HP 8970B Option 020

Service Manual Supplement

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HP Part Number	Title
08970-90054	HP 8970B Noise Figure Meter Service Manual

About this Manual

This document is a supplement to the HP 8970B Noise Figure Meter Service Manual (08970-90054) and provides information useful for operating the HP 8970B Option 020. It also gives some troubleshooting tips.

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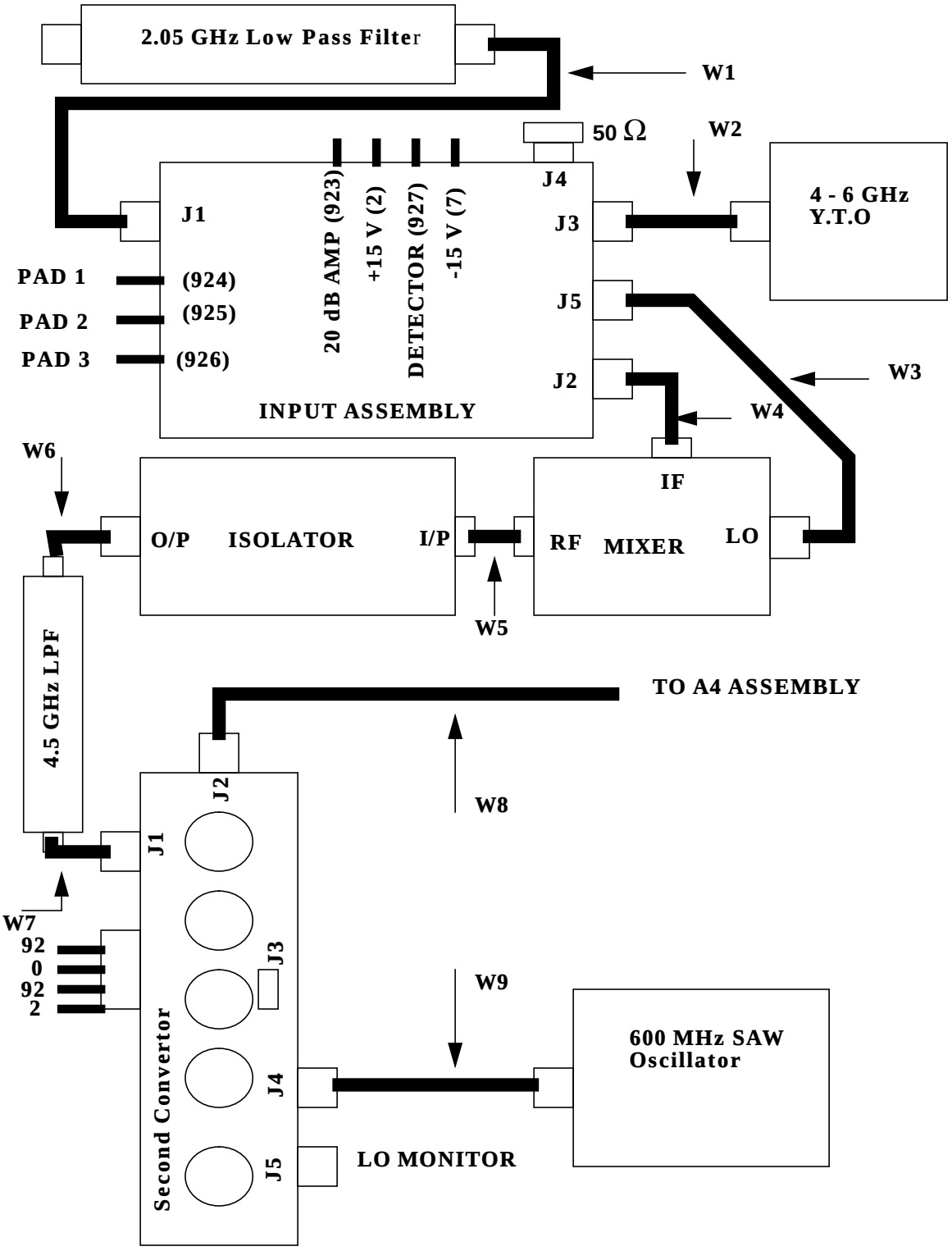
Block Diagram and Parts List

