

# **SINGLE PHASE MOTOR DRIVER WITH INTERNAL HALL EFFECT LATCH SENSOR**

## **Description**

The AH5772 is a single chip solution for driving single-coil brushless direct current (BLDC) fans and motors. The integrated full-bridge driver output stage uses soft switching to minimize audible switching noise and electromagnetic interference (EMI) providing a low noise solution.

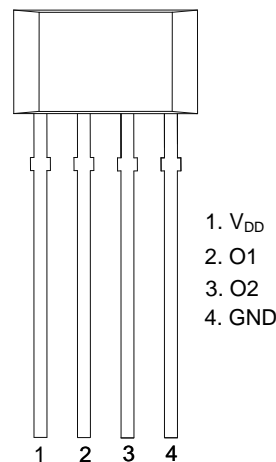
To simplify system circuit and minimize external components, the device integrates a stable high sensitivity Hall-Effect sensor, voltage and temperature compensated internal references, amplifiers and the output H-bridge power switches with low  $R_{DS(on)}$ .

To help protect the motor coil, the AH5772 provides Rotor Lock Protection which shuts down the output drive if rotor lock is detected. The device automatically re-starts when the rotor lock is removed. In case of over voltage, the device shuts down the output drive and enters standby mode to help prevent over voltage stress on the coil. Over temperature shutdown provides thermal protection for the device.

The AH5772 is available in industry standard TO94 package.

## **Pin Assignments**

**(Front View)**



**TO94**

## **Features**

- Supports Single-phase Full Wave BLDC Fan/Motor Drive
- Wide Operating Voltage Range: 2.4V to 18V
- Built-in High Sensitivity Hall Effect Sensor
  - Very Low Temperature and Voltage Coefficient of the Magnetic Operating Switch Points
- Built-in H-Bridge with Low  $R_{DS(on)}$  Resistance
- Soft Switching for Low Noise DC Fan Motor Applications
- Rotor Lock Protection (Lock Detection, Output Shutdown and Automatic Re-start)
- Over Voltage Shutdown
- Thermal Protection
- No External Timing Capacitor - Reduces the Numbers of External Components Required
- Industry Standard TO94 Package
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1 & 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**

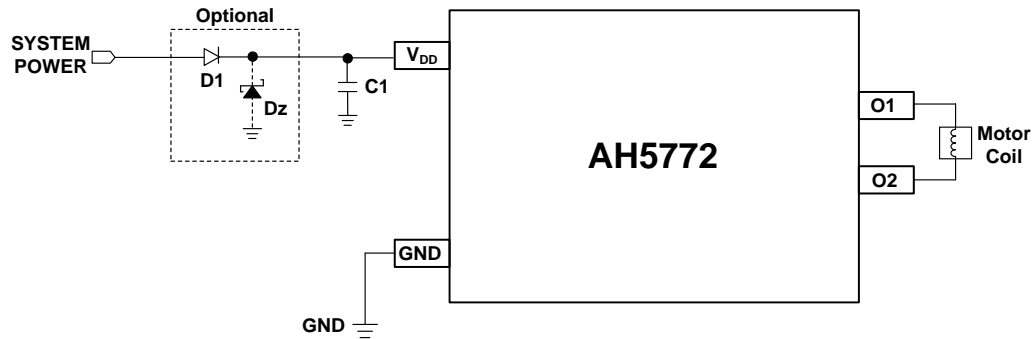
## **Applications**

- 5V / 9V / 12V / 15V Min. BLDC Cooling Fans
- Netbook/ Notebook and Desktop BLDC Fans
- Instruments Cooling Fans
- Medium Voltage/ Low Power BLDC Motors

Notes:

1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS) & 2011/65/EU (RoHS 2) compliant.
2. See [http://www.diodes.com/quality/lead\\_free.html](http://www.diodes.com/quality/lead_free.html) for more information about Diodes Incorporated's definitions of Halogen- and Antimony-free, "Green" and Lead-free.
3. Halogen- and Antimony-free "Green" products are defined as those which contain <900ppm bromine, <900ppm chlorine (<1500ppm total Br + Cl) and <1000ppm antimony compounds.

