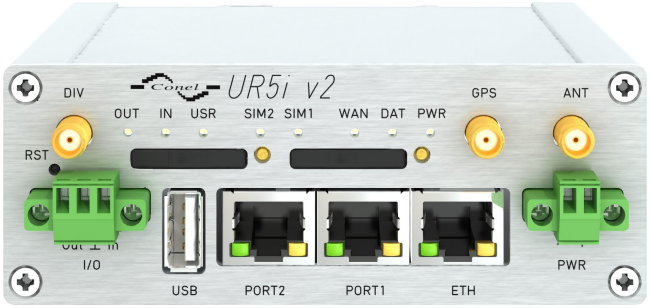
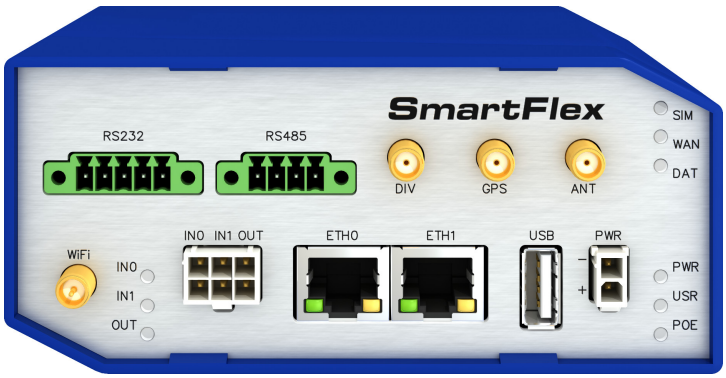
User Module

AT Modem Emulator

APPLICATION NOTE





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Used symbols

Danger – Information regarding user safety or potential damage to the router.

Attention – Problems that may arise in specific situations.

Information or notice – Useful tips or information of special interest.

Example – example of function, command or script.

Advantech B+B SmartWorx s.r.o., Sokolska 71, 562 04 Usti nad Orlici, Czech Republic
Document No. APP-0028-EN, revised on November 22, 2018. Released in the Czech Republic.

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1. User Module Description

User module *AT Modem Emulator* is not a part of the router's firmware. Uploading of the user module is described in the Configuration Manual (see [1, 2]). This user module is v2 and v3 router platform compatible. This user module will only work properly if the serial expansion port RS-232 is installed in the router.

The *AT Modem Emulator* user module to emulate telephone modem behavior. The modem can receive a dial-up request via the serial port and convert it to a TCP/IP connection. A device connected to the Advantech router serial interface sees the router as a HAYES-compatible modem. The device can use the standard AT commands to establish the connection, configure the parameters and terminate the connection. A connection with another *AT Modem Emulator* (in the router) or with any TCP server listening on the proper port can be established. For the *AT Modem Emulator* supported commands and protocol specifications, see Chapter 4.

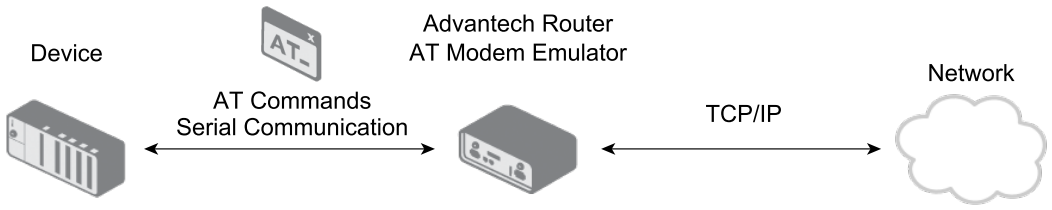

Figure 1: *AT Modem Emulator* in the router enabling the communication

This user module enables the router to connect the parts of the distributed system without adjustments in its software. This is typically for older equipment that is out in the field and still functioning well, but is only equipped with an RS-232 connection, (e.g. water-treatment stations), secured transmission of data between a shop and its remote stock, database update at a remote workplace, etc.

To access the user module Web interface, click the *User Modules* and then *AT Modem Emulator* in the router Web interface. You will see the menu as on the Fig. 2.

