

FAN8729

Spindle+4-CH Motor Drive IC

Features

- Built-in Power Save Circuit
- Built-in Current Limit Circuit
- Built-in Thermal Shutdown Circuit (TSD)
- Built-in TSD Monitor Circuit
- Built-in FG Signal Output Circuit
- Built-in Rotational Direction Detecting Circuit
- Built-in Protection Circuit For Reverse Rotation
- Built-in 4-CH Balanced Transformerless (BTL) Driver
- Built-in BTL MUTE Circuit (CH123 and CH4)
- Corresponds to 3.3V DSP

Description

The FAN8729 is a monolithic integrated circuit built-in 4Channel BTL motor and spindle motor drivers, which can drive tracking actuator, focus actuator, sled motor, loading motor, 3-phase BLDC motor, and it is applicable to DVD-P/MDP/CAR-MD/CAR-NAVIGATION systems.



Typical Application

- Mini Disk Player
- Digital Video Disk Player
- Car Mini Disk Player
- Car navigation System

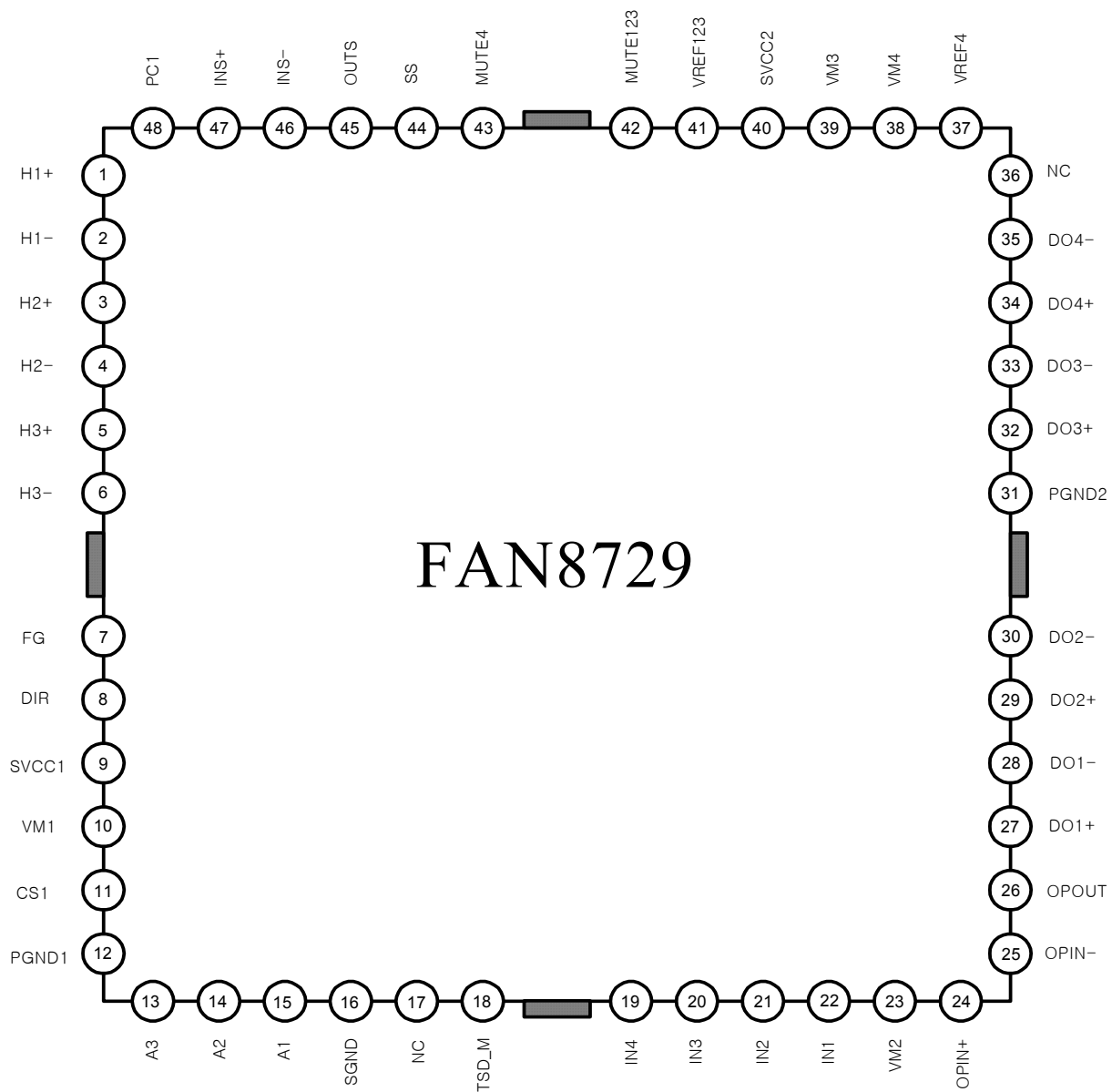
Ordering Information

| Device | Package | Operating Temperature |
|-----------------|--------------|-----------------------|
| FAN8729 | 48-QFPH-1414 | -35°C ~ +85°C |
| FAN8729_NL*note | 48-QFPH-1414 | -35°C ~ +85°C |

