FAN8035

6-CH Motor Driver

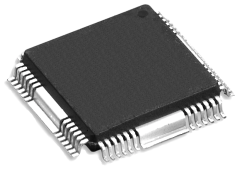
Features

- 5-CH balanced transformerless (BTL) driver
- 1-CH (forward reverse) control DC motor driver
- Operating supply voltage (4.5 V ~ 13.2 V)
- Built in thermal shut down circuit (TSD)
- Built in channel mute circuit
- Built in power save mode circuit
- Built in TSD monitor circuit
- Built in 2-OP AMPs

Description

The FAN8035 is a monolithic integrated circuit suitable for a 6-CH motor driver which drives the tracking actuator, focus actuator, sled motor, spindle motor, and tray motor of the CDP/CAR-CD/DVDP systems.

48-QFPH-1414



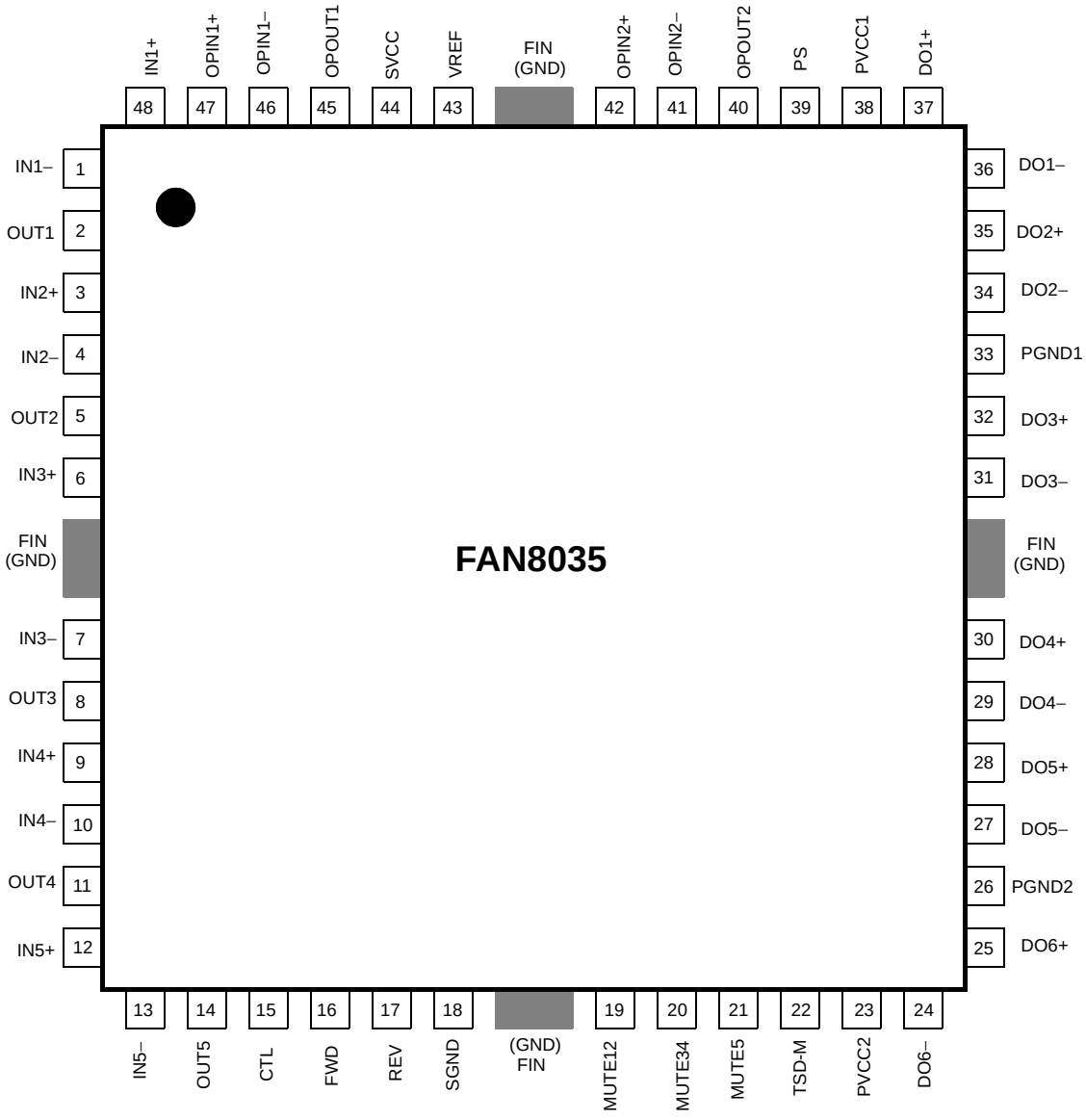
Typical Application

- Compact disk player
- Video compact disk player
- Car compact disk player
- Digital video disk player

Ordering Information

Device	Package	Operating Temperature
FAN8035	48-QFPH-1414	−35°C ~ +85°C
FAN8035L (Lead Free)	48-QFPH-1414	−35°C ~ +85°C

