M56789FP

4 CHANNEL ACTUATOR DRIVER

DESCRIPTION

The M56789FP is a semiconductor integrated circuit in order to drive 4ch actuator.

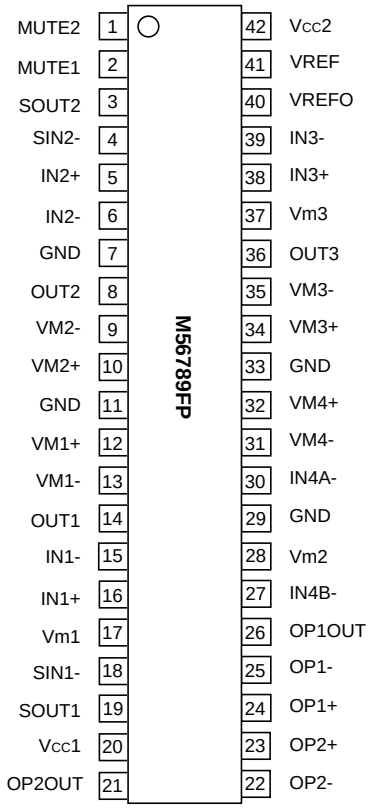
FEATURES

- Large power dissipation (Power Package).
- 3.3V DSP available.
- Low saturation voltage (typical 0.6V at load current 500mA).
- Low cross-over distortion.
- Wide supply voltage range.(4.5V–13.2V)
- Divided Motor power supplies into three parts.
- Ch1, Ch2 and Ch3 can be controlled by PWM.
- Ch1 and Ch2 can act in the Current Control mode.
- Two naked Operational Amplifiers.
- TSD(Thermal Shut Down) circuit.
- Two mute circuits.

APPLICATION

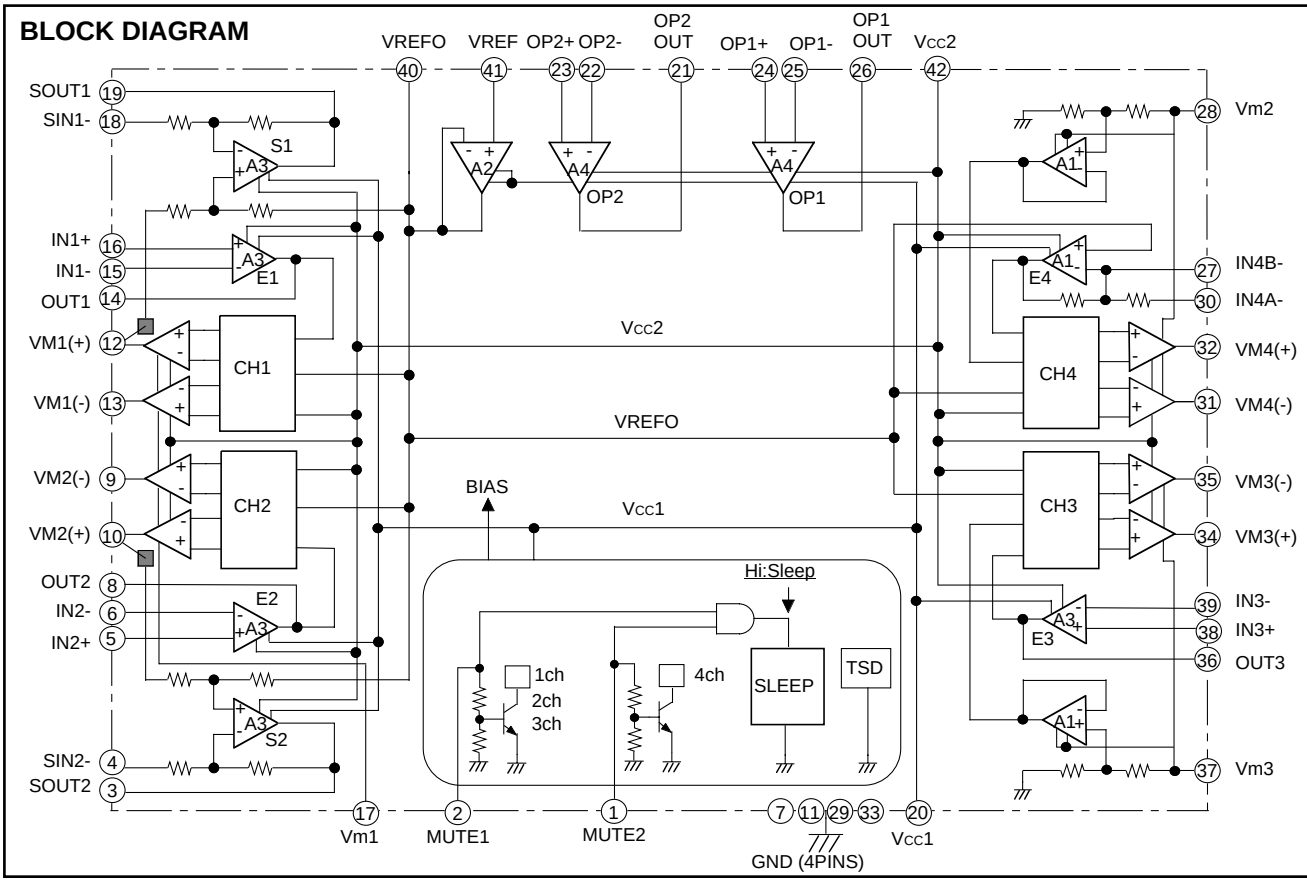
CD-ROM, DVD, DVD-ROM etc.

PIN CONFIGURATION (TOP VIEW)



Outline 42P9R-B

BLOCK DIAGRAM



PIN DESCRIPTIONS

Pin No.	Symbol	Function	Pin No.	Symbol	Function
①	MUTE2	CH4 mute	㊷	Vcc2	Bootstrap power supply
②	MUTE1	CH1,2 and 3 mute	㊶	VREF	Reference voltage input
③	SOUT2	S2 amplifier output	㊵	VREFO	Reference voltage output
④	SIN2-	S2 amplifier inverted input	㊴	IN3-	E3 amplifier inverted input
⑤	IN2+	E2 amplifier non-inverted input	㊳	IN3+	E3 amplifier non-inverted input
⑥	IN2-	E2 amplifier inverted input	㊲	Vm3	Motor power supply - 3
⑧	OUT2	E2 amplifier output	㊱	OUT3	E3 amplifier output
⑨	VM2(-)	CH2 inverted output	㉟	VM3(-)	CH3 inverted output
⑩	VM2(+)	CH2 non-inverted output	㉞	VM3(+)	CH3 non-inverted output
⑦, ⑪	GND	GND	㉙, ㉝	GND	GND
⑫	VM1(+)	CH1 non-inverted output	㉜	VM4(+)	CH4 non-inverted output
⑬	VM1(-)	CH1 inverted output	㉛	VM4(-)	CH4 inverted output
⑭	OUT1	E1 amplifier output	㉚	IN4A-	E4 amplifier low gain input
⑮	IN1-	E1 amplifier inverted input	㉘	Vm2	Motor power supply - 2
⑯	IN1+	E1 amplifier non-inverted input	㉗	IN4B-	E4 amplifier high gain input
⑰	Vm1	Motor power supply - 1	㉖	OP1OUT	OP1 amplifier output
⑱	SIN1-	S1 amplifier inverted input	㉕	OP1-	OP1 amplifier inverted input
⑲	SOUT1	S1 amplifier output	㉔	OP1+	OP1 amplifier non-inverted input
⑳	Vcc1	5V power supply	㉓	OP2+	OP2 amplifier non-inverted input
㉑	OP2OUT	OP2 amplifier output	㉒	OP2-	OP2 amplifier inverted input

