

## RACAL INSTRUMENTATION DATA

These pages date from about 1961 and provide a good indication of the state of the art at that time.

Frequency measurement above 1 Mc/s (1 MHz) was difficult with valve and early transistor technology and frequency converters such as the SA33 were devised to extend the range.

Note also the various digital displays used. Vertical banks of 10 neon tubes are used in the early counters. The SA67 "in line readout" unit (from 1963?) has "nodistron" indicating tubes – now known as Nixie tubes. The SA505 transistorised meter has projection display units using filament lamps.

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SA44B/10	Frequency Meter
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MA51	Photoelectric Probe
SA52	Universal Counter/Timer
SA67 SA71	Digital Readout and Printing Equipment
SA503	Voltage to Frequency Converter
SA505	Frequency Meter – Transistorised

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#### FEATURES

- ★ For use in Control Systems.
- ★ Operates with any Racal Counter.
- ★ Completely encapsulated for reliability.
- ★ No moving parts.
- ★ Operates with standard gear wheels.

The Racal Magnetic Transducer Type MA.95 is a coaxial magnetic probe unit primarily intended for the direct measurement of shaft speed where no physical connection to the shaft under test is possible.

In operation it is merely necessary to position the transducer close to an ordinary gear wheel or toothed wheel of ferrous material and an output is obtained which can then be counted and indicated on a digital counter.

The M.A.95 comprises a permanent magnet and associated coil encapsulated in a coaxial housing. Shaped detachable pole pieces can be supplied to suit various tooth forms and the output is brought to a connector situated at the rear of the unit.

No moving parts are involved in the transducer and as it can be rigidly mounted close to the gear and shaft under test a high order of reliability in performance is ensured.

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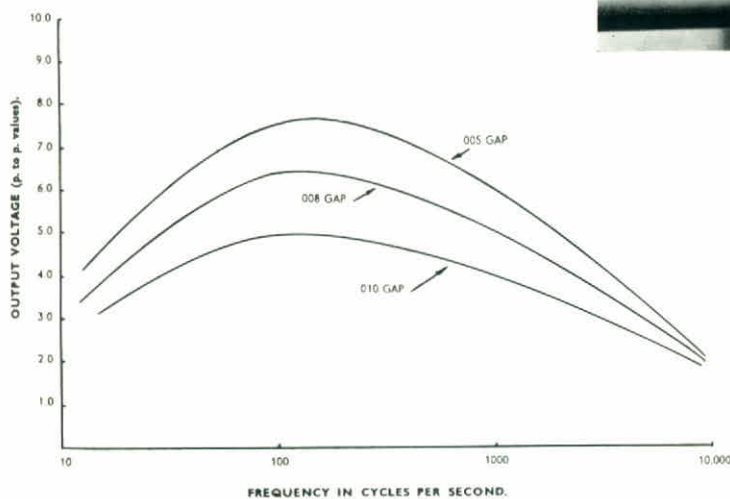
# COAXIAL MAGNETIC TRANSDUCER TYPE MA.95 www.ElectroJumble.org.uk

Direct shaft speed measurement may be made using a digital counter operating with the magnetic transducer and toothed wheel.

In operation a 60 toothed wheel is fitted to the shaft under test and the MA.95 connected to an SA.20 or other type counter with a gating period of 1 second. An indication of shaft speed is thus obtained directly in revs/min. To obtain higher accuracies a wheel with 360 teeth (such as illustrated opposite) can be used.



## Typical Operating Characteristics



Measurements taken with MA.95 operating with a 9in. diameter Mechanite 360-toothed wheel of 40 D.P. and tooth form to BS436 Fig.4. (20° pressure angle.)

NOTE :—

$$f = \frac{Nx}{60}$$

$f$  = frequency in c/s

$N$  = Shaft Speed in r.p.m.

$x$  = No. of teeth on wheel

## TECHNICAL SPECIFICATION

### Electrical

D.C. Resistance — 40 k.ohm  
Output — See curve

Impedance at 100 c/s — 100 k.ohm

### Mechanical

Body diam. — 1.936 in. (5 cms.)  
Fixing — standard Kee Klamp type fixing.

Body length — 4¼ in. (11 cms.)  
Weight — 2 lbs. (1 kg.) approx.

Pole pieces shaped to suit particular tooth form available.

Efforts are continually being made to effect improvement in performance, consequently the equipment supplied may vary in detail from the description contained herein.

**RACAL** Instruments Limited

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Cables/Grams : Racal, Bracknell, Berks. Printed by The Bracknell Press, Bracknell, Berks

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**STABILISED POWER UNIT****PU.156C  
PA.47/1**

There is a growing need to-day for an efficient yet economical means of ensuring that H.T. supplied to electronic circuits is kept stable and it is to meet this demand that Racal present their PU.156C Stabilised Power Unit for laboratory use or incorporation in production and test equipments.

The Power Unit is designed for inclusion behind a standard 19 inch panel and the depth dimension has been kept to a minimum to allow ample space for circuitry that it may be required to feed. It is normally supplied on a bare chassis — as illustrated above, but can also be supplied as the PA.47/1 and is then assembled in a case with terminals, meters, fuses etc.

Fully regulated H.T. at currents up to  $\frac{1}{4}$  amp. is provided and stabilised negative H.T. at lower current is available for bias and control purposes. The unit also gives three unregulated outputs at 6.3 volts A.C.

**CIRCUIT DESCRIPTION**

The Power Unit Type PU.156C employs a conventional series stabiliser circuit. Two 5V4G valves are arranged for full wave rectification, and the cathodes are connected to double triodes type 6080 in parallel acting as the series valve.

The two stage control circuit uses an ECF80 which obtains its reference voltage from an 85A2 neon stabiliser. As a safety precaution the anode of the control valve is connected to earth through five type CC3L neon lamps so that the potentials on the grids of the series valves remain at a fixed safe value even if the control valve fails.

**RACAL**TECHNICAL PUBLICATION NO. **126D2**



# STABILISED POWER UNIT TYPES PU.156C & PA.47/1

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The positive outputs cover two ranges — 200/250 V. and 250/300 V. The desired range may simply be selected by changing links situated on an easily accessible panel. Voltage variation within each range is obtained by means of a potentiometer connected to the grid of a control valve.

Two metal rectifiers connected in a full wave system provide the —150 V. supply. The 150C2 stabiliser holds the voltage constant for loads of 0 to 15mA.

## PA.47/1

For bench mounting applications the PA.47/1 is available. Here the PU.156 is fitted to a standard 19" front panel which also contains terminals, meters and fuses. Voltage and current are metered separately and fuses are provided in the input mains lead and the positive H.T. output. Setting of H.T. to the desired value is achieved by a potentiometer situated on the front panel and the current may be monitored by operation of a push button.



## SPECIFICATION

### Positive H.T. Output

D.C. Voltage:  
Range (i) +200 to 250V } Stabilised  
Range (ii) +250 to 300V }  
D.C. Current: 0–250 mA.  
Effective Source Resistance:  
1 Ohm approx.  
Input Regulation: 0.1% for  $\pm 6\%$   
mains voltage variation.  
Ripple Voltage: 8 mV r.m.s.

### A.C. Output

4 or 6.3V at 3A } un stabilised.  
4 or 6.3V at 3A }  
6.3V at 2½A }

### Dimensions

PU.156C bare chassis = 17" long  $\times$  5" wide  $\times$  8"  
PA.47/1 ex cabinet = 19"  $\times$  12½"  $\times$  8¾"

### Negative H.T. Output

D.C. Voltage: —150V stabilised.  
D.C. Current: 0–15mA.  
Total Regulation: 3% total change in voltage  
for change of load from 0 to 15 mA and  
change of mains voltage within  $\pm 6\%$ .

Ripple Voltage: 100 mV r.m.s.

### Mains Input

200–250V in 10V steps.  
45/60 c/s.

Efforts are continually being made to effect improvement in performance, consequently the equipment supplied may differ in detail from the description contained herein.



