AVS47-232/USB CONVERTER

For Interfacing the AVS-47B with Computers

User Guide

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CONTENTS

WARRANTY

Picowatt warrants the **AVS47-232/USB hardware** to be free from defects in materials and workmanship. Our liability under this warranty is limited to repairing or replacing any instrument or part thereof which, within three (3) years after the shipment to the original purchaser, proves defective. This warranty is void if the instrument has not been used according to the instruction manual, or if it has been used under exceptional environmental conditions.

In need of warranty repair, the instrument must be returned to **Picowatt**, prepaid , and with a detailed description of the fault or misfunction following the instrument.

The name, address and e-mail address of a person who is able to give supplementary information should be included whenever possible. If the repair was covered by warranty, **Picowatt** will return the instrument on our cost using an economical shipping method.

If no fault is found, or if there is a strong indication that the warranty is void, the purchaser is charged for the return freight and costs in addition to the repair. It is recommended that **Picowatt** be contacted prior to shipment. We can possibly give instructions for additional tests or simple component replacements so that unnecessary shipments may be avoided.

The **firmware must not be considered a commercial product**. It is given as is, for free, without any kind of warranties or liability. The program and this user guide may contain errors, and we would be glad to get feedback, corrections and suggestions for improvements.

Important: The AVS-47B uses +/- 5 Volt levels for data communications in its standard configuration, whereas the AVS47-232/USB can be damaged by applying negative voltages to its 15-pin connector.

Therefore, short circuit piece JP204 MUST BE CHANGED to position JP203 on circuit board "E" (the board with the power supply unit) before connecting the AVS-47B and the converter together.

If the AVS-47B is used with model AVS47-IB GPIB box, or with the USB-Picobus LabView programs, this jumper shall be returned to JP204.

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BACKGROUND

The AVS47-232/USB is an external protocol converter that creates an optically isolated RS232 interface for the model AVS-47B AC Resistance Bridge. Until now, **Picowatt** have offered two possibilities for interfacing the AVS-47B with computers: The direct Picobus interface and the model AVS47-IB external GPIB (IEEE-488) interface unit. Both alternatives have limitations with respect to computer type, operating system and programming language. The AVS47-232/USB removes many of these limitations at a low cost, offering new possibilities for computer interfacing. A short description of the three available interfacing solutions follows.

Some commands are for the TS-530A Temperature Controller. This product has been discontinued, those features are only for the existing instruments.

USB-Picobus

Picobus is a proprietary synchronous, serial protocol that is based on two coming and two leaving signal lines. Suitable four lines are provided by the hardware handshake outputs and inputs of traditional Com: ports of PC-type computers. The asynchronous TXD and RXD signals of the RS232 interface are *not* used by Picobus. Today's computers seldom have physical Com: ports, but a virtual Com: port can be created by a **USB-232 converter**.

Unfortunately, low-level Picobus communications is complicated, as it requires computer program to write and read states of independent bits of some hardware registers. In order to make programs portable between different platforms, operating systems do not favour direct hardware access. For this reason, we have offered driving programs (**USB-Picobus**) only for a **Windows-PC** running **LabView2012** or higher (base version or better).

This has been a serious limitation that excludes Mac computers and programming languages other than LabView. The great advantages of Picobus are, that the protocol is almost bullet-proof, it has low EMI noise, and for customers with a suitable computer environment, it is completely free with the exception of a possibly needed USB-232 converter.

The AVS47-IB is a protocol converter between GPIB (IEE-488) and Picobus. It is the heart of the GPIB-Picobus interface.

GPIB-Picobus

This interfacing solution is based on an external converter, AVS47-IB, between IEEE-488 and Picobus protocols.

This very powerful converter offers automatic scanning of sensors, buffering of data and many macro commands. The box is connected to - but galvanically isolated from - the AVS-47B via Picobus and to the computer via GPIB (therefore the name of this option is **GPIB-Picobus**). It has its own mains power supply and it can be located far from the cryostat in order to minimize electromagnetic or ground current problems that the GPIB line may cause. The box can be used with computers having an GPIB controller and suitable software for GPIB communications. It is highly compatible with the IEEE-488.2 standard with its mnemonic and common commands and error reporting. We offer a versatile free **LabView Driver** that was written for LV7.1 and can still be used with today's LabView versions. For the most noise-critical applications, a 5-meter optical fibre link is available (**Picolink**).

The GPIB-Picobus has a much wider range of applications than USB-Picobus, e.g. it can be interfaced also with Mac and Linux computers. However, for customers that do not already use GPIB, the cost of this alternative is significant.

AVS47-232/USB

The AVS47-232/USB is also an external protocol converter box that is connected to the resistance bridge via galvanically isolated Picobus. It can be connected to the computer's Com: port using a one-to-one cable with 9-pin connectors. More typically,

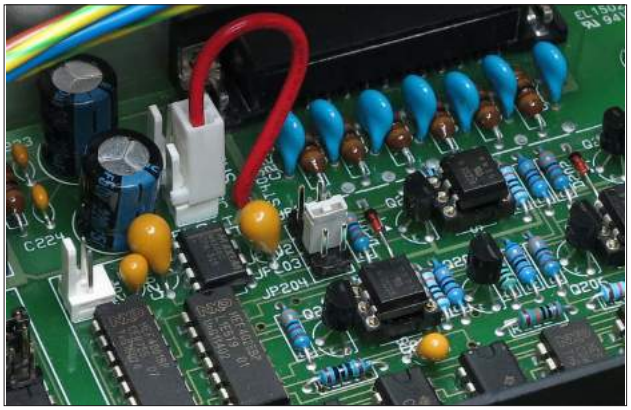
it is connected to a virtual RS232 port using a USB-232 converter which enables RS232 communications between the computer and the box. The important difference between USB-Picobus and AVS47-232/USB is that the former uses the proprietary synchronous Picobus protocol and the latter is based on asynchronous RS232.

