MH3610 is a single-chip solution designed in mixed-signal CMOS technology for driving single-coil brushless DC motors like PWM cooling fans. The device integrates a voltage regulator, a Hall sensor with an advanced offset cancellation system, a power output H-bridge all controlled by a sophisticated digital state machine, all in a single package. The included voltage regulator operates from 3.5V to 16V, covering a wide range of applications. With the built-in reverse voltage protection, no supply-line diode is required. In critical low-voltage operation, the Brown-Out Detection will automatically stop the device operation until normal supply voltage in the operational range is applied.

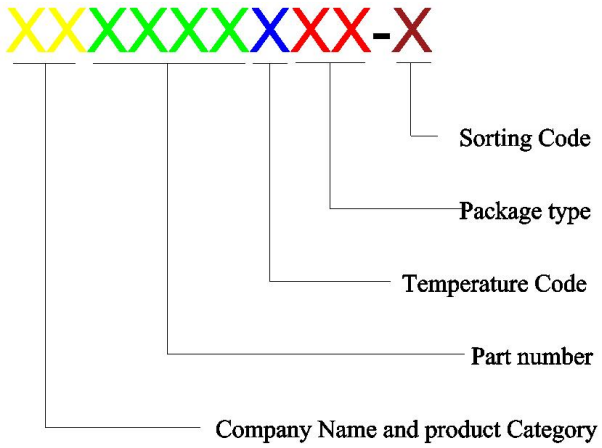
## Features and Benefits

- Wide operating voltage range:3.5V~16V
- Supports speed regulation via PWM or DC voltage control
- Wide PWM input frequency range (100 Hz to 100 kHz) for duty-cycle control
- Soft start suppresses peak currents during start-up
- Minimal speed setting
- Built-in PWM input resistor
- Soft switching：Optimum low-noise performance at different rotational speeds with no external components
- Integrated protection：Reverse Voltage、Locked Rotor、Brown-Out、Thermal Shutdown and High ESD Rating
- Built-in FG output

## *Applications*

- Single Phase BLDC Motors
- Single Phase BLDC Fan
- CPU/GPU Cooling Fan

## *Ordering Information*




**Company Name and Product Category**

MH:MST Hall Effect/MP:MST Power MOSFET

**Part number**

181,182,183,184,185,248,249,276,477,381,381F,381R,382…..

If part # is just 3 digits, the fourth digit will be omitted.

