

***MINIMUM
FILM FORMING
TEMPERATURE BAR***



***OPERATING
INSTRUCTIONS***

RHOPOINT INSTRUMENTATION LTD

SPECIFICATION

Platen:	Copper, dull, nickel plated (other options available)
Platen Dimensions:	483mm x 235mm
Parallel Tracks:	Using 1" cube applicator (maximum 10)
Weight:	38kg (85lb)
Dimensions:	550mm wide x 350mm high x 610mm deep
Temperature Sensing:	10 points on centreline at width intervals, 37mm
Resolution:	0.1, -C
Accuracy:	(-5°C to +70°C +/- 0.1%) (70°C to 90°C-2.2%+0.3%)
Display:	Point temperature and temperature differential between adjacent points.
Indication:	Lamps; instrument ON, heating, cooling. Coolant failure.
Alarms:	Audible and visual for water flow failure.

SERVICES REQUIRED

Mains:	220 - 240 volts AC 110 - 120 volts AC
Air:	4 litres/minimum at 100 psig
Water:	Normal mains supply
Water Drain:	Gravity

COMPLETE INSTRUMENT COMPRISES

- MFFT Instrument
- Mains cable
- Air connector
- Water connectors
- Roving temperature sensor; M176/1 Bead and Cable Probe
- Cube applicator 75µm x 1" cube
- Guide bar
- Quantity - desiccant
- Quantity - indicator crystals
- Five hypodermic type dispensers
- Spare fuses
- Instruction book

OPTIONAL EXTRAS

- Additional cube applicators
- Frame for up to five applicators

SPECIAL OPTIONS

- Extended range by the addition of three programmes; 43-70, 53-80, 63-90 °C
- Unit for Nitrogen supply only, no air processor fitted
- Unplated copper platen

MINIMUM FILM FORMING TEMPERATURE BAR

The "minimum film forming temperature" has been described as "the minimum temperature at which a water-borne synthetic latex or emulsion will coalesce when laid on a substrate as a thin film. When this process occurs, in the absence of pigmentation or other opacifying materials, a clear transparent film is formed. At lower temperatures than the minimum, a white, powdery, cracked film will result".

The minimum film forming temperature is usually closely related to the glass transition temperature (Tg) but not synonymous with it; whilst the Tg may be determined by predicted calculation, the minimum film forming temperature is best determined by the use of a MFFT Bar, the basic principles of which are described in ASTM D2354. Early instruments were usually cumbersome, inaccurate and slow to achieve equilibrium. ICI plc devised a simple integrated instrument, which was able to achieve the desired results quickly and efficiently. The initial development was carried out in ICI Paints' laboratories.

PRINCIPLE OF OPERATION

A nickel plated copper platen is electronically cooled at one end and warmed at the other end. Air or nitrogen is caused to flow over the surface, from cool end to warm end as a uniform blanket. To achieve the required degree of uniformity the air or gas is delivered via a carefully designed sintered metal distribution block; the design is such that freezing does not take place at the inlet.

For use with air, a drying system is incorporated into the housing together with a flow controller. The air dryer contains indicator crystals, which are clearly visible in a transparent container. The complete air conditioning system is readily accessible at the side of the instrument.

Water at normal mains pressure removes the excess heat from the coolers. Quick release couplings are provided. Water is normally drawn from a laboratory tap and the outlet is run to drain by gravity. Alarms, both audible and visual are actuated in the event of cooling water supply failure.

Temperature sensors are mounted at intervals under the surface of the platen. These are used to control the temperature of the platen in accordance with the chosen programme. They are also used to indicate the platen temperatures down the length of the bar, or they can be switched to indicate differential temperatures between adjacent sensing points, so providing an instantaneous indication of temperature gradient.

A roving probe temperature sensor is provided to facilitate temperature measurement at every point on the platen, it also serves to check the static sensors.

A hinged perspex cover over the platen provides thermal insulation whilst allowing visual inspection of the determination as it progresses. A transparent cursor is mounted on the cover to simplify the identification of the exact film forming temperature.

