NOVOSENSE

NSM2031-Q0

High-Accuracy, Hall-Effect-Based Linear Sensor IC with High-Bandwidth Analog Output

Datasheet (EN)1.0

Product Overview

The NOVOSNS NSM2031-Q0 IC incorporates a Hall element with CMOS integrated circuitry to provide a fully monolithic linear current sensor IC. The IC is sensitive to magnetic flux density orthogonal to the IC package surface and the output is an analog voltage proportional to the applied flux density.

The NSM2031-Q0 is designed to be used in conjunction with a ferromagnetic core to provide highly accurate current sensing.

Due to NSM2031-Q0 internal accurate temperature compensation algorithm and factory accuracy calibration, IC can maintain good accuracy in the full temperature working range, and the customer does not need to do secondary programming or calibration.

Support 5V power supply.

Key Features

- High bandwidth and fast response time
- 240kHz bandwidth
- 2.2μs response time
- High-precision current measurement
- Full temperature < ±2% sensitivity error drift
- Full temperature < ±10mV offset drift
- NOVOSENSE innovative "Spin Current" technology makes offset temperature drift very small
- Ratiometric output
- High-resolution offset and sensitivity trim
- Factory-programmed sensitivity by customer's requirements
- Working temperature: -40°C ~ 150°C
- AEC - Q100 Grade 0
- TO94, BS/BV bending package offering
- RoHS-compliant package

Applications

- DCDC converters
- High voltage traction motor inverter
- 48 V / 12 V auxiliary inverter
- Battery monitoring
- Overcurrent detection
- DC/DC converter
- Smart fuse
- Power distribution unit (PDU)

Device Information

Part Number	***Package***	***Body Size***
NSM2031-Q0	TO94	5.21mm*3.43mm
NSM2031-Q0	BS	5.21mm*3.43mm
NSM2031-Q0	BV	5.21mm*3.43mm

Functional Block Diagrams

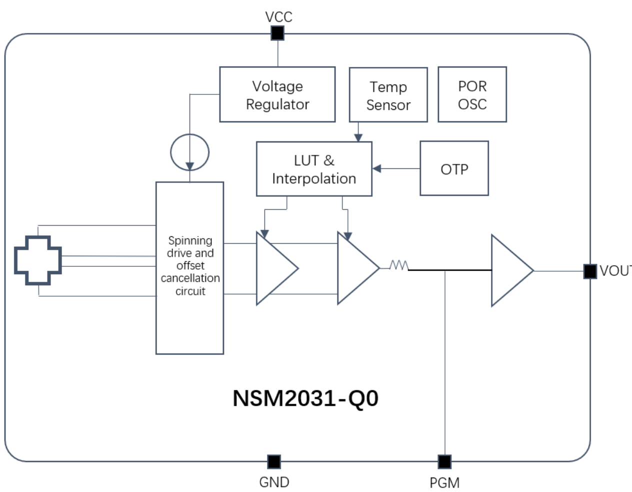

Figure 1. NSM2031-Q0 Block Diagram

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1. Pin Configuration and Functions

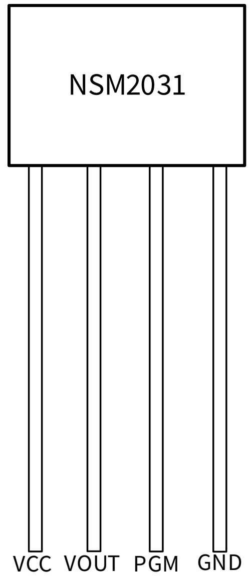


Figure 1.1 NSM2031-Q0 Pin Out

Table 1.1 NSM2031-Q0 Pin Configuration and Description

NSM2031-Q0PIN NO.	Symbol	Function
1	VCC	Supply voltage
2	VOUT	Sensor output
3[1]	PGM	Programming pin, this pin can be connected to GND for Ratiometirc Mode
4	GND	Ground

[1]: For Ratiometric version, pin3 is no connection (internal circuit no connection, this pin can connect to GND;

2. Absolute Maximum Ratings

Parameters	Symbol	Min	Typ	Max	Unit	Comments
Power Supply Voltage	V_{CC}	-0.3		6.5	V	25°C
Vout Voltage	V_{out}	-0.3		V_{cc}+0.3	V	25°C
Others Pin		-0.3		V_{cc}+0.3	V	25°C
Storage temperature	$T_{Storage}$	-40		150	°C	
Ambient temperature	$T_{operation}$	-40		150	°C	
Junction temperature	T_J	-40		150	°C	

3. ESD Ratings

Parameters	Symbol	Value	Unit
V(ESD) Electrostatic Discharge	Human-Body Model (HBM), per AEC-Q100-002/ESDA-JEDEC JS-001	±8000	V
	Charged-Device Model (CDM), per AEC-Q100-011/ESDA-JEDEC JS-002	±2000	V

4. Specifications

4.1. Common Characteristics (TA= -40°C to 150°C, VCC = 5V, unless otherwise specified)

Parameters	Symbol	Min	Typ	Max	Unit	Comments
Supply voltage	V_{CC}	4.5	5	5.5	V	
Supply current	I_{CC}		10	15	mA	No load, V_{CC} =5V
Power-on time	T_{po}		1		ms	before 1ms internal OTP is loading, T_A = 25°C
Output capacitance load [1][2]	C_L			10	nF	
Output resistance load [1][2]	R_L	10			kΩ	
Output short current	I_{short}		±25		mA	Short to V_{CC} and short to GND, T_A = 25°C
Rail to Rail output voltage [1][2]	Vs	0.1		VCC-0.1	V	T_A = 25°C, C_L =1nF, R_L=10kΩ to V_{CC} or GND
Linear range [1]	V_{Olin}	0.5		4.5	V	V_{CC} =5V
Rise time [1][2]	T_r		1.2	2	µs	T_A = 25°C, C_L =1nF, V_{CC}=5V, Sensitivity=10mV/G
Propagation delay [1][2]	T_{pd}		0.8	2	µs	T_A = 25°C, C_L =1nF, V_{CC}=5V, Sensitivity=10mV/G
Response time [1][2]	$T_{response}$		2.2	3	µs	T_A = 25°C, C_L =1nF, V_{CC}=5V, Sensitivity=10mV/G
Bandwidth [1]	BW		240		kHz	-3dB bandwidth
Noise [1][2]	ND		1.1		mVrms	T_A = 25°C, C_L =1nF, V_{CC}= 5V, Sensitivity=1mV/G
Non-linearity [1][2]	E_{NL}	-0.5		0.5	%	
Ratiometric output sensitivity error [1][2]	S_{ERR}		±0.5		%	Ratiometric version, V_{CC}= 4.85V~5.15V, T_A = 25°C

