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

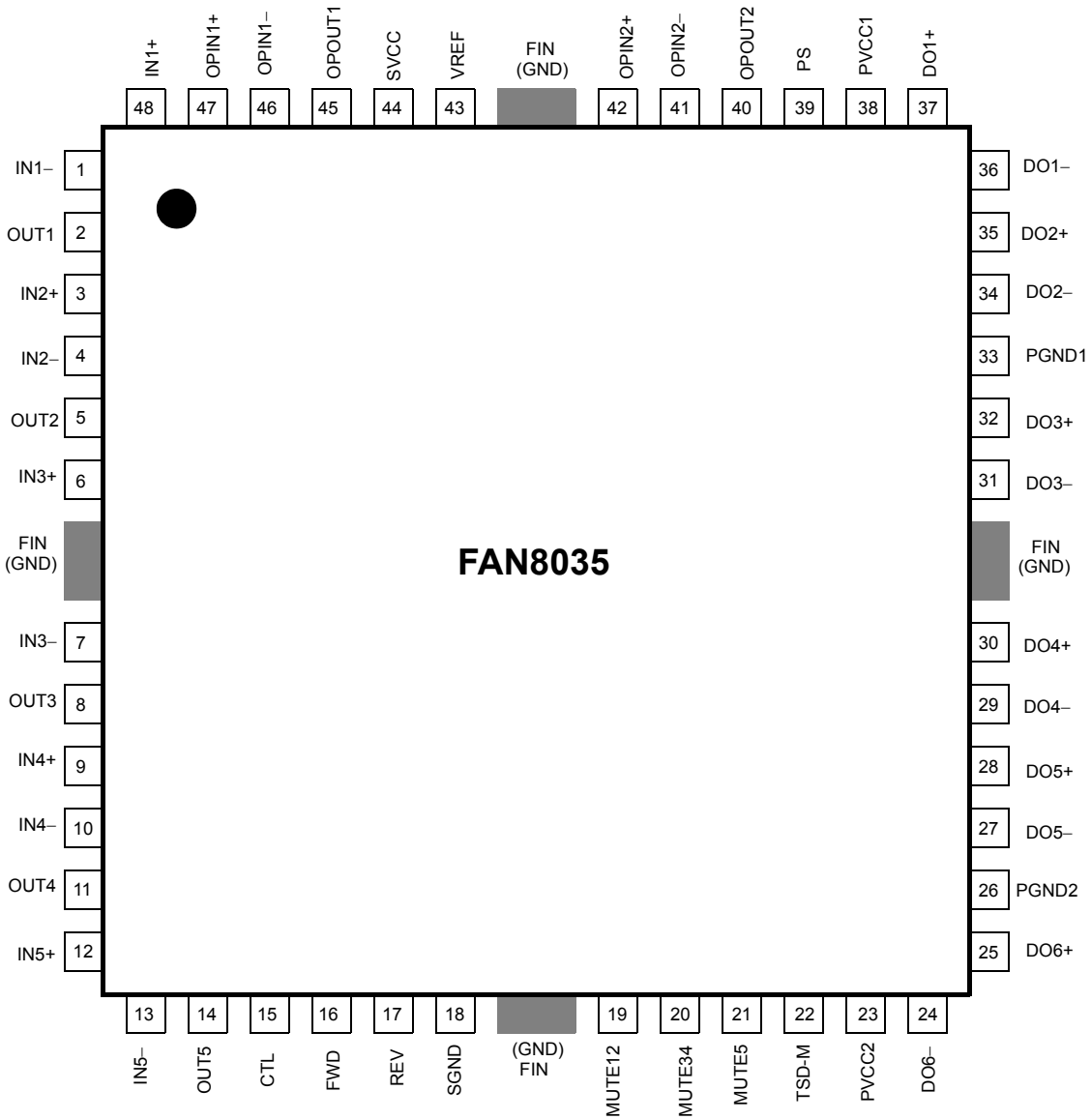
- Compact Disk Player
- Video Compact Disk Player
- Car Compact Disk Player
- Digital Video Disk Player

Ordering Information

Device	Package	Operating Temperature
FAN8035	48-QFPH-1414	-35°C ~ +85°C
FAN8035L	48-QFPH-1414	-35°C ~ +85°C
FAN8035_NL[note]	48-QFPH-1414	-35°C ~ +85°C

