AN8410SA (Under development)

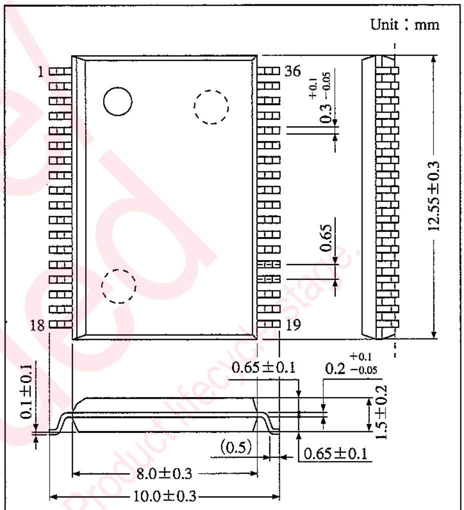
Actuator Motor Drive IC

■ Overview

The AN8410SA is a head actuator drive IC for disk memory device.

The operating supply voltage is designed to support the 5V or 3.3V system.

This IC incorporates the power PNP transistor in the motor drive, realizing the low saturation output without any external parts.

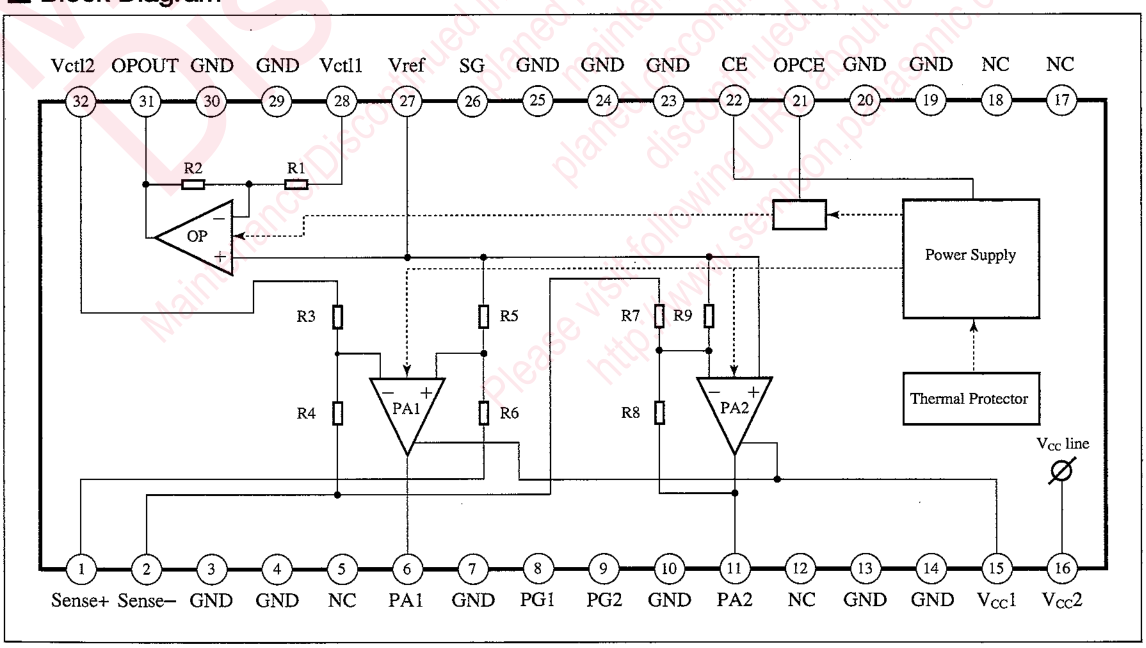


36-pin SOP Package

■ Features

- Wide operating supply voltage range : 3.3V and 5V systems supported
- Small cross-over distortion
- Low saturation output realized by power PNP transistor

■ Block Diagram



■ Absolute Maximum Rating (Ta = 25°C)

