# FAN8037 (KA3037)

7-CH Motor Driver

Features

- 4-CH balanced transformerless (BTL) driver
- 3-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 all channel mute circuit
- Built-in power save mode circuit
- Built-in stand by mode circuit
- Built-in variable regulator

Description

The FAN8037 is a monolithic integrated circuit suitable for a 7-ch motor driver which drives the tracking actuator, focus actuator, sled motor, tray motor, changer motor, panel motor and, spindle motor of the CDP/CAR-CD systems.

48-QFPH-1414

Target Application

- Compact disk player (Tray, Changer)
- Video compact disk player (Tray, Changer)
- Car compact disk player (Tray, Changer)
- Mixing with compact disk player and mini disk player (Tray, Changer, Panel)

Ordering Information

Device	Package	Operating Temp.
FAN8037	48-QFPH-1414	−35°C ~ +85°C

Rev. .1.0.1
May. 2000.

1

Pin Assignments
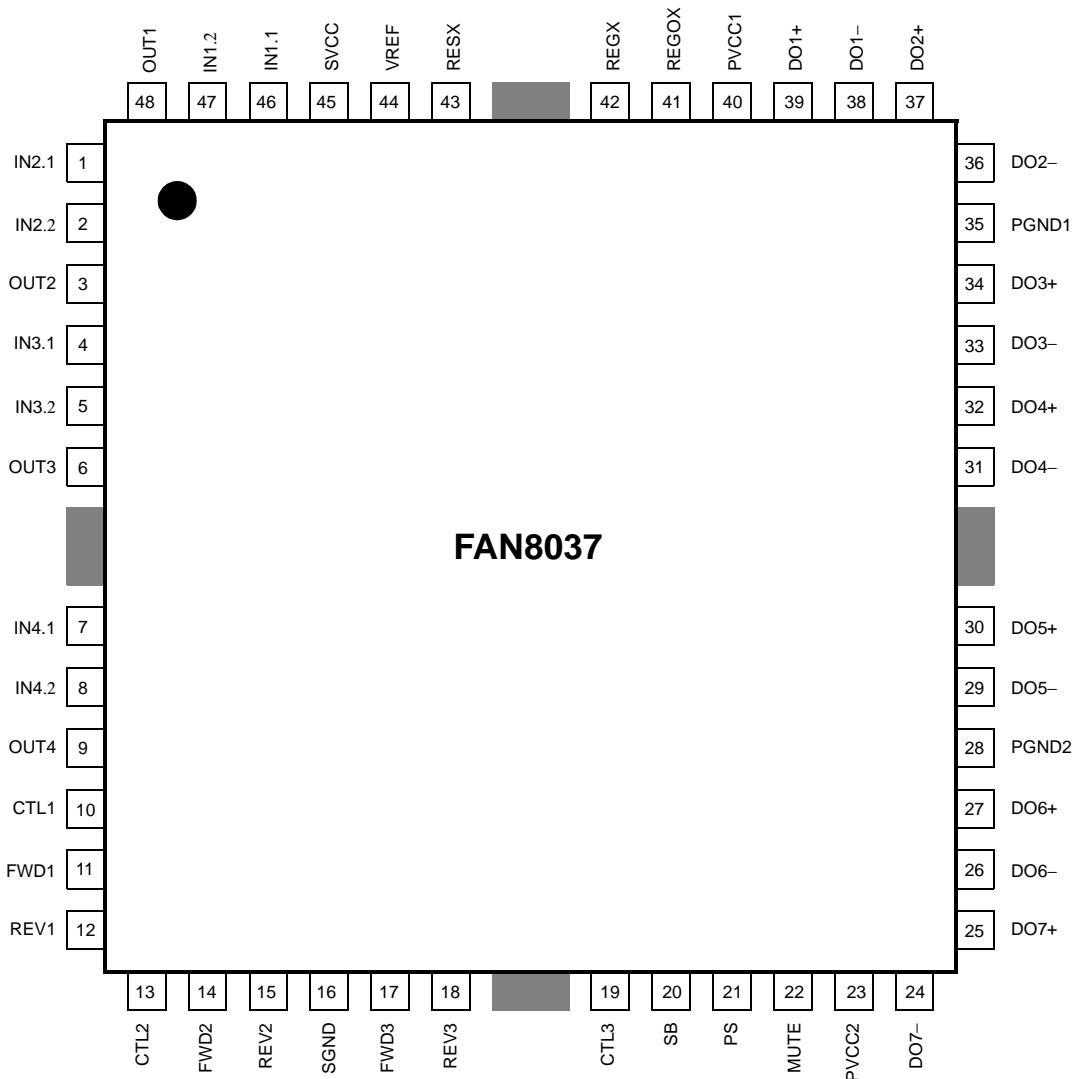
Pin Definitions

Pin Number	Pin Name	I/O	Pin Function Descrition
1	IN2.1	I	CH2 op-amp input (+)
2	IN2.2	I	CH2 op-amp input (−)
3	OUT2	O	CH2 op-amp output
4	IN3.1	I	CH3 op-amp input (+)
5	IN3.2	I	CH3 op-amp input (−)
6	OUT3	O	CH3 op-amp output
7	IN4.1	I	CH4 op-amp input (+)
8	IN4.2	I	CH4 op-amp input (−)
9	OUT4	O	CH4 op-amp output
10	CTL1	I	CH5 motor speed control
11	FWD1	I	CH5 forward input
12	REV1	I	CH5 reverse input
13	CTL2	I	CH6 motor speed control
14	FWD2	I	CH6 forward input
15	REV2	I	CH6 reverse input
16	SGND	-	Signal groung
17	FWD3	I	CH7 forward input
18	REV3	I	CH7 reverse input
19	CTL3	I	CH7 motor speed control
20	SB	I	Stand by
21	PS	I	Power save
22	MUTE	I	All mute
23	PVCC2	-	Power supply voltage (For CH5, CH6, CH7)
24	DO7−	O	CH7 drive ouptut (−)
25	DO7+	O	CH7 drive output (+)
26	DO6−	O	CH6 drive output (−)
27	DO6+	O	CH6 drive output (+)
28	PGND2	-	Power ground2 (FOR CH5, CH6, CH7)
29	DO5−	O	CH5 drive output (−)
30	DO5+	O	CH5 drive output (+)
31	DO4−	O	CH4 drive output (−)
32	DO4+	O	CH4 drive output (+)

Pin Definitions (Continued)

Pin Number	Pin Name	I/O	Pin Function Descrition
33	DO3−	O	CH3 drive output (−)
34	DO3+	O	CH3 drive output (+)
35	PGND1	-	Power ground 1 (FOR CH1, CH2, CH3, CH4)
36	DO2−	O	CH2 drive output (−)
37	DO2+	O	CH2 drive output (+)
38	DO1−	O	CH1 drive output (−)
39	DO1+	O	CH1 drive output (+)
40	PVCC1	-	Power supply voltage (FOR CH1, CH2, CH3, CH4)
41	REGOX	I	Regulator feedback input
42	REGX	O	Regulator output
43	RESX	I	Regulator reset input
44	VREF	I	Bias voltage input
45	SVCC	-	Signal supply voltage
46	IN1.1	I	CH1 op-amp input (+)
47	IN1.2	I	CH1 op-amp input (−)
48	OUT1	O	CH1 op-amp output

