

Client Side Telephony (CST) Chipset Mode

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ABSTRACT

The purpose of this document is to provide information required to test the basic functionality of the C54CST data modem and voice applications in chipset mode. It is recommended that this testing be done on the TMS320C54CST evaluation module (EVM) board for quick verification, but other custom platforms may be used.

A list of required equipment (hardware) will be presented, along with the hardware installation steps. Two software methods of using the client side telephony (CST) chip will be presented: controlling the chipset using a voice and data terminal application (CSTHost), and using a windows Dial-up Networking session to connect to an ISP. Step-by-step instructions will be provided to guide you through the setup required for each of these methods.

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1 Introduction

The purpose of this document is to provide information required to test the basic functionality of the C54CST data modem and voice applications in chipset mode. It is recommended that this testing be done on the TMS320C54CST evaluation module (EVM) board for quick verification, but other custom platforms may be used.

A list of required equipment (hardware) will be presented, along with the hardware installation steps. Two software methods of using the client side telephony (CST) chip will be presented: controlling the chipset using a voice and data terminal application (CSTHost), and using a windows Dial-up Networking session to connect to an ISP. Step-by-step instructions will be provided to guide you through the setup required for each of these methods.

1.1 Abbreviations and Acronyms

A list of abbreviations and acronyms in the document are shown in Table 1.

Table 1. Abbreviations and Acronyms

Name	Description
ADC	Analog-digital converter
ADPCM	Adaptive differential pulse code modulation. A type of waveform coding implemented in G.726 codec.
AGC	Automatic gain control
CID	Caller ID
Chipset Mode	Mode of CST chip operation when it is controlled only externally, via assembly test (AT) commands sent over serial link.
CNG	Comfort noise generator
CPTD	Call progress tone detector
CST	Client side telephony, also means the CST chip solution
DAA	Data access arrangement, hardware interface with telephone line
DAC	Digital-analog converter
DTMF	Dual-tone modulated frequency signal
EVM	TMS320C54CST evaluation module supplied by Spectrum Digital.
Flex Mode	Mode of CST chip operation when it is controlled internally by a user program loaded into internal or external memory of the CST chip.
ISP	Internet service provider
PCM	Pulse code modulation. This term means representation of a waveform by quantized digital signal using linear or logarithmic laws, rather than a modulation technique.
PSTN	Public switched telephone network
UART	Universal asynchronous receiver/transmitter, the chip which allows data exchange over serial link
VAD	Voice activity detector
XDAIS, XDAS	TMS320 DSP algorithm standard (Also known as eXpressDSP).

Notice on DAA part number:

Throughout the document, Silicon Lab's DAA is referred to as Si3016 or Si3044 chip. Here is the explanation of part names:

Si3016 – line-side DAA, directly connected to telephone line. External chip.

Si3021 – DSP-side DAA, connected to line-side only via capacitors. This part is on-chip in C54CST chip.

Si3044 – compound part name, denoting Si3016 and Si3021 together.

Notice on C54CST part number:

The TMS320VC54CST chip is a current version of the chip, having CST bundle V2.0 in ROM, and is also referred to as CST2.

TMX320VC54CST chip is a previous version of the chip, having CST bundle V1.0 in ROM, and is also referred to as CST1.

Throughout the document, the C54CST name refers to both of these chips, unless noted otherwise.

2 Quick Start

There are two main modes of the CST chip operation – Chipset mode and Flex mode.

In Chipset mode, only CST software is running inside the CST chip. It is controlled from outside via serial link by AT commands. In this mode, the CST chip can be used as standard data modem with voice features, including duplex voice transfer (all standard functionality of CST software is accessible via AT commands).

The CST chip does not require any external random-access memory (RAM) or other hardware to run CST tasks. At the same time, it is possible to load additional code to control the CST chip into the internal RAM of the TMS320C54CST, and use CST software in read-only memory (ROM) as a library of XDAIS objects, thus eliminating the need for the host controller.

NOTE: Chipset mode is useful mostly for quick start and verification of chip and EVM operation. **The main and most beneficial mode for CST chip is Flex mode.**

The most generic hardware setup for the CST chip is shown in Figure 1.

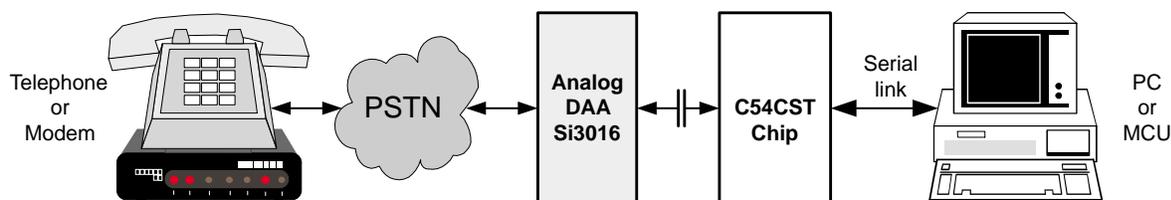


Figure 1. General Hardware Setup of the CST Chip

This document concentrates mostly on usage 54CST chip in chipset mode.

2.1 Required Equipment

The following pieces of equipment are required to correctly setup and test the C54CST chipset:

- Spectrum Digital Incorporated TMS320VC54CST EVM board with 54CST DSP
- Analog Telephone Line
- RJ11 telephone cable with TIP and RING on the inner 2 wires (US version)

- RS232 DB9 female-to-female STRAIGHT THROUGH modem cable
- Personal computer (PC) with the following minimum specifications:
 - Windows 95/98/ME/2000/XP Operation System
 - One (1) free DB9 COM (Serial) Port
 - CST Host Application (Terminal)
 - Microsoft Dial-Up Networking
 - Web Browser
- 5-V Power supply

2.2 Hardware Installation

Follow the steps below to correctly install the hardware components.

