TWO-WIRE AUTOMOTIVE HALL SWITCHES INTEGRATED SELF-DIAGNOSTICS

Description

The AH3241Q-AH3244Q/AH3280Q-AH3282Q are high-voltage, high-sensitivity, two-wire Hall-effect unipolar/latch switch ICs with integrated self-diagnostics and 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.

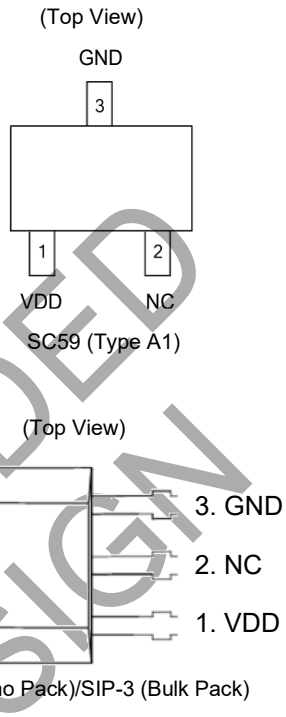
To support a wide range of demanding applications, the AH3241Q-AH3244Q/AH3280Q-AH3282Q are optimized to operate over a supply range of 2.7V to 27V. These features include a chopper-stabilized architecture and an internal bandgap regulator to provide temperature compensated supply for internal circuits. 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 AH3241Q, AH3242Q, AH3243Q, and AH3244Q 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 AH3280Q, AH3281Q, and AH3282Q 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



Features and Performance

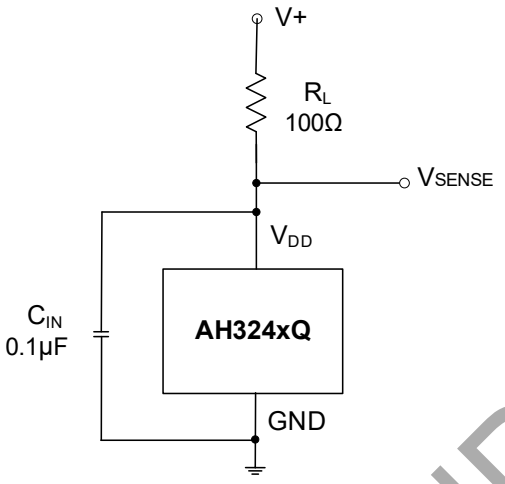
- Unipolar: AH3241Q, AH3242Q, AH3243Q, AH3244Q
- Latch: AH3280Q, AH3281Q, AH3282Q
- Output Polarity:
  - Direct: AH3242Q, AH3243Q
  - Inverted: AH3241Q, AH3244Q
- Wide Supply Voltage Operation: 2.7V to 27V
- Temperature Coefficient -1100ppm/°C (AH3242Q, AH3243Q, AH3244Q)
- Chopper Stabilized Design Provides:
  - Superior Temperature Stability
  - Minimal Switch Point Drift
  - Enhanced Immunity to Stress
- Battery Polarity Reverse Connection Protection
- Transient Spike Voltage Protection
- Overtemperature Shutdown and Auto-Restart
- UVLO Protection
- High ESD Rating: HBM = 8kV, CDM = 1kV
- Ready for ISO 26262
- 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 AH3241Q-AH3244Q/AH3280Q-AH3282Q 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

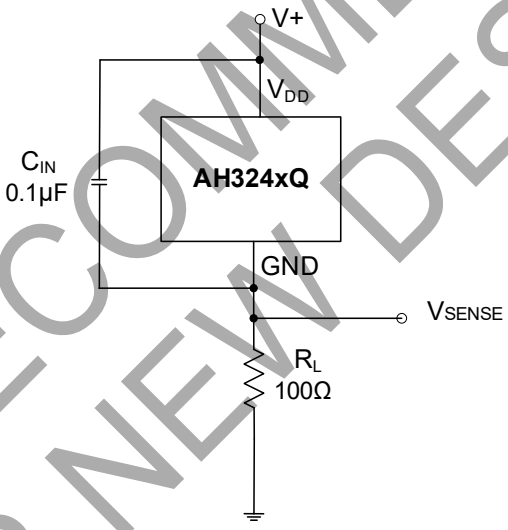
- Position and proximity sensing in automotive applications
- Seat positioning
- Seatbelt buckles
- Wiper positioning
- Window lifters
- Gear selection positioning

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



(1) High-Side Sensing



(2) Low-Side Sensing

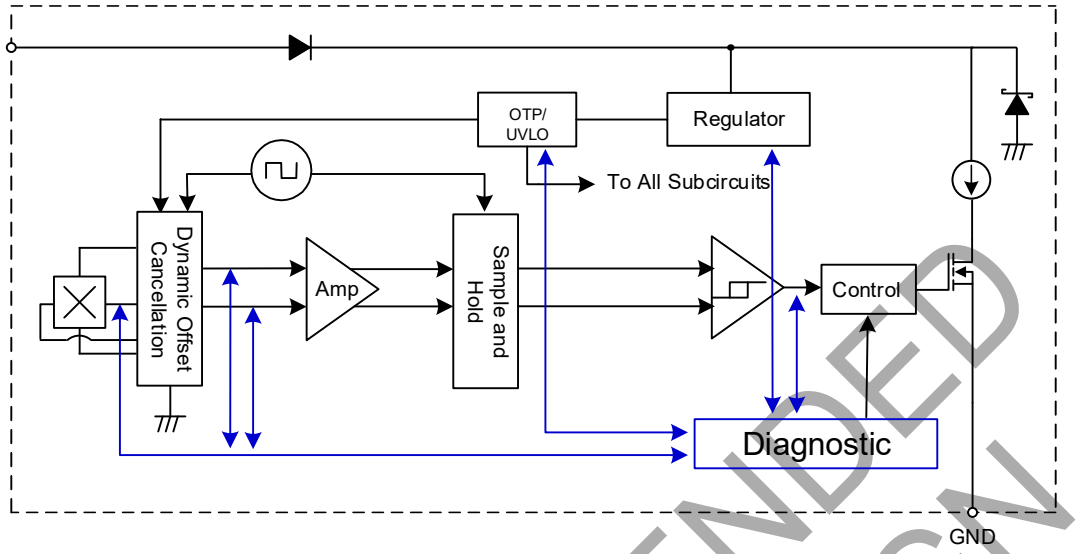
Note: 4. A 100nF or larger decoupling capacitor (CIN) between VDD and GND pins is needed for power stabilization and to strengthen noise immunity; CIN needs to be as close to IC as possible. Typical RL value is 100Ω. Larger or additional series resistor is recommended if there are disturbances on VDD.

Pin Descriptions

Packages: SC59 (Type A1) and SIP-3 (Ammo Pack and Bulk Pack)

Pin Number	Pin Name	Function
1	VDD	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 to +180	°C
ESD (HBM)	ESD (Human Body Model)	8000	V
ESD (CDM)	ESD (Charged Device Model)	1000	V

Notes: 5. Stresses greater than those listed under *Absolute Maximum Ratings* can cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions* is not implied. Exposure to *Absolute Maximum Ratings* for extended periods can affect device reliability.
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 VDD and GND Pins	2.7	27	V
T_{OP}	Operating Ambient Temperature	-40	+150	°C

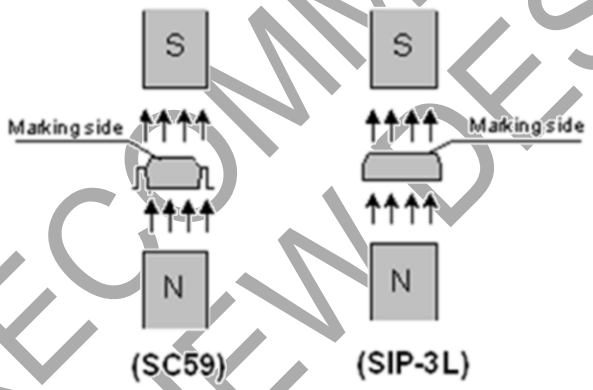
Electrical Characteristics (Note 7) (@ T_A = -40°C to +150°C, T_J = -40°C to +165°C, V_{DD} = 2.7V to 27V, unless otherwise specified)

