Upper Silesian Regional Seismic Network (GRSS)

General information

Mining operations have been conducted in the Upper Silesian Coal Basin (USCB) for more than 200 years. The USCB in Poland is one of the most seismically active mining areas in the world. Seismic observations supported by the Central Mining Institute (GIG) date back to the 1950s. More than 60 000 mine tremors of local magnitude $M_L \geq 1.5$ (energy E $\geq 10^5$ J) occurred over the period 1974 to 2014 (Fig 1a). The GRSS seismic network, currently consists of 10 seismic stations continuously recorded seismic events in the area of USCB. Local magnitude of the strongest mining seismic events exceed level of 4,2. The main tasks of the GRSS seismic network is continuous monitoring & processing seismic events and assessment of seismic hazard in the Upper Silesia Coal Basin and cooperation in this respect with local authorities and the mining industry. Data Center for registration and analysis of the seismic events is located in the Central Mining Institute (GIG) – Katowice, Poland. Additionally, local velocity model for MIS GRSS as well as tectonic maps is also available.

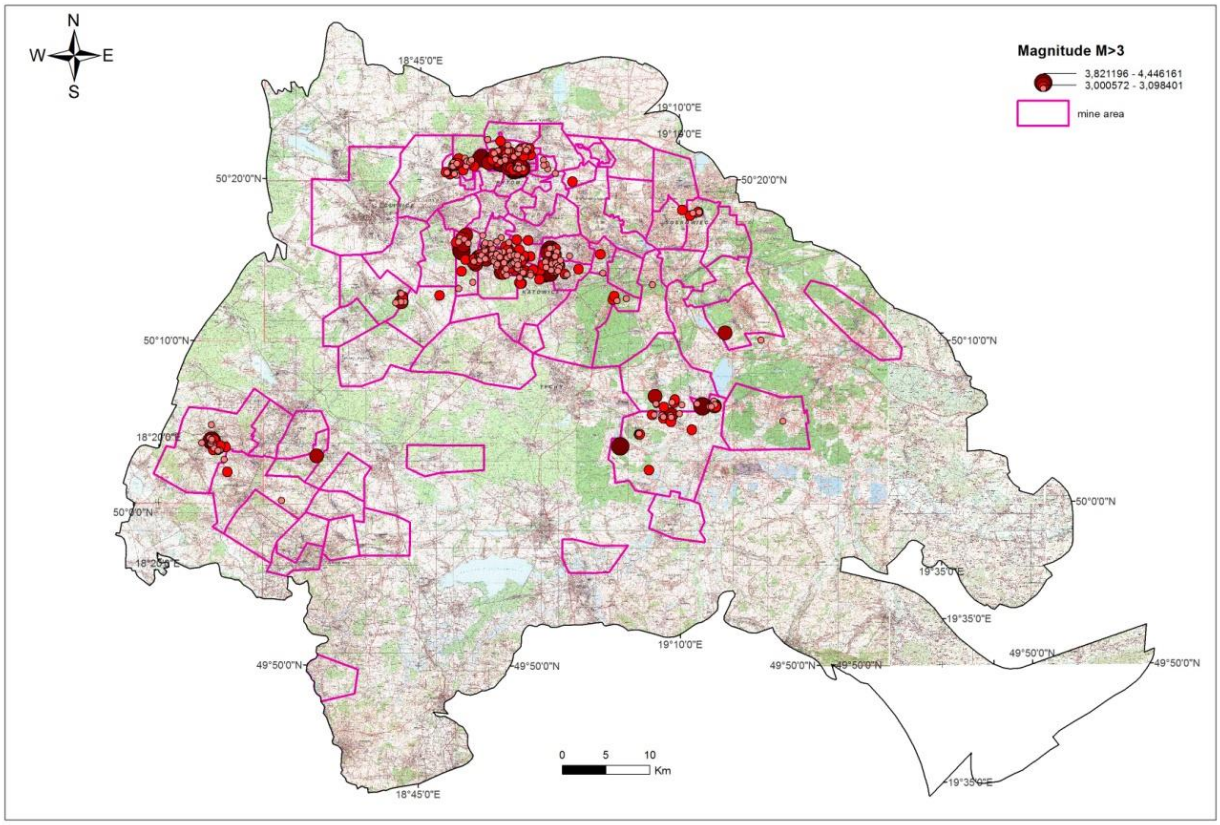


Fig.1a. Mining induced seismic events in Upper Silesian Coal Basin with local magnitude M_L>3.0 for the last 30 years