***Note:**

NL: Lead free Type

Pin Assignments



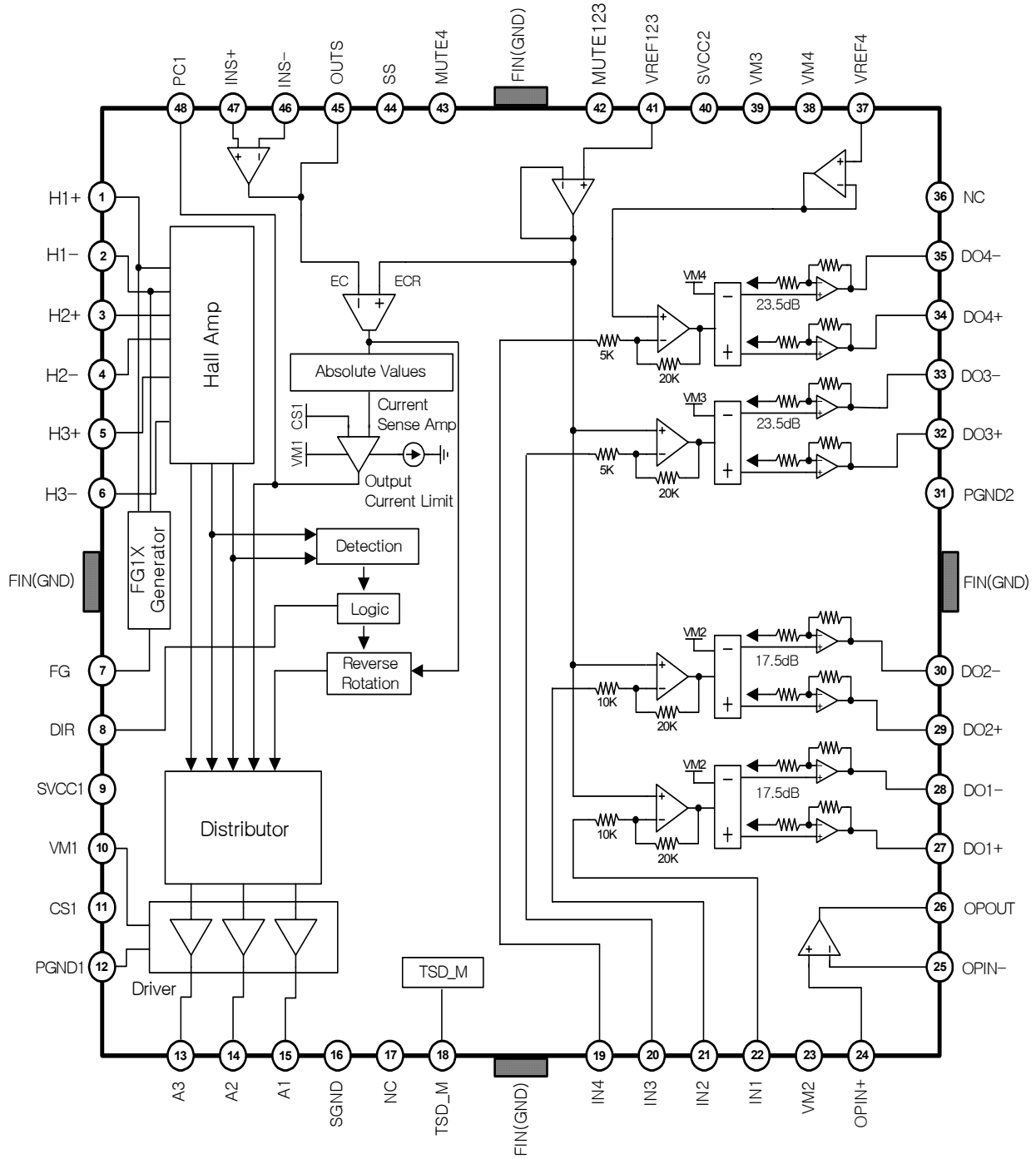
Pin Definitions

| Pin Number | Pin Name | I/O | Pin Function Description |
|------------|----------|-----|--------------------------|
| 1 | H1+ | I | Hall1(+) Input |
| 2 | H1- | I | Hall1(-) Input |
| 3 | H2+ | I | Hall2(+) Input |
| 4 | H2- | I | Hall2(-) Input |
| 5 | H3+ | I | Hall3(+) Input |
| 6 | H3- | I | Hall3(-) Input |
| 7 | FG | O | FG Output |
| 8 | DIR | O | Direction |
| 9 | SVCC1 | - | Signal VCC1 |
| 10 | VM1 | - | BLDC Motor Power Supply |
| 11 | CS1 | I | Current Sensor |
| 12 | PGND1 | - | Power Ground1 |
| 13 | A3 | O | 3-Phase Output 3 |
| 14 | A2 | O | 3-Phase Output 2 |
| 15 | A1 | O | 3-Phase Output 1 |
| 16 | SGND | - | Signal Ground |
| 17 | NC | - | NC |
| 18 | TSD_M | O | TSD Monitor |
| 19 | IN4 | I | CH4 Input |
| 20 | IN3 | I | CH3 Input |
| 21 | IN2 | I | CH2 Input |
| 22 | IN1 | I | CH1 Input |
| 23 | VM2 | - | BTL CH1,2 Supply Voltage |
| 24 | OPIN+ | I | Normal OP-AMP Input(+) |
| 25 | OPIN- | I | Normal OP-AMP Input(-) |
| 26 | OPOUT | O | Normal OP-AMP Output |
| 27 | DO1+ | O | BTL Drive 1 Output(+) |
| 28 | DO1- | O | BTL Drive 1 Output(-) |
| 29 | DO2+ | O | BTL Drive 2 Output(+) |
| 30 | DO2- | O | BTL Drive 2 Output(-) |
| 31 | PGND2 | - | BTL Power Ground2 |
| 32 | DO3+ | O | BTL Drive 3 Output(+) |
| 33 | DO3- | O | BTL Drive 3 Output(-) |

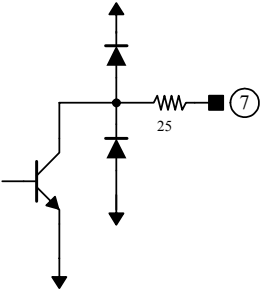
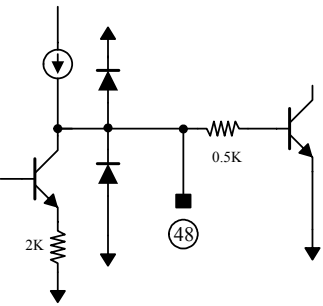
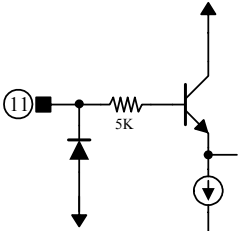
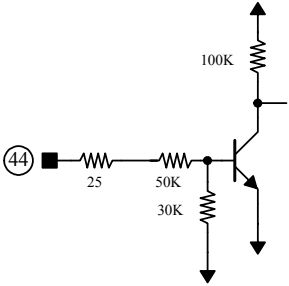
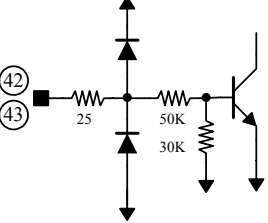
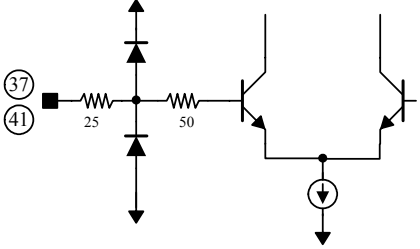
Pin Definitions (Continued)

| Pin Number | Pin Name | I/O | Pin Function Description |
|------------|----------|-----|--------------------------|
| 34 | DO4+ | O | BTL Drive 4 Output(+) |
| 35 | DO4- | O | BTL Drive 4 Output(-) |
| 36 | NC | - | NC |
| 37 | VREF4 | I | BTL CH4 Reference |
| 38 | VM4 | - | BTL CH4 Motor Supply |
| 39 | VM3 | - | BTL CH3 Motor Supply |
| 40 | SVCC2 | - | BTL Signal VCC |
| 41 | VREF123 | I | BTL CH1,2,3 Reference |
| 42 | MUTE123 | I | BTL CH1,2,3 Mute |
| 43 | MUTE4 | I | BTL CH4 Mute |
| 44 | SS | I | Spindle Start/Stop |
| 45 | OUTS | O | OP-AMP Spindle Output |
| 46 | INS- | I | OP-AMP Spindle Input(-) |
| 47 | INS+ | I | OP-AMP Spindle Input(+) |
| 48 | PC1 | I | Phase Compensation Cap. |

Internal Block Diagram



Equivalent Circuits

| FG Signal Output | Phase Compensation Capacitor |
|---|--|
|  |  |
| Current Detector | Start/Stop |
|  |  |
| BTL Drive Mute | BTL Bias Voltage |
|  |  |

Equivalent Circuits (Continued)

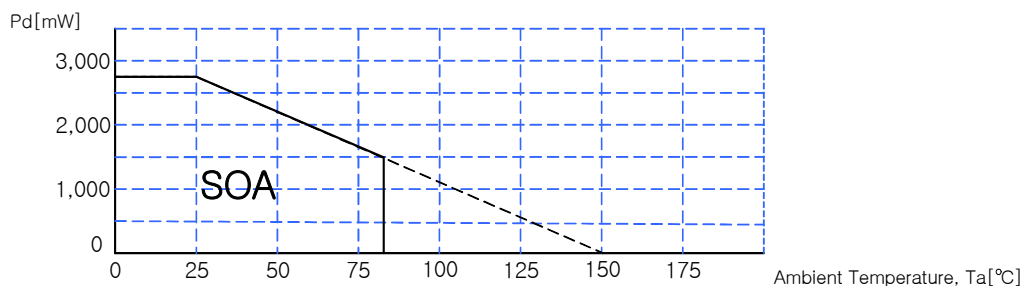
| | |
|---|--|
| <p style="text-align: center;">3-Phase Rotational Direction Output</p> | <p style="text-align: center;">BTL Drive Output</p> |
| <p style="text-align: center;">3-Phase Output</p> | <p style="text-align: center;">TSD_M</p> |
| <p style="text-align: center;">BTL Input(CH1,2)</p> | <p style="text-align: center;">BTL Input(CH3,4)</p> |
| <p style="text-align: center;">OP-AMP Input</p> | <p style="text-align: center;">OP-AMP Output</p> |
| <p style="text-align: center;">SVCC</p> | <p style="text-align: center;">SVCC</p> |