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£ 178

7 days.  
Contact via  
posting and  
equipment will  
be sent



The Racal Digital Frequency Meter Type SA.20 has been designed to provide a portable reliable instrument capable of measuring accurately frequencies in the range of 10 c/s to 100,000 c/s. The equipment will also count pulses and may be made to measure and indicate time intervals in the range 10  $\mu$ secs to 1 second.

**FEATURES**

- ★ Operates as Frequency Meter—Counter—Timer
- ★ 4 Decade Illuminated Presentation
- ★ Accuracy  $\pm 1$  count  $\pm .005\%$
- ★ .001, .01, .1, and 1 second Gate Times
- ★ 5 seconds Display Time
- ★ Crystal Controlled Test Frequencies available
- ★ Small and portable—Easy to use
- ★ Plug-in Units ease servicing
- ★ Printed wiring increases reliability



# DIGITAL FREQUENCY METER TYPE SA.20

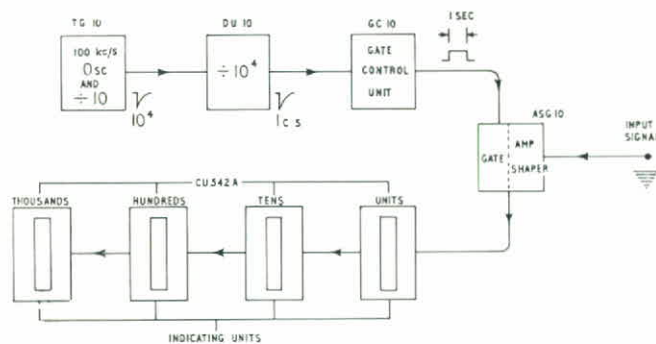
## PRINCIPLE OF OPERATION

To measure a frequency the circuit uses a 100 kc/s crystal frequency divided down to give a series of 1 second pulses to open an electronic gate through which the input waveforms, after being suitably amplified and shaped, are fed to four Digital Counting Units Type CU.542A.

The total count, which is displayed on the illuminated number scales of these indicating units, is held for 5 seconds before the unit automatically resets and continues to repeat the count. Alternative provision is made for manual resetting, and operation of a push button allows the count to be displayed for any required time. Similar alternative manual arrangements are provided for control of the gate.

For the measurement of period or time an inverted form of the above principle is used. Successive cycles of the input signal are used to open and close the gate respectively. During the period for which the gate is opened, a fixed frequency passes through the gate and registers on the counting units. Two crystal controlled frequencies either 100 kc/s or 10 kc/s are obtained internally for this facility.

A self-checking feature is incorporated whereby, with the Operate/Test switch set to Test and the reset switch set to Automatic, a 10,000 c/s signal is applied to the input terminals. Display of this count indicates that the instrument has been completely checked and is fully serviceable.



## DESCRIPTION OF THE INSTRUMENT

### Plug-in Unit Construction

The mechanical arrangement of the Frequency Meter has been rendered simple yet effective by the adoption of 'unit construction' methods. Apart from the power supplies and controls, all circuitry has been assembled together into 'plug-in units', thus making for extreme ease in servicing and replacement of parts.

### Controls

The following controls are situated on the lower escutcheon on the front panel:

Mains ON-OFF Switch	Mains ON Lamp
Test/Operate Switch	Manual/Auto Reset
Reset Push Button	Manual Gate Push Button
Input Terminals	Manual Gate Switch

## APPLICATIONS

### Frequency Measurement

The Frequency Meter is primarily intended for direct measurement of frequency and will measure and display frequencies in the range 10 c/s to 100,000 c/s with an accuracy of  $\pm 1$  count  $\pm .005\%$ .

### Period and Time Interval Measurement

The instrument is capable of measuring the period of regular and irregular wave forms. The time interval between two successive events whose input form may be either sinusoidal or pulse can also be determined accurately. The latter facility is available on single channel input only.



### Counting and Totalising

The Frequency Meter employs a signal gate which enables input signals to be measured over a precise time interval. The gate may be switched out of use and any number up to 9,999 events that can be fed to the unit as electrical impulses, will be counted or totalised and the total number displayed.

### Test Frequencies

Outputs at 100 kc/s, 10 kc/s, 1,000 c/s, 100 c/s, 10 c/s and 1 c/s are available on sockets on Units Type TG.10A and DU.10B, situated at the rear of the instrument.

Apart from the 100 kc/s output which is sine wave, the remainder are pulse outputs derived from the 100 kc/s crystal oscillator which is nominally accurate to .005% but can be made to operate to .001% accuracy.

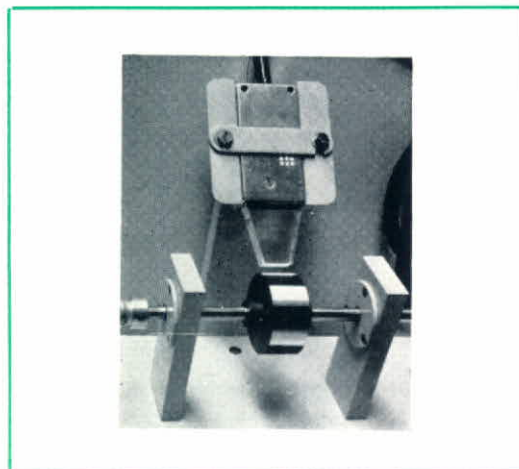
### Shaft Speed Measurement

Used with suitable RACAL transducers, described below, the SA.20 enables direct measurements to be made. Measurements of linear or other movements may also be taken by first transforming to rotary action. These facilities have many applications in flow and process control.

## AUXILIARY EQUIPMENT

### RACAL Tachometer Generator Type MA.38

This comprises a rotor with sixty teeth rotating in a magnetic field, and producing sixty pulses for every rotor revolution. If the rotor is driven by the shaft under consideration in a 1:1 ratio and a one second time-base is used, a direct reading in r.p.m. is obtained. The range of the MA.38 is 100 r.p.m. to 20,000 r.p.m.



### RACAL Photo-electric Probe Unit Type MA.51

This instrument is suitable for use in those cases where the torque available is insufficient to drive the MA.38. It consists of a germanium photo transistor and an associated light source, housed together in the form of a probe. The probe is fitted near to the shaft under test and any suitable mark on the shaft will vary the light reflected from the light source, and a pulse will result. A direct reading in r.p.m. may be obtained by affixing a disc with sixty marks on it to the shaft, and using the one second time base of the SA.20. The range of the MA.51 extends to 180,000 r.p.m. The probe can be supplied with a suitable Power Unit.

A comprehensive range of transducers is available, details of which will gladly be supplied on request.



# DIGITAL FREQUENCY METER TYPE SA.20

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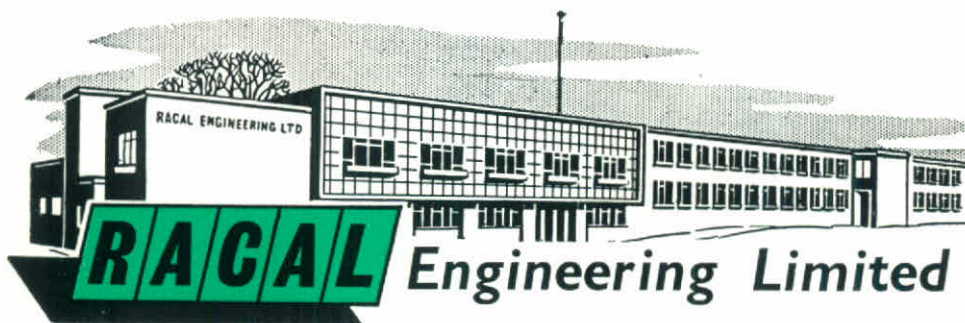
## TECHNICAL SPECIFICATION