The MIS GRSS seismic network

The thirst analogue-optical seismic stations of Upper Silesian Regional Seismological Network (GRSS) were deployed in the end of 50s of the twentieth century. Since than GRSS monitor seismicity in the Upper Silesia Coal Basin in its Polish part. In 2010, the GRSS received new 10 seismic stations to the continued digital recording of seismic events. 10 seismic field stations located in Upper Silesia Coal Basin (part in Poland) (fig,1b) consist of:

1. *10 triaxial velocity sensor VE-53 BB (Band width: 0,2 to 160 Hz, Dynamic range: >120 dB (1-30 Hz), 10 GPS*
2. *10 Digitizer GMS-18 (dynamic > 130 dB (manufactured by GeoSIG)*
3. *Data Center in GIG (Communication PC, Processing PC, Archive PC, storage capacity : 6TB)*

Data set: location and magnitude, continuous and triggered waveforms - format *mini SEED*

Codes and geographical coordinates of GRSS seismic stations

No	Name	B	L	Z
449	JAN	50.0854	19.3465	266
450	BAL	50.1654	19.3924	300
451	CZE	50.0171	19.1091	243
452	PLA	50.2894	18.9938	319
453	GLI	50.3038	18.6916	242
454	MAK	50.2663	18.7663	227
455	LAZ	50.1397	18.8775	308
456	MUR	50.1907	19.0444	351
458	MAR	50.0411	18.4890	285
464	HUB	50.3903	18.8946	290

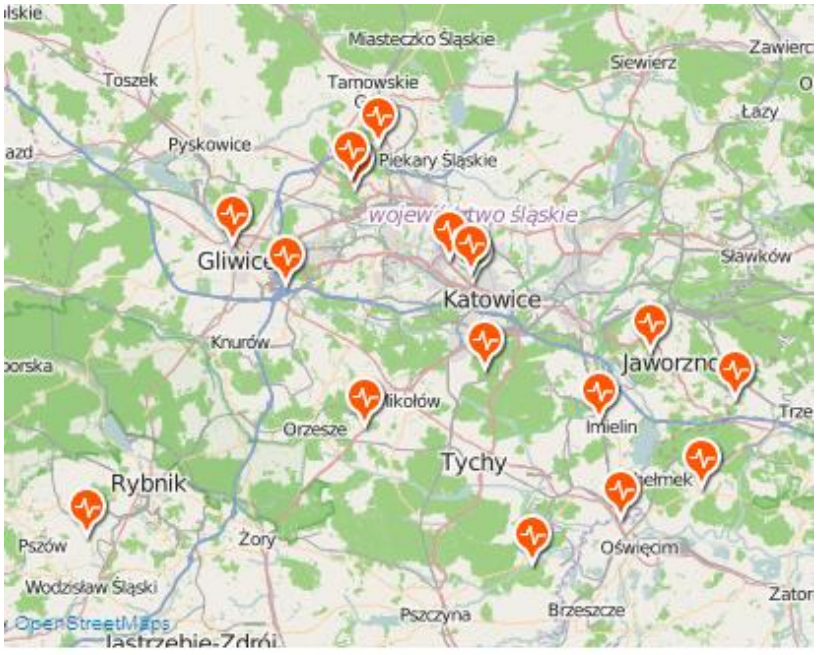
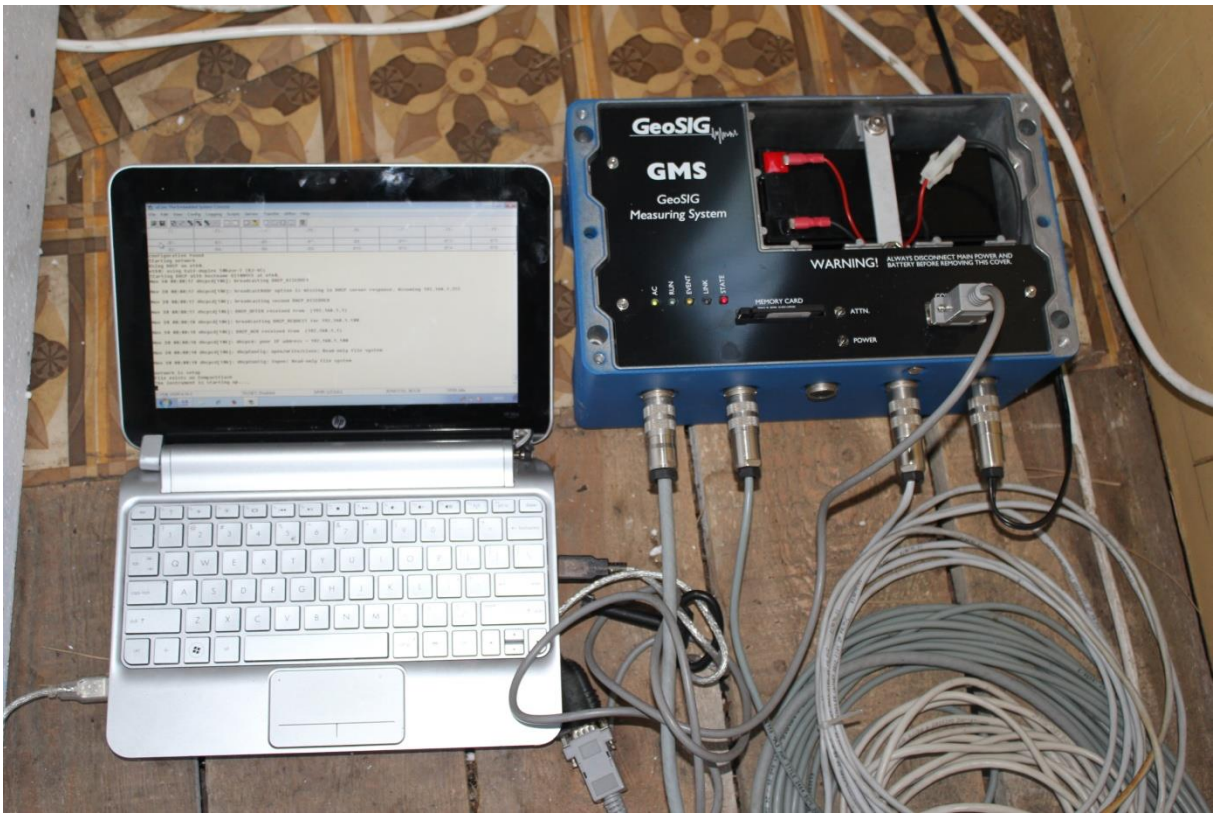


