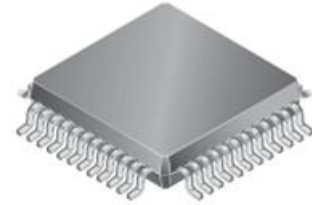


Low Noise, 256 Microstepping Motor Driver

PRODUCT DESCRIPTION

The MS35930 is a two-phase stepper driver featured by high-precision, low noise and interface communication. The MS35930 integrates automatic speed up and down function and advanced stepper motor driver procedure. It is built in power MOSFET. The average operating current for long time can reach 2A and the peak current is 2.5A. The MS35930 integrates protection function, including thermal shutdown, undervoltage protection, overcurrent protection, short-circuit protection and short-power protection.



TQFP48

FEATURES

- Two-phase Stepper Motor, Reach 2A Coil Current (2.5A Peak Current)
- Internal Motion Controller: Speed up and down Function and Stable Operation
- Silence Mode
- Fast-speed Mode
- Low On-resistance. HS, LS: 340mΩ, 320mΩ
- Voltage Range: 4.75V~36V
- Microstep Interpolation Function
- Logical Level Range: 1.8V~5V
- Internal 256 Microstep
- Single-wire UART Bus and SPI Communication Interface
- Load Detection Technology Without Sensor
- Self-adaptive Current Adjustment Function
- Internal Optional Detection Resistance Mode (No Need for External Detection Resistor)
- 7x7 mm² TQFP48 Package with Back Thermal Pad

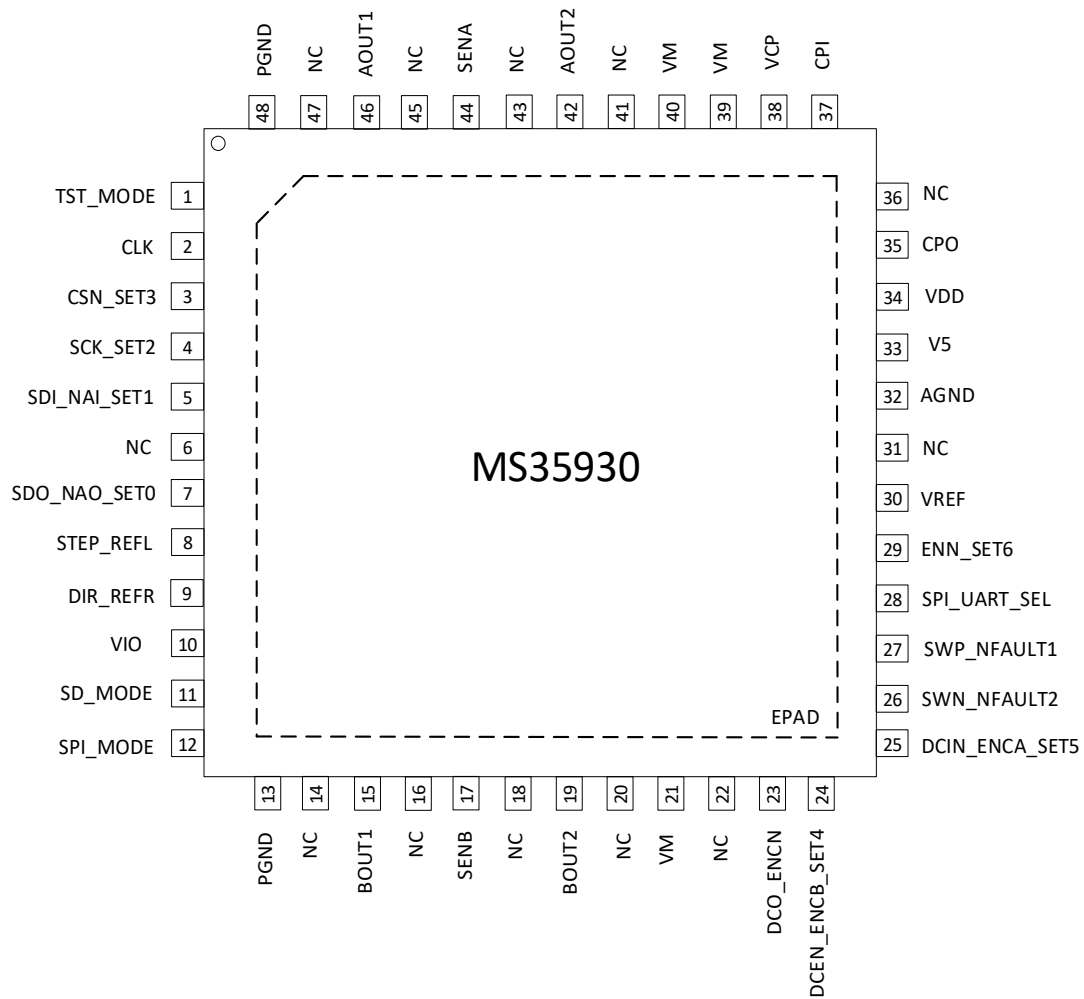
APPLICATIONS

- Precise Industrial Device
- Medical Device
- 3D Print
- Video Monitoring
- Factory / Laboratory Automation

PRODUCT SPECIFICATION

| Part Number | Package | Marking |
|-------------|---------|---------|
| MS35930 | TQFP48 | MS35930 |