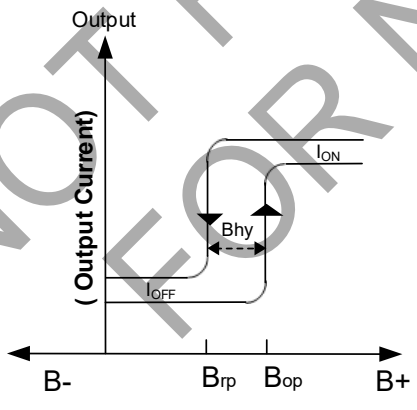
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{DD}	Supply Voltage (Note 8)	—	2.7	12	27	V
$I_{OFF}(2)$	Supply Current Off State	V_{DD} = 2.7V to 27V (AH3280Q, AH3282Q)	2	3.3	5	mA
$I_{OFF}(1)$	Supply Current Off State	V_{DD} = 2.7V to 27V (AH3241Q, AH3242Q, AH3243Q, AH3244Q, AH3281Q)	5	6	6.9	mA
I_{ON}	Supply Current On State	V_{DD} = 2.7V to 27V	12	14.5	17	mA
V_{UVLO}	Undervoltage Lockout Threshold	Voltage dropping	—	2.2	2.7	V
t_{UVLO}	Undervoltage Lockout Reaction Time	—	—	10	—	µs
I_{DDR}	Reverse Supply Current	V_{DD} = -18V, T = -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
I_{SAFE}	Safe Mode Supply Current	Safe mode supply current / error current (mA)	0.5	1	1.5	mA
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 T_A = +25°C, V_{DD} = 12V. Maximum and minimum values over the operating temperature range are not tested in production but guaranteed by design, process control and characterization.
8. V_{DD} 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 startup 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}.

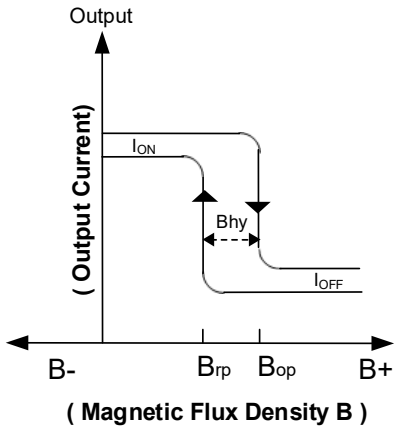
Magnetic Characteristics (Notes 12, 13) (T_A = -40°C to +150°C, T_J = -40°C to +165°C, V_{DD} = 2.7V to 27V, unless otherwise specified)

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		
AH3241Q	T_A = +25°C	65	90	120	45	70	100	0	6	South	Inverted
	T_A = -40°C to +150°C	55	90	135	35	70	115				
AH3242Q	T_A = +25°C	40	60	80	20	40	60	-1100	6	South	Direct
	T_A = -40°C to +150°C	30	60	90	10	40	70				
AH3243Q	T_A = +25°C	27	45	63	10	28	46	-1100	6	South	Direct
	T_A = -40°C to +150°C	20	45	70	3	28	53				
AH3244Q	T_A = +25°C	27	45	63	10	28	46	-1100	6	South	Inverted
	T_A = -40°C to +150°C	20	45	70	3	28	53				
AH3280Q	T_A = +25°C	8	18	28	-28	-18	-8	0	3.3	South	Direct
	T_A = -40°C to +150°C	3	18	33	-33	-18	-3				
AH3281Q	T_A = +25°C	8	18	28	-28	-18	-8	0	6	South	Direct
	T_A = -40°C to +150°C	3	18	33	-33	-18	-3				
AH3282Q	T_A = +25°C	15	30	45	-45	-30	-15	0	3.3	South	Direct
	T_A = -40°C to +150°C	10	30	50	-50	-30	-10				





1) Direct South Pole Active

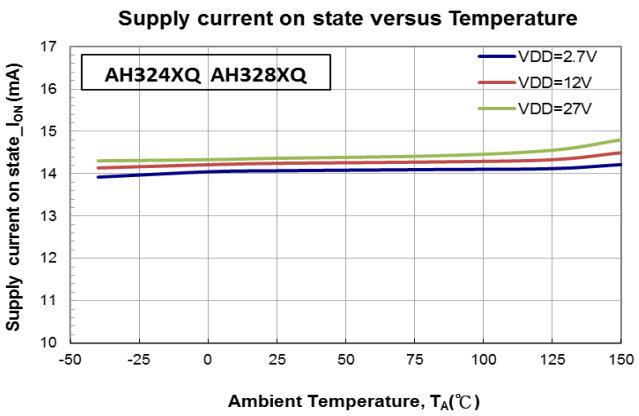


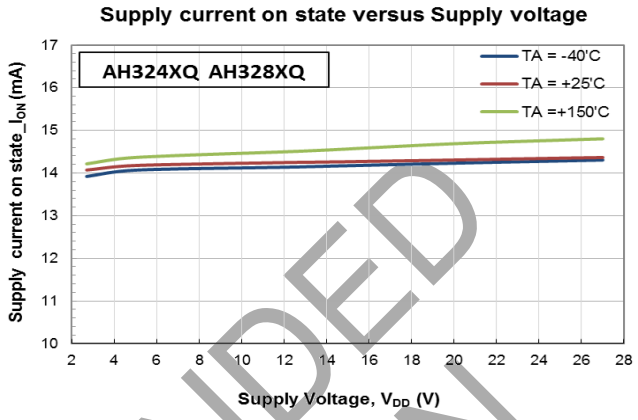
2) Inverted South Pole Active

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.

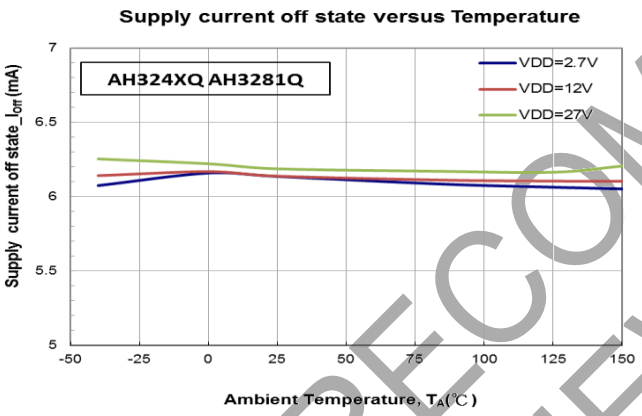
Typical Operating Characteristics

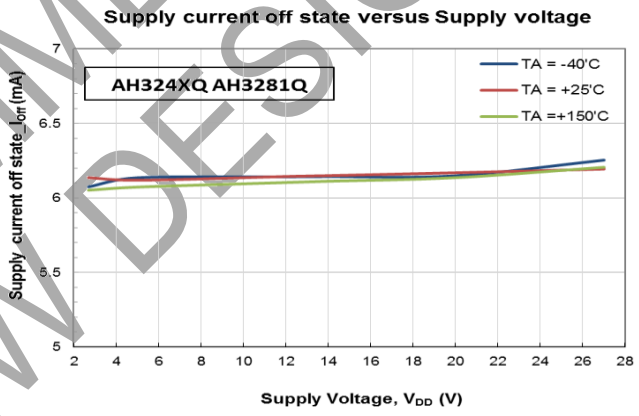
AH324XQ_AH328XQ Supply Current ON, I_{ON} Performance



