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DEVICE OF WIRELESS SHAFT COMMUNICATION

ECHO-S

TECHNICAL AND OPERATING MANUAL
No DTR-28S/2009

April 2013.

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LIST OF DRAWINGS

Hazards identification

The cage unit is powered by 12VDC NiMH battery. It should be taken to consider that in a fully charged battery during setting up might be done by accident shorting pins which may cause battery leakage, overheat and in a consequence may cause injuries (such as burns). The battery should be charged only by the original charger ŁAE-S3. Used batteries should not be thrown away in the trash.

Headframe unit is supplied from 230 VAC network and should be connected to a wall outlet with a protective pin (this applies to primary and reserve power supply). The casing of headframe unit is made of sheet steel, so it should be grounded. Opening the housing is allowed only after turning off power. The "!" sign on the input/output block means that the inside can be dangerous voltage from the shaft system.

1. Use and range of application

Device of wireless shaft communication **ECHO-S** is designed to communicate between crew in conveyance (cage or skip) and hoist operator in mine shaft.
The basic advantages of this system are following:
- two-way half duplex audio communication,
- sending remote control signals from cage to hoist,
- receiving information signals from hoist to cage.

The cage unit is made as intrinsically safe device group I, category M1.
The device is intended to use in time of shaft inspection, person ride, emergency egress as well as maintenance in shaft.
The principle of working of this device is utilization rope as carrier to move electromagnetic waves. Carrier is created by:

- headrope, tailrope and conveyances (in case of friction hoist),
- guiderope and earth (in case of drum hoist),
- additional rope and earth (in other cases).

Electric continuity of such loop is the main condition of correct work of device.
Electromagnetic wave is generated to the loop and received from it by inductive couplers. In headframe there are fixed two inductive couplers (transmitter and receiver) in such way, that headrope crosses by their center. Over cage there are fixed another pair of couplers.
Headframe unit sends signal by inductive coupler (transmitter) to rope and cage unit receive signals from rope by other inductive coupler (receiver). Communication from cage unit to headframe unit is performed in the same way by other pair of couplers.
Only one device can work in one loop. The device has 4 frequency performances: A, B, C, D thanks to which, it is possible to use four devices in one shaft.

2. Marking

MARKING	ABBREVIATED MARKING
Device of wireless shaft communication **ECHO-S**	**ECHO-S**

The device consists of a headframe unit, cage unit and battery charger.

Cage unit consists of:

MARKING	ABBREVIATED MARKING
Cage device type **ECHO/AK-S** frequency performance **A,B,C,D**	**ECHO/AK-S-A,B,C,D**
Battery type **BAKS-9**	**BAKS-9**
Box type **SAKN**	**SAKN**
Coupler type **SK-32** (transmitter, frequency performance **A**)	**SK-32**
Coupler type **SK-64** (receiver, frequency performance **A**)	**SK-64**
Coupler type **SK-48** (transmitter, frequency performance **B**)	**SK-48**
Coupler type **SK-80** (receiver, frequency performance **B**)	**SK-80**
Coupler type **SK-80** (transmitter, frequency performance **C**)	**SK-80**
Coupler type **SK-80** (receiver, frequency performance **C**)	**SK-80**
Coupler type **SK-80** (transmitter, frequency performance **D**)	**SK-80**
Coupler type **SK-80** (receiver, frequency performance **D**)	**SK-80**
Junction box type **STK/E**	**STK/E**

Headframe unit consists of:

MARKING	ABBREVIATED MARKING
Headframe device type **ECHO/AS-S** frequency performance **A,B,C,D**	**ECHO/AS-S-A,B,C,D**
Microphone with foot switch microphone type **MNO**	**MNO**
Loudspeaker	
Feedback microphone type **MK**	**MK**
Coupler type **SS-32** (receiver, frequency performance **A**)	**SS-32**
Coupler type **SS-64** (transmitter, frequency performance **A**)	**SS-64**
Coupler type **SS-48** (receiver, frequency performance **B**)	**SS-48**
Coupler type **SS-80** (transmitter, frequency performance **B**)	**SS-80**
Coupler type **SS-80** (receiver, frequency performance **C**)	**SS-80**
Coupler type **SS-80** (transmitter, frequency performance **C**)	**SS-80**
Coupler type **SS-80** (receiver, frequency performance **D**)	**SS-80**
Coupler type **SS-80** (transmitter, frequency performance **D**)	**SS-80**
Junction box type **SPSS**	**SPSS**

MARKING	ABBREVIATED MARKING
Battery charger **ŁAE-S3**	**ŁAE-S3**

3. Certificates

Headrfame unit met requirement of the European Union directive no. **94/9/WE (ATEX)** and other standards which are harmonized with them certificate no. **KDB 09ATEX023X** issued by the **Notified Body no. 1453** Central Mining Institute. Experimental Mine „BARBARA" 43-190 Mikołów , ul. Podleska 72. The PCA (Polish Centre for Accreditation) accreditation no. **AC038**.

As well as met requirement of electromagnetic compatibility in accordance with the European Union directive no. **89/336/EEC** including the changes **91/263/EEC,92/31/EEC** and **93/68/EEC** and standards harmonized with it protocol no. **LKE/043/2004** issued by the Laboratory of Electromagnetic Compatibility, Institute of Telecommunication and Acoustics Wroclaw Engineering College. The PCA (Polish Centre for Accreditation) accreditation no **AB 167**.

4. Terms of application

4.1. The shaft has to have tailrope, the conveyance must be suspended on at least two ropes or two guide ropes must exist.
4.2. There should be electrical connection between headrope and tailrope or between two guideropes.
4.3. Over the conveyance which we want to get communication should be mounted a pair of couplers, and second pair of couplers should be mounted in headframe.
4.4. In one shaft there may work only one cage unit in specific frequency performance, in the case of using two devices they have to have different frequency performance. The same applies to two cage units installed in one conveyance.
4.5. Couplers type SK (or SS in variant 2) can be connected only to cage unit ECHO/AK-S-x, connection may be made either directly or through box STK/E.
4.6. Battery type BAKS-9 can be charged only by battery charger type ŁAE-S3 made by CARBONEX.
4.7. Maintenance may be carried out only by authorized personnel.
4.8. It is forbidden to make any change in device and use the device in another way as mentioned in this manual.

5. Technical data

5.1. Normal working conditions.

5.1.1. Cage unit	
5.1.1.1. Temperature range	-20ºC to + 40ºC
5.1.1.2. Humidity	< 98%
5.1.2. Headframe unit	
5.1.2.1. Temperature range	0ºC to + 40ºC
5.1.2.2. Humidity	< 80%

5.2. General parameters

5.2.1. Type of work	
- audio signal	semiduplex
- remote control signals	duplex
5.2.2. Type of modulation	FM
5.2.3. Frequency performance:	
- A (from cage unit to headframe unit)	32 kHz
- A (from headframe unit to cage unit)	64 kHz
- B (from cage unit to headframe unit)	48 kHz
- B (from headframe unit to cage unit)	80 kHz
- C (from cage unit to headframe unit)	112 kHz
- C (from headframe unit to cage unit)	144 kHz
- D (from cage unit to headframe unit)	128 kHz
- D (from headframe unit to cage unit)	160 kHz
5.2.4. Method of sending signals	serial
5.2.5. Delay of sending signals	< 0,1 s
5.2.6. Range of work	1250 m

5.3. Cage unit

5.3.1. Power supply	battery 12 V (10.5÷15 V)
5.3.2. Indication of low battery	11.5 V
5.3.3. Current consumption	max. 400 mA
5.3.4. Output signal	14 Vpp
5.3.5. Receiver sensitivity	1 mV
5.3.6. Operating time without battery replacement	10 h
5.3.7. Marking	I M1 Ex ia I Ma
5.3.8. Protection degree	IP54
5.3.9. Dimensions	520 x 300 x 145 mm
5.3.10. Weight	15 kg

5.4. Headframe unit

5.4.1. Main and reserve power supply	230 VAC
5.4.2. Power consumption	50 VA
5.4.3. Output signal	14 Vpp
5.4.4. Receiver sensitivity	2 mV
5.4.5. Number, type and parameters of outputs	11 relays (DPDT 1A, 250VAC) 1 opto relay (2A, 200 VDC)
5.4.6. Number and type of input	14 NO contact
5.4.7. Dimensions	282 x 350 x 240 mm
5.4.8. Weight	10 kg

5.5. Coupler type SK

5.5.1. Nominal inductance		
	SK-32	178 µH
	SK-48	80 µH
	SK-64	40 µH
	SK-80	40 µH
5.5.2. Protection degree		IP54
5.5.3. Dimensions		265 x 220 x 90 mm
5.5.4. Weight		4,5 kg

5.6. Coupler type SS

5.6.1. Nominal inductance		
	SK-32	178 µH
	SK-48	80 µH
	SK-64	40 µH
	SK-80	40 µH
5.6.2. Protection degree		IP54
5.6.3. Dimensions		335 x 265 x 40 mm
5.6.4. Weight		4,5 kg

6. Description

Drawing no. 28S shows overall structure the communication system in arrangement with the headrope and tailrope. Drawing no. 28S.2 explains principle of work the communication system in arrangement with the guiderope. In headframe there are installed two inductive couplers in such a way that the rope passes through the center of couplers. One of them is transceiver and the second one is receiver. The second pair of couplers are fitted over conveyance. Transceiver coupler sends current signal, which flows through rope to the receiving coupler. The main condition of proper work of system is existence of a closed loop for current flow. This loop is formed by headrope, tailrope and conveyances. Other way of making such loop is by connecting two headropes. In case of existing guiderope loop may be done by making connection between two such ropes or by connecting to ground ends of guiderope. Blok diagram of cage device is shown in drawing no. 28S.01.S.01. Blok diagram of headframe device is shown in drawing no. 28S.02.S.01. Transmitters of both devices emit continuously carrier frequencies. There are two carrier frequencies at each system, which depend on devices performance. When the carrier frequency is received the device is switched to ready mode.

6.1. Audio communication is realized in an semiduplex way. In cage device broadcast is done after pressing the button "N/O", conveyance has priority. In headframe unit broadcast is done after pressing microphone foot switch.

6.2. Signal SJ is used to transmit the Code of Signal. After pressing button "SYGNAŁY JEDNOUDERZENIOWE" in cage device, output opto relay “SJ” is turned on for 200 milliseconds in headframe unit. In cage unit we should hear bell if feedback microphone would be fastened near to signal bell. Control block “BT” in headframe device turns on output opto relay “SJ” under following conditions:

- closed input no. 2 (person ride) or 3 (shaft inspection).

6.3. Signal alarm is send from cage device after pressing button "ALARM". It is possible to hear alarm bell in cage device, for this purpose should be closed input no. 4 in headframe unit. This input activates feedback microphone.

6.4. Signal blockade is done by switching the switch "BLOKADA" in cage unit into position “ZAŁ”. Next to the switch is red led confirming the activation of the lock (closed input no. 5 in headframe unit).

6.5. Automatic control is possible after switching the switch "ZDALNE URUCHOMIENIE" in cage unit into position "ZAŁ" and receiving confirmation of activation that state (closed input no. 8 in headframe unit).

Automatic control can only be enabled in shaft inspection mode (closed input no. 3 in headframe unit), using the following control buttons:

↑ –raise,
STOP –stop,
↓ –lower,
V2 –middle speed,
V3 –high speed.

Note:
The low speed “V1” should be automatically turned on when automatic control mode is selected.

Warning:
High speed V3 can only be available when the crew is in a safe place.
Identification of the location is realized by closing input US (man riding) in cage unit.

TABLE OF OUTPUTS OF HEADFRAME UNIT

Relay	Function	Description
P1	Ready (GOT)	Relay is turned on, when cage unit and headframe unit are turned on, both are operational, and there is communication between them.
P2	Checking of Code of Signal (KI)	Relay will be turned on for 6 seconds when: - closed input no. 2 (person ride) or 3 (shaft inspection) and, - closed input no. 6 (machine in rest) and, - closed input no. 7 two or three times (raise, lower). Relay is released: - after 6 seconds or, - after opening input no. 6 (machine in rest) or, - after closing input no. 7 one time (stop).
P3	Alarm (A)	In normal operation when headframe unit is in ready mode, relay is turned on. The relay will be turned off when: - closed input no. 2 (person ride) or 3 (shaft inspection) and, - button "ALARM" in cage device would be pressed or, - there will be a loss of communication between units.
P4	Blockade (B)	In normal operation when headframe unit is in ready mode, relay is turned on. The relay will be turned off when: - switch "BLOKADA" in cage unit would be set in position “ZAŁ” or, - there will be a loss of communication between units.

