System Power Supply LSIs for use in automotive electronics

Highly Stable Bipolar System Power Supply ICs

Pb Free ROHM Electronic Components RoHS Directive Compliance

BA4911 / BA4911-V4

● **Description**

The BA4911/BA4911-V4 provides multiple supply voltage outputs for use in car audio, satellite navigation systems, CD player, radio, and other systems. In addition to overcurrent, overvoltage, and thermal shutdown circuits, it incorporates circuitry for dealing with sudden BATTERY power failures, and is therefore ideal for car audio and satellite navigation systems.

● **Features**

1) Built-in power supplies for car audio and satellite navigation systems
   - 5.0 V microcontroller power supply
   - 8.12 V audio power supply
   - 7.9 V and 8.12 V radio power supplies
   - 10.3 V lighting power supply
   - 1 V_{DD}-linked high side switch
   - 2 V_{CC}-linked high side switches
2) The ability to operate (V_{DD}) using the charge stored in a backup capacitor makes the IC unlikely to malfunction in the event of a sudden BATTERY power failure.
3) Output pins use low dropout PNP output.
4) Built-in overcurrent protection circuits
5) Built-in overvoltage protection circuit
6) Built-in thermal shutdown circuit
7) A 12-pin power package gives the IC large power dissipation capabilities and is ideal for space-saving designs.

● **Applications**

Car audio and satellite navigation systems

Ver.B Oct.2005

●Absolute maximum ratings (Ta = 25°C)

Parameter	Symbol	Limits	Unit
Supply Voltage	V_{CC}	36	V
Power Dissipation	Pd	3400	mW
Operating Temperature Range	Topr	−30 to +85	°C
Storage Temperature Range	Tstg	−55 to +150	°C
Maximum Junction Temperature	Tjmax	150	°C
Peak Supply Voltage	V_{CC} PEAK	50*1	V

*1 tr ≥ 1 ms; Bias voltage is applied for less than 200 ms.

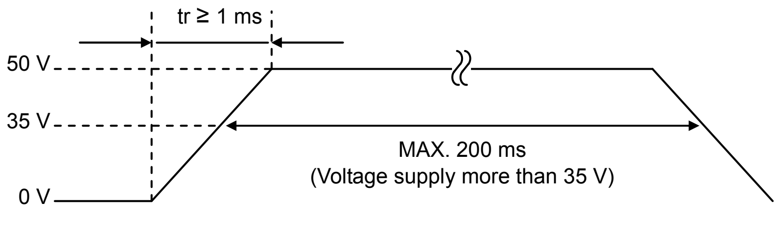


Fig. 1 Peak Supply Voltage Waveform

●Recommended operating ranges (Ta = 25°C)

Parameter	Limits	Unit	Comment
Recommended Supply Voltage Range 1	10 to 18	V	Except V_{DD} and ILM output
Recommended Supply Voltage Range 2	8.2 to 18	V	V_{DD} output
Recommended Supply Voltage Range 3	11.4 to 18	V	ILM output

●Electrical characteristics (Unless otherwise specified, Ta = 25°C; V_{CC} = 14.4 V)

Parameter	Symbol	Limits			Unit	Condition
		Min.	Typ.	Max.		
Standby Circuit Current 1	Ist1	—	100	150	μA	V_{CC} = 13.2 V
Standby Circuit Current 2	Ist2	—	100	150	μA	
Output Voltage (V_{DD}) 1	V_O1	4.80	5.00	5.20	V	I_O = 300 mA V_{CC} = 10 V to 18 V
Dropout Voltage 1	ΔV_O1	—	0.4	0.7	V	I_O = 300 mA, VBU-V_O1
Dropout Voltage 2	ΔV_O1’	—	2.5	3.0	V	I_O = 300 mA, V_{CC}-V_O1
Peak Output Current	I_O1	300	—	—	mA	V_O1 ≥ 4.8 V
Ripple Rejection	R.R1	—	55	—	dB	f = 100 Hz, VRR = −10 dBV
Low Vcc Output Voltage	V_O1’	3.7	4.0	—	V	V_{CC} = 5 V, Io = 10 mA
Output Voltage (AUDIO) 2	V_O2	7.8	8.12	8.3	V	I_O2 = 200 mA, V_{CC} = 10 V to 18 V −30°C to 80°C *1
Dropout Voltage	ΔV_O2	—	0.4	0.7	V	I_O2 = 200 mA, V_{CC}-V_O2
Peak Output Current	I_O2	200	—	—	mA	V_O 2 ≥ 7.8 V
Ripple Rejection	R.R2	—	55	—	dB	f = 100 Hz, VRR = −10 dBV

*1 Design guarantee (Output inspection is not done on all products.)

⦿ This IC is not designed to be radiation-resistant.

⦿ Use Peak Output Current less than Limits Min. values.

●**Electrical Characteristics** (Unless otherwise specified, Ta = 25°C; Vcc = 14.4 V)

Parameter	Symbol	Limits			Unit	Condition
		Min.	Typ.	Max.		
Dropout Voltage (P.CON) 3	ΔVo3	—	0.4	0.7	V	Io3 = 200 mA
Peak Output Current	Io3	300	—	—	mA	Vo3 ≥ 13.7 V
Dropout Voltage (P.ANT) 4	ΔVo4	—	0.4	0.7	V	Io4 = 200 mA
Peak Output Current	Io4	300	—	—	mA	Vo4 ≥ 13.7 V
Output Voltage (AM) 5	Vo5	7.5	7.9	8.3	V	Io5 = 50 mA, Vcc = 10 V to 18 V −30°C to 80°C*1
Dropout Voltage	ΔVo5	—	0.4	0.7	V	Io5 = 50 mA
Peak Output Current	Io5	50	—	—	mA	Vo5 ≥ 7.5 V
Ripple Rejection	R.R5	—	55	—	dB	f = 100 Hz,VRR = −10 dBV
Output Voltage (FM) 6	Vo6	7.8	8.12	8.3	V	Io6 = 50mA, Vcc = 10 V to 18 V −30°C to 80°C*1
Dropout Voltage	ΔVo6	—	0.4	0.7	V	Io6 = 50 mA, Vcc-Vo6
Peak Output Current	Io6	50	—	—	mA	Vo6 ≥ 7.8 V
Ripple Rejection	R.R6	—	55	—	dB	f = 100 Hz, VRR = −10 dBV
Output Voltage (ILM) 7	Vo7	9.9	10.3	10.7	V	Io7 = 250 mA, Vcc = 10 V to 18 V
Dropout Voltage	ΔVo7	—	0.4	0.7	V	Io7 = 250 mA, Vcc-Vo7
Peak Output Current	Io7	250	—	—	mA	Vo7 ≥ 9.9 V
Ripple Rejection	R.R7	—	50	—	dB	f = 100 Hz, VRR = −10 dBV
Input Pin (SW1)						
Standby Input Voltage	Vth1-1	—	—	1.0	V	
AUDIO ON	Vth1-2	1.5	—	3.0	V	
AUDIO, P-CON ON	Vth1-3	3.5	—	5.0	V	
AUDIO, P-CON, P-ANT ON	Vth1-4	7.0	—	Vcc	V	
SW1 Input Impedance	Rin1	100	—	—	kΩ	
Input Pin (SW2)						
Standby Input Voltage	Vth2-1	—	—	1.0	V	
ILM, FM ON	Vth2-2	2.0	—	3.0	V	
ILM, AM ON	Vth2-3	4.0	—	Vcc	V	
SW2 Input Impedance	Rin2	100	—		kΩ	

*1 Design guarantee (Output inspection is not done on all products.)