<b>Frequency Range:</b>	10 c/s to 100 kc/s, sine wave No lower limit for pulse input. As detailed below
<b>Total Count:</b>	9,999
<b>Display Time:</b>	5 secs. or manual
<b>Accuracy:</b>	$\pm 1$ count $\pm 0.005\%$
<b>Resolution:</b>	5 $\mu$ secs, between paired pulses
<b>Input required:</b>	
Frequency Measurements	Amplitude sine wave: 0.5 to 50 V.R.M.S. Pulse: 0.7 volt minimum Rise Time: 1 to 2 $\mu$ secs. Duration: 2 to 10 $\mu$ secs
Period and Time Interval Measurements:	Sine Wave: 20 V.R.M.S. minimum Pulse: 40 V positive going Minimum Duration: 2 $\mu$ secs. Nominal Rise Time: 1 $\mu$ sec
<b>Input Impedance:</b>	470 k.ohms and 25 pF
<b>Power Supplies:</b>	200/250 v. 45/65 c/s, consumption—120 watts
<b>Dimensions:</b>	12 $\frac{1}{2}$ in. (31.7 cms) high 16 $\frac{3}{8}$ in. (41.5 cms) deep 8 $\frac{1}{2}$ in. (21.6 cms) wide
<b>Weight:</b>	32 lbs. (14.5 kgs)

## VALVES

12 AU7	24 off
6F33	2 off
6AS6	5 off
EA76	5 off
5V4G	1 off

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#### FEATURES

- ★ Operates as Frequency Meter/Chronometer.
- ★ Accuracy of  $\pm 1$  count  $\pm 1$  part in 10%.
- ★ Uses Plug-in Units with Printed Wiring.
- ★ Digital Time Base.
- ★ .1, 1 and 10 secs. Gate Time.
- ★ Operates with Remote Readout or Printer.

The RACAL Digital Frequency Meter Type SA.21B is capable of measuring accurately and displaying in digital form, frequencies in the range 10 c/s to 1 Mc/s. Time intervals in the range 3  $\mu$ Secs. to 1000 Secs. can also be determined from pulse outputs on single line input. Access is also available to the time base enabling frequency ratios and periods to be measured. Provision is made for connection of Translator Unit Type SA.65 so that in addition to local indication of the count, a digital In-line Readout Type SA.67A can be remotely situated. Alternatively, a printed record can be obtained with the Digital Printing Equipment Type SA.71.

The SA.21B consists of two separate units housed in a strong steel cabinet finished in silver-grey. The upper unit contains two standard stabilised power units type PU.156C whilst the circuitry is housed in standard RACAL plug-in units which are assembled on the lower unit. To extend its maximum frequency range to 30 Mc/s, the SA.21B can be supplied together with a Frequency Converter Unit Type SA.33 in a three-tier bench mounting cabinet and then comprises the Digital Frequency Meter Type SA.28B.

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# DIGITAL FREQUENCY METER TYPE SA.2IB

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## OPERATION

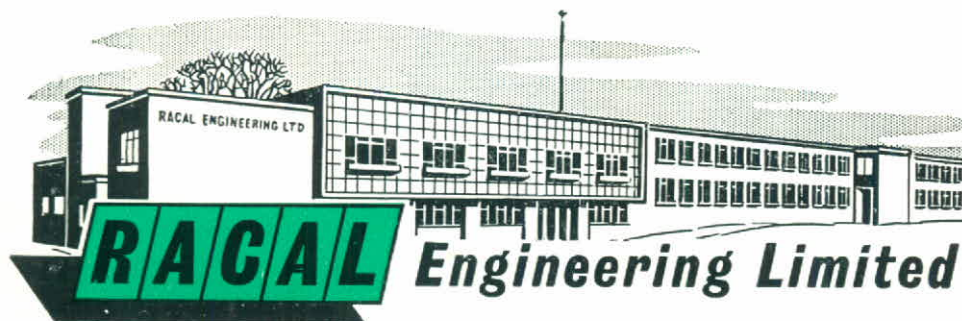
When used as a frequency meter a temperature controlled 1 Mc/s crystal is divided down to obtain a range of time intervals which controls an electronic gate. The unknown frequency after amplification and shaping is passed through the gate and finally registers on 6 Digital Counting Units. The count is displayed for a selected time before the equipment automatically resets and repeats the count.

For Time Interval measurement, successive input pulses of the required shape and amplitude open and close the gate respectively. During the period for which the gate is open, pre-selected pulses from the time base occurring every 1  $\mu$ Sec, 10  $\mu$ Secs, 100  $\mu$ Secs or 1,000  $\mu$ Secs are counted on the decades in the counting chain. Provision is also made for clock pulses other than those internally derived, to be applied to the counting chain.

## TECHNICAL SPECIFICATION

	Frequency Meter	Time Intervals
Frequency Range	10 c/s to 1 Mc/s	
Time Interval Range	3 $\mu$ Secs. to 1,000 Secs.	
Accuracy	$\pm 1$ count	$\pm 1$ $\mu$ Sec.
Stability	$\pm 1$ part in $10^6$ short term	
Indication	6 digits with 1 neon	
Signal Input Level required	0.1 Volt RMS min.	15v. positive pulse
Input Impedance	470 k $\Omega$ 20 pF	
External Standard Frequency	1 Mc/s and 100 kc/s	
External Standard Frequency Level required	1 Volt RMS	
Display Time	0.1 to 5 Secs and infinite	
Reset	auto or manual	
Time Base	0.01, 0.1, 1 and 10 secs	
Clock Pulses	1, 10, 100 and 1,000 $\mu$ Secs.	
Output Frequency	1 Mc/s at 1 Volt RMS	
Auxiliary Outputs	Binary coded decimal voltage for operation into Printer or Readout (Translator Unit Type SA.65)	
Power Supplies	200/250v AC 45/65 c/s Consumption approx. 390 watts	
Dimensions ex cabinet	19" $\times$ 17 $\frac{1}{2}$ " $\times$ 18" 48 $\times$ 44 $\times$ 46 cms	
Dimensions in cabinet	20 $\frac{1}{2}$ " $\times$ 21" $\times$ 20 $\frac{1}{2}$ " 52 $\times$ 53 $\times$ 52 cms	
Weight in cabinet	164 lbs. 74.5 kgs.	

Efforts are continually being made to effect improvement in performance, consequently the equipment supplied may vary in detail from the description contained herein.



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The RACAL Frequency Converter Unit Type SA.33 has been designed to operate in conjunction with the Digital Frequency Meter Type SA.21B (range 10 c/s to 1 Mc/s) to extend its maximum range of operation from 1 Mc/s to 30 Mc/s. This is achieved by an ingenious patented circuit that enables the entire range to be covered without bandswitching.

In operation, the SA.33 requires an external signal of 1 Mc/s which is obtained from a temperature-controlled crystal oscillator in the SA.21B. The stability is  $\pm 1$  part in  $10^6$  and this is maintained throughout the range of the SA.33. The equipment can also be used with other counters having a maximum range of 1 Mc/s and an output at a frequency of 1 Mc/s available for control of the converter.

The SA.33 contains its own power supply and may be supplied suitable for 19" rack mounting or in an attractive bench mounting cabinet. Alternatively, the SA.33 and an SA.21B can be fitted together in a three tier cabinet and then comprise the Digital Frequency Meter Type SA.28B.



