Contract for the delivery of Active Hydrogen Maser (H-maser)

(hereinafter the "Contract")
Buyer Contract No: 290/2021
Seller Contract No: 63/21
concluded within the meaning of provisions of Section 2079 et seq. of Act No 89/2012, the Civil Code, as amended (hereinafter the “Civil Code”), between

the Buyer:

Name:	**CESNET, interest association of legal entities**
Registered in:	the Register of Associations kept by the Municipal Court in Prague, file no L 58848
Registered office:	Zikova 1903/4, 160 00 Prague 6
ID No:	63839172
Tax ID:	CZ63839172
Bank details:	Komerční banka, a.s., Prague 6 Branch
Account No:	19-8482200297/0100
Represented by:	Ing. Jan Gruntorád, CSc., based on a written mandate by the Board of Directors

and

the Seller:

Name / firm:	**Systemics-PAB Sp. z o.o.**
Registered in:	NATIONAL COURT REGISTER (KRS) : No. 0000194884
Registered office:	ul. WOŁODYJOWSKIEGO, nr 46B, WARSZAWA, kod 02-724, POLSKA
ID No / REGON:	006910401
Tax ID:	PL1130023394
Bank details:	mBank S.A. FORMERLY BRE BANK S.A. (RETAIL BANKING) LODZ
Account No:	PL71 1140 1977 0000 3066 8400 1002, SWIFT: BREXPLPWXXX
Represented by:	Anna Szóstak, Independent Proxy

1. Introductory provisions

1.1. This Contract sets out the content of the legal relationship between the aforementioned parties. In case of doubt, the provisions of this Contract shall be construed in accordance with the tender specifications specified in the tender documentation, including the annexes, to the performance of the public contract entitled "Supply of Active Hydrogen Maser (H-maser) - II", hereinafter the "Public Contract", as well as in accordance with the results of the negotiations within the tender procedure and the Seller's tender submitted for the performance of this Public Contract, the technical and price parts of which form Annex 1 to this Contract.

2. Subject-matter of the contract

2.1. The subject-matter of this Contract is the Seller's obligation to deliver/provide the following to the Buyer:

2.1.1. **Delivery and transfer of ownership** of the complete Active Hydrogen Maser (H-maser), hereinafter the “H-maser” or “equipment”), including any software/firmware necessary for proper operation of the H-maser (hereinafter the “SW”), according to the technical parameters specified in Annex 1 of this Contract.

The Seller guarantees that:

- the delivered H-maser will be new, unused, genuine and fully functional and that the Seller is entitled to deliver it to the Czech Republic;

- the SW, which is integral part of the equipment, was created or acquired in accordance with legal regulations and that the Seller is entitled to deliver it / provide a licence.

2.1.2. **Installation**

The Seller shall install (by itself or its partner) the delivered equipment in the site of performance – Buyer´s registered office (as specified in paragraph 5.2 below). The price for installation is included in the contract price.

2.1.3. **Warranty**

The Seller also, as a part of performance of this Contract, provides the Buyer with a warranty for the quality and proper functioning of the delivered equipment pursuant to the provisions of Section 2113 et seq. of Act No 89/2012, the Civil Code (hereinafter the "Civil Code") for the period set out in sec. 5.1.2. below.

2.2. The Buyer undertakes to pay the Seller the price specified below for a properly provided performance.

3. Price for the subject-matter of performance

3.1. The total price for the performance of this Contract is **192 036 EUR**, excluding VAT.

3.2. Detailed price specification is provided in Annex 1 to this Contract.

3.3. The price for performance of this Contract was determined on the basis of the results of the negotiations within the tender procedure and Seller's tender submitted to the tender procedure for the Public Contract and it includes all fees and all other costs relating to the performance of the subject-matter of the Contract and it is the maximum possible price. The price includes installation service and warranty as specified in sec. 2.1.2. and 2.1.3. above and is based on the Incoterms DDP (Delivered Duty Paid).

3.4. VAT (if relevant) will be charged at the statutory rate in accordance with applicable and effective legal regulations.

4. Terms of payment

4.1. The price for performance of this Contract shall be paid by the Buyer to the Seller on a one-time basis based on the Seller's invoice (hereinafter the "Invoice"), which the Seller is entitled to issue after delivery and installation of the equipment (see paragraphs 6.1. and 6.2.).

4.2. The invoice must, as an annex, include a copy of the relevant acceptance report signed by the authorized person of the Buyer (see paragraph 6.1. of this Contract), otherwise it does not create the obligation of the Buyer to pay. The Buyer accepts electronic invoice, provided that it meets the legal conditions (of Czech law) and that it includes all necessary data and information according to the law and this Contract. In such a case, the electronic invoice shall be sent to the e-mail podatelna@cesnet.cz.

4.3. The invoice is due within 15 days from the date of its delivery to the Buyer. The invoice must contain all the particulars of a proper accounting and tax document within the meaning of the relevant legal provisions. The invoice must also contain **a reference to this Contract** (at least the Buyer´s contract number given in the header of this Contract). If the invoice does not have the appropriate particulars, the Buyer is entitled to return it to the Seller within the maturity date for completion or correction without being in default with the maturity date; the maturity period starts to run again from the delivery of a duly completed or corrected invoice.

4.4. The Buyer shall pay the Seller for the performance of this Contract by non-cash transfer to the Seller's account provided on the cover page of this Contract, or to the account indicated on the invoice. The Seller bears all the bank costs for international financial transfer. The Buyer bears all costs associated with currency exchange.

4.5. The Buyer does not provide advance payments.

4.6. <u>If the Seller´s registered office is in the Czech Republic, the following shall apply:</u>

In case the Seller is, at the time of performance of this Contract, declared by the official Czech tax authority as an "unreliable taxpayer" pursuant to Section 106a of Czech Act No 235/2004 on value added tax, as amended (hereinafter the "VAT Act"), or if the Seller's account, which the Seller provided on the invoice issued by the Seller will not be published by the tax authority pursuant to Section 98(d) of the VAT Act, or if the Seller's account, which the Seller provided on the invoice issued by the Seller will be an

account maintained by a payment service provider outside the Czech Republic, the performance under this Contract shall be considered paid even in the case the Buyer pays the price without the VAT and the VAT will be paid directly to the account of the relevant Czech tax authority.

5. Time and site of performance

5.1. The time of performance is determined as follows:

5.1.1. **the delivery of the equipment (including SW, if relevant) and its installation** according to paragraphs 2.1.1. and 2.1.2. of this contract shall be executed by the Seller no later **than 120 days from the date of conclusion of this Contract**;

5.1.2. **the warranty** period for the delivered equipment is **36 months**. The warranty starts on the day of signing the acceptance report (see paragraph 6.1.).

5.2. The site of performance of this Contract is the registered office of the Buyer as defined in the header of this Contract. The services included within the warranty can be provided by the Seller also remotely (through telephonic / e-mail support, through electronic provision of the SW updates etc.).

6. The method of acceptance and the rights and obligations of the parties in the course of performing the contract

6.1. Acceptance shall take place upon delivery and installation of the equipment at the site of performance and shall be confirmed by the acceptance report signed by the representatives of both parties. The Buyer is entitled to refuse to accept the equipment if it is defective at the moment of the handover. The equipment is considered delivered and installed and the Seller's obligation to deliver and install the equipment is performed only at the moment of handover and installation of the non-defective equipment to the Buyer.

6.2. In regard to warranty, a duly provided performance shall mean the due and timely provision of such performance in accordance with the terms and conditions specified in this Contract.

6.3. Defects / faults / malfunctions shall be reported by the Buyer under warranty support:

- on phone number: [redacted]
- by email: support_t[redacted]

The Seller undertakes to notify the Buyer immediately of any change in contact details for reporting defect, at least 48 hours before the new contacts start to be used.