⦿ This IC is not designed to be radiation-resistant.

⦿ Use Peak Output Current less than limits minimum values.

●**Reference data** (Unless otherwise specified, VCC = 14.4 V)

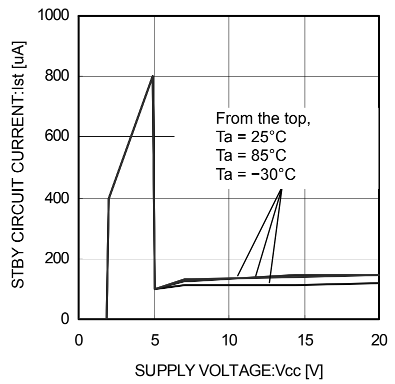


Fig. 2 Standby Circuit Current

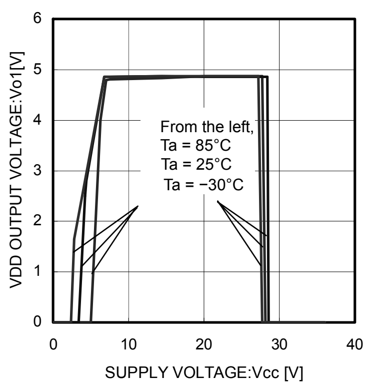


Fig. 3 VDD Line Regulation (IO = No load)

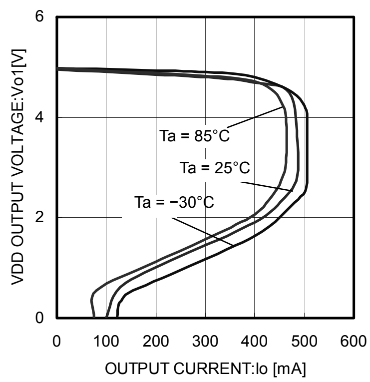


Fig. 4 VDD Load Regulation

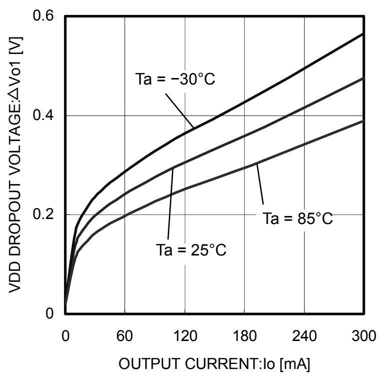


Fig. 5 VDD Dropout Voltage (VCC = 4.8 V)

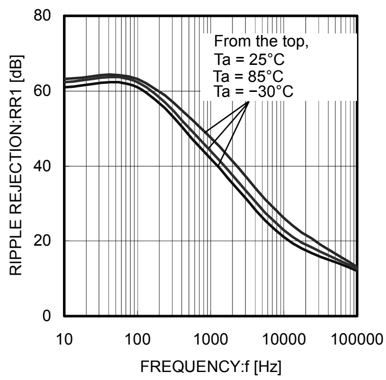


Fig. 6 VDD Ripple Rejection Ratio (IO = 300 mA)

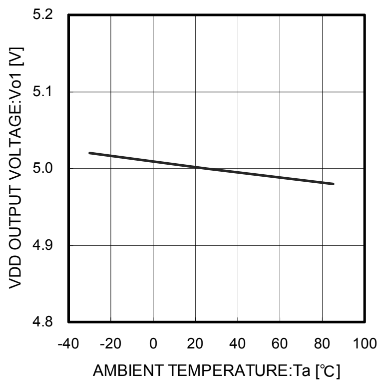


Fig. 7 VDD Output Voltage vs Temperature

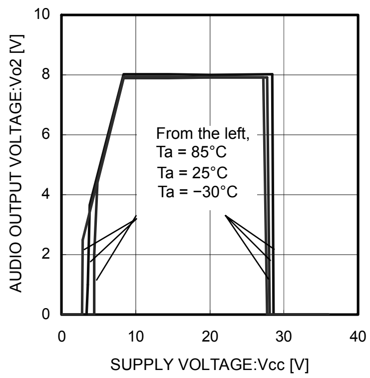


Fig. 8 AUDIO Line Regulation (IO = No load)

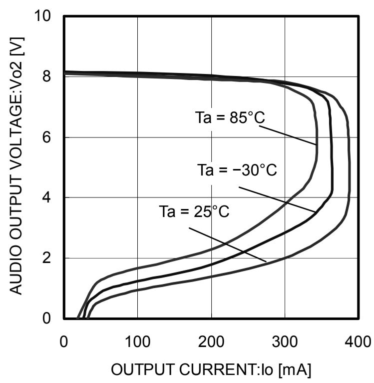


Fig. 9 AUDIO Load Regulation

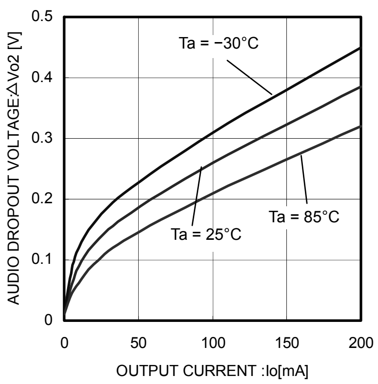


Fig. 10 AUDIO Dropout Voltage (VCC = 7.8 V)

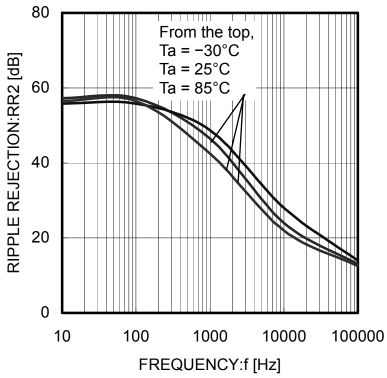


Fig. 11 AUDIO Ripple Rejection Ratio
(IO = 200 mA)

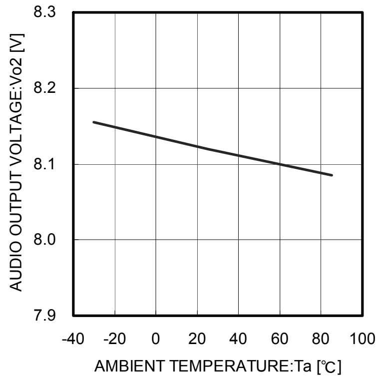


Fig. 12 AUDIO Output Voltage vs Temperature

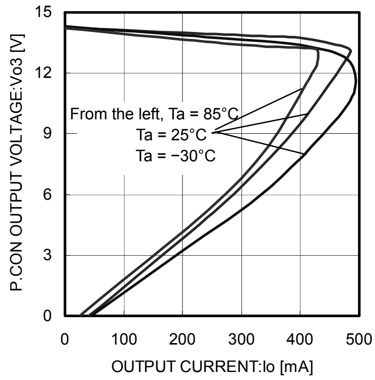


Fig. 13 P.CON Peak Output Current

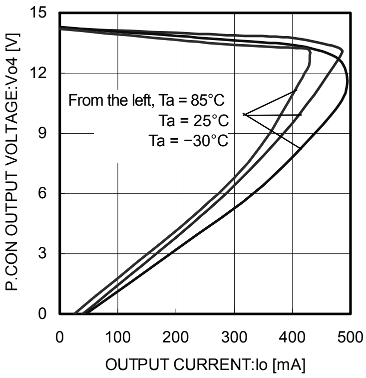


Fig. 14 P.ANT Peak Output Current

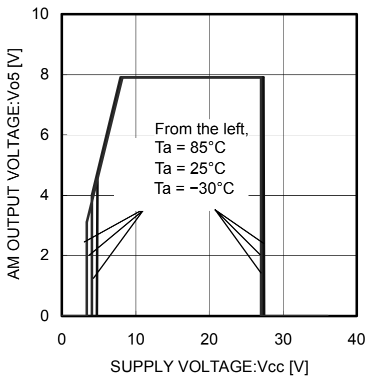


Fig. 15 AM Line Regulation
(IO = No load)