Block Diagram

Figure 1-1: HP 8970B Option 020 Front End Schematic



Front End

Figure 1-2: HP 8970B Front End Schematic

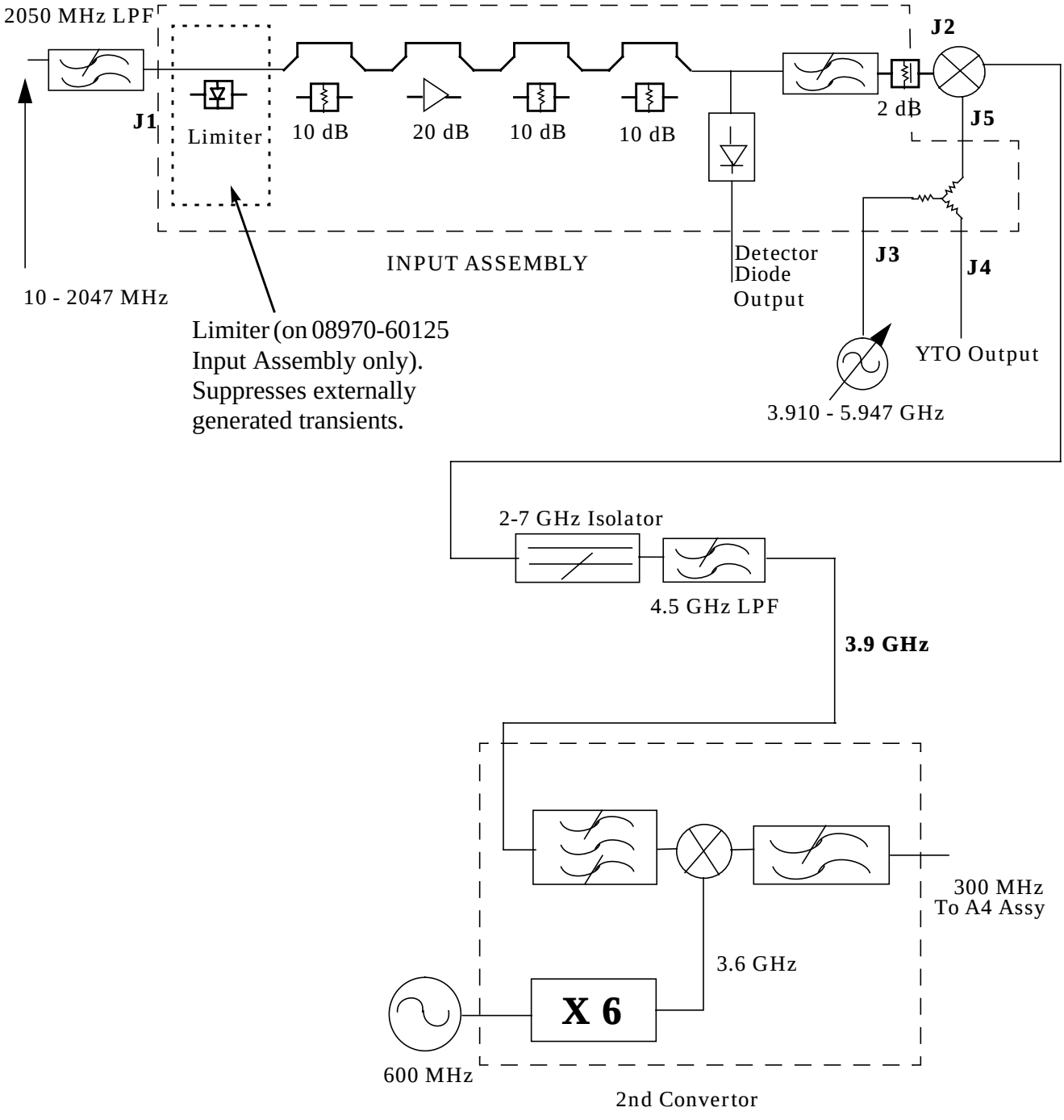
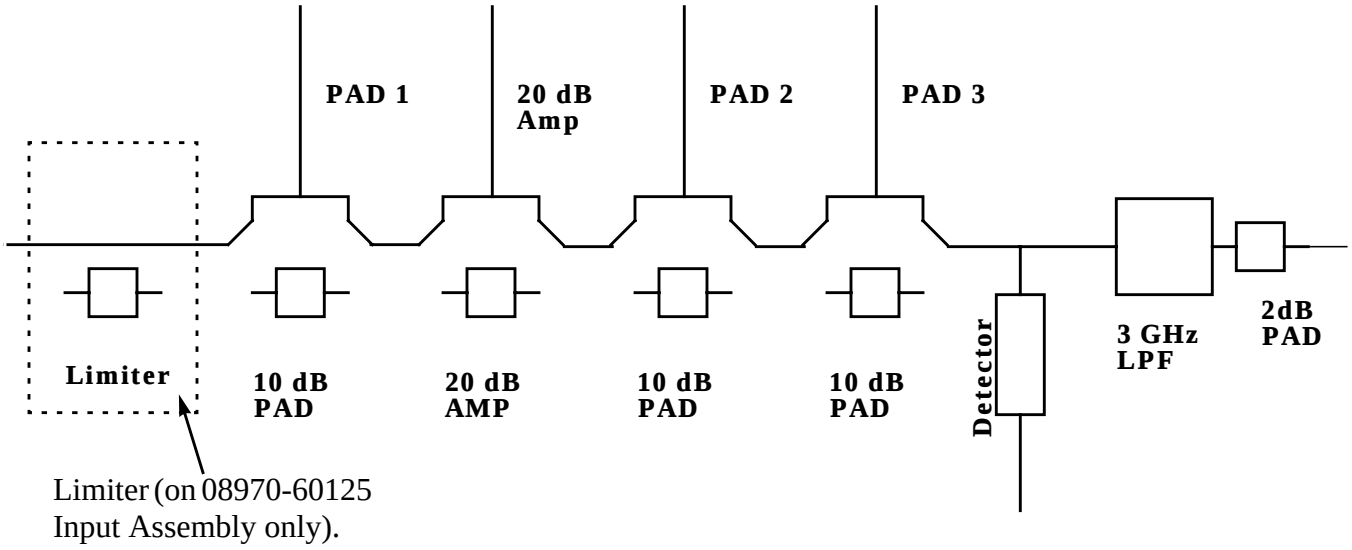


Figure 1-3: Schematic Representation of Input Assembly



This is a schematic representation of the RF input assembly. The amplifier section and each and each of the attenuator sections are switchable by the control lines.

On units using the Input Assembly 08970-60125, the Limiter suppresses externally generated transients.

In Figure 1-1 the numbers in brackets inside the input assembly refer to the wire colors.

The numbers at the side of the second convertor refer to the wire colors attached to the connector which connects up to the second convertor.

Material List

Table 1-1: HP 8970B Option 020 Material List - main differences for Option 020

Description	Part Number	Quantity
2.05 GHz Low Pass Filter	0955-0634	1
Semi-rigid cable W1	08970-20082	1
Input Assembly	08970-60097	1
Input Assembly	08970-60125[1]	1
2 to 8 GHz YIG Tuned Oscillator	0955-0630	1
YIG Tuned Oscillator Interface Board	08970-60045	1
YIG Tuned Oscillator Shield	08590-00047	1
Semi-rigid cable W2	08970-20081	1
Semi-rigid cable W3	08970-20083	1
Semi-rigid cable W4	08970-20085	1
Microwave Mixer	0955-0635	1
Semi-rigid cable W5	08970-20084	1
Microwave Isolator	0960-0638	1
Right Angle SMA(F) to SMA (M) Adapter W6	1250-1249	1
4.5 GHz Low Pass Filter	9135-0169	1
SMA(M) to SMA (M) Adapter W7	1250-2189	1
Second Convertor	5086-7909	1
600 MHz SAW Oscillator	08970-60093	1
Flexi Cable W8	83711-60035	1
Flexi Cable W9	83711-60035	1
Main Wiring Harness	08970-60046[2]	1
Firmware EPROM's	08970-80071/72[3]	2
20 MHz IF Assembly	08970-60050[4]	1
Driver Board Assembly	08970-60089[5]	1
SMA (M) 50 Ω Termination	0960-0053	1

1. Replaces 08970-60097 from prefix break 3811.
2. This is the same part number as the main instrument but different wires are used. The wires that are not used are tied back.
3. These replace 08970-80051/52
4. Replaces 08970-60003
5. Replaces 08970-60034

2

Theory of Operation

General

The input range of the instrument is 10 MHz to 2047 MHz.

The input signal is first low pass filtered, using the 2050 MHz filter, to avoid images.

The YIG tuned oscillator tunes over the range 3910 MHz to 5947 MHz to mix the incoming signal to a first IF of 3900 MHz.

The isolator ensures that any rejected signals are absorbed in the isolator and do not interfere with the front end detector circuitry.

The second convertor mixes 3900 MHz down to 300 MHz. There is a cavity tuned bandpass filter which is tuned for 3900 MHz. This is set at the factory and should not be adjusted. The LO input is 600 MHz, but this is multiplied up to 3600 MHz by a X6 circuit. The 3600 MHz can be monitored at the LO Monitor port.

The 600 MHz supplied to the second convertor comes from a 600 MHz SAW Oscillator. The frequency is adjusted for 600 MHz $\pm$ 50 KHz. The power should be > -3 dBm.

3

Adjustments

General

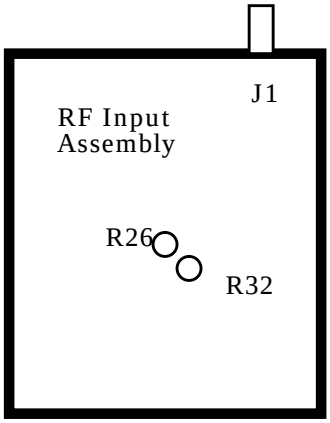
There are 2 adjustments that need to be made:

1. Input power detector gain and offset.
2. The 600 MHz SAW oscillator frequency adjustment.

Input power detector Gain and Offset Adjustment

Follow the adjustment procedure in section 5-13 of the Adjustments Chapter in the 8970B Service Manual with the following exceptions.

