



RF ELECTRONIC ATTENUATOR AT8-01M

Operating Manual

Rev. 1.0

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1 Package Contents

The following items are included to the delivery package:

Item#	Description	Qty.	Note
1	AT8 RF Electronic Attenuator 300 kHz – 8 GHz	1	
2	AC power cord with CEE 7/7 (E+F Type) plug	1	Note 1
3	USB Cable A-B, 3m (9.8ft.)	1	
4	RS-232 Cable, D-sub 9F - D-sub 9M, 3m (9.8ft.)	0/1	Note 2
5	CD with drivers and documentation	1	
6	AT8 Operating Manual (printed version)	1	
7	Calibration certificate	1	
8	Warranty certificate	1	
9	Packing List	1	

Note 1: By default the power cord with CEE 7/7 (E+F Type) plug is placed if not explicitly specified by the customer.

Note 2: By default it's not placed if not requested by customer.

2 Overview

AT8 electronic attenuator is designed to attenuate input RF signal by specified value in wide frequency and dynamic range. It can be applied in testing and debugging of communication receivers, as well as in other applications which require very small signal level and high dynamic and frequency range.

Figure 1 shows the block diagram of electronic attenuator, the main block of the instrument. It consists of five digitally controlled attenuators. First four attenuators operate with 20 dB step (can be set 0 or 20 dB), the fifth attenuator has 0.5 dB step in range 0 to 31.5 dB attenuation. Connected in series they result in 0 to 111.5 dB attenuation range with 0.5 dB step. RF1 and RF2 ports can be used as input or output. Internal attenuators are based on electronic switches, so they feature long lifespan and fast switching, but relatively high insertion loss (IL) compared to mechanical switches. IL is a minimum attenuation value when all internal attenuators are set to 0 attenuation. Total insertion loss of the instrument depends on frequency, and can vary from 0.5 dB at low frequencies to about 20 dB at high frequency. AT8 is factory calibrated, which means that when user sets the desired attenuation value, the instrument automatically takes into account the insertion loss and errors of each internal attenuator at given frequency, and sets the nearest possible attenuation value.

Figure 2 shows an example of instrument application. Signal from high power output stage of the transmitter is fed to high power fixed attenuator, then to the RF1 input of AT8. Small level signal from RF2 port of AT8 is fed to the input of the receiver. Adjusting attenuation of AT8 it's possible to measure sensitivity of the receiver.


 Actual attenuation accuracy depend on source and load impedance (50Ω nominal). For best accuracy it's recommended to use sources and loads with VSWR less than 1.5

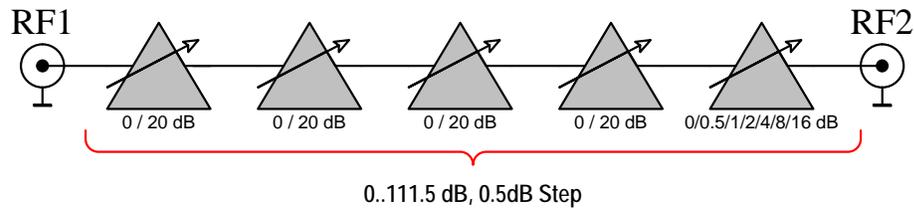


Figure 1: Block diagram of AT8 electronic attenuator

3 Installation, Maintenance and Safety



When installing the instrument, please note the following:

- AT8 Electronic Attenuator is designed for laboratory use only and is not protected against moisture and mud.
- Some space from the bottom and rear side should be provided to ensure proper air cooling of the instrument.
- During connecting cables or other equipment make certain that connectors correspond to each other, and are in proper condition. Otherwise some damage to instrument's connectors may occur.
- A grounded, three pin AC power receptacle should be used for power supply of the instrument. The grounded pin of the AC power cord is internally connected to the instrument's chassis.
- When connecting equipment to the instrument, make sure that all equipment are properly grounded and there is no voltage difference between their cases. Otherwise it may result in damage of the instrument's input or output.



When installing and turning on the instrument, it is recommended to follow the order listed below:

1. Verify that front panel power ON/OFF button (item 3, fig. 3) is turned off (not in depressed position).
2. Verify that rear panel AC power ON/OFF switch (item 1, fig. 4) is turned off.
3. Connect AC power cord to the instrument and to AC wall power supply.
4. Turn on the AC power switch at the rear panel of the instrument.
5. Turn on the ON/OFF button at the front panel of the instrument. Text corresponding to the current operation mode should be displayed on the screen.

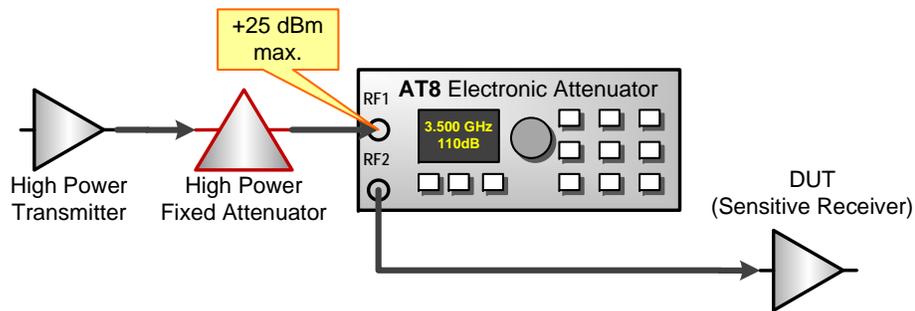


Figure 2: Example of the instrument connection

6. To turn off the instrument just press the ON/OFF button at the front panel.

By default attenuation of the instrument is always set at maximum when the device is turned on or reset via remote control. With long-term non-use of the device it is recommended to turn off the AC power switch at the rear panel. Before doing this make certain that the instrument is off.

Over time, the deviation of the attenuation from the specified values may increase, so the device should be calibrated periodically. Recommended calibration interval is 1 year.



4 Control Elements and Interfaces

Figure 3 shows the front panel view of the instrument. The elements are designated with the following callouts:

1. RF2 port (input/output), SMA-connector, female;
2. RF1 port (input/output), SMA-connector, female;
3. Power On/Off button. It turns off all circuits except primary AC/DC convertor;
4. Graphical OLED display with 128 x 64 resolution, yellow color, 4-bit;
5. Rotary knob, 24 positions per 360°;
6. Keyboard;
7. Context sensitive menu keys.

