GENERAL

All entered parameters are first stored only in the RAM memory. They are volatile until saved into the EEPROM using appropriate commands. If a parameter has never been changed by the user, its factory default value is used.

When querying a value, be careful not to forget the question mark. Without a question mark or a numeric argument, the input is interpreted as a command with an argument of zero value.

*IDN?, IDN?

Identification query, response stored in program code. E.g. “PICOWATT,AVS-48SI,1R5,2020-06-16”. The last item is the compile date of the current firmware version, here 1R5.

ADC[1..1000 | ?]

Command for making 1..1000 A/D conversions at max. speed and for calculating their average, standard deviation, maximum, minimum and the ratio (max-min)/std (= qratio). The ADC? query returns the average. Other queries exist for the remaining calculated values. The RES? query differs from ADC? in that the result is scaled by the currently selected resistance range. The ADCx and RESx commands are interchangeable.

ADCIP[0..25 | ?]

Selector for the ADC input. The converter can measure 26 different internal voltages, of only few are useful in daily routine - the others are for service. For example, #4 is the normal bridge output, #0 is sero (ground) and #1 is the reference voltage of the ADC (should be near to 3.00V). Query returns the currently selected ADC input. This parameter has always value 4 after booting

ADCOFFSET[0..∞ | ?]

A digital calibration factor. This factor is usually determined by the adc calibration program but it can also be entered manually. The RESETALL command sets this factor to 0. It can be saved by the SAVEADC command. Query returns the offset that is currently in effect (= in RAM). The adcoffset calibrates also the outputs of the 8 digital-to-analog converters by means of digital feedback.

ADCOVR?

Query for ADC overload. This flag is set if an ADC reading, even one in an average, exceeds 3 Volts. This flag is set also if the measured resistance exceeds the selected measuring range. A query resets this flag.

ADCSCALE[0..∞ | ?]

A digital calibration factor. This factor is usually determined by the adc calibration program but it can also be entered manually. The RESETALL command sets this factor to 1. It can be saved by the SAVEADC command. Query returns the ADC scale factor that is currently in effect (=in RAM) The adcscale calibrates also the outputs of the 8 digital-to-analog converters by means of digital

	feedback.
ADCUR?	Query for ADC underrange. This flag will never be set in normal applications. However, if difference output is shown with suitable polarity and if the resistance is above the selected range, this flag can be set.
AL?	Query for the Alarm Line (AL) status. AL is set by a too high noise level in the measured signal from the sensor (signal overload), or by too high lead resistance. The former is likely when measuring a very high resistance (3MΩ or 30MΩ range) using a low excitation. The latter is possibe when measuring a low-ohmic sensors at a high excitation and using poorly conducting lead wires.
ARENAB[0..1 | ?]1	Enable autoranging. This parameter exists only for the AVS48si.vi LabView program. Its value is saved as a part of each sensor channel's preset settings for later recalling. 0=manual, 1= automatic ranging.
ARN[0..60 | ?]	Autorange command for serial operation. ARN0 means manual ranging. ARN1..ARN60 means automatic ranging with 1..60 second delay between successive changes of the range. This parameter cannot be saved. Query returns the currently effective setting.
ARRIDX[00..77 | ?]]	This array index is formed by two integers: the first is range and the second is excitation. The array index is needed when setting or asking the offset or scale correction factor of any combination of range and excitation. For example, array index 37 means range 3=300Ω and excitation 7=10mV. See also "offsetcorr" and "scalecorr". The correction factors are determined by the calibration program and they are within 0.1 .. 2.99V. Typical values are near to 1.5V. In the previous example, set ARRIDX37 and then query "OFFSETCORR?" or "SCALECORR?".
BNC[0..1 | ?]	The rear panel "ANALOG OUT" BNC connector can show either a voltage proportional to the sensor resistance or the difference =(resistance-set point). Both the bridge output and the deviation output are filtered by a 3rd order analog Bessel filter having a -3dB corner of 1.2Hz. The normal resistance output is BNC0 and BNC1 is the deviation. Query returns the currently effective setting.
CALADC	This command starts a procedure for **aligning** the user's own DVM with the A/D converter of the the AVS-48SI. The two obtained calibration values, offset and scale, are volatile until saved into EEPROM by SAVEADC.

