

AUDIO CASSETTE INTERFACE DOCUMENTATION

INTRODUCTION

The Audio Cassette Interface for the Altair Clone duplicates the functionality of the original Altair 88-ACR Audio Cassette Interface. The cassette interface provides the ability to load BASIC and to load and save BASIC programs using a standard audio cassette recorder. The same modulation as the original 88-ACR is used (2400Hz/1850Hz) so that tapes are interchangeable between the Altair Clone's cassette interface and the original 88-ACR.

The Audio Cassette Interface adds a third serial port to the Altair Clone so that both of the original serial ports remain available for other uses. The third serial port is also broken out as an additional DB-25 connector on the rear panel of the Altair Clone. The additional serial port can be used as an 88-SIO or 88-2SIO serial port when not needed for cassette I/O. For example, run three simultaneous users in Timesharing BASIC! The serial port added by the cassette interface is "Port 3" in the Serial Port Menu of the Configuration Monitor.

For connection to a tape recorder, the Audio Cassette Interface provides the same 3.5mm "Tape Record Out" and "Tape Play In" jacks on the rear panel of the Altair Clone as used with the original 88-ACR.

Along with this manual, you may want to reference the original 88-ACR Cassette Interface manual. Hints for loading BASIC are provided towards the end of the manual. The manual is present in the Clone Support Package and is also available for individual download on the AltairClone.com support page under "Original Altair and CP/M Manuals."

CONTENT OF THIS MANUAL

Installation. It is important to read this section even if you purchased the Altair Clone with the cassette interface already installed.

Calibration. This section covers the procedure for determining the ideal output volume level for the cassette recorder you are using.

Creating MITS Distribution Tapes. If you do not already have MITS software on tape (e.g., 4K BASIC, 8K BASIC, etc.), this section provides instructions for creating these tapes.

Loading BASIC from Cassette Tape. Demonstration of how to bootstrap and load 8K BASIC from cassette.

Using CLOAD and CSAVE in BASIC. Loading and saving programs in BASIC using the CLOAD and CSAVE commands.

Using Audio In and Out on a PC instead of a Cassette Recorder. This section provides an overview of how to use the audio input and output jacks on a PC to record and playback tape audio instead of using a cassette recorder.

INSTALLATION

Even if you purchased the Altair Clone with the cassette interface already installed, please open the Clone and check connections as mentioned below.

Follow these steps to remove the cover of the Altair Clone:

- 1) Remove the two screws towards the rear of the case cover that hold the top cover in place.
- 2) Slide the cover straight back about an inch to free the lip from inside the front blue bezel, then lift off the case cover

WARNING: TO AVOID STATIC DAMAGE TO SENSITIVE ELECTRONIC COMPONENTS,
FREQUENTLY TOUCH THE UNPAINTED ALUMINUM FRONT PANEL BRACKET
AS YOU WORK INSIDE THE ALTAIR CLONE!

Checking a Pre-Installed Cassette Interface

If the cassette interface is already installed in your computer, a ribbon cable or four wire harness runs from the cassette interface board in the rear of the Clone to a header on the back of the Altair Clone's main circuit board. The push-on connector from the cable easily pulls off. It may have come loose during shipping. Fully push the connector into place on both the cassette interface board and on the front panel circuit board.

Installing the Cassette Interface Yourself

To assist with installation, you may want to look at photos present on the Altair Clone website at <http://altairclone.com/cassette.htm>.

- 1) Connect the DB-25 ribbon cable to the large header on the cassette interface board. Carefully note the orientation of the ribbon cable socket on the interface board by looking at the center "bump" on the connector and on the circuit board silkscreen.
- 2) Remove the dress nuts from the two phone jacks on the cassette interface board. From the inside of the Clone case, insert the threaded portion of the phone jacks through the two 1/4 inch holes in the Altair Clone rear panel. Secure the board in place by threading the dress nuts back onto the phone jacks from the outside of the Clone case.
- 3) Remove the two stud-nuts from the DB-25 connector and insert the DB-25 connector from the inside of the Clone case through the DB-25 hole directly above the large header on the cassette interface board. Secure the DB-25 connector to the rear panel by re-installing the stud-nuts from the outside of the Clone case.
- 4) Be sure to support the cassette interface board with you free hand while performing this step: Connect the ribbon cable or four wire harness to the header on the cassette interface board and to the corresponding header on the rear of the front panel board. The connector is keyed so that it can only be installed one way. You may want to tie-wrap the cable into the existing tie-wrap bundle to help the connectors stay in place.
- 5) When viewed from the outside rear of the Clone, place the "Tape Play In" sticker under the left phone jack and the "Tape Record Out" sticker under the right phone jack.

CALIBRATION

Unlike the original 88-ACR cassette interface, there is nothing on the cassette interface for the Clone that needs to be calibrated. However, it is important to determine the optimum playback volume level for the tape recorder being used with the cassette interface.