Fig.1b. Localisation of GRSS seismic stations in the Upper Silesia Coal Basin (www.grss.gig.eu)

Photos below show the seismic stations of GRSS



Calibration of a vibrations' registration apparatus used within the GRSS seismic network

Calibration measurements of the apparatus used within the GRSS were conducted by the method of a vibration table and consisted of:

a) calibration and measurement of amplitude-frequency characteristics of the measurement sensors
b) calibration and measurement of amplitude-frequency characteristics of the particular measurement channels (sensor together with measurement apparatus) for a signal of a constant frequency and constant acceleration or velocity of the vibrations

Ad a) Calibration of the small (up to 0.5 kg) measurement sensors is performed using the vibration table together with a set of a controlling apparatus. The sensor is being excited to sinusoidal vibrations by a vibration table BK 4808 controlled by a generator BK 1052 through a power amplifier BK 2712. Apart from the investigated accelerometer, there is a controlling sensor 4343 located on a tabletop. The signal from it is transmitted as a feedback to a controlling generator, through a charge amplifier BK 2626 and a concurrent filter BK 5888.

The feedback's scheme is intended to maintain the table's vibrations according to the presumed parameters. The applied measurement system is controlled systematically using the model vibrations' sensor BK 4371.

The sensors were excited to vibrations with a constant frequency and a constant amplitude of acceleration or velocity, and their voltage was recorded on their output. Results were processed digitally in order to calculate their coefficients of sensitivity and plot amplitude - frequency characteristics.

