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### IMPORTANT!

This edition covers the 500 ps resolution PM6680 as well as the 250 ps Resolution PM6680B, in both Fluke and Philips versions  
The modifications necessary to obtain the higher resolution was introduced in PM 6680s with revision 15 of the main PCA (4031 100 48210). See yellow revision label for identification.

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### PM 6680 Performance Check Report

***Chapter 1***

# **Safety Instructions**

**WARNING:** These servicing instructions are for use by qualified personnel only. To reduce the risk of electric shock, do not perform any servicing other than that specified in the Operating Manual unless you are fully qualified to do so.

Authorized service and calibration of this instrument is available worldwide. A list of service centers is printed on the last page of this manual.

Read this chapter carefully before you check, adjust or repair an instrument.

## **Caution and Warning Statements**

You will find specific warning and caution statements where necessary throughout the manual.

**CAUTION:** Indicates where incorrect operating procedures can cause damage to, or destruction of, equipment or other property.

**WARNING:** Indicates a potential danger that requires correct procedures or practices in order to prevent personal injury.

This Timer/Counter has been designed and tested in accordance with safety class 1 requirements for Electronic Measuring Apparatus of IEC publication 1010-1, and CSA C22.2 No.231, and has been supplied in a safe condition.

This manual contains information and warnings that should be followed by the user and the service technician to ensure safe operation and repair in order to keep the instrument in a safe condition.

**WARNING:** The opening of covers or removal of parts, except those to which access can be gained by hand, is likely to expose live parts and accessible terminals which can cause death.

The instrument must be disconnected from all voltage sources before it is opened. Remember that the capacitors inside the instrument retain their charge even if the instrument has been disconnected from all voltage sources.

## **Grounding**

This instrument is connected to ground via a sealed three-core power cable, which must be plugged into socket outlets with protective ground contacts. No other method of grounding is permitted for this instrument.



The ground symbol on the rear panel indicates where the protective ground lead is connected inside the instrument. Never remove or loosen this screw.

When the instrument is brought from a cold to a warm environment, condensation may cause hazardous conditions. Therefore, ensure that the grounding requirements are strictly met. Power extension cables must always have a protective ground conductor.



Indicates that the operator should consult the manual.

**WARNING:** Any interruption of the protective ground conductor inside or outside the instrument, or disconnection of the protective ground terminal, is likely to make the instrument dangerous. Do not intentionally disrupt the protective grounding.

## **Disposal of Hazardous Materials**

**WARNING:** Disposal of lithium batteries requires special attention. Do not expose the batteries to heat or put them under extensive pressure. These measures may cause the batteries to explode.

A lithium battery is used to power the nonvolatile RAM in this instrument. Our world suffers from pollution, so don't throw batteries into your wastebasket. Return used batteries to your supplier or to the Philips or Fluke organization in your country.

## **Line Voltage**

The Timer/Counter can be powered by any voltage between 90 and 265 VAC without any range switching. This makes it suitable for all nominal line voltages between 100 and 240 V.

### **• Replacing Components in Primary Circuits**

Components that are important for the safety of this instrument may only be replaced by components obtained from your local Philips or Fluke organization. After exchange of the primary circuits, perform the safety inspection and tests, as described in Chapter 5, "Repair".

### **• Fuses**

This instrument is protected by an ordinary 1.6 A slow blow fuse mounted inside the instrument. NEVER replace this fuse without first examining the Power Supply Unit.

***Chapter 2***

# ***Performance Check***

# General Information

**WARNING:** Before turning on the instrument, ensure that it has been installed in accordance with the Installation Instructions outlined in Chapter 3 of the Operators Manual.

This performance procedure is intended to:

- Check the instrument's specification.
- Be used for incoming inspection to determine the acceptability of newly purchased instruments and recently recalibrated instruments.
- Check the necessity of recalibration after the specified recalibration intervals.

NOTE: The procedure does not check every facet of the instrument's calibration; rather, it is concerned primarily with those parts of the instrument which are essential for determining the function of the instrument.

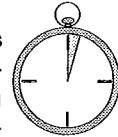
It is not necessary to remove the cover of the instrument to perform this procedure.

If the test is started less than 20 minutes after turning on the instrument, results may be out of specification, due to insufficient warm-up time.

\*) Two of the cables must have 10 ns difference in delay, for example: 5 ns and 15 ns.

## Preparations

Power up your instruments at least 20 minutes before checking to let them reach normal operating temperature. Failure to do so may result in certain test steps not meeting equipment specifications.



## Front Panel Controls

### Power-On Test

At power-on the timer/counter performs an automatic self-test of the following:

- Microprocessor
- RAM
- ROM
- Measuring circuits
- Display

If a GPIB interface is installed, the GPIB address is displayed.

If there are any test failures, an error message is shown.



Fig. 2-1 Text on the display

- Turn on your counter and check that all segments light up on the display and that no error message appears.

### Internal Self-Tests

The built-in test programs from the power-on test can also be activated from the front panel as follows:

- Enter the Auxiliary Menu by pressing **AUX MENU**.
  - Select the test submenu by pressing **SELECT** up or down.
  - Enter the test menu by pressing the **ENTER** key.
- Selections for internal self-tests are:

- 1 TEST RO (ROM)
  - 2 TEST RA (RAM)
  - 3 TEST ASIC (Measuring Logic)
  - 4 TEST DISP (Display Test)
  - 5 TEST ALL (Test 1 to 4 in sequence)
- Use **SELECT/SET** to select TEST ALL, then press **ENTER**.
  - If any fault is detected, an error message appears on the display and the program halts.
  - If no faults are detected, the program returns to measuring mode.

Type of instrument	Required Specifications	Suggested Instrument
LF Synthesizer	Square; Sine up to 2 MHz	PM 5193
Digital Multimeter	to 300 VAC & VDC	PM 2518; Fluke 77
Power Splitter		PM 9584/02
T-piece		PM 9067; Y9107
Termination	50 Ω	PM 9585; Y9103
Low pass filter	50 kHz	PM 9665B/01
Reference oscillator	10 MHz $1 \times 10^{-8}$ for 01 to 04 oscillator $1 \times 10^{-12}$ for 05 osc.	Counter with calibrated PM 9691 Rubidium, PM6685R
HF signal generator	to 2.1 GHz for PM9621, to 5 GHz for PM9624 & 25	Fluke 6062A Wiltron 6717B-20
Pulse Generator	to 125 MHz	PM 5786B; PM 5781
Oscilloscope with probes	350 MHz	PM 3295
Power Supply	min 40 Vdc	PM2811/113, PE 1537; PE 1542
BNC-cables	5 to 7 cables	*)

Table 2-1 Recommended Test Equipment

## Keyboard Test

This test verifies that the timer/counter responds when you press any key. To check the function behind the keys, see the tests further on in this chapter.

Press the keys as described in the left column and look on the display for the text, as described in the second column. Some keys change more text on the display than described here. The display text mentioned here is the text mostly associated with the selected key.

**NOTE:** For the instrument to respond correctly, this test must be carried out in sequence and you must start with the Preset setting.

Key(s)	Display	Pass /Fail	Note
<b>STAND-BY</b>	Display Off		Red LED beside the key On
<b>ON</b>	Backlight on		
<b>PRESET ENTER</b> ENTER is not required for PM 6680B	DEFAULT? 0		Default setting
<b>EXT REF</b>	EXT REF		
<b>Input A</b>			
<b>FILTER</b>	FILTER		
<b>IMP</b>	50 Ω		
<b>SLOPE</b>	–		
<b>COUPL</b>	DC		
<b>AUTO</b>	1X		
<b>ATT</b>	10X		
<b>SET A 1 . 7 3</b>	1.73 V Enter		
<b>ENTER</b>	0		
<b>A ↔ B</b>	A ↔ B		
<b>Input B</b>			
<b>SLOPE</b>	–		
<b>IMP</b>	50 Ω		
<b>SET B 0 . 9 8 -</b>	–0.98 V Enter		
<b>ENTER</b>	0		
<b>COUPL</b>	AC		
<b>ATT</b>	10X		
<b>COM A</b>	COM A		
<b>HOLD OFF ON</b>	HOLD OFF		
<b>HOLD OFF SET</b>	10 <sup>-6</sup>		
<b>PRESET</b>	0		
<b>Other</b>			
<b>PRESET ENTER</b>	DEFAULT? 0		Default setting
<b>MEAS TIME SET</b>	200 <sup>-3</sup> s		
<b>SELECT ↑</b>	500 <sup>-3</sup> s		
<b>ENTER</b>	0		
<b>DISPL HOLD</b>	DISPL HOLD		
<b>DISPL HOLD</b>			
<b>SINGLE</b>	SINGLE		
<b>FUNCTION ←</b>	VOLT A MAX/MIN		
<b>FUNCTION ←</b>	RISE/FALL A		

Key(s)	Display	Pass /Fail	Note
<b>FUNCTION →</b>	VOLT A MAX/MIN		
<b>FUNCTION →</b>	FREQ A		
<b>AUX MENU</b>	Previous AUX MENU selection (TEST, if you have done Internal self-test)		
<b>RESTART</b>	0		
<b>PRESET ENTER</b>	DEFAULT? 0		Default setting
ENTER is not required for PM 6680B			
<b>ARM START</b>	OFF		
<b>RESTART</b>	0		
<b>ARM STOP</b>	OFF		
<b>CHECK</b>	10.00000000 <sup>6</sup> Hz*		Start counting
<b>MATH SELECT ↓ ENTER</b>	OFF ON		
<b>K= 2</b>	2		
<b>ENTER</b>	20.00000000 <sup>6</sup> Hz*		Counting
<b>L= Xn-1 ENTER</b>	30.00000000 <sup>6</sup> Hz*		Counting
<b>L=</b>	n-1		
<b>0 ENTER</b>	20.00000000 <sup>6</sup> Hz*		Counting
<b>L= Xo ENTER</b>	40.00000000 <sup>6</sup> Hz*		Counting
<b>L=</b>	20.00000000 <sup>6</sup> Hz*		
<b>CLEAR</b>	0		
<b>4 EE 6 ENTER</b>	24.00000000 <sup>6</sup> Hz*		Counting
<b>M= . 5</b>	0.5		
<b>ENTER</b>	48.00000000 <sup>6</sup> Hz*		Counting
<b>STAT</b>	OFF		
<b>ENTER</b>	48.00000000 <sup>6</sup> Hz*		Counting
<b>FUNCTION← (6 times)</b>	TOT A-B MAN		
<b>TOT St/St</b>	Gate LED lit		
<b>MENU</b>	Displays all available functions, processes and input controls. Selected items are blinking.		
<b>PRESET ENTER</b>	DEFAULT? 0**		Default setting
ENTER is not required for PM 6680B			

**Table 2-2** Keyboard test.

\* The LSD digit may vary.

\*\* MENU is not disabled by setting DEFAULT, press menu again.

# Short Form Specification Test

## Sensitivity and Frequency Range

- Press the **PRESET** key to set the timer/counter in the default setting. Then confirm by pressing **ENTER**.
- Select **IMP A = 50 Ω** and **Non AUTO, (X1)**.
- Connect a signal from a HF generator to a BNC power splitter.
- Connect the power splitter to your counter and an oscilloscope.
- Set input impedance to  $50 \Omega$  on the oscilloscope.
- Adjust the amplitude according to the following table. Read the level on the oscilloscope. The Timer/Counter should display the correct frequency.

Frequency	Level			Pass/Fail		
	MHz	mV <sub>PP</sub>	mV <sub>RMS</sub>	dBm	Input A	Input B
1	60	20	-21			
25	60	20	-21			
50	60	20	-21			
160	90	30	-17			
200	120	40	-15			max 160MHz
225	120	40	-15			

**Table 2-3** Sensitivity for A & B inputs at various frequencies

- Connect the signal to input B.
- Select **IMP B = 50 Ω** and **SWAP A ↔ B** on the counter.
- Repeat the above measurements for input B.

## Check VMAX/VMIN

Check DAC for trigger level settings.

- Set your timer/counter in default setting by pressing **PRESET**, then press **ENTER**.
- Select DC-coupling,  $1 M\Omega$  input impedance and **VOLT A MAX/MIN**, but do not connect any input signal.
- The counter should now indicate  $V_{MAX} = 0 \pm 30 mV$  and  $V_{MIN} = 0 \pm 30 mV$ .
- Connect a  $4.00 V_{DC}$  level to channel A, using an external low pass filter on the input.
- The readings should be  $V_{MAX} = 4.00 \pm 0.12 V$ ,  $V_{MIN} = 4.00 \pm 0.12 V$ .
- Change the DC level to  $40 V$ . The counter should indicate  $V_{MAX} = 40.0 V \pm 1.6 V$ ,  $V_{MIN} = 40.0 \pm 1.6 V$ .
- Repeat the measurement with inverted polarity.
- Connect a sinusoidal signal to channel A with an amplitude  $4.00 V_{PP}$  and a frequency of  $100 kHz$ . The indication should be  $V_{MAX} = 2.00 \pm 0.28 V$ ,  $V_{MIN} = -2.00 \pm 0.28 V$ .
- Change the amplitude to  $18 V_{PP}$ .
- The display should read  
 $V_{MAX} = 9.0 \pm 1.6 V$ ,  $V_{MIN} = -9.0 \pm 1.6 V$ .
- Select **SWAP A ↔ B**, and connect the signal to channel B. Repeat the measurements for B as described above.

## Trigger Indicators and Controls

NOTE: This test must be performed in the sequence given.

- Press the **PRESET** key, then press **ENTER** to set the Timer/ Counter in the default setting.
- Select **Non AUTO, ATT X1, and IMP 1 MΩ** for channel A.
- Connect the following signal to channel A:  
 Sine,  $10 kHz$ ,  $0.9 V_{PP}$ , and  $+ 0.50 V_{DC}$ .
- Verify that the three modes for the trigger indicator are working properly by changing the trigger level:

Press the **SET A** key and enter **1** via the keyboard, then verify by pressing **ENTER**. Check the trigger indicator according to the following table.

Press the **SET A** key and enter **-1** via the keyboard, then verify by pressing **ENTER**. Check the trigger indicator according to the following table.

Press the **SET A** key and enter **0** via the keyboard, then verify by pressing **ENTER**. Check the trigger indicator according to the following table.

Manually set trigger level	Trigger indicator	Pass/Fail	
		Input A	Input B
+ 1.0 V	off		
- 1.0 V	on		
0.0 V	blinking		

**Table 2-4** Trigger indicator check

- Select **SWAP A ↔ B**, and **Coupl B = AC**, and repeat the exercise for channel B.
- Deselect **SWAP A ↔ B**, connect the generator to channel A and check the trigger settings and indicators according to the following table.

Trigger setting	Trigger indicator	Pass/Fail	
		Input A	Input B
SET A = 0 V	blinking		
COUPL = DC	on		
SET A = 0.7 V	blinking		
IMP = 50 Ω	off		
SET A = 0.2 V	blinking		
COUPL = AC & IMP = 1 MΩ	blinking		
ATT = X10	off		
SET A = 0.0 V	blinking		
ATT = X1	blinking		

**Table 2-5** Trigger level check

- Select **SWAP A ↔ B**.
- Select **COUPL = AC** on channel B, and repeat the previous settings for channel B.
- Connect the signal to channel A.
- Only the trigger indicator for channel A should be blinking.
- Press **COM A**.
- Both indicators should be blinking.
- Connect the signal to channel B.
- No trigger indicator should be blinking.

## Reference Oscillators

X-tal oscillators are affected by a number of external conditions like ambient temperature and supply voltage but also by ageing. Therefore it is hard to give limits for the allowed frequency deviation. The user himself must decide the limits depending on his application, and recalibrate the oscillator accordingly. See the Preventive Maintenance chapter.

Oscillator	Max temperature dependence	Max ageing month	Max ageing year
Standard, 01	$\pm 100$ Hz	$\pm 5$ Hz	$\pm 50$ Hz
PM 9678B, 02	$\pm 10$ Hz	$\pm 1$ Hz	$\pm 5$ Hz
PM 9690, 04	$\pm 0.15$ Hz	$\pm 0.2$ Hz	$\pm 1$ Hz
PM 9691, 05	$\pm 0.05$ Hz	$\pm 0.1$ Hz	$\pm 0.75$ Hz

Table 2-6 Deviation (for PM 9690 and PM 9691 after 48 hours warm up time)

To check the accuracy of the oscillator you must have a calibrated reference signal that is at least five times as stable as the oscillator that you are testing, see the following table. If you use a non 10 MHz reference, you can use the mathematics in PM 6680 to multiply the reading.

- Set the counter to default settings by pressing **PRESET** and **ENTER**.
- Connect the reference to input A
- Check the readout against the accuracy requirements of your application.

### • Acceptance Test

As an acceptance test the following table gives a worst case figure after 30 minutes warm up time. All deviations that can occur in a year are added together.

Oscillator	Frequency readout	Suitable reference	Pass /Fail
Standard, 01	10.00000000 MHz $\pm 150$ Hz	PM 9678B	
PM 9678B, 02	10.00000000 MHz $\pm 15$ Hz	PM 9690	
PM 9690, 04	10.00000000 MHz $\pm 2$ Hz	PM 6685R	
PM 9691, 05	10.00000000 MHz $\pm 1$ Hz	PM 6685R	.

Table 2-7 Acceptance test for oscillators

## Resolution Test

- Connect a pulse generator to a power splitter.
  - Connect one side of the power splitter to the A input of the counter via a coaxial cable.
  - Connect the other side of the power splitter to the B input of the counter.
- Settings for the pulse generator.  $1\text{ }\mu\text{s}-\text{stairway}$
- Amplitude = 1 VPP, (high level +1V and low level 0V)
  - Period approximately 1  $\mu\text{s}$
  - Duration = approximately 50 ns
  - Rise time 2 ns
- Settings for the timer/counter, after Preset:
- Function = Time A-B

- Single
- Press **STAT** key under PROCESS
- Press **SELECT** key until display show 'ST DEV'.
- Meas Time = 50  $\mu\text{s}$
- A and B inputs:
  - 50  $\Omega$  input impedance
  - Non AUTO
  - Trigger level = 0.5V
  - DC coupling
- The result should be (std dev)  $< 0.25 \times 10^{-9}$  s for PM 6680B and  $< 0.5 \times 10^{-9}$  s for PM 6680.

## Rear Input/Output

### INT REF OUT

- Connect an oscilloscope to the 10 MHz output on the rear of the counter. Use coaxial cable and 50  $\Omega$  termination.
- The output voltage is sine wave shaped and should be above 1.4 VPP.

### GATE OPEN Output

- Set your timer/counter in Default setting by pressing the **PRESET** key followed by **ENTER** key.
- Select CHECK, Non AUTO, and Meas Time = 5 ms.
- Connect the oscilloscope to the Gate Monitor output via a coaxial cable. Set the oscilloscope to 1ms/division.
- The Gate Monitor output should be a pulse similar to the following figure.

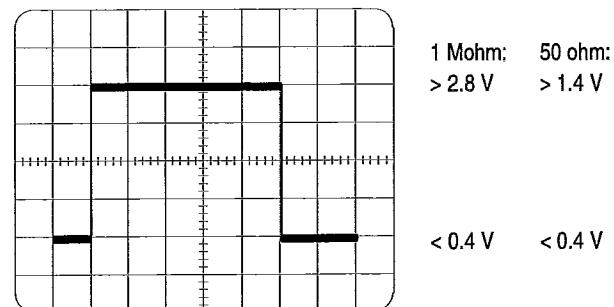


Fig. 2-2 Signal on gate open output

### EXT REF Input

- Set the counter to Default Setting by pressing **PRESET** and **ENTER**.
- Apply 10 MHz sine to input A equipped with a T-piece and to Ext Ref input at the rear, terminated with 50  $\Omega$ . Amplitude on 10 MHz signal; 500 mVRMS, (1.4 VPP)
- Select Ext Ref.
- The display should show  $10.0000000^6$  Hz  $\pm 5$  LSD.

## EXT ARM INPUT

- Press the **PRESET** key, and confirm with **ENTER** key, to set your timer/counter in the Default setting.
- Use the same settings as described in 'EXT REF input' above.
- The counter measures and displays 10 MHz.
- Press **START** key under ARM.
- Press **SELECT** key until display shows 'POS', confirm with **ENTER** key.
- The counter does not measure.
- Connect a pulse generator to Ext Arm input.
- Settings for pulse generator: single shot pulse, amplitude TTL = 0 - 2 V<sub>PP</sub>, and duration = 10 ns.
- Apply one single pulse to Ext Arm input.
- The counter measures once and shows 10 MHz on the display.

## Trig Level Outputs

- Press the **PRESET** key, and **ENTER** to confirm, to set the timer/counter in the default setting.
- Connect a voltmeter to TRIG LEVEL A(B) OUT at the rear.
- Set the Trigger Level (SET A/B) on the front to the following values, and verify the voltmeter's readout:

SET A(B)	Readout	Pass/Fail	
		Input A	Input B
+ 5.00 V	+ 0.5 V ± 0.06 V		
- 5.00 V	- 0.5 V ± 0.06 V		
0.00 V	0 V ± 0.05 V		

Table 2-8 Trigger level outputs check

## Probe Comp View

- Press the **PRESET** key to set the timer/counter in default setting, and confirm with **ENTER**.

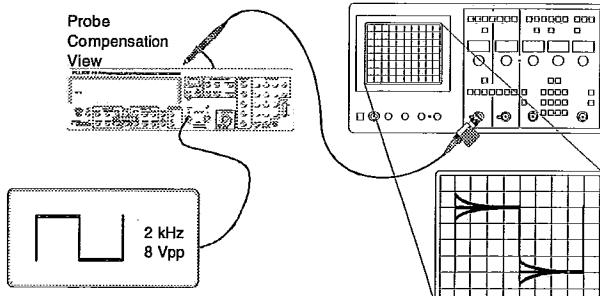


Figure 2-3 Adjustment of the counters probe.

- Select TIME A-B, non AUTO, x1 and DC for both channels.
- Apply a 2 kHz square wave with 4 V<sub>PP</sub> amplitude to Input A via a BNC-cable.
- Use an oscilloscope to check the signal at Probe Comp View, at the rear. The square wave will have the same step response and 4 V<sub>PP</sub> amplitude.
- Select ATT = X10.
- Check that the square wave is 2 kHz and 0.4 V<sub>PP</sub>.

- Repeat this test for channel B.

## Measuring Functions

Preparation for Check of Measuring Function:

- Connect a 10 MHz sine wave signal with 2.0 V<sub>PP</sub> amplitude into 50 Ω to Input A.
- Select the measuring function as in the 'Selected Function' column and check that the timer/counter performs the correct measurement, by displaying the result as shown under the "Display" column in the following table.

Selected Function	Display	Note	Pass/Fail
PRESET ENTER	DEFAULT? 10 MHz <sup>2)</sup>	Default setting	
ENTER is not required for PM 6680B			
IMP A 50 Ω	10 MHz <sup>2)</sup>		
Non AUTO	10 MHz <sup>2)</sup>		
COM A	10 MHz <sup>2)</sup>		
PER A	100 ns <sup>2)</sup>		
RATIO A/B	1.000000		
PWIDTH A	50 ns	1)	
TIME A-B			
NEG SLOPE B	50 ns	1)	
PHASE A-B	180 or -180	1)	
TOT A-B	0		
Not COM A	0		
St/St	counting		
St/St	stop counting		
COM A	0		
TOT A St/St B	1		
TOT A gated B	1		
POS SLOPE B	0		
DUTY FACT	0.500000	1)	
AUTO	0.500000	1)	
RISE/FALL	30 ns	approximately	
VOLT	+1.00 V – 1.00 V	approximately	
MAX/MIN			

Table 2-9 Measuring functions check

- 1) Value depends on the symmetry of the signal.  
2) Exact value depends on input signal.

## Check on HOLD OFF function

Press the **PRESET** key, and confirm with **ENTER**, to set the timer/counter in default setting.

Select the following settings for the timer/counter:

- IMP A and IMP B =  $50\ \Omega$
- Coupl A and Coupl B= DC
- Non AUTO, X1 for A and B
- Trigger level = 0.5 V

Select the following settings for the pulse generator:

- Period =  $100\ \mu s$
- Delay =  $1\ \mu s$
- Double pulse
- Amplitude =  $1.0\ V_{PP}$ , (high level +1V and low level 0V)
- Duration 10 ns
- Rise time 2 ns

Waveshow 145

- Connect the Pulse generator Pulse Out to Input A and check the following results:

Freq A measuring without Hold Off = 20 kHz

Freq A measuring with Hold Off = 10 kHz

Connect the signal to Input B, press the SWAP A↔B key, and repeat the test for Input B.

## Options

### Check on Prescalers

Your Timer/Counter can be equipped with one of the following prescalers: PM 9621, PM 9624, PM 9625B, or PM 9625.

To verify the specification of the HF inputs in the instrument, perform the measurements below.

#### • PM 9621

Required Test Equipment	Suggested instrument
HF signal generator	Fluke 6062A

Table 2-10 Test equipment for 1.3 GHz HF-input

- Connect the output of the signal generator to the HF input of the counter.
- Connect the 10 MHz REFERENCE OUT of the generator to the REFERENCE IN at the rear panel of the counter.

Setting for the *timer/counter* after Preset.

- Function = FREQ C.
- EXT REF.

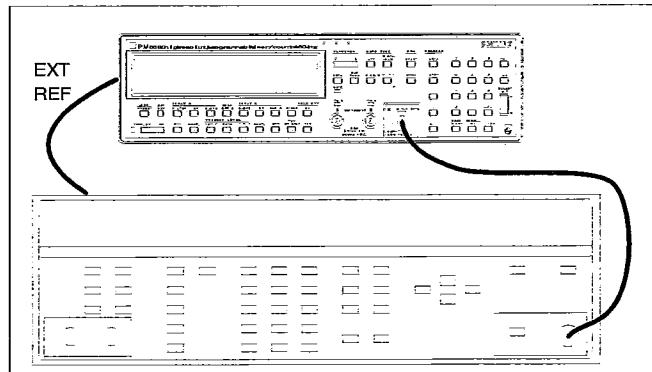


Fig 2-4 Connect the output of the signal generator to the HF-input of the counter.

- Generate a sine wave in accordance with the corresponding table below.

Frequency MHz	Amplitude		Pass/Fail
	mV <sub>BMS</sub>	dBm	
70-900	10	-27	
-1100	15	-23	
-1300	40	-15	

Table 2-11 Sensitivity of PM 9621

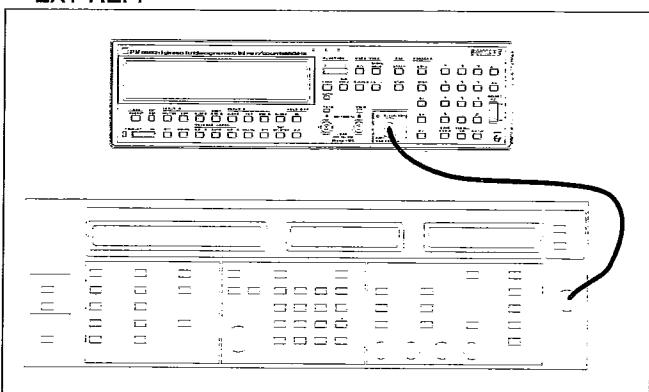
- Verify that the counter counts correctly. (The last digit will be unstable).

- PM 9624, PM 9625B, or PM 9625

Required Test Equipment	Suggested instrument	
HF signal generator	Wiltron 6717B-20	
Frequency	Amplitude	Pass/Fail
MHz	mV <sub>RMS</sub>	dBm

**Table 2-12** Test equipment for 2.7, 4.2, and 4.5 GHz HF-inputs

- Connect the output of the signal generator to the HF input of the counter.
  - Connect the 10 MHz REFERENCE OUT of the generator to the REFERENCE IN at the rear panel of the counter.
- Setting for the *timer/counter* after Preset.
- Function = FREQ C.
  - EXT REF.



**Fig 2-5** Connect the output of the signal generator to the HF-input of the counter.

- Generate a sine wave in accordance with the corresponding tables below.

Frequency	Amplitude	Pass/Fail
MHz	mV <sub>RMS</sub>	dBm
100-300	20	-21
-2500	10	-27
-2700	20	-21

**Table 2-13** Sensitivity of PM 9624..

Frequency	Amplitude	Pass/Fail
MHz	mV <sub>RMS</sub>	dBm
150-300	20	-21
-2200	10	-27
-3500	15	-23.5
-4200	25	-19

**Table 2-14** Sensitivity of PM 9625B.

Frequency	Amplitude	Pass/Fail
MHz	mV <sub>RMS</sub>	dBm
150-300	20	-21
-2500	10	-27
-3500	15	-23.5
-4200	25	-19
-4500	50	-13

**Table 2-15** Sensitivity of PM 9625.

- Verify that the counter counts correctly. (The last digit will be unstable).

## PM 9697 External Reference Frequency Multiplier

### • X10 position

- Press the PRESET key, then press the ENTER key to set your counter in the Default setting.
- Apply 1 MHz sine to input A equipped with a T-piece and to Ext Ref input at the rear, terminated with 50 Ω. Amplitude on 1 MHz signal; 500 mV<sub>RMS</sub>, (1.4 V<sub>PP</sub>).
- Select Ext Ref.
- The display should show 1.00000000<sup>6</sup> Hz ±5 LSD.

NOTE: If the counter does not count, the multiplier may be set to position X5 or X1. If this is the case, do the following.

### • X5 position

- Change the output frequency to 5 MHz.
- The display should show 5.00000000<sup>6</sup> Hz ±5 LSD.

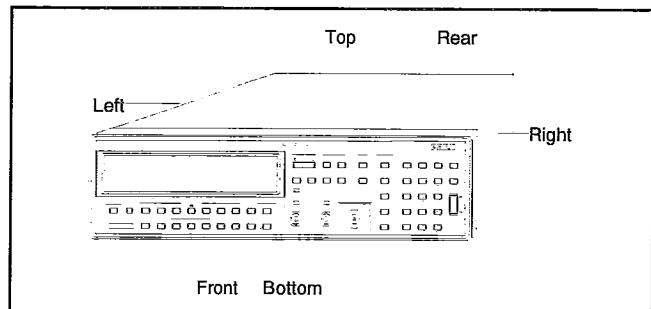
### • X1 position

- Change the output frequency to 10 MHz.
- The display should show 10.00000000<sup>6</sup> Hz ±5 LSD.

*Chapter 3*

# ***Disassembly***

The terms in the following figure are used in all descriptions in this manual.



**Fig. 3-1** Terms used in this manual.

The PM 6680 is available with a number of options and accessories. The labels on the rear panel of the counter identify the options and accessories included. If there are no labels, the counter contains an uncompensated crystal oscillator and no options. The following labels exist:

PM 9611/80 Rear Panel Inputs

PM 9621 1.3 GHz HF input

PM 9624 2.7 GHz HF input

PM 9625B 4.2 GHz HF input

PM 9625 4.5 GHz HF input

PM 9626 GPIB Interface

PM 9628 Fan

PM 9678B TCXO

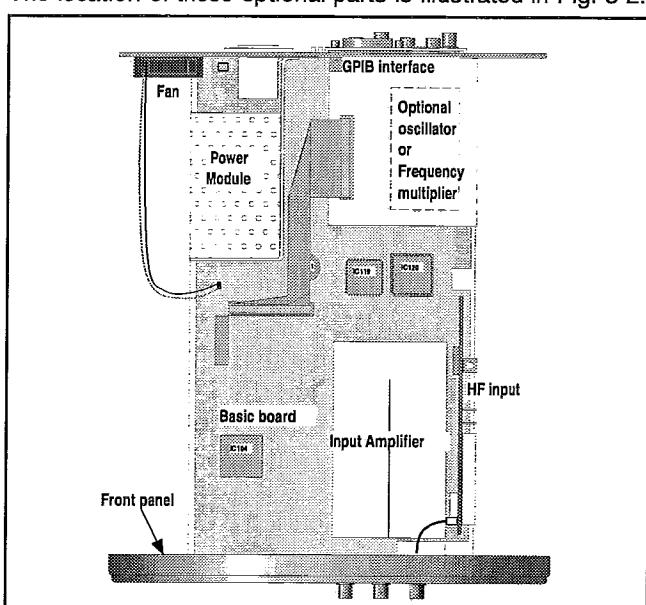
PM 9690 Oven Oscillator

PM 9691 Oven Oscillator

PM 9697 Frequency Multiplier

The Optional Oscillators and Frequency Multiplier cannot be installed in the same instrument.

The location of these optional parts is illustrated in Fig. 3-2.



**Fig. 3-2** Location of the boards in the counter.

## Removing the Cover

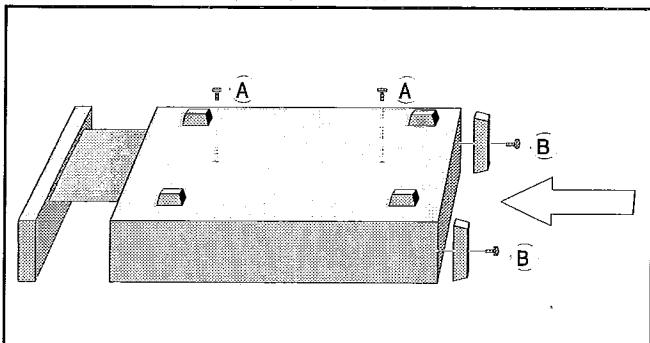
**WARNING:** Do not perform any internal service or adjustment of this instrument unless you are qualified to do so.

**WARNING:** When you remove the cover you will expose live parts and accessible terminals which can cause death.

**WARNING:** Although the power switch is in the off position, line voltage is present on the printed circuit board. Use extreme caution.

**WARNING:** Capacitors inside the instrument can hold their charge even if the instrument has been separated from all voltage sources.

- Make sure the power cord is disconnected from the counter.
- Turn the counter upside down.
- Loosen the two screws (**A**) at the bottom and the two screws (**B**) in the rear feet.
- Grip the front panel and gently push at the rear.
- Pull the counter out of the cover.



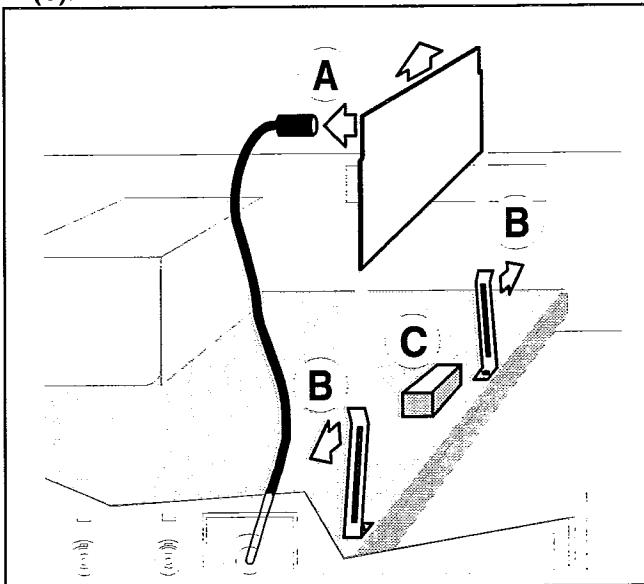
**Fig. 3-3** Remove the screws and push out the counter from the cover.

## Reinstalling the Cover

- Push the counter gently back in the cover.
- Turn it upside down
- Install the two screws (**A**) at the bottom.
- Install the two rear feet with the screws (**B**) to the rear panel.

## PM 9621, PM 9624 or PM 9625 HF Input

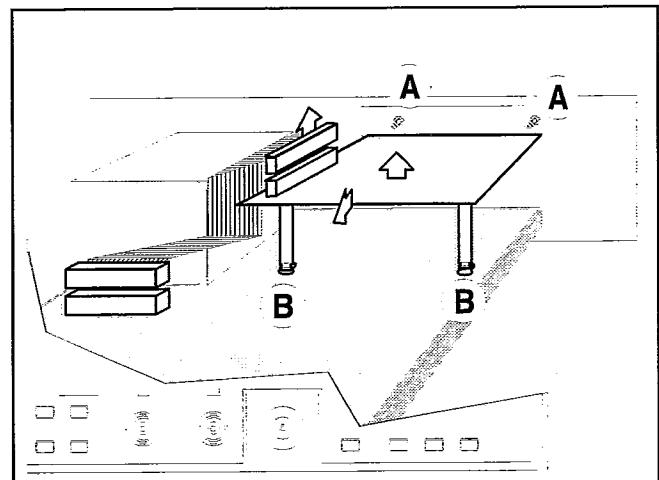
- Disconnect the power cable.
- Remove the cover from the counter.
- Disconnect the cable from the mini-coax connector (**A**) on the HF input.
- Press the clips (**B**) apart and lift the HF input pca straight up and out.
- When installing the HF input, make sure that the connector pins fit exactly in the holes in the connector housing (**C**).



**Fig. 3-4** Removing the HF input.

## PM 9626 GPIB Interface

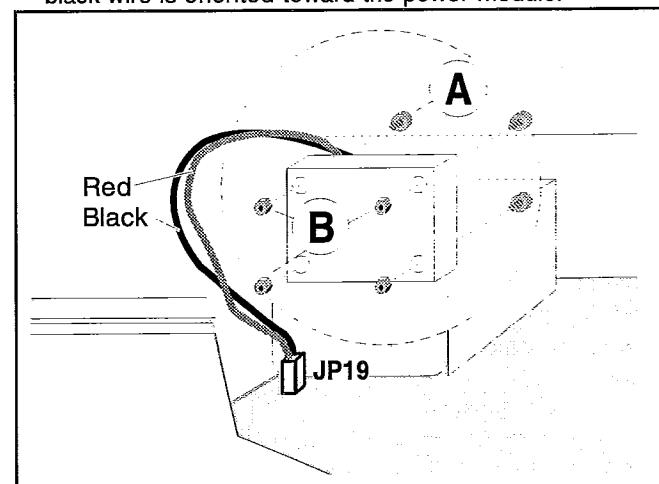
- Disconnect the power cable.
- Remove the cover from the counter.
- Loosen the two screws (**A**) holding the GPIB interface to the rear panel.
- Disconnect the interface cable from BU101.
- Move the GPIB interface pca toward the front of the counter and lift the pca supports out from the "keyholes" (**B**) on the main pca.



**Fig. 3-5** Loosen the two screws in the rear panel and disengage the board from the keyholes.

## PM 9628 Fan

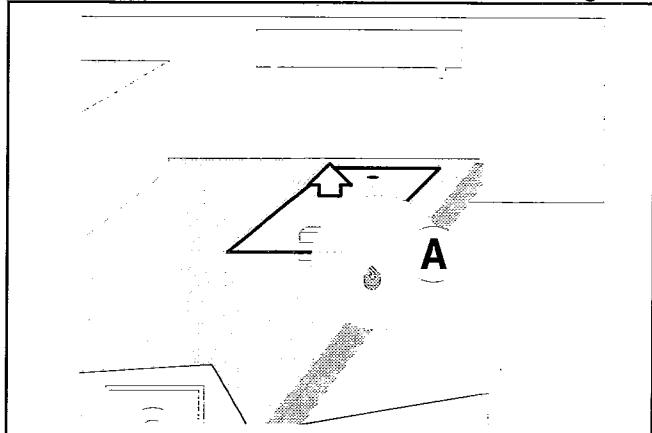
- Disconnect the power cable.
- Remove the cover from the counter.
- Remove the four screws (**A**) and nuts (**B**) from the fan.
- Disconnect the fan cable from JP19.
- When reinstalling the fan, be sure that the air-flow arrow on the fan points to the rear of the counter and that the black wire is oriented toward the power module.



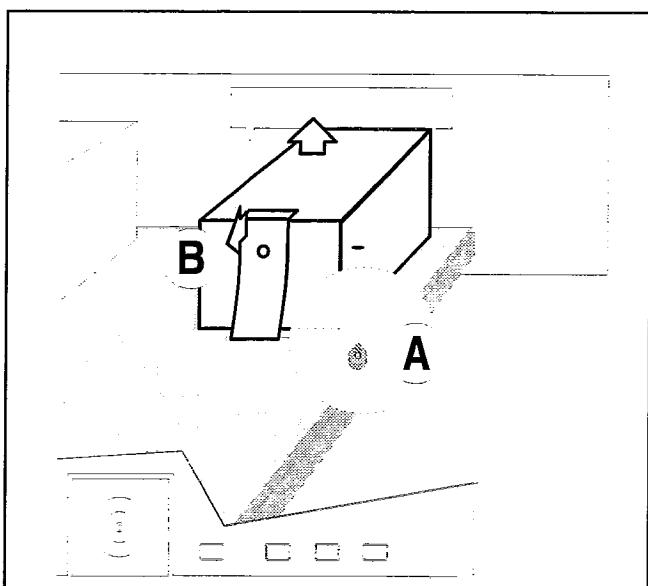
**Fig. 3-6** The fan is fastened with four screws and nuts.

## PM 9678B TCXO

- Disconnect the power cable.
- Remove the cover of the counter.
- Remove the screw (**A**) holding the TCXO to the main pca from beneath.
- Lift the TCXO straight up.
- Make sure that the jumpers JP14 and JP15 are set in the correct position.
- When installing the TCXO, make sure that the connector pins fit exactly in the holes in the connector housing.



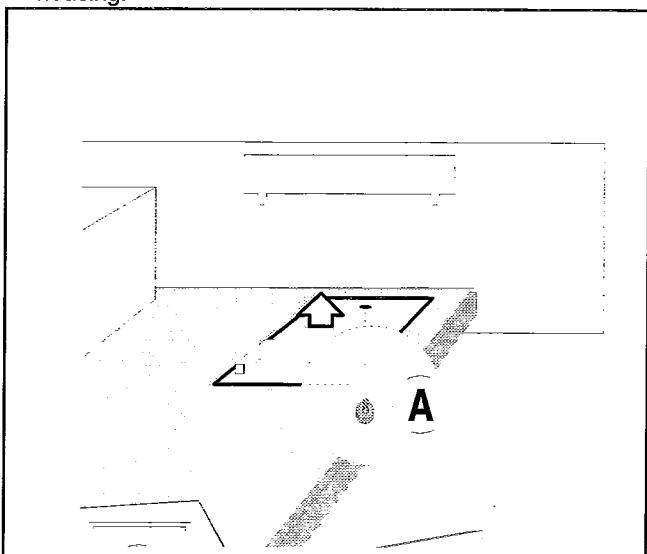
**Fig. 3-7** Lift the TCXO straight up after removing the fastening screw.



