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DISA

TYPE 55M10

INSTRUCTION MANUAL

DISA 55M SYSTEM WITH 55M10 CTA STANDARD BRIDGE

M10

Published by DISA Information Department

55M SYSTEM WITH 55M10 CTA STANDARD BRIDGE

Contents:

Controls and Their Functions

55M05 POWER PACK

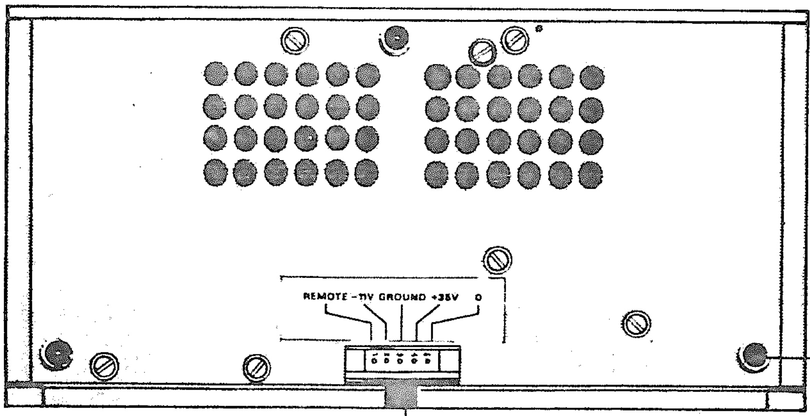


Fig. 1.

OUTPUT CONNECTOR
Delivers supply voltages for 55M01 Main Unit and provides the connection for the REMOTE CONTROL socket.

FIXING SCREWS
These screws serve the purpose of securing the Power Pack to the Main Unit.

PROBE CURRENT
This switch should always be in the NORMAL position when using the 55M10 Standard Bridge. The HIGH position will be used only in conjunction with the 55M11 CTA Booster Adapter.

NOMINAL LINE VOLTAGE RANGE
Indicates nominal line voltage range for which Power Pack is switched.

VOLTAGE SELECTOR
Selector plugs permit switching to different line voltages (plug becomes accessible on removal of rear wall).

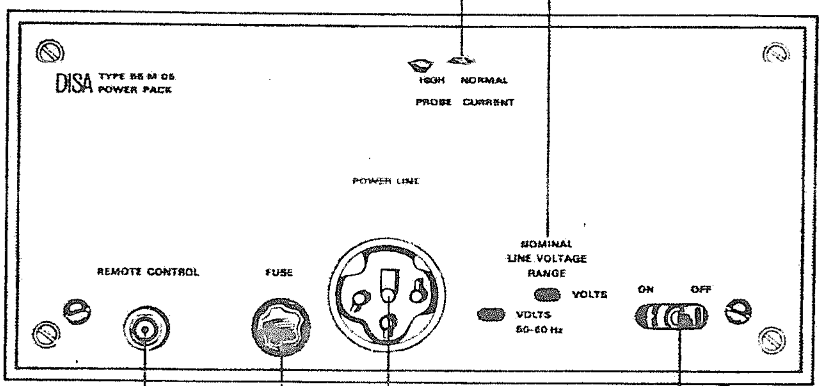


Fig. 2.

REMOTE CONTROL
Shorting this socket has the same effect as turning the FUNCTION switch from OPERATE to STD. BY.

ON/OFF
Turns line power on and off.

FUSE
Breaks power transformer primary circuit.

POWER LINE
The line cord plugs into this socket.

55M01 MAIN UNIT

METER
For measurement of probe resistance, probe current, output voltage, and DC voltage applied from external source.

SQUARE WAVE
This switch selects the frequency of the built-in square-wave generator in making the square-wave test (operated by screwdriver).

DECADE RESISTANCE (OHMS)
For measurement of probe resistance and adjustment of overheating ratio (comparison resistance).

ZERO OHMS
Potentiometer for compensation of probe cable resistance (operated by screwdriver).

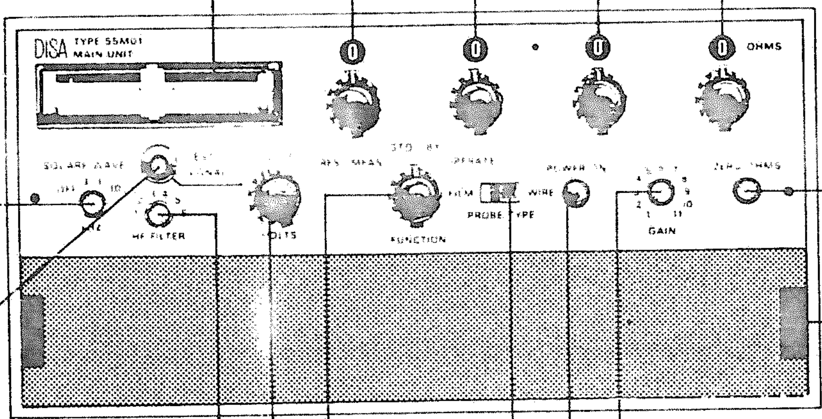


Fig. 3.

TEST SIGNAL
An external test signal may be applied through this banana jack. With the VOLTS switch in its extreme counter-clockwise position, this jack serves as input terminal for measurement of external DC voltages by means of the meter.

HF FILTER
This switch selects the upper frequency limit of the amplifier (operated by screwdriver).

VOLTS
This switch selects the various meter ranges.

FUNCTION
Rotary switch with three positions: RES. MEAS. -STD. BY–OPERATE.

PLUG-IN HOLDERS
When a plug-in unit is inserted, these two holders lock the plug-in unit into position in the Main Unit. Pressing the holders down will cause the plug-in unit to be pushed so far outward that it can be pulled out easily.

GAIN
Gain adjustment switch of the servo amplifier (operated by screwdriver).

POWER ON
Pilot lamp – shows light when power is applied to the instrument.

PROBE TYPE
This switch provides a choice of two types of system frequency response: for film and wire probes, respectively.

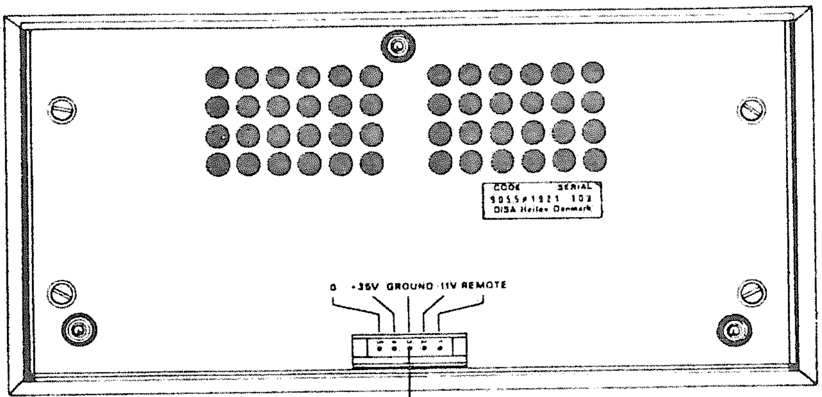


Fig. 4.

POWER CONNECTOR
For connection of supply voltages – either from a 55M05 Power Pack or from external batteries via a battery cable – and a remote-control switch.

55M10 CTA STANDARD BRIDGE

GROUND
Banana jack for grounding the instrument. Behind the jack is a potentiometer (operated by screwdriver) for adjustment of anemometer no-signal voltage; in normal operation, however, a fixed value is used and the potentiometer is inoperative.

PROBE
BNC socket for connection of probe.

CABLE LENGTH
Window which indicates probe cable length to be used (depends on Cable Compensation Unit in use).

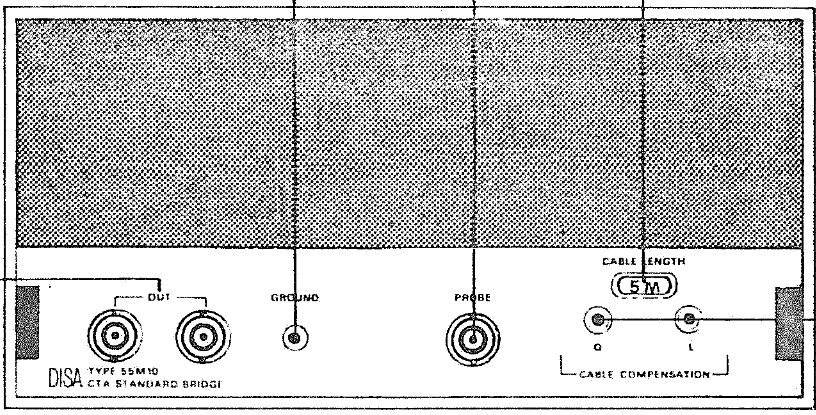
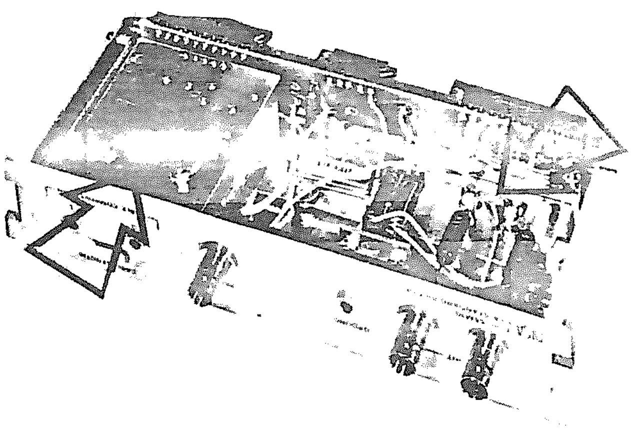


Fig. 5.

OUT
Two identical output sockets for connection of indicating or recording instruments (bridge voltage).

CABLE COMPENSATION Q and L
Adjusting screws for probe-cable impedance compensation; they are located in the Cable Compensation Unit installed in the Standard Bridge.

Connecting wire to be removed when filters etc. are to be connected in the bridge.



CABLE COMPENSATION UNIT

Fig. 6.

INTERNAL SLIDE SWITCH
For switching the amplifier frequency response. Normal setting (locked): Shaped frequency response. Other setting, to be used only in special measurements: Flat frequency response.