PROGRAMMES

Standard model MFFT-60	°C					
	Cool end (Left)	-5	0	+5	+15	+23
Warm end (Right)	+13	+18	+23	+33	+50	+60

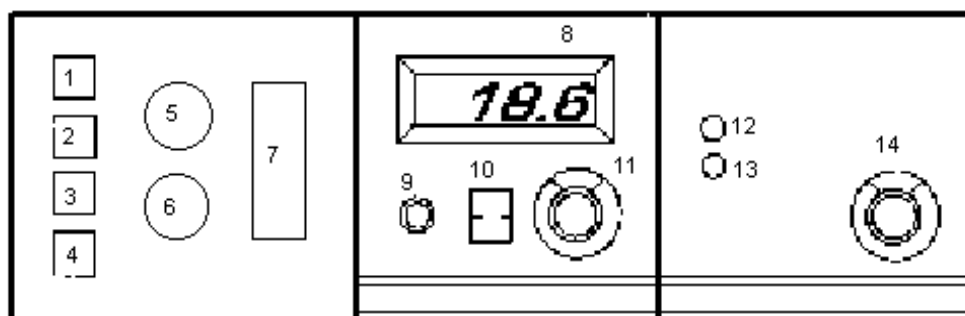
Extended range model MFFT90

Additional programmes

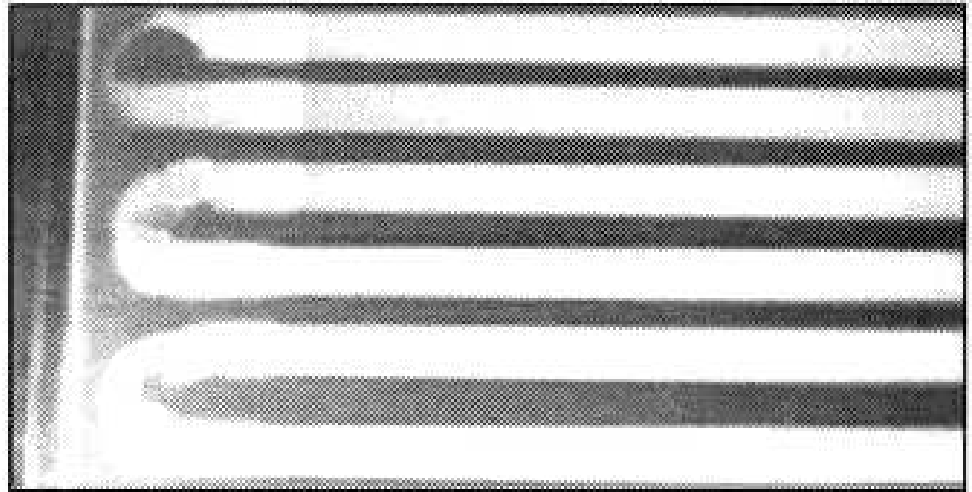
Cool end	+43	+53	+63
Warm end	+70	+80	+90

