

S E R V I C E N O T E

SUPERSEDES: None

37717B PDH/SDH/Jitter Test Set**Serial Numbers:** 3509U00100/GB99999999**Build Status:** 1.00 and above**Replacing the Processor Assembly (CPU)****To be Performed by:** Qualified Service Personnel**Parts Required**

Description	Part Number	Qty.	Where Used
Replacement Processor Kit	37717-60158	01	37717B with disk drive
Replacement Processor Board	37717-60004	01	37717B without disk drive

Situation

The 37717B has two possible types of processor - one with a disk-drive and one without.

This Service Note gives information on parts and instructions required when changing a processor on either version.

Continued

DATE: October 1996

ADMINISTRATIVE INFORMATION

SERVICE NOTE CLASSIFICATION:

INFORMATION ONLY

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ENTITY:

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ADDITIONAL INFORMATION:

Action

First check which type of processor is fitted. The disk drive version is easily recognised as it has a slot for a 3.5 inch floppy disk just in front of the ON/OFF switch.

When changing the processor order the appropriate part from the table above and use one of the following procedures to fit the parts.

Procedure A is for the disk drive version (see page 2)

Procedure B is for the non disk drive version (see page 7)

Procedure A - Disk Drive Processor

Use these instructions when replacing the CPU on a 37717B with a disk drive.

The instructions cover the following:

- Correct procedure for removing the old CPU Module from the instrument.
- Procedure for dismantling the old CPU Module.
- Procedure for transferring the special Memory IC from the old CPU Assembly.

This IC stores information on the option structure of the instrument and all soft calibration constants for the instrument. Transferring this IC means that it is not necessary to recalibrate the instrument or replace firmware options.

- Procedure for transferring the NVM Battery from the old CPU Board Assembly.

A new lithium battery is not supplied with the new CPU due to special handling requirements required when shipping this. The old battery may be used after checking the voltage.

- Procedure for assembling the new CPU Board into the Module and replacing in the Instrument.
- Checking Options and Calibration Dates.
- Setting the Internal Clock Time and Date.
- Testing the instrument with the New CPU.
- Changing the MAC address Label (applies to option A3B units only).

Every instrument shipped with Option A3B LAN interface has a unique MAC address associated with it. This address is stored in U15 on the CPU, so will be transferred over with U15 (see above). There is also a label fitted to the old CPU with this unique address which must also be transferred.

Warning

The CPU board contains a battery. To prevent overheating or explosion, DO NOT expose to high temperature or short circuit.

CAUTION

These procedures should only be carried out by qualified Service Personnel.

Anti-static precautions must be observed at all times. - Use the anti-static wrist-strap provided in this kit if an anti-static work-area conforming to Corporate Standard 741.808 is unavailable.

Read the anti-static documentation at the end of this procedure.

Removing the old CPU Assembly.

Remove the old CPU Assembly as follows:

1. Switch off the instrument and disconnect the power cord and any interconnecting cables.
2. Place the instrument face down on the workbench.
3. Remove the 4 screws securing the rubber feet to the rear panel.
4. If Optical Modules are fitted, unscrew optical shield from the input and output connectors.
5. Withdraw the outer cabinet sleeve back and out of the instrument.
6. Remove the two clamp screws on the top and bottom right-hand side of the chassis which secure the CPU module.
7. Withdraw the CPU module from the instrument using the two knobs to help with removal.

Dismantling the old CPU Module.

1. Unscrew the four posidrive screws which secure the Disk Drive Assembly with its metal shield to the CPU Board Assembly standoffs.
2. Unscrew the nut which secures the Disk Drive Assembly to the module front panel.
3. Unclip the GPIB and RS-232 ribbon cables from their sockets on the CPU board Assembly. Feed the GPIB ribbon cable out through the slot in the disk drive metal shield.
4. Unclip the disk-drive ribbon cable from its socket on the CPU board Assembly and place the disk-drive assembly and metal shield to one side in an anti-static bag.
5. Unscrew the two nuts which secure the PARALLEL Interface Connector to the module Front Panel.
6. Using a long posidrive screwdriver, unscrew the two screws which secure the module Front Panel to the CPU Board Assembly.
7. Remove the module Front Panel and place to one side.