ABSOLUTE MAXIMUM RATING (Ta=25˚C)

Symbol	Parameter	Conditions	Rating	Unit
Vcc2	Bootstrap power supply	㊷ pin input voltage	15	V
Vm	Motor power supply	⑰, ㉘ and ㊲ pins input voltage	15	V
Vcc1	5V power supply	⑳ pin input voltage	7.0	V
Io	Output Current		700	mA
Vin1	Maximum input voltage of terminals	①,②,⑤,⑥, ⑮, ⑯, ㉒, ㉓, ㉔, ㉕, ㉗, ㉚, ㉘, ㉙, ㊶ pins	0 – Vcc1	V
Vin2		④, ⑱ pins	0 – Vm1	
Pt	Power dissipation	Free Air	1.2	W
Kθ	Thermal derating	Free Air	9.6	mW / ˚C
Tj	Junction temperature		150	˚C
Topr	Operating temperature		-20 – +75	˚C
Tstg	Storage temperature		-40 – +150	˚C

RECOMMENDED OPERATING CONDITIONS

Symbol	Parameter	Limits			Unit
		Min.	Typ.	Max.	
Vcc1	5V power supply	4.5	5.0	5.5	V
Vcc2	Bootstrap power supply		Vm + 1.0		V
Vm1, 2, 3	Motor power supply-1, 2, 3		5.0		V

ELECTRICAL CHARACTERISTICS

(Ta=25˚C, Vcc1=Vm1=Vm2=Vm3=5V,Vcc2=12V, no-load current unless otherwise noted.)

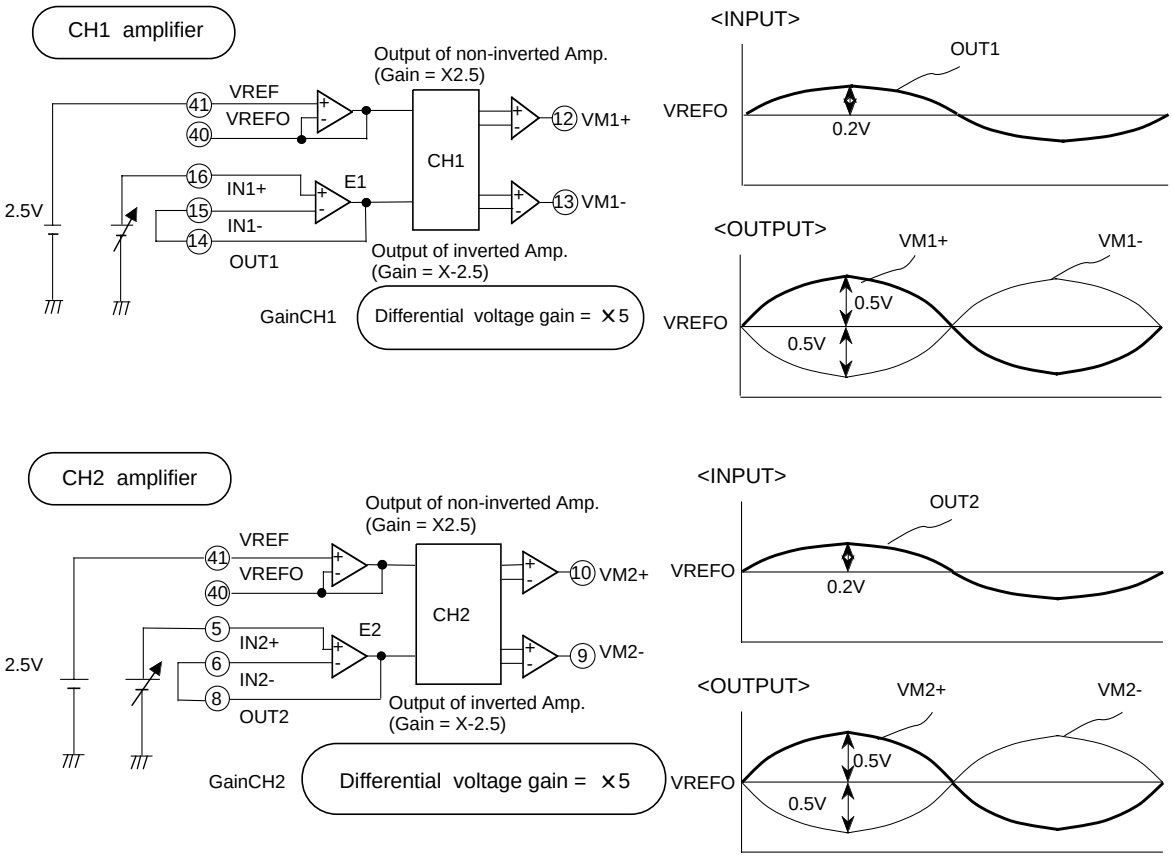
Symbol	Parameter	Conditions	Limits			Unit
			Min.	Typ.	Max.	
Icc1	Supply current - 1	⑰,㉘,㊲,㊷ pins supply current (Vref=Vctl=2.5V)	——	24	36	mA
Icc2	Supply current - 2	⑳ pin[Vcc1] supply current (Vref=Vctl=2.5V)	——	9.5	15	mA
Icc3	Sleep Mode Supply current - 3	⑰,⑳,㉘,㊲,㊷ pins supply current (MUTE1,2=H)	——	——	500	μA
VsatCH1	Ch1 Saturation voltage	Top and Bottom saturation voltage. Load current 500mA. At bootstrap.	——	0.85	1.28	V
VsatCH2	Ch2 Saturation voltage		——	0.85	1.28	V
VsatCH3	Ch3 Saturation voltage		——	0.6	0.9	V
VsatCH4	Ch4 Saturation voltage		——	0.7	1.0	V
Vmute-on	Mute-on voltage	Mute-on	2.0	——	——	V
Vmute-off	Mute-off voltage	Mute-off	——	——	0.8	V
Imute	Mute terminals input current	①and② pin input current at 5V input voltage.	——	170	250	μA
VinOP	OP1 and OP2 amplifier Input voltage range		0.5	——	Vcc2-1.0	V
VoutOP	OP1 and OP2 amplifier output voltage range	Io= ±2.0mA	0.5	——	Vcc1-0.5	V
VofOP	OP1 and OP2 amplifier input offset voltage	Vin = 2.5V(at buffer)	-10	——	+10	mV
IinOP	OP1 and OP2 amplifier input current	inverted input = non-inverted input =2.5V	-1.0	-0.15	0	μA
IofOP	OP1 and OP2 amplifier input current offset	inverted input = non-inverted input =2.5V	-100	0	+100	nA
GBOP	OP1 and OP2 amplifier GB		2.3	4	——	MHz
VinE	E1,E2 and E3 amplifier Input voltage range		0.5	——	Vcc2-2.0	V
VoutE	E1,E2 and E3 amplifier output voltage range	No load	1.0	——	Vcc1-0.5	V
VofE	E1,E2 and E3 amplifier input offset voltage	Vin = 2.5V(at buffer)	-10	——	+10	mV
IinE	E1,E2 and E3 amplifier input current	inverted input = non-inverted input =2.5V	-1.0	-0.15	0	μA
IofE	E1,E2 and E3 amplifier input current offset	inverted input = non-inverted input =2.5V	-100	0	+100	nA
VoutS	S1 and S2 amplifier output voltage range	No load	1.0	——	Vcc1-0.5	V
VinVREF	VREF buffer amplifier Input voltage range		1.5	2.5	Vcc1-1.2	V
VofVREF	VREF buffer amplifier offset voltage	㊶ pin input voltage = 2.5V	-10	——	+10	mV
VofCH1	Ch1 output offset voltage	VREFO = OUT1 = 2.5V when the OUT1 voltage is adjusted at the same VREFO voltage, at VREF= 2.5V	-26	——	+26	mV
VofCH2	Ch2 output offset voltage	VREFO = OUT2 = 2.5V when the OUT2 voltage is adjusted at the same VREFO voltage, at VREF= 2.5V	-26	——	+26	mV
VofCH3	Ch3 output offset voltage	VREFO = OUT3 = 2.5V when the OUT3 voltage is adjusted at the same VREFO voltage, at VREF= 2.5V	-26	——	+26	mV
VofCH4	Ch4 output offset voltage	VREFO = IN4A- = 2.5V when the IN4A- voltage is adjusted at the same VREFO voltage, at VREF= 2.5V	-26	——	+26	mV
VofS1	S1 output offset voltage	SOUT1-VREFO (at SI N1[-] = VM1[+]) at VREF = 2.5V	-20	——	+20	mV
VofS2	S2 output offset voltage	SOUT2-VREFO (at SI N2[-] = VM2[+]) at VREF = 2.5V	-20	——	+20	mV

