

AT Modem Emulator

APPLICATION NOTE



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1. USER MODULE DESCRIPTION

The AT Modem Emulator user module is not a part of the router's firmware. Uploading the user module to your router is described in the Configuration Manual. The user module is v2 and v3 router platform compatible. This user module will only work properly if the serial expansion port is installed in the router (RS-232 or RS-485/422 serial ports are available).

You may use the AT Modem Emulator user module to emulate telephone modem behavior. The router can receive a dial-up request via the serial port and convert it to a TCP/IP connection. A device connected to the router's serial interface sees the router as a HAYES-compatible modem. The connected 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.

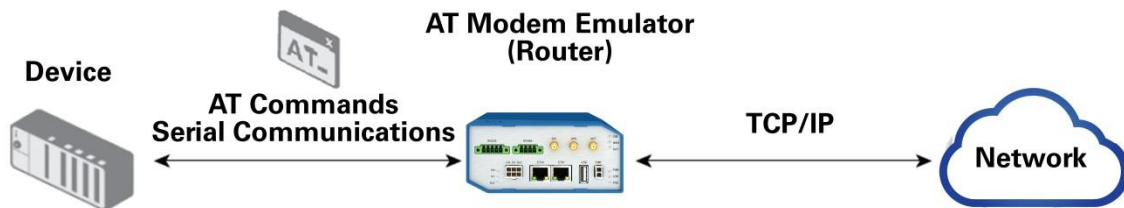


Figure 1. AT Modem Emulator in the router enabling the communication

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, (examples include water-treatment stations), secured transmission of data between a shop and its remote stock, database update at a remote workplace, etc.