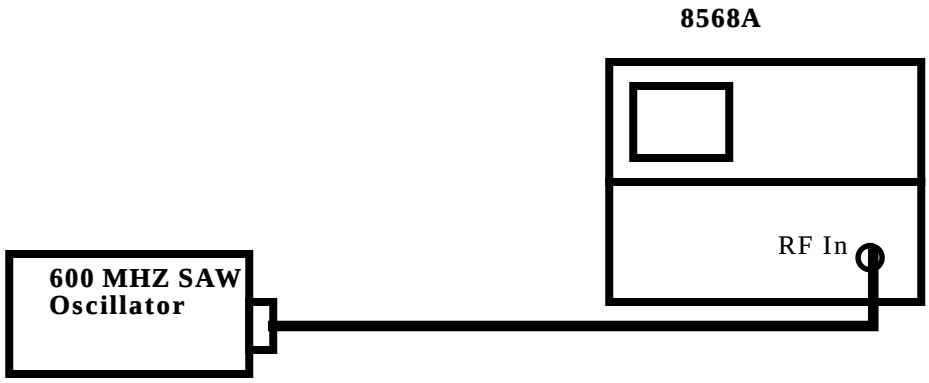
Figure 3-1: Input detector gain and offset adjustment



1. The input level must be -21 dBm $\pm$ 0.1 dB.
2. R32 is the offset adjustment.
3. R26 is the gain adjustment.

600 MHz SAW Oscillator Frequency Adjustment

Figure 3-2: 600 MHz SAW Oscillator Frequency Adjustment



1. Disconnect the 600 MHz SAW Resonator from the second convertor 600 MHz input.
2. On the 8568A. Press **PRESET, CENTRE FREQUENCY 600 MHz, SPAN 500 KHz**.
3. Connect the 600 MHz SAW Resonator to the 8568A RF Input.
4. Adjust R6 until the signal on the screen is 600 MHz $\pm$ 50 KHz.

4

Board Differences

General

As well as the complete front end being changed there are a number of board differences that need to be documented here.

Microprocessor Board

The same part number 08970-60033 is used in both instruments. However the firmware is different for the option 20 compared to the standard.

Table 4-1: Firmware Part Numbers

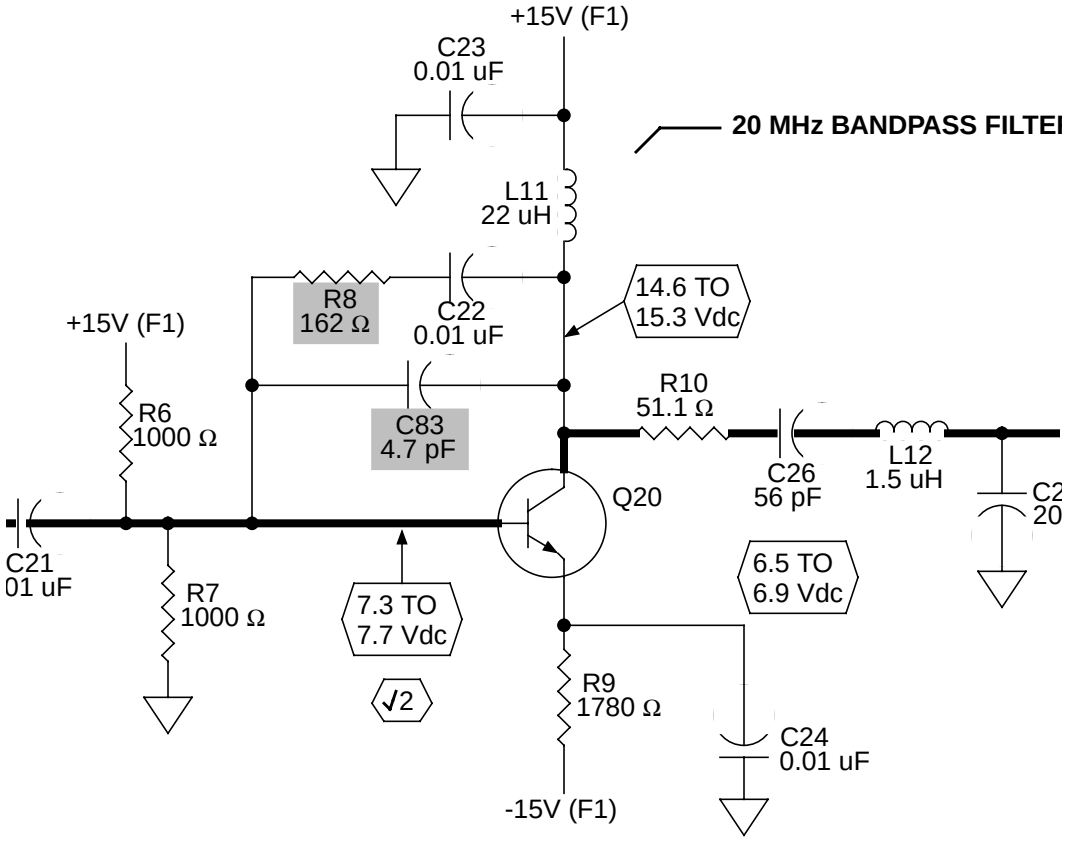
Options	ROM #1	ROM #2
STD	08970-80050	08970-80051
Option 20	08970-80070	08970-80071

20 MHz IF Assembly (08970-60050)

The 08970-60050 assembly has been created from the 08970-60003 assembly with the following changes.

1. C83 changes from 7.5 pF (0160-3029) to 4.7 pF (0160-3873)
2. R8 changes from 110 Ω (0757-0402) to 162 Ω (0757-0405)

Figure 4-1: Schematic differences in 08970-60050[1]



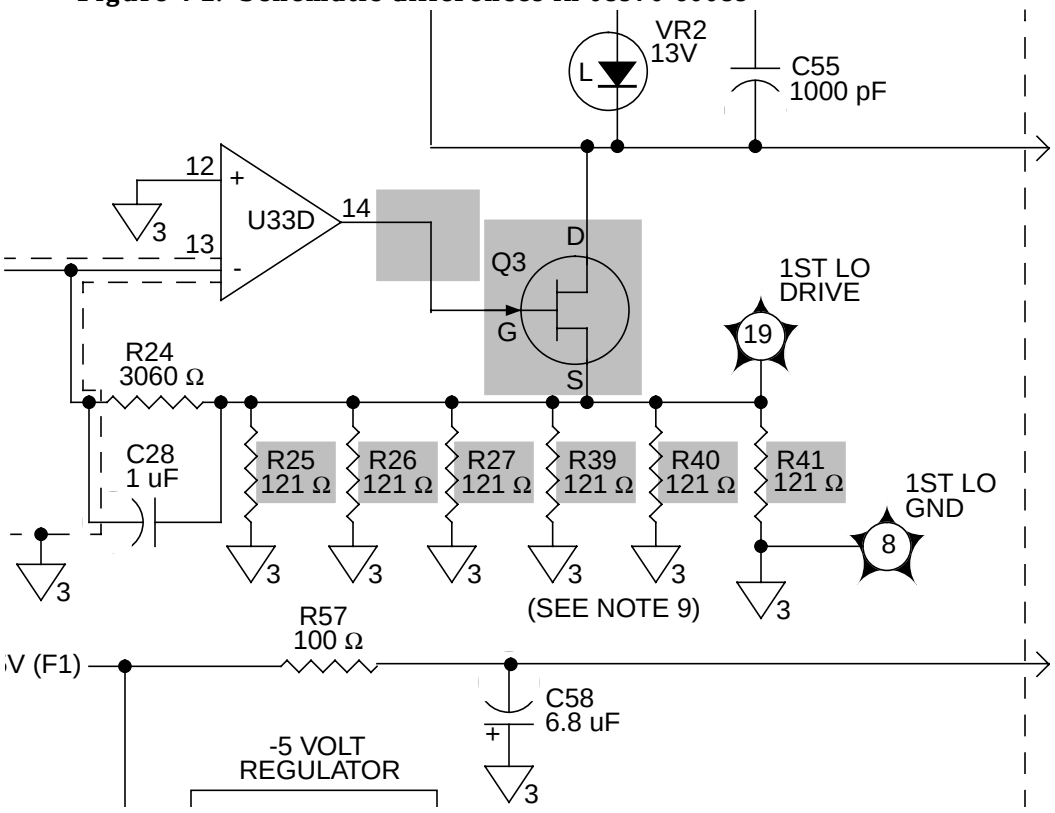
1. Differences are highlighted with a shaded background.