Internal Block Diagram
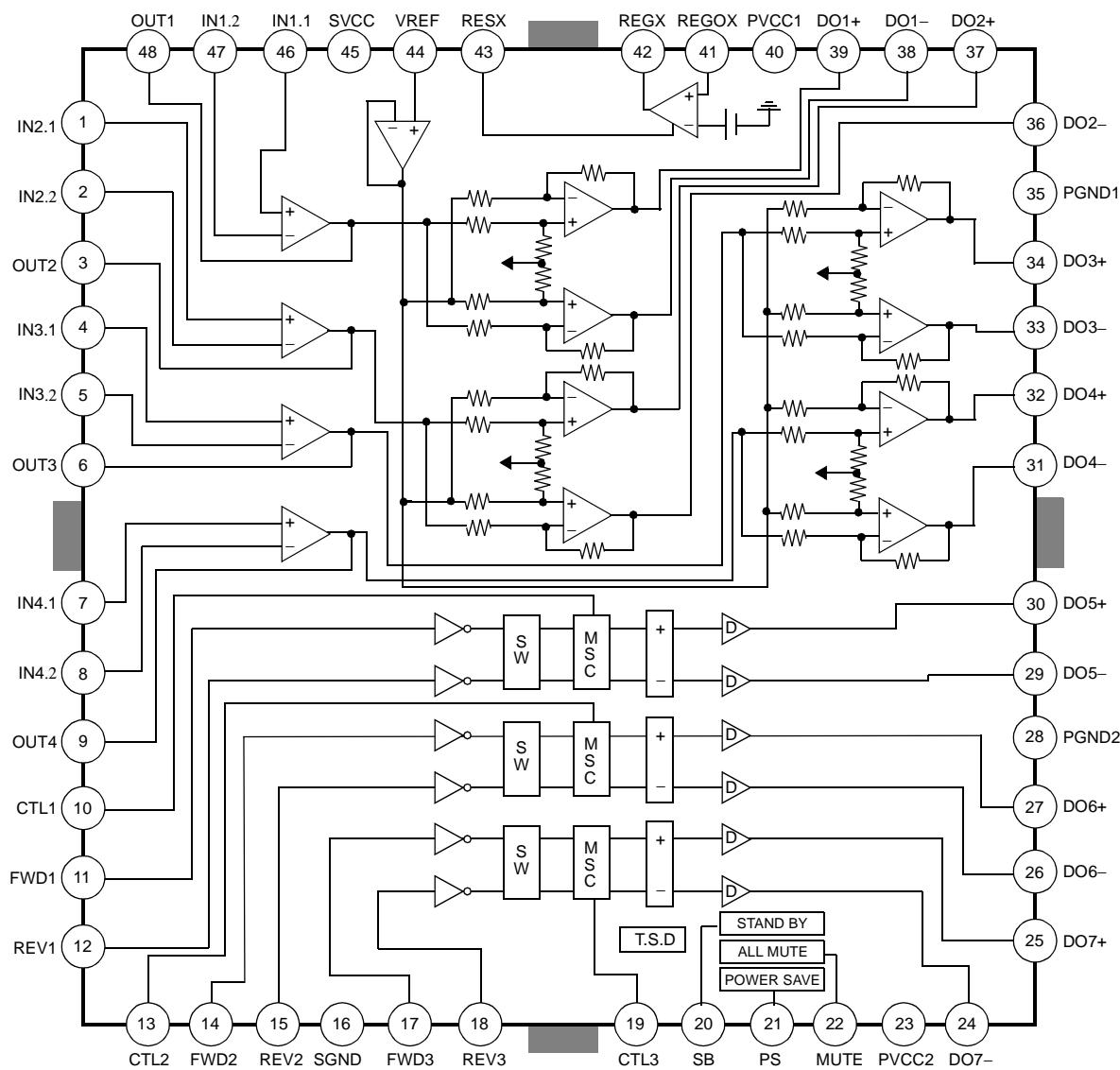
Notes:

1. SW = Logic switch
2. MSC = Motor speed control
3. D = Output driver

Equivalent Circuits

Description	Pin No.	Internal circuit
Input OPIN (+) OPIN (−)	46,47,1,2 4,5,7,8	
Input opout	48,3,6,9	
CTL	10,13,19	
Logic drive FWD input REV input	11,12, 14,15, 17,18	

Equivalent Circuits (Continued)

Description	Pin No.	Internal circuit
Power save Standby	20,21	
Mute	22	
Logic drive output	24, 25 26, 27 29,30	
4-CH drive output	31, 32 33, 34 36, 37 38, 39	
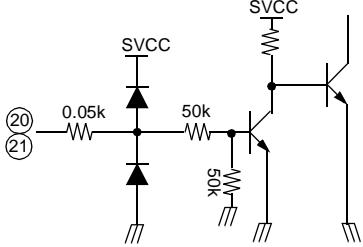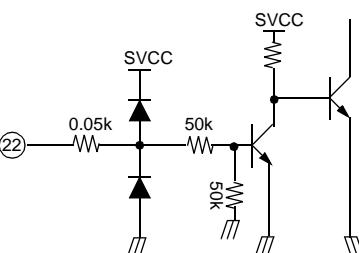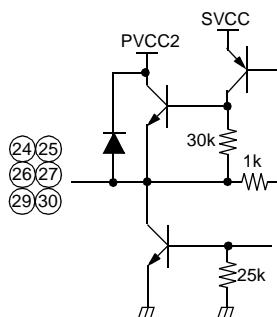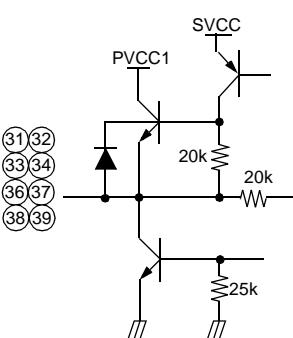
Equivalent Circuits (Continued)

Description	Pin No.	Internal circuit
Ref	44	
RESX	43	
REG0X	41	
REGX	42	

Absolute Maximum Ratings (Ta=25°C)

Parameter	Symbol	Value	Unit
Maximum Supply Voltage	$SVCC_{MAX}$	18	V
	PVCC1	18	V
	PVCC2	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 reduces 24mW/°C for using above T_A = 25°C
3. Do not exceed P_D and SOA (Safe Operating Area)
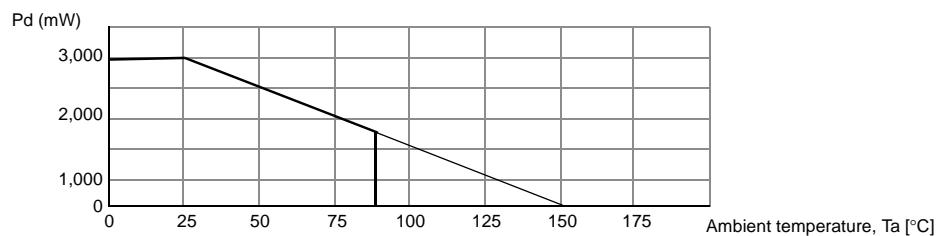
Recommended Operating Conditions (Ta=25°C)

Parameter	Symbol	Min.	Typ.	Max.	Unit
Operating Supply Voltage	SVCC	4.5	-	13.2	V
	PVCC1	4.5	-	SVCC	V
	PVCC2	4.5	-	SVCC	V

Electrical Characteristics

(SV$_{CC}$ = PV$_{CC1}$ = PV$_{CC2}$ = 8V, T$_A$ = 25°C, unless otherwise specified)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
Quiescent circuit current	I$_{CC}$	Under no-load	15	25	35	mA
Power save on current	I$_{PS}$	Pin21=GND	-	1	2	mA
Stand by on voltage	V$_{SBON}$	Pin20=Variation	-	-	0.5	V
Stand by off voltage	V$_{SBOFF}$	Pin20=Variation	2	-	-	V
Power save on voltage	V$_{PSON}$	Pin21=Variation	-	-	0.5	V
Power save off voltage	V$_{PSOFF}$	Pin21=Variation	2	-	-	V
All mute on voltage	V$_{MON}$	Pin22=Variation	-	-	0.5	V
All mute off voltage	V$_{MOFF}$	Pin22=Variation	2	-	-	V
DRIVER CIRCUIT (R$_L$=12Ω)						
Output offset voltage	V$_{OO}$	V$_{IN}$=2.5V	–80	-	+80	mV
Maximum output voltage 1	V$_{OM1}$	V$_{CC}$=PV$_{CC1}$=PV$_{CC2}$=8V, R$_L$=12Ω	5.5	6.5	-	V
Maximum output voltage 2	V$_{OM2}$	V$_{CC}$=PV$_{CC1}$=PV$_{CC2}$=13V, R$_L$=24Ω	10.5	11.5	-	V
Closed-loop voltage gain	A$_{VF}$	V$_{IN}$=0.1Vrms,f=1kHz	10.5	12	13.5	dB
Slew rate	SR	Square, Vout=4Vp-p,f=120kHz	-	2	-	V/μs
INPUT OPAMP CIRCUIT						
Input offset voltage	V$_{OF}$	-	–30	-	+30	mV
Input bias current	I$_B$	-	-	-	300	nA
High level output voltage	V$_{OH}$	R$_L$=Open	7.2	7.7	-	V
Low level output voltage	V$_{OL}$	R$_L$=Open	-	0.2	0.5	V
Output sink current	I$_{SINK}$	R$_L$=50Ω	2	4	-	mA
Output source current	I$_{SOURCE}$	R$_L$=50Ω	2	4	-	mA
Open loop voltage gain	G$_{VO}$	V$_{IN}$=−75dB	-	70	-	dB
Slew rate	SR	Square, Vout=2Vp-p, f=120kHz	-	2.5	-	V/μs