Ratiometric output offset error [1][2]	V_{OUTOR}		±0.1		%	Ratiometric version, V_{CC}= 4.85V~5.15V, T_A = 25°C
Zero current output voltage	QVO		$V_{CC}/2$			Ratiometric version, V_{CC} =5V
Sensitivity range	SEN	0.5		15	mV/G	
Factory sensitivity error [3]	E_{sens}		±1		%	T_A = 25°C Sensitivity=1mV/G
Sensitivity drift over temperature [3]	Δsens	-1.5		1.5	%	T_A = 25°C~150°C Sensitivity=1mV/G
		-2		2	%	T_A = -40°C~25°C Sensitivity=1mV/G
Factory offset error [3]	V_{OE}	-10		10	mV	T_A = 25°C
Offset drift over temperature [3]	Δoffset	-10		10	mV	T_A = 25°C~150°C
		-10		10	mV	T_A = -40°C~25°C
Sensitivity lifetime drift [4][5]			±1.1		%	T_A = 25°C, Sensitivity=1mV/G
Offset lifetime drift [4][5]			2		mV	T_A = 25°C, Sensitivity=1mV/G

[1]: Guaranteed by design
[2]: Guaranteed by Bench Validation
[3]: Min/Max value is the limit of Final test in production.
[4]: The reliability data is implemented in accordance with the AEC-Q100 standard. This item is derived from the experimental results with the largest change after the PC, HTS, HAST, UHAST, HTOL, TC and other test data required by AEC-Q100 Grade0 as a reference. , Is the worst case.
[5]: Lifetime drift parameter is average value from reliability testing.

5. Typical Performance Characteristics

Power-on time is 1ms (max) from V_{ccmin} to stable V_{out}, red rectangle means OTP is loading, V_{out} is in 'Not-sure' status, we recommend customer to read V_{out} after 1ms when IC is powered up.

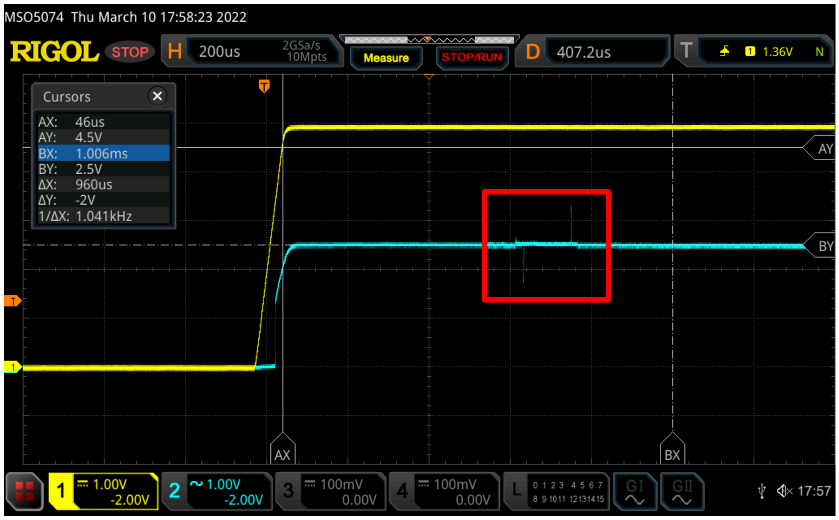


Figure 5.1 NSM2031-Q0 Power-on time

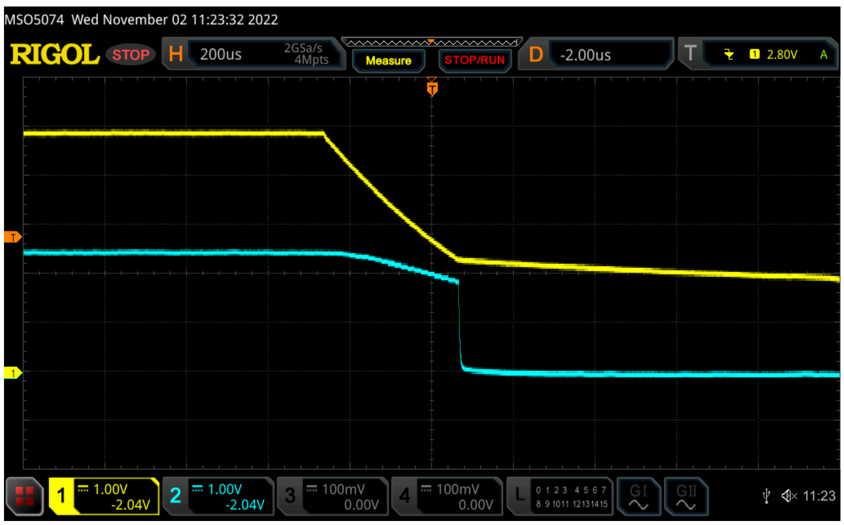


Figure 5.2 NSM2031-Q0 Power-down

Typical response time is 2.2μs, the yellow line is waveform of power stage to generate magnetic field, the blue line is V_{out}. (DUT sensitivity = 10mV/G)