Absolute Maximum Ratings (Ta=25°C)

| Parameter | Symbol | Value | Unit |
|---------------------------------------|------------|---------------------|------|
| Supply Voltage (Spindle Signal) | SVCC1max | 7 | V |
| Supply Voltage (BTL Signal) | SVCC2max | 15 | V |
| Supply Voltage (Spindle Motor) | VM1max | 15 | V |
| Supply Voltage (BTL Motor) | VM2,3,4max | 15 | V |
| Power Dissipation | Pd | 2.7 ^{note} | W |
| Operating Temperature Range | Topr | -35 ~ +85 | °C |
| Storage Temperature Range | Tstg | -55 ~ +150 | °C |
| Maximum Output Current (Spindle Part) | IOMAXS | 1.3 | A |
| Maximum Output Current (BTL Part) | IOMAXB | 1 | A |

Note:

1. When mounted on the PCB (phenolic resin material) of which size is 114mm × 76mm x1.6mm.
2. Power dissipation is reduced with the rate of -21.6mW/°C for TA≥25°C.
3. Do not exceed Pd and SOA.



Recommended Operating Conditions (Ta=25°C)

| Parameter | Symbol | Min. | Type. | Max. | Unit |
|---|---------|------|-------|-------|------|
| Operating Supply Voltage (Spindle Signal) | SVCC1 | 4.5 | - | 5.5 | V |
| Operating Supply Voltage (BTL Signal) | SVCC2 | 4.5 | - | 13.2 | V |
| Operating Supply Voltage (Spindle Motor) | VM1 | 4.5 | - | 13.2 | V |
| Operating Supply Voltage (BTL Motor) | VM2,3,4 | 4.5 | - | SVCC2 | V |

Electrical Characteristics

(Unless otherwise specified, Ta=25°C, SVCC1=5V, VM1=8V, BTL driver part: SVCC2=9V, VM2=5V, RL1=8Ω, VM3=8V, VM4=9V, RL2=15Ω)

| Parameter | Symbol | Condition | Min. | Typ. | Max. | Unit |
|-------------------------------|--------|------------------------|------|------|------|-------|
| Circuit Current 2 | ICC2 | Start/Stop =5V | - | 4.5 | - | mA |
| START/STOP | | | | | | |
| SS On Voltage Range | VSSON | L-H Circuit On | 2.5 | - | - | V |
| SS Off Voltage Range | VSSOFF | H-L Circuit Off | - | - | 1.0 | V |
| HALL AMP | | | | | | |
| Hall Bias Current | IHA | - | - | 1 | 5 | uA |
| Common Mode Voltage Range | VHAR | - | 1.5 | - | 4.0 | V |
| Minimum In Level | VINH | - | 60 | - | - | mVpp |
| TORQUE CONTROL | | | | | | |
| EC Input Voltage Range | EC | | 0.5 | - | 3.3 | V |
| Offset Voltage (-) | ECOFF- | ECR=1.65V | -100 | -50 | -20 | mV |
| Offset Voltage (+) | ECOFF+ | ECR=1.65V | 20 | 50 | 100 | mV |
| Input Current | ECIN | EC=ECR=1.65V | -5 | -1 | - | uA |
| In/Output Gain | GEC | ECR=1.65V, RCS=0.5Ω | 0.56 | 0.71 | 0.84 | A / V |
| FG | | | | | | |
| FG Output Voltage (L) | VFHL | IFG=10uA | - | - | 0.5 | V |
| Input Voltage Range | VFGR | Hn+, Hn- Input D-range | 1.5 | - | 4.0 | V |
| OUTPUT BLOCK | | | | | | |
| Saturation Voltage (Upper TR) | VOH | IO= -300mA | - | 0.9 | 1.6 | V |
| Saturation Voltage (Lower TR) | VOL | IO=300mA | - | 0.2 | 0.6 | V |
| Torque Limit Current | ITL | RCS=0.5Ω | 560 | 700 | 840 | mA |
| DIRECTION DETECTOR | | | | | | |
| DIR Output Voltage (L) | VDIRL | IDIR=10uA | - | - | 0.5 | V |

Electrical Characteristics (continued)

(Unless otherwise specified, Ta=25°C, SVCC1=5V, VM1=8V, BTL driver part: SVCC2=9V, VM2=5V, RL1=8Ω, VM3=8V, VM4=9V, RL2=15Ω)

| Parameter | Symbol | Condition | Min. | Typ. | Max. | Unit |
|---|----------|------------------------|------|------|------|------|
| BTL DRIVE PART | | | | | | |
| Quiescent Circuit Current | ICC3 | - | - | 16.5 | - | mA |
| CH MUTE123 Off Voltage | VMOFF123 | Pin42 = Variation | 2.5 | - | - | V |
| CH MUTE123 On Voltage | VMON123 | Pin42 = Variation | - | - | 1.0 | V |
| CH MUTE4 Off Voltage | VMOFF4 | Pin43 = Variation | 2.5 | - | - | V |
| CH MUTE4 On Voltage | VMON4 | Pin43 = Variation | - | - | 1.0 | V |
| CH1,2 Actuator Driver (SVCC2=9V, VM2=5V, RL1=8Ω) | | | | | | |
| Output Offset Voltage | VOF1,2 | VIN = 1.65V | -50 | - | +50 | mV |
| Maximum Output Voltage1,2 | VOM1,2 | VIN = 1.65V | 3.6 | 4.0 | - | V |
| Close Loop Voltage Gain | GVC1,2 | f=1kHz, VIN= -0.1Vrms | 15.5 | 17.5 | 19.5 | dB |
| Ripple Rejection Ratio*note | RR1,2 | f=120Hz, VIN= -20dB | - | 60 | - | dB |
| Slew Rate 1,2*note | SR1,2 | f=120Hz, 2Vp-p | - | 1.0 | - | V/us |
| CH3 BTL Driver (SVCC2=9V, VM3=8V, RL2=15Ω) | | | | | | |
| Output Offset Voltage3 | VOF3 | VIN = 1.65V | -100 | - | +100 | mV |
| Maximum Output Voltage3 | VOM3 | VIN = 1.65V | 6.5 | 7.0 | - | V |
| Close Loop Voltage Gain | GVC3 | f= 1kHz, VIN= -0.1Vrms | 21.5 | 23.5 | 25.5 | dB |
| Ripple Rejection Ratio3*note | RR3 | f= 120Hz, VIN= -20dB | - | 60 | - | dB |
| Slew Rate 3*note | SR3 | f= 120Hz, 2Vp-p | - | 1.0 | - | V/us |
| CH4 BTL Driver (SVCC2=9V, VM4=9V, RL2=15Ω) | | | | | | |
| Output Offset Voltage4 | VOF4 | VIN = 1.65V | -100 | - | +100 | mV |
| Maximum Output Voltage4 | VOM4 | VIN = 1.65V | 7.0 | 7.5 | - | V |
| Close Loop Voltage Gain | GVC4 | f= 1kHz, VIN= -0.1Vrms | 21.5 | 23.5 | 25.5 | dB |
| Ripple Rejection Ratio4*note | RR4 | f= 120Hz, VIN= -20dB | - | 60 | - | dB |
| Slew Rate 4*note | SR4 | f= 120Hz, 2Vp-p | - | 1.0 | - | V/us |
| OP- AMP | | | | | | |
| Input Offset Voltage | VOF | - | -20 | - | +20 | mV |
| Input Bias Current | IB1 | - | - | - | 300 | nA |
| High Level Output Voltage | VOHOP | - | 8 | - | - | V |
| Low Level Output Voltage | VOLOP | - | - | - | 0.1 | V |
| Output Sink Current | ISINK | - | - | 5.5 | - | mA |
| Output Source Current | ISOURCE | - | - | 4.5 | - | mA |
| Open Loop Voltage Gain*note | GVOOP | f= 1kHz, VIN= -75dB | - | 75 | - | dB |
| Ripple Rejection Ratio*note | RROP | f= 120Hz, VIN= -20dB | - | 65 | - | dB |
| Slew Rate*note | SROP | f= 120Hz, 2Vp-p | - | 1 | - | V/us |
| Common Mode Rejection Ratio*note | CMRROP | f= 1kHz, VIN= -20dB | - | 80 | - | dB |

