

Roxar™ Sand Acoustic Monitor

Non-intrusive Sand Monitoring



The Roxar Sand Acoustic Monitor (SAM) is a non-intrusive sand monitoring system that identifies real-time sand production in water, oil, gas or multiphase flow lines for onshore and offshore locations. It offers a cost effective tool for operators to optimize production by enabling the determination of maximum sand-free rates or maximum acceptable sand production rates.

Roxar Sand Acoustic Monitor

Decreasing production costs are becoming more and more important as reservoirs are maturing. As a result, sand production needs to be closely measured and monitored in order to avoid serious damages. One consequence of increased sand production can be serious damage to production equipment, such as valves, chokes and pipe bends. If not controlled, high sand production can have a damaging impact on the integrity of the production system. Roxar SAM is valuable for ensuring production system integrity.

The benefits of using Roxar SAM include:

- Allows monitoring and prediction of erosion in process equipment in order to ensure safe production and reduced down time.
- Enables optimized production through the determination of Maximum Sand Free Rate (MSFR) or Acceptable Sand Rates (ASR).
- Allows for improved production processes in order to prevent pipelines or separators filling with sand.
- Enables monitoring of sand screen integrity.

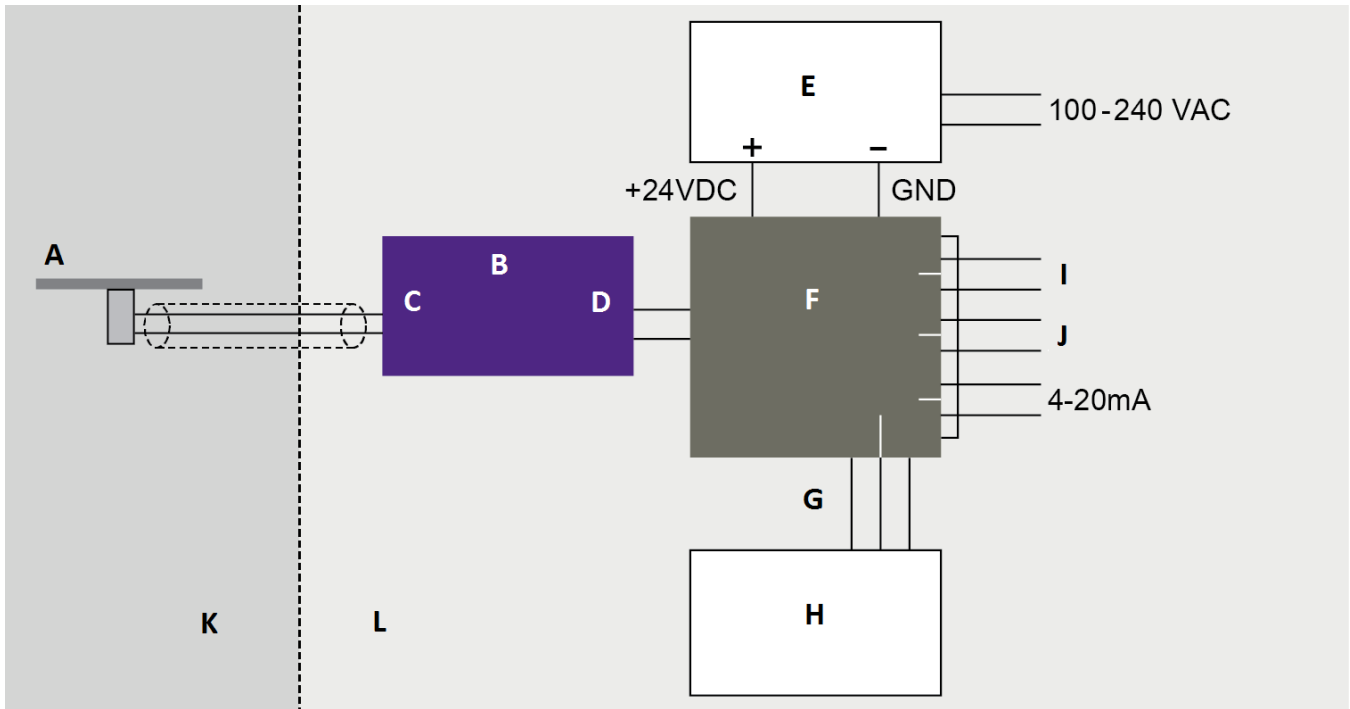
The Roxar SAM is an acoustic type device and includes the following benefits:

- Real time measurement of sand production in any water, oil, gas, or multiple flow line for onshore and offshore locations.
- Quantification of sand accumulating in the system by calculating grams per second passing through the pipeline. This supports Acceptable Sand Rate (ASR), with on-site sand calibration measured against actual conditions in grams per second.
- Ability to detect sand noise without calibration.
- No mechanical moving parts, resulting in low maintenance.
- Compact and low weight device.
- Non-intrusive design benefits include:
 - No wetted parts
 - No pipe pressure drop
 - Easy to install
 - No shutdown required for installation
 - Easy to retrofit for existing installations

Building Blocks behind the Roxar SAM

The Roxar SAM design consists of several parts:

- A monitor consisting of a transducer and housing damped on to the pipe.
- The basic safe area electronics consisting of a Calculation & Interface Unit (CIU) and a safety barrier.

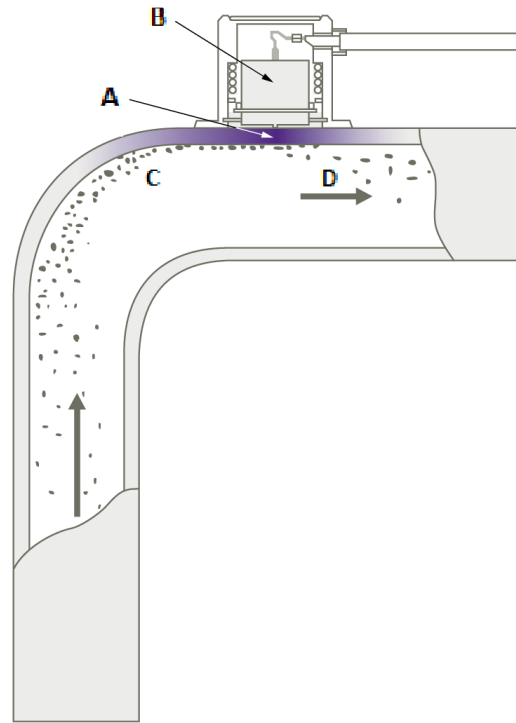


- A. Flowline Monitor
- B. Safety Barrier
- C. Hazard
- D. Safe
- E. Power Supply (PSU) (optional)
- F. Calculation & Interface Unit (CIU)
- G. Service Bus RS232
- H. PC with service software (optional)
- I. Modbus RTU/RS485
- J. Volt Free Contact
- K. Hazardous Area
- L. Safe Area or Ex-d Enclosure

Roxar SAM working principle

Roxar SAM is a non-intrusive device that utilizes the acoustic noise generated by the sand particles to derive a sand production measurement. It utilizes the fact that the sand, while transported with the flow, impacts the pipe wall due to inertia in pipe bends and creates noise. This noise is then processed and used to identify and calculate real-time sand production in any water, oil, gas or multiple pipeline flows.

