

VLBA ACQUISITION MEMO #203

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Instructions for using Baseband Converter Test Program

Introduction

This program, BBCTEST, is used for testing a Baseband converter in various ways. Included are routines to check the filter passband responses, the single sideband mixer image rejection, the internal attenuators and the operation of the phase locked oscillator.

Also included are a low-level test of monitor/control (M/C) bus operation and a general module monitor and test routine.

Getting started

To run the program it is first necessary to have the program file itself, BBCTEST.EXE. In addition, a general test set up including a synthesized signal generator and a source of properly synchronized 5 MHz and 1 PPS signals. Generally I use a 5 MHz sine wave and an L108 Station Timing module to ensure properly synchronized signals, although something else may work as well. To do an accurate phase check of the BBC, the synthesizer must use the 5 MHz as a reference, so that they also are synchronized.

In addition, of course, the proper signals and voltages must be supplied to the module. An IBM PC/XT/AT/PS2 computer must be connected to the module by a serial link using the RS-422/485 standard. This serial I/O link must operate on the standard DOS COM1 or COM2 port.

To start the program, insert the disk with the program into the computer, and type A:BBCTEST, or if any drive or directory other than the A: drive is used, include the correct path name. The program can of course be copied onto a hard disk and run from that.

After the program loads, you are asked which COM port will be used, 1 or 2. Simply press 1 or 2 depending. The default is 1, so pressing <RETURN> (--<ENTER>) will select COM1. Then you are asked which type of rack the module is plugged into. This depends on the bin that the module is in, or, if the module is in a rack, which position the switch at the bottom is set to. My bin is wired to simulate Rack 2, so that is the default selected by pressing <RETURN>. The "Green Bank" rack is wired differently, and is generally only selected for testing a rack, not an individual module.

After selecting a rack, you are presented with a menu such as the following:

These are the available units:

Slot 0 is	NOT CONNECTED
Slot 1 is	NOT CONNECTED
Slot 2 is	NOT CONNECTED
Slot 3 is	NOT CONNECTED
Slot 4 is	NOT CONNECTED
Slot 5 is	NOT CONNECTED
Slot 6 is	NOT CONNECTED
Slot 7 is	connected

QUIT -- press Q

Enter Slot number: 7

This menu tells which module(s) is/are active and responding ("connected") to the M/C bus. In a test fixture there would normally be only one connected. My test bin is hooked up so that the module indicates being in Slot 7, and that is the default selected by hitting <RETURN>. As usual, if your test fixture is wired differently, select the correct slot.

If no Slot indicates connected then the module is not responding. There are a myriad possible reasons including:

1. Module not powered up -- check power supply and connections.
2. M/C bus not connected properly -- can be checked with scope.
3. Incorrect COM port or Rack number selected before.
4. Something wrong with the serial card in the computer.
5. Module has problem with digital board -- big trouble.

In any case this problem must be solved before performing most of the tests. One possible help is that the computer continuously polls the module when in the above menu, so that the bus is continuously active. This can be helpful when checking with a scope.

When the problem is corrected, enter the correct slot number to get to the main menu. There will be a pause, while the program checks the baseline power reading from the internal power detectors.

Main Menu

The main menu looks like this:

These are the options:

Re-Connect to module -- press R
Initial Test -- press I
Loop Test -- press H
New BW & Comp Codes -- press N

Filter Sweep -- press F
Mixer Rej. Test -- press M
Attenuator Test -- press A
PLL test -- press P

QUIT -- press Q

Select one:

The block of four selections at the top are utilities and non-automated tests. Selecting "Re-Connect to module" will cause the program to try to reconnect to the same module. This might be useful if the power went off or whatever, although I almost never use it. Selecting any of the other modes will also try to reconnect, and selecting the "Initial Test" will actually indicate what the connect status of the module is.

