User Manual

Piezo Positioning Electronic ANC300

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List of Abbreviations

A	Ampere. The unit of electrical current.
AC	Alternating Current.
AC-IN	Input connector on the frontplate for AC voltages. Also used for the corresponding mode, which (de-)activates this input.
ASCII	American Standard Code for Information Interchange. A character-encoding scheme based on the ordering of the English alphabet.
BNC	Bayonet Navy Connector. Standard connector for coaxial cables, here only used for 50 Ohm impedance connectors/cables.
°C	Degree Celsius. The unit of temperature. Compare to K.
COM Port	Communications port. Used to identify RS232 serial ports in PC operating systems, such as Linux or Windows. Examples: COM1, COM2, etc.
CPU	Central Processing Unit. The main controller in the ANC300.
CR	Carriage Return. ASCII character code 13.
DC	Direct Current. Identifies constant offsets or slow changing voltage levels.
DC-IN	Input connector on the frontplate for DC voltages. Also used for the corresponding mode, which (de-)activates this input.
DHCP	Dynamic Host Configuration Protocol. Protocol to automatically assign an IP address on a LAN network.
DOS	Disk Operating System.
EC	European Community.
EMC	Electro-Magnetic Compatibility. Refers to corresponding CE regulations.
ESD	Electrostatic Discharge. Sudden current equilibrating the electrical potentials of two different objects. ESD currents may damage electronic equipment.
ETH	Short for Ethernet. Used as synonym for LAN.
F	Farad. The unit of electrical capacitance. F = As/V
FAT	File Allocation Table. FAT16 or FAT32 are file system architectures widely used on many computer systems, especially Windows™ PCs.
FPGA	Field Programmable Gate Array. An integrated circuit that can be configured at runtime by uploading certain boot code. The FPGA in the ANC300 controls fast actions such as stepping as well as communication functions.
FRQ	Frequency. Used in conjunction with the stepping functionality of the ANC300.
FTP	File Transport Protocol. A basic internet protocol for sending/receiving files over a LAN network or the internet.
GND	Ground. Connection of chassis mass. Also used as description of a controller mode, in which the outputs are deactivated and connected to chassis mass.
GUI	Graphical User Interface. The interface displayed on the screen for user interaction
HTTP	Hypertext Transfer Protocol. Standard protocol used on LANs and the internet.
Hz	Hertz. The unit of frequency.
IP	Internet protocol. The underlying basic protocol to FTP, HTTP, and others.
I/O	Input / Output
LAN	Local Area Network. Standard way of connecting several PCs or devices for exchanging data over the internet.
LED	Light Emitting Diode.
LF	Line Feed. ASCII character code 10.

LUA	A programming language for embedded devices. See www.lua.org.
LVTTL	Low Voltage Transistor to Transistor Logic. Triggering standard for direct electrical end-to-end connections between two devices. Voltage levels are 0 and 3.3V. Compare to TTL.
m	Meter. The unit of length.
OEM	Original Equipment Manufacturer.
OSV	Offset Voltage.
PC	Personal Computer.
PCB	Printed Circuit Board.
RoHS	Reduction of Harmful Substances. Directive of the European Community.
RS232	Industry standard that defines characteristics of a serial, binary, single-ended port. Used as synonym for COM port.
s	Seconds. The unit of time.
STP	Step. Used in conjunction with the stepping functionality of the ANC300.
Sub-D	Subminiature D-type connector. Industry standard for serial connectors, which is subdivided by the number of electrical pins on the connector, e.g. Sub-D25. Often also called D-Sub.
TTL	Transistor-Transistor Logic. Used to describe the TTL-compatible logic levels for the in- and outputs of electronic instruments. Voltage levels are 0 and 5 V. Compare to LVTTL.
USB	Universal Serial Bus. A single-ended serial bus.
V	Volt. The unit of voltage.
VI	Virtual Instrument. A complete program or subunit within the Labview programming environment.
WEEE	Waste Electrical and Electronic Equipment. Directive of the European Community.

I. Introduction

I.1. System Overview

The Piezo Positioning Electronic ANC300 is a modular positioner control unit providing the suitable drive signals to actuate attocube systems positioners or scanners manually or under computer control. The ANC300 is available as a modular housing that can host up to seven modules. There are modules that enable (individually or combined):

- performing single as well as continuous stepping,

- applying DC offset voltages,

- amplifying DC voltages,

- mixing in of AC voltages, and/or

- measurement of the attached capacitance.

The ANC300 can be controlled either manually from the front panel, or remotely using:

- a virtual COM port over an USB connection to a PC,

- a serial port via an USB/serial adapter on the USB master port, or

- a terminal connection via the LAN port (2 types).

As the ANC300 can be connected to the local area network using the LAN interface (ETH), one can also access the unit by connecting via web browser or FTP (for updates only). For example, one can download the manual or the USB drivers using the built in web server.

The attocube systems positioners are to be connected to the outputs of the ANC300 using either the cable delivered with the system for table-top applications, or by using user supplied cabling for applications in extreme environments such as low temperatures or ultra-high vacuum. Please refer to the sections below for a description of the respective cabling requirements.

I.2. Safety Information

For the continuing safety of the operators of this equipment and the protection of the equipment itself, the operator should take note of the **Warnings, Cautions,** and **Notes** throughout this user manual and, where visible, on the ANC300 itself.

I.2.a. Safety Symbols on the Equipment

WARNING. Risk of electric shock. High voltages present.

WARNING. Risk of an immediate hazard, which will lead to severe personal injury or death danger. Refer to the manual for details on this hazard.

Caution. Hot surface. May cause injury when touched.

Caution. Electro-statically sensitive device. Equipment may get damaged if touched by personnel not grounded. Only touch with earthed wristband attached or otherwise connected to ground.

Functional (EMC) earth/ground terminal.

I.2.b. Safety Symbols in this Manual

It is important to recognize safety information. The safety alert symbol-

⚠ - is used to draw your attention to potentials for personal injury or property damage. The signal words WARNING and CAUTION are used with the safety alert symbol and identify the level of hazard seriousness.

⚠	**WARNING.** An instruction, which draws attention to hazards or unsafe practices which could result in severe personal injury or death, if the security advice is not obeyed.

⚠	**CAUTION**. An instruction, which draws attention to hazards or unsafe practices which may result in minor personal injury or damage to the product, process, or surroundings.

🛈	*Note*. Clarification of an instruction or additional information.

I.2.c. Warnings

WARNING. Risk of electrical shock. The piezo translators and controllers, as described herein, are high voltage devices, capable of generating high output currents. They may cause serious or even lethal injuries if used improperly. **Never touch any part that might have connection to the high voltage output.** Working with high voltage devices requires adequately educated operating personnel.

WARNING. Risk of electrical shock. If the outputs are enabled while plugging cables in or out there is a risk of touching harmful voltages. Never connect any cabling to the electronics when the electronics is not in GND mode!

WARNING. Risk of electric shock. If covers are opened, there is a risk to touch hazardous voltages. If malfunction is suspected, immediately contact attocube systems for repair or replacement. Modified or opened electronics cannot be covered by the attocube warranty anymore. Only personnel trained in the servicing and maintenance of this equipment should remove its covers or attempt any repairs or adjustments. Follow the General Accident Prevention Rules.

WARNING. Risk of electrical shock. If this product is used in a manner not specified by the manufacturer, the protection provided by the product may be impaired. Do not operate the product outside its rated supply voltages or environmental range.
- For laboratory use only.
- This product is intended for operation in the temperature range 5° to 40°C, 20% to 80% RH. In particular, excessive moisture may impair safety.
- If the unit has been stored at a low temperature or in an environment of high humidity, it must be allowed to reach ambient conditions before being powered up.
- The product must be connected only to an earthed fused single-phase supply of 100V, 115V or 230 V, 50/60 Hz.
- To ensure reliable operation the unit should not be exposed to corrosive agents or excessive moisture, heat or dust.

	CAUTION. Risk of damage. Plugging or unplugging modules of the electronics while connected to power line will irreversibly damage them. Internal capacitors need to be discharged before plugging in or out components. To replace modules, disconnect the ANC300 from mains power and wait for about **5 minutes** before proceeding.

	CAUTION. Risk of damage. Using the electronics in conjunction or connection with equipment from other manufacturers not approved by attocube may result in damage to the electronics or other equipment. attocube is not liable for any damage resulting from wrong usage or usage in conjunction with other equipment

I.3. Declarations of Conformity

For Customers in Europe
The ANC300 has been tested and found to comply with the EC Directives 89/336/EEC 'EMC Directive' and 73/23/EEC 'Low Voltage Directive' as amended by 93/68/EEC.
Compliance was demonstrated by conformance to the following specifications which have been listed in the Official Journal of the European Communities:
Safety EN61010: 2001
EMC EN61326: 1997

I.4. Waste Electrical and Electronic Equipment (WEEE) Directive

DE16963721

Compliance

As required by the Waste Electrical and Electronic Equipment (WEEE) Directive of the European Community and the corresponding national laws, attocube systems offers all end users in the EC the possibility to return "end of life" units without incurring disposal charges.

This offer is valid for attocube systems electrical and electronic equipment:

- sold after August 13th 2005,
- marked correspondingly with the crossed out "wheelie bin" logo (see logo to the left),
- sold to a company or institute within the EC,
- currently owned by a company or institute within the EC,
- still complete, not disassembled, and not contaminated.

As the WEEE directive applies to self contained operational electrical and electronic products, this "end of life" take back service does not refer to other attocube products, such as

- pure OEM products, that means assemblies to be built into a unit by the user (e. g. OEM electronic drivers),
- components,
- mechanics and optics,
- left over parts of units disassembled by the user (PCB's, housings etc.).

If you wish to return an attocube unit for waste recovery, please contact attocube systems or your nearest dealer for further information.

Waste treatment on your own responsibility

If you do not return an "end of life" product to attocube systems, you must hand it to a company specialized in waste recovery. Do not dispose of the unit in a litter bin or at a public waste disposal site.

Ecological background

It is well known that WEEE pollutes the environment by releasing toxic products during decomposition. The aim of the European RoHS directive is to reduce the content of toxic substances in electronic products in the future.

The intent of the WEEE directive is to enforce the recycling of WEEE. A controlled recycling of end of live products will thereby avoid negative impacts on the environment.

II. Setup Procedure

II.1. Mechanical Installation

II.1.a.   Positioning

Carefully unpack and visually inspect the controller and stages for any damage. Place all components on a flat and clean surface.

When placing the ANC300, it should be positioned so as not to impede the operation of the main power supply plug and switch on the rear panel. Ensure that proper airflow is maintained to the ANC300.

> **WARNING. Risk of fire.** If airflow from the ANC300 is blocked, the unit may overheat. Do not obscure any ventilation holes.

> **Note.** In applications requiring the highest level of accuracy and repeatability, it is recommended that the controller unit is powered up approximately 30 minutes before use, in order to allow the internal temperature to stabilize.

II.2. Electrical Installation

II.2.a.   Connecting to the Voltage Supply

> **WARNING. Risk of electric shock.** If this product is used in a manner not specified by the manufacturer, the protection provided by the product may be impaired. The product must be connected only to an earthed fused single-phase supply of 100 V, 115 V or 230 V, 50/60 Hz. To change the system voltage, see section 0.

The ANC300 is shipped with appropriate power cables for use in Europe, UK, USA, and Japan. When shipped to other territories the appropriate power plug must be fitted by the user. Use only power supply cables supplied by attocube systems, other cables may not be rated to the same current.

II.2.b.   Fuses

>
>
> **WARNING. Risk of electrical shock.** To exchange fuses:
> 1) Switch off the power and disconnect from mains voltage before removing the fuse cover.
> 2) After switching off, always wait 2 minutes before opening the ANC300, and before removing or inserting any module or card.
> 3) Always replace broken fuses with fuses of the same type and rating.

