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INTERNAL REPORT

THE RYGGFONN PROJECT

DESCRIPTION OF INSTRUMENTATION AND DATA REGISTRATION SYSTEM.

By Terje Kvisterøy

58120-3 10 Juni 1983

Norges Geotekniske Institutt

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S U M M A R Y

The Ryggfonn avalanche path has been instrumented to measure: deflections on a 6 m high steel mast mounted at top of the test embankment by means of weldable strain gauges; wind speed of powder snow fronts by means of a three direciton propeller based wind speed sensor; snow pressure forces on an 18 cm diameter strain gauge based load cell mounted at top of the test embankment; axial tension in three high tension cables crossing the avalanche path by means of strain gauge based in-line load cells; snow pressure forces acting upon a 4.5 m high concrete structure by means of three strain gauge based load cells totally covering the wall facing the avalanche; vertical vibration velocity by means of a seismometer mounted at the concrete structure.

Skj.nr.092.Mars 77.1000.Reclamo.

Norwegian Geotechnical Institute NGI

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Much effort has been made to protect sensors and cables from mechanical destruction and to protect sensors from generated high electrical potentials.

Data is recorded using a small and battery operated Pulse-Code-Modulation system with 12-bit resolution.

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1. GENERAL

In 1981 a test embankment for providing protection from avalanches was built in the vicinity of NGI's snow research station at Grasdalen in western Norway. The experimental embankment, which is 15 m high and 100 m long and constructed of moraine, is located at the lower end of the Ryggfonn avalanche path. It has been constructed to provide full-scale performance data needed for evaluation of different methods of protecting buildings in avalanche prone areas. In 1982 the program was expanded through a collaboration with NVE (Norwegian Water Resources and Electricity Board) to include measurements of snow pressure forces acting upon constructions in the avalanche path.

On top of the test embankment a 6.5 m high steel mast has been erected. The mast is instrumented with strain-gauges for measuring deflections on the mast as well as a three directions (X, Y, Z) wind speed sensor mounted at top of the mast for measuring powder snow wind fronts. An 18 cm diameter load cell is mounted at the east end on top of the embankment at a location reconed to be exposed for dense snow flow. A few hundred metres up the avalanche path; axial tension at both ends of high tension cables crossing the slide path at a height of respectively 8, 12 and 16 m is measured. In the centre of the avalanche path a 4.5 m high and 0.6 m wide concrete structure has been constructed. Three rectangular load cells, each 1.20 x 0.6 m, completely covers the front end of the concrete structure facing the avalanche. A vibration sensor measuring vertical vibration velocity is also mounted to the concrete structure. A special problem arose in locating the recording equipment. This had to be placed at a resonable safe loction and should be manually operated. The location for a small instrumentation hut ultimately selected, led to cable lengths of up to approximately 700 m.

To be able to make registrations, the avalanche must be artificially released and the test site is equipped for releasing three

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avalanches a year. During registration the avalanche will be photographed both in front and from the side for estimation of the speed and size of the avalanche. Description of explosives releasing system and photographic systems will not be given in this report.

All instrumentation work was carried out during autumn 1982 by personell from NGI and NVE. For these purposes a construction site road was built to each instrumentation point. Both track vehicles and helicopters were used to a great extent during the installation work. The instrumentation hut was prefabricated and lifted in place by use of helicopter.

A general view of the test site is given in fig. 1. A table in fig. 1 also gives general details of the Ryggfonn avalanche.

2. INSTALLATION STRUCTURES AND SENSORS

A general rule in this project was to use well proven standard comercial sensors when possible. The installation structures were constructed to incorporate these sensors in a correct way. The high dynamic frequency range (typ. DC-kHz) of strain gauge based sensors was maintained by a rigid mounting between the sensors and the installation structurs.

2.1 **Steel mast at top of test embankment**

This installation is shown in fig. 2. A 5 m high steel tube with top flange was fundamented 4 m down in the top of the test embankment. To this fundament a 5.6 m high and 0.3 m diameter steel tube with bottom flange was mounted.

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The steel mast was instrumented with 6 weldable strain gauges of type Ailtech SG-359-11-25-65 at two cross sections. The manufacturers description and specification of these gauges is given in Appendix A1. At the lower cross section a strain gauge was mounted at each quadrant and at the upper cross section one strain gauge was mounted at the avalanche side and the other 180° oposit.

The gauges were due to the mouting procedure mounted at the outer surface of the steel mast and therefore protected by steel covers filled with petroleum jelly. The shielded sensor cables were penetrating the steel walls of the mast inside the protecting covers and pulled straight into a local junction box at the lower end of the mast.

The dimensions of the mast was choosen to give yield point strain (typ. 1250 με) at the flange level with a linear snow powder pressure at 4 t/m^2. This would provide for maximum signal level from the strain gauges. A calibration test was performed by using a wire from top of the mast to a winch mounted on a track vehicle placed approximately 100 m up the avalanche path. Details of calibrations are given in Appendix B1. Readings were taken using a portable digital strain meter.

At top of the mast a three direction wind speed sensor of type R.M. Young Company Gill UVW Anemometer model 27004j was mounted. The manufacturers description and specification of this sensor is given in Appendix A2. The range for the high resolution propeller is 50 m/s. Calibration of the propeller is given in Appendix B2. The shielded cable from the sensor was protected by a steel hose a short distance before penetrating the mast wall and pulled down inside the mast and straight into the junction box. The sensor assembly was strengthened to withstand the high forces using a special made steel construction mounted at top of the mast.

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2.2 Load cell at top of test embankment

This installation is shown in fig. 2. A 1.8 m high steel tube with top flange was fundamented 1 m down in the top of the test embankment. To the flange an 18 cm diameter circular load cell was mounted. The load cell assembly was constructed using a strain gauge based sensor of type Kyowa BL-500KB. The manufacturers description and specification of the sensor is given in Appendix A3. Calibration sheet is given in Appendix B3. The sensors full range snow pressure is 1.96 kg/cm^2.

Both the cable and a local junction box were mounted inside the steel tube and therefore completely protected.

During the installation the load cell was tested using known static weights and a portable digital strain meter.

2.3 High tension cables crossing the avalanche path

This installation is shown in fig. 3. Two 16 m high masts were installed one on each side of the avalanche path with a distance between them of approximately 150 m. Both masts were fundamented using big concrete blocks under the ground interconnecting all four mast feets.

Three high tension cables were installed at three different heights respectively 8, 12 and 16 m above the ground and instrumented with an in-line load cell at both ends. The strain gauge based load cell used was of type R.D.P. Ltd. Sensotec RM 50klbs. The manufacturers description and specification of the sensor is given in appendix A4. Calibration data is given in Appendix B4. The instrumentation assembly was made up of tongue- and yoke-shackles as well as a rotation device. This provides for minimum linear and rotational moment acting upon the sensor as well as providing for the sensor to closly follow the axial direction of the cable. The full range of the sensors is 50 klbs tension.

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During installation the cables were pulled to approximately 3 t tension and the sensor output signal was checked at this static load using a portable digital strain meter.

The shielded sensor cables were pulled through a protecting steel hose and strain reliefed at both the sensor side and the mast side. A local junction box was mounted at a working platform at 12 m level in the masts.

To by-pass eventual high developed potentials on the high tension cables a 25 mm^2 copper wire is connected parallel to the instrumentation assembly.

2.4 Concrete structure in the avalanche path

This installation is shown in fig. 4. In the middle of the avalanche path a 4.5 m high and 0.6 m wide concrete structure was fundamented direct to rock. The 0.6 m wide side facing the avalanche was instrumented with three rectangular load cells of 1.2 x 0.6 m each. Mounted at three sucessive following heights they are capable of measuring snow pressure at three different heights in the dense snow region. The reason for covering the complete wall with load cells is to measure total load acting upon the wall and therefore avoid difficult assumptions of eventual edge effects. Load cells with big surfaces will also provide for an averaging of local pressure effects.

Each load cell assembly is based on the use of three load cell support points. The nine strain gauge based support load cells are of type Bofors KIS-1 20 t. The manufacturers description and specification of the sensors is given in Appendix A5, and the calibration data is given in Appendix B5. A special self aligning bearing system was made to suspend the load cell plates to the support sensors. This system will take care of eventual temperature effects on the load cell assembly. Shear force com-

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ponents will not make any significant influence on the measurements.

Each load cell has a full range of 83 t/m^2.

The shielded sensor cables were pulled through a protecting steel hose which was pulled straight into cable penetration tubes in the concrete structure. The steel hose is protected in a steel tube at places which can be exposed to snow pressure. All sensors cables were terminated in a local junction box mounted at the back of the concrete structure. This junction box is protected with steel plates.

Just beside the junction box a vibration sensor of seismometer type was installed with a vertical sensitive axis. This sensor of type Applied Magnetics Geo Space HS-1 miniature geophone gives an output signal proportional to the vibration velocity amplitude. The manufacturers description and specification of the sensor is given in Appendix A6, and calibration data is given in Appendix B6.

3. CABLING AND OVERVOLTAGE PROTECTION

3.1 **Cabling**

From each of the five measuring points a multipair armoured cable with a petroleum jelly filled core was run to the measuring hut located approximately 300 m west of the test embankment. Fig. 1 shows the cable paths. The cables are of type STK (Standard Telefon og Kabelfabrikk) FEQE. The manufacturers description and specification of the cable is given in Appendix A7.

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At snow avalanche exposed areas the cables were dug into the ground. In the especially difficult area close to the concrete structure the cable was protected by solid steel plates.

The mulitpair cables are connected to the sensors through screw type terminals in the local junction boxes. All five multipair cables are terminated in screw type terminals at a marshalling cabinet located on the wall of the measuring hut.

A one-line diagram of the cabling system is shown in fig. 5. Appendix C1, C2, C3, C4 and C5 contains complete wiring diagrams.

To avoid humidity, silica gel is placed inside each junction box.

3.2 **Overvoltage protection**

Damage to sensors and associated electronics due to accumulation of static charges or induction of high potentials from direct lightning flashes are often experienced in mountain areas in western Norway. In our case up to 700 m cable lengths make this problem even more crude. To minimize the problem, Faraday's cage principle is used between the local junction boxes and the sensors. This was acheived by carefully terminating the protecting steel hoses on the outer surface of sensors and cable glands. A 25 mm^2 copper conductor was run along all multipair cables and is interconnection all installation structures and all armourings to form an equipotential system. To short circuit eventual high potential differences, bipolar supression diodes of type General Semiconductor Industries Inc. Transorb 1N 6042 A are used for each conductor at each end of all cables. The manufacturers description and specification of the diodes is given in Appendix A8.

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No part of the measuring system is connected to 220 VAC mains line power which is advantageous in respect to overvoltage protection.

4. DATA REGISTRATION SYSTEM

4.1 **Measuring circuits**

Some basic principles were followed to minimize errors in the strain gauge measurements. For all measuring channels a 6 wire system is used. This provid for remote sensing of the bridge excitation voltage and therefore eliminates errors due to unknown voltage drop in supply leads. For all circuits full symmetry was tried to be achieved in connections, installation and location. This provid for elimination of thermoelectrical effects due to different temperature on different connection points as well as different resistance changes at unsymmetric bridge conductors due to temperature changes and mechanical stresses. Lead lengths within bridge connections were also minimized to a practical limit. All self-contained sensors used were based on temperature- and offset- compensated full bridge connections.

At the concrete structure three sensors were parallel connected at the junction box to give a signal proportional to the total load at that load cell. The Ailtech strain gauges were internal equiped with a dummy gauge which allowed us to use a half bridge connection for the four lower strain measuring points. This provid for total symmetry in respect to temperature compensation. The two upper gauges was connected to form a full bridge at the junction box. This will give a signal proportional to the bending stresses. All half-bridge connections were supplemented with dummy gauges at the signal conditioning side to form a full bridge.

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DC-voltage is used to excitate the bridges. DC-excitation will not give problems with capacitive unbalance due to long cables compared to AC-excitation. Offset-drift is not considered to be a problem since measurements take place not long after null-balancing the signals. The noise level is considered to be very low due to the fact that no electrical installations excist in the area and the data registration system is battery powered. DC-voltage excitation provides for easy testing both at the sensor- and signal conditioning side by use of hand held digital multimeters. To improve the signal to noise ratio maximum allowable voltage level is used for each channel (typ. ±5 VDC).

Basic bridge circuits for the system is shown in fig. 6.

The DC-output voltage from the wind speed sensor is interfaced direct to the signal conditioning amplifier.

To achieve correct damping for the vibration sensor a matched load-resistor is included at the signal conditioning input side.

Basic measuring circuits for wind- and vibration sensors are shown in fig. 6.

4.2 **Data recording system**

All data recording units are installed in the measuring hut during measurements. The inside of the hut is heated to above 0°C with use of a propan oven.

A block diagram of the data recording system is shown in fig. 7. The main part consists of bridge DC-differential amplifiers with automatic null-balance and automatic adjustment of bridge excitation voltage using the remote sensing signals; standard DC-differential amplifiers for wind and vibration channels; 5-pole Butterworth lowpass filters to improve signal to noise ratio and to eliminate aliasing errors; analog multiplexers to

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multiplex 32-channels to a 2-channel system; PCM-modulator which digitize the analog signals to 12-bit (1 part in 4096) accuracy and puts the digital signals on a serial bit-stream; magnetic tape-recorder to record the digital data.

To check the recorded data a PCM-demodulator which resyncronize and serial to parallel convert the data is necessary as well as a digital to analog converter.

Except for the small battery operated tape recorder all parts of the data recording system are installed in a small (40 x 60 x 40 cm) and rough cabinet.

The complete system is powered from a 24 V battery through three DC/DC converters. Maximum current consumption is approximately 4 A.

All measuring signals are connected to the system using 4 m long individual and shielded cables form the marshalling cabinet. Wiring diagrams for these cables are given in fig. 6.

The DC-excitation signal is ± V in respect to PCM-system power common which in turn is connected to the interconnecting copper wire system and the battery minus pole.

All parts of the data recording system are of type Johne + Reilhofer Multidin and description of these system modules are given in Appendix A9. This appendix includes block diagrams describing PCM (Pulse-Code-Modulation) technique as well. Description and specification of the type Brandner KG Industrie-Elektronik DC/DC Converter SR 992 is given in Appendix A10.

Bridge excitation voltage level and amplification level are adjustable inside the amplifier modules. Low pass filter cut-off frequency are selectable through switches. Sampling rate is selectable by choosing an oppropriate number of channels and a bit rate. In this set-up the number of main channels are 2 and

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the bit-rate 160 kbit/s which gives a sampling rate of 333.33 samples/s for each of the 32 premuliplexed channels. The sampling is not simultaneous but time-multiplexed between channels. The filters are set to a cut-off frequency of 75 Hz.

Filter response curves for this type of filter are given in fig. 8. Table 1 summarize sensor serial numbers, sensor calibration factors and channel amplification levels.

The bridge amplification modules include a functioning test feature. In this mode the channel under test do have one of the sensor bridge arms parallel connected to a known internal resistor which in turn shall give a known output signal. In this way both sensor and data registration system are tested.

For easy operation, null-balancing the bridge channels are done automatical after pressing a switch to a 15-bit digital accuracy.

5. FIRST PHASE SIGNAL PROCESSING

The first phase signal processing consists of converting the PCM-formated tape to a standard 1600 bpi 9-track computer tape. This is done at NGI using a HP-1000L minicomputer with tape station. See fig. 7.

A PRIME-750 computer is used to read this tape and to put data as well as calibration values on a file directed structure. Computation of engineering values with a following first time plotting of data can now be performed.

Reference to wanted time scale; eventual correction of linear drift; eventual interpolation to achieve simultaneous sample-points and eventual fourier transforms to check frequency distribution of signal energy can now take place.

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Furhter signal processing will typically be performed during data analyses and are not considered in this report.

6. MISCELLANEOUS

A few modifications on the data registration system are planned before the 1983/84 season.

The PCM bit-stream will be put through a 384 kbit digital delay device of type Johne + Reilhofer VS13 with internal single channel event detector. The event detector will trig the tape recorder in case of positive detection of snow avalanche pressure at the upper load cell on the concrete structure. The battery capacity will be increased to last for approximately 100 hours. A PCM-timecode generator will be included in the system as well.

These modifications will allow the operator to turn on the system, which will operate automatically for 100 hours, during periods with high probability for natural released snow avalanches.

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T A B L E 1

Sensor	Serial no.	Calibration		Channel no.	Amp.x
SL-1	-	0.475	µv/v/µε*	1-1	398
SL-2	-	0.475	µv/v/µε*	1-2	398
SL-3	-	0.475	µv/v/µε*	1-3	398
SL-4	-	0.475	µv/v/µε*	1-4	398
SL-5A	-	0.475	µv/v/µε*	1-5	398
SL-5B	-	0.475	µv/v/µε*	1-5	398
TC-1	BH2564	2.310	µv/v/kg	1-6	398
SC-1	78351	43.9	µv/v/klbs	1-7	200
SC-2	78349	43.9	µv/v/klbs	1-8	200
SC-3	78350	43.7	µv/v/klbs	1-9	200
SC-4	78348	43.8	µv/v/klbs	1-10	200
SC-5	78347	43.9	µv/v/klbs	-11	200
SC-6	78346	43.7	µv/v/klbs	1-12	200
LC-1A	51298	100	µv/v/t	1-13	200
LC-1B	51581	100	µv/v/t	1-13	200
LC-1C	51577	100	µv/v/t	1-13	200
LC-2A	51576	100	µv/v/t	1-14	200
LC-2B	51571	100	µv/v/t	1-14	200
LC-2C	51277	100	µv/v/t	1-14	200
LC-3A	51289	100	µv/v/t	1-15	200
LC-3B	51566	100	µv/v/t	1-15	200
LC-3C	51296	100	µv/v/t	1-15	200
TG-1	-		-	1-16	-
VM-1	-	56.8	mv/m/s	2-1	1
VM-2	-	56.8	mv/m/s	2-2	1
VM-3	-	56.8	mv/m/s	2-3	1
RM-1	-	15.3	mv/mm/s	2-4	1

* Based on factory data: Gauge factor = 1.90 ±3%

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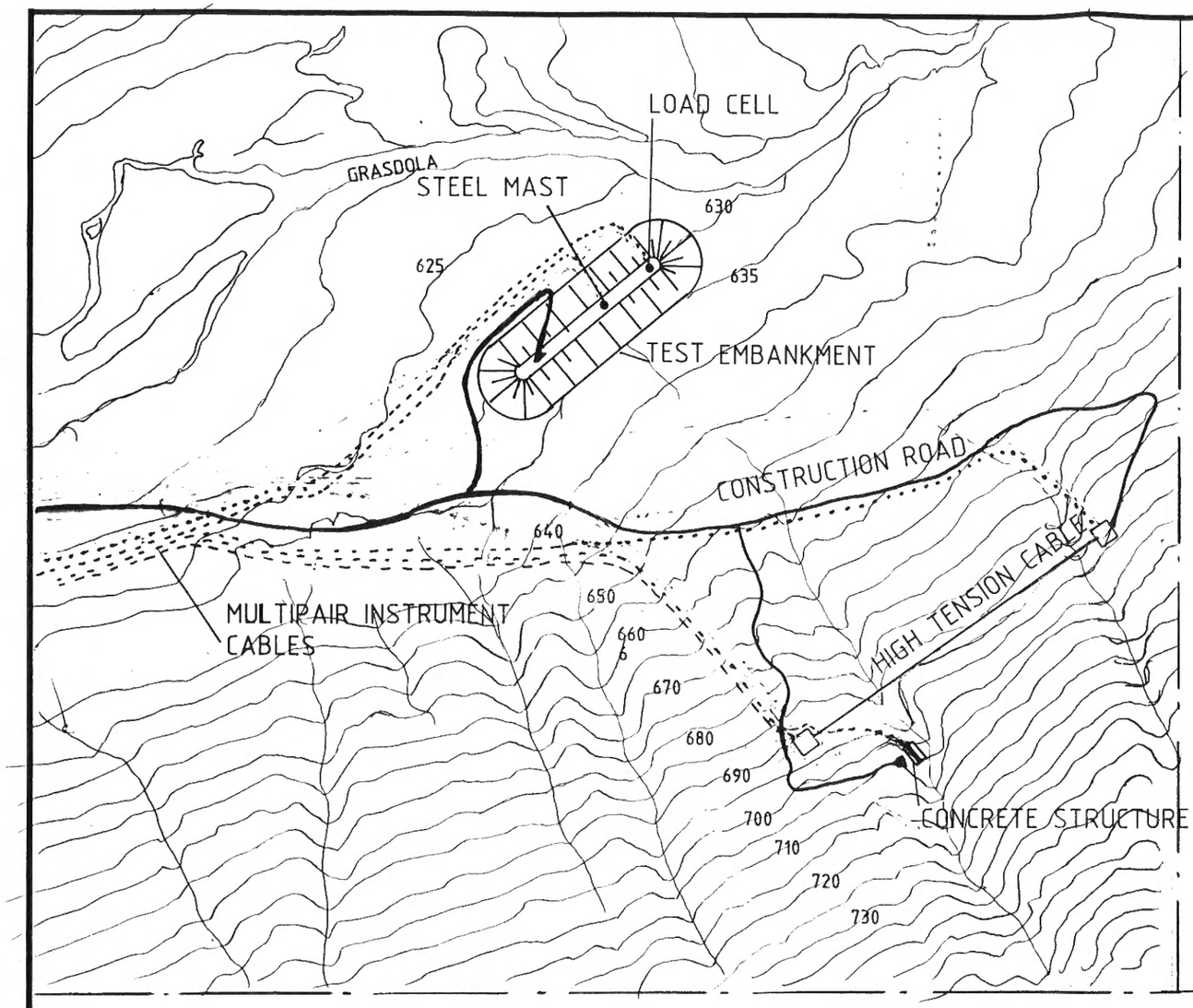

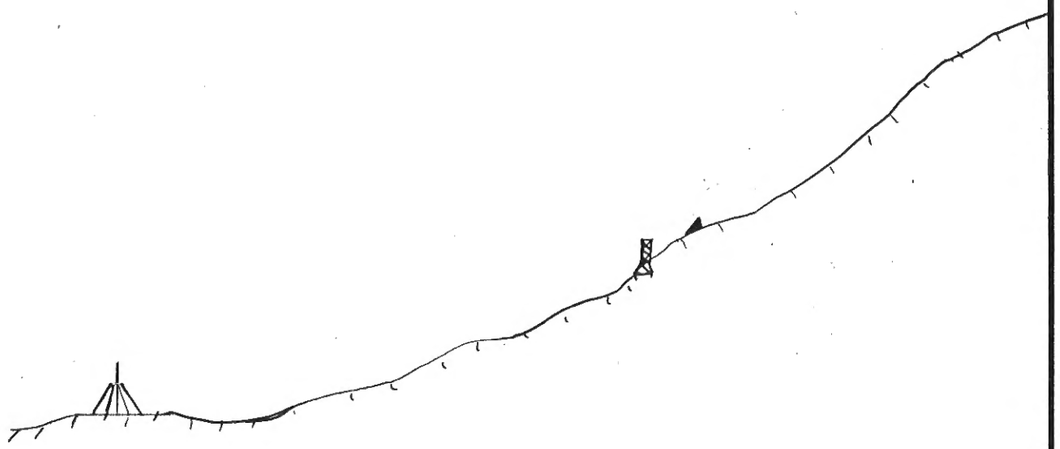

SECTION THROUGH TEST SITE

DETAILS OF RYGGFONN AVALANCHE.

HEIGHT DIFFERENCE OF AVALANCHE PATH :940M
MEAN SLOPE FROM TOP TO TEST EMBANKMENT :28°.
TYPICAL MAX VELOCITY : 40-60 M/S
TYPICAL SNOW CONTENT : 50000-200000 M^3

No. of	No.	Item description	Drwg. No.	Material	Dimensions	Supplier/Notes/Spec.

Max. deviations for dimensions without tolerance indications.
NS 1430 Middle
O-ring grooves, confer drwg. 34536

Surface finish/Treatment/Coating:

Cat. No.

Parts list/Assy. drwg.

Date	Changes	Sign.

THE RYGGFONN-PROJECT
GENERAL VIEW OF TEST SITE.
DETAILS OF RYGGFONN AVALANCHE

Scale

Drawn by/Date
Confer
Approved
Group

Norwegian Geotechnical Institute
P.O.Box 40 Tåsen
Oslo 8
Norway
Telephone:
(02) 23 03 88
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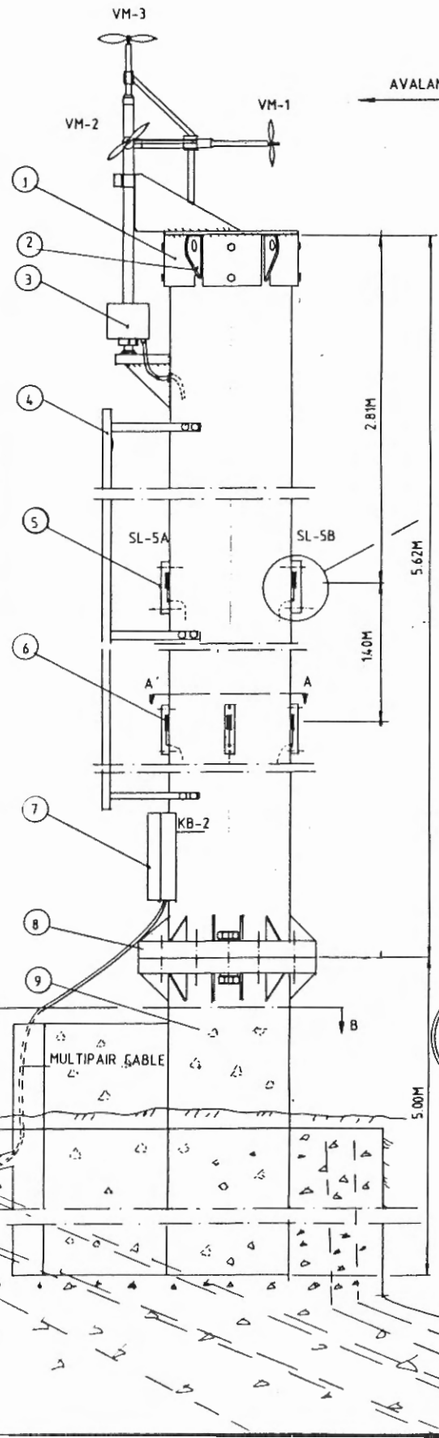
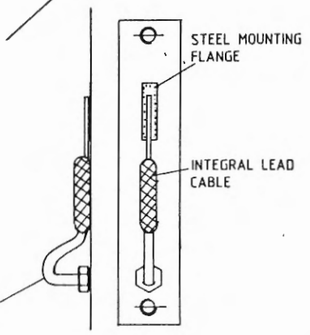
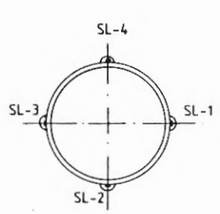
Substn. for | Substd. by

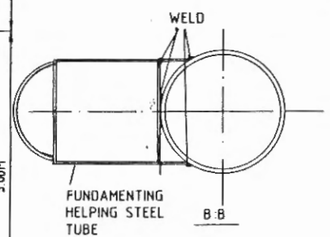
Drwg.no.

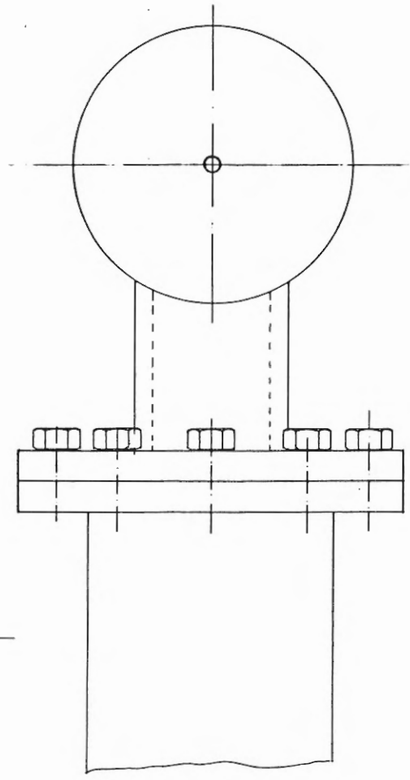
FIG.NO 1

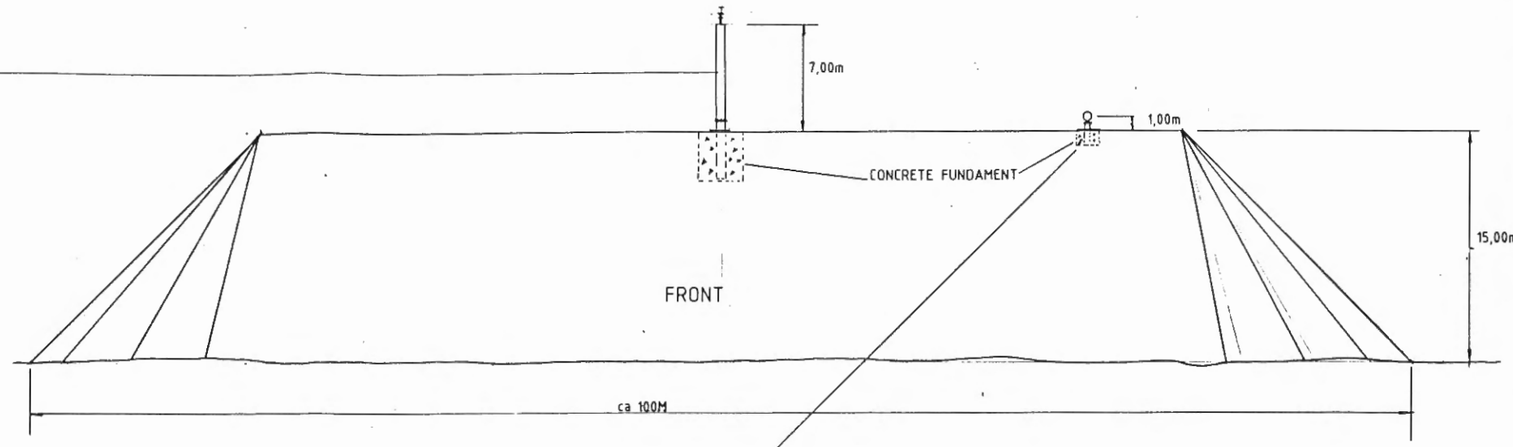


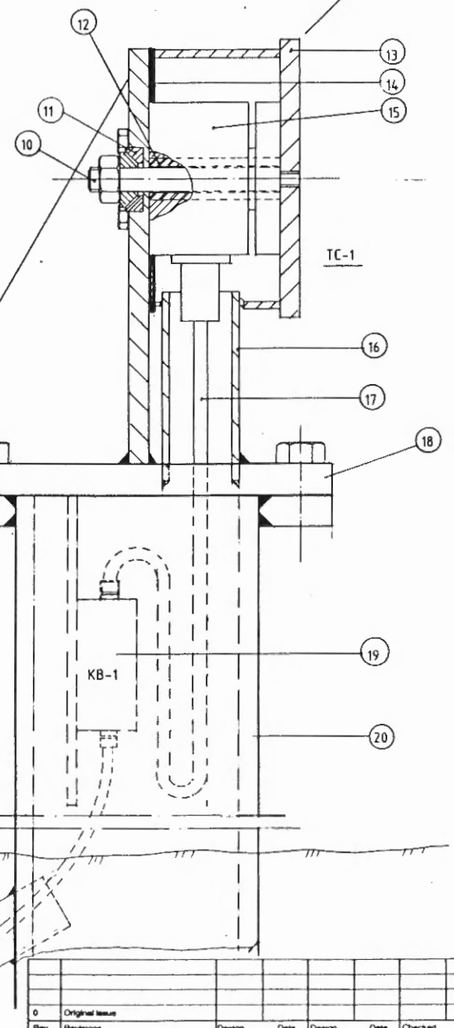












1	20	Main pipe	St	ϕ150x12x2000	
1	19	Local junction box		K3-3498,0	
1	18	Blind flange	St,52-3	ϕ250x20	
1	17	Cable			
1	16	Protection pipe	St		
1	15	Load cell		BL-500KB	
1	14	Rubber gasket			
1	13	Pressure plate	St,52-3	ϕ180x12	
1	12	Teflon bush			
1	11	Spherical bearing		GX-15F	SKF
1	10	Center bolt			
1	9	Pipe	St,52-3	ϕ273x16x3000	
2	8	Flange	St,52	NS 2527	
1	7	Local junction box			
6	6	Straingauges			Ailtech
6	5	Protecting cover			
1	4	Ladder	St		
1	3	Anemometer		Gill VVW	R.M Young
4	2	Lifting lugs	St		
1	1	Cap	St		
No. of	No.	Description	Material	Dimensions/Standard	Supplier/Notes

Max. deviations for dimensions without tolerance specifications: NS 1430 Middle

Surface finish

Scale

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Subst. for | Subst. by

THE RYGGFONN-PROJECT.

INSTRUMENTATION AT TOP OF TEST EMBANKMENT

Drwg. no. FIG NO 2 | Rev.

Assy. drwg. / Parts list | Rev.

Ref. no. 58120-3

Rev. Index	Revisions	Design Date	Design consultation Date	Checked Date	Approved Date
0	Original issue				

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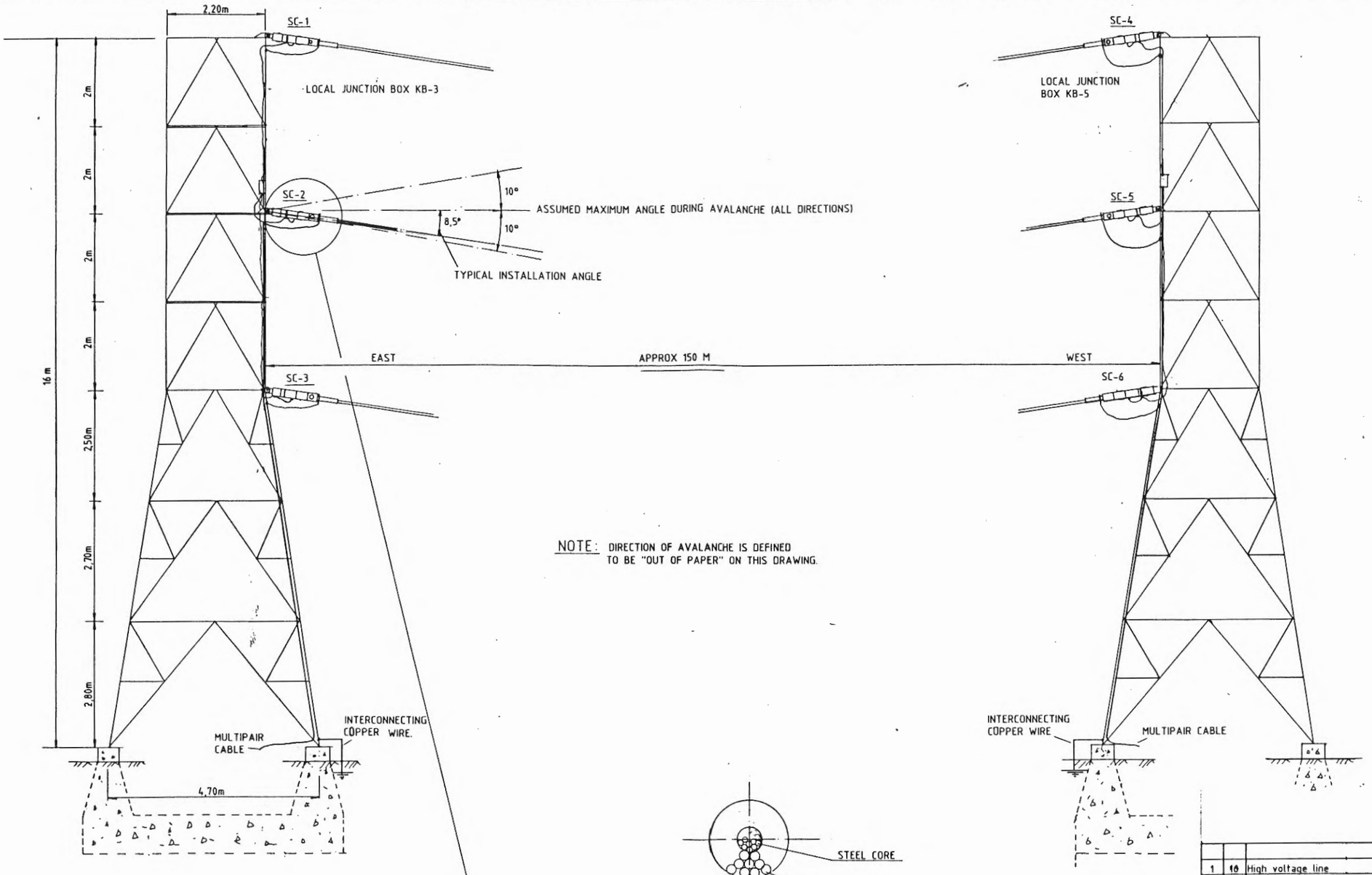
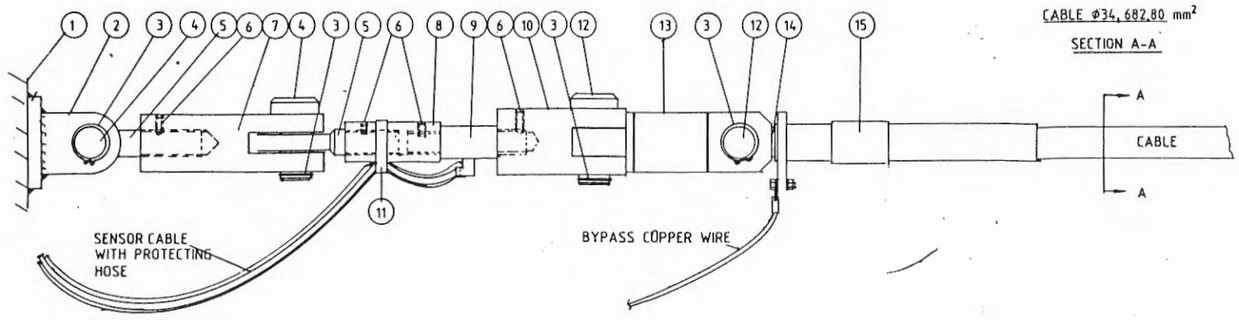


NOTE: DIRECTION OF AVALANCHE IS DEFINED TO BE "OUT OF PAPER" ON THIS DRAWING.



CABLE $\phi 34,682,80$ mm²

SECTION A-A

No. of	No.	Description	Material	Dimensions/Standard	Supplier/Notes
1	16	High voltage line			NVE
1	15	Explosion shrink sleeve	AL/PVC		NVE
1	14	Fork bolt	St,52		NVE
1	13	Swivel with ball bearing	Stainless	Type Sw40S	
2	12	Bolt	St,52	ϕ75x146	
1	11	Straps			
1	10	Fork for swivel	St,52	100x100x210	
1	9	Loadcell Sensotec RM	Stainless	Type 50000Lbs	Gallus Plesner
1	8	Socket	St,52	ϕ65x150	
1	7	Fork	St,52	100x6x300	
4	6	Unbrako set screw	Stainless	M8	
2	5	Ball joint	St	GAR50-DO-2RS	INA-Norma a/s
2	4	Bolt	St,52	ϕ75x132	
4	3	Seeger ring	St	Type A50	
2	2	Fork plate	St,52	100x30x130	
1	1	Anchor plate	St,52	□150x30	

Max. deviations for dimensions without tolerance specifications: NS 1430 Middle

Surface finish

Scale

Norwegian Geotechnical Institute
P.O.Box 40 Tåsen, Oslo 8, Norway
Telephones: (02) 23 03 88
NGI

THE RYGGFONN-PROJECT.

HIGH TENSION CABLES CROSSING THE AVALANCHE PATH

Subst. for

Subst. by

Drawing no. FIG.NR 3

Rev.

Assy. dwg./ Parts list

Rev.

Ref. no.

Rev. Index	Revisions	Design	Date	Design consultation	Date	Checked	Date	Approved	Date
0	Original issue								

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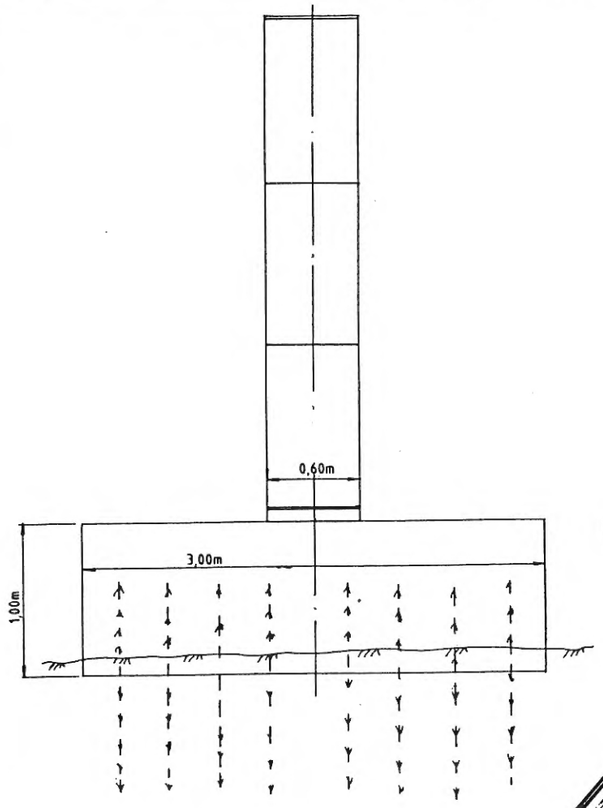

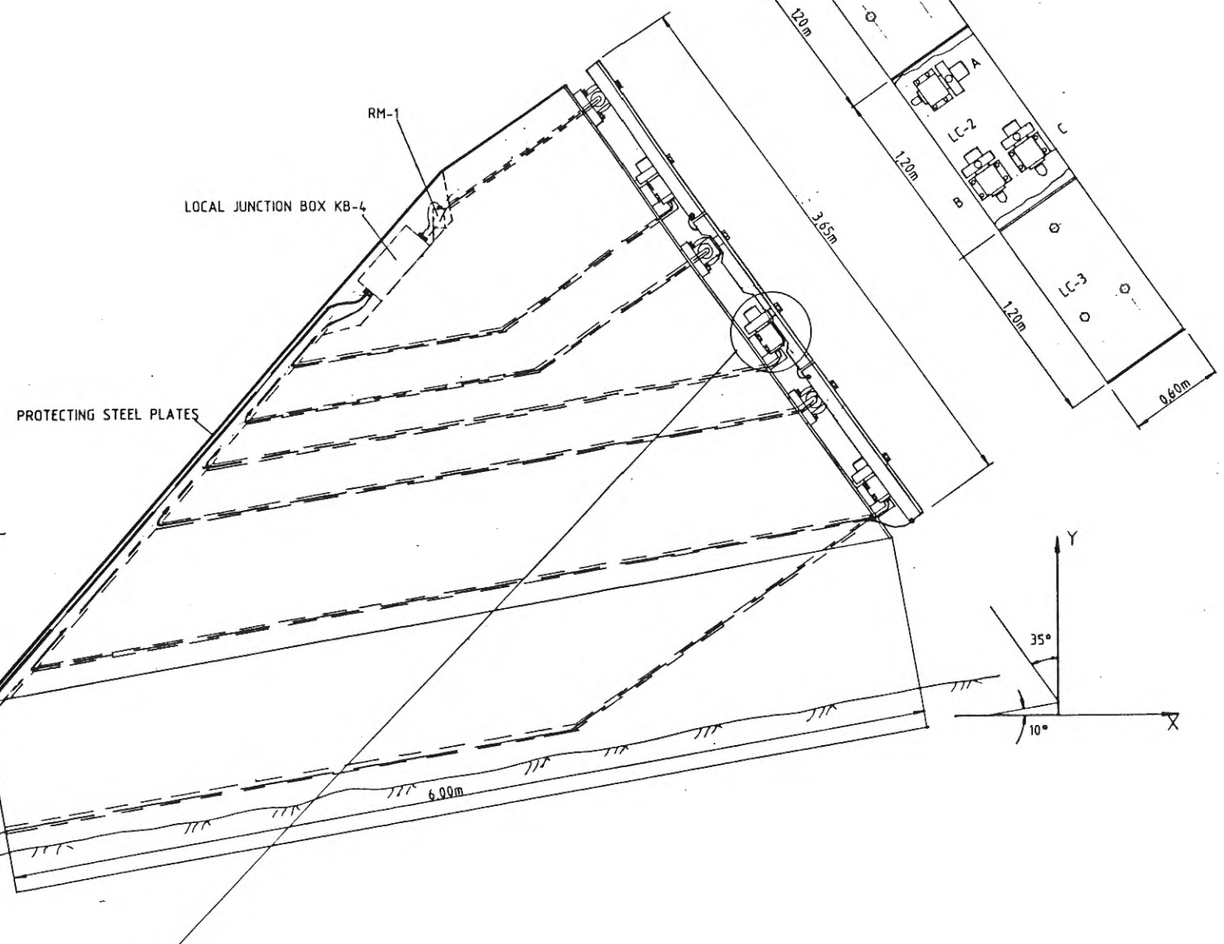

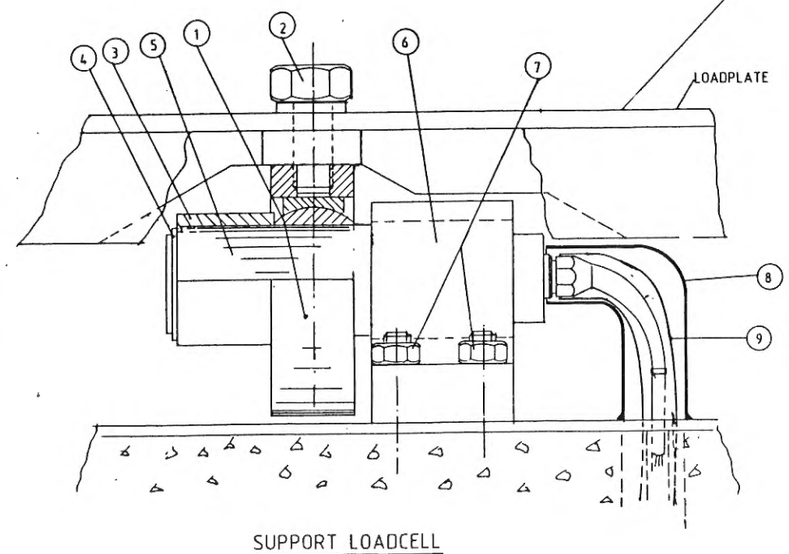

SUPPORT LOADCELL

NOTE. ONLY THE NORMAL FORCE COMPONENTS TO THE LOADCELL PLATES ARE MEASURED.