6.4. The Seller undertakes to remove defects within the warranty within 30 days from the date of their reporting by the Buyer or to supply the Buyer with new equipment. Defective equipment for repair in case of claiming warranty rights, repaired equipment or new equipment in case of replacement will always be handed over at the site of performance according to paragraph 5.2. The Seller bears all the costs associated with sending of the defective equipment for reparation and / or with sending of the new / repaired equipment.

6.5. Rights stemming from defective performance are governed by the provision of Section 2099 et seq. of the Civil Code, unless otherwise specified in this Contract.

6.6. The Buyer undertakes to provide the Seller with proper cooperation in the course of performance of this contract. If the Buyer fails to cooperate, the period of performance will be extended by the length of the time period when the Seller could not comply with its obligations due to the failure of the Buyer to cooperate.

6.7. The Seller is obliged to deliver only genuine and new equipment and is required to provide proof of its origin at the Buyer's request at any time. The Seller is also obliged to promptly provide the relevant certificates and attestations for the equipment at the Buyer's request, for example (but not limited to) that the delivered equipment complies with the relevant technical standards and legal regulations valid in the Czech Republic.

6.8. The Seller undertakes to provide the Buyer with servicing even in the event that the defects (faults) of the delivered equipment or individual components arise from improper storage or placement, unprofessional intervention or manipulation, mechanical damage etc. by the Buyer, or by using the equipment not in accordance with the manufacturer's technical conditions or due to natural disaster; the price for service in

these cases is not a part of the price for performance of this Contract and will it be agreed upon by the parties ad hoc (in advance if the situation allows it).

6.9. By signing this Contract, both parties undertake not to assign their rights or obligations to any third party without prior written consent of the other party.

6.10. The warranty service does not cover damage caused by using the device contrary to its intended use, including mechanical damage, attempts to repair outside the service.

6.11. The warranty service will expire in the event of any interference with the device software of equipment.

7. The property right, risk of damage to property and regulation of intellectual property rights

7.1. The property right to the equipment will pass to the Buyer at the moment of full payment of the price of the equipment. Payment is deemed to have been made at the moment of sending of the financial amount corresponding to the full price as set out in paragraph 3.1. to the Seller´s bank account.

7.2. The risk of damage passes to the Buyer at the moment the equipment is delivered and handed over to the Buyer.

7.3. If a part of the performance under this Contract by the Seller is the provision of any third party SW, the Seller is obliged to ensure that all necessary rights (licenses) to use such SW are transferred to the Buyer to perform the purpose of this Contract under the following conditions:

7.3.1. the Buyer shall be entitled to use all SW to exercise the right to the extent necessary for proper use of the equipment;

7.3.2. the right to use (the license) must be granted for unlimited time;

7.3.3. the price of the license is included in the total price of performance according to Article 3 of this Contract.

8. Liability

8.1. All parties are responsible for delay, defects and damage caused. The conditions and consequences of liability are based on this Contract and on generally binding legal regulations, in particular the Civil Code. The parties undertake to make every effort to prevent damage and to minimize the damage incurred.

8.2. None of the parties shall be liable for any damage caused as a result of circumstances that exclude liability within the meaning of the Civil Code (Section 2913(2)). In particular the Seller shall not be responsible for the delay if it is caused by circumstances resulted by Covid-19 circumstances such as acts of Polish or Czech government imposing administrative restrictions regarding transport of people and/or goods (i.e. quarantine or prohibition of crossing the border). The parties undertake to notify the other party without undue delay of liability excluding circumstances that arise and prevent the proper performance of the Contract and they undertake to exercise maximum effort to avert and overcome them.

8.3. The Seller is responsible for ensuring that the equipment delivered under this Contract will be unused (new) at the date of delivery, fully functional and will comply with the parameters set out in Annexe 1 of this Contract.

8.4. The Seller is responsible for having been entitled to provide a license for the SW to the required extent pursuant to paragraph 7.3. of this Contract.

9. Compensation for damage, contractual penalties and withdrawal

9.1. Compensation for damage incurred by one party to another is governed by the provisions of the Civil Code.

9.2. The Buyer is entitled to a contractual penalty amounting to 0.1% of the total price of performance pursuant to Article 3 of this Contract (excluding VAT) for each commenced day of delayed handover pursuant to paragraph 5.1.1, but no more than 10% of the total price of performance [except the situation when the delay is caused by circumstances mentioned above in paragraph 8.2]. The Buyer shall be entitled to set off any claim for a contractual penalty under this paragraph against the price the Buyer will be obliged to pay under this Contract. The Buyer has the right to withdraw from this Contract or to terminate it with immediate effect in the event of the Seller's delay in delivering performance for a period exceeding 30 days.

9.3. If during the performance of this Contract it becomes clear that the properties (in particular technical properties) of the delivered goods and/or services are demonstrably contrary to the information provided by the Seller in his tender (see Annex 1 of this Contract) and such wrong properties cannot be repaired easily (in period of 7 days), the Buyer shall have the right for a contractual penalty of CZK 100 000 (or equivalent in EUR or USD). At the same time, the Buyer shall have the right to withdraw from this Contract; however, such withdrawal will not affect the Buyer's right for the contractual penalty.

9.4. If the Buyer is in default in payment of the invoice duly made out and delivered to the Buyer by the Seller, the Seller shall be entitled to late payment interest of 0.1% of the outstanding amount for each commenced day of default in payment. The Seller is entitled to withdraw from this Contract if the Buyer is in default in payment of the purchase price (its part) for more than 30 days; the Seller's right to compensation of damage and the contractual penalty referred to in this paragraph shall remain unaffected.

9.5. Both parties have the right to withdraw from this Contract in the event of a repeated default by the other party to perform any obligation under this Contract. Claims for compensation for damage and contractual penalties until the date of withdrawal shall remain unaffected.

9.6. The amount of compensation for damage in accordance with this Contract in any direction and of any party is limited to CZK 500 000,- or EUR 19 400,- (depends on which is higher). No provision in regard to the contractual penalty or the actual payment of it shall affect the parties' claim for compensation for damage.

9.7. Any of the parties may, under the terms of this Contract, withdraw only from a part of the Contract, unless this is precluded by the nature of the performance.

9.8. The effects of withdrawal from the Contract (termination) will become effective when the written statement of will expressing the withdrawal (termination) is delivered to the other party.

10. Final provisions

10.1. The parties shall cooperate with each other and provide each other with all the information necessary for the proper performance of their respective obligations. The parties are obliged to inform the other party of any facts that will, are or may be important for the proper performance of the Contract.

10.2. The parties shall inform each other of any organisational change (e.g. change of telephone numbers, address, bank connection, etc.) without undue delay.

10.3. The parties are obliged to perform their obligations arising from this Contract so that there is no unnecessary delay in complying with individual deadlines and that there are no default regarding the maturity of individual monetary obligations.

10.4. All notifications between the parties relating to or stemming from the Contract must be made in writing and demonstrably delivered to the other party to the address specified in the Contract, unless otherwise specified or agreed upon by the parties.

10.5. By signing this Contract, the Seller acknowledges and agrees that:

10.5.1. the Seller becomes, in accordance with Section 2(e) of Act 320/2001, on Financial Control in Public Administration, as amended, a person obliged to cooperate in the performance of financial control; as part of this control, the Seller is obliged to allow inspection in accordance with the conditions stipulated by the mentioned Act and shall allow authorized inspection bodies access to those parts of the tender, contract and related documents that are subject to protection under special legal regulations (e.g. business secrets, classified information) provided that the requirements laid down by legal regulations (e.g. Act No 255/2012, on Inspection, as amended) are met;

10.5.2. the Seller is obliged to contractually ensure that the subsidy provider's representatives and, if applicable, other authorized persons are entitled to control its prospective subcontractors in a similar way;

10.5.3. in addition to Act No 134/2016, on Public Procurement, the procurement procedure, the performance of the Public Contract and the subsequent control are also pursuant to other legal regulations (especially Act No 320/2001, on Financial Control in Public Administration and Act No 255/2012, on Inspection (Inspection Code)).

