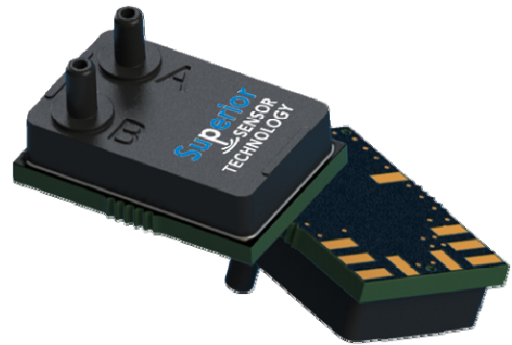


HS Series

Pressure Transmitter Subsystem

HVAC Applications

- Supports Full Featured Pressure Transmitter
- Up to 12 Field DIP Switch Functions Supported
- Up to 2 Push Button Functions Supported
- Factory Programmable Pressure Ranges
- Up to 32 Field Selectable Pressure Ranges
- Up to 4 Field Selectable Bandwidths
- Integrated 50/60Hz Notch Filter
- Very High Accuracy +/- 0.1% of Selected Range
- Supports Bidirectional/Unidirectional/Asymmetric Outputs
- Supports 0-5/0-10/1-5/2-10 Volt Outputs
- Highly integrated sensor with ADC, DAC and DSP
- Long Term Stability +/- 0.1% FSS
- Temperature Compensated 0°C to 50°C



Product Summary

Superior Sensor Technology's HS Series Family offers the industry's highest performing and most flexible Differential Low Pressure Sensors for HVAC (Heating, Ventilation, and Air Conditioning) pressure transmitters. Targeting pressure ranges from as low as 0.1" inH₂O (Water Column) to 60" inH₂O with a complement of field selectable features that can easily be customized at the factory without additional programming or hardware changes.

The HS Series family employs Superior's proprietary NimbleSense™ architecture to create the industry's first generation of "Transmitter Subsystems." This system provides a platform to create a highly flexible and feature rich pressure transmitter while maintain an overall low BOM and inventory cost.

In addition, the same platform can be used to create a full featured pressure transmitter or a

simple/dedicated pressure transmitter while retaining the capability to fully customize the product at the factory.

The incorporation of advanced digital signal processing enables the complete pressure transmitter subsystem to be incorporated into the sensor itself by inclusion of the ADC, DAC, advanced compensation and self calibration features while providing a versatile and flexible pressure transmitter solution.

Constructed with a high reliability plastic enclosure, the HS Series family provides the ideal combination of very high performance, flexibility, ease of development and reliability while ensuring customers have a high volume, cost effective solution optimized for their HVAC pressure transmitter.

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1 Maximum Ratings

Parameter	Sym	Min	Max	Units
Supply Voltage	V _{DDM}	Gnd-0.3	4.0	V
Voltage on I/O Pins	V _{DD} > 3.3V	Gnd-0.3	5.8	V
	V _{DD} ≤ 3.3V	Gnd-0.3	V _{DD} +2.5	V
I/O Current	I _{IOM}	-25	25	mA

2 Suggested Operating Conditions

Parameter	Sym	Min	Max	Units
Supply Voltage	V _{DDOP}	2.8	3.5	V
Temperature	T _A	0	50	°C

3 Environmental

Parameter	Sym	Min	Max	Units
Temperature Range	Compensated	0	50	°C
	Operating	-20	85	°C
	Storage	-40	85	°C
Humidity (Non-condensing)	RH _{OP}	0	95	% RH
Vibration (10Hz-2kHz)	G _{VIBE}	-	15	g
Shock (6 ms)	G _{SHOCK}	-	100	g
Life	CY _{LIFE}	10M	-	Pressure Cycles

4 Equivalent Circuit

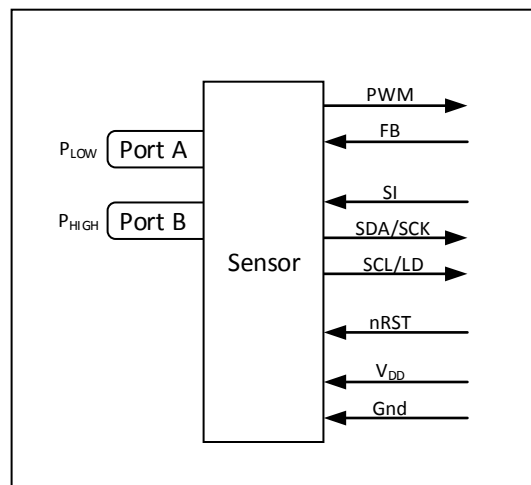


FIG-0088B

HS Series

Pressure Transmitter Subsystem

5 Feature List

The HS series is a complete transmitter subsystem with a host of features. It is designed for easy implementation of a complete, flexible and full featured pressure transmitter. It works with the following elements:

- External EEPROM - The external EEPROM holds the hardware configuration information. That is, how many DIP switches and their function, the number of push buttons and their function along with other miscellaneous functions. The EEPROM also holds the specific values associated with the DIP switch functions and other related settings.
- DIP Switches and Push Buttons - External DIP switches and push buttons (for field settable features) are read by the sensor and their functions coordinated by way of the EEPROM.
- External Amplifier - An external amplifier takes the sensor output (Delta-Sigma modulated PWM) and converts it to the analog output voltage from 0 to 10 volts or any other range of voltages within 0-10V. In addition, the sensor self calibrates the external hardware by use of a proprietary control system so no factory hardware calibration is required. An additional amplifier circuit can be added to create a current loop output (both 2-wire and 3-wire can be supported).

5.1 Programmable Pressure Ranges

The pressure range(s) of the HS Series are programmable within their respective model limits. Up to 5 DIP switches (32 unique settings) can be assigned to field selectable pressure ranges. They can include multiple units for the pressure ranges. For example, 4 total DIP switches could be used to allow 8 pressure range settings in units of inH₂O with an additional 8 pressure range settings in units of Pa totaling 16 unique field selectable pressure ranges.

If no DIP switches are assigned for field selectable pressure ranges, a single pressure range can be factory programmed into the associated EEPROM making the unit a dedicated (or custom) pressure range transmitter.

In addition, the values of the pressure ranges are continuously variable provided they are within the allowable limit (see table below for model range limits).

Parameter	Sym	HS160	HS120	HS110	HS210	Units	Notes
Programmable FS Range Limits	P _{LIM}	2.5 to 60	2.5 to 20	0.5 to 10	0.1 to 10	inH ₂ O	1

5.2 Programmable Pressure Modes

Up to 2 DIP switches (4 settings) can be assigned to allow field selectable pressure modes of operation. This allows field selectable differential (-100%FS to 100%FS), gage (0 to 100%FS), asymmetric (i.e. -10%FS to 100%FS) or any other custom range within ±100% of the selected full scale range (the selected full scale range as in the above section).

If no DIP switches are allocated for the pressure mode, then one of the desired modes can be factory programmed into the EEPROM.

5.3 Programmable Voltage Output Modes

Up to 2 DIP switches (4 settings) can be assigned to allow field selectable output modes of operation. This allows up to 4 field selectable voltage output modes of 0-5V, 1-5V, 0-10V or 2-10V. The output voltage mode is not restricted to the standard output voltage modes. They can be programmed to any voltage range within 0 to 10V.

If no DIP switches are allocated for the voltage output mode, then one of the desired modes can be factory programmed into the EEPROM as the default.

Note: If a current loop driver is included in the transmitter hardware, a typical hardware design would have the voltage output mode set to 1-5V in order to obtain 4-20mA of loop current.

5.4 Programmable Bandwidths (response times)

Up to 2 DIP switches (4 settings) can be assigned to allow field selectable bandwidths. This allows field selectable bandwidths of any value between 0.1Hz to 10Hz.

If no DIP switches are allocated for the bandwidth, then one bandwidth can be factory programmed into the EEPROM as the default.

5.5 Field Selectable Notch Filter

One DIP switch can be assigned to allow field control (enable/disable) the internal notch filter.

HS Series

Pressure Transmitter Subsystem

If no DIP switches are allocated for the notch filter, then the factory default setting (enabled or disabled) can be set in the EEPROM.

5.6 Field Zero Button

One push button can be assigned as a field zero button. If the button is pressed momentarily, the sensor will zero the output. If the button is held for 10 seconds, the field zero value will be reset.

If there no push button assigned to the hardware, then this feature is disabled.

5.7 Field Full Scale Button

One push button can be assigned as a field full scale button. If the button is pressed momentarily, the sensor will capture the currently applied pressure and re-compute the internal gain to make this, the applied pressure, the new full scale of the transmitter. If the button is held for 10 seconds, the field full scale value will be reset.