Driver Assembly (08970-60089)

The 08970-60089 assembly has been created from the 08970-60034 assembly with the following changes:

1. R25, 26, 27, R39, R40 and R41 change from 214.2 Ω (0699-1911) to 121 Ω (0699-3460)
2. Q2 is deleted and a wire is place between U33 pin 14 and the base of Q3.

Figure 4-2: Schematic differences in 08970-60089[1]



1. Differences are highlighted with a shaded background.

5

Fault-Finding Tips

General

The Option 20 front end is relatively easy to fault find because it is a combination of defined RF components.

Instead of using the noise source it is possible to use a signal generator to inject a signal and then trace the signal levels through the RF paths to the 300 MHz second IF using a spectrum analyzer. It is much easier to do it this way because the signals can be seen on the spectrum analyzer display.

Filter (0955-0634)

The specifications on this part are:

Table 5-1: 2050 MHz Low Pass Filter Specifications

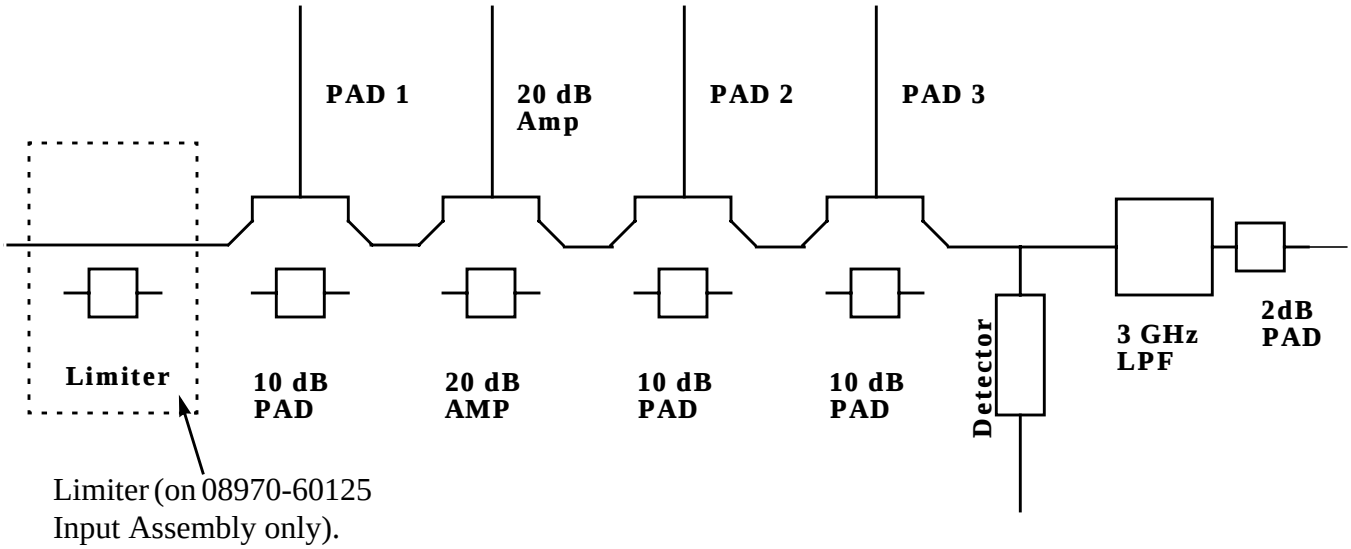
Frequency	Insertion Loss
10 MHz to 2050 MHz	< 0.5 dB
2.35 GHz to 3.85GHz	> 35 dB
3.85 GHz to 13.0 GHz	> 65 dB
13.0 GHz to 26.5 GHz	> 50 dB

The best way to measure this part is to use a network analyzer. An alternate way is to use a spectrum analyzer, e.g. 8593E with a tracking generator or a separate sweeper.

Verify over the frequency ranges above that the insertion losses are correct.

Input Assembly (08970-60097 or 08970-60125)

Figure 5-1: Input Assembly



The easiest way to determine any problems with this section is to use a signal generator or sweeper which can cover the frequency range 10 MHz to 2047 MHz and can output -20 dBm.

The main source of problem with this assembly is that the pads are not switching or the amplifier has been blown up. The common error when this is the case is error 27. The philosophy of repair for this assembly is board level repair so these diagnostics are intended to prove that the assembly is defective or not and replace it.

From the functionality viewpoint it is possible to check that pads and amplifier are working individually by using Special 63.X.

To verify the pads and amplifiers of with the 8970B completely boxed up use the procedure “RF Attenuator Checks” in the Service Sheet BD1 section of the standard 8970B manual. The voltages will be approximately correct.

It is also possible to measure the pads switching with the input section removed.

Using a 30 MHz signal at -20 dBm measure at J2 using a spectrum analyzer.

1. Select Special 63.0 and take a reference on the Spectrum Analyzer (straight through).
2. Select Special 63.1. The level should go down by ~10 dB from 1 (PAD 1).
3. Select Special 63.2. The level should increase by ~20 dB from 1 (AMP).
4. Select Special 63.4. The level should decrease by ~10 dB from 1 (PAD 2).
5. Select Special 63.5. The level should decrease by ~10 dB from 1 (PAD 3).

If it is necessary to look for power holes in any of the components then sweep the input and monitor the output over the desired frequency range.

The detector can be checked by going through the detector check as indicated in “Input power detector Gain and Offset Adjustment”, on page 3-2.

The 3 GHz LPF is board etched and there should be no reason why this would fail.

If there is low signal in the through path with Special Function 63.0 then it is either the coupling capacitors or the 2 dB pad is damaged.

The supply and control connections are shown in Figure 1-1.

YIG Tuned Oscillator (0955-0630)

The YTO has a range of 4 to 7 GHz but we use it over the range 3.910 to 5.947 GHz.

Check pins 1,2,7,8 and 9 for correct supply voltages.

Disconnect the YTO cable from J3 on the input assembly and connect this to a spectrum analyzer.