Calibration of large measurement sensors (over 0.5 kg) is performed by replacing the vibrations exciter of BK 4808 type with a one of the TIRA GmbypeH S50101/L type, equipped with a power amplifier TIRA GmbH type BA1000, operating in a following measurement system:

Vibrations exciter of TIRA GmbH type S50101/L

1. Power amplifier of TIRA GmbH type BA1000.
2. Power supply system of a TIRA GmbH Type FPS vibrations exciter
3. Panel TMC-2 TIRA GmbH Type TMC N
4. Module of a generator of a type 3160-A-042
5. Laptop computer DELL with a software BK3629
6. Accelometer of the BK 4371 type
7. Charge amplifier of the BK 2647 type

Basic parameters of this measurement set:

- Frequency range: from 1 Hz to 7000Hz
- Maximum load of the table: 25kg
- Maximum displacement (peak-peak): 25,4mm
- Maximum force: 650N

Ad b) Measurement of characteristics of complete measuring channels was performed by setting subsequently the measuring sensors of three components, including a connected measurement apparatus, together with a controlling sensor on the tabletop. In order to determine the coefficient of amplification of the channel of the measurement trace the following characteristics were determined:

- amplitude-frequency characteristics of the measurement sensor
- amplitude-frequency characteristics of the measurement trace, including the A/C converter of the apparatus

Documentation index:

1. Instruction Manual Vibration Transducer Calibration System Type 3629

2. Technical Documentation:

a) Shaker S 50101/LS-80
b) Safety instruction for operating Vibration Test System
c) Amplifier BAA 1000-ET

Figure 2,b,c shows the frequency response of sensor and recorder

Upper Silesian Regional Seismic Network "GRSS"

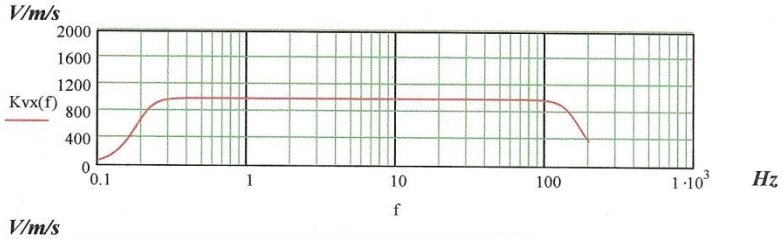
Fig.2a

"GeoSIG" seismic station

Frequency response sensor type VE-53-BB

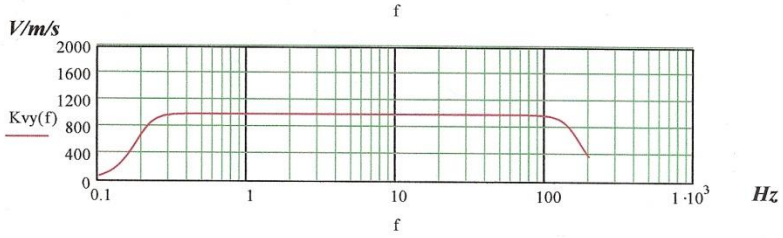
channel 1 comp. X (E-W)

sensitivity for f=10Hz Kvx(10) = 1000



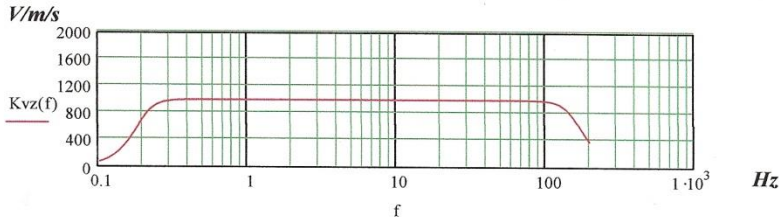
channel 2 comp. Y (N-S)

sensitivity for f=10Hz Kvy(10) = 1000



channel 3 comp. Z (Z)

sensitivity for f=10Hz Kvz(10) = 1000

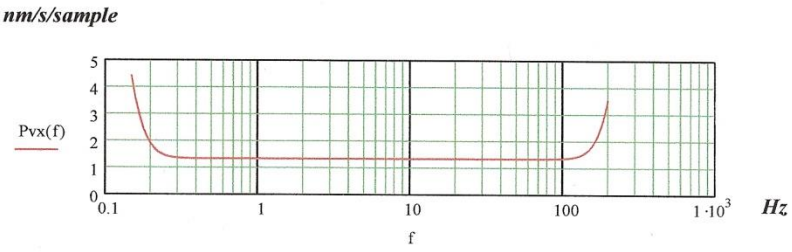


Frequency response sensor and recorder model GMS-18

channel 1 comp. X (E-W)