INSTRUCTIONS FOR AN MFFT BAR

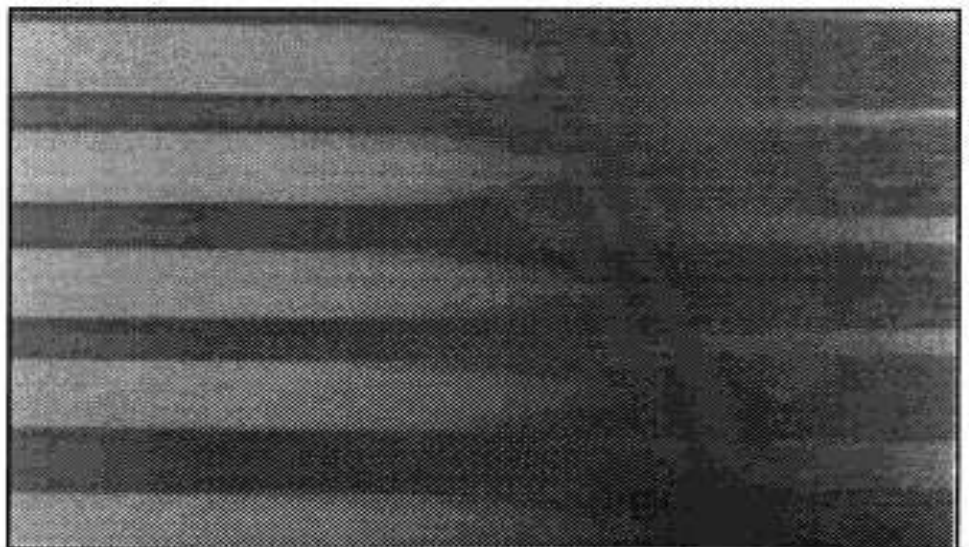
- 1 Check that the platen is clean and free from grease.
- 2 Check that air dryer indicator crystals are blue. If pink, change crystals. Unscrew transparent container, empty refill with activated alumina and silica gel indicating crystals.
- 3 Connect airline via coupler. Right hand side of air control panel.
- 4 Connect cold mains water and water drain (gravity). IN is right spigot, left is OUT spigot.
- 5 Close cover.
- 6 Turn on water. Water will flow only when cooling lamp is ON.
- 7 Turn on air supply. Check flow rate which should be 4 litres/minimum. Adjust flow rate if necessary. (See page 8.)
- 8 Select desired temperature programme. (14)
- 9 Plug in mains 240V 50Hz or 115V 60Hz dependent on model.
- 10 Switch on (1).
- 11 Lamps (1), (2) and (3) will be illuminated (except at higher temperature programmes when cooling light may illuminate at a low repetitive rate). On low temperature programmes cooling light is ON almost continuously. Allow 10-20 minutes for equilibrium condition to be achieved, this will be signalled by very slow intermittency of illumination of heating and cooling lamps (2) and (3).
- 12 Check temperature gradient using temperature selector control (11) either mode. Select on (10) temperature increments or differential temperature. (2°C lower temperature programmes 3°C higher temperature programmes.)



Alarm and On Module	Indication Module	Control Module
1 Mains switch - On/O11	8 Temperature display	12 Heating LED
2 Heating lamp indicator	9 Probe socket	13 Cooling LED
3 Cooling lamp indicator	10 Temperature mode switch	14 Programme selector
4 Coolant failure lamp	11 Temperature sensor selector	
5 Pressure gauge		
6 Pressure regulator		
7 Air flow controller		