**Temperature range**

E: 85 ℃, I: 105 ℃, K: 125 ℃, L: 150 ℃

**Package type**

UA:TO-92S,VK:TO-92S(4pin),VF:TO-92S(5pin),VS/VP:SOP8

SO:SOT-23,SQ:QFN-3,ST:TSOT-23,SN:SOT-553,SD:DFN2*2-6L

SR:SOT-26L,SM:DFN1.6*1.6-6L,SY:DFN3*3*1-10L

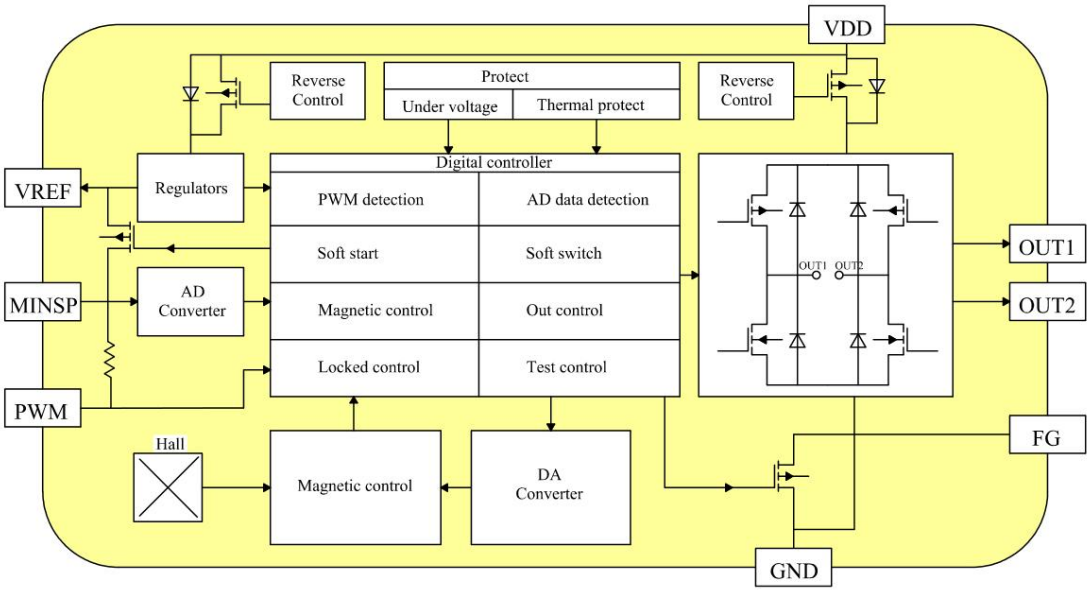
**Sorting**

α,β,Blank…..

| Part No. | Temperature Suffix | Package Type |
|---|---|---|
| MH3610KVP | K (-40°C to +125°C) | VP (SOP8） |
| MH3610KVS | K (-40°C to +125°C) | VS (SOP8 Straight Lead） |
| MH3610KVS-DB | K (-40°C to +125°C) | VS (SOP8 Straight Lead） |

*K spec is used in industrial and automotive applications. Special high- temperature testing is performed.*

## *Functional Diagram*




## *Absolute Maximum Ratings* *At (Ta=25℃)*

| Parameter | Symbol | Value | Units |
|---|---|---|---|
| Supply Voltage | $V_{DD}$ | +18 | V |
| Supply Current | $I_{DD}$ | +20 | mA |
| Reverse Supply Voltage | $V_{DDREV}$ | -18 | V |
| Reverse Supply Current | $I_{DDREV}$ | -20 | mA |
| FG Output Voltage | $V_{FG}$ | +18 | V |
| FG Output Current | $I_{FG}$ | +30 | mA |
| Reverse FG Output Current | $I_{FG}$ | -50 | mA |
| PWM Input Voltage | $V_{PWM}$ | +7 | V |
| Reverse PWM Input Voltage | $V_{PWM}$ | -0.3 | V |
| MINSP Input Voltage | $V_{MINSP}$ | +3.6 | V |
| Reverse MINSP Input Voltage | $V_{MINSP}$ | -0.3 | V |
| Reverse Current on MINSP or PWM | $I_{MINSP}$, $I_{PWM}$ | -10 | mA |
| Average Output Current | $I_{OUT}$ | +550 | mA |
| Peak Output Current | $I_{OUT}$ | +1000 | mA |
| Operating Temperature Range | $T_A$ | -40 to+150 | ℃ |
| Storage Temperature Range | $T_S$ | -55 to+165 | ℃ |
| Maximum Junction Temperature | $T_J$ | +165 | ℃ |
| ESD Sensitivity - HBM | - | 6000 | V |
| Magnetic Flux Density | B | Unlimited | mT |