No. of	No.	Description	Dwg. no.	Material	Dimensions/Standard	Supplier/Notes
	10					
9	9	STEEL HOSE		ST		
9	8	Cable protection		St		
40	7	Nut with washer		St	M24	
9	6	Bracket for loadcell		St		
9	5	Loadcell			200KN	Bofors KIS-1
9	4	Retaining ring			A-90	
9	3	Spacer sleeve		Ms	ϕ120x96,5	
9	2	Bolt		St	M36x75	
9	1	Complete bearing unit			SCF 100 ES	SKF

Max. deviations for dimensions without tolerance specifications: NS 1430 Middle
Surface finish
Scale: -

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THE RYGGFONN-PROJECT.

CONCRETE STRUCTURE IN THE AVALANCE PATH

Dwg. no. FIG.NR 4 Rev.

Assy. dwg./ Parts list Rev.

Ref. no. 58120-3

Rev. Index	Revisions	Design Date	Design consultation Date	Checked Date	Approved Date
0	Original issue				

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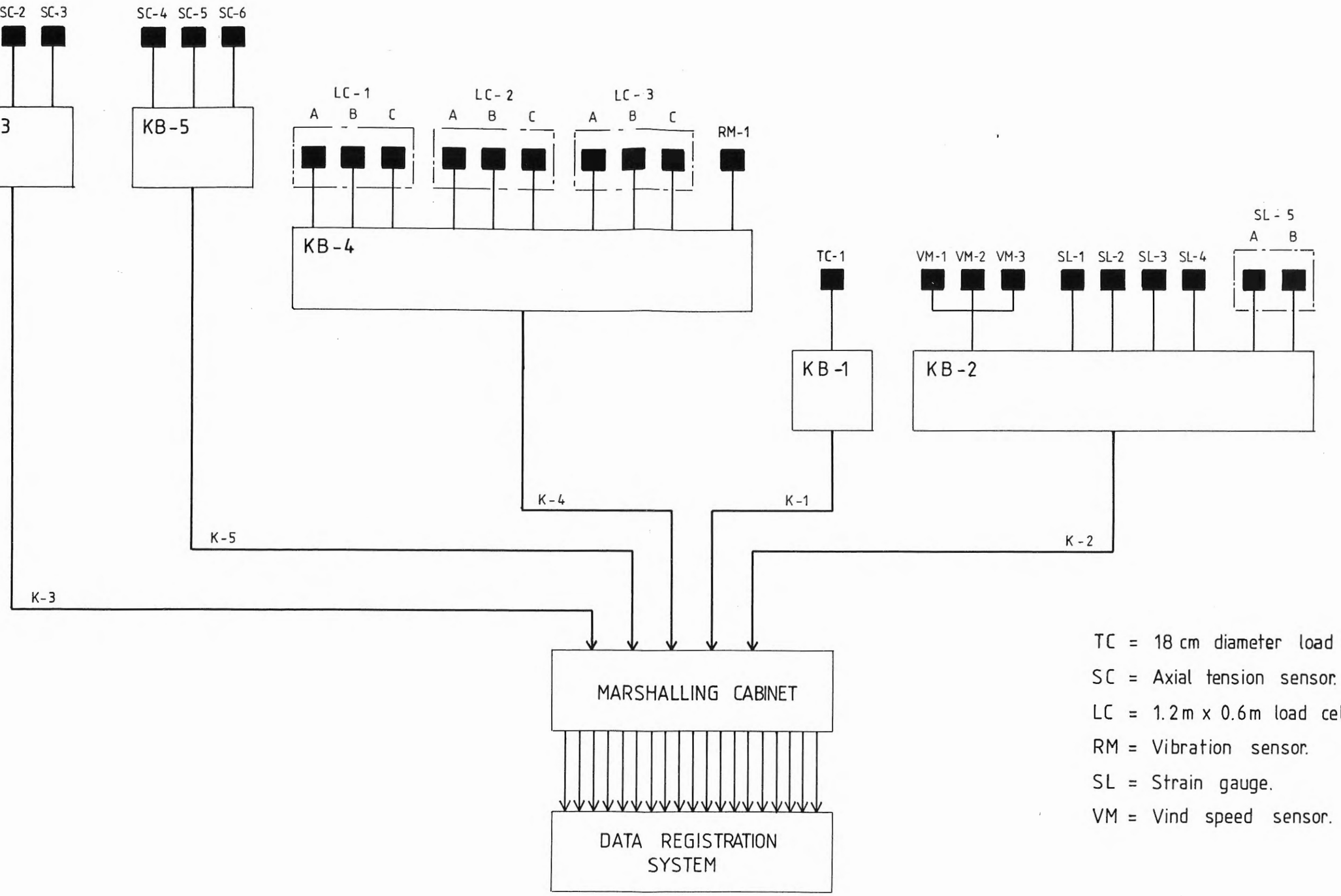


TC = 18 cm diameter load cell.

SC = Axial tension sensor.

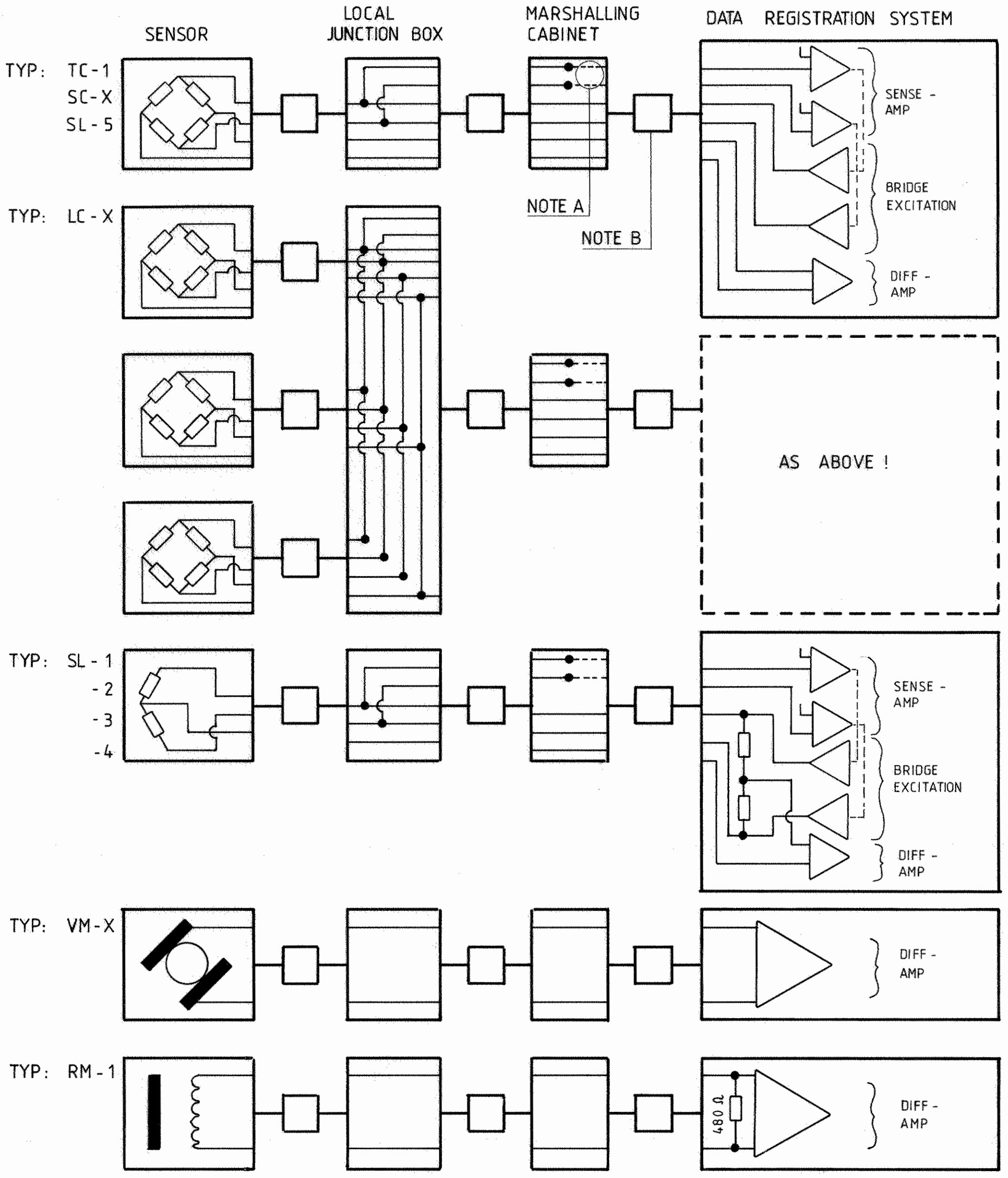
LC = 1.2m x 0.6m load cell.

RM = Vibration sensor.

SL = Strain gauge.

VM = Vind speed sensor.

THE RYGGFONN - PROJECT	Date	Drawn by
ONE - LINE DIAGRAM OF INSTRUMENTATION SYSTEM.	Approved	
	Project no. 58120 - 3	
Norwegian Geotechnical Institute	Fig. no. 5	



NOTES:

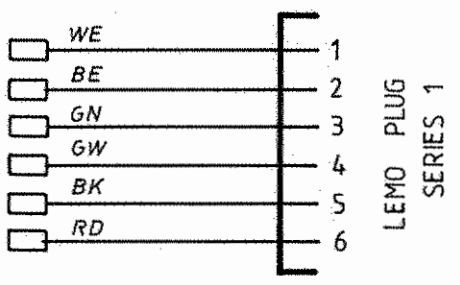
NOTE A

Automatical excitation voltage feature can be excluded if problems with oscillations. Excitation voltage can be measured in Marshalling cabinet.

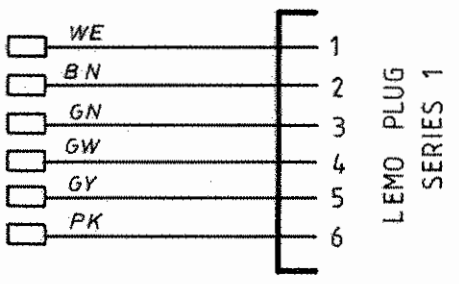
NOTE B

Wiring diagram given below:

TYPE A



TYPE B



THE RYGGFONN - PROJECT

BASIC MEASURING CIRCUITS

Norwegian Geotechnical Institute

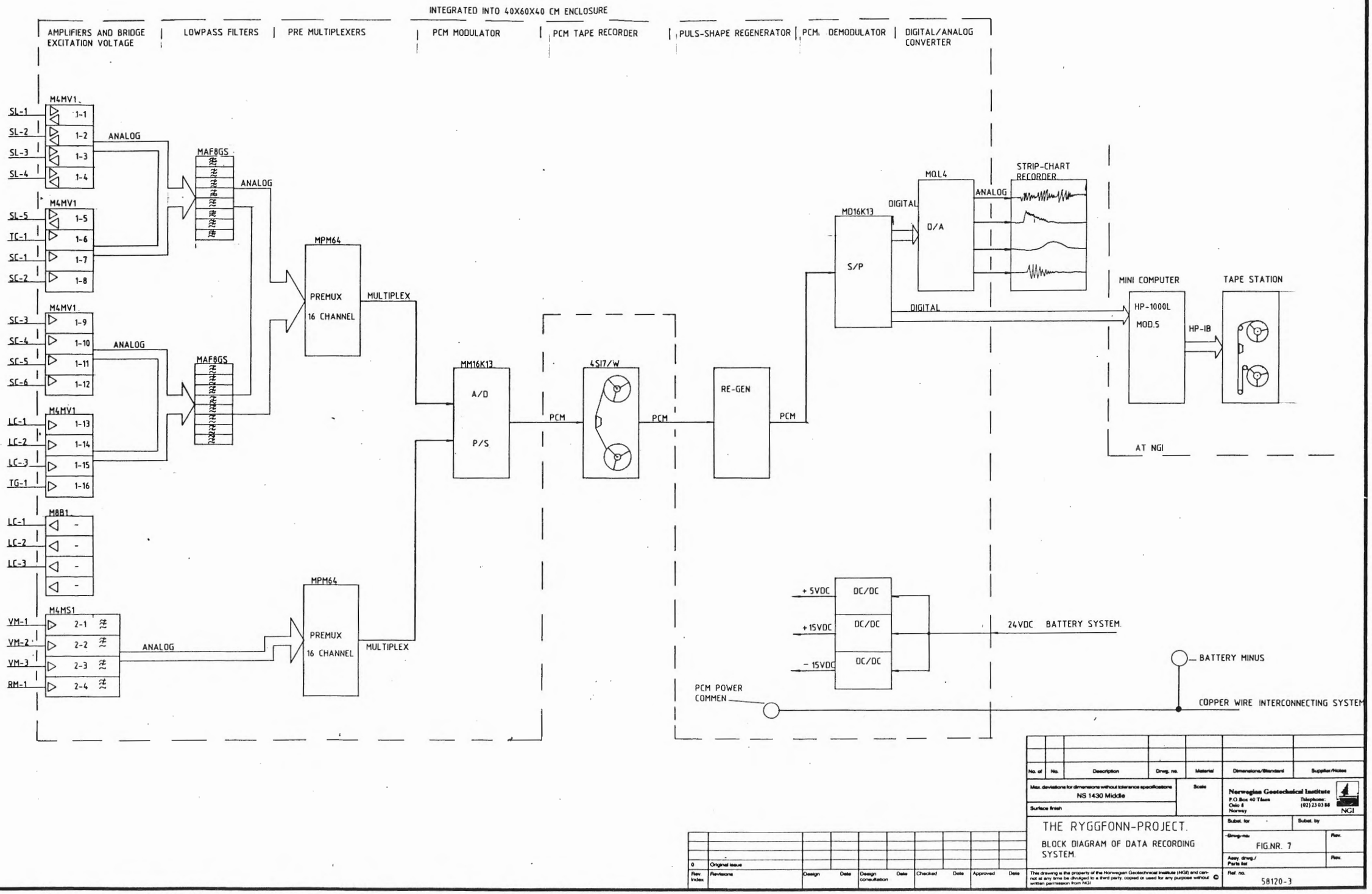
Date

Drawn by

Approved

Project no. 58120 - 3

Fig. no. 6



No. of	No.	Description	Dwg. no.	Material	Dimensions/Standard	Supplier/Notes

Max. deviations for dimensions without tolerance specifications: NS 1430 Middle
Surface finish
Scale

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THE RYGGFONN-PROJECT.

BLOCK DIAGRAM OF DATA RECORDING SYSTEM.

Subst. for
Subst. by
Dwng.-no. FIG.NR. 7
Rev.
Assy. dwg./ Parts list
Rev.
Ref. no. 58120-3

Rev. Index	Revisions	Design	Date	Design consultation	Date	Checked	Date	Approved	Date
0	Original issue								

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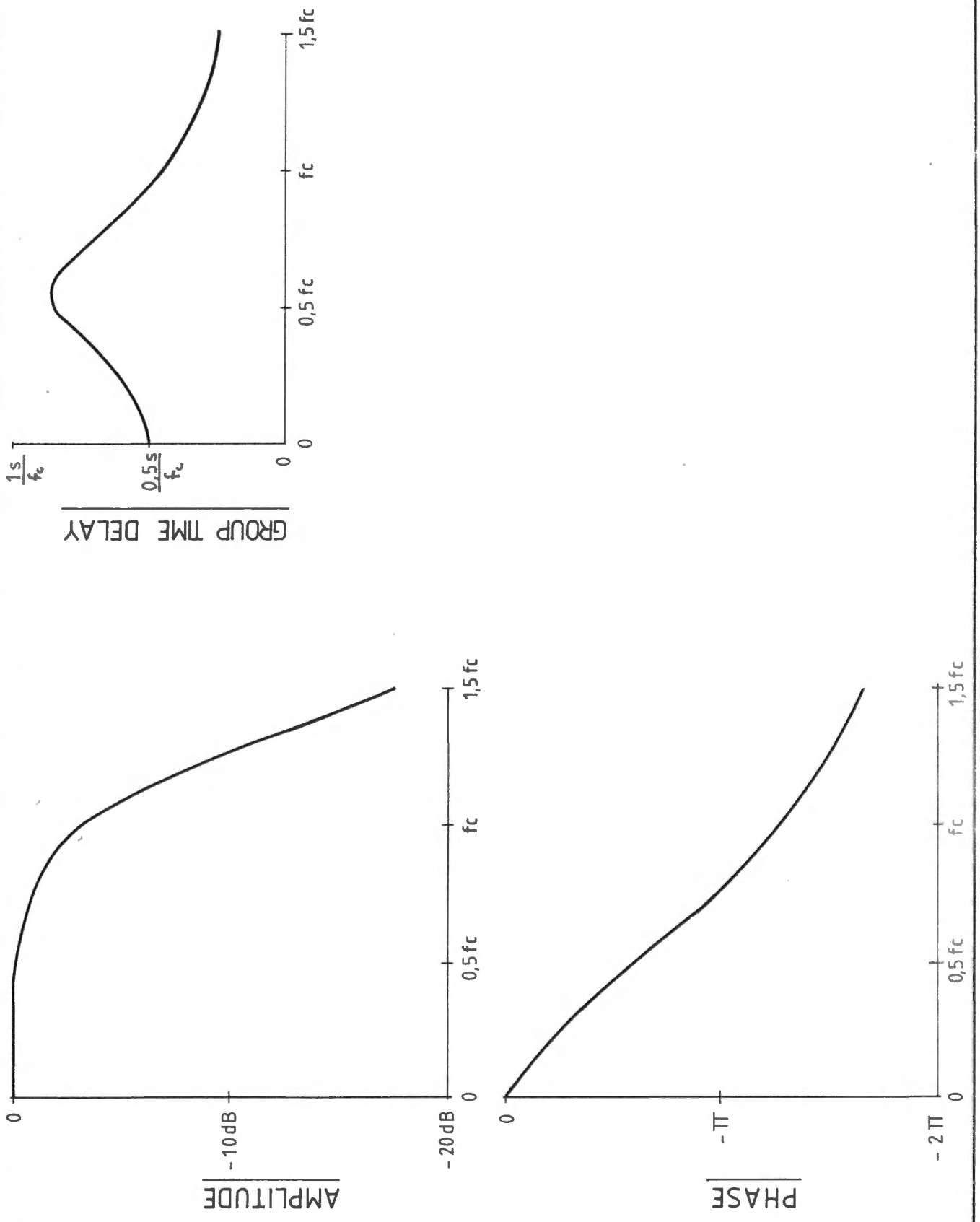


THE RYGGFONN - PROJECT

Date	Drawn by
Approved	
Project no. 58120 - 3	
Fig. no. 8	

FILTER RESPONSE CURVES FOR 5-POLE BUTTERWORTH LOWPASS FILTER.

Norwegian Geotechnical Institute

Skj. nr 001E 12 81 2000 Heclarno

NGI

A P P E N D I X A

A1 Manufacturers description and specification of Ailtech strain gauges.

A2 Manufacturers description and specification of R.M. Young UVW Anemometer.

A3 Manufacturers description and specification of Kyowa BL load cell.

A4 Manufacturers description and specification of Sensotec RM load cell.

A5 Manufacturers description and specification of Bofors KIS load cell.

A6 Manufacturers description and specification of Geo Space HS-1 geophone.

A7 Manufacturers description and specification of STK FEQE cable.

A8 Manufacturers description and specification of Transorb diodes.

A9 Manufacturers description and specification of Johne + Reilhofer Multidin PCM-system.

A10 Manufacturers description and specification of Brandner DC/DC converters.

An introduction to AILTECH weldable strain gages

The strain gage has been an essential element in the technological revolution of the past quarter century. Its development has made possible the static and dynamic testing of such diverse objects as jet aircraft, nuclear containment vessels, submarine hulls, rocket and missile surfaces, and heavy construction projects.

AILTECH (formerly Microdot Instrumentation Division) has been an innovator and leader in the development of strain gages throughout this period. It was the first to realize the limitations of the early metallic gages with their comparatively costly, time consuming, and complicated method of bonding. This realization led to the development of the Weldable wire resistance strain gage — a strain gage capable of being installed in minutes and in any environment. This unique technique, utilizing capacitive discharge spot welding equipment, eliminates the need for all bonding materials.

Gage types

For the measurement of strains on metallic surfaces, AILTECH strain gages are available as either basic gages or with integral lead cables.

The integral lead eliminates the necessity for other wire attachment and provides a pre-tested, waterproofed, hermetically sealed gage system which may be used under water, in high pressure, high temperature, steam or other difficult, corrosive environments.

For strain measurement within the body of concrete or other composite materials, AILTECH offers its line of Embedment gages. Equipped with suitable integral lead cables, these gages are available in three lengths and two integral lead configurations.

Applications

AILTECH strain gages can be used for a wide range of static and dynamic measurement applications. They have been used on rocket test stands, on the wings and fuselage of experimental aircraft, on submarines, bridges, dams, arctic and oceanic pipe lines, and in nuclear reactors.

The design, rugged construction and positive attachment of these gages make it possible to measure strain at high or low temperatures and in severe environments, including shock and vibration, steam, liquid sodium, salt water, chemicals, and other corrosive atmospheres. Neither the gage housing nor the welding bond will weaken or deteriorate under these conditions.

Perhaps the most unique single feature of the weldable strain gage is its method of attachment by spot welding, which eliminates all adhesive materials and enables the AILTECH strain gages to be utilized at all the noted conditions.

Weldable gage installation

The installation of strain gages with spot welding is easier, simpler, and faster than with conventional bonding procedures. Installed cost is lower in many applications. The spot welding techniques can be learned and applied quickly to assure reliable strain measurements in nearly any environment.

Successful gage welding requires only a reasonably clean test specimen surface, a small capacitive discharge welder and weld probe, and some basic knowledge of the factors determining a good weld. The process includes surface preparation, weld schedule determination, gage placement and the welding. For integral lead gages, cable routing and securing are essential parts of the installation technique.

After welding, the gage is immediately ready for use with any type strain gage signal conditioning equipment normally used with wire resistance strain gages.

For further information, send for the Weldable Strain Gage Manual which contains complete installation procedures.

Embedment gage installation

Since AILTECH Embedment Gages are supplied with waterproofed and pre-tested cables attached, installation of the gages is exceptionally simple and rugged. They require no special knowledge or tools. Reasonable care and an understanding of the desired strain measurements are the only requisites.

The installation of an embedment gage consists only of gage orientation, cable routing, and securing. Once secured, concrete is poured into the structure. The gage will track the concrete once the concrete has gained 25-50% of its final strength.

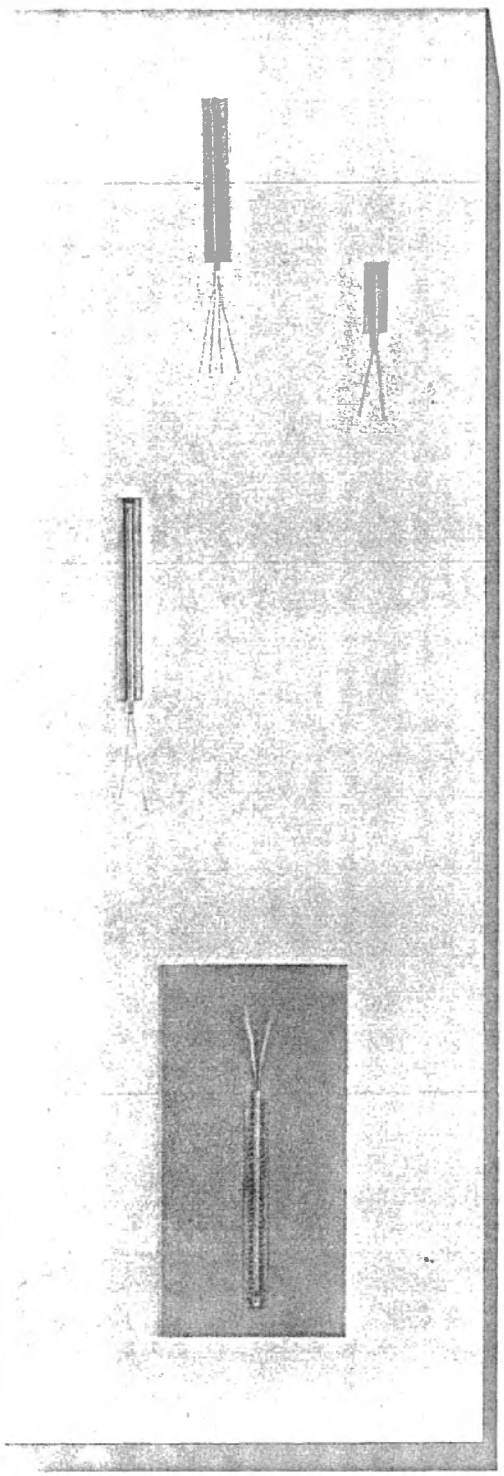
Gage construction, general

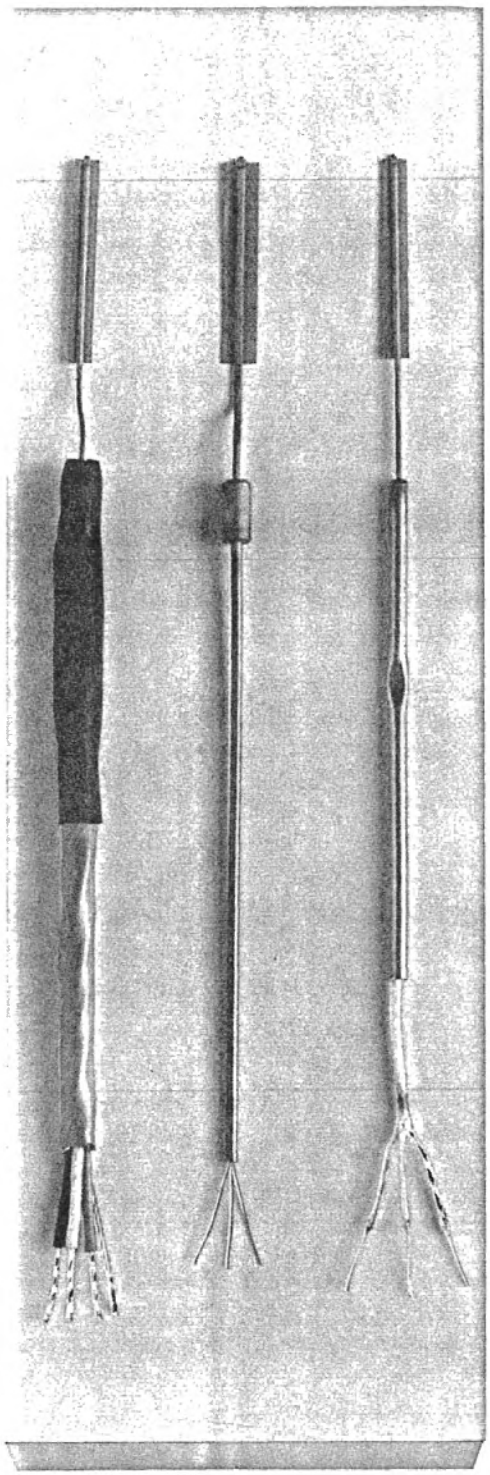
The ruggedness and environmental protection for which AILTECH gages are noted is provided by a unique construction technique. The strain sensitive element (Nickel Chrome or Platinum Tungsten) is housed within a small diameter stainless steel tube. The strain element is insulated from the tube with highly compacted ceramic insulation, which also serves as a strain transfer medium from the housing to the strain element.

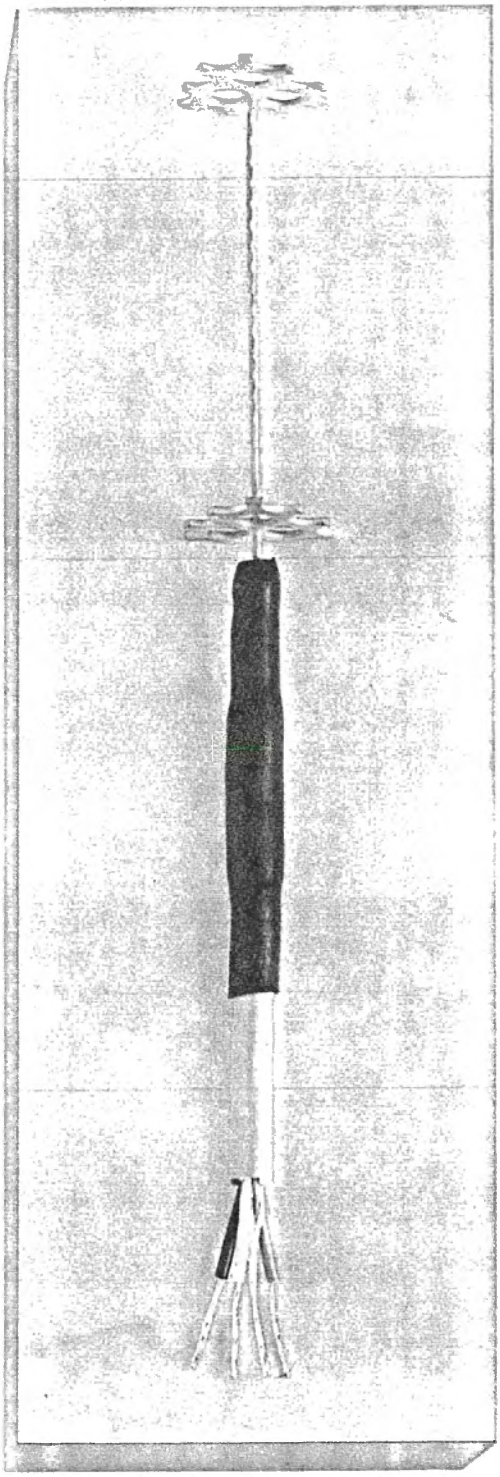
The Weldable gages are equipped with a thin flange spotwelded to the strain tube. This flange is subsequently spotwelded to the structure under test and provides the bond required to transfer strain. The insulation resistance is provided by the ceramic insulation and is not dependent on installation techniques.

Integral leads are attached to the basic gage by welding or encapsulation. These techniques provide an hermetically sealed construction which is pre-tested to assure its continuing protection from difficult environments.

Embedment gages are made using the same techniques, except that no flange is attached to the strain tube. In its place, end discs are provided to aid in alignment of the gage. These gages are available with the same style integral leads as the weldables.







Strain gage configurations

APPLICATION	PREFERRED [1] GAGE TYPE	FILAMENT MATERIAL	DESCRIPTION
Strain Measurements in the Field Bridges, buildings, pilings — whenever humidity, rain, direct immersion, or a simple, rugged installation procedure is required	SG 189	Nickel Chrome Alloy	**Flexlead Strain Gage**[2,3] ¼ bridge, 120 ohm, self-compensated gages with pre-waterproofed, vinyl insulated; 3 conductor, shielded cable.
Extended Temperature Ranges to 650°F static or 1500°F dynamic even when water, steam or corrosive media surrounds gages	SG 125 SG 128	Nickel Chrome Alloy	**Integral Lead Strain Gage**[2,3] ¼ bridge, 120 ohm, self-compensated gages with hermetically sealed, stainless steel jacketed cable. Leads insulated with fiberglass (SG 128) or magnesium oxide (SG 125) for the most severe applications.
Cryogenic Temperatures up to 650°F — coupled with water, steam, corrosive media	SG 325 SG 328	Nickel Chrome Alloy	**Integral Lead Strain Gages**[2] ½ bridge versions of SG 125 or SG 128 gage provide optimum thermal compensation in the cryogenic or sub-zero ranges. Also available for minimizing drift at 650°F.
Ultra-Temperature Environments to 950°F static (1200°F for short times) with protection from corrosive media	SG 425	Platinum Tungsten Alloy	**Integral Lead Strain Gages** ½ bridge Pt-W gage for static strain measurements to 1200°F, equipped with stainless steel jacketed, magnesium oxide insulated integral leads.
Embedment in Concrete for models or full size structures	CG 129	Nickel Chrome Alloy	**Flexlead Strain Gage** designed for direct embedment in concrete, 0-180°F. Other temperature ranges available.

[1] Basic Gage types (without integral leads) are available. They provide features of ruggedness and simplicity of installation when integral lead, hermetically sealed cables are not required. Some basic gages are useful to 1800°F for dynamic measurements.

[2] 350 ohm gages are available.

[3] Short length gages are available.

— Hydrostatic testing, special temperature ranges, etc. are available.

— Spot welding equipment available for loan/rent/sale.

— For the specific gage and cable, combinations suitable for your problem, please give us a call. Let us know temperatures, material types, media; and we'll advise you the easiest way to make your measurement.

Strain gage selection chart

A description of AILTECH weldable strain gages

Strain filament

The heart of the gage consists of a unique strain filament configuration in which the strain sensing filament and leadout wire are of unitized construction. The leadout section is electroformed (using gold) to a diameter of 0.007 in. A carefully controlled taper between the 0.007" diameter and the strain wire is provided. This construction technique eliminates joint fatigue problems or instabilities due to erratic electrical connections and contact resistance problems experienced using other techniques.

Two types of strain sensitive alloys are commonly used: Nickel Chrome and Platinum Tungsten. Both materials are excellent for strain measurement but exhibit certain limitations.

Nickel Chrome alloys exhibit a natural strain sensitivity (Gage Factor) of about 2.0. The alloy is thermally stable to about 650°F. At higher temperatures a resistance drift begins. This is due to the filament reaching the lower boundaries of the Ni-Cr alloy heat-treatment range. The actual installation conditions and applied voltage, of course, affect actual filament operating temperatures; for most applications the nickel-chrome gage will exhibit drift rates of less than 20 μe per hour at 650°F. Drift rates diminish rapidly as the temperature is reduced. This drift at high temperature will alter both resistance and resistivity, thus will alter temperature compensation.

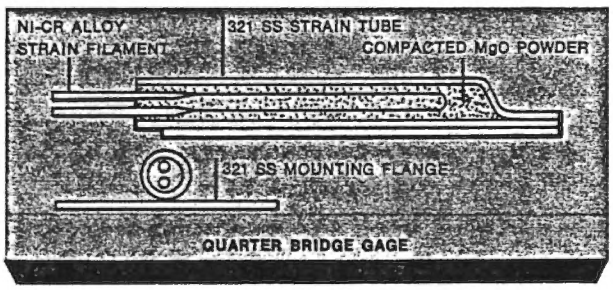
For even higher temperatures platinum tungsten alloys are preferred. This alloy has a natural Gage Factor of about 4.5 and is not heat-treatable. The latter effect permits the use of the alloy at 950° and even 1200°F for static measurements. With this class of alloy, drift which does occur is not a metallurgical change of the type exhibited by the nickel chrome alloy. Instead, it is related to variables such as tungsten migration. Depending on stabilization procedures during gage fabrication, the resultant drift is less than 20 μe per hour at 1150 to 1200°F. The platinum alloys do exhibit a large (predictable and reversible) resistance change vs. temperature. Thus, the temperature compensation technique used with them is different from the nickel chrome alloy.

Two strain filament geometric configurations are used — the active and dummy filaments. Their need depends on temperature considerations described below. The active element is simply the filament, formed in a "V" shape. The dummy is the identical filament wound in a helix. This produces a so-called "true dummy" strain gage filament. When placed in a strain field it has a zero Gage Factor. The secret of this is the pitch angle of the helix. It matches the Poisson's ratio so that no net dimensional change results when the gage is strained. This is unique — and provides for temperature compensation in a manner different from other types of strain gages. Since the "dummy" may be placed in a strain field, it may be placed next to (or in the same strain tube as) the active element. The dummy is only sensitive to temperature, not strain.

Strain gage assembly

The strain filament is encased in a strain tube that is made by welding a tubular metallic shell to a flat flange stock. Stainless steel tubes and flanges are used for attaching the gage to most ferrous test materials. For attachment to other metals, such as aluminum and magnesium, strain gage housings have been manufactured from a stainless steel tube and flange of a proprietary alloy of high gold content or other alloys.

The filament is mechanically coupled to the strain tube but electrically isolated from it by highly compacted metallic oxide powder, normally high purity magnesium oxide. This compaction is obtained by use of a programmed high speed centrifuge and swaging operation.



Theory of operation

When the gage is welded to a specimen and the test specimen put into tension or compression, the stress is transmitted through the welds to the mounting flange, into the strain tube, and through the magnesium oxide powder. The powder is so highly compacted that the strain is transmitted to the sensing filament all along its length with no slippage. This results in a gage that measures structural strains in compression as well as in tension. This property of stable, reversible, strain transfer is due to the geometrical fact that in wires of small diameter the ratio of unit surface area to unit cross sectional area is a large value. Thus, only moderate values of sheer stress in the magnesium oxide powder are required to develop tensile stresses of large value in the sensing filament.

Temperature compensation

All AILTECH gages are of the self-compensated type. That is, they are compensated for a specific material type and specific temperature range. This is true for single active (quarter bridge) or active plus dummy (half bridge) gages.

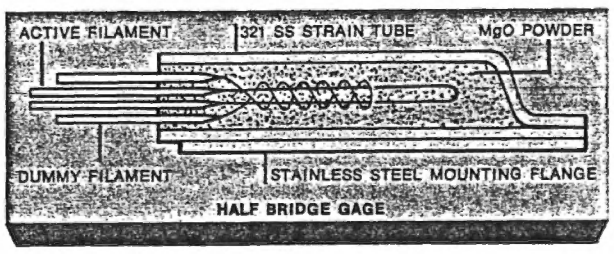
In the nickel chrome gage, the alloy's thermal coefficient of resistance is adjusted by heat treatment. This adjustment yields a resulting change of resistance vs. temperature equal to, but of opposite polarity as the expected apparent strain; this is the differential expansion between gage alloy and test specimen multiplied by the temperature change of interest. The apparent strain of the mounted gage is thus zero — except for non-linearities over the temperature range.

When used, the dummy tends to reduce these non-linearities. For example, when a single active strain gage is compensated over a temperature range such as +75° to 600°F, it matches the test specimen very well. The apparent strain error over these ranges is small and because of this no dummy strain gage technique need be used.

If the single active element gage is compensated over a temperature range of −320° to +75°F or −65° to +250°F, the bow in the apparent strain curve is about 250 microstrain. This bow may or may not be significant. If a single active strain gage is compensated over the temperature of −320° to +600°F (total temperature range of 920°F), the bow in the apparent strain error curve is about 700 microstrain. This bow is significant for static strain measurements.

To reduce the bow in the apparent strain curve in the cryogenic ranges, dummy strain gages are used. The dummy strain gage has the same thermal properties as the active strain gage and reduces the bow to less than $\pm 50\ \mu e$.

This dummy strain gage is usually placed beside the active strain gage, and need not be located in a strain-free area since it has a zero Gage Factor. This single-tube half bridge gage is the most commonly used model.



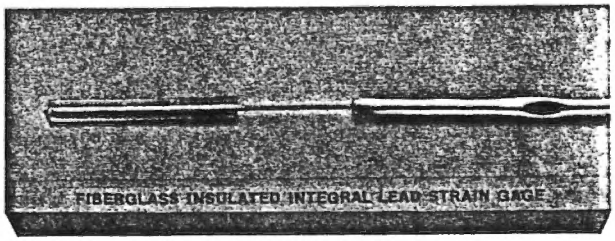
In the case of the High Temperature Strain Gage series, a platinum-tungsten alloy is used for both the active and dummy strain filaments. With this single-tube half bridge strain gage construction, the true dummy provides temperature compensation in a more complex manner from that provided by the nickel chrome alloy strain gages. Both the active and dummy gages change resistance substantially with temperature. This is true because of the high thermal coefficient of resistance of platinum alloys. Since both elements are at precisely the same temperature, the outputs due to thermal coefficient of resistance cancel each other in the normal Wheatstone bridge circuit. The remaining thermal error is due to strain induced by differential coefficients of expansion between strain filament and test structure. This apparent strain error is eliminated by placing a small value fixed resistor in series with the active element. This tends to desensitize the output of the gage slightly, approximately 10%, but provides effective temperature compensation. Since this desensitization is small and easily calculable, it introduces no error in strain measurement. This technique provides a compensated gage exhibiting less than 150 microstrain bow 75° to 900°F, an extremely low value.

Integral leads

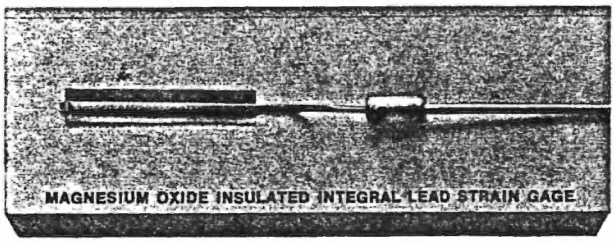
AILTECH strain gages can be provided with hermetically sealed integral leads that can be extended out from corrosive liquids and other media for remote connection, making possible measurements under water, in live steam, and in similar conditions where the gage is completely enveloped in a hostile atmosphere. In this configuration, the lead wires are enclosed in a stainless steel tube permanently attached to the gage and tested for an hermetic seal. The welded joints can be factory tested to assure a pressure seal up to 500°F and 2500 psi and have proven leak tight to temperatures of 950°F and above. Integral leads have been used successfully in lengths over 100 feet. For moderate temperatures a vinyl insulated cable is encapsulated to the gage to form the hermetic seal.

Fiberglass insulated integral lead strain gage

In this assembly, the fiberglass insulated lead wires are silver brazed to the strain gage leads. A close-fitting, 0.093" diameter, stainless steel tubing encloses the leadwire and is welded to the end of the strain tube.

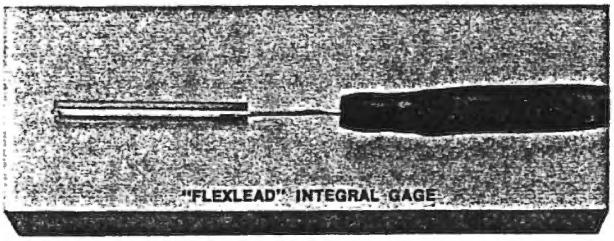


This assembly is tested for integrity against moisture by a 4-hour soak in near-boiling water. For more severe environments, the joints may be hydrotested to conditions as high as 500°F x 2500 psi.



Magnesium oxide insulated integral lead strain gage

These are similar to fiberglass insulated integral leads except for the configuration of the leadwire. In this assembly, an 0.062" diameter stainless steel jacketed, swaged magnesium oxide insulated cable is used. A transition sleeve is welded between the cable and strain tube to provide this connection.



"Flexlead" integral lead

Many times a not-too-severe environment exists in which a plastic jacketed leadwire assembly is sufficient protection. The third series of integral leads is waterproofed (water soak tested) and may be used to conditions such as 100 psi or 180°F. These assemblies are easier to handle due to the flexibility and are suitable for many field applications not involving very extreme conditions of humidity, corrosive media, pressure or temperature.

Summary

The unique design of the AILTECH family of Strain Gages provides you with the reliable, economical product you need. The rugged protection of the strain filament, the ease of attachment and installation, and the pre-tested, hermetically sealed cabling systems are designed to let you make the strain measurement — with assurance that your installation will survive!

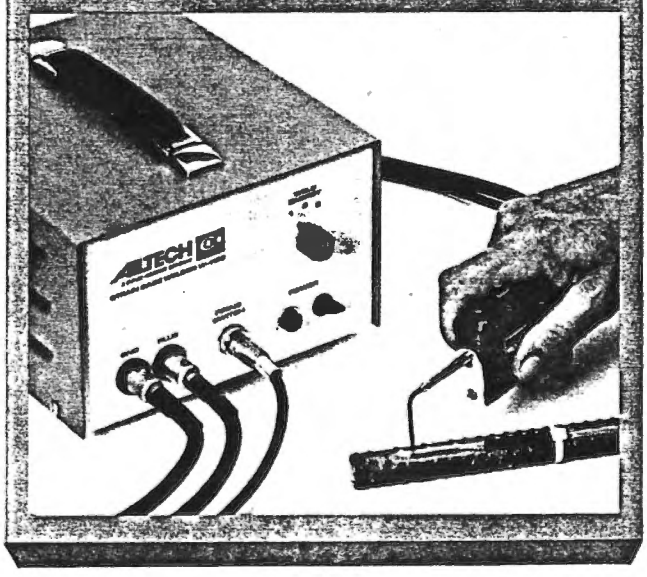
Detailed specifications of the gage products available to you follow. Please DO contact the factory for further information or assistance on your special requirements.

Installation

One of the many superior features of AILTECH strain gages is their ease of installation. The spot welding technique employed is simpler and faster than conventional bonding procedures, can be easily learned and applied to provide reliable strain measurements in virtually any environment.

Successful gage welding requires only a reasonably clean test surface, a small capacitive discharge welder and weld probe, and some basic knowledge of the factors determining a good weld. The process includes surface preparation, weld schedule determination, gage placement and the welding. For integral lead gages, cable routing and securing is an essential part of the operation.

The typical sequence for mounting gages is: (1) prepare a rust, scale and grease-free surface with file and sandpaper; (2) secure cable to surface with "Flexties"; and (3) spotweld. Shown below is a gage being welded in place with AILTECH W1100 Welder and W1150 Handprobe. This operation requires one or two minutes. Typical weld schedules on ferrous material are one to two pounds force, 10 to 12 watt seconds energy and a 0.030 DIA RWMA No. 2 tip on the hand probe.

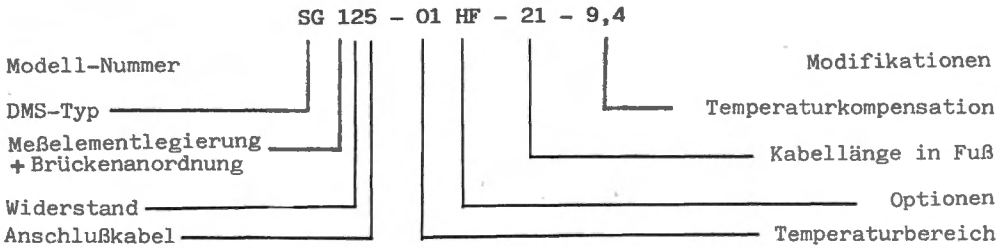


Bestellinformationen

Kunden-DMS

Das vollständige Bestellkennzeichen setzt sich aus Modellnummer, Temperaturbereich, Optionen, integrierte Kabellänge und Temperaturkompensation zusammen und beschreibt einen kundenspezifischen DMS, der den erwarteten Testbedingungen angepaßt ist. Unterstützung und Beratung bei der Auswahl des richtigen DMS erhalten Sie von Micro-Epsilon Meßtechnik.

Bestellnummernsystem:



Modellnummer

Die Modellnummer besteht aus 4 Bezeichnungen und sollte als erstes bei der DMS-Auswahl für ein bestimmtes Meßproblem berücksichtigt werden. Die Reihenfolge ist: DMS-Typ, Meßelementlegierung und Brückenanordnung, Widerstand und Anschlußkabel.