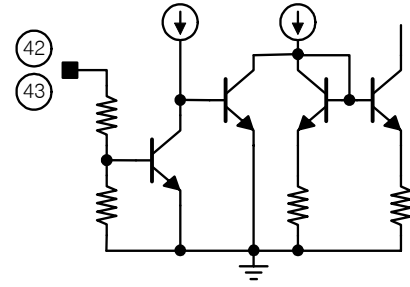
Note: Guaranteed field.(No EDS/Final test)

Application Information

1. MUTE Function

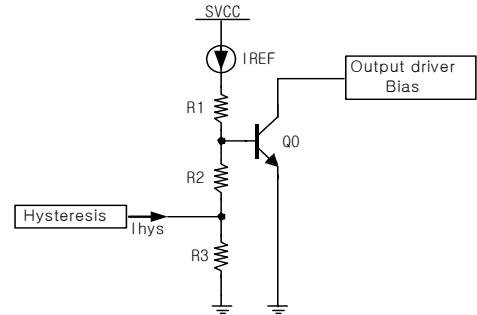
- MUTE circuit turns BTL output ON/OFF.
- When MUTE terminal (pin42, pin43) is OPEN, or terminal voltage is lower than 1V, BTL is disable.
- When MUTE terminal (pin42, pin43) is voltage is higher than 1.5V, BTL output operates normally.
- Feature Table.

| MUTE circuit voltage | MUTE status |
|----------------------|-------------|
| Above 1.5V | OFF |
| Below 1V or Open | ON |



2. TSD Function

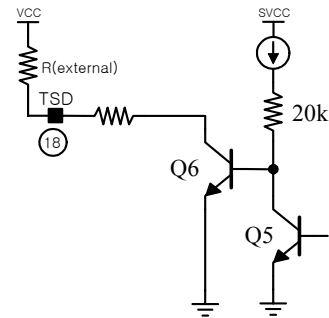
- TSD circuit intercepts all IC output to protect the IC against high temperatures.
- When chip temperature rises above 165°C, BTL and spindle output is disable.
- When chip temperature falls below 140°C, BTL and spindle output operates normally.
- TSD has hysteresis of 25°C.



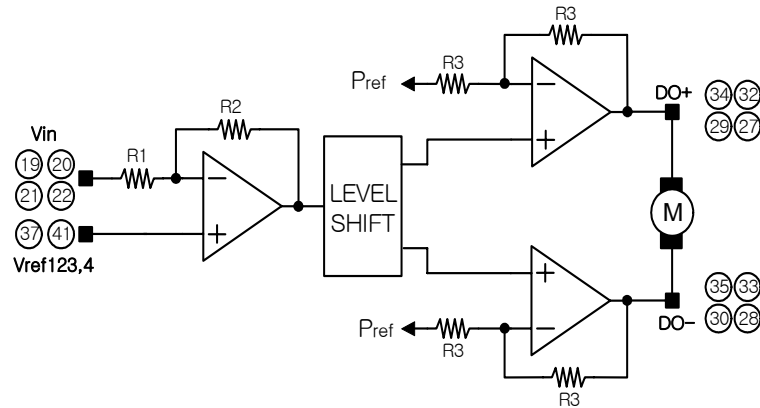
3. TSD Monitor Function

- TSD monitor circuit displays TSD status.
- When TSD is ON, pin18 is HIGH.
- When TSD is OFF, pin18 is LOW.
- Since output pin(PIN18) is open-collector, pull-up resistance should be attached outside.
- Feature Table.

| TSD | Pin18 |
|---------|-------|
| TSD On | High |
| TSD Off | Low |



4. CH1,2,3,4 Balanced Transformerless (BTL) Drive



- Diagram above shows each input/output BTL channel structure.
- When BTL input voltage is V_{ref} , the output voltage is P_{ref} . P_{ref} has the value of $V_M/2$.
- BTL Channel's output voltage is found as follows;

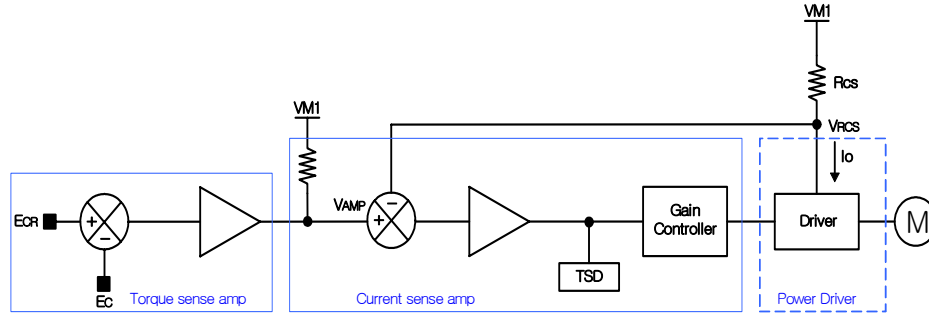
$$Do+ = P_{ref} + \frac{R2}{R1} \times \left(1 + \frac{R3}{R3}\right) \times (V_{in} - V_{ref})$$

$$Do- = P_{ref} - \frac{R2}{R1} \times \left(1 + \frac{R3}{R3}\right) \times (V_{in} - V_{ref})$$

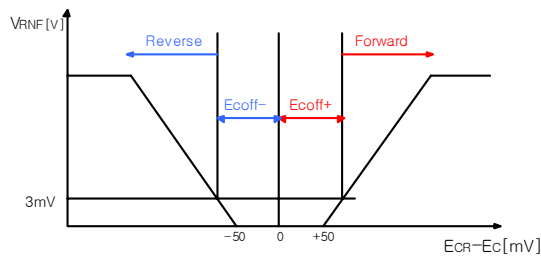
- BTL gain value is found as follows;

$$Gain = 4 \times \frac{R2}{R1}$$

5. Spindle

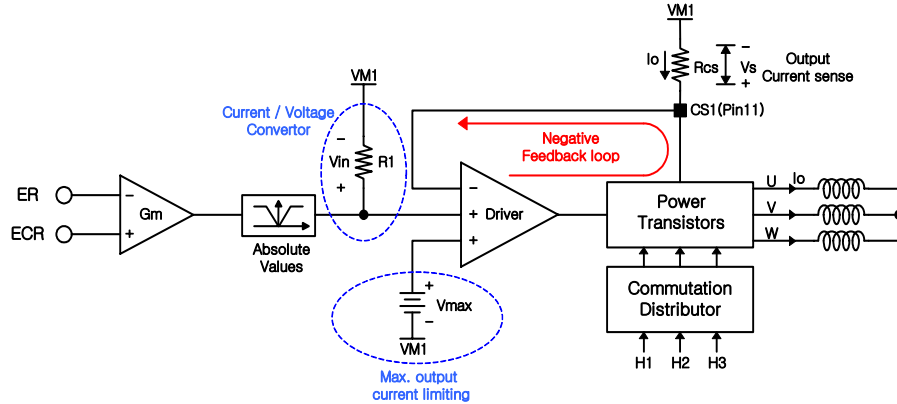


- The spindle driver circuit consists of 3 section: Torque sense amp, Current sense amp, and Power driver.
- Torque sense amp compares and amplifies EC and ECR signals from SERVO, and sends them to current sense amp. With voltage comparison, it determines the signal as forward or reverse.
- Current sense amp limits the current in Motor(Io) by comparing output current signal from torque sense amp with the current of RCS.
- Power driver output the current to the motor based on the current generated form current sense amp.
- Feature Table



| | Rotation |
|------------|---------------------------------------|
| $EC < ECR$ | Forward rotation |
| $EC > ECR$ | Stop after detecting reverse rotation |