Originally, MITS recommended setting the cassette player to maximum volume for playback. However, customer experience showed that some tape recorders distorted significantly when run at full volume, so MITS later recommended running playback at 1/2 or 2/3 volume. The procedure below writes a test pattern to a cassette, then loads and displays that test pattern while you adjust the cassette recorder volume for the optimum level.

- 1) Use the "Serial Port Menu" in the Configuration Monitor to set Port 3 to be an SIO port running at 300 baud, 8N1.
- 2) Configure your cassette player for recording: Connect the audio cable from the "Tape Record Out" jack on the Altair Clone to the microphone input jack on the cassette recorder.
- 3) Use the "Load .HEX File" option in the Configuration Monitor to load the file "Cassette Interface\GENTEST.HEX" into Altair memory. (You may need to download the file from the "Cassette Interface" directory on the AltairClone.com support page if you have not recently downloaded the Clone Support Package.)
- 4) Start recording on the cassette player. After about five seconds of recording idle tone, reset the Altair and depress RUN to start the program. Let it run for about a minute and then stop recording.
- 5) Use the "Load .HEX File" option in the Configuration Monitor to load the file "Cassette Interface\CASTEST.HEX" into Altair memory. Reset the Altair and depress RUN to start the program. (You may need to download the file from the "Cassette Interface" directory on the AltairClone.com support page if you have not recently downloaded the Clone Support Package.)
- 6) Rewind the cassette to where you started recording the test pattern. Connect the audio cable from the "Tape Play In" jack on the Altair clone to the headphone output jack on the tape recorder. Set volume on the cassette record to minimum and press Play.
- 7) Raise the volume on the cassette recorder until the letter "U" is consistently streaming across the screen. Give yourself some headroom and raise the volume another 25%-50% above this point. Mark this point as the desired playback volume level.

CREATING MITS DISTRIBUTION TAPES

This section describes how to write copies of original MITS software to cassette (e.g., 4K BASIC, 8K BASIC, etc.). A CP/M disk image is available that contains copies of common MITS software. Also on this disk is a utility to write the tape images of MITS software to the cassette.

- 1) Use the "Insert Floppy" option in the "Floppy Disk Menu" of the Configuration Monitor to load the disk image "Cassette Interface\MITS Tapes.dsk" into the Altair Clone. Either load the content directly into drive 0, or use the "Change Drive Assignment" menu option after uploading to assign the floppy to drive 0. Once uploaded, you do not need to repeat this step unless you over-write the floppy with other content. (You may need to download the disk image from the "Cassette Interface" directory on the AltairClone.com support page if you have not recently downloaded the Clone Support Package.)
- 2) Use the "Serial Port" menu in the Configuration Monitor to set Port 3 to be an SIO port running 8N1 at 300 baud. Once configured, you do not need to repeat this step unless you subsequently modify port 3's settings.
- 3) Boot CP/M by examining location 177400 (switches A15-A8 up) and then depressing "Run."
- 4) Configure your cassette player for recording: Connect the audio cable from the "Tape Record Out" jack on the Altair Clone to the microphone input jack on the cassette recorder.
- 5) Type the WRTAPE (Write Tape) command to write the desired tape image file to cassette, but DO NOT PRESS RETURN yet. For example, to write 8K BASIC version 4.0 to tape, type the following command at the A> prompt (do not press return yet):

```
A>WRTAPE 8KBAS40.TAP
```
- 6) Press record on the cassette player. After recording five to ten seconds of idle tone, press RETURN to execute the command in step five. The transfer to tape is at 30 cps, so 4K BASIC takes a little over two minutes to record, 8K BASIC takes about 4-1/2 minutes to record, etc.

Repeat steps 5 and 6 as needed to record other MITS software.

LOADING BASIC FROM CASSETTE TAPE

In this demonstration, we will load 8K BASIC Version 4.0 from cassette tape.

Computer Configuration

Serial port 1 on the Altair Clone (the upper DB-25 connector) should be configured as a 2SIO port at octal I/O address 20/21. This port connects to the operator's terminal. Set the baud rate to match the baud rate of the terminal or terminal emulator you are using.

Data from the cassette interface comes in on serial port 3. This port should be configured as an SIO port at I/O address 6/7, 300 baud, 8N1.

Confirm and change the serial port settings as needed using the "Serial Port Menu" in the Configuration Monitor.

Terminal Emulator Configuration

If you are using the TeraTerm emulator as your console terminal, choose "Setup->Serial Port" and set the "Data" field to 7 bits, the "Parity" field to "Space" and verify the baud rate matches the setting you chose for the console port in the Altair Clone.