Pin Assignments



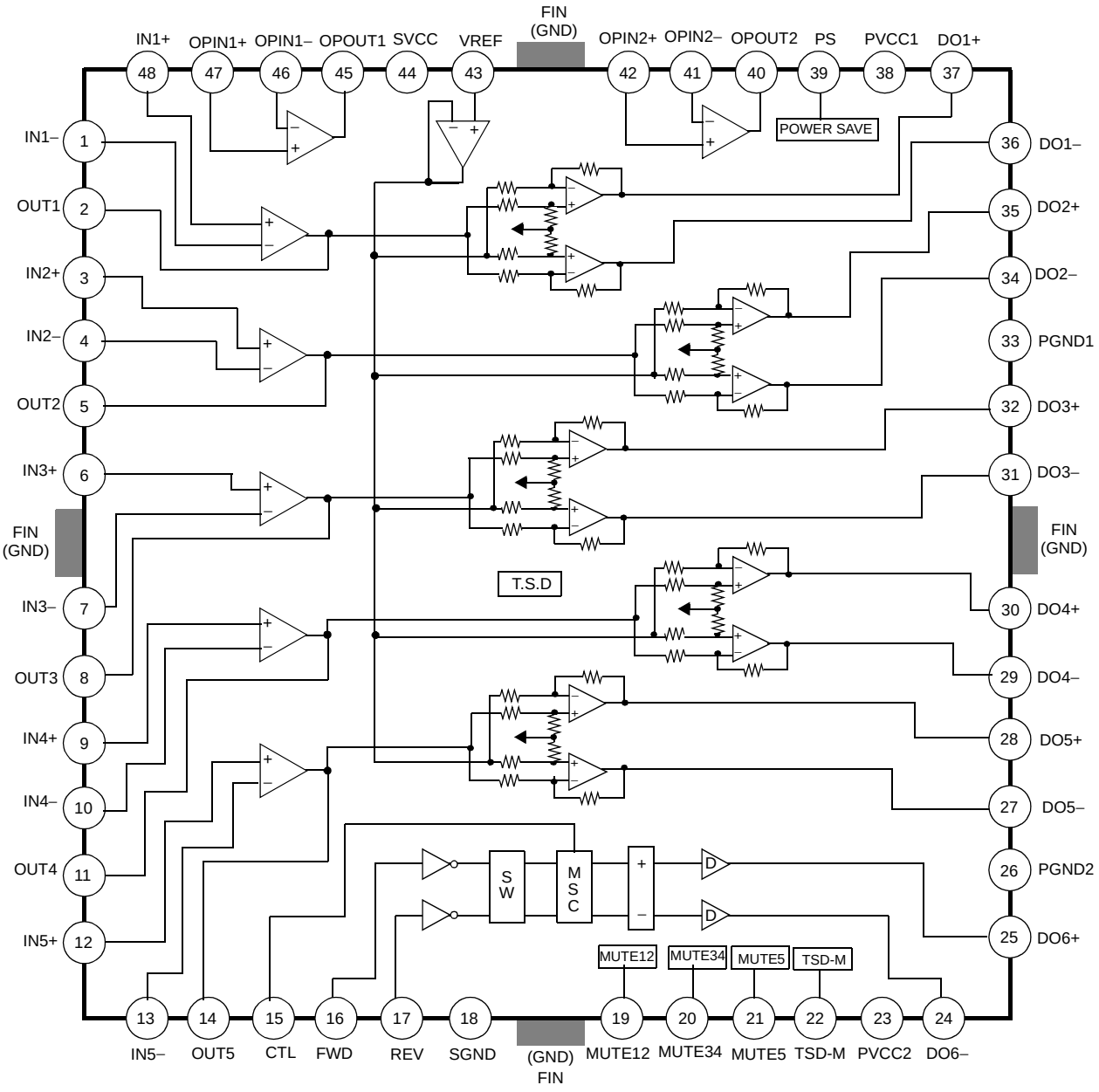
Pin Definitions

Pin Number	Pin Name	I/O	Pin Function Descrition
1	IN1–	I	CH1 op-amp input (–)
2	OUT1	O	CH1 op-amp output
3	IN2+	I	CH2 op-amp input (+)
4	IN2–	I	CH2 op-amp input (–)
5	OUT2	O	CH2 op-amp output
6	IN3+	I	CH3 op-amp input (+)
7	IN3–	I	CH3 op-amp input (–)
8	OUT3	O	CH3 op-amp output
9	IN4+	I	CH4 op-amp input (+)
10	IN4–	I	CH4 op-amp input (–)
11	OUT4	O	CH4 op-amp output
12	IN5+	I	CH5op-amp input (+)
13	IN5–	I	CH5 op-amp input (–)
14	OUT5	O	CH5 op-amp output
15	CTL	I	CH6 motor speed control
16	FWD	I	CH6 forward input
17	REV	I	CH6 reverse input
18	SGND	-	Signal ground
19	MUTE12	I	Mute for CH1,2
20	MUTE34	I	Mute for CH3,4
21	MUTE5	I	Mute for CH5
22	TSD-M	O	TSD monitor
23	PVCC2	-	Power supply voltage 2 (For CH3,CH4,CH5, CH6)
24	DO6–	O	CH6 drive ouptut (–)
25	DO6+	O	CH6 drive output (+)
26	PGND2	-	Power ground 2 (FOR CH3,CH4,CH5, CH6)
27	DO5–	O	CH5 drive ouptut (–)
28	DO5+	O	CH5 drive output (+)
29	DO4–	O	CH4 drive ouptut (–)
30	DO4+	O	CH4 drive output (+)
31	DO3–	O	CH3 drive ouptut (–)
32	DO3+	O	CH3 drive output (+)

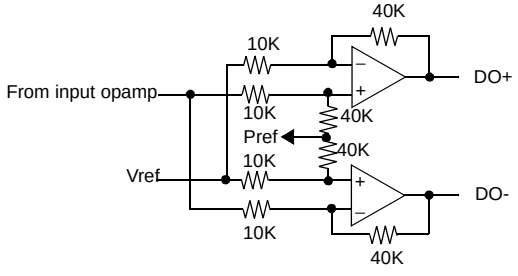
Pin Definitions (Continued)

Pin Number	Pin Name	I/O	Pin Function Descrition
33	PGND1	-	Power ground 1 (FOR CH1, CH2)
34	DO2–	O	CH2 drive ouptut (–)
35	DO2+	O	CH2 drive output (+)
36	DO1–	O	CH1 drive ouptut (–)
37	DO1+	O	CH1 drive output (+)
38	PVCC1	-	Power supply voltage 1 (FOR CH1, CH2)
39	PS	I	Power save
40	OPOUT2	O	Normal op-amp2 output
41	OPIN2–	I	Normal op-amp2 input (–)
42	OPIN2+	I	Normal op-amp2 input (+)
43	VREF	I	Bias voltage input
44	SVCC	-	Signal & OPAMPs supply voltage
45	OPOUT1	O	Normal op-amp1 output
46	OPIN1–	I	Normal op-amp1 input (–)
47	OPIN1+	I	Normal op-amp1 input (+)
48	IN1+	I	CH1 op-amp intput (+)