CALIBRATE[0..2]

Command for automatic calibration (no query). Calibrate 0 starts a slow accurate calibration of all combinations of range and excitation. It uses very long averages in order to reduce calibration noise. It takes 3.5-4 hours to complete. Calibrate 1 is faster, less than one hour. It measures also all combinations, but uses short averages and delays, therefore it causes more calibration noise. Calibrate 2 calibrates only the currently selected combination of range and excitation using long averages. For each combination, the proecedure determines two correction voltages: “offsetcorr” and “scalecorr”. The former modifies the analog offset of the bridge. The latter modifies the magnitude of the excitation current.

The idea is to adjust the **analog** output so that its average value corresponds to the saved value of the appropriate calibration reference resistor. When this output is measured with the A/D converter, which has previously also been calibrated, both the analog and digital outputs read the same. Limits to calibration accuracy are set by a) measurement noise after averaging, b) calibration accuracy of the references, c) calibration accuracy of the A/D converter and d) linearity of the instrument (highest ranges).

Calibration results are volatile but they can be saved using the SAVECAL command.

Calibration is ready when both the CP and DC front panel indicators stay lighted.

The calibration procedure can be aborted by sending any character to the CPU via the serial interface. Any on-going averaging measurement is completed before stopping takes action. Please be patient.

CALREF

This command starts a procedure for measuring and/or entering the values of the seven calibrator resistors 1, 10 and 100Ω, 1, 10 and 100 kΩ and 1 MΩ. How to use this procedure is explained in the manual. A high-end 4-wire ohmmeter with at leat 6 digits is required.

CALSENSITIVITY

This command starts an automatic procedure for measuring, how much a change of 1 Volt in the outputs of the offset and scale correction DACs changes the analog output of the bridge. The heater output’s offset is also determined. This process is automatically run by the CALIBRATE0 and CALIBRATE2 commands. It can also be run alone. Results, “offsetsensitivity” and “scalesensitivity”, can be saved by SAVECAL.

CAPCOMP[0..1 | ?]

This command disables automatic compensation of input capacitance. It is automatically disabled on the two lowest ranges and

enabled on all higher ranges. Keep it enabled in order to avoid non-linearity caused by capacitive shunting effect. 0=enabled, 1=disabled. Query returns the current state of capacitance compensation.

The AVS-48SI preamplifier compares an almost ideal square wave feedback signal with a voltage drop from the sensor. This voltage drop is square rounded by the input capacitance in parallel with the sensor resistance. Comparison results in spikes that are detected by the compensation circuit, and then opposite spikes are generated and fed to the input. These opposite spikes charge the input capacitance quickly so that, in balance, the resulting signal contains much smaller spikes, if any.

CH[0..7 | ?]

Selects the input channel. CH0 is not for external sensors, it is devoted to measurement of any one of the calibration reference resistors. The calibrator resistor, in turn, is selected by the CALREF command.

CP[0..1]

Clock Pulse from the computer to the CPU (Picobus signal). Turning CP on (=CP1) lights the CP led on the physical AVS-48SI front panel. No query.

CTRLCH

This command has meaning only with the avs48si.vi LabView program. It specifies the sensor channel that is used for temperature control. In serial operation, this parameter has no effect. Query returns the current value. It is saved by command SAVETCR and read from EEPROM at boot up.

DC

Data from Computer (Picobus signal). Turning DC on (=DC1) lights the DC led on the physical AVS-48SI front panel. No query.

DEFAULTS

This macro sets most settings to “factory defaults”.

Recallable values specific for measuring channels CHx:
RAN7, EXC0, GNDS0, TW0, ARN0. These are set for all channels except the reference channel CH0, which is set for RAN2 and EXC7 (300Ω and 10mV).

In the LabView avs48si.vi program, all channels are set for:
ARENAB0 autoranging disabled
FILTERL0 no digital filtering
FILTERD0 smart filter delay parameter is zero
FILTERMODE0 stability checking in smart filter is on

Recallable values specific for temperature controller heater ranges HTRRANx:
PGAIN1, IGAIN1, DGAIN0. These are set for all heater ranges except the no-power range HTRRAN0, which is set for PGAIN0 and

IGAIN0. The possibly important integrator voltage is reset when HTRRAN0 is selected. This operation also disables control..