Transferring the Memory IC and NVM Battery from the old CPU Board Assembly

1. With the old CPU Board Assembly on the bench, locate U15 (marked on the topside of the board). This has part number 37714-80032.
2. Carefully remove this IC from it's socket using using a Quilext 1 Universal IC Extraction tool or equivaqlent.
3. Fit U15 into the socket on the new CPU assembly taking great care not to touch any pins on the IC or socket. Ensure correct alignment before pushing firmly home in the socket.

NOTE

There may already be an IC fitted into U15 position on the new CPU board. If so, this must be removed and the part from the old CPU fitted instead.

4. Locate the NVM Battery on the old CPU Board Assembly and check the voltage using a DVM. If the measured voltage is greater than 3.55 Volts the battery may be removed and soldered into the new CPU Board Assembly. If the measured voltage is less than 3.55 Volts, a new battery should be fitted into the new CPU Board Assembly.
5. There are four standoffs which retain the disk-drive assembly to the CPU board. These may already be fitted to the new boards, but if not, remove them from the old CPU Board and fit to the new CPU Board Assembly.

Once all these parts have been fitted, check the switches on the new CPU Assembly are set as follows;

Assembly Description	Switch Number	Finger Number	Position
A4 Processor Assembly	SW1	1,2 & 4	Closed
A4 Processor Assembly	SW1	3	Open
A4 Processor Assembly	SW2	1,4,5,6,7,8	Closed
A4 Processor Assembly	SW2	2 & 3	Open

Assembling the new CPU Board into the Module.

1. Using a long posidrive screwdriver, replace the two screws which secure the module Front Panel to the CPU Board Assembly.
2. Replace the two nuts which secure the PARALLEL Interface Connector to the module Front Panel.
3. Replace the disk-drive ribbon cable in it's socket on the new CPU board Assembly and screw the disk-drive assembly and metal shield into position on the four standoffs. Do not tighten these screws until you have replaced and tightened the nut which secures the disk-Drive Assembly to the module front panel.
4. Feed the GPIB ribbon cable through the slot in the disk-drive metal shield then replace the GPIB and RS-232 ribbon cables into their sockets on the CPU board Assembly.

Transferring the LAN Interface MAC Address Label (Option A3B only)

1. Check the instrument rear panel to see if option A3B (LAN Interface) is fitted. If it is, there will be a MAC ADDRESS label stuck to the rear of the old CPU board. Write down the number on this label (this will be keyed into the CPU memory later), then remove the label and attach it to the new CPU board in the same position.

Fitting the CPU Module and Re-assembling the Instrument.

1. Replace the CPU module back into the instrument.

VERY IMPORTANT NOTE

To prevent removal of, or damage to the metal RFI STRIP on the module next to the CPU, you **MUST** use special tool part number 03776-00016 or a thin LOW-STATIC plastic or fibre card (200mm x 135mm x 0.5mm) when inserting the CPU module back into the instrument. Place this card against the RFI Strip, then slide the CPU Module back into the instrument. Push the CPU Module fully home, then pull out the card. See Figure 1.

CAUTION

Severe damage can result if an RFI Strip is dislodged and falls inside the instrument. Always ensure that RFI strips are securely in position and unbroken.

2. Replace the outer cabinet sleeve, optical module shields and rear panel feet - this is a reversal of the removal procedure.

Checking Options and Calibration Dates.

1. Switch on the instrument and check for a valid power-up routine.
2. Press the OTHER key, then [MORE] softkey until [OPTIONS] softkey is displayed.
3. Press the [OPTIONS] softkey and select each option type in turn (i.e PDH, SDH, JITTER, ATM etc).
4. Ensure that the options shown as FITTED on the display agree with the options listed on the instrument rear panel.
5. Press the [MORE] softkey until [CALIBRATION] softkey appears at the bottom of the display.
6. Enter the Calibration password [1243].
7. Select each Calibration Item and ensure the calibration dates are valid.

NOTE

It is recommended that the 37717B receives an annual Calibration cycle.

Setting the Internal Clock Date and Time

You will need to set the internal clock to the correct time and date as this may be incorrect after changing the CPU.

