Programmable Timer — Counters
PM 6652, -54

Service Manual

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S&I
Scientific & Industrial Equipment Division

PHILIPS
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PHILIPS

Programmable Timer — Counters
PM 6652...54

Service Manual

PHILIPS

PHILIPS

CONTENTS

1. SAFETY INSTRUCTIONS

CONTENTS

SAFETY INSTRUCTIONS

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

General information

This counter has been designed and tested in accordance with IEC Publication 348, Safety Requirements For Electronic Measuring Apparatus For Class 1 instruments, and has been supplied in a safe condition. This manual contains information and warnings that should be followed by the user and service technician to ensure safe operation and repair in order to keep the counter 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 be dangerous to life.

The counter must be disconnected from all voltage sources before it is opened.

Remember that capacitors inside the counter retain their charge even if the counter has been disconnected from all voltage sources.

Grounding

The counter is connected to ground via a sealed three core power cable, which must be plugged into a socket outlet with a protective ground contact. No other method of grounding is permitted for this counter. When the counter is brought from a cold to a warm environment, condensation may cause a harzadous condition. Therfore, ensure that the grounding requirements are strictly met.

Power extension cables must always have a protective ground conductor.

WARNING: Any interruption of the protective ground conductor inside or outside the counter, or disconnection of the protective ground terminal, is likely to make the counter dangerous. DO NOT intentionally disrupt the protective grounding.

Line voltage setting

Before connecting the counter to the line, ensure that it is set to the local line voltage. On delivery the counter is set to either 115 V or 220 V, as indicated an the line voltage selector on the rear panel. If the voltage setting is incorrect, set the line voltage selector in accordance with the local voltage before connecting the counter to the line.

CAUTION: If the counter has been unintentionally connected to a 220 V line when set to 115 V, an internal protection circuit as well as the primary fuse will blow. These components must be replaced afterwards, see chapter 7.

Components which are important for the safety of the instrument may only be renewed by components obtained from your local Philips organisation.

After repair and maintenance in the primary circuit, safety inspection and tests, as described in Chapter 5, have to be performed.

Fuses

The counter is protected by two fuses. The primary fuse has to be replaced when the line voltage setting is changed. For 220 V, use a 0.4 A slow-blow fuse and for 115 V, a 0.8 A slow-blow fuse. The secondary fuse on the power supply PC-board shall be a 4 A fast-blow. Disconnect the power plug before replacing a fuse. Ensure that only fuses of the specified type are used.

See chapter 9 for spare part ordering No.

2. QUICK FAULT-FINDING

CONTENTS

SERVICING PHILOSOPHY

The PM 6652 and PM 6654 are very complex instruments which contain microprocessors, ECL-, TTL-, CMOS-logic, analog HF-circuitry, a tailor-made LSI circuit etc. To troubleshoot the complete instrument using conventional fault-finding methods, with oscilloscope and multimeter, would be almost impossible.

The fault-finding procedures developed for this instrument are therefore based on self test programs and the use of signature analysis, in addition to conventional fault-finding.

A single fault-finding tree directs you (the serviceman) to various troubleshooting routines using the techniques mentioned above.

WHERE DO I START?

If this is your first session with the PM 6652/54, start by taking a look at the Operating Manual to get to know the instrument. Also read chapter 7, "Dismantling", in this manual, and the block diagram description in chapter 4.

If you have more experience of the instrument, or when you have read the above, turn directly to the fault-finding tree in chapter 5 and start checking the instrument. If you find faults in any area which is not covered by signature analysis, go back to chapter 4 and read the functional description.

INSTRUMENTS REQUIRED

The instruments required to follow the procedures are:

1) A signature analyzer that can handle a 10 MHz clock frequency and has adjustable trigger levels for both the 'pod' and the probe. Faultfinding is simplified if the instrument has a built-in frequency counter and voltmeter but separate units can also be used. When the text in the manual was prepared, a Philips PM 2544 Logic multimeter, which has all the necessary functions, was used.
2) A two-channel oscilloscope with a minimum bandwith of 25 MHz.; e.g. Philips PM 3215 with probes.
3) An LF synthesizer, Philips PM 5190.
4) An RF signal generator, e.g. Wavetek 2002A.
5) An variable power supply, e.g. Philips PE 1542.
6) A 20 dB BNC attenuator.
7) An adapter, PM9051.
8) 10 MHz reference signal source with an inaccuracy (relative error) of max $1x10^{-6}$.; e.g. any Philips counter containing a properly calibrated 02 to 05 oscillator (PM 9678B, PM 9679E, PM 9680, PM 9681, PM 9690 or PM 9691).
9) Trimming screwdriver for standard oscillator adjustment. ELCOMA Nos. 7122 347 21600 and 7122 005 47910.

For PM 6654 only

10) A sampling oscilloscope with a maximum rise-time of 0.5 ns, with FET-probe.

IDENTIFICATION

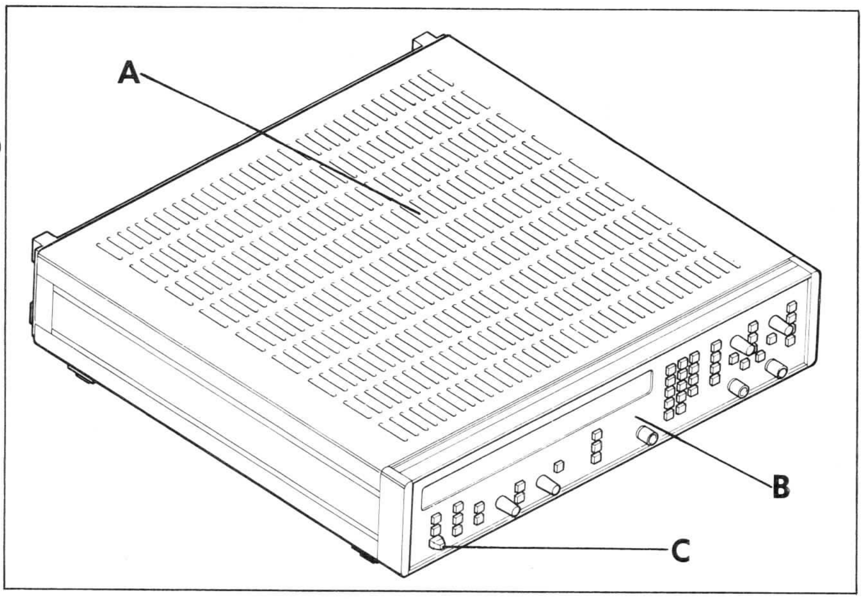
Exterior parts

The names given in these figures are used in this manual.

Front view

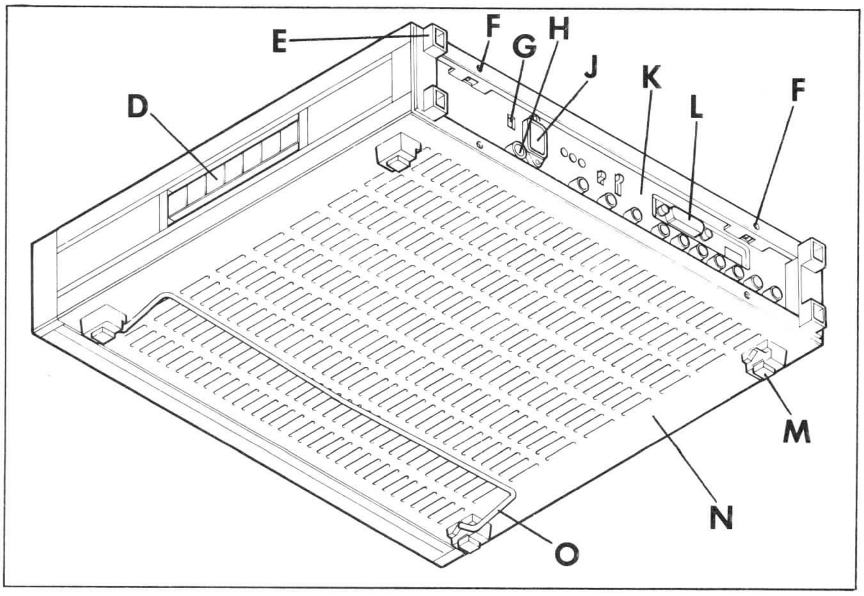
A Top cover
B Front panel
C STBY/ON button (power switch)

NOTE: A detailed description of the front panel is given in the Operating Manual.



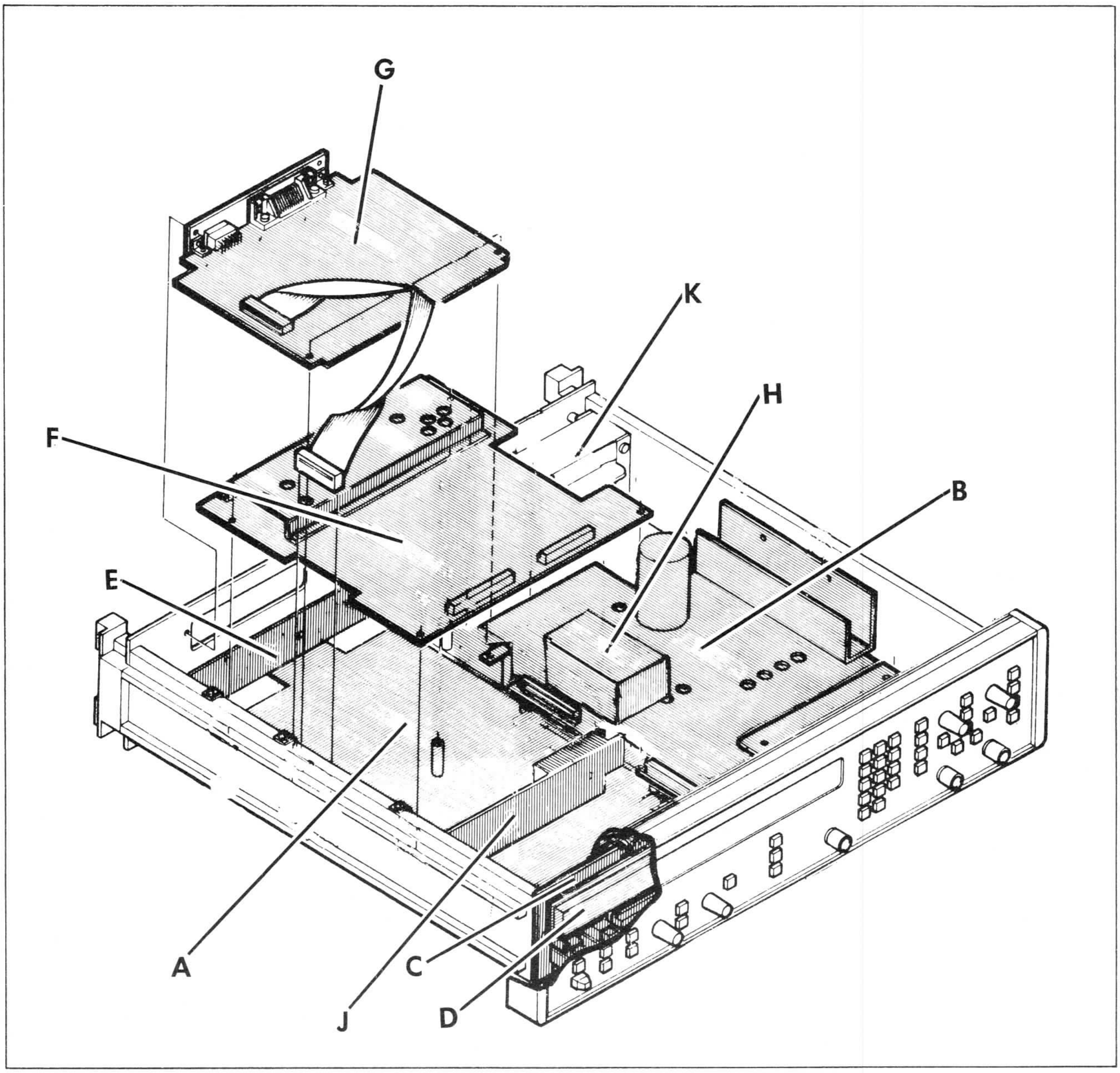
Rear view

D Handle
E Rear bumpers
F Top cover retaining screw
G Line voltage selector
H Primary fuse
J Line inlet socket
K Rear panel
L Connector on optional IEEE-488 interface or Analog recorder output
M Foot
N Bottom cover
O Tilting support



Interior parts

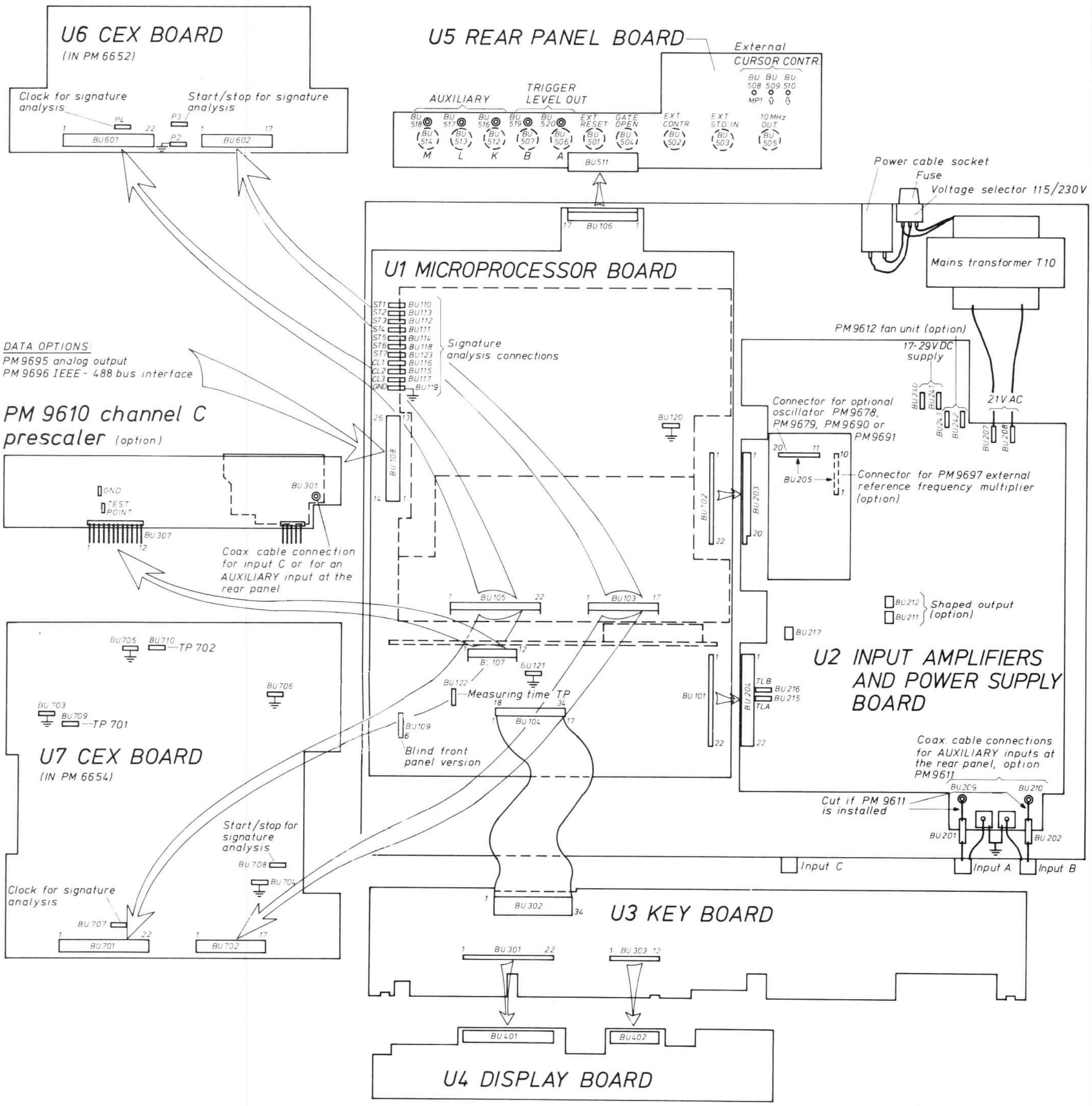
A Unit 1, Microprocessor Board U1
B Unit 2, Input Amplifiers and Power Supply U2
C Unit 3, Keyboard U3
D Unit 4, Display board U4
E Unit 5, Rear Panel Board U5
F Unit 6, CEX Board U6 for PM 6652 (not illustrated)
F Unit 7, CEX Board U7 for PM 6654
G IEEE-488 Bus Interface PM 9696
G Analog Recorder Output PM 9695 (not illustrated)
H Optional oscillator PM 9678, PM 9679, PM 9690 or PM 9691
H Frequency multiplier PM 9697 (not illustrated)
J Prescaler (Channel C) PM 9610
K Mains transformer



Interconnections

The following diagram clarifies which connectors are used to interconnect the various boards in the counter.

PM6652/54 CIRCUIT BOARDS AND CONNECTIONS



Versions

With the help of this table it is possible to find out which options are included in a counter.

VERSION	PM 9610 Channel-C	PM 9678 02 TCXO	PM 9679 03 Oven	PM 9690 04 Oven	PM 9691 05 Oven	PM 9695 Ana. outp	PM 9696 IEEE-488	PM 9697 Multipl.	Blind panel
PM 665X/011									
012							*		*
015						*			
016							*		
021		*							
022		*					*		*
025		*				*			
026		*					*		
031			*						
032			*				*		*
035			*			*			
036			*				*		
041				*					
042				*			*		*
045				*		*			
046				*			*		
051					*				
052					*		*		*
055					*	*			
056					*		*		
081								*	
082							*	*	*
085						*		*	
086							*	*	
511	*								
512	*						*		*
515	*					*			
516	*						*		
521	*	*							
522	*	*					*		*
525	*	*				*			
526	*	*					*		
531	*		*						
532	*		*				*		*
535	*		*			*			
536	*		*				*		
541	*			*					
542	*			*			*		*
545	*			*		*			
546	*			*			*		
551	*				*				
552	*				*		*		*
555	*				*	*			
556	*				*		*		
581	*							*	
582	*						*	*	*
585	*					*		*	
586	*						*	*	

PM 9611, rear panel input cables, and PM 9612, fan, are separate options

3. TEST PROGRAMS

CONTENTS

SELF TESTS

Introduction

Five different test programs are available to allow testing of parts of the circuitry without opening the cabinet. All the tests are activated in the same way:

- Set the cursor to the TEST position by means of the FUNCTION keys.
- Select the test NO. (1...6) by pressing the number on the numeric KEYBOARD.
- During the test the display will show the number of the selected test.
- When the test is completed satisfactory, the display will show zeros.
- If an error is detected, it is indicated by an "E" followed by the test number that failed.

Test 1

Checking the PROGRAM MEMORY. This test takes about 12 s. The appearance of error code E1 on the display can be caused by the following:

- PROM packages IC103...IC105 are faulty.
- The IC sockets for these PROMs are faulty.
- The printed wiring for these PROMs is faulty.

To remedy the fault, replace the PROM packages IC103...IC105 (2764).

Test 2

Checking the RAM MEMORY in IC107. This test takes about 2 s.

Test 3

Checking the NON-VOLATILE MEMORY (EAROM). This test takes about 12 s. The appearance of error code E3 on the display can be caused by the following:

- EAROM package IC108 (ER1400) is faulty.
- Multiplexer package IC127 (4053) is faulty.
- Transistors TS102...TS105 (BC558B) are faulty.
- FET transistor TS101 (BF256A) is faulty.

To remedy the fault, replace these components successively.

Test 4

Checking the MEASURING LOGIC. This test takes about 4 s. The appearance of the error code "E4" could be caused by incorrect setting of the INT/EXT STD switch on the rear panel.

Test 5

Checking the DISPLAY.

This test takes about 50 s, and has the following sequence:

- The display shows 0000000000 EXP 0
  1111111111 EXP 1
  2222222222 EXP 2
  3333333333 EXP 3
  4444444444 EXP 4
  5555555555 EXP 5
  6666666666 EXP 6
  7777777777 EXP 7
  8888888888 EXP 8
  9999999999 EXP 9

- The display shows all decimal points.

- The display shows a shifting 8 plus the "-" in front of the exponent.

- All unit indicators, function cursors and LEDs in the control buttons are lit in sequence.

- The entire display and all LED:s will light at the same time, except for the function cursor FREQ A...TEST and STAND BY.

Test 6

Running through tests 1...5 in one sequence. The test takes about 80 s.

Power ON test

A POWER ON test is activated whenever power is switched from ST BY to ON. This test consist of tests number 2, 4 and part of number 5.

STIMULUS PROGRAMS FOR SERVICE

Introduction

These programs generates stable patterns on the buses and in the discrete logic in the counter. Patterns that can be easily identified on an oscilloscope screen or by a signature analyser. See chapter 5 for further instructions.

Preparations

- Set the two switches on the counter's rear panel to INT (i.e. internal clock oscillator) and OFF (i.e. no external control) respectively.
- Set jumper DV101 on U1 to the NORMAL position and DV102 on U1 to the TEST position.

"For testing U1"

This program runs automatically when the above-mentioned preparations are completed; the program is used for testing:

- Front and rear panels
- IC107 RAM 8155
- IC110 Multiplexer port
- IC111 Relay port
- IC118 Slave Processor (supply voltage and input signals)
- IC125 Input port
- IC137 Strobe generator

Starting the stimulus program "PHILIPS 0" to "PHILIPS 6"

- Set the switches and the jumpers on the counter as given in "Preparations".
- Switch ON the counter (ST BY/ON switch).
- Press and release the RESET key. The text PHILIPS should now appear on the counter display.
- Press the numeric keyboard key corresponding to the number of the program. This causes the same digit to be added to PHILIPS on the display. After approximately 4 s the stimulus program will start.

"PHILIPS 0"

This stimulus program is a production test only used in the factory.

"PHILIPS 1"

This stimulus program tests the CEX board U6 (PM6652).

"PHILIPS 2"

This stimulus program tests the CEX board U7 (PM6654).

"PHILIPS 3"

This test is used for testing the keyboard. A unique two digit code will be shown for each key, when the key is pressed.

"PHILIPS 4"

This stimulus program tests the analog output from DAC A and DAC B.

"PHILIPS 5"

This stimulus program tests the IEEE-488 bus interface, PM 9696.

"PHILIPS 6"

This stimulus program is a production test only used in the factory.

"FREE RUN"

This stimulus program tests:
IC101 Microprocessor
IC102 Address latch
IC103...IC105 Program memory (ROM)
IC106 Address decoder

Start "FREE RUN" the following way:

Disconnect the IEEE-488 bus interface option PM 9696 or analog output option PM 9695 from the Processor board.

Remove the following IC packages from U1:

Position	Type of circuit
IC107	8155 (RAM, I/O port,timer)
IC111	74LS374 (Relay port)
IC118	8741A (Slave Processor)
IC150	DIP shunt

Position jumper DV101 at position SIG.TEST and jumper DV102 at position NORMAL and then switch ON the power switch on U1.

4. FUNCTIONAL DESCRIPTION

CONTENTS

BLOCK DIAGRAM DESCRIPTION

Introduction

This description consists of:

1. An introduction to the names of the blocks.
2. A section on the inputs.
3. A section on the counting circuits and the microprocessor.
4. A section on the man - machine interface.

Complete counter

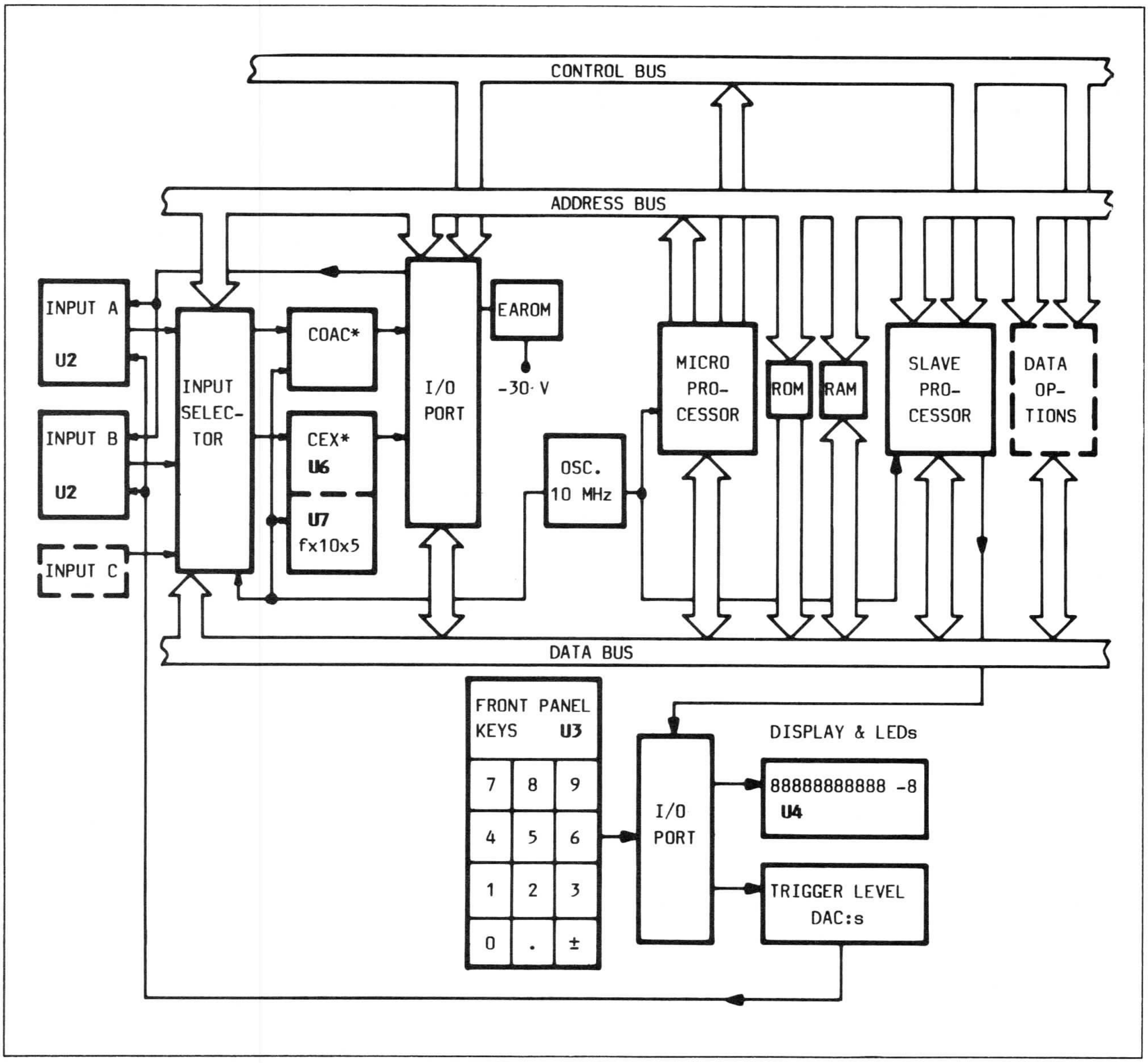
The counter consists of the following parts:

- **INPUT A...C,** input amplifiers, which shape the input signal to a well defined pulse train.
- **INPUT SELECTOR,** an electronic switch to select which input and clock signals should be used.
- **COAC = Counter On A Chip and CEX = COAC EXtention,** these are the actual counters, containing synchronisation circuitry, main gates and counting registers. The COAC works up to 10 MHz, and the CEX from 10 MHz up to 120 MHz.
- **I/O PORT,** these ports are used by the microprocessor to read the results from the counting registers and to handle the communication with the EAROM.
- **EAROM,** the memory in which the eight front panel programs P1...P8 are stored.
- **OSCILLATOR,** this block generates the stable reference frequency on which the accuracy of the instrument is based. It does also generate the clock frequencies for the Microprocessor and the Slave Processor.
- **MICROPROCESSOR,** the controller which supervises everything in the counter.
- **ROM,** a memory, containing the program which tells the Microprocessor what to do.
- **RAM,** a small read/write memory used by the Microprocessor as a scratchpad.
- **Slave Processor,** a single chip microcomputer, which serves the Microprocessor by collecting information from the front panel keys and displaying results on the Display & LEDs.
- **FRONT PANEL KEYS,** the interface between the operator and the instrument.
- DISPLAY & LEDs, **these indicators give information** feedback to the operator.
- **DACs,** producing an output voltage corresponding to the selected trigger level.
- **DATA OPTIONS,** a connector to which the IEEE-488 bus board or the DAC option can be connected.

NOTE: The designations U1...U7 in the lower edge of some blocks indicate on which unit the functional block is located. Blocks without unit identifiers are located on unit U1.

U1 = Microprocessor Board U1
U2 = Input Amplifier and Power Supply board U2
U3 = Keyboard U3
U4 = Display Board U4
U5 = Rear Panel Board U5
U6 = CEX board U6 for PM 6652
U7 = CEX board U7 for PM 6654

Block diagram, complete counter



*) COAC = Counter On A Chip
CEX = Counter EXtension for high frequency

Input circuitry

The signal to be measured can be connected to input A, B or C (if the channel-C option is installed). Input A is an input for signals up to 120 MHz. Input B is used as timing input for start/stop signals etc. with a frequency up to 120 MHz. Input C is a prescaler input for 100 MHz to 1.5 GHz signals.

Input amplifiers A and B are electronically controlled to enable remote set-up via the IEEE-488.

Before measurement is started, the operator uses the front panel controls to select the desired trigger levels, attenuation, AC or DC coupling, input impedance etc. (A detailed description appears in the Operating Manual.) These settings result in digital and analog (trigg level) control signals from the Microprocessor I/O ports and the DACs to the input amplifiers. These control signals actuate relays in the input amplifiers and set them up for a correct measurement.

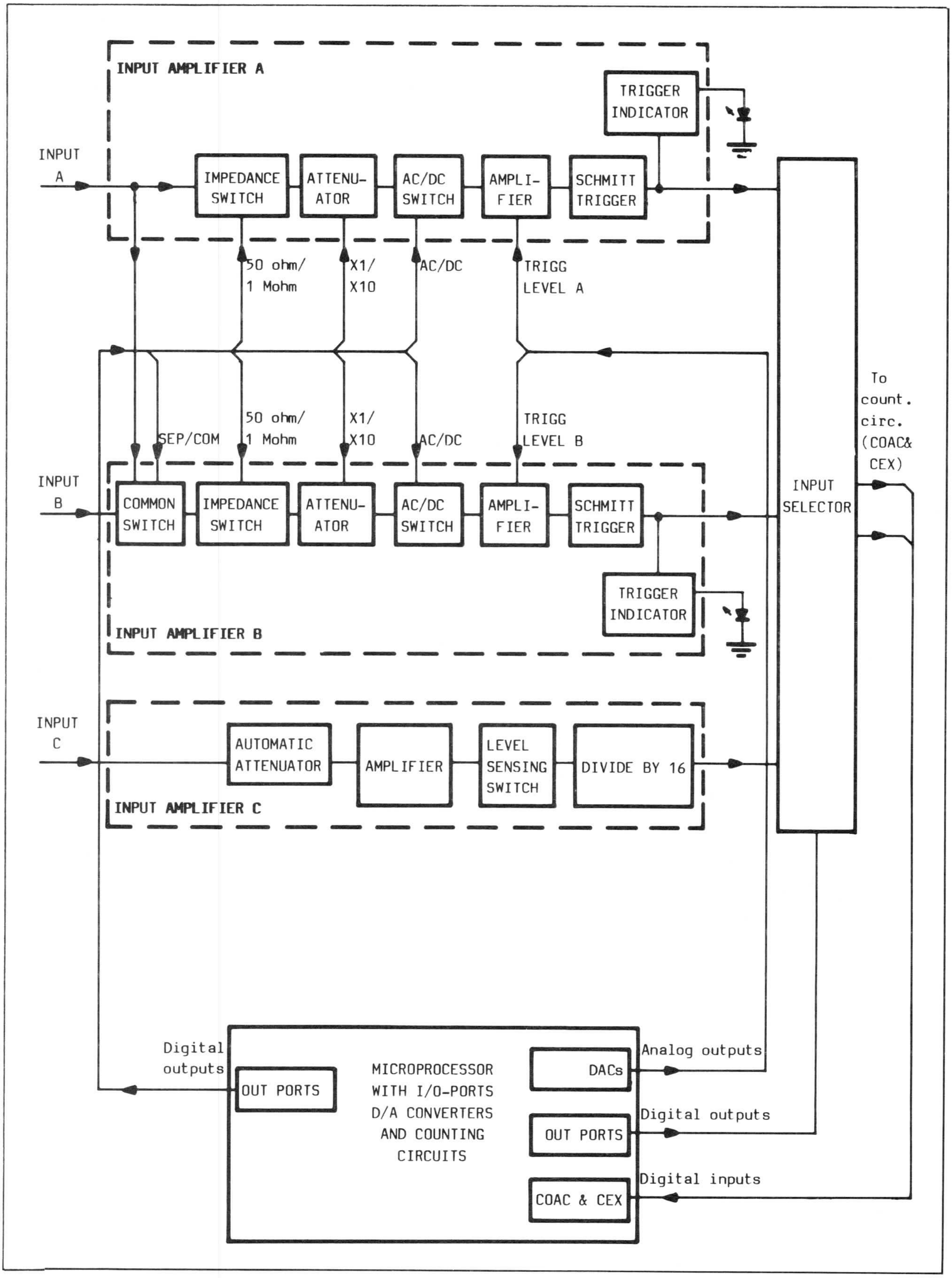
A Schmitt trigger in the input amplifier is used for pulse shaping the signal. As a result, a square wave signal with ECL-levels is obtained at the output. The pulse shaped signal is gated in an input selector by digital control signals from the Microprocessor. The input selector setting depends on the measuring mode setting on the front panel.

Input amplifiers A and B also output TRIGG IND A and B signals which directly drives the trigger indicator LEDs on the front panel. These LEDs indicate whether the Schmitt triggers have been correctly triggered or not:

- If the trigger level setting is correct, the LED will blink (the signal to be measured is then continually crossing the hysteresis band).
- If the signal is above the set trigger level, the LED will glow steadily.
- If the signal is below the set trigger level, the LED will remain OFF.

A more detailed description of the input amplifiers and the input selector can be found in the circuit description later in this chapter.

Simplified block diagram, input circuits



Counting circuitry

Introduction

The actual counting is performed by the measuring logic, consisting of a low frequency part - the COAC, a high frequency part - the CEX, and the auxiliary Microprocessor.

Counter on a chip (COAC)

The COAC is a tailor made LSI chip with all necessary counting circuitry for a 10 MHz timer/counter.

It contains:

- The **INPUT SYNC NETWORK** with:
  - o One electronic switch which connects the input signal A0, or the CARRY signal from the CEX, to the internal counters.
  - o A second switch that selects which reference frequency, B or CL, should be used.
  - o Timing circuits which start and stop the counting syncronous with the input signal or the reference frequency.

  For further information, see Operating Manual, chapter 'Measurement theory'.

- Two **MAIN GATES,** one which gates the signal into the input cycle counter, and a second which gates the reference frequency into the time counter.

- The **INPUT CYCLE COUNTER** which is nine and a half decade counters connected in series. The half decade counter is used to detect overflow.

- The **TIME COUNTER** consisting of nine decade counters in series, which counts reference frequency cycles.

- A **MULTIPLEXER** which switches the nine decades of each counter to the COAC output, one at a time, when reading the results.

- A **SCAN COUNTER** which controls the multiplexer.

- A **FUNCTION CONTROL** which sets up the circuit according to the instructions given by the microprocessor in a 39-bit word read into the COAC via a serial port.

COAC extension, CEX

The CEX is a PC-board which carries the extension necessary to enable direct gating measurements up to 120 MHz.

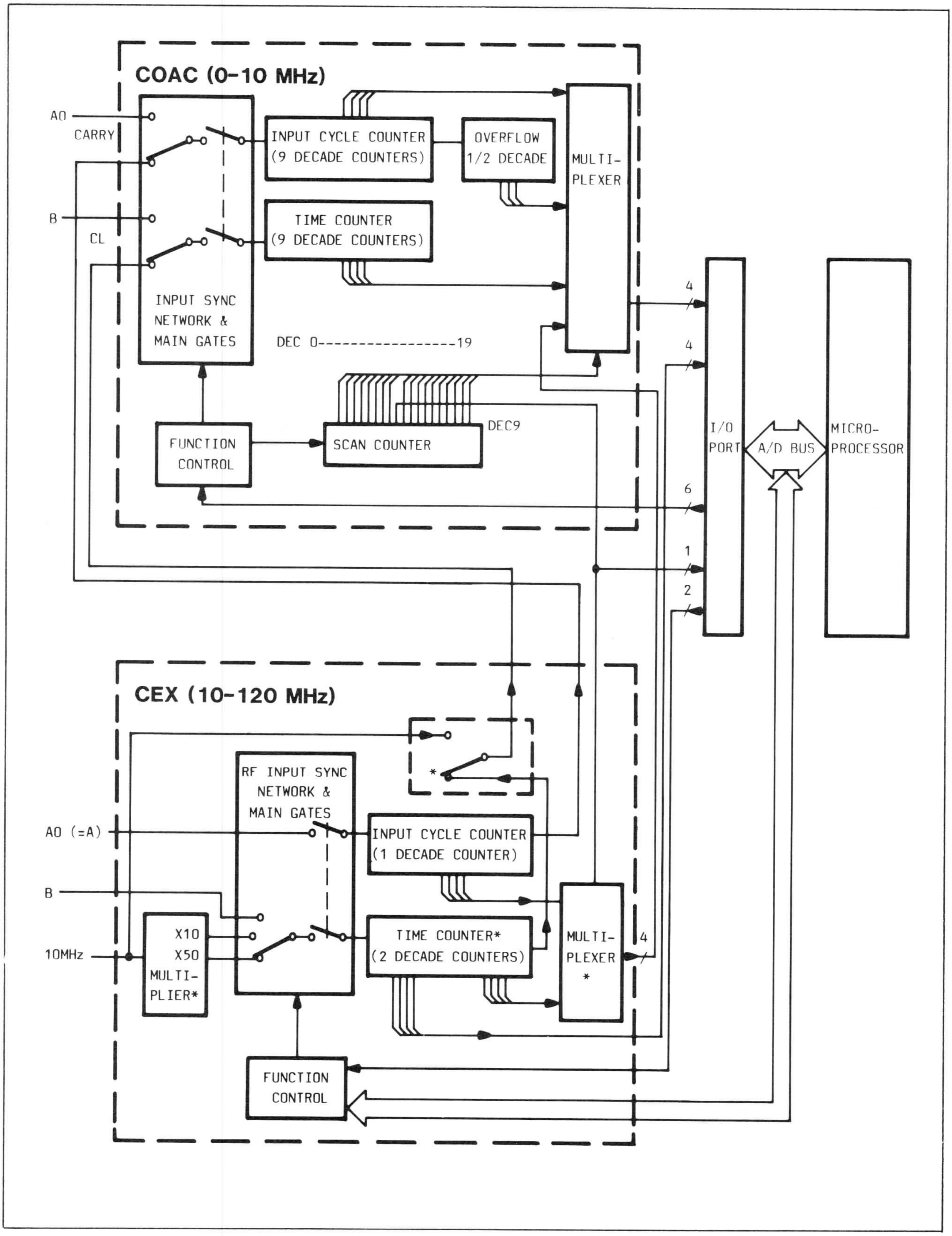
The CEX is available in two versions, one for the PM 6652 (U6) and one for the PM 6654 (U7). The major difference is that the PM 6654 CEX uses higher reference frequencies generated on the board and therfore enables the counter to present the results with a higher resolution.

The CEX functional blocks are similar to those of the COAC except:

- The **MULTIPLEXER,** which is controlled by the scan counter in the COAC.

- The **MULTIPLIER,** which generates 100 MHz and 500 MHz reference pulses which are syncronized by the 10 MHz reference oscillator.

Simplified block diagram, counting circuitry



*) Not on PM 6652.

Man-machine interface

Introduction

A special single-chip microcomputer is used for controlling the front panel. This is a circuit with microprocessor, RAM, ROM, timer and I/O-ports on the same chip. One eight-bit I/O-port is used as a databus for the peripheral circuits.

This microcomputer is called the 'Slave Processor', since it works for the main Microprocessor. It collects the information from the keyboard keyswitches, and displays the result on the display and LEDs. The Slave Processor is connected to the main microprocessor via the Address/Data-bus and control-bus.

One single large X-Y matrix is common to nearly all input and output devices:

1. The 44 keys.
2. The 11 LED-displays.
3. 38 LEDs (all LEDs except the cursor, trigger indicators and the STAND BY LED).

The matrix has eight Y-conductors and 28 X-conductors. All Y-conductors, MP1-MP6 + G and H, are connected to a scan counter[1] which pulls them to +5 V, one at a time.

1) The scan counter is not really a counter but a one-of-eight decoder. The actual counting is performed by the Slave Processor.

Reading the switches

When for example, the CHECK-key is depressed and the Scan Counter reaches the position where MP5 goes high, the MP5 signal is connected via the switch to the M1 input of the Button Code Buffer. When the Slave Processor reads the buffer it receives the information about which key has been depressed.

The diodes connected in series with every switch prevents the current from going backwards, disturbing the displays and LEDs, as otherwise would be the case if more than one switch where depressed at the same time.

Driving an LED

After having informed the main Microprocessor that the CHECK-key has been depressed the Slave Processor has to light the LED in the key.

The LEDs are driven via an LED driver which contains one latch for each X-output. The latch is fed with data about which LED should be lit from the Slave Processor via the I/O data bus. The selected LED driver output goes low. When the scan counter pulls the appropriate Y-conductor high, current will flow from the Y-conductor via the LED to the X-conductor and the LED will light.

The "STAND BY" LED is driven via the power switch from the +12 V supply.

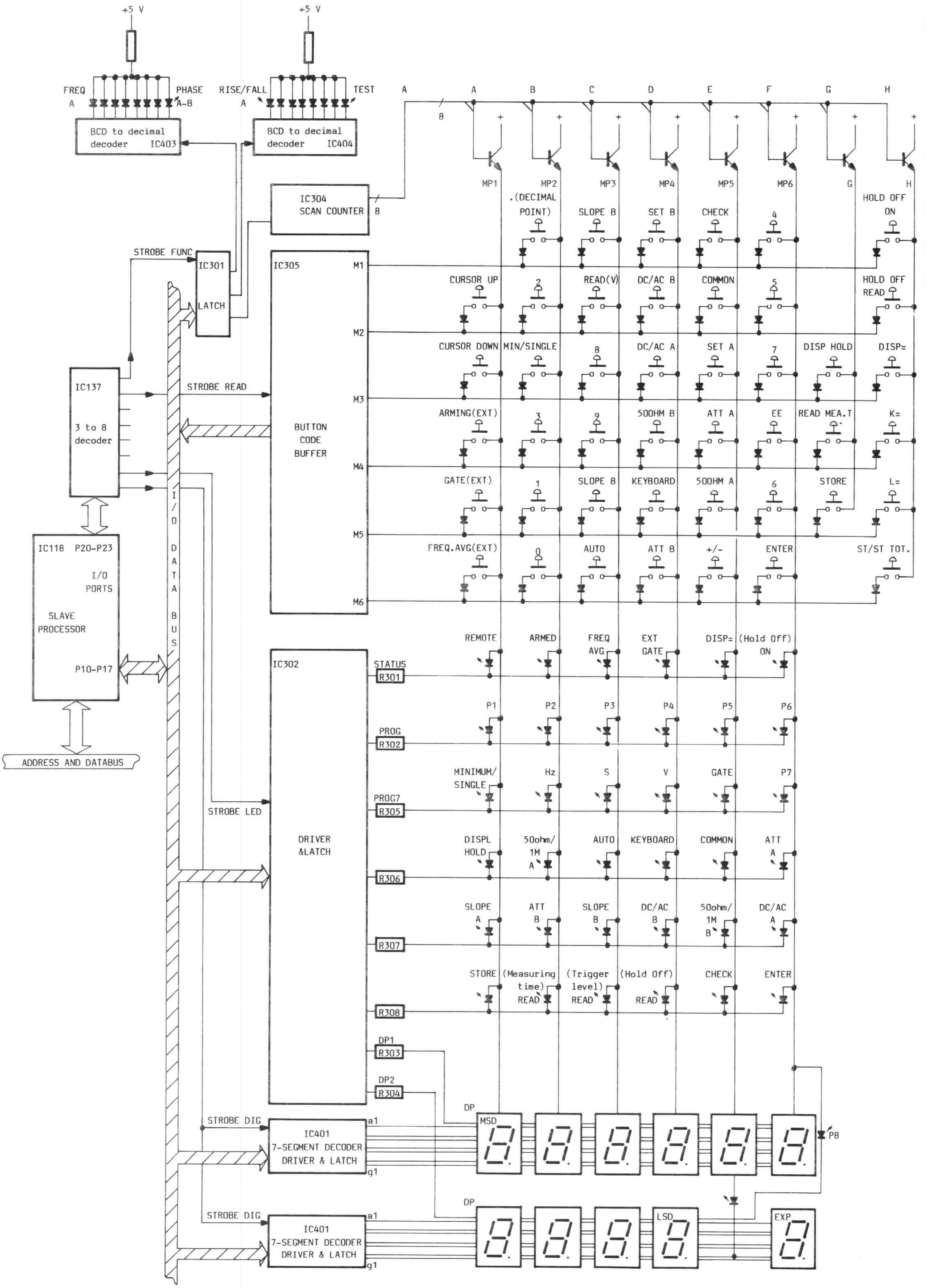
Driving the display

The displays are driven in the same way as the LEDs. The signals from the I/O data bus are converted from BCD code to seven segment code for the LED displays. Two displays are activated simultaneously by each Y-conductor.

The decimal point is driven from the LED driver.

Cursor

The cursor LEDs are fed by two drivers, one for each eight LEDs. When the Slave Processor is required to move the cursor, it outputs the new code on the I/O data bus while selecting the latch.


+5 V
FREQ A
PHASE A-B
RISE/FALL A
TEST
BCD to decimal decoder IC403
BCD to decimal decoder IC404
IC304 SCAN COUNTER
8
STROBE FUNC
IC301 LATCH
IC305
M1
M2
M3
M4
M5
M6
BUTTON CODE BUFFER
IC137
3 to 8 decoder
STROBE READ
IC118 P20-P23
I/O PORTS
SLAVE PROCESSOR
P10-P17
ADDRESS AND DATABUS
I/O DATA BUS
A
B
C
D
E
F
G
H
MP1
MP2
MP3
MP4
MP5
MP6
.(DECIMAL POINT)
SLOPE B
SET B
CHECK
4
HOLD OFF ON
CURSOR UP
2
READ(V)
DC/AC B
COMMON
5
HOLD OFF READ
CURSOR DOWN
MIN/SINGLE
8
DC/AC A
SET A
7
DISP HOLD
DISP=
ARMING(EXT)
3
9
50OHM B
ATT A
EE
READ MEA.T
K=
GATE(EXT)
1
SLOPE B
KEYBOARD
50OHM A
6
STORE
L=
FREQ.AVG(EXT)
0
AUTO
ATT B
+/-
ENTER
ST/ST TOT.
IC302
DRIVER &LATCH
STROBE LED
STATUS
R301
REMOTE
ARMED
FREQ AVG
EXT GATE
DISP=
(Hold Off) ON
PROG
R302
P1
P2
P3
P4
P5
P6
PROG7
R305
MINIMUM/ SINGLE
Hz
S
V
GATE
P7
R306
DISPL HOLD
50ohm/ 1M A
AUTO
KEYBOARD
COMMON
ATT A
R307
SLOPE A
ATT B
SLOPE B
DC/AC B
50ohm/ 1M B
DC/AC A
R308
STORE
(Measuring time) READ
(Trigger level) READ
(Hold Off) READ
CHECK
ENTER
DP1
R303
DP2
R304
DP
MSD
P8
STROBE DIG
IC401 7-SEGMENT DECODER DRIVER & LATCH
a1
g1
LSD
EXP

CIRCUIT DESCRIPTIONS

Introduction

Only those parts of the counter where traditional fault-finding methods are required are described.