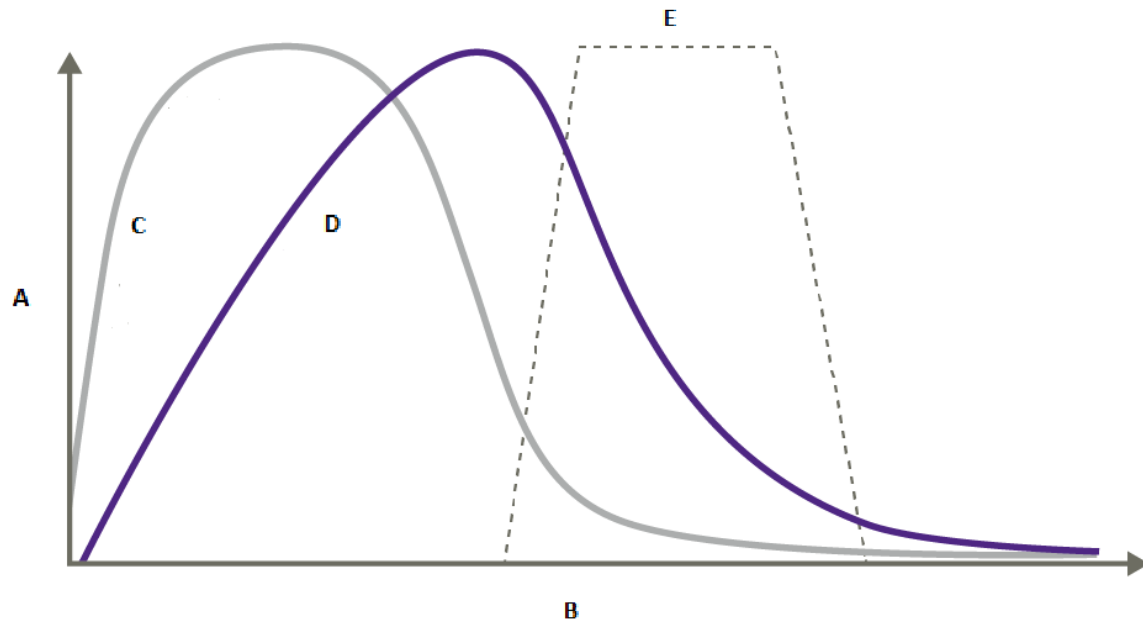
Figure 1: Pipe Bend and Process Flow with Digital Output (Mean Value/One Second)



- A. Sand-Generated Noise (Impact Center Point)
- B. Spring-Loaded Microphone
- C. Impacting Particles
- D. Flow

The sensor picks up noise that propagates in the pipe wall and converts it to a digital signal that is transmitted on the sensor signal and built-in algorithms. Detector readings are stored for up to 90 days in an internal flash drive based on 10 second average intervals.

Figure 2: Piping installation Guidelines



- A. Noise Amplitude %
- B. Frequency
- C. Flow-generated Noise
- D. Sand-generated Noise
- E. Microphone Filter

Technical specifications

Detector Approvals	ATEX, IECEx, CSA, Inmetro and EAC
Uncertainty	+/- 5% (with sand injection calibration)
Repeatability	The sensors have repeatability better than 1%, meaning that the sensor signal will read the same values with less than 1% deviation for fixed noise reference signals generated by a calibrated noise generator. The reference signals range from zero to maximum sensor reading of 2 mil (100nV).
Required flow velocity	Minimum 1 m/s
Data storage	Up to 90 days, based on 10 second averaging intervals
Detector / monitor dimensions & weight	88 mm (OD) x 100 mm and 3.0 kg
Detector ingress protection	IP66-67
Calculation Interface Unit (CIU) dimensions & weight	23 mm + 6 mm x 99 mm x 113 mm (WxLxH) and 0.2 kg
Safety barrier dimensions	12.6 mm x 105 mm x 90 mm (WxLxH)
Electrical specifications detector	24 VDC (powered through CIU)
Calculation Interface Unit (CIU) supply voltage	24 VDC
System Power Consumption	1.2 to 2.5W (depends on which barrier is used)
Ambient Temperature	-40 °F (-40.0 °C) to 176 °F (80.0 °C)
Pipe Surface Temperature	<ul style="list-style-type: none"> ■ Standard Temperature: -40 °F (-40.0 °C) to 239 °F (115.0 °C) ■ High Temperature: -40 °F (-40.0 °C) to 554 °F (290.0 °C)
Installation	Detector/monitor: Fixed on pipe exterior (OD from 2” to 48”) in Exia/Zone 0,1,2 CIU or Safety Barrier: DIN-rail mountable in safe area or optional in field enclosure