1. Connect the RS232 cable between the C54CST EVM board and the DB9 COM port on your PC. Note which COM port you are connecting to on your PC. Typically, this is COM1.
2. Connect the RJ11 telephone cable from your telephone line socket to the RJ11 socket on the C54CST EVM board.
3. Connect the 5-V power supply to the black socket, J3, on the C54CST EVM board.
4. Be sure that the jumper on the C54CST EVM board is set the following way (ON – pins 1 and 2 connected, OFF – pins 2 and 3 connected):

JP1 – OFF	JP2 – OFF
JP3 – OFF	JP4 – ON
JP5 – OFF	JP6 – OFF
5. Power up the board by turning switch SW2 on the C54CST EVM board away from the RS232 connector.
6. Type AT symbols via terminal, connected to EMV's UART to start TMS320C54CST in Chipset mode.

2.3 LED Indication

The C54CST chip uses its input/output (I/O) Port #0 to output indication information about some of the internal events. On Spectrum Digital's EVM this port is connected to 4 light-emitting diodes (LEDs), DS3 through DS6.

The meaning of this indication is described in Table 2:

Table 2. Indication of LEDs' Meaning

Data Bit No. in Port 0	EVM LED No.	CST's LED No.	Meaning
0	DS3	LED0	<p>Not enough MIPS for real-time operation</p> <p>This LED is toggled every time a buffer in the DAA driver or UART driver overflows. Buffer overflow usually happens when some parts of the code consume so many MIPS that the CST framework consumes less data from these buffers than it is supposed to, according to real-time requirements (for example, 8000 samples per second from the DAA).</p>
1	DS4	LED1	<p>Voice buffer underrun</p> <p>Voice controller has a buffer-storing bitstream to be decoded and played out in voice mode. This LED is toggled every time this buffer underruns. This happens when the host does not send the bitstream to be played out fast enough, and this leads to interruptions in the output voice signal and sometimes even to incorrect decoding of further bitstream.</p>
2	DS5	LED2	<p>CTS (clear-to-send) circuit state</p> <p>When the CST's UART driver receive buffer gets filled to 3/4 of its size (capacity), the driver turns OFF CTS circuit, telling the host to wait and not send data. When the buffer frees up to 1/2 of its size, the driver turns CTS circuit back ON.</p>
3	DS6	LED3	<p>DSP in IDLE Mode (power saving)</p> <p>When the power-saving mode is enabled (via ATP command), this LED is turned on when the DSP enters IDLE mode, and is turned off when the DSP leaves IDLE mode. This LED allows you to estimate roughly how loaded the DSP is MIPS-wise: the darker this LED is, the more time the DSP spends processing the eCST's routines, and the less time it spends in IDLE mode. When power-saving mode is disabled, this LED should be off.</p>

If you need to use I/O Port 0 for some other purposes, it is possible to reload the CST peripheral driver in Flex mode.

3 CST Host

To better control the CST chip over serial link, SPIRIT has developed a special PC application – CST Host. It can be used as a terminal in data mode, as a play and record utility in voice mode, and it also simplifies setting the CST chip settings.

3.1 Application Files

Table 3 lists files needed to run CST Host application.

Table 3. List of Files for This Application

File Name	Purpose
CST Host.exe	Main executable
CSTPatch_ROM1.hex	Patch for CST Rom 1.0 (TMX version)
CSTPatch_ROM2.hex	Patch for CST Rom 2.0 (TMS version)
CST_Greeting.wav	Initial greeting file, mono, 8 kHz sampling rate, 14 bit samples
CST_Greeting_PCM.bin	Initial greeting file, G.711 64 kbps/sec
CST_Greeting_A40.bin	Initial greeting file, G.726 40 kbps/sec
CST_Greeting_A32.bin	Initial greeting file, G.726 32 kbps/sec
CST_Greeting_A24.bin	Initial greeting file, G.726 24 kbps/sec
CST_Greeting_A16.bin	Initial greeting file, G.726 16 kbps/sec

3.2 CST Host Settings

The steps below are procedures for starting and setting up the CST voice and data terminal application, CST Host.

Start CST Host by clicking CSTHost.exe. The CST Host screen, shown in Figure 2, will appear. Power up the C54CST EVM board. If you are using the CST1.0 silicon (TMX version), the CST greeting message will only be displayed after downloading the patch code (there is no other simple way to switch CST1 into chipset mode but via loading a patch).