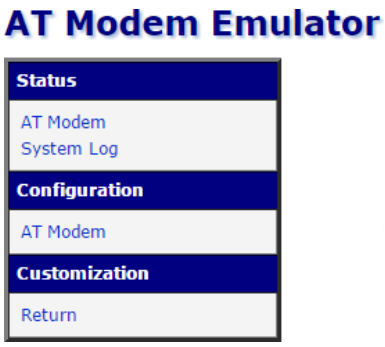

Figure 2: User module menu

- The *Status* section shows the status and the system log (see Chapter 2).
- In the *Configuration* section (chapter 3) you can configure the serial and TCP communication parameters, set the S-registers, choose the action on DTR signal and write a ***Configuration Script*** – this is a feature for substitution rules – e.g. to substitute a telephone number with an IP address (some old devices can not dial an IP address) or to define your own responses to some commands – see Chapter 3.1
- In the *Customization* section you may select the *Return* item to return to the router's Web interface.

2. Status

2.1 AT Modem Emulator Status

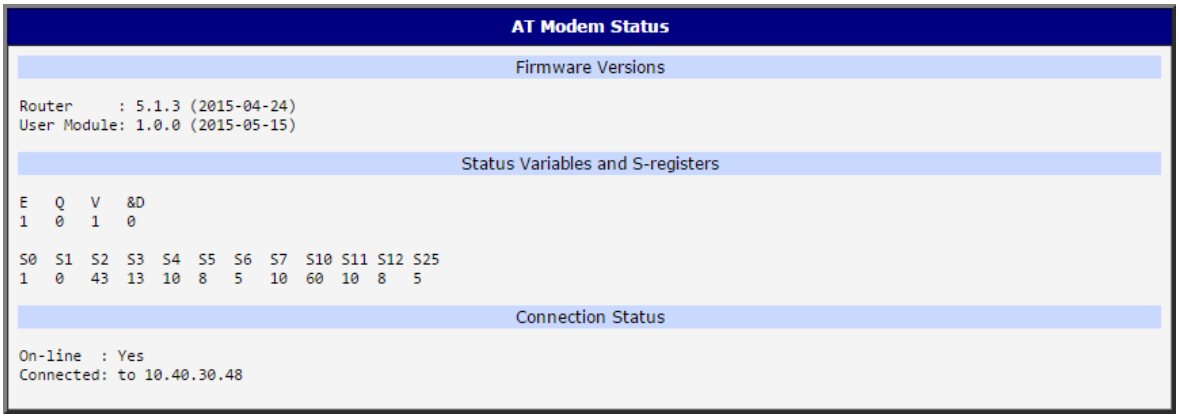

Figure 3: AT Modem Emulator Status

The *Status* page will display this information:

- **Firmware Versions**
  - Router FW version. A connected device can view this via AT command `ATI2`.
  - User module version. A connected device can view this via AT command `ATI3`.
- **Status Variables and S-registers**
  - Status variables E (ECHO), Q (responses), V (responses format), &D (action on DTR signal - can be set in *Configuration*). These can be set from the connected device via AT commands – see the table in Chapter 4 for details.
  - S-registers S0 to S25 defining the behavior of the *AT Modem Emulator* (auto response, characters and time intervals) – some of them can be set in *Configuration*, all of them can be set via AT commands – see the table in Chapter 4.
- **Connection Status**
  - On-line:
    No – *Operating mode* (disconnected), or *Command mode* for AT commands only (off-line for data communication).
    Yes – *On-line mode* for serial data communication.
    See figure 4 for explanation of modes and how to switch them.
  - Connected: *No* for *Operating mode* (disconnected), *IP address* for *On-line mode* and *Command mode* (connected). See Figure 4.

To understand the *AT Modem Emulator* modes, see the figure below. Operating Mode is the initial *AT Modem Emulator* status after enabling it in the *Configuration* section. There are AT commands to switch the modes and *Status* page messages in the figure. For details on AT commands, see Ch. 4.

