[redacted]

BM 445 E

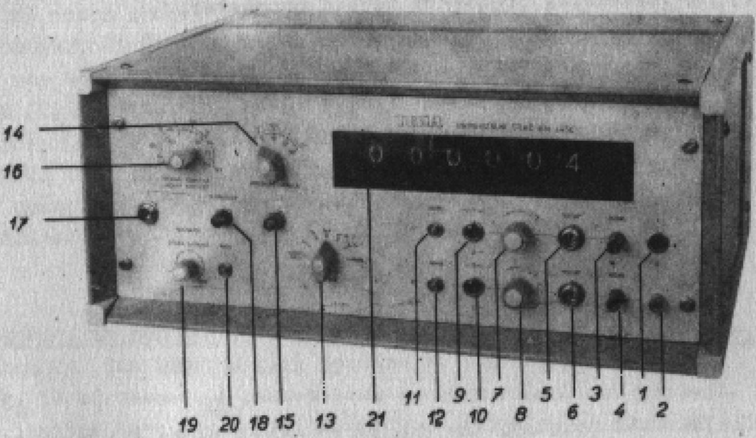


Fig. 1

1 - Mains switch
2 - Earth terminal
3, 4 - Contact circuit binding posts
5 - Input of channel A
6 - Input of channel B
7 - Sensitivity control (channel A)
8 - Sensitivity control (channel B)
9 - Input signal polarity changing switch (channel A)
10 - Input signal polarity changing switch (channel B)

Notes: The decades are numbered from left to right, i.e. the highest one is marked No. 1.

All the listed voltage levels are at no load.

Logic "0" is given at a lower voltage level, logic "1" at a higher one.

Decade functional code

State	A	B	C	D
0	0	0	0	0
1	1	0	0	0
2	0	0	0	1
3	1	0	0	1
4	0	1	0	1
5	1	1	0	1
6	0	0	1	1
7	1	0	1	1
8	0	1	1	1
9	1	1	1	1

Connector II (6)

Blade	Output (approx.)	Function	Max. load
A	Pulse +5.5 V; 500 μsec	Clearing pulse	5 kΩ
B,C		Blocking of counter clearing by printer	
J		Remote clearing of counter by connection to framework	

R	Pulse -5.5 V; 6C μsec of basic level +5.8 V	Command pulse for printer	10 kΩ
S		Output of the flip-flop circuit for register blocking	
E	⏚	Framework of instrument	
V	+ 6 V DC	Positive pole of stabilized supply	50 mA
F	Staircase	Analog output of 6th decade	200 μA
G	Staircase	Analog output of 5th decade	
H	Staircase	Analog output of 4th decade	
W	Staircase	Analog output of 3rd decade	
X	Staircase	Analog output of 2nd decade	
Y	Staircase	Analog output of 1st decade	
M	Voltage +12C/8C V	Output of neon lamp No. 1	1.6 MΩ
N	Voltage +120/80 V	Output of neon lamp No. 2	
O	Voltage +120/80 V	Output of neon lamp No. 3	
P	Voltage +120/8C V	Output of neon lamp No. 4	
Q	Voltage +120/80 V	Output of neon lamp No. 5	

Notes: All the listed voltages are at no load.
The decimal point neon lamps are numbered from right to left.

Socket "100 kc/s EXT" (7)

Even though the built-in frequency standard has a high stability which is sufficient for practically all measurements, for certain special purposes (phase coincidence of the measuring interval, etc.) an external standard frequency of 100 kc/s can be employed.

For the external standard input a special socket with break contact is provided which disconnects the built-in frequency standard when a plug is inserted. The channel of the measuring interval and measuring unit is then synchronized by the external standard. The input impedance of the socket is higher than 20 kΩ, the required voltage is more than 1 V.

As long as the plug is not fully inserted, the internal standard remains connected and its frequency of 100 kc/s at approximately 1.2 V can be employed outside the counter at an output impedance of approximately 1 kΩ.

Break socket of external clearing (8)

By means of this socket the clearing can be effected remotely. The socket is provided with a break contact, so that when a plug is inserted in it, the automatic clearing becomes ineffective and is replaced by remote clearing caused by connecting the socket to the framework of the counter.

Switch C - E (9)

This switch serves for adapting the counter for use either in its original function (position C), or as an evaluating

instrument (position E) in conjunction with the BM 480 voltage to frequency converter. For all the functions described in these Instructions, the switch must remain set <u>to position C.</u>

Connector D (10)

Facility for operation in conjunction with the BP 4451 frequency divider, the operation of which is described in the appropriate Instructions for Use, is given by this connector.

TECHNICAL DATA

a) Frequency measurement

Range:	10 c/s to 1 Mc/s for sinusoidal waveforms
	0 to 1 Mc/s for arbitrary pulse forms
Sensitivity:	100 mV
Max. input voltage:	30 V peak at full sensitivity, 250 V peak with input attenuator employed
Accuracy:	± 1 c/s ± oscillator stability at 1 sec measuring interval
Input impedance:	Approx. 120 kΩ with 60 pF in parallel at 0.2 V input voltage up to 100 kc/s. At higher frequencies and voltages the real component is lower.
Measuring intervals:	10^{-3}, 10^{-2}, 10^{-1}, 1 and 10 sec

b) Waveform period measurement

Range:	10 c/s to 100 kc/s for sinusoidal waveforms 0 to 100 kc/s for arbitrary pulse forms
Sensitivity:	200 mV
Max. input voltage:	30 V peak at full sensitivity, 250 V peak with input attenuator employed
Input voltage waveform:	Sinusoidal or pulse-shaped and of either polarity (duration min. 0.5 μsec), leading edge slope min. 100 mV/10 μsec
Measuring units:	1, 10, 100 μsec; 1, 10 msec
Accuracy: Sinusoidal input:	$\pm \frac{0.01}{n.E_V}$ % ± 1 measuring unit ± oscillator stability where n = number of periods E_V = RMS value of the input voltage in terms of V
Pulse-shaped input:	± 1 measuring unit ± oscillator stability
Measurable number of periods:	1, 10, 100, 1000
Input impedance:	Approx. 120 kΩ with 60 pF in parallel at 0.2 V input voltage up to 100 kc/s. At higher frequencies and voltages the real component is lower.

c) Time interval measurement (double-channel system)

Range:	10 μsec to 10^7 sec
Sensitivity:	200 mV peak
Max. input voltage:	30 V peak at full sensitivity, 250 V peak with input attenuator employed
Input voltage waveform:	Pulses of either polarity (duration min. 0.5 μsec), leading edge slope min. 100 mV/ /10 μsec
Measuring units:	1, 10, 100 μsec; 1, 10, 100 msec; 1, 10 sec
Accuracy:	± 1 measuring unit ± oscillator stability
Input impedance:	Approx. 120 kΩ with 60 pF in parallel at 0.2 V input voltage up to 100 kc/s. At higher frequencies and voltages the real component is lower.

Time intervals determined by contact closing or opening are also measurable (the required auxiliary circuits are built-in).

d) Frequency ratio measurement (f_A/f_B)

Range:	Frequency A: 10 c/s to 1 Mc/s Frequency B: 10 c/s to 100 kc/s
Sensitivity:	100 mV

Max. input voltage:	**30 V peak at full sensitivity, 250 V peak with input attenuator employed**
Accuracy:	$\pm \frac{0.005}{n \cdot E_B}$ % $\pm$ 1 c/s of frequency F_A where n = number of periods of the signal of f_B frequency E_B = RMS value of the voltage of f_B frequency in terms of V
Input impedance:	Approx. 120 kΩ with 60 pF in parallel at 0.2 V input voltage up to the frequency of 100 kc/s. At higher frequencies and voltages, the real component is lower.
Ratio measurement:	1, 10, 100, 1000 x (f_A/f_B)

e) Measuring frequencies

Frequencies:	10^6, 10^5, 10^4, 10^3, 10^2, 10^1; 10^0 and 10^{-1} c/s
Frequency accuracy:	Depending on the oscillator stability (see same)
Output pulse shape:	1 Mc/s triangular pulses 10^5 to 10^{-1} c/s negative-going pips
Output pulse impedance:	1 Mc/s - approx. 2 V peak-to-peak 10^5 to 10^{-1} c/s - approx. 4 V peak

Output resistance:	Approx. 1 kΩ
Counting capacity:	10^6 pulses (6 decades)
Presentation:	Continuous
Repetition rate of measurement:	Approx. 0.1 to 5 sec or ∞ (manual control)
Oscillator:	100 kc/s in thermostatically controlled oven
Oscillator stability:	Time dependent: better than $2 \cdot 10^{-7}$ weak. Temperature dependent: the ambient temperature has an influence smaller than $1 \cdot 10^{-7}$ over the whole range of the counter.
Ambient temperature range:	-5 °C to +40 °C
Powering and power consumption:	AC mains 220 or 120 V, 50 c/s; 30 VA
Fuses:	P1 - 0.25 A/250 V for 220 V 0.4 A/250 V for 120 V P2 - 1 A P3 - 0.1 A

Complement:	6 x OA5, 17 x GAZ51, 1 x 3NZ70, 6 x ZM1020, 5 x KY701, KY703, 1 x KY704, 3 x KY705, OC27, 61 x 103NU71, OC72, 51 x 156NU70, 88 x 155NU70, 57 x 104NU71, 346 x GA203, 2 x 101NU71, 9 x neon lamp
Dimensions and weight:	235 x 520 x 390 mm; 17 kg
Accessories:	2 Plugs 1AK 463 06 2 Cables 1AK 642 47 1 Plug 1AF 895 57 1 Mains cord 1AK 643 53 1 Bag of spare fuses Instructions for Use

PREPARATIONS FOR MEASUREMENT

Connection to the mains and voltage selection

Before connecting the counter to the mains it is essential to ensure that it is adapted to the available mains voltage, for the changing over of which a selector switch (2) is provided on the back panel of the counter (Fig. 3).

Fig. 4

After removing the retaining screw in the centre of the selector, the disc has to be pulled out and turned until the marking of the available mains voltage appears below the triangular mark above the disc. Then the disc has to be pushed home again and the retaining screw tightened. When the disc is in the position shown in Fig. 4, the counter is prepared for powering by 220 V.

Whenever the mains voltage setting is altered, the mains fuse positioned next to the mains voltage selector must be exchanged. The correct ratings of this fuse for 120 V and 220 V respectively are given in the section "Technical data".

The design of the instrument responds to safety class I. according to IEC. (Metal parts accessible to the touch are connected to the protective conductor and the insulation of mains voltage carrying parts responds to IEC recommendations.)

Stabilization of the built-in frequency standard (oscillator)

The counter is capable of operation immediately after being switched on. However, for correct stabilization of the frequency standard, it is necessary to allow the thermostatically controlled oven, in which the oscillator circuits are housed, to become heated. The thermal stabilization has roughly the following course:

After 15 minutes the frequency accuracy is approximately $1 \cdot 10^{-6}$.

After 30 minutes the frequency becomes stabilized, so that during the following hour it changes only by 1 to $2 \cdot 10^{-7}$.

The heating cycles of the oven are indicated by a pilot lamp on the front panel of the counter.

The frequency of the oscillator is monitored by the makers for 1 month and then is adjusted with an accuracy better than $1 \cdot 10^{-7}$ at 20 °C to 25 °C ambient temperature.

The frequency can be adjusted at any time according to the instructions given in the section "Adjustment of the frequency standard".

Note: Before commencing each measurement, it is necessary to ensure that the change-over switch C - E on the back panel (9 in Fig. 3) is in the position C. This is essential so as to avoid a considerable error in the measurement.

Self-testing

The self-testing operation serves for checking all the functions of the counter by means of a test frequency of 1 Mc/s.

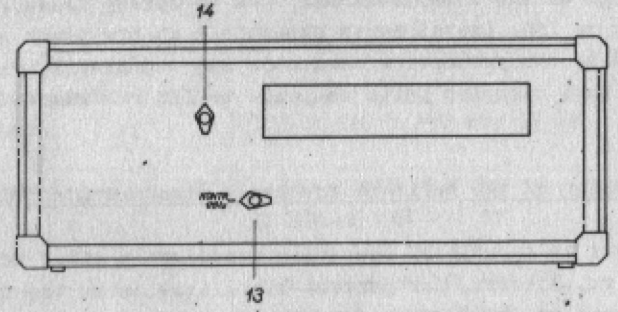


Fig. 5

Selector 13 (FUNCTION) has to be set to the position marked "CONT. 1 Mc/s".
Selector 14 (GATE TIME) is set to all the positions successively.
Clearing is described in detail in the section "Clearing controls".
Provided the counter operates correctly, the display of the readout in the basic positions of selector 14 should be as follows:

Position of selector 14	Display of readout
1 ms	001000. kc/s ± 1
10 ms	01000.0 kc/s ± 1
100 ms	1000.00 kc/s ± 1
1 s	000.000 kc/s ± 1
10 s	00.0000 kc/s ± 1

The self-testing operation can be carried out at any time during a measurement.

MEASUREMENTS

Frequency measurement

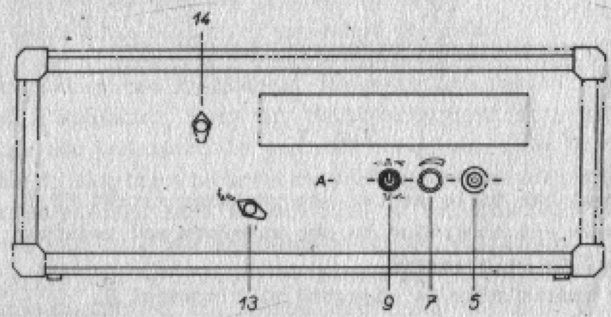


Fig. 6

Selector 13 (FUNCTION) has to be set to the position marked "f_A" and switch 9 according to the waveform and polarity of the applied signal. The sensitivity of the counter is adjusted with control 7 (see the section "Input attenuators").
The signal to be processed has to be applied to connector 5 (Fig. 6). Then the counter is cleared (see the section "Clearing controls") and selector 14 set according to the measuring interval required (i.e. accuracy of the measurement). The result of measurement appears on the readout.

Note:

The frequency range of the counter has ample reserve, so that frequencies up to approximately 1.5 Mc/s are measurable. However, the input sensitivity is somewhat lower.

Waveform period measurement

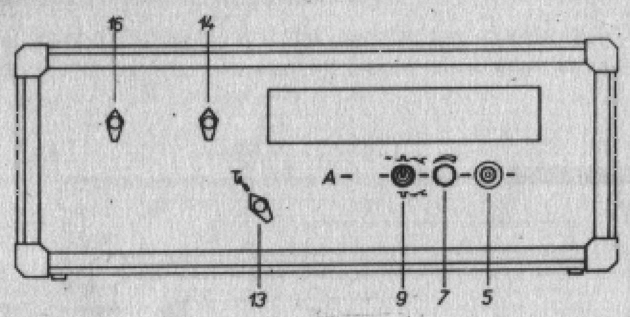


Fig. 7

Selector 13 has to be set to the position marked "T_A".
Switch 9 is set according to the waveform and polarity of the signal to be measured.
Then the sensitivity is adjusted with control 7.
The voltage of the frequency, the waveform period of which has to be ascertained, has to be applied to connector 5 (INPUT).

Selector 14 is set to the appropriate position according to the number of measured periods required (see the section "Gate interval selector").
Selector 16 is set according to the required accuracy of the measurement.

Note:

In a waveform measurement, only the first five positions of selector 16 are applicable, i.e. only the measuring units 1 µsec to 10 msec can be used. The selector positions 6 to 8, i.e. the measuring units 100 msec to 10 sec cannot be employed. The result of measurement is read in the same manner as described before.

When 10, 100 or 1000 waveform periods are measured, the position of the decimal point remains unchanged. If the

actual duration of one period has to be ascertained, the display of the readout must be divided by the number of the measured periods:

$$T = \frac{d}{n}$$

where T = the waveform period
d = the display of the readout
n = the number of measured periods

The signal of the frequency, the waveform period of which is being measured, must not be superimposed on another AC voltage nor modulated by another frequency (hum or the like).
The input shaping circuits respond approximately to all passages through zero which could be considerably phase shifted and thus the measurement made inaccurate. The relative error can be reduced by measuring 10 or more periods.
The application of the lowest measuring units (1 usec, 10 µsec) is justifiable only when the waveform period of a signal produced by a source of extraordinarily stable frequency and phase has to be measured. In all other cases the application of longer units (100 µsec and more) is advisable.