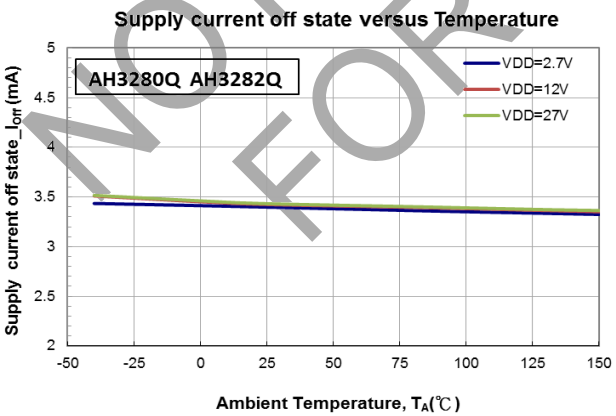


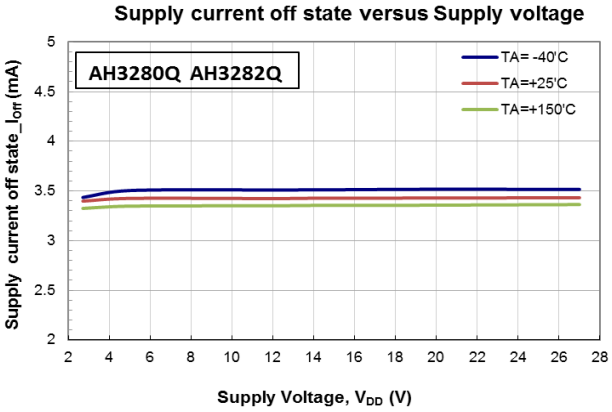
AH324XQ_AH3281Q Supply Current OFF, I_{OFF}(1) Performance





AH3280Q_AH3282Q Supply Current OFF, I_{OFF}(2) Performance

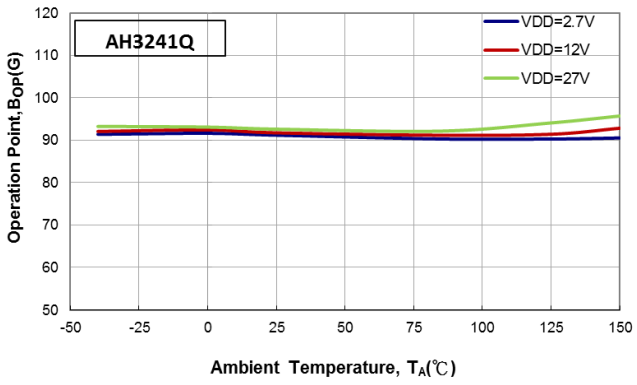




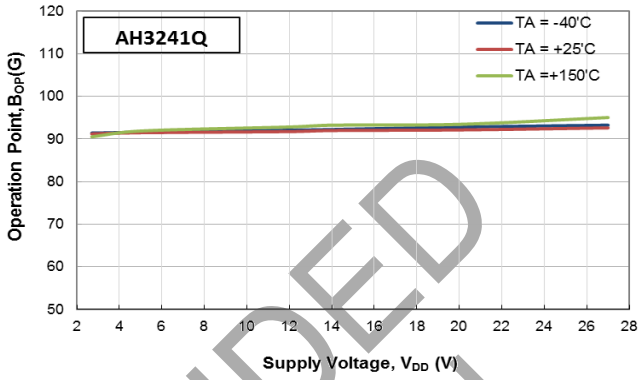
Typical Operating Characteristics (continued)

AH3241Q Magnetic Characteristics Performance

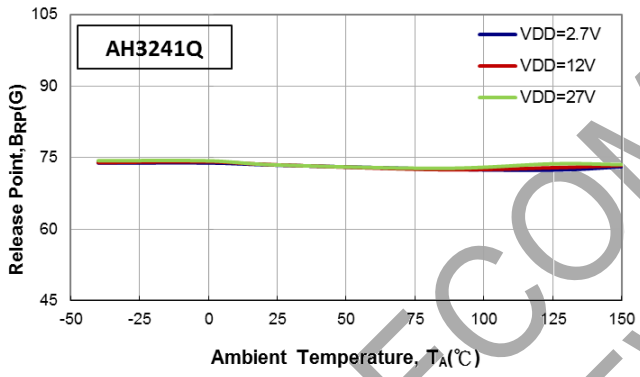
Operation Point versus Temperature



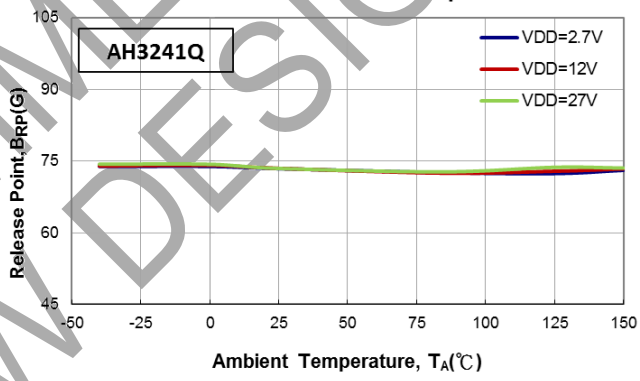
Operation Point versus Supply voltage



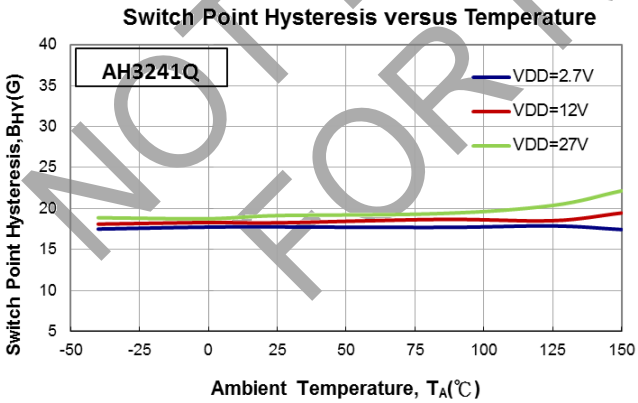
Release Point versus Temperature



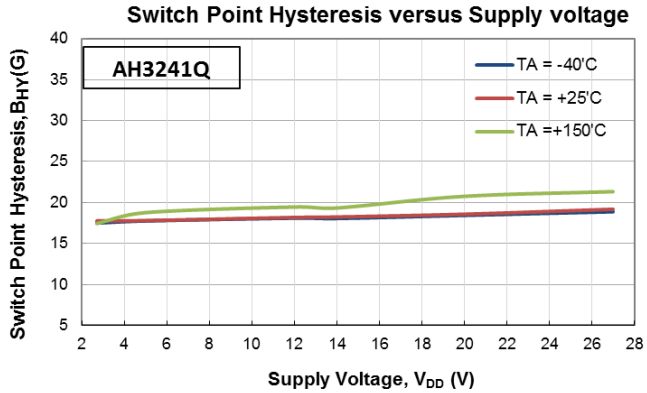
Release Point versus Temperature



Switch Point Hysteresis versus Temperature



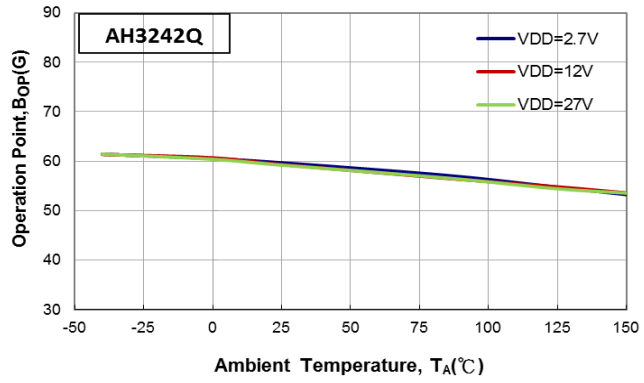
Switch Point Hysteresis versus Supply voltage



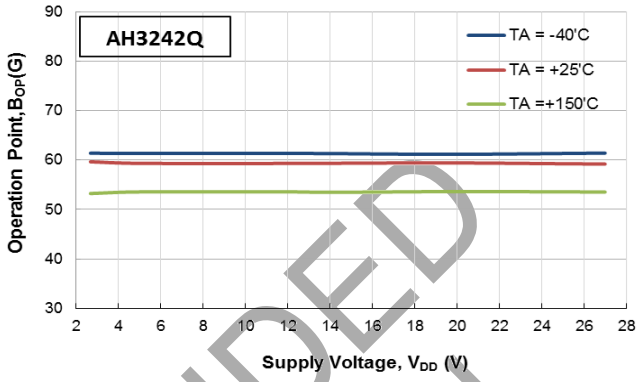
Typical Operating Characteristics (continued)