Electrical Characteristics (Continued)

(SV$_{CC}$ = PV$_{CC1}$ = PV$_{CC2}$ = 8V, T$_A$ = 25°C, unless otherwise specified)

Parameter	Symbol	Conditions	Min.	Typ.	Max.	Units
TRAY, CHANGER,PANEL DRIVE CIRCUIT (R$_L$=45Ω)						
Input high level voltage	V$_{IH}$	-	2	-	-	V
Input low level voltage	V$_{IL}$	-	-	-	0.5	V
Output voltage 1	V$_{O1}$	V$_{CC}$=8V, V$_{CTL}$=2.5V, R$_L$=12Ω	-	5	-	V
Output voltage 2	V$_{O2}$	V$_{CC}$=8V, V$_{CTL}$=3V, R$_L$=45Ω	-	6	-	V
Output voltage 3	V$_{O3}$	V$_{CC}$=13V, V$_{CTL}$=4.5V, R$_L$=45Ω	-	9	-	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
VARIABLE REGULATOR CIRCUIT						
Load regulation	ΔV$_{RL}$	I$_L$=0 → 200mA	−40	0	+10	V
Line regulation	ΔV$_{CC}$	I$_L$=200mA, V$_{CC}$=6V → 9V	−20	0	+30	mV
Regulator output voltage 1	V$_{REG1}$	I$_L$=100mA	4.75	5.0	5.25	V
Regulator output voltage 2	V$_{REG2}$	I$_L$=100mA	3.135	3.3	3.465	V
Regulator reset on voltage	Reson	Pin43=Varivation	-	-	0.5	V
Regulator reset off voltage	Resoff	Pin43=Varivation	2	-	-	V

Application Information

1. THERMAL SHUTDOWN

- When the chip temperature reaches to 175°C, then the TSD circuit is activated.
- This shuts down the bias current of the output drivers, and all the output drivers are in cut-off state. Thus the chip temperature begins to decrease.
- when the chip temperature falls to 150°C, the TSD circuit is deactivated and the output drivers are normally operated.
- The TSD circuit has the hysteresis temperature of 25°C.
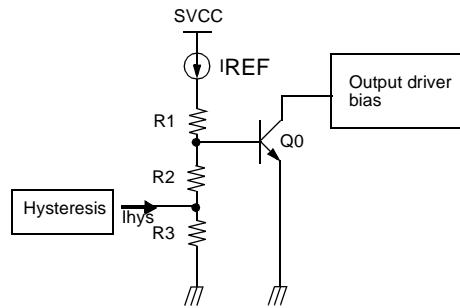
2. ALL MUTE FUNCTION

- When the pin22 is high, the TR Q1 is turned on and Q2 is off, so the bias circuit is enabled. On the other hand, when the pin22 is Low (GND) , the TR Q1 is turned off and Q2 is on, so the bias circuit is disabled.
- This function will cause all the output drivers to be in mute state.
- Truth table is as follows;

Pin#22	FAN8037
HIGH	MUTE-OFF
LOW	MUTE-ON
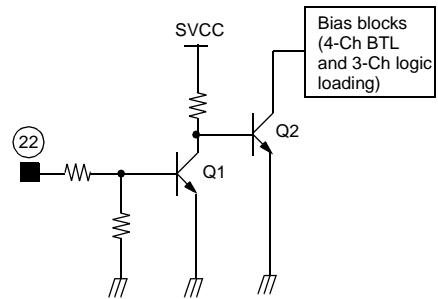
3. POWER SAVE FUNCTION

- When the pin21 is high, the TR Q3 is turned on and Q4 is off, so the bias circuit is enabled. On the other hand, when the pin21 is Low (GND) , the TR Q3 is turned off and Q4 is on, so the bias circuit is disabled.
- That is, this function will cause all the circuit blocks of the chip except for the variable regulator to be in the off state. thus the low power quiescent state is established
- Truth table is as follows;

Pin#21	FAN8037
HIGH	POWER SAVE OFF
LOW	POWER SAVE ON
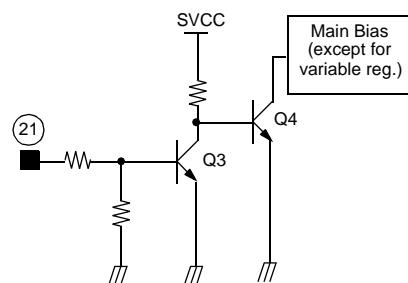
4. STANDBY FUNCTION

- When the pin20 is high, the TR Q5 is turned on and Q6 is off, and the bias circuit is enabled. On the other hand, when the pin20 is Low (GND) , the TR Q5 is turned off and Q6 is on, and the bias circuit is disabled.
- This function will cause the output drivers of the 4-CH BTL circuit (Focus, Tracking, Spindle, Sled) to be in off state.
- Truth table is as follows

Pin20	KA3037
HIGH	STANDBY OFF
LOW	STANDBY ON
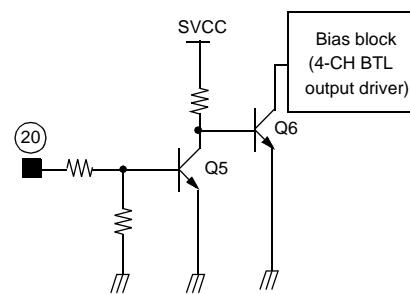
5. REGULATOR & RESET FUNCTION

The regulator and reset circuits are illustrated in the figure 1.

- The external circuit is composed of the PNP transistor(KSB772), capacitor(about 33μF) and 2 feedback resistors.
- The capacitor is used as a ripple filter and should have good temperature characteristics.
- The regulator output voltage is determined as follows.
  $V_{REG} = (1+R1/R2) \times 2.5$
- When the voltage of the pin 43 (Vreset) is high, the regulator circuit operates normally. If the voltage of pin 43 is low, the regulator circuit is disabled .
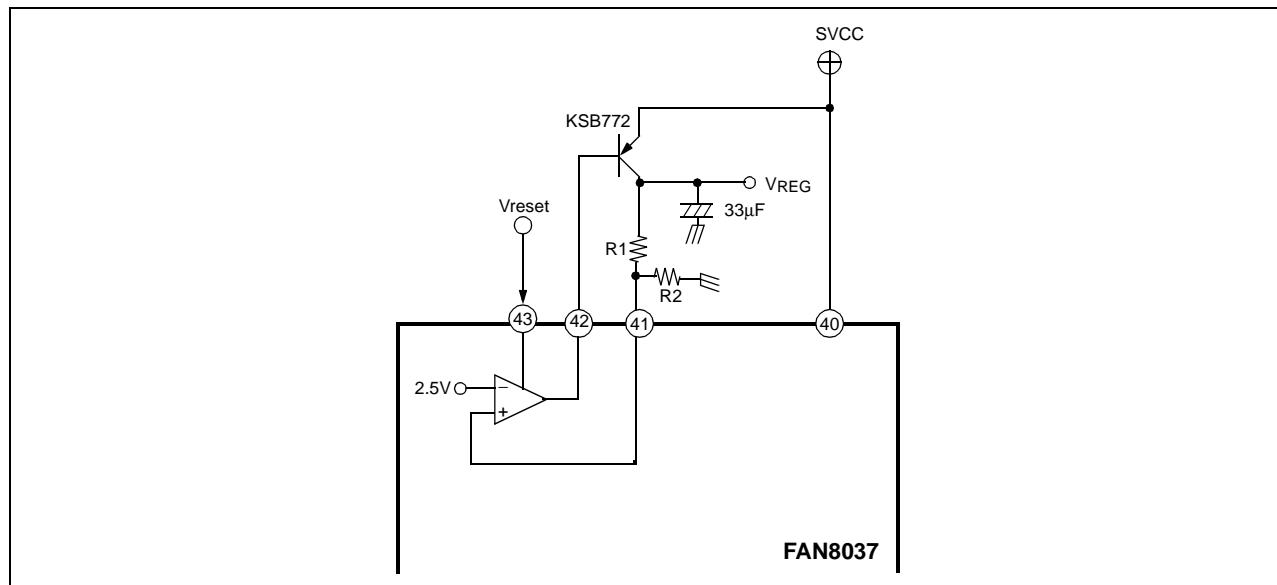
Figure 1. Regulator circuit