Figure 4 shows rear panel view of the instrument. Its elements are designated with the following callouts:

1. Main AC power supply switch, it turns off all circuits including primary AC/DC convertor;



Be sure that input signal level is within specified maximum ratings (see. AT8 Datasheet for detailed information), otherwise it may cause permanent damage to the instrument. Exposure to absolute maximum rating conditions for extended periods may affect device reliability. When using in applications with high level signals, please don't forget to connect high power fixed attenuator at the input as shown on figure 2.



Figure 3: Front panel view

2. USB interface for the connection to PC;
3. RS-232 interface for the PC's COM-port connection. 9-pin D-Sub connector;
4. Fan for cooling;
5. Grounding terminal. Actually grounding is provided via central pin of the standard power supply cord, so this auxiliary terminal should be used only if your AC socket has no any grounding pins;
6. Aux In (Ext. TRIG input), BNC connector, female. It's used for external triggering events in sweep mode of operation.
7. AC power supply connector with fuse.

i It's recommended to use
2A / 250V fuse

5 Graphical User Interface

Figure 5 shows the display screen view. It is divided into several fields: *Status Bar* (1), *Menu Items* which can be textual, numeric and graphical (2), *Context Sensitive Menu* (3) which depends on the currently selected item, and *Scroll bar* (4) showing the current position of the displayed window relative to the whole menu item list. Menu consists of the items arranged in left-to-right and top-to-bottom order (2.1-2.4). The number of the items can vary from a few to dozens making up several lines of the screen. One line can contain more than one item. In the case of more than three lines scroll bar appears on the screen. Some items can be shaded (have less brightness, 2.3). It means that in this operation mode these items are blocked (not used) or used only to display information (i.e. not editable by the user) or can't be used to launch the operation corresponding this

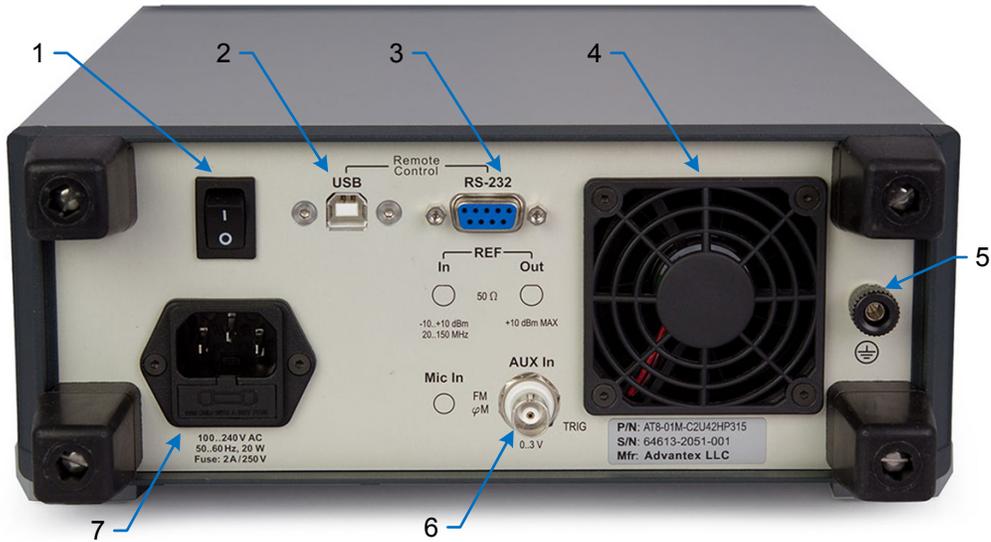


Figure 4: Rear panel view

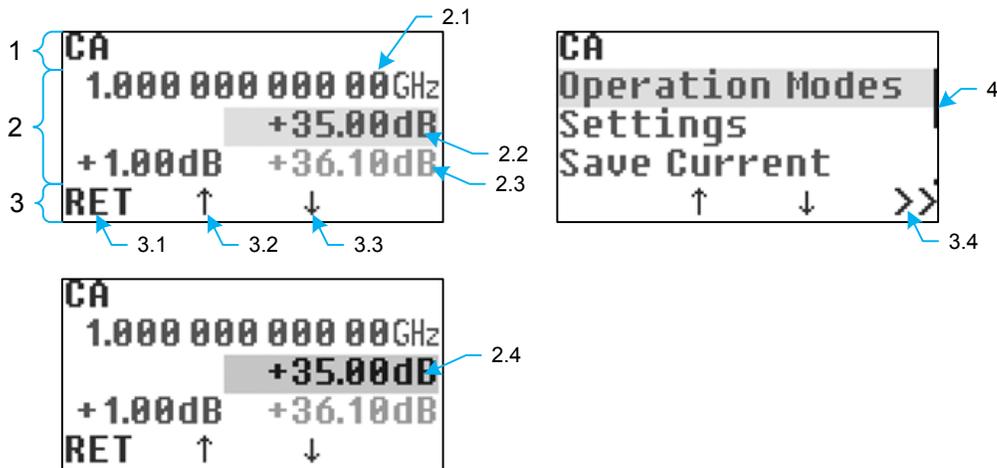


Figure 5: Display



item. When navigating through menu items the current item is being selected (2.2). When entering data numerical item turns *active* (i.e. becomes brighter, see 2.4), it means that the item is in the numerical data *editing mode*. Menu can have hierarchical structure, the moving between levels can be performed with aid of context sensitive menu (3).

5.1 Menu Navigation

Navigation through the menu items (moving to next or previous item, entering to sub-menu or one level up) can be performed by the context menu buttons (see figure 3, item 7), and rotary knob (item 5).

- RET – moving one level up;
- ↑ – moving to previous item;
- ↓ – moving to the next item;
- >> – entering to the sub-menu (one level down);
- OPT – entering to the options menu of the current operation mode.

Rotating knob clockwise corresponds to ↓ command, counterclockwise – ↑, pressing knob – >>.

5.2 Status Bar

Status bar (top line of the screen) displays the current operation mode and settings of the instrument. An information displayed in the status bar in symbol form is listed below.

Current operation mode:

- CA** – Continuous Attenuation;
- SWA** – Sweep Attenuation.

The shape or type of the attenuation sweep:

-  – Saw, defines the shape of the sweep;
-  – Triangle, defines the shape of the sweep.