## Typical Applications Circuit

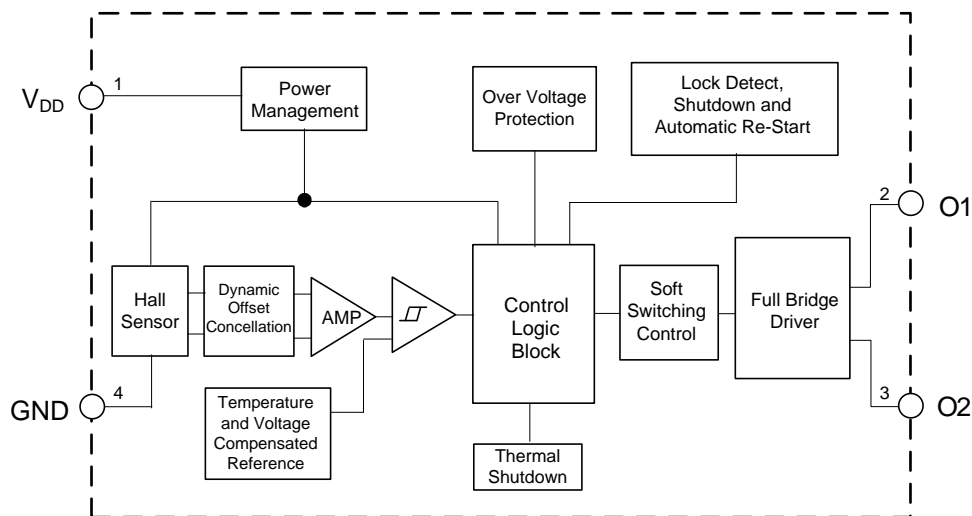


Note: 4. C1 is for power stabilization and to strengthen the noise immunity, the recommended capacitance is 0.1 $\mu$ F for small motor current to 1 $\mu$ F or higher for larger motor current. The value of C1 should be selected adequately to support the motor current.

## Pin Descriptions

Pin Number	Pin Name	Description
1	V <sub>DD</sub>	Power supply input pin
2	O1	Output drive sourcing & sinking pin
3	O2	Output drive sourcing & sinking pin
4	GND	Ground pin

## Functional Block Diagram



## Absolute Maximum Ratings (Notes 5 and 6) @T<sub>A</sub> = +25°C, unless otherwise specified.)

Symbol	Characteristics	Rating	Unit
V <sub>DD_MAX</sub>	Maximum Supply Voltage (Note 6)	24	V
V <sub>REVERSE</sub>	Reverse Supply Voltage on All Pins	-0.3	V
I <sub>O(PEAK)</sub>	Maximum Output Current (Peak)	1000	mA
B	Maximum Magnetic Flux Density	Unlimited	–
P <sub>D</sub>	Power Dissipation	TO94	mW
T <sub>STG</sub>	Storage Temperature Range	-65 to +150	°C
T <sub>J</sub>	Maximum Junction Temperature	+150	°C
ESD HBM	Human Body Model ESD Capability	V <sub>DD</sub> , O1, O2 and GND pins	4
			kV

Notes: 5. Stresses greater than the 'Absolute Maximum Ratings' specified above may cause permanent damage to the device. These are stress ratings only; functional operation of the device at these or any other conditions exceeding those indicated in this specification is not implied. Device reliability may be affected by exposure to absolute maximum rating conditions for extended periods of time.  
6. The absolute maximum V<sub>DD</sub> of 24V is a transient stress rating and is not meant as a functional operating condition. It is not recommended to operate the device at the absolute maximum rated conditions for any period of time.

## Recommended Operating Conditions

Symbol	Characteristic	Conditions	Min	Max	Unit
V <sub>DD</sub>	Supply Voltage	Operating	2.4	18	V
T <sub>A</sub>	Operating Temperature Range	Operating	-40	+105	°C

## Electrical Characteristics (Note 7) (@T<sub>A</sub> = +25°C, V<sub>DD</sub> = 12V, unless otherwise specified.)

Symbol	Characteristics	Conditions	Min	Typ	Max	Unit
I <sub>DD</sub>	Supply Current	No Load, PWM switching or high	–	3	4.5	mA
V <sub>OV_TH</sub>	Over Voltage Protection Threshold for Shutdown to Standby Mode	Voltage increasing	19	21	23	V
V <sub>OV_RLTH</sub>	Over Voltage Release Threshold	Voltage decreasing	18	20	22	V
V <sub>OH</sub>	Output Voltage High	V <sub>DD</sub> = 12V, I <sub>OUT</sub> = 500mA	V <sub>DD</sub> -0.65	V <sub>DD</sub> -0.35	–	V
		V <sub>DD</sub> = 12V, I <sub>OUT</sub> = 500mA T <sub>A</sub> = -40°C to +105°C	V <sub>DD</sub> -0.75	V <sub>DD</sub> -0.35	–	V
		V <sub>DD</sub> = 3V, I <sub>OUT</sub> = 300mA	V <sub>DD</sub> -0.35	V <sub>DD</sub> -0.23	–	V
		V <sub>DD</sub> = 3V, I <sub>OUT</sub> = 300mA T <sub>A</sub> = -40°C to +105°C	V <sub>DD</sub> -0.45	V <sub>DD</sub> -0.23	–	V
V <sub>OL</sub>	Output Voltage Low	V <sub>DD</sub> = 12V, I <sub>OUT</sub> = 500mA	–	0.29	0.40	V
		V <sub>DD</sub> = 12V, I <sub>OUT</sub> = 500mA T <sub>A</sub> = -40°C to +105°C	–	0.29	0.55	V
		V <sub>DD</sub> = 3V, I <sub>OUT</sub> = 300mA	–	0.19	0.26	V
		V <sub>DD</sub> = 3V, I <sub>OUT</sub> = 300mA	–	0.19	0.35	V
		T <sub>A</sub> = -40°C to +105°C	–	0.19	0.35	V