PIN CONFIGURATION



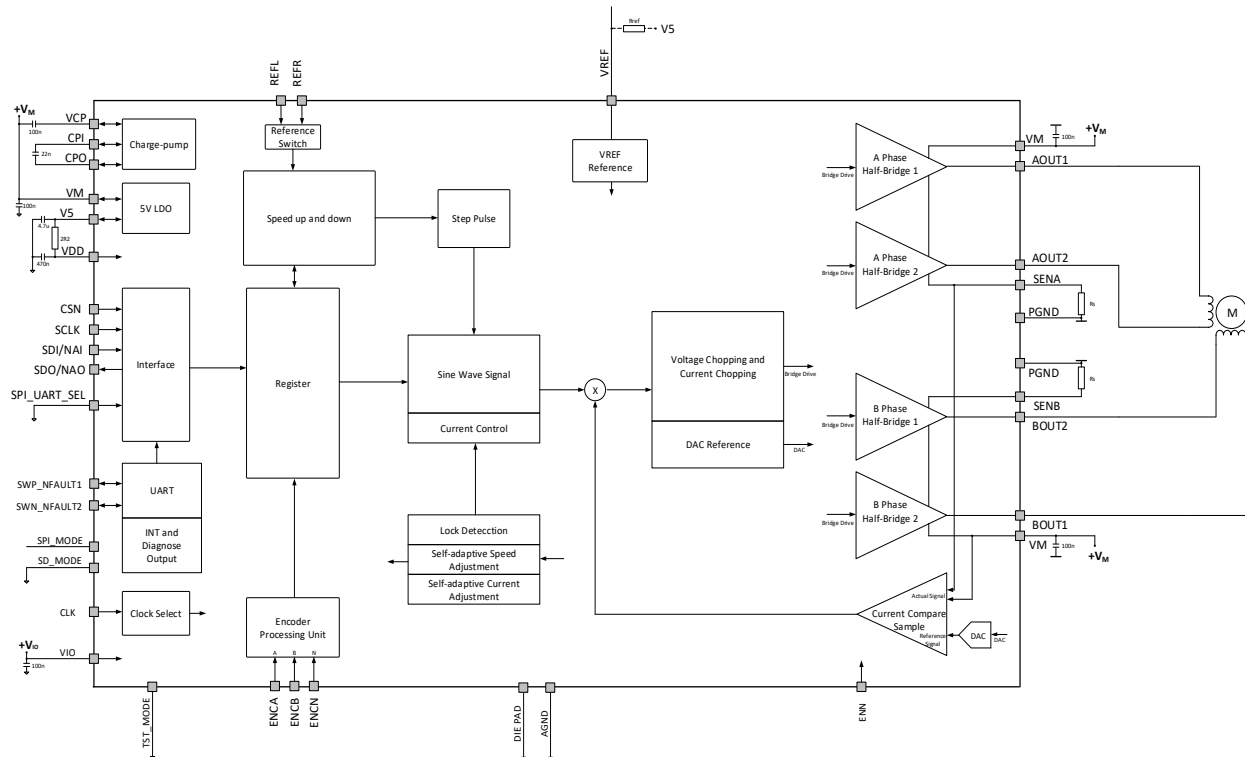
PIN DESCRIPTION

| Pin | Name | Type | Description |
|--------------------------------|------------------|------|--|
| 1 | TST_MODE | DI | Test Mode Input. Connect to Ground |
| 2 | CLK | DI | Clock Input. Connect to External Clock. When internal clock is used, connect to ground |
| 3 | CSN_SET3 | DI | SPI Chip Select Input CSN (SPI_MODE=1); Mode Setting SET3 (SPI_MODE=0) |
| 4 | SCK_SET2 | DI | SPI Clock Input SCK (SPI_MODE=1); Microstep Configuration Port SET2 (SPI_MODE=0) |
| 5 | SDI_ NAI_SET1 | DI | SPI Data Input SDI (SPI_MODE=1); Microstep Configuration Port SET1 (SPI_MODE=0) or Next Address Input NAI in Single-wire Interface Mode |
| 6,31,36 | NC | - | Not Used Pin, can connect to ground |
| 7 | SDO_ NAO_SET0 | DO | SPI Data Output SDO (SPI_MODE=1); Chopping Off Time Setting SET0 (SPI_MODE=0) or Next Address Output NAO in Single-wire Interface Mode |
| 8 | STEP_REFL | DI | Left Reference Input REFL (SPI_MODE=1, SD_MODE=0); Microstep Input STEP (SPI_MODE=0 or SD_MODE=1) |
| 9 | DIR_REFR | DI | Right Reference Input REFR (SPI_MODE=1, SD_MODE=0); Direction Input DIR (SPI_MODE=0 or SD_MODE=1) |
| 10 | VIO | - | Digital Input and Output Power Supply, 1.8V to 5V |
| 11 | SD_MODE | DI | Control Mode Select Pin, Built-in Pull-up Resistor SD_MODE=0: In motion control mode, step signal is generated from automatic speed up and down module. SD_MODE=1: STEP DIR input interface mode controls output |
| 12 | SPI_MODE | DI | Communication Mode Select Pin, Built-in Pull-up Resistor SPI_MODE=0: Hardware Mode, SET0~SET6 set corresponding parameters. SPI_MODE=1: Enable SPI/UART Interface |
| 13,48 | PGND | - | Power Ground |
| 14,16,18,20, 22,41,43,45,47 | NC | - | Floating |
| 15 | BOUT1 | IO | Motor Coil B Output 1 |