10.6. The Seller acknowledges that pursuant to Section 219 of Act No 134/2016, On Public Procurement, as amended, the Buyer is obliged to publish this Contract on its profile (website https://zakazky.cesnet.cz/). The Seller agrees with publication of the contract in full text.

10.7. The contractual relationship established by this Contract is governed by the Civil Code.

10.8. The effective date of this Contract is the date of signature by the last party.

10.9. This Contract is made in electronic form and signed by the authorized representatives of the parties through electronic signature (in form of facsimile or digital signature based on qualified certificate issued by a Certification Authority listed on the Trusted List Browser on https://webgate.ec.europa.eu/tl-browser/#/).

10.10. The parties declare that this Contract was prepared according to their true and free will, they have read the Contract, agree with its content and in witness whereof they attach the signatures of their authorized representatives.

For the Buyer:

Date _____

Ing. Jakub Papírník

Digitálně podepsal Ing. Jakub Papírník
Datum: 2021.08.27 11:28:58 +02'00'

Ing. Jakub Papírník
director

For the Seller:

Date _____

Signature Not Verified
Dokument podpisany przez Anna Szóstak
Data: 2021.09.09 14:35:24 CEST

Anna Szóstak
Independent Proxy

List of annexes to the Contract:

Annex 1: Equipment specification - technical and price part of the Seller's tender

Annex 1 to the Contract

Equipment specification - technical and price part of the Seller's tender

TECHNICAL INFORMATION AND PRICE

SYSTEMICS PAB
Network Quality Experts

Subject-matter of the public contract - Supply of Active Hydrogen Maser (H-maser)	
3.1. The subject-matter of this public contract is the acquisition of the Active Hydrogen Maser	**VCH-1003M Std.**
3.2. Minimum technical requirements of the Contracting Authority for the equipment:	
3.2.1. at least one 10 MHz output;	2 outputs
3.2.2. at least one pulse per second (PPS) output;	1 output
3.2.3. all outputs to be 50 Ohm impedance;	YES
3.2.4. frequency stability 1.5 E-13 or better at 1 second averaging time;	**1.3 × 10-13**
3.2.5. frequency stability 2 E-15 or better1 at 10 000 seconds averaging time;	2.0 × 10-15
3.2.6.	
- phase noise -110 dBc/Hz or better1 at 1Hz offset, offset (10 MHz output);	**< -115**
- phase noise -145 dBc/Hz or better1 at 1 kHz, offset (10 MHz output);	< -149
3.2.7. magnetic sensitivity better1 than 5 E-14 per Gauss;	< 5×10-15/Gauss
3.2.8. temperature sensitivity better1 than 5 E-15 per degree Celsius.	< ±1.5×10-15/ºC.
3.3. The Contracting Authority also requires warranty of at least 24 months for the equipment.	36 months
3.4. Lifetime of the equipment should be at least 15 years.	>= 15 years
Atomic clocks participating in TAI statistics	YES
Total tender price (excl. VAT) (according to sec. 9. of the Tender Documentation)	**192 036.00 Euro**
Length of warranty	**36 months**
Utilization for calculation of **TAI time scale** (VCH-1003M ACTIVE H-MASER)	https://webtai.bipm.org/ftp/pub/tai/other-products/weights/w21.04 VCH-1003M – code number 41 53xx **is nine times listed with the best scores of TAI**
SLA - [redacted]	

In Warsaw, on 16.07.2021

Anna Szóstak PROXY

ACTIVE HYDROGEN MASER VCH-1003M Operations Manual 411141.03.2 O

SYSTEMICS PAB
Network Quality Experts

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Contents

1. INTRODUCTION

The VREMYA-CH Active Hydrogen Maser VCH-1003M is intended to be used as a source of high stable low noise sine signals at standard frequencies and one pulse per second timing signals. It can operate both as standalone instrument and as a reference of time and frequency measurement systems. Remote control and parameters monitoring through RS-232 interface is provided.

The main maser's applications:

– Radioastronomy;
– Radionavigation;
– Time keeping;
– Scientific research.

The unique automatic cavity tuning techniques of cavity frequency switching method provides unsurpassed long term stability to be reached, typically less than 1×10^{-15} for a day. Properly set cavity tuning system parameters also doesn't degrade short term stability and eliminate frequency shift because of spin-exchange.

This method main advantage is that the maser requires no other stable frequency reference for its cavity to be tuned.

Figure 1 illustrates the maser VCH-1003M outward appearance.

2. Specifications

2.1 Environmental conditions requirements:

– Normal air temperature range is (20±5)°C;
– Operating temperature range is 10°C to 35°C;
– barometric pressure range is from 84kPa up to 106 kPa (from 630 up to 795 mm Hg);
– Humidity range is 30% to 80% at 25°C.

2.2 Power requirements:

– mains voltage is 84V to 264V (47-60Hz);
– DC source or battery voltage is 22V to 30V.

The maser has one AC input and two separately fused DC inputs on its back. The power required is 150VA max on AC (with automatic crossover to DC) and 100 watts max on 27V DC.

2.3 Output frequencies.

There are two 5 MHz, two 10 MHz, two 100 MHz sine signals with (1±0.2)V RMS outputs at 50Ohm load and two 1PPS timing signal outputs of positive polarity with the following parameters:

– amplitude ≥ 2.5V at 50 Ohm load;
– pulse length is 10μs to 20μs;
– rise time ≤ 3ns;

Sync of 1PPS signal is available to a similar signal applied to the sync input “ 1 PPS”. The sync error doesn’t exceed ±50ns. Sync procedure is described in User Guide 411141.032 UG from the delivery set.

All sine signals have type N connectors and are located on the front of the maser. 1PPS signals both outputs and input have type BNC connectors and are also on the maser front panel.

2.4 Stability, Allan variance is shown in Table 1:

Table 1 Active Hydrogen Maser VCH-1003M stability, time domain

Time domain	Standard	Option L	
	3 Hz measuring bandwidth	0.5 Hz measuring bandwidth	3 Hz measuring bandwidth
1s	1.3×10^{-13}	6.0×10^{-14}	8.0×10^{-14}
10s	2.5×10^{-14}	1.3×10^{-14}	1.4×10^{-14}
100s	6.0×10^{-15}	3.6×10^{-15}	4.0×10^{-15}
1000s	2.0×10^{-15}	1.5×10^{-15}	1.5×10^{-15}
1h	1.5×10^{-15}	1.3×10^{-15}	1.3×10^{-15}
1d	7.0×10^{-16}	5.0×10^{-16}	5.0×10^{-16}

Notice: Environmental temperature changing rang e is ±1°C at changing rate 1°C/hour.
Long term:<3.0×10^{-16} per day. Achieved after 1 year of unperturbed, continuous operation.