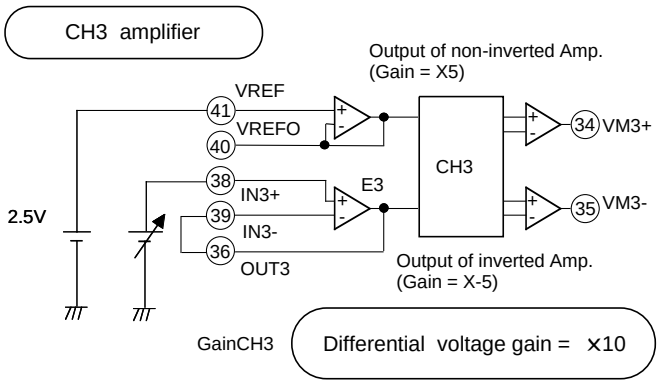
ELECTRICAL CHARACTERISTICS

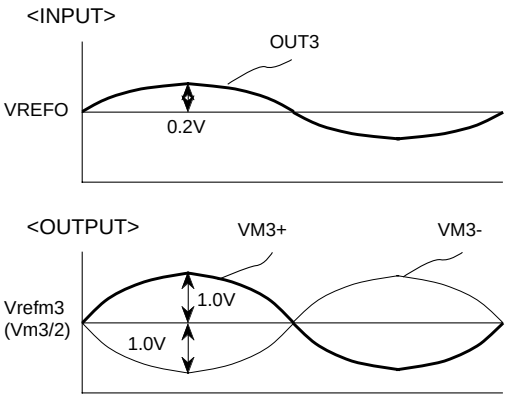
(Ta=25˚C, Vcc1=Vm1=Vm2=Vm3=5V,Vcc2=12V, no-load current unless otherwise noted.)

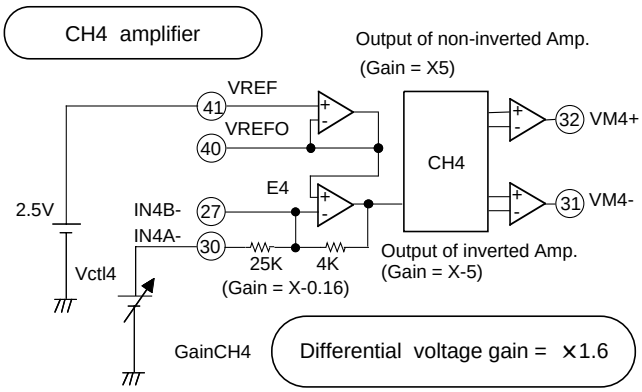
Symbol	Parameter	Conditions	Limits			Unit
			Min.	Typ.	Max.	
GainCH1	Ch1 power amplifier voltage gain	$\frac{\{VM1(+) - VM1(-)\}}{(OUT1 - VREFO)}$ at VREF=2.5V	13.1	14	14.8	dB
GainCH2	Ch2 power amplifier voltage gain	$\frac{\{VM2(+) - VM2(-)\}}{(OUT2 - VREFO)}$ at VREF=2.5V	13.1	14	14.8	dB
GainCH3	Ch3 power amplifier voltage gain	$\frac{\{VM3(+) - VM3(-)\}}{(OUT3 - VREFO)}$ at VREF=2.5V	19.1	20	20.8	dB
GainCH4	Ch4 power amplifier voltage gain	$\frac{-1 \bullet \{VM4(+) - VM4(-)\}}{(I\ N4A[-] - VREFO)}$ at VREF=2.5V	3.17	4.08	4.91	dB
GainS1	S1 amplifier voltage gain	$\frac{\{SOUT1 - VREFO\}}{(VM1[+] - SI\ N1[-])}$ at VREF=2.5V	5.11	6.02	6.85	dB
GainS2	S2 amplifier voltage gain	$\frac{\{SOUT2 - VREFO\}}{(VM2[+] - SI\ N2[-])}$ at VREF=2.5V	5.11	6.02	6.85	dB

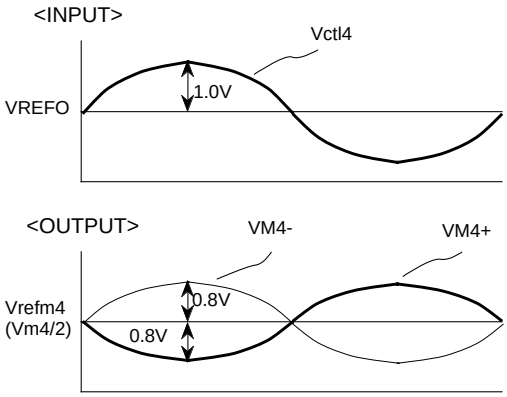
INPUT and OUTPUT CHARACTERISTICS of EACH CHANNELS



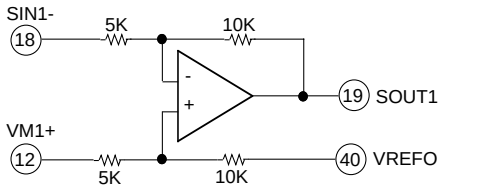

CH3 amplifier
Output of non-inverted Amp.
(Gain = X5)
VREF
41
VREFO
40
38
IN3+
39
IN3-
36
OUT3
E3
CH3
34
VM3+
35
VM3-
2.5V
Output of inverted Amp.
(Gain = X-5)
GainCH3
Differential voltage gain = ×10