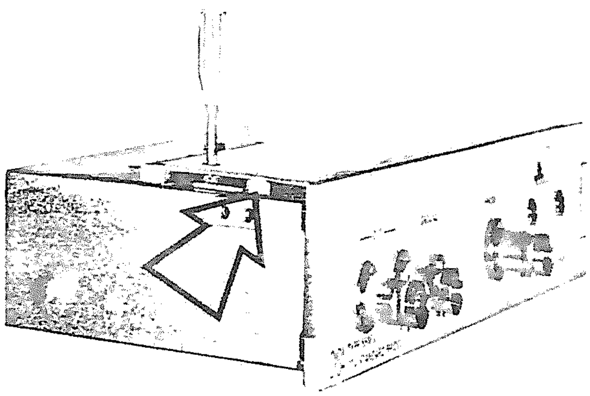
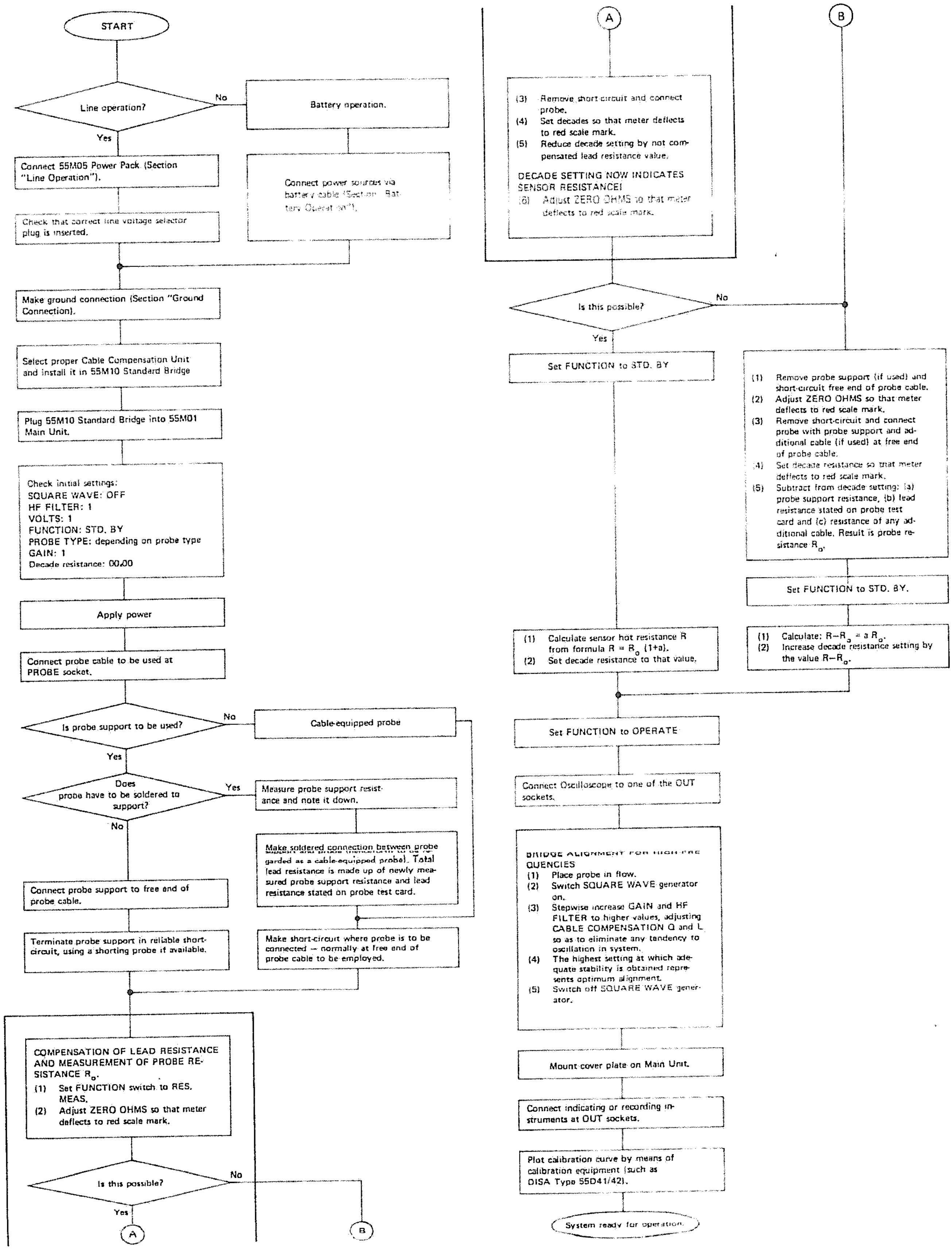
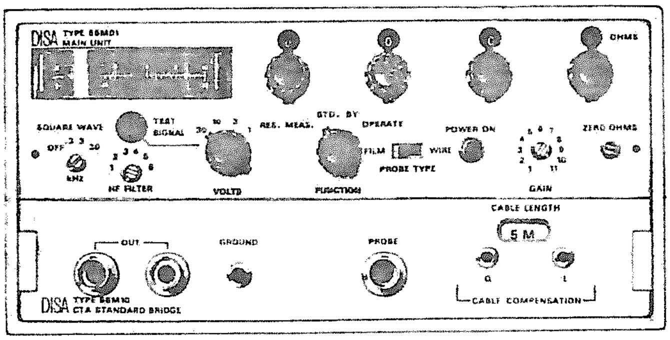


Fig. 7.

Flow Chart


START
Line operation?
No
Battery operation.
Yes
Connect 55M05 Power Pack (Section "Line Operation").
Connect power sources via battery cable (Section "Battery Operation").
Check that correct line voltage selector plug is inserted.
Make ground connection (Section "Ground Connection).
Select proper Cable Compensation Unit and install it in 55M10 Standard Bridge
Plug 55M10 Standard Bridge into 55M01 Main Unit.
Check initial settings:
SQUARE WAVE: OFF
HF FILTER: 1
VOLTS: 1
FUNCTION: STD. BY
PROBE TYPE: depending on probe type
GAIN: 1
Decade resistance: 00.00
Apply power
Connect probe cable to be used at PROBE socket.
Is probe support to be used?
No
Cable-equipped probe
Yes
Does probe have to be soldered to support?
Yes
Measure probe support resistance and note it down.
No
Make soldered connection between probe
garded as a cable-equipped probe). Total lead resistance is made up of newly measured probe support resistance and lead resistance stated on probe test card.
Connect probe support to free end of probe cable.
Terminate probe support in reliable short-circuit, using a shorting probe if available.
Make short-circuit where probe is to be connected — normally at free end of probe cable to be employed.
COMPENSATION OF LEAD RESISTANCE AND MEASUREMENT OF PROBE RESISTANCE R_o.
(1) Set FUNCTION switch to RES. MEAS.
(2) Adjust ZERO OHMS so that meter deflects to red scale mark.
Is this possible?
No
Yes
A
B
A
(3) Remove short-circuit and connect probe.
(4) Set decades so that meter deflects to red scale mark.
(5) Reduce decade setting by not compensated lead resistance value.
DECADE SETTING NOW INDICATES SENSOR RESISTANCE!
(6) Adjust ZERO OHMS so that meter deflects to red scale mark.
B
Is this possible?
No
Yes
Set FUNCTION to STD. BY
(1) Remove probe support (if used) and short-circuit free end of probe cable.
(2) Adjust ZERO OHMS so that meter deflects to red scale mark.
(3) Remove short-circuit and connect probe with probe support and additional cable (if used) at free end of probe cable.
(4) Set decade resistance so that meter deflects to red scale mark.
(5) Subtract from decade setting: (a) probe support resistance, (b) lead resistance stated on probe test card and (c) resistance of any additional cable. Result is probe resistance R_o.
Set FUNCTION to STD. BY.
(1) Calculate sensor hot resistance R from formula $R = R_o (1+a)$.
(2) Set decade resistance to that value.
(1) Calculate: $R-R_o = a R_o$.
(2) Increase decade resistance setting by the value $R-R_o$.
Set FUNCTION to OPERATE
Connect Oscilloscope to one of the OUT sockets.
BRIDGE ALIGNMENT FOR HIGH FREQUENCIES
(1) Place probe in flow.
(2) Switch SQUARE WAVE generator on.
(3) Stepwise increase GAIN and HF FILTER to higher values, adjusting CABLE COMPENSATION Q and L so as to eliminate any tendency to oscillation in system.
(4) The highest setting at which adequate stability is obtained represents optimum alignment.
(5) Switch off SQUARE WAVE generator.
Mount cover plate on Main Unit.
Connect indicating or recording instruments at OUT sockets.
Plot calibration curve by means of calibration equipment (such as DISA Type 55D41/42).
System ready for operation.

Detailed Operating Instructions



POWER SUPPLY

The supply voltages required for operating the 55M System are brought in through a 5-contact connector on the rear wall of the 55M01 Main Unit. The instrument requires two supply voltages: One between +16 and +36 V DC and one between −10 and −13 V DC.

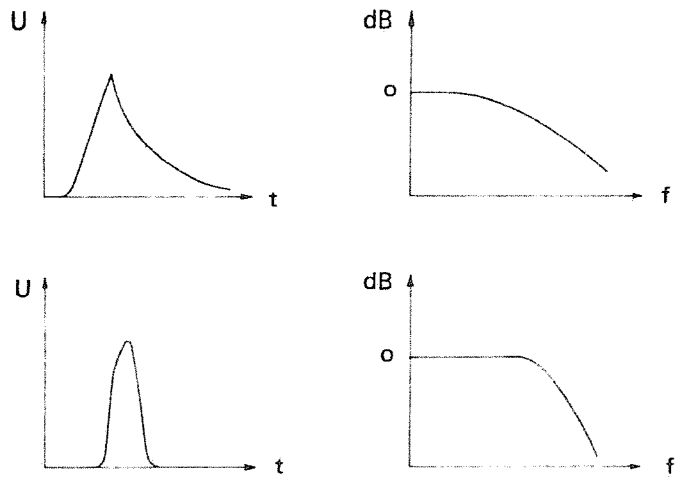
The main purpose served by the positive supply voltage is that of providing probe current; the working range – and hence also the available probe power – depends on the value of this voltage.

The 55M System may be powered either from the 55M05 Power Pack or from external power sources (batteries etc.).

