

## SAAV

### Model 001

ShapeArray and its cyclical installation are patented technology.

SAAV is designed to enable faster and simpler installation with direct installation in casing sizes from 47 mm to 100 mm inside diameter, as well as 27 mm ID conduit. SAAV can be installed into existing casings, even those that are too distorted for conventional use, which eliminates the need to drill new boreholes when converting from manual to automated monitoring. SAAV is available in 250<sup>1</sup> mm and 500 mm segment lengths and can be installed vertically, horizontally, or in an arc.

SAAV's rugged joint design enables the instrument to zigzag into various sizes of standard inclinometer casing sizes. A spring box at the top holds the joints firmly in contact with the casing, without any additional grouting. This cyclical installation method is unique to SAAV (patent pending). Software tracks the medial axis within the casing in 3D to produce traditional inclinometer data plots. Silent segments and extension tubes—two technologies specific to SAAV installed vertically/vertical SAAV installations—allow greater flexibility and control to place SAAV's sensorized segments in a zone of interest.

Clients may choose SAAV for vertical installation in 27 mm ID conduit or horizontally in schedule 80 (60 mm OD) casing, which can be configured at the time of order or changed in the field with the use of a conversion kit (purchased separately). SAAV installed in an arc to monitor convergence feature a new installation method. SAAV sold for convergence applications are inserted into 21 mm ID PVC flex conduit at the factory and coiled onto its shipping reel, which arrive ready for the client to install directly to the tunnel wall with U-clamps.

All ShapeArray instruments are manufactured in an ISO 9001:2015 certified facility.

<sup>1</sup> Contact Measurand for additional details.

# SPECIFICATIONS



## PHYSICAL PROPERTIES

SEGMENT LENGTH	250 mm or 500 mm (joint center to joint center)
STANDARD LENGTH OF SAAV	Up to 150 m (500 mm segments) or 50 m (250 mm) or 30 m (convergence installation)
CUSTOM LENGTH OF SAAV	Over 150 m (Contact Measurand for details)
CONDUIT & CASING INSIDE DIAMETERS	27 mm, 47 mm to 100 mm
JOINT DIAMETER	19 mm
LENGTH OF UNSENSORIZED NEAR CABLE END SEGMENT	500 mm
LENGTH OF FIBERGLASS EXTENSION	1 m or 2 m
LENGTH OF COMMUNICATION CABLE	Standard 15 m
WEIGHT	0.6 kg/m
MINIMUM AXIAL COMPRESSION TO PROVIDE SNUG FIT IN CASING	30 kgf
MAXIMUM JOINT BEND ANGLES	90°
STORAGE TEMPERATURE	-40°C to 60°C
INSTALLATION TEMPERATURE	-20°C to 60°C
OPERATING TEMPERATURE	-35°C to 60°C polynomial temperature algorithm corrected
WATERPROOF TO	2000 kPa (200 m Water)
POWER REQUIREMENTS	12 VDC at 1.8 mA/segment

# STATIC SHAPE MEASUREMENTS

ANGULAR RANGE OF MEMS SENSORS	± 360° (software selection required for 2D/3D modes)
RANGE OF 3D MODE (VERTICAL)	± 60° with respect to vertical
DEFORMATION ACCURACY <sup>1,2,3,</sup>	± 1.5 mm for 32 m ShapeArray
RESOLUTION OF SINGLE SEGMENT	+/- 1 arcsecond <sup>4</sup>
AZIMUTH ERROR IN JOINTS	< ±0.01°
LONG-TERM RELIABILITY MTBF <sup>5</sup>	38 years for 32 m ShapeArray

# NOTES



<sup>1</sup> One-sigma value, based on cyclical installation in 59 mm ID casing. Accuracy degrades as square root of length.

<sup>2</sup> Value based on AIA (Average in Array) setting of 1000 samples.

<sup>3</sup> Specification is for 3D mode within  $\pm 20^\circ$  of vertical. Vertical accuracy degrades with angular deviation from the vertical.

<sup>4</sup> RMS, calculated from published noise figure of sensor (verified by Measurand Inc.), and bandwidth of system using highest AIA setting of 25,600 samples.