6. FOCUS, TRACKING ACTUATOR, SPINDLE, SLED MOTOR DRIVE PART
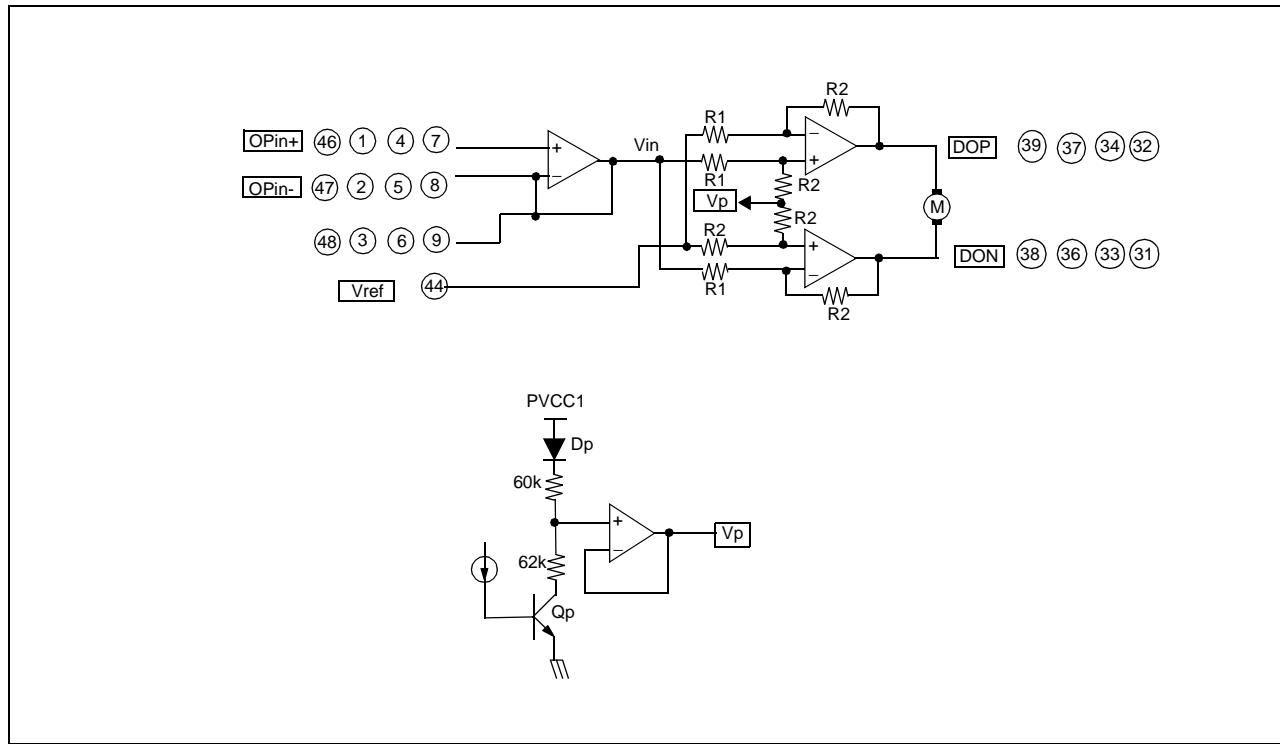
- Vref is given by the external bias voltage of the pin 44.
- The input signal (Vin) through pins 46, 1, 4 and 7 is amplified one time and then fed to the output stage.
  (assume that input opamp was used as a buffer)
- The total closed loop voltage gain is as follows

$$Vin = Vref + \Delta V$$
$$DOP = Vp + 2\Delta V$$
$$DON = Vp - 2\Delta V$$
$$Vout = DOP - DON = 4\Delta V$$
$$Gain = 20\log\frac{Vout}{\Delta V} = 20\log 4 = 12dB$$

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

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

7. TRAY, CHANGER,PANEL MOTOR DRIVE PART
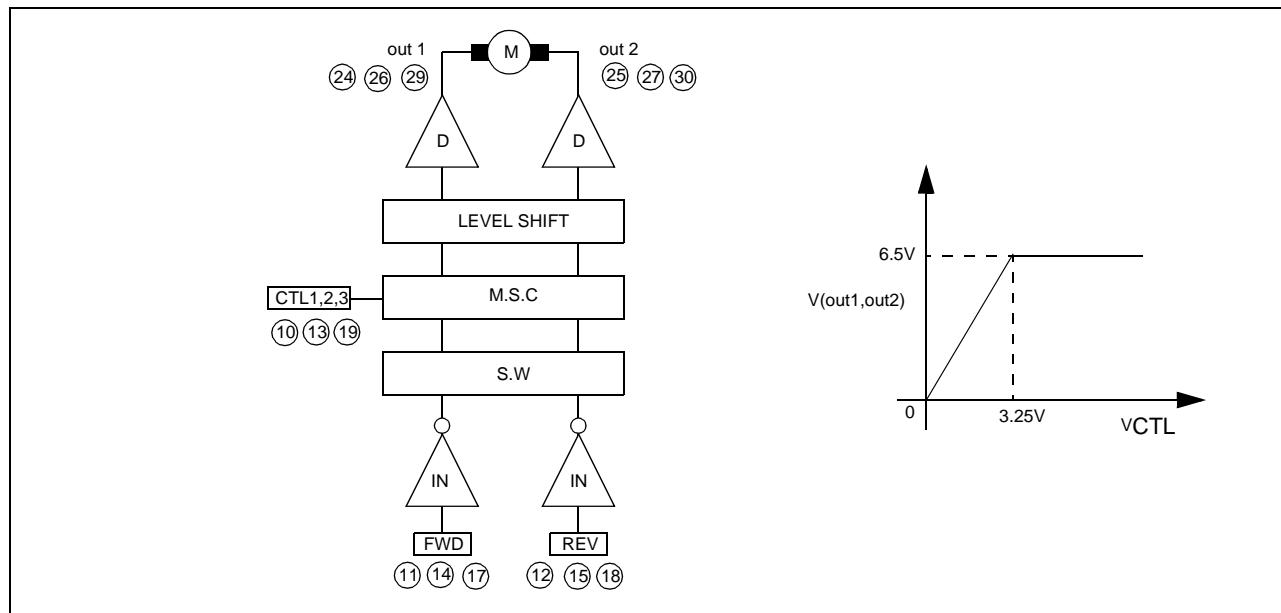
- Rotational direction control
  The forward and reverse rotational direction is controlled by FWD (pin 11,14, 17) and REV (pin 12,15,18) and the input conditions are as follows.

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 about 3.75V at PVCC2=8V) according to equation (1).
- Where out1 pins are pins24,26,29 and out2 pins are pins25,27,30
- Motor speed control (When SVCC=PVCC2=8V)
  - Maximum torque is obtained when the pins (10,13 and 19 (CTL1, 2, 3)) are open.
  - If the voltages of the pins (10,13 and 19 (CTL1, 2, 3)) are 0V, the motor will not operate.
  - When the control voltage of the pins 10,13 and 19 (CTL1, 2, 3) are between 0 and 3.25V, the differential output voltage(V(out1,out2)) is about two times of control voltage. Hence, the control to the differential output gain is two.
  - When the control voltage is greater than 3.25V, the output voltage is saturated at the 6.5V due to the output swing limitation.