Triggering type used in SWA (Sweep Attenuation) mode:

-  – Auto. The instrument doesn't wait for external triggering event to repeat new run. New run starts immediately after the previous one is over;

Table 1: Status bar Info

Operation Mode	Waveform / Shape	Triggering	Source	Warnings
CA				UNC
SWA				OVT
				#XX

 – Single run. After one run (period) is over, the instrument waits for the triggering event to start new run;

 – Step. The instrument waits for the triggering event after each sweep step.

The source of external triggering event:

 – (Manual) manual triggering by means of pressing TRIG softkey in SWA mode;

 – (Positive Slope) triggering event occurs at the rising edge of the signal fed to Aux In input in SWA mode;

 – (Negative Slope) triggering event occurs at the falling edge of the signal fed to Aux In input in SWA mode.

Warnings and Errors:

UNC – (Uncalibrated) means that value of one of the parameters of the current mode of operation is out of calibrated range;

OVT – (Overtime) microcontroller does not have time to process the event queue;

#XX – (Error Code) last error code.

Table 1 shows status bar symbols in the order they appear on the screen.

5.3 Data Entry

Numerical data entry can be performed either using the keyboard (fig. 3, item 6) or the rotary knob (item 5).

The default state of the rotary knob is the menu navigation mode. Single click the knob on the selected numerical menu item (e.g. see fig. 5, item. 2.2)

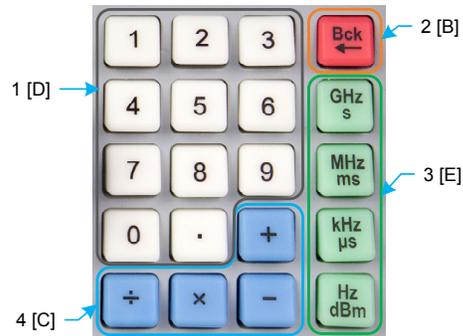


Figure 6: Keyboard

puts the menu item to the numerical data entry mode, rotation of the knob corresponds to the increase or decrease of the numerical value. To exit from the numerical entry mode to the navigation mode just click the knob again or press one of the context sensitive menu keys (RET, ↓, ↑).

The instrument keyboard is divided into several groups (fig. 6):

1. Numeric buttons (D group);
2. Backspace (B) – deletes the last input symbol;
3. Enter/Units (E group);
4. Operations (C group).

Numerical entry mode is automatically activated by pressing any of the D, B or C group keys. The pressing on any key of E group performs the entry of the input data following by the exit from the numerical entry mode. When pressing E group key in navigation mode, the change of the unit scale factor is performed, e.g. if the current frequency value is 1'000'000'000.00 Hz, then after pressing [MHz] key the value 1'000.000 000 00 MHz will appear on the screen, and so on. When changing unit scale factor (i.e. k – kilo, M – mega, e.t.c.) the increment step of the edited value while rotating the knob will also change. Typically the minimum step while rotating the knob equals to the one-tenth of the selected unit scale, i.e. if the current unit scale is kHz, then rotary knob step will be 0.1 kHz. With increasing rotation speed step increases.

Table 2 shows examples of some operations and corresponding command sequences.

Table 2: Math operations and numerical data entry

Sequence	Expression	Description
E	R	Used for unit scale factor entry, e.g. Hz, kHz, MHz, GHz, also it's used to repeat the last entered command. To do so (to repeat the operation with the last operand) the same button of E-group which was used last time should be pressed. Otherwise the exit from command repeat mode is performed. ¹
C E	$R \cdot (-1)$	As a valid "C"-key it's possible only "-". Used for negative value entry.
D E	D	Direct input of numeric value. Unit scale factor is defined by pressed "E" button, i.e. by pressed unit (μ s, ms, dBm, kHz and so on)
D C E	$D \cdot (-1)$	As a valid "C"-key it's possible only "-". Used for negative value entry. For example, to enter -10 dBm you should press the following: "1", "0", "-", "dBm"
C D E	$R \otimes D$	It is used in conjunction with "E"-key for quick data entry with linear or exponential increment step. For example, to set consequently frequencies 100, 110, 120, 130, 140 MHz just set 100 MHz at first, then press "+", "1", "0", "MHz", and after each next pressing of "MHz" key the value will be increased by 10 MHz. This sequence can also be useful to offset from current value. For example, you need to set 0.999 998 GHz. It will take less time if you set 1 GHz first by D E sequence, and then subtract from it 2 kHz by pressing C D E sequence.
D C D E	$D_1 \otimes D_2$	Can be used for evaluation of mathematical expression along with result data entry. For example, when entering multiple frequencies. ²

(continued on next page)

¹Exit from last operation repeat mode can also be performed by pressing "Bck" (after last pressed E-group button)

²When evaluating expressions with several operands – all of them except the last one have current unit scale factor (μ , m, k, M, G), i.e. the factor that was valid before the entry process. The last operand has unit scale factor corresponding to pressed "E"-key closing the sequence. For the operands without units like in expressions "*" and "/" scale factor equals 1.



(continued Table 2, beginning on the preceding page)

Sequence	Expression	Description
C D C E	$(R \otimes D) \cdot (-1)$	Rarely used
C D C D E	$(R \otimes_A D_1) \otimes_B D_2$	Can be used for evaluation of mathematical expression along with result data entry. When used sequences with arbitrary number of operands, the intermediate result isn't loaded to the instrument immediately, only the final result after pressing "E"-key is loaded. Thus the intermediate results are restricted only to the capacity of operands while evaluation the expression. ³ Each next "E"-key pressing repeats the last operation with the last operand of the input sequence.
D C D C D E	$(D_1 \otimes_A D_2) \otimes_B D_3$	Can be used to evaluate expressions such as $D \cdot m/n$

R – current value, \otimes – operation (+, −, ÷, *), D – entered numerical value.

6 Instrument Functions

6.1 Main Menu

Main menu of the instrument consists of the following items (fig. 7):

Operation Modes – contains sub-menu corresponding to modes of operation – CA (Continuous Attenuation), SWA (Sweep Attenuation);

Settings – contains sub-menu with the basic settings of the instrument relating to all modes of operations or to a group of modes;

Save Current – the command saves the current settings and values of all numerical parameters. When powering up the instrument it will be initialized by the values stored by Save Current command;

Load Default – the command loads default values for all parameters;

Info – contains information about the instrument.

When powering up the instrument tries to read from the nonvolatile memory (EEPROM) setting values stored previously by Save Current command. If

For example the sequence "*" "2", "kHz" multiplies current value by 2 and displays the result in "kHz" units. Factor values in "*" and "/" operations have 10^{-3} accuracy and maximum value not less than 10^{+3} .