Initial Test

The Initial Test has this menu:

BOARD CONDITION: Connected

Frequency: 650.00
Bandwidth: 16 MHz
Comp (USB): 6
Comp (LSB): 6
Mode: 0
IF Input: A

Serial Num: 20
uP Status: 0111 UNLOCKED
Gain (USB): -3.059 dB Code: 2D Press "+" to increment code
Gain (LSB): -3.059 dB Code: 2D Press "-" to decrement code
USB Power: -13.397 dBm
LSB Power: -18.020 dBm

Reinitialize -- Press R

QUIT -- press Q

1. BOARD CONDITION: Will indicate Connected if the module is responding to commands, or Unconnected if not.
2. Frequency: Displays current LO synthesizer frequency. If 'F' is pressed, the program asks you to enter a new synthesizer frequency. The frequency can also be changed by using the 7/1, the 8/2, and the 9/3 cursor key pairs. The 7/1 pair changes the frequency in MHz steps, 8/2 changes it in 100 kHz steps and 9/3 in 10 kHz steps. The 7, 8, and 9 keys increase the frequency, and 1, 2, and 3 decrease.
3. Comp: Displays current compensation gain, in dB. Pressing 'C' will bring up a small menu to select whether to change USB, LSB or both. After selecting one of these, the new compensation gain can be entered.
4. Mode: Displays the mode. A '0' indicates the manual AGC mode where the AGC gain (see below) is constant. A '1' indicates the auto mode where the module adjusts the AGC to keep a constant power output of approximately 0 dBm from the module. This can be changed by pressing 'M'. There are other mode number, see the manual for more information. Normally these are controlled by the program and are not used directly for testing.
5. IF Input: Displays the current selected input. Pressing 'I' allows this to be changed to B, C, or D input.
6. Serial Number: Displays the serial number of the module. This should agree with that on the front panel.
7. uP Status: Displays the most significant four bits of the status/serial number word. The first bit indicates LO synthesizer lock status, which is also written out next to the four bits. The next is the radiometry cycle bit, which should contain an 80 Hz signal. This will blink randomly depending on its state when the program polls it. The last two bits are the processor status. Only the last is assigned, to check the 80 Hz timing. If the 1 PPS signal is absent, or not synchronized with the 80 Hz it will be 0. Under normal operating conditions it is a 1.

8. Gain: Displays the AGC gain for USB and LSB. Pressing 'G' will call up the USB/LSB/Both menu as for setting the Comp. After selecting which to change, you are asked for the new gain. Any time the AGC Gain is changed, there is a delay, since it must be changed step by step. The gain can also be stepped up or down by pressing '+' or '-' respectively. This affects both upper and lower sidebands.
9. Power: Displays the current power measured by the internal detectors. The maximum measurable power is 6 dBm. The actual reading has the zero reading of the detector subtracted off, so the maximum displayed reading may be a few hundredths of a dB lower than 6 dBm. The zero reading is measured at the start of the program, and at various other times.
10. Reinitialize: Pressing 'R' causes the program to set all the settings except the AGC to the default settings, which are the same as used on startup.
11. QUIT: Gets out of the Initial test mode and back to the main menu.

Other Utilities

The other utilities are the Loop test and the routine to change the bandwidth and compensation gain codes. The loop test allow continuous monitoring of the raw data coming back from any of the monitor points in the module. Additionally, it is possible to command these. The data are displayed and entered as raw hexadecimal values. After selecting 'L', you are presented with a list of the various Command and Monitor functions. Select them one by one as needed. As each is selected, you are asked whether a command should be sent, a monitor requested or both. If command or both is chosen, you are prompted for the command value.

After the last selection is made, press <ENTER> to indicate it to the program, and the looping starts. A table is shown of the monitor values requested. This is continuously updated until a key is pressed, halting the looping. You are then asked whether to resume looping. If 'Y' is answered, the program loops as before. An 'N' gets you back to the main Menu.

The last utility allows you to change the codes for compensation and bandwidth. Pressing 'N' results in this menu:

Select action:

Change Compensation codes	-- press C
Change Bandwidth codes	-- press B
Save new codes	-- press S
QUIT	-- press Q

Enter selection:

Selecting either of the first two choices will display a table of the current values of compensation or bandwidth codes. Select a number to choose which to change, or <ENTER> if no changes are desired. After all changes have been made, press <ENTER> to return to the code change menu as shown above. Pressing 'S' will save the codes to a file called CODES.DAT in the current directory. If this file is in the current directory when the program is run next, the same values will be loaded and used.