RS232 is a very old protocol which has disappeared from many instruments because of its low speed and poorly standardized software behaviour. However, asynchronous serial communications is far from dead: Most operating systems, like Windows, Linux and Mac OS, and most common programming languages, like C/C++, Python, versions of Basic etc., LabView and Matlab, support it. The speed is not an issue with slow instruments, like the AVS-47B, which produce only tiny amounts of data. The AVS47-232/USB expands computer-interfacing of the AVS-47B beyond a Windows-PC and LabView to almost any application and platform where RS232 communications is supported.

Commands and queries to the AVS47-232/USB are simple and mnemonic, like “RAN3” for the 200Ω range. Communications is based on the most common default format without handshaking. Therefore many low-cost USB-232 converters are likely to perform well in this application.

The AVS47-232/USB is based on the very popular Arduino Mega2560 unit.

AVS47-232/USB Unit measures 130x105x60 mm and gets power from the AVS-47B.



Change short circuit piece JP204 to position JP203 before making any connections in order to avoid damage to the AVS47-232/USB, which uses 0/+5V voltage levels for communications with the AVS-47B resistance bridge.

CONNECTING THE AVS47-232/USB

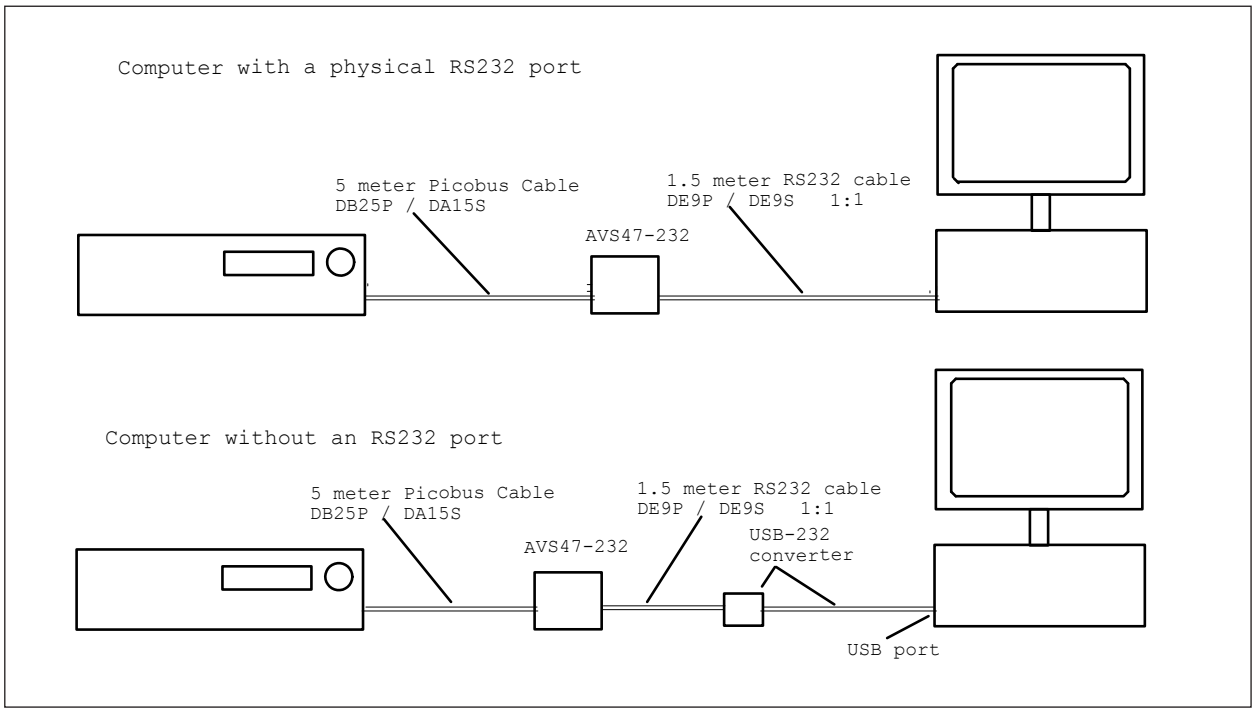
The AVS47-232/USB uses 0/+5V voltage levels for communications with the AVS-47B Resistance Bridge, which is set for -5/+5V levels by default. Therefore, open the top cover of the bridge and move short circuit piece JP204 to position JP203 before making any connections.

The jumper must be in JP204 for use with USB-Picobus programs and for use with the AVS47-IB GPIB box.

The device is connected to the AVS-47B Resistance Bridge using the supplied 5-meter long DB25P/DA15P cable. The AVS47-232/USB box should be located near to the computer and far from the cryostat. Connection from the box to the computer varies depending on available hardware:

- Computer has a physical RS232 port:
Connect the supplied 1.5m cable with male and female 9-pin D-connectors from the AVS47-232/USB box to the RS232 port of your computer.

- Computer has only USB ports:
You need a USB-232 converter and its software installed. Plug the USB connector to your computer and the our supplied 9-pin cable between the converter and the AVS47-232/USB box. The USB-



There are two ways to connect the AVS47-232/USB: Either directly to computer's RS232 port, or via a USB-232 converter to computers USB port. The converter creates a virtual RS232 port that your high-level program will access.

232 converter from National Instruments (NI part number 778472-01) is known to work well, but it is expensive. Cheaper converters are available from other manufacturers.

STARTING THE AVS47-232/USB

The box starts when it gets power from the AVS-47B via the 25/15-pin cable. The "REMOTE" indicator on the AVS-47B front panel is blanked. The box starts always in local mode. Change from local to remote or vice versa does not alter the state of the bridge.

Re-starting the AVS47-232/USB

If needed, the box can be re-initialized by a) switching the AVS-47B off and on, or b) unplugging and then re-connecting the 25/15-pin cable. The latter can be used even during temperature control, because this operation does not change the states of the bridge or the controller.