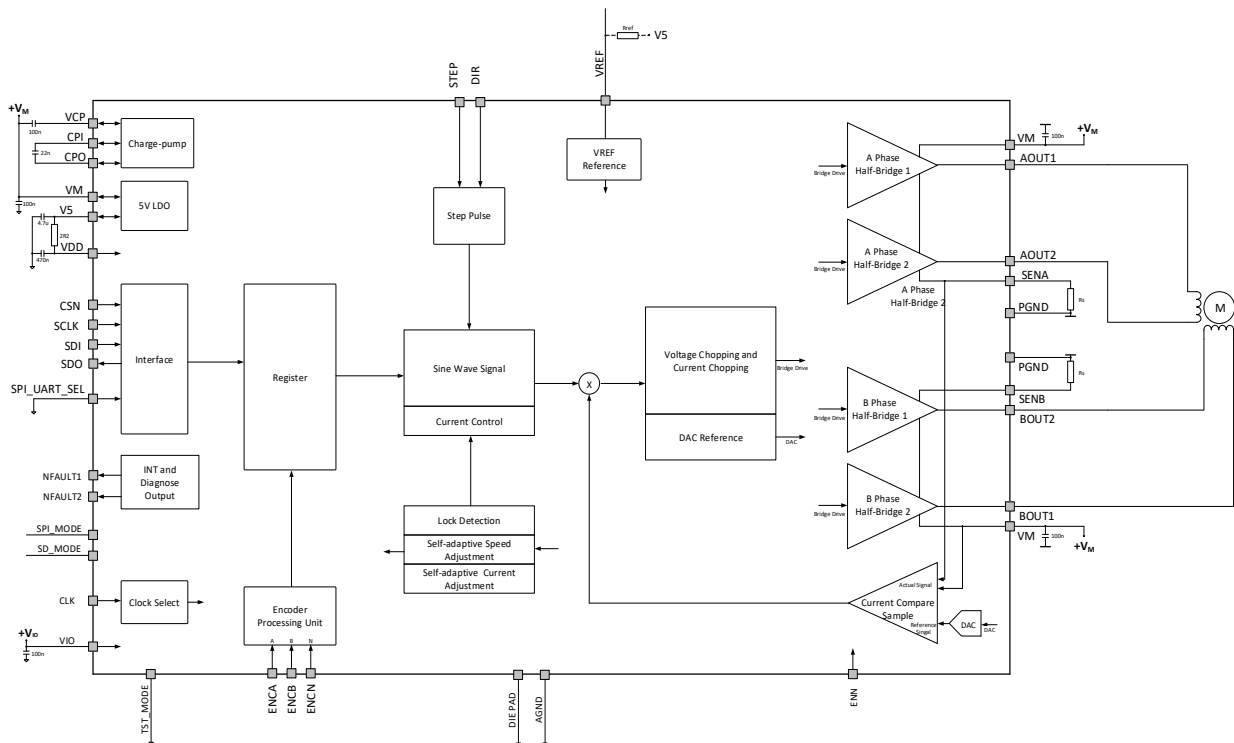
| Pin | Name | Type | Description |
|----------|--------------------|------|---|
| 17 | SENB | IO | Coil B Low-side MOS Source Terminal, connected to ground with sense resistor. Can ground directly in internal sense resistor mode |
| 19 | BOUT2 | IO | Motor Coil B Output 2 |
| 21,39,40 | VM | - | Power Supply. |
| 23 | DCO_ENCN | DIO | Encoder N Channel Input ENCN (SD_MODE=0); Self-adaptive Speed Adjustment Function Output DCO (SD_MODE=0) |
| 24 | DCEN_ ENCB_SET4 | DI | Encoder B Channel Input ENCB (SPI_MODE=1, SD_MODE=0); Self-adaptive Speed Adjustment Function Enable Input DCEN (SPI_MODE=1, SD_MODE=1); Chopping Hysteresis End Setting SET4 (SPI_MODE=0) |
| 25 | DCIN_ ENCA_SET5 | DI | Encoder A Channel Input ENCA (SPI_MODE=1, SD_MODE=0); Self-adaptive speed adjustment function is used to synchronize multiple enable drivers DCIN (SPI_MODE=1, SD_MODE=1); Comparator Blank Time Setting SET5 (SPI_MODE=0) |
| 26 | SWN_ NFAULT2 | DO | Diagnose Output NFAULT2; Interrupt Output or Step Output in Internal Slope Generator Mode (SPI_MODE=1, SD_MODE=0); In open-drain mode, it is needed to use external pull-up resistor that is less than or equal to 47kΩ; Negative Signal of Single-wire I/O Communication SWN (only SPI_UART_SEL=1) |
| 27 | SWP_ NFAULT1 | DO | Diagnose Output NFAULT1; Position Comparator Output or Direction Output in Internal Slope Generator Mode (SPI_MODE=1, SD_MODE=0); In open-drain mode, it is needed to use external pull-up resistor that is less than or equal to 47kΩ; Positive Signal of Single-wire I/O Communication SWP (only SPI_UART_SEL=1) |
| 28 | SPI_ UART_SEL | DI | Single-wire Interface Select Input. High-level with single-wire interface (only SPI_MODE=1); Internal pull-down resistor |
| 29 | ENN_SET6 | DI | Enable Input Pin ENN or Configuration/Enable Input SET6. High-level: Output Off (all motor outputs are floating) |
| 30 | VREF | AI | Analog Reference Voltage Input Pin Control Output Current or Analog Reference Current Input in Internal Sense Resistor Mode |

| Pin | Name | Type | Description |
|-----|-------|------|---|
| 32 | AGND | - | Analog Ground |
| 33 | V5 | IO | Internal 5V LDO, connect 2.2 μ F-4.7 μ F capacitor to ground |
| 34 | VDD | IO | Power Input for 5V Digital Circuit, connect 470nF capacitor to ground |
| 35 | CPO | IO | Charge-pump Capacitance Output |
| 37 | CPI | IO | Charge-pump Capacitance Input. Connect 22nF(50V) capacitor with CPO |
| 38 | VCP | IO | Charge-pump Voltage. Connect 100nF capacitor with VM |
| 42 | AOUT2 | IO | Motor Coil A Output 2 |
| 44 | SENA | IO | Coil A Low-side MOS Source Terminal, connected to ground with sense resistor. Can ground directly in internal sense resistor mode |
| 46 | AOUT1 | IO | Motor Coil A Output 1 |
| - | EPAD | - | Thermal Pad, must be connected to ground |