Line Operation
When the 55M System is operated from the 55M05 Power Pack, the output of the +35 V supply – and hence the max. obtainable probe current – will be dependent on the line voltage available (see data for 55M05 Power Pack).
The connection between the 55M01 Main Unit and the 55M05 Power Pack may be made in two different ways:
(a)
The Power Pack is bolted to the Main Unit with three non-losable screws so that it constitutes an extension of the Main Unit cabinet. The electrical connections will then be made simultaneously and automatically via a 5-contact plug and socket.
(b)
If the 55M05 Power Pack is to be set up physically separate from the Main Unit, the electrical connections are made via a cable included in the equipment package. The two plugs at the cable ends are designed so that they cannot be inserted the wrong way.

When the connection between the Main Unit and the Power Pack has been made in one of the two ways described, the next thing to do is to check if the Power Pack is switched to your local line voltage. The two windows to the left of the ON/OFF switch indicate the nominal range of the permissible line voltage. Should the latter fail to agree with your local line voltage, you should remove the rear wall of the 55M05 Power Pack (to do so, loosen the four fixing screws). This will enable you to remove the red selector plug and replace it with one of the correct type for your local line voltage. Bracketed voltages on the selector plug indicate max. permissible voltage fluctuations (see also under Technical Data).
The free end of the instrument power cable supplied should be fitted with a plug of the type prescribed by your local authorities. The plug at the other end of the cable fits into the instrument socket, from where it can only be removed after you have pressed the white button.
The fuse holder is adjacent to the power socket; the fuse rating is independent of the line voltage in use. It should be 0.5 A (slow-acting).
After the power cable has been plugged in, the instrument can be turned on and off with the power switch (ON/OFF).
NOTE: Before applying power, turn the FUNCTION switch on the Main Unit to the STD. BY position in order to eliminate any risk of probe damage.
If the 55M System is operated in conjunction with the 55M10 CTA Standard Bridge, the PROBE CURRENT switch on the rear wall of the 55M05 Power Pack should always be at NORMAL. The HIGH position will be used only in conjunction with the 55M11 CTA Booster Adapter.

Battery Operation
If the 55M System is to be operated in places where no line voltage is available, or if it is to be used as a portable unit that is ready for operation at any time, storage batteries or dry batteries etc. will be used as power sources. The 55M05 Power Pack will not be required, resulting in a considerable saving in weight.
Between +16 V and +36 V DC is required for producing the probe current.



Response signal and frequency response of a CTA to square-wave signal at incorrect GAIN and FILTER settings.

Response signal and frequency response of a CTA to square-wave signal at optimum adjustment.

Fig. 13.

into the PROBE socket, with the free cable end terminated in a reliable short-circuit.
Next, the ZERO OHMS potentiometer should be set so that the meter needle covers the red scale mark.
Replace the short-circuit with the probe and its associated support and additional cables (if used).
Thereafter set the decade resistance so that the meter needle once more covers the red scale mark.
The resistance reading will now equal the sensor resistance plus the non-compensated resistances in the probe body, in the probe support, and in any additional cable. These resistances must be subtracted from the decade reading in order to find the value of the sensor resistance.
Set the FUNCTION switch to STD. BY.

(5a) Calculation and Adjustment of Overheating Ratio
The next thing to do is to adjust the overheating ratio a, calculating

$$R-R_o = a \cdot R_o$$

and increasing the decade resistance setting by the value $R-R_o$.

(6) Closing the Servo Loop
Turning the FUNCTION switch to the OPERATE position will close the servo loop, the probe will be heated, and the anemometer is in operation.
The meter range switch will be in operation, too; hence there is a choice between ranges of 1, 3, 10, or 30 V.
As long as the probe is not exposed to flow, the meter will read the voltage V_o – that is: output voltage at zero flow velocity (approx. 2.9 V for 5 μm wires probes in air).

(7) Balancing the Bridge
Adjustment of bridge balance is performed by the aid of the square-wave generator incorporated in the 55M01 Main Unit. An oscilloscope, set to a sensitivity of approx. 0.1 V/cm, should be connected at one of the OUT sockets.

The frequency behavior of an anemometer system can be determined by producing a sudden change in the velocity of the flow acting on the probe. However, since it is difficult to produce accurately defined sudden velocity changes, it is the practice to simulate them by feeding square-wave signals into the bridge.
Such a square-wave test should produce an oscilloscope pattern showing the shortest possible impulse response without superimposed oscillation. If this condition is met, the bridge and servo amplifier are in optimum alignment.
During the square-wave test the probe should be exposed to a constant flow whose magnitude should at least equal the maximum velocity occurring during the measurement. If this is not possible, so that the test has to be carried out at a lower velocity or even at zero flow velocity, it will be necessary, on completion of the adjustment, to reduce the amplifier gain setting until the point is reached where the anemometer system can also operate stably during the measurement.
To balance the bridge, proceed as follows:
(a)
The probe should be exposed – if at all possible – to a constant flow velocity as described above.
(b)
Switch on the square-wave generator (SQUARE WAVE switch). Which of the three frequencies should be used depends entirely on the oscilloscope pattern. The test frequency and the oscilloscope sweep frequency should be selected so that the pattern is easily readable and will provide clear indications of the changes caused by operating the controls. You may switch the frequencies at will during the test.
(c)
Now stepwise increase the GAIN switch setting until the response signal on the oscilloscope screen shows damped oscillations on the base line (Fig. 12). Thereafter stepwise increase the HF FILTER switch setting, This will first reduce the oscillations but as the switch is advanced still further oscillations will appear at the skirts of the signal. These oscillations can be compensat-

Technical Data

TYPE 55M01 MAIN UNIT

AMPLIFIER

The following data apply solely to the 55M01 Main Unit.
When using plug-in units with feedback via the bridge the resulting sensitivity, frequency response and noise of the system will be dependent on measuring conditions, probe type, plug-in unit, etc.

Amplifier Gain:

GAIN Setting	1	2	3	4	5	6	7	8	9	10	11
DC Gain ±15%	16500	20500	26000	31500	36500	43000	47500	53500	59000	62000	66000
AC Gain ± 5%	340	440	600	800	1100	1450	1950	2550	3500	4700	6000

Gain in SHAPED operation falls, depending on frequency, from DC gain to AC gain at the rate of 3 dB/octave or 1.2 dB/octave, AC gain being reached at approx. 100 kHz. (Below approx. 10 Hz, however, a slightly steeper slope than 1.2 dB/octave is permitted). This secures optimum frequency response for the system with film and wire probes and provides bridge balance independently of velocity. Depending on connections in the plug-in unit the amplifier may be set up to have a flat characteristic with gain equal to AC gain (or, specifically, with gain equal to DC gain).

Typical Nonlinearity of Amplifier:

The relative small-signal gain at 1 kHz has typical dependence on DC output voltage, as specified below (at approx. 200 Ω load).

DC Output Voltage	30	20	10	5	2	1	0.5	0.2
% of Specified Gain	98	100	98	96	94	91	87	80

Typical Max. Upper Frequency Limit:

HF FILTER Setting	1	2	3	4	5	6
Frequency Limit kHz	60	120	250	520	850	1500

The HF FILTER is a bridged-T filter which secures stability in closed-loop operation.

Typical Max. Output Voltage Swing (peak-to-peak):

At +36 V supply voltage under no-load conditions.

Frequency, kHz	<10	50	100	300	1000	2000
Voltage Swing, V	30	28	25	16	6	2

Max. Output Current:

(see data for plug-in unit)

Sensitivity During Resistance Measurement:

Approx. 1% f.s.d./mΩ (with 0.8 mA probe current)

Typical Equivalent Input Noise and Ripple:

The total equivalent input noise consists of amplifier noise proper, ripple voltages from the Power Pack, and induced hum voltages, if any.

The amplifier input noise spectrum follows, with approximation, the formula

$$n_{RMS} = \sqrt{n_w^2 \left(1 + \frac{200}{f}\right)} \; ;$$

Typical White Noise Spectrum (n_w):

1.8 nV/ $\sqrt{Hz}$

Typical Hum Induced in Input:

1 μV_{RMS} (reduced by factor of approx. 10 if intermediate power-supply cable is used).

Typical Attenuation Factor for Ripple from Positive Supply Voltage to Amplifier Output:

40 dB

Typical Temperature Drift:

The total drift consists of equivalent contributions from input (ΔV_{in}) and output (ΔV_{out}).

Typical Equivalent Input Drift: ±0.5 μV/°C
Typical Equivalent Output Drift: ±15 mV/°C

Typical Common Mode Rejection:

80 dB

SQUARE WAVE GENERATOR

Frequencies:
Approx. 0.3, 3, and 30 kHz

Rise Time:
Approx. 0.15 μsec

Typical Output Signal During Performance Test:
0.5 V
(Square-wave signal is applied at amplifier output to obtain correct testing of the system.)

PROBE PROTECTION CIRCUIT

Electronic circuit which cuts off bridge current instantly in case of supply-voltage drop-out, bridge-circuit interruption, or plug-in unit removal.
The circuit controls probe-current increase during probe cut-in and when supply voltage is applied.
It can be remotely activated via the REMOTE CONTROL socket.

Bridge Voltage Increase During Cut-in:
Approx. 0.4 V/msec

Start Delay Time:
Approx. 1 to 3 min. depending on positive supply voltage

VOLTMETER

Used for measurement of internal and external voltages and as balance indicator in resistance measurements.

Ranges for Internal Voltages:
30, 10, 3, and 1 V

Range for External Voltages:
10 V

Accuracy:
2% of f.s.d.

DECADE RESISTANCES

Range:
0–99.99 Ω

Accuracy:
0.1% ±3 mΩ
Temperature Coefficient: <10 × 10^{-6}/°C

Switch Contact Resistances:
Correspond to max. 0.25 mΩ probe resistance

Resolution of ZERO OHMS Potentiometer:
Corresponds to 1.7 mΩ probe resistance

Range of ZERO OHMS Potentiometer:
Corresponds to 1.25 Ω probe resistance

POWER SUPPLY

The 55M01 Main Unit is normally operated from the 55M05 Power Pack but may be operated from external power sources via a 9055M2181 battery cable.