AH3242Q Magnetic Characteristics Performance

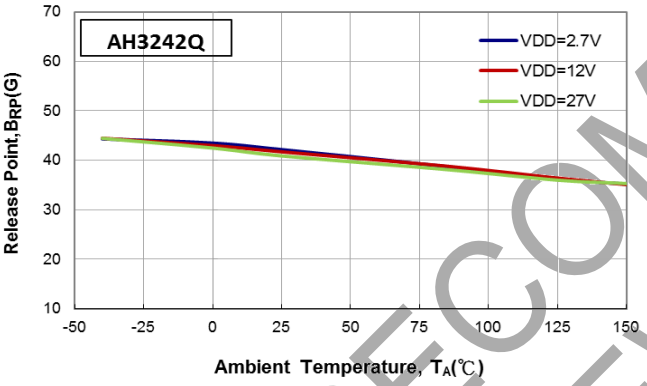
Operation Point versus Temperature



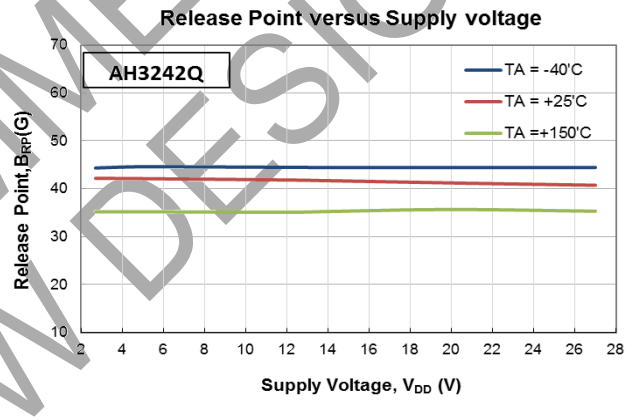
Operation Point versus Supply voltage



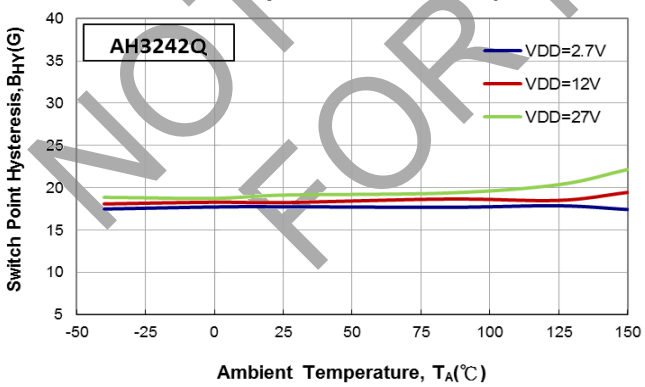
Release Point versus Temperature



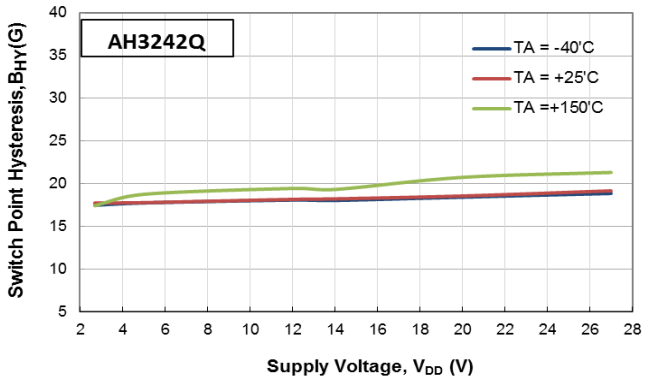
Release Point versus Supply voltage



Switch Point Hysteresis versus Temperature



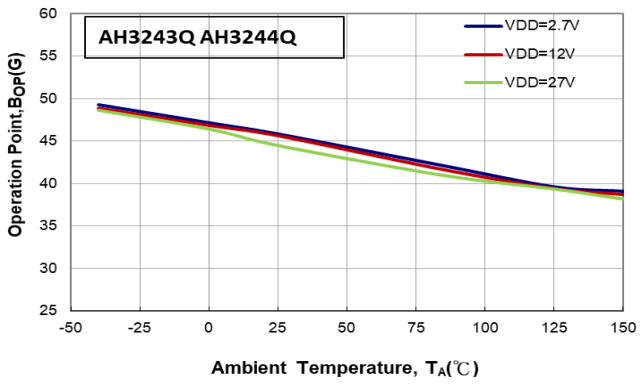
Switch Point Hysteresis versus Supply voltage



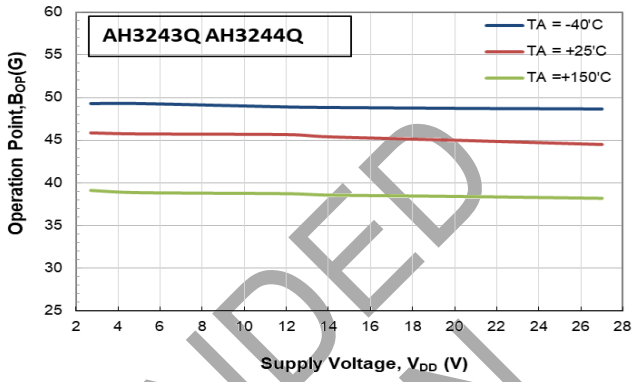
Typical Operating Characteristics (continued)