Parameter	Symbol	Rating	Unit
Supply voltage	V_{CC}	6.5	V
Supply current	I_{CC}	—	mA
Output current Note 1)	I_{max}	±200	mA
Output peak current Note 1)	I_{peak}	±300	mA
Output voltage	V_O	−0.3 to V_{CC}+0.3	V
Input voltage	V_I	−0.3 to V_{CC}+0.3	V
Power dissipation	P_D	—	mW
Operating ambient temperature	T_{opr}	−5 to +75	°C
Storage temperature	T_{stg}	−40 to +125	°C

Note 1) Only for power transistor output terminal (PA1, PA2)

■ Recommended Operating Range (Ta = 25°C)

Parameter	Symbol	Range
Operating supply voltage	V_{CC}	2.9V to 5.5V

■ Electrical Characteristics (V_{CC} = 5V, Ta = 25±2°C)

Parameter	Symbol	Condition	min	typ	max	Unit
No-Signal Time Consumption Current						
In sleep mode	Isleep	$V_{CE}=V_{CC}-0.8V$	—	0.1	0.4	mA
Set-up time	Isetup	$V_{CC}=3V$ $V_{SE}=0.8V$ $V_{OPCE}=0.8V$	—	13	20	mA
Set-up time	Isetup	$V_{CC}=5V$ $V_{CE}=0.8V$ $V_{OPCE}=0.8V$	—	16	23	mA
Interface Block OPCE Terminal						
Input high voltage	V_{HOPCE}	$V_{CE}=0.8V$	0	—	0.8	V
Input low voltage	V_{LOPCE}	$V_{CE}=0.8V$	2.0	—	V_{CC}	V
Input high current	I_{HOPCE}	$V_{CE}=0.8V$ $V_{OPCE}=2.0V$	—	240	—	μA
Input low current	I_{LOPCE}	$V_{CE}=0.8V$ $V_{OPCE}=0.8V$	—	−90	—	μA
Interface Block CE Terminal						
Input high voltage	V_{HCE}		$V_{CC}-0.8$	—	V_{CC}	V
Input low voltage	V_{LCE}		0	—	0.8	V
Input high current	I_{HCE}	$V_{CE}=V_{CC}-0.8V$	—	−20	—	μA
Input low current	I_{LCE}	$V_{CE}=0.8V$	—	−130	—	μA
Impedance						
V_{CTL1} to OPOUT impedance	Z_1		18.75	25	32.25	kΩ
V_{CTL2} to sense ⊖ impedance	Z_2		9.0	12	15	kΩ
V_{REF} to sense ⊕ impedance	Z_3		9.0	12	15	kΩ
PA1, PA2 Output Block						
No-signal time voltage	V_{OPA}	$V_{REF}=\frac{1}{2}V_{CC}$	$\frac{1}{2}V_{CC}-0.35$	$\frac{1}{2}V_{CC}$	$\frac{1}{2}V_{CC}+0.35$	V
Leak current	I_{LPA}		—	0.01	0.5	mA
Output total saturation voltage	V_{sat}	$I_O=200mA$	—	0.40	0.7	V

■ Electrical Characteristics (cont.) ($V_{CC}=5V$, Ta=25±2℃)

Parameter	Symbol	Condition	min	typ	max	Unit
V_{CTL1} to PA Input/Output Block						
V/I transmission gain	gm1	$R_S=1\Omega$, $R_L=10\Omega$	200	250	300	mA/V
Input offset voltage	ΔV_I	$V_{REF}=V_{CTL1}=\frac{1}{2}V_{CC}$	—	—	±30	mV
Total harmonics distortion ratio	D1	f=1kHz, I_O=0.1Arms	—	—	2	%
V_{CTL1} to OPOUT Input/Output Block						
Transmission gain	G1	$V_{REF}=\frac{1}{2}V_{CC}$	0.22	0.25	0.28	Times
Output impedance 1	V_{Z1}	$V_{REF}=\frac{1}{2}V_{CC}$ $I_O=-0.6mA$	$\frac{1}{2}V_{CC}$ -0.2	$\frac{1}{2}V_{CC}$	$\frac{1}{2}V_{CC}$ $+0.2$	V
Output impedance 2	V_{Z2}	$V_{REF}=\frac{1}{2}V_{CC}$ $I_O=-1mA$	$\frac{1}{2}V_{CC}$ -0.2	$\frac{1}{2}V_{CC}$	$\frac{1}{2}V_{CC}$ $+0.2$	V
Output amplitude	V_{OPOUT}		0.4	—	$V_{CC}-1$	V