Double-channel measurement of time intervals

The interval is limited by two pulses derived from separate sources

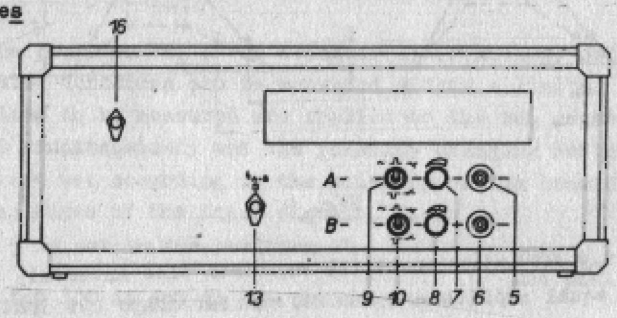


Fig. 8

Selector 13 has to be set to the position marked "t_{A-B}".
Switches 9 and 10 are set according to the polarity of the pulses.
The counter sensitivity is adjusted with controls 7 and 8.

Note:

When the input sensitivity of the channels is being adjusted, it is necessary to take into consideration the fact that the use of an attenuator always influences the moment when the counter starts or ceases to operate. In an ideal case, when the leading and trailing edges of the pulses are theoretically absolutely vertical, this effect would not take place. However, in actual practice, when sloping leading and trailing edges are employed for determining the measuring interval pulses, erroneous results can be arrived at when the sensitivity of the channels is adjusted incorrectly. This can be demonstrated by the following example, in which for reasons of simplicity the two pulses are drawn as if they had a common time axis (even though they are produced by two separate sources).

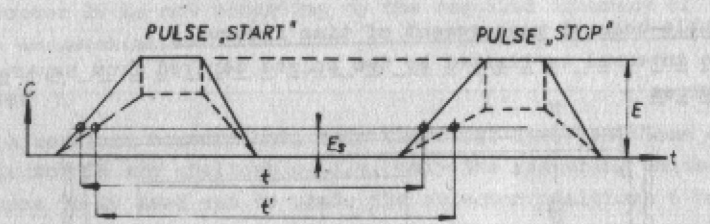


Fig. 9

The two pulses which limit the measured time interval t are e.g. of equal amplitude E and of similar shape (as indicated

by full lines). The starting level of the counter and the level at which it ceases to operate is E_s. The pulses indicated by dashed lines are those pertaining to the reduced sensitivity. It is clear that the actual duration of the measured interval t differs from the one t′ which is being measured (i.e. t′>t).

In order to reduce or to preclude this error, it is advisable to use the full sensitivity of the counter, provided there are no limiting factors present (such as excessive amplitude, background, etc. - see the section "Input attenuators"). Otherwise, lowered accuracy must be accepted and longer measuring units must be employed.

The pulse determining the beginning of the measuring interval (the "start" pulse) must be applied to connector 5 (channel A); the pulse determining the end of the measuring interval (the "stop" pulse) to connector 6 (channel B).

For instructions for clearing, refer to the section "Clearing controls").

The actual interval measurement is carried out with selector 16 set to any position, according to the required accuracy of the result (any measuring unit can be employed, i.e. 1μsec to 10 sec). The result of the measurement is presented by the readout.

Note:

With the position "t_{A-B}" of selector 13 (FUNCTION) selected, also pulse durations can be measured within a limited range. The pulses to be measured are applied to the two connectors 5 and 6 simultaneously and the polarity changing switches 9 and 10 are set according to the polarity of the leading and trailing edges of the input signals, i.e.
Switch 9 is set to the position ⎍ and switch 100 is set to the position ⎍ when the pulses are positive

or, switch 9 is set to the position ⊔
and switch 10 set to the position ⊓ — when the pulses are negative

Thus, the polarity switches are always in opposite positions. In this manner pulse durations of 10 µsec can be measured at maximum 1 : 5 pulse duration-to-pause ratio. If the ratio is higher than 1:5, a suitable differentiating element must be inserted into the input to produce two pulses of opposite polarity from the leading and trailing edges respectively. An example of such a differentiating element of approximately 6 usec time constant is given in Fig. 10.

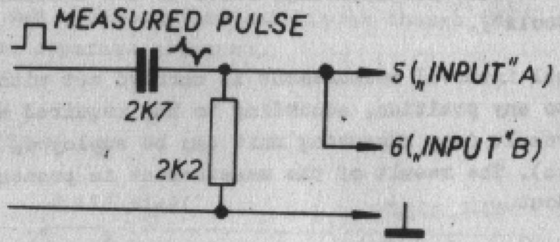


Fig. 10

For pulse duration measurement also apply all the instructions for sensitivity adjustment (section "Input attenuators"), clearing (section "Clearing controls") and application of the measuring unit.

Interval limited by contact closing or opening

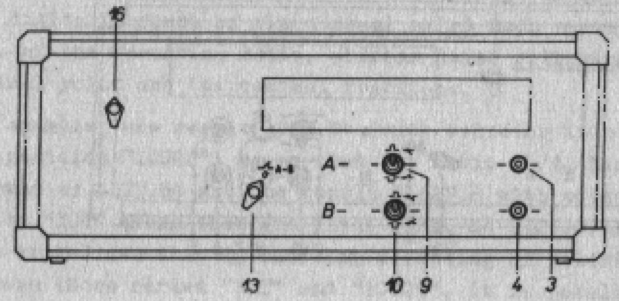


Fig. 11

Selector 13 has to be set to the position marked "$-\!\!\!\!/\_{A-B}$".

Switches 9 and 10 are set according to whether contact opening or closing will be employed (see the section "Polarity change-over switches").

The contact which determines the beginning of the measured interval is connected to terminal 3 (channel A); the contact which determines the end of the interval is connected to terminal 4 (channel B).

For instructions about clearing, see the section "Clearing controls").

Selector 16 is set according to the required accuracy of the measurement. The result will be presented by the readout.

Note:

It is not permissible to insert a resistor (resistance of the conductors, or the like) exceeding 20 Ω into the circuit of the contacts.

Frequency ratio measurement

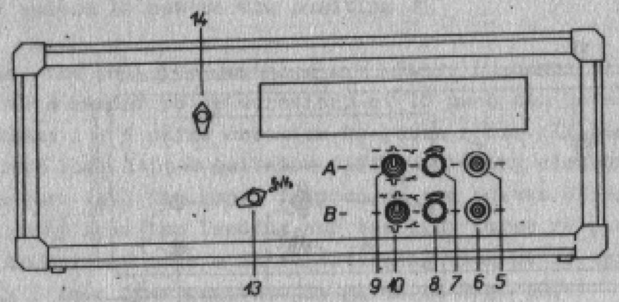


Fig. 12

The selector 13 has to be set to the position marked "f_A/f_B".

The polarity change-over switches are set according to the shape and polarity of the applied signals, i.e.

switch 9 according to signal f_A

switch 10 according to signal f_B

The sensitivity of the counter is adjusted with controls 7 and 8 (7 for f_A, 8 for f_B).

The input voltage of f_A frequency is applied to connector 5 (channel A).
The input voltage of f_B frequency is applied to connector 6 (channel B).

Note:

The frequency f_B is the <u>lower</u> one of the two compared inputs.

The gate interval selector 14 is set according to whether f_A/f_B (1T), 10 x f_A/f_B (10 T), 100 x f_A/f_B (100T), or 1000 x f_A/f_B (1000T) has to be measured.
The resulting ratio will be displayed by the readout.

Note:

In this type of measurement, the position of the decimal point alters when the setting of selector 14 is changed. The digits in <u>front of the decimal point</u> mean units, tens, etc. of the resulting ratio, whereas those <u>following</u> the decimal point are its decimal fractions.

For example, the result 1327.84 (with selector 14 set to the position "1000T") means that the ratio f_A/f_B has to be read as 1327.84 and the result 01327.8 with selector 14 set to "10T" means that the ratio f_A/f_B is 1327.8. From this it follows that by choosing a setting of selector 14 between those marked "10T" and "1000T", it is possible to increase the accuracy of the measurement 10 to 1000x, which feature is advantageous when two frequencies close to each other are being measured.

Simple totalizing counting of events

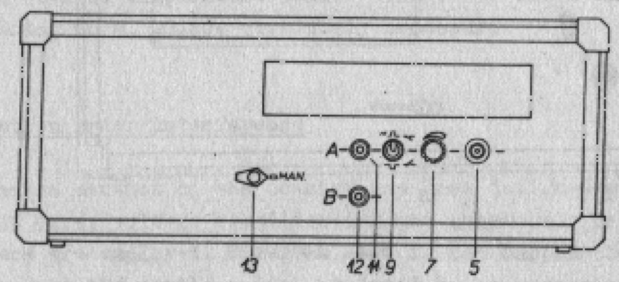


Fig. 13

Selector 13 has to be set to the position marked "MAN".

Switch 9 is set according to the shape and polarity of the applied signal.

The required sensitivity is adjusted with control 7.

11 - Push-button for manual opening of gate
12 - Push-button for manual closing of gate
13 - Function selector
14 - Gate interval selector
15 - Pilot lamp - gate open
16 - Measuring unit and measuring frequency selector
17 - Measuring frequency output connector
18 - Thermostat pilot lamp
19 - Display duration control
20 - Push-button for manual clearing
21 - Readout

APPLICATION

The BM 445E counter, the design of which meets all demands for high technical performance which can be placed on a precision measuring instrument, is a counter of the most modern conception. It is fully transistorized for reliability, rugged lightweight construction and low power consumption. Further advantageous features are: 6-digit in-line readout with display storage memory, automatic indication of the decimal point and polarity sign, facility for the connection of a printer and other peripheral instruments. The BM 445E counter is a universal instrument for the measurement of frequency, waveform periods, decadic period multiples, time intervals with double-channel control by pulses or contact triggering, and frequency ratio decadic multiples, as well as for simple totalizing counting of events. Standard frequencies produced by the built-in crystal-controlled oscillator are carried by a connector on the panel , rendering the counter applicable also as a source of standard frequencies.

DESCRIPTION

The counter is formed by four basic assemblies which are variously interconnected by means of the function selector F (Fig. 2). These assemblies are: amplifiers and shapers (CM, VZ, H) which process the input signal of arbitrary waveform to convert it into negative-going pulses suitable for driving the decades; a source of measuring frequencies and intervals (O, N, D 10 kc/s to D 0.1 c/s); counter decades and display (D1 to D6, P + DR, readout) which form the evaluating part of the counter; automatic section (KO, R) which controls the operation of the counter with definite function and operation sequence.

<u>Frequency measurement</u> (FUNCTION SELECTOR F1 to F6 set to position 2). The input signal applied to the input connector (Fig. 1) of channel A passes over an attenuator and protective limiter into input amplifier VZ - start, the output of which is connected to gate H (via F4) which in the open state passes the negative pulses into which the measured signal has been converted, into counter decades D1 to D6. The final stage of these decades is transferred to display memory circuits D, converted into display code in decoders DR and displayed by readout I. Gate H is controlled by a pair of flip-flop circuits KO, which together with control unit R form the automatic section of the counter. Reversing of the flip-flop circuits KO is controlled by time pulses derived from the standard frequency of 100 kc/s by dividers D 10 kc/s to D 0.1 c/s and shaped in Schmitt´s circuit SO and shaper T. The duration of the measuring interval thus produced is adjustable with GATE TIME SELECTOR (IH). The command for transferring the information from the decades into the memory, for clearing the decades and for a further counting operation is given by the control unit. The course of operation during <u>checking with 1 Mc/s</u> (FUNCTION SELECTOR in position 1) is

The pulses to be counted are applied to connector 5.

The gate interval, i.e. the period during which the gate is open until its closure, is determined by means of the push-buttons 11 (A - start) and 12 (B - stop) after previous clearing of the counter (see the section "Push-buttons").

For details about clearing, see the section "Clearing controls".)

For lengthy measurements it is recommended to employ manual clearing (see the section "Operation under interference"). The result of the measurement will be presented by the read-out.

Measuring frequencies

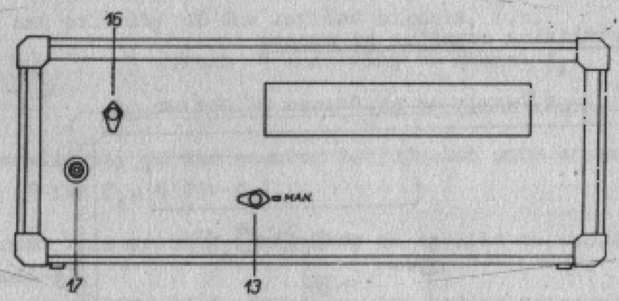


Fig. 14

Selector 13 has to be set to the position marked "MAN".

The measuring frequency selected with selector 16 is available from connector 17 (see the section "Measuring unit and measuring frequency selector").

Note:
Connector 17 is DC separated from the source of measuring frequencies by the use of a capacitor of 10,000 pF insulated for 100 V DC.

Connection of a printer

From connectors I and II carried by the back panel of the counter are available all information and command signals required for operating a printer (see the section "Output connectors").

REMARKS

Ambient conditions

Even though the counter can operate within a wide range of environmental conditions, it is obvious that extreme ambient conditions have an influence on the service life of its parts and components.

Consequently, it is recommended not to expose the counter to an ambient temperature higher than 35 °C and a humidity exceeding 60 %, unless absolutely necessary.

Operation under interference

The mains section of the counter has been designed with the utmost care; voltage stabilization and generously rated filters are employed. Nevertheless, it can happen that sudden changes in the supply mains, produced by an excessive load, especially of inductive character, caused by a large electric machine, transitorily impairs the accuracy of measurement, especially when a long gate interval has been selected. Consequently, it is advisable to connect the counter to the mains at a sufficiently long distance from large appliances, or to a phase other than the one used for their powering. Also important is the residual voltage of the neutral at the moment of switching on an appliance in a three-phase, four-wire system. Under such circumstances it is advantageous to disconnect the counter from the protective mains conductor and to employ a separate earth by using the terminal provided for the purpose (thus interference through earth loops, etc. can be avoided).

Adjustment of the frequency standard

As has been mentioned already, the standard oscillator of the counter has been adjusted precisely by the makers at an accuracy better than $1 \cdot 10^{-7}$. Should it become necessary to adjust the oscillator after a long period of use, the upper cover of the counter has to be removed after unscrewing the four screws which fasten it, so as to gain access to the small cover under which is situated capacitive trimmer C (see Fig. 15) which serves for frequency adjustment.

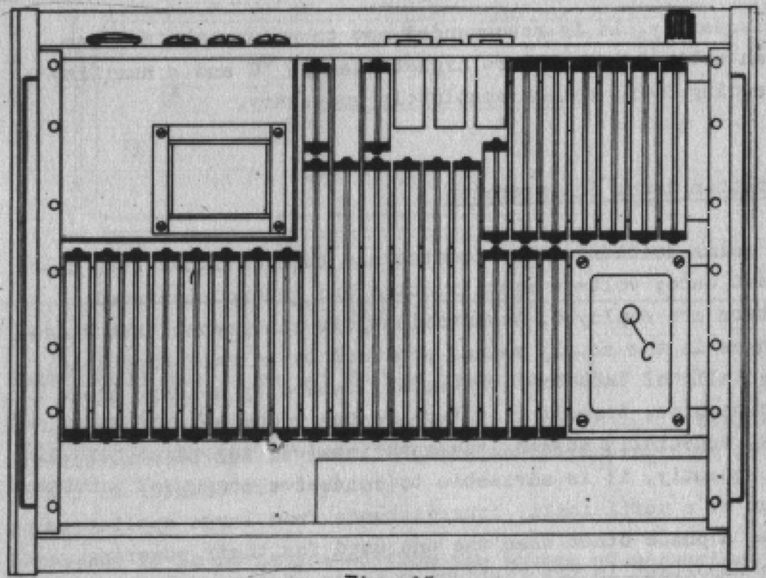


Fig. 15

For checking, the socket "100 kc/s EXT" can be used to advantage (see the section "Socket 100 kc/s EXT").

Even though the frequency adjustment is very easy, it is essential to follow its effect for a certain time. It is recommended to entrust this operation to an expert detailed by the makers.