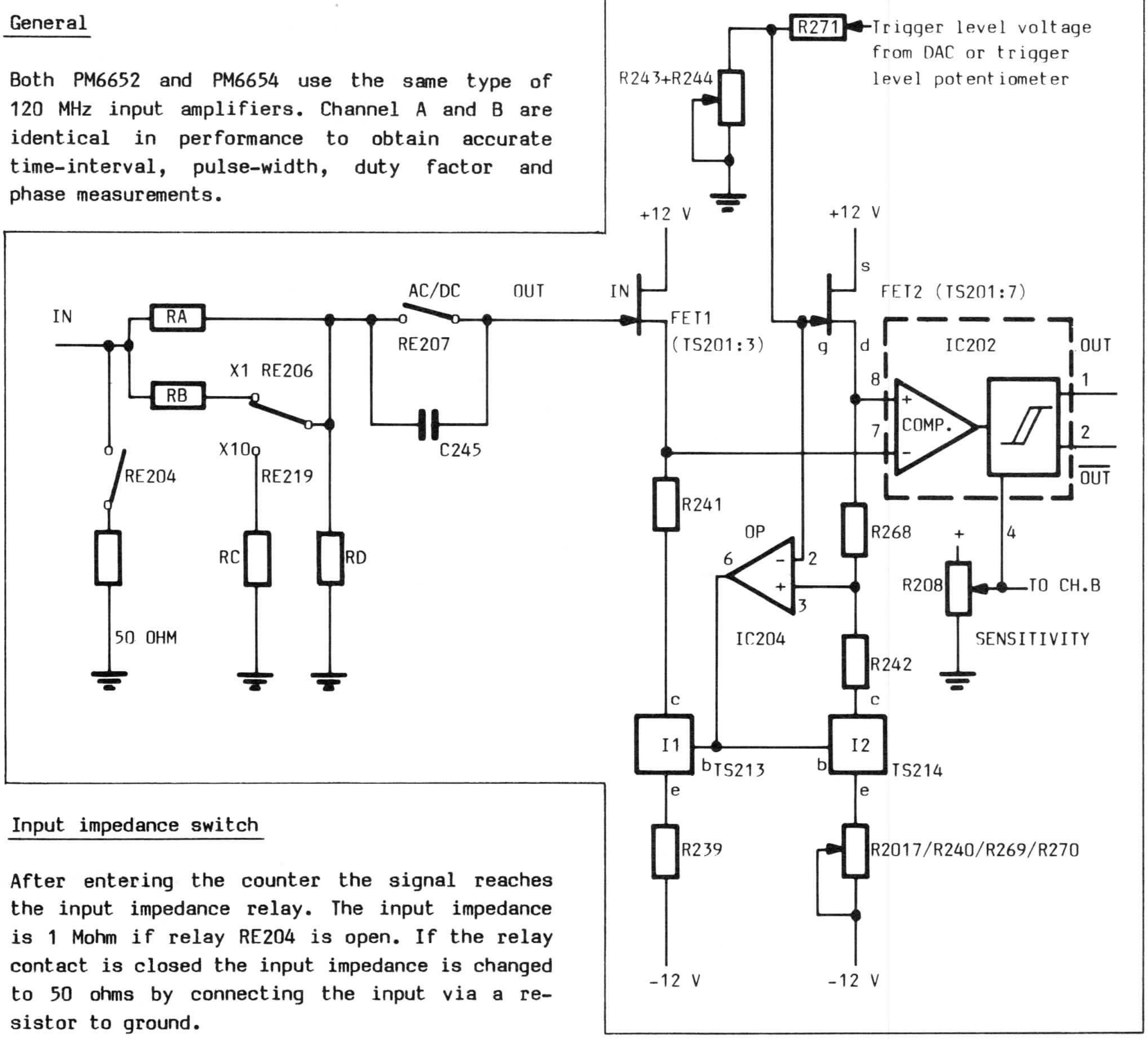
The description of the input amplifier, trigger indicators etc. applies to both channels, but only components for channel A will be mentioned.

NOTE: The drawings in the text are simplified functional diagrams. See the circuit diagram in chapter 10 for detailed information.

Input amplifiers A and B

General

Both PM6652 and PM6654 use the same type of 120 MHz input amplifiers. Channel A and B are identical in performance to obtain accurate time-interval, pulse-width, duty factor and phase measurements.



Input impedance switch

After entering the counter the signal reaches the input impedance relay. The input impedance is 1 Mohm if relay RE204 is open. If the relay contact is closed the input impedance is changed to 50 ohms by connecting the input via a resistor to ground.

Attenuator

After the impedance relay the signal is fed to the X1/X10 attenuator. The attenuation is actually not one or ten, but 2.37 or 23.7.

X1 attenuation is accomplished by dividing the signal between RD, and RA in parallel with RB.

X10 attenuation is accomplished by dividing the signal between RA, and RC in parallel with RD.

If you look at the diagram you will see that things are not so simple as in this figure. RA is R267. RB consists of R257 + R266 + R254. RC consists of R256 + R253. RD is R251 + R252. A lot of capacitors are also added to improve the frequency response. See 'Adjustments'.

AC/DC switch

If AC operation is selected the signal is fed through capacitor C245. If DC operation is selected, the capacitor is bypassed by relay RE207.

Impedance converter

After the attenuator the signal is fed to an FET transistor impedance converter, FET1 (TS201:3), then to a comparator (IC202:7). The voltage drop between the gate and drain of FET2 (TS201:7) plus the voltage over R268 is sensed by an OP-amp, IC204. The output of this OP-amp controls a current generator, I2 (TS214), which adjusts I_{dss} so that the voltage drop will be zero volts and the FET will be at the proper working point. Another current generator, I1 (TS213), sets I_{dss} for FET1 (TS201:3) to the same value as for FET2.

Trigger level setting

FET2 is used to select the trigger level in the following way:

A DC voltage from either the trigger level potentiometer or the DAC is applied to the gate of FET2. The FET now tries to increase the current flowing through itself but, this is impossible since FET2 is fed by a constant current from the constant current generator I2.

Instead the drain voltage increases proportionally with the potentiometer/DAC voltage. The FET2 output (drain) voltage is now fed to the inverting input of the comparator where it acts as the comparator threshold level.

IC202 also works as a Schmitt trigger, whose hysteresis can be controlled by the DC level on pin 4. A trimmer potentiometer, R208, is used for adjusting the hysteresis. The trimmer is common for both channels. See 'Adjustments'.

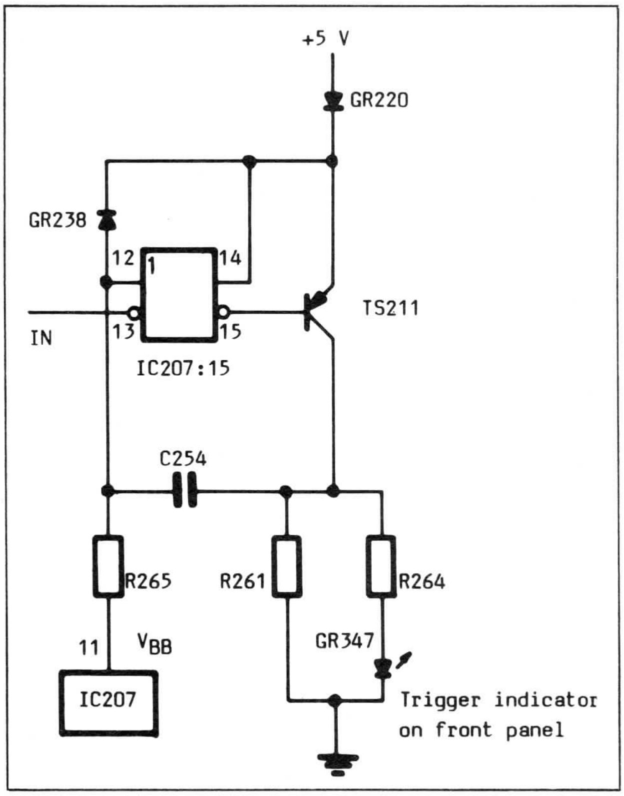
The outputs of IC202 give negative ECL levels. These levels are converted by two transistors, TS209 & TS210, to positive ECL as used in the rest of the counter.

When the input signal has been converted into a clean square wave signal with fixed ECL levels in the input amplifier, it goes to the input selector on the Microprocessor Board.

Trigger indicators

General

The outputs of the input amplifiers are connected to the two trigger indicators on the front panel via trigger indicator circuits.



Trigger indication

The line receiver IC207 is used as a comparator. Pin 11 on IC207 sets the reference voltage V_{BB} = 3.7 V. When the voltage at IC207:13 is lower than the voltage at IC207:12, transistor TS211 is turned ON, i.e. the trigger indicator is turned ON, indicating that the trigger level is set too low. If the trigger level is set to high the indicator is switched OFF.

When the input amplifier triggers correctly, transistor TS211 is turned ON and OFF, i.e. the LED blinks. For high input frequencies the blinking frequency is set to a fixed frequency 3 Hz by resistor R265 and capacitor C254. For input frequencies lower than 3 Hz, the blinking frequency will equal the input frequency.

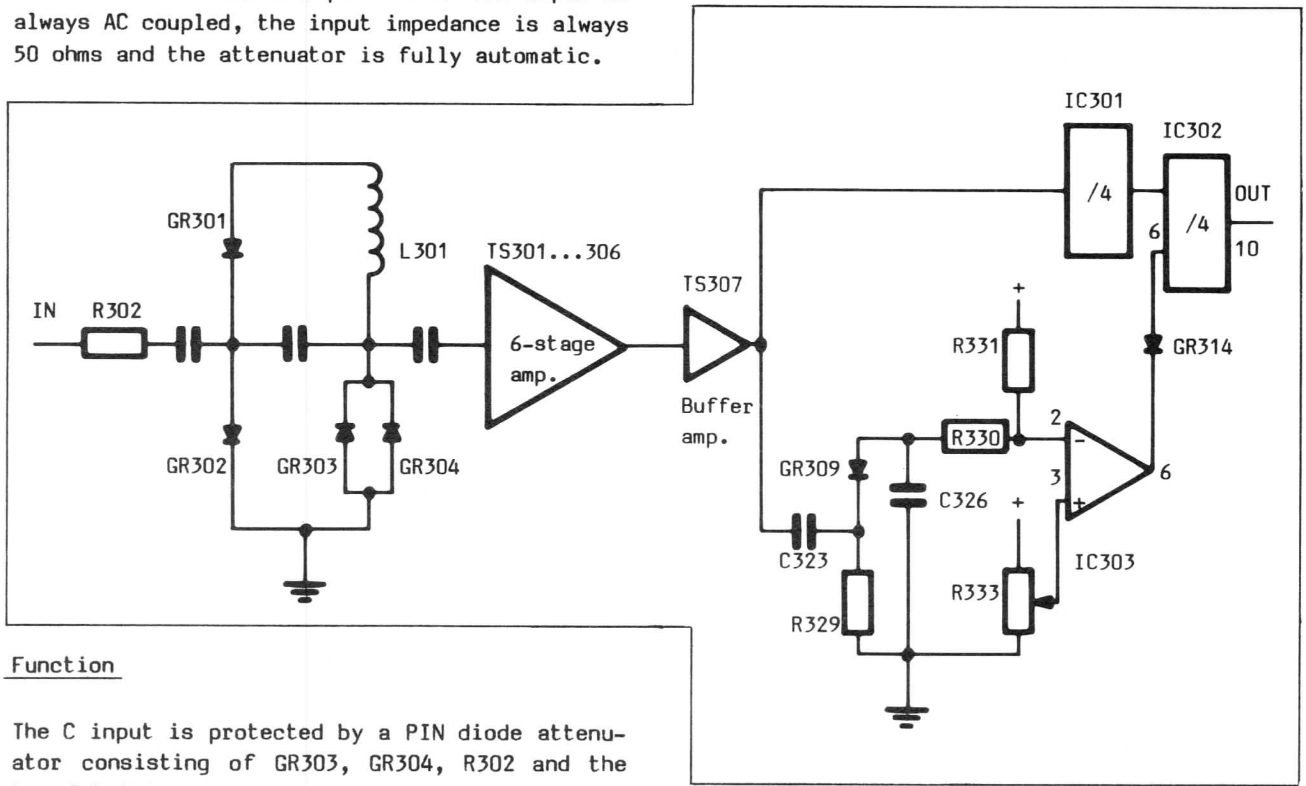
NOTE: A proper trigger indication does not necessarily mean that you will get a readout on the display, the GATE indicator must also flash.

Channel C (PM 9610 prescaler)

General

Channel C is available in an early version and a new version which functionally are exactly equal. The component numbers mentioned here are valid for the early version.

Channel C is a 1.5 GHz prescaler. The input is always AC coupled, the input impedance is always 50 ohms and the attenuator is fully automatic.



Function

The C input is protected by a PIN diode attenuator consisting of GR303, GR304, R302 and the two Schottky diodes GR301 and GR302. When the amplitude of the input signal increases above the forward voltage drop of the Schottky diodes, the current through the Schottky diodes increases. This results in an increased current through the PIN diodes which results in a decrease of their impedance. The voltage ratio between the R302 and the PIN diodes changes so that the amplitude into the 6-stage amplifier is constant.

Transistors TS301...306 form a 6-stage DC amplifier with frequency compensation. The high frequency response can be adjusted with capacitors C308 and C318. The DC gain is less than one but the AC gain is 30...35 dB. IC301 and IC302 each divide the frequency of the input signal by four, i.e. the frequency is divided by 16 in total. The ECL level output signal is sent to the input selector on the Microprocessor board. This signal input is called CHANNEL C on the Microprocessor board U1.

Low level cancelling

The amplitude of the input signal is sensed via the network C323, R329, GR309, C326 and R330. With no input signal, IC303:2 is at a potential set by the voltage divider R331/R330+GR309+R329.

When a signal is applied, an increased current flows through GR309 and C323 into the buffer amplifier. The voltage on IC303:2 then decreases as the amplitude of the signal increases. When the detector voltage is lower than the reference voltage, set by potentiometer R333, the output of IC303 is high i.e. the signal to be counted is able to pass through IC302.

When the amplitude of the input signal is too low, the output of IC303 is low, which results in a current through diode GR314 shutting OFF IC302, i.e. the signal is stopped. This prevents erroneous counting. For testing purposes, it is possible to open IC302 even for small amplitudes. This is accomplished by connecting +5 V to BU307:2 (TEST).

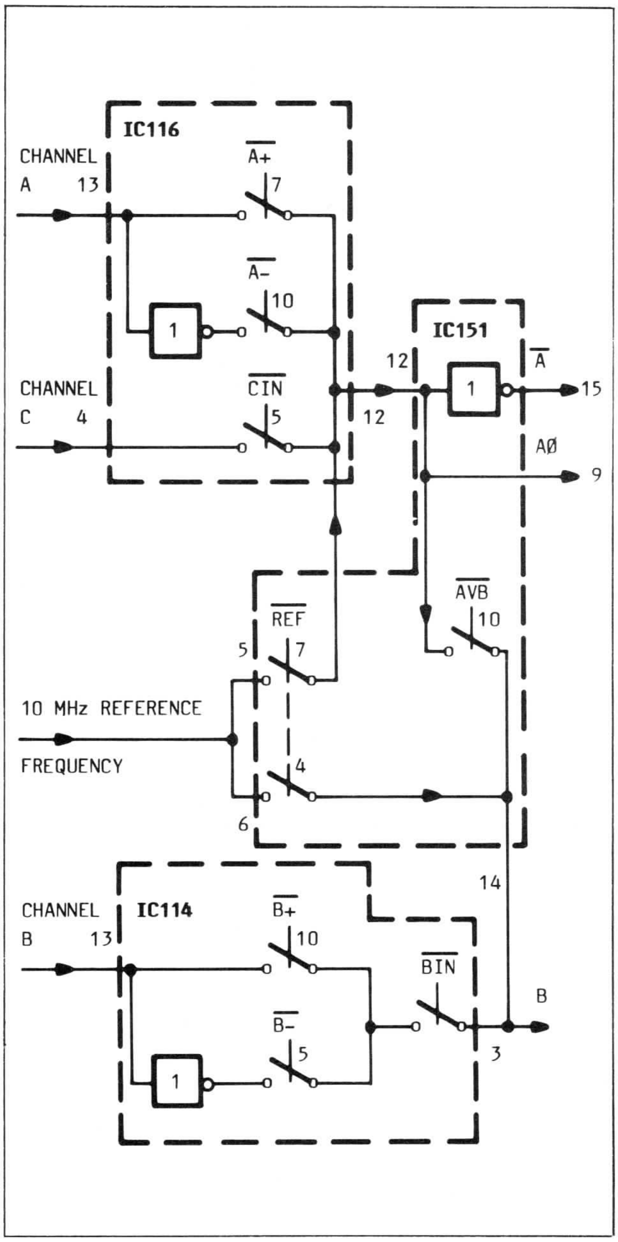
The TEST POINT connector is used when adjusting the frequency response. See 'Adjustments'.

Input selector

General

The purpose of the input selector is to direct the right input signal to the COAC and the CEX. The different possible selections are:

* A or B separately, with slope selection.
* C separately, without slope selection.
* A and B at the same time (with slope selection).
* Reference frequency to A and B.



NOTE: The digits refer to the pin number of the integrated circuits.

The selections are made by the Microprocessor, IC101, via a latch, IC110.

The input selector consists of ECL NOR gates, IC116 + IC117 + IC151. This drawing shows them as switches to simplify understanding. See the diagram in chapter 10 for detailed information.

Selecting a signal

Channel A and B signals are first fed to inverters, which output one non-inverted and one inverted signal each. Control signals A+ and A-, or B+ and B-, can then select if the counter shall trig on the positive or the negative edge.

If a prescaler is installed, then Channel C can be selected by control signal CIN.

Signal AØ can be switched to the B signal output by control signal AVB. This selection is used for voltage measurements.

The internal 10 MHz oscillator frequency is connected to both A and B channels by control signal REF. This control signal is present when the CHECK key on the front panel is actuated.

Channel B is connected to the B output by control signal BIN.

Signals AØ and B are now fed to the COAC and the A and B signals are fed to the CEX.

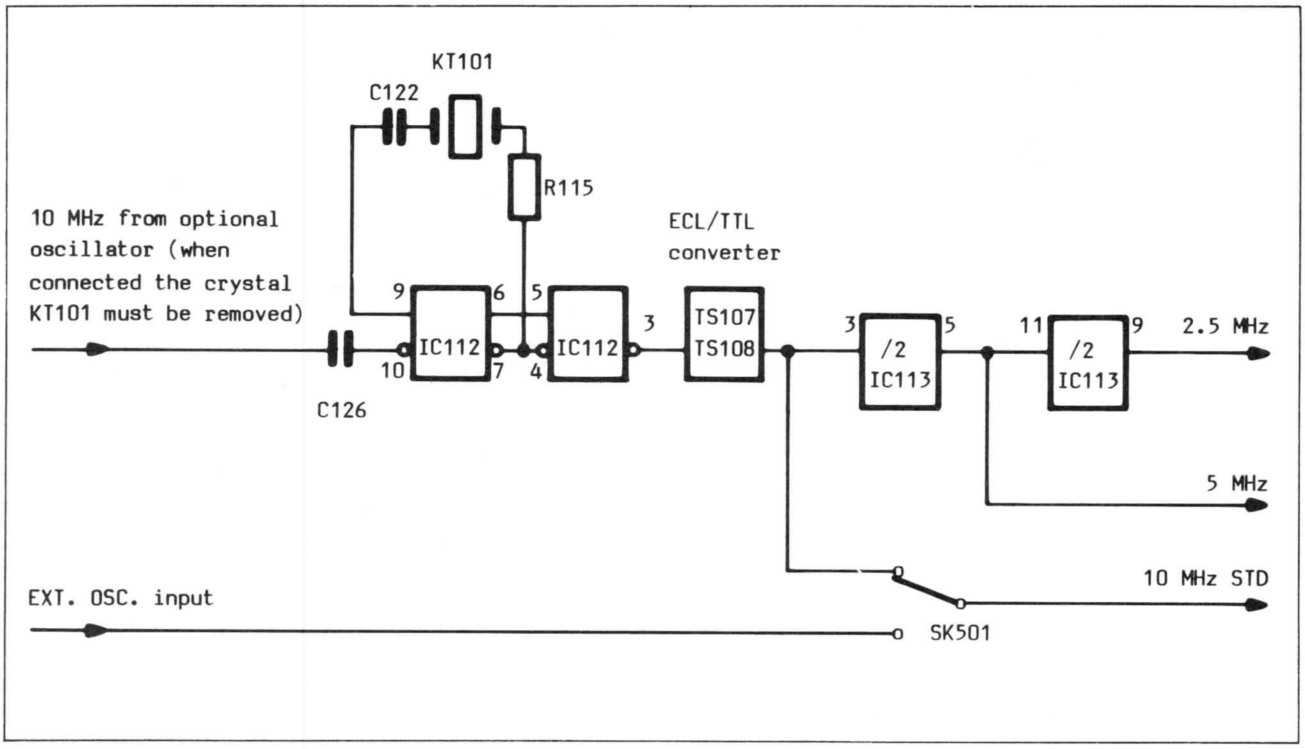
Standard oscillator

General

The oscillator generates the stable frequencies required as reference frequency for the counter registers and as clock frequency for the two microprocessors.

Optional oscillators

A TCXO or an oven enclosed oscillator can be connected to the inverting input of IC112:6, via C126, if the crystal KT101 is removed. The function of IC112:6 is then changed from oscillator to buffer amplifier.



Functional description

Crystal KT101 is connected in the feedback loop of IC112:6. The circuit oscillates with a frequency of 10 MHz. The frequency can be adjusted with capacitor C122. Resistor R115 increases the output impedance of IC112:6 and makes the oscillator more stable. The 10 MHz output frequency is then buffered by IC112:3 and converted to TTL levels by TS107, TS108. The signal is now divided by IC113:5 to the Microprocessor clock frequency 5 MHz and by IC113:9 to 2.5 MHz for the data options (IEEE-488 bus interface etc.).

External oscillators

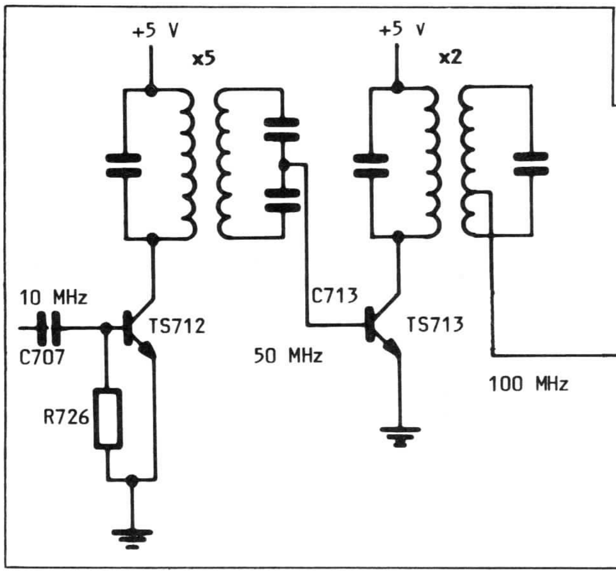
An external reference oscillator can be connected to the counter via an input on the rear panel. External or internal frequency reference is selected with SK501.

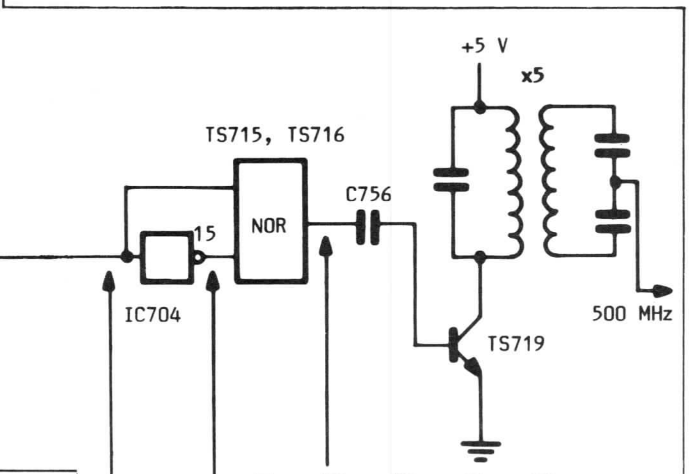
The microprocessors and the data options always run from the 2.5 and 5 MHz derived from the built-in 10 MHz crystal oscillator.

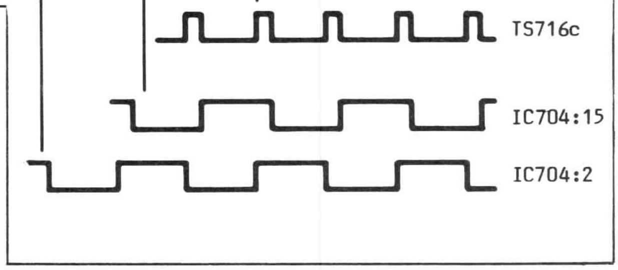
Frequency multiplier

General

The multiplier is used to generate the frequencies, 100 MHz and 500 MHz, used by the CEX in the PM 6654 to enable higher resolution. Actually the 'multiplier' consists of three different multipliers: x5 and x2 to generate 100 MHz, then x5 again to generate 500 MHz.







100 MHz generation

Each stage of the multiplier is a resonant circuit tuned to the frequency it should generate. In order to produce short pulses, the 10 MHz reference frequency is fed through capacitor C707 and resistor R726. The pulses are fed to the first resonant circuit which starts oscillating at 50 MHz. Every five cycles a new pulse arrives, which synchronizes the oscillation to five times the input frequency i.e. 50 MHz.

The 50 MHz output frequency is fed through capacitor C713, removing the DC-component from the signal. This makes TS713 works as a Class C amplifier, which only amplifies the positive half-cycles of the signal. The second resonant circuit oscillates at twice its input frequency i.e. 100 MHz. The output signal is buffered with ECL gates IC704:7 and IC704:3. It is then used as the 100 MHz reference.

NOTE: The inductors in the resonant circuits are not discrete components, but a part of the PC-board pattern.

500 MHz generation

The third multiplier is somewhat more complicated. Due to the high frequencies it is not sufficient to use a capacitor and a resistor to form pulses short enough to synchronize the multiplier.

Instead the signal is divided into two signals, one passing through an ECL inverter, IC704:15, and the other one bypassing it.
These signals are then fed to a NOR gate made of TS715, TS716. The output signal from the NOR gate consists of short spikes due to the 1.5 ns delay in the ECL inverter. The spikes are fed via TS719, which works as a class C amplifier, to the third resonance circuit.

Accuracy

The resonant circuits are accurately tuned so that no pulse will be missing. Therefore these generated frequencies have the same percentage of accuracy as the 10 MHz reference frequency. This enables the counter to display the results with higher resolution (more digits) without loss in accuracy.

Where are the 100 and 500 MHz used?

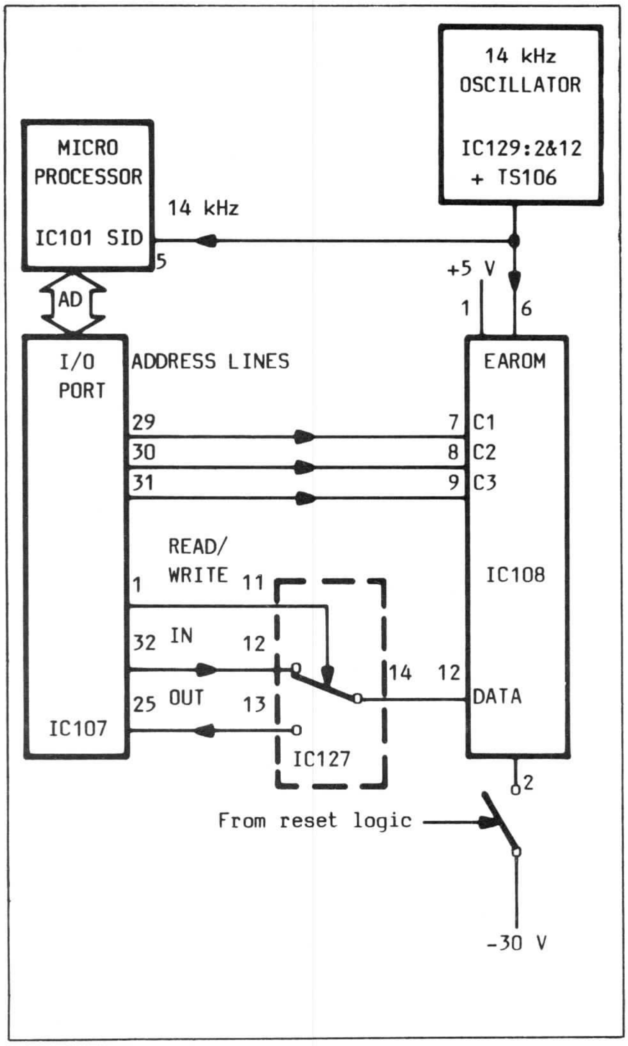
The 500 MHz is used as reference frequency for Frequency A, C and Single Time measurements. The 100 MHz is used for Average Time measurements.

Both multiplier outputs are connected to the input of the first decade counter, IC703:14. The Microprocessor switches in the 100 MHz or the 500 MHz reference frequency via TS723 or IC704:12 respectively. To avoid interference, IC741 pulls the output of the 500 MHz multiplier to ground when the 500 MHz is not used.

EAROM

General

The EAROM, IC108, is an Electrically Alterable Read Only Memory which is used to store the eight different panel programs, P1...P8. The memory contains 100 words of 14 bits each. The data stored in the memory will be retained without any power supplied to the circuit.



NOTE: The frequency of the 14 kHz oscillator is not critical. Frequencies between 10 and 17 kHz are acceptable.

Communication

The Microprocessor communicates with the memory via I/O-port IC107. The single DATA pin on the EAROM is used as both input and output for data as well as input for addresses. Data is clocked in and out with a 14 kHz clock signal generated by a free-running oscillator, IC129:2 and IC129:12. The frequency is used by the Microprocessor to synchronize the reading, writing and addressing speed. Inputs C1...C3 are used to select which mode the EAROM should work in: Stand-by, addressing, reading, erasing or writing. The signal levels for all signals to the EAROM are converted by transistors TS103...TS105 to: Logical Ø = +5 V, logical 1 = -5 V. The output levels from the EAROM, logical Ø = +4 V and logical 1 = -7 V, are converted to TTL levels by FET transistor TS101.

Programming voltage

A special programming voltage of -30 V is also required. The programming voltage is switched OFF by the Power Supply during power up, to avoid accidental reprogramming or erasing of the EAROM.

Digital to analog converters (DACs)

General

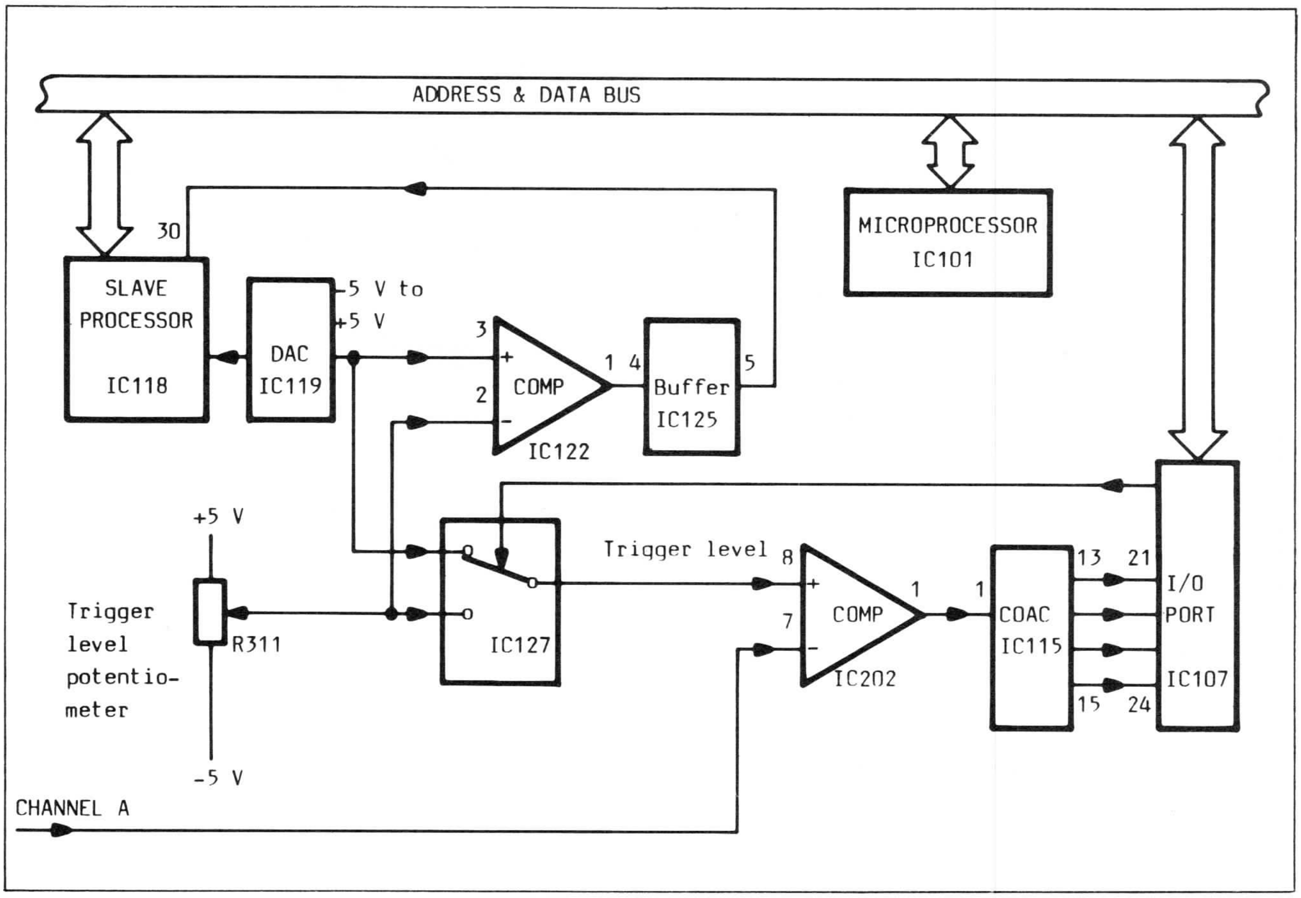
Since the counter is fully programmable it must be possible for the internal microcomputer to select trigger levels for the input amplifiers.

This is achieved with the help of two digital to analog converters, one for the A and one for the B channel.

Voltage measurement

The procedure to measure the voltage of the input signals is similar to the trigger level setting. The Microprocessor requests a voltage measurement from the Slave Processor.

The switch IC127 is set for DAC output voltage to the comparator IC202. There it is compared with the voltage on CHANNEL A input.



Trigger level setting

The DAC and the trigger level potentiometer outputs voltages to the switch IC127. The Microprocessor sets the switch either for manual trigger level setting via the potentiometer, or for automatic (or preset) trigger level from the DAC.

The switch output is connected to the comparator IC202 in the input amplifier, where it is used as a threshold voltage (see input amplifier description).

The Slave Processor changes the DAC output voltage frequently in accordance with an iterative formula, at the same time checking the output signal from the comparator for a change of status. When the output of the DAC equals the input voltage, the comparator changes status.

This status change is clocked into the COAC and read by the Microprocessor IC101 which instructs the Slave Processor to display the present DAC voltage.

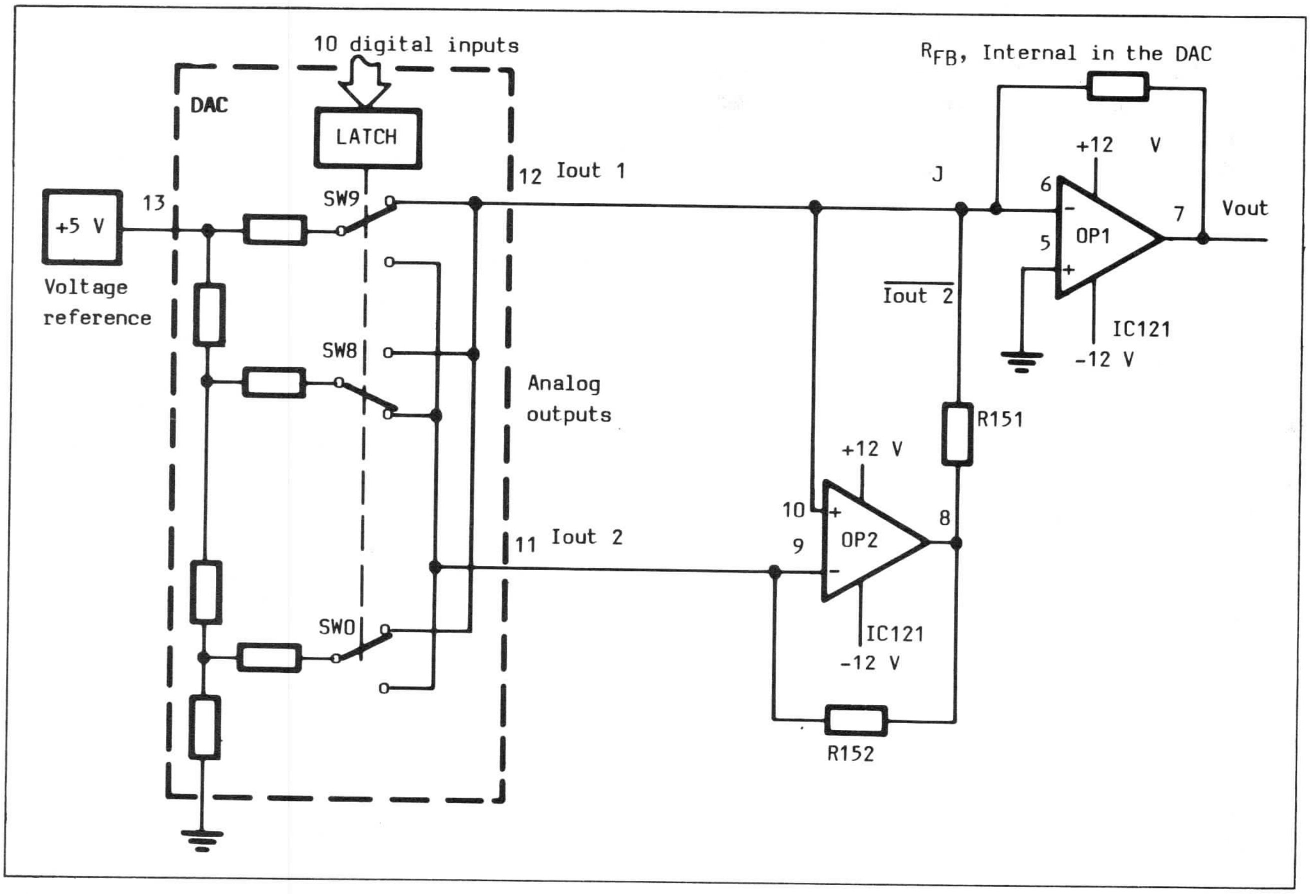
Reading the settings of the trigger level potentiometers

To be able to display the trigger level settings the Microprocessor must be able to read the output voltages from the trigger level potentiometers. Comparator IC122 compares the voltage from potentiometer R311 and the output voltage of DAC IC119. The Slave Processor changes the DAC output voltage until the comparator changes status. This signal is fed via buffer IC125 to the Slave Processor. The Slave Processor knows the DAC output voltage and can show it on the display.

Example: A logical Ø in bit 4 means that switch 4 is connected to the Iout 2.

Current to voltage conversion

If the outputs of the DAC are connected to ground potential, they produce output currents that are proportional to the digital word written into the DAC latch. The current output at Iout 1 is larger than the one at Iout 2 for positive voltages and vice versa. These currents must be converted to output voltages between -5 V and +5 V.



Digital code to current conversion

The digital to analog conversion is performed the following way:

A constant voltage is fed to a R-2R ladder voltage-divider. The steps of the ladder are connected to ten analog switches. The outputs of the switches are connected to two output lines, the ON positions to Iout 1 and the OFF positions to Iout 2. The settings of the switches are controlled by the 10-bit data word written into the DAC by the Microcomputer.

This is done by two operational amplifiers. The current Iout 1 is fed to the inverting input of OP1 (junction J). OP1 then gives a negative output voltage. This voltage produces a current through R_{FB} back to the junction J forcing it to 0 V (virtual ground).

To get a bipolar output voltage from OP1 we need a bipolar input current. Since Iout 1 and Iout 2 both output current, we need to invert one of them. This inversion is performed by OP2. If the digital code for zero volts is fed to the DAC, the current $\overline{\text{Iout 2}}$ equals the current Iout 1.

For digital codes below the code for zero volts, OP2 starts extracting more current from the junction J than Iout 1 delivers. This forces the output of OP1 high, again producing a current through R_{FB} but, in the opposite direction. So junction J is still held at virtual ground potential, but OP1 gives a positive output voltage.

DAC adjustment points

- Voltage reference

The voltage reference for the DACs is an integrated circuit, IC138, which delivers 2.5 V. This voltage is then amplified to 5.0 V by one operational amplifier, IC123:14 (or 8), for each DAC. The gain of each OP-amp is adjustable with the 'full scale adjustment' potentiometers R146 (or R149).

- Zero balance

Potentiometer R153 (or R156) is connected to the output of OP2 in the current to voltage converter to allow adjustment of the zero level of the DAC to ground potential.

NOTE: Refer to chapter 'Adjustments' for trimming instructions.

Setting the measuring time

General

The measuring time can be controlled by a potentiometer on the front panel. The range is 0.1 ms to 96 s and the selected time can be shown on the display.

Operation

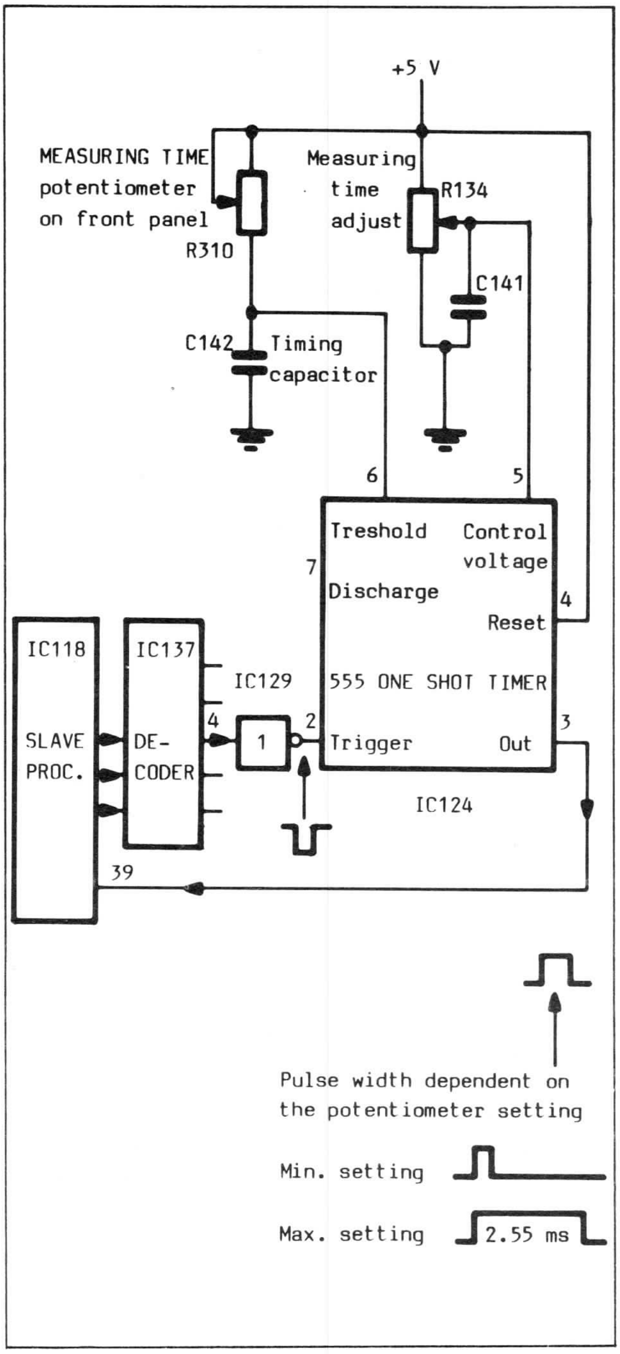
The Microprocessor, IC101, requests a measuring time check from the Slave Processor, IC118. The Slave Processor outputs a pulse on the measuring time output port, IC137:4. The pulse triggers the one shot timer IC124. This timer creates an output pulse whose pulse width depends on the setting of the measuring time control on the front panel. The Slave Processor receives the output pulse and measures the duration of the pulse. An interrupt is sent to the Microprocessor IC101 pin 9, RST5.5. The Microprocessor then stores the new measuring time in the RAM.

If the READ key is actuated, the Microprocessor sends the time reading to the display.

One-shot timer description

IC124 is a type NE555 timer circuit connected as a one-shot, i.e. when a negative trigger pulse is detected on the trigger input pin 2, the output is switched ON and the discharge output pin 7 is released. The current through the measuring time potentiometer, R310, starts charging the timing capacitor C142. The voltage across the capacitor is monitored all the time by the threshold input pin 6. When this voltage exceeds the control voltage on pin 5, the output of the timer, pin 3, is switched OFF and the timing capacitor is discharged.

R134 is used to set the maximum pulse duration to 2.55 ms, see the 'Adjustments' chapter.

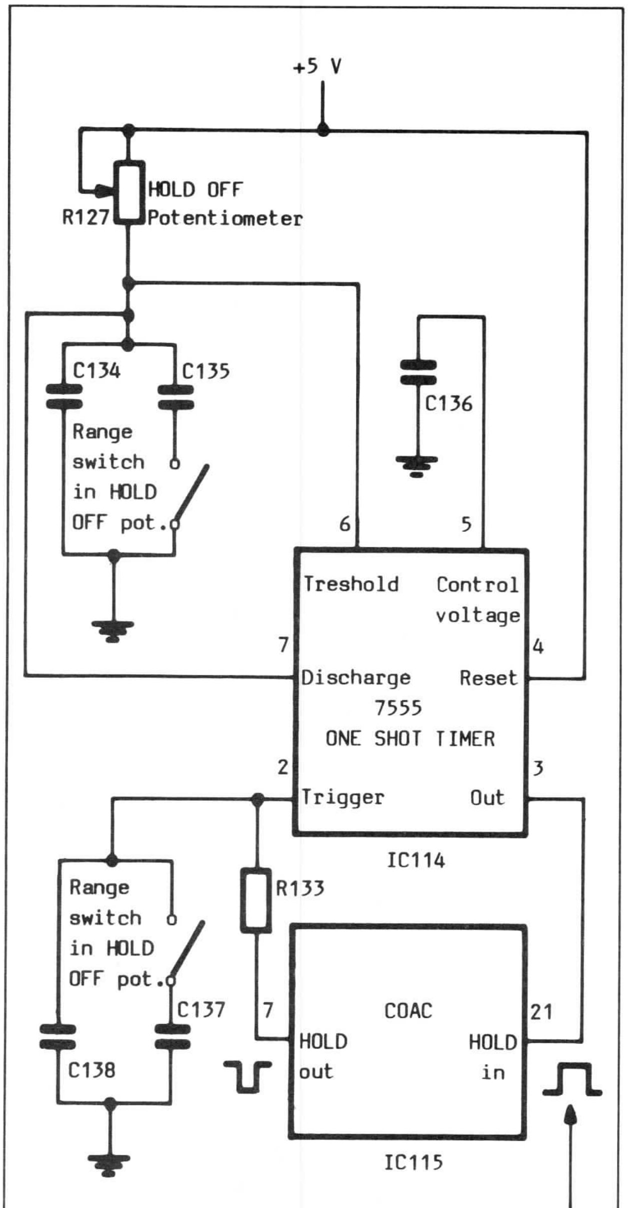


HOLD OFF circuitry

General

During the HOLD OFF time the counter ignores the input signal to avoid retriggering.

The HOLD OFF time is controlled by a potentiometer on the front panel. There are two ranges: 5 µs to 1 ms and 1 ms to 200 ms. The selected time can be shown on the display.



The pulse width is dependent on the HOLD OFF potentiometer setting

Operation

If the HOLD OFF ON function is activated, the COAC, IC115, outputs a pulse on the HOLD output. The pulse triggers the one-shot, IC114, creating an output pulse which pulsewidth depends on the setting of the HOLD OFF Control on the front panel. The COAC receives the output pulse on the HOLD input, IC115:21, which prevents retriggering as long as the pulse is high.

If the READ key is activated, a dummy measurement is made, where the HOLD OFF input is used as input signal. The result is then shown on the display as the HOLD OFF time.