DMS-Typ

SG - Ein DMS mit einem 27,7 mm langen, auf das Meßobjekt schweißbaren Flansch. DMS-Gehäuse aus rostfreiem Stahl AISI 321 (DIN 1.4541) oder wahlweise Inconel 600 (siehe Optionen). MgO-Isolierung.

MG - DMS wie SG-Type jedoch in Miniaturausführung. Flanschlänge 12,7 mm (Viertelbrücken) oder 15,7 mm (Halbbrücken)

CG - Ein DMS für Messungen im Beton. Der Beton-DMS ist in 3 Längen erhältlich: 50 mm (CG2), 100 mm (CG4) und 150 mm (CG6). Die DMS-Länge sollte gleich dem 4 bis 5-fachen Betonaggregatdurchmessers sein.

Dehnungselementlegierung und Brückenanordnung

Die folgenden Bezeichnungen sind lieferbar:

1XX - NiCr-Legierung als aktives Element in Viertelbrückenanordnung

3XX - NiCr-Legierung als aktives und Dummy-Element in Halbbrückenanordnung

4XX - PtW-Legierung als aktives und Dummy-Element in Halbbrückenanordnung

6XX - PtW-Legierung als aktives Element in Viertelbrückenanordnung

Widerstand

X2X - 120 Ohm; wird für die meisten Messungen verwendet.

X5X - 350 Ohm; wird bei sehr langen Anschlußleitungen oder bei hohen Brückenspannungen verwendet.

Anschlußkabel

Sowohl Viertel- als auch Halbbrücken-DMS werden mit 3-Leiter-Anschlußkabel ausgestattet. Die anwendbaren Umweltbedingungen für die verschiedenen Typen sind dem Abschnitt 'Integrierte Anschlußkabel' zu entnehmen.

XX0 - bezeichnet einen Basis-DMS ohne Kabel

XX3 - Glasfaserisoliertes Kabel für Temperaturen bis 516 K (342°C) und trockener Atmosphäre, ungeschirmt, 3-adrig, Kupferadern (28 AWG), Widerstand 0,3 Ohm /m

XX4 - Teflon-isoliertes Flachkabel, ungeschirmt, 3-adrig, Kupferadern (24 AWG), Widerstand 0,13 Ohm/m. Nicht für Dampfatmosphäre geeignet.

XX5 - Rostfreies Stahlrohrkabel mit MgO-isolierten Kupferleitungen (30 AWG), 3-adrig, Widerstand 0,33 Ohm/m. Mantelwerkstoff AISI 347 (entspricht etwa DIN 1.4550), wahlweise Inconel 600 (siehe Optionen).

XX6 - PVC-isoliertes Flachkabel, ungeschirmt, 3-adrig, Kupferadern (26 AWG), Widerstand 0,14 Ohm/m.

XX8 - Rostfreies Stahlrohrkabel mit glasfaser-isolierten Kupferleitungen (28 AWG),- 3-adrig, Widerstand 0,32 Ohm/m. Mantelwerkstoff AISI 321 (entspricht DIN 1.4541), wahlweise Inconel 600 (siehe Optionen).

XX9 - PVC-isoliertes Kabel, geschirmt mit PVC-Schutzmantel, 3-adrig, Kupferadern (22 AWG), Widerstand 0,05 Ohm/m.

Modifikationen

Temperaturbereiche

Die folgenden Bezeichnungen werden verwendet, um den erwarteten Temperaturbereich zu beschreiben, dem während der Messung der DMS ausgesetzt sein wird. Durch Festlegung des Temperaturbereichs wird der temperaturabhängige Fehler (scheinbare Dehnung) auf ein Minimum reduziert. Der Verlauf der scheinbaren

Dehnung ist qualitativ im Abschnitt 'Temperaturkompensation' graphisch dargestellt

01 = 297 - 588 K (24 - 315°C)

08 = 297 - 755 k (24 - 482°C)

11 = 255 - 355 K (-18 - 82°C)

09 = Spezieller Bereich nach Kundenangabe (maximale Temperaturen für statische Messungen beachten). Oberhalb der maximalen Temperatur für statische Messungen wird diese Bezeichnung auch für rein dynamische Messungen mit spezieller Voralterung des DMS im Werk verwendet.
Der gewünschte Temperaturbereich muß durch eine Fußnote zur kompletten Bestellkennzeichnung hinzugefügt werden.

Optionen

Folgende Optionen können gewählt werden:

"J" Hydrotest bei 20°C und 7 bar

für alle Typen außer XX4 und XX3, Testdauer 15 min.

"H" Hydrotest bei 260°C und 175 bar

für XX5 und XX8 Typen, Testdauer 3 h. Dieser Hydrotest ist erforderlich bei DMS-Anwendungen in Drurckwasser, hochgespanntem Heißdampf, Natrium u.a.m.

"F" Kabelendabschluß

für XX5 und XX8-Typen, abgedichteter Übergang vom Stahlrohrkabel auf flexible Leitung (45 cm lang).

"M" Miniaturkabelverbindung (2,3mm)

für XX5-Typen, Miniaturübergangsmuffe vom verlängerten DMS-Röhrchen zum Stahlrohrkabel, 2,3 mm Durchmesser.

"P" Gepaarte DMS

nach Widerstand ausgesuchte 1/4-Brückenpaare, maximale Abweichung (pro Paar) 0,5 Ohm.

"S" Gepaarte DMS

nach Temperaturgang (unaufgepunktet) ausgesuchte Paare, maximale Abweichung (pro Paar) ± 25 um/m.

"G" Druckdichte Kabeldurchführung durch Gefäßwandungen

Quetschverschraubung mit Neopren-Dichtung, geeignet für DMS-Stahlrohrkabel mit den Durchmessern 1,60 mm, 2,36 mm und 3,18 mm. Befestigungsgewinde 1/8" NPT.

"N" Hartgelötete Übergangsverbindung

für XX5-Typen, die Übergangsmuffe von der DMS-Gehäusefortsetzung zum Stahlrohrkabel ist mit "Nicrobraze" hartgelötet, geeignet zur Anwendung in flüssigem Natrium.

"T" Hochtemperatur Kabelendabschluß

wie Option "F", jedoch für Temperaturen bis 315°C.

"V" Gefüllte Übergangsverbindung

für XX5-Kabel. Die Standardübergangsmuffe von der DMS-Gehäusefortsetzung zum Stahlrohrkabel ist mit MgO-Pulver gefüllt. Diese Option ist erforderlich bei Vibration oder hohen Beschleunigungen, denen DMS und Kabel ausgesetzt sind.

"L" DMS-Gehäuse und Kabelmantel sind aus Inconel 600.

"C" DMS-Gehäuse aus Inconel 600

der Kabelmantel ist aus rostfreiem Stahl.

Integrierte Kabellänge

Kunden-DMS werden mit der für das Meßproblem nötigen integrierten Kabellänge gefertigt.
Die Länge wird in Fuß = 304,8mm angegeben.

Temperaturkompensation

Jeder Ailtech-DMS wird individuell temperaturkompensiert und der thermischen Ausdehnung des Meßobjekts angepaßt. Dazu wird die Angabe des mittleren thermischen Ausdehnungskoeffizienten im zu kompensierenden Temperaturbereich benötigt. Dieser kann durch Einsenden einer Werkstoffprobe im Werk oder auch kundenseitig durch eine Dilatometermessung bestimmt werden. Die Angabe im Bestellkennzeichen erfolgt in ppm/F oder 10^{-6}/K.
Als Standardkompensation sind 6S und 9S mit Anpassung an Baustahl AISI 1018 (entspr. etwa DIN 1.1141) bzw. AISI 321 (entspr. DIN 1.4541) erhältlich.

Standard-DMS

Die folgenden Modelle sind in begrenzten Stückzahlen am Lager vorrätig. Sie sind preislich günstiger als vergleichbare Kunden-DMS. Die abgekürzte Bezeichnung beschreibt das Modell und den angezeigten Temperaturbereich. Sie werden temperaturkompensiert für 6S und 9S.

Standard-DMS		Temperatur-Bereich	
SG124-6S oder 9S	01	293 - 533	24 - 260
SG125-6S oder 9S	01	293 - 588	24 - 315
SG128-6S oder 9S	01	293 - 588	24 - 315
SG129-6S oder 9S	11	255 - 355	-18 - 82
SG425-6S oder 9S	08	293 - 755	24 - 482
CGX129-6S	11	255 - 355	-18 - 82

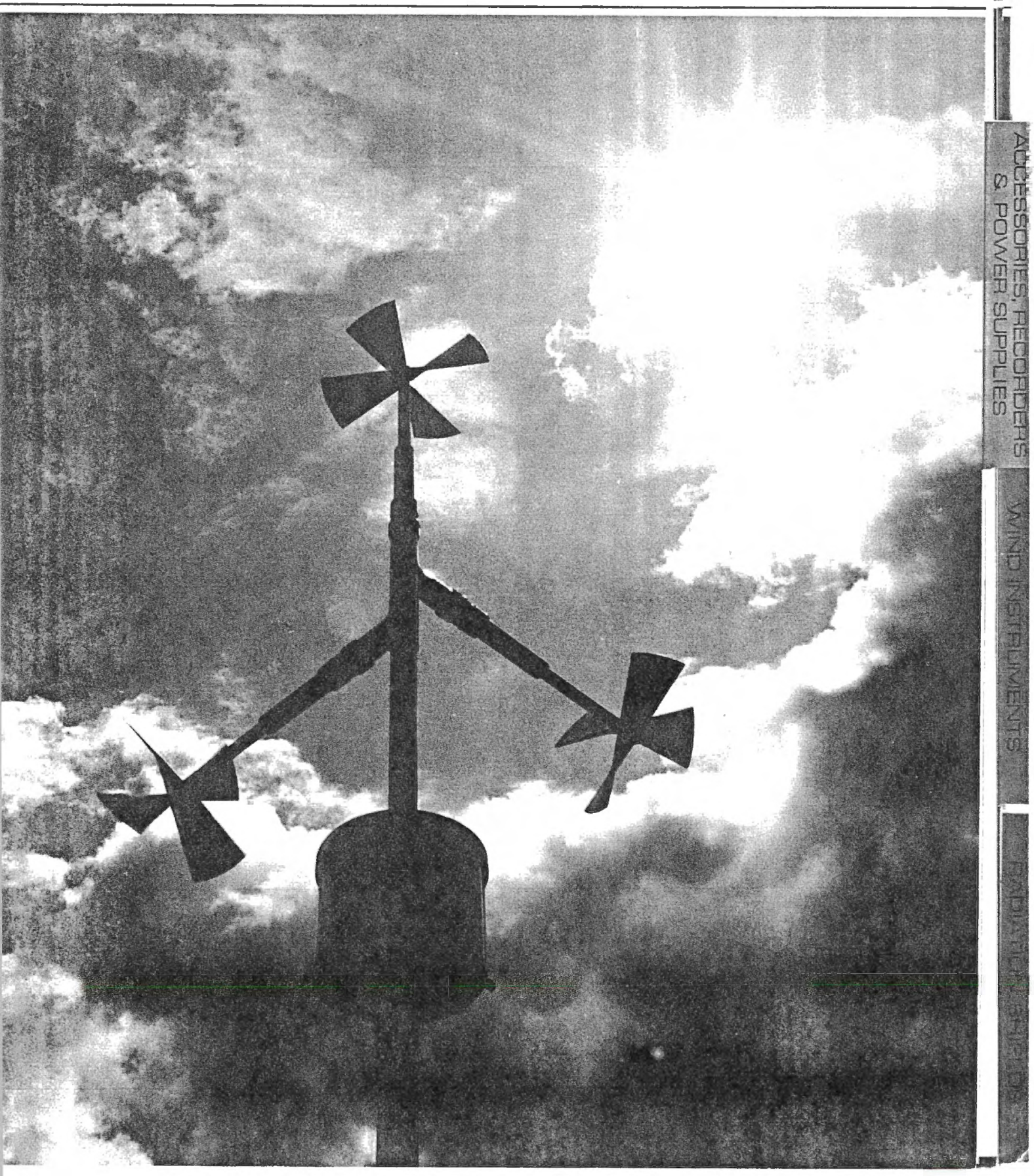
X = 2,4 oder 6

Optionen (Beschreibung siehe Kunden-DMS)

Die Optionen H,J,F, und G können mit Standard-DMS bestellt werden. Die entsprechende Bezeichnung wird in die Typenbezeichnung eingefügt.

Beispiel: SG125-6S.....mit Hydrotest und Kabelendabschluß = SG125HF-6S

GILL UVW ANEMOMETER



GILL UVW ANEMOMETER

The Gill UVW Anemometer represents an entirely new concept in wind measurement. This instrument measures directly the three orthogonal vectors of the wind—along wind component "U", across wind component "V", and vertical wind component "W".

Three helicoid propeller sensors are mounted at right angles to each other on a common mast with sufficient sensor separation to eliminate any effect of one propeller upon another at all normal wind angles. Each propeller responds only to that component of the wind which is parallel with its axis of rotation. When the wind is exactly perpendicular to the axis of the propeller it will stop rotating altogether. The propeller response as a function of its orientation to the wind very closely approximates the cosine law (refer to the propeller response curve). Each sensor measures both forward and reverse air movement providing an analog d.c. voltage signal whose magnitude is proportional to propeller speed and whose polarity indicates direction of propeller rotation.

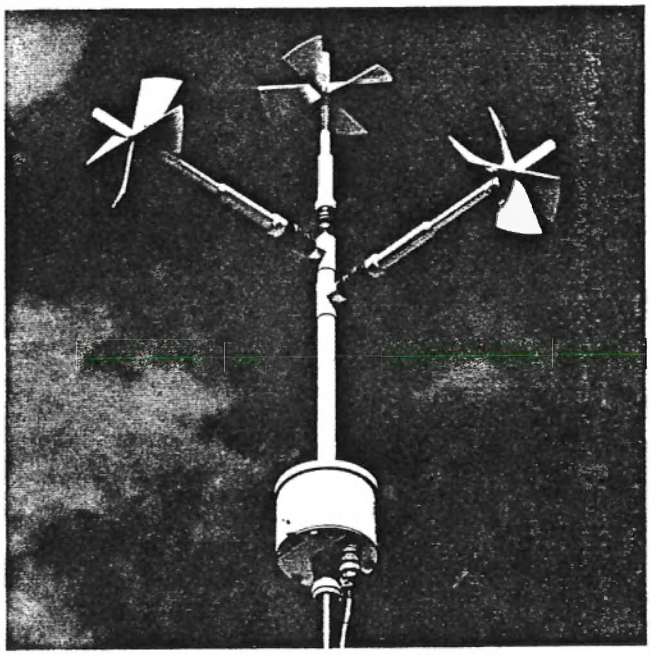
The propeller was designed to provide one revolution for 30 cm of passing wind. The propeller drives a miniature d.c. tachometer generator through a unique flexible coupling which prevents side or end loading of the generator bearings. The expected life of the generator is in excess of 1000 million revolutions (equal to 3-4 years of normal operation).

The signals from the three sensors are fed through a multiconductor cable to the Indicator-Translator Unit which has three meters calibrated directly in meters per second. Each meter has two ranges; low range: 6-0-6 m/s, high range: 30-0-30 m/s. Each range is provided with an independent calibration adjustment. In addition, a separate adjustment is provided for operation of either galvanometer, servo, or magnetic tape recorders.

Calibration of the instrument is accomplished after installation by driving each sensor at a known rpm by means of the Synchronous Motor Calibrating Unit and trimming the calibration adjustment to bring the meter reading to the exact equivalent wind speed. A 115 volt convenience outlet is provided in the lower housing of the instrument for operation of the Calibrating Unit.

The lower housing also contains a small continuous duty air blower and dust filter which keeps the internal portion of the instrument under a small positive pressure. Filtered air moves continuously out through each sensor to the propeller hub where it is expelled to the atmosphere. This prevents rain and dust from entering the precision ball bearings and other internal parts of the sensors.

An MS type electrical connector provides physical mounting as well as electrical connection for each sensor. When the instrument is not in use the individual sensors can be easily removed for storage without disturbing the installation of the mounting arm assembly.



Shown with optional propeller extensions.

The UVW Anemometer is designed for maximum sensitivity at the lower wind speeds and has a working range from 0-22 m/s when used with standard 23 cm diameter x 30 cm pitch polystyrene propellers which provide maximum threshold sensitivity. Smaller diameter propellers are available to extend the working range (with some sacrifice in threshold sensitivity). For critical low speed measurements optional propeller extensions can be used to improve the low speed response in the stall region (90° wind angle) by reducing the stall angle and also improve the symmetry of response each side of stall.

ORDERING INFORMATION

GILL UVW ANEMOMETER. Includes three sensors with standard 23 cm x 30 cm polystyrene propellers, mounting arm assembly with blower and filter located in lower housing. Instruction manual included ..... **CAT. NO. 27004**

SPARE PROPELLER - Standard 23 cm dia. x 30 cm pitch (polystyrene). Threshold 0.1-0.2 m/s; maximum speed 22 m/s (all angle flow) ..... **CAT. NO. 21281**

SPARE PROPELLER - Optional 19 cm dia. x 30 cm pitch (polystyrene). Threshold 0.2-0.3 m/s; maximum speed 30 m/s (all angle flow) ..... **CAT. NO. 21282**

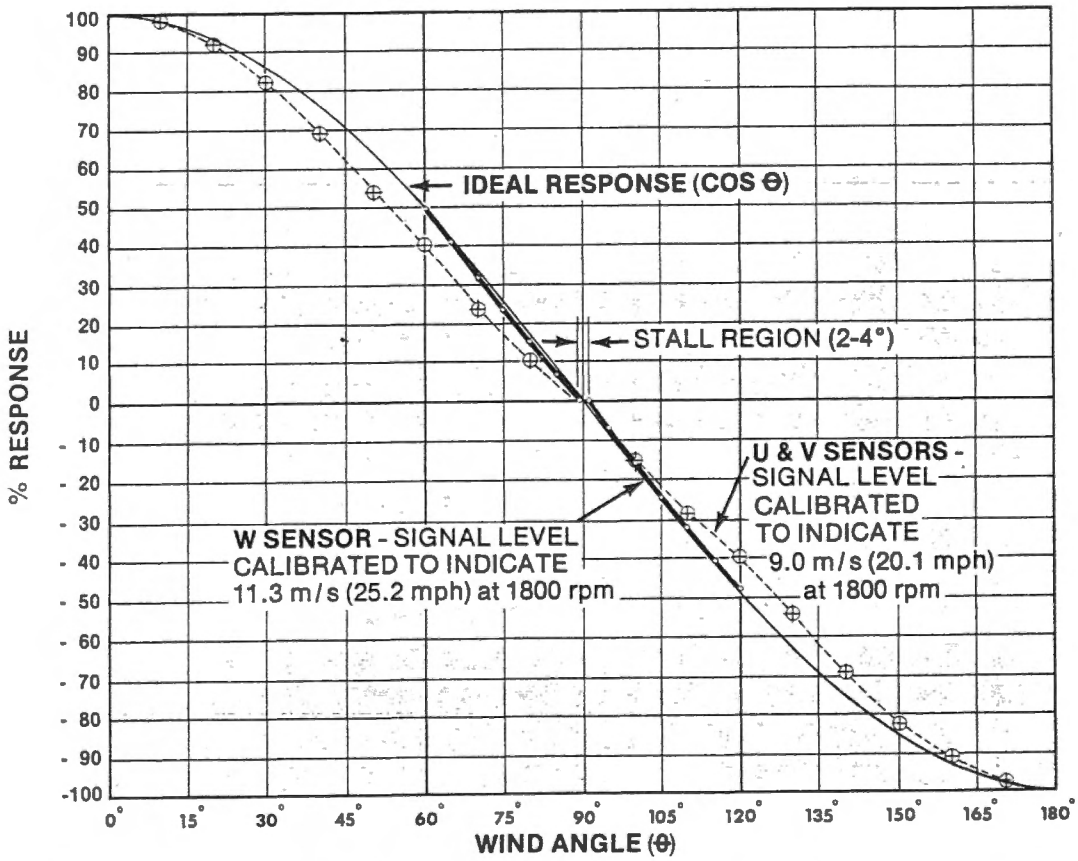
PROPELLER EXTENSION. Installed in place of propeller nut and washer. Improves low speed response in the stall region (90° wind angle) ..... **CAT. NO. 27160**

Principle:	Direct measurement of the three orthogonal coordinates (along wind component, across wind component, and vertical wind component) throughout any wind angle (0-360°) at each sensor. Propeller response very closely approximates the cosine law (see propeller response vs wind angle below).
Range:	0-22 m/s (0-50 mph) for all angle flow with standard 23 cm x 30 cm propeller - most sensitive. 0-38 m/s (0-70 mph) for all angle flow with optional 19 cm x 30 cm propeller.
Threshold:*	Threshold sensitivity of each sensor 0.1-0.2 m/s (0.3-0.5 mph) with standard 23 cm x 30 cm propeller; 0.2-0.3 m/s (0.5-0.7 mph) with optional 19 cm x 30 cm propeller.
Dynamic Response:*	Distance constant of standard propeller 1.0 meter (3.1 feet). Distance constant of optional propeller 0.8 meter (2.7 feet). Distance constant equals wind passage for 63% recovery from step change in wind speed.
Signal Output:	Analog d.c. voltage directly proportional to the axial wind component at each sensor. Signal polarity reverses with reverse propeller rotation. Tachometer generator in each sensor has armature resistance of 32 ohms and provides 500 mV output at 1800 rpm which equals 9.0 m/s (20.1 mph) with the 30 cm pitch polystyrene propellers. Signals are suitable for recording on most galvo or millivolt chart recorders and magnetic tape recorders. Requires three channels with center zero (bipolar). Life expectancy of tachometer generator 1 x 10^9 revolutions (3-4 years normal operation).
Calibration:	Polystyrene propeller rotates 1 revolution per 30 cm of wind passage. 1800 rpm equals 9.0 m/s (20.1 mph) for horizontal wind components (U and V sensors) and provides cosine response shown in curve below. Calibration for vertical wind component (W sensor) to 11.3 m/s (25.2 mph) at 1800 rpm provides improved cosine response between 60° and 120° wind angles as shown by curve below.
Weight:	Overall net weight (including 3 sensors) 3.6 kg (8 pounds). Shipping weight approximately 7.7 kg (17 pounds).
Dimensions:	Overall height 107 cm (42 inches). Projection of each sensor from centerline of mounting assembly 41 cm (16 inches). Diameter of standard propellers 23 cm (9 inches); optional propellers 19 cm (7½ inches). Diameter of base housing 16 cm (6¼ inches). Mounts on standard 1" iron pipe; orientation ring provided. Sensors individually removable from mounting assembly.
Power Required:	115 V/60 Hz for operation of blower in lower housing and convenience outlet provided for Synchronous Motor Calibrating Unit. 230 V/50 Hz optional.

*Nominal Values

PROPELLER RESPONSE vs WIND ANGLE

MAXIMUM RESPONSE POLYSTYRENE PROPELLER



CTUAL SIGNAL OUTPUT VS IDEAL SIGNAL AT ALL WIND ANGLES FROM 0° (AXIAL FLOW) THROUGH 90° TALL) TO 180° (REVERSE AXIAL FLOW). HEAVIER CURVE BETWEEN 60° AND 120° INDICATES OUTPUT ITH CALIBRATION SHIFTED FOR VERTICAL COMPONENT MEASUREMENTS.

JAN 79

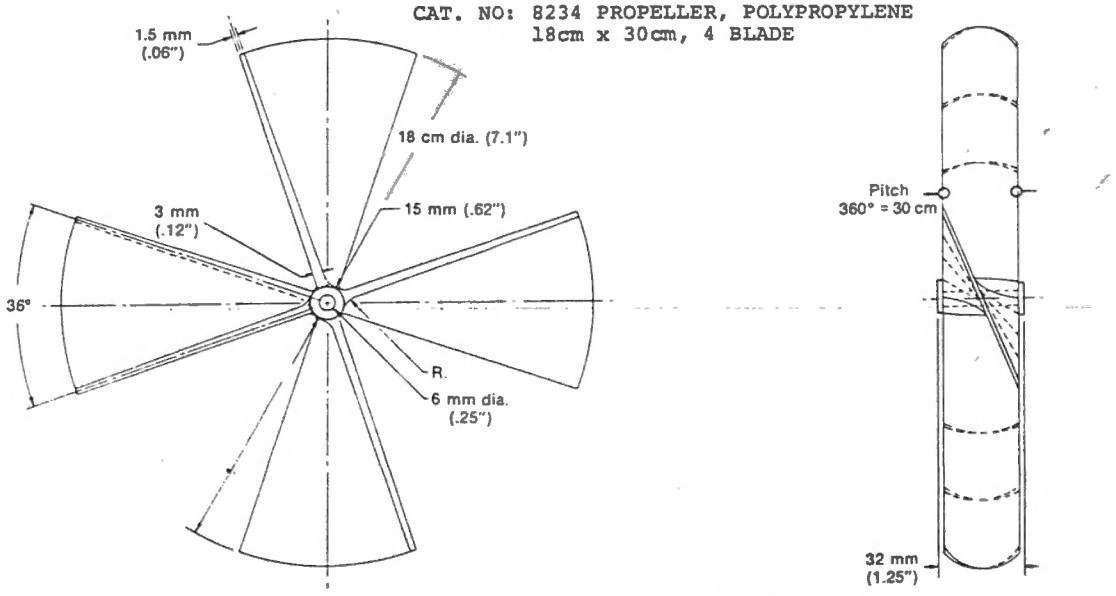
HIGH RESOLUTION PROPELLER

These injection molded thermoplastic propellers are intended for direct substitution for the polystyrene 4 blade propellers for applications requiring greater physical strength as well as an extended working range. They may be used in place of the sensitive polystyrene 4 blade propellers without significant change in calibration. Cosine response is also similar.

The helicoid shape 18cm diameter x 30cm pitch propeller is a one piece molding of polypropylene plastic with a specific gravity of 0.9, resulting in a total weight of 31gm (1.1 oz). Distance constant is 3.3m (10.5 ft). (Distance constant is the wind passage required for 63% recovery from a step change in wind speed.) Polypropylene is a very flexible and durable material making this propeller highly resistant to failure from high winds as well as icing and hail damage.

Working range is 0-50m/s (112mph). Threshold is 0.2-0.4m/s (0.5-0.9mph). Threshold is measured with the propeller mounted on a standard sensor with precision instrument grade ball bearings and driving a miniature tachometer generator.

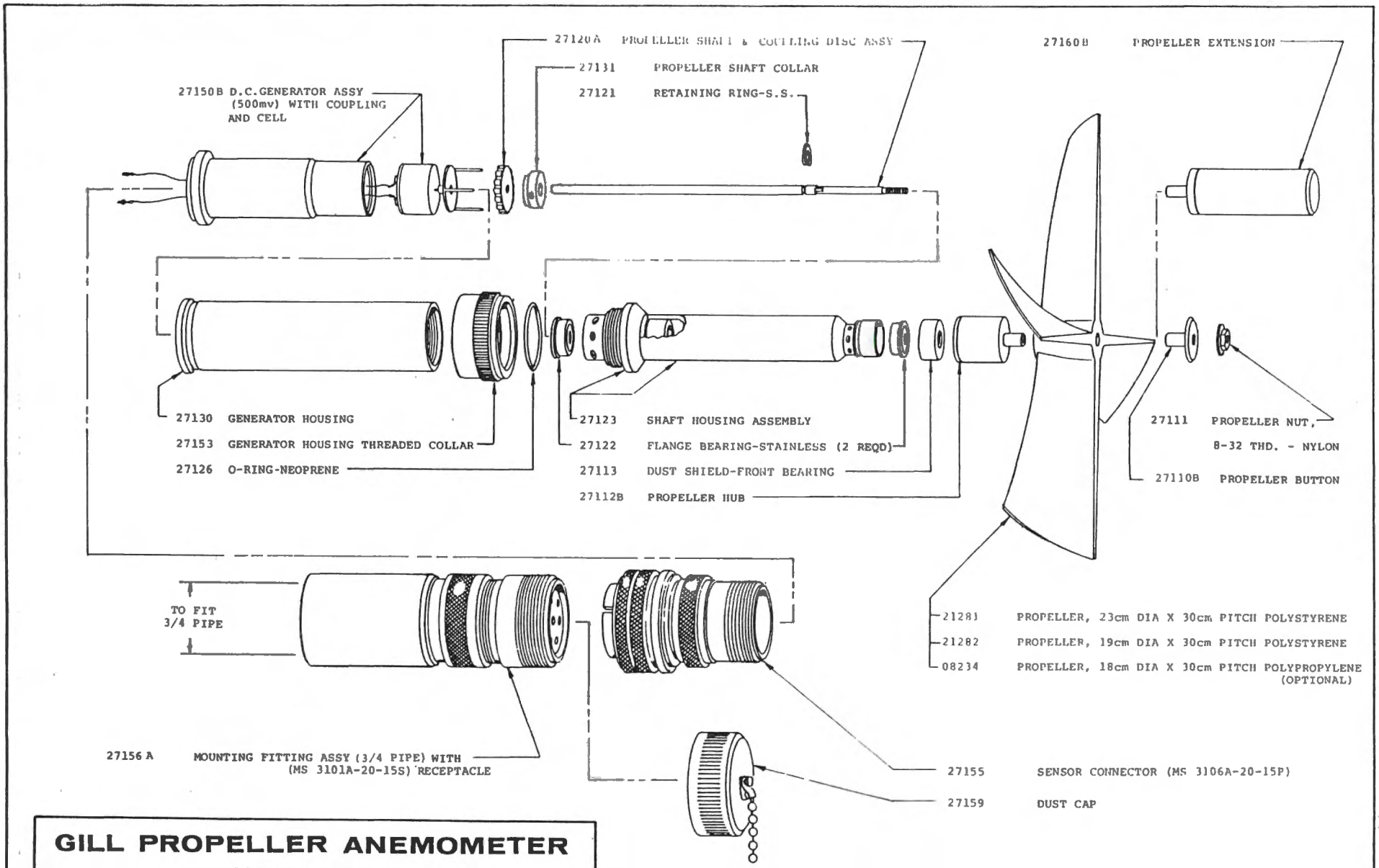
CAT. NO: 8234 PROPELLER, POLYPROPYLENE
18cm x 30cm, 4 BLADE



SPECIFICATIONS:	
RANGE - AXIAL FLOW:	50 m/s (112 mph)
RANGE - ALL ANGLE:	50 m/s (112 mph)
THRESHOLD:	0.2 - 0.4 m/s (0.5 - 0.9 mph)
DISTANCE CONSTANT:	3.3m (10.5 ft.)
EFFECTIVE PITCH:	29.4cm (0.96 ft.)
WORKING TEMPERATURE:	120°C (248°F)
MATERIAL:	POLYPROPYLENE (SPECIFIC GRAVITY 0.9)

CALIBRATION POINTS:		
HORIZONTAL -	3600 rpm	17.6 m/s (39.5 mph)
	3000 rpm	14.7 m/s (32.9 mph)
	1800 rpm	8.8 m/s (19.7 mph)
	1500 rpm	7.4 m/s (16.4 mph)
	300 rpm	1.5 m/s (3.4 mph)
	250 rpm	1.2 m/s (2.7 mph)
VERTICAL -	1800 rpm	11.0 m/s (24.6 mph)
	1500 rpm	9.3 m/s (20.8 mph)
	300 rpm	1.8 m/s (4.0 mph)
	250 rpm	1.5 m/s (3.4 mph)

R.M. YOUNG COMPANY
2801 Aero-Park Drive, Traverse City, MI 49684, U.S.A.
Phone (616) 946-3980 TWX 810-291-3366



GILL PROPELLER ANEMOMETER

MODEL 27106

GENERAL ASSEMBLY & REPLACEMENT PARTS

R. M. YOUNG COMPANY
2801 AERO PARK DRIVE, TRAVERSE CITY MICHIGAN 49684

REPLACEMENT PARTS (NOT SHOWN) PROPELLER ANEMOMETER W/2400mV GENERATOR MODEL 27105 (OPTIONAL)

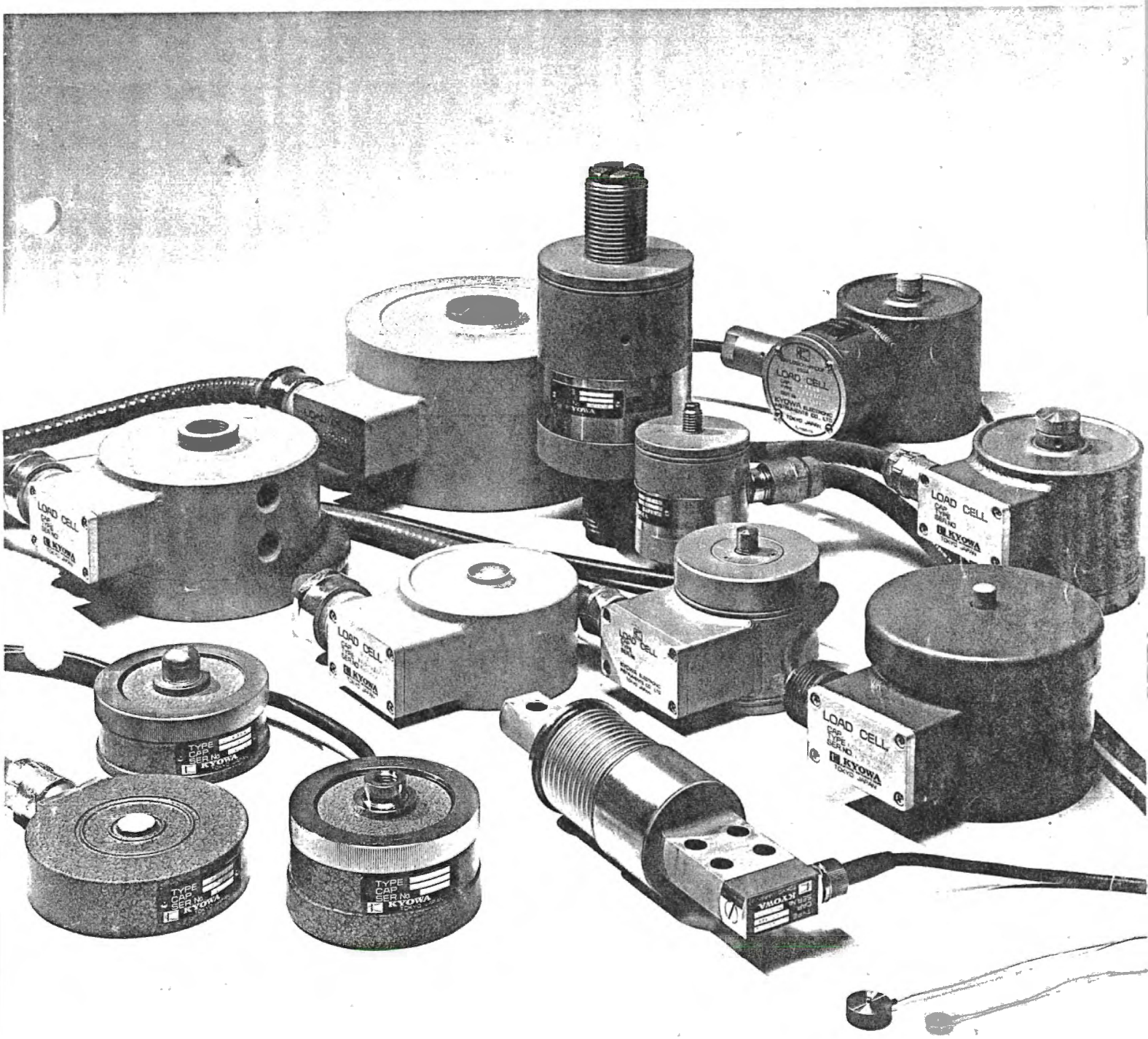
PART NO. 27130A	GENERATOR HOUSING-2400mV GEN.
PART NO. 27144	GENERATOR CELL-2400mV GEN.
PART NO. 27152	D.C.GENERATOR ASSY (2400mV) W/CPLG.

AUG 81

KYOWA

strain gage based

LOAD CELLS



Robust performers for repetitive loadings

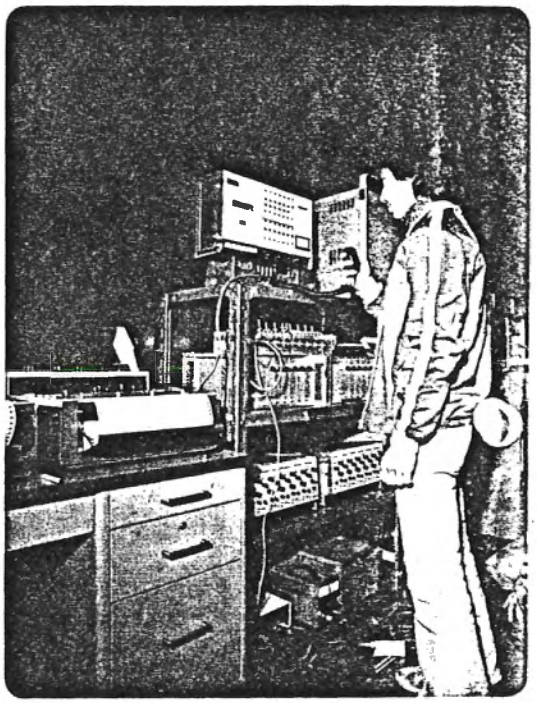
A rich variety of high reliability load cells available from Kyowa

The strain gage based load cell is a unit for converting weight or force into an electrical output by virtue of the internal strain gage installation. Depending on application purposes, the electrical output is connected to different types of measuring instruments for weight indication, recording and control. The load cell provides the excellent advantages that it is available in a samll size, light weight unit exhibiting extremely small mechanical displacement, its simple construction facilitates maintenance and installation, and its excellent linearity and high response performance allows it to be used for dynamic load measurement. Conventionally it had been employed for experimental and research applications, but recently many load cell applications are found in weighing systems for the production line because of all such factors as performance improvement on load cells themselves, development of electronics techniques for peripherals and automation-oriented labour-saving.

Kyowa load cells are produced using excellent production techniques starting with the development of exclusive high accuracy strain gages, high accuracy calibration equipment and many years of rich experiences, and they are excellent products exhibiting high accuracy but without aging change under exacting operating conditions and maintaining performance requirements for a long period of time.

Especially the performance of high accuracy type LCH and LTH series cells, developed only by the pure Japanese-originated techniques is excellent and on an international level. Designed for use in every industrial sector, Kyowa load cells are available in different types and configurations including those for compression and tension application, explosion-proof types for operation under the atmosphere of highly dangerous expolsive liquids, gases and powders, and washer types for roll/press down force measurement. The wide field of applications as detectors covers general load measurement for experimental research work and weight measurement and control for tanks, hoppers, rolls and locomotives.

Kyowa's uniquely integrated manufacturing knowhow in stress measuring equipment covers detectors, amplifiers, recorders and data processing equipment. The same engineering knowhow also makes available, in measuring equipment for load cells, different types of high accuracy and high reliability devices for your selection to meet specific measurement conditions.



• High accuracy weight measurement

With over 20 years of experience in load cell manufacture Kyowa produces high accuracy load cells including LCH and LTH series of 0.02% non-linearity representing the highest level on an international basis, employing excellent production techniques and facilities.

• Long-term, stable operation under exacting operating conditions

Most of the Kyowa load cells are of completely air tight construction with an inert gas filled inside. It provides prevention against the lowering of insulation resistance and the oxidization of strain gages and other compensating resistors, which are the major causes for an aging change. Thus, initial high accuracy is maintained for a long time period under severe operating conditions.

• Remote indication/control

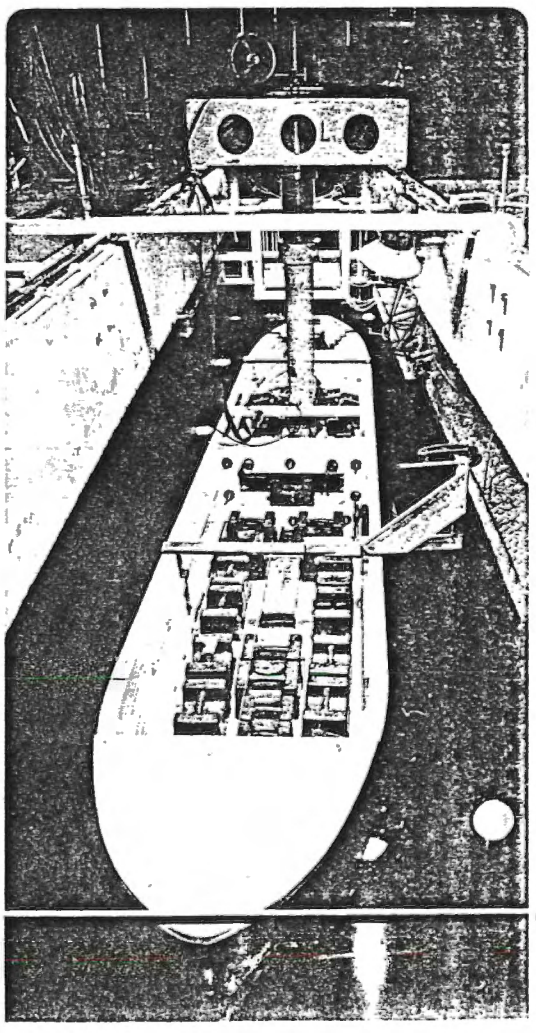
The load cell transduces load or force into an electrical signal, which can be indicated or recorded in a remote location or may be turned into a control signal for the cell to work as a detector in process control.

• Longer service life against repetitive loadings

How many times a load cell can be operated is an important consideration for repetitive operation of load cells. Kyowa load cells provide longer service life. A test on the particular series LCH and LTH with repetitive loading equipment has indicated that they can be operated over one million times at a 100% load.

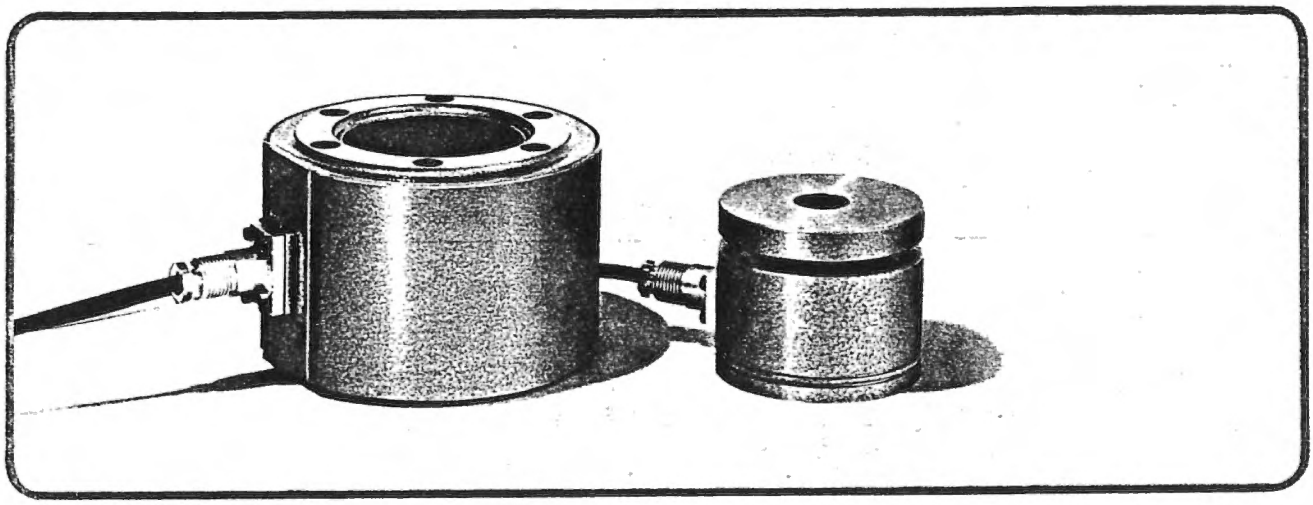
• Weighing-law verified 'SCALE' for commercial transactions

Equipped with apparatuses specified by the Weighing Law, Kyowa is registered as manufacturer of mass weighing meters, the 3rd classification of the Weighing Law and can accomplish calibration according to the Weighing Law. Therefore, weighing equipment calibrated by Kyowa can be used as 'scale' for commercial transaction.



Center-Hole Type Load Cell

BL-B Series



Designed for use in civil engineering measurement, these load cells are for measurement of loads on tunnel supports and soil pressure on protective walls to aid control in construction projects.
Their center-hole design makes them suit a wide variety of uses including tension measurement where it is used as a tie-rod tension gages. All models are moistureproof and drip-proof to survive use in unfavorable environments.

Features:
- Easy installation with hole in center.
- Competitive price.

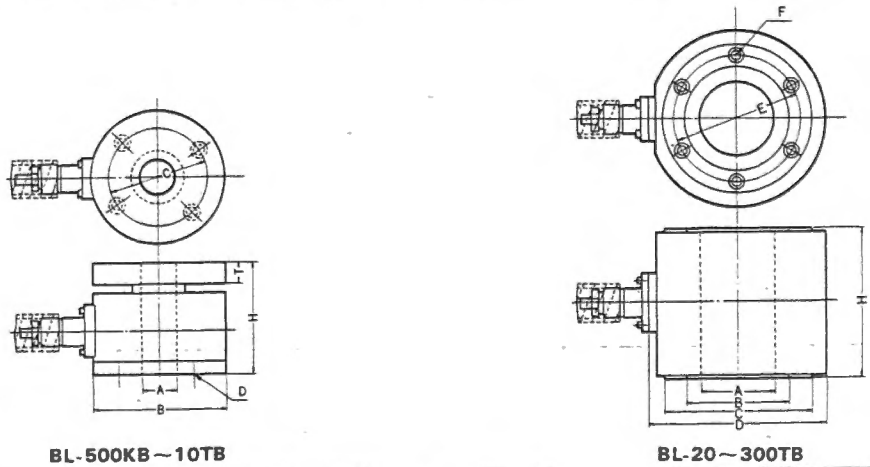
Specifications

Type	BL–B
Capacity	500kgf~300tf
Output voltage sensitivity	More tham 1mV/V
Non-linearity	BL–500KB~10TB 1%FS BL–20TB~300TB 2%FS
Allowable bridge woltage	2~10V
Input/Output resistance	350Ω
Allowable temperature range	–20 ~ +70°C

BL-B Series — Types & Dimensions (unit: mm)

Type	Capacity	A	B	C	H	T	D
BL-500KB	500kgf	ϕ26	ϕ 98	ϕ 70	82	15	4 – M10 x 10
BL- 1TB	1tf	ϕ26	ϕ 98	ϕ 70	82	15	4 – M10 x 10
BL- 2TB	2tf	ϕ26	ϕ 98	ϕ 70	82	15	4 – M10 x 10
BL- 5TB	5tf	ϕ26	ϕ 98	ϕ 70	82	15	4 – M10 x 10
BL- 10TB	10tf	ϕ26	ϕ129	ϕ100	95	18	4 – M12 x 12

Type	Capacity	A	B	C	D	E	H	F
BL- 20TB	20tf	ϕ 45	ϕ 55	ϕ 67	90	ϕ 61	80	8 – M 6 x 6
BL- 50TB	50tf	ϕ 80	ϕ 91	ϕ109	120	ϕ100	110	12 – M 8 x 10
BL-100TB	100tf	ϕ 85	ϕ 96	ϕ128	160	ϕ113	110	12 – M12 x 10
BL-200TB	200tf	ϕ120	ϕ150	ϕ190	220	ϕ170	120	12 – M12 x 12
BL-300TB	300tf	ϕ120	ϕ135	ϕ195	220	ϕ170	120	12 – M12 x 12



BL-500KB~10TB BL-20~300TB

Technical Note

● Advantages of remote sensing method

When longer extension cable is used with a load cell, type LCH, type LUH or type LTH for high accuracy measurement, the effects of cable conductor resistance and ambient temperature changes come up to create an error in the measurement. It is the function of remote sensing that eliminates the error factor and stabilizes the bridge supply voltage.
Now, suppose that 100 meters extension is made with Cabtyre cable of 0.5mm^2, and then the conductor resistance is about 3.3 ohms. In Fig -1, if r=3.3 ohms, the total resistance in the input circuit is 6.6 ohms.