■ Electrical Characteristics (Design Reference Values) (Ta=25±2℃)

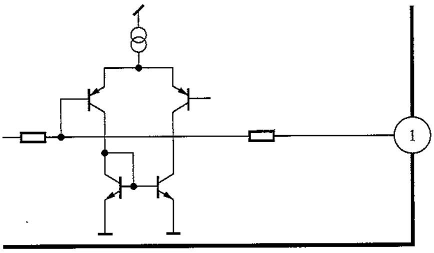
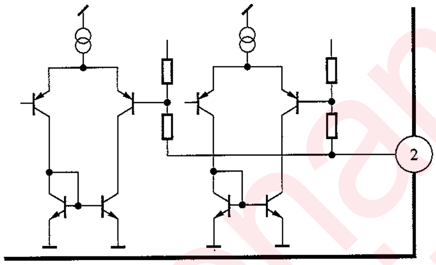
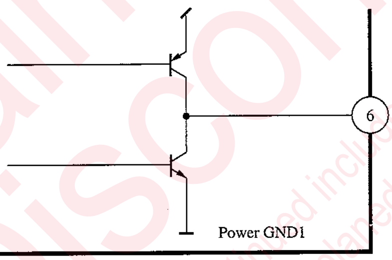
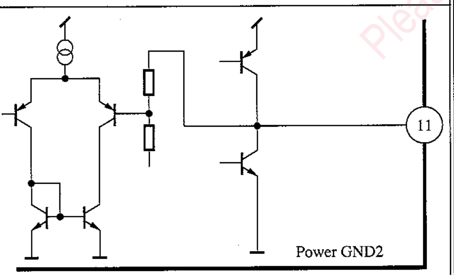
Parameter	Symbol	Condition	min	typ	max	Unit
Thermal Protection Circuit						
Thermal protection operation temperature	T_P		—	150	—	℃
Thermal protection reset temperature	T_{PR}		—	125	—	℃
V_{CTL1} to PA Input/Output Block						
Gain band width	B1	$R_S=1.0\Omega$, $R_L=10\Omega$ gm=−3dB	—	42	—	kHz
Phase shift	$\Delta\phi 1$	f=1kHz	—	1.6	—	deg
V_{CTL2} to PA Input/Output Block						
V/I transmission gain	gm2	$R_S=2\Omega$, $R_L=10\Omega$	—	500	—	mA/V
Total harmonics distortion ratio	D2	f=1kHz I_O=0.1Arms	—	0.4	—	%
Gain band width	B2	g=−3dB	—	100	—	kHz
Phase shift	$\Delta\phi 2$	f=1kHz	—	0.9	—	deg
V_{CTL1} to PA Input/Output Block						
Input voltage range 1		V_{CC}=4.5 to 5.5V	—	$\frac{1}{2}V_{CC}$	—	V

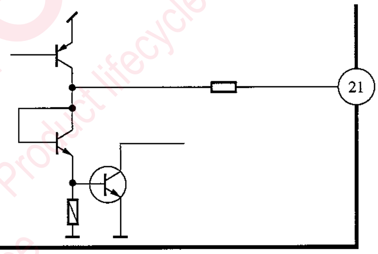
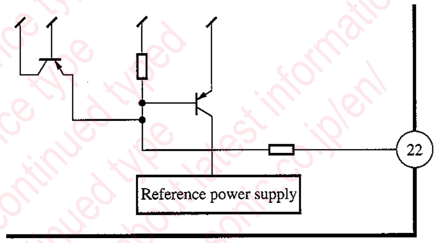
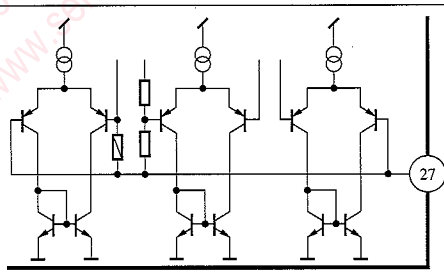
■ Pin Descriptions