Installation requirements

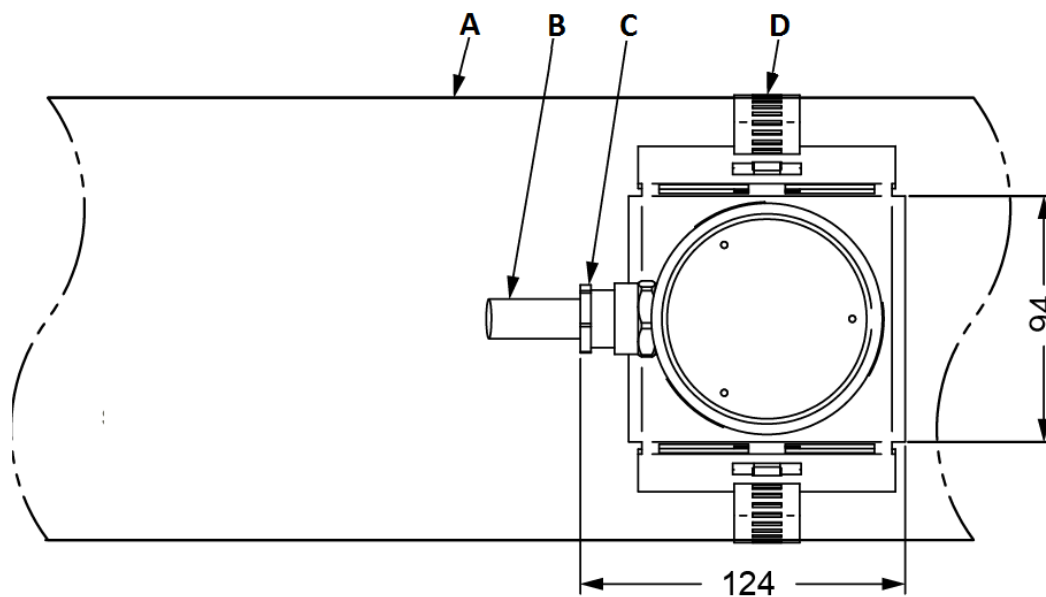
The detector unit is non-intrusive and can be installed in production pipe work of any diameter between 2" and 48". To facilitate inspection, the Ex classification marking must be visible after installation.

The figures below shows the assembly and envelope for the different versions available, Standard Temperature (ST) and High Temperature (HT) of a Roxar acoustic sensor. Dependent on specific models of acoustic sensors (PDS or SAM), some special installation requirements may apply. General Arrangement (GA) drawings for the different models and versions can be provided upon request. Contact your Emerson sales representatives for inquiries.

Piping, ST, and HT installation guidelines

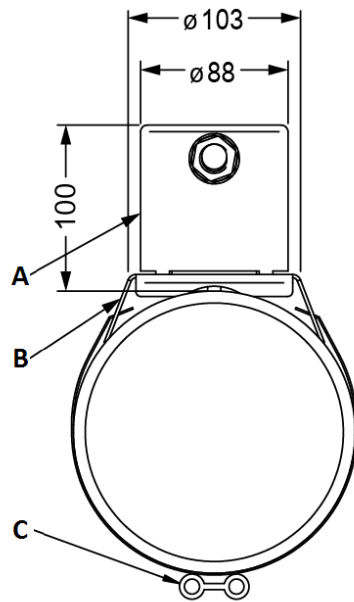
The piping arrangement upstream of the of the detector/monitor depends on the model; see the detailed description for specific requirements.

Figure 3: Piping installation Guidelines



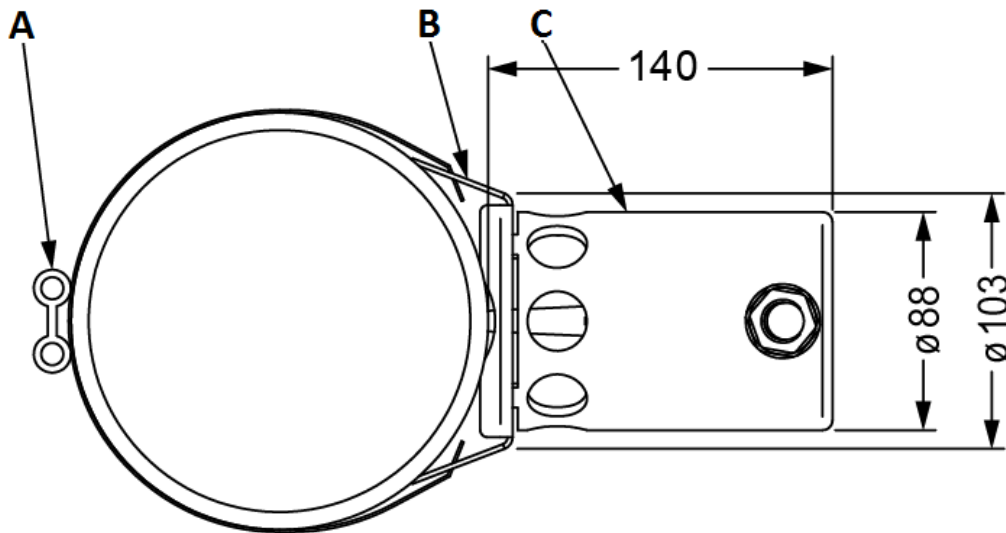
- A. Piping
- B. Cable (one twisted pair)
- C. Cable gland
- D. Mounting strap (AISI 316)