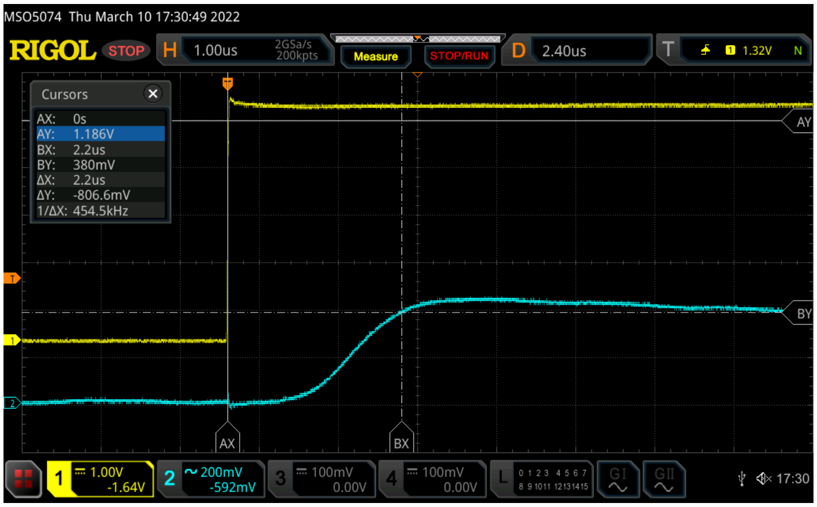


Figure 5.3 NSM2031-Q0 response time

Typical rising time is 1.2μs, the yellow line is waveform of power stage to generate magnetic field, the blue line is V_{out}. (DUT sensitivity = 10mV/G)

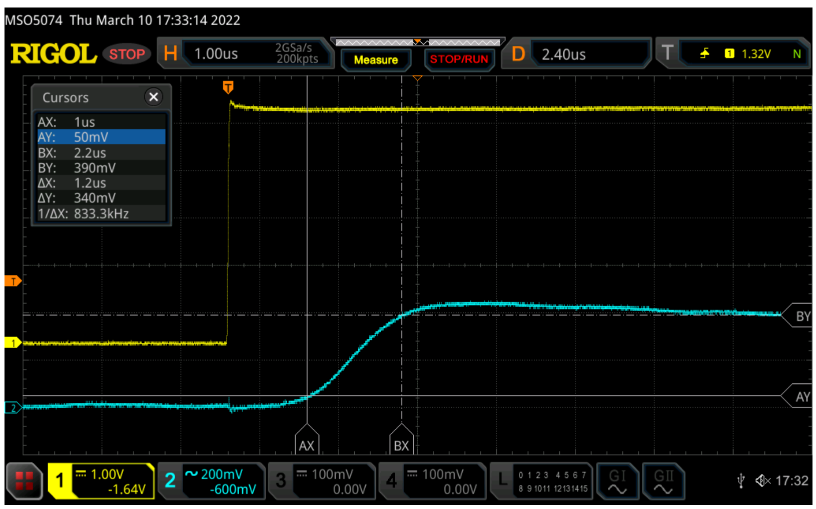


Figure 5.4 NSM2031-Q0 rising time

Typical propagation delay time is 800ns, the yellow line is waveform of power stage to generate magnetic field, the blue line is V_{out}. (DUT sensitivity = 10mV/G)

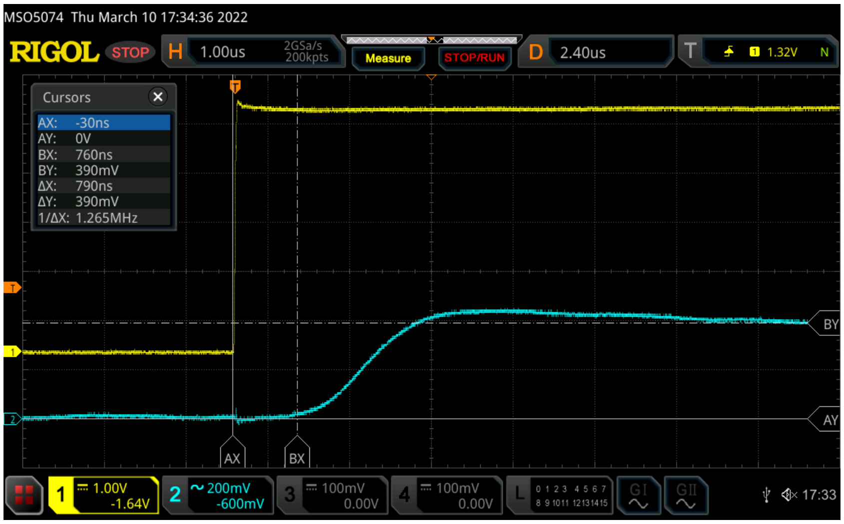


Figure 5.5 NSM2031-Q0 propagation delay time

6. Function Description

6.1. Power-on time (Tpo)

When the power supply climbs from 0 to the chip's working range, NSM2031-Q0 needs some time to establish the internal working logic. Tpo time is defined as: the time from the power supply climbing to V_{ccmin} to the output reaching the steady state within ±10%, As shown below:

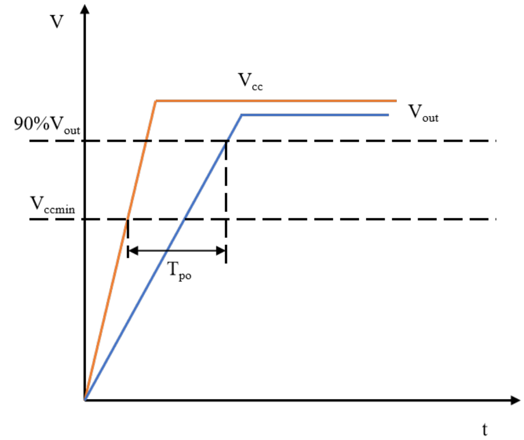


Figure 6.1 NSM2031-Q0 Power-on time

6.2. Rise time (Tr)

The time from 10% to 90% of the output signal is defined as the output rise time. For step input signals, there is such an approximate relationship between the rise time and bandwidth of the output signal: f(-3dB) = 0.35/Tr.

6.3. Propagation delay (Tpd)

The time from 20% of the primary current to 20% of the output signal is defined as the output propagation delay time.

6.4. Response time (Tresponse)

The time from 90% of the primary current to 90% of the output signal is defined as the output response time.

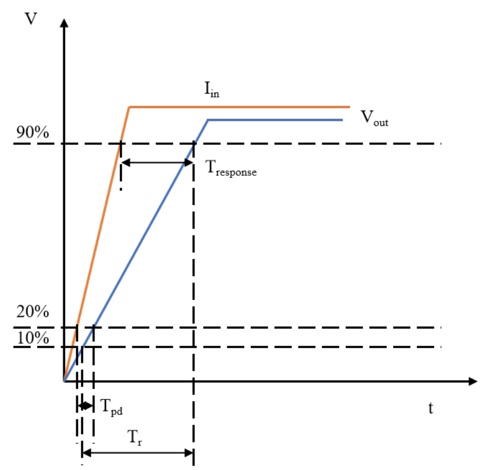


Figure 6.2 NSM2031-Q0 response time

6.5. Sensitivity and sensitivity error

Sensitivity is defined as the ratio of the output voltage proportional to the input magnetic field. Sensitivity is the slope of the curve in the figure below.

