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THREE-COMPONENT MOLECULAR-ELECTRONIC BROADBAND SEISMOMETER CME-6111

TECHNICAL PASSPORT AND OPERATION MANUAL

Model	CME-6111
Serial number	000___
Frequency band	60 sec – 50 Hz
Sensitivity	2000 V/(m/sec)

Outgoing inspection:	__.__.2020	
	Date	Signature
Delivery:		
	Date	Signature

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1. Introduction

The three-component molecular-electronic broadband seismometer CME-6111 is designed for registration of ground motion in three orthogonal directions.

The device is primarily intended for use on stationary seismic stations, but can also be used in the field measurements. The seismometer CME-6111 has an analog output (voltage output signal is proportional to the velocity of external signal) and the operation requires connection to an analog-to-digital recorder (not supplied in the delivery set).

The sensing elements of molecular-electronic (electrochemical) type are very rugged and are not equipped with arresters and other special devices for handling, packing, unpacking and transportation. Unlike traditional broadband seismometers, the molecular-electronic instrument does not require mass centering and thus does not have mass position outputs and centering inputs. The seismometer does not require superfluous leveling and will be fully functional within installation tilts up to 15°.

The seismometer contains three identical high-sensitive molecular-electronic sensors (a.k.a. transducers) rotated by 120° in horizontal plane symmetrically and installed with 45° tilt. Each transducer is equipped with a force-balance feedback which can serve as a calibration coil. Output signals proportional to the velocity of the ground motion in the **Vertical** (V) and in two horizontal **North** (N) and **East** (E) directions are formed by an electronic summation of signals from transducers with the corresponding coefficients.

Being exposed to an external mechanical force due to the seismic motion of the ground, the working fluid inside the transducers (a concentrated electrolyte solution) is moved between the electrodes of the sensing cells, bringing to or drawing away from them ions of the dissolved substance. Convective flow of charged ions causes an electrical response at the electrodes. The electrical response is amplified and converted by the electronic unit into an electrical output voltage proportional to the velocity of external action (ground motion).

Power requirements: unipolar DC source with 12 V DC nominal voltage and permissible range from 10.5 to 16 V DC. Current consumption depends on the level of the detected seismic signals and is usually less than 35 mA at nominal voltage. During a short settling period after power-up the current consumption may increase up to 150 mA. It is desirable to use either a stabilized power source or a battery. The device is protected from reverse power supply polarity.

Due to permanent technical improvement and modernization of the products, changes which are not described in this manual and which do not affect the conditions of installation, operation and technical characteristics can be introduced in the design.

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The delivery set contains the following:

- molecular-electronic broadband seismometer;
- cable with connector (standard cable length – 1.5 m);
- dust protective cap for connector (mounted on top cover);
- leveling feet legs – 3 sets;
- this manual.

The seismometer is not explosive, toxic and is not a source of environmental pollution.

2. Installation and Connection

The seismometer has an arrow, two pointers, three adjustable feet and a bubble level to ensure its proper installation. By means of the adjustable feet and the bubble level, the seismometer can be centered horizontally even if the surface is far from the ideally leveled. The best way to do this is to screw the feet into the bottom as far as possible in order to minimize the distance between the earth's surface and the sensor. The seismometer is fully functional at tilt angles up to 15°.

Place the seismometer on the base and orient it so that the arrow would point to the North. To ensure the alignment along the North-South direction, use the pointers at the bottom of the sensor. Align the sensor horizontally by means of the adjustable legs. Once you have the sensor leveled, fix the feet by locking them with the knurled discs.

See "The installation hints" Appendix A to this manual for the details.

Connect cable wires (see "The Cable Marking" Appendix B) to the power source and data recorder according to the following Table:

+POWER	+12V of the power source
-POWER (GND)	"-" of the power source, the wire has a connection to the sensor's Signal ground inside the seismometer
GND	Signal ground, connect to the data recorder
+V (Vertical), -V, +N (North), -N, +E (East), -E	Channels outputs, connect to the differential inputs of the data recorder
Calibr Enable	Apply +3..+12V to enable calibration mode Leave floating or tie to GND to disable calibration mode
Calibr input	Test signals input; (Apply test signals of 1 Vp-p amplitude)
U_X_OUT V_Y_OUT W_Z_OUT	Test output of the transducers. Output signals are present only in calibration mode

Apply voltage from the power source. No special means like mass unlock or mass centering is needed.