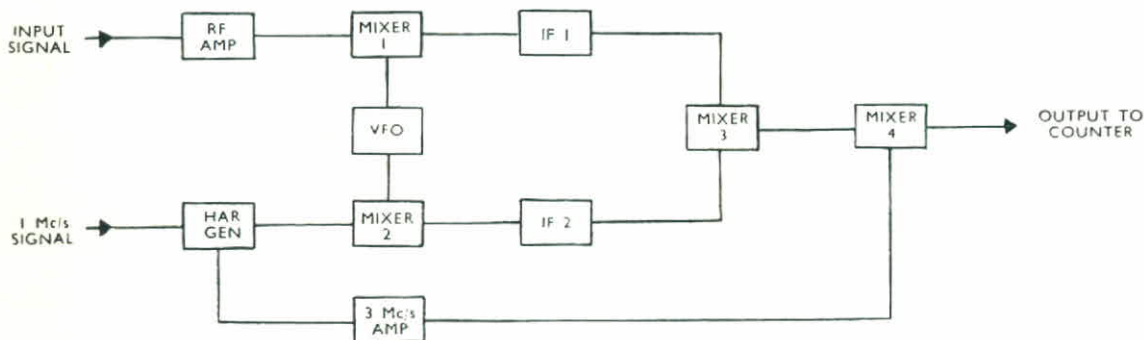
# FREQUENCY CONVERTER UNIT TYPE SA.33

## OPERATION

Reference to the schematic diagram below shows that the input signal is mixed with the output of the VFO. (range 41.5 Mc/s to 69.5 Mc/s.) to produce the first IF of 40 Mc/s  $\pm$  .65 Mc/s. The VFO output is simultaneously mixed with harmonics derived from the 1 Mc/s external signal producing a second IF of 37.5 Mc/s  $\pm$  .15 Mc/s. The outputs from IF 1 and IF 2 are then fed to Mixer 3 giving an output of between 2 Mc/s and 3 Mc/s. This is mixed in Mixer 4 with a signal at 3 Mc/s to give a final output frequency in the range 10 c/s to 1.05 Mc/s. This is available on a socket for connection to the counter.

The dial of the VFO operating from 41.5 Mc/s to 69.5 Mc/s is calibrated from 1—29 in 1 Mc/s steps.

## SCHEMATIC DIAGRAM



Techniques in the Converter are covered by British Patent No. 714684.

## TECHNICAL SPECIFICATION

### Frequency Range:

1 Mc/s to 30 Mc/s.

### Stability:

That of external frequency of 1 Mc/s. (in SA.21B  $\pm$  1 part in 10<sup>6</sup>).

### External Frequency Level required:

1 Mc/s—1 volt RMS.

### Input Signal Level:

0.1 volt RMS—2 volts RMS.

### Input Impedance:

100k.ohms—30 pF.

### Output Frequency:

10 c/s to 1.05 Mc/s at 0.15 volt RMS.

### Indication:

Dial calibrated in 1 Mc/s steps from 1—29 Mc/s.

### Power Supply:

200/250v AC, 45/65 c/s. Consumption 36 watts approx.

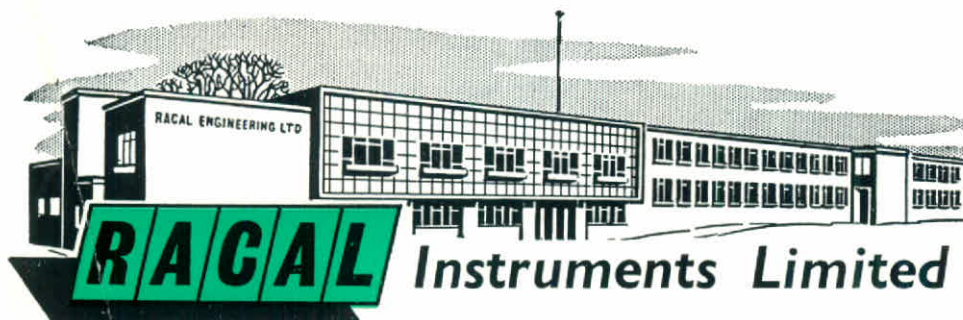
### Dimensions:

ex cabinet: 19"  $\times$  8 $\frac{3}{4}$ "  $\times$  18".  
48 cms.  $\times$  22 cms.  $\times$  46 cms.  
in cabinet: 20 $\frac{1}{2}$ "  $\times$  11"  $\times$  20 $\frac{1}{2}$ ".  
52 cms.  $\times$  28 cms.  $\times$  52 cms.

### Weight:

94 lbs. in cabinet.  
42.7 kgs.

Efforts are continually being made to effect improvement in performance, consequently the equipment supplied may vary in detail from the description contained herein.



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# DIGITAL FREQUENCY METERS

SA.43B/10  
SA.44B/10

£ 270 + 1  
100 + 40  
100 + 40  
100 + 40



The RACAL Digital Frequency Meters Types SA.43B/10 and SA.44B/10 are presented as multi-purpose low cost instruments designed to measure frequencies in the range 10 c/s to 100 kc/s with an accuracy of  $\pm 1$  count  $\pm 0.005\%$ , and time intervals in the range 10  $\mu$ secs to 1 second with an accuracy of  $\pm 10$   $\mu$ secs. Variable clock pulses are provided (10  $\mu$ secs., 100  $\mu$ secs., 1,000  $\mu$ secs and 10,000  $\mu$ secs.) enabling time intervals up to 1,000 secs to be measured.

Both instruments are supplied with variable counting periods (0.01, 0.1, 1 and 10 seconds) and with clear five digit display.

Each unit is constructed from standard RACAL plug-in units incorporating printed wiring, contributing to ease of service and the utmost in reliability. The SA.44B/10 using a digital time base giving a high order of accuracy is contained in a two tier bench mounting cabinet. The SA.43B/10, shown above, employs an analogue time base involving fewer plug-in units and is contained in a single tier bench mounting cabinet.

Both cabinets are finished in a durable hammer grey with matt black front panels.

**APPLICATIONS** include:

- ★ Frequency Measurement
- ★ Time Interval Checking
- ★ Relay Speed Timing
- ★ Pulse Counting
- ★ Velocity Measurement
- ★ Tachometry
- ★ Events Counting



TECHNICAL PUBLICATION NO. **139D1**



**OPERATION**

To measure a frequency the input signal is fed firstly to a plug-in unit type ASG.10 comprising an amplifier, shaping circuits and an electronic gate. When the gate is opened, pulses are allowed to pass for a predetermined time and are counted by five Digital Counting Units type CU.542 connected in cascade. The resultant count is displayed in digital form on the front panel escutcheon.

The opening and closing of the electronic gate for an accurately controlled time is determined by the Time Base, which may be one of two alternative types:—

**(1) Analogue Time Base**

In the SA.43B/10 the 100 kc/s output from a crystal oscillator is divided down successively by factors of 10 to give a 10 second timing interval.

This is accomplished in the following way: A TG.10A Plug-in unit comprising a 100 kc/s crystal oscillator, together with a phantastron divider, provides an output at 10 kc/s. This is used to drive a further plug-in unit type DU.10B which consists of four phantastron divider stages, each of which divides by 10 giving a final output of 1 c/s. A further division to give a timing interval of 10 seconds is accomplished by the addition of a plug-in unit type CU.542E.

**(2) Digital Time Base**

The SA.44B/10 employs a fully digital time base. A plug-in unit type TGS.10A comprising a 100 kc/s crystal oscillator and shaper stage provides a 100 kc/s output suitable for driving five scale-of-ten counting units type CU.542A connected in cascade to give an output of 1 c/s. This is further divided to give a time interval of 10 seconds by the addition of counting unit type CU.542E.

The output pulses from either type of time base are passed to a gate control unit type GC.10, which opens and closes the electronic gate in the ASG.10 unit at the input to the counting and indicating chain.

An automatic reset unit type AR.10 enables the display time of the indicated count to be adjusted from 0.1 to 5 seconds, after which the counting units in both the indicating and time base chains are reset for the succeeding counting period. Alternatively, the indicated count can be displayed continuously until the manual reset button is depressed. A time interval measurement facility is available, by which means the time interval between two successive events in pulse form can be determined accurately.

Provision is made on both instruments whereby information from the indicating decades is brought to connectors situated at the rear of the instrument for the operation of suitable translators for driving remote read-out or print-out equipment. RACAL can supply both the translator (type SA.65) and the suitable control panel (type SA.69) for operation of print-out equipment. The remote in-line read-out panel (type SA.67) is also available. Literature on these items will gladly be supplied on request.

Both the SA.43B/10 and SA.44B/10 are powered by RACAL standard Power Supply Unit Type PU.156C, which provides the LT and stabilised HT supplies.