8. BOOTSTRAPPED OPERATION

- IC has two kinds of power supplies, the power supply , SVCC is for predrivers and the other circuit blocks(SVCC). PVCC1 and PVCC2 are for the power transistors.
- When SVCC=PVCCn $(n=1,2)$, no bootstrapped operation occurs. Thus the single-ended maximum output voltage is

$$SVCC - (VcesatQ3 + Vbe1) \cong SVCC - 1V$$

- If larger output swing is requied, use the bootstrap function. When

  $SVCC > PVCCn + 1V$ the bootsrap function is operated.
- In this mode, the single-ended maximum output voltage is

  $PVCCn - VcesatQ1 \cong PVCCn - 0.5$; Thus wide output dynamic range can be obtained.
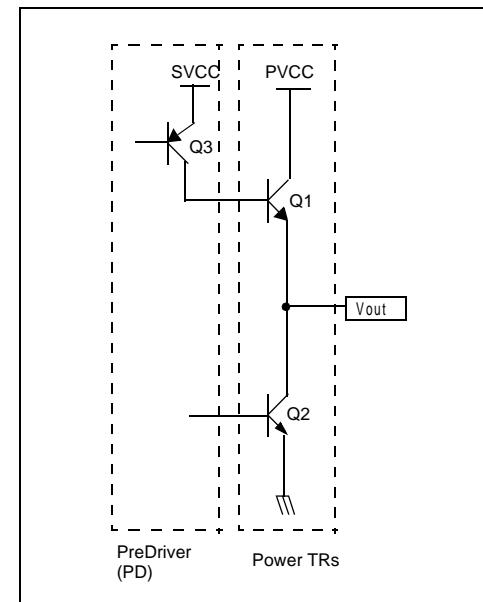
Typical Performance Characteristics
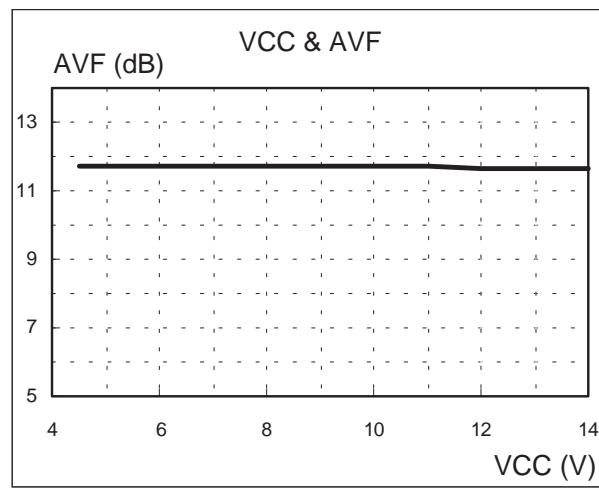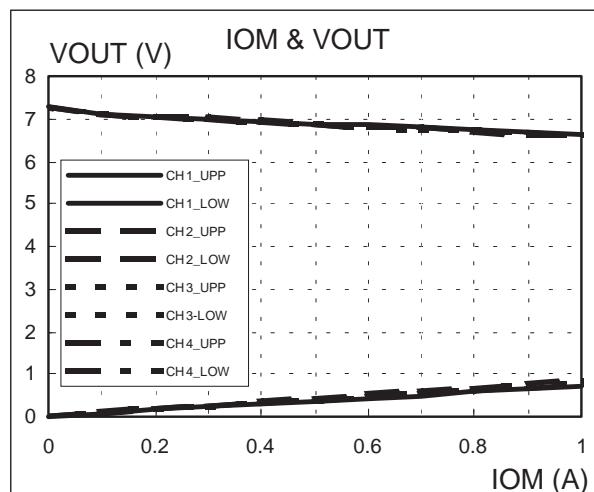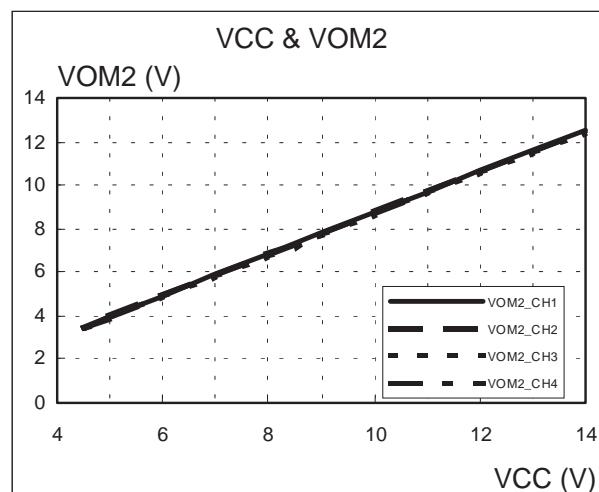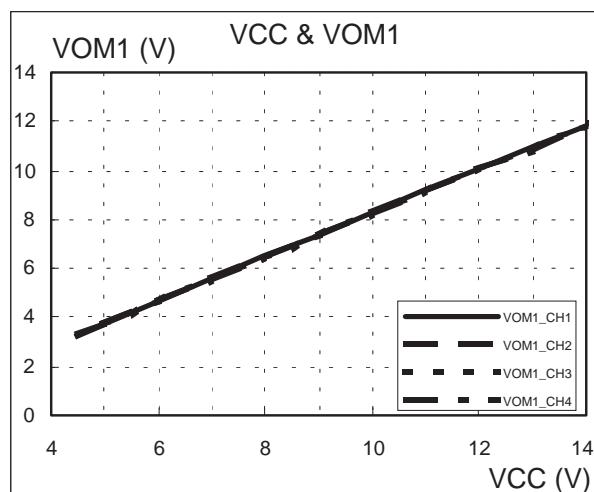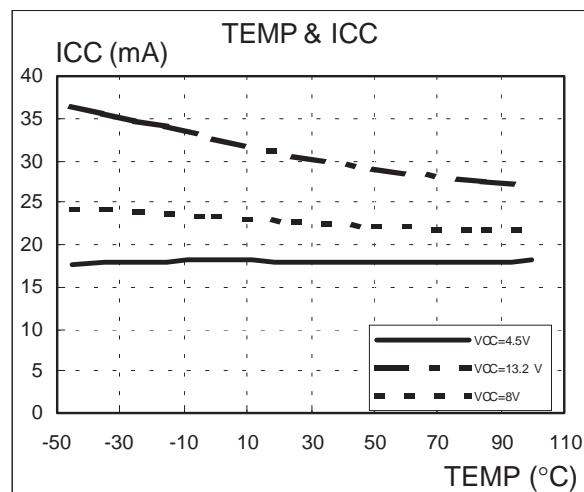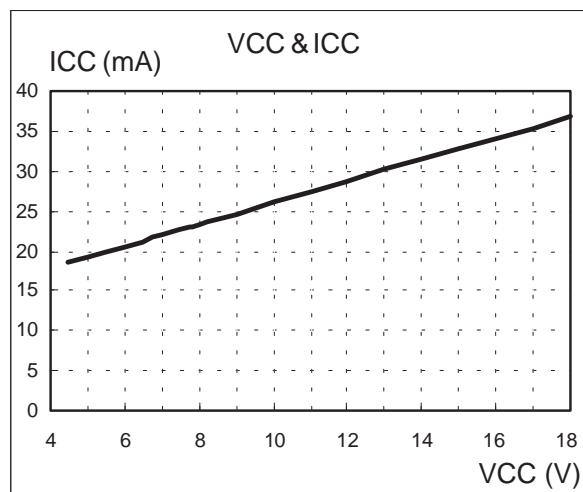
VCC & ICC

ICC (mA)

TEMP & ICC

ICC (mA)

VCC=4.5V
VCC=13.2 V
VCC=8V

VCC & VOM1

VOM1 (V)

VOM1_CH1
VOM1_CH2
VOM1_CH3
VOM1_CH4

VCC & VOM2

VOM2 (V)

VOM2_CH1
VOM2_CH2
VOM2_CH3
VOM2_CH4

IOM & VOUT

VOUT (V)

CH1_UPP
CH1_LOW
CH2_UPP
CH2_LOW
CH3_UPP
CH3-LOW
CH4_UPP
CH4_LOW

VCC & AVF

AVF (dB)

Typical Performance Characteristics (Continued)

TEMP & VOM

VCC & VO1

Vctl & VO (Loading)

TEMP & VO (Loading)

VCC&VREG

TEMP & VREG

Typical Performance Characteristics (Continued)

VCC & Isource

Isource (mA)

VCC(V)

VCC & Isink

Isink (mA)