P5	Automatic control (ZU)	Relay will be turned on when: - closed input no. 3 (shaft inspection) and, - switch "ZDALNE URUCHOMIENIE" in cage unit would be set in position “ZAŁ”.
P6	Middle speed (V2)	Relay will be turned on when: - closed input no. 3 (shaft inspection) and, - switch "ZDALNE URUCHOMIENIE" in cage unit would be set in position “ZAŁ” and, - button "V2" in cage device would be pressed.
P7	High speed (V3)	Relay will be turned on when: - closed input no. 3 (shaft inspection) and, - switch "ZDALNE URUCHOMIENIE" in cage unit would be set in position “ZAŁ” and, - button "V3" in cage device would be pressed and, - input US (pin 4, 7 in coupler socket) in cage unit is closed.
P8	Raise (↑)	Relay will be turned on when: - closed input no. 3 (shaft inspection) and, - switch "ZDALNE URUCHOMIENIE" in cage unit would be set in position “ZAŁ” and, - button "↑" in cage device would be pressed.
P9	Stop (STOP)	In normal operation when headframe unit is in ready mode, relay is turned on. The relay will be turned off when: - button "STOP" in cage device would be pressed or, - there will be a loss of communication between units.
P10	Lower (↓)	Relay will be turned on when: - closed input no. 3 (shaft inspection) and, - switch "ZDALNE URUCHOMIENIE" in cage unit would be set in position “ZAŁ” and, - button "↓" in cage device would be pressed.
P11	Man riding (US)	Relay will be turned on when: - closed input US (man riding) in cage unit,
P12	Code of Signal (SJ)	Opto relay will be turned on for 200 milliseconds when: - closed input no. 2 (person ride) or 3 (shaft inspection) and, - button "SJ" in cage device would be pressed. **Caution: when input no. 8 (automatic control) is closed, opto relay is blocked.**

6.6. Description of faceplate of cage unit

- "ZASILANIE"-switch on/off, when red led next to the switch lights means that the battery voltage is correct, when led flashes means discharging the battery.
- "ZDALNE URUCHOMIENIE"-automatic control switch, green led next to the switch lights when input no.8 in headframe unit is closed.
- "BLOKADA"-blockade switch, red led next to the switch lights when input no.5 in headframe unit is closed.
- "ALARM"-alarm button.
- "SYGNALIZACJA JEDNOUDERZENIOWA"-button to transmit the Code of Signal, yellow led “ZSJ” next to the button lights when input no.1 in headframe unit is closed, this led is used to indicate the Code of Signal mode.
- "V3"-high sped button, green led next to the button lights when input no.13 in headframe unit is closed.
- "V2"-medium sped button, green led next to the button lights when input no.12 in headframe unit is closed.
- "V1"-green led lights when input no.11 in headframe unit is closed.
- "↑"-raise button, green led next to the button lights when input no.9 in headframe unit is closed.
- "STOP"-stop button.
- "↓"-lower button, green led next to the button lights when input no.10 in headframe unit is closed.
- "N/O"-button for audio broadcasting.
- "SN"-yellow led lights when the transmitter coupler is unserviceable.
- "SO"-yellow led lights when the receiver coupler is unserviceable.
- "FNN"-yellow led lights when there is a lack of carrier frequency of the transmitter.
- "FNO"-yellow led lights when there is a lack of carrier frequency of the receiver.
- "RSz"-green led indicates shaft inspection mode, lights when input no.3 in headframe unit is closed.
- "JO"-green led indicates person ride mode, lights when input no.2 in headframe unit is closed.
- "SPR"-green led indicates when the cage unit is ready for use.
- "US"-yellow led indicates when input “man riding” (pin 4, 7 in coupler socket) in cage unit is closed.

6.7. Description of faceplate of headframe unit

6.7.1. Power Block.

The leds indicates the presence of power supply.

6.7.2. Block BN

The led "SN" lights when the transmitter coupler is unserviceable.
The led "KN" lights when there is a lack of carrier frequency of the transmitter.
Led indicator indicates the level of transmitting wave.

6.7.3. Block BT

GOT	Ready
SJ	Code of Signal
A	Alarm
B	Blockade
ZU	Automatic control
↑	Raise
Stop	Stop
↓	Lower
V2	Medium speed
V3	High speed
US	Man riding

6.7.4. Block BO

The led "SO" lights when the receiver coupler is unserviceable.
The led "KO" lights when there is a lack of carrier frequency of the receiver.
Led indicator indicates the level of receiving wave. Knob is used to adjust volume level.

6.7.5. Block BKI

KI	Checking of Code of Signal

6.7.6. Block BSG1

ZSJ	Code of Signal mode
JO	Person ride
RSz	Shaft inspection
AL	Alarm
BL	Blockade
MZ	Machine in rest
SJW	Input of checking of Code of Signal

6.7.7. Block BSG2

ZU	Automatic control
↑	Raise
↓	Lower
V1	Low speed
V2	Medium speed
V3	High speed
S1/S2	Control of pair of couplers

6.7.8. Block BSS

The led “S1” lights when pair of couplers S1 is turned on.
The led “S2” lights when pair of couplers S2 is turned on
Couplers can be switched by the switch which is located on the front of the block or by input no. 14 in that case the switch should set in position "0". Open contact at input no. 14 switched pair of couplers S1 whereas closed input switched pair of couplers S2.

7. Installation

7.1. Unpacking

During unpacking, check the completeness of the set according to the proof of delivery. Check if the power switch on the cage unit was in off position during transport and storage. The switch in on position could cause discharging of battery.

7.2. Cage device

Cage device is shown in drawing no.28S.01. Housing is divided into two parts. At the bottom there are placed electronics board, buttons and switches, at the top battery socket. The walls of the housing are made of stainless steel sheet. In the bottom side of the housing there is a socket for connecting couplers and in the right side socket to charge battery without removing it out of housing. Access to battery and electronics board is possible after unscrewing proper cover. Device is designed for mounting on the wall of conveyance using 4 screws M8. If device is exposed to rain or water in shaft it is recommended to mount it in additional box SAKN.

7.3. Coupler type SK

Coupler type SK is shown in drawing no.28.03. Coupler consists of two parts, to allow his assembly around rope. There is an ferromagnetic core with coil inside housing of device. Core and coil are encapsulated by chemical compound. There are two variant of installation of coupler. There is shown in drawings no.28.03.M1 and 28.03.M2.

7.4. Box type STK/E

Box type STK/E is shown in drawing no.28.05.S.01. It is designed to connect cables: PAK, PAKS and PAKD with couplers.

Note:

The PAKD cable has incorporated connection between pins 4 and 7 for indicating "man riding" mode.

7.5. Headframe unit

Headframe device is shown in drawing no.28S.02. Housing consist of three parts: power supply unit from the left side, main unit in the center and input/output circuit unit at the right side. Center unit consist of mainboard and subrack for 7 eurocards. Headframe unit is designed for mounting in the winding engine room using 4 screws M8. Method of connecting headframe unit is shown in drawing no.28S.02.S.02, 28S.02.S.03 and 28.S.02.S.04.

7.6. Coupler type SS

Coupler type SS is shown in drawing no.28.04. Coupler consists of two parts, to allow his assembly around rope. There is an ferromagnetic core with coil inside housing of device. Core and coil are encapsulated by chemical compound. There are two variant of installation of coupler. There is shown in drawings no.28.04.M1 and 28.04.M2. The couplers differ only way of fixing.

7.4. Box type SPSS

Box type SPSS is shown in drawing no.28.06.S.01. It is designed to connect coaxial cables with couplers if necessary.

8. Maintenance

Before using any cage device it is recommended to charge the battery, using a charger type ŁAE-S3 CARBONEX company production. Charging may take place only in room without any danger vapours. Battery, on which there are traces of leakage should be withdrawn by person of service and returned to the manufacturer. The battery may not have dents. In the headframe device power-up sequence is as follows: first "ZASILANIE PODSTAWOWE" (MAIN POWER) and second "ZASILANIE REZERWOWE" (RESERVE POWER). In other case there might be occur an arc on contacts of power supply switch relay. Cage device should not be at the same time, use the audio and control. After pressing simultaneously two control buttons only one of them will be send. The foot switch should be pushed only in time of audio transmission. Measurements of the installation should be performed at least once a year.

Inductance of coupler type SK should be measured in disconnected plug of cage unit. During the measurements the headframe unit must be turned off.

Type	Value (Required)	Comments	Pin
SK-32	178 µH (150-240) µH	Perf. (A)	3-6
SK-64	40 µH (30-60) µH	Perf. (A)	2-5
SK-48	80 µH (65-120) µH	Perf. (B)	3-6
SK-80	40 µH (30-60) µH	Perf. (B,C,D)	2-5

Insulation resistance of coupler type SK should be measured in disconnected plug of cage unit. Measurement voltage 500 V. Measurement performed in safe zone between conveyance and Pin in accordance with the table.

Type	Value	Comments	Pin
SK-32	> 100 kΩ	Perf. (A)	3
SK-64	> 100 kΩ	Perf. (A)	2
SK-48	> 100 kΩ	Perf. (B)	3
SK-80	> 100 kΩ	Perf. (B,C,D)	2

Inductance of coupler type SS should be measured in disconnected plug of cage unit. During the measurements the cage unit must be turned off.

Type	Value (Required)	Comments	Pin
SS-32	178 µH (150-240) µH	Perf. (A)	3-6
SS-64	40 µH (30-60) µH	Perf. (A)	2-5
SS-48	80 µH (65-120) µH	Perf. (B)	3-6
SS-80	40 µH (30-60) µH	Perf. (B,C,D)	2-5

Insulation resistance of coupler type SS should be measured in disconnected plug of headframe unit. Measurement voltage 60 V. Measurement performed between ground and Pin in accordance with the table.

Type	Value	Comments	Pin
SS-32	> 100 kΩ	Perf. (A)	4
SS-64	> 100 kΩ	Perf. (A)	4
SS-48	> 100 kΩ	Perf. (B)	4
SS-80	> 100 kΩ	Perf. (B)	4

9. Transport and storage

The device can be transported by any means of transport. During transport, equipment shall be protected against rain and strong mechanical shock. The temperature during transport should be in the range of -25ºC ÷ +60ºC. The device will be ready for use after keeping it in the room temperature for 6 hours. The device shall be stored in a closed room where the humidity should not exceed the permissible limit of 75% and the temperature ranging from 0°C to 60ºC. The room should be free of active vapours or chemical compounds. In case of storage longer than 14 days before installing cage device should be connected to the battery charger.

10. List of spare parts

10.1 Cage unit

10.1.1. Cage device type ECHO/AK-S-(A or B or C or D)
10.1.2. Battery type BAKS-9
10.1.3. Box type SAKN
10.1.4. Coupler type SK-32, 64, 48, 80
10.1.5. Plug type ZGT28KP7a
10.1.6. Socket ZGT28B7S
10.1.7. Box type STK/E
10.1.8. Cable PAK
10.1.9. Cable PAKD
10.1.10. Cable PAKS
10.1.11. Protection cover ZGT28W

10.2 Headframe unit

10.2.1. Headframe device type ECHO/AS-S-(A or B or C or D)

- Block BZ - power supply block
- Block BN - block of transmission
- Block BT - control block
- Block BO - block of receiving
- Block BKI - checking of Code of Signal block
- Block BSG1 - galvanic separation block
- Block BSG2 - galvanic separation block
- Block BSS - control of couplers block
- Opto relay type W6212DDX-1
- Relay type Finder 48.52 (12VDC)

10.2.2. Microphone with foot switch microphone type MNO
10.2.3. Loudspeaker
10.2.4. Feedback microphone type MK
10.2.5. Coupler type SS-32, 64, 48, 80
10.2.6. Box type SPSS
10.2.7. Plug type MIC-324
10.2.8. Plug type MIC-323
10.2.9. Plug type MIC-322
10.2.10. Plug type XLR

It is allowed to replace these items. Any repair of components may only be performed by authorized employees of the CARBONEX company.