AAH3243Q_AH3244Q Magnetic Characteristics Performance

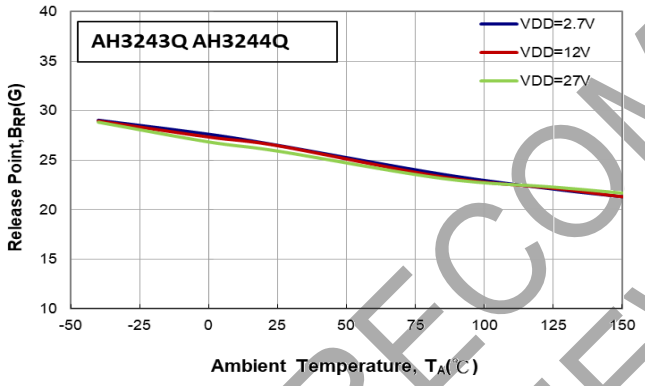
Operation Point versus Temperature



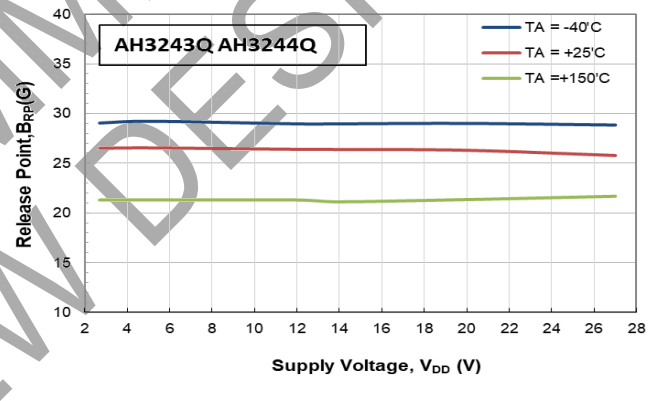
Operation Point versus Supply voltage



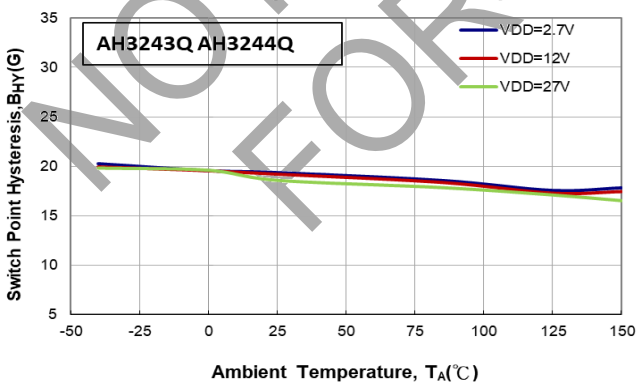
Release Point versus Temperature



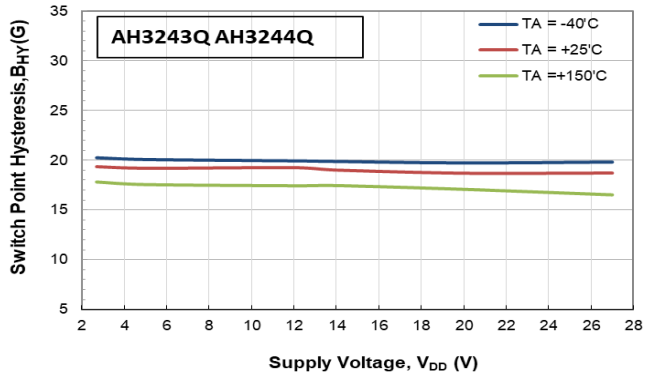
Release Point versus Supply voltage



Switch Point Hysteresis versus Temperature



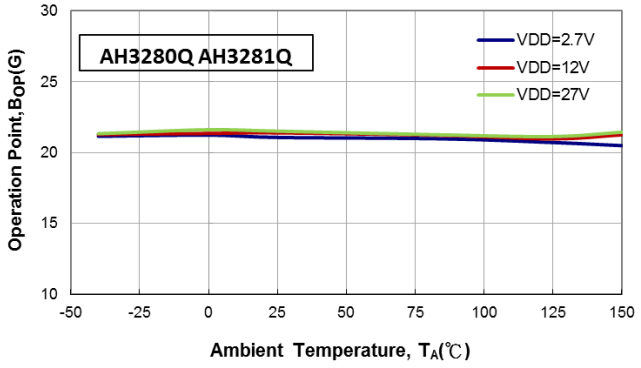
Switch Point Hysteresis versus Supply voltage



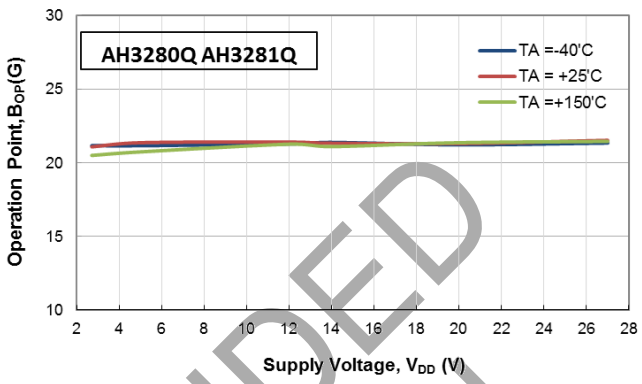
Typical Operating Characteristics (continued)

AH3280Q_AH3281Q Magnetic Characteristics Performance

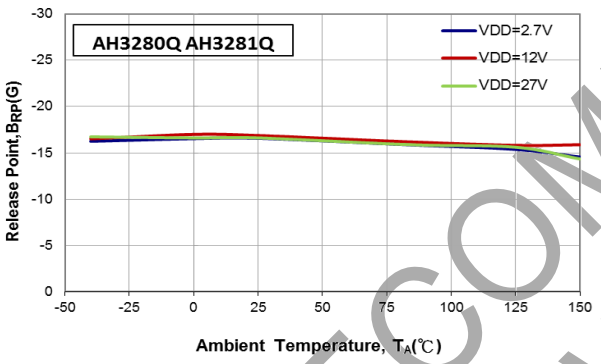
Operation Point versus Temperature



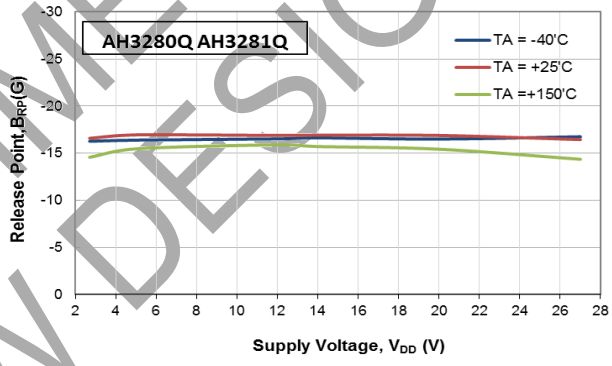
Operation Point versus Supply voltage



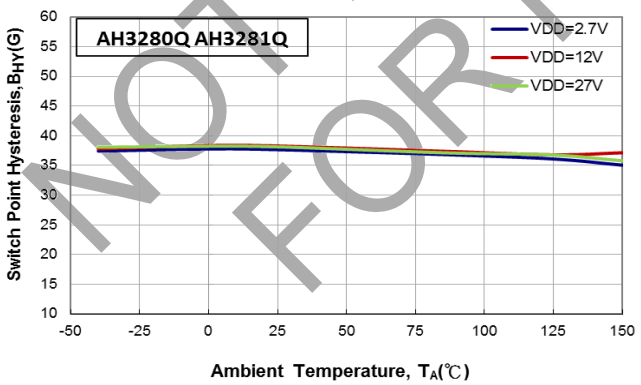
Release Point versus Temperature



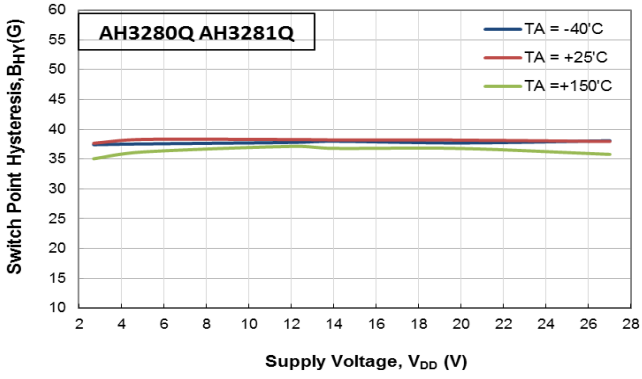
Release Point versus Supply voltage



Switch Point Hysteresis versus Temperature



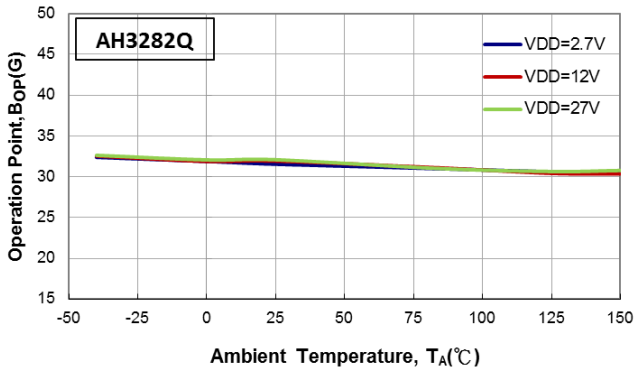
Switch Point Hysteresis versus Supply voltage



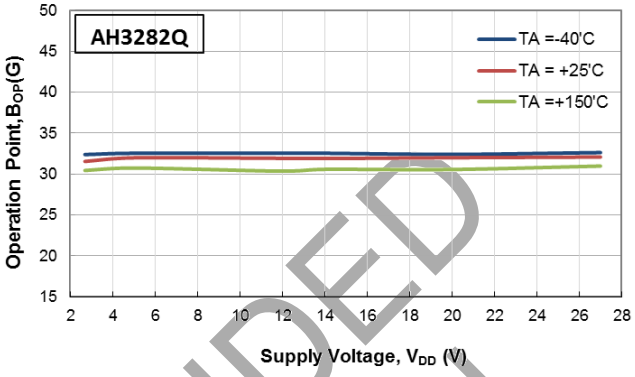
Typical Operating Characteristics (continued)