If there no push button assigned to the hardware, then this feature is disabled.

5.8 Factory Offset

A factory offset parameter is provided in the EEPROM space where a final offset adjustment can be made after transmitter assembly (if desired) and prior to packaging/shipping a unit. This value can only be adjusted at the factory. It is independent of the field settable offset and it is not affected by the resetting of the field offset value.

5.9 Factory Gain

A factory gain parameter is provided in the EEPROM space where a final gain adjustment can be made after transmitter assembly (if desired) and prior to packaging/shipping a unit. This value can only be adjusted at the factory. It is independent of the field settable full scale and it is not affected by the resetting of the field full scale value.

5.10 Device Information Fields

After power on, the sensor will write the following information to the EEPROM: Model, Build Number and Serial Number. This information can be viewed at the factory with a simple EEPROM viewing application.

6 Performance Characteristics, Sensor

Note: Unless otherwise specified, characteristics specified with $V_{DD} = 3.3V$, $T_A = 25C$

Parameter	Sym	HS160			HS110/HS120			HS210			Units	Notes
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max		
Accuracy	P_{ACC}	-	0.05	0.1	-	0.05	0.1	-	0.05	0.1	% RNG	1, 2
Total Error Band	TEB	-	0.1	0.3	-	0.1	0.3	-	0.05	0.15	% FSS	3
Long Term Stability	LTS	-	0.1	0.25	-	0.1	0.25	-	0.05	0.1	% FSS/YR1	5
Thermal Hysteresis	T_{HYS}	-	0.05	-	-	0.05	-	-	0.025	-	% FSS	
Pressure Hysteresis	P_{HYS}	-	0.05	-	-	0.05	-	-	0.05	-	% RNG	1
Position Sensitivity	P_{PS}	-	2.0	-	-	2.0	-	-	0.25	-	Pa	
Supply Rejection	P_{SR}	-	0.0005	-	-	0.0005	-	-	0.0005	-	Pa/mV	
Data Update Rate	f_{UPDATE}	90.5	93	95.5	90.5	93	95.5	90.5	93	95.5	Hz	4

1) Percentage of selected range.

2) Uncertainty limited by system noise for ranges of 0.5 inH₂O and below.

3) Includes errors of offset, span and thermal effects.

4) The internal update rate is fixed and does not change with range or filter settings.

5) YR1 is the first year. The most significant drift occurs during the first year and is lessened for each subsequent year. For each subsequent year, use 25% of the prior years' drift figure to estimate the drift for that specific year

7 Performance Characteristics, Output Modulator

Note: Unless otherwise specified, characteristics specified with sensor $V_{DD} = 3.3V$, $T_A = 25C$

Parameter	Sym	Condition	HS110 / HS120 / HS160/ HS210			Units	Notes
			Min	Typ	Max		
Modulator Error Band	MEB	0-10V Output Mode	-	2.5	10	mV	
Modulator Temperature Error	M _{TC}	0-10V Output Mode	-	550	-	uV/°C	

8 Pressure Ratings

Parameter	Sym	HS160	HS120	HS110	HS210	Units	Notes
Common Mode Pressure	P _{CM}	700	500	500	500	inH ₂ O	1
Proof Pressure	P _{PROOF}	400	40	40	40	inH ₂ O	2
Burst Pressure	P _{BURST}	480	120	120	120	inH ₂ O	3

9 Electrical Characteristics

9.1 Supply Characteristics

Parameter	Sym	HS110/HS120/HS160			HS210			Units	Notes
		Min	Typ	Max	Min	Typ	Max		
Supply Current	I _{DD}	-	3.2	3.5	-	4.2	4.5	mA	
Supply Capacitance	C _{DD}	-	10	-	-	10	-	uF	1

1) Supply capacitance is provided within the part however it is recommended to include a 0.1 uF decoupling cap near the supply pads.

9.2 Reset Characteristics

Parameter	Sym	Condition	HS110 / HS120 / HS160/ HS210			Units	Notes
			Min	Typ	Max		
Power On Time	T _{PO}	From POR or External Reset	-	-	200	ms	1
External Reset Low	t _{RSTL}		15	-	-	us	3
Input High Voltage	V _{IH}		V _{DD} -0.6	-	-		2
Input Low Voltage	V _{IL}		-	-	0.6		2
Internal Pull-Up Current	I _{PU}	V _{IN} = 0V	-	-10	-30	uA	2
Input Capacitance	C _{IN}		-	7	-	pF	2

1) The filter settling time to ensure the first reading and modulator is completely settled.