1. Switch on the instrument.
2. Press OTHER key, then [MORE] softkey until [TIME & DATE] softkey is displayed.
3. Press [TIME & DATE] softkey then move the cursor to CLOCK MODE.
4. Select [SETUP] then move the cursor to TIME. Set the clock to the correct time using [<],[>], and [INCREASE DIGIT], [DECREASE DIGIT] softkeys.
5. Move the cursor to DATE. Set the clock to the correct date using [<],[>], and [INCREASE DIGIT], [DECREASE DIGIT] softkeys.
6. Return the cursor to CLOCK MODE and press [RUN].

The internal clock is now set.

Checking the LAN Interface MAC Address (Option A3B only)

Check the MAC address in memory after ensuring option A3B is enabled (see above) by carrying out the following procedure:

1. Switch on the instrument and press the OTHER key then [MORE] softkey. Select the [CALIBRATION] function.
2. Select CALIBRATE PASSWORD and set to [1243] using the INCREASE DIGIT and DECREASE DIGIT softkeys.
3. Select the calibration item [SET MAC ADDRESS].

The MAC Address is displayed at the bottom of this page. If it is different to that on the label which you transferred from the old CPU, then you will need to change it as follows;

4. Move the cursor to the [MAC ADDRESS EDIT] field and change the address to that shown above using the INCREASE DIGIT and DECREASE DIGIT softkeys.
5. Move the cursor to the [ACCEPT CHANGES] field and press the ON softkey.
6. Ensure the change is reflected at the bottom of the display.

Testing

Perform all the instrument selftests.

NOTE

It is very important to cable the instrument correctly when running the selftests. Cabling depends on options fitted - see Calibration or Service Manual for this information.

When a pass has been obtained on all selftests the instrument is ready for use.

Procedure B - Non Disk Drive Processor

Use these instructions when fitting a new CPU Board Assembly into an 37717B without a disk drive fitted.

The instructions cover the following;

- Fitting some special parts from the old CPU Assembly onto the new CPU Assembly.

These parts need to be transferred as they are not shipped with the new assembly.

- Initializing the new CPU data storage eeprom.
- Entering the instrument serial number and a list of all the firmware options fitted.

This needs to be done because this data is stored in the above eeprom on old CPU Assembly which cannot be transferred to the new CPU Assembly.

- Setting the current time and date.

This must be done for the calibration to run and timestamp correctly.

- Recalibrating the 10 MHz Reference Oscillator, VCX0 and Jitter Transmitter Modules.

This needs to be done because this data is stored in the above eeprom on old CPU Assembly which cannot be transferred to the new CPU Assembly.

CAUTION

This procedure should only be carried out by qualified Service Personnel. Anti-static precautions must be observed at all times. - Use the anti-static wrist-strap provided in this kit if an anti-static work-area conforming to Corporate Standard 741.808 is unavailable. Read the anti-static documentation at the end of this procedure.

Removing the old CPU Assembly.

Remove the old CPU Assembly as follows:

1. Switch off the instrument and disconnect the power cord and any interconnecting cables.
2. Place the instrument face down on the workbench.
3. Remove the 4 screws securing the rubber feet to the rear panel.
4. If Optical Modules are fitted, unscrew optical shield from the input and output connectors.
5. Withdraw the outer cabinet sleeve back and out of the instrument.
6. Remove the two clamp screws on the top and bottom right-hand side of the chassis which secure the CPU module.
7. Withdraw the CPU module from the instrument using the two knobs to help with removal.

Transferring Parts from the Old CPU Assembly.

The following parts need to be transferred from the CPU board on your old module:

- Metalwork - fit the Module Front Panel from the old CPU. This is retained to the board by two screws.

NOTE

If the RS232 or GPIB board (37714-60015) is fitted, this will need to be removed to gain access to these two screws.

- A4 U14 - fit this 8-pin DIL IC from the old CPU board. It is fitted in a socket.
- ROM Drawer Runners - Fit the two plastic runners from the old CPU. These are located with two screws and nuts each.
- ROM Drawer - Fit the A5 ROM Drawer from the old CPU. It is recommended that new eeproms are fitted in this board. Refer to Service Note 37717B-01C or contact the Agilent QTO Division Product Support Engineer to find out the latest part numbers for these eeproms.
- NVM Battery - A new battery (part number 1420-0380) should be fitted. If not available, you may fit the old battery provided the voltage is greater than 3.55 volts - TAKE CARE TO GET THE POLARITY CORRECT.