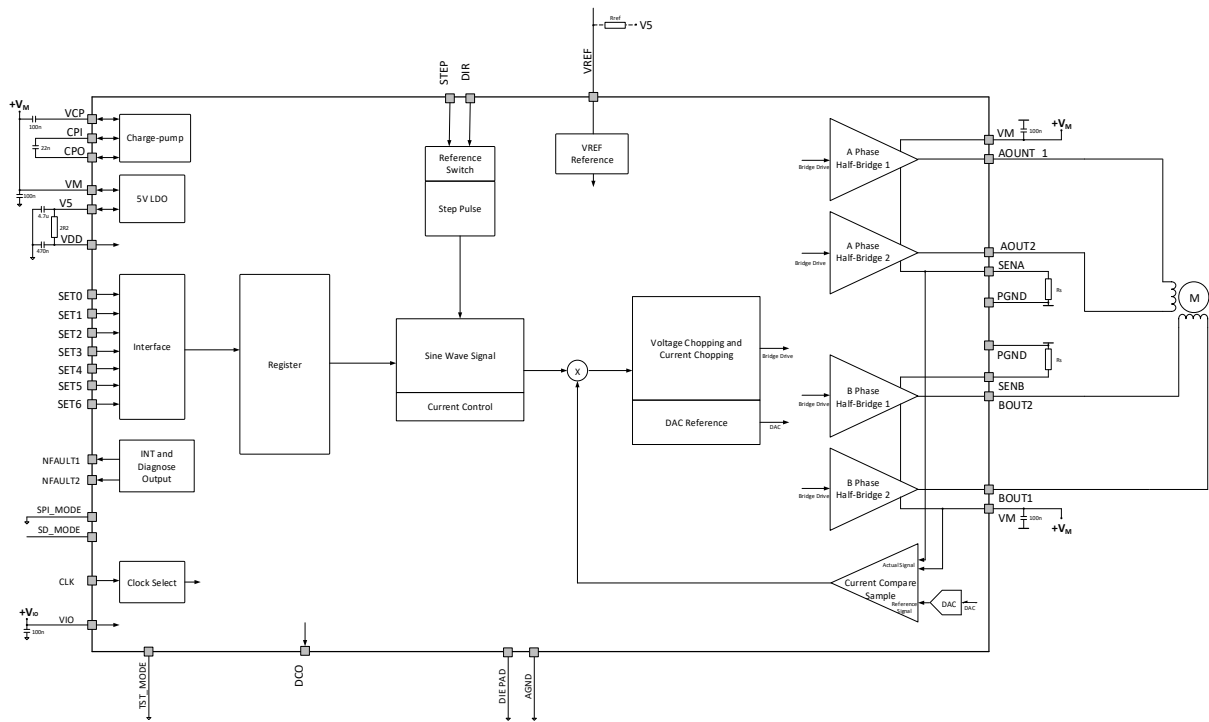
BLOCK DIAGRAM



Mode 1: Full Function Operation Mode



Mode 2: Step and Direction Drive Operation Mode



Mode 3: Simple Step and Direction Drive Operation Mode

ABSOLUTE MAXIMUM RATINGS

Any exceeding absolute maximum rating application causes permanent damage to device. Because long-time absolute operation state affects device reliability. Absolute ratings just conclude from a series of extreme tests. It doesn't represent chip can operate normally in these extreme conditions.

| Parameter | Symbol | Range | Unit |
|--|-----------------|---------------------|------|
| Power Supply (with Inductive Load) | V_{VM} | -0.5 ~ 42 | V |
| IO Supply Voltage | V_{VIO} | -0.5 ~ 5.5 | V |
| Digital Power Supply (with External Power) | V_{VDD} | -0.5 ~ 5.5 | V |
| Logic Input Voltage | V_I | -0.5 ~ $V_{IO}+0.5$ | V |
| Maximum Current on Analog, Digital Ports | I_{IO} | ±10 | mA |
| 5V LDO Output Driving Capacity | I_{VS} | 50 | mA |
| Power Driving Output Current | I_{OX} | 3 | A |
| Junction Temperature | T_J | -50 ~ 150 | °C |
| Storage Temperature | T_{STG} | -55 ~ 150 | °C |
| ESD(HBM) | V_{ESD} | ±4000 | V |
| Thermal Resistance, Junction to Ambient | $R_{\theta JA}$ | 25.99 | °C/W |

RECOMMENDED OPERATING CONDITIONS

| Parameter | Symbol | Range | | Unit |
|---|-----------|-------|------|------|
| | | Min | Max | |
| Power Supply Range | V_{VM} | 5.5 | 40 | V |
| Power Supply Range (Internal 5V regulator is shorted out: $V_{VDD}=V_{VM}$) | V_{VM} | 4.7 | 5.4 | V |
| I/O Supply Voltage Range | V_{VIO} | 1.6 | 5.25 | V |
| VDD Voltage Range | V_{VDD} | 4.6 | 5.25 | V |
| Motor Coil RMS Output Current | I_{RMS} | | 1.4 | A |
| Motor Coil Peak Output Current | I_{OX} | | 2.5 | A |
| Operating Junction Temperature | T_J | -40 | 125 | °C |

ELECTRICAL CHARACTERISTICS

VM=24V. Note: Unless otherwise noted, Ta = 25°C ±2°C.

