Lead-free Green

TWO-WIRE AUTOMOTIVE HALL EFFECT UNIPOLAR / LATCH SWITCHES

Description

The AH3231Q, AH3232Q, AH3233Q, AH3270Q, AH3271Q, and AH3272Q are high voltage, high sensitivity two-wire Hall Effect Unipolar/Latch switch ICs with automotive-compliant AEC-Q100 qualification; designed for position and proximity sensing in automotive applications, such as seat and seatbelt buckle, transmission actuator, gear position, wiper, door/trunk closure, etc.

To support a wide range of demanding applications, the design is optimized to operate over a supply range of 2.7V to 27V. These features include a chopper-stabilized architecture and an internal bandgap regulator to provide temperature compensated supply for internal circuits. For robustness and protection, the device has built-in reverse blocking diode with a Zener clamp on the supply.

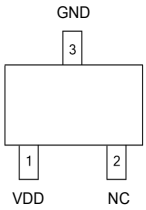
The built-in thermal protection also shuts down the chip if temperature rises to an abnormal value. This will automatically restart the chip once the junction temperature drops below the safe value.

For AH3231Q, AH3232Q, and AH3233Q 2-wire unipolar switches: when the flux density (south pole) exceeds B_{OP}, the supply current state is turned on (low or high). The output is held until a magnetic flux density falls below B_{RP}, causing output current to be turned off.

For AH3270Q, AH3271Q, and AH3272Q 2-wire latch switches: when the magnetic flux density is larger than B_{OP}, output current is turned on (high). The output state is held until a magnetic flux density reversal falls below B_{RP}, causing output current to be turned off (low).

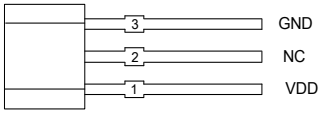
Pin Assignments

(Top View)



SC59 (Type A1)

(Top View)



SIP-3 (Future Product)

Features and Performance

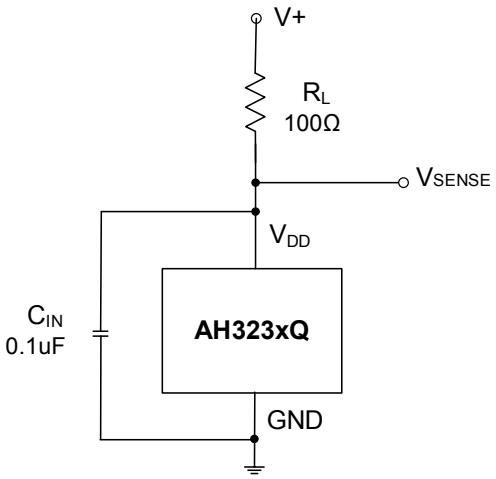
- Unipolar: AH3231Q, AH3232Q, AH3233Q
  Latch: AH3270Q, AH3271Q, AH3272Q
- Output Polarity:
  - Direct: AH3232Q, AH3233Q
  - Inverted: AH3231Q
- Wide Supply Voltage Operation: 2.7V to 27V
- Temperature Coefficient -1100ppm/°C (AH3232Q, AH3233Q)
- Chopper Stabilized Design Provides:
  - Superior Temperature Stability
  - Minimal Switch Point Drift
  - Enhanced Immunity to Stress
- Battery polarity reverse connection protection
- Transient Spike Voltage Protection
- Over-Temperature Shut Down and Auto-Restart
- UVLO Protection
- High ESD Rating: HBM = 8kV, CDM = 1kV
- Temperature Range:-40°C to +150°C
- **Totally Lead-Free & Fully RoHS Compliant (Notes 1, 2)**
- **Halogen and Antimony Free. "Green" Device (Note 3)**
- **The AH3231Q, AH3232Q, AH3233Q, AH3270Q, AH3271Q, and AH3272Q are suitable for automotive applications requiring specific change control; these parts are AEC-Q100 qualified, PPAP capable, and manufactured in IATF 16949 certified facilities.**
  https://www.diodes.com/quality/product-definitions/

Applications

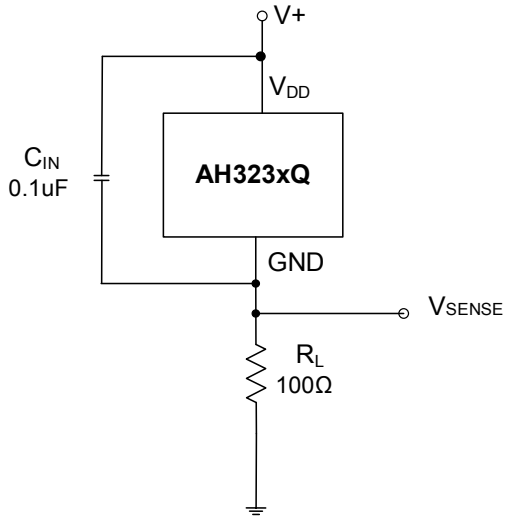
- Position and Proximity Sensing in Automotive Applications
- Seat position
- Seatbelt buckle
- Wiper position
- Window lifter
- Gear selection position

Notes:
1. No purposely added lead. Fully EU Directive 2002/95/EC (RoHS), 2011/65/EU (RoHS 2) & 2015/863/EU (RoHS 3) compliant.
2. See https://www.diodes.com/quality/lead-free/ 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



High-side sensing



Low-side sensing

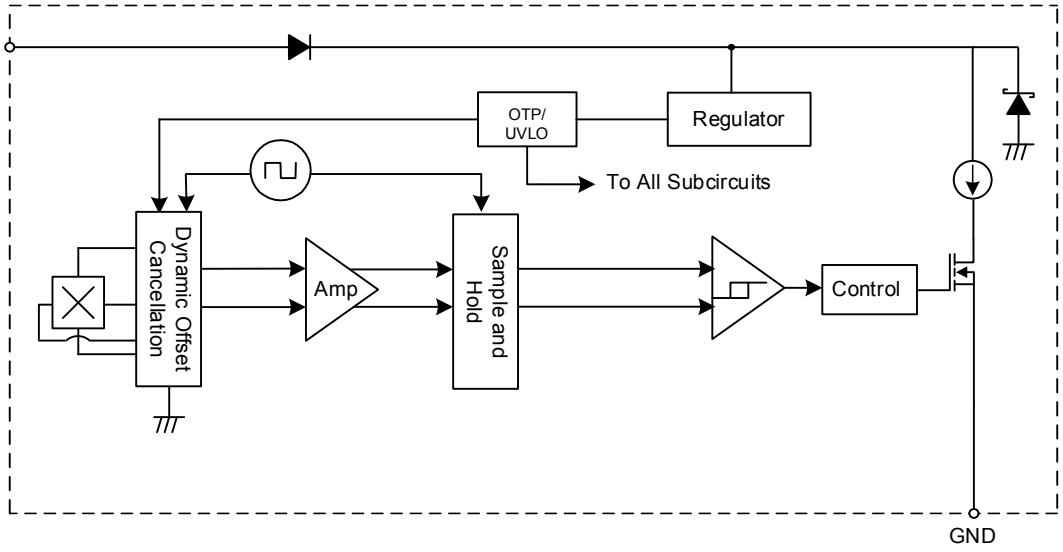
Note: 4. A 100nF or larger decoupling capacitor (C_{IN}) between V_{DD} and GND pins is needed for power stabilization and to strengthen noise immunity; C_{IN} needs to be as close to IC as possible. Typical R_L value is 100Ω. Larger or additional series resistor is recommended if there are disturbances on V_{DD}.

Pin Descriptions

Package: SC59 and SIP-3 (Ammo Pack and Bulk Pack)

Pin Number	Pin Name	Function
1	V_{DD}	Supply voltage input
2	NC	No connection; can be connected to V_{DD}, GND, or left open.
3	GND	Ground

Functional Block Diagram



Absolute Maximum Ratings (Note 5) (@ T_A = +25°C, unless otherwise specified.)

Symbol	Parameter	Rating	Unit
V_{DD} (Note 6)	Supply Voltage	32	V
V_{DDR} (Note 6)	Reverse Supply Voltage	-32	V
B	Magnetic Flux Density	Unlimited	Gauss
T_{J_MAX}	Maximum Junction Temperature	180	°C
T_S	Storage Temperature	-55~180	°C
ESD (HBM)	ESD (Human Body Model)	8000	V
ESD (CDM)	ESD (Charged Device Model)	1000	V

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. Should not be exceeded the maximum junction temperature and maximum duration of 500ms.