³Integer 64-bit. Internal fixed point evaluation algorithm applies 10^4 factor for Hz, 10^2 – for dBm and degrees, 10^9 – for seconds.

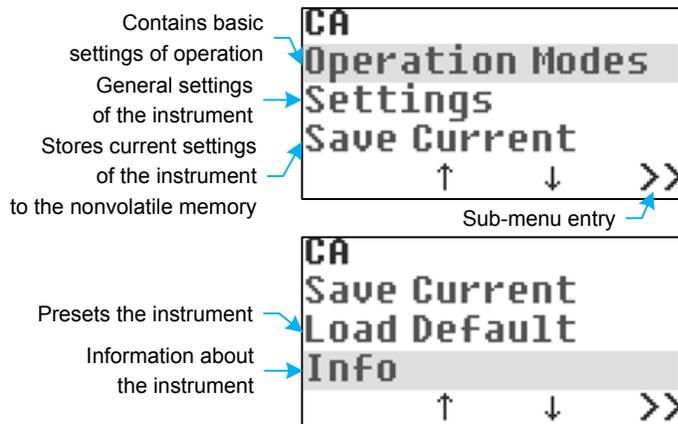


Figure 7: Main menu

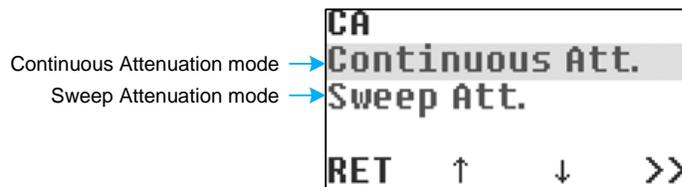


Figure 8: Operation Modes

checksum is valid, i.e. data is valid, then stored values are loaded, if not – the default values which are defined by the vendor are loaded to the instrument.

6.2 Operation Modes

The instrument has two operation modes listed in Operation Modes menu (fig. 8):

Continuous Attenuation – CA;

Sweep Attenuation – SWA.

When powering up, the instrument is in one of the modes listed above regardless of the current position within the menu system. The current mode of operation is displayed in the status bar at the top left corner of the screen (see section 5.2 on page 10). The switching between modes is performed by entering the corresponding menu item. Each operation mode has its own independent set of parameters. Any changes made to operation mode settings are saved while exiting and switching to another mode until the power is turned off.

When powering up, that mode is loaded which was current before the Save Current command was clicked. Continuous Attenuation (CA) is the default mode of operation.

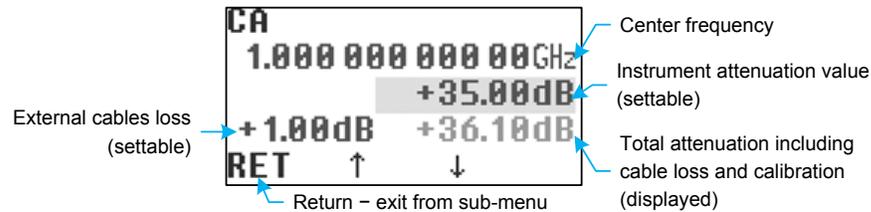


Figure 9: Continuous attenuation operation mode menu (Operation Modes > Continuous Att.)

6.2.1 Continuous Attenuation Operation Mode (CA)

Continuous Attenuation operation mode (CA) has the following parameters (fig. 9):

i For best attenuation accuracy don't forget to enter center frequency of the signal

Center Frequency – center frequency of input signal. This value is used for attenuation digital correction which includes insertion loss of the instrument and internal attenuators errors which were calibrated. Calibration points forms grid on frequency axis, the correction data for frequency between any two calibration points is calculated by interpolation;

Instrument Attenuation – desired attenuation of the instrument set by user (editable). Here implies that attenuation is positive value.

Cable Loss – external cable loss for given frequency (settable by user). It serves only for informational purposes, its value is included to total attenuation displayed in the next field;

Total Attenuation – total attenuation of the instrument including external cables loss (see previous field) and including internal attenuators errors. The instrument finds the nearest value to the attenuation which was set by user and displays it in this field. This field is only informative (not editable) and represents the most accurate (real) attenuation at given frequency.

i Please note that the instrument implies attenuation as a positive value

Let's consider an example of how it works. User sets the desired attenuation of the instrument 35 dB and sets external cable loss to 1 dB as shown in figure 9. The instrument tries to find the combination of internal attenuators which results in nearest to desired value (35.1 dB in this example). 0.1 dB difference is caused by error of minimum attenuator which is not actually equal to 0.5 dB at all frequencies. Thus actual total attenuation equals to 36.1 dB as displayed in the field at lower left corner of the screen.

6.2.2 Sweep Attenuation Operation Mode (SWA)

Sweep attenuation is a step change of attenuation according to the specified shape (e.g. triangle or saw). Figure 10 shows parameters used in the instrument

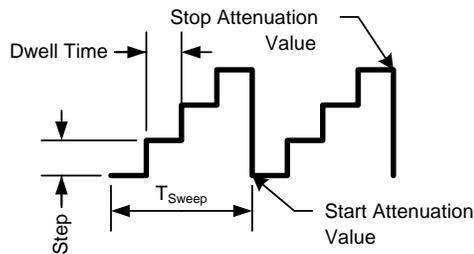


Figure 10: Sweep attenuation parameters

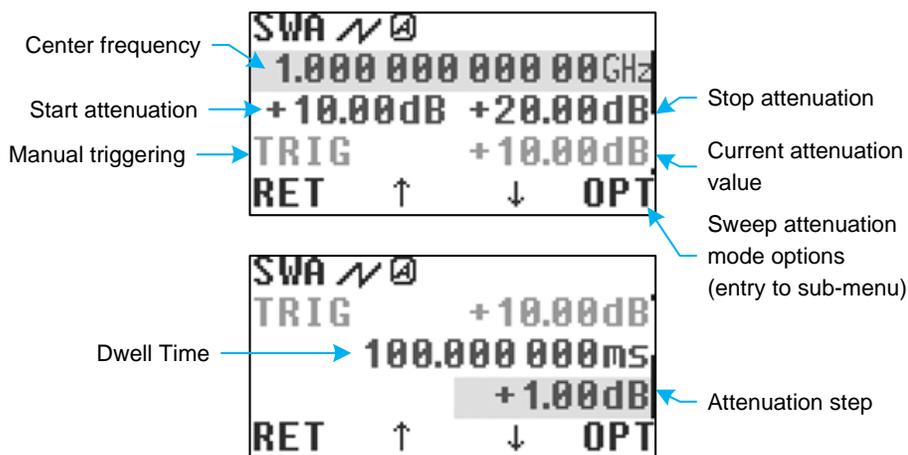


Figure 11: Sweep attenuation operation mode menu (Operation Modes ▷ Sweep Att.)

