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APS12625 and APS12626

2D Hall-Effect Speed and Direction Sensor ICs

FEATURES AND BENEFITS

- Flexible and easy-to-use sensor for motors/encoders
- ISO 26262 / ASIL A functional safety compliance
- 2D magnetic sensing via planar and vertical Hall elements
  - □ Quadrature independent of magnet pole pitch and air gap—no target optimization required
  - □ Works in almost any orientation to the target (XY, ZX, and ZY options)
- Reduces accumulation of lost counts/pulses
  - □ System can restore correct state after power-cycling (-P option)
- Dual outputs of quadrature or speed/direction signals
- High magnetic sensitivity
- Optimized for applications with regulated power rails
  - □ Operation from 2.8 to 5.5 V
- Automotive grade/qualified per AEC-Q100
  - □ T_J up to 175°C
  - □ Output short-circuit protection
  - □ Resistant to physical stress
- Small size

TYPICAL APPLICATIONS

- Automotive
  - □ Power closures/actuators
  - □ Electronic power steering
  - □ Seat/window/sunroof motors
  - □ Trunk/door/liftgate motors
- Industrial motors/encoders
- Garage door openers
- Motorized window blinds
- White goods

DESCRIPTION

The APS12625 and APS12626 integrated circuits are dual ultrasensitive Hall-effect latches optimized for use with ring magnets. They feature both vertical and planar Hall elements with sensing axes that are orthogonal to one another, providing 90° of phase separation. This phase separation is inherently independent of magnet pole spacing and air gap. No target optimization is required, making them extremely flexible and easy to use.

For example, the ring magnet pole-pitch can be changed without having to modify the sensor position or other mechanical design details. Additionally, XY, ZX, and ZY options are available to work in almost any orientation to the target. The APS12625 features Speed and Direction outputs, while the APS12626 has quadrature outputs (Channel A/B).

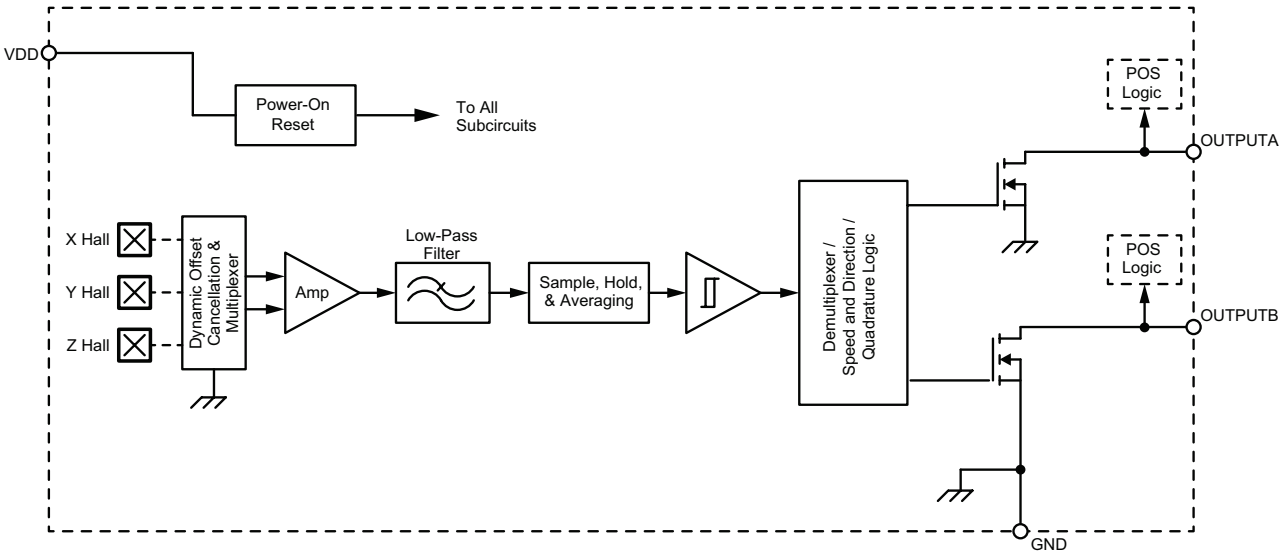
A unique feature allows the host system to restore the correct state after power-cycling the device (-P option). This reduces the potential accumulation of lost counts/pulses when the device wakes up with one or more sensors in its hysteresis region.

Continued on the next page…

PACKAGE

5-Pin SOT23-W (Suffix LH)

Not to scale



Functional Block Diagram

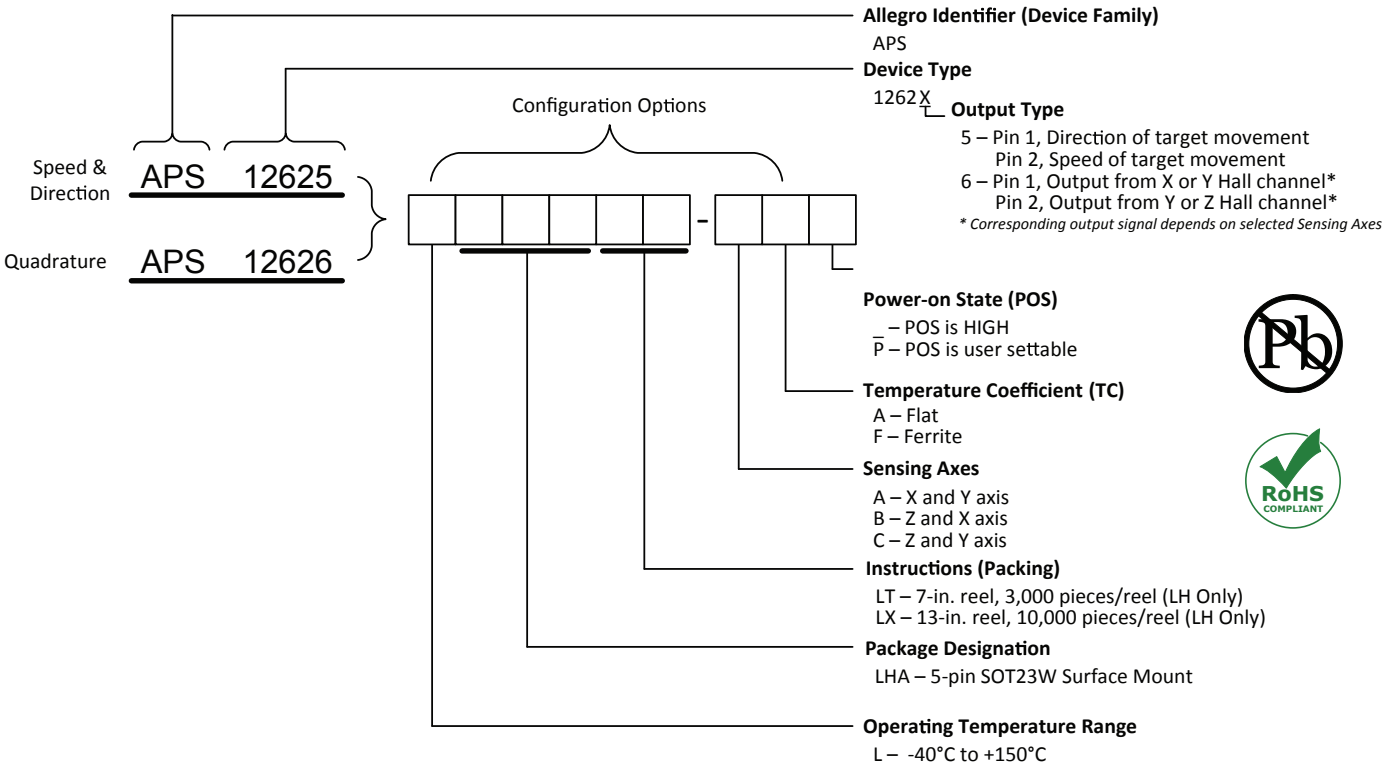
DESCRIPTION (continued)

On a single silicon chip, these devices include: three Hall plates (one planar and two vertical), a multiplexer, a small-signal amplifier, chopper stabilization, a Schmitt trigger, and two NMOS output transistors which can sink up to 10 mA continuously. They operate from a regulated supply voltage of 2.8 to 5.5 V and have been qualified beyond the requirements of AEC-Q100 grade 0 for operation up to 175°C junction temperature.

The small geometries of the BiCMOS process allow these devices to be offered in an ultrasmall package. Package designator "LH" indicates a modified SOT23-W surface-mount package. This package is RoHS compliant and lead (Pb) free, with 100% matte tin leadframe plating.