6. Calculation of Gain & Torque Current



- Torque limit circuit limits the current of spindle motor.
- Driver amp circuit limits the current of spindle motor by comparing the voltage detected from RCS and the voltage output from torque sense map.
- Output current of the motor can be limited by adjusting the RCS value.
- Maximum output current of motor is found as follows;

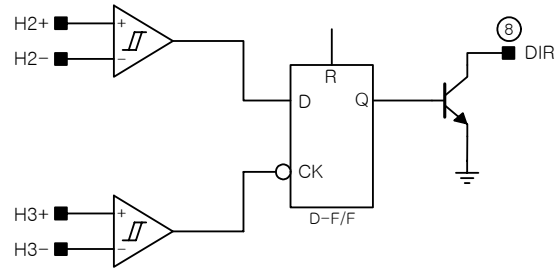
$$I_o[mA] = \frac{V_{\max}}{R_{cs}} = \frac{350mV}{R_{cs}}$$

- VMAX within IC is fixed at 350mV.
- Gm of torque sense amp is set to 0.71.

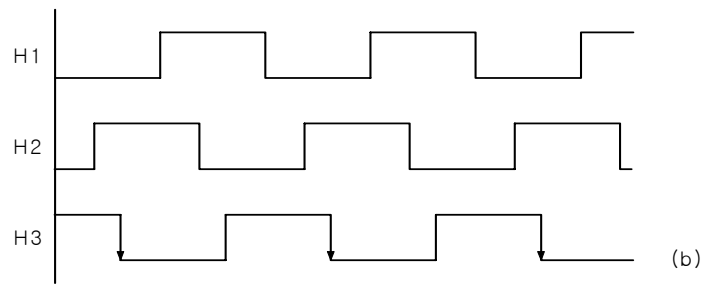
7. Rotational Direction Detecting Function

- Rotation detection circuit gives the result to DIR pin by detecting the MD's rotational direction.
- Detects the MD's rotational direction using hall signals H2 and H3.
- Feature Table.

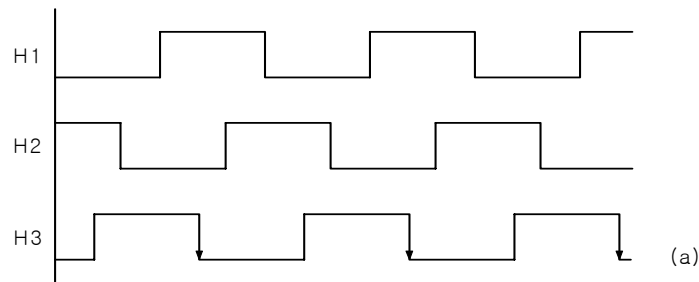
| | Rotation | DIR |
|----------|----------|------|
| EC < ECR | Forward | Low |
| EC > ECR | Reverse | High |



- In case of forward rotational detection, the phase of hall signal shows as H3 → H2 → H1 as follows;

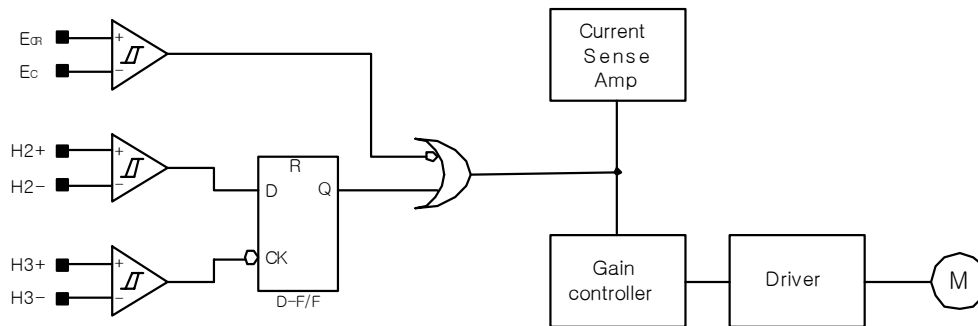


- In case of reverse rotational detection, the phase of hall signal shows as H1 → H2 → H3 as follows;



- Forward/Reverse rotational direction is decided as follows. When hall signal H3 is falling edge, if H2 shows "High", the rotational direction is "Forward", and if H2 shows "Low", rotational direction is "Reverse".

8 Reverse Rotation Preventing Function

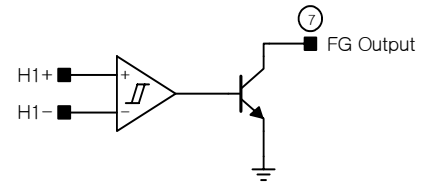
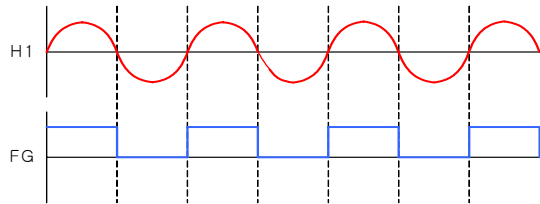


- Reverse rotation prevention circuit has a function for intercepting the reverse rotation of MD.
- When SERVO control input is $EC < ECR$, MD rotates forward and Q which is the output of D-F/F goes "High".
- When SERVO control input is $EC > ECR$, motor puts on reverse brake and MD speed is rapidly reduced.
- When SERVO control input remains $EC > ECR$, MD rotates reverse and Q which is the output of D-F/F goes "Low", in result current sense amp is interrupted. Accordingly gain controller goes OFF and motor is stopped.
- Feature Table.

| Rotation | H2 | H3 | D-F/F | DIR | Reverse Rotation Preventer | |
|----------|----|-------|-------|-----|----------------------------|----------------|
| | | | | | $EC < ECR$ | $EC > ECR$ |
| Forward | H | H → L | H | L | Forward | Brake and Stop |
| Reverse | L | H → L | L | H | – | Stop |