Recommended Operating Conditions (@ T_A = -40°C to +150°C, T_J = -40°C to +165°C unless otherwise specified.)

Symbol	Parameter	Min	Max	Unit
V_{DD}	Supply Voltage, between V_{DD} and GND pins	2.7	27	V
T_{OP}	Operating Ambient Temperature	-40	150	°C

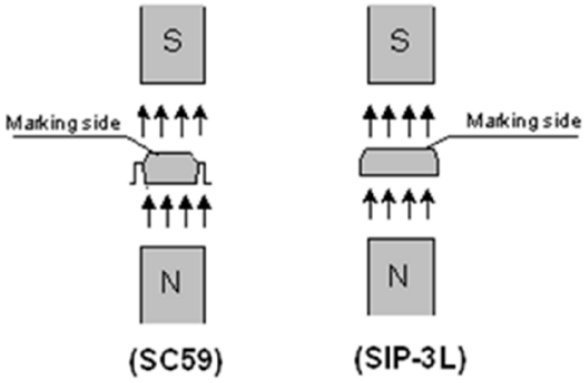
Electrical Characteristics (Note 7) (@ T_A = -40°C to +150°C, T_J = -40°C to +165°C, V_{DD} = 2.7V to 27V, unless otherwise specified)

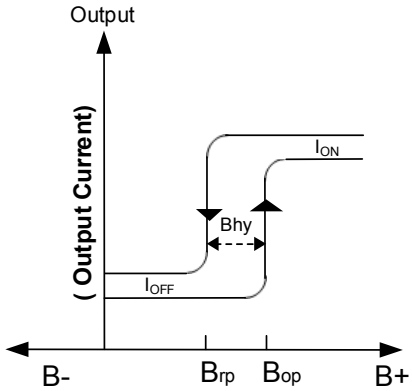
Symbol	Parameter	Conditions	Min	Typ	Max	Units
V_{DD}	Supply voltage (Note 8)	-	2.7	12	27	V
I_{OFF}(1)	Supply current off state	V_{DD} =2.7 to 27 V (AH3270Q, AH3272Q)	2	3.3	5	mA
I_{OFF}(2)	Supply current off state	V_{DD} = 2.7 to 27 V (AH3231Q, AH3232Q, AH3233Q, AH3271Q)	5	6	6.9	mA
I_{ON}	Supply current on state	V_{DD} = 2.7 to 27 V	12	14.5	17	mA
V_{UVLO}	Under voltage lockout threshold	Voltage dropping	-	2.2	2.7	V
t_{UVLO}	Under-voltage lockout reaction time	-	-	10	-	μs
I_{DDR}	Reverse supply current	V_{DD} = -18V , T_A = -40°C to +150°C	-1.5	-	-	mA
T_{TP}	Thermal protection threshold	Junction temperature	-	190	-	°C
T_{TPR}	Thermal protection release threshold	Junction temperature	-	180	-	°C
F_M	Maximum magnet switching frequency	B > 3*B_{OP}, alternative square magnet field	30	50	-	kHz
F_C	Chopping frequency	-	-	1000	-	kHz
T_{PON}	Power on delay time (Note 9)	B > B_{OP}+10GS	-	28	40	μs
T_D	Response delay time (Note 10)	B > 3*B_{OP}	-	7	-	μs
T_{RF}	Current rise/fall time	V_{DD} = 12V, No bypass capacitor, C_{LOAD} = 50pF to GND	0.1	0.3	1	μs
POS	Power-Up State (Notes 9, 11)	t > T_{PON}(max), V_{DD} slew rate > 1V/μs	-	I_{OFF}	-	-
-	Output jitter	B≥3*B_{OPMAX} 1000 successive square wave switching under 1KHz.	-	±3.3	-	μs

Notes:
7. Typical values are defined at TA = +25°C, VDD = 12V. Maximum and minimum values over the operating temperature range are not tested in production but guaranteed by design, process control and characterization.
8. VDD is the voltage between the VDD pin and the GND pin.
9. When power is initially turned on, V_{DD} must be operated in the correct voltage range to guarantee proper magnetic field sampling, output supply current state level is valid after the start up time of 28μs from V_{DD} higher than 2.7V. Guaranteed by design.
10. Time delayed from the magnetic threshold reached to the output rise or fall.
11. t > T_{PON} and B_{RP}<B<B_{OP}.

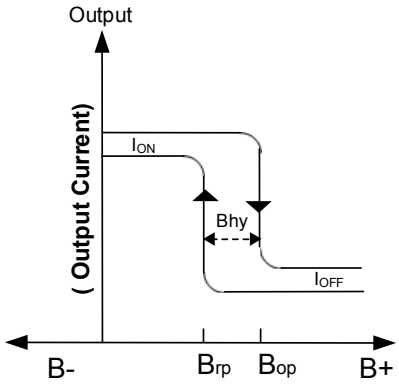
Magnetic Characteristics (Notes 12, 13) (T_A = -40°C to +150°C, T_J = -40°C to +165°C, V_{DD}= 2.7V to 27V, unless otherwise specified)

Part Name	Test Condition	Operating Point B_{OP}(Gauss)			Release Point B_{RP} (Gauss)			Temperature Coefficient (ppm/°C)	I_{OFF} (mA)	Active Pole	Output Polarity
		Min	Typ	Max	Min	Typ	Max	Typ	Typ		
AH3231Q	T_A=25°C	65	90	120	45	70	100	0	6	South	Inverted
	T_A=-40~150°C	55	90	135	35	70	115				
AH3232Q	T_A=25°C	40	60	80	20	40	60	-1100	6	South	Direct
	T_A=-40~150°C	30	60	90	10	40	70				
AH3233Q	T_A=25°C	27	45	63	10	28	46	-1100	6	South	Direct
	T_A=-40~150°C	20	45	70	3	28	53				
AH3270Q	T_A=25°C	8	18	28	-28	-18	-8	0	3.3	South	Direct
	T_A=-40~150°C	3	18	33	-33	-18	-3				
AH3271Q	T_A=25°C	8	18	28	-28	-18	-8	0	6	South	Direct
	T_A=-40~150°C	3	18	33	-33	-18	-3				
AH3272Q	T_A=25°C	15	30	45	-45	-30	-15	0	3.3	South	Direct
	T_A=-40~150°C	10	30	50	-50	-30	-10				





1) Direct South Pole Active

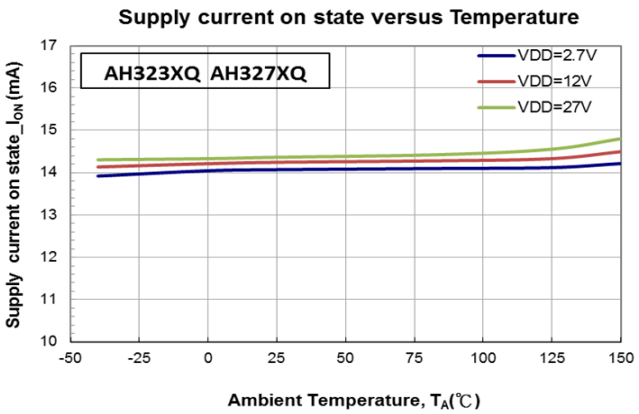


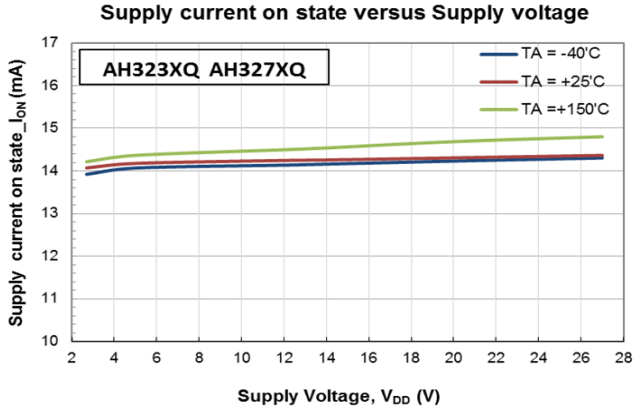
2) Inverted South Pole Active

Notes:
12. Positive x-axis direction indicates the South Pole approaching the part marking surface of SIP3 and SC59 i.e. increasing south pole magnetic field strength to the sensor; reversing direction x-axis toward 0 means the decreasing south magnetic field strength to the sensor. Negative x-axis indicates north pole magnetic field to the part marking surface.
13. Typical values are defined at T_A = +25°C, V_{DD} = 12V. Maximum and minimum values over the operating temperature range is not tested in production but guaranteed by design, process control and characterization.