AT Modem

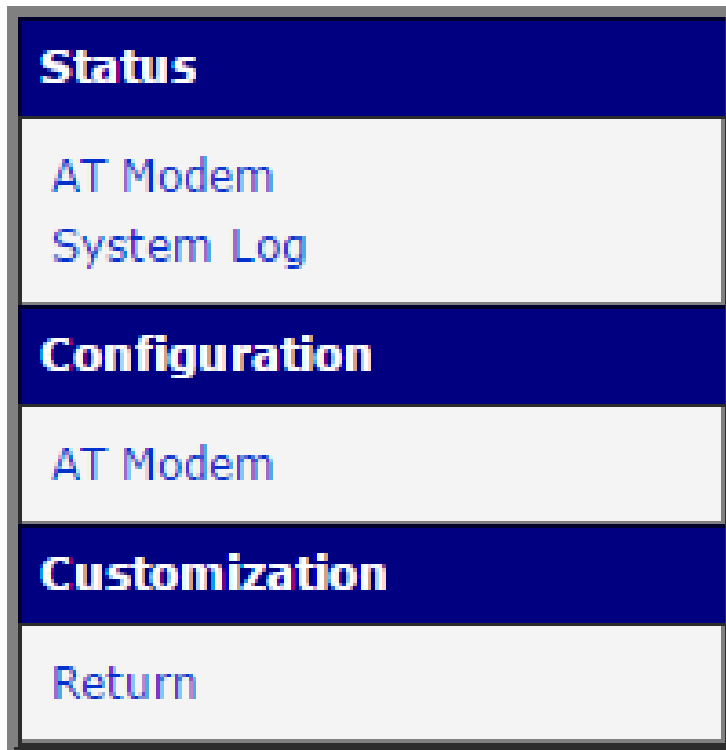


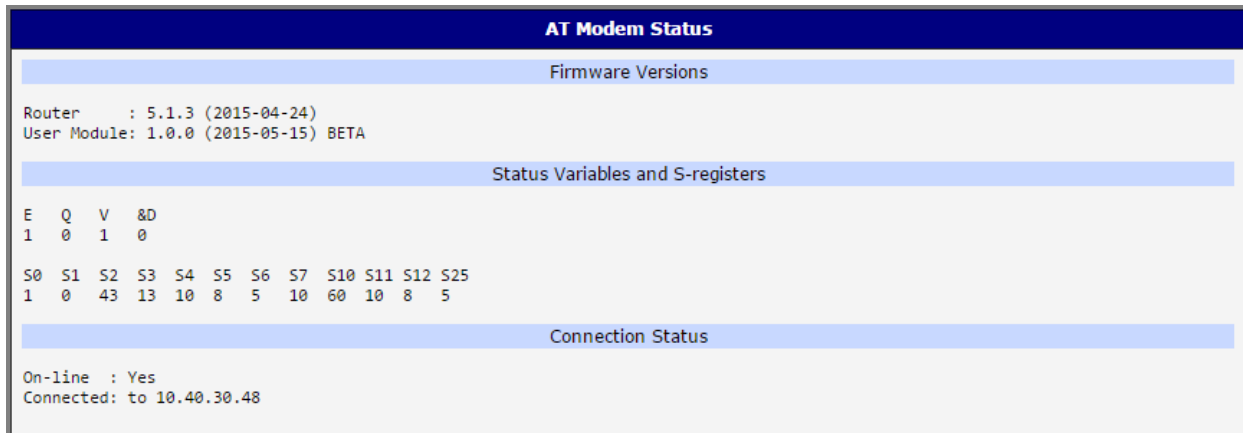
Figure 2. User module menu

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

- 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 – for example, to substitute a telephone number with an IP address (some old devices cannot 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



AT Modem Status												
Firmware Versions												
Router	:	5.1.3 (2015-04-24)										
User Module:	:	1.0.0 (2015-05-15) BETA										
Status Variables and S-registers												
E	Q	V	&D									
1	0	1	0									
S0	S1	S2	S3	S4	S5	S6	S7	S10	S11	S12	S25	
1	0	43	13	10	8	5	10	60	10	8	5	
Connection Status												
On-line	:	Yes										
Connected:	:	to 10.40.30.48										

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 AT12.
- User module version. A connected device can view this via AT command AT13.

- **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.)