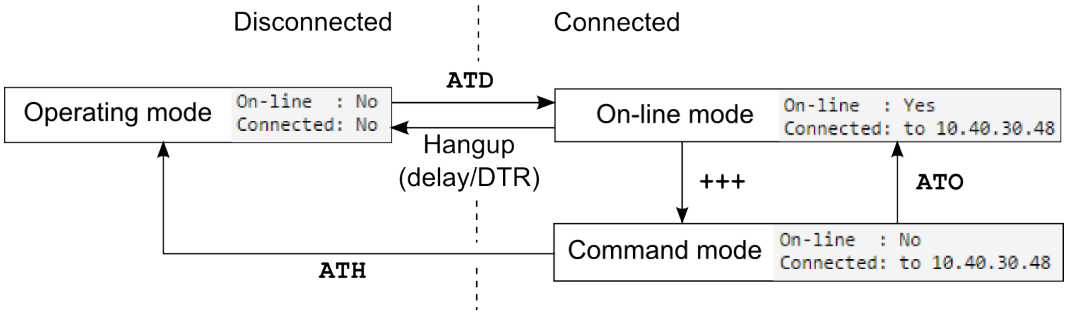

Figure 4: AT commands for switching AT modes

2.2 System Log

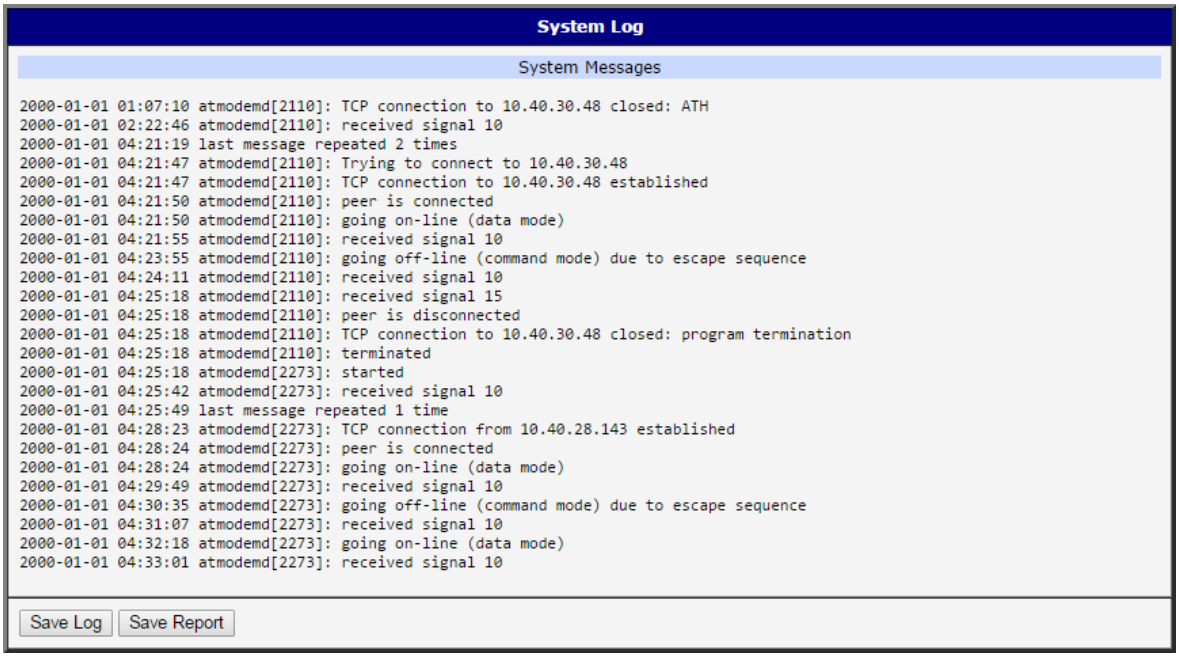

Figure 5: System Log

The *System Log* page displays log messages. It is the same system log as the one in the main menu of the router. User module messages are indicated by `atmodemd` string. You can check out the operation of the user module in the log or view the messages if there are problems with configuration. You can download the messages and save them to your computer as a text file (.log) by clicking the *Save Log* button. You can also download a detailed report (.txt) for communication with support by clicking the *Save Report* button.

