BXS
BATTERY EXPANSION SENSOR

General Description

The Flexpoint Battery Expansion Sensor (BXS) is a carbon-based resistive sensor that can measure the expansion of Lithium-Ion, Lithium Polymer and other batteries due to accumulating gasses. Batteries tend to expand due to age, overtemperature and overcurrent. The BXS is an analog sensor but with a tiny IC can connect to the system using an I2C interface.

Features

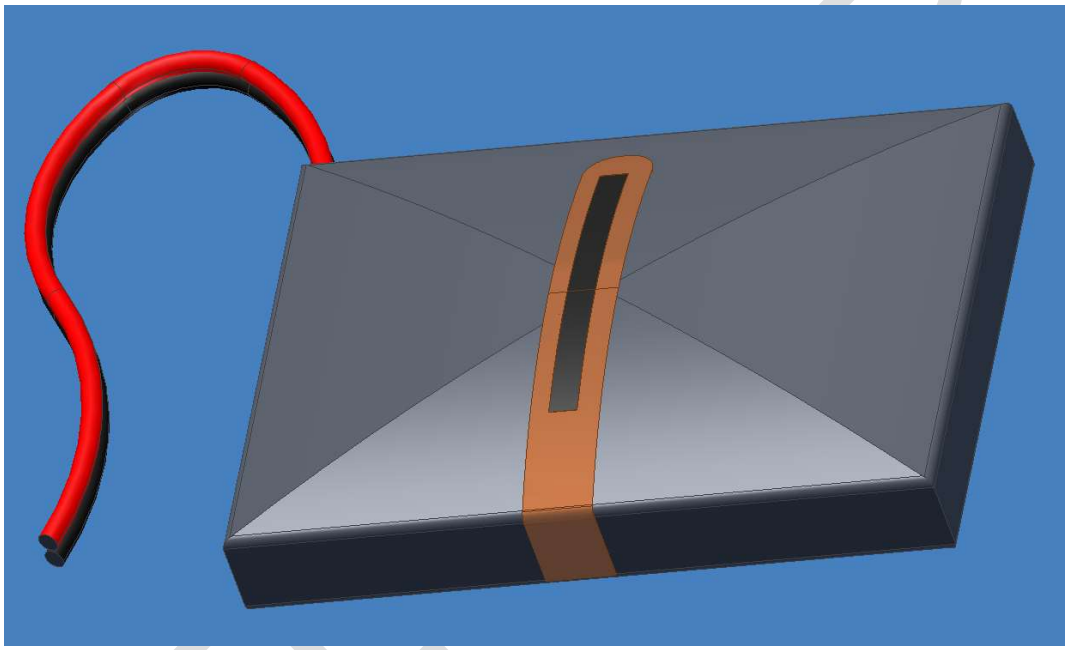
- Single Layer Construction
- Does not require enclosure pressure to actuate
- Excellent in harsh environments
- Resistant to liquids, dust and dirt
- Durable, tested to over 30 million cycles
- I2C Interface (Up to 400kbps)
- 8-bit resolution (0 to 255)
- Up to 10 Samples per Second
- Super low shutdown current
- Wide voltage range (1.71V – 5.5V)
- -40º C to 85º C rated (can be configured to 200 ºC operating temp)