Set the HP 8970B to:

1. Start Frequency 10 MHz.
2. Stop Frequency 2047 MHz
3. Step Frequency 20 MHz

Set the Spectrum Analyzer to:

1. Start Frequency 3.9 GHz
2. Stop Frequency 6 GHz
3. Reference Level 20 dBm
4. Scale 2 dB/division

Ensure that the signal level measured on the spectrum analyzer is between 14 and 18.5 dBm.

Note You can monitor the YTO from J4, which is the unused side of the splitter. However, if you use this alternative, be aware that the levels will be approximately 3 dB lower than when monitoring at J3.

Mixer (0955-0635)

The labelling on the schematic in figure 1 may be a little confusing but that is due to the configuration that the mixer is being used in.

The input signal (10 MHz to 2047 MHz) is mixed up to a frequency of 3900 MHz (Lower Sideband) by and L.O varying between 3910 MHz and 5947 MHz.

The LO port is connected to the YTO 3910 MHz to 5947 MHz

The IF port is connected to the RF input 10 MHz to 2047 MHz

The RF port is a fixed frequency output at 3900 MHz

In order for the mixer to work correctly the input level to the L.O port should be greater than 10 dBm. This can be tested over the frequency range by carrying out the test in section 5.3 but measured at J5 rather than the YTO output.

Note J5 should be the same level as J4 (the other side of the splitter). Therefore you can make both YTO and Mixer measurements from J4.

The conversion loss is < 7dB. This is the loss between the IF port and the RF port with the LO > 10 dBm.

The best way to do this is at spot frequencies say 100 MHz steps or if the problem is at a known frequency then do it there. The example is for 100 MHz.

Setup the 8970B. Preset, Frequency 100 MHz, Special 63.0

Set the source for -20 dBm, 100 MHz

Measure the signal level at J2 and record it.

Connect the mixer in place and measure the signal at the RF port. This will be at 3900 MHz.

The difference between the 2 signal levels should be less than 7 dB.

Isolator (0960-0638)

This device will improve the match looking back from the 4 GHz low pass filter.

The insertion loss will be between 1 dB and 1.2 dB depending on the temperature.

This can be measured with a network analyzer, a spectrum analyzer and tracking generator or a spectrum analyzer and sweeper.

The operating frequency of the isolator is 2 to 7 GH but we need only check it 50 MHz either side of 3900 MHz.

4.5 GHz Low Pass Filter (9135-0169)

The specifications on this part are shown in Table 5-2.

These specifications can be verified by using a network analyzer, a spectrum analyzer with a tracking generator or a spectrum analyzer with a sweeper.

Table 5-2: 4500 MHz Filter Specifications

Frequency	Insertion Loss
DC to 4050 MHz	< 0.5 dB
DC to 4500 MHz	< 1 dB
6300 to 8400 MHz	>60 dB

Second Convertor (5086-7909)

This part contains a X6 multiplier, a bandpass filter, a mixer and a lowpass filter.

The 3900 MHz is mixed with the 600 MHz (multiplied by 6) to give a 300 MHz IF. Internally the 3900 MHz is bandpass filtered and the 300 MHz is lowpass filter to prevent the generation of images.

Under no circumstances should the bandpass filter be adjusted as this is a very complicated process and will impair the performance of the microcircuit.

1. J1 is the RF input at 3900 MHz.
2. J2 is the IF output at 300 MHz
3. J3 is not used
4. J4 is the LO input at 600 MHz. Power should be between -1 and +4 dBm.
5. J5 is the LO monitor at 3600 MHz. This is about -30 dBm with the above input range for the 600 MHz.

The conversion loss between the 3900 MHz input at J1 and the 300 MHz output at J2 is about 6 dB. With a -25 dBm input signal at J1 the output at J2 would be approximately -31 dBm.

It is possible to verify these levels by using a signal generator and a spectrum analyzer.

The supply connections are shown in Figure 1-1.

600 MHz SAW Oscillator (08970-60093)

This board delivers the 600 MHz to the second convertor.

Figure 3-2 shows the adjustment procedure.

