## DESCRIPTION

The M54678FP is a semiconductor integrated circuit designed for stepper motor driver used to printer, PPC and facsimile.

## FEATURES

● Wide supply voltage range (10 – 35V)
● Output current is controlled by PWM operation
● Few external components (This IC can be operated with 1 capacitor and 2 resistances)
● Voltage stabilizer circuit (Regout = 3.5V)
● Thermal protection circuit
● Flywheel diode

## APPLICATION

Printers, PPC, facsimile

## FUNCTION

The M54678FP is a integrated circuit which can drive two phase stepper motor. The output current direction is determined by phase terminal function, and the output current level is controlled by Vref terminals voltage.

## PIN CONFIGURATION (TOP VIEW)

| Pin | Name | | Pin | Name |
|---|---|---|---|---|
| 1 | P.GND | | 36 | N.C |
| 2 | Out1 | | 35 | Out2 |
| 3 | Out1B | | 34 | Out2B |
| 4 | Rs1 | | 33 | Rs2 |
| 5 | S1 | | 32 | S2 |
| 6 | Vm | | 31 | Vm |
| 7 | GND | | 30 | GND |
| 8 | | | 29 | |
| 9 | | | 28 | |
| 10 | | | 27 | |
| 11 | | | 26 | |
| 12 | | | 25 | |
| 13 | N.C | | 24 | N.C |
| 14 | Vcc | | 23 | N.C |
| 15 | Ph1 | | 22 | Ph2 |
| 16 | En1 | | 21 | En2 |
| 17 | Vref1 | | 20 | Vref2 |
| 18 | Regout | | 19 | Fref |

M54678FP
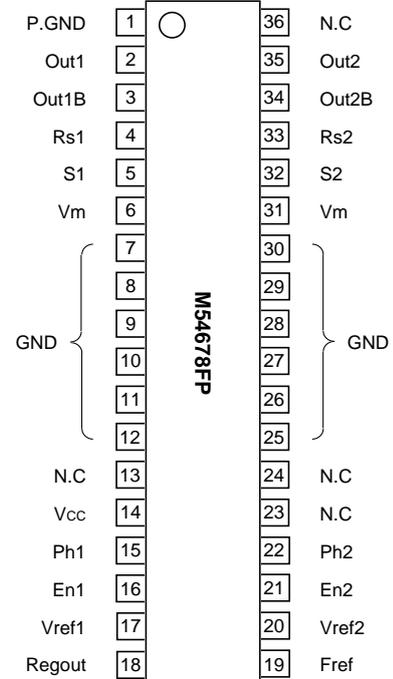
Outline 36P2R-D    N.C: no connection

