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Shake table for seismic sensors

VOLNA

BC4

Operational manual



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Terms and key concepts

Shake table – whole complex

Stand–mechanical part without generator and control unit

Platform–mechanical moving part

Meter - a system of measuring the position of the platform, including the displacement sensor , a frequency converter to a voltage, detector amplitude, peak voltmeter, digital voltmeter , pointer and dial indicator

Application:

Volna Shake Table is designed for sinusoidal vibration of devices such as seismometers and accelerometers, velocimeters with a given amplitude and frequency. The method allows to calibrate the devices in accordance with sensitivity, to determine the fault type mashing, jams, etc. Displacement sensor of stand allows to explore phase-frequency characteristics of the devices.

Complex Construction

1. Generator.
2. Control unit.
3. Shake table with the platform.
4. Power cables of the generator and block.
5. Generator connecting cord (wire), block cord, stand cord , oscilloscope connecting cord.
6. Digital control unit.
7. Micrometer screw.
8. Kit for mounting the stand and platform.

Unpacking, installation

In the transport position, the platform fix to a stationary part by the arresters screws: two attracting and four supporting screws. When caging first crew to until tight the attracting the screws, then screw support a light stop (do not over-tighten - this can ruin the tape suspension). When installing the first unscrew the supporting screws on one - two turns, then attracting -on five or six turns.

Platform can be installed on a firm , level surface, but it should not swing under the influence of the vibration. For better reproducibility of measurements, it is desirable to strengthen the concrete foundation flat metal plate mounted horizontally, and arrange fixtures. When operating at frequencies above 10 Hz, the platform should be attracted to the plate by levers from the mounting kit.

General Provisions

Cables and wire connected to the appropriate connector and put a divider on the control unit to the end position clockwise, turn the power switch block.

Can be connected to the sensor output amplitude with the system of registration of seismic vibrations. Use this connection if you want to see the behavior of the platform itself , for example, to define the oscillations phase or check sinusoidal. Adjustment platform zero is made by the dial indicator. Characteristics and methods are described further in the section control unit.

Amplitude and frequency of oscillations drive from the generator, you can change the amplitude by the lever DIVIDER (ДЕЛИТЕЛЬ). The generator can be disconnected from the amplifier switch on the control unit.