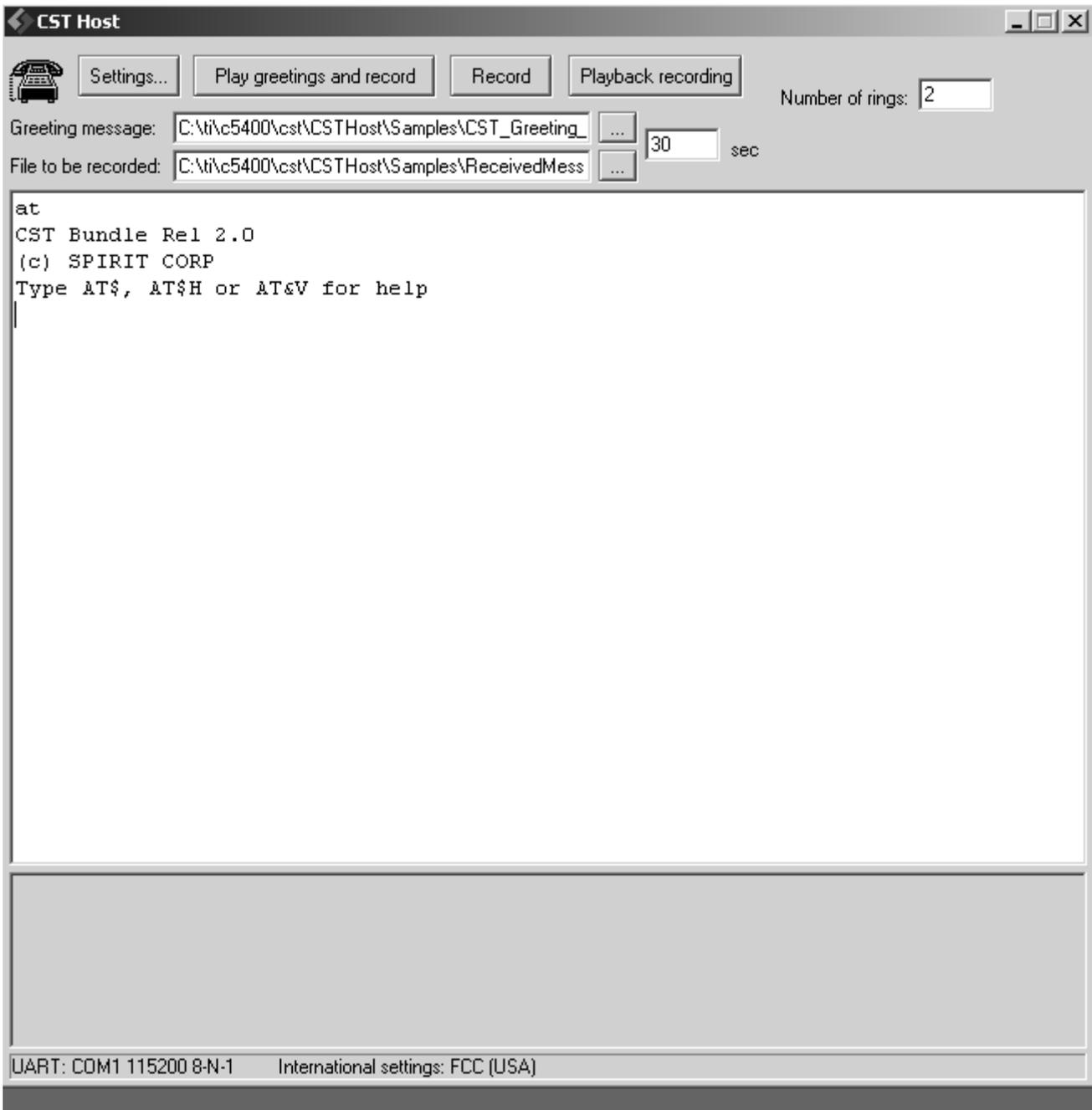


Figure 2. CST Host Terminal Window

The number of rings field in the CST host terminal window contains the amount of rings the CST host should wait before sending an off-hook command to CST chip.

In the CST Host window, click the Settings tab to get the settings window, shown in Figure 3, to change the CST chip and host settings.

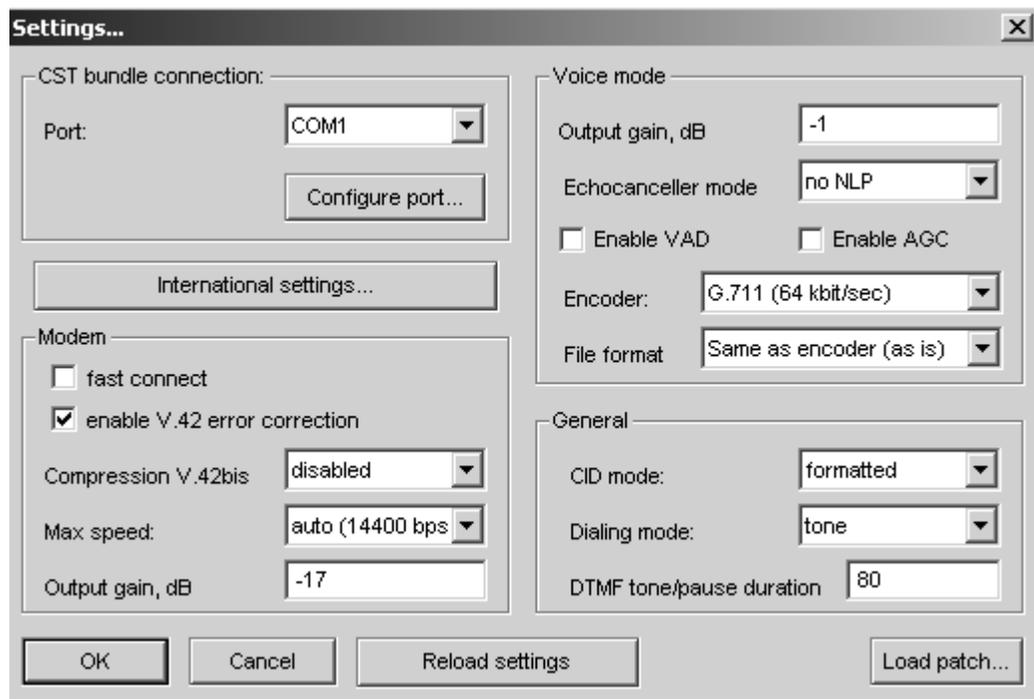


Figure 3. Settings Window

These settings affect the format of the received Caller-ID information, the type of dialing used, and the length of generated DTMF digits, if used. The available options are listed below:

Caller ID (CID)

- Disabled – No CID information displayed.
- Formatted – Decoded CID data formatted before display
- Unformatted – Raw decoded CID data displayed

Dialing mode

- Tone – Dual-tones used for dialing
- Pulse – Line pulses used for dialing

DTMF digit duration

Set the appropriate length for your application.

3.2.1 Voice Mode Settings

These settings affect the CST voice path (encode, decode, echo cancellation) and the storage and playback of compressed voice. The available options are listed below:

Output Gain, dB

Set gain appropriately for your application.

Echocanceller mode

- Disabled – EC disabled
- No NLP – EC enabled without non-linear processing
- NLP Enabled – EC enabled with non-linear processing

Enable VAD

Check this box to enable VAD.

Enable AGC

Check this box to enable AGC.

Encoder

- G.711 – 64 kbps 64-kbit/sec G.711 encode/decode
- G.726 – 40 kbps 40-kbit/sec G.726 encode/decode
- G.726 – 32 kbps 32-kbit/sec G.726 encode/decode
- G.726 – 24 kbps 24-kbit/sec G.726 encode/decode
- G.726 – 16 kbps 16-kbit/sec G.726 encode/decode

File Format

- Same as encoder (as is) Data files contain encoded voice data with DLE stuffing.
- Wave file (16bit, 8kHz mono) Data files contain raw PCM voice data.

3.2.2 **Modem Settings**

These settings affect the data modem speed, protocols, and features. Below are the available options:

Fast connect

Check this box to enable fast connect protocol.

Enable V.42 error correction

Check this box to enable the V.42 error correction protocol.