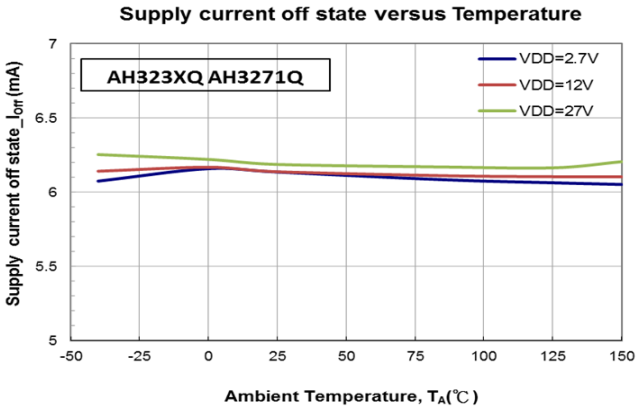
Typical Operating Characteristics

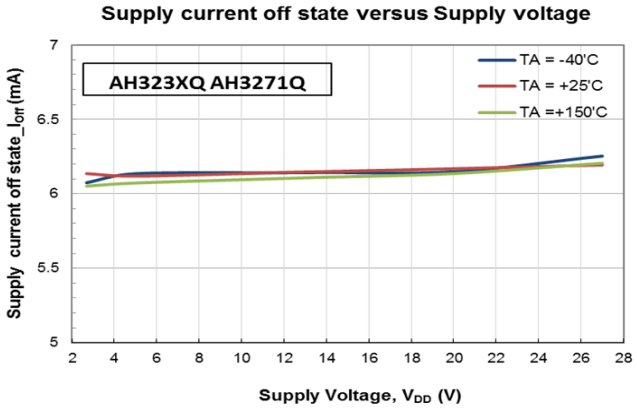
AH323XQ_AH327XQ Supply Current ON, I_{ON} Performance



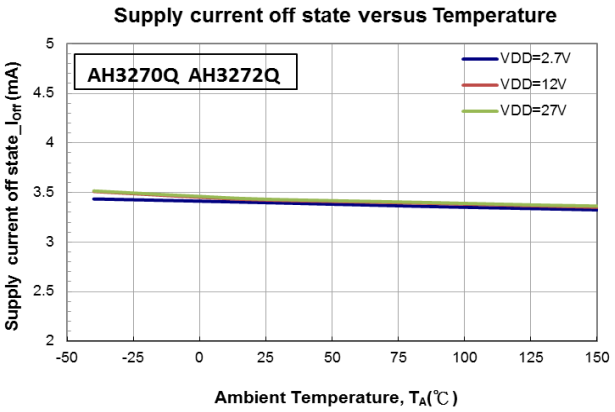


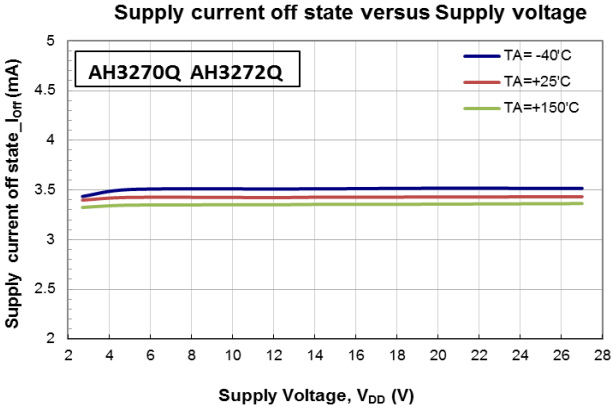
AH323XQ_AH3271Q Supply Current OFF, I_{OFF}(1) Performance





AH3270Q_AH3272Q Supply Current OFF, I_{OFF}(2) Performance

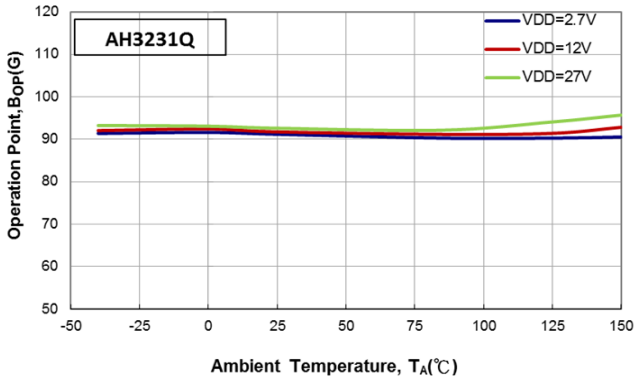




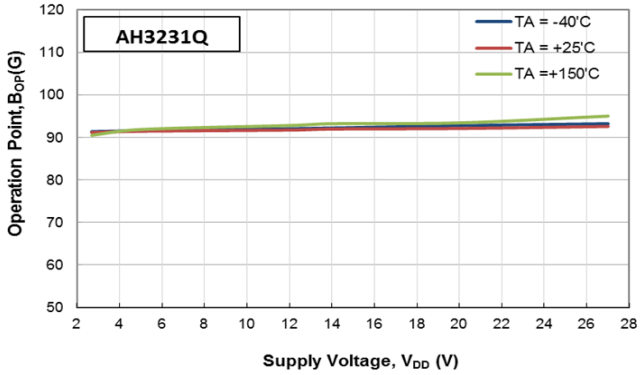
Typical Operating Characteristics (cont.)

