



User Control of the HP 8510 for Millimeter Wave Configuration

This procedure will take the user through the HP 8510 front panel entries necessary for millimeter wave operation with test sets other than those produced by HP. This procedure will allow the operation of the HP 8510 on any millimeter waveguide band. The procedure addresses both the "one path two port" measurement utilizing one T/R type Module, one T type Module and the "two path two port" utilizing two T/R type modules. Provision is made for the use of the various versions of the 85105A or the HP 8510 I.F. Interface Cable (HP P/N 08510-60105). This procedure is a refined version of that was used in the HP 85106A millimeter wave test system. Carefully follow the procedure on a step-by-step basis for maximum user efficiency. This procedure assumes that the user has some degree of familiarity with the basic HP 8510 system.

- A) Physically configure the HP 8510 system using the equipment described in the "Necessary HP Equipment" section above. All equipment should be "off".
- 1) Establish the communication path between the instruments by connecting HPIB cables between the HP 8510 System Port and the HPIB ports on each synthesizer.
 - 2) Designate one synthesizer as the master synthesizer (the R.F. synthesizer) and connect the output of its reference oscillator to the external reference input of the second synthesizer, (the L.O. synthesizer). Connect the reference oscillator output of the second synthesizer to the HP 8510 external reference input. The system will now be coherent.
 - 3) System interface set up based on the Test Set Controller. There are three variations of 8510 systems that can be configured for millimeter waveguide test sets. These include the use of: the 85105A-H01 (the user modified 85105A uses the same set up), the 85105A-K10, or the IF Interface Cable (Keysight P/N 08510-60105). Select the appropriate set up diagram, found at the end of this paper, that matches the Test Set Controller available and configure the system as shown.

Example: Set up for the IF Interface Cable (Keysight P/N 08510-60105)

Connect the output of the R.F. Synthesizer to the R.F. Input of the T/R Module through a high quality microwave SMA cable. The level of the microwave R.F. signal should be between +7 and +12 dBm at the T/R Module R.F. input. Connect the output of the L.O. Synthesizer to input of a high quality microwave two way power splitter (8 to 20 GHz). Connect one output of the splitter to the L.O. Input of the T/R Module.

Connect the remaining output of the splitter to the L.O. Input of the T Module. High quality microwave SMA cables should be used for all three L.O. related cables. The L.O. level available to the each of the Modules should be +5 dBm minimum. Attach the HP P/N 08510-60105 cable to the “J1 Test Set Interconnect” in the upper right hand corner of the rear panel of the lower HP 8510 unit. The BNC connectors at the other end of this cable are labeled: A1, B1, A2, and B2. The A1 connector is the HP 8510 1st reference channel input and is connected to the Ref. output of the T/R Module. This channel will provide the reference signal for ratioed measurements. The B1 connector is the HP 8510 1st test channel input and is connected to the Test output of the T/R Module. This channel will be used for measuring return loss (S11) of the DUT. The B2 connector is the HP 8510 2nd test channel input and is connected to the Test output of the T Module. This channel will be used for measuring the insertion loss (S21) of the DUT. The A2 connector is the HP 8510 2nd reference channel input and is not used in the test configuration. Using the power cables provided by OML, (the connectors are polarized for proper polarity) connect the T/R and T Modules to a high quality + 15 VDC power supply with at least 2 amps DC current capability.

B) Turn on both synthesizers.

- 1) Press “Instr Preset” (Green button) on each synthesizer
- 2) Set the master synthesizer (RF) address to 19.
 - a) Press “Shift” and then “Local”, the current address will appear.
 - b) Press “19” followed by “X1”
- 3) Set the second synthesizer (LO) address to 18.
 - a) Press “Shift” and then “Local”, the current address will appear.
 - b) Press “18” followed by “X1”

C) Turn on the HP 8510. When the HP 8510 has finished “booting up”, the synthesizer displays may be blank if the HP 8510 is able to communicate with them at this time. This does not necessarily indicate any problems. The next series of steps will set the addresses that the HP 8510 will need to function with the configuration that has been described.

- 1) Press “Preset” (Green button)
- 2) Press the “System” button under “Auxiliary Menus”
- 3) Press the “HPIB Addresses” soft key
- 4) Press the “Source #1” soft key

- 5) If the address does not read as "19", Press "19" on the Entry Keypad (Keypad) followed by "X1".
- 6) Press the "Source #2" soft key
- 7) If the address does not read as "18", Press "18" on the Keypad followed by "X1".
- 8) Press the "Test Set" soft key
- 9) Press "21" on the Keypad followed by "X1" when using any version of the 85105A Test Set Controller. Make sure that the address of "21" is entered on the rear of the 85105A.

Press "31" on the Keypad followed by "X1" when using the IF Interface Cable.

- 10) Press "31" and "X1" for the "RF Switch" and the "Power Meter"
- 11) Press "More"
- 12) Set "Disc", "Plotter", and "Printer" to a user desired address other than those used above.

D) Millimeter Wave Frequency Setting: The following steps enter the frequency commands needed to program the synthesizers for the desired band of operation. It is recommended that each band be saved as a specific setup. The methodology used is to enter the "Source" (synthesizer) commands as a fraction of the desired operating frequency. The "values" shown in the following steps apply for the example given in the next paragraph. Those values will need to be amended to reflect the desired band of operation using the data supplied with the millimeter wave test Module.

Example: If the desired band is 75 to 110 GHz, "Source 1" (RF) will be set to operate at 1/6, and "Source 2" (LO) will operate at 1/8 of 75 to 110 GHz. "Source 2" will also be "Offset" +/-20 MHz. Choose "+" or "-" Offset" for best test results in the response shown on the HP 8510 display. The "Receiver" is set to a "Constant Frequency" of 20 MHz. OML Modules with the "x2", available only in WR-08 and higher band Modules, use an RF "Multiplier Denom" that is twice its normal value.