2.5 Temperature sensitivity is less than $\pm 1.5 \times 10^{-15}$/°C.

2.6 Magnetic field sensitivity is less than 5×10^{-15}/Gauss.

2.7 Harmonic distortion in 5 MHz output signal ≤-40dB;

2.8 Non-harmonic distortion ≤-100dB;

2.9 Phase noise specification is shown in Table 2:

Table 2 Phase noise, dBc/Hz

	Stadard			Option L		
Frequency offset Hz	5 MHz	10 MHz	100 MHz	5 MHz	10 MHz	100 MHz
1	≤−118	≤−115	≤−92	≤−127	≤−121	≤−100
10	≤−135	≤−129	≤−109	≤−141	≤−135	≤−115
100	≤−149	≤−143	≤−122	≤−151	≤−145	≤−125
1 000	≤−156	≤−149	≤−122	≤−156	≤−150	≤−130
10 000	≤−158	≤−150	≤−152	≤−159	≤−153	≤−153
100 000	≤−158	≤−150	≤−152	≤−159	≤−153	≤−153

2.10 The output maser's frequency is adjustable in range to within 1×10^{-10} with resolution 1×10^{-16}. Remote frequency control is also available as described below.

2.11 The maser incorporates a frequency comparator for taking measurements of an external source of standard frequencies 5MHz, 10MHz or 100MHz with from 0.5V to 1V RMS at 50Ohm signals. The comparator input of N-type is labeled as " 100 MHz" on the front panel. The comparator measurements bandwidth is 10Hz. The additional stability is shown in Table 3:

Table 3 Stability of internal comparator, time domain

Time domain	Allan variance	Comparator bandwidth, Hz
1s	1.5×10^{-13}	10
10s	2.0×10^{-14}	10
100s	2.5×10^{-15}	10
1h	5×10^{-16}	10

Notice: Environmental temperature changing range is ±1°C.

2.12 Warm-up time from a cold start is approximately 240 hours (10 days).

2.13 The maser is 550mm wide by 550mm deep by 1010mm high. The overall weight is 100 kg, in transportation crate 190 kg.

2.14 The maser lifetime is more than 15 years.

3. Delivery Set

Active Hydrogen Maser VCH-1003M delivery set is shown in Table 4

Table 4 Active Hydrogen Maser VCH-1003M delivery set

Item	Designation	Quantity	Notice
1. Active Hydrogen Maser VCH-1003M	411141.032	1	
2. Power cord	PC-186-15	1	AC power cord
3. Interface cable	685670.026-01	1	RS-232C
4. Interface adapter	UC232R-10	1	USB-RS232
5. Accessory kit:			
5.1. Socket	2PMT14	2	DC power
5.2. Fuse	2 A	2	250V 2A
5.3. Fuse	3.15 A	2	250V 3.15A
5.4. Fuse	5 A	2	250V 5A
5.5. Fuse	1 A	2	250V 1A
5.6. Fuse	2 A	2	250V 2A
6. Operations manual	411141.032 OM	1	
7. User's Guide	411141.032 UG	1	
8. Certificate		1	
9. VCH-1003M software	RU.00046-01	1	Installation CD 00046-01 Software and documentation
10. Shipping crate	411915.023	1	

4. Brief description of the Maser and its operation

4.1 Active Hydrogen Maser VCH-1003M

Active Hydrogen Maser VCH-1003M structure is shown in Figure 2.

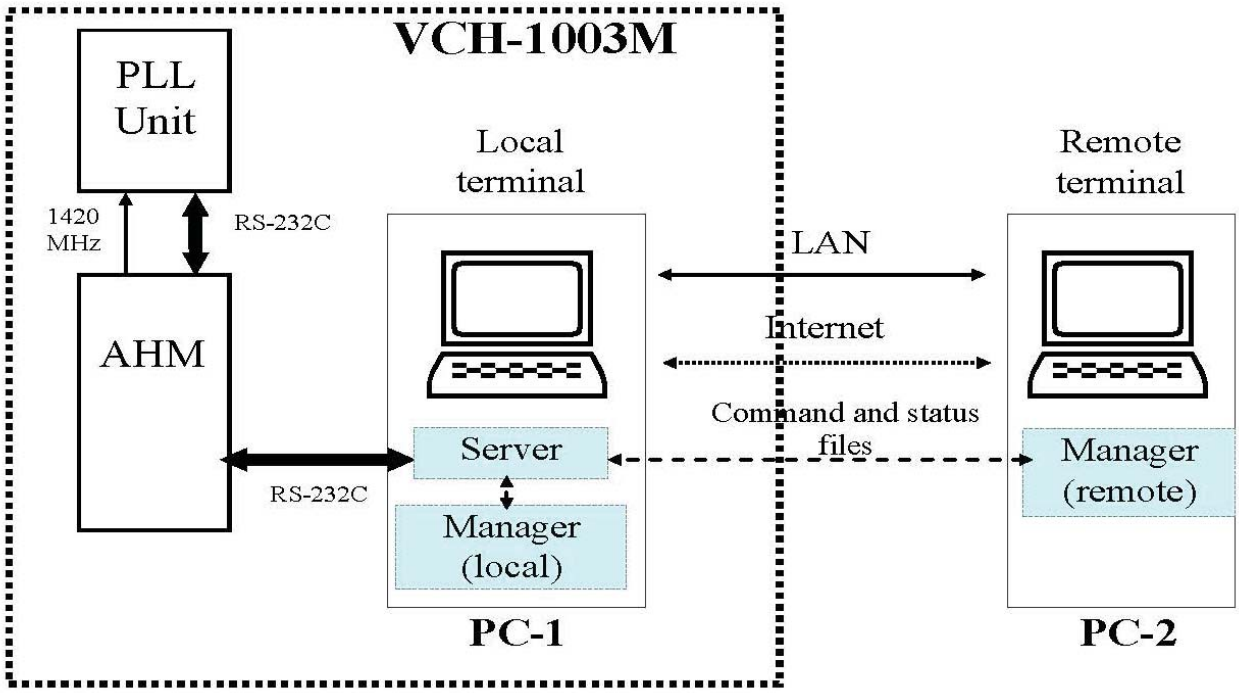


Figure 2 – Structure of the Active Hydrogen Maser VCH-1003M with the remote user's terminal

Designations in Figure 2 are the following:
AHM – Active Hydrogen Maser – Physics Package with surrounding units providing its operation such as a power unit, high voltage ion pumps, multi-level thermal control system, beam intensity stabilizer, source discharge oscillator and processor which enables all mentioned above units to be controlled and monitored via RS-232 connection.

Physics Package produces signal of hydrogen transition frequency 1420 MHz, applied to PLL Unit.

PLL Unit combines two functions. On the one hand it keeps a voltage controlled crystal oscillator phase-locked to the maser output. On the other hand it produces signals for cavity tuning. And so it assures the excellent maser performance.

Local terminal PC-1 contains Server and Manger software. Remote terminal PC-2 contains only Manager software.

PC-1 and PC-2 terminals both allow a User to take all information about maser operation he needs.

User may choose which terminal to control the maser from.

The software installation in detail is described in User Guide 411141.032 UG.

4.2 Physics Package

Figure 3 illustrates Physics Package Layout.

Small metal cylinder filled with intermetal combination of La Ni_5H_x is used as a molecular hydrogen source. When heated it releases hydrogen flow which goes to the Purifier. This is a thin wall nickel tube of spiral form. Beam stabilizer transmits the current of about 0.5A through the tube and so regulates the hydrogen flux to the discharge bulb where the source discharge oscillator dissociates them into atoms. Atoms emerge through the multichannel collimator and magnetic state selector, which directs a beam in right state into the Teflon coated storage bulb.

A microwave cavity causes the atoms to produce the microwave emission. Receiving loop transmits the hydrogen emission power outside to the low noise receiver. Hydrogen maser output power is about 100 -200 fW.

Two high voltage ion pumps and the getter provide vacuum inside the whole system.

Magnetic shields reduce the magnetic sensitivity of the maser and multi-level external and internal thermal system decreases temperature sensitivity significantly.

4.3 PLL Unit.

PLL Unit is intended to keep VCO 5MHz phase locked to the maser signal. The Multiplier forms from crystal oscillator signal standard outputs 100 MHz and output signal 1400 MHz.