AH3231Q Magnetic Characteristics Performance

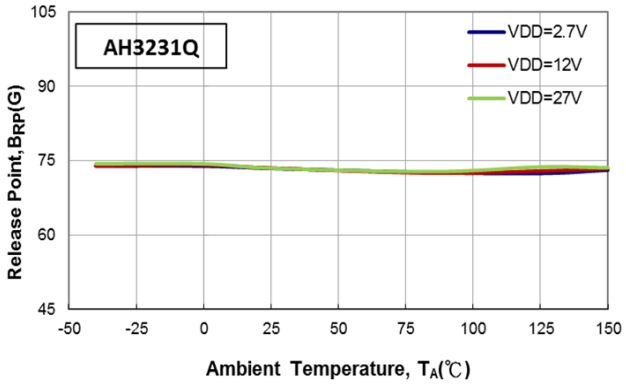
Operation Point versus Temperature



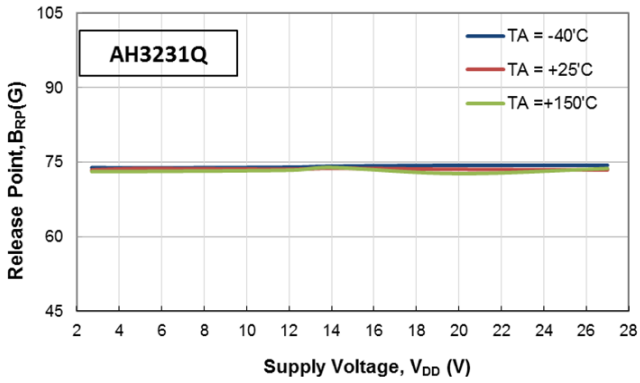
Operation Point versus Supply voltage



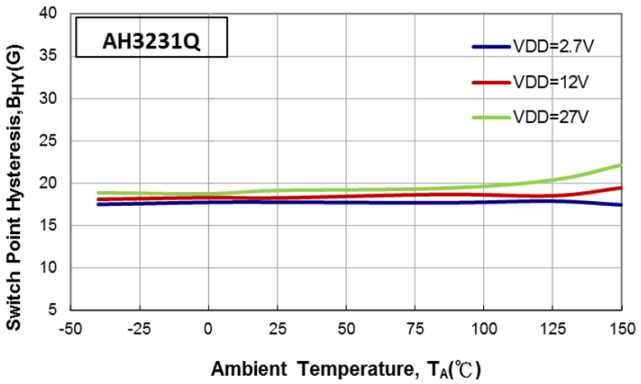
Release Point versus Temperature



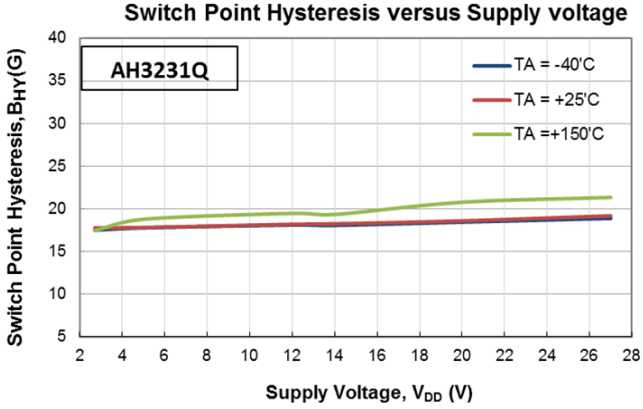
Release Point versus Supply voltage



Switch Point Hysteresis versus Temperature



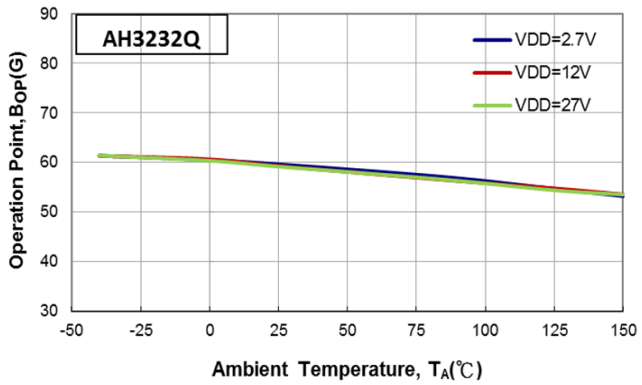
Switch Point Hysteresis versus Supply voltage



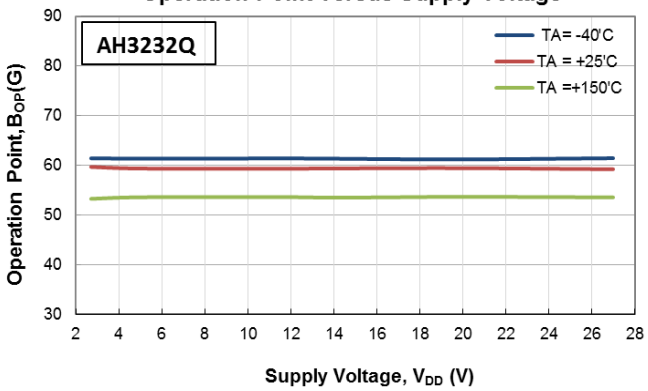
Typical Operating Characteristics (cont.)

AH3232Q Magnetic Characteristics Performance

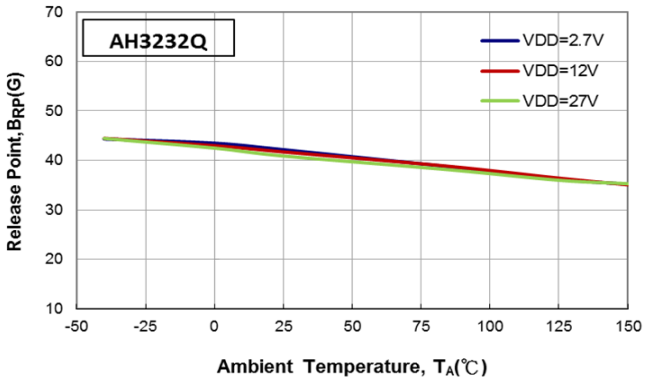
Operation Point versus Temperature



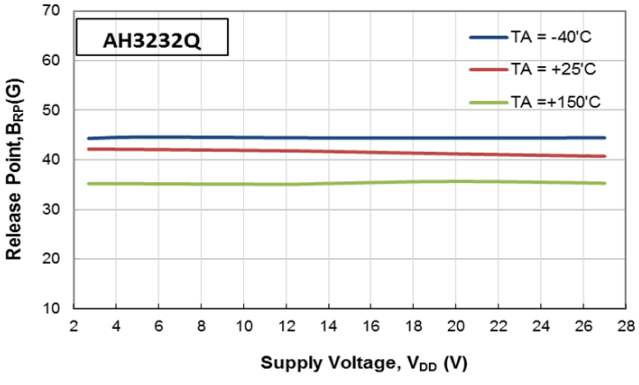
Operation Point versus Supply voltage



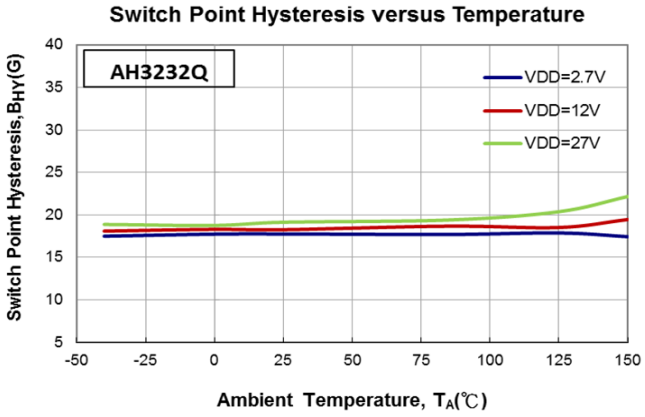
Release Point versus Temperature

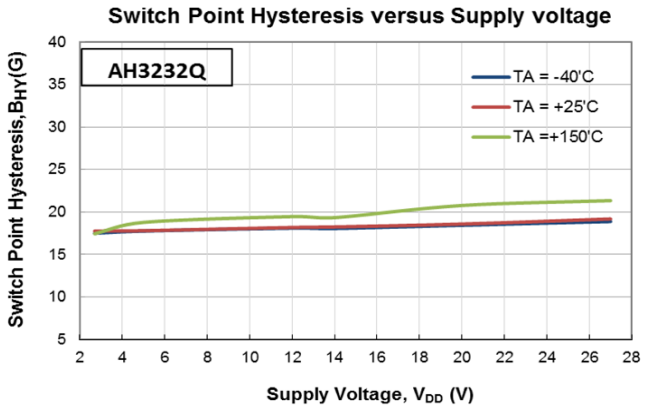


Release Point versus Supply voltage



Typical Operating Characteristics (cont.)

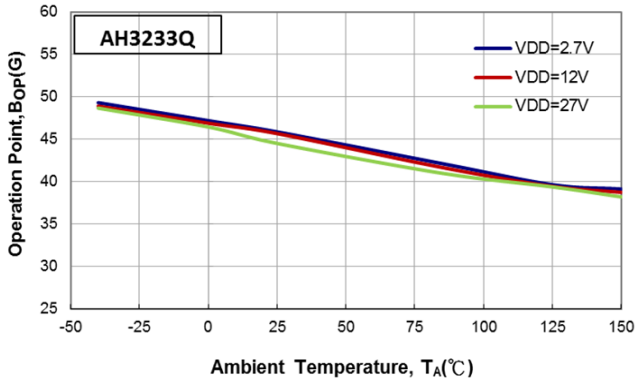




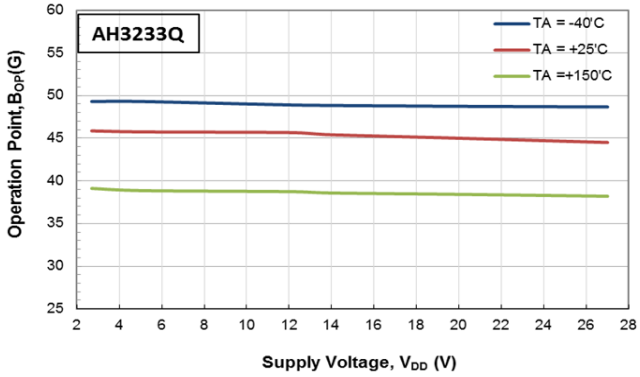
Typical Operating Characteristics (cont.)