The box can be re-started by command "RST". It will bring the bridge to a safe setup: input=ZERO, multiplexer channel=0, range=2MΩ, excitation=3μV and display=R. In addition, command separator defaults to ";" (semicolon) and response line terminator to CRLF. Software reset is a less powerful way to initialize the program than the power-off-on method.

RS232 Format

The AVS47-232/USB uses the most common RS232 format: baud rate 9600, 8 data bits, 1 stop bit, no parity and no flow control. This format can be changed only by changing the Arduino firmware and re-loading it. Do not change this format, if there is no compelling reason to do so.

COMMANDS AND COMMAND LINES

It is a good idea to get acquainted with the AVS47-232/USB by using an RS232 hyperterminal program. It lets you control the bridge by writing commands/queries and reading the responses. Although such a program is no longer included in Windows, many free programs are available from the Internet. For example, we have used

`https://sourceforge.net/p/hypeterminal/wiki/Home/`

and, if you have LabView, you can try

`https://decibel.ni.com/content/docs/DOC-16284`

Commands to the AVS47-232/USB are not case sensitive. You may insert blank space(s) between the command and argument part. Commands “ran5”, “RAN5”, “ran 5”, “RAN 5” or “ran 5” are all equivalent.

The first part of a command or query can contain only alphabetic letters. The second, argument part of a *command*, is made of integral numbers. The argument part of a *query* is a question mark “?” like in “RAN ?” or “ran?”.

Several commands can be placed on a single command line. The commands/queries must have a command separator, or delimiter, between them (colon or semicolon, which is the start-up default). Your own computer program can terminate the command line either by carriage return (CR or \r, ASCII 13), by linefeed (LF or \n, ASCII 10) or by CRLF. These are called line terminators . The commands/queries are performed in sequential order, the previous command must be completed before the next one can be handled.

For example: “rem1;inp1;ran3;exc7” (quotation marks are not parts of the actual string) sets the bridge in remote mode, sensor measuring input, 200Ω range and 10mV excitation. After having waited for some seconds (settling time), one can take the reading.

Maximum number of characters on one line, including command separators and possible blanks, is 60. Handling the commands starts after a line terminator has been received. If the command line is not terminated with CR, LF or CRLF, processing will not start.

Do not issue further commands or queries before all the commands/queries on the previous command line have been executed.

Responses

The AVS47-232/USB obeys the strict principle, that only a query can produce response. So your application program needs not poll and read the serial port after commands.

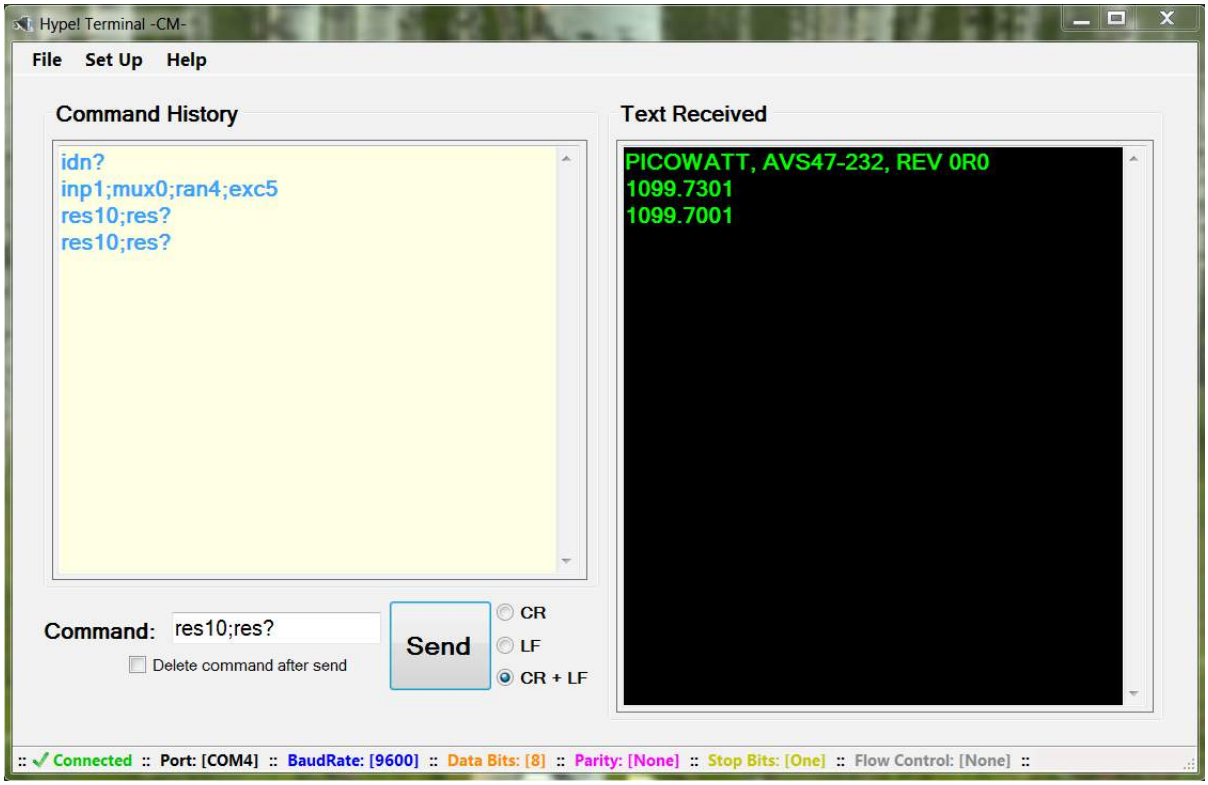
Responses can consist of printable alphanumeric characters, but most queries return only a number. Some values are output as floating point numbers, but exponential format is not supported. The responses do not have headers in order to make them easier to read into a program.