Figure 4: ST Installation Guidelines



- A. Detector housing (AISI 316)
- B. Mounting socket
- C. Fastening arrangement (AISI 316)

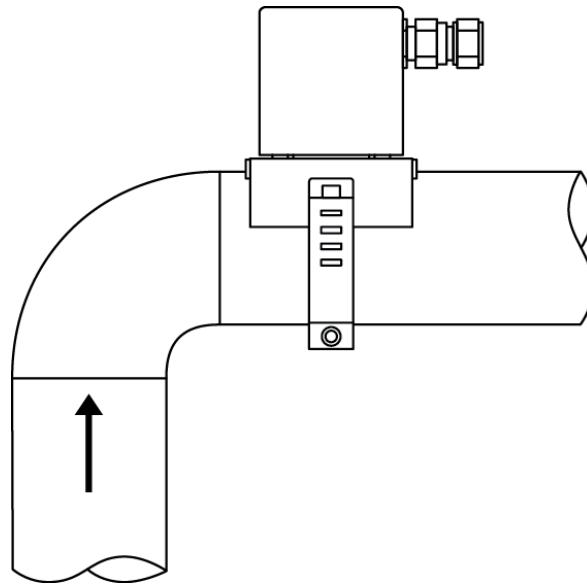
Figure 5: HT Installation Guidelines



- A. Fastening arrangement (AISI 316)
- B. Mounting socket
- C. HT Detector housing (AISI 316)

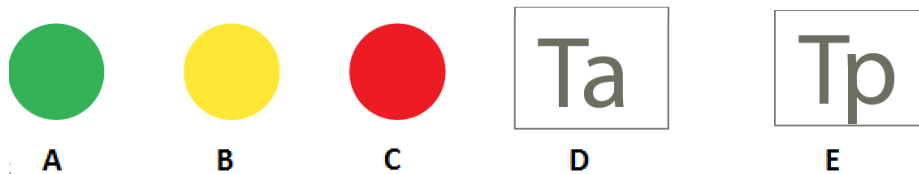
In order to achieve best sensitivity, the Roxar SAM should be installed downstream from and as close as possible to a 90° bend and not farther away than 75 cm. This is because of the need for the pipe geometry particle inertia work to increase the concentration and force of the particle impact, and thereby the sand response, allowing for high quality measurements. Care should be taken to avoid installation near known sources of unwanted noise, for example, choke valves or cyclonic de-sanding equipment. Excessive levels of unwanted noise may compromise the measurement principle.

Figure 6: SAM Installation Near 90° Bend



Installation considerations

Figure 7: Installation Use Guidelines


























- A. Green – Safe use
- B. Yellow – Safe use, but not recommended (risk for non-safety-critical sensor damage)
- C. Red – Unsafe use (outside certified temperature envelope)
- D. Ambient temperature: The temperature of air or other media in a designated area surround the equipment.
- E. Surface temperature of the pipe on which the equipment is mounted.

Standard Temperature (ST) version

For the ST version, the only installation requirement is that there is a space between the detector housing and the pipe installation to allow the heat to dissipate from the detector and the pipe. This space ensures the detector's temperature is kept as low as possible.

Figure 8: ST version chart

	T6	T5	T4		T3	T2
Ta max	Tp max 80 °C	Tp max 95 °C	Tp max 115 °C	Tp max 130 °C	Tp max 195 °C	Tp max 290 °C
40 °C	 A	 A	 A	 A	 B	 C
50 °C	 A	 A	 A	 B	 C	 C
60 °C	 A	 A	 B	 B	 C	 C
70 °C	 C	 B	 B	 B	 C	 C
80 °C	 C	 B	 B	 B	 C	 C

- A. Green – Safe Use
- B. Yellow – Safe Use, But Not Recommended
- C. Red – Unsafe Use




































High Temperature (HT) version

The HT version must always be mounted horizontally on the pipe.