to setup the sweep mode. T_{Sweep} – time of one period. SWA mode has the following parameters (fig. 11):

Center Frequency – center frequency of input signal. It's used for correction of attenuation caused by insertion loss and internal errors;

Start Attenuation – start value of attenuation;

Stop Attenuation – stop value of attenuation;

Dwell Time – one step time;

Attenuation Step – attenuation step size;

Current Attenuation – (not editable) this field shows the current attenuation value, it's updated every 0.5 sec on the screen.

SWA mode has the following options (press OPT menu button), figure 12:

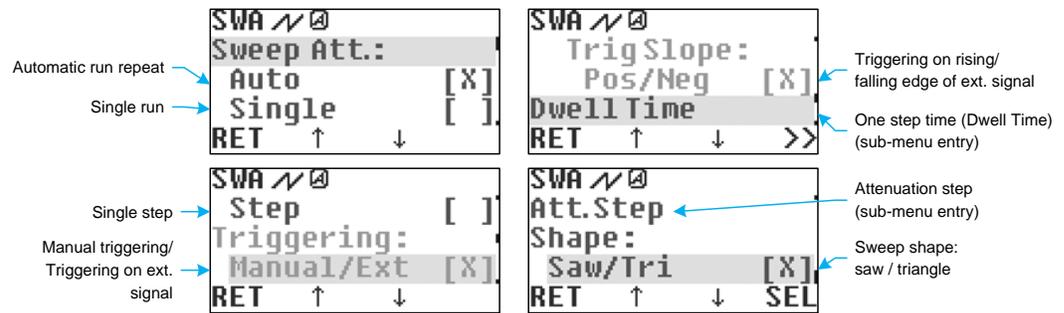


Figure 12: Sweep attenuation mode options (Operation Modes > Sweep Att.> OPT)

- Sweep mode type:
 - Auto – automatic, after one period pass, it repeats automatically;
 - Single – single period run. Sweep starts at triggering event. Then after one pass it returns to the start and waits for the next triggering event;
 - Step – stepping mode. Each step is performed after triggering event;
- Triggering options:
 - Manual – triggering event performed manually by pressing TRIG softkey (see fig. 11);
 - External – triggering event is generated by external signal fed to Aux In input;
 - * Trig Slope:
 - Positive – triggering event is generated at the rising edge of the external signal;
 - Negative – triggering event is generated at the falling edge of the external signal;
- Dwell Time – this sub-menu item duplicates the corresponding menu item in fig. 11;
- Att. Step – (attenuation step) this sub-menu item duplicates the corresponding menu item in fig. 11;
- Sweeping law (i.e. Shape):
 - Saw - saw shape;
 - Tri - triangle.

i When Ext. Triggering option is activated triggering event can also be generated manually by TRIG softkey

Table 3 shows shapes at various relations of start and stop attenuation values.

Table 3: Sweep attenuation shapes

SWA	$Att_{Start} < Att_{Stop}$	$Att_{Start} < Att_{Stop}$
Saw		
Triangle		

6.3 Settings of the Instrument

Settings menu is not used in current firmware revision and is reserved for future use.

6.4 Storing the Current Settings of the Instrument (Save Current)

This menu command stores the current settings and values of parameters of the instrument to nonvolatile memory (EEPROM). After power on the instrument reads stored data, analyzes its integrity, and initializes parameters and values by the stored data. If integrity check is failed,⁴ the default values are loaded.

6.5 Preset the Instrument (Load Default)

This menu command presets all parameters of the instrument by the default values and enters the CA operation mode. It can be useful if you want to reset all parameters.

6.6 Information about the Instrument(Info)

Info menu contains the following items (fig. 13):

Part Number – the full name of the instrument, including the series number, its modification, and assembly variant;

Serial Number – the unique ID number of the instrument.

Firmware Revision – the version of the firmware in Rx.x mm/dd/yy format, where x.x – firmware revision, mm - month, dd – day, yy – year of the firmware;

Operation Time – total time of operation of the instrument in hours. It increments each hour. If operation time since powering on is less than one hour then when powering off it remains the same;

Power-On Count – number of powering up events.

⁴It could be after firmware update, when new version's parameter set is incompatible with the older version

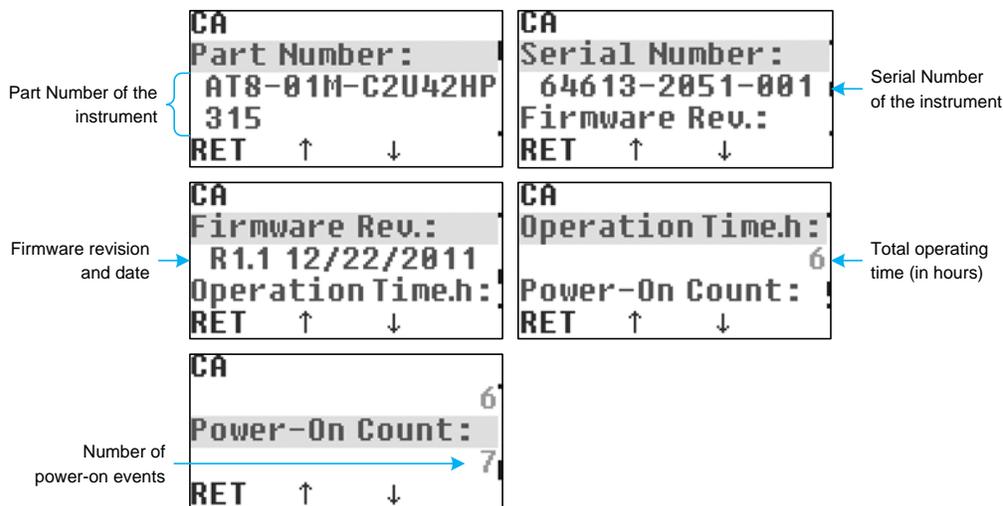


Figure 13: Information about the instrument (Info)

7 Remote Control

The remote control of the instrument is based on the SCPI (Standard Commands for Programmable Instruments) protocol. It is implemented via RS-232 and USB interfaces located on the rear panel of the instrument, fig. 4, (USB looks in OS like COM-port), so it can be easily managed by any software which has access to the COM-port of the PC. Only one port can be active, the choice is automatic and remains the same until the power off. The choice of the active port occurs when any byte comes to the one of the ports (not necessary a valid command). The connection via USB is implemented with aid of USB to UART bridge, so from the view point of PC software it looks like a COM-port, fig. 18. This method requires driver installation ⁵ (integral circuit CP2102). The driver is available for the following OSes: Win2K/XP/2K3, Vista, Windows 7, Mac OS, Linux 3.1.

