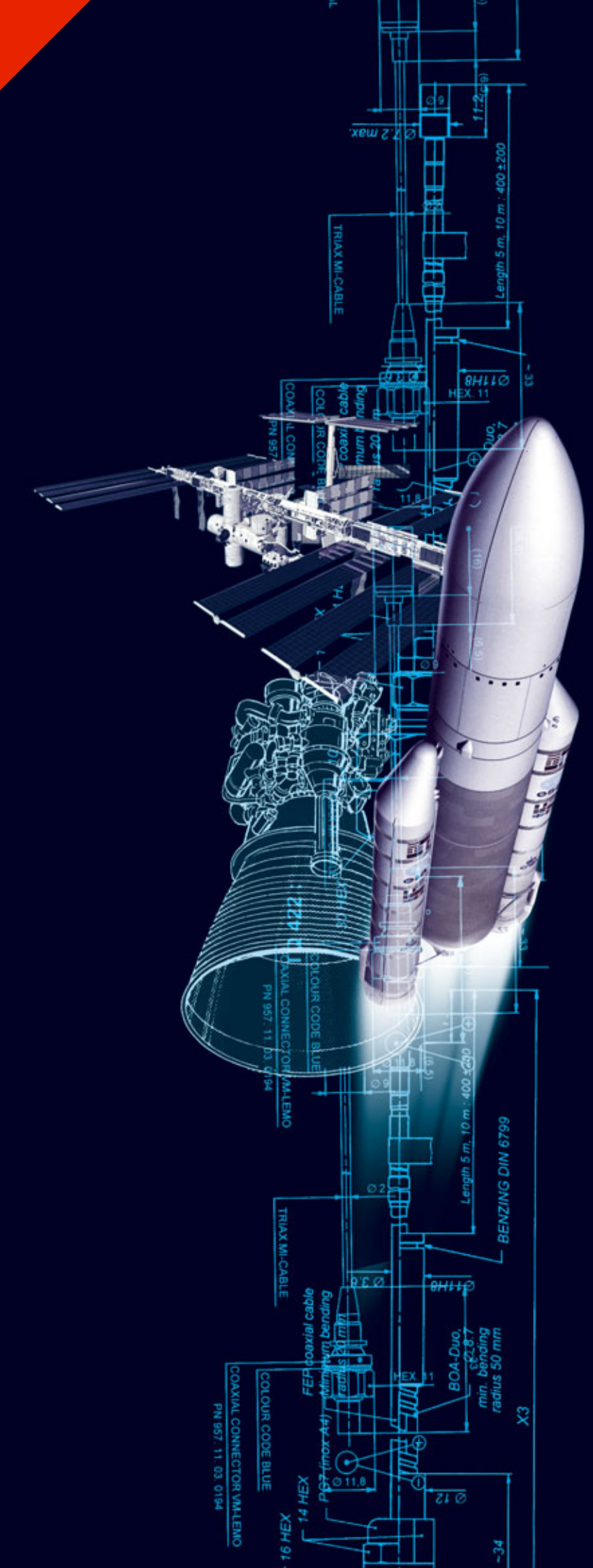
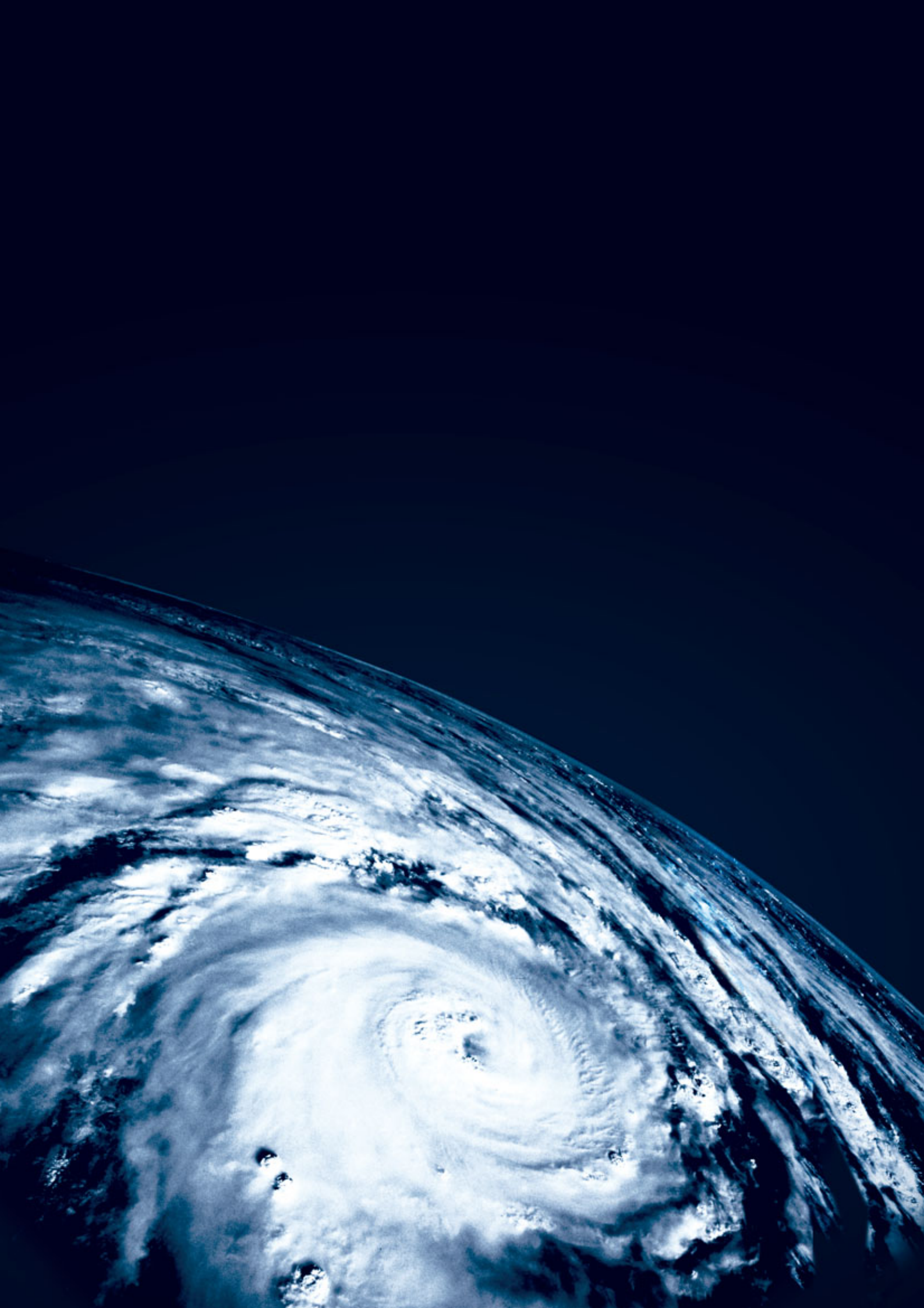
Vibro-Meter