The frequency should be 600 MHz $\pm$ 50 KHz

The power should be > -3 dBm

6

Board Details

Figure 6-1: 600 MHz SAW Oscillator Component Layout Drawing

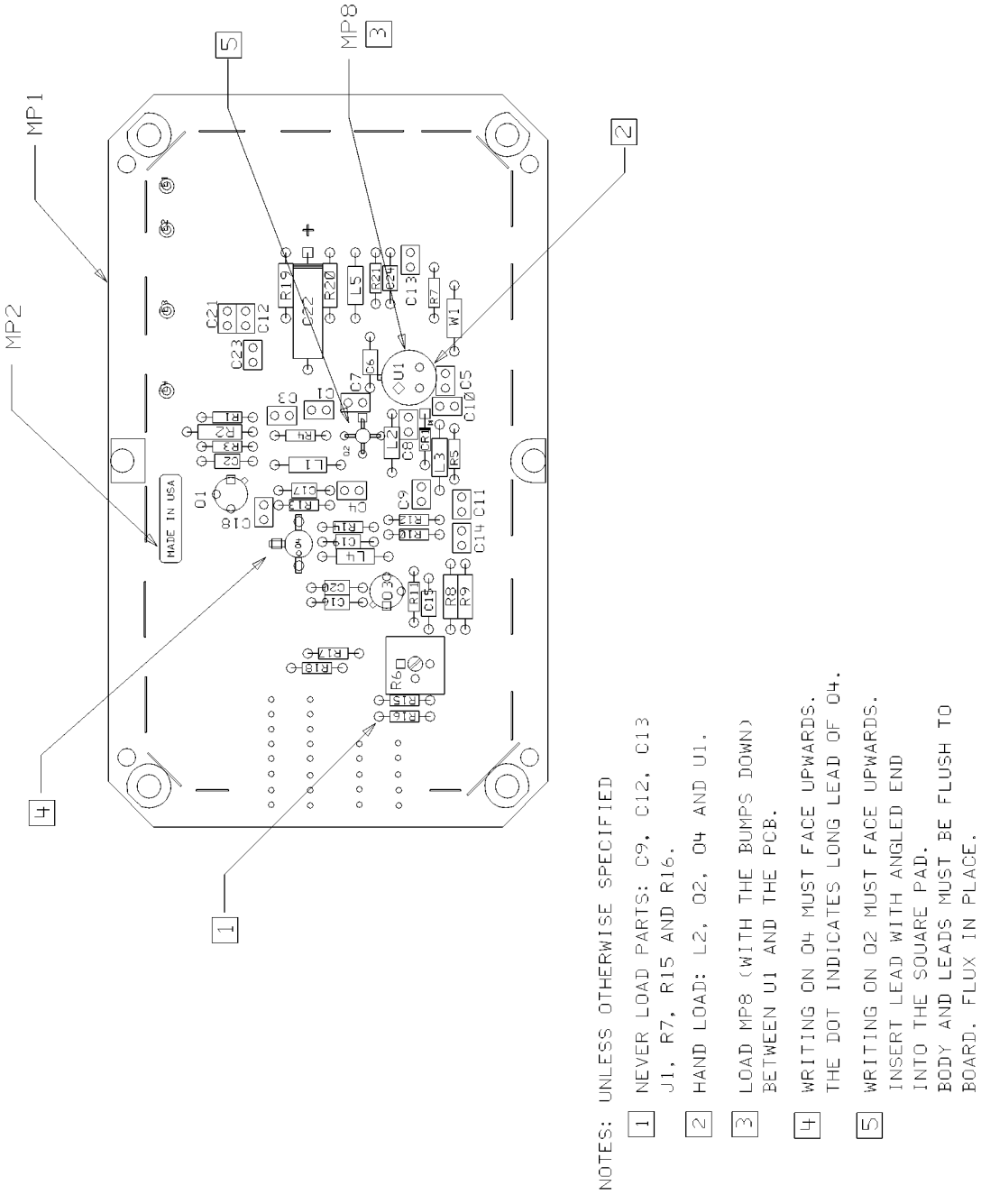


Figure 6-2: 600 MHz Schematic

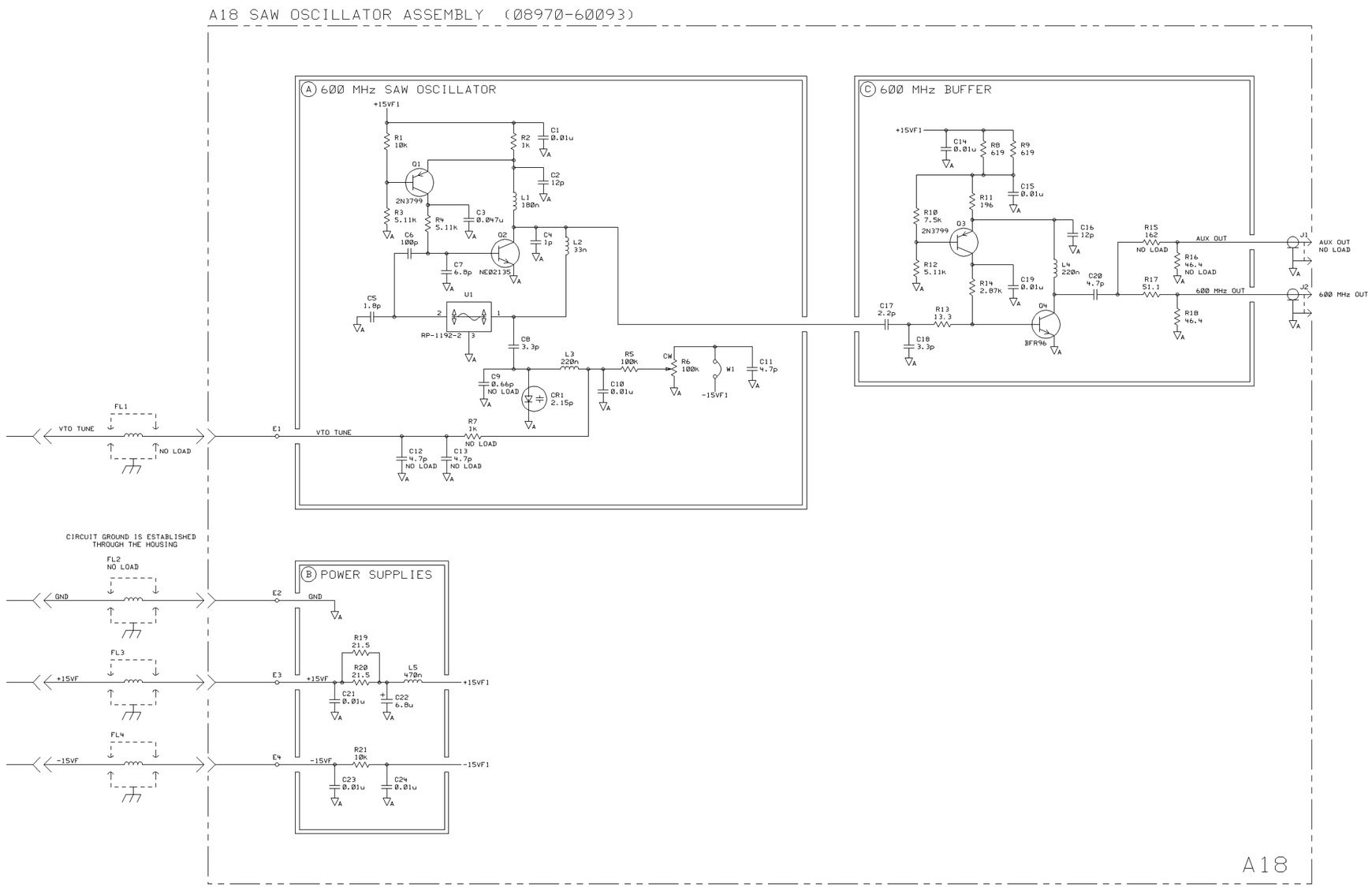


Figure 6-3: Input Section Component Layout Drawing (for Assembly 08970-60097)

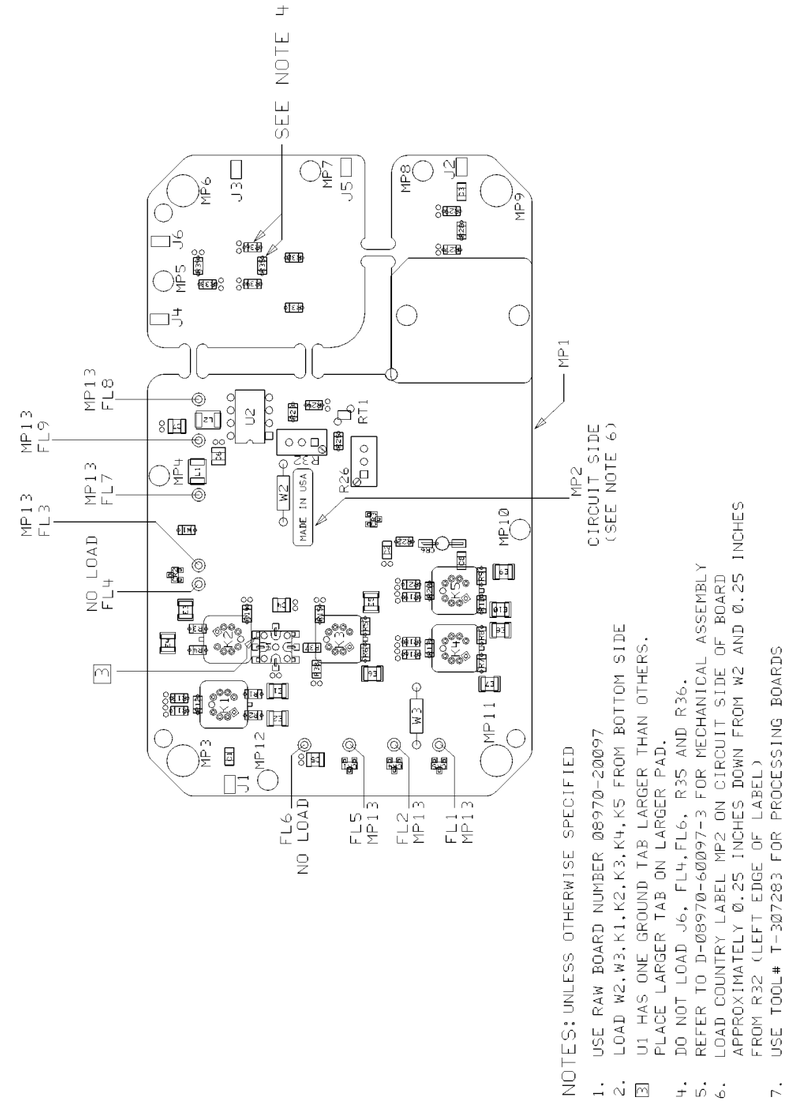


Figure 6-4: Input Section Schematic (for Assembly 08970-60097)