Default power-up values for the bridge, serial operation:
CH0, RAN2, EXC7, REFID3, LINETERM3

Default power-up values for the controller, serial operation:
PGAIN0, IGAIN0, DGAIN0, HTRRAN0
Temperature control is disabled and heater current is 0.
Control channel = CH0 (cannot be used for control)
Heater resistance 100Ω.
External (normal) heater.

Default power-up values for the avs48si.vi LabView program:
Reference channel measuring100Ω reference ,300Ω range, 10mV excitation. No autorange, no digital filtering, 4-wire, floating sensor. No temperature control, all PID parameters are zero. User DAC and Setpoint DAC are zero (= few millivolts). LINETERM1.

DERG[0..10 | ?]

Derivator gain. The actual values are complicated as the derivator has a modified frequency response that reduces derivation action at high frequencies. The values are in the logarithmic 1-2-5-10 etc. sequence. Query returs the current value.

DI?

Data from instrument (Picobus signal). Only query. If the value stays constantly at 0 or 1, there might be a fault e.g. in optical isolation.

DLY[1..30000]

Delay in milliseconds. This parameter is mainly intended to offer a settling time in simple scanning applications. Insert a delay after having recalled or re-programmed a new channel before taking the readings. The required settling time depends on desired accuracy, size of the resistance jump and on excitation. Try values in the range from 5 seconds to 20 seconds. In situations where settings change much and often, the SCK command may work better and require less attention.

DRDT

Polarity of the deviation output and temperature control. For temperature control, use: DRDT0 for sensors having a positive dR/dT coefficient and DRDT1 for most cryogenic sensors having negative dR/dT.

In non-control applications, DRDT determines the polarity of the ERROR output signal:
DRDT0 means deviation (signal-set point)
DRDT1 means deviation (set point - signal)
DRDT2 deviation (test voltage - set point)
DRDT3 deviation (set point - test voltage)

The test voltage is obtained from a forward-biased silicon diode that is in thermal connection with the internal 100Ω heater. The diode voltage is typically in the range 0.6....0.7 V. This heater-diode assembly is used for testing temperature controller without an external heater. Only limited range of PID parameters and heater ranges are possible. See the manual!

DVMHI[0...∞ | ?]

Higher of two readings of an external voltmeter, when the A/D converter is calibrated against a high-quality DVM. See "CALADC" Query returns the value that was used for the latest calibration.

DVMLO[0...∞ | ?]

Lower of two readings of an external voltmeter, when the A/D converter is calibrated against a high-quality DVM. See "CALADC" Query returns the value that was used for the latest calibration.

EFSDAC[0.005...2.99]

Excitation fast-settle DAC. Integrator of the phase-sensitive detector in excitation channel can be set quicky to a voltage given by EFSDAC.

EFSMODE[0..3]

Fast-settle mode of the excitation channel PSD integrator. 0 and 2 are for normal operation, 1=reset to zero, 3=fast settle to and then follow the EFSDAC voltage.

EPRADC

Read calibration parameters of the A/D converter. from EEPROM to RAM No argument.

EPRCAL

Read from EEPROM to RAM (no argument)
- all 128 parameters for bridge scale factors and offsets.
- offset and scale sensitivities
- offset of heater voltage measurement.

EPRREF

Read the measured "true" values of the calibrator resistors from EEPROM to RAM.

ERR?

Error query. Return is a string with unspecified length. "0" means no error. Few errors can be found by ERR: a misspelled command or query, signal overload, lead resistance, ADC overrange. Some errors during calibration are also recognized.

ERRSIGNAL?

This command connects the ADC to the ERROR output and then takes an average of 5 conversions. Only query.

EXC[0..7 | ?]

Set excitation to 3, 10, 30, 100 or 300µV, 1, 3, or 10mV for values 0..7. respectively. This nominal excitation voltage V_E determines