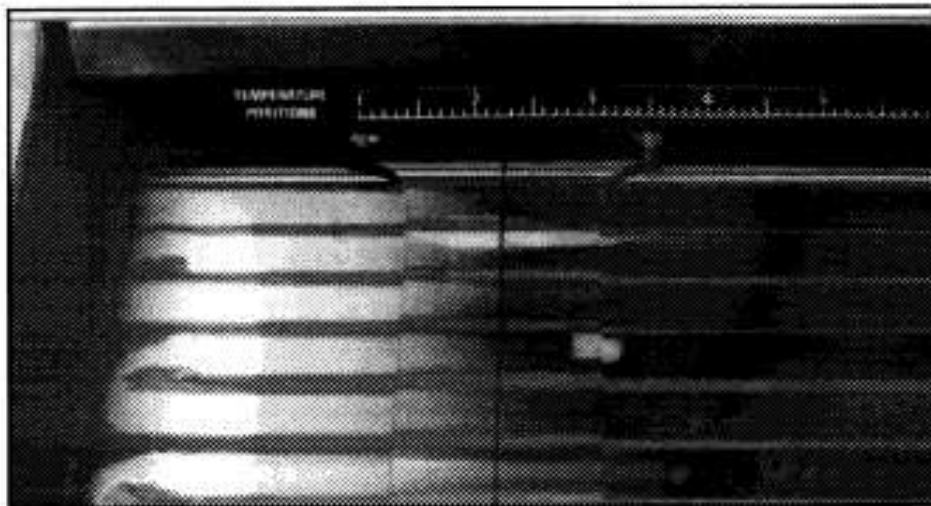


- 13 Apply emulsion using 75 micron cube applicator from warm end right to cold end left, or in form starting and finishing right hand side. Apply control strip using emulsion of known MFFT Up to 10 single tracks can be applied. All coatings should be applied within ten minutes. If there is a delay in applying a track, close the cover to prevent ice formation, reopening the cover as soon as the next coating material is ready. The use of several applicators is recommended if more than one emulsion is to be applied. If the hypodermic barrel dispensers are part filled with emulsion(s) beforehand, the cube applicator(s) can be charged quickly and easily. The guide bar is used to maintain even, straight tracks.
- 14 Close cover.
- 15 Check after about one hour when the film should be started to form.
- 16 When films have formed (see illustration) set cursor to read point on track where the film has coalesced over 90% of the track width.
- 17 Read scale number above cursor - set temperature sensor selector (11) to corresponding number. If cursor is between two scale numbers read temperatures corresponding to higher and lower scale numbers and interpolate result.
- 18 Use roving probe to read exact temperature of platen at MFFT point.



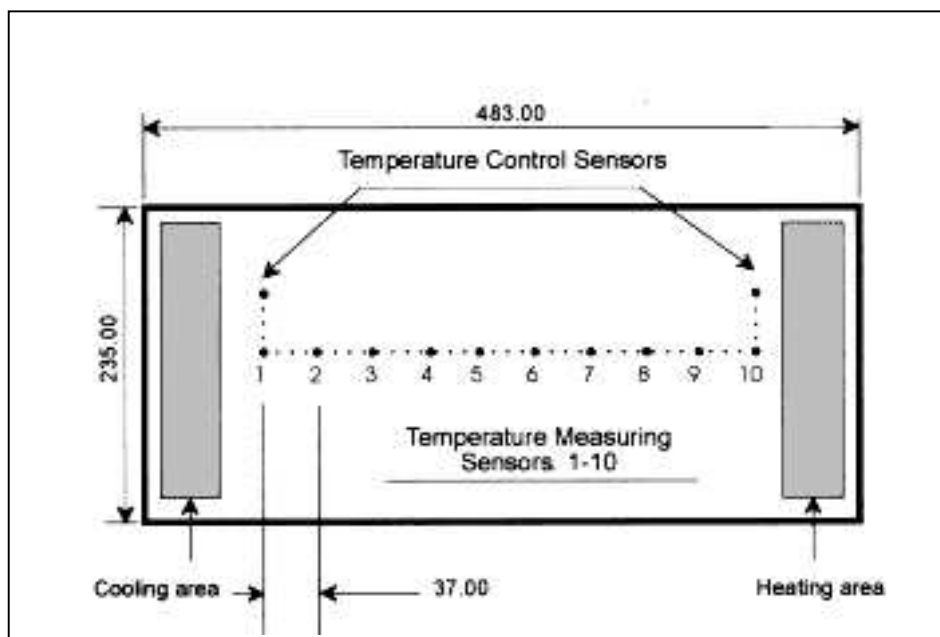
In the illustration below the cursor would be moved until it aligned with the point at which 90% of the track width has coalesced, i.e. on line with two on the scale.

Temperatures corresponding with two will depend on the programme selected for the test.