Pin No.	Pin name	Function description
1	Sense+	It has double function : as feedback terminal for power amp. 1 and input terminal for power amp. 2. It should be connected to PA1 and detection resistor R_S.
2	Sense−	It is the current feedback terminal for power amp. 1. It should be connected to detection resistor R_S and VCM.
3, 4	PG	Power ground
5	NC	————
6	PA1	Output terminal for power amp. 1, which drives the voice coil motor.
7	GND	Ground terminal
8	PG	Power ground
9	PG	Power ground
10	PG	Power ground
11	PA2	Output terminal for power amp. 2, which drives the voice coil motor.
12	NC	————
13, 14	PG	Power ground
15	$V_{CC}1$	Terminal supplying the supply voltage to the power system
16	$V_{CC}2$	Terminal supplying the supply voltage to the system
17, 18	NC	————
19, 20	PG	Power ground
21	OPCE	Terminal putting the operational amp. block into a condition able to operate.
22	CE	Terminal putting the IC (chip) into a condition able to operate.
23~25	PG	Power ground
26	SG	Signal ground
27	VREF	Terminal inputting the reference voltage
28	VCTL1	Terminal inputting the control voltage
29, 30	PG	Power ground
31	OPOUT	Terminal outputting the output voltage of operational amp. It should be connected to the VCTL2 when the operation amp. is used.
32	VCTL2	It is a terminal inputting the control voltage. When the operational amp. is used, it should be connected to OPOUT. When the operational amp is not used, the control voltage is applied to this terminal.

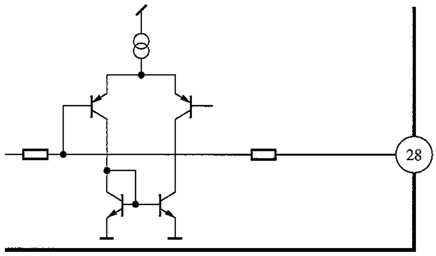
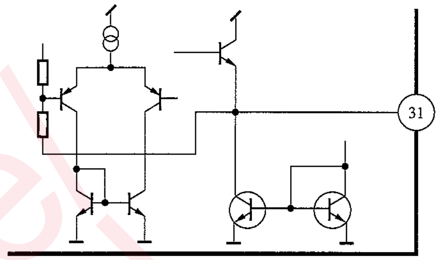
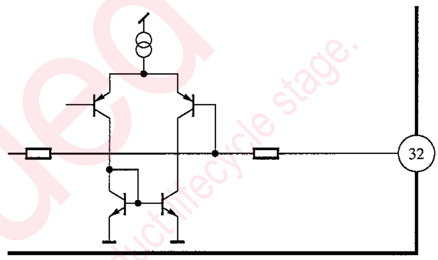
All power ground (PG) terminals should be connected to ground.

■ Pin Internal Circuit Descriptions

Pin No.	Internal circuit
1 Sense^{+}	
2 Sense^{-}	
3, 4 GND	Power ground
5 NC	
6 PAI	
7 GND	Power ground
8 PG	POWER GND
9 PG	POWER GND
10 GND	Power ground
11 PA2	

Pin No.	Internal circuit
12 NC	
13, 14 GND	Power ground
15 $V_{CC}1$	POWER V_{CC}
16 $V_{CC}2$	SIGNAL V_{CC}
17, 18 NC	
19, 20 GND	Power ground
21 OPCE	
22 CE	
23~25 GND	Power ground
26 SG	SIGNAL GND
27 V_{REF}	

■ Pin Internal Circuit Descriptions (cont.)