3. Operation

If the seismometer is unpacked, installed and connected as instructed above, the instrument will be operational within 10-20 min. Within first 24 hours, depending on the ambient conditions, the noise level will be little higher and sparse spikes may occur in output signal. This is normal for settling.

The seismometer is protected from variations in temperature and atmospheric pressure. This is sufficient to maintain operability of the device in most cases including field measurements. A styrofoam box could be used as an additional protection. Operating temperature is from –12 to +55°C (–40 to +55°C for low-temp make).

In accordance with the International Protection Marking the protection degree for this device is **IP 65** – Dust-tight, Water jets (*complete protection against contact; water projected in powerful jets against the enclosure from any direction shall have no harmful effects*).

According to NEMA 250-2003 standard, the device corresponds to **NEMA TYPE 4** (*to provide a degree of protection to personnel against access to hazardous parts; to provide a degree of protection of the equipment inside the enclosure against ingress of solid foreign objects (falling dirt and windblown dust; to provide a degree of protection with respect to harmful effects on the equipment due to the ingress of water (rain, sleet, snow, splashing water, and hose directed water); and that will be undamaged by the external formation of ice on the enclosure.*).

The seismometer must not be immersed into water or installed in flooded places without additional protection.

4. Calibration

The seismometer is factory calibrated and adjusted (with a typical precision of ± 0.5 dB) to provide a velocity-flat response over the pass band with the -3 dB slope at the edges of the frequency band. To check the device consistency, a procedure of self-calibration may be used.

Before starting the self-calibration, make sure the power supply voltage is within 12 ± 0.5V. Apply +3..12V with respect to GND to "**Calibr Enable**" terminal. The device enters the self-calibration mode. Each transducer has a built-in calibration coil with a current amplifier. In the self-calibration mode the current amplifier is connected to an external signal source via the "**Calibr input**" pin. The response of the system can be measured by applying different sinusoidal signals at frequencies across the system's passband. The recommended voltage swing for the calibration signal is 1 $V_{p\text{-}p}$.

The output signals can be seen both at the transducers outputs (U_X_OUT, V_Y_OUT, W_Z_OUT) and on the orthogonal outputs (+V (**Vertical**), -V, +N (**North**), -N, +E (**East**), -E). The derived calibration curve represents unitless response charts and shows only the shape of the amplitude-frequency characteristic. Meanwhile to verify the actual sensor's sensitivity, a simultaneous record should be made with a reference sensor of known sensitivity.

5. Transportation and Storage

The seismometer is very rugged and virtually impervious to damage during transportation. Nevertheless, it is recommended to avoid abrupt impacts to exclude possible negative influence to the seismometer. Use package provided with the seismometer or any standard packing materials to prevent damage to the connector or scratching of the case. Use the connector cap to protect the output connector from damage during transportation.

The storage temperature range is – 15 to + 70 °C (+5 to +158 °F) (for low-temperature version: – 40 .. +70°C (-40 to 158 °F). The short time (~ 4 hours) storage temperatures a little below or above these limits are permissible.

It is strongly recommended to fix the seismometer vertically during transportation. Transportation upside down or on the side can cause a long-lasting period –over 24 hours- after which the seismometer gets operational with a minimum self-noise level from the moment of its installation and switching on.

6. Warranty and Service

The warranty period of the device is 18 months. Within this period the device which proves defective should be returned to the manufacturer for free repair or replacement. Unless otherwise stated by the selling agreement, all transport expenses are to be borne by the buyer.

This warranty shall remain valid provided there are no signs of opening and/or external damage to the housing resulting from abnormal use of the device.

After this period the regular repairing charges will apply.

7. Manufacturer

Country of origin: The Russian Federation.

Manufacturer: **LLC "R-sensors" (ООО "Р-сенсорс"),** INN(VAT) 5008037570

Manufacturer address: 8A, Zhukovskogo Street, Dolgoprudny,
Moscow region, 141701, Russia.