	the excitation current as $I_E = V_E/(1/3 \text{ RANGE})$. For example, 30 kΩ range and 100µV excitation result in excitation current of 1E-4V/(30kΩ/3) = 10nA. Query returns the currently selected excitation.
FILTERD	Filter delay. Only for the avs48si.vi smart filter.
FILTERL	Filter length. Only for the avs48si.vi smart filter.
FILTERM	Filter mode. Only for the avs48si.vi smart filter.
GNDS[0..1 | ?]	Sensor grounding. GNDS0 is used when no part of the sensor is connected to the cryostat ground, but the I- lead is grounded to the AVS-48SI preamplifier. GNDS1 must be selected if the sensor's I- lead is connected to the cryostat. Then the connection to AVS-48SI preamplifier is removed in order to maintain only one grounding point at the input.
HDACV[0.005..2.99V | ?]	Heater DAC voltage is used for the macro function that changes heater range with minimum possible transient in heating power. It can also be used for direct software control of the heater output. Query returns the current value. Note: HDACV is the voltage driving the heater stage, not the actual heater output voltage.
HEATERDAC[0..∞]	This command is only for testing purposes. It is also used for setting the heater DAC. No query.
HEATERENAB[0..1 | ?]	Enable the heater output. In order to get any current out from the heater output, it must be enabled, the heater range must not be zero and the internal heater must not be selected (INTHEATER0). The CPU takes care of all these operations when HTRRAN is set >0. Query returns the currently enabled state.
HOLDMODE[0..1 | ?]	HOLDMODE1 is for stopping active temperature control and for maintaining the output current constant at its latest value. When holding, one can measure other sensors using any parameters. After such a visit, select the control sensor and its previous settings before issuing HOLDMODE0. Active control starts again. Hold mode works the better the closer the system is to equilibrium and the more stable is the heat load. Query returns the currently effective hold state.
HTRDIR[0..1 | ?]	As an alternative to the analog PID circuitry, the AVS-48SI heater can be controlled also directly using a voltage from an internal DAC. This enables the user to write his own digital control programs. The heater output works then as a voltage-controlled current source. This command changes only the driving source, also other settings, like HTRRAN and INTHEATER must be properly

specified. The drive voltage is programmed using the HDACV command. HTRDIR0 means PID control whereas HRDIR1 means direct digital control. Query returns the current drive state.

HTRI?

Query for heater output current. Response is a floating point number with 6 digits. The A/D converter measures the voltage drop across the selected heater range's current sense resistor. This voltage, which is between 0..1V, is then divided by the tabulated sense resistor of the heater range for getting the current.

HTROFFSETV[-∞..+ ∞| ?]

Command and query for the saved value of the offset voltage of the heater output when heating current is zero. Changing this value does not affect the output, only its measured offset.

HTRP?

Query for heater power. In order to calculate the power, the internal A/D converter measures both the output current and the output voltage, and it is therefore a slow command, taking about 0.5 seconds. The current, which is between 0..1V is easy to measure, whereas the voltage can be very small on an low heater range. The voltage measurement is affected by an offset, which is automatically subtracted (see HTRVOFFSETV). The value for the offset is determined and saved into EEPROM as a part of the two slow calibration processes.

As both the current and voltage are measured, the HTRP? reacts to both open circuits (heating power is then 0) and shorts in the heater wires (power is much less than expected). If the heater resistor is very small, one can calculate heating power from HTRI? alone, but then short circuits cannot be detected.

HTRRAN[0..18 | ?]

Heater range. Arguments 1..18 result in heater powers whose magnitudes are I^2R_H. Ranges are spaced logarithmically so, that the power ratios between adjacent ranges are about 2.5. HTRRAN0 disables the heater and resets the PID parameters.

Unlike with most temperature controllers, the AVS-48SI uses the HOLD MODE and its internal DACs for maintainin the output power even when the heater range is changed, without changing anything else. The transient caused by switching to the adjacent or nearby range is negligible if the system was in good balance. By changing heater range, one can keep the power in the middle region of the power range, which is convenient as it offers tolerance into both directions. Query returns the currently active heater range.

HTRRES[0..∞ | ?]

Heater resistance command/query. This parameter meaning only the avs48si.vi LabView program where it is used for calculating the maximum available nominal power on each heater range.

The AVS-48SI accepts any heater value, but we recommend 100Ω as the "standard" value. Nominal maximum power into a 100Ω heater is 1W. The maximum power that the AVS-48SI can supply is 1.5W into a 50Ω heater.

HTRV? — Query for heater voltage. This voltage is very low on the lowest heater ranges and it is very important that the zero offset of this measurement is calibrated so that it can be deducted. Calibration is made automatically each time one of the slow calibration programs (CALIBRATE0 or CALIBRATE2) is run. Query returns a floating point number.