**DESCRIPTION**

The following controls are situated on the front panel:

Gate Period Selector with following positions:

- Periods 0.01 sec., 0.1 sec., 1 sec. and 10 secs.
- External Gate Control
- Manual Gate Control

Manual Gate Push Button

Display Time Control—0.1 sec to 5 secs approx., and switch to infinity.

Manual Reset Button

Count Selector—External

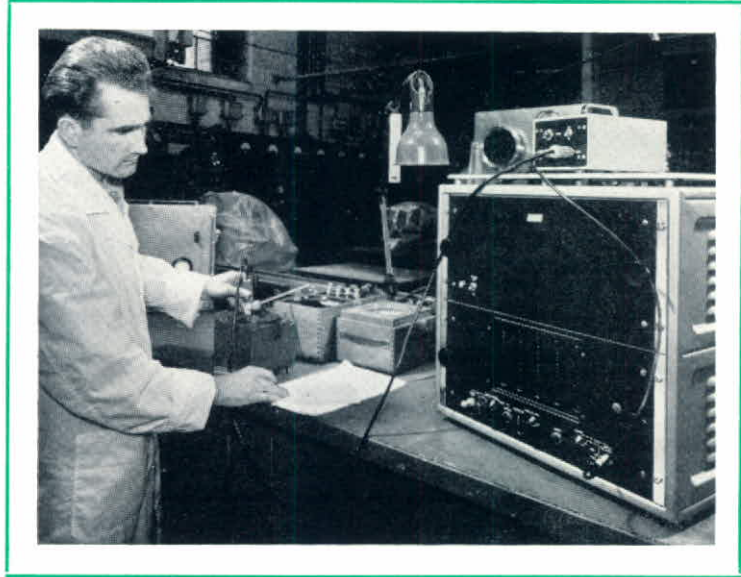
- 10  $\mu$ sec chronometer units
- 100  $\mu$ sec chronometer units
- 1,000  $\mu$ sec chronometer units
- 10,000  $\mu$ sec chronometer units

SA.43B/10 only, behind sub-panel

- Time Base Potentiometers (pre-set)
- Timing Generator adjustment (pre-set)

An SA.44B/10 is shown here operating with a RACAL MA.51 photo electric probe described below, and is checking speeds of gyroscopes used in air and marine applications.

*(photograph by kind permission of S. G. Brown Ltd. of Watford.)*



#### SHAFT SPEED MEASUREMENT

Used with suitable RACAL transducers, the SA.43B/10 or SA.44B/10 enable direct shaft speed measurements to be made. Measurements of linear or other movements may also be taken by first transforming to rotary action. These facilities have many applications in flow and process control.

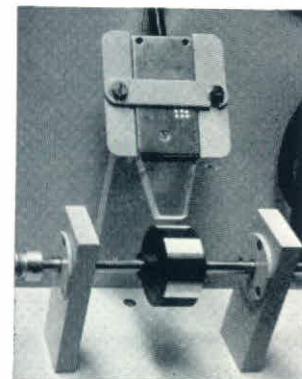


#### RACAL Tachometer Generator Type MA.38.

This comprises a rotor with sixty teeth rotating in a magnetic field, and producing sixty pulses for every rotor revolution. If the rotor is driven by the shaft under consideration in a 1:1 ratio and a one second time-base is used, a direct reading in r.p.m. is obtained. The range of the MA.38 is 100 r.p.m. to 20,000 r.p.m.

#### RACAL Photo-electric Probe Unit Type MA.51.

This instrument is suitable for use in those cases where the torque available is insufficient to drive the MA.38. It consists of a germanium photo transistor and an associated light source, housed together in the form of a probe. The probe is fitted near to the shaft under test and any suitable mark on the shaft will vary the light reflected from the light source, and a pulse will result. A direct reading in r.p.m. may be obtained by affixing a disc with sixty marks on it to the shaft, and using the one second time base of the Frequency Meter. The range of the MA.51 extends to 180,000 r.p.m. The probe can be supplied with a suitable Power Unit.



Further details of the above transducers may be obtained from Technical Publication No. 124D1 which will be supplied gladly on request.



**TECHNICAL SPECIFICATION**

SA.43B/10 and SA.44B/10

**FREQUENCY MEASUREMENT**

Frequency range	10 c/s—100 kc/s
Pulse counting rate	0—100,000 pulses per sec
Counting periods	0.01, 0.1, 1 and 10 secs.
Input voltage range	0.5 v. r.m.s.—50 v. r.m.s.
Accuracy	$\pm 0.005\% \pm 1$ count
Input impedance	470 k ohms 25 pF

**TIME MEASUREMENT**

Range of measurement	10 $\mu$ sec.—1000 sec. (according to clock pulse periods)
Clock Pulse Periods	10, 100, 1000, and 10,000 $\mu$ sec
Timing Input Voltage	15 v. positive pulse, rise time 0.5 $\mu$ sec
Accuracy	$\pm 0.005\% \pm 1$ clock pulse period
Input impedance	50 k ohms 25 pF

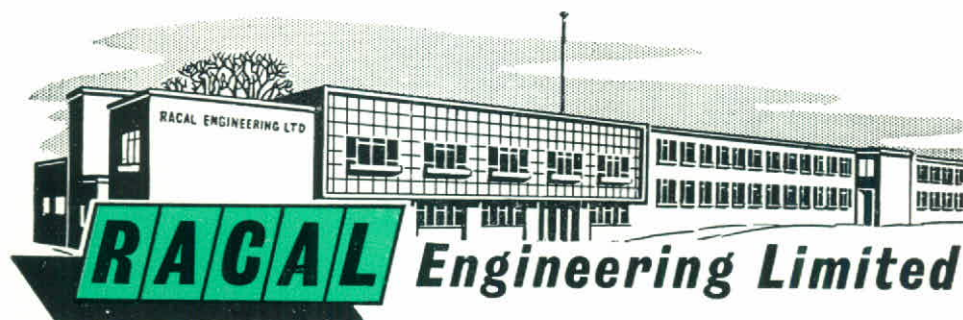
**GENERAL**

Stability	1 part in $10^5$
Max. indicated count	99999
Display time	Variable 0.1 to 5 sec. and infinity
Power requirements	200-250 v., 45-65 c/s,
Consumption	SA.43B/10 200 watts approx. SA.44B/10 250 watts approx.

**Dimensions:**

SA.43B/10	20 $\frac{1}{2}$ " wide, 21 $\frac{1}{2}$ " deep, 11 $\frac{3}{4}$ " high (52.1 cms. $\times$ 54.6 cms. $\times$ 29.8 cms.)
SA.44B/10	20 $\frac{1}{2}$ " wide, 21 $\frac{1}{2}$ " deep, 20 $\frac{1}{2}$ " high (52.1 cms. $\times$ 54.6 cms. $\times$ 52.1 cms.)

Efforts are continually being made to effect improvement in performance, consequently the equipment supplied may vary in detail from the description contained herein.

**BRACKNELL . BERKSHIRE . ENGLAND**

Telephone: Bracknell 941.

Cables/Grams: Racal, Bracknell, Berks.

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**RACAL**

**UNIVERSAL  
COUNTER/TIMER  
TYPE SA.52**



- ★ **Measures frequencies from 10 c/s to 1 Mc/s.**
- ★ **Measures Time Intervals from 3 usecs. to 27.8 hrs.**

*Features*

- Accuracy of  $\pm 1$  count.
- Stability  $\pm 1$  part in  $10^6$
- 0.01, 0.1, 1 and 10 Secs. Sampling Time.
- Completely Digital Time Base.
- Provision for external standard frequencies
- Variable Display Time.
- Self Checking.
- Uses Plug-In Unit construction.

## OPERATION

A temperature controlled 1 Mc/s crystal is used to derive a range of time intervals which control an electronic gate. The unknown frequency after being amplified and shaped is passed through the gate and finally registers on 6 Digital Counting and Indicating Units, the count being held for a selected time before the equipment automatically resets and repeats the count.