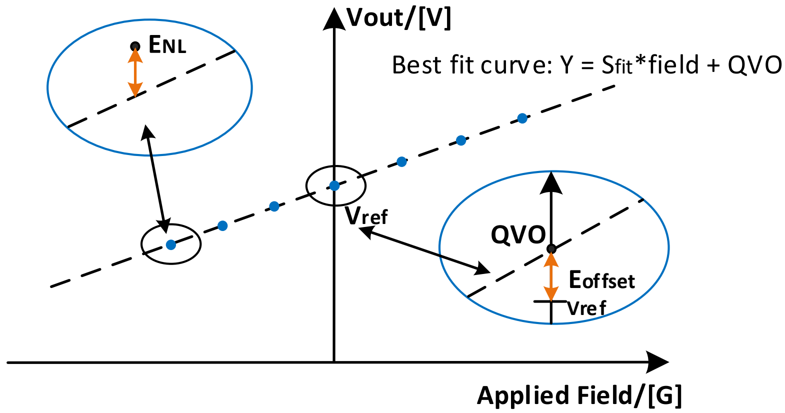


Figure 6.3 NSM2031-Q0 Sensitivity and error

The sensitivity error is defined as the deviation between the slope of the best-fit curve and the slope of the ideal curve. The slope of the best-fit curve comes from the measured value:

$$E_{sens} = \frac{(S_{fit} - S_{ideal})}{S_{ideal}} * 100\%$$

6.6. Offset error

The zero magnetic field output error is defined as the difference between the output voltage and the reference voltage when the magnetic field is 0, reference voltage here is V_{CC} /2 (Ratiometric version):

$$E_{offset} = QVO - V_{ref}$$

6.7. Non-linear error

The linearity error is defined as the error from the maximum deviation point of the best-fit curve to the full scale. The mathematical expression is as follows:

$$V_{NL} = V_{outmax} - (S_{fit} * Field_{max} + QVO)$$

among them:

V_{outmax} is the output voltage furthest from the fitted curve;

$Field_{max}$ is the input magnetic field farthest from the fitted curve;

Therefore, the nonlinear error can be mathematically expressed as the following formula:

$$E_{NL} = \frac{V_{NL}}{FS} * 100\%$$

6.8. Ratiometric output sensitivity error

The ratiometric output sensitivity error is defined as the error of the sensitivity change with the change of V_{cc}. In a perfectly ideal situation, when V_{cc} changes by 10%, the sensitivity should also change by 10%. The error is expressed by the following formula:

$$S_{ERR} = 100\% \times \{\left(\frac{S(V_{CC})}{S(5V)}\right) - \left(\frac{V_{CC}}{5}\right)\}$$

6.9. Ratiometric output offset error

The offset error of the ratiometric output is defined as the error condition of the zero-point change with the change of V_{cc}. In a perfectly ideal situation, the output zero point is V_{cc}/2, V_{cc} changes 10%, and the zero point should also change 10%. The error is expressed by the following formula:

$$V_{out0R} = 100\% \times \{\left(\frac{V_{out0}(V_{cc})}{V_{out0}(5V)}\right) - \left(\frac{V_{cc}}{5}\right)\}$$

6.10. Magnetic field direction

south polarity magnetic field, increasing the output voltage from its quiescent value toward the supply voltage rail.