<sup>5</sup> Conservatively based on longevity data for electronic components used in ShapeArray, a) assuming total system failure if any single component fails, b) system powered on 100% of the time, c) ambient 6°C, d) internal temperature rise of 8°C above ambient due to 100% powered-on duty, and e) a benign ambient environment typical of geotechnical instrumentation. MTBF will increase for more typical duty cycles (not powered on 100% of the time). At higher temperatures, MTBF will decrease (e.g. by ~half at 52°C). MTBF is based on "MIL-HDBK-217F Notice 2" performed by, ALD/SoHaR.

## PATENT INFORMATION

ShapeArray and its cyclical installation are patented technology.

Measurand's patents include, but are not limited to:

Shape-Acceleration Measurement Device and Method, Canadian Patent 2,472,421 & 2,747,236

Shape-Acceleration Measurement Device and Apparatus, US Patent 7,296,363

Cyclical Sensor Array, Canadian Application 2,815,199 & 2,911,178

Bipartite Sensor Array, Canadian Application 2,815,195 & 2,911,175

ShapeArray patents include coverage in: United States, Canada, France, United Kingdom, Italy, Japan and Germany.

Installation patents include coverage in United States, Canada, France, United Kingdom, Italy, Germany, China, Hong Kong, and Korea.

Patent families are sufficiently broad to capture most or all usage of ShapeArray in longer lists of countries.

# SPRING BOX ASSEMBLY

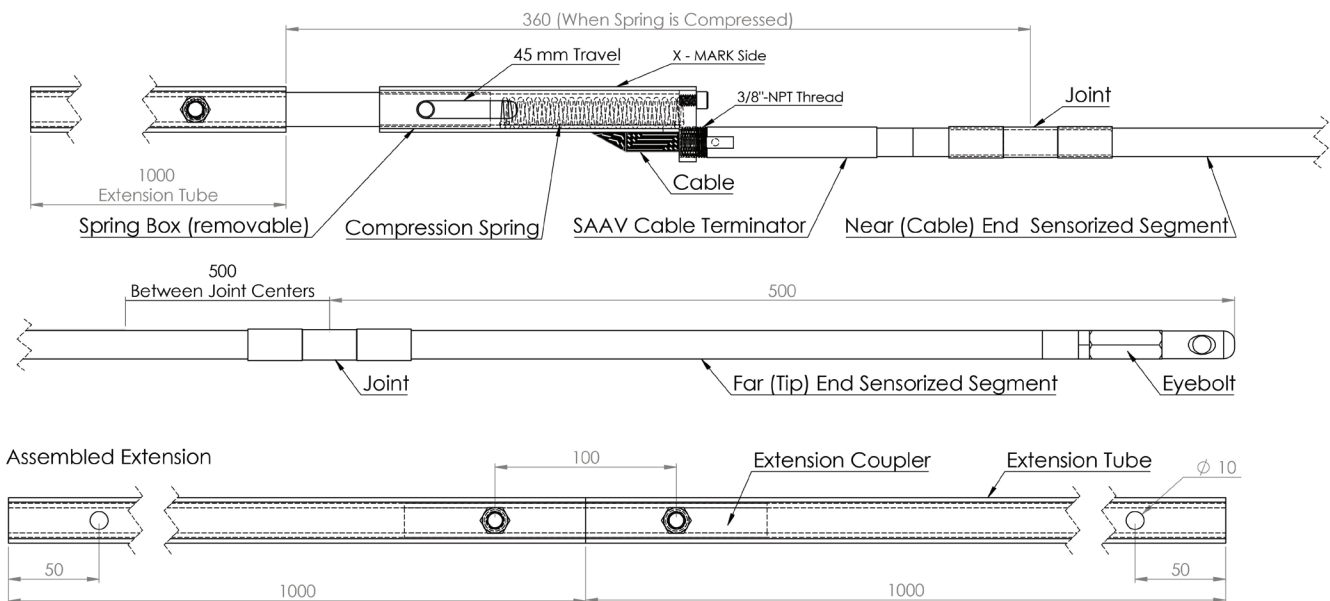


Capped SAAV length = Extension Tube (125 mm min) + Spring Box/Cable Terminator (360 mm) + Sensorized Length -

Extension Tubes: Two 1000 mm Extension Tubes are included. Additional Extension Tube kits are sold separately.

Sensorized length = Near cable end sensorized segment through far tip end sensorized segment.

Sensorized tolerance on measurement: +/- 2 mm unless otherwise stated.