## BLOCK DIAGRAM
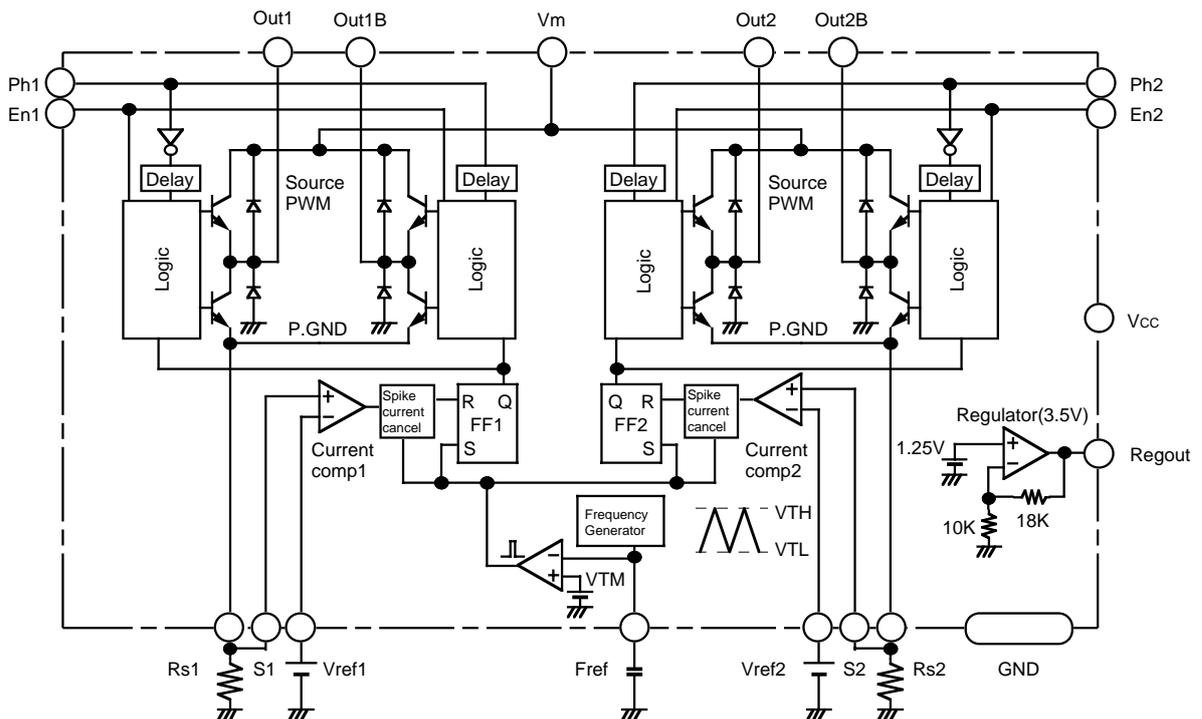
## PIN FUNCTION

| Symbol | Terminal | Functions |
|---|---|---|
| Vm | Output stage supply voltage | Power supply for motor working |
| Out1, Out1B, Out2, Out2B | Output terminal | Motor drive output terminal |
| Rs1,Rs2 | Current sensor | Output current sensing resistor (Rs) connect terminal |
| Vcc | Power supply | Control circuit power supply |
| Ph1, Ph2 | Phase input | Output current direction switch |
| En1, En2 | Enable input | "L" input → Motor on  "H" input → Enable |
| S1, S2 | Sense input | Comparator input voltage terminal |
| Vref1, Vref2 | Vref input | Comparator reference voltage terminal |
| Regout | Voltage stabilizer output | Constant voltage output (Vout = 3.5V) |

## ABSOLUTE MAXIMUM RATINGS (Ta = 25°C unless otherwise noted.)

| Symbol | Parameter | Conditions | Ratings | Unit |
|---|---|---|---|---|
| Vm | Output stage supply voltage | | -0.3 – 37 | V |
| Iout | Output current | 1phase | ±1.0 | A |
| Vcc | Supply voltage | | -0.3 – 7 | V |
| Vlogic | Logic input voltage | Ph, En Pin | -0.3 – Vcc | V |
| Vanalog | Analog input voltage | Vref, S Pin | -0.3 – Vcc | V |
| VRs | Current sensor voltage | Rs Pin | 1.5 | V |
| Pd | Power dissipation | 100mm × 100mm, t = 1.6mm glassfiber epoxy resin circuit board | 2.0 | W |
| Kθ | Thermal derating | 100mm × 100mm, t = 1.6mm glassfiber epoxy resin circuit board | 62.5 | °C/W |
| Tj | Junction temperature | | 150 | °C |
| Topr | Operating temperature | | -20 – 75 | °C |
| Tstg | Storage temperature | | -40 – 125 | °C |

## RECOMMENDED OPERATIONAL CONDITIONS

| Symbol | Parameter | Limits | | | Unit |
|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | |
| Vcc | Supply voltage | 4.5 | 5.0 | 5.5 | V |
| Vm | Output stage supply voltage | 10 | — | 35 | V |
| Iout | Output current | 50 | — | 800 | mA |
| tPLH | Logic input rise time | — | — | 2 | µS |
| tPHL | Logic input fall time | — | — | 2 | µS |
| Ton | PWM on time | 5 | — | 50 | µS |
| Toff | PWM off time | 5 | — | 50 | µS |
| TSDon | Thermal shutdown temperature | — | 160 | — | °C |