SELECTION GUIDE

Complete Part Number Format



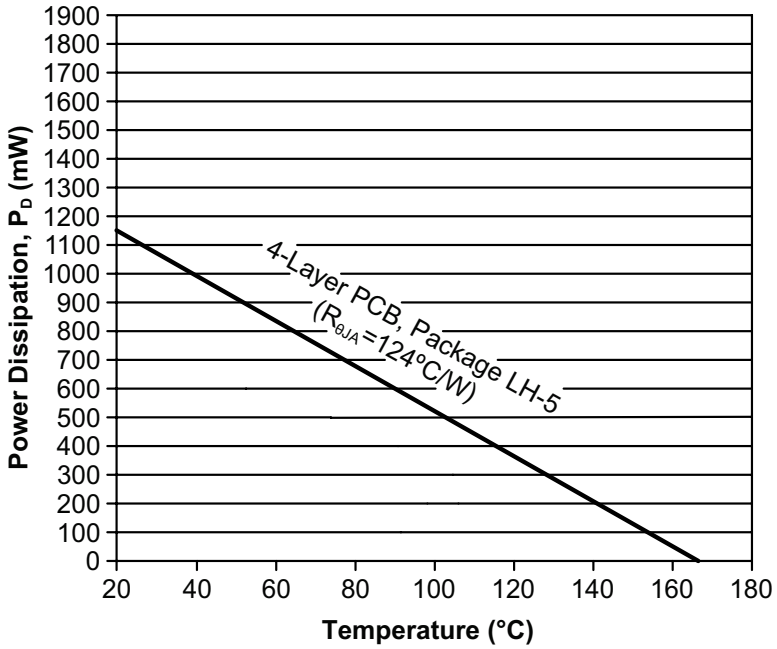
ABSOLUTE MAXIMUM RATINGS

Characteristic	Symbol	Notes	Rating	Unit
Forward Supply Voltage	V_{DD}		6	V
Reverse Supply Voltage	V_{RDD}		–0.3	V
Magnetic Flux Density	B		Unlimited	G
Output Off Voltage	V_{OUT}		6	V
Output Current	I_{OUT}	Through short-circuit current-limiting device	45	mA
Maximum Junction Temperature	$T_{J(MAX)}$		165	°C
		For 500 hours	175	°C
Storage Temperature	T_{stg}		–65 to 170	°C

THERMAL CHARACTERISTICS: May require derating at maximum conditions; see application information

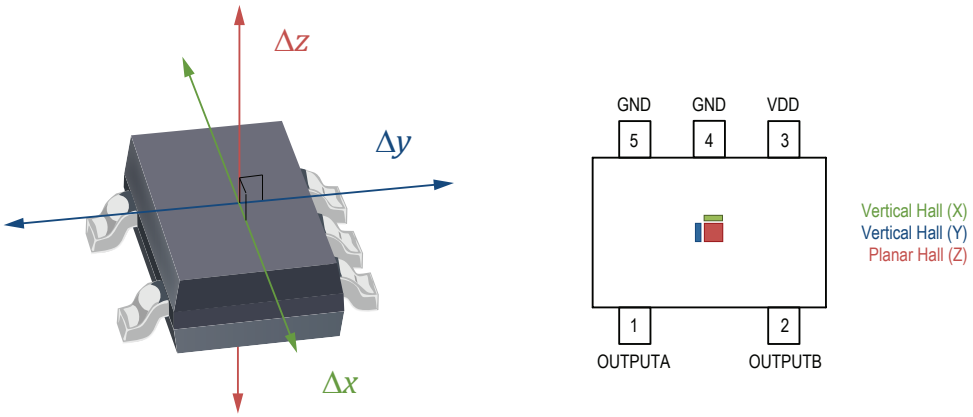
Characteristic	Symbol	Notes	Rating	Unit
Package Thermal Resistance	$R_{\theta JA}$	Package LH-5 4-layer board based on the JEDEC standard JESD51-7	124	°C/W

* Additional thermal information available on the Allegro website.



Maximum Power Dissipation versus Ambient Temperature

PINOUT DIAGRAMS, TERMINAL LIST, AND OUTPUT OPTION TABLES



Package LH, 5-Pin SOT23-W

Terminal List Table

Number	Symbol	Description
1	OUTPUTA	*See output option table*
2	OUTPUTB	*See output option table*
3	VDD	Connects power supply to chip
4	GND	Ground [1]
5	GND	Ground [1]

[1] Only one GND connection is required; other GND pin can float or also be tied to GND.

Output Option Table

Device	Order Option [2]	Sensing Axes	OUTPUT A (Pin 1)	OUTPUTB (Pin 2)
APS12625	A	XY	Speed of target movement	Direction of target movement
	B	ZX		
	C	ZY		
APS12626	A	XY	X channel output	Y channel output
	B	ZX	Z channel output	X channel output
	C	ZY	Z channel output	Y channel output

[2] See Selection Guide.

ELECTRICAL CHARACTERISTICS: Valid over full operating voltage and ambient temperature range T_A = –40°C to 150°C, unless otherwise specified

Characteristics	Symbol	Test Conditions	Min.	Typ. [1]	Max.	Unit
Supply Voltage	V_{DD}	Operating, $T_J \le T_J$(max)	2.8	–	5.5	V
Output Leakage Current	I_{OUTOFF}	$B < B_{RP}$	–	–	10	µA
Output On Voltage	$V_{OUT(SAT)}$	I_{OUT} = 2 mA, $B > B_{OP}$	–	180	500	mV
Output Off Voltage	$V_{OUT(OFF)}$	OUTA and OUTB are open-drain; application sets output off voltage	–	–	5.5	V
Supply Current	I_{DD}		–	3	4.5	mA
Output Current	I_{OUT}	Value used during characterization	–	5	–	mA
Output Sink Current	$I_{OUTPUT(SINK)}$		–	–	10	mA
Output Short-Circuit Current Limit	I_{OM}	V_{DD} = 5.5 V, $T_J \le T_J$(max)	15	–	45	mA
Output Rise Time [2][3]	t_r	C_{LOAD} = 20 pF, R_{LOAD} = 820 Ω	–	0.2	–	µs
Output Fall Time [2][3]	t_f	C_{LOAD} = 20 pF, R_{LOAD} = 820 Ω	–	0.1	–	µs
Power-On Time	t_{ON}	Both outputs, APS12625	–	150	300	µs
		Both outputs, APS12626	–	50	100	µs
Power-On State External Input	t_{POS_input}	Hold time for external POS setting signal, -*P* option only; see Figure 10	100	–	–	µs
Power-On State, Output A and B	POS			High		–
Delay Between Direction and Speed Pin Update	$t_{dir\text{-}to\text{-}speed}$	Only valid for APS12625	2.8	4.0	8	µs
Speed Pin Input Low Level Channel A / B Input Low Level	$V_{IN(LOW)}$	For APS12625 -*P* option For APS12626 -*P* option	–	–	0.8	V
Speed Pin Input High Level Channel A / B Input High Level	$V_{IN(HIGH)}$	For APS12625 -*P* option For APS12626 -*P* option	2.0	–	–	V

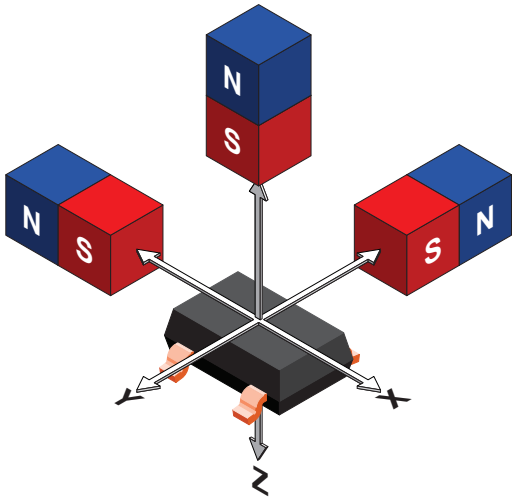
[1] Typical data are at T_A = 25°C and V_{DD} = 4 V.
[2] Power-on time, rise time, and fall time are guaranteed through device characterization.
[3] C_{LOAD} = oscilloscope probe capacitance.

MAGNETIC CHARACTERISTICS: **Valid over full operating voltage and temperature ranges, unless otherwise specified**

Characteristics	Symbol	Test Conditions		Min.	Typ. [1]	Max.	Unit [2]
Operate Point [3]	$B_{OP(A)}$, $B_{OP(B)}$	TC = 0	T_A = –40°C	12	27.8	44	G
			T_A = 25°C	11	25.0	41	G
			T_A = 150°C	1	19.7	39	G
		TC = 1		1	21	40	G
Release Point [3]	$B_{RP(A)}$, $B_{RP(B)}$	TC = 0	T_A = –40°C	–44	–27.8	–12	G
			T_A = 25°C	–41	–25.0	–11	G
			T_A = 150°C	–39	–19.7	–1	G
		TC = 1		–40	–21	–1	G
Hysteresis ($B_{OP} – B_{RP}$)	$B_{HYS(A)}$, $B_{HYS(B)}$	TC = 0	T_A = –40°C	38	55.5	72	G
			T_A = 25°C	35	50.0	66	G
			T_A = 150°C	25	39.4	54	G
		TC = 1		25	42	65	G
Symmetry: Channel A, Channel B, $B_{OP(A)} + B_{RP(A)}$, $B_{OP(B)} + B_{RP(B)}$	$B_{SYM(A)}$, $B_{SYM(B)}$			–35	–	35	G
Operate Symmetry: $B_{OP(A)} – B_{OP(B)}$	$B_{SYM(AB,OP)}$			–15	–	15	G
Release Symmetry: $B_{RP(A)} – B_{RP(B)}$	$B_{SYM(AB,RP)}$			–15	–	15	G
Temperature Coefficient	TC	TC = 0, APS12625-F, APS12626-F		–	–0.17	–	%/°C
		TC = 1, APS12625, APS12626		–	0	–	%/°C

[1] Typical data are at T_A = 25°C and V_{DD} = 4 V.
[2] 1 G (gauss) = 0.1 mT (millitesla)
[3] Applicable to all directions (X, Y, and Z).

South polarity magnetic fields, in the orientations illustrated (right), are considered positive fields.