AH3233Q Magnetic Characteristics Performance

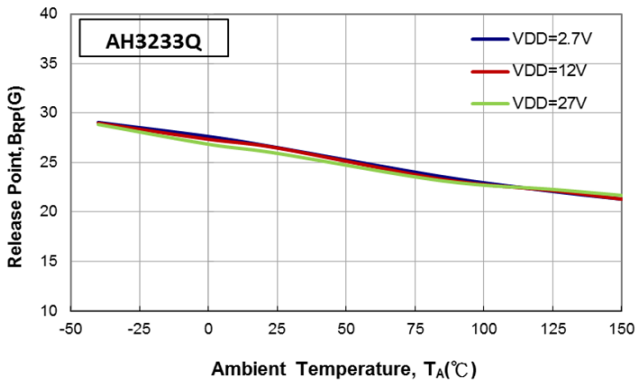
Operation Point versus Temperature



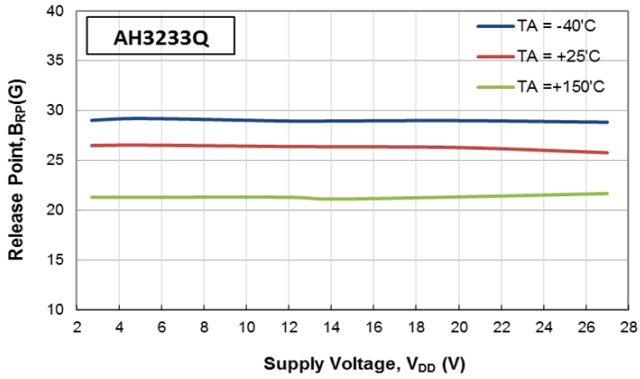
Operation Point versus Supply voltage



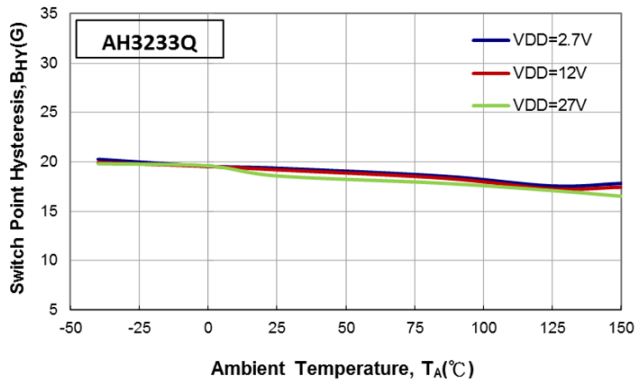
Release Point versus Temperature



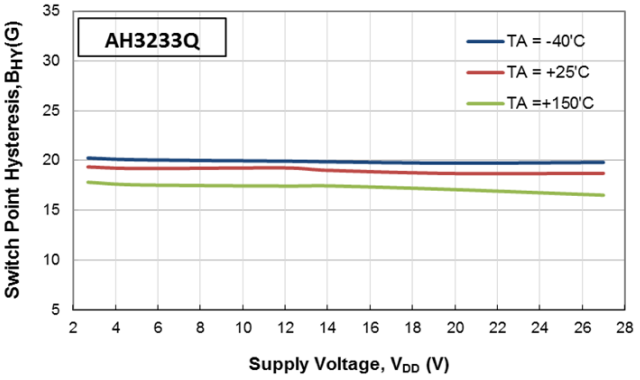
Release Point versus Supply voltage



Switch Point Hysteresis versus Temperature



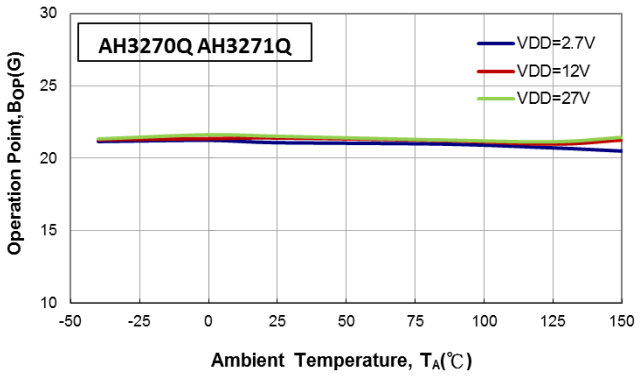
Switch Point Hysteresis versus Supply voltage



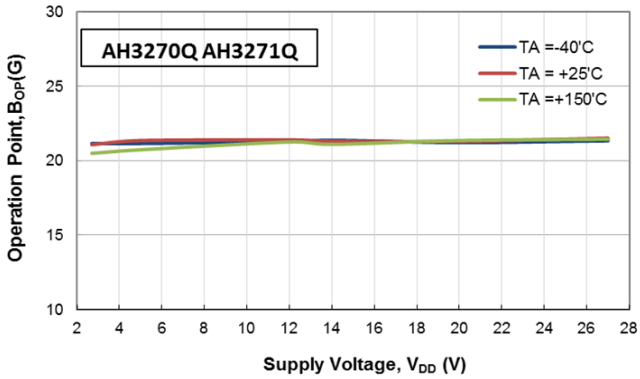
Typical Operating Characteristics (cont.)

AH3270Q_AH3271Q Magnetic Characteristics Performance

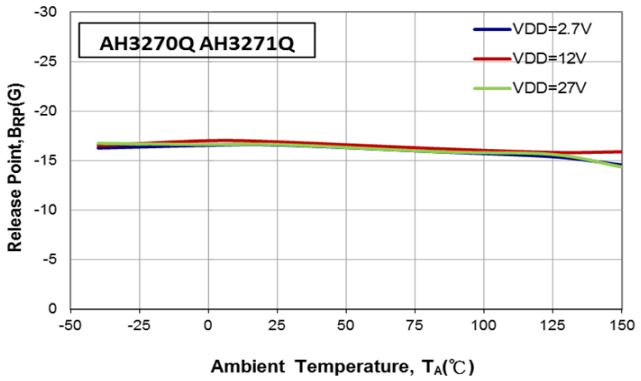
Operation Point versus Temperature



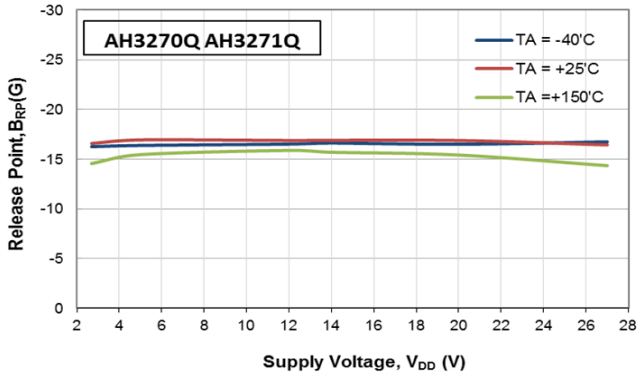
Operation Point versus Supply voltage



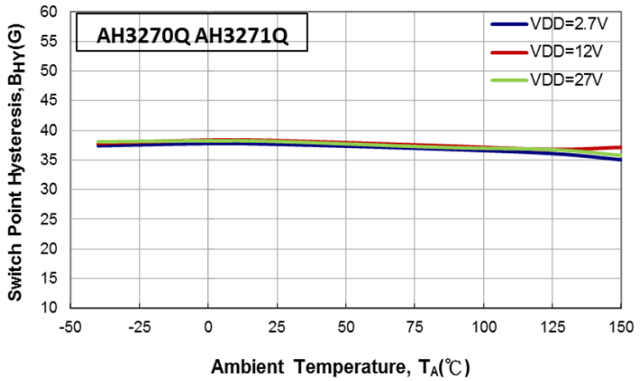
Release Point versus Temperature



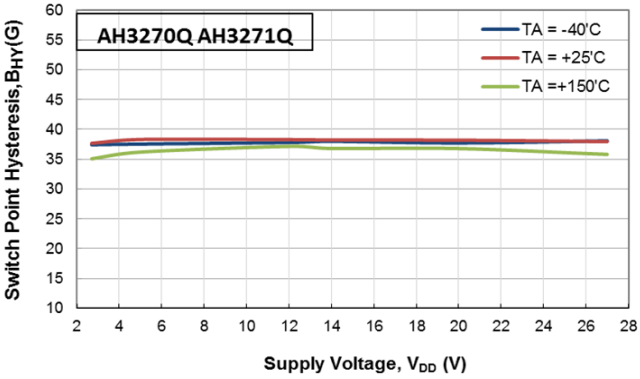
Release Point versus Supply voltage



Switch Point Hysteresis versus Temperature



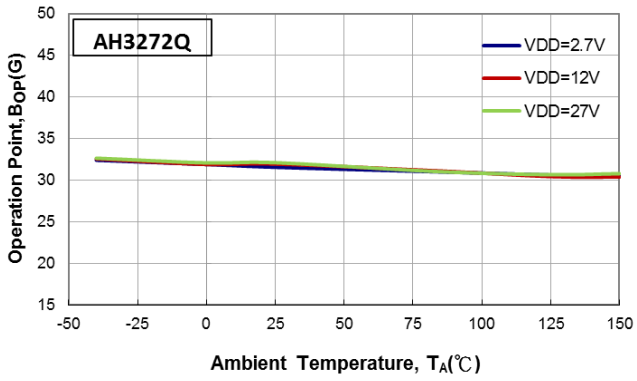
Switch Point Hysteresis versus Supply voltage



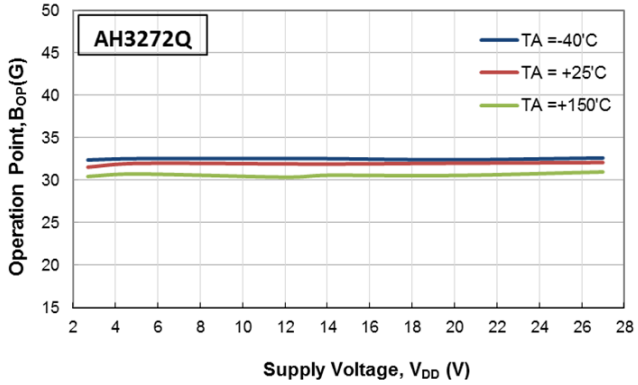
Typical Operating Characteristics (cont.)