The PLL Unit circuit is shown in Figure 4.

Low noise receiver transmits the maser signal 1420 MHz to the low frequency 405.7 kHz. This is the operating frequency of the Phase Detector. Another signal comes to the Phase Detector from the Synthesizer which is able to change the output frequency within 1×10^{-10} range with the resolution of 1×10^{-15}. Thus the Phase Detector controls the VCO frequency.

Frequency divider produces 1PPS timing signals. Sync input enables output signals to be synchronized to external 1PPS signal.

Processor provides the possibility of monitoring different PLL Unit parameters and controls the standard output frequencies via RS-232 port. For more detail information see User's Guide 411141.032 UG.

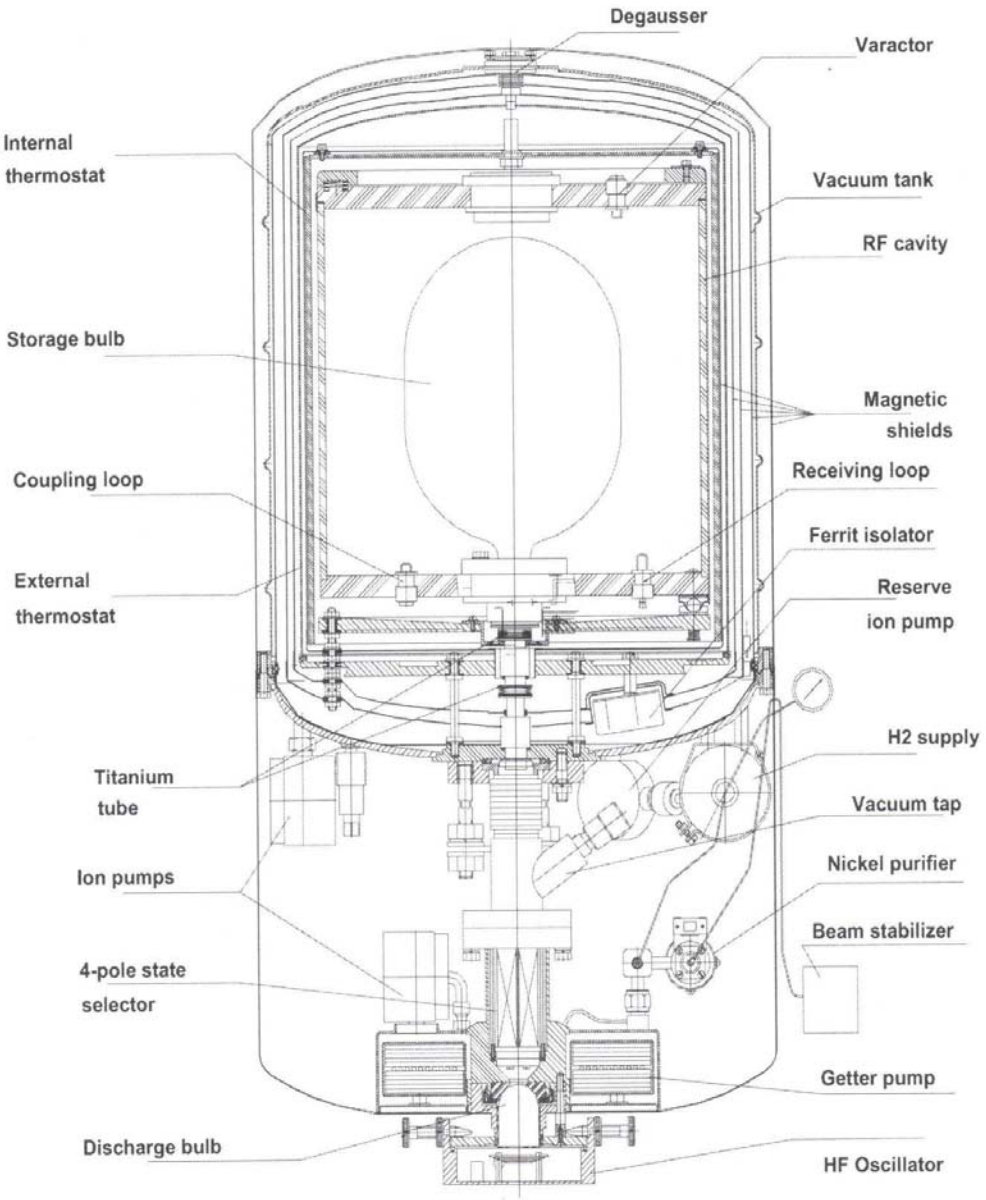


Figure 3 Physics Package Layout

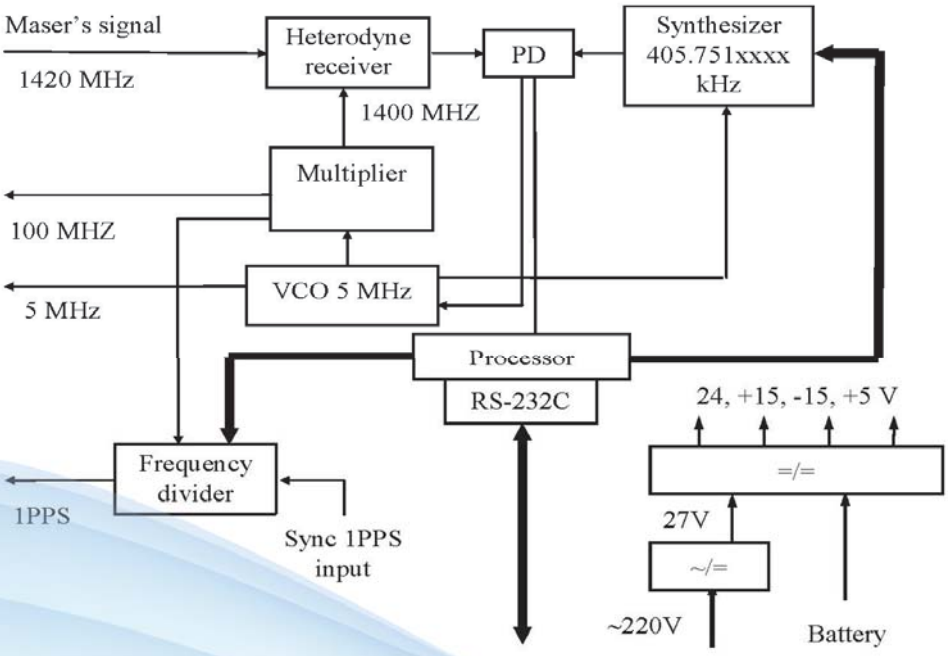


Figure 4 PLL Unit circuit

4.4 Cavity auto-tuning.
This auto-tuning system uses cavity frequency switching method in its operation. Figure 5 illustrates its circuit.

Modulator changes data of modulating digital-to-analog converter DAC2 register with modulation frequency and its voltage applied to modulating varactor switches the cavity frequency.

Amplitude detector and low pass filter derives mistuning signal, which amplitude depends on cavity mistuning, from the maser signal and transmit it to synchronous detector. This detector changes DAC1 register and its voltage applied to tuning varactor shifts cavity frequency to the hydrogen emission line frequency.

Cavity tuning system parameters are adjusted at factory and are not to be changed by customer. Only tuning DAC readings are important during the operation.
For more details consult the User's Guide 411141.032 UG.