Note:
NL : Lead free Type

Pin Assignments



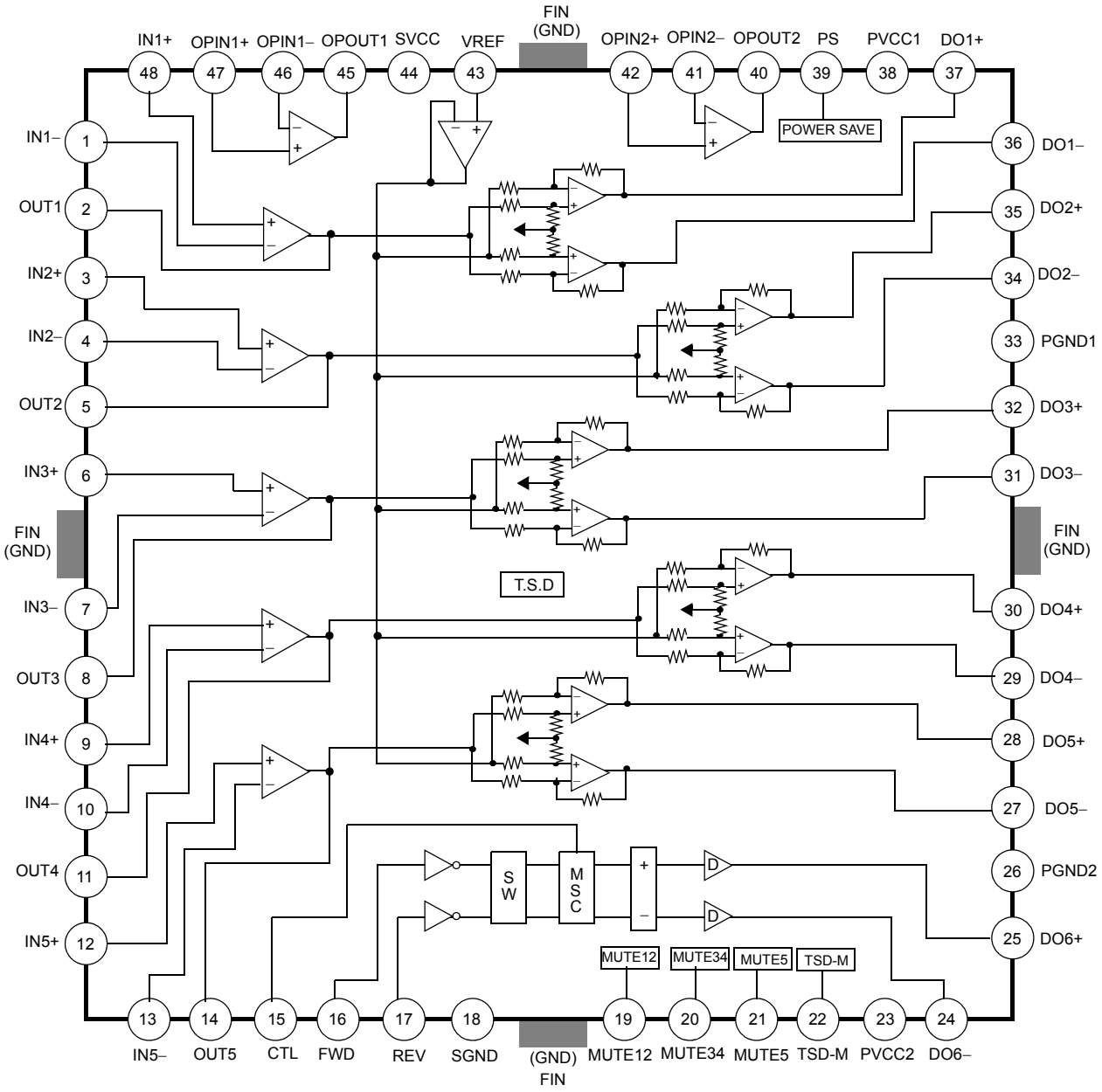
Pin Definitions

Pin Number	Pin Name	I/O	Pin Function Description
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	CH5 OP-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 CH5, CH6)
24	DO6-	O	CH6 Drive Ouptut (-)
25	DO6+	O	CH6 Drive Output (+)
26	PGND2	-	Power Ground 2 (FOR 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 (+)

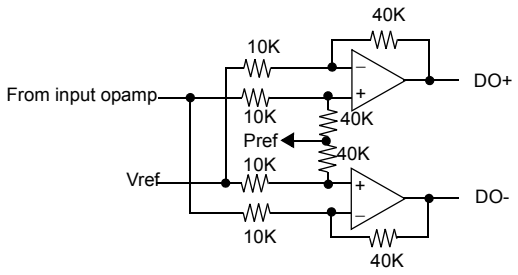
Pin Definitions (Continued)

Pin Number	Pin Name	I/O	Pin Function Description
33	PGND1	-	Power Ground 1 (FOR CH1, CH2, CH3, CH4)
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, CH3, CH4)
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

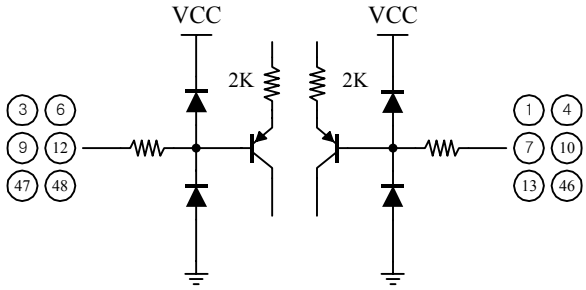
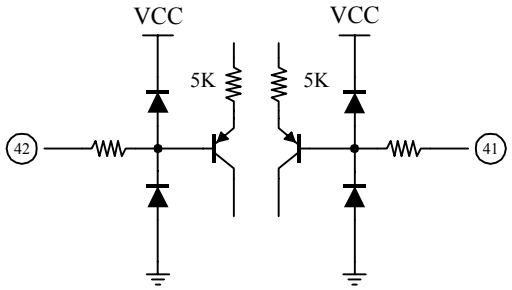
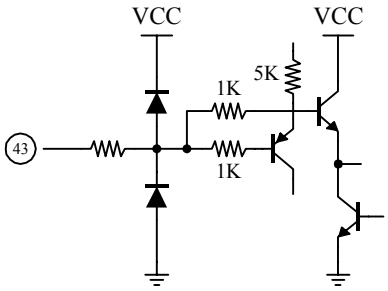
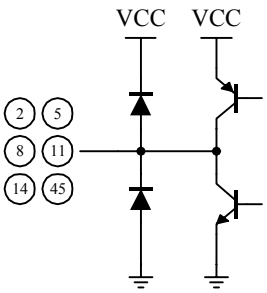