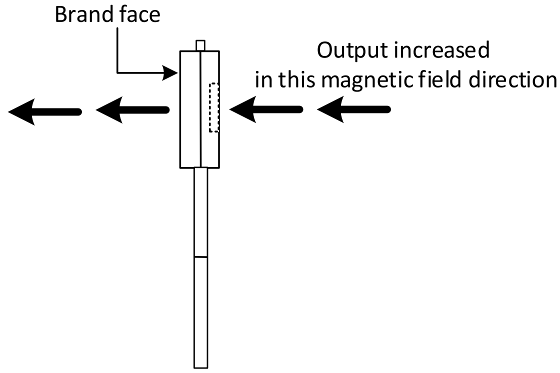


Figure 6.4 magnetic field direction

7. Application Note

7.1. Typical Application Circuit

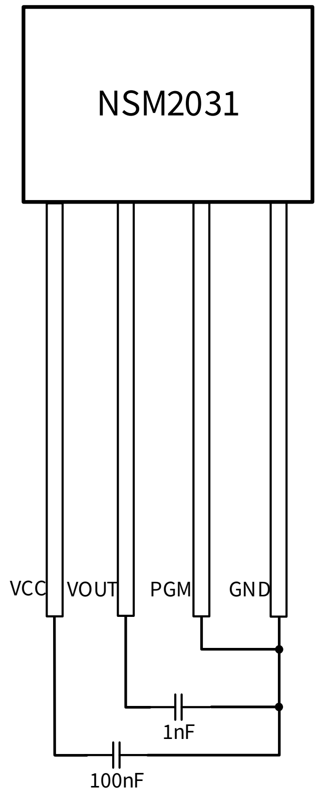


Figure 7.1 Typical application circuit of NSM2031-Q0

8. Package Information

BS package

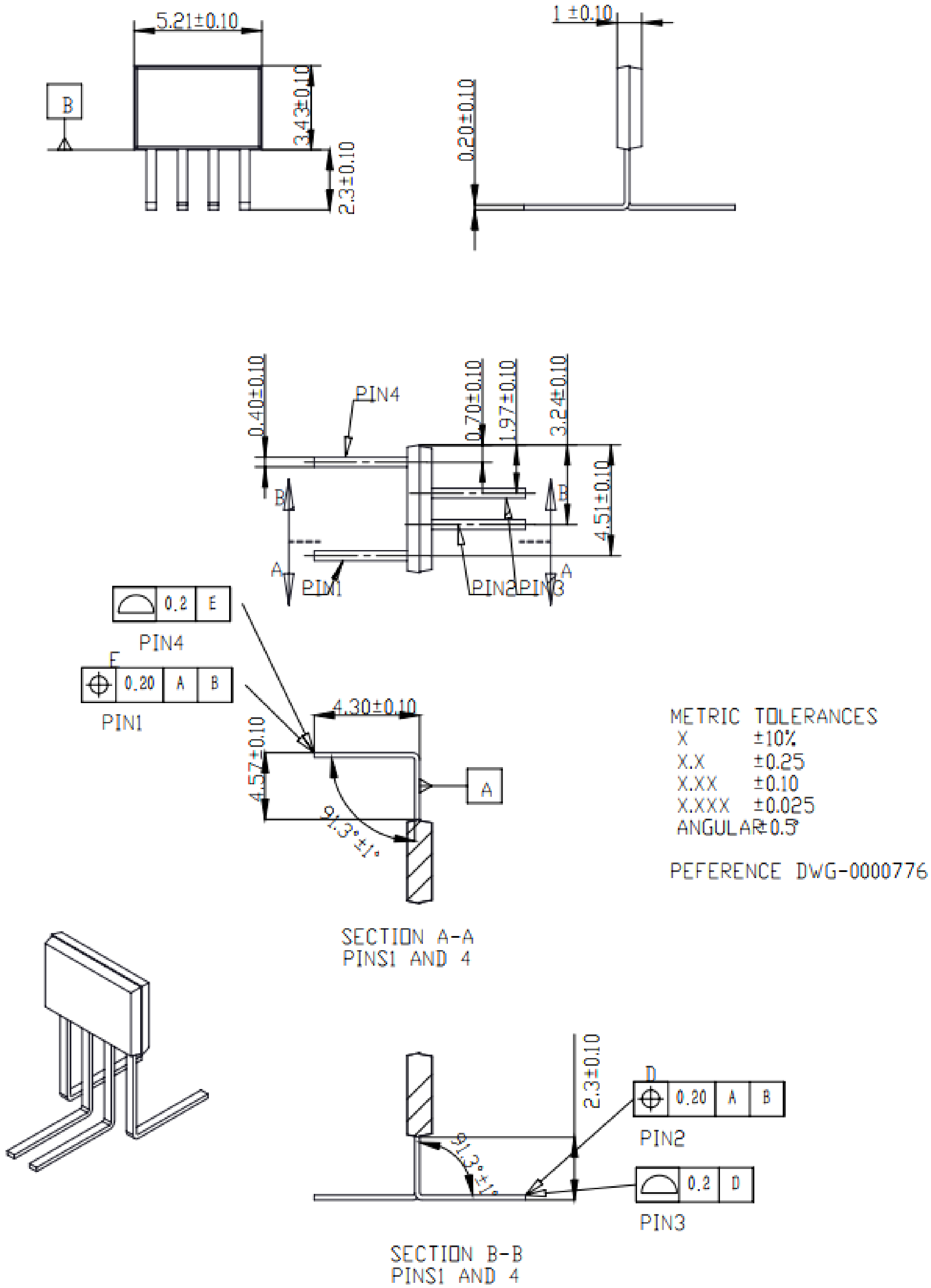


Figure 8.1 BS package shape and dimension in millimeters

BV package

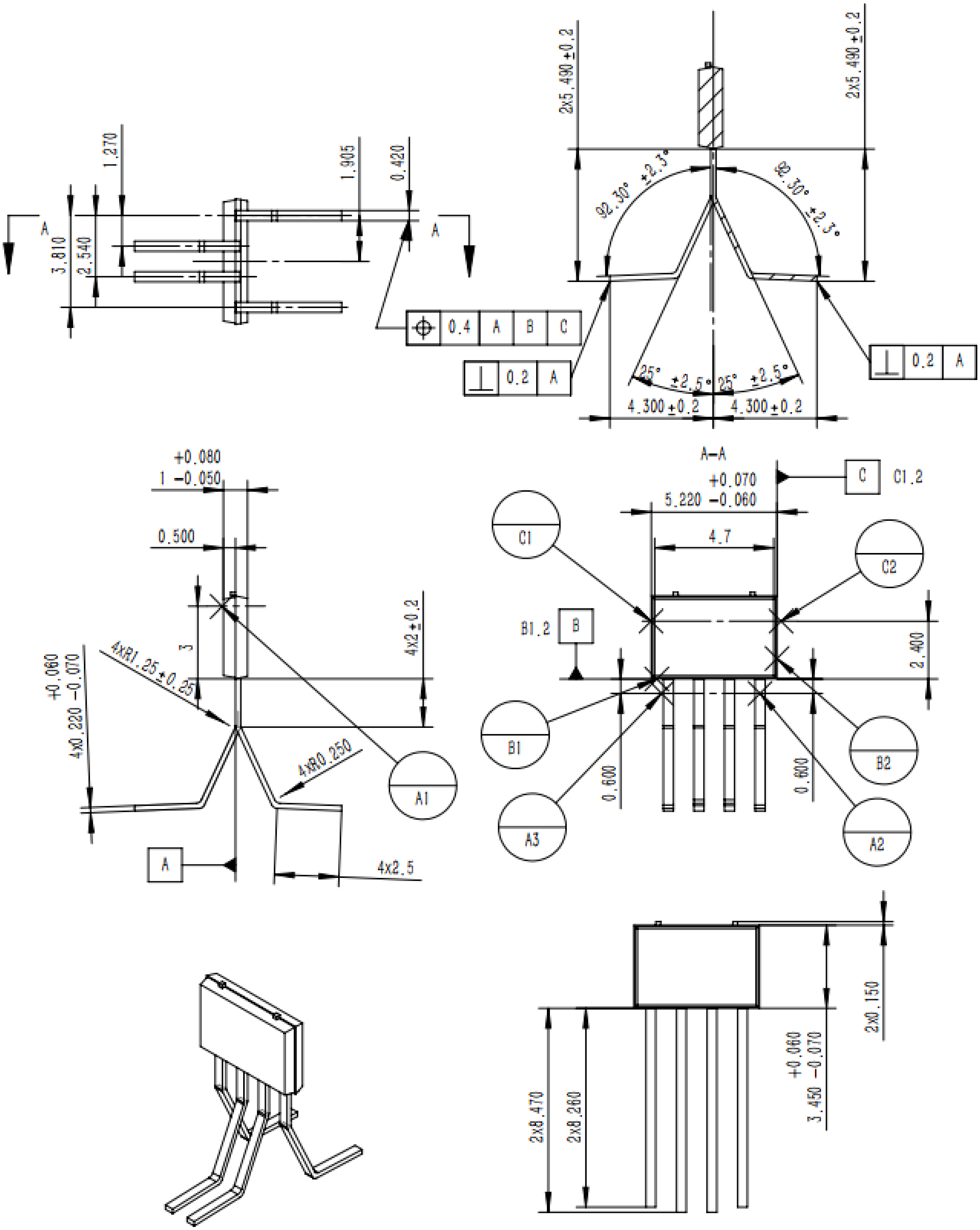
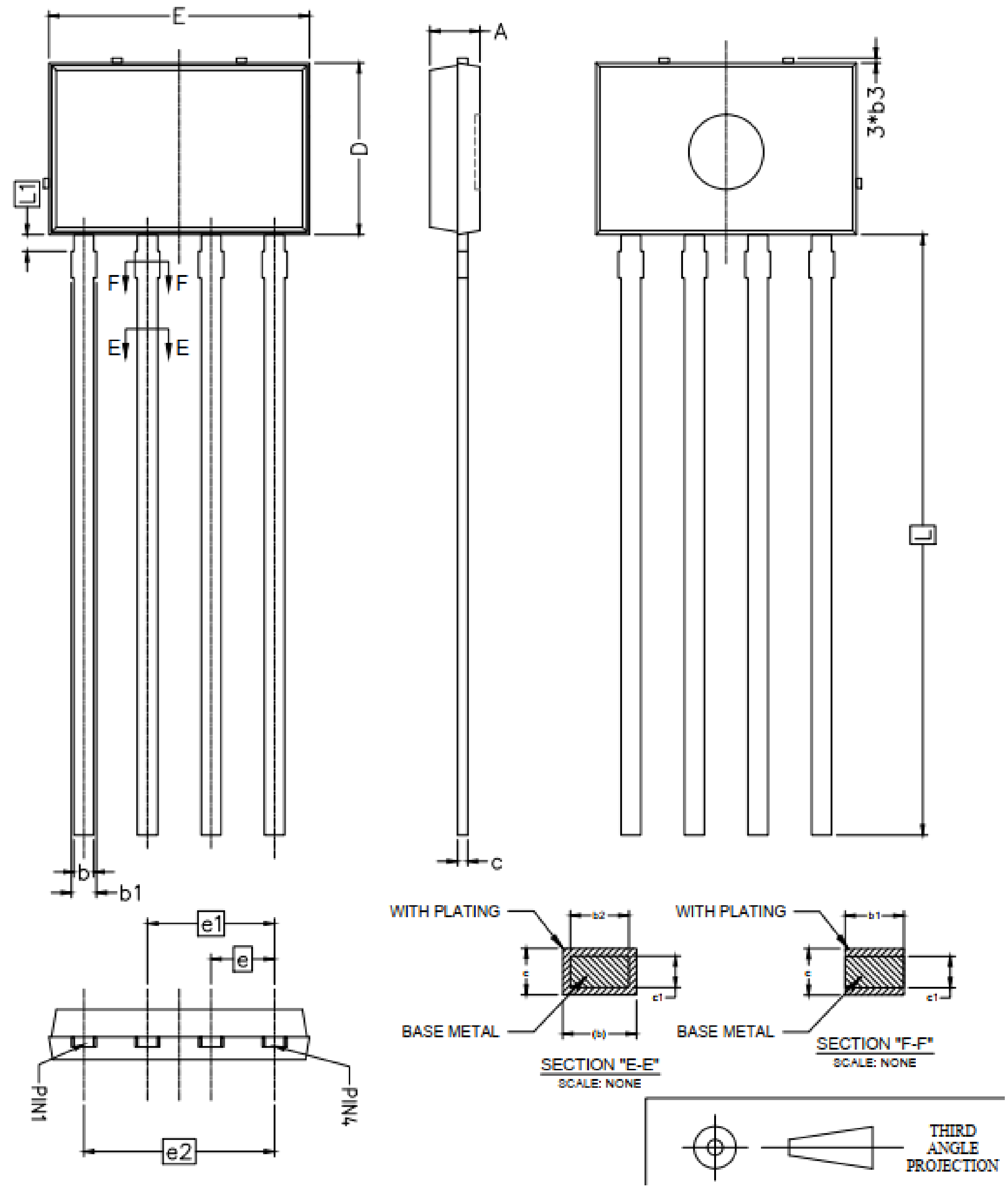


Figure 8.3 BV package shape and dimension in millimeters