Compression – V.42bis

- Disabled – V.42bis disabled in both directions
- Transmit Direction – V.42bis enabled only in transmit direction
- Receive Direction – V.42bis enabled only in receive direction
- Both Directions – V.42bis enabled in both directions

Max Speed

- Auto (14400 bps) – Modem will connect at 14400bps or below
- 1200 bps – Modem will connect at 1200 bps or below.
- 2400 bps – Modem will connect at 2400 bps or below.
- 4800 bps – Modem will connect at 4800 bps or below.
- 9600 bps – Modem will connect at 9600 bps or below.
- 12000 bps – Modem will connect at 12000 bps or below.

Output Gain, dB

Set the appropriate gain for your application.

3.2.3 Loading Settings

The changes made above are not automatically transferred to the CST device. After updating the settings, click the “Reload settings” button to download these settings to the CST chip.

3.3 CST Host COM Port Settings

Select the COM port to which you connected the RS232 cable.

Click on “Configure port” to get the COM port properties screen, shown in Figure 4. Set the port for **115200 bps, 8 bits of data, 1 stop bit, no parity, Hardware flow control**, and press OK. Type `AT<ENTER>` to check if the COM was configured correctly, and the EVM can receive and send data over it. If everything is correct, you should see an echo of the command that you entered, and then the OK response:

```
AT
OK
```

The CST chip UART driver has a limited capability of autobaud detection, so if for some reason the port speed was selected other than 115200, you must help the CST chip to synchronize to the new baud rate. To do this, keep typing several continuous AT commands without <Enter> until you see the correct echo.

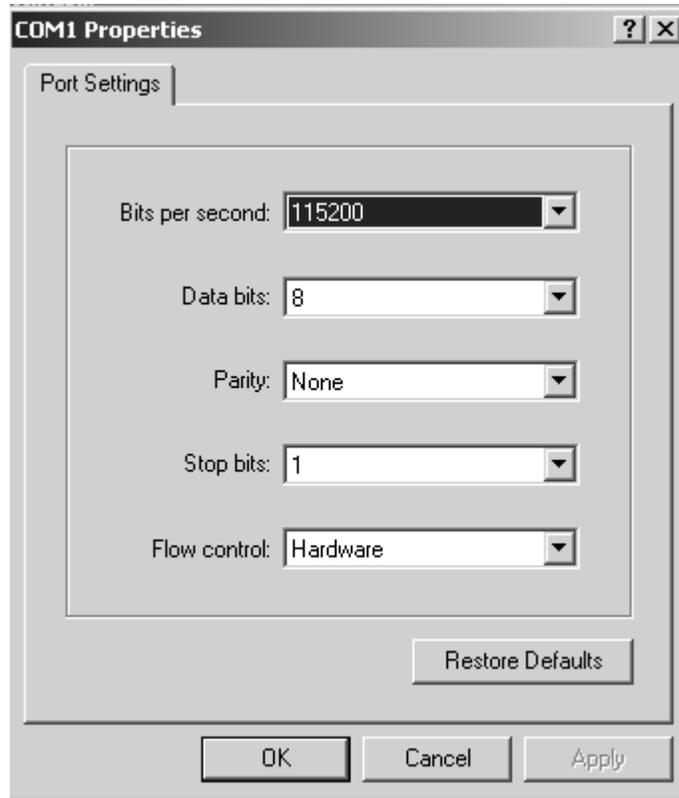


Figure 4. COM Port Settings

3.4 DAA International Settings

It is important to properly tune the telephony interface (DAA) for the standards of your country (see Table 4).

Table 4. Country-Specific DAA Register Settings

AT bit reference:	S-Register 116					117	118
	S116.6 OHS	S116.5 ACT	S116.2,3 DCT[1:0]	S116.1 RZ	S116.0 RT	S117.4 LIM	S118.4 VOL
Country							
Australia	1	1	01	0	0	0	0
Bulgaria	0	0 or 1	10	0	0	0	0
China	0	0	01	0	0	0	0
CTR21	0	0 or 1	11	0	0	1	0
Czech Republic	0	1	10	0	0	0	0
FCC	0	0	10	0	0	0	0
Hungary	0	0	10	0	0	0	0
Japan	0	0	01	0	0	0	0
Malaysia	0	0	01	0	0	0	0
New Zealand	0	1	10	0	0	0	0
Philippines	0	0	01	0	0	0	1
Poland	0	0	10	1	1	0	0
Singapore	0	0	10	0	0	0	0
Slovakia	0	0 or 1	10	0	0	0	0
Slovenia	0	1	10	0	0	0	0
South Africa	1	1	10	1	0	0	0
South Korea	0	0	01	1	0	0	0

NOTES: 1. CTR21 includes the following countries: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and the United Kingdom.

2. This table is copied from [7] with some modifications, © Silicon Laboratories.

Click the “International settings...” button to get the dialog box shown in Figure 5.

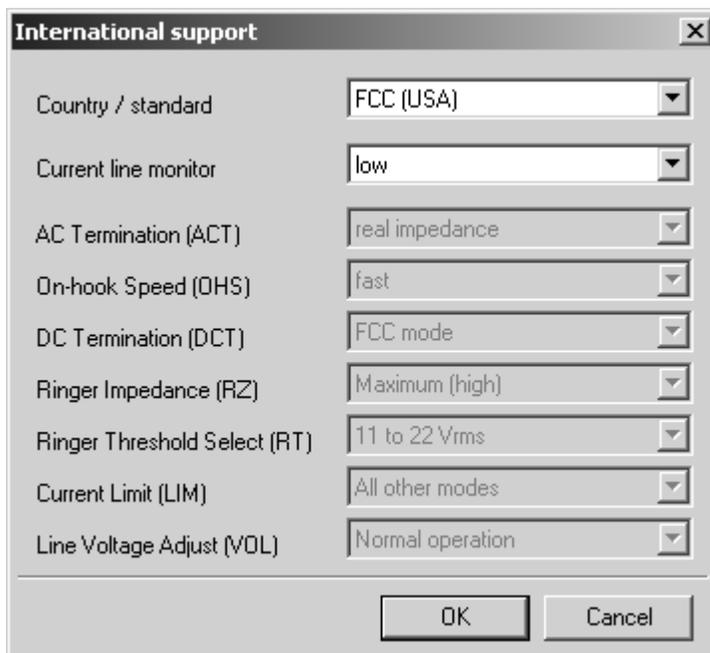


Figure 5. International Settings

In the first field, select the country or standard region you are in. Select “user-defined” if your country or region is not in the pulldown list.