The HT version also contains:

- An extended waveguide 'noise' at the front end to retract the sensor electronics away from the hot pipe surface
- Vent holes in the detector housing to provide more efficient heat evacuation

Figure 9: HT version chart

	T6	T5	T4	T3		T2	
Ta max	Tp max 80 °C	Tp max 95 °C	Tp max 130 °C	Tp max 170 °C	Tp max 195 °C	Tp max 240 °C	Tp max 290 °C
40 °C	 A	 A	 A	 A	 A	 A	 A
50 °C	 A	 A	 A	 A	 A	 A	 B
60 °C	 A	 A	 A	 A	 B	 B	 B
70 °C	 A	 A	 A	 B	 B	 B	 B
80 °C	 C	 A	 B	 B	 B	 B	 C

- A. Green – Safe Use
- B. Yellow – Safe Use, But Not Recommended
- C. Red – Unsafe Use

Model code numbering system

Roxar Sand monitor - product model numbers

Mode code structure for the Roxar Sand monitor - acoustic

A complete model code includes the ordering options.

Example code	Description
SAM 01	Product description
ST	Functional properties
012	Pipe size
A	Main material (sensor housing)
A2	Detector approvals
G0	Field cable gland
0	Field cable size range
0B	Communication interface
1	Customer supply voltage
000	Barrier
0000	Installation location for electronics (CIU barrier)
ZZ	Tag plates
C0	Product specific options
Z	Factory options

Product description

Code	Product description option
SAM01	Roxar Sand monitor – Acoustic

Functional properties

Code	Functional properties
ST	Standard temperature version (-40 °F (-40.0 °C) to 239 °F (115.0 °C))
HT	High temperature version (-40 °F (-40.0 °C) to 554 °F (290.0 °C))

Pipe size

Code	Pipe Size
002	Mounting fixture for 2 in pipe size
012	Mounting fixture for 2½ to 12 in pipe size
024	Mounting fixtures from 12 in to 24 in pipe size
036	Mounting fixtures from 24 in to 36 in pipe size
048	Mounting fixtures from 36 in to 48 in pipe size

Main material (sensor housing)

Code	Sensor housing
A	Stainless steel

Detector approvals

All detector approvals are certified for Intrinsically Safe installations.

Code	Detector approvals
A2	ATEX
A3	IECEX
A4	CSA
A5	Inmetro
A6	EAC

Field cable gland

All field cable glands have the following certification: Hawke 501/453/Universal Ex de.

Code	Field cable gland
G0	No Gland (Client provided)
M2	Metric; Brass
M3	Metric; Nickel-plated brass
M4	Metric; Stainless steel
N2	NPT; Brass
N3	NPT; Nickel-plated brass
N4	NPT; Stainless steel
X9 ⁽¹⁾	Other gland; ATEX

(1) Not available with Factory option Z.

Field cable size range

Code	Field cable size range
0 ⁽¹⁾	Not applicable
1 ⁽²⁾	5,5 - 12 mm OD / 3,5 - 8.1 ID
2 ⁽²⁾	9,5 - 16 mm OD / 6,5 - 11,4mm ID; Selection for Roxar heavy duty BFOU field cable
3 ⁽²⁾	12,5 - 20.5 mm OD / 8,4 - 14.3 mm ID
4 ⁽²⁾	16,9 - 26 mm ID / 11,1 - 19,7 mm ID

(1) Only available with Field cable gland option G0 (no gland).

(2) Not available with Field Cable Gland option G0.

Communication interface

Code	Communication interface
0B	Modbus RTU
0C	Analog 4-20 mA
0D	Voltage free contact

Customer supply voltage

Code	Customer supply voltage
1	24VDC
2	100-240 VAC, 50/60Hz (power supply to be offered separately)

Barrier

Code	Barrier
000 ⁽¹⁾	No barrier, no Roxar CIU; When integrated with Roxar MPFM
00N	Client provided barrier; Roxar CIU
02A	Zener barrier (IS); Roxar CIU
02B	Galvanic isolator barrier (Non ISE); Roxar CIU

(1) Only available with Installation location for Electronics (CIU barrier) option Z6.