The control unit

Controls and connections

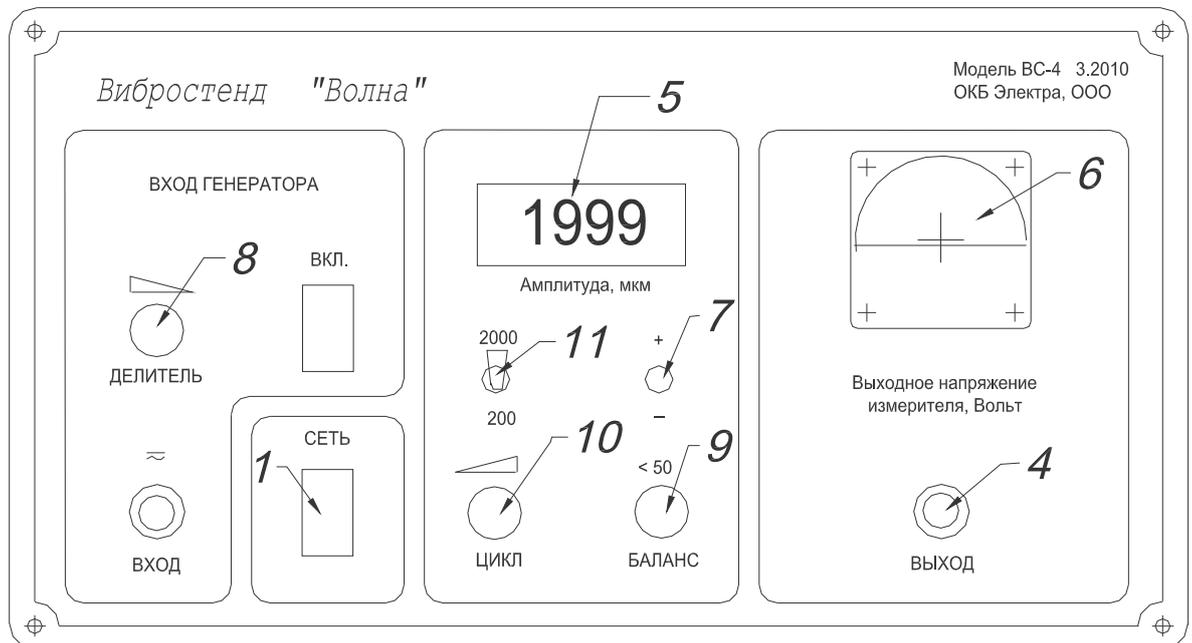


Fig.1. Control unit panel

1. Power switch
2. Electromagnet connector (at the rear)
3. Connector for the measurement of displacement sensor (at the rear)
4. Jack of the output voltage meter
5. Index for amplitudes
6. Point indicator of output of the Meter
7. Button for forced switch polarity index
8. Generator signal depression
9. Handle electronic balancing zero pointer (+/- 50 micrometers)
10. Time control for indication of amplitude of the same polarity
11. Switch of pointer rangers
12. Connector for output voltage control of the amplifiers supplied to the electromagnets (rectangular connector on the rear panel)

Characteristics

Supply voltage of 50 Hz, V	220(+/-10 %)
Frequency range swing of the platform, Hz	0.01 –100
The maximum amplitude of the platform oscillation, мм	+/-2
Operational range, мм	+/-1,5
The maximum voltage of the output of the displacement sensor, V	+/-2
Allowable voltage amplitude of the generator (no more than 5 minutes), V	+/-10
Loading weight for the vertical swing, кг	3,5 – 10,5

Pointer amplitudes:

Maximum indicated value, мкм	+/- 1999, +/-199.9
Maximum measurement error at frequency range in the position 2000, мкм, frequency more then 200 мкм, no more	0,5 -10 Hz +/-20
in position 200, мкм, no more then	+/-10
the error of the reproducibility in the position 2000 мкм , no more then	+/- 5
the same in position , в положении 200, мкм	+/-2
Nonlinearity of the pointer, % от диапазона from the range	2.5
Nonlinearity of the peak- to- peak amplitude , %, no more	1
Period of time of the indication of the amplitude of the same polarity, sec.	1 – 20

About the displacement sensor.

Compensated (differential) inductive transducer the position of the platform in the frequency. is applied in the shake table. The transducer is connected with the transducer of the difference in the frequency to the voltage, which is measured by the peak (amplitude) voltmeter. In general, a device called the measurement displacement for approximation to seismic terminology and the uniqueness of the term.

Output of the displacement sensors.

To the connector labeled "Exit" can be connected an oscilloscope or recorder seismic data instead of one of seismometers, and you can observe the phase difference between the oscillations of the platform and oscillations of seismometer installed on it, as well as to compare the shape and amplitude. Depending on the system of registration it may require additional divider output voltage.