**Fig. 3-8** A clip and a screw hold the oven oscillators in place.

## PM 9697 Frequency Multiplier

- Disconnect the power cable.
- Remove the cover of the counter.
- Remove the screw (**A**) holding the Frequency Multiplier to the main pca from beneath.
- Lift the Frequency Multiplier straight up.
- Make sure that the jumper JP17 is set in the correct position.
- When fitting the Frequency Multiplier, make sure that the connector pins fit exactly in the holes in the connector housing.



**Fig. 3-9** Lift the multiplier straight up after removing the fastening screw.

## ***Reinstalling the Battery***

The instrument will lose its stored programs and front panel settings when the battery is replaced.

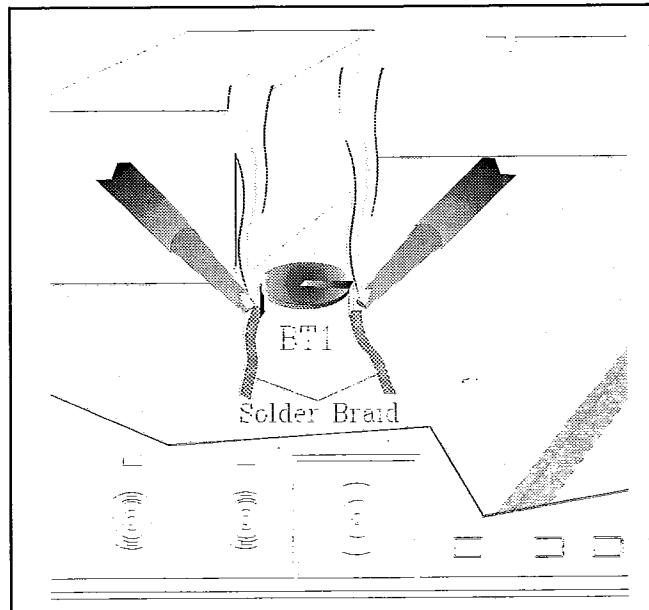
Please consult your Programming Manual for instructions on reading the front panel settings to a file and reloading the file to the counter after replacing the battery.

**WARNING: Disposal of lithium batteries requires special attention. Do not expose the batteries to heat or put them under extensive pressure. These measures may cause the batteries to explode.**

Return used batteries to your supplier or to your local Fluke/Philips organization.

### ***Exchange Procedure***

- Disconnect the power cable.
- Remove the cover of the counter.
- Remove solder with desoldering braid.



**Fig. 3-10 Remove solder with desoldering braid.**

- Replace the battery with a new one. You will find the ordering number in the Replacements Parts Chapter.
- Solder the leads to the board.
- Reinstall the cover to the counter.  
Don't throw batteries in your wastebasket. Return used batteries to your supplier.

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*Chapter 4*

# ***Circuit Descriptions***

# *Block Diagram Description*

## ***General***

The PM 6680 Timer/Counter consists of three main units:

- Front unit
- Main board unit
- Rear panel unit

Several options can be added, these are:

- GPIB interface including analog output (PM 9626).
- Prescalers (1.3 GHz PM 9621, 2.7 GHz PM 9624, 4.2 GHz PM 9625B, and 4.5 GHz PM 9625).
- Oscillators (TCXO PM 9678B and oven oscillators PM 9690 and PM 9691).
- Reference frequency multiplier (PM 9697 for 1, 5, and 10 MHz).
- Fan option (PM 9628).
- Rack mount adapter (PM 9622).
- Rear panel inputs (PM 9611/80).

The chassis of the counter consists of a front piece molded in aluminum, an aluminum rear panel, and two aluminum profiles

that hold the front and rear panels together. This unit can be slid into the aluminum cover of the instrument.

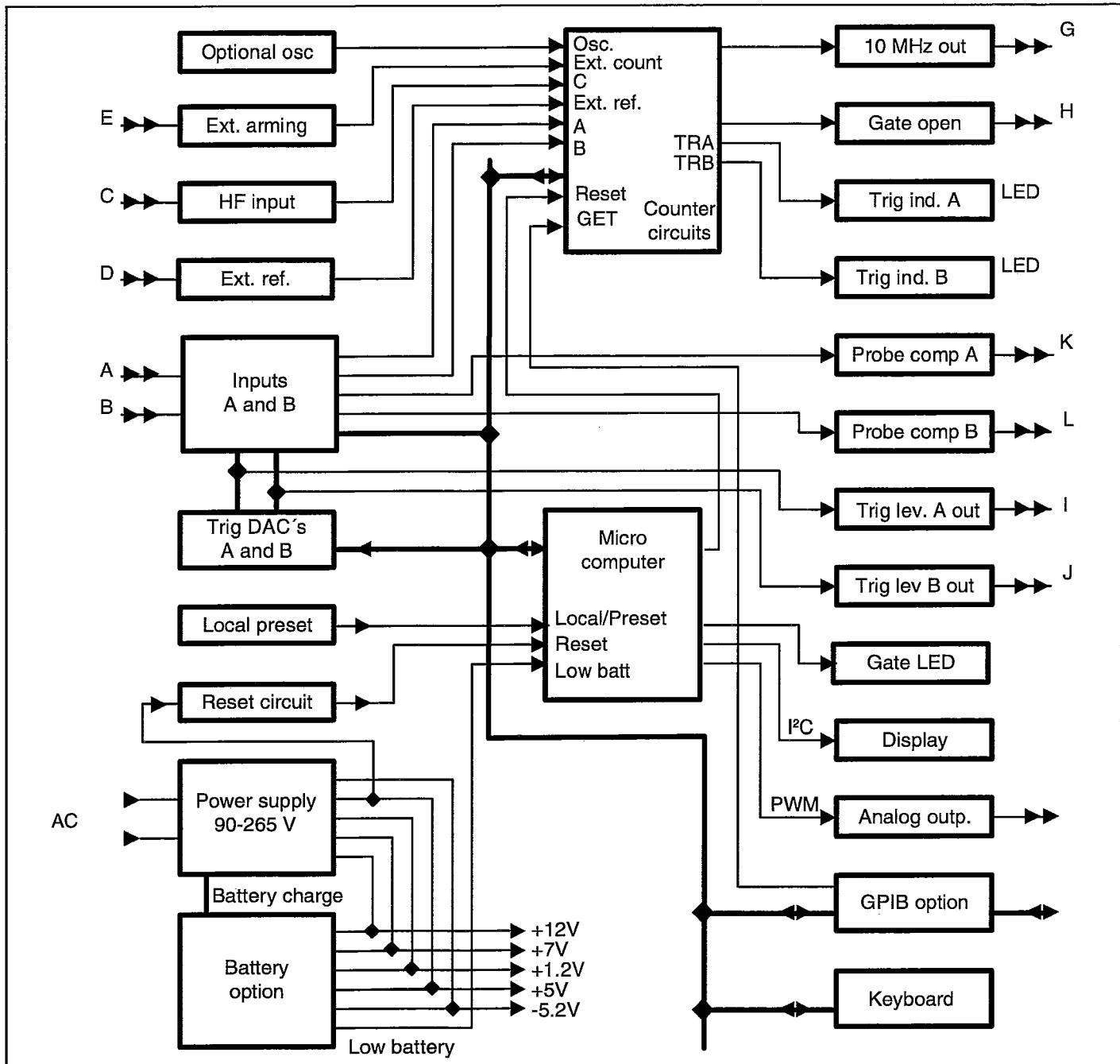
The front unit contains all functions needed for the user communication. It is connected to the main board unit with a flat cable, and the molded front-piece screws onto the two aluminum profiles.

The main board unit consists of a main board mounted on two aluminum profiles. Most functions, such as the following, are placed on the main board:

- Input amplifiers with trigger level circuits
- Power supply
- Measurement logic
- Microcomputer circuitry

Some outputs, such as the trigger levels and probe compensation view outputs are directly mounted on the main board.

The rear panel unit is an aluminum panel with a number of mounted connectors. Most of the connectors are soldered directly to the main board. The rear panel screws onto the two aluminum profiles.

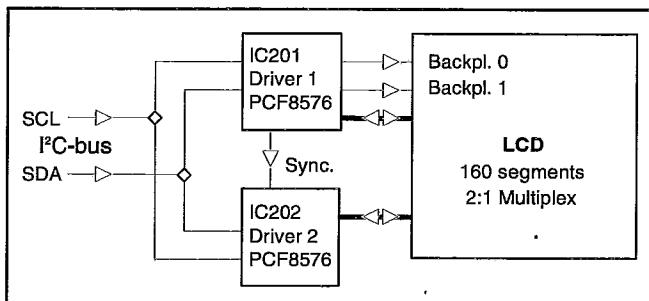


**Fig. 4-1 Block diagram PM 6680**

# Hardware Functional Description

## Front Unit

### LCD Drivers



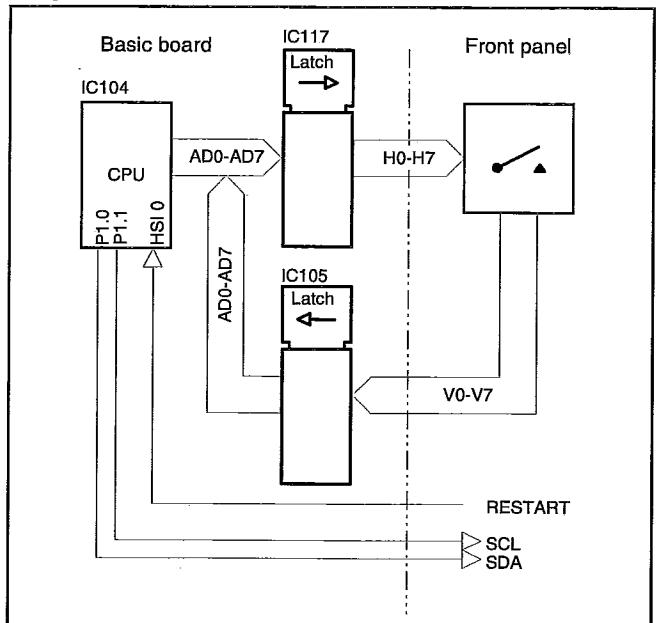
**Fig. 4-2** Front panel LCD drivers.

The front unit is made of a molded aluminum front. The keypad is made of silicon rubber with screened carbon pads on a pc board that covers the total front. An LCD and four LEDs are used as indicators. The LCD is used to show both the measurement result and the state indicators of the instrument setting. The LEDs shows standby, gating, triggering channel A and B.

The LCD has 160 segments that are multiplexed with a ratio of 2:1. Two cascade coupled LCD drivers (IC201 and IC202) are used. The drivers are connected by a serial I<sup>2</sup>C bus to the microcomputer on the main board. The clock frequency of the drivers is approximately 140 kHz, set by R201. The VLCD pin is connected to GND on the main board.

The LCD is provided with a backlight. This is an LED array integrated to one component. It uses approximately 0.35 A and dissipates approximately 1.5 W.

## Keyboard



**Fig. 4-3** Keyboard scanning.

The pushbuttons are connected in a matrix. The scanning signals H0 to H7 are coming from the main board. If a button is pressed and H0 to H7 is high, one of the output signals V0 to V7 will be high. The STAND-BY/ON and LOCAL-PRESET buttons are not part of the scanning, but connected directly to the base board.

The front unit is mounted to the main board unit by means of three screws. The electrical connection is made with a 40 connection flat cable to the main board.

# Main Board

## Input Amplifier A

Input amplifiers A and B are two matched 225 MHz amplifier circuits, channel A and channel B. Channels A and B are identical except for a 100-kHz filter in channel A, the switching circuitry for the separate/common modes, the B-channel delay line, and event delay output. The following description refers to channel A but is also valid for channel B.

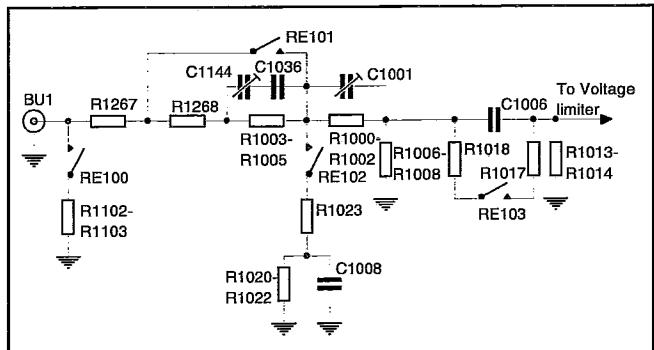
The input amplifier contains four main stages: input stage, impedance converter stage, comparator stage and buffer stage.

### • Input Stage

The input stage contains:

- $50 \Omega$ /1 M $\Omega$  impedance selector
- x1/x10 attenuator
- AC/DC coupling
- Voltage limiter

### 50 $\Omega$ /1 M $\Omega$ impedance selector



**Fig. 4-4** Impedance selector, 1X/10X attenuator and AC/DC coupling.

The 50  $\Omega$  or 1 M $\Omega$  impedance modes are selected by relay RE 100. 50  $\Omega$  is selected via 100  $\Omega$  resistors R1102 and R1103 if the relay switch is closed. 1 M $\Omega$  is selected if the

switch is open. Depending on selected attenuation, the 1 M $\Omega$  input impedance is determined by different combination of resistors. In x1 attenuation mode the impedance is determined by resistor network R1000 - R1002, R1006 - R1008, R1018, R1017, R1013, and R1014. In x10 attenuation mode the same network as in the x1 case plus the resistor network R1005, R1004, R1003, R1023, and R1020-R1022 sets the impedance. The input capacitance in parallel with 1 M $\Omega$  is 30 pF at x1 attenuation and 17 pF at x10 attenuation. The series resistor R1267 immediately after the selector serves both as current limiter with the voltage limiter (see below) and as impedance matching resistor. The resistor also improves the V Standing Wave Ratio of the amplifier.

### x1/x10 attenuator

The x1 attenuator consists of the resistive low frequency divider, which reduces the input signal by a factor of 2.3. The attenuator is formed by the resistors R1000 - R1002, and R1006 - R1008 in parallel with R1013, and R1014. The capacitive high frequency divider in parallel with R1006-R1008 is formed by the variable capacitor C1001 and the parasitic capacitance. The capacitive attenuator is adjusted via variable capacitor C1001 to the same attenuation as the resistive.

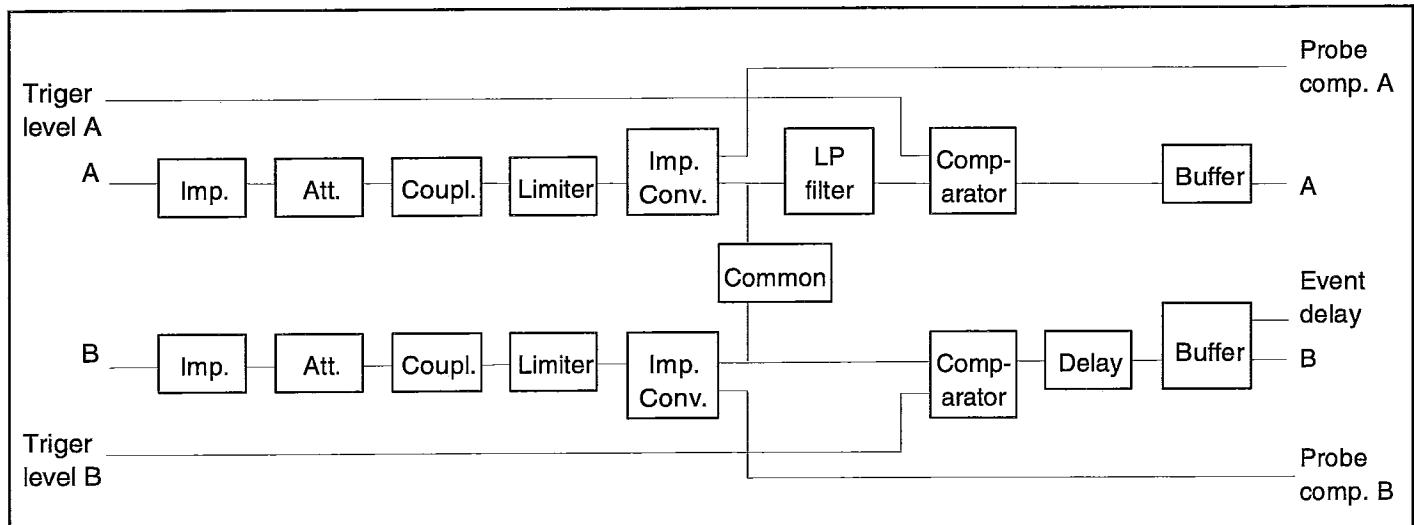
The x10 attenuator consists of the resistive low frequency divider. It is formed by resistors R1268, R1003 - R1005, and the four resistors R1020 - R1023 in parallel with 1 M $\Omega$  (the x1 attenuator impedance). The capacitive divider is formed by the resistor R1268, the variable capacitor C1144, the capacitor C1036, and the resistor R1023 in series with the capacitor C1008. The parasitic capacitance is in parallel with resistor R1023 and capacitor C1008.

The purpose of resistors R1268 and R1023 is to improve the frequency response.

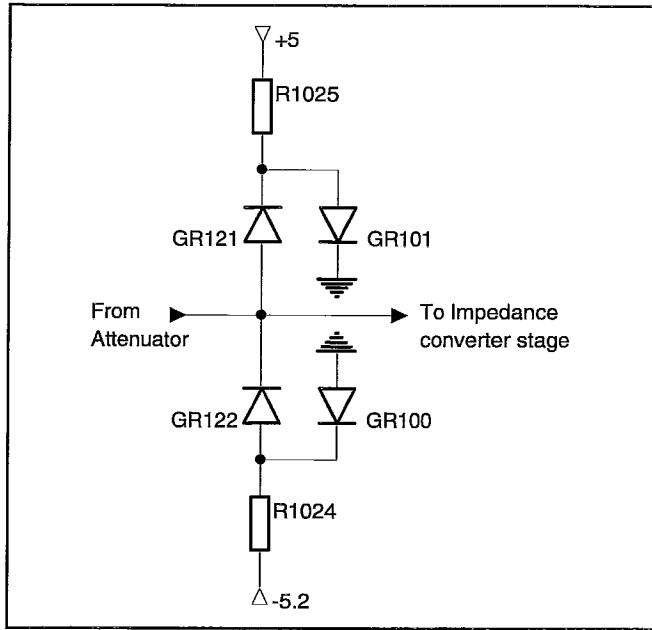
### AC/DC coupling

The selection of AC/DC - coupling is done by relay RE103. In AC coupling relay RE103 is open and the signal is fed through the AC capacitor C1006. In DC coupling the relay RE103 is closed and the AC capacitor C1006 is short-circuited. The two resistors R1017 and R1018 serve as current limiters to protect the relay contact.

### Voltage limiter



**Fig. 4-5** Input amplifier block diagram.



**Fig. 4-6** Voltage limiter.

A voltage limiter that protects the impedance converter against overvoltage is placed between the AC/DC selector and the impedance converter. It consists of resistor R1025 and the diodes GR101 and GR121 to clamp positive voltage and resistor R1024 plus the diodes GR100 and GR122 to

clamp negative voltage. The clamp voltage is approximately 2.7 V at low frequency signals. At high frequency the clamp voltage rises to approximately 3.0 V.

### • Impedance Converter Stage

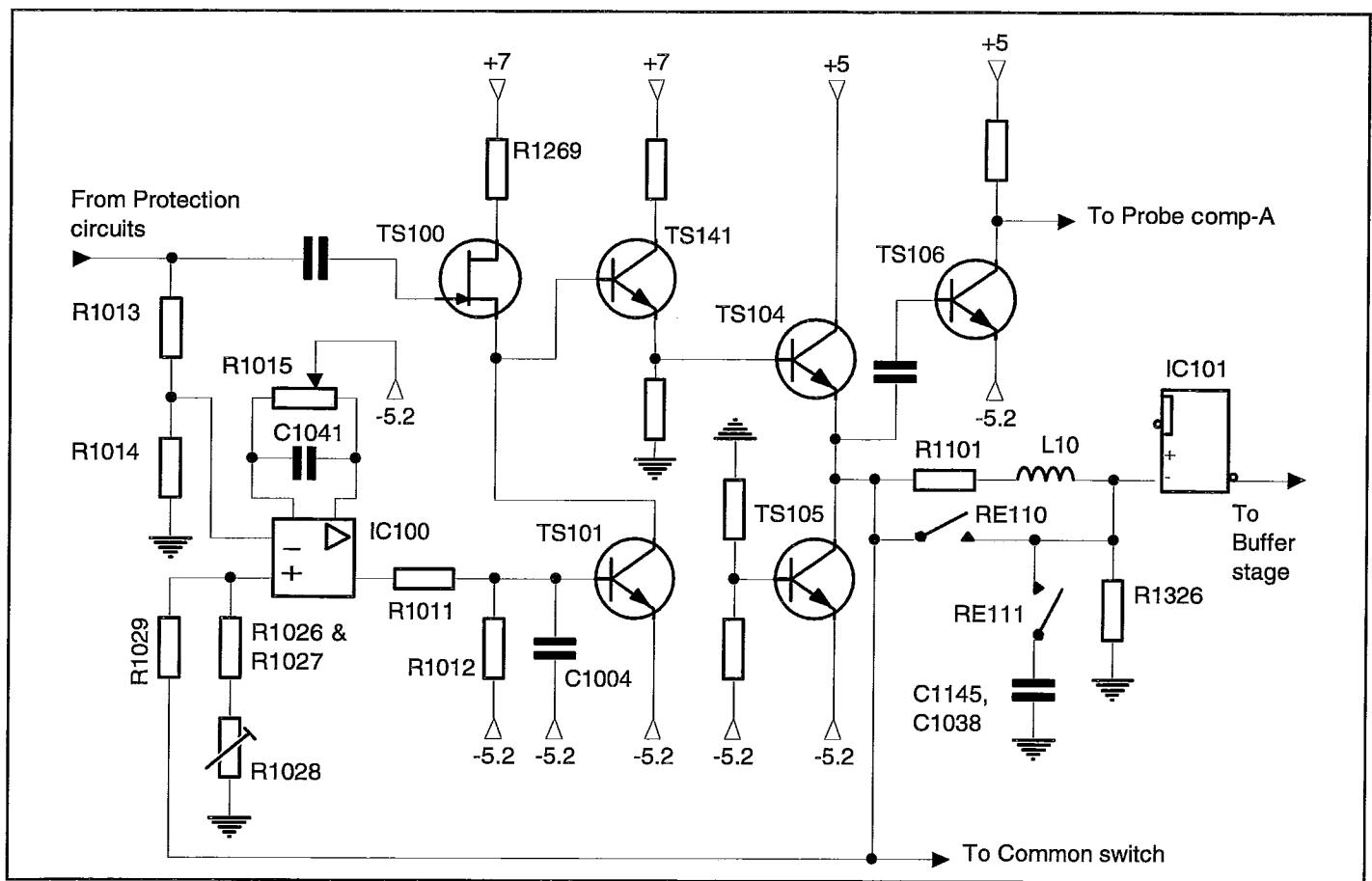
The analog signal from the input stage is fed to an amplifier stage where split-band technique is used to get a good frequency response over a wide range. This means that the high frequency path of the signal is fed via a high impedance AC-coupled FET transistor stage. The low frequency path is fed in parallel via a DC coupled feedback operational amplifier stage. The low frequency path handles frequencies up to approximately 5 kHz.

The high frequency signal is fed through the FET TS100 gate. The high impedance at the gate is converted to a low impedance at the source. The source is connected to the HF-transistor TS101, common for both high frequency and low frequency path.

To make the FET work well in its active region within the whole dynamic range, the FET drain is supplied with +7 V via resistor R1269.

The low frequency signal is divided by the two resistors R1013 and R1014 before it is coupled to the input pin 2 of the operational amplifier IC100. Resistors R1011 and R1012 at operational amplifier output pin 6 center the output swing, and capacitor C1004 stabilizes the operational amplifier stage.

The low frequency path is fed via the operational amplifier and transistor TS101 to the collector of this transistor TS101. This



**Fig. 4-7** Impedance converter.

point is the common point for the high and low frequency paths of the input frequency.

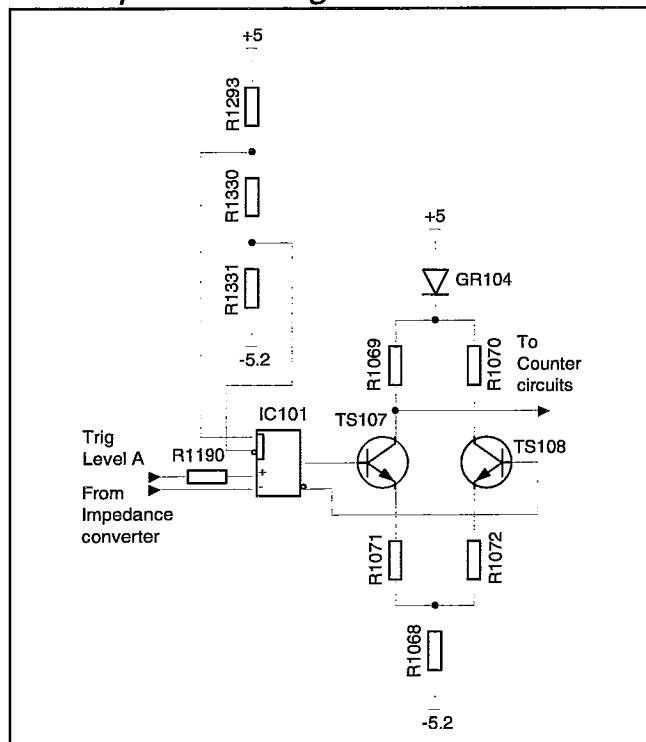
An amplifier with high output current is used to get a linear output in the  $100\Omega$  load resistor R1326 over a swing of 2 V. This amplifier consists of a driver stage TS141, an output stage TS104, and a current generator TS105.

From the output of this second amplifier stage, the signal is fed back to the op amp pin 3 via divider R1026 - R1029. Trim potentiometer R1028 sets the gain of the low frequency path equal to the high frequency gain of about 0.9. Capacitor C1041 is connected to operational amplifier pin 1 and 8 to achieve stable operation. The trim potentiometer R1015 between pin 1 and 5 on the operational amplifier is used to adjust the offset voltage of the operational amplifier.

The channel A filter connected to the output of the second amplifier stage is a 100 kHz LC filter. It consists of the resistor R1101, the coil L10, and the two capacitors C1145 and C1038 in parallel. The filter is controlled by the two relays RE110 and RE111. The filter output is connected to the input of the comparator stage.

The output of the amplifier stage is also connected to the rear panel via an AC coupled buffer stage TS106 with a gain of about 2. By using this output called "probe compensation A" it is possible to compensate a probe connected to the counter.

- *Comparator Stage*



**Fig. 4-9** Comparator and buffer stages.

The comparator stage converts the analog signal from the impedance converter stage to a square wave. This circuit consists mainly of the high speed integrated comparator IC101 and a separate trigger level circuit connected to the comparator at pin 10 via resistor R1190.

The trigger level circuits, which are described later, are generating a DC level in the range of approximately  $-2\text{ V}$  to  $+2\text{ V}$ . This covers a dynamic range of  $5\text{ V}$  since the input signal is divided by a factor of 2.3 before it reaches the comparator.

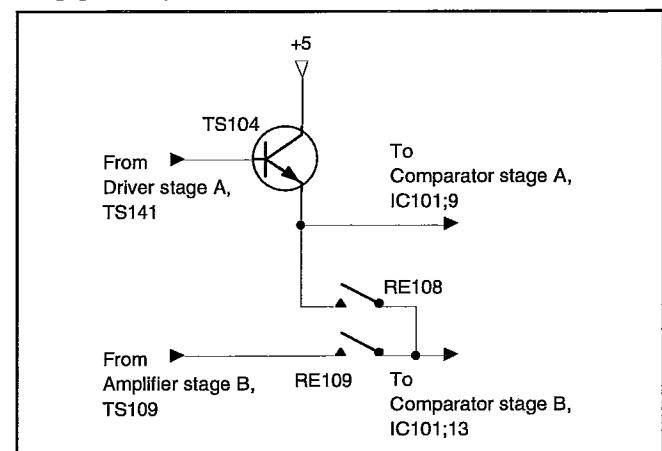
The counter is provided with fixed hysteresis, i.e., it is not controllable via the front panel or GPIB.

- *Buffer Stage*

Before the signal is fed further into the ASIC OQ0502, IC120 it has to be converted by the buffer stage. The negative ECL logic levels ( $\sim -0.9$  V to  $\sim -1.7$  V) from IC101 pins 2 and 3, are converted to a single-ended signal with positive ECL logic levels ( $\sim 4.1$  V to  $\sim 3.3$  V), .

The buffer is a differential amplifier consisting of the two transistors TS107 and TS108 whose bases are fed differentially from the two comparator outputs. Diode GR104 sets the high ECL level when transistor TS107 is cut off. Resistor R1068 sets the current in the stage. Resistors R1071 and R1072 serve as current limiters to stabilize the stage and the two collector resistors R1069 and R1070.

- Common B via A



**Fig. 4-8** Common B via A.

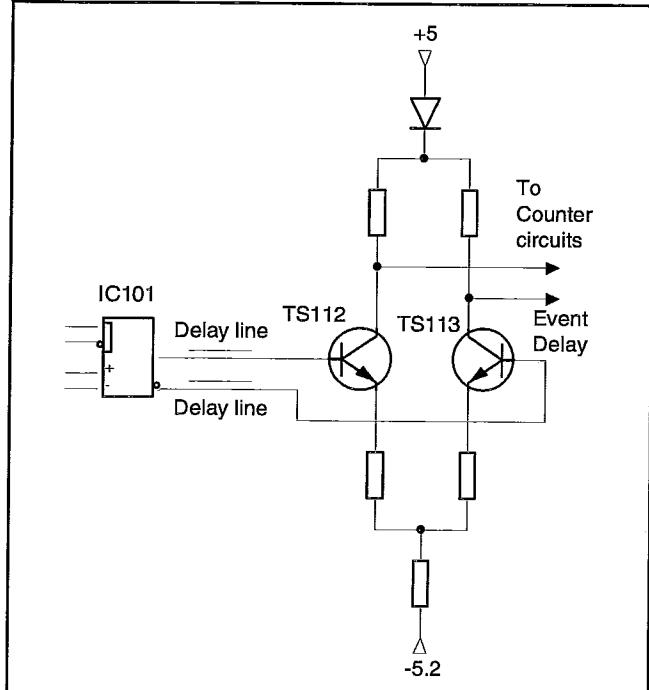
The output signal from TS104 can also be fed to the B-channel comparator. This is done in Common B via A mode. Relay RE108 connects the comparator inputs pin 9 (A) and 13 (B) in parallel. Simultaneously relay RE109 disconnects the output signal from TS109 to the B-channel comparator. In separate mode, the relays connect the output signal from TS109 to B-channel comparator input pin 13 (RE 109), and disconnect the signal from TS104 to the B-channel input pin 13 (RE108).

## **Input Amplifier B**

Input channel B is the same as input channel A with the following exceptions:

- The common B via A switches that connect the B-channel comparator to the input signal on channel A.
- The B-channel delay line.
- The B-channel has no low-pass filter.
- The B-channel has a special event-delay signal output to OQ0504 IC 119.

### • Delay Line



**Fig. 4-10 Event delay and Delay lines.**

A line of approximately 1.35 ns delay is placed between the B-

channel comparator outputs pins 19 and 20 and the buffer stage TS112 and TS113. This delay line is a twisted-pair cable placed on the solder side of the circuit board. It should compensate for delays in OQ0502 IC120.

### • Event Delay

Also for use in the arming function, the inverse output from the buffer stage TS113 of channel B is used. This signal called EVENT DELAY is connected to the OQ0504 circuit IC119 via a positive ECL-to-TTL converter. The converter consists of transistor TS137, diodes GR146-GR147 and resistors R1306, R1307, R1308 and R1310.

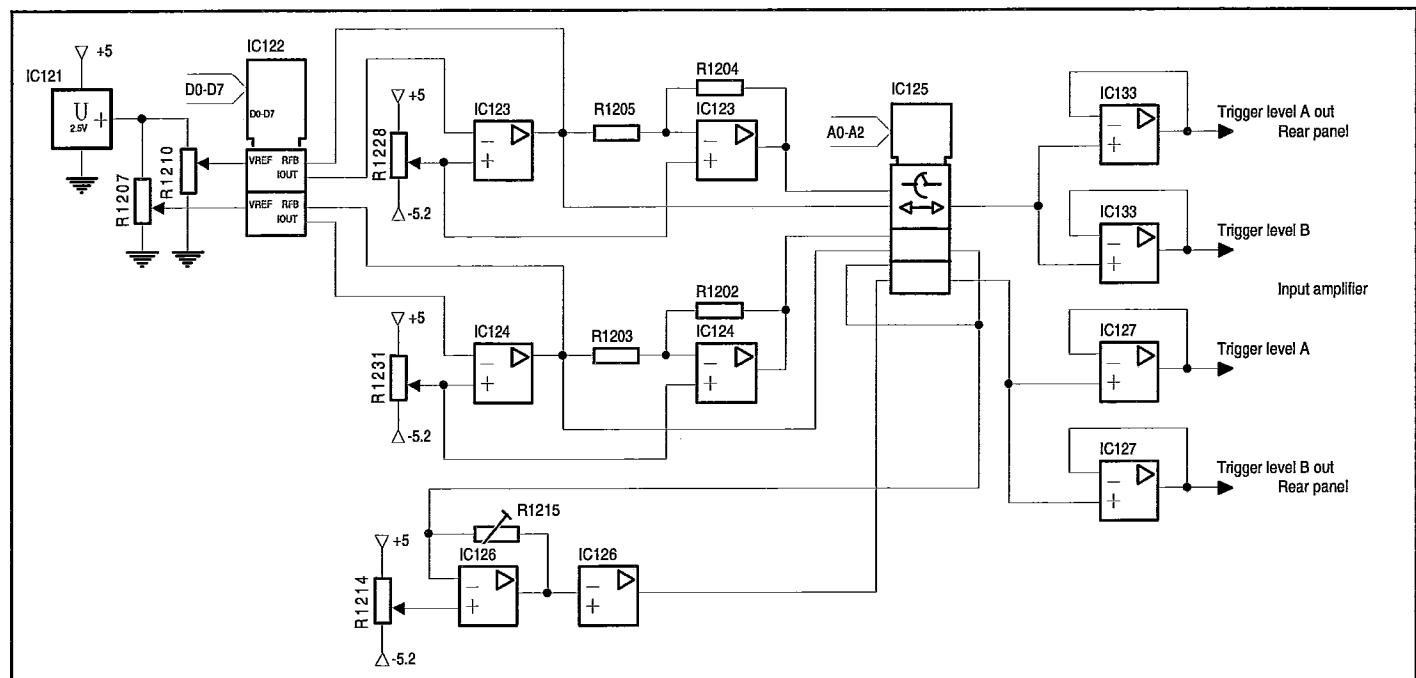
## Trigger Level Circuits

The trigger level circuits generate the trigger levels to the A and B inputs. The trigger level range is  $-5.1\text{ V}$  to  $+5.1\text{ V}$  with a resolution of  $20\text{ mV}$ . The input amplifier attenuation is approximately 2.3 times. The trigger level circuits generate a DC level that has the same attenuation. This means that the output of this circuit has a range of  $-2.2\text{ V}$  to  $+2.2\text{ V}$  with a resolution of  $8.7\text{ mV}$ . A dual 8-bit DAC is used. To get the resolution of  $20\text{ mV}$  9 bits are needed. This is achieved by an external 9th sign bit. The DAC's only generate voltages between 0 and  $+2.2\text{ V}$ , but by using an inverting X1 amplifier and a multiplexer, voltages between  $-2.2\text{ V}$  and  $+2.2\text{ V}$  are available. The supply voltages to the trigger level circuits are filtered by L and C to prevent noise from the digital circuitry to influence the trigger level. The earth plane under the trigger level circuit is separated from the rest of the ground plane, and the planes are only connected at the front of the counter.

The trigger level circuits consists of:

- Reference voltage circuit ( $2.5\text{ V}$ ) with separate trim potentiometers for full scale of each channel, (IC121, R1207, R1207).
- A double DAC (IC122).
- Two current-to-voltage converters. These circuits convert the current at the IOUT pins of the DAC's to a voltage. This signal has a range of 0 to approximately  $2.5\text{ V}$ . (1/2 IC123 and 1/2 IC124).

- Two amplifiers with a  $-1$  times amplification, to generate a signal with a range of 0 to  $-2.5\text{ V}$ . (1/2 IC123 and 1/2 IC124). To get exactly  $-1$ ,  $0.5\%$  precision resistors are used: R1202, R1203, R1204, and R1205.
- The zero adjust of the trigger levels is done with trim potentiometers connected to the amplifiers in IC123 and IC124. (R1228 and R1231).
- Two multiplexers to select between the two different ranges. With this there is a total trigger level range of  $-2.5\text{ V}$  to  $+2.5\text{ V}$ . (2/3 IC125).
- Two output buffers and LC filters for the trigger level outputs on the rear panel. (IC133).
- Two low-pass filters and buffers on the trigger level signal sent to the input amplifier. (IC127).
- Common A adjustment circuit. This circuit is necessary to enable a different adjustment of the trigger level on the B channel when the COMMON VIA A mode is used. The trigger level is adjusted to fit to a specific input amplifier. Since the B comparator has two different input paths, B or common via A, there must be two different trigger levels for the B trigger level. Both full scale and zero adjustment are available. (IC126, R1215, R1214).
- A multiplexer to select trigger levels on the B channel, between normal mode and common via A. (1/3 IC125).



**Fig. 4-11** Trigger level circuits.

## Power Supply

NOTE: The new Power Supply are described in the Appendix chapter at page Chapter 9.

The power supply generates four regulated DC supply voltages to the counter, as well as some other supply voltages for special purposes. The power supply block also contains the ON/STANDBY logic.

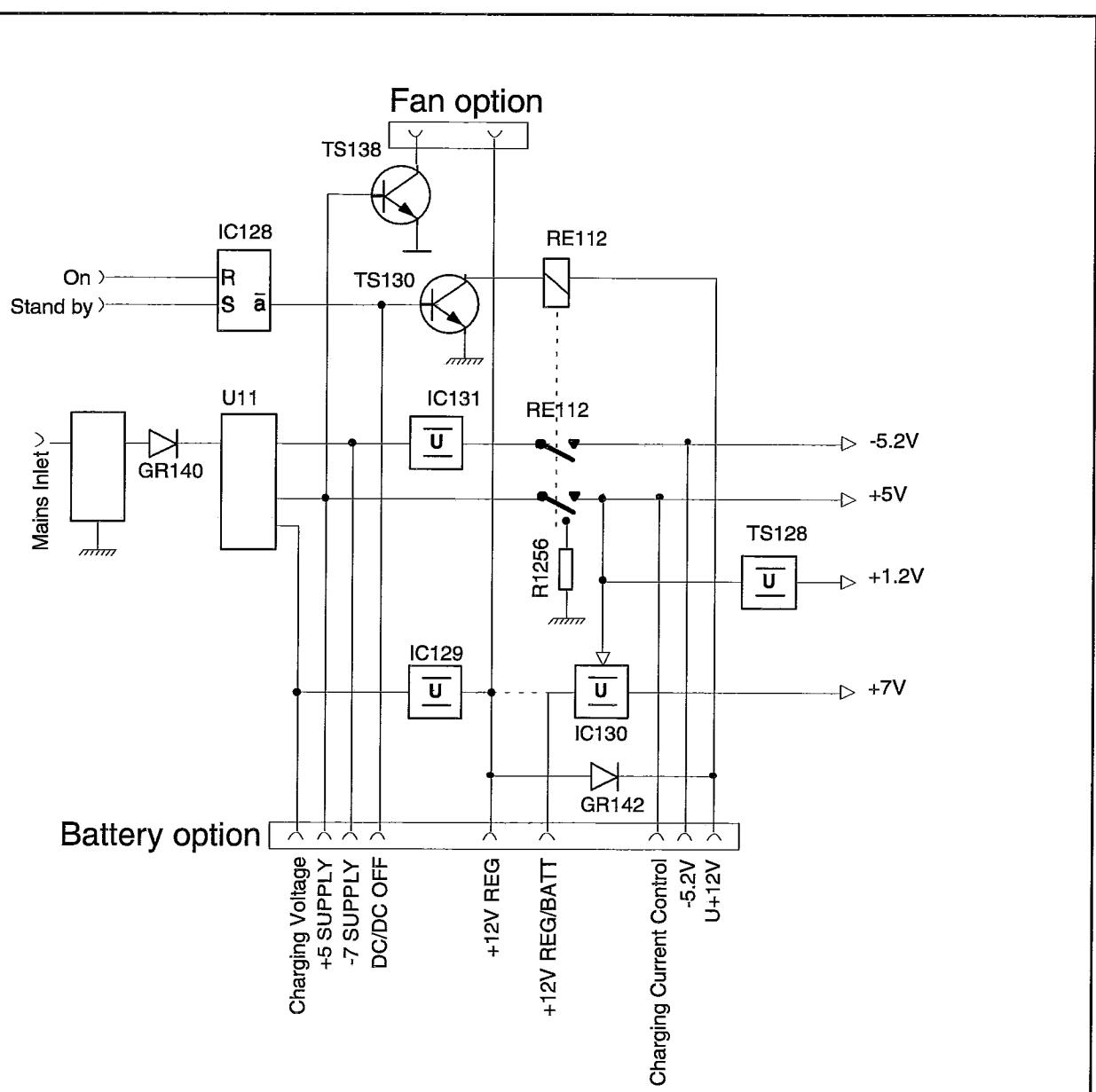
The main building-block of the power supply is a primary switch mode power module (U11). The line power AC voltage (90 V to 265 V) is rectified to a DC voltage, before it is fed to the power module.