If a command line consists of more than one query, the responses are output in the corresponding order and they are separated by the specified command separator (delimiter).

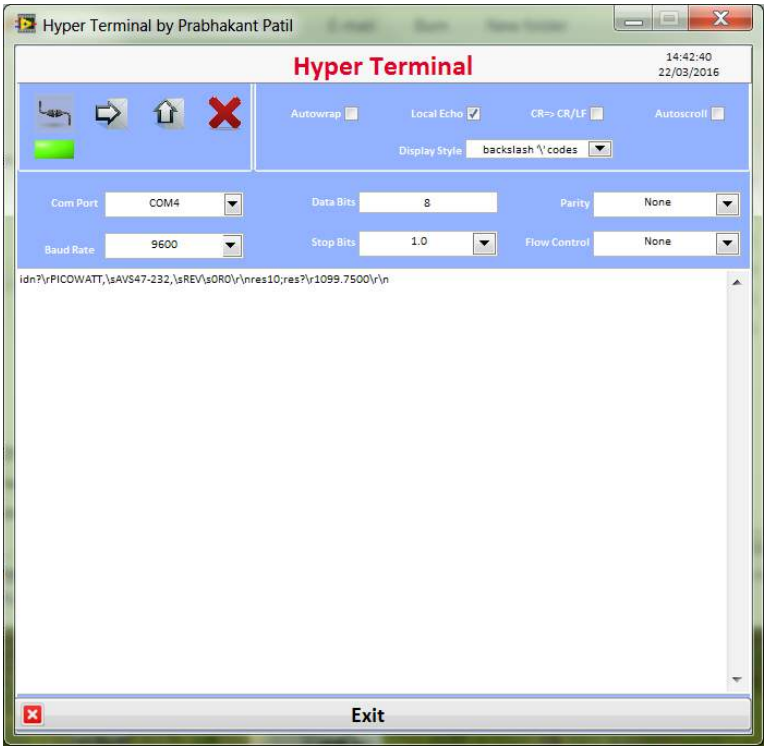
For example, command line “ARN10;RES5;RES?;RAN?” instructs the bridge to go to autorange mode, wait for 10 seconds after each automatic change of range (if needed), then take a mean of 5 A/D conversions, and place the result and the range setting (which was possibly altered by autoranging) in the output queue. The result is sent via the RS232 port to the computer, which must detect that data has arrived and then read it or place it in a buffer. The response could be like “1234.5;4” (i.e. 1234.5Ω; 2kΩ range).

You may save programming overhead by giving *commands* for a measurement on one line. Responses to *queries* may be easier to read into variables, if queries are made separately. Then one does not need to remove the delimiters and parse the response line.

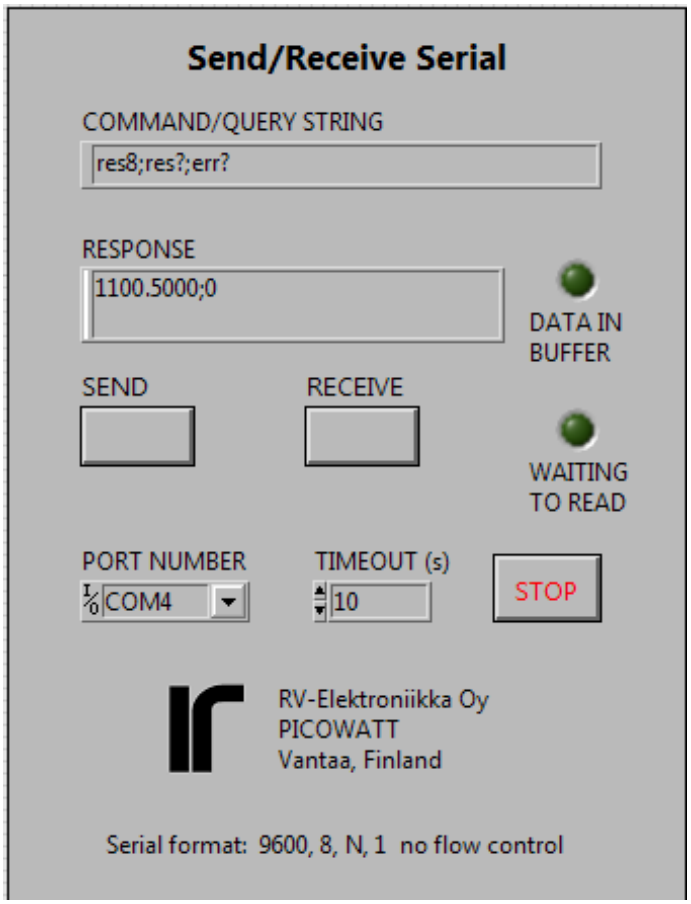
The response ends by the line terminator specified by the TER command (default is CRLF). The terminator can, but it must not, be the same for both transmitting and receiving. The AVS47-232/USB will always recognize any of the three line terminators, CR, LF or CRLF.



The "Hype! Terminal" (see text for link) is easy to use: Just specify the Com port number (SetUp) and it is ready. After identification, the bridge is set for measure input, channel 0, range 2kΩ, and excitation 300µV. Then 10 A/D conversions are taken (RES10) and the output is read by RES?. This RS232 terminal program for a Windows PC does not require LabView.



Users of LabView can also try this program (see text for link). The output includes all printing and non-printing characters in both transmitted and received strings, which can be useful for debugging. But otherwise it is far less convenient to use.



Send/Receive Serial tool

This handy LabView VI was written for developing programs for the AVS47-232/USB and AVS48-232/USB. It allows one to send commands and queries and to read the response to queries. It requires the base version or better of LabView2012 or later.