Note: 7. Typical data is measured at T<sub>A</sub> = +25°C, V<sub>DD</sub> = 12V. The maximum and minimum parameters values over operating temperature range are not tested in production, they are guaranteed by design, characterization and process control.

## Electrical Characteristics (continued) (Note 8) (@T<sub>A</sub> = +25°C, V<sub>DD</sub> = 12V, unless otherwise specified.)

Symbol	Characteristics	Conditions	Min	Typ	Max	Unit
R <sub>ON_TOTAL</sub>	Combined N- and PMOS R <sub>DS(on)</sub> Including Bond Wire Resistance	V <sub>DD</sub> = 12V, I <sub>OUT</sub> = 500mA	—	1.28	2.1	Ω
		V <sub>DD</sub> = 12V, I <sub>OUT</sub> = 500mA T <sub>A</sub> = -40°C to +105°C	—	1.28	2.6	Ω
		V <sub>DD</sub> = 3V, I <sub>OUT</sub> = 300mA	—	1.40	2.03	Ω
		V <sub>DD</sub> = 3V, I <sub>OUT</sub> = 300mA T <sub>A</sub> = -40°C to +105°C	—	1.40	2.67	Ω
t <sub>SW</sub>	Output Soft Switch Time	17Ω load on out1/out2	—	200	—	μs
t <sub>ON</sub>	On Time - Lock Detect Time	—	—	420	—	ms
R <sub>DR</sub>	Duty Ratio - Lock Detect to Shutdown Time	t <sub>OFF</sub> / t <sub>ON</sub>	—	10	—	—
T <sub>J_SDN_TH</sub>	IC Junction Temperature Thermal Shutdown Threshold	—	—	+170	—	°C
T <sub>J_SDN_HYST</sub>	IC Junction Temperature Thermal Shutdown Hysteresis	—	—	+25	—	°C

Note: 8. Typical data is measured at T<sub>A</sub> = +25°C, V<sub>DD</sub> = 12V. The maximum and minimum parameters values over operating temperature range are not tested in production, they are guaranteed by design, characterization and process control.

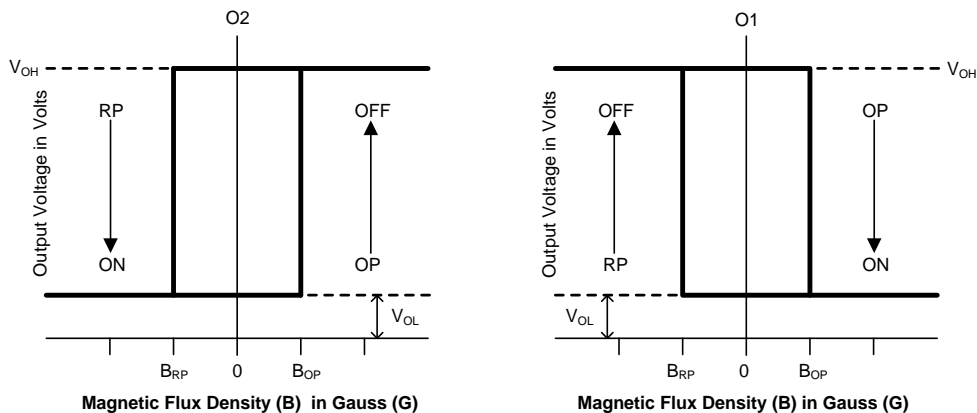
## Magnetic Characteristics (Note 9, 10, 11) (@T<sub>A</sub> = -40°C to +105°C, V<sub>DD</sub> = 2.4V to 18V, unless otherwise specified.)