Component level description

The one-shot timer is built around IC114, a CMOS 555 timer type ICL7555. It is connected as a monostable multivibrator, i.e. when a negative trigger pulse is detected on the trigger input pin 2, the output is switched ON and the discharge output pin 7 is released. The current through the HOLD OFF potentiometer, R127, starts charging the timing capacitor. The timing capacitor is C134 if the lower range is selected, and C134 + C135 if the higher range is selected. The voltage across the capacitor(s) is monitored all the time by the threshold input pin 6. When this voltage exceeds the control voltage on pin 5, the output of the timer, pin 3, is switched OFF and the timing capacitor is discharged. The control voltage is internally set to 3.3 V.

The trigger pulse is delayed differently for the high and low range. Capacitor C137 is switched in for the higher range, delaying the pulse further.

No adjustments are necessary for this circuitry.

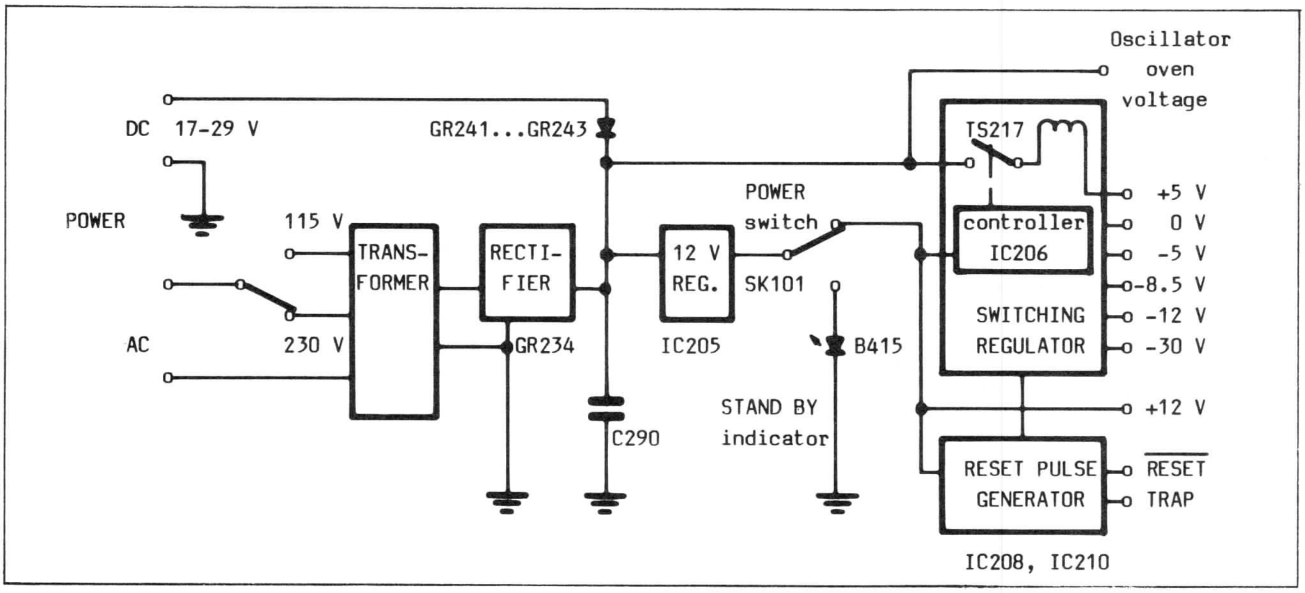
Power supply

General

The power supply delivers the necessary supply voltages to the counter, reset pulses for the Microprocessors and standby supply voltage for the oven in an optional oscillator. It is a secondary-switched power supply which works on both AC and DC.

Voltage regulation

The voltage across C290 is fed to the switching transistor TS217, the oscillator oven and to the 12 V regulator, IC205. When the counter is in standby IC205 feeds the STAND BY indicator B415:6 via the POWER switch SK101. When the counter is switched ON IC205 feeds the controller IC206.



AC operation

The AC power is connected to a line voltage selector with two positions, 115 and 230 V. The AC voltage is then fed directly to the mains transformer which consequently is always on-line.

WARNING: There is always mains voltage on the line inlet socket, the line voltage selector and the primary winding of the transformer even if the power switch is set to standby.

The 21 V transformer output voltage is rectified by GR234 and smoothed by C290 to about 23 V DC.

DC operation

Voltage from an external DC source is fed to the smoothing capacitor C290 via diodes GR241, GR242 and G R243. These diodes protect the counter against reversed DC polarity.

When the switch (SK101) is closed the controller IC206 of the switching regulator receives power and starts working. IC206:14 outputs pulses to the switching transistor which feeds the coil T201:1. The +5 V output on the other end of the coil rises. This voltage is filtered and fed back to IC206:3, which senses the voltage and adjusts the pulse width until the output voltage is +5 V. The +5 V can be adjusted with the trim-potentiometer R293, see 'Adjustments'.

Generating negative voltages

The coil has three additional windings. The voltages induced in these windings are rectified and filtered to -8.5 V, -12 V and -30 V. The -8.5 V output voltage is also regulated to -5 V by IC209 and TS220.

Protection circuitry

To protect the counter against excessively high supply voltage e.g. when the counter is set to 115 V but connected to 220 V, two zener diodes, GR240, are connected back to back across the 21 V AC inlet of the power supply board. GR240 starts conducting if the voltage exceeds 34 V, blowing the primary fuse. GR240 must be replaced after such an 'accident'.

A current limiter is incorporated. It consists of transistor TS219, which senses the voltage drop over R280. When the voltage drop exceeds approx. 0.9 V, the transistor starts conducting and pulls the current limit input of the controller high, thus limiting the current.

If the flyback diode GR228 fails, the negative voltages will rise to several hundred volts. To avoid this the -12 V is fed to the 18 V zener diode, GR236. When the voltage across GR236 exceeds the zener voltage, pin 10 of IC206 is pulled low shutting OFF the switching regulator until the voltage has dropped again. If the flyback diode fails, the -12 V output will oscillate around -18 V.

Power ON

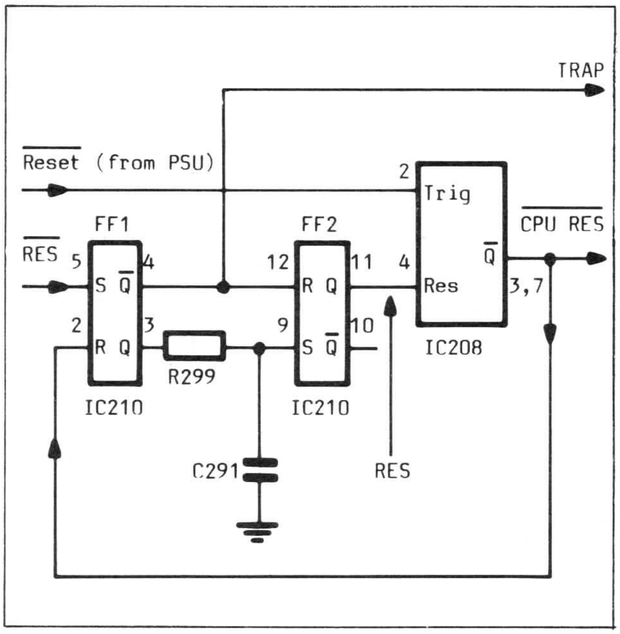
General

When the counter is switched ON, the two microprocessors in the counter each need a reset pulse to be able to start working correctly. This pulse which is called $\overline{\text{CPU RES}}$, is generated by the power supply.

Power ON reset

A type 555 timer circuit, IC208, is used to generate the $\overline{\text{CPU RES}}$ signal. As the POWER switch is pressed, the +12 V will be fed to the timer and to the SMPS controller IC206:1 whose gain output, IC206:4, will rise to approx. +8 V.

This output will charge the timing capacitor C281, of the timer circuit, via R290 and GR231. When IC208:6 goes high, the outputs, IC208:3 and 7 ($\overline{\text{CPU RES}}$), goes low resetting the microprocessors.



To avoid undesired changes of the EAROM contents, the signal on IC208 pin 3 also cuts OFF the -30 V supply needed to write in the EAROM.

The GAIN output of the SMPS controller will fall (below +5 V) when the circuit starts working. This causes the timing capacitor C281 to discharge via R286 to IC208:7, which is low. After a time (T1) the voltage across the timing capacitor will reach the threshold value and the timer output will switch over to high. The $\overline{\text{CPU RES}}$ will be removed and the -30 V will be switched ON.

The counter will now run some self-tests, and then start normal operation

Safety inspection and tests

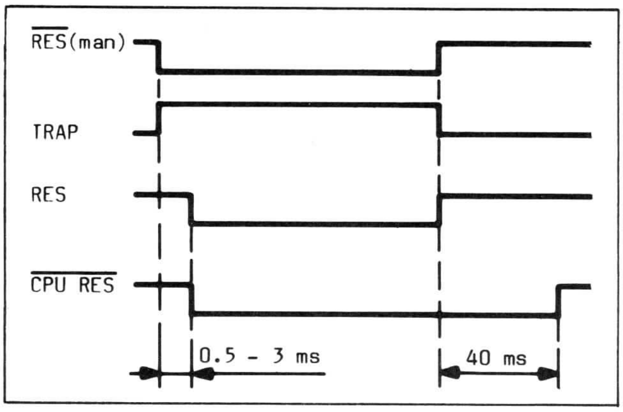
A safety inspection and tests must always be performed after repair in the primary circuits of the power supply. See chapter 5.

Manual or external reset

General

The counter can also be reset by pushing the RESET key on the front panel or by sending a reset signal to the external reset (EXT RESET) input on the rear panel.

When reset is activated in these ways, running the Power ON self-tests is not desired, because the time it takes to run them may be considered irritating.



When manual or external reset is activated ($\overline{RES}$ goes low) the Microprocessor receives the TRAP[2]) signal which forces it to store a specific pattern[1]) on the stack. The storing procedure takes just under 0.5 ms, so a delay must be generated between the key depression and the $\overline{CPU\ RES}$ generation.

The Microprocessor needs a $\overline{CPU\ RES}$ pulse of a certain length to start up properly. To avoid getting too short a pulse, a timer is started when $\overline{RES}$ is released. This generates a 40 ms min. $\overline{CPU\ RES}$ pulse.

1) When the reset sequence is completed, this pattern can be detected informing the Microprocessor that the reset was activated manually.
2) TRAP is the Microprocessor interrupt which has the highest priority.

The $\overline{CPU\ RES}$ makes the Microprocessor restart from the beginning of the program. But The Microprocessor immedeately finds the information stored on the stack by the TRAP routine, jumps over the self test routines to another address, where it starts operating. About three seconds of the start up time is saved by eliminating the self test.

The output of the timer, IC208, is also fed back to pin 2 of IC210, enabling FF1 to receive new manual or external resets.

Activating the reset

The signal $\overline{RES}$ from the RESET key or the EXT RESET input causes the first of the two Flip-Flops (FF1) to toggle, causing the TRAP signal to go high.

At the same time the Q output of FF1 goes low, discharging C291 via R299. After 0.5 to 3 ms the voltage across C291 reaches the trigger level of FF2.

$\overline{CPU\ RES}$ Generation

The 40 ms $\overline{CPU\ RES}$ pulse is generated by the timer IC208.

When the RESET key is released, the $\overline{RES}$ signal goes high, causing FF2 to toggle. The Q output of FF2, which is the RES signal, goes high, releasing the reset input of IC208.

The output of the timer, signal $\overline{CPU\ RES}$, goes low for 40 ms, resetting the Microprocessors and FF1. This in turn removes the TRAP signal. When the $\overline{Q}$ output of FF1 goes low, it resets FF2. This results in the RES pulse to the timer going high again.

5. FAULT-FINDING

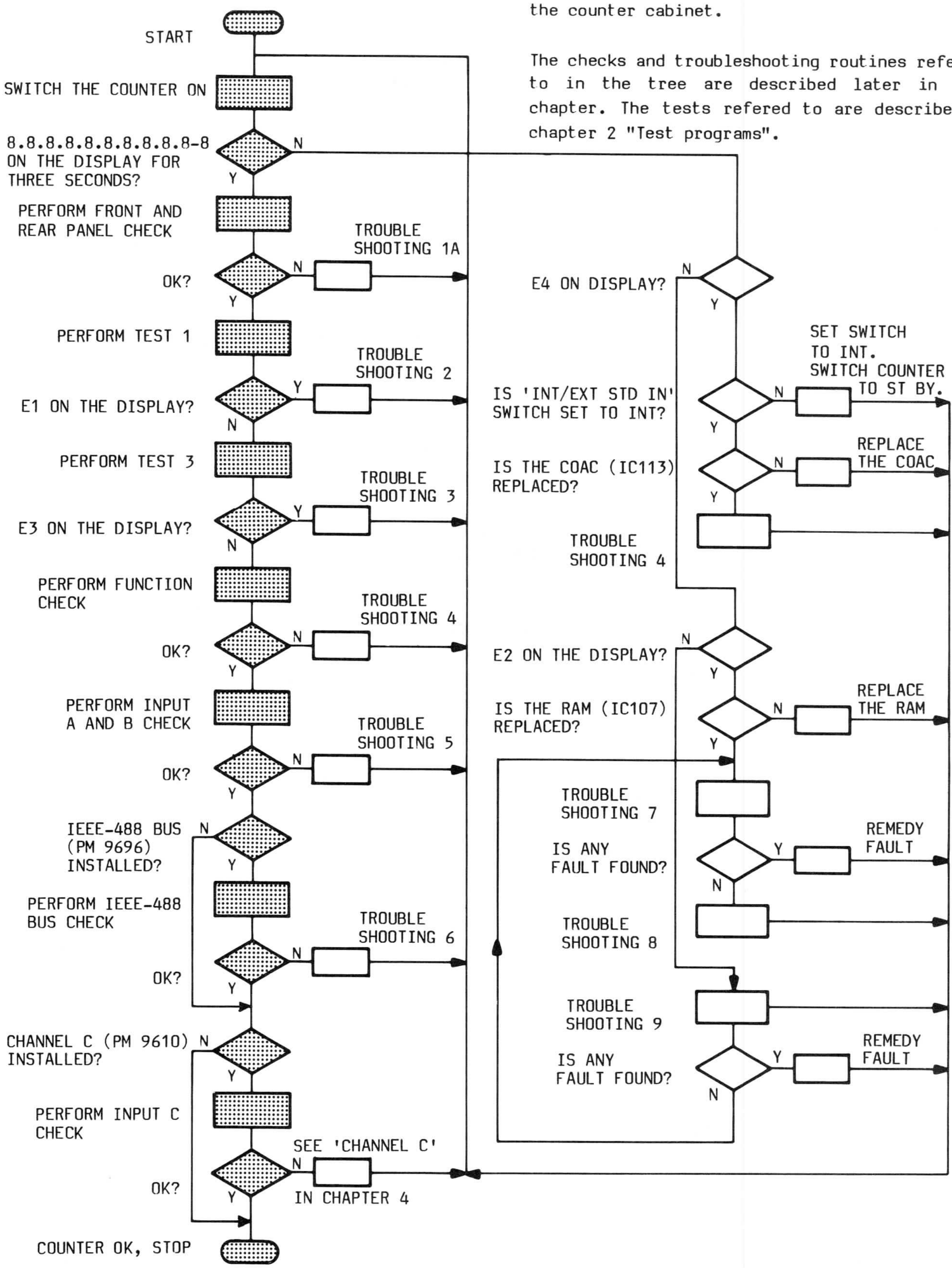
CONTENTS

NOTE: This description is based on faultfinding a counter with program revision 05 and Slave Processor version 03. Check the Rev. numbers on the lables of IC103-105 and IC118. If programs and/or Slave Processor of another revision are installed, replace them with the revisions mentioned above when testing otherwise all signatures will be wrong. See the spare parts list for order numbers.

FAULT-FINDING TREE

The fault-finding tree is intended as a guide for carrying out status checks on the counter. If the counter functions properly, no trouble-shooting will be necessary. The status checks (filled boxes) can be performed without opening the counter cabinet.

The checks and troubleshooting routines referred to in the tree are described later in this chapter. The tests refered to are described in chapter 2 "Test programs".



INITIAL SET UP

The cursor of the counter must be set to a non-program setting before starting the test.

FRONT AND REAR PANELS

Front panel check

RESET

Depress key:	Correct reaction
RESET	The display is switched OFF while this key is pressed, and it fills with zeros when the key is released.

MATH

Depress key:	Correct reaction
DISP=K·X+L	The keytop LED can be switched ON and OFF by repeted depression of this key.
K=	The LED in the ENTER key lights and the display shows 1.
Enter on keyboard 123456789+/-EE9+/-	-123456789 EXP-9 is shown on the display and the LED in the ENTER key blinks.
ENTER	The value on the display disappears.
K=	The display indicates -123.456789 EXP-3.
K= + L=	The ENTER-key LED lights and the display shows 0.

Depress key:	Correct reaction
Enter 1234.5 on keyboard	ENTER is blinking.
ENTER L=	The display shows 1.2345 EXP3.
L=	The test is completed.

HOLD OFF

Depress key:	Correct reaction
ON	The keytop LED lights.
READ	Both LEDs light.

- Turn the HOLD OFF potentiometer knob and check the display reading against the table.

HOLD OFF knob	Potentiometer fully counter-clockwise	Potentiometer fully clockwise
Pulled out	999 EXP-6	200 EXP-3
Pushed in	5 EXP-6	1.00 EXP-3

- Push the potentiometer knob in.

Depress key:	Correct reaction
ON + READ	Switches the HOLD OFF and READ functions OFF.

MEASURING TIME

Depress key:	Correct reaction
DISPL HOLD	The keytop LED can be switched ON and OFF by repeated depression of this key.
READ	The keytop LED lights.

- Turn the MEASURING TIME potentiometer fully counter-clockwise.
- Check that the display shows 0.1 ms.
- Turn the potentiometer fully clockwise.
- The display should indicate 96 s.

Depress key:	Correct reaction
READ	Switches OFF the READ function.
MINIMUM/ SINGLE	The keytop LED can be switched ON and OFF by repeated depression of this key.

FUNCTION

Depress key:	Correct reaction
FUNCTION (up/down)	The cursor can be moved through all measuring functions and programs both stepwise and in repetitive "scrolling" mode. The cursor jumps over the FREQ C and RATIO C/B functions if the Channel C option is not installed. It hesitates briefly at FREQ A and TEST. Check both FUNCTION keys (up/down).

STORE

Depress key:	Correct reaction
STORE	The keytop LED lights.
RESET	The STORE keytop LED is switched OFF.

NOTE: Press STORE only once to avoid corrupting any stored panel program.

START/STOP TOTALIZE A

Depress key:	Correct reaction
FUNCTION (up/down)	FREQ A, FREQ C, PERIOD A, RATIO A/B, RATIO C/B, TIME A-B, P WIDTH A, PHASE A-B°, RISE/FALL A, DUTY FACT A, TOT A/⎍B, TOT A/⎍⎍B, ▶ TOT A/MAN, Vmax Vmin, Vpp A, TEST
START/STOP TOTALIZE A	The GATE-indicator can be switched ON and OFF by repeted depression of this key.

INPUT AMPLIFIERS A AND B

Depress key:	Correct reaction
SLOPE; **DC / AC**; **ATT X1 / X10**; **1MΩ / 50Ω**	Press each key twice, the LED must switch ON and OFF properly. Check the keys for both inputs.
COM, **CHECK**	Press each key twice, the LED must switch ON and OFF properly.

TRIGGER LEVEL

Depress key:	Correct reaction
AUTO	The keytop LED switches ON and OFF by repeated depression of this key.
KEYBOARD	The LED lights, leave it ON.
AUTO + AUTO	Both AUTO and KEYBOARD should be switched OFF.
READ	Keytop LED lights.
ATT X1 X10	Keytop LED OFF, both channels.

- Turn both TRIGGER LEVEL potentiometers fully counter-clockwise.
- Check the trigger level settings. The display should indicate -5.00 V for both channels.
- Repeat for the fully clockwise position. The values should be +5.00 V.

SET A and SET B

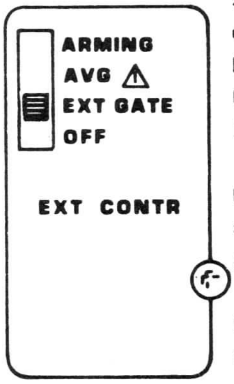
Depress key:	Correct reaction
SET A	The ENTER LED lights.
Enter 123 on the numeric keyboard	The display shows 1.23. The ENTER LED should be blinking.
ENTER	The keytop LED is switched OFF.

- Repeat the same procedure for channel B.

ATT X1 X10	Check that the keytop LEDs for both channels are switched OFF.
KEYBOARD READ	The display should now indicate 1.23 for both channels.

Rear panel check

EXT CONTR switch



Set the external control switch on the rear panel to position EXT GATE and check that the EXT GATE indicator on the display is switched ON.

Check in the same way the switch positions AVG and ARMING.

Set the switch back to position OFF.

INT/EXT STD IN switch

Set the switch to position EXT STD IN.

Switch the counter to STBY and ON again.

When no signal is connected to the EXT STD IN input on the rear panel, the counter should indicate error code E4.

Return to the fault-finding tree if no fault is found.

Troubleshooting routine No. 1A

Front and rear panels

General

The front panel consists of a front panel control board U3 and a display board U4. The rear panel consists of rear panel board U5.

Fault tracing on the front- and rear panel can be carried out by means of signature analysis, making use of a built-in stimulus program.

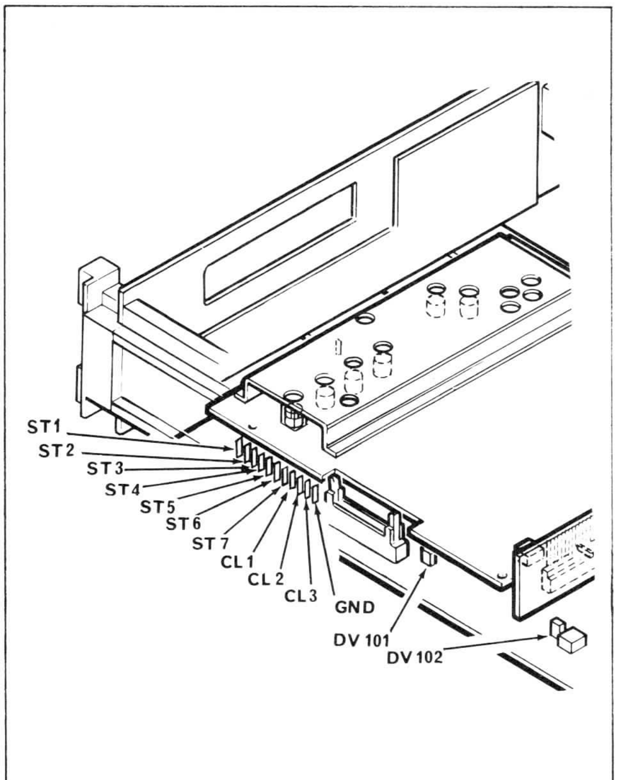
The following is required for fault tracing:

- Signature Analyzer, Philips PM2544 Logic Multimeter.

Preparations

- Set the two switches on the rear panel of the counter to INT and OFF respectively.
- Switch the counter to ST BY.

CAUTION: The power switch on the counter should always be switched to ST BY when no tests are in progress in order to protect the relays on U2.



START/STOP CLOCK Connectors on U1

- Remove the CEX board U7 in a PM 6654 to gain access to the START/STOP acd CLOCK connectors on the Microprocessor board.
- Check whether the GATE indicator on the Signature Analyzer display is blinking. If not, continue with the " **Troubleshooting routine No.1B** ". The connection and settings of the Signature Analyzer should not be changed.
- Connect the Signature Analyzer "pod" to the appropriate soldering lugs on U1 and select the trigger levels in accordance with the signature map on the next page.

NOTE: The trigger levels for the probe and the pod shall be TTL levels. This also applies for the CMOS ICs IC301 and IC304.

- Start the stimulus program"for testing U1"by positioning jumper DV101 at position NORMAL and jumper DV102 at position TEST and then switching ON the power switch.

Scan counter IC304

- Measure the signatures at IC304. Check the results against the signature map on the next page. The signatures at pins 10, 12 and 13 of IC304 are uncertain due to delays caused by the data probe. In certain cases, this problem can be remedied by pressing the START/STOP TOTALIZE A key during measurement. If all signatures are correct, continue with: "LED driver IC302".

Latch for scan counter and function code IC301

- Measure the signatures at IC301. The signatures at pins 2, 5 and 6 of IC301 are uncertain due to delays caused by the data probe. In certain cases, this problem can be avoided by pressing the START/STOP TOTALIZE A key during measurement. Check the measured signatures against the signature map.

If any incorrect signature is obtained, the Slave Processor and Strobe Generator shall be checked. See " **Troubleshooting routine No. 1B**

LED driver IC302

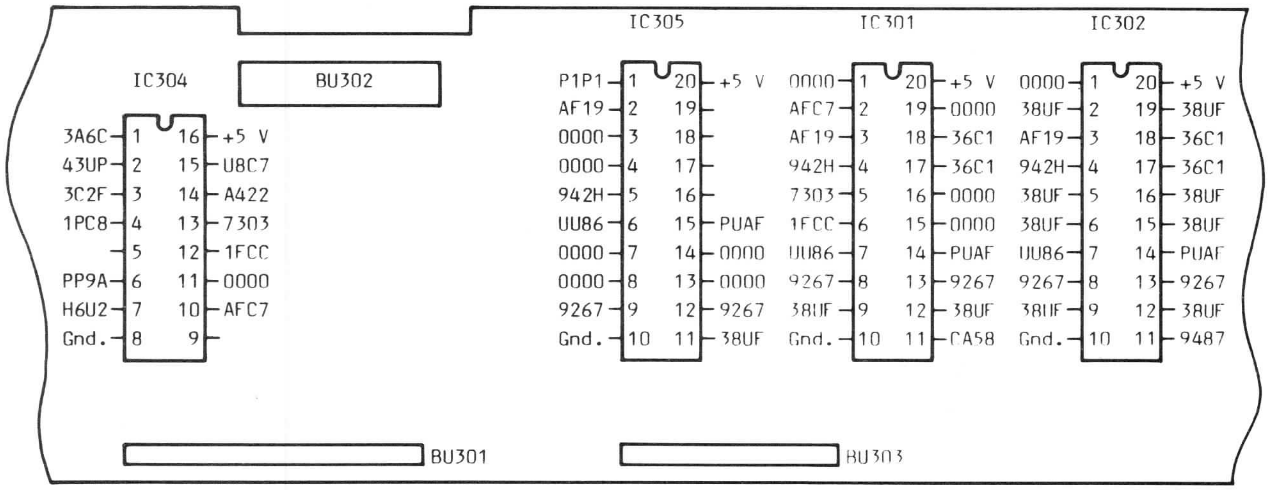
- Measure the signatures at IC302.

Key code buffer IC305

- Measure the signatures at IC305. (NOTE: Do not press any key during measurement.)

Configuration of Signature Analyzer:

Signal	CLOCK	START	STOP	GND	DATA
Connected to	CL3	ST6	ST6	GND	
Trigger edge	↓	↑	↑		
Trigger level	TTL				
Stimulus program	For testing U1				



Signature map for the front panel control board (U3)

NOTE: The signature map shows the board viewed from the component side. The pins of each IC can easily be identified from the soldering side of the board without further dismantling.

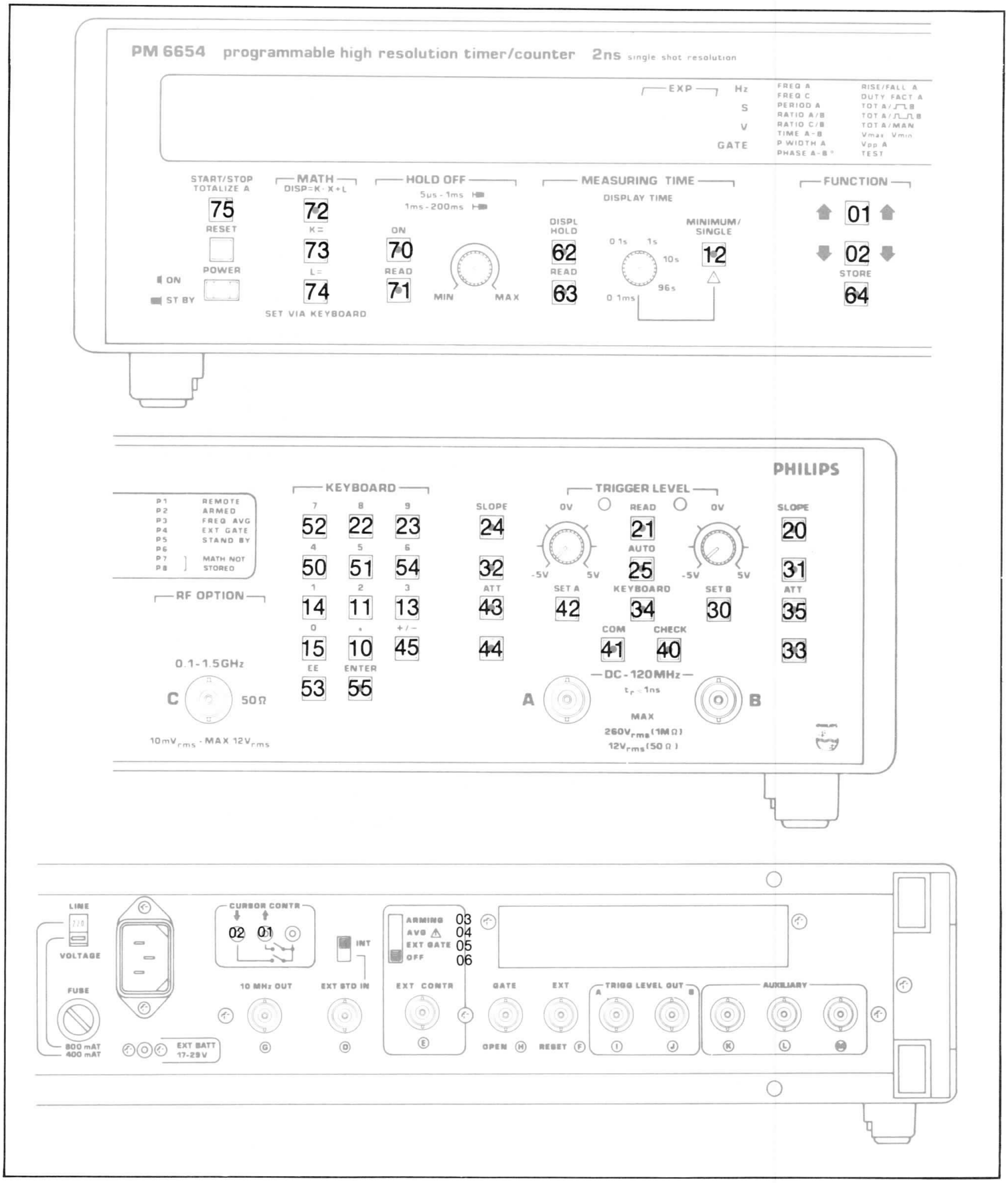
Keyboard

The keyboard is tested with the help of the "PHILIPS 3" test program.

Starting the program

- Set the two switches on the rear panel of the counter to INT and OFF.
- Set jumpers DV101 and DV102 on U1 in the NORMAL and TEST positions respectively.
- Switch the counter ON (ST BY/ON switch).
- Press and release the RESET key.
- Press key No. 3. After approximately 4 s the program will start.

A unique two digit code will be shown for each key, when the key is pressed. Compare the code with the one printed in the diagram below.



Code map for the keyboard.

If no fault is found, continue with trouble-shoting routine No. 1 B

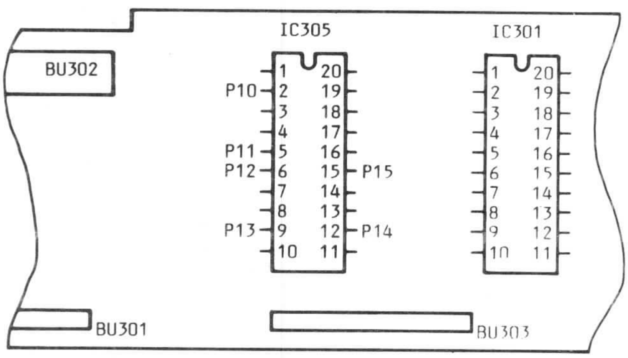
Keyboard, continued

The table to the right contains the signatures for all keys on the front panel (except RESET) and for the EXT CONTR switch on the rear panel. When a key is pressed, its signature should be obtained at one of the outputs P10...P15 from IC305.

- Connect the Signature Analyser according to the table below.
- Switch the counter ON.
- Put the probe on the first testpoint mentioned in the table.
- Depress the first key in the signature table and compare the signatures.
- Continue with the next key.

Configuration of Signature Analyzer:

Signal	CLOCK	START	STOP	GND	DATA
Connected to	CL3	ST6	ST6	GND	
Trigger edge	↓	↑	↑		
Trigger level	TTL				
Stimulus program	For testing U1				



NOTE: The figure shows the board viewed from the componentside. The pins of the IC can easily be identified from the soldering side of the board without further dismantling.

KEY	TEST POINT	SIGNATURE
4	P10	2CF4
. (decimal point)	P10	AA3A
CHECK	P10	5071
SLOPE B	P10	23PP
HOLD OFF READ	P11	37F3
CURSOR UP	P11	2149
5	P11	13U0
2	P11	920P
TRIGG. LEV. READ	P11	1CHA
COM	P11	6845
DC/AC B	P11	4AU3
DISP=K•X+L	P12	5F68
DISPL HOLD	P12	1FAP
MINIMUM/SINGLE	P12	49A5
CURSOR DOWN	P12	4AP2
7	P12	785C
8	P12	7071
DC/AC A	P12	2158
SET A	P12	03PP
K=	P13	3189
HOLD OFF ON	P13	0UU7
MEA TIME READ	P13	714U
EE	P13	15CA
9	P13	1H90
3	P13	9444
SLOPE A	P13	1H90
ATT A	P13	6P0U
1 MOHM/50 OHM B	P13	4FC9
L=	P14	3189
STORE	P14	714U
1	P14	9444
0	P14	P98U
6	P14	15CA
1 MOHM/50 OHM A	P14	6P0U
KEYBOARD	P14	4FC9
START/STOP		
TOTALIZE A	P15	4F42
ENTER	P15	6871
±	P15	13F4
AUTO	P15	605C
ATT B	P15	3172
RESET	No test is possible.	

Troubleshooting routine No. 1B

Slave Processor IC118 and Strobe Generator IC137

The following is required for checking:

- Signature Analyzer, Philips PM2544 Logic Multimeter
- Signature maps (see the following pages)

Preparations

- Switch the counter to ST BY.
- Remove U7 (only PM 6654).
- Connect the Signature Analyzer "pod" and select the trigger edges in accordance with the signature map.
- Start the stimulus program"for testing U1" by positioning jumper DV101 at position NORMAL and jumper DV102 at position TEST and then switching ON the the counter.

CAUTION: The power switch on the counter should always be switched to ST BY when no tests are in progress in order to protect the relays on U2.

Checking procedures

- Check whether the GATE indicator on the Signature Analyzer display is blinking. If not, continue with "IC118 supply voltage and input signals".
- Measure the signature for +5 V at IC118:40. This signature should be 38UF.
- Measure the signatures at IC118:27-35, 37 and 38.
- If any incorrect signature is obtained, continue with "IC118 supply voltage and input signals".
- Measure the signatures at IC137, IC125:1, IC128:8 and IC129:4.
- If these signatures are OK the Slave Processor and and strobe generator works, return to the fault finding tree.

IC118 supply voltage and input signals

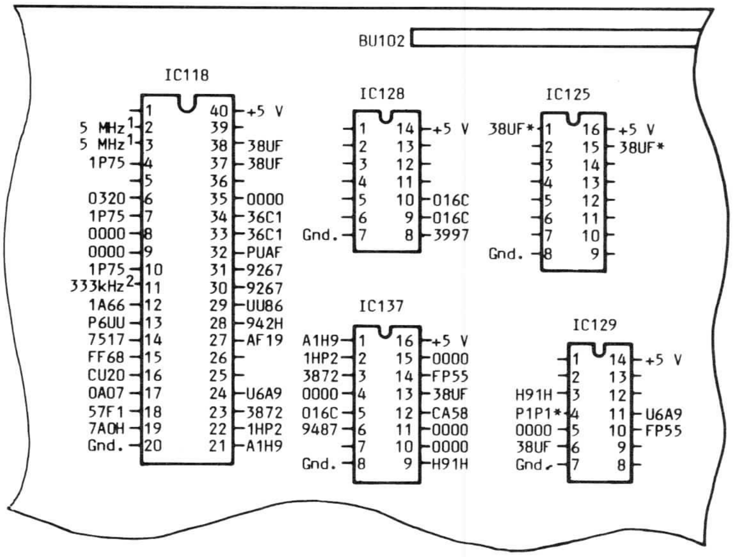
- Use the oscilloscope to check the frequencies and signal levels for IC118:2, 3 and 11.
- If the GATE indicator on the signature analyzer is blinking, continue fault tracing at "Remaining signals at IC118".

- If the GATE indicator is not blinking, use the signature analyzer to check the signals at the soldering lugs CL3 and ST6 as follows:

Pin	Frequency	Signal levels	
CL3	333 kHz	High: 2.4 V	Low: 0.45 V
ST6	81 Hz	High: 3.5 V	Low: 1.5 V

Signal	CLOCK	START	STOP	GND	DATA
Connected to	CL3	ST6	ST6	GND	
Trigger edge	⌐L (falling)	_Γ (rising)	_Γ (rising)		
Trigger level	TTL				
Stimulus program	For testing U1				

*) CMOS levels on probe.
1) High = equal to, or above 2 V.
   Low = equal to, or below 0.8 V.
2) High = equal to, or above 2.4 V.
   Low = equal to, or below 0.45 V.



Signature map for Slave Processor and Strobe Generator.

Strobe generator IC137

- Measure the signatures at IC137:1-3 and 13-15 and compare with the map on the previous page. If any of these are faulty check IC118 21-24. Are any of these faulty, replace the Slave Processor.

Remaining signals at IC118

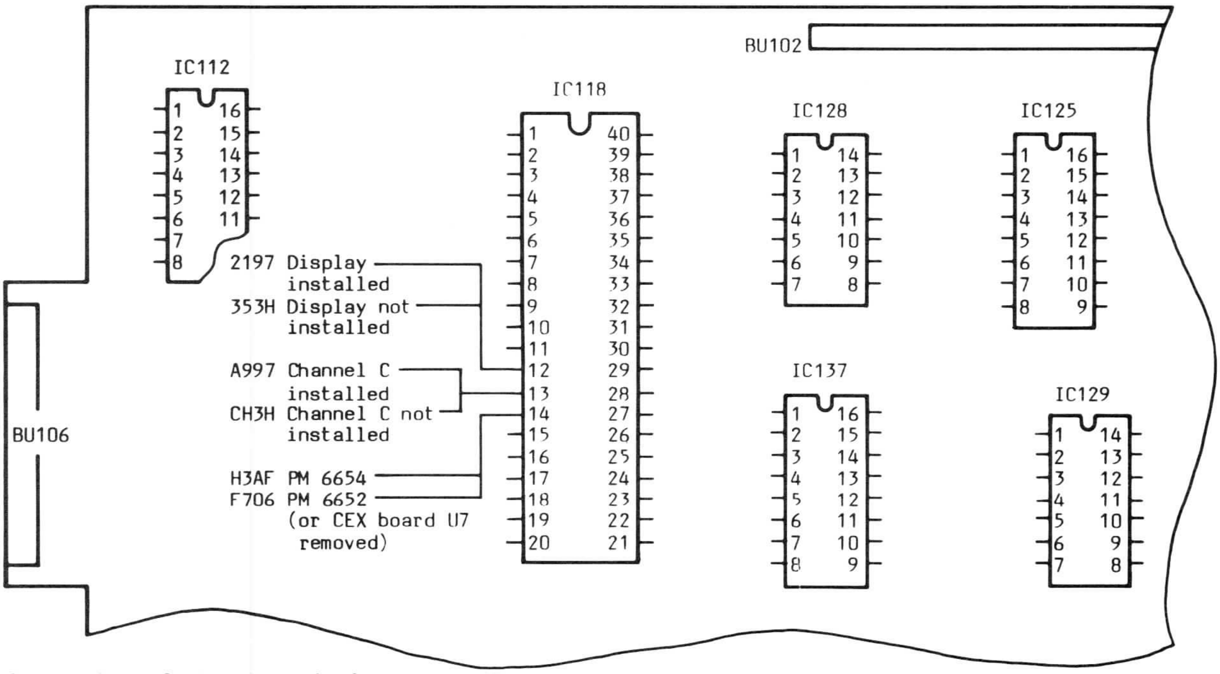
- Measure the signatures at IC118:7-10, 12-19 and compare with the map on the previous page.
- Connect the pod's CLOCK lead to IC101:31 (i.e. the WR output from the Microprocessor.
- Measure the signature at IC118:6. This signature should be 0320. If not continue with troubleshooting routine No.7.

Input port IC125

In normal operation the Slave Processor IC118 reads input port IC125 once when the counter is switched ON and stores the byte read from the port in a separate buffer.

Via the stimulus program used for testing U1, the buffer content is read continuously into IC101(CPU). Bits P10...P15 from the port are thus present at AD0...AD5 as long as the signals at ST7 (SOD) and CL1 (RD) are low.

- Connect the signature analyzer "pod" to the appropriate soldering lugs on U1 and select the trigger edges in the table below.
- Measure the signatures for AD0...AD2 at IC118:12-14.



Configuration of Signature Analyzer:

Signal	CLOCK	START	STOP	GND	DATA
Connected to	CL1	ST7	ST7	GND	
Trigger edge	rising	falling	rising		
Trigger level	TTL				
Stimulus program	For testing U1				

Signature for +5 V: 38UF

Signature map for fault tracing in the input port IC125.

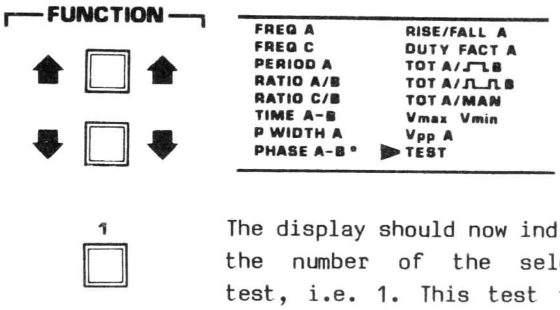
When the fault is fixed, return to the fault finding tree.

PROGRAM MEMORY

Check

Both the PM 6652 and the PM 6654 have built-in test programs which can be activated and monitored by the user. To carry out a program memory check, Test No. 1 should be activated. Proceed as follows:

Depress key: Correct reaction



The display should now indicate the number of the selected test, i.e. 1. This test takes about 12 s. When the test is completed satisfactorily, the display will show zeros. If an error is detected, the display will show error code E1.

If the check runs without problems, return to the fault finding tree.

Troubleshooting routine No. 2

program memory

The appearance of error code E1 on the display can be caused by the following:

- ROM packages IC103...IC105 are faulty.
- The IC sockets for these ROMs are faulty.
- The printed wiring for these ROMs is faulty.

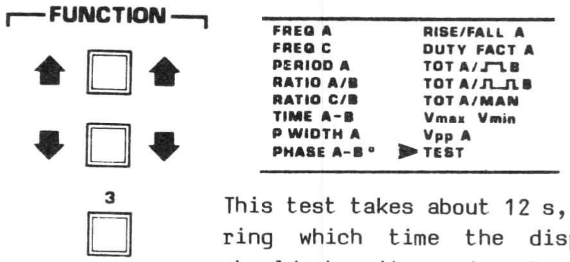
To remedy the fault, successively replace the ROM packages IC103...IC105 and retest. If this fails to cure the fault, replace the IC sockets and check the PC-board.

NON-VOLATILE MEMORY

Check

This check can also be carried out by activating a built-in test program, namely Test No. 3. Proceed as follows:

Depress key: Correct reaction



This test takes about 12 s, during which time the display should show the number 3. When the test is completed satisfactorily, the display will again show zeros. If an error is detected, the display will show error code E3.

If the check runs without problems, return to the fault finding tree.

Troubleshooting routine No. 3

EAROM IC108

- Check that a 14 kHz clock signal is present at IC108:6 (clock input to the EAROM).
- Check that -30 V is present at IC108:2. If not, see the description headed "Power supply" in the chapter on "Circuit Descriptions".

The appearance of error code E3 on the display can be caused by the following:

- EAROM package IC108 (ER1400) is faulty.
- Multiplexer package IC127 (4053) is faulty.
- Transistors TS102...TS105 (BC558B) are faulty.
- FET transistor TS101 (BF256A) is faulty.

To remedy the fault, replace these components successively.

FUNCTION CHECK

- Check the position of the cursor. If the cursor indicates one of the programs P1...P8, set it in a non-programmed mode by moving it out of the program area by means of the FUNCTION keys.
- Switch the counter OFF and then ON again.
- Turn the MEASURING TIME control knob fully counterclockwise.
- Press the CHECK key.
- Using one of the FUNCTION keys step through the measuring modes listed in the following table and simultaneously check that the display shows the values listed in the table.

Measuring mode	PM 6652 display	PM 6654 display
FREQ A	10.00 EXP6 Hz[2]	10.000 EXP6 Hz[2]
FREQ C[1]	160.00 EXP6 Hz[2]	160.00 EXP6 Hz[2]
PERIOD A	100.00 EXP-9 Hz[2]	100.00 EXP-9 Hz[2]
RATIO A/B	1.000[2]	1.000[2]
RATIO C/B[1]	16.00[2]	16.00[2]
TOT A/⎍B	0.	0.
TOT A/⎍⎍B	1.	1.

1) FREQ C and RATIO C/B can be checked only if the channel C option PM 9610 is installed.

2) The least significant digit can vary with ±2.

If an error is found in this check continue with **"Troubleshooting routine No. 4"** .

Troubleshooting routine No. 4

CEX BOARD U7 (PM 6654)

Fault tracing on the CEX board can be carried out by means of a Signature Analyzer or an oscilloscope, making use of a built-in stimulus program.

The following is required for fault tracing:

- Signature Analyzer, Philips PM 2544
- Oscilloscope, 25 MHz or better, e.g. Philips PM 3215 with probes
- Pulse number table and timing diagrams for the CEX board U7
- Fault tracing diagram with signal paths marked in different colors (see chapter 10)
- Signature maps for the CEX board U7

Preparations

- Set the two switches on the rear panel of the counter to INT and OFF respectively.
- Set jumpers DV101 and DV102 on U1 to the NORMAL and TEST positions respectively.

Start the stimulus program "PHILIPS 2" as follows:

- Switch ON the counter.
- Press and release the RESET key. The text PHILIPS should now appear on the counter display.
- Press key 2 on the numeric keyboard. The digit 2 should now be added to PHILIPS on the display. After approximately 4 s the stimulus program will start, indicated by the GATE indicator on the Signature Analyser blinking.

Oscilloscope measurement

Oscilloscope settings:
- DC coupling for channels A and B
- Chop mode
- External triggering
- Sensitivity for channels A and B: 1 V/div.

Probe connections:

- Connect the oscilloscope's external trigger input to the START/STOP testpoint on U7 or R705 if no START/STOP testpoint is present.
- Connect one of the oscilloscope probes to the same testpoint (START/STOP), and adjust the sweep speed and the horizontal position so that exactly one period of the signal extends across the entire screen (see pulse number 2 in the timing diagram).
- Move the probe to the CLOCK testpoint on U7 or IC715:11 if no testpoint is present, and check that the signal corresponds to pulse number 1 in the timing diagram. This CLOCK pulse train serves as a reference during the oscilloscope measurement.