Contents

How the BXS Works

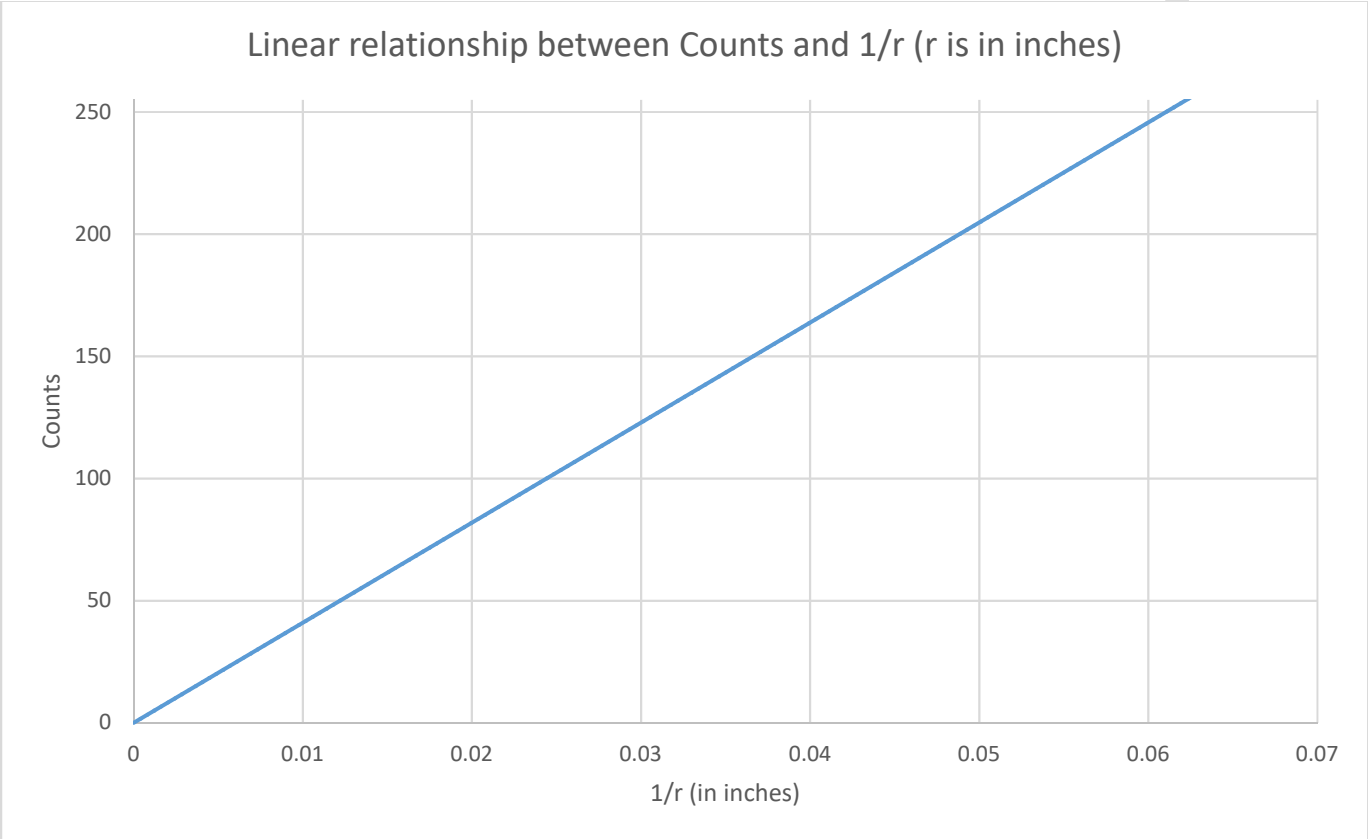
Flexpoint's patented BXS device consists of a single layer, thin, (0.005" typ.) flexible piece of material that is coated with a proprietary carbon/polymer-based ink. This type of resistive element is commonly used to make thick film resistors, resistor networks, slide potentiometers and transducers. Flexpoint's proprietary inks are primarily printed on thin plastic films.

The BXS's resistance increases when it is bent. Therefore, when the BXS is adhered to the expanding surface of the battery the sensor's resistance increases when the surface of the battery expands creating a bent or dome surface. The more the battery expands the higher the BXS resistance increases.



Bend to Counts Conversion

The BXS value is reported as an 8-bit value called Counts. There is a linear relationship between the output of the BXS in Counts and 1/radius.



Electrical Specifications

Absolute Maximum Ratings

Parameter	Description	Min	Typical	Max	Units
VDD_{ABS}	Digital supply relative to VSS	-0.5	-	6	V
VIO_{ABS}	IO pin voltage	-0.5	-	VDD+0.5	V
IIO_{ABS}	IO pin sink/source current	-25	-	25	mA
ESD_HBM	Electrostatic discharge human body model	2200	-	-	V
ESD_CDM	Electrostatic discharge charged device model	500	-	-	V
ST	Storage Temperature	-60	-	110	ºC

DC Specifications

Parameter	Description	Min	Typical	Max	Units
OT	Operating Temperature	-40	-	85	ºC
VDD	Digital supply relative to VSS	1.8	-	5.5	V
IDD_{active}	Active supply current	-	-	1.0	mA
$IDD_{shutdown}$	Shutdown supply current (wakeup on I2C)	-	150	-	nA
VIH	Input voltage high threshold	0.7*VDD	-	-	V
VIL	Input voltage low threshold	-	-	0.3*VDD	V