<INPUT>
OUT3
VREFO
0.2V
<OUTPUT>
VM3+
VM3-
Vrefm3
(Vm3/2)
1.0V
1.0V

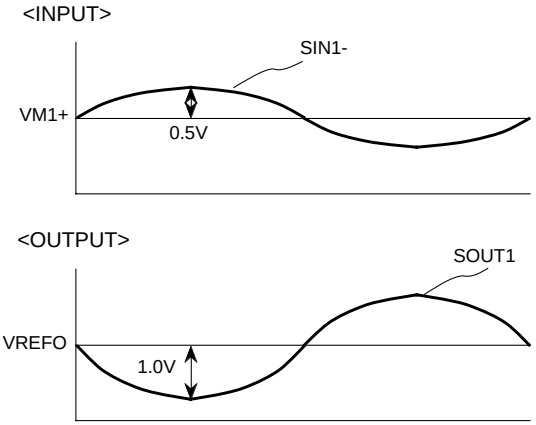

CH4 amplifier
Output of non-inverted Amp.
(Gain = X5)
VREF
41
VREFO
40
E4
CH4
32
VM4+
31
VM4-
2.5V
IN4B-
27
IN4A-
30
25K
4K
(Gain = X-0.16)
Vctl4
Output of inverted Amp.
(Gain = X-5)
GainCH4
Differential voltage gain = ×1.6


<INPUT>
Vctl4
VREFO
1.0V
<OUTPUT>
VM4-
VM4+
Vrefm4
(Vm4/2)
0.8V
0.8V

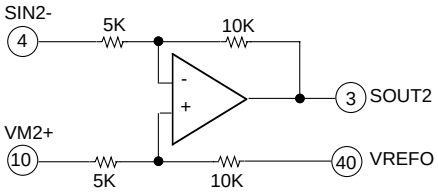
S1 amplifier



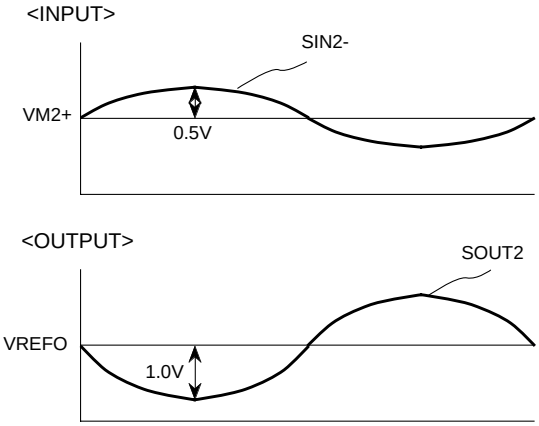
GainS1 Voltage gain = ×2



S2 amplifier

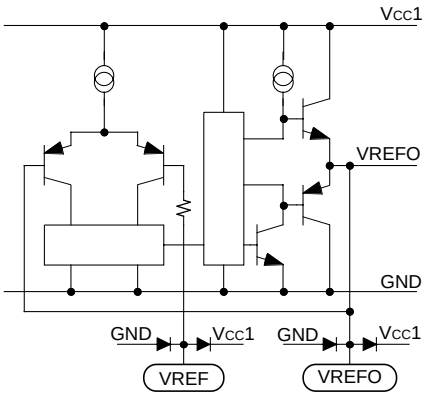


GainS2 Voltage gain = ×2

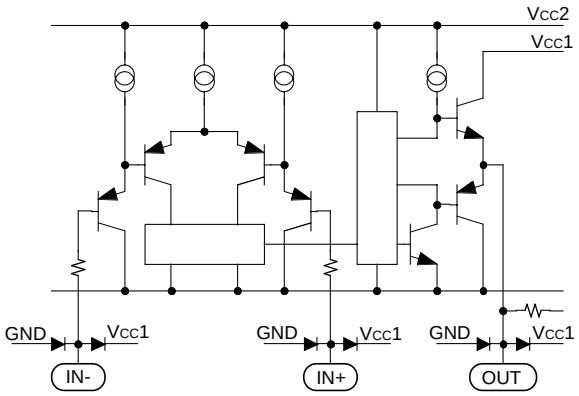


I/O terminal equivalent circuit

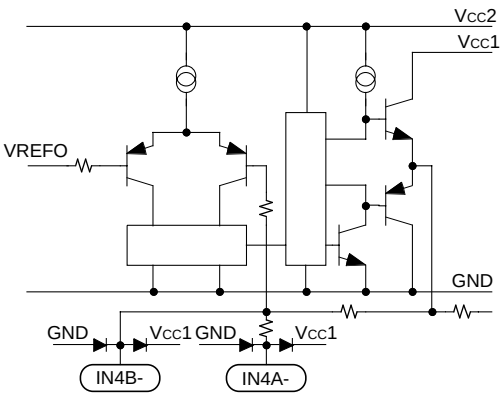
(1)VREF amplifier I/O terminal equivalent circuit
(VREF, VREFO)



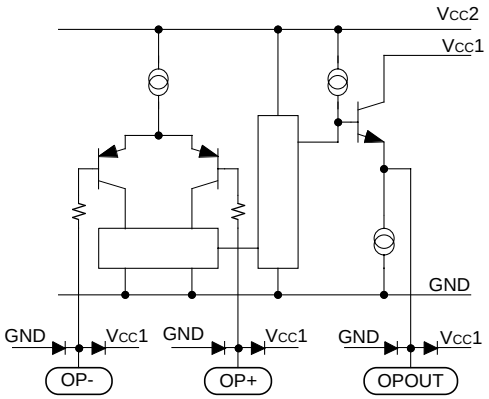
(2)E1,E2,E3 amplifier I/O terminal equivalent circuit
(IN1+, IN1-, OUT1, IN2+, IN2-, OUT2, IN3+, IN3-, OUT3)



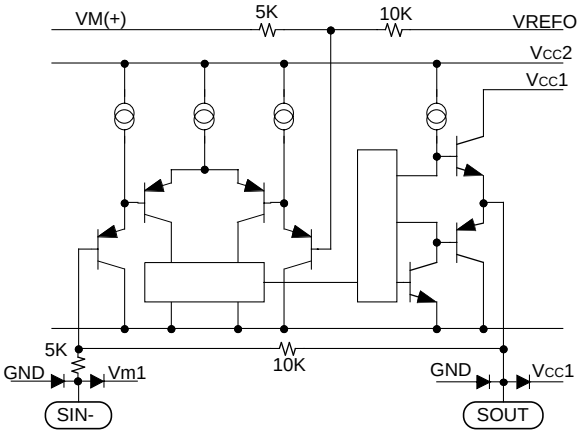
(3)E4 amplifier I/O terminal equivalent circuit
(IN4A-, IN4B-)



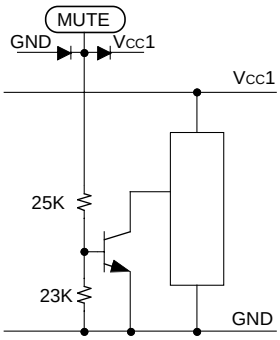
(4)OP1, OP2 amplifier I/O terminal equivalent circuit
(OP1+, OP1-, OP1OUT, OP2+, OP2-, OP2OUT)



(5)S1,S2 amplifier I/O terminal equivalent circuit
(SIN1-, SOUT1, SIN2-, SOUT2)