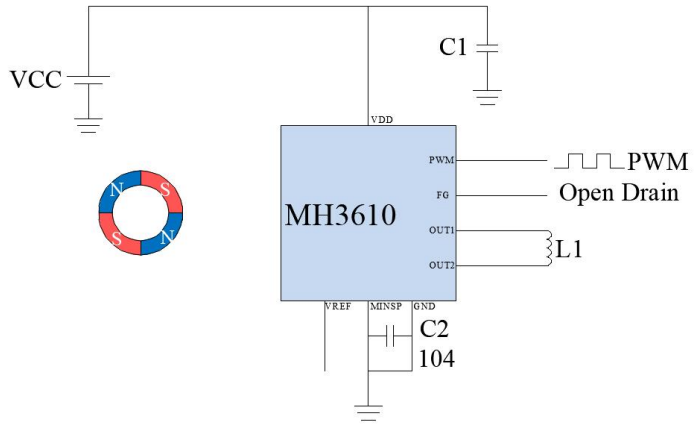
## *Electrical Specifications*

*(Ta=25℃,VDD=12V,unless otherwise specified)*

| Parameters | Symbol | Test Conditions | Min | Typ. | Max | Units |
|---|---|---|---|---|---|---|
| Supply Voltage | $V_{DD}$ | | 3.5 | 12 | 16 | V |
| Supply Current | $I_{DD}$ | | - | 3 | 6 | mA |
| Reverse Supply Current | $I_{DDREV}$ | $V_{DD}$= -16V | - | - | 10 | uA |
| PWM Input Low Voltage | $V_{IL}$ | | - | - | 0.8 | V |
| PWM Input High Voltage | $V_{IH}$ | | 2.1 | | 5.5 | V |
| PWM Input Frequency | $F_{IN}$ | -2%<DCERR<2% | 0.1 | - | 100 | kHz |
| PWM internal pull-up resistor | $R_{IN}$ | | - | 10 | - | kΩ |
| Full Bridge On Resistance | $R_{DSON}$ | TJ=25℃ | - | 3.0 | - | Ω |
| Full Bridge On Resistance | $R_{DSON}$ | TJ=105℃ | - | 4.0 | - | Ω |
| Output PWM frequency | $F_{OUT}$ | 10%<$DC_{IN}$<100% | - | 22.5 | - | kHz |
| Output Duty Cycle Range | $DC_{OUT}$ | $V_{MINSP}$=0V | 0 | - | 100 | % |
| Output Duty Cycle Range | $DC_{OUT}$ | Resistor R1 between MINSP to VREF, $DC_{IN}$<10% | 10 | - | 100 | % |
| Minimal Speed Setting Resistor | $R_{MINSP}$ | $DC_{IN}$<10%,10%<$DC_{OUT}$ <100%,$R_{REF}$=68k | 40 | - | 100 | kΩ |
| Output Duty Cycle Mismatch | $DC_{ERR}$ | $DC_{OUT}$–$DC_{IN}$, $V_{DD}$=12V,$T_A$=25℃ | -2 | - | 2 | % |
| Freewheel Period | $T_{FW}$ | | - | 1 | - | ms |
| Soft Start Initial Overdrive | $K_{SOFT}$ | | - | 30 | - | % |
| Soft Start Rotation Detector | $E_{SOFT}$ | | - | 4 | - | edges |
| Soft Start Duration | $T_{SOFT}$ | | - | 1.0 | - | s |
| FG Output Saturation Voltage | $V_{OL}$ | B>$B_{OP}$,$I_{OUT}$=5mA | - | 0.2 | 0.5 | V |
| FG Output Current Limit | $I_{CL}$ | B>$B_{OP}$ | - | 25 | - | mA |
| FG Output Leakage Current | $I_{OFF}$ | $V_{OUT}$=16V,$V_{DD}$=12V, B<Brp | - | 0.1 | 10 | uA |
| Minimum recommended magnetic field | $B_{HALL}$ | $B_{OP}$=\|$B_{HALL}$\| $B_{RP}$= -\|$B_{HALL}$\| | - | ±15 | ±25 | Gauss |
| Output Slope Duration | $T_{SLOPE}$ | Total Regulation Range | 300 | - | 4000 | us |
| Slope to Torque Ratio | $S_{LRATIO}$ | | - | 12.5 | - | % |
| Reference Output Voltage | $V_{REF}$ | | 2.9 | 3.1 | 3.4 | V |
| Reference Output Current Capability | $I_{REF}$ | | - | - | 5 | mA |
| Brown-Out Detector Threshold | $V_{BOD}$ | | 2.8 | 3.1 | 3.4 | V |
| Brown-Out Detector Reaction Time | $T_{BOD}$ | | - | 8 | - | ms |
| Locked Rotor Protection ON time | $T_{ON}$ | | - | 1.0 | - | s |
| Locked Rotor Protection OFF time | $T_{OFF}$ | | - | 4.0 | - | s |