AH3272Q Magnetic Characteristics Performance

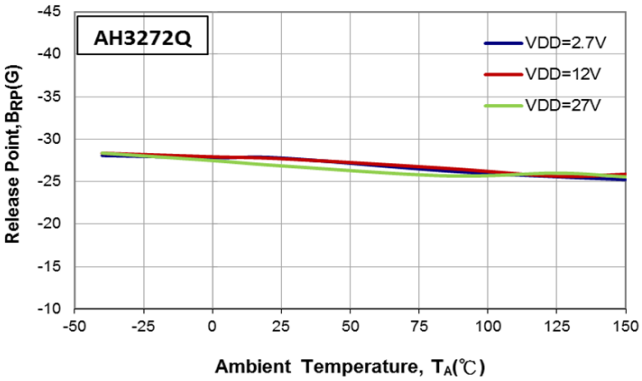
Operation Point versus Temperature



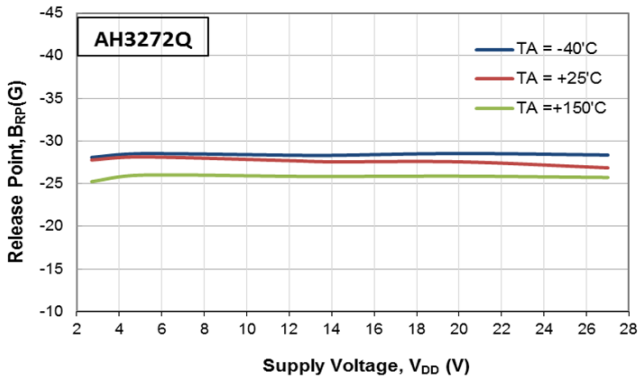
Operation Point versus Supply voltage



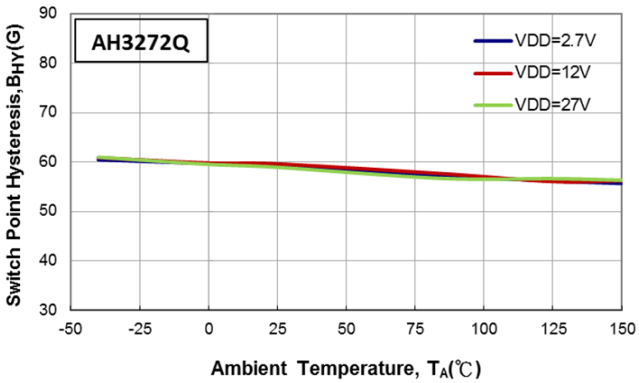
Release Point versus Temperature



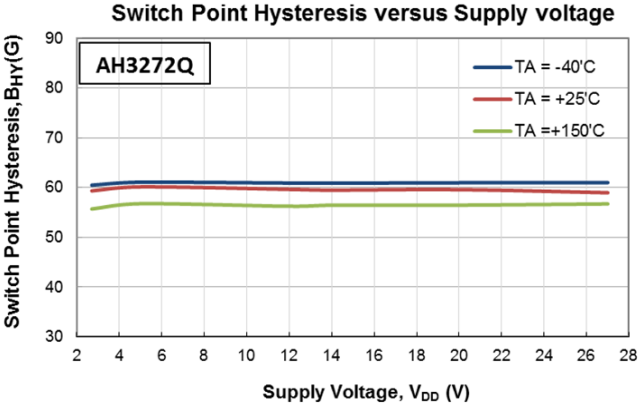
Release Point versus Supply voltage



Switch Point Hysteresis versus Temperature



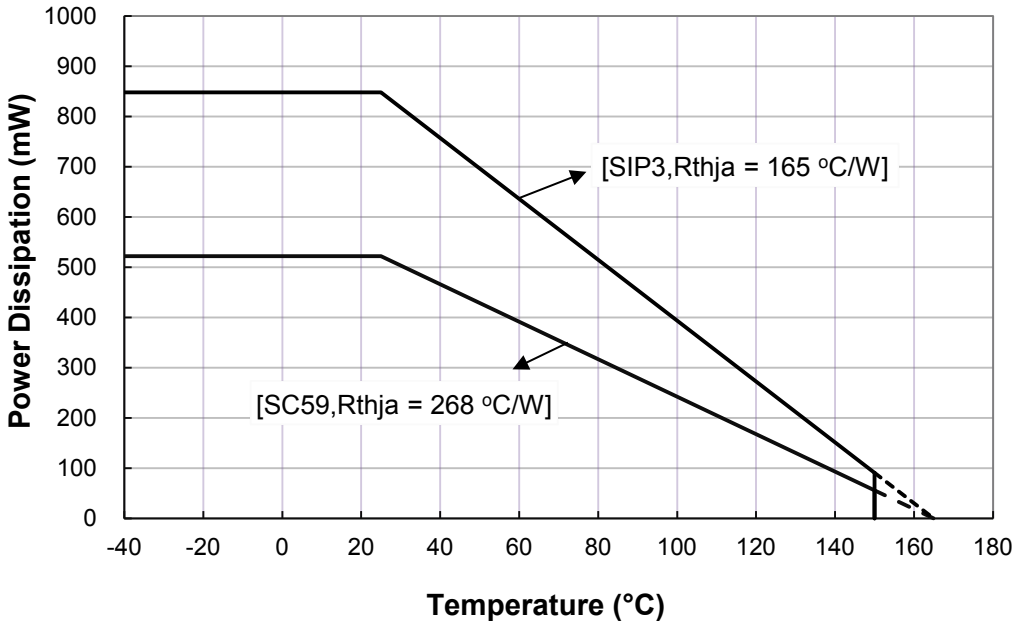
Switch Point Hysteresis versus Supply voltage



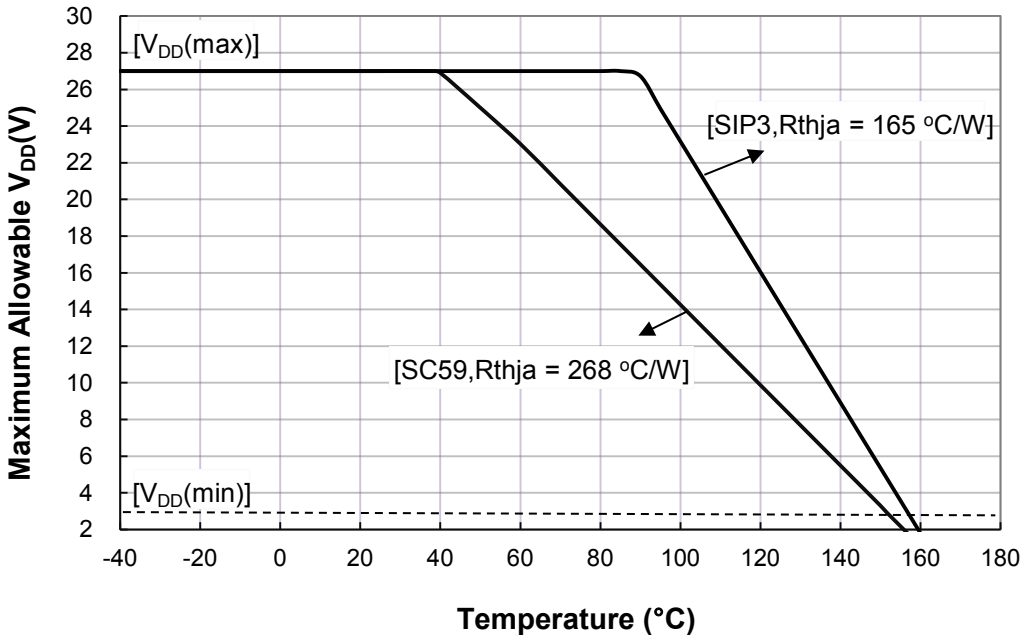
Thermal Performance Characteristics

Symbol	Parameter	Conditions	Rating	Unit
$R_{\theta JA}$	Package Thermal Resistance	SC59, 50mm*50mm 2oz MRB PCB, single layer	268	°C/W
		SIP-3, 50mm*50mm 2oz MRB PCB, single layer	143	°C/W