After a line power filter in the power inlet, a fuse of 1.6 AT and a NTC resistor protect the power supply. The fuse VL1 should only blow if a catastrophic error occurs on the primary side of the power supply. A short-circuit on the secondary side should not affect the primary side. To minimize the "current rush" to the capacitors at the connection of the power cord, an NTC resistor (R1252) is used. The resistance is  $15\Omega$  when the resis-

tor is cold, but decrease to a few ohms and is then warmed up by the current. The AC voltage is rectified in the bridge rectifier GR140 and filtered in C1111. C1320 should suppress noise from GR140. L103 and C1114, C1113 forms filters.

All inputs and outputs of the power module have HF chokes. The module is mounted with distance washers on the main board. Please note that one of the large heatsinks is connected to line power!

From the module there are three DC voltages outputs. One of those is regulated (+ 5 V) and the others are unregulated. These voltages will vary with input line voltage, the current at + 5 V, and at the unregulated voltages. The output marked +15 will be approximately +18 V, and the output marked -7 will be approximately -8 V. The outputs are filtered, HF-filtered by C1116, C1117, C1118, and C1119 and LF-filtered by L11, L12, L13, C1109, C1120, and C1121.



**Fig. 4-12** Power supply.

These three DC voltages are used to make the following four supply voltages in the counter:

#### **+5 V**

Regulated +5 V from the module is used directly.

#### **-5.2 V**

-8 V is used, with regulator IC131.

#### **+12 V**

+18 V is used, with regulator IC129.

#### **+7 V**

Stabilized +12 V is used, with regulator IC130.

The voltages for special purposes are:

#### **U+12 V**

This voltage comes from the +12 V regulator IC129, but is isolated from the +12 V via a diode GR142. (If battery unit is mounted U+12 V should come from the battery, but this voltage should not be used as the normal +12 V). The voltage U+12 V will be present if the power cord is connected, regardless the ON/STANDBY switch. It is used for the ON/STANDBY logic.

#### **+12 VREG/BATT**

This voltage also comes from the +12 V regulator IC129, but is placed after the battery unit connector. If no battery is installed, +12 VREG/BATT will be present if the power cord is connected. If the battery is installed, +12 VREG/BATT will be dependent on the switch BATTERY ON/OFF on the rear panel. If ON, the voltage will come from the battery, if OFF, the voltage will be dependent of the connection of the power cord (Connected: +12 V, not connected: 0 V). +12 VREG/BATT is used for the optional oven oscillator and the STAND-BY indicator.

#### **+1.2 V**

The +5 V is used with zener diode GR144 and TS128 to generate +1.2 V. This voltage is used in IC120 only.

At stand-by, the four supply voltages are switched off, but some special voltages are not, because the oven oscillator should be on and the ON/STANDBY logic should function. Therefore, the power module will never be switched off, and PM 6680 has only a secondary power switch.

A relay (RE112) disconnects the load of the +5 V and -5.2 V at stand-by. Because the power module always must have a load on the regulated voltage, a bleeder resistor R1323 is always connected to +5 V. At standby the counter only needs +18 V and to get enough current of this voltage, a certain current of the regulated +5 V must be used. Therefore, in stand-by, a 15Ω resistor (R1256) is connected to +5 V.

+5 V controls the switching on/off of +12 V and +7 V. When +5 V is on, TS129 conducts, and the base of TS126 will be approximately +7 V and the transistor will conduct, i.e., +12 V will be on. If there is no +5 V, TS129 will be off, and the base of TS126 will be +12 V, thus blocking the +12 V.

The ON/STANDBY logic controls relay RE112, which operates as described above. It is also possible to open relay RE112 by changing the position of JP16.

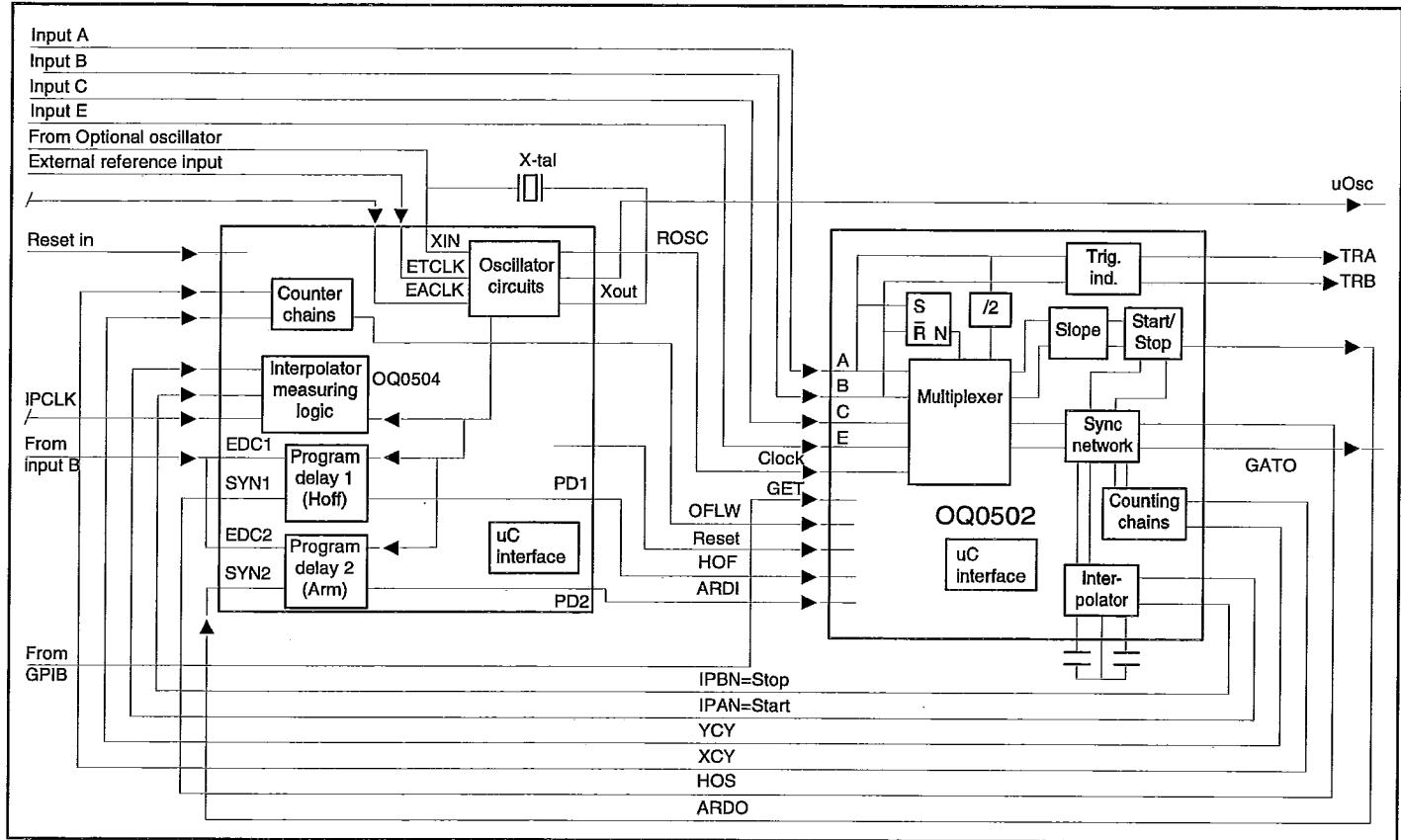
The ON/STANDBY logic consists of a Set-Reset flip-flop IC128 and a means to send pulses to its set and reset inputs. Pressing the STAND-BY button will give a high voltage (U+12 V) on the set input. The inverting output of IC128 will be low, which, disconnects RE112, via TS130. Pressing the ON button will give a high voltage (U+12 V) on the reset input. The inverting output of IC128 will be high, which, via TS130 connects RE112. Inserting the power cord into the power inlet will cause a pulse on the reset input, via C1127. It is possible for the microcomputer to disable the STAND-BY button via TS133 and TS134. This is done during remote mode and during RAM-testing. A high level on the base of TS134 enables STAND-BY, and a low level disable it.

The STAND-BY indicator on the front panel is controlled by the +5 V, via TS127. +5 V off lights the STAND-BY LED.

+5 V also controls the PM 9628, fan-option. The fan is a 12 V DC fan, and operates only if +5 V is on. It will never operate if the counter is supplied from the battery unit.

The power supply also contains a connector for the battery option.

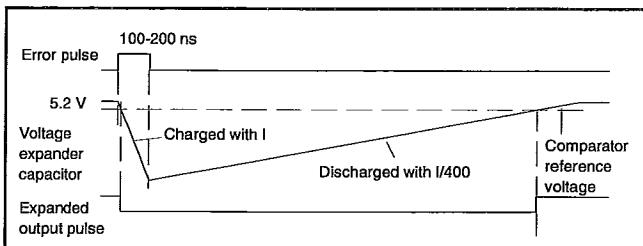
## Counter Circuits



**Fig. 4-15** OQ0502 and OQ0504 Block diagram.

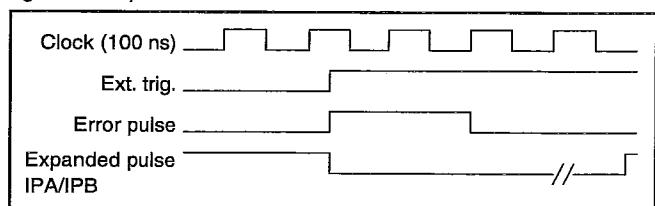
The PM 6680 measuring logic consists of two ASIC's, one high speed bipolar ECL circuit and one CMOS circuit. The bipolar SMTC, IC120, contains the measuring control functions, high speed counters and some analog parts used to increase the time resolution. The CMOS ASMTc, IC119 consists of two counter chains for the measurement and logic for measuring the expanded interpolator pulses. It also contains two programmable mono flip flops (100 ns resolution), an oscillator and an external reference input.

The bipolar circuit has a small analog part. This part increases the resolution in time and frequency measurements by means of an analog interpolator. The principle of an analog interpolator is basically that a capacitor is charged and discharged with different currents (ratio approximately 400) and that a small error pulse is extended with the ratio of these currents (see figure 4-13).



**Fig. 4-13** The Interpolator expands the error pulse 400 times.

Using the standard clock frequency as a reference we can measure this new extended pulse length. There are two interpolators, one start and one stop interpolator. The generation of the error pulse and the time expander are included in the OQ0502 circuit. The measuring logic for the expanded pulse is found in OQ0504. The small error pulse is the time from the external trigger event to the second positive clock transition. The error pulse is, consequently, between 100 ns and 200 ns long. The extended pulse is approximately 30 to 70  $\mu$ s, (see figure 4-14).

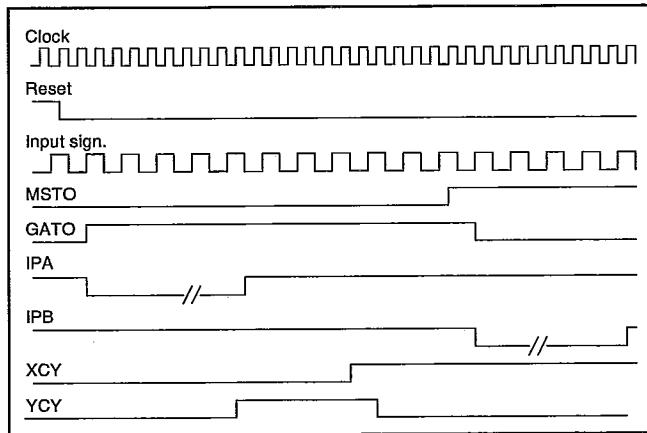


**Fig. 4-14** Measuring the expanded pulse in the OQ0504.

The following timing diagram (figure 4-16) shows a number of measurement signals for a frequency measurement of 11 periods. This measurement is started directly when reset is released. The measurement start can be controlled in a much more detailed manner. The arming signals, GET and arming delays (event or time) can be used to qualify the measurement start. The stop could be qualified in the same advanced way. The basic method is to send a Measurement STOp (MSTO)

signal to the circuits via the  $\mu$ C interface. This signal cannot be viewed externally.

The length of IPA and IPB is not correctly viewed (approximately 30 to 70 s).



**Fig. 4-16** A number of measurement signals for a frequency measurements of 11 periods.

XCY (X carry) is the input signal divided by 8. YCY (Y carry) is the clock divided by 8 ( 1.25 MHz ). These two signals will normally look like a burst signal of 1.25 MHz and the input signal divided by 8. The burst length is as long as the gate time. The OFLW signal sends an OverFLow Warning message to the OQ0502 circuit. This means that the counter chains in OQ0504 will soon overflow and that the start/stop logic should stop the measurement when possible.

The RESET signal is coupled as a ripple through chain. By this method the reset signal resets the whole measuring logic in a correct order. The reset chain starts at the RESET IN pin on OQ0504, ripples through the measuring logic of OQ0504 and

comes out on RESET OUT. This signal is connected to the RESET IN pin of OQ0502 and resets the measuring logic of OQ0502.

The TRigA and TRigB signals are directly controlling the trigger LED's on the front panel. C1067 and C1068 connected to TRAC and TRBC inputs control the blinking rate.

The measuring logic also has two programmable delays with a resolution of 100 ns. These are used as arming delay and hold off and are generated in the OQ0504. They are triggered from OQ0502 by the signals HOS/ARDO (to SYN1 and SYN2 in OQ0504). The delayed signal is fed back to the OQ0502 with the signals PD1 and PD2 from OQ0504 to HOF/ARDI inputs on OQ0502. The delay can be programmed to an event delay instead of a time delay. The EDC1/EDC2 inputs of OQ0504 are therefore connected to the B input enabling, event delay for events on the B channel.

The signal GATO from OQ0502 gives a real time indication of the state of the measuring logic. Main gate open is indicated by a high level and main gate closed is indicated by a low level. TS122 makes it possible to make the high level 1.4 V in  $50\Omega$ .

The signals A (A-channel), B (B-channel), C (prescaler signal), and E (rear panel external arming input) go to an input multiplexer in OQ0502. The A and B inputs also have slope selections (positive edge and negative edge) in OQ0502. R1198, C1078, and R1382, C1374 terminates the C resp E signals.

The rear panel input external arming is a DC-coupled TTL level input. R1238 -R1241 with GR129 and GR130 protects the input. TS115 and TS116 are a Schmitt-trigger with approximately 1.4 V threshold level.

The ECL-inputs in OQ0502 get their reference (VBB) from an external ECL-circuit IC132.

The GET-signal from an optional GPIB-interface can control the start of the measurement.

## Oscillator Circuits

The 10 MHz reference oscillator is used as: 1) a clock for the microcontroller and 2) as a reference for the measuring logic. The clock for 1) must always be present, or the microcontroller will stop working. If an external reference is used as measuring reference, the internal oscillator must still be used as clock for the microcontroller.

For the internal oscillator, there are several optional oscillators to choose from. The uncompensated 01-oscillator is always mounted in the PM 6680. If a better oscillator is needed, it should be connected to the opt. osc connector BU105. A TCXO PM 9678B, oven oscillator PM 9690, or oven oscillator PM 9691 can be mounted. If this is done the oscillator type jumpers JP14 and JP15 should be placed in the OPT position. This disconnects the 01-oscillator and connects the crystal to GND, to prevent it from disturbing the optional oscillator.

The 01-oscillator consists of a crystal KT1, C1063, C1064, C1065, R1160, R1161, and the trim capacitor C1073. The inverting amplifier is placed in OQ0504, IC119 (XIN and XOUT pins). C1073 adjusts the frequency.

If an optional oscillator is mounted, the 10 MHz signal is amplified in a two stage amplifier (TS123, TS124). The reference signal goes to the XIN pin on OQ0504, IC119.

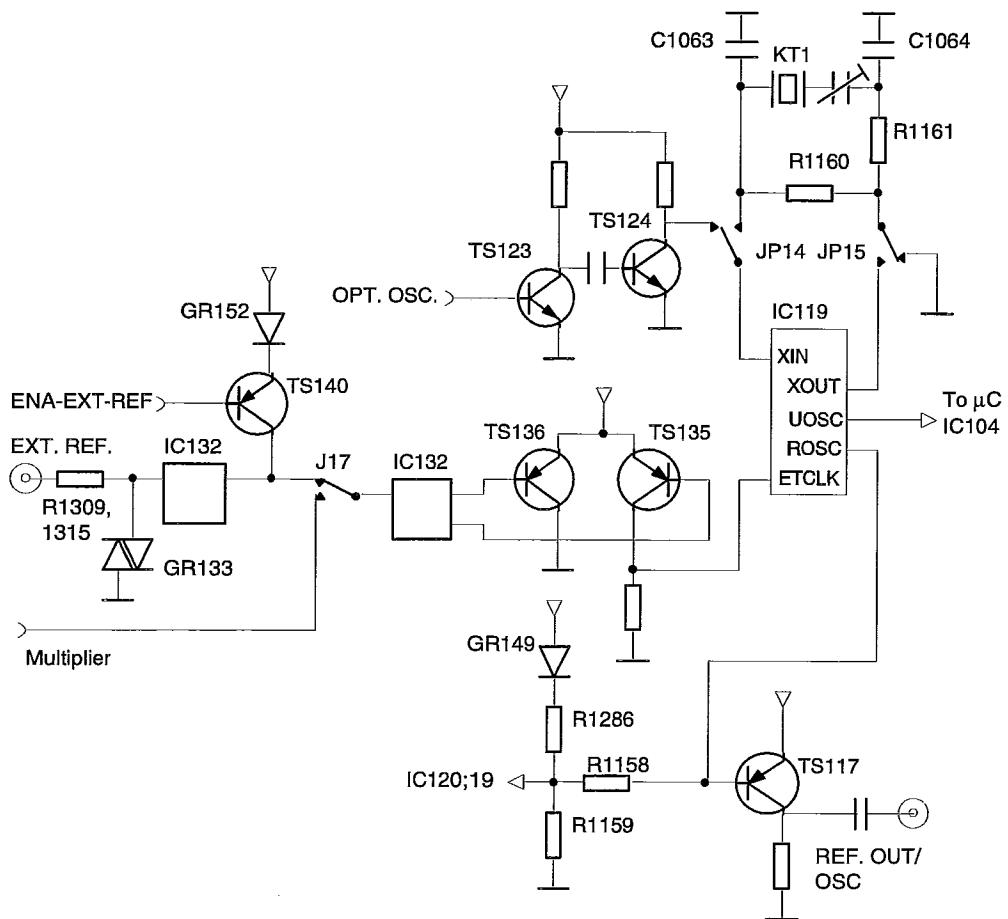
For the external reference, there is an AC-coupled input amplifier. R1309, R1315, and GR133 protect the input. The amplifier is a Schmitt-trigger coupled ECL line receiver, 1/3 of IC132. This ECL circuit is working with positive ECL levels. It

is possible to switch off the external reference signal with the signal ENA-EXT-REF from the microcontroller. A low level of this signal makes TS140 conductive, and that forces a high ECL-level on the output of IC132. GR152 makes the level +4.3 V. After an ECL-buffer, 1/3 of IC132, the signal is converted to TTL-levels in the level-converter TS136 and TS135. The TTL-signal goes to ETCLK pin on OQ0504, IC119.

To be able to handle other external references except 10 MHz, an external reference multiplier PM 9697 can be mounted. It is mounted on the area where the optional oscillator normally is mounted, but connected to BU114 instead of BU105. Jumper JP17 should be placed in "PM 9697 installed" position. 01-oscillator must be used as internal oscillator. The selection between 1 and 5 MHz is done with jumpers on PM 9697.

A microcontroller controlled multiplexer in OQ0504, IC119 chooses between internal oscillator (XIN) or external reference (ETCLK). The selected reference is output on pin ROSC. This CMOS signal is converted by R1158, R1159, R1286 and GR149 to a positive ECL signal used as measuring reference in OQ0502, IC120. The same signal is also used as 10 MHz out. The square wave is transformed to a sine signal in an amplifier stage TS117. This stage has  $50\Omega$  driving capabilities.

At pin UOSC, the internal oscillator (input at XIN) is output for use as clock in the microcontroller. The clock is divided by two in the microcontroller, and used as a clock for circuits on the PM 9626 GPIB option.



**Fig. 4-17** Oscillator circuits.

## Logical Circuits

### • Microcomputer Circuits incl. I/O

The microcomputer in PM 6680 is an Intel 16-bit CMOS microcontroller 80C196KB10, IC104. It is a fast microcontroller, intended for controller applications, i.e., it has many I/O ports and other facilities to control and react on the external world. It contains 232 RAM-bytes.

The microcontroller can operate in both 8 and 16-bits mode externally. In PM 6680, only 8-bit mode is used (pin 64 = GND). Internally the microcontroller uses 16-bits. The address and data-bus AD0 to AD7 is shared (time multiplexed) between addresses and data. Therefore the address must be stored in an address-latch (IC107) by using the signal ALE (pin 62). AD8 to AD15 are only used for addresses and they are latched in the microcontroller directly.

If the surrounding circuits are slow compared to the microcontroller, wait states must be issued. The ready-pin (pin 43) goes low to get wait states. When the microcontroller communi-

cates with the RAM, the GPIB-chip and the trigger level circuits, wait states are automatically inserted. Also the instruction fetching from the PROM can insert wait states. In PM 6680 a fast PROM is used, so the wait states are not used. (R1278 is not mounted.)

The PROM (IC111) used is a 27C512, i.e., a 64K byte memory. The address mapping is done so we can only address 32K bytes directly. Bank switching is used to be able to use all 64K bytes. The signal from IC104 pin 32 controls that half of the memory that is used for the moment. At reset the upper half is selected (IC104 pin 32 goes high).

To be able to make a CRC-check of the contents of the PROM, the microcontroller must be able to read the contents of the PROM as data. The INST signal (IC104 pin 63) can be overruled by a signal from pin 31 to read program as data.

There are several features for testing and troubleshooting. The test pins P11, P12, and P13 are used during the start-up routine after reset of the microcontroller. It sends a new code to these test pins for each step of the start-up that is completed. The same information is sent to the display, but if the

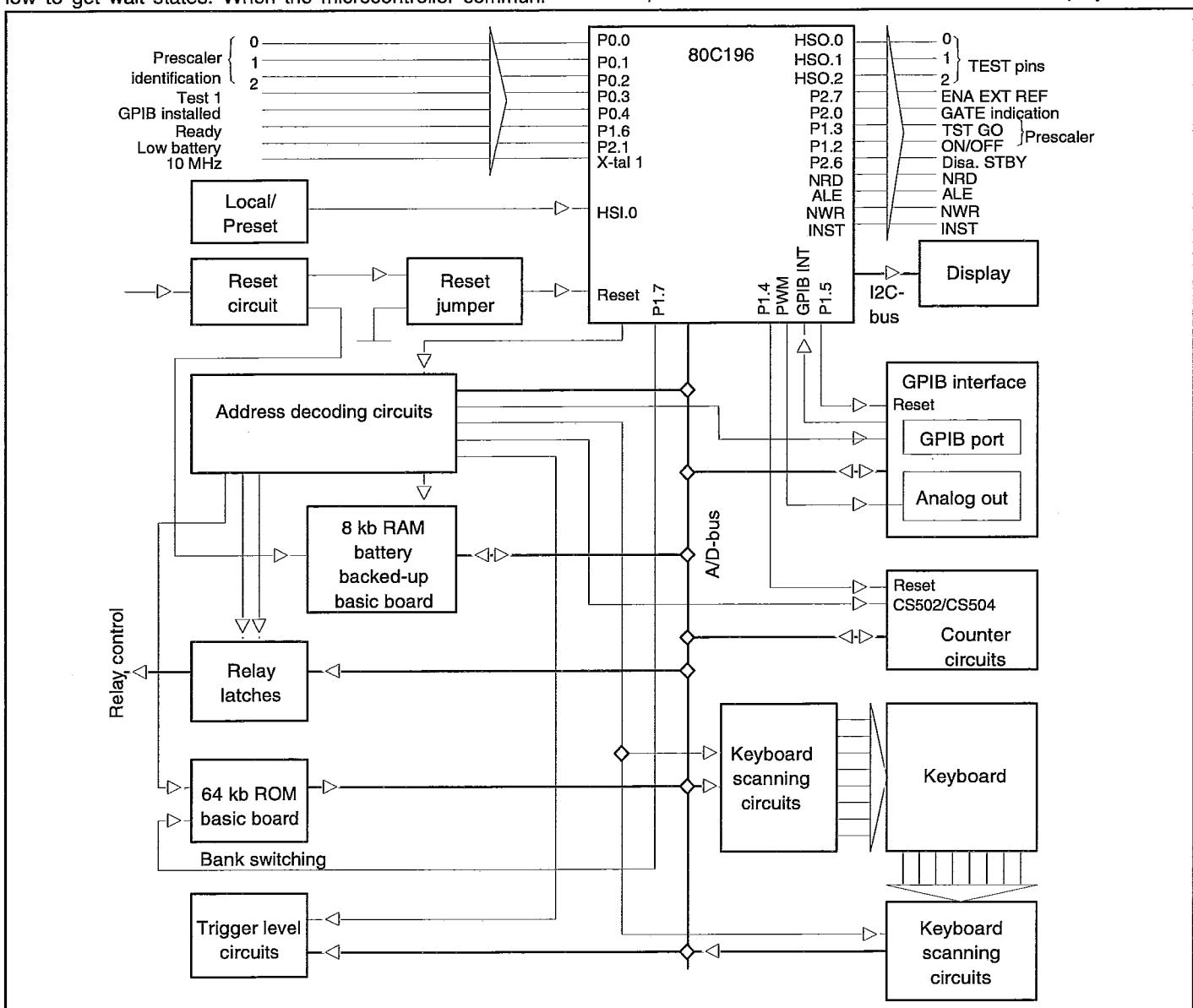


Fig. 4-18 Block diagram, PM 6680 logical circuits.

display is out of order, the start-up can be checked here. The address and data bus AD0 to AD7 can be separated into two parts. By removing resistors R1131 - R1133, R1135 - R1138, and R1142 you can separate the microcontroller, the address latch and the PROM from all other circuits on the bus.

The microcontroller communicates with the outer world by I/O circuits connected to the address and data bus AD0 - AD7. The WR (pin 40) and RD (pin 61) signals from IC104 control the direction of information. These two signals, with the address decoding logic, produce "chip select" signals for the I/O circuits. The address decoding logic uses the AD8 - AD15 to produce chip select signals. Chip select signals are generated for:

- PROM, IC111, RAM and IC113.
- The input amplifier relay drivers IC115 and IC116, display scanning circuits IC117 and IC105 and the GPIB optional board.
- The trigger level circuits IC122 and IC125 and the counter circuits IC119 and IC120.

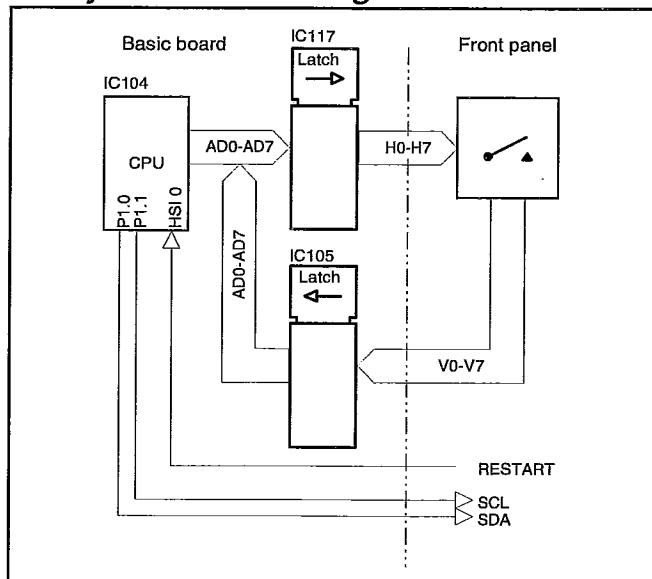
To show that the counter measures, a gate indicator is placed on the front panel. It is controlled from the microcontroller IC104 pin18 via TS114. The blinking of the LED is software controlled, and does not necessarily reflect the true state of the measuring hardware.

The RAM, IC113 has battery backup. If the counter is on, the +7 V gives power to the RAM, via GR148, GR126, and GR127 to get +5 V. If the counter is in standby or not connected to the line power at all, the 3 V battery gives power to the RAM. The Schottky diode GR128 isolates the battery and preserves power when +7 V is present. When this happens pin 26 of the RAM is low, and the RAM goes to the power-down mode. At this point the RAM needs a 2 V supply voltage.

### • Reset Circuit

A special reset circuit is included in the design. IC110 is a special supply supervisor. If the +5 V becomes lower than 4.5 V, the reset output pin 4 goes low. This gives a microcontroller reset. For test purposes jumper JP13 RESET can force a reset of the microcontroller. The length of the reset pulse is set by C1060; 2.2  $\mu$ F gives a pulse of approximately 40 ms. The supervisor circuit also controls the reset pulse during the power-on, so the microcontroller starts in a controlled manner.

### • Keyboard Scanning



**Fig. 4-19** Keyboard scanning.

The keyboard scanning is done in two modes. The first mode is when no button has been detected as pressed. Then all outputs of IC117 are set high, and the buffer IC105 is read. If no button is pressed, all outputs are low. This check is done at every timer interrupt in the microcontroller, which is every 25 ms. If a button is pressed, one of the output bits is high. When this is detected, mode two is entered. The outputs of IC117 must be set high one after the other to find the specific button pressed. Then found, only this button will be checked in the future, so other simultaneously pressed buttons will not be recognized. The pressed button must stay pressed for several timer interrupts before action is taken. After the action has been done, the timer interrupt SW waits for the button to be released. The button must be released for several timer interrupts before the keyboard scanning returns to mode 1 looking for another pressed button.

Three buttons are not scanned in this way:

The ON and STAND-BY buttons are connected to the ON/STANDBY logic in the power supply. The LOCAL/PRESET button is connected directly to an input pin (24) on the microcontroller IC104. Pressing this button sends an interrupt to a special handler in the SW.

## Rear Panel Unit

The rear panel consists of an aluminum panel with some mounted connectors. The following connectors are mounted on the rear panel:

### INPUTS:

- External reference input - BNC ( D )
- External arming input - BNC ( E )
- Rear panel inputs (factory-mounted option)

Power supply inlet including EMI filter

### OUTPUTS:

- Internal reference output - BNC ( G )
- Gate open output - BNC ( H )

If a battery option is mounted in the instrument, then the battery on/off switch is also mounted on the rear panel.

If a GPIB interface is installed in the device, it is mounted on the rear panel and connected to the main board with a flat cable.

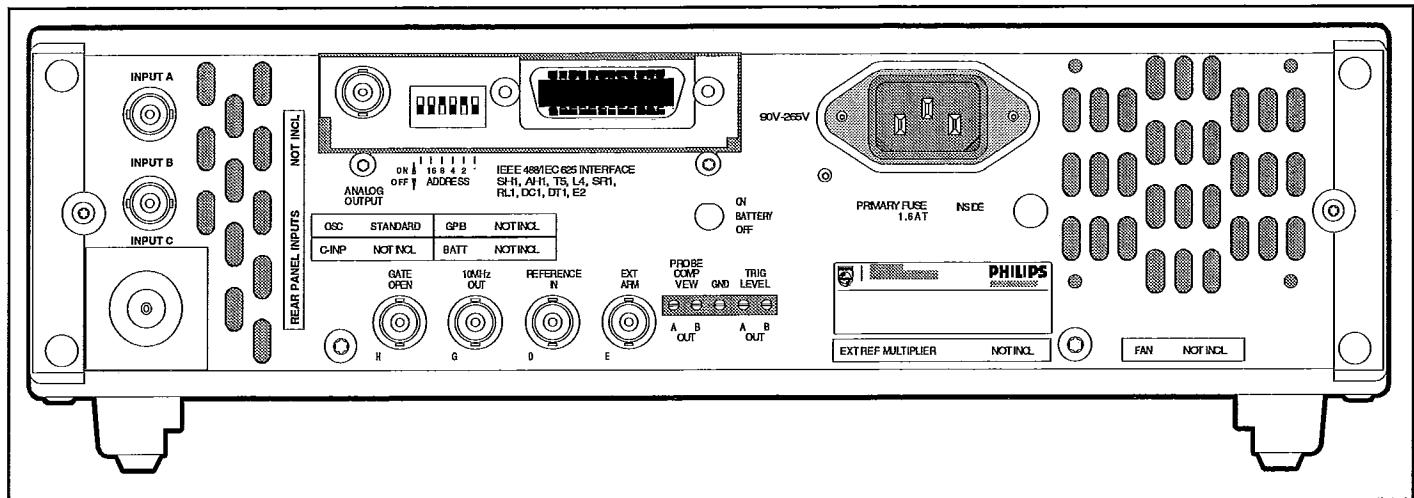
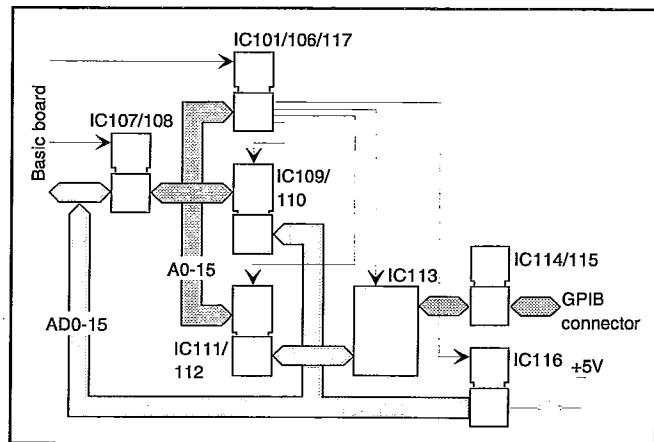


Fig. 4-20 Rear Panel.

## Optional Units

### GPIB Interface Including Analog Output

- **GPIB**



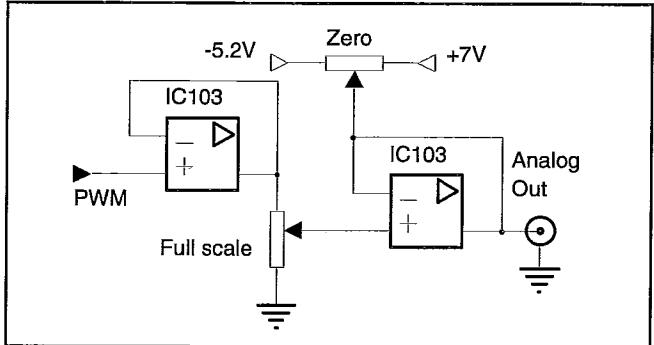
**Fig. 4-21** GPIB interface.

The PM 9626 GPIB interface controls the communication between the internal microprocessor and the external GPIB bus. A 32K extension of the ROM and RAM is placed on PM 9626. An analog output is also included.

The GPIB control circuit, IC113, communicates with the external GPIB bus via the bidirectional bus drivers IC114 and IC115. IC113 is controlled from the microprocessor by writing and reading in the internal control registers. If IC113 has a message for the microprocessor, it uses the GPIB interrupt signal. The address switch setting is read by the microprocessor via IC116.

A 32K extension of both ROM (IC109 and IC110) and RAM (IC111 and IC112) is placed on PM 9626. The circuit board is prepared for a 16-bit extension, but only 8 bits are used in PM 6680. IC110 (ROM), IC112 (RAM) and R118 are not mounted. IC107, IC108 are address latches and IC101, IC106 and IC117 use the latched address to generate chip select and chip enable signals for internal use on PM 9626.

- **Analog Out**



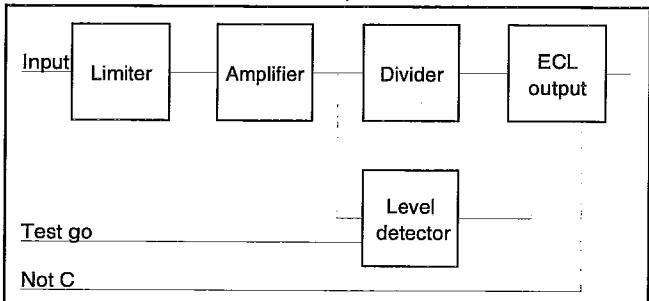
**Fig. 4-22** Analog output.

The result on the display can be converted to an analog signal. The PWM signal from the microprocessor is a digital pulse width modulated signal. The signal is filtered and integrated (IC103) to give an analog DC level between 0 and 4.98 V with a resolution of 20 mV. The analog output has a separate analog ground connected to the cabinet.

### HF Inputs

There is a choice of three different optional HF inputs; PM 9621, PM 9624, and PM 9625. The inputs are all mounted on the same place on the main board, to the right of the input amplifier. They are connected to BU107, and only one prescaler at a time can be mounted. In BU7 there are 3 ID pins. Different prescalers have different coding of these pins. PM 9624 and PM 9625 are factory repair only, due to the need of instrumentation for high frequencies.

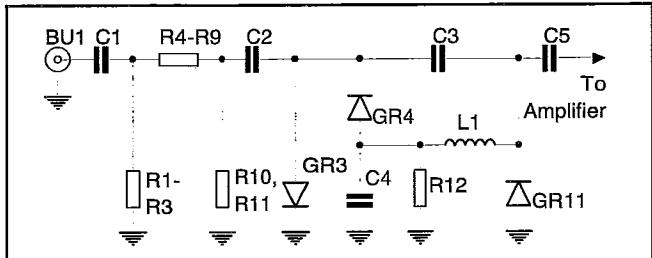
- **Prescaler 1.3 GHz, PM 9621**



**Fig. 4-23** PM 9621 Block diagram.

The frequency range for the prescaler is 70 MHz to 1.3 GHz. The frequency is divided by 256 to be able to be handled by the measuring logic in the counter. The input is AC-coupled and the input impedance is 50Ω nominal. The prescaler consists of the following main blocks: limiter, amplifier, divider, ECL output, and level detector.

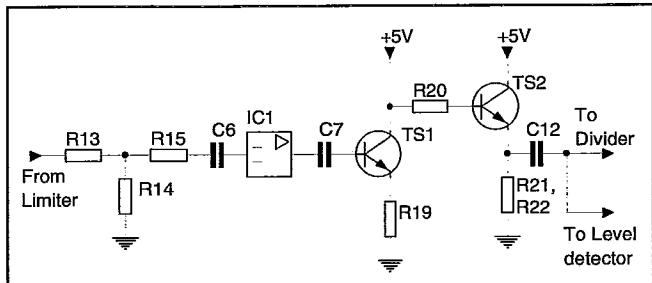
## Limiter



**Fig. 4-24** Limiter circuits.

The 6 dB attenuator (R1 to R11) keeps the VSWR low for all input levels, even the PIN diodes have low impedance. When the peak-to-peak level of the input signal is greater than the sum of the voltage drops of the Schottky diodes GR3 and GR4, the charging of capacitor C4 starts. Capacitor C4 filters the voltage after the Schottky diodes. The PIN diodes GR11 start to conduct when the voltage is lower than approximately  $-0.65$  V. More current through the diodes means lower impedance. This means that the HF voltage over GR11 is constant. R12 discharges C4 then the input level decreases. L1 prevents capacitor C4 from short-circuiting the HF signal.

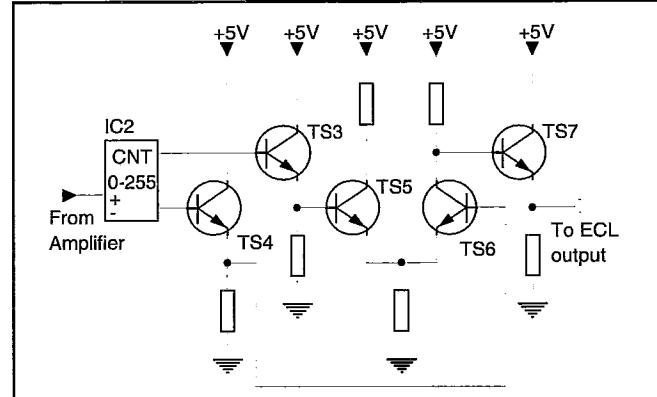
## Amplifier



**Fig. 4-25** Amplifier circuits.

R13, R14, and R15 attenuate the HF signal 3 dB, to prevent overloading of the amplifier circuit IC1. IC1 amplifies the HF signal approximately 15 dB. TS1 amplifies the frequency range 0.9 to 1.4 GHz by 8 dB, to increase the level for these frequencies due to the falling frequency response of IC2. TS2 is an impedance converter.

## Divider



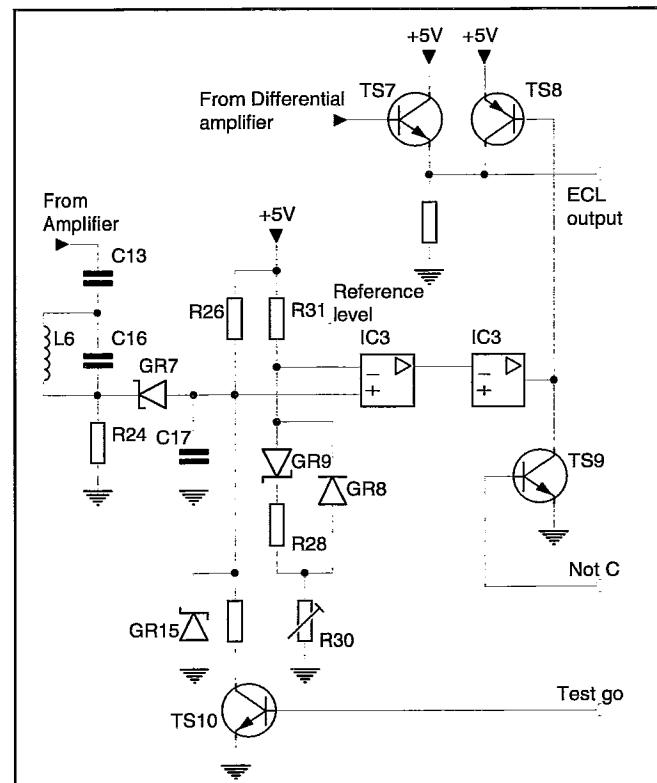
**Fig. 4-26** Divider and ECL-converter circuits.

The divider IC, IC2, divides the input frequency by 256. The output frequency is max 5.5 MHz.