HW? — Hardware query, which returns only the version of the mother board to which the Arduino Mega2560 CPU is fixed. Typical response is "PICOWATT,RS232PB_A2".

IDN? and *IDN? — Identification query, response is stored in program code. Returns e.g. "PICOWATT,AVS-48SI,1R5,2020-06-16". The date tells when firmware version, e.g. 1R5, was compiled.

INTG[0..10 | ?] — Integrator gain. INTG0 keeps the integrator at reset. Note that also HTRRAN0 resets the integrator as a part of ensuring that no current would flow from the output to the heater. Therefore, be careful not to select either INTG0 or HTRRAN0 by mistake in the middle of a control session. Gains are in the logarithmic 1, 2, 5, 10..etc sequence. Query returns the currently active integrator gain.

INTHEATER[0..1 | ?] — Internal heater command. INTHEATER1 feeds the output current into an internal 100Ω resistor that is in thermal contact with a forward-biased silicon diode. The diode generates a voltage drop of 0.6..0.7V depending on the temperature generated by the heater. The difference of this voltage and a suitable setpoint, e.g. SDACV0.63, can be used as the error signal for testing the temperature controller. See also the LabView section of the user guide.

LINETERM[0..3 — Termination character for the response line.
LINETERM0 = no terminator
LINETERM1 = LF (ASCII 10, linefeed, newline)
LINETERM2 = CR (ASCII 13, carriage return)
LINETERM3 = CRLF
The AVS-48SI CPU uses the selected terminator in its reponses to the external computer. The CPU accepts any of the above combinations 1-3 when receiving data from the computer.
The selected lineterminator can be saved into EEPROM by command SAVELINETERM. The saved terminator is read from memory whenever the CPU is started or RESTARTED.

Check with your programming language, which terminator it needs. For example, LabView needs only one character, LINE-TERM1.

MADC?	Query for asking from memory an A/D conversion result of a previously measured channel. Returns a floating point number 1..3 having 6 digits after decimal point. This query must be preceded by an MCH[0..7] command (see below).
MAX?	Query for the maximum value among the n averaged readings taken after command ADCn.
MCH[0..7]	Command for selecting a previously measured channel. Next, ask the A/D conversion result using either the MADC? query or the resistance by the MRES? query.
MIN	Query for the minimum value among the n averaged readings taken after command ADCn.
MRAN?	Query for asking the range 0..7 that was used when channel MCH was measured. This query exists because autoranging might have changed the channel's range.
MRES?	Query for asking from memory the A/D conversion result of a previously measured channel. The result is expressed in floating point resistance including a maximum of 7 significant digits. This query must be preceded by the MCH[0..7] command that specifies the channel whose result will next be queried.
NORANGE[0..1]	Controls injection of the excitation current. 0: normal operation (default). 1: all injection relays are open regardless of selected measuring range.
NRECALLBR[0..7]	This command is only for the avs48si.vi LabView program. Same as RECALLBR but does not make the recalled bridge settings effective (it does not send them from the CPU to the shift registers in the bridge). Argument is the number of the recalled channel.
NRECALLTC[0..18]	This command is only for the avs48si.vi LabView program. Same as RECALLTC but does not make the recalled temperature controller settings effective (it does not send them from the CPU to the shift registers in the controller). Argument is the number of the recalled heater range.

OFFSETCORR[-∞ .. +∞ | ?]

Command for setting or asking the offset correction voltage for a combination of range and excitation. These factors are generated by the CALIBRATE[0..2] calibration program. The RESETALL sets all offset correction voltages to 1.5, which in the middle of their range 0.005 to 2.99V.

Before querying a correction voltage of a range/excitation pair, one must first issue the ARRIDXre command, where r is the range like 2 (300Ω) and e is the excitation like 7 (10mV). Then, without sending anything more to the CPU, query OFFSETCORR?

OFFSETDAC[0.005..2.99]

Sets the output of the DAC that changes the zero offset of the bridge. The 64 values for all combinations of range and excitation are tabulated by the calibration programs. This command is for service only.

OFFSETSENSITIVITY?

Query for offset sensitivity. This figure indicates the voltage change of the analog output when the output of the offset correction DAC changes 1 Volt. It is typically 0.1V. See also SCALESENSITIVITY.

OPC?

Output complete query. When the command interpreter encounters this query, it places character “1” in the output queue.