Once all these parts have been fitted, check the switches on the new CPU Assembly are set as follows:

Assembly Description	Switch Number	Finger Number	Position
A4 Processor Assembly	SW1	1 & 2	Closed
A4 Processor Assembly	SW1	3 & 4	Open
A4 Processor Assembly	SW2	1,2,3,4,5,6,7	Closed
A4 Processor Assembly	SW2	8	Open
A15 GPIB/RS232 Assembly	S1	1,2,3,4	see board
A5 ROM Drawer Assembly	S1	1	Open
A5 ROM Drawer Assembly	S1	2,3,4	Closed

Fitting the CPU Module and Re-assembling the Instrument.

1. Replace the CPU module back into the instrument.

VERY IMPORTANT NOTE

To prevent removal of, or damage to the metal RFI STRIP on the module next to the CPU, you MUST use special tool part number 03776-00016 or a thin LOW-STATIC plastic or fibre card (200mm x 135mm x 0.5mm) when inserting the CPU module back into the instrument. Place this card against the RFI Strip, then slide the CPU Module back into the instrument. Push the CPU Module fully home, then pull out the card.

CAUTION

Severe damage can result if an RFI Strip is dislodged and falls inside the instrument. Always ensure that RFI strips are securely in position and unbroken.

2. Replace the outer cabinet sleeve, optical module shields and rear panel feet - this is a reversal of the removal procedure.

Eeprom Initialization.

1. Switch on the instrument and check for a valid power-up routine.
2. Make the following key sequence to obtain the MODULE DEBUG page on the 37717B.

Press [OTHER]; [<^]; [MORE]; [<^]; [MORE]; [<^]; [MORE]; [OTHER]. Press [MORE] until MODULE DEBUG appears in the softkey menu.

CAUTION

When using the MODULE DEBUG display only modify parameters shown below. Altering other parameters can cause damage to the instrument - prevent accidental damage by leaving the Module Debug Page after setting up.

3. Move the cursor to [EEPROM INITIALIZE] field and press initialize.
4. After a short time, [OFF] will be displayed beside the [EEPROM INITIALIZE] field indicating that the initialization is complete.
5. Press [OTHER] key to exit the MODULE DEBUG page.

Internal Clock - Setting the Date and Time

Before performing calibration, you will need to set the 37717B internal clock to the correct time and date as this is used to log calibration information.

1. Switch on the instrument.
2. Press OTHER key, then [MORE] softkey until [TIME & DATE] softkey is displayed.
3. Press [TIME & DATE] softkey then move the cursor to CLOCK MODE.
4. Select [SETUP] then move the cursor to TIME. Set the clock to the correct time using [<],[>], and [INCREASE DIGIT], [DECREASE DIGIT] softkeys.
5. Move the cursor to DATE. Set the clock to the correct date using [<],[>], and [INCREASE DIGIT], [DECREASE DIGIT] softkeys.
6. Return the cursor to CLOCK MODE and press [RUN].

The 37717B internal clock is now set.

Restoring the Instrument Serial Number

The instrument serial number will need to be entered into the eeprom on the new CPU Assembly before the firmware options can be added.

NOTE

Restoring the serial number and options requires a special Codeword to be entered via the front panel.

This Codeword is unique to every 37717B unit and can only be obtained by contacting the Agilent QTO Division Product Support Engineer.

Enter the serial number by carrying out the following procedure.

1. Switch on the 37717B.
2. Make the following key sequence on the 37717B to obtain the OPTION ENABLE display.

Press [OTHER]; [<^]; [MORE]; [<^]; [MORE]; [<^]; [MORE]; [OTHER]. Press [MORE] until OPTION ENABLE appears in the softkey menu.
3. Press OPTION ENABLE softkey.
4. Move cursor down one place and select SERIAL NUMBER.
5. Move cursor down one place and enter the serial number (as shown on the rear panel label) using [<],[>], and [INCREASE DIGIT], [DECREASE DIGIT] softkeys.
6. Move cursor to CODEWORD field and insert the special codeword into this field using the [<],[>], and [INCREASE DIGIT], [DECREASE DIGIT] softkeys.
7. Move the cursor to TOGGLE TO SET OPTION field and enter the serial number by pressing the [SET OPTION] softkey. The display will flash momentarily and the message "Option Structure Changed" will be displayed. The unit will assume Default Settings.