(1mT = 10 G)

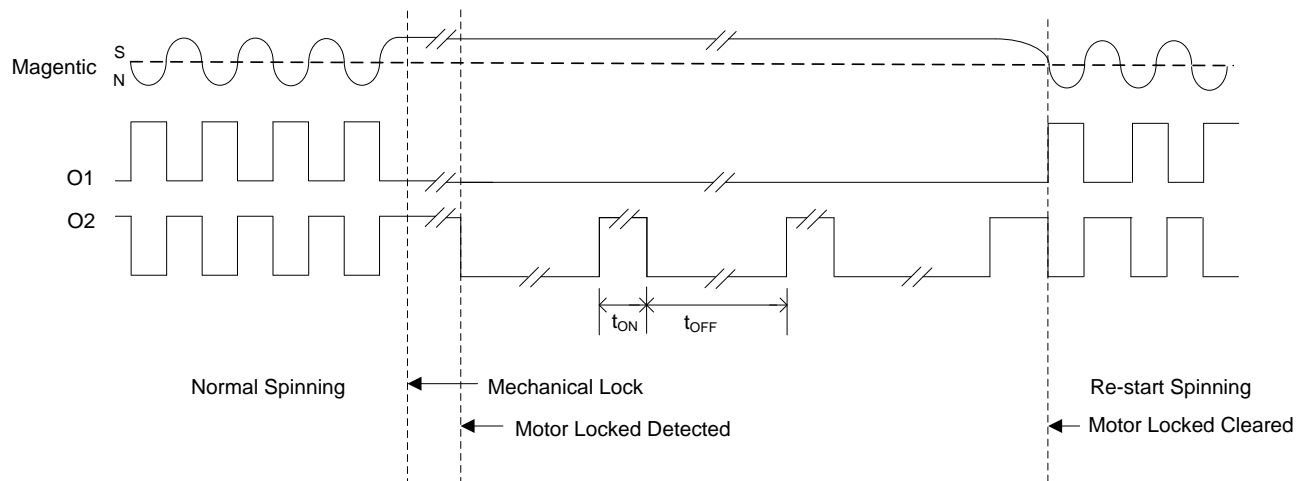
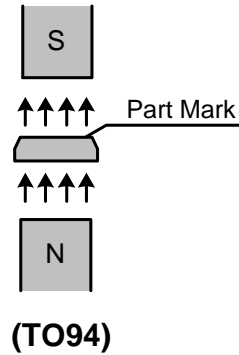
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
B <sub>OP</sub> (South Pole to Part Marking Side)	Operate Point	(Note 10, 11)	5	20	35	Gauss
B <sub>RP</sub> (North Pole to Part Marking Side)	Release Point	(Note 10, 11)	-35	-20	-5	
B <sub>HY</sub> (B <sub>OP</sub> -B <sub>RP</sub> )	Hysteresis	—	—	40	—	

Notes: 9. Typical data is measured at T<sub>A</sub> = +25°C, V<sub>DD</sub> = 12V. The maximum and minimum parameters values over operating temperature range are not tested in production, they are guaranteed by design, characterization and process control.  
10. Magnetic characteristics may vary with supply voltage, operating temperature and after soldering.  
11. The peak amplitude of the rotating motor magnetic flux density at the sensor location should be greater than +/-70G.

## Operating Characteristics



## Operating Characteristics (Continued) (Notes 12 and 13)



**Truth Table**

O1	O2	Magnetic Flux Density B
H	L	$B < B_{RP}$
L	H	$B > B_{OP}$

- Notes:
12. When the motor locks with South pole at the Hall element, O2 is kept on "L" and O1 is a clock with  $t_{ON}/t_{OFF}$  ratio. When motor locks with North pole at the Hall element, O1 is kept on "L", O2 is a clock with  $t_{ON}/t_{OFF}$  ratio.
  13. When "Re-start spinning" occurs, the motor speed ramps up to the "Normal Spinning" speed from zero. Speed ramp-up profile depends on motor characteristics.

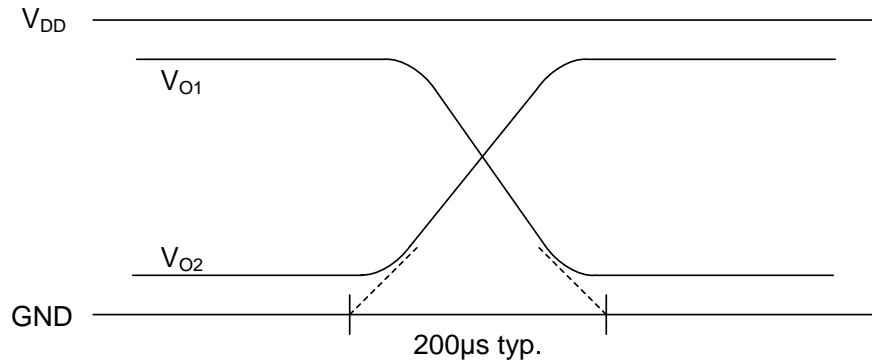
## Application Note

### DC Supply Voltage Speed Control

Motor speed can be controlled by varying the  $V_{DD}$  supply voltage. For example, with 12V nominal motor, changing supply voltage between 12V to 2.4V, speed can be reduced from 100% to 20% typically.