Supply Voltages Required:
Positive DC voltage, between 16 and 36 V
Negative DC voltage, between 10 and 13 V

Drain on Positive Supply:
200 mA + bridge current + current consumed by plug-in unit (if any)

Drain on Negative Supply:
Max. 130 mA

PHYSICAL DATA

Ambient Temperature Range:
0° to +45°C

Dimensions (HWD):
106 x 212 x 230 mm
(106 x 212 x 296 mm incl. of 55M05 Power Pack)

Finish:
Pastel green and light gray enamel

Weigt:
2.9 kg

Shock:
70 g, 11 msec, 3 axes, non-operating

Line Voltage:

The instrument is designed for operation on any nominal line voltage within the ranges 100–129 and 200–259 V AC, 50–60 Hz, and will tolerate voltage variations within the ranges 90–138 and 180–276 V.

Line voltage selection is carried out by means of six plugs which fit into a 9-pin miniature socket on the back of the instrument. The proper plug is selected on a basis of the Table below.

Plug Code No.	*Nominal Range, Volts*)*	*Max. Variations, Volts*
9005A1321	100 – 109	90 – 115
9005A1331	110 – 119	99 – 126
9005A1341	120 – 129	108 – 138
9005A1351	200 – 219	180 – 231
9005A1361	220 – 239	198 – 253
9005A1371	240 – 259	216 – 276

Maximum permissible voltage variations – that is, deviations from the nominal voltage due to local conditions – are listed in the Table and, in parantheses, on the plug.

As shipped to you, the instrument is fitted with a plug for your local line voltage. However, all plugs are available at your DISA supplier.

*) *If your local line voltage differs permanently from the nominal value, the plug should be selected accordingly.*

Fuse:

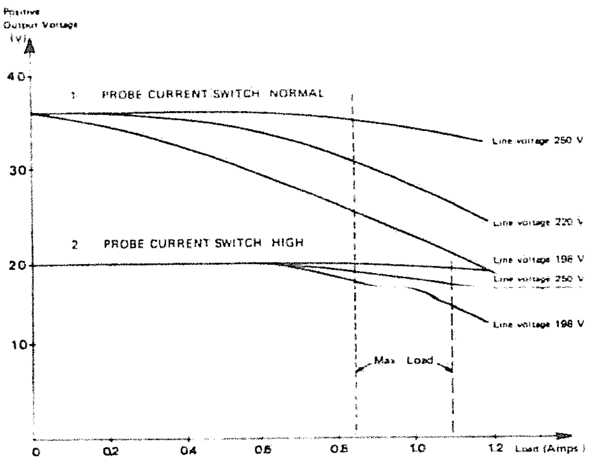
0.5 amp., slow-acting

Positive Supply:

Depends on PROBE CURRENT switch setting

PROBE CURRENT Switch Setting	Max. output voltage	Max. load current
NORMAL	36±0.5 V	0.85 A
HIGH	20±0.5 V	1.1 A

Load characteristics:



Dependence of Unstabilized Plus Voltage on Load Current, Line Voltage, and Setting of PROBE CURRENT Switch (Nominal Line Voltage Range 220 V – 239 V)

Short-circuit protection:
Withstands prolonged direct short-circuit (short-circuit current approx. 20 mA).
Typical ripple voltage at max. load:
300 mV_{RMS}

Negative Supply:

Output voltage: 11 V ±0.5 V (without load)
Max. output current: 130 mA
Output impedance: approx. 5 Ω
Typical ripple voltage at max. load: 15 mV_{RMS}
Short-circuit protection: Withstands prolonged short-circuit.

PHYSICAL DATA

Ambient Temperature Range:

0^{o} to $+45^{o}$C

Dimensions (HWD):

106 x 212 x 93 mm

Finish:

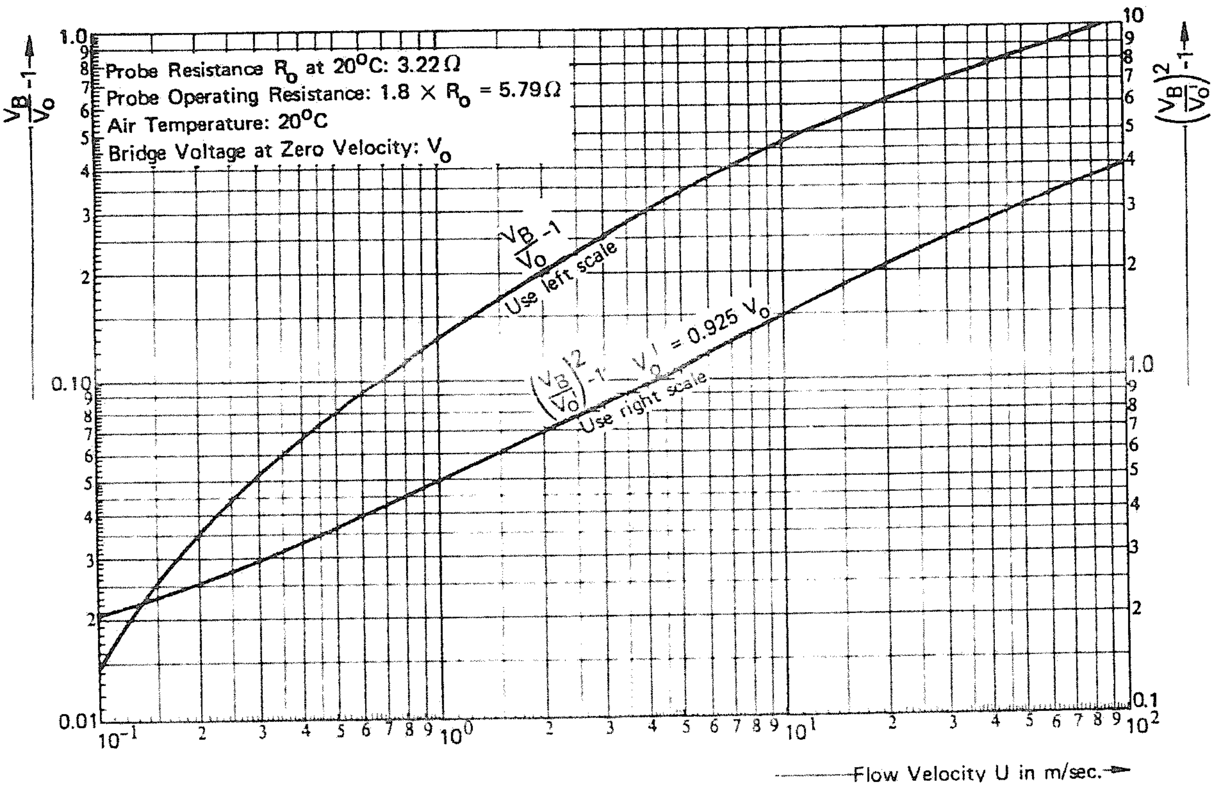
Pastel green enamel

Weight:

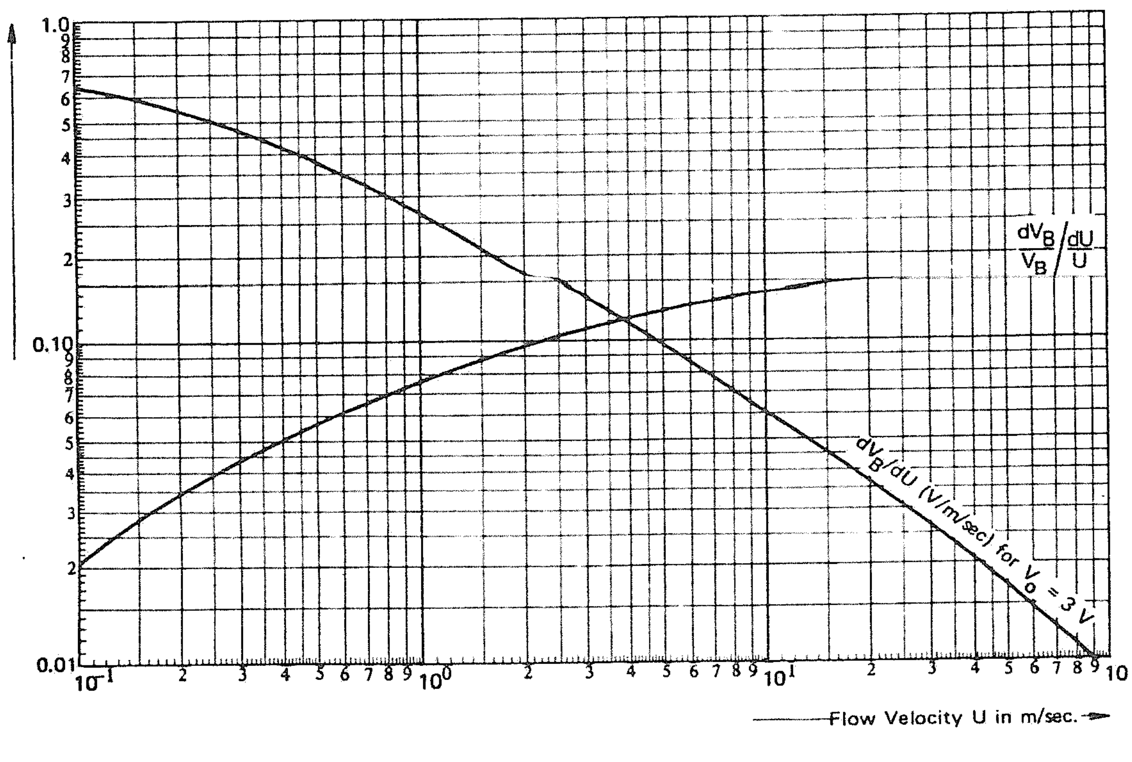
3.2 kg

Shock:

70 g, 11 msec, 3 axes, non-operating



Typical calibration curve for Type 55A22 Hot-Wire Probe in air flow.



Slope of typical calibration curve for Type 55A 22 Hot-Wire Probe in air flow.