Internal Block Diagram

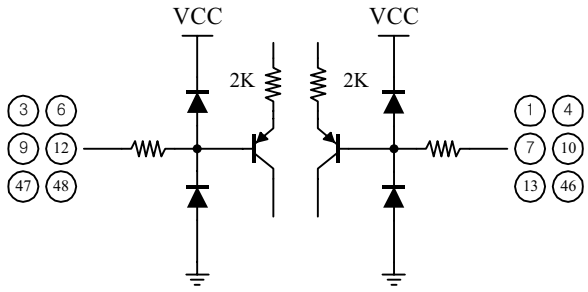
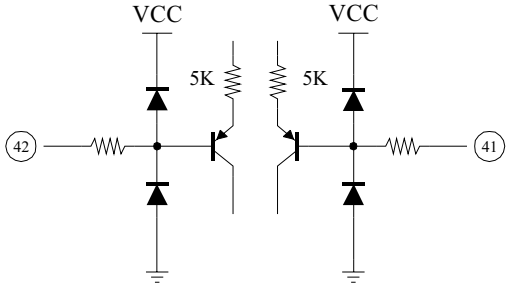
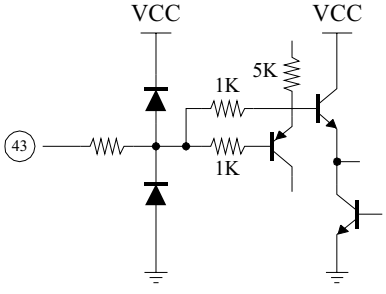
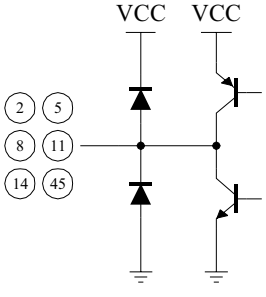


Note. Detailed circuit of the output power amp

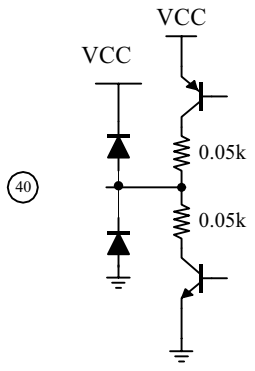
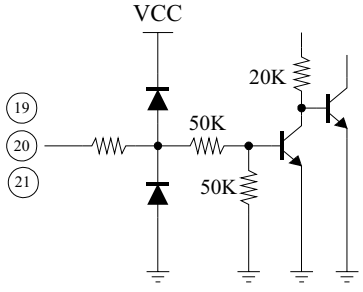
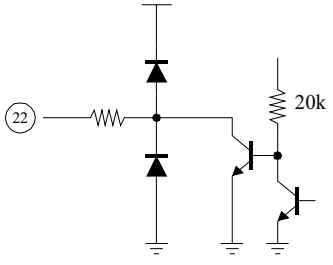


Pref1 is almost PVCC1 / 2
Pref2 is almost PVCC2 / 2

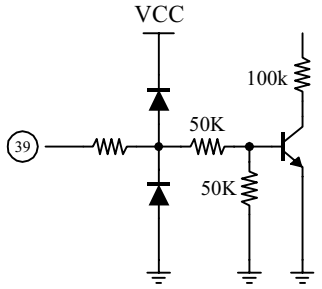
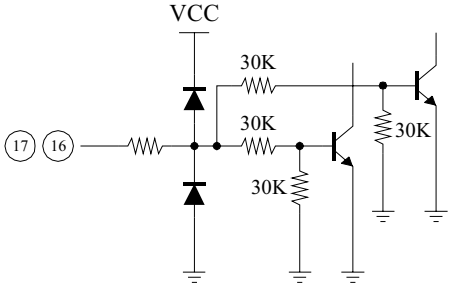
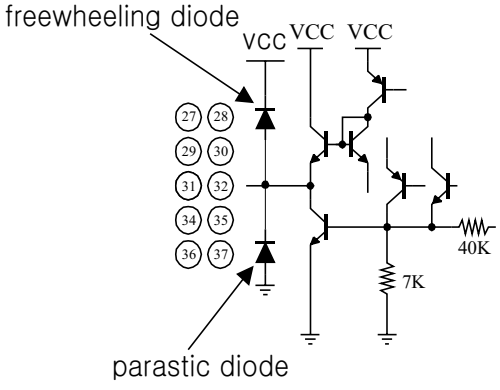
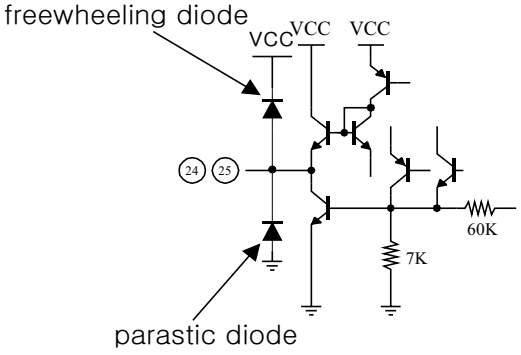
Equivalent Circuits

Description	Pin No	Internal Circuit
BTL INPUT	1,4,7,10,13,46 3,6,9,12,47,48	
OP AMP INPUT	41,42	
VREF	43	
OUTPUT	2,5,8,11,14,45	

Equivalent Circuits

Description	Pin No	Internal Circuit
OP OUT	40	
MUTE1234,5	19,20,21	
TSD-M	22	

Equivalent Circuits

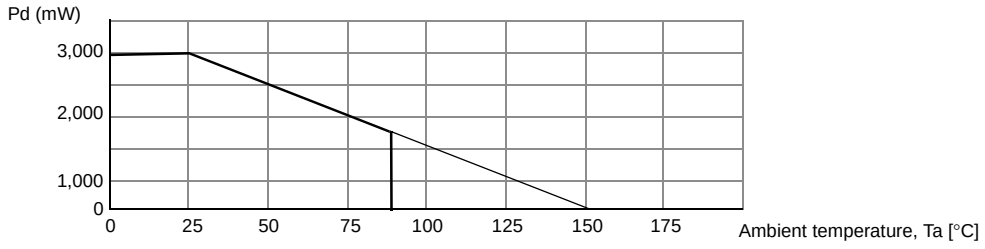
Description	Pin No	Internal Circuit
PS	39	
FWD,REV	16,17	
OUTPUT	27,28,29,30,31,32 ,34,35,36,37	
OUTPUT	24,25	

Absolute Maximum Ratings (Ta=25°C)

Parameter	Symbol	Value	Unit
Maximum Supply Voltage	$SVCC_{MAX}$	18	V
	PV_{CC1}	18	V
	PV_{CC2}	18	V
Power Dissipation	P_D	3[note]	W
Operating Temperature	T_{OPR}	–35 ~ +85	°C
Storge Temperature	T_{STG}	–55 ~ +150	°C
Maximum Output Current	I_{OMAX}	1	A

Note:

1. When mounted on 70mm × 70mm × 1.6mm PCB
2. Power dissipation reduces 24mW/°C for using above T_A = 25°C
3. Do not exceed P_D and SOA



Recommended Operating Conditions (Ta=25°C)