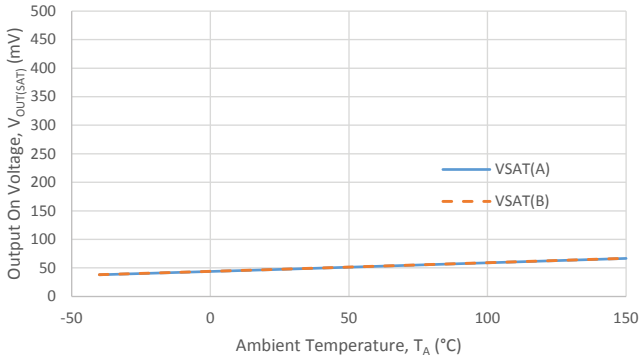


CHARACTERISTIC DATA

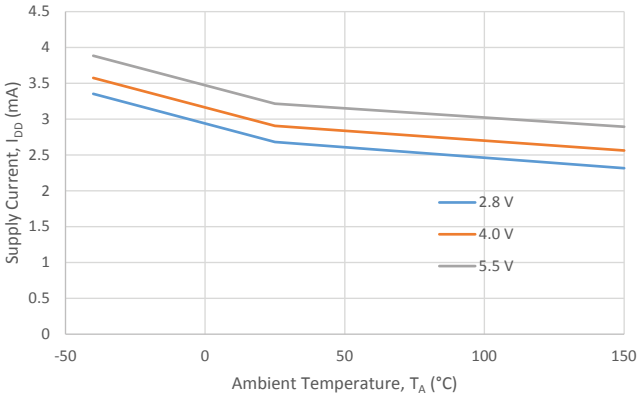
Electrical Characteristics

Output On Voltage vs. Temperature

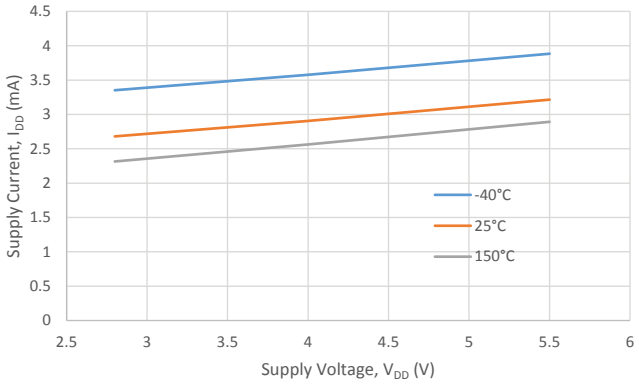
I_{OUT} = 2 mA, B > B_{OP}



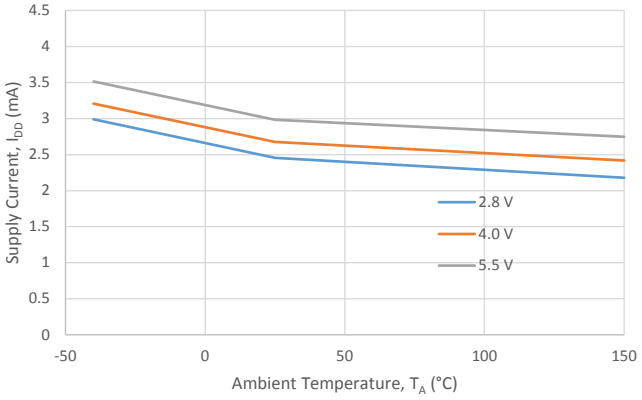
Supply Current (XY) vs. Temperature



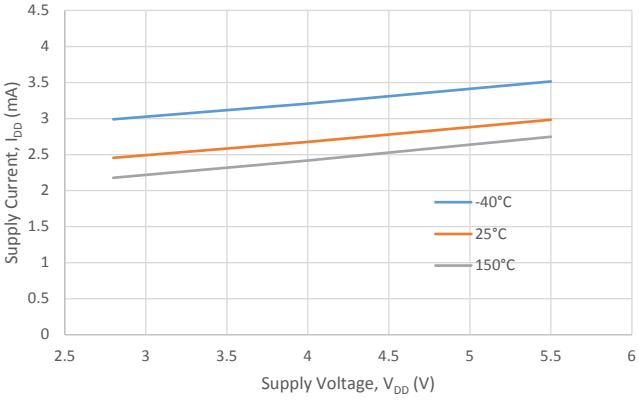
Supply Current (XY) vs. Supply Voltage



Supply Current (ZX & ZY) vs. Temperature

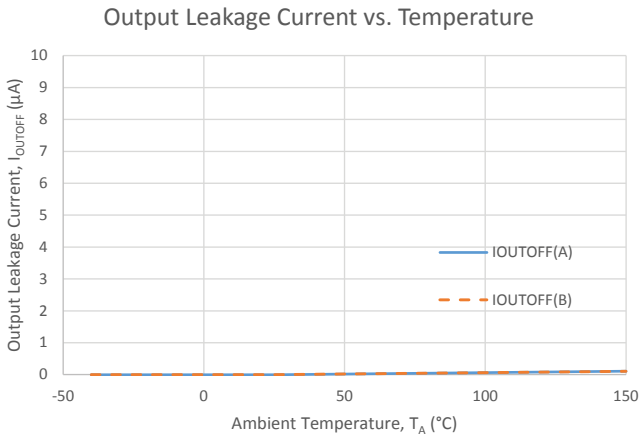


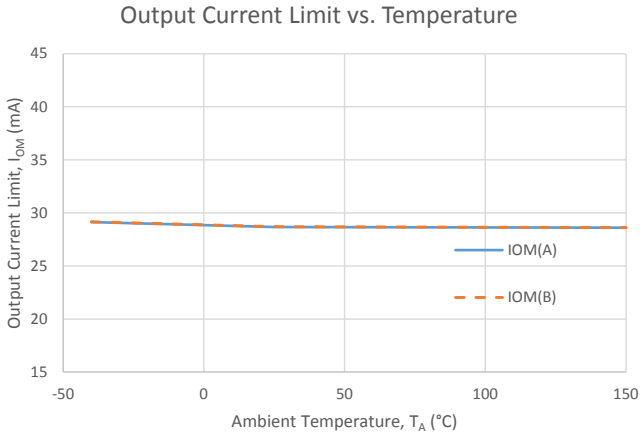
Supply Current (ZX & ZY) vs. Supply Voltage



CHARACTERISTIC DATA

Electrical Characteristics (continued)





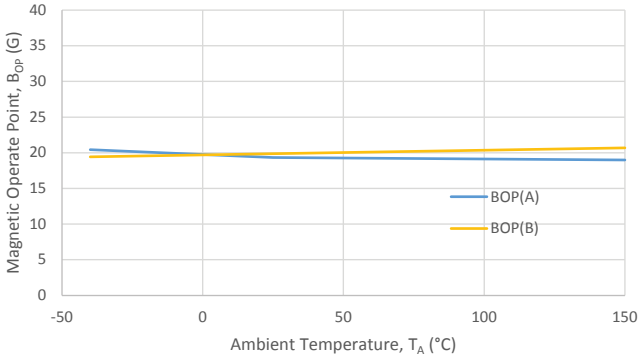
CHARACTERISTIC DATA

Magnetic Characteristics

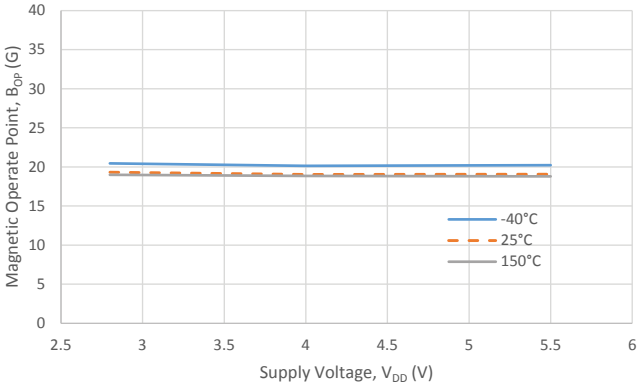
Option A (XY) with TC option A (flat)