Two main fuses are located on the back panel for the mains voltage. Four additional fuses are located on the inside of the power supply module.
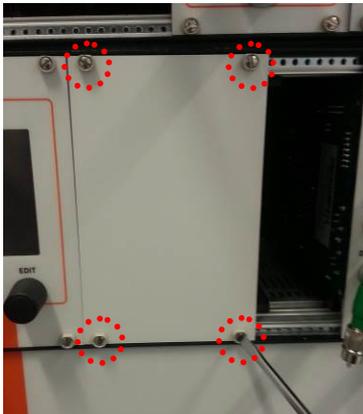
Inspecting the main fuses

For inspecting the main fuses, switch off, remove the mains power cable, and wait 2 minutes. Then:

- Lift the catch of the fuse holder carefully up and pull it out.

- Inspect the fuses.

- If the fuses are ok, re-insert the fuse holder into the controller.

Changing the Internal Fuses

There are four fuses located on the power supply itself. Inspect and change them as follows:

- Switch off and separate from mains power.

- Wait 2 minutes before going on.

- Open and remove the frontcover or the module next to the power supply.

- Open the four screws of the front cover of the power supply.
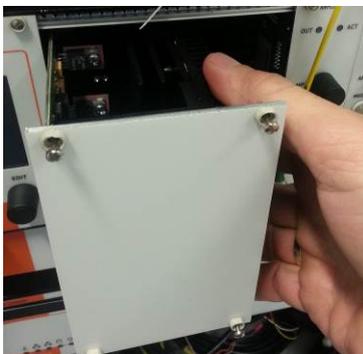
- Pull out the power supply by grabbing the cooling body inside the ANC300. Do not pull on the frontplate!

>
>
> **WARNING. Risk of damage.** If pulling excessively on the front plate, the front plate holder might break. Pull the cooling body instead!
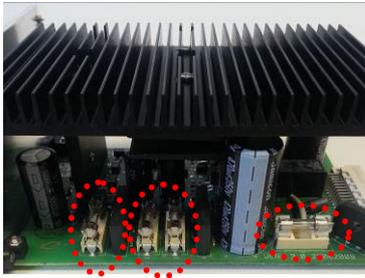
- Check the four fuses and replace them if necessary.

Fuse name	value
Fu 1 (leftmost)	2 A /250V fast blow
Fu 2	1 A /250V slow blow
Fu 3	1 A /250V slow blow
Fu 4 (rightmost)	1 A /250V slow blow

- Once all fuses are ok, re-insert the power supply.

- Close the front cover screws.

- Put back the front cover/module in the slot next to the power supply.

- Make sure to disconnect any BNC cabling for a first test.

- Connect to mains voltage and switch on to check the functionality.

Changing the System Voltage

For changing the system voltage setting you will have to remove the fuse holder and replace the fuses:

- Lift the catch of the fuse holder carefully and pull it out.

- Remove the right of the two fuse cartridges.

- Turn the white inner fuse cartridge so that it shows desired voltage value in the window.

- Reinsert the fuse cartridge into the fuse holder. Double-check that the correct voltage is shown in the window.

- Replace the fuses with the correct fuse for your mains voltage (see the correct fuse values in the following table).
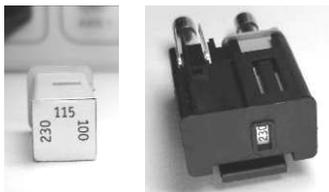
Mains voltage	Fuses
230 VAC, 50 / 60 Hz	1 A /250V slow blow
115 VAC, 50 / 60 Hz	2 A /250V slow blow
100 VAC, 50 / 60 Hz	2 A /250V slow blow

- Once you have the correct fuses and the correct voltage setting, re-insert the fuse holder into the controller.

- Make sure to disconnect any BNC cabling for a first test.

- Connect to mains voltage and switch on to check the functionality.

II.3. Front Panel Controls and Indicators

Figure 1: *Front panel of the ANC300 with seven ANM modules in place.*

The front panel is arranged as follows:

1) Main display with touch screen functionality (CPU behind it),
2) *View* knob to move the focus in the main screen,
3) *Edit* knob to change values and activate options,
4) Power supply. There are fuses directly in the power supply that can be checked in case of malfunctioning of the device. Unplug the ANC300 from mains before attempting to open and slide out the power supply.
5) 7 slots for modules.

See section III on how to use the controller. See section V.2 for removing and section V.3 for installing modules.

Here, the ANC300 is shown equipped with seven ANM modules. These modules feature stepping as well as scanning functionality. There are different types of modules available. There are (see Figure 2):

- ANM150, stepping module
- ANM200, scanning module
- ANM300, combined stepping and scanning module.

Figure 2: *Front panel of the ANM150, ANM200 and ANM300 modules. The different items are explained in the text.*

On these modules, there are, dependent on the model type:
1) OUT LED to indicate active outputs,
2) ACT LED to indicate activity such as stepping,
3) FRQ dial to change the frequency value for the respective axis,
4) AMP dial to change the stepping or offset amplitude,
5) AC-IN or MOD BNC connector to input AC voltages,
6) DC-IN BNC connector to input DC voltages,
7) STEP switch for triggering single steps up- or downwards (one step per switching), and

CONT switch for triggering continuous stepping up- or downwards (stepping as long as pressed).

II.4. Back Panel Connections

Figure 3: *Back panel of the ANC 300 piezo positioning electronic.*

On the back panel, there are:
1) voltage selector (100 / 115 / 230 V) with integrated fuse holder (see fuse description above),
2) main power switch,
3) main power supply connector, (IEC connector, 100 / 115 / 230 V, each +/- 10%, 50 / 60 Hz, max. 100 VA),
4) output BNC's (max. 160 V DC, max 4.5 A peak),
5) RS232 connector for serial connections to a PC,
6) 25 pin SubD in-/output connector for TTL triggering,
7) USB master port for updates and USB / Serial adapters,
8) USB device port for connections to the PC,
9) Ethernet 10/100 port for LAN connections, and
10) CE label with serial number and address of manufacturer.

II.4.a. How to connect a positioner
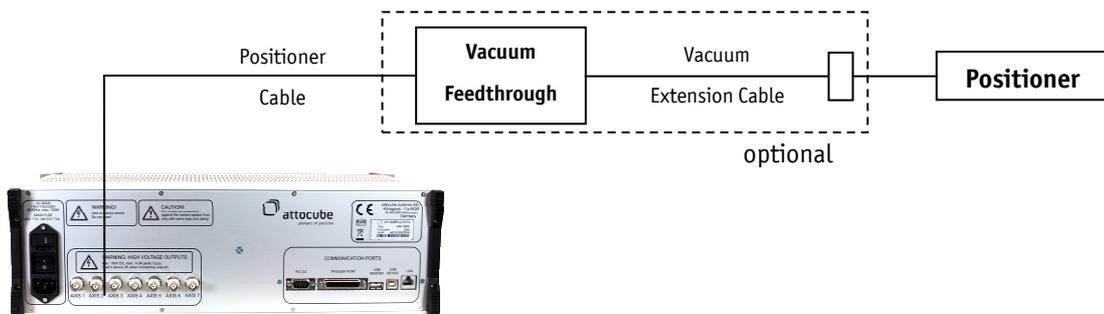
Connecting a positioner is simply done by connecting an adapter cable to the BNC output port of the respective axis and to the connector of the positioner.

|	WARNING. Risk of electric shock. Touching the inner connector of the BNC connectors may be dangerous, as there might be high voltages present. Do not touch them.

	CAUTION. Risk of damage. Equipment may be damaged if not connected correctly. The correct polarity is indicated by a red pin, which corresponds always to the inner, positive contact of the BNC.

II.5. Pin Assignment

II.5.a.   Trigger Port

The pin assignment of the 25 pin Sub-D connector (trigger port) as seen on the back panel of the electronics is given in the table below:
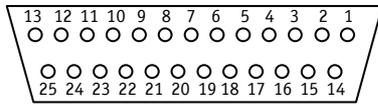
Pin No.	Trigger Name	Default Use	Pin No.	Trigger Name	Default Use
1	1	Axis 1 UP	14	2	Axis 1 DOWN
2	3	Axis 2 UP	15	4	Axis 2 DOWN
3	5	Axis 3 UP	16	6	Axis 3 DOWN
4	7	Axis 4 UP	17	8	Axis 4 DOWN
5	9	Axis 5 UP	18	10	Axis 5 DOWN
6	11	Axis 6 UP	19	12	Axis 6 DOWN
7	13	Axis 7 UP	20	14	Axis 7 DOWN
8	15		21	16	
9	Out 1		22	Out 2	
10	Out 3		23	Out 4	
11	reserved		24	reserved	
12	3.3 V Supply		25	GND	
13	3.3 V Supply				

WARNING. Risk of injury and fire hazard. Do not, under any circumstances, attempt to connect the digital I/O to any external equipment that is not galvanically isolated from the mains or is connected to a voltage higher than the limits specified in section II.2.

Note. The output triggers have an output voltage level in high state of about 3.3 V, with a maximum output current of about 20 mA.
The maximum output current on the 3.3 V supply is about 300 mA (10 Ohm output impedance). The maximum reliable frequency is around 1.5 kHz.

III. Description of the Controller and General Use

III.1.   Overview

The ANC300 consists of a casing that houses up to seven modules. The ANC300 is an electronics that fits in 19" rack installation; it is 3 rack units high (13.3 cm), 84 rack units wide (45 cm), and 29.5 cm in depth. The axis modules are individual electronics boards with frontplates.

The ANC300 has a power supply that generates the voltages needed by the modules, i.e. +5 V, +15 V, -15 V, and +150 V. Appropriate mains filtering is employed to achieve CE-compatibility as well as low emission and low noise.

The ANC300 hosts a main CPU (behind the touch panel), which is the main interface for user interaction. The CPU communicates to external devices via the different connectors on the back panel. It communicates with the axis modules using an internal bus. The analog signals generated by the modules are guided over the bus to the outputs on the back side.

On the front screen, an easy to use menu allows to set parameters and display the current status. Parameters can be modified using the two knobs just under the screen by turning or pushing. Values can be changed and functions can be triggered in the following different ways of equal priority:

- Using the touch-screen one can browse through the menu structure and set values and start actions such as measuring the capacitance. See section III.2.

- Using the buttons and switches on the front panel one can also navigate the menu structure and also issue stepping manually. See sections III.3, III.4, and III.5.

- The full functionality of the ANC300 is also accessible using any of the remote control possibilities. See section IV for details.

III.2. Main Graphical User Interface

III.2.a. Start-up Screens

Axis	Type	Serial
1	ANC300	M-1000007
2	ANC300	M-1000008
3	ANC300	M-1000009
4	-	-
5	-	-
6		

Scanning bus...

When starting the ANC300, the screen at first shows the logo screen followed by the initialization procedure.

Then, the internal bus is scanned for present modules and their types. The type and the serial numbers are listed at their respective position. The system is then configured accordingly.

Note. The serial numbers can be listed at a later stage as well (see section III.2.c).

Note. It is possible to remove or introduce modules only when the ANC300 is completely switched off and separated from mains. See sections V.2 and V.3 for detailed instructions.
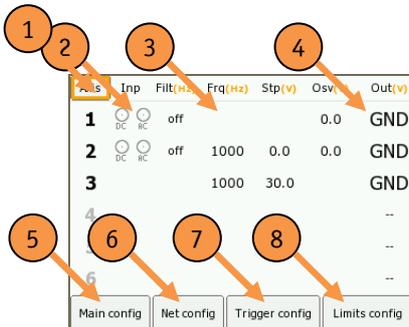
After the initialization procedure, the *Main Screen* is shown. It contains the following elements:

1) the *Axis* button. Click on it to go to the first axis screen.
2) the status of the AC-IN, DC-IN, and Filter functionality for each axis,
3) the Frequency, Step, and Offset Voltage settings for each axis
4) the output status or the current output voltage for each axis. If a limit is exceeded on a certain axis, the corresponding number will be shown in red. Also active stepping is indicated by the word "stp".

2), 3), and 4) depend on the module type. Click on a line to directly switch to the respective axis screen.

In the lower row, there are buttons for different configuration options:
5) main
6) network
7) trigger
8) limits configuration dialog.

These dialogs are discussed below.

III.2.b.   General Usage of the ANC300 GUI

There are different ways, how to change values and activate functions. One can use the touch-screen directly or use the two turning knobs underneath the display.