AH3282Q Magnetic Characteristics Performance

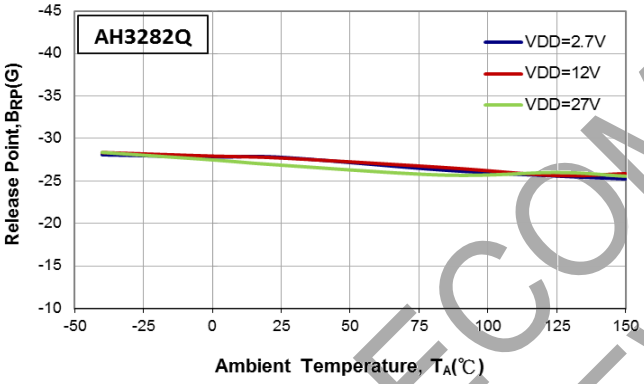
Operation Point versus Temperature



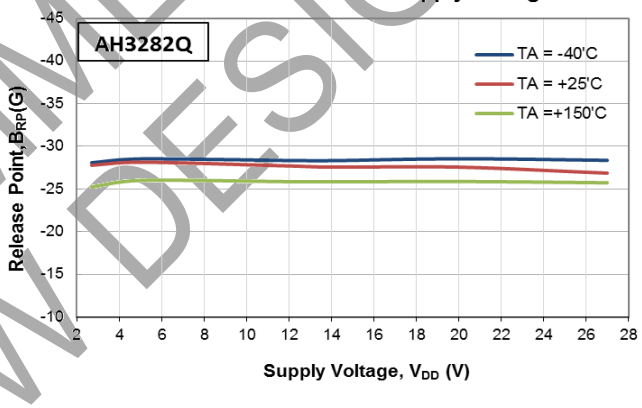
Operation Point versus Supply voltage



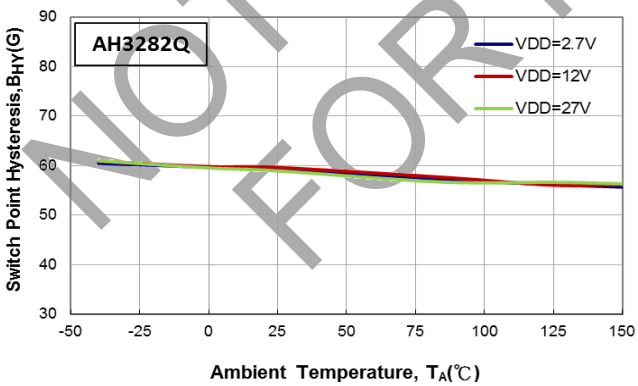
Release Point versus Temperature



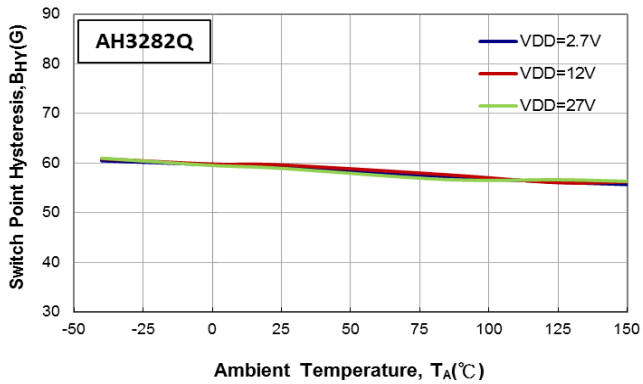
Release Point versus Supply voltage



Switch Point Hysteresis versus Temperature



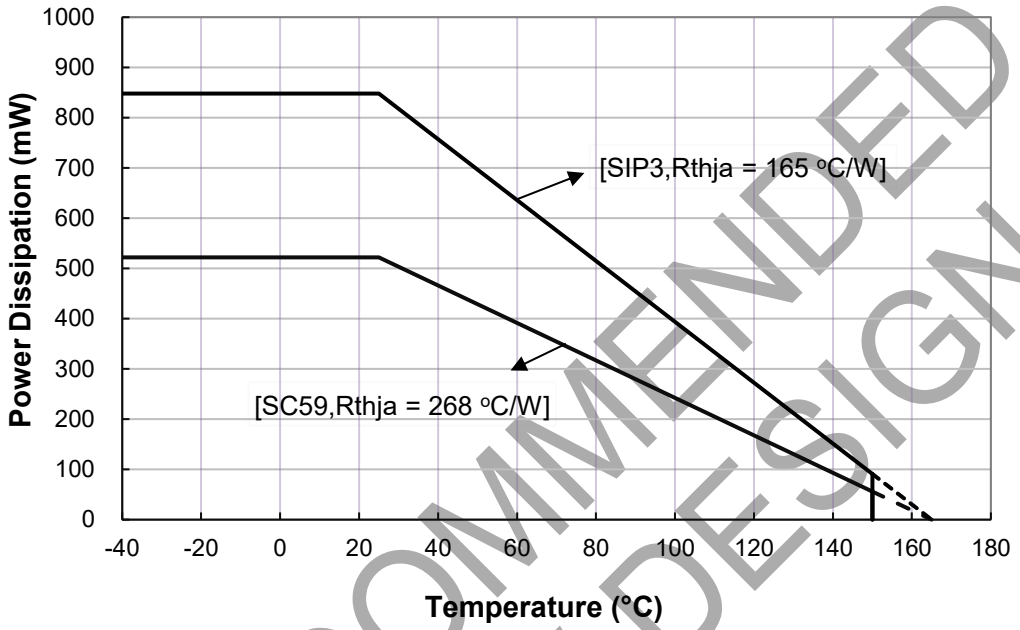
Switch Point Hysteresis versus Temperature



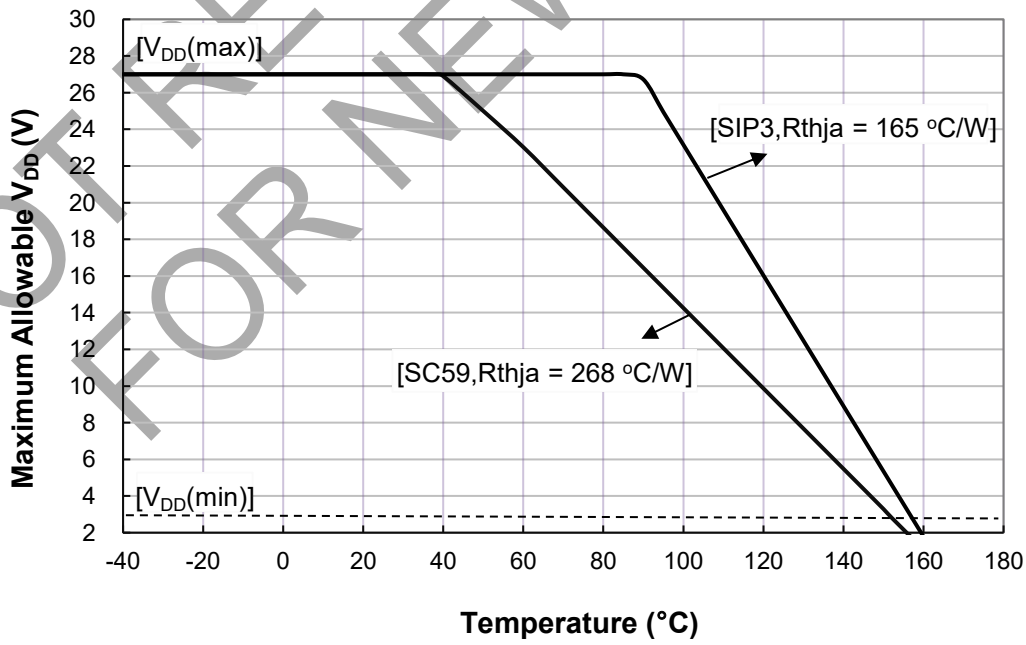
Thermal Performance Characteristics

Symbol	Parameter	Conditions	Rating	Unit
$R_{\theta JA}$	Package Thermal Resistance	SC59 (Type A1), 50mm*50mm 2oz MRB PCB, single layer	268	°C/W
		SIP-3 (Ammo Pack and Bulk Pack), 50mm*50mm 2oz MRB PCB, single layer	143	°C/W