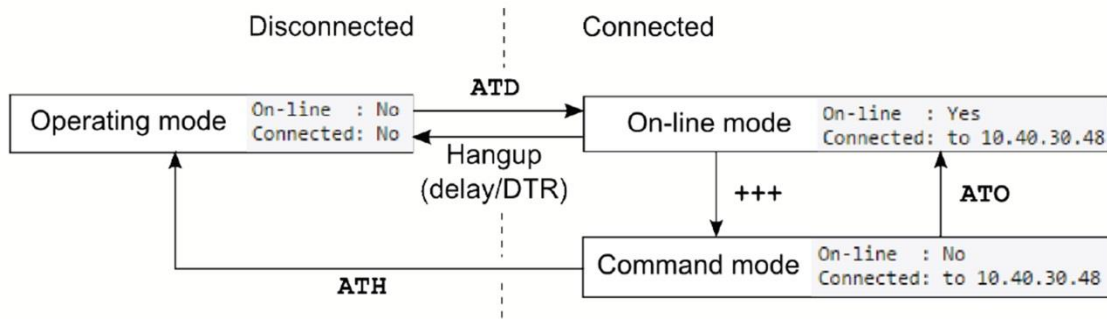


Figure 4. AT commands for switching AT modes

2.2 SYSTEM LOG

```

System Log
System Messages
2000-01-01 01:07:10 atmodemd[2110]: TCP connection to 10.40.30.48 closed: ATH
2000-01-01 02:22:46 atmodemd[2110]: received signal 10
2000-01-01 04:21:19 last message repeated 2 times
2000-01-01 04:21:47 atmodemd[2110]: Trying to connect to 10.40.30.48
2000-01-01 04:21:47 atmodemd[2110]: TCP connection to 10.40.30.48 established
2000-01-01 04:21:50 atmodemd[2110]: peer is connected
2000-01-01 04:21:50 atmodemd[2110]: going on-line (data mode)
2000-01-01 04:21:55 atmodemd[2110]: received signal 10
2000-01-01 04:23:55 atmodemd[2110]: going off-line (command mode) due to escape sequence
2000-01-01 04:24:11 atmodemd[2110]: received signal 10
2000-01-01 04:25:18 atmodemd[2110]: received signal 15
2000-01-01 04:25:18 atmodemd[2110]: peer is disconnected
2000-01-01 04:25:18 atmodemd[2110]: TCP connection to 10.40.30.48 closed: program termination
2000-01-01 04:25:18 atmodemd[2110]: terminated
2000-01-01 04:25:18 atmodemd[2273]: started
2000-01-01 04:25:42 atmodemd[2273]: received signal 10
2000-01-01 04:25:49 last message repeated 1 time
2000-01-01 04:28:23 atmodemd[2273]: TCP connection from 10.40.28.143 established
2000-01-01 04:28:24 atmodemd[2273]: peer is connected
2000-01-01 04:28:24 atmodemd[2273]: going on-line (data mode)
2000-01-01 04:29:49 atmodemd[2273]: received signal 10
2000-01-01 04:30:35 atmodemd[2273]: going off-line (command mode) due to escape sequence
2000-01-01 04:31:07 atmodemd[2273]: received signal 10
2000-01-01 04:32:18 atmodemd[2273]: going on-line (data mode)
2000-01-01 04:33:01 atmodemd[2273]: received signal 10
Save Log Save Report
  
```

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 the *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 Emulator* 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.

AT Modem Configuration	
<input checked="" type="checkbox"/> Enable AT Modem	
Expansion Port	PORT1 ▼
Baudrate	9600 ▼
Data Bits	8 ▼
Parity	none ▼
Stop Bits	1 ▼
TCP Port	23003
Check TCP connection	Disabled ▼
Keepalive Time	3600 sec
Keepalive Interval	10 sec
Keepalive Probes	5
Drop DTR Action	None ▼
S0 (Auto-answer)	Auto 1 ▼
S6 (RING Interval)	5 sec
S7 (CONNECT timeout)	10 sec
S10 (Hang-up delay)	60 10 sec
S11 (Split Timeout)	10 msec
S12 (Esc Delays)	8 1/50 sec
S25 (DTR Ignore)	5 10 msec
Configuration Script	<pre>I4: I am modem emulator D+420 123 256:010000002145</pre>
Syslog Level	Informational ▼
<input type="button" value="Apply"/>	

Figure 6. AT Modem Emulator Configuration

Item	Description
Expansion Port	Choose the serial expansion port PORT1 or PORT2 (RS-232 or RS-485/422) the <i>AT Modem Emulator</i> will communicate on.
Baudrate	Serial parameter – communication speed. 300 to 115200.
Data Bits	Serial parameter – number of data bits. 7 or 8.
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
Check TCP	Disabled or TCP Keepalive. If TCP Keepalive set, the check of
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
Drop DTR Action	Choose the action AT Modem Emulator will perform when the
S0 (Auto-answer)	Automatic ATA answer on the RING message. Manual, Auto 1
S6 (RING Interval)	Time in sec. between RING messages. The default is 5. Range:
S7	Time in sec. to wait for the CONNECT response. Default is 10.
S10 (Hang-up delay)	Hangup after this interval in 10 times sec. if there is no communi-
S11 (Split Timeout)	Maximum interval between the characters sent as one message.
S12 (Esc Delays)	Interval in 1/50 sec. (times 20 msec) before and after ESC se-
S25 (DTR Ignore)	Interval in tens of msec. to ignore DTR signal changes. Drop DTR
Configuration Script	Substitution rules definitions. See Ch. 3.1 below for more details.
Syslog Level	Amount of information logged in the System Log. Warning, Noti-

Table 1. AT Modem Emulator Configuration

3.1 CONFIGURATION SCRIPT

The purpose of the *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. For example, some devices cannot dial IP addresses, but you can define the substitution rule here and assign the phone number to 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:	li: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: The AT Modem Emulator is programmed to print the user module version as a response to the AT+I3 command. But if there is a substitution rule I3: a b c then entering the AT+I3 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 as well.
- The 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.