7.1 Quick Start

As a simple remote control application you can use the standard Windows application – *HyperTerminal* (Start>Programs>Accessories>Communications>HyperTerminal) to send the SCPI commands to the instrument, fig. 14. COM-port settings are the following: 115200 bps, 8 data bits, parity none, 1 stop bit, flow control none, fig. 15. For more convenient use of the *HyperTerminal* it's recommended to configure the settings (File>Properties, Settings tab, ASCII

⁵The driver (its last version) can be downloaded from CP2102 bridge vendor site [Silicon Labs](http://www.siliconlabs.com)

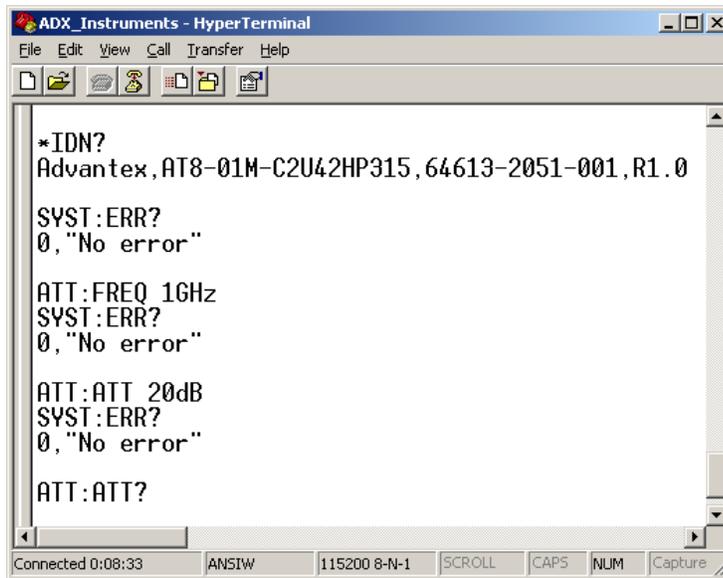


Figure 14: Example of the remote control using *HyperTerminal* application

Setup... button) “Echo typed characters locally” and “Send line ends with line feeds”. For example, the following typed sequence in *HyperTerminal* application

```
*rst
att:freq 100MHz
att:att 30dB
```

will reset the instrument, set the output frequency to 100 MHz, and attenuation to 30 dB.

7.2 SCPI Commands

Figure 16 shows the model of SCPI command processing.

7.2.1 SCPI Compliance

Instrument control command set is based on the SCPI v. 1999.0, but it’s not fully compatible. The differences are listed below:

- not all required commands are implemented (see the command list);
- command parser recognizes only one command in single string, and the string size shall not exceed 64 symbols;
- command buffer length equals two, i.e. it is possible to send second command after the first one immediately (not waiting for completion of the first command), but not more;

i In applications where one command follows after another immediately without any time delay, for proper SCPI operation it is recommended to use *OPC? command

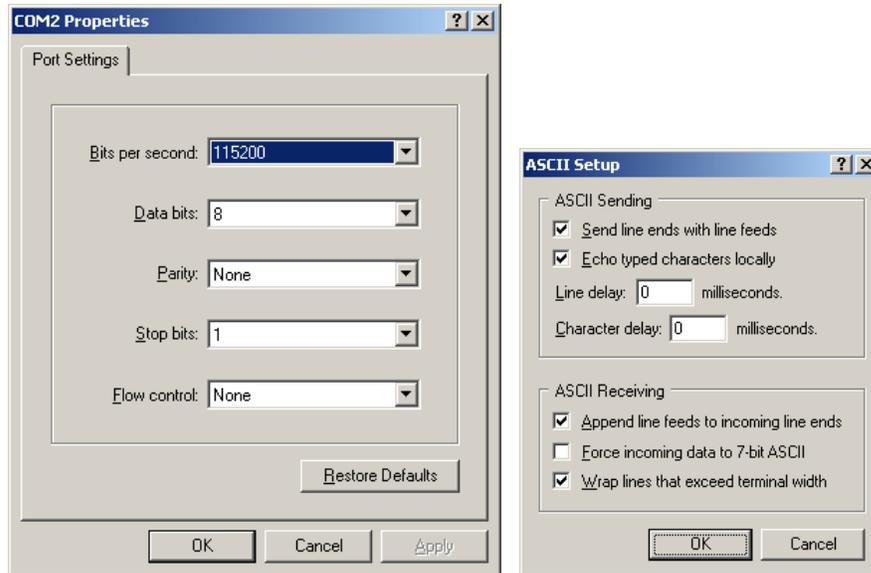


Figure 15: COM-port settings

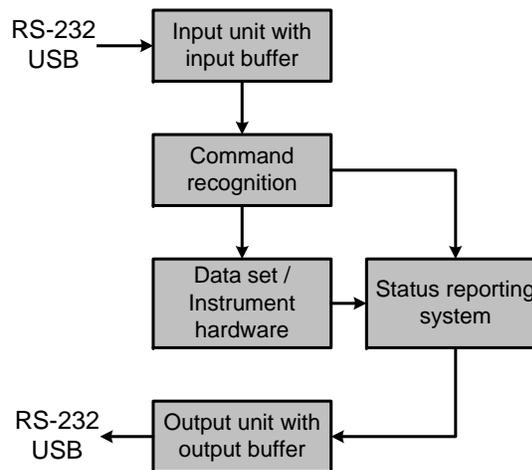


Figure 16: Instrument control and command processing model

- status information is not fully supported;
- not all data formats are supported;
- documentation doesn't meet all the requirements of the standard.

7.2.2 SCPI Summary

Some notes listed below can help the newcomers to start the work with SCPI instrument.