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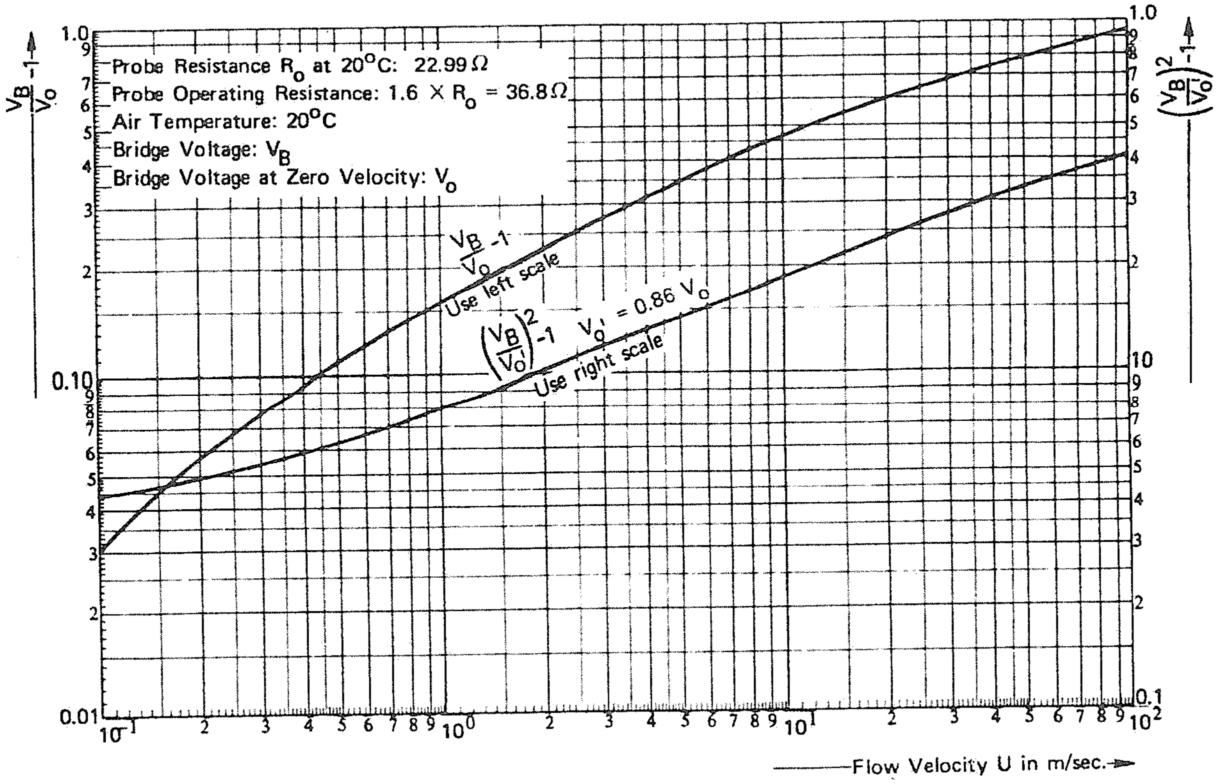
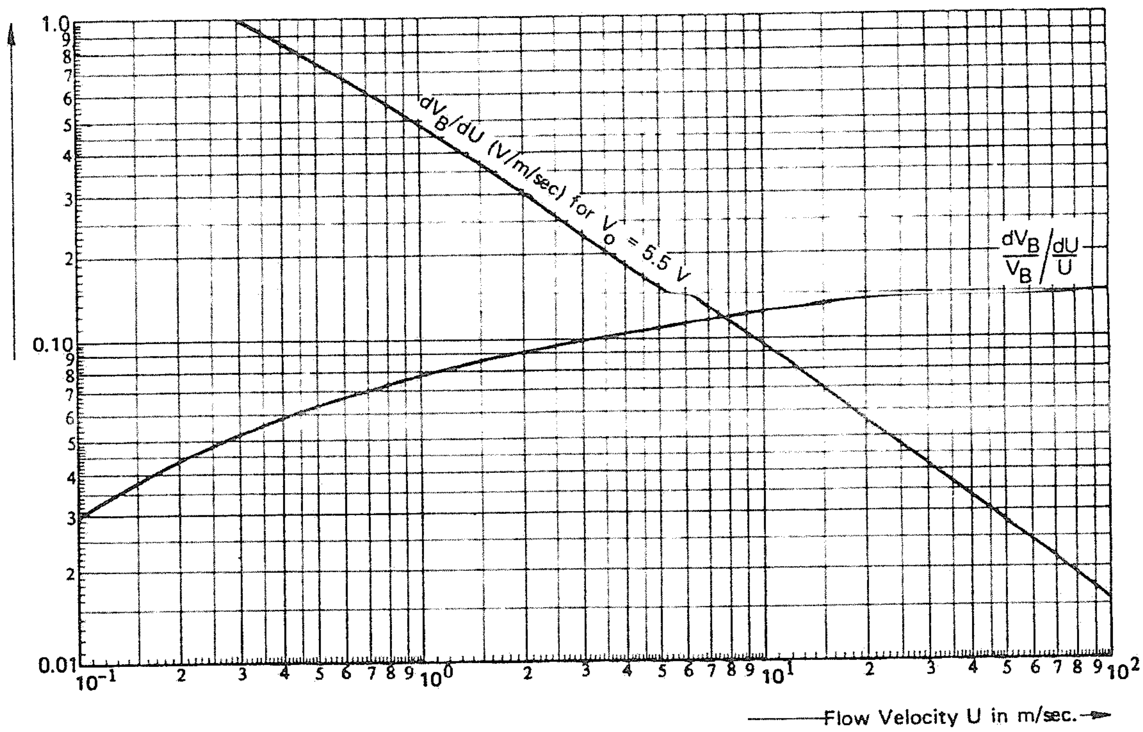


Typical calibration curve for Type 55A80 Hot-Film Probe in air flow.



Slope of typical calibration curve for Type 55A80 Hot-Film Probe in air flow.

TYPE 55M10 CTA STANDARD BRIDGE

Top Resistance (R_T):
50 Ω

Bridge Ratio:
1:20
(Total bridge current (I_B) equal to 1.05 × probe current (I_p)).

Sensitivity:
V_{out} = $(R_p + R_T + R_{ca})\, I_p$, where
R_{ca} = Cable resistance (approx. 0.06 Ω/m), and
R_p = Probe resistance.

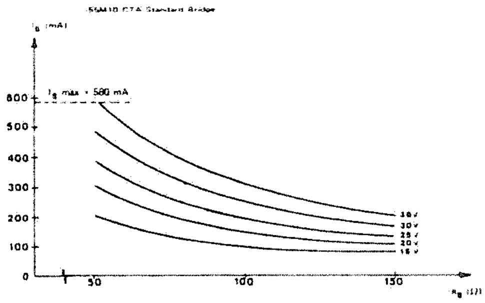
Sensor Current (I_p):
Sensor current depends on probe type and measuring conditions, and is determined by calibration (see examples of calibration curves).
Max. probe current: 0.55 A.
Depends on probe resistance and supply voltage, and is determined from the diagram below.

$$I_p = \frac{1}{1.05} I_B,$$

bridge impedance R_B =

$$\frac{1}{1.05} (R_p + R_T + R_{ca}).$$

Supply voltage is determined from Power Pack data. Total load current is calculated as I_B + 0.2 A.



Max. Bridge Current (I_B) versus Bridge Resistance (R_B) at different supply voltages
($R_B = \frac{1}{1.05} (R_p + R_{ca} + 50)$)

Max. Obtainable Probe Power:
$R_p \times I_p^2 = 4$ W

Accuracy of Resistance Measurements:
±0.25% ±3 mΩ

Operating Current in Resistance Measurements:
0.8 mA

Probe Cable Lengths:
5 m ±0.6 m (4 m and 5 m cables supplied)
20 m ±3 m (with 55M85 Extension Kit)
100 m ±7 m (with 55M86 Extension Kit)

Max. Upper Frequency Limit:
Approx. 200 kHz.
Max. obtainable upper frequency limit depends on probe type, probe cable, measuring conditions, etc. See examples of frequency characteristics.

Typical Output Noise:
Output noise depends on feedback via the bridge and will therefore normally be much lower than the noise in open-loop operation.
For example:
5 μm tungsten probe: 80 μV_{RMS} corresponding to 0.013% turbulence (10 kHz bandwidth, 10 m/sec air velocity)
Film probe (Type 55A81): 0.19 mV_{RMS} corresponding to 0.006% turbulence (10 kHz bandwidth, 3 m/sec water velocity). Values were measured at zero velocity and corrected for the reduction in loop gain which takes place when the velocity is increased.

Amplifier Setting:
SHAPED (switching to FLAT requires switching inside the plug-in unit).

Output Impedance:
Approx. 10 Ω (with normal feedback through bridge)

