5 Fault Localization to Subassembly Level

5.1 Initial Fault Localization when a Measurement Error Occurs

The first step is to localize the fault to one of the following subassemblies. To do this, perform the checks detailed in the following chapters.

Checking the power supply output voltages	-> chapter 5.2
Checking the synthesizer function	-> chapter 5.6.2 and chapter 5.6.3
Checking internal and external calibration sources	-> chapter 5.5
Checking the frequency converter (input section)	-> chapter 5.3.1 and chapter 5.3.2
Checking the IF measurement unit	-> chapter 5.4

5.2 Checking the Power Supply Output Voltages

All power supply output voltages can be measured on the voltage distribution board [2101-BD] (fitted on top of the power supply); the values are given in the table below. The reference ground point is MT2 on board [2101-BD].

Test point on [2101-BD]	Value	Test point on [2101-BD]	Value
MT1	+5 V	B15	+12 V
MT3	+5 V	ST1.4	-21 V
B1	+6.8 V	ST1.8	+12 V
B2	+23 V	ST12.3	+5 V *
B8	-6.8 V	ST12.4	+15 V*
B10	+18 V	ST6.3	-18 V*
B11	-12 V		

Table 5-1 Test points for checking the power supply output voltages
*) These voltages are generated on board [2101-BD].

If one of the output voltages from the power supply is incorrect, the power supply should be replaced. Further troubleshooting of the power supply is not covered by this service manual. If one of the voltages generated on the voltage distribution board [2101-B] is incorrect, the circuit diagram can be used for further troubleshooting.

5.3 Fault Localization in the Frequency Converter (Input Section)

5.3.1 Checking the Attenuator (ATTN) Settings

First check whether a level error is present in all attenuator (ATTN) settings.

To check the attenuator, connect a level generator to the measurement input of the device under test (d.u.t) and make the following settings.

Instrument settings

D.U.T. (SNA-23):

MODE	SPECTRUM ANALYSIS (CW)
FCENT	e.g. 10 MHz
FSPAN	10 kHz
RUN	SWEEP
REFERENCE	-30 dBm
RBW	1 kHz
ATTN	10 dB

Level generator:

F	same as FCENT of D.U.T.
L	-30 dBm (50 Ω)

The measurement signal is first displayed on the reference line of the D.U.T. Next check all attenuator settings by changing the ATTN settings. The level display must remain the same for all ATTN settings. If the level changes, the attenuator is faulty.

5.3.2 Checking the Level in all Receive Bands

First check whether a level error is present in all bands.

To do this, connect a level generator to the measurement input of the D.U.T. and a spectrum analyzer to the IF output of the 422 MHz/22 MHz converter, 6BU2.

Instrument settings

D.U.T.:	
MODE	SPECTRUM ANALYSIS (CW)
FCENT	see table
FSPAN	0 Hz
RUN	HOLD or MAN
REFERENCE	0 dBm
RBW	10 MHz
ATTN	40 dB
Level generator:	
F	same as FCENT of D.U.T.
L	0 dBm (50 Ω)
Spectrum analyzer:	
MODE	SPECTRUM ANALYSIS (CW)
FCENT	21.99 MHz
FSPAN	5 MHz
REFERENCE	-30 dBm/1 dB/DIV (SCALE 10 dB)

Measure the level at the IF output of the 422 MHz/22 MHz converter (6BU2) using the spectrum analyzer in accordance with table 5-5.

D.U.T. (FCENT)	Value at 6BU2	Value at [60] *
22 MHz (Band 0)	-30 dBm	-10 dBm
3.3 GHz (Band 1)	-35 dBm (-38 dBm)	-11 dBm (-14 dBm)
13 GHz (Band 2)	-35 dBm (-38 dBm)	-11 dBm (-14 dBm)
21 GHz (Band 3)	-35 dBm (-38 dBm)	-11 dBm (-14 dBm)

Table 5-2 Table of levels for checking the frequency converter (input section)
Values in brackets apply to Series A + B instruments

Important: The column marked (*) contains the measured values after the IF selection. A measurement at this point can be made easily, since the test point is socket [60] on the instrument back panel. If a level error is detected here, the measurement should be repeated at 6BU2 to exclude the possibility of the fault being in the IF selection.

If an error is detected in the test, further troubleshooting in the frequency converter is described in chapter 5.3 on page 5-2.