Current Dissipation

| Parameter | Symbol | Condition | Min | Typ | Max | Unit |
|---|------------|------------------------------------|-----|-----|-----|--------|
| Shutdown Output Current without Load, $I_{VM}+I_{VDD}$ | I_S | $f_{CLK}=12MHz$, without chopping | | 18 | | mA |
| Operating Current without Load, $I_{VM}+I_{VDD}$ | I_S | $f_{CLK}=12MHz$, 23.4kHz chopping | | 20 | | mA |
| VDD Supply Current | I_{VDD} | $f_{CLK}=12MHz$, 23.4kHz chopping | | 16 | | mA |
| VDD Supply Current VS. CLK | I_{VDDX} | | | 1 | | mA/MHz |
| IO Supply Current | I_{VIO} | | | 10 | 30 | μA |

Digital Input and Output

| Parameter | Symbol | Condition | Min | Typ | Max | Unit |
|-------------------------------|-----------------|-----------|---------|---------|---------|------|
| Input Low Voltage | V_{INLO} | | -0.3 | | 0.3Vio | V |
| Input High Voltage | V_{INHI} | | 0.7Vio | | Vio+0.3 | V |
| Input SMIT Hysteresis | V_{INHYS} | | | 0.12Vio | | V |
| Output High Voltage | V_{OUTLO} | $I=2mA$ | Vio-0.2 | | | V |
| Output Low Voltage | V_{OUTH} | $I=2mA$ | | | 0.2 | V |
| Input Leakage Current | I_{LEAK} | | -10 | | 10 | μA |
| Pull-up, Pull-down Resistance | R_{PU}/R_{PD} | | 132 | 155 | 200 | kΩ |

Motor Driver

| Parameter | Symbol | Condition | Min | Typ | Max | Unit |
|------------------------------|--------------|-----------------------|-----|------|------|------|
| Low -side rdson | R_{ONL} | $I=100mA$ | | 0.32 | 0.38 | Ω |
| High-side rdson | R_{ONH} | $I=100mA$ | | 0.34 | 0.39 | Ω |
| Rise Time | t_{SLPON} | $I=700mA$ | 40 | 80 | 160 | ns |
| Fall Time | t_{SLPOFF} | $I=700mA$ | 40 | 80 | 160 | ns |
| Source Current at Driver Off | I_{Oidle} | OUTX connected to GND | 210 | 270 | 330 | μA |

Charge-pump

| Parameter | Symbol | Condition | Min | Typ | Max | Unit |
|--|------------------|-------------------------------|-----|---------------|-----------|------|
| Charge-pump Output Voltage | $V_{VCP}-V_{VM}$ | Operating at $f_{chop}<40kHz$ | 4 | $V_{VDD}-0.3$ | V_{VDD} | V |
| Charge-pump Output Undervoltage Threshold | $V_{VCP}-V_{VM}$ | Using internal 5V LDO | 3.7 | 4 | 4.3 | V |
| Charge-pump Frequency | f_{CP} | | | 1/16CLK | | |

LDO

| Parameter | Symbol | Condition | Min | Typ | Max | Unit |
|--------------------------------------|----------------------|--|-----|-----|------|--------|
| V5 Output Voltage | V _{V5} | I _{V5} =0mA, 25°C | 4.8 | 5 | 5.25 | V |
| V5 Output Resistance | R _{V5} | Static Load | | 3 | | Ω |
| Deviation in Whole Temperature Range | V _{V5(DEV)} | I _{V5} =16mA, whole operating temperature rang | | ±60 | ±100 | mV |
| Deviation in Whole Voltage Range | V _{V5(DEV)} | I=5mA, whole operating voltage range | | ±15 | ±30 | mV/10V |

Clock Oscillator

| Parameter | Symbol | Condition | Min | Typ | Max | Unit |
|---|---------------------|---|------|------|------|------|
| Clock Frequency (Default Setting) | f _{CLKOSC} | T=-40°C | 11.6 | 12.1 | | MHz |
| | | T=25°C | 11.5 | 12 | 12.5 | MHz |
| | | T=125°C | | 11.7 | 12.2 | MHz |
| Additional Clock Frequency | f _{CLK} | | | 12 | | MHz |
| Rise and Fall Time for Additional Clock Frequency | t _{CLK} | CLK from 0.1V _{io} to 0.9V _{io} | 10 | | | ns |

Detection Signal

| Parameter | Symbol | Condition | Min | Typ | Max | Unit |
|---|-------------------------|------------------------|-----|-----|-----|------|
| Undervoltage Protection Threshold Voltage | V _{UV_VM} | Power supply rises | 4.2 | 4.5 | 4.6 | V |
| 5V LDO Undervoltage Protection Threshold Voltage | V _{UV_V5} | 5V LDO rises | | 4.3 | | V |
| V _{VIO} Undervoltage Protection Threshold Voltage | V _{UV_VIO} | V _{VIO} rises | 1.4 | 1.5 | 1.6 | V |
| V _{VIO} Undervoltage Protection Hysteresis | V _{UV_VIOHYST} | | | 0.1 | | V |
| Overcurrent Protection Detection Threshold Voltage | V _{VM-Vox} | | 2 | 2.5 | 3 | V |
| Short-circuit Protection Detection Time | t _{S2G} | | 0.8 | 1.3 | 2 | μs |
| Overtemperature Pre-warning | t _{OTPW} | Temperature rises | | 120 | | °C |
| Overtemperature Shutdown | t _{OT150} | Temperature rises | | 160 | | °C |