2) Input nRST

3) Minimum time required to reset the device.

9.3 PWM Characteristics

Parameter	Sym	Condition	HS110 / HS120 / HS160/ HS210			Units	Notes
			Min	Typ	Max		
Output High Voltage	V _{OH}	I _O = -3 mA	V _{DD} -0.7	-	-	V	
Output Low Voltage	V _{OL}	I _O = 8 mA	-	-	0.6	V	

HS Series

Pressure Transmitter Subsystem

10 Materials

10.1 Wetted Materials

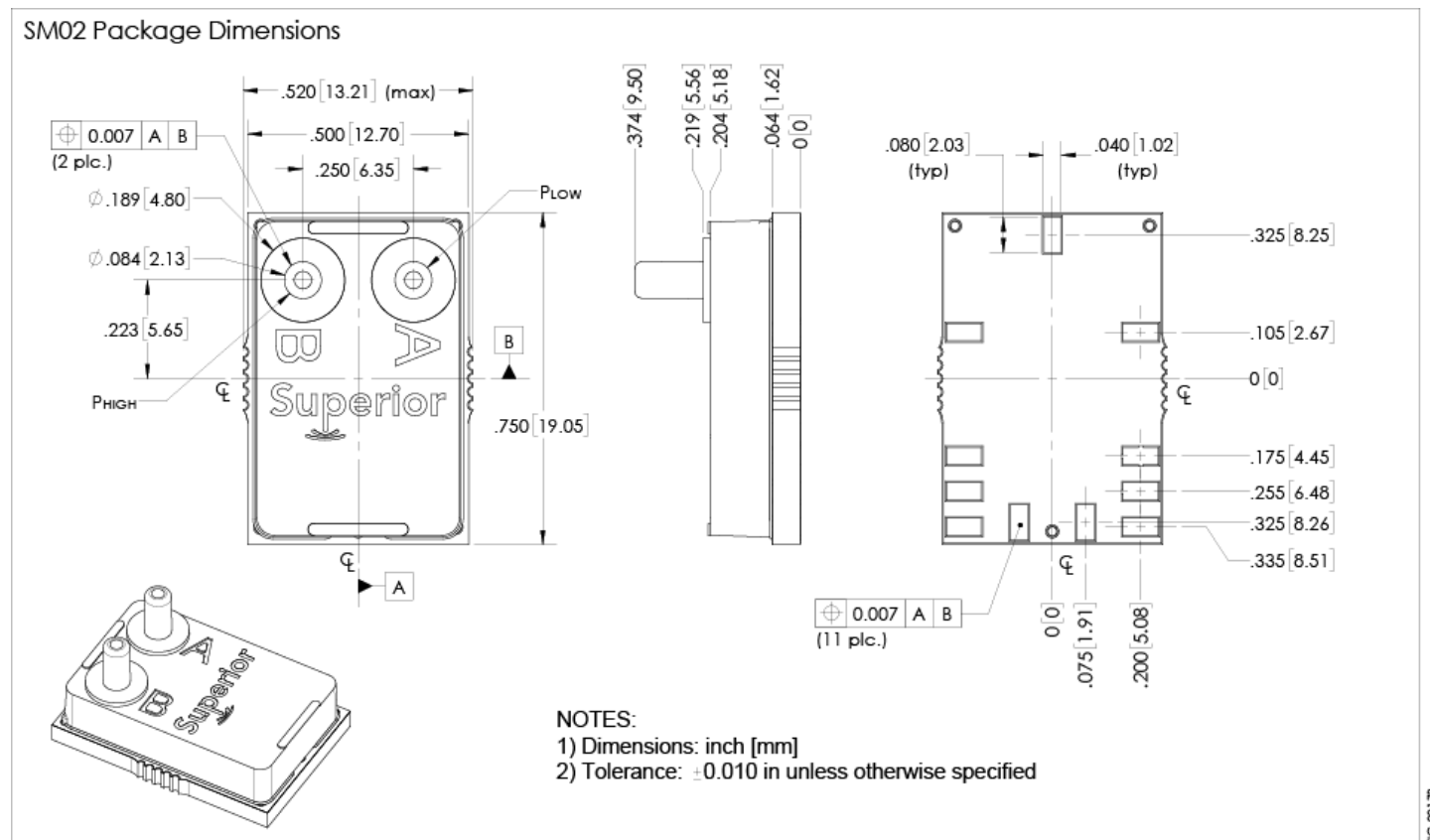
Parameter	Sym	HS110/HS120/HS160		HS210		Units	Notes
		P _A	P _B	P _A	P _B		
Wetted Materials	MAT _{WET}	Epoxy Nylon RTV Silicon	Epoxy Nylon RTV Silicon Gold Aluminum	Epoxy Nylon RTV Silicon Gold Aluminum	Epoxy Nylon RTV Silicon Gold Aluminum		