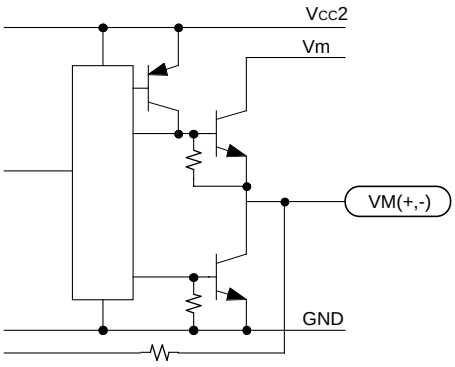


(6)MUTE circuits equivalent circuit
(MUTE1, MUTE2)



I/O terminal equivalent circuit

(7)CH1,2,3,4 power amplifier
OUTPUT terminal equivalent circuit
(VM1(+), VM1(-), VM2(+), VM2(-),
VM3(+), VM3(-), VM4(+), VM4(-),)



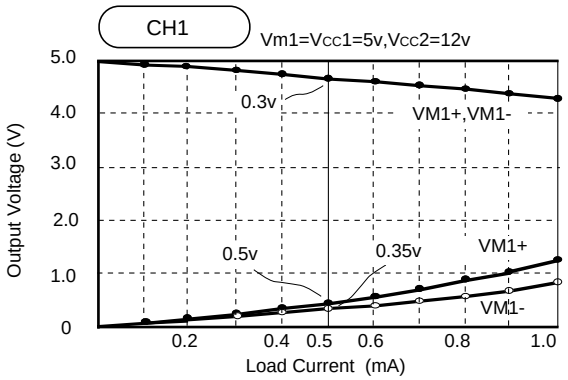
The equivalent circuits of an output stage of the power amplifier are shown in (7) .
The power supplies of CH1,CH2 are Vm1.
The power supply of CH3 is Vm3, and the power supply of CH4 is Vm2.
The source side of the power amplifier output stage consists of a PNP and a NPN. The emitta of the PNP is connected to Vcc2. So the power supplies of the PNP can be adjusted externally.

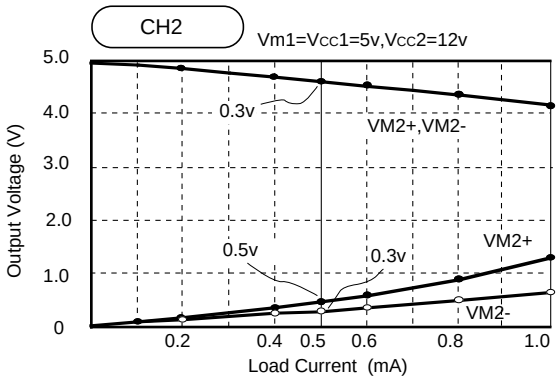
[About bootstrap advantage]
The output stage of the power amplifier consists of the preceding components. If Vcc2 is provided with higher voltage input than Vm* (The recommendation voltage is Vm*+1V) externally, the output range can be wider than that of Vcc2=Vm*.
Please take advantage of this bootstrap function for the system which has many power supplies. And it is the same with the external bootstrap circuit which provides Vcc2 with higher voltage inputs than Vm*.
Also the bootstrap can decrease the saturation voltage at the source side of the power amplifier output stage. Therefore, when the outputs of the power amplifiers which drive motors and actuators are fully swung, the power dissipation of the IC will be decreased.

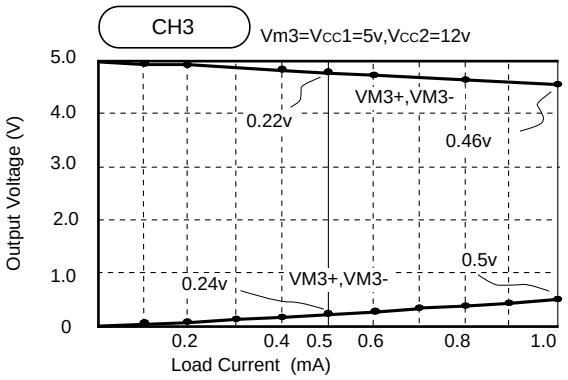
BASICALLY CHARACTERISTICS

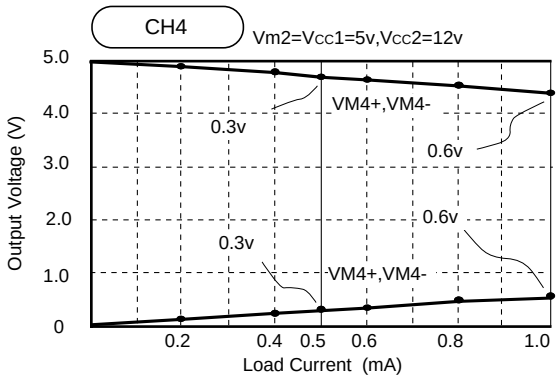
Output saturation voltage and Load current characteristic.
This data is an example for typical sample.