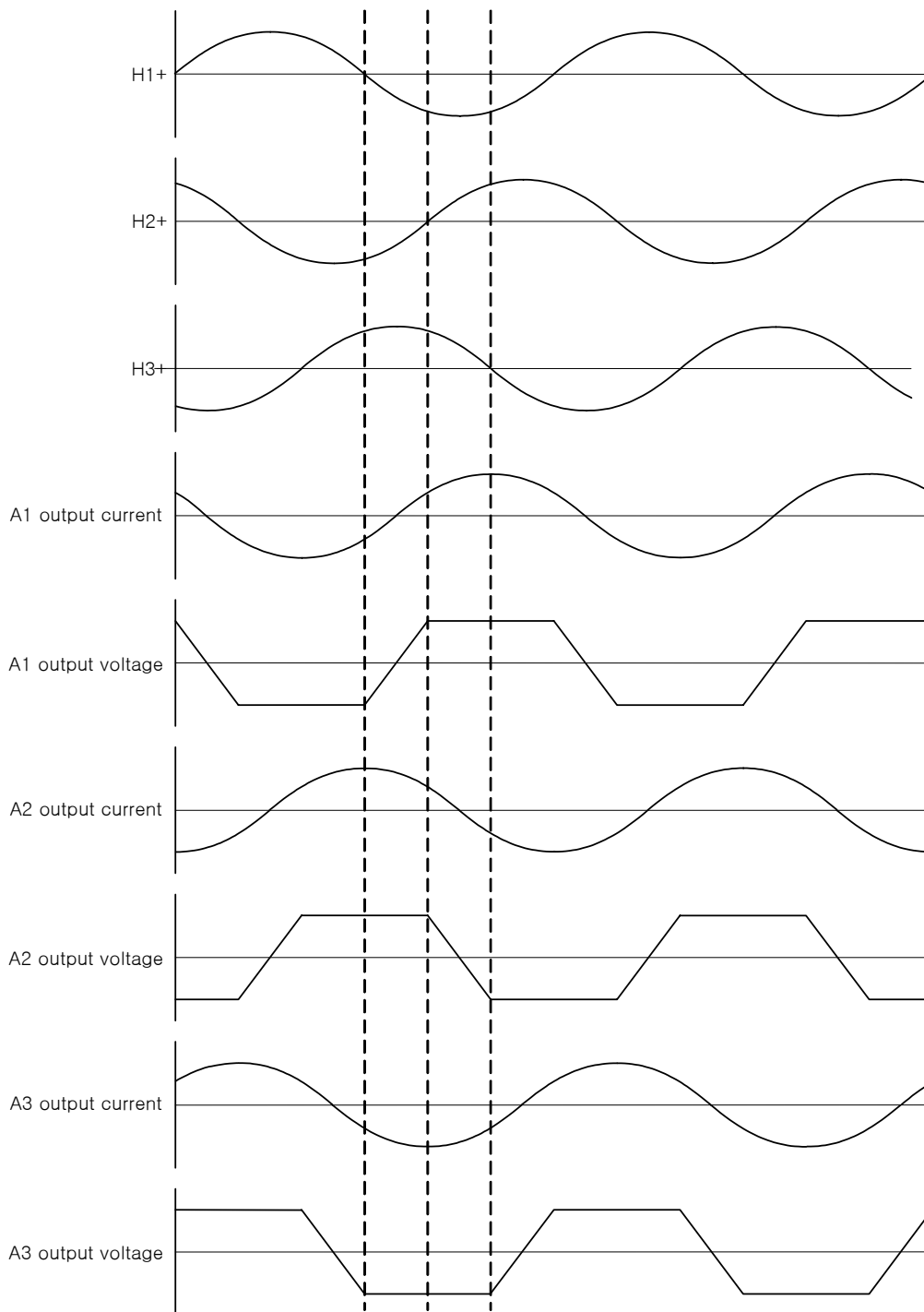
8. FG Output Function

- FG circuit outputs the number of motor rotation.
- One pulse per rotation is output of FG.
- FG uses hall signal H1 as its input, and creates output using hysteresis comparator.
- Input/Output wavelength is shown below;

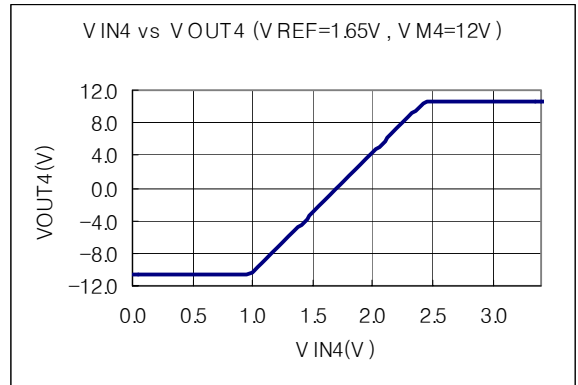
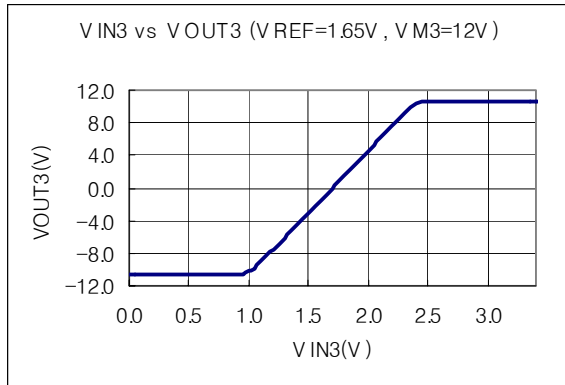
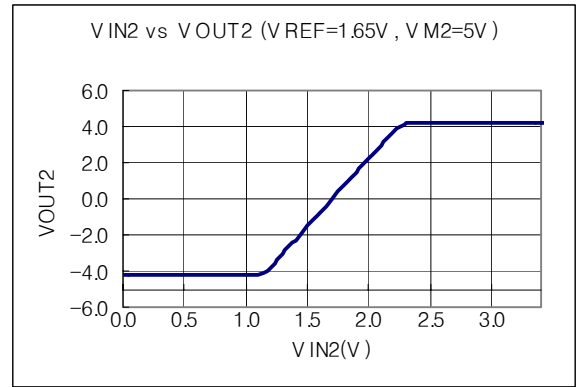
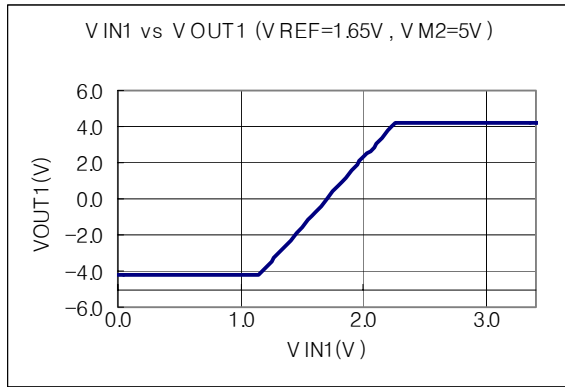
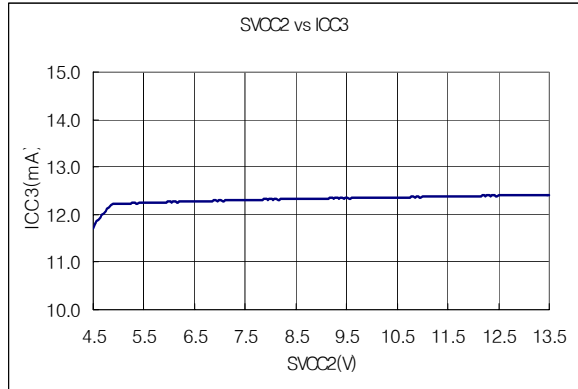
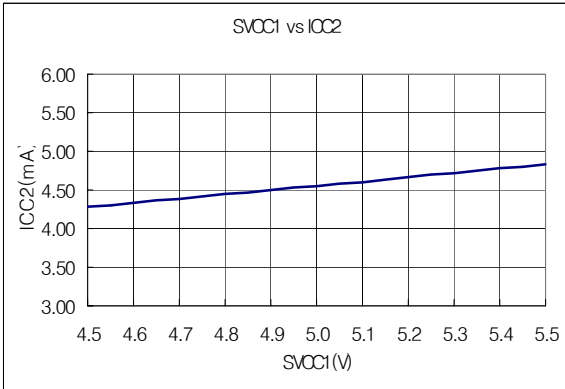