10.2 Material Compliance

Parameter	Sym	HS110 / HS120 / HS160/ HS210	Units	Notes
RoHS	REG _{RoHS}	RoHS Compliant		
REACH	REG _{REAC}	REACH Compliant		

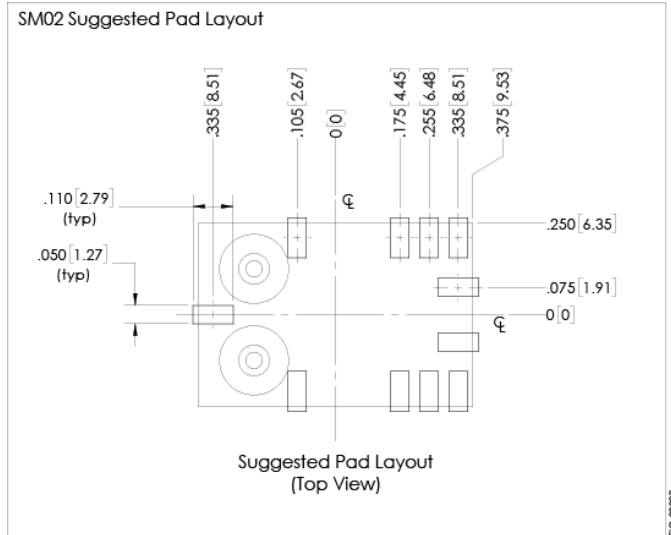
11 Mechanical and Manufacturing

11.1 Package Dimensions



11.2 Suggested Pad Layout

The suggested pad layout is shown in the figure to the right. An Eagle PCB symbol library is available with the shown pad dimensions. Please consult the factory to obtain the library.

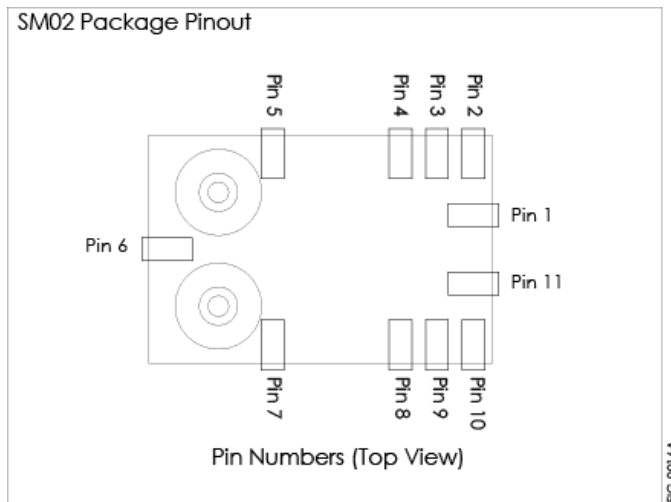


11.3 Reflow Soldering and Handling Conditions

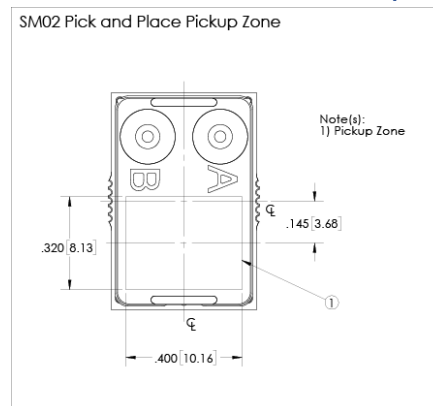
Parameter	Sym	Val	Units
Soldering Specifications (Max)			
Preheat Ramp Rate	t_{PHRR}	3	°C/s
Soak Time	t_{SOAK}	3	min
Time Above 217C	t_{GT217}	50	s
Time Above 230C	t_{GT230}	40	s
Time Above 250C	t_{GT250}	15	s
Peak Temperature	t_{PT}	255	°C
Cooling Ramp Rate	t_{CRR}	-4	°C/s
Weight	W_{PRT}	3.5	gm
Moisture Sensitivity	MSL	3	
ESD (Human Body Model)	ESD	2	kV