When using the touch-screen, the following actions are possible:

- Pressing on buttons will activate functions (menu buttons), toggle values (on/off type fields), cycle through possible settings (e.g. filter setting), or cycle the change rate (numerical value fields).
- Pressing and sliding on numerical value fields, such as frequency or voltage fields will increase (rightwards) or decrease (leftwards) their value according to the current rate.

There are two turning knobs below the display that can be used for these actions respectively: The *VIEW* and the *EDIT* knob.

- Turn the VIEW knob to move the focus through the screen,
- Press either knob to activate a menu button, to toggle on/off fields, cycle filter setting, or cycle the change rate of numerical value fields.
- Turn the EDIT knob to change numerical value fields.

Note: Turning the EDIT knob with the focus on the *Axis* field or the axis number field will cycle through the different axes available. Turn the EDIT knob completely to the left to go back to the *Main Screen*. Pressing on the *Axis* button in the Main Screen, as well as on the axis number in each axis screen will cycle through the different axis screens.

Note: After a waiting time, the ANC300 will automatically switch back to the Main Screen. This waiting time can be set in the *Main Config* dialog.

On each axis module, there are additional knobs and switches (dependent on the module type). These give direct access to the most important values and functions on the respective axis. Please refer to the module description below to learn about the functionality available.
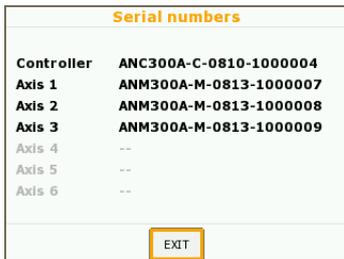

III.2.c.   Main Configuration Dialogs

If pressing on the *Main Config* button in the Main Screen, one can further select whether to list the important serial numbers or to change GUI settings. Also the menu for the Feature Codes can be accessed here.

Press on the buttons to activate the sub-menus.

Press *EXIT* to go back to the *Main Screen*.

Serial numbers

Controller	ANC300A-C-0810-1000004
Axis 1	ANM300A-M-0813-1000007
Axis 2	ANM300A-M-0813-1000008
Axis 3	ANM300A-M-0813-1000009
Axis 4	--
Axis 5	--
Axis 6	--

EXIT

The serial numbers listing shows the important serial numbers including the serial number of the controller itself. Please have these numbers at hand when contacting attocube systems for any support.

The serial numbers can also be listed via remote control (see section IV.2.a).
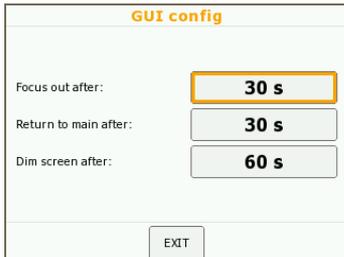
GUI config

Focus out after:	30 s
Return to main after:	30 s
Dim screen after:	60 s

EXIT

In the GUI configuration dialog, one can set:

- *Focus out after*: The time after which the focus will jump back to the button in the upper left corner.

- *Return to main after*: The time after which the GUI will switch to the main screen again.

- *Dim screen after*: Timeout for the screensaver. The brightness will be reduced in this example 60 s after the last user input has been made.

# III.2.d.   Feature Codes
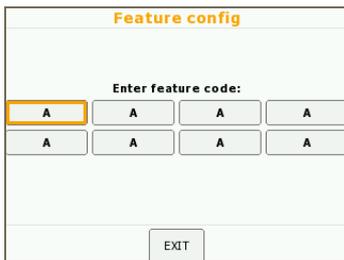
Feature config

Enter feature code:

A	A	A	A
A	A	A	A

EXIT

Feature Codes allow for enabling certain additional features of the ANC300.

Feature Codes can either be entered using the Feature Code screen or using the corresponding command ("setfc") on the console. Feature Codes are only usable for certain electronics and cannot be transferred. On successful recognition of a feature code, the ANC300 displays an acknowledgement. Enabled features stay enabled also after rebooting of the electronics.

III.2.e.   Network Configuration Dialog
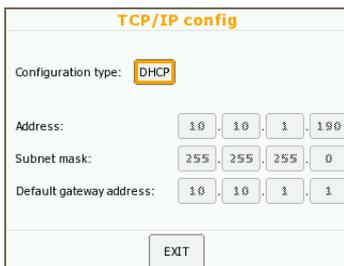
TCP/IP config

Configuration type:	DHCP
Address:	10 . 10 . 1 . 190
Subnet mask:	255 . 255 . 255 . 0
Default gateway address:	10 . 10 . 1 . 1

EXIT

For the ANC300 to be visible and accessible on the local area network, a valid network address is required. In the Network Configuration Dialog, the user can choose between two methods for determining the network address (IP address): *DHCP* or *Manual* setting.

If set to *DHCP*, the ANC300 tries to find a DHCP master in the LAN and will query for a valid address.
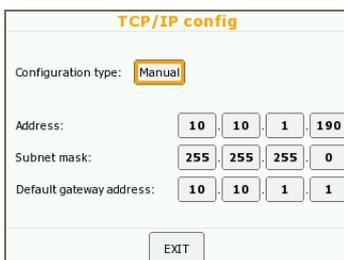
TCP/IP config

Configuration type:	Manual
Address:	10 . 10 . 1 . 190
Subnet mask:	255 . 255 . 255 . 0
Default gateway address:	10 . 10 . 1 . 1

EXIT

If set to *Manual,* you can change the IP address, the subnet mask and the default gateway to valid values for your local area network. These settings have immediate effect.

Click on a number field to toggle its change rate between 1 and 10.

III.2.f.　Trigger Configuration Dialog
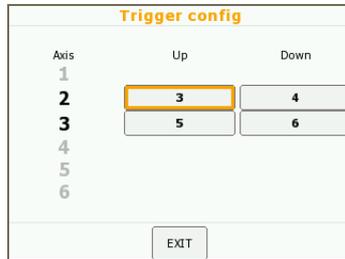
In the trigger configuration dialog, one can link trigger inputs to certain axes and directions. There are 16 trigger inputs on the trigger port as shown in section II.5.a. On successful recognition of a trigger event, the corresponding axis will perform one step each in the given direction.

Click on a number field to cycle its number or select the number by turning the *EDIT* button.

It is also possible to have several axes listening to the same input trigger by simply entering the same trigger number in these axes.

Note. It is possible to enter the same trigger input to up and downward motion at the same time. Still, only one step is performed in either up or down direction. It is suggested to have different triggers for up and down motion for one axis.

III.2.g.   Limits Configuration Dialog

Limits config

Active limit setting:	Low temperature
Active axis setting:	1
Step frequency limit:	10000 Hz
Step voltage limit:	70.0 V
Out voltage limit:	150.0 V

EXIT
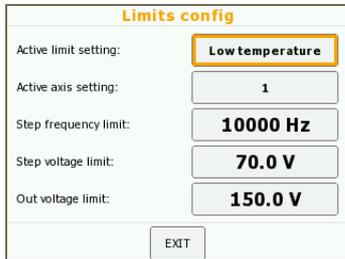
In the limit configuration dialog, the user can activate certain limit settings per axis. Choose one of two limit sets, *Room Temperature* or *Low Temperature*. This setting allows choosing different limit settings for e.g. two different temperatures.

Note. The Output Voltage Limit limits the overall output voltage (Step Voltage + Offset Voltage). If the Out limit is exceeded, stepping will be blocked.

Enter a maximum Step Frequency, a maximum Step Voltage, and an Out Voltage Limit. This way, one can protect a piezo from too high voltage and additionally avoid e.g. too much heating in a sensitive setup. See section III.3.j for a description of the limit functionality.

CAUTION. Risk of damage. The DC-IN functionality is **not** affected by the limit functionality and hence equipment connected to the outputs may be damaged due to too high voltages. Make sure to restrict the input voltage accordingly!

CAUTION. Risk of damage. If another electronics (e.g. ASC500) is connected to the DC-IN port, and is turned on or off while DC-IN is enabled, any produced transients or voltage spikes may be amplified and given to the outputs. This may destroy attached piezos due to over-voltages. Make sure to switch to GND mode during such procedures and to enable the DC-IN functionality only if there is no risk of uncontrolled voltages on the input.

III.3.   ANM300 Module

The ANM300 module is an open loop positioning and scanning module. The nominal output voltage is unipolar from 0 to 150 V. The outputs are protected against short-circuits and have a current limiter in order to protect them. The following functions are available (see schematic graph below):

- Stepping with up to 150 V or up to 10 kHz rate,
- Setting an offset voltage (value after amplification: 0 .. +150 V),
- Amplifying DC-IN voltages from -10 .. +10 V input coerced to (nominally) 0 .. +150 V output,
- Adding an AC-IN voltage to the output (not amplified),
- Filtering of the output voltage with either 16 or 160 Hz or no filtering,
- Measuring the capacitance of an attached piezo,
- OUT LED to indicate positive output voltage above ~1 V,
- ACT LED to indicate stepping,
- Single, continuous, or endless stepping.
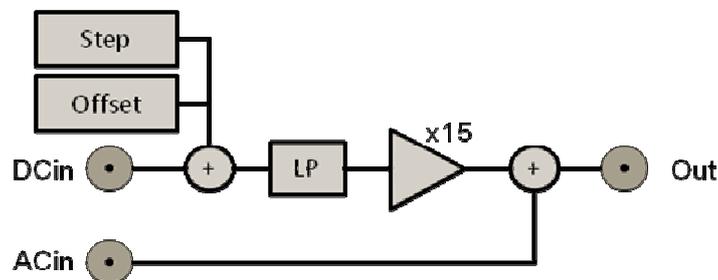
Figure 4: *Schematic diagram for the ANM300. Step, Offset, and DC-IN signals are added up, low pass filtered, and then amplified. The AC-IN is added after the amplifier.*

III.3.a.   ANM300 Front Panel Usage
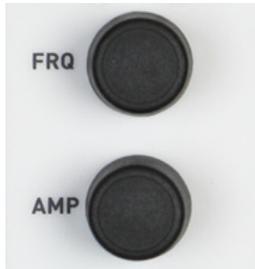
By turning or pressing any knob on a certain module front plate, the axis screen as shown in Figure 5 below will appear. Another way to get to the axis screen is to select the axis from the main overview list, or to cycle to the axis by clicking on the axis button repeatedly.

The module can be controlled by the dedicated knobs on the axis or by the axis screen itself. The use of the knobs is as follows:

- Turning a knob will change the respective value according to the given rate.
- Pressing on the amplitude or frequency field or knob will cycle the change rate through the following options: x0.1, x1, and x10.

Note. Please note that for the amplitude knob, the focus will jump to the stepping voltage or the offset voltage depending on which field is being activated. If both are active, there is a strict binding of the knob to one of them. Double-click on the amplitude knob to toggle this binding.

Additionally, there are two switches for the stepping functionality on the front-plate. The upper switch triggers only one step each time the switch is pressed. The lower switch corresponds to continuous stepping, i.e. the axis will generate steps as long as the switch is held.