## ECL output

TS3 and TS4 convert the output signal from IC2 to ECL levels. The rise and fall time of the output signal must be shortened. This is done in the differential amplifier TS5 and TS6. TS7 restores the ECL levels and buffers the single ended output signal.

## Level detector

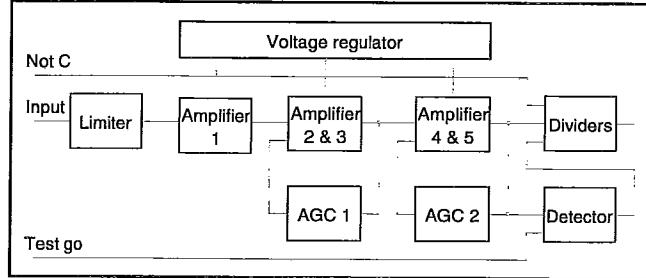


**Fig. 4-27** Level detector.

The filter consisting of C13, C16, and L6 make the frequency response of the signal to the level detector diode GR7 the same as the signal to IC2. The detector voltage is filtered and

fed to IC3. Diode GR15 prevents the level from being too negative (IC3 is then locked). The first stage in IC3 amplifies the level approximately 15 times and the second stage is a schmitt trigger. The output from the Schmitt trigger can block, via TS8, the ECL output signal. A low output signal from IC3 pin 7 makes TS8 conduct. The ECL output signal will be 4.5 V. If IC3 pin 7 is high, TS8 is not conducting, and the output signal from TS7 is not blocked. The Schmitt trigger is controlled from the first amplifier in IC3. If the level on IC3 pin 3 (detected level) is lower than the reference level on IC3 pin 2 (an HF signal with sufficient level present), IC3 pin 1 is low and the Schmitt trigger output is high, thus not blocking the ECL output signal. The reference level on IC3 pin 2 is set by trim-potentiometer R30. GR8, GR9, and R28 form a temperature compensation circuit, to compensate for the temperature behavior of the detector diode GR7. For testing purposes, the level detection can be overruled by the signal TEST GO. A high level makes TS10 conduct, and that enables the ECL output signal, despite the HF input signal amplitude. The ECL output signal can also be switched off, despite the level detection. A high level on signal NOT C makes TS9 conduct and thus makes the level to TS8 low. TS8 makes the ECL output signal +4.5 V.

### • Prescaler 2.7 GHz, PM 9624



**Fig. 4-28 PM 9624 Block diagram.**

The PM 9624 prescaler cannot be repaired at a local workshop. It must be sent to the factory for repair.

The prescaler consists of the following parts:

#### Limiter

- The limiter consists of a 6 dB attenuator and a PIN diode attenuator to achieve constant input amplitude to the amplifiers.

#### Amplifier

- Five amplifier stages are divided into three blocks. One block consists of one amplifier. Two blocks consists of two amplifiers each and an AGC control.

#### Automatic Gain Control (AGC)

- Helps the amplifiers to retain a constant output amplitude.

#### Dividers

- Two dividers divide the input signal frequency by 16.

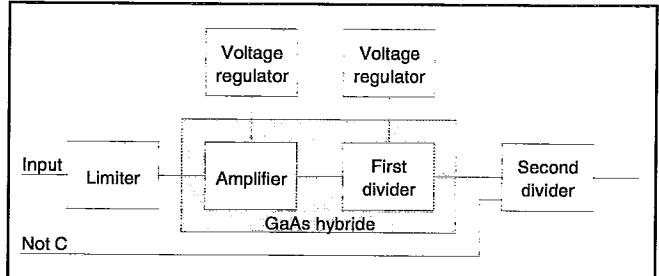
#### Detector

- Detects whether the level of the input signal is high enough to ensure correct measurement and, if not, blocks the output signal from the prescaler.

#### Positive Voltage Regulator

- Positive voltage supply for the amplifiers.

### • Prescaler 4.5 GHz, PM 9625



**Fig. 4-29 PM 9625 Block diagram.**

The PM 9625 prescaler cannot be repaired at a local workshop. It must be sent to the factory for repair.

The prescaler consists of the following parts:

#### Limiter

- The limiter consists of a 6 dB attenuator and a PIN diode attenuator to achieve constant input amplitude to the amplifiers.

#### Amplifier

- The amplifier consists of 4 cascade coupled integrated GaAs amplifiers; each amplifies approximately 8 dB.

#### First divider

- The GaAs divider chip consists of an input buffer, 3 divider stages, and 2 output buffer stages. The circuit divides by 8.

#### Second divider

- This divider divides the signal from the first divider by 4. In total the frequency is divided by 32, and the output frequency from the prescaler is 155 MHz at maximum.

#### Voltage regulators

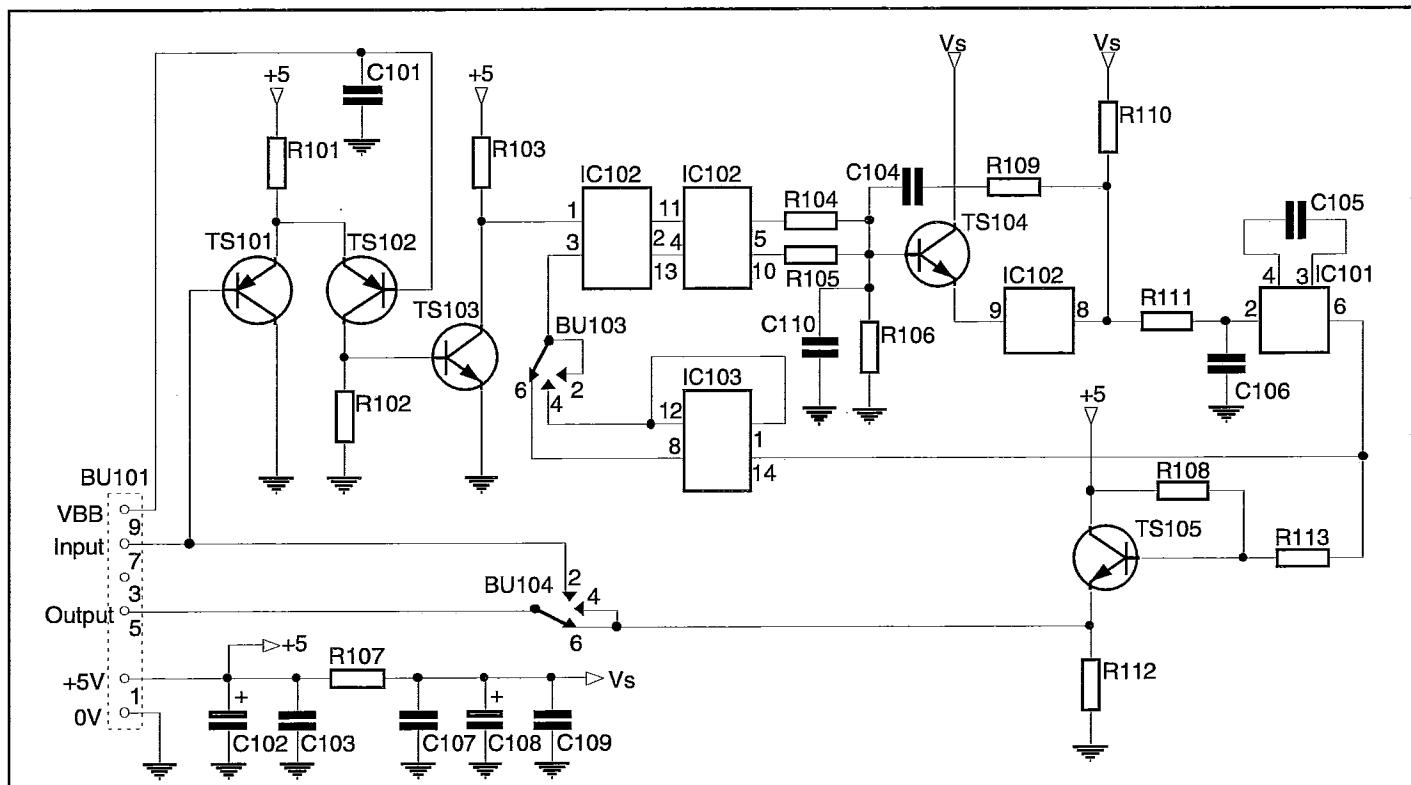
- Two positive voltage regulators are used for the GaAs amplifier and the first divider.

## External Reference Frequency

### Multiplier, PM 9697

Transistors TS101 to TS103 convert the incoming ECL signal to TTL levels. IC102 and IC103 form a frequency and phase detector, (PLL).

The BU103 jumpers in the feedback loop set the multiplying factor to 1, 5 or 10. The DC voltage at IC101 pin 2 ensures that the VCO in IC101 is oscillating at 10 MHz. Transistor TS105 changes the TTL signal to ECL levels.



**Fig. 4-30** External Reference Frequency Multiplier, PM 9697.

# *Software Functional Description*

## **General**

The PM 6680 software is divided into two main modules: the GPIB and DEVICE modules. The GPIB fully implements the Message Exchange protocol as described in the IEEE 488.2 - 1987 standard.

The DEVICE module is a real-time measurement executive that can be interrupted to do other tasks, such as: handle the keyboard, perform bus commands etc.

The basic structure of the main module is as follows:

```
main PM 6680()
{
    Initialize();

    while (TRUE)
    {
        if (BREAKFLAG_KEYBOARD)
        {
            HandleKeyboard();
        }
        if (BREAKFLAG_PRESET)
        {
            PresetDevice();
        }
        if (BREAKFLAG_GPIBCOMMAND)
        {
            ExecuteGpibCommands();
        }
        if (BREAKFLAG_RESTART)
        {
            RestartMeasurement();
        }
        while (not any BREAKFLAG)
        {
            Measure( );
        }
    }
}
```

All break flags are set by interrupt driven events, either external (from the GPIB interface) or from internal functions ( like timers etc.).

The **Initialize** procedure does all necessary initialization at power up. It also does the power up tests. See Power on tests.

The **HandleKeyboard** procedure controls all user input/output via the front panel, except displaying the measurement results.

The **PresetDevice** procedure reprograms the complete device when the PRESET key has been pressed ( in local mode). It aborts pending measurements.

The **ExecuteGpibCommands** procedure executes GPIB commands and, if a query is received, it starts the response formatter and sends the requested data to the GPIB interface. If the display is switched on, then the results are also displayed.

The **RestartMeasurement** procedure aborts pending measurements; the measure loop will later continue to measure. This is mainly used when the RESTART key is pressed.

The **Measure** procedure is the measurement control loop that is used in local mode. It sends its result to the display.

The **ParseGpibInputData** procedure parses the GPIB messages found in the input buffer and sends executable statements to the **ExecuteGpibCommands** procedure. The input of data to the input buffer from the external GPIB interface is fully controlled in interrupts. These interrupts are always enabled so the new data bytes can be stored in the input buffer while parsing commands. This **ParseGpibInputData** is also executed in interrupt.

---

## **Test Routines**

### **Test Routines via AUX MENU Key**

The test routines are the routines accessible via the aux menu key.

Refer to the PM 6680 Operators Manual.

### **Power-On Tests**

At power on, some tests are automatically performed. If any of these tests fails, an error message is displayed and the instrument is halted. Pressing the LOCAL/PRESET key makes the device continue independently of the detected error, but without performing the next tests in start up sequence. The following tests/actions are performed:

- Write 001 to internal test pins
- Pulse all microcomputer i/o ports twice

- Write 0.1 on display
- Write 0.1.2. on display and 010 on test pins
- Test µC internal RAM ( error = Err µC & halt)
- Write 0.1.2.3 to display and 011 on test pins
- Test µC timer ( error = Err µC & halt)
- Write 0.1.2.3.4. on display and 100 on test pins
- Test main board RAM ( error = Err ra. & halt )
- Write 0.1.2.3.4.5. to display and 101 to test pins
- Test ASIC's ( error = Err ASIC & halt)
- Write 110 on test pins
- Check display (light all segments for 2 s)
- Clear Display
- Perform GPIB RAM test if GPIB is installed (error = Err ra. & halt)
- Write 111 on test pins ( final value)
- Write PHILIPS on display
- Clear display and start normal measurement procedure

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***Chapter 5***

# ***Repair***

# Preventive Maintenance

## Calibration

To maintain performance of PM 6680 we recommend that you calibrate your instrument every year, or more often, if greater time base accuracy is required. Calibration should be performed with traceable references and instruments at a certified calibration laboratory. Contact your local Fluke/Philips service center for calibration.

To know the present status of your instrument, test your timer/counter from time to time. The test can be made according to the information in Chapter 2, Performance Check.

## Oscillators

The frequency of the reference crystal oscillator is the main parameter affecting accuracy in a counter. The frequency is affected by external conditions like the ambient temperature and supply voltage, but also by aging. When recalibrating, the reference crystal oscillator is compensated only for deviation in frequency due to aging.

### • Some important points:

- The high stability oscillators have been built into an oven in order to keep the oscillator temperature as stable as possible. Continuous operation is also important for stability. After a power interruption, the oscillator restarts at a slightly different frequency. It will then, as time goes on, age at an equal rate.
- The stability indicated for the oscillators is valid within a temperature range of 0 to 50°C, with a reference temperature of 23°C. If the timer/counter is used in a room temperature of 20 to 30°C, the temperature stability of a TCXO or OCXO will be increased by a factor of 3.
- The temperature stability indicated for TCXO and standard oscillators are mainly dependent on the ambient temperature. When operating there is always a temperature increase inside the counter which will influence the oscillator.

### • Recalibration intervals

The Mean Time Between ReCalibration, MTBRC, is defined as:

$$MTBRC = \frac{(Acceptable\ error) - (Temperature\ stability)}{(Aging)}$$

MTBRC can be calculated when the total acceptable error and the oscillator specifications are known.

The total acceptable error is defined as:

$$(Acceptable\ error) = \frac{(Deviation\ of\ reference\ frequency)}{(Nominal\ frequency\ reference)}$$

### Example:

- A user can accept a maximum of 3 Hz deviation on the 10 MHz frequency of the oscillator. This results in:

$$(Acceptable\ error) = \frac{3}{10 \cdot 10^6} = 3 \cdot 10^{-7}$$

The aging and temperature factors can be selected from the table on page 5-3.

The value of the aging factor is correctly selected from the table when the calculation of MTBRC results in 1 to 30 days (use /24h), 1 to 12 months (use /month) or over 1 year (use /year) (not, e.g., 43 days or 17 months or 0.8 years).

### Example:

- The user has the same requirements as in the example above. The counter has a PM 9690 oscillator.
- Look up information about PM 9690 in the table on page 5-3. The results will be the following:

Relative Frequency deviation caused by:

- Ambient temperature deviation  
(within 0 to 50°C; reference point at 23°C): Less than  $1.5 \cdot 10^{-8}$
- Aging/year: Less than  $1 \cdot 10^{-7}$
- Use the MTBRC formula with the above values. This gives a MTBRC of maximum:

$$\frac{(3 \cdot 10^{-7}) - (1.5 \cdot 10^{-8})}{1 \cdot 10^{-7}} = 2.85 \text{ years}$$

NOTE: When recalibrating, the reference crystal oscillator will be compensated only for frequency deviation caused by aging.

Stability against	Model Options			
	/1.	/2.	/4.	/5.
		PM 9678B	PM 9690	PM 9691
Standard	TCXO	Oven	Oven	
Aging: /24h after 48 hours of continuous operation	n.a.	n.a.	$< 1 \times 10^{-9}$	$< 5 \times 10^{-10}$
Aging: /month	$< 5 \times 10^{-7}$	$< 1 \times 10^{-7}$	$< 2 \times 10^{-8}$	$< 1 \times 10^{-8}$
Aging: /year	$< 5 \times 10^{-6}$	$< 5 \times 10^{-7}$	$< 1 \times 10^{-7}$	$< 7.5 \times 10^{-8}$
Temperature: 0 to 50°C ref. to + 23°C	$< 1 \times 10^{-5}$	$< 1 \times 10^{-6}$	$< 1.5 \times 10^{-8}$	$< 5 \times 10^{-9}$
Line Voltage ± 10%	$< 1 \times 10^{-8}$	$< 1 \times 10^{-9}$	$< 5 \times 10^{-10}$	$< 5 \times 10^{-10}$
Warm-up Time to Reach $10^{-7}$ of Final Value	n.a.	n.a.	< 15 min	< 15 min

## When to Replace the Fan

To maintain the high reliability of a counter used in 'around-the-clock' applications, you must replace the fan every second year. For part time and low ambient temperature use, you can extend this service interval to 6-10 years or more. Fan replacement is described in Chapter 3, Disassembly.

## Battery Replacement

To preserve data and variables needed for the use of PM 6680 a lithium battery is included. The lithium battery has an estimated lifetime of five to ten years. We recommend replacing the battery every five years to avoid loss of data in operation.

When battery is empty, the timer&counter will lose all settings, and any data in memory.

# Troubleshooting

## General

### Quick Troubleshooting

The PM 6680 is a highly integrated Timer/Counter with dedicated LSI counter circuits and microcontrollers that control the complete units. The microcontroller can help you to locate faulty parts by running test programs and generating stable signal patterns on the bus. If the microcontroller does not work or the fault is in a part of the counter that cannot be accessed by the microcontroller, traditional faultfinding must be performed.

### Where to Start

After reading the safety instructions, continue with this Chapter for faultfinding and repair instructions. When you have fixed the instrument, always do the Safety Inspection and Test after Repair, as described later in this Chapter. Then do the checks in Chapter 2, Performance Check. Recalibrate if required by following the adjustment instructions in Chapter 6, Calibration Adjustments.

### Logical Levels

The PM 6680 contains logic of four families. The levels for these families are listed in the following table.

	Positive ECL	Negative ECL	CMOS	TTL
Supply voltage	+5 V	-5 V	+5 V	+5 V
Signal ground	0 V	0 V	0 V	0 V
Input voltage				
High, VIH	>+3.9 V	>-1.1 V	>+4 V	>+2 V
Low, VIL	<+3.5 V	<-1.5 V	<+1 V	<+0.8 V
Output voltage				
High, VOH	>+4 V	>-1 V	>+4.9 V	>+2.7 V
Low, VOL	<-3.3 V	<-1.7 V	<+0.05 V	<+0.4 V
Bias ref. voltage, VBB	+3.7 V	-1.3 V	-	-

Table 5-1 Logical levels.

### Required Test Equipment

To be able to test the instrument properly using this manual you will need the equipment listed below. The list contains not only suggested Philips and Fluke test equipment, but also the critical parameter specifications required if you have instruments from other manufacturers.

Type	Performance	Philips model No	Fluke model No
DMM	-	PM 2518	77
Oscilloscope	50 MHz 2-channel	PM 3050	-
Signal generator	1300 MHz	-	6062A
BNC-BNC cables	-	-	-
Service kit		5322 310 10546	

Table 5-2 Required test equipment.

### PROM Identification

The different PROMs in the PM 6680 are marked as follows:

Main PROM	IEEE PROM	Service PROM
6680*	9626/80**	6680S***
V1.00A	V1.10A	V1.01B

Table 5-3 PROM Identification.

\*6680 indicates the instrument in which the PROM is used, that is PM 6680. V1.00 is the version and "A" indicates that this PROM will work together with a PROM marked "A" in the IEEE-bus.

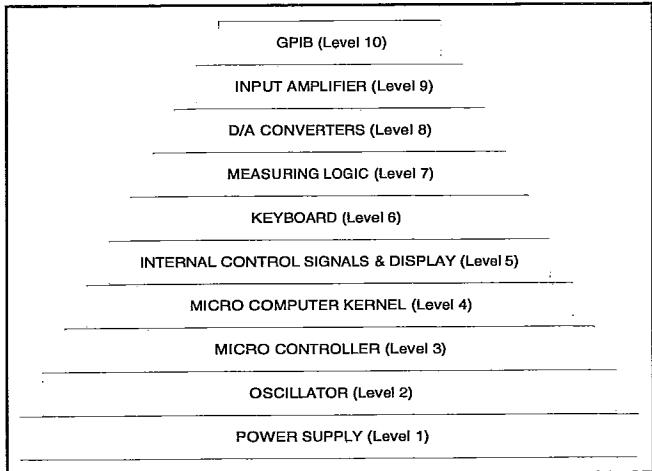
\*\*9626/80 shows that this is a PROM for the IEEE bus PM 9626 for use in a PM 6680 counter.

\*\*\*6680S shows that this is a Service PROM for use in PM 6680. "Err ro" will be displayed if you are using version "B" of the service PROM with an IEEE PROM marked with any other letter. You can avoid this error by disconnecting the IEEE bus from the main board.

### Operating Conditions

Power voltage must be in the range of 90 to 260 VAC.

## Introduction



**Fig. 5-1 Functional levels.**

The troubleshooting strategy in PM 6680 is an integrated part of the overall service strategy for the instrument. This instrument is hierarchically designed in different levels, and troubleshooting can be performed in any design level if the lower levels are OK. It is therefore important to disconnect all options in the beginning of the troubleshooting procedure.

## Running Test Programs

- Replace the PROM, IC111 by the Service PROM included in the Service kit.
  - Switch on the counter.
- Test 0, Test 1, and Test 2 runs automatically, but Test 3 begins after LOCAL/PRESET is pressed. After Test 11 the test-program starts from the beginning again. Use LOCAL/PRESET to step through the different tests.

NOTE: Test 5 and Test 11 are described under Level 4 and Level 5 respectively, but they cannot be run before you have checked Level 6.

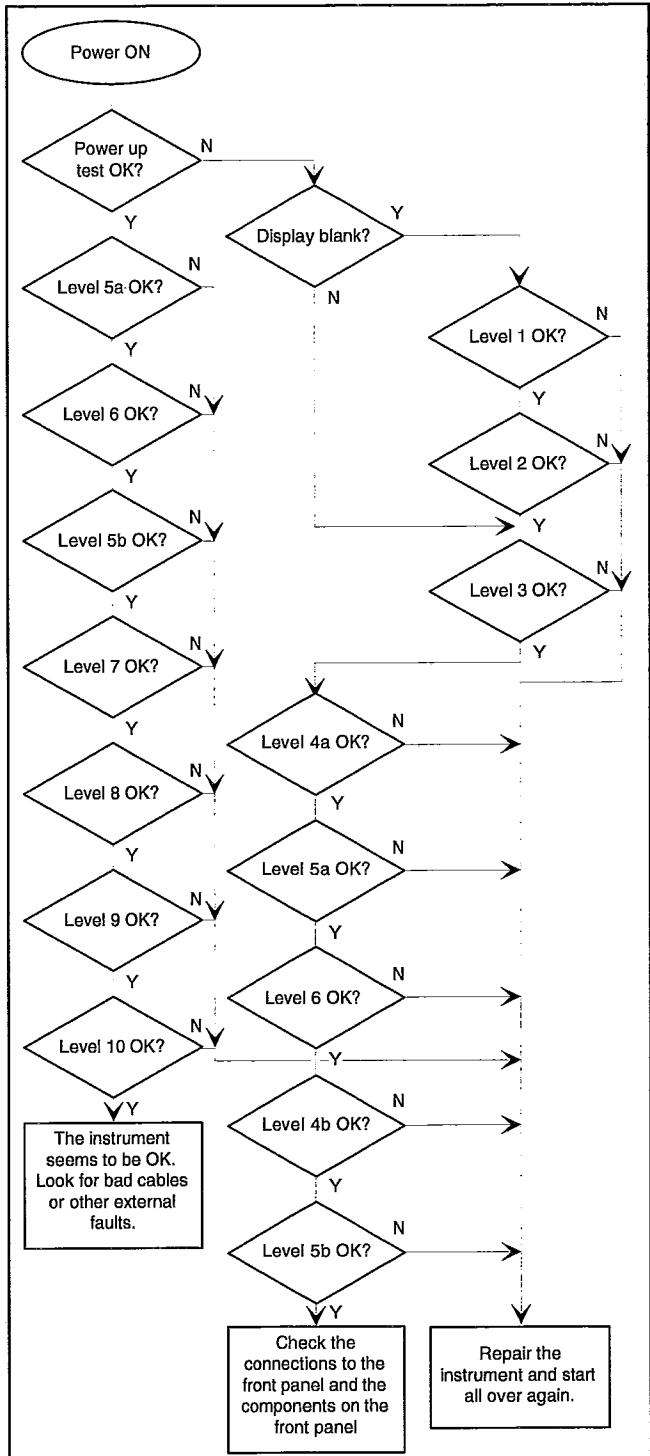
Text	Function	Level	Exit	Note
Test 0	ROM test	3	Automatically	*
Test 1	RAM test	3	Automatically	
Test 2	$\mu$ C Kernel test	3+4	LOCAL/PRESET	Stimuli signals
Test 3	Control signal test	5	LOCAL/PRESET	Stimuli signals
Test 4	Keyboard test	6	LOCAL/PRESET	Manual
Test 5	Address test	4	LOCAL/PRESET	Manual
Test 6	ASIC's test 1	7	Automatically	
Test 7	ASIC's test 2	7	LOCAL/PRESET	Stimuli signals
Test 8	DAC test	8	LOCAL/PRESET	Stimuli signals
Test 9	Analog out test 1	10	LOCAL/PRESET	Stimuli signals
Test10	Analog out test 2	10	LOCAL/PRESET	Manual
Test11	Display test	5	LOCAL/PRESET	Manual

**Table 5-4 Test programs.**

\*NOTE: See also PROM Identification.

NOTE: Do not forget to change back to the original PROM after repair.

## Troubleshooting Tree

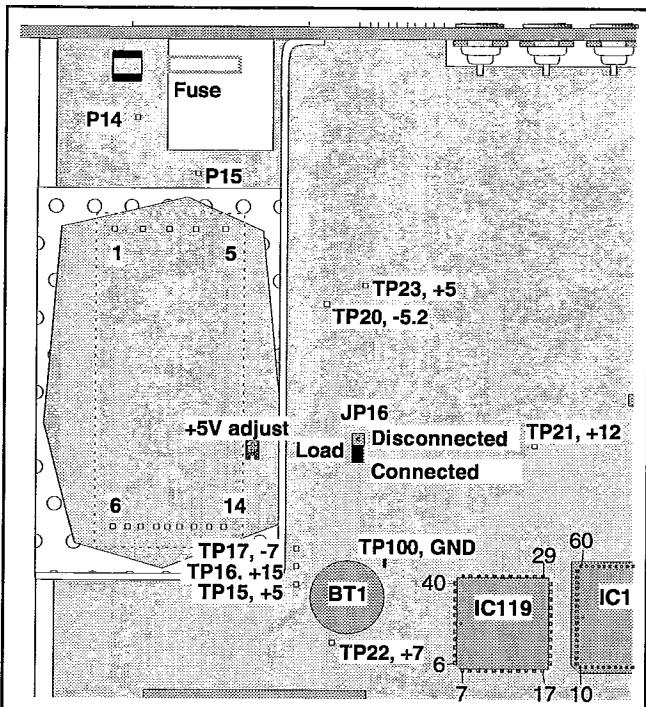


**Fig. 5-2 Functional levels.**

The levels mentioned in the troubleshooting tree refer to the functional levels. For example Level 3 are equal to Microcontroller (3). (Do the microcontroller check later in this Chapter.)

## Power Supply (Functional Level 1)

NOTE: The new Power Supply are described in the Appendix chapter at page Chapter 9.



**Fig. 5-3** Test points and trimmers for the Power supply.

- Connect the counter to the line power.
- Set the counter to STAND-BY mode.
- Check that the voltage between P14 and P15 is in the range of 90 to 260 VAC.
- Check that the input voltage to the power module, U11 between pin 1 and pins 4 and 5 on the bottom side of the PCA, is 120 to 375 Vdc.
- Move the jumper JP16 to the DISCONNECT position.
- Check the "STAND BY" voltages after the power module, U11. Use TP100 as ground.

Test points	Voltage
TP15	+5.10 V $\pm 10$ mV*
TP16	+14.8 V to +21 V
TP17	-12.5 V to -7.5 V
TP21	+12 V $\pm 0.5$ V

**Table 5-5** Standby voltages.

\*NOTE: If this voltage does not meet the above-mentioned spec, and it is not possible to adjust, the output resistances of the module must be checked as follows.

To verify the Power Module proceed as follows:

- If the primary fuse is broken, there is a short circuit in the primary circuits. Use a DMM and try to locate the fault by resistance measuring.
- Disconnect L103 and check the resistance between pin 1 and pins 4 and 5 on the power module. The DMM should **not** show a short circuit. Put L103 back in position.
- Check that the DC voltage between pin 1 and pins 4 and 5 on the power module is about  $\sqrt{2}$  times the input AC-voltage. If not, use traditional faultfinding techniques to locate the fault.
- Remove the power cable from the counter.

– Measure the resistances according to the table below.

Test pins	Resistance
TP100 (GND) and TP15 (+5 V)	$\approx 10 \Omega$
TP100 (GND) and TP16 (+15 V)	$\approx 1.5 \text{ k}\Omega$
TP100 (GND) and TP17 (-7 V)	$\approx 270 \Omega$

**Table 5-6** Output resistances.

- If one of the above-mentioned measurements shows 0  $\Omega$ , remove L11, L12, and L13 and use conventional troubleshooting techniques to isolate the fault.
- Measure the resistances according to the table below.

Test pins	Resistance
10, 11 and 13, 14	$\approx 150 \Omega$
8 and 9	$\approx 1.5 \text{ k}\Omega$
6 and 7	$\approx 270 \Omega$

**Table 5-7** Output resistances.

If the resistances do not correspond to the values in the table above, the complete power module must be replaced.

- Move jumper JP16 to CONNeCT position.
- Connect the power cable to the counter.
- Switch ON the counter.
- Check the "POWER ON" voltages. Use TP100 as ground.

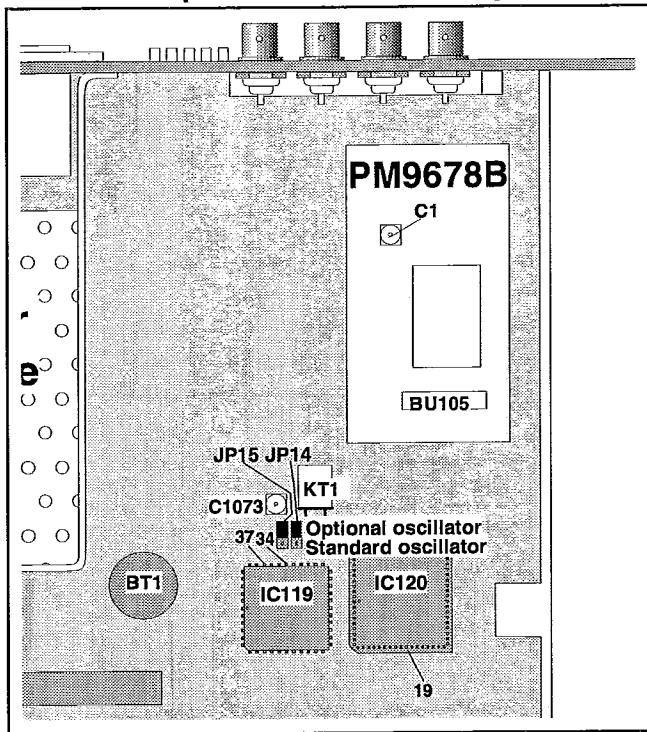
Test points	Voltage
TP23	+5.06 V $\pm 30$ mV*
TP20	-5.2 V $\pm 50$ mV
TP22	+7 V $\pm 100$ mV

**Table 5-8** Power-on voltages.

\*NOTE: If the +5 V voltage is outside the specification, all other levels will be wrong, since they are based on the +5 V level.

If you find any fault, continue with traditional troubleshooting techniques and replace defective circuits. See also Chapter 4, Circuit Descriptions, Power Supply.

## Oscillator (Functional Level 2)



**Fig. 5-4** Trimmers for the Standard- and TCXO reference frequency oscillator.

### • Standard Oscillator

- Be sure that jumpers JP14 and JP15 are in the STD position.
- Check that 10 MHz is present at IC119 pins 34, 36, 35 and pin 37.
- Check that 10 MHz is present at IC120 pin 19.
- Check that 10 MHz is present at IC104 pin 67.
- Check that 10 MHz is present at the rear panel connector 10 MHz OUT, BU109.

If you find any fault, continue with traditional troubleshooting techniques and replace defective circuits. See also Chapter 4, Circuit Descriptions, Oscillator Circuits.

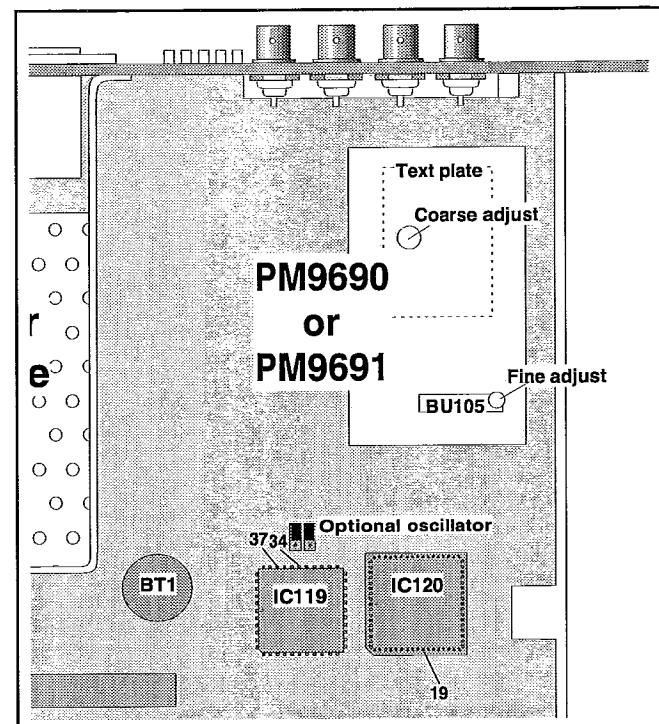
### • Optional Oscillator, PM 9678B

This test can be carried out only if the counter is equipped with an optional oscillator, PM 9678B.

- Be sure that jumpers JP14 and JP15 are in the OPT position.
- Check that 10 MHz is present at IC119 pins 34, 36, 35 and pin 37.
- Check that 10 MHz is present at IC120 pin 19.
- Check that 10 MHz is present at IC104 pin 67.
- Check that 10 MHz is present at the rear panel connector 10 MHz OUT, BU109.

If you find any fault, continue with traditional troubleshooting techniques and replace defective circuits. See also Chapter 4, Circuit Descriptions, Optional Oscillator, PM 9678B.

### • Optional Oscillator, PM 9690 and PM 9691



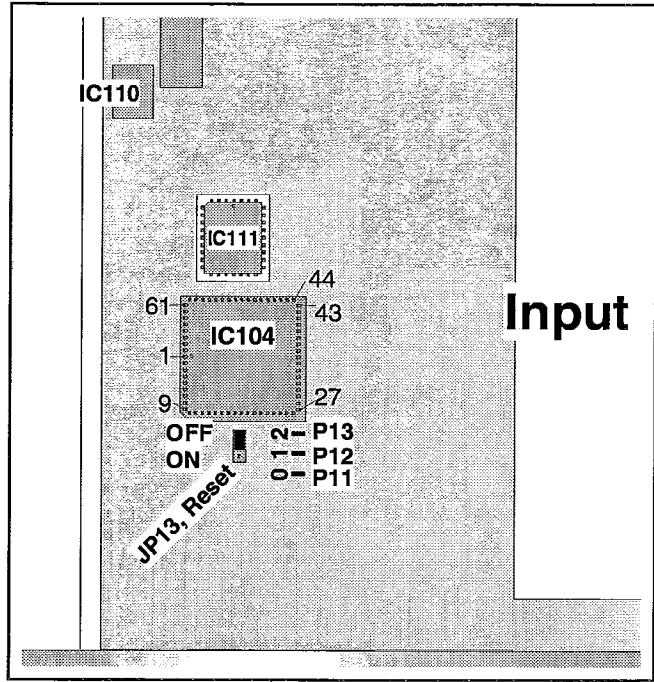
**Fig. 5-5** Trimmers for the Oven enclosed reference frequency oscillator.

This test can be carried out only if the counter is equipped with an optional oscillator, PM 9690 or PM 9691.

- Be sure that the jumpers JP14 and JP15 are in the OPT position.
- Check that 10 MHz is present at IC119 pins 34, 36, 35 and pin 37.
- Check that 10 MHz is present at IC120 pin 19.
- Check that 10 MHz is present at IC104 pin 67.
- Check that 10 MHz is present at the rear panel connector 10 MHz OUT, BU109.

These oscillators cannot be repaired in a local workshop. They must be sent to the factory for repair.

## Microcontroller (Functional Level 3)



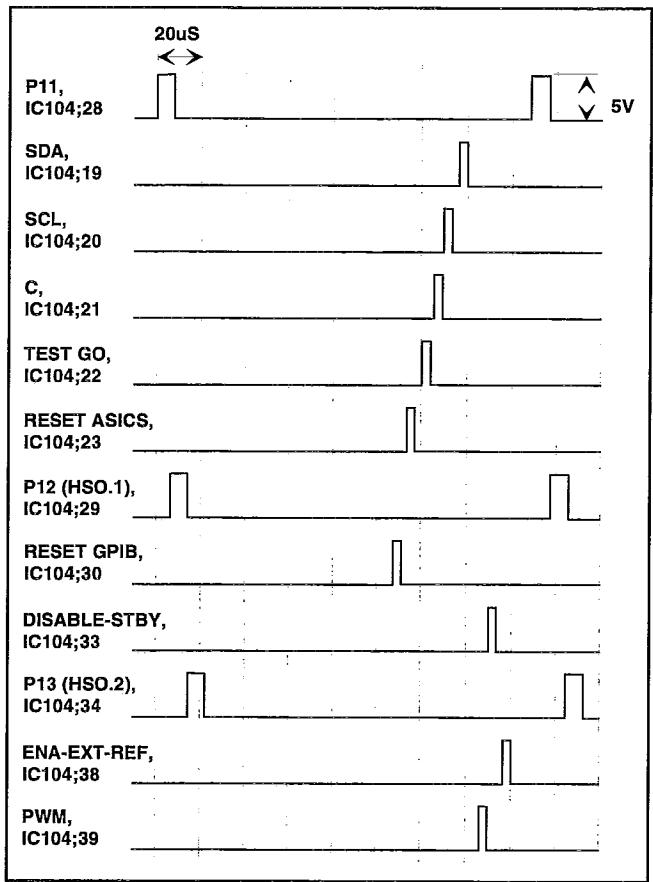
**Fig. 5-6** Test points and jumpers for testing the microcontroller.

- Check that 10 MHz is present at IC104 pin 67.
- Check that 5 MHz is present at IC104 pin 65.
- Check that the RESET circuitry IC110 works properly by moving the RESET jumper, JP13 to the ON position.

If the CPU is not running, check the state of the pins P11-P13. See table below.

Display	P11, P12, P13	Message	Error	Action
0.1	0, 0, 1	-	μC I/O port error	Replace IC104
0.1.2	0, 1, 0	Err UC	μC internal RAM error	Replace IC104
0.1.2.3	0, 1, 1	Err UC	μC timer error	Replace IC104
0.1.2.3.4	1, 0, 0	Err rA	RAM error	Replace IC113
0.1.2.3.4.5	1, 0, 1	Err ASIC	ASIC error	Replace IC119 and/or IC120
All segments	1, 1, 0			
PHILIPS	1, 1, 1	Err rA	GPIB RAM error	Replace IC111 on GPIB
				Test OK

**Table 5-9** Error messages.



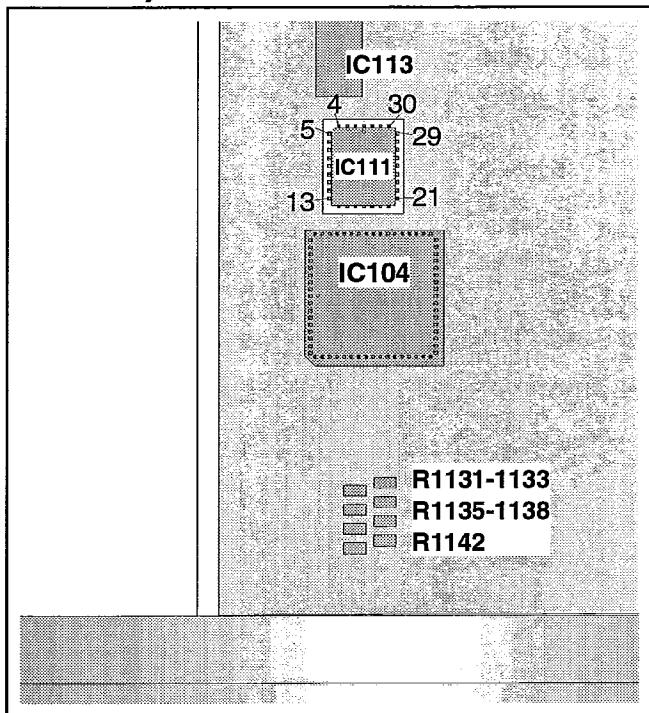
**Fig. 5-7** Timing diagram for μ-controller.

- Run μC Kernel test, Test 2.
  - Set the oscilloscope to 2 V/div and 20 μs/div.
  - Check the output signals from the μC, IC104. Use test pin P11 to trigger the oscilloscope.
  - The timing diagram, fig. 5-7, shows the signals generated by the stimuli program.
- If you find any fault, continue with traditional troubleshooting techniques and replace defective circuits. See also Chapter 4.