AIN/IREF

| Parameter | Symbol | Condition | Min | Typ | Max | Unit |
|---|------------|---|-----|------------|------------|------------|
| VREF Input Resistance to 2.5V | R_{AIN} | External sample resistor mode | | 180 | | k Ω |
| AIN/IREF Input Voltage Range for Linear Current Sacle | V_{AIN} | Analog voltage input control current mode | 0 | 0.5-2.4 | $V_{V5}/2$ | V |
| AIN/IREF Floating Voltage | | External sample resistor mode | | $V_{V5}/2$ | | V |
| AIN/IREF Input Resistance to Ground | R_{IREF} | Internal sample resistor mode | | 1.4 | | k Ω |
| AIN/IREF Current Amplification Multiple | | $I_{IREF}=0.25mA$, Internal sample resistor mode | | 6200 | | Times |

Sense

| Parameter | Symbol | Condition | Min | Typ | Max | Unit |
|---|-------------|------------|-----|-----|-----|------------|
| Sense Peak Voltage (Low Sensitivity) | V_{SRTL} | $vsense=0$ | | 325 | | mV |
| Sense Peak Voltage (High Sensitivity) | V_{SRTTH} | $vsense=1$ | | 180 | | mV |
| Internal Resistance between Internal Brx to External Sense Resistance | R_{xy} | | | 30 | | m Ω |

FUNCTION DESCRIPTION

The MS35930 is a stepper motor driver, which combines perfect motion control function and driving capacity. All function logic are realized in chip internal.

Three operation modes of the MS35930 are as follows:

Mode 1: Full Function Motion Control Mode:

In this mode, just need to provide target position without software arithmetic control.

The mode is enabled by SD_MODE low, floating or high.

Mode 2: Step Signal and Direction Driving Mode:

Configure the function by communication. Use external step signal and direction signal to drive motor.

The mode is enabled by SPI_MODE, SD_MODE floating or high.

Mode 3: Simple Step Signal and Direction Driving Mode:

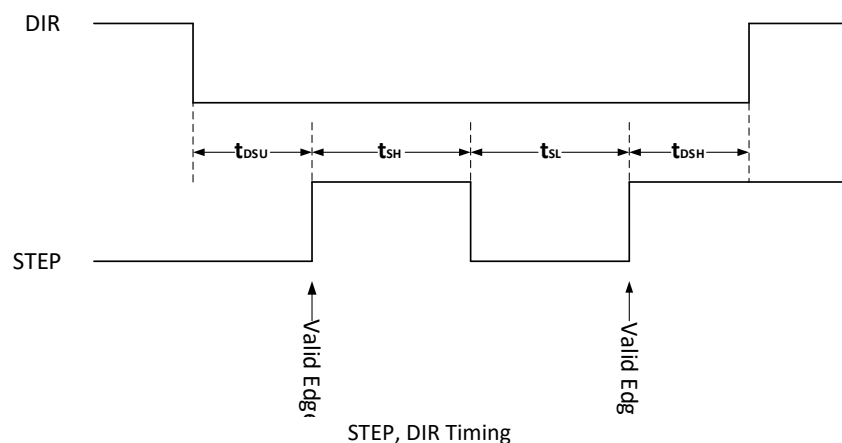
Configure by Hardware Pin. Use external step signal and direction signal to drive motor.

The mode is enabled by SD_MODE high or floating, SPI_MODE low.

STEP/DIR

The step signal and direction signal can be provided by external MCU. Internal speed up and down function is off, but silence mode and fast-speed mode can still operate. Step signal can be triggered on rising edge or dual edge (dedge enabled). A full motor period step could be 2,4,8,16,32,64,128 or 256 microstep. After interpolation mode is enabled, all microsteps are interpolated as 256 microstep.

The motor direction is controlled by DIR pin. STEP signal is only valid on the riding edge. STEP and DIR signals are sampled and synchronized to system clock. One analog filter removes signal interference. The following figure is timing diagram of STEP and DIR.



STEP, DIR Timing

| Parameter | Symbol | Condition | Min | Typ | Max | Unit |
|---|---------------|--------------------------|--------------------------------|--------------|---------------|------|
| STEP Frequency | f_{STEP} | | | | $1/2 f_{CLK}$ | |
| Full-step Frequency | f_{FS} | | | | $f_{CLK}/512$ | |
| STEP Minimum Low Level Time | t_{SL} | | $\max(t_{FILTSD}, t_{CLK}+20)$ | 100 | | ns |
| STEP Minimum High Level Time | t_{SH} | | $\max(t_{FILTSD}, t_{CLK}+20)$ | 100 | | ns |
| Setup Time, DIR to STEP | t_{DSU} | | 20 | | | ns |
| Hold Time, DIR to STEP | t_{DSH} | | 20 | | | ns |
| Filtering Time for STEP and DIR Glitches | t_{FILTSD} | Rising or Falling Edge | 13 | 20 | 30 | ns |
| STEP, DIR Relative to Rising Edge of Sample Clock | $t_{SDCLKHI}$ | Before clock rising edge | | t_{FILTSD} | | ns |

5V LDO

The MS35930 also provides 5V regulated power output, which is required to connect with a capacitor of 2.2 μ F to 4.7 μ F in applications. The MS35930 has internal V5 voltage detection structure. If fault occurs (low-voltage), all outputs are turned off.

Detection Resistor

The maximum motor current can be set by selecting an appropriate sensitive resistor.