sensitivity for f=10Hz

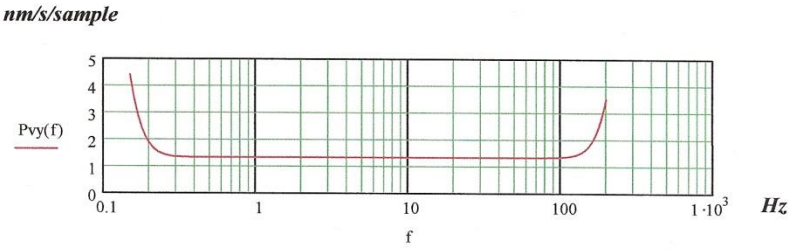
Pvx(10) = 1.32455



channel 2 comp. Y (N-S)

sensitivity for f=10Hz

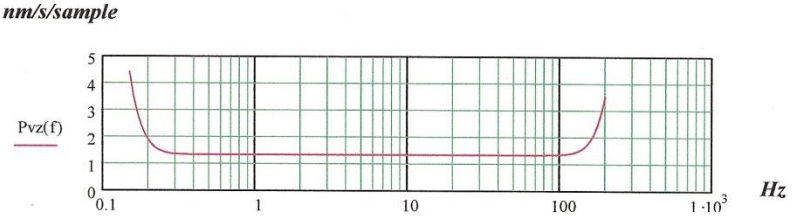
Pvy(10) = 1.32455



channel 1 comp. Z (Z)

sensitivity for f=10Hz

Pvz(10) = 1.32455



Upper Silesian Regional Seismic Network "GRSS"

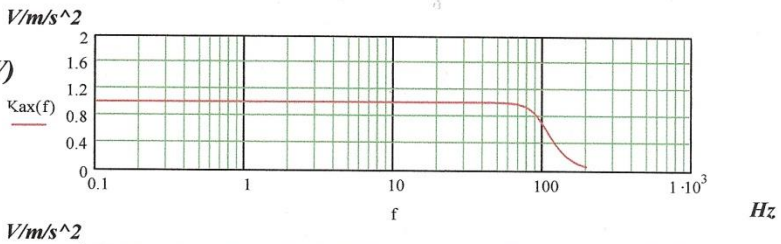
Fig. 2b

"GeoSIG" seismics station

Frequency respons sensor type AC-63

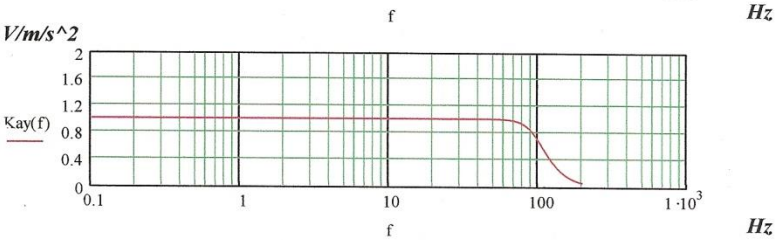
channel 1 comp. X (E-W)

sensitivity for f=10Hz Kax(10) = 1.01928



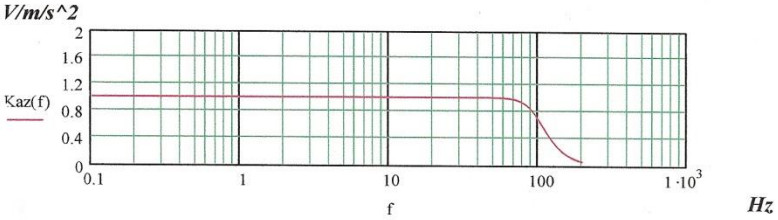
channel 2 comp. Y (N-S)

sensitivity for f=10Hz Kay(10) = 1.01928



channel 3 comp. Z (Z)

sensitivity for f=10Hz Kaz(10) = 1.01928

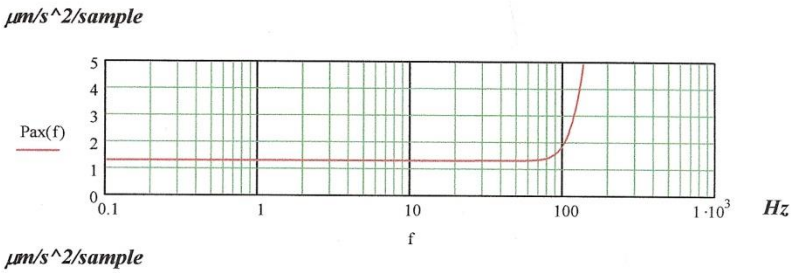


Frequency response sensor and recorder model GMS-18

channel 1 comp. X (E-W)