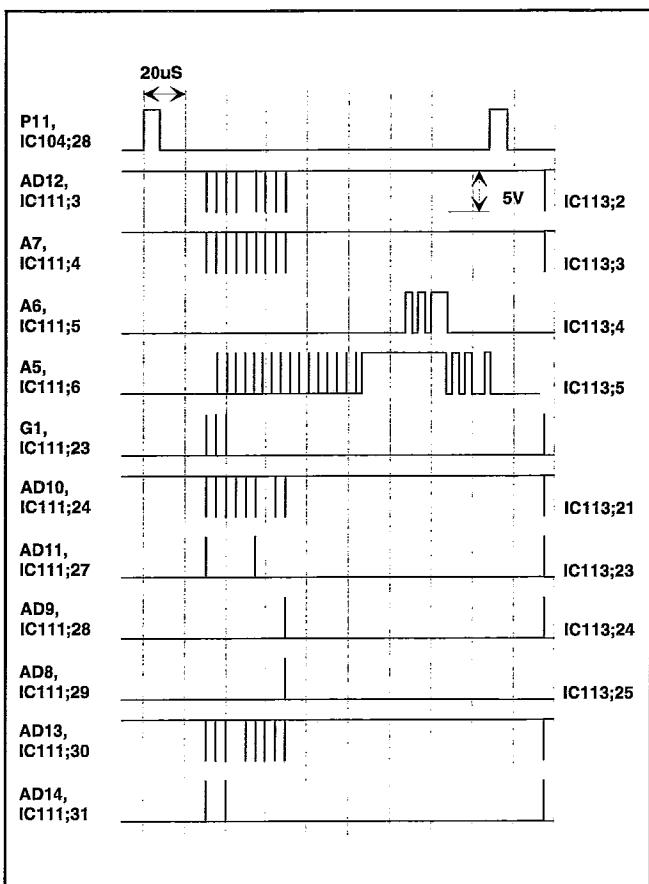
**NOTE:** Check that activity is going on at IC104 pin 62 (ALE), IC104 pin 61 (RD), IC104 pin 61 (INST), and IC104 pin 43 (READY). These pins should not be stuck to HIGH or LOW.

- If one or more bits on the AD-bus are corrupt, the μC often reads the same instructions repeatedly. When the μC discovers are invalid OP code, it will RESET itself and start from the beginning again. The μC sets the RESET input low when it resets itself. This can be discovered at the RESET input of IC104, (pin 16). If +5 V to IC110 is OK, this could be the case.

## Microcomputer Kernel (Functional Level 4a)



**Fig. 5-9** Pinning diagram for IC111.



**Fig. 5-8** Timing diagram for μC kernel.

- Set the oscilloscope to 2 V/div and 20  $\mu$ s/div.
- Run  $\mu$ C Kernel test, Test 2.
- Check all signals on IC111 and IC113. Use test pin P11 to trigger the oscilloscope.
- The timing diagram, fig. 5-8, shows the signals generated by the stimuli program.

**NOTE:** By removing R1131-R1133, R1135-R1138 and R1142 the microcomputer kernel (AD0-AD7) can be separated from the rest of the counter logic.

If you find any fault, continue with traditional troubleshooting techniques and replace defective circuits. See also Chapter 4, Circuit Descriptions, Logical Circuits.

## Microcomputer Kernel (Functional Level 4b)

NOTE: It is not possible to run this test before you have run the Keyboard test, test 4.

- Set the oscilloscope to 2 V/div. on channel A and B.
- Set the time base to 0.1  $\mu$ s/div.
- Connect the WR/WRL signal (IC104 pin 40) to the B channel and select trigger on this channel.
- Run the Address test, Test 5.
- Enter the address code 5555 on the DATA ENTRY keypad.
- Press ENTER.
- Enter the data code 55 on the DATA ENTRY keypad.
- Press ENTER.

The DATA ENTRY keypad is used as a HEX keypad; see Table 5-10.

Key	Function	Key	Function
0 to 9	0 to 9	SELECT/SET DOWN	D
X <sub>n-1</sub>	A	+/-	E
X <sub>0</sub>	B	. (point)	F
SELECT/SET UP	C		

Table 5-10 HEX keypad, Test 5.

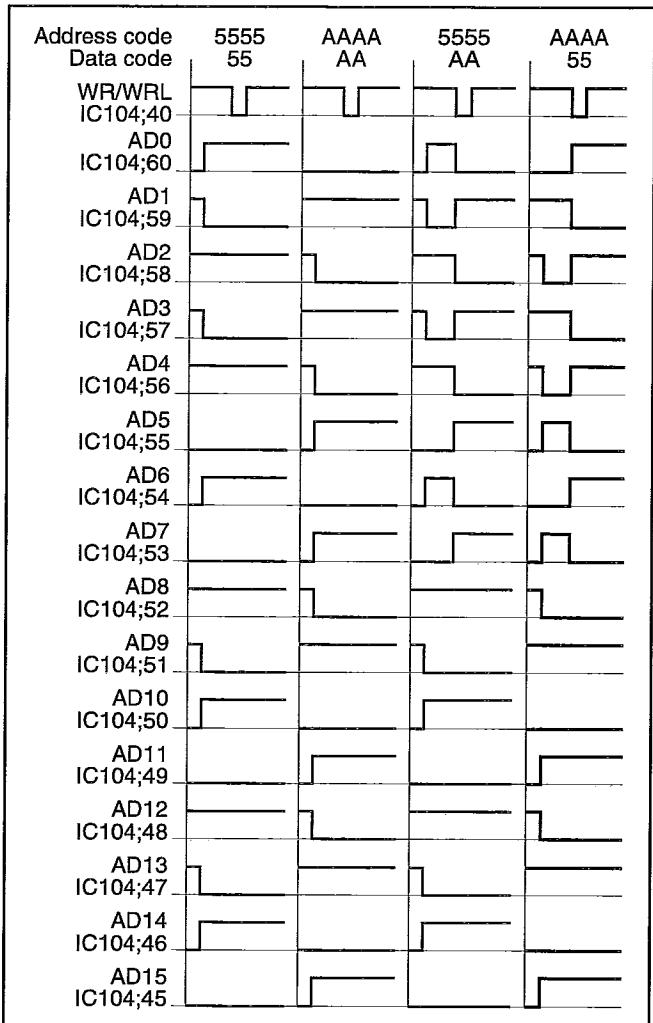


Fig. 5-10 Data-bus lines diagram.

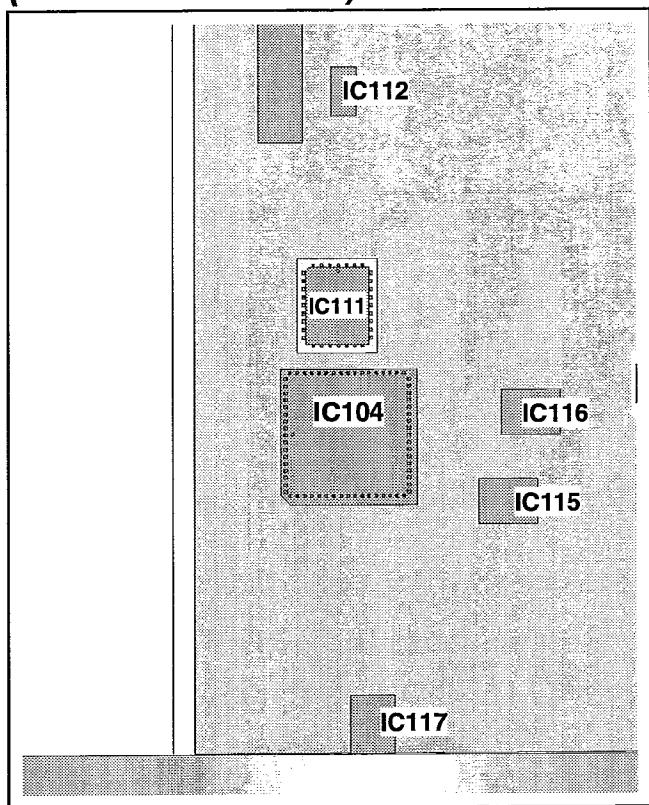
- Examine the DATA bus lines AD0-AD15 (IC104 pin 45-60) with the probe connected to the A-channel, and compare the signal to with the figure.

The interesting part of the data bus signal is where the WR/WRL-signal is in the low state.

- Press LOCAL/PRESET until you reach test number 5 again.
- Enter the address and data codes as shown in the figure and examine the data bus lines according to the figure. If you find any fault, continue with traditional troubleshooting techniques and replace defective circuits. See also Chapter 4,

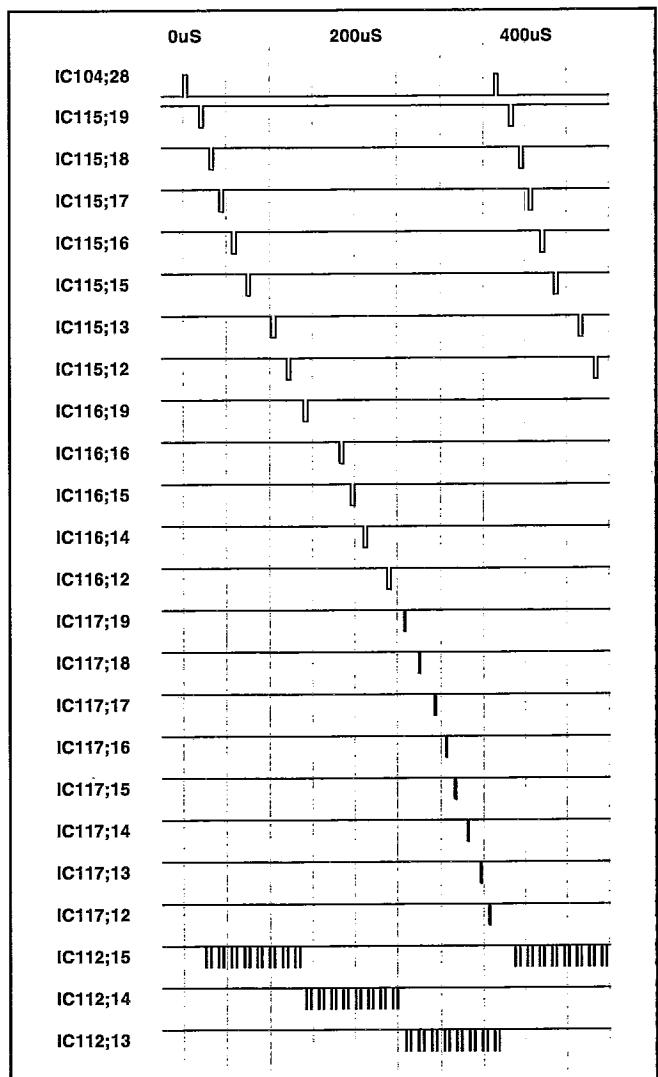
CAUTION: Do not enter an address code between E000 and FFFF because this changes the status of the RAM, which has battery backup. This can cause irregular operation of the counter when in normal use.

## Internal Control Signals and Display (Functional Level 5a)



**Fig. 5-11** Display driving signals and internal control signals can be measured here.

- Run the Control signal test, Test 3.
- Set the oscilloscope to 2 V/div and 50  $\mu$ s/div.
- Check the output signals of IC112, IC115, IC116, and IC117. Use test pin P11, (IC104 pin 28) to trigger the oscilloscope.



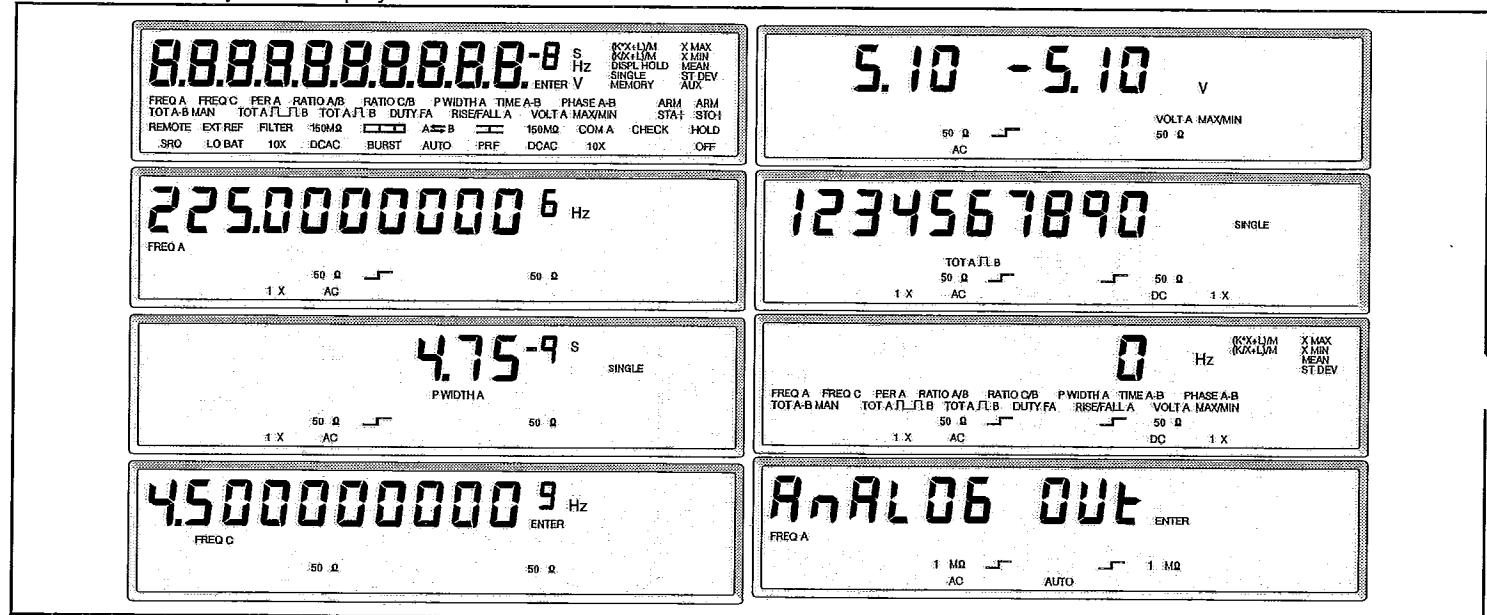
**Fig. 5-12** Timing diagram for Control signals.

- The timing diagram above shows the signals generated by the stimuli program. If you find any fault, continue with traditional troubleshooting techniques and replace defective circuits. See also Chapter 4, Circuit Descriptions, Logical Circuits.

## ***Internal Control Signals and Display (Functional Level 5b)***

**NOTE:** It is not possible to run this test before you have run Keyboard test, Level 6.

- Run DISPLAY test, Test 11.
  - Use SELECT/SET, UP/DOWN button to choose from different display configurations.
  - Check the validity of the display readout.



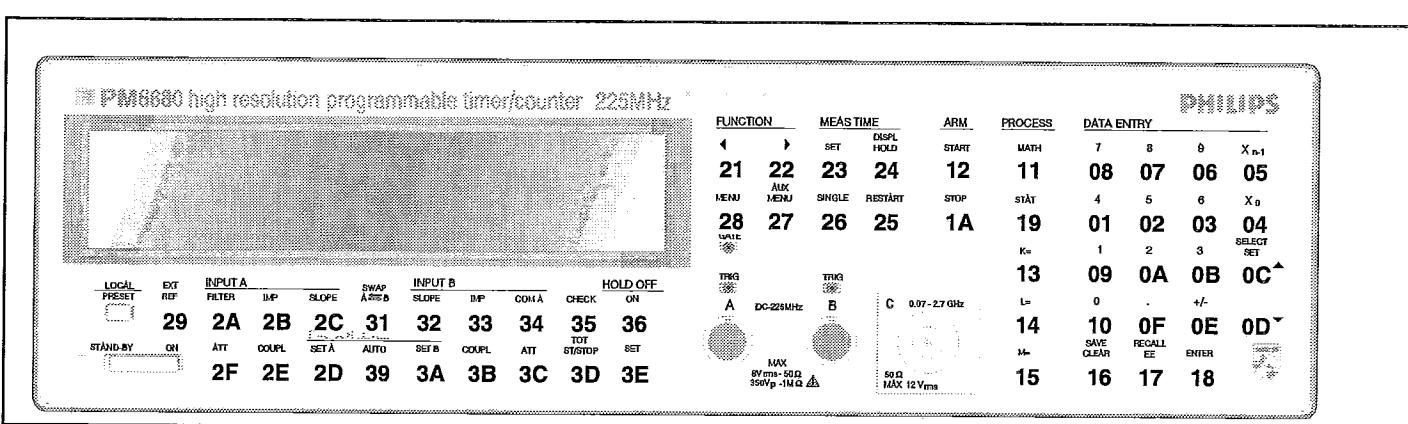
**Fig. 5-14** Display readout, test 11.

## ***Keyboard (Functional Level 6)***

- Run the Keyboard test, Test 4.
  - Press a pushbutton on the front panel and check that the displayed code are as in the fig. 5-13.

**NOTE:** The STAND BY/POWER ON and LOCAL/RESET pushbuttons cannot be tested with this tool.

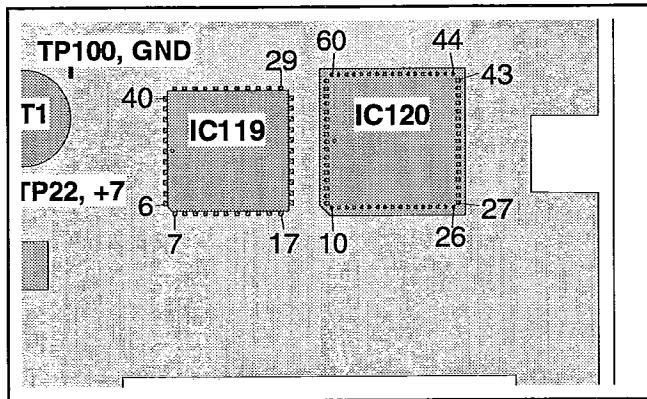
If you find any fault, continue with traditional troubleshooting techniques and replace defective circuits. See also Chapter 4, Circuit Descriptions, Front Unit, and Keyboard Scanning.



**Fig. 5-13** Codes for each key, test 4.

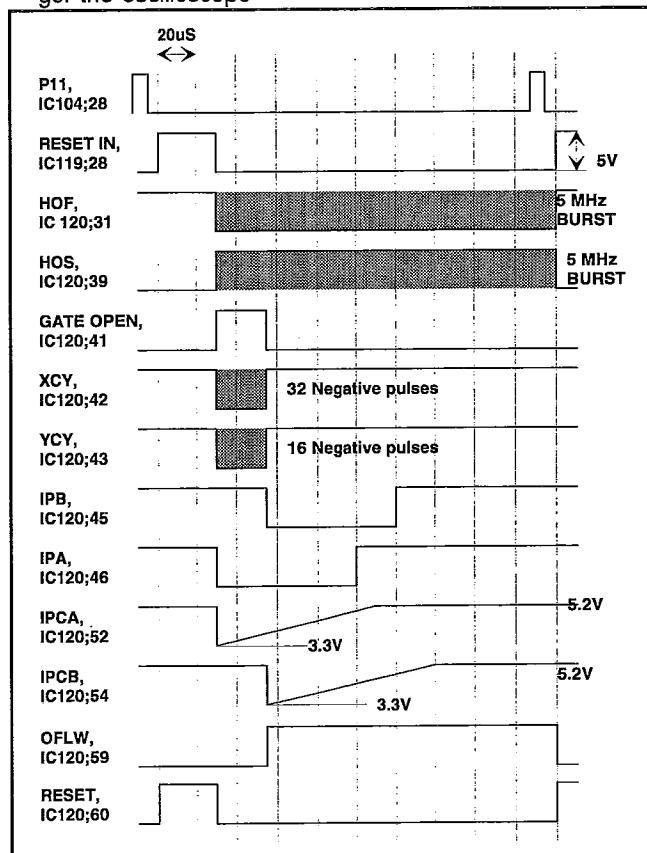
## Measuring Logic (Functional Level 7)

### • ASIC Stimuli



**Fig. 5-15** Pinning diagram for IC119 & IC120.

- Run the ASIC tests, Test 6 and 7.
- NOTE: Test 6 runs automatically without stimuli signals.
- Set the oscilloscope to 2 V/div and 20  $\mu$ s/div.
  - Check all signals on IC119 and IC120. Use P11 to trigger the oscilloscope



**Fig. 5-16** Timing diagram for ASIC stimuli test program.

- The timing diagram above shows the signals generated by the stimuli program.

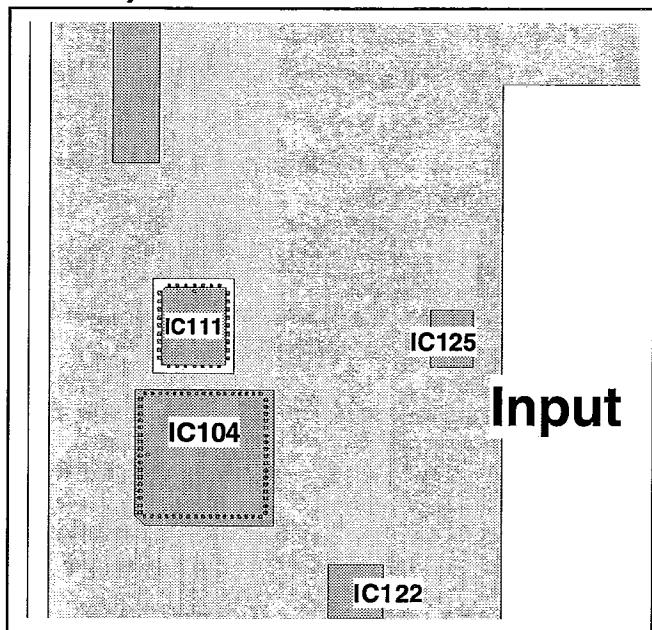
If you find any fault, continue with traditional troubleshooting techniques and replace defective circuits. See also Chapter 4, Circuit Descriptions, Counter Circuits.

The following tests should be done with the standard PROM installed in the counter.

- Switch on the counter.
- Connect an arbitrary signal to the EXT ARM input, BU108 at the rear panel.
- Trace the signal from BU108 to IC120 pin 27
- Connect a 10 MHz signal to the REFERENCE IN input, BU106 at the rear panel.
- Check that JP17 is in the NOT INSTALLED position.
- Trace the signal from BU106 to IC119 pin 38
- Select EXT REF.
- Trace the signal from IC119 pin 35 to the 10 MHz OUT, BU109 at the rear panel.
- Trace the signal from IC120 pin 41 to GATE OPEN output, BU110 at the rear panel.
- Trace the signal from IC120 pin 37 and 38 to BU104 pin 30 and 34 at the front panel and to the display and keyboard board.

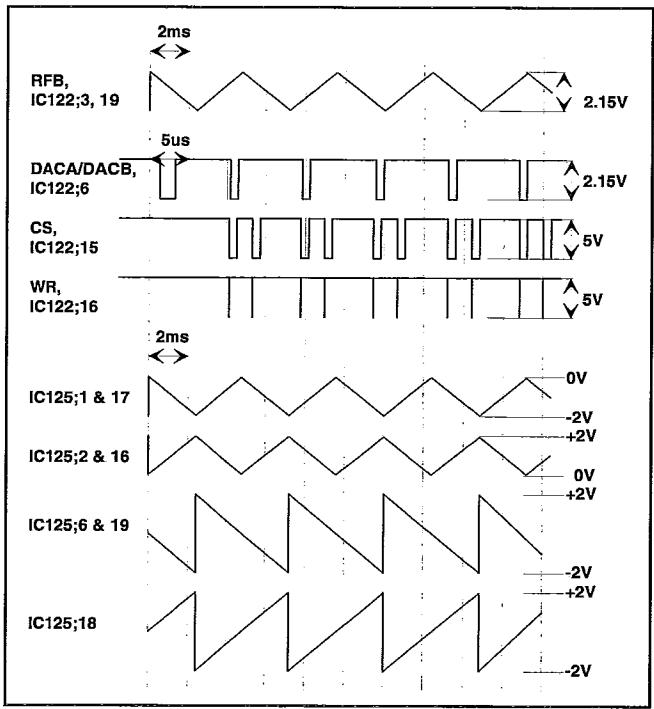
If you find any fault, replace the defective circuits. See also Chapter 4, Circuit Descriptions.

## Trigger Level DAC's (Functional Level 8)



**Fig. 5-17** Trigger level DACs, IC122 and IC125.

- Run the DAC test, Test 8.
- Use P11 to trigger the oscilloscope.

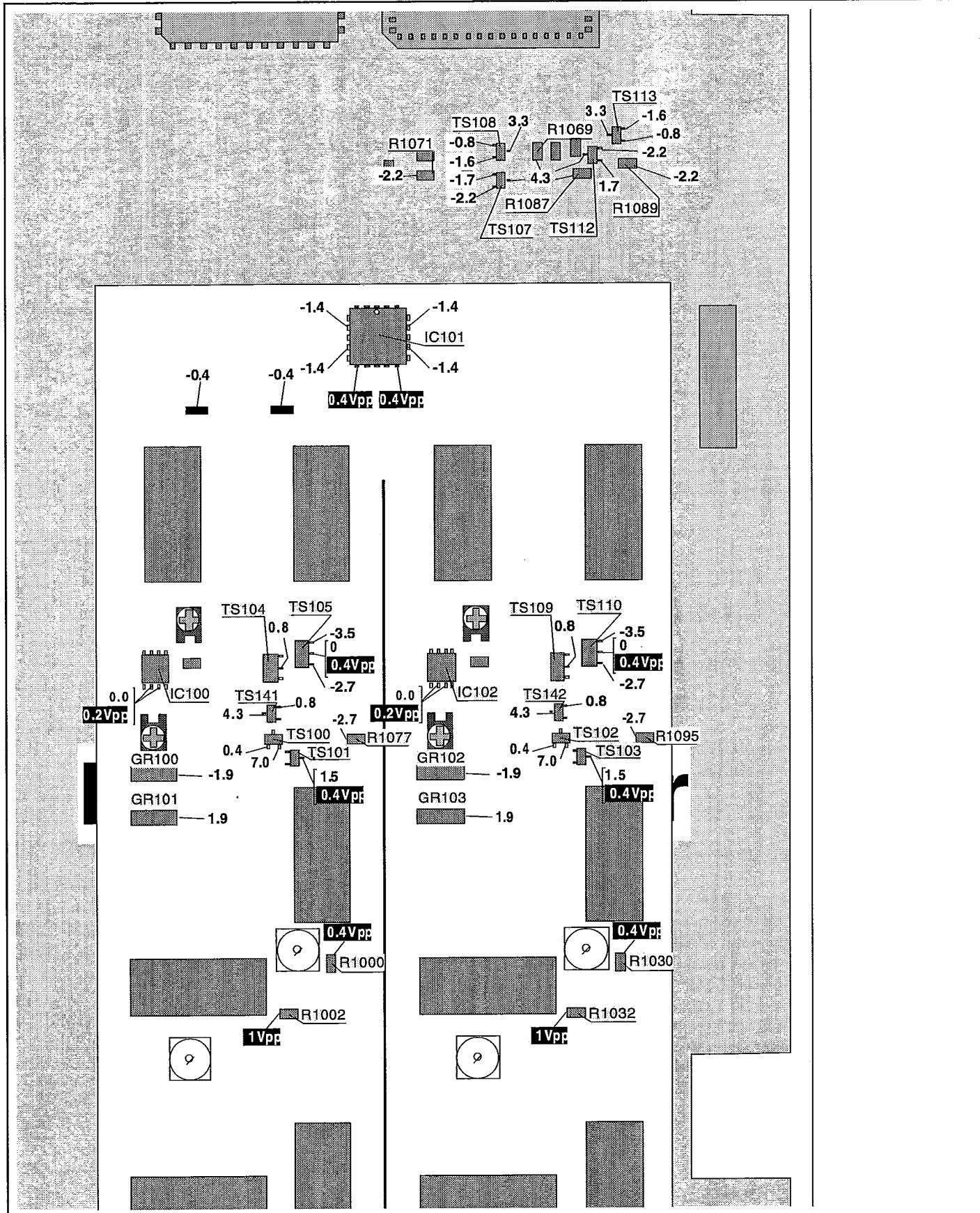


**Fig. 5-18** Timing diagram for Trigger level DAC's.

A sawtooth signal of approximately 200 Hz is generated on both the A and B trigger levels. The sawtooth spans over the complete trigger level range, and the B value equals the A value multiplied by -1. This means that both signals can be added by using the oscilloscopes ADD TRACE function with the result of approximately zero.

- Check all signals on IC122 and IC125.
- Trace the signal from IC125 pin 18 and 5 to TRIGGER LEVEL A and B OUT, BU111 pin 1 and 2 at the rear panel.
- Connect TRIGGER LEVEL A and B OUT to the oscilloscope and check the result by using the ADD TRACE function.

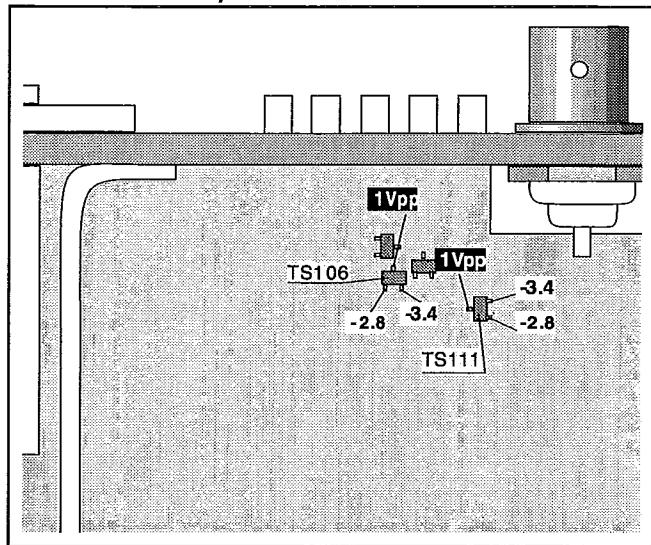
If you find any fault, continue with traditional troubleshooting techniques and replace defective circuits. See also Chapter 4, Circuit Descriptions, Trigger Level Circuits.



**Fig. 5-19** Typical voltages, Input Amplifier.

## Input Amplifier (Functional Level 9)

### • A and B Input Check



**Fig. 5-20** Typical voltages, Input Amplifier.

#### DC levels

- Switch on the counter.
- Press LOCAL/PRESET and ENTER.
- Select Time A-B.
- Deselect AUTO and set the trigger level to -1 V on both inputs.
- Select ATTENUATION A and B to x1.
- Select DC on both inputs.
- Measure the DC voltages according to figures 5-19 and 5-20. Use the DMM with a 10 kΩ resistor in series with the test cable.

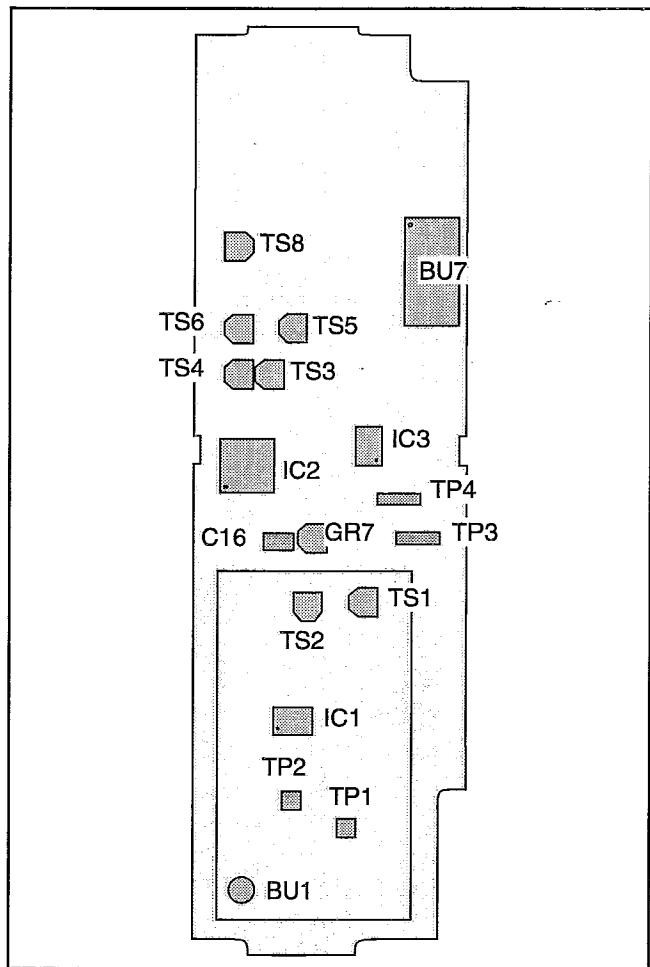
#### AC levels

- Connect a 1000 Hz sine wave signal with an amplitude of 1 V<sub>p-p</sub> to Input A.
- Set the input amplitude to 1 V<sub>p-p</sub>.
- Measure the AC-levels according to figures 5-19 and 5-20. Use the oscilloscope and a 10 MΩ probe.
- Trace the signal from TS104 pin E and TS109 pin E to PROBE COMP VIEW A and B OUT, BU111 pin 4 and 5 at the rear panel.

If you find any fault, continue with traditional troubleshooting techniques and replace defective circuits. See also Chapter 4, CIRCUIT DESCRIPTIONS, Input Amplifiers A and B.

### • Prescaler 1.3 GHz, PM 9621

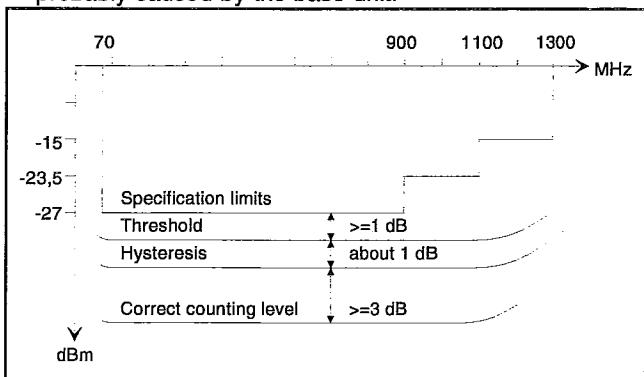
In all measurements you should use TP4 as ground.



**Fig. 5-21** Test points, 1.3 GHz prescaler.

#### Sensitivity Check

- Connect the signal generator to the HF input of the counter.
- Check the "Correct sensitivity and counting" levels according to figure 5-22 to find out which part may have caused the fault. If everything seems all right, the fault is probably caused by the base unit.



**Fig. 5-22** Sensitivity and Counting levels.

## DC-voltages

- Use a DMM to measure the DC-levels according to the table below.

Test point	Measured voltage
IC1 pin 1	$\approx 0.9$ V
IC1 pin 5	$\approx 3.1$ V
TS1 pin b	$\approx 1.6$ V
TS1 pin c	$\approx 3.1$ V
TS2 pin e	$\approx 2.3$ V
IC2 pin 2,3	$\approx 1.5$ V
IC2 pin 6,7	$\approx 4.5$ V
TS5;c	$\approx 4.5$ V
TS6;c	$\approx 4.5$ V
BU7 pin 4	$\approx 4.7$ V
TP3	$\approx 0.57$ V

Table 5-11 DC-voltages, PM 9621.

- Connect the signal generator to the HF input of the counter.
- Set the input frequency to 100 MHz and set the amplitude to -15 dBm, (40 mVRMS).
- Connect the oscilloscope to BU7 pin 4.
- Verify that the amplitude is 800 mV p-p and that the period time is 2.56  $\mu$ s, (frequency 390 kHz). The DC level should be 3.8 V. If everything seems all right the fault is probably caused by the base unit.
- Connect the DMM to TP3 and TP4 (GND).
- Disconnect the input signal.
- Check that the DC voltage drops  $\approx$  200 mV.

If this last measurement is OK, you can skip the Overvoltage Protection Control.

## Overvoltage Protection Control

- Connect the signal generator to the HF input of the counter.
- Set the input frequency to 100 MHz, and set the amplitude to 13 dBm, (1 VRMS).
- Check the DC voltages according to the table below.

Test point	Measured voltage	Comment
TP1	$-100 \pm 50$ mV	Correct
TP1	$\approx +300$ mV	GR3 faulty
TP1	$\approx -300$ mV	GR4 faulty
TP2	$-220 \pm 100$ mV	Correct
TP2	$\approx -400$ mV	GR11 faulty
TP1 & TP2	$\approx \pm 50$ mV	Short circuit in one of GR3, GR4 or GR11

Table 5-12 DC voltages, Overvoltage protection control, PM 9621.

- Connect the DMM to IC2 pin 2.
- Check that the DC voltage is  $\approx$  300 mV.
- Check that the amplitude at IC1 pin 1 is one third of the amplitude at BU1.
- Check that the amplitude at IC1 pin 5 is  $\approx$  300 mVp-p.
- Check that the amplitude at TS1 collector and TS2 emitter is  $\approx$  500 mVp-p.

## Level Detector Control

- Disconnect the signal generator from the counter.
- Check the level detector according to the table below.
- Connect the signal generator to the HF input of the counter.
- Set the input frequency to 100 MHz and the amplitude to 13 dBm, (1 VRMS).
- Check the level detector according to the table below.

Test point	Without input signal	With input signal
GR7, C16	$\approx 320$ mV	$\approx 10$ mV
IC3 pin 3	$\approx 570$ mV	$\approx 370$ mV
IC3 pin 1, 6	$\approx 2.2$ V	$< 0.1$ V
IC3 pin 5	$\approx 2.07$ V	$\approx 2.1$ V
IC3 pin 7	$< 0.8$ V	$\approx 4.4$ V
TS8;b	$\approx 4.9$ V	$\approx 4.2$ V
BU7 pin 4	$\approx 4.7$ V	$\approx 3.8$ V

Table 5-13 DC voltages, Level detector, PM 9621.

## Divider and Differential Stage Control

- Connect the oscilloscope to IC2 pins 6 and 7.
- Check that the amplitude is 800 mVp-p and that the period time is 2.56  $\mu$ s, (frequency 390 kHz). The DC level is 4.5 V.
- Connect the oscilloscope to TS3;b and TS4;b.
- Check that the amplitude is 800 mVp-p and that the period time is 2.56  $\mu$ s, (frequency 390 kHz). The DC level is 3.8 V.
- Connect the oscilloscope to TS5;c and TS6;c.
- Check that the amplitude is 800 mVp-p and that the period time is 2.56  $\mu$ s, (frequency 390 kHz). The DC level is 4.5 V.

## Signal Measurement

- Connect the signal generator to the HF input of the counter.
- Connect the Y-input of the oscilloscope to TP3 and TP4 (GND).
- Connect the X-input of the oscilloscope to the horizontal output of the generator.
- Set the frequency range of the generator to 70-1300 MHz.
- Set the amplitude to -15 dBm, (40 mVRMS).
- Figure 5-23 shows the typical frequency curve of the prescaler.

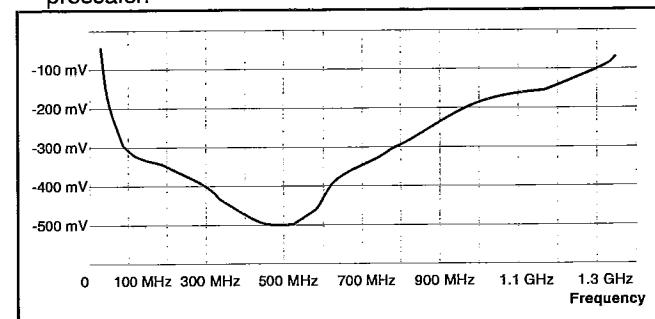
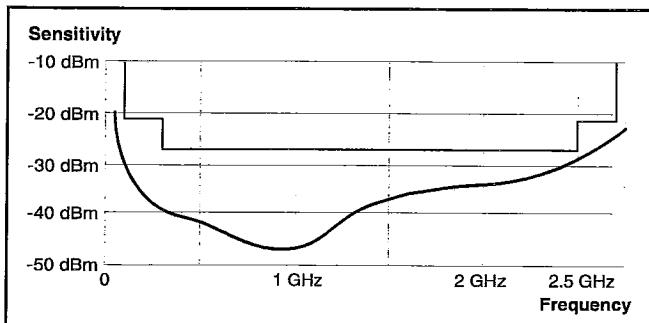


Fig. 5-23 Typical Frequency Curve PM9621.

## • Prescaler 2.7 GHz, PM 9624

See Chapter 2, Performance Check, for verification.

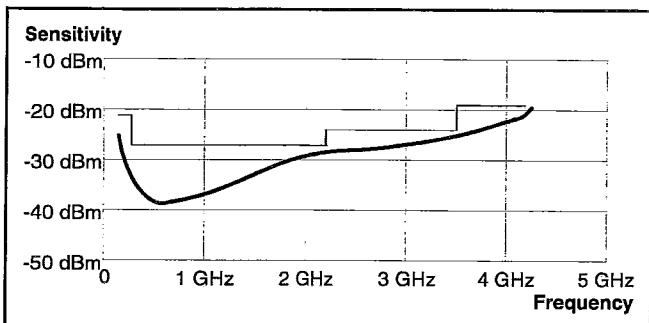


**Fig. 5-24** Specified and typical sensitivity of input C with option PM9624.

This prescaler cannot be repaired in a local workshop. It must be sent to a Fluke/Philips Service Center, who will transfer the prescaler to the factory for repair.

## • Prescaler 4.2 GHz, PM 9625B

See Chapter 2, Performance Check, for verification.

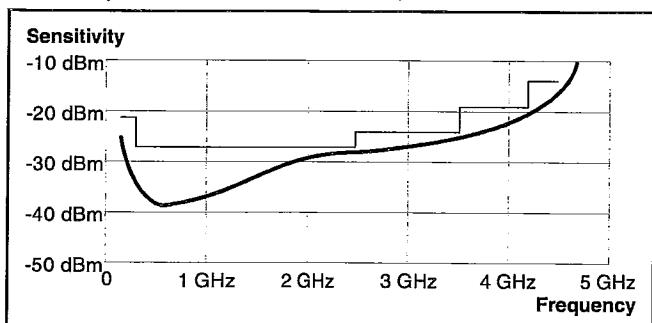


**Fig. 5-27** Specified and typical sensitivity of input C with option PM 9625B.

This prescaler cannot be repaired in a local workshop. It must be sent to a Fluke/Philips Service Center, who will transfer the prescaler to the factory for repair.