Installation location for electronics (CIU barrier)

Code	Installation location for electronics (CIU barrier)
Z0	Customer provided (CIU and barrier included as loose items)
Z1	Rail kit – loose items (Rail kit offered separately); (CIU and barrier included as loose items)
Z2	Rail kit – assembled (ETO ITEM offered separately); (Rail kit offered separately); (CIU and barrier included on the rail kit)
Z3	External supplied EX d/EX de enclosure (ETO ITEM offered separately; (CIU and barrier included in the enclosure)
Z4 ⁽¹⁾	External supplied EX d/EX de enclosure with reset function; (ETO ITEM offered separately; (CIU and barrier included in the enclosure)
Z5	Safe area cabinet; (ETO ITEM offered separately); (CIU and barrier included in the cabinet)
Z6 ⁽²⁾	Integration with Roxar MPFM; (CIU and barrier included in the MPFM enclosure)

(1) Not available with Field Reset Box options FRB1 or FRB2, or 0909.

(2) Only available with Barrier option 000.

Tag plates

Code	Tag Plates
ZZ	No tag plates
TG	Standard tag plates
XX ⁽¹⁾	Project-specific tag plates

(1) Not available with Factory option Z.

Product specific options

Code	Product specific options
C0	No coating
C6	Roxar standard coating for stainless steel (ss); Sensor housing and mounting socket
C7 ⁽¹⁾	Roxar standard coating for ss; Field reset box
C8 ⁽¹⁾	Roxar standard coating for ss; Sensor housing, mounting socket, and field reset box
CX ⁽²⁾	Project-specific coating

(1) Not available with Field reset Box option 0000.

(2) Not available with Factory option Z.

Factory options

Code	Factory options
Z	Standard product
X	ETO product

SAM electronics enclosure assembly kit - product model numbers

Model code structure for the SAM electronics enclosure assembly kit

A complete model code includes the ordering options.

Example code	Description
SAMPDSENC	Product description
1	Sensor type
S	Enclosure location
C	Material
A2	Enclosure approvals
W	Mounting
01	CIU option
A	Barrier
1	Customer supply voltage
0B	Communication output
M2	Communication and sensor cable glands
1	Communication and sensor cable size range
M2	Power cable gland
1	Power cable size range
TG	Tag plates
Z	Electronics option
Z	Factory option

Product description

Code	Product description
SAMPDSENC	SAM/PDS electronics enclosure assembly kit

Sensor type

Code	Sensor type
1	SAM - Sand Acoustic Monitoring
X ⁽¹⁾	Other

(1) Not available with Factory option Z.

Enclosure location

Code	Enclosure location
S ⁽¹⁾	Safe area
H ⁽²⁾	Hazardous area (zone 1, 2)
X ⁽³⁾	Other

(1) Not available with Approvals options D2, D3.

(2) Not available with Approvals option NO.

(3) Not available with Factory option Z.

Material

Code	Material
C	Sheet steel - painted RAL 7035
S	Stainless steel 316
A	Aluminum
X ⁽¹⁾	Other materials

(1) Not available with Factory option Z.

Enclosure approvals

Code	Enclosure approvals
NO ⁽¹⁾	Not applicable; Non Ex IP 66
A1 ⁽²⁾	ATEX IIC; SS:TÜV 12ATEX102320X
A2	ATEX IIB; SS:TÜV 12ATEX101309X
I1 ⁽²⁾	IECEX IIC; SS:TUN 12.0018X
I2	IECEX IIB; SS:TUN 12.0014X
A3	ATEX IIC; AL
A4	ATEX IIB; AL
I3	IECEX IIC; AL
I4	IECEX IIB; AL
X9 ⁽³⁾	Other

(1) Not available with Material, option S.

(2) Not available with Material, option C.

(3) Not available with Factory option Z.

Mounting

Code	Mounting
W	Wall mounted (mounting accessories included)
X ⁽¹⁾	Other

(1) Not available with Factory option Z.

CIU option

Code	CIU option
Material Code C (Sheet steel - painted RAL 7035)	
01	1 CIU
02	2 CIU
03	3 CIU
04	4 CIU
X ⁽¹⁾	Other

(1) Not available with Factory option Z.