3. Configuration

Click the *AT Modem* item in the *Configuration* section to enable and configure the *AT Modem Emulator*. This is the landing page from the router Web interface. Check the ***Enable AT Modem*** box at the top and click the *Apply* button at the bottom. All changes in the configuration will take effect after clicking the *Apply* button. Configuration items are explained in the table below.

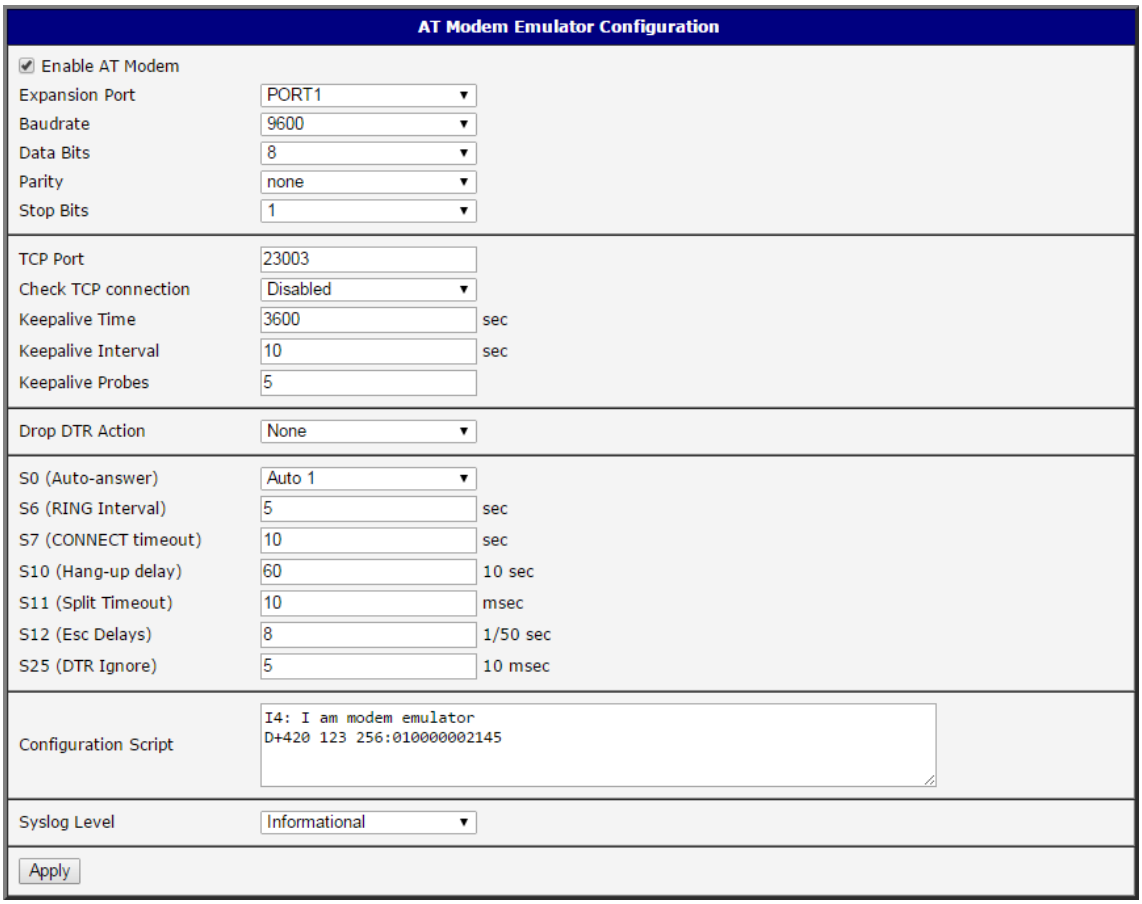

Figure 6: AT Modem Emulator Configuration

Item	Description
Expansion Port	Choose the serial expansion port PORT1 or PORT2 (RS-232) the *AT Modem Emulator* will communicate on.
Baudrate	Serial parameter – communication speed. 300 to 115200.
Data Bits	Serial parameter – number of data bits. 7 or 8.