Max. Capacitive Load Without Data Reduction:
Approx. 1 nF

PHYSICAL DATA

Ambient Temperature Range:
0^{o} to $+45^{o}$C

Dimensions (HWD):
39 x 202 x 103 mm

Finish:
Pastel green and light gray enamel

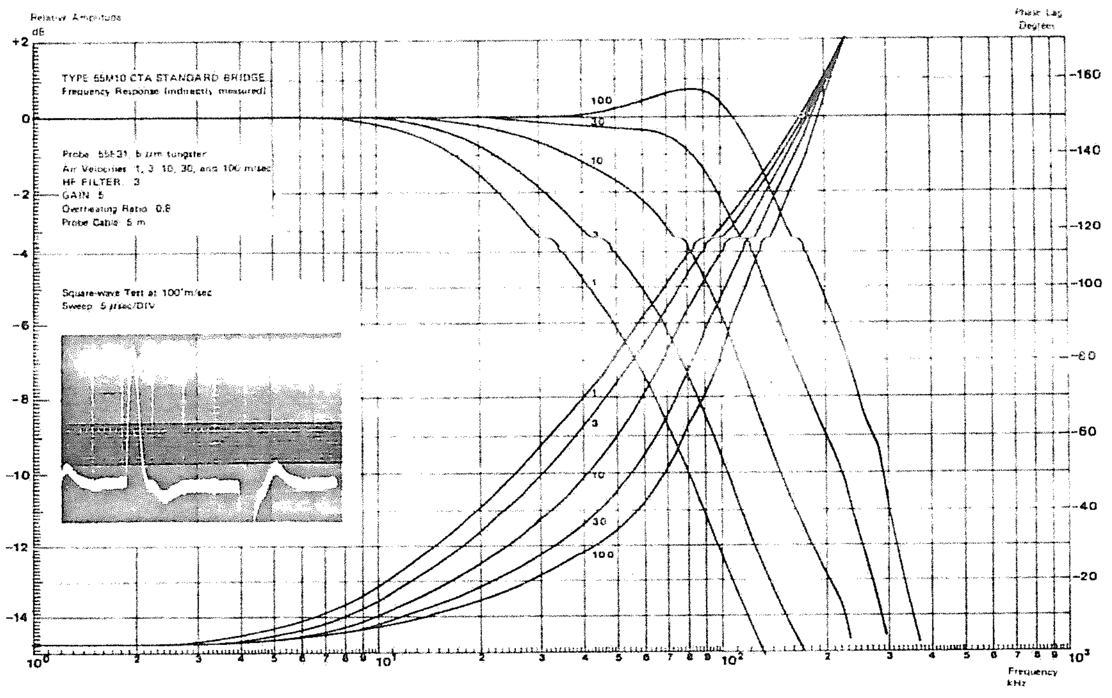
Weight:
0.65 kg

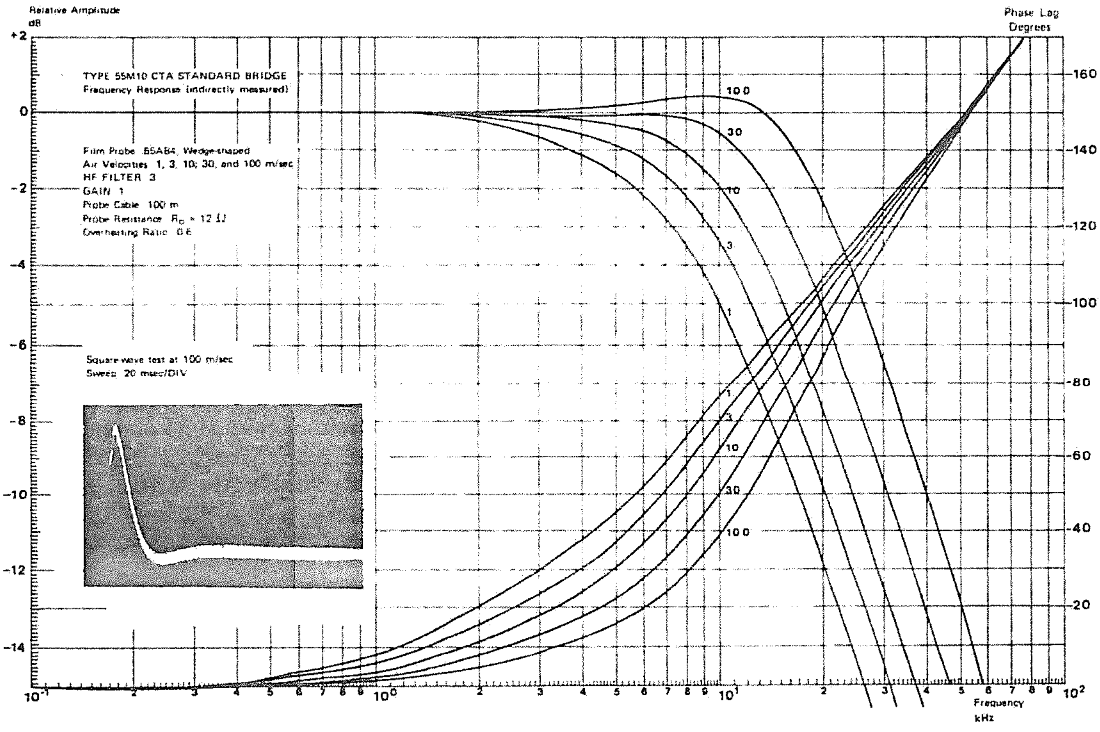
Shock:
70 g, 11 msec, 3 axes, non-operating

EXAMPLES OF FREQUENCY CHARACTERISTICS

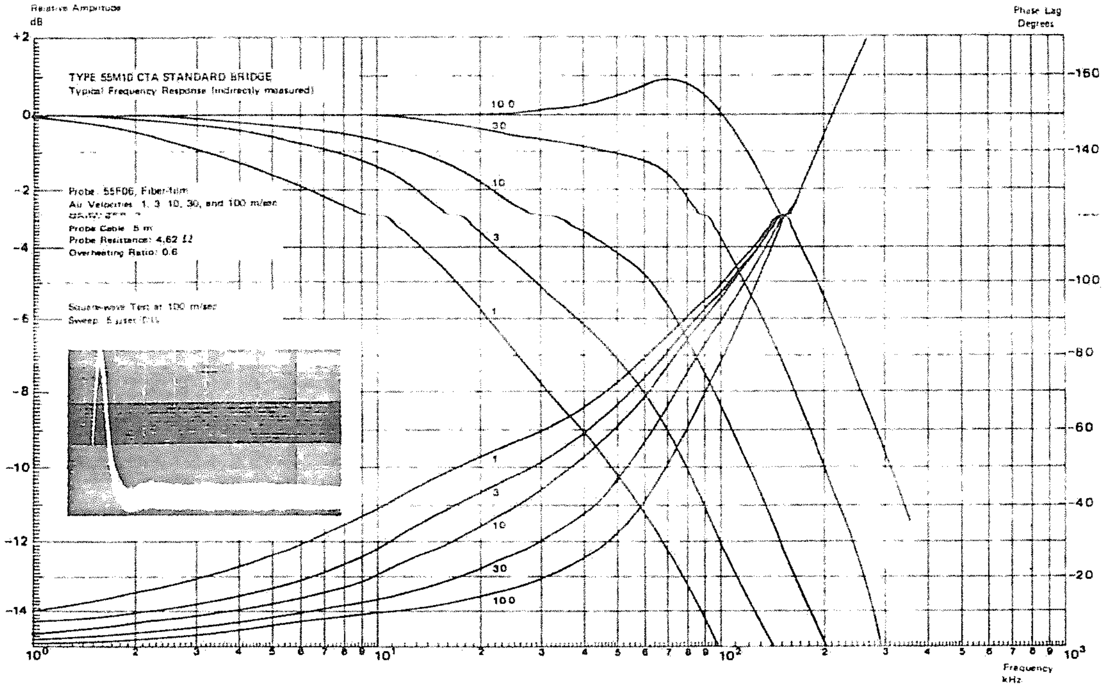
The frequency characteristics of a constant-temperature anemometer are dependent on a large number of parameters such as: medium under measurement, velocity, probe type, overheat temperature, amplifier gain and frequency response, bridge balance, etc. Hence it is practically impossible to specify such characteristics for all cases; however, some of the more important cases are covered by the examples given, which show characteristics corresponding to a specific adjustment at various velocities. Also shown is the appearance of the square-wave test signal corresponding to maximum velocity, and it is therefore possible to reproduce the adjustment of bridge balance. These examples could also be used as a basis for evaluating the frequency limit of the system from a recorded square-wave test curve, but this method can be rather unreliable at frequencies at which the bridge is out of balance. The characteristics shown for low velocities could, in many cases, be improved by increasing the gain of the amplifier and reducing its bandwidth; however, this assumes lower maximum velocity in order to ensure stable operation.
The measurements were made indirectly, which means that velocity changes were simulated by electric signals applied to the probe. Moreover, it was assumed that the probe proper has a linearly declining characteristic within the frequency range measured. For wire probes a slope of 20 dB/decade was used; for wedge-shaped film probes and fiber-film probes slopes used were 10.6 and 10.8 dB/decade, respectively.

These slopes were determined through measurements within the range 3 to 30 kHz and were used with extrapolation to higher frequencies.
No measurements were made at frequencies below approx. 100 Hz because a flat characteristic will always be found at low frequencies in (correct) indirect measurements provided that the loop gain is of reasonable magnitude.
The indirect measuring method will not produce correct results in certain cases although comparisons with, for example, shock tube measurements have justified its use (see DISA Information No. 6). In turbulence measurements the space resolution of the probe will reduce the maximum frequency limit to approx. 50–100 kHz. However, higher frequency limits are desirable in order to minimize phase shift and permit one-dimensional measurements. For film probes for measurements in water, bandwidth will be limited to approx. 30 kHz, due to their quartz coating.
At velocities below approx. 1 m/sec in air, the frequency limit is restricted by a thermal boundary layer effect, and the indirect method is inapplicable here. It applies specially to wedge-shaped film probes that their sensitivity below approx. 0.1 Hz is approximately twice as high as at approx. 500 Hz, there being a gradual variation between these limits. This is due to the fact that velocity variations affect the film, not only directly but also indirectly on the back of the film, through the probe body. Only the direct method is usable for measuring this effect, and the characteristics listed do not allow for this fact. The effect is independent of the Anemometer's servo control.