Note. Detailed circuit of the output power amp

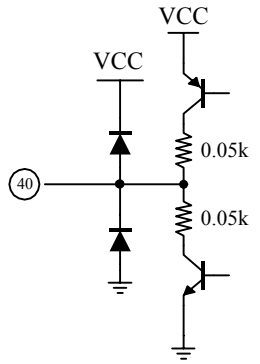
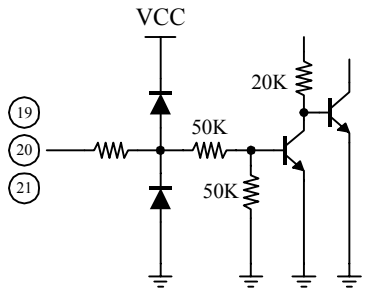
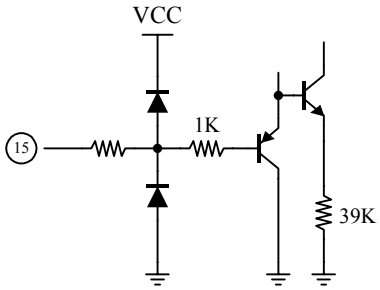
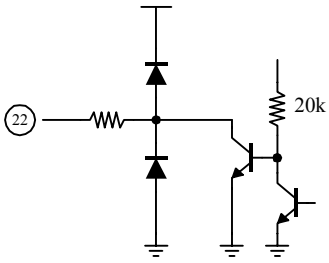


Pref1 is almost PVCC1 / 2
Pref2 is almost PVCC2 / 2

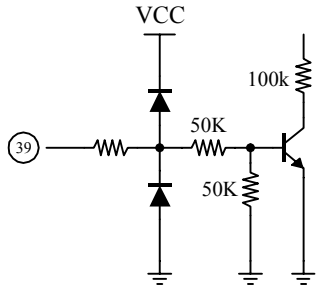
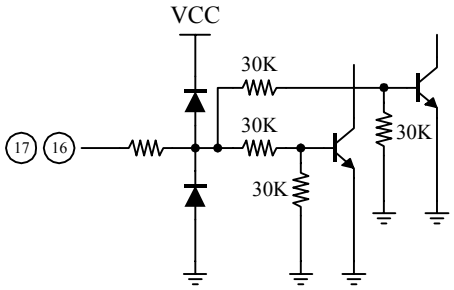
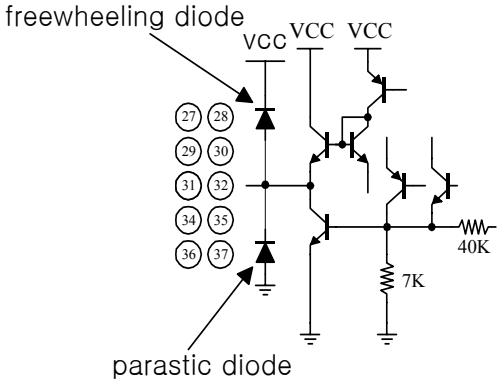
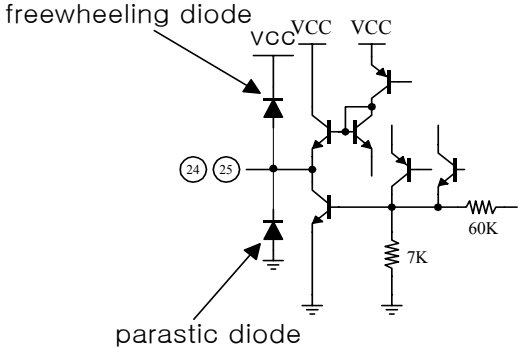
Equivalent Circuits

Description	Pin No	Internal Circuit
BTL INPUT & OP-AMP1 INPUT	1,4,7,10,13,46 3,6,9,12,47,48	
OP-AMP2 INPUT	41,42	
VREF	43	
BTL OP-AMP OUT & OP-AMP1 OUT	2,5,8,11,14,45	

Equivalent Circuits (Continued)

Description	Pin No	Internal Circuit
OP-AMP2 OUT	40	
MUTE12,34,5	19,20,21	
CTL	15	
TSD-M	22	

Equivalent Circuits (Continued)

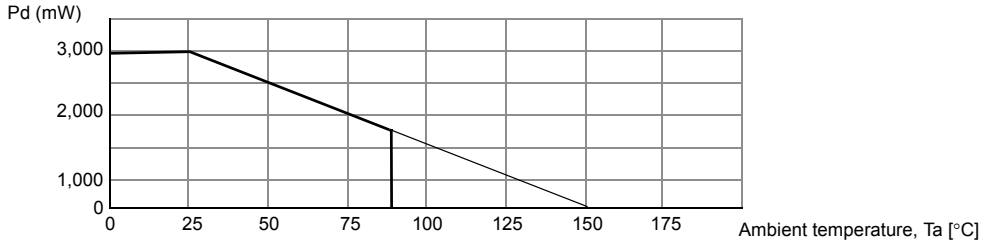
Description	Pin No	Internal Circuit
PS	39	
FWD,REV	16,17	
BTL CH1,2,3,4,5 OUTPUT	27,28,29,30,31 32,34,35,36,37	
BTL CH6 OUTPUT	24,25	

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

Notes:

1. When mounted on 70mm × 70mm × 1.6mm PCB.
2. Power dissipation is derated with the rate of -24mW/°C for $T_A \geq 25°C$.
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} = 5V, PV_{CC2} = 12V, 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	I_{PS}[note1]	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 Voltage1	V_{OM1}	R_L = 10Ω, CH1,2	2.5	3.5	-	V
Maximum Output Voltage2	V_{OM2}	R_L = 18Ω, CH3,4,5	8.5	10.0	-	V
Closed-loop Voltage Gain	A_{VF}	V_{IN} = 0.1Vrms	16.8	18	19.2	dB
Ripple Rejection Ratio[note2]	RR	V_{IN} = 0.1Vrms, f = 120Hz	-	60	-	dB
Slew Rate[note2]	SR	Square, Vout = 4Vp-p	1	2	-	V/μs
INPUT OPAMP CIRCUIT						
Input Offset Voltage1	V_{OF1}	-	-10	-	+10	mV
Input Bias Current1	I_{B1}	-	-	-	400	nA
High Level Output Voltage1	V_{OH1}	-	4.4	4.7	-	V
Low Level Output Voltage1	V_{OL1}	-	-	0.2	0.5	V
Output Sink Current1	I_{SINK1}	R_L = 50Ω	1	2	-	mA
Output Source Current1	I_{SOU1}	R_L = 50Ω	1	2	-	mA
Common Mode Input Range1[note2]	Vicm1	-	-0.3	-	4.0	V
Open Loop Voltage Gain1[note2]	G_{VO1}	V_{IN} = -75dB	-	80	-	dB
Ripple Rejection Ratio1[note2]	RR1	V_{IN} = -20dB, f = 120Hz	-	65	-	dB
Common Mode Rejection Ratio1[note2]	CMRR1	V_{IN} = -20dB	-	80	-	dB
Slew Rate1[note2]	SR1	Square, Vout = 3Vp-p	-	1.5	-	V/μs

Note :

1. When the voltage at pin39 goes below 0.5V, the power save circuit makes the main bias current sources stop operating. As a result, the whole circuits are disable. (The whole circuits mean the driver circuit, the input Op-amp circuit, and the normal Op-amp circuit.)
2. Guaranteed field.(No EDS/Final test)

Electrical Characteristics (Continued)

(SV_{CC} = 5V, PV_{CC1} = 5V, PV_{CC2} = 12V, T_A = 25°C, unless otherwise specified)

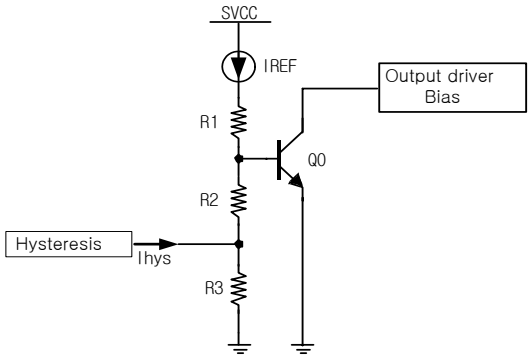
Parameter	Symbol	Conditions	Min.	Typ.	Max.	Unit
NORMAL OP AMP CIRCUIT 1						
Input Offset Voltage2	V_{OF2}	-	-10	-	+10	mV
Input Bias Current2	I_{B2}	-	-	-	400	nA
High Level Output Voltage2	V_{OH2}	-	4.4	4.7	-	V
Low Level Output Voltage2	V_{OL2}	-	-	0.2	0.5	V
Output Sink Current2	I_{SINK2}	R_L= 50Ω	2	4	-	mA
Output Source Current2	I_{SOU2}	R_L= 50Ω	2	4	-	mA
Common Mode Input Range2*note	Vicm2	-	-0.3	-	4.0	V
Open Loop Voltage Gain2*note	G_{VO2}	V_{IN} = -75dB	-	80	-	dB
Ripple Rejection Ratio2*note	RR2	V_{IN} = -20dB, f = 120Hz	-	65	-	dB
Common Mode Rejection Ratio2*note	CMRR2	V_{IN} = -20dB	-	80	-	dB
Slew Rate2*note	SR2	Square, Vout = 3Vp-p	-	1.5	-	V/μs
NORMAL OP AMP CIRCUIT 2						
Input Offset Voltage3	V_{OF3}	-	-15	-	+15	mV
Input Bias Current3	I_{B3}	-	-	-	400	nA
High Level Output Voltage3	V_{OH3}	-	3	3.8	-	V
Low Level Output Voltage3	V_{OL3}	-	-	1.0	1.5	V
Output Sink Current3	I_{SINK3}	R_L = 50Ω	10	-	-	mA
Output Source Current3	I_{SOU3}	R_L = 50Ω	10	-	-	mA
Open Loop Voltage Gain3*note	G_{VO3}	V_{IN} = -75dB	-	80	-	dB
Ripple Rejection Ratio3*note	RR3	V_{IN} = -20dB, f = 120Hz	-	65	-	dB
Common Mode Rejection Ratio3*note	CMRR3	V_{IN} = -20dB	-	80	-	dB
Slew Rate3*note	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 Voltage1	V_{O1}	PV_{CC2} = 11V, V_{CTL} = 3V, R_L= 45Ω	-	6	-	V
Output Voltage2	V_{O2}	PV_{CC2} = 13V, V_{CTL} = 4.5V, R_L= 45Ω	-	9	-	V
Output Voltage3	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 Voltage1	V_{OO1}	V_{IN} = 5V, 5V	-40	-	+40	mV
Output Offset Voltage2	V_{OO2}	V_{IN} = 0V, 0V	-40	-	+40	mV

Note: Guaranteed field.(No EDS/Final test)

Application Information

1. Thermal Shutdown

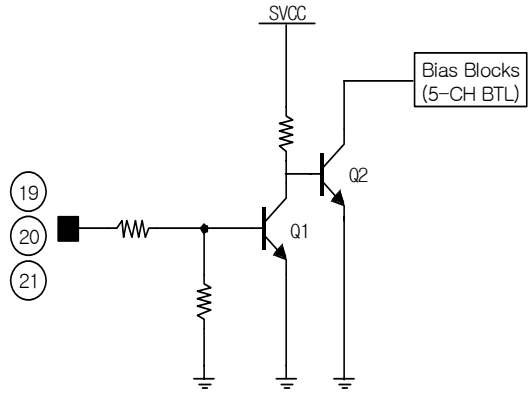
- The TSD circuit is activated at the junction temperature of 160°C and deactivated at 135°C with the hysteresis of 25°C. During the thermal shutdown, the TSD circuit keeps all the output driver off.