Manufacturer contacts: Phone: +7-498-744-6995, +7-499-707-7657,
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8. TECHNICAL CHARACTERISTICS of the seismometer CME-6111 version 01

Sensitivity in the passband	**2000** V/(m/sec)
Output type	analog, differential
Number of orthogonal components	3 (Vertical, North, East)
Clip level	± 15 V (or ± 7.5 mm/sec)
Passband (by -3dBs level)	0.0167 Hz (60 sec) – 50 Hz
Power supply voltage	12 V DC , unipolar (10.5 V – 16 V permissible)
Consumption (Current consumption)	below 35 mA at 12 V DC in steady-state
Max. installation tilt	± 15°
Temperature range	– 12..+55°C
Output impedance	2*500 Ohm
Dynamic range	134 dB
Self noise at 1 Hz	1.4 nm/sec
Housing material	duraliminium/stainless steel
Housing dimension – diameter	204 mm (8,0315 in)
Height	210 mm (8,2677 in)
Weight	7.2 kg (18.87 lbs)
Self noise	see plot below
Connector type on the housing	MS3102E-20-27P (14 pin hermetical)
Connector type on the cable	MS3106E-20-27S (14 pin)

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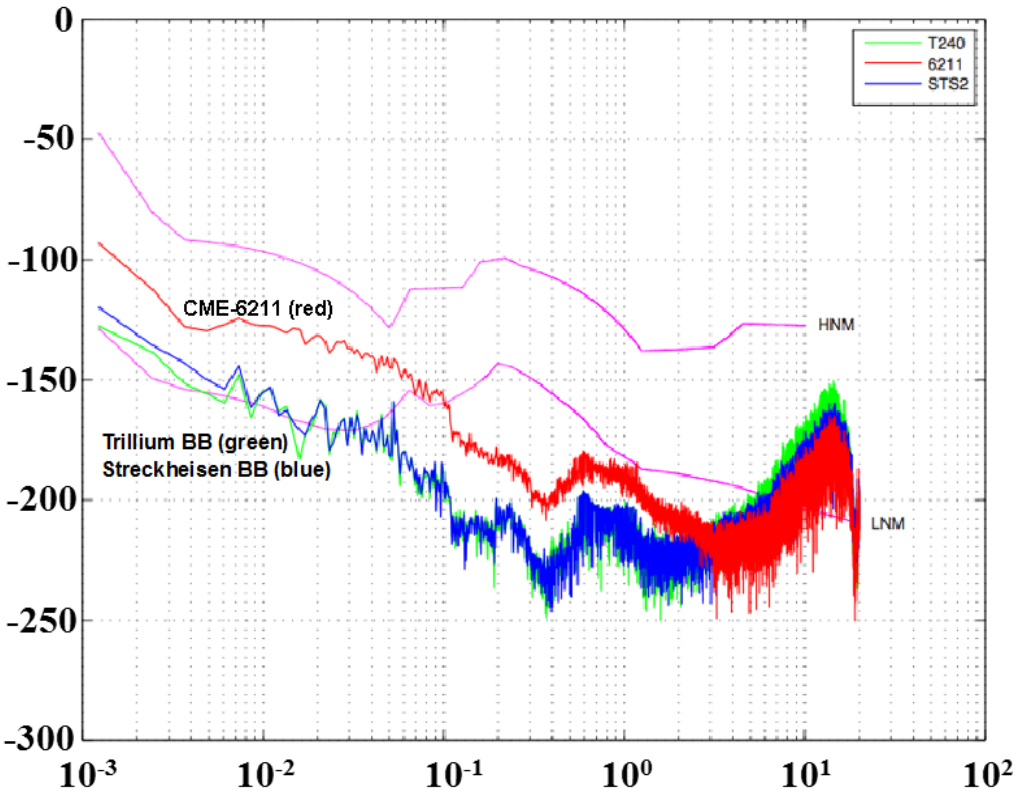
9. Noise plot for the seismometer CME-6111 version 01



Source: ***Incorporated Research Institutions for Seismology (IRIS), Program for Array Seismic Studies of the Continental Lithosphere (PASSCAL) instrument center and EarthScope USArray array operations facility , 2010***