LIST OF ELECTRICAL COMPONENTS

Decade 1 Mc/s 1AK 055 18

Resistors:

No.	Type	Value	Max. load W	Tolerance ± %	Standard ČSSR
R1	Carbon layer	1.5 kΩ	0.125	10	TR 112a 1k5/A
R2	Carbon layer	15 kΩ	0.125	10	TR 112a 15k/A
R3	Carbon layer	10 kΩ	0.125	10	TR 112a 10k/A
R4	Carbon layer	1.5 kΩ	0.125	10	TR 112a 1k5/A
R5	Carbon layer	1.5 kΩ	0.125	10	TR 112a 1k5/A
R6	Carbon layer	390 Ω	0.125	10	TR 112a 390/A
R7	Carbon layer	15 kΩ	0.125	10	TR 112a 15k/A
R8	Carbon layer	10 kΩ	0.125	10	TR 112a 10k/A
R9	Carbon layer	82 kΩ	0.125	10	TR 112a 82k/A
R10	Carbon layer	2.2 kΩ	0.125	10	TR 112a 2k2/A
R11	Carbon layer	10 kΩ	0.125	10	TR 112a 10k/A
R12	Carbon layer	15 kΩ	0.125	10	TR 112a 15k/A
R13	Carbon layer	1.5 kΩ	0.125	10	TR 112a 1k5/A
R14	Carbon layer	1.5 kΩ	0.125	10	TR 112a 1k5/A
R15	Carbon layer	390 Ω	0.125	10	TR 112a 390/A
R16	Carbon layer	15 kΩ	0.125	10	TR 112a 15k/A
R17	Carbon layer	10 kΩ	0.125	10	TR 112a 10k/A
R18	Carbon layer	39 kΩ	0.125	10	TR 112a 39k/A
R19	Carbon layer	1.5 kΩ	0.125	10	TR 112a 1k5/A
R20	Carbon layer	10 kΩ	0.125	10	TR 112a 10k/A
R21	Carbon layer	15 kΩ	0.125	10	TR 112a 15k/A
R22	Carbon layer	1.5 kΩ	0.125	10	TR 112a 1k5/A
R23	Carbon layer	1.5 kΩ	0.125	10	TR 112a 1k5/A
R24	Carbon layer	390 Ω	0.125	10	TR 112a 390/A
R25	Carbon layer	15 kΩ	0.125	10	TR 112a 15k/A
R26	Carbon layer	39 kΩ	0.125	10	TR 112a 39k/A

No.	Type	Value	Max. load W	Tolerance ± %	Standard ČSSR
R27	Carbon layer	39 kΩ	0.125	10	TR 112a 39k/A
R28	Carbon layer	10 kΩ	0.125	10	TR 112a 10k/A
R29	Carbon layer	1.5 kΩ	0.125	10	TR 112a 1k5/A
R30	Carbon layer	10 kΩ	0.125	10	TR 112a 10k/A
R31	Carbon layer	15 kΩ	0.125	10	TR 112a 15k/A
R32	Carbon layer	1.5 kΩ	0.125	10	TR 112a 1k5/A
R33	Carbon layer	1.5 kΩ	0.125	10	TR 112a 1k5/A
R34	Carbon layer	390 Ω	0.125	10	TR 112a 390/A
R35	Carbon layer	39 kΩ	0.125	10	TR 112a 39k/A
R36	Carbon layer	15 kΩ	0.125	10	TR 112a 15k/A
R37	Carbon layer	10 kΩ	0.125	10	TR 112a 10k/A
R38	Carbon layer	1.5 kΩ	0.125	10	TR 112a 1k5/A
R39	Carbon layer	27 kΩ	0.125	10	TR 112a 27k/A
R40	Carbon layer	27 kΩ	0.125	10	TR 112a 27k/A
R41	Carbon layer	27 kΩ	0.125	10	TR 112a 27k/A
R42	Carbon layer	27 kΩ	0.125	10	TR 112a 27k/A
R43	Carbon layer	27 kΩ	0.125	10	TR 112a 27k/A
R44	Carbon layer	27 kΩ	0.125	10	TR 112a 27k/A
R45	Carbon layer	27 kΩ	0.125	10	TR 112a 27k/A
R46	Carbon layer	27 kΩ	0.125	10	TR 112a 27k/A
R47	Carbon layer	3.3 kΩ	0.125	10	TR 112a 3k3/A
R48	Carbon layer	3.3 kΩ	0.125	10	TR 112a 3k3/A

Capacitors:

No.	Type	Value	Max. DC voltage	Tolerance ± %	Czechoslovak Standard
C1	Mica	390 pF	500	5	TC 210 390/B
C2	Mica	100 pF	500	5	TC 210 100/B
C3	Styroflex	10,000 pF	100	10	TC 281 10k/A
C4	Mica	100 pF	500	5	TC 210 100/B
C5	Mica	120 pF	500	5	TC 210 120/B
C6	Mica	100 pF	500	5	TC 210 100/B
C7	Styroflex	10,000 pF	100	10	TC 281 10k/A
C8	Mica	100 pF	500	5	TC 210 100/B

C9	Mica	100 pF	500	5	TC 210 100/B
C10	Mica	220 pF	500	5	TC 210 220/B
C11	Styroflex	10,000 pF	100	10	TC 281 10k/A
C12	Mica	220 pF	500	5	TC 210 220/B
C13	Mica	100 pF	500	5	TC 210 100/B
C14	Mica	100 pF	500	5	TC 210 100/B
C15	Styroflex	10,000 pF	100	10	TC 281 10k/A
C16	Mica	100 pF	500	5	TC 210 100/B
C17	Mica	100 pF	500	5	TC 210 100/B
C18	Mica	220 pF	500	5	TC 210 220/B

S u n d r y   e l e c t r i c a l   c o m p o n e n t s :

Component	Type - Value	Drawing No.
Germanium diode E1, E2, E5, E6, E7, E10, E11, E14, E15, E18	GA203	1AN 111 85
Pair of transistors E3-E4, E8-E9, E12-E13, E16-E17	156NU70	1AN 111 78

Gate 1AK 055 19

R e s i s t o r s :

No.	Type	Value	Max. load W	Tole-rance ± %	Standard ČSSR
R1	Carbon layer	47 kΩ	0.125	-	TR 112a 47k
R2	Carbon layer	1.2 kΩ	0.125	10	TR 112a 1k2/A

S u n d r y   e l e c t r i c a l   c o m p o n e n t s :

Component	Type - Value	Drawing No.
Pair of transistors E1-E2	156NU70	1AN 111 78

Multiplier 1AK 055 20

R e s i s t o r s :

No.	Type	Value	Max. load W	Tole-rance ± %	Standard ČSSR
R1	Carbon layer	68 kΩ	0.125	-	TR 112a 68k
R2	Potentiometer	68 kΩ	0.2	-	TP 038 68k
R3	Carbon layer	1 kΩ	0.125	-	TR 112a 1k
R4	Carbon layer	1.2 kΩ	0.125	10	TR 112a 1k2/A
R5	Carbon layer	330 Ω	0.125	-	TR 112a 330
R6	Carbon layer	330 Ω	0.125	-	TR 112a 330
R9	Carbon layer	220 Ω	0.125	-	TR 112a 220
R10	Carbon layer	470 Ω	0.125	10	TR 112a 470/A
R11	Carbon layer	47 Ω	0.125	10	TR 112a 47/A

C a p a c i t o r s :

No.	Type	Value	Max. DC voltage	Tole-rance ± %	Standard ČSSR
C1	Mica	68 pF	500	-	TC 210 68
C2	Mica	390 pF	500	5	TC 210 390/B
C3	Mica	1000 pF	1000	10	TC 211 1k/A
C4	Mica	390 pF	500	5	TC 210 390/B
C5	Electrolytic	20 µF	6	-	TC 941 20M
C7	Mica	43 pF	500	5	WK 714 07 43/B
C7	Mica	47 pF	500	5	WK 714 07 47/B

C7	Mica	51 pF	500	5	WK 714 07 51/B
C9	Mica	43 pF	500	5	WK 714 07 43/B
C9	Mica	47 pF	500	5	WK 714 07 47/B
C9	Mica	51 pF	500	5	WK 714 07 51/B
C10	Ceramic	4700 pF	250	-	TK 751 4k7
C11	Ceramic	4700 pF	250	-	TK 751 4k7
C12	Electrolytic	20 μF	6	-	TC 941 2CM

T r a n s f o r m e r s   a n d   c o i l s :

Component	Marking	Drawing No.	No. of tap	No. of turns	Wire Ø in mm
Coil	L1	1AK 588 41	1 - 2	60	0.1
			3 - 4	20	0.18
Coil	L2	1AK 601 90	1 - 2	110	20 x 0.05
			2 - 3	30	20 x 0.05
			4 - 5	7	20 x 0.05
Coil	L3	1AK 601 90	1 - 2	110	20 x 0.05
			2 - 3	30	20 x 0.05
			4 - 5	7	20 x 0.05

S u n d r y   e l e c t r i c a l   c o m p o n e n t s :

Component	Type - Value	Drawing No.
Transistor E1, E3, E4, E5	156NU70	1AN 111 77
Germanium diode E2	GA203	1AN 111 85

R e s i s t o r s :

No.	Type	Value	Max. load W	Tolerance ± %	Standard ČSSR
R1	Carbon layer	12 kΩ	0.125	10	TR 112a 12k/A
R2	Carbon layer	3.3 kΩ	0.125	10	TR 112a 3k3/A
R3	Carbon layer	1.5 kΩ	0.125	10	TR 112a 1k5/A
R5	Carbon layer	1.5 kΩ	0.125	10	TR 112a 1k5/A
R6	Carbon layer	12 kΩ	0.125	10	TR 112a 12k/A
R7	Carbon layer	3.3 kΩ	0.125	10	TR 112a 3k3/A
R8	Carbon layer	12 kΩ	0.125	10	TR 112a 12k/A
R9	Carbon layer	3.3 kΩ	0.125	10	TR 112a 3k3/A
R10	Carbon layer	1.5 kΩ	0.125	10	TR 112a 1k5/A
R11	Carbon layer	1.5 kΩ	0.125	10	TR 112a 1k5/A
R13	Carbon layer	12 kΩ	0.125	10	TR 112a 12k/A
R14	Carbon layer	3.3 kΩ	0.125	10	TR 112a 3k3/A
R15	Carbon layer	12 kΩ	0.125	10	TR 112a 12k/A
R16	Carbon layer	3.3 kΩ	0.125	10	TR 112a 3k3/A
R17	Carbon layer	1.5 kΩ	0.125	10	TR 112a 1k5/A
R18	Carbon layer	1.5 kΩ	0.125	10	TR 112a 1k5/A
R20	Carbon layer	12 kΩ	0.125	10	TR 112a 12k/A
R21	Carbon layer	3.3 kΩ	0.125	10	TR 112a 3k3/A
R22	Carbon layer	12 kΩ	0.125	10	TR 112a 12k/A
R23	Carbon layer	3.3 kΩ	0.125	10	TR 112a 3k3/A
R24	Carbon layer	1.5 kΩ	0.125	10	TR 112a 1k5/A
R25	Carbon layer	1.5 kΩ	0.125	10	TR 112a 1k5/A
R27	Carbon layer	12 kΩ	0.125	10	TR 112a 12k/A
R28	Carbon layer	3.3 kΩ	0.125	10	TR 112a 3k3/A
R29	Carbon layer	33 kΩ	0.125	10	TR 112a 33k/A
R30	Carbon layer	33 kΩ	0.125	10	TR 112a 33k/A
R31	Carbon layer	33 kΩ	0.125	10	TR 112a 33k/A
R32	Carbon layer	33 kΩ	0.125	10	TR 112a 33k/A
R33	Carbon layer	33 kΩ	0.125	10	TR 112a 33k/A

R34	Carbon layer	33 kΩ	0.125	10	TR 112a 33k/A
R35	Carbon layer	33 kΩ	0.125	10	TR 112a 33k/A
R36	Carbon layer	33 kΩ	0.125	10	TR 112a 33k/A
R37	Carbon layer	33 kΩ	0.125	10	TR 112a 33k/A
R38	Carbon layer	33 kΩ	0.125	10	TR 112a 33k/A
R39	Carbon layer	15 Ω	0.125	10	TR 112a 15/A
R40	Carbon layer	680 Ω	0.125	10	TR 112a 680/A
R41	Carbon layer	47 kΩ	0.125	10	TR 112a 47k/A
R42	Carbon layer	47 kΩ	0.125	10	TR 112a 47k/A
R43	Carbon layer	47 kΩ	0.125	10	TR 112a 47k/A
R44	Carbon layer	47 kΩ	0.125	10	TR 112a 47k/A
R45	Carbon layer	47 kΩ	0.125	10	TR 112a 47k/A
R46	Carbon layer	47 kΩ	0.125	10	TR 112a 47k/A
R47	Carbon layer	47 kΩ	0.125	10	TR 112a 47k/A
R48	Carbon layer	47 kΩ	0.125	10	TR 112a 47k/A
R49	Carbon layer	47 kΩ	0.125	10	TR 112a 47k/A
R50	Carbon layer	47 kΩ	0.125	10	TR 112a 47k/A

C a p a c i t o r s :

No.	Type	Value	Max. DC volt.	Tole-rance ± %	Standard ČSSR
C1	Styroflex	1500 pF	100	10	TC 281 1k5/A
C2	Styroflex	1500 pF	100	10	TC 281 1k5/A
C3	Mica	470 pF	500	10	TC 210 470/A
C5	Mica	470 pF	500	10	TC 210 470/A
C6	Styroflex	1500 pF	100	10	TC 281 1k5/A
C7	Styroflex	1500 pF	100	10	TC 281 1k5/A
C8	Mica	470 pF	500	10	TC 210 470/A
C10	Mica	470 pF	500	10	TC 210 470/A
C11	Styroflex	1500 pF	100	10	TC 281 1k5/A
C12	Styroflex	1500 pF	100	10	TC 281 1k5/A
C13	Mica	470 pF	500	10	TC 210 470/A
C15	Mica	470 pF	500	10	TC 210 470/A
C16	Styroflex	1500 pF	100	10	TC 281 1k5/A
C17	Styroflex	1500 pF	100	10	TC 281 1k5/A
C18	Mica	470 pF	500	10	TC 210 470/A
C20	Mica	470 pF	500	10	TC 210 470/A

S u n d r y   e l e c t r i c a l   c o m p o n e n t s :

Component	Type - Value	Drawing No.
Germanium diode E1, E4, E5, E8, E9, E12, E13, E16÷E46	GA203	1AN 111 85
Pair of transistors E2-E3, E6-E7, E10-E11, E14-E15	104NU71	1AN 111 80
Transistor E47-E56	103NU71	-

Double flip-flop circuit 1AK 055 22

R e s i s t o r s :

No.	Type	Value	Max. load W	Tole-rance ± %	Standard ČSSR
R1	Carbon layer	6.8 kΩ	0.125	10	TR 112a 6k8/A
R2	Carbon layer	15 kΩ	0.125	10	TR 112a 15k/A
R3	Carbon layer	10 kΩ	0.125	10	TR 112a 10k/A
R4	Carbon layer	1 kΩ	0.125	10	TR 112a 1k/A
R5	Carbon layer	390 Ω	0.125	10	TR 112a 390/A
R6	Carbon layer	1 kΩ	0.125	10	TR 112a 1k/A
R7	Carbon layer	15 kΩ	0.125	10	TR 112a 15k/A
R8	Carbon layer	10 kΩ	0.125	10	TR 112a 10k/A
R9	Carbon layer	6.8 kΩ	0.125	10	TR 112a 6k8/A
R10	Carbon layer	6.8 kΩ	0.125	10	TR 112a 6k8/A
R11	Carbon layer	15 kΩ	0.125	10	TR 112a 15k/A
R12	Carbon layer	10 kΩ	0.125	10	TR 112a 10k/A

R13	Carbon layer	1 kΩ	0.125	10	TR 112a 1k/A
R14	Carbon layer	390 Ω	0.125	10	TR 112a 390/A
R15	Carbon layer	1 kΩ	0.125	10	TR 112a 1k/A
R16	Carbon layer	15 kΩ	0.125	10	TR 112a 15k/A
R17	Carbon layer	10 kΩ	0.125	10	TR 112a 10k/A
R18	Carbon layer	6.8 kΩ	0.125	10	TR 112a 6k8/A

C a p a c i t o r s :