Parameter	Symbol	Min.	Typ.	Max.	Unit
Operating Supply Voltage	SV_{CC}	4.5	-	13.2	V
	PV_{CC1}	4.5	-	13.2	V
	PV_{CC2}	4.5	-	13.2	V

Electrical Characteristics

(SV_{CC} =5V, PV_{CC1} = PV_{CC2} = 11V, T_A = 25°C, unless otherwise specified)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
Quiescent circuit current	I_{CC}	Under no-load	-	30	-	mA
Power save on current	*note1 I_{PS}	Under no-load	-	-	1	mA
Power save on voltage	V_{PSON}	Pin39 = Variation	-	-	0.5	V
Power save off voltage	V_{PSOFF}	Pin39 = Variation	2	-	-	V
Mute12 on voltage	V_{MON12}	Pin19 = Variation	-	-	0.5	V
Mute12 off voltage	V_{MOFF12}	Pin19 = Variation	2	-	-	V
Mute34 on voltage	V_{MON34}	Pin20 = Variation	-	-	0.5	V
Mute34 off voltage	V_{MOFF34}	Pin20 = Variation	2	-	-	V
Mute5 on voltage	V_{MON5}	Pin21 = Variation	-	-	0.5	V
Mute5 off voltage	V_{MOFF5}	Pin21 = Variation	2	-	-	V
BTL DRIVER CIRCUIT						
Output offset voltage	V_{OO}	V_{IN} = 2.5V	−100	-	+100	mV
Maximum output voltage 1	V_{OM1}	R_L = 10Ω	7.5	9.0	-	V
Maximum output voltage 2	V_{OM2}	R_L = 18Ω	8.5	9.5	-	V
Closed-loop voltage gain	A_{VF}	V_{IN} = 0.1Vrms	16.8	18	19.2	dB
Ripple rejection ratio	RR	V_{IN} = 0.1Vrms, f = 120Hz	-	60	-	dB
Slew rate	SR	Square, Vout = 4Vp-p	1	2	-	V/μs
INPUT OPAMP CIRCUIT						
Input offset voltage 1	V_{OF1}	-	−10	-	+10	mV
Input bias current 1	I_{B1}	-	-	-	400	nA
High level output voltage 1	V_{OH1}	-	4.4	4.7	-	V
Low level output voltage 1	V_{OL1}	-	-	0.2	0.5	V
Output sink current 1	I_{SINK1}	R_L = 50Ω	1	2	-	mA
Output source current 1	I_{SOU1}	R_L = 50Ω	1	2	-	mA
Common mode input range1	Vicm1	-	-0.3	-	4.0	V
Open loop voltage gain 1	G_{VO1}	V_{IN} = −75dB	-	80	-	dB
Ripple rejection ratio 1	RR1	V_{IN} = −20dB, f = 120Hz	-	65	-	dB
Common mode rejection ratio 1	CMRR1	V_{IN} = −20dB	-	80	-	dB
Slew rate 1	SR1	Square, Vout = 3Vp-p	-	1.5	-	V/μs

Note:

1. When the voltage of the pin 39 is below 0.5V then the power save circuit cuts off the main bias current, so that the whole circuits are disabled (Whole circuits are " drive circuit ", " input op amp circuit " and " normal op amp circuit ")

Electrical Characteristics (Continued)

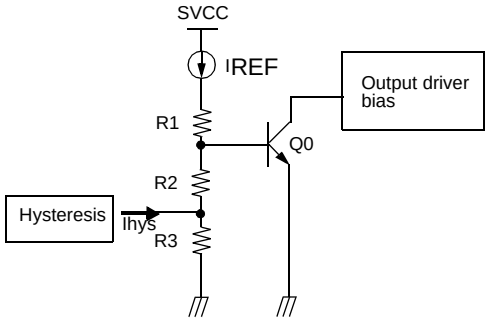
(SV_{CC} = 5V, PV_{CC1} = PV_{CC2} = 11V, T_A = 25ºC, unless otherwise specified)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
NORMAL OP AMP CIRCUIT 1						
Input offset voltage 2	V_{OF2}	-	–10	-	+10	mV
Input bias current 2	I_{B2}	-	-	-	400	nA
High level output voltage 2	V_{OH2}	-	4.4	4.7	-	V
Low level output voltage 2	V_{OL2}	-	-	0.2	0.5	V
Output sink current 2	I_{SINK2}	R_L= 50Ω	2	4	-	mA
Output source current 2	I_{SOU2}	R_L= 50Ω	2	4	-	mA
Common mode input range 2	Vicm2	-	-0.3	-	4.0	V
Open loop voltage gain 2	G_{VO2}	V_{IN} = –75dB	-	80	-	dB
Ripple rejection ratio 2	RR2	V_{IN} = –20dB, f = 120Hz	-	65	-	dB
Common mode rejection ratio 2	CMRR2	V_{IN} = –20dB	-	80	-	dB
Slew rate 2	SR2	Square, Vout = 3Vp-p	-	1.5	-	V/μs
NORMAL OP AMP CIRCUIT 2						
Input offset voltage 3	V_{OF3}	-	–15	-	+15	mV
Input bias current 3	I_{B3}	-	-	-	400	nA
High level output voltage 3	V_{OH3}	-	3	3.8	-	V
Low level output voltage 3	V_{OL3}	-	-	1.0	1.5	V
Output sink current 3	I_{SINK3}	R_L = 50Ω	10	-	-	mA
Output source current 3	I_{SOU3}	R_L = 50Ω	10	-	-	mA
Open loop voltage gain 3	G_{VO3}	V_{IN} = –75dB	-	80	-	dB
Ripple rejection ratio 3	RR3	V_{IN} = –20dB, f = 120Hz	-	65	-	dB
Common mode rejection ratio 3	CMRR3	V_{IN} = –20dB	-	80	-	dB
Slew rate 3	SR3	Square, Vout = 3Vp-p	-	1.5	-	V/μs
TRAY DRIVE CIRTUIT						
Input high level voltage	V_{IH}	-	2	-	-	V
Input low level voltage	V_{IL}	-	-	-	0.5	V
Output voltage 1	V_{O1}	PV_{CC2} = 11V, V_{CTL} = 3V, R_L= 45Ω	-	6	-	V
Output voltage 2	V_{O2}	PV_{CC2} = 13V, V_{CTL} = 4.5V, R_L= 45Ω	-	9	-	V
Output voltage 3	V_{O3}	PV_{CC2} = 11V, V_{CTL} = 1.5V, R_L = 10Ω	2.5	3	3.5	V
Output load regulation	ΔV_{RL}	V_{CTL}=3V, I_L=100mA → 400mA	-	300	700	mV
Output offset voltage 1	V_{OO1}	V_{IN} = 5V, 5V	–40	-	+40	mV
Output offset voltage 2	V_{OO2}	V_{IN} = 0V, 0V	–40	-	+40	mV