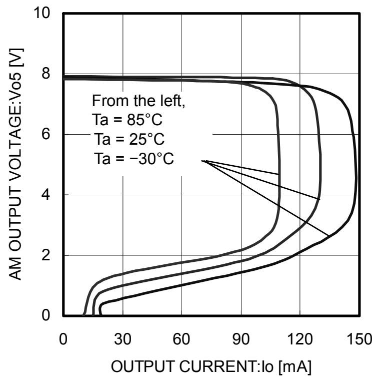


Fig. 16 AM Load Regulation

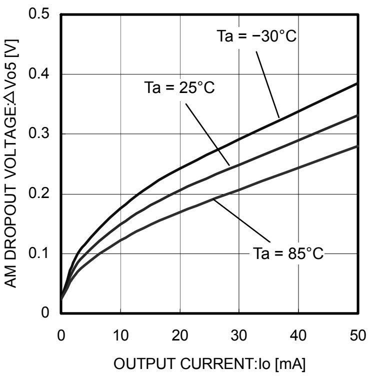


Fig. 17 AM Dropout Voltage
(VCC = 7.5 V)

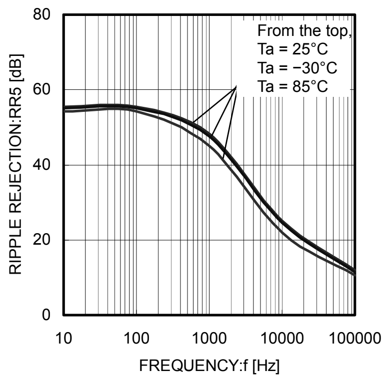


Fig. 18 AM Ripple Rejection Ratio
(IO = 50 mA)

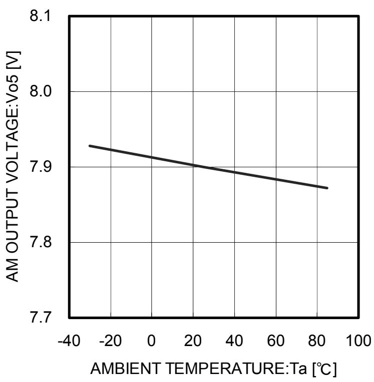


Fig. 19 AM Output Voltage vs Temperature

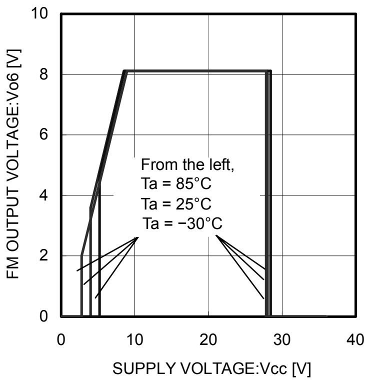


Fig. 20 FM Line Regulation
(IO = No load)

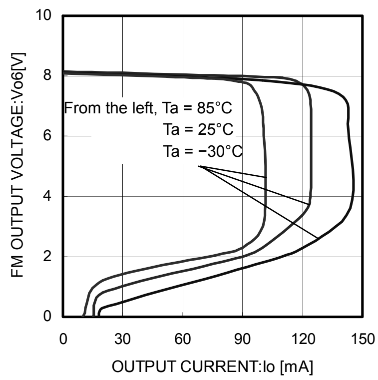


Fig. 21 FM Load Regulation

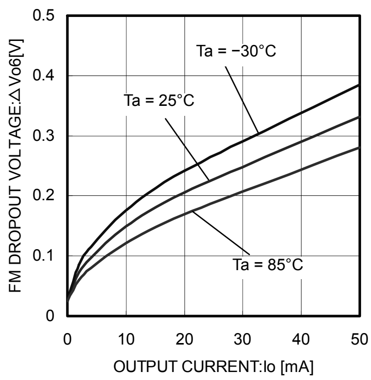


Fig. 22 FM Dropout Voltage
(VCC = 7.8 V)

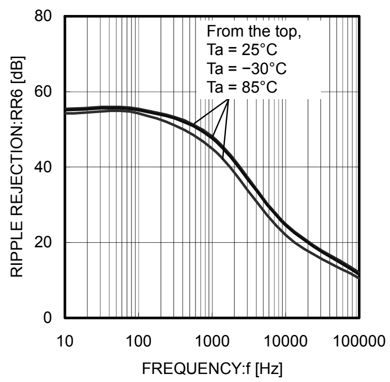


Fig.23 FM Ripple Rejection Ratio
(IO = 50 mA)

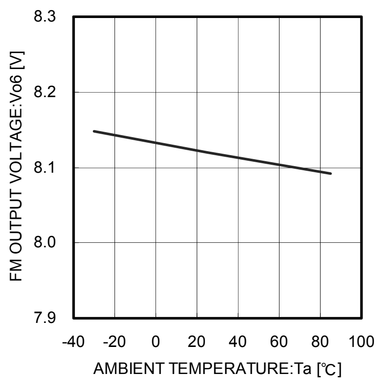


Fig. 24 FM Output Voltage vs Temperature

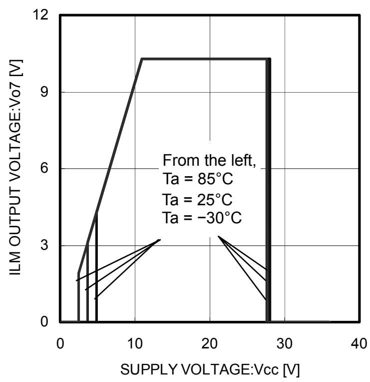


Fig. 25 ILM Line Regulation
(IO = No load)

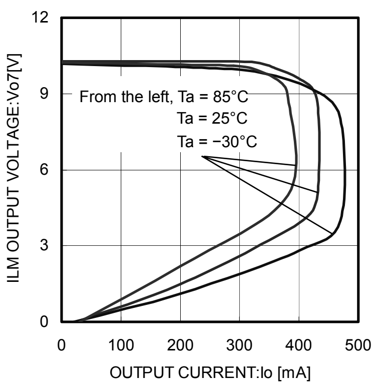


Fig. 26 ILM Load Regulation

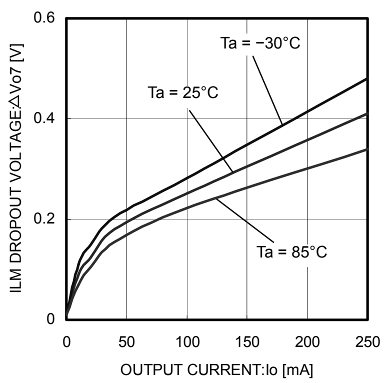


Fig. 27 ILM Dropout Voltage
(VCC = 9.9 V)

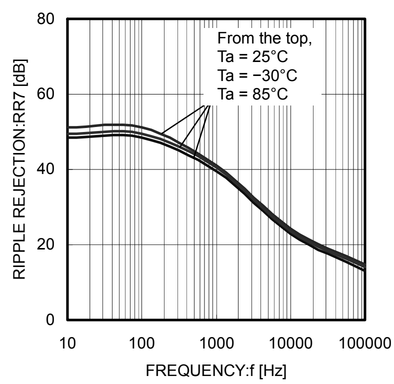


Fig. 28 ILM Ripple Rejection Ratio (IO = 250 mA)