Measurement procedure:

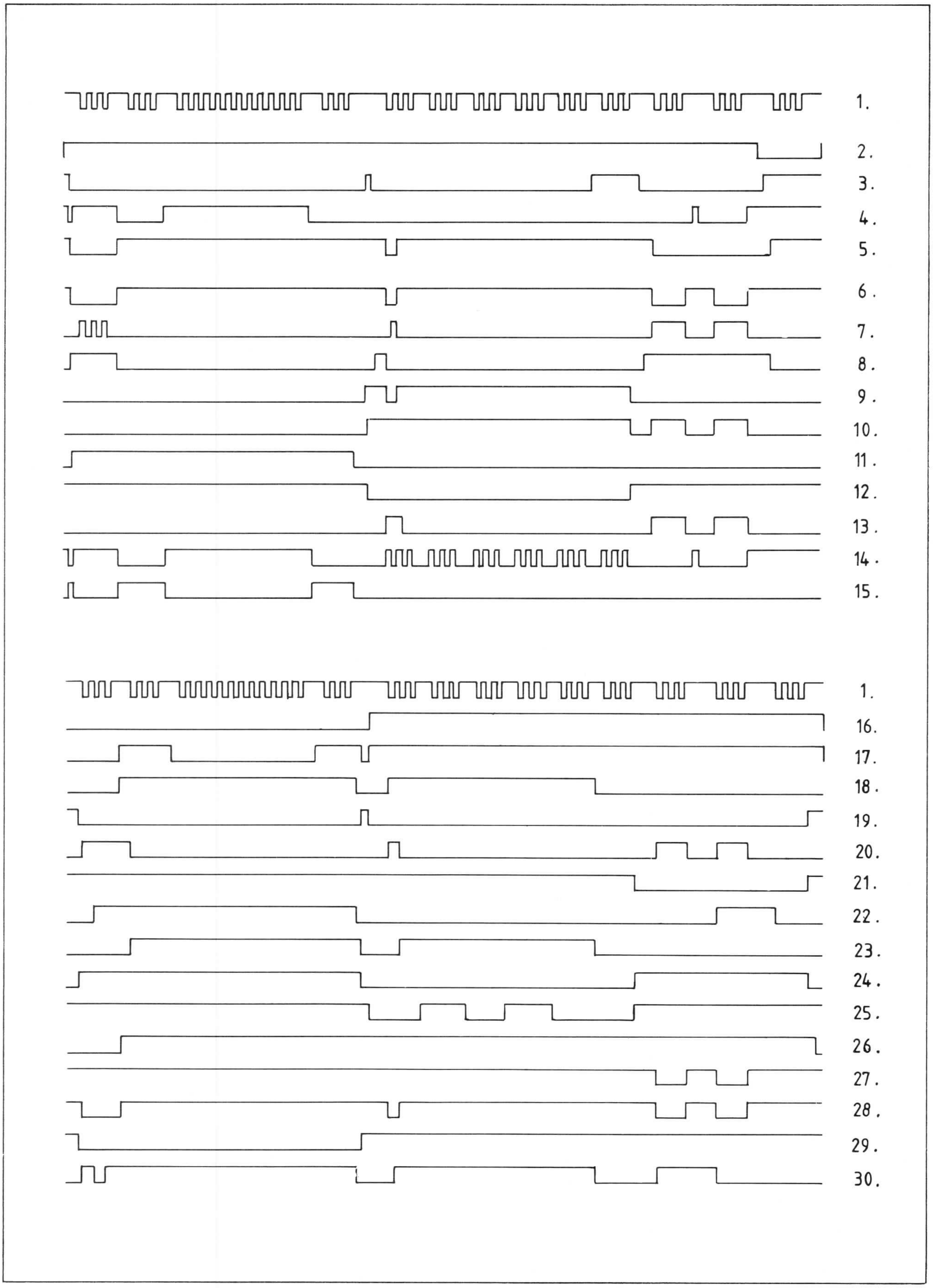
- Find the desired test point on U7 and connect the second oscilloscope probe to it.
- Look up the pulse number for the test point in question in the pulse number table below.
- Look up the corresponding pulse shape in the timing diagram on the next page.
- Check that this pulse shape corresponds to the measured pulse.

NOTE: The amplitude on the oscilloscope screen is not equal for all testpoints.

IC	Pin numbers															
	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	19
702		6	I-6	I-6	I-27			LOW		27	27	LOW	I-6			
703		2											10		9	
705								3								
706*	22	22		30				LOW	LOW		LOW		LOW	LOW		
707		HIGH	HIGH		LOW	LOW				LOW	HIGH	HIGH		LOW		
708	21			12	HIGH			I-16			LOW			26	12	16
709	9		13	12					9	12	I-8	I-16	I-6	I-6		
710	LOW		LOW			I-30		3			7	22	I-30	30		
711	24	24		16	3	16		3	I-3	I-3	3	LOW	3			
712	I-16			16	I-12			LOW			I-16			16	25	HIGH
713	8	27	21			20			11			21		LOW		
714	20	28	3		I-1	8			24	14		3	29	11		
715	3	1	HIGH	25		I-1			12	1	1		14	I-1		
716	I-5	LOW	5	HIGH	3			5	3	23	I-16	20	I-5	5		
717	7	17	29	16	14			I-1	28	12	1	16	28	7		
718	13	7	28	11	21	27			16	11	16	8	19	28		
719	I-3	I-3	3	3	LOW	3		I-3	26	HIGH	I-3	I-3	LOW	3		
720	23	5	20	20	16	I-6			3	5	LOW	I-5	I-5	5		
721		18	HIGH	HIGH	8	I-8		3	18	19	LOW	LOW	HIGH			
722	HIGH		3		17	I-3			HIGH	17		3	I-18	18		
723	17	15	I-16	15	14	16		14	HIGH	I-16		4	15			

*) The pulse number for IC706 pin 1 is 30.
I = The letter "I" in front of a pulse number indicates that the pulse in question is inverted.

Pulse number table for the CEX board U7.



Timing diagram for the CEX board U7 (PM 6654)

NOTE: The amplitude on the oscilloscope screen is not equal for all testpoints.

Signature analysis

- Switch ON the Signature Analyzer.
- Connect the "pod" and select the trigger edges and trigger levels in accordance with the table on the signature map.
  NOTE: Unusual trigger levels.
- Start the stimulus program "PHILIPS 2".

Number of clock pulses

- Turn the function selector switch on the Signature Analyzer to EVENTS.
- Measure the No. of clock pulses at BU701:15.
- Check that the display shows 48 pulses.
- Turn the function selector switch to NORMAL.

Feedback network

The feedback network is marked red on the diagram in chapter 10.

- Check the feedback network function by measuring the signatures for IC714:7, 10, IC713:13, IC722:6.
- If the signatures obtained are correct, continue with "Decade clock, $\overline{\text{GATE OPEN}}$ and READY".
- If any incorrect signature is obtained, continue with "Input- and control signals for U7".

Decade clock, $\overline{\text{GATE OPEN}}$ and READY

- Measure the signatures at the points listed in the following table.

Test points	Signal name
IC710:12	Decade clock
BU701:7	$\overline{\text{GATE OPEN}}$
BU701:9	READY

- If the signatures obtained are correct, go to "Decade counter IC705 and multiplexer IC706".
- If the signature for the decade clock at IC710:12 is incorrect, check also the signatures at the other points listed in the decade clock column in the following table.
- If the signature at IC710:12 is correct, measure the signature for $\overline{\text{GATE OPEN}}$ at IC702:3. If this signature is incorrect, check also the signatures at the other points listed in the $\overline{\text{GATE OPEN}}$ column in the following table.
- If the signature at IC702:3 is correct, measure the signature for READY at IC720:15. If this signature is incorrect, check also the signatures at the other points listed in the READY column in the following table.

Test points		
Decade clock	$\overline{\text{GATE OPEN}}$	READY
IC710:12	IC702:3	IC720:15
IC717:9	IC709:10	IC716:9
IC717:10	IC709:11	IC716:10
IC717:11	IC709:12	IC716:11
IC717:12	IC709:13	IC716:12
IC717:13	IC709:14	IC716:13
IC717:14		IC716:14
IC718:3		IC720:3
IC718:6		IC720:6
IC718:7		IC720:7

Input- and control signals for U7

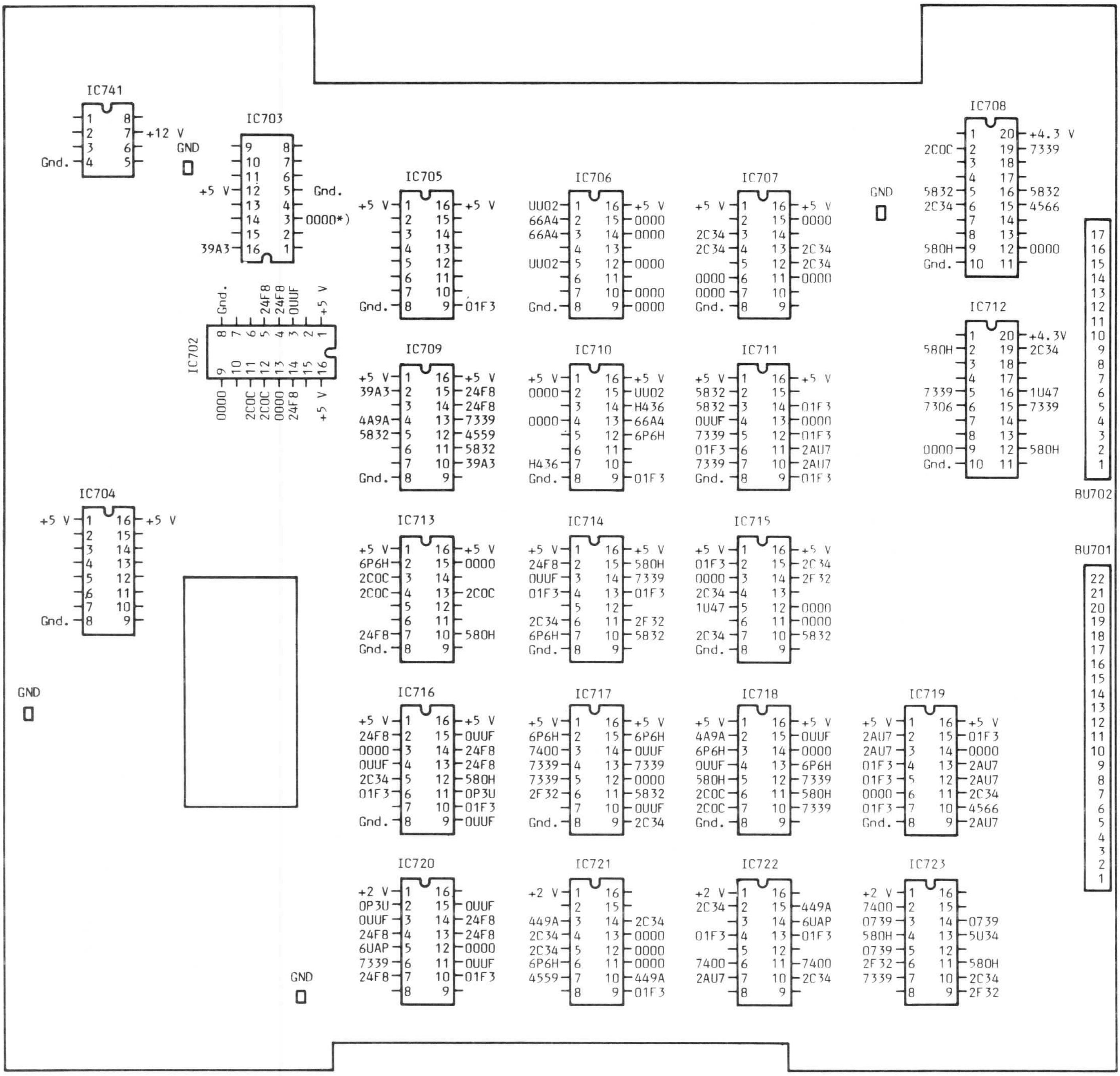
- The signal paths for all input and control signals to U7 are marked blue on the diagram in chapter 10. Measure those signatures.

Decade counter IC705 and multiplexer IC706

NOTE: This fault tracing procedure need not be carried out if the procedure described in the section headed "Input- and control signals for U7" has been carried out.

- Measure the signatures for the signals RESET 1 on IC703:3, RESET 2 on IC710:9, IC705:9 and DEC9 on IC706:9.
- Measure the signatures for the four multiplexer outputs at connector BU701, pins 10, 11, 12 and 13.
- If any incorrect signature is obtained at BU701, measure the signatures at the multiplexer inputs (IC706, pins 3, 5, 10 and 12).
- If any incorrect signature is obtained at the multiplexer inputs, measure the signatures at the decade counter outputs (IC710, pins 2, 4, 13 and 15).

When the fault is fixed, return to the fault-finding tree.



Signal	CLOCK	START	STOP	GND	DATA
Connected to	CLOCK	START/STOP		GND	
Trigger edge	⎍ (rising)	⎍ (rising)	(falling)		
Trigger level	3.70	3.70	3.70		3.90H, 3.50L
Stimulus program	PHILIPS 2				

*) Trigger levels for the data probe: High = 7.0 V, low = 5.8 V

Signature map for U7, CEX board for PM 6654

Troubleshooting routine No. 4

CEX board U6 (PM 6652)

Fault tracing on the CEX board can be carried out by means of a signature analyzer or an oscilloscope, making use of a built-in stimulus program.

The following is required for fault tracing:

- Signature analyzer, Philips PM 2544
- Oscilloscope, 25 MHz or better, e.g. Philips PM 3215 with probes

Preparations

- Set the two switches on the rear panel of the counter to INT and OFF respectively.
- Set jumpers DV101 and DV102 on U1 to the NORMAL and TEST positions respectively.

Oscilloscope measurement

Start the stimulus program "PHILIPS 1" as follows:
- Switch ON the counter.
- Press and release the RESET key. The text PHILIPS shall now appear on the counter display.
- Press key 1 on the numeric keyboard. The digit 1 shall now be added to PHILIPS on the display. After approximately 4 s the stimulus program will start.

Oscilloscope settings:
- DC coupling for channels A and B
- Chop mode
- External triggering
- Sensitivity for channels A and B: 1 V/div.

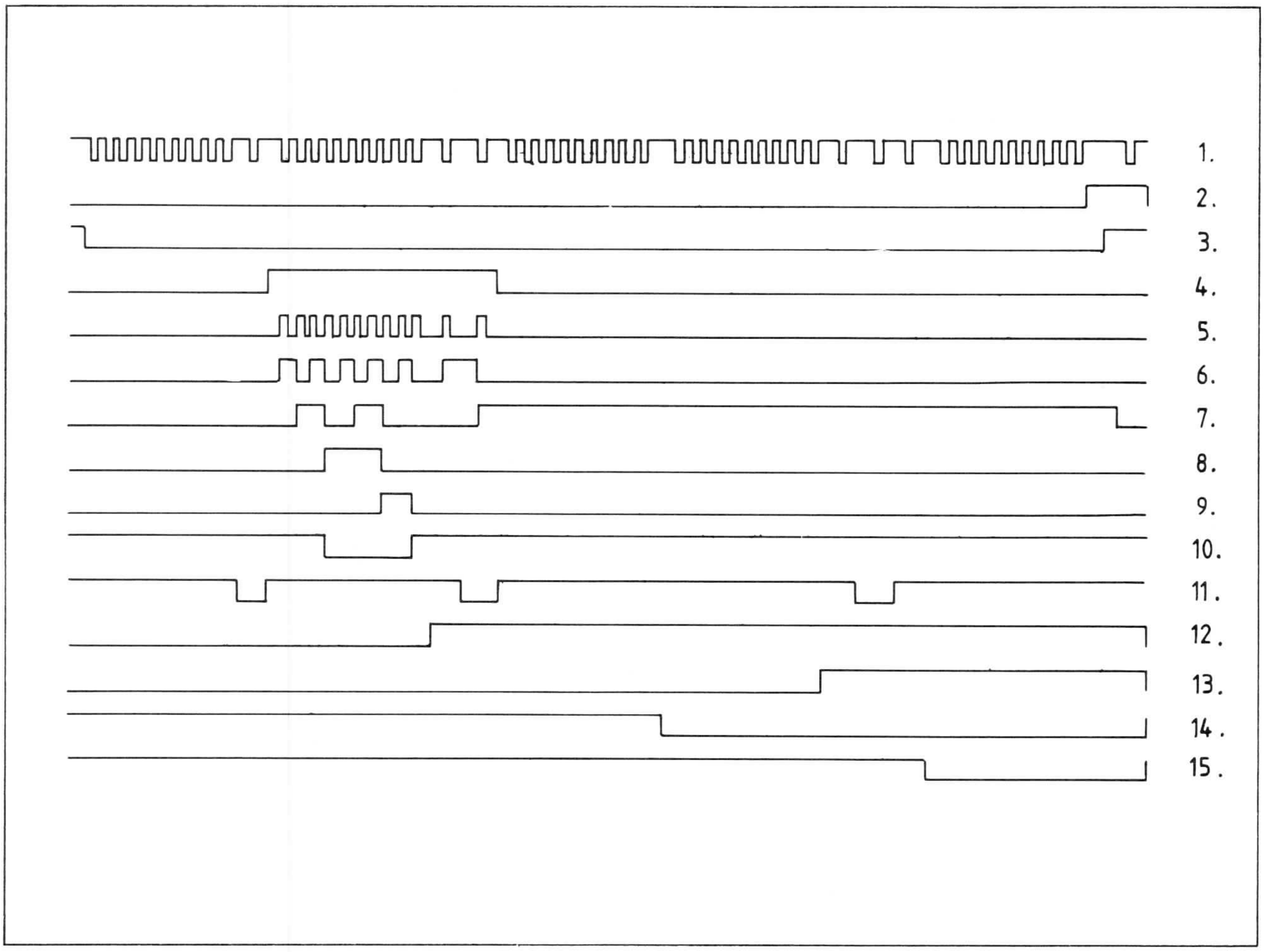
Probe connections:
- Connect the oscilloscope's external trigger input to soldering lug P3 (i.e. START/STOP) on U6.
- Connect one of the oscilloscope probes to the same soldering lug (P3), and adjust the sweep speed and the horizontal position so that exactly one period of the signal extends across the entire screen (see pulse number 2 in the timing diagram on the next page).
- Move the probe to soldering lug P4 (i.e. CLOCK) on U6, and check that the signal corresponds to pulse number 1 in the timing diagram. This CLOCK pulse train serves as a reference during the oscilloscope measurement.
- Find the desired test point on U6 and connect the second oscilloscope probe to the it. Then look up the pulse number for the test point in question in the pulse number table and the corresponding pulse shape in the timing diagram on the next page. Check that this pulse shape corresponds with the measured pulse.

NOTE: On early versions of the CEX board U6 the printed designations START/STOP and CLOCK are interchanged. On the circuit diagrams and in other documentation the designations are correct, i.e. P3 = START/STOP and P4 = CLOCK.

IC	Pin numbers														
	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	19
601	I-11	I-11	HIGH	HIGH	2	11		HIGH		I-11	12	HIGH	11			
603	10	I-4	8	9	11	15			I-4		4	LOW	4	I-4		
605	4	I-4	3		11	I-4		13	HIGH	I-4		3		I-4		
606		11	3	HIGH					4	I-1		3	I-5			
607	1	5	I-1		I-4	I-5		I-5	1		1		I-1			
609	HIGH	LOW	14	I-4	LOW			HIGH	3	LOW	LOW	LOW	HIGH	LOW		
611	9		8			I-6		3			5	7	I-6	6		
613	11			HIGH	12			LOW			13			14	15	LOW

NOTE: I = The letter "I" in front of a pulse number indicates that the pulse in question is inverted.

Pulse number table for the CEX board U6.



Timing diagram for the CEX board U6 (PM 6652)

Signature Analysis

- Switch the Signature Analyzer ON.
- Connect the "pod" and select the trigger edges and trigger levels as in the table on the next page.

Start the stimulus program "PHILIPS 1" as follows:

- Switch the counter ON.
- Press and release the RESET key. The text PHILIPS shall now appear on the counter display.
- Press key 1 on the numeric keyboard. The digit 1 shall now be added to PHILIPS on the display. After approximately 4 s the stimulus program will start, indicated by the GATE indicator on the Signature Analyzer blinking.

Number of clock pulses

- Turn the function selector switch on the Signature Analyzer to EVENTS.
- Measure the number of clock pulses at BU601:15.
- Check that the display shows that there are 57 pulses.
- Turn the function selector switch back to the NORMAL position.

Decade clock, $\overline{\text{GATE OPEN}}$ and READY signals

- Measure the following signatures:

Test points		
Decade clock	$\overline{\text{GATE OPEN}}$	READY
IC611:12 IC609:4 IC609:5	BU601:7	BU601:9

- If the signatures obtained are correct, continue with "Decade counter IC611".
- If any incorrect signature is obtained, continue with "Input- and control signals for U6".

Input- and control signals for U6

- Measure the following signals:

Test points			
IC603:6	IC605:6	IC606:4	IC609:4
IC603:7	IC605:9	IC606:5	IC609:9
IC603:12	IC605:10	IC606:11	IC609:10
IC603:13	IC605:13	IC606:13	IC609:11
IC605:4	IC606:3	IC607:12	

Main gate IC607

- Check the signature at IC607:6. If the signature is correct, continue with "Remaining network excl. decade counter IC611".
- Check that +2 V is present at pin 1 on the following resistor network circuits: IC604, IC608 and IC610.
- Check that the same signature is obtained at the following points and that this signature is stable:

Test points			
IC607:6	IC603:15	IC605:11	IC605:15
IC603:10	IC603:3		

Remaining network, excl. decade counter IC611

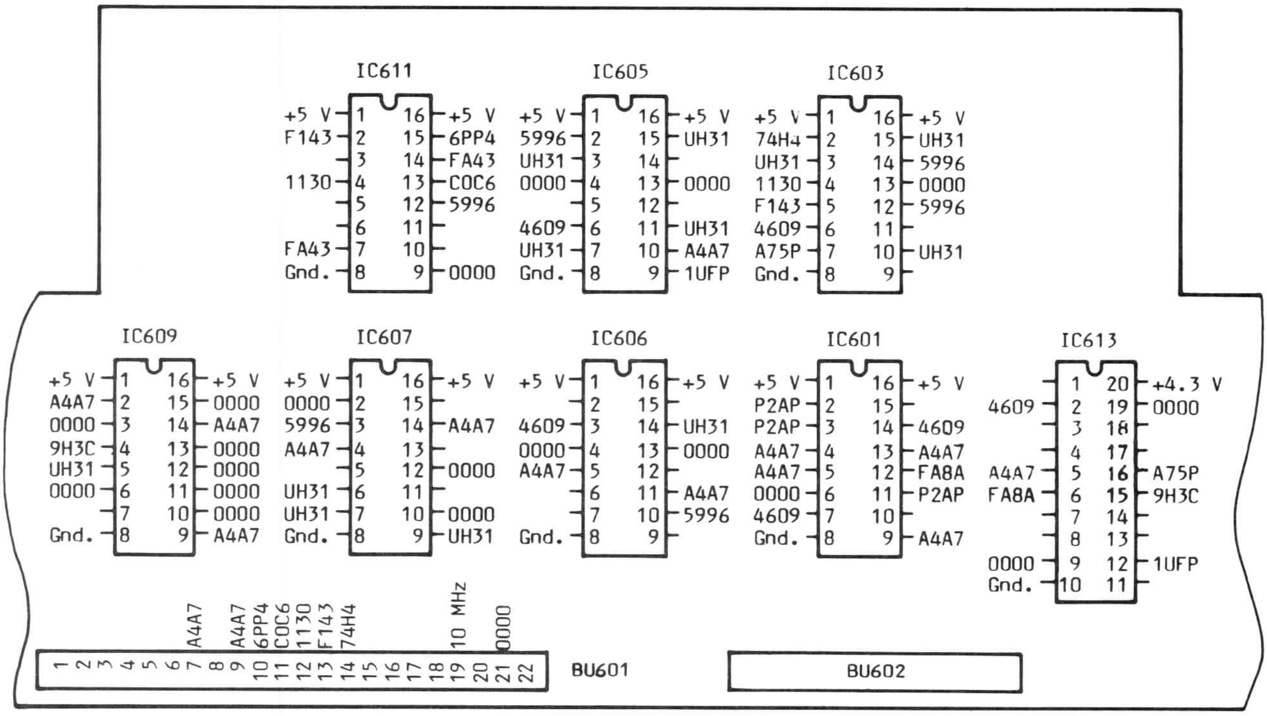
- Measure the signatures for the decade clock and for the $\overline{\text{GATE OPEN}}$ and READY signals at the points listed in the following table.

Test points		
Decade clock	$\overline{\text{GATE OPEN}}$	READY
IC603:14 IC606:10 IC606:14 IC607:7 IC611:12	IC609:5 IC609:2 IC609:3 BU601:7	IC609:14 IC609:15 BU601:9

Decade counter IC611

- Using the oscilloscope, check that a 10 MHz clock signal is present at BU601:19.
- Check that the signature at BU601:21 is 0000.
- Check the signatures at IC611:9 and IC609:10.
- Measure the signatures for the decade counter output signals at the points listed in the left-hand column in the table to the right. If any incorrect signature is obtained, measure also the signatures at the points listed in the right-hand column.

Test points	
BU601:10	IC611:15
BU601:11	IC611:13
BU601:12	IC611:4
BU601:13	IC611:2
BU601:14	IC603:2



Signal	CLOCK	START	STOP	GND	DATA
Connected to	P4	P3	P3	GND	
Trigger edge	rising	falling	rising		
Trigger level	3.70	3.70	3.70		3.90H, 3.50L
Stimulus program	PHILIPS 1				

Signature map for PM 6652 CEX, U6

When the fault is fixed, return to the fault finding tree.

INPUT AMPLIFIERS

C input check

This test can be carried out if the counter is equipped with a PM 9610 prescaler.

The following test equipment is required:
- HF signal generator e.g. Wavetek 2002A.

Test procedure:
- Select the FREQ C measuring mode.
- Connect a HF-generator to input C.
- Check that the counter counts correctly from 100...1000 MHz at a signal level of -27 dBm.
- Check that the counter counts correctly from 1000...1500 MHz at a signal level of -17 dBm.
- Check that the counter display is blank if the signal levels is below the specified values.

If any fault is found, continue with traditional fault finding.

A and B input check

Preparations:
- Connect the output '10 MHz OUT' on the rear panel to Input A by means of a coaxial cable.
- Release the CHECK key.
- RATIO A/B
- Minimum measuring time
- COMmon
- 50 ohm termination for channel A

Check that the display shows 1.000.

If the check is OK, return to the fault finding tree.

Troubleshooting routine No. 5A

Input amplifiers A and B

The following test equipment is required:

- Voltmeter
- Oscilloscope, 25 MHz, e.g. PM 3215
- Storage oscilloscope, e.g. PM 3243

Begin this troubleshooting routine by checking the trigger levels for channels A and B:

Make the following settings on the counter:
- Press KEYBOARD.
- Press SET A (or SET B for channel B).
- Select a trigger level value between -5.11 and +5.12 V on the numeric keyboard.
- Press ENTER.

Connect a voltmeter to GND and TLA (or TLB respectively) on U2 and check that the voltmeter indicates the trigger level value selected via the numeric keyboard (±0.01 V).

If the trigger levels are correct, continue by fault tracing the input amplifier circuits by means of an oscilloscope. See the section headed "Input amplifiers A and B" in the chapter "Functional Description".

NOTE: The input signal proceeds through both amplifiers. Consequently, a 10 MHz ECL signal should be present at the outputs from both amplifiers. Check at BU211 (channel A) and BU212 (channel B).

If the check is OK, return to the fault-finding tree.

Troubleshooting routine No. 5B

IC119 DAC A and IC120 DAC B

The following test equipment is required:

- Signature Analyzer, Philips PM2544
- Signature map

Preparations

- Set the two switches on the rear panel of the counter to INT and OFF respectively.

Supply voltages and reference voltage

- Using an oscilloscope, check the DC levels for the signals listed in the following table.

Test point	Signal name	DC level
IC119-IC120:10	GND	0 V
IC119-IC120:20	Supply volt.	+12 V
IC119-IC120:13	VREF	+5 V
IC119-IC120:3	BYTE1/BYTE2	+5 V
IC119-IC120:2	WR	0 V
IC119-IC120:4	XFER	0 V
IC121-IC122:11	Supply volt.	-12 V
IC121-IC122:4	Supply volt.	+12 V
IC123:4	Supply volt.	+12 V
IC123:11	GND	0 V

Input signals to DAC A and DAC B

- Switch OFF the counter.
- Connect the "pod" and select the trigger edges according to the table below.
- Start the stimulus program"for testing U1"by positioning jumper DV101 at position NORMAL and jumper DV102 at position TEST and then switching ON the power switch.

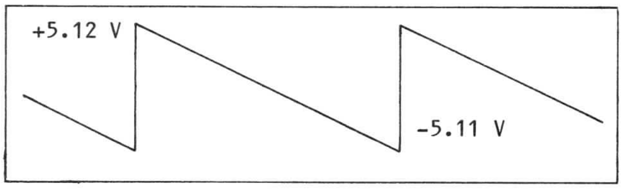
CAUTION: The power switch should always be switched to ST BY when no tests are in progress, in order to protect the relays on U2.

- Check if the GATE indicator on the Signature Analyzer is blinking. If not, continue with " **Troubleshooting routine No. 1B** ".

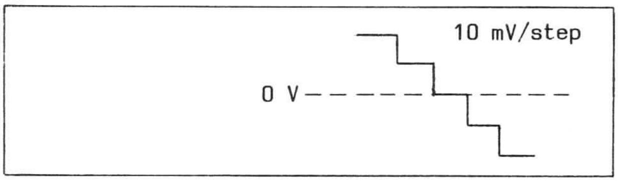
Analog output from DAC A and DAC B

- The counter is provided with a built-in program which generates a sawtooth wave at the output from DAC A and DAC B. The linearity and resolution of the DAC circuits can be checked by measuring the sawtooth wave by means of a storage oscilloscope. Proceed as follows:

Start the stimulus program "PHILIPS 4":
- Set jumpers DV101 and DV102 on U1 to NORMAL and TEST positions respectively.
- Switch the counter ON.
- Press and release the RESET key. The text PHILIPS should now appear on the counter display.
- Press key 4 on the numeric keyboard. The digit 4 should now be added to PHILIPS on the display.
- Connect the probe of the storage oscilloscope to IC122:3 (for DAC A) or to IC122:5 (for DAC B).
- Check the linearity of the DAC circuit against the following diagram.

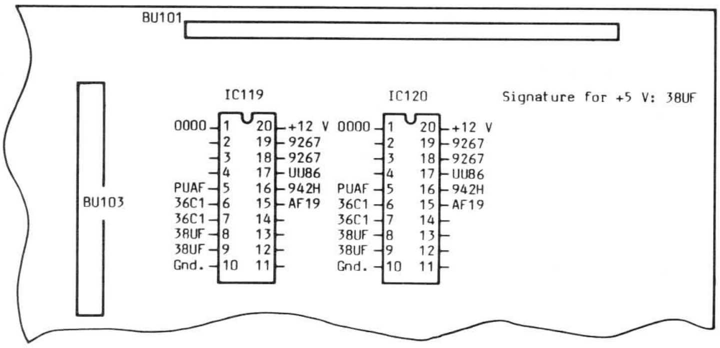


- Check the resolution of the DAC circuit against the following diagram



Configuration of Signature Analyzer:

Signal	CLOCK	START	STOP	GND	DATA
Connected to	CL3	ST6	ST6	GND	
Trigger edge					
Trigger level	TTL				
Stimulus program	For testing U1				



Signature map for checking DAC A (IC119) and DAC B (IC120).

When the fault is fixed, return to the fault finding tree.

IEEE-488 BUS

Check

The following checking procedure can be carried out only if the counter is equipped with the PM 9696 option.

For this checking procedure it is assumed that an HP85 controller will be used. The same procedure is relevant for almost all HP controllers. If you use a different type of controller (e.g. Philips), refer to the appropriate controller manual to translate the commands appearing below to the commands required for the controller being used.

- Connect an HP85 controller to the IEEE-488 bus interface, option PM 9696.
- Set the TALK ONLY switch ON the PM 9696 rear panel to 0 (i.e. not TALK ONLY).
- Select an address e.g. address $10_{decimal}$ ($=01010_{binary}$) by means of the five Address Switches on the PM 9696 rear panel.
- Switch the counter ON.
- Select measuring time 0.1 ms and press the CHECK key.
- The counter should display 10 MHz.

- Via the controller, give the command REMOTE 7 followed immediately by the selected address. (Thus, the complete address in our example becomes REMOTE 710.)
- The counter should go to remote mode; the indicator REMOTE on the counter display should light and the internal 10 MHz measurement should continue. All front panel controls are now disabled.
- From the controller, program the counter to measure PERIOD A by sending the command OUTPUT 710; "F3".
- The counter should carry out period measurements and display 100 ns.

- Give the command LOCAL 710.
- The counter should go back to local mode; the REMOTE indicator should go OFF.
- Activate the DISPLAY HOLD function by pressing the DISPL HOLD key on the counter.
- Give the command REMOTE 710.
- The counter should go over to remote mode; the indicator REMOTE should be ON. All controls are now disabled and no measurement takes place; the display shows only zeros.

- Via the controller, check the status of the counter (serial poll) by giving the following commands:

  S=SPOLL (710)
  DISP S.
- The result should be 19 (decimal).

- Give a TRIGGER 710 command via the controller.
- The counter should perform one measurement.
- The result should be 100 ns.
- Give the following commands:
  ENTER 710; A$
  DISP A$.
  The above result will now be read into the controller: For a PM 6652, the controller should display PA 000000100.0E-9; for a PM 6654, it should display PA 00000100.00E-9. If the controller is unable to read the result, check the selected input delimiter in the PM 9696.

- The counter should now wait for the next trigger command.
- Give a TRIGGER 710 command via the controller.
- The counter should perform one measurement; check that the GATE indicator lights up once.

- Give the command CLEAR 710.
- The counter should go to the FREQ A function.
- The DISPLAY HOLD and CHECK functions should be deactivated.
- The display should show only zeros.

- Set the counter to the CHECK mode by sending the command OUTPUT 710; "CH1".
- Then send the command OUTPUT 710; "F17".
- The counter should stop the measurement and issue a service request message.

- Via the controller, check the status of the counter (serial poll) by giving the following commands:
  S=SPOLL (710)
  DISP S.
- The answer should be 111 (decimal).
- The counter should start to measure and display 10 MHz.

- Give the command CLEAR 710.
- The CHECK function will be deactivated.
- The counter should not measure, and the dis--play should show only zeros.

- Give the command LOCAL 710.
- The counter should go to local mode; the RE-MOTE indicator switches OFF. All controls are now enabled again.

If no fault is found, return to the fault-finding tree.

Troubleshooting routine No. 6

IEEE-488 bus interface - PM 9696

Fault tracing on the IEEE-488 bus interface in the PM 6652/54 counters can be carried out by means of signature analysis. For this purpose, the counters have been provided with a built-in stimulus program intended for the signature analysis.

The following instruments are required:

- PM 6652/54 counter <u>without</u> CEX board.
- Test plug (to be plugged into the IC socket for IC29 on the IEEE-bus interface board).
- Signature analyzer, Philips PM2544 Logic Multimeter.
- Oscilloscope, 20 MHz or better.

<u>Preparations</u>

Check as follows, whether the fault is caused by IC29 (HEF4738) or IC33 (PROM) on the bus interface board:

- Remove IC33 from its socket.
- Replace IC29 by a new IC package.
- Carry out an IEEE-488 bus check again.

If the fault persists:

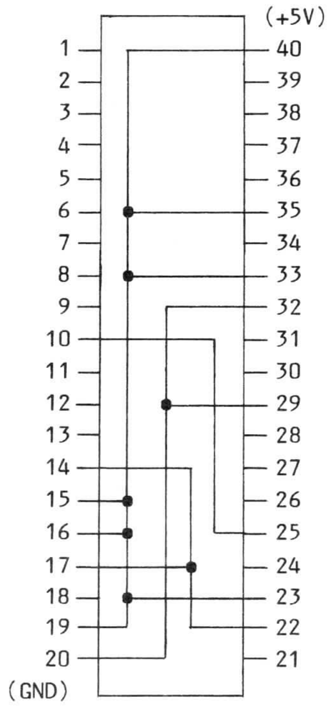
- Connect the flat cable connector of the bus interface to the DATA OPTIONS connector in the counter.

NOTE: The CEX board must be removed from the counter.

- Set the two switches on the rear panel of the counter to INT and OFF respectively.
- Set jumpers DV101 and DV102 on U1 to the NORMAL and TEST positions respectively.

- Replace IC29 (HEF4738) with a test plug made in accordance with this diagram

It can be made by soldering wires to a 40-pin component board or a 40-pin IC-socket



- Connect the Signature Analyzer "pod" and select the correct trigger edges, see the table on the signature map for the bus interface.

Start the stimulus program "PHILIPS 5":

- The jumpers on the Microprocessor Board must be in positions: DV101 = NORMAL, DV102 = TEST.
- Switch the counter ON.
- Press and release the RESET key. The text PHILIPS shall now appear on the counter display. (If it does not, continue as described in the section headed "If the stimulus program cannot be started").
- Press key 5 on the numeric keyboard. The digit 5 should now be added to PHILIPS on the display.

If the display shows PHILIPS 5 continue with <u>"Code display"</u>.

If the stimulus program cannot be started

This fault tracing procedure must be carried out in the conventional way, i.e. using an oscilloscope. Difficulty in starting the stimulus program is probably due to the bus interface loading on the data bus AD0...AD7 and/or one or more of the signals A8...A10, ALE, WR, RD, CS or CS2 on U1 (Microprocessor Board). The incorrect loading can be caused by faulty components, poor soldering, etc. Begin the fault tracing procedure by checking that the +5 V supply voltage and the 2.5 MHz clock signal are present on the bus interface board.

NOTE: On the circuit diagrams, the signal names on U1 at BU108 and on the bus interface board at BU2 differ from each other. See the following table.

Pin No.	BU108	BU2	Pin No.	BU108	BU2
1	A8	P20	14	AD7	DB7
2	A9	P21	15	AD6	DB6
3	A10	P22	16	AD5	DB5
4	CS2	P23	17	AD4	DB4
5	-8.5	-	18	AD3	DB3
6	-	-	19	AD2	DB2
7	ALE	ALE	20	AD1	DB1
8	$\overline{RD}$	$\overline{PSEN}$	21	AD0	DB0
9	X22	2.5 MHz	22	+5	+5
10	GND	GND	23	$\overline{RD}$	$\overline{RD}$
11	WR	WR	24	TEST	-
12	EXT CONT	-	25	EXT CONT	EXT
13	CS	P27	26	$\overline{INTR}$	$\overline{INT}$

Code display

- Check that, in about three seconds, the text PHILIPS 5 is replaced by code in accordance with the table below. In the code X4, X specifies the delimiters selected by means of jumpers DV1 and DV2 on the Bus Interface board, see the following table. The digit 4 indicates that an IEEE-488 bus interface is connected to the counter.

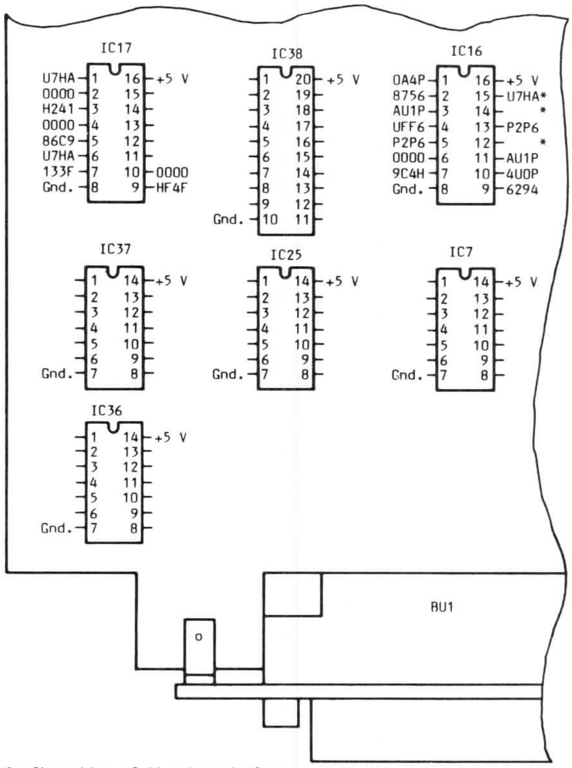
X = blank	X = 1	X = 2	X = 3
CR DV1 LF DV2	CR DV1 LF DV2	CR DV1 LF DV2	CR DV1 LF DV2

- If the X in code X4 is erroneous, measure the signatures listed in this table.

Circuit	Pin	Signatures for X = blank	X=1	X=2	X=3	Trigger level Probe	Pod
IC16	12	0000	U7HA	0000	U7HA	CMOS	TTL
-"-	14	0000	0000	U7HA	U7HA	CMOS	TTL
-"-	15	U7HA	U7HA	U7HA	U7HA	CMOS	TTL

- If the digit 4 is erroneous, measure the signatures listed in this table.

Test points				
IC17:1	IC17:2	IC17:4	IC17:6	IC17:10



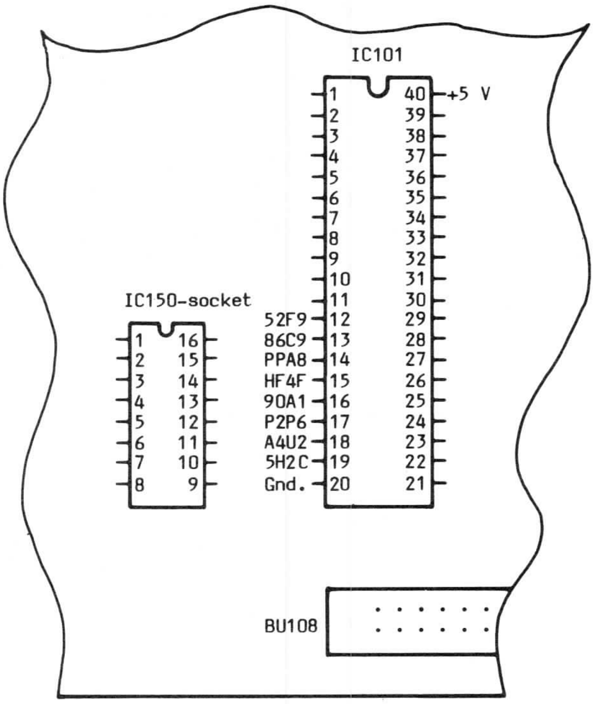
Configuration of Signature Analyzer:

Signal	CLOCK	START	STOP	GND	DATA
Connected to	CL1	ST7	ST7	GND	
Trigger edge					
Trigger level	TTL				TTL * = CMOS
Stimulus program "PHILIPS 5"					

Data bus

- Set the trigger levels for the probe to TTL.
- The data bus should now be checked, regardless of whether the signatures measured were correct or not. The data bus is checked by measuring the signatures at IC101 (CPU on U1). See Table below.

Pin	Signal name	Pin	Signal name
IC101:12	AD0	IC101:16	AD4
IC101:13	AD1	IC101:17	AD5
IC101:14	AD2	IC101:18	AD6
IC101:15	AD3	IC101:19	AD7



Configuration of Signature Analyzer:

Signal	CLOCK	START	STOP	GND	DATA
Connected to	CL1	ST7	ST7	GND	
Trigger edge					
Trigger level	——	TTL	——		TTL
Stimulus program "PHILIPS 5"					

This fault tracing procedure deals with those circuits on the bus interface board which are directly affected by faults on the data bus, namely: address decoder IC40, ports IC38, IC39, IC15, IC16, IC17 and IC18 and the two NAND gates IC36 and IC37 which control the ports.

In principle, the stimulus program functions as follows: First an 8-bit pattern is sent out via ports IC38 and IC39, whereupon ports IC15, IC16 and IC18 are read. Then a new pattern is sent out via ports IC38 and IC39, and the ports IC15, IC16 and IC18 are read again, etc.

Output port IC38 is connected to input ports IC15 and IC18 via AND gates IC24, IC25, transistors TS1...TS8 and Schmitt triggers IC7, IC8, IC13.

The function of this gate and transistor network can be checked by measuring the signatures for DO1...DO7 and ENO at IC38 and then comparing them with the signatures for DI1...DI7 and ENI obtained at IC15 and IC18. These signatures should be identical.

An open circuit on the data bus can be located by measuring the signatures for DB0...DB7 at all circuits where DB0...DB7 should be present and then comparing the signatures with each other.

Moreover, if the same signature is obtained from two bus lines, the reason is probably a short-circuit between the lines, caused by a soldering fault.

Interrupt logic

- If the signatures at IC101 are correct, check the interrupt logic by measuring the signature for the interrupt signal at IC129:9 on U1 (CMOS levels for the data probe). Check that the signature obtained at IC129:9 corresponds to the signature for IC6:13. See the signature map.
- If the signature at IC6:13 is incorrect, proceed by fault tracing in the remaining gating network.

Remaining signals

- Check the remaining bus interface signals by measuring the signatures at the points shown in the following tables:

Test points		
IFC	ATN	REN
IC29:11	IC29:18	IC29:28

- Set the probe trigger levels to TTL.
- The signatures shown in the table below can be measured at the connector on the rear panel of the bus interface (i.e. the connector used for connecting the controller).

Pin No.	Signal name	Signature	Pin No.	Signal name	Signature
1	DIO1	1116	9	IFC	U7HA
2	DIO2	OCP5	10	SRQ	0000
3	DIO3	4767	11	ATN	U7HA
4	DIO4	4511	13	DIO5	P6FF
5	EOI	C2FC	14	DIO6	UF3U
6	DAV	0000	15	DIO7	COCH
7	NRFD	0000	16	DIO8	U7HA
8	NDAC	0000	17	REN	U7HA

If any of the signatures measured in accordance with the tables above are incorrect, fault tracing should be continued in the conventional way, i.e. using an oscilloscope.

Shift register IC10 and IC11

- Connect the signature analyzer "pod" and select the trigger edges in accordance with the following table.

Signal	CLOCK	START	STOP	GND
Connected to	IC10:10	IC10:9	IC10:9	GND
Trigger edge	_|‾	‾|_	_|‾	
Trigger level	3.70V			

- Using the six switches on the rear panel of the bus interface (TALK ONLY and ADDRESS), select the addresses listed in the table below and measure the signatures at IC29:9. Check that they correspond to the signatures listed in the following table.

TALK ONLY	ADDRESS B5	B4	B3	B2	B1	Signature
0	0	1	0	1	0	370P
0	0	0	0	0	0	645C
0	0	0	0	0	1	4686
0	0	0	0	1	1	033H
0	0	0	1	1	1	884A
0	0	1	1	1	1	9PA4
0	1	1	1	1	1	C379
1	1	1	1	1	1	2217

NOTE: On the circuit diagram for the bus interface the signals corresponding to the five ADDRESS switches B1...B5 are designated A1...A5.

- Check that the signature at IC10:3 is 0000.
- Check that all inputs to IC11 (pins 1, 4, 5, 13, 14 and 15) can be switched over between +5 V (signature 3696) and 0 V (signature 0000) by means of the ADDRESS switches.