Space systems



MEGGiTT
smart engineering for
extreme environments



Transducers and electronics for launchers and satellites

Vibro-Meter was established in Fribourg, Switzerland in 1952. During the early years, the company concentrated on designing and manufacturing high quality instrumentation. In the mid-1960s, Vibro-Meter expanded into aviation, supplying the first engine vibration monitoring systems for commercial aircraft.

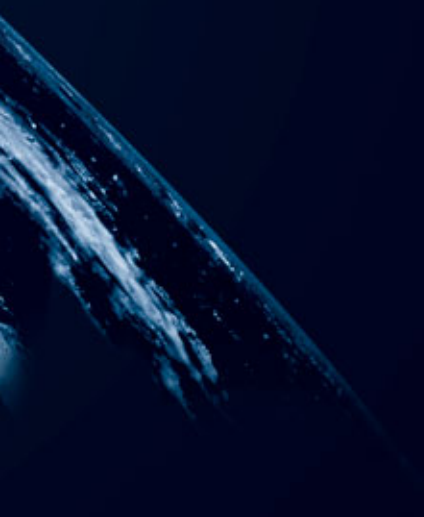
In the early 1970s, Vibro-Meter diversified into the nuclear industry, supplying piezo-electric transducers qualified for start-up, hot functional tests and permanent monitoring of nuclear reactors. The systems designed for these applications were high reliability vibration and dynamic pressure transducers with their associated remote charge converter and interface cables.