9. Hall Input Output Timing Chart

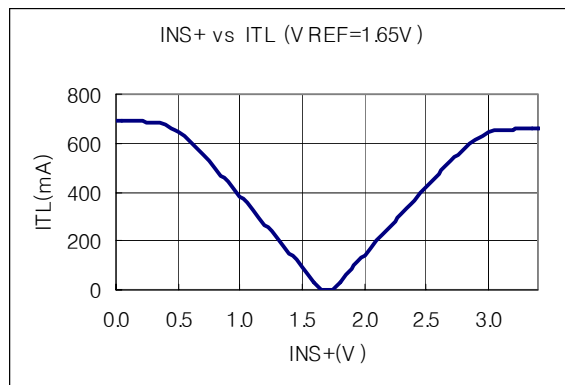
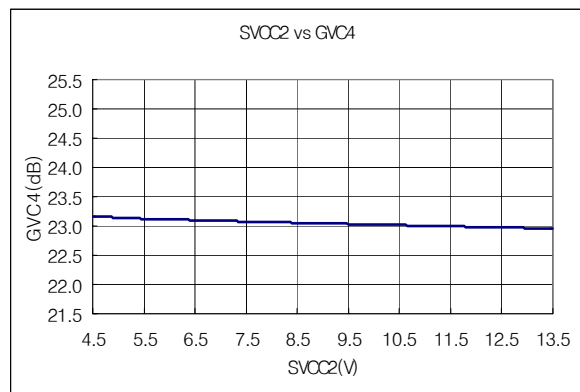
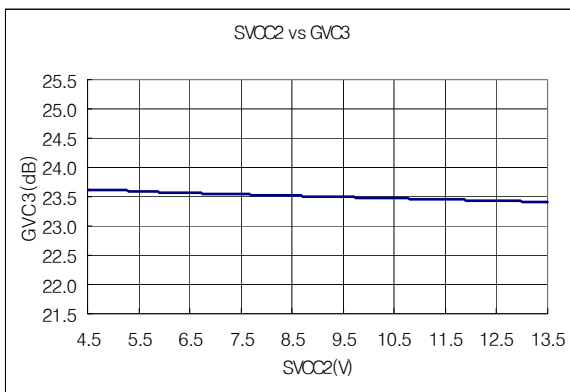
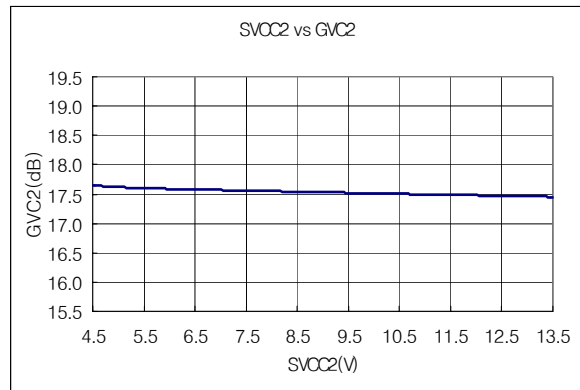
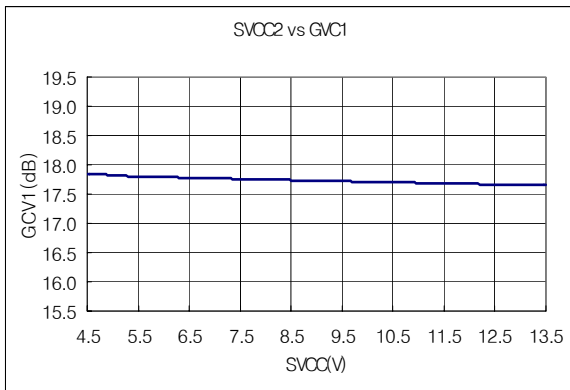
- Output voltage and current wavelength of each of the 3-phase hall input is shown below.
- The following diagram is the motor's output wavelength in the forward rotation direction.