For Time Interval or period measurements, successive cycles or pulses of the input signal open and close the gate respectively. In the period for which the gate is open, 1  $\mu$ Sec pulses from the crystal are counted, indicating the elapsed time interval. An amplitude discriminator is also incorporated so that only signals of a predetermined level will operate the gate.

The Universal Counter/Timer like the Digital Frequency Meter Type SA.20 (range 100 kc/s) and SA.21 (range 1 Mc/s) is assembled from Racal standard plug-in units with printed wiring, thus providing easy and quick servicing.

The Frequency Converter Unit Type SA.33 may be used with the SA.52 to extend the frequency range to 30 Mc/s. For the measurement of shaft speed, Racal Optical and Magnetic Transducers are also available.

## TECHNICAL SPECIFICATION

	Frequency Measurement.	Time Interval Measurement
Range	10 c/s to 1 Mc/s	3 $\mu$ secs. to 27.8 hrs.
Accuracy	$\pm 1$ count $\pm 1$ part in $10^6$	
Input Required	0.1 volt R.M.S. Minimum	
Input Impedance	Approx. 0.5 ohms & 30 pF	
Amplitude Discriminator	0 to $\pm 100$ volts $\pm 10\%$	
Display Time :	0.1 to 5 secs and infinity	
Ext. Frequency Standard.	1 Mc/s or 100 kc/s --- 1 volt R.M.S. required	
Power Supply	200/250 volts 45/65 c/s. Consumption 260 Watts.	
Dimensions	In cabinet 20 $\frac{1}{2}$ " wide 21" high 20 $\frac{1}{2}$ " deep	

Efforts are continually being made to effect improvements in performance ; consequently equipment supplied may differ in detail from that described in this leaflet.

## **RACAL ENGINEERING LIMITED**

**BRACKNELL - BERKSHIRE**

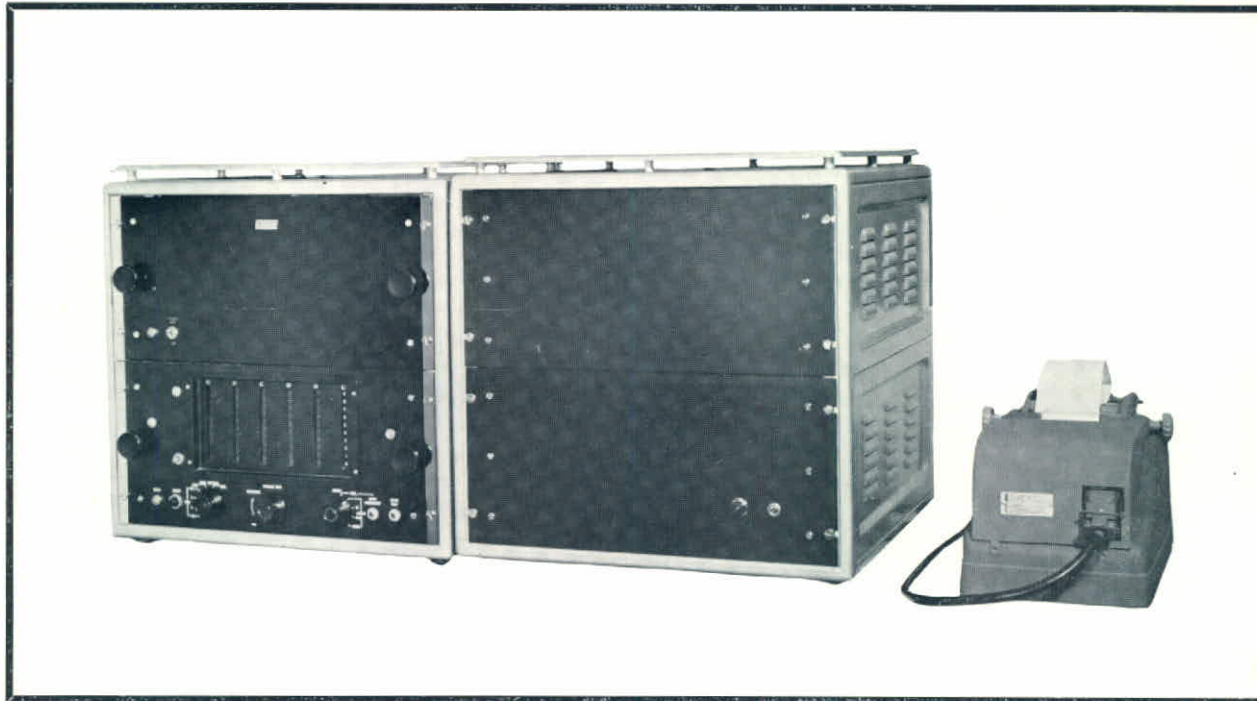
Telephone : BRACKNELL 941

Cables/Grams: RACAL, BRACKNELL, BERKS

ATS.

## DIGITAL PRINTING EQUIPMENT IN-LINE READ-OUT

# SA.71 SA.67



The Racal SA.71 Digital Printing Equipment provides a rapid and reliable means of permanently recording measurements indicated by Racal Counters Types SA.21B and SA.43 and suitable counters of other manufacture.

Entirely automatic in operation, it is invaluable for such applications as the measurement of oscillator drift, shaft speed variation, process control and other applications where it is required to make measurements over short and long periods without attendance.

The Racal In-line Read-out Unit Type SA.67, repeats measurements indicated by Racal Digital Counters and other compatible instruments in a form easily read at considerable distances. This accessory also has many useful applications in production testing and industrial control. These systems embody several unique and outstanding features.

- Printer speed controls counter recycle rate.
- High printing speed : approx. 60 measurements/prints per minute.
- Printer can operate while a further count is being made.
- Large and clear decimal In-line Read-out.
- In-line Read-out displays during further count, thus giving longer display time.
- Successive counts differing by only one digit, show change of that digit only on In-line Read-out.

# **RACAL**

TECHNICAL PUBLICATION NO. **132D1**



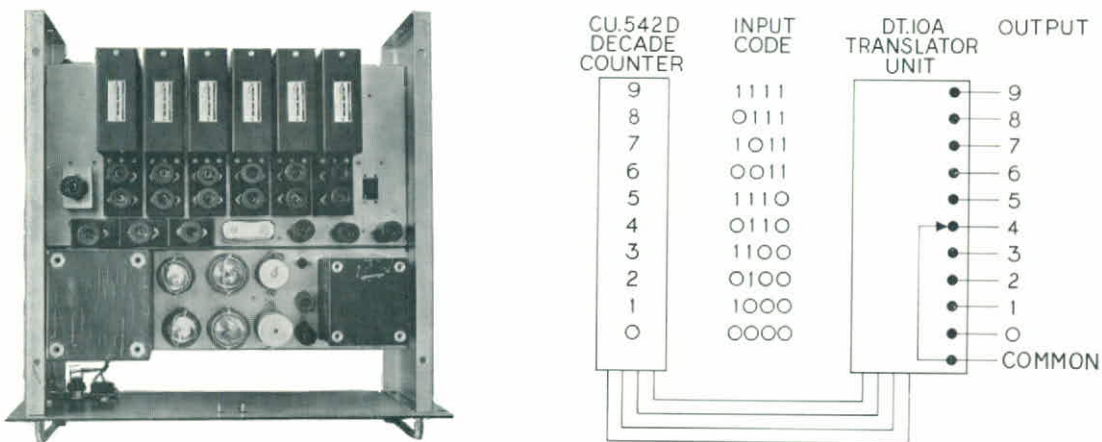
The SA.71 Digital Printing System comprises three units :

- Translator Panel Type SA.65.
- Print Control Unit Type SA.69.
- “Addo” Printing Machine.

All three units are required for printing applications, but to drive the In-line Read-out Panel, only the Translator Panel is necessary.