Since 1978, Vibro-Meter's nuclear systems have been expanded to cover the monitoring of loose parts, reactor internal vibration monitoring, fuel pin flow-induced vibration, steam generator and in-core fuel flow-induced vibration.

Vibro-Meter's involvement in designing measuring systems for space applications began in 1987, thanks to the experience acquired in designing monitoring systems for aircraft engines and nuclear reactors. Vibro-Meter's instrumentation supported the development of the Vulcain and Vulcain 2 engines of the Ariane 5 launcher. Today, many Vibro-Meter systems are flight qualified for Ariane 5. We measure displacement, relative and absolute vibration, rotational speed and dynamic pressure of the engine's liquid oxygen and hydrogen turbopumps, shocks on pyrotechnic devices, absolute vibration and dynamic pressure of the engine's gas generator and output nozzle and absolute vibration of the whole launcher. Vibro-Meter sensors withstand temperatures from -253°C to +780°C, pressures up to 350 bar and vibration up to 10,000 g.

We advanced our technology further in 1996 when we developed a high resolution proximity sensor (HRSPS) for satellite use under an ESA GSTP contract. The HRSPS is intended to become the standard for space qualified high-resolution displacement measuring systems.

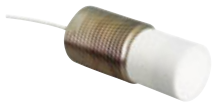
Vibro-Meter's voyage into space was based on experience acquired with jet engines, nuclear reactors, rocket engines and systems for industrial and marine applications. By looking after customers and continually developing our technology, Vibro-Meter remains the world leader in specialised sensors for extreme environment applications.



HRSPS

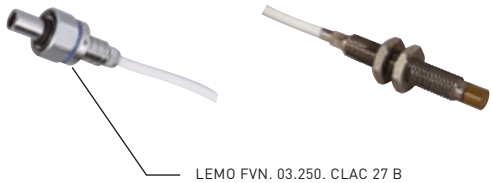
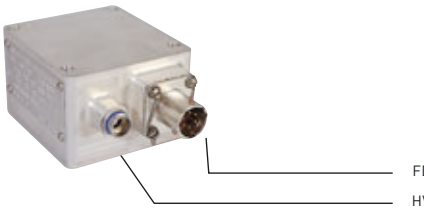
HIGH RESOLUTION STANDARD PROXIMITY SENSOR

SPACE QUALIFIED, HIGH RELIABILITY

	TQ 4X1 IQS 1X4	TQ 4X2 IQS 1X4	TQ 4X3 IQS 1X4
MEASURING RANGE (mm)	± 0.5 DIFF, 0-1 SINGLE	± 1 DIFF, 0-2 SINGLE	± 3 DIFF, 0-6 SINGLE
TIP DIAMETER (mm)	5	8	17
RTI NOISE FLOOR (FSD/√Hz)	1.00 E-07 FSD / √Hz		
LINEARITY (%)	< 0.5 DIFF.		
SENSOR OP. TEMP. (K)	133 to 398		
TRANSDUCER OP. PRESSURE (BAR)	ATMOSPHERIC to VACUUM		
FREQUENCY RESPONSE (Hz)	DC to 16.5 kHz (-3dB)		
CONSUMPTION (W)	< 1.5		
WEIGHT TRANSDUCER (g)	< 100		
WEIGHT CONDITIONER (g)	< 500		
ELECTRICAL OUTPUT	0 to 5VDC OPTIONAL + 7 VDC		
APPLICATIONS	HIGH RESOLUTION SPACE POSITIONING		
FULL DOCUMENTATION	DSS 1829	DSS 1894	DSS 1895
SENSOR DESCRIPTION	 TQ 4X1	 TQ 4X2	 TQ 4X3
	OUTGASING TQ AND CABLE	ASSESSED AND VALIDATED	
CABLE LENGTH (m)	1 to 2 ON REQUEST		
CONDITIONER DESCRIPTION	IQS 1X4 		
CONDITIONER OPERATING TEMP. (K)	218 to 343		
VIBRATIONS	WITHSTANDS THE LAUNCH AND ORBITAL PHASE		
ORDERING INFORMATION	RADIATION LEVEL	10^5 RAD	
	DMS 111 : IQS 114+TQ 46X DMS 124 : IQS 124+TQ 47X DMS 134 : IQS 134+TQ 47X	Engineering models FM for microgravity FM for hi rel applications	