Application Information

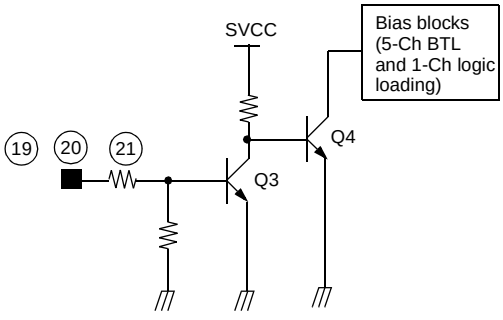
1. Thermal Shutdown

The TSD circuit turns activated when the junction temperature becomes over 175°C. It cuts off the bias current on the output driver and keeps all the output drivers off. Meanwhile, the junction temperature begins to decrease. The TSD circuit can be deactivated when the unction temperature falls under 150°C, so the output driver begins operating in normal condition. The TSD circuit has the hysteresis temperature of 25°C.



2. CH Mute Function

When the pin19,20,21 is high, the TR Q3 is turned on and Q4 is off, so the bias circuit is enabled. that is, it will make all the circuit blocks except for variable regulator off, so low power quiescent state can be established.

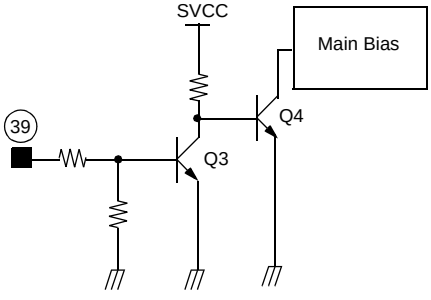


- Truth table is as follows

Pin 19,20,21	FAN8035
High	Mute-Off
Low	Mute-On

3. Power Save Function

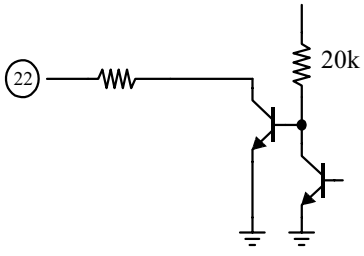
- When the pin39 is high, the TR Q3 is turned on and Q4 is off, so the bias circuit is enabled. On the other hand, when the pin39 is Low (GND) , the TR Q3 is turned off and Q4 is on, so the bias circuit is disabled.
- That is, this function keeps all the circuit blocks of the chip off, thus the low power quiscent state is established.
- Truth table is as follows;



Pin39	FAN8035
High	Power Save Off
Low	Power Save On

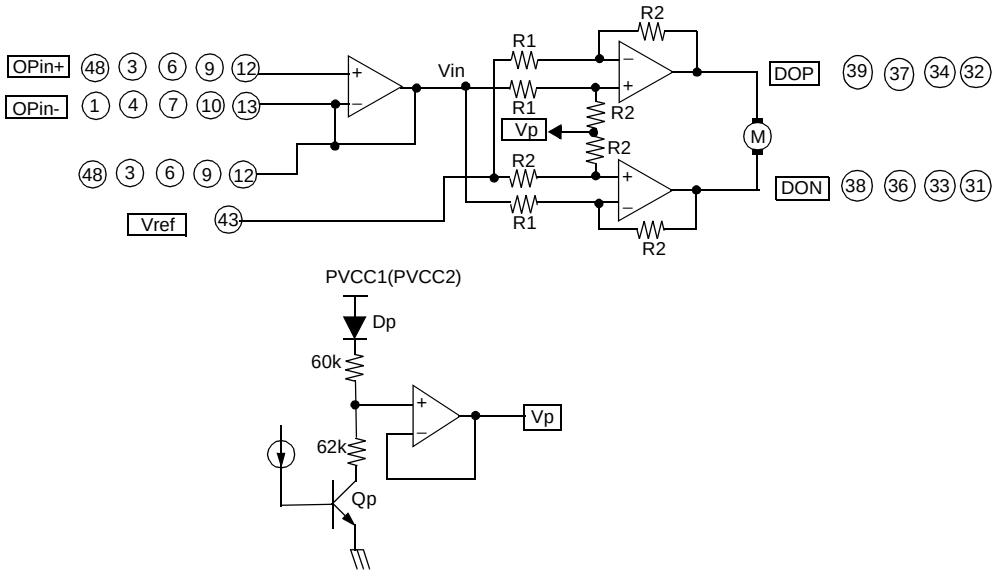
4. Tsd Monitor Function

- PIN22 is TSD monitor pin which detects the state of the TSD block and generates the TSD-monitor signal.
- In normal state Q5 is turned on, so Q6 is turned off. on the otherhand, When the TSD block is is activated then Q5 is turned off, so the voltage of pin22 is low.
- Truth table is as follows



TSD Circuit	pin22	FAN8035
-	High	Tsd Off
-	Low	Tsd On

5. Focus, Tracking Actuator, Spindle, Sled Motor Drive Part



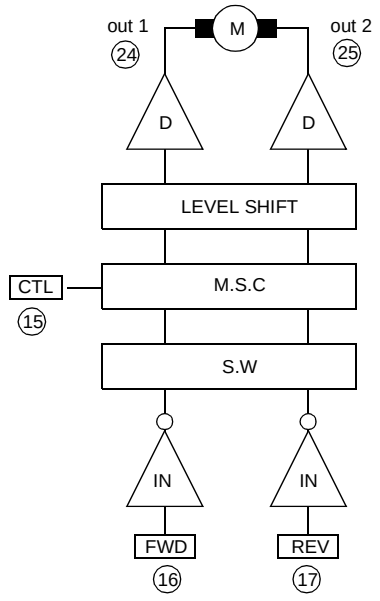
- The voltage, Vref is the reference voltage driven by the external bias voltage of the pin 43.
- The input signal (Vin) through pins 1,4,7, 10 and 13 is amplified one time and then fed to the output stage. (assume that input opamp was used as a buffer)
- The total closed loop voltage gain is as follows