2. CH Mute Function

- When the mute pin is high, the TR Q1 is on and Q2 is off, so the bias circuit is enabled. When the mute pin is low (GND), the TR Q1 is off and Q2 is on, so the bias circuit is disabled.
- During the mute on state, all the circuit blocks except for the variable regulator remain off, and the low power quiescent state is established.
- Truth table is as follows;

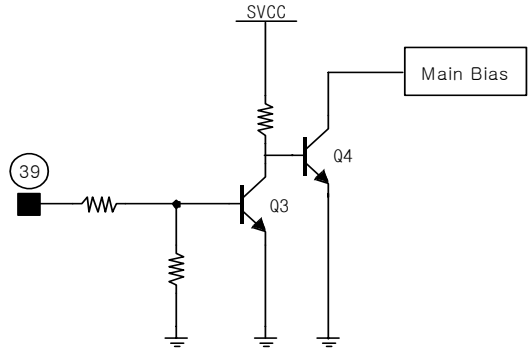
Pin 19, 20, 21	Mute
High	Mute-Off
Low	Mute-On



3. Power Save Function

- When the pin39 is high, the TR Q3 becomes on and Q4 off, so the bias circuit is enabled. When the pin39 is low (GND) , the TR Q3 becomes off and Q4 is on, so the bias circuit is disabled.
- During the power save on state, this function keeps all the circuit blocks off, and the low power quiescent state is established.
- Truth table is as follows;

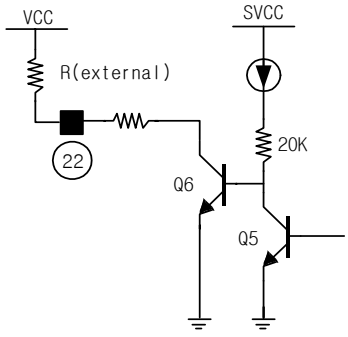
Pin39	Power Save
High	Power Save Off
Low	Power Save On



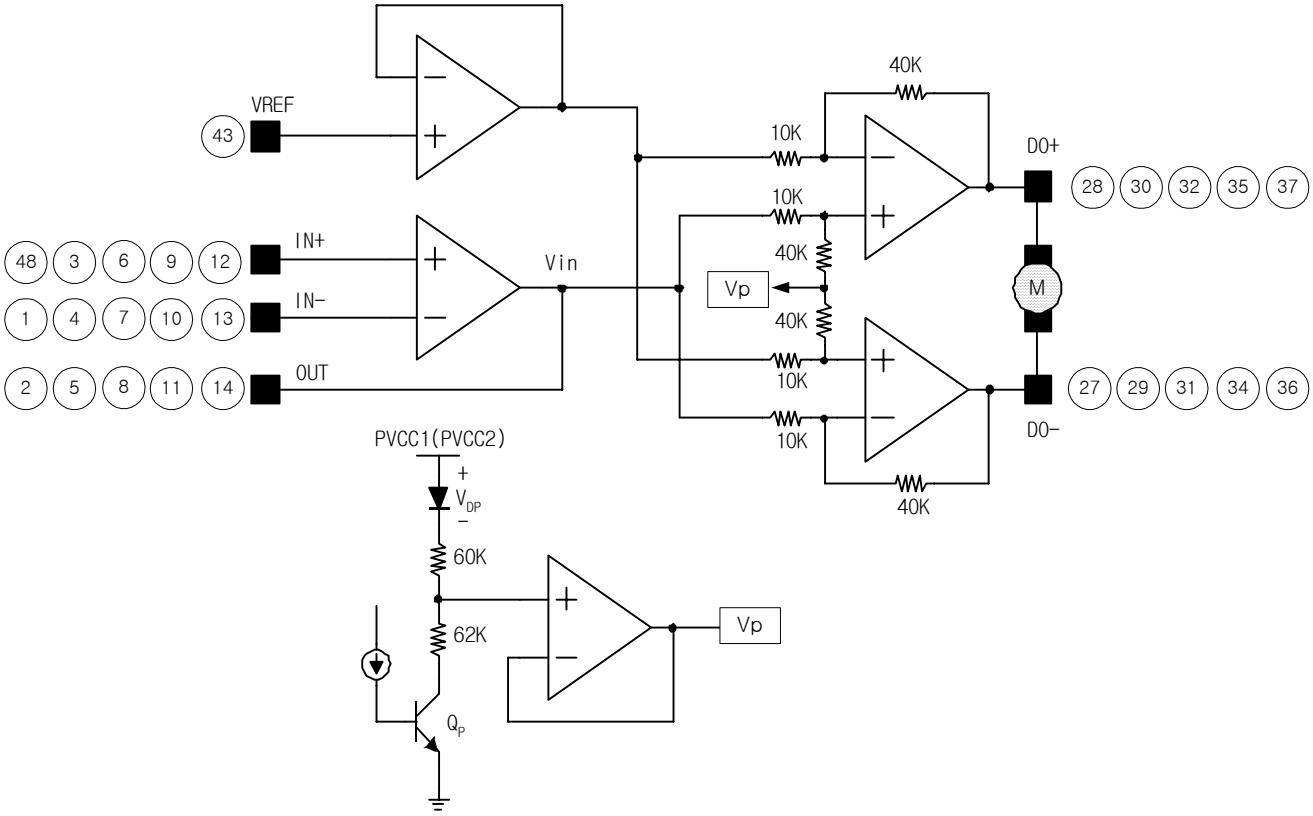
4. TDS Monitor Function

- Pin22 is TSD monitor pin, which detects the state of the TSD block and generates the TSD-monitor signal.
- In the normal state Q5 is on, and Q6 is off. When the TSD block is activated Q5 becomes off, and thus the voltage of pin22 keeps low.
- Truth table is as follows;