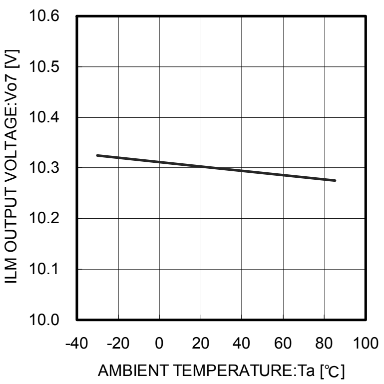


Fig. 29 ILM Output Voltage vs Temperature

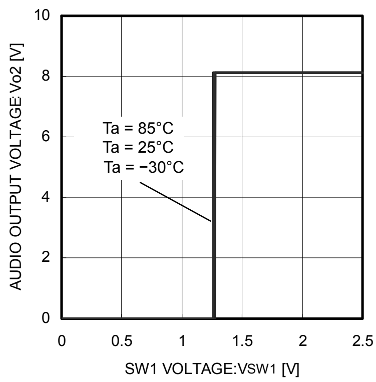


Fig. 30 AUDIO Input Threshold Voltage

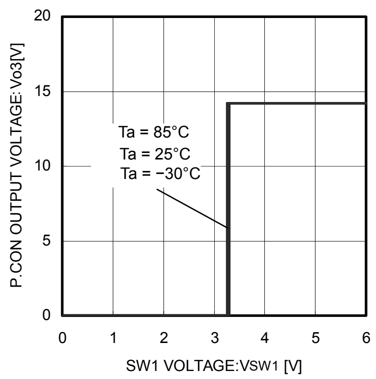


Fig. 31 P.CON Input Threshold Voltage

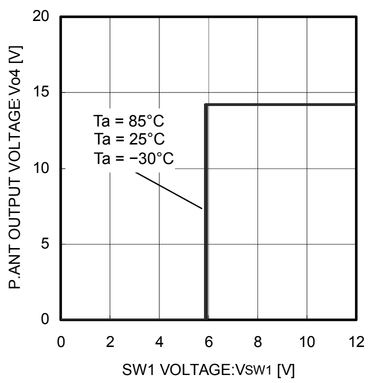


Fig. 32 P.ANT Input Threshold Voltage

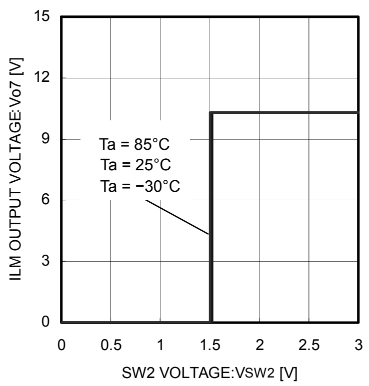


Fig. 33 ILM Input Threshold Voltage

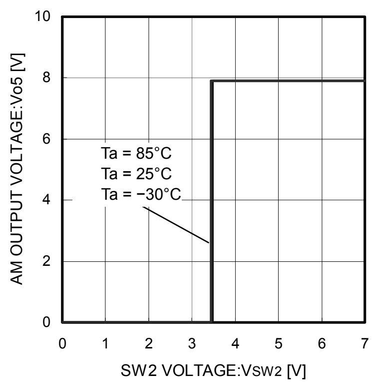


Fig.34 AM Input Threshold Voltage

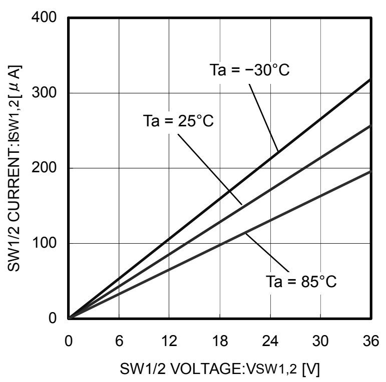


Fig. 35 SW1/SW2 Input Current

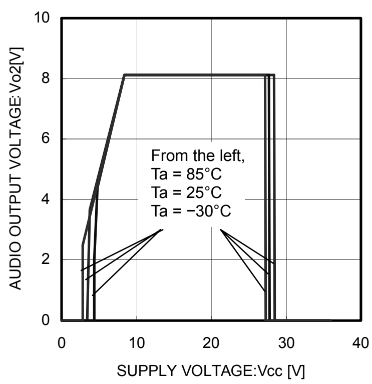


Fig. 36 Overvoltage Operation

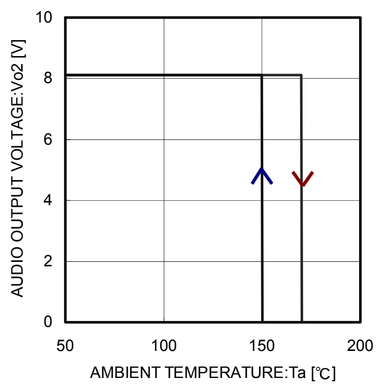


Fig. 37 Thermal Shutdown Operation

●Block diagram

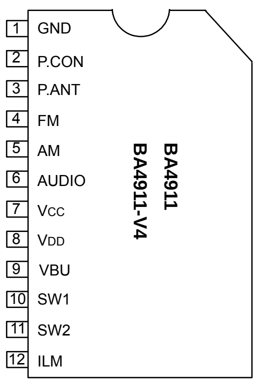


Fig. 38 Pin Assignment Diagram

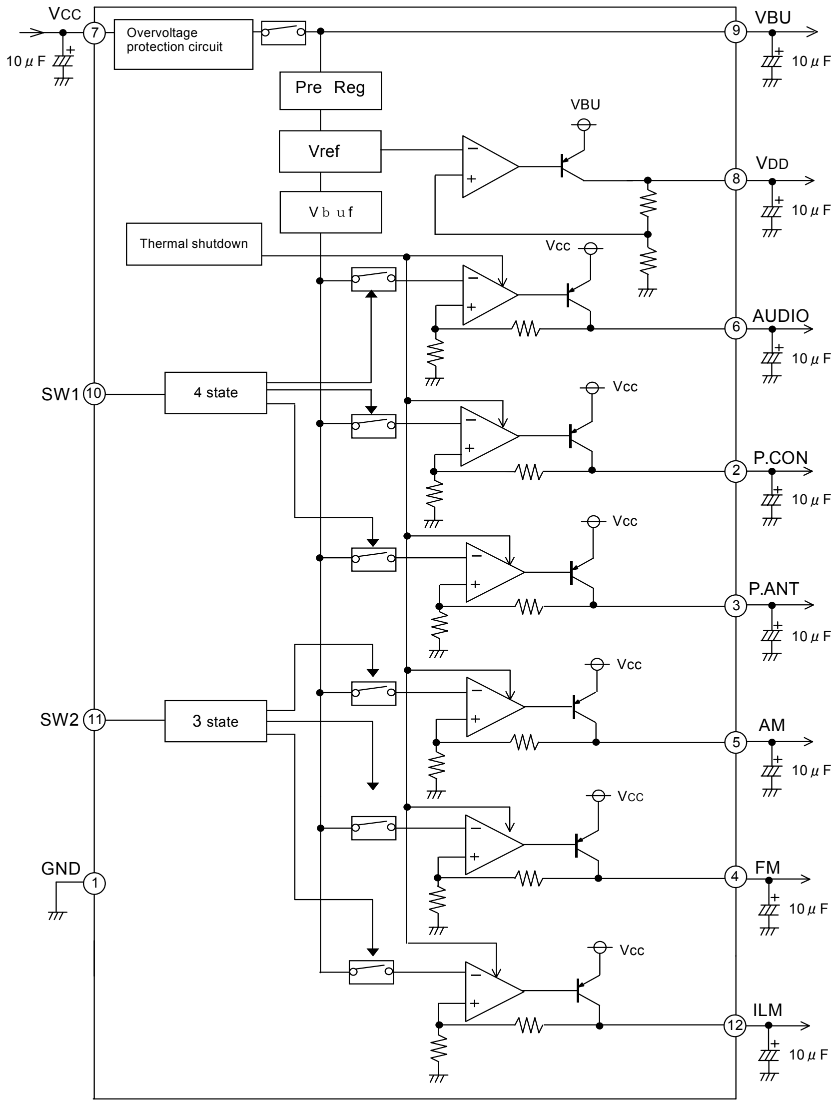
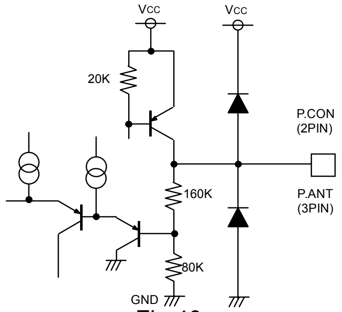
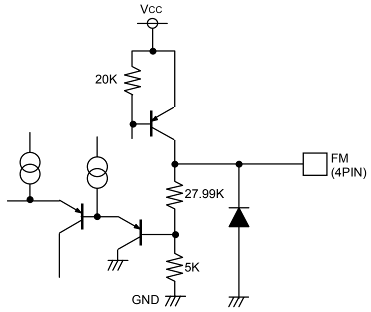
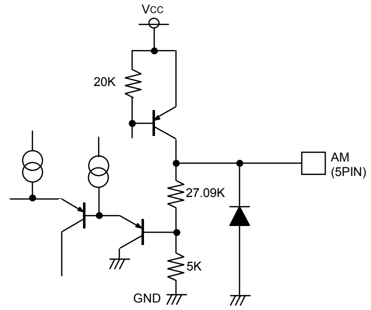
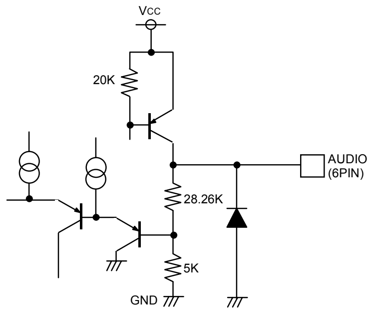
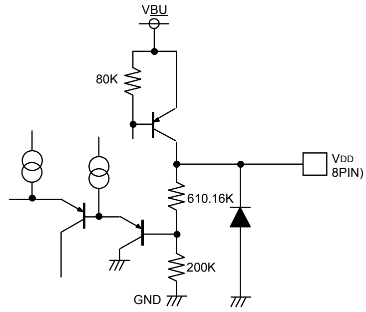
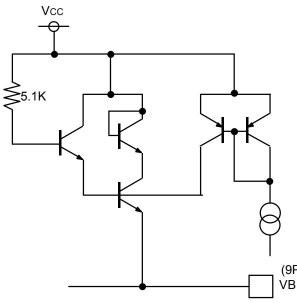
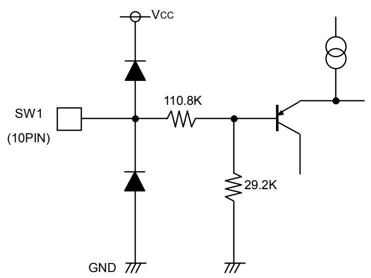
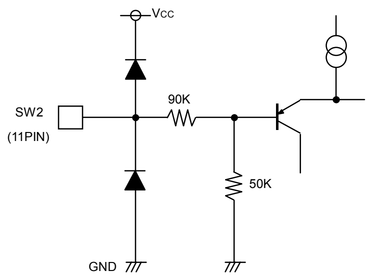
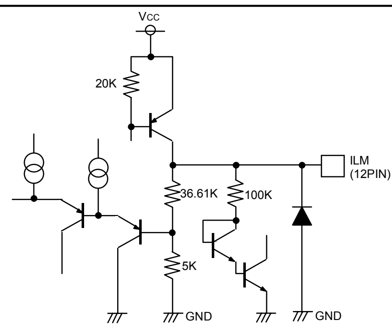


Fig. 39 Block Diagram

●Pin descriptions

1	GND	This pin is connected to the IC's substrate.
2	P.CON	This pin outputs a voltage that is approximately 0.4 V (TYP) lower than the VCC pin voltage. Peak output current is 300 mA.