5.3.3 Further Fault Localization Using the Level Diagram

Further fault localization can be done using the level diagram, figure 5-1 on page 5-5. The corresponding level and frequency values are given in table 5-3 on page 5-6 and table 5-4 on page 5-6. The level values are approximate and may vary by up to 3 dB.

Explanatory notes on the level tables

D.U.T. settings:

FCENT	see table (Band 0 = 10 MHz; Band 1 = 3.3 GHz)
FSPAN	0
INPUT ATTN	10 dB
SWEEP	HOLD or MAN

Level generator settings:

FCENT	see table (Band 0 = 10 MHz; Band 1 = 3.3 GHz)
FSPAN	0
SEND LEVEL	-30 dBm (50 Ω)

Connect the level generator to the input of the SNA and check the level values as per table 5-3 and table 5-4. All levels should be measured using a spectrum analyzer (50 Ω) directly, without a probe, by breaking the signal path (unless otherwise stated).

The level values given are approximate. Deviations from the values stated do not affect the accuracy of the D.U.T. as the level differences are calculated out by the internal and external calibration. Level deviations are only significant if the D.U.T. indicates incorrect levels despite internal and external calibration having been performed.

Caution!

If the fault is localized to a microwave module, the entire module and associated control circuit must be replaced. The microwave modules must not be opened. Opening these modules invalidates the guarantee, and the module can no longer be repaired in the factory.

Note: The coaxial SMA connectors for the microwave assemblies must be tightened to the specified torque value using the torque wrench specified in chapter 1.