Thermal Derating Curve vs. Ambient Temperature



Power Derating Curve



Ordering Information (Note 14)

AH32xxQ - XXX - X

Package	Packing
W: SC59 (Type A1) P: SIP-3 (Ammo Pack and Bulk Pack)	7: Tape & Reel A: Ammo Box (Note 15) B: Bulk (Note 16)

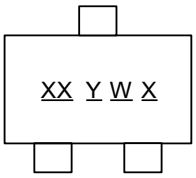
Orderable Part Number	Package Code	Package	Packing	
			Qty.	Carrier
AH3241Q-P-A	P	SIP-3 (Ammo Pack)	4000	Ammo Box
AH3241Q-P-B	P	SIP-3 (Bulk Pack)	1000	Bulk Box
AH3241Q-W-7	W	SC59 (Type A1)	3000	Tape & Reel
AH3242Q-P-A	P	SIP-3 (Ammo Pack)	4000	Ammo Box
AH3242Q-P-B	P	SIP-3 (Bulk Pack)	1000	Bulk Box
AH3242Q-W-7	W	SC59 (Type A1)	3000	Tape & Reel
AH3243Q-P-A	P	SIP-3 (Ammo Pack)	4000	Ammo Box
AH3243Q-P-B	P	SIP-3 (Bulk Pack)	1000	Bulk Box
AH3243Q-W-7	W	SC59 (Type A1)	3000	Tape & Reel
AH3244Q-P-A	P	SIP-3 (Ammo Pack)	4000	Ammo Box
AH3244Q-P-B	P	SIP-3 (Bulk Pack)	1000	Bulk Box
AH3244Q-W-7	W	SC59 (Type A1)	3000	Tape & Reel
AH3280Q-P-A	P	SIP-3 (Ammo Pack)	4000	Ammo Box
AH3280Q-P-B	P	SIP-3 (Bulk Pack)	1000	Bulk Box
AH3280Q-W-7	W	SC59 (Type A1)	3000	Tape & Reel
AH3281Q-P-A	P	SIP-3 (Ammo Pack)	4000	Ammo Box
AH3281Q-P-B	P	SIP-3 (Bulk Pack)	1000	Bulk Box
AH3281Q-W-7	W	SC59 (Type A1)	3000	Tape & Reel
AH3282Q-P-A	P	SIP-3 (Ammo Pack)	4000	Ammo Box
AH3282Q-P-B	P	SIP-3 (Bulk Pack)	1000	Bulk BOx
AH3282Q-W-7	W	SC59 (Type A1)	3000	Tape & Reel

Notes:
14. For packaging details, go to our website at https://www.diodes.com/design/support/packaging/diodes-packaging/.
15. Ammo Box is for SIP-3 (Ammo Pack) Spread Lead.
16. Bulk is for SIP-3 (Bulk Pack) Straight Lead.

Marking Information

(1) Package Type: SC59 (Type-A1)

(Top View)

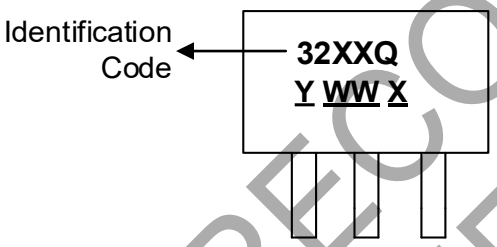


XX : Identification Code
Y : Year 0 to 9 (ex: 5 = 2025)
W : Week : A to Z : week 1 to 26;
a to z : week 27 to 52; z represents
week 52 and 53
X : Internal Code

Orderable Part Number	Package	Identification Code
AH3241Q-W-7	SC59 (Type A1)	BR
AH3242Q-W-7	SC59 (Type A1)	BS
AH3243Q-W-7	SC59 (Type A1)	BT
AH3244Q-W-7	SC59 (Type A1)	BX
AH3280Q-W-7	SC59 (Type A1)	BW
AH3281Q-W-7	SC59 (Type A1)	BU
AH3282Q-W-7	SC59 (Type A1)	BV

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

(Top View)



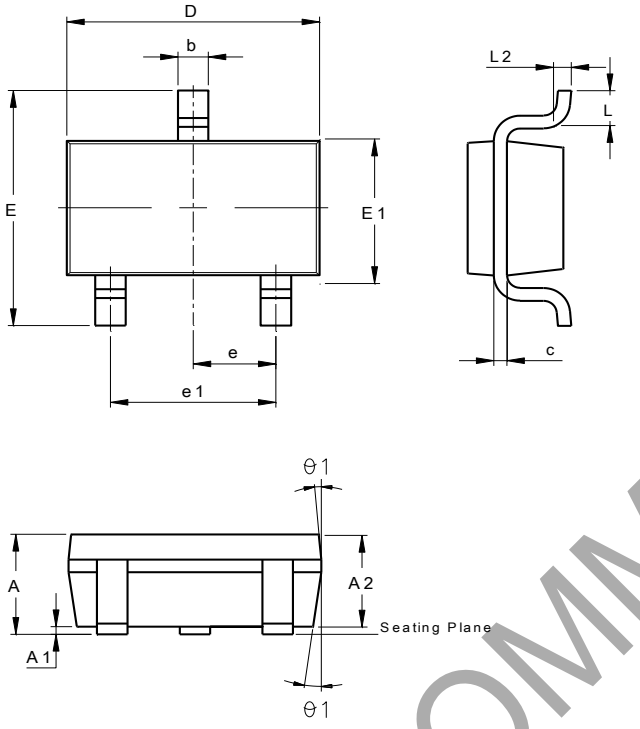
32XXQ : Identification Code
Y : Year : 0 to 9 (ex: 5 = 2025)
WW : Week : 01 to 52, "52" represents
week 52 and 53
X : Internal Code

Orderable Part Number	Package	Identification Code
AH3241Q-P-A	SIP-3 (Ammo Pack)	3241Q
AH3241Q-P-B	SIP-3 (Bulk Pack)	3241Q
AH3242Q-P-A	SIP-3 (Ammo Pack)	3242Q
AH3242Q-P-B	SIP-3 (Bulk Pack)	3242Q
AH3243Q-P-A	SIP-3 (Ammo Pack)	3243Q
AH3243Q-P-B	SIP-3 (Bulk Pack)	3243Q
AH3244Q-P-A	SIP-3 (Ammo Pack)	3244Q
AH3244Q-P-B	SIP-3 (Bulk Pack)	3244Q
AH3280Q-P-A	SIP-3 (Ammo Pack)	3280Q
AH3280Q-P-B	SIP-3 (Bulk Pack)	3280Q
AH3281Q-P-A	SIP-3 (Ammo Pack)	3281Q
AH3281Q-P-B	SIP-3 (Bulk Pack)	3281Q
AH3282Q-P-A	SIP-3 (Ammo Pack)	3282Q
AH3282Q-P-B	SIP-3 (Bulk Pack)	3282Q

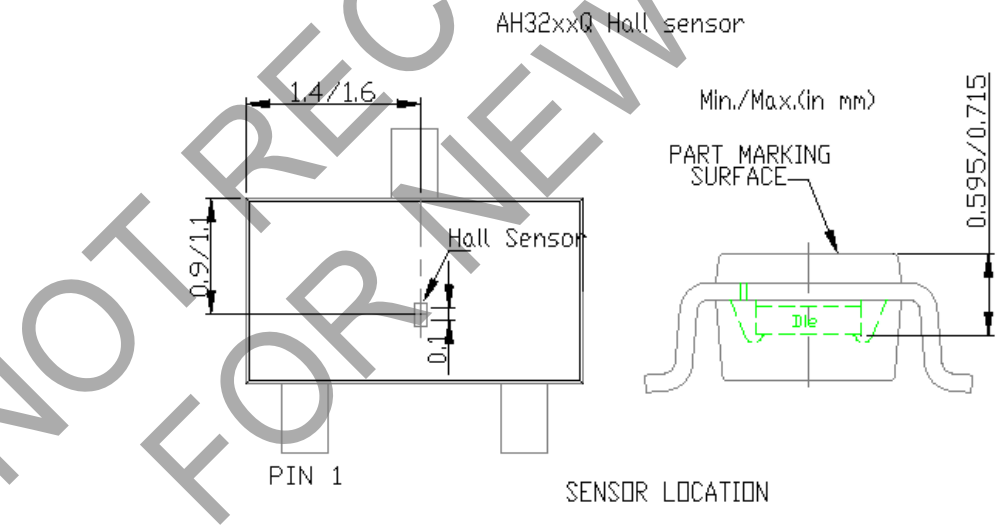
Package Outline Dimensions (All dimensions in mm.)