## ELECTRICAL CHARACTERISTICS (Ta=25°C, Vcc=5V, VM=24V unless otherwise noted.)
### CONTROL CIRCUIT

| Symbol | Parameter | Test condition | Limits | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min. | Typ. | Max. | |
| Icc1 | Supply current | Vcc = 5V, En = H | 19 | 33 | 50 | mA |
| Icc2 | | Vcc = 5V, En = L | 34 | 58 | 87 | |
| VIH | Logic input voltage | | 2.4 | — | Vcc | V |
| VIL | (Ph, En terminal) | | 0 | — | 0.6 | |
| IIH | Logic input current | Vin = 5V | -5 | — | 5 | μA |
| IIL | (Ph, En terminal) | Vin = 0V | -20 | — | 5 | |
| VCH | Comparator input offset voltage | Vref = 500mV, VCH = Vref-S | -5 | +1 | +7 | mV |
| Ic | Comparator input current | S terminal input current S = 0V, Vref = 500mV | -20 | -5 | — | μA |
| Vc | Comparator input voltage range | | 0 | — | 1.5 | V |
| Iref | Vref input current | Vref terminal input current Vref = 0V, 2 = 500mVÅj | -20 | -5 | — | μA |
| Vref | Vref input voltage range | | 0 | — | 1.5 | V |
| FrefH | Fref terminal output voltage | Fref terminal | 2.4 | 2.5 | 2.6 | V |
| FrefL | | | 0.4 | 0.5 | 0.6 | |
| Fc | Fref oscillating frequency | Fref terminal, C = 390pF | 20 | 30 | 40 | kHz |
| Vreg | Regulator output voltage | Iout = -0.1mA – +1mA | 3.4 | 3.5 | 3.6 | V |

*Fref oscillating frequency is Career frequency of Output PWM control.

### OUTPUT CIRCUIT (Ta=25°C, Vcc=5V, VM=24V unless otherwise noted.)

| Symbol | Parameter | Test condition | Limits | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min. | Typ. | Max. | |
| Vsat | Output saturation voltage | Sensing resistor not included. Io = 0.75A | — | 1.8 | 2.6 | V |
| Ileak | Output leak current | | -100 | — | +100 | μA |
| tdon | Output turn-on delay | Time until output on after Fref 2.5V → 0.5V | — | 0.5 | 2.0 | μS |
| tdoff | Output turn-off delay | Time until output off after S < Vref | — | 2.0 | 3.5 | μS |

## APPLICATION DIRECTIONS

(1) Ph input, En input determines output function.

| Ph* | En* | Out* | Out*B |
|-----|-----|------|-------|
| H | L | H | L |
| L | L | L | H |
| H | H | Z | Z |
| L | H | Z | Z |

*: 1 or 2
Z : High impedance

(2) Vref (reference voltage)
Output current level is controlled by Vref voltage.
(3) Current comparator
Under VRS (current sensing resistor voltage) > Vref (reference voltage) condition, the current comparator switches, fip-flop is reset and output circuit is set to off.
(4) Oscillating circuit
Frequency of PWM operation synchronize with Fref terminal frequency.
If you change frequency of PWM operation, please change capacitor value of Fref terminal.
This IC is designed oscillating frequency to be 30kHz when capacitor = 390pF is connected to Fref terminal. Oscillating frequency is inversely proportional to capacitor value. When capacitor value become half, Oscillating frequency will be two times.
(5) Spike current cancellation circuit
This IC includes Spike cancellation circuit to prevent the failure function of current comparator by influence of this spike current. Thus, current comparator don't function during approximately 2μS from the moment of output transistor is set to on.
(6) Phase delay circuit
This IC includes Phase delay circuit to prevent output through current at Ph switching time.
Four output transistors of H bridge don't function during approximately 3μS at Ph switching time.
(7) Rs terminal and S terminal
Difference of current sensing that caused by wiring resistance of board (wiring resistance between RS terminal and current sensing resistor) can be prevented by connecting S terminal (plus input of current comparator) to current sensing resistor as close as possible.
(8) Voltage stabilizer circuit
This IC includes voltage stabilizer circuit. (3.5volts output). Vref reference voltage can be generated by resistance potential dividing from constant voltage output terminal (Regout). Current capability of constant voltage output terminal is I source = +1mA, I sink = -0.1mA