The CPU performs all commands, both quick and time taking, in the correct order without starting the next until the previous one has been handled. Commands on one line do not pose any problems to the CPU. However, if there is a command last on a line, the external computer may try to send a new message line to the Arduino CPU. If it is still handling the last command of the previous message, it will forget the new message line completely.

The resulting timing problem is most easily avoided by ending a line of commands by a query. If no query is actually needed, use the OPC?. Poll for the character “1” and after it has been received, send the new message line.

Please observe that a calibration command may take hours. Calibration is probably best to do under purely manual control. Calibration is complete when both the CP and DC indicators stay permanently lighted.

PBD [50..10000]

Picobus Delay in microseconds. PBD controls the length of the low and high levels of the signals transmitted via the Picobus Cable from the CPU to the computer and vice versa.

PDACV[0.005..2.99 | ?]

The PDACV determines the voltage to which the PID integrator is set when PFSMODE=3 (PID Fast Settle Mode). It is used when changing the heater power range. The voltage that is required on

the new range is calculated from the previous output current using the ratio of the old and new current sense resistors.

Do not use PDACV for resetting the integrator as this voltage has an offset or a few millivolts. Instead, use PFSMODE.

PFSMODE

The PID fast settle modes are: 0 and 2 for normal temperature control, 1 for resetting and keeping the integrator at zero and 3 for setting the integrator quickly to the voltage determined by PDACV.

PIDDAC

For setting the PID DAC voltage. No query. For service only.

PIDINT?

Query for asking the voltage of the PID integrator during normal analog temperature control. The response should be positive and less than 3 Volts. Integrator voltage of 3 Volts is sufficient to drive the heater output to maximum of the currently effective heater range even if proportional error is zero.

PRESETMODE[0..1]

Each sensor channel can have its individual set of measuring parameters range, excitation, sensor grounding and 4-or 2-wire measurement. When PRESETMODE0 (default), they can be saved by setting the bridge to measure a channel, choosing the proper parameters and calling SAVEBRD. The inconvenience of this method is that the bridge must really be measuring each sensor in turn. PRESETMODE1 prohibits sending the settings to the analog bridge so, that channels can be programmed while the bridge continues measuring its current channel.

Before exiting this mode by PRESETMODE0, the new programmed values must be saved by SAVEBRD.

PROPG[0..13 | ?]

Proportional gain. If PROPG=0, the proportional amplifier is shorted to ground and the heater output is controlled solely by the PID integrator. Query returns the currently effective P gain.

PSDF[0..2 | ?]

Operating frequency of the phase-sensitive detector (PSD). Three crystal-controlled frequencies are available

0: 12.5Hz
1: 13.64Hz
2: 15.0Hz

13.64Hz is the shipping default. It works both in 50 and 60Hz countries. As 12.5Hz is a sub-multiple of 50Hz, use 15.0Hz in a 50Hz country and 12.5Hz in a 60Hz country. The idea is to make beating with possible mains hum faster and therefore easier to filter off by averaging. Operation at 12.5 or 15.0 in a 50 or 60Hz country may seem to yield lower noise, but it can be the beating that has a very low frequency, ideally zero Hz. Then the beating

	would look like an offset and it would be impossible to eliminate it from the results.
QRATIO?	If the measurement noise is white and purely random, the quality ratio (MAX?-MIN?)/STD? would be about five. Usually QRATIO is between 5 and 7. A very low figure means probably too few samples, whereas a too high figure can mean a sharp spike in data. QRATIO is useful only on low excitation ranges. On the highest excitations, digitising steps can increase or decrease the ratio. Qratio can be queried after an A/D conversion if more than one conversions are averaged (ADCn, n>1).
RAN[0..7 | ?]	Ranges are 3, 30 and 300Ω, 3, 30 and 300kΩ, 3 and 30 MΩ. The setting is made effective immediately. Both RAN and EXC functions include re-programming of two DACs, so they are completed slowly. Query returns the currenty effective settings.
RECALLBR[0..7] RCB[0..7]	This command is for recalling preset settings for one of the 8 channels. Recalled settings are made effective immediately: sensor channel, measuring range, excitation, sensor grounding and 4/2-wire configuration. Settings for the temperature controller must be recalled separately. See below.
RECALLTC[1..18]	This command is for recalling the preset PID parameters for one of the 18 heater power ranges: proportional gain, integrator gain and derivator gain. Recalled settings are made active immediately, i.e. the heater range is changed together with its three PID parameters. 0 is not included as selecting HTRRAN=0 would reset the controller and disable control.
REFID[0..7 | ?]	This command selects the calibrator reference resistor, whose ordinal number is the argument. 0 means zero, 1 is 3Ω and 7 is 1MΩ. The selected resistor is connected to channel 0 and it can be measured like any other sensor by selecting CH0. Query returns the currently connected calibrator.
REFVALUE[0..∞ | ?]	Command gives a value to the calibrator resistor that has been previously selected by REFID. It is used during initial calibration of the AVS-48SI or if the calibrator values are later updated. The updated values can be saved into EEPROM by command SAVEREF. Query return the existing saved value of the currently connected calibrator. Be careful not to give the REFVALUE command without an argument: no argument is interpreted as zero!
REPEAT	This command is for repeating automatically one message line.