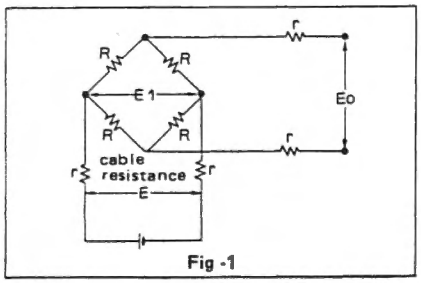


Fig -1

When the input/output resistance of the load cell is 350 ohms, the voltage across the bridge ends at supply voltage EV is given by:

$$\frac{350E}{350+6.6} = 0.981E(V)$$

By the relation, $Eo=\frac{E}{4}Ks.\epsilon$,
the sensitivity of the cell will be reduced by about 2%.
Furthermore, if a 10°C change has occurred in the ambient temperature during measurement, the voltage across the ends of load cell will fluctuate by about 0.072%, thus making useless the application of a 0.02% accuracy load cell. As shown by Fig. -2, the remote sensing method uses a cable of 6 conductors, 2 additionals of which are arranged in a pair (error-detecting wire) to the input side of the bridge. The bridge voltage is lowered by the cable resistance, r and the voltage reduction is led into the error amplifying section by the detecting wire. The voltage reduction is compared with the reference voltage, and the differential voltage is amplified by the error voltage amplifier of high amplification and high impedance so that the output will actuate the control circuit to keep the bridge input voltage constant and independent of the cable resistance, r, accomplishing good accuracy and stability measurement. The symbols A to G and colour indications given in Fig. -2 are for connector connection.

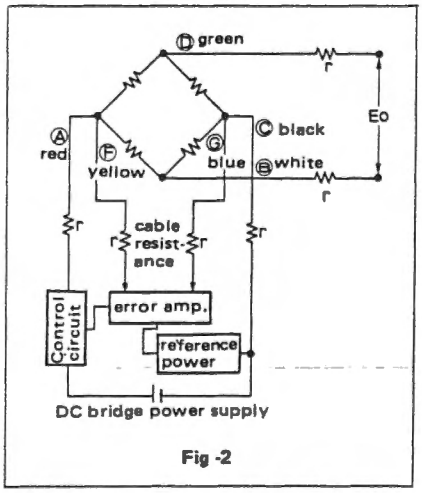


Fig -2

● Considerations for explosion proofing of load cells

Load measurement with electric measuring instruments in locations of danger with gasoline, Nafsa and particle explosion requires the mounting instruments to be of explosion proof construction. In this case, pressure-resistant, explosion proof type load cells (LCS type and LUS type) are employed or an intrinsically safe, explosion proof system is constituted by using a safety holder, ZENER BARRIER'

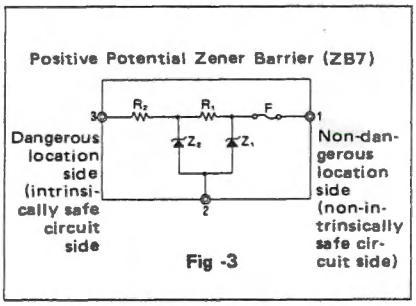


Fig -3

Arrangement with the load cell is made as shown by Fig -4.

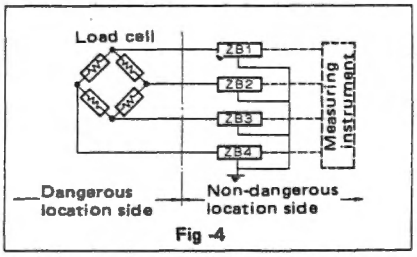


Fig -4

The arrangement has met the requirements of the Industrial Safety Research Institute, Ministry of Labour for the intrinsically safe, explosion proof system and obtained the certification. (Certification No.15409)

● Connection of connector with bridge

The bridge/connector connection, internal of the load cell is as per Fig -5, and the resistances between the respective terminals are given in Table -1. Use it for checking.

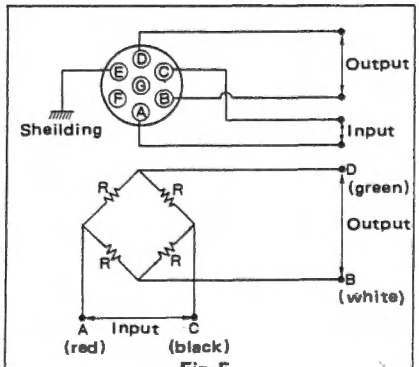


Fig -5

(1)	(2)	(3)	A−B	A−D	B−C	C−D
350Ω	350Ω	350Ω	260Ω	260Ω	260Ω	260Ω
120Ω	120Ω	120Ω	90Ω	90Ω	90Ω	90Ω

(1)bridge resistance(R) (2)Input(A-C)
(3)Output(B-D)
Table -1

Performance/characteristics Terminology & Definitions

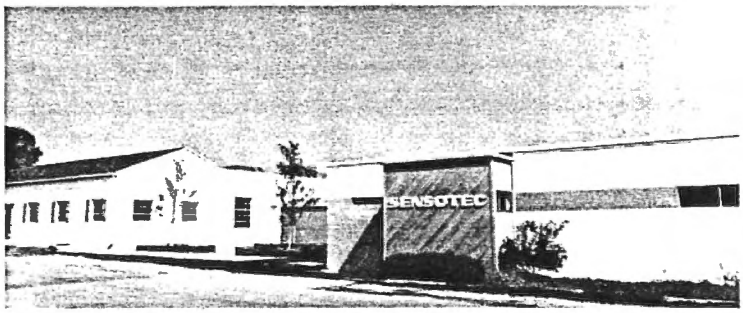
• The specifications in this catalogue are based on the following terms.

Capacity - The upper limit of the measuring range is referred to as the rating or rated capacity.
Allowable load - The maximum value of load applicable on the condition that the stated performance specifications may not be satisfied against a load exceeding the rating, but they must be met when the cell is again loaded up to the rating for measurement and expressed in % of the rating.
Maximum allowable load - The limit load over which a structural rupture is caused in the cell, expressed in % of the rating.
Rated output voltage - Rated output, expressed in output voltage with open ends. Bridge voltage at that time is given together.
Output voltage sensitivity - Rated output voltage, expressed per volt of bridge voltage.
Non-linearity - The maximum output deviation of calibration curve from a straight line drawn between the no-load output and the rated load output, expressed in per cent of the rated output, but measured in load increasing cycle.
Hysteresis - The maximum difference in outputs provided during increasing and decreasing load cycles from zero load to the rated one, expressed in per cent of the rated output.
Recommended bridge voltage - Recommended bridge voltage is a one which can satisfy all the related performance items on the specifications. Expressed in □V - □V or □V±□V at □°C.- □°C.
Allowable bridge voltage - The maximum value of voltage applicable without impairing the performance characteristics of the cell on the condition that the stated cell characteristics specifications may be not be satisfied with the allowable bridge voltage applied, but they must be met when the recommended bridge voltage is again applied.
Maximum allowable bridge voltage - The limit value of voltage over which the cell cannot be excited without failure.
Input/output resistance - The value of composite resistance, when viewed from the bridge power supply and output sides, measured with current applied.
Guaranteed temperature range - The range of temperatures over which the stated performance specifications can be satisfied.
Allowable temperature range - The upper and lower limits of temperature range over which the cell can be used without permanent characteristics change.
Thermal zero effect - No- load output change per °C of ambient temperature change, expressed in per cent of the rated output. Temperature change range at that time is indicated together.
Thermal output effect - Rated output change per °C of ambient temperature change, expressed in per cent of the rated output. Temperature change range at that time is indicated together.
Initial unbalance - No-load output at normal mounting position, expressed in per cent of the rated output.
Repetitivity - The maximum difference in rated outputs provided with repeated rated loadings under an identical environmental condition, expressed in per cent of an average rated output. The average value of rated output is the arithmetic average of indicated values of three cyclings made.

STRAIN GAGE

LOAD CELLS

SENSOTEC

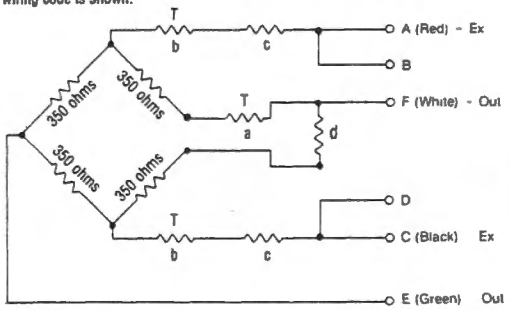


The load cells illustrated in this catalog are all based on utilizing strain gages. Most of the load cells utilize a metal foil strain gage which is bonded to the various load cell element designs to achieve a specific configuration or specification required. For some of the special load cells and the low range miniature load cells semiconductor strain gages are used to improve the output. Each model shown in the catalog has been specifically designed to take advantage of the wide variety of load cell element designs that have been developed by Sensotec engineering over the past years.

In the discussion of each load cell, when we refer to the element, we are concerned about the shape of the structure on which the strain gages are bonded. Sensotec's wide variety of designs covers the load range capacity from 50 grams to several million pounds, and have been utilized in thousands of different applications for industrial test measurement and development applications. We welcome the opportunity to discuss specific requirements with customers to provide improvements or new load cell designs to meet specific applications.

Electrical Connections

The strain gages are wired into four active arms of a Wheatstone Bridge and bonded to the sensing element of the transducer. Optional lead wires: multi-conductor, color-coded lead wires can be provided at no additional charge. The typical wiring code is shown.



STANDARD FOR WIRE COLOR STANDARD PIN CONNECTIONS FOR BENDIX PT 1H-10-6P AND MS3102E-14S-6P CONNECTOR

The electrical circuit illustrates a typical 350 ohm foil bridge with additional circuit components used for:

1) **Zero Temperature Compensation** - The temperature dependent resistor at (a) is placed at the open (output) corner of the bridge to offset the change of resistance in the bridge due to temperature.

2) **Span Temperature Compensation** - The temperature dependent resistors at (b) are connected in series with the input leads to compensate for the change in modulus of elasticity of the strain gages.

3) **Standardizing the Full Scale Output** - The non-temperature sensitive resistors at (c) are placed in series with the input leads to limit the input voltage, thus "standardizing" the millivolt output to a precise value.

4) **Trimming the Electrical Zero Balance** - The resistor at (d) is placed in series with the appropriate arm of the open corner bridge to electrically balance the bridge circuit.

METRIC THREAD OPTION

AMERICAN STANDARD THREADS	METRIC THREAD SUBSTITUTE
#4-40 UNC	M3 × 0,5
#6-32 UNC	M4 × 0,7
#10-32 UNF	M5 × 0,8
¼-28 UNF	M6 × 1,0
⅜-24 UNF	M10 × 1,0 or M10 × 1,5
½-20 UNF	M12 × 1,5 or M14 × 2,0
¾-16 UNF	M20 × 1,5
1-14 UNS	M24 × 1,5 or M27 × 3,0
1½-12 UNF	M36 × 3,0 or M39 × 1,5
2-8 or 2-12 UN	M52 × 3,0 or M52 × 1,5
2½-8 or 2½-12 UN	M64 × 2,0 or M72 × 4,0
3½-8 or 3½-12 UN	M90 × 4,0

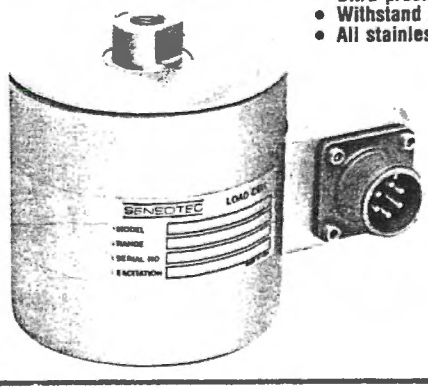
Most Sensotec load cells can be supplied with metric threads as an extra charge option. The following table is the closest metric thread to the English thread. For example, if the load cell has a 1-14 thread standard, a M24 x 1.5 can be substituted without changing their size or specifications of the cell.

ULTRA-PRECISION WEIGHING LOAD CELLS—

MODEL W

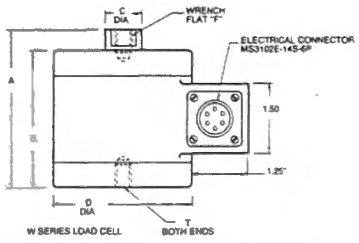
50 Lbs. thru 20,000 Lbs.

FEATURES:
- **Very rugged**
- **General purpose**
- **Ultra precision**
- **Withstand high off axis forces**
- **All stainless**



The Model W is an all stainless steel rugged precision tension/compression load cell. It is designed for those applications where extreme precision is required in load or weighing measurement.

1. O/L stops both directions standard — 50 lbs. thru 4,000 lbs. only.
2. Spherical radius available for compression only



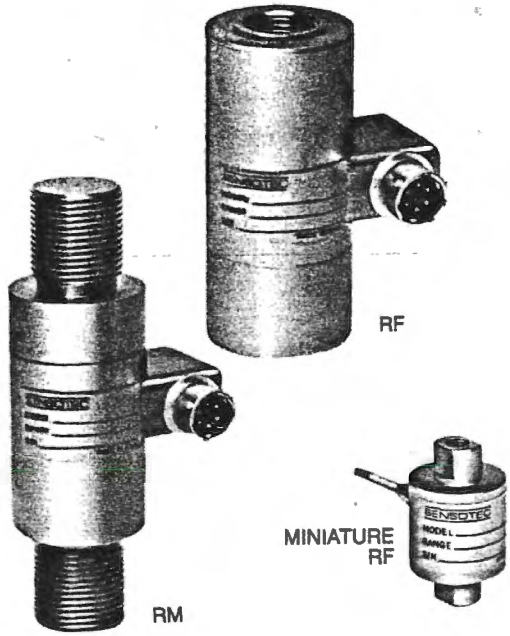
SPECIFICATIONS

CAPACITIES:	50# thru 20,000#
Rated Output (MV/V)	3
Linearity (% FS)	0.05
Hysteresis (% FS)	0.03
Temperature Effect:	
Zero (% F.S./°F)	0.001
Span (%Rdg./°F)	0.0008
Compensated Range	60°F to 160°F
Operating Range	−65°F to 250°F
Bridge Resistance	350 ohms
Input Voltage	10 volts
Overload (%)	150

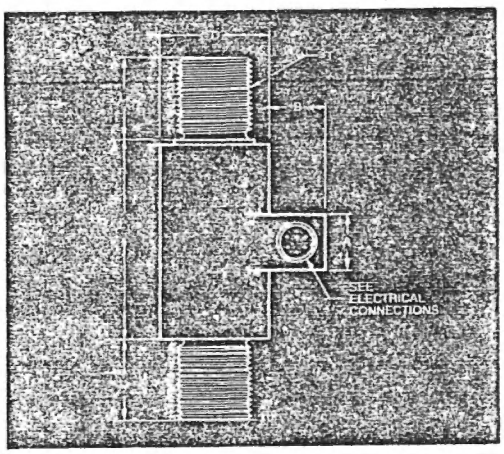
Capacity	"A"	"B"	"C"	"D"	"F"	"T"
50, 100, 250, 500#	3.5"	3.0"	.75"	3.0"	.625"	⅜-24"
1000, 2000, 3000, 4000#	3.5"	3.0"	.87"	3.5"	.750"	½-20"
5000, 7500#	4.5"	3.5"	1.50"	4.5"	1.25"	¾-16"
10,000, 15,000, 20,000#	4.6"	3.6"	1.90"	5.5"	1.50"	1-14"

SENSOTEC

ROD END AND

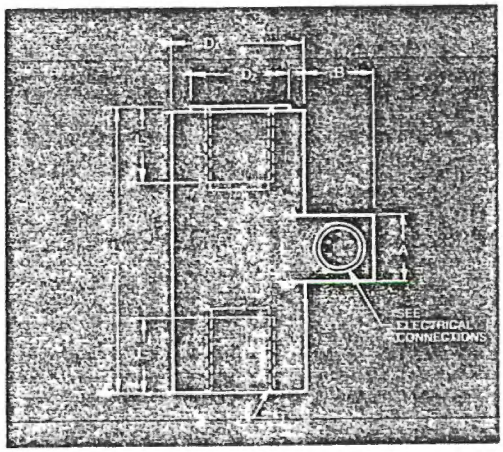


Rod End Load Cells — Both the Model RM and RF load cells are designed with a unique "I- beam" sensing element that provides excellent off-axis stability. The unique "I-beam" construction allows the gages to be mounted on the closest possible center line of the load cell and permits excellent long-term stability. Each load cell is made of 17-4 ph stainless steel and hermetically sealed with welded construction. The load cell can be used in corrosive and very high humidity environments. In addition, because of the hermetic sealing, the rod end load cells can be used outside provided a hermetic mating electrical connector is utilized for the cable running from the load cell to the instrumentation.



MODEL RM The Model RM is designed with male threads integrally machined as a part of the load cell.

CAPACITY	"D"	"T"	"L_1"	"L_2"	"A"	"B"
5, 10, 25, 50, 100#	1.0"	¼-28 UNF	1.25	.35	.25	.38
250, 500#	1.25"	⅜-24 UNF	1.75	.50	.75	.75
1K, 2K, 3K, 4K, 5K#	1.25"	½-20 UNF	2.00	.63	.75	.75
7.5K, 10K#	1.25"	¾-16 UNF	2.50	1.00	.75	.75
15K, 20K#	1.50"	1-14 UNS	2.75	1.12	.75	.75
30K, 50K#	2.25"	1½-12 UNF	3.50	2.00	.75	.75
60K, 75K, 100K#	3.50"	2½-8 UN	4.00	3.00	1.50	1.25
125K, 150K, 200K#	4.50"	3½-8 UN	5.00	4.00	1.50	1.25



MODEL RF The Model RF load cell is designed with female threads machined as an integral part of the load cell.

CAPACITY	"D_1"	D_2	"T"	"L_1"	"L_2"	A	B
5, 10, 25, 50, 100#	1.0"	.50	¼-28 UNF	1.75	.30	.25	.38
250, 500#	1.25"	.63	⅜-24 UNF	2.50	.50	.75	.75
1K, 2K, 3K, 4K, 5K#	1.25"	.69	½-20 UNF	3.00	.63	.75	.75
7.5K, 10K#	1.50"	.94	¾-16 UNF	3.30	.87	.75	.75
15K, 20K#	1.75"	1.19	1-14 UNS	4.25	1.12	.75	.75
30K, 50K#	2.25"	1.75	1½-12 UNF	8.00	2.00	.75	.75
60K, 75K, 100K#	4.50"	3.50	2½-8 UN	14.00	3.50	1.50	1.25
125K, 150K, 200K#	5.50"	4.50	3½-8 UN	18.00	4.00	1.50	1.25

SENSOTEC

NE LOAD CELLS

SPECIFICATIONS MODEL RF & RM

Input:	10VDC
Output:	2MV/V Nom.
Bridge Resistance	350 ohms Nom.
Linearity and Hysteresis (BFSL)	0.2% F.S.
Temp. Effect	Zero: .005% FS/°F
	Span: .005% Rdg/°F
Overload:	150% F.S.
Temperature Range:	−65 to +250°F
Compensated Range:	60° to 160°F

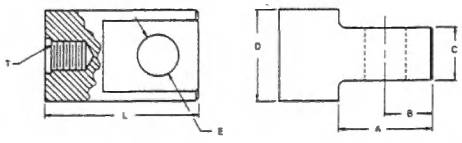
OPTIONS:
- Hermetic Sealing
- Male or Female Eye Bolts
- Can be Specified with one end Male Thread, the other Female (Model RN)
- Different Threads
- Waterproof Cable
- Fatigue Rating

HOW TO ORDER
Specify Model RF or Model RM
Specify Capacity
Specify Options

ROD END ATTACHMENTS

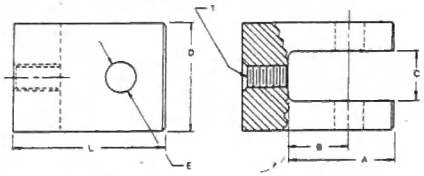
Shown below are various attachments that are available for use with the rod end load cells. The attachments shown are not kept as a standard stock item but in many cases, the attachments can be purchased directly from companies that supply shackles, etc. Other attachments can be provided to suit the customer's specific needs.

TONGUE SHACKLE



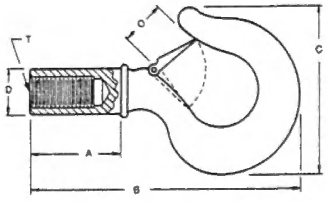
A	B	C	D Dia	E Dia	L	T thread	Approx. Wt. (lbs.)	Safe Static Load Rating
1¾"	⅞"	1"	1⅝"	¾"	2¾"	½-20 UNF	1	5,000#
2½"	1"	1"	2"	⅞"	4"	1-14 UNS	2	25,000#
4⅛"	1⅝"	1½"	3½"	1½"	6½"	1½-12 UNF	10	50,000#
5¼"	2¼"	1⅞"	4½"	2"	8¼"	2½-8 UN	20	100,000#

YOKE SHACKLE



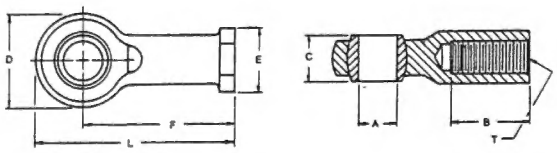
A	B	C	D Dia.	E Dia.	L	T Thread	Approx. Wt. (lbs.)	Safe Static Load Rating
2⅝"	1⅝"	15/32"	2½"	¾"	3½"	½-20 UNF	5	6,000#
3⅛"	1⅞"	19/32"	2½"	⅞"	4¼"	1-14 UNS	7	25,000#
4¾"	3"	111/16"	4"	1½"	6¼"	1½-12 UNF	20	50,000#
5¼"	3"	21/32"	5"	2"	7¾"	2½-8 UN	30	100,000#

STATIONARY HOOK



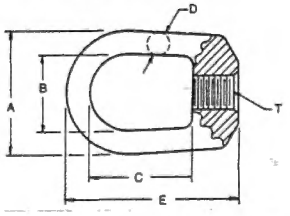
A	B	C	D Dia.	O	T Thread	Approx. Wt. (lbs.)	Safe Static Load Rating
1½"	5⅜"	4⅛"	⅜"	1⅛"	½-20 UNF	2	6,000#
2"	8½"	6½"	1⅜"	1⅝"	¾-16 UNF	7	15,000#

ROD END BEARING (SELF ALIGNING)



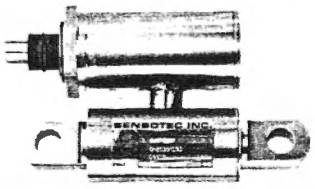
A Dia	B	C	D Dia	E Dia	F	L	T Thread	Approx. Wt. (oz.)	Safe Static Load Rating
¼"	11/16"	⅜"	¾"	½"	15/16"	111/16"	¼-28 UNF	1 oz.	3,500#
⅜"	13/16"	½"	1"	11/16"	1⅝"	2⅛"	⅜-24 UNF	2 oz.	5,500#
½"	11/16"	⅝"	19/16"	⅞"	2⅛"	2¾"	½-20 UNF	4½ oz.	9,500#
¾"	19/16"	⅞"	1¾"	1⅛"	2⅞"	3¾"	¾-16 UNF	10 oz.	15,000#

LIFTING EYE



A	B	C	D Dia.	E	T Thread	Approx. Wt. (lbs.)	Safe Static Load Rating
3"	1¾"	2⅜"	⅝"	3⅛"	½-20 UNF	1	5,000#
4"	2¼"	3 1/16"	⅞"	5"	¾-16 UNF	2½	10,000#
5⅝"	3⅛"	4"	1¼"	6¾"	1-14 UNS	7	25,000#
7"	4"	6¼"	1½"	10"	1½-12 UNF	17	50,000#

SUBMERSIBLE ROD-END AND IN-LINE LOAD CELLS



features:
- **Submersible for Underwater Applications (Fresh or Seawater)**
- **Highly Anti-Corrosive Stainless Steel Construction**

SENSOTEC will modify standard designs or make special load cells to suit almost every customer requirement. The photo above shows a special underwater cable tension load cell design with a solid state amplifier to give 5VDC output at full scale. The underwater connector and stainless steel welded construction make the load cell capable of permanent underwater operation.

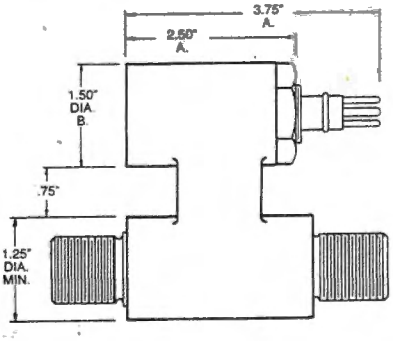
UNDERWATER:

Submersible connectors for underwater applications: The connector is welded to the transducer body and will withstand up to 10,000 psi external pressure without leakage. The standard is a four-pin connector, however, special-order different connectors can be provided.

The mating connector is a female with a locking screw to prevent accidential loosening. The price of the mate includes ten feet of cable molded to the mating half. Additional lengths of cable are optional.

For less demanding applications, cable without a connector can be provided. Neoprene-coated, four conductor shielded cable exists through moisture-proof O-ring seal and locking nut.

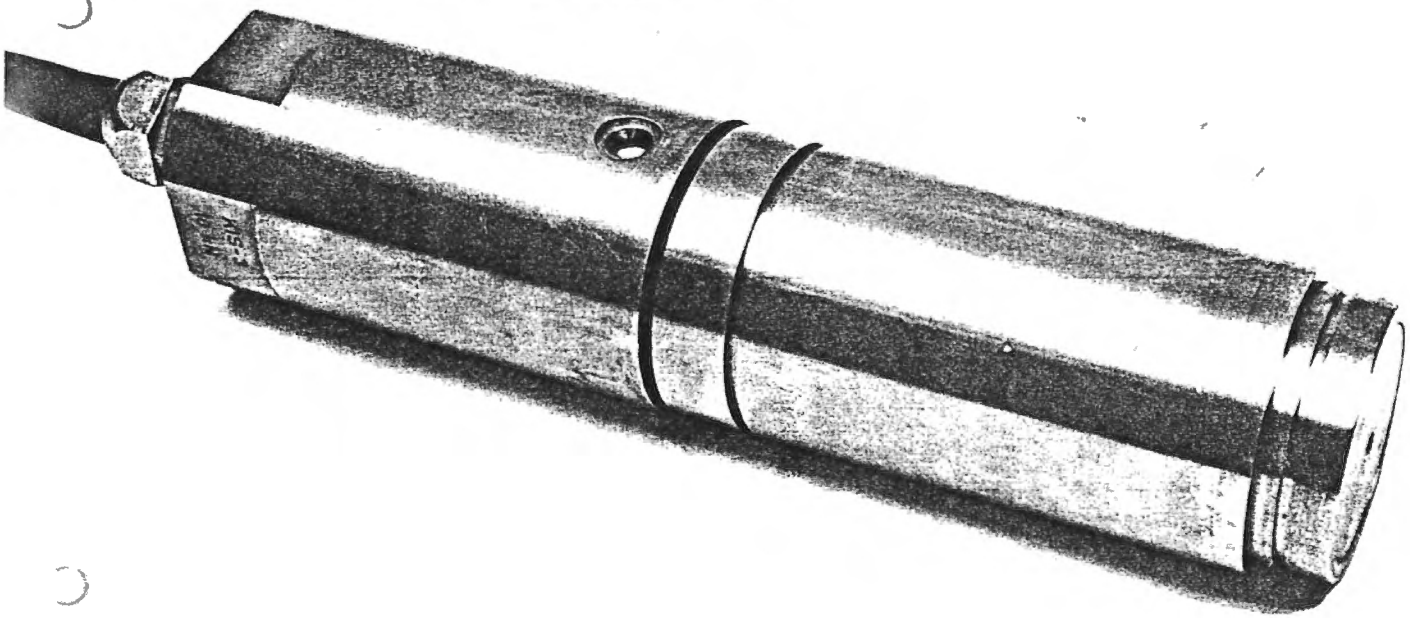
A third optional water-proofing method is to provide the lead wire exit through a pressure fitting at the cable end so that the conduit can be attached directly to the transducer, thus providing a water-proof joint at the transducer.

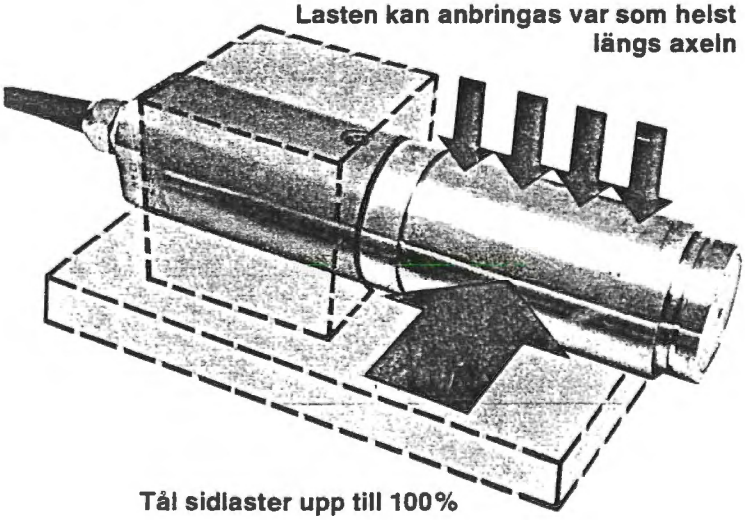


EMG 1008

GALLUS-PLESNER
INDUSTRI A-S
Ulvenveien 111 - Oslo 6 - Tlf. (02) 66 60 50

BOFORS unika
LASTCELL KIS
Cylindrisk form ger enklast tänkbara inbyggnad





Lasten kan anbringas var som helst längs axeln

Tål sidlaster upp till 100%

Mycket enkel installation

BOFORS patenterade lastcell KIS är utformad som en axel – alltså samma form som det vanligaste mekaniska konstruktionselementet – vilket gör att den kan ersätta en axel, en bult, en skruv etc. Detta förenklar installationen i såväl nya som äldre konstruktioner och ger minsta möjliga installationskostnader.
Lastcell KIS har t.o.m. gjort det möjligt att väga där man tidigare varit tvungen att avstå pga inbyggnadsproblem.

Hög noggrannhet

Kombinerat fel	± 0,02% (KIS-3)
	± 0,03% (KIS-1)
Repeterbarhet inom	0,01%

Stor kapacitet

0–1 till 0–500 kN
0–100 kg till 0–50 ton

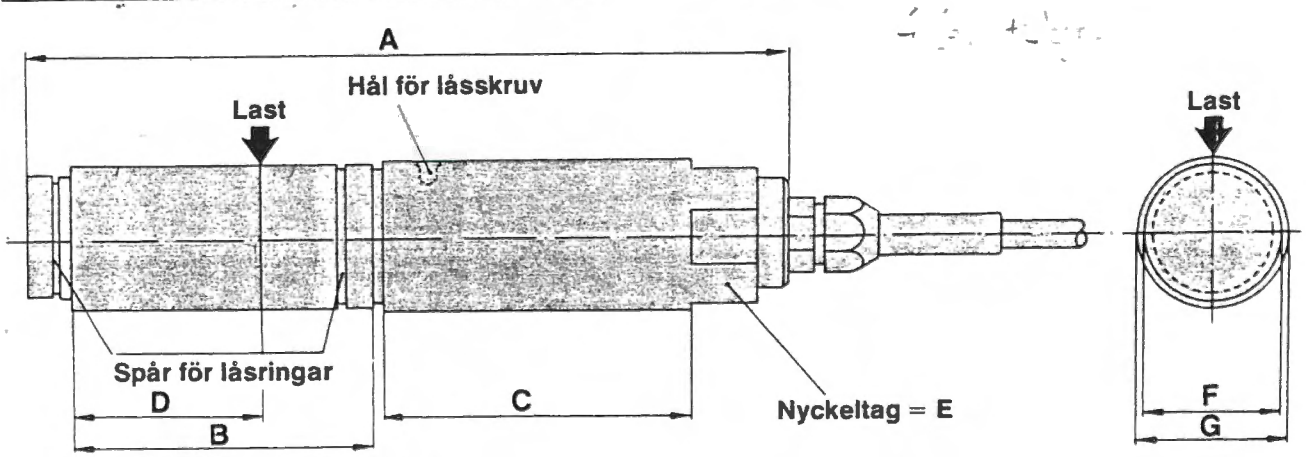
Tekniska data

		KIS-1	KIS-2	KIS-3
Nominell last (N.L.)	kN	50, 100, 200, 500	1, 2, 5, 10, 20	1, 2, 5, 10, 20
	Mp	5, 10, 20, 50	0.1, 0.2, 0.5, 1, 2	0.1, 0.2, 0.5, 1, 2
Kombinerat fel	± %	0,03	0,05	0,02
Repeterbarhet	% av N.L.	0,01	0,01	0,01
Överbelastning, tillåten (vid rek.belastn.punkt)	% av N.L.	100	100	100
Överbelastning, maximal (vid rek.belastn.punkt)	% av N.L.	200	200	200
Sidlast, tillåten	% av N.L.	100	100	100
Sidlast, maximal	% av N.L.	200	200	200
Inspänning, rekommenderad	V DC el. AC	15	12	12
Inspänning, maximal	V DC el. AC	18	18	18
Ingångsresistans	ohm	350±3	350±3	350±3
Utgångsresistans	ohm	350±0,5	350±3	350±0,5
Nom. utspänning N.U.	mV/V	2,040	2,040	2,040
Tolerans i N.U.	±%	0,1	0,25	0,1
Nollbalans	±%	1	5	1
Tolerans i shuntkal.värde	±%	0,1	0,25	0,1
Krypning efter 30 min.	±%	0,04	0,03	0,01
Temperaturområde	°C	-40 – +100	-40 – +100	-40 – +100
Temperatureffekt (-10°C – +50°C)				
på utspänning	±% av utsp./°C	0,0015	0,005	0,001
på nollbalans	±% av N.U./°C	0,003	0,005	0,001
Fjädring vid N.L.	mm	0,4 – 0,8 (1 – 2 mm för 500 kN)	0,1 – 0,3	0,1 – 0,3
Isolationsresistans vid 20V testsp.	> Mohm	4000	4000	4000
Ytbehandling		kadmierad och kromaterad	rostfritt stål	rostfritt stål
Skyddsnormer		SEN 431604	SEN 431604	SEN 431604
Elanslutning		10 m fyrledar-kabel	5 m fyrledar-kabel	5 m fyrledar-kabel

Dimensioner

Nom. last		Dimensioner i mm						
Typ	kN	A	B	C	D	E	F	G
KIS-2/3	1	173	69	70	43.5	30	33	34
"	2	173	69	70	43.5	30	33	34
"	5	173	69	70	43.5	30	33	34
"	10	220	100	75	67	46	50	51
"	20	220	100	75	67	46	50	51

Nom. last		Dimensioner i mm						
Typ	kN	A	B	C	D	E	F	G
KIS-1	50	295	144	109	105.5	55	75	77
"	100	321	155	119	114.5	60	90	92
"	200	353	176	129	133	80	100	101
"	500	457	202	180	140	80	140	142

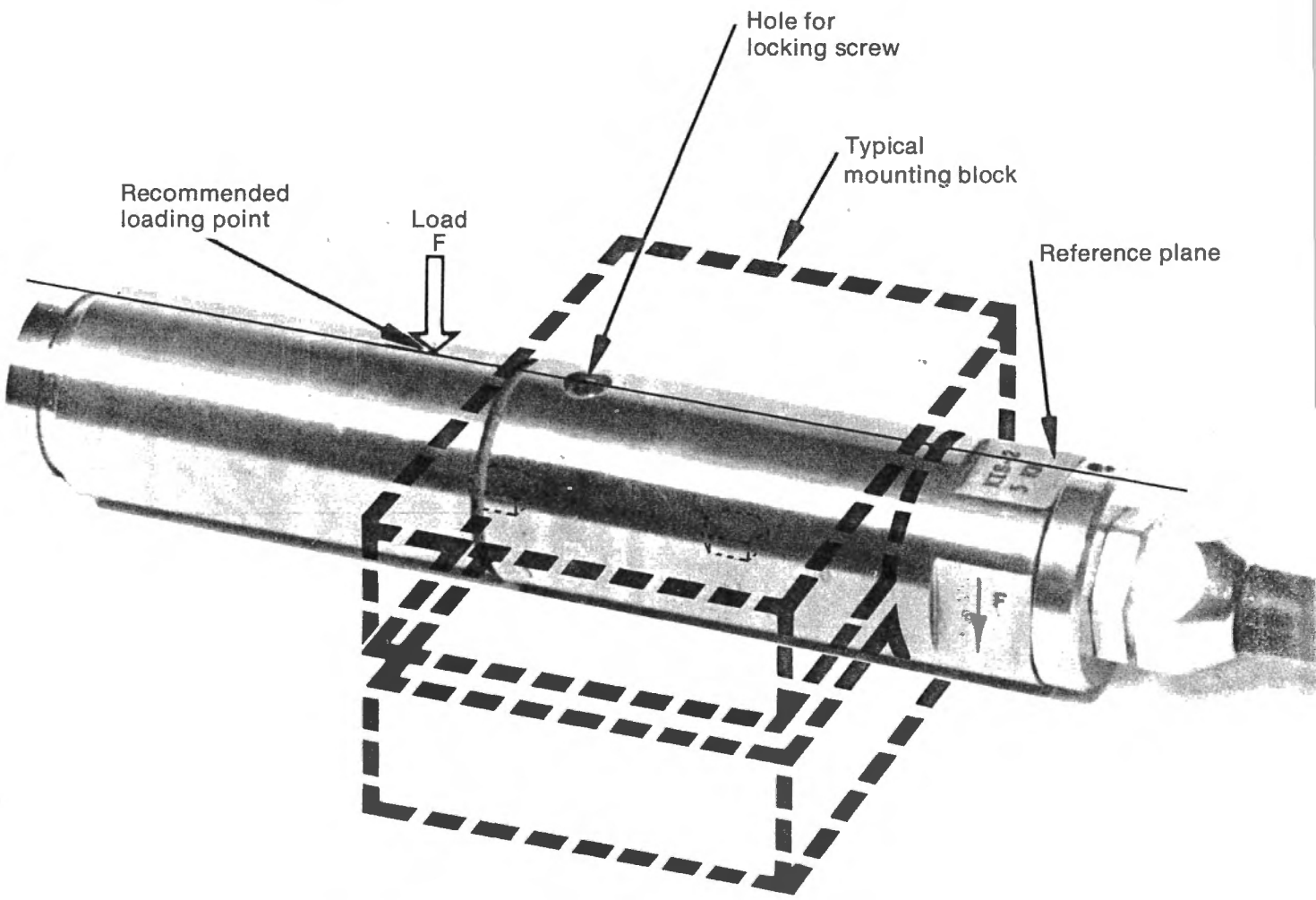


Lasten kan anbringas var som helst längst cylindern.
Avstånd D anger rekommenderad belastningspunkt.

BOFORS ELEKTRONIK
Adress: Box 600, 690 20 Bofors
Tel. 0586/360 00. Telex: 73574 Bonik S

BOFORS ELEKTRONIK

How to mount the KIS load cell



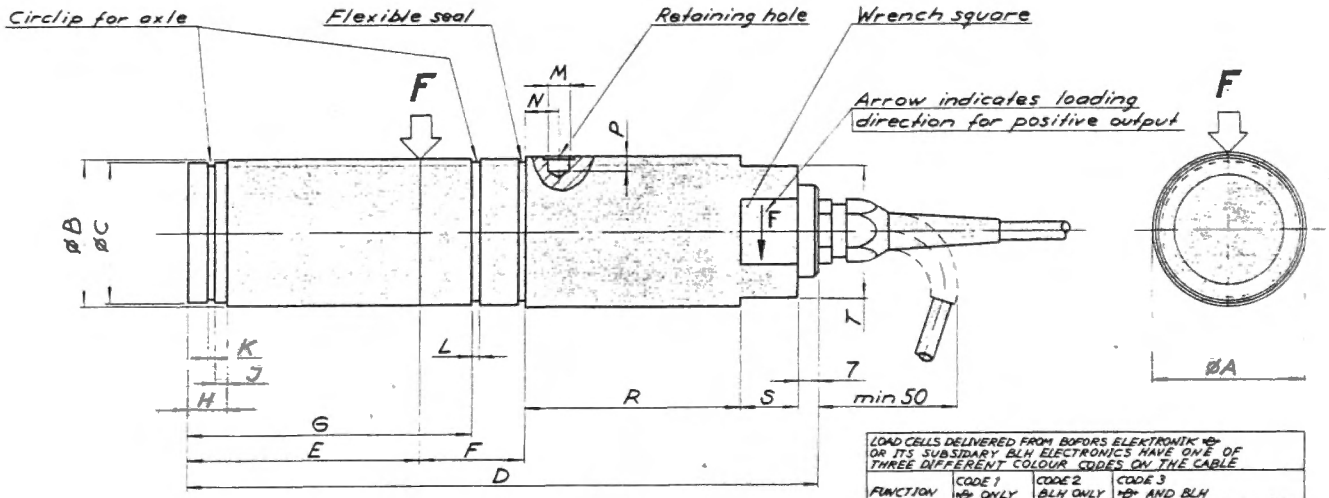
The KIS load cell should be mounted so that the load or force to be measured acts at a right angle to the Reference Plane and is applied as close as possible to the Recommended Loading Point. For weighing this is achieved by placing a spirit level on the Reference Plane, when the load cell has been put in its mounting block, levelling the spirit level by rotating the KIS and tightening the clamping bolts, ensuring the Reference Plane is still level.
The load cell is calibrated at the Recommended Loading Point. Loading at another point has very little effect on the calibration. A typical value is 0.002 %/mm distance from the Recommended Loading Point. Max. value is 0.005 %/mm.

If the Reference Plane is off level at an angle α in any direction,or if the load F is applied at an angle α with respect to the defined measuring direction, the output of the load cell (F_m) corresponds to

$$F_m = F \cos \alpha$$

When a side load (F_S) is present (defined as a "parasitic" load applied at a right angle to the load to be measured), a component of this load (Fsm) will act in the measuring direction of the load cell if the Reference Plane is off level. At an angle α the output F_{sm} produced by F_S will be

$$F_{sm} = F_S \sin \alpha$$



LOAD CELLS DELIVERED FROM BOFORS ELEKTRONIK OR ITS SUBSIDIARY BLH ELECTRONICS HAVE ONE OF THREE DIFFERENT COLOUR CODES ON THE CABLE			
FUNCTION	CODE 1 BLH ONLY	CODE 2 BLH ONLY	CODE 3 BLH AND BLH
EXITATION +	RED	GREEN	GREEN WITH RED STRIPE
EXITATION -	BLACK	BLACK	BLACK
SIGNAL +	GREEN	WHITE	WHITE WITH GREEN STRIPE
SIGNAL -	WHITE	RED	RED WITH WHITE STRIPE
SHIELD	BLANK OR YELLOW	YELLOW	YELLOW/

Load	øA	øB	øC	D	E	F	G	H	J	K(DIN471)	L(DIN471)	M	N	P	R	S	T
1 kN 2 kN 5 kN	$34^{+0}_{-0,1}$	$33^{-0,025}_{-0,064}$	$29^{+0}_{-0,21}$	173	46	35	—	10	2,5	1,6 (29×1,6)	—	4,4	10	2,3	70	15	30
10 kN 20 kN	$51^{+0}_{-0,12}$	$50^{-0,025}_{-0,064}$	$45^{+0}_{-0,25}$	217	60	55	97,85	13	4	1,85 (45×1,85)	2,15(50×2,15)	7,5	12	5	75	20	46
50 kN	$77^{+0}_{-0,12}$	$75^{-0,030}_{-0,076}$	$70^{+0}_{-0,3}$	295	93	65	141,35	12	5	2,65(70×2,65)	2,65(75×2,65)	9,1	14	7	110	20	60
100 kN	$92^{+0}_{-0,14}$	$90^{-0,036}_{-0,090}$	$82^{+0}_{-0,35}$	319	107	65	154,85	15	6	2,65(82×2,65)	3,15(90×3,15)	12,6	17	8	120	20	70
200 kN	$101^{+0}_{-0,14}$	$100^{-0,036}_{-0,090}$	$90^{+0}_{-0,35}$	350	128	65	175,85	15	6	3,15(90×3,15)	3,15(100×3,15)	15,7	19	8,5	130	20	80
500 kN	$142^{+0}_{-0,063}$	$140^{-0,043}_{-0,106}$	$130^{+0}_{-0,4}$	457	175	65	212,85	35	20	4,15(130×4,15)	4,15(140×4,15)	15,7	30	8,5	180	27	80

Notes

* Only left hand slot on KIS 1,2 and 5 kN

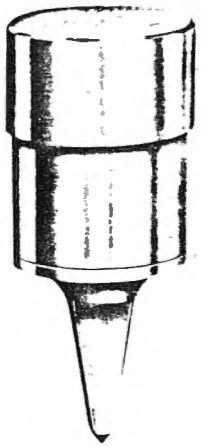
** Recommended method of mounting KIS is by using a split block with a hole drilled through it to take dimension ø A and clamped over most of dimension R. If a split block cannot be used then a block with a hole drilled through it to take dimension ø A can be used, with an appropriate threaded hole for a locking screw.