3	P.ANT	This pin outputs a voltage that is approximately 0.4 V (TYP) lower than the VCC pin voltage. Peak output current is 350 mA.
4	FM	This pin serves as the FM receiver power supply (8.12 V; peak output current: 50 mA).
5	AM	This pin serves as the AM receiver power supply (7.9 V; peak output current: 50 mA).
6	AUDIO	This pin serves as the common system power supply for volume and sound control (8.12 V, peak output current: 200 mA) as well as the power supply for variable capacitance diodes and other components used for electronic tuning and cassette player features, such as the equalizer.
7	VCC	This pin is connected to the car's backup and ACC power supplies.
8	VDD	This pin serves as the microcontroller power supply (5.0 V; peak output current: 300 mA).
9	VBU	This pin is connected to a capacitor for maintaining the VDD and backup voltages.
10	SW1	The AUDIO/AUDIO, P.CON/AUDIO, P.CON, and P.ANT outputs rise when a 2 V, 4 V, or 8 V is applied to the this pin.
11	SW2	The ILM, FM/ILM, and AM outputs rise when a 2.5 V or 5 V signal is applied to this pin.
12	ILM	This pin serves as the lighting power supply (10.3 V; peak output current: 250 mA).

●I/O Equivalent circuit diagrams

2PIN(P.CON), 3PIN(P.ANT)	4PIN(FM)	5PIN(AM)
 Fig.40	 Fig.41	 Fig.42
6PIN(AUDIO)	8PIN(VDD)	9PIN(VBU)
 Fig.43	 Fig.44	 Fig.45
10PIN(SW1)	11PIN(SW2)	12PIN(ILM)
 Fig.46	 Fig.47	 Fig.48