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Item	Description
Parity	Serial parameter – control parity bit. None, even or odd.
Stop Bits	Serial parameter – number of stop bits. 1 or 2.
TCP Port	Port the TCP side will communicate on. TCP server has to listen on this port or the remote modem emulator has to communicate on this port.
Check TCP connection	Disabled or TCP Keepalive. If TCP Keepalive set, the check of the link will be performed to prevent it from being broken and the following Keepalive parameters will take effect.
Keepalive Time	Interval between the connection tests.
Keepalive Interval	Time to wait for the answer when the other side is not responding.
Keepalive Probes	Number of attempts to test the connection before it is declared to be unavailable.
Drop DTR Action	Choose the action *AT Modem Emulator* will perform when the DTR signal from the connected device (DTE) is lost. None, Off-line (command mode) or Disconnect (hangup). This can be set via AT command `&Dn` (`AT&Dn`), too – see the table in Chap. 4.
S0 (Auto-answer)	Automatic `ATA` answer on the `RING` message. Manual, Auto 1 (after one `RING` – default) to Auto 5 (after 5 `RING`s). See the command table in Chap. 4 for details.
S6 (RING Interval)	Time in sec. between `RING` messages. The default is 5. Range: 2 to 255 sec. See the command table in Chap. 4 for details.
S7 (CONNECT timeout)	Time in sec. to wait for the `CONNECT` response. Default is 10. Range: 1 to 255 s. See the command table in Chap. 4 for details.
S10 (Hang-up delay)	Hangup after this interval in 10 times sec. if there is no communication. Default is 60. 0 means the connection is not automatically canceled. 1 to 255. See the command table in Ch. 4 for details.
S11 (Split Timeout)	Maximum interval between the characters sent as one message. The default is 10 msec. Range. 0 to 255 ms. See the command table in Ch. 4 for details.
S12 (Esc Delays)	Interval in 1/50 sec. (times 20 msec) before and after ESC sequence switching the *AT Modem Emulator* to Command off-line mode. 0 to 255. Default is 8. See the commands in Ch. 4.
S25 (DTR Ignore)	Interval in tens of msec. to ignore DTR signal changes. Drop DTR Action will take effect after this interval if DTR really dropped. 0 to 255, default is 5. See the command table in Chap. 4 for details.
Configuration Script	Substitution rules definitions. See Ch. 3.1 below for more details.

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Item	Description
Syslog Level	Amount of information logged in the System Log. Warning, Notification, Informational, Debugging, Verbose debugging.

Table 1: AT Modem Emulator Configuration

3.1 Configuration Script

The purpose of *Configuration Script* is to change the default response to AT commands received from your application (DTE) connected to the *AT Modem Emulator*. This is to adapt the modem emulator to these applications because they can't be usually modified. E.g. some devices can not dial IP addresses, but you can define the substitution rule here and assign the phone number to the the IP address.

Every line of the *Configuration Script* is one substitution rule or definition.
There are two types of substitution rules:

"I" type substitution rule:

General format:	`Ii:text`
`i`	index - unsigned integer number. 0 to 9 range.
`text`	all characters from behind ":" until the end of line
Example of substitution rule:	`I4:  I am modem emulator`
Terminal input (from user or application):	`ATI4` (+ Enter)
Terminal output (from emulator):	`I am modem emulator` `OK`

"D" type substitution rule:

General format:	`Dpn:IP`
`pn`	phone number in any format, letters are not allowed
`IP`	IP address as a series of 12 digits
Example of substitution rule:	`D+420 123 256:010000002145`
Terminal input (from user or application):	`ATD+420123256` (+ Enter)
Result	*AT Modem Emulator* connecting to IP 10.0.2.145

General notes on substitution rules:

- Substitution rules have priority over standard behavior if in conflict.
  Example 1: *AT Modem Emulator* is programmed to print the user module version as a response to `ATI3` command. But if there is a substitution rule telling `I3: a b c` then entering `ATI3` command will return the `"a b c"` string.
  Example 2: The standard response to the `ATD010000002145` command is trying to connect to the 10.0.2.145 IP address. But if there is a substitution rule `D010000002145:010000002146` the result is trying to connect to the 10.0.2.146 IP address instead.
- There can be any number of white characters (spaces) in the rules. There can be any number of spaces on the AT command input, too.
- Maximum number of substitution rules is 100.