Check the jumper JP203 (no other short circuit pieces) inside the AVS-47B bridge and connect the cables as was instructed earlier. The AVS47-232/USB starts when it gets power from the bridge. Select the correct Com port. The serial format is fixed to the most common standard, 9600,8,N,1 with no flow control. Run the VI and click "SEND" for sending the default IDN? query. DATA IN BUFFER should light. Click "RECEIVE" for reading the response. If this works, save the VI so that you do not need to re-enter the port number when you load the VI next time.

Use this tool for getting acquainted with the behaviour of the software before starting to write your own application in whatever programming language you prefer. This VI uses the `'\n'` (newline) character for terminating the transmitted string, but your program can as well use `'\r'` (carriage return) or \r\n or \n\r.

Define the response line terminator by the command TER. You can see the non-printing characters in the response if you stop the VI, click the RESPONSE field and select `'\' Codes Display` or `Hex Display` from the context menu. Start the VI again.

If you try to receive before a response is available, the program waits until the input buffer is non-empty or timeout occurs. See the block diagram, how this was done. You can put the OPC? query after a time-taking long average like `RES100;OPC?` The "operation complete" query places character '1' in the output queue when averaging is ready. But anyway, your program must poll the input in order to see when you can send the RES? query and read the response.

This VI can be downloaded from our WEB site at www.picowatt.fi .

FIRST COMMANDS AND QUERIES

All queries work in both remote and local modes, so that you can read bridge settings although it is in local. Commands that control the operation of the AVS47-232/USB firmware are also effective in both modes, whereas hardware commands to the AVS-47B can be used only in remote. These initial commands are for making the AVS47-IB firmware to correspond to your application program.

IDN? Identification query. You can check succesful starting and firmware version of the AVS47-232/USB by this query. The response is like "PICOWATT, AVS47-232/USB, REV 0R0"

HW? Hardware version query. Returns the version of the AVS47-232/USB hardware. The response is like "PICOWATT, RS232PB_A0". The latter item is the version of the circuit board.

AL? Alarm line query. This query transacts with the AVS-47B bridge and checks the state of the "AL" Picobus signal line (AL is used for preventing multiple reads of a single A/D conversion). Response should be 1 if the bridge is powered, if the 25/15 pin cable is in place and everything is OK. If the response is 0, check that the cable is plugged and OK. Re-start the bridge, which re-starts also the box. The bridge should end up to local mode. If this does not happen, or if AL? still returns zero, contact factory.

LIM [0..1] Select the command delimiter (or command separator).

0 = semicolon (dec ASCII 59). This is the start-up default, which is used also by the IEE-488.2 standard.

1 = comma (dec ASCII 44). May be useful if a comma-separated format (CSV) is preferred.

TER [0..3] Select the response line terminator. Depending on your computer software, you may need to modify the default value of CRLF. When *reading* the serial port, the AVS47-232/USB firmware looks for both CR and LF, and when either of them is encountered, the line is considered as ended. The possibly remaining terminator is neglected. You can modify the response line terminator by sending the TERx command:

0 = nothing
1 = linefeed (LF, \n, dec ASCII 10)
2 = carriage return (CR, \r, dec ASCII 13)
3 = CRLF (start-up default)

REM [0..1 | ?] Remote mode command/query. The change from local to remote does not change the state of the bridge: the program reads the setup in local mode and then sends this setup to the bridge in remote mode. Any hardware commands sent before the REM1 command are forgotten. The AVS-47B shows remote mode by a yellow light on the front panel.

0 = local
1 = remote
REM? returns 0 or 1

HARDWARE COMMANDS

INP [0..2 | ?] Input selector command/query.

0 = Grounded input (zero resistance)
1 = Measure the selected sensor channel
2 = Calibrate (bridge measures internal 100Ω)
INP? returns 0..2

MUX [0..7 | ?] Multiplexer channel command/query. The bridge will need a settling time after channel has been changed. The required time is longer if excitation is low. Use the DLY command after setup commands like MUX, RAN and EXC, before starting to take readings.

0..7 = sensor channel
MUX? returns 0..7

RAN [0..7 | ?] Range command/query

0 = no range is connected. No excitation can run into the sensor, but output is random. Avoid using this value in order to avoid accidental heating of the sensor when another range is selected. If you do not know the proper range, start from 2MΩ.

1..7 = ranges from 2Ω to 2MΩ
RAN? returns 0..7

EXC [0..7 | ?] Excitation command/query. Excitation voltage, as the term is used in the context of the AVS-47B, means the RMS voltage across a sensor whose value is half of the selected range. Excitation is symmetrical square wave -shaped current at 13.7Hz.

0 = no excitation
1..7 = 3µV, 10µV, 30µV...3mV
EXC? returns 0..7.

REF [0..20000] Reference command for deviation (ΔR) measurements. For example, REF10000 sets the AVS-47B's reference DAC to 1 Volt, which corresponds to the middle of any currently selected resistance range.

The resulting DAC voltage can be measured by switching the ADC input to DIS3 (the internal reference). Then issue ADCx for measuring the output voltage of the DAC.

The programmed reference DAC has only 12 bits (0..4095), whereas the 0..20000 output of the bridge corresponds to about 14 bits.The reference value is therefore divided internally by 5 for scaling it to range 0..4000. The DAC output changes in steps of 5 digits (500µV) and has a typical accuracy of an economical 12-bit D/A converter.

NULDEV [1..100] Null deviation command.

This is a macro command that measures whatever was previously selected by the DIS command and then sends this value to the reference DAC. The argument determines, how many A/D conversions are used for the measurement. A longer average improves accuracy if readings are noisy.

This command is intended to be used only with DIS0. The REF POT / REF MEM front panel switch must be in REF MEM position. After the NULDEV command, the rear panel DIFFERENCE BNCoutput is near to zero. Select DIS1 for measuring the difference.

RFS? Reference source query.