Programme	<i>Degrees Celsius</i>									
1	-5	-3	-1	+1	+3	+5	+7	+9	+11	+13
2	0	+2	+4	+6	+8	+10	+12	+14	+16	+18
3	+5	+7	+9	+11	+13	+15	+17	+19	+21	+23
4	+15	+17	+19	+21	+23	+25	+27	+29	+31	+33
5	+23	+26	+29	+32	+35	+38	+41	+44	+47	+50
6	+33	+36	+39	+42	+45	+48	+51	+54	+57	+60
Extended Range										
7	+43	+46	+49	+52	+55	+58	+61	+64	+67	+70
8	+53	+56	+59	+62	+65	+68	+71	+74	+77	+80
9	+63	+66	+69	+72	+75	+78	+81	+84	+87	+90

Copper plate



NINE RANGE TEMPERATURE CORRECTION

Non linearity above 80°C gives a repeatable error. Use indicated temperature and table below to give corrected temperature.

Display	80.5	81.0	81.5	82.0	82.5	83.0	83.5	84.0	84.5	85.0
Actual	81.3	81.8	82.4	83.0	83.6	84.2	84.8	85.4	85.9	86.5

Display	85.5	86.0	86.5	87.0	87.5	88.0	88.5	89.0	89.5	90.0
Actual	87.2	87.8	88.4	89.0	89.6	90.2	90.8	91.5	92.1	92.7

PIGMENTED EMULSIONS

The MFFT bar is sometimes used for tests on pigmented emulsion, where the MFFT determination is more difficult because there is no clearly defined change in "colour" of the coalesced film.

There is, however, a slight change in the shininess of the surface and using a wooden spatula, lightly scraped on the surface, it is easy to define where the coalesced film stops and where the remaining film is poorly integrated and heavily cracked with very poor adhesion.

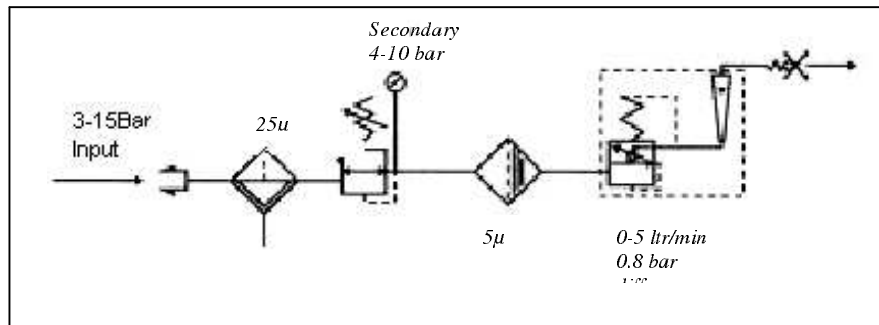
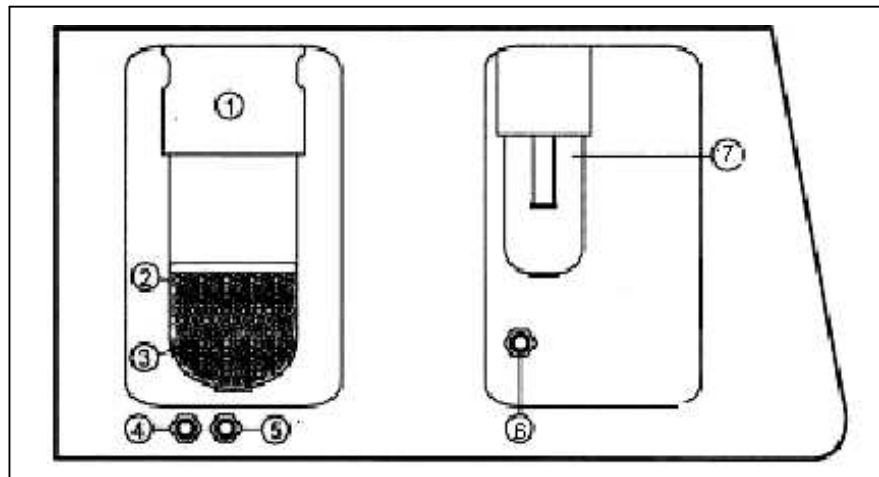
CLEANING

Immediately after use the platen should be cleaned; the most common method is to use a dilute detergent applied with a nylon scouring pad. Solvents to the particular coating can be used.