- Check the pulse width of the control signals sent to the shift registers by turning the function selector switch on the Signature Analyzer to "s" and selecting the following trigger edges:

START: ‾|_   STOP: _|‾

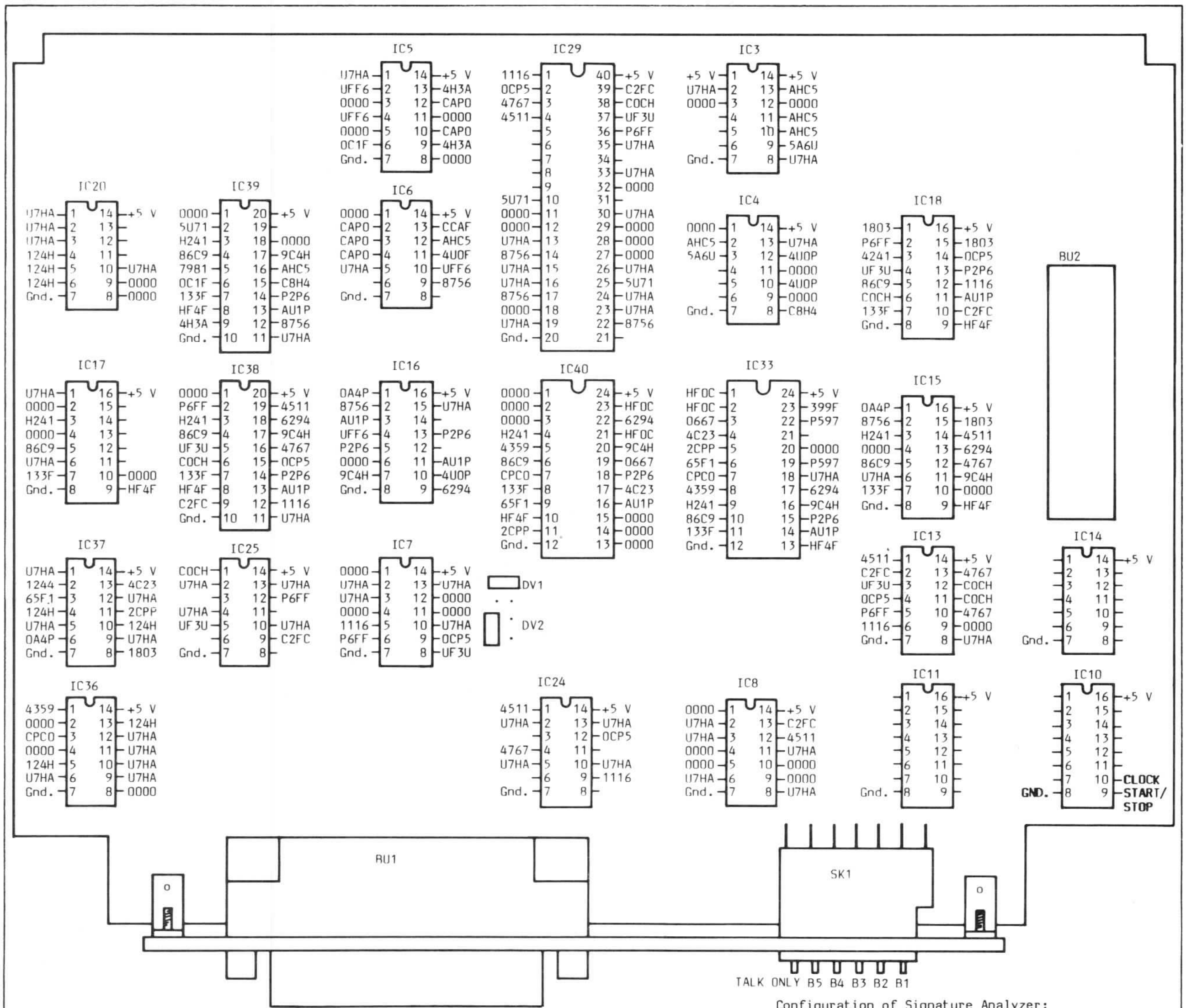
This will trigger a measurement of the time interval between the start and stop signals to the pod. The Signature Analyzer should indicate 72 µs.

- Check the number of clock pulses at the clock inputs to the shift registers by turning the function selector switch on the Signature Analyzer to "EVENTS" and selecting the following trigger edges:

START: ‾|_   STOP: _|‾

- Connect the probe to IC10:10.

The Signature Analyzer will now count the number of pulses at the input to the data probe between the pod's start and stop signals. The Signature Analyzer should indicate 90 pulses for both IC10:10 and IC11:10.



Configuration of Signature Analyzer:

Signal	CLOCK	START	STOP	GND	DATA
Connected to	CL1	ST7	ST7	GND	
Trigger edge	_|‾	_|‾	‾|_		
Trigger level	TTL				TTL * = CMOS*
Stimulus program "PHILIPS 5"					

Signature map for IEEE-488 bus interface board, PM 9696

When the fault is fixed, return to the fault finding tree.

MICROPROCESSOR

Troubleshooting routine No. 7

IC101 CPU, IC102 address latch, IC106 address decoder and IC103...IC105 ROM

The following test equipment is required:

- Signature Analyzer, Philips PM 2544
- Voltmeter
- Oscilloscope, 25 MHz, e.g. PM 3215
- Storage oscilloscope, e.g. PM 3243

Preparations

- Switch the counter to ST BY.
- Set the two switches on the rear panel of the counter to INT and OFF respectively.
- Remove PM 9695 and PM 9696 if installed.
- Connect the "pod" and set the Signature Analyzer according to the signature map below.
- Start the stimulus program "FREE RUN" as follows:

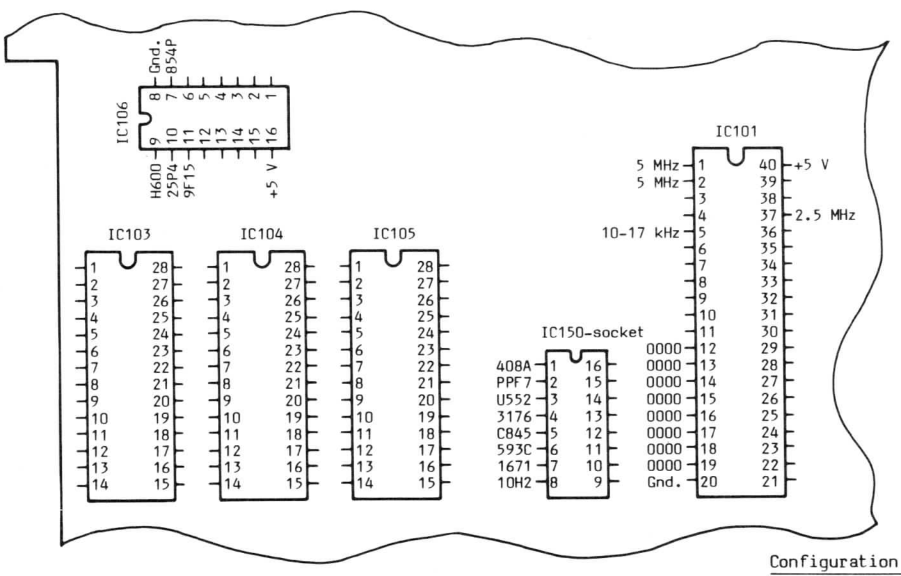
Remove the following IC packages from U1:

Position	Type of circuit
IC150	DIP shunt
IC118	8741A (Slave Processor)
IC107	8155 (RAM, I/O port, timer)
IC111	74LS374 (relay port)

Set jumper DV101 to position TEST and jumper DV102 to position NORMAL then switch the counter ON.

Check

- Check that the GATE indicator on the Signature Analyzer display is blinking. If not, continue with "Supply voltage and input signals to the CPU".
- If the GATE indicator is blinking, measure the signature for +5 V at IC101:40. This signature should be 0001.
- Measure the signatures in the map below.



Configuration of Signature Analyzer:

Signal	CLOCK	START	STOP	GND	DATA
Connected to	CL1	ST1	ST1	GND	
Trigger edge	⎍ (rising)	⎍ (rising)	⎍ (rising)		
Trigger level	TTL				
Stimulus program FREE RUN					

Signature map for IC101 (CPU), IC102 (address latch), IC106 (address decoder and IC103...IC105 (ROMs)

Supply voltage and input signals to the CPU

- Use the oscilloscope to check the signal levels and frequencies at the points listed in the following table.

Test points	Signal levels	Frequencies
IC101:40	+5 V	DC
IC101:20	0 V	DC
IC101:1	High: ⩾2 V Low: ⩽0.8 V	5 MHz
IC101:2	High: ⩾2 V Low: ⩽0.8 V	5 MHz
IC101:5	High: ⩾2 V Low: ⩽ 0.8 V	10...17 kHz
IC101:37	High: ⩾2.4 V Low: ⩽ 0.45 V	2.5 MHz

- If the GATE indicator on the Signature Analyzer is blinking, continue with "Pull-down resistors".
- If the GATE indicator is not blinking, use the oscilloscope to check the signals at the soldering lugs CL1, CL2 and ST1 as follows:

Testpoint	Signal levels	Frequency
CL1	High:⩾2.4 V, Low:⩽0.45 V	620 kHz
CL2	High:⩾2.4 V, Low:⩽0.45 V	620 kHz
ST1	High:⩾2.4 V, Low:⩽0.45 V	10 Hz

- If the signal level or frequency at any of these soldering lugs is incorrect, check that pin 1 on resistor network IC135 is grounded via jumper DV101 (i.e. DV101 must be positioned at the SIG.TEST position).

Pull-down resistors

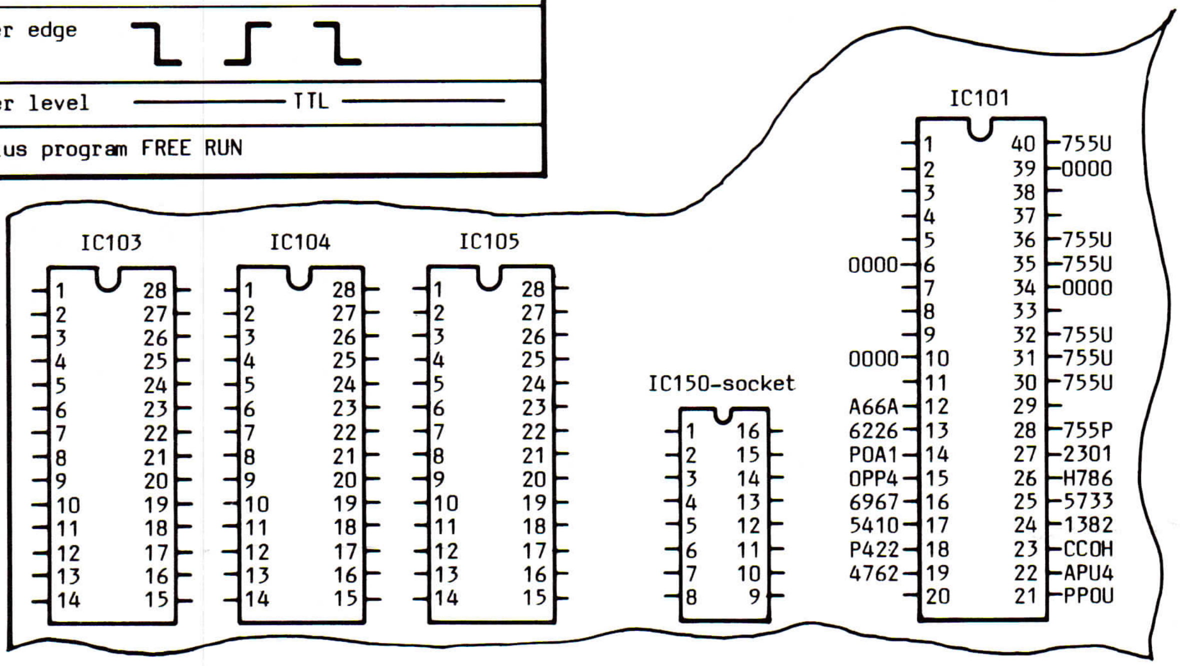
- Measure the signatures at IC101:12-19. (See the signature map on the previous page.)
- If any of the signatures are incorrect, check that pin 1 on resistor network IC135 is grounded via DV101.

Microprocessor

- Reconnect the Signature Analyzer pod and select the trigger edges in accordance with the table in the map below.
- Measure the signatures for IC101.

Configuration of Signature Analyzer:

Signal	CLOCK	START	STOP	GND	DATA
Connected to	CL2	ST1	ST1	GND	
Trigger edge	falling edge	rising edge	falling edge		
Trigger level	TTL				
Stimulus program FREE RUN					



Signature map for checking the input and output signals for the Microprocessor.

Address latch IC102:

- Reconnect the Signature Analyzer pod and select the trigger edges in accordance with the table below.
- Measure the signature for +5 V at IC102:20. This signature should be 755U.
- Measure the green signatures.

Select the following trigger edge for CLOCK:

↓

Measure the yellow signatures.

Address decoder IC106

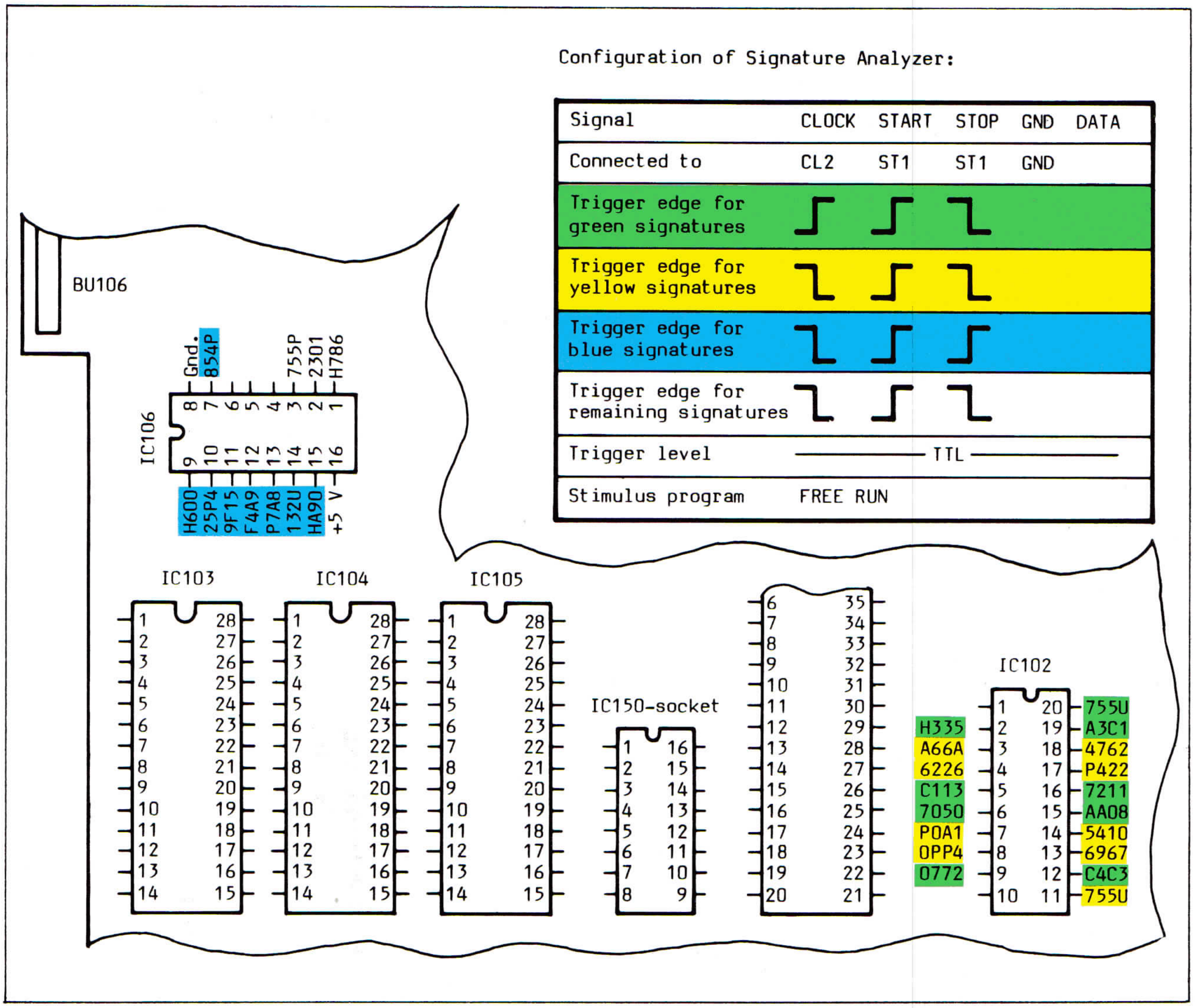
- Reconnect the Signature Analyzer pod and select the trigger edges in accordance with the signature map below.
- Measure the blue signatures.
- If all signatures are correct, continue with "Outputs from IC103...IC105" and "Inputs to IC103...105".
- Select the following trigger edge for STOP:

↓

- Measure the rest of the signatures.

Configuration of Signature Analyzer:

Signal	CLOCK	START	STOP	GND	DATA
Connected to	CL2	ST1	ST1	GND	
Trigger edge for green signatures	↑	↑	↓		
Trigger edge for yellow signatures	↓	↑	↓		
Trigger edge for blue signatures	↓	↑	↑		
Trigger edge for remaining signatures	↓	↑	↓		
Trigger level	TTL				
Stimulus program	FREE RUN				



Signature map for fault tracing in the address latch IC102 and for the address decoder IC106

Outputs from IC103...IC105

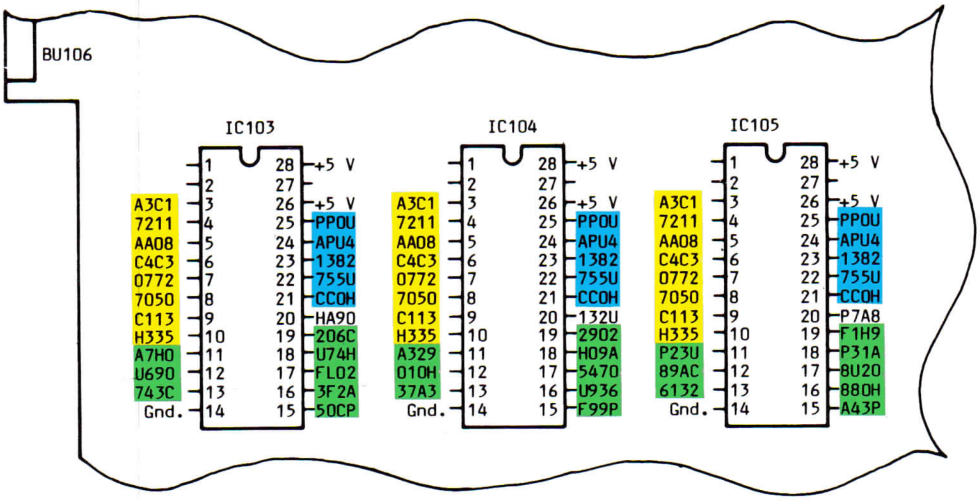
- Reconnect the pod and select the trigger edges in accordance with the table below. Note that the pod connection is different for the three ROMs.
- Measure the green signatures at IC103...IC105.
- If any incorrect signature is obtained, continue with "Inputs to IC103...IC105".

Inputs to IC103...IC105

- Reconnect the pod and select the trigger edges in accordance with the right hand table.
- Measure the yellow signatures.
- Change the trigger edge for CLOCK to ↓
- Measure the blue signatures.
- Change the trigger edge for STOP to ↑
- Measure the remaining signatures.
- After all fault tracing operations have been concluded, restore the previously removed IC packages (IC150, IC118, IC107 and IC111) to their proper positions.

Signal	CLOCK	START	STOP	GND	DATA
Testing IC103	CL1	ST2	ST3	GND	
Testing IC104	CL1	ST3	ST4	GND	
Testing IC105	CL1	ST4	ST5	GND	
Trigger edge green	↑	↓	↓		

Signal	CLOCK	START	STOP	GND	DATA
Connections	CL2	ST1	ST1	GND	
Trigger edge yellow	↑	↑	↓		
Trigger edge blue	↓	↑	↓		
Trigger edge white	↓	↑	↑		
Trigger level	TTL				
Stimulus program FREE RUN					



Signature map for fault tracing ROM packages IC103...IC105.

RELAY- AND MULTIPLEXER PORTS

Troubleshooting routine No. 8

IC107 RAM 8155, IC111 relay port and IC110 multiplexer port

Signal	CLOCK	START	STOP	GND	DATA
Connections	CL1	ST7	ST7	GND	
Trigger edge	↑	↑	↓		
Trigger level	TTL				
Trigger level *)	TTL				CMOS
Stimulus program FREE RUN					

Preparations

- Set the two switches on the rear panel of the counter to INT and OFF respectively.
- Switch the counter to ST BY.
- Switch the Signature Analyzer ON.
- Connect the "pod" to the appropriate soldering lugs on U1 and select the trigger edges in accordance with the table on the signature map.
- Start the stimulus program"for testing U1"by setting jumper DV101 to position NORMAL and jumper DV102 to position TEST and then switching ON the power switch.

  CAUTION: The power switch should always be switched to ST BY when no tests are in progress, in order to protect the relays on U2.

- Check whether the GATE indicator on the signature analyzer display is blinking. If not, continue with "IC107 supply voltage and input signals".

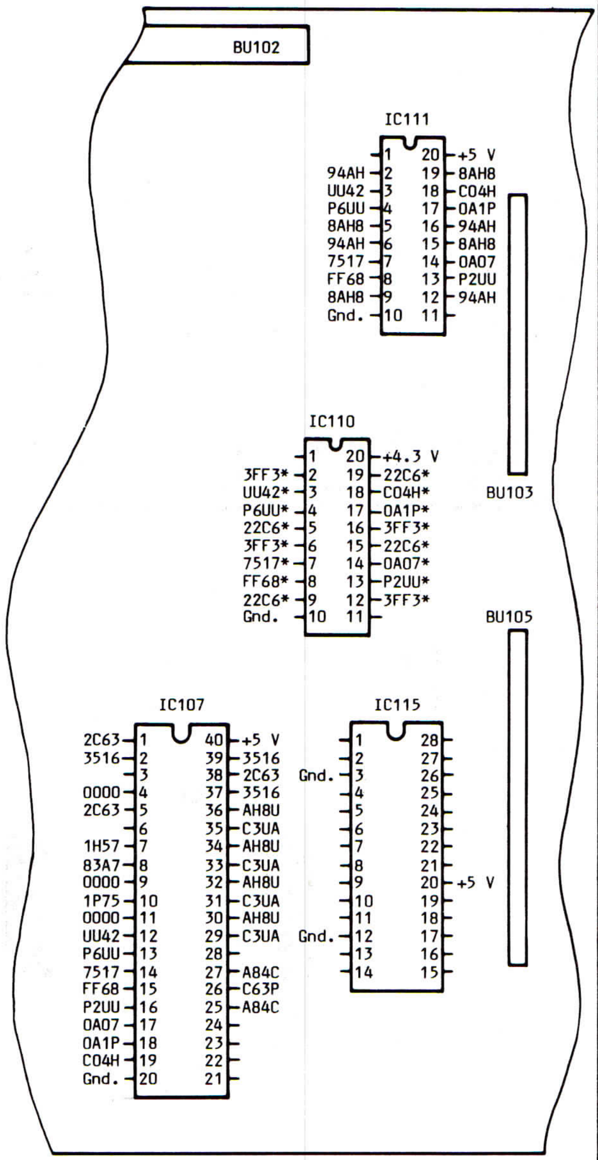
- Measure the signature for +5 V at IC107:40. This signature should be 1P75.

IC107 RAM 8155

- Measure the following signatures at IC107:

Circuit IC107					
Pin	Signal name	Pin	Signal name	Pin	Signal name
25	PA4	32	PB3	38	PC1
26	PA5	33	PB4	39	PC2
27	PA6	34	PB5	1	PC3
29	PB0	35	PB6	2	PC4
30	PB1	36	PB7	5	PC5
31	PB2	37	PC0		

- If any incorrect signature is obtained, continue with "IC107 supply voltage and input signals".



IC107 supply voltage and input signals

- Use an oscilloscope to check the frequencies and signal levels listed in following table:

IC107			
Pin	Signal name	Signal levels	Frequency
40	Supply volt.	+5 V	DC
20	GND	0 V	DC
3	TIMI	H: ⩾ 2 V L:⩽0.8 V	330 kHz(3 μs)

- If the GATE indicator on the Signature Analyzer is blinking, continue fault tracing at "Remaining signals at IC107".
- If the GATE indicator is not blinking, use the oscilloscope to check the signals listed in the following table:

Pin	Signal name	Signal levels	Frequency
ST7	SOD	H:⩾2.4V;L:⩽0.45V	27 Hz (36 ms)
CL1	RD	H:⩾2.4V;L:⩽0.45V	620kHz (1.6μs)
IC101:5	SID	+5 V	DC

Remaining signals at IC107

- Measure the signatures at the following pins of IC107, see table below.

IC107					
Pin	Signal name	Pin	Signal name	Pin	Signal name
4	RESET	11	ALE	16	AD4
7	IO/$\overline{M}$	12	AD0	17	AD5
8	CE	13	AD1	18	AD6
9	RD	14	AD2	19	AD7
10	WR	15	AD3		

- The signatures obtained should correspond to those in the signature map on the next page. The signatures should remain the same even if IC111 (relay port) and IC118 (Slave Processor) are removed.
- Thus, if any of these signatures are incorrect, IC111 and IC118 can be removed, and the measurement repeated in order to ascertain whether the measurements are influenced by these components.
- If all signatures are correct, continue fault tracing at "IC111 relay port".
- If any of the signatures measured against the signature map on the next page are incorrect, remove IC107, IC111 and IC118.
- Connect the CLOCK lead of the pod to IC101:31 (i.e. the WR output from the Microprocessor IC).
- Now measure the signatures again at the pins of the IC socket for IC107. They should correspond to those listed in the table below.

NOTE: These signatures differ from those shown on the signature map.

IC107					
Pin	Signature	Pin	Signature	Pin	Signature
4	0000	11	0000	16	U6U1
7	C70H	12	6515	17	C9A8
8	4153	13	9P61	18	UPOF
9	0320	14	6HP8	19	7424
10	0000	15	53PH		

Re-install IC107, IC111, IC118 and IC150.

IC111, relay port

- Connect the pod and set the trigger levels according to the table on the next page.
- Measure the signatures at IC111.

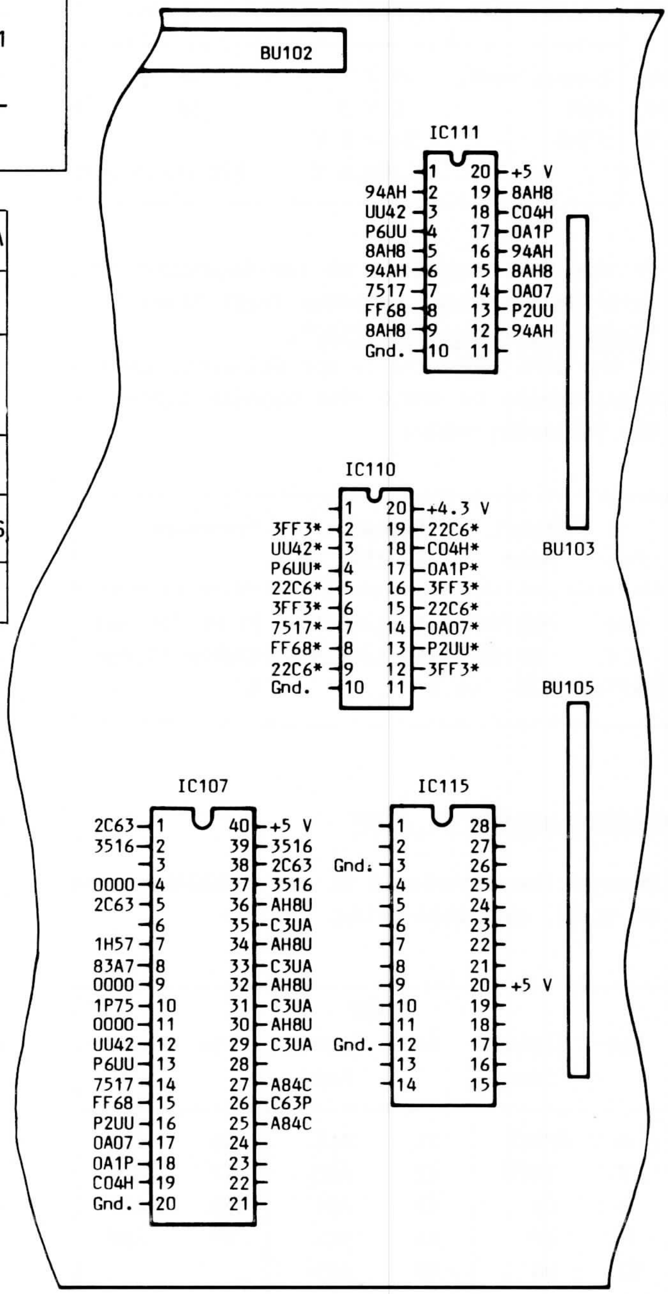
- Connect the CLOCK lead of the pod to IC101:31 (i.e. the WR output from the Microprocessor IC).
- Measure the signature at IC111:11. This signature should be 7H42.

- If all signatures are correct, continue with "IC110 multiplexer port".

IC110, multiplexer port

- Change the trigger levels for the data probe to CMOS by pressing the DATA key on the Signature Analyzer. Check that the LED in the key lights up.
- Measure the signatures at the pins on IC110 given in the following table.
- Connect the CLOCK lead of the pod to IC101:31 (i.e. the WR output from the Microprocessor).
- Measure the signature at IC110:11. This signature should be 3F11.

Signal	CLOCK	START	STOP	GND	DATA
Connections	CL1	ST7	ST7	GND	
Trigger edge	_|‾	_|‾	‾|_		
Trigger level	TTL				
Trigger level *)	TTL				CMOS
Stimulus program FREE RUN					



Signature map for Relay port IC111 and multiplexer port IC110

When the fault is fixed, return to the fault-finding tree.

FATAL ERROR

Troubleshooting routine No. 9

Fatal error check

A fatal error in the counter is indicated by the fact that the display immediately shows zeros when power is turned on. This may, for example, be caused by a key which is stuck in the depressed position. If this is not the case, the following basic checks should be carried out:

- Check that the flat cable connector from the Keyboard is properly connected to the Microprocessor board. Also check the other connectors.
- Check the power supply, see below.
- Replace IC118 (Slave Processor) on U1.
- Replace IC101 (Microprocessor) on U1.
- Replace IC107 (RAM, I/O, TIMER) on U1.
- Replace IC103...IC105 (ROMs) on U1.
- Check that a 5 MHz clock signal is present at pins 1 and 2 on IC101 and at pins 2 and 3 on IC118. Check also that the clock signal has acceptable TTL levels.
- Check that a 10-17 kHz clock signal is present at IC101:5 (SID input) and that the signal has acceptable TTL levels.
- Check that the reset signal at IC101:36 and at IC118:4 is high (+5 V) when power has been turned on.
- Set the measuring time to 96 s. Check that a positive pulse with a pulse duration of approximately 2.5 ms is obtained at the MEA.TIME TP test point on U1.

Power supply

When servicing the power supply, be careful with the connected mains voltage, if possible power the counter from a 24 V DC supply.

If the primary fuse VL10 has blown, the protection diodes GR235 and GR 240 must also be replaced.

Check that the output voltages are according to the following table.

Voltage	Range(V)	Ripple	Test point
+12	11.4... 12.6	15 mV_{pp}	BU203:12
+5	5.1... 5.2	15 mV_{pp}	BU203:8
-5	-5.0... -5.3	10 mV_{pp}	BU203:10
-8.5	-8.3... -9.0	30 mV_{pp}	BU203:3
-12	-11.5...-13.0	30 mV_{pp}	BU203:11
-30	-28.0...-32.0	50 mV_{pp}	BU203:6

If any voltage differs, check that particular part of the power supply and distribution system.

Check if the current limiter is activated by measuring the voltage on IC206:11. The voltage should be 0 V otherwise there is a short circuit on the secondary side.

It is possible to check if the counter circuits loads the power supply too much:
- Remove the power cord.
- Disconnect BU203 and connecting a 4.7 ohms reostat in series with an Ampere-meter between BU203:4 and BU203:8.
- Install a jumper connection between BU203:5 and 12.
- Connect the power cord and adjust the reostat to 1 A.

Check all voltages according to the table above.

If all output voltages are missing, measure the DC voltage on both sides of the secondary fuse VL201. The voltage should be 24 V. If it is OK, check IC205.

If all voltages except +12 V are missing, then IC206 or the switch transistor TS217 is not working properly.

Check with an oscilloscope on IC206:14 for 50 kHz output pulses. the output swing should be from 0 V to 9 V and the duty cycle around 25%.

If the pulses are OK, check the signals at TS217 and the outputs from coil T201. Compare with the circuit diagram in chapter 10.

Note that the negative outputs from T201 swings positive up to +80 V before the rectifying diode.

Check the +12 V on IC206:14 and the stabilized +8.6 V output on IC206:2.

Check the remote OFF input IC206:10. It must be high (approx. 4.85 V).

Use the oscilloscope to check IC 206:4 at power ON. The voltage should rise to +8 V and then as the circuit starts, fall to below +5 V.

After replacement of any components in the power supply, repeat the adjustment procedure described in chapter 6.

SAFETY INSPECTION AND TEST AFTER REPAIR

General directives

Take care that creeping distances and clearances have not been reduced.

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 circuit are important to the safety of the instrument and may only be renewed by components obtained from your local Philips organisation.

Check the protective earth connection

The correct connection and condition is checked by visual control and by measuring the resistance between the protective lead at the plug and the cabinet. The resistance must not be more than 0.5 ohms. During measurement, the power cord should be moved. Resistance variations indicate a defect.

6. ADJUSTMENTS

CONTENTS

GENERAL INFORMATION

The following information provides the complete checking and adjusting procedure for the instrument. As various control functions are interdependent, a certain order of adjustment is often necessary.

The procedure is therefore presented in a sequence which is best suited to this order, cross references being made to any circuit which may affect a particular adjustment.

Before any check or adjustment, the instrument must attain its normal operating temperature.

- Warming up time under average conditions is 45 minutes.

- Where possible, instrument performance should be checked before an adjustment is made.

- All limits and tolerances given in this section are calibration guidelines, and should not be interpretated as instrument specifications unless they are also published in chapter "Technical specification" of the Operating Manual.
- Tolerances given are for the instrument under test and do not include test equipment errors.

REQUIRED TEST EQUIPMENT

- Oscilloscope, 25 MHz or better, e.g. Philips PM 3215 with probes

- Sampling oscilloscope with a maximum risetime of 0.5 ns, with FET probe

- LF synthesizer, Philips PM 5190

- RF signal generator, e.g. Wavetek 2002A

- Power supply, e.g. Philips PE 1542

- Logic multimeter, e.g. Philips PM 2544

- Counter, e.g. Philips PM 6670-72 with probe PM 8922

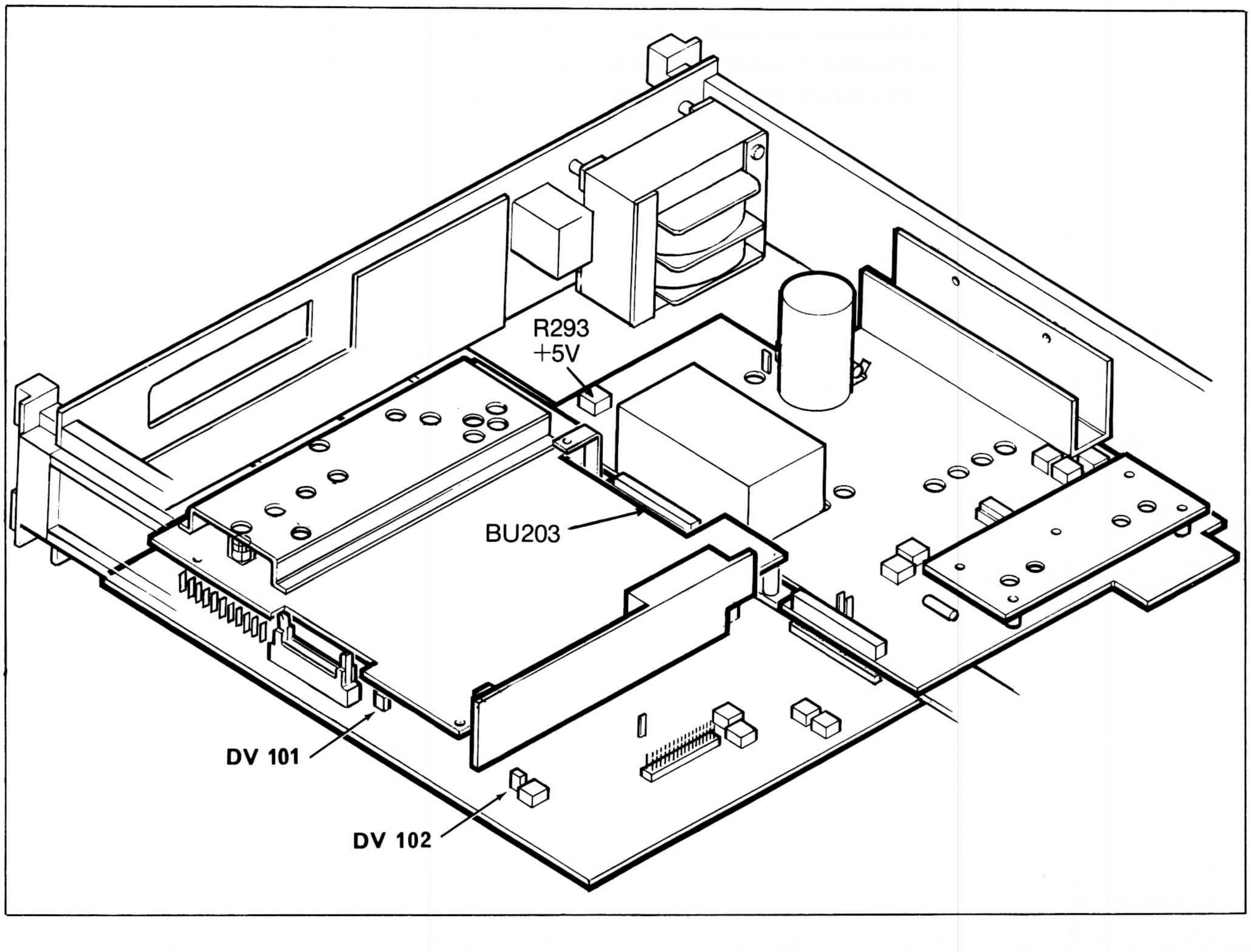
- 20 dB BNC attenuator

- Adapter PM 9051

- Rheostat, 4.7 ohm, 10 A

- 10 MHz ref. signal source, inaccuracy 1×10^{-6}

- Trimming screwdriver for standard oscillator adjustment, ELCOMA Nos. 7122 347 21600 and 7122 005 47910



INITIAL SETTINGS

- Set the INT/EXT STD IN switch on the rear panel to the INT position (i.e. internal clock oscillator).

- Set the EXT CONTR switch on the rear panel to the OFF position (i.e. no external control).

- Check that jumpers DV101 and DV102 on U1 (Microprocessor board) are in the NORMAL positions.
- Switch the counter ON (POWER ON switch on the front panel). If the cursor indicates one of the programs P1...P8, set it in a non-programmed mode. i.e. moving it out of the program area by means of the FUNCTION keys.
- Switch the counter to ST BY.

ADJUSTMENT PROCEDURES

General

Switch ON the counter and wait for approximately 45 minutes to make sure that the counter is properly warmed up before you begin the adjustment procedures. Check the internal supply voltages as described below.

Power Supply

- Connect a voltmeter to connector BU203:4 (GND) and BU203:8 (+5 V).

- Adjust the +5 V supply voltage to 5.15 ±0.01 V by means of potentiometer R293.

- Check that the other supply voltages are within the voltage ranges specified in the table below. The table also presents typical ripple values.

- Measure the time between TRAP (BU203:2 goes high) and CPU RES (BU203:1 goes low). Press the RESET key on the counter. The measured time T should be between 0.5 ms and 3 ms.

- Check that the -30 V supply voltage is cut OFF before +5 V drops below +4.7 V. Trigger the oscilloscope using -30 V (BU203:6) and observe the +5 V supply as the power supply is switched to ST BY.

- The reset time at power ON shall be more than 40 ms.

Voltage	Range(V)	Ripple	Test point
+12	11.4... 12.6	15 mV_{pp}	BU203:12
+5	5.1... 5.2	15 mV_{pp}	BU203:8
-5	-5.0... -5.3	10 mV_{pp}	BU203:10
-8.5	-8.3... -9.0	30 mV_{pp}	BU203:3
-12	-11.5...-13.0	30 mV_{pp}	BU203:11
-30	-28.0...-32.0	50 mV_{pp}	BU203:6

Checking the trigger levels

- Select the TRIGGER LEVEL potentiometers as follows:
  - o Not AUTO (LED OFF)
  - o Not KEYBOARD (LED OFF)
  - o READ (LED ON)

  The display should now show the trigger levels for channels A and B.

- Turn both TRIGGER LEVEL potentiometers fully clockwise.

- Check on the display that the trigger levels are between +5.02 V and +5.10 V, in both channels.

- Turn both TRIGGER LEVEL potentiometers fully counterclockwise.

- Check on the display that the trigger levels are $<$ -5.00 V in both channels.

If the trigger levels are outside the specified limits, fine adjust the +5 V supply voltage (R293) to within a range of 5.1...5.2 V.

Attenuators

- Carry out the initial setting operations as described in the section headed INITIAL SETTINGS. Then restart the counter and wait for approximately 3 s.

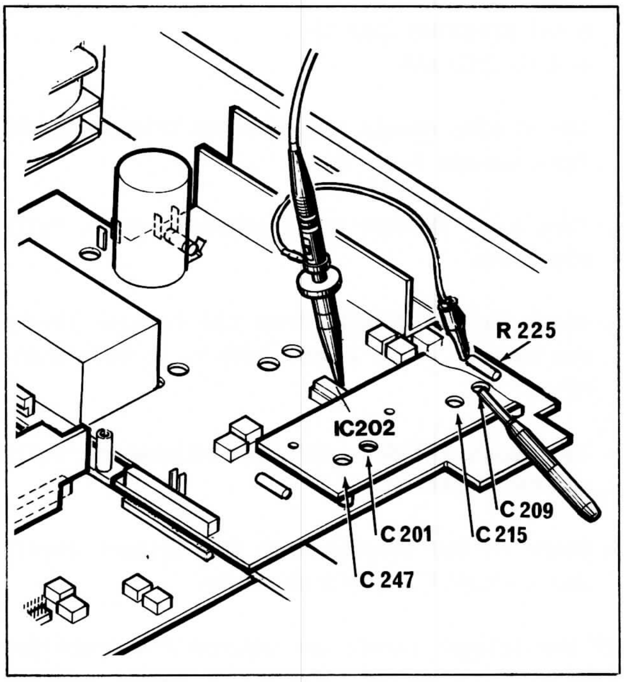
- Turn the MEASURING TIME control knob fully clockwise.

- Select the numeric keyboard by pressing the KEYBOARD key.

- Select 50 ohm termination for channels A and B.

- Connect an LF synthesizer to input A when the attenuator for channel A is to be adjusted and to input B when the attenuator for channel B is to be adjusted.

- Use the oscilloscope to measure the step response for channel A between IC202:7 and GND (the grounded side of R201) and for channel B between IC202:10 and GND (the grounded side of R225).

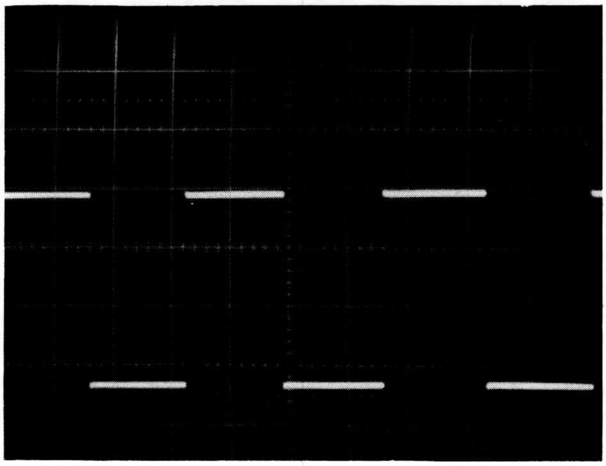


LF response

- Set the LF synthesizer to: 3 kHz square-wave signal, amplitude 3 V_{pp}.

- Oscilloscope setting:
  o Ampl/div - 20 mV
  o Time/div - 0.1 ms

- Adjust C247 and C209 on U2 (for channels A and B respectively) to obtain a step response that resembles a square wave as closely as possible.



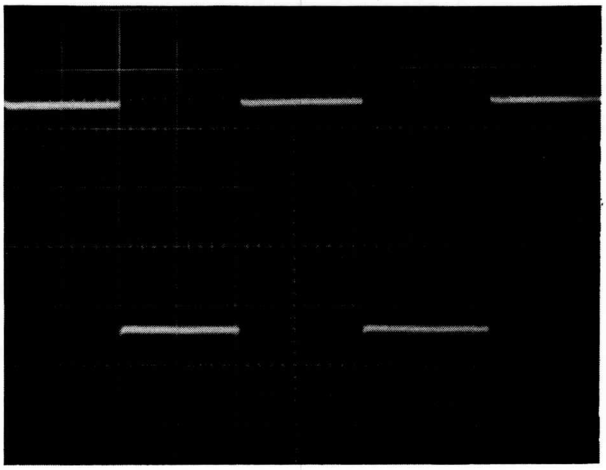
RF response

- Change the setting of the LF synthesizer to: 12 kHz square-wave signal, amplitude 18 V_{pp}.

- Select ATT X10 for channels A and B.

- Change the oscilloscope setting to:
  o Ampl/div - 10 mV
  o Time/div - 20 µs

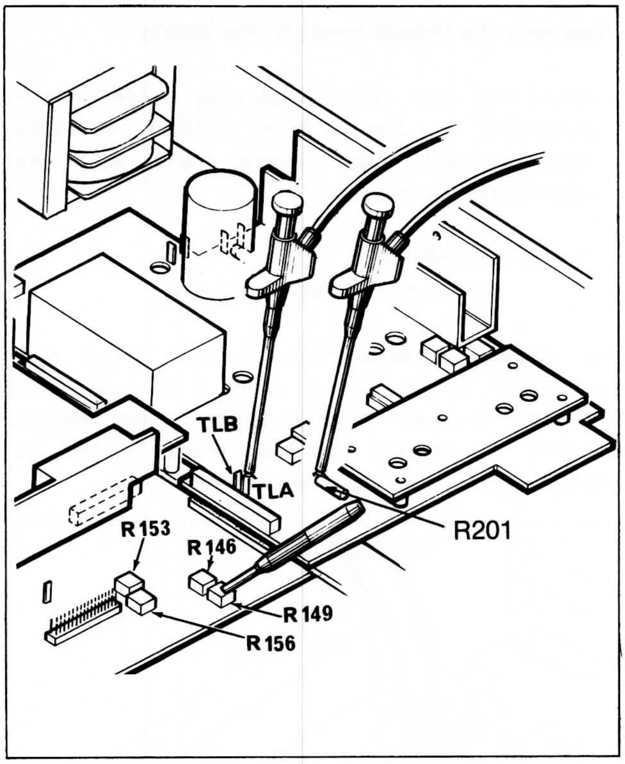
- Adjust C201 and C215 on U2 (for channels A and B respectively) to obtain a step response that resembles a square wave as closely as possible.



DAC A and DAC B

- Carry out the initial setting procedures as described in the section INITIAL SETTINGS. Then restart the counter and wait for approximately 3 s.

- Connect a voltmeter - for DAC A to test point TLA and GND (the grounded side of R201) and for DAC B to TLB and GND (the grounded side of R225) on U2.



- Adjust the ZERO A potentiometer R153 for DAC A (or the ZERO B potentiometer R156 for DAC B) on U1 until the voltmeter indicates 0 ±0.5 mV.

- Set the trigger level for channel A (or channel B) to 5.12 V as follows:
  o Press the SET A (or SET B) key.
  o Enter 5.12 on the numeric keyboard.
  o Press the ENTER key.

- Adjust the F.S.A (FULL SCALE A) potentiometer R146 for DAC A (or the F.S.B potentiometer R149 for DAC B) on U1 until the voltmeter indicates +5.120 ±0.003 V.

- Set the trigger level for channel A (or channel B) to -5.11 V in the same way as described above.

- The voltmeter should indicate -5.110 ±0.005 V.

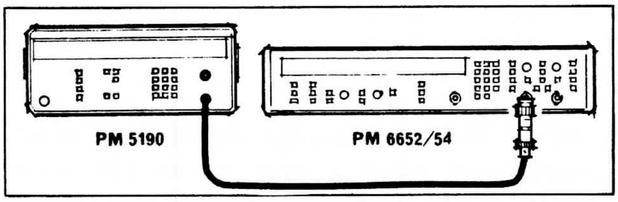
- If the error exceeds ±0.005 V, adjust F.S.A (or F.S.B) so that the error is distributed evenly between -5.110 V and +5.120 V. After this adjustment, the voltmeter should indicate +5.12 ±0.01 V and -5.11 ±0.01 V respectively. (Note that the setting of the ZERO A and ZERO B potentiometers must not be changed during these adjustments.)

Offset and Sensitivity

- Carry out the initial setting operations as described in the section INITIAL SETTINGS. Then restart the counter and wait for approximately 3 s.