DMS 110

DISPLACEMENT MEASURING SYSTEM

TQ 401 IQS 110	TQ 402 IQS 110	TQ 403 IQS 110	TQ 117 IQS 147
0 to 2	0 to 4	0 to 12	0 to 1.5
5.1	8.2	18	8.5
1.40 E-06 FSD / √Hz			1.40 E-06 FSD / √Hz
< 5			< 5
93 to 493			20 to 323
5			300
DC to 5 kHz (-3dB)			DC to 5 kHz (-3dB)
< 1.1			< 1.1
< 100			< 150
< 230			< 230
0 to 5 VDC			0 to 5 VDC
ARIANE 4, SOFIA			
DSS - 1705			DSS - 1766
TQ 401  LEMO FVN. 03.250. CLAC 27 B			TQ 117  SAME CONNECTOR AS TQ 401
1 to 5 ON REQUEST			4
IQS 110/147  FDBA 50 H 10-6 PN-K HVP .03.250.CLL5.0198			
218 to 343			
SEE DSS - 1705			SEE DSS - 1766
IQS 110 : 201-110-000-XXX TQ 401 : 111-401-000-XXX TQ 402 : 111-402-000-XXX TQ 403 : 111-403-000-XXX DMS 110 : 401-110-000-XXX			IQS 147 : 201-147-000-XXX TQ 117 : 111-117-000-XXX

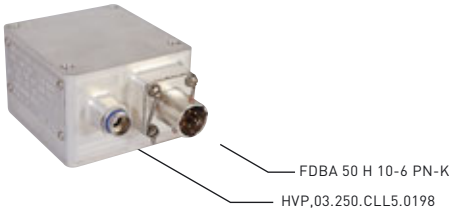
DMS 112

DISPLACEMENT MEASURING SYSTEM

HIGH PRESSURE, LOX, LH2
TQ 116 IQS 631
0 to 3 (DEPENDS ON TARGET)
8.5
DEPENDS ON ENVIRONMENT SEE DSS-1327
20 to 323
300
DC to 5 kHz (-3dB)
< 1.9
< 150
580, FLIGHT: 710
0 to 10 VDC, FLIGHT: 0-5 VDC
ARIANE 5 TURBOPUMPS
DSS-1659
TQ 116  SAME CONNECTOR AS TQ 401
1 to 5 ON REQUEST
IQS 631  SAME CONNECTOR AS SPC 12X / 14X
218 to 343
DSS - 1659
IQS 631 : 204-631-000-XXX TQ 116 : 111-116-000-XXX

SPEED PROBE CONDITIONERS

LAUNCHER QUALIFIED, BUILT-IN TEST EQUIPMENT (BITE)