11. Guarantee

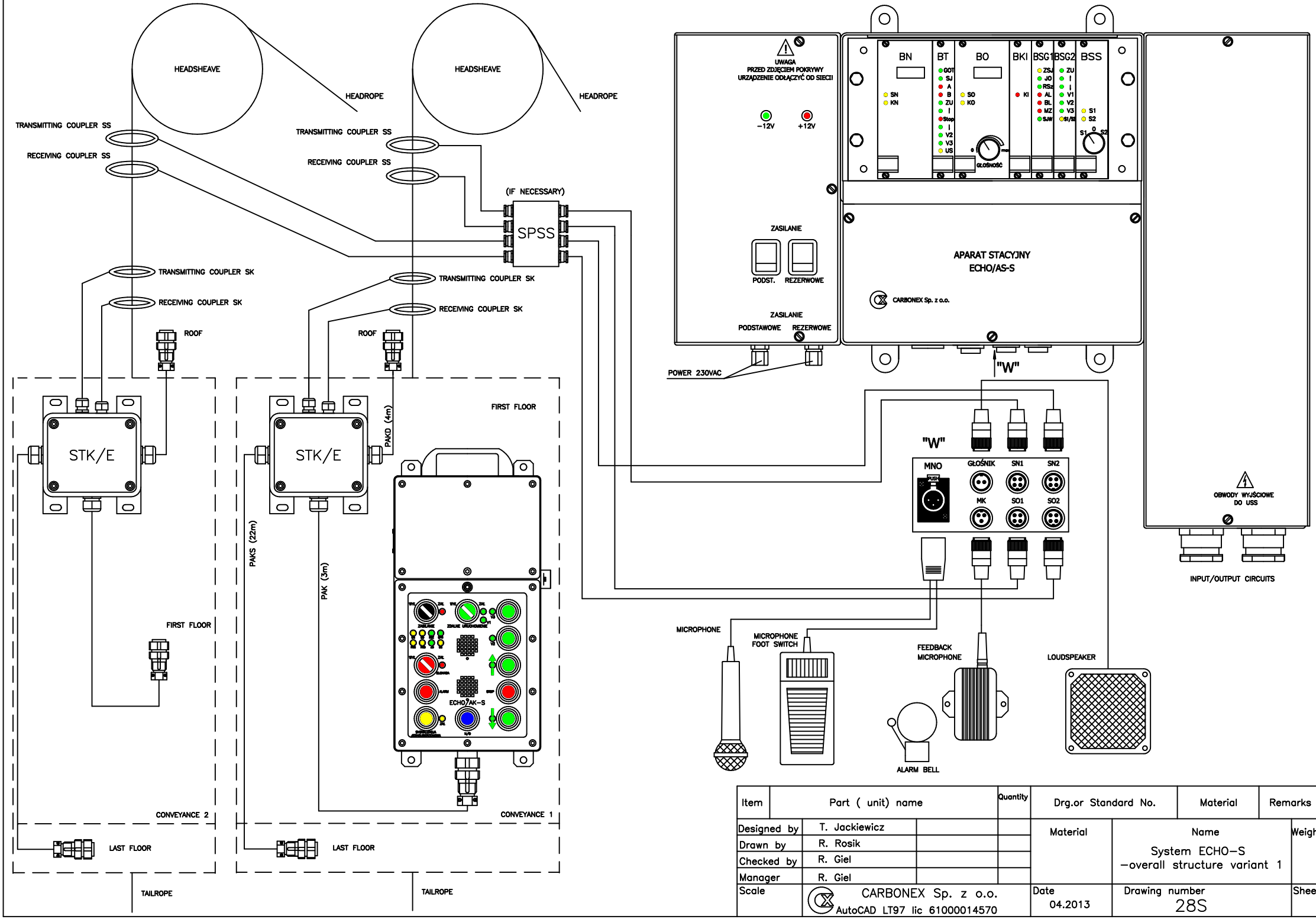
The manufacturer,

CARBONEX Sp. z o.o.
ul. Budowlana 19
41- 100 Siemianowice Śląskie, Poland

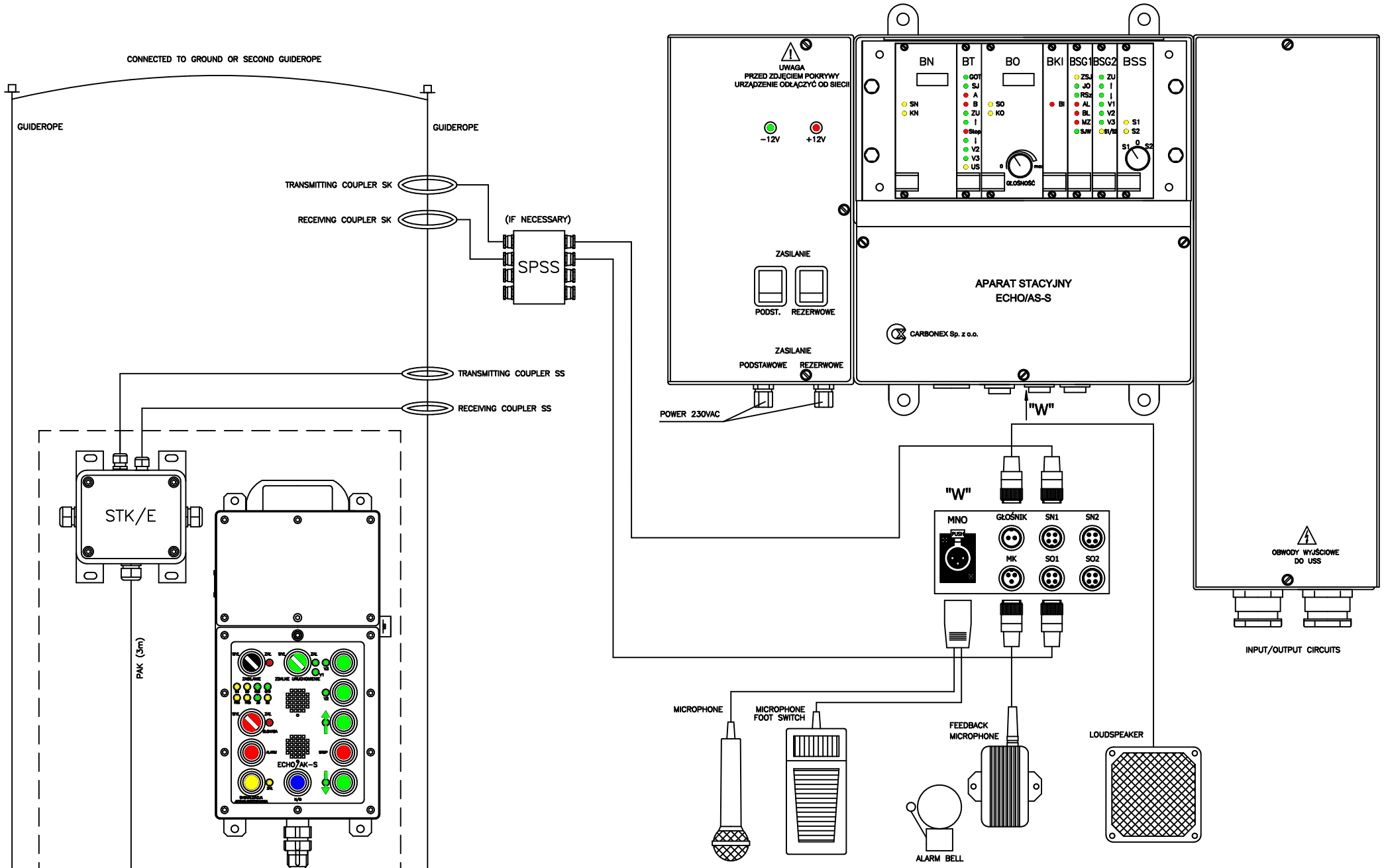
guarantees:

12.1. The highest quality and proper functioning of the device in accordance with the terms and conditions given in this manual.
12.2. Guarantee period: 12 months from the date of purchase.
12.3. During guarantee period, all the repairs are carried out free of cost, provided that the customer shall be responsible for any transportation cost.
12.4. Guarantee terms and conditions do not apply if the mechanical damages are caused by improper use and operation of the device.
12.5. Sales and after sales service. After sales service and supply of spare parts on payment. Any repair/damage shall be reported through phone/fax no. +48 32 203 08 19 or to service department of:

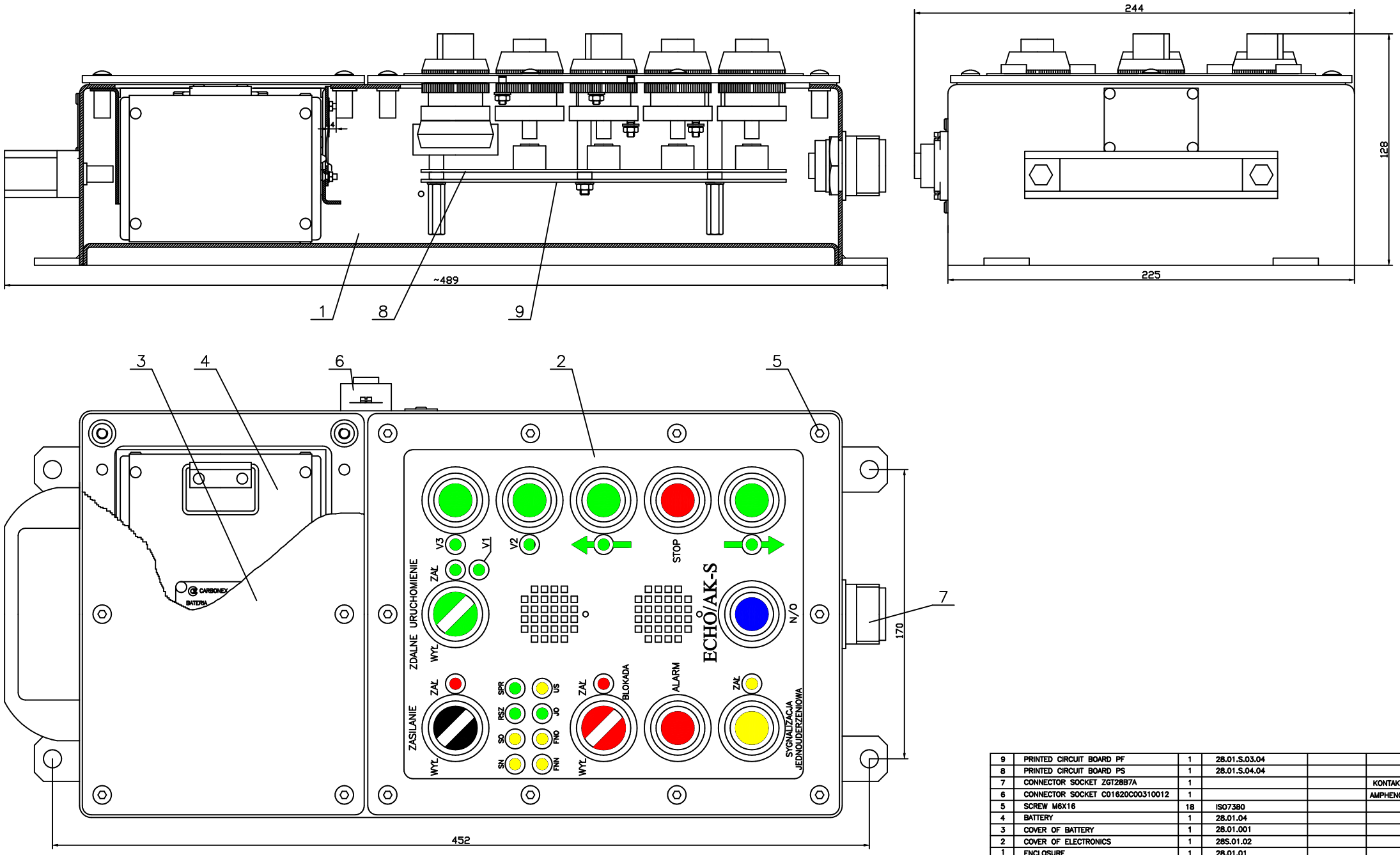
CARBONEX Sp. z o.o.
ul. Budowlana 19
41- 100 Siemianowice Śląskie, Poland
e-mail: biuro@carbonex.katowice.pl
web: carbonex.katowice.pl



Item	Part (unit) name	Quantity	Drg.or Standard No.	Material	Remarks
Designed by	T. Jackiewicz		Material	Name	Weight
Drawn by	R. Rosik			System ECHO−S −overall structure variant 1	
Checked by	R. Giel				
Manager	R. Giel				
Scale	CARBONEX Sp. z o.o. AutoCAD LT97 lic 61000014570		Date 04.2013	Drawing number 28S	Sheet

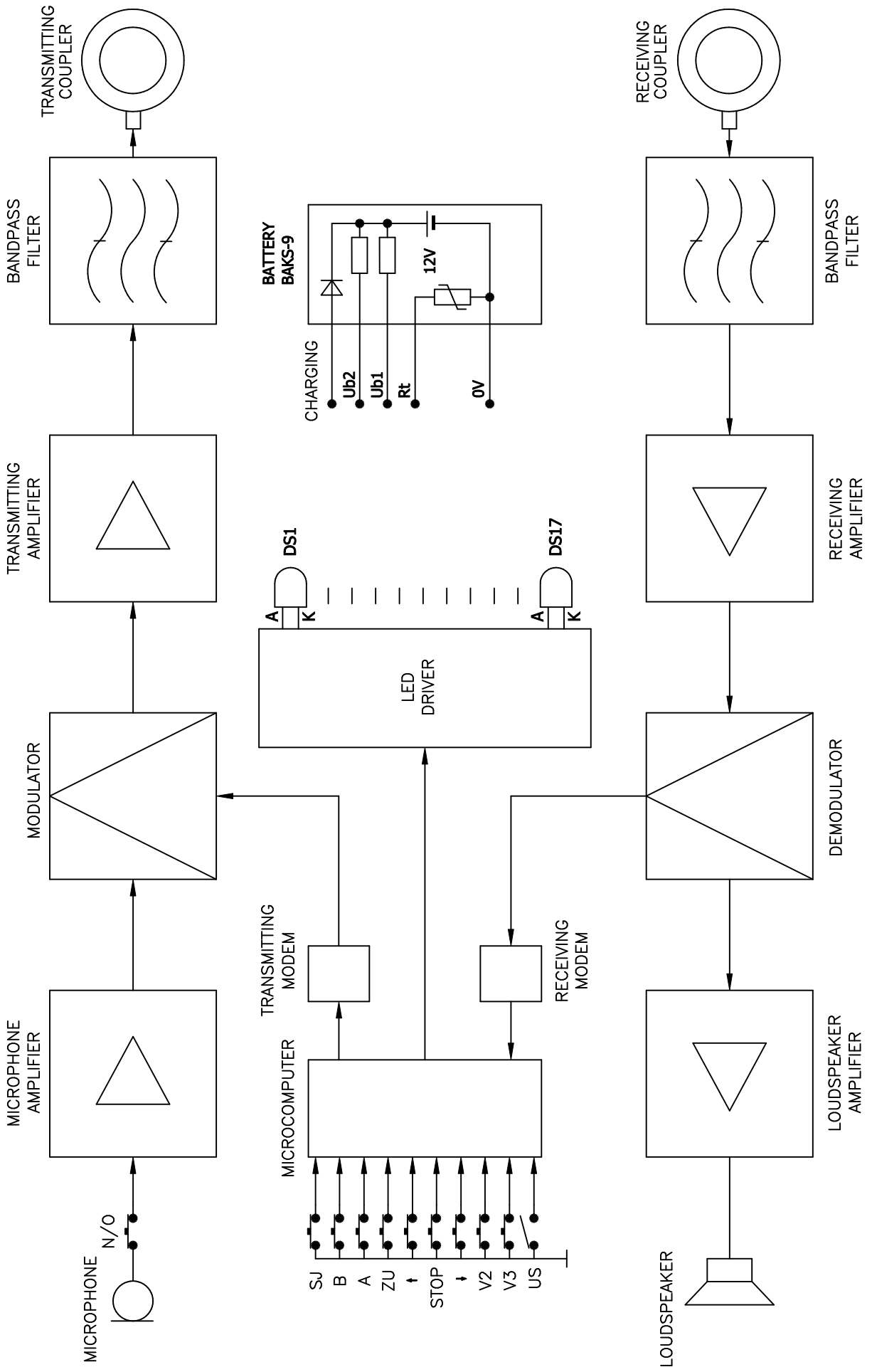


Item	Part (unit) name	Quantity	Drg.or Standard No.	Material	Remarks
Designed by	T. Jackiewicz		Material	Name	Weight
Drawn by	R. Rosik			System ECHO-S -overall structure variant 2	
Checked by	R. Giel				
Manager	R. Giel				
Scale	CARBONEX Sp. z o.o. AutoCAD LT97 lic 61000014570		Date 04.2013	Drawing number 28S2	Sheet