Stand

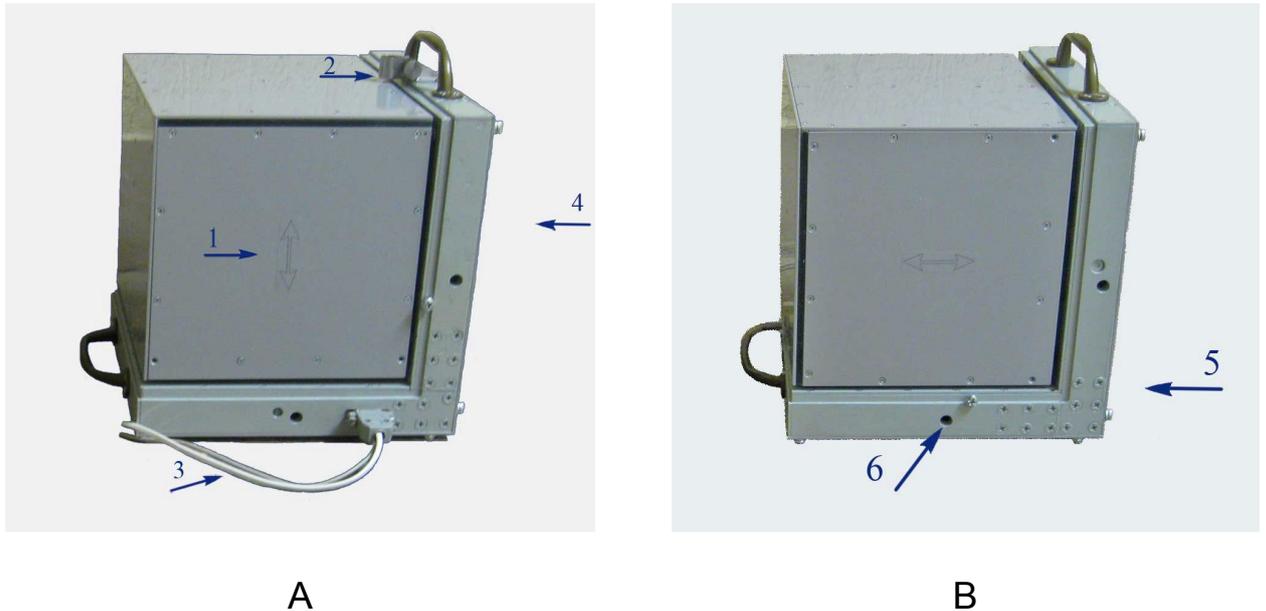


Fig.2. Stand.

A - Position for vertical seismometer.

B - Position for horizontal seismometer.

1. Direction of the vibration.
2. Clamp for screw with the metric scale.
3. Cables of electromagnet and displacement sensor.
4. Here is the handle for compensation of weight loaded platform in the mode of vertical vibrations (mechanical balancing); in the corners - 4 holes for access to the screws to support the platform during transportation (! Just to light stop!-tighten after attracting screws), it is Ok if screws loosened by 1-2 turns.
5. Hole for screw access mechanical balancing in a horizontal position; above - two holes for the screws, attractive platform during transportation, OK - loosened by 5-6 turns; above - window switch direction swings, upward - horizontal swing.
6. Holes for mounting to the foundation.

The movable part of the stand is suspended on steel ribbons to maximum prevent torsional vibration platform. (Dimensions of ribbons are 13X28X0,1 mm.)

To swing vertical seismometers is installed power adjustable spring compensating weight of seismometers and platforms.

To switch between modes of horizontal vibrations in the vertical position of the lever 4 is transferred down the body of the stand is turns over 90 degrees and handle balancing is installed. In the reverse translation is desirable to weaken the force of the spring by unscrewing the knob counter-clockwise, but so that the screw under the handle does not extend beyond the body of the stand. After turning the body in the I position of horizontal swing the lever switch is transferred up to the stop. In this case, the force spring disconnect from the moving part.

Without the need to change the setting should not be displacement sensor with the screws, otherwise change the proportionality factor and zero the sensor, which can not be installed without major calibration.

After the installation of the test sensor and warm-up of the generator and the control unit (5 min.), You must set up the average position of the platform. For this

- To use the generator connector 50 Ohm,
 - On the control knob set the Divider lever in the far right position (clockwise)
 - Adjust the generator to sinusoidal frequency of about 1 Hz, with an output voltage of about 5V (maximum 10V) - AMPL knob in the middle position, OFFSET- also in the middle position,
 - In the position of the vertical swing using lever , Figure 2, first visual output moving part to the swing zone, then by a dial indicator to adjust the average, the zero position,
 - In the position of the horizontal swing center position should be adjusted by screw 5, Figure 2,
 - CYCLE knob turn fully counter-clockwise,
- Using knob DIVIDED to adjust the peak-to-peak amplitude of 1-2 mm and by the mentioned above screws and by knob BALANCE of the control unit until the same indications of positive and negative amplitudes of the digital pointer is reached
- The sum of these amplitudes – peak-to-peak amplitudes , is the measured value of the displacement meter platform
 - Adjust the CYCLE for easy reading
- Sometimes you can not achieve the same amplitude, achieving only opposite-polarity indicator, but the linearity is significantly improved with identical amplitudes, positive and negative.
- In the future, if necessary, you can adjust the zero BALANCE knob on the control unit, item 9 (Figure 1).

Operational aspects on high and low frequencies

At low frequencies, the power amplifier is not being used to the maximum, there is a visible limit, which comes as a ping (slap) on the moving part. (However, at the lowest the slap can not be heard.) According to the dial indicator is easy to set up swing within the operating range.

Not so at higher frequencies. Lacking the power for mechanical constraints and excess voltage from the generator enters the amplifier into saturation, on the sinusoid appear nonlinear sections, amplifiers quickly overheat. Distortion can be observed by measuring the output voltage of the oscilloscope amplifier - with square type socket on the rear side of CA control unit (cable - included). Distortion will appear at the output of the sensor seismometric. They can also be seen with an oscilloscope or a system of registration, via the OUTPUT

To prevent distortion can be plotted limiting amplitude versus frequency, observing the shape of the output voltage of the amplifier, and subsequently use the graph, without an oscilloscope.