TO94 package



METRIC TOLERANCES
X ±10%
X.X ±0.25
X.XX ±0.10
X.XXX ±0.025
ANGULAR ±0.5°

ALL SURFACES TO BE 32 μin （0.80 μm）OR BETTER
BREAK ALL SHARP EDGES 0.015″*0.015″（0.4mm x 0.4mm）
HOLD ALL DIMS AFTER PLATING

SYMBLE	MIN	MAX
A	0.90	1.10
b	0.30	0.50
b1	0.30	0.60
b2	0.30	0.45
b3	-	0.10
c	0.10	0.30
c1	0.10	0.25
D	3.33	3.53
E	5.11	5.31
e	1.27 BSC	
e1	2.54 BSC	
e2	3.81 BSC	
L	11.90	12.10
L1	0.25	0.45

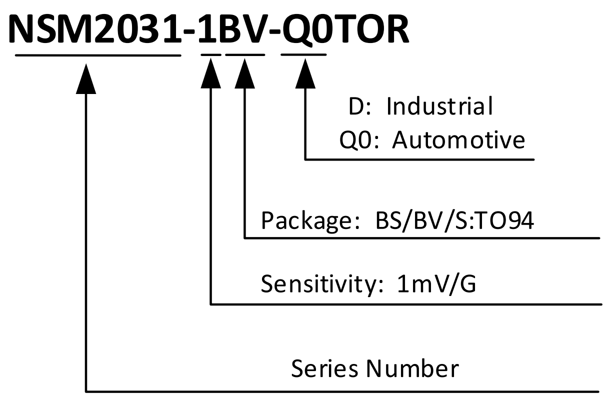
Figure 8.4 TO94 package shape and dimension in millimeters