BOOTSTRAP

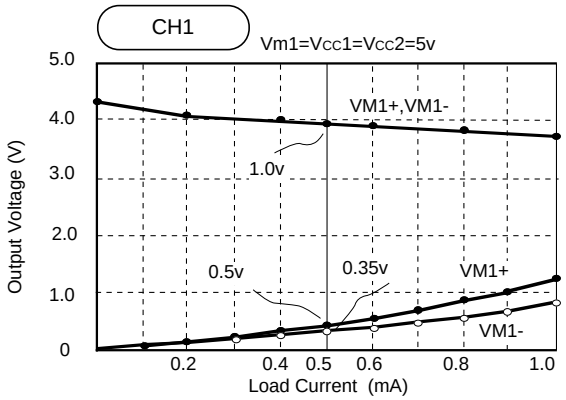


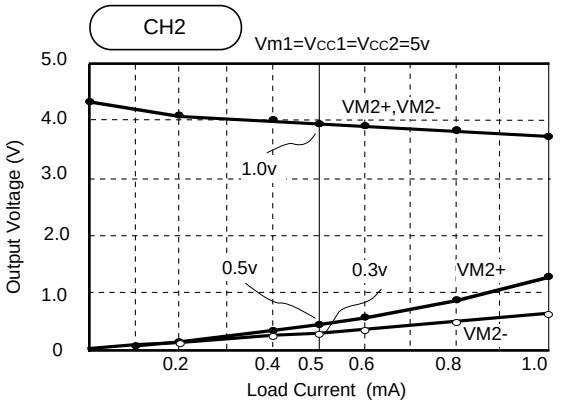


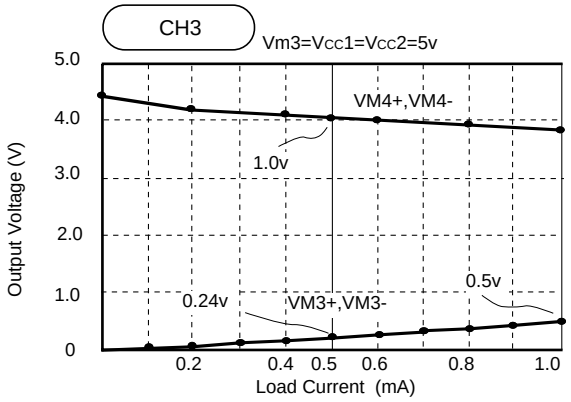


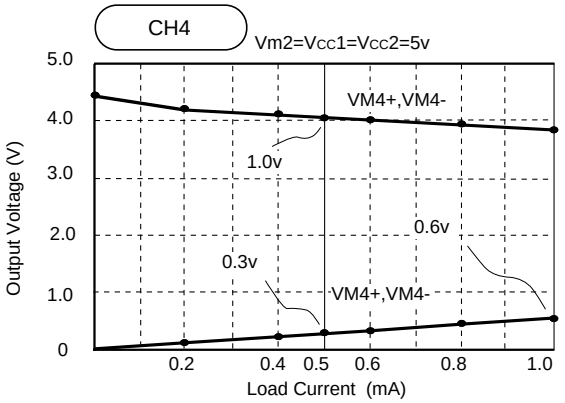


NON-BOOTSTRAP

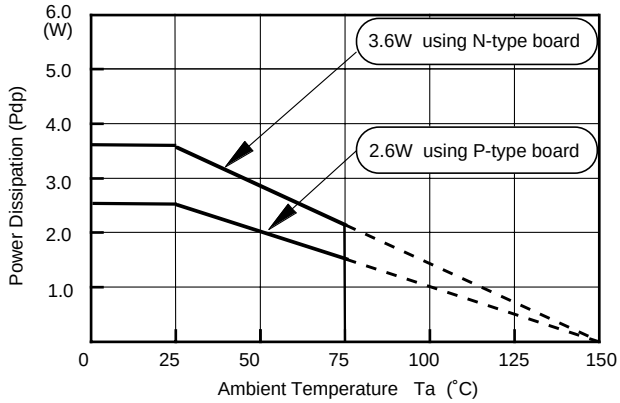








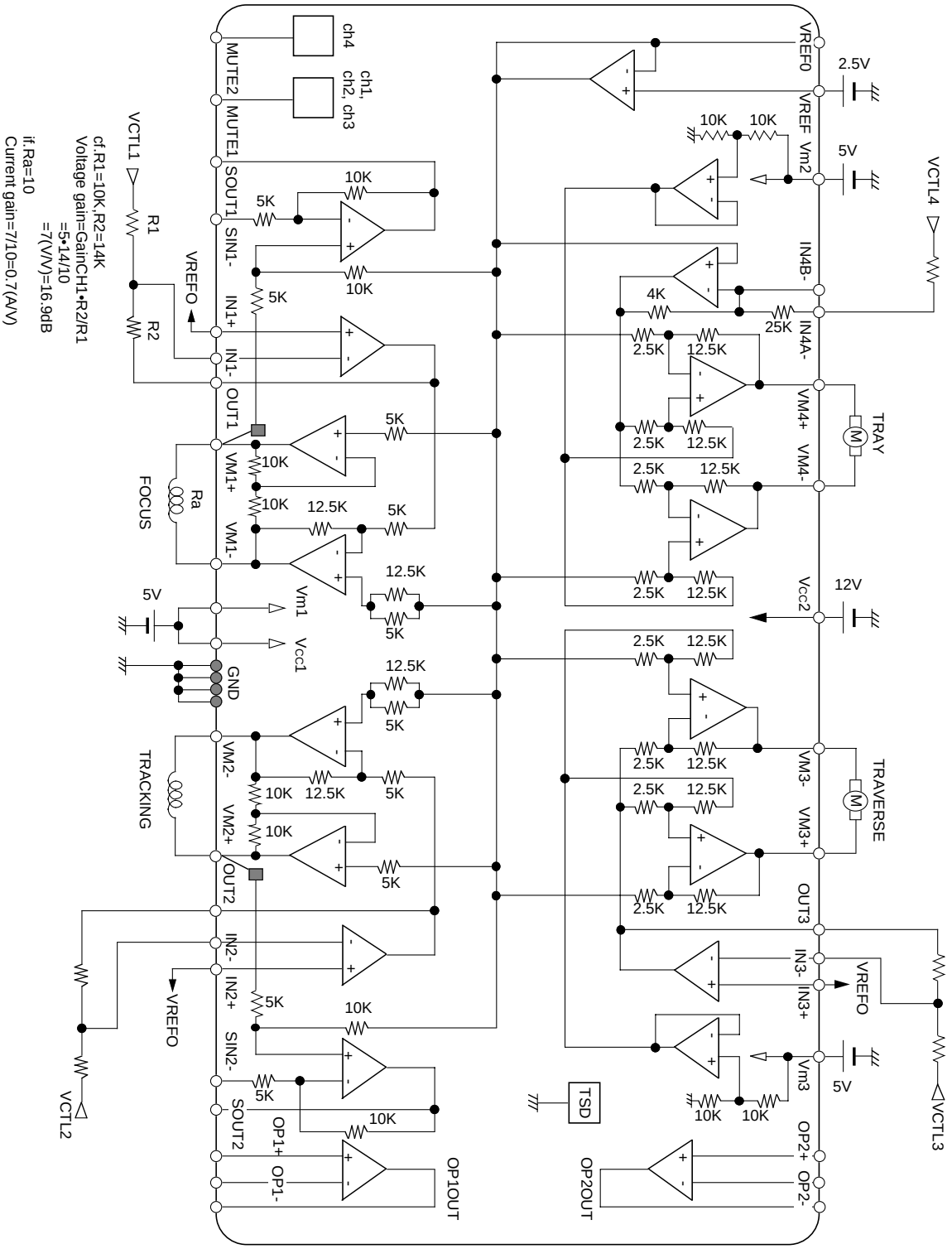
THERMAL DERATING



This IC's package is POWER-SSOP, so improving the board on which the IC is mounted enables a large power dissipation without a heat sink.
For example, using an 1 layer glass epoxy resin board, the IC's power dissipation is 2.6W at least. And it comes to 3.6W by using an improved 2 layer board.
The information of the N, P type board is shown in the board information.