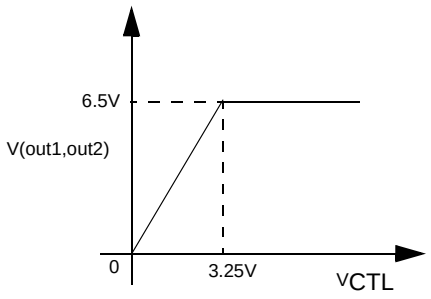
$$Vin = Vref + \Delta V$$
$$DOP = Vp + 4\Delta V$$
$$DON = Vp - 4\Delta V$$
$$Vout = DOP - DON = 8\Delta V$$
$$Gain = 20\log\frac{Vout}{\Delta V} = 20\log 8 = 18dB$$

- If you want to change the total closed loop voltage gain, you must use the input opamp as an amplifier
- The output stage is the balanced transformerless (BTL) driver.
- The bias voltage Vp is expressed as ;

$$Vp = (PVCC1 - VDp - VcesatQp) \times \frac{62k}{60k + 62k} + VcesatQp$$
$$= \frac{PVCC1 - VDp + VcesatQp}{1.97} + VcesatQp \quad \text{----------} \quad (1)$$

6. Tray, Changer,panel Motor Drive Part



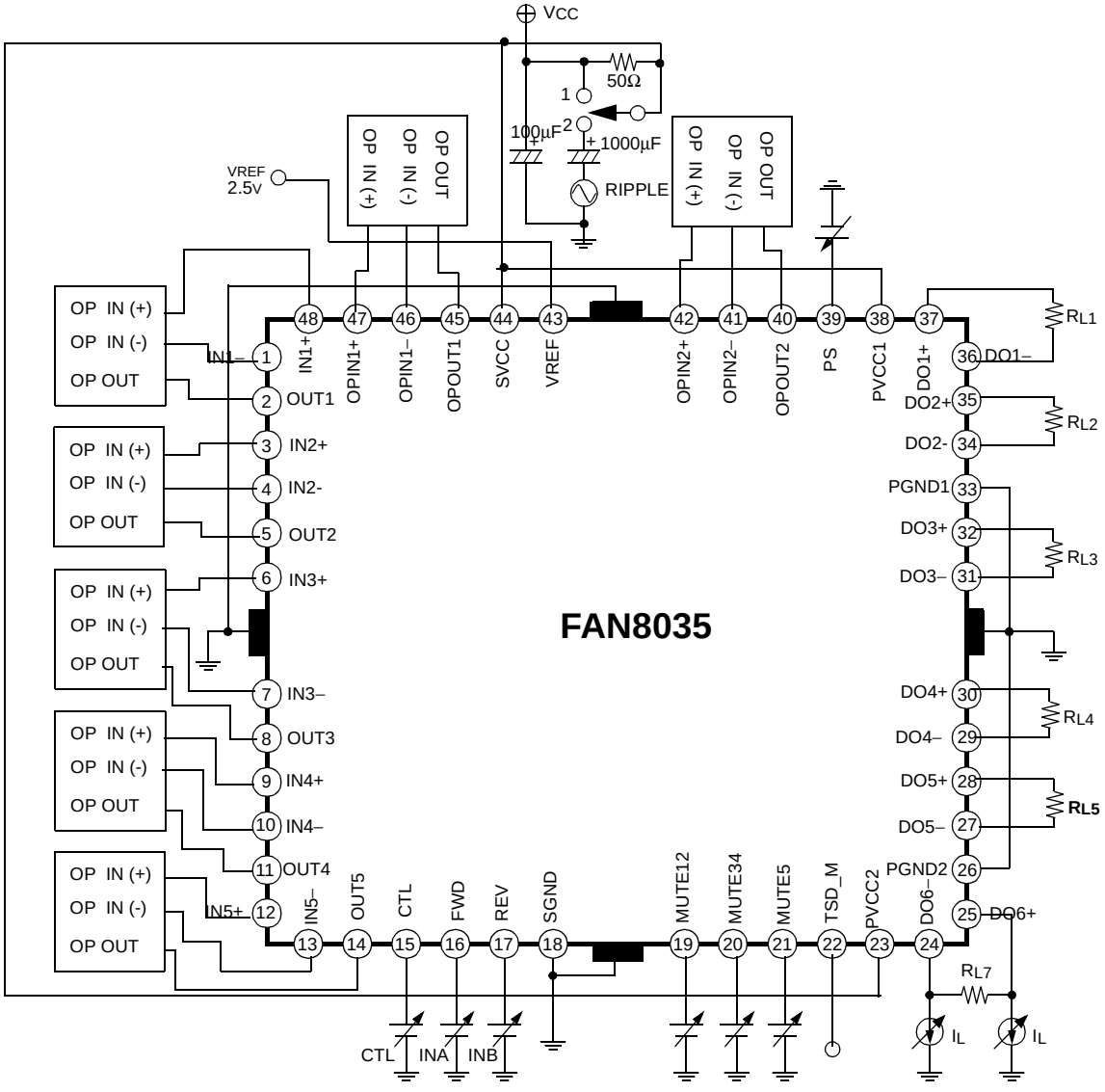


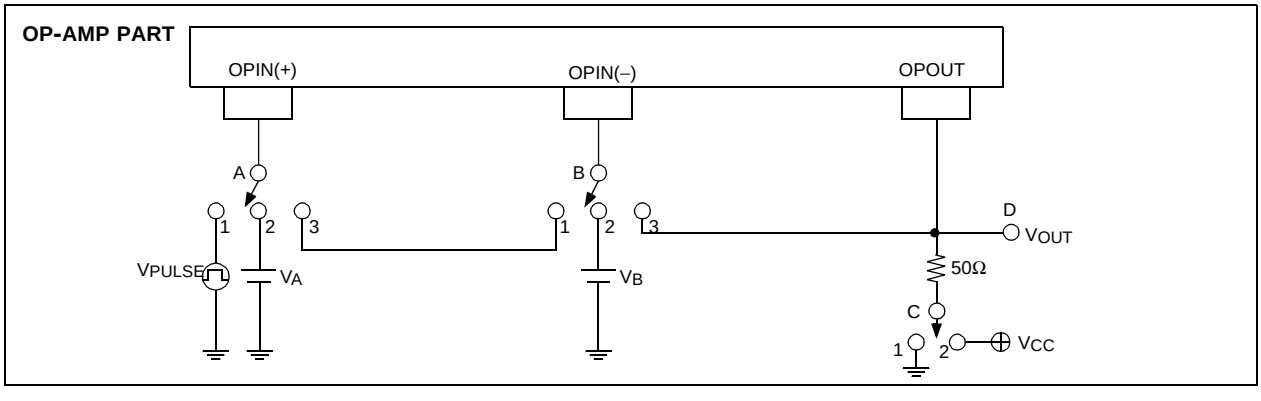
- Rotational direction control
  The forward and reverse rotational direction is controlled by FWD (pin16) and REV (pin17) and the input conditions are as follows.