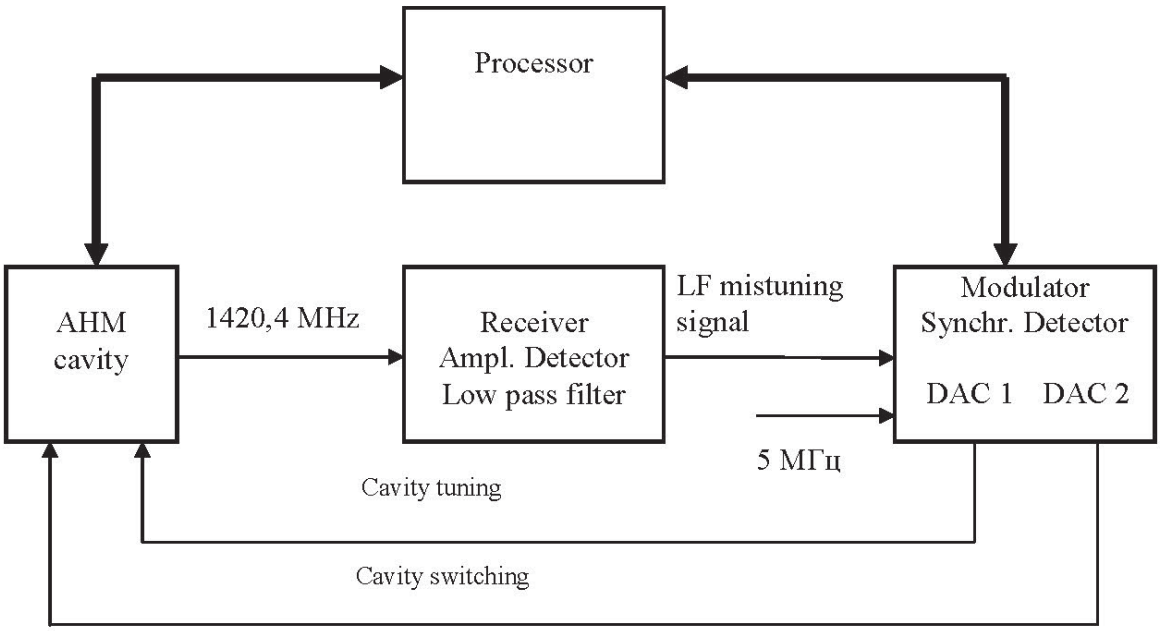


Figure 5 Cavity tuning system

5. Transportation and storage

5.1 The maser should be kept in vertical position during the transportation. It's necessary to avoid heavy shocks and vibration, turning it over, ingress of moisture and dust. Environmental conditions are:

– Air temperature from -20°C up to +50°C;
– Humidity up to 90% at temperature +30°C;

5.2 Storage conditions are:

– Air temperature from +5°C up to +40°C;
– Humidity up to 80% at temperature +25°C;

The maser should be switched on monthly to start ion pumps for at least 30 minutes to avoid the vacuum loss inside the Physics Package. In 30 minute or 1 hour period high voltage current shouldn't exceed 100μA.

6. Installation

6.1 Shipping crate unpacking

The maser unpacking has the following consequence (see Figure 6):

– Unscrew four nuts M16 from the top cover;
– Unscrew four bolts M12 from the top cover;
– Remove top cover carefully;
– Heel the crate slightly and unscrew four bolts M12 at the bottom;
– Unscrew eight cap screws from the front wall;
– Screw two ring-bolt at the opposite corners of the maser and using the pulley block lift the maser out of the crate gently and carefully;

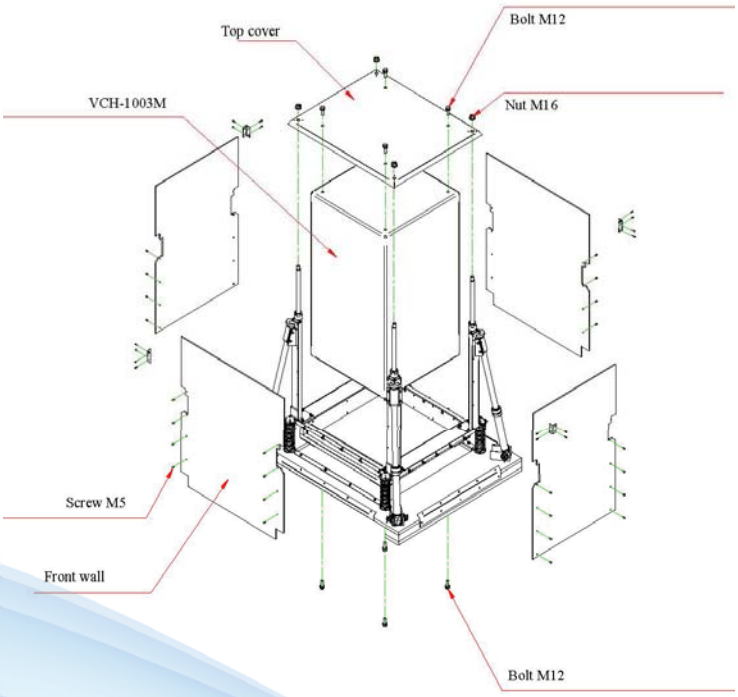


Figure 6 Shipping crate Layout

6.2 Starting up the maser

To achieve the best performance the maser should be located at the area with minimal temperature transition. The maser meets its specification only if environmental temperature changes within ±1°C range at the rate slower than 1°C/hour.

Please read the following information carefully before continuing.
Table 5 and Figure 7 describe indicators, connectors and switches on the maser's front panel.

Table 5 Indicators, connectors and switches on the maser's front panel

Items in figure 7	Designation	Description
1	POWER	LED indicator. It illuminates green when PLL Unit operates on AC power
2	BATTERY	LED indicator. It illuminates green when DC source is connected to the maser but PLL Unit still operates on AC power and blinks with a period about 1s when PLL Unit operates on DC power.
3	CAVITY TUNING	LED indicator. It illuminates green when the maser operates in cavity tune mode
4	PLL	LED indicator. It illuminates green when VCO is locked.
5	POWER	LED indicator. It illuminates green when the maser operates on AC power
6	POWER	Power switch.
7	BATTERY 1, 2	LED indicators. They illuminate green when DC source is connected to the maser DC input 1 or 2 correspondingly but the maser still operates on AC power and blink with a period about 1s when the maser operates on DC power.
8	1 PPS	Sync input BNC-type
9	100 MHz	Internal comparator input N-type
10	1 PPS 1,2	1 PPS outputs BNC-type
11	5 MHz 1,2	5 MHz sine signal outputs N-type
12	10 MHz 1,2	10 MHz sine signal outputs N-type
13	100 MHz 1,2	100 MHz sine signal outputs N-type