The deviation signal V_{dR}, is the difference between measured resistance value (analog voltage from the self-balancing circuitry) and the reference voltage. The reference voltage, in turn, can be either the output voltage from the reference DAC or the voltage of the front panel potentiometer. This selection is made by the front panel REF POT/REF MEM -switch. There is no remote command for changing the switch position.

The reference DAC is programmed remotely by sending the REFx command (see above). It can also be programmed manually by lifting the SET REF switch momentarily. Then the DAC takes the *displayed reading* as input. Deviation can be nulled this way manually. The NULDEV command is for making it remotely.

In remote-controlled applications, the reference-source switch should be in REF MEM position. You can verify this by quering RFS?. The response is:

0 = reference DAC (reference memory)
1 = front panel potentiometer

MAG? Magnifier query

The deviation voltage V_{dR} can be amplified by a factor of 10. Amplification is made by a simple circuit and is therefore not very accurate. The ΔRx10 mode is suitable for recording only small changes, not for measuring absolute values. It is best when excitation is high and readings therefore less noisy. Magnification can be selected only manually. MAG? returns

0 = 1xΔR
1 = 10xΔR

MEASUREMENT AND READOUT COMMANDS/QUERIES

These commands are for determining what the A/D converter measures, for making single or averaged A/D conversions, and for reading the result. There is also a command for detecting the possible overload.

DIS [0..7 | ?] Display selector command

This command selects one of 8 possible voltages to be measured. The current selection can be queried by DIS?.

Use the RES command and query only when displaying DIS0 and DIS1. The RES? query can also be used for reading item 7 (Set point of the old TS-530A temperature controller).

Then you get the set point in resistance, scaled correctly by the currently selected measuring range. However, because of the very old design, the TS-530A set point cannot be given in resistance but it must be given as an integer. Refer to the "SPT" command below.

Use the ADC command and query for all other display items than 0,1 and 7 because the RES values are scaled by the currently selected measuring range. The ADC? query returns integers -19999..19999 corresponding to its input voltages from -2V to +2V. Refer to the AVS-47B manual for how to use the various display items.

0= Voltage proportional to the sensor value R
1= Deviation ΔR between R and the reference
2= Adjust reference. This is the voltage from the front panel potentiometer
3= Reference. This is output voltage from the reference D/A converter
4= Excitation voltage. This is the approximate excitation voltage across the sensor. Useful only on the lowest resistance ranges and high excitation. Can be used for estimating current lead resistance.
5= 530A heater voltage, (amplified inside TS-530A, negative reading)
6= TS-530A heater current (actually, voltage across current sense resistor in volts)
7= TS-530A set point voltage (V).

ADC [1..1000] A/D conversion command

The A/D conversion is made from voltage that has been previously selected for measurement by using the DISn command. This command can be used both in local and remote modes.

ADC1 makes one single measurement, ADCn makes n successive measurements and calculates their average. Conversions take 0.4 seconds each, rate is 2.5 conversions/second.

If the result is an exact zero, the conversion is automatically repeated for detecting possible overrange (because the ICL7135 ADC yields a blinking zero in case of an overload).

ADC? A/D conversion query

This query returns the mean value of n conversions (see above). The conversion result is given as an integer -19999 to 19999 for ADC input voltages -2V..+2V. Polarity is indicated by minus sign and it is also returned by the POL? query. Use ADCn and ADC? at least for measuring items 4..6, which are not directly dependent on range. Use RESn and RES? for measuring intems 0, 1 or 7. Items 2 and 3 can be measured using either command. ADC overrange yields an exact zero, which can be distinguished from a real zero ONLY by checking the OVL? response. See also OVL? and ARN.

RES [1..1000] A/D conversion command for resistance.

The ADC reading is scaled by the currently selected resistance range, therefore measurement of display items 4-6 can produce misleading results.

RES1 makes a single conversion, RESn makes n successive measurements at 0.4 second intervals and their mean value is calculated.

If the A/D converter outputs an exact zero, the conversion is repeated for detecting a possible overload. The OVL? check should be a routine part of your application program.

RES? Query for resistance

Resistance is output as a floating point number with four decimal places for R and ΔR displays, and with five decimal places for 10xΔR display. It is scaled by the currently selected resistance range. The reading may include a preceding minus sign. Exponential form is not supported.

POL? Polarity query

The ADC? and RES? return values are preceded by a minus-sign if the reading is negative. You will probably not need this query, it is used by the firmware. POL? returns
0= negative
1= positive

OVR? Overrange query.

An overrange-reading from the ADC is an exact zero, which would be impossible to distinquish from a true exact zero. An internal alternating signal makes it possible to sepa-

rate these two cases. However, it requires that each zero reading must be repeated once. The AVS47-232/USB does this automatically.

If n in ADCn or RESn is greater than 1, the average may contain one or more over-range- readings. Overrange detections are internally OR'ed together so, that the final average can be seen faulty even if there is only one single overrange reading in it. Such an average is distorted and it should not be used.

If there is any possibility for such a situation, use autoranging. It will react to the first over-ranged conversion and, after the selectable delay, averaging is re-started. This quarantees a correct mean value. OVR? returns

0= no overrange
1= reading was overrange, or at least one sample in the average was overrange.

ARN [0..30] Autorange mode command.

In autorange mode, each A/D conversion result is compared against two limits:

• If lower than 1800 (out of 19999), range is changed downwards, provided that it is not already 2Ω.

• If the reading is higher than 19900, the range is changed upwards, provided that it is not already 2MΩ.

• If the argument in ADCn or RESn is greater than 1 (average of many conversions), the first encountered overloaded or underranged conversion causes an autoranging operation, and after a delay, averaging is started from the beginning. This guarantees a correct average.

The ICL7135 ADC circuit is overloaded, if reading exceeds 19999. Then the AVS-47B front panel display shows blinking zeros and an internal overload indicator blinks between true and false. During overload, a measurement like ADC;ADC? returns an exact zero, which cannot be distinguished from a real exact zero.