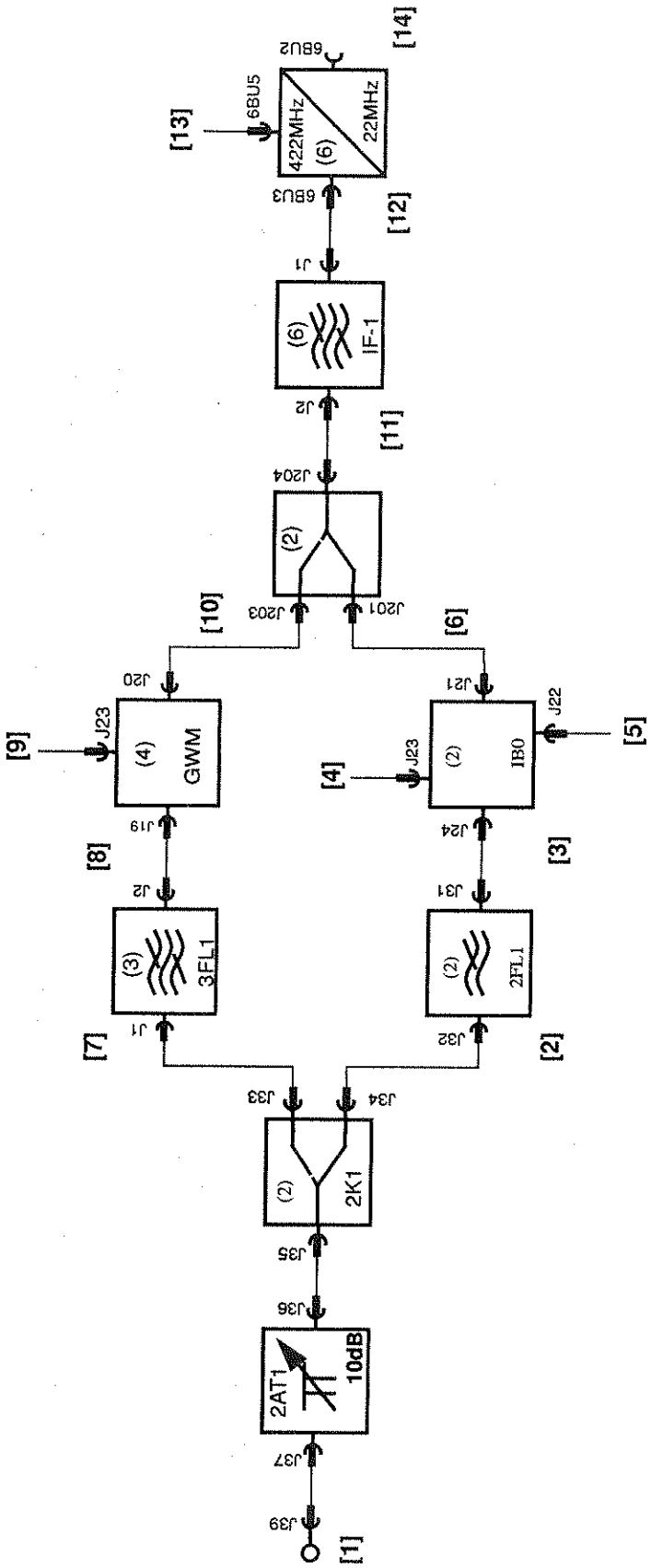

Fig. 5-1 Test points for the frequency converter level tables

Test point [ ] (see fig. 5-1)	Band 0		Band 1	
	Level	Frequency	Level	Frequency
1	-30 dBm	10 MHz	-30 dBm	3.3 GHz
2	-40 dBm	10 MHz	-	-
3	-40 dBm	10 MHz	-	-
4	+18 dBm	4.432 GHz	-	-
5	-2 dBm	400 MHz	-	-
6	-42 dBm	422 MHz	-	-
7	-	-	-41 dBm	3.3 GHz
8	-	-	-48 dBm	3.3 GHz
9	+15 dBm	4.432 GHz	+15 dBm	3.722 GHz
BU [71] 1st LO out	> +10 dBm	4.432 GHz	> +10 dBm	3.722 GHz
10	-	-	-58 dBm	422 MHz
11	-33 dBm	422 MHz	-41 dBm	422 MHz
12	-35 dBm	422 MHz	-43 dBm	422 MHz
13 *	+15 dBm	20 MHz	+15 dBm	20 MHz
14	-30 dBm	22 MHz	-38 dBm	22 MHz

Table 5-3 Level table for series A und B instruments
* high-impedance measurement using TK-10

Test point [ ]	Band 0		Band 1	
	Level	Frequency	Level	Frequency
1	-30 dBm	10 MHz	-30 dBm	3.3 GHz
2	-40 dBm	10 MHz	-	-
3	-40 dBm	10 MHz	-	-
4	+18 dBm	4.432 GHz	-	-
5	-2 dBm	400 MHz	-	-
6	-42 dBm	422 MHz	-	-
7	-	-	-42 dBm	3.3 GHz
8	-	-	-48 dBm	3.3 GHz
9	+15 dBm	4.432 GHz	+15 dBm	3.722 GHz
BU [71] 1st LO out	> +10 dBm	4.432 GHz	> +10 dBm	3.722 GHz
10	-	-	-58 dBm	422 MHz
11	-33 dBm	422 MHz	-38dBm	422 MHz

Table 5-4 Level table for instruments from series C onwards
* high-impedance measurement using TK-10

Test point [ ]	Band 0		Band 1	
	Level	Frequency	Level	Frequency
12	-35 dBm	422 MHz	-40 dBm	422 MHz
13*	+15 dBm	20 MHz	+15 dBm	20 MHz
14	-30 dBm	22 MHz	-35 dBm	22 MHz

Table 5-4 Level table for instruments from series C onwards
* high-impedance measurement using TK-10

5.4 Fault Localization in the IF Measurement Unit

5.4.1 Manual Check of the IF Measurement Unit

To check the IF measurement unit manually, connect a level generator to the measurement input of the D.U.T. Connect a spectrum analyzer to the IF output of the 422 MHz/22 MHz converter, 6BU2, and make the following instrument settings:

D.U.T.

MODE	SPECTRUM ANALYSIS (CW)
FCENT	Frequency in Band 0 (e.g. 10 MHz)
FSPAN	0 Hz
RUN	HOLD or MAN
REFERENCE	0 dBm
RBW	10 MHz
ATTN	40 dB

Level generator:

F	same as FCENT of D.U.T.
L	0dBm (50 Ω)

Spectrum analyzer:

MODE	SPECTRUM ANALYSIS (CW)
FCENT	21.99 MHz
FSPAN	5 MHz
REFERENCE	-30 dBm/1 dB/DIV (SCALE 10 dB)

Use the spectrum analyzer to measure the level at the IF output of the 422 MHz/22 MHz converter (6BU2).

With the above settings, the level at the input of the IF selection (7) BU1 should be - 30 dBm (reference level for the following measurements). To check the level within the IF measurement unit subassembly, check the signal path as per table 5-5.