Operate Point vs. Temperature

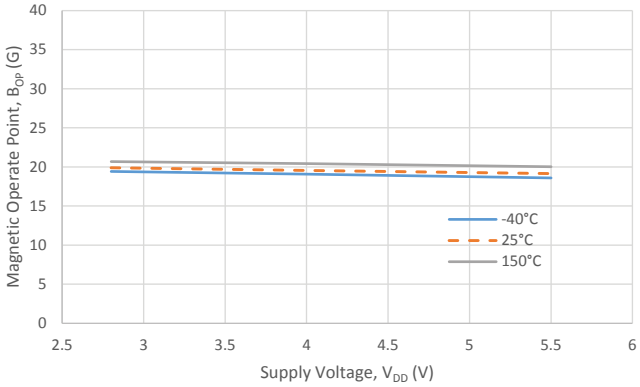
V_{DD} = 2.8 V



Operate Point (A) vs. Supply Voltage



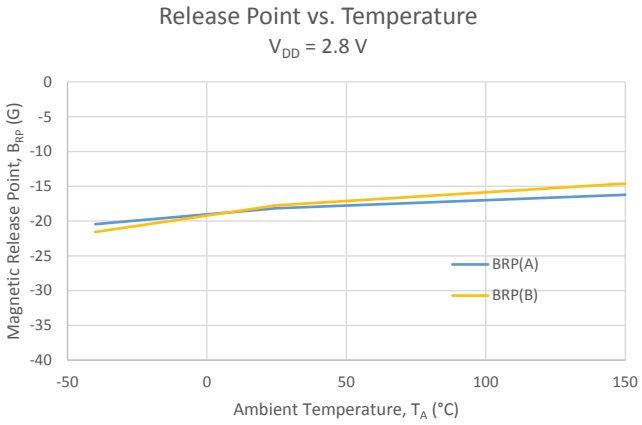
Operate Point (B) vs. Supply Voltage

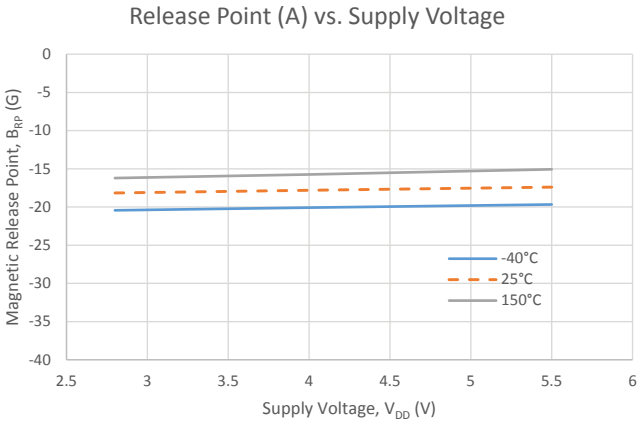


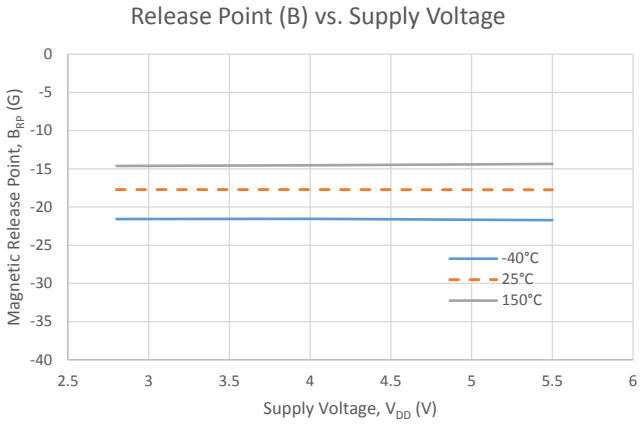
CHARACTERISTIC DATA

Magnetic Characteristics

Option A (XY) with TC option A (flat) (continued)



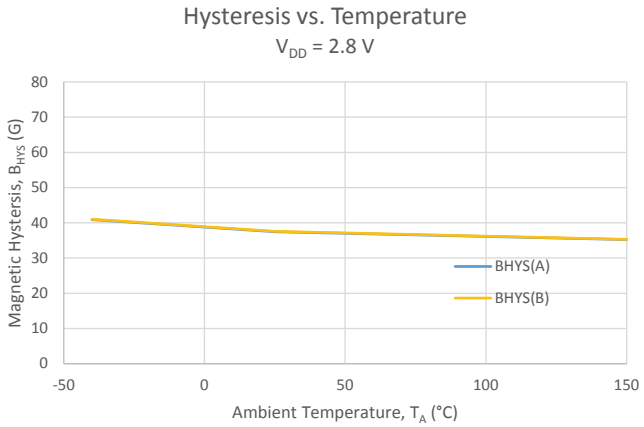


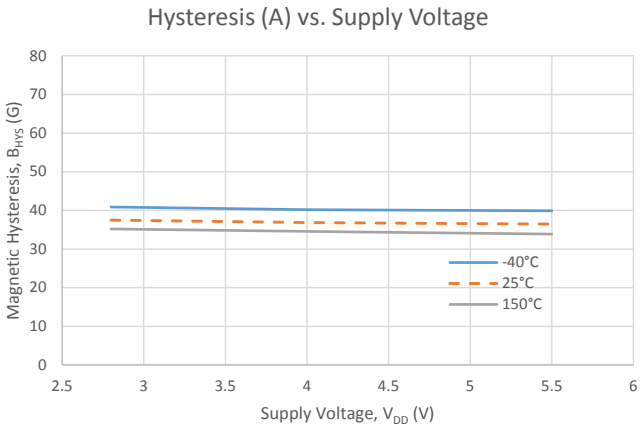


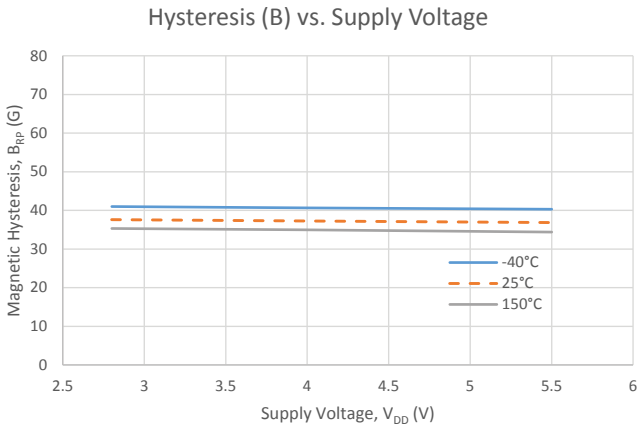
CHARACTERISTIC DATA

Magnetic Characteristics

Option A (XY) with TC option A (flat) (continued)





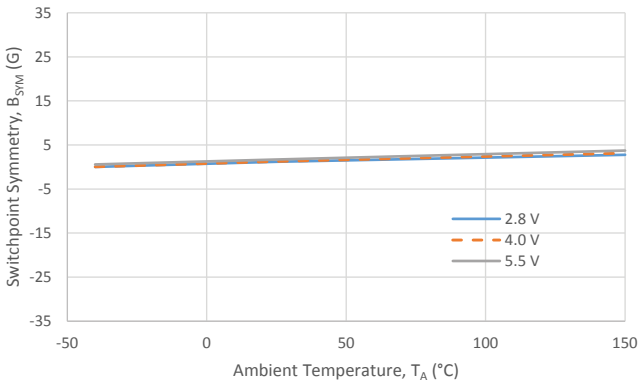


CHARACTERISTIC DATA

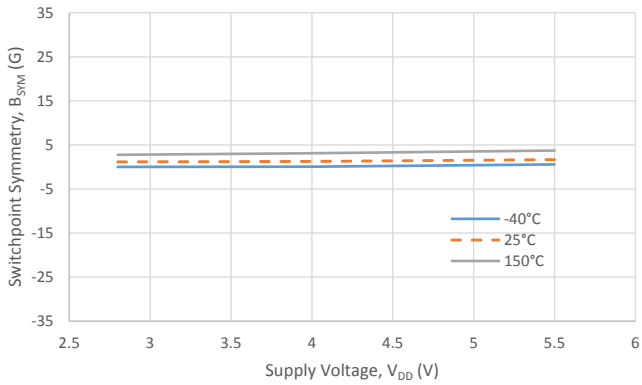
Magnetic Characteristics

Option A (XY) with TC option A (flat) (continued)

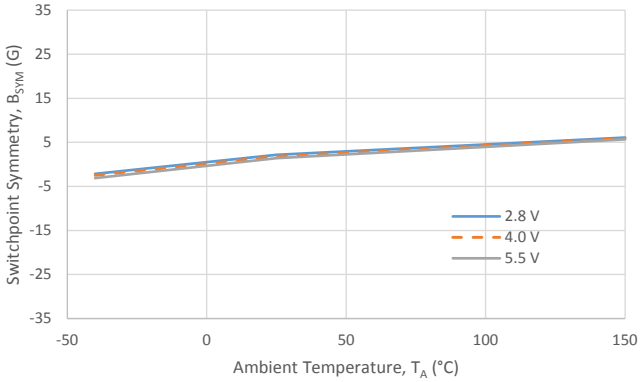
Symmetry (A) vs. Temperature



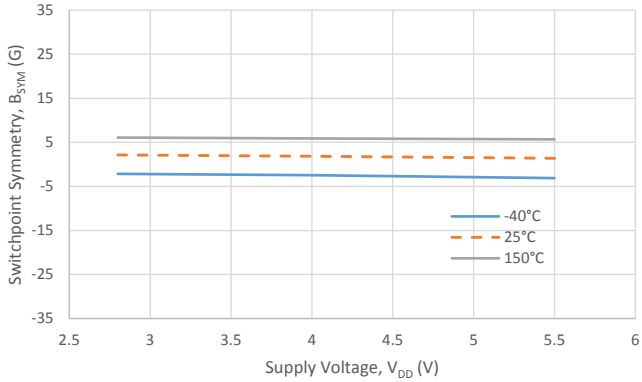
Symmetry (A) vs. Supply Voltage



Symmetry (B) vs. Temperature



Symmetry (B) vs. Supply Voltage

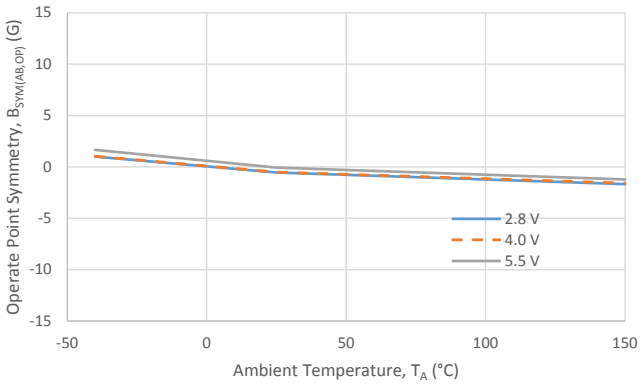


CHARACTERISTIC DATA

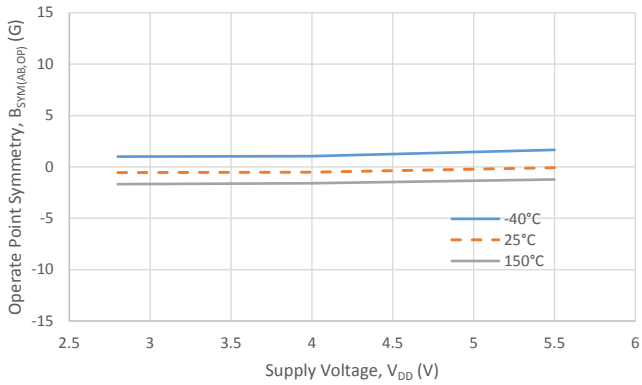
Magnetic Characteristics

Option A (XY) with TC option A (flat) (continued)