VCC(V)
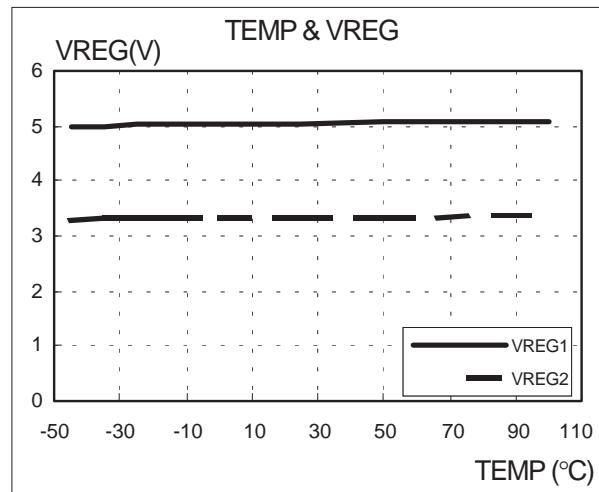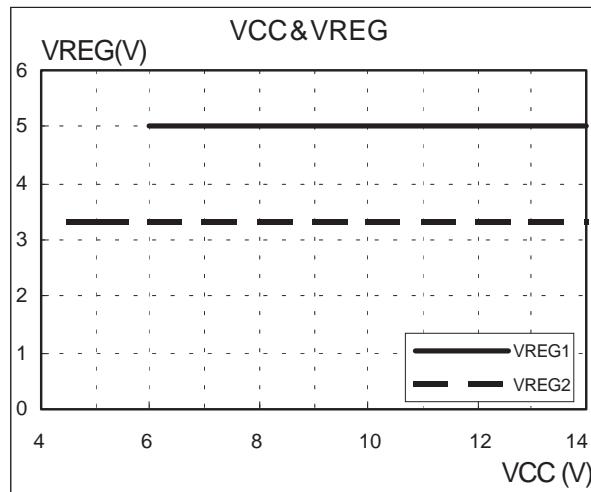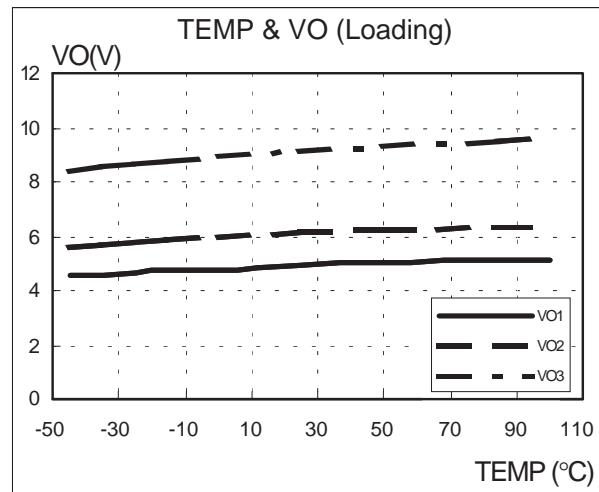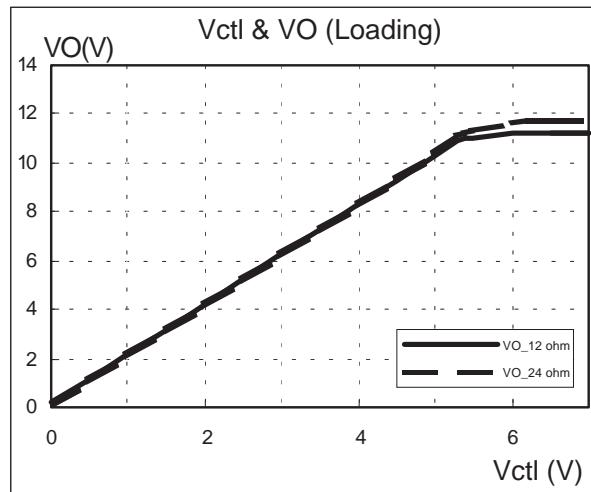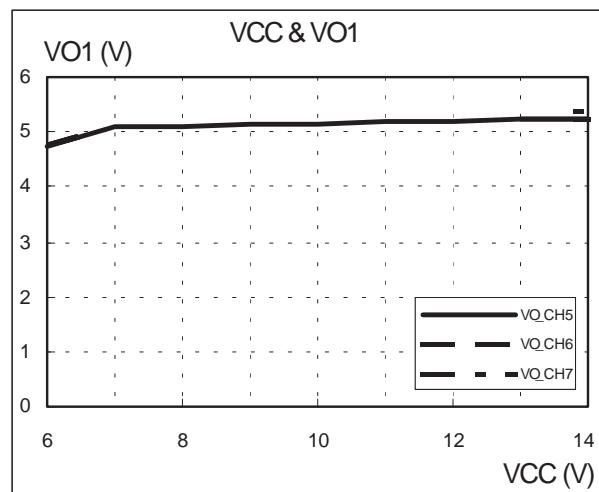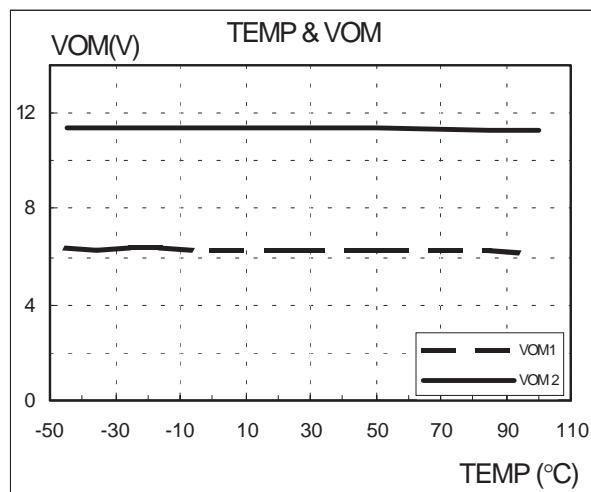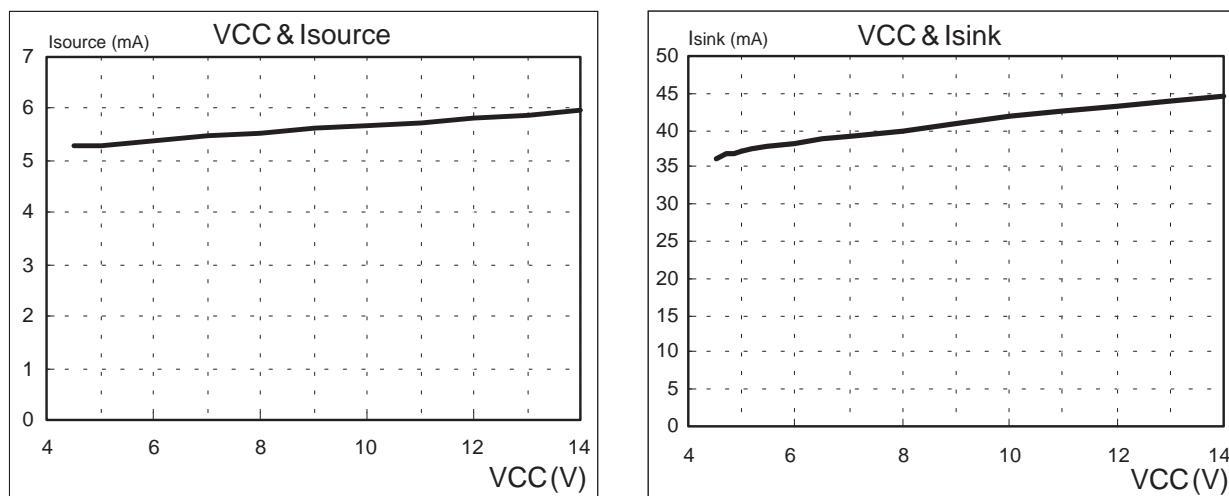
Test Circuits
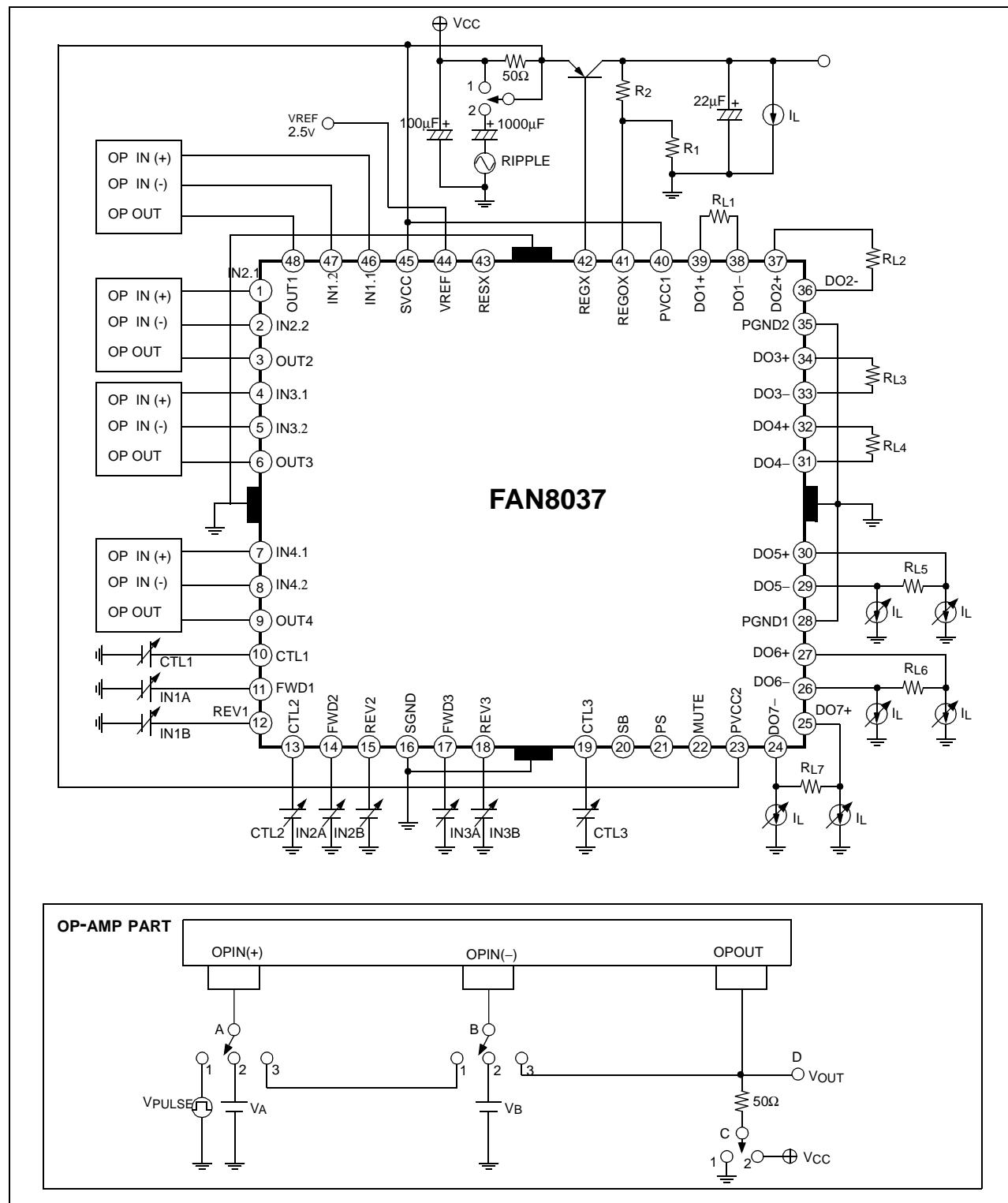
Typical Application Circuits 1