NOTE

If an incorrect CODEWORD has been entered, the unit will freeze in the [OPTIONS ENABLE] page. If this happens, cycle the power by switching the 37717B off then on again. You can then re-enter the CODEWORD.

Restoring Firmware Options.

Restore the firmware options by carrying out the following procedure.

1. Return to FIRMWARE OPTION on the OPTION ENABLE page.
2. Enter the first option you need to restore (i.e US1).
3. Move cursor to CODEWORD field and insert the special codeword into this field using the [<],[>], and [INCREASE DIGIT], [DECREASE DIGIT] softkeys.
4. Move the cursor to TOGGLE TO SET OPTION field and enter the new option by pressing the [SET OPTION] softkey. The display will flash momentarily and the

message "Option Structure Changed" will be displayed. The unit will assume Default Settings.

NOTE

If an incorrect CODEWORD has been entered, the unit will freeze in the [OPTIONS ENABLE] page. If this happens, cycle the power by switching the 37717B off then on again. You can then re-enter the CODEWORD.

5. Repeat steps 1 to 4 for each additional firmware option you need to add. Note that a different Codeword is required for each option.

Checking Firmware Options are Now Fitted.

After you have entered all the firmware options, check they have been correctly installed as follows;

6. Switch OFF the 37717B.
7. Press the OTHER key then [MORE] softkey until softkey labeled [OPTIONS] is displayed.
8. Press the [OPTIONS] softkey and ensure that the required option has now been added.

Calibration Procedures

NOTE

Carry out the following procedures only after fitting the new parts, initializing the CPU eeprom, setting the time and date, entering the serial number and restoring all firmware options.

Warm-Up Time

To ensure accuracy, the equipment must be switched on for a minimum of 30 minutes before carrying out these calibration procedures.

Calibration Sequence

The calibration should be performed in the sequence given below.

10MHz Reference Clock Frequency and VCXO Calibration

The 10MHz Reference Clock Source is calibrated by connecting to a Frequency Counter and adjusting within limits. The VCXO Calibration is automatic.

Equipment

Frequency Counter	5335A Opt 001
10:1 Scope Probe	10435A

Procedure 10 MHz Reference Clock Frequency

1. Select the CALIBRATION function on the OTHER display.
2. Select CALIBRATE PASSWORD and using the DECREASE DIGIT and INCREASE DIGIT softkeys set the password to [1243].
3. Select CALIBRATION ITEM : [10MHz] and MODE : [MANUAL].

4. Select FREQUENCY A and 1Mohm input impedance on the Counter.
5. Connect the Counter Input A via the 10:1 Divider Probe to TP14 on the 37717B CPU Assembly (A4). Ground the probe on TP7 (GND) on this assembly. These Test Points are accessible through a slot on the bottom of the instrument.
6. Adjust A4 R1 to obtain a reading of 10,000,000Hz on the counter.
7. Select the MEASURED FREQUENCY field on the 37717B display and enter the counter frequency reading using [INCREASE DIGIT] and [DECREASE DIGIT] softkeys.
8. Disconnect the Counter.

VCXO Calibration

9. Select CALIBRATION : [VCXO's] and press RUN/STOP to start the calibration routine.
10. After approximately 5 minutes, the Calibration Complete message for each of the VCXO's should appear at the bottom of the 37717B display.
11. Disconnect all test equipment.

Jitter Transmitter and Receiver Calibration

Description

The Jitter Transmitter Calibration is semi-automatic and is performed by using a special internal calibration routine and a Spectrum Analyzer. The 37717B TX PDH OUTPUT is connected to the Analyzer (via 75/50 ohm Matching Pad) and set to the first calibration point in the routine. With the Analyzer set to display the transmitted data spectrum, a Bessel Null should be observed. The 37717B DAC output is adjusted using the calibration routine to optimise this Bessel Null. This sets the transmitted jitter to exactly 0.765UI. This process is repeated for all other Calibration points in the routine.