9. Ordering Information

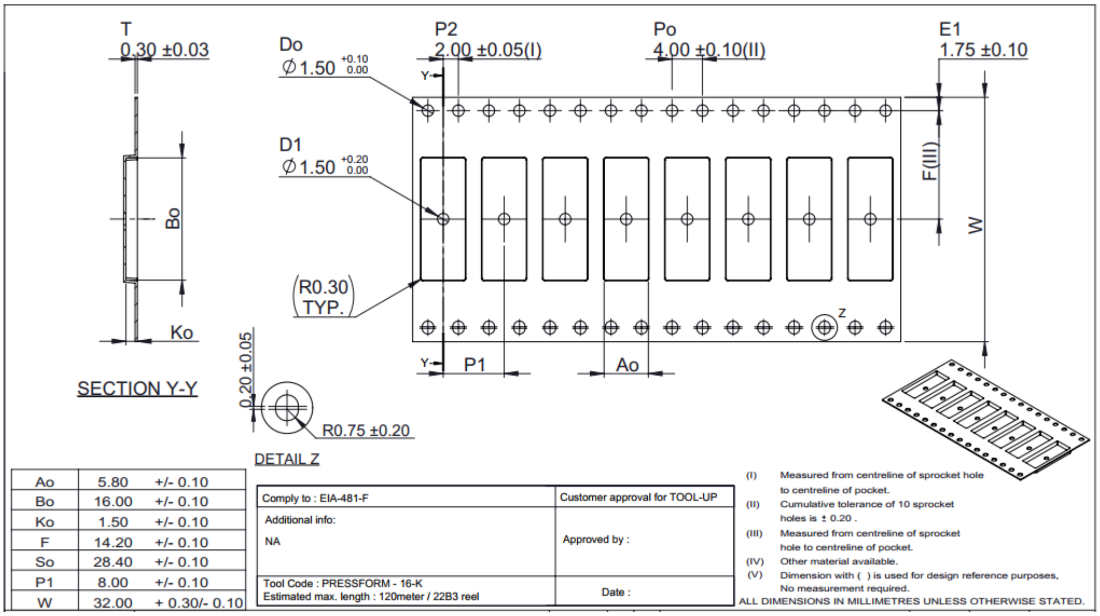
Part number	Power Supply(V)	Sensitivity(mV/G)	Package	SPQ	MSL
NSM2031-1BV-Q0TOR	5	1	BV	550	1

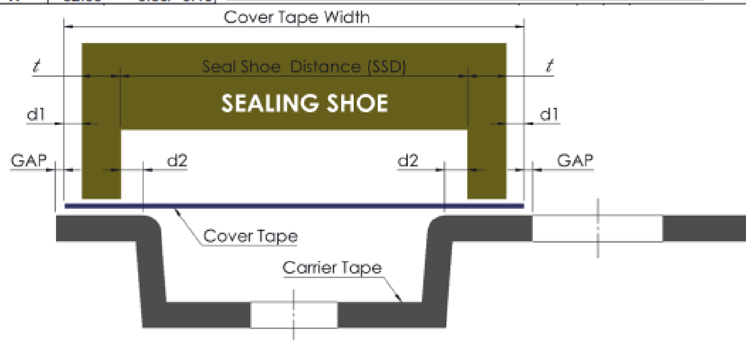
SPQ: TO94: 4500； BS:800； BV:550；

Part Number Rule:



10. Tape and Reel Information



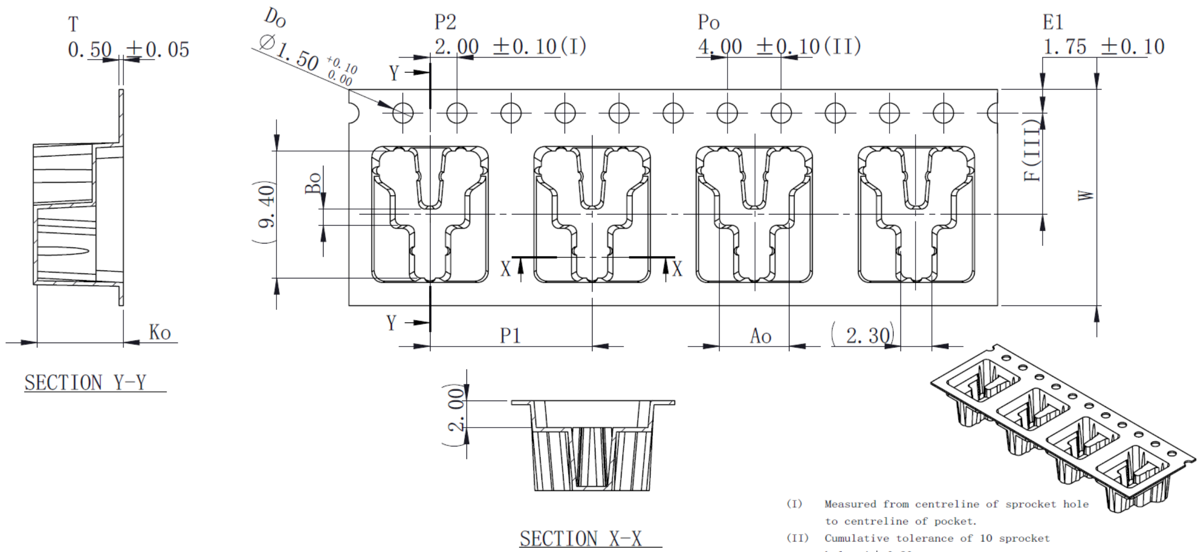


Carrier Tape Width	Common Cover Tape Width	Normal Package					Thin Seal Package				
		t	d1	d2 (MIN)	GAP	SSD	t	d1	d2 (MIN)	GAP	SSD
8.00	5.30	0.40	0.50	0.50	0.10	3.50	0.40	0.20	0.20	0.10	4.10
12.00	9.20	0.45	0.50	0.50	0.10	7.30	0.45	0.20	0.20	0.10	7.90
16.00	13.30	0.45	0.50	0.50	0.10	11.40	0.45	0.20	0.20	0.10	12.00
24.00	21.30	0.45	0.50	0.50	0.10	19.40	0.45	0.20	0.20	0.10	20.00

t = Sealing Shoe Thickness
d1 = Distance between cover tape edge and sealing shoe (outer)
d2 = Distance between sealing shoe (inner) and pocket opening edge (at carrier tape sealing plane)
GAP = Distance between cover tape and carrier tape edges (for reference)
SSD = Sealing Shoe Distance (inner)