Bear in mind using the latter method that the tolerance on the hole for dimension ø A needs to be tighter and no rotational adjustments of the KIS in its bracket can be carried out if it is found during commissioning that the Reference Plane is not at right angles to the force or weight to be measured.

Standard brackets and yokes are available for normal weighing applications. See brochure "KIS Assembly Components".

BOFORS ELEKTRONIK
Address: P.O. Box 600, S-691 80 Bofors, Sweden.
Tel. 0586/810 00 Telex: 73574 Bonik S.

HS-1 MINIATURE GEOPHONES



Land

Marsh

High Temperature

Downhole
Omni-Directional

High Pressure

Available in a wide range of models, the 4.5 Hz or 7.5 Hz HS-1 is an excellent choice for refraction surveys; as is the 10 or 14 Hz unit for reflection surveys. Dual coil construction permits its use where electromagnetic interference is a problem.

Special models of this rugged geophone are available for extreme hostile environments such as high temperature, high pressure and radioactive.

APPLICATIONS

- Reflection Surveys
- Refraction Surveys
- Downhole Logging
- Intrusion Detection
- Vibration Monitoring

THE KALAMOS COMPANY LTD.
325, UPPER ELMERS END ROAD,
BECKENHAM, KENT, ENGLAND.
TELEPHONE: 01-650 2549
TELEX: 946123. KALMOS G.

DESIGNED, MANUFACTURED AND SERVICED WORLD-WIDE BY...

Applied Magnetics
Geo Space

SPECIAL HS-1

KALAMOS

Reg Off. : THE KALAMOS COMPANY L
325 Upper Elmers End Road,
BECKENHAM, Kent
BR3 3QP.
Telephone 01 650 2549
Cables KALAMOS BECKENHAM KE
Telex 946 129 KALMOG G

R. M. BRAHAM,
General Manager

High Temperature:	266 or 500°F
High Pressure:	Up to 20,000 PSI
High Radiation:	Resists deteriora
Omni Tilt:	Operates in any c
Omni-Directional Vibration Detector:	Consists of three separate detectors — measures components of vibration in any direction

SPECIFICATIONS
STANDARD HS-1

Vertical or Horizontal Basic Unit

Natural frequency, Hz:	4.5, 7.5, 10, 14, 20, or 28
Damping constant (R_c+R_d) (b_i-b_o):	253, 244, 183, 187, 131, or 94
*Optional coil resistances, Ω@25°C ±5%:	125, 500, 900, 1250

	English	Metric
	V/in/s	V/m/s
Intrinsic sensitivity:	0.51	20.1
Transduction constant:	0.035 $\sqrt{R_c}$	1.38 $\sqrt{R_c}$
	V/in/s/oz	V/m/s/gm
Output to Weight ratio:	0.054	0.075
	oz	gm
Total moving mass:		
4.5 Hz	1.006	28.50
7.5 and 10 Hz	.644	18.25
14, 20 and 28 Hz	.452	12.80
Weight:		
Aluminum	9.5	269
Brass	16	454
	in	cm
Maximum coil excursion P-P:	0.10	0.254
Height:	1.87	4.76
Diameter:	1.62	4.13
	PSI	Kgs/cm2
Pressure (High pressure model only):	20,000	1406
	°F	°C
Temp (standard):	160	71

*215Ω coil standard (All sensitivity and damping specifications for 215Ω coil)

We reserve the right to change specifications without notice.

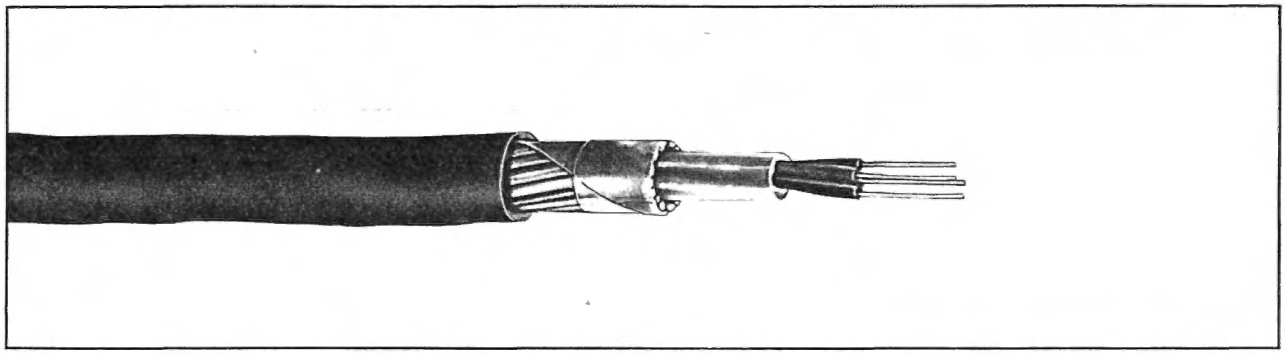
TYPE FEQE-L manufactured by Standard Telephone and Cable.
(A)

Specifications.

Conductor: High conductivity copper wire 0.9 mm
Insulation: Polyethylene
Elements: Star quads
Number of pair: 2, 8, 14, 24, 38
Petroleum jelly-filled
Inner jacket: Polyethylene
Armouring: Galvanized steel wire, 1.6 diameter
Outer sheath: Polyethylene

FEQE
plast abonnentkabel „kombi"

KATALOGDEL 2



A - 0,6 FEQE - 45 D
A - 0,9 FEQE - 45 D

Plastisolert abonnentkabel jord/luft/sjø – «kombi»

Konstruksjon:
Leder: Entrådet kobber.
Lederisolasjon: Polyetylen.
Revolvering: Fire ledere tvinnes sammen til en diagonalrevolvert firer (stjerne firer).
Fylling: Vaselin.
Indre kappe: Polyetylen over vaselinfylt kjerne.
Armering: Galvanisert ståltråd (1,6 mm).
Ytre kappe: Sort forsterket polyetylen.

Merking:
0,6 mm gruppeoppbygging, se side 6.5.
0,9 mm oppbygging i konsentriske lag i flg. tabell:

Firer nr. i hvert lag	Leder merking	
	Par 1	Par 2
Første	Blå-rød	grønn-sort
2, 4, 6, osv	Hvit-rød	—•—
3, 5, 7, osv	Gul-rød	—•—
Siste	Orange-rød	—•—

Bruksområde:
I abonnentnett til telefon og signaloverføring.

1) Som **luftkabel** på spesielt værharde steder.
2) Som **jordkabel** i vanskelig fjellterreng.
3) Som **elve- og innsjøkabel** ved gunstige strøm- og landtaksforhold.

El-nr. Hovedgr. 10-	Bruksområde Partall Lederdiam. mm	Ståltråd-arm. antall tråder x diam.	Ytre diam. mm	Vekt ca. kg/km	Armeringens brudd-last ca. kp.	Normale trommellengder m	På trommel nr.
843 06	A 6 - 0,6	16 x 1,6	18	450	1 260	1 500	K11
10	A 10 - 0,6	20 x 1,6	19	570	1 580	1 500	K12
20	A 20 - 0,6	29 x 1,6	24	880	2 300	1 500	K16
844 06	A 6 - 0,9	24 x 1,6	18	690	1 890	1 000	K11
10	A 10 - 0,9	29 x 1,6	21	890	2 300	1 000	K12
20	A 20 - 0,9	37 x 1,6	25	1 260	2 920	1 000	K16

Par	Opplegging av firere i 0,9 mm	
	Senter	Lag I
A 6 - 0,9	3	
A 10 - 0,9	5	
A 20 - 0,9	2	8

Opphengning: Montasjebeskrivelse nr. 225
Skjøting: Montasjebeskrivelse nr. 222

Kabelen er beregnet på anlegg med vanskelig terrengforhold hvor den dels henges opp som luftkabel, dels legges i jord, og dels krysser elver og innsjøer.

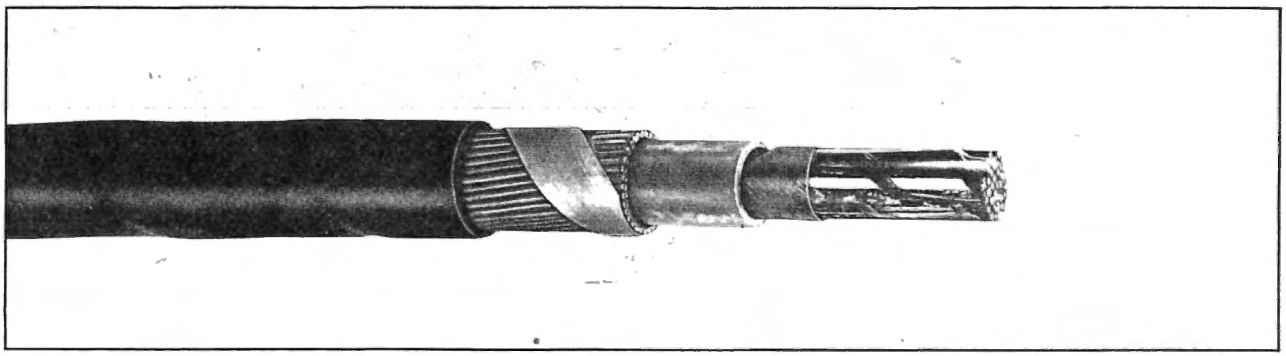
Elektriske data:
Kobbermotstand: Maks. middelverdi
0,6 mm: 162,2 ohm/km sløyfe.
0,9 mm: 56,1 ohm/km sløyfe
Midlere kapasitet: ca. 45 nF/km.
Speningsprøve: Leder-armering 4000 V likespenning i 2 sek.

Føres som lagervare.

FEQE
plast langlinjekabel „kombi"

STK

KATALOGDEL 2



L - 0,9 FEQE - 45 D
Plastisolert langlinjekabel jord/luft/sjø - «Kombi»

Etter Teledirektoratets spesifikasjon

Konstruksjon:

Leder: Entrådet kobber.
Lederisolasjon: Polyetylen.
Revolvering: Fire ledere tvinnes sammen til en diagonalrevolvert firer (stjerne-firer).
Oppbygging: Konsentrisk.
Fylling: Vaselin.
Indre kappe: Polyetylen over vaselinfylt kjerne.
Armering: Galvaniserte ståltråder 1,6 mm.
Ytre kappe: Sort polyetylen.

Bruksområde:

For fjern- og nærsamband.
1) Som **luftkabel** på spesielt værharde steder.
2) Som **jordkabel** i vanskelig fjellterreng.
3) Som **elve- og innsjøkabel** ved gunstige strøm- og landtaksforhold.

Kabelen er beregnet på anlegg med vanskelige terrengforhold hvor den dels henges opp som luftkabel, dels legges i jord og dels krysser elver og innsjøer.

Elektriske data:

Kobbermotstand: Maks. middelverdi 56,1 ohm/km sløyfe.
Kapasitet: Midlere 45 ± 2nF/km ved 800 Hz.
Kapasitets ubalanse: Side-side maks. enkeltverdi 110 pF/700 m.

Bruksområde Partall Lederdiam. mm	Herav BF-par	Ståltråd-arm. antall tråder x diam.	Ytre diam. mm	Vekt ca. kg/km	Armeringens bruddlast ca. kp.	Norm. trommellengder m	På trommel nr.
L 2 - 0,9	0	15 x 1,6	13	380	1 180	7 000	K20
L 8 - 0,9	0	29 x 1,6	20	810	2 290	700	K11
L 14 - 0,9	4	33 x 1,6	23	1 040	2 600	700	K12
L 24 - 0,9	6	41 x 1,6	27	1 420	3 230	700	K14
L 38 - 0,9	6	48 x 1,6	32	1 830	3 780	700	K14
L 54 - 0,9	6	56 x 1,6	37	2 290	4 480	700	K20

Andre lengder kan leveres på trommel eller nedlagt på jernbanevogn.

Par	Opplegging av firere		
	Senter	Lag I	Lag II
2	1		
8	4		
14	1	6	
24	3	9	
38	1	6	12
54	3	9	15

Opphengning: Montasjebeskrivelse nr. 225
Skjøting: Montasjebeskrivelse nr. 222

Par-par maks. enkeltverdi 100 pF/700 m.
Spenningsprøve:
Leder/leder 2000 V likespenning i 2 sek.
Leder/armering 4000 V likespenning i 2 sek.

Føres som lagervare.

Merking:

Oppbygging av firere i konsentriske lag i flg. tabell:

Firer nr. i hvert lag	Leder merking	
	Par 1	Par 2
Første	Blå-blå	sort-sort
2, 4, 6, osv	Hvit-hvit	—•—
3, 5, 7, osv	Gul-gul	—•—
Siste	Orange-orange	—•—

Bærefrekvensfirere er merket med henholdsvis sort, rød og grønn fireromvikling.

TRANSZORB DEFINITIONS AND SPECIFICATIONS

TransZorbs are PN Silicon transient voltage suppressors that are characterized by their phenomenal surge handling capabilities, extremely fast response time ($1x10^{-12}$ seconds), and low series resistance (R_{on}). Unlike the zener diode whose function is voltage regulation, the TransZorb is designed, manufactured, specified and tested for transient suppression.

When selecting a TransZorb, first determine the transient condition or the source of the pulse for each application. Specify maximum DC or AC peak voltage with tolerance. This maximum voltage level should be equal to or less than the reverse standoff voltage of the TransZorb.

Consider what is the minimum and maximum voltage for a given circuit.

Because of the temperature coefficient, the minimum clamping voltage (V_C) should be considered as the reverse standoff voltage (V_R) when operating at the extreme temperature of –65°C.

The maximum clamping voltage (V_C) is a desired voltage to provide adequate protection for a circuit or component.

Determine the proper device according to the peak pulse power. This can be accomplished in knowing the source impedance and the maximum transient voltage. Once the maximum peak pulse current (I_{PP}) is known (and if its value is less than the maximum I_{PP}), use the maximum clamping voltage (V_C) to calculate power for worst case design for most applications.

The TransZorb can be used in applications where induced lightning on rural or remote transmission lines present a hazard to the electronic circuitry. (Reference: REA Specification P.E. 60)

TransZorbs have proven to be effective in Airborne Avionics and Controls, Mobile Communications equipment, Computer power supplies, Numerically Controlled Machinery, and in many other applications where inductive and switching transients are present.

With their fast response times and low clamping factors, TransZorbs can protect Integrated Circuits, MOS devices, Hybrids, and other voltage-sensitive components. TransZorbs can also be used in series or parallel to increase the peak power ratings.

TransZorbs have been evaluated for susceptibility to neutron and gamma radiation. Neutron flux irradiation of 1.4×10^{13} neutrons/cm and cumulative gamma dosage of 2×10^{7} rad(Si) have been applied to the TransZorb without causing appreciable parameter changes.

They have also been proven effective for EMP suppression. For actual test results and applications send for the EMP report #AD 909267L, at the Defense Documentation Center, Alexandria, Virginia 22314.

Because of the unpredictable nature of transients and the variation of the impedance with respect to these transients, impedance is not specified as a parametric value. However, a minimum voltage (BV) at low current conditions and a maximum clamping voltage (V_C) at a maximum peak pulse current is specified.

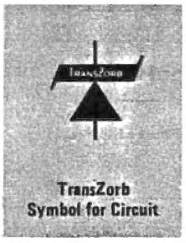
The maximum observed clamping voltage (V_C) is approximately the same for all pulses shown within the limits of the curve in Figure 1. In some instances, the thermal effect may be responsible for 50 to 70% of the observed change in voltage when subjected to high current pulses or severe duty cycles. The maximum reverse leakage current must be doubled for voltage types up to 11 volts for bipolar devices.

Figure 3 shows a typical power derating curve for TransZorbs when derated above 25°C. Clamping voltage vs. varying peak pulse current curves at one millisecond, extended power curves vs. time, and detailed technical data sheets are available.

ABBREVIATIONS AND SYMBOLS

- V_R Stand Off Voltage: Applied Reverse Voltage to assure a nonconductive condition. (See Note 1)
- BV(min) This is the minimum Breakdown Voltage the device will exhibit and is used to assure that conduction does not occur prior to this voltage level at 25°C.
- Vc(max) Maximum Clamping Voltage. The maximum peak voltage appearing across the TransZorb when subjected to the peak pulse current in a one millisecond time interval. The peak pulse voltages are the combination of voltage rise due to both the series resistance and thermal rise.
- I_{PP} Peak Pulse Current – See Figure 2
- P_P Peak Pulse Power
- I_R Reverse Leakage

Note 1:
A TransZorb is normally selected according to the reverse "Stand Off Voltage" (V_R) which should be equal to or greater than the DC or continuous peak operating voltage level.



TransZorb Symbol for Circuit

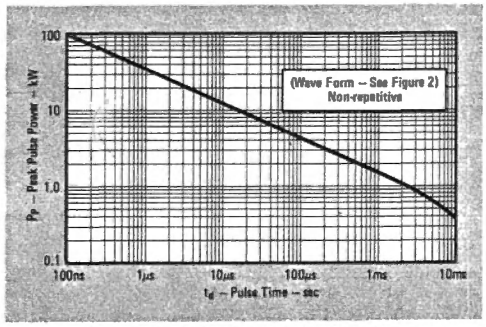


FIGURE 1 – Peak Pulse Power vs. Pulse Time

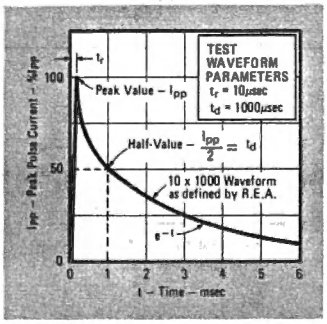


FIGURE 2 – Pulse Wave Form (10 x 1000)

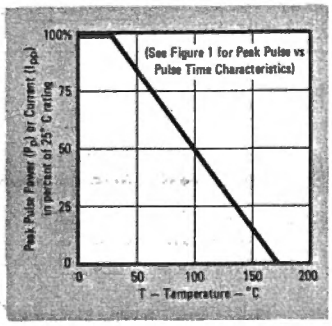
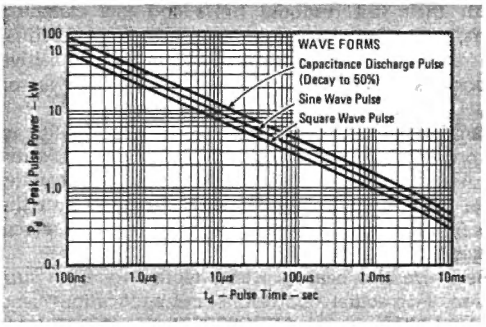
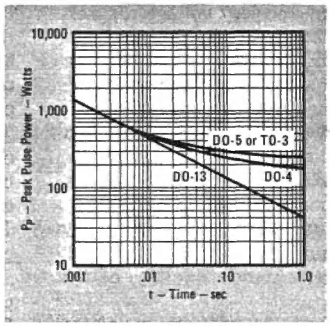


FIGURE 3 – Power or Current vs. Temperature Derating Curve

TRANSZORB APPLICATION CURVES FOR 1.5K AND 1.5KE SERIES



Peak Pulse Power vs. Pulse Time



Peak Pulse Power vs Pulse Time (Extended)

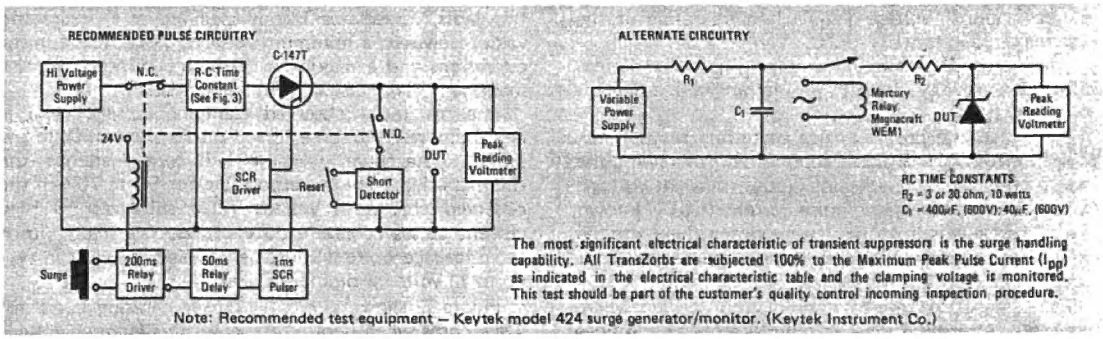


FIGURE 4 – Capacitor Discharge Circuit for Testing TransZorbs

TYPICAL TRANSZORB APPLICATIONS

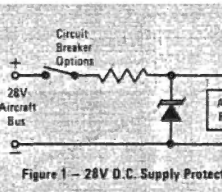


Figure 1 – 28V D.C. Supply Protection

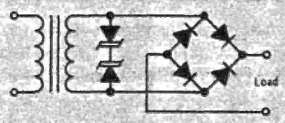


Figure 2 – 115V A.C. Supply Protection

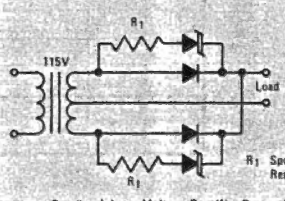


Figure 3 – Breakdown Voltage Rectifier Protection

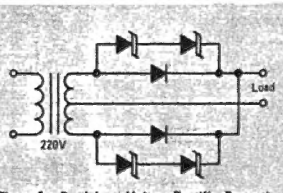


Figure 4 – Breakdown Voltage Rectifier Protection*

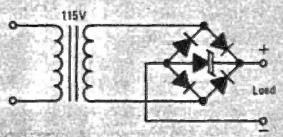


Figure 5 – 115V A.C. Supply Protection

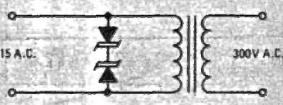


Figure 6 – Circuit Protection from Overvoltage Supply Power

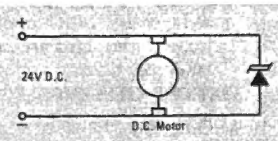


Figure 7 – EMI Limiting

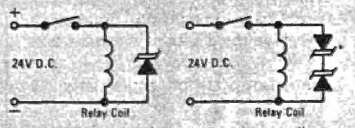


Figure 8 – Relay and Contactor Transient Limiting

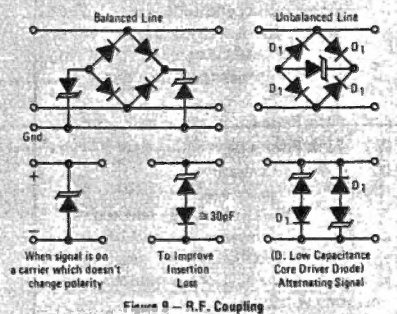


Figure 9 – R.F. Coupling

GENERAL SEMICONDUCTOR INDUSTRIES, INC.

BIDIRECTIONAL
TRANSZORB®
TRANSIENT VOLTAGE SUPPRESSORS
1N6036
THRU
1N6072A

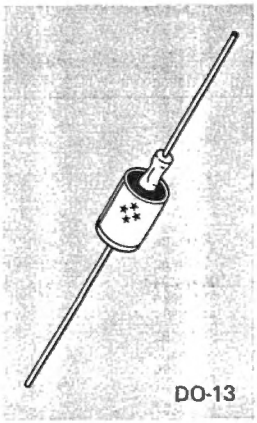
DESCRIPTION

. . . a series of Bidirectional Silicon Transient Suppressors used in AC applications where large voltage transients can permanently damage voltage-sensitive components.

These devices are manufactured using two silicon PN, low voltage junction in a back to back configuration. They are characterized by their high surge capability, extremely fast response time, and low impedance, (R_{on}).

The TransZorb has a peak pulse power rating of 1500 watts for one millisecond and therefore can be used in applications where induced lightning on rural or remote transmission lines presents a hazard to electronic circuitry (ref: R.E.A. specification P.E. 60). The response time of TransZorb clamping action is less than (5×10^{-9}) sec; therefore, they can protect integrated Circuits, MOS devices, Hybrids, and other voltage-sensitive semiconductors and components.

This series of devices has been proven very effective as EMP Suppressors.
Also available as JAN, JANTX, JANTXV devices per MIL-S-19500/507.



DO-13

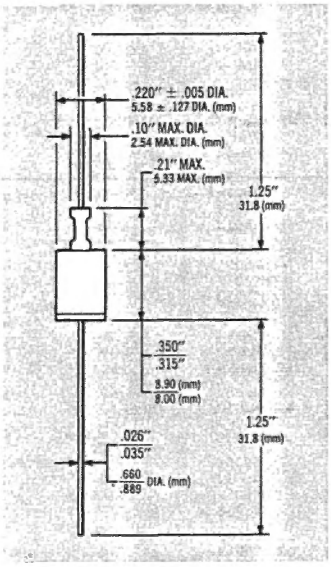
- **1500 watts peak power dissipation**
- **Available in standoff voltages from 5.5V to 185V**
- **DO-13 hermetically sealed package**
- **MIL qualified per MIL-S-19500/507**
- **BIDIRECTIONAL**
- **UL Recognized (Ⓤ IN6070A)**

MAXIMUM RATINGS

- 1500 Watts of Peak Pulse Power dissipation at 25°C
- $t_{clamping}$ (0 volts to BV min): Less than 5×10^{-9} seconds
- Operating and Storage Temperatures: –65° to +175°C
- Steady State power dissipation: 1.0 watt
- Repetition rate (duty cycle): .01%

MECHANICAL CHARACTERISTICS

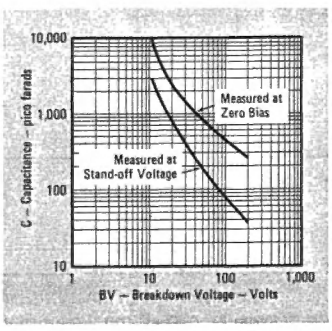
- Standard DO-13 package, glass and metal hermetically sealed
- Weight: 1.5 grams (approximate)
- Body marked with Logo ⁂ and type number



ELECTRICAL CHARACTERISTICS

- Clamping Factor: 1.33 @ Full rated power
  1.20 @ 50% rated power

Clamping Factor: The ratio of the actual V_C (Clamping Voltage) to the actual BV (Breakdown Voltage) as measured on a specific device. (See Figure 2, Page 1-1 for Test Pulse Wave Shape.)



Typical Capacitance vs Breakdown Voltage

ELECTRICAL CHARACTERISTICS @ 25°C (Test Both Polarities)

JEDEC TYPE NUMBER	REVERSE STAND-OFF VOLTAGE (Note 1) V_R VOLTS	BREAKDOWN VOLTAGE BV @ I_T VOLTS	mA	MAXIMUM CLAMPING VOLTAGE @ I_{PP} (1 mSEC) V_C VOLTS	MAXIMUM REVERSE LEAKAGE @ V_R I_R µA	MAXIMUM PEAK PULSE CURRENT (Fig. 2) I_{PP} A	MAXIMUM TEMPERATURE COEFFICIENT OF BV %/°C
1N6036	5.5	6.75 - 8.25	10	11.7	1000	128	.061
※ 1N6036A	6.0	7.13 - 7.88	10	11.3	1000	132	.061
1N6037	6.5	7.38 - 9.02	10	12.5	500	120	.065
※ 1N6037A	7.0	7.79 - 8.61	10	12.1	500	124	.065
1N6038	7.0	8.19 - 10.0	10	13.8	200	109	.068
※ 1N6038A	7.5	8.65 - 9.55	10	13.4	200	112	.068
1N6039	8.0	9.00 - 11.0	1	15.0	50	100	.073
※ 1N6039A	8.5	9.5 - 10.5	1	14.5	50	103	.073
1N6040	8.5	9.9 - 12.1	1	16.2	10	93	.075
※ 1N6040A	9.0	10.5 - 11.6	1	15.6	10	96	.075
1N6041	9.0	10.8 - 13.2	1	17.3	5	87	.078
※ 1N6041A	10.0	11.4 - 12.6	1	16.7	5	90	.078
1N6042	10.0	11.7 - 14.3	1	19.0	5	79	.081
※ 1N6042A	11.0	12.4 - 13.7	1	18.2	5	82	.081
1N6043	11.0	13.5 - 16.5	1	22.0	5	68	.084
※ 1N6043A	12.0	14.3 - 15.8	1	21.2	5	71	.084
1N6044	12.0	14.4 - 17.6	1	23.5	5	64	.086
※ 1N6044A	13.0	15.2 - 16.8	1	22.5	5	67	.086
1N6045	14.0	16.2 - 19.8	1	26.5	5	56.5	.088
※ 1N6045A	15.0	17.1 - 18.9	1	25.2	5	59.5	.088
1N6046	16.0	18.0 - 22.0	1	29.1	5	51.5	.090
※ 1N6046A	17.0	19.0 - 21.0	1	27.7	5	54	.090
1N6047	17.0	19.8 - 24.2	1	31.9	5	47	.092
※ 1N6047A	18.0	20.9 - 23.1	1	30.6	5	49	.092
1N6048	19.0	21.6 - 26.4	1	34.7	5	43	.094
※ 1N6048A	20.0	22.8 - 25.2	1	33.2	5	45	.094
1N6049	21.0	24.3 - 29.7	1	39.1	5	38.5	.096
※ 1N6049A	22.0	25.7 - 28.4	1	37.5	5	40	.096
1N6050	24.0	27.0 - 33.0	1	43.5	5	34.5	.097
※ 1N6050A	25.0	28.5 - 31.5	1	41.4	5	36	.097
1N6051	26.0	29.7 - 36.3	1	47.7	5	31.5	.098
※ 1N6051A	28.0	31.4 - 34.7	1	45.7	5	33	.098
1N6052	29.0	32.4 - 39.6	1	52.0	5	29	.099
※ 1N6052A	30.0	34.2 - 37.8	1	49.9	5	30	.099
1N6053	31.0	35.1 - 42.9	1	56.4	5	26.5	.100
※ 1N6053A	33.0	37.1 - 41.0	1	53.9	5	28	.100
1N6054	34.0	38.7 - 47.3	1	61.9	5	24	.101
※ 1N6054A	36.0	40.9 - 45.2	1	59.3	5	25.3	.101
1N6055	38.0	42.3 - 51.7	1	67.8	5	22.2	.101
※ 1N6055A	40.0	44.7 - 49.4	1	64.8	5	23.2	.101
1N6056	41.0	45.9 - 56.1	1	73.5	5	20.4	.102
※ 1N6056A	43.0	48.5 - 53.6	1	70.1	5	21.4	.102
1N6057	45.0	50.4 - 61.6	1	80.5	5	18.6	.103
※ 1N6057A	47.0	53.2 - 58.8	1	77.0	5	19.5	.103
1N6058	48.0	55.8 - 68.2	1	89.0	5	16.9	.104
※ 1N6058A	53.0	58.9 - 65.1	1	85.0	5	17.7	.104
1N6059	55.0	61.2 - 74.8	1	98.0	5	15.3	.104
※ 1N6059A	58.0	64.6 - 71.4	1	92.0	5	16.3	.104
1N6060	60.0	67.5 - 82.5	1	108.0	5	13.9	.105
※ 1N6060A	64.0	71.3 - 78.8	1	103.0	5	14.6	.105
1N6061	66.0	73.8 - 90.2	1	118.0	5	12.7	.105
※ 1N6061A	70.0	77.9 - 86.1	1	113.0	5	13.3	.105
1N6062	73.0	81.9 - 100.0	1	131.0	5	11.4	.106
※ 1N6062A	75.0	86.5 - 95.5	1	125.0	5	12.0	.106
1N6063	81.0	90.0 - 110.0	1	144.0	5	10.4	.106
※ 1N6063A	82.0	95.0 - 105.0	1	137.0	5	11.0	.106
1N6064	90.0	99.0 - 121.0	1	158.0	5	9.5	.107
※ 1N6064A	94.0	105.0 - 116.0	1	152.0	5	9.9	.107
1N6065	95.0	108.0 - 132.0	1	176.0	5	8.5	.107
※ 1N6065A	100.0	114.0 - 126.0	1	168.0	5	8.9	.107
1N6066	105.0	117.0 - 143.0	1	191.0	5	7.8	.107
※ 1N6066A	110.0	124.0 - 137.0	1	182.0	5	8.2	.107
1N6067	121.0	135.0 - 165.0	1	223.0	5	6.7	.108
※ 1N6067A	128.0	143.0 - 158.0	1	213.0	5	7.0	.108
1N6068	137.0	153.0 - 187.0	1	258.0	5	5.8	.108
※ 1N6068A	145.0	162.0 - 179.0	1	245.0	5	6.1	.108
1N6069	145.0	162.0 - 198.0	1	274.0	5	5.5	.108
※ 1N6069A	150.0	171.0 - 189.0	1	261.0	5	5.7	.108
1N6070	155.0	171.0 - 210.0	1	292.0	5	5.1	.108
※ 1N6070A	160.0	181.0 - 200.0	1	278.0	5	5.4	.108
1N6071	165.0	180.0 - 220.0	1	308.0	5	4.9	.108
※ 1N6071A	170.0	190.0 - 210.0	1	294.0	5	5.1	.108
1N6072	175.0	198.0 - 242.0	1	344.0	5	4.3	.108
※ 1N6072A	185.0	209.0 - 231.0	1	328.0	5	4.6	.108

※ Available in JAN, JANTX & JANTXV per MIL-S-19500/507

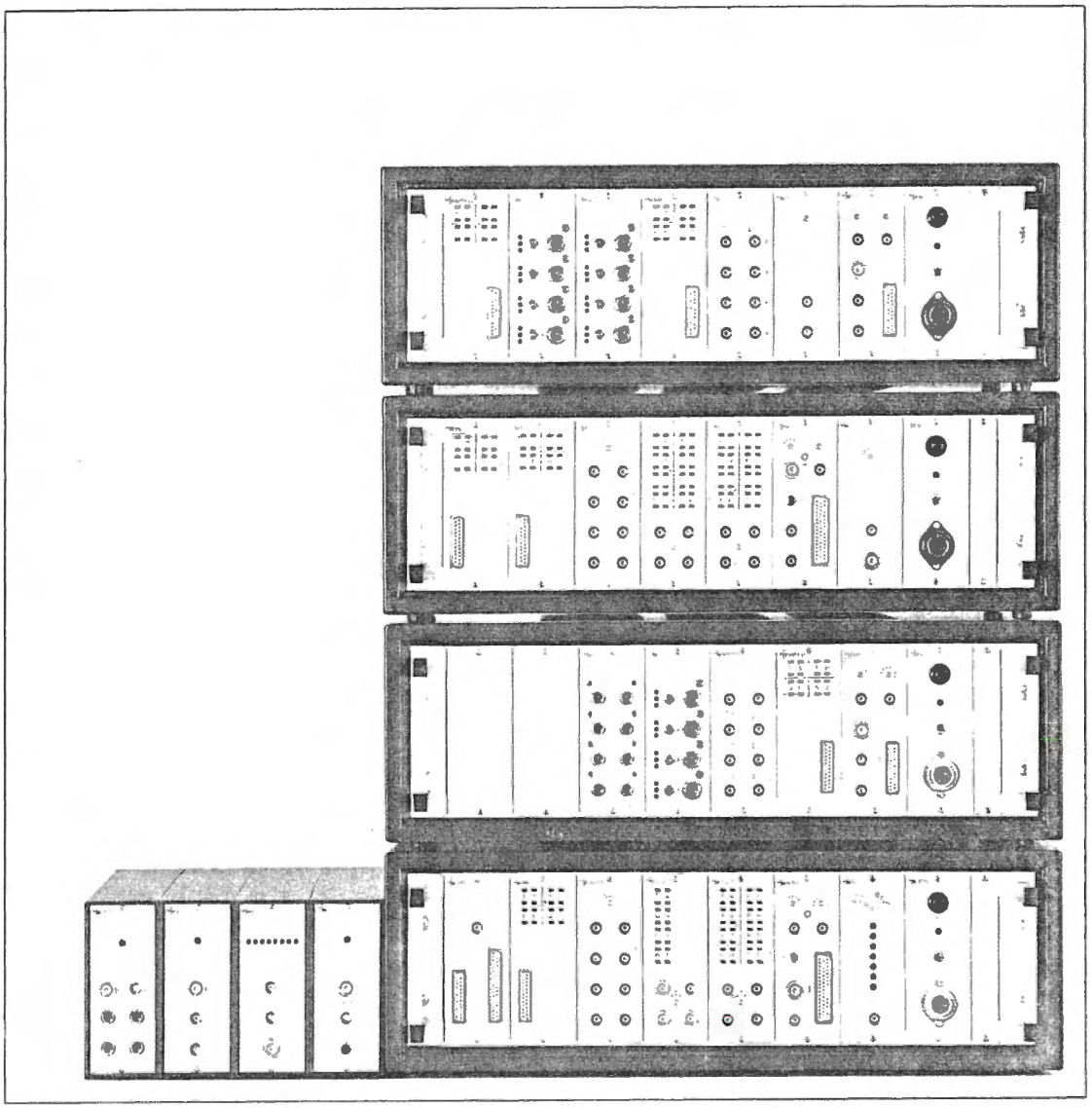
Note 1: A TransZorb is normally selected according to the reverse "Stand Off Voltage" (V_R) which should be equal to or greater than the DC or continuous peak operating voltage level.

Johne + Reilhofer

Multi – DIN

Family of Modular Building Blocks for Data Acquisition with PCM

- **Modules may be combined freely to cover the entire range from compact mobile units to large scale data acquisition systems**
- **Module interconnection with plug-in ribbon cables**
- **Meets DIN specifications while offering maximum flexibility**
- **Clear-cut system architecture provides maximum user comfort**



Applications

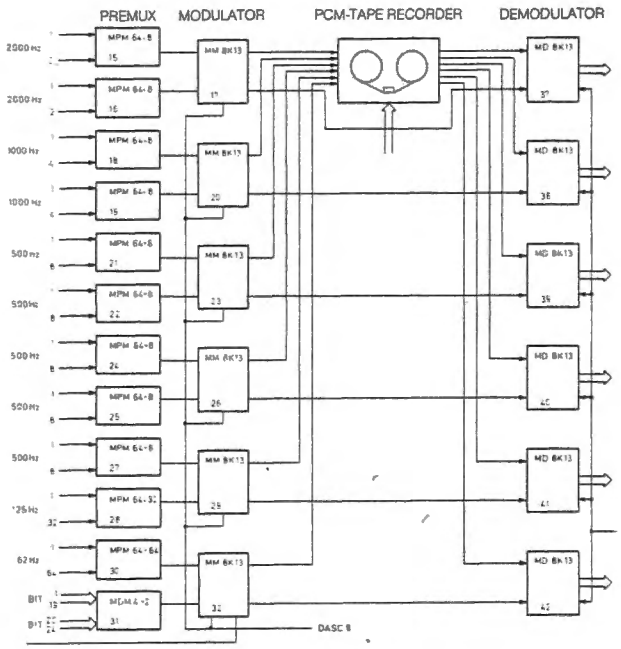
This novel modular system has three main areas of application:

1. Compact system for mobile operation
Ideal conditions for portable systems are given by the combination of small volume with low weight and power consumption.

Example: An 8 channel data acquisition system for direct recording on magnetic tape or wireless telemetry of DMS measurements. There are only two components required besides tape recorder or RF transmitter: Module M 8 VBF 1 (it combines 8 DC differential amplifiers with 8 anti-aliasing filters and 8 bridge excitation circuits) plus module MM 16 K 13 (it contains a complete PCM modulator for up to 16 channels, as well as head driver for direct connection to the recording head of a tape recorder or line driver).

2. Multi-channel large-scale systems
Large-scale systems can be realized in a small space thanks to low volume and power consumption of the modules. Additionally, user specific system requirements, such as number of channels, required signal band-widths, various forms of signal conditioning etc. can be readily satisfied. Modules may be readily exchanged as desired at any time. The block diagram illustrates the use of very few types of modules in the design of a fully DIN-compatible data acquisition system where the number of data channels and their band-widths are easily varied by switch-selection on Premultiplexers (1 ... 64 channels) and Modulators (1 ... 16 channels).

3. Systems for varying use
Frequently, the operational requirements of a data acquisition system remain stable for but a limited time. In such cases, the superiority of the modular concept becomes most evident, because it can be modified quickly and easily (e. g. expanded, reduced or separated into a number of independent systems).



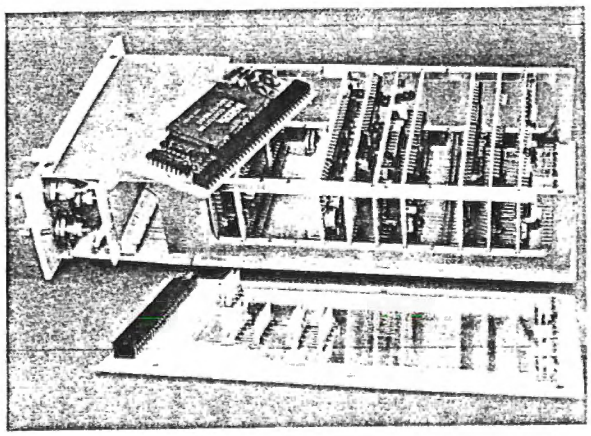
Example of a multi-channel "Multi-DIN" system.

Technology

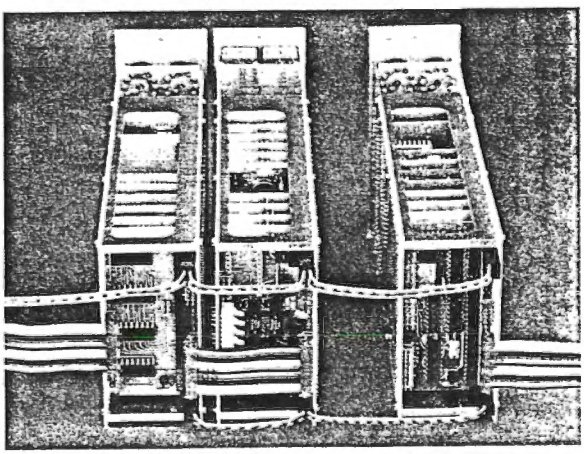
The modules are compact, self-contained functional units, that are interconnected with pre-fabricated plug-in ribbon cables. It is thus easy, to assemble even large data acquisition systems from proven series modules, or to subsequently re-configure complete systems.

Common Specifications

Height 135 mm, width 60 mm, depth 290 mm. A total of eight modules fit side by side in a 19" rack.
Each module ist supplied with three DC voltages: + 15 V, − 15 V, + 5 V.
Weight of each module: 1500 g.



A "Multi-DIN" module



Module interconnection with ribbon cables

Instrumentation Amplifier with Bridge Excitation

M 8 VBF 1 for 8 channels

Each module:

8 DC-Differential Amplifiers, eg. for resistive strain gauges or transducers with resistance bridges. Drift 1µV/°C, gain 1 ... 1000 (coarsely adjustable by plug-in jumpers, finely with potentiometers).

8 Anti-Aliasing Filters. 6-pole low-pass filters with Butterworth or Tschebyscheff characteristic for a fixed cut-off frequency.

8 Bridge Excitation Circuits. Suited, e. g., to DMS bridges. Voltage ± 5 V and ± 10 V, max. current 40 mA each bridge.

M 4 MV 1 for 4 channels

Each module:

4 DC-Differential Amplifiers with automatic null balance, eg. for resistive strain gauges and transducers with resistance bridges. Drift 1µV/°C, gain 1 ... 1000 (coarsely adjustable by plug-in jumpers, finely with potentiometers). Accuracy of the automatic null balancing 15 bit = 1 part in 32 768.

4 Anti-Aliasing Filters. 6-pole low-pass filters with Butterworth or Tschebyscheff characteristic for a fixed cut-off frequency.

4 Bridge Excitation Circuits. Suited, e. g. to DMS bridges. Voltage ± 5 V and ± 10 V, max. current 40 mA each bridge.

M 8 ETS 1

Each module:

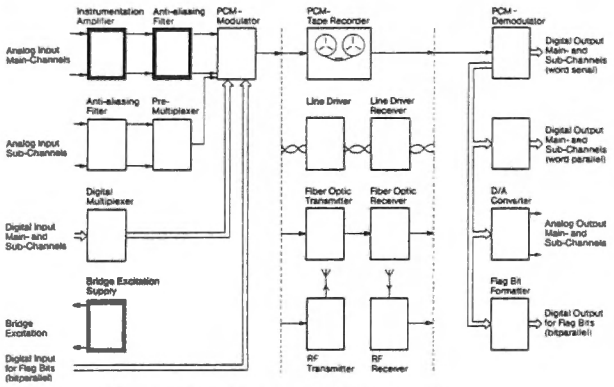
8 Input Amplifiers with selectable input sensitivity (± 2.5 V; ± 5 V; ± 10 V).

8 Anti-Aliasing Filters. 6-pole low-pass filters with Butterworth or Tschebyscheff characteristic. One preset cut-off frequency.

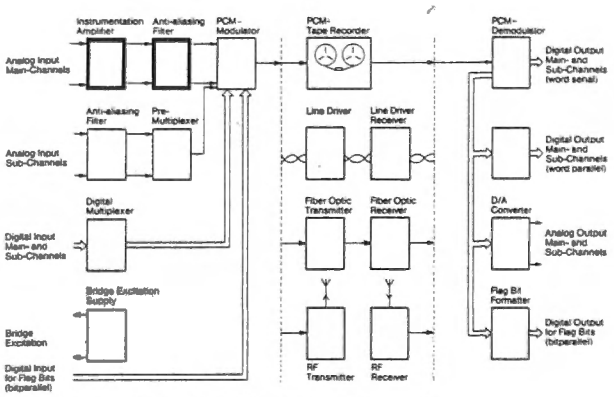
M 8 VT 1 for Thermoelements

Each module:

8 DC-Differential Amplifiers with particularly low drift (0.1µV/°C) and common mode rejection. Internal temperature measurement at each of the eight junction points (input sockets) with automatic compensation referred to 0 °C. Thus no thermostat and no reference channel required. Correction factor for all popular thermoelements separately selectable for each channel.



Example of a "Multi-DIN" system (functional area of the module type opposite has been highlighted).



Example of a "Multi-DIN" system (functional area of the module type opposite has been highlighted).

Anti-Aliasing Filter

MAF 16 GX for 16 channels

Each module:

16 Low-pass Filters with 6-pole Butterworth or Tschebyscheff characteristic. Single speed (1 preset cut-off frequency). Input voltage ± 5 V, 1 MOhm.