Fig 1. CME-6111 (CME-6211) noise spectrum density

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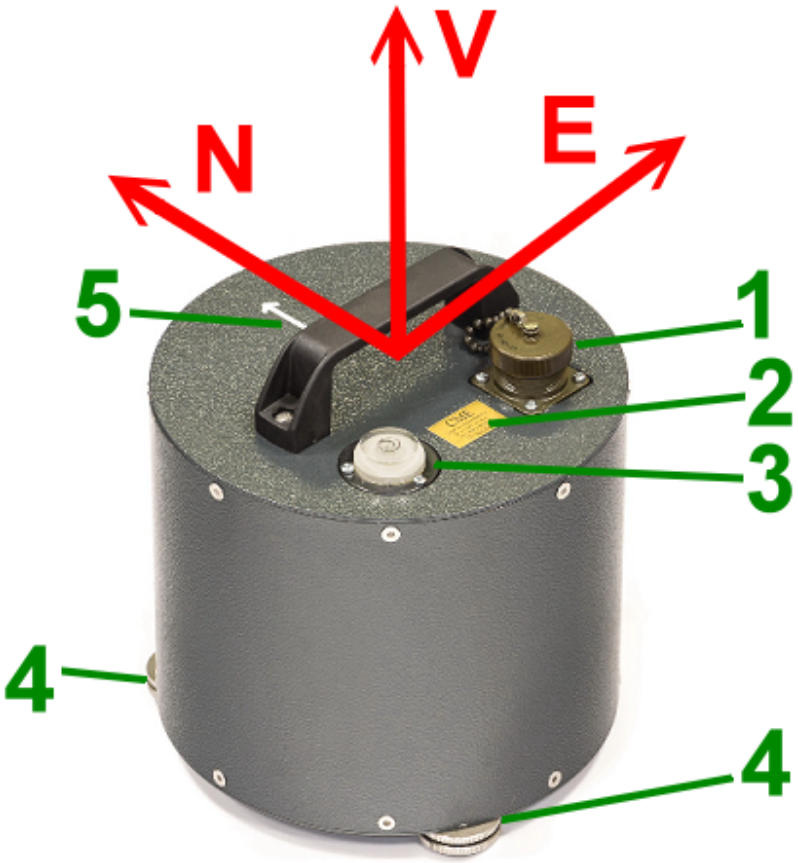
APPENDIX A

THE SEISMOMETER'S OVERVIEW



Marked on the figure :

"V,N,E" in red – axis of sensitivity

"1" – Output connector, the protective cap is installed
"2" – Serial number plate
"3" – Bubble level
"4" – Leveling feet
"5" – North direction arrow

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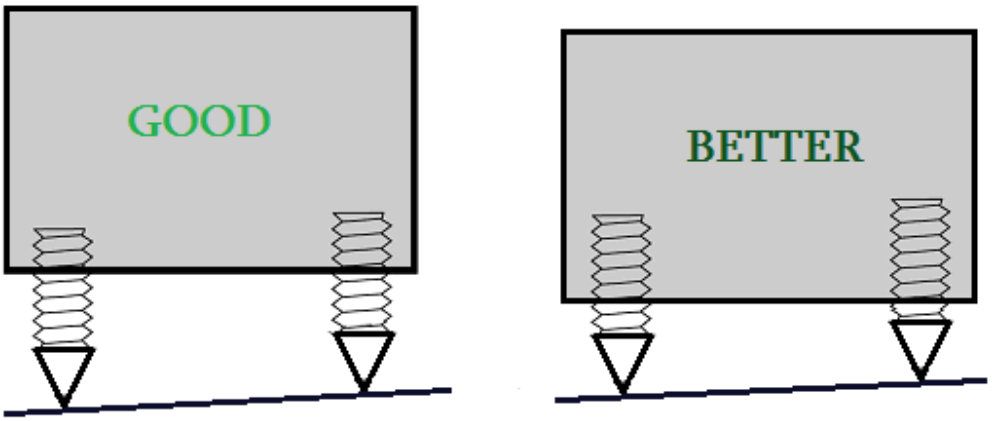
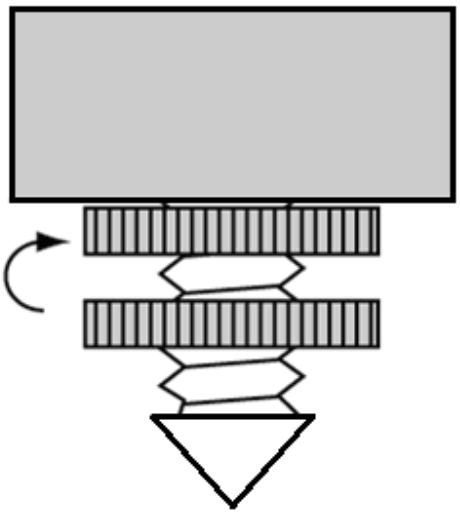
ISTALLATION HINTS