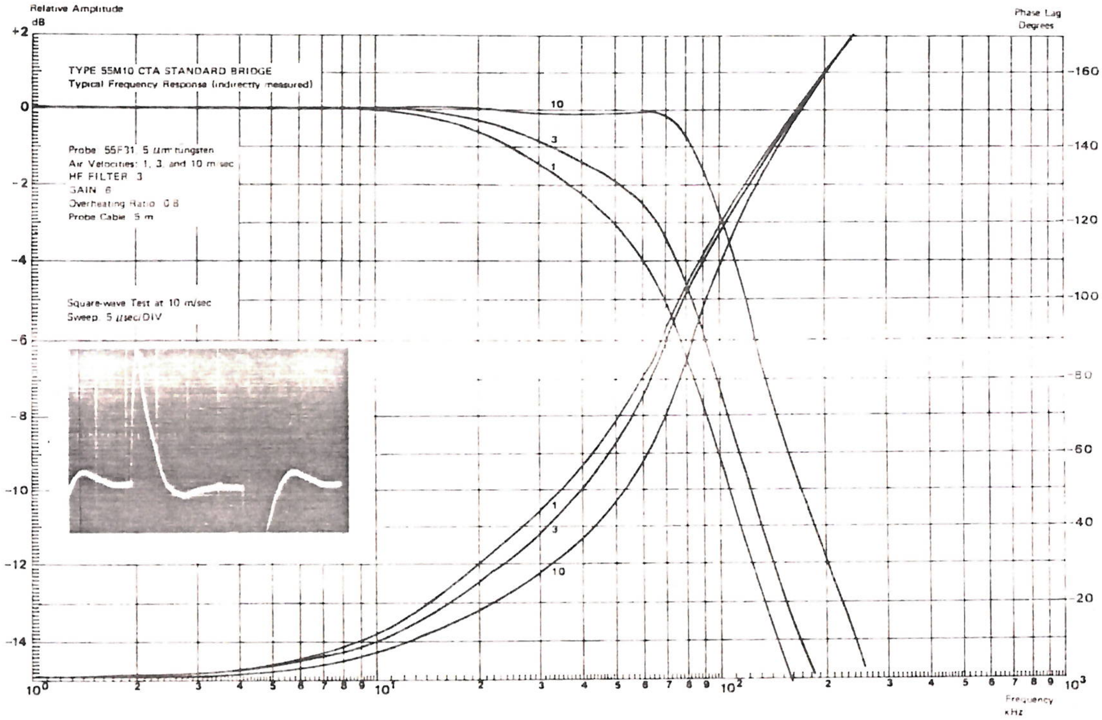




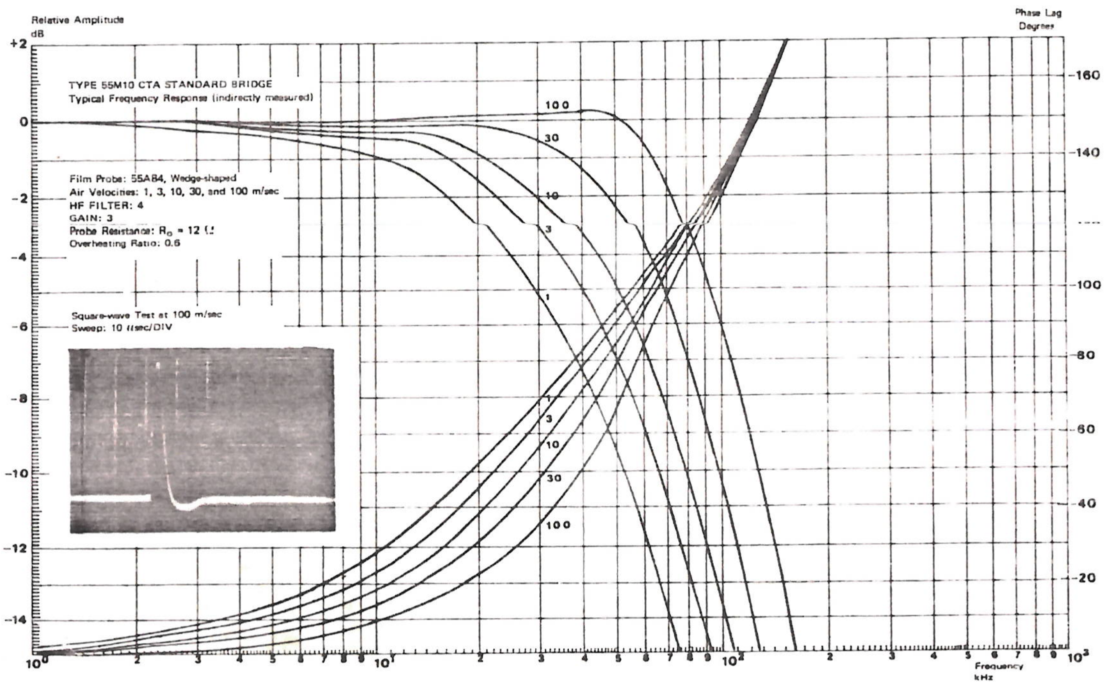
Relative Amplitude
dB
Phase Lag
Degrees
TYPE 55M10 CTA STANDARD BRIDGE
Frequency Response (indirectly measured)
Film Probe 55A84, Wedge-shaped
Air Velocities 1, 3, 10, 30, and 100 m/sec
HF FILTER 3
GAIN 1
Probe Cable 100 m
Probe Resistance R_o = 12 Ω
Overheating Ratio 0.6
Square-wave test at 100 m/sec
Sweep 20 msec/DIV
Frequency
kHz



Relative Amplitude
dB
Phase Lag
Degrees
TYPE 55M10 CTA STANDARD BRIDGE
Typical Frequency Response (indirectly measured)
Probe 55F06, Fiber-film
Air Velocities 1, 3, 10, 30, and 100 m/sec
Probe Cable 5 m
Probe Resistance: 4,62 Ω
Overheating Ratio: 0.6
Frequency
kHz



Relative Amplitude
dB
Phase Lag
Degrees
TYPE 55M10 CTA STANDARD BRIDGE
Typical Frequency Response (indirectly measured)
Probe: 55F31, 5 μm tungsten
Air Velocities: 1, 3, and 10 m/sec
HF FILTER: 3
GAIN: 6
Overheating Ratio: 0.8
Probe Cable: 5 m
Square-wave Test at 10 m/sec
Sweep: 5 μsec/DIV
Frequency
kHz



Relative Amplitude
dB
Phase Lag
Degrees
TYPE 55M10 CTA STANDARD BRIDGE
Typical Frequency Response (indirectly measured)
Film Probe: 55A84, Wedge-shaped
Air Velocities: 1, 3, 10, 30, and 100 m/sec
HF FILTER: 4
GAIN: 3
Probe Resistance: R_0 = 12 Ω
Overheating Ratio: 0.6
Square-wave Test at 100 m/sec
Sweep: 10 μsec/DIV
Frequency
kHz

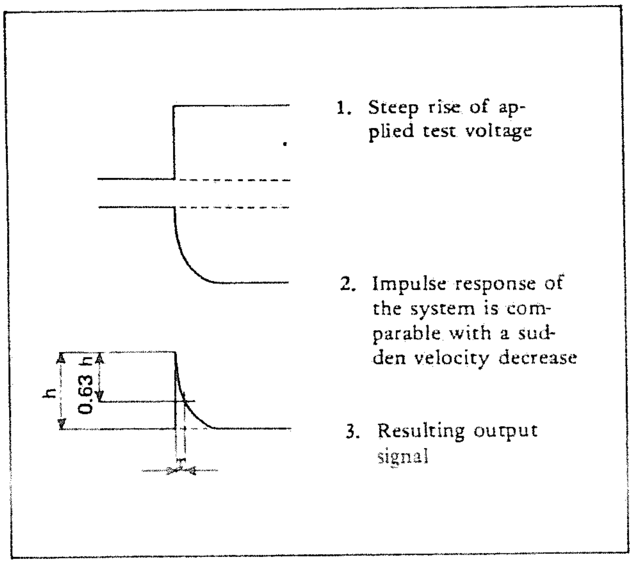


Fig. 11. Response signal of a CTA to square-wave impulse.

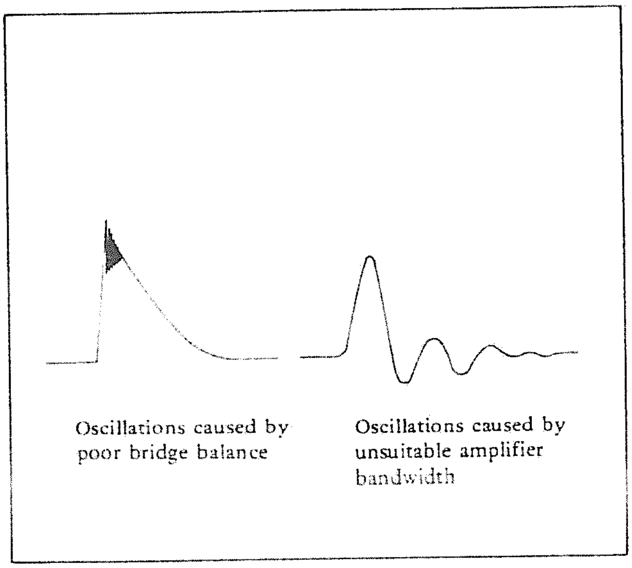


Fig. 12.

(c)
Using a screwdriver, set the ZERO OHMS potentiometer so that the meter needle covers the red mid-scale mark.

NOTE: When special-purpose probes are operated with cables of 20 meters or 100 meters, it may be found that the control range of the ZERO OHMS potentiometer is not large enough, so that the meter needle cannot be made to cover the red scale mark. A modified procedure for this case is described in connection with (5) under (4a) and (5a).

(d)
Replace the short-circuit with the probe to be used. This will cause the meter reading to go below zero.
NOTE: Should the meter needle nevertheless go all the way to the right, it is likely that the bridge arm connected to the PROBE socket is broken due to a defective probe.

(e)
[illegible]
meter needle again covers the red scale mark. The best way to do this is first to increase the left decade stepwise from zero until the meter needle suddenly goes to the opposite scale end. Then turn the decade one step backwards and repeat the procedure with the next decade, etc. As the last decade is advanced stepwise, the meter needle should only move slightly to the right at each step. The decade should now be set at the value that will bring the meter needle closest to the red mark.

(f)
Now reduce the decade resistance setting by an amount corresponding to the probe-lead resistance. This will once again cause the meter reading to change.
THE VALUE INDICATED BY THE DECADE SETTING IS THE SENSOR RESISTANCE AT THE EXISTING ROOM TEMPERATURE (IN OHMS).
By interpolating on the meter scale the resistance value can be read to an accuracy that is one place better than that obtained by reading the decade resistance.

(g)
Adjust the ZERO OHMS potentiometer so that the meter needle returns to the red mark.
With these adjustments completed, all sensor lead resistances are compensated.
If this cannot be accomplished because the range covered by the ZERO OHMS potentiometer is inadequate proceed according to the "Modified Procedure" described in connection with (5) under (4a) and (5a).
Set the FUNCTION switch to STD. BY.

(5) *Calculation and Adjustment of Overheating Ratio*
The constant-temperature anemometer employs a sensor which is kept at a preselected excess temperature by means of an electronic control circuit. The excess temperature is defined by the so-called overheating ratio

$$a = \frac{R - R_o}{R_o}$$

(R = sensor hot resistance, R_o = sensor cold resistance at ambient temperature).
[illegible] lows:

$$R = R_o(1+a)$$

The decade resistance should be set at this value. When the FUNCTION switch is subsequently turned to OPERATE, the calculated overheating ratio will be provided automatically.