	REPEAT must be the last command on the line. For example: RES100;RES?;REPEAT would make 100 A/D conversions, and place their average in the output buffer. It is then the user's responsibility to write a program that polls the serial output in order to get the readings into her application.
RES[1..1000]	Command for starting 1..1000 A/D conversions and for calculating their average, standard deviation, maximum, minimum and the ratio (max-min)/std (=qratio). The ADC and RES commands are interchangeable (e.g. RES20 = ADC20). Both have the same effect. However, the queries ADC? and RES? give different outputs.
RES?	Query for asking the result of an A/D conversion (or average) in terms of resistance. Response is a floating point number consisting of a maximum of six significant digits. RES? query differs from the ADC? query in that the response is scaled by the currently selected measuring range.
RESETALL	This powerful command is only for service. It differs from the DEFAULTS command in that it resets to zeros all settings including the EEPROM memory. RESETALL affects calibration of the offset and scale, of the ADC and of the reference resistors. After RESETALL everything must be calibrated from scracth. DEFAULTS, in turn, does not affect any of the calibration factors, it affects only the measuring settings and PID parameters.
RESTART	RESTART is a macro command that - resets the input and output queues and the error message - sets channel=0, range=300Ω, excitation=10mV, calibrator=100Ω floating sensor and 4-wire configuration. It reads the calibration factors from the EEPROM and sets response line terminator to the value that is in non-volatile memory. - Re-booting by power-off-on sequence has an almost similar effect, but it can be used even if the firmware has stopped operating.
SAVEADC	This command saves the ADCOFFSET and ADCSCALE into the EEPROM. If new correction factors were measured using the CALADC procedure, the old values in the EEPROM will be replaced, and they cannot be restored. Unless saved, the newly measured values are in effect but volatile.
SAVEBRD	This command saves the currently effective measuring parameters as properties of the currently selected sensor channel. In order to make such properties of each or any channel recallable by RECALLBRn, you must select a channel and all settings for it, and

	then issue SAVEBRD. Alternatively, use PRESETMODE.
SAVECAL	This command saves all 128 offset and scale correction factors into the EEPROM. They are read into the RAM at boot-up, but they can also be read using the EPRCAL command. Calibration factors are usually got from the CALIBRATE[0..2] procedure. Unsaved factors are effective until old values are returned by re-booting or RESTARTing. .
SAVELINETERM	This command is for saving the selected line terminator (see the LINETERM command) into non-volatile memory. The saved terminator is read from memory each time the CPU is started or RESTARTed.
SAVEREF	This command saves the “true” values of the calibrator references into EEPROM. These values may have been got from the CALREF procedure, they may have been measured by the user, or the initial “shipping time” values may have been copied from this instrument’s individual documentation. Unsaved new calibrator values are volatile. Values in EEPROM are returned by re-booting or RESTARTing.
SAVETCR	Like the SAVEBRD on the bridge side, SAVETCR on the controller side saves the three currently effective PID parameters *as properties of the currently effective heater power range*. In order to save a set of PID values for HTRRANx, select the power range “x”, set the parameters and then call SAVETCR. Alternatively, go into the PRESETMODE and modify settings of one channel “x”. Change the heater range to “y” and modify its settings and so on. Finally, call SAVETCR for saving the settings of all channels at one time. Unsaved PID parameters are volatile.
SCALECORR[0..∞ | ?]	The scale correction voltage, that affects both the analog and digital outputs, can be entered but only temporarily: some operations fetch the old value from the EEPROM. Query returns the correction factor for the currently selected combination of range and excitation. It should be between 0.1 and 2.99V.. When querying, be sure to include the question mark, otherwise the factor will be set to 0.
SCALEDAC[0..∞]	This D/A converter (one of the eight converters of the AVS-48SI) modifies the scale of the analog output together with OFFSETDACso that, when measuring a calibrator reference, the output corresponds to the entered “true” values of the reference. The values for each combination of range and exctitation are obtained from a