Pressing both switches at the same time will start endless stepping in the direction chosen (both up or both down). This can be stopped by pressing one of the switches again

III.3.b.   ANM300 Axis Screen Elements and Usage
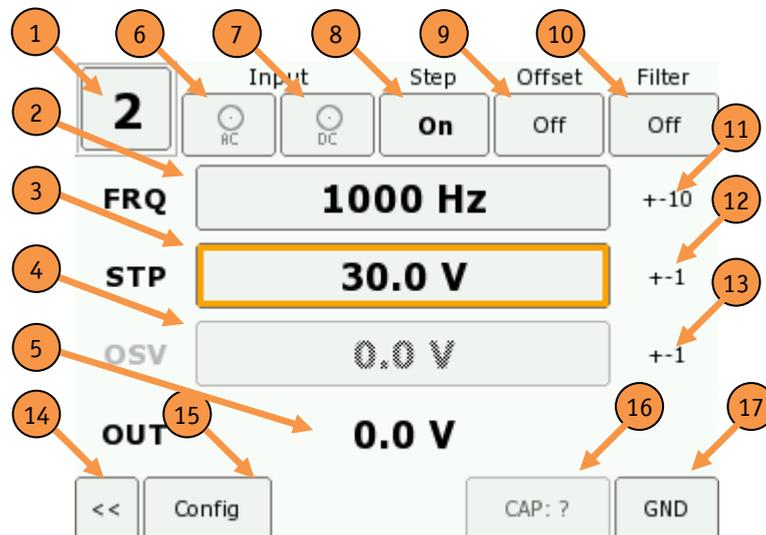
Figure 5: *Screen shot of the Axis View. Here, only the stepping functionality is enabled.*

The following elements are shown in the axis screen and allow for the described actions:

1) Axis number. Click to cycle to the next axis screen.
2) Step frequency. Press to set the focus. Press and slide to change. Greyed if stepping is disabled.
3) Step voltage. Press to set the focus. Press and slide to change. Greyed if stepping is disabled.
4) Offset voltage (after amplification). Press to set the focus. Press and slide to change. Greyed if stepping is disabled.
5) Measured output voltage.
6) AC-IN switch. Press to toggle.
7) DC-IN switch. Press to toggle.
8) Stepping switch. Press to toggle.
9) Offset switch. Press to toggle.
10) Filter setting. Press to cycle through the filter settings.
11) Change rate FRQ. Press to cycle through the change rates.
12) Change rate STP. Press to cycle through the change rates.
13) Change rate OSV. Press to cycle through the change rates.
14) Back to main menu button. Press to go back to the main screen.
15) Configuration button. Press to go to the limit configuration menu.
16) Capacitance Measurement. Press to perform one measurement.
17) Ground switch. Press to set the axis module to ground.

III.3.c.   Stepping Functionality

The stepping output signal is by default a sawtooth wave. See section IV.2.c on programming new patterns.

One step corresponds either to a linear rise to the nominal voltage in time $t = 1/frequency$ and a steep decrease to zero (on the order of $10 - 20$ µs), or a steep increase to the step voltage and a linear decrease. These different waveforms correspond to the two directions: The first one to stepping "up" (as seen when driving a z-positioner with normal orientation), the latter one to stepping down.

Note. The steep flank of the signal is done as fast as possible, which is important to initiate the sliding phase of the slip-stick drive of the positioners. Due to the possible high capacitances of the piezos attached, there might be considerable currents on the outputs. The ANM300 module can supply peak currents of 4.5 A.

Note. Due to the high currents it is important that the attached leads to the positioners have low resistance. Please double-check your positioners' manual for acceptable resistance values.

To enable stepping, activate the respective field in the GUI (see Figure 5). This will also enable the step voltage and the frequency field and allows changing them.

Note. Certain limits apply (see sections III.2.g and III.3.j) for the stepping voltage. When the stepping voltage is too high, the **output limit** can be reached and thus stepping will be deactivated. In such case, "Limit exceeded" will be written on the display. If step frequency and voltage exceed a certain output power, the **power limit** (same display "Limit exceeded") can be reached. Note that this limit depends on the actual capacitance value shown. Hence, it is recommended to measure the capacitance before stepping is enabled.

The steps are initiated either by the switches on the front plate as described in section III.3.a or can be commanded using the remote control.

On Stepping, the *ACT* LED will illuminate and indicate stepping activity. The output voltage measurement will indicate "STEPPING". In the main screen, STP will be written on stepping activity.

III.3.d.　Offset Voltage Functionality

The ANM300 also includes an offset voltage feature. When enabling the offset voltage feature, one can set a constant offset voltage to be given out on the outputs. This also enables the offset voltage field *OSV*.

Note. Limits apply (see section III.2.g and III.3.j) for the offset voltage. The offset voltage is limited by the output limit.

CAUTION. Risk of damage. The offset voltage is given out immediately when the offset feature is enabled. For security, the voltage value will be set to zero when disabling the offset voltage feature.

III.3.e.   DC-IN Functionality

There are two BNCs on the module frontplate, labeled DC-IN and AC-IN. The DC-IN input accepts -10 .. +10 V, while the output is (nominally) 0 .. +150 V. The gain is 15 (see Figure 6).

Note. It is possible to input negative voltages on the DC-in of up to -10 V in order to pull down a positive offset voltage. The minimum voltage on the outputs is defined by the internal amplifier which coerces the output to approximately -7 .. +150 V.

CAUTION. Risk of damage. If high frequency signals (> 1 kHz) of high amplitude (> 1 V) are given to the DC-IN inputs and high capacitors are connected to the output (> 500 nF), it is possible to damage the amplifier. Sudden extreme jumps on very high capacitors may cause immediate damage. Restrict the input frequencies and signal levels so that the electronics does not overheat or might be damaged.
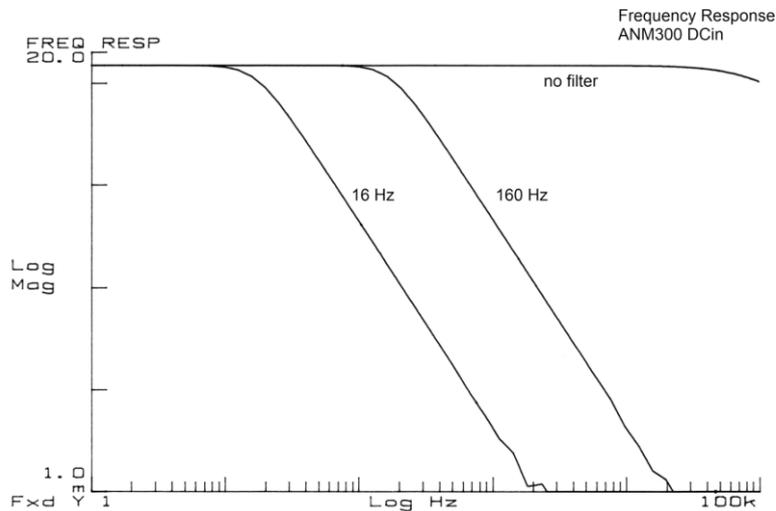
Figure 6: *Frequency response of the ANM300 DC-IN input with different output filters applied. Note that the gain is 15 up to a frequency nearly up to 100 kHz. Note though that too high frequencies and amplitudes may damage the amplifier.*

III.3.f. AC-IN Functionality

When switching on the AC-IN feature, a voltage of up to 10 VAC can be added to the output (gain 1, no amplification) using the AC-IN BNC on the frontplate of the module. Additional filtering can be switched on, with a second order low pass filter with approx. 16 Hz, 160 Hz, or no filter.
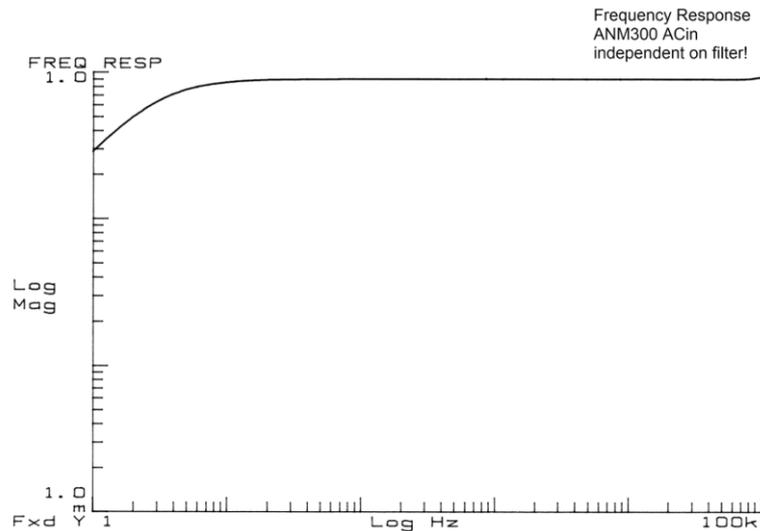
Figure 7: *Frequency response of the ANM300 AC-IN input. Note that the gain is nearly 1 starting from a frequency of about 10 Hz and independent on the output filtering.*

III.3.g. Filter Settings

The ANM300 module has built in low-pass filters that can be activated in order to filter high frequency noise. These filters are nominal 16 Hz and 160 Hz or can be disabled.

Note. It is *not* allowed to generate a stepping signal with the filters enabled. Upon enabling the filters, the step functionality will be disabled and vice versa.

III.3.h. GND Functionality

Upon pressing of the GND button, the ANM300 will disable all AC-IN, DC-IN, Stepping, and Offset functionality and will connect the outputs to chassis mass.

Note. Connecting the piezoelectric actuator leads to a mass is important in order to reduce electro-mechanical noise on the actuator that might be produced by the electronics. This is the recommended mode for sensitive measurements. It is recommended that the controller is always kept in GND state during changes (setup, software, temperature, etc.) and when not in use.

CAUTION. Risk of damage. During major temperature changes of the attached piezos, static voltages may accumulate. Hence, voltage limits may be violated and the piezos damaged. It is recommended to keep the electronics attached in GND mode.

III.3.i. Capacitance Measurement

The ANM300 module is capable of measuring the capacitance of a connected piezo. The capacitance is an indicator for an electrically functional system. If there is short-circuit in the wiring or if there is an open connection, the capacitance measurement will not show correct values.

Moreover, the capacitance is an indicator for the temperature of the piezo, as the capacitance of a piezo is temperature dependent.

Upon pressing on the respective button in the GUI, the ANM300 will apply a voltage of ~100 mV to charge the capacitance first then measures the time for the discharging. The corresponding value is shown in the respective field on the GUI or can be queried remotely.

Note. The capacitance measurement is only available when all other functions are turned off (*GND* mode).

Note. The capacitance value changes the limits for the output power limit (see section III.3.j).

CAUTION. Risk of damage. During a capacitance measurement, a small voltage of ~100 mV is applied to the output. There might be small mechanical motions on attached piezo systems. Such motions may damage sensitive structures or experiments. Hence, measure the capacitance *only* if any such systems are in safe positions.

Note. Piezoelectric actuators are temperature dependent capacitances. The values measured with the ANC300 can easily differ by about 10-20% from the specified value. This applies particularly at room temperature. Moreover, the values measured with the ANM300 can differ from values obtained by other measurement techniques.

III.3.j.   Limit Functionality

The ANM300 allows setting output (*Out*) and stepping (*Step*) limits by the user. These limits will not allow increasing the output voltage above the given limit nor allow increasing the step voltage above the Step limit. Additionally, the ANM300 will not start any stepping when the Out limit is exceeded. Note that the Out limit restricts the sum of offset and stepping voltage, while the Step limit only limits the stepping voltage. The display will show "Limit exceeded" on the respective axis.

CAUTION. Risk of damage. The DC-IN functionality is **not** affected by the limit functionality and hence equipment connected to the outputs may be damaged due to too high voltages. Make sure to restrict the input voltage accordingly!

CAUTION. Risk of damage. If another electronic (e.g. ASC500) is connected to the DC-IN port, and is turned on or off while DC-IN is enabled, any produced transients or voltage spikes may be amplified and given to the outputs. This may damage attached piezos due to over-voltages. Make sure to switch to GND mode during such procedures and to enable the DC-IN functionality only if there is no risk of uncontrolled voltages on the input.

Note. In case stepping is active and the voltage is changed at the same time, then any such stepping will be stopped once a limit is reached.

There are two limit sets, **Room Temperature** or **Low Temperature** limits. Please note that this setting applies for all axes globally. This allows choosing different limit settings for e.g. two different temperatures. Please refer to positioner specification sheets for maximum voltage and frequency limits.

Additionally, a **power limit** applies. The power limit restricts the stepping output power of the ANC300 to a certain maximum output power, hence will only allow certain combinations of frequency and voltage. The display will show "Limit exceeded" on the respective axis.

The power limit is dependent on the actual capacitance, as the output power is scaling linearly with the capacitance. Unless a new capacitance value is measured, the shown value will be used for the limit calculation. Hence, it is mandatory to measure the capacitance before applying any voltage to the outputs, in order to protect the ANC300 and the positioners.

> ⚠ **CAUTION. Risk of damage.** If a capacitance value shown on the ANC300 outdates due to large temperature change or change of positioners, there is a risk of overheating and damaging of internal components. Make sure always to have the right capacitance value shown, by measuring it again after changing a setup (also changing the temperature).