TSD	Pin22
TSD Off	High
TSD On	Low



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



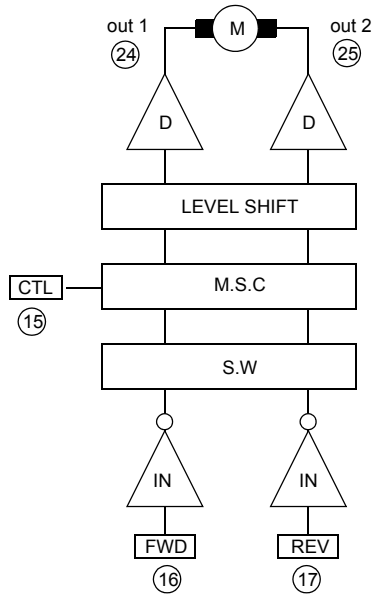
- The Vref at pin 43 is for eliminating the dc components from the input signals and can set by an exteranl circuit.
- The voltage gain from Vin to output is as follows ;

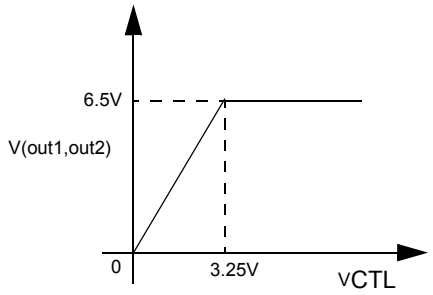
$$Vin = Vref + \Delta V$$
$$DOP = V_D + 4\Delta V$$
$$DON = V_D - 4\Delta V$$
$$Vout = DOP - DON = 8\Delta V$$
$$Gain = 20\log\frac{Vout}{\Delta V} = 20\log 8 = 18dB$$

- Where ΔV means just ac component.
- The total input to output voltage gain is the sum of the input OP amp network gain and 18dB.
- The output stage is the balanced transformerless (BTL) driver.
- The bias voltage Vp is expressed as ;

$$V_P = (PVCC1 - V_{DP} - V_{CESAT}Q_P) \times \frac{62k}{60k + 62k} + V_{CESAT}Q_P$$
$$= \frac{PVCC1 - V_{DP} - V_{CESAT}Q_P}{1.97} + V_{CESAT}Q_P \quad \text{----------} \quad (1)$$