1. Screw the feet into the bottom as far as possible in order to minimize the distance between the earth's surface and the sensor.



2. Once you have the sensor leveled, fix the feet by locking them with the knurled discs.



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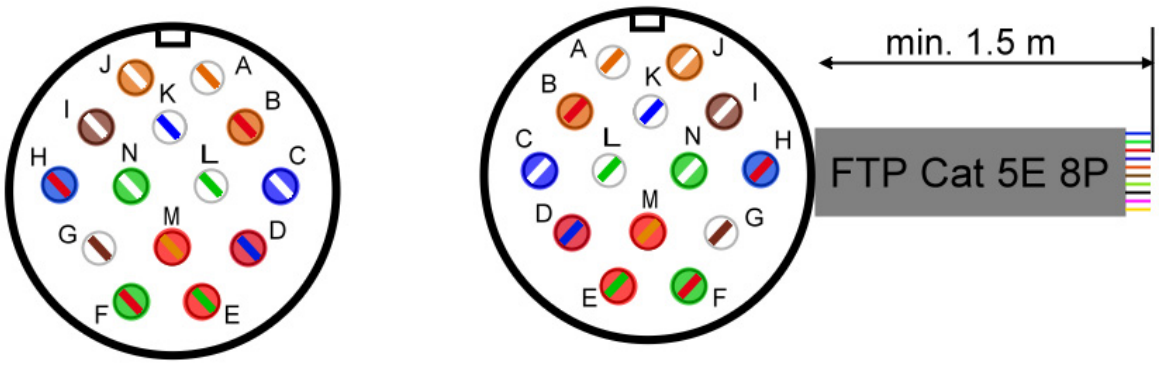
APPENDIX B

CABLE MARKING



Sensor connector
MS3102E-20-27P

Cable connector
MS3106E-20-27S

Standard cable

A	-EAST	White-orange
B	Calibr input	Orange (with red)
C	+NORD	Blue (with white)
D	+POWER	Red (with blue)
E	V_Y_OUT	Red (with green)
F	W_Z_OUT	Green (with red)
G	U_X_OUT	White-brown
H	-POWER(GND)	Blue(with red)
I	GND	Brown (with white)
J	+EAST	Orange (with white)
K	-NORD	White-blue
L	-VERTICAL	White-green
M	Calibr Enable	Red (with orange)
N	+VERTICAL	Green (with white)