Copper platens can be bright finished using dilute citric acid.

Some users apply the coatings to self-adhesive plastic tape or film which has been laid on the platen. The temperature error due to the intervening layer is said to be about 0.1 °C. Cleaning is accomplished very quickly - the method commends itself when the MFFT bar is used for production control.

AIR PROCESSOR



- | | |
|--|----------------------------------|
| 1. Dessicator | 5. Water inlet and outlet |
| 2. Dessicator (need replacing when
Indicating crystals turn pink) | 6. Air inlet |
| 3. Indicating crystals | 7. Air inlet filter (auto-drain) |
| 4. Water inlet and outlet | |

RHOPOINT HIGH-LOW TEMPERATURE CONTROLLER S1212114

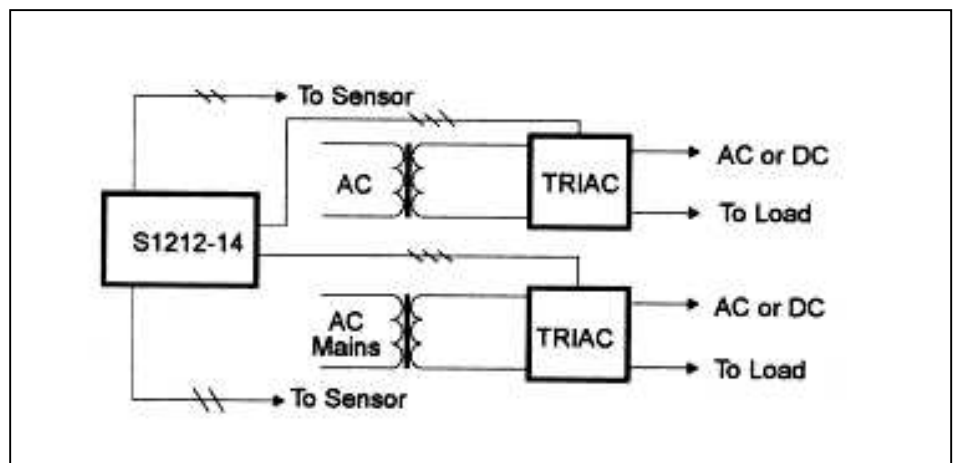
The controller is used with transformers to provide control over the heating and cooling systems operated at low voltage but high current.

Power for the controller at about 60mA is derived from the load supply. Zero crossing gate switching is employed for minimal R.F. Interference. Pre-selected levels of temperature can be switched in each of the two channels; lamps indicate operation of the Triac units.

Triac units are fitted adjacent to the heater and/or coolers.

The controller is mounted on a Eurocard 100mm x 160mm.

Module size 3U x 21E (137mm high X 107mm wide).



OPERATIONAL AND TEST NOTES

- 1 The Rhopoint S1212 indicator multipoint temperature indicator is a self-contained module. To withdraw it from the front panel, release the four screws, one each, top and bottom, left and right of the module's panel and pull the unit forward using the handle provided.

The roving probe sensor is not waterproof but alternative sheathed sensors are available for tests in ice and boiling water.

- 2 Differential temperatures should be checked with air flowing and the platen cover closed, with coolant water flowing.

The temperature differential between sensing points should be $2.0 \pm 0.2^\circ\text{C}$ on lower programmes, $3.0 \pm 0.2^\circ\text{C}$ on higher programmes. See table page.

- 3 Test the evenness of film formation using two emulsions of known MFFT. A 6°C emulsion can be tested on programmes 1 or 2, a 15°C emulsion can be tested on programmes 2 or 3. If both emulsions are used simultaneously, programme 2 would be the appropriate range.

- 4 The range of MFFT points on dried paints should be less than $\pm 0.75^\circ\text{C}$ from the mean position.

- 5 The temperature controller is tested *in situ*. Adjustment is provided to minimise overshoot or undershoot to $\pm 0.2^\circ\text{C}$.