Pin No.	Internal circuit	Pin No.	Internal circuit
28 V_{CTL1}		31 OP_{OUT}	
29, 30 GND		32 V_{CTL2}	

■ Current Detection Resistance R_S (Application Circuit 1)

Resistance R_S is the detection resistance for current which flows in the voice coil motor and sets the gm of current feedback amp. (Power amp. 1)
(Output voltage of PA1 terminal : V_{OUT}, End to end voltage of R_S : V_S, Load current of voice coil motor : I_{OUT})

$$R_3 = R_4 = R_5 = R_6 = R$$

$$V^+ = V_{REF} + \frac{R_5}{R_5 + R_6}(V_{OUT} - V_S - V_{REF})$$

$$= \left(1 - \frac{R_5}{R_5 + R_6}\right) V_{REF} + \frac{R_5}{R_5 + R_6} V_{OUT} - \frac{R_5}{R_5 + R_6} V_S$$

$$= \frac{1}{2} V_{REF} + \frac{1}{2} V_{OUT} - \frac{1}{2} V_S \quad \cdots\cdots (1)$$

$$V^- = V_{CTL2} + \frac{R_3}{R_3 + R_4}(V_{OUT} - V_{CTL2})$$

$$= \left(1 - \frac{R_3}{R_3 + R_4}\right) V_{CTL2} + \frac{R_3}{R_3 + R_4} V_{OUT}$$

$$= \frac{1}{2} V_{CTL2} + \frac{1}{2} V_{OUT} \quad \cdots\cdots (2)$$

Since $V^+ = V^-$

$$\frac{1}{2} V_{REF} + \frac{1}{2} V_{OUT} - \frac{1}{2} V_S = \frac{1}{2} V_{CTL2} + \frac{1}{2} V_{OUT}$$

$$-V_S = V_{CTL2} - V_{REF} \quad \cdots\cdots (3)$$

Since $V_S = I_{OUT} R_S$, putting equation (3) into this equation :

$$-I_{OUT} \cdot R_S = V_{CTL2} - V_{REF} \quad \cdots\cdots (4)$$

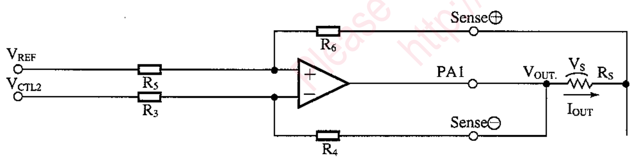
$$\frac{I_{OUT}}{V_{CTL2} - V_{REF}} = -\frac{1}{R_S} \quad \cdots\cdots (5)$$

Input voltage change $\Delta V_{IN} = \Delta(V_{CTL2} - V_{REF})$ and $gm = \dfrac{\text{Output current change } \Delta I_{OUT}}{\text{Input voltage change } \Delta V_{IN}}$

Therefore, from equation (5) :

$$gm = \frac{\Delta I_{OUT}}{\Delta V_{IN}} = \frac{\Delta I_{OUT}}{\Delta(V_{CTL2} - V_{REF})}$$

$$= -\frac{1}{R_S} \quad \cdots\cdots (6)$$



Current feedback amp.

When the operational amp. (OP) is used (Refer to Application Circuit 2),

$$V^{-}=(V_{CTL2}-V_{CTL1})\frac{R_1}{R_1+R_2}+V_{CTL1} \quad \cdots\cdots (7)$$

$$V^{+}=V_{REF} \quad \cdots\cdots (8)$$

Since $V^{+}=V^{-}$

$$V_{REF}=(V_{CTL2}-V_{CTL1})\frac{R_1}{R_1+R_2}+V_{CTL1}$$

Therefore,

$$-(V_{CTL2}-V_{CTL1})\frac{R_1}{R_1+R_2}=V_{CTL1}-V_{REF}$$

$$-(V_{CTL2}-V_{CTL1})=(V_{CTL1}-V_{REF})\frac{R1+R2}{R1}$$

$$-V_{CTL2}=(V_{CTL1}-V_{REF})\left(1+\frac{R_2}{R_1}\right)-V_{CTL1}$$

$$V_{CTL2}=V_{REF}-\frac{R_2}{R_1}(V_{CTL1}-V_{REF}) \quad \cdots\cdots (9)$$

Putting equation (9) into equation (4) :