1. Sealing area is required at 1.50mm (MIN) per side for normal package. Package with sealing area fall in between 1.00 and 1.50mm (per side) will be classified as Thin Seal Package.
2. Peel Back Force spec will be 20 - 80 grams
3. Thin Seal Package will encounter high RISK of sealing issue such as cover tape tearing, wavy seal line, open seal & etc.
4. Sealing Shoe Size may differ from above recommendation upon the sealing test is conducted during FA evaluation.
5. User must share the evaluation report with sealing parameter, sealing shoe dimension and type of cover tape to C-Pak for documentation purposes (especially Thin Seal Package).
6. Recomandation for sealing shoe thickness (t) will be 0.45mm (18mils) as a standard. Other thickness is subjected to application condition.
7. Package with sealing area (per side) can't meet item (1) will not be recommended by C-PAK.

Figure 10.1 Tape and reel information of TO94



Ao	5. 15	+/− 0. 10
Bo	1. 20	+/− 0. 10
Ko	6. 35	+/− 0. 10
F	7. 50	+/− 0. 10
P1	12. 00	+/− 0. 10
W	16. 00	+0. 30/−0. 10

Comply to : EIA-481-F	Customer approval for TOOL-UP
Additional info: NA	Approved by :
Tool Code : FLATBED − 08 Estimated max. length : 30meter / 22B3 reel	Date :

(I) Measured from centreline of sprocket hole to centreline of pocket.

(II) Cumulative tolerance of 10 sprocket holes is ± 0. 20 .

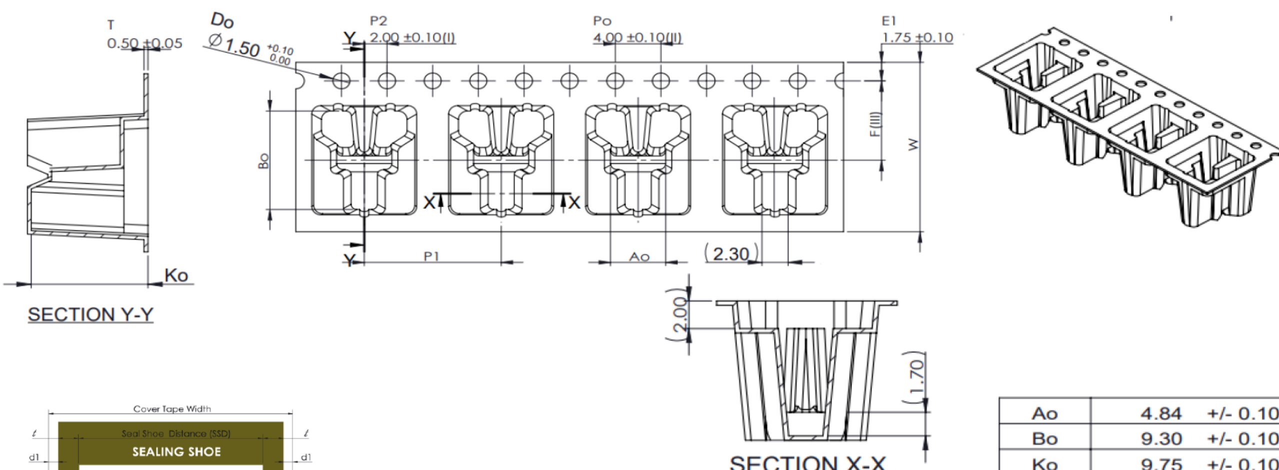
(III) Measured from centreline of sprocket hole to centreline of pocket.

(IV) Other material available.

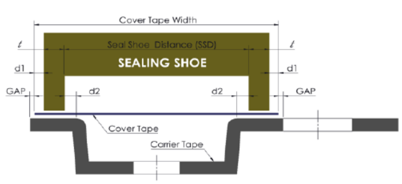
(V) Dimension with () is use for design reference purpose only, NO measurement required.

ALL DIMENSIONS IN MILLIMETRES UNLESS OTHERWISE STATED.

Figure 10.2 Tape and reel information of BS



Ao	4.84	+/- 0.10
Bo	9.30	+/- 0.10
Ko	9.75	+/- 0.10
F	7.50	+/- 0.10
P1	12.00	+/- 0.10
W	16.00	+0.20/-0.10



Carrier Tape Width	Common Cover Tape Width	Normal Package					Thin Seal Package				
		t	d1	d2 (MIN)	GAP	SSD	t	d1	d2 (MIN)	GAP	SSD
8.00	5.30	0.40	0.50	0.50	0.10	3.50	0.40	0.20	0.20	0.10	4.10
12.00	9.20	0.45	0.50	0.50	0.10	7.30	0.45	0.20	0.20	0.10	7.90
16.00	13.30	0.45	0.50	0.50	0.10	11.40	0.45	0.20	0.20	0.10	12.00
24.00	21.30	0.45	0.50	0.50	0.10	19.40	0.45	0.20	0.20	0.10	20.00

t = Sealing Shoe Thickness
d1 = Distance between cover tape edge and sealing shoe (outer)
d2 = Distance between sealing shoe (inner) and pocket opening edge (at carrier tape sealing plane)
GAP = Distance between cover tape and carrier tape edges (for reference)
SSD = Sealing Shoe Distance (inner)

(I) Measured from centreline of sprocket hole to centreline of pocket.

(II) Cumulative tolerance of 10 sprocket holes is ± 0.20 .

(III) Measured from centreline of sprocket hole to centreline of pocket.

(IV) Other material available.

(V) Dimension with ( ) is use for design reference purpose only, NO measurement required.

Figure 10.3 Tape and reel information of BV

11. Revision History

Revision	Description	Date
1.0	Released Version.	2025/6/12

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