> ⚠ **CAUTION. Risk of damage.** Overriding the voltage limits of a piezo attached, may damage the piezo. Always obey the limitations given by the specifications sheet of your positioner.

The maximum allowed frequency for a pair of capacitance value and voltage is shown in the following table. Note that if no capacitance value is measured ("?"), the output will be restricted the most.

| Max. Frequency [Hz]		Capacitance [µF]								
		1	2	2.5	3	3.5	4	4.5	5	5.5
Voltage [V]	**10**	10000	3815	3624	3433	3338	3242	3147	2400	1329
	20	10000	3052	2899	2747	2670	2594	2518	1800	1208
	30	5500	2441	2319	2197	2136	2075	2014	1600	1098
	40	3100	1953	1855	1758	1709	1660	1611	1300	998
	50	2000	1563	1484	1406	1367	1328	1289	1100	908
	60	1300	1250	1188	1125	1094	1063	1031	900	825
	70	1000	1000	950	900	875	850	825	800	750

III.4.   ANM150 Module

The ANM150 module is an open loop positioning module. The nominal output voltage is unipolar from 0 .. +150 V. The outputs are protected against short-circuits and have a current limiter in order to protect them. The following functions are available (see schematic graph below):

- Stepping with up to 150 V or up to 10 kHz rate (see section III.3.j on power limit before),
- Measuring the capacitance of an attached piezo,
- OUT LED to indicate positive output voltage above ~1 V
- ACT LED to indicate stepping.
- Single, continuous or endless stepping. The stepping functionality is identical to the ANM300 described before in section III.3.c.

As the usage and features are very similar to the ANM300, in the following there will be only remarks to differences to the ANM300.
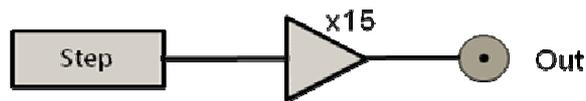
Figure 8: *Schematic diagram for the ANM150. There is only the step generator and its signal is amplified to the final output voltage.*

III.4.a.   ANM150 Axis Screen Elements and Usage
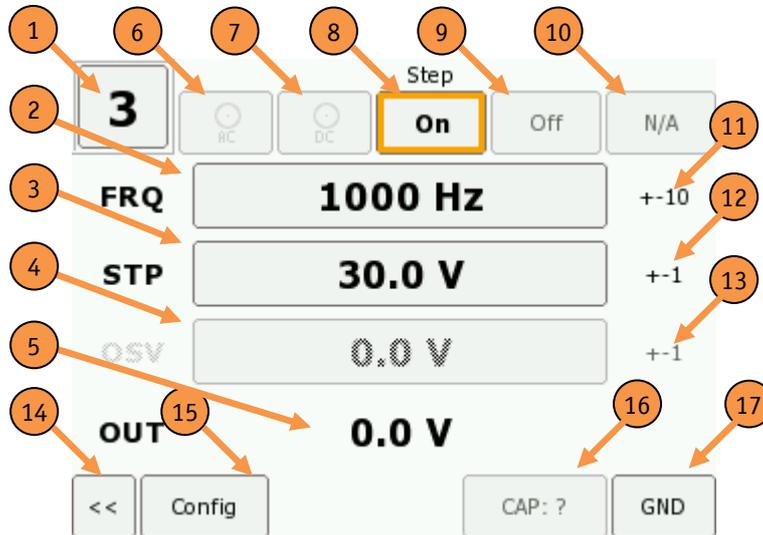
Figure 9: *Screen shot of the ANM150 axis view. Only the stepping functionality and the capacitance measurement can be enabled.*

The following elements are shown in the axis screen and allow for the described actions:

1) Axis number. Click to cycle to the next axis screen.
2) Step frequency. Press to set the focus. Press and slide to change. Greyed if stepping is disabled.
3) Step voltage. Press to set the focus. Press and slide to change. Greyed if stepping is disabled.
4) Offset voltage. Disabled.
5) Measured output voltage.
6) AC-IN switch. Disabled.
7) DC-IN switch. Disabled.
8) Stepping switch. Press to toggle.
9) Offset switch. Disabled.
10) Filter setting. Disabled.
11) Change rate FRQ. Press to cycle through the change rates.
12) Change rate STP. Press to cycle through the change rates.
13) Change rate OSV. Disabled.
14) Back to main menu button. Press to go back to the main screen.
15) Configuration button. Press to go to the limit configuration menu.
16) Capacitance Measurement. Press to perform one measurement.
17) Ground switch. Press to set the axis module to ground.

III.5. ANM200 Module

The ANM200 module is an open loop, low noise scanning module. The nominal output voltage is unipolar from 0 .. +150 V. The outputs are protected against short-circuits and have a current limiter in order to protect them. The following functions are available (see schematic graph below):

- Setting an Offset voltage (0 .. +150 V),
- Amplifying DC-IN voltages from -10 .. +10 V to 0 to 150 V,
- Adding an AC-IN voltage to the output (not amplified),
- Filtering of the output voltage with either 1.6, 16, 160, or 1600 Hz,
- Measuring the capacitance of an attached piezo,
- OUT LED to indicate positive output voltage above ~1 V.

As the usage and features are very similar to the ANM300, in the following there will be only remarks to differences to the ANM300.
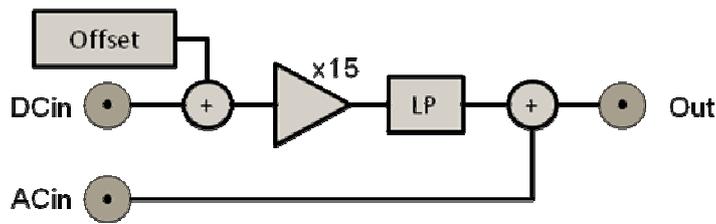
**Figure 10:** *Schematic diagram for the ANM200. Offset and DC-IN signals are added up and amplified. Low pass filtering and AC-IN are added after the amplifier.*

Note. It is possible to input negative voltages on the DC-in of up to -10 V in order to pull down a positive offset voltage. The minimum voltage on the outputs is defined by the internal amplifier which coerces the output to approximately -7 to +150 V.

III.5.a.   ANM200 Axis Screen Elements and Usage
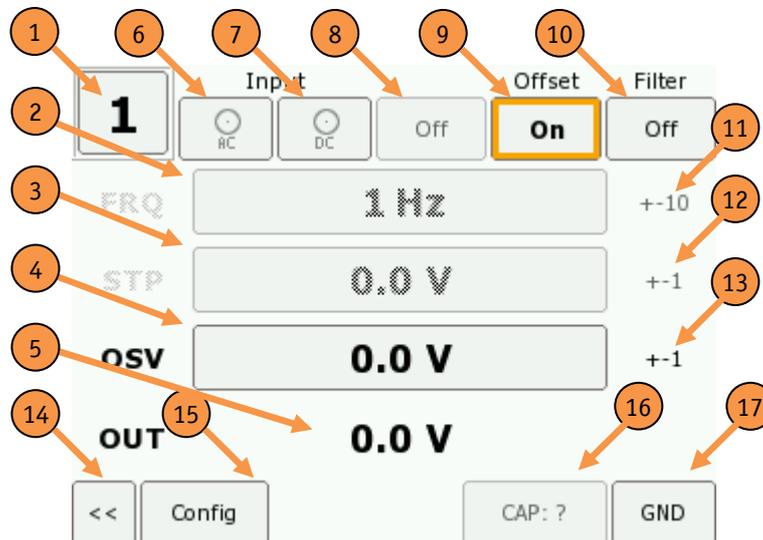
Figure 11: *Screen shot of the Axis View. Here, only the offset functionality is enabled.*

The following elements are shown in the axis screen and allow for the described actions:

1) Axis number. Click to cycle to the next axis screen.
2) Step frequency. Disabled.
3) Step voltage. Disabled.
4) Offset voltage. Press to set the focus. Press and slide to change. Greyed if stepping is disabled.
5) Measured output voltage.
6) AC-IN switch. Press to toggle.
7) DC-IN switch. Press to toggle.
8) Stepping switch. Disabled.
9) Offset switch. Press to toggle.
10) Filter setting. Press to cycle through the filter settings.
11) Change rate FRQ. Disabled.
12) Change rate STP. Disabled.
13) Change rate OSV. Press to cycle through the change rates.
14) Back to main menu button. Press to go back to the main screen.
15) Configuration button. Press to go to the limit configuration menu.
16) Capacitance Measurement. Press to perform one measurement.
17) Ground switch. Press to set the axis module to ground.
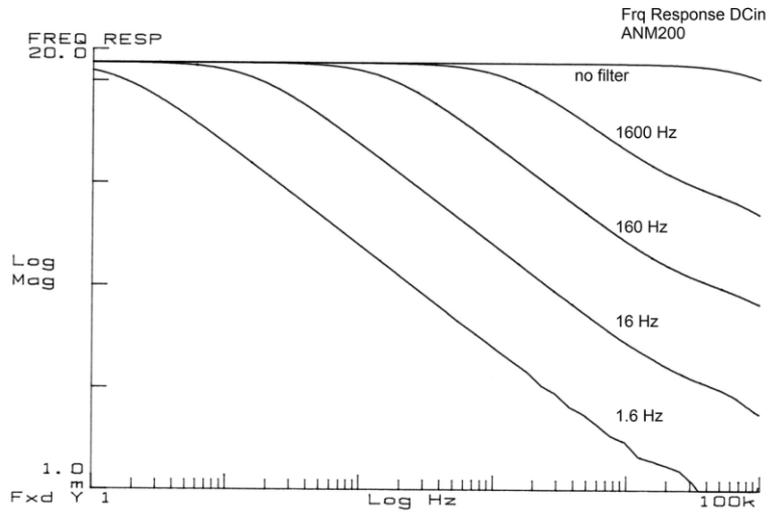
Figure 12: *Frequency response of the ANM300 DC-IN input.*
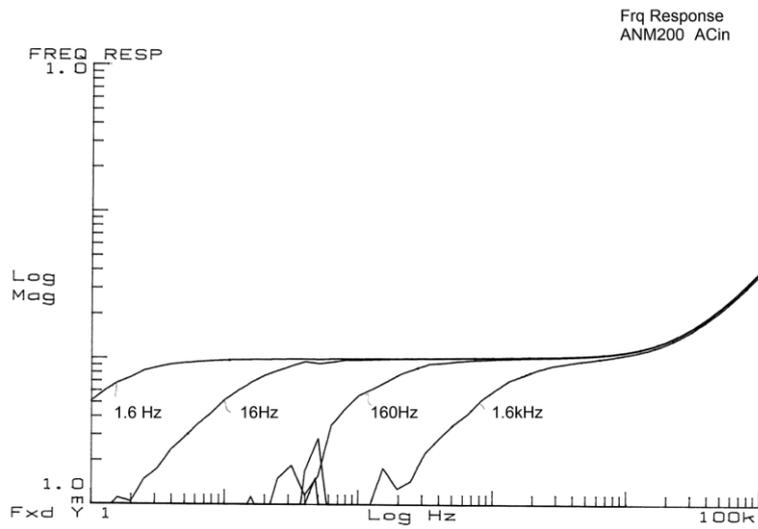
Figure 13: *Frequency response of the ANM200 MOD modulation input. Note that the gain is 0.01 up to a frequency of 10 kHz.*

IV. Remote Control of the ANC300

IV.1. Connecting the ANC300

IV.1.a.   Ethernet Connection

The ANC300 has a LAN port on the backside to connect it to the local net-work. The IP-address for the ANC300 can either be chosen manually or by DHCP (see section III.2.e). Different protocols are supported by the LAN adapter:

- HTTP: An integrated web-server allows downloading drivers for the USB port, the manual, specification sheets, and additional informa-tion. In the future, it is planned to supply a web-interface for status information and simple tasks.

- FTP: For updates, one can connect to the ANC300 via FTP. Log in as user "update" with password "1234". Send the update via a "put" command to the ANC300. It will evaluate the update and install it in case it is suitable and valid.

- Telnet: On ports **7230** and **7231** there are two different consoles, a standard console and a programmable LUA console. One can connect to these using e.g. Hyperterminal or another terminal program.