Test point	Value	Notes
(7)BU1, (6)BU2	-30 dBm	IF selection input level, f = 21.99 MHz
(7)BU4, [60]	-10 dBm	IF selection test output. Switch the selection filter (RBW) between LC, crystal and bypass paths. The level at the test output should be practically the same for all signal paths.
(7)TP14, (7)BU3	-7 dB	IF selection output. High-impedance measurement using test probe. Test points (TP14, BU3) are DC coupled.
(8) TP24	4.5 to 5V	Logarithmizer output (DC). This voltage must also be present when the D.U.T settings remain the same and +5 dBm (50 Ω) is fed into the input of the logarithmizer (8)BU1.
(9) ST/BU 9, [63]	4.5 to 5V	Y output, same voltage as at (8)TP24. This is the analog input voltage for both the AD converters on the IF converter board. The voltage should be practically the same for all video filter (VBW) settings.

Table 5-5 Level table for checking the signal path in the IF measurement unitl

Important: With the settings stated above, the measurement line should be displayed on the top line of the display graticule if there is no fault present. The D.U.T. measurement line is, however, not indicative of the magnitude of the analog measurement signal, because the result of internal calibration is taken into account mathematically when displaying the value, i.e. the instrument display shows the mathematically corrected combination of the digitized value and the digitized result of internal calibration. This correction using calibration data is performed by the measurement unit controller.

5.5 Checking Internal and External Calibration Sources

The calibration source cannot be switched on permanently via the measurement software menus. It can be switched on permanently using the following procedure.

Switching on the cal source: Connect an external keyboard to the SNA. Switch the SNA on and wait until the measurement display appears. Now press <ALT> + <F10> simultaneously (SNA switches to DOS mode). Using the external keyboard, type "SET CALOUT=1" and press RETURN. (Entering "SET CALOUT=1" changes the CAL menu when the measurement software is re-started). Now type "K" to re-start the SNA measurement software. Select AUTO CAL OFF in the CAL menu of the D.U.T. The calibration source can now be switched on or off using the same menu (CAL. OUTPUT: ACTIVE/INACTIVE).

Important: If an internal calibration is triggered by changing a parameter (e.g. RBW, FCENT, etc.), the calibration source will be switched off afterwards and must be activated again from the CAL menu of the SNA. For this reason, AUTO CAL OFF mode should be set to avoid having to reactivate the source every time a parameter change is made.

Switching the instrument off resets the CAL menu to the original form (CAL. OUTPUT: ACTIVE/ INACTIVE is deleted from the menu).

Checking the external calibration source

Connect a precision level meter (50 Ω) to the external cal. output (socket [11] on front panel) of the D.U.T. The output level must be exactly -30 dBm (50 Ω) and the output frequency exactly 21.99 MHz.

Checking the internal calibration source

Connect a precision level meter (50 Ω) to the cal. output (11 BU13) for internal calibration of the D.U.T. The output level must be exactly -30 dBm (50 Ω) and the output frequency exactly 21.99 MHz.

Important: This method is not suitable for checking the guaranteed error limits of the calibration source as the level meter is not normally accurate enough. Exact checking of the calibration level specification can be done using the method suggested in the chapter "Checking the Specifications".

5.6 Fault Localization in the Synthesizer

5.6.1 General Information

The synthesizer generates the first local oscillator (carrier) frequency (1st LO), the other carrier frequencies and various clock signals.
A general check of the function of the synthesizer can be made by measurements at the 1st LO output (socket [71], back panel). The 1st LO frequency depends on the receive frequency selected (FCENT for FSPAN = 0). Calculation of the 1st LO frequency for receive frequencies in all receive bands is indicated in chapter 5.6.3.

5.6.2 Checking the 10 MHz Reference Frequency

Use a spectrum analyzer (e.g. SNA-7, SNA-23/33) to check the 10 MHz output signal at BU13 [64] on the D.U.T. back panel.

5.6.3 Checking the 1st LO Frequency

Connect a spectrum analyzer, e.g. SNA-7, SNA-23/33 to the 1st LO output socket [71] of the D.U.T. Synchronize the D.U.T. externally to the 10 MHz from the SNA-7/23 via socket 10 [62]. Set the D.U.T. to FSPAN = 0 and FCENT as per the following table. set the D.U.T. to MANUAL (Sweep Mode [RUN] = MAN).

Measure the frequency and level of the 1st LO for each setting.
The level should be **> +10 dBm** for each frequency setting.