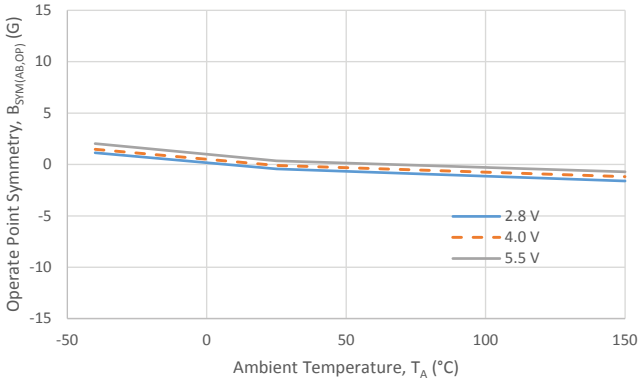
Operate Symmetry (AB) vs. Temperature



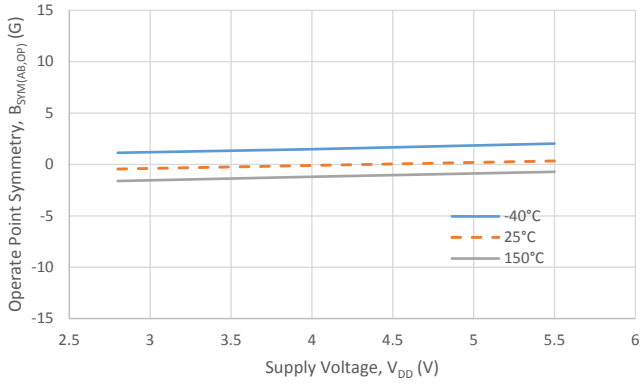
Operate Symmetry (AB) vs. Supply Voltage



Release Symmetry (AB) vs. Temperature



Release Symmetry (AB) vs. Supply Voltage



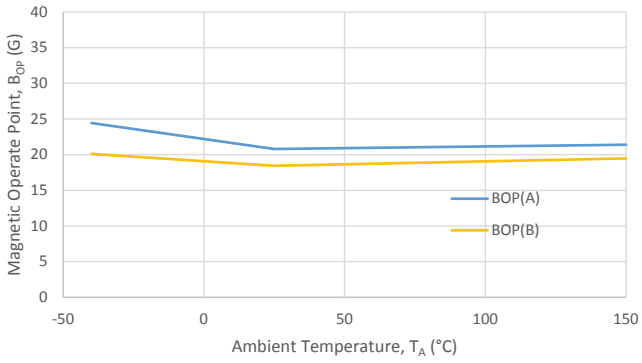
CHARACTERISTIC DATA

Magnetic Characteristics

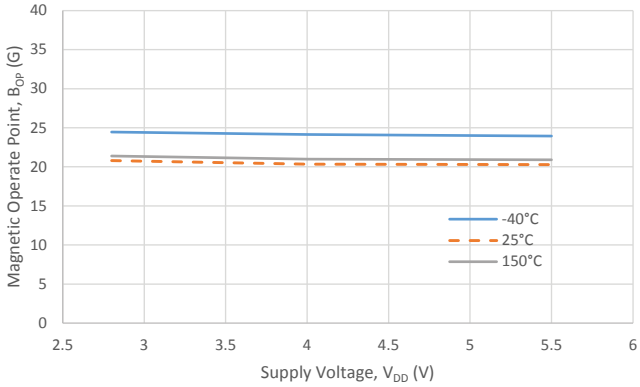
Option B & C (ZX & ZY) with TC option A (flat)

Operate Point vs. Temperature

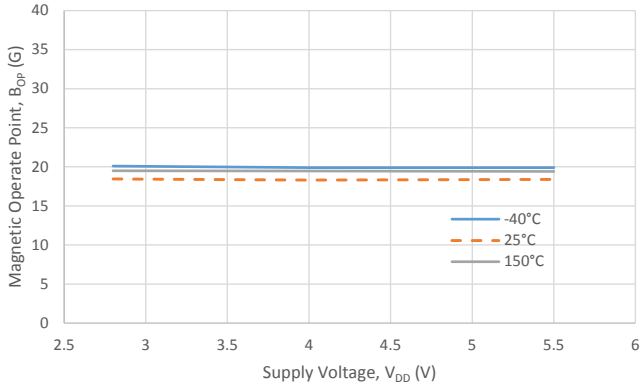
V_{DD} = 2.8 V



Operate Point (A) vs. Supply Voltage



Operate Point (B) vs. Supply Voltage



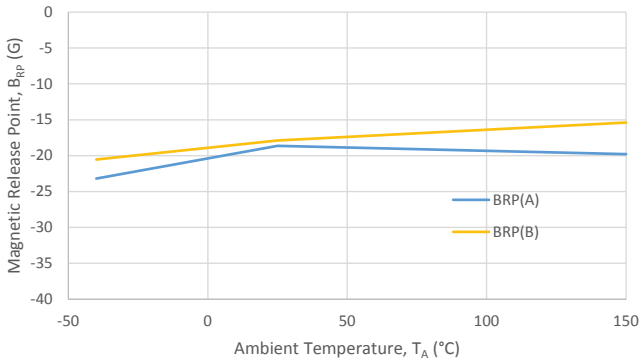
CHARACTERISTIC DATA

Magnetic Characteristics

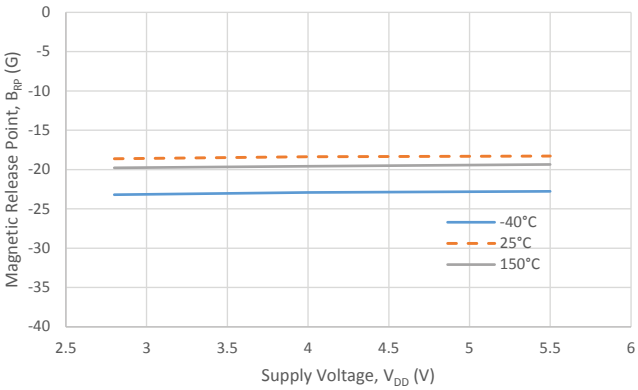
Option B & C (ZX & ZY) with TC option A (flat) (continued)

Release Point vs. Temperature

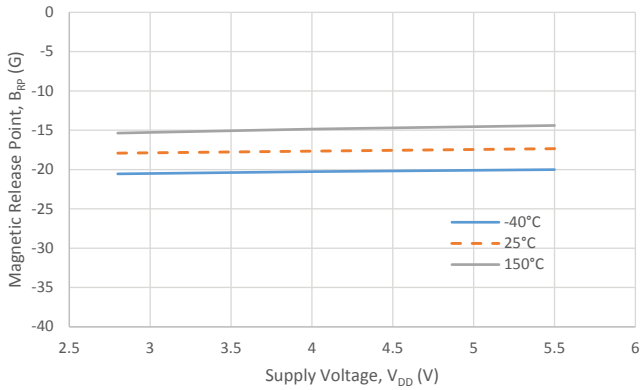
V_{DD} = 2.8 V



Release Point (A) vs. Supply Voltage



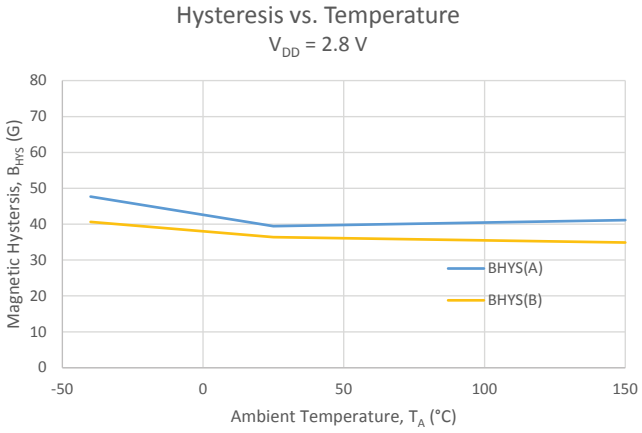
Release Point (B) vs. Supply Voltage

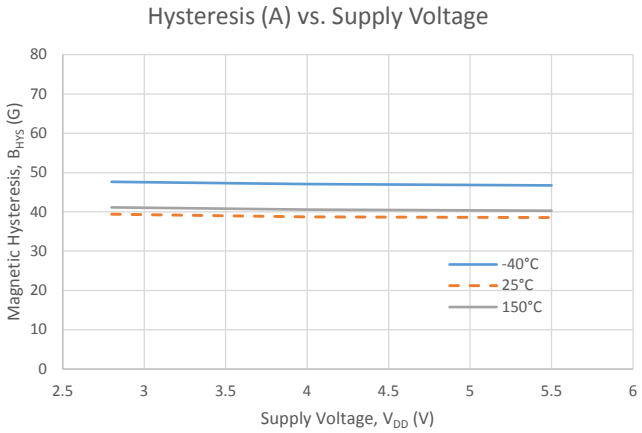


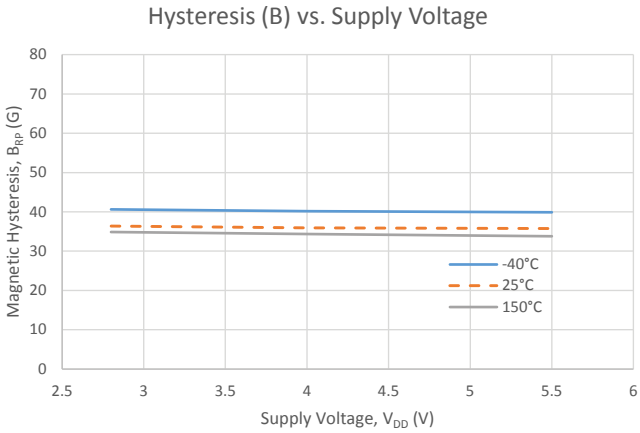
CHARACTERISTIC DATA

Magnetic Characteristics

Option B & C (ZX & ZY) with TC option A (flat) (continued)