All preset settings for your country/standard will be grayed out, and you need to set only those that are not. For further details, refer to the *Client Side Telephony (CST) Chip Software User’s Guide* (SPRU029).

NOTE: A wrong setting of the “Current line monitor” mode (Low/High) will result in a Caller ID Type I detection failure. Should this occur, simply toggle your initial setting, reload the settings, and retest Caller ID.

3.5 Loading the Patch Code or Flex Application

To upgrade CST silicon (this is mostly needed for data modem functionality on the CST1 chip), it is necessary to download a software patch after power up before running any tests/demos. Below are instructions for loading the patch. If you are only using the voice features of CST, there is no need to upload the patch.

Click on the “Load patch0” button to download the software patch. The dialog box window will appear (see Figure 6). Verify that the correct patch file name is selected and click the “Load” button on this window. The patch will then be loaded to the CST chipset. You should see the LEDs on the C54CST EVM blink for a short while and a CST greeting message displayed on the CST Host terminal window.

NOTE: For the CST2 chip, specifically the CSTPatch_ROM2.HEX file should be loaded. The patch code **MUST** be loaded each time the board/device is powered up.

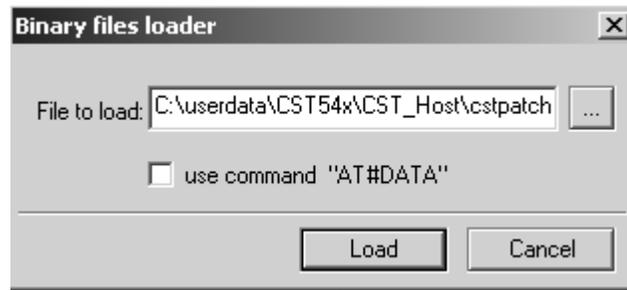


Figure 6. Binary Files Loader

This option can also be used to download CST Flex applications into CST chip via serial link.

The binary format of the file being downloaded is described in the *TMS320VC5407 Technical Reference CST Bootloader*, (SPRA827).

To create a binary file from a Flex application's *.out file, you just need to run hexCST.bat (for non-DSP/BIOS™-based applications) or hexCST_BIOS.bat (for DSP/BIOS based applications).

Both patch loading and flex application loading has to be done when the CST chip is in its initial state after reset.

For the CST2 chip, however, it is also possible to load the patch or flex application when CST has already entered Chipset mode (via an AT command sent to bootloader, for example). In this case, option "**use command AT#DATA**" should be checked.

4 Running Voice and Data Modem Demos Using CST Host

This section provides instructions for running the voice record/playback demos available in CST Host, and using CST Host as a terminal for controlling the CST modem.

4.1 Voice Demos

These demos play and record compressed voice data stored in the files listed in section 3.1. The demos allow you to execute any of the following four applications:

- Detect Caller ID
- Play a greeting and record a new message
- Record a new message
- Playback a recorded message

Important tips for voice demos

- It is highly recommended that you close Code Composer Studio™, and any other applications you may be running, on your PC. This frees up central processing unit (CPU) resources to prevent loss of real-time speech playback and record.
- Whenever possible, use even G.726 compression rates (16-kbps and 32-kbps). This minimizes the chances of losing bit synchronization whenever real time on PC problems arise.

DSP/BIOS is a trademark of Texas Instruments.
Code Composer Studio is a trademark of Texas Instruments.

- Make sure that the path and filename of the “Greeting Message” correctly match the selected compression rate. Please refer to “Package Contents” for list of files and corresponding compression rates. A mismatch of the selected rate and file will result in demos 1, 2, and 3 not starting.
- Should anything go wrong with the demo, simply turn off the power on the C54CST EVM, turn it back on to reset the system, and redo the settings.
- To test Caller ID, ensure that the phone line connected to the C54CST EVM board has Caller-ID service enabled. You can verify this with your local telephone service provider.

NOTE: The patch code loading is mostly needed for using the data modem functionality in CST1.0 silicon. Voice applications do not need the patch download.

4.1.1 Detect Caller ID

Call the telephone line connected to the C54CST EVM from another line. After the first ring, you will see a “RING” message displayed on the main terminal window, and then the Caller-ID information of the line you are calling from will be displayed.

4.1.2 Play a Greeting and Record a New Message

Click the “Play greetings and record” button. A “waiting for ring” message will appear in the lower gray portion of the terminal. The application is now ready to start as soon as the next new incoming ring is detected. If the Caller-ID detection demo has not been run before this, then you need to call the telephone line connected to the C54CST EVM from another line.

The call will be answered after the next new ring (off-hook condition) and a greeting message played out. At the same time, you may record a voice message. You do not need to wait for the greeting message to end. This demonstrates the use of the line echo canceller.

You have 30 seconds to record a message after which the application will playback your recorded message. You will be prompted by a message in the lower gray area of the terminal window when playback terminates. The application will then hang up the phone line (on-hook condition).

4.1.3 Record a New Message

Click the “Record” button. A “waiting for ring” message will appear in the lower gray portion of the terminal. The application is now ready to start as soon as the next new incoming ring is detected. If the Caller-ID detection demo has not been run before this, you need to call the telephone line connected to the C54CST EVM from another line.

The call will be answered after the next new ring (off-hook condition) and recording of your voice message will begin immediately.

You have 30 seconds to record a message. You will be prompted when recording terminates by a message in the lower gray area of the terminal window. The application will then hang up the phone line (on-hook condition).

4.1.4 **Play Back a Recorded Message**

Click the “Playback recording” button. A “waiting for ring” message will appear in the lower gray portion of the terminal. The application is now ready to start as soon as the next new incoming ring is detected. If the Caller-ID detection demo has not been run before this, you need to call the telephone line connected to the C54CST EVM from another line.