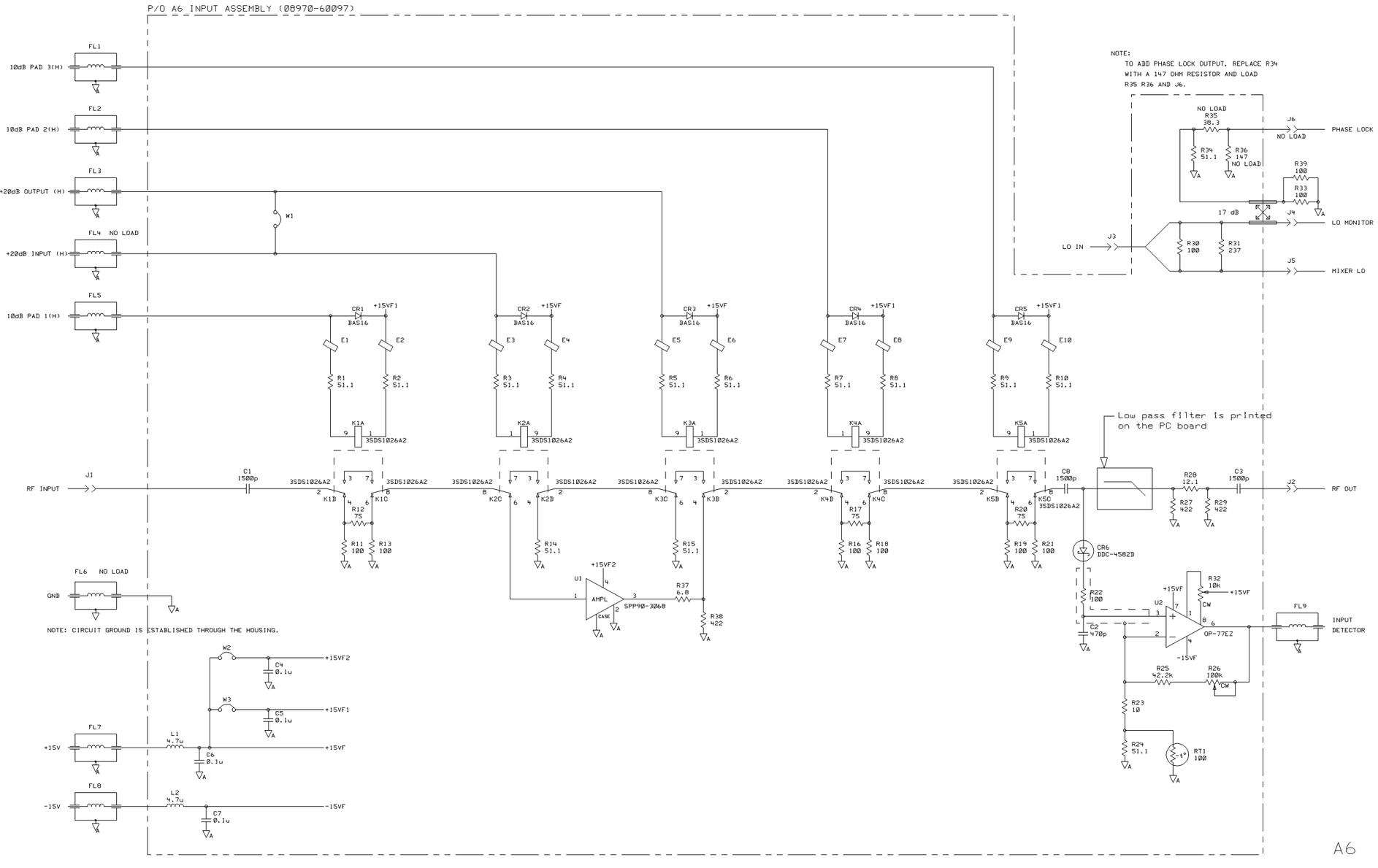


Figure 6-5: Input Section Component Layout Drawing (for Assembly 08970-60125)

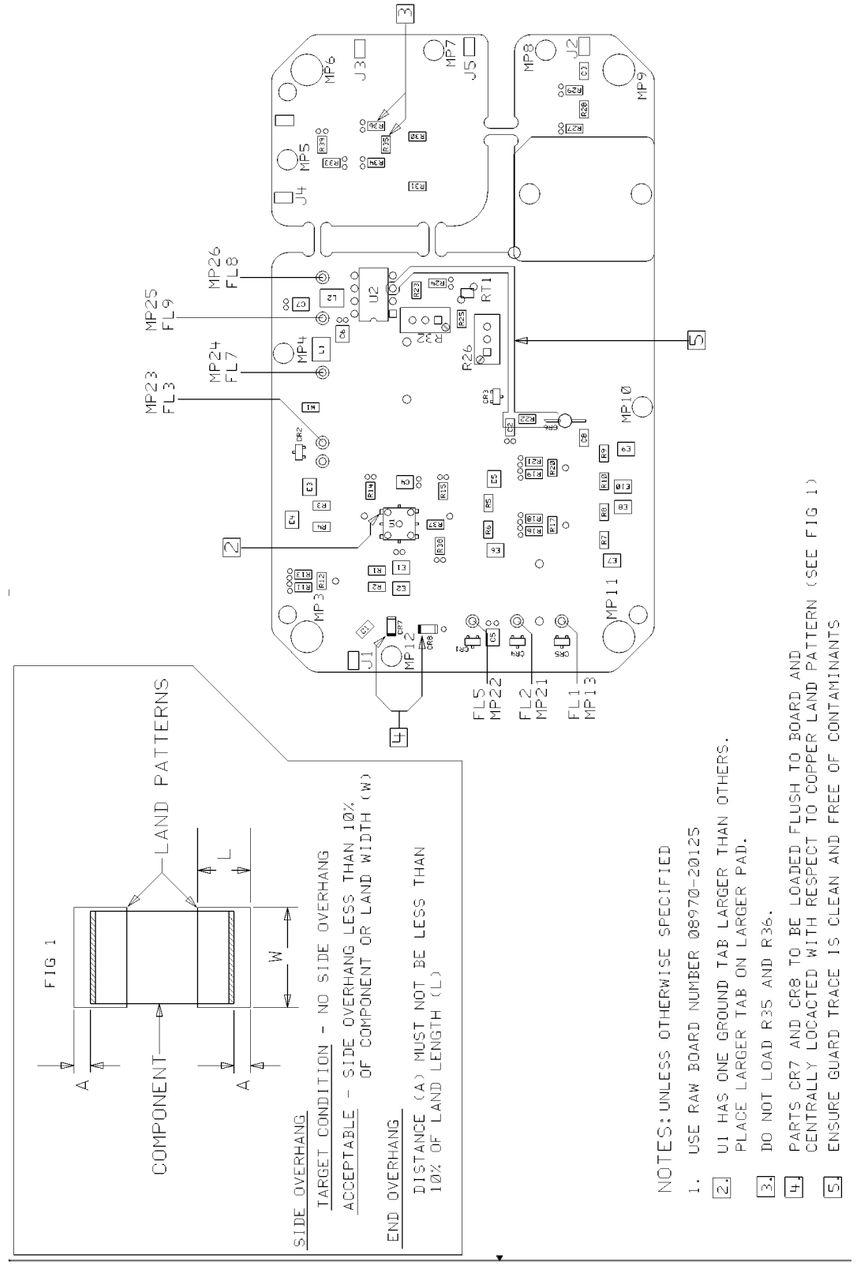


Figure 6-6: Input Section Schematic (for Assembly 08970-60125)