Pressing 'Q' gets you back to the main menu.

Filter Sweep

Selecting 'F' from the main menu will cause the program to sweep the LO synthesizer to get a profile of the internal filter response, which is then plotted. This plotting requires a VGA, EGA, Hercules or CGA compatible graphics board. The plot can also be printed out on an Epson compatible printer connected to the standard LPT1 parallel port. I have not tried all these graphics boards, so cannot guarantee they will work. Please let me know of any problems.

After selecting Filter Sweep, you will be told to set the external test synthesized generator to a specified power level, -40 dBm. This is really only a guideline, and if it is set 5 dB lower, it should make no difference. During the sweep itself, the measured power will be displayed, and the input power should be such that the measured power does not exceed +3 or +4 dBm or so.

The program then asks for a center frequency, which will be the frequency to which the external signal will be set. The default for this is 650 MHz, chosen arbitrarily. This default will be selected by pressing <RETURN> or <ENTER>.

After a frequency is chosen, the program asks for a bandwidth to sweep. This can be selected by entering one of those shown. Pressing the <space> bar will cause the program to sweep all bandwidths sequentially. You have the option of printing these plots out, which the program asks after the <space> is pressed.

When the bandwidth is selected, the program sweeps the LO synthesizer and measures the response, while displaying the frequency and powers continuously. The program then plots the response of both sidebands, including a header. If a single bandwidth was chosen, or if the non-print all-bandwidth mode was chosen, the program then asks if a hard copy should be sent to the printer. Pressing 'Y' gets a printout, pressing 'N' goes to the next bandwidth or back to the main menu, depending on whether the all-bandwidth option was selected.

Mixer Rejection Test

Pressing 'M' will activate the mixer rejection test. This option also produces a plot, and the same comments regarding the printer that were stated in the Filter Sweep section apply for the Mixer Rejection Test also.

As with the filter test, you are instructed to set the external synthesized signal generator to a specified power level, -32 dBm. This also is not critical, although it should not be more than 3 or 4 dB higher, and no more than 6 or so dB lower. Then the frequency is entered. Usually, you would not want to select the default 650 MHz, since this test is frequency dependant, and must be done at several frequencies, for example 550, 750 and 950 MHz.

After the frequency is selected, a logarithmic sweep on each side of the center frequency is performed, and the ratio of wanted sideband power to rejected sideband power is calculated for both sidebands. These ratios are plotted as a function of the logarithm of the base band frequency on the same plot. The broken line is the lower sideband. The option of printing the plot is again presented, and one proceeds as with the filter test.

Attenuator Test

Selecting the Attenuator Test will make the program test both the compensation attenuators and the AGC attenuators. A general check of the module gain is also made.

After the test is selected, you are again instructed to set the generator to the specified power level, -55 dBm and enter the frequency. The default frequency is usually the easiest choice. The program then commands given attenuator settings to the module and measures the resultant power. This is subtracted from the input level and displayed as module gain along with the nominal desired gain and tolerance. The actual gain may be out of tolerance, due to variations in signal generator output levels, as well as losses in the cables. These should be allowed for. In any case, the two gains should agree to within 2 dB.

After the gain check, all of the AGC and Compensation gain settings are run through, and the power checked. The deviations are then plotted, as with the other tests. The deviations are plotted as a function of AGC code from 1 to 255. As with the filter test, the plot can be routed to a printer. After the plot, any codes which deviate more than 1 dB from the nominal value will be indicated. Often codes 1 and maybe 2 will deviate by more than 1 dB. These codes are normally not selected in operation, and the codes below 8 (-18 dB gain) are not specified anyway. Also, the low signal levels at these codes make the measurements less accurate. This could be compensated for by raising the signal generator level, but unless told otherwise, I think this is not worth the effort.

PLL Test

The last test is the PLL test which checks that the LO synthesizer locks all the way across the band. This simply selects every 10 MHz starting at 1100 MHz down to whenever lock is lost below 500 MHz. This test does not require the external signal generator. A running display of the results at each frequency is shown, and at the end of the test, the lowest and highest locking frequencies are displayed, along with intermediate frequencies (up to 10 in number) at which the synthesizer did not lock.