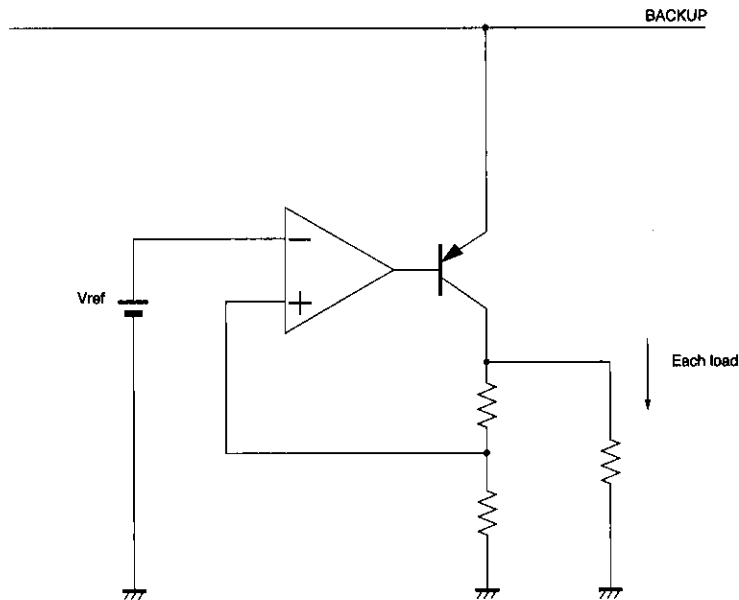


## ● AM/FM output timing chart



● Rough estimation of IC 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<sub>1</sub> = maximum output current for V<sub>DD</sub> (80mA)
- I<sub>2</sub> = maximum output current for COM (300mA)
- I<sub>3</sub> = maximum output current for FM (300mA)
- I<sub>4</sub> = maximum output current for AM (200mA)
- I<sub>5</sub> = maximum output current for AR (200mA)
- I<sub>6</sub> = maximum output current for ANT (250mA)
- I<sub>7</sub> = maximum output current for AMP (100mA)

- Power consumed by V<sub>DD</sub> 5.0V P<sub>1</sub> = (B - 5.0V) × I<sub>1</sub> + (I<sub>1</sub>/16 + I<sub>1</sub>/10) × B
- Power consumed by COM 8.5V P<sub>2</sub> = (A - 8.5V) × I<sub>2</sub> + (I<sub>2</sub>/60 + I<sub>2</sub>/10) × A
- Power consumed by FM 8.5V P<sub>3</sub> = (A - 8.5V) × I<sub>3</sub> + (I<sub>3</sub>/60 + I<sub>3</sub>/10) × A
- Power consumed by AM 8.5V P<sub>4</sub> = (A - 8.5V) × I<sub>4</sub> + (I<sub>4</sub>/40 + I<sub>4</sub>/10) × A
- Power consumed by AR 8.5V P<sub>5</sub> = (A - 8.5V) × I<sub>5</sub> + (I<sub>5</sub>/40 + I<sub>5</sub>/10) × A
- Power consumed by ANT P<sub>6</sub> = (0.6V) × I<sub>6</sub> + (I<sub>6</sub>/50 + I<sub>6</sub>/10) × A
- Power consumed by AMP P<sub>7</sub> = (0.6V) × I<sub>7</sub> + (I<sub>7</sub>/50 + I<sub>7</sub>/10) × A
- Power consumed internally by each circuit P<sub>8</sub> = A × 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) Application circuit

The application circuit is recommended for use. Make sure to confirm the adequacy of parts characteristics. When using the circuit with changes to external circuit constants, make sure to leave sufficient margins in consideration of fluctuations in the IC and external components including static and transitional characteristics. Note that ROHM has not carried out extensive survey regarding the patent right of this application.

(3) Operating power supply

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.

(4) 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.

(5) 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.

(6) Preventing oscillation at each output

To stop output oscillation, make sure to connect a capacitor having a capacitance of 10  $\mu$ F or greater between GND and each of the ANT (pin 1), AMP (pin 2), V<sub>DD</sub> (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.