	SPC 12X	SPC 14X
MEASURING RANGE (RPM)	250 to 150,000	250 to 150,000
ROTATIONAL DETECTION (RPM)	0 to 250	0 to 250
ROTATIONAL SPEED TRANSIENT (RPM/SEC)	150'000	
DRAG ERROR (MSEC)	20	
LINEARITY (%)	LOW SPEED < 0.4, HIGH SPEED < 0.1	
OPERATING TEMPERATURE (K)	213 to 373	188 to 398
POWER SUPPLY (VDC)	22 to 35 VDC	
CONSUMPTION (W)	< 1.3	
WEIGHT (G)	280	
ELECTRICAL OUTPUT	0 to 5 VDC; ^{1}/Rev ^{0}/P for SPC 15X	
BUILT-IN TEST EQUIPMENT (BITE)	100% OF SPEED PROBE, 90% OF INTERNAL COMPONENTS	
APPLICATIONS	VULCAIN 2 AND VINCI TURBOPUMPS, ANY ROTATIONAL EQUIPMENT	
FULL DOCUMENTATION	DSS 1775	DSS 1867
OPERATING WITH THE FOLLOWING SPEED PROBE: TQ 116  OPERATING:TQ 490 SERIES / TQ 117 	SPC 12X / 14X / 15X 	
SENSOR ENVIRONMENT	TITANIUM TA 6V, INCONEL 718	
TARGET MATERIAL	TITANIUM TA 6V, INCONEL 718	
VIBRATIONS	SEE DSS-1775	SEE DSS-1867

SPC 122 : 201-122-000-XXX
SPC 123 : 201-123-000-XXX
SPC 148 : 201-148-000-XXX
SPC 149 : 201-149-000-XXX

Transducers and electronics

- Displacement / position measuring systems for space applications
- Relative vibration measurement for space applications
- Rotational speed measuring systems (150,000 rpm/sec)
- Extreme temperature capability 20 K to 490 K
- Compatility to high pressure LOX and LH2 (450 bar, 6,520 PSI)
- Eddy current measurement principle
- 30 years in eddy current displacement measuring systems

Description

The true contactless eddy current measuring system operates in a RLC parallel network where the amplitude of the oscillation is proportional to the displacement to be measured. The passive sensor consists of a coil (L) and a cable (R, C) fed by a high frequency excitation generated by a nearby conditioner. The magnetic fields that penetrate the front of the sensor induce eddy currents in an adjacent conductive target resulting in an increase of losses, i.e. in a reduction of the amplitude of the oscillator. The value of the equivalent parallel resistance (Rp) will depend on the proximity and the target material. The target is part of the measuring system but can be at any electrical potential. The task of the signal conditioner is to generate the high frequency oscillation and to convert the resulting signal into a linear output proportional to the relative distance of the target.

News

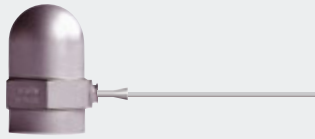
- Small 5 mm tip diameter high pressure sensor for displacement and rotational speed measurements
- HRSPS DMS 111, DMS 124 and DMS 134 can be delivered with an extended range of + 50%, i.e. 1,5 mm, 3 mm and 9 mm in single mode and 0,75 mm, 1,5 mm and 4,5 mm in differential mode

References

Our displacement measuring systems have been used to develop, qualify and fly:

- Ariane 5 VINCI engine
- Ariane 5 Vulcain and Vulcain 2 engine turbopump (LOX/LH2) relative vibration, axial shaft position and rotational speed
- Ariane 4 HM7 B10 LOX turbopump axial shaft position
- Ariane 5 ESC-A HM7B engine
- Stratospheric Observatory for Infrared Astronomy (SOFIA) secondary mirror mechanism (SMM)
- HRSPS DMS 134 with TQ 473 on International Space Station ISS

Ariane 4/5 is a ESA financed program. The company responsible for development and qualification is SNECMA MOTEURS under CNES