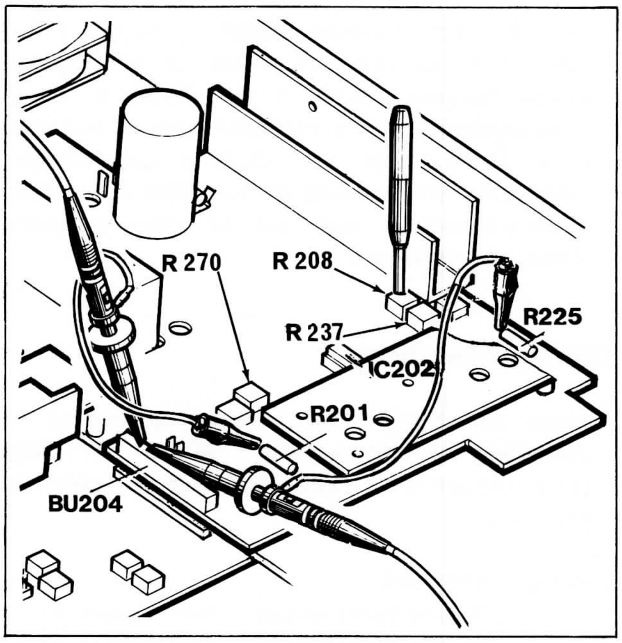
- Select: KEYBOARD
  50 ohm termination - for channel A
  50 ohm termination - for channel B
  AC coupling - for channel B

- Connect a 20 dB attenuator to channel A (or channel B) and then connect the LF synthesizer to the attenuator.

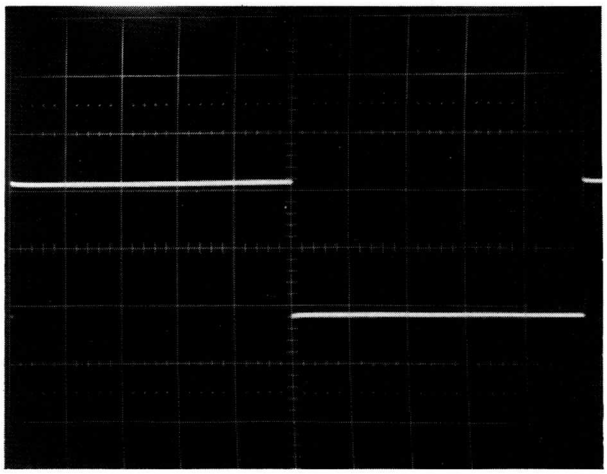


- Set the LF synthesizer to: 10 kHz sine-wave signal, amplitude 0.60 V_{pp}.

- Connect a Voltmeter to IC202:13.
- If IC202 is a AD687, Turn the SENS potentiometer R208 on U2 until the voltage on IC202:13 is 0 V
- If IC202 is a AD9687, Turn the SENS potentiometer R208 on U2 until the voltage on IC202:13 is as much negative as possible.



- Connect the oscilloscope: for channel A to BU204:6 and GND (the grounded side of R201), and for channel B to BU204:4 and GND (the grounded side of R225) on U2.
- Oscilloscope setting:
  - o Ampl/div - 50 mV
  - o Time/div - 10 üs
  - o DC-coupled triggering
  - o AC coupled input
- Adjust the oscilloscope so that a single square-wave pulse extends across the entire width of the screen and so that the leading and trailing edges of the pulse coincide exactly with the left-hand and right-hand edges of the graticule.



- Adjust the OFFSET A potentiometer R270 for channel A (or the OFFSET B potentiometer R237 for channel B) on U2 for a duty factor of 0.5.

- Turn back the SENS potentiometer until the signal image on the oscilloscope screen just stops jittering.

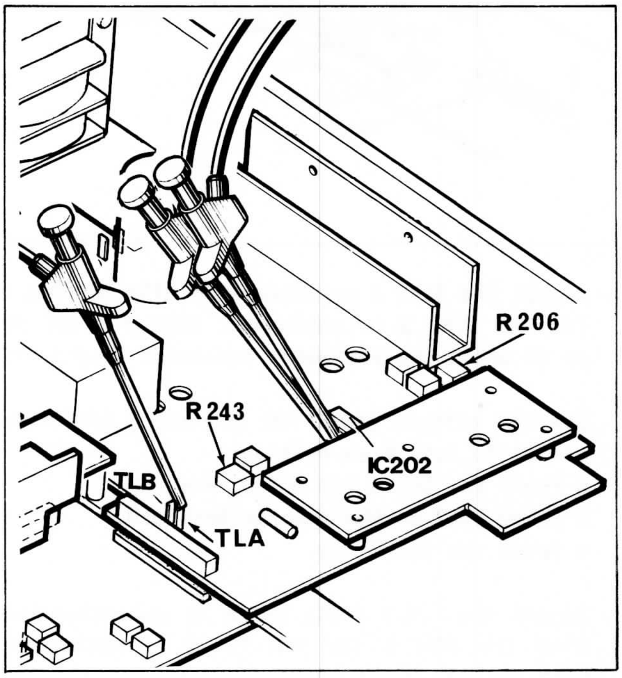
- Fine adjust the OFFSET A (or OFFSET B) and SENS potentiometers once again.

Adapting the trigger levels to the inputs

- Carry out the initial setting procedures as described in the section INITIAL SETTINGS. Then restart the counter and wait for approximately 3 s.

- Select: KEYBOARD
  DC coupling for channel A

For channel A adjustment, connect input A to test point TLA an U2 (or input B to test point TLB for channel B adjustment). Use adapter PM 9051 to connect the test point to the BNC centre pin on the input connector.



- Connect a voltmeter to IC202, pins 7 and 8, on U2 (channel A) or to IC202, pins 9 and 10 (channel B).

- Set the trigger level for channel A (or channel B) to +5 V via the numeric keyboard.

- Adjust the ATT A potentiometer R243 for channel A (or the ATT B potentiometer R206 for channel B) on U2 until the voltmeter indicates 0 ±3 mV.

- Set the trigger level for channel A (or channel B) to -5 V via the numeric keyboard.

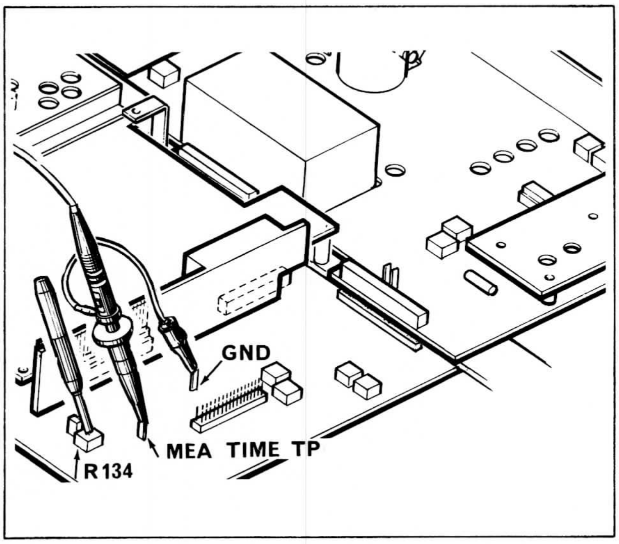
- Check that the voltmeter indicates 0 ±3 mV.

Measuring time

- Connect the A input of an external counter (e.g. PM 6670...72) via the probe PM 8922 to the MEA. TIME TP test point (or to IC124:3, if no test point is provided) and the closest GND point on U1.

- External counter setting:
  - o Function: TIME INT
  - o SLOPE A:
  - o SLOPE B:
  - o COMmon key: pressed
  - o TRIGGER LEVEL A: +0.25 V
  - o TRIGGER LEVEL B: +0.25 V
  - o Coupling A: DC
  - o MEASURING TIME: minimum

- Turn the MEASURING TIME control knob on the instrument to be tested fully clockwise.

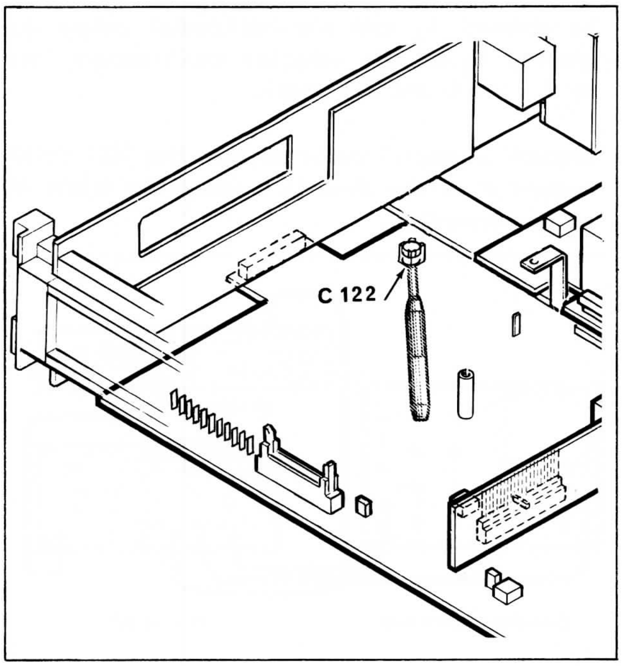


- Adjust the MEASURING TIME potentiometer R134 on U1 until the time displayed on the external counter becomes 2.55 ±0.05 ms.

Standard oscillator (version 01)

- Carry out the initial setting procedures as described in the section INITIAL SETTINGS. Then restart the counter and wait for approximately 3 s.

- Set the measuring time to 0.8 s.



- Connect the external 10 MHz reference signal source to input A.

- Set the oscillator frequency to 10 MHz ±10 Hz by adjusting the 10 MHz trimmer capacitor C122 on U1. If the counter has a hole in the board under the trimmer, the trimming should be performed from the solderside of U1, through the hole in the board. Use the screwdriver specified in 'Required test equipment'.

NOTE: The frequency adjustment instructions for the optional oscillators (versions 02..05)appear in the "Options" chapter.

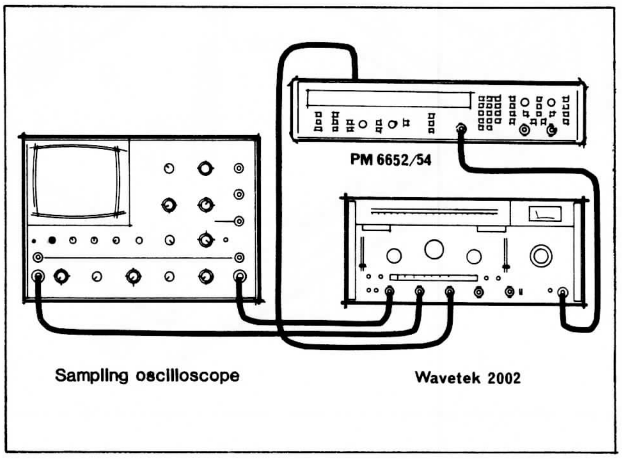
Channel C input (PM 9610)

- Connect an RF signal generator with a 1500 MHz frequency range (e.g. a Wavetek 2002A) to the Channel C input.

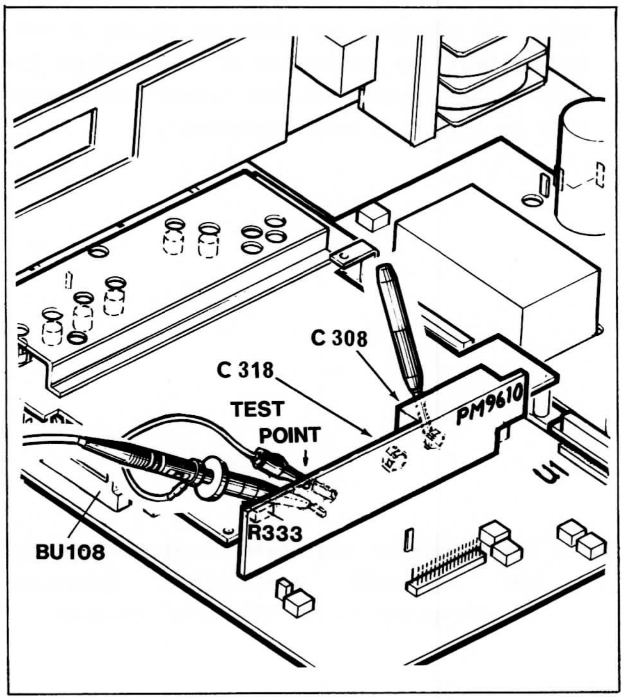
- Set the generator output level to -30 dBm.

- Connect the vertical output of the generator to channel Y_A and the horizontal output to channel Y_B of the sampling oscilloscope (set to 0.1 V/div and X/Y mode).

- Connect a coaxial cable between the TEST POINT connector on the Channel C board and DEMOD IN on the generator.



- Adjust C308 and C318 on the Channel C board for max output at 1500 MHz. The output level at 1200...1400 MHz must not be lower than at 1500 MHz.



- Connect BU108:22 to BU108:24 on U1.

- Measure the minimum input level for which the counter counts correctly at 100, 200, 1000 and 1500 MHz.

- Remove the connection between BU108:22 and 24.

- Adjust R333 on the C-channel board to -30 dBm sensitivity at 1000 MHz. The difference in sensitivity between TEST high and TEST low should be greater than 1 dB.

- Check the sensitivity at 100, 200, 900 and 1500 MHz. The sensitivity should be -27 dBm for 100...1000 MHz and fall to -17 dBm at 1500 MHz.

- Connect a 50 MHz signal with a high amplitude, maximum 12 V_{RMS} to the Channel C input. Check that the counter measures correctly.

CEX board U7 for PM 6654

- Carry out the initial setting operations as described in the section INITIAL SETTINGS, but set the EXT CONTR switch on the rear panel to the ARMING position. Then restart the counter and wait for approx. 3 s.

- Store the following settings as programs P1 and P2:

Program P1:
o Select the TIME A-B function.
o Set the measuring time to 0.1 s.
o Set the trigger levels for channels A and B to 0.5 V via the numeric keyboard.
o Select the following:

* SLOPE A:
* DC coupling for channel A
* 50-ohm termination for channel A
* KEYBOARD
* COM

Program P2:
o Select the FREQ A function.
o Set the measuring time to 96 s.
o Set the trigger levels for channels A and B to 0.5 V via the numeric keyboard.
o Select the following:

* SLOPE A:
* DC coupling for channel A
* 50-ohm termination for channel A
* KEYBOARD
* COM

- Select program P1.

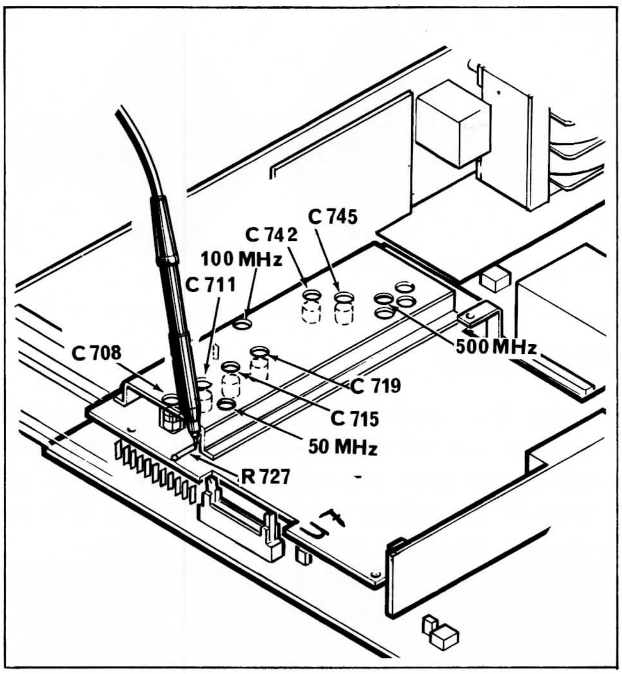
- Connect +3 V from a DC power source to the EXT RESET input on the rear panel.

- If a trimmer capacitor has to be replaced, look carefully at the setting of the old capacitor before removing it. Then set the new capacitor exactly to the same position. Do not make any other adjustments to the trimmer capacitors yet.

NOTE: To facilitate triggering, the sampling oscilloscope can be connected to the counter's 10 MHz OUT output via a 20 dB attenuator.

10 MHz signal

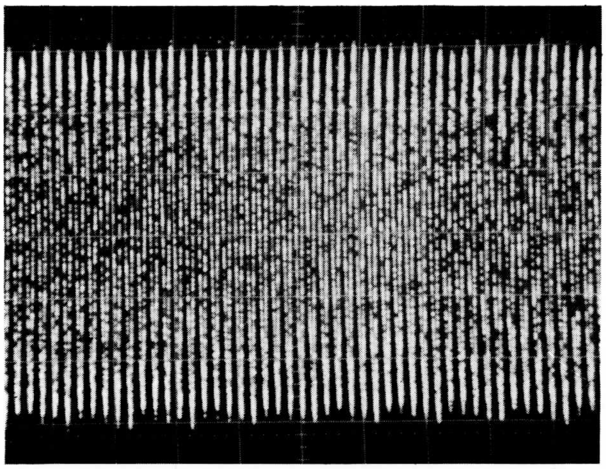
- Using the sampling oscilloscope, measure the 10 MHz signal at resistor R727 or at BU701:19 (use the edge of the screen box as ground).



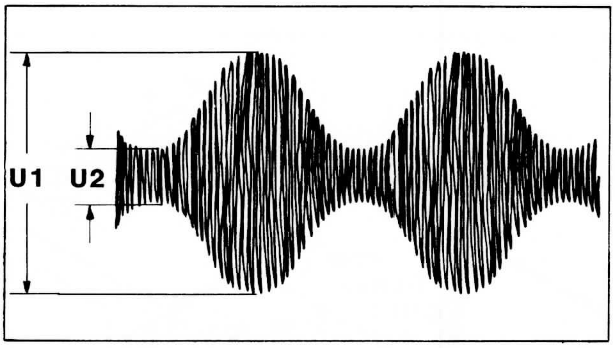
- Check the following:
  o Frequency = 10 MHz (0.1 us)
  o Amplitude 0.8 V_{pp}

50 MHz signal

- Using the sampling oscilloscope (100 ns/div), measure the 50 MHz signal at the 50 MHz soldering pin (use the hole in the screen box as ground) and adjust capacitors C708 and C711 to maximum amplitude and minimum modulation.

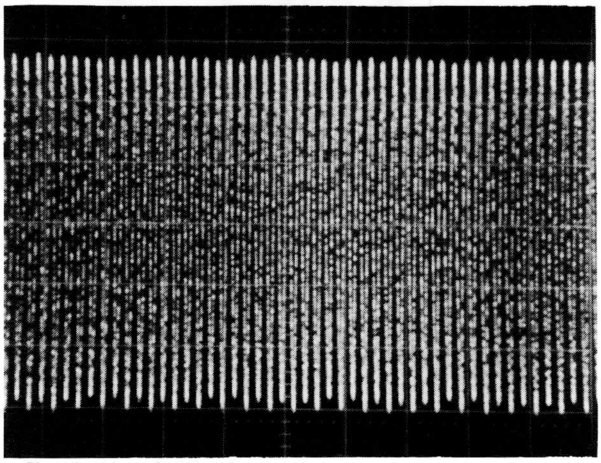


- Check the following:
  - o Frequency = 50 MHz (20 ns)
  - o Amplitude U_2 = 250...400 mV_{pp}
  - o Modulation $\leqslant$ 10% (U_1-U_2 $\leqslant$ 10% of U_2)



100 MHz signal

- Using the sampling oscilloscope (50 ns/div) measure the 100 MHz signal at the 100 MHz soldering pin (use the hole in the screen box as ground) and adjust capacitors C715 and C719 to maximum amplitude and minimum modulation.

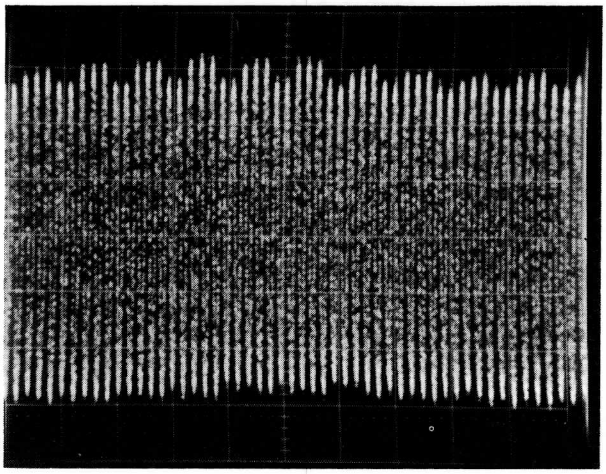


- Check the following:
  - o Frequency = 100 MHz (10 ns)
  - o Amplitude U_2 = 1.0...2.0 V_{pp}
  - o Modulation $\leqslant$ 10% (U_1-U_2 $\leqslant$ 10% of U_2)
- Repeat the adjustment of 50 MHz and 100 MHz.

500 MHz signal

- Disconnect the DC power source from the EXT RESET input. Select program P2 by moving the cursor to P2. Connect the DC power source again to the EXT RESET input.

- Using the sampling oscilloscope (10 ns/div), measure the 500 MHz signal at the 500 MHz test point (use the edge of the hole in the screen box as ground) and adjust C742 and C745 to the maximum amplitude and minimum modulation.



- Check the following:
  - o Frequency = 500 MHz (2 ns)
  - o Amplitude U_2 = 500...800 mV_{pp}*)
  - o Modulation $\leqslant$ 15% (U_1-U_2 $\leqslant$ 15% of U_2)

*) If the amplitude is too low:
Replace R742 with an 82.5 ohm resistor.
If the amplitude is too high:
Replace R742 with a 147 ohm resistor.

Symmetry of the 500 MHz signal

- Set the sensitivity of the sampling oscilloscope to 50 mV/div and measure at IC703:1. Set the DC level to the middle of the oscilloscope screen.

- Measure the 500 MHz signal at the 500 MHz testpoint and check that the signal is positioned symmetrically around the horizontal centre line of the oscilloscope screen graticule.

TIME A-B function

- Disconnect the DC power source from the EXT RESET input.

- Select program P1.

- Connect a cable between the 10 MHz OUT output on the rear panel and input A.

- Check that the display indicates 35...65 ns. If it does not, try changing the slope for channels A and B.

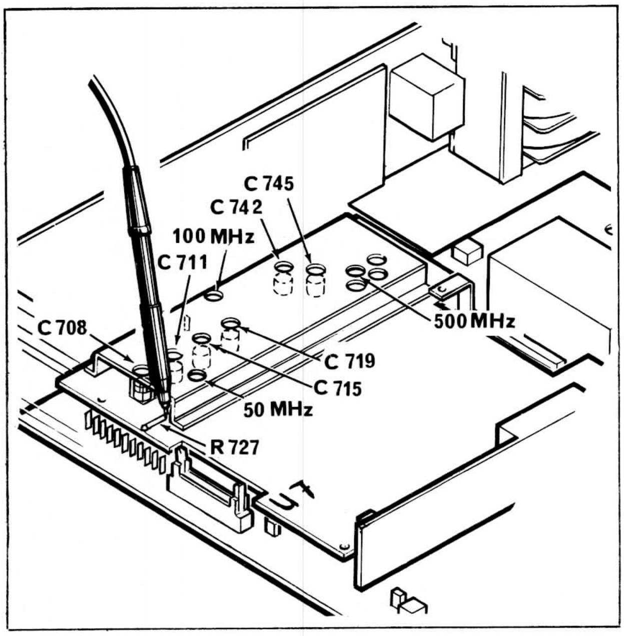
Symmetry of the 100 MHz signal

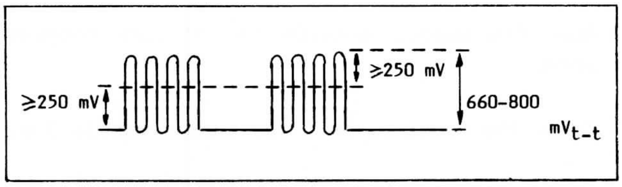
NOTE: The power must have been switched ON for at least 3 min before the following measurement is started.

- Set the measuring time to 96 s by turning the control knob first fully counterclockwise and then fully clockwise.

- Trigger the sampling oscilloscope internally on the same channel as that which is used for the measurement.

- Set the sensitivity of the oscilloscope to 200 mV/div and the sweep speed to 20 ns/div. Then measure at IC703:1 (GND at IC703:5). Set the DC level to the middle of the oscilloscope screen.





- Measure the 100 MHz signal at IC703:14 and check its symmetry in accordance with the illustration above. If the signal vanishes, press the RESET key once.

  o If the amplitude is too low or if the signal is positioned too high: Remove the ferrite bead which is located on one of the pins of C747 by crushing it with a pair of pliers.
  o If the signal is positioned too low: Cut away R766 (this will lift the signal by 50 mV) or cut away R766 and R718 (this will lift the signal by 100 mV).

- Check that the number of complete pulses corresponds to the first digit of the result, e.g. 4 complete pulses provide a result of 40...49.

FREQ A function

- Select program P2.

- Press CHECK.

- Set the measuring time to 1.8 s.

- Check that the display indicates either:
  9.99999998 EXP 6 Hz
  or:
  10.00000000 EXP 6 Hz
  NOTHING ELSE IS ACCEPTABLE.

TOT A/ _|‾|_ B function

- Move the cursor outside the P1...P8 program area.

- Reset the counter. Wait for approximately 3 s.

- Set the measuring time to 0.1 s.

- Select the following:
  o COM
  o CHECK

  o TOT A/ _|‾|_ B

- Check that the display indicates 0.

TOT A/_|‾|_|‾|_B function

- Move the cursor to the TOT A/_|‾|_|‾|_B function.

- Check that the display indicates 1.

External control function

- Connect +3 V from a DC power source to the EXT CONTR input on the rear panel.

- Check that the GATE diode on the display is extinguished.

7. DISMANTLING AND UNIT EXCHANGE

CONTENTS

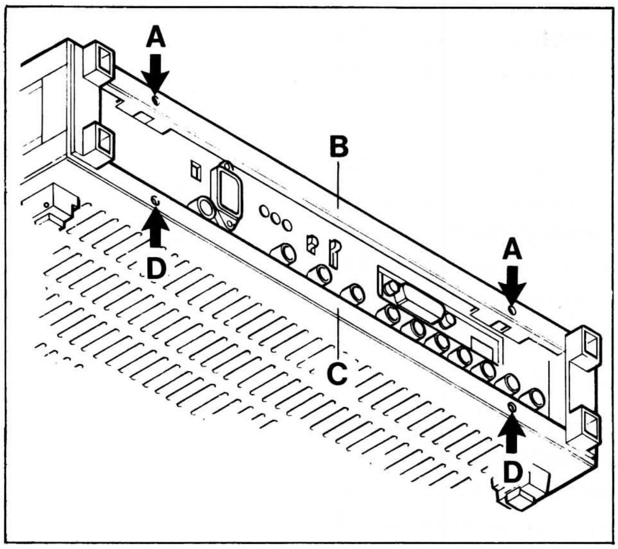
DISMANTLING

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 be dangerous to life.

- The counter must be disconnected from all voltage sources before it is opened.
- Bear in mind that capacitors inside the counter can hold their voltages even if the counter has been separated from all voltage sources.

Top and bottom covers

a) Disconnect the counter from the power source.

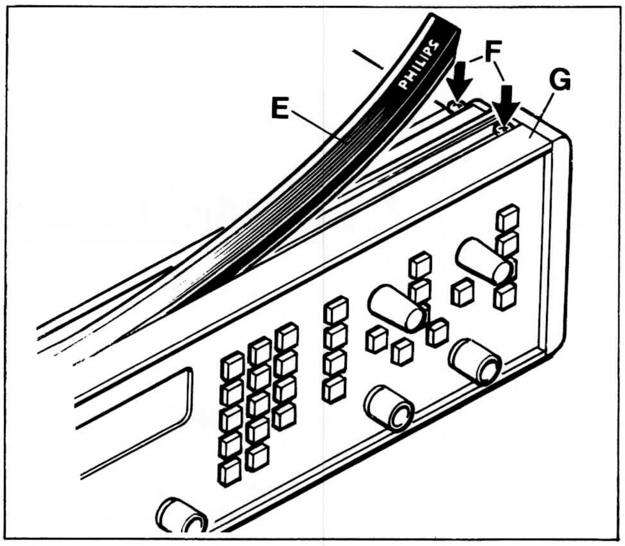


b) Loosen the two top cover retaining screws (A).

c) Lift up the rear edge of the top cover (B), then pull it backwards.

NOTE: The procedure for removing the bottom cover (C) is the same as the above procedure, except that the counter must first be turned upside down, and screws (D) are loosened.

Upper and lower front panel edging

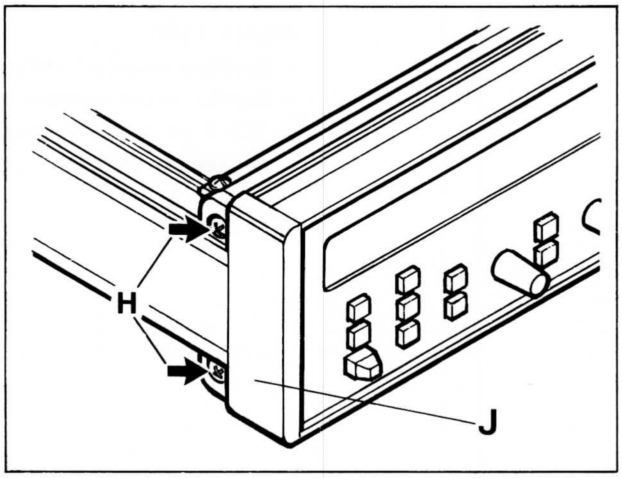


a) Remove the top and bottom covers.

b) Remove the brown and black ornament strip (E) from the upper panel edging (G) and the corresponding strip in the lower panel edging.

c) Remove the four fixing screws (F) and lift OFF the edging.

Left and right side-pieces



a) Remove the top and bottom covers.

b) Remove the two fixing screws (H) and lift off the side piece (J).

UNIT EXCHANGE

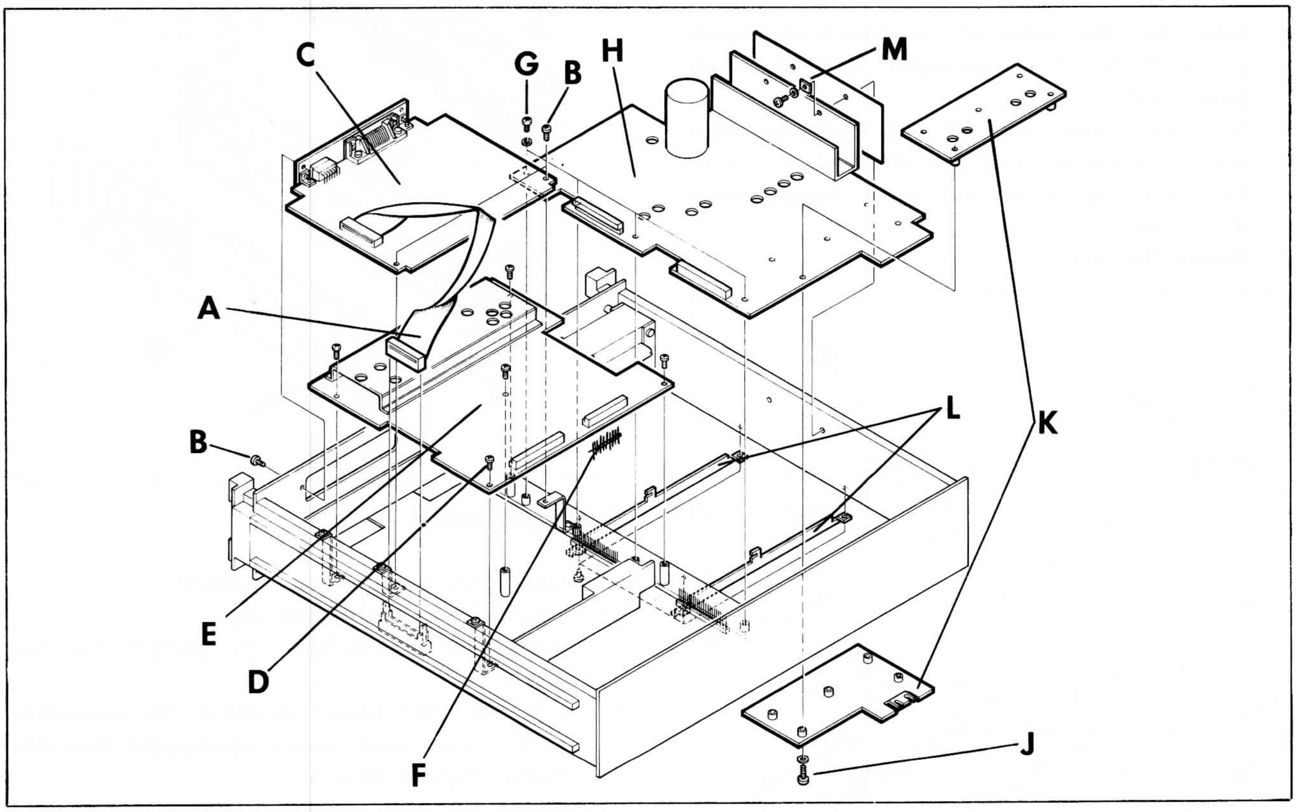
IEEE-488 bus interface

a) Remove the top cover.
b) Remove the cable (A) from the Microprocessor board.
c) Remove the four screws (B) holding the IEEE-488 bus interface (C), two inside the counter and two on the rear panel.
d) Lift away the bus interface.

Input Amplifiers and Power Supply board

Removal

a) Remove the top and bottom cover.
b) Remove the bus interface (C) if fitted.
c) Remove the optional oscillator if fitted.
d) Remove the CEX board (E).



CEX board

Removal

a) Remove the top cover.
b) Remove the IEEE-488 interface board (C).
c) Remove the three (PM 6652) or five (PM 6654) CEX board fixing screws (D).
d) Lift the CEX board (E) straight up so that it disengages from the Microprocessor board connectors.

Reassembly

e) Fit the loose connector pin-strips (F) from the soldering side through the board into the CEX-board connectors.

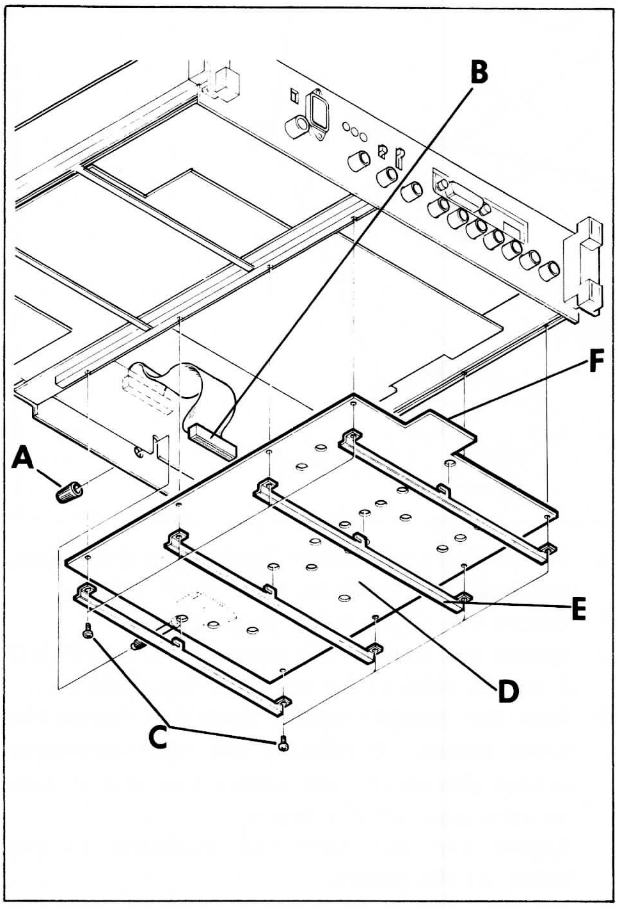
e) Remove the transformer leads from the board, and also the leads to the fan if fitted.
f) Remove the lower front panel edging.
g) Remove the screws (G) holding the board (H), 2 in the side plate and 3 in the PC-board.
h) Turn the counter upside down and remove the seven screws (J) holding the input connector screen plates (K) and remove the plates (one on each side of the board).
j) Remove the two bars (L) engaging in the holes in the board.
k) Desolder the Input A and B contacts from the board.
l) Turn the counter upright again and lift out the board, disengaging it from the two connectors on the processor board.

Reassembly

m) Remember to fit the isolating plate (M) between the heatsink and the side plate.

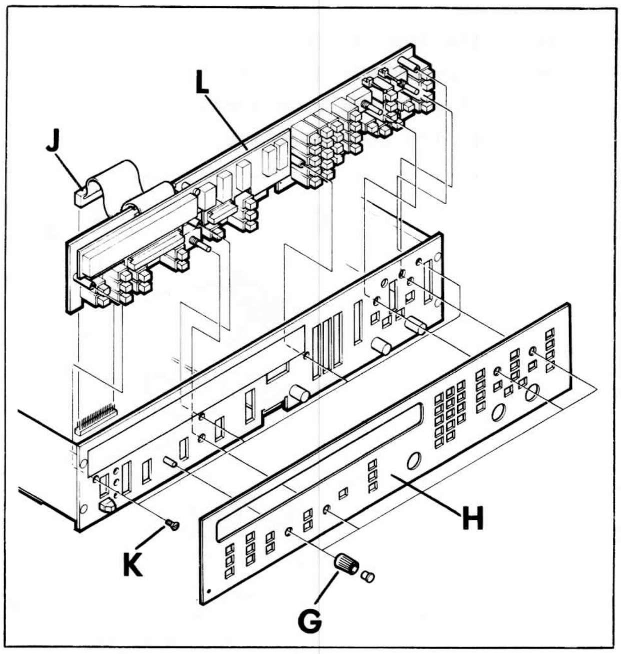
Microprocessor board

a) Remove the top and bottom cover.
b) Remove the hold off potentiometer knob (A).
c) Remove the IEEE-488 bus interface board and prescaler (if fitted).
d) Remove the CEX board.
e) Remove the keyboard cable (B).
f) Turn the counter upside down and remove the eight screws (C) holding the Microprocessor board (D) and the four board stabilizers (E).
g) Pull the rear edge of the board downwards until BU106 (F) disengages from the Rear panel board.
h) Pull the inner edge of the Microprocessor board downwards until the two connectors to the input amplifier and power supply board disengage.
j) Remove the board.



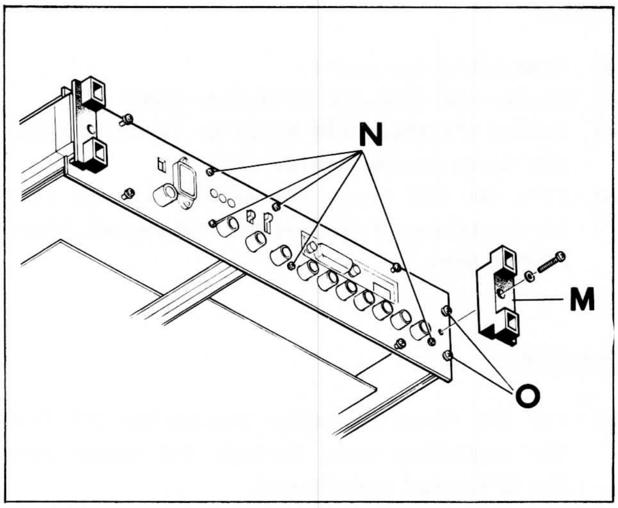
Keyboard/Display assembly

a) Remove the top and bottom cover.
b) Remove the front panel edging (all four pieces).
c) Remove all potentiometer knobs (G).
d) Remove the text plate (H).
e) Remove the upper input amplifier screening plate (five screws).
f) Disconnect the keyboard cable (J).
g) Remove the four screws (K) holding the Keyboard/Display board assy. (L).
h) Disengage the board from the three bottom blade springs (not shown) and remove the assy.



Rear panel board

a) Remove the top and bottom cover.
b) Remove the rear bumpers (M).
c) Remove the five screws (N) holding the rear panel.
d) Lift the rear panel up until the connector on the rear panel board disengages from the Microprocessor Board.
e) Remove the five screws (O) holding the rear panel board to the rear panel and remove the board.



REPAIR HINTS

Surface mounted chip components

Both the early and the new version of the pre-scaler PM 9610 use surface mounted chip components.

A special technique is required when handling and replacing these components:

1) Only open the package with the spare part when the component is to be used. The components are extremely small and unmarked.

2) Use a low voltage, temperature controlled soldering iron with the thinest tip available.

3) Carefully unsolder both soldering tags on the chip component.

4) While the solder is fluid, turn the component using a pair of tweezers until it loosens from the adhesive. Avoid lifting the printed conductor on the PCB.

5) Remove all superflous material. Use a sucking iron or sucking copper litze wire.

6) Make a fixing point with soldering tin. Use only resin core solder containing silver (60% tin, 36% lead, 4% Silver)

7) Locate the replacement chip exactly in place.

8) Solder each tag to the relevant printed conductor on the PCB.

9) After a short coling period, resolder the first soldered joint to release the tensions in the chip.

NOTE:
- Do not use unsoldered chips again.
- Only use the specified component.
- Do not use any adhesive to fix components.
- Replacement chips must be positioned flat on the PCB exactly in the same position as the component to be replaced.
- Chip resistors must be mounted with the resistance coating facing the PCB.

Repair after connecting a counter set to 115V to a 220V mains outlet.

In addition to the primary fuse, the two diodes GR235 and GR240 must always be replaced otherwise the Power Supply may be without protection the next time this accident happens.

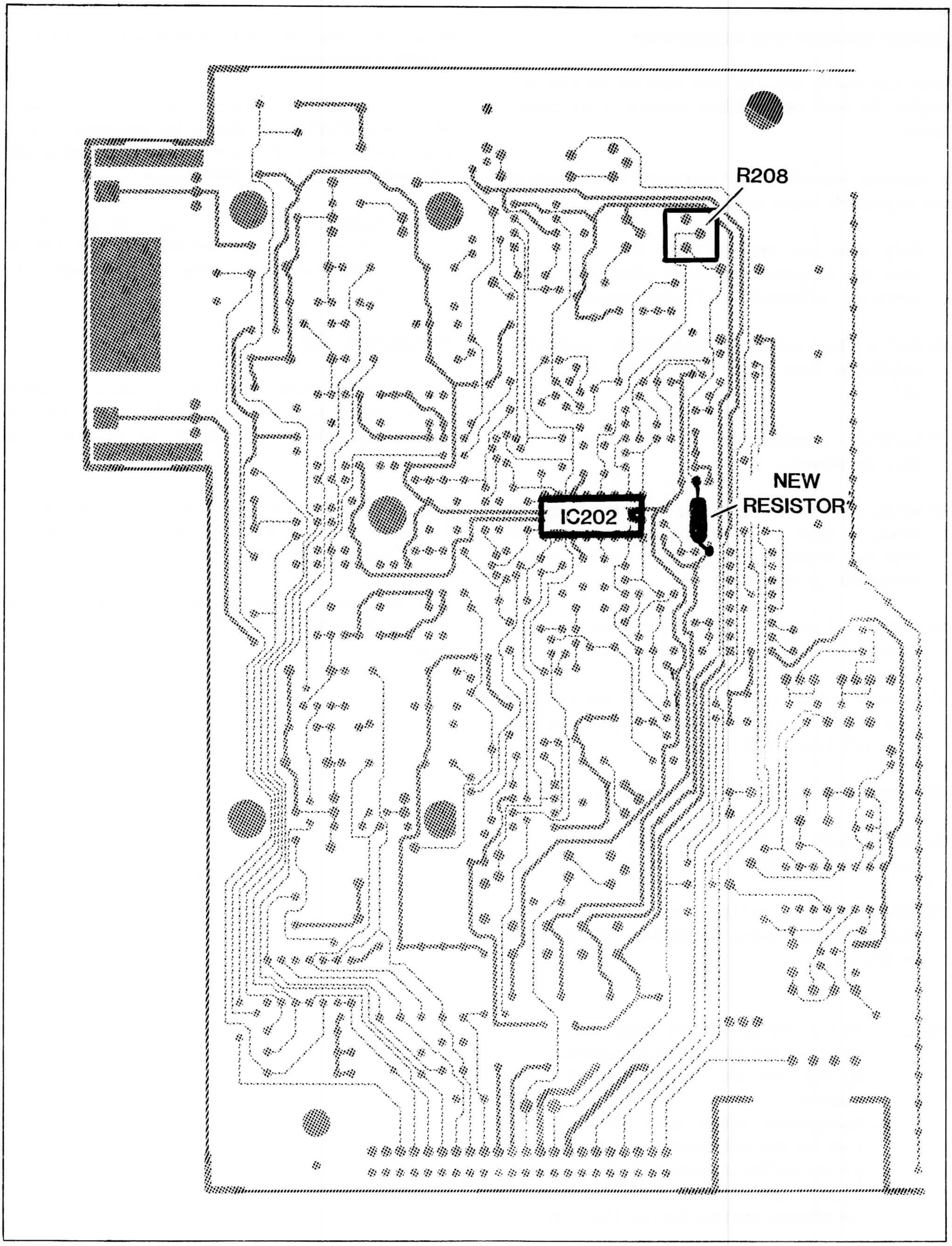
NOTE: Remember to set the mains voltage selector to the appropriate voltage before connecting the counter to the power outlet.

Replacing IC 202

Two different input amplifier circuits for the A and B inputs have been used. The AM687 and the new AD9687. Only the AD9687 is available as spare part.

When an AM687 is to be replaced by an AD9687, a 3.83 kohm resistor must be installed between pin 3 of potentiometer R208 and the -5 V supply.

This resistor can be fitted on the solder-side of the PC board as in the diagram on the next page.



Soldering side of the input amplifiers and power supply board, U2

8. OPTIONAL OSCILLATORS

CONTENTS

Technical specification

	02 version PM 9678B	03 version PM 9679E	04 version PM 9690	05 version PM 9691
Nominal frequency	10 MHz	10 MHz	10 MHz	10 MHz
Trimming range 1)	>±20 Hz	-100...+40 Hz	-7...+3 Hz	-7...+3 Hz
Output voltage into 1 kohm	>100 mV_{RMS}	>1 V_{RMS}	>150 mV_{RMS}	>150 mV_{RMS}
Supply voltage, DC	+17...29 V	+17...29 V	+17...29 V	+17...29 V
Power consumption (+23 °C)				
- Continuous operation	<15 mA	<100 mA	<125 mA	<125 mA
- Stand-by	none	<100 mA	<125 mA	<125 mA
- Warm-up	none	<400 mA	<400 mA	<400 mA
Stability against:				
- Ageing /24h	NA	NA	$< 1.5\times10^{-9}$ 2)	$< 5\times10^{-10}$ 2)
/month	$< 1\times10^{-7}$	$< 1\times10^{-7}$	$< 3\times10^{-8}$	$< 1\times10^{-8}$
/year	$< 5\times10^{-7}$	$< 5\times10^{-7}$	$< 1.5\times10^{-7}$	$< 7.5\times10^{-8}$
- Temperature 0...50 °C ref. to 23 °C	$< 1\times10^{-6}$	$< 1\times10^{-7}$	$< 3\times10^{-8}$	$< 5\times10^{-9}$
- Line voltage ±10 %	$< 1\times10^{-9}$	$< 1\times10^{-9}$	$< 5\times10^{-10}$	$< 5\times10^{-10}$
- Change of measuring mode and change between LINE and EXT/INT battery	$< 5\times10^{-8}$	$< 1\times10^{-8}$	$< 3\times10^{-9}$	$< 3\times10^{-9}$
Warm-up time to reach 1×10^{-7} of final value	NA	<10 min	<15 min	<15 min
Dimensions	93x50x15 mm	100x52x35 mm	100x52x35 mm	100x52x35 mm
Weight	25 g	100 g	100 g	100 g
Environmental conditions	All oscillators meet the same specifications as the PM 6652, 54 counters.			