IV.1.b.   USB Slave Port

The ANC300 has an USB slave device port on the backside of the casing. When connecting to a PC, one needs to have the respective drivers for Windows installed. Windows will then recognize a virtual COM port accord-ingly.

The drivers can be downloaded via the Ethernet connection as described before or can be found on the accompanying CD.

Installation of the drivers is straight forward. Guide the assistant to the place where you have stored the driver. Do not search on the Internet for drivers as suggested by the assistant. Please note that the drivers have not been subject of the Windows Logo Test, so that the assistant will complain about it. Install the drivers anyway.

Opening a Hyperterminal connection to the new virtual COM port will open a standard console as described in the next sections.

IV.1.c.   USB Master Port

The ANC300 has a USB master port that can be used to connect different slave devices, e.g.:

- an USB stick to implement updates,

- an USB joystick for directing the positioners manually (in future).

If an USB stick has been recognized, the ANC300 will try to read its contents and look for a mating update file in the root folder. See section V for details on the firmware upgrade procedure.

Note. In order to be able to read from the USB stick, it has to be formatted with the FAT16 or FAT32 file system.

IV.1.d.   RS232 Port

The RS232 port on the backside of the ANC300 can be used to connect to a PC in order to establish a serial connection. The correct settings for the port are 38400 baud, 8 data bits, no parity, 1 stop bit, no flow control.

See the section below (IV.2.a) for a description of the console and its commands.

IV.2. Remote Control

There are two different types of consoles; one can connect to them using e.g. telnet or Hyperterminal over the LAN port, or by directly connecting a PC to the USB port (using a virtual COM port).

Only, when connecting over the LAN interface, one can connect to the programmable Lua console. All other consoles are based on the standard console. Note, that the standard console over the LAN interface is on port 7230 while the Lua console is on port 7231. For the consoles that connect over the LAN port, one has to enter a password for security. This password is "123456" per default.

Note, that the consoles have the same priority as the front panel. This means that changes will have immediate effect, no matter through which channel a command or a change has been issued.

The standard console features a simple text based command prompt, where one can issue single commands that are instantly evaluated and executed.

The Lua console is more sophisticated. Here, it is possible to program also little functions that perform more elaborate actions, such as scanning a voltage up or down, triggering steps on different axes at the same time, or the like. A few examples of the possibilities are given in the section below.

IV.2.a.   Standard Console Commands

A command on the standard console is composed of normal ASCII characters and needs to be ended by a carriage return and a line feed character (DOS line endings: CR = ASCII code 13; LF = ASCII code 10). When a command has been executed, the answer should be "OK ", with optional lines before containing data. In case of an error, the electronics returns "ERROR" together with an error message if applicable. The typical timeout for these commands is about 30 ms.

General commands for the usage of the ANC300:

Command	Explanation
help	Print out a short help text.
echo [on|off]	Enable/disable console echo.
ver	Print the version number and the manufacturer.
getser <AID>	List the serial number of axis <AID>.
getcser	List the serial number of the controller board.
setfc <CODE>	Send a feature code to the ANC300.

Get/Set commands define or query certain properties of axis module <AID>. These are type-dependent, hence give an error message if the requested functionality is not available.

Set Command	Get Command	Explanation
setm <AID> <AMODE>	getm <AID>	Set/get mode <AMODE>.
setf <AID> <FRQ>	getf <AID>	Set/get the stepping frequency <FRQ>.
setv <AID> <VOL>	getv <AID>	Set/get the stepping amplitude <VOL>.
seta <AID> <VOL>	geta <AID>	Set/get the offset voltage <VOL>.
setaci <AID> [on|off]	getaci <AID>	Set/get status of AC-IN input.
setdci <AID> [on|off]	getdci <AID>	Set/get status of DC-IN input.
setfil <AID> <FIL>	getfil <AID>	Set/get filter setting <FIL>.note different filter options are available on ANM200 and ANM300.

Note: Using the remote console more modes are available as compared to the front panel. Setting to a certain mode typically switches other functionalities off. Especially, there are the following modes:

- **gnd:** Setting to this mode diables all outputs and connects them to chassis mass.

- **inp:** In this mode, AC-IN and DC-IN can be enabled using the setaci and setdci commands. Setting to inp mode disables stepping and offset modes.

- **cap:** Setting to cap mode starts a capacitance measurement. The axis returns to gnd mode afterwards. It is not needed to switch to gnd mode before.

- **stp:** This enables stepping mode. AC-IN and DC-IN functionalities are

not modified, while an offset function would be turned off.

- **off:** This enables offset mode. AC-IN and DC-IN functionalities are not modified, while any stepping would be turned off.

- **stp+:** This enables additive offset + stepping mode. Stepping waveforms are added to an offset. AC-IN and DC-IN functionalities are not modified.

- **stp-:** This enables subtractive offset + stepping mode. Stepping waveforms are subtracted from an offset. AC-IN and DC-IN functionalities are not modified.

Note. The allowed filter values are
- for the ANM300 module: "16", "160" and "off".
- for the ANM200 module: "1.6", "16", "160", and "1600".

Pattern commands modify the step patterns on axis module <AID> (see section IV.2.c for details on programming patterns):

Set Command	Get Command	Explanation
setpu <AID> [0-255] setpd <AID> [0-255]	getpu <AID> getpd <AID>	Set/get step up pattern (256 bytes) Set/get step up pattern (256 bytes)

Note. The pattern values for the up or down patterns must be given as 256 integer numbers, separated only by spaces.

Axis commands start or stop actions of axis module <AID>:

Command	Explanation
stepu <AID> [<C>]	Move <C> steps or continuously upwards (outwards). An error occurs when the axis is not in "stp" mode.
stepd <AID> <C>	Move number of steps or continuously downwards (inwards).
stop <AID>	Stop any motion.
geto <AID>	Return the measured output voltage.
getc <AID>	Return the saved capacitance value.
stepw <AID>	Wait for stepping to finish.
capw <AID>	Wait for the capacitance measurement to finish.

Trigger Commands modify input or output trigger settings:

Set Command	Get Command	Explanation
settu <AID> [1-7 | off]	gettu <AID>	Set/get input trigger up number on axis <AID>
settd <AID> [1-7 | off]	gettd <AID>	Set/get input trigger down numbers on axis <AID>
setto <TNUM> [0 | 1]	getto <TNUM>	Set/get output trigger status

Note. Setting the status of the output triggers is only available if the feature is enabled.

Valid Variables for these commands are:

Variable	Name	Type	Valid values
<AID>	axis id	integer	1, 2, 3, 4, 5, 6, 7
<AMODE>	axis mode	text	gnd, inp, cap, stp, off, stp+, stp-
<C>	run mode	text/integer	c (continuous run), 1, 2, ... [steps]
<FRQ>	frequency	integer	1, 2, ... , 10000 [Hertz]
<VOL>	voltage	float	0.000, ... , 150.000 [Volt]
<TNUM>	trigger number	integer	1, 2, 3
<FIL>	filter	integer	1.6, 16, 160, 1600, off (dependent on axis type)

IV.2.b.   Example Console Session

This commented log of an example session demonstrates some basic features of the console.

```
> setm 1 stp          Switch mode to stepping on axis 1
OK
> setf 1 1000         Set frequency on axis 1 to 1000 Hz
OK
> setv 1 20           Set the step voltage on axis 1 to 20 V
OK
> stepu 1 1000        Start 1,000 steps in upward direction on axis 1
OK
> setm 2 off          Switch axis 2 to offset mode
OK
> seta 2 2.345678     Set the offset voltage on axis 2 to 2.345678 V
OK
> geta 2              Read the offset voltage on axis 2:
voltage = 2.345000 V  result: 2.345 V
OK
> geto 1              Read the output voltage on axis 1 (not stepping):
voltage = 0.000000 V  result: 0 V
```

```
OK

> stepu 1 10000                      Start 10,000 steps in upward direction on axis 1
OK
> geto 1                             While stepping, read the output voltage:
voltage = 10.500000 V                result: 10.500 V
OK
```
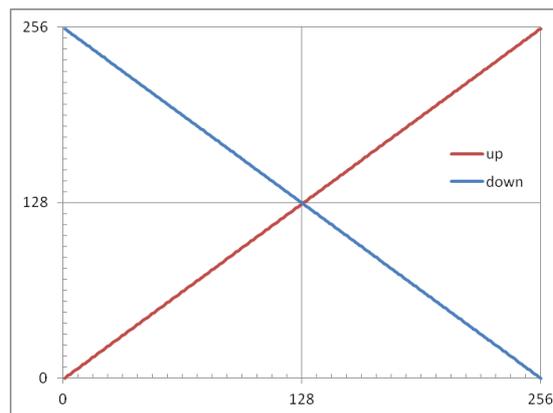
IV.2.c.   Programming new patterns

The normal patterns of the ANM150 and ANM300 are shown in Figure 14 below. These can be changed if needed.

A signal is generated from 256 sequential values, with the values ranging from 0 to 255. A linear pattern for example consists of 256 small steps with increments of 1/256 multiplied by the voltage that has been set on the front panel. The time for each individual step is t= 1/256 * 1/*f*, with *f* being the chosen frequency.

In the ANC300, the up and down patterns stored on each respective module can be modified individually.

Figure 14: *Default Up and Down Patterns.*

If you query the upwards pattern the ANC300 will list the respective values separated by newlines:
```
> getpu 1
0
1
(more lines here)
254
255
OK
```
Programming a new pattern is very simple. Just list all 256 values after the axis number.
```
> setpu 1 0 1 2 3 4 [...] 254 255
OK
```

IV.2.d.   Lua Console

Using this console, it is possible to program more sophisticated tasks. The Lua console offers programming of functions, tab completion, as well as a history function. For a general overview on Lua it is recommended to look up www.lua.org or *http://www.lua.org/manual/5.1/manual.html*.

Some few examples will be given in the following.

Axes are referred to as „*modules*" on the Lua console. Hence, axis no. 1 is addressed as module 1, alas "*m1*", axis no. 2 is "*m2*", and so on.

Like other object oriented languages, Lua differentiates between properties and methods. Properties are called with a single dot ".", methods are addressed using the colon ":", as demonstrated in the following example:

Example No. 1: Setting the step-voltage on axis no. 1 to 20 V:

```
> m1.stp = 20
```

Hence, switching on or off an axis functionality is simply done by setting the respective variable.

For the module objects, the following properties are available. Pressing tab (tab completion) lists all possibilities.

Property	Explanation	Valid values
.acin	AC-IN functionality	ON, OFF
.dcin	DC-IN functionality	ON, OFF
.mode	Mode setting	GND, INP, CAP, STP, OSV, STPP, STPM
.filt	Filter setting	0,1,2,3,4
.cap	Capacitance value	(Read only value)
.frq	Frequency setting	1, 2, ... , 10000 [Hertz]
.stp	Step voltage	0.000, ... , 150.000 [Volt]
.osv	Offset voltage	0.000, ... , 150.000 [Volt]
.out	Measured output voltage	(Read only value)
.act	Activity indicator	(Read only value)
.safe	Limit indicator	(Read only value)
.frqlimit	Frequency limit value	(Read only value)
.stplimit	Step voltage limit	(Read only value)
.outlimit	Output voltage limit	(Read only value)
.serial	Axis serial number	(Read only value)
.trigu	Trigger input up	1, 2, 3, 4, 5, 6, 7
.trigd	Trigger input down	1, 2, 3, 4, 5, 6, 7
.patu	Pattern up	table of pattern values
.patd	Pattern down	table of pattern values

In the same way, the output trigger values can be modified:

```
> trig1.value = 1
```

This will set to output trigger no. 1 to high level (3.3 V). Set it to 0 again to commence the trigger pulse. The trigger object only has the .value property.

Example No. 2: Switching axis no. 1 to step mode:

```
> m1.mode = STP
```

STP is a constant and represents a numerical value (4). Note, that a single command doesn't have to be ended by a semicolon ";".

The following mode constants are predefined:

Mode name	Short	Value
Ground	GND	0
Input	INP	1
Capacitance	CAP	2
Offset	OSV	3
Step mode	STP	4
Offset + Step	STPP	5
Offset - Step	STPM	6

Note. AC-IN and DC-IN are activated by separate variables.