MAF 8 GS for 8 channels

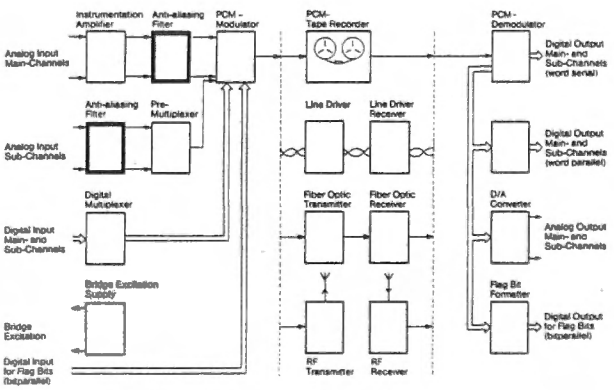
Each module:

8 Low-pass Filters with 6-pole Butterworth or Tschebyscheff characteristic. 8 switch-selectable cut-off frequencies (in binary sequence). Input voltage ± 5 V, 1 MOhm.

MAF 8 GM for 8 channels

Each module:

8 Low-pass Filters with 6-pole Butterworth or Tschebyscheff characteristic. 8 cut-off frequencies and multiplex operations (channels 1 ... 16) switch-selectable. Input voltage ± 5 V, 1 MOhm.



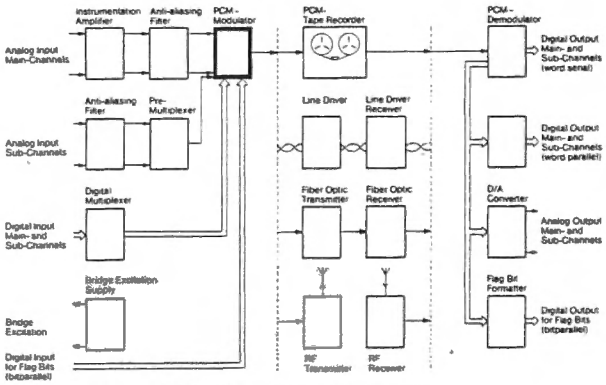
Example of a "Multi-DIN" system (functional area of the module type opposite has been highlighted).

PCM-Modulator

MM 16 K 13 for max. 16 channels

Each module:

Complete PCM-Modulator for the digital recording or transmission of 8 analog signal channels. Switch-selectable for 16, 8, 4, 2 or 1 channel operation, 8 switch-selectable bit rates (in binary sequence) up to 1280 kb/s, optional master or slave operation, full scale input voltage ± 5 V, input resistance 1 MOhm, 3 data-word structures selectable (10 data bits, 10 data bits + 1 flag bit and 12 data bits + 1 flag bit), parallel input for max. 16 flag bits for event marking, identification, status, real-time codes, subchannel synchronisation etc. Also head or line driver. Test loop output.



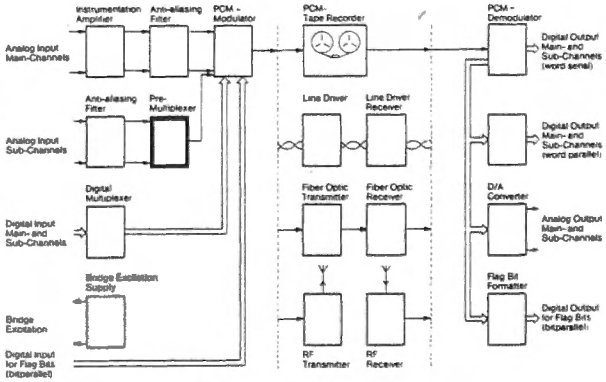
Example of a "Multi-DIN" system (functional area of the module type opposite has been highlighted).

Premultiplexer

MPM 64 for max. 64 analog channels

Each module:

Premultiplexer for expanding 1 main channel (e. g. channel 1 of the 16 channels of the MM 16 K 13) into up to 64 subchannels under control by the PCM-Modulator. Expansion in 8 groups of 8 channels, switch-selectable operation of 1 ... 64 channels (in binary sequence). Optional master or slave operation full scale input voltage for ± 5 V, input resistance 1 MOhm.



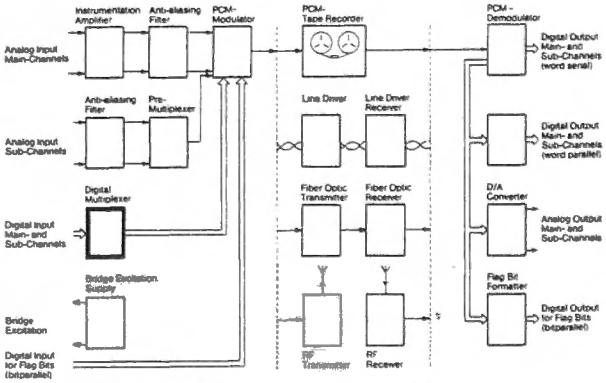
Example of a "Multi-DIN" system (functional area of the module type opposite has been highlighted).

Digital Multiplexer

MDM 4 for max. 4 digital channels

Each module:

Multiplexer for bit-parallel input of digital data words (10, 11 or 13 bits, depending on type of modulator) into any one arbitrarily selectable main-channel (e. g. 1 ... 16) or sub-channel (e. g. 1 ... 64) under control by the PCM-Modulator. In place of externally supplied digital data, the current reading of the built-in counter (for event marks or dock pulses) may be transferred.



Example of a "Multi-DIN" system (functional area of the module type opposite has been highlighted).

Transmitter

MS 433/1. Power 1 W

Each module:

A **FM Transmitter** modulated by PCM-Modulators equipped with LED-bar display of output power. Carrier frequencies (optionally preset) 433.4 MHz, 433.9 MHz, 434.4 MHz. Maximum bit rate 80 kb/s.

MS 433/2. Power 10 mW

Difference to MS 433/1: output power only 10 mW, no power display.

MS 245/2. Power 10 mW

Each module:

A **Telemetry Transmitter** with the carrier frequency (optional) 2.4 ... 2.5 GHz.

MSL 1

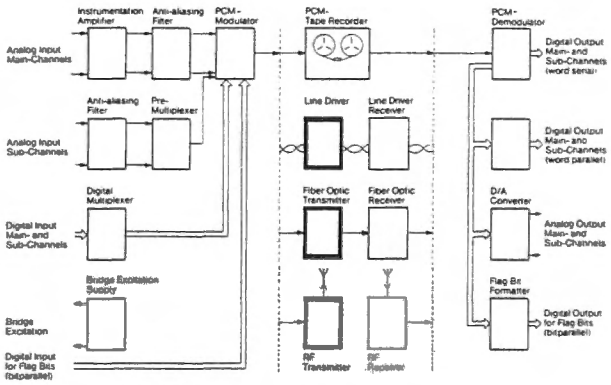
Each module:

Fiber Optic Transmitter for short range (10 m).

MSL 2

Each module:

Fiber Optic Transmitter for middle range (100 m).



Example of a "Multi-DIN" system (functional area of the module type opposite has been highlighted).

MKT 1

Each module:

Line Driver for long range (10 km) with opto-coupler input and galvanic isolation of the power supply.

Receiver

ME 433/1 for long range

Each module:

RF Receiver, matching transmitter MS 433/1 and MS 433/2 with LED-bar display of field strength. Output for PCM-Demodulator sensitivity 2 µV at 14 dB S/N.

ME 433/2 for short range

Each module:

RF Receiver, matching transmitter MS 433/1 and MS 433/2, without field strength display, transmission range 30 m (appr. 100 ft.) with MS 433/2 (10 mW).

MEV 433

RF Pre-Amplifier, weatherproof for mast-mounting power supply via signal cable (50 Ohm, BNC) from the ME 433/1. Gain: 12 dB.

MEL 2

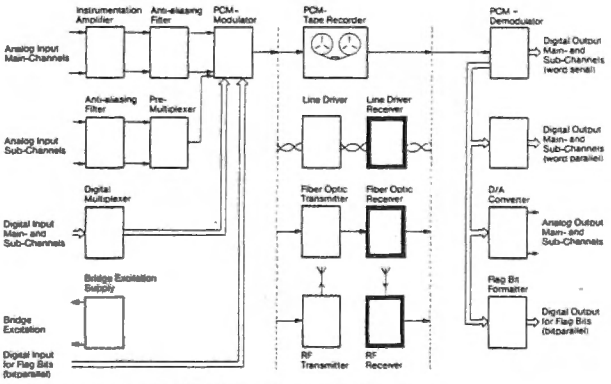
Each module:

Fiber Optic Receiver for the MSL 1 or MSL 2 module.

MKE 1

Each module:

Line Driver Receiver for the MKT 1 module.



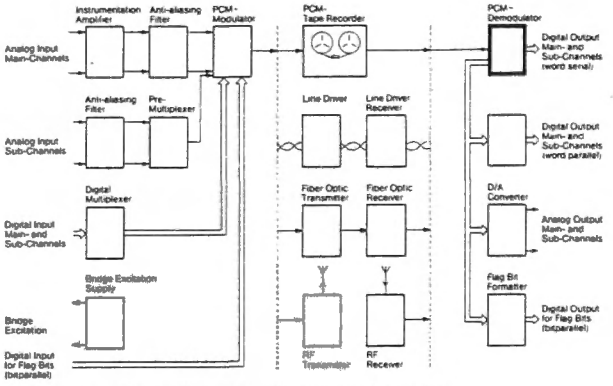
Example of a "Multi-DIN" system (functional area of the module type opposite has been highlighted).

PCM-Demodulator

MD 16 K 13 for max. 16 channels

Each module:

Complete PCM-Demodulator matching Modulator MM 16 K 13 as well as all other J + R Modulators, switch-selectable pulse-shape regeneration for tape recorder and RF receiver or for tape recorder and cable short range. Test loop input. Word-sequential output of the demodulated data words (10, 11 or 13 bits wide, depending on type of Modulator) plus address and strobe pulse. Bit-serial outputs of regenerated data for tape recording or cable transmission.



Example of a "Multi-DIN" system (functional area of the module type opposite has been highlighted).

Demultiplexer

MDA 2 for 2 digital channels

Each module:

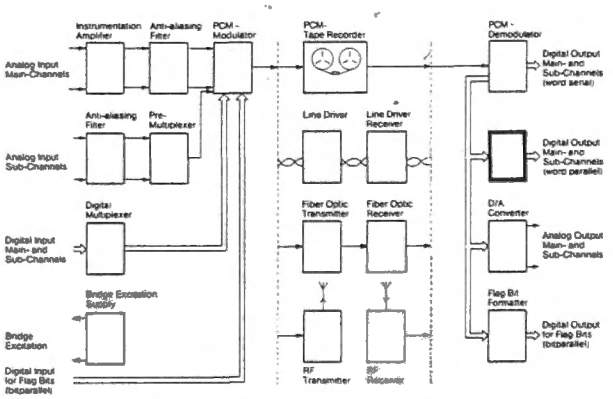
Demultiplexer for digital output of any two of the 16 main-channels or the 64 sub-channels in 2 parallel-data-words (10, 11 or 13 bits wide, depending on type of Modulator). Channels are selected with thumbwheel switches. Output at TTL-levels (50 mA).

MQL 4 for 4 analog channels

Each module:

Demultiplexer and 4 D/A Converters for the analog output of any main channel (1 ... 16) or subchannel (1 ... 64) selectable with thumbwheel switches. In case of synchronisation loss, output drops to zero. Full scale output voltage (switch selectable) ± 2.5, ± 5 and ± 10 V. Max. output current 20, 50 or 100 mA (limit internally preset).

4 Output Filters for smoothing the stair-step analog output signal (6-pole low-pass filters with fixed cut-off frequency).



Example of a "Multi-DIN" system (functional area of the module type opposite has been highlighted).

MAAD 4 for 4 analog channels

Each module:

Demultiplexer and 4 D/A Converters for the analog output of any 4 main-channels (1 ... 16) selectable with thumbwheel switches. No sub-channel selection. Otherwise same as MQL 4.

MAA 8 for 8 analog channels

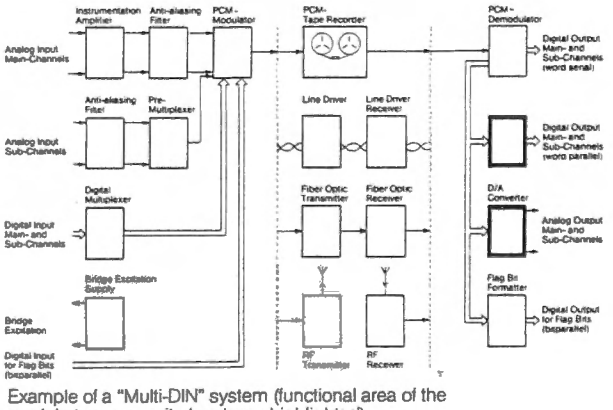
Each module:

Demultiplexer and D/A Converter for the analog output of main-channels 1 ... 8 or 9 ... 16 (either one of the two 8-channel groups internally selectable). No coding switches. **8 Output Filters,** otherwise as MQL 4.

MBU 1 Watch-Dog Module

Each module:

For **Automatic Registration** of operational parameters (supply current, temperatures, control signals etc.) where access to PCM-Modulator or data source is difficult (e.g. below ground, under water, or with rotating machinery). Each MQL 4 module serves up to 64 such signals transmitted as a PCM-subframe.



Example of a "Multi-DIN" system (functional area of the module type opposite has been highlighted).

MPV 1 Level-Shifter Module

Each module:

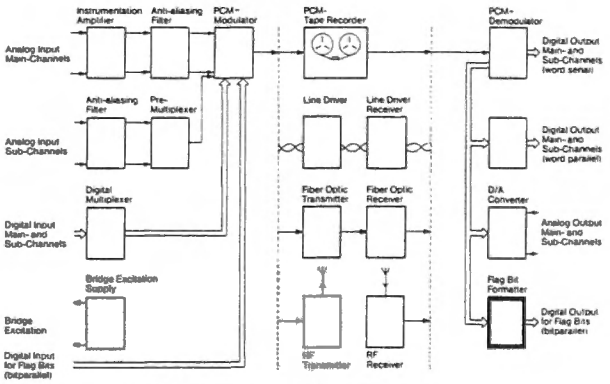
8 Level-Shifter permitting continuous full scale zero reference adjustment. Application: Bridge balancing where PCM-Modulators are hard to reach.

Flag Bit Formatter

MB 1 for 16 bit

Each module:

Parallel output of up to 16 flag bits (11th or 13th bits of the data-words). Outputs TTL, 50 mA. Optional galvanic isolation by relays (1per bit). Max. 2 A current load.



Example of a "Multi-DIN" system (functional area of the module type opposite has been highlighted).

Output Filter

MWF 8 GS for 8 channels

Each module:

8 Output Filters for smoothing the stair-step analog output signals. Low-pass filters with 6-pole Butterworth or Tschebyscheff characteristic. 8 switch-selectable cut-off frequencies (in binary sequence). Unity gain output current 20, 50 or 100 mA (limit internally preset). Max. output voltage ± 5 V.

MWF 8 GM for 8 channels

Each module:

8 Output Filters for smoothing the stair-step analog output signals. Low-pass filters with 6-pole Butterworth or Tschebyscheff characteristic. 8 switch-selectable cut-off frequencies (in binary sequence). Selectable multiplex operations (channels 1 ... 16). Unity gain output current 20, 50 or 100 mA (limit internally preset). Max. output voltage ± 5 V.

Power Supply Units

MSN for AC Voltage

Each module:

AC (Line) Power Supply for 220 V, ± 10%, 50 ... 60 Hz. Output voltage ± 15 V and + 5 V.

MSU 1 Power Supply Sensor

Each module:

For Remote Sensing of supply voltages and currents in situations where the power supply of inaccessible data acquisition or modulator modules has to be placed in the vicinity of the receiving side of the system.

MSD for DC Voltage

Each module:

DC (Battery) Power Supply for 10 ... 30 V input/output voltage ± 15 V and + 5 V.

Rack Mounts and Housings

19" Rack Mount

Each module:

Up to 8 modules fit side by side in one frame with three height adjustments. Cable connections on the rear with plug-in ribbon cables.

19" Housing

One 19" Housing encases one 19" Rack Mount.

Compact Casing

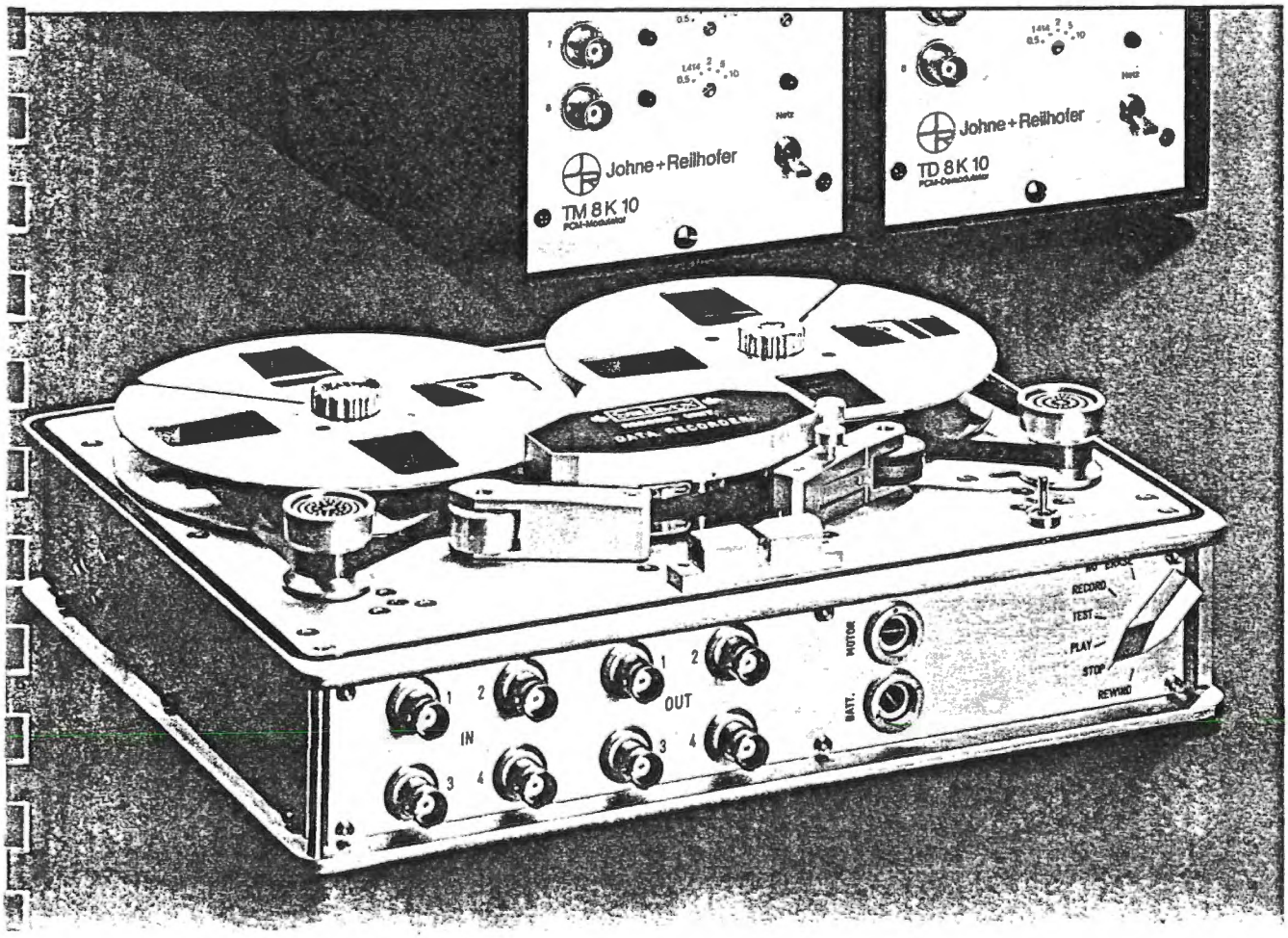
This casing holds one module. Module interconnection with plug-in ribbon cables (CANNON plug series D).

Johne + Reilhofer

PCM-Magnetbandspelare X SI 7

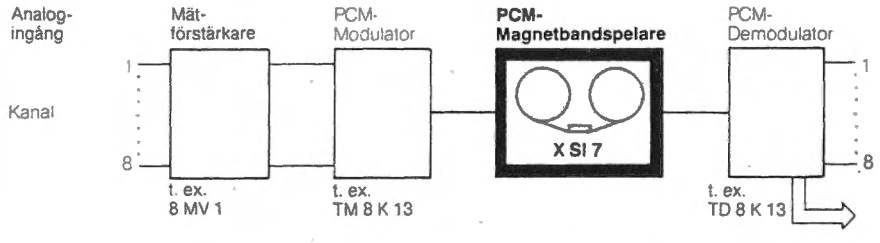
för inspelning och avspelning av PCM-signaler

- **4 dataspår och 1 kommentarspår på 1/4-tums band (4 SI 7 och 4 SI 7/W)**
- **7 dataspår och 1 kommentarspår på 1/2-tums band (7 SI 7/W)**
- **5 omkopplingsbara bandhastigheter med områdena 15/16-15 ips el. 1 7/8-30 ips**
- **Tröghetsfri kapstanmotor**
- **Okänslig mot vridning och skakningar (utvecklad för mobil användning)**
- **Mycket lätthanterlig (basytan mindre än ett A4 papper)**
- **Med storspolsadapter speltid upp till 16 timmar**
- **Dubbla signalbandbredden med PCM-specialhuvuden (option)**



PCM-Magnetbandspelare X SI 7

Johne+Reilhofer



Användning

Bandspelarna 4 SI 7, och 4 SI 7/W och 7 SI 7/W användes för inspelning och avspelning av pulskodmodulerade mätsignaler tillsammans med Johne + Reilhofers PCM-system.
4 SI 7 är med sin ringa vikt (3,5 kg) och lätthanterliga format (basytan mindre än ett A4 papper) idealisk för mobila applikationer men är för den skull ej sämre än större bandspelare i sitt tekniska utförande och handhavande.

Teknik

Bandspelarna har ett raffinerat drivsystem med en servostyrd skivmotor som gör den okänslig mot stötar och vibrationer. För inspelning finns 5 omkopplingsbara bandhastigheter med områdena $^{15}/_{16}$-15 ips eller 1 $^{7}/_{8}$-30 ips. På ett $^{1}/_{4}$'' band finns det plats för 4 PCM-dataspår och 1 kommentarspår. Detta utförande finns också som option med special-wide-bandhuvuden (4 SI 7/W), som med samma bandhastighet höjer packningstätheten med faktor 2, vilket samtidigt betyder en fördubbling av signalbandbredden. Utförande 3 (7 SI 7/W) har 7 PCM-spår samt kommentarspår på ett $^{1}/_{2}$'' band och är utrustad med special-widebandhuvuden.
Talkanalen har utstyrningsautomatik som förenklar inspelningen av tal.
För långtidsinspelning finns en storspolsadapter, (förbandspolar med diameter upp till 26,5 cm), som ger en speltid på 16 timmar (bandhastighet $^{15}/_{16}$ ips). Nedanstående tabell visar sambandet mellan spolstorlek och bandlängd, bandtyp och speltid.

Bandspole 13 cm diam.

Bandhastighet		Bandtyp (Bandlängd)			
ips	cm/s	Standard-band (360m)	LP-band (549m)	DP-band (732m)	Trippel-band (1098m)
30	76	3,75 min	5,62 min	7,5 min	11,25 min
15	38	7,5 min	11,25 min	15 min	22,5 min
$7\,^{1}/_{2}$	19	15 min	22,5 min	30 min	45 min
$3\,^{3}/_{4}$	9,5	30 min	45 min	1 tim	1,5 tim
$1\,^{7}/_{8}$	4,75	1 tim	1,5 tim	2 tim	3 tim
$^{15}/_{16}$	2,38	2 tim	3 tim	4 tim	6 tim

Bandspole 26 cm diam. (med storspoladapter)

Bandhastighet		Bandtyp (Bandlängd)			
30	cm/s	Standard-band (360m)	LP-band (549m)	DP-band (732m)	Trippel-band (1098m)
30	76	15 min	22,5 min	30 min	45 min
15	38	30 min	45 min	1 tim	1,5 tim
$7\,^{1}/_{2}$	19	1 tim	1,5 tim	2 tim	3 tim
$3\,^{3}/_{4}$	9,5	2 tim	3 tim	4 tim	6 tim
$1\,^{7}/_{8}$	4,75	4 tim	6 tim	8 tim	12 tim
$^{15}/_{16}$	2,38	8 tim	12 tim	16 tim	24 tim

Optioner

1. Talkanal
2. Spåromkopplingsenhet, för inkoppling av en PCM-kanal på valfritt bandspår. (Endast för 4-spårs varianten.)

Specifikationer

Antal bandspår	
Utförande 4 SI 7, 4 SI 7/W	4 PCM-spår + talkanal
Utförande 7 SI 7	7 PCM-spår + talkanal
Bandhastigheter	$1^{7}/_{8}$, $3^{3}/_{4}$, $7^{1}/_{2}$, 15, 30 ips
eller för 4 SI endast	$^{15}/_{16}$, $1^{7}/_{8}$, $3^{3}/_{4}$, $7^{1}/_{2}$, 15 ips
Bandmaterial	$^{1}/_{4}$'' eller $^{1}/_{2}$'' instrumentationsband
Spoldiameter	13 cm eller 26,5 cm med adapter
Strömförsörjning	Inbyggda Ni-Cd accumulatorer eller externt nätaggregat APS 75 110/220V 50 Hz
Vikt	3,5 kg
Dimensioner	8 × 21,5 × 27 cm

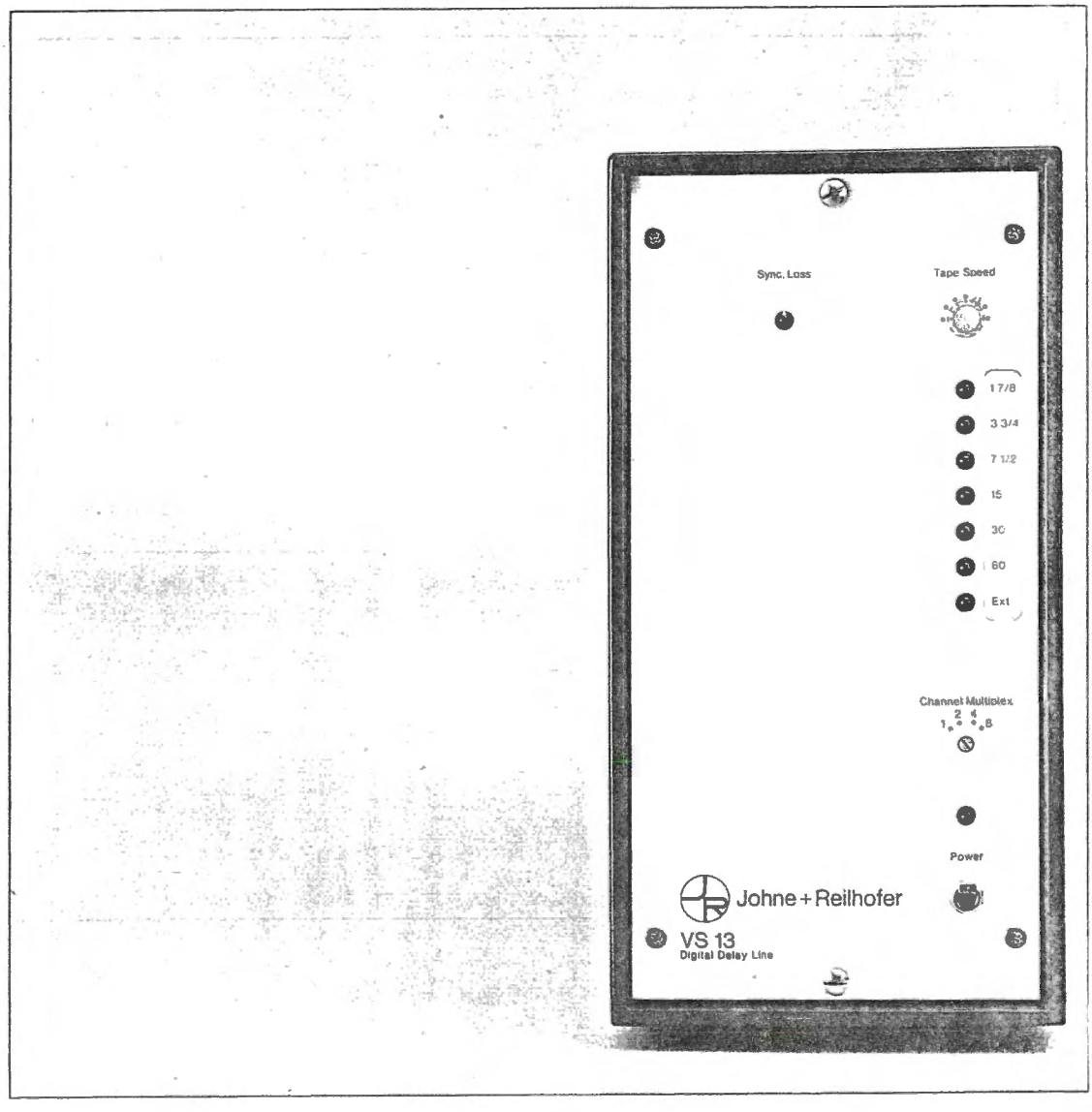
Johne + Reilhofer AB
Box 503
S-195 01 Märsta
Tel. 0760-150 75
Tlx. 197 12 JORE S

8.79 Tekniska ändringar förbehålles

Johne + Reilhofer

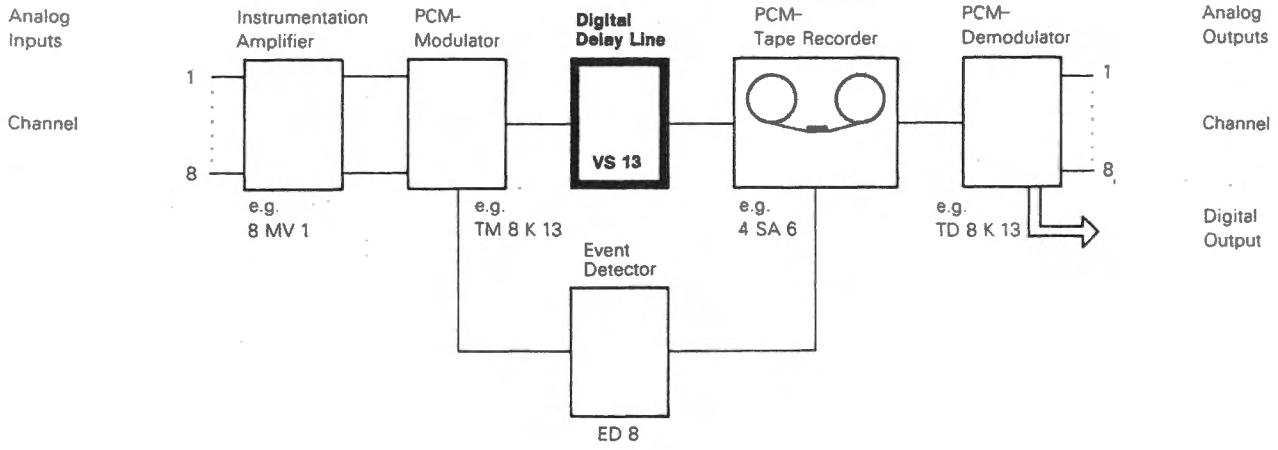
Digital Delay Line VS 13
for PCM Systems

- **Max. delay (storage time) approx. 3½ minutes at $^{15}/_{32}$ ips**
- **6 tape speeds binary graded within the total range of $^{15}/_{32}$ - 240 ips**
- **Storage capacity 512 kbit**
- **Expansion of storage capacity to max. 1.28 Mbit (option)**
- **Partial configuration possible (64 kbit per board, option)**
- **Integrated event detector (option)**
- **Remote controlled speed change (option)**



Digital Delay Line VS 13

Johne + Reilhofer



Application

The serial bit stream between PCM System and magnetic tape recorder, resp. PCM System and transmission range can be delayed with the aid of the VS 13 Digital Delay Line. The measuring data are stored in the VS 13 for a short period, which allows for example, the bridging of the run-up time of a magnetic tape recorder.
The VS 13 Digital Delay Line is often used in those cases, in which only few events, or events of short duration are of interest within a long observation period. For example, in geophysics in order to record the case history of earthquakes.

Technical Data

The delay is selectable in steps of 128 kbits each:
A maximum of 4 plug-in boards can store a total of 512 kbit, which corresponds to a total delay of approx. 3½ minutes at a tape speed of $^{15}/_{32}$ ips. Six different tape speeds are available for the total range of $^{15}/_{32}$ ... 240 ips.
The following table shows the attainable storage time, dependent on tape speed and configuration.

Tape speed (ips)	Bit rate (kbit/s)	Delay time for various configurations (s)			
		128 kbit	256 kbit	384 kbit	512 kbit
$^{15}/_{32}$	2.5	52.4	104.8	157.2	209.6
$^{15}/_{16}$	5	26.2	52.4	78.6	104.8
1⅞	10	13.1	26.2	39.3	52.4
3¾	20	6.5	13.1	19.6	26.2
7½	40	3.2	6.5	9.8	13.1
15	80	1.6	3.2	4.9	6.5
30	160	0.8	1.6	2.4	3.2
60	320	0.4	0.8	1.2	1.6
120	640	0.2	0.4	0.6	0.8
240	1280	0.1	0.2	0,3	0,4

In the case of power supply failure, data protection is provided by a built-in accumulator.

Options

1 Partial configuration: 64 kbit storage capacity per board
2 Expansion of the storage capacity to a total of 1,28 Mbit (10 boards)
3 Single channel event detector (installed in the basic unit)
4 Remote control: speed switching of the Digital Delay Line by switch setting on the tape recorder

Specifications

Storage capacity	max. 512 000 bit
Tape speeds	6
Tape speed ranges	$^{15}/_{32}$ - 15 ips, $^{15}/_{16}$ - 30 ips 1⅞ - 60 ips, 3¾ - 120 ips 7½ - 240 ips
Power supply	110/220 V, 50 to 60 Hz or 12 ... 28 V DC
Weight	approx. 6 kg (13 lbs)
Dimensions	125 x 238 x 380 mm ($4^{15}/_{16}$ x 9⅜ x 15 inches)

power consumption
how does length mod 16K13
min ~~6464 kbit~~ 128 x 3
wouldn't under event detector option.

VS 13 5,850
12tk 3,000

12V 650 mA / 24V
5V 80 mA

Kommanditgesellschaft
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Fraunhoferstrasse 14
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Telephone (089) 85 87-0
Telex 521 738

6.80 Subject to technical modifications.

Controls and Indicators

1. Time-Code Generator ZG77, Front Panel

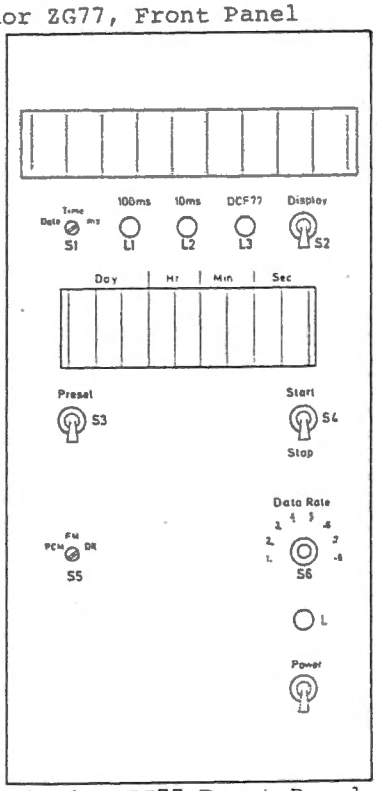


Fig.1: ZG77 Front Panel

Time selection

Initial (start-)time is pre-selected by the setting of the switch register consisting of at most 9 thumb-wheel switches. This setting takes effect only after an externally or internally generated transfer command.

Pre-setting the time (S3 "PRESET")

The time pre-set into the switch register is transferred to display and internal clock register when momentary action switch S3 is raised to position PRESET.

Start/stop clock (S4"START/STOP")

Lifting this momentary action switch from its center (rest) position to START, sets the clock running with the time count as currently displayed. Depressing this switch towards STOP halts the clock. The recording of time codes (with the displayed value) on tape continues, however.

Time display

The standard model ZG77 Time-Code Generator has an 8-digit decimal LED-display. Normal display format is " (counting) day, hour, minute, second". Display of 2 additional (millisecond) digits may be selected with switch S1.

Display format (S1 "DATE/TIME/MS")	In the standard model ZG77, this switch selects one of two display formats: either "(counting) day, hour, minute, second" (in position TIME) or "hour, minute, second, millisecond" (in position MS). The second choice in effect shifts the display left by two digits. For Time-Code Generators equipped with option "DCF 77", the third switch position, DATE, may be used to display the complete calendar date in the format "day (of the month), month, year".
Display on/off (S2 "DISPLAY")	Power drain may be reduced by using this switch to turn the LED display off; this may be important in battery powered operation of the Time-Code Generator.
Time resolution indicators (L1 "100 ms", L2 "10 ms")	Normally, time-codes are updated and recorded once per second. Depending on the setting of rear panel switch S7, TIME RESOLUTION, this may be increased to 10 resp. 100 per second. The increased time resolution is signalled by the appropriate indicator lighting up.
Indicator "DCF 77" (L3)	While option "DCF 77" is in use, this indicator stays lit as long as the standard time-codes broadcast by station DCF 77 (at Mainflingen Germany) are properly received. In times of disturbed reception, this indicator turns dark and the built-in ZG 77 time base automatically takes over in order to insure uninterrupted time-code recording.
Recording mode (S5 "PCM/FM/DR")	Time-Code Generator ZG 77 may be used with all popular recording methodes, i.e. PCM-, FM- or DIRECT Recording as selected by switch positions "PCM/FM/DR". FM- and direct recording of ZG 77 time-codes requires a plug-in option board.
Bit rate selection (S6 "DATA RATE")	For FM- or DIRECT recording of time-codes, limitation of the ZG 77 output bit rate to the permissible recorder input bit rate may be required. The selection depends on several parameters such as tape speed and recorder design. A table supplied with the Time-Code System ZG 77 / ZE 77 lists appropriate settings of switch S6 for various conditions.

2. Time-Code Generator ZG 77, Rear Panel

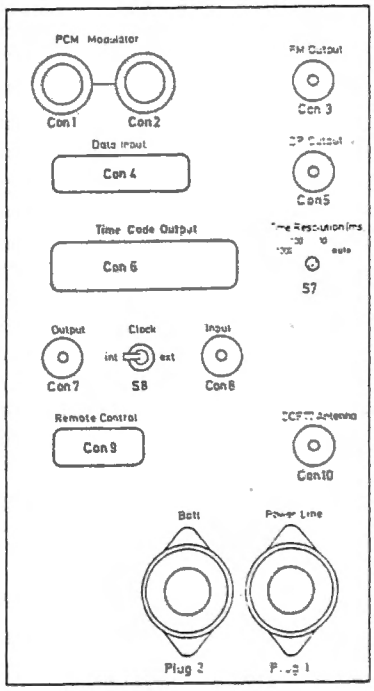
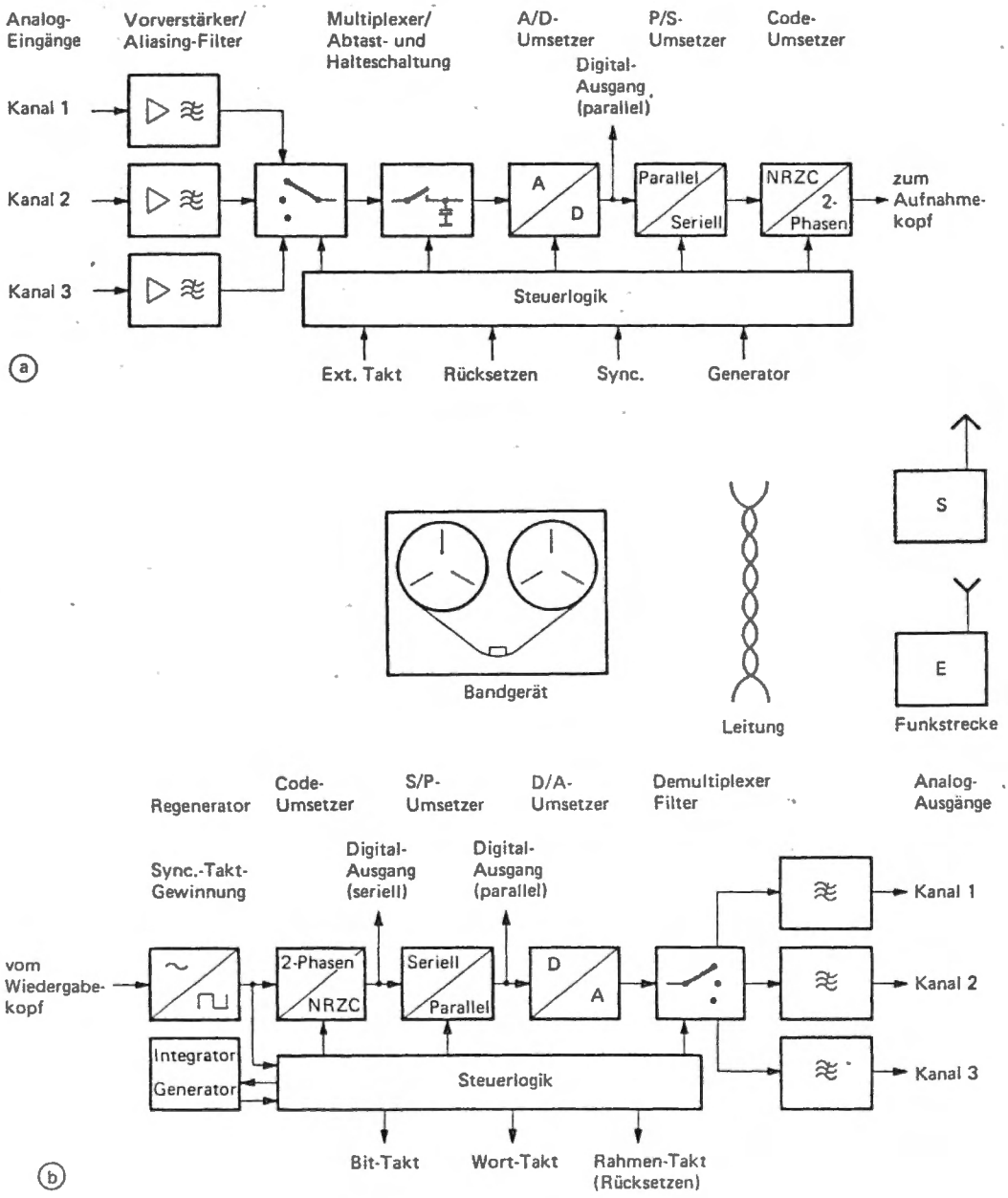


Fig.2: ZG 77 Rear Panel

Bit-serial outputs PCM (Con1, Con 2 "PCM MODULATOR")	This is the standard interface to all JOHNE + REILHOFER PCM-Systems, to be used as described in the system manuals. The bit-serial ZG 77 time-code "telegram" is blended into the PCM-bit stream such that neither a separate timing track nor a separate information channel are required.
FM (Con 3 "FM OUTPUT")	Time-code output jack for FM-recorders.
Direct recording (Con 5 "DR OUTPUT")	Output jack for direct recording tape decks including audio-type recorders.
Bit-parallel data Input (Con4 "DATA INPUT")	Time-Code System ZG 77 / ZE 77 provides for transmission of a 16-bit digital data word in addition to the real-time codes. These bits may be used independently for up to 16 event marks or encoded to represent identifying numbers, experimental parameters etc. as desired. The data are applied in bit-parallel format at this connector and are available, on play-back, at the corresponding Time-Code Receiver ZE 77 output connector. They are updated and transmitted at the same rate as the time-codes.

Output (Con6 "TIME CODE OUTPUT")	BCD-formatted ZG 77 time-codes and strobe for transfer, e.g., to a digital computer are available in bit-parallel, word-serial format at this connector.
Time base (S8 "CLOCK INT/EXT", Con8"INPUT", Con7 "OUTPUT")	In position EXT of switch CLOCK (S8), an external time base applied to connector INPUT (Con 8) is connected to the ZG 77 circuitry; the built-in time base is activated in switch position INT. The (derived) 1 per second (1 Hz) clock is always available at the OUTPUT-connector (Con 7).
Time resolution (S7 "TIME RESOLUTION" 1000/ 100/10 MS)	The real-time codes (and the digital input data at Con 4) are updated and recorded 1, 10 or 100 times per second according to the setting of switch S7 (1000, 100 or 10 MS). The choice depends on the maximum permissible recorder input bit rate and may, at low tape speeds, have to be limited to 1/sec. Automatic selection of the highest possible time resolution is obtained in position AUTO of switch S7. 100 resp. 10 msec resolutions are signalled by the appropriate front panel indicator (L1 resp. L2).
Remote control (Con 9 "REMOTE CONTROL")	Remote START/STOP control signals, equivalent to front panel start/stop switch S4, may be connected here.
HF-input (Con 10 "DCF 77 ANTENNA")	For operation of the ZG 77 Time-Code Generator with option "DCF 77" the HF- (antenna-) signal is applied to this jack. In solid buildings, the antenna should, at least, be placed near a window. The antenna cable may be up to several tens of meters long.
Power supply (Plug 1 "POWER LINE", Plug 2 "BATT").	The standard model ZG 77 is supplied for 220 / 110 V a.c. power line operation; power input is then plug 1. For battery operation, the power supply plug-in board is exchanged for an optional d.c. converter plug-in, and battery power is connected to plug 2.