### Soft Switching

AH5772 uses soft switching of the motor coil current during commutation to minimize audible switching noise and electromagnetic interference (EMI) to provide a low noise solution.

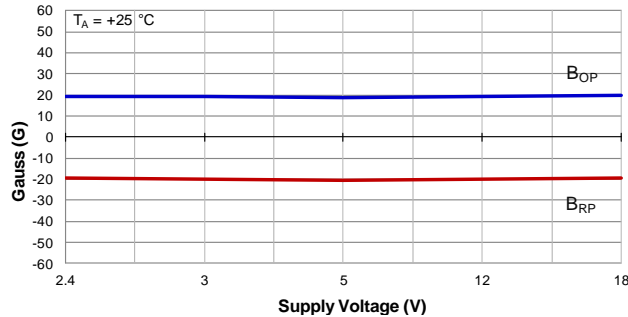


### Overvoltage Shutdown of Output Drive

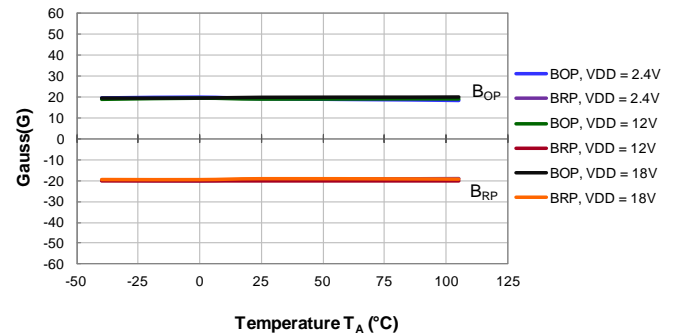
When the supply voltage reaches the over voltage shutdown threshold,  $V_{OV\_TH}$ , the AH5772 shuts down all the output drive switches and enters standby mode to help prevent over voltage stress on the coil.