	PERFORMANCES	APPLICATIONS	TRANSDUCER OUT
CA250M8xx	ACCELEROMETER 1 pC/g : 0.1 g to 5'000 g Res. Frequ. : 48 kHz Temp. : -253 °C to +777 °C	Extreme temperature	
CP215	DYNAMIC PRESSURE TRANSDUCER 25 pC/bar : + 0.5 mbar to 250 bar Res. Frequ. : 80 kHz Temp. : -190 °C to +780 °C Pressure : 350 bar	Compatible with LOX and LH2 Extreme temperature range	
CP231	MICROPHONE 850 pC/bar : + 0.05 mbar to 20 bar Res. Frequ. : 55 kHz Temp. : -55 °C to +520 °C Pressure : 100 bar	High temperature microphone for buffeting measurement	
CE256	ACCELEROMETER WITH BUILT-IN ELECTRONICS 1,5 mV/g : 0.02 g to 2500 g Res. Frequ. : 58 kHz Temp. : -253 °C to +125 °C	Up to 30 kHZ capability	
CA250M9xx	ACCELEROMETER 1 pC/g : 0.1 g to 5'000 g Res. Frequ. : 48 kHz Temp. : -253 °C to +777 °C	Extreme temperature capability	
CE254	ACCELEROMETER WITH BUILT-IN ELECTRONICS 50 mV/g : 0.001 g to 100 g ; 1 to 2'500 Hz 20 mV/g : 0.001 g to 250 g Res. Frequ. : 25 kHz Temp. : -55 °C to +125 °C	Modal analysis accelerometer Low frequency phase shift vs temperature	
CE252	ACCELEROMETER WITH BUILT-IN ELECTRONICS 5 mV/g ; 0.01 g to 1'000 g Res. Frequ. : 44 kHz Temp. : -253 °C to +125 °C	Cryogenic temperature capability	
PE255	DYNAMIC PRESSURE TRANSDUCER WITH BUILT-IN ELECTRONICS 17 mV/bar : 2 mbar to 100 bar Res. Frequ. : 80 kHz Temp. : -253 °C to +125 °C Pressure : 350 bar	Compatible with high pressure LOX and LH2 Overload static and dynamic 350 bar	

CA 250 M2XX / M8XX :	144-250-000-2XX test bed version	144-250-000-8XX flight qualified version	
CA 250 M30X / M90X :	144-250-000-30X test bed version	144-250-000-90X flight qualified version	
CP 215 M50X :	143-215-000-50X		
CP 231 M1XX :	143-231-000-1XX		
CE 252 M50X :	444-252-000-50X		
CE 254 M03X / M501 :	444-254-000-03X 50mv/g test bed version	444-254-000-501 50 mV/g flight qualified version	
CE 254 M13X / M601 :	444-254-000-13X 20mv/g test bed version	444-254-000-601 20 mV/g flight qualified version	
CE 256 M0XX :	444-256-000-0XX test bed version		
PE 255 M501 / 601 :	443-255-000-02X 5/16"	443-255-000-03X/05X M10x1	443-255-000-50X/60X Flight qualified version

TLINE

GG 180

CG 182 — EC 907 — CG 180

TCC

REMOTE CHARGE CONVERTER

FLIGHT QUALIFIED

	CA250 FSD	CP215 FSD	CP231 FSD
TCC 165	2500 g	100 bar	3 bar
TCC 168	500 g	20 bar	600 mbar
TCC 170	5000 g	200 bar	6 bar
TCC 171	2000 g		
TCC 172	100 g	4 bar	117 mbar
TCC 173	250 g	10 bar	300 mbar