The following constants are equal to these numerical values:

Constant	Value
ON	1
OFF	0
UP	1
DOWN	0

Additionally, the following filter settings are available:

Filter setting	ANM200	ANM300
0	1600 Hz	off
1	160 Hz	16 Hz
2	16 Hz	160 Hz
3	1.6 Hz	off
4, 5, …	1600 Hz	off

Example No. 3: Making 100 steps upwards on axis 1:

```
> m1:step(UP,100)
```

Here, the method *step* is called with the parameters direction and number of steps. Again, UP or DOWN are constants representing the numerical values 0 and 1. Hence, stepping is invoked by calling the proper method. These other methods are available:

Method	Explanation
:step(*DIR*,*N*)	step *N* steps in direction *DIR*
:stop()	stop any actions
:wait()	wait for stepping to complete

Example No. 4: Reading the status of the AC-IN input port on axis 1:

```
> print(m1.acin)
0
```

Here, we make use of a built-in Lua function, *print*. In this example the AC-IN feature was switched off; if the feature was switched on, *1* would be the result.

Example No. 5: Programming a simple function *test*, that lists all values from 1 to *n*. In a normal Lua program the function could, for example, look like this:

```
function test(n)
  i=0;
  while i<n do
        i=i+1;
        print(i);
  end;
end
```

On the console, the whole function has to be written in one line, hence one types:

```
> function test(n) i=0; while i<n ↵
do i=i+1; print(i); end; end
```

You don't have to declare *n*, nor the output of the function. For example, you call the function with the parameter 5 in this way:

```
> test(5)
1
2
3
4
5
```

This example shows that in Lua it is possible to program functions and subroutines, which enables much more sophisticated possibilities than only calling single commands. The great advantage versus having a program running on a PC is that delays due to repetitive commands through the serial communication are minimized.

Example No. 6: Calculating the faculty of a number *n*:

```
> function factorial(n) if n==0 then ↵
return 1; else return n*factorial(n-1); ↵
end; end
```

Call the function as follows:

```
> print(factorial(5))
120
```

Note, that this is a recursive function.

Example No. 7: Ramping a voltage continuously up on axis *module* from start voltage *start* to end voltage *end* in *steps* number of steps:

```
> function scan(axis,start,stop,step) ↵
axis.mode=3; i=start; while i<stop do ↵
axis.osv=i; i=i+step; end; end
```

Call the function for example in the following way:

```
> scan(m1,10,20,0.001)
```

This will increase the voltage from 10 V to 20 V with 1 mV step width on axis 1. Note that 1 mV is much more precise than the electronics can generate. The value is for the output rounded to the closest value. As an idea for your own experiments, please try constructing an xy-scan function.

Example No. 8: Reading a pattern and defining a new one.

```
> for k,v in pairs(m2.patu) do print(k,v)
end;
```

As the result, the indexed up-pattern will be given out (index, value):

```
1       0
2       1
3       2
...
```

For setting the table, we need to define a table and then fill it. Note that indexing in Lua starts with index 1:

```
> t={}
> for i = 1,256 do table.insert(t,i-1) end
> m2.patu = t
```

The last command sets the up-pattern to the constructed pattern table *t*.

IV.3. LabView™ Drivers

All the commands described above are also available as LabView™ VIs. You can find them on the CD delivered with the system. The drivers are only available for a specific LabView version and are provided "as is".

Copy all of them to a convenient location on your disk.

All VI's communicate to the ANC300 via USB or Ethernet. If no value for the COM port number is given, Ethernet is selected by default.

Some of the VI's only write certain values, some only read, while others can read and write values. In the latter case, a Boolean value is required that decides whether to write or to read a value.

Most of the VI's generate a *command string* for convenience, which is sent to the ANC300. It can be used to trace problems and to debug your own programs. Also in *read data* the data read from the ANC300 is given without any conversion, so that the correct functionality can be traced.

Most of the VI's feature error in and error out terminals. This can be used for instance, to order them in a series.

The following VIs are provided (ANC300_v0.5.llb):

ANC300_Open.vi

ANC300_Open.vi

This VI opens the communication channel and supplies the connection ID for further vis.

Milliseconds to wait: Timeout for opening the device. If the timeout is met, an error is given out
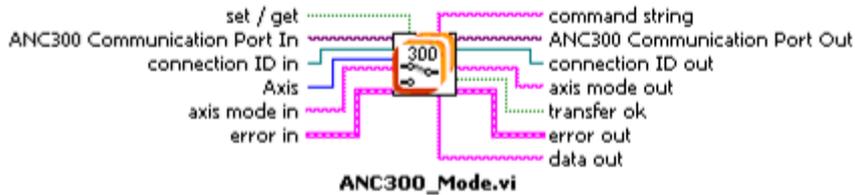
OpeningData_x: Response from the ANC300 [only via Ethernet]

ANC300_Close.vi

ANC300_Close.vi

This VI closes the communication channel.

ANC300_Mode.vi

ANC300_Mode.vi can read or set the mode for a respective *Axis*.

The VI writes the resulting mode to *Axis mode out,* when the mode is queried. *Transfer ok* is true when the command was successful. *Data out* is the direct response from the ANC300.
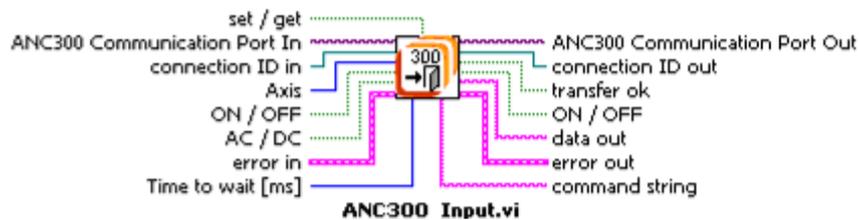
Allowed mode values that can be set, are:

Mode name	Short
Ground	GND
Input	INP
Capacitance	CAP
Offset	OSV
Step mode	STP
Offset + Step	STPP
Offset - Step	STPM

For more details on these modes see the first note in section IV.2.a

**Note.** Measure the capacitance The result has to be read with the ANC300_preferences.vi.

ANC300_Input.vi

This VI controls the AC-IN and DC-IN inputs.

set /get determines whether the value is written or read. Use *ON/OFF* respectively. *Transfer ok* is true when the command was successful. *Data out* is the direct response from the ANC300.

ANC300_Preferences.vi

ANC300_Preferences.vi
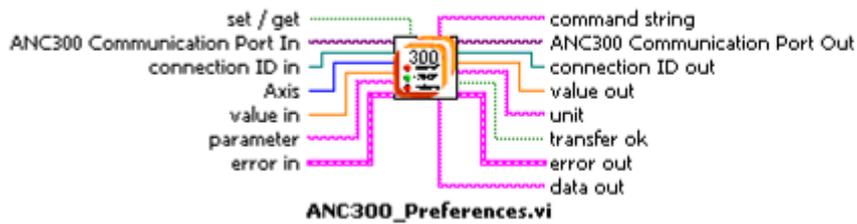
ANC300_preferences.vi reads and writes stepping or offset voltage, or frequency. It can also read the capacitance or measured output value. *set /get* determines whether the value is written or read. Use *value in* and *value out* respectively. *Transfer ok* is true when the command was successful. *Data out* is the direct response from the ANC300.

parameter can be one of the following:

Cap [only get], Freq, Volt, Output [only get], Offset

Please note that for the capacitance measurement, the ANC300 has to be switched to cap mode first before the capacitance value can be read with the ANC300_preferences.vi.

ANC300_Step.vi
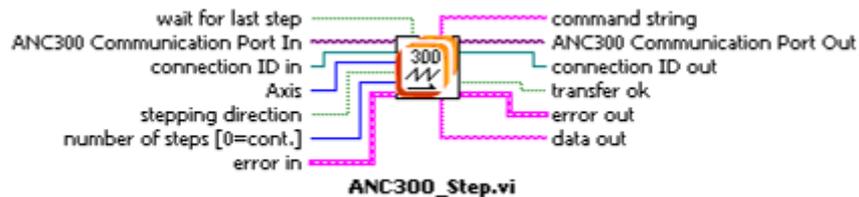
ANC300_Step.vi

ANC300_Step.vi starts stepping a given number of steps. Send "0" to start continuous stepping. *Transfer ok* is true when the command was successful. *Data out* is the direct response from the ANC300.
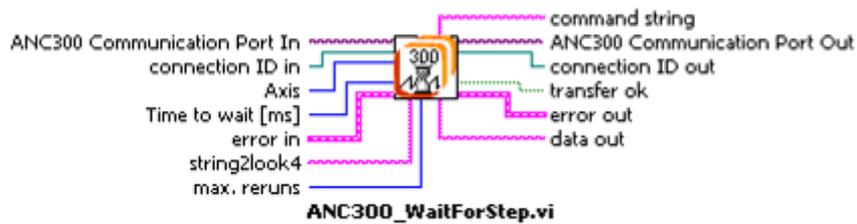
ANC300_Stop.vi

ANC300_Stop.vi

Stops stepping on axis *Axis*.
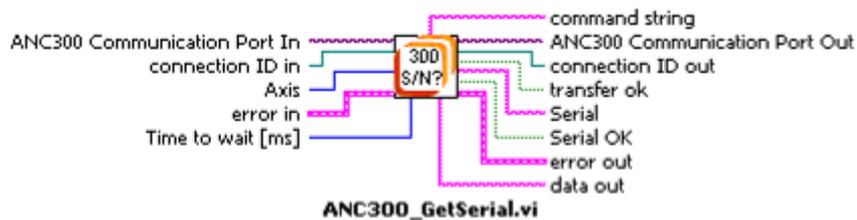*Transfer ok* is true when the command was successful. *Data out* is the direct response from the ANC300.

ANC300_WaitForStep.vi

This sub-VI waits for the end of a stepping command on a given axis.

Transfer ok is true when the command was successful. *Data out* is the direct response from the ANC300.

ANC300_GetSerial.vi

This VI reads the serial number of a given axis. Specify "0" as the Axis ID in order to read the serial number of the controller.

Transfer ok is true when the command was successful.

The serial number is given in *Serial*. The program determines whether a valid serial number was returned and writes this result to *Serial OK*. *Data out* is the direct response from the ANC300.

ANC300_trigger_setget.vi
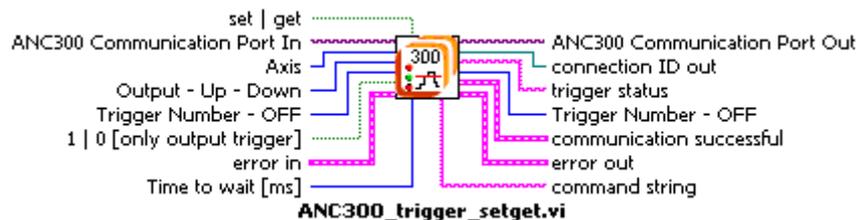
ANC300_trigger_SetGet.vi reads and writes trigger status.
set /get determines whether the value is written or read.
Trigger *Up / Down* relates the trigger to an axis and direction, and respectively shows the association. [only ANM150/ANM300]
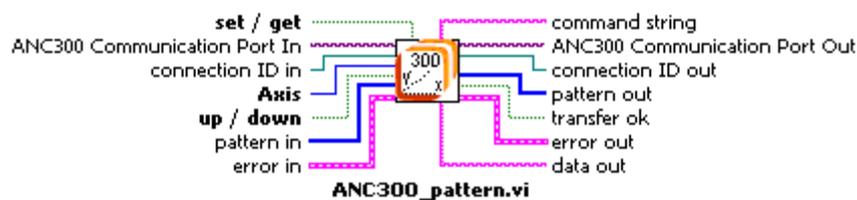*Output* switches output trigger to *high/ low* [mainly for use with LUA IV.2.d]