The formula of RMS current is as follows:

$$I_{RMS} = (CS+1)/32 \times V_{FS}/(R_{SENSE}+30m\Omega) \times 1/\sqrt{2}$$

In analog voltage input control current mode:

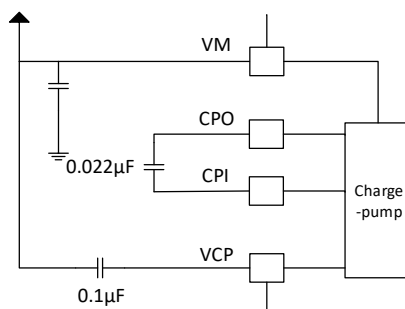
$$V'_{FS} = V_{FS} \times V_{AIN}/2.5V$$

VREF voltage range :0-V_{VS}/2. VREF voltage is not less than 0.5V.

Charge-pump

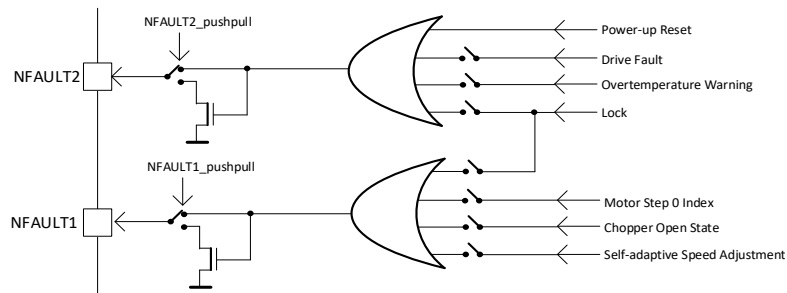
Because output stage adopts N-channel FETs, which are fully enabled only when the required gate drive voltage is higher than power supply. And the MS35930 integrates charge-pump circuit to generate this high-voltage.

In normal operation, charge-pump circuit needs to connect with two external capacitors as shown below.



NFAULT Output

External motion controller usually needs to make fast respond to some states of stepper motor driver. In STEP/DIR mode, real time internal information can be achieved by configuring NFAULT pin. NFAULT2 and NFAULT1 can set output contents and types (Default setting is low active, Open-circuit output. Or high active pushpull output). In order to determine driver reset, during reset period, NFAULT2 is always pulled down to show power-up reset state.



NFAULT Outputs in STEP/DIR Mode

Protection Circuit

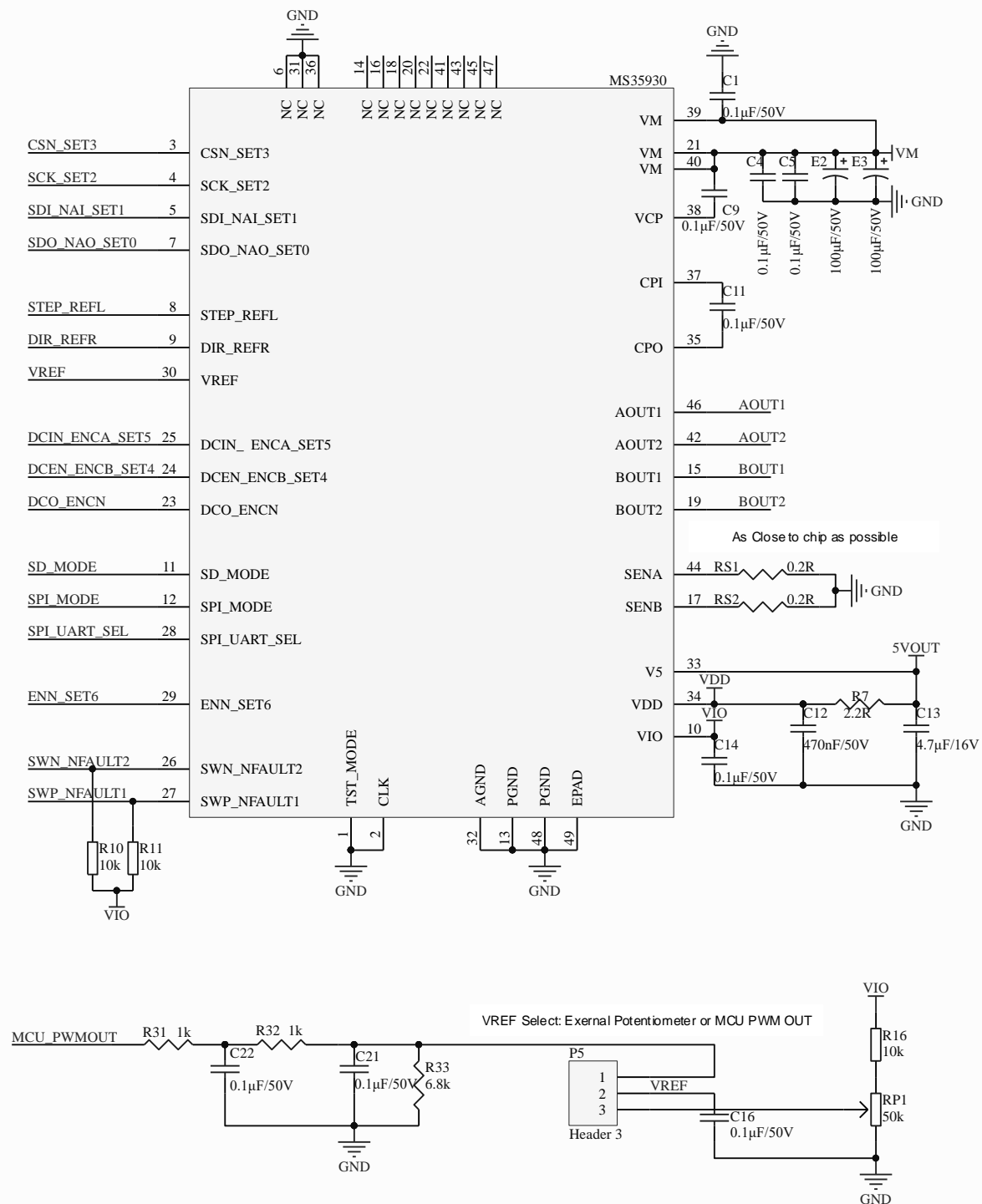
The MS35930 has protection function, including overcurrent protection, undervoltage protection and overtemperature protection.