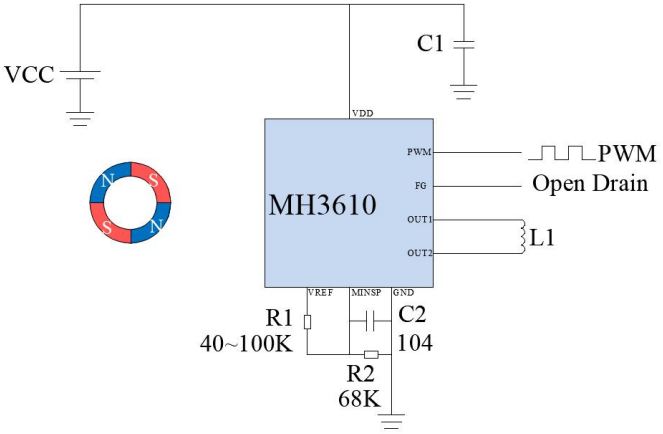
## *Typical Application Circuit*

### (1) *PWM Cooling Fan (without minimal speed setting)*



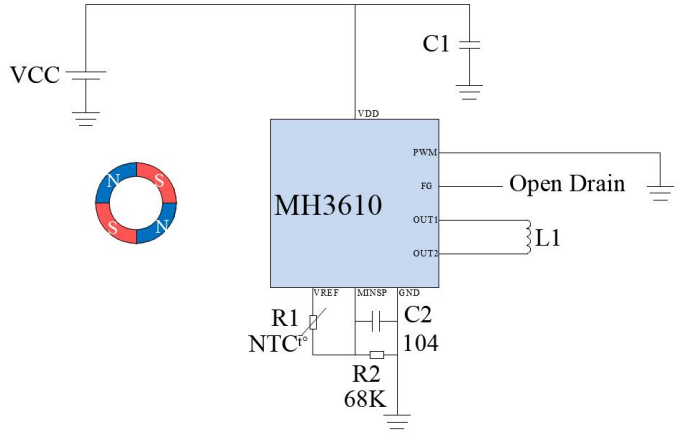

***Note: C2 must be added and placed as close as possible to MH3610.***

### *(2) PWM Cooling Fan (with minimal speed setting)*



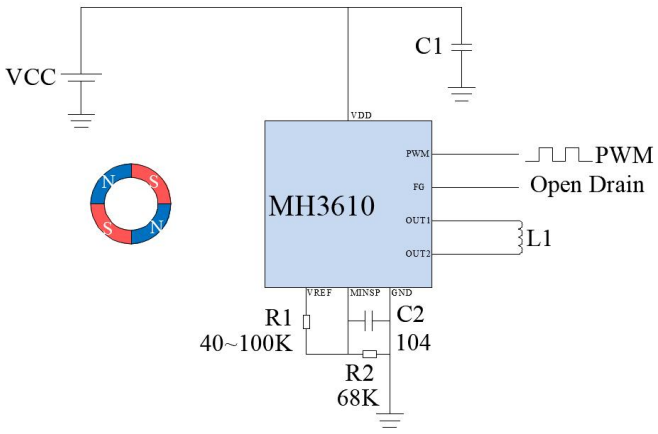

***Note: C2 must be added and placed as close as possible to MH3610.***

### *(3) Temperature Controlled Cooling Fan*




***Note: C2 must be added and placed as close as possible to MH3610.***

### *(4) 2-Speed Cooling Fan*




***Note: C2 must be added and placed as close as possible to MH3610.***

## *Magnetic Specifications*

*DC Operating Parameters：* $T_A$*=25℃,* $V_{DD}$*=12V*

| Parameter | Symbol | Test condition | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Operate Point | $B_{OP}$ | VP/VS | - | 15 | 25 | Gauss |
| Release Point | $B_{RP}$ | VP/VS | -25 | -15 | - | Gauss |
| Hysteresis | $B_{HYS}$ | VP/VS | | 30 | | Gauss |

## *Output Behavior versus Magnetic Polarity*

*(Ta=25℃,*$V_{DD}$*=12V,unless otherwise specified)*

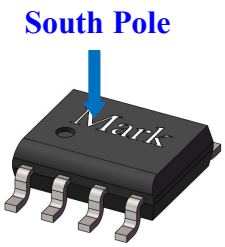
| *Parameter* | *Test Conditions* | *OUT1* | *OUT2* | *FG* |
|---|---|---|---|---|
| South | B>BOP | Low | High | Low |
| North | B<BRP | High | Low | High |