Code	CIU option
Material Code S (Stainless Steel 316)	
01	1 CIU
02	2 CIU
03	3 CIU
04	4 CIU
X ⁽¹⁾	Other

(1) Not available with Factory option Z.

Barrier

Code	Barrier
A	Zener barrier
B	Galvanic barrier

Customer supply voltage

Code	Customer supply voltage
Material Code C (Sheet steel - painted RAL 7035)	
1	240 VAC
2	24 VDC
X ⁽¹⁾	Other power supply

(1) Not available with Factory option Z.

Code	Customer supply voltage
Material Code S (Stainless Steel 316)	
1	240 VAC
2	24 VDC
X ⁽¹⁾	Other power supply

(1) Not available with Factory option Z.

Communication output

Code	Communication output
0B	RS485
0C	Analog 4-20 mA
0D	Voltage free contact
0E	TCP/IP
9X ⁽¹⁾	Other communication

(1) Not available with Factory option Z.

Communication and sensor cable glands

Code	Power cable size range
G0 ⁽¹⁾	No gland (client provided)
M2 ⁽²⁾	Metric brass; Hawke Ex de
M3 ⁽²⁾	Metric nickel-plated brass; Hawke Ex de
M4 ⁽²⁾	Metric stainless steel; Hawke Ex de
N2 ⁽²⁾	NPT brass; Hawke Ex de
N3 ⁽²⁾	NPT brass nickel-plated; Hawke Ex de
N4 ⁽²⁾	NPT stainless steel; Hawke Ex de
X9 ⁽²⁾⁽³⁾	Other

(1) Available only with Communication and Sensor Cable Range, option 0.

(2) Not available with Communication and Cable Size Range, option 0.

(3) Not available with Factory option Z.

Communication and sensor cable size range

Code	Communication and sensor cable size range
0	Not applicable
1	5,5 - 12mm OD / 3,5-8,1 ID
2	9,5 - 16 mm OD / 6,5 - 11,4 mm ID
3	12,5 - 20,5 mm OD / 8,4 - 14,3 mm ID
4	16,9 - 26 mm OD / 11,1 - 19,7 mm ID

Power cable gland

Code	Power cable size range
G0 ⁽¹⁾	No gland (client provided)
M2 ⁽²⁾	Metric brass; Hawke Ex de
M3 ⁽²⁾	Metric nickel-plated brass; Hawke Ex de
M4 ⁽²⁾	Metric stainless steel; Hawke Ex de
N2 ⁽²⁾	NPT brass; Hawke Ex de
N3 ⁽²⁾	NPT brass nickel-plated; Hawke Ex de
N4 ⁽²⁾	NPT stainless steel; Hawke Ex de
X9 ⁽²⁾⁽³⁾	Other

(1) Available only with Power Cable Size Range, option 0.

(2) Not available with Power Cable Size Range, option 0.

(3) Not available with Factory option Z.

Power cable size range

Code	Power cable size range
0	Not applicable
1	5,5 - 12mm OD / 3,5-8,1 ID
2	9,5 - 16 mm OD / 6,5 - 11,4 mm ID
3	12,5 - 20,5 mm OD / 8,4 - 14,3 mm ID
4	16,9 - 26 mm OD / 11,1 - 19,7 mm ID

Tag plates

Code	Tag Plates
ZZ	No tag plates
TG	Standard tag plate; Trapholite, size 70 mm x 20 mm - customer information required
XX ⁽¹⁾	Project-specific tag plates

(1) Not available with factory option Z.

Electronics option

Code	Electronics option
Z	Standard

Factory option

Code	Factory Options
Z	Standard product
X	ETO product

Emerson Automation Solutions

Roxar
Gamle Forusveien 17
4031 Stavanger
Norway
Europe: + 47 51 81 8800
Russian CIS countries: + 7 495 504 3405

www.Emerson.com/Roxar
info.roxar@emerson.com

Emerson Automation Solutions

North America: + 1 281 879 2328
Latin America:
Mexico: +52 55 5809 5010
Argentina: + 54 11 4809 2700
Brazil: + 55 15 3413 8000
Chile: + 56 2 2928 4800
Peru + 51 15190130

Emerson Automation Solutions

Asia Pacific: + 60 3 5624 2888
Australia: + 61 8 9208 1600
Middle East: + 971 4811 8100

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