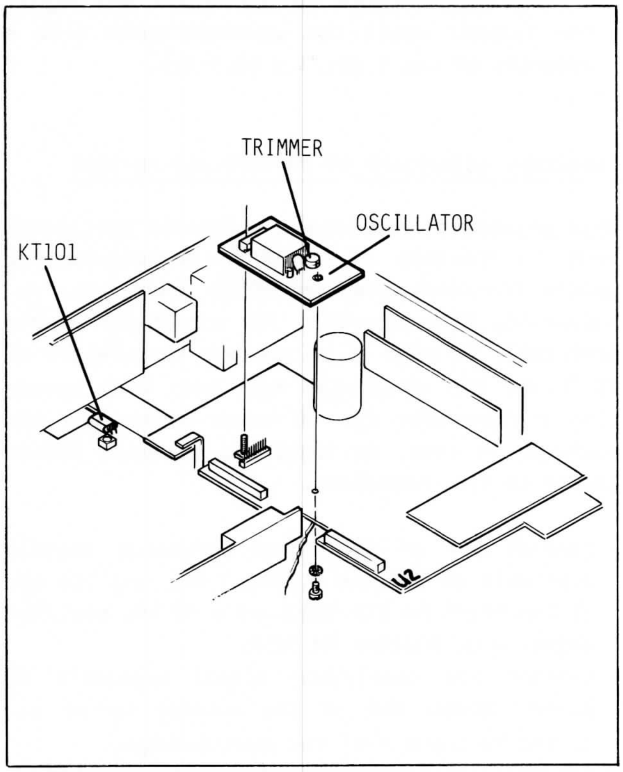
1) The trimming range will cover at least 10 years of operation since the ageing will decrease substantially after the first 6 months. For PM 9690 and PM 9691 the indicated values apply only to the fine trimming range. However, a coarse trimmer is also available.

2) After 48 hours of continuous operation.

PM 9678B

Installation

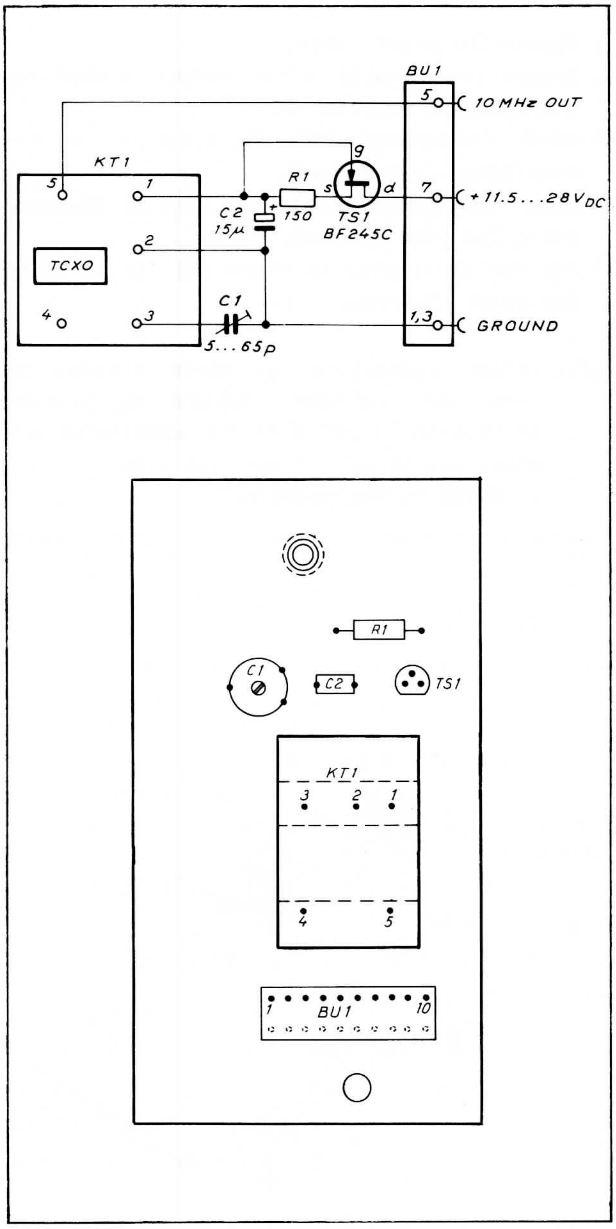
a) Remove the power cable.
b) Remove the crystal KT101 before installing the oscillator PM 9678B.
c) Fit the oscillator.
d) Fix the oscillator with a screw.



Frequency adjustment

This adjustment requires a reference oscillator with an accuracy of $< 1 \times 10^{-7}$. Philips oven enclosed oscillators PM 9680, PM 9681, PM 9690 and PM 9691 meet this requirement, if calibrated. The adjustment should preferably be made at an ambient temperature of +23 °C.

- Connect the reference signal to Input A of the counter to be adjusted.
- Set the measuring time to 2 s.
- Adjust Trimmer capacitor C1 on the oscillator board until the display read-out is:
  10.00000000 EXP6 ± 1 Hz.
- Set the measuring time to 10 s and check that the display read-out is the same as before. If not, adjust C1 slightly to obtain the correct read-out.



Spare parts

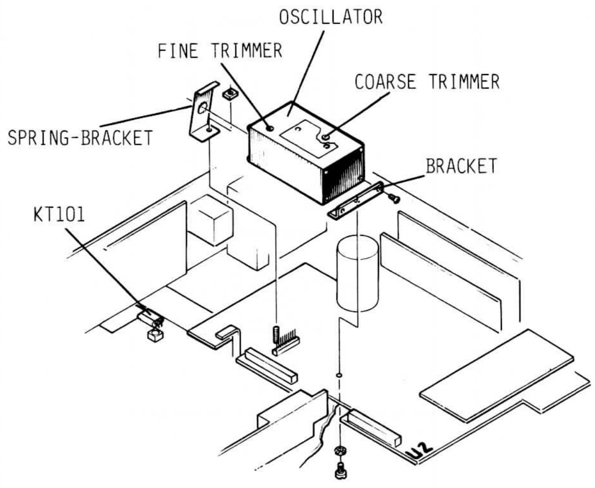
See Chapter 9.

PM 9679E, PM 9690 and PM 9691

Installation

a) Remove the power cable.
b) Remove the crystal KT101 before installing the optional oscillator.
c) Mount the bracket with the rivet nut on the oscillator (two screws).
d) Mount the spring bracket on the U2 PC-board using the long M3 screw and nut.
e) Fit the oscillator in place and fix it using the short M3 screw.

NOTE: Before installing an older version of these oven enclosed oscillators, measure if terminal 1 and 2 of the oscillator are short-circuited. If so, cut pins 1 and 2 on BU205 in the counter.



Frequency adjustment of PM 9679E

This adjustment requires a reference oscillator with an accuracy of 3×10^{-8}. Philips oven enclosed oscillators PM 9680, PM 9681, PM 9690 and PM 9691 meet this requirement, if calibrated.
The adjustment should preferably be made at an ambient temperature of 23 °C and the oscillator must have been operating continuously for 48 hours before any adjustment is made. An insulated trimming screwdriver is also neccessary.

- Connect the reference signal to EXT TRIGG of a 50 MHz oscilloscope, e.g. Philips PM 3215.
- Connect the oscillator signal available at socket 10 MHz OUT of the counter to be adjusted to Input Y of the oscilloscope.
- Set the oscilloscope to 100 ns/div and adjust the trimmer until the waveform moves with a velocity of max 1 div/3 s (0.3 Hz).

Frequency adjustment of PM 9690 and PM 9691

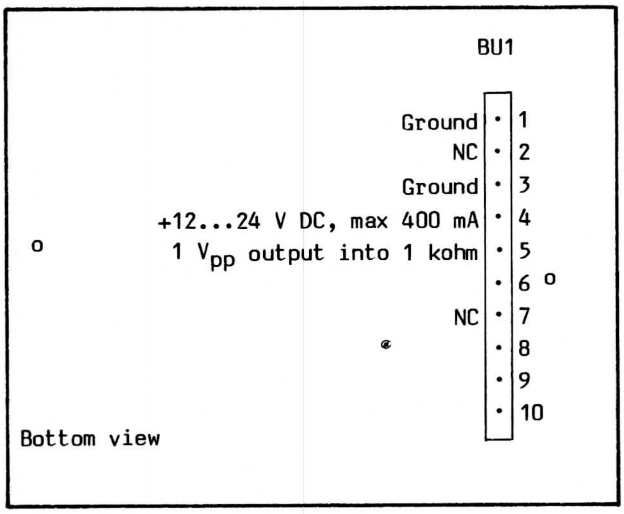
This adjustment requires a reference oscillator with an accuracy of $< 1 \times 10^{-9}$. Hewlett-Packard quartz frequency standard HP105 meets this requirement, if calibrated. The adjustment should preferably be made at an ambient temperature of 23 °C and the oscillator must have been operating continuously for 48 hours before any adjustment is made. An insulated trimming screwdriver is also necessary.

- Connect any of the three reference signals available at sockets 5 MHz, 1 MHz and 100 kHz of the HP105 to EXT TRIGG of a 50 MHz oscilloscope, e.g. Philips PM 3215.
- Connect the oscillator signal available at socket 10 MHz OUT of the counter to be adjusted to Input Y of the oscilloscope.
- Set the oscilloscope to 100 ns/ div and adjust the fine trimmer in the oscillator until the waveform moves with a velocity of max 1 div/10 s (0.1 Hz).

If the adjustment range is too narrow, proceed as follows:

- Set the fine trimmer fully clockwise.
- Remove the two screws fixing the oscillator's text plate to the unit.
- Remove the small plastic cylinder beneath the text plate using a pair of tweezers.
- Connect an external counter via a 10 Mohm probe to socket 10 MHz OUT of the counter to be adjusted.
- Adjust the coarse trimmer until the display read-out on the external counter is:
  10000003 Hz.
- Refit the plastic cylinder and the text plate.
- Recheck that the waveform velocity is 1 div/10 s, see above.

Pin assignment



NOTE: Pins 6, 8, 9 and 10 are for factory use only.

Repair

Repair of these oscillators may not be carried out by the local service organization. The complete sealed oscillator unit must be sent to the factory for repair.

Contact your local Philips organisation.

Recalibration intervals

When making a recalibration, the reference crystal oscillator will only be compensated for deviation in frequency due to ageing.

The mean time between recalibration, MTBRC, can be calculated when the total tolerated error is known. The total tolerated error is defined as:

$$\frac{\text{Deviation of reference frequency}}{\text{Nominal reference frequency}}$$

One example: A user can accept a maximum of ±3 Hz deviation on the 10 MHz frequency of the oscillator.

$$\text{Total tolerated error} = \frac{3}{10 \times 10^{6}\ \text{Hz}} = 3 \times 10^{-7}$$

The mean time between recalibration, MTBRC, is defined as:

$$\frac{\text{Acceptable error} - \text{Temp. stability}}{\text{Ageing}}$$

The value for Ageing is correctly selected from the table when the calculation of MTBRC results in 1...30 days, 1...12 months or more than 1 year.

One example: The user has the same requirements as in the example above. The counter has an oscillator PM 9690 with following data:

- Temperature stability: Better than 3×10^{-8}
- Ageing: less than 1.5×10^{-7}/year

This gives a MTBRC of less than:

$$\frac{3 \times 10^{-7} - 3 \times 10^{-8}}{1.5 \times 10^{-7}} = 1.8 \text{ year}$$

9. SPARE PARTS

CONTENTS

NOTE: Overscored order numbers means that no order No. is available at time of publication. The number printed is instead the factory code.

Example:

Pos. No.	Order No.	Description
IC33	4031-100-33890	IC, PM 9696 PROM

REPLACEMENTS

Standard parts

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

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

Special parts

In addition to standard electronic components, some special components are used:

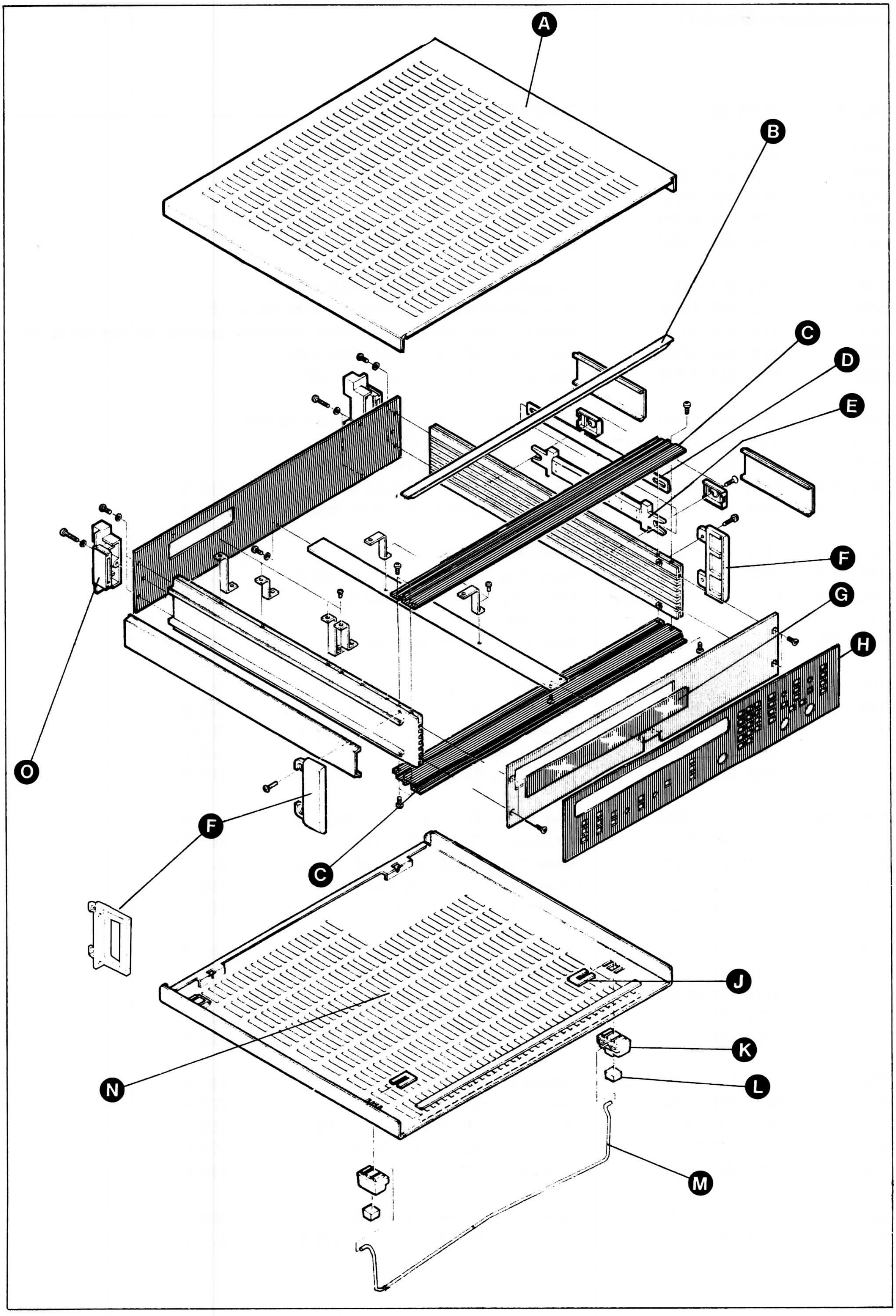
- Components, manufactured or selected by Philips to meet specific performance requirements.
- Components which are important for the safety of the instrument.

Both type of components may only be replaced by components obtained through your local Philips organisation.

SPARE PARTS FOR PM 6652...54

Mechanical parts

Pos. No.	Order No.	Description
A	5322 462 40762	Top cover
B	5322 460 60382	Profile ornament with text
C	5322 447 90502	Frontpanel edging,upper/lower
D	5322 462 40759	Steel insert for handle
E	5322 498 50176	Rubber handle
F	5322 447 90501	Sidepiece, front
F	5322 263 70186	Rack mount adapters
G	5322 466 70542	Window
H	5322 447 90504	Text plate PM 6652
H	5322 447 90505	Text plate PM 6654
H	5322 447 90506	Text plate PM 6652 blind panel (not shown)
H	5322 447 90507	Text plate PM 6654 blind panel (not shown)
J	5322 492 64745	Locking clip for plastic foot
K	5322 462 40756	Plastic foot
L	5322 462 44434	Rubber foot, self adhesive
M	5322 401 10867	Tilting support
N	5322 447 90503	Bottom cover
O	5322 462 40761	Rear bumper


A
B
C
D
E
F
G
H
O
F
C
J
K
L
N
M

Microprocessor board U1

Pos. No.	Order No.	Description	
BU101	5322 265 51064	Connector, MOLEX 22 pol 4030-22FG	
BU102	5322 265 51065	Connector, MOLEX 22 pol 403022AAG	
BU103	5322 267 50519	Connector, MOLEX 17 pol 4455-17CK	
BU103	5322 265 40382	Pin-Connector, to connect U1 with U6 or U7	
BU104	5322 265 61047	Connector, 34 pol F095 Double row	
BU105	5322 267 60149	Connector, MOLEX 22 pol 4455-22CK	
BU105	5322 265 51068	Pin-connector, to connect U1 with U6 or U7	
BU105	5322 532 60387	Ceramic tube, sets the correct distance between U1 and U6 or U7	
BU106	5322 267 50519	Connector, MOLEX 17 pol 4455-17CK	
BU107	5322 267 50518	Connector, MOLEX 12 pol 4455-CC	
BU108	5322 268 90087	Clamp/Ejector, F303 W.O. strain relief	
BU108	5322 267 60152	Connector, 26 pol F303 Header	
BU109	5322 265 44057	Connector, MOLEX 6 pol 4030-06	
C101, 102	4822 122 31414	Capacitor, 10 nF -20/+50 %	100 V
C103..109	5322 124 10455	Capacitor, Solid al. 68 µF ±20 %	6.3 V
C110	4822 122 31414	Capacitor, 10 nF -20/+50 %	100 V
C111..113	5322 124 10455	Capacitor, Solid al. 68 µF ±20 %	6.3 V
C114, 115	4822 122 31414	Capacitor, 10 nF -20/+50 %	100 V
C116	-	Not used	
C117, 118	4822 122 31414	Capacitor, 10 nF -20/+50 %	100 V
C119	4822 124 20977	Capacitor, Solid al. 15 µF ±20 %	16 V
C120	4822 122 31414	Capacitor, 10 nF -20/+50 %	100 V
C121	4822 124 20945	Capacitor, Solid al. 33 µF ±20 %	10 V
C122	5322 125 54024	Trim. Capacitor, 2-9pF	300 V
C123	4822 122 31063	Capacitor, 22 pF ±2 % NPO	100 V
C124, 125	4822 122 31237	Capacitor, 82 pF ±2 % NPO	100 V
C126, 127	4822 122 31414	Capacitor, 10 nF -20/+50 %	100 V
C128	5322 124 10455	Capacitor, Solid al. 68 µF ±20 %	6.3 V
C129, 130	4822 122 31414	Capacitor, 10 nF -20/+50 %	100 V
C131	4822 122 30027	Capacitor, 1 nF ±10 %	100 V
C132, 133	4822 121 41672	Capacitor, 100 nF ±10 %	100 V
C134	5322 121 50948	Capacitor, polystyren 3.92 nF ±1 %	63 V
C135	5322 121 40233	Capacitor, 680 nF ±10 %	100 V
C136	4822 122 31414	Capacitor, 10 nF -20/+50 %	100 V
C137	4822 122 31125	Capacitor, 4.7 nF ±10 %	100 V
C138	4822 122 31072	Capacitor, 47 pF ±2 % NPO	100 V
C139	4822 122 30034	Capacitor, 470 pF ±10 %	100 V
C140	4822 122 31349	Capacitor, 68 pF ±2 % NPO	100 V
C141	4822 122 31414	Capacitor, 10 nF -20/+50 %	100 V
C142	5322 121 44201	Capacitor, 10 nF ±10 %	630 V
C143	4822 122 31414	Capacitor, 10 nF -20/+50 %	100 V
C144	5322 124 10455	Capacitor, Solid al. 68 µF ±20 %	6.3 V

Microprocessor board U1 (continued)

Pos. No.	Order No.	Description		
C145, 146	4822 122 31414	Capacitor, 10 nF -20/+50 %		100 V
C147, 148	4822 122 30114	Capacitor, 2.2 nF ±10 %		100 V
C149, 150	5322 124 40977	Capacitor, bipol 22 µF		16 V
C151, 152	-	Not used		
C153, 154	4822 122 31072	Capacitor, 47 pF ±2 %	NPO	100 V
C155, 156	5322 124 10455	Capacitor, Solid al. 68 µF ±20 %		6.3 V
C157..160	4822 122 31414	Capacitor, 10 nF -20/+50 %		100 V
C161, 162	4822 124 20977	Capacitor, Solid al. 15 µF ±20 %		16 V
C163	4822 122 30034	Capacitor, 470 pF ±10 %		100 V
C164..166	4822 121 41672	Capacitor, 100 nF ±10 %		100 V
DV101, 102	5322 263 64007	Jumper connector, 2 pol F088		
GR101..103	4822 130 30613	Diode, BAW62/75		0.2 A
GR104, 105	4822 130 34174	Diode, ZENER BZX79/C4V7		0.4 W
GR106..108	4822 130 30613	Diode, BAW62/75		0.2 A
IC101	5322 209 86035	IC-MOS, 8085A		
IC101	5322 255 40426	IC-Socket, 40 pol		
IC102	5322 209 86062	IC-TTL, 74LS373		
IC103	5322 255 44234	IC-Socket, 28 pol		
IC103	5322 209 10991	IC-PROM, PM 6652, 54 PROM-1		
IC104	5322 255 44234	IC-Socket, 28 pol		
IC104	5322 209 10991	IC-PROM, PM 6652, 54 PROM-1		
IC105	5322 255 44234	IC-Socket, 28 pol		
IC105	5322 209 10997	IC-PROM, PM 6652, 54 PROM-3		
IC106	5322 209 85647	IC-TTL, 74LS138		
IC107	5322 255 40426	IC-Socket, 40 pol		
IC107	5322 209 14563	IC-MOS, 8155 RAM-I/O-Timer		
IC108	4822 209 10238	IC-MOS, ER1400 EAROM		
IC109	5322 209 85647	IC-TTL, 74LS138		
IC110	5322 209 10385	IC-CMOS, 40374BP		
IC111	5322 255 40425	IC-Socket, 20 pol		
IC111	5322 209 85869	IC-TTL, 74LS374		
IC112	5322 209 86441	IC-ECL, GXB10116		
IC113	4822 209 80782	IC-TTL, 74LS74		
IC114	5322 209 82831	IC-CMOS, ICM7555IPA		
IC115	5322 255 44234	IC-Socket, 28 pol		
IC115	5322 209 10988	IC-ECL, COAC 0QØØ4Ø		
IC116, 117	5322 209 84643	IC-ECL, MC10102P		
IC118	5322 255 40426	IC-Socket, 40 pol		
IC118	5322 209 10993	IC-MOS, PM 6652, 54 UPI (Slave Processor)		
IC119, 120	5322 209 82865	IC, 10 BIT DAC1006LC		
IC121	4822 209 80747	IC-CMOS, TL084C QUAD JFET OP-AMP		
IC122, 123	5322 209 86514	IC, LM324 QUAD OP-AMP		

Microprocessor board U1 (continued)

Pos. No.	Order No.	Description		
IC124	4822 209 80775	IC, NE555		
IC125	4822 209 10317	IC-CMOS, 40097BP		
IC126	4822 209 80782	IC-TTL, 74LS74		
IC127	5322 209 14121	IC-CMOS, 4053B		
IC128	5322 209 84923	IC-TTL, 74LS00		
IC129	4822 209 10185	IC-CMOS, 4069B		
IC130, 131	5322 111 90737	Res. Network, 6.2 kohm ±5 %		1/8 W
IC132	5322 111 90079	Res. Network, 10 kohm ±10 %		1/8 W
IC133, 134	5322 111 94031	Res. Network, 47 kohm ±10 %		1/8 W
IC135	5322 111 90739	Res. Network, 5.1 kohm ±5%		1/8 W
IC136	5322 111 94015	Res. Network, 1 kohm ±10 %		1/8 W
IC137	5322 209 86007	IC-TTL, 74LS259		
IC138	5322 209 82864	IC-REF, 2.50 V MC1403U		
IC150	5322 267 50523	Connector Shunt, 16 pol Dip-shunt		
IC150	5322 255 40428	IC-Socket 16 pol		
IC151	5322 209 84643	IC-ECL, MC10102		
IC155	5322 111 90079	Res. Network, 10 kohm ±10 %		1/8 W
KT101	5322 242 74372	Crystal, 10 MHz for standard oscillator 01		
R101, 102	5322 116 50579	Resistor, 3.16 kohm ±1 %	MR25	0.4 W
R103	4822 116 51235	Resistor, 1.00 kohm ±1 %	MR25	0.4 W
R104	5322 116 50484	Resistor, 4.64 kohm ±1 %	MR25	0.4 W
R106..109	5322 116 50579	Resistor, 3.16 kohm ±1 %	MR25	0.4 W
R110	5322 116 54558	Resistor, 82.5 kohm ±1 %	MR25	0.4 W
R111	5322 116 50579	Resistor, 3.16 kohm ±1 %	MR25	0.4 W
R112, 112	4822 116 51235	Resistor, 1.00 kohm ±1 %	MR25	0.4 W
R114	5322 116 54608	Resistor, 7.50 kohm ±1 %	MR25	0.4 W
R115	5322 116 54515	Resistor, 348 ohm ±1 %	MR25	0.4 W
R116	5322 116 54426	Resistor, 121 ohm ±1 %	MR25	0.4 W
R117	5322 116 55368	Resistor, 383 ohm ±1 %	MR25	0.4 W
R118, 119	4822 116 51233	Resistor, 681 ohm ±1 %	MR25	0.4 W
R120	4822 116 51105	Resistor, 470 ohm ±5 %	PR37	1.6 W
R121	4822 116 51235	Resistor, 1.00 kohm ±1 % m	MR25	0.4 W
R122..124	5322 116 50536	Resistor, 464 ohm ±1 %	MR25	0.4 W
R125	5322 116 55368	Resistor, 383 ohm ±1 %	MR25	0.4 W
R126	5322 116 54426	Resistor, 121 ohm ±1 %	metal film	0.4 W
R127	5322 101 20807	Hold off potentimeter 470 kohm ±20 % LOG with switch		
R127	5322 414 30044	Potentiometer knob		
R127	5322 414 70016	Cover to potentiometer knob		
R128	5322 116 50571	Resistor, 715 ohm ±1 %	MR25	0.4 W
R129	5322 116 50515	Resistor, 1.78 kohm ±1 %	MR25	0.4 W
R130	5322 116 50635	Resistor, 1.47 kohm ±1 %	MR25	0.4 W
R131	-	Not used		
R132, 133	4822 116 51253	Resistor, 10.0 kohm ±1 %	MR25	0.4 W

Microprocessor board U1 (continued)

Pos. No.	Order No.	Description			
R134	5322 101 14194	Trim. pot, 10 kohm ±1+ %			0.5 W
R135	4822 116 51234	Resistor, 750 ohm ±1 %	MR25		0.4 W
R136	-	Not used			
R137..139	4822 116 51253	Resistor, 10.0 kohm ±1 %	MR25		0.4 W
R140	5322 116 50767	Resistor, 2.15 kohm ±1 %	MR25		0.4 W
R141	5322 116 54557	Resistor, 1.21 kohm ±1 %	MR25		0.4 W
R142	5322 116 55368	Resistor, 383 ohm ±1 %	MR25		0.4 W
R143	5322 116 50536	Resistor, 464 ohm ±1 %	MR25		0.4 W
R144	4822 116 51233	Resistor, 681 ohm ±1 %	MR25		0.4 W
R145	4822 116 51234	Resistor, 750 ohm ±1 %	MR25		0.4 W
R146	5322 105 14037	Trim Pot, 200 ohm ±10 %			
R147	4822 116 51234	Resistor, 750 ohm ±1 %	MR25		0.4 W
R148	4822 116 51233	Resistor, 681 ohm ±1 %	MR25		0.4 W
R149	5322 105 14037	Trim Pot, 200 ohm ±10 %			
R150	5322 116 50492	Resistor, 46.4 ohm ±1 %	MR25		0.4 W
R151, 152	4822 116 51252	Resistor, 6.81 kohm ±1 %	MR25		0.4 W
R153	5322 105 14037	Trim Pot, 200 ohm ±10 %			
R154, 155	4822 116 51252	Resistor, 6.81 kohm ±1 %	MR25		0.4 W
R156	5322 105 14037	Trim Pot, 200 ohm ±10 %			
R157, 158	5322 116 50767	Resistor, 2.15 kohm ±1 %	MR25		0.4 W
R159, 160	4822 116 51253	Resistor, 10.0 kohm ±1 %	MR25		0.4 W
R161, 162	-	Not used			
R163, 164	5322 116 50767	Resistor, 2.15 kohm ±1 %	MR25		0.4 W
R165, 166	-	Not used			
R167	5322 116 54466	Resistor, 90.9 ohm ±1 %	MR25		0.4 W
R168	4822 116 51235	Resistor, 1.00 kohm ±1 %	MR25		0.4 W
R169	5322 116 50766	Resistor, 147 ohm ±1 %	MR25		0.4 W
R170	5322 116 55549	Resistor, 100 ohm ±1 %	MR25		0.4 W
R171	5322 116 50766	Resistor, 147 ohm ±1 %	MR25		0.4 W
R172..177	5322 116 50536	Resistor, 464 ohm ±1 %	MR25		0.4 W
R178	5322 116 55368	Resistor, 383 ohm ±1 %	MR25		0.4 W
R179	5322 116 50557	Resistor, 46.4 kohm ±1 %	MR25		0.4 W
R180, 181	5322 116 50671	Resistor, 2.61 kohm ±1 %	MR25		0.4 W
R182	4822 116 51235	Resistor, 1.00 kohm ±1 %	MR25		0.4 W
SK101	5322 276 11447	Switch, ST BY/ON Schadow	DPDT		
SK101	5322 414 20033	Push button for ST BY/ON switch			
SK101	5322 535 91232	Ext. bar for ST BY/ON switch			
TS101	5322 130 44418	Transistor, N-FET BF256A			30 V
TS102..106	4822 130 44197	Transistor, NPN BC558B		0.1 A	30 V
TS107..110	5322 130 44845	Transistor, PNP, 2N5771		0.05 A	15 V
TS111	5322 130 44435	Transistor, NPN 2N5770		0.05 A	15 V
TS112	4822 130 44197	Transistor, NPN BC558B		0.1 A	30 V
TS113	4822 130 40937	Transistor, NPN BC548B		0.1 A	30 V

Input Amplifiers and Power Supply board, U2

Pos. No.	Order No.	Description	
BU203	5322 265 51066	Connector, MOLEX 20 pol 4030-20AG	
BU204	5322 267 60151	Connector, MOLEX 20 pol 4455-22BK	
BU205	5322 265 64028	Connector, MOLEX 10 pol 4030-10A	
C201	5322 125 50256	Trim Capacitor, 1.4-5.5 pF	300 V
C202	4822 122 31414	Capacitor, 10 nF -20/+50 %	100 V
C203	4822 121 41672	Capacitor, 100 nF ±10 %	100 V
C204	4822 122 31414	Capacitor, 10 nF -20/+50 %	100 V
C205	4822 122 30027	Capacitor, 1 nF ±10 %	100 V
C206	4822 122 31414	Capacitor, 10 nF -20/+50 %	100 V
C207	5322 121 42349	Capacitor, 33 nF ±10 %	250 V
C208	5322 122 32418	Capacitor, 15.0 pF ±2 % N750	500 V
C209	5322 125 54029	Trim Capacitor, 2-18 pF	300 V
C210, 211	4822 122 31414	Capacitor, 10 nF -20/+50 %	100 V
C212, 213	4822 122 30027	Capacitor, 1 nF ±10 %	100 V
C214	5322 122 32418	Capacitor, 15.0 pF ±2 % N750	500 V
C215	5322 125 50256	Trim Capacitor, 1.4-5.5 pF	300 V
C216	5322 122 32418	Capacitor, 15.0 pF ±2 % N750	500 V
C217..225	4822 122 31414	Capacitor, 10 nF -20/+50 %	100 V
C226	5322 124 10455	Capacitor, Solid Al. 68 µF ±20 %	6.3 V
C227	4822 121 41672	Capacitor, 100 nF ±10 %	100 V
C228	4822 122 30114	Capacitor, 2.2 nF ±10 %	100 V
C229..232	4822 122 31414	Capacitor, 10 nF -20/+50 %	100 V
C233, 234	5322 124 10455	Capacitor, Solid Al. 68 µF ±20 %	6.3 V
C235..238	4822 122 31414	Capacitor, 10 nF -20/+50 %	100 V
C239	4822 122 31036	Capacitor, 2.2 pF ±0.25 pF	100 V
C240	4822 122 30027	Capacitor, 1 nF ±10 %	100 V
C241	4822 122 31414	Capacitor, 10 nF -20/+50 %	100 V
C242	4822 121 41672	Capacitor, 100 nF ±10 %	100 V
C243	-	Not used	
C244	4822 122 30027	Capacitor, 1 nF ±10 %	100 V
C245	5322 121 42349	Capacitor, 33 nF ±10 %	250 V
C246	5322 122 32418	Capacitor, 15.0 pF ±2 % N750	500 V
C247	5322 125 54029	Trim Capacitor, 2-18 pF	300 V
C248	4822 122 31414	Capacitor, 10 nF -20/+50 %	100 V
C249	-	Not used	
C250, 251	4822 122 30027	Capacitor, 1 nF ±10 %	100 V
C252, 253	5322 122 32418	Capacitor, 15.0 pF ±2 % N750	500 V
C254	5322 124 10455	Capacitor, Solid Al. 68 µF ±20 %	6.3 V
C255	4822 122 31414	Capacitor, 10 nF -20/+50 %	100 V
C256	4822 122 30114	Capacitor, 2.2 nF ±10 %	100 V
C257..259	4822 122 31414	Capacitor, 10 nF -20/+50 %	100 V
C260	4822 122 31821	Capacitor, 3.3 pF ±0.25 pF	100 V
C261	4822 122 30027	Capacitor, 1 nF ±10 %	100 V
C262, 263	4822 124 20977	Capacitor, Solid Al. 15 µF ±20 %	16 V

Input Amplifiers and Power Supply board, U2 (continued)

Pos. No.	Order No.	Description		
C264	4822 122 30034	Capacitor, 470 pF ±10 %		100 V
C265	-	Not used		
C266	5322 124 10478	Capacitor, Solid Al. 1.5 µF ±20 %		40 V (25 V)
C267	4822 124 20713	Capacitor, 47 µF -10/+50 %		40 V
C268	4822 124 20777	Capacitor, 1000 µF -10/+50 %		16 V
C269	4822 124 20768	Capacitor, 1000 µF -10/+50 %		10 V
C270	4822 124 20977	Capacitor, Solid Al. 15 µF ±20 %		16 V
C271	4822 124 20945	Capacitor, Solid Al. 33 µF ±20 %		10 V
C272	5322 124 10455	Capacitor, Solid Al. 68 µF ±20 %		6.3 V
C273	5322 124 21587	Capacitor, 2200 µF -10/+50 %		6.3 V
C274	4822 124 20945	Capacitor, Solid Al. 33 µF ±20 %		10 V
C275	4822 122 30114	Capacitor, 2.2 nF ±10 %		100 V
C276	4822 124 20713	Capacitor, 47 µF -10/+50 %		40 V
C277	4822 124 20977	Capacitor, Solid Al. 15 µF ±20 %		16 V
C278	4822 122 30114	Capacitor, 2.2 nF ±10 %		100 V
C279	4822 124 20945	Capacitor, Solid Al. 33 µF ±20 %		10 V
C280	4822 122 31414	Capacitor, 10 nF -20/+50 %		100 V
C281	5322 124 14081	Capacitor, Solid Al. 6.8 µF ±20 %		25 V
C282	4822 122 31414	Capacitor, 10 nF -20/+50 %		100 V
C283	4822 122 30114	Capacitor, 2.2 nF ±10 %		100 V
C284	4822 122 30098	Capacitor, 3.9 nF ±10 %		100 V
C285	4822 124 20945	Capacitor, Solid Al. 33 µF ±20 %		10 V
C286	4822 124 20693	Capacitor, 220 µF -10/+50 %		16 V
C287	4822 121 41672	Capacitor, 100 nF ±10 %		100 V
C288	5322 124 10455	Capacitor, Solid Al. 68 µF ±20 %		6.3 V
C289	-	Not used		
C290	5233 124 70406	Capacitor, 10000 µF		40 V
C291	5322 121 42351	Capacitor, 15 nF ±10 %		400 V
C292	4822 122 30045	Capacitor, 27.0 pF ±2 %		100 V
C293	5322 122 32417	Capacitor, 22.0 pF ±2 %		500 V
C294	4822 122 30045	Capacitor, 27.0 pF ±2 %		100 V
C295	5322 122 32417	Capacitor, 22.0 pF ±2 %		500 V
C296..298	4822 122 31414	Capacitor, 10 nF -20/+50 %		100 V
C2002..2003	4822 122 31414	Capacitor, 10 nF -20/+50 %		100 V
GR201, 202	4822 130 32656	Diode, BA483	0.1 A	35 V
GR203..213	4822 130 30613	Diode, BAW62/75		0.2 A
GR214, 215	5322 130 31504	Diode, ZENER BZX79/C3V3		0.4 W
GR216	4822 130 32656	Diode, BA483	0.1 A	35 V
GR217	4822 130 30613	Diode, BAW62/75		0.2 A
GR218	5322 130 31504	Diode, ZENER BZX79/C3V3		0.4 W
GR219	4822 130 32656	Diode, BA483	0.1 A	35 V
GR220, 221	4822 130 30613	Diode, BAW62/75		0.2 A
GR222..224	5322 130 31504	Diode, ZENER BZX79/C3V3		0.4 W
GR225..227	4822 130 41487	Diode, BYV95C SOD-57	1.5 A	600 V

Input Amplifiers and Power Supply board, U2 (continued)

Pos. No.	Order No.	Description		
GR228	5322 130 34755	Diode, BYW29/100	7 A	100 V
GR228	4822 526 10011	TXC Tube, 3B red		
GR228	5322 401 10868	Mounting bracket		
GR229	5322 130 32667	Diode, Transorb BZW70/5V6		3 kW
GR230	4822 130 30613	Diode, BAW62/75		0.2 A
GR231	5322 130 31504	Diode, ZENER BZX79/C3V3		0.4 W
GR232	4822 130 34142	Diode, ZENER BZX79/C33		0.4 W
GR233	-	Not used		
GR234	4822 130 50312	Rectifier Bridge, BY225/200		4.8 A
GR234	5322 492 62551	Fixing clip		
GR235	-	Not used		
GR236	4822 130 31024	Diode, ZENER BZX79/C18		0.4 W
GR237..239	4822 130 30613	Diode, BAW62/75		0.2 A
GR240	5322 130 32683	Diode, BZT03/C33		1.3 W
GR241..243	4822 130 31174	Diode, 1N4003 DO-41	1 A	200 V
GR244	4822 130 31248	Diode, ZENER BZV46/2V0		0.25 W
GR245	4822 130 30613	Diode, BAW62/75		0.2 A
IC201	5322 209 86201	IC-CMOS, CA3140E		
IC202	5322 255 40428	IC-Socket, 16 pol DIL		
IC202	5322 209 82868	IC, AD9687BD		
IC203	-	Not used		
IC204	5322 209 86201	IC-CMOS, CA3140E		
IC205	5322 209 86176	IC, 7812UC	1 A	12 V
IC205	5322 401 10868	Mounting bracket		
IC206	5322 209 85662	IC, TDA1060, not version 5		
IC207	5322 209 84825	IC-ECL, MC10216		
IC208	4822 209 80775	IC, NE555		
IC209	5322 209 86201	IC-CMOS, CA3140E		
IC210	4822 209 10247	IC-CMOS, 4011		
IC211..213	-	Not used		
IC214	5322 209 85265	IC-TTL, 74LS03N		
L201..204	5322 158 10052	HF Choke		
L205	5322 157 52133	Choke,	6 µH	6 A
L206	-	Not used		
L207	5322 158 10052	HF Choke		
L208..210	-	Not used		
L211, 212	5322 158 10052	HF Choke		
R150	4822 116 51281	Resistor, 5.62 kohm ±1 %	MR25	0.4 W
R201	5322 116 54392	Resistor, 100 ohm ±5 %	PR52	2.5 W
R202	5322 116 54502	Resistor, 261 ohm ±1 %	MR25	0.4 W
R203	5322 116 54515	Resistor, 348 ohm ±1 %	MR25	0.4 W
R204	5322 116 50679	Resistor, 237 ohm ±1 %	MR25	0.4 W
R205	5322 116 55274	Resistor, 215 ohm ±1 %	MR25	0.4 W
R206	5322 101 14194	Pot, 10 kohm ±10 %		0.5 W

Input Amplifiers and Power Supply board, U2 (continued)

Pos. No.	Order No.	Description		
R207	5322 116 54694	Resistor, 90.9 kohm ±1 %	MR25	0.4 W
R208	5322 101 10542	Pot, 100 ohm ±10 %		0.5 W
R209	5322 116 54589	Resistor, 3.83 kohm ±1 %	MR25	0.4 W
R210, 211	5322 116 55368	Resistor, 383 ohm ±1 %	MR25	0.4 W
R212	5322 116 54492	Resistor, 178 ohm ±1 %	MR25	0.4 W
R213, 214	5322 116 50766	Resistor, 147 ohm ±1 %	MR25	0.4 W
R215	5322 116 54541	Resistor, 825 ohm ±1 %	MR25	0.4 W
R216	5322 116 55247	Resistor, 422 kohm ±1 %	MR25	0.4 W
R217	4822 116 51235	Resistor, 1.00 kohm ±1 %	MR25	0.4 W
R218	5322 116 55357	Resistor, 82.5 ohm ±1 %	MR25	0.4 W
R219	5322 116 55097	Resistor, 47 ohm ±5 %	PR37	1.6 W
R220	4822 116 51104	Resistor, 390 ohm ±5 %	PR37	1.6 W
R221	5322 116 50557	Resistor, 46.4 kohm ±1 %	MR25	0.4 W
R222	5322 116 55535	Resistor, 1.00 Mohm ±1 %	MR25	0.4 W
R223	5322 116 54541	Resistor, 825 ohm ±1 %	MR25	0.4 W
R224	5322 116 54502	Resistor, 261 ohm ±1 %	MR25	0.4 W
R225, 226	5322 116 54392	Resistor, 100 ohm ±5 %	PR52	2.5 W
R227	5322 116 50557	Resistor, 46.4 kohm ±1 %	MR25	0.4 W
R228, 229	5322 116 50536	Resistor, 464 ohm ±1 %	MR25	0.4 W
R230	4822 116 51253	Resistor, 10.0 kohm ±1 %	MR25	0.4 W
R231	5322 116 54502	Resistor, 261 ohm ±1 %	MR25	0.4 W
R232	4822 116 51235	Resistor, 1.00 kohm ±1 %	MR25	0.4 W
R233	5322 116 55207	Resistor, 464 kohm ±1 %	MR25	0.4 W
R234	5322 116 55382	Resistor, 953 kohm ±1 %	MR30	0.5 W
R235	5322 116 54014	Resistor, 23.7 ohm ±1 %	MR25	0.4 W
R236	5322 116 55279	Resistor, 2.87 kohm ±1 %	MR25	0.4 W
R237	5322 101 14193	Trim-Pot, 1.0 kohm ±10 %		
R238	5322 116 54707	Resistor, 130 kohm ±1 %	MR25	0.4 W
R239	5322 116 54502	Resistor, 261 ohm ±1 %	MR25	0.4 W
R240	5322 116 54515	Resistor, 348 ohm ±1 %	MR25	0.4 W
R241	5322 116 50679	Resistor, 237 ohm ±1 %	MR25	0.4 W
R242	5322 116 55274	Resistor, 215 ohm ±1 %	MR25	0.4 W
R243	5322 101 14194	Trim. pot,10 kohm ±10 %		0.5 W
R244	5322 116 54694	Resistor, 90.9 kohm ±1 %	MR25	0.4 W
R245, 246	5322 116 55368	Resistor, 383 ohm ±1 %	MR25	0.4 W
R247	5322 116 54492	Resistor, 178 ohm ±1 %	MR25	0.4 W
R248, 249	5322 116 50766	Resistor, 147 ohm ±1 %	MR25	0.4 W
R250	5322 116 54541	Resistor, 825 ohm ±1 %	MR25	0.4 W
R251	5322 116 55247	Resistor, 422 kohm ±1 %	MR25	0.4 W
R252	4822 116 51235	Resistor, 1.00 kohm ±1 %	MR25	0.4 W
R253	5322 116 54455	Resistor, 68.1 ohm ±1 %	MR25	0.4 W
R254	5322 116 55097	Resistor, 47 ohm ±5 %	PR37	1.6 W
R255	4822 116 51104	Resistor, 390 ohm ±5 %	PR37	1.6 W
R256	5322 116 50557	Resistor, 46.4 kohm ±1 %	MR25	0.4 W

Input Amplifiers and Power Supply board, U2 (continued)

Pos. No.	Order No.	Description		
R257	5322 116 55535	Resistor, 1.00 Mohm ±1 %	MR25	0.4 W
R258	5322 116 54541	Resistor, 825 ohm ±1 %	MR25	0.4 W
R259	5322 116 54502	Resistor, 261 ohm ±1 %	MR25	0.4 W
R260	5322 116 54392	Resistor, 100 ohm ±5 %	PR52	2.5 W
R261, 262	5322 116 50536	Resistor, 464 ohm ±1 %	MR25	0.4 W
R263	4822 116 51253	Resistor, 10.0 kohm ±1 %	MR25	0.4 W
R264	5322 116 54502	Resistor, 261 ohm ±1 %	MR25	0.4 W
R265	4822 116 51235	Resistor, 1.00 kohm ±1 %	MR25	0.4 W
R266	5322 116 55207	Resistor, 464 kohm ±1 %	MR25	0.4 W
R267	5322 116 55382	Resistor, 953 kohm ±1 %	MR30	0.5 W
R268	5322 116 54014	Resistor, 23.7 ohm ±1 %	MR25	0.4 W
R269	5322 116 55279	Resistor, 2.87 kohm ±1 %	MR25	0.4 W
R270	5322 101 14193	Trim-Pot, 1.0 kohm ±10 %		
R271	5322 116 54707	Resistor, 130 kohm ±1 %	MR25	0.4 W
R272	5322 116 54446	Resistor, 56.2 ohm ±1 %	MR25	0.4 W
R273	4822 116 51253	Resistor, 10.0 kohm ±1 %	MR25	0.4 W
R274	5322 116 52558	Resistor, 3.83 kohm ±1 %	MR25	0.4 W
R275	4822 116 51235	Resistor, 1.00 kohm ±1 %	MR25	0.4 W
R276	5322 116 50635	Resistor, 1.47 kohm ±1 %	MR25	0.4 W
R277	5322 116 50484	Resistor, 4.64 kohm ±1 %	MR25	0.4 W
R278	5322 116 55357	Resistor, 82.5 ohm ±1 %	MR25	0.4 W
R279	4822 116 51281	Resistor, 5.62 kohm ±1 %	MR25	0.4 W
R280	5322 113 44175	Resistor, 0.1 ohm ±10 %		4 W
R281	5322 116 50767	Resistor, 2.15 kohm ±1 %	MR25	0.4 W
R282	4822 116 51233	Resistor, 681 ohm ±1 %	MR25	0.4 W
R283	4822 116 51253	Resistor, 10.0 kohm ±1 %	MR25	0.4 W
R284	5322 116 50572	Resistor, 12.1 kohm ±1 %	MR25	0.4 W
R285	4822 116 51253	Resistor, 10.0 kohm ±1 %	MR25	0.4 W
R286	5322 116 54651	Resistor, 26.1 kohm ±1 %	MR25	0.4 W
R287	5322 116 54502	Resistor, 261 ohm ±1 %	MR25	0.4 W
R288	4822 116 51268	Resistor, 100 kohm ±1 %	MR25	0.4 W
R289, 290	4822 116 51253	Resistor, 10.0 kohm ±1 %	MR25	0.4 W
R291	-	Not used		
R292	5322 116 54589	Resistor, 3.83 kohm ±1 %	MR25	0.4 W
R293	5322 101 14193	Trim-Pot, 1.0 kohm ±10 %		
R294	5322 116 50484	Resistor, 4.64 kohm ±1 %	MR25	0.4 W
R295	5322 116 55422	Resistor, 1.33 kohm ±1 %	MR25	0.4 W
R296	4822 116 51235	Resistor, 1.00 kohm ±1 %	MR25	0.4 W
R297	-	Not used		
R298	4822 116 51253	Resistor, 10.0 kohm ±1 %	MR25	0.4 W
R299	5322 116 54704	Resistor, 121 kohm ±1 %	MR25	0.4 W
R2001	4822 116 51252	Resistor, 6.81 kohm ±1 %	MR25	0.4 W
R2003..2006	5322 116 54446	Resistor, 56.2 ohm ±1 %	MR25	0.4 W
R2007	5322 116 55274	Resistor, 215 ohm ±1 %	MR25	0.4 W