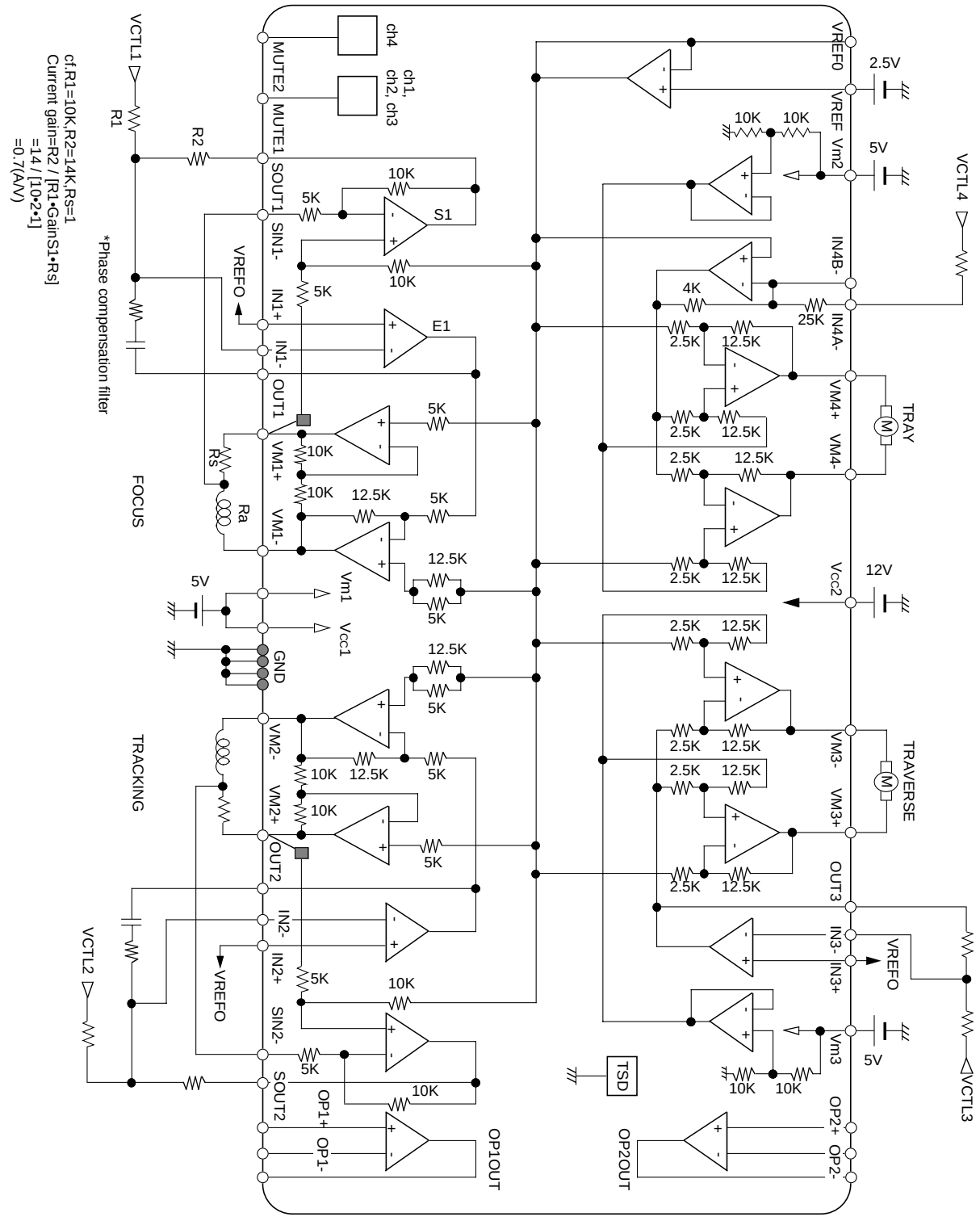
APPLICATION CIRCUIT No.1

* single input (linear signal)
* Direct voltage control



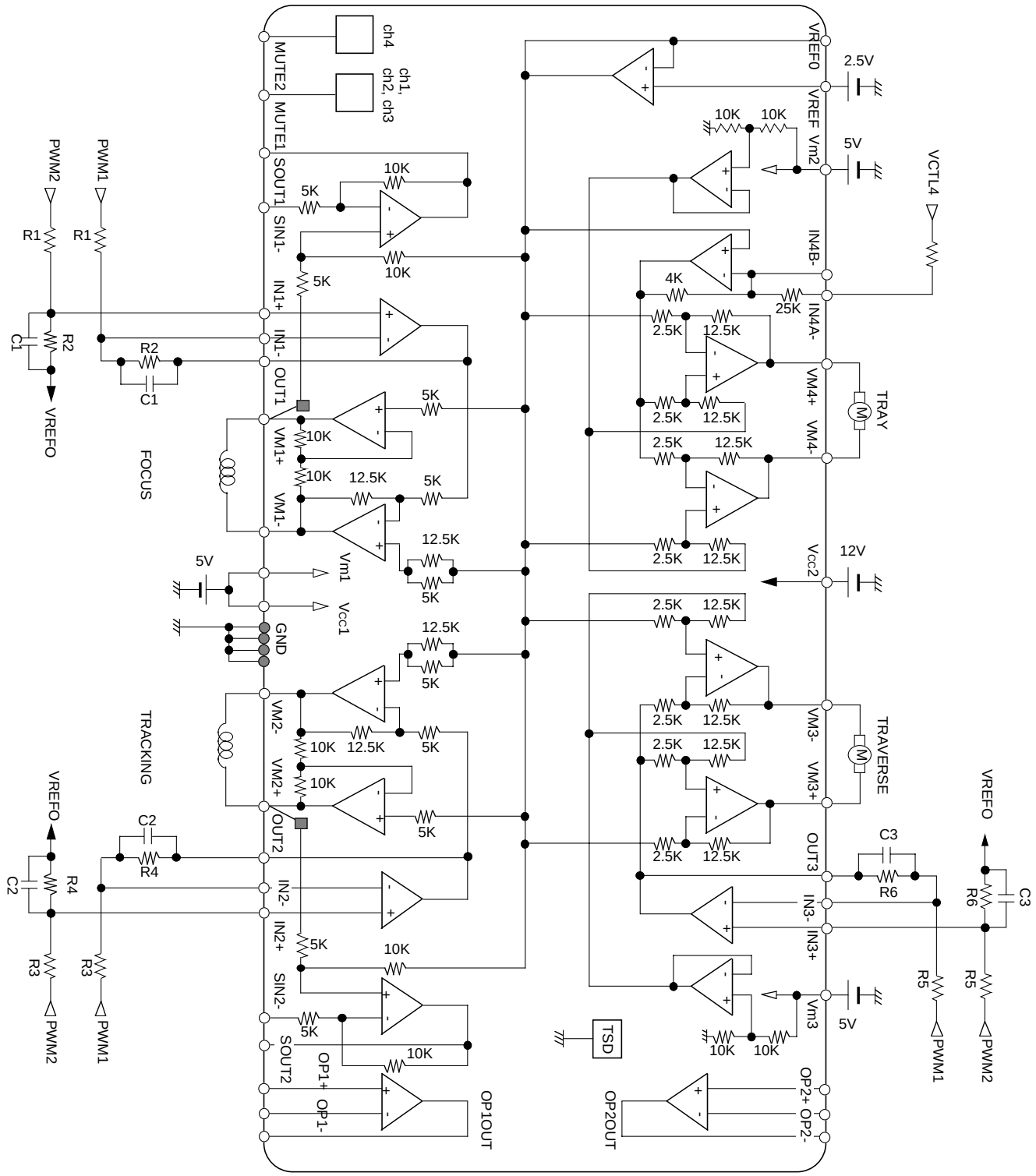
APPLICATION CIRCUIT No.2

* single input (linear signal)
* Direct current control (for FOCUS and TRACKING)