It is also necessary to limit the duration of the operation at high frequencies: heating control housing means that the power transformer and radiators, amplifiers too hot, although the amplifiers have protection against overheating - they are switched off, after cooling down - turn on. This mode is not the best conditions for the electronics and better allow to cool for an hour or more.

At frequencies below 0.1 Hz for reading pointer, use the button 7, Figure 1, polarity switch, and turn the knob CYCLE to the end position in a clockwise direction.

Sensors installation

Install the sensors in the centre of the swinging platform with the sensitivity axis in respective direction.

Cable from the seismometer is better to locate the direction perpendicular to the rocking platform so that it does not interfere too pulled and swings, as it can change the sinusoidal oscillation amplitude so the amplitude changes is reflected by sensor in accordance with the actual value.

For proper operation of the power spring weight is loaded onto the platform shall not be less than 3.5 kg. If necessary, additional weight being loaded.

Seismometers usually not fixed on the platform, and if you want to come up fastening, screwing them to the cover. In this case, for machining is necessary to remove the cover and arrange it so that does not affect other parts and prevent rocking of the moving part.

Accelerometers can be installed in the same way. The latter can also be mounted on any heavy object with a hole and thread met withing limits in respect to accelerometer.

The record of the measuring result.

Seismometer mounted on a vibrating table should be connected to the data recorder in the usual way.

In digital systems with visualization on the computer it is most convenient to establish a computer (laptop), the same place where installed seismometers and shake table, but there are no major obstacles to the use and stationary system. Sensor output offset connect to an available channel directly from the control unit or, if necessary, through an additional resistive divider.

In systems with a visible registration on paper, you may have to coordinate resistance displacement sensor output and input of the galvanometer. Here experiments can not do without. In systems with amplifiers only need to agree on the amplitude, the results did not exceed the range of registration and will remain visible.

Less convenient to use the stand in systems with recording on photographic paper. Alternatively, you can put the platform in a dark room next to seismometers and recorded, and the generator and control unit - in lit. For this it is necessary to extend the connecting cables

With sufficient amplitude of oscillation measurements can be observed on an oscilloscope, i comparing the oscillation phase of the seismometer and displacement sensor on the dual-channel. We can built the amplitude and phase characteristics, see the distortion problem, but the seismometers should be calibrated in the complete system of registration. When calibration is usually not required phase measurements. Sinusoidal output can be violated if the amplifiers into saturation. It is easy to control by the voltage supplied to the electromagnets, oscilloscope, see. Section features work at higher frequencies.

Operation check

It is recommended that the local check is performed when you install a new place and when in doubt about the accuracy of data..

It checks the

1 sinusoidal shape of the platform swing.

2 complex parameter: the difference of the amplitude of oscillations of the platform and the data of the pointer.

Waveshape can be observed with an oscilloscope, chart recorder or as a result of registration, as from the output from the displacement sensor and from the seismometer or accelerometer.

With respect to the amplitudes is recommended to build calibration curves in accordance with seismometers calibrated more accurate means. The results of measurements of the amplitudes are calculated according to the method adopted for the calibrated seismometer. The generator signal should be sinusoidal, the distortion of sinusoidal wave further distort the case of hardware differentiation seismometer and an accelerometer.

Test conditions without calibrated seismometer.

Measurements are carried out under normal conditions (20 to 25 degrees C) after heating devices within 10 minutes.

.Measurements in the family data range

Set the platform at about the middle of the range of the swing by amplitude indicator and by the dial indicator. Build graphs linking the scope of deviations from zero and values microscopes or by microscope separately in +/- 1500 microns and 200 microns +/-.

If the plotted points deviate no more than specified in the specifications, - it means that operability is satisfy.

When using microscrews position of the moving part is not set up in the middle position, but in the end of the range, as the screw moves the movable part only in one direction, but the graphics need to build computing peak to peak position, eg +/- 0.25mm; +/- 0.5mm; 0.75 +/- etc.

Measurements in dynamics

As samples of the microscope and amplitude pointer use the values of the amplitudes of oscillations range - the sum of the amplitudes of opposite sign, as may be zero drift at the output of the generator and the output amplifier, moreover, in a manner some non-linearity of the meter is compensated. It should be use close to each other values of the amplitudes of different polarity, but not necessarily exactly equal.

Graphs should not diverge from the average straight lines more than specified in the specifications.

Adjustment of characteristics.