### TRANSLATOR PANEL TYPE SA.65.

The Translator Panel converts binary coded data to decimal form by means of valve controlled relays. Four relays with two double triode control valves are assembled as a Racal Plug-in Unit Type DT.10A. One such unit is used for each decade to be translated. When used with the Racal SA.21B Counter/Timer, six DT.10A units are employed, but provision is made for the accommodation of up to eight units in the Translator Panel. The outputs from the binary stages in Racal Digital Counters or other compatible instruments are applied to the relay control valves resulting in relay closures according to the binary states. The relay contacts are arranged in a matrix to provide a ten line output for each decade translated and these outputs are connected either to the Print Control Unit or direct to the In-line Read-out Unit. The Translator Panel contains its own stabilised power supply and can be supplied as a self-contained bench mounting unit for numerous other applications such as the operation of card or tape punches, typewriters and similar equipment.



### PRINT CONTROL PANEL TYPE SA.69.

The ten line outputs from the Translator Panel are brought into this unit and scanned by a Uniselect System, which energises the printer solenoids in serial manner. Control circuits operating in conjunction with those in the Translator Panel ensure a correctly timed sequence of operation and control the overall measurement/print cycle. This facility enables the printer to operate while the counter is making a further count so that the printer can operate continuously at maximum speed when required.

Power supplies for the control circuits, are drawn from the Translator Panel, the power supply for the printer solenoid being incorporated in the Print Control Unit.

Normally up to 6 digits are printed giving a maximum of 999,999 but an additional facility provides for the “Spill Over” +1 from Racal Digital Counters Type SA.21B, to be printed, thereby giving a recording of 1,000,000.

## Printer

The Translation and Print Control Equipment is designed to operate a printer such as the "Addo" calculating machine. This machine is of the serial type—that is, it is operated by solenoids which require to be energised sequentially, and the mechanical arrangement is such that any number of up to ten digits is selected by ten solenoids. Any similar solenoid operated machine can also be used.

## Construction

The Translator Panel and Print Control Unit are of standard 19 inch rack mounting construction and are housed in a robust steel cabinet attractively finished in silver grey. There are no controls to operate apart from the mains ON/OFF switches which are mounted on the front panels with their associated indicating lamps.

## In-Line Read-Out Type SA.67

The In-line Read-out Type SA.67 consists of six nodistron indicating tubes arranged in a panel suitable for either remote mounting or incorporation in rack equipment. The illuminated numerals are approximately  $\frac{3}{4}$ " high and clearly visible from considerable distances.

It can also be supplied complete with a Translator Panel in a single tier cabinet, when it draws its power requirements from the power unit in the panel.

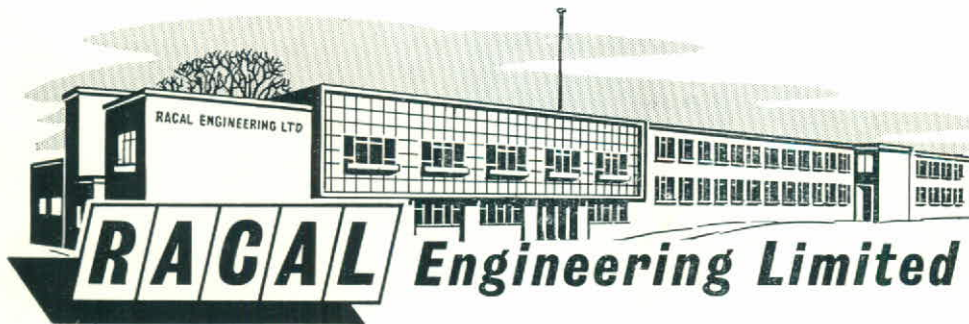
When supplied without the Translator Panel, it requires a supply of 300 Volts at 25mA.



**SPECIFICATION**

Decimal Digits printed per line .. ..	Seven.
Printing Rate .. .. .	Approx. 60 prints per minute maximum.
Input requirements .. .. .	Code per Decade : Binary 1 - 2 - 2 - 4 (5 decades). Binary 1 - 2 - 4 - 2 (1 decade).
Levels : Binary 0 : Zero	} In series with 1M.ohm to —ve. 150 volts for 1 - 2 - 2 - 4 coded translator units and 820kOhm for 1 - 2 - 4 - 2 coded translator units.
Binary 1 : —20V	
Reset Control : +160 volts while count is in progress. +60 volts at end of count.	
Reset Pulse : 30 volts positive.	
Outputs from Translator Panel .. ..	6 decades of relay closures connecting a common line to any one of ten.
Contact Rating .. .. .	1 Amp.
Pull in and Drop out Time .. .. .	each 5 milliseconds.
Power Requirements .. .. .	200/250 volts. 45/65 c/s.
Dimensions .. .. .	Translator and Print Control Unit : in cabinet : 20½" wide. 21" high. 20½" deep.

*The information contained herein is provisional and subject to alteration without notice.*



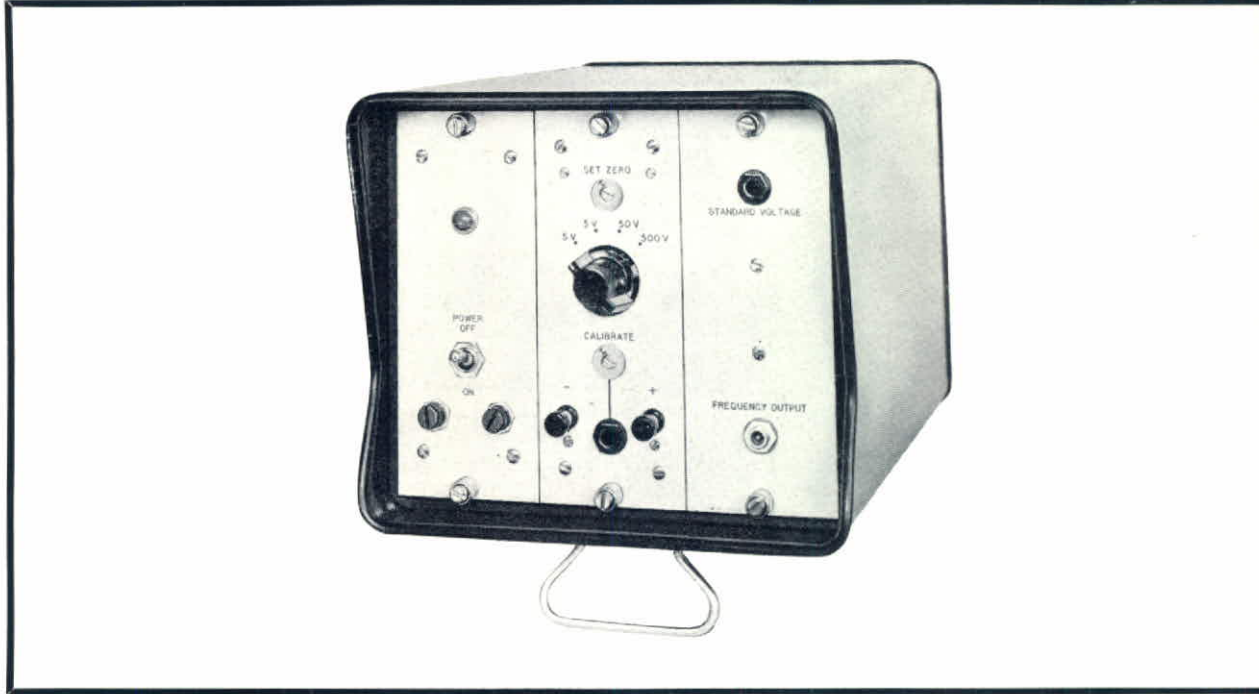
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Telephone : Bracknell 941 158 (Sales)  
Cables/Grams: Racal, Bracknell, Berks



# VOLTAGE-TO-FREQUENCY CONVERTER

# SA.503



The SA.503 is a fully transistorised instrument which when operated with a digital counter provides an accurate and convenient method of measuring and displaying d.c. voltages. An analogue-to-digital converter is also readily available since RACAL counters provide binary coded decimal or digital outputs. The SA.503 may also be employed as a digital integrator, providing an output in volt-seconds of various analogue input signals representing parameters such as flow, temperature, pressure etc.