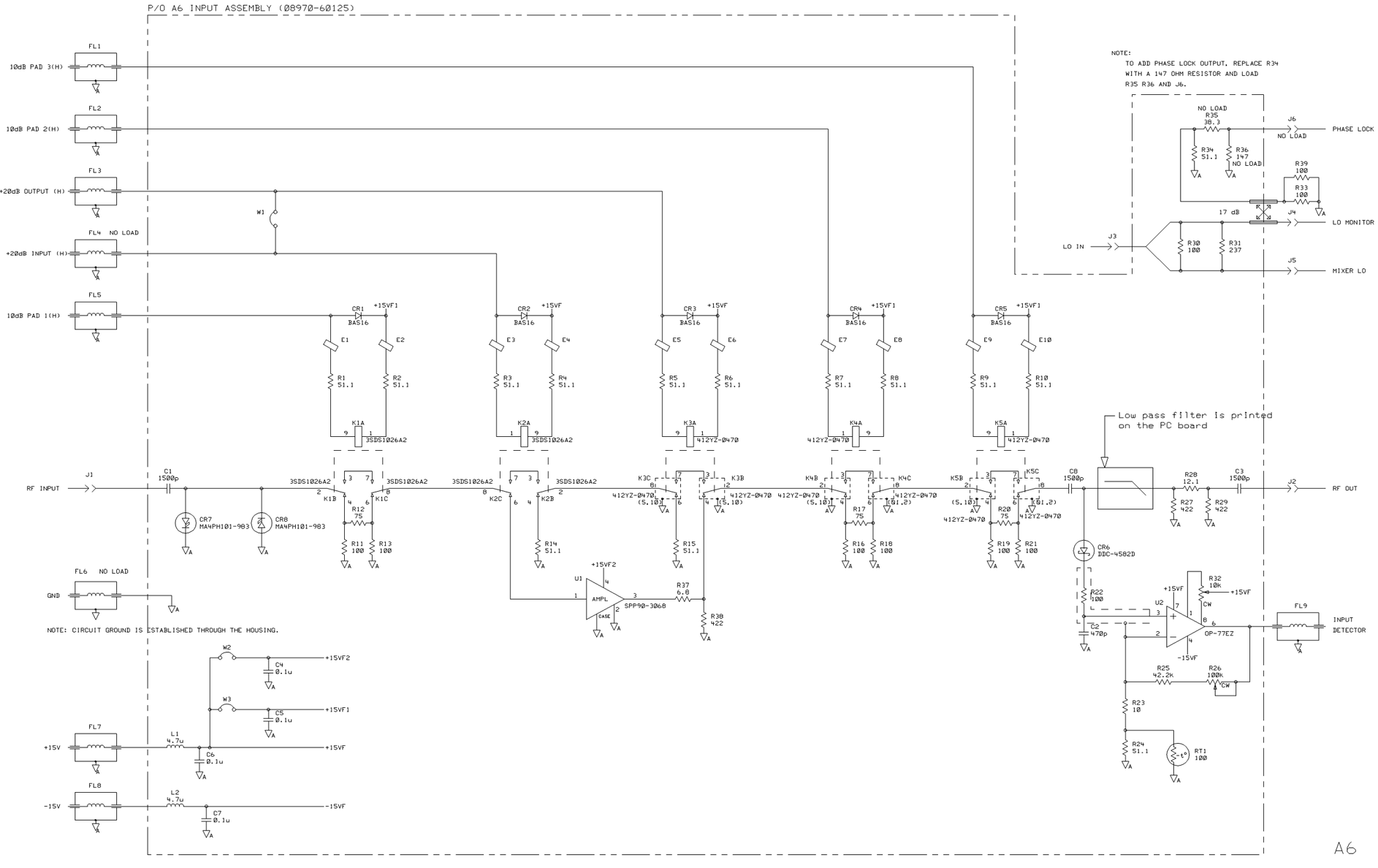
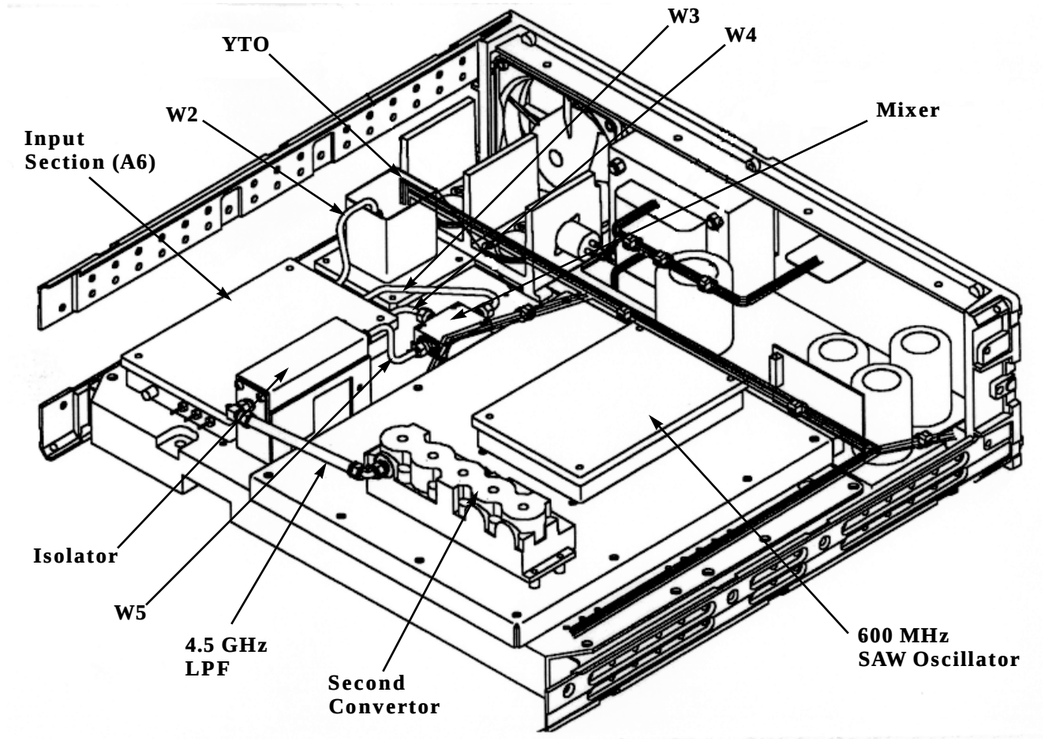


Figure 6-7: HP 8970B Option 20 Hardware



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