Thermal Derating Curve vs. Ambient Temperature



Power Derating Curve



Ordering Information

AH32xxQ - XXX - X

- Package
  - W: SC59 (Type A1)
  - P: SIP-3 (Future Product)
- Packing
  - 7: Tape & Reel
  - A: Ammo Box (Note 14)
  - B: Bulk (Note 15)

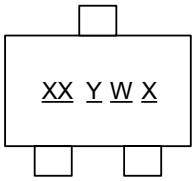
Part Number	Package Code	Packaging	Bulk Box		7" Tape and Reel		Ammo Box	
			Quantity	Part Number Suffix	Quantity	Part Number Suffix	Quantity	Part Number Suffix
AH3231Q-P-A	P	SIP-3 (Ammo Pack)	NA	NA	NA	NA	4000/Box	-A
AH3231Q-P-B	P	SIP-3 (Bulk Pack)	1000	-B	NA	NA	NA	NA
AH3231Q-W-7	W	SC59 (Type A1)	NA	NA	3000/Tape & Reel	-7	NA	NA
AH3232Q-P-A	P	SIP-3 (Ammo Pack)	NA	NA	NA	NA	4000/Box	-A
AH3232Q-P-B	P	SIP-3 (Bulk Pack)	1000	-B	NA	NA	NA	NA
AH3232Q-W-7	W	SC59 (Type A1)	NA	NA	3000/Tape & Reel	-7	NA	NA
AH3233Q-P-A	P	SIP-3 (Ammo Pack)	NA	NA	NA	NA	4000/Box	-A
AH3233Q-P-B	P	SIP-3 (Bulk Pack)	1000	-B	NA	NA	NA	NA
AH3233Q-W-7	W	SC59 (Type A1)	NA	NA	3000/Tape & Reel	-7	NA	NA
AH3270Q-P-A	P	SIP-3 (Ammo Pack)	NA	NA	NA	NA	4000/Box	-A
AH3270Q-P-B	P	SIP-3 (Bulk Pack)	1000	-B	NA	NA	NA	NA
AH3270Q-W-7	W	SC59 (Type A1)	NA	NA	3000/Tape & Reel	-7	NA	NA
AH3271Q-P-A	P	SIP-3 (Ammo Pack)	NA	NA	NA	NA	4000/Box	-A
AH3271Q-P-B	P	SIP-3 (Bulk Pack)	1000	-B	NA	NA	NA	NA
AH3271Q-W-7	W	SC59 (Type A1)	NA	NA	3000/Tape & Reel	-7	NA	NA
AH3272Q-P-A	P	SIP-3 (Ammo Pack)	NA	NA	NA	NA	4000/Box	-A
AH3272Q-P-B	P	SIP-3 (Bulk Pack)	1000	-B	NA	NA	NA	NA
AH3272Q-W-7	W	SC59 (Type A1)	NA	NA	3000/Tape & Reel	-7	NA	NA

Notes: 14. Ammo Box is for SIP-3 (Ammo Pack) Spread Lead.
15. Bulk is for SIP-3 (Bulk Pack) Straight Lead.

Marking Information

(1) Package Type: SC59 (Type A1)

(Top View)

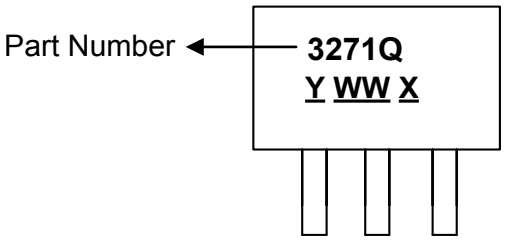


XX : Identification code
Y : Year 0 to 9
W : Week : A to Z : 1 to 26 week;
a to z : 27 to 52 week; z represents
52 and 53 week
X : Internal code

Part Number	Package	Identification Code
AH3231Q	SC59 (Type A1)	AT
AH3232Q	SC59 (Type A1)	AR
AH3233Q	SC59 (Type A1)	AV
AH3270Q	SC59 (Type A1)	AW
AH3271Q	SC59 (Type A1)	AU
AH3272Q	SC59 (Type A1)	AS

(2) Package Type: SIP-3 (Ammo Pack), SIP-3 (Bulk Pack)

(Top View)



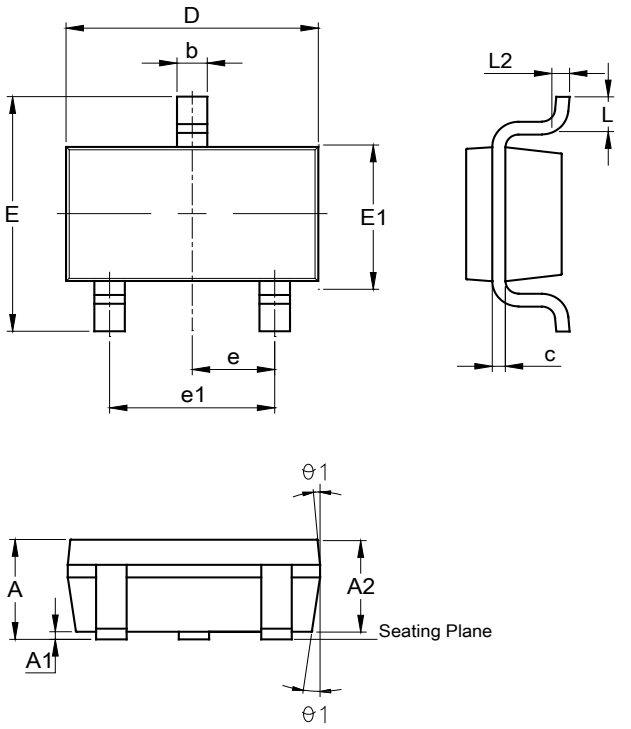
Y : Year : 0~9
WW : Week : 01~52, "52" represents
52 and 53 week
X : Internal Code

Part Number	Package	Identification Code
AH3231Q	SIP-3(Ammo Pack)	3231Q
AH3231Q	SIP-3 (Bulk Pack)	3231Q
AH3232Q	SIP-3(Ammo Pack)	3232Q
AH3232Q	SIP-3(Bulk Pack)	3232Q
AH3233Q	SIP-3(Ammo Pack)	3233Q
AH3233Q	SIP-3(Bulk Pack)	3233Q
AH3270Q	SIP-3(Ammo Pack)	3270Q
AH3270Q	SIP-3(Bulk Pack)	3270Q
AH3271Q	SIP-3(Ammo Pack)	3271Q
AH3271Q	SIP-3 (Bulk Pack)	3271Q
AH3272Q	SIP-3 (Ammo Pack)	3272Q
AH3272Q	SIP-3 (Bulk Pack)	3272Q

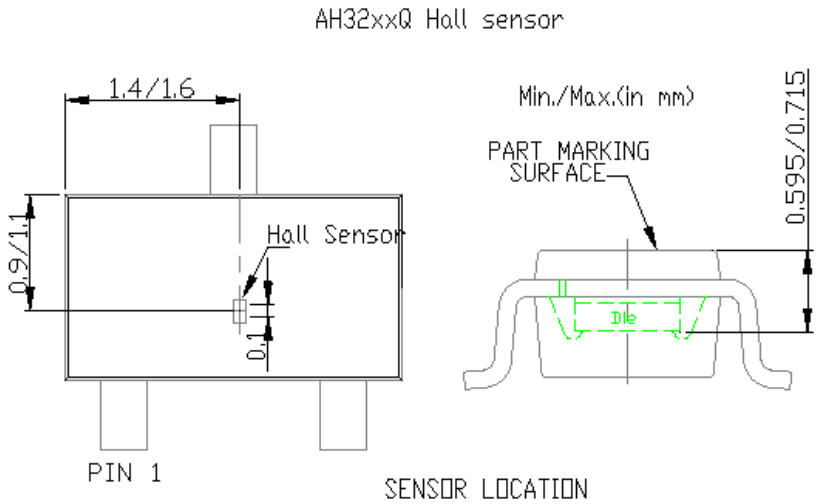
Package Outline Dimensions (All dimensions in mm.)