No.	Type	Value	Max.DC voltage	Tole-rance ± %	Standard ČSSR
C1	Mica	39 pF	500	5	TC 210 39/B
C2	Mica	220 pF	500	5	TC 210 220/B
C3	Styroflex	10,000pF	100	10	TC 281 10k/A
C4	Mica	220 pF	500	5	TC 210 220/B
C5	Mica	68 pF	500	5	TC 210 68/B
C6	Mica	68 pF	500	5	TC 210 68/B
C7	Mica	220 pF	500	5	TC 210 220/B
C8	Styroflex	10,000 pF	100	10	TC 281 10k/A
C9	Mica	220 pF	500	5	TC 210 220/B
C10	Mica	39 pF	500	5	TC 210 39/B

S u n d r y e l e c t r i c a l c o m p o n e n t s :

Coponent	Type - Value	Drawing No.
Germanium diode E1, E2, E3, E6, E7, E8, E9, E10, E12, E14, E15, E16	GA203	1AN 111 85
Pair of transistors E4-E5, E11-E13	156NU70	1AN 111 78

Triple emitter follower 1AK 055 23

R e s i s t o r :

No.	Type	Value	Max. load W	Tole-rance ± %	Standard ČSSR
R1	Carbon layer	2.2 MΩ	0.125	10	TR 113a 2M2/A
R2	Carbon layer	2.2 MΩ	0.125	10	TR 113a 2M2/A
R3	Carbon layer	4.7 kΩ	0.125	10	TR 112a 4k7/A
R4	Carbon layer	2.2 kΩ	0.125	10	TR 112a 2k2/A
R5	Carbon layer	10 kΩ	0.125	10	TR 112a 10k/A
R6	Carbon layer	4.7 kΩ	0.125	10	TR 112a 4k7/A
R7	Carbon layer	2.2 MΩ	0.125	10	TR 113a 2M2/A
R8	Carbon layer	2.2 kΩ	0.125	10	TR 112a 2k2/A
R9	Carbon layer	2.2 MΩ	0.125	10	TR 113a 2M2/A
R10	Carbon layer	4.7 kΩ	0.125	10	TR 112a 4k7/A
R11	Carbon layer	2.2 MΩ	0.125	10	TR 113a 2M2/A
R12	Carbon layer	2.2 kΩ	0.125	10	TR 112a 2k2/A

C a p a c i t o r s :

No.	Type	Value	Max.DC voltage	Tole-rance ± %	Standard ČSSR
C1	Ceramic	1000 pF	500	-	TK 249 1k/M
C2	Ceramic	680 pF	500	-	TK 249 680/M

S u n d r y e l e c t r i c a l c o m p o n e n t s :

Component	Type - Value	Drawing No.
Transistor E1, E2, E3	156NU70	1AN 111 76

Control unit 1AK 055 24

R e s i s t o r s :

No.	Type	Value	Max. load W	Tole-rance ± %	Standard ČSSR
R1	Carbon layer	15 kΩ	C.125	10	TR 112a 15k/A
R2	Carbon layer	10 kΩ	0.125	10	TR 112a 10k/A
R3	Carbon layer	15 kΩ	0.125	10	TR 112a 15k/A
R4	Carbon layer	1.5 kΩ	0.125	10	TR 112a 1k5/A
R5	Carbon layer	33 kΩ	0.125	10	TR 112a 33k/A
R6	Carbon layer	220 Ω	0.125	10	TR 112a 220/A
R7	Carbon layer	220 Ω	0.125	10	TR 112a 220/A
R8	Carbon layer	470 Ω	0.125	10	TR 112a 470/A
R9	Carbon layer	4.7 kΩ	0.125	10	TR 112a 4k7/A
R10	Carbon layer	2.7 kΩ	0.125	10	TR 112a 2k7/A
R11	Carbon layer	1.2 kΩ	0.125	10	TR 112a 1k2/A
R12	Carbon layer	10 kΩ	0.125	10	TR 112a 10k/A
R13	Carbon layer	100 kΩ	0.125	10	TR 112a M1/A
R14	Carbon layer	15 kΩ	0.125	10	TR 112a 15k/A
R15	Carbon layer	6.8 kΩ	0.125	10	TR 112a 6k8/A
R16	Carbon layer	15 kΩ	0.125	10	TR 112a 15k/A
R17	Carbon layer	15 kΩ	0.125	10	TR 112a 15k/A
R18	Carbon layer	680 Ω	0.125	10	TR 112a 680/A
R19	Carbon layer	1.5 kΩ	0.125	10	TR 112a 1k5/A
R20	Carbon layer	82 Ω	0.125	10	TR 112a 82/A
R21	Carbon layer	1 kΩ	0.125	10	TR 112a 1k/A
R22	Carbon layer	15 kΩ	0.125	10	TR 112a 15k/A
R23	Carbon layer	10 kΩ	0.125	10	TR 112a 10k/A
R24	Carbon layer	1.2 kΩ	0.125	10	TR 112a 1k2/A
R25	Carbon layer	8.2 kΩ	0.125	10	TR 112a 8k2/A
R26	Carbon layer	4.7 kΩ	0.125	10	TR 112a 4k7/A
R27	Carbon layer	22 kΩ	0.125	10	TR 112a 22k/A
R28	Carbon layer	2.2 kΩ	0.125	10	TR 112a 2k2/A
R29	Carbon layer	22 kΩ	0.125	10	TR 112a 22k/A

R30	Carbon layer	390 Ω	0.125	10	TR 112a 390/A
R31	Carbon layer	39 kΩ	C.125	10	TR 112a 39k/A
R32	Carbon layer	1.8 kΩ	C.125	10	TR 112a 1k8/A
R33	Carbon layer	1.2 MΩ	C.125	10	TR 112a 1M2/A
R34	Carbon layer	22 kΩ	0.125	10	TR 112a 22k/A

C a p a c i t o r s :

No.	Type	Value	Max.DC voltage	Tole-rance ± %	Standard ČSSR
C1	Mica	220 pF	500	10	TC 210 220/A
C2	Mica	22C pF	50C	10	TC 210 220/A
C3	Electrolytic	2 µF	12	-	TC 923 2M
C4	Styroflex	1000 pF	100	10	TC 281 1k/A
C5	Mica	100 pF	500	10	TC 210 100/A
C6	Styroflex	1500 pF	100	10	TC 281 1k5/A
C7	Styroflex	680C pF	100	10	TC 281 6k8/A
C8	Electrolytic	20 µF	6	-	TC 922 20M
C9	Ceramic	15000 pF	40	-	TK 749 15k
C10	Ceramic	1500C pF	40	-	TK 749 15k
C11	Styroflex	10,000pF	100	1C	TC 281 10k/A
C12	Styroflex	2,200 pF	10C	1C	TC 281 2k2/A

S u n d r y e l e c t r i c a l c o m p o n e n t s :

Component	Type - Value	Drawing No.
Pair of transistors E1-E3	156NU70	1AN 111 78
Transistor E2	103NU71	-
Germanium diode E4, E12	GA203	1AN 111 85
Transistor E5, E6, E7, E10, E11, E13, E14	104NU71	1AN 111 81
Pair of transistors E8-E9	104NU71	1AN 111 80

Input unit 1AK 055 25

R e s i s t o r s :

No.	Type	Value	Max. load W	Tolerance ± %	Standard ČSSR
R1	Potentiometer	2.2 MΩ	0.2	-	TP 038 2M2
R2	Carbon layer	1 MΩ	0.125	10	TR 112a 1M/A
R3	Carbon layer	2.2 kΩ	1	10	TR 153 2k2/A
R4	Carbon layer	22 kΩ	0.125	10	TR 112a 22k/A
R5	Carbon layer	2.2 kΩ	0.125	10	TR 112a 2k2/A
R6	Carbon layer	220 Ω	0.125	10	TR 112a 220/A
R7	Carbon layer	4.7 kΩ	0.125	10	TR 112a 4k7/A
R8	Carbon layer	4.7 kΩ	0.125	10	TR 112a 4k7/A
R9	Carbon layer	1.2 kΩ	0.125	10	TR 112a 1k2/A
R10	Carbon layer	560 Ω	0.125	10	TR 112a 560/A
R11	Carbon layer	1.2 kΩ	0.125	10	TR 112a 1k2/A
R12	Carbon layer	1.2 kΩ	0.125	10	TR 112a 1k2/A
R13	Carbon layer	1.2 kΩ	0.125	10	TR 112a 1k2/A
R14	Potentiometer	68 kΩ	0.2	-	WN 790 30 68k
R15	Carbon layer	1.2 kΩ	0.125	10	TR 112a 1k2/A
R16	Carbon layer	220 Ω	0.125	10	TR 112a 220/A
R17	Carbon layer	33 kΩ	0.125	10	TR 112a 33k/A
R18	Carbon layer	2.7 kΩ	0.125	10	TR 112a 2k7/A
R19	Carbon layer	470 Ω	0.125	10	TR 112a 470/A
R20	Carbon layer	1.5 kΩ	0.125	10	TR 112a 1k5/A
R21	Carbon layer	6.8 kΩ	0.125	10	TR 112a 6k8/A
R22	Carbon layer	10 kΩ	0.125	10	TR 112a 10k/A
R23	Carbon layer	2.7 kΩ	0.125	10	TR 112a 2k7/A
R24	Carbon layer	1.2 kΩ	0.125	10	TR 112a 1k2/A
R25	Carbon layer	10 kΩ	0.125	10	TR 112a 10k/A
R26	Carbon layer	56 kΩ	0.125	10	TR 112a 56k/A
R27	Carbon layer	27 Ω	0.125	10	TR 112a 27/A

C a p a c i t o r s :

No.	Type	Value	Max.DC voltage	Tolerance ± %	Standard ČSSR
C1	Paper	0.47 μF	160	-	TC 181 M47
C3	Electrolytic	100 μF	6	-	TC 962 G1-PVC
C4	Electrolytic	20 μF	6	-	TC 922 20M
C5	Electrolytic	100 μF	6	-	TC 962 G1-PVC
C6	Electrolytic	20 μF	6	-	TC 922 20M
C7	Mica	68 pF	500	10	TC 210 68/A
C8	Mica	220 pF	500	10	TC 210 220/A
C9	Mica	220 pF	500	10	TC 210 220/A
C10	Styroflex	4700 pF	100	10	TC 281 4k7/A

S u n d r y e l e c t r i c a l c o m p o n e n t s :

Component	Type - Value	Drawing No.
Germanium diode E1, E2, E6, E7, E8, E9, E17	GAZ51	-
Transistor E3, E10, E11, E16	156NU70	1AN 111 76
Transistor E4, E5	156NU70	1AN 111 75
Pair of transistors E12-E13	156NU70	1AN 111 78
Transistor E14	156NU70	1AN 111 77
Germanium diode E15	GA203	1AN 111 85

Double shaper 1AK 055 26

R e s i s t o r s :

No.	Type	Value	Max. load W	Tolerance ± %	Standard ČSSR
R1	Carbon layer	27 kΩ	0.125	10	TR 112a 27k/A
R2	Potentiometer	150 kΩ	0.2	-	TP 038 M15
R3	Carbon layer	2.7 kΩ	0.125	10	TR 112a 2k7/A
R4	Carbon layer	470 Ω	0.125	10	TR 112a 470/A
R5	Carbon layer	6.8 kΩ	0.125	10	TR 112a 6k8/A
R6	Carbon layer	10 kΩ	0.125	10	TR 112a 10k/A
R7	Carbon layer	1.5 kΩ	0.125	10	TR 112a 1k5/A
R8	Carbon layer	27 kΩ	0.125	10	TR 112a 27k/A
R9	Potentiometer	150 kΩ	0.2	-	TP 038 M15
R10	Carbon layer	2.7 kΩ	0.125	10	TR 112a 2k7/A
R11	Carbon layer	470 Ω	0.125	10	TR 112a 470/A
R12	Carbon layer	6.8 kΩ	0.125	10	TR 112a 6k8/A
R13	Carbon layer	10 kΩ	0.125	10	TR 112a 10k/A
R14	Carbon layer	1.5 kΩ	0.125	10	TR 112a 1k5/A
R15	Carbon layer	2.7 kΩ	0.125	10	TR 112a 2k7/A
R16	Carbon layer	1.2 kΩ	0.125	10	TR 112a 1k2/A
R17	Carbon layer	2.7 kΩ	0.125	10	TR 112a 2k7/A
R18	Carbon layer	1.2 kΩ	0.125	10	TR 112a 1k2/A

C a p a c i t o r s :

No.	Type	Value	Max. DC voltage	Tolerance ± %	Standard ČSSR
C1	Electrolytic	20 μF	6	-	TC 922 20M
C2	Styroflex	560 pF	500	10	TC 210 560/A
C3	Styroflex	220 pF	500	10	TC 210 220/A
C4	Styroflex	560 pF	500	10	TC 210 560/A
C5	Styroflex	220 pF	500	10	TC 210 220/A
C6	Styroflex	220 pF	500	10	TC 210 220/A
C7	Styroflex	220 pF	500	10	TC 210 220/A

S u n d r y   e l e c t r i c a l   c o m p o n e n t s :

Component	Type - Value	Drawing No.
Pair of transistors E1-E2, E3-E4	156NU70	1AN 111 78
Transistor E5, E8	156NU70	1AN 111 77
Germanium diode E6, E9	GA203	1AN 111 85
Transistor E7, E10	156NU70	1AN 111 76

Power supply 1AK 055 28

R e s i s t o r s :

No.	Type	Value	Max. load W	Tolerance ± %	Standard ČSSR
R1	Carbon layer	680 kΩ	1	-	TR 146 M68
R4	Carbon layer	680 kΩ	1	-	TR 146 M68
R6	Carbon layer	68 Ω	0.5	10	TR 144 68/A
R7	Carbon layer	68 Ω	0.5	10	TR 144 68/A
R9	Potentiometer	150 Ω	0.5	10	TP 680 11E 150/A
R10	Carbon layer	390 Ω	0.5	10	TR 144 390/A
R11	Carbon layer	1 Ω	0.5	10	TR 144 1/A

similar to that for frequency measurement, but instead of the input signal, the frequency of 1 Mc/s (produced by multiplication of the standard frequency of 100 kc/s in multiplier N) is applied to the input of amplifier VZ. During <u>waveform period measurement</u> (FUNCTION SELECTOR in position 3) the output of amplifier VZ-start and gate interval selector IH are interconnected (via F5 and F6) with the inputs of flip-flop circuits KO and gate H respectively. Thus decades D1 to D6 are connected to the output of decades D 10 kc/s to D 100 c/s (via F4, shaping circuits SO and T and TIME UNIT SELECTOR MJ). The remaining three divider decades D 10 c/s to D 0.1 c/s are used for dividing the measured signal (by 10, 100 and 1000) in the measurement of decadic period multiples. The gate is controlled by pulses, the frequency (or the decadic divisions) of which tally with the input signal and the decades count exact frequencies derived from the built-in standard.

<u>Double-channel measurement of time intervals</u> (FUNCTION SELECTOR in position 4). The operation is similar as in waveform period measurement, except that the gate opening is effected by the flip-flop circuits KO by a pulse on input A and its closing by a pulse on input B. In the <u>measurement of a time interval duration</u> limited by the closing or opening of contacts (with the FUNCTION SELECTOR set to position 5), instead of connectors A and B, the contact circuits K are connected to the input of amplifier VZ. When the appropriate terminal is connected to or disconnected from the framework of the counter, a pulse is produced which is processed further in the same manner as in the previously described case.

<u>Ratio measurement of two frequencies</u> (FUNCTION SELECTOR in position 6). Basically the waveform period duration of the lower frequency (f_B) is measured by the higher frequency (f/A). The gate is controlled in the same manner as in a waveform

period measurement (including the possibility of dividing the frequency of the input signal by the decades D 10 c/s to D 0.1 c/s for increasing the accuracy). The only difference lies in the processing of the control signal in channel B. Whilst the gate is open the decades count all pulses of the signal frequency applied to input A.

<u>Totalizing pulse counting</u> (FUNCTION SELECTOR in position 7). The time base is inoperative and the gate is controlled manually by means of the push-buttons marked MAN. Otherwise, the interconnection of the basic assemblies is the same as in frequency measurement.

The repetition rate of the measurements is controllable with a potentiometer (DISPLAY TIME) of control unit R. This control is ganged with a switch for cancelling the automatic clearing operation. With the automatic operation out of action, the beginning of a measurement is determined by the depressing of manual clearing push-button MAN or by connecting the socket of external clearing VN to the framework of the counter.