Input Amplifiers and Power Supply board, U2 (continued)

Pos. No.	Order No.	Description			
R2008	5322 116 30239	Thermistor, 4.7 kohm ±5 %	NTC	0.5 W	
R2009	5322 116 50515	Resistor, 1.78 kohm ±1 %	MR25	0.4 W	
R2010..2011	5322 116 50766	Resistor, 147 ohm ±1 %	MR25	0.4 W	
R2012..2015	-	Not used			
R2016	5322 116 50557	Resistor, 46.4 kohm ±1 %	MR25	0.4 W	
R2017	-	Not used			
R2018	4822 110 72214	Resistor, 10 Mohm ±10 %	CR25	0.33 W	
R2019, 2020	-	Not used			
R2021	5322 116 54589	Resistor, 3.83 kohm ±1 %	MR25	0.4 W	
RE202-RE210	5322 280 20144	Reed Relay, HE321A0400	1 pol	5 V	
RE211..215	-	Not used			
RE216	5322 280 20144	Reed Relay, HE321A0400	1 pol	5 V	
RE217, 218	-	Not used			
RE219	5322 280 20144	Reed Relay, HE321A0400	1 pol	5 V	
T201	5322 146 20983	Transformer, Ferrite			
TS201	5322 130 44383	Transistor, FET WD453	Dual N-Channel		**Selected**
TS202, 203	5322 130 44435	Transistor, NPN 2N5770	0.05 A	15 V	
TS204	5322 130 44845	Transistor, PNP 2N5771	0.05 A	15 V	
TS205	5322 130 44383	Transistor, FET WD453	Dual N-Channel		**Selected**
TS206	-	Not used			
TS207, 208	5322 130 44435	Transistor, NPN 2N5770	0.05 A	15 V	
TS207, 208	5322 255 40424	Cooling clip			
TS209..210	5322 130 44435	Transistor, NPN 2N5770	0.05 A	15 V	
TS211	5322 130 44845	Transistor, PNP 2N5771	0.05 A	15 V	
TS213, 214	5322 130 44435	Transistor, NPN 2N5770	0.05 A	15 V	
TS213, 214	5322 255 40424	Cooling clip			
TS215	4822 130 40959	Transistor, NPN BC547B	0.1 A	45 V	
TS216	4822 130 40854	Transistor, PNP BC327	0.5 A	45 V	
TS217	5322 130 42508	Transistor, NPN D45H8	10 A	60 V	
TS217	5322 401 10868	Mounting bracket			
TS218	4822 130 40959	Transistor, NPN BC547B	0.1 A	45 V	
TS219	4822 130 44256	Transistor, NPN BC557B	0.1 A	45 V	
TS220	5322 130 44325	Transistor, NPN BD203	8 A	60 V	
TS220	5322 401 10868	Mounting bracket			
VL201	5322 256 34104	Fuse Holder, PCB- mounted			
VL201	4822 253 20026	Fuse, FAST-BLOW 5x20 mm		4 A	
BU10	5322 121 42352	Power cable socket with mains filter			
SK10	5322 272 10217	Mains voltage selector			
T10	5322 146 20984	Mains transformer			
VL10	5322 256 34102	Fuse holder, rear panel			
VL10	4822 253 30016	Fuse for 230 V, SLOW-BLOW 5x20 mm		400 mA	
VL10	4822 253 30019	Fuse for 115 V, SLOW-BLOW 5x20 mm		800 mA	
	5322 268 10147	Connector, external battery input			
	5322 466 91588	Insulating plate, fitted between right side-profile and heat-sink			
	5322 466 81579	Insulating plate, self adhesive, for heat-sink			

Keyboard Unit, U3

Pos. No.	Order No.	Description		
BU301	5322 265 51064	Connector, MOLEX 22 pole 4030-22FG		
BU303	5322 265 40381	Connector, MOLEX 12 pole 4030-12FG		
C301	4822 122 31414	Capacitor, 10 nF -20/+50 %		100 V
C302	-	Not used		
C303	4822 122 31414	Capacitor, 10 nF -20/+50 %		100 V
C304	-	Not used		
C305	5322 124 10455	Capacitor, Solid Al. 68 µF ±20 %		6.3 V
C306..311	4822 122 30114	Capacitor, 2.2 nF ±10 %		100 V
GR301..343	4822 130 30613	Diode, BAW62/75	0.2 A	75 V
GR344	-	Not used		
GR345, 346	4822 130 30613	Diode, BAW62/75	0.2 A	75 V
GR347	5322 130 31502	Trigger indicator LED,	yellow	3 mm
GR347	5322 267 30393	Connector, 2 pole MOLEX 4455-CC		
GR348	5322 130 31502	Trigger indicator LED,	yellow	3 mm
GR348	5322 267 30393	Connector, 2 pole MOLEX 4455-CC		
IC301	5322 209 10491	IC-CMOS, 40373B		
IC302	5322 209 86062	IC-TTL, 74LS373		
IC303	5322 111 94015	Res. Network, 1 kohm ±10 %		1/8 W
IC304	4822 209 10301	IC-CMOS, 4028B		
IC305	5322 209 86062	IC-TTL, 74LS373		
R301..307	5322 116 54455	Resistor, 68.1 ohm ±1 %	MR25	0.4 W
R308	5322 116 55549	Resistor, 100 ohm ±1 %	MR25	0.4 W
R309	5322 101 20805	Trigg Level B Pot. 10 kohm ±20 % LIN		
R309	5322 414 30044	Potentiometer knob		
R309	5322 414 70016	Cover to potentiometer knob		
R310	5322 101 20806	Measuring Time Pot. 220 kohm ±10 % LIN		
R310	5322 414 30044	Potentiometer knob		
R310	5322 414 70016	Cover to potentiometer knob		
R311	5322 101 20805	Trigg Level A Pot. 10 kohm ±20 % LIN		
R311	5322 414 30044	Potentiometer knob		
R311	5322 414 70016	Cover to potentiometer knob		
R312	4822 116 51235	Resistor, 1.00 kohm ±1 %	MR25	0.4 W
SK301..304	5322 276 11448	Key Switch, 1 pol with green LED		
SK305	5322 276 11446	Key Switch, 1 pol with red LED		
SK306, 307	5322 276 11448	Key Switch, 1 pol with green LED		
SK308	5322 276 14404	Key Switch, 1 pol		
SK309	5322 276 11446	Key Switch, 1 pol with red LED		
SK310	5322 276 11448	Key Switch, 1 pol with green LED		
SK311	5322 276 14404	Key Switch, 1 pol		
SK312..315	5322 276 11448	Key Switch, 1 pol with green LED		

Keyboard Unit, U3 (continued)

Pos. No.	Order No.	Description
SK316..319	5322 276 14404	Key Switch, 1 pol
SK320	5322 276 11446	Key Switch, 1 pol with red LED
SK321..331	5322 276 14404	Key Switch, 1 pol
SK332	5322 276 11446	Key Switch, 1 pol with red LED
SK333	5322 276 11448	Key Switch, 1 pol with green LED
SK334	-	Not used
SK335	5322 276 11448	Key Switch, 1 pol with green LED
SK336	5322 276 11446	Key Switch, 1 pol with red LED
SK337	5322 276 11448	Key Switch, 1 pol with green LED
SK338	5322 276 11446	Key Switch, 1 pol with red LED
SK339	5322 276 11448	Key Switch, 1 pol with green LED
SK340	5322 276 14404	Key Switch, 1 pol
SK241	-	Not used
SK342, 343	5322 276 14404	Key Switch, 1 pol
TS301, 302	4822 130 40937	Transistor, NPN BC548B 0.1 A 30 V
	5322 414 60036	Keytop, for key switch without LED
	5322 414 60038	Keytop, for key switch with LED
	5322 466 81578	Dustcover to BNC
	5322 321 20504	Cable assy, for prescaler
	5322 321 21094	Flat cable assy for keyboard

Blind panel

Pos. No.	Order No.	Description
	5322 321 21093	Cable assy. for blind panel
	5322 255 40423	LED holder for blindpanel
	5322 130 31502	LED, yellow for trigger indicators
	5322 130 32684	LED, green for blindpanel
	5322 130 32686	LED, red for blindpanel

Display board U4

Pos. No.	Order No.	Description		
B401..411	5322 130 90227	Display, 7651 7-Segment		10.9 mm
B412..415	5322 130 36282	LED-bargraph, MV57164		
BU401	5322 267 60151	Connector, MOLEX 22 pol 4455-22BK		
BU402	5322 267 50522	Connector, MOLEX 12 pol 4455-12BK		
C401, 402	5322 122 32416	Capacitor, 100 nF +80 %		50 V
C403, 404	4822 124 20673	Capacitor, 470 μF -10/+50 %		6.3 V
GR401..405	5322 130 32681	LED, 3 mm, red		
IC401, 402	5322 209 81435	IC, NE587		
IC403, 404	4822 209 81083	IC-TTL, 74LS145 (1/10 decoder)		
R401, 402	5322 116 54511	Resistor, 316 ohm ±1 %	MR25	0.4 W
R403	-	Not used		
R404, 405	5322 116 50635	Resistor, 1.47 kohm ±1 %	MR25	0.4 W
TS401..406	5322 130 41682	Transistor, NPN Darling MPS-A12	0.5 A	20 V

Rear panel board U5

Pos. No.	Order No.	Description		
BU501..507	5322 267 10004	Connector BNC, KC-79-35		
BU501..507	5322 466 81578	Dustcover to BNC		
BU508..510	5322 268 20136	Connector mini coax		
BU511	5322 265 40378	Connector, Molex 17 pol 4094-MAG		
BU512..514	5322 267 10004	Connector BNC, KC-79-35		
BU512..514	5322 466 81578	Dustcover to BNC		
C501..503	4822 122 31414	Capacitor, 10 nF -20/+50 %		100 V
C504	4822 121 41672	Capacitor, 100 nF ±10 %		100 V
GR501, 502	4822 130 30613	Diode, BAW62/75		0.2 A
GR503	4822 130 31353	Diode, BAT43/30		0.1 A
R501	5322 116 54909	Resistor, 1.0 kohm ±5 %	PR37	1.6 W
R502	5322 116 50484	Resistor, 4.64 kohm ±1 %	MR25	0.4 W
R503	5322 116 54909	Resistor, 1.0 kohm ±5 %	PR37	1.6 W
R504	5322 116 50484	Resistor, 4.64 kohm ±1 %	MR25	0.4 W
R505..508	4822 116 51235	Resistor, 1.00 kohm ±1 %	MR25	0.4 W
SK501	5322 277 10808	Slide Switch, 2 pol 2-pos		
SK502	5322 277 20995	Slide Switch, 2 pol 4-pos		
TS501, 502	4822 130 40937	Transistor, NPN BC548B	0.1 A	30 V

CEX board U6 for PM 6652

Pos. No.	Order No.	Description		
BU601	5322 267 60151	Connector, MOLEX 22 pol 4455-22BK		
BU602	5322 267 50521	Connector, MOLEX 17 pol 4455-17BK		
C601	5322 124 10455	Capacitor, Solid al. 68 µF ±20 %		6.3 V
C602..604	4822 122 31414	Capacitor, 10 nF -20/+50 %		100 V
C605	4822 122 30113	Capacitor, 180 pF ±10 %		100 V
C606	4822 122 31072	Capacitor, 47.0 pF ±2 % NPO		100 V
GR601	4822 130 30613	Diode, BAW62/75		0.2 A
GR602	4822 130 31248	Diode, ZENER BZV46/2V0		0.25 W
GR603	5322 130 34865	Diode, ZENER BZV46/1V5		0.25 W
GR604, 605	4822 130 31248	Diode, ZENER BZV46/2V0		0.25 W
IC601	5322 209 84643	IC-ECL, MC10102		
IC602	-	Not used		
IC603	5322 209 84643	IC-ECL, MC10102		
IC604	5322 111 90738	Res. Network, 150 ohm ±10 %		1/8 W
IC605, 606	5322 209 85802	IC-ECL, MC10131		
IC607	5322 209 84643	IC-ECL, MC10102		
IC608	5322 111 90738	Res. Network, 150 ohm ±10 %		1/8 W
IC609	5322 209 80964	IC-ECL, MC10105		
IC610	5322 111 90738	Res. Network, 150 ohm ±10 %		1/8 W
IC611	5322 209 86203	IC-ECL, MC10138		
IC612	5322 111 94015	Res. Network, 1 kohm ±10 %		1/8 W
IC613	5322 209 10385	IC-ECL, 40374B		
R601	5322 116 54541	Resistor, 825 ohm ±1 %	MR25	0.4 W
R602	5322 116 55368	Resistor, 383 ohm ±1 %	MR25	0.4 W
R603	-	Not used		
R604	5322 116 54541	Resistor, 825 ohm ±1 %	MR25	0.4 W
R605..607	4822 116 51253	Resistor, 10.0 kohm ±1 %	MR25	0.4 W
R608, 609	5322 116 50536	Resistor, 464 ohm ±1 %	MR25	0.4 W
R610	5322 116 50671	Resistor, 2.61 kohm ±1 %	MR25	0.4 W
R611	5322 116 50536	Resistor, 464 ohm ±1 %	MR25	0.4 W
R612	5322 116 54557	Resistor, 1.21 kohm ±1 %	MR25	0.4 W
R613, 614	5322 116 50536	Resistor, 464 ohm ±1 %	MR25	0.4 W
R615	5322 116 55368	Resistor, 383 ohm ±1 %	MR25	0.4 W
R616	4822 116 51235	Resistor, 1.00 kohm ±1 %	MR25	0.4 W
R617	5322 116 50766	Resistor, 147 ohm ±1 %	MR25	0.4 W
R618	-	Not used		
R619	5322 116 50536	Resistor, 464 ohm ±1 %	MR25	0.4 W
TS601	5322 130 44845	Transistor, PNP 2N5771	0.05 A	15 V
TS602	5322 130 44435	Transistor, NPN 2N5770	0.05 A	15 V
TS603	4822 130 44197	Transistor, PNP BC558B	0.1 A	30 V
TS604	5322 130 44435	Transistor, NPN 2N5770	0.05 A	15 V
TS605	5322 130 44845	Transistor, PNP 2N5771	0.05 A	15 V
TS606, 607	4822 130 40937	Transistor, NPN BC548B	0.1 A	30 V
TS608	5322 130 44845	Transistor, PNP 2N5771	0.05 A	15 V

CEX board U7 for PM 6654

Pos. No.	Order No.	Description		
BU701	5322 267 60151	Connector, MOLEX 22 pol 4455-22BK		
BU702	5322 267 50521	Connector, MOLEX 17 pol 4455-17BK		
C701..704	4822 122 31072	Capacitor, 47.0 pF ±2 %	NPO	100 V
C705	4822 122 31067	Capacitor, 33.0 pF ±2 %	NPO	100 V
C706	4822 122 30027	Capacitor, 1 nF ±10 %		100 V
C707	4822 122 31823	Capacitor, 15.0 pF ±2 %	NPO	100 V
C708	5322 125 54029	Trim Capacitor, 2-18 pF		300V
C709	4822 122 32185	Capacitor, 10.0 pF ±2 %	NPO	100 V
C710	4822 122 31414	Capacitor, 10 nF -20/+50 %		100 V
C711	5322 125 54029	Trim Capacitor, 2-18 pF		300V
C712	4822 122 31063	Capacitor, 22.0 pF ±2 %	NPO	100 V
C713	4822 122 32185	Capacitor, 10.0 pF ±2 %	NPO	100 V
C714	4822 122 31414	Capacitor, 10 nF -20/+50 %		100 V
C715	5322 125 54029	Trim Capacitor, 2-18 pF		300V
C716	4822 122 31067	Capacitor, 33.0 pF ±2 %	NPO	100 V
C717, 718	4822 122 31414	Capacitor, 10 nF -20/+50 %		100 V
C719	5322 125 54029	Trim Capacitor, 2-18 pF		300V
C720	4822 122 31067	Capacitor, 33.0 pF ±2 %	NPO	100 V
C721	4822 124 20977	Capacitor, Solid al. 15 μF ±20 %		16 V
C722	5322 124 14066	Capacitor, Solid al. 10 μF ±20 %		6.3 V
C723	4822 122 31414	Capacitor, 10 nF -20/+50 %		100 V
C724	-	Not used		
C725	4822 122 30027	Capacitor, 1 nF ±10 %		100 V
C726..736	4822 122 31414	Capacitor, 10 nF -20/+50 %		100 V
C737	5322 124 10455	Capacitor, Solid al. 68 μF ±20 %		6.3 V
C738..741	4822 122 31414	Capacitor, 10 nF -20/+50 %		100 V
C742	5322 125 50256	Trim Capacitor, 1.4-5.5 pF		300V
C743	4822 122 31049	Capacitor, 6.8 pF ±0.25 pF	NPO	100 V
C744	4822 122 32185	Capacitor, 10.0 pF ±2 %	NPO	100 V
C745	5322 125 50256	Trim Capacitor, 1.4-5.5 pF		300V
C746	4822 122 31069	Capacitor, 39.0 pF ±2 %	NPO	100 V
C747	4822 526 10025	FXC Tube, 4B yellow		
C747	4822 122 31168	Capacitor, 270 pF ±10 %		100 V
C748	4822 122 31072	Capacitor, 47.0 pF ±2 %	NPO	100 V
C749	4822 122 31414	Capacitor, 10 nF -20/+50 %		100 V
C750	4822 122 30027	Capacitor, 1 nF ±10 %		100 V
C751..754	4822 122 31414	Capacitor, 10 nF -20/+50 %		100 V
C755	4822 122 31056	Capacitor, 12.0 pF ±2 %	NPO	100 V
C756	4822 122 31061	Capacitor, 18.0 pF ±2 %	NPO	100 V
C757	4822 122 31072	Capacitor, 47.0 pF ±2 %	NPO	100 V
C758	4822 122 30027	Capacitor, 1 nF ±10 %		100 V

CEX board U7 for PM 6654 (continued)

Pos. No.	Order No.	Description		
C759	4822 122 31414	Capacitor, 10 nF -20/+50 %		100 V
C760, 761	-	Not used		
C762	4822 122 31316	Capacitor, 100 pF ±2 %	NPO	100 V
C763	4822 122 31168	Capacitor, 270 pF ±10 %		100 V
C764	4822 122 31414	Capacitor, 10 nF -20/+50 %		100 V
C765	4822 122 31072	Capacitor, 47.0 pF ±2 %	NPO	100 V
GR701	4822 130 30613	Diode, BAW62/75		0.2 A
GR702	5322 130 34865	Diode, Zener BZV46/1V5		0.25 W
GR703	4822 130 31248	Diode, Zener BZV46/2V0		0.25 W
GR704	4822 130 30613	Diode, BAW62/75		0.2 A
GR705..710	4822 130 31248	Diode, Zener BZV46/2V0		0.25 W
GR711	-	Not used		
GR712	4822 130 31248	Diode, Zener BZV46/2V0		0.25 W
GR713, 714	4822 130 30613	Diode, BAW62/75		0.2 A
GR715	4822 130 31248	Diode, Zener BZV46/2V0		0.25 W
GR716..718	4822 130 30613	Diode, BAW62/75		0.2 A
IC701	-	Not used		
IC702	5322 209 80964	IC-ECL, MC10105		
IC703	5322 209 85204	IC-ECL, SP8635B		
IC704	5322 209 84825	IC-ECL, MC10216		
IC705	5322 209 86203	IC-ECL, MC10138		
IC706	5322 209 82867	IC-ECL, MC10173		
IC707	5322 209 84643	IC-ECL, MC10102		
IC708	5322 209 10385	IC-CMOS, 40374B		
IC709	5322 209 84643	IC-ECL, MC10102		
IC710	5322 209 86203	IC-ECL, MC10138		
IC711	5322 209 84643	IC-ECL, MC10102		
IC712	5322 209 10385	IC-CMOS, 40374B		
IC713, 714	5322 209 85802	IC-ECL, MC10131		
IC715	5322 209 84643	IC-ECL, MC10102		
IC716, 717	5322 209 86266	IC-ECL, MC10106		
IC718..720	5322 209 84643	IC-ECL, MC10102		
IC721	5322 209 80964	IC-ECL, MC10105		
IC722	5322 209 85802	IC-ECL, MC10131		
IC723	5322 209 84643	IC-ECL, MC10102		
IC724..730	-	Not used		
IC731..733	5322 111 94015	Res. Network, 1 kohm ±10 %		1/8 W
IC734..736	5322 111 90738	Res. Network, 150 ohm ±10 %		1/8 W
IC737	5322 111 94015	Res. Network, 1 kohm ±10 %		1/8 W
IC738..740	5322 111 90738	Res. Network, 150 ohm ±10 %		1/8 W
IC741	5322 209 86201	IC-CMOS, CA3140E		
L701..703	5322 158 10052	HF Choke		
L704	4822 526 10097	FXF Tube		

CEX board U7 for PM 6654 (continued)

Pos. No.	Order No.	Description		
L705	5322 158 10052	HF Choke		
R701	4822 116 51253	Resistor, 10.0 kohm ±1 %	MR25	0.4 W
R702	5322 116 50515	Resistor, 1.78 kohm ±1 %	MR25	0.4 W
R703	5322 116 54558	Resistor, 8.25 kohm ±1 %	MR25	0.4 W
R704	5322 116 50536	Resistor, 464 ohm ±1 %	MR25	0.4 W
R705	4822 116 51252	Resistor, 6.81 kohm ±1 %	MR25	0.4 W
R706	4822 116 51235	Resistor, 1.00 kohm ±1 %	MR25	0.4 W
R707	5322 116 55368	Resistor, 383 ohm ±1 %	MR25	0.4 W
R708	5322 116 54541	Resistor, 825 ohm ±1 %	MR25	0.4 W
R709	4822 116 51281	Resistor, 5.62 kohm ±1 %	MR25	0.4 W
R710	5322 116 54589	Resistor, 3.83 kohm ±1 %	MR25	0.4 W
R711	4822 116 51281	Resistor, 5.62 kohm ±1 %	MR25	0.4 W
R712	5322 116 54589	Resistor, 3.83 kohm ±1 %	MR25	0.4 W
R713	4822 116 51281	Resistor, 5.62 kohm ±1 %	MR25	0.4 W
R714	5322 116 54589	Resistor, 3.83 kohm ±1 %	MR25	0.4 W
R715	4822 116 51281	Resistor, 5.62 kohm ±1 %	MR25	0.4 W
R716	5322 116 54589	Resistor, 3.83 kohm ±1 %	MR25	0.4 W
R717	5322 116 54492	Resistor, 178 ohm ±1 %	MR25	0.4 W
R718	5322 116 50635	Resistor, 1.47 kohm ±1 %	MR25	0.4 W
R719	5322 116 50484	Resistor, 4.64 kohm ±1 %	MR25	0.4 W
R720	4822 116 51235	Resistor, 1.00 kohm ±1 %	MR25	0.4 W
R721	5322 116 50492	Resistor, 46.4 kohm ±1 %	MR25	0.4 W
R722	5322 116 50635	Resistor, 1.47 kohm ±1 %	MR25	0.4 W
R723	5322 116 54511	Resistor, 316 ohm ±1 %	MR25	0.4 W
R724	5322 116 54557	Resistor, 1.21 kohm ±1 %	MR25	0.4 W
R725	5322 116 50536	Resistor, 464 ohm ±1 %	MR25	0.4 W
R726	5322 116 54426	Resistor, 121 ohm ±1 %	MR25	0.4 W
R727	5322 116 54455	Resistor, 68.1 ohm ±1 %	MR25	0.4 W
R728	5322 116 50484	Resistor, 4.64 kohm ±1 %	MR25	0.4 W
R729..731	5322 116 54511	Resistor, 316 ohm ±1 %	MR25	0.4 W
R732	4822 116 51253	Resistor, 10.0 kohm ±1 %	MR25	0.4 W
R733	4822 116 51235	Resistor, 1.00 kohm ±1 %	MR25	0.4 W
R734	5322 116 50766	Resistor, 147 ohm ±1 %	MR25	0.4 W
R735	5322 116 54541	Resistor, 825 ohm ±1 %	MR25	0.4 W
R736	5322 116 55368	Resistor, 383 ohm ±1 %	MR25	0.4 W
R737	4822 116 51235	Resistor, 1.00 kohm ±1 %	MR25	0.4 W
R738	5322 116 50766	Resistor, 147 ohm ±1 %	MR25	0.4 W
R739	5322 116 54515	Resistor, 348 ohm ±1 %	MR25	0.4 W
R740	5322 116 54502	Resistor, 261 ohm ±1 %	MR25	0.4 W
R741	4822 116 51235	Resistor, 1.00 kohm ±1 %	MR25	0.4 W

CEX board U7 for PM 6654 (continued)

Pos. No.	Order No.	Description		
R742	5322 116 55549	Resistor, 100 ohm ±1 %	MR25	0.4 W
R744	4822 116 51253	Resistor, 10.0 kohm ±1 %	MR25	0.4 W
R745	5322 116 50671	Resistor, 2.61 kohm ±1 %	MR25	0.4 W
R746	5322 116 50635	Resistor, 1.47 kohm ±1 %	MR25	0.4 W
R747, 748	5322 116 50536	Resistor, 464 ohm ±1 %	MR25	0.4 W
R749	5322 116 50557	Resistor, 46.4 kohm ±1 %	MR25	0.4 W
R750	5322 116 50671	Resistor, 2.61 kohm ±1 %	MR25	0.4 W
R751	5322 116 55274	Resistor, 215 ohm ±1 %	MR25	0.4 W
R752	5322 116 50766	Resistor, 147 ohm ±1 %	MR25	0.4 W
R753	5322 116 54511	Resistor, 316 ohm ±1 %	MR25	0.4 W
R754	5322 116 50536	Resistor, 464 ohm ±1 %	MR25	0.4 W
R755	5322 116 54541	Resistor, 825 ohm ±1 %	MR25	0.4 W
R756	5322 116 50492	Resistor, 46.4 kohm ±1 %	MR25	0.4 W
R758	5322 116 55549	Resistor, 100 ohm ±1 %	MR25	0.4 W
R759	4822 116 51235	Resistor, 1.00 kohm ±1 %	MR25	0.4 W
R760	5322 116 54637	Resistor, 17.8 kohm ±1 %	MR25	0.4 W
R761	5322 116 50536	Resistor, 464 ohm ±1 %	MR25	0.4 W
R762	5322 116 55274	Resistor, 215 ohm ±1 %	MR25	0.4 W
R763	5322 116 54632	Resistor, 14.7 kohm ±1 %	MR25	0.4 W
R764	5322 116 50536	Resistor, 464 ohm ±1 %	MR25	0.4 W
R765	5322 116 54589	Resistor, 3.83 kohm ±1 %	MR25	0.4 W
R766	5322 116 50635	Resistor, 1.47 kohm ±1 %	MR25	0.4 W
TS701	5322 130 44435	Transistor, NPN 2N5770	0.05 A	15 V
TS702	4822 130 40937	Transistor, NPN BC548B	0.1 A	30 V
TS703, 704	5322 130 44845	Transistor, PNP 2N5771	0.05 A	15 V
TS705	5322 130 44435	Transistor, NPN 2N5770	0.05 A	15 V
TS706..710	4822 130 44197	Transistor, PNP BC558B	0.1 A	30 V
TS711	5322 130 44845	Transistor, PNP 2N5771	0.05 A	15 V
TS712, 713	5322 130 44435	Transistor, NPN 2N5770	0.05 A	15 V
TS714	4822 130 40937	Transistor, NPN BC548B	0.1 A	30 V
TS715, 716	5322 130 44909	Transistor, NPN BFR90	0.025 A	15 V
TS717	4822 130 44197	Transistor, PNP BC558B	0.1 A	30 V
TS718	4822 130 40937	Transistor, NPN BC548B	0.1 A	30 V
TS719	5322 130 44909	Transistor, NPN BFR90	0.025 A	15 V
TS721	4822 130 44197	Transistor, PNP BC558B	0.1 A	30 V
TS722	5322 130 44435	Transistor, NPN 2N5770	0.05 A	15 V
TS723	4822 130 40937	Transistor, NPN BC548B	0.1 A	30 V
TS724	5322 130 44845	Transistor, PNP 2N5771	0.05 A	15 V

Channel C prescaler, PM 9610 early version

Pos. No.	Order No.	Description		
BU301	5322 267 34043	Plug, mini-coax, Female		
BU302	5322 265 40182	Connector, MOLEX	7 Pins	
BU 303..306	-	Not used		
BU307	5322 265 40182	Connector, MOLEX	7 Pins	
C301..307	5322 122 34098	Capacitor, 10 nF ±20%	Chip	50 V
C308	5322 125 54055	Trim capacitor, 4.5pF		
C310	5322 122 34098	Capacitor, 10 nF ±20%	Chip	50 V
C311	5322 122 34096	Capacitor, 5.6 pF ±10%	Chip	50 V
C312	5322 122 34098	Capacitor, 10 nF ±20%	Chip	50 V
C314	5322 122 34096	Capacitor, 5.6 pF ±10%	Chip	50 V
C315..317	5322 122 34098	Capacitor, 10 nF ±20%	Chip	50 V
C318	5322 125 54055	Trim capacitor, 4.5 pF		
C319..322	5322 122 34098	Capacitor, 10 nF ±20%	Chip	50 V
C323	5322 122 31594	Capacitor, 3.3 pF ±10%	Ceram	50 V
C324..27	5322 122 34098	Capacitor, 10 nF ±20%	Chip	50 V
C328..29	5322 124 14064	Capacitor, 4.7 µF ±20%	Elec.	25 V
C330	5322 122 31594	Capacitor, 3.3 pF ±10%	Ceram	50 V
C331	5322 122 34046	Capacitor, 10 pF ±10%	Chip	50 V
C332, 333	5322 122 34098	Capacitor, 10 nF ±20%	Chip	50 V
C334, 335	~~2222-679-03108~~	Capacitor 1 pF ±0.25 pF		100 V
GR301, 302	5322 130 34283	Diode, HP5082-2835		
GR303, 304	5322 130 34364	Diode, BAW379		
GR305	4822 130 30613	Diode, BAW62		
GR306	4822 130 34048	Diode, Zener BZX75-C2V8		
GR307, 308	4822 130 30765	Diode, Zener BZX75-C3V6		
GR309..311	5322 130 34283	Diode, HP5082-2835		
GR312..315	4822 130 30613	Diode, BAW62		
IC301	5322 209 86264	IC, SAB1534P		
IC302	5322 209 86263	IC, SAB1048		
IC303	5322 209 85254	IC, 741N		
L301	5322 158 14119	Coil		
L302, 303	5322 158 10052	Coil		
R301	4822 116 51142	Resistor, 150 ohm ±5%	M.Film	1.6 W
R302	4822 116 51087	Resistor, 33 ohm ±5%	M.Film	2.5 W
R303	5322 116 50766	Resistor, 147 ohm ±1%	M.Film	0.4 W
R304	5322 116 54511	Resistor, 316 ohm ±1%	M.Film	0.4 W
R305	4822 111 30271	Resistor, 820 ohm ±5%	Carbon	0.2 W
R306	5322 111 30074	Resistor, 56 ohm ±5%	Carbon	0.2 W
R307	5322 111 30383	Resistor, 68 ohm ±5%	Carbon	0.2 W
R308	5322 111 90078	Resistor, 27 ohm ±5%	Chip	0.15W

Channel C prescaler, PM 9610 early version (continued)

Pos. No.	Order No.	Description		
R310	4822 111 30324	Resistor, 100 ohm ±5%	Carbon	0.2W
R311	5322 111 90078	Resistor, 27 ohm ±5%	Chip	0.15W
R312	5322 116 54506	Resistor, 287 ohm ±1%	M.Film	0.4W
R313	5322 111 90078	Resistor, 27 ohm ±5%	Chip	0.15W
R314	5322 111 30383	Resistor, 68 ohm ±5%	Carbon	0.2W
R316	5322 116 54506	Resistor, 287 ohm ±1%	M.Film	0.4W
R317	5322 111 90078	Resistor, 27 ohm ±5%	Chip	0.15W
R318	4822 111 30324	Resistor, 100 ohm ±5%	Carbon	0.2W
R319	5322 116 54128	Resistor, 5.62 ohm ±1%	M.Film	0.4W
R320	5322 111 30383	Resistor, 68 ohm ±5%	Carbon	0.2W
R321	5322 111 90078	Resistor, 27 ohm ±5%	Chip	0.15W
R322	4822 111 30324	Resistor, 100 ohm ±5%	Carbon	0.2W
R323, 324	5322 111 90078	Resistor, 27 ohm ±5%	Chip	0.15W
R325	5322 116 54506	Resistor, 287 ohm ±1%	M.Film	0.4W
R226	4822 111 30323	Resistor, 270 ohm ±5%	Carbon	0.2W
R327	5322 116 54128	Resistor, 5.62 ohm ±1%	M.Film	0.4W
R328	5322 111 90078	Resistor, 27 ohm ±5%	Chip	0.15W
R329	4822 111 30324	Resistor, 100 ohm ±5%	Carbon	0.2W
R332	4822 116 51253	Resistor, 10 kohm ±1%	M.Film	0.4W
R333	5322 101 14299	Potentiometer, Trim 1 kohm		
R335	5322 116 54128	Resistor, 5.62 ohm ±1%	M.Film	0.4W
R336, 337	5322 116 50766	Resistor, 147 ohm ±1%	M.Film	0.4W
R338, 339	5322 116 54518	Resistor, 383 ohm ±1%	M.Film	0.4W
R340	5322 116 54511	Resistor, 316 ohm ±1%	M.Film	0.4W
R341	4822 116 51253	Resistor, 10 kohm ±1%	M.Film	0.4W
R342	4822 116 51268	Resistor, 100 kohm ±1%	M.Film	0.4W
R343..345	5322 116 54549	Resistor, 1 kohm ±1%	M.Film	0.4W
R346	5322 116 54009	Resistor, 562 ohm ±1%	M.Film	0.4W
TS301, 302	5322 130 44179	Transistor, BFR90		
TS303, 304	5322 130 41683	Transistor, ON586 = BFQ51		
TS305, 306	5322 130 44179	Transistor, BFR90		
TS307	5322 130 44181	Transistor, BFR91		
	5322 466 81578	Dustcover to BNC		
	5322 321 20504	Cable assy, for prescaler		

Channel C prescaler, PM 9610 new version

Pos. No.	Order No.	Description			
	5322 255 40443	Complete board			
BU1	5322 267 30501	- Connector, mini coax			
BU2	5322 265 40379	- Connector, MOLEX 5-pole			
BU3	5322 267 30501	- Connector, mini coax			
BU7	*)	- Connector, MOLEX 12-pole			
	5322 265 40182	- Connector, MOLEX 7-pole			
C1	5322 122 32452	- Capacitor, 47 pF ±5 %	NPO	Chip	50 V
C2...4	5322 122 34123	- Capacitor, 1 nF ±20 %	X7R	Chip	50 V
C5	5322 122 32453	- Capacitor, 10 nF ±20 %	X7R	Chip	50 V
C6	5322 122 34123	- Capacitor, 1 nF ±20 %	X7R	Chip	50 V
C21	5322 122 34123	- Capacitor, 1 nF ±20 %	X7R	Chip	50 V
C23	5322 122 34123	- Capacitor, 1 nF ±20 %	X7R	Chip	50 V
C24	5322 122 32451	- Capacitor, 4.7 pF ±5 %	NPO	Chip	50 V
C25	5322 122 34123	- Capacitor, 1 nF ±20 %	X7R	Chip	50 V
C27	5322 122 34123	- Capacitor, 1 nF ±20 %	X7R	Chip	50 V
C28	5322 122 32451	- Capacitor, 4.7 pF ±5 %	NPO	Chip	50 V
C29	5322 122 34123	- Capacitor, 1 nF ±20 %	X7R	Chip	50 V
C31	5322 122 34123	- Capacitor, 1 nF ±20 %	X7R	Chip	50 V
C32	5322 122 32481	- Capacitor, 15 pF ±5 %	NPO	Chip	50 V
C33...34	5322 122 34123	- Capacitor, 1 nF ±20 %	X7R	Chip	50 V
C36	5322 122 32448	- Capacitor, 10 pF ±5 %	NPO	Chip	50 V
C37	5322 122 34123	- Capacitor, 1 nF ±20 %	X7R	Chip	50 V
C39	5322 122 34123	- Capacitor, 1 nF ±20 %	X7R	Chip	50 V
C40	5322 122 32451	- Capacitor, 4.7 pF ±5 %	NPO	Chip	50 V
C41	5322 122 34123	- Capacitor, 1 nF ±20 %	X7R	Chip	50 V
C42	5322 122 32447	- Capacitor, 1 pF ±5 %	NPO	Chip	50 V
C43	5322 122 34123	- Capacitor, 1 nF ±20 %	X7R	Chip	50 V
C44	5322 122 32449	- Capacitor, 3.3 pF ±5 %	NPO	Chip	50 V
C45, 46	5322 122 34123	- Capacitor, 1 nF ±20 %	X7R	Chip	50 V
C47	5322 122 32446	- Capacitor, 470 nF ±20 %	X7R	Chip	50 V
C48	5322 122 32448	- Capacitor, 10 pF ±5 %	NPO	Chip	50 V
C49	5322 122 32447	- Capacitor, 1 pF ±5 %	NPO	Chip	50 V
C50	5322 122 34123	- Capacitor, 1 nF ±20 %	X7R	Chip	50 V
C51...54	5322 122 32453	- Capacitor, 10 nF ±20 %	X7R	Chip	50 V
C55	5322 122 32446	- Capacitor, 470 nF ±20 %	X7R	Chip	50 V
GR1	5322 130 31544	- Diode, BAT17			0.03 A
GR10	5322 130 34337	- Diode, BAV99			0.1 A
GR12	5322 130 32739	- Diode, Zener BZX84/C3V0			0.35 W
GR13...15	5322 130 31544	- Diode, BAT17			0.03 A
GR16, 17	5322 130 34337	- Diode, BAV99			0.1 A
GR18, 19	5322 130 31544	- Diode, BAT17			0.03 A

*) To get one 12-pole connector (BU7), order one 5-pole (BU2) and one 7-pole MOLEX connector.

Channel C prescaler, PM 9610 new version (continued)

Pos. No.	Order No.	Description		
	5322 255 40443	Complete board (continued)		
GR2	5322 130 31544	- Diode, BAT17		0.03 A
GR21, 22	5322 130 34337	- Diode, BAV99		0.1 A
GR3, 4	5322 130 30762	- Diode, HP 5082-3080		
GR5	5322 130 34337	- Diode, BAV99		0.1 A
GR6	5322 130 32739	- Diode, Zener BZX84/C3V0		0.35 W
GR7, 8	5322 130 31544	- Diode, BAT17		0.03 A
GR9	5322 130 32731	- Diode, Zener BZX84/C3V6		0.35 W
IC1	5322 268 20097	- IC-socket		
IC1	5322 209 86264	- SAB1534P		
IC2	5322 255 40445	- IC-socket		
IC2	5322 209 86257	- SAB1034P		
IC3	5322 209 83001	- NE5512D		
L1	5322 157 52176	- Coil, 680 nH ±10%	Q=28	
R1, 2	5322 111 90109	- Resistor, 470 ohm ±5 %	Chip	1/8 W
R3...8	4822 111 90186	- Resistor, 22 ohm ±5 %	Chip	1/8 W
R9	4822 111 90154	- Resistor, 270 ohm ±5 %	Chip	1/8 W
R10	5322 111 90138	- Resistor, 390 ohm ±5 %	Chip	1/8 W
R11	5322 111 90106	- Resistor, 330 ohm ±5 %	Chip	1/8 W
R12	5322 111 90109	- Resistor, 470 ohm ±5 %	Chip	1/8 W
R13	4822 111 90361	- Resistor, 39 ohm ±5 %	Chip	1/8 W
R14	4822 111 90186	- Resistor, 22 ohm ±5 %	Chip	1/8 W
R21	4822 111 90572	- Resistor, 5.6 kohm ±5 %	Chip	1/8 W
R22	5322 111 90096	- Resistor, 1.2 kohm ±5 %	Chip	1/8 W
R23	4822 111 90124	- Resistor, 82 ohm ±5 %	Chip	1/8 W
R24	5322 111 90105	- Resistor, 27 ohm ±5 %	Chip	1/8 W
R25	4822 111 90203	- Resistor, 68 ohm ±5 %	Chip	1/8 W
R26	4822 111 90124	- Resistor, 82 ohm ±5 %	Chip	1/8 W
R27	5322 111 90754	- Resistor, 33 ohm ±5 %	Chip	1/8 W
R28	5322 111 90138	- Resistor, 390 ohm ±5 %	Chip	1/8 W
R29	4822 111 90203	- Resistor, 68 ohm ±5 %	Chip	1/8 W
R30	5322 111 90105	- Resistor, 27 ohm ±5 %	Chip	1/8 W
R31	4822 111 90239	- Resistor, 56 ohm ±5 %	Chip	1/8 W
R32	5322 111 90109	- Resistor, 470 ohm ±5 %	Chip	1/8 W
R33	5322 111 90754	- Resistor, 33 ohm ±5 %	Chip	1/8 W
R34	4822 111 90239	- Resistor, 56 ohm ±5 %	Chip	1/8 W
R35	4822 111 90124	- Resistor, 82 ohm ±5 %	Chip	1/8 W
R36	5322 111 90105	- Resistor, 27 ohm ±5 %	Chip	1/8 W
R37	4822 111 90203	- Resistor, 68 ohm ±5 %	Chip	1/8 W
R38	4822 111 90124	- Resistor, 82 ohm ±5 %	Chip	1/8 W
R39	5322 111 90105	- Resistor, 27 ohm ±5 %	Chip	1/8 W

Channel C prescaler, PM 9610 new version (continued)

Pos. No.	Order No.	Description		
	5322 255 40443	Complete board (continued)		
R40	5322 111 90138	- Resistor, 390 ohm ±5 %	Chip	1/8 W
R41	5322 111 90105	- Resistor, 27 ohm ±5 %	Chip	1/8 W
R42	4822 111 90154	- Resistor, 270 ohm ±5 %	Chip	1/8 W
R43	5322 111 90091	- Resistor, 100 ohm ±5 %	Chip	1/8 W
R44	4822 111 90157	- Resistor, 3.3 kohm ±5 %	Chip	1/8 W
R45	4822 111 90214	- Resistor, 100 kohm ±5 %	Chip	1/8 W
R46	4822 111 90249	- Resistor, 10 kohm ±5 %	Chip	1/8 W
R47	5322 101 14299	- Trim. pot, 1 kohm ±10 %	72X	
R48	5322 111 90092	- Resistor, 1 kohm ±5 %	Chip	1/8 W
R49	5322 111 90106	- Resistor, 330 ohm ±5 %	Chip	1/8 W
R50	4822 111 90157	- Resistor, 3.3 kohm ±5 %	Chip	1/8 W
R51	5322 111 90092	- Resistor, 1 kohm ±5 %	Chip	1/8 W
R52	4822 111 90214	- Resistor, 100 kohm ±5 %	Chip	1/8 W
R53, 54	5322 111 90092	- Resistor, 1 kohm ±5 %	Chip	1/8 W
R55	4822 111 90186	- Resistor, 22 ohm ±5 %	Chip	1/8 W
R56, 57	5322 111 90098	- Resistor, 150 ohm ±5 %	Chip	1/8 W
R58, 59	5322 111 90138	- Resistor, 390 ohm ±5 %	Chip	1/8 W
R60	5322 111 90113	- Resistor, 560 ohm ±5 %	Chip	1/8 W
R61, 62	5322 111 90755	- Resistor, 4.7 ohm ±10 %	Chip	1/8 W
R63	4822 111 90249	- Resistor, 10 kohm ±5 %	Chip	1/8 W
TS1, 2	5322 130 42567	- Transistor, BFQ67		
TS3, 4	5322 130 44713	- Transistor, BFT92R		
TS5...7	5322 130 42567	- Transistor, BFQ67		
	5322 255 40444	- Screening box cover		
	5322 466 81578	Dustcover to BNC		
	5322 321 20504	Cable assy, prescaler to front panel		

TCXO, PM 9678B

Pos. No.	Order No.	Description	
BU1	5322 267 50336	Connector, 10 poles	
C1	4822 125 50017	Trim Capacitor, 5.5-65 pF	
C2	4822 124 20977	Capacitor, Solid Aluminium 15 μF	16 V
KT1	5322 216 94047	TCXO Oscillator, 10 MHz	
R1	4822 110 63085	Resistor, 150 ohm ±5 %	0.4 W
TS1	4822 130 41065	Transistor, N-FET BF245C	

NOTE: No spare parts are available for the oven enclosed oscillators. Send the complete sealed oscillator to your local Philips organisation for factory repair.

IEEE-488 bus interface, PM 9696

Pos. No.	Order No.	Description		
BU1	5322 267 60148	Connector, IEEE-488 24 pol Bus connector		
BU2	5322 321 21092	Cable Assy, 300 mm PM 9696-Microproc. board		
C1..4	4822 122 31414	Capacitor, 10 nF -20/+50 %		100 V
C5	5322 124 10455	Capacitor, solid al. 68 ÜF ±20 %		6.3 V
C6	4822 124 20977	Capacitor, solid al. 15 ÜF ±20 %		16 V
C7	4822 122 30094	Capacitor, 220 pF ±10 %		100 V
C8 *)	4822 122 31414	Capacitor, 10 nF -20/+50 %		100 V
C9	4822 124 20977	Capacitor, solid al. 15 ÜF ±20 %		16 V
DV1..3	5322 263 64007	Jumper connector, 2 pol F088		
GR2	~~4822 130 21353~~	No longer used, improved reset circuit published in SPC58		
IC1, 2	5322 111 90737	Res. Network, 6.2 kohm ±5 %		1/8 W
IC3	5322 209 14124	IC CMOS, 4030B		
IC4, 5	4822 209 10246	IC CMOS, 4001		
IC5	5322 255 40419	IC-Socket, 14 pol		
IC6	4822 209 10293	IC CMOS, 4002B		
IC7, 8	5322 209 85199	IC TTL, 74LS14		
IC10, 11	4822 209 10296	IC CMOS, 4014B		
IC12	5322 111 94031	Res. Network, 47 kohm ±10 %		1/8 W
IC13	5322 209 85199	IC TTL, 74LS14		
IC14	4822 209 10248	IC CMOS, 4013B		
IC15..18	4822 209 10317	IC CMOS, 40097B		
IC20	5322 209 84995	IC TTL, 74LS08		
IC21..23	5322 111 94031	Res. Network, 47 kohm ±10 %		1/8 W
IC24, 26	5322 209 85801	IC TTL, 74LS09		
IC26..28	5322 111 90741	Res. Network, 3.0 kohm ±5 %		1/8 W
IC29	5322 209 14509	IC CMOS, 4738V		
IC29	5322 255 40422	IC-Socket, 40 pol DIL		
IC33	5322 209 82853	IC, PM 9696 PROM		
IC33	5322 255 40421	IC-Socket, 24 pol DIL		
IC34, 35	5322 111 94031	Res. Network, 47 kohm ±10 %		1/8 W
IC36, 37	5322 209 84996	IC TTL, 74LS10		
IC38, 39	5322 209 10385	IC CMOS, 40374B		
IC40	5322 209 14559	IC CMOS, 5408B		
R1, 4	5322 116 50671	Resistor, 2.61 kohm ±1 %	MR25	0.4 W
R5	5322 116 50515	Resistor, 1.78 kohm ±1 %	MR25	0.4 W
R6	4822 116 51266	Resistor, 68.1 kohm ±1 %	MR25	0.4 W
R7	4822 116 51233	Resistor, 681 ohm ±1 %	MR25	0.4 W
R8	4822 116 51266	Resistor, 68.1 kohm ±1 %	MR25	0.4 W
R9 *)	4822 116 51268	Resistor, 100 kohm ±1 %	MR25	0.4 W
R10, 11 *)	4822 116 51253	Resistor, 10.0 kohm ±1 %	MR25	0.4 W
SK1	5322 277 10805	Dip Switch, 6 pol 206-006		
TS1..13	4822 130 40855	Transistor, NPN BC337	0.5 A	45 V
TS14 *)	4822 130 44256	Transistor, PNP BC557	0.1 A	45 V

*) Fitted on units with a metal-colored text-plate

Programmable Timer — Counters

PM 6652, -54

Service Manual

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