●Timing chart

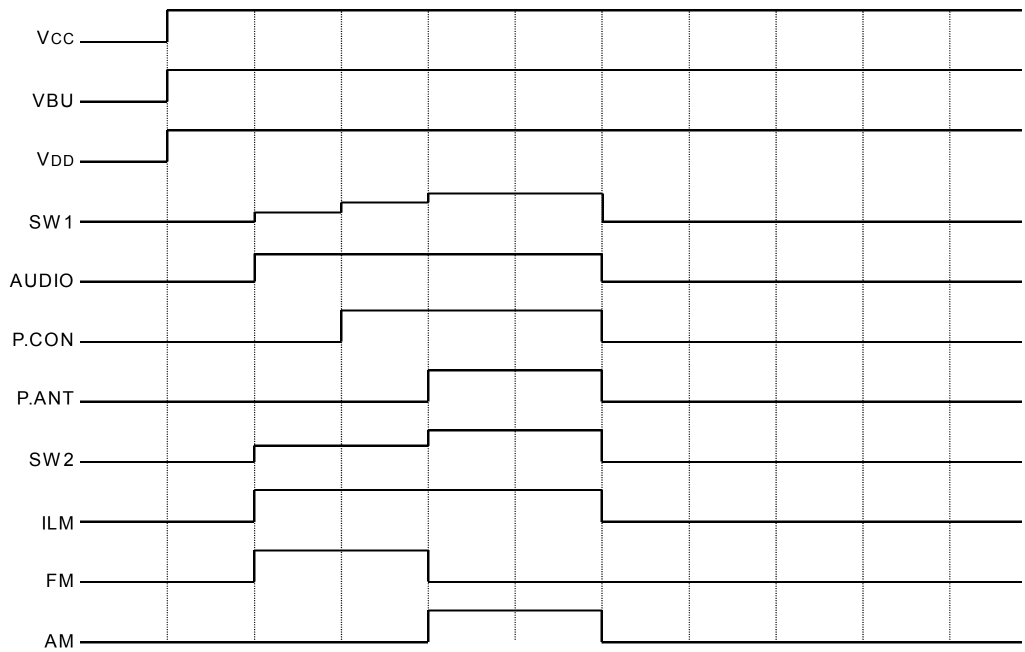
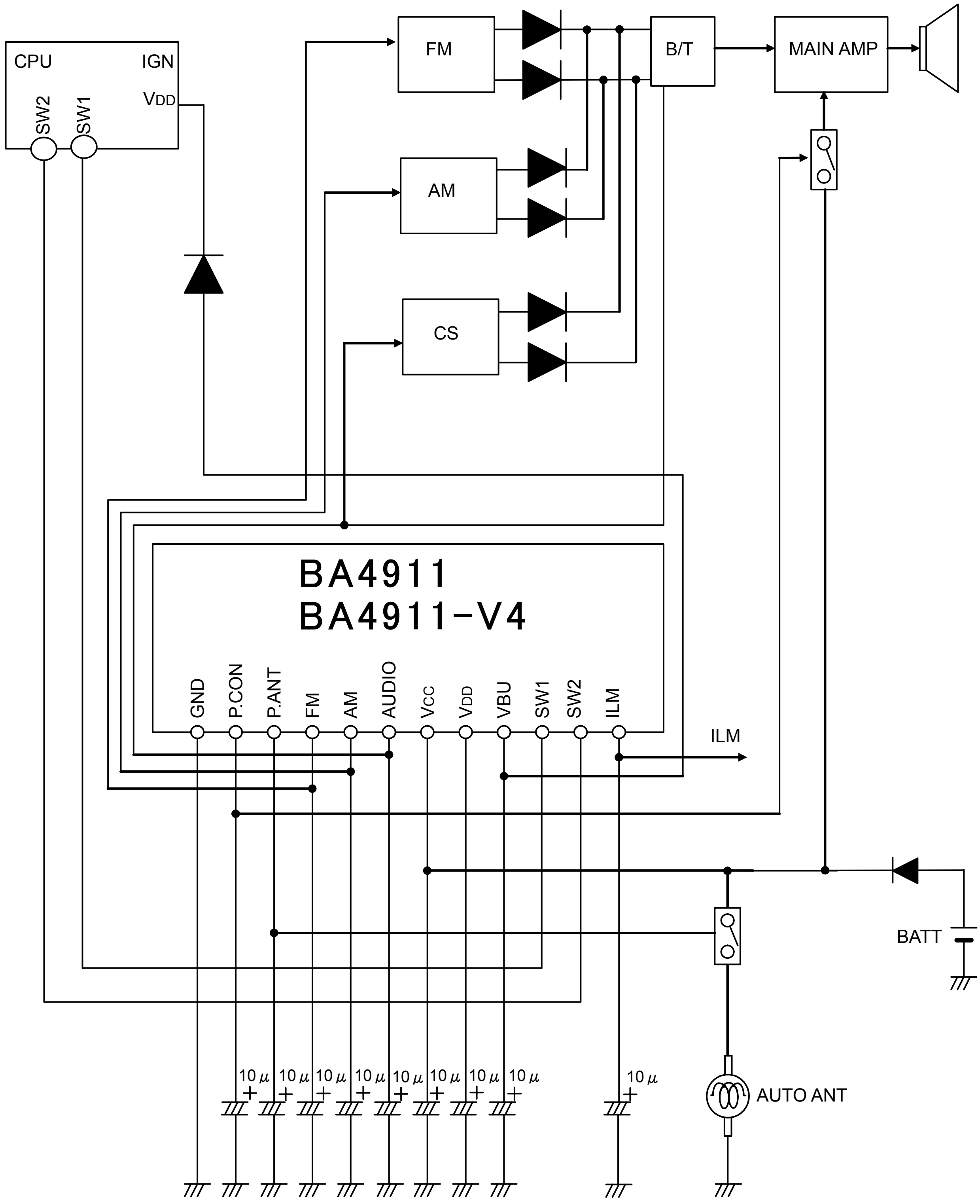


Fig. 49 Timing Chart

● **Application circuit**



(Unit R : Ω, C : F)

Fig. 50 Application Circuits Example

●Thermal design

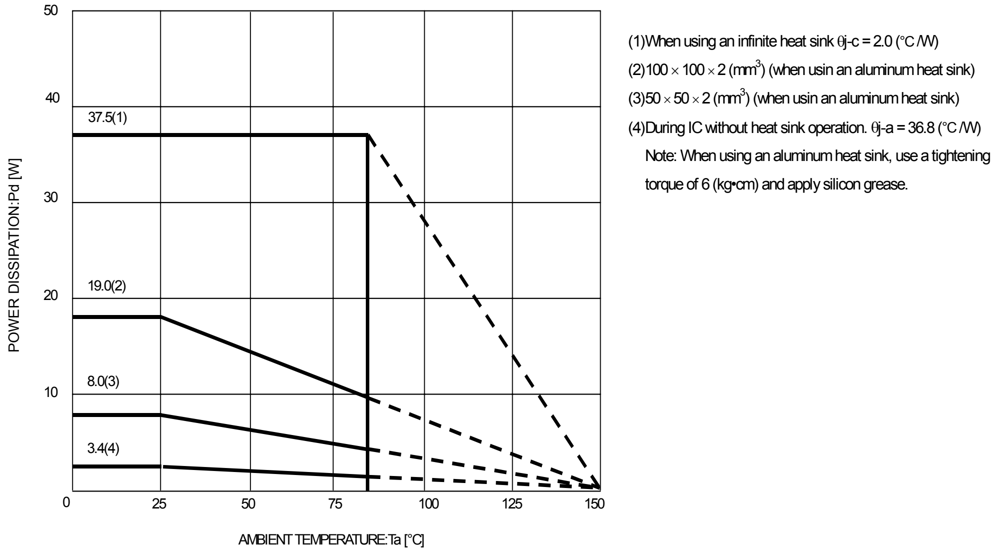


Fig. 51 Power Dissipation Characteristics

Refer to the power dissipation characteristics illustrated in Fig. 51 when using the IC in an environment where Ta ≥ 25°C. The characteristics of the IC are greatly influenced by the operating temperature. If the temperature exceeds the maximum junction temperature Tjmax, the elements of the IC may be damaged or deteriorated. It is necessary to give sufficient consideration to the heat of the IC in view of two points, i.e., the protection of the IC from instantaneous damage and the maintenance of the reliability of the IC in long-time operation.
In order to protect the IC from thermal destruction, it is necessary to operate the IC not in excess of the maximum junction temperature Tjmax.
The chip's (junction area) temperature Tj may rise considerably even when the IC is being used at room temperature (25°C). Always operate the IC within the power dissipation Pd.