[Voltage control mode]
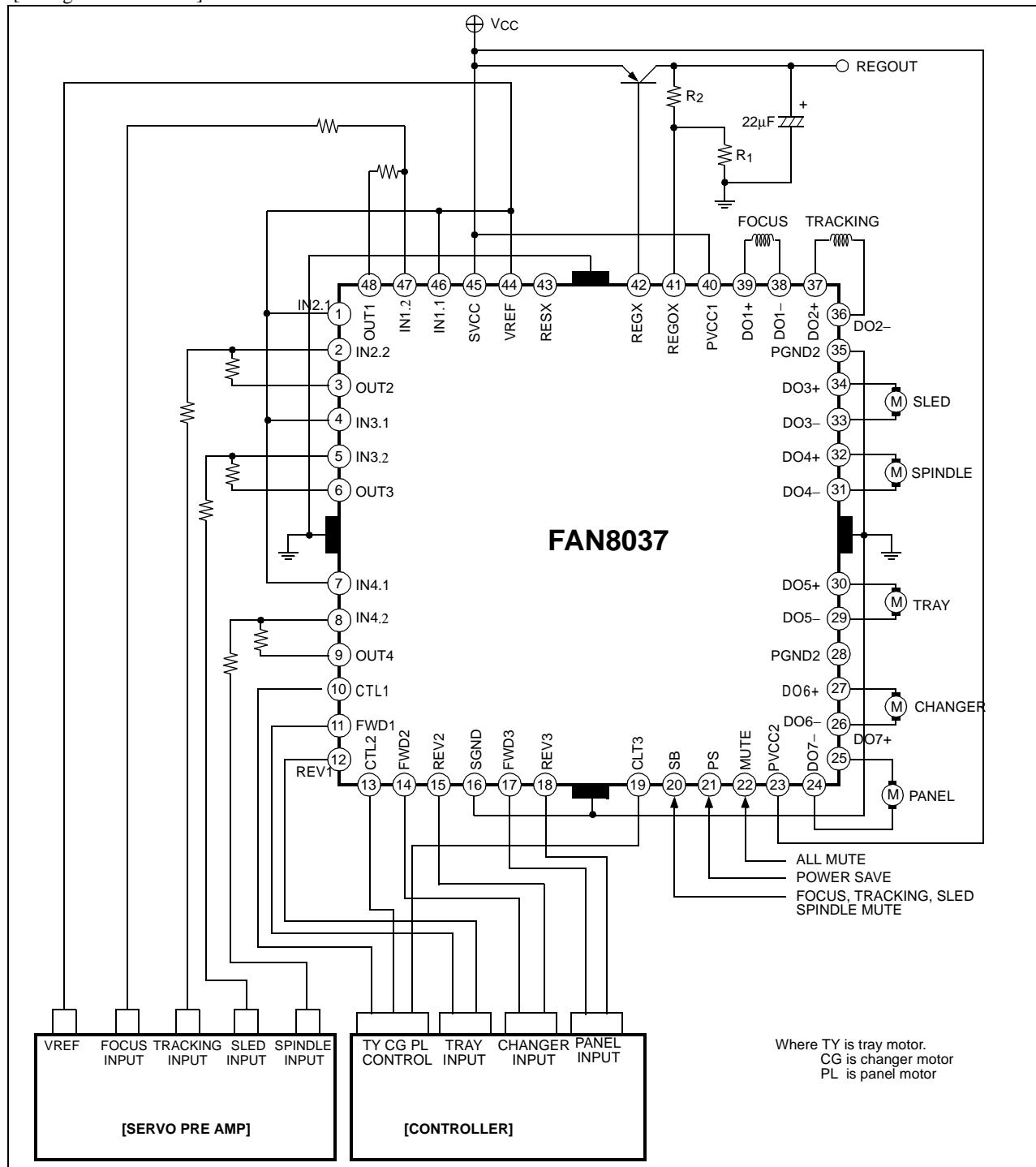

Notes:

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

Connect the pin to the external GND.