OUT1=High

OUT2=Low

FG=High

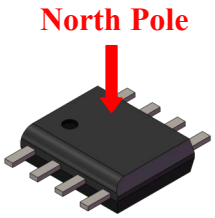



OUT1=Low

OUT2=High

FG=Low

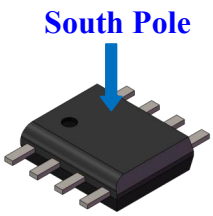
**VP Package**




OUT1=High

OUT2=Low

FG=High

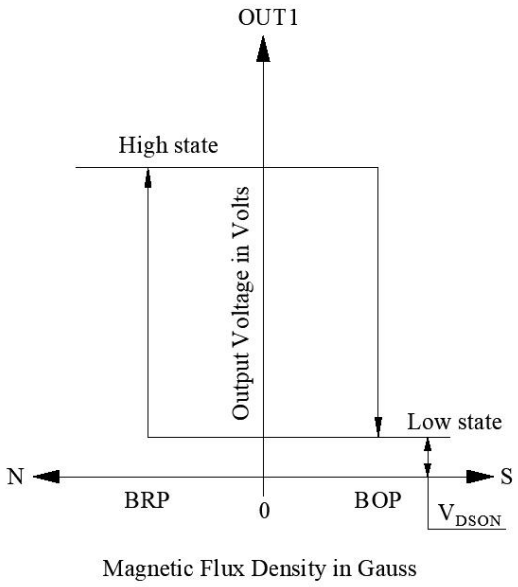


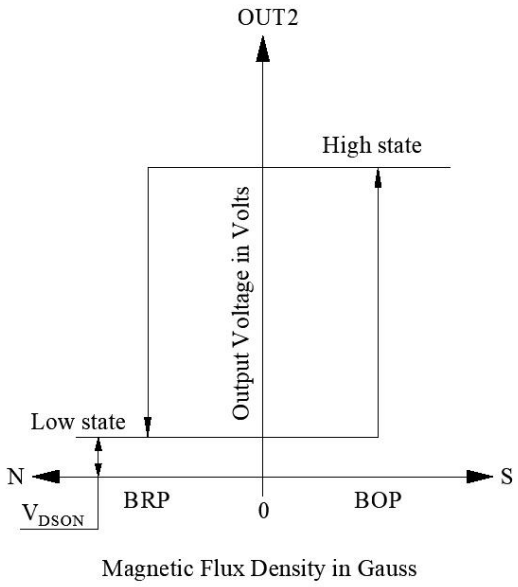

OUT1=Low

OUT2=High

FG=Low

**VS Package**

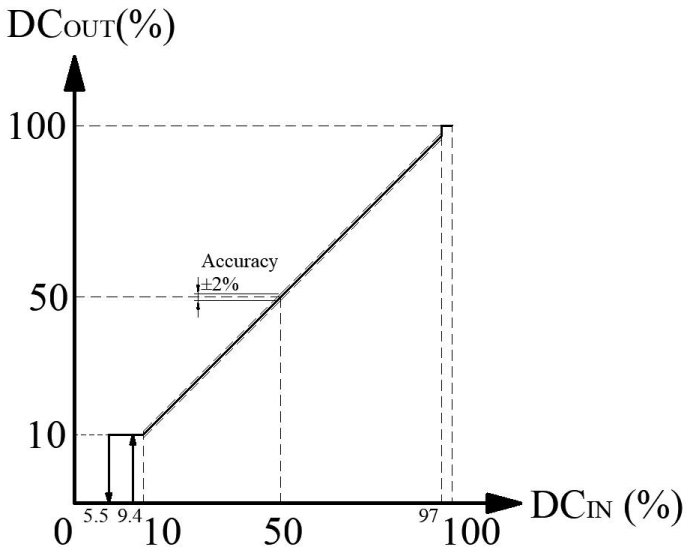



## *General Description*

### *(1) PWM Input*

The PWM input supports a very wide input frequency range (100Hz to 100kHz) while the output PWM frequency is kept constant above the audible frequency range. The input duty cycle controls the driving of the output duty cycle applied to the motor coil, thus the rotational speed is directly proportional to the input duty cycle with very high accuracy of +/-2% ensuring very good linearity.




The PWM input features a built-in pull-up resistor of 10 kΩ tied to the Reference Output Voltage (VREF). Since the interface providing the PWM signal is generally open-collector/drain type, an external resistor is no longer required. In addition, it provides a fail/safe functionality as it will drive the motor at full speed in case of PWM signal wire-break.