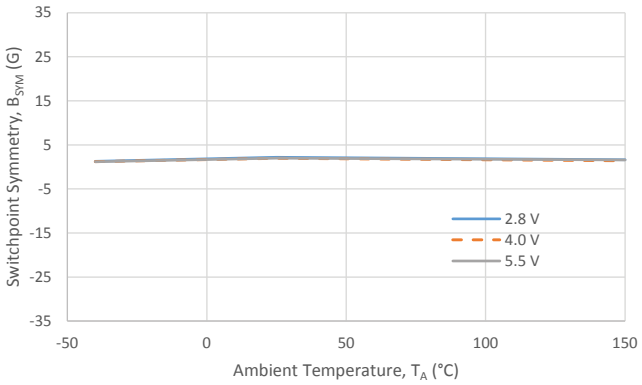


CHARACTERISTIC DATA

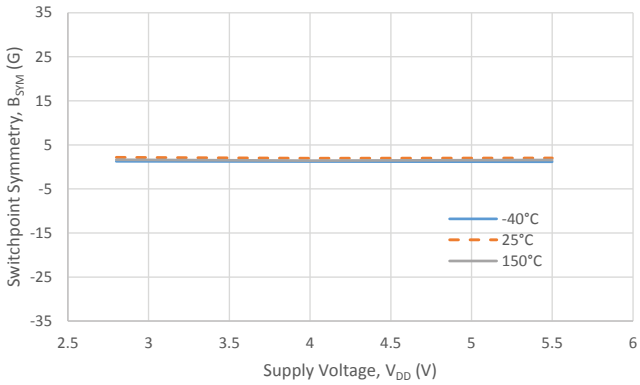
Magnetic Characteristics

Option B & C (ZX & ZY) with TC option A (flat) (continued)

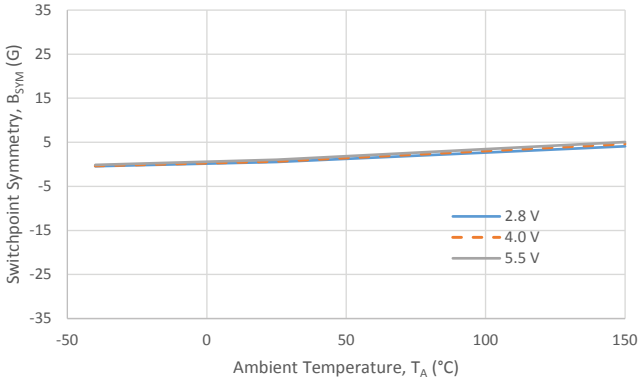
Symmetry (A) vs. Temperature



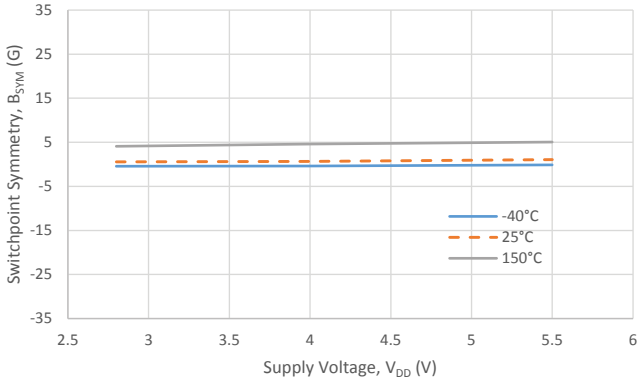
Symmetry (A) vs. Supply Voltage



Symmetry (B) vs. Temperature



Symmetry (B) vs. Supply Voltage

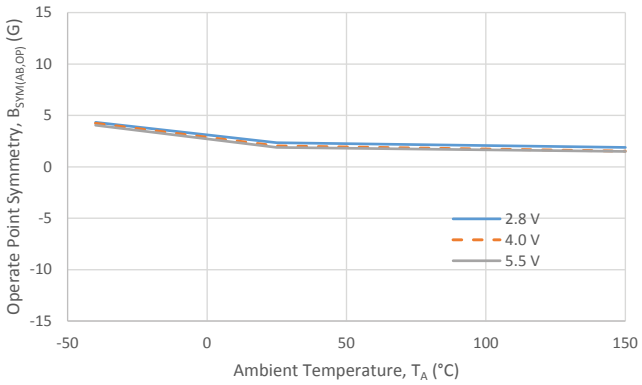


CHARACTERISTIC DATA

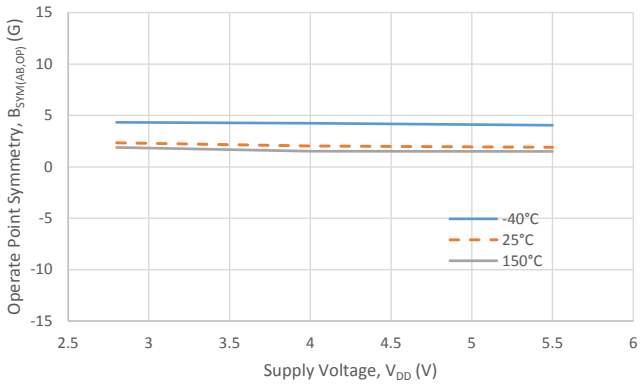
Magnetic Characteristics

Option B & C (ZX & ZY) with TC option A (flat) (continued)

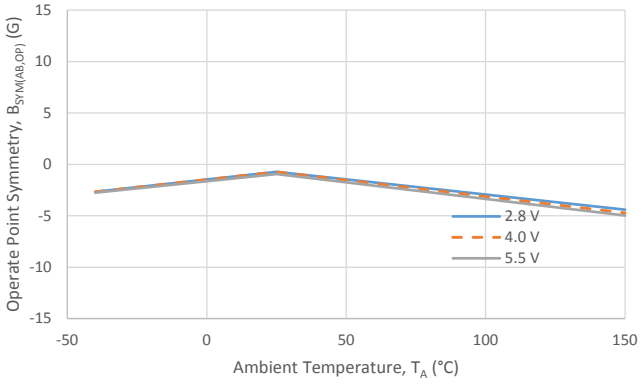
Operate Symmetry (AB) vs. Temperature



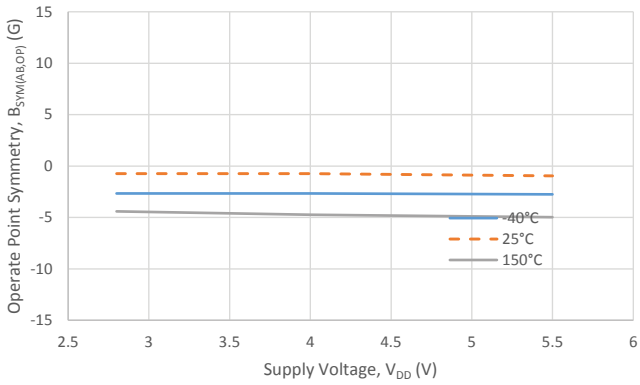
Operate Symmetry (AB) vs. Supply Voltage



Release Symmetry (AB) vs. Temperature



Release Symmetry (AB) vs. Supply Voltage



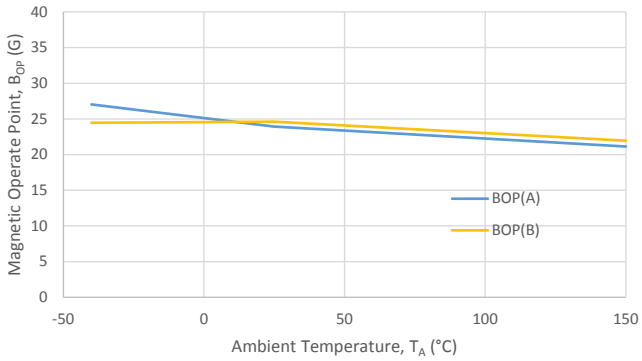
CHARACTERISTIC DATA

Magnetic Characteristics

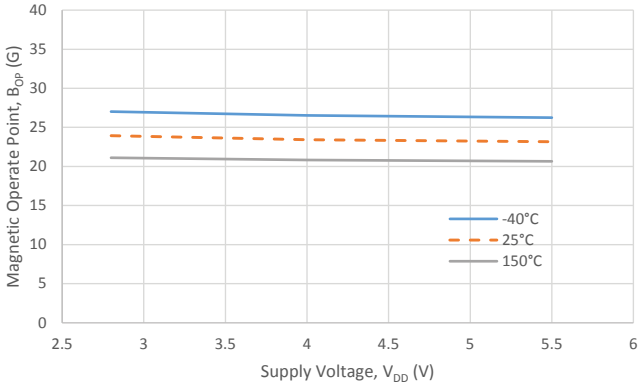
Option A (XY) with TC option F (ferrite)