# 27 MM ID CONDUIT ADAPTER ASSEMBLY

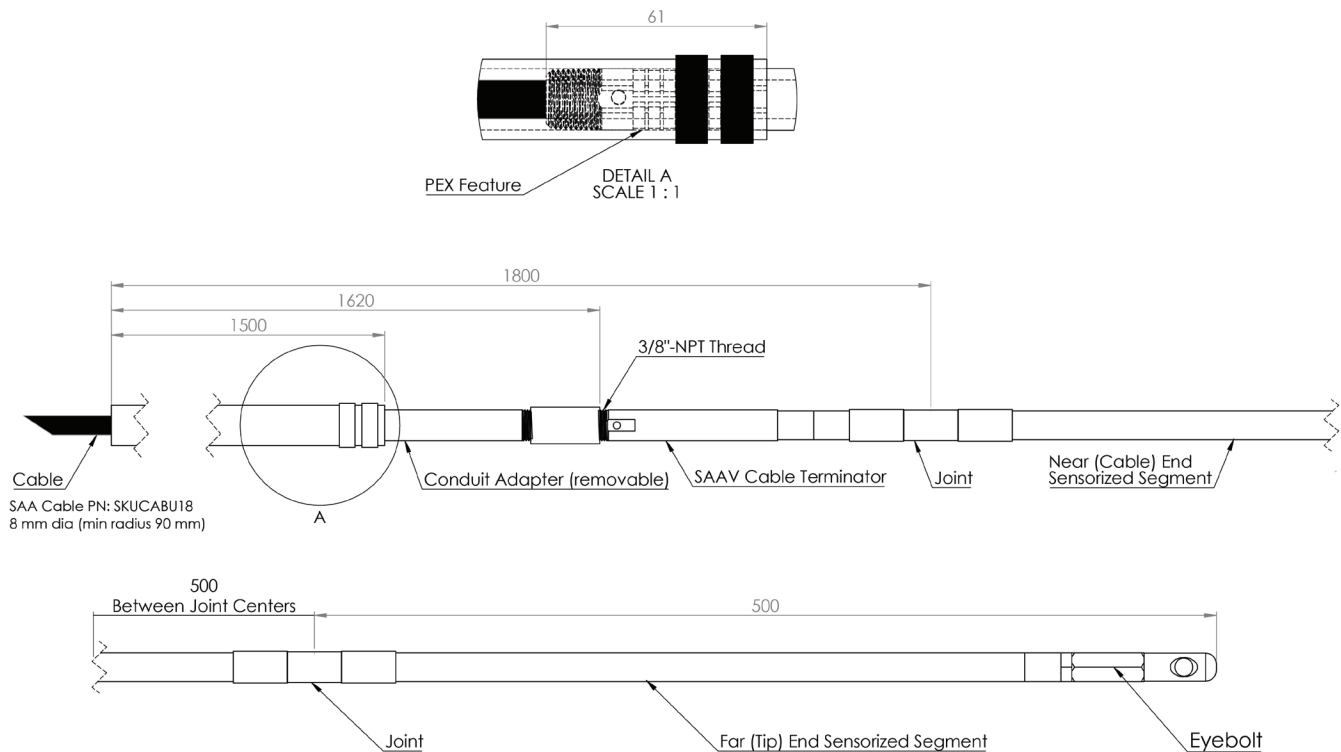


Capped SAAV length = PEX length (80 mm min) + Conduit Adaptor/Cable Terminator (300 mm) + Sensorized Length - Packing (0.5 mm / segment)

Included 1500 mm PEX.

Sensorized length = Near cable end sensorized segment through far tip end sensorized segment.

Sensorized tolerance on measurement: +/- 2 mm unless otherwise stated.



# CONVERGENCE ASSEMBLY



SAAV 250: Casing length = ShapeArray length - 85 mm (if eyebolt removed)

SAAV 500: Casing length = ShapeArray length

\* Suggested Routing Clamps are stainless steel with two mounting points.

For the 1" Trade Size Clamp: Max Fastener Size = 6.7 mm (17/64")

Fastener Spacing = 63.5 mm (2 1/2")

For the 3/4" Trade Size Clamp: Max Fastener Size = 7 mm (9/32")

Fastener Spacing = 54 mm (2 1/8")

\*\* Casing Length = ShapeArray Length (-85 mm for SAAV 250)

{Note: For SAAV 250, Measurand suggests to remove the eyebolt}

\*\*\* Capped Length = Casing Length + 75 mm