sensitivity for f=10Hz

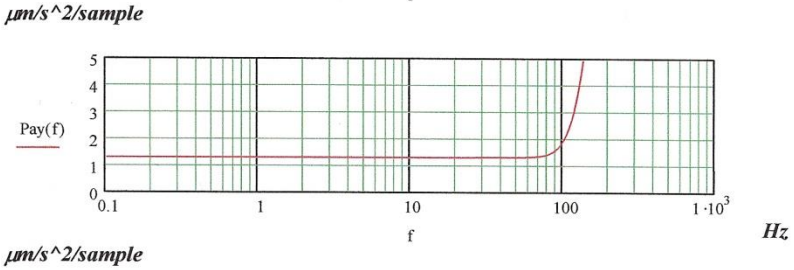
Pax(10) = 1.29938



channel 2 comp. Y (N-S)

sensitivity for f=10Hz

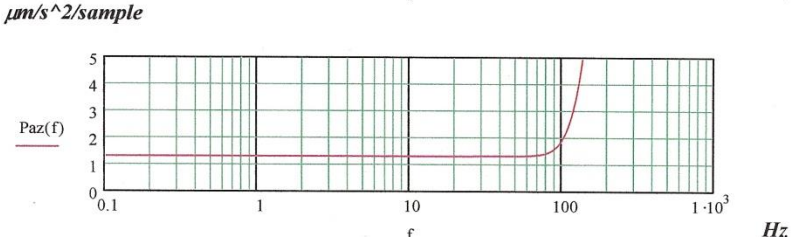
Pay(10) = 1.29938



channel 3 comp. Z (Z)

sensitivity for f=10Hz

Paz(10) = 1.29938



Upper Silesian Regional Seismic Network "GRSS"

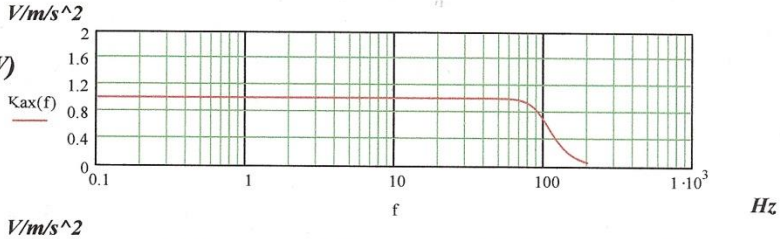
Fig. 2c

"GeoSIG" seismic station

Frequency response sensor type AC-63-DH

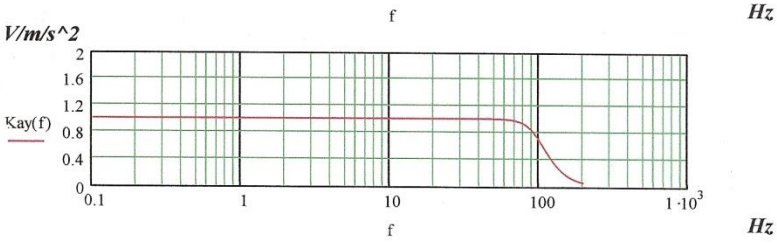
channel 1 comp. X (E-W)

sensitivity for f=10Hz Kax(10) = 1.01928



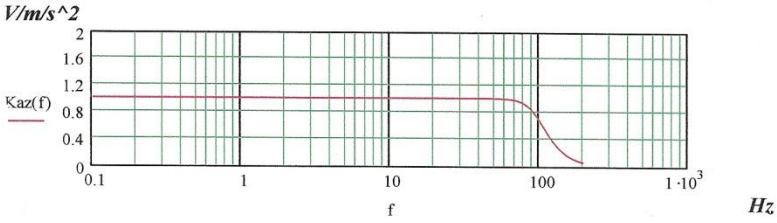
channel 2 comp. Y (N-S)

sensitivity for f=10Hz Kay(10) = 1.01928



channel 3 comp. Z (Z)