By using selector MJ, to connector MK (STANDARD FREQUENCY) can be connected the outputs of the individual divider steps shaped in Schmitt's circuit SO and impedance-separated by emitter follower ES. All information required for the operation of peripheral instruments (i.e. logic voltage levels, clearing and control pulses, etc.) are available from connectors I and II.

All the circuits are housed in modules formed by plug-in printed circuit boards which are easily exchangeable and have exactly determined electrical properties facilitating testing. The lightweight duralumin frame and easily removable covers keep the weight of the instrument low. All the controls are on the front panel; the back panel carries connectors for a printer and/or other peripheral instruments.

C a p a c i t o r s :

No.	Type	Value	Max. DC voltage	Tolerance ± %	Standard ČSSR
C1	Electrolytic	1000 μF	25	-	TC 936 1G
C2 C11	Electrolytic	25/25 μF	350/350	-	TC 535 25/25M
C3	Electrolytic	20 μF	150	-	TC 967 20M-PVC
C4	Electrolytic	20 μF	150	-	TC 967 20M-PVC
C5	Electrolytic	50 μF	50	-	TC 965 50M-PVC
C6	Electrolytic	200 μF	12	-	TC 963 G2-PVC
C7	Electrolytic	50 μF	50	-	TC 965 50M-PVC
C8	Electrolytic	1000 μF	25	-	TC 936 1G
C9	Electrolytic	200 μF	12	-	TC 963 G2-PVC
C10	Electrolytic	200 μF	12	-	TC 963 G2-PVC

T r a n s f o r m e r s   a n d   c o i l s :

Component	Marking	Drawing No.	No. of tap	No. of turns	Wire Ø in mm
Transformer	T1	1AN 663 06			
Coil		1AK 623 72	1-2	527	0.28
			3-4	527	0.28
			4-5	48	0.40
			6-7	188	0.10
			7-8	168	0.10
			8-9	192	0.10
			9-10	750	0.10
			11-12	66	0.60
			13-14	33	1.12

S u n d r y   e l e c t r i c a l   c o m p o n e n t s :

Component	Type - Value	Drawing No.
Quartz diode E1, E2, E3, E4	KY701	-
Quartz diode E5, E6, E7	KY705	-

Quartz diode E8	KY704	-
Quartz diode E9	KY703	-
Zener diode E10	3NZ70	-
Transistor E11	OC72	-
Transistor E12	OC27	-
Fuse cartridge P1	0.25 A/250 V for 220 V	ČSN 35 4731
Fuse cartridge P1	0.4 A/250 V for 120 V	ČSN 35 4731
Fuse cartridge P2	1 A/250 V	ČSN 35 4731
Fuse cartridge P3	0.1 A/250 V	ČSN 35 4731

Frequency standard 100 kc/s 1AK 055 35

R e s i s t o r s :

No.	Type	Value	Max. load W	Tolerance ± %	Standard ČSSR
R1	Carbon layer	120 kΩ	0.125	10	TR 112a M12/A
R2	Carbon layer	22 kΩ	0.125	10	TR 112a 22k/A
R3	Carbon layer	2.7 kΩ	0.125	10	TR 112a 2k7/A
R4	Carbon layer	5.6 kΩ	0.125	10	TR 112a 5k6/A
R5	Carbon layer	120 kΩ	0.125	10	TR 112a M12/A
R6	Carbon layer	47 kΩ	0.125	10	TR 112a 47k/A
R7	Carbon layer	1 kΩ	0.125	10	TR 112a 1k/A
R8	Potentiometer	1 MΩ	0.2	-	TP 035 1M
R9	Carbon layer	68 kΩ	0.125	10	TR 112a 68k/A
R10	Carbon layer	33 kΩ	0.125	10	TR 112a 33k/A
R11	Carbon layer	330 Ω	0.125	-	TR 112a 330
R14	Carbon layer	270 Ω	0.25	5	TR 151 270/B
R15	Resistor	9 Ω	-	+5	1AK 672 00

Capacitors:

No.	Type	Value	Max. DC volt.	Tolerance ± %	Standard ČSSR
C1	Styroflex	220 pF	100	-	TC 281 220
C2	Trimmer	100 pF	500	-	TK 812 100
C3	Styroflex	8200 pF	100	10	TC 281 6k8/A
C4	Styroflex	8200 pF	100	10	TC 281 6k8/A
C5	Styroflex	68 pF	100	-	TC 281 68
C6	Mica	680 pF	500	-	TC 210 680
C10	Electrolytic	50 μF	12	-	TC 963 50M
C11	Styroflex	100 pF	100	-	TC 281 100
C12	Styroflex	390 pF	100	10	TC 281 390/A
C13	Styroflex	470 pF	100	-	TC 281 470
C14	Styroflex	680 pF	100	-	TC 281 680
C15	Styroflex	220 pF	100	-	TC 281 220

Ca = C11 or C12 or C13 or C14 or C15

Transformers and coils:

Component	Marking	Drawing No.	No. of tap	No. of turns	Wire Ø in mm
Coil assembled	L1,L2	1AK 587 88			
Coil		1AK 601 29	1-2	300	0.200
			2-3	80	0.200
			4-5	35	0.200

Sundry electrical components:

Component	Type - Value	Drawing No.
Transistor E1, E2	156NU70	-
Transistor E3, E4	101NU71	-
Quartz diode E5	KY701	-
Germanium diode E6	GA203	-
Relay		1AN 599 11

Crystal K	1AK 609 17
Contact thermometer	1AN 940 00

Decade 30C kc/s 1AK 055 5C

Resistors:

No.	Type	Value	Max. load W	Tolerance ± %	Standard ČSSR
R1	Carbon layer	10 kΩ	0.125	10	TR 112a 10k/A
R2	Carbon layer	15 kΩ	0.125	10	TR 112a 15k/A
R3	Carbon layer	10 kΩ	0.125	10	TR 112a 10k/A
R4	Carbon layer	1.5 kΩ	0.125	10	TR 112a 1k5/A
R5	Carbon layer	1.5 kΩ	0.125	10	TR 112a 1k5/A
R6	Carbon layer	330 Ω	0.125	10	TR 112a 330/A
R7	Carbon layer	15 kΩ	0.125	10	TR 112a 15k/A
R8	Carbon layer	10 kΩ	0.125	10	TR 112a 10k/A
R9	Carbon layer	82 kΩ	0.125	10	TR 112a 82k/A
R10	Carbon layer	5.6 kΩ	0.125	10	TR 112a 5k6/A
R11	Carbon layer	10 kΩ	0.125	10	TR 112a 10k/A
R12	Carbon layer	15 kΩ	0.125	10	TR 112a 15k/A
R13	Carbon layer	1.5 kΩ	0.125	10	TR 112a 1k5/A
R14	Carbon layer	1.5 kΩ	0.125	10	TR 112a 1k5/A
R15	Carbon layer	330 Ω	0.125	10	TR 112a 330/A
R16	Carbon layer	15 kΩ	0.125	10	TR 112a 15k/A
R17	Carbon layer	10 kΩ	0.125	10	TR 112a 10k/A
R18	Carbon layer	39 kΩ	0.125	10	TR 112a 39k/A
R19	Carbon layer	10 kΩ	0.125	10	TR 112a 10k/A
R20	Carbon layer	10 kΩ	0.125	10	TR 112a 10k/A
R21	Carbon layer	15 kΩ	0.125	10	TR 112a 15k/A
R22	Carbon layer	1.5 kΩ	0.125	10	TR 112a 1k5/A
R23	Carbon layer	1.5 kΩ	0.125	10	TR 112a 1k5/A
R24	Carbon layer	330 Ω	0.125	10	TR 112a 330/A
R25	Carbon layer	15 kΩ	0.125	10	TR 112a 15k/A

R26	Carbon layer	39 kΩ	0.125	10	TR 112a 39k/A
R27	Carbon layer	39 kΩ	0.125	10	TR 112a 39k/A
R28	Carbon layer	10 kΩ	0.125	10	TR 112a 10k/A
R29	Carbon layer	10 kΩ	0.125	10	TR 112a 10k/A
R30	Carbon layer	10 kΩ	0.125	10	TR 112a 10k/A
R31	Carbon layer	15 kΩ	0.125	10	TR 112a 15k/A
R32	Carbon layer	1.5 kΩ	0.125	10	TR 112a 1k5/A
R33	Carbon layer	1.5 kΩ	0.125	10	TR 112a 1k5/A
R34	Carbon layer	330 Ω	0.125	10	TR 112a 330/A
R35	Carbon layer	39 kΩ	0.125	10	TR 112 39k/A
R36	Carbon layer	15 kΩ	0.125	10	TR 112a 15k/A
R37	Carbon layer	10 kΩ	0.125	10	TR 112a 10k/A
R38	Carbon layer	10 kΩ	0.125	10	TR 112a 10k/A
R39	Carbon layer	27 kΩ	0.125	10	TR 112a 27k/A
R40	Carbon layer	27 kΩ	0.125	10	TR 112a 27k/A
R41	Carbon layer	27 kΩ	0.125	10	TR 112a 27k/A
R42	Carbon layer	27 kΩ	0.125	10	TR 112a 27k/A
R43	Carbon layer	27 kΩ	0.125	10	TR 112a 27k/A
R44	Carbon layer	27 kΩ	0.125	10	TR 112a 27k/A
R45	Carbon layer	27 kΩ	0.125	10	TR 112a 27k/A
R46	Carbon layer	27 kΩ	0.125	10	TR 112a 27k/A
R47	Carbon layer	3.3 kΩ	0.125	10	TR 112a 3k3/A
R48	Carbon layer	3.3 kΩ	0.125	10	TR 112a 3k3/A

C a p a c i t o r s :

No.	Type	Value	Max. DC volt.	Tolerance ± %	Standard ČSSR
C1	Mica	150 pF	500	5	TC 210 150/B
C2	Mica	220 pF	500	5	TC 210 220/B
C3	Styroflex	10000 pF	100	10	TC 281 10k/A
C4	Mica	220 pF	500	5	TC 210 220/B
C5	Mica	100 pF	500	5	TC 210 100/B
C6	Mica	330 pF	500	5	TC 210 330/B
C7	Styroflex	10000pF	100	10	TC 281 10k/A
C8	Mica	330 pF	500	5	TC 210 330/B
C9	Mica	100 pF	500	5	TC 210 100/B
C10	Mica	330 pF	500	5	TC 210 330/B
C11	Styroflex	10000 pF	100	10	TC 281 10k/A
C12	Mica	330 pF	500	5	TC 210 330/B
C13	Mica	120 pF	500	5	TC 210 120/B
C14	Mica	330 pF	500	5	TC 210 330/B
C15	Styroflex	10000 pF	100	10	TC 281 10k/A
C16	Mica	330 pF	500	5	TC 210 330/B
C17	Mica	100 pF	500	5	TC 210 100/B
C18	Mica	220 pF	500	5	TC 210 220/B

S u n d r y   e l e c t r i c a l   c o m p o n e n t :

Component	Type - Value	Drawing No.
Germanium diode E1, E6, E7, E10, E11, E14, E15, E18	GA203	1AN 111 85
Pair of transistors E3-E4, E8-E9, E12-E13, E16-E17	155NU70	1AN 111 79

Universal counter 1X1 832 26

R e s i s t o r s :

No.	Type	Value	Max. load W	Tolerance ± %	Standard ČSSR
R1	Carbon layer	120 kΩ	0.125	10	TR 112a M12/A
R2	Carbon layer	56 kΩ	0.125	10	TR 112a 56k/A
R3	Carbon layer	120 kΩ	0.125	10	TR 112a M12/A
R4	Carbon layer	120 kΩ	0.125	10	TR 112a M12/A
R5	Carbon layer	82 kΩ	0.5	10	TR 152 82k/A
R6	Carbon layer	82 kΩ	0.5	10	TR 152 82k/A
R7	Carbon layer	82 kΩ	0.5	10	TR 152 82k/A

R8	Carbon layer	82 kΩ	0.5	10	TR 152 82k/A
R9	Carbon layer	82 kΩ	0.5	10	TR 152 82k/A
R10	Carbon layer	82 kΩ	0.5	10	TR 152 82k/A
R11	Carbon layer	1.8 kΩ	0.125	10	TR 112a 1k8/A
R12	Carbon layer	56 Ω	0.125	10	TR 112a 56/A
R13	Carbon layer	56 Ω	0.125	10	TR 112a 56/A
R14	Carbon layer	1.8 kΩ	0.125	10	TR 112a 1k8/A
R15	Potentiometer	500 kΩ	0.5	-	TP 280b 20A M5/N
R16	Potentiometer	500 kΩ	0.5	-	TP 280b 20A M5/N
R17	Carbon layer	1 MΩ	0.125	10	TR 112a 1M/A
R18	Carbon layer	1 MΩ	0.125	10	TR 112a 1M/A
R19	Carbon layer	1 MΩ	0.125	10	TR 112a 1M/A
R20	Carbon layer	1 MΩ	0.125	10	TR 112a 1M/A
R21	Potentiometer	250 kΩ	0.5	-	1AN 692 35
R22	Potentiometer	4.7 MΩ	0.2	-	TP 035 4M7
R24	Carbon layer	100 kΩ	0.125	10	TR 112a M1/A
R25	Carbon layer	1.5 kΩ	0.125	10	TR 112a 1k5/A
R27	Carbon layer	1 MΩ	0.125	10	TR 112a 1M/A
R28	Carbon layer	120 kΩ	0.125	10	TR 112a M12/A
R29	Carbon layer	120 kΩ	0.125	10	TR 112a M12/A
R30	Carbon layer	120 kΩ	0.125	10	TR 112a M12/A
R31	Carbon layer	120 kΩ	0.125	10	TR 112a M12/A
R32	Carbon layer	27 kΩ	0.125	10	TR 112a 27k/A
R33	Carbon layer	22 kΩ	0.125	10	TR 112a 22k/A

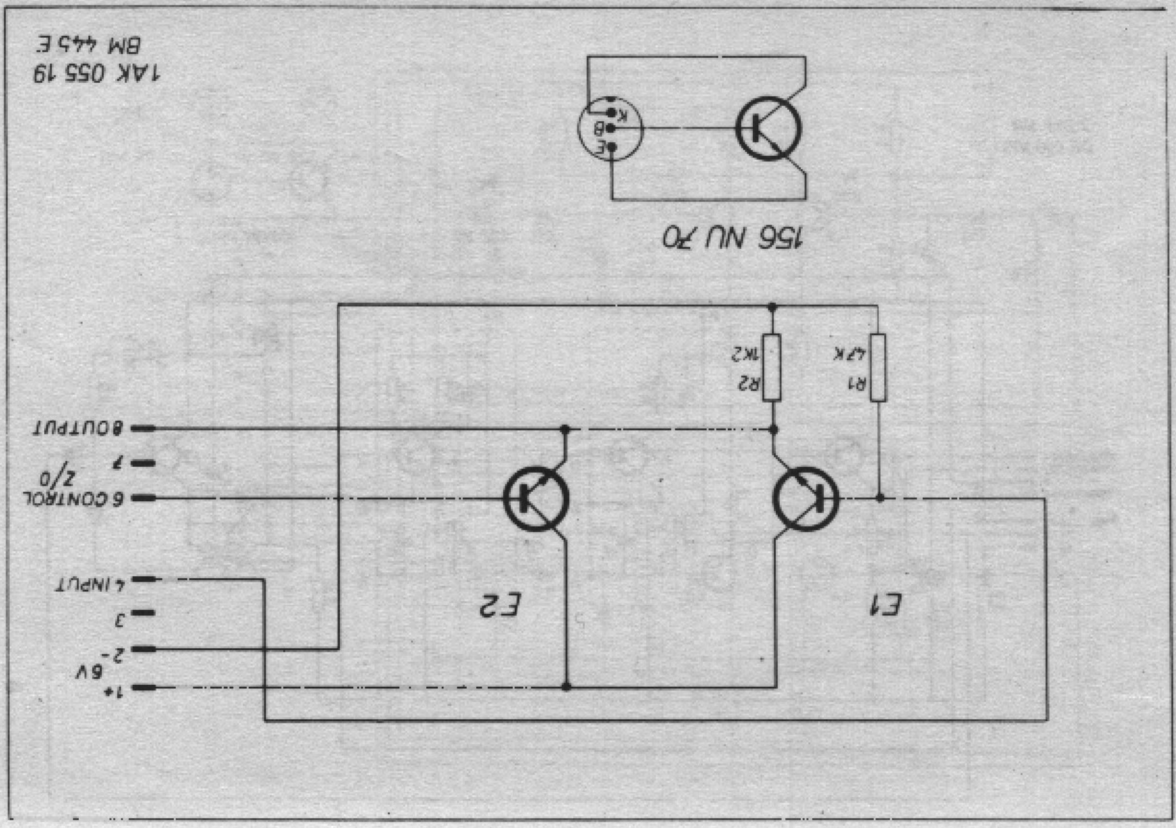
C a p a c i t o r s :