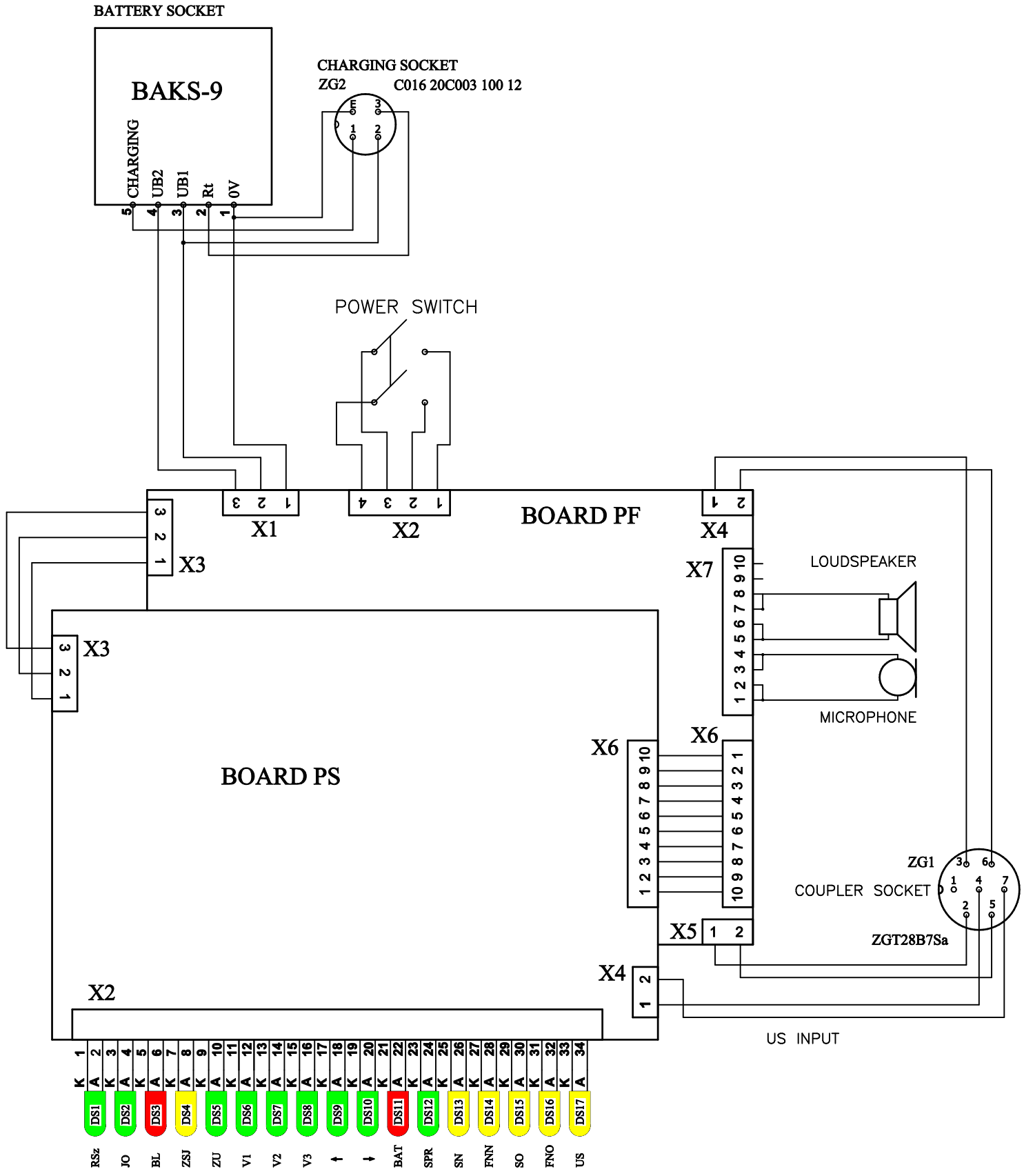


Item	Part (unit) name	Quantity	Drg.or Standard No.	Material	Remarks
9	PRINTED CIRCUIT BOARD PF	1	28.01.S.03.04		
8	PRINTED CIRCUIT BOARD PS	1	28.01.S.04.04		
7	CONNECTOR SOCKET ZGT28B7A	1			KONTAKT
6	CONNECTOR SOCKET C01620C00310012	1			AMPHENOL
5	SCREW M6X16	18	ISO7380		
4	BATTERY	1	28.01.04		
3	COVER OF BATTERY	1	28.01.001		
2	COVER OF ELECTRONICS	1	28S.01.02		
1	ENCLOSURE	1	28.01.01		

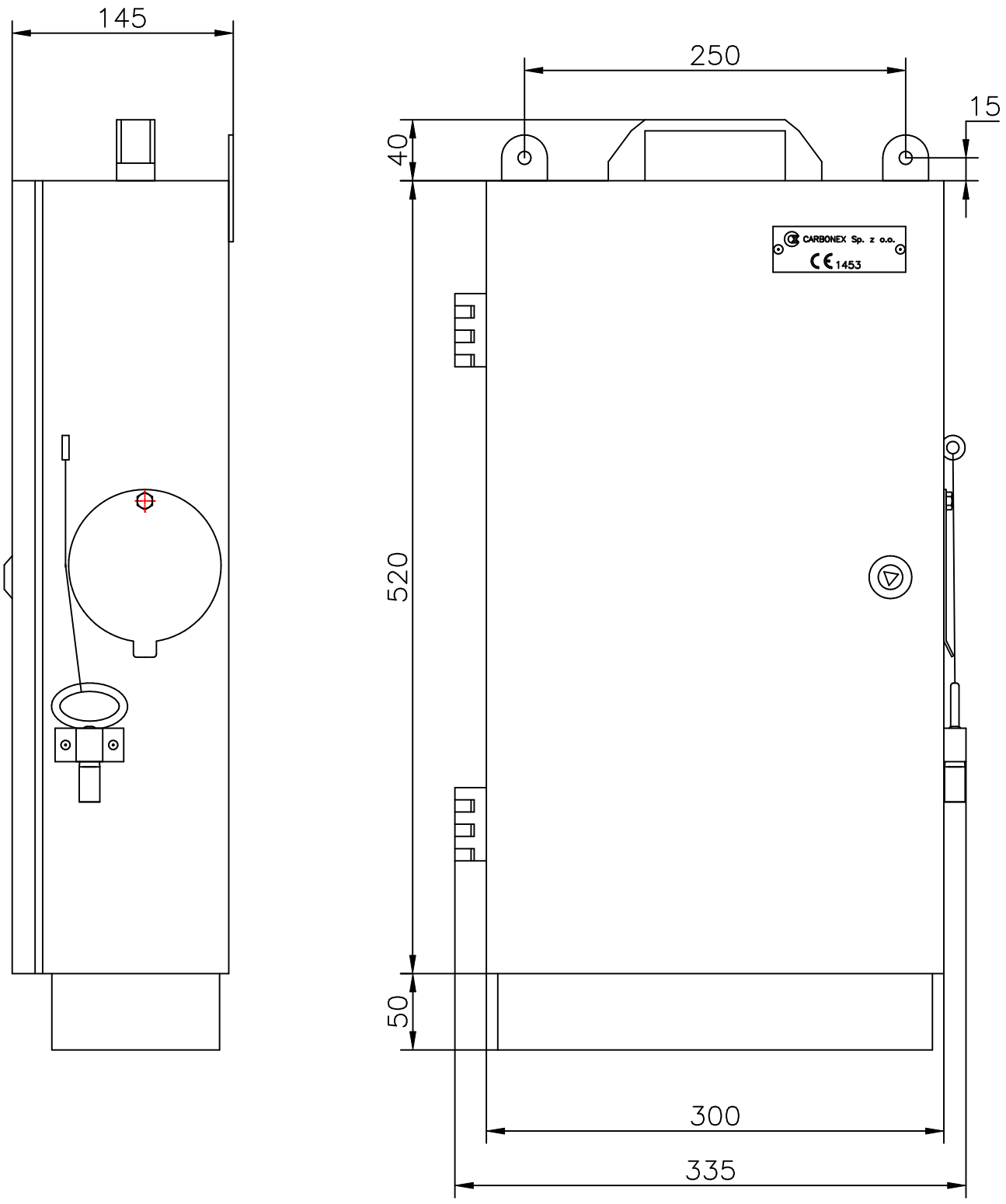
Designed by	T. Jackiewicz		Material	Name	Weight
Drawn by	R. Rosik			Cage device – outline drawing	
Checked by	R. Giel				
Manager	R. Giel				
Scale	CARBONEX Sp. z o.o. AutoCAD LT97 lic 61000014570		Date 04.2013	Drawing number 28S.01	Sheet



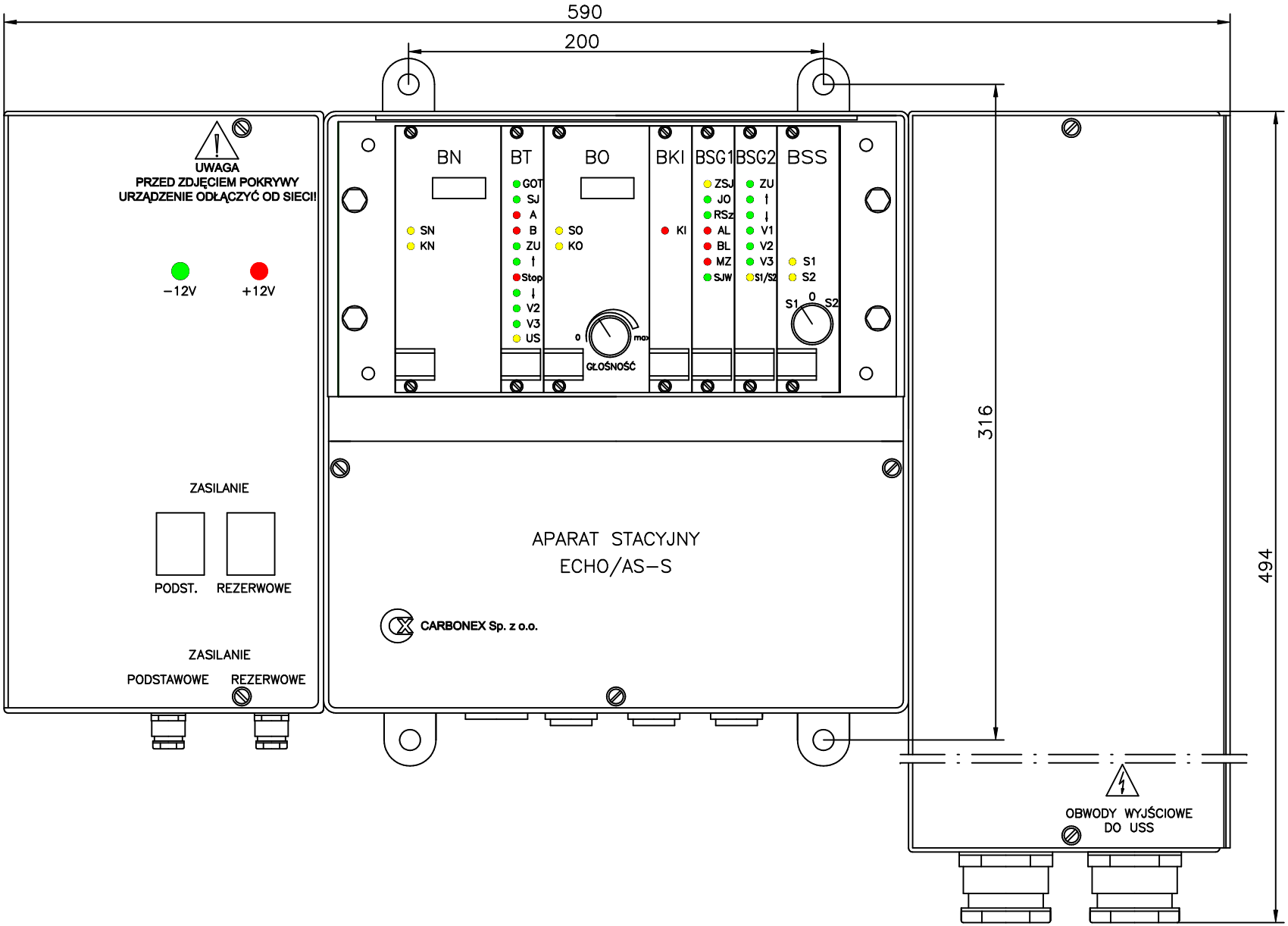
Designed by	T. Jackiewicz			Material	Name	Weight
Drawn by	R. Rosik				Cage device – block diagram	
Checked by	R. Giel					
Manager	R. Giel					
Scale	CARBONEX Sp. z o.o. AutoCAD LT97 lic 61000014570			Date 04.2013	Drawing number 28S.01.S.01	Sheet