When motor loads are shorted together or grounded directly, the MS35930 will protect itself by detecting overcurrent and turn off shorted FETs, preventing internal devices from damage. NFAULT2 pin would output a high-level signal, and ENN pin is needed to reset.

When the temperature exceeds setting threshold, the overtemperature protection circuit will work. At this time, all channels would be off and NFAULT2 outputs a high-level signal. When the temperature drops to safety temperature, the MS35930 will return to normal operation state.

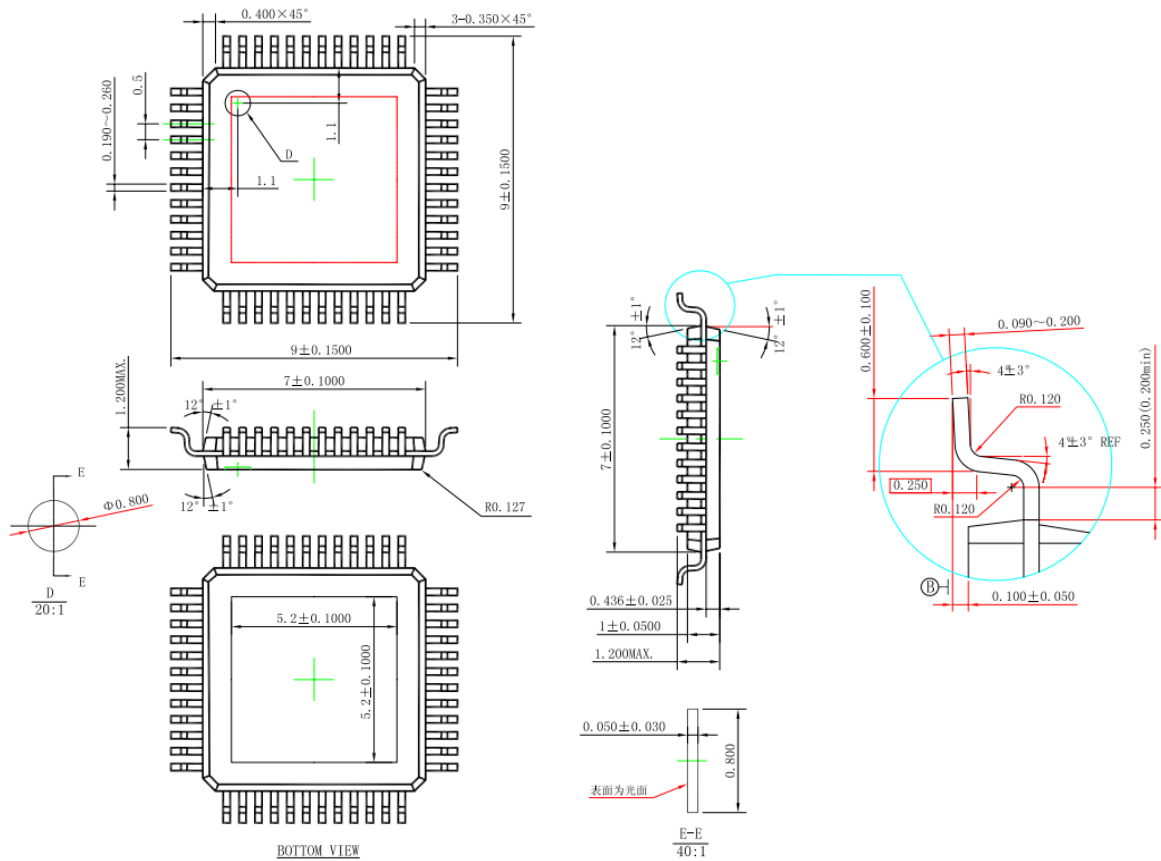
When the power supply drops to threshold voltage of undervoltage protection, all channels will be off and internal logic circuit is reset. When voltage returns to value higher than threshold, the MS35930 will return to normal operation state.

TYPICAL APPLICATION DIAGRAM



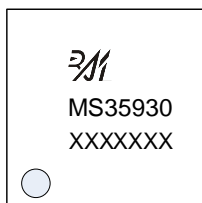
PACKAGE OUTLINE DIMENSIONS

TQFP48(07X07) (with Back Thermal Pad)



MARKING and PACKAGING SPECIFICATION

1. Marking Drawing Description



Product Name: MS35930

Product Code: XXXXXXXX

2. Marking Drawing Demand

Laser printing, contents in the middle, font type Arial.

3. Packaging Specification

| Device | Package | Piece/Tray | Tray/Box | Piece/Box | Box/Carton | Piece/Carton |
|---------|---------|------------|----------|-----------|------------|--------------|
| MS35930 | TQFP48 | 250 | 10 | 2500 | 4 | 10000 |

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- The process of improving product is endless. And our company would sincerely provide more excellent product for customer.

**MOS CIRCUIT OPERATION PRECAUTIONS**

Static electricity can be generated in many places. The following precautions can be taken to effectively prevent the damage of MOS circuit caused by electrostatic discharge:

1. The operator shall ground through the anti-static wristband.
2. The equipment shell must be grounded.
3. The tools used in the assembly process must be grounded.
4. Must use conductor packaging or anti-static materials packaging or transportation.



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