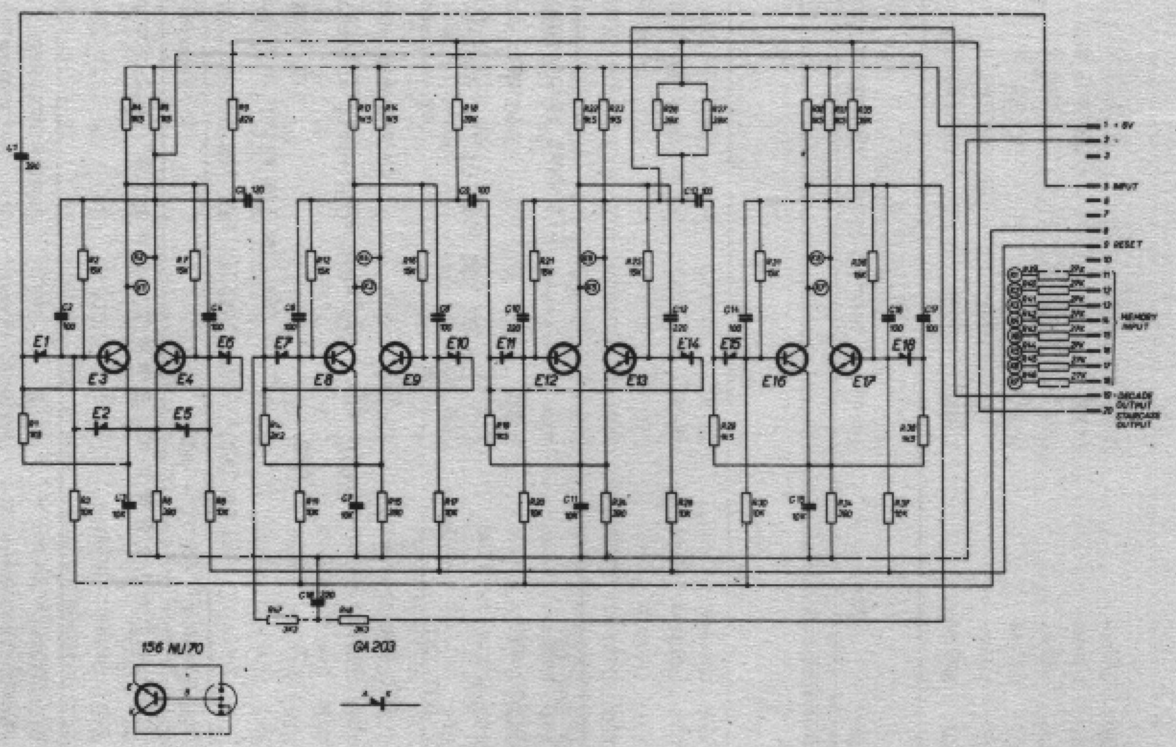
No.	Type	Value	Max.DC voltage	Tolerance ± %	Standard ČSSR
C1	Paper	1 μF	160	-	TC 181 1M
C2	Paper	1 μF	160	-	TC 181 1M
C3	Paper	0.1 μF	160	-	TC 181 M1
C4	Paper	0.1 μF	160	-	TC 181 M1
C5	Paper	0.22 μF	400	-	TC 183 M22
C6	Paper	0.22 μF	400	-	TC 183 M22

C7	Styroflex	10000 pF	100	10	TC 281 10k/A
C8	Styroflex	10000 pF	100	10	TC 281 10k/A
C9	Electrolytic	1 μF	25	-	TC 924 1M

S u n d r y   e l e c t r i c a l   c o m p o n e n t s :

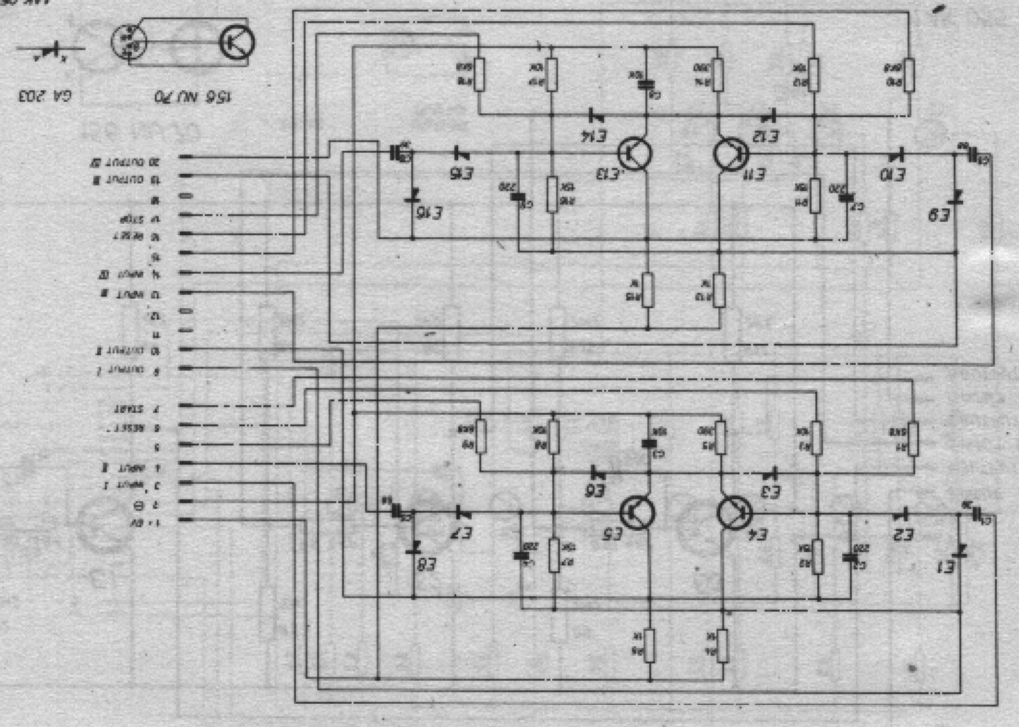
Component	Type - Value	Drawing No.
Digitron E1, E2, E3, E4, E5, E6	ZM1020	-
Germanium diode E7, E8, E9, E11, E12, E13	OA5	-
Germanium diode E10, E14, E15	GAZ51	-
Glow-tube D1, D3		1AN 109 19
Glow-tube D2		1AN 109 20
Glow-tube D4, D5, D6, D7, D8		1AN 109 39
Glow-tube D9		1AN 109 13
Incandescent lamp Z1		1AN 109 17