4. AT Modem Emulator Protocol

There is a list of supported AT commands in the table below, followed by an explanation of establishment and termination and general notes on *AT Modem Emulator* protocol usage.

4.1 AT Commands Overview

Note: Some commands are not used by *AT Modem Emulator*, because there is no practical use for them. Although the response may be OK, they will be ignored. This is for compatibility purposes and to allow for the use of standard programs for data (telephone) modems. There are no range limitations for setting the values variables and S-registers via AT commands.

Command	Description	Example
AT	Attention – indicates all commands except for "+++", "A/"; basic part of a command.	
A	Answer incoming call. This is a response to a "RING" call message from the other station.	ATA
A/	Repeat the last command, no <CR> (Enter) needed.	A/
D	Dial a phone number or an IP address (12 numbers). The address of the opposite station follows after the command.	ATD10
E0	Commands are not echoed (ECHO OFF). The modem does not return characters received from the computer.	ATE0
E1	Commands are echoed (ECHO ON) – default. The modem returns characters received from the computer (you can see what you type).	ATE1
H	Hangup - termination of the connection. See Figure 4.	ATH
I2	Returns the firmware version of the router.	ATI2
I3	Returns the version of the *AT Modem Emulator* user module.	ATI3
O	Return to the *On-line* mode when in *Command mode* (Off-line). See Figure 4. The connection is still established.	ATO
Q0	Quiet mode OFF – responses to commands are displayed (returned). E.g. OK or ERROR. This is default.	ATQ0
Q1	Quiet mode ON – responses to commands not displayed (returned) – result codes suppressed.	ATQ1
V0	Verbose OFF – return codes are in the numeric form only.	ATV0
V1	Verbose ON – return codes are in the text English form (e.g. CONNECT, BUSY). This is default.	ATV1

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Command	Description	Example
Sr=n	Set the value to the S-register: r – is the number of S-register being set, n – is the value being set to the S-register.	ATS0=1
Sr?	Return (show) the value of the r-th S-register	ATS10?
Z	Usually performs the reset of the modem before the connection establishment. This does not reset the router *AT Modem Emulator* is running on, but does the reset of the *AT Modem Emulator* user module only (sets the default parameters as a modem would do the same if reset). The response is OK.	ATZ
+++	ESCAPE sequence. Switch from On-line (data) mode to Command mode (off-line) without dropping the line. See Figure 4. Before and after the sequence there has to be a time delay defined in the S12 register. The escape sequence character can be changed in S2 register. Switch back to the On-line data mode using the ATO command.	+++
&Dn	Set the action the *AT Modem Emulator* will perform on the DTR signal drop. n options: 0 – *AT Modem Emulator* ignores the DTR signal. 1 – Go to the Command mode (connection still established). This is the same as the escape sequence. 2 – Hangup (disconnect). 3 – Reset the *AT Modem Emulator* (same as ATZ). The result will be hangup, too.	AT&D1
&V	Display the current values of status variables and S-registers. Same as on the Status page in the Web interface.	AT&V
&W	Save the current setting of status variables and S-registers to the router's configuration file. The saved configuration is used when reset is performed (ATZ) or starting the AT Modem Emulator (router).	AT&W
S0	This S-register defines the nature of the response to a call. The content specifies the number of "RINGs" the *AT Modem Emulator* will automatically establish the connection after. 0 – manual response using ATA command is necessary 1 – automatic connection (Auto Response) after 1st ringing 2 – automatic connection (Auto Response) after 2nd ringing etc.	ATS0=1