$$-I_{OUT}\cdot R_S=V_{CTL2}-V_{REF}$$

$$=\left\{V_{REF}-\frac{R2}{R1}(V_{CTL1}-V_{REF})\right\}-V_{REF}$$

$$=-\frac{R_2}{R_1}(V_{CTL1}-V_{REF})$$

$$\frac{I_{OUT}}{V_{CTL1}-V_{REF}}=\frac{R_2}{R_1}\cdot\frac{1}{R_S} \quad \cdots\cdots (10)$$

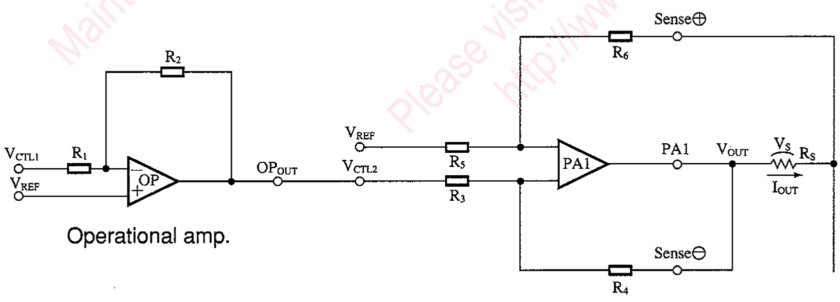
$$gm=\frac{\Delta I_{OUT}}{\Delta V_{IN}}=\frac{\Delta I_{OUT}}{\Delta(V_{CTL1}-V_{REF})}$$

$$=\frac{R_2}{R_1}\cdot\frac{1}{R_S} \quad \cdots\cdots (11)$$

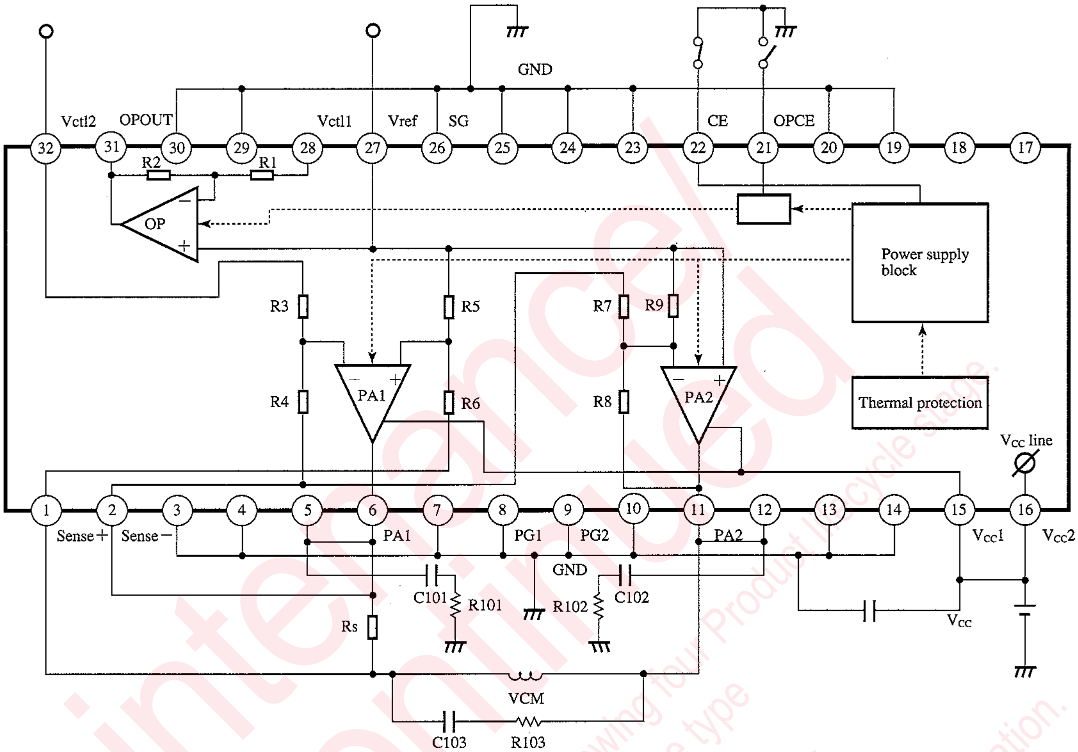
Since $R_1 : R_2=4 : 1$ is set :