(7) Overcurrent protection circuit

An overcurrent protection circuit is installed on the ANT (pin 1), AMP (pin 2), V<sub>DD</sub> (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<sub>F</sub> (considered as short mode).

(8) Thermal protection circuit

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

(9) 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<sub>F</sub>, this diode is fully turned on.

(10) 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.

(11) Grounding

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

(12) We recommend installing a bypass line in your application if there is a mode where potential difference between each output and input (V<sub>CC</sub>) or GND is reversed from the normal state.

●Electrical characteristic curves

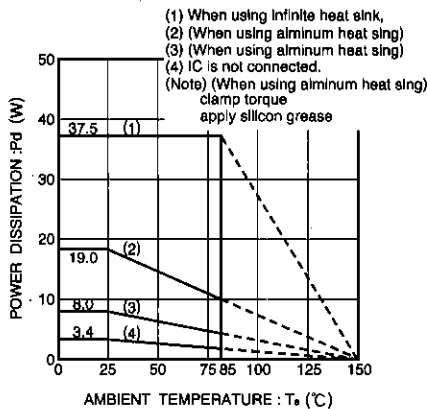


Fig.4 Temperature dependence of power dissipation

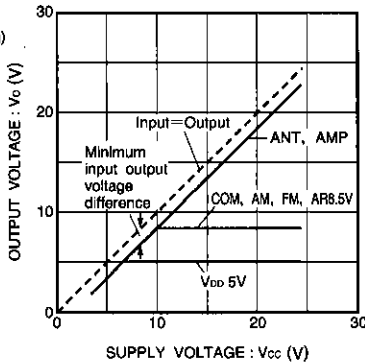


Fig.5 Relationship between output voltage and supply voltage

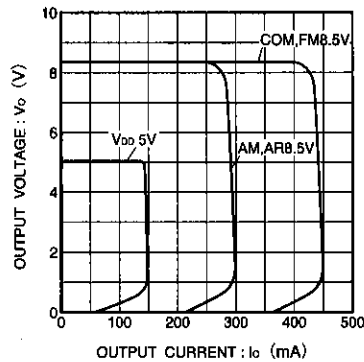


Fig.6 Relationship between output voltage and output current

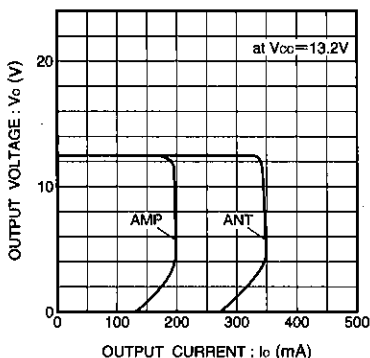


Fig.7 Relationship between output voltage and output current

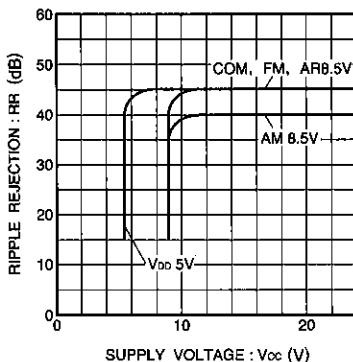
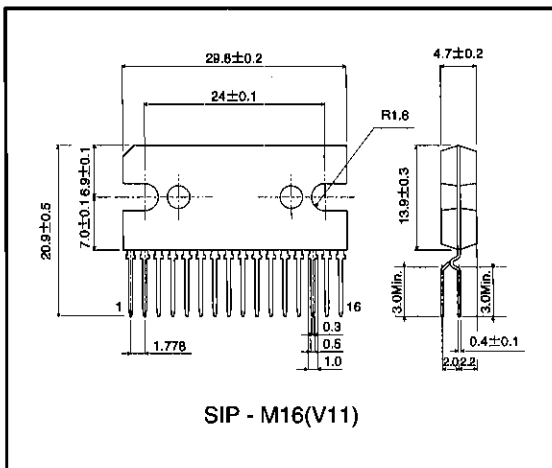


Fig.8 Relationship between the ripple rejection ratio and supply voltage

●External dimensions (Units: mm)





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