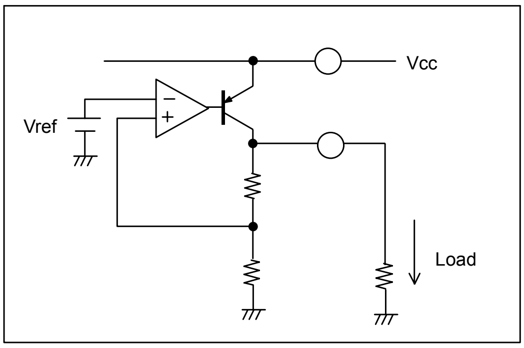


Fig.52

The maximum power consumption P_{MAX} (W) can be calculated as described below, where A denotes the maximum V_{CC} input voltage:

I_1 = Max. V_{DD} output current
I_2 = Max. AUDIO output current
I_3 = Max. P.CON output current
I_4 = Max. P.ANT output current
I_5 = Max. AM output current
I_6 = Max. FM output current
I_7 = Max. ILM output current

- •Power consumed by V_{DD} — $P_1 = (A - 5.0\text{ V}) \times I_1 + (I_1 / 100 + I_1 / 10) \times A$
- •Power consumed by AUDIO — $P_2 = (A - 8.12\text{V}) \times I_2 + (I_2/100 + I_2/10) \times A$
- •Power consumed by P.CON — $P_3 = 1\text{V} \times I_3 + (30\text{ mA}) \times A$
- •Power consumed by P.ANT — $P_4 = 1\text{V} \times I_4 + (30\text{ mA}) \times A$
- •Power consumed by AM — $P_5 = (A - 7.9\text{ V}) \times I_5 + (I_5/20 + I_5/10) \times A$
- •Power consumed by FM — $P_6 = (A - 8.12\text{ V}) \times I_6 + (I_6/20 + I_6/10) \times A$
- •Power consumed by ILM — $P_7 = (A - 10.3\text{ V}) \times I_7 + (I_7/80 + I_7/10) \times A$
- •Power consumed by each circuit's current — $P_8 = A \times$ circuit current (circuit current is approximately 5 mA)

$P_{MAX} = P_1 + P_2 + P_3 + P_4 + P_5 + P_6 + P_7 + P_8$

●**Operating notes**

1. Absolute maximum ratings
   An excess in the absolute maximum ratings, such as supply voltage, temperature range of operating conditions, etc., can break down the devices, thus making impossible to identify breaking mode, such as a short circuit or an open circuit. If any over rated values will expect to exceed the absolute maximum ratings, consider adding circuit protection devices, such as fuses.

2. GND voltage
   The potential of GND pin must be minimum potential in all operating conditions.

3. Thermal design
   Use a thermal design that allows for a sufficient margin in light of the power dissipation (Pd) in actual operating conditions.

4. Pin short shorts and mounting errors
   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 pins caused by the presence of a foreign object may result in damage to the IC.

5. Inter-pin shorts and mounting errors
   Use caution when positioning the IC for mounting on printed circuit boards. The IC may be damaged if there is any connection error or if pins are shorted together.

6. Testing on application boards
   When testing the IC on an application board, connecting a capacitor to a pin with low impedance subjects the IC to stress. Always discharge capacitors after each process or step. Always turn the IC's power supply off before connecting it to or removing it from a jig or fixture during the inspection process. Ground the IC during assembly steps as an antistatic measure. Use similar precaution when transporting or storing the IC.

7. Regarding input pin of the IC
   This monolithic IC contains P+ isolation and P substrate layers between adjacent elements in order to keep them isolated.
   P-N junctions are formed at the intersection of these P layers with the N layers of other elements, creating a parasitic diode or transistor. For example, the relation between each potential is as follows:
   When GND > Pin A and GND > Pin B, the P-N junction operates as a parasitic diode.
   When GND > Pin B, the P-N junction operates as a parasitic transistor.
   Parasitic diodes can occur inevitable in the structure of the IC. The operation of parasitic diodes can result in mutual interference among circuits, operational faults, or physical damage. Accordingly, methods by which parasitic diodes operate, such as applying a voltage that is lower than the GND (P substrate) voltage to an input pin, should not be used.

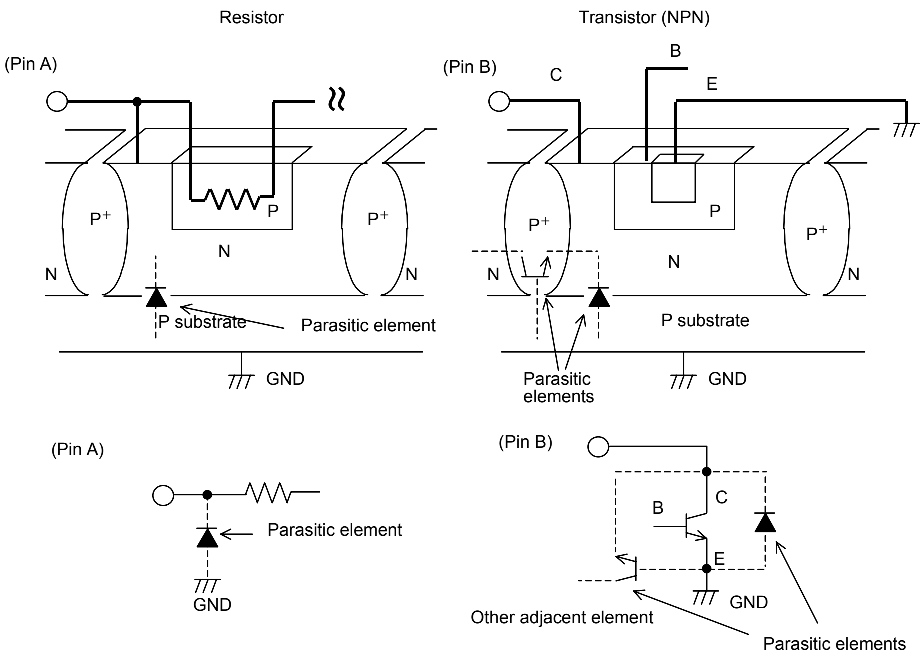


Fig. 53 Example of a Simple Monolithic IC Architecture

8. Ground Wiring Pattern

When using both small signal and large current GND patterns, it is recommended to isolate the two ground patterns, placing a single ground point at the ground potential of application so that the pattern wiring resistance and voltage variations caused by large currents do not cause variations in the small signal ground voltage. Be careful not to change the GND wiring pattern of any external components, either.

9. Recommended operating ranges

Proper circuit functionality is guaranteed within the operating temperature range for supply voltages that fall within the recommended ranges.

Although standard electrical characteristics values are not guaranteed, characteristics values will not vary suddenly within these ranges.

10. Output capacitors

Capacitors for stopping oscillation must be placed between the V_{DD} (pin 8), AUDIO (pin 6), AM (pin 5), FM (pin 4), P.CON (pin 2), P.ANT (pin 3), and ILM (pin 12) output pins and the GND pin.

It is recommended to use tantalum electrolytic capacitors, which have only slight variations in temperature and other characteristics, with capacitance values of at least 10 µF.

For capacitors that are subject to large temperature variations, characteristics can be improved by connecting an in-series 1 µF or higher ceramic capacitor and 1 Ω resistor in parallel with the output capacitor.