CG 182 — EC 272

CG 182 — EC 212

CG 115 — EB 102

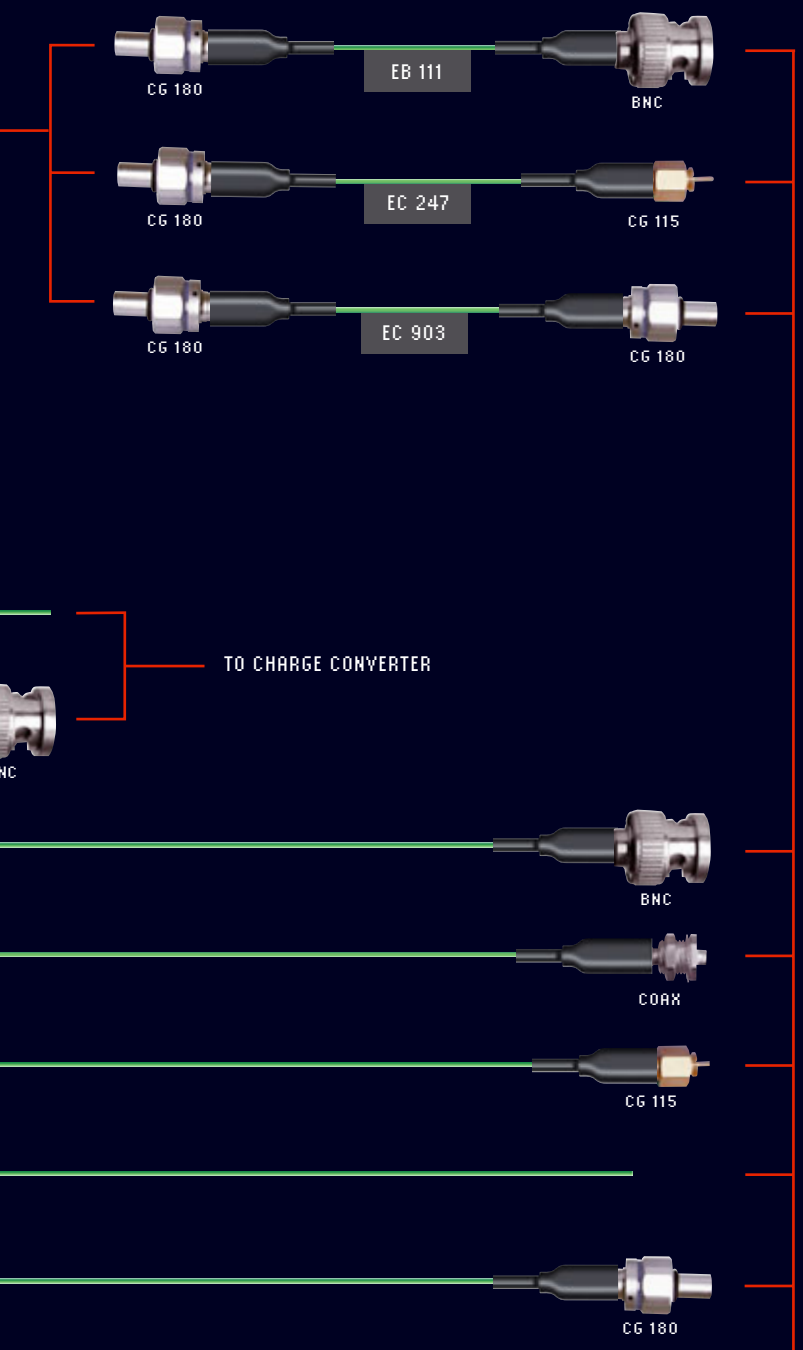
CG 115 — EC 904

CG 115 — EC 264

CG 115 — EC 242

CG 115 — EC 247

EB 102 :	914-102-000 D0X2	Cable	K102	
EB 111 :	914-111-000 D0X1	Cable	K102	
EC 212 :	912-212-000 D0XX	Cable	K102	
EC 242 :	912-242-000 D0X1	Cable	K102	DSS-1615
EC 247 :	912-247-000 D0X1	Cable	K102	DSS-1777
EC 264 :	912-264-000 D0X1	Cable	K102	DSS-1695
EB 272 :	912-272-000 D0X1	Cable	K102	
EC 903 :	912-903-000 D0X1	Cable	K188	
EC 904 :	912-904-000 D0X1	Cable	K102	DSS-1740
EC 907 :	912-907-000 D0X1	Cable	K102	DSS-1778