- SCPI-commands are not case sensitive, i.e. commands `*RST` and `*rst` are identical.
- The first part of the command name, which is written in capitals, corresponds to a short form of the command. For example, to set frequency you can write `FREQ`, as well as `FREQuency`.
- Commands placed to the brackets are optional. For example the command `[SOURce:]FREQuency[:CW]` have the same effect when written in following forms `SOURce:FREQuency:CW`, `FREQuency:CW`, `SOURce:FREQuency`, `FREQuency`.
- If command requires the numerical parameter expressed in some units then the default unit exists. For example commands `FREQ 1GHz`, `FREQ 1E9Hz` and `FREQ 1000000000` sets the same frequency value 1 GHz, and the default unit is one Hz.
- Commands ending with a question mark, are the queries and return a response. For example the `*IDN?` command returns an instrument ID. Many commands that set some value, also have a query form to read the current value, e.g. `FREQ?` – returns the current value of frequency.
- Commands that provide input of numerical parameters, can also take the following: `MINimum` – minimum value, `MAXimum` – maximum value, `DEFault` – default value. For example `ATT:FREQ MAX` command sets the maximum frequency (8 GHz), and `ATT:FREQ DEF` sets 1 GHz (default value).
- If the entered command didn't produce the desired effect, it's worth checking the error buffer by means of request `SYSTem:ERRor:[NEXT]?`. If it were not an error, the return value will be the following string `0,'No error'`, otherwise it returns error code and short description.

7.3 SCPI Command List

Figure 17 represents the available command tree (except standard commands). Optional parts of commands are marked with dotted line.

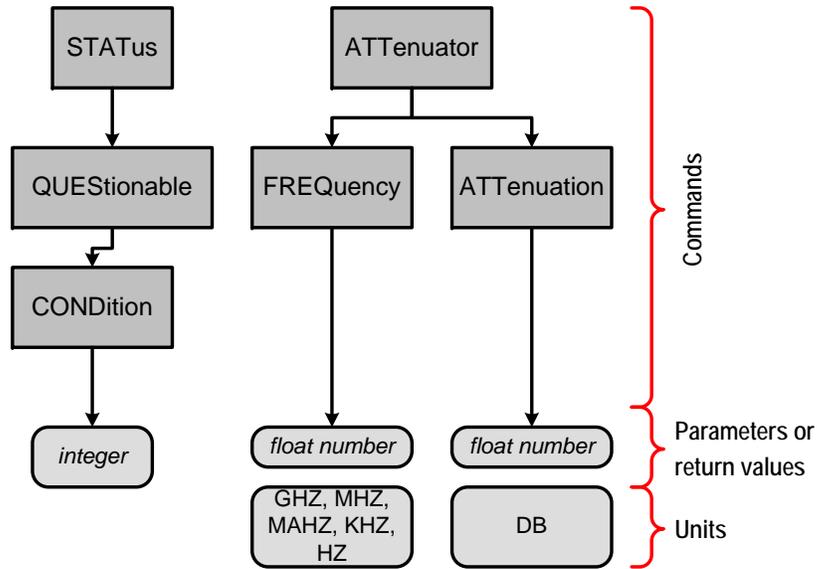


Figure 17: Command structure

7.3.1 *CLS

*CLS command clears error buffer.

7.3.2 *IDN?

This query command returns the string containing the information about the instrument in the following format: *manufacturer,part number,serial number,firmware info*.

7.3.3 *RST

This command presets the instrument (as the Load Default menu command do), in more detail: frequency 1 GHz, attenuation 110 dB.

It's a good practice to start the remote control process with the *RST command.

7.3.4 *OPC?

This query command returns 1 after its completion. It means that all previous commands are completed. It's good practice to use this command instead of fixed time delay between commands.

Examples: If you need to send several commands following immediately one after another, for example to set frequency and level, it's recommended to do it this way:

```
att:freq 100 mhz
*opc?
1
att:att 30db
*opc?
1
```

7.3.5 SYSTem:ERRor[:NEXT]?

This query command returns the string containing the error code and its description from the error buffer. If the buffer is empty then the returned string contains 0, "No error".

Error buffer is organized in form of FIFO (First In First Out). If input command doesn't meet the requirements of parser, or for whatever reason can not be executed, the corresponding message is placed to the error buffer. The buffer can contain 2 messages. There are two ways to clear the buffer: by reading the errors with aid of SYST:ERR? command one by another, or using *CLS command. When the buffer is already full, and one more error message comes, then the last error message will be rewritten by the following -350, "Queue overflow".

7.3.6 ATTenuator:FREQuency

The command sets input signal frequency used in attenuation correction calculations

Parameters: Parameter has the following form
 [+|-]float_num[E[+|-]int_num] [GHZ|MHZ|MAHZ|KHZ|HZ].

The default unit is HZ. Input value is rounded with accuracy of 10^{-4} . If the specified value is out of valid range, then the nearest limit value is applied, error message will not be formed.

Query form of the command returns current frequency in Hz. The result has the following form: [+|-]float_num.

Examples:

```
att:freq 2.1GHZ
attenuator:frequency 21e-1ghz
att:freq max
```

7.3.7 ATTenuator:ATTenuation

The command sets instrument attenuation.



Parameters: Parameter has the following form `[+|-]float_num[E[+|-]int_num] [DB]`. The default unit is DB. Input value is rounded with accuracy of 10^{-2} . If the specified value is out of valid range, then the nearest limit value is applied, error message will not be formed.

Query form of the command returns current *actual calibrated* attenuation in dB. It's recommended to use this command in query form (after each setting operation) to obtain more accurate results. For example you can set 35 dB attenuation, but command in query form may return slightly different value (e.g. 35.1 dB). This returned value is actual attenuation of the instrument (not including external cable loss). The result has the following form: `[+|-]float_num`.

Examples:

```
att:att 5.1db
attenuator:att 1.23
ATT:attenuation 123E-2DBM
att:att MAX
```

7.3.8 STATus:QUEStionable:CONDition?

The command returns current status of the instrument. The result has the following form: `integer_num`. Zero value means that all is OK, "1" in 3-rd bit means that parameters which was set to the instrument is outside of the calibrated area.