11. Applications with modes that reverse V_{CC} and pin potentials may cause damage to internal IC circuits. For example, such damage might occur when VCC is shorted with the GND pin while an external capacitor is charged. Table 1 lists the maximum capacitance values for individual pins.

It is recommended to connect a diode for adverse current prevention in series to the Vcc pin or insert a bypass diode between each pin and Vcc pin. When the possibility exists that the VCC pin will carry a lower voltage than the GND pin, insert a protective diode between the VCC and GND pins.

Output pin	Output capacitor
AM	10 µF to 22 µF
AUDIO	10 µF to 2200 µF
V_{DD}	10 µF to 22 µF
ILM	10 µF to 22 µF
FM	10 µF to 2200 µF

Table 1

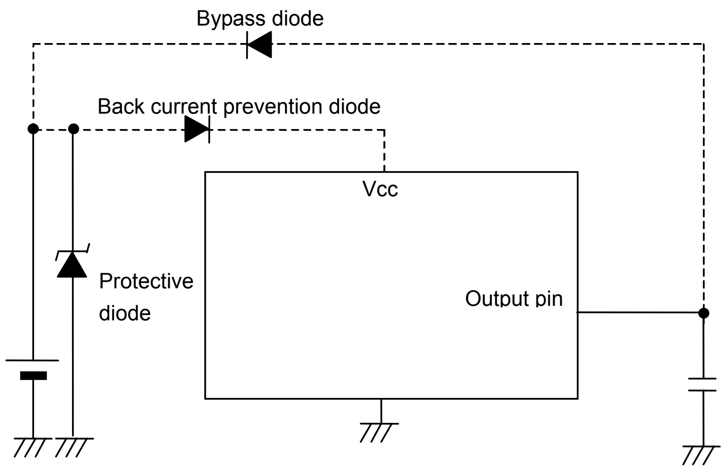


Fig. 54 Example of Back Current Prevention Diode and Bypass Diode Insertion

12. Overcurrent protection circuits

The IC incorporates built-in overcurrent protection circuits for the V_{DD} (pin 8), AUDIO (pin 6), AM (pin 5), FM (pin 4), P.CON (pin 2), P.ANT (pin 3), and ILM (pin 12) output pins. This circuit serves to protect the IC from damage when the load is shorted. The protection circuit is designed to limit current flow by not latching in the event of a large and instantaneous current flow originating from a large capacitor or other component. These protection circuits are effective in preventing damage due to sudden and unexpected accidents. However, the IC should not be used in applications characterized by the continuous operation or transitioning of the protection circuits. At the time of thermal designing, keep in mind that the current capability has negative characteristics to temperatures.

13. Overvoltage protection circuit

Overvoltage protection is designed to turn off all output when the voltage differential between the V_{CC} (pin 7) and GND (pin 1) pins exceeds approximately 27 V (at room temperature).

Use caution when determining the supply voltage range to use.

14. Thermal shutdown circuit (TSD)
This IC incorporates a built-in temperature protection circuit for the protection from thermal destruction. The IC should be used within the specified power dissipation range. However, in the event that the IC continues to be operated in excess of its power dissipation limits, the attendant rise in the chip's temperature Tj will trigger the thermal shutdown circuit to turn off all output power elements. The circuit will automatically reset once the chip's temperature Tj drops.
Operation of the thermal shutdown circuit presumes that the IC's absolute maximum ratings have been exceeded. Application designs should never make use of the thermal shutdown circuit.

15. Ground patterns
Pattern routes connecting the ground points to the GND pin (pin 1), indicated in the application circuits example, must be as short and thick as possible to reduce line impedance.

16. Bypass capacitor between the VCC and GND pin
It is recommended to insert a bypass capacitor from 10 μF to 10 mF between the VCC and GND pins, positioning it as close as possible to the pins.

17. Grounding the P.CON and P.ANT pin
When the IC's GND pin (pin 1) is open and the P.CON (pin 2) and P.ANT (pin 3) pins are connected to a negative battery terminal, a parasitic element may occur inside the IC, resulting in damage. To prevent such damage, it is recommended to insert a schottky diode between the P.CON and P.ANT pins and the GND pin. (See Fig. 55.)

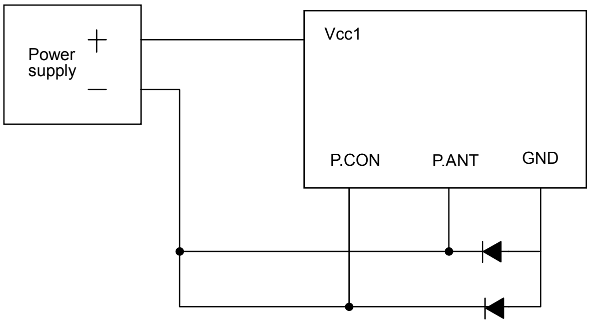


Fig. 55 Ground Prevention Circuit Diagram

18. Applications with modes where the potentials of the input (VCC) and GND pins and other output pins may be reversed from their normal states, may cause damage to the IC's internal circuitry. It is recommended to create a bypass route with diodes or other components when loads, including large impedance components, are connected as with the P.ANT and P.CON pins in applications where back EMF may be generated during startup or when output is turned off.

(Example)
Output pin

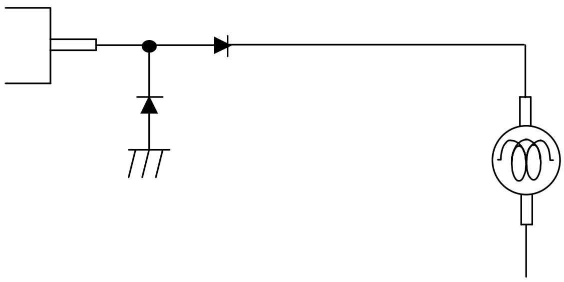


Fig. 56 Example of Protective Diode Insertion

19. Although ROHM is confident that the example application circuit reflects the best possible recommendations, be sure to verify circuit characteristics for your particular application. Modification of constants for other externally connected circuits may cause variations in both static and transient characteristics for external components as well as this Rohm IC. Allow for sufficient margins when determining circuit constants.

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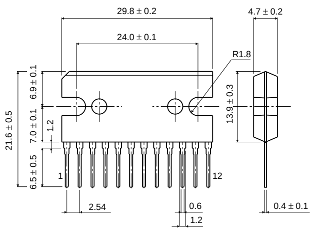
<Dimension>



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<Packing information>

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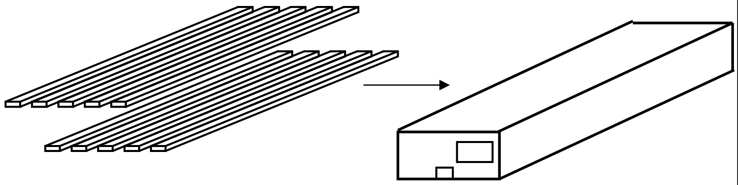
Direction of feed	Direction of products is fixed in a container tube.



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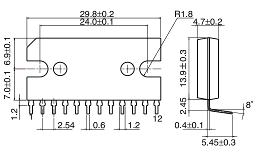

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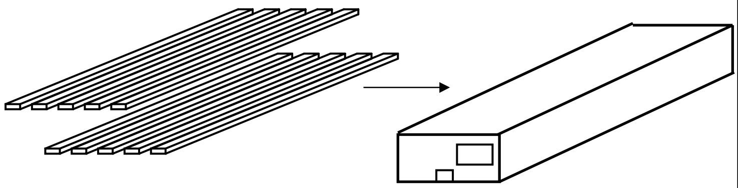

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TEL : +81-75-311-2121
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