11.4 Pinout

Pin	Sym	SPI
1	PWM	PWM Output
2	SCL	EEPROM SCL
3	SDA	EEPROM SDA
4	FB	Feedback
5	DNC	Do Not Connect
6	DNC	Do Not Connect
7	DNC	Do Not Connect
8	Gnd	Ground
9	VDD	Sensor Supply
10	nRST	Reset (active low)
11	SI	Serial Input



11.5 Pick and Place Pick-up Zone

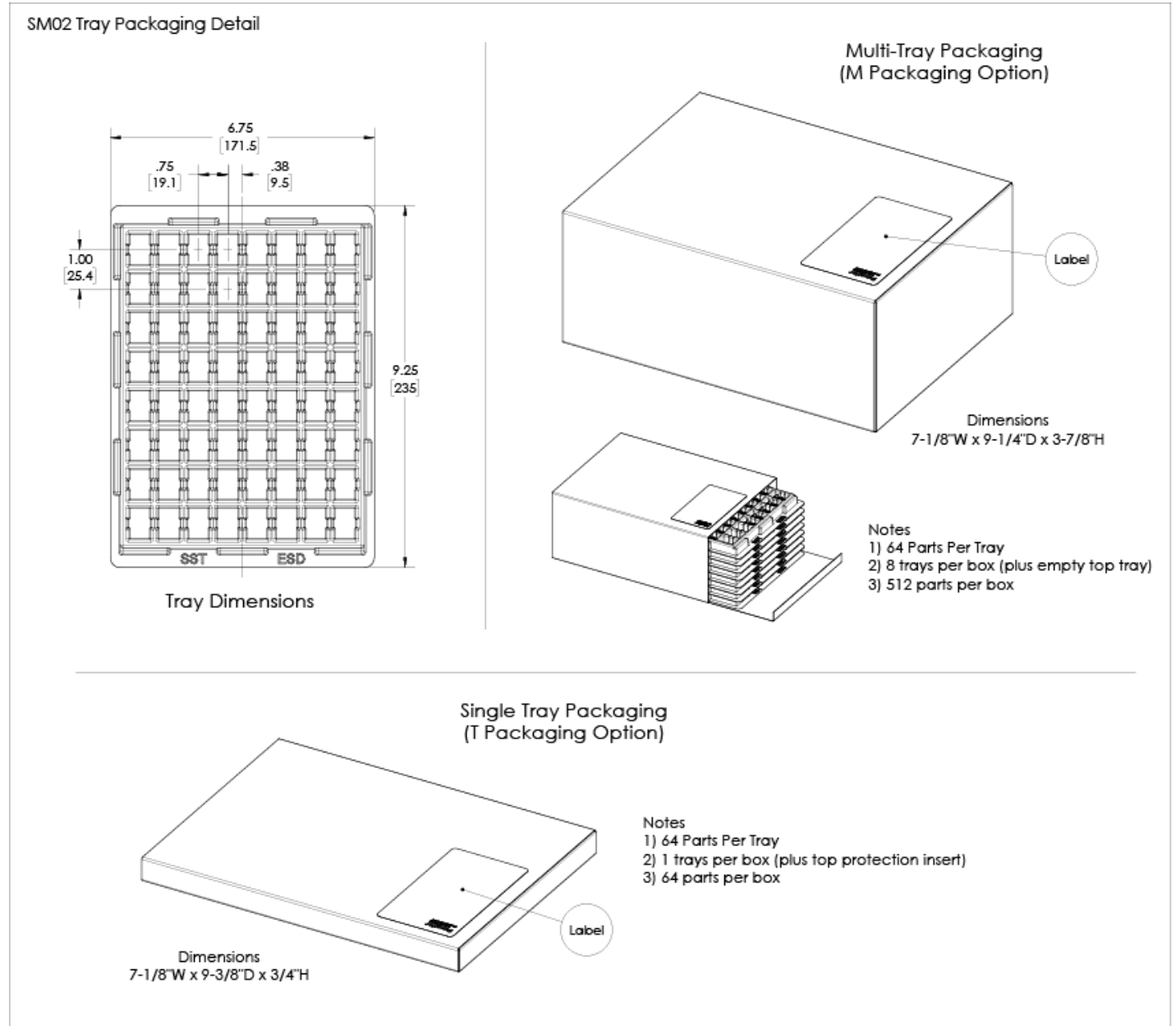