The EVM board will answer after the first ring and start playing back the recorded message in the file immediately.

You will be prompted when playback terminates (after 30 seconds) by a message in the lower gray area of the terminal window. The application will then hang up the phone line (on-hook condition).

4.2 **Data Modem Demos**

The main CST Host terminal window can be used as a standard terminal application (e.g., HyperTerminal, ProComm, etc.). To do this, simply click in the terminal window and enter commands. The CST modem will respond appropriately. For details on supported AT commands, refer to the *Client Side Telephony (CST) Chip Software User’s Guide* (SPRU029).

5 **Using the CST Model via Dial-Up Networking**

Dial-up Networking allows a connection to be established with an ISP. Desired networking applications can then be run over this connection. This section will present the steps involved in installing the windows driver for the CST modem, setting up a connection to an ISP, and show how a web browser application can be run over this connection.

CAUTIONS:

For CST1.0 silicon users, the patch code must be loaded each time the board is reset (powered off and on) before starting a dial-up networking session.

Ensure that there is no active CST Host session while trying to set up a dial-up networking session.

5.1 **C54CST Windows Device Driver Installation**

Below are the steps required to install the windows device driver for the C54CST modem. This is required to be able to set up a windows Dial-up Networking session.

1. Open the Control Panel window.
2. Click the Modems icon.

If you already have a modem installed, you will get a screen similar to that shown in Figure 7, showing all modems you have installed. Click the “Add” button to get to the screen shown in Figure 8.

If you don’t have other modems installed, you will get the screen shown in Figure 8 directly.

3. Check the “Don’t detect my modem; I will select from a list” box, and click “Next”.

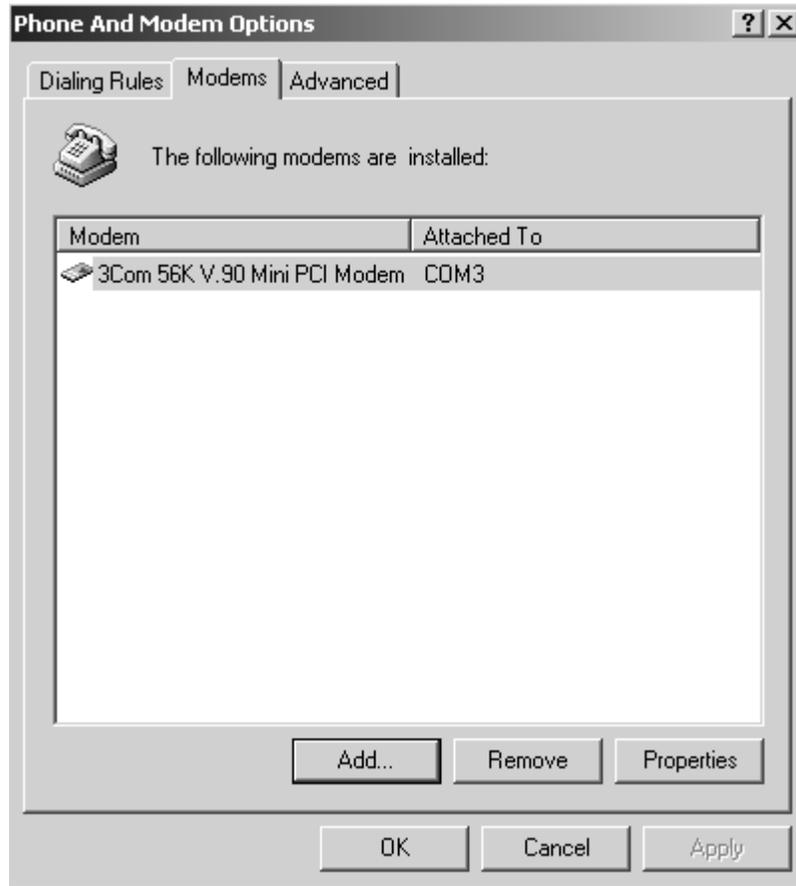


Figure 7. Modem Properties Before CST Installation



Figure 8. Modem Autodetection

The screen in Figure 9 will appear. Select “[Standard Modem Types]” manufacturer, and “Standard 14400 bps modem” model.

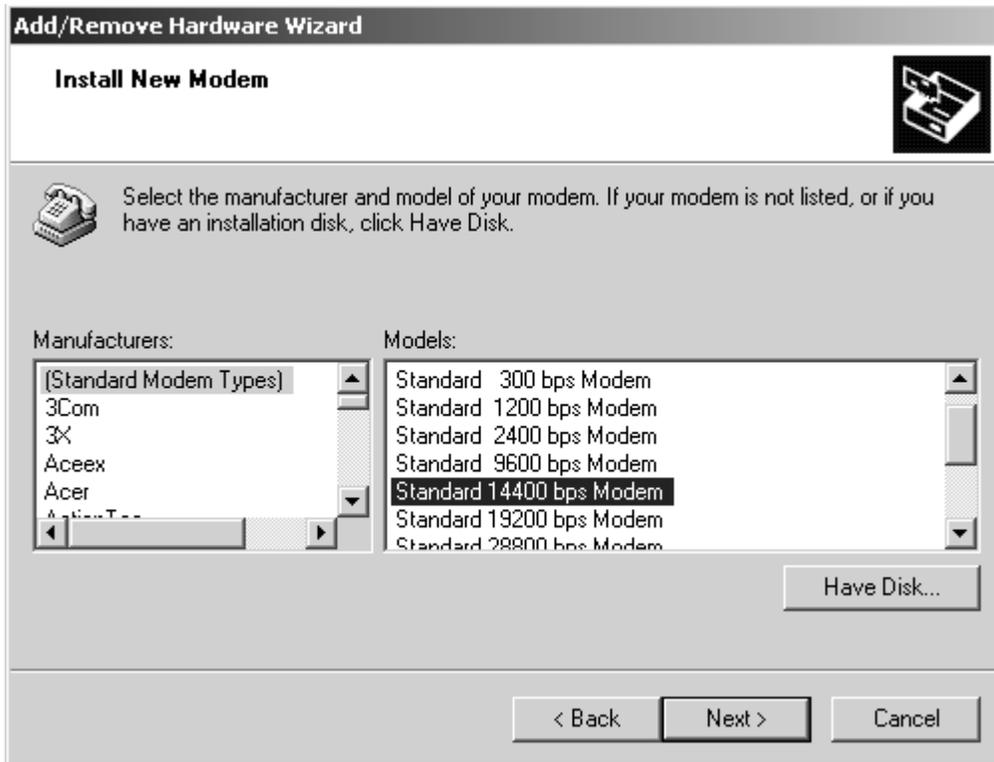


Figure 9. Modem Installation

Click Next to get the screen in Figure 10, and select the port to which the modem is attached. This should be the COM port to which you connected the RS232 cable from the C54CST EVM board. Typically, this is COM1. After selecting the port, click Next.