The Jitter Receiver Calibration is fully automatic and uses a special internal calibration routine to measure and adjust the received jitter amplitude values with respect to the known transmitted values. Because receiver calibration relies on the accuracy of the transmitted jitter levels, the Jitter Transmitter calibration must be performed before the Jitter Receiver calibration.

Equipment

Spectrum analyzer	8568B
75/50 ohm Matching Pad	11852B

Pre-Adjustment Setup

Before carrying out Jitter Calibration, you will need to perform the following pre-adjustment setup.

1. Recall the 37717B Default Settings with the following key sequence:

Press OTHER key, then [STORED SETTINGS] softkey. Select STORED SETTINGS NUMBER [0]. Select ACTION [RECALL]

2. Couple the 37717B transmitter and Receiver with the following key sequence:

Press OTHER key, then [SETTINGS CONTROL] softkey. Select TRANSMITTER & RECEIVER [COUPLED].

3. Make the following key sequence on the 37717B to obtain the MODULE DEBUG display.

Press [OTHER]; [<^]; [MORE]; [<^]; [MORE]; [<^]; [MORE]; [OTHER]. Press [MORE] until MODULE DEBUG appears in the softkey menu.

CAUTION

When using the MODULE DEBUG display only modify parameters shown below. Altering other parameters can cause damage to the instrument - prevent accidental damage by leaving the Module Debug Page after setting up.

4. Press [MODULE DEBUG] and select MODULE [PDH MODULE] on the Display.
5. Select VCO CONTROL MODE [FIXED].
6. Select MODULE [JITTER MODULE] on the Module Debug Display.
7. Select TX CALIBRATION [OFF].
8. Select RX CALIBRATION [OFF].

CAUTION

The above pre-adjustment sequence will need to be performed again if power is cycled during Jitter Calibration, as MODULE DEBUG parameters return to default values when instrument power is cycled.

Jitter Transmitter Calibration Procedure

1. Connect the 37717B Transmitter Output to the Spectrum Analyzer via the 75/50 ohm Matching Pad.
2. Set the Spectrum Analyzer as follows:

Centre Frequency	2048kHz	Frequency Span	100kHz
Reference Level	0dBm	Sweep Time	1.0 seconds
Video Bandwidth	1kHz	Resolution Bandwidth	100Hz
3. Press the OTHER key then [MORE] softkey (twice). Select the [CALIBRATION] function.
4. Select CALIBRATE PASSWORD and set to [1243] using the INCREASE DIGIT and DECREASE DIGIT softkeys.
5. Select the calibration item [JITTER Tx].

6. Press RUN/STOP key to start calibration. The Spectrum analyzer should display a symmetrical spectrum of lines similar to that shown in Figure 2. The central line is the transmission carrier.
7. Move the cursor to DAC and adjust the DAC value (using only the Least Significant Bit) until the carrier level displayed on the Spectrum Analyzer is at a minimum. (Bessel Null).
8. When the Bessel Null is obtained, move the cursor to TOGGLE WHEN AT ZERO POINT and press [ZERO POINT] softkey. This stores the value for the modulation frequency and the routine automatically moves on to the next calibration value.
9. Repeat steps 7 and 8 for each new calibration value. At each change of BIT RATE, set the Spectrum Analyzer center frequency to the new BIT RATE and re-adjust the span to optimise the spectrum around the carrier.
10. When finished, the 37717B display should indicate CALIBRATION PROCESS COMPLETE.
11. Press [OTHER] to return to normal operation then disconnect all test equipment.

Jitter Receiver Calibration Procedure

1. SWITCH OFF THE 37717B TO RESET CALIBRATION PARAMETERS.
2. Connect the 37717B Unbalanced 75 ohm PDH Signal Out to the Unbalanced 75 ohm PDH Signal In.
3. Press the OTHER key then [MORE] softkey (twice). Select the [CALIBRATION] function.
4. Select CALIBRATE PASSWORD and set to [1243] using the INCREASE DIGIT and DECREASE DIGIT softkeys.
5. Select the calibration item [JITTER Rx].
6. Press the RUN/STOP key to start calibration.

Calibration is automatic and takes around 30 minutes. When complete, the 37717B display will indicate CALIBRATION PROCESS COMPLETE.

7. Press [OTHER] to return to normal operation.

Testing

After the above calibration, ensure the instrument is operating correctly by carrying out all the selftests - see Calibration or Service Manual.