sensitivity for f=10Hz Kaz(10) = 1.01928

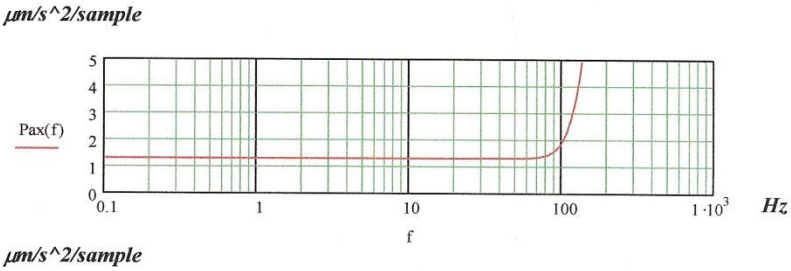


Frequency response sensor and recorder model GMS-18

channel 1 comp. X (E-W)

sensitivity for f=10Hz

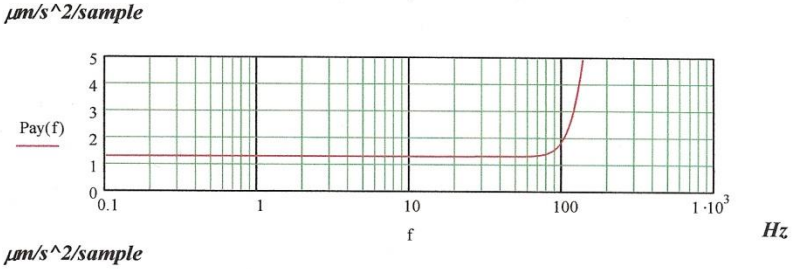
Pax(10) = 1.29938



channel 2 comp. Y (N-S)

sensitivity for f=10Hz

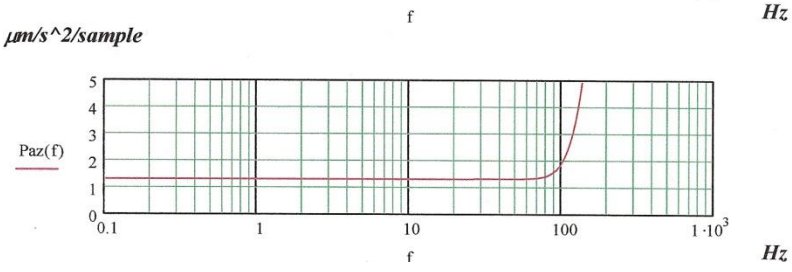
Pay(10) = 1.29938



channel 3 comp. Z (Z)

sensitivity for f=10Hz

Paz(10) = 1.29938



The tables below show detailed parameters of seismic stations

Station *JAN*

Seismic station no.	**449**		
Location	**Chrzanów**		
Seismic sensor type	**VE-53-BB**		
Parameter	**Velocity, mm/s**		
Geographical coordinates	**B**	**L**	**Z**
	50,0854	**19,3465**	**266**
Components	**N-S**	**E-W**	**Z**
Channel no.	**C10**	**C11**	**C12**
Polarity of P-wave motion *	**N ↑+**	**W ↑+**	**Z↑+**
Sensitivity (sample/mm/s)**	**754973**		

*** - direction of positive polarity (+)**

**** - amplitude – frequency characteristics – figure 2a**

Station *BAL*

Seismic station no.	**450**		
Location	**Balin**		
Seismic sensor type	**VE-53-BB**		
Parameter	**Velocity, mm/s**		
Geographical coordinates	**B**	**L**	**Z**
	50,1654	**19,3924**	**300**
Components	**N-S**	**E-W**	**Z**
Channel no.	**C13**	**C14**	**C15**
Polarity of P-wave motion *	**N ↑+**	**W ↑+**	**Z↑+**
Sensitivity (sample/mm/s)**	**754973**		

*** - direction of positive polarity (+)**

**** - amplitude – frequency characteristics – figure 2a**

Station *CZE*

Seismic station no.	**451**		
Location	**Czeczott**		
Seismic sensor type	**VE-53-BB**		
Parameter	**Velocity, mm/s**		
Geographical coordinates	**B**	**L**	**Z**
	50,0171	**19,1091**	**243**
Components	**N-S**	**E-W**	**Z**
Channel no.	**C01**	**C02**	**C03**
Polarity of P-wave motion *	**N ↑+**	**W ↑+**	**Z↑+**
Sensitivity (sample/mm/s)**	**754973**		