Operate Point vs. Temperature

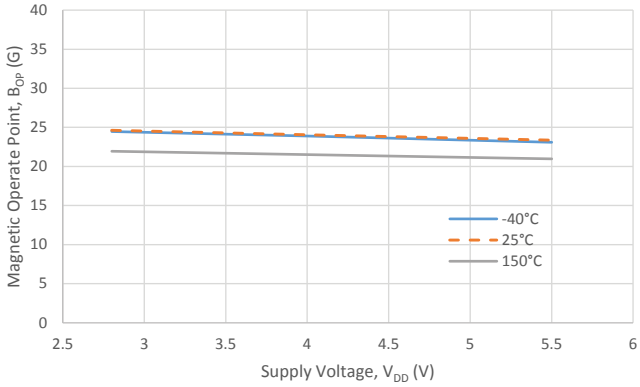
V_{DD} = 2.8 V



Operate Point (A) vs. Supply Voltage



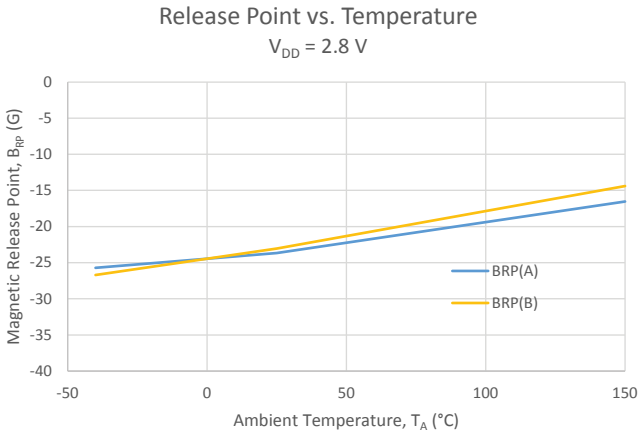
Operate Point (B) vs. Supply Voltage

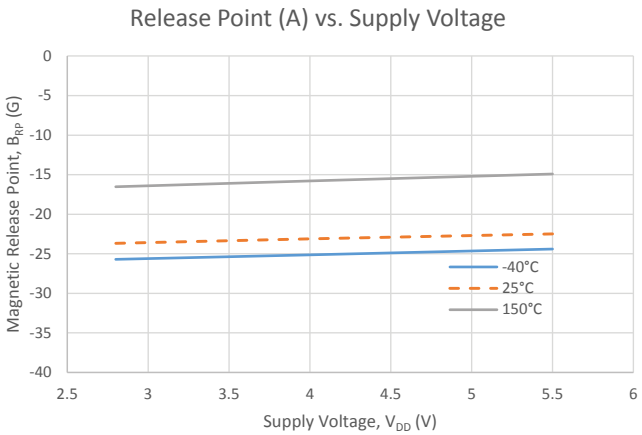


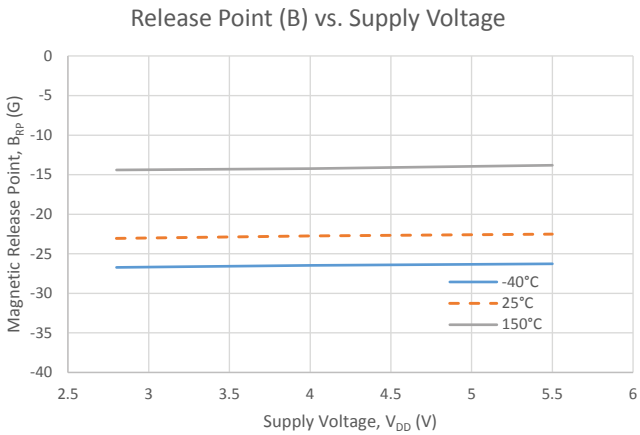
CHARACTERISTIC DATA

Magnetic Characteristics

Option A (XY) with TC option F (ferrite) (continued)







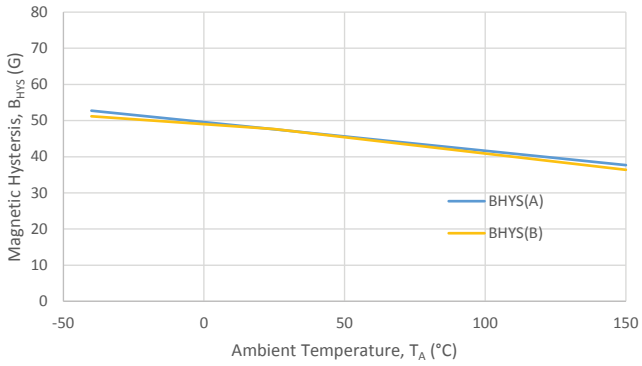
CHARACTERISTIC DATA

Magnetic Characteristics

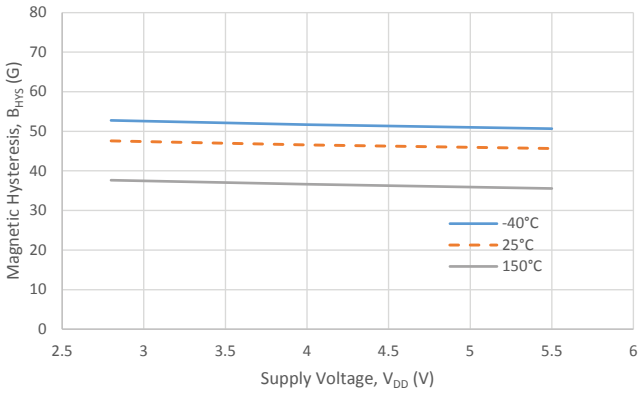
Option A (XY) with TC option F (ferrite) (continued)

Hysteresis vs. Temperature

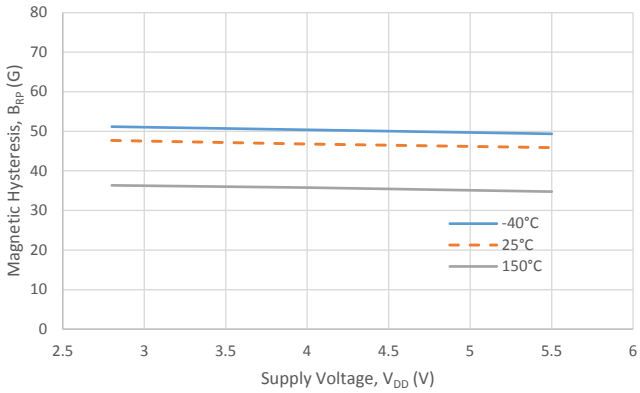
V_{DD} = 2.8 V



Hysteresis (A) vs. Supply Voltage



Hysteresis (B) vs. Supply Voltage

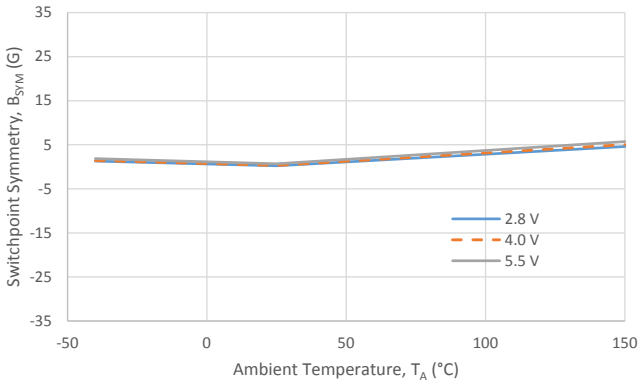


CHARACTERISTIC DATA

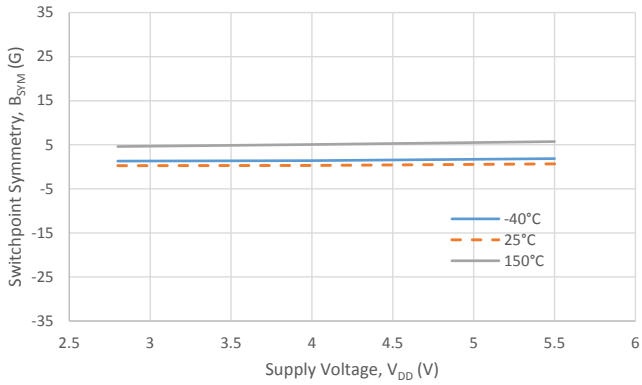
Magnetic Characteristics

Option A (XY) with TC option F (ferrite) (continued)