Item	Part (unit) name	Quantity	Drg.or Standard No.	Material	Remarks
Designed by	T. Jackiewicz		Material	Name	Weight
Drawn by	R. Rosik			Cage device – assembly diagram	
Checked by	R. Giel				
Manager	R. Giel				
Scale	CARBONEX Sp. z o.o. AutoCAD LT97 lic 61000014570		Date 04.2013	Drawing number 28S.01.S.02	Sheet

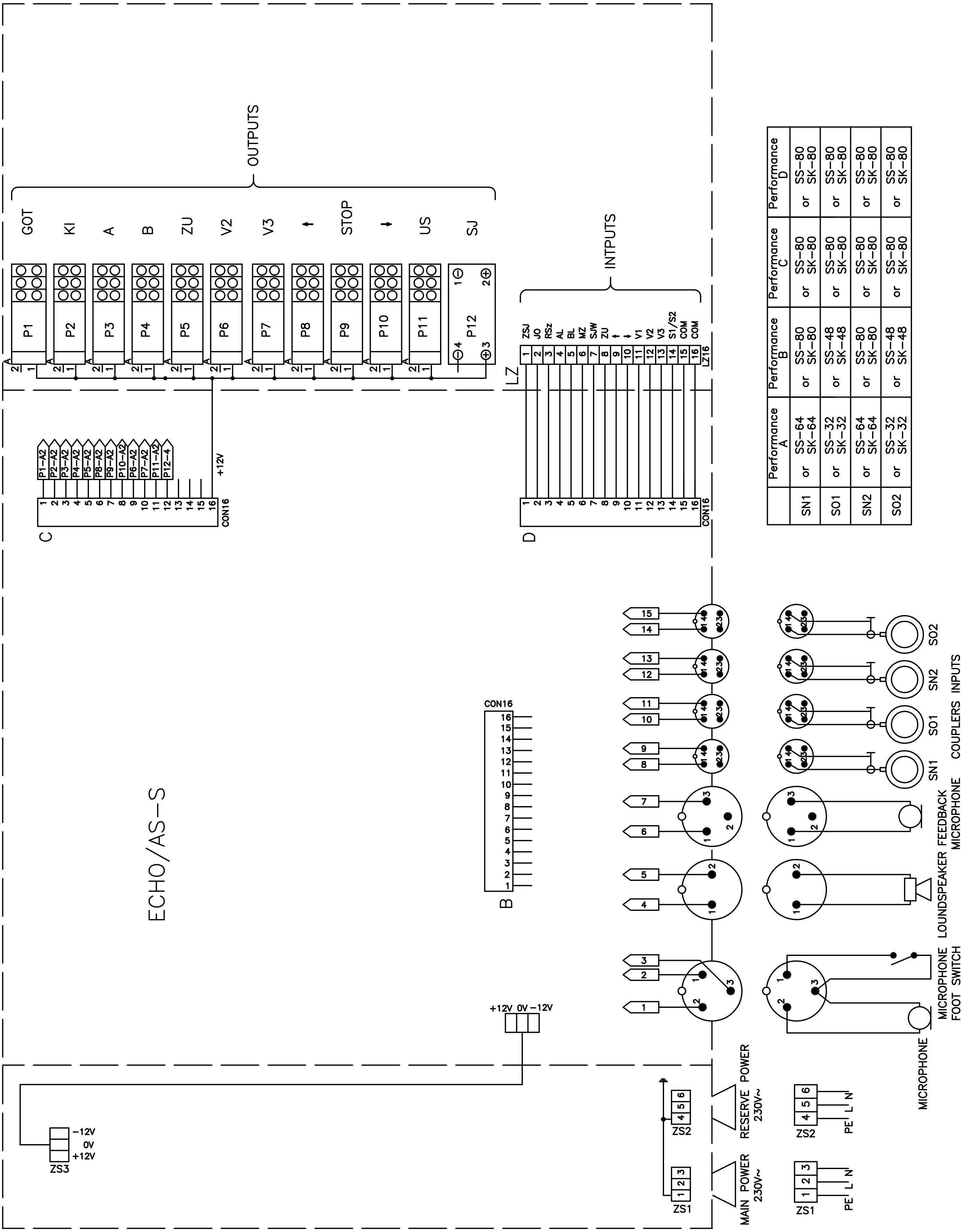


Designed by	T. Jackiewicz			Material	Name	Weight
Drawn by	R. Rosik				Cage device – box type SAKN	
Checked by	R. Giel					
Manager	R. Giel					
Scale	CARBONEX Sp. z o.o. AutoCAD LT97 lic 61000014570			Date 04.2013	Drawing number 28.01.05	Sheet



Item	Part (unit) name	Quantity	Drg.or Standard No.	Material	Remarks
Designed by	T. Jackiewicz		Material	Name: Headframe unit – outline drawing	Weight
Drawn by	R. Rosik				
Checked by	R. Giel				
Manager	R. Giel				
Scale	CARBONEX Sp. z o.o. AutoCAD LT97 lic 61000014570		Date 04.2013	Drawing number 28S.02	Sheet

Designed by	T. Jackiewicz			Material	Name	Weight
Drawn by	R. Rosik				Headframe unit – block diagram	
Checked by	R. Giel					
Manager	R. Giel					
Scale	CARBONEX Sp. z o.o. AutoCAD LT97 lic 61000014570			Date 04.2013	Drawing number 28S.02.S.01	Sheet

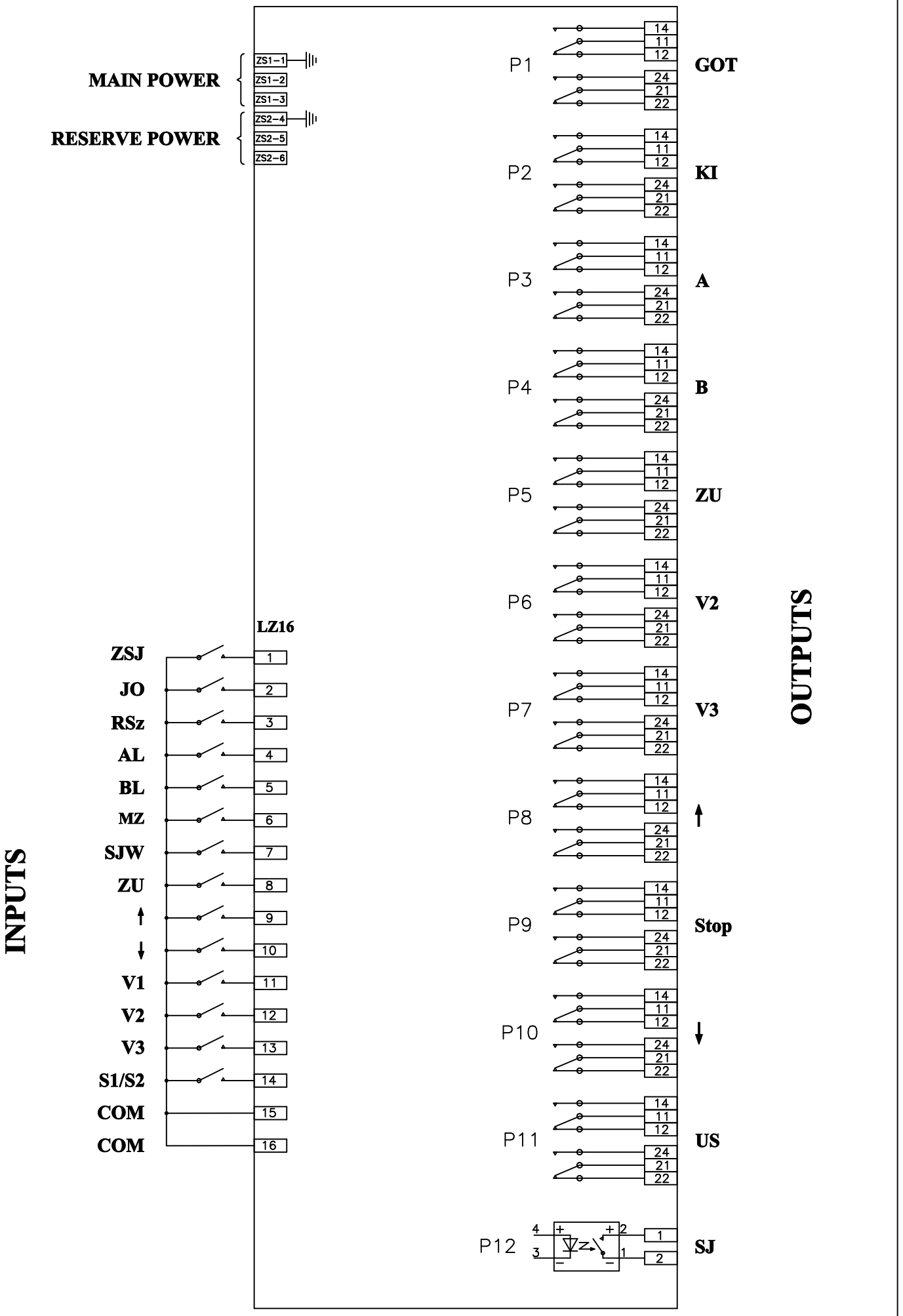


	Performance A	Performance B	Performance C	Performance D
SN1	SS-64 or SK-64	SS-80 or SK-80	SS-80 or SK-80	SS-80 or SK-80
SO1	SS-32 or SK-32	SS-48 or SK-48	SS-80 or SK-80	SS-80 or SK-80
SN2	SS-64 or SK-64	SS-80 or SK-80	SS-80 or SK-80	SS-80 or SK-80
SO2	SS-32 or SK-32	SS-48 or SK-48	SS-80 or SK-80	SS-80 or SK-80

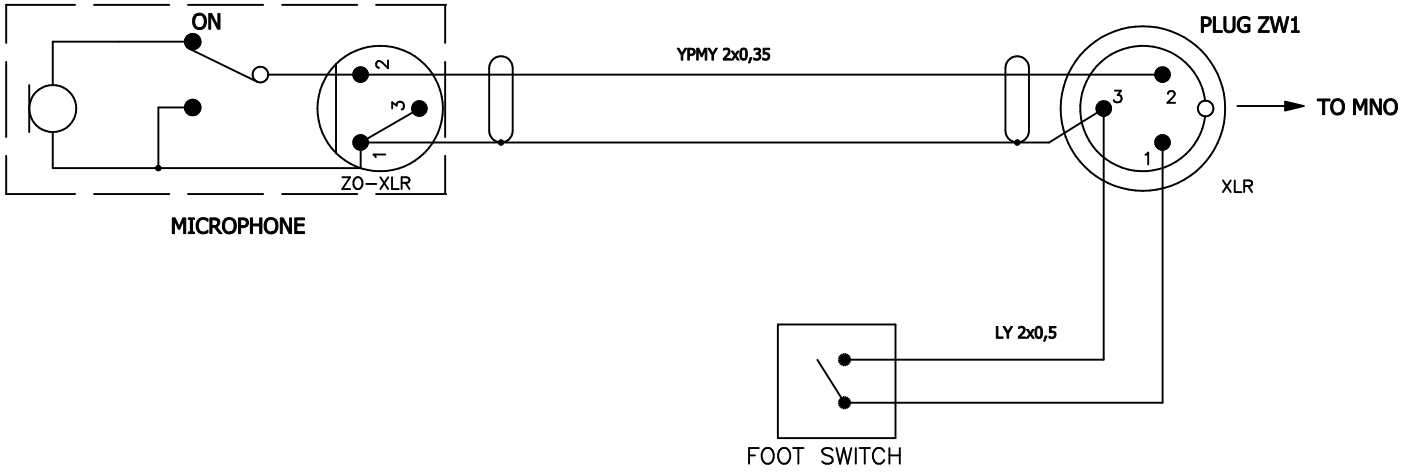
Item	Part (unit) name	Quantity	Drg.or Standard No.	Material	Remarks