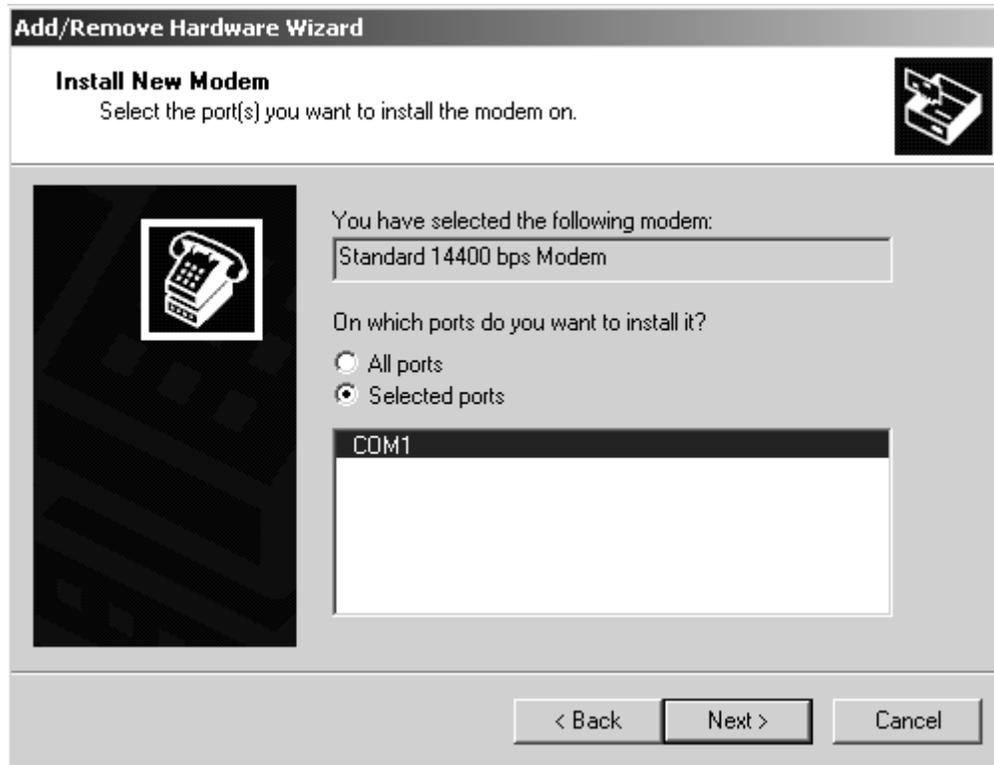


Figure 10. Modem Connection

The screen in Figure 11 will be displayed when the installation is completed. Click Finish to complete the installation.



Figure 11. Completing Modem Installation

The Modem Properties window in Figure 12 will be displayed, showing "Standard 14400 bps Modem" in the list of modems. Your driver installation is now complete. Close this window.

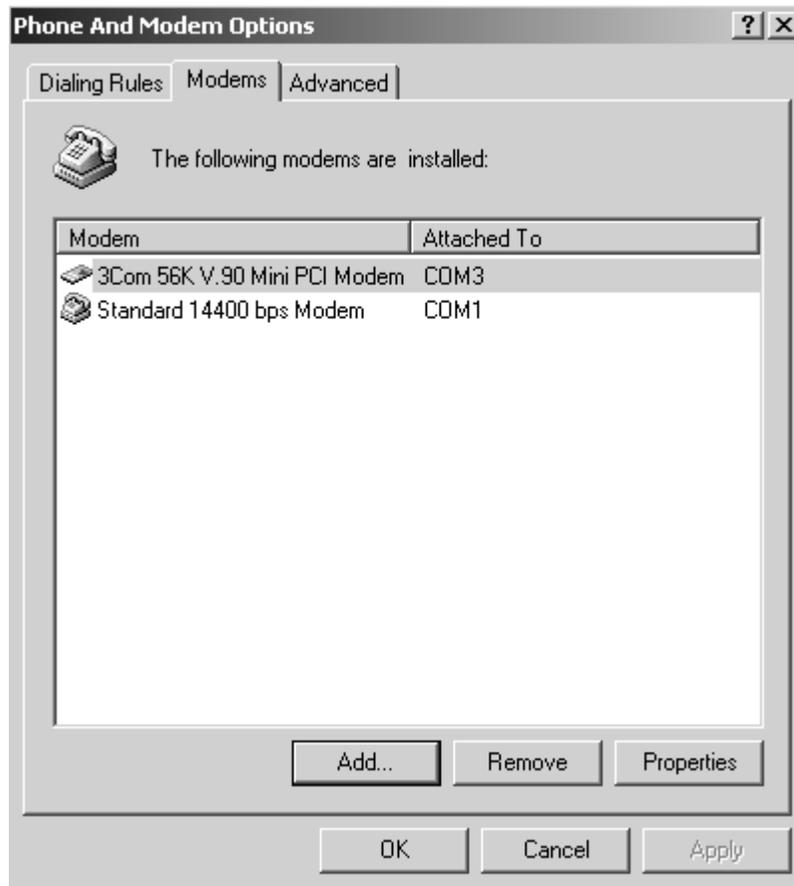


Figure 12. Modem Properties Window

5.2 Setting Up a Dial-Up Networking Session

This section will present the steps involved in setting up a Dial-up Networking session to connect to an ISP.