## • Prescaler 4.5 GHz, PM 9625

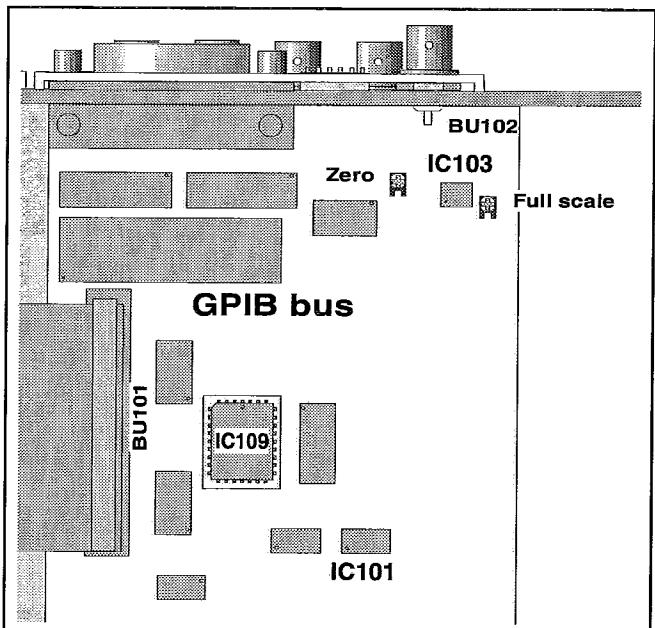
See Chapter 2, Performance Check, for verification.



**Fig. 5-25** Specified and typical sensitivity of input C with option PM 9625.

This prescaler cannot be repaired in a local workshop. It must be sent to a Fluke/Philips Service Center, who will transfer the prescaler to the factory for repair.

## GPIB-interface and Analog output (Functional Level 10)



**Fig. 5-26** Component layout, GPIB interface.

– Set the oscilloscope to 2 V/div and 10 ms/div.

– Run the Analog out 1 test, Test 9.

The µController generates a PWM signal with a variable duty cycle. This PWW signal is converted by IC101 to a sawtooth signal of approximately 20 Hz. IC103 makes a DC voltage in the range 0 to 4.98 V of the sawtooth and feeds it to the analog output on the GPIB interface.

Trace the signal from IC104 pin 39 on the main board to ANALOG OUT, BU102 at the rear panel.

– Use P11 on the main board to trigger the oscilloscope.

– Run the ANALOG OUT 2 test, Test 10.

– The analog output now outputs a DC voltage that can be controlled by pressing the UP/DOWN keys.

0 = min value = 0 V

249 = max value = 4.98 V

– Connect an IBM PC or compatible, equipped with a PM 2201 GPIB interface and its software, to the interface in the counter.

– Insert the floppy disc containing the test program service tool. This test program is included in Service Kit 5322 310 10546.

– Change to the drive where the test floppy is inserted.

– Type PM 9626 and press enter to start to program.

All instructions needed to run the program are supplied by the program itself.

NOTE: This test program does not test the analog output.

If you find any fault, continue with traditional troubleshooting techniques and replace defective circuits. See also Chapter 4, Circuit Descriptions, GPIB-Interface, PM 9626.

# *Safety Inspection and Test After Repair*

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## ***General Directives***

After repair in the primary circuits, make sure that you have not reduced the creepage distances and clearances.

Before soldering, component pins must be bent on the solder side of the board. Replace insulating guards and plates.

## ***Safety Components***

Components in the primary circuits are important to the safety of the instrument and may only be replaced by components obtained from your local Philips or Fluke organization.

## ***Check the Protective Ground Connection***

Visually check the correct connection and condition and measure the resistance between the protective lead at the plug and the cabinet. The resistance must not be more than  $0.5\Omega$ . During measurement, the power cord should be moved. Any variations in resistance shows a defect.

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*Chapter 6*

# ***Calibration Adjustments***

# Introduction

## Required Test Equipment

Type	Performance	Philips model No.	Fluke model No.
2xDMM		PM 2518	77
DC source	5 V	PE 1536	
LF-synthesizer	10 kHz/20 Vpp	PM 5190	
Counter		PM 6669	
Signal generator	1300 MHz		6062A
Oscilloscope	50 MHz 2-channel	PM 3050	
Probe	10:1	PM 8926	
Terminator	50 Ω/1 W	PM9585	Y9103
Attenuator	20 dB	PM 9591	Y9102
Power splitter	50 Ω/4W	PM 9584	
10 MHz reference	$1 \times 10^{-7}$	PM 9691	
10 MHz reference	$1 \times 10^{-9}$	HP105*	
BNC-BNC cables			
Screwdriver		,	

Table 6-1

\* For adjustment of PM9690 and PM 9691 Oven Oscillators only.

## Preparation

**WARNING:** Live parts and accessible terminals which can be dangerous to life are always exposed inside the unit when it is connected to the line power. Use extreme caution when handling, testing, or adjusting the counter.

Before beginning the calibration adjustments, power up the instrument and leave it on for at least 30 minutes to let it reach normal operating temperature.

## Power Supply

NOTE: The new Power Supply are described in the Appendix chapter at page Table 9-2.

### • Setup

- Remove the protective cover above the power module.

**WARNING:** The heat sink inside the power module is connected to the line power.

- Connect the counter to the line power.
- Switch on the counter.
- Press PRESET, then press ENTER.

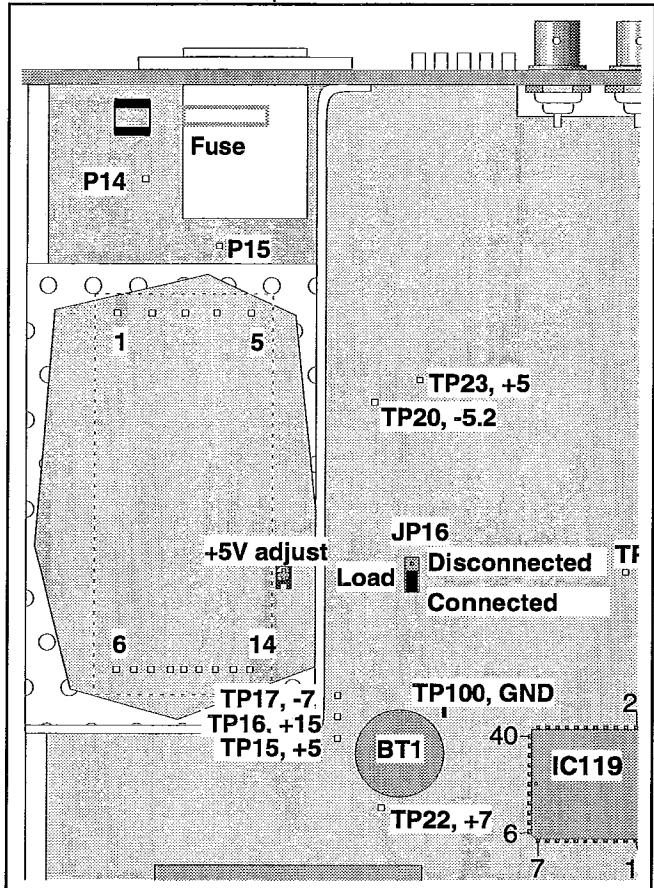


Fig. 6-1 Test points and trimmer for the Power Supply.

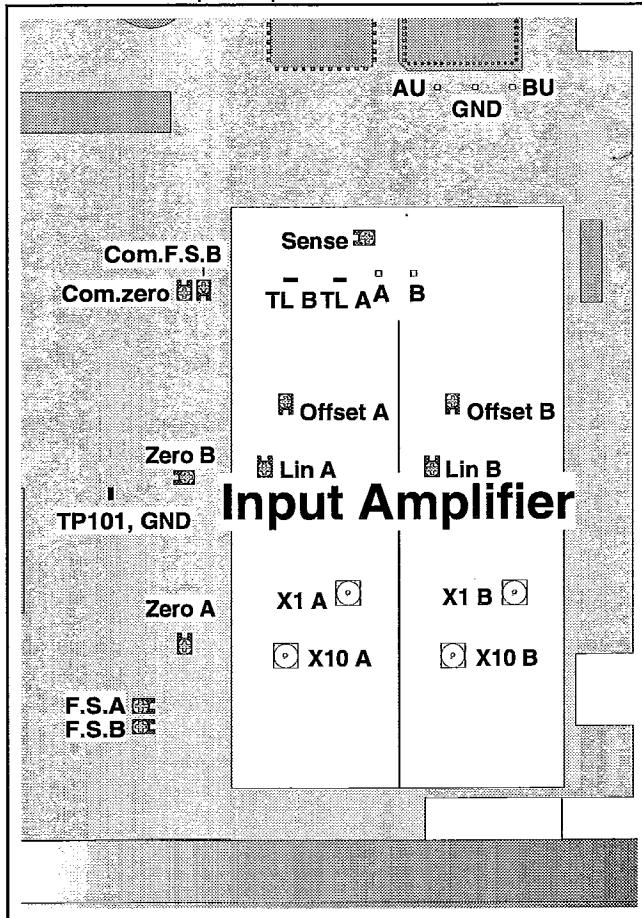
### • Adjustment

- Connect the DMM to test points TP15=+5 and TP100=GND.
- Adjust the +5V trim potentiometer inside the power module until the DMM reads  $+5.10 \pm 0.01$  V.
- Check that the voltage at the test points TP23=+5 and TP100=GND is  $+5.06 \pm 0.03$  V.
- Check that the unregulated voltage from the power module at test points TP16=+15 and TP100=GND is about +18 V.
- Check that the unregulated voltage from the power module at test points TP17=-7 and TP100=GND is about -8 V.
- Reinstall the protective cover onto the power module.

# Input Amplifier

## • Setup

- Remove the screen shield before performing any adjustments in the input amplifier.



**Fig. 6-2** Test points and trimmers for the Input amplifiers.

## Step Answer

### • Setup

- Connect the counter to the line power.
- Switch on the counter.
- Press PRESET, then press ENTER.

Counter	Function	TIME A/B
	Input A+B	50 Ω/DC/Manual trigger level
	Attenuation	1x
LF-synthesizer	Amplitude	19 Vpp*
	Frequency	500 Hz square wave
Oscilloscope	Time	200 μs/div.
	Setting: A	1 V/div., 50 Ω, DC
	Setting: B	50 mV/div. (10:1 probe), DC

**Table 6-2**

\* The mentioned output amplitude is the set amplitude, and it is only valid for an open output of the synthesizer.

- Connect the LF synthesizer to the A input of the counter (B input) via the power splitter.
- Connect the other output from the power splitter to channel A of the oscilloscope.
- Use the probe to connect channel B of the oscilloscope to test point A (B) near IC101 in the input amplifier.

## • Adjustment

### x1 Attenuator

#### • LF Compensation

- Adjust C1001=X1 A (C1013=X1 B) until both signals on the screen look as alike as possible, without any overshoots or undershoots.

#### • Tilt adjustment

- Change the timebase to 100 μs/div.
- Adjust R1028=LIN A (R1058=LIN B) until both signals look as alike as possible.

### x10 Attenuator

#### • Setup

Counter	Function	TIME A/B
	Input A+B	50 Ω/DC/Manual trigger level
	Attenuation	10X
Oscilloscope	Amplitude	50 mV/div on channel B (10:1 probe)
	Time	200 μs/div

**Table 6-3**

- Adjust C1144=X10 A (C1142=X10 B) until both signals on the screen look as alike as possible, without any overshoots or undershoots.

### Trigger Levels

#### • Setup

- Connect the counter to the line power.
- Switch on the counter.
- Press PRESET, then press ENTER.
- Disconnect all input signals to the counter.

Counter	Function	TIME A/B
	Input A+B	1 MΩ/DC/Manual trigger levels
	Attenuation	1X

**Table 6-4**

## • Zero levels

### Channel A

- Connect the DMM to test points TP10=TL A and GND=screen.
- Adjust R1228=ZERO A until the DMM reads  $0.0 \pm 0.5$  mV.

### Channel B

- Connect the DMM to test points TP11=TL B and GND=screen.
- Adjust R1231=ZERO B until the DMM reads  $0.0 \pm 0.5$  mV.

### Common

- Select COMMON.
- Connect the DMM to test points TP11=TL B and GND=screen.
- Adjust R1214=COM ZERO B until the DMM reads  $0.0 \pm 0.5$  mV.

## • Full scale

## • Setup

- Connect the counter to the line power.
- Switch on the counter.
- Press PRESET, then press ENTER.

Counter	Function	TIME A/B
	Input A+B	1MΩ/DC/Manual trigger levels
DC source	Amplitude	$4.90 \pm 0.1$ V.

**Table 6-5**

### Channel A

- Connect a stable DC voltage to the A input of the counter.
- Connect a DMM to the A input of the counter.
- Connect a second DMM to test points TP10=TL A and A near IC101.
- Set the trigger level via SET A to the displayed value  $\pm 0.01$  V on the first DMM.
- Adjust R1210=F.S.A until the second DMM reads  $0.0 \pm 0.5$  mV.

### Channel B

- Connect a stable DC voltage to the B input of the counter.
- Connect a DMM to the B input of the counter.
- Connect a second DMM to test points TP11=TL B and B near IC101.
- Set the trigger level via SET B to the displayed value  $\pm 0.01$  V on the first DMM.
- Adjust R1207=F.S.B until the second DMM reads  $0.0 \pm 0.5$  mV.

### Common

- Connect a stable DC-voltage to the A input of the counter.
- Connect a DMM to the A input of the counter.
- Select COMMON.
- Connect the second DMM to test points TP11=TL B and B near IC101.
- Set the trigger level via SET B to the displayed value  $\pm 0.01$  V of the first DMM.
- Adjust R1215=COM F.S.B until the second DMM reads  $0.0 \pm 0.5$  mV.

## Sensitivity and Offset

## • Setup

- Connect the counter to the line power.
- Switch on the counter.
- Press PRESET, the press ENTER.

Counter	Function	TIME A/B
	Input A+B	50 Ω/AC/Manual trigger levels

**Table 6-6**

## • Sensitivity

NOTE: On most instruments, R1295 is not installed and consequently, this step can be skipped.

- Measure the DC voltage between IC101 pin 15 and GND=screen.
- Measure the DC voltage between IC101 pin 17 and GND=screen.
- Adjust R1295=SENSE until the DMM reads the same value  $\pm 0.5$  mV as the first measurement.

## • Offset

## • Setup

Counter	Function	TIME A/B
	Input A+B	50 Ω/AC/Manual trigger levels
LF synthesizer	Amplitude	0.6 Vpp*
	Frequency	10 kHz sinus wave
Oscilloscope	Amplitude	500 mV/div (10:1 probe)
	Coupling	AC
	Time	10 μs/div

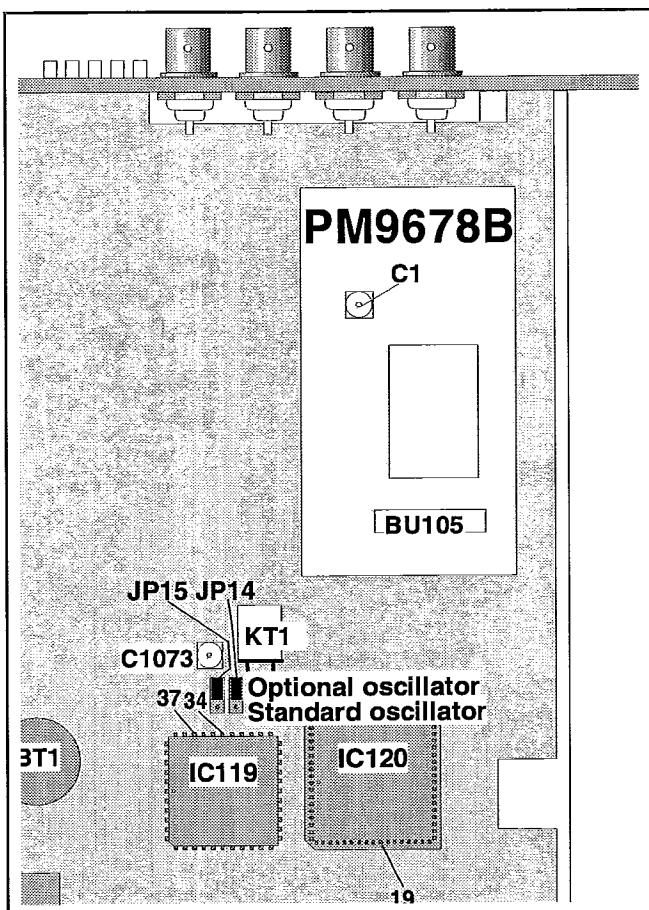
**Table 6-7**

\* The mentioned output amplitude is the set amplitude, and it is only valid for an open output of the synthesizer.

- Connect the LF-synthesizer via a 20 dB attenuator to the A input (B input) of the counter.
- Use the probe to connect the oscilloscope to the test points AU (BU) near IC120 and GND.
- Adjust R1015=OFFS A (R1045=OFFS B) until the duty factor is exactly 0.5.

Note: Reinstall the screen shield after making these adjustments.

## Reference Oscillator



**Fig. 6-3** Trimmers for the reference oscillator frequency.

NOTE: The standard oscillator is always mounted in the unit and must be adjusted even if an optional oscillator is installed. Always set the jumpers JP14 to the STD position to avoid interference between the two oscillators.

### Standard Oscillator

#### • Setup

- Connect the counter to the line power.
- Switch on the counter.
- Press PRESET, then press ENTER.
- Connect the 10 MHz reference to the A input of the counter.

The adjustment should preferably be made at an ambient temperature of +23°C.

#### • Adjustment

- Adjust C1073=STD OSC ADJ until the counter reads 10 MHz  $\pm 5$  Hz.

NOTE: Move the two jumpers JP14 back to position OPT if an optional oscillator is installed.

## Optional TCXO, PM 9678B

#### • Setup

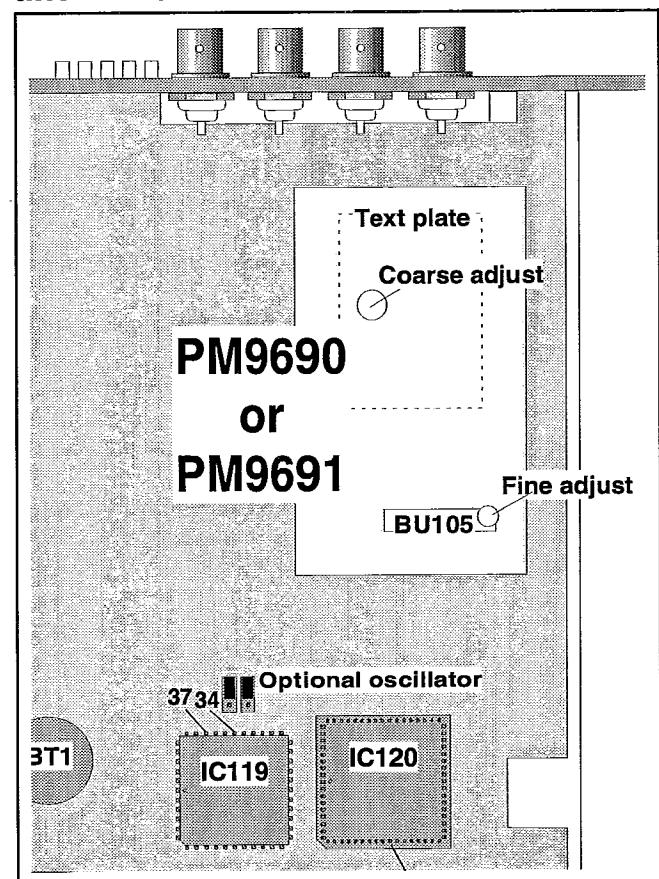
- Connect the counter to the line power.
- Switch on the counter.
- Press PRESET, then press ENTER.
- Connect the 10 MHz reference to the A input of the counter.

The adjustment should preferably be made at an ambient temperature of +23°C.

#### • Adjustment

- Adjust the trim capacitor C1 on the optional oscillator until the counter reads 10 MHz  $\pm 1$  Hz.

## Optional Oven Oscillators, PM 9690 and PM 9691



**Fig. 6-4** Trimmers for the reference oscillator frequency.

## • Setup

- Connect the counter to the line power.
- Switch on the counter.
- Press PRESET, then press ENTER.

Oscilloscope	Time   100ns/div.
--------------	-------------------

**Table 6-8**

The adjustment should preferably be made at an ambient temperature of +23°C.

The oscillator must have been operating continuously for 48 hours before any adjustment is made.

- Connect the 5 MHz reference signal of the HP105 to EXT TRIG of the oscilloscope.
- Connect the 10 MHz out of the counter to the A-input of the oscilloscope.

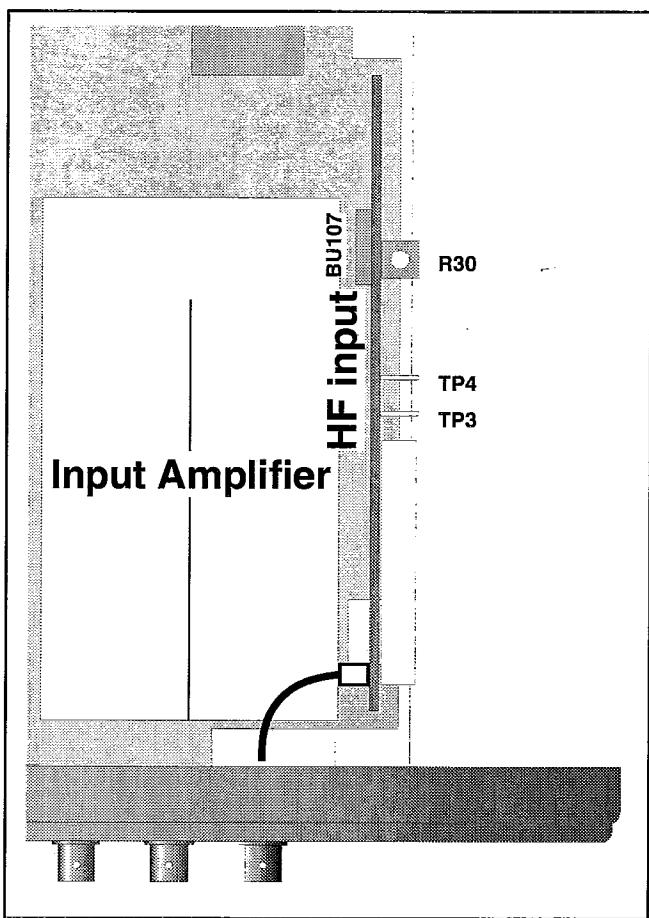
## • Adjustment

- Adjust the FINE trimmer on the oscillator until the waveform moves with a velocity of a maximum of 1 div/10s (0.1 Hz).

If the adjustment is too narrow, proceed as follows:

- Set the FINE trimmer fully clockwise.
- Remove the two screws holding the oscillators text plate.
- Use a pair of tweezers to remove the small plastic cylinder beneath the text plate.
- Connect an external counter to the 10 MHz OUT socket of the counter to be adjusted.
- Adjust the COURSE trimmer until the display reads 10000003 Hz on the external counter.
- Adjust the FINE trimmer until the display reads 10000000 Hz on the external counter.
- Reinstall the plastic cylinder and the text plate to the oscillator.
- Adjust the FINE trimmer on the oscillator until the waveform moves with a velocity of a maximum of 1 div/10s (0.1 Hz).

## 1.3 GHz HF-input, PM 9621



**Fig. 6-5** Test points and trimmers for the 1.3 GHz HF-input.

NOTE: Before beginning any adjustments, the HF input must have been in operation for at least one minute, to let it reach normal operating temperature.

## • Setup

- Connect the counter to the line power.
- Switch on the counter.
- Press PRESET, then press ENTER.

Counter	Input C	FREQ C
Signal generator	Frequency	900 ±25 MHz
	Amplitude	7.5 ±0.5 mV RMS

**Table 6-9**

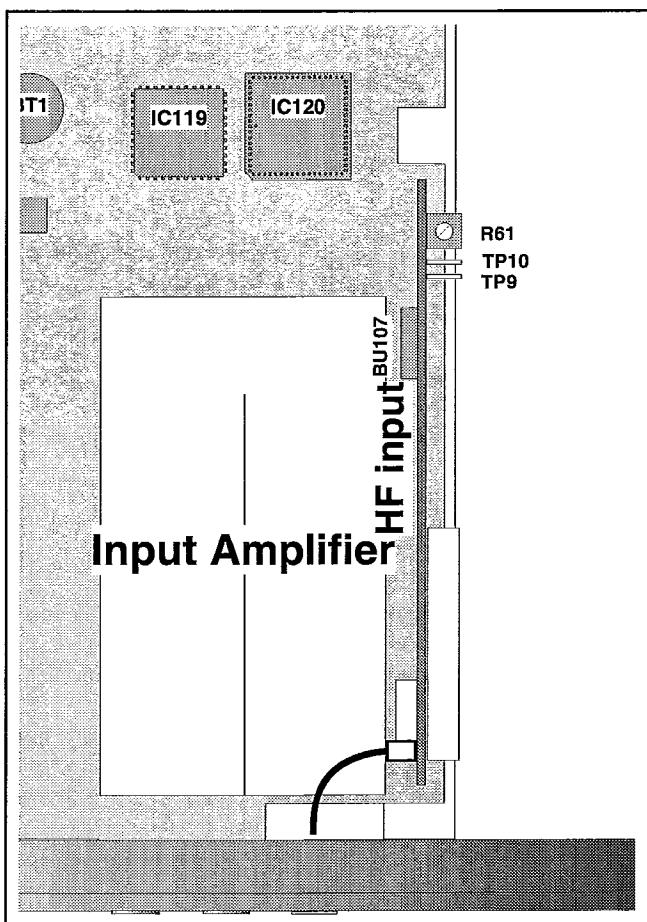
- Connect the signal generator to the HF-input.

## • Adjustment

- Turn the potentiometer R30 fully counterclockwise.
- Check that the GATE indicator stops blinking.
- Turn R30 slowly clockwise until the GATE indicator starts blinking.

The input frequency, 900 ±25 MHz will now be displayed.

## **2.7 GHz HF-input, PM 9624**



**Fig. 6-6 Test points and trimmers for the 2.7 GHz HF-input.**

**NOTE:** Before beginning any adjustments, the HF input must have been in operation for at least one minute, to let it reach normal operating temperature.

### **• Setup**

- Connect the counter to the line power.
- Switch on the counter.
- Press PRESET, then press ENTER.
- Connect the signal generator to the HF-input.

Counter	Input C	FREQ C
Signal generator	Frequency	$1000 \pm 25$ MHz

**Table 6-10**

### **• Adjustment**

- Turn the potentiometer R61 fully counterclockwise.
- Check that the GATE indicator stops blinking.
- Turn R61 slowly clockwise until the GATE indicator starts blinking.

The input frequency,  $1000 \pm 25$  MHz shall now be displayed.

## **4.2 GHz HF-input, PM 9625B**

It is not possible to make any adjustments to the PM 9625B. Therefore, if you suspect any faults, we recommend you to send the unit to the factory for repair. Contact your local Philips or FLUKE service center.

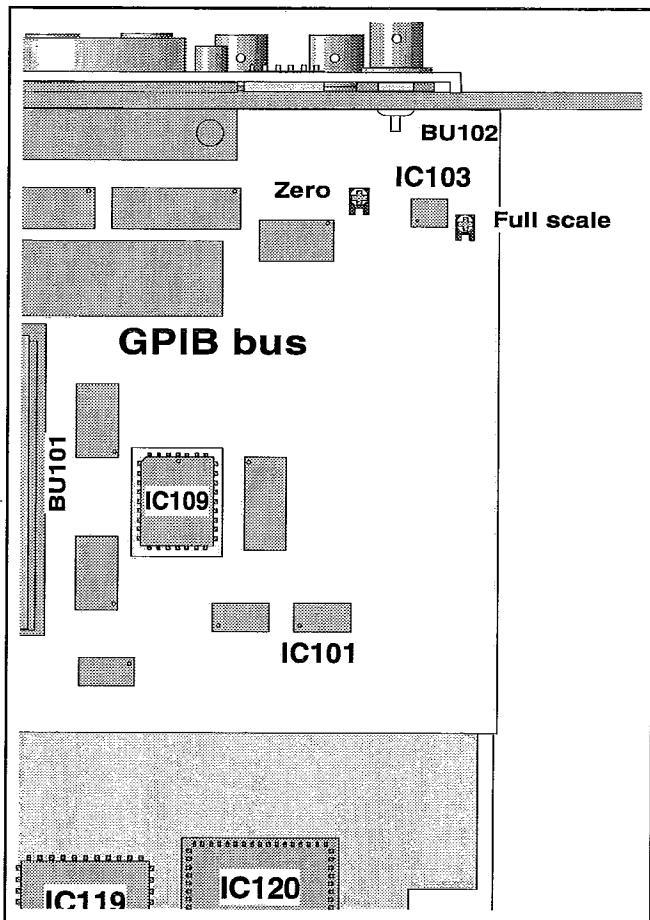
To verify the 4.2 GHz HF input a sweep frequency synthesizer, (Wiltron 6717B-20) is needed.

## **4.5 GHz HF-input, PM 9625**

It is not possible to make any adjustments to the PM 9625. Therefore, if you suspect any faults, we recommend you to send the unit to the factory for repair. Contact your local Philips or FLUKE service center.

To verify the 4.5 GHz HF input a sweep frequency synthesizer, (Wiltron 6717B-20) is needed.

## GPIB Interface, PM 9626



**Fig. 6-7** Trimmers for the GPIB interface.

### • Setup

- Connect the counter to the line power.
- Switch on the counter.
- Press PRESET, then press ENTER.

Counter	Input A	50 Ω/AC/Manual trigger levels
LF synthesizer	Amplitude	1 Vpp*
	Frequency	1000.01 Hz square wave

**Table 6-11**

- \* The output amplitude mentioned is the set amplitude; it is only valid for an open output of the synthesizer.
- Connect the DMM to the BNC output of the analog output.
- Activate the analog output.
- Select AUX MENU.
- Press SELECT/SET until the display reads ANALOG OUT.
- Press ENTER.
- Press SELECT/SET to select ON.
- Press ENTER.
- Type 0.001 ENTER via the keyboard.
- Connect the LF synthesizer to the A input of the counter. The counter should read 1000.0xxxxx Hz.
- Adjust the trimmer ZERO (see figure 6-7) until the output voltage is 0 V  $\pm 1$  mV.
- Set the LF synthesizer to 999.90 Hz/1 Vpp square wave. The counter should read 999.9xxxxx Hz.
- Adjust the trimmer FULL SCALE (see figure 6-7) until the output voltage is 4.980 V  $\pm 3$  mV.
- Set the LF synthesizer to 100.01 Hz/1 Vpp square wave. The counter should read 100.0xxxxx Hz.
- Check that the output voltage is 500 mV  $\pm 5$  mV.

*Chapter 7*

# *Replacement Parts*

# Introduction

## Standard Parts

Electrical and mechanical replacement parts can be obtained through your local Philips or Fluke organization or representative. However, many of the standard components can be obtained from other local suppliers. Before purchasing or ordering replacements parts, check the parts list for value, tolerance, rating, and description.

If the value of the physical component differs from what is described in the parts list, you should always replace the part with the same value as originally mounted.

**NOTE:** Physical size and shape of a component may affect the performance of the instrument, particularly at high frequencies. Always use direct replacements unless it is known that a substitute will not degrade the performance of the instrument.

## Special Parts

In addition to standard electronic components, the following special components are used:

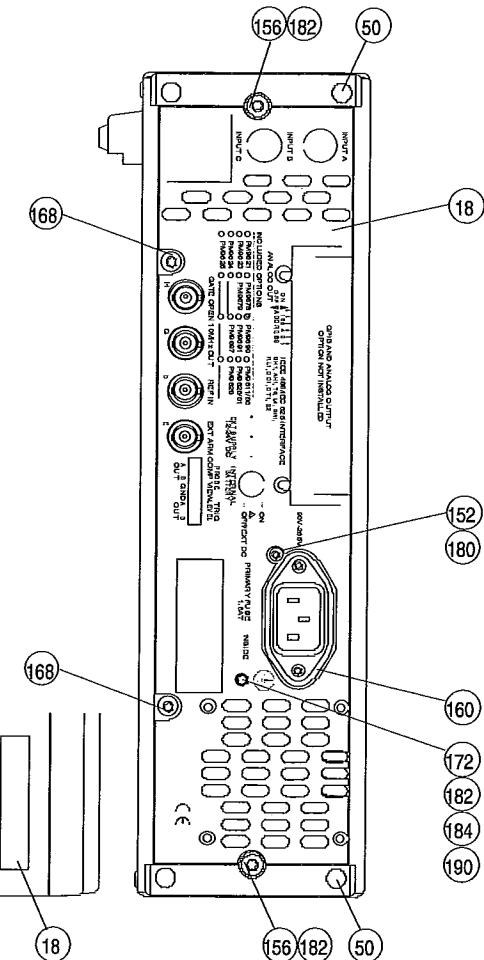
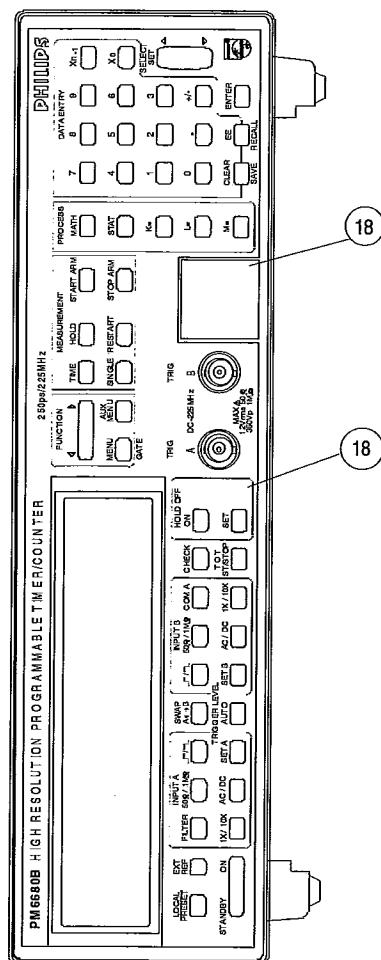
- Components that are manufactured or selected by Philips to meet specific performance requirements.
- Components that are important for the safety of the instrument.

Both type of components may be replaced only by components obtained through your local Philips or Fluke organization.

The abovementioned parts are 'Recommended Replacement Parts' and are marked with an 'R' in the  $\star$  column of the parts list.

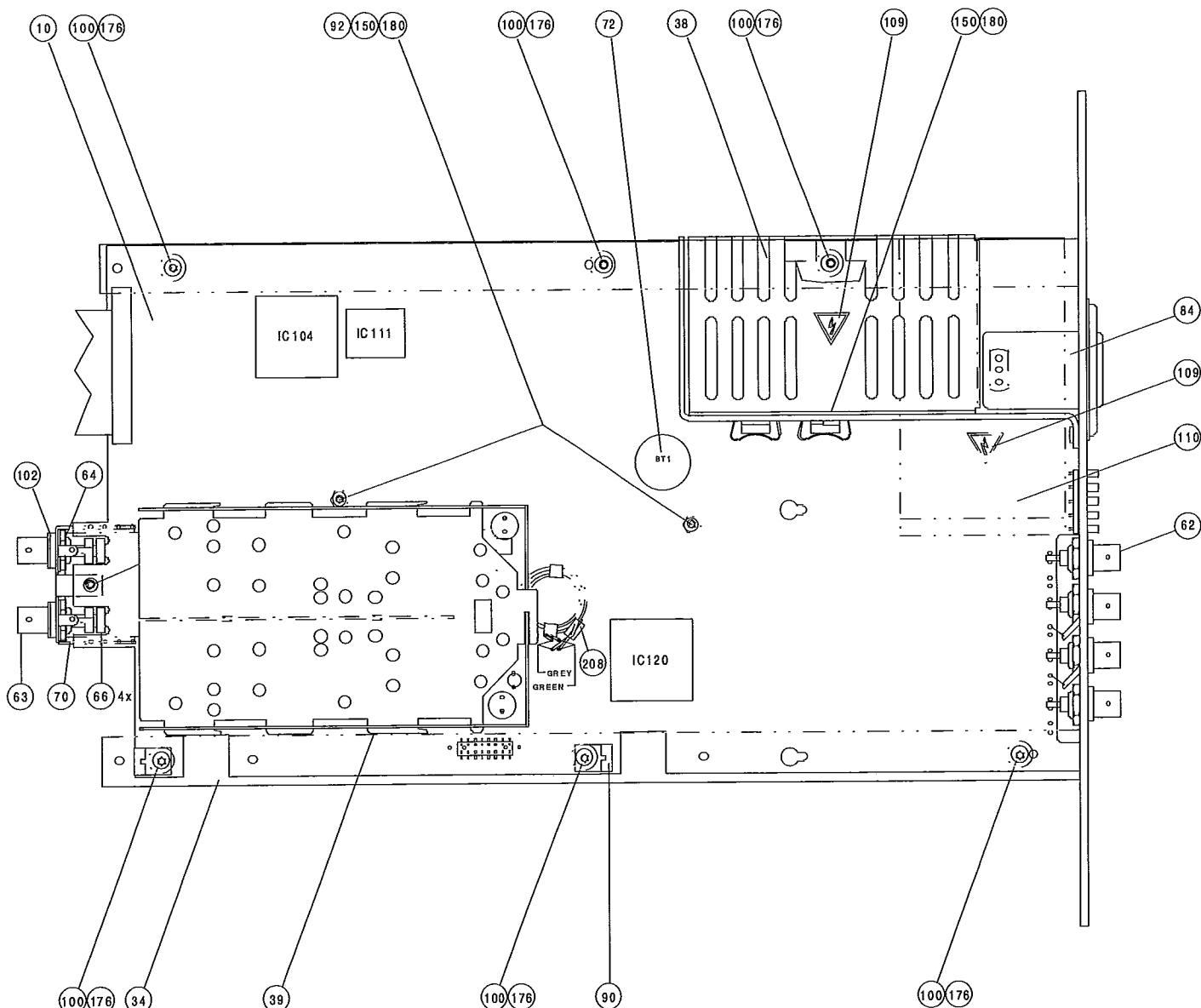
Components marked with a 'P' in the  $\star$  column are 'Production items' not kept in replacement parts stock. These items can be ordered, but the delivery time is longer than for normal replacement parts.

NOTE: The new Power Supply are described in the Appendix chapter at page Table 9-3.