## FEATURES

Used with a RACAL counter the SA.503 provides:—

- ★ A Digital Voltmeter
- ★ A Digital Integrator for analogue input signals
- ★ An Analogue-to-digital converter.

## DESCRIPTION

The Voltage-to-Frequency Converter provides a pulse output whose rate is proportional to the voltage applied at the input terminals. The conversion is achieved by utilizing the characteristics of semi-conductor diodes which act as variable capacitors when a varying d.c. voltage is applied. Two oscillators, incorporating these diodes, are employed in a beat frequency system together with a mixer stage to provide an output of zero cycles with zero d.c. input and 10 kc/sec with an input of 1V.

Range switching provides for d.c. voltage ranges of 0.5, 5, 50 and 500 V f.s.d. and means is provided whereby the converter may be calibrated using DORAN miniature standard cells.

The SA.503 comprises the converter sub-assembly type SA.504, a Power Unit type PU.506 and a calibration reference unit type SA.509, housed together in a portable bench mounting cabinet.

Each sub-unit is available as a separate item for inclusion in data-handling and recording systems, 6 such units being accommodated side-by-side in a standard 19-in. rack mounting panel.

# RACAL

TECHNICAL PUBLICATION No.  
(Preliminary Information)

# 179D1

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**VOLTAGE-TO-FREQUENCY CONVERTER TYPE SA.503****TECHNICAL SPECIFICATION****Input**

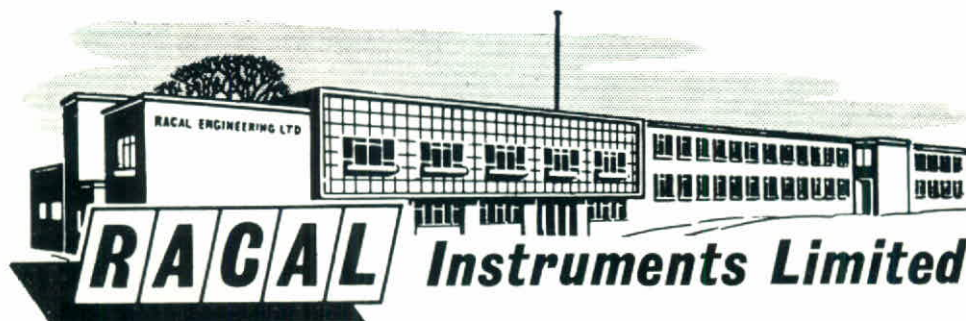
<i>Voltage Ranges</i>	0.5v d.c. 5.0V d.c. 50.0v d.c. 500.0v d.c.
<i>Input impedance</i>	A special procedure enables a very high input impedance to be achieved on the 0.5v range. Nominally greater than $5M\Omega$
<i>Input attenuator</i>	On the 5v, 50v and 500v ranges input impedances $20,000$ ohms per volt
<i>Attenuator accuracy</i>	$\pm 1\%$

Note: Higher input impedances on 5v, 50v and 500v ranges may be obtained with the use of an external attenuator.

**Output**

<i>Frequency</i>	0-5 kc/sec (full-scale)
<i>Amplitude</i>	Continuously adjustable 0-8v peak-to-peak square wave
<i>Impedance</i>	$2\text{ k}\Omega$ (maximum)
<i>Linearity</i>	$\pm 0.1\%$ of f.s.d.
<i>Stability</i>	0.05% f.s.d. per $^{\circ}\text{C}$ .
<i>Self Check</i>	external standard cell
<i>Power Requirement</i>	110/220v 40/60 c/s
<i>Consumption</i>	16 watts
<i>Dimensions in cabinet</i>	9" wide x $8\frac{1}{2}$ " high x 14" deep
<i>Dimensions of sub-assembly</i>	each $2\frac{3}{4}$ " wide x 7" high x $10\frac{1}{2}$ " deep

Efforts are continually being made to effect improvement in performance consequently the equipment supplied may vary in detail from the description contained herein.



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# 10 Mc/s TRANSISTORISED DIGITAL FREQUENCY METER

# SA.505



**Racal announce an entirely new  
FULLY TRANSISTORISED 10 Mc/s DIRECT READING  
DIGITAL FREQUENCY METER incorporating in-line  
projection display**

Designed to meet the needs of all laboratory applications in the field of frequency and time interval measurement the SA.505 combines the latest transistor techniques in a compact self-contained instrument. All circuitry is mounted on plug-in printed boards and the front panel controls have been minimised for simplicity of operation.

#### THE OUTSTANDING FEATURES INCLUDE

- ★ Direct Frequency Measurement 0—10 Mc/s
- ★ Accurate Period Measurement
- ★ In-Line Projection Display
- ★ Self-Contained Frequency Standard 1 part in  $10^7$
- ★ Time Interval Measurement 0.1  $\mu$ S to  $10^4$  Secs.
- ★ Operates remote read-out or digital printer
- ★ Fully Transistorised with printed wiring
- ★ Clock pulse source

#### DESCRIPTION

The SA.505 utilizes transistors in reliable decade counting circuits in both the counting and time-base chains. A high stability crystal controlled oscillator is employed to control the gating periods and to provide a range of accurately timed clock-pulse periods.

A seven digit IN-LINE PROJECTION display is incorporated which is arranged to display continuously, any change in the measurement is indicated by a change in the appropriate digits only. Facilities are incorporated whereby time intervals between two pulses, positive or negative going applied on a single line, can be measured with an accuracy of 0.1  $\mu$ S.

Digital outputs are available from the indicator in the form of relay contact closures, enabling a remote readout to be operated directly. Alternatively, using the 10-Way Serialiser type SA.138 and an Addo-X printing machine a permanent printed digital record may be obtained.

# RACAL

TECHNICAL PUBLICATION NO.  
(Preliminary Information)

# 181D1



# 10 Mc/s TRANSISTORISED DIGITAL FREQUENCY METER TYPE SA.505

## TECHNICAL SPECIFICATION

### Frequency Measurement

Range	0 — 10 Mc/s
Accuracy	± 1 count ± crystal stability
Counting Periods	1 mS, 10 mS, 100 mS, 1 sec. & 10 secs.
Input Signal	0.1v r.m.s. sinewave 0.5v peak amplitude pulse
Input Impedance	5 kΩ in parallel with 30μF.

### Period Measurement

Range	0 — 100 kc/s
Accuracy	Up to 1 part in 10 <sup>6</sup>
Measurement Period	1, 10 and 100 cycles of unknown
Clock Frequencies	1 kc/s, 10 kc/s, 100 kc/s, 1 Mc/s and 10 Mc/s

### Time Interval Measurement

Range	0.1μS to 10 <sup>4</sup> secs.
Accuracy	± 1 count ± crystal stability
Start and Stop	Single line, positive or negative pulse
Level	0.5v peak amplitude pulse
Input Impedance	5 kΩ in parallel with 30μF.

### Other Facilities

Display	7 digit in-line projection readout
Crystal Stability	1 part in 10 <sup>7</sup> with internal crystal
External Standard	Provision for operating from 1 Mc/s and 100 kc/s standard
Level required	50mv into 1 kΩ
Display Time	0.1 to 5 secs. or infinite
Reset	Automatic, manual or by external signal
Additional outputs	(1) One out of ten contact closures per decade for operation of external readout or digital printer (2) Clock pulses available on sockets or front panel — 0.1μS, 1μS, 10μS, 100μS, 1mS, 10mS, 100mS, 1 sec. & 10 secs.
Power Requirements	110/220v 45/60 c/s
Consumption	120 watts
Dimensions	9¾" high x 13¼" wide x 23" deep 25 cms. x 35 cms. x 59 cms.

Efforts are continually being made to effect improvement in performance consequently the equipment supplied may vary in detail from the description contained herein.