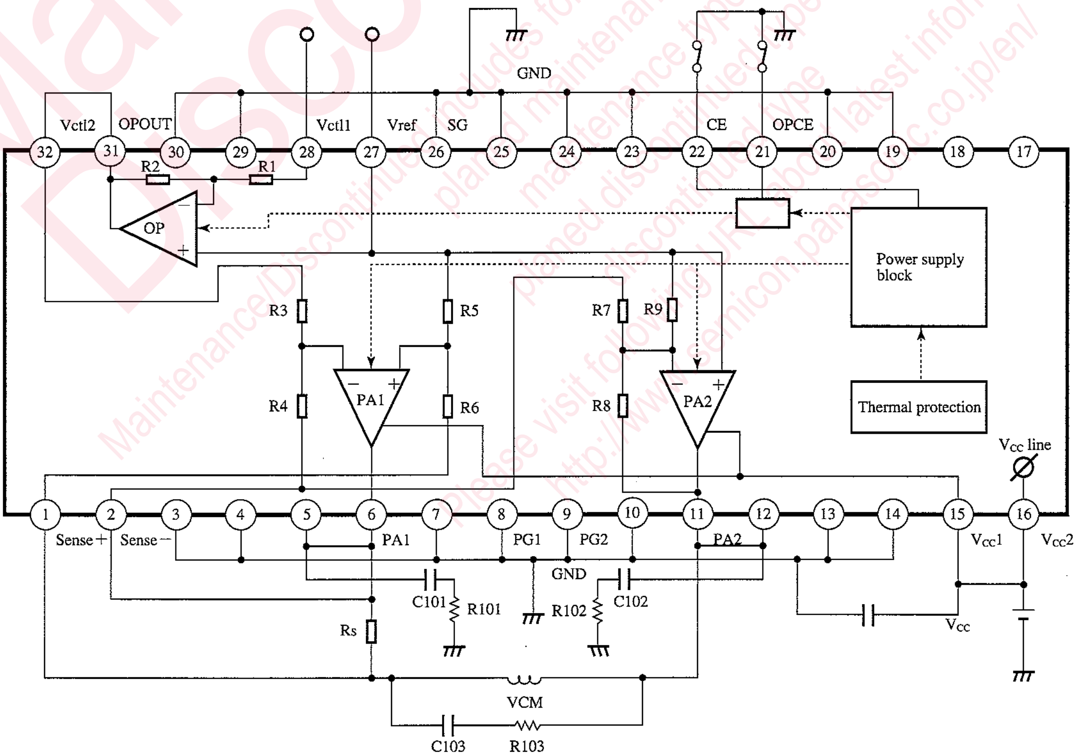
$$gm=\frac{1}{4}\cdot\frac{1}{R_S} \quad \cdots\cdots (12)$$

The sense resistance can be reduced to 1/4 when the gm is set equal to it by using the operational amp. (OP). Since the operational amp. is reversal type, the direction of output current I_{OUT} to the control voltage V_{CTL} is reversed by using the operational amp.



■ Application Circuits





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