To load 8K BASIC, we must first enter a small program via the front panel called a "bootstrap loader." The job of the bootstrap loader is to receive a second loader from the tape called the "checksum loader." The checksum loader is at the beginning of the BASIC tape and is responsible for reading in BASIC from the remainder of the cassette tape.

The code for the bootstrap loader is provided by Altair in the BASIC manual. Different versions of the bootstrap loader are required based on the version of BASIC and the type of interface card being used to load BASIC. For this demonstration, we need the bootstrap loader for the 88-ACR cassette interface and for 8K BASIC Version 4.0. Following is the bootstrap loader code for this combination of BASIC and serial port type:

Addr	Data	Addr	Data	Addr	Data
----	----	----	----	----	----
000	041	010	017	020	300
001	302	011	330	021	351
002	037	012	333	022	003
003	061	013	007	023	000
004	022	014	275		
005	000	015	310		
006	333	016	055		
007	006	017	167		

Follow these steps to enter the bootstrap loader:

- 1) Turn the power switch on.
- 2) Raise and hold the STOP switch in the STOP position, then raise and release the RESET switch. Finally, release the STOP switch. This performs a hard reset on the computer and sets all address lights to zero.
- 3) Put the first data byte in switches 7 through 0, then raise DEPOSIT.
- 4) Put the data for the next address in switches 7 through 0, then depress DEPOSIT NEXT.
- 5) Repeat step 4 until all bytes have been entered.
- 6) Raise and release RESET to force all address lights back to zero.
- 7) Verify the data shown on D7-D0 matches the data byte for the current address. If the value is correct, go to step 9, otherwise go to step 8.

- 8) Put the correct value in switches 7 through 0, then raise DEPOSIT.
- 9) Depress EXAMINE NEXT
- 10) Repeat steps 7 through 9 to validate entry of the entire program.

Once the bootstrap loader is entered and verified, we're almost ready to load BASIC. But first, we must set the run address to zero and then set the front panel sense switches to tell the checksum loader and BASIC the type of serial ports in use for the console device and for the load device:

- 1) Set all address switches to zero.
- 2) Raise EXAMINE to set all address lights (and the 8080's PC) to zero.
- 3) Raise A12 to the up position. A15-A12 now specify a four-bit value of one. This tells the checksum loader and BASIC that you are using a 2SIO serial board with one stop bit as the console interface.
- 4) Raise A9 and A8 to the up position. A11-A8 now specify a four-bit value of three. This tells the checksum loader that you are using the cassette interface to load BASIC.

Now we're finally ready to actually load BASIC!

- 1) Insert the tape containing 8K BASIC in the tape recorder and position the tape to the start of the idle tone. You may want to verify that the tape is positioned correctly by listening for the idle tone with the audio cable unplugged from the cassette recorder.
- 2) With the tape positioned properly and stopped, connect the audio cable from the "Tape Play In" jack on the Altair to the headphone jack on the cassette player. Set the volume on the tape player to the ideal output level determined previously (see the "Calibrate" section).
- 3) Press Play on the tape recorder and then depress RUN on the Altair to run the bootstrap loader. If the bootstrap loader was entered correctly, address lights A10-A9, and A4-A0 should be on.
- 4) After about 15-20 seconds, the bootstrap loader completes the process of loading the checksum loader and the checksum loader takes over. This transition is apparent by a change in the front panel lights (A12-A7 and A6-A0 will be lit). Once the checksum loader is running, it takes about another four minutes to load 8K BASIC from the rest of the tape.

NOTE: If the transition to the checksum loader as described in step 4 does not take place, the load process is NOT going to work. This was a common problem when using the 88-ACR to boot BASIC. To resolve this problem, look in the original Altair 88-ACR manual ("Cassette Interface (88-ACR).pdf") starting on page 68, "88-ACR User Notes." Specifically, note item 2 and the "Bootstrap Leader Detector" on page 69. This additional code was often necessary in order to reliably boot BASIC from cassette tape. The video demonstration, "Loading Altair 8K BASIC from Cassette Tape" on the AltairClone.com website demonstrates loading 8K BASIC from cassette using the leader detector code.

- 5) Turn on "Caps Lock" on the console keyboard.
- 6) In response to the "MEMORY SIZE" prompt, press RETURN to let BASIC determine the amount of RAM present.
- 7) In response to the "TERMINAL WIDTH" prompt, press RETURN.
- 8) In response to the "WANT SIN?" prompt, key in "Y" and press return.

At this point, 8K BASIC is up and running!

USING CLOAD AND CSAVE IN BASIC

In 8K and Extended BASIC, the "CLOAD" and "CSAVE" commands can be used to load and save programs from cassette. CLOAD command cannot be used to load a program in printable (ASCII) format - only programs previously saved with a CSAVE command. Unfortunately, tapes written by 8K BASIC cannot be read by Extended BASIC and vice-versa.