## Typical Operating Characteristics

### Magnetic Operating Switch Points

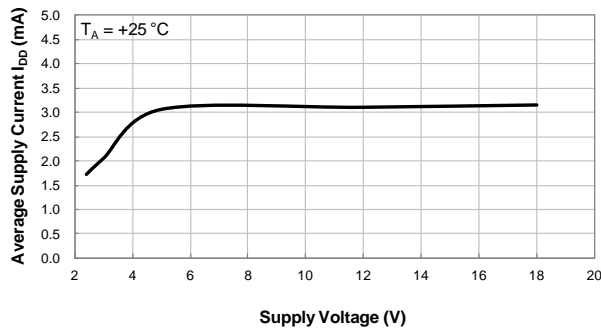


Magnetic Switch Points Bop & Brp vs. Supply Voltage

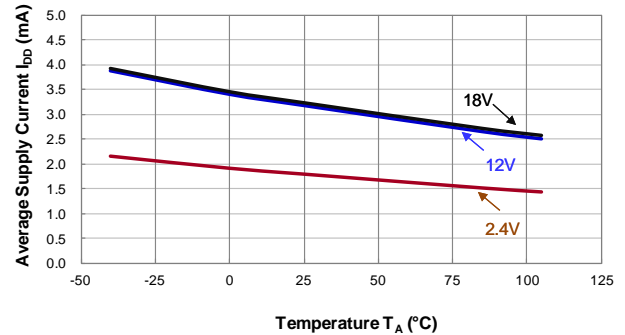


Magnetic Switch Points Bop & Brp vs. Temperature

### Average Supply Current

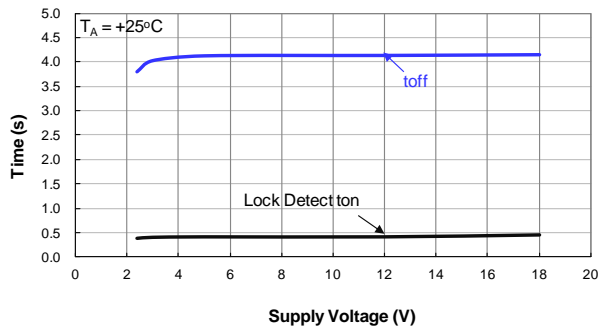


Average Supply Current vs. Supply Voltage

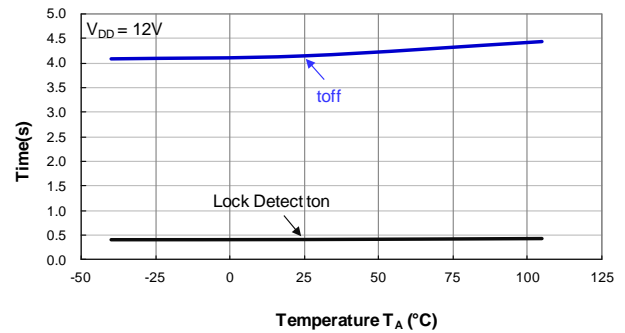


Average Supply Current vs. Temperature

### Lock Detect Ton and Shutdown Toff Periods



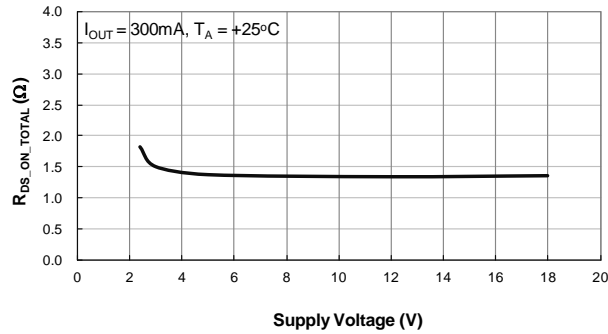
Lock Detect Ton and Toff vs. Supply Voltage



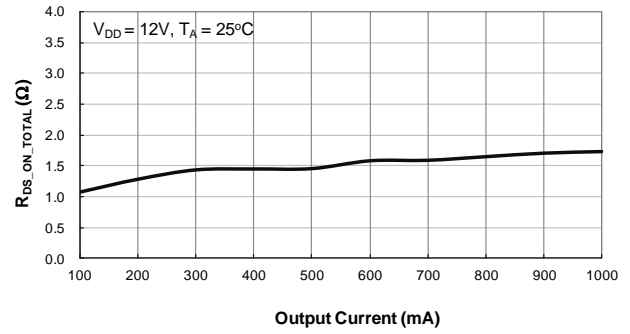
Lock Detect Ton and Toff vs. Temperature

## Typical Operating Characteristics (Continued)

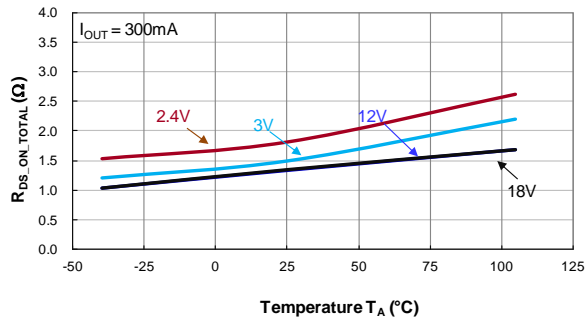
### Total H-Bridge Path Resistance – Total $R_{DS(on)}$ of High Side and Low Side Switches



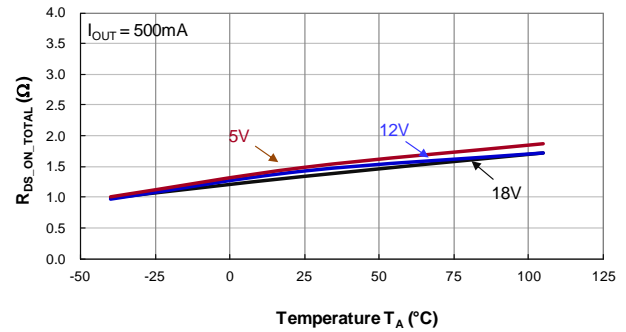
High+Low Side Resistance  $R_{DS(on)_TOTAL}$  vs. Supply Voltage