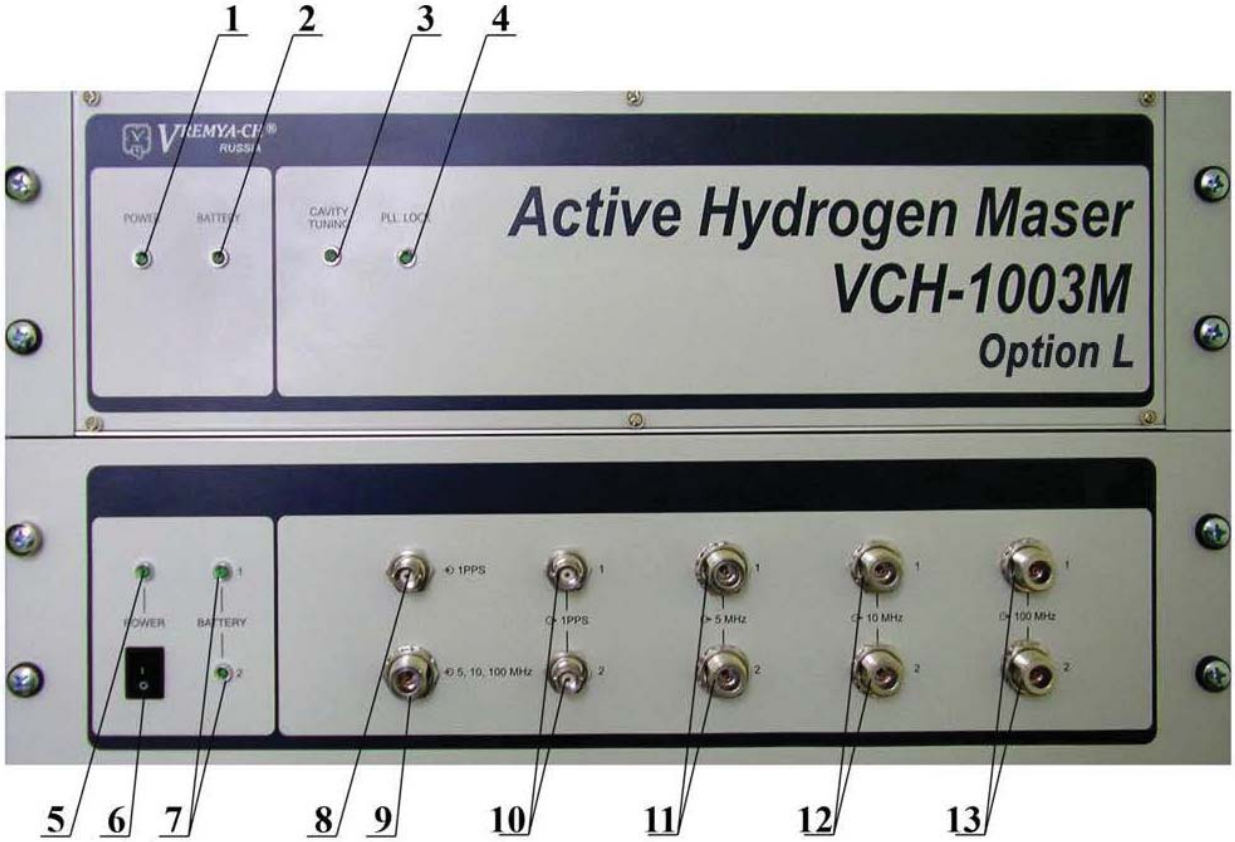


Figure 7 Indicators, connectors and switches on the maser's front panel

Table 6 and Figure 8 describe connectors and switches on the maser's rear panel.

Table 6 Connectors and switches on the maser's rear panel

Items in Figure 8	Designation	Description
1	RS-232C	Interface connector RS-232C
2	F1 5A, F2 5A	DC power connectors' fuses 250V 5A
3	F3 1A, F4 1A	AC power fuses of PLL Unit 250V 3.15A.
4	BATTERY 1, 2	DC power sources 1 and 2 connectors
5	F5 2A, F6 2A	DC power fuses of Physics package 250V 2A
6	~220 V 50 Hz 160 VA	AC power connector

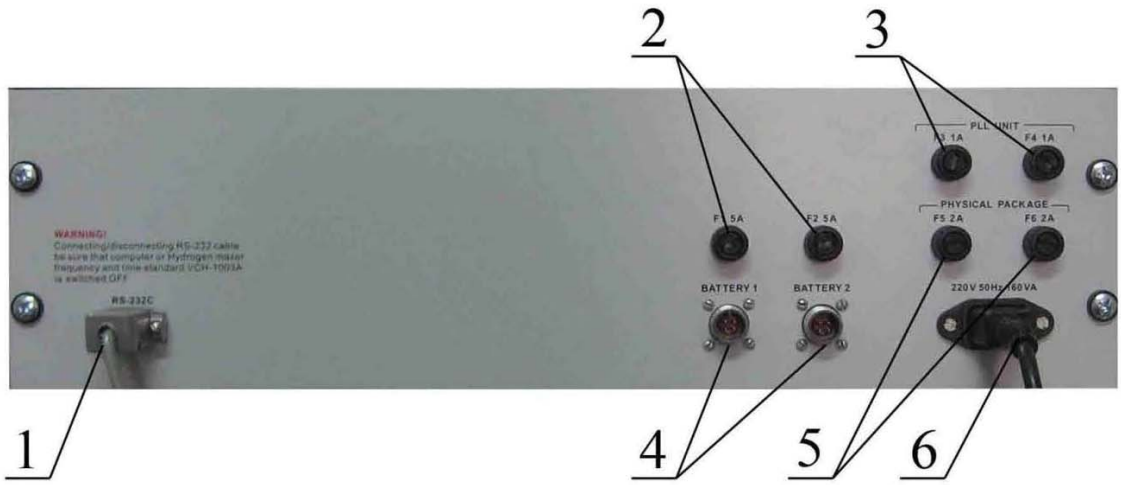


Figure 8 Connectors and switches on the maser's rear panel

Before switching the maser on connect RS-232 interface cable 685670.026-01 via interface adapter UC232R-10 to the computer USB port to avoid any interface damage. Then install the software on the computer according to the description in User's Guide 411141.032 UG and then start up the maser. Switch on the "POWER". Launch Server and Manager software and implement all procedures as it is describes in User's Guide 411141.032 UG.

To avoid any maser's operation disturbances due to AC power failures the continuous connection of DC power 24V sources is recommended.

7. Marking and identification

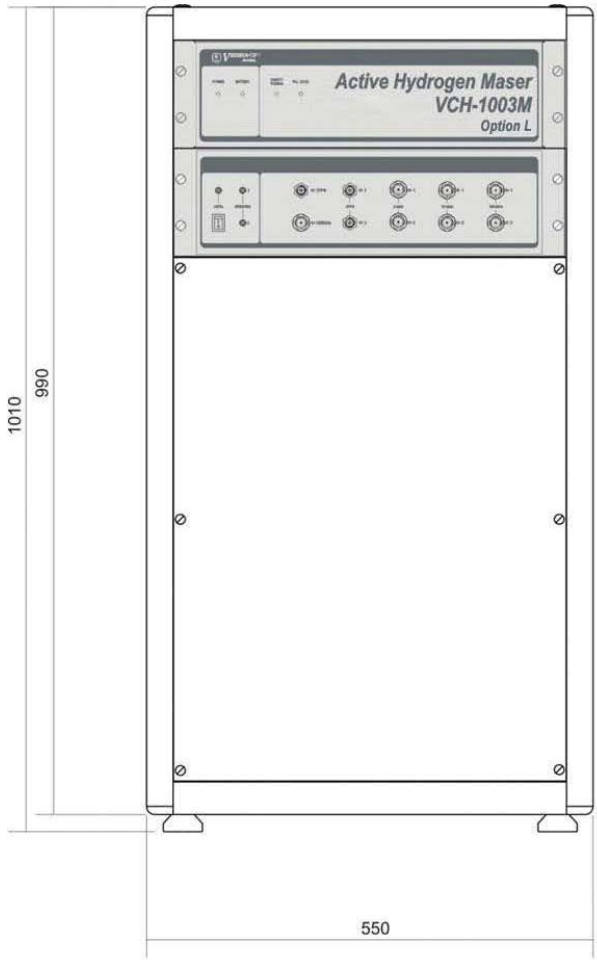
Trade mark of the manufacturer (1) and model of the maser (2) are located on the front panel (see Figure 9).