In the absence of faults change proportionality within a small range can be by trimmer on the amplitudes indicator. To do this, the control unit is necessary to unscrew the four corner screws from the front of the frame. On the bezel enhanced board voltmeter pointer (not be confused with the main board), is the only trimmer. on the electronic board.

Digital control unit option (DCU option). *



The NI USB – 6215 unit is used for the calibration digital control in case of this option is used.

When connecting various sensors to the DCU, you can use differential, single-ended, or a combination of single-ended and differential connections.

To attain more accurate measurements and less noise, use a differential measurement configuration. A differential measurement configuration requires two inputs for each measurement (see Table 1 for details). This method of connection should be considered as a preferable in most cases.

Fig. 3. Digital control unit

Using the referenced single-ended (RSE) measurement configuration allows to take measurements on all 16 Analog input channels when all channels share a common ground. In an referenced single-ended connection configuration, each input channel is measured with respect to AI GND (see Table 1 for details).

To reach a compromise between referenced single-ended and differential measurements, you can use an non-referenced single-ended (NRSE) measurement configuration. The behavior of this configuration is similar to that of referenced single-ended connections, except it provides improved noise rejection. In non-referenced single-ended connection configuration, each input channel is measured with respect to AI SENSE (see Table 1 for details).

*-Optional, not included in standard delivery set

The pinout of the device is shown on Fig. 4.

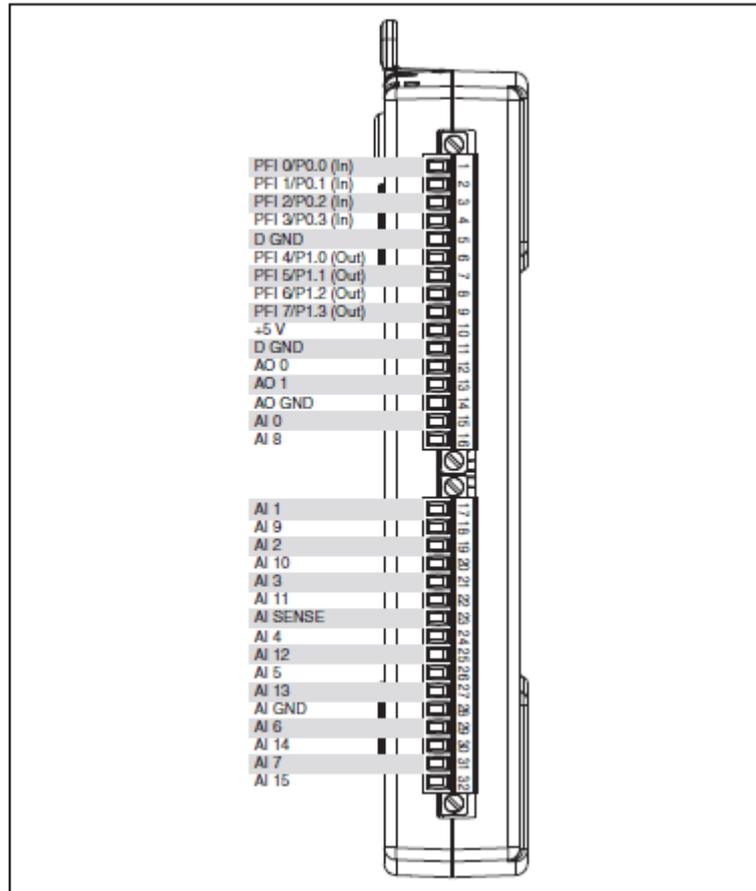


Fig. 4. Digital control unit pinout.

Table 1. Input/output connector signals.

Signal Name	Reference	Direction	Description
AI GND	-	-	Analog Input Ground —These terminals are the reference point for single-ended AI measurements and the bias current return point for differential measurements. All three ground references—AI GND, AO GND, and D GND—are connected on the device.
AI <0..15>	Varies	Input	Analog Input Channels 0 to 31 —For single-ended measurements, each signal is an analog input voltage channel. In RSE mode, AI GND is the reference for these signals. In NRSE mode, the reference for each AI <0..15> signal is AI SENSE. For differential measurements, AI 0 and AI 8 are the positive and negative inputs of differential analog input channel 0. Similarly, the following signal pairs also form differential input channels: <AI 1, AI 9>, <AI 2, AI 10>, <AI 3, AI 11>, <AI 4,