High+Low Side Resistance  $R_{DS(on)_TOTAL}$  vs. Current



High+Low Side Resistance  $R_{DS(on)_TOTAL}$  vs. Temperature



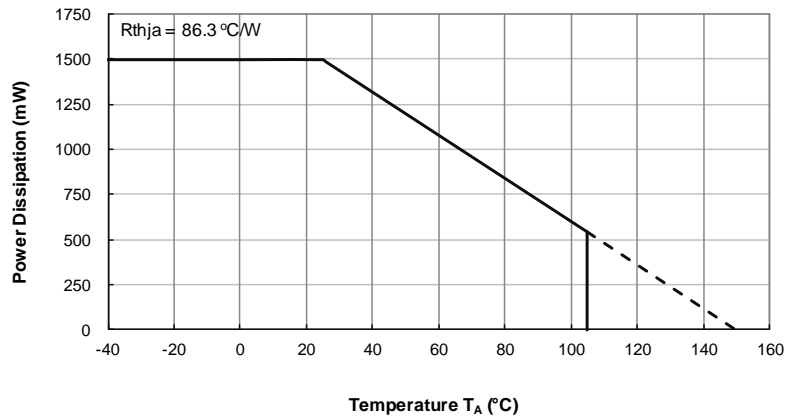
High+Low Side Resistance  $R_{DS(on)_TOTAL}$  vs. Temperature



## Thermal Performance

TO94 Power Dissipation De-rating Curve (Note 14)

T <sub>A</sub> (°C)	-40	0	25	50	60	70	80	85	90	95	100	105	110	120	125	130	140	150
P <sub>D</sub> (mW)	1500	1500	1500	1200	1080	960	840	780	720	660	600	540	480	360	300	240	120	0

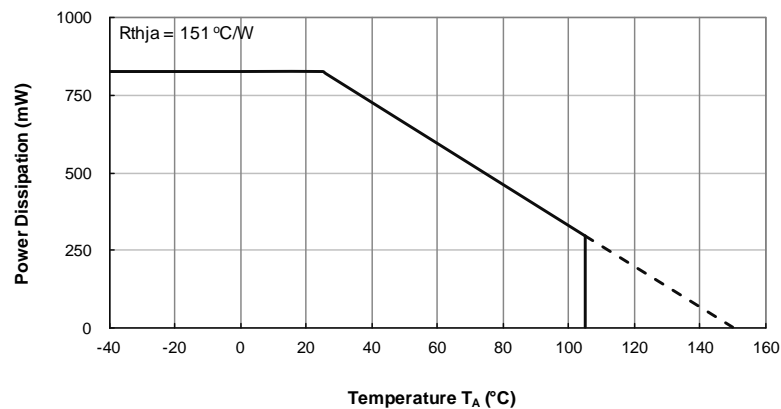


TO94 Thermal Derating Curve

Note 14: TO94 through-hole mounted to minimum recommended landing pads (through holes) on a 2"x2" two-layer 2oz.copper FR4 PCB (1.6mm thickness) with copper flood on the top but without copper flood on the bottom layer.

TO94 Power Dissipation De-rating Curve for Circular PCB with Center Hole Cut-Out (Note 15)

T <sub>A</sub> (°C)	-40	0	25	50	60	70	80	85	90	95	100	105	110	120	125	130	140	150
P <sub>D</sub> (mW)	827	827	827	662	595	529	463	430	397	364	331	298	298	265	198	165	132	0



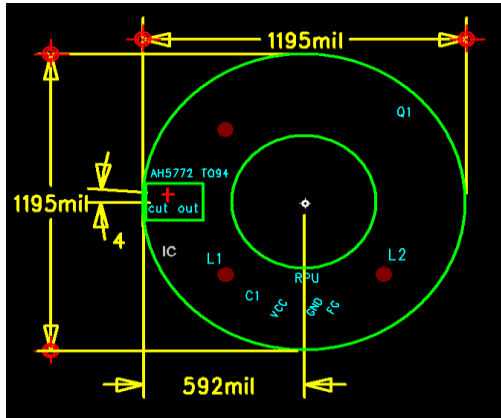
TO94 Thermal Derating Curve  
(Custom Circular PCB with Centre Hole Cut-Out)

Note 15: TO94 through-hole mounted in a circular PCB with center hole cutout, single-layer 2oz.copper FR4 PCB (1.6mm thickness) with partial copper flood on the bottom layer. The circular PCB diameter is 1.2" with the centre circular cutout diameter of 0.53". The TO94 space cut-out is 0.2"x0.135". See below for details.

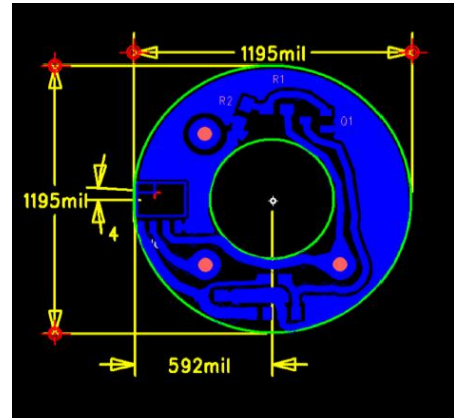
## Thermal Performance (Continued)

### Circular PCB Dimensions

The circular PCB diameter is 1.2" with the centre circular cutout diameter of 0.53". The TO94 space cut-out is 0.2"x0.135". single-layer 2oz.copper FR4 PCB (1.6mm thickness) with partial copper flood on the bottom layer.