Saving a BASIC Program to Cassette Tape

- 1) Configure your cassette player for recording: Connect the audio cable from the "Tape Record Out" jack on the Altair Clone to the microphone input jack on the cassette recorder. You'll want to use the tape counter on the cassette player to make note of where different programs are stored on the cassette tape.
- 2) Type CSAVE "X" but DO NOT PRESS RETURN yet. The letter in quotes can be any letter to help you identify the program. Think of it as a one character file name. You'll have to provide the proper letter to CLOAD in order to later read in the program.
- 3) Start recording on the cassette player. After about five seconds of recording idle tone, press RETURN to execute the CSAVE command. When the save operation completes, BASIC displays "OK."

Loading a BASIC Program from Cassette Tape

- 1) Position the tape to the start of the program you want to load. You may want to verify that the tape is positioned correctly by listening for the idle tone with the audio cable unplugged from the cassette recorder.
- 2) With the tape positioned properly and stopped, connect the audio cable from the "Tape Play In" jack on the Altair to the headphone jack on the cassette player. Set the volume on the tape player to the ideal output level determined previously (see the "Calibrate" section).
- 3) Type CLOAD "X" where the letter in quotes matches the character used when the program was saved, and then press RETURN.
- 4) Press Play on the tape recorder. When the program finishes loading, "OK" is displayed.

Initial Load of BASIC Programs from a PC

Originally, the only way to get a BASIC program onto tape was to load a program from someone else's tape and then save it to your own tape, or, to type in an entire program from scratch and then save it to tape. However, with a PC running a terminal emulator, you can upload ASCII listings of BASIC programs directly into the Altair and then save the programs to tape.

In TeraTerm, choose the "Setup->Serial Port" menu option and enter "300" in the "msec/line" field. This provides a 0.3 second delay after each line of code to give the Altair time to process the line. (You may have to increase the delay to 500 msec/line to load large programs since the line encoding process gets slower as the program size increases.)

Program files compatible with 8K BASIC are present in the "4K BASIC," "8K BASIC" and the "Games (Creative Comp)" folders inside the "BASIC\BASIC programs" folder. Note, most of the programs in the Games folder will work in 8K BASIC, but not all of them. The 72 character line length limit in 8K BASIC is typically the culprit. Extended BASIC will generally run all of the BASIC programs provided.

Follow these steps to load a program from the PC:

- 1) Type "NEW" followed by RETURN to clear program memory.
- 2) Use the "File->Send File" menu option in TeraTerm to browse to and transmit the BASIC program you want to load.
- 3) The program will display on the screen as BASIC reads it in. The file transmit dialog box will close before the PC actually finishes transmitting the program. This is normal.
- 4) Once the program is loaded, type "RUN" followed by RETURN to execute and try the program. If you want the program on tape, follow the steps above for saving a program to tape using the CSAVE command
- 5) Repeat steps 1-5 to look at and save other programs.

When you are finished, use the TeraTerm "Setup->Serial Port" menu to restore 8N1 and to set the transmit delay back to zero. This helps avoid problems and confusion with the next exercise you may try!

More Information

Be sure to look at the 1977 BASIC manual (Altair Manuals\BASIC Manual 77.pdf) for more information about 8K BASIC, Extended BASIC and using the cassette interface.

USING AUDIO IN AND OUT ON A PC INSTEAD OF A CASSETTE RECORDER

The audio input and output jacks on a PC can generally be used instead of a cassette tape player to record and play cassette audio. Because of the wide variety of sound hardware and versions of windows, no attempt is made here to provide specific details of how to do this, however, the overview provided here should be enough to get you started.

Playing Tapes (Audio Out)

A number of MITS software packages are available as .wav sound files in the file "Cassette Interface\Altair Cassette Audio.zip". You may need to download this file from the Cassette Interface directory on the AltairClone.com support page if you haven't recently downloaded the Clone Support Package.

To play a "cassette" from the PC's audio output, connect the audio cable from the Altair "Tape Play In" jack to the audio output jack on the PC. You may have to adjust volume settings a few times to see what works best. In general, set the volume of the player to maximum, then set the windows master volume control (bottom right corner of the screen) to about half.

Recording Tapes (Audio or Microphone In)

Recording output from the cassette interface on the PC can be a bit tricky. The output of the cassette interface is microphone level, not line level. In the Sound control panel for your computer, look for audio recording settings and the volume control for recording. Look for anything related to "microphone" and "microphone boost." Most likely you'll need to adjust these settings to get a proper recording level. Using a third-party sound editor like "Goldwave" (<http://goldwave.com>) provides more flexibility in recording (though you'll still need to get the control panel record settings right). Using a mono, 8-bit, 22050hz format provides audio quality sufficient for proper operation and it compresses dramatically better than 16-bit formats.