Fig. 1 Connector pinout and cable colors assignment

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APPENDIX C

WIRING SUGGESTIONS

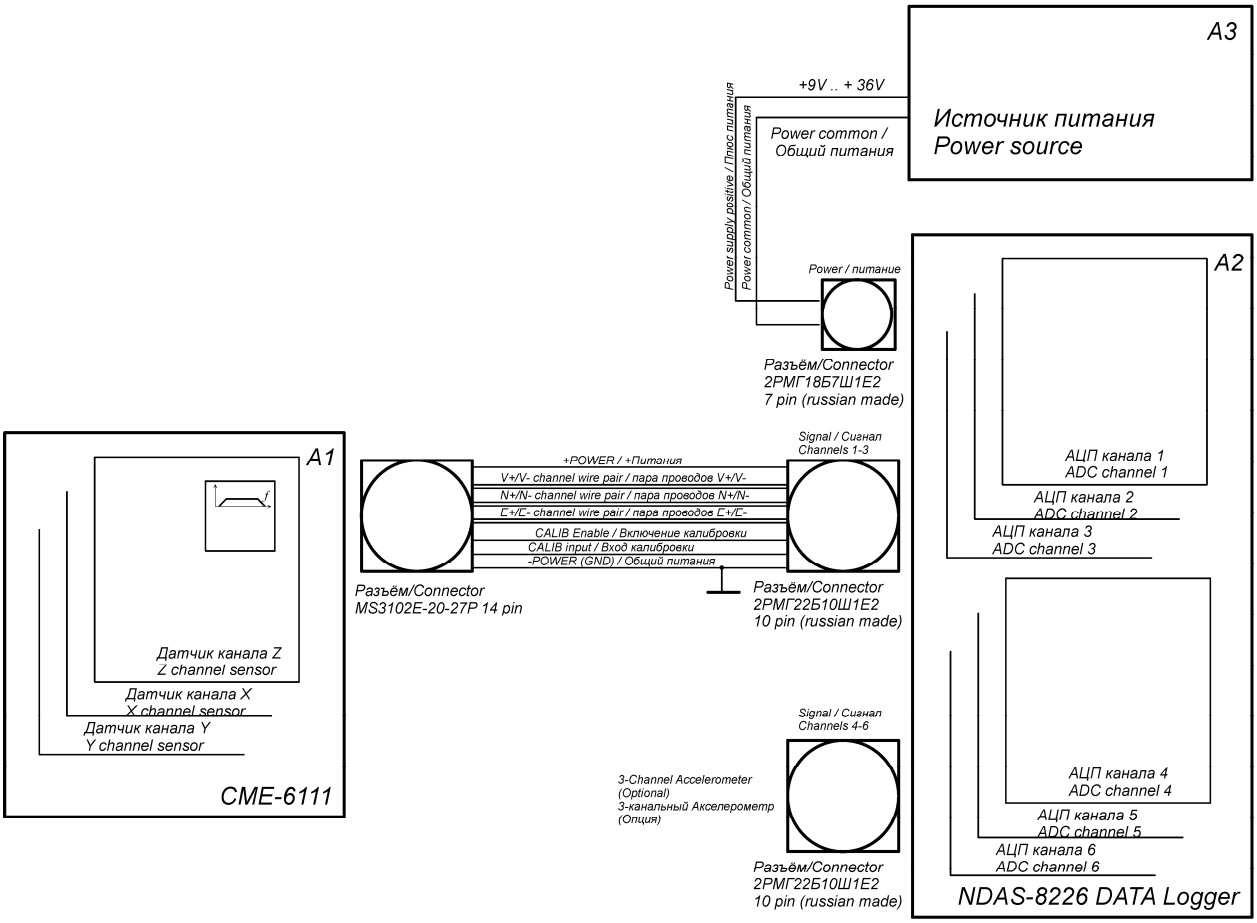

Diagram 1 Wiring suggestion for NDAS-8226 Data logger

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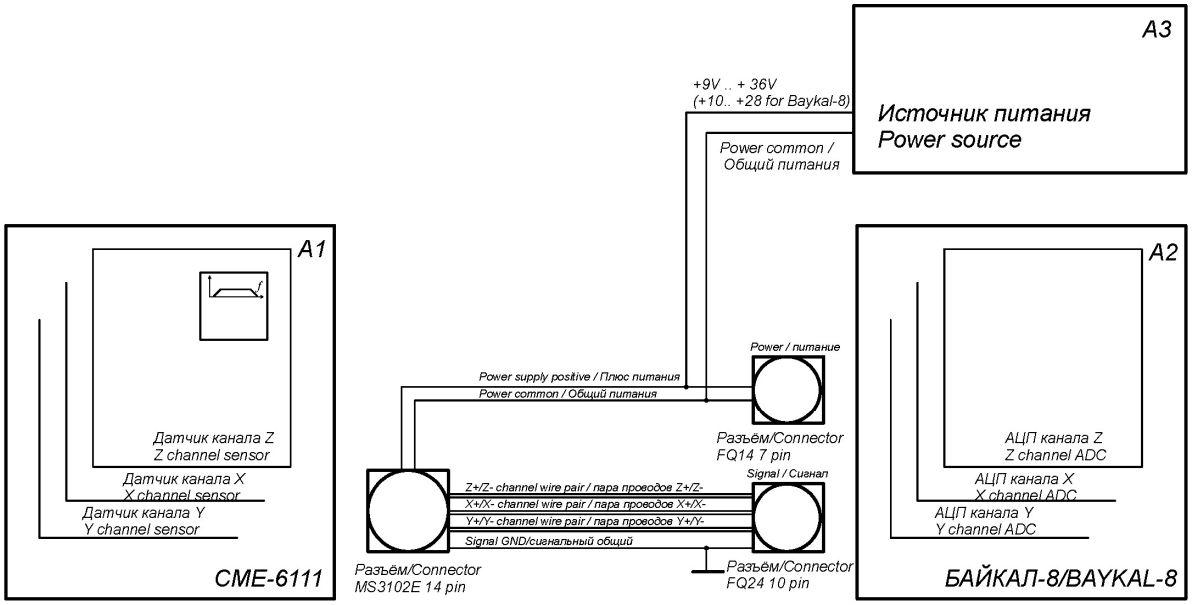