*** - direction of positive polarity (+)**

**** - amplitude – frequency characteristics – figure 2a**

Station *PLA*

Seismic station no.	**452**		
Location	**Katowice**		
Seismic sensor type	**VE-53-BB**		
Parameter	**Velocity, mm/s**		
Geographical coordinates	**B**	**L**	**Z**
	50,2894	**18,9938**	**319**
Components	**N-S**	**E-W**	**Z**
Channel no.	**C16**	**C17**	**C18**
Polarity of P-wave motion *	**N ↑+**	**W ↑+**	**Z↑+**
Sensitivity (sample/mm/s)**	**754973**		

*** - direction of positive polarity (+)**

**** - amplitude – frequency characteristics – figure 2a**

Station *GLI*

Seismic station no.	**453**		
Location	**Gliwice**		
Seismic sensor type	**VE-53-BB**		
Parameter	**Velocity, mm/s**		
Geographical coordinates	**B**	**L**	**Z**
	50,3038	**18,6916**	**242**
Components	**N-S**	**E-W**	**Z**
Channel no.	**C04**	**C05**	**C06**
Polarity of P-wave motion *	**N ↑+**	**W ↑+**	**Z↑+**
Sensitivity (sample/mm/s)**	**754973**		

*** - direction of positive polarity (+)**

**** - amplitude – frequency characteristics – figure 2a**

Station *MAK*

Seismic station no.	**454**		
Location	**Radlin**		
Seismic sensor type	**VE-53-BB**		
Parameter	**Velocity, mm/s**		
Geographical coordinates	**B**	**L**	**Z**
	50,2663	**18,7663**	**227**
Components	**N-S**	**E-W**	**Z**
Channel no.	**C19**	**C20**	**C21**
Polarity of P-wave motion *	**N ↑+**	**W ↑+**	**Z↑+**
Sensitivity (sample/mm/s)**	**754973**		

*** - direction of positive polarity (+)**

**** - amplitude – frequency characteristics – figure 2a**

Station *LAZ*

Seismic station no.	**455**		
Location	**Radlin**		
Seismic sensor type	**VE-53-BB**		
Parameter	**Velocity, mm/s**		
Geographical coordinates	**B**	**L**	**Z**
	50,1397	**18,8775**	**308**
Components	**N-S**	**E-W**	**Z**
Channel no.	**C28**	**C29**	**C30**
Polarity of P-wave motion *	**N ↑+**	**W ↑+**	**Z↑+**
Sensitivity (sample/mm/s)**	**754973**		

*** - direction of positive polarity (+)**

**** - amplitude – frequency characteristics – figure 2a**

Station *MUR*

Seismic station no.	**456**		
Location	**Murcki**		
Seismic sensor type	**VE-53-BB**		
Parameter	**Velocity, mm/s**		
Geographical coordinates	**B**	**L**	**Z**
	50,1907	**19,0444**	**351**
Components	**N-S**	**E-W**	**Z**
Channel no.	**C22**	**C23**	**C24**
Polarity of P-wave motion *	**N ↑+**	**W ↑+**	**Z↑+**
Sensitivity (sample/mm/s)**	**754973**		

*** - direction of positive polarity (+)**

**** - amplitude – frequency characteristics – figure 2a**

Station *MAR*

Seismic station no.	**458**		
Location	**Radlin**		
Seismic sensor type	**VE-53-BB**		
Parameter	**Velocity, mm/s**		
Geographical coordinates	**B**	**L**	**Z**
	50,0411	**18,4890**	**285**
Components	**N-S**	**E-W**	**Z**
Channel no.	**C25**	**C26**	**C27**
Polarity of P-wave motion *	**N ↑+**	**W ↑+**	**Z↑+**
Sensitivity (sample/mm/s)**	**754973**		

*** - direction of positive polarity (+)**

**** - amplitude – frequency characteristics – figure 2a**

Station *HUB*

Seismic station no.	**464**		
Location	**Radzionków**		
Seismic sensor type	**VE-53-BB**		
Parameter	**Velocity, mm/s**		
Geographical coordinates	**B**	**L**	**Z**
	50,3903	**18,8946**	**290**
Components	**N-S**	**E-W**	**Z**
Channel no.	**C07**	**C08**	**C09**
Polarity of P-wave motion *	**N ↑+**	**W ↑+**	**Z↑+**
Sensitivity (sample/mm/s)**	**754973**		

*** - direction of positive polarity (+)**

**** - amplitude – frequency characteristics – figure 2a**