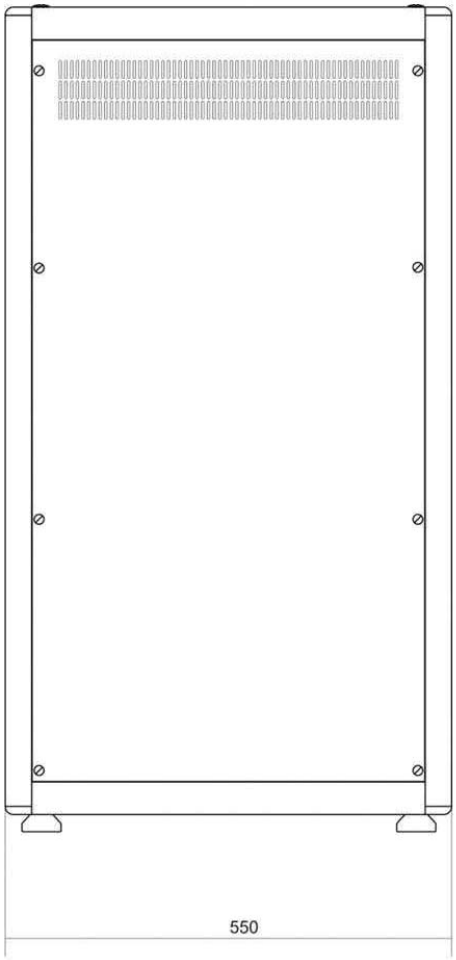
Serial number and production date are labeled on the back panel (1) (see figure 10).

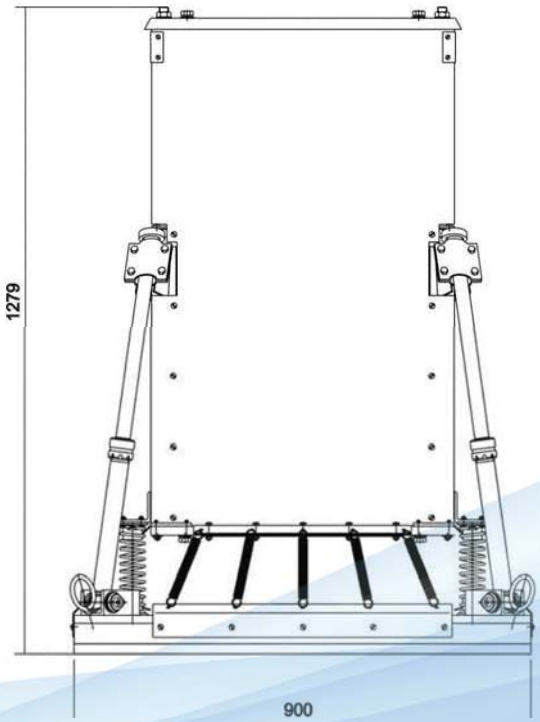
Figure 9 Trademark of the manufacturer (1) and model of the maser (2)

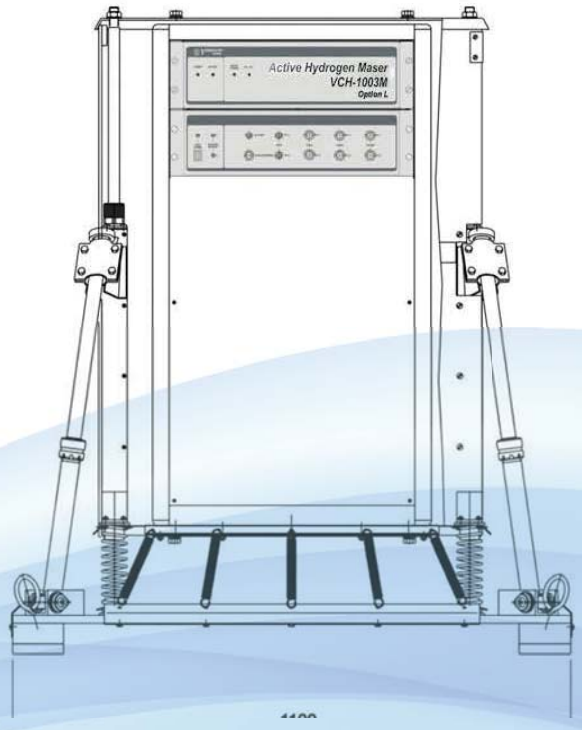
Figure 10 Serial number and production date label

Appendix A
Dimensions of the maser and shipping crate









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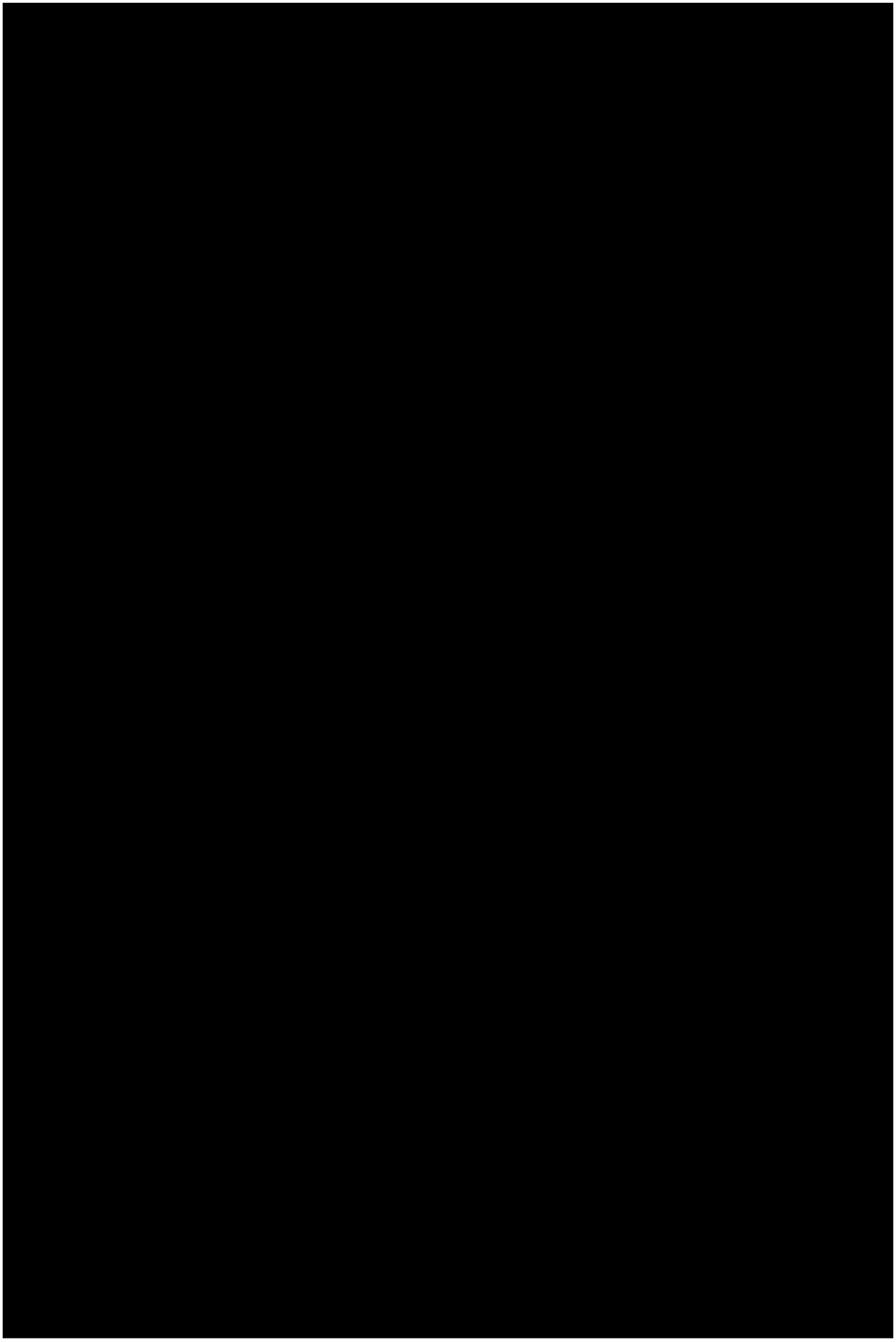

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