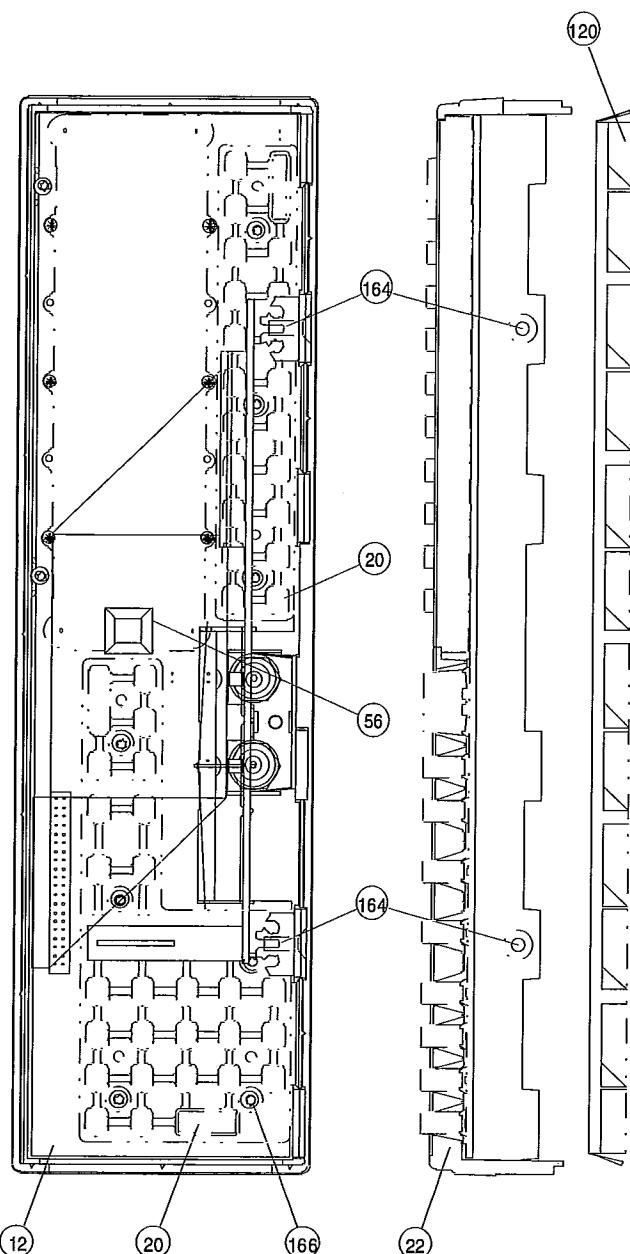


## Mechanical Parts

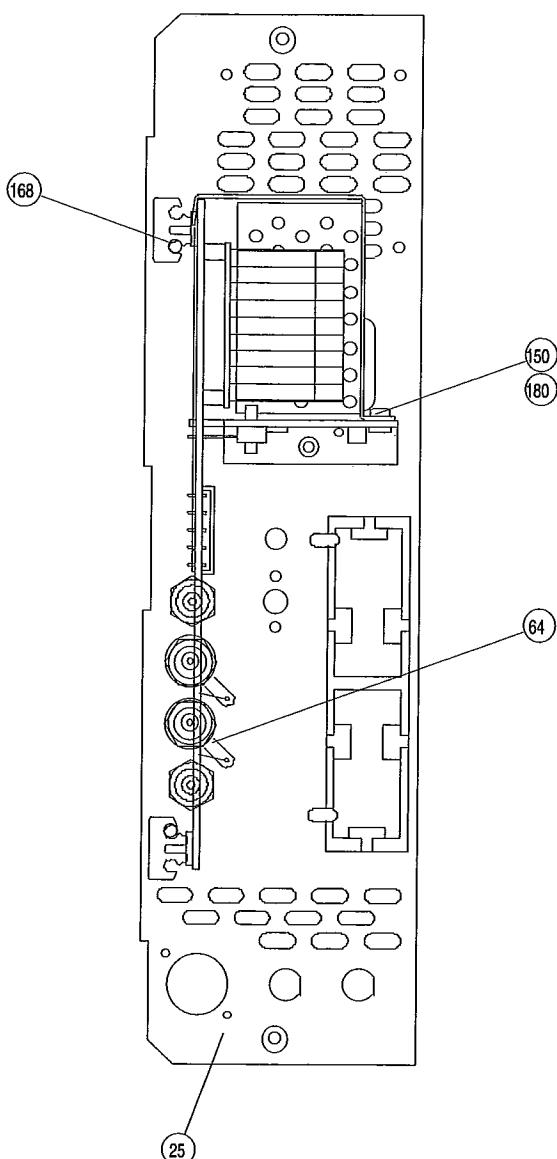
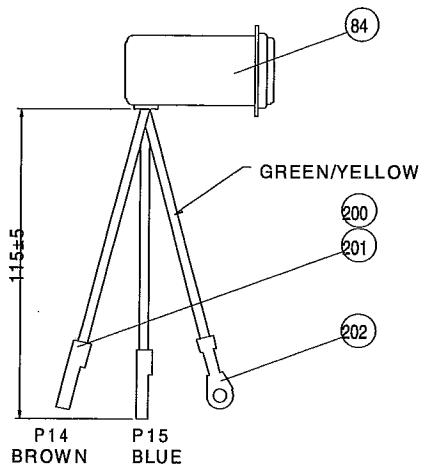
Pos	Description	Part Number	★	Pos	Description	Part Number	★
	Service kit	5322 310 10546	P	53	Bracket,	5322 401 11422	R
	First Aid kit	5322 310 10547	P	54	Spring	5322 492 64745	R
	Jumper connector, 2 pin	5322 263 50101	P	56	Rubber Foot, SJ-5018 BLACK	5322 462 44434	
10	Pca 1 , Main board	5322 218 70108	P	58	Tilting support	5322 401 11348	R
12	Pca 2 , Display	5322 218 70109	P	62	Connector, KC-79-35	5322 267 10004	
18	Textplate kit, PM 6680	5322 456 10016	R	63	Connector, Coaxial	5322 265 10264	R
18	Textplate kit, PM 6680B	5322 456 10028	R	64	Soldering Tag, 0, 9.6X15/15 MS FS	5322 290 30318	
20	Rubber keypad	5322 276 80389	R	66	Toroid Core, 30nH, ROC9/6/3 4C65 VIOLET	5322 526 10545	P
22	Cover & Front panel, grey	5322 447 92194	P	68	Bottom shield, for input amplifier	5322 447 91829	P
25	Rear Plate,	5322 447 91929	P	72	Battery, 3V, BP2032-1HM 180mAh	5322 138 10412	P
34	Mounting profile	5322 460 60542	P	84	Line power filter, 1A, FS3514-1/07	5322 121 42352	
38	Shield Cover,	5322 447 91931	P	90	Pca guide, for prescaler	5322 401 11347	P
39	Shield cover, to input amplifier	5322 462 50459	P	100	Washer, 4.0X10X2 PA6-6	5322 532 52364	P
50	Rear foot, grey	5322 462 41719	R	102	Washer, 9.5X13X2.3	4822 532 10222	P
52	Bottom Foot, M-90	5322 462 41554	R	104	Bnc Plate, 0, 25.4X25.4	5322 466 82868	P



Pos	Description	Part Number	★
109	HIGH VOLTAGE WARNING label	5322 456 90366	P
110	Insulate Plate	5322 466 61932	P
120	Shield, front	5322 462 50466	P
122	Shield,	5322 466 62077	P
150	Screw, MRT-KOMBI 3X06 STFZ	4822 502 11658	P
152	Screw, MRT-KOMBI 3X08 STFZ	4822 502 11669	P
156	Screw, MRT-KOMBI 4X16 STFZ	5322 502 13559	P
160	Screw, 0, MFT-TT 3X08 STFZB TX	4822 402 11713	P
161	Screw, MFT-TT 3X08 ST FZ POZ	5322 502 12003	P
164	Screw, MFT-TT 4X12 STFZB TX	5322 502 13553	P
166	Screw, 0, MFT-TT 3X08 STFZB TX	4822 502 11691	P
168	Screw, MFT-TT 4X16 STFZB TX	5322 502 13552	P
172	Screw, MFT 4X10 ST FZB TX	5322 502 13641	P
176	Screw, RTK-KO ST3.5X10 STFZ	5322 502 13841	P
180	Spring Washer, KBA 3.2 ST FZ DIN137	4822 530 80173	P
182	Spring Washer, KBA 4.3 ST FZ DIN137	4822 530 80076	P
184	Lock Washer, YT4.3 ST FZ DIN6798A	4822 530 80083	P

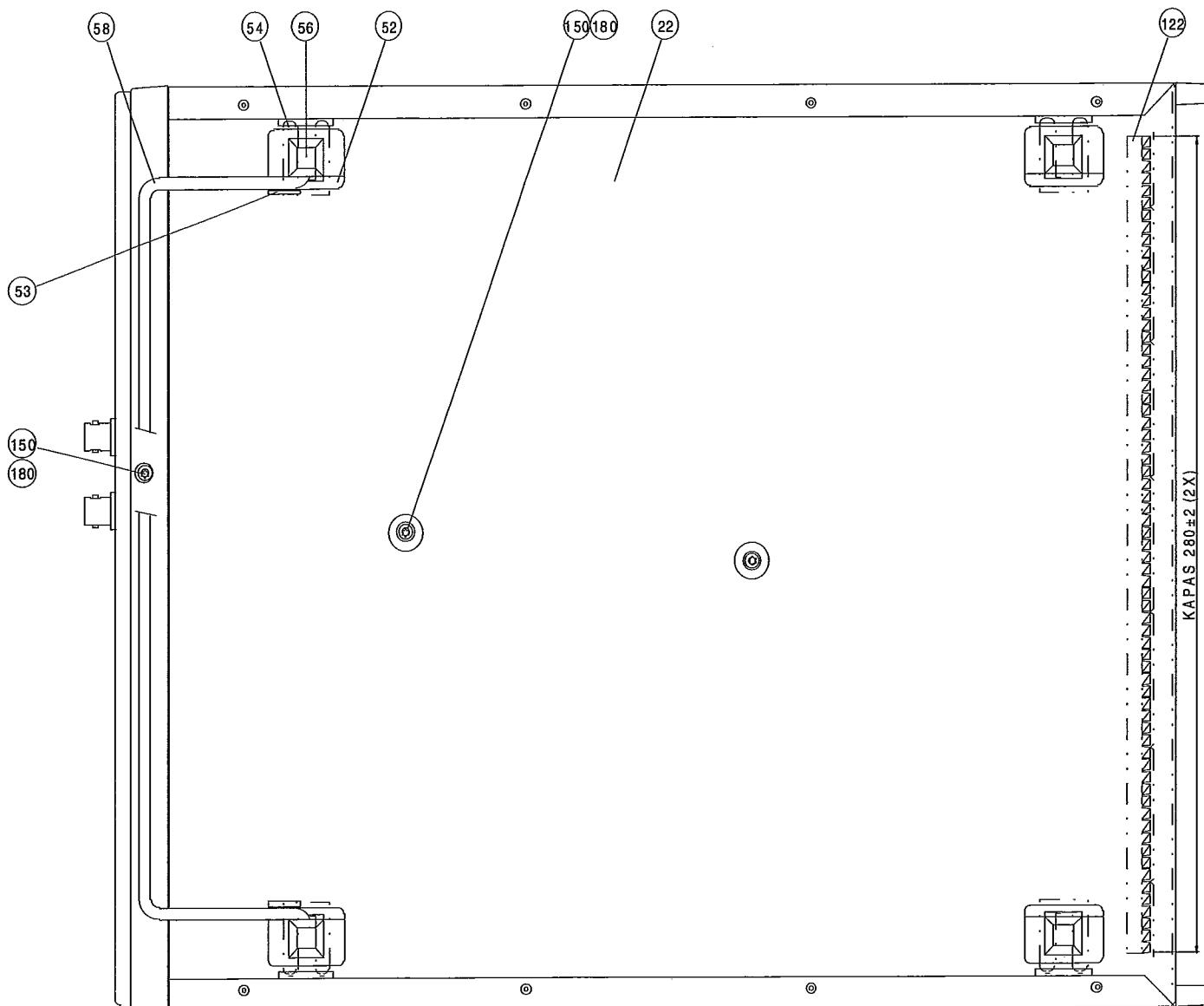


Pos	Description	Part Number	★
190	Nut, M6M 04 ST FZB	4822 505 10326	P
200	Receptacle, 0, 140825-2 2.8X0.8	5322 268 10275	P
201	Protct Sleeve, 2.8mm, N94610	5322 321 40117	P
202	Cable Clip, reel, SPB-2.5T-M4	5322 358 50107	P
208	Fx Tube, 3B 4.3X2 L=7.2	4822 526 10097	



## Main Board

Pos	Description	Part Number	★	Pos	Description	Part Number	★
BT1	Battery, 3V, BR2032-1HM 180MAH	5322 138 10412	P	C1011	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098	
BU103	Connector, 40pin, LOW PROFILE HEADER	5322 265 41051		C1013	Capacitor, 18pF, 2.0-18PF 300V	5322 125 50051	
BU104	Cable assy,	5322 321 60669	R	C1014	Capacitor, 47pF, 5% 50V NPO 0805	5322 122 32452	
BU105	Connector, 10pin, 22-03-2101 4030-10A	5322 265 64028		C1015	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098	
BU106	Connector Coax, 0, KC-79-302-M06	5322 266 10081		C1016	Capacitor, 1nF, 20% 50V X7R 0805	5322 122 34123	
BU107	Connector, 16pin, TMH-108-01-L-DW	5322 265 41013		C1017	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098	
BU108	Connector, KC-79-35	5322 267 10004		C1018	Capacitor, 15nF, 10% 400V 4X10.5 3M	5322 121 42351	
BU109	Connector, KC-79-35	5322 267 10004		C1020	Capacitor, 10pF, 5% 50V NPO 0805	5322 122 32448	
BU110	Connector, KC-79-35	5322 267 10004		C1022	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098	
BU111	Connector, 5pin, 334 0902 2 05 53 0	5322 265 41049		C1023	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098	
BU113	Connector, 20pin, LOW PROFILE HEADER	5322 265 51296		C1024	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098	
C1001	Capacitor, 18pF, 2.0-18PF 300V	5322 125 50051		C1025	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098	
C1003	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		C1027	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098	
C1004	Capacitor, 1nF, 20% 50V X7R 0805	5322 122 34123		C1029	Capacitor, 22F, 20%-6.3V 3.2X1.6 MOLD	5322 124 10685	
C1005	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		C1030	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098	
C1006	Capacitor, 15nF, 10% 400V 4X10.5 3M	5322 121 42351		C1031	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098	
C1008	Capacitor, 10pF, 5% 50V NPO 0805	5322 122 32448		C1032	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098	
C1010	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		C1033	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098	



<b>Pos</b>	<b>Description</b>	<b>Part Number</b>	★	<b>Pos</b>	<b>Description</b>	<b>Part Number</b>	★
C1035	Capacitor, 2.4μF, 20%6.3V 3.2X1.6 MOLD	5322 124 10685		C1111	Capacitor, 150μF,,SMG 20% 400V 22X40	5322 124 23404	
C1036	Capacitor, 8.2pF, +0.25PF 500V NP0 2M	4822 122 31194		C1112	Capaditor, 33μF,,20% 40V RADIAL 2M	4822 124 40743	
C1037	Capacitor, 8.2pF, +0.25PF 500V NP0 2M	4822 122 31194		C1113	Capacitor, 2.2nF, PME289MA4220MR04	5322 121 43756	
C1038	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		C1114	Capacitor, 2.2nF, PME289MA4220MR04	5322 121 43756	
C1041	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		C1115	Capacitor, 33μF,,20% 40V RADIAL 2M	4822 124 40743	
C1042	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		C1116	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098	
C1045	Capacitor, 100nF, 10% 63V X7R 1206	4822 122 33496		C1117	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098	
C1046	Capacitor, 100nF, 10% 63V X7R 1206	4822 122 33496		C1118	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098	
C1049	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		C1119	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098	
C1050	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		C1120	Capacitor, 33μF,,20% 40V RADIAL 2M	4822 124 40743	
C1051	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		C1121	Capacitor, 33μF,,20% 40V RADIAL 2M	4822 124 40743	
C1052	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		C1123	Capaditor, 10μF,,20% 50V RADIAL 2M	4822 124 40435	
C1053	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		C1126	Capacitor, 6.8μF,,20% 16V 6.0X3.2 MOLD	5322 124 10687	
C1054	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		C1127	Capacitor, 470nF, 20% 50V X7R 2220	5322 122 32446	
C1055	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		C1128	Capacitor, 15μF,,20%6.3V 6.0X3.2 MOLD	5322 124 10684	
C1056	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		C1129	Capacitor, 15μF,,20%6.3V 6.0X3.2 MOLD	5322 124 10684	
C1057	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		C1130	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098	
C1058	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		C1131	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098	
C1060	Capacitor, 2.2μF,,20%6.3V 3.2X1.6 MOLD	5322 124 10685		C1135	Capacitor, 100nF, 10% 63V X7R 1206	4822 122 33496	
C1061	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		C1136	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098	
C1062	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		C1137	Capaditor, 10μF,,20% 50V RADIAL 2M	4822 124 40435	
C1063	Capacitor, 82pF, 5% 50V NP0 0805	4822 122 33515		C1138	Capacitor, 220μF,,20% 25V RADIAL 2M	4822 124 40209	
C1064	Capacitor, 82pF, 5% 50V NP0 0805	4822 122 33515		C1139	Capacitor, 220μF,,20% 25V RADIAL 2M	4822 124 40209	
C1065	Capacitor, 22pF, 5% 50V NP0 0805	5322 122 32658		C1140	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098	
C1067	Capacitor, 6.8μF,,20% 16V 6.0X3.2 MOLD	5322 124 10687		C1141	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098	
C1068	Capacitor, 6.8μF,,20% 16V 6.0X3.2 MOLD	5322 124 10687		C1142	Capacitor, 18pF, 2.0-18PF 300V	5322 125 50051	
C1069	Capacitor, 1nF, 20% 50V X7R 0805	5322 122 34123		C1143	Capaditor, 10nF, 20% 50V X7R 0805	5322 122 34098	
C1070	Capacitor, 1nF, 20% 50V X7R 0805	5322 122 34123		C1144	Capacitor, 18pF, 2.0-18PF 300V	5322 125 50051	
C1071	Capacitor, 1nF, 20% 50V X7R 0805	5322 122 34123		C1145	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098	
C1072	Capacitor, 1nF, 20% 50V X7R 0805	5322 122 34123		C1146	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098	
C1073	Capacitor, 18pF, 2.0-18PF 300V	5322 125 50051		C1147	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098	
C1075	Capacitor, 220pF, 10% 100V, PM 6680B	4822 122 30094		C1148	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098	
C1076	Capacitor, 15μF,,20%6.3V 6.0X3.2 MOLD	5322 124 10684		C1149	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098	
C1077	Capacitor, 220pF, 10% 100V, PM 6680B	4822 122 30094		C1150	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098	
C1078	Capacitor, 1nF, 20% 50V X7R 0805	5322 122 34123		C1151	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098	
C1079	Capacitor, 10pF, 5% 50V NP0 0805	5322 122 32448		C1152	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098	
C1080	Capacitor, 220pF, 5% 50V NP0 0805	4822 122 33575		C1153	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098	
C1081	Capacitor, 10pF, 5% 50V NP0 0805	5322 122 32448		C1154	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098	
C1082	Capacitor, 220pF, 5% 50V NP0 0805	4822 122 33575		C1155	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098	
C1083	Capacitor, 100nF, 10% 63V X7R 1206	4822 122 33496		C1156	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098	
C1084	Capacitor, 220pF, 5% 50V NP0 0805	4822 122 33575		C1157	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098	
C1085	Capacitor, 220pF, 5% 50V NP0 0805	4822 122 33575		C1158	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098	
C1086	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		C1159	Capacitor, 1pF, 5% 50V NP0 0805	5322 122 32447	
C1087	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		C1160	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098	
C1089	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		C1162	Capaditor, 1pF, 5% 50V NP0 0805	5322 122 32447	
C1090	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		C1163	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098	
C1091	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		C1164	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098	
C1092	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		C1165	Capacitor, 100nF, 10% 63V X7R 1206	4822 122 33496	
C1093	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		C1166	Capadotor, 10nF, 20% 50V X7R 0805	5322 122 34098	
C1096	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		C1167	Capadotor, 100nF, 10% 63V X7R 1206	4822 122 33496	
C1097	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		C1168	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098	
C1101	Capacitor, 100nF, 10% 63V X7R 1206	4822 122 33496		C1169	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098	
C1102	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		C1170	Capacitor, 15μF,,20%6.3V 6.0X3.2 MOLD	5322 124 10684	
C1103	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		C1171	Capacitor, 220pF, 5% 50V NP0, PM 6680	4822 122 33575	
C1104	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		C1172	Capacitor, 220pF, 5% 50V NP0, PM 6680	4822 122 33575	
C1105	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		C1173	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098	
C1108	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		C1174	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098	
C1109	Capacitor, 68μF,,20%6.3V SOLID AL	5322 124 10455		C1175	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098	
C1110	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		C1176	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098	

Pos	Description	Part Number	★	Pos	Description	Part Number
C1177	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		C1372	Capacitor, 100nF, 10% 63V X7R 1206	4822 122 33496
C1178	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		C1373	Capacitor, 100nF, 10% 63V X7R 1206	4822 122 33496
C1179	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		C1374	Capacitor, 1nF, 20% 50V X7R 0805	5322 122 34123
C1180	Capacitor, 33μF,,20% 40V RADIAL 2M	4822 124 40743		C1375	Capacitor, 100nF, 10% 63V X7R 1206	4822 122 33496
C1181	Capacitor, 100nF, 10% 63V X7R 1206	4822 122 33496		C1376	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098
C1182	Capaditor, 10nF, 20% 50V X7R 0805	5322 122 34098		C1377	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098
C1183	Capacitor, 33μF,,20% 40V RADIAL 2M	4822 124 40743		C1378	Capacitor, 100pF, 5% 50V NPO 0805	5322 122 32531
C1184	Capacitor, 15μF,,20%6.3V 6.0X3.2 MOLD	5322 124 10684		C1379	Capacitor, 100nF, 10% 63V X7R 1206	4822 122 33496
C1185	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		C1380	Capacitor, 100pF, 5% 50V NPO 0805	5322 122 32531
C1186	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		C1381	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098
C1187	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		C1382	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098
C1188	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		C1383	Capacitor, 47pF, 5% 50V NPO 0805	5322 122 32452
C1189	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		C1384	Capacitor, 10μF,20%/25V SOLID AL	5322 124 21976
C1190	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		GR100	Diode, 0.25A, BZV86-2V0	4822 130 81424
C1191	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		GR101	Diode, 0.25A, BZV86-2V0	4822 130 81424
C1195	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		GR102	Diode, 0.25A, BZV86-2V0	4822 130 81424
C1197	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		GR103	Diode, 0.25A, BZV86-2V0	4822 130 81424
C1198	Capacitor, 100nF, 10% 63V X7R 1206	4822 122 33496		GR107	Diode, 0.25A, BAW56 70V SOT23	5322 130 30691
C1199	Capacitor, 100nF, 10% 63V X7R 1206	4822 122 33496		GR110	Diode, 0.25A, BAW56 70V SOT23	5322 130 30691
C1200	Capacitor, 100nF, 10% 63V X7R 1206	4822 122 33496		GR111	Diode, 0.25A, BAW56 70V SOT23	5322 130 30691
C1201	Capacitor, 100nF, 10% 63V X7R 1206	4822 122 33496		GR112	Diode, 0.25A, BAW56 70V SOT23	5322 130 30691
C1202	Capacitor, 15μF,,20%6.3V 6.0X3.2 MOLD	5322 124 10684		GR113	Diode, 0.25A, BAW56 70V SOT23	5322 130 30691
C1313	Capacitor, 15μF,,20%6.3V 6.0X3.2 MOLD	5322 124 10684		GR114	Diode, 0.25A, BAW56 70V SOT23	5322 130 30691
C1314	Capacitor, 15μF,,20%6.3V 6.0X3.2 MOLD	5322 124 10684		GR115	Diode, 0.25A, BAW56 70V SOT23	5322 130 30691
C1315	Capacitor, 100nF, 10% 63V X7R 1206	4822 122 33496		GR116	Diode, 0.25A, BAW56 70V SOT23	5322 130 30691
C1320	Capacitor, 100nF, 20% 250V	5322 121 44302		GR117	Diode, 0.25A, BAW56 70V SOT23	5322 130 30691
C1321	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		GR118	Diode, 0.25A, BAW56 70V SOT23	5322 130 30691
C1323	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		GR119	Diode, 0.25A, BAW56 70V SOT23	5322 130 30691
C1324	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		GR120	Diode, 0.25A, BAW56 70V SOT23	5322 130 30691
C1325	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		GR121	Diode, 0.1A, BAT18 35V 1PF SOT23	5322 130 32076
C1326	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		GR122	Diode, 0.1A, BAT18 35V 1PF SOT23	5322 130 32076
C1327	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		GR123	Diode, 0.1A, BAT18 35V 1PF SOT23	5322 130 32076
C1328	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		GR124	Diode, 0.1A, BAT18 35V 1PF SOT23	5322 130 32076
C1329	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		GR125	Diode, 0.25A, BAW56 70V SOT23	5322 130 30691
C1330	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		GR126	Diode, 0.1A, BAT18 35V 1PF SOT23	5322 130 32076
C1331	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		GR127	Diode, 0.1A, BAT18 35V 1PF SOT23	5322 130 32076
C1332	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		GR128	Diode, 0.1A, BAR42 30V SOT23	5322 130 80247
C1333	Capaditor, 10nF, 20% 50V X7R 0805	5322 122 34098		GR129	Diode, 0.1A, BAV99 SOT23	5322 130 34337
C1334	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		GR130	Diode, 0.1A, BAV99 SOT23	5322 130 34337
C1336	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		GR133	Diode, 0.1A, BAV99 SOT23	5322 130 34337
C1342	Capacitor, 100nF, 10% 63V X7R 1206	4822 122 33496		GR139	Diode, 0.1A, BAV99 SOT23	5322 130 34337
C1350	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		GR140	Bridge Rectifie, 2A, 2KBP08 800V	5322 130 50474
C1351	Capaditor, 10nF, 20% 50V X7R 0805	5322 122 34098		GR142	Diode, 1A, 1N4003/200 DO-41	4822 130 31878
C1352	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		GR143	Diode, 0.25A, BAW56 70V SOT23	5322 130 30691
C1353	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		GR144	Diode, 0.25A, BZV86-2V0	4822 130 81424
C1354	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		GR145	Diode, 0.25A, BAW56 70V SOT23	5322 130 30691
C1355	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		GR146	Diode, 0.1A, BAR42 30V SOT23	5322 130 80247
C1356	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		GR147	Diode, 0.25A, BAW56 70V SOT23	5322 130 30691
C1357	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		GR148	Diode, 0.1A, BAV99 SOT23	5322 130 34337
C1358	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		GR149	Diode, 0.1A, BAV99 SOT23	5322 130 34337
C1359	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		GR150	Diode, 0.1A, BAV99 SOT23	5322 130 34337
C1360	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		GR151	Diode, 0.1A, BAV99 SOT23	5322 130 34337
C1361	Capadotor, 10nF, 20% 50V X7R 0805	5322 122 34098		GR152	Diode, 0.1A, BAV99 SOT23	5322 130 34337
C1362	Capacitor, 220pF, 5% 50V NPO 0805	4822 122 33575		IC100	IC, CA3140M SO8	4822 209 62796
C1363	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		IC101	IC, AD96687BP PLCC20	4822 209 62795
C1366	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		IC102	IC, CA3140M SO8	4822 209 62796
C1369	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		IC103	IC, PC74HC21T SO14	5322 209 60437
C1370	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		IC104	IC Socket, 68pd, 821574-1 F PLCC	5322 255 40677
C1371	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		IC104	IC, μP	5322 209 52203

Pos	Description	Part Number	★	Pos	Description	Part Number	★
IC105	IC, PC74HC573T SO20	5322 209 60424		R1011	Resistor, 1.5kΩ, 1% 1/8W 100PPM 1206	5322 116 80432	
IC107	IC, PC74HC573T SO20	5322 209 60424		R1012	Resistor, 1kΩ, 1% 1/8W 100PPM 1206	5322 116 80427	
IC109	IC, PC74HC00T SO14	5322 209 71802		R1013	Resistor, 470kΩ, 1% 1/8W 100PPM 1206	5322 116 80447	
IC110	Ic, 0, TL7770-50W	5322 209 30397		R1014	Resistor, 470kΩ, 1% 1/8W 100PPM 1206	5322 116 80447	
IC111	IC socket, 32pol, P/N 213-032-602	5322 255 41141		R1015	Potentiometer, 10kΩ, 25% 0.1W 3304X-1-103	5322 100 11143	
IC111	IC-PROM, PM6680, (Ind. in First Aid kit)	5322 209 52111	R	R1016	Resistor, 10kΩ, 1% 1/8W 100PPM 1206	5322 116 80428	
IC111	Service PROM, (Incl. in Service kit)	5322 209 52195	P	R1017	Resistor, 1kΩ, 1% 1/8W 100PPM 1206	5322 116 80427	
IC112	IC, PC74HC138T SO16	5322 209 73178		R1018	Resistor, 1kΩ, 1% 1/8W 100PPM 1206	5322 116 80427	
IC113	IC, 64.00kbyte, TC5564AFL-15 SO28	4822 209 62804		R1020	Resistor, 100kΩ, 1% 1/8W 100PPM 1206	5322 116 80429	
IC114	IC, PC74HC32T SO14	4822 209 63475		R1021	Resistor, 10kΩ, 1% 1/8W 100PPM 1206	5322 116 80428	
IC115	IC, PC74HC574T SO20	4822 209 60451		R1022	Resistor, 1.2kΩ, 1% 1/8W 100PPM 1206	5322 116 82259	
IC116	IC, PC74HC574T SO20	4822 209 60451		R1023	Resistor, 220Ω, 1% 1/8W 100PPM 1206	4822 051 10229	
IC117	IC, PC74HC574T SO20	4822 209 60451		R1024	Resistor, 470Ω, 1% 1/8W 100PPM 1206	5322 116 80444	
IC118	IC, PC74HC02T SO14	5322 209 71563		R1025	Resistor, 470Ω, 1% 1/8W 100PPM 1206	5322 116 80444	
IC119	IC-LSI, OQ0504, (Ind. in First Aid kit)	5322 209 62844	R	R1026	Resistor, 22kΩ, 1% 1/8W 100PPM 1206	5322 116 80435	
IC120	IC Socket, 68pol, 821574-1 F PLCC	5322 255 40677		R1027	Resistor, 470kΩ, 1% 1/8W 100PPM 1206	5322 116 80447	
IC120	IC-LSI, OQ0502, (Ind. in First Aid kit)	5322 209 62843	R	R1028	Potentiometer, 100kΩ, 3304X-1-104	5322 101 10841	
IC121	Io-Ref, 2.5V, MC1403U DIL-8	5322 209 82864		R1029	Resistor, 470kΩ, 1% 1/8W 100PPM 1206	5322 116 80447	
IC122	IC, 8byte, PM7528HPC PLCC20	4822 209 62803		R1030	Resistor, 3.9kΩ, 1% 1/8W 100PPM 1206	5322 116 80443	
IC123	IC, NE532D DUAL SO-8	5322 209 71553		R1031	Resistor, 100kΩ, 1% 1/8W 100PPM 1206	5322 116 80429	
IC124	IC, NE532D DUAL SO-8	5322 209 71553		R1032	Resistor, 470kΩ, 1% 1/8W 100PPM 1206	5322 116 80447	
IC125	IC, PC74HC4353T SO20	4822 209 62805		R1033	Resistor, 220kΩ, 1% 1/8W 100PPM 1206	5322 116 80436	
IC126	IC, NE532D DUAL SO-8	5322 209 71553		R1034	Resistor, 220kΩ, 1% 1/8W 100PPM 1206	5322 116 80436	
IC127	IC, NE532D DUAL SO-8	5322 209 71553		R1035	Resistor, 470kΩ, 1% 1/8W 100PPM 1206	5322 116 80447	
IC128	IC, HEF4013BT SO14	5322 209 14477		R1036	Resistor, 470kΩ, 1% 1/8W 100PPM 1206	5322 116 80447	
IC129	Clamp, TO220	5322 401 11257	P	R1037	Resistor, 220kΩ, 1% 1/8W 100PPM 1206	5322 116 80436	
IC129	IC, 12V, UA7812UC 1A TO-220	5322 209 86176		R1038	Resistor, 100kΩ, 1% 1/8W 100PPM 1206	5322 116 80429	
IC129	Insulat.Washer, 15X22 CLIP TO220	5322 466 61813	P	R1040	Resistor, 220Ω, 1% 1/8W 100PPM 1206	5322 116 80433	
IC130	IC, 1.5A, LM317T TO-220	4822 209 80591		R1041	Resistor, 1.5kΩ, 1% 1/8W 100PPM 1206	5322 116 80432	
IC131	Clamp, TO220	5322 401 11257	P	R1042	Resistor, 1kΩ, 1% 1/8W 100PPM 1206	5322 116 80427	
IC131	IC, 1.5A, LM337T TO-220	5322 209 81236		R1043	Resistor, 470kΩ, 1% 1/8W 100PPM 1206	5322 116 80447	
IC131	Insulat.Washer, 15X22 CLIP TO220	5322 466 61813	P	R1044	Resistor, 470kΩ, 1% 1/8W 100PPM 1206	5322 116 80447	
IC132	IC, GBX10116P	5322 209 86441		R1045	Potentiometer, 10kΩ, 25% 0.1W 3304X-1-103	5322 100 11143	
IC133	IC, NE532D DUAL SO-8	5322 209 71553		R1046	Resistor, 10kΩ, 1% 1/8W 100PPM 1206	5322 116 80428	
KT1	Crystal, 10MHz, HC-49U	5322 242 74372	R	R1047	Resistor, 1kΩ, 1% 1/8W 100PPM 1206	5322 116 80427	
L10	Choke, 220H, 10% NL453232T-221K	5322 157 61918		R1048	Resistor, 1kΩ, 1% 1/8W 100PPM 1206	5322 116 80427	
L100	Choke, 33H, TSL0807-330K1R2	5322 157 53568		R1050	Resistor, 100kΩ, 1% 1/8W 100PPM 1206	5322 116 80429	
L101	Choke, 33H, TSL0807-330K1R2	5322 157 53568		R1051	Resistor, 10kΩ, 1% 1/8W 100PPM 1206	5322 116 80428	
L102	Choke, 1H, 10% MLF3216D1R0K	5322 157 62555		R1052	Resistor, 1.2kΩ, 1% 1/8W 100PPM 1206	5322 116 82259	
L104	Choke, 80Ω, 4S2 3.5X6MM BANDAD	5322 157 61928		R1053	Resistor, 220Ω, 1% 1/8W 100PPM 1206	4822 051 10229	
L105	Choke, 80Ω, 4S2 3.5X6MM BANDAD	5322 157 61928		R1054	Resistor, 470Ω, 1% 1/8W 100PPM 1206	5322 116 80444	
L11	Choke, 33H, TSL0807-330K1R2	5322 157 53568		R1055	Resistor, 470Ω, 1% 1/8W 100PPM 1206	5322 116 80444	
L12	Choke, 10H, TSL1110-100M3R2	5322 157 52513		R1056	Resistor, 22kΩ, 1% 1/8W 100PPM 1206	5322 116 80435	
L13	Choke, 10H, TSL1110-100M3R2	5322 157 52513		R1057	Resistor, 470kΩ, 1% 1/8W 100PPM 1206	5322 116 80447	
L14	Choke, 33H, TSL0807-330K1R2	5322 157 53568		R1058	Potentiometer, 100kΩ, 3304X-1-104	5322 101 10841	
L15	Choke, 33H, TSL0807-330K1R2	5322 157 53568		R1059	Resistor, 470kΩ, 1% 1/8W 100PPM 1206	5322 116 80447	
L16	Choke, 80Ω, 4S2 3.5X6MM BANDAD	5322 157 61928		R1060	Resistor, 150Ω, 1% 1/8W 100PPM 1206	5322 116 80431	
L17	Choke, 80Ω, 4S2 3.5X6MM BANDAD	5322 157 61928		R1061	Resistor, 33Ω, 1% 1/8W 100PPM 1206	4822 051 10339	
L18	Choke, 80Ω, 4S2 3.5X6MM BANDAD	5322 157 61928		R1062	Resistor, 4.7kΩ, 1% 1/8W 100PPM 1206	5322 116 80445	
R1000	Resistor, 3.9kΩ, 1% 1/8W 100PPM 1206	5322 116 80443		R1063	Resistor, 1.8kΩ, 1% 1/8W 100PPM 1206	4822 051 10182	
R1001	Resistor, 100kΩ, 1% 1/8W 100PPM 1206	5322 116 80429		R1064	Resistor, 100kΩ, 1% 1/8W 100PPM 1206	5322 116 80429	
R1002	Resistor, 470kΩ, 1% 1/8W 100PPM 1206	5322 116 80447		R1065	Resistor, 33kΩ, 1% 1/8W 100PPM 1206	5322 116 80441	
R1003	Resistor, 220kΩ, 1% 1/8W 100PPM 1206	5322 116 80436		R1066	Resistor, 390Ω, 1% 1/8W 100PPM 1206	5322 116 80442	
R1004	Resistor, 220kΩ, 1% 1/8W 100PPM 1206	5322 116 80436		R1067	Resistor, 390Ω, 1% 1/8W 100PPM 1206	5322 116 80442	
R1005	Resistor, 470kΩ, 1% 1/8W 100PPM 1206	5322 116 80447		R1068	Resistor, 220Ω, 1% 1/8W 100PPM 1206	5322 116 80433	
R1006	Resistor, 470kΩ, 1% 1/8W 100PPM 1206	5322 116 80447		R1069	Resistor, 68Ω, 1% 1/8W 100PPM 1206	4822 051 10689	
R1007	Resistor, 220kΩ, 1% 1/8W 100PPM 1206	5322 116 80436					
R1008	Resistor, 100kΩ, 1% 1/8W 100PPM 1206	5322 116 80429					
R1010	Resistor, 220Ω, 1% 1/8W 100PPM 1206	5322 116 80433					

Pos	Description	Part Number	☆
R1070	Resistor, 68Ω, 1% 1/8W 100PPM 1206	4822 051 10689	
R1071	Resistor, 47Ω, 1% 1/8W 100PPM 1206	5322 116 80448	
R1072	Resistor, 47Ω, 1% 1/8W 100PPM 1206	5322 116 80448	
R1076	Resistor, 1kΩ, 1% 1/8W 100PPM 1206	5322 116 80427	
R1077	Resistor, 150Ω, 1% 1/8W 100PPM 1206	5322 116 80431	
R1078	Resistor, 150Ω, 1% 1/8W 100PPM 1206	5322 116 80431	
R1079	Resistor, 33Ω, 1% 1/8W 100PPM 1206	4822 051 10639	
R1080	Resistor, 4.7kΩ, 1% 1/8W 100PPM 1206	5322 116 80445	
R1081	Resistor, 1.8kΩ, 1% 1/8W 100PPM 1206	4822 051 10182	
R1082	Resistor, 100kΩ, 1% 1/8W 100PPM 1206	5322 116 80429	
R1083	Resistor, 33kΩ, 1% 1/8W 100PPM 1206	5322 116 80441	
R1084	Resistor, 390Ω, 1% 1/8W 100PPM 1206	5322 116 80442	
R1085	Resistor, 390Ω, 1% 1/8W 100PPM 1206	5322 116 80442	
R1086	Resistor, 220Ω, 1% 1/8W 100PPM 1206	5322 116 80433	
R1087	Resistor, 68Ω, 1% 1/8W 100PPM 1206	4822 051 10689	
R1088	Resistor, 150Ω, 1% 1/8W 100PPM 1206	5322 116 80431	
R1089	Resistor, 47Ω, 1% 1/8W 100PPM 1206	5322 116 80448	
R1090	Resistor, 47Ω, 1% 1/8W 100PPM 1206	5322 116 80448	
R1094	Resistor, 1kΩ, 1% 1/8W 100PPM 1206	5322 116 80427	
R1095	Resistor, 150Ω, 1% 1/8W 100PPM 1206	5322 116 80431	
R1102	Resistor, 100Ω, 5% 1.6W PR37	4822 053 11101	
R1103	Resistor, 100Ω, 5% 1.6W PR37	4822 053 11101	
R1104	Resistor, 100Ω, 5% 1.6W PR37	4822 053 11101	
R1105	Resistor, 100Ω, 5% 1.6W PR37	4822 053 11101	
R1106	Resistor, 220Ω, 1% 1/8W 100PPM 1206	4822 051 10229	
R1107	Resistor, 220Ω, 1% 1/8W 100PPM 1206	4822 051 10229	
R1108	Resistor, 10kΩ, 1% 1/8W 100PPM 1206	5322 116 80428	
R1109	Resistor, 330Ω, 1% 1/8W 100PPM 1206	5322 116 80438	
R1110	Resistor, 560Ω, 1% 1/8W 100PPM 1206	4822 051 10561	
R1111	Resistor, 2.2kΩ, 1% 1/8W 100PPM 1206	5322 116 80434	
R1112	Resistor, 2.2kΩ, 1% 1/8W 100PPM 1206	5322 116 80434	
R1113	Resistor, 100kΩ, 1% 1/8W 100PPM 1206	5322 116 80429	
R1114	Resistor, 100kΩ, 1% 1/8W 100PPM 1206	5322 116 80429	
R1115	Resistor, 100kΩ, 1% 1/8W 100PPM 1206	5322 116 80429	
R1116	Resistor, 100kΩ, 1% 1/8W 100PPM 1206	5322 116 80429	
R1117	Resistor, 100kΩ, 1% 1/8W 100PPM 1206	5322 116 80429	
R1118	Resistor, 100kΩ, 1% 1/8W 100PPM 1206	5322 116 80429	
R1119	Resistor, 100kΩ, 1% 1/8W 100PPM 1206	5322 116 80429	
R1120	Resistor, 100kΩ, 1% 1/8W 100PPM 1206	5322 116 80429	
R1126	Resistor, 100kΩ, 1% 1/8W 100PPM 1206	5322 116 80429	
R1130	Resistor, 10kΩ, 1% 1/8W 100PPM 1206	5322 116 80428	
R1131	Resistor, 56Ω, 1% 1/8W 100PPM 1206	4822 051 10569	
R1132	Resistor, 56Ω, 1% 1/8W 100PPM 1206	4822 051 10569	
R1133	Resistor, 56Ω, 1% 1/8W 100PPM 1206	4822 051 10569	
R1135	Resistor, 56Ω, 1% 1/8W 100PPM 1206	4822 051 10569	
R1136	Resistor, 56Ω, 1% 1/8W 100PPM 1206	4822 051 10569	
R1137	Resistor, 56Ω, 1% 1/8W 100PPM 1206	4822 051 10569	
R1138	Resistor, 56Ω, 1% 1/8W 100PPM 1206	4822 051 10569	
R1142	Resistor, 56Ω, 1% 1/8W 100PPM 1206	4822 051 10569	
R1149	Resistor, 10kΩ, 1% 1/8W 100PPM 1206	5322 116 80428	
R1153	Resistor, 270Ω, 1% 1/8W 100PPM 1206	4822 051 10271	
R1154	Resistor, 56Ω, 1% 1/8W 100PPM 1206	4822 051 10569	
R1155	Resistor, 56Ω, 1% 1/8W 100PPM 1206	4822 051 10569	
R1156	Resistor, 100Ω, 1% 1/8W 100PPM 1206	5322 116 80426	
R1157	Resistor, 1kΩ, 1% 1/8W 100PPM 1206	5322 116 80427	
R1158	Resistor, 1kΩ, 1% 1/8W 100PPM 1206	5322 116 80427	
R1159	Resistor, 10kΩ, 1% 1/8W 100PPM 1206	5322 116 80428	