(9) Setting of output current
Since output circuit of this IC consists of NPN type transistor, current flow through the motor coil (Iout) becomes approximately 20mA (typical value) smaller than current flow through the current sensing resistor (IRS) by influence of the base current (Ib) of transistor.
Thus, please consider this current when you set up output current.



$$Iout = IRS - Ib$$
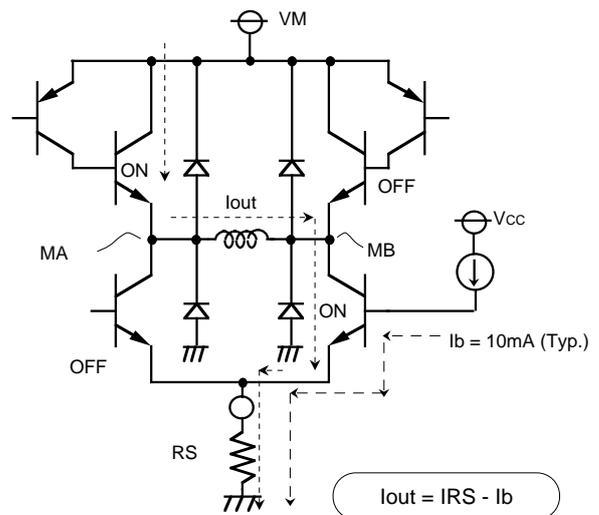
*If Vcc, Tj and manufacturing dispersion are considered, dispersion of Ib will vary maximum ±5mA
(minimum = 5mA, maximum = 15mA)

## THERMAL DERATING
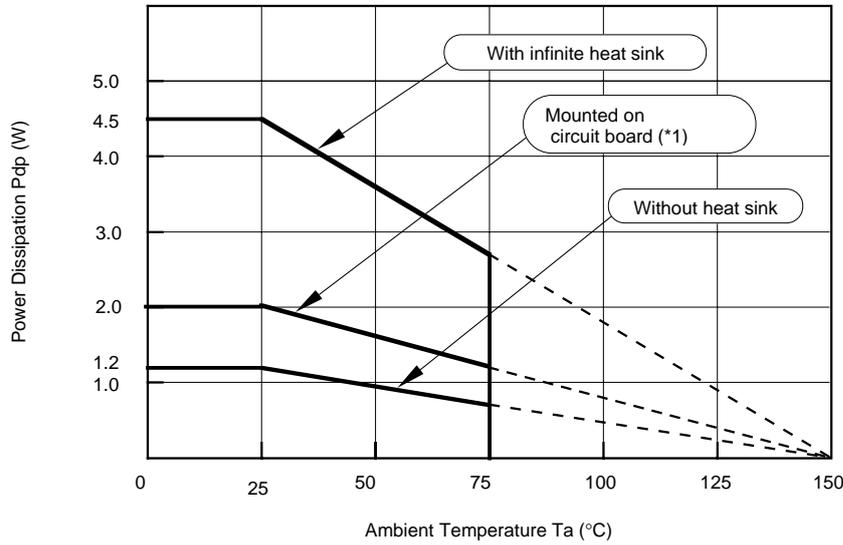


(*1): Mounted on 100mm $\times$ 100mm, t = 1.6$\mu$m (copper foil = 35$\mu$m) circuit board

## APPLICATION CIRCUIT

STEPPER MOTOR



| | | |
|---|---|---|
| 1 | P.GND | N.C 36 |
| 2 | Out1 | Out2 35 |
| 3 | Out1B | Out2B 34 |
| 4 | Rs1 | Rs2 33 |
| 5 | S1 | S2 32 |
| 6 | Vm1 | Vm2 31 |
| 7 | | 30 |
| 8 | | 29 |
| 9 | GND | 28 |
| 10 | | 27 |
| 11 | | 26 |
| 12 | | 25 |
| 13 | N.C | N.C 24 |
| 14 | Vcc | N.C 23 |
| 15 | Ph1 | Ph2 22 |
| 16 | En1 | En2 21 |
| 17 | Vref1 | Vref2 20 |
| 18 | Regout | Fref 19 |

M54678FP

An example of the setting

Rrs1, Rrs2 = 0.5 – 1.0$\Omega$
Cfref      = 390pF