HS Series

Pressure Transmitter Subsystem

11.6 Packaging Options

11.6.1 Tray Packaging



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11.6.2 Tape and Reel

SM02 Tape and Reel Detail

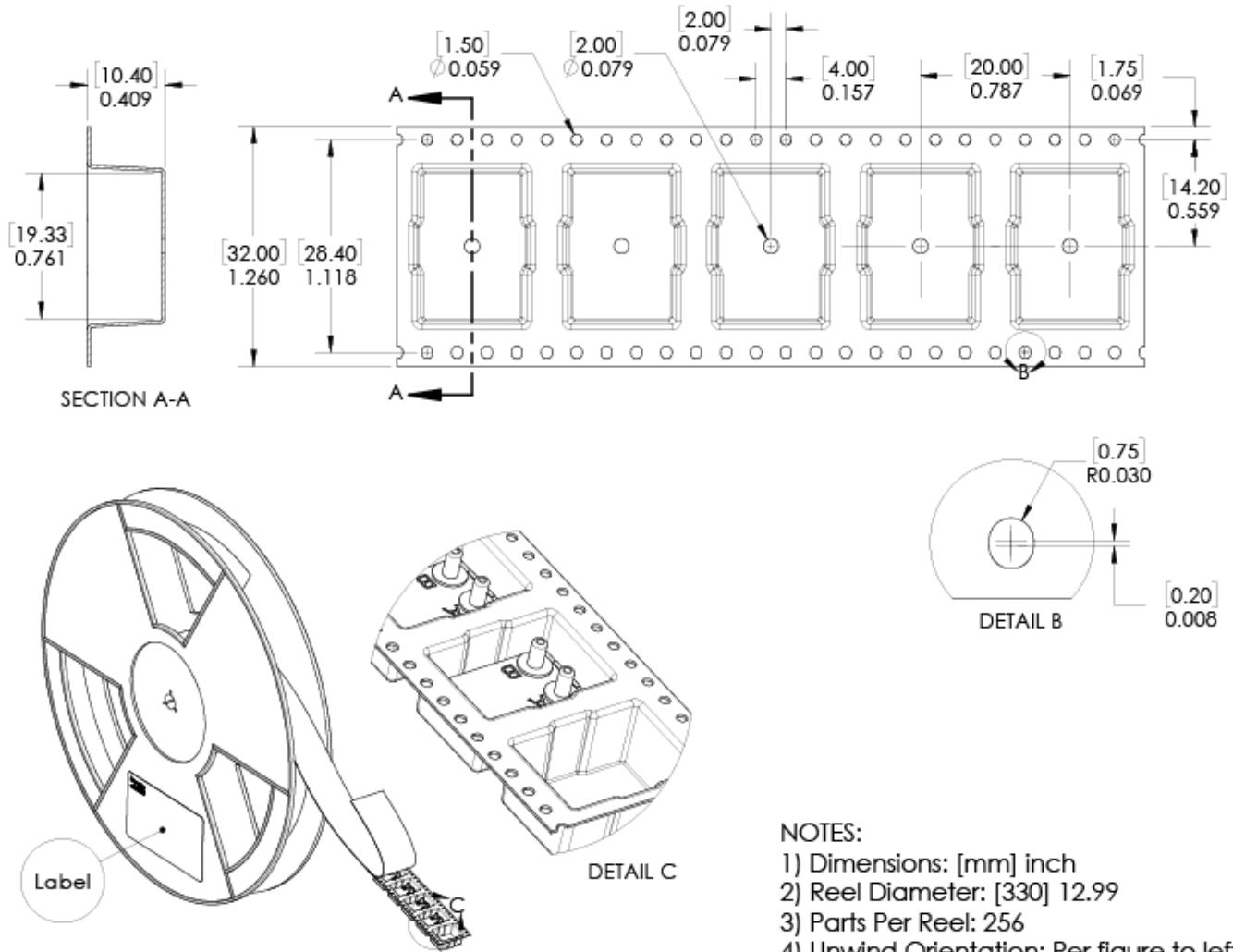
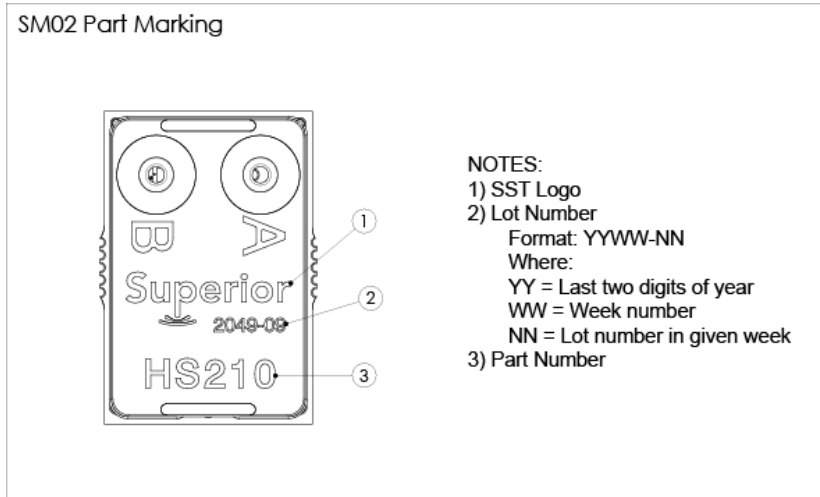