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 <i>AT Modem Emulator</i> user module.	ATI3
0	Return to the <i>On-line</i> mode when in <i>Command mode</i> (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.	ATV1
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	ATS0=1
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 milliseconds) 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

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:

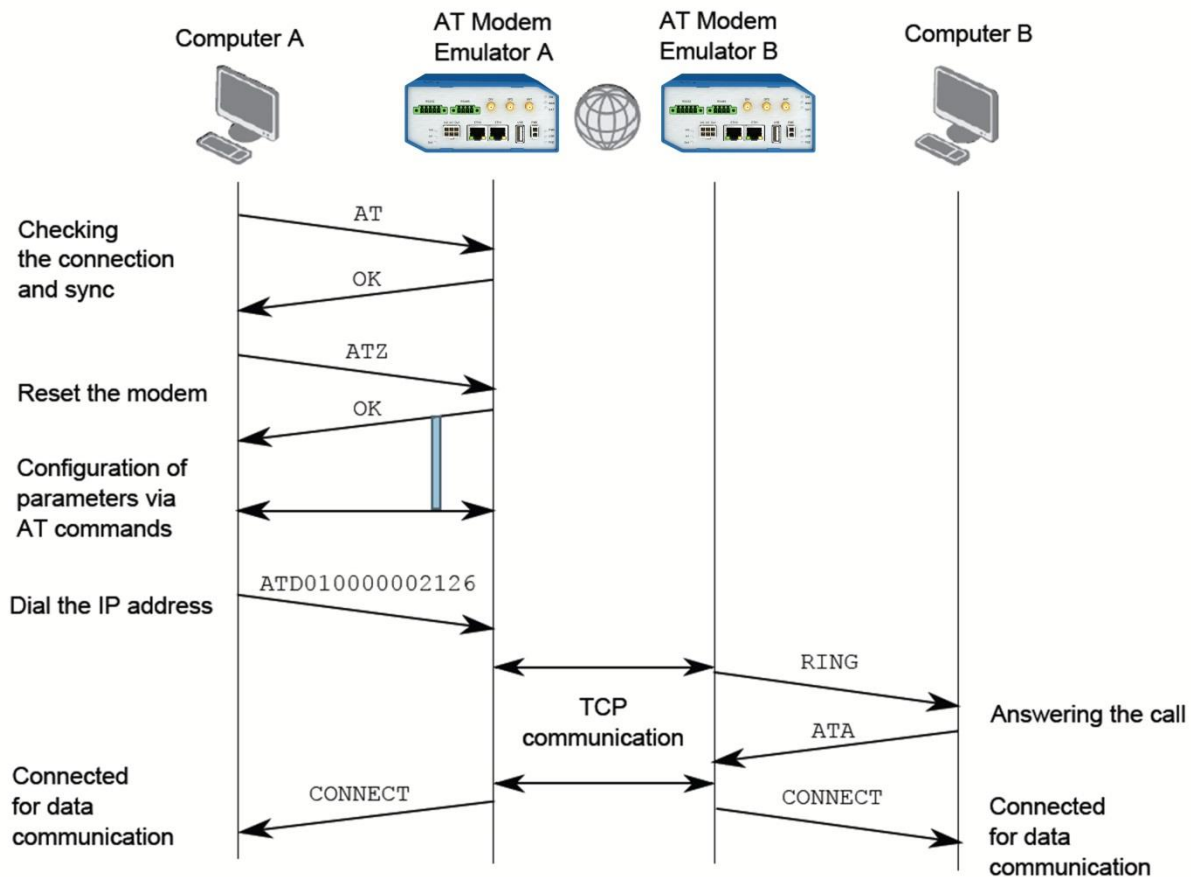


Figure 7. Typical connection establishment

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 the software reset of the AT Modem Emulator user module).

4.3 COMMUNICATION AND MODES

See 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 hang up 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] Configuration Manual for v2 Routers

[2] Configuration Manual for v3 Routers

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