Please see http://www.diodes.com/package-outlines.html for the latest version.

(1) Package Type: SC59 (Type A1)



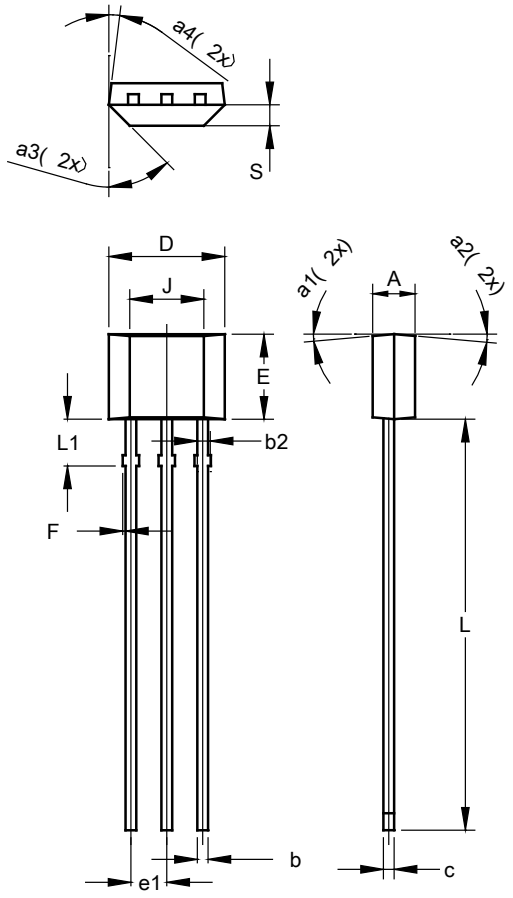
SC59 (Type A1)			
Dim	**Min**	**Max**	**Typ**
A	--	1.45	--
A1	0.00	0.15	--
A2	0.90	1.30	1.15
b	0.30	0.50	--
c	0.08	0.22	--
D	2.90 BSC		
E	2.80 BSC		
E1	1.60 BSC		
e	0.95 BSC		
e1	1.90 BSC		
L	0.30	0.60	0.45
L2	0.25 BSC		
θ1	5°	15°	10°
All Dimensions in mm			



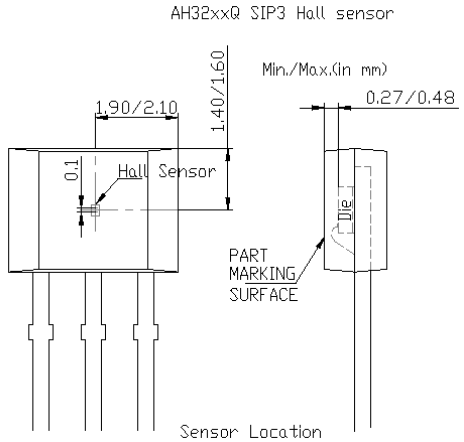
Package Outline Dimensions (cont.) (All dimensions in mm.)

Please see http://www.diodes.com/package-outlines.html for the latest version.

(2) Package Type: SIP-3 (Bulk Pack)



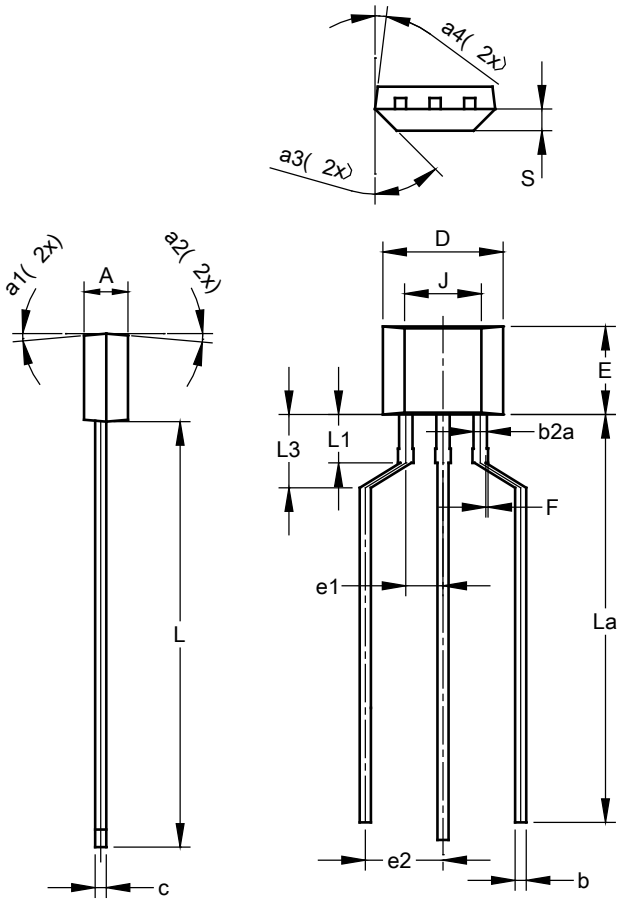
SIP-3 (Bulk Pack)			
Dim	**Min**	**Max**	**Typ**
A	1.40	1.60	1.50
b	0.33	0.43	0.38
b2	0.40	0.508	0.46
c	0.35	0.41	0.38
D	3.90	4.30	4.10
E	2.80	3.20	3.00
e1	1.24	1.30	1.27
F	0.00	0.20	—
J	2.62 REF		
L	14.00	15.00	14.50
L1	1.55	1.75	1.65
S	0.63	0.84	0.74
a1	—	—	5°
a2	—	—	5°
a3	—	—	45°
a4	—	—	3°
All Dimensions in mm			



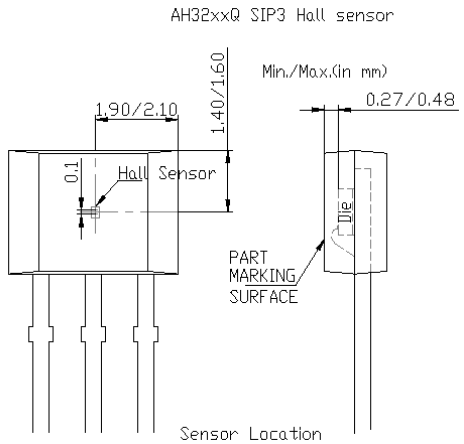
Package Outline Dimensions (cont.) (All dimensions in mm.)

Please see http://www.diodes.com/package-outlines.html for the latest version.

(3) Package Type: SIP-3 (Ammo Pack)



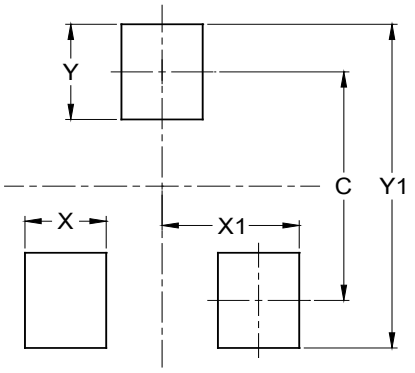
SIP-3 (Ammo Pack)			
Dim	**Min**	**Max**	**Typ**
A	1.40	1.60	1.50
b	0.33	0.43	0.38
b2a	0.40	0.52	0.46
c	0.35	0.41	0.38
D	3.90	4.30	4.10
E	2.80	3.20	3.00
e1	1.24	1.30	1.27
e2	2.40	2.90	2.65
F	0.00	0.20	—
J	2.62 REF		
L	14.00	15.00	14.50
La	12.90	14.90	13.90
L1	1.55	1.75	1.65
L3	2.00	3.00	2.50
S	0.63	0.84	0.74
a1	—	—	5°
a2	—	—	5°
a3	—	—	45°
a4	—	—	3°
All Dimensions in mm			



Suggested Pad Layout

Please see http://www.diodes.com/package-outlines.html for the latest version.

(1) Package Type: SC59 (Type A1)



Dimensions	Value (in mm)
C	2.40
X	0.80
X1	1.35
Y	1.00
Y1	3.40

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