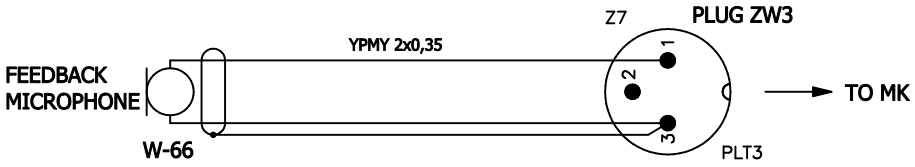
		Material	Name	Weight
Designed by	T. Jackiewicz		Headframe unit – assembly diagram	
Drawn by	R. Rosik			
Checked by	R. Giel			
Manager	R. Giel			
Scale	CARBONEX Sp. z o.o. AutoCAD LT97 lic 61000014570	Date 04.2013	Drawing number 28S.02.S.02	Sheet

ECHO/AS–S

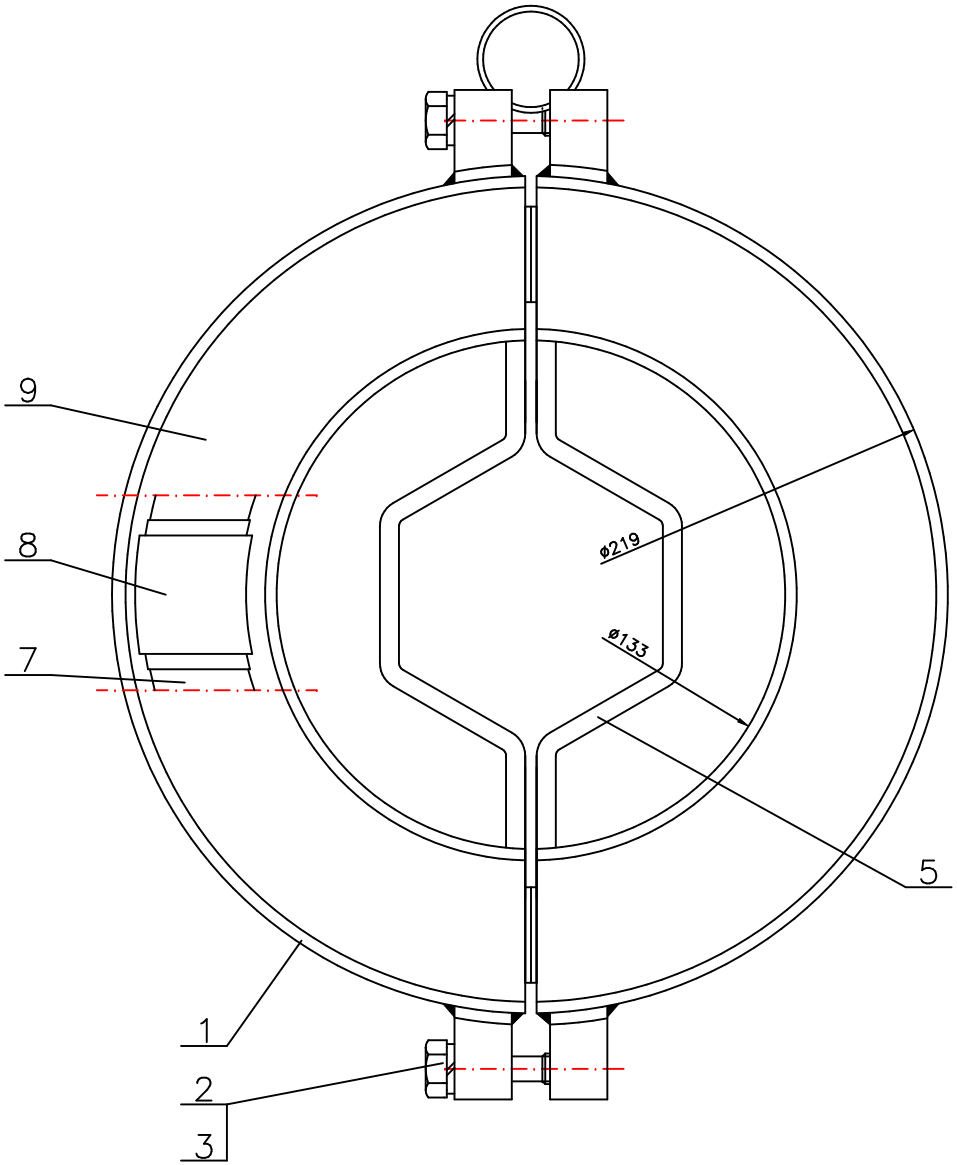


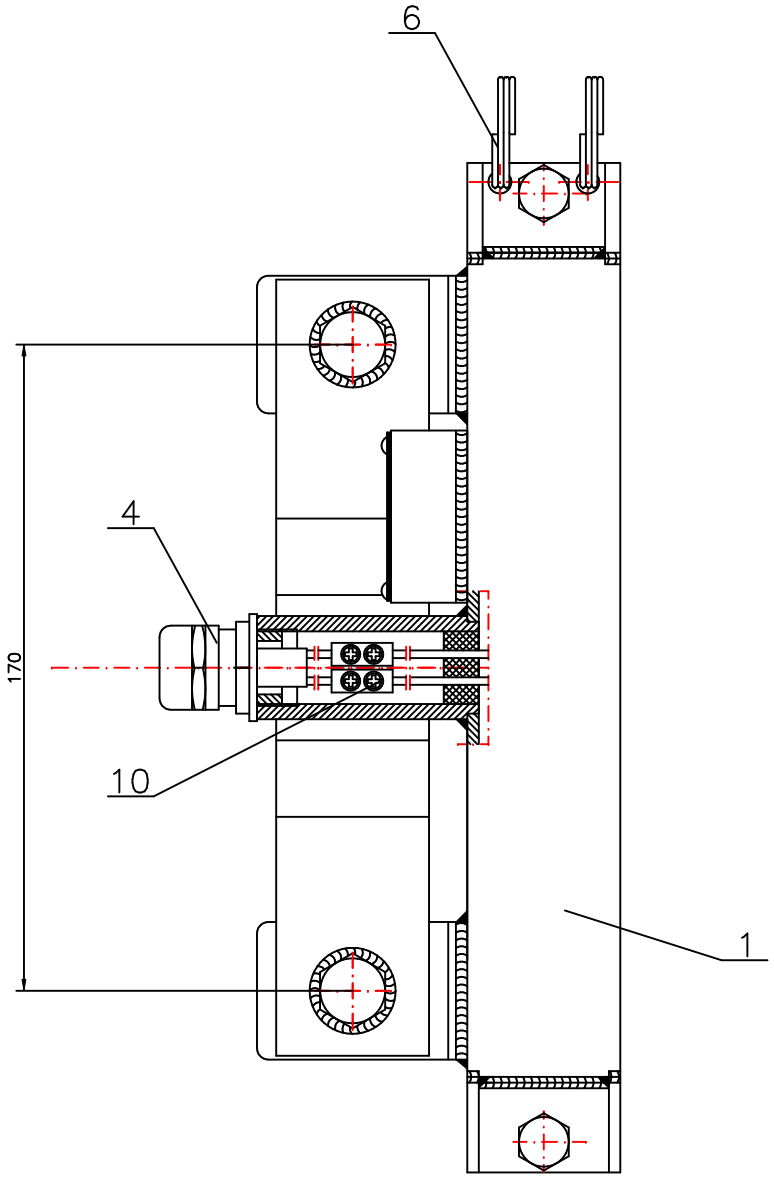
Designed by	T. Jackiewicz	Name	Headframe unit – input/output circuits
Drawn by	R. Rosik		
Manager	R. Giel		
CARBONEX Sp. z o.o. AutoCAD LT97 lic. 610–00014570		Date 04.2013	Drawing number 28S.02.S.03





Item	Part (unit) name		Quantity	Drg.or Standard No.	Material	Remarks
Designed by	T. Jackiewicz			Material	Name Headframe unit – diagram of microphone and feedback microphone	Weight
Drawn by	R. Rosik					
Checked by	R. Giel					
Manager	R. Giel					
Scale	CARBONEX Sp. z o.o. AutoCAD LT97 lic 61000014570			Date 04.2013	Drawing number 28.02.S.04	Sheet