FCENT (D.U.T.)	1st LO frequency
2.5 GHz (Band 0)	6.92199 GHz
5.5 GHz (Band 1)	5.92199 GHz
13 GHz (Band 2)	6.710995 GHz
21 GHz (Band 3)	5.3554975 GHz

Table 5-6 Table for checking the synthesizer (1st LO)

If a fault is detected in this test, localize the fault further within the synthesizer module using the instructions in chapter 5.6 on page 5-10.

Relationship between the synthesizer frequency (1st LO) and the receive frequency (RF)

The 1st LO frequency depends on the selected receive frequency (FCENT for FSPAN = 0). The complete frequency range of the SNA-23 from 0 Hz to 30 GHz is split into four frequency bands (Band 0 to Band 3). The 1st LO frequency (synthesizer output) is used to convert the RF signal to the IF (421.99 MHz). The LO frequency is used directly for conversion in frequency bands 0 and 1. In band 2, the LO frequency is first doubled; in band 3, it is quadrupled. Multiplication of the 1st LO is performed by the "Fundamental Mixer" microwave module.
The 1st LO can be calculated in each frequency band using the following relationships. The frequency limits for the various receive bands are shown in table 5-7.

Band 0: 1st LO = RF +IF1 (4.42199 GHz)

Example: The SNA is tuned to a receive frequency of 2.5 GHz (FCENT). The frequency span (FSPAN) is 0 Hz. The synthesizer output frequency (1st LO) will then be:

1st LO = 2.5 GHz +4.42199 GHz = 6.92199 GHz

Band 1: 1st LO = RF + IF2 (421.99 MHz)

Example: The SNA is tuned to a receive frequency of 5.5 GHz (FCENT). The frequency span (FSPAN) is 0 Hz. The synthesizer output frequency (1st LO) will then be:

1st LO = 5.5 GHz +421.99 MHz = 5.92199 GHz

Band 2: $1st\ LO = \frac{RF + IF2\ (421.99\ MHz)}{2}$

Example: The SNA is tuned to a receive frequency of 13 GHz (FCENT). The frequency span (FSPAN) is 0 Hz. The synthesizer output frequency (1st LO) will then be:

1st LO = (13 GHz +421.99 MHz) : 2 = 6.710995 GHz

Band 3: $1st\ LO = \frac{RF + IF2\ (421.99\ MHz)}{4}$

Example: The SNA is tuned to a receive frequency of 21 GHz (FCENT). The frequency span (FSPAN) is 0 Hz. The synthesizer output frequency (1st LO) will then be:

1st LO = (21 GHz +421.99 MHz) : 4 = 5.3554975 GHz

Band limits and corresponding LO frequencies for SNA-23

The complete frequency range of the SNA-23 from 0 Hz to 30 GHz is split into four frequency bands (Band 0 to Band 3). The table below shows the exact frequency limits for these bands and the synthesizer LO frequencies for these bands.

Band	Frequency range(FCENT, FSPAN = 0)		Synthesizer output frequency (1st LO)
0	0 Hz	to 3.199 999 999 GHz	4.421 990 000 GHz to 7.621 989 999 GHz
1	3.2 GHz	to 7.499 999 999 GHz	3.621 990 000 GHz to 7.921 989 999 GHz
3	7.5 GHz	to 14.999 999 999 GHz	3.960 995 000 GHz to 7.710 995 000 GHz
0	15 GHz	to 30 GHz	3.855 497 500 GHz to 7.605 497 500 GHz

Table 5-7 Band limits and corresponding synthesizer output frequencies (1st LO)

5.7 Fault Localization in the Controller

The controller core is an AT CPU. The operating system used is MS-DOS. A knowledge of this operating system is assumed in the following . The DOS handbook is very useful for interpreting the messages and commands.

If a fault is suspected in the controller, start troubleshooting in the AT CPU.

5.7.1 Procedure when a Fault is Suspected in the Controller

- Switch on the SNA (make sure there is no disk in drive A:)
- Compare the instrument behavior with the normal boot up behavior described in chapter 4.1.
- Check the settings in the CMOS setup (see chapter 4.5)
- If the instrument does not boot the operating system when switched on, try to boot it from a bootable disk (see chapter 4.3)
- If error messages are displayed after the operating system and instrument software have loaded, or if the instrument software is aborted due to an error (2101 Debug Output is displayed), evaluate the error messages as indicated in chapter 4.4.