To start up a dial-up networking session, do the following:

- Click on the My Computer icon on your desktop.
- In the My Computer window, click the “Network and Dial-up Connection” icon.
- In the Network and Dial-up Connection window, click on the “Make New Connection” icon.
- You will get the “Network Connection Wizard” screen shown in Figure 13. Click “Next”.



Figure 13. Network Connection Wizard

Select the "Dial-up private network" option (Figure 14), and click "Next".

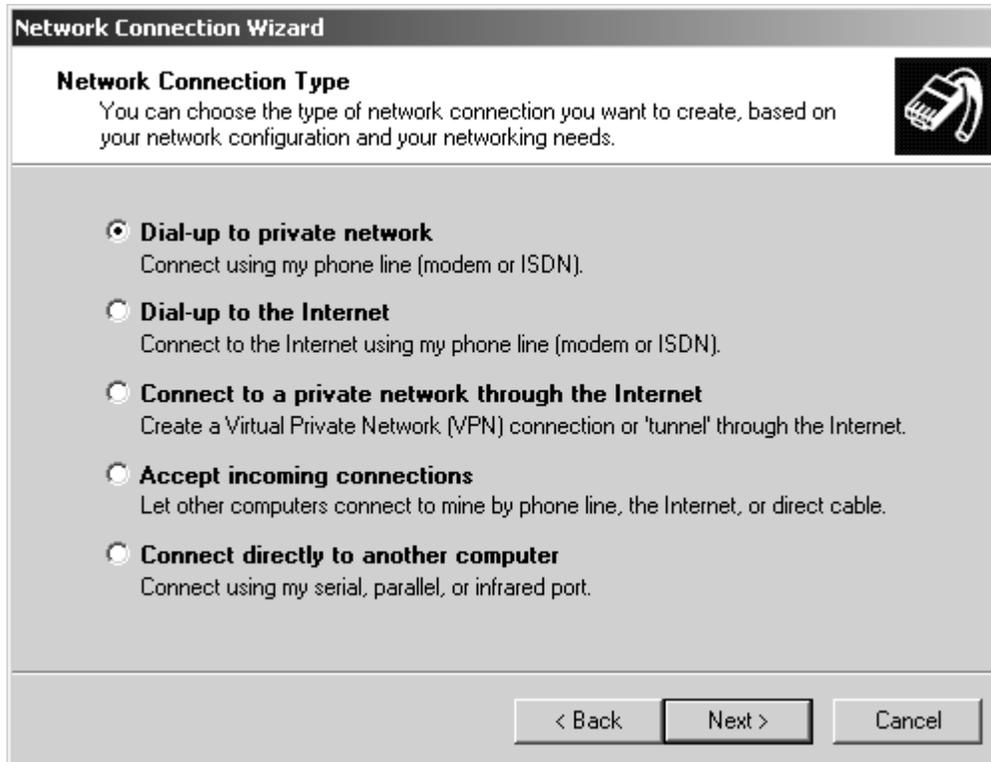


Figure 14. Network Connection Type

You will get a screen similar to that shown in Figure 15. Select the “Modem-Standard 14400 bps Modem”, and click “Next”.



Figure 15. Device Selection

In this screen, select the phone number to dial and the country (Figure 16). Click “Next”.

Network Connection Wizard

Phone Number to Dial
You must specify the phone number of the computer or network you want to connect to.

Type the phone number of the computer or network you are connecting to. If you want your computer to determine automatically how to dial from different locations, check Use dialing rules.

Area code: Phone number:

Country/region code:

Use dialing rules

< Back Next > Cancel

Figure 16. Phone Number Selection

You will get a screen similar to that shown in Figure 17. Select “For all users”. Click “Next”.



Figure 17. Connection Availability

This is the last step of the Network Connection Wizard, shown in Figure 18. Give a name to the connection, and click "Finish".



Figure 18. Connection Setup Completion

In your Dial-up Networking window, there will be a new icon with the name of the connection you just set up. Click on this icon to get the screen shown in Figure 19.

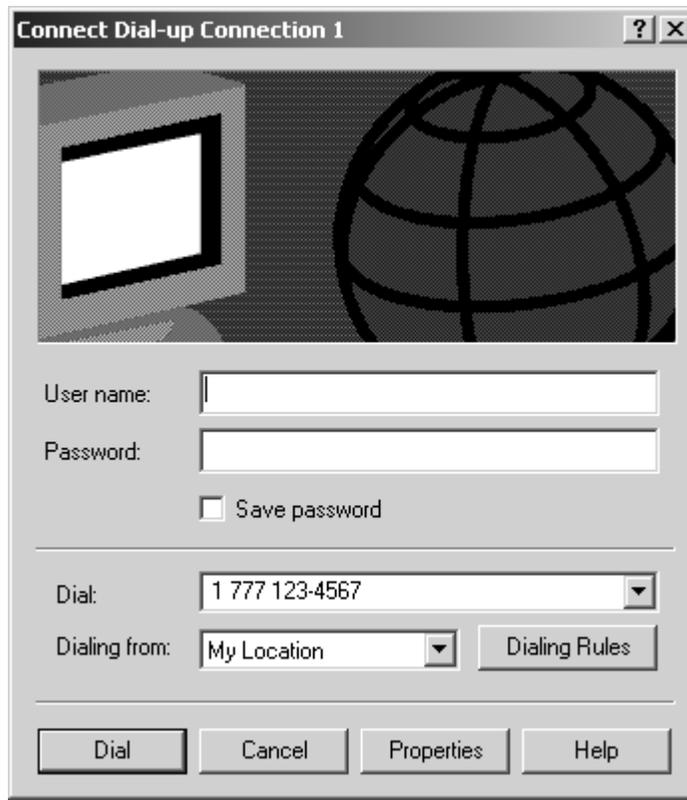


Figure 19. Dial-Up Connection

Enter your username and password. If required, click Dial Properties to modify the dialing properties. Click *connect* when done to make the connection.

The modem will dial the number and attempt to verify your username and password. If the ISP accepts this connection, an icon will be displayed in the right corner of the Windows toolbar at the bottom of your screen.

Start a web browser application to visit some sites.

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