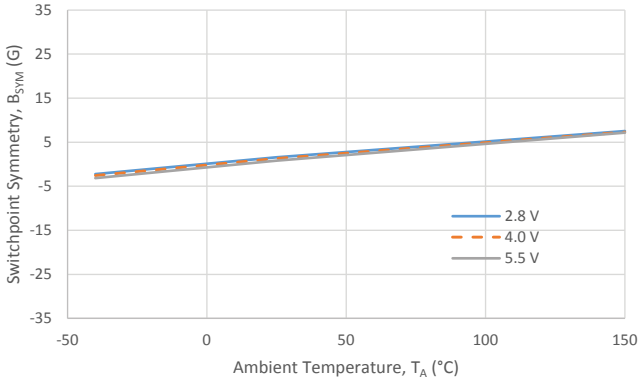
Symmetry (A) vs. Temperature



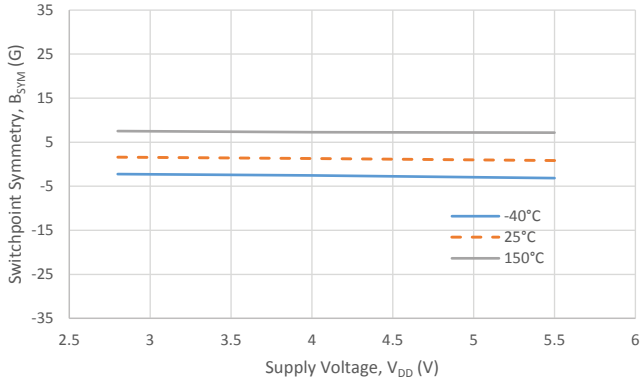
Symmetry (A) vs. Supply Voltage



Symmetry (B) vs. Temperature



Symmetry (B) vs. Supply Voltage

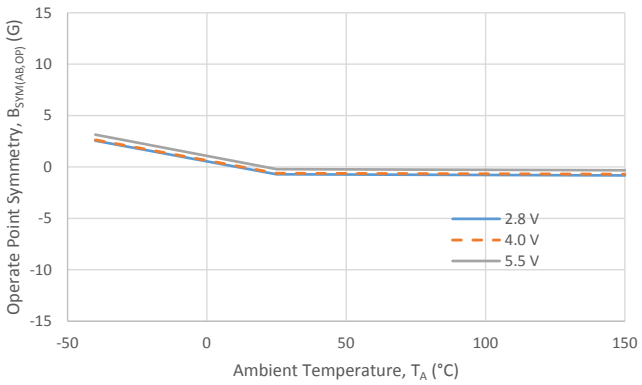


CHARACTERISTIC DATA

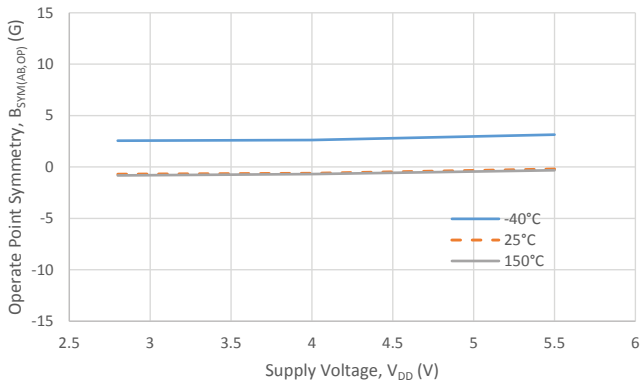
Magnetic Characteristics

Option A (XY) with TC option F (ferrite) (continued)

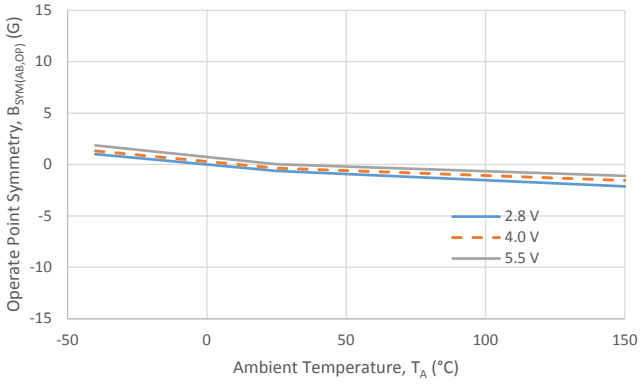
Operate Symmetry (AB) vs. Temperature



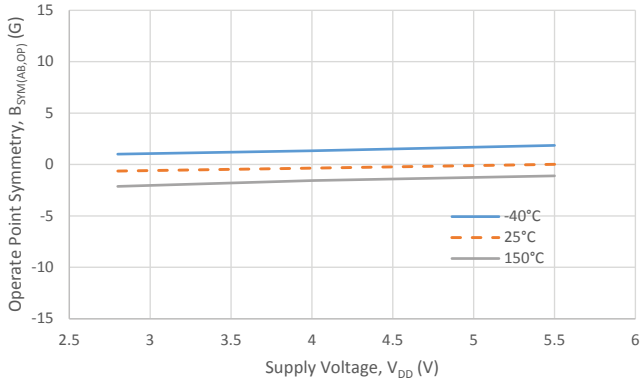
Operate Symmetry (AB) vs. Supply Voltage



Release Symmetry (AB) vs. Temperature



Release Symmetry (AB) vs. Supply Voltage



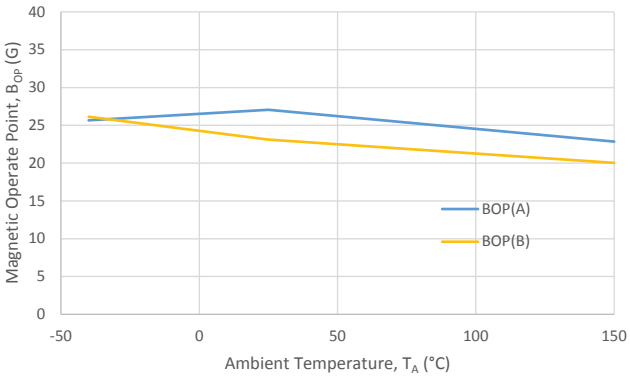
CHARACTERISTIC DATA

Magnetic Characteristics

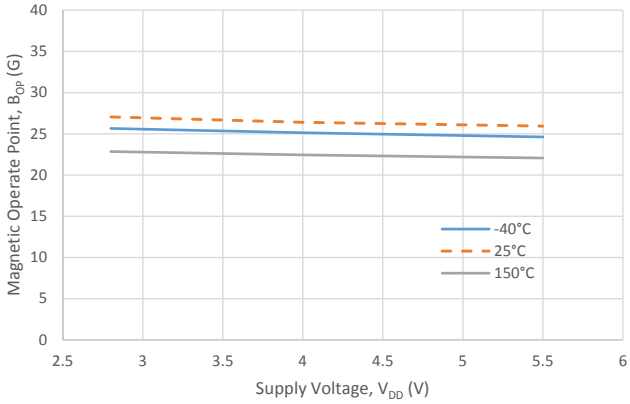
Option B & C (ZX & ZY) with TC option F (ferrite)

Operate Point vs. Temperature

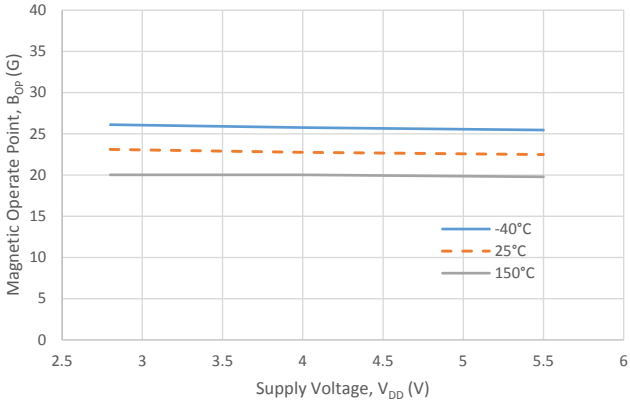
V_{DD} = 2.8 V



Operate Point (A) vs. Supply Voltage



Operate Point (B) vs. Supply Voltage



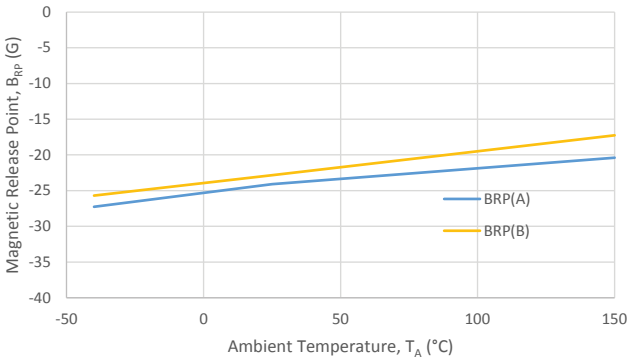
CHARACTERISTIC DATA

Magnetic Characteristics

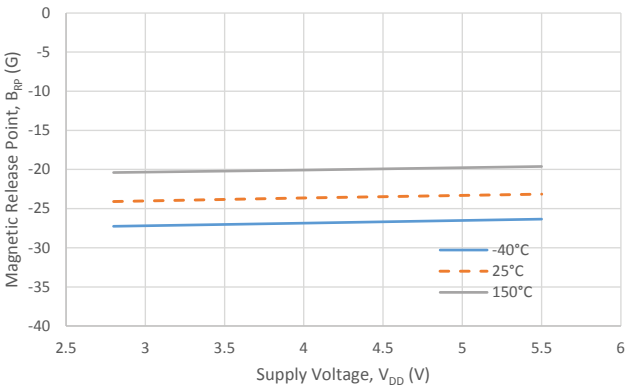
Option B & C (ZX & ZY) with TC option F (ferrite) (continued)

Release Point vs. Temperature

V_{DD} = 2.8 V



Release Point (A) vs. Supply Voltage



Release Point (B) vs. Supply Voltage