	128-element table together with offset correction values.
SCALESENSITIVITY?	Query for scale sensitivity. This figure indicates the voltage change of the analog output when the output of the scale correction DAC changes 1 Volt. It is typically 0.1V. See also OFFSETSENSITIV-ITY? Required internally for the CALIBRATE function
SCENAB	Enable automatic scanning. This setting is only for the avs48si.vi LabView program.
SCK[1..100]	Sign-check. Makes continuous A/D conversions until the difference between two successive conversions has changed sign n times or 100 conversions have been made. Then proceeds to the next com-mand on the command line. Used for delaying reading until settling transient has decayed to within p-p noise.
SCNARRSTR	Internal parameter for automatic scanning. Only for the avs48si.vi LabView Program.
SDACV[0.005..2.99 | ?]	Set point DAC voltage. Can be used for two purposes: either as the control set point when controlling temperature, or as a reference when monitoring changes in sensor value. SDACV is given as a voltage in the range 0.005..2.99V for any measuring range. Often it is more convenient to use the SETPOINT[0..∞] command where set point can be given in ohms (floating point number, no expo-nent). Query returns the DAC output voltage, it is measured by the ADC, it is not only the digital programming input.
SETPOINT[0..∞]	Use for entering the control set point in ohms. Full range value would result in DAC voltage of 2.99V. Lowest generated set point voltage is 0.05V.
SETPTDAC	Service command for setting the set point DAC (or SDAC). Not for use in appications.
SFSDAC[0.05..2.99]	Signal channel fast-settle DAC. Integrator of the phase-sensitive detector in signal channel can be set quicky to a voltage given by SFSDAC.
SFSMODE[0..3]	Fast-settle mode of the signal channel PSD integrator: 0 and 2 for normal operation, 1=reset to zero, 3=fast settle to and then stay at the SFSDAC voltage.

SPT	This command for entering the set point is **only for the avs48si.vi** program, which features giving set point also in temperature if a conversion file is available.
SPTU	SPT is used **by the avs48si.vi** together with the set point unit SPTU that indicates whether the setting is resistance or temperature.
STD?	Standard deviation of the n samples averaged for one ADCn command. The lower is the excitation, the larger should n be in order get a somewhat reliable result, do not go below 50..100 samples. STD is very much the same as the RMS noise of the measurement. Use STD for verifying quality of the measurement. Measure STD from your cooled sensor, then from the most suitable internal calibrator reference using the same range and excitation settings. In an ideal situation, the cooled value should be lower. If it is very much higher, either there is a trend or some external interference. Compare also the measured STD with the specifications in the user guide. STD is not very useful on the highest excitations because of the digitising steps.
TIME and TIME?	Time needed to perform the instructions on one message line can be measured by adding the TIME command as the first item on the line and the TIME? query as the last item. The query returns milliseconds.
TW[0..1 | ?]	Enable two-wire measurement (0=4-wire, 1=two-wire). The normal default mode is always 4-wires. Two-wire measurement can be used - for saving connector pins or cabling if sensor resistance is high compared with lead resistances - for measuring the total resistance of current leads (2-wire reading minus 4-wire reading) - Keeping track of the above difference for detecting possible shorts between the sensor leads.
UDACV[0.005..2.99 | ?]	Of the 8 digital-to-analog converters, one is always available for the user's own applications. This user DAC goes from 5mV to 2.99V. Things like a level-shifting network followed by a voltage-controlled current source for cryostat management can be built inside the AVS-48SI. There is a -12V, -5V, 0, +5V, +12V power connector available for such purposes. Contact factory. Query returns the DAC output voltage, actually measured from the circuit. If temperature control is not used, the set point DAC can be used also for user's own purposes. This output is programmed by command SDACV.