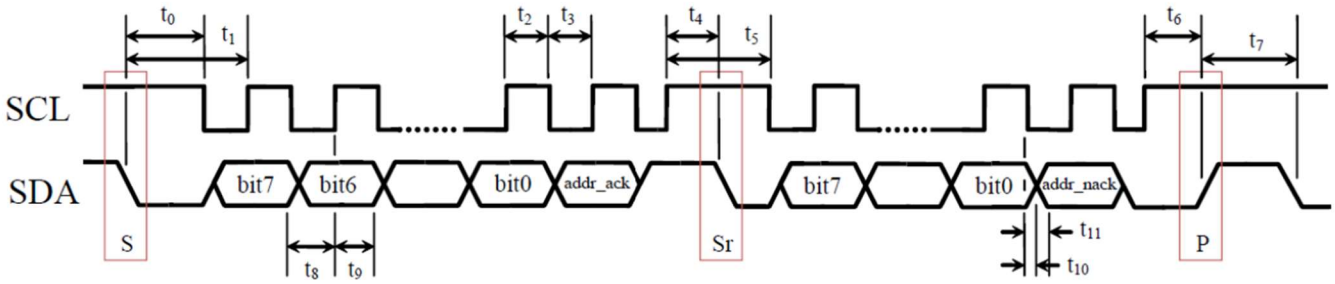
AC Specifications

Parameter	Description	Min	Typical	Max	Units
$t_{shutdown}$	Wake up from shutdown mode	-	-	TBD	µs
F_{I2C}	Maximum I2C bit rate	-	-	1	Mbps

Mechanical Specifications

Parameter	Description	Min	Typical	Max	Units
$S_{tension}$	Maximum tension before damage	-	-	TBD	N
S_{cycles}	Number of cycles	-	30	-	million
$TOL_{ambient}$	Tolerance fully bent over a 1” radius at ambient temperature (25 ºC) and humidity (25%)	TBD	-	TBD	%
$TOL_{humidity}$	Tolerance fully bent over a 1” radius across temperature and humidity	TBD	-	TBD	%

I2C Timing Diagram



S = Start
Sr = Repeated Start
P = Stop

Parameter	Description	Min	Typical	Max	Units
t_0	SDA low to SCL low transition (Start Event)	50	-	-	ns
t_1	SDA low to first SCL rising edge	100	-	-	ns
t_2	SCL pulse width: high	100	-	-	ns
t_3	SCL pulse width: low	100	-	-	ns
t_4	SCL high before SDA falling edge (Repeated Start)	50	-	-	ns
t_5	SCL pulse width: high during a Start/Repeated Start or Stop event	100	-	-	ns
t_6	SCL high before SDA rising edge (Stop)	50	-	-	ns
t_7	SDA pulse width: high	25	-	-	ns
t_8	SDA valid to SCL rising edge	50	-	-	ns
t_9	SCL rising edge to SDA invalid	50	-	-	ns
t_{10}	SCL falling edge to SDA valid	-	-	100	ns
t_{11}	SCL falling edge to SDA invalid	0	-	-	ns

Register Map

Address	Register Name	Description
0x00	WHOAMI	Device ID
0x01	CTRLREG	Control Register
0x02	BXSDATA	BXS Data

WHOAMI (0x00, reset value 0xB1)

This register contains the Device ID which is 0xB1.

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
1	0	1	1	0	0	0	1

CTRLREG (0x01, reset value 0x00)

This register contains bits that enable/disable features inside the BXS.

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	SHUTDOWN

SHUTDOWN – When this bit is set the device goes into shutdown power mode. It will only wake up with an I2C transfer. The bit is automatically cleared when the device wakes up.

BXSDATA (0x02)

This register contains the most recent BXS Data Sample.

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
DS[7]	DS[6]	DS[5]	DS[4]	DS[3]	DS[2]	DS[1]	DS[0]

I2C Interface

The BXS supports a standard I2C access protocol using a Register Address to point to the starting register for a write or read sequence. The first byte after the I2C address in a write is the Register Address. A read on the I2C bus starts at the Register Address set by the last write. Subsequent writes and reads auto-increment the Register Address.

Single Register Write

Start	Device Address + W (0x14)	Register Address	Write to Register [Register Address]	Stop

Multiple Register Write

Start	Device Address + W (0x14)	Register Address	Write to Register [Register Address]	Write to Register [Register Address+1]	…	Write to Register [Register Address+N]	Stop

Single Register Read

Start	Device Address + W (0x14)	Register Address	Repeated Start	Device Address + R (0x15)	Read from Register [Register Address]	Stop

Multiple Register Read

Start	Device Address + W (0x14)	Register Address	Repeated Start	Device Address + R (0x15)	Read from Register [Register Address]	Read from Register [Register Address+1]	…	Read from Register [Register Address+N]	Stop