MODIFIED PROCEDURE

(4a) *Measurement of Sensor Resistance*
If the range covered by the ZERO OHMS potentiometer is too small, it will not be possible to compensate for the total lead resistance. It will then be necessary to partly take the lead resistance into account when calculating and adjusting the overheating ratio.
In that case only the normal probe cable (normally 5 meters, 20 meters, or 100 meters) should be plugged

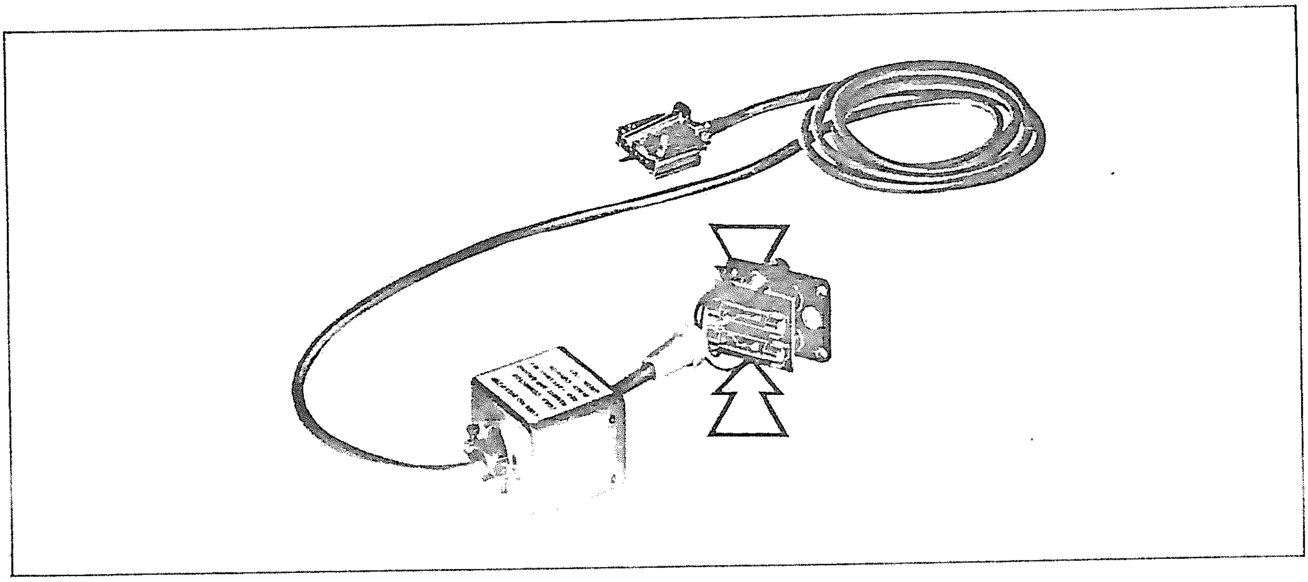


Fig. 8. The fuses in the battery cable.

The other supply voltage operates some electronic circuits which require between −10 V and −13 V DC at approx. 130 mA. Because of the limited load, this supply voltage can be provided easily by connecting a few dry cells in series.
The power sources should be connected to the 55M01 Main Unit via the battery cable. The plug goes into the connector on the rear wall of the Main Unit (it cannot be inserted the wrong way).
The power sources should be provided with cables and banana plugs, which should be inserted in the connector socket fitted to the battery cable.
The connector socket comprises three banana jacks and one BNC coaxial socket, the last-mentioned being intended for the remote control lead. The system is grounded through the outer conductor of the BNC socket. The banana jacks are color coded as follows: Red, for positive voltage. Green, for negative voltage. Black, for the common zero potential of the two power sources.
The connector socket also contains two fuses which protect the instrument against unintentional polarity reversal. These fuses ([illegible], slow acting) can be replaced after removal of the four screws which hold the plate carrying the banana jacks and BNC socket. The fuses are located on a small circuit board below the jacks and socket (Fig. 8).
In this case, too, it applies that the FUNCTION switch on the Main Unit should be set to STD. BY before the supply voltages are connected, so as to avoid damage to the probe.

A good ground connection is extremely important in measurements in water and in other conducting liquids; otherwise there is a risk that the probe may be destroyed!

Ground Connection
A probe will be destroyed if excessive voltage is present between it and the conducting medium as this will cause the thin protective quartz coating to be broken. This hazard can be eliminated by carefully grounding both the 55M System and the flow medium and connecting the 55M System to the flow medium electrically. In line operation the 55M System will as a rule be grounded via the "third" (safety) conductor of the line cable (Fig. 9).
All plug-and-socket connections under water must be sealed carefully (rubber hoses, silicon grease etc.). Any ingress of water will tend to cause unstable operating conditions, which might likewise result in the destruction of the probe.
It is important that the probe body be insulated from ground (in measurements in gases and liquids) as a direct short-circuit between both ends of the probe cable shielding can introduce unstability in the system (the unavoidable short-circuit through the water is not to be considered as a direct short-circuit).
Occasionally a ripple voltage between the ground points may cause a flow of current through the probe cable shielding that will interfere with the measurement. An attempt may then be made to ground the probe body directly; however, this requires that the ground connection of the 55M System (and the ground connections of any auxiliary instruments in the setup) be broken (Fig. 10).

OPERATING PROCEDURE

(1) Selecting and Installing Cable Compensation Units
First, check that the probe cable length indicated in the CABLE LENGTH window of the 55M10 Standard Bridge is suited for the measurement to be carried out (5 meters, 20 meters, or 100 meters). If it is, select a cable of the proper length; if it is not, replace the Cable Compensation Unit accordingly.
This requires removal of the bottom plate of the cabinet of the 55M10 Standard Bridge. To do this, loosen the two retaining screws, then pull the Cable Compensation Unit upwards and out, thereby breaking the electrical plug-and-socket connection. This requires that the two CABLE COMPENSATION L and Q adjustment screws have been screwed so far into the Cable Compen-

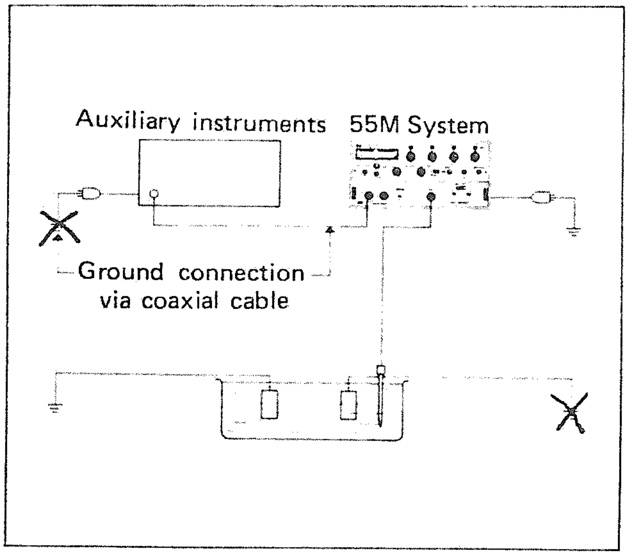


Fig. 9.

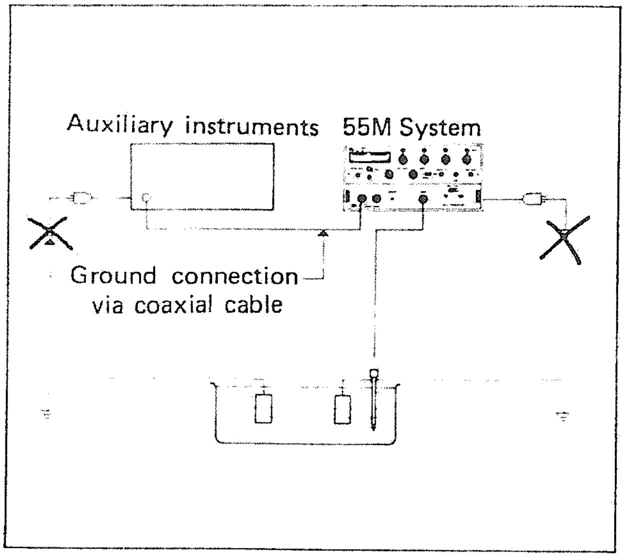


Fig. 10.

sation Unit that the guide bushings of the Standard Bridge will not obstruct their passage when the unit is pulled out.
The Cable Compensation Unit required for the probe cable length to be used may now be installed. Bolt the cabinet plate into place and thereafter slide the Standard Bridge into the Main Unit. When the plug-in unit is properly in place, both plug-in holders will snap upwards.

(2) Initial Settings of Controls
Before first applying power to the setup after the Main Unit, Bridge, cables, probe etc. have been connected up the controls should be set as described below. This initial procedure need not be repeated once the setup has been tuned up. Thereafter it is only necessary to set the FUNCTION switch to STD. BY before removing power from the equipment. After power has been re-applied, the setup will be ready for operation when, after sufficient warm-up time has been allowed, the FUNCTION switch is set to OPERATE

SQUARE WAVE:	OFF
HF FILTER:	1
VOLTS:	1
FUNCTION:	STD. BY
PROBE TYPE:	depending on probe type
GAIN:	1
Decade resistance:	00.00

(3) Applying Power
When power has been applied, the POWER ON pilot lamp on the Main Unit front panel will show light.
The meter will first deflect to the left, to below zero.
If the instrument was cold when power was applied, the meter needle will after approx. 90 seconds move slowly to the right, indicating that the various internal circuits are ready for operation. If the setup was in operation a short time previously, this time will be correspondingly shorter.
Before beginning any measurement the instrument should be allowed to warm up for at least 15 minutes.
Temperature balance will be reached after approx. two hours' operation at constant load (that is: with the probe current turned on). The length of the warm-up time should be chosen on a basis of how much drift can be tolerated.

(4) Measurement of Sensor Resistance
When the probe is plugged into the PROBE socket, a lead resistance is introduced in the active arm of the bridge, in addition to the sensor resistance. The sensor lead resistance depends on the probe type and on the various types of connection that are possible with it. It is composed of the resistance of the probe cable used, the resistance of the probe support, and the resistance of the leads in the probe body (between the points of connection and the sensor wire or film). The last-mentioned resistance is stated on the probe test card; for cable-equipped probes this cable resistance is included in the figure.
(a)
Plug the probe cable to be used into the PROBE socket.
When using cable-equipped probes, the free end of the probe cable which has just been plugged into the PROBE socket should be terminated in a reliable short-circuit.
If a probe is used which connects to the probe cable through a probe support, the support should be connected to the free end of the cable and thereafter short-circuited (with a shorting probe if possible).

If the probe to be used is to be soldered to the support, the resistance of the probe support should be measured and the probe thereafter soldered to the support. The probe may now be regarded as a cable-equipped probe, and the lead resistance will then be the sum of the probe support resistance and the resistance value stated on the probe test card.
(b)
Now turn the FUNCTION switch to the RES. MEAS position. This should cause a change in meter reading.