			AI 12>, <AI 5, AI 13>, <AI 6, AI 14>, <AI 7, AI 15>
AI SENSE	-	Input	Analog Input Sense —In NRSE mode, the reference for each AI <0..15> signal is AI SENSE.
AO <0..1>	AO GND	Output	Analog Output Channels 0 to 1 —These terminals supply the voltage output of AO channels 0 to 1.
AO GND	-	-	Analog Output Ground —AO GND is the reference for AO <0..1>. All three ground references—AI GND, AO GND, and D GND—are connected on the device.
D GND	-	-	Digital Ground —D GND supplies the reference for PFI <0..15>/P0/P1 and +5 V. All three ground references—AI GND, AO GND, and D GND—are connected on the device.
+5 V	D GND	Input or Output	+5 V Power —These terminals provide a +5 V power
PFI <0..3>/P0<0..3>	D GND	Input	Programmable Function Interface or Static Digital Input Channels 0 to 3 —Each PFI terminal can be used to supply an external source for AI, AO, or counter/timer inputs. You also can use these terminals as static digital input lines. <i>These pins are not used in our application.</i>
PFI <4..7>/P1<0..3>	D GND	Output	Programmable Function Interface or Static Digital Output Channels 0 to 3 7 —You can route many different internal AI, AO, or counter/timer outputs to each PFI terminal. You also can use these terminals as static digital output lines. <i>These pins are not used in our application.</i>

Shipment

For transportation platform catch, as specified in section Unpacking.

In the car mount stand closer to the middle of the car and protected from hard blows.

Service

Regular maintenance does not required. When the intensive use every 1-2 years should be grease places friction roller screws tension springs, cams detent; Loose screws tighten. Removing the outer covers are safe for the settings.

Assembling and disassembling

The stand is assembled with screws with cross grooves. Alloy plate material requires careful handling with threads. Pick a screwdriver with a form appropriate slots. When assembling the screws should be tightened, but not over, so how to get ripped off a cross screw or thread can only by qualified mechanic.

Access to primary detector bias is possible when removing the top cover in the position of the horizontal vibrations.

If necessary, all external cover (plate) can be removed without damage to the settings.

When assembling the first tighten all the screws of the plate, but do not tighten the cone of p'o-t'ai, and then tighten. At the slightest resistance, remove the screw and cut tapping enshrined in hand vice (fix).

The control unit is disassembled in the following order: on the back of the untwisted 2 M6 screws that secure the mounting electronics; on the front panel can be unscrewed the 4 screws at the corners of the front panel and remove the front bezel; removable connectors on the panel ground wire sealed off the frame, then pulled mounting the electronics housing.

For access to fix the support handles need to remove the side panels 4, as shown in Figure 3, along with the dismantling of the handle.

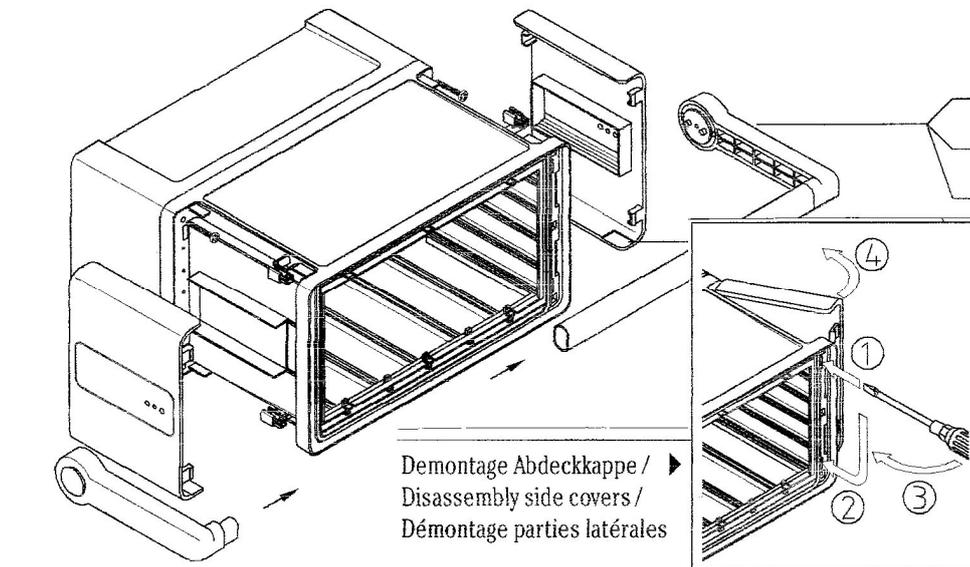


Fig.3. Control unit , removing the side panels and the rear parts

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