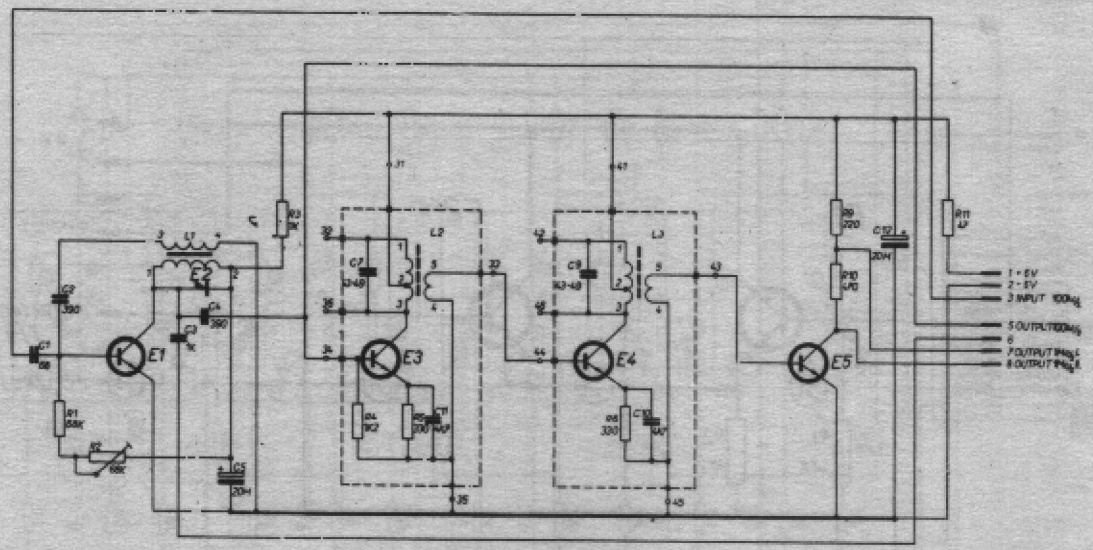




1AK 055 18
BM 445 E

1AK 055 22
BM 445 E

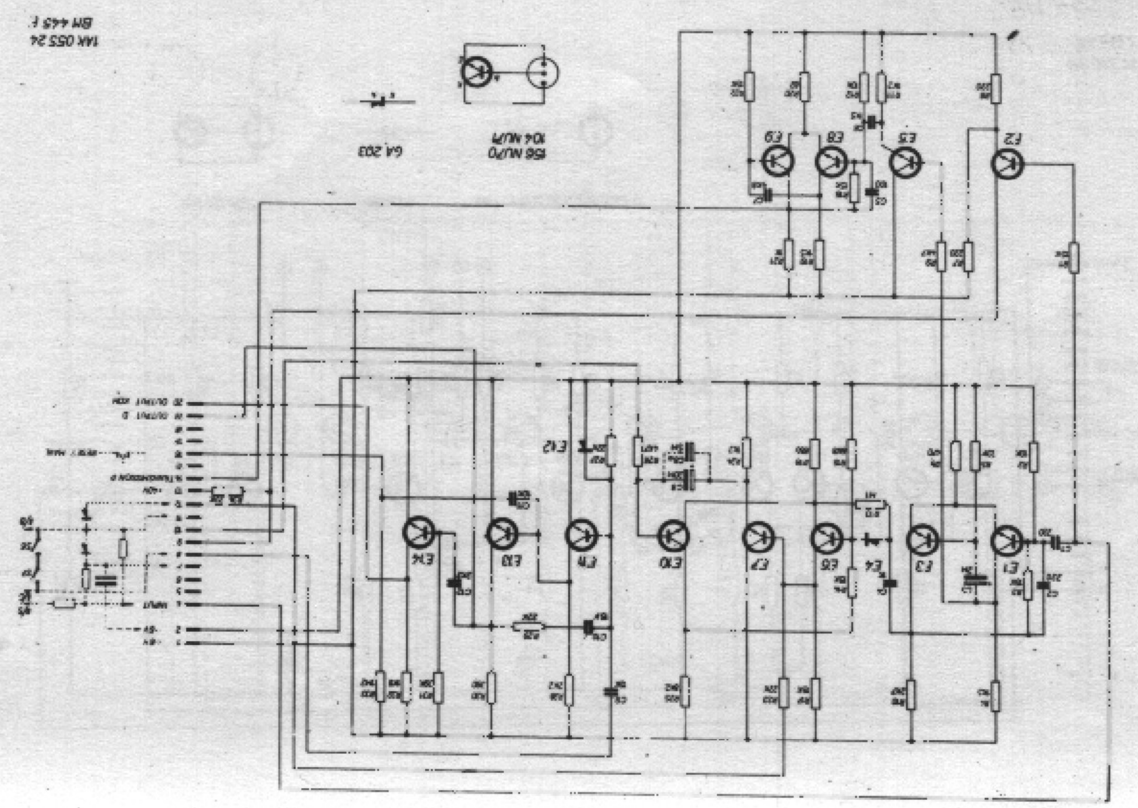


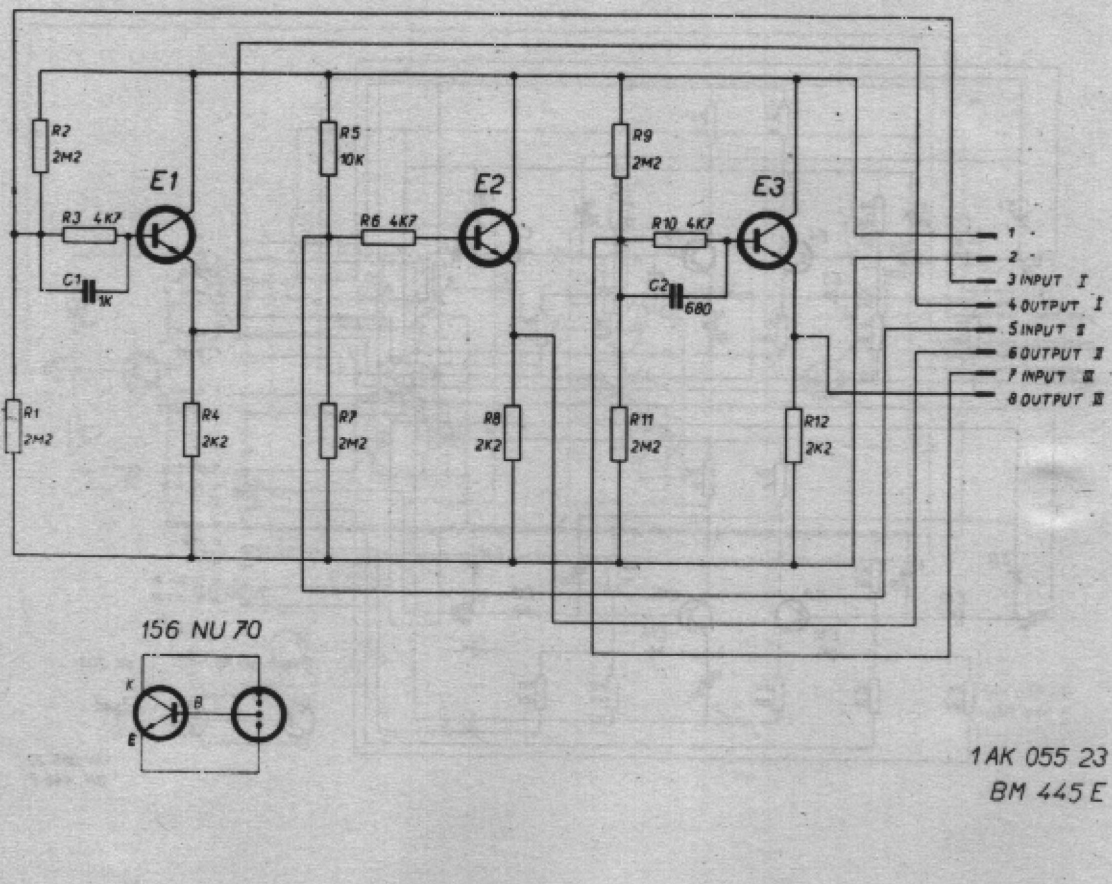


156 NU 70

GA 203

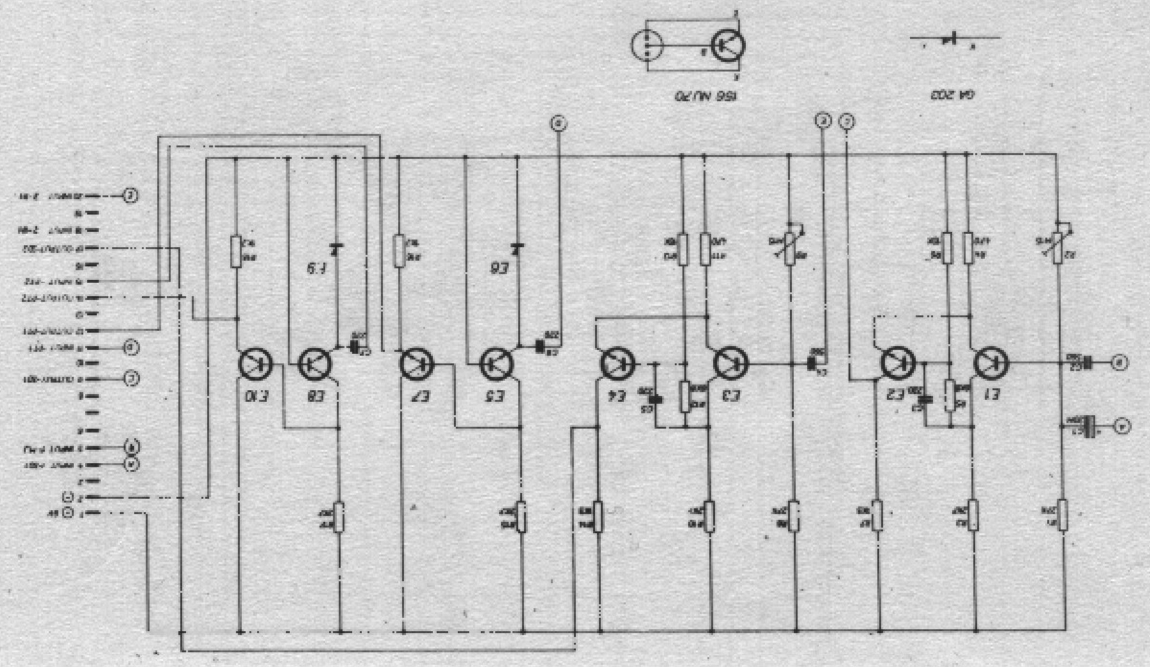
1AK 055 20
BM 445 E

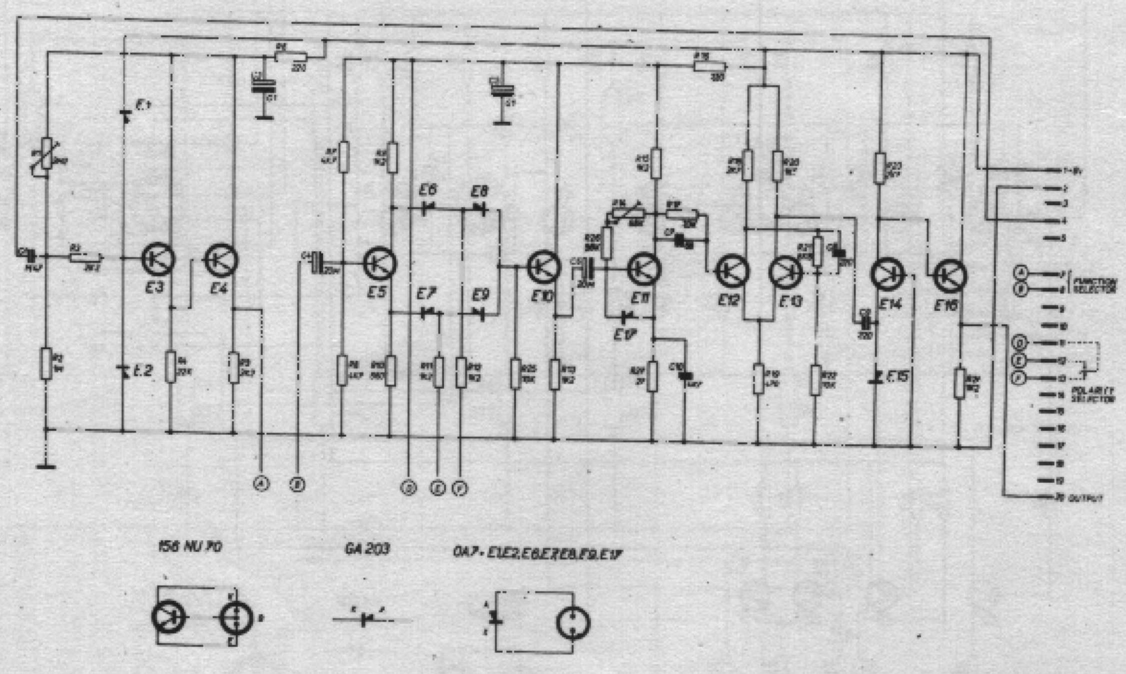




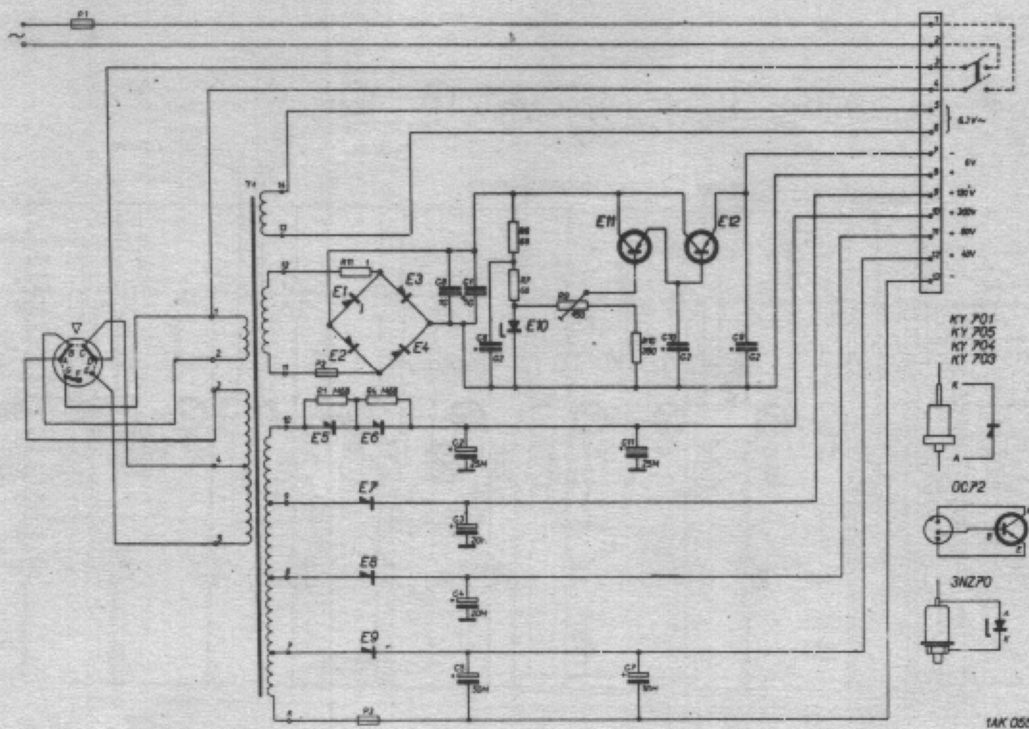
1AK 055 23
BM 445 E

1AK 055 25
BM 445 E



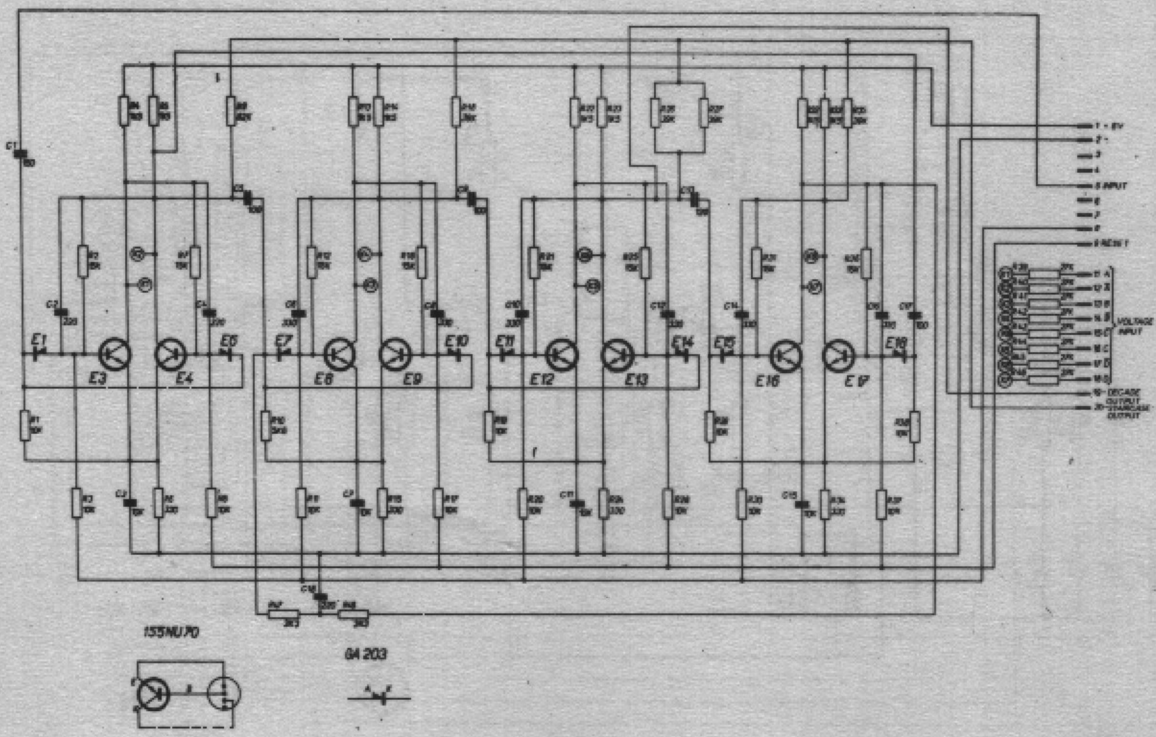


1AK 055 25
BM 445 E



1AK 055 28
BM 445 E

1AK 055 35
BM 445 E



SCHODY

1AK 058 50
BM 445 E

BLOCK DIAGRAM

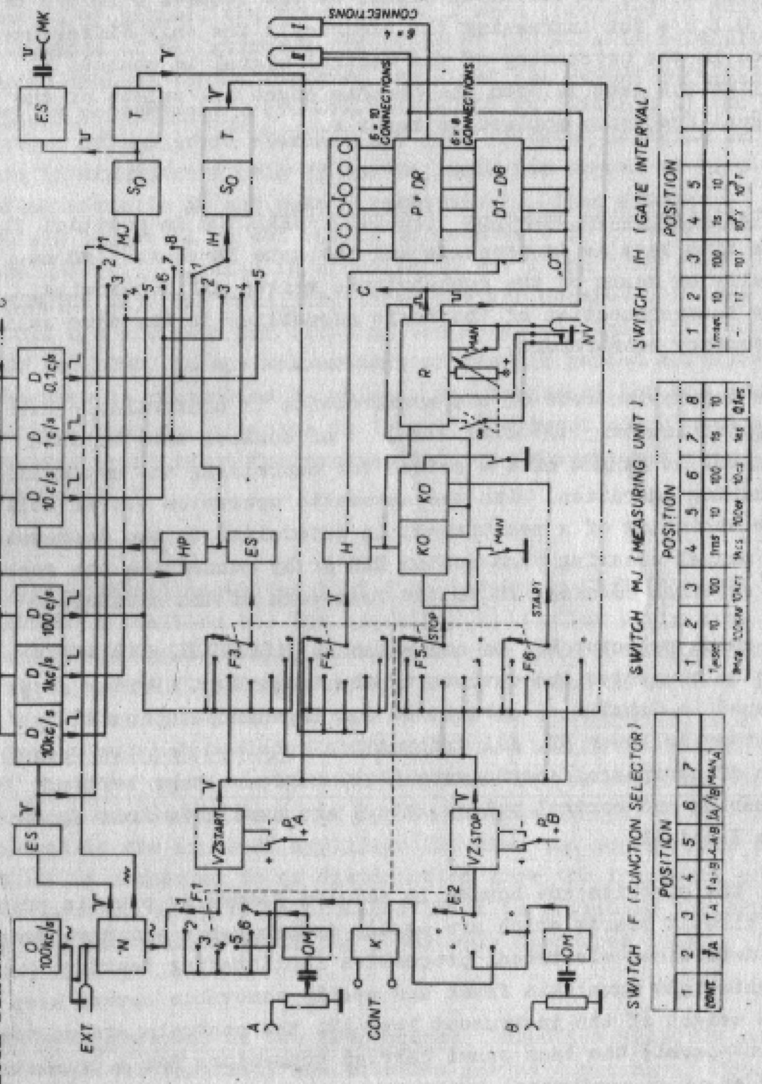


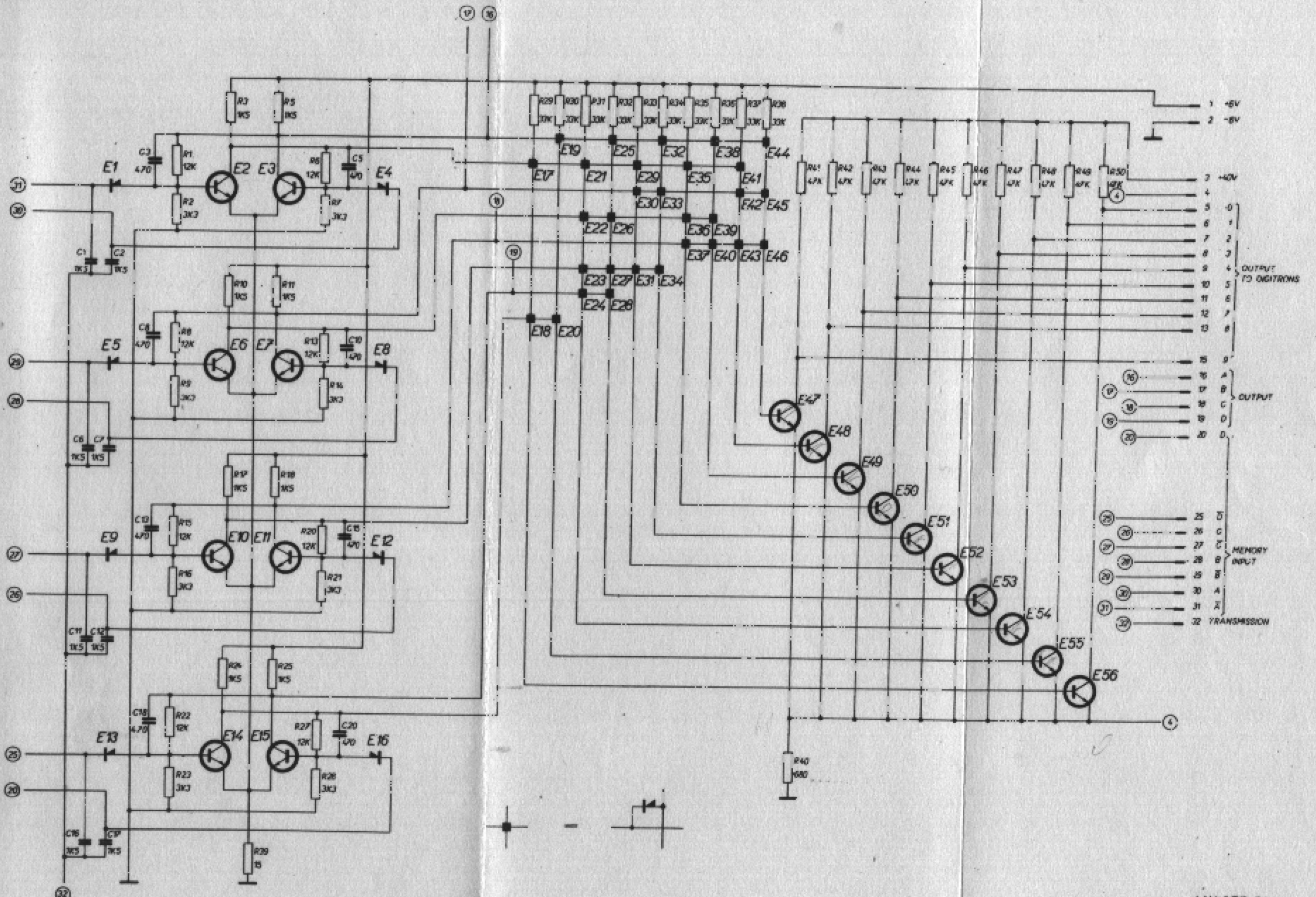
Fig. 2

O - Oscillator 100 kc/s
N - Multiplier
ES - Emitter follower
VZ - Input amplifier
OM - Limiter
K - Contact circuit
D 0.1 c/s - D 10 kc/s - Divider decades
D1 - D6 - Counter decades
KO - Flip-flop circuit
H - Gate
HP - Auxiliary gate
SO - Schmitt's circuit
T - Shaper
P - Memory
DR - Decoder
I - Display
R - Control unit
NV - Socket for external clearing
I - II - Output connectors
F1 - F6 - Function selector
MJ - Measuring unit selector
IH - Gate interval selector
P_A - P_B - Polarity change-over switches
EXT. - Socket for external 100 kc/s standard
A - Input for channel A
B - Input for channel B
KONT. - Contact circuit terminals
MK - Measuring frequency output
MAN - Manual control push-button