Because of this uncertainty, the AVS47-232/USB repeats once any conversion that returned zero, which enables detection of overload. The overload indicator is set to 1 (queried by OVR?).

ARN 0 means manual ranging. Argument higher than 0 enables autoranging. A value between 1 and 30 determines, in seconds, how long the system waits, after having changed the range, until measurements can be started again, or until a new autorange operation can take place, or until any new command can be performed. A time like 5 seconds may suffice at high excitations, when the bridge settles quickly. A longer time, up to 15-20 seconds, should be used at the lowest excitation in order to guarantee good balance before readings are taken.

If the resistance changes several decades, which is typical when switching channel, the settling delay time of x seconds is applied after each change of range. This can make scanning unnecessarily slow or too fast. You can avoid this by storing in your own program the last used range and excitation settings for each scanned channel. Disable autorange and set excitation to 3µV before selecting a new channel, send the saved previous good settings to the bridge, wait for settling (DLYz) and finally re-enable autoranging. This will speed up scanning, if sensors have very different values. You can still be sure that there are no over- or underranged readings.

Use the RAN? query if you want to check the possibly changed range.

Autoranging is especially useful in scanning. If you do not use autoranging, you MUST check with OVR? whether the single conversion or the average contained overload.

NOTE: The AVS-47B's hardware autoranging must not be enabled when the bridge is under remote control. This would cause a rival condition.

OTHER COMMANDS AND QUERIES

OPC? Operation complete query

This query can be placed after slow operations, like long averaging. When encountered, it places a "1" into the output queue. It should be the last item on a command row.

DLY [0..30] Delay command

The argument is delay time in seconds. Use DLY for giving the AVS-47B time to settle after a change in channel, range or excitation.

Note that autorange has its own settling delay after each change of range before starting to make A/D conversions. This delay is determined by n in ARNn (see ARN).

RST Reset command

This command works only when the program is idling, i.e. it is not extracting commands from a previously received command line or performing those commands. RST cannot be used for stopping long averaging.

The RST command sets the AVS-47B into a safe state: input 200Ω, channel 0, range 2M, excitation 3μV and display to R (resistance). Response line terminator is CRLF and command separator is semicolon. The AVS-47B is left in local mode, which is shown by the blanked REMOTE light.

RST works differently than initial power-on start: both leave the bridge in local mode, but start-up does no alter the previous local-mode settings whereas RST changes settings to "safe values".

ERR? Error query

The AVS47-232/USB has only weak error reporting capability. Errors are not reported automatically, they must be queried.

If the letter part of a command or query is misspelled, the ERR? query returns "`command (or query) xxx not recognized`".

Arguments, which fall outside their specified limits, are coerced to those limits. The ERR? query then returns "`argument in XXX exceeds maximum`" or "`argument in XXX less than minimum`".

The error register is cleared by issuing ERR?.

COMMANDS FOR THE TS-530A TEMPERATURE CONTROLLER

The **TS-530A** is a very old design, and it has been recently discontinued. We offer now a low-cost analog temperature controller option for the **AVS-48** bridge. However, the AVS47-232/USB includes also the basic commands for the TS-530A. They are for customers, who already have this controller. These commands have no corresponding queries. The analog setpoint voltage, the heater output voltage and the heater current can be *measured* by the A/D converter of the AVS-47B bridge (see the DIS command and refer also to the TS-530A and AVS-47B manuals).

The TS-530A must be connected to the AVS-47B with the supplied 37-way ribbon cable for data and with the supplied short BNC-BNC coaxial cable for the analog output from the bridge.

The TS-530A does not have a separate "remote" mode. Neither can the front panel settings be read remotely. This means that one can -but should not- change the remotely programmed PID settings by using the TS-530A front panel switches, and the firmware has no way to detect it. If this appears to be a problem, write your program so that the settings of the TS-530A are updated frequently. Re-programming the existing settings will not disturb the analog control circuitry in any way.

SPT [10..42000] Set point command

Set point is given as a long integer. One digit corresponds to 100μV and the range is from 1mV to 4.2 Volts. The slow integrating D/A converter of the TS-530A is very accurate and

linear, but it does not go to exact zero, therefore 1mV is the minimum. Arguments less than 10 are coerced to 10. Maximum value for the converter is 4.2Volts, corresponding to 42000, but only 2 Volts maximum is meaningful with the AVS-47B.

If you want to give the set point in resistance, you must scale and convert it yourself to a long or unsigned integer suitable for this converter. For example, SPT10000 produces 1 Volt setpoint. If the AVS-47B measures on range RAN, calculate the set point integer from set point resistance R_S as follows:

SPT = R_S / (10 ^ (RAN-1)) * 10000
where R_S=setpoint in ohms

If desired set point is e.g. 110 ohms and range=200R, (RAN=3)
SPT = 110/(10^(3-1)) * 10000 = 11000

PRO [0..11] Proportional gain command

Gain increases in steps of five decibels. Values are very approximate.
0..14: 5-10-15-20...60dB
15: no gain. Input of the proportional amplifier is connected to ground.

ITC [0..15] Integrator time constant command.

Values are very approximate.
0: integrator is reset to zero. P and PD mode control
1-10: 1-2-5-10-20..1000s. Higher number means weaker integration
11: analog integrator is latched by leaving its input open
12..15: integrator is reset to zero. Same as ITC=0.

DTC [0..7] Derivator time constant command.

Values are very approximate.
0: No derivation. P and PI mode control.
1..7: 1-2-5-10-20-50-100s

Higher number means stronger derivation. High proportional gain with strong derivation leads easily to oscillation of the control system.

BIA [0..5] Power bias command

Power bias can be used to reduce control error in P and PD modes. It is not useful in PI or PID modes.