BLOCK DIAGRAM OF J + R PCM-SYSTEM 1



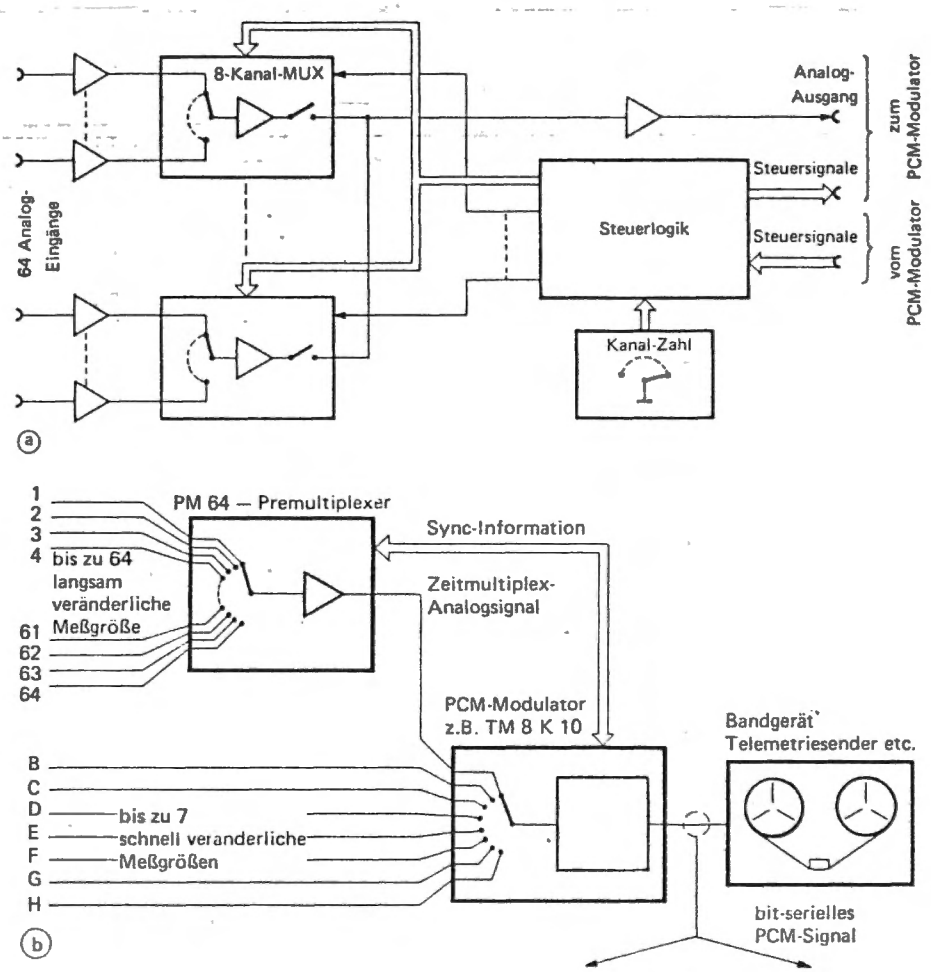
PCM-SYSTEM SIGNAL FLOW DIAGRAM

MAIN CHANNEL NO.

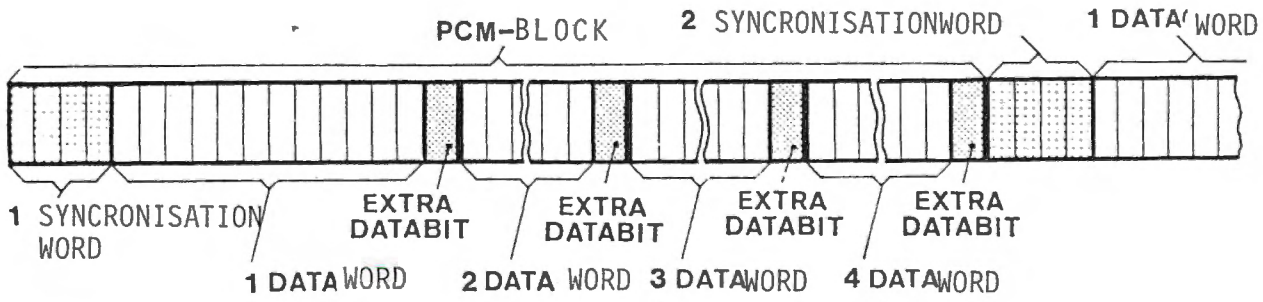
Bit/rate	1	2	4	8
640	37 647	21 333	11 428	5 926
320	18 823	10 666	5 714	2 963
160	9 412	5 333	2 857	1 481
80	4 706	2 666	1 428	741
40	2 353	1 333	714	370
20	1 176	666	357	185
10	588	333	178	92
5	294	166	89	46

SAMPLING RATE

BLOCK DIAGRAM OF J + R PCM-SYSTEM 2



PCM-PREMULTIPLEX SYSTEM



PCM-FORMAT

BRANDNER KG
Industrie-Elektronik

Potentialgetrennte Schaltregler SR 992/993/995

Besondere Merkmale

- Wirkungsgrad über 70 %
- Taktfrequenz 20 KHz
- Potentialtrennung 500 VDC
- kurze Lieferzeiten
- attraktive Preise
- Sonderausführungen möglich
- geringe Restwelligkeit typ. 20 m V_{ss}
- gute Regeldaten
- Überspannungsschutz Standard
- Strombegrenzung serienmäßig
- Fühlleitungsbetrieb serienmäßig
- echter Parallelbetrieb möglich (SR 993/995)

ELTRON A/S
Bogstadvn. 27, Oslo 3
Tlf. 02-46 28 70
Tlx. 17144 eltro n

Beschreibung/Wirkungsweise

Der Schaltregler ist als Gleichspannungswandler mit Pulsbreitenregelung aufgebaut. Die Eingangsspannung – je nach gewähltem Bereich werden Spannungen von 10 V bis 72 V verarbeitet – wird über einen Gegentaktwandler mit 20 KHz zerhackt. Die zerhackte Spannung wird über einen HF-Transformator, der die Potentialtrennung sicherstellt, übertragen. Die Regelung erfolgt durch die Pulsbreitenmodulation, d. h. die Taktfrequenz bleibt konstant, aber durch die Pulsbreite wird der Energieinhalt – und damit die Ausgangsspannung – geregelt. Besonders hervorzuheben ist die Möglichkeit **echten** Parallelbetriebes, bei dem jeder der Regler die gleiche Leistung liefert (SR 993/995).

Technische Daten

Eingang

24 V ± 25 % Standard

12/48/60/110 ± 20 % Option

Ausgangswerte

	5 V	12/15 V	24 V
SR 992	5 A	3 A	2 A
SR 993	10 A	5 A (7 A)	4 A
SR 995	20 A	10 A	6 A

Die angegebenen Spannungswerte sind Standardeinstellungen und durch ein Potentiometer in Grenzen veränderbar:
5 V (4 – 6 V)/15 V (7 – 16 V)/24 V (16 – 25 V)
Andere Ausgangsspannungen sind auf Wunsch erhältlich.
Bei 12 V Eingang reduziert sich der Ausgangsstrom um 25 %.

Regelverhalten

Bei Eingangsschwankungen ± 10 % beträgt die Abweichung typ. 0,04 %, max. 0,1 %.
Bei statischer Laständerung 10 % – 90 % beträgt die Abweichung typ. 0,4 %, max. 0,8 %.
Bei dynamischen Wechseln 10 % – 90 % typ. 0,5 % (max. 2 %) und die Rückkehrzeit in den Regelbereich 0,5 ms (max. 2 ms).

Restwelligkeit

typ. 20 mV_{ss}, max. 50m V_{ss}
typ. 5 mV_{eff}, max. 20 mV_{eff}

Temperaturbereich

0 – 70 °C, ab 50 °C nimmt die Leistung mit 2,5 %/°C ab.

Temperaturkoeffizient

typ. 0,01 %/°C, max. 0,05 %/°C

Wirkungsgrad

größer 70 % bei 5 V Ausgang,
größer 75 % bei 15/24 V Ausgang

Taktfrequenz

typ. 20 kHz

Überlastschutz

Als Überlastschutz wird die Strombegrenzung fabrikmäßig auf 110 % des jeweiligen Nennstromes eingestellt. Andere Einstellungen sind auf Wunsch möglich. Die Geräte sind dauerkurzschlußfest.

Überspannungsschutz

Die Schaltregler haben eine elektronische Sicherung, die zwischen 50 % und 150 % V_{Nen} einstellbar ist. Typische Einstellung 1 – 2 V über V_{Nen}. Ansprechzeit typ. 3 µs, max. 10 µs.

Isolationsspannung

500 VDC primär/sekundär.

Störspannung

N nach VDE 0875

Fühlleitungsbetrieb

Anschlußmöglichkeiten für Fühlerleitungen sind serienmäßig vorhanden.

Parallelbetrieb

Die Typen SR 993/995 sind für echten Parallelbetrieb geeignet. Über die Ausgleichsleitung wird erreicht daß jede der parallelgeschalteten Karten zu jedem Zeitpunkt gleich belastet wird.

Synchronisierbarkeit

Dient zur Synchronisation mehrerer Geräte.

Mechanische Daten

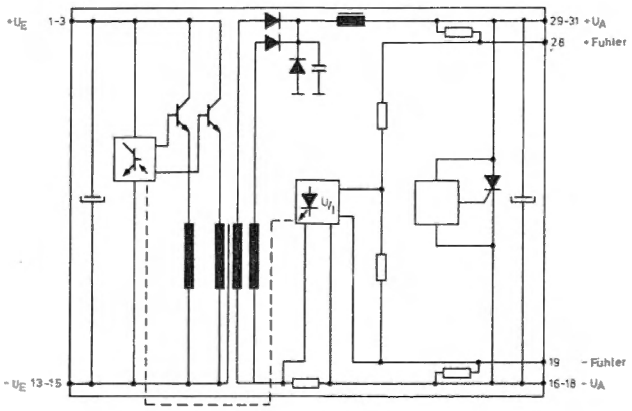
SR 992 Europakarte 100 x 160 mm
Bauhöhe 30 mm/6 TE
SR 993 Europakarte 100 x 160 mm
Bauhöhe 65 mm/13 TE
SR 995 Eurokarte 100 x 160 mm
Bauhöhe 72 mm / 14 TE

Steckverbinder

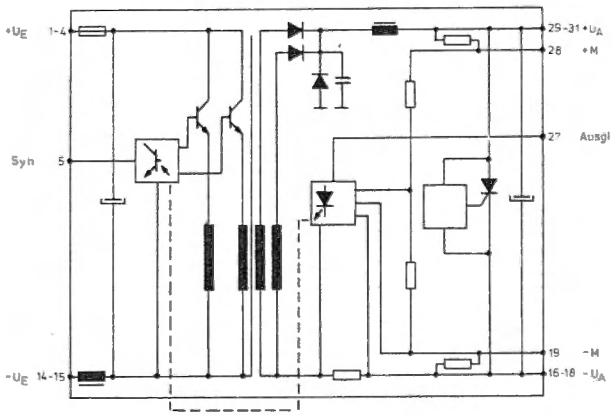
SR 992/993 31pol DIN 41617
32pol DIN 41612 B/D
SR 995 DIN 41612 H 15

Änderungen vorbehalten.

Prinzipschaltbild SR 992



Prinzipschaltbild SR 993



Bestellbeispiel: **SR 992** | **24 V** | **5 V/5 A** | **32pol** | (B/D)

Typ | Eingang | Ausgang | Stecker

Bei Bestellung Steckerbaureihe unbedingt angeben!

Federleiste gehört nicht zum Lieferumfang. muß getrennt bestellt werden!

Hersteller: BRANDNER KG Industrie-Elektronik
Arbachtalstraße 22
7412 Eningen u. A.
Telefon (07121) 82107 – 08
Telex 0729817 brare d

Vertrieb: BRANDNER Vertriebs-GmbH
Stresemannstraße 19
6450 Hanau 1
Telefon (06181) 32037 – 38
Telex 4184670 brav d

NGI

A P P E N D I X B

Skj.nr. 036. 1-83. 20000. Reclamo

NGI

Calibration of mast at top of test embankment.

1. Point force acting approximately 5° from horizontal direction was applied at top of mast in SL-1, SL-5B direction.

2. Following formulas are used:

$$\varepsilon_v = F \cos\beta \cdot l/E \cdot W \qquad (A)$$

$$W = M_v/\sigma_v$$

when ε_v = bending strain
F = applied point force
β = angle with horizontal direction
l = distance between gauge and load point
E = Young's modulus
W = resistance moment
M_v = bending moment
σ_v = bending stress

$l_1 = 4.21$ m
$l_2 = 2.81$ m
$E = 2.15 \cdot 10^{11}$ Pa
$W = 7.8 \cdot 10^{-4}$ m^3 (estimated)

3. Results are summarized (Appendix B1, page 2)
The results should only be taken as a general check confirming proper operation and correct level of output signal. The computation of theoretical values are based on several assumptions about force distribution and therefore can be inaccurate.

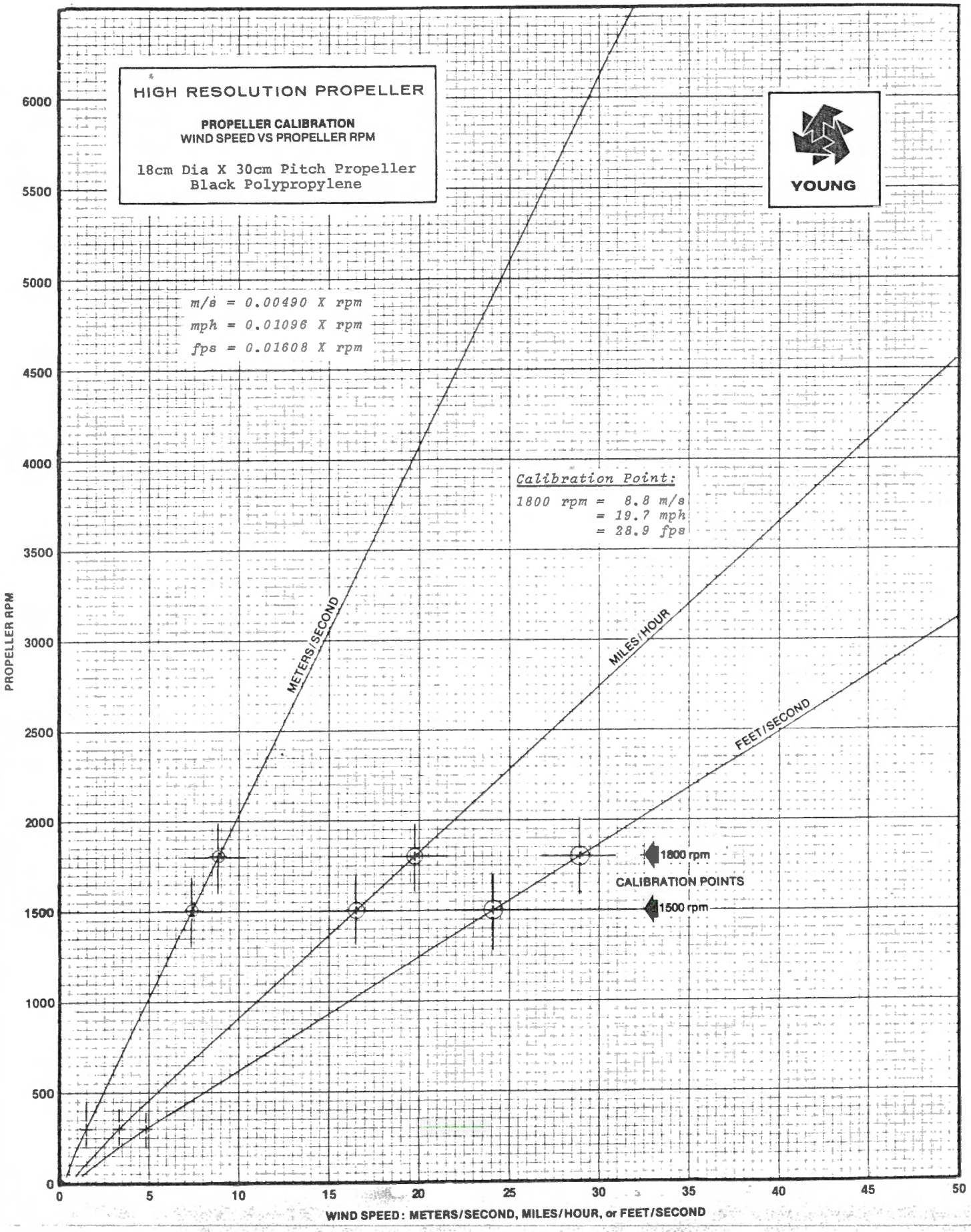
Skj.nr. 036. 1-83. 20000. Reclamo

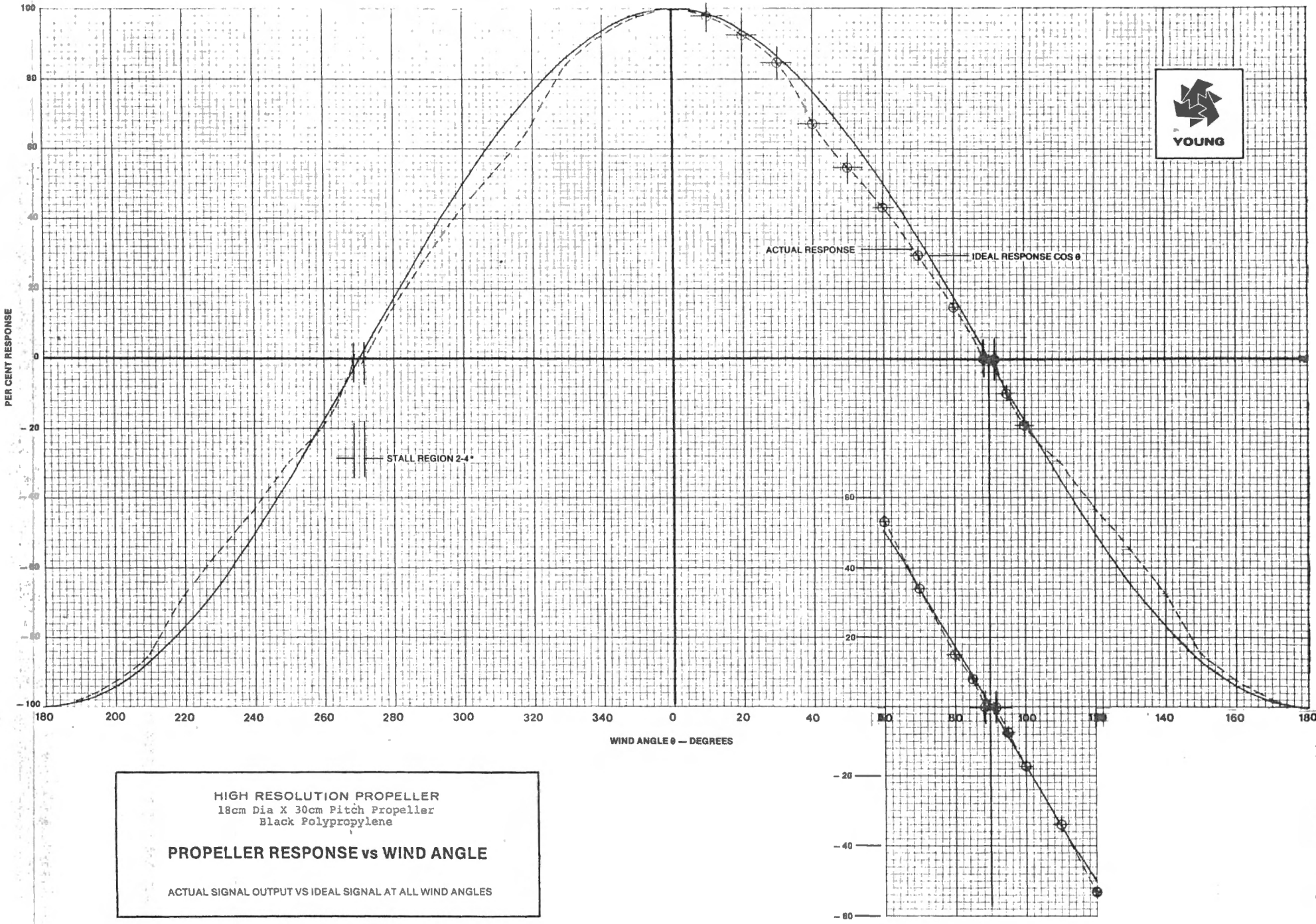
NGI

Sensor	Applied point force	Measured value	Theoretical computed value
SL-1	0 kN	- 0 με	- 0 με
	2.47 kN	- 66 με	- 62 με
	5.70 kN	- 142 με	- 142 με
	10.10 kN	- 242 με	- 252 με
	14.40 kN	- 344 με	- 360 με
	19.00 kN	- 450 με	- 474 με
	25.40 kN	- 598 με	- 636 με
	0 kN	0 με	0 με
SL-3	0 kN	0 με	0 με
	2.47 kN	+ 58 με	+ 62 με
	5.70 kN	+ 132 με	+ 142 με
	9.72 kN	+ 224 με	+ 243 με
	13.80 kN	+ 312 με	+ 345 με
	20.70 kN	+ 460 με	+ 518 με
	25.40 kN	+ 569 με	+ 636 με
	0 kN	0 με	0 με
SL-5B	0 kN	0 με	0 με
	2.83 kN	- 46 με	- 47 με
	5.88 kN	- 97 με	- 98 με
	9.54 kN	- 151 με	- 160 με
	13.30 kN	- 211 με	- 222 με
	19.40 kN	- 304 με	- 324 με
	24.90 kN	- 387 με	- 416 με
	0 kN	0 με	0 με
SL-5A	0 kN	0 με	0 με
	1.94 kN	+ 30 με	+ 33 με
	5.35 kN	+ 81 με	+ 89 με
	9 36 kN	+ 142 με	+ 157 με
	12.90 kN	+ 191 με	+ 216 με
	18.80 kN	+ 273 με	+ 315 με
	24.70 kN	+ 358 με	+ 413 με
	0 kN	0 με	0 με

Skj.nr. 036.1-83. 20000. Reclamo

JAN 79


HIGH RESOLUTION PROPELLER
PROPELLER CALIBRATION
WIND SPEED VS PROPELLER RPM
18cm Dia X 30cm Pitch Propeller
Black Polypropylene
YOUNG
m/s = 0.00490 X rpm
mph = 0.01096 X rpm
fps = 0.01608 X rpm
Calibration Point:
1800 rpm = 8.8 m/s
= 19.7 mph
= 28.9 fps
METERS/SECOND
MILES/HOUR
FEET/SECOND
1800 rpm
CALIBRATION POINTS
1500 rpm
PROPELLER RPM
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
0
5
10
15
20
25
30
35
40
45
50
WIND SPEED: METERS/SECOND, MILES/HOUR, or FEET/SECOND



HIGH RESOLUTION PROPELLER
18cm Dia X 30cm Pitch Propeller
Black Polypropylene

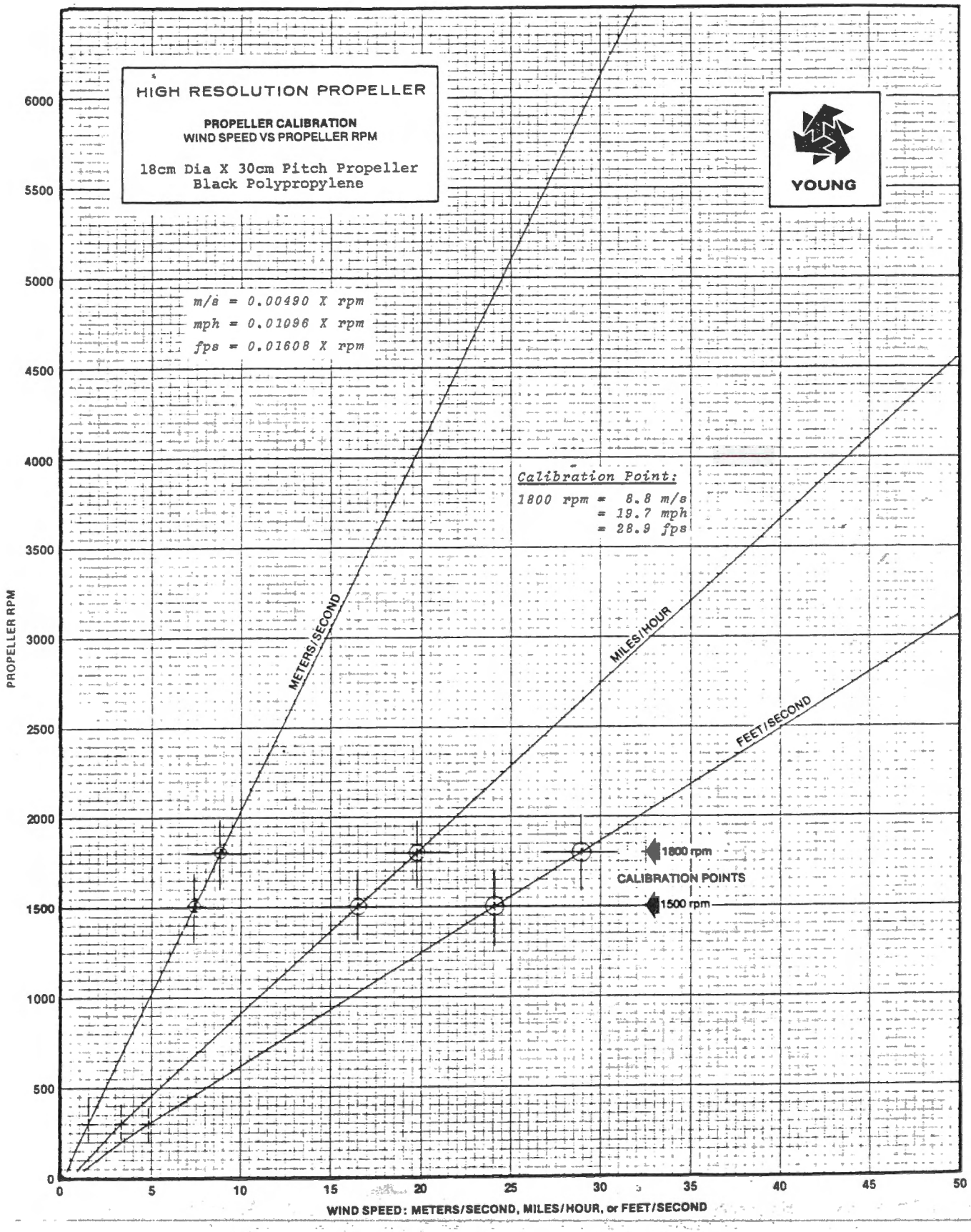
PROPELLER RESPONSE vs WIND ANGLE

ACTUAL SIGNAL OUTPUT VS IDEAL SIGNAL AT ALL WIND ANGLES

CALIBRATION SHIFTED FOR VERTICAL COMPONENT MEASUREMENTS.

JAN 79

JAN 79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1800 rpm
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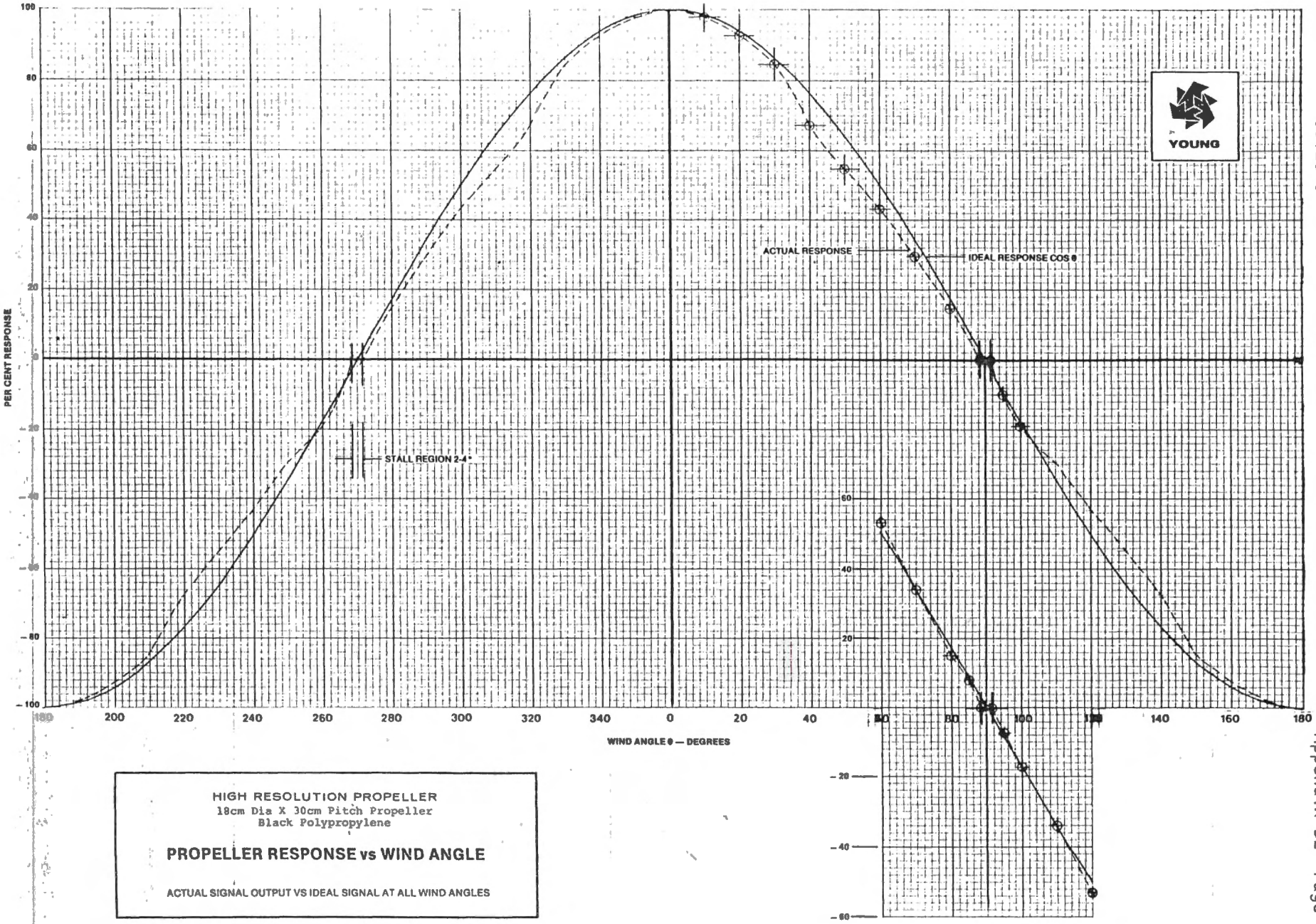
1500 rpm
PROPELLER RPM
0
500
1000
1500
2000
2500
3000
3500
4000
4500
5000
5500
6000
0
5
10
15
20
25
30
35
40
45
50
WIND SPEED: METERS/SECOND, MILES/HOUR, or FEET/SECOND



HIGH RESOLUTION PROPELLER
18cm Dia X 30cm Pitch Propeller
Black Polypropylene

PROPELLER RESPONSE vs WIND ANGLE

ACTUAL SIGNAL OUTPUT VS IDEAL SIGNAL AT ALL WIND ANGLES

CALIBRATION SHIFTED FOR VERTICAL COMPONENT MEASUREMENTS.

JAN 79

検 査 成 績 表

CALIBRATION SHEET

土 木 用 変 換 器

TRANSDUCERS FOR CIVIL ENGINEERING

型式名 Model	BL-500KB	容 量 Capacity	500kgf	製造番号 Serial No.	BH2663
検査年月日 Inspected date	1981.6.26	温 度 Temperature	24 ℃	湿 度 Humidity	60 %

1．出力電圧感度 Sensitivity
1.454 μV/V
(2308 ×10⁻⁶)

2．初期不平衡 Initial bridge unbalance
-50 μV/V
(-99 ×10⁻⁶)

3．較正係数 Calibration constant
0.433 kgf /1 μV/V
(2.217 kgf /1.0×10⁻⁶)

4．入出力抵抗 Input & output resistance
入力 Input 351.7 Ω
出力 Output 351.7 Ω

5．絶縁抵抗 Insulation resistance
1000 MΩ (50VDC)

注 Note 1 μV/V = 2 ×10⁻⁶ 等価ひずみ (G.F.=2.00)
Equivalent strain

株式会社 共和電業
KYOWA
ELECTRONIC INSTRUMENTS CO.,LTD.

検査者 Inspector 宮田
責任者 Supervisor 嶺崎

TRANSDUCERS AND INSTRUMENTATION

R.D.P. Electronics Ltd.

Grove Street, Heath Town, Wolverhampton, England, WV10 0PY.
Telephone (0902) 57512
Telex: 335430 (RDP-G)

FORCE TRANSDUCER CALIBRATION RECORD

Type: Compression ____
Tension X

Model No. RM/2764

Serial No. 78346

Capacity 0 - 50K LBS.

Date 8/10/82.

Excitation (Input) Volts 10.0 DC

Compensated Temperature Range:

~~60 °F to 160 °F~~
-10 °C to +30 °C

Capacity:		Output:	
	0% of Capacity	0	Millivolts
Ascending	50% " "	10.386	Millivolts
	100% " "	21.853	Millivolts
Descending	50% " "	10.389	Millivolts
	0% " "	0	Millivolts

Resistance:

Input = 378 Ohms
Output = 351 Ohms
Leakage = ∞ Ohms

Connector Type N/A

Non-Standard X Standard ____

BROWN = -INPUT
RED = +INPUT
YELLOW = -OUTPUT
ORANGE = +OUTPUT

Input: + A & B
- C & D

Output: - E
+ F

Mating Connector N/A

Wiring ✓

- White = + Output
- Red = + Input
- Green = - Output
- Black = - Input

Shunt Resistor Value of 59K Ohms Across

BROWN + YELLOW 4.869 Millivolts Output

Signed Michael L Turner

TRANSDUCERS AND INSTRUMENTATION

R.D.P. Electronics Ltd.

Grove Street, Heath Town, Wolverhampton, England, WV10 0PY.

Telephone (0902) 57512

Telex: 335430 (RDP-G)

FORCE TRANSDUCER CALIBRATION RECORD

Type: Compression ____

Tension X

Model No. RM/2764

Serial No. 93347

Capacity 0-50K LBS.

Date 3/10/82

Excitation (Input) Volts 10.0 DC

Compensated Temperature Range:

~~60~~ °F ~~to~~ ~~160~~ °F

-10 °C to +30 °C

Capacity:		Output:	
	0% of Capacity	0	Millivolts
Ascending	50% " "	10.976	Millivolts
	100% " "	21.944	Millivolts
Descending	50% " "	10.995	Millivolts
	0% " "	0	Millivolts

Resistance:

Input = 378 Ohms

Output = 351 Ohms

Leakage = ∞ Ohms

Connector Type N/A

Non-Standard X Standard ____

BROWN = -INPUT
RED = +INPUT
YELLOW = -OUTPUT
ORANGE = +OUTPUT

Input: + A & B
- C & D

Output: - E
+ F

Mating Connector N/A

Wiring ✓

- White = + Output
- Red = + Input
- Green = - Output
- Black = - Input

Shunt Resistor Value of 59K Ohms Across

BROWN + YELLOW 4.854 Millivolts Output

Signed Michael Turner

RDP GROUP

R.D.P. Electronics Ltd.

Grove Street, Heath Town, Wolverhampton, England, WV10 0PY.

Telephone (0902) 57512

Telex: 335430 (RDP-G)

FORCE TRANSDUCER CALIBRATION RECORD

Type: Compression ____ Tension X

Model No. RM/2764

Serial No. 75345

Capacity 0-50K LBS.

Date 3/10/82

Excitation (Input) Volts 10.0 DC

Compensated Temperature Range:

~~60~~ °F to ~~160~~ °F

-10 °C to +30 °C

Capacity:		Output:	
	0% of Capacity	0	Millivolts
Ascending	50% " "	10.914	Millivolts
	100% " "	21.919	Millivolts
Descending	50% " "	10.907	Millivolts
	0% " "	0	Millivolts

Resistance:

Input = 378 Ohms

Output = 351 Ohms

Leakage = ~~∞~~ Ohms

Connector Type N/A

Non-Standard X Standard ____

BROWN = -INPUT
RED = +INPUT
YELLOW = -OUTPUT
ORANGE = +OUTPUT

Input: + A & B
- C & D

Output: - E
+ F

Mating Connector N/A

Wiring ✓

- White = + Output
- Red = + Input
- Green = - Output
- Black = - Input

Shunt Resistor Value of 59K Ohms Across BROWN + YELLOW 14.840 Millivolts Output

Signed Michael L Turner

R.D.P. Electronics Ltd.
Grove Street, Heath Town, Wolverhampton, England, WV10 0PY.
Telephone (0902) 57512
Telex: 335430 (RDP-G)

FORCE TRANSDUCER CALIBRATION RECORD

Type: Compression ____
Tension X

Model No. RM/2764

Serial No. 78349

Capacity 0 - 50K LBS.

Date 3/10/82

Excitation (Input) Volts 10.0 DC

Compensated Temperature Range:
~~60~~ °F to ~~160~~ °F
-10 °C to +30 °C

Capacity:		Output:	
	0% of Capacity	0	Millivolts
Ascending	50% " "	10.940	Millivolts
	100% " "	21.961	Millivolts
Descending	50% " "	10.899	Millivolts
	0% " "	0	Millivolts

Resistance:
Input = 378 Ohms
Output = 351 Ohms
Leakage = ∞ Ohms

Connector Type N/A

Non-Standard X Standard ____

BROWN = -INPUT
RED = +INPUT
YELLOW = -OUTPUT
ORANGE = +OUTPUT

Input: + A & B
- C & D
Output: - E
+ F

Mating Connector N/A

Wiring ✓

- White = + Output
- Red = + Input
- Green = - Output
- Black = - Input

Shunt Resistor Value of 59K Ohms Across
BROWN + YELLOW 4.841 Millivolts Output

Signed Michael Turner

RDP GROUP

R.D.P. Electronics Ltd.

Grove Street, Heath Town, Wolverhampton, England, WV10 0PY.
Telephone (0902) 57512
Telex: 335430 (RDP-G)

FORCE TRANSDUCER CALIBRATION RECORD

Type: Compression ____
Tension X

Model No. RM/2764

Serial No. 73350

Capacity 0 - 50K LBS.

Date 5/10/82.

Excitation (Input) Volts 10.0 DC

Compensated Temperature Range:

~~60~~ °F to ~~160~~ °F
-10°C to + 30°C

Capacity:

	0% of Capacity	0	Millivolts
Ascending	50% " "	10.571	Millivolts
	100% " "	21.535	Millivolts
Descending	50% " "	10.535	Millivolts
	0% " "	0	Millivolts

Resistance:

Input = 378 Ohms
Output = 351 Ohms
Leakage = ∞ Ohms

Connector Type N/A

Non-Standard X Standard ____

BROWN = -INPUT
RED = +INPUT
YELLOW = -OUTPUT
ORANGE = +OUTPUT

Input: + A & B
- C & D
Output: - E
+ F

Mating Connector N/A

Wiring ✓

- White = + Output
- Red = + Input
- Green = - Output
- Black = - Input

Shunt Resistor Value of 59K Ohms Across

BROWN + YELLOW 14.881 Millivolts Output

Signed Michael J Turner

R.D.P. Electronics Ltd.
Grove Street, Heath Town, Wolverhampton, England, WV10 0PY.
Telephone (0902) 57512
Telex: 335430 (RDP-G)

FORCE TRANSDUCER CALIBRATION RECORD

Type: Compression ____
Tension X

Model No. RM/2764

Serial No. 78351

Capacity 0 - 50K LBS.

Date 3/10/82.

Excitation (Input) Volts 10.0 DC

Compensated Temperature Range:
~~60~~ °F to ~~160~~ °F
-10°C to +30°C

Capacity:		Output:	
	0% of Capacity	0	Millivolts
Ascending	50% " "	10.933	Millivolts
	100% " "	21.944	Millivolts
Descending	50% " "	10.935	Millivolts
	0% " "	0	Millivolts

Resistance:

Input = 379 Ohms

Output = 351 Ohms

Leakage = ∞ Ohms

Connector Type N/A

Non-Standard X Standard ____

BROWN = -INPUT
RED = +INPUT
YELLOW = -OUTPUT
ORANGE = +OUTPUT

Input: + A & B
- C & D

Output: - E
+ F

Mating Connector N/A

Wiring ✓

- White = + Output
- Red = + Input
- Green = - Output
- Black = - Input

Shunt Resistor Value of 59K Ohms Across BROWN + YELLOW ____ Millivolts Output

Signed Michael L Turner

DATA AND CALIBRATION SHEET

LOAD CELL KIS-1-T10 SERIAL NO 51277

RATED LOAD (R.L.)	20.000	MP (20 tonn f, Megapond)	
OVERLOAD, SAFE	100	% R.L.	
OVERLOAD, ULTIMATE	200	% R.L.	
SIDE LOAD, SAFE	100	% R.L.	
SIDE LOAD, ULTIMATE	100	% R.L.	
DEFLECTION	0.8	MM AT R.L.	
ELECTRICAL CONNECTION	10 M SHIELDED 4-CONDUCTOR CABLE, THE SHIELD IS NOT CONNECTED TO THE TRANSDUCER HOUSING.		
INPUT VOLTAGE, RECOMMENDED	15	V AC OR DC	
INPUT VOLTAGE, MAXIMUM	18	V AC OR DC	

INPUT (A-C, A POSITIVE, A=RED, C=BLACK)
RESISTANCE 351.0 OHMS INCL 10 M CABLE

OUTPUT (B-D, D POSITIVE, B=WHITE, D=GREEN)
RESISTANCE 350.2 OHMS INCL 10 M CABLE

TEMPERATURE RANGE -40 TO +100 /DEG.

TEMPERATURE EFFECT (-10 TO +50 DEG. C)
ON OUTPUT +-0.0015 % OUTPUT/DEG. C
ON ZERO BALANCE +-0.003 % R.O./DEG. C

RATED OUTPUT(R.O.) (TOLERANCE 0.1%)	2.000	MV/V INPUT
NONLINEARITY (BEST FIT THROUGH ZERO)	+-0.01	% R.O.
ZERO BALANCE	-0.02	% R.O.
CREEP 0-5 MINUTES	-0.02	% R.O.

CALIBRATION VALUES (TOLERANCE 0.1%)

40 KOHMS CORRESPOND TO	21.427	MP	} RKAL mellom B og C
80 KOHMS CORRESPOND TO	10.738	MP	

THE VALUES INDICATED FOR OUTPUT VOLTAGE AND CALIBRATION VALUES ARE APPLICABLE AT OPEN CIRCUIT AND WITHOUT EXTERNAL BALANCING RESISTORS AND WITH A CONNECTING CABLE OF THE INDICATED LENGTH.

AB BOFORS, ELECTRONICS DIVISION
S-69020 BOFORS, SWEDEN

BOFORS 82-09-02

Ove Jonsson

DATA AND CALIBRATION SHEET

LOAD CELL KIS-1-T10 SERIAL NO 51289

RATED LOAD (R.L.)	20	MP
OVERLOAD, SAFE	100	% R.L.
OVERLOAD, ULTIMATE	200	% R.L.
SIDE LOAD, SAFE	100	% R.L.
SIDE LOAD, ULTIMATE	100	% R.L.
DEFLECTION	0.8	MM AT R.L.
ELECTRICAL CONNECTION	10 M SHIELDED 4-CONDUCTOR CABLE, THE SHIELD IS NOT CONNECTED TO THE TRANSDUCER HOUSING.	
INPUT VOLTAGE, RECOMMENDED	15	V AC OR DC
INPUT VOLTAGE, MAXIMUM	18	V AC OR DC

INPUT (A-C, A POSITIVE, A=RED, C=BLACK)
RESISTANCE 350.9 OHMS INCL 10 M CABLE

OUTPUT (B-D, D POSITIVE, B=WHITE, D=GREEN)
RESISTANCE 350.2 OHMS INCL 10 M CABLE

TEMPERATURE RANGE -40 TO +100 /DEG.

TEMPERATURE EFFECT (-10 TO +50 DEG. C)
ON OUTPUT +-0.0015 % OUTPUT/DEG. C
ON ZERO BALANCE +-0.003 % R.O./DEG. C

RATED OUTPUT(R.O.) (TOLERANCE 0.1%)	2.000	MV/V INPUT
NONLINEARITY (BEST FIT THROUGH ZERO)	+-0.02	% R.O.
ZERO BALANCE	-0.35	% R.O.
CREEP 0-5 MINUTES	-0.02	% R.O.

CALIBRATION VALUES (TOLERANCE 0.1%)

40	KOHMS CORRESPOND TO	21.405	MP
80	KOHMS CORRESPOND TO	10.731	MP

THE VALUES INDICATED FOR OUTPUT VOLTAGE AND CALIBRATION VALUES ARE APPLICABLE AT OPEN CIRCUIT AND WITHOUT EXTERNAL BALANCING RESISTORS AND WITH A CONNECTING CABLE OF THE INDICATED LENGTH.

AB BOFORS, ELECTRONICS DIVISION
S-69020 BOFORS, SWEDEN

BOFORS 82-09-02

Sten Jonsson

DATA AND CALIBRATION SHEET

LOAD CELL KIS-1-T10 SERIAL NO 51296

RATED LOAD (R.L.)	20	MP
OVERLOAD, SAFE	100	% R.L.
OVERLOAD, ULTIMATE	200	% R.L.
SIDE LOAD, SAFE	100	% R.L.
SIDE LOAD, ULTIMATE	100	% R.L.
DEFLECTION	0.8	MM AT R.L.
ELECTRICAL CONNECTION	10 M SHIELDED 4-CONDUCTOR CABLE, THE SHIELD IS NOT CONNECTED TO THE TRANSDUCER HOUSING.	
INPUT VOLTAGE, RECOMMENDED	15	V AC OR DC
INPUT VOLTAGE, MAXIMUM	18	V AC OR DC

INPUT (A-C, A POSITIVE, A=RED, C=BLACK)
RESISTANCE 350.7 OHMS INCL 10 M CABLE

OUTPUT (B-D, D POSITIVE, B=WHITE, D=GREEN)
RESISTANCE 350.1 OHMS INCL 10 M CABLE

TEMPERATURE RANGE -40 TO +100 /DEG.

TEMPERATURE EFFECT (-10 TO +50 DEG. C)
ON OUTPUT +-0.0015 % OUTPUT/DEG. C
ON ZERO BALANCE +-0.003 % R.O./DEG. C

RATED OUTPUT(R.O.) (TOLERANCE 0.1%)	2.000	MV/V INPUT
NONLINEARITY (BEST FIT THROUGH ZERO)	+-0.01	% R.O.
ZERO BALANCE	0.03	% R.O.
CREEP 0-5 MINUTES	-0.02	% R.O.

CALIBRATION VALUES (TOLERANCE 0.1%)

40	KOHMS CORRESPOND TO	21.307	MP
80	KOHMS CORRESPOND TO	10.679	MP

THE VALUES INDICATED FOR OUTPUT VOLTAGE AND CALIBRATION VALUES ARE APPLICABLE AT OPEN CIRCUIT AND WITHOUT EXTERNAL BALANCING RESISTORS AND WITH A CONNECTING CABLE OF THE INDICATED LENGTH.