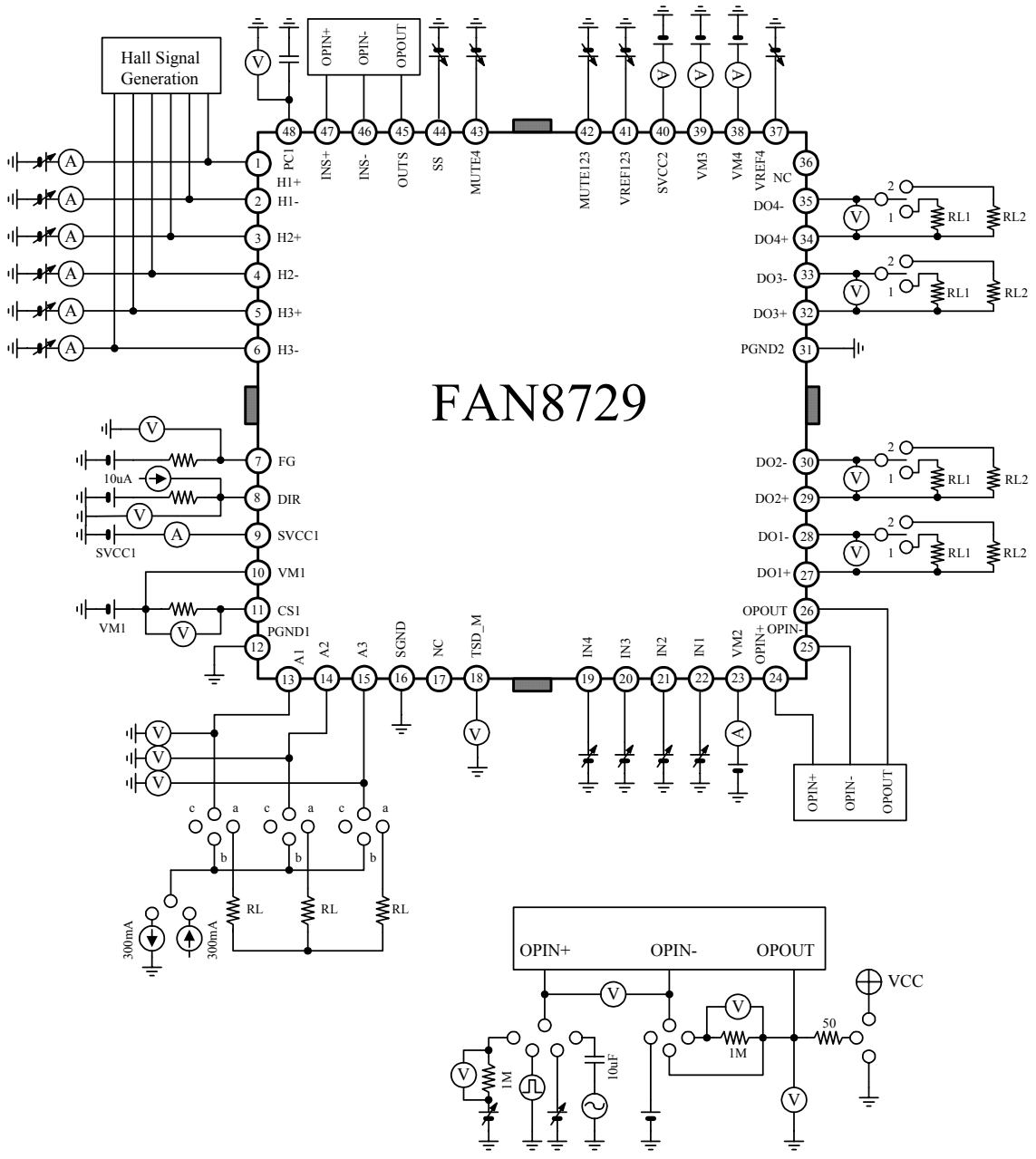
Typical Performance Characteristics



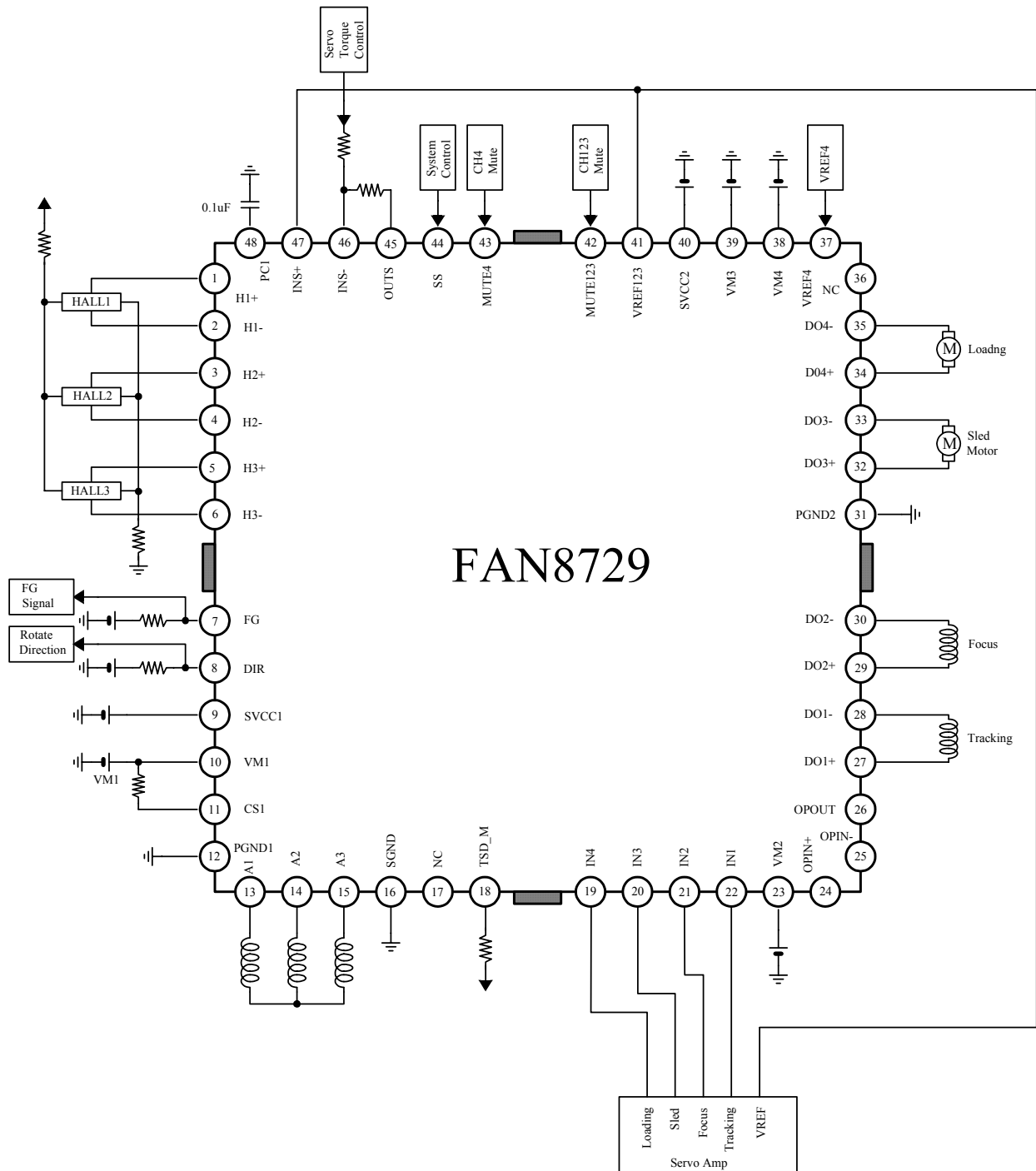
Typical Performance Characteristics



Test Circuits



Typical Application Circuits

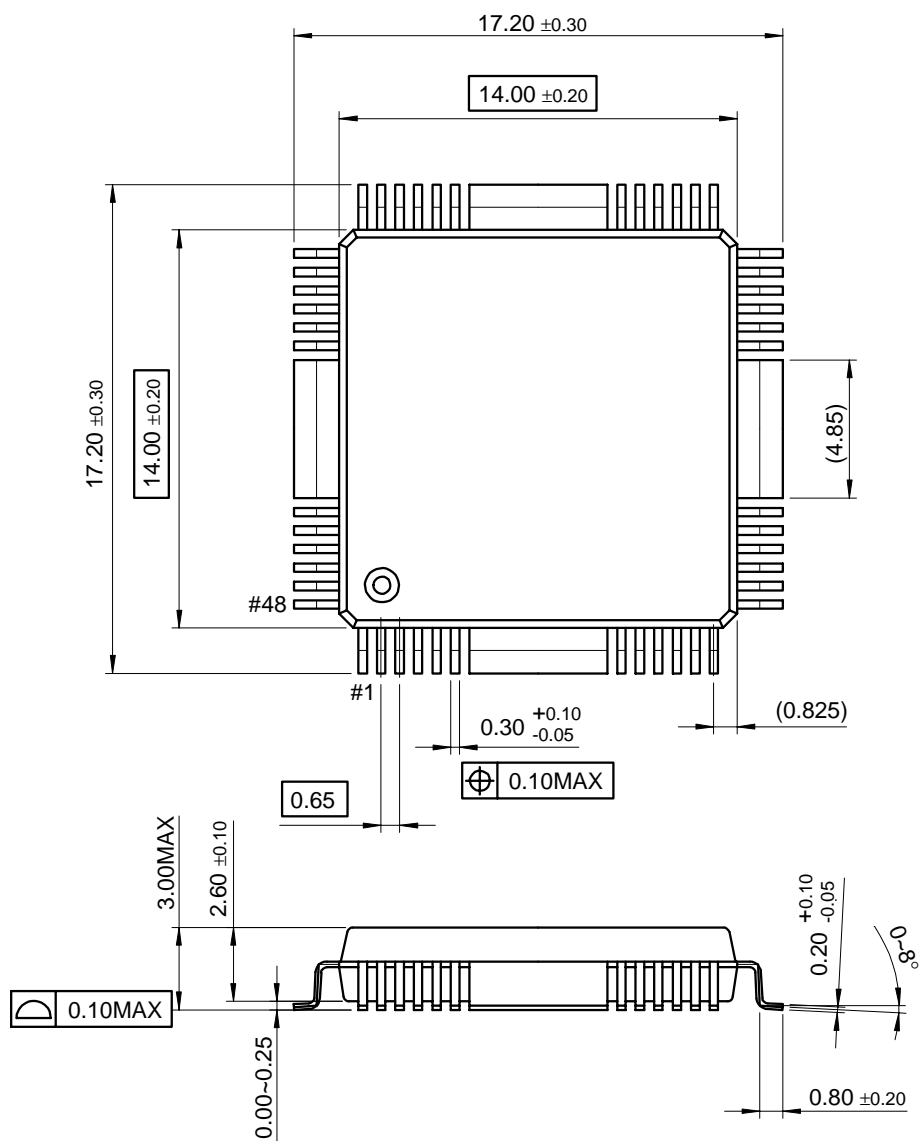


Notes:

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

Package Dimensions

48-QFPH-1414



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