ANC300_feature_code.vi

ANC300_feature_code.vi
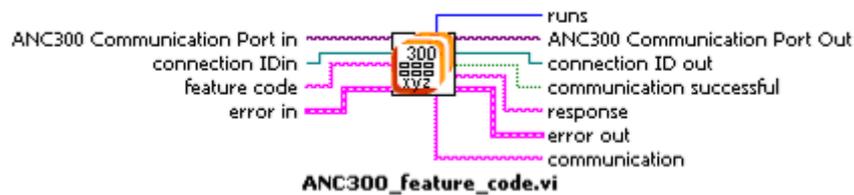
ANC300_feature_code.vi writes feature codes to enable / disable special features. [III.2.d]

ANC300_pattern.vi

ANC300_pattern.vi

This sub-vi writes a new stepping pattern [2^8 data points] for the selected axis and direction, and respectively reads the programmed pattern. Empty fields will be filled with "0". [IV.2.c]
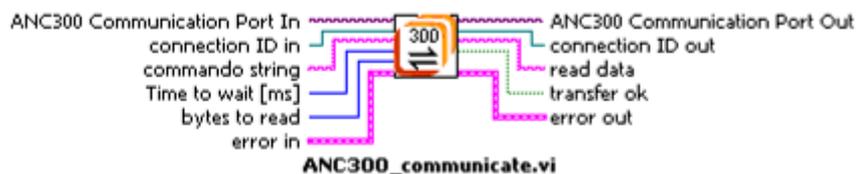
ANC300_filter.vi

ANC300_Filter.vi
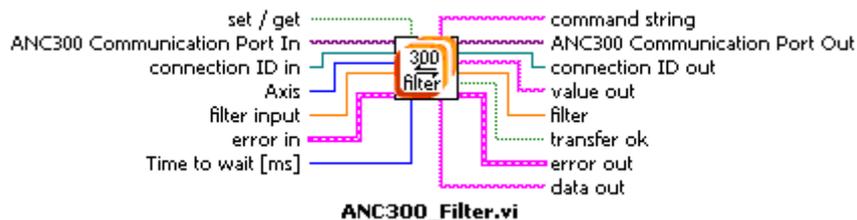
This sub-vi writes and reads the filter settings for the selected axis.
set /get determines whether the value is written or read.
Available are the settings:

ANM300	OFF	16Hz	160Hz	-
ANM200	1.6Hz	16Hz	160Hz	1600Hz
ANM150	-	-	-	-

ANC300_communicate.vi

ANC300_communicate.vi

This sub-VI is used by other vis to handle the communication to the ANC300. A given command is written to the console. After certain waiting time the answer is read and interpreted.

V. Upgrades and Add-ons

V.1. Firmware Upgrade

At some point, a new firmware might be available for the ANC300. The following step-by-step description explains how to load this new firmware.

Method A:
1. Copy the update file on a FAT16 or FAT32 formatted USB stick. Place it in the root directory of the stick.
2. Switch on the ANC300 and wait for the initialization to finish.
3. Plug in the USB stick to the USB master port of the ANC300.
4. The ANC300 will ask whether to search for an update. Click "OK".
5. In case a mating update is found, the ANC300 will ask whether to load the specific update. Again, click "OK" to load the update.
6. Wait for the update procedure to finalize and do not switch off until the procedure is finished. During the update procedure, the ANC300 might restart once or twice.
7. The update is finished when the main screen comes up again.
8. Remove the USB stick.
9. The controller is now ready to work with the new firmware.

Method B:
1. Connect the ANC300 to a LAN and manually select a suitable IP address.
2. On your computer, open a command window.
3. Type "FTP <IP-address>" and start an FTP session with the ANC300.
4. Login as user "update" with password "123456" (default).
5. Select binary protocol and upload the update file.
6. In case a mating update file is sent, the ANC300 will load and install the update. During the update procedure, the ANC300 might restart once or twice.
7. Wait for the update procedure to finalize and do not switch off until the procedure is finished.
8. The update is finished when the main screen comes up again.
9. The controller is now ready to work with the new firmware.

V.2. Removal of an Axis Module

⚠️ **WARNING. Risk of electric shock.** If covers are opened, there is a risk to touch hazardous voltages. If malfunction is suspected, immediately contact attocube systems for repair or replacement. Modified or opened electronics cannot be covered by the attocube warranty anymore. Only personnel trained in the servicing and maintenance of this equipment should remove its covers or attempt any repairs or adjustments. Follow the General Accident Prevention Rules.

⚠️ **CAUTION. Risk of damage.** Plugging or unplugging modules of the electronics while connected to power line will irreversibly damage them. Internal capacitors need to be discharged before plugging in or out components. To replace modules, disconnect the ANC300 from mains power and wait for about **5 minutes** before proceeding.

⚠️ **CAUTION. Risk of damage.** The components shown are sensitive to static charges. Please use proper care when working with such electronics devices. Avoid static charges by having a grounded wristband on while working with the components or otherwise grounding yourself.

To open the housing, unscrew the two screws on the front side of the respective axis. The boards are connected to a backplate by a connector, so some force is required to pull them out. If possible, open a blank cover next to the module and hence get a better grip on the frontplate. Otherwise, use the BNC connectors (attach e.g. a T-piece) or the dials and carefully pull on them to withdraw the module.

When pulling the module out, have an eye on the solder joints on the left side of the module. Avoid any contact with the metallic front plate of the neighboring module.

As soon as you have pulled out the module, please make sure to store it in an ESD safe environment to prevent damages.

Finally, close the opening by attaching a blank cover plate and tightening the screws.

🛈 *Note*. The ANC300 may not be used with the front cover open.
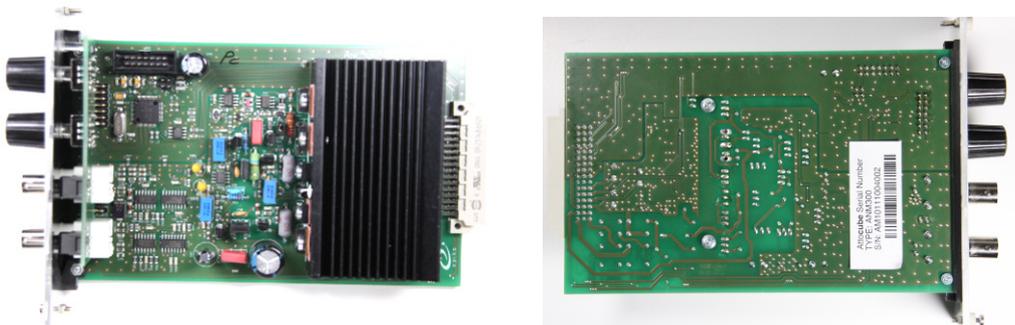
V.3. Installation of an Axis Module

	WARNING. Risk of electric shock. If covers are opened, there is a risk to touch hazardous voltages. If malfunction is suspected, immediately contact attocube systems for repair or replacement. Modified or opened electronics cannot be covered by the attocube warranty anymore. Only personnel trained in the servicing and maintenance of this equipment should remove its covers or attempt any repairs or adjustments. Follow the General Accident Prevention Rules.

	CAUTION. Risk of damage. Plugging or unplugging modules of the electronics while connected to power line will irreversibly damage them. Internal capacitors need to be discharged before plugging in or out components. To replace modules, disconnect the ANC300 from mains power and wait for about **5 minutes** before proceeding.

	CAUTION. Risk of damage. The components shown are sensitive to static charges. Please use proper care when working with such electronics devices. Avoid static charges by having a grounded wristband on while working with the components or otherwise grounding yourself.

Figure 15: Right and left side of an ANM300 module.

After mains and all other cabling have been removed, open the cover of a free slot in the ANC300. Carefully insert the module taking care not to touch the electronics with bare hands to avoid damages due to static electricity.

When inserting the module be sure to have the board sliding in the lower and upper rail to ensure a proper connection of the module connector. Firmly press the module into the connector.

After tightening the frontplate screws, the ANC300 can be switched on again. Please check that the start-up screen lists the new module.

VI. Preventive Maintenance

> **WARNING. Risk of electric shock.** If covers are opened, there is a risk to touch hazardous voltages. If malfunction is suspected, immediately contact attocube systems for repair or replacement. Modified or opened electronics cannot be covered by the attocube warranty anymore. Only personnel trained in the servicing and maintenance of this equipment should remove its covers or attempt any repairs or adjustments. Follow the General Accident Prevention Rules. Maintenance is limited to safety testing and cleaning as described in the following sections.

> **Note:** Please note that you may void the warranty for the ANC300 in case unauthorized persons have opened the housing or unauthorized parts or actions have been employed. This is especially true in case of the usage of fuses not meeting the specifications.

VI.1. Safety Testing

Safety testing in accordance with local regulations, should be performed on a regular basis, (typically annually for an instrument in daily use).

> **CAUTION. Risk of damage.** The instrument contains a power supply filter. Insulation testing of the power supply connector should be performed using a DC voltage.

VI.2. Fuses

See section II.2.b for fuse specifications and exchange of fuses.

VI.3. Cleaning

> **WARNING. Risk of electric shock.** If water gets inside the casing, there is a fire hazard, as well as a risk of electric shock. To avoid such:
> - Disconnect the power supply before cleaning the unit.
> - Never allow water to get inside the case.
> - Do not saturate the unit.
> - Do not use any type of abrasive pad, scouring powder, or solvent, e.g. alcohol or benzene.

The fascia may be cleaned with a soft cloth, lightly dampened with water or a mild detergent.

VII. Questions & Answers

Note: Any time you call for technical support, the ***firmware version and date, and the serial numbers (CPU, modules, housing)*** are essential to trouble-shoot a problem. They can be queried with the "ver" and "ser" commands on the console.

Q) The positioner is not moving properly.
A) This might have several reasons. Double-check the following:

- Connect the outputs of the ANC300 to an oscilloscope. Set to e.g. 1000Hz and 20V. Does it show the sawtooth patterns below? If the output is correct, there might be a problem of the attached circuitry. If there is no output at all, check the fuses at first.
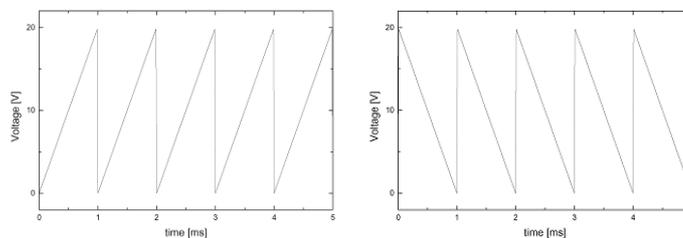
- Check all internal and external fuses of the ANC300. In most cases a fuse blows due to a short-circuit or an overload of the ANC300. Check any attached circuitry on shorts.
- Check the mains voltage level. If the voltage differs more than ±10% tolerance from the nominal voltage level, the internal voltages might be affected and too low or too high. As a consequence, the controller might become unstable, fuses may blow or it may not work at all.
- Is the cabling low-ohmic (less than 5 Ohm)? If not, the positioners step efficiency will go down or stop the positioner completely.
- If the problem is related to the positioner, please refer to the positioner manual.

Q) The ANC300 has no output and makes/made a clicking sound.
A) The ANC300 features short-circuit protection and turns off all outputs when it detects too high currents. Please check your setup and cabling. It may be required to re-start the ANC300 in case the clicking cannot be stopped.

Q) One axis of the ANC300 has no output and the red LED on one or more modules is blinking.
A) The ANM modules feature overheat protection and shut down when too much heat is generated. Please ensure that you are operating within the voltage and frequency limits and that proper airflow is maintained to the unit and the ventilation holes are not blocked.
Also, the LEDs will blink red if the 150V supply voltage is not present. In this case switch off and check all fuses (internal and external ones).

Q) Can the axis control system be controlled by GPIB interfaces?
A) The controller features an USB, and an Ethernet port, which can easily be programmed with simple text commands. Labview drivers and some sample VIs are supplied with the system. Currently attocube systems does not offer a GPIB interface for the ANC300.

Q) I want to reduce the heat load on the cryostat. Can I connect the positioners using resistive wires?
A) Resistive wires are not recommended. A resistance of 10 Ohms or more may be enough to prevent the positioners from working, as they require high currents (at low temperature about 0.5 to 1 A maximum). Alternatively, one can use superconducting wires reducing the heat transfer without increasing the resistance, or resistive wires with big diameters, respectively. Also, we suggest applying a combination of different techniques.

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