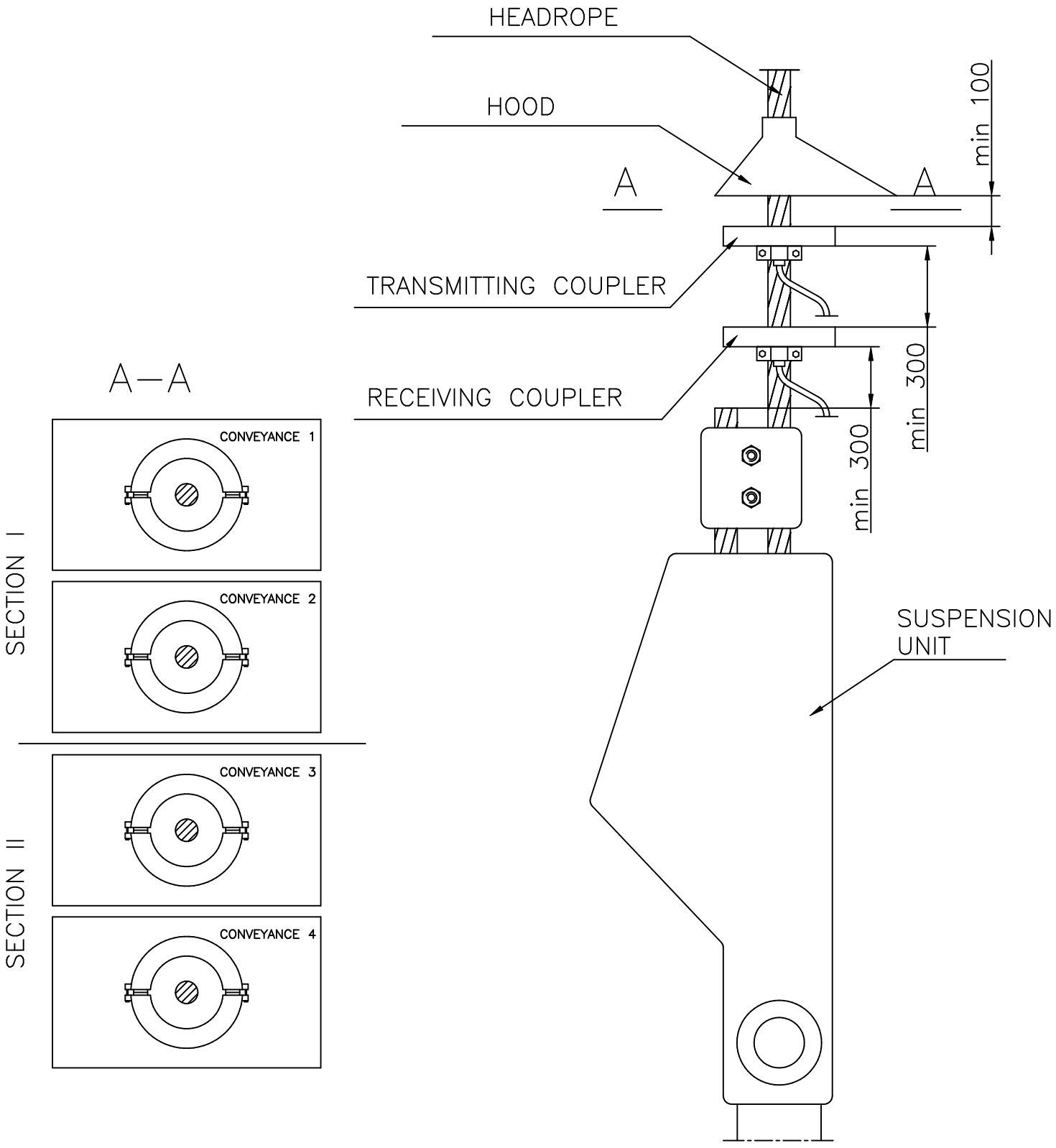




NOTE:
ALL DIMENSIONS IN MILIMETERS

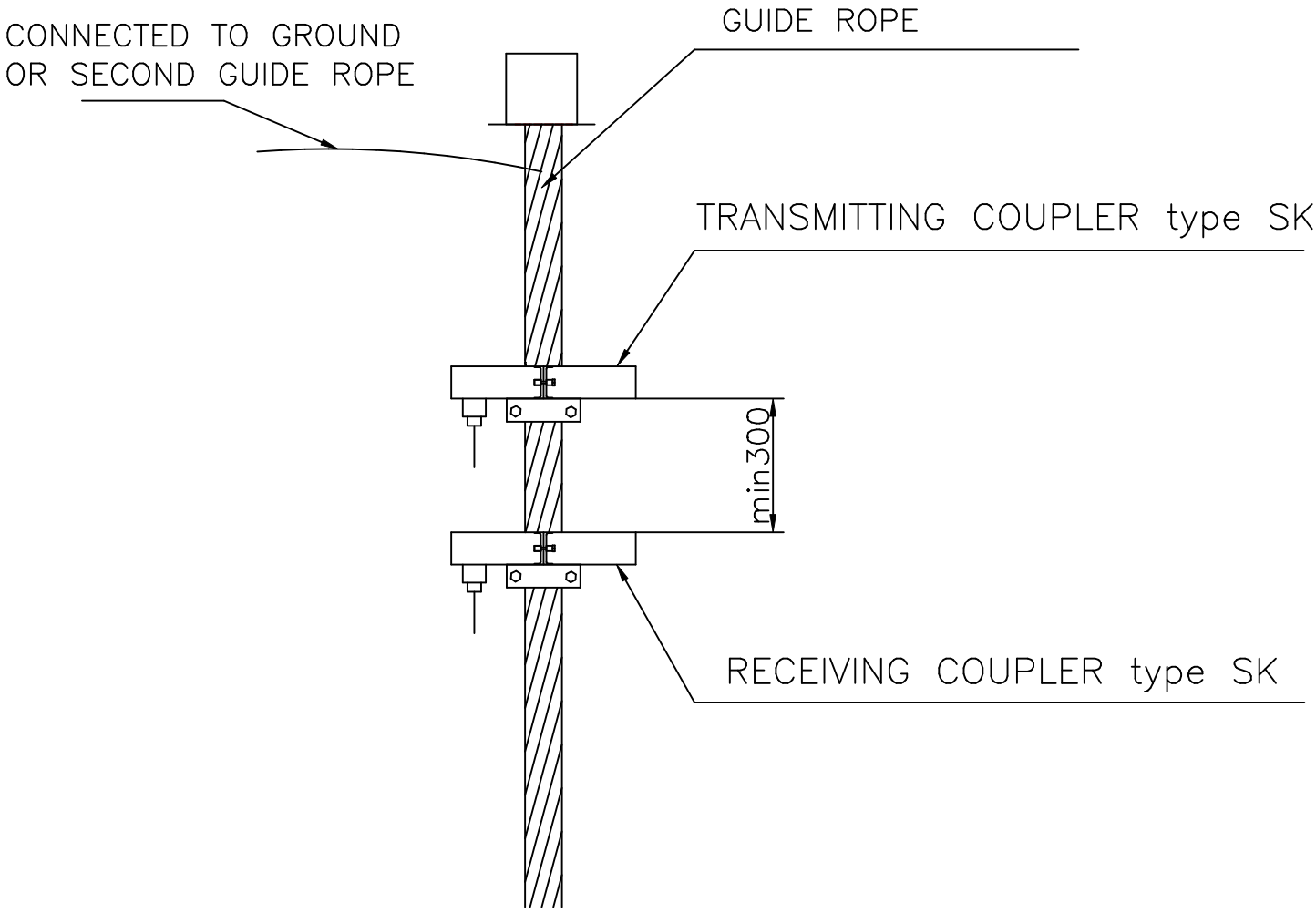
Item	Part (unit) name	Quantity	Drg.or Standard No.	Material	Remarks
10	TERMINAL BLOCK	1			Sp.POKÓJ
9	ENCAPSUCATING COMPOUND	0.5l			CIBA
8	COIL	1		LgY 0,75mm^2	
7	FERRITE CORE	kpl.		EPCOS	
6	PROTECTIVE RING	1			
5	ROPE CLAMP	2	28.03.005		Fe/Zn9c
4	GLAND PG13,5	1			
3	SPRING WASHER Z8,2	2	PN-M-82008:1977		Fe/Zn9c
2	BOLT M8X40	2	28.03.002	M8X40	Fe/Zn9c
1	ENCLOSURE	1	28.03.001	ST3s	Fe/Zn9c

Designed by	T. Jackiewicz	Material	Name	Weight
Drawn by	R. Rosik		Coupler type SK – outline drawing	
Checked by	R. Giel			
Manager	R. Giel			
Scale 1:1	CARBONEX Sp. z o.o. AutoCAD LT97 lic 61000014570	Date 04.2013	Drawing number 28.03	Sheet



NOTE:
ALL DIMENSIONS IN MILIMETERS

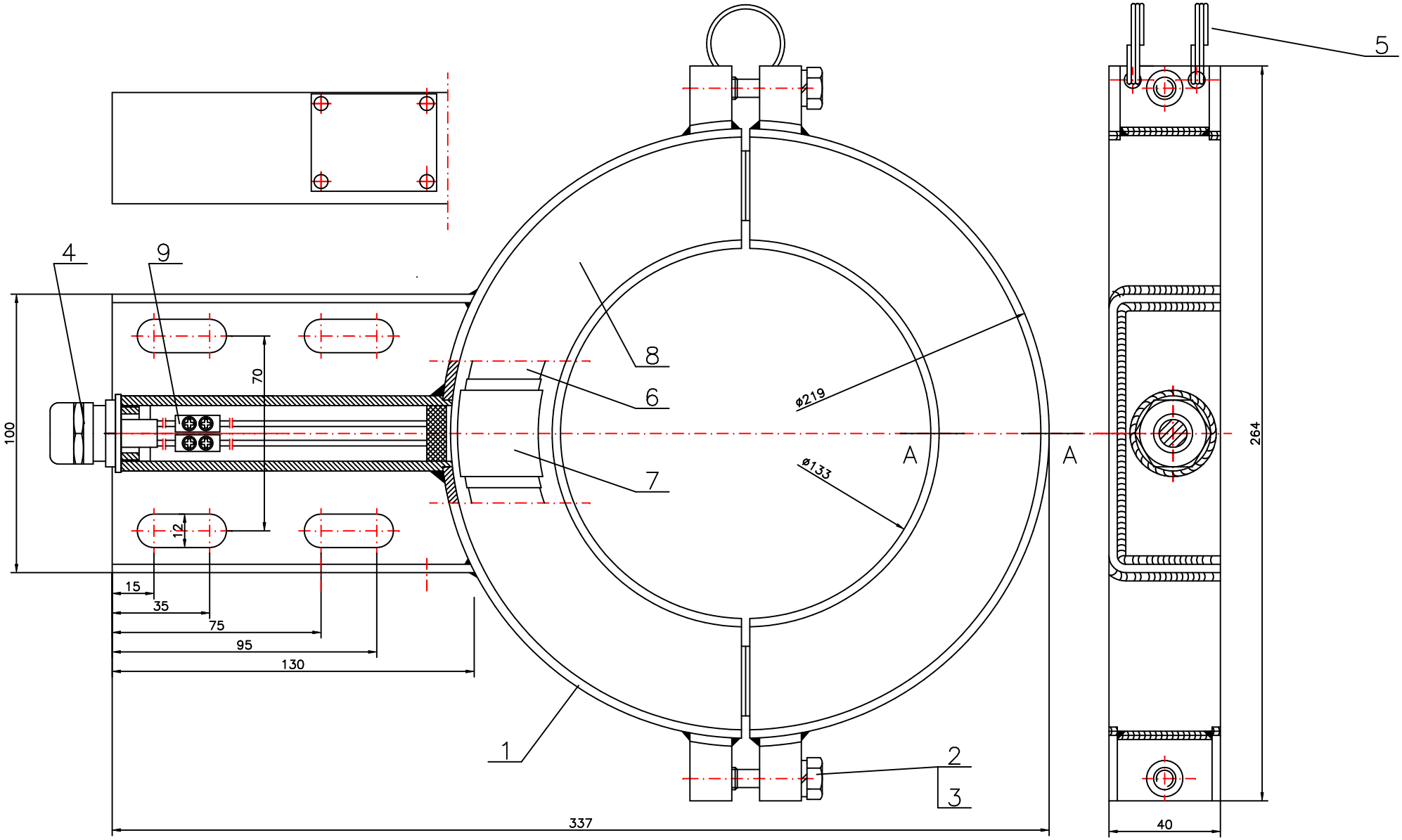
Item	Part (unit) name	Quantity	Drg.or Standard No.	Material	Remarks
Designed by	T. Jackiewicz		Material	Name: Coupler type SK – installation drawing variant 1	Weight
Drawn by	R. Rosik				
Checked by	R. Giel				
Manager	R. Giel				
Scale	CARBONEX Sp. z o.o. AutoCAD LT97 lic 61000014570		Date 04.2013	Drawing number 28.03.M1	Sheet



NOTE:

ALL DIMENSIONS IN MILIMETERS

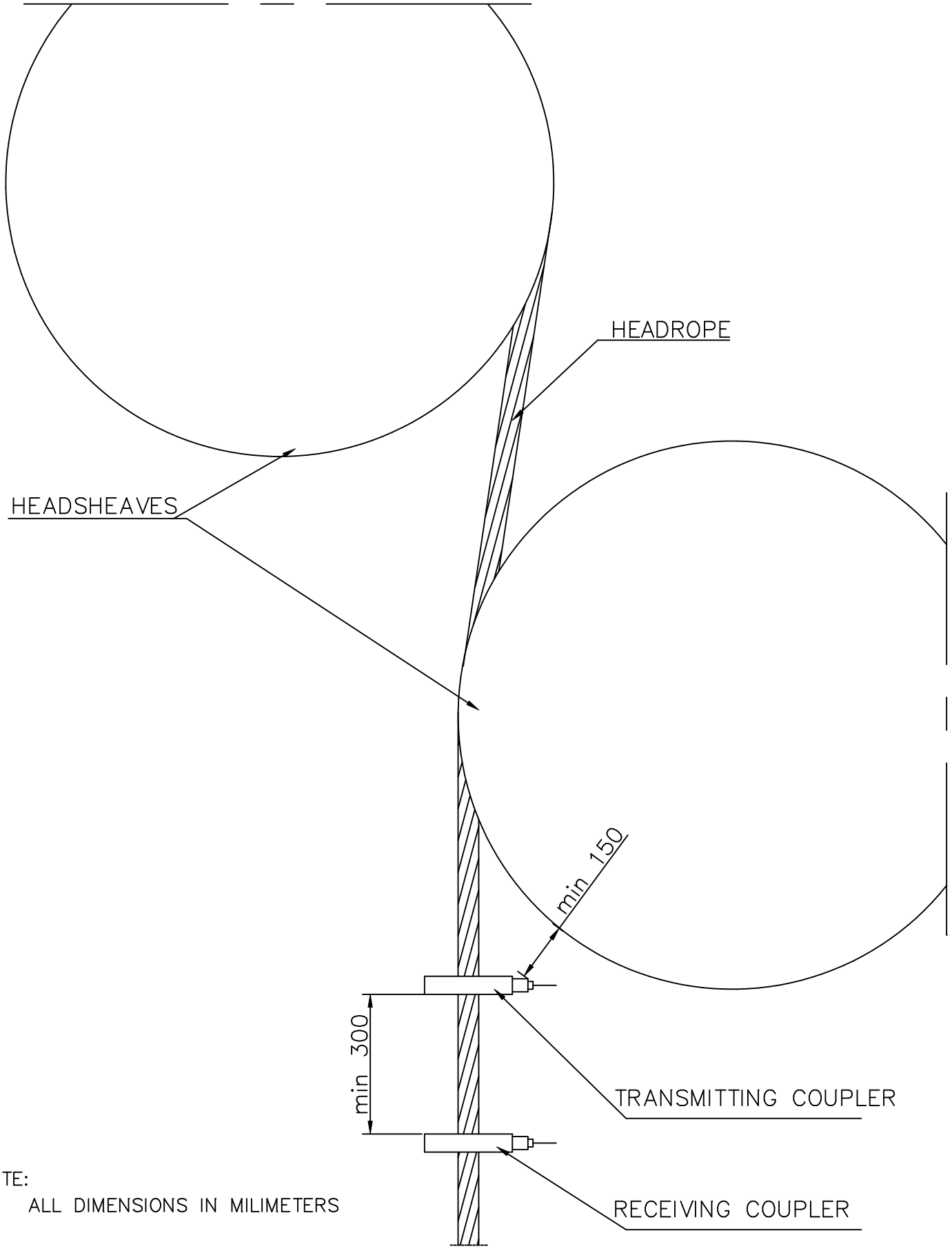
Item	Part (unit) name		Quantity	Drg.or Standard No.	Material	Remarks
Designed by	T. Jackiewicz			Material	Name Coupler type SK – installation drawing variant 2	Weight
Drawn by	R. Rosik					
Checked by	R. Giel					
Manager	R. Giel					
Scale	CARBONEX Sp. z o.o. AutoCAD LT97 lic 61000014570			Date 04.2013	Drawing number 28.03.M2	Sheet