FIG-001.5A

HS Series

Pressure Transmitter Subsystem

11.7 Part Identification



12 Packaging Labeling

Packaging labels are provided with barcode Code 128 symbology. The provided fields are Company Name, Part Number, Packaging ID and Quantity. The Packaging ID traces back to the Lot Number (or Lot Numbers) contained in the package. The purpose is to eliminate multiple labels (one for each included Lot Number) in the event of multiple Lot Numbers within a single package. This is for ease of customer tracking and maintenance. The Packaging ID is a 24-bit value printed in hexadecimal format.



13 Ordering Information

Part Number	Part Package	Packaging	Packaging Qty	Order Number
HS160-SM02	SM02	Tape and Reel	256	HS160-SM02-R
		¼ Tape and Reel	64	HS160-SM02-Q
		Multi-Tray	512	HS160-SM02-M
		Single Tray	64	HS160-SM02-T
		Cut Tape	1-63	HS160-SM02-C
HS120-SM02	SM02	Tape and Reel	256	HS120-SM02-R
		¼ Tape and Reel	64	HS120-SM02-Q
		Multi-Tray	512	HS120-SM02-M
		Single Tray	64	HS120-SM02-T
		Cut Tape	1-63	HS120-SM02-C
HS110-SM02	SM02	Tape and Reel	256	HS110-SM02-R
		¼ Tape and Reel	64	HS110-SM02-Q
		Multi-Tray	512	HS110-SM02-M
		Single Tray	64	HS110-SM02-T
		Cut Tape	1-63	HS110-SM02-C
HS210-SM02	SM02	Tape and Reel	256	HS210-SM02-R
		¼ Tape and Reel	64	HS210-SM02-Q
		Multi-Tray	512	HS210-SM02-M
		Single Tray	64	HS210-SM02-T
		Cut Tape	1-63	HS210-SM02-C

14 Revisions

Rev	Change Description(s)	Date	By
A	Initial Release	3/23/2021	T.S.
B	Correct Equivalent Circuit port assignment	1/27/2022	T.S.

15 Warranty

Superior Sensor Technology and its subsidiaries warrant goods of its manufacture as being free of defective materials and faulty workmanship during the applicable warranty period. In all cases, Superior Sensor Technology's standard product warranty applies; please refer to your order acknowledgement or consult your local sales office for specific warranty details.

If warranted goods are returned to Superior Sensor Technology during the period of coverage, Superior Sensor Technology will repair or replace, at its option, without charge those items that Superior Sensor Technology, in its sole discretion, finds defective. **The foregoing is buyer's sole remedy and is in lieu of all other warranties, expressed or implied. In no event shall Superior Sensor Technology be liable for consequential, special, or indirect damages.**

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