AB BOFORS, ELECTRONICS DIVISION
S-69020 BOFORS, SWEDEN

BOFORS 82-09-02

Sten Jonsson

DATA AND CALIBRATION SHEET

LOAD CELL KIS-1-T10 SERIAL NO 51298

RATED LOAD (R.L.)	20	MP
OVERLOAD, SAFE	100	% R.L.
OVERLOAD, ULTIMATE	200	% R.L.
SIDE LOAD, SAFE	100	% R.L.
SIDE LOAD, ULTIMATE	100	% R.L.
DEFLECTION	0.8	MM AT R.L.
ELECTRICAL CONNECTION	10 M SHIELDED 4-CONDUCTOR CABLE, THE SHIELD IS NOT CONNECTED TO THE TRANSDUCER HOUSING.	
INPUT VOLTAGE, RECOMMENDED	15	V AC OR DC
INPUT VOLTAGE, MAXIMUM	18	V AC OR DC

INPUT (A-C, A POSITIVE, A=RED, C=BLACK)
RESISTANCE 351.1 OHMS INCL 10 M CABLE

OUTPUT (B-D, D POSITIVE, B=WHITE, D=GREEN)
RESISTANCE 350.1 OHMS INCL 10 M CABLE

TEMPERATURE RANGE -40 TO +100 /DEG.

TEMPERATURE EFFECT (-10 TO +50 DEG. C)
ON OUTPUT +-0.0015 % OUTPUT/DEG. C
ON ZERO BALANCE +-0.003 % R.O./DEG. C

RATED OUTPUT(R.O.) (TOLERANCE 0.1%)	2.000	MV/V INPUT
NONLINEARITY (BEST FIT THROUGH ZERO)	+-0.02	% R.O.
ZERO BALANCE	-0.16	% R.O.
CREEP 0-5 MINUTES	-0.02	% R.O.

CALIBRATION VALUES (TOLERANCE 0.1%)

40 KOHMS CORRESPOND TO	21.396	MP
80 KOHMS CORRESPOND TO	10.724	MP

THE VALUES INDICATED FOR OUTPUT VOLTAGE AND CALIBRATION VALUES ARE APPLICABLE AT OPEN CIRCUIT AND WITHOUT EXTERNAL BALANCING RESISTORS AND WITH A CONNECTING CABLE OF THE INDICATED LENGTH.

AB BOFORS, ELECTRONICS DIVISION
S-69020 BOFORS, SWEDEN

BOFORS 82-09-02

Sten Jonsson

DATA AND CALIBRATION SHEET

LOAD CELL KIS-1-T10 SERIAL NO 51566

RATED LOAD (R.L.)	20	MP
OVERLOAD, SAFE	100	% R.L.
OVERLOAD, ULTIMATE	200	% R.L.
SIDE LOAD, SAFE	100	% R.L.
SIDE LOAD, ULTIMATE	100	% R.L.
DEFLECTION	0.8	MM AT R.L.
ELECTRICAL CONNECTION	10 M SHIELDED 4-CONDUCTOR CABLE, THE SHIELD IS NOT CONNECTED TO THE TRANSDUCER HOUSING.	
INPUT VOLTAGE, RECOMMENDED	15	V AC OR DC
INPUT VOLTAGE, MAXIMUM	18	V AC OR DC

INPUT (A-C, A POSITIVE, A=RED, C=BLACK)
RESISTANCE 351.0 OHMS INCL 10 M CABLE

OUTPUT (B-D, D POSITIVE, B=WHITE, D=GREEN)
RESISTANCE 350.4 OHMS INCL 10 M CABLE

TEMPERATURE RANGE -40 TO +100 /DEG.

TEMPERATURE EFFECT (-10 TO +50 DEG. C)
ON OUTPUT +-0.0015 % OUTPUT/DEG. C
ON ZERO BALANCE +-0.003 % R.O./DEG. C

RATED OUTPUT(R.O.) (TOLERANCE 0.1%)	2.000	MV/V INPUT
NONLINEARITY (BEST FIT THROUGH ZERO)	+-0.02	% R.O.
ZERO BALANCE	-0.29	% R.O.
CREEP 0-5 MINUTES	-0.03	% R.O.
CALIBRATION VALUES (TOLERANCE 0.1%)		
40 KOHMS CORRESPOND TO	21.525	MP
80 KOHMS CORRESPOND TO	10.789	MP

THE VALUES INDICATED FOR OUTPUT VOLTAGE AND CALIBRATION VALUES ARE APPLICABLE AT OPEN CIRCUIT AND WITHOUT EXTERNAL BALANCING RESISTORS AND WITH A CONNECTING CABLE OF THE INDICATED LENGTH.

AB BOFORS, ELECTRONICS DIVISION
S-69020 BOFORS, SWEDEN

BOFORS 82-09-02

Stel Jonsson

DATA AND CALIBRATION SHEET

LOAD CELL KIS-1-T10 SERIAL NO 51571

RATED LOAD (R.L.)	20	MP
OVERLOAD, SAFE	100	% R.L.
OVERLOAD, ULTIMATE	200	% R.L.
SIDE LOAD, SAFE	100	% R.L.
SIDE LOAD, ULTIMATE	100	% R.L.
DEFLECTION	0.8	MM AT R.L.
ELECTRICAL CONNECTION	10 M SHIELDED 4-CONDUCTOR CABLE, THE SHIELD IS NOT CONNECTED TO THE TRANSDUCER HOUSING.	
INPUT VOLTAGE, RECOMMENDED	15	V AC OR DC
INPUT VOLTAGE, MAXIMUM	18	V AC OR DC

INPUT (A-C, A POSITIVE, A=RED, C=BLACK)
RESISTANCE 350.7 OHMS INCL 10 M CABLE

OUTPUT (B-D, B POSITIVE, B=WHITE, D=GREEN)
RESISTANCE 350.0 OHMS INCL 10 M CABLE

TEMPERATURE RANGE -40 TO +100 /DEG.

TEMPERATURE EFFECT (-10 TO +50 DEG. C)
ON OUTPUT +-0.0015 % OUTPUT/DEG. C
ON ZERO BALANCE +-0.003 % R.O./DEG. C

RATED OUTPUT(R.O.) (TOLERANCE 0.1%)	2.000	MV/V INPUT
NONLINEARITY (BEST FIT THROUGH ZERO)	+-0.01	% R.O.
ZERO BALANCE	-0.42	% R.O.
CREEP 0-5 MINUTES	-0.02	% R.O.

CALIBRATION VALUES (TOLERANCE 0.1%)

40	KOHMS CORRESPOND TO	21.382	MP
80	KOHMS CORRESPOND TO	10.710	MP

THE VALUES INDICATED FOR OUTPUT VOLTAGE AND CALIBRATION VALUES ARE APPLICABLE AT OPEN CIRCUIT AND WITHOUT EXTERNAL BALANCING RESISTORS AND WITH A CONNECTING CABLE OF THE INDICATED LENGTH.

AB BOFORS, ELECTRONICS DIVISION
S-69020 BOFORS, SWEDEN

BOFORS 82-09-02

Sgt Jansson

DATA AND CALIBRATION SHEET

LOAD CELL KIS-1-T10 SERIAL NO 51576

RATED LOAD (R.L.)	20	MP
OVERLOAD, SAFE	100	% R.L.
OVERLOAD, ULTIMATE	200	% R.L.
SIDE LOAD, SAFE	100	% R.L.
SIDE LOAD, ULTIMATE	100	% R.L.
DEFLECTION	0.8	MM AT R.L.

ELECTRICAL CONNECTION 10 M SHIELDED 4-CONDUCTOR CABLE, THE SHIELD IS NOT CONNECTED TO THE TRANSDUCER HOUSING.

INPUT VOLTAGE, RECOMMENDED	15	V AC OR DC
INPUT VOLTAGE, MAXIMUM	18	V AC OR DC

INPUT (A-C, A POSITIVE, A=RED, C=BLACK)
RESISTANCE 351.5 OHMS INCL 10 M CABLE

OUTPUT (B-D, D POSITIVE, B=WHITE, D=GREEN)
RESISTANCE 350.2 OHMS INCL 10 M CABLE

TEMPERATURE RANGE -40 TO +100 /DEG.

TEMPERATURE EFFECT (-10 TO +50 DEG. C)
ON OUTPUT +-0.0015 % OUTPUT/DEG. C
ON ZERO BALANCE +-0.003 % R.O./DEG. C

RATED OUTPUT(R.O.) (TOLERANCE 0.1%)	2.000	MV/V INPUT
NONLINEARITY (BEST FIT THROUGH ZERO)	+-0.01	% R.O.
ZERO BALANCE	0.32	% R.O.
CREEP 0-5 MINUTES	-0.02	% R.O.

CALIBRATION VALUES (TOLERANCE 0.1%)

40	KOHMS CORRESPOND TO	21.473	MP
80	KOHMS CORRESPOND TO	10.761	MP

THE VALUES INDICATED FOR OUTPUT VOLTAGE AND CALIBRATION VALUES ARE APPLICABLE AT OPEN CIRCUIT. AND WITHOUT EXTERNAL BALANCING RESISTORS AND WITH A CONNECTING CABLE OF THE INDICATED LENGTH.

AB BOFORS, ELECTRONICS DIVISION
S-69020 BOFORS, SWEDEN

BOFORS 82-09-02

Sten Jonsson

DATA AND CALIBRATION SHEET

LOAD CELL KIS-1-T10 SERIAL NO 51577

RATED LOAD (R.L.)	20	MP
OVERLOAD, SAFE	100	% R.L.
OVERLOAD, ULTIMATE	200	% R.L.
SIDE LOAD, SAFE	100	% R.L.
SIDE LOAD, ULTIMATE	100	% R.L.
DEFLECTION	0.8	MM AT R.L.
ELECTRICAL CONNECTION	10 M SHIELDED 4-CONDUCTOR CABLE, THE SHIELD IS NOT CONNECTED TO THE TRANSDUCER HOUSING.	
INPUT VOLTAGE, RECOMMENDED	15	V AC OR DC
INPUT VOLTAGE, MAXIMUM	18	V AC OR DC

INPUT (A-C, A POSITIVE, A=RED, C=BLACK)
RESISTANCE 350.7 OHMS INCL 10 M CABLE

OUTPUT (B-D, D POSITIVE, B=WHITE, D=GREEN)
RESISTANCE 349.9 OHMS INCL 10 M CABLE

TEMPERATURE RANGE -40 TO +100 /DEG.

TEMPERATURE EFFECT (-10 TO +50 DEG. C)
ON OUTPUT +-0.0015 % OUTPUT/DEG. C
ON ZERO BALANCE +-0.003 % R.O./DEG. C

RATED OUTPUT(R.O.) (TOLERANCE 0.1%)	2.000	MV/V INPUT
NONLINEARITY (BEST FIT THROUGH ZERO)	+-0.01	% R.O.
ZERO BALANCE	0.34	% R.O.
CREEP 0-5 MINUTES	-0.02	% R.O.

CALIBRATION VALUES (TOLERANCE 0.1%)

40	KOHMS CORRESPOND TO	21.477	MP
80	KOHMS CORRESPOND TO	10.761	MP

THE VALUES INDICATED FOR OUTPUT VOLTAGE AND CALIBRATION VALUES ARE APPLICABLE AT OPEN CIRCUIT AND WITHOUT EXTERNAL BALANCING RESISTORS AND WITH A CONNECTING CABLE OF THE INDICATED LENGTH.

AB BOFORS, ELECTRONICS DIVISION
S-69020 BOFORS, SWEDEN

BOFORS 84-09-02

Sten Jonsson

DATA AND CALIBRATION SHEET

LOAD CELL KIS-1-T10 SERIAL NO 51581

RATED LOAD (R.L.)	20	MP
OVERLOAD, SAFE	100	% R.L.
OVERLOAD, ULTIMATE	200	% R.L.
SIDE LOAD, SAFE	100	% R.L.
SIDE LOAD, ULTIMATE	100	% R.L.
DEFLECTION	0.8	MM AT R.L.
ELECTRICAL CONNECTION	10 M SHIELDED 4-CONDUCTOR CABLE, THE SHIELD IS NOT CONNECTED TO THE TRANSDUCER HOUSING.	
INPUT VOLTAGE, RECOMMENDED	15	V AC OR DC
INPUT VOLTAGE, MAXIMUM	18	V AC OR DC

INPUT (A-C, A POSITIVE, A=RED, C=BLACK)
RESISTANCE 350.8 OHMS INCL 10 M CABLE

OUTPUT (B-D, D POSITIVE, B=WHITE, D=GREEN)
RESISTANCE 349.7 OHMS INCL 10 M CABLE

TEMPERATURE RANGE -40 TO +100 /DEG.

TEMPERATURE EFFECT (-10 TO +50 DEG. C)
ON OUTPUT +-0.0015 % OUTPUT/DEG. C
ON ZERO BALANCE +-0.003 % R.O./DEG. C

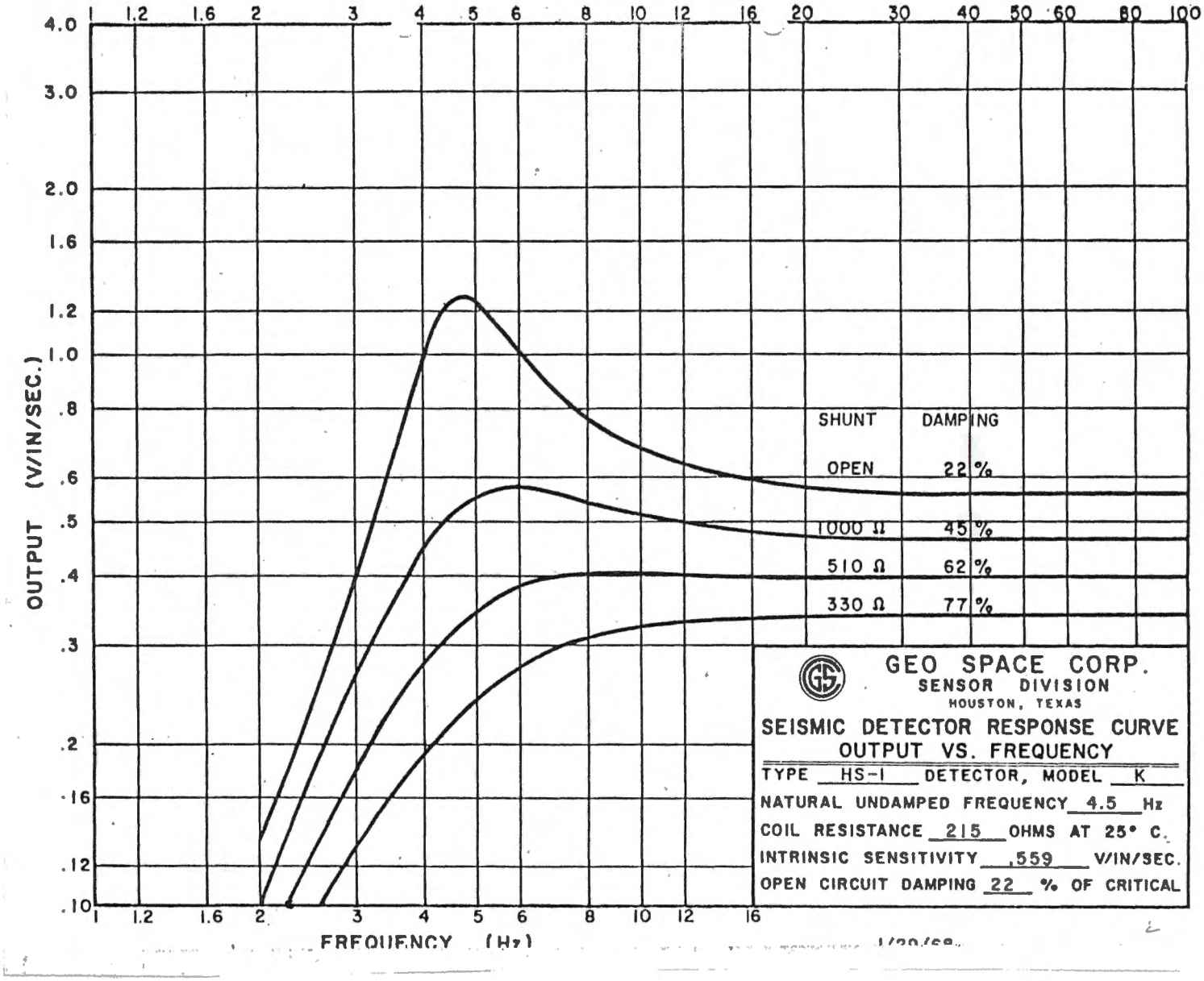
RATED OUTPUT(R.O.) (TOLERANCE 0.1%)	2.000	MV/V INPUT
NONLINEARITY (BEST FIT THROUGH ZERO)	+-0.02	% R.O.
ZERO BALANCE	0.65	% R.O.
CREEP 0-5 MINUTES	-0.01	% R.O.
CALIBRATION VALUES (TOLERANCE 0.1%)		
40 KOHMS CORRESPOND TO	21.413	MP
80 KOHMS CORRESPOND TO	10.734	MP

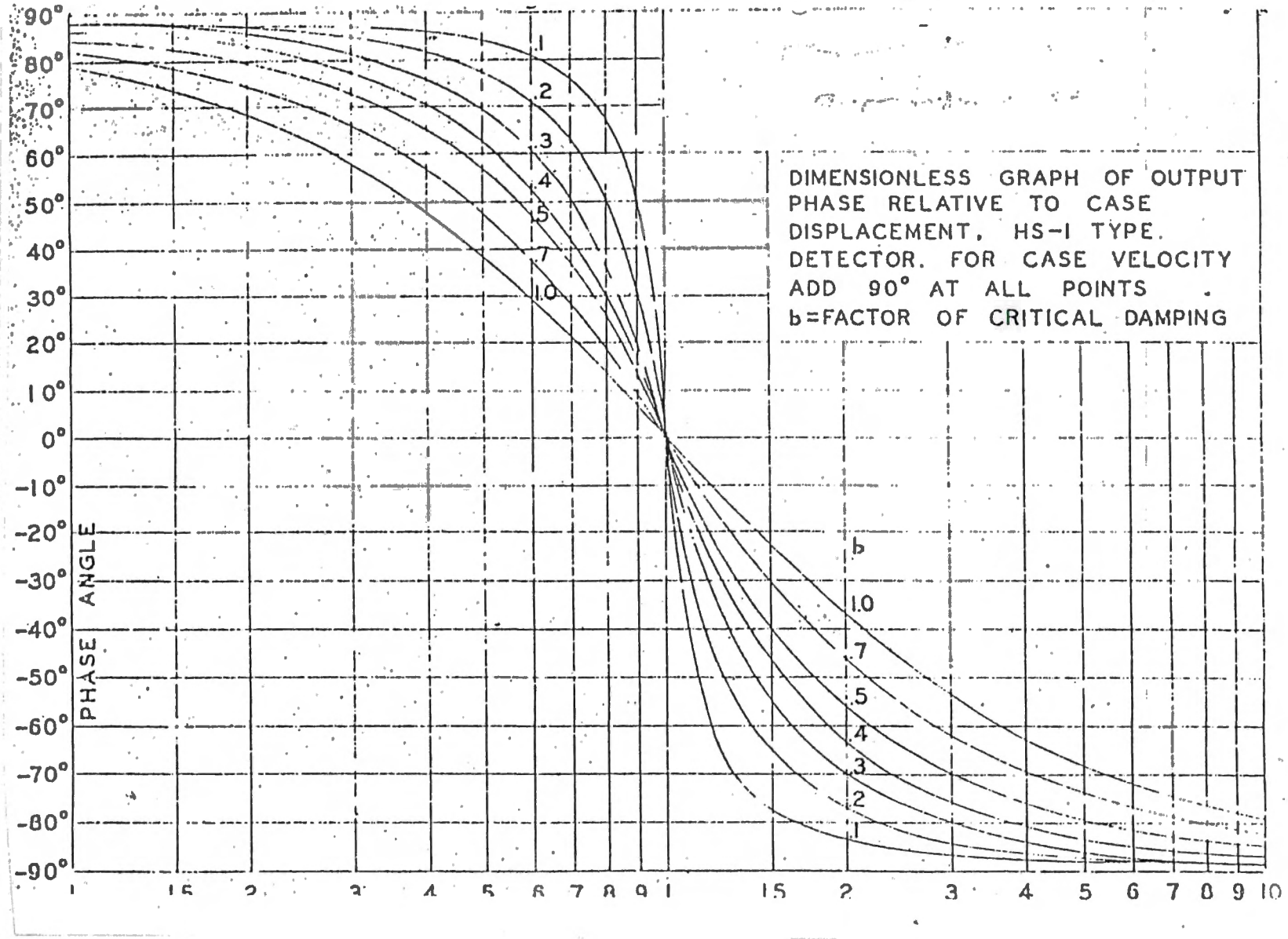
THE VALUES INDICATED FOR OUTPUT VOLTAGE AND CALIBRATION VALUES ARE APPLICABLE AT OPEN CIRCUIT AND WITHOUT EXTERNAL BALANCING RESISTORS AND WITH A CONNECTING CABLE OF THE INDICATED LENGTH.

AB BOFORS, ELECTRONICS DIVISION
S-69020 BOFORS, SWEDEN

BOFORS 82-09-02

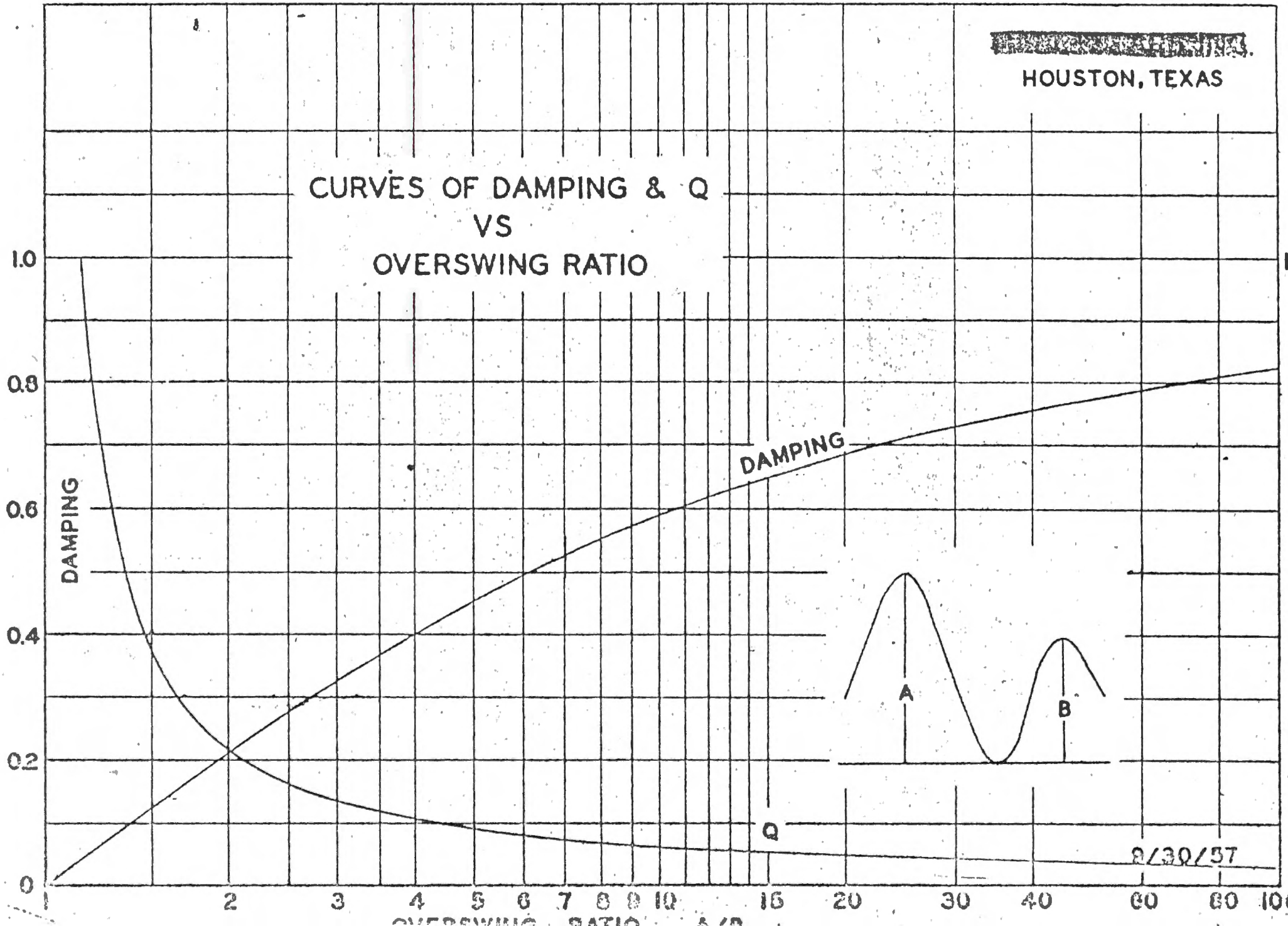
Stig Jansson


4.0
3.0
2.0
1.6
1.2
1.0
.8
.6
.5
.4
.3
.2
.16
.12
.10
OUTPUT (V/IN/SEC.)
1 1.2 1.6 2 3 4 5 6 8 10 12 16 20 30 40 50 60 80 100
1 1.2 1.6 2 3 4 5 6 8 10 12 16
FREQUENCY (Hz)
SHUNT DAMPING
OPEN 22 %
1000 Ω 45 %
510 Ω 62 %
330 Ω 77 %
GEO SPACE CORP.
SENSOR DIVISION
HOUSTON, TEXAS
SEISMIC DETECTOR RESPONSE CURVE
OUTPUT VS. FREQUENCY
TYPE HS-1 DETECTOR, MODEL K
NATURAL UNDAMPED FREQUENCY 4.5 Hz
COIL RESISTANCE 215 OHMS AT 25° C.
INTRINSIC SENSITIVITY .559 V/IN/SEC.
OPEN CIRCUIT DAMPING 22 % OF CRITICAL


DIMENSIONLESS GRAPH OF OUTPUT PHASE RELATIVE TO CASE DISPLACEMENT, HS-1 TYPE. DETECTOR. FOR CASE VELOCITY ADD 90° AT ALL POINTS .
b=FACTOR OF CRITICAL DAMPING
PHASE ANGLE
90°
80°
70°
60°
50°
40°
30°
20°
10°
0°
-10°
-20°
-30°
-40°
-50°
-60°
-70°
-80°
-90°
1
.2
.3
.4
.5
.7
1.0
b
1.0
.7
.5
.4
.3
.2
.1
1
1.5
2
3
4
5
6
7
8
9
10

[redacted]
HOUSTON, TEXAS

CURVES OF DAMPING & Q VS OVERSWING RATIO

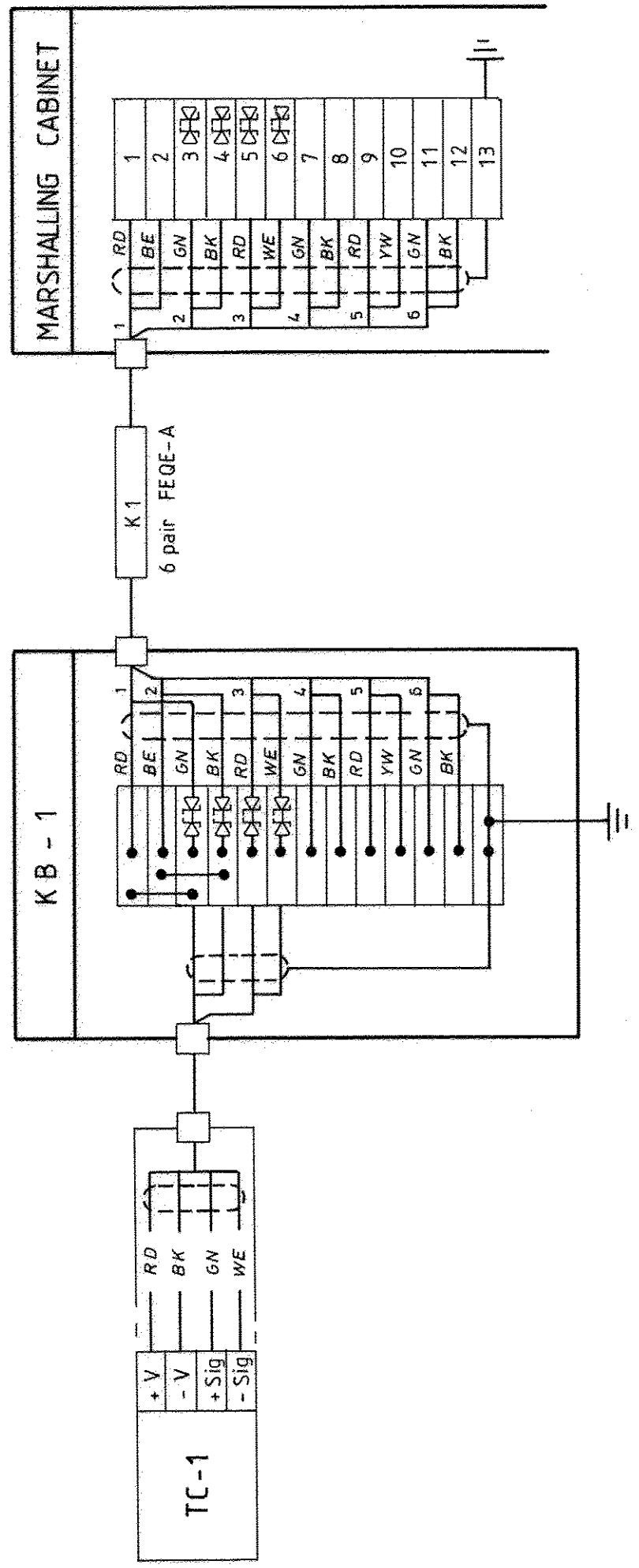


NGI

A P P E N D I X C

C1	Wiring diagram.	Load cell at top of test embankment.
C2	Wiring diagram.	Steel mast at top of test embankment.
C3	Wiring diagram.	High tension cables crossing the avalanche path. East side.
C4	Wiring diagram.	Concrete structure in the avalanche path.
C5	Wiring diagram.	High tension cables crossing the avalanche path. West side.

Skj.nr. 036. 1-83. 20000. Reclamo



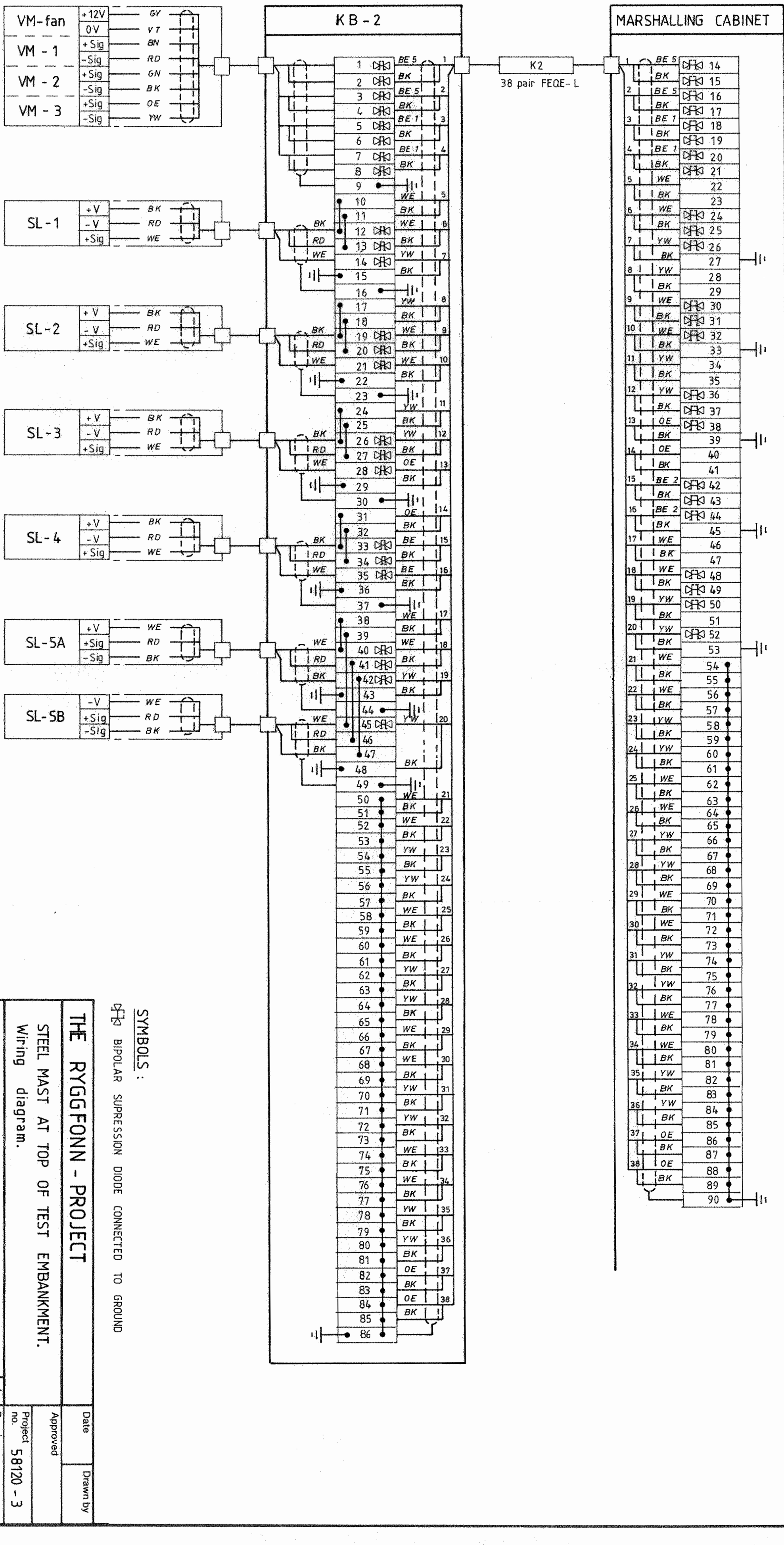
SYMBOLS :

BIPOLAR SUPRESSION DIODE CONNECTED TO GROUND

THE RYGGFONN - PROJECT	Date	Drawn by
	Approved	
LOAD CELL AT TOP OF TEST EMBANKMENT. Wiring diagram.	Project no. 58120 - 3	
Norwegian Geotechnical Institute	Drawing no. C1	

Skjema nr. 0005E. 12-82. 1000. Reclamo

Skjema nr. 003E. 12-82. 1000. Reclamo



SYMBOLS :

BIPOLAR SUPRESSION DIODE CONNECTED TO GROUND

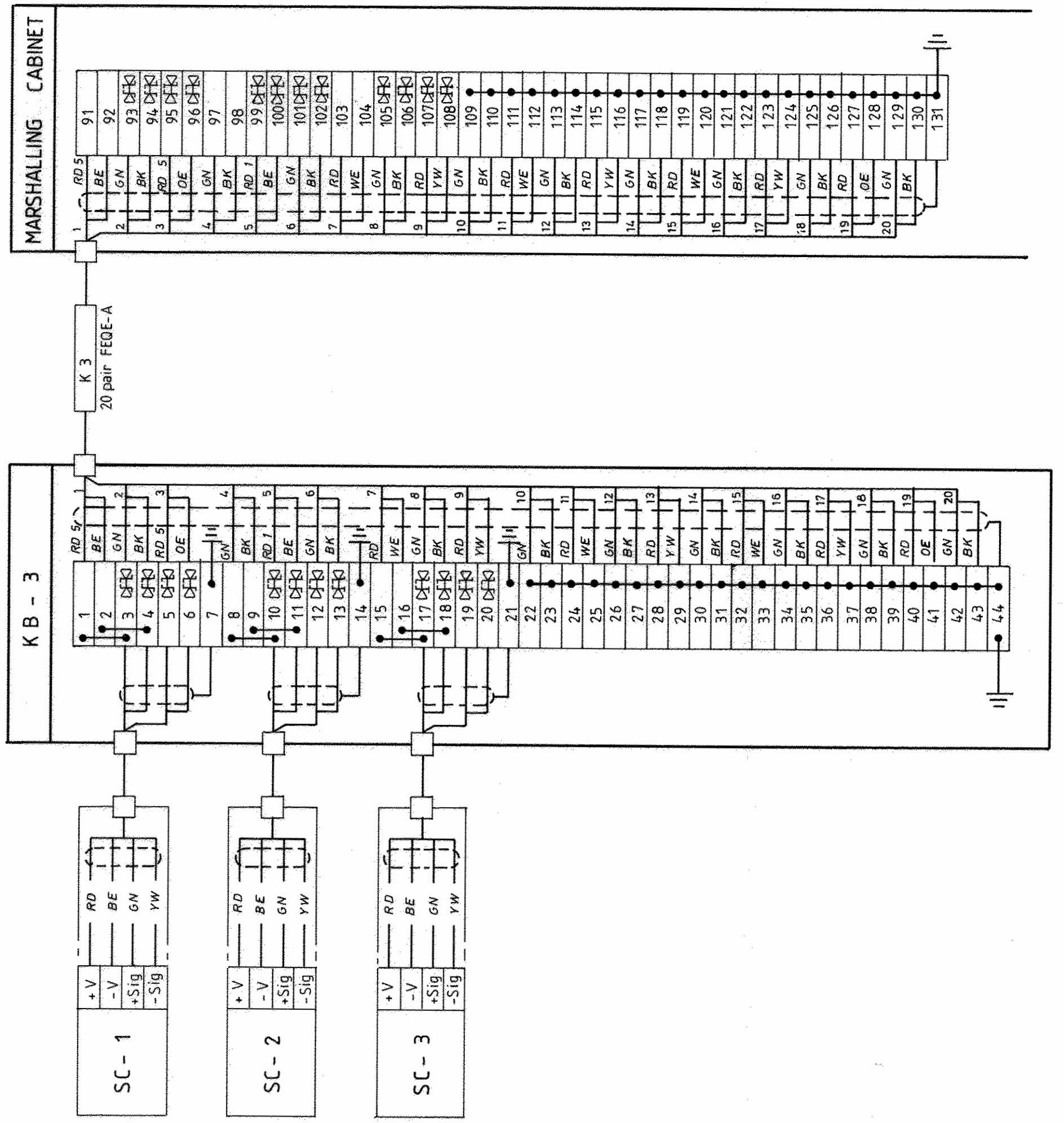
THE RYGGFONN - PROJECT

STEEL MAST AT TOP OF TEST EMBANKMENT.

Wiring diagram.

Norwegian Geotechnical Institute

Date	Drawn by
Approved	
Project no.	58120 - 3
Drawing no.	C2

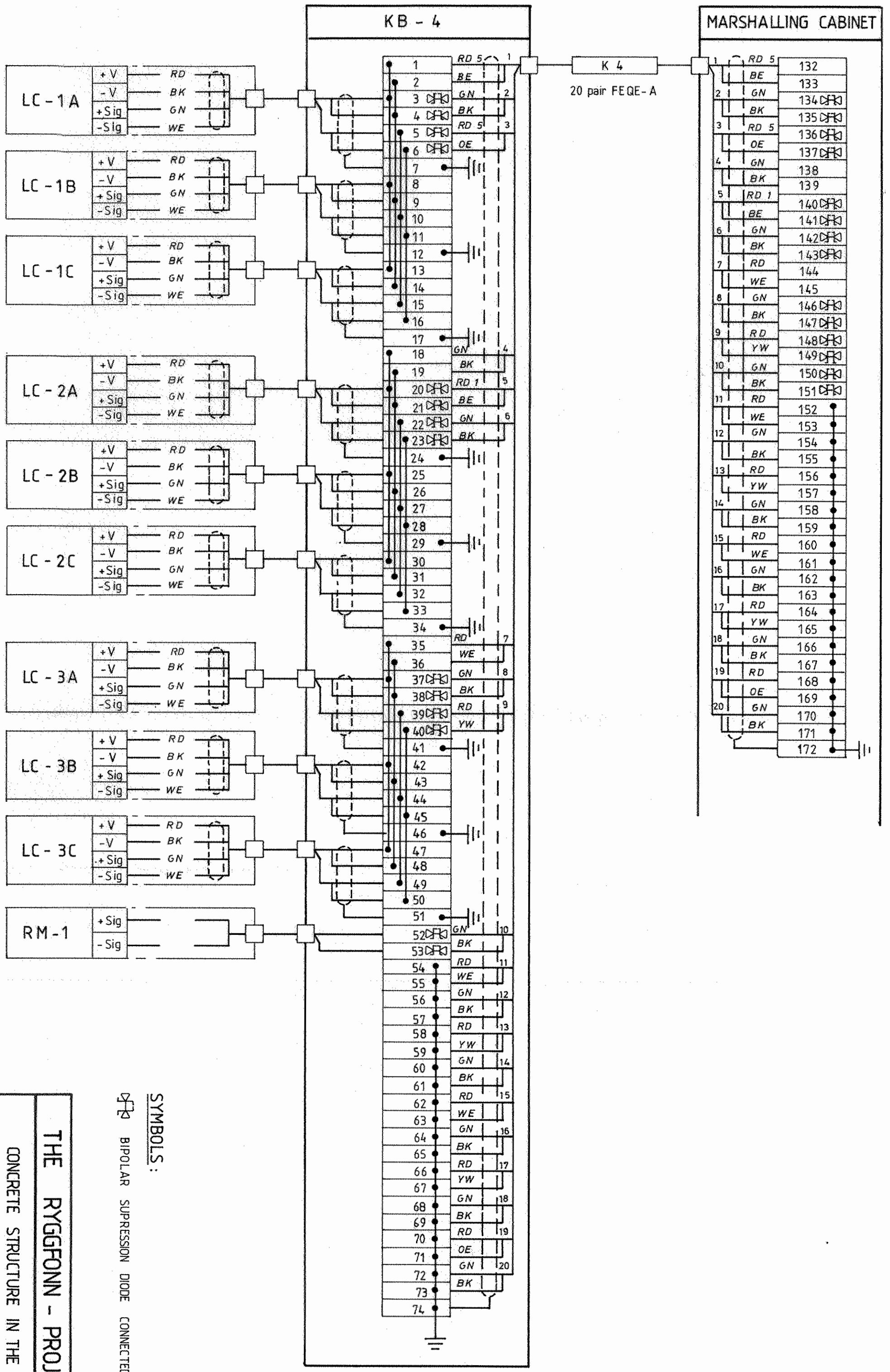


SYMBOLS:

BIPOLAR SUPRESSION DIODE CONNECTED TO GROUND

THE RYGGFONN - PROJECT	Date	Drawn by
HIGH TENSION CABLES CROSSING THE AVALANCHE PATH EAST MAST Wiring diagram	Approved	
	Project no. 58120 - 3	
Norwegian Geotechnical Institute	Drawing no. C 3	

Skjema nr. 003E. 12-82. 1000. Reclamo



SYMBOLS:

BIPOLAR SUPRESSION DIODE CONNECTED TO GROUND

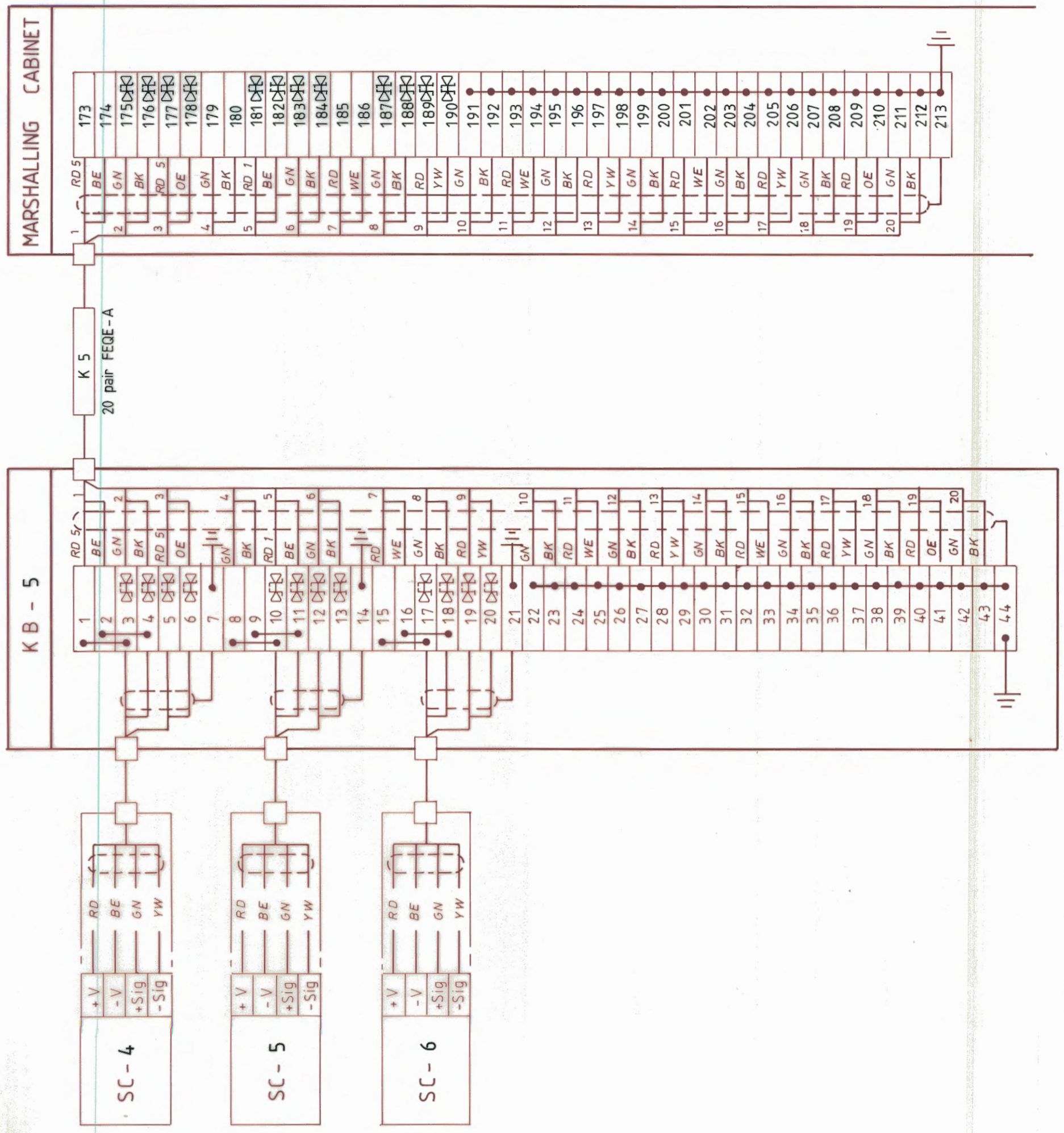
THE RYGGFONN - PROJECT

CONCRETE STRUCTURE IN THE AVALANCHE PATH

Wiring diagram

Norwegian Geotechnical Institute

Date	Drawn by
Approved	
Project no. 58120 - 3	
Drawing no. C 4	



SYMBOLS:

BIPOLAR SUPRESSION DIODE CONNECTED TO GROUND

THE RYGGFONN - PROJECT	Date	Drawn by
HIGH TENSION CABLES CROSSING THE AVALANCHE PATH. WEST MAST. Wiring diagram.	Approved	
Norwegian Geotechnical Institute	Project no. 58120 - 3	
	Drawing no. C5	