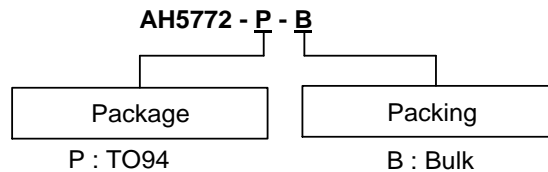


Custom Circular PCB – Top View



Custom Circular PCB – Bottom View

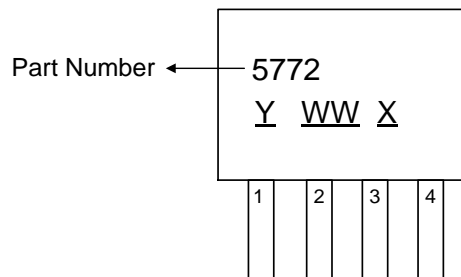
## Ordering Information



Part Number	Package Code	Packaging	Bulk	
			Quantity	Part Number Suffix
AH5772-P-B	P	TO94	1000	-B

## Marking Information

### (1) Package Type: TO94

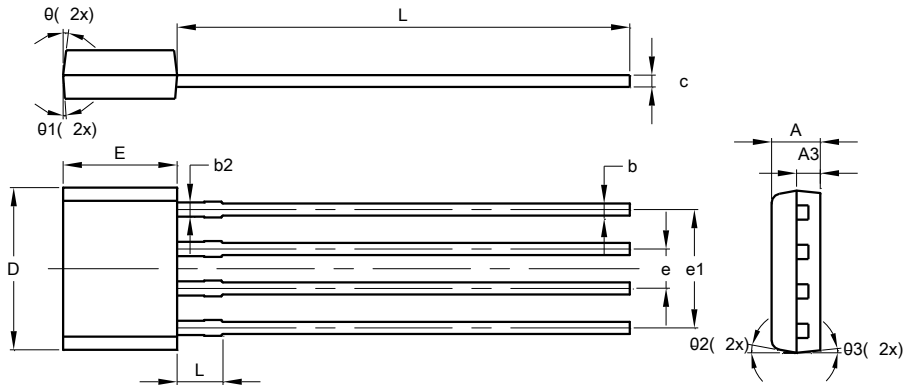


Y : Year : 0~9  
WW : Week : 01 ~ 52;  
           52 represents 52 and 53 week  
X : Internal code

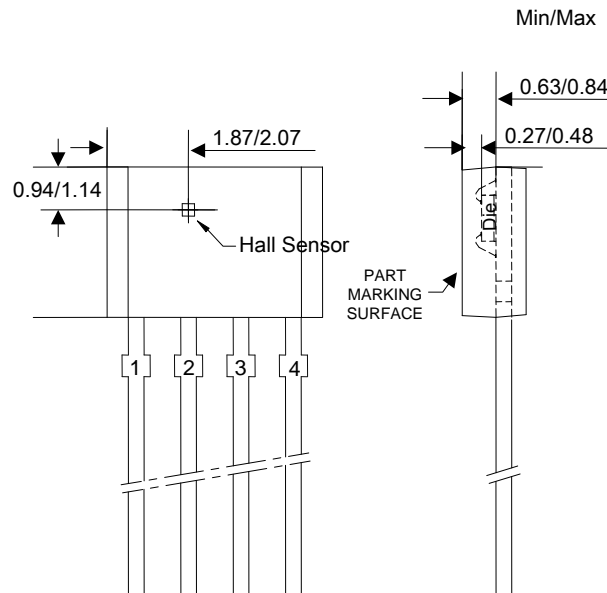
# Package Outline Dimensions (All dimensions in mm.)

Please see AP02002 at <http://www.diodes.com/datasheets/ap02002.pdf> for latest version.

## (1) Package Type: TO94



TO94			
Dim	Min	Max	Typ
A	1.46	1.66	1.56
A3	-	-	0.76
b	0.35	0.56	0.39
b2	-	-	0.46
c	0.36	0.51	0.38
D	5.12	5.32	5.22
E	3.55	3.75	3.65
e	-	-	1.27
e1	-	-	3.81
L	13.50	15.50	14.50
L1	-	-	1.42
S	0.63	0.83	0.73
θ	-	-	6°
θ1	-	-	4°
θ2	-	-	11°
θ3	-	-	6°
All Dimensions in mm			



**Sensor Location**

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