***(2) Soft Switching***

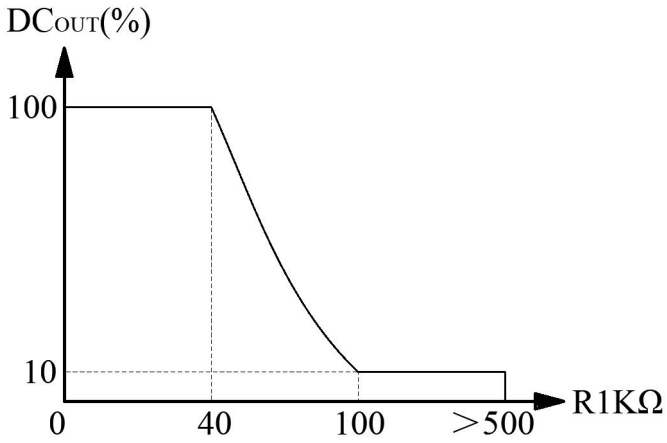
Soft Switching is performed using the output duty cycle rather than analog voltage sweep, leading to much less power dissipation. The device automatically adjusts its slope duration targeting 12.5% from the torque period independently of the rotor magnet strength, producing an optimum balance between high efficiency and low-noise performance. The possibility for very long slope duration guarantees extremely quiet operation even at very low rotational speeds.

***(3) Soft Start***

The Intelligent Soft Start prevents very high peak current during start-up. An additional system guarantees proper motor start-up even with low PWM input duty cycle, ensuring enough initial torque to the motor is generated to enable rotation. When motor rotation is detected, the output duty cycle is adjusted linearly to the input duty cycle.

***(4) MINSP Control***

The Minimal Speed input allows setting of a minimum required rotational speed of the motor by using 2 inexpensive resistors. This is especially useful for applications where minimum cooling is a requirement to avoid system damage (for example: computer CPU, VGA graphics, etc).



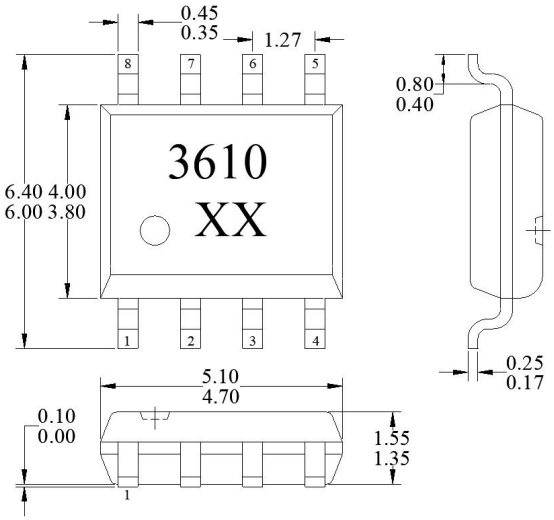

***(5) FG Output***

The tachometer open-drain output (FG) feeds back motor rotational speed to the system and is fully protected against short-circuit.

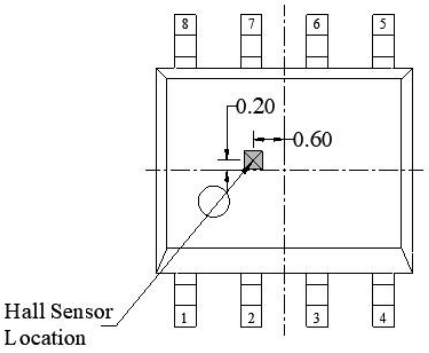
## *Sensor Location, Package Dimension and Marking*

### *VP Package(SOP8）*

**(Top View)**




**Hall Plate Chip Location**

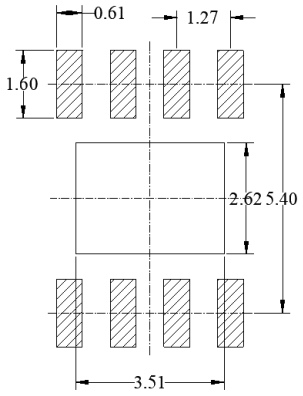



**NOTES:**

1. Controlling dimension: mm
2. Leads must be free of flash and plating voids
3. Lead thickness after solder plating will be 0.254mm maximum
4. Marking:Line1:3610； Line2: Date Code, Refer to DC table.
5. PINOUT:

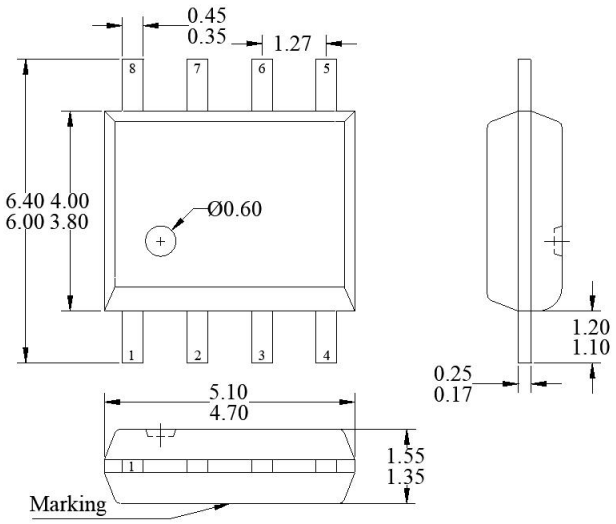
| Pin No. | Pin Name | Pin No. | Pin Name |
|---|---|---|---|
| 1 | PWM | 5 | OUT2 |
| 2 | FG | 6 | GND |
| 3 | OUT1 | 7 | MINSP |
| 4 | VDD | 8 | VREF |

**(For reference only) Land pattern**

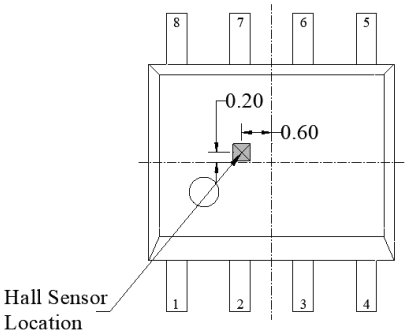


## *VS Package（SOP8-Straight Lead）*

**(Top View)**




**Hall Plate Chip Location**

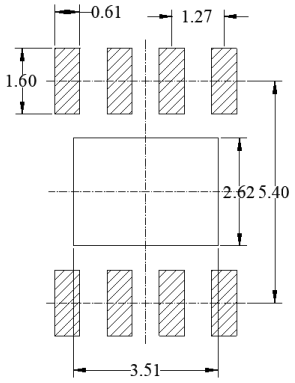



**NOTES:**

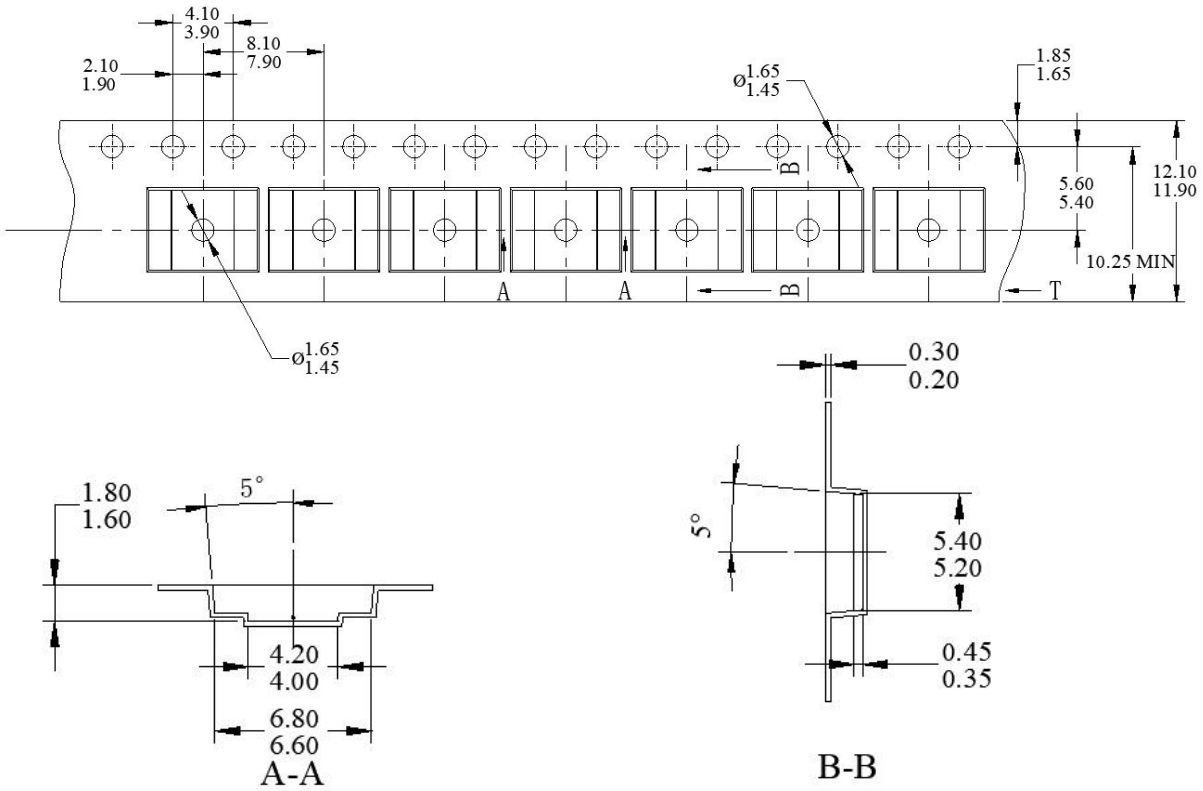
6. Controlling dimension: mm
7. Leads must be free of flash and plating voids
8. Lead thickness after solder plating will be 0.254mm maximum
9. Marking:Bottom Side； Line1:3610； Line2: Date Code, Refer to DC table.
10. PINOUT:

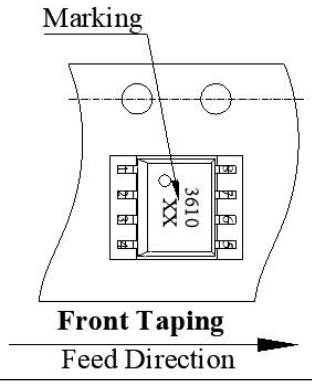
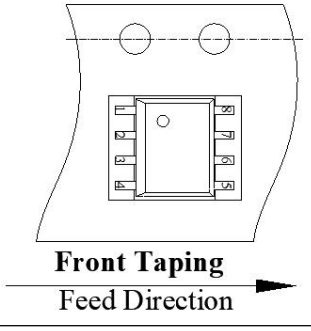
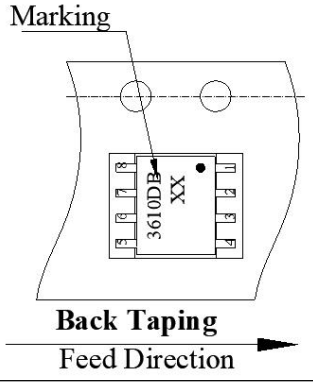
| Pin No. | Pin Name | Pin No. | Pin Name |
|---|---|---|---|
| 1 | PWM | 5 | OUT2 |
| 2 | FG | 6 | GND |
| 3 | OUT1 | 7 | MINSP |
| 4 | VDD | 8 | VREF |

**(For reference only) Land pattern**



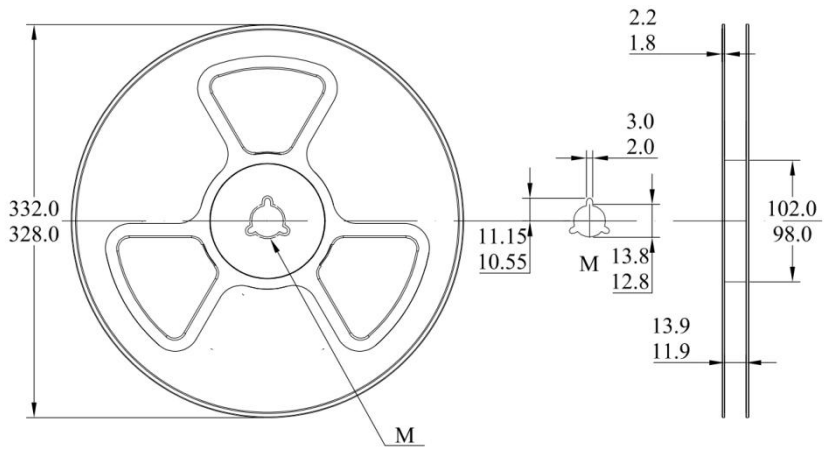
## *VP/VS package Tape and Reel Dimension*




| MH3610KVP | MH3610KVS | MH3610KVS-DB |
|---|---|---|
|  |  |  |
| Front Taping<br>Feed Direction | Front Taping<br>Feed Direction | Back Taping<br>Feed Direction |








**NOTES:**

1.Material: Conductive polystyrene;
2.DIM in mm;
3.10 sprocket hole pitch cumulative tolerance ±0.2;
4.Camber not to exceed 1mm in 100mm;
5.Pocket position relative to sprocket hole measured as true position of pocket, not pocket hole;
6.(S.R.OHM/SQ) Means surface electrical resistivity of the carrier tape.