Diagram 2 Wiring suggestion for BAYKAL-8 Data logger

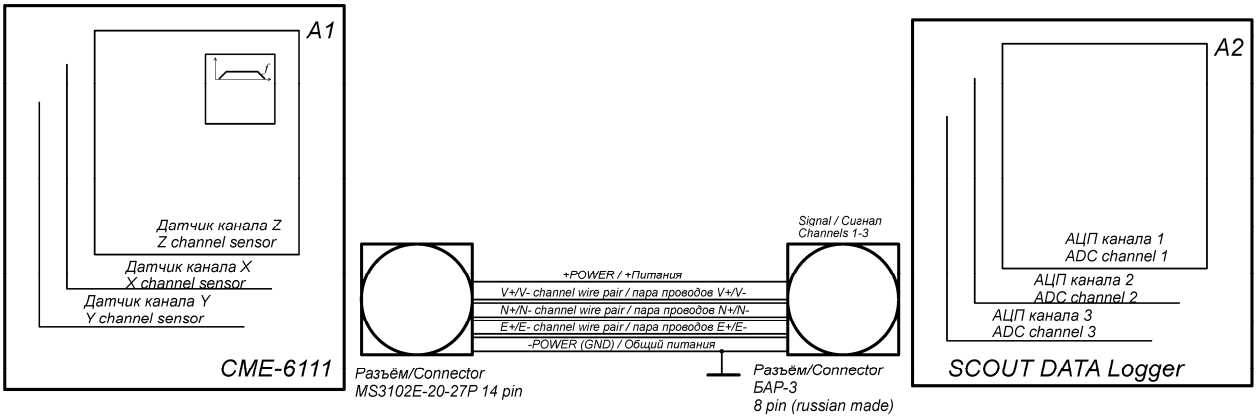

Diagram 3 Wiring suggestion for SCOUT Data logger

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SENSOR CABLE WIRING LISTS

CME-6111 Pin no	Signal	NDAS-8226 Pin no.	BAYKAL-8 Pin no.	Taurus** Pin no.	Delta-03*** Pin no.	SCOUT Pin no.
A	-EAST	6	6	P	7	7
B	Calibr Input	10		N	16[VI]	
C	+NORD	3	3	A	5	4
D	+POWER	9	External*	F	19	8
E	V_Y_OUT					
F	W_Z_OUT					
G	U_X_OUT					
H	-POWER(GND)	8	External*	D	17	1
I	GND		9	D	3	
J	+EAST	5	5	A	8	6
K	-NORD	4	4	S	4	5
L	-VERTICAL	2	2	C	1	3
M	Calibr Enable	7		Z	16 [VI]	
N	+VERTICAL	1	1	U	2	2

Notes:

* - External connection from the power supply
** - Verify with **Taurus Portable Seismograph User Guide** for proper connection and setup
*** -Verify with Delta-03 **Seismic recorder User Guide** (ИТЛЯ.416611.004 РЭ) for proper connection
[VI] – Connect both wires together, only Pulse response available