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

(1) Package Type: SC59 (Type A1)



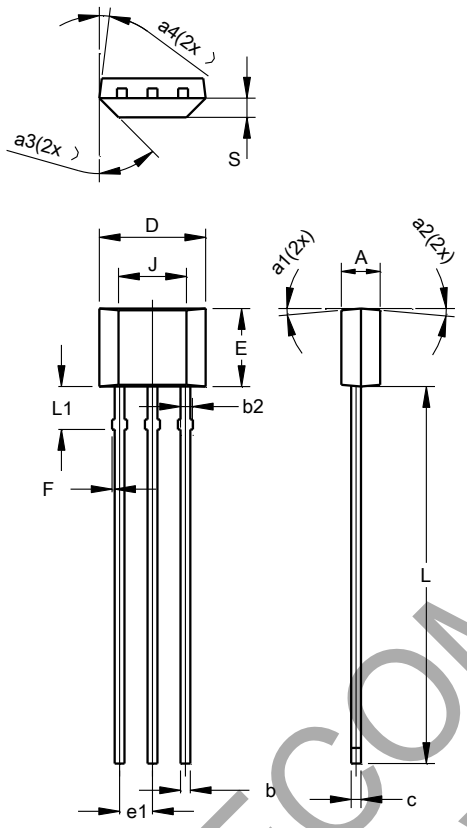
SC59 (Type A1)			
Dim	**Min**	**Max**	**Typ**
A	--	1.45	--
A1	0.00	0.15	--
A2	0.90	1.30	1.15
b	0.30	0.50	--
c	0.08	0.22	--
D	2.90 BSC		
E	2.80 BSC		
E1	1.60 BSC		
e	0.95 BSC		
e1	1.90 BSC		
L	0.30	0.60	0.45
L2	0.25 BSC		
θ1	5°	15°	10°
All Dimensions in mm			



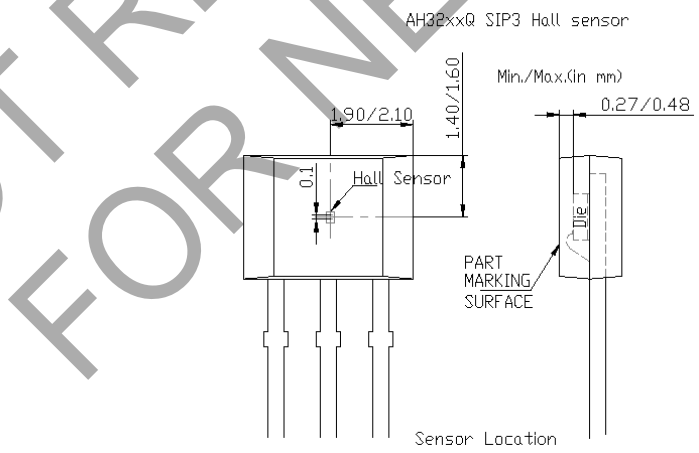
Package Outline Dimensions (continued) (All dimensions in mm.)

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

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



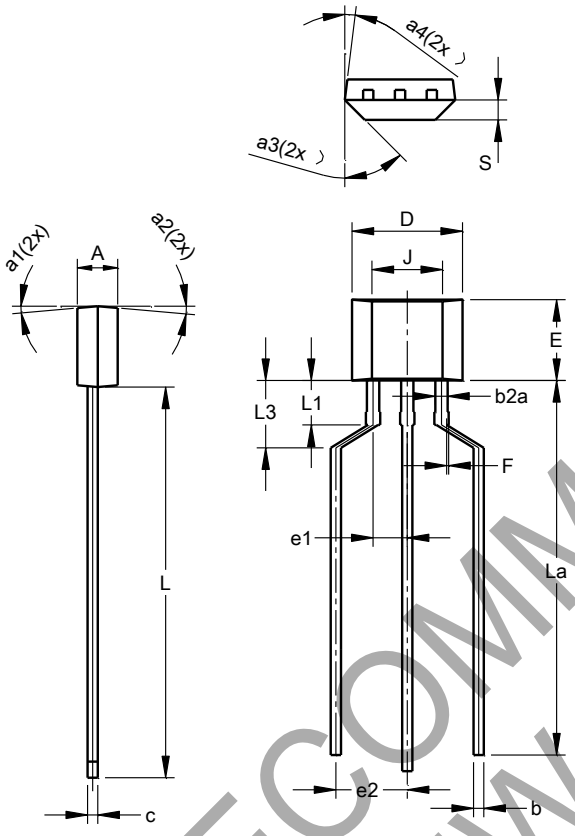
SIP-3 (Bulk Pack)			
Dim	**Min**	**Max**	**Typ**
A	1.40	1.60	1.50
b	0.33	0.43	0.38
b2	0.40	0.508	0.46
c	0.35	0.41	0.38
D	3.90	4.30	4.10
E	2.80	3.20	3.00
e1	1.24	1.30	1.27
F	0.00	0.20	—
J	2.62 REF		
L	14.00	15.00	14.50
L1	1.55	1.75	1.65
S	0.63	0.84	0.74
a1	—	—	5°
a2	—	—	5°
a3	—	—	45°
a4	—	—	3°
All Dimensions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



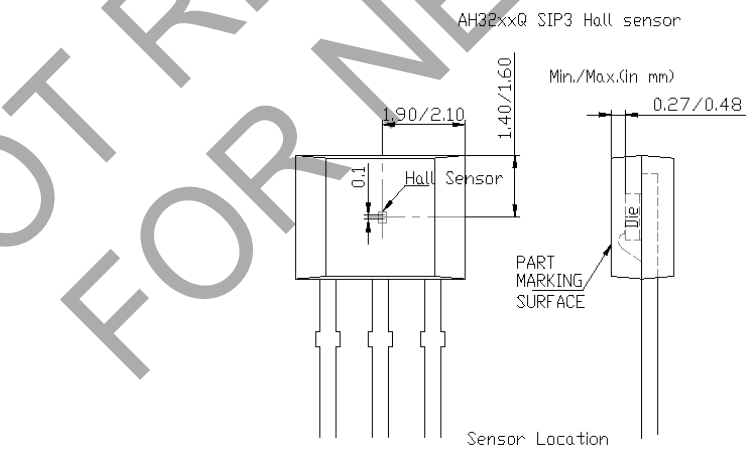
Package Outline Dimensions (continued) (All dimensions in mm.)

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

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



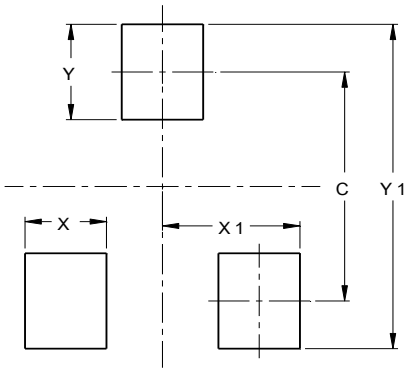
SIP-3 (Ammo Pack)			
Dim	**Min**	**Max**	**Typ**
A	1.40	1.60	1.50
b	0.33	0.43	0.38
b2a	0.40	0.52	0.46
c	0.35	0.41	0.38
D	3.90	4.30	4.10
E	2.80	3.20	3.00
e1	1.24	1.30	1.27
e2	2.40	2.90	2.65
F	0.00	0.20	—
J	2.62 REF		
L	14.00	15.00	14.50
La	12.90	14.90	13.90
L1	1.55	1.75	1.65
L3	2.00	3.00	2.50
S	0.63	0.84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