6. Tray, Changer,panel Motor Drive Part



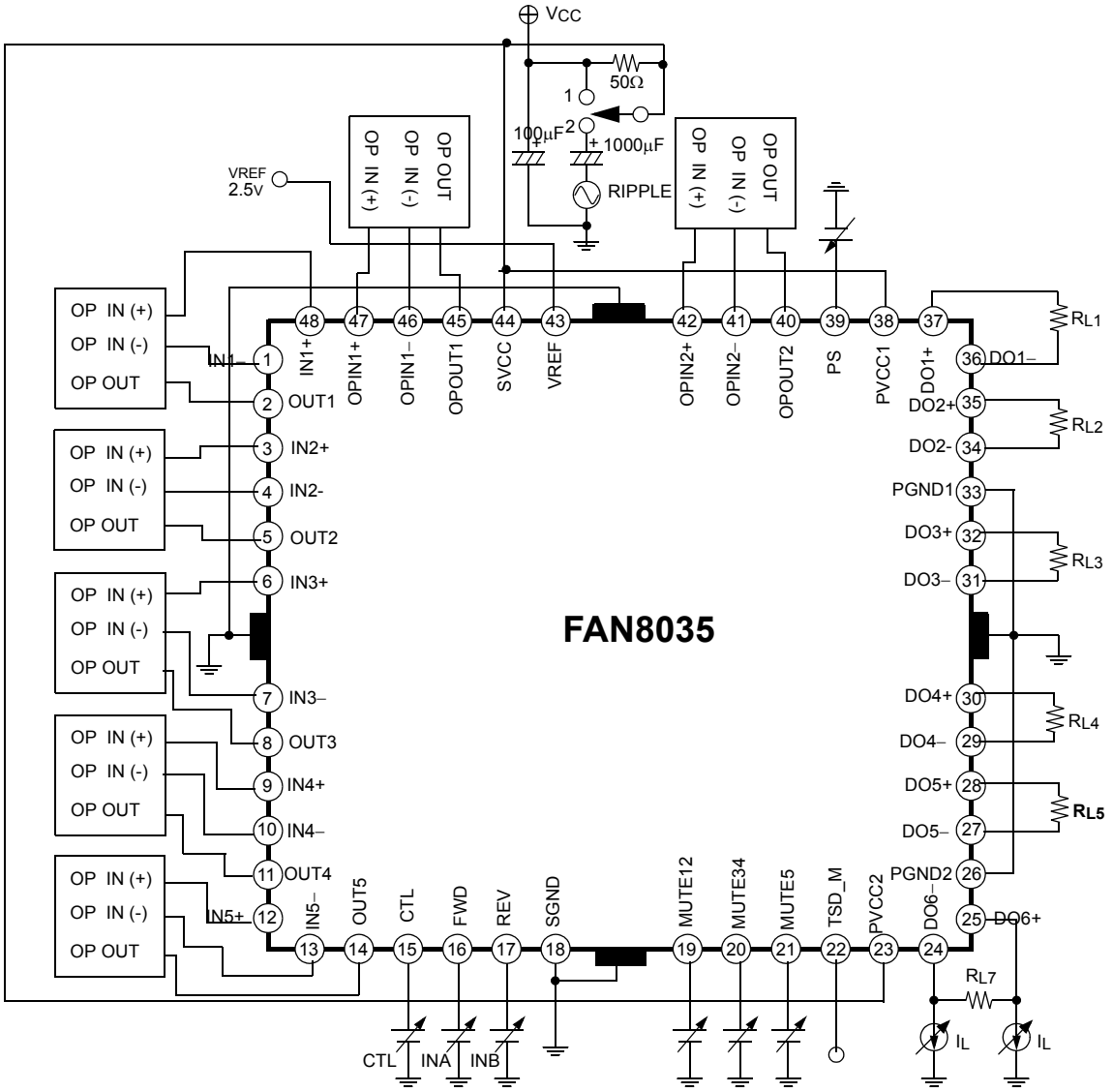


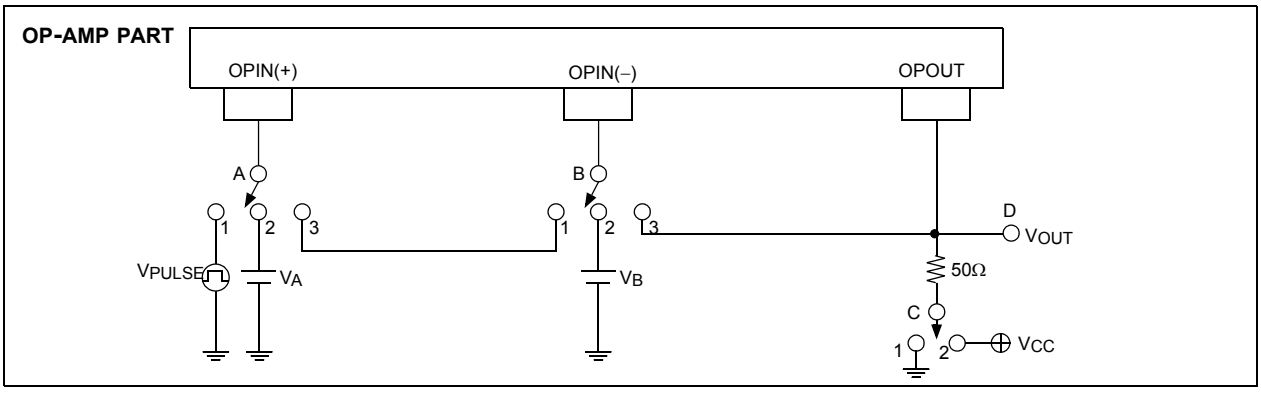
- Rotational direction control
  The forward and reverse rotational direction is controlled by FWD (pin16) and REV (pin17) and the input conditions are as follows;

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

- Where 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 pin15(CTL) is open.
  - If the voltage of the pin15 (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. The output gain is 6dB.
  - When the control voltage is greater than 3.25V, the output voltage is saturated at the 6.5V because of the output swing limitation.