Examples:

```
STAT:QUES:COND?
8
```

8 Firmware Update

The instrument comprises a microcontroller (MCU), which controls all RF-blocks, graphical display and handles keyboard and rotary knob events. MCU has two types of nonvolatile memory: Flash that contains program code, and EEPROM which stores all information about the device, including information about current firmware version. Thus the firmware update consists of two files in Intel Hex format, one – for Flash, and the other – for EEPROM. Firmware update is carried out through RS-232 or USB interface, connected to the PC. The connection via USB is implemented with aid of USB to UART bridge, so from the view point of PC software it looks like a COM-port, fig. 18. This method requires driver installation ⁶ (integral circuit CP2102).

⁶The driver (its last version) can be downloaded from CP2102 bridge vendor site [Silicon Labs](http://www.siliconlabs.com)

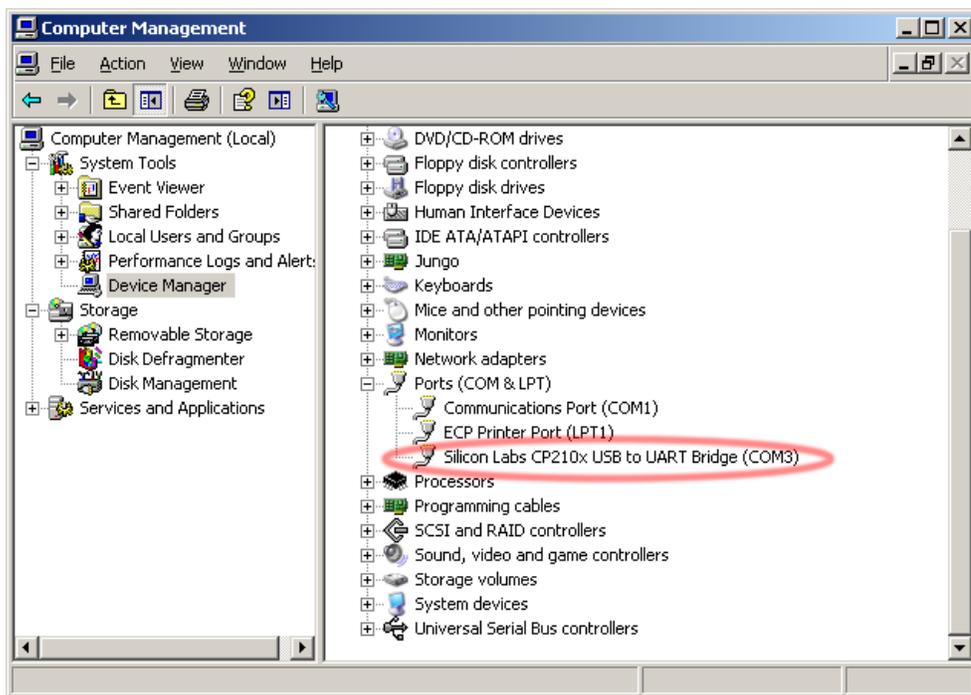


Figure 18: *Device Manager* window (My Computer> Manage)

After driver installation and when the instrument is connected to the PC, the COM-port appears in the hardware list. Its number is indicated at the end of the string (fig. 18).

When powering up the instrument, it enters firmware update mode and waits for the appropriate command from the PC. If it doesn't receive the command within a half of a second, it exits the update mode and no longer responds to the read/write Flash or EEPROM commands, since in regular mode RS-232 and USB interfaces are used for remote control. For the firmware updating the XMI Programmer (XMEGA Instrument Programmer)⁷ application is used, fig. 19. The sequence of actions is the following:

1. Turn off the instrument;
2. Connect it to the PC via RS-232 or USB cable;
3. Launch the XMI Programmer software;
4. Select the port, then press **Connect** button. If you chose the wrong port, then press the **Stop** button, select the right port, then press **Connect**;
5. Turn on the instrument. The connection should be established within a second (you will see the string **Connecting... Ok!**). If it's not happened then probably wrong port was selected. In such a case press the **Stop** button, turn off the instrument, change the port in drop-down list, press **Connect** and then turn on the instrument. The string **Connecting... Ok!** should be displayed;
6. Select the **Write to MCU** radio-box, the **Rewrite All EEPROM Data** flag should remain inactive⁸;
7. Select the files for Flash and EEPROM;
8. Press **Go!** button. The firmware update process takes about 30 seconds and comprises the data integrity check, the results of the operations are displayed in the log window;
9. After successful verifying the written data you may close the application.

You can save the current firmware and EEPROM data by selecting **Read from MCU** radio-button at 6-th step.

9 Disposal

Once a lifetime of the product has ended, it should be disposed of by the local representative of the company specializing in electronic equipment recycling, or you can contact us by email sales@advantex.ru.

⁷XMI Programmer software supports the following OSes: WinXP, Vista, Windows 7.

⁸If you select this flag, then all EEPROM memory will be re written, not only the part, that contains the information about current firmware revision. That is the personal data of the instrument (serial number, operation time, power-on count) will be erased, which is not desirable

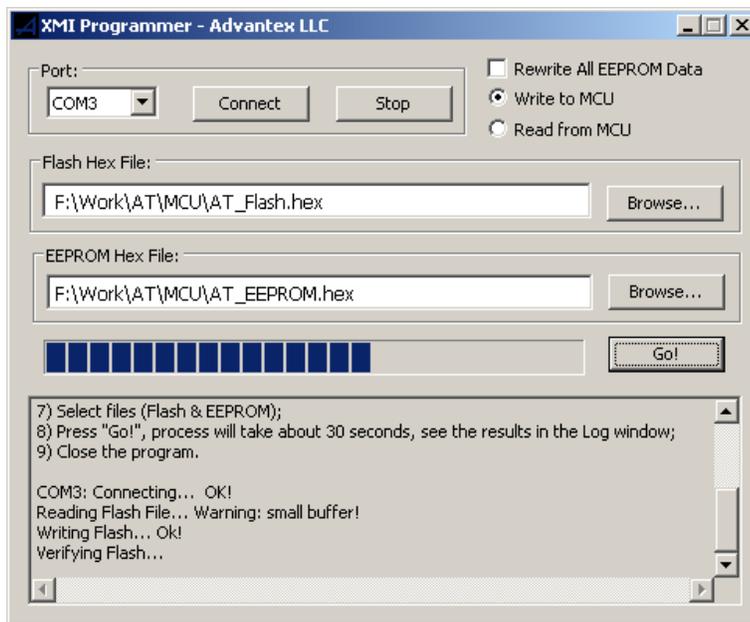


Figure 19: Firmware update application – XMI Programmer