TRANSFER FUNCTION OF TCC

TCC 165	TCC 168
1 mV / pC 1 Hz - 10 kHz 5% 6 dB / oct	5 mV / pC 1 Hz - 2.5 kHz 5% 6 dB / oct
TCC 169	**TCC 170**
0.5 mV / pC 1 Hz - 10 kHz 5% 6 dB / oct	0.5 mV/pC 1 Hz - 10 kHz 5% 6 dB / oct
TCC 171	**TCC 172**
1.25 mV / pC 30 Hz - 3 kHz (-3dB) 18 dB / oct	25 mV / pC 5 Hz - 500 Hz (-3dB) 18 dB / oct
TCC 173	
10 mV / pC 5 Hz - 500 Hz (-3dB) 18 dB / oct	

POWER SUPPLY

CONSTANT CURRENT: 4 TO 20 mA

NOMINAL: 6 mA

VOLTAGE LIMIT: < 22 VDC

TEMP: -55 C TO +100°C

TCC 165 :	241-165-000-01X	DSS-1433	
TCC 168 :	241-168-000-01X	DSS-1428	
TCC 169 :	241-169-000-01X	DSS-1429	
TCC 170 :	241-170-000-01X	DSS-1430	
TCC 171 :	241-171-000-50X	DSS-1694	Flight qualified version
TCC 172 :	241-172-000-50X	DSS-1874	Flight qualified version
TCC 173 :	241-173-000-50X	DSS-1875	Flight qualified version

Transducers and electronics

- Absolute vibration for rocket engine LOX/LH2 turbopumps, output nozzle and solid propellant boosters
- Dynamic pressure for the engine's gas generator
- High temperature microphones for in-flight aerodynamic pressure/flow measurements
- Extreme temperature capability: 4 K to 1050 K
- Dynamic pressure measuring range: 0,05 mbar up to 350 bar
- Our vibration and pressure measuring systems are the result of over 40 years' experience
- Piezoelectric transducers
- No maintenance required

Description

Our vibration and pressure measuring systems, charge converters and cables cover the full range of measurement applications needed for rocket engine development. They are the result of 40 years' use on jet engines and 20 years on rockets.

The accelerometers and pressure sensors are both built with a piezoelectric material as sensitive element, showing a linearity better than 1%. Their hermetically-sealed construction and absence of moving parts means they can be relied on in the most extreme environments.

Some transducers are available with built-in electronics. High temperature transducers must be connected to charge converters. Both use the two-wire technique and require a typical constant current of 6 mA.

References

Vibro-Meter vibration and pressure transducers have been used for developing, qualifying and flying:

- Ariane 5 main engine Vulcain and Vulcain 2
- Ariane 5 second stage engine Vinci
- Various satellite applications
- JAXA, H2 A

Vibro-Meter

Since its foundation in 1952, Vibro-Meter has established itself as a leader in designing and manufacturing electronic measurement and processing systems. The company's most significant asset is its ability to engineer reliable, high-quality, customer-oriented solutions.

Vibro-Meter's space division offers piezoelectric, vibration and dynamic pressure instrumentation qualified for space applications within extreme environments ranging from 4 K to 1100 K (-4520°F to 1520°F). The displacement and speed measurement sensors have an extreme environment capability allowing them to be used in liquid LOX, LH2 or in a space vacuum. The piezoelectric sensors are supplied with internal electronics or charge converters. The displacement and speed measurement sensors come with external electronics. All electronics are qualified for use in space.

Vibro-Meter is a specialist in avionics, transducers and cables for the engine vibration monitoring systems used on almost all commercial aircraft and engines. This experience, producing highly reliable products, has also been applied to the central maintenance computer, data management unit and specific advanced engine vibration monitoring and health systems.

The space industry benefits from Vibro-Meter's vast experience on health monitoring systems in aerospace and industry. As well as traditional space rocket engine instrumentation, Vibro-Meter has been awarded contracts on reusable launcher engine health monitoring systems [ESA Future Launchers Preparatory Programme FLPP] covering health monitor hardware and software architecture definition, turbomachinery vibration analysis and delivery of the turbopump hardware prototype.

Vibro-Meter is a Meggitt group company. Headquartered in the UK, Meggitt PLC is an international group of companies operating in North America, Europe and Asia. Known for its specialist extreme environment engineering, Meggitt is a world leader in the aerospace, defence and electronics industries.

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