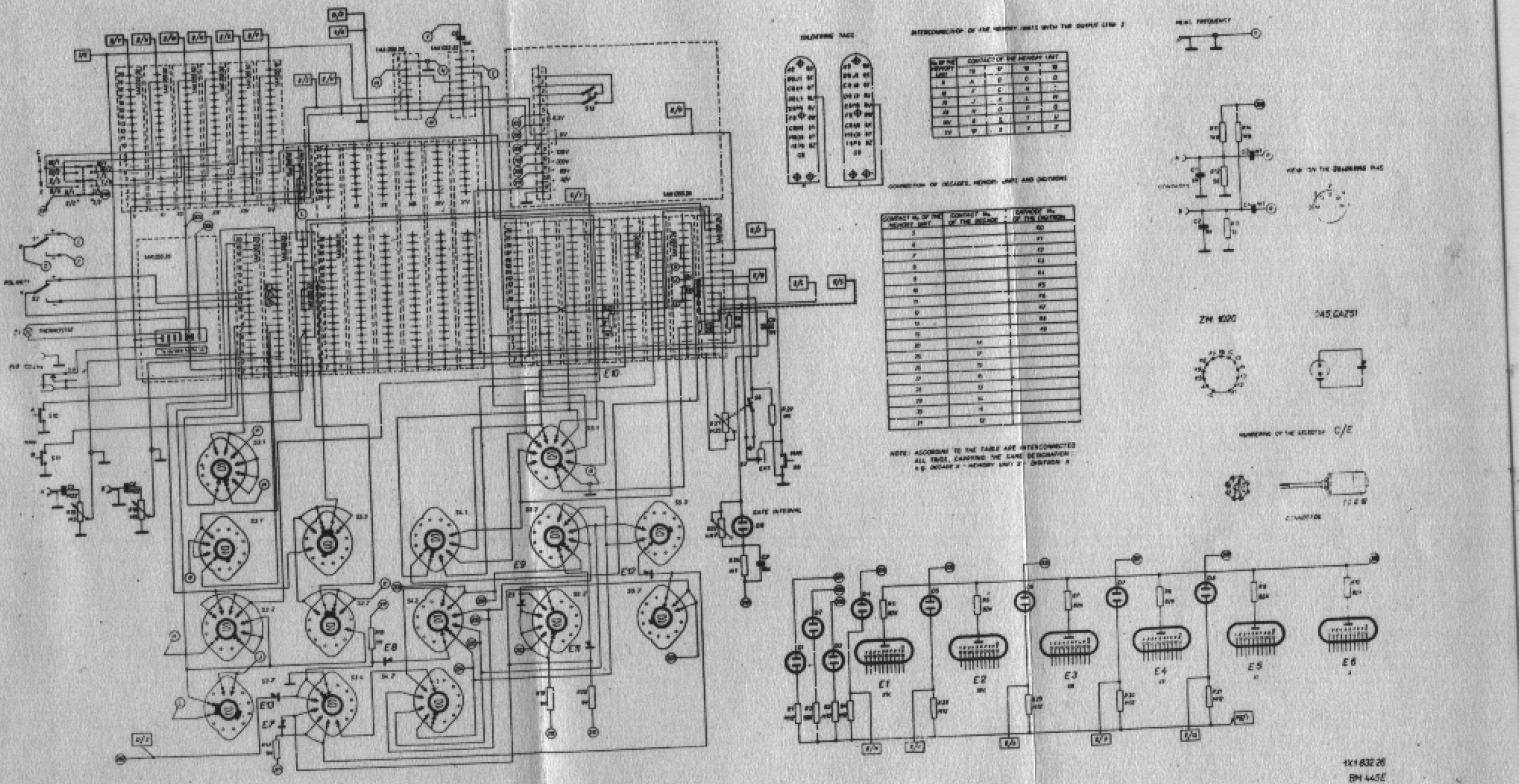
Control elements on the front panel

Input connectors (5, 6)

The counter has two amplifying and shaping channels A and B accessible via coaxial connector 5 (channel A) and 6 (channel B) respectively. To connector 5 is applied the input signal



1AK 055 21
BM 445E



INTERCONNECTION OF THE MEMORY UNITS WITH THE OUTPUT STRIP

No. OF THE MEMORY UNIT	CONTACT OF THE MEMORY UNIT			
	19	17	18	16
I	A	B	C	D
II	F	C	H	[illegible]
III	J	K	L	M
IV	N	O	P	Q
XV	S	L	T	U
XV	W	X	Y	Z

CONNECTION OF DECADES, MEMORY UNITS AND DIGITRONS

CONTACT No. OF THE MEMORY UNIT	CONTACT No. OF THE DECADE	CATHODE No. OF THE DIGITRON
5		60
6		61
7		62
8		63
9		64
10		65
11		66
12		67
13		68
15		69
20	14	
21	17	
25	15	
27	16	
24	13	
28	16	
29	15	
31	12	

NOTE: ACCORDING TO THE TABLE ARE INTERCONNECTED ALL TAGS, CARRYING THE SAME DESIGNATION; e.g. DECADE 2 - MEMORY UNIT 2 - DIGITRON 2

1X1 832 26
BM 445E

during the measurement of frequency (f_A) and waveform period (T_A), further the triggering (start) pulse during time interval (t_{A-B}) measurement, the frequency A during frequency ratio (f_A/f_B) measurement, as well as the input pulses during simple totalizing counting (MAN_A).
To connector 6 is applied the terminating (stop) pulse during time interval (t_{A-B}) measurement and the frequency B during frequency ratio (f_A/f_B) measurement.

Input attenuators (7, 8)

The controls 7 and 8 serve for continuously controlling (reducing) the input signal level applied to connectors 5 and 6 respectively. The maximum voltage which can be applied to these inputs at full sensitivity (controls 7 and 8 turned fully clockwise) is 30 V peak. If the voltage of the input signal is higher or if it is essential to separate the signal from the background (this is not possible in every case), the attenuators are used for sensitivity reduction. If the voltage to be applied to the input is unknown, it is advisable to turn the respective control counter-clockwise to its extreme position. After applying the input, the sensitivity is increased slowly until the counter starts to operate and finally the control is turned slightly further so that by trial and error reliable operation is ensured. During waveform period measurements, it is advantageous to employ as high a sensitivity as possible, keeping in mind that the input circuits must not be endangered by an excessive input voltage.

The above described procedures apply to both input channels (A and B) and to all types of measurements, except when the counter is being tested and when time intervals are being measured with contact triggering employed, as then the attenuators are inoperative and therefore have no influence on the operation.

Polarity change-over switches (9, 10)

The polarity changing switches 9 (channel A) and 10 (channel B) serve for adjustment of the appropriate channels to process pulses of either one polarity or the other, or to respond to the contact making or breaking. The two switches are marked P_A and P_B respectively in the block diagram (Fig. 2).

Meanings of the employed symbols:

∼ Sinusoidal waveform
⎍ Positive-going pulse
⎎ Negative-going pulse
⌐ Contact opening (break)
⌙ Contact closing (make)

Push-buttons (11, 12)

The push-buttons 11 and 12 serve for manually opening and closing the gate respectively, especially in totalizing counting operation (FUNCTION SELECTOR set to the position MAN_A). They can be used also in other measurements, e.g. for terminating the counting cycle. By depressing push-button 11 (channel A) the counter can be set in operation only if the decades have been cleared previously.

Contact binding posts (3, 4)

The binding posts 3, 4 belong to the contact circuits. The counter is started when circuit A is connected to or disconnected from the framework by the action of contacts P_A. Similarly the counting cycle is terminated by the action of contacts P_B in circuit B.

Function selector (13)

The selector 13, marked F1 to F6 in the block diagram, has a total of seven positions; their significance is given in the following table:

Position	Marking	Function	Notes
1	CONT 1 Mc/s	Self-testing with 1 Mc/s from the built-in standard	Measuring interval set with selector 14
2	f_A	Frequency measurement of signal on input A	Measuring interval set with selector 14
3	T_A	Waveform period measurement of signal on input A	Measuring unit set with selector 16; number of periods with selector 14
4	t_{A-B}	Time interval measurement between pulses applied to inputs A and B	Measuring unit set with selector 16
5	⌐ A-B	Time interval measurement between making or breaking of contacts in circuits A and B	Measuring unit set with selector 16
6	f_A/f_B	Frequency ratio measurement between two signals on inputs A and B	Frequency B is divided at a ratio set with selector 14

Position	Marking	Function	Notes
7	MAN_A	Totalizing counting	Manual start and stop by means of push-buttons MAN

Gate interval selector (14) and pilot lamp (15)

Selector 14, marked IH in the block diagram, has five positions, the significance of which is given in the following table:

Position	Marking	Function	Notes
1	1 ms	Measuring interval 1 msec	a) Selector 13 set to position CONT 1 Mc/s or f_A (red mark)
2	10 ms	Measuring interval 10 msec	See note a)
	1 T	Measurement of 1 period	b) Selector 13 set to position T_A
		Ratio measurement f_A/f_B	c) Selector 13 set to position f_A/f_B
3	100 ms	Measuring interval 100 msec	See note a)
	10 T	Measurement of 10 periods	See note b)
		Ratio measurement $10 \times f_A/f_B$	See note c)

4	1 s	Measuring interval 1 sec	See note a)
	100 T	Measurement of 100 periods	See note b)
		Ratio measurement 100 x f_A/f_B	See note c)
5	10 s	Measuring interval 10 sec	See note a)
	1000 T	Measurement of 1000 periods	See note b)
		Ratio measurement 1000 x f_A/f_B	See note c)

The duration of the gate open interval is indicated by pilot lamp 15.

<u>Measuring unit and frequency measuring selector (16) and connector (17)</u>

Selector 16, marked MJ in the block diagram, has a total of eight positions, the significance of which is given in the following table:

Position	Marking	Function	Notes
1	1 Mc/s	Measuring frequency 1 Mc/s	a) On connector 17 with selector 13 set to position MAN_A
	1 µs	Measuring unit 1 µsec	b) Selector 13 set to position T_A, t_{A-B}, or ⏌$_{A-B}$
2	100 kc/s	Measuring frequency 100 kc/s	See note a)
	10 µs	Measuring unit 10 µsec	See note b)
3	10 kc/s	Measuring frequency 10 kc/s	See note a)
	100 µsc	Measuring unit 100 µsec	See note b)
4	1 kc/s	Measuring frequency 1 kc/s	See note a)
	1 ms	Measuring unit 1 msec	See note b)
5	100 c/s	Measuring frequency 100 c/s	See note a)
	10 ms	Measuring unit 10 msec	See note b)
6	10 c/s	Measuring frequency 10 c/s	See note a)
	100 ms	Measuring unit 100 msec	c) Selector 13 set to position t_{A-B}, or ⏌$_{A-B}$
7	1 c/s	Measuring frequency 1 c/s	See note a)
	1 s	Measuring unit 1 sec	See note c)
8	0.1 c/s	Measuring frequency 0.1 c/s	See note a)
	10 s	Measuring unite 10 sec	See note c)

Clearing controls (19, 20)

Even though the results display is continuous, it is possible with control 19 to select the frequency or repetition rate of the automatic measurement, or in other words, the time which elapses between the termination of one measuring cycle and the beginning of the following one, within the range of approximately 0.1 sec (extreme clockwise position marked "min.") to 5 sec (position marked "max."); further counter-clockwise turning of this control causes the cancellation of the automatic clearing operation (position marked "∞"). The interval is further controlled by depressing push-button 20. This control can be used for terminating the counting even during automatic operation, but it must be borne in mind that after the elapse of a period depending on the setting of the respective control, the counter will automatically clear the decades once more. Automatic clearing operation can be chosen only when the gate interval is minimum 10 µsec. If a shorter interval has been set by mistake, or should the counter fail to start counting after being switched on, it will be necessary to employ the manual clearing for recommencing its operation.

Thermostat pilot lamp (18)

When the oven which houses the standard oscillator is heated, this pilot lamp glows. It is necessary to observe whether this lamp is switched on and off alternately (indicating that the thermostatically controlled oven is cycling), as in the case of a failure, e.g. in the thermometer (the lamp glows all the time), the oscillator could suffer damage.

Readout (21)

The in-line readout of the counter has 6 digits formed by neon figure display tubes, which serve for presenting the numerical result of the measurement, plus and minus signs for indicating the polarity of the result displayed in terms of kc/s, msec or sec, and five neon lamps which show the position of the decimal point. When the decades are cleared, the display is not cancelled (as is usual with other types of counters), nor is the readout set back to read zero at the end of measuring cycles. The continuous coherent readout alters if the result differs from that of the penultimate measurement, and even then only in those digits which are affected by the successive cycle.

This feature greatly improves the reading of results at high sampling rates, without ambiguity.

The results of measurements are displayed by the readout in the conventional order of writing numbers, i.e. from left to right. Thus the digit of the highest order (10^6) is at the left and the lowest one (10^0) at the right.

The plus or minus sign and the decimal point are switched and positioned respectively automatically when the settings of the selectors 13, 14 and 16 are altered. Therefore the result is always unambiguous, except in the measurement of 10 to 1000 waveform periods. In this case the readout displays the total time, i.e. the duration of 10, 100 or 1000 periods (not that of only one period). In double-channel measurement of a time interval (t_{A-B}) with the measuring unit 10 set, the decimal point and the plus or minus sign are not displayed, as the decimal point is beyond the range of display.

Mains switch (1)

The "Off" position of this switch is marked "O", the "On" position is marked "I".

Earth terminal (2)

This terminal, marked ⏚, serves as connection in contact measurements.

Description of the elements on the back panel

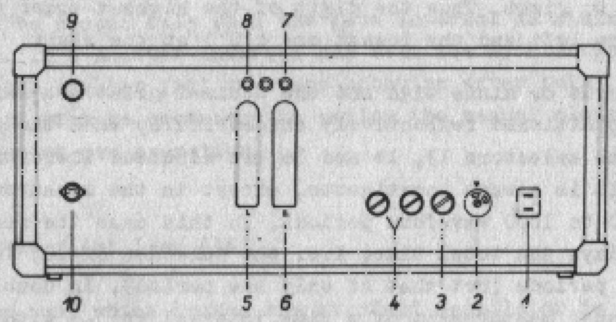


Fig. 3

Mains connector (1), voltage selector (2) and fuses (3, 4)

The manipulation of the counter before the actual measurement is described in detail in the section "Preparations for measurement".

Output connectors (5, 6)

The 26-pole output connectors (5 and 6) marked I and II respectively, serve for the connection of peripheral instruments, e.g. a printer, a large display board, etc. From the contacts of these connectors the following information is available: decimal binary coded decades output (code 1 - 2 - - 4 - 2), analog decades output (staircase), print and clear commands, DC voltage of +6 V and earth.

The connections are listed in the following table:

Connector I (5)

Blade	Output (approx.)		Function	max. load
A	+C.4 V or +5.5 V	A		
B	+0.4 V or +5.5 V	B	of 1st decade	
C	+C.4 V or +5.5 V	C		
D	+0.4 V or +5.5 V	D		
F	+0.4 V or +5.5 V	A		
G	+0.4 V or +5.5 V	B		
H	+0.4 V or +5.5 V	C	of 2nd decade	1 mA
I	+0.4 V or +5.5 V	D		
J	+0.4 V or +5.5 V	A		
K	+0.4 V or +5.5 V	B		
L	+0.4 V or +5.5 V	C	of 3rd decade	
M	+0.4 V or +5.5 V	D		
N	+0.4 V or +5.5 V	A		
O	+0.4 V or +5.5 V	B	of 4th decade	
P	+0.4 V or +5.5 V	C		
Q	+0.4 V or +5.5 V	D		
R	+0.4 V or +5.5 V	A		
S	+0.4 V or +5.5 V	B		
T	+0.4 V or +5.5 V	C	of 5th decade	1 mA
U	+0.4 V or +5.5 V	D		
W	+0.4 V or +5.5 V	A		
X	+0.4 V or +5.5 V	B		
Y	+0.4 V or +5.5 V	C	of 6th decade	
Z	+0.4 V or +5.5 V	D		
E	100 kc/s, 1.2 V		Output of the frequency standard	5 kΩ