0..5: 0-20-40-60-80-100% of maximum heater power. The highest setting is sufficient for maximum output on the selected heater range when proportional input is zero and integrator is reset.

POW [0..7] Heater power range command

Power ranges are calculated for a 100Ω heater. If heater resistance is higher, output voltage compliance (about 10V) will reduce the maximum power. If heater resistance is lower, the available output current (100mA) will reduce the maximum possible output.

0: Heater output is disabled
1..7: 1µW-10µW-100µW...1W

The heater output stage has seven current sensing resistors 10kΩ, 3.16kΩ, 1kΩ, 316Ω, 100Ω, 31.6Ω and 10Ω corresponding to heater ranges 1µW..1W. One volt across a sensing resistor means full output of the range. Based on the above figures, you can calculate correct ranges for heaters other than 100Ω. Similarly, you can measure the output current using DIS6 and calculate the heating power from R_H*I^2.

CABLE SPECIFICATIONS

The AVS47-232/USB comes with two cables, Picobus Cable and Serial Cable. The 5 meter Picobus cable connects the converter to the AVS-47B and the 1.5 meter Serial cable connects the box to the computer directly or via an USB-232 converter. This Picobus cable is distinguished from the Picobus cable that is supplied with the AVS-47B by its male 25- and 15 pin D-connectors. The resistance bridge is supplied with a cable that has male and female 25-way D-connectors.

Picobus Cable

The male DB25P and male DA15P are connected by a braided (shielded) cable with 6 conductors (e.g. Tasker C6015). Length: 5 meters.

DB25P	DA15P	Description
1	-	braid grounded only in DB25P
4	4	CP clock from box to bridge
5	5	DI data from bridge to box
6	6	AL alarm line from bridge to box
7	7	Isolated ground
20	15	DC data from box to bridge
9	9	Isolated +5V (referred to pin 7)
Other pins are unused.		

Note that the shielding braid must remain isolated from everything inside the 15-pin connector shell. A 100nF ceramic capacitor with shortest possible leads connects the braid to the connector shell. The braid *is* connected to the shell of the 25-way connector at the AVS-47B end.

This arrangement prevents the cable from acting as an antenna at high frequencies while not providing a path for ground currents at the mains frequency. Inside the AVS-47B, Picobus signals and its power supply are galvanically isolated from the bridge ground .

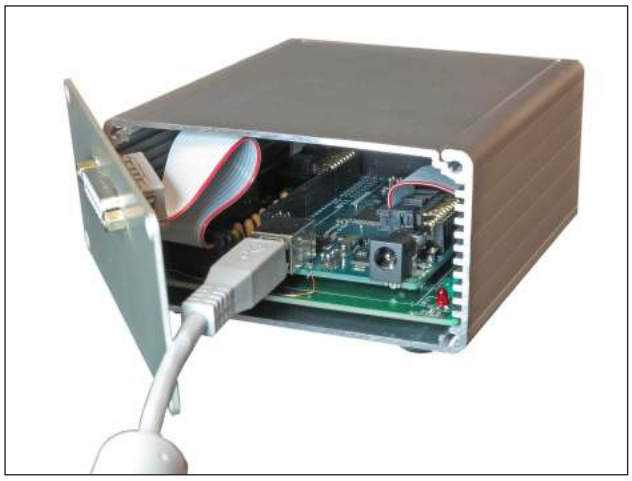
Serial Cable

The male DE9P and female DE9S are connected by a braided 1:1 cable of 6 conductors (e.g. Tasker C6015). Length: 1.5 meters.

DE9S DE9P	RS232	Description
1	-	-
6	DSR	AL for Picobus applications
2	RXD	RS232 output box=>computer
7	RTS	CP for Picobus applications
3	TXD	RS232 input computer=>box
8	CTS	DI for Picobus applications
4	DTR	DC for Picobus applications
9	-	
5	Computer ground = shielding braid	

Shielding braid is connected, in addition to pins 5, also to both connector shells.

RE-PROGRAMMING THE AVS47-232/USB



The firmware can be updated by reprogramming the Arduino Mega2560 board. In order to do this, you need

- a USB cable (type A/B)
- Arduino development software for Mega2560. This can be downloaded from Arduino WEB site.
- The new firmware version. It is available from us.

1. Follow Arduino's instructions to download and install their software, start it and select the

Arduino Mega board type.

2. Open the four screws holding the "front" panel of the AVS47-232/USB, the panel with the DA15 connector. There must be no cable from this connector to the AVS-47B. Plug the "A" type connector into the USB connector of your computer and the "B" end into the "hidden" USB connector inside the AVS47-232. The box will now start, as it gets power from the USB.

3. Open the downloaded new version of the "avs47_232_USB" software ("sketch", as they call it). From the Sketch menu, select UPLOAD. If you do not get any error messages, updating has been done in few seconds. You can now detach the USB cable, fix the rear panel and connect the 25/15 Picobus cable to the resistance bridge. Then test the new firmware using an RS232 terminal program or your own software.

Before asking us to email an updated version, please check and tell us your old firmware version so, that we can send to you also the old version for backup.

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DECLARATION OF CONFORMITY

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declares that under our sole responsibility

Product Name: AVS47-232/USB Converter

Product Description: Protocol Converter between the Picobus Primary interface of the AVS-47B Resistance Bridge and RS232 or USB port of an external computer.

is in conformity with the following Directives:

2004/108/EC: Electromagnetic Compatibility
2011/65/EU: ROHS Directive

and that the following harmonized standards have been applied:

EN 50 081-1: Generic emission standard, Part 1: Residential, commercial and light industry

EN 50 082-1: Generic immunity standard, Part 1: Residential, commercial and light industry

EN 50 581: ROHS

Additional information: This product uses only +5V power, which it gets from the AVS-47B Resistance Bridge.

Vantaa, 14 March 2016

RV-Elektroniikka Oy Picowatt

Reijo Voutilainen
President

INDEX