NOTE:
ALL DIMENSIONS IN MILIMETERS

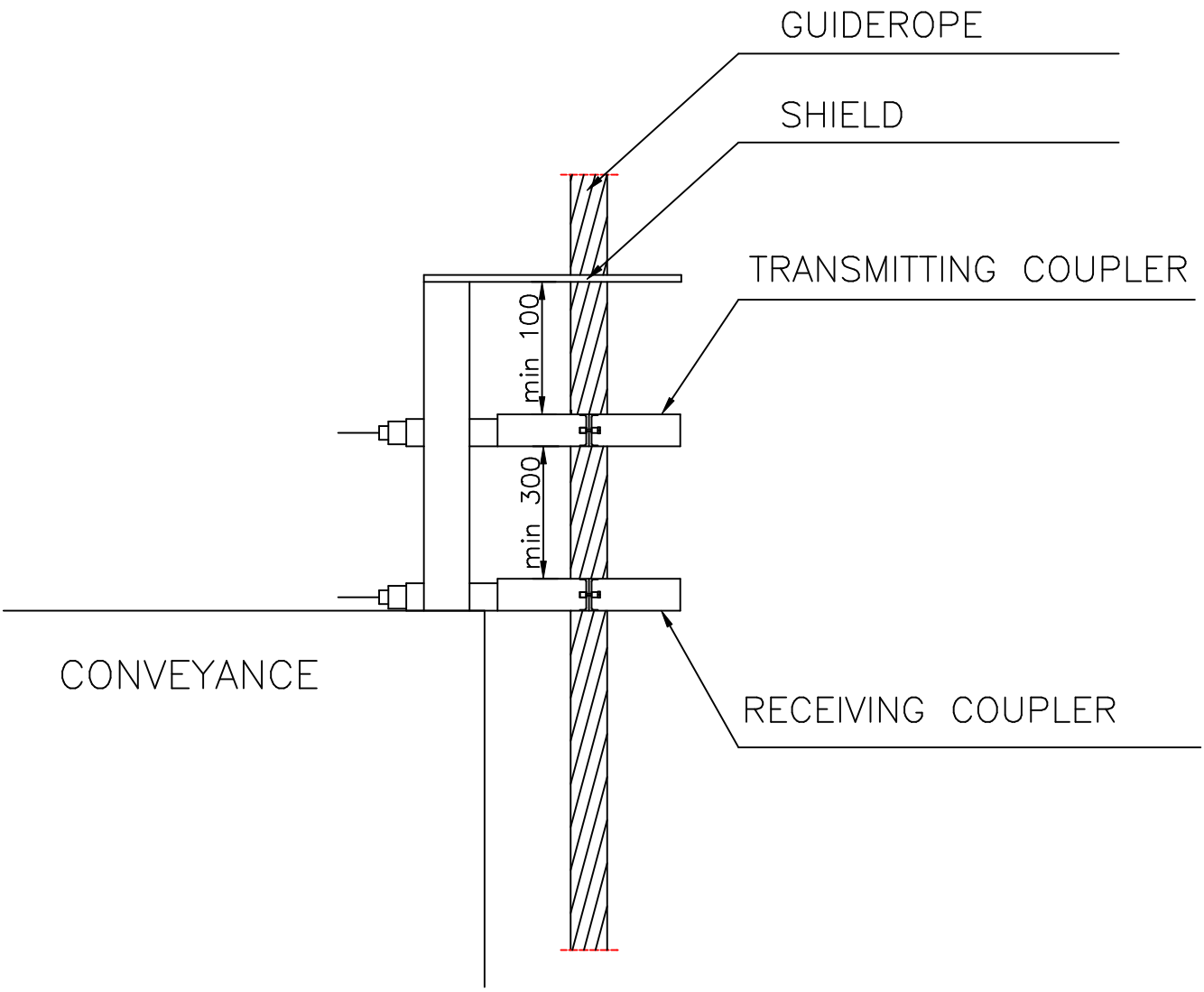
Item	Part (unit) name	Quantity	Drg.or Standard No.	Material	Remarks
9	TERMINAL BLOCK	1			Sp.POKÓJ
8	ENCAPSUCATING COMPOUND	0.5l			CIBA
7	COIL	1		LgY 0,75mm^2	
6	FERRITE CORE	kpl.		EPCOS	
5	PROTECTIVE RING	1			
4	GLAND PG13,5	1			
3	SPRING WASHER Z8,2	2	PN-M-82008:1977		Fe/Zn9c
2	BOLT M8X40	2	28.03.002	M8X40	Fe/Zn9c
1	ENCLOSURE	1	28.03.001	ST3s	Fe/Zn9c

Designed by	T. Jackiewicz	Material	Name	Weight
Drawn by	R. Rosik		Coupler type SK – outline drawing	
Checked by	R. Giel			
Manager	R. Giel			
Scale 1:1	CARBONEX Sp. z o.o. AutoCAD LT97 lic 61000014570	Date 04.2013	Drawing number 28.04	Sheet



NOTE:
ALL DIMENSIONS IN MILIMETERS

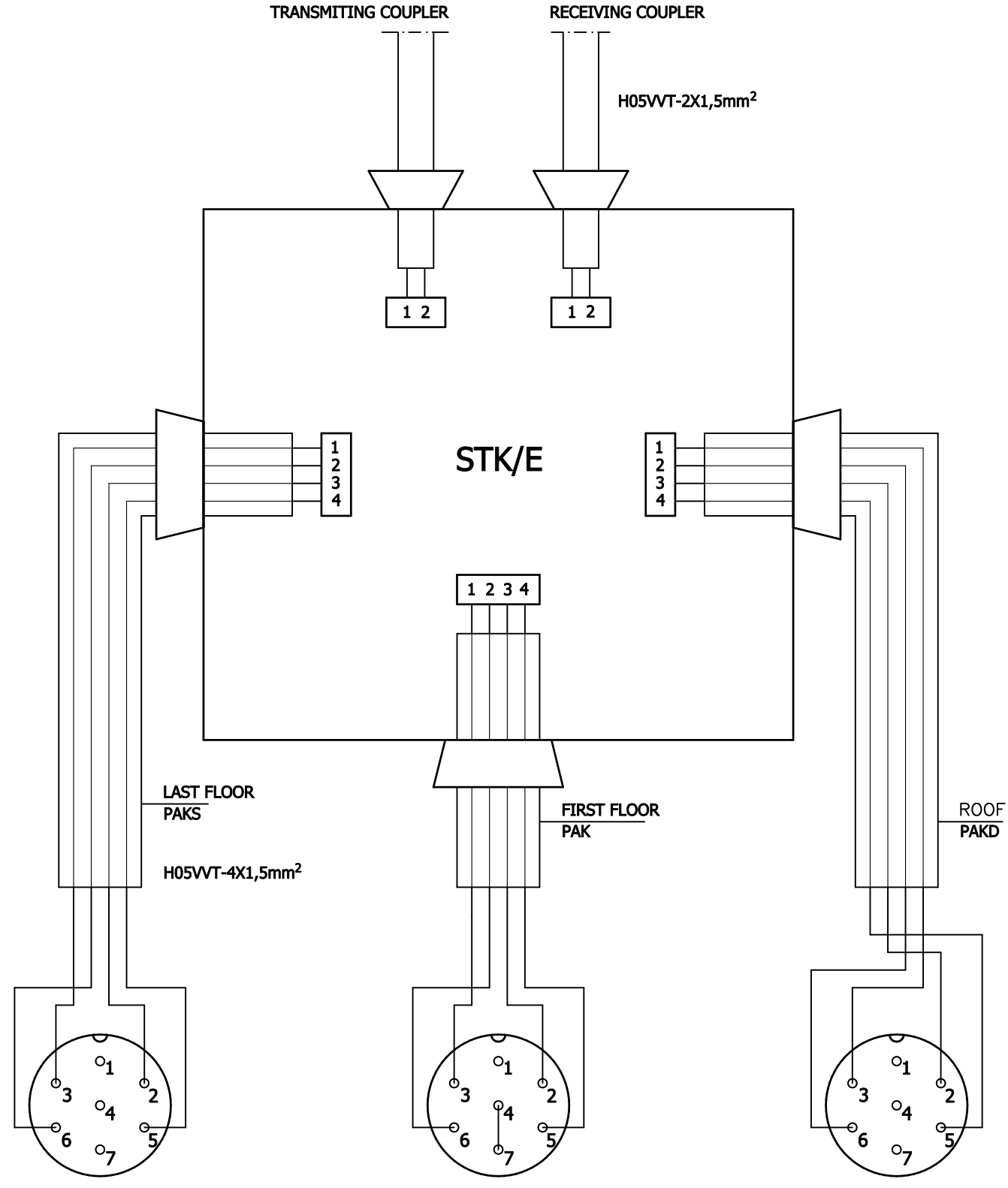
Item	Part (unit) name		Quantity	Drg.or Standard No.	Material	Remarks
Designed by	T. Jackiewicz			Material	Name	Weight
Drawn by	R. Rosik				Coupler type SS – installation drawing variant 1	
Checked by	R. Giel					
Manager	R. Giel					
Scale	CARBONEX Sp. z o.o. AutoCAD LT97 lic 61000014570			Date 04.2013	Drawing number 28.04.M1	Sheet



NOTE:

ALL DIMENSIONS IN MILIMETERS

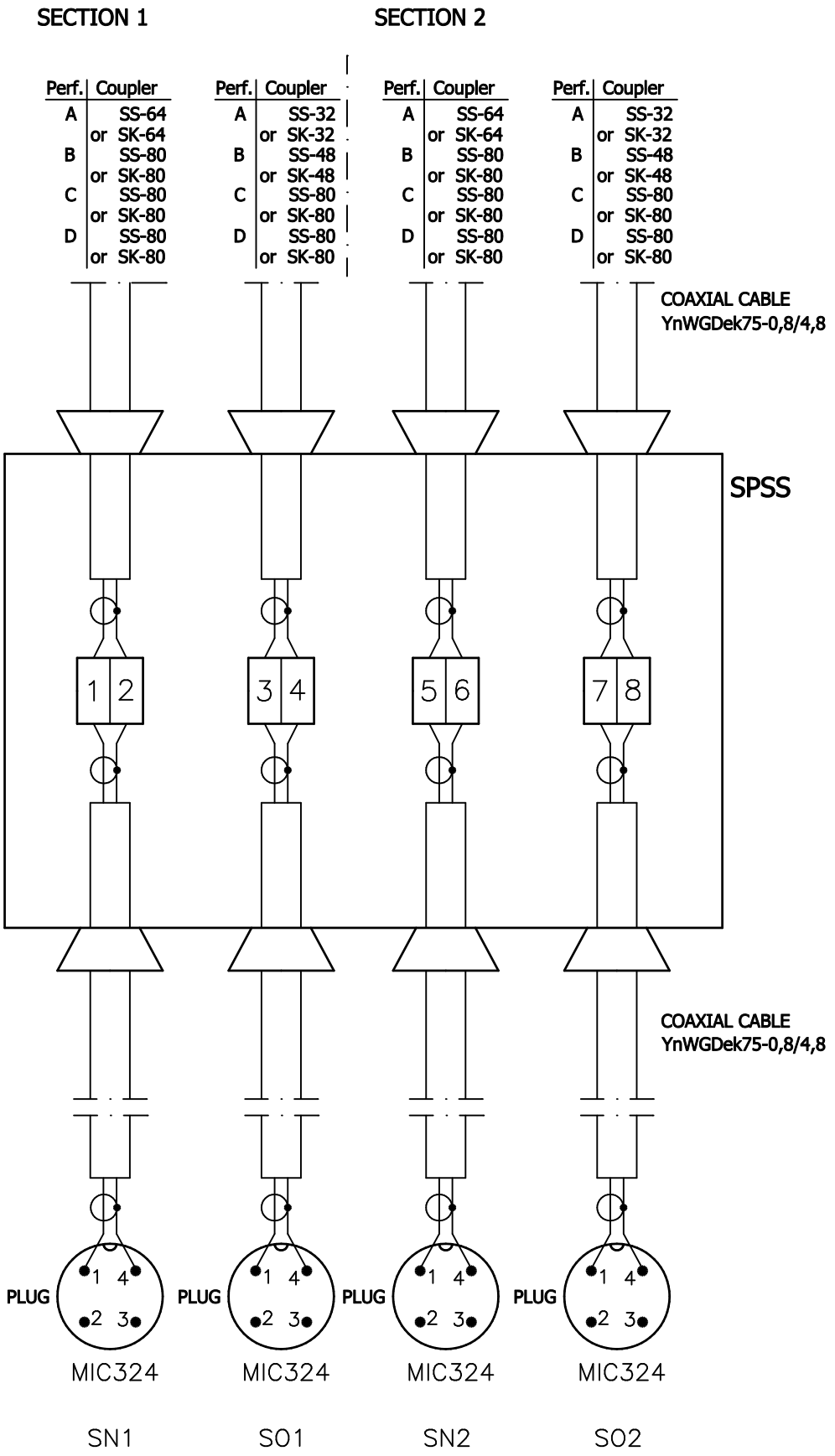
Item	Part (unit) name	Quantity	Drg.or Standard No.	Material	Remarks
Designed by	T. Jackiewicz		Material	Name: Coupler type SS – installation drawing variant 2	Weight
Drawn by	R. Rosik				
Checked by	R. Giel				
Manager	R. Giel				
Scale	CARBONEX Sp. z o.o. AutoCAD LT97 lic 61000014570		Date 04.2013	Drawing number 28.04.M2	Sheet



Pin	Inductance	Perf.
3-6	178uH	A tr.
2-5	40uH	A re.
3-6	80uH	B tr.
2-5	40uH	B re.
3-6	40uH	C tr.
2-5	40uH	C re.
3-6	40uH	D tr.
2-5	40uH	D re.

PIN 4–7
CONNECTED FOR MAN RIDING

Item	Part (unit) name	Quantity	Drg.or Standard No.	Material	Remarks
Designed by	T. Jackiewicz		Material	Name: Junction box type STK/E –interconnect wiring diagram	Weight
Drawn by	R. Rosik				
Checked by	R. Giel				
Manager	R. Giel				
Scale	CARBONEX Sp. z o.o. AutoCAD LT97 lic 61000014570		Date 04.2013	Drawing number 28.05.S.01	Sheet



Item	Part (unit) name	Quantity	Drg.or Standard No.	Material	Remarks
Designed by	T. Jackiewicz		Material	Name: Junction box type SPSS –interconnect wiring diagram	Weight
Drawn by	R. Rosik				
Checked by	R. Giel				
Manager	R. Giel				
Scale	CARBONEX Sp. z o.o. AutoCAD LT97 lic 61000014570		Date 04.2013	Drawing number 28.06.S.01	Sheet