INPUT		OUTPUT		
FWD	**REV**	**OUT 1**	**OUT 2**	**State**
H	H	Vp	Vp	Brake
H	L	H	L	Forward
L	H	L	H	Reverse
L	L	-	-	Hign impedance

- Vp(Power reference voltage) is approximately 3.75V at PV_{CC2}=8V according to equation (1).
- Motor speed control (When SV_{CC}=PV_{CC2}=8V)
  - The maximum torque is obtained when the pin (15(CTL1, 2, 3)) is open.
  - If the voltage of the pins (15 (CTL)) is 0V, the motor will not operate.
  - When the control voltage (pin15) is between 0 and 3.25V, the differential output voltage(V(out1,out2)) is about two times of control voltage. Threfore, output gain is 6dB.
  - When the control voltage is greater than 3.25V, the output voltage is saturated at 6.5V due to the output swing limitation.

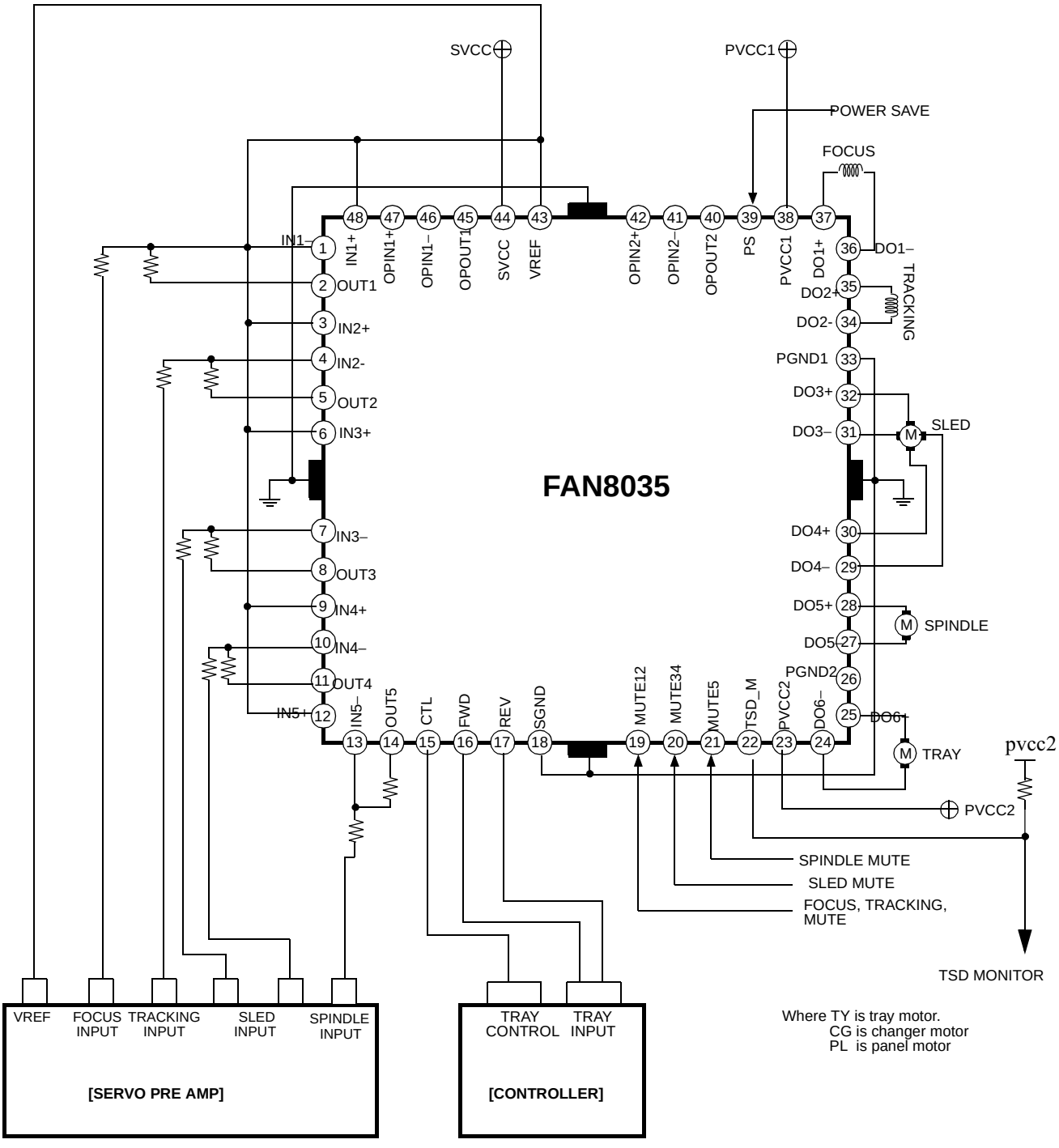
Test Circuits





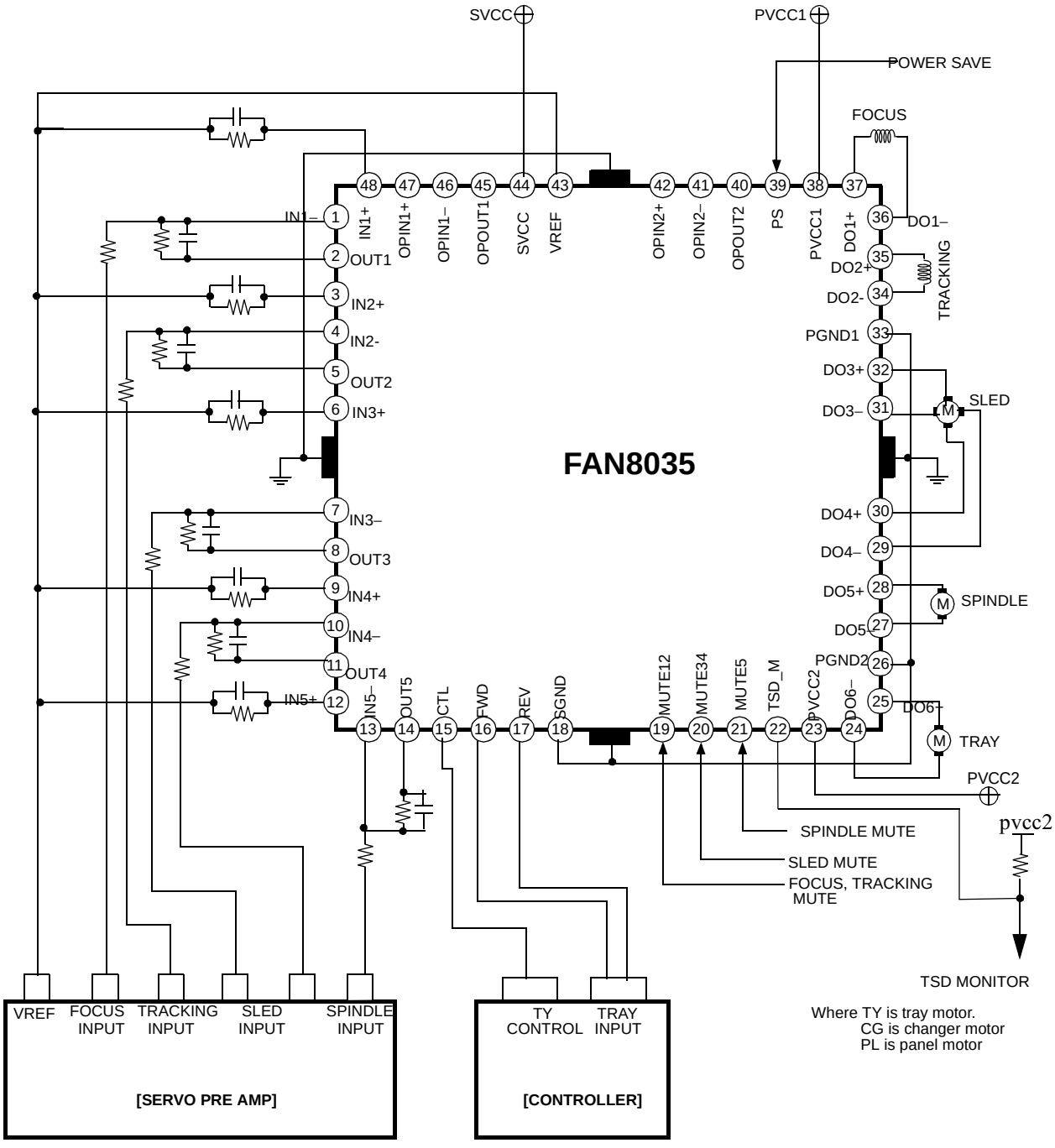
Typical Application Circuits 1

[Voltage control mode]



Typical Application Circuits 2

[Differential PWM control mode]



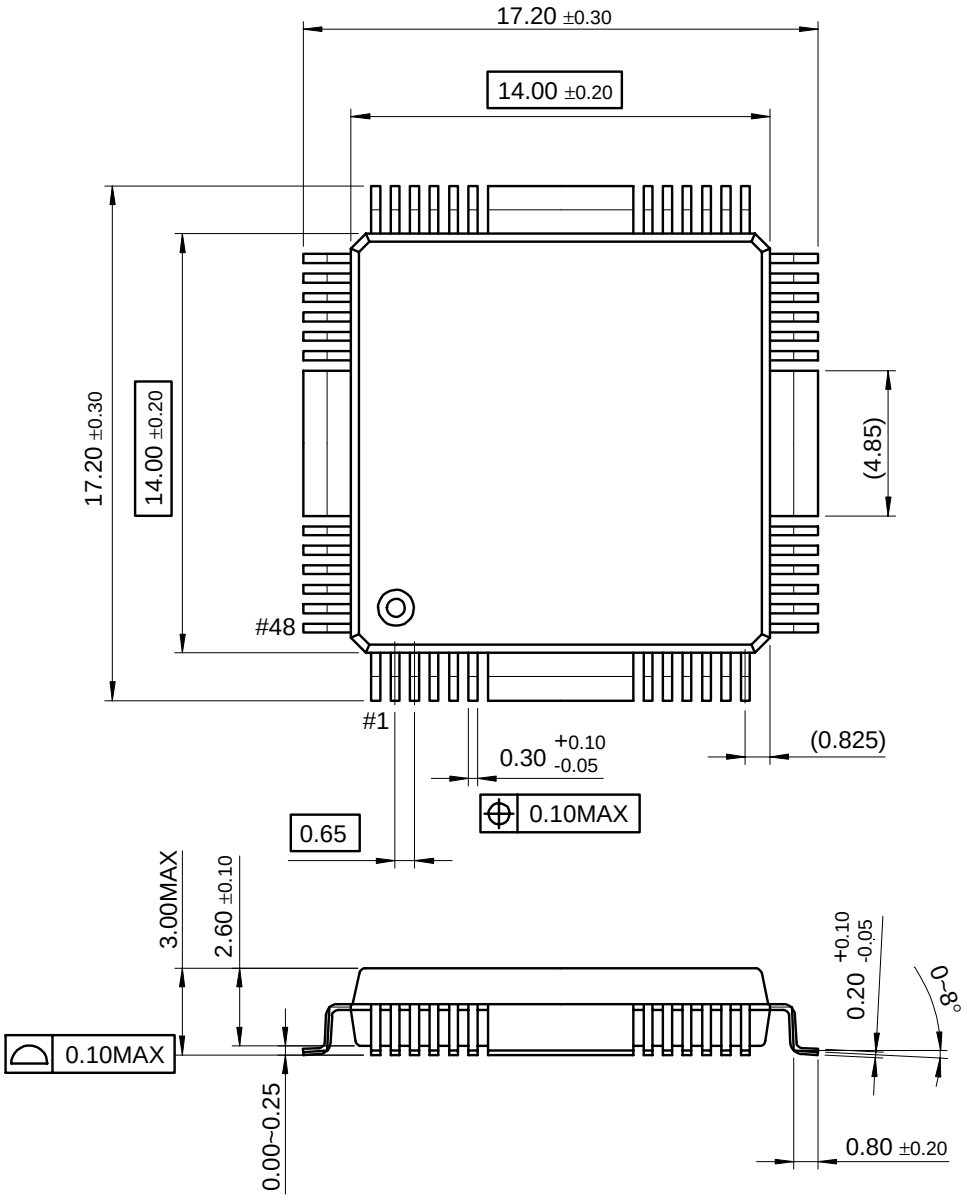
Notes:

Radiation pin is connected to the internal GND of the package.

Mechanical Dimensions

Package

48-QFPH-1414



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