Applicable RF multipliers (denominator numbers)

Band	RF Input	RF "Denom"	RF Input "x2"	RF "Denom" "x2"	LO Input	LO "Denom"
WR-22	11.0-16.7	3	N/A	N/A	8.2-12.5	4
WR-15	12.5-18.8	4	N/A	N/A	10.0-15.0	5
WR-12	10.0-15.0	6	N/A	N/A	12.0-18.0	5
WR-10	12.5-18.4	6	N/A	N/A	9.3-13.8	8
WR-08	15.0-23.4	6	7.5-11.7	12	11.2-17.5	8
WR-06	18.3-28.4	6	9.1-14.2	12	11.0-17.0	10
WR-05	17.5-27.5	8	8.7-13.8	16	11.6-18.4	12
WR-04	17.0-26.0	10	8.5-13.0	20	12.1-18.6	14
WR-03	18.3-27.1	12	9.1-13.6	24	12.2-18.1	18

D) Millimeter Wave Frequency Settings

- 1) Press "System" under "Auxiliary Menu"
- 2) Press the "More" soft key
- 3) Press the "EDIT Mult. Src." soft key
- 4) Press the "Source 1" soft key
- 5) Press the "Multiplier Numer." soft key
 - a) Press "1" on the Keypad followed by "X1"
- 6) Press the "Multiplier Denom" soft key
 - a) Press "6" on the Keypad followed by "X1"
 "12" and "X1" would be pressed if the OML Module was equipped with a "x2" option.
- 7) Press the "Done" soft key
- 8) Press the "Source 2" soft key
- 9) Press the "Multiplier Numer." soft key
 - a) Press "1" on the Keypad followed by "X1"

- 10) Press the “Multiplier Denom” soft key
 - a) Press “8” on the Keypad followed by “X1”
 - 11) Press the “Offset Frequency” soft key
 - a) Press “20” on the Keypad followed by “M”
 - 12) Press the “Done” soft key
 - 13) Press the “Receiver” soft key
 - 14) Press the “Constant Frequency” soft key
 - a) Press “20” on the Keypad followed by “M”
 - 15) Press the “Done” soft key
 - 16) Press the “Mult. Src.:ON/SAVE” soft key
- Steps 17) and 18) are optional.
- 17) Press “Save” under “Instrument State”
 - 18) Press the “Inst State *()” location desired for this band setup
 - 19) Press “Start” under “Stimulus”
 - a) Press “75” on the keyboard followed by “G”
 - 20) Press “Stop” under “Stimulus”
 - a) Press “110” on the keyboard followed by “G”

E) Millimeter Wave Operating Settings: These steps set the remaining parameters needed for millimeter wave operation. ***If “System Phaselock” is not showing on the display, Press “System” under “Auxiliary Menu”.***

- 1) Press “More”
- 2) Press the “System Phaselock” soft key
 - a) Press “None” under “Lock Type” Because we are using two synthesizers, this feature is not needed.

- 3) Press "Menu" under "Stimulus"
 - a) Press the "Power Menu" soft key
 - b) Press the "Power Source 1" soft key
 - 1) Press "7" on the keypad followed by "X1"
 - c) Press the "Power Source 2" soft key
 - 1) Press "14" on the keypad followed by "X1"

Steps 4 are needed *only* for the set up of a "one path two port" system.

"Caution" *The 8510 does not save these entries into a "Instrument State" or on to a "Setup Disc." This is a 8510 system "bug." They "might" be saved if the 8510 is turned off and later turned on with no changes. If calibration problems are encountered or if the system is trying to switch direction these entries ("states") must be reentered. If the system is being started on a "setup Disc" these "states" must always be reentered.*

- 4) Press "Menu" under "Parameter"
 - a) Press the "Redefine Parameter" soft key
 - b) Press the "Drive" soft key
 - c) Press the "Port 1" soft key
 - d) Press the "Phase Lock" soft key
 - e) Press the "None" soft key

F) First System Test: At this point the system is programmed. If you have a millimeter test set, proceed with the physical connections needed. If you have purchased an OML Millimeter Wave VNA System a system block diagram is attached. Also attached are typical block diagrams and physical layouts of the OML millimeter wave Modules. After the millimeter wave test set(s) has been connected, a trace representing the output of the reference downconverter can be displayed. A trace of the output of the test downconverter can also be displayed. The downconverter trace should change as the termination on the test set “test port” is changed. A simple scalar measurement, using ratioed parameters, can be setup with the following steps:

- 1) Press “Channel 1”
 - a) Press “S11” under “Parameter”
- 2) Press “Channel 2”
 - a) Press “S21” under “Parameter”

G) Calibration of the System: If a Calibration Kit, from one of the first three vendors listed under the fourth section of “Necessary 8510 Equipment”, is available, the user can proceed to load that data using the standard HP 8510 procedure. If the user currently has an HP millimeter wave test system, the data on the system or calibration disk can be loaded into the HP 8510 and modified for use with a new waveguide kit using the “Modify Cal Set” procedure built into the HP 8510 Cal.

The user can put together his own set of waveguide components, such as a kit from Aerowave. The calibration data can be generated using the built-in HP 8510 procedures. The following documents will aid the user in implementing this procedure: 1) HP Product Note 8510-5A, Network Analysis, “Specifying calibration standards for the HP 8510 network analyzer”, 2) HP Product Note 8510-8A, Network Analysis, “Applying the HP 8510 TRL calibration for non-coaxial measurements”, 3) HP Product Note 8510-12. Millimeter-Wave Measurements, “Using the HP 8510 Network Analyzer”.