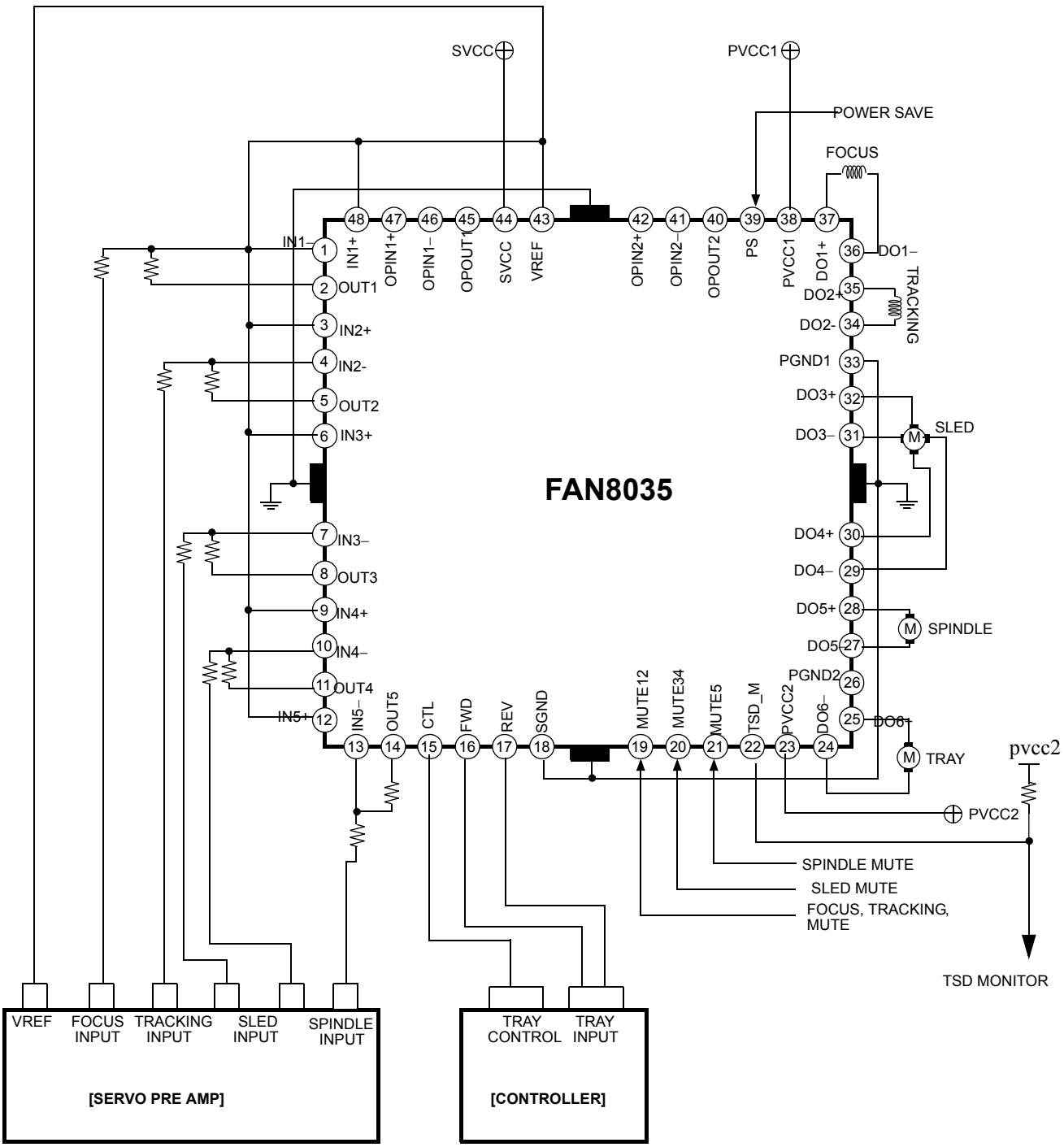
Test Circuits





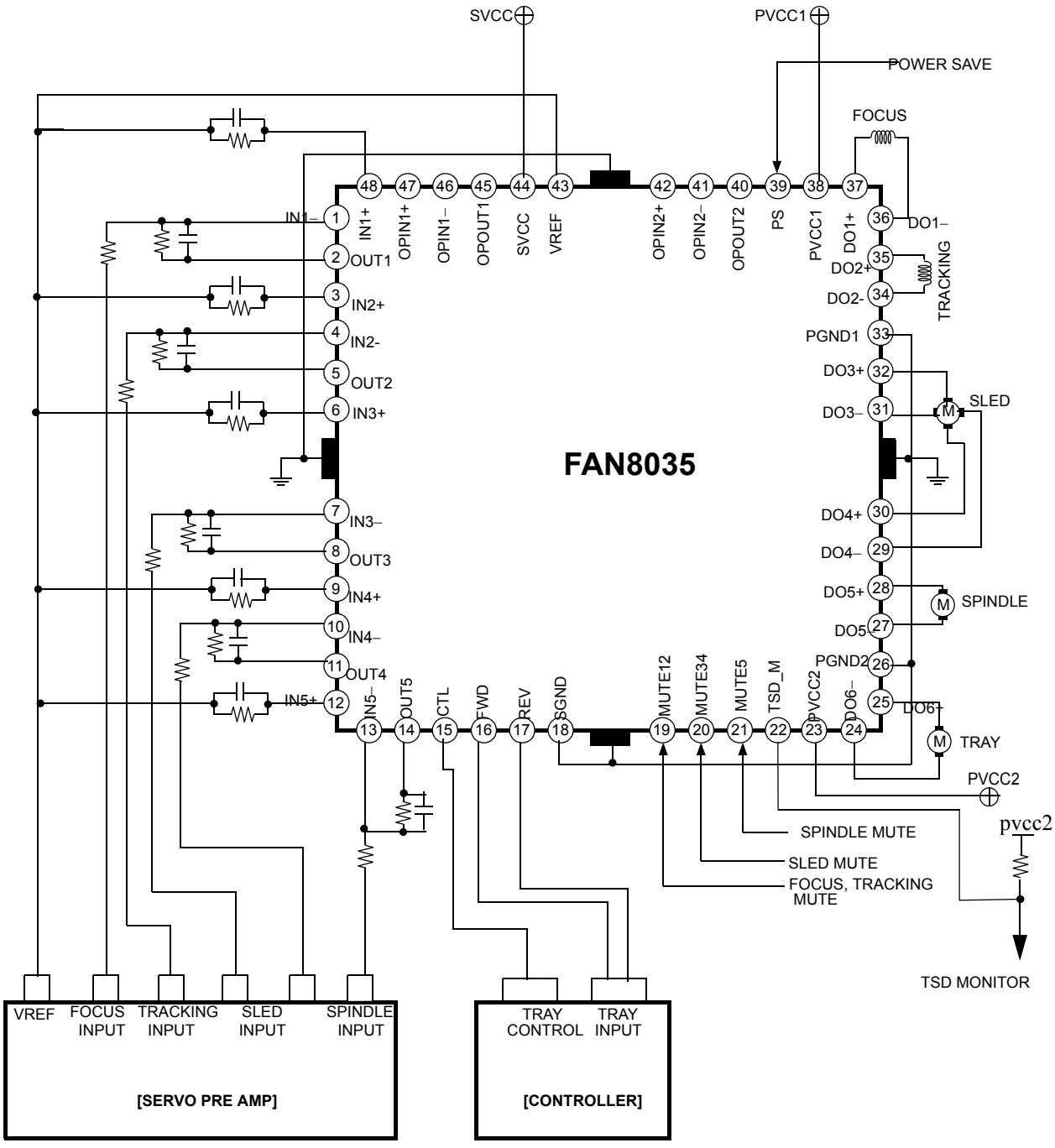
Typical Application Circuits 1

[Voltage control mode]



Typical Application Circuits 2

[Differential PWM control mode]



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

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