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Command	Description	Example
S1	Ring counter – this S-register is incremented every time the "RING" signal is heard on the telephone line. Reasonable range is 0 to 255.	ATS1
S2	Escape character — a special character used to move from the On-line mode to the Command mode (Off-line). See Figure 4. The default value is "+" (43).	ATS2=43
S3	Defines the CARRIAGE RETURN character (return to the line start). The default value is CR (13) (Enter key).	ATS3=13
S4	Setting the LINE FEED character (new line). The default value is LF (10).	ATS4=10
S5	Setting the BACKSPACE character (a character for deleting the characters). The default value is 8 (the Backspace key).	ATS5=8
S6	Setting the time (in seconds) between the repetitions of the RING signal when the other side is calling. The default is 5 seconds.	ATS6=5
S7	Setting the time the *AT Modem Emulator* waits for the CONNECT response. After the interval the modem sends the NO RESPONSE message to the connected device (computer). The default is 10 sec.	ATS7=10
S10	Time in tens of seconds the connection is cancelled after there has been no data communication. 0 means the connection is not automatically cancelled. The default is 60 x 10 sec.	ATS10=60
S11	Maximum time between two subsequent characters in a block of data in milliseconds. The message is closed and transmitted after this interval. Reasonable range is 0 to 255 ms. Default is 10 msec.	ATS11=10
S12	Time delay in 1/50 seconds (20 miliseconds) before and after the Escape sequence of three characters switching the modem to the Command (Off-line) mode. Default is 8 x 20 msec.	ATS12=50
S25	Interval in tens of msec. to ignore DTR signal changes before taking the action. Drop DTR Action (AT&D commands) will take effect after this interval if DTR really dropped. The default is 5 x 10 msec.	ATS25=5

Table 2: AT Commands Overview

4.2 Initial Status and Connection Establishment

After enabling the *AT Modem Emulator* user module (or booting the router with *AT Modem Emulator* enabled), the *AT Modem Emulator* is in the *Operating Mode*, see Figure 4. It receives the commands from the connected device or computer (DTE). The CD signal is reserved and you may configure the parameters via AT Commands or the user module's Web interface.

The typical connection establishment may look like this:

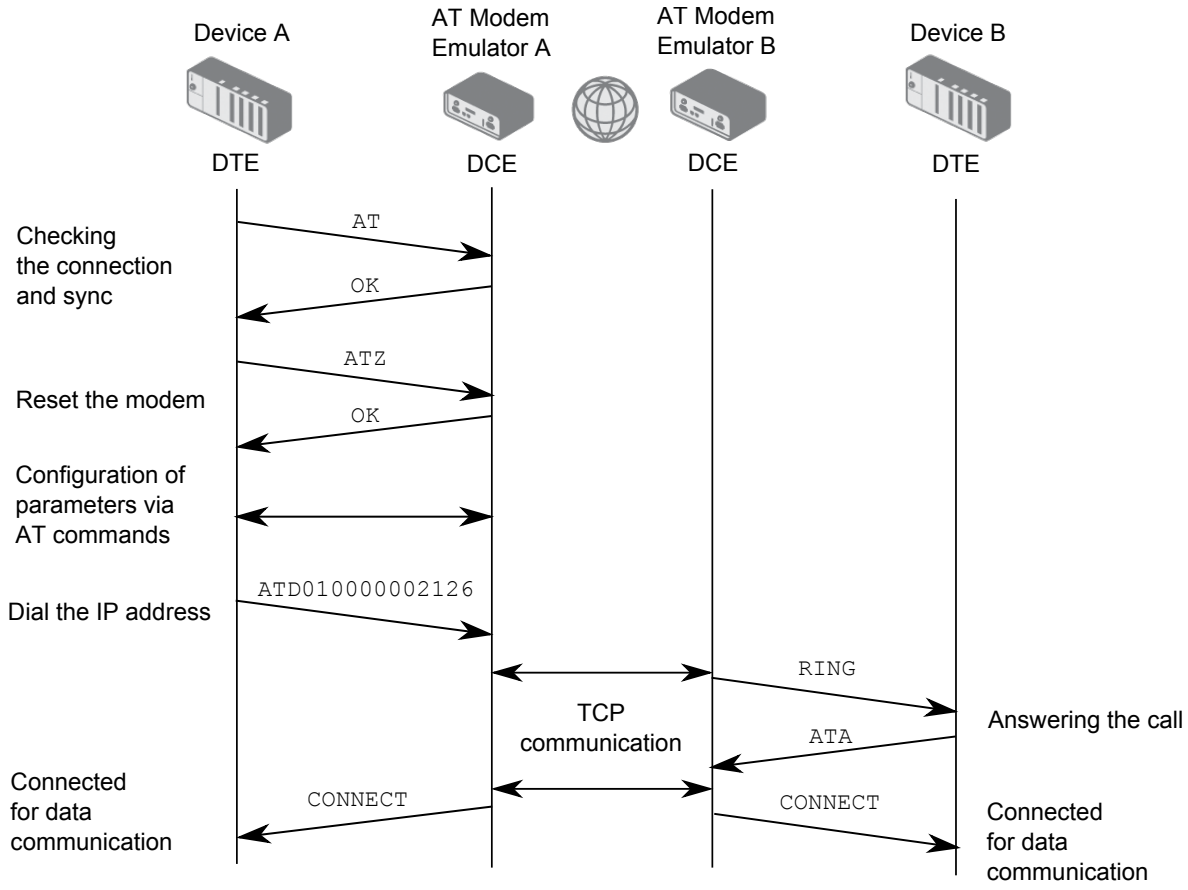

Figure 7: Typical connection establishment

Now the *AT Modem Emulator* is in the *On-line mode*. The CD signal is set to the active status and the data communication is running. If the opposite modem is not ready for communication, the `RING` message is repeated according to the settings in the S1 register. After the interval set in S7 register, it returns the `NO CARRIER` message to the computer. If the opposite modem has already established a connection with another modem, the `BUSY` response is returned. Note that `ATZ` leads to default settings only, not the reboot of the router (just software reset of the *AT Modem Emulator* user module).

4.3 Communication and Modes

See the Figure 4 in Chapter 2 to understand the modes the *AT Modem Emulator* can operate in and how to switch the modes (AT commands in the image or in the table above). When connected (*On-line mode*) it has to be switched to the *Command mode* to perform AT commands while still connected. See +++ command in the table above for the details. The connected application or computer (DTE) can now set the parameters, S-variables, etc. using AT commands in the table above. You can return to the *On-line mode* with the `ATO` command or hangup with the `ATH` command.

4.4 Connection Termination

There are several ways to terminate the connection:

- The standard method to terminate the connection is to switch the *AT modem Emulator* to the *Command mode* using the Escape sequence "+++" and then applying the `ATH` (or `ATH0`) command to hangup. Note that there needs to be a time delay inserted before and after the escape sequence defined in the S12 register. Then a message about the termination of the connection is sent to the opposite modem and the opposite modem sends the "`NO CARRIER`" message to the opposite connected computer.
- Another option is to set the action on the DTR signal drop. See `&D` command in the table above (`AT&D2`). When the DTR signal is lost in the *On-line mode*, the AT Modem Emulator waits the S25 time and then disconnects (hangup).
- When there is no data communication for S10 interval, the AT Modem Emulator disconnects automatically (hangup).

5. Recommended Literature

[1] Advantech B+B SmartWorx: **v2 Routers Configuration Manual** (MAN-0021-EN)
[2] Advantech B+B SmartWorx: **SmartFlex Configuration Manual** (MAN-0023-EN)
[3] Advantech B+B SmartWorx: **SmartMotion Configuration Manual** (MAN-0024-EN)
[4] Advantech B+B SmartWorx: **SmartStart Configuration Manual** (MAN-0022-EN)
[5] Advantech B+B SmartWorx: **ICR-3200 Configuration Manual** (MAN-0042-EN)

Product related documents can be obtained on *Engineering Portal* at https://ep.advantech-bb.cz/ address.