When a pass has been obtained on all selftests the instrument is ready for use.

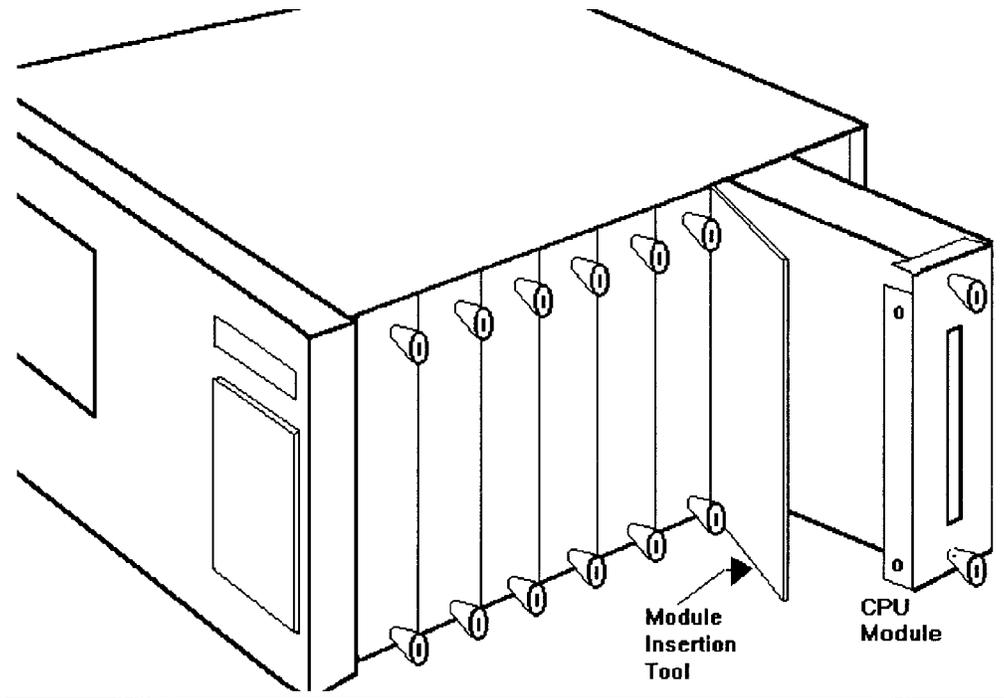


Figure 3 Position of Processor Module and Insertion Tool
Figure 1. Position of Processor Module and Insertion Tool

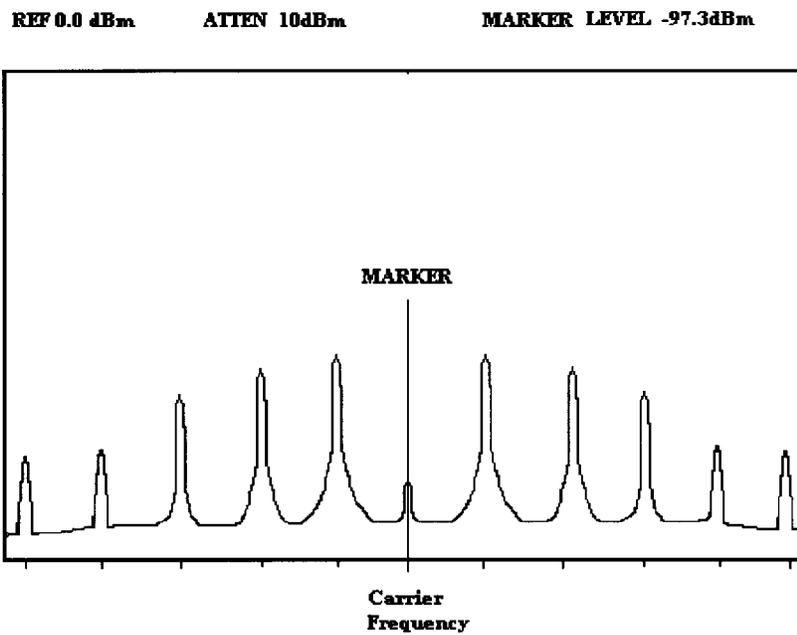


Figure 2. Typical Jitter Transmit Spectrum