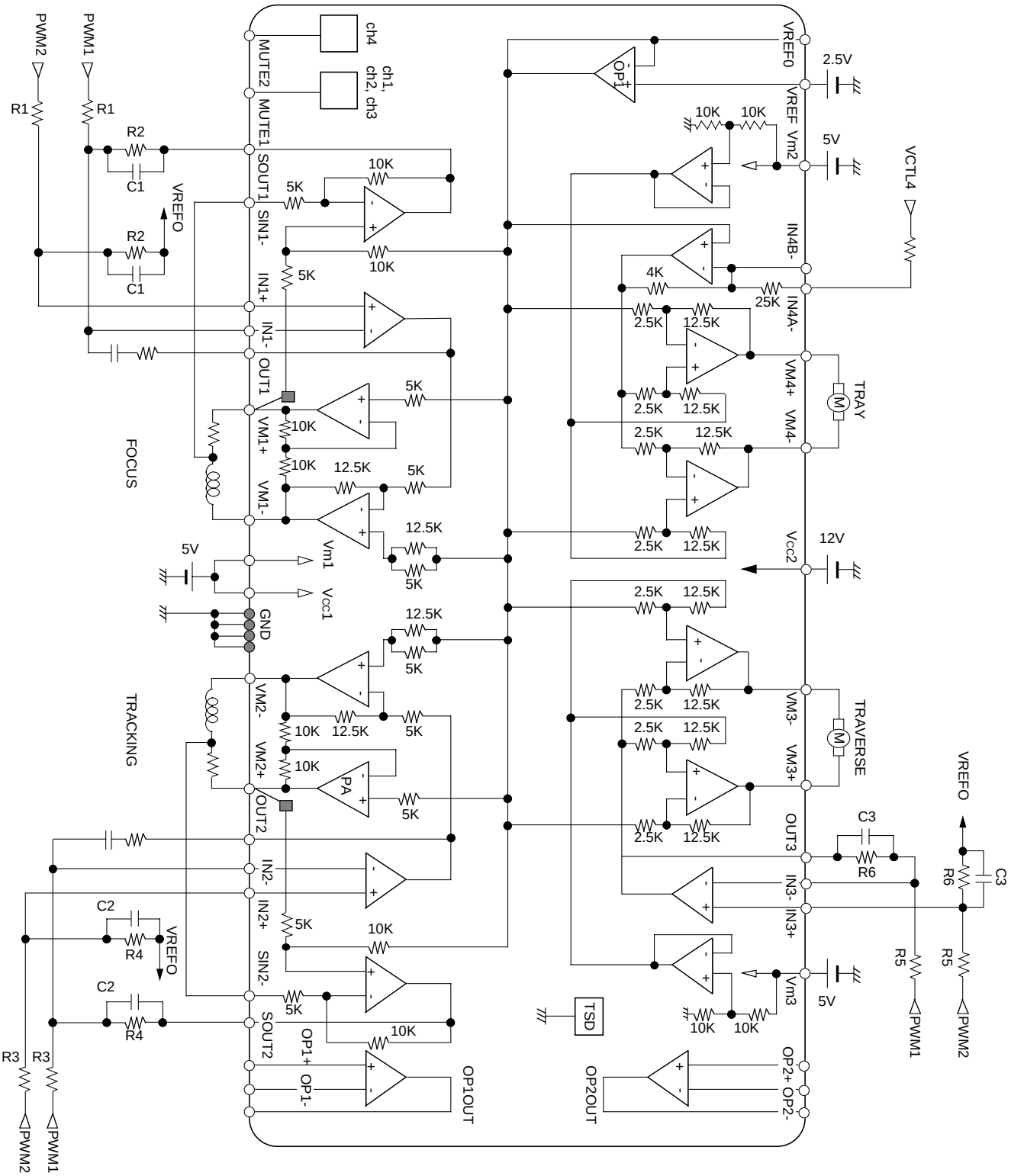
APPLICATION CIRCUIT No.3

* Differential PWM input (for FOCUS,TRACKING and TRAVERSE)
* Direct voltage control



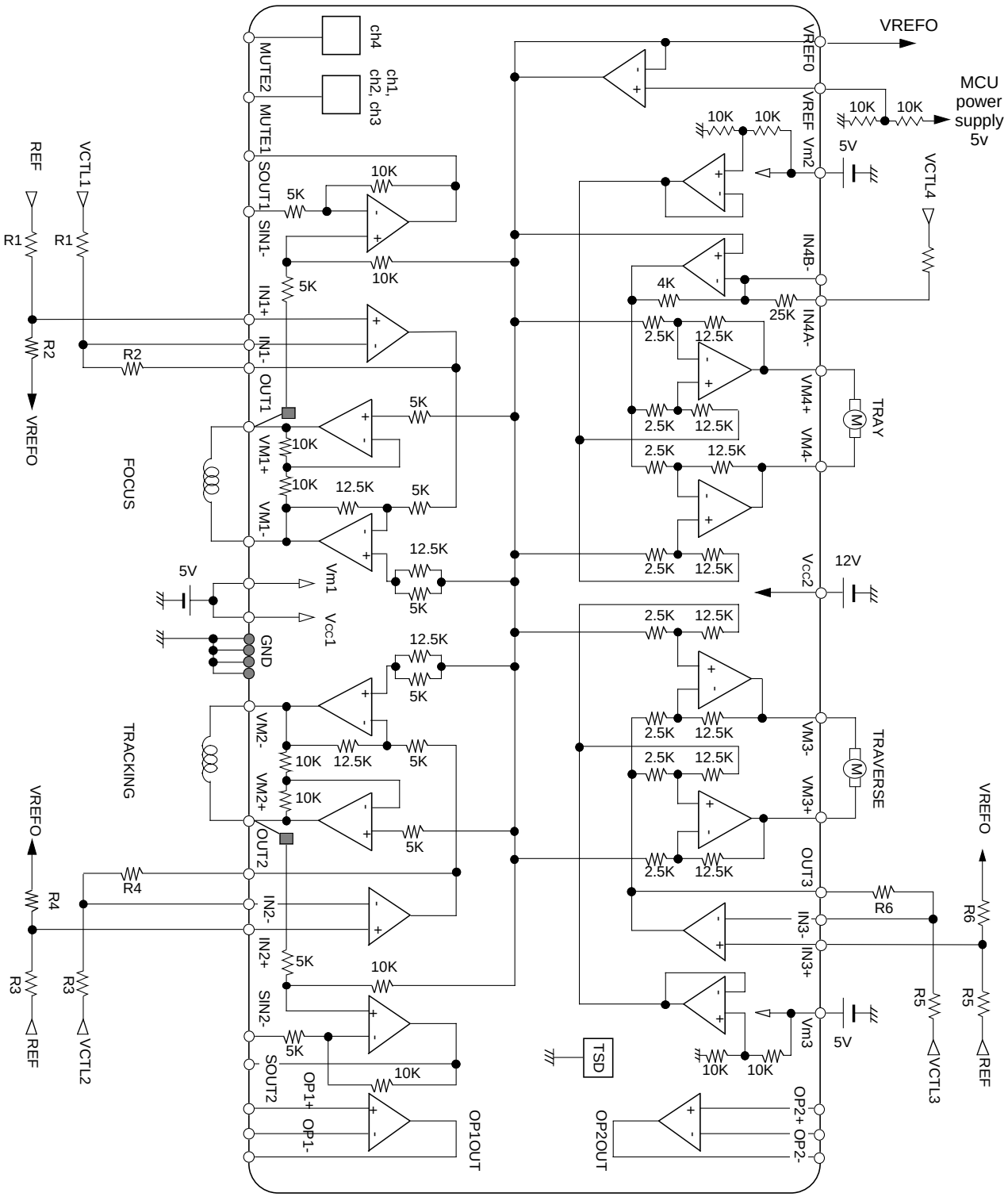
APPLICATION CIRCUIT No.4

* Differential PWM input (for FOCUS,TRACKING and TRAVERSE)
* Direct current control (for FOCUS and TRACKING)



APPLICATION CIRCUIT No.5 (for 3.3V DSP)

* single input (linear signal)
* Direct voltage control



APPLICATION CIRCUIT No.6 (for 3.3V DSP)

* single input (linear signal)
* Direct current control (for FOCUS and TRACKING)