Typical Application Circuits 2

[Differential PWM control mode]


Where TY is tray motor.
CG is changer motor
PL is panel motor

Notes:
Radiation pin is connected to the internal GND of the package.
Connect the pin to the external GND

48-QFPH-1414

17.20 ±0.30

14.00 ±0.20

17.20 ±0.30

14.00 ±0.20

(4.85)

#48

#1

0.30 +0.10 -0.05

⊕ 0.10MAX

(0.825)

0.65

3.00MAX

2.60 ±0.10

⬭ 0.10MAX

0.00~0.25

0.20 +0.10 -0.05

0~8°

0.80 ±0.20
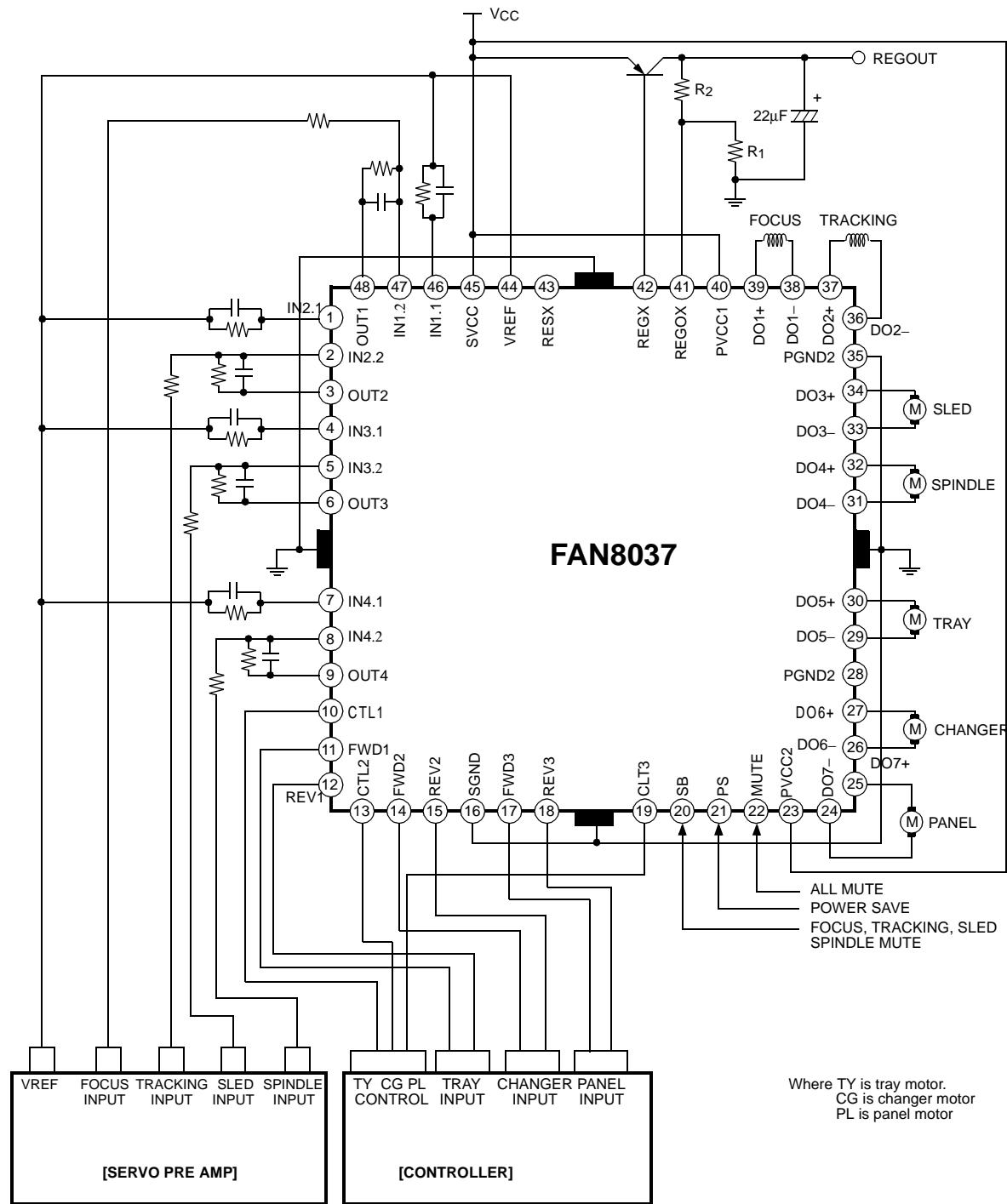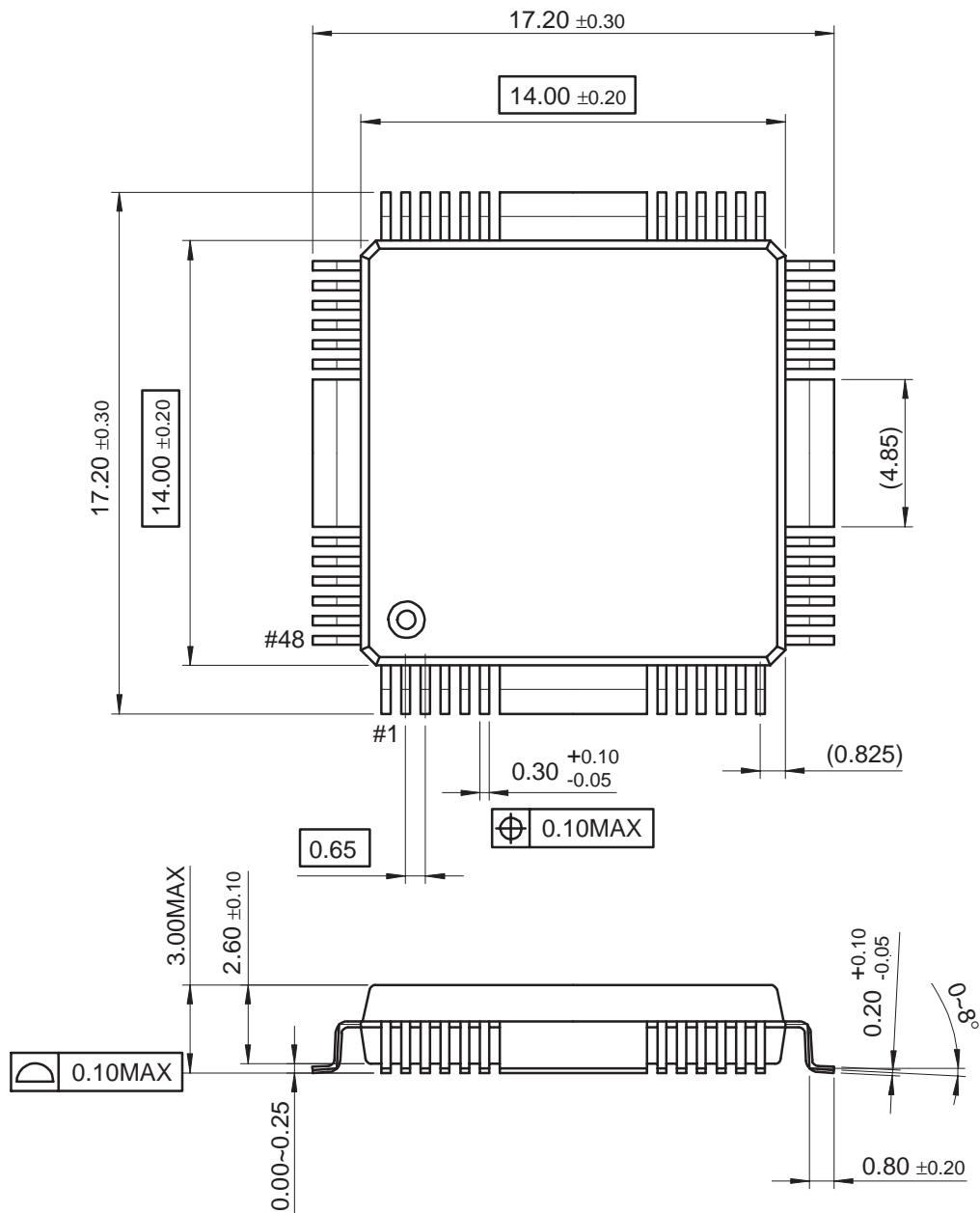
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E²CMOS™	MICROWIRE™	SuperSOT™-6	
EnSigna™	OPTOLOGIC™	SuperSOT™-8	
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1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, or (c) whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in significant injury to the user.

2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

PRODUCT STATUS DEFINITIONS

Definition of Terms

Datasheet Identification	Product Status	Definition
Advance Information	Formative or In Design	This datasheet contains the design specifications for product development. Specifications may change in any manner without notice.
Preliminary	First Production	This datasheet contains preliminary data, and supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice in order to improve design.
No Identification Needed	Full Production	This datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice in order to improve design.
Obsolete	Not In Production	This datasheet contains specifications on a product that has been discontinued by Fairchild semiconductor. The datasheet is printed for reference information only.