Pos	Description	Part Number	☆
R1160	Resistor, 1MΩ, 1% 1/8W 100PPM 1206	4822 051 10105	
R1161	Resistor, 560Ω, 1% 1/8W 100PPM 1206	4822 051 10561	
R1162	Resistor, 1kΩ, 1% 1/8W 100PPM 1206	5322 116 80427	
R1163	Resistor, 47Ω, 1% 1/8W 100PPM 1206	5322 116 80448	
R1164	Resistor, 68Ω, 1% 1/8W 100PPM 1206	4822 051 10689	
R1169	Resistor, 56Ω, 1% 1/8W 100PPM 1206	4822 051 10569	
R1170	Resistor, 56Ω, 1% 1/8W 100PPM 1206	4822 051 10569	
R1171	Resistor, 1kΩ, 1% 1/8W 100PPM 1206	5322 116 80427	
R1172	Resistor, 68Ω, 1% 1/8W 100PPM 1206	4822 051 10689	
R1173	Resistor, 68Ω, 1% 1/8W 100PPM 1206	4822 051 10689	
R1182	Resistor, 15kΩ, 1% 1/8W 100PPM 1206	5322 116 82261	
R1183	Resistor, 15kΩ, 1% 1/8W 100PPM 1206	5322 116 82261	
R1184	Resistor, 560Ω, 1% 1/8W 100PPM 1206	4822 051 10561	
R1185	Resistor, 4.7kΩ, 1% 1/8W 100PPM 1206	5322 116 80445	
R1186	Resistor, 120Ω, 1% 1/8W 100PPM 1206	4822 051 10121	
R1187	Resistor, 47Ω, 1% 1/8W 100PPM 1206	5322 116 80448	
R1188	Resistor, 4.7kΩ, 1% 1/8W 100PPM 1206	5322 116 80445	
R1189	Resistor, 270Ω, 1% 1/8W 100PPM 1206	4822 051 10271	
R1190	Resistor, 82Ω, 1% 1/8W 100PPM 1206	4822 051 10829	
R1191	Resistor, 82Ω, 1% 1/8W 100PPM 1206	4822 051 10829	
R1194	Resistor, 5.6kΩ, 1% 1/8W 100PPM 1206	4822 111 90562	
R1195	Resistor, 6.8kΩ, 1% 1/8W 100PPM 1206	4822 051 10682	
R1197	Resistor, 10kΩ, 1% 1/8W 100PPM 1206	5322 116 80428	
R1198	Resistor, 150Ω, 1% 1/8W 100PPM 1206	5322 116 80431	
R1199	Resistor, 1.5kΩ, 1% 1/8W 100PPM 1206	5322 116 80432	
R1202	Resistor, 10kΩ, 0.1% 1/4W MPR24	5322 116 82868	
R1203	Resistor, 10kΩ, 0.1% 1/4W MPR24	5322 116 82868	
R1204	Resistor, 10kΩ, 0.1% 1/4W MPR24	5322 116 82868	
R1205	Resistor, 10kΩ, 0.1% 1/4W MPR24	5322 116 82868	
R1206	Resistor, 47Ω, 1% 1/8W 100PPM 1206	5322 116 80448	
R1207	Potentiometer, 100Ω, CVR-4A-101	5322 101 10989	
R1208	Resistor, 560Ω, 1% 1/8W 100PPM 1206	4822 051 10561	
R1209	Resistor, 47Ω, 1% 1/8W 100PPM 1206	5322 116 80448	
R1210	Potentiometer, 100Ω, CVR-4A-101	5322 101 10989	
R1211	Resistor, 560Ω, 1% 1/8W 100PPM 1206	4822 051 10561	
R1212	Resistor, 220Ω, 1% 1/8W 100PPM 1206	5322 116 80433	
R1213	Resistor, 100kΩ, 1% 1/8W 100PPM 1206	5322 116 80429	
R1214	Potentiometer, 100kΩ, 3304X-1-104	5322 101 10841	
R1215	Potentiometer, 1kΩ, 3304X-1-102E	5322 101 11095	
R1216	Resistor, 8.2kΩ, 1% 1/8W 100PPM 1206	5322 051 10822	
R1217	Resistor, 10kΩ, 1% 1/8W 100PPM 1206	5322 116 80428	
R1218	Resistor, 10kΩ, 1% 1/8W 100PPM 1206	5322 116 80428	
R1219	Resistor, 10kΩ, 1% 1/8W 100PPM 1206	5322 116 80428	
R1220	Resistor, 3.3kΩ, 1% 1/8W 100PPM 1206	5322 116 80439	
R1221	Resistor, 1kΩ, 1% 1/8W 100PPM 1206	5322 116 80427	
R1222	Resistor, 1kΩ, 1% 1/8W 100PPM 1206	5322 116 80427	
R1223	Resistor, 3.3kΩ, 1% 1/8W 100PPM 1206	5322 116 80439	
R1224	Resistor, 1kΩ, 1% 1/8W 100PPM 1206	5322 116 80427	
R1225	Resistor, 1kΩ, 1% 1/8W 100PPM 1206	5322 116 80427	
R1226	Resistor, 220Ω, 1% 1/8W 100PPM 1206	5322 116 80433	
R1227	Resistor, 100kΩ, 1% 1/8W 100PPM 1206	5322 116 80429	
R1228	Potentiometer, 100kΩ, 3304X-1-104	5322 101 10841	
R1229	Resistor, 220Ω, 1% 1/8W 100PPM 1206	5322 116 80433	
R1230	Resistor, 100kΩ, 1% 1/8W 100PPM 1206	5322 116 80429	
R1231	Potentiometer, 100kΩ, 3304X-1-104	5322 101 10841	
R1232	Resistor, 1kΩ, 1% 1/8W 100PPM 1206	5322 116 80427	
R1235	Resistor, 1kΩ, 1% 1/8W 100PPM 1206	5322 116 80427	

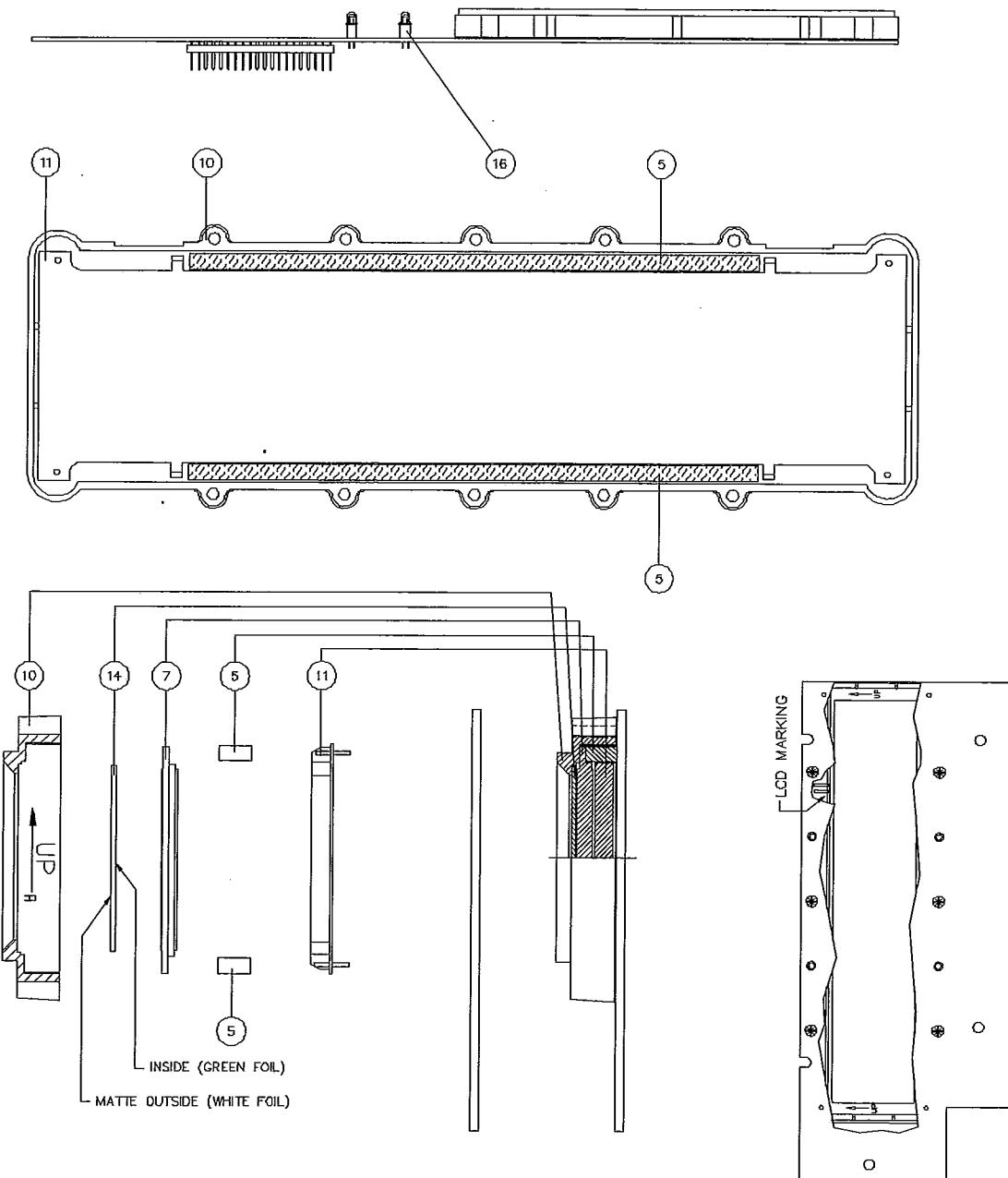
Pos	Description	Part Number	★	Pos	Description	Part Number	★
R1236	Resistor, 1kΩ, 1% 1/8W 100PPM 1206	5322 116 80427		R1297	Resistor, 1kΩ, 1% 1/8W 100PPM 1206	5322 116 80427	
R1237	Resistor, 1kΩ, 1% 1/8W 100PPM 1206	5322 116 80427		R1301	Resistor, 470Ω, 1% 1/8W 100PPM 1206	5322 116 80444	
R1238	Resistor, 1kΩ, 1% 1/8W 100PPM 1206	5322 116 80427		R1302	Resistor, 100Ω, 1% 1/8W 100PPM 1206	5322 116 80426	
R1239	Resistor, 1kΩ, 1% 1/8W 100PPM 1206	5322 116 80427		R1303	Resistor, 470Ω, 1% 1/8W 100PPM 1206	5322 116 80444	
R1240	Resistor, 1kΩ, 1% 1/8W 100PPM 1206	5322 116 80427		R1304	Resistor, 33Ω, 1% 1/8W 100PPM 1206	4822 051 10339	
R1241	Resistor, 1kΩ, 1% 1/8W 100PPM 1206	5322 116 80427		R1305	Resistor, 150Ω, 1% 1/8W 100PPM 1206	5322 116 80431	
R1244	Resistor, 560Ω, 1% 1/8W 100PPM 1206	4822 051 10561		R1306	Resistor, 33Ω, 1% 1/8W 100PPM 1206	4822 051 10339	
R1245	Resistor, 1kΩ, 1% 1/8W 100PPM 1206	5322 116 80427		R1307	Resistor, 150Ω, 1% 1/8W 100PPM 1206	4822 051 10159	
R1246	Resistor, 2.2kΩ, 1% 1/8W 100PPM 1206	5322 116 80434		R1308	Resistor, 150Ω, 1% 1/8W 100PPM 1206	5322 116 80431	
R1247	Resistor, 15kΩ, 1% 1/8W 100PPM 1206	5322 116 82261		R1309	Resistor, 1kΩ, 1% 1/8W 100PPM 1206	5322 116 80427	
R1248	Resistor, 100kΩ, 1% 1/8W 100PPM 1206	5322 116 80429		R1310	Resistor, 180Ω, 1% 1/8W 100PPM 1206	4822 051 10181	
R1249	Resistor, 100kΩ, 1% 1/8W 100PPM 1206	5322 116 80429		R1312	Resistor, 10Ω, 1% 1/8W 100PPM 1206	4822 051 10109	
R1251	Resistor, 270Ω, 1% 1/8W 100PPM 1206	4822 051 10271		R1314	Resistor, 1kΩ, 1% 1/8W 100PPM 1206	5322 116 80427	
R1252	Thermistor, 15Ω, 20% 1W NTC	5322 116 30422		R1315	Resistor, 1kΩ, 1% 1/8W 100PPM 1206	5322 116 80427	
R1253	Resistor, 560Ω, 1% 1/8W 100PPM 1206	4822 051 10561		R1318	Resistor, 1kΩ, 1% 1/8W 100PPM 1206	5322 116 80427	
R1254	Resistor, 390Ω, 1% 1/8W 100PPM 1206	5322 116 80442		R1319	Resistor, 27Ω, 1% 1/8W 100PPM 1206	5322 116 82262	
R1255	Resistor, 2.2kΩ, 1% 1/8W 100PPM 1206	5322 116 80434		R1320	Resistor, 1.5kΩ, 1% 1/8W 100PPM 1206	5322 116 80432	
R1256	Ceramic Tube, 6mm, 1.0/2.8MM	5322 532 60487		R1323	Resistor, 33Ω, 5% 1.6WPR37	4822 116 51167	
R1256	Resistor, 15Ω, 5% 2.5W PR52	4822 116 51093		R1324	Resistor, 1kΩ, 1% 1/8W 100PPM 1206	5322 116 80427	
R1257	Resistor, 470Ω, 1% 1/8W 100PPM 1206	5322 116 80444		R1325	Resistor, 47Ω, 1% 1/8W 100PPM 1206	5322 116 80448	
R1258	Resistor, 1.5kΩ, 1% 1/8W 100PPM 1206	5322 116 80432		R1326	Resistor, 100Ω, 1% 1/8W 100PPM 1206	5322 116 80426	
R1259	Resistor, 470Ω, 1% 1/8W 100PPM 1206	5322 116 80444		R1327	Resistor, 100Ω, 1% 1/8W 100PPM 1206	5322 116 80426	
R1260	Resistor, 2.2kΩ, 1% 1/8W 100PPM 1206	5322 116 80434		R1328	Resistor, 47Ω, 1% 1/8W 100PPM 1206	5322 116 80448	
R1261	Resistor, 560Ω, 1% 1/8W 100PPM 1206	4822 051 10561		R1330	Resistor, 47Ω, 1% 1/8W 100PPM 1206	5322 116 80448	
R1262	Resistor, 1kΩ, 1% 1/8W 100PPM 1206	5322 116 80427		R1331	Resistor, 47Ω, 1% 1/8W 100PPM 1206	5322 116 80448	
R1263	Resistor, 2.2kΩ, 1% 1/8W 100PPM 1206	5322 116 80434		R1332	Resistor, 120Ω, 1% 1/8W 100PPM 1206	4822 051 10121	
R1264	Resistor, 100Ω, 1% 1/8W 100PPM 1206	5322 116 80426		R1333	Resistor, 120Ω, 1% 1/8W 100PPM 1206	4822 051 10121	
R1265	Resistor, 47Ω, 1% 1/8W 100PPM 1206	5322 116 80448		R1365	Resistor, 0Ω, RC-01 1206	4822 051 10008	
R1266	Resistor, 15Ω, 1% 1/8W 100PPM 1206	4822 051 10159		R1366	Resistor, 560Ω, 1% 1/8W 100PPM 1206	4822 051 10561	
R1267	Resistor, 47Ω, 1% 1/8W 100PPM 1206	5322 116 80448		R1367	Resistor, 1.5kΩ, 1% 1/8W 100PPM 1206	5322 116 80432	
R1268	Resistor, 100Ω, 1% 1/8W 100PPM 1206	5322 116 80426		R1380	Resistor, 0Ω, RC-01 1206	4822 051 10008	
R1269	Resistor, 15Ω, 1% 1/8W 100PPM 1206	4822 051 10159		R1381	Resistor, 0Ω, RC-01 1206	4822 051 10008	
R1270	Resistor, 10kΩ, 1% 1/8W 100PPM 1206	5322 116 80428		R1382	Resistor, 150Ω, 1% 1/8W 100PPM 1206	5322 116 80431	
R1271	Resistor, 10kΩ, 1% 1/8W 100PPM 1206	5322 116 80428		R1383	Resistor, 470Ω, 1% 1/8W 100PPM 1206	5322 116 80444	
R1272	Resistor, 10kΩ, 1% 1/8W 100PPM 1206	5322 116 80428		R1384	Resistor, 470Ω, 1% 1/8W 100PPM 1206	5322 116 80444	
R1273	Resistor, 10kΩ, 1% 1/8W 100PPM 1206	5322 116 80428		R1385	Resistor, 470Ω, 1% 1/8W 100PPM 1206	5322 116 80444	
R1274	Resistor, 10kΩ, 1% 1/8W 100PPM 1206	5322 116 80428		R1386	Resistor, 470Ω, 1% 1/8W 100PPM 1206	5322 116 80444	
R1276	Resistor, 10kΩ, 1% 1/8W 100PPM 1206	5322 116 80428		R1387	Resistor, 5.6kΩ, 1% 1/8W 100PPM 1206	4822 111 90562	
R1277	Resistor, 56Ω, 1% 1/8W 100PPM 1206	4822 051 10569		R1390	Resistor, 56Ω, 1% 1/8W 100PPM 1206	4822 051 10569	
R1278	Resistor, 0Ω, RC-01 1206	4822 051 10008		R1391	Resistor, 56Ω, 1% 1/8W 100PPM 1206	4822 051 10569	
R1279	Resistor, 10kΩ, 1% 1/8W 100PPM 1206	5322 116 80428		R1392	Resistor, 56Ω, 1% 1/8W 100PPM 1206	4822 051 10569	
R1281	Resistor, 100Ω, 1% 1/8W 100PPM 1206	5322 116 80426		R1393	Resistor, 56Ω, 1% 1/8W 100PPM 1206	4822 051 10569	
R1282	Resistor, 100Ω, 1% 1/8W 100PPM 1206	5322 116 80426		R1394	Resistor, 56Ω, 1% 1/8W 100PPM 1206	4822 051 10569	
R1283	Resistor, 1kΩ, 1% 1/8W 100PPM 1206	5322 116 80427		R1395	Resistor, 47Ω, 1% 1/8W 100PPM 1206	5322 116 80448	
R1284	Resistor, 10kΩ, 1% 1/8W 100PPM 1206	5322 116 80428		R1396	Resistor, 47Ω, 1% 1/8W 100PPM 1206	5322 116 80448	
R1285	Resistor, 10kΩ, 1% 1/8W 100PPM 1206	5322 116 80428		R1397	Resistor, 56Ω, 1% 1/8W 100PPM 1206	4822 051 10569	
R1286	Resistor, 330Ω, 1% 1/8W 100PPM 1206	5322 116 80438		R1398	Resistor, 56Ω, 1% 1/8W 100PPM 1206	4822 051 10569	
R1287	Resistor, 1MΩ, 1% 1/8W 100PPM 1206	4822 051 10105		R1399	Resistor, 10Mohm, 10% 1/4W RC-01 1206	4822 051 10106	
R1288	Resistor, 10kΩ, 1% 1/8W 100PPM 1206	5322 116 80428		R1400	Resistor, 1kΩ, 1% 1/8W 100PPM 1206	5322 116 80427	
R1289	Resistor, 100kΩ, 1% 1/8W 100PPM 1206	5322 116 80429		R1401	Resistor, 100Ω, 1% 1/8W 100PPM 1206	5322 116 80426	
R1290	Resistor, 100kΩ, 1% 1/8W 100PPM 1206	5322 116 80429		R1402	Resistor, 100Ω, 1% 1/8W 100PPM 1206	5322 116 80426	
R1291	Resistor, 1kΩ, 1% 1/8W 100PPM 1206	5322 116 80427		R1403	Resistor, 1kΩ, 1% 1/8W 100PPM 1206	5322 116 80427	
R1292	Resistor, 1kΩ, 1% 1/8W 100PPM 1206	5322 116 80427		R1404	Resistor, 10Mohm, 10% 1/4W RC-01 1206	4822 051 10106	
R1293	Resistor, 8.2kΩ, 1% 1/8W 100PPM 1206	5322 051 10822		R1405	Resistor, 121Ω, 1% 1/2W MRS25	4822 050 21214	
R1294	Resistor, 3.3kΩ, 1% 1/8W 100PPM 1206	5322 116 80439		R1406	Resistor, 121Ω, 1% 1/2W MRS25	4822 050 21214	
R1295	Potentiometer, 100Ω, CVR-4A-101	5322 101 10989		RE100	Relay Reed, 5V, (Ind. in First Aid kit)	5322 280 20489	R
R1296	Resistor, 1.8kΩ, 1% 1/8W 100PPM 1206	4822 051 10182		RE101	Relay Reed, 5V, PRMA-15157-3790	5322 280 20489	R

<b>Pos</b>	<b>Description</b>	<b>Part Number</b>	<b>★</b>	<b>Pos</b>	<b>Description</b>	<b>Part Number</b>	<b>★</b>
RE102	Relay Reed, 5V, PRMA-15157-3790	5322 280 20489	R	TS113	Transistor, BFS17 .05A 15V SOT23	5322 130 40781	
RE103	Relay Reed, 5V, PRMA-15157-3790	5322 280 20489	R	TS114	Transistor, BC857B .1A45V SOT23	5322 130 60508	
RE104	Relay Reed, 5V, PRMA-15157-3790	5322 280 20489	R	TS115	Transistor, BFS17 .05A 15V SOT23	5322 130 40781	
RE105	Relay Reed, 5V, PRMA-15157-3790	5322 280 20489	R	TS116	Transistor, BFS17 .05A 15V SOT23	5322 130 40781	
RE106	Relay Reed, 5V, PRMA-15157-3790	5322 280 20489	R	TS117	Transistor, 0.1A, BSR12 15V SOT23	5322 130 44743	
RE107	Relay Reed, 5V, PRMA-15157-3790	5322 280 20489	R	TS122	Transistor, 0.1A, BSV52 12V SOT23	5322 130 44386	
RE108	Relay Reed, 5V, PRMA-15157-3790	5322 280 20489	R	TS123	Transistor, BC847B .1A45V SOT23	4822 130 60511	
RE109	Relay Reed, 5V, PRMA-15157-3790	5322 280 20489	R	TS124	Transistor, BC847B .1A45V SOT23	4822 130 60511	
RE110	Relay Reed, 5V, PRMA-15157-3790	5322 280 20489	R	TS126	Transistor, 1A, BC369 20V TO92	5322 130 44593	
RE111	Relay Reed, 5V, PRMA-15157-3790	5322 280 20489	R	TS127	Transistor, BC847B .1A45V SOT23	4822 130 60511	
RE112	Relay, 2P VX, V23042-A1003-B101	5322 280 60557	R	TS128	Transistor, BC635 1A 45V TO92	5322 130 44349	
TP10	Flat Pin, 2.8mm, E184/8 LESA SN BAND	5322 290 34064		TS129	Transistor, BC847B .1A45V SOT23	4822 130 60511	
TP100	Flat Pin, 2.8mm, E184/8 LESA SN BAND	5322 290 34064		TS130	Transistor, BC847B .1A45V SOT23	4822 130 60511	
TP101	Flat Pin, 2.8mm, E184/8 LESA SN BAND	5322 290 34064		TS131	Transistor, BC847B .1A45V SOT23	4822 130 60511	
TP11	Flat Pin, 2.8mm, E184/8 LESA SN BAND	5322 290 34064		TS132	Transistor, BC847B .1A45V SOT23	4822 130 60511	
TS100	Transistor, 0, BF513 .03A20V SOT23	4822 130 60686		TS133	Transistor, 0.5A, BC807-25 45V SOT23	5322 130 60845	
TS101	Transistor, BFS17 .05A 15V SOT23	5322 130 40781		TS134	Transistor, BC847B .1A45V SOT23	4822 130 60511	
TS102	Transistor, 0, BF513 .03A20V SOT23	4822 130 60686		TS135	Transistor, 0.1A, BSR12 15V SOT23	5322 130 44743	
TS103	Transistor, BFS17 .05A 15V SOT23	5322 130 40781		TS136	Transistor, 0.1A, BSR12 15V SOT23	5322 130 44743	
TS104	Transistor, 0.15A, BFQ18A 15V SOT89	5322 130 60673		TS137	Transistor, 0.1A, BSR12 15V SOT23	5322 130 44743	
TS105	Transistor, 0.15A, BFQ18A 15V SOT89	5322 130 60673		TS139	Transistor, 0.5A, BC817-25 45V SOT23	4822 130 42804	
TS106	Transistor, BC847B .1A45V SOT23	4822 130 60511		TS140	Transistor, BC857B .1A45V SOT23	5322 130 60508	
TS107	Transistor, BFS17 .05A 15V SOT23	5322 130 40781		TS141	Transistor, 25mA, BFR92A 20V SOT23	5322 130 60647	
TS108	Transistor, BFS17 .05A 15V SOT23	5322 130 40781		TS142	Transistor, 25mA, BFR92A 20V SOT23	5322 130 60647	
TS109	Transistor, 0.15A, BFQ18A 15V SOT89	5322 130 60673		U11	PE1093/02, 7.5V, POWERMOD 5 15	5322 693 22828	R
TS110	Transistor, 0.15A, BFQ18A 15V SOT89	5322 130 60673		VL1	Fuse, 800mA,	4822 070 38001	R
TS111	Transistor, BC847B .1A45V SOT23	4822 130 60511		VL1	Fuse holder,	4822 256 30139	
TS112	Transistor, BFS17 .05A 15V SOT23	5322 130 40781					

## Front board

Pos	Description	Part Number	★	Pos	Description	Part Number	★
5	Zebra strip	5322 267 70294	R	C202	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098	
7	LCD display, (ind. in First Aid kit)	5322 130 90889	R	GP201	LED, 3mm, HLMP-1300 Red	5322 130 32681	
10	LCD rim	5322 464 90667	R	GP202	LED, 3mm, GLL590NM 4-8VDC/10MA	4822 130 30953	R
11	Back light	5322 130 82201	R	GP203	LED, 3mm, GLL590NM 4-8VDC/10MA	4822 130 30953	R
14	LCD window	5322 381 11136		GP204	LED, 3mm, GLL590NM 4-8VDC/10MA	4822 130 30953	R
16	LED spacer	5322 255 41228		IC201	IC, PCF8576T VSO66	5322 209 11129	
20	Rubber keypad	5322 276 80389	R	IC202	IC, PCF8576T VSO66	5322 209 11129	
32	Screw, RX-PTZ Z-28x8 FZB	4822 502 30081	P	R201	Resistor, 220kΩ, 1% 1/8W 100PPM 1206	5322 116 80436	
B201	LCD display, (ind. in First Aid kit)	5322 130 90889	R	R202	Resistor, 390Ω, 1% 1/8W 100PPM 1206	5322 116 80442	
B202	Back light	5322 130 82201	R	R203	Resistor, 390Ω, 1% 1/8W 100PPM 1206	5322 116 80442	
BU204	Connector, 40pin, TMH-120-01-L-DW	5322 265 51295		R204	Resistor, 4.7Ω, 10% 1/4W RC-01 1206	4833 051 10478	
C201	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		R205	Resistor, 4.7Ω, 10% 1/4W RC-01 1206	4833 051 10478	

ITEM 63 .66 CATHODE  
ANODE



# PM 9621

<b>Pos</b>	<b>Description</b>	<b>Part Number</b>	<b>★</b>	<b>Pos</b>	<b>Description</b>	<b>Part Number</b>	<b>★</b>
	Cable assy,	5322 321 22313		L8	Choke, 0.1H, 10% MLF3216DR10K	5322 157 52986	
	Shield cover,	5322 447 91673	P	L9	Choke, 0.1H, 10% MLF3216DR10K	5322 157 52986	
	Shield,	5322 447 91672	P	R1	Resistor, 470Ω, 1% 1/8W 100PPM 1206	5322 116 80444	
BU1	Connector, R 114426 SMB	5322 267 60199		R10	Resistor, 270Ω, 1% 1/8W 100PPM 1206	4822 051 10271	
BU7	Connector, 16pin, F095 90deg d. Row	5322 267 74032		R11	Resistor, 330Ω, 1% 1/8W 100PPM 1206	5322 116 80438	
C1	Capacitor, 100pF, 5% 50V NP0 0805	5322 122 32531		R12	Resistor, 330Ω, 1% 1/8W 100PPM 1206	5322 116 80438	
C10	Capacitor, 4.7pF, 5% 50V NP0 0805	5322 122 32287		R13	Resistor, 8.2Ω, 10% 1/4W RC-01 1206	4822 051 10828	
C11	Capacitor, 1nF, 20% 50V X7R 0805	5322 122 34123		R14	Resistor, 150Ω, 1% 1/8W 100PPM 1206	5322 116 80431	
C12	Capacitor, 1nF, 20% 50V X7R 0805	5322 122 34123		R15	Resistor, 8.2Ω, 10% 1/4W RC-01 1206	4822 051 10828	
C13	Capacitor, 15pF, 5% 50V NP0 0805	5322 122 33869		R16	Resistor, 220Ω, 1% 1/8W 100PPM 1206	5322 116 80433	
C14	Capacitor, 1nF, 20% 50V X7R 0805	5322 122 34123		R19	Resistor, 33Ω, 1% 1/8W 100PPM 1206	4822 051 10339	
C16	Capacitor, 1pF, 5% 50V NP0 0805	5322 122 32447		R2	Resistor, 470Ω, 1% 1/8W 100PPM 1206	5322 116 80444	
C17	Capacitor, 1nF, 20% 50V X7R 0805	5322 122 34123		R20	Resistor, 10Ω, 1% 1/8W 100PPM 1206	4822 051 10109	
C18	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		R21	Resistor, 47Ω, 1% 1/8W 100PPM 1206	5322 116 80448	
C19	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		R22	Resistor, 47Ω, 1% 1/8W 100PPM 1206	5322 116 80448	
C2	Capacitor, 1nF, 20% 50V X7R 0805	5322 122 34123		R24	Resistor, 180Ω, 1% 1/8W 100PPM 1206	4822 051 10181	
C20	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		R25	Resistor, 2.7kΩ, 1% 1/8W 100PPM 1206	5322 116 80437	
C21	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		R26	Resistor, 47kΩ, 1% 1/8W 100PPM 1206	5322 116 80446	
C22	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		R27	Resistor, 2.2kΩ, 1% 1/8W 100PPM 1206	5322 116 80434	
C23	Capacitor, 15μF, 20% 6.3V 6.0X3.2 mold	5322 124 10684		R28	Resistor, 270Ω, 1% 1/8W 100PPM 1206	4822 051 10271	
C24	Capacitor, 1nF, 20% 50V X7R 0805	5322 122 34123		R29	Resistor, 330Ω, 1% 1/8W 100PPM 1206	5322 116 80438	
C25	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		R3	Resistor, 470Ω, 1% 1/8W 100PPM 1206	5322 116 80444	
C26	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		R30	Potentiometer, 1kΩ, 10% 72X	5322 101 14299	
C27	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		R31	Resistor, 47kΩ, 1% 1/8W 100PPM 1206	5322 116 80446	
C3	Capacitor, 1nF, 20% 50V X7R 0805	5322 122 34123		R32	Resistor, 4.7kΩ, 1% 1/8W 100PPM 1206	5322 116 80445	
C31	Capacitor, 1pF, 5% 50V NP0 0805	5322 122 32447		R33	Resistor, 3.3kΩ, 1% 1/8W 100PPM 1206	5322 116 80439	
C32	Capacitor, 3.3pF, 5% 50V NP0 0805	5322 122 32286		R35	Resistor, 220kΩ, 1% 1/8W 100PPM 1206	5322 116 80436	
C34	Capacitor, 3.3pF, 5% 50V NP0 0805	5322 122 32286		R38	Resistor, 1kΩ, 1% 1/8W 100PPM 1206	5322 116 80427	
C35	Capacitor, 22pF, 5% 50V NP0 0805	5322 122 32658		R39	Resistor, 470kΩ, 1% 1/8W 100PPM 1206	5322 116 80447	
C36	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		R4	Resistor, 22Ω, 1% 1/8W 100PPM 1206	4822 051 10229	
C37	Capacitor, 2.2pF, 5% 50V NP0 0805	5322 122 33063		R40	Resistor, 33kΩ, 1% 1/8W 100PPM 1206	5322 116 80441	
C38	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		R41	Resistor, 560Ω, 1% 1/8W 100PPM 1206	4822 051 10561	
C39	Capacitor, 1nF, 20% 50V X7R 0805	5322 122 34123		R42	Resistor, 27Ω, 1% 1/8W 100PPM 1206	5322 116 82262	
C4	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		R43	Resistor, 1.8kΩ, 1% 1/8W 100PPM 1206	4822 051 10182	
C40	Capacitor, 1nF, 20% 50V X7R 0805	5322 122 34123		R44	Resistor, 3.3kΩ, 1% 1/8W 100PPM 1206	5322 116 80439	
C5	Capacitor, 1nF, 20% 50V X7R 0805	5322 122 34123		R47	Resistor, 470Ω, 1% 1/8W 100PPM 1206	5322 116 80444	
C6	Capacitor, 1nF, 20% 50V X7R 0805	5322 122 34123		R48	Resistor, 82Ω, 1% 1/8W 100PPM 1206	4822 051 10829	
C7	Capacitor, 47pF, 5% 50V NP0 0805	5322 122 32452		R5	Resistor, 22Ω, 1% 1/8W 100PPM 1206	4822 051 10229	
C8	Capacitor, 1nF, 20% 50V X7R 0805	5322 122 34123		R52	Resistor, 47kΩ, 1% 1/8W 100PPM 1206	5322 116 80446	
GR11	Diode, BAR 16-1 SOT23	5322 130 80246		R53	Resistor, 10kΩ, 1% 1/8W 100PPM 1206	5322 116 80428	
GR15	Diode, 0.03A, BAT17 SOT23	5322 130 31544		R55	Resistor, 33Ω, 1% 1/8W 100PPM 1206	4822 051 10339	
GR16	Diode, 0.1A, BAV99 SOT23	5322 130 34337		R56	Resistor, 22Ω, 1% 1/8W 100PPM 1206	4822 051 10229	
GR17	Diode, 0.1A, BAV99 SOT23	5322 130 34337		R57	Resistor, 100Ω, 1% 1/8W 100PPM 1206	5322 116 80426	
GR18	Diode, 0.1A, BAV99 SOT23	5322 130 34337		R58	Resistor, 1kΩ, 1% 1/8W 100PPM 1206	5322 116 80427	
GR3	Diode, 0.03A, BAT17 SOT23	5322 130 31544		R59	Resistor, 1kΩ, 1% 1/8W 100PPM 1206	5322 116 80427	
GP4	Diode, 0.03A, BAT17 SOT23	5322 130 31544		R6	Resistor, 22Ω, 1% 1/8W 100PPM 1206	4822 051 10229	
GP5	Diode, 0.03A, BAT17 SOT23	5322 130 31544		R60	Resistor, 120Ω, 1% 1/8W 100PPM 1206	4822 051 10121	
GP6	Diode, 0.03A, BAT17 SOT23	5322 130 31544		R61	Resistor, 120Ω, 1% 1/8W 100PPM 1206	4822 051 10121	
GP7	Diode, 0.03A, BAT17 SOT23	5322 130 31544		R62	Resistor, 330Ω, 1% 1/8W 100PPM 1206	5322 116 80438	
GP8	Diode, 0.1A, BAV99 SOT23	5322 130 34337		R63	Resistor, 100Ω, 1% 1/8W 100PPM 1206	5322 116 80426	
GP9	Diode, 0.03A, BAT17 SOT23	5322 130 31544		R64	Resistor, 470kΩ, 1% 1/8W 100PPM 1206	5322 116 80447	
IC1	IC, 1.2GHz, UPC1652G SO-8 VAR	5322 209 71557		R65	Resistor, 220kΩ, 1% 1/8W 100PPM 1206	5322 116 80436	
IC2	IC, 1.3GHz, U833BS	5322 209 61399		R66	Resistor, 0Ω, RC-01 1206	4822 051 10008	
IC3	IC, NE532D DUAL SO-8	5322 209 71553		R7	Resistor, 22Ω, 1% 1/8W 100PPM 1206	4822 051 10229	
L1	Choke, 0.1H, 10% MLF3216DR10K	5322 157 52986					
L7	Choke, 0.1H, 10% MLF3216DR10K	5322 157 52986					

# PM 9626

<b>Pos</b>	<b>Description</b>	<b>Part Number</b>	<b>★</b>	<b>Pos</b>	<b>Description</b>	<b>Part Number</b>	<b>★</b>
	Connector, KC-79-35	5322 267 10004		IC109	IC socket, 32pin, P/N 213-032-602	5322 255 41141	
	IC-Socket, 40pin, DIL	5322 255 44217		IC109	IC-PROM, PM9626 N27C256	5322 209 51853	R
	Lock Washer, YT3.2 ST FZ DIN6798A	4822 530 80082	P	IC110	IC socket, 32pin, P/N 213-032-602	5322 255 41141	
	Screw, MRT-KOMBI 3X08 STFZ	4822 502 11669	P	IC111	IC, 256kbyte, UPD43256GU-12L SO28	5322 209 62421	
	Screw, MRT-KOMBI 3X10 STFZ	5322 502 13556	P	IC113	IC, F8291A TALK/LISTEN	5322 209 81264	
	Spring Washer, KBA 3.2 ST FZ DIN137	4822 530 80173	P	IC113	IC-Socket, 40pin, 641 603-3	5322 255 44217	
BU101	Cable Assy	5322 321 61341	R	IC114	IC, SN75160AN	5322 209 81807	
BU102	Connector, KC-79-35	5322 267 10004		IC115	IC, SN75161AN	5322 209 81842	
BU103	Connector, 24pin, 57LE-20240-77OOD35G	5322 267 60148		IC116	IC, PC74HC573T SO20	5322 209 60424	
C101	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		IC117	IC, PC74HC86T SO-14	5322 209 71562	
C102	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		R101	Resistor, 47kΩ, 1% 1/8W 100PPM 1206	5322 116 80446	
C103	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		R102	Resistor, 47kΩ, 1% 1/8W 100PPM 1206	5322 116 80446	
C104	Capacitor, 220pF, 5% 50V NP0 0805	4822 122 33575		R103	Resistor, 4.7kΩ, 1% 1/8W 100PPM 1206	5322 116 80445	
C105	Capacitor, 100nF, 10% 63V X7R 1206	4822 122 33496		R104	Potentiometer, 1kΩ, 3304X-1-102E	5322 101 11095	
C106	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		R105	Resistor, 10kΩ, 1% 1/8W 100PPM 1206	5322 116 80428	
C107	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		R106	Resistor, 330Ω, 1% 1/8W 100PPM 1206	5322 116 80438	
C108	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		R107	Potentiometer, 10kΩ, 25% 0.1W 3304X-1-103	5322 100 11143	
C109	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		R108	Resistor, 3.3kΩ, 1% 1/8W 100PPM 1206	5322 116 80439	
C110	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		R109	Resistor, 100Ω, 1% 1/8W 100PPM 1206	5322 116 80426	
C111	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		R110	Resistor, 100Ω, 1% 1/8W 100PPM 1206	5322 116 80426	
C112	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		R111	Resistor, 1kΩ, 1% 1/8W 100PPM 1206	5322 116 80427	
C113	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		R112	Resistor, 100kΩ, 1% 1/8W 100PPM 1206	5322 116 80429	
C114	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		R113	Resistor, 100kΩ, 1% 1/8W 100PPM 1206	5322 116 80429	
C115	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		R114	Resistor, 100kΩ, 1% 1/8W 100PPM 1206	5322 116 80429	
C116	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		R115	Resistor, 100kΩ, 1% 1/8W 100PPM 1206	5322 116 80429	
C117	Capacitor, 10nF, 20% 50V X7R 0805	5322 122 34098		R116	Resistor, 100kΩ, 1% 1/8W 100PPM 1206	5322 116 80429	
C118	Capacitor, 68pF, 20% 6.3V SOLID AL	5322 124 10455		R117	Resistor, 100kΩ, 1% 1/8W 100PPM 1206	5322 116 80429	
IC101	IC, PC74HC32T SO14	5322 209 60429		R118	Resistor, 100kΩ, 1% 1/8W 100PPM 1206	5322 116 80429	
IC103	IC, NE532D DUAL SO-8	5322 209 71553		SK101	DIP switch, 6pin, 206-6 RAST	5322 277 21125	
IC106	IC, PC74HC00T SO14	5322 209 71802					
IC107	IC, PC74HC573T SO20	5322 209 60424					
IC108	IC, PC74HC573T SO20	5322 209 60424					

# **PM 9678B**

<b>Pos</b>	<b>Description</b>	<b>Part Number</b>	<b>☆</b>	<b>Pos</b>	<b>Description</b>	<b>Part Number</b>	<b>☆</b>
	Screw, MRT-KOMBI 3X06 STFZ	4822 502 11658	P	C2	Capacitor, 15µF, 20% 16V SOLID AL	4822 124 20977	
	Spring Washer, KBA 3.2 ST FZ DIN137	4822 530 80173	P	KT1	Oscillator, 10MHz, TCXO	5322 216 94047	R
BU1	Connector, 10pin, 22-14-2104 4455-BC	5322 267 50336		R1	Resistor, 147, 1% 0.5W MRS25	4822 050 21471	
C1	Capacitor, 65pF, 5.5-65PF 100V	4822 125 50017		TS1	Transistor, BF245C.025A 30V TO92	4822 130 41065	

# PM 9697

<b>Pos</b>	<b>Description</b>	<b>Part Number</b>	<b>P</b>	<b>Pos</b>	<b>Description</b>	<b>Part Number</b>	<b>P</b>
	Connector, 2pin, F095 JUMPER grey	5322 263 50101		IC103	IC, SN74LS90N	5322 209 85255	
	Crystal, 10MHz, HC49U	5322 242 74372	R	R101	Resistor, 121, 1%, 0.4W	5322 116 54426	
	IC socket,	5322 255 44125		R102	Resistor, 316, 1%, 0.4W	5322 116 54511	
	Mounting kit,	5322 218 70079	R	R103	Resistor, 464, 1%, 0.4W	5322 116 50536	
	Text plate,	5322 456 30016	R	R104	Resistor, 1.47k, 1%, 0.4W	5322 116 50635	
BU1	Connector, 10pin, 22-03-2101 4030-10A	5322 265 64028		R105	Resistor, 1.47k, 1%, 0.4W	5322 116 50635	
BU103	Connector, 6pin, 22-03-2061 A-4030-06	5322 265 44057		R106	Resistor, 1M, 1%, 0.4W	5322 116 55535	
BU104	Connector, 6pin, 22-03-2061 A-4030-06	5322 265 44057		R107	Resistor, 10, 1%, 0.4W	5322 116 50452	
C101	Capacitor, 100nF, 10% 100V 4X10.5 3M	4822 121 41672		R108	Resistor, 464, 1%, 0.4W	5322 116 50536	
C102	Capacitor, 10 $\mu$ F, 20% 16V SOLID AL	4822 124 21314		R109	Resistor, 422, 1%, 0.4W	5322 116 50459	
C103	Capacitor, 10nF, -20+50% 100V 2M	4822 122 31414		R110	Resistor, 3.16k, 1%, 1/8W	5322 116 50579	
C104	Capacitor, 100nF, 10% 100V 4X10.5 3M	4822 121 41672		R111	Resistor, 681, 0.5%, 0.4W	4822 116 51233	
C105	Capacitor, 18pF, 2% 100V NPO 2M	4822 122 31061		R112	Resistor, 1k, 0.5%, 0.4W	4822 116 51235	
C106	Capacitor, 470pF, 10% 100V 2M	4822 122 30034		R113	Resistor, 681, 0.5%, 0.4W	4822 116 51233	
C107	Capacitor, 10nF, -20+50% 100V 2M	4822 122 31414		TS101	Transistor, 2N5771 .05A 15V TO92	5322 130 44845	
C108	Capacitor, 470 $\mu$ F, 50%, 10V	4822 124 20684		TS102	Transistor, 2N5771 .05A 15V TO92	5322 130 44845	
C109	Capacitor, 10nF, -20+50% 100V 2M	4822 122 31414		TS103	Transistor, 2N5770 .05A 15V TO92	5322 130 44435	
C110	Capacitor, 220pF, 10% 100V 2M	4822 122 30094		TS104	Transistor, BC548B .1A 30V TO92	4822 130 40937	
IC101	IC, MC4024P	5322 209 85819		TS105	Transistor, BC548B .1A 30V TO92	4822 130 40937	
IC102	IC, MC4044	5322 209 85821					