- 6 Coolant water is checked by ensuring that it flows from the outlet to drain. Water flows only when cooling lamp is on.

- 7 Coolant alarm is checked by turning off the water coolant for a **SHORT TIME**. If difficulty is experienced with alarm, reset reverse water flow with mains on until alarm is silenced.

- 8 Air leaks are identified by checking with a 10 litre air storage bottle with pressure set at 15 PSI, flow at 4 litres per minute supply should last $2\frac{1}{2}$ minutes.

Check air dispersion plastic filter - left hand side of platen cover. Ensure that it is free of paint or contamination which would affect linear air flow. Check that lid seal fits uniformly without gaps and that the air exit - right hand side of platen cover is uniform and not distorted.

- 10 Set pressure regulator to 60 PSI.

- 11 Check flow controller over its range and set finally to 4 litres per minute.

- 12 Check that cursor is free running and square and free of contamination.

- 13 The desiccant will normally last for 4 or 5 determinations, when the indicator crystals will turn from blue to pink. The desiccant (activated alumina) and indicator crystals (silica gel) should be replaced. Remove container by rotation. Discard contents and refill to red line. Replace container making sure that it seats on the ring seal.

FUSES

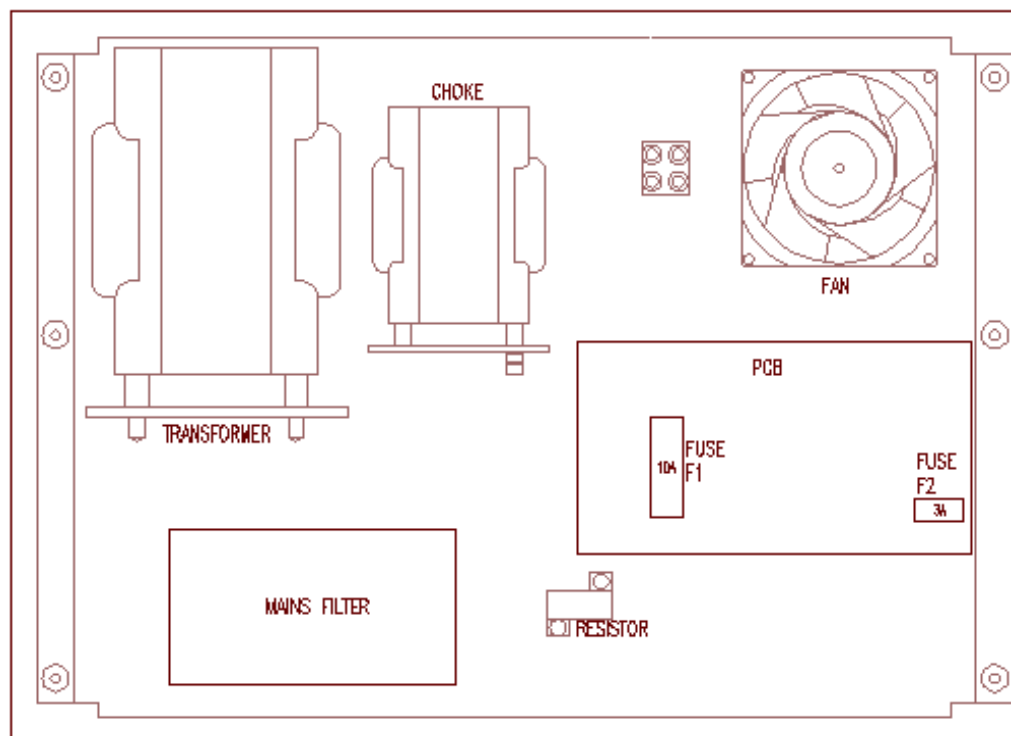
Fuses fitted.

FS1 One 50mA, A/S, 20x5 mm fuse is fitted in the temperature indicator unit. See diagram on page 9.

FS2 One 3,15A/S, 20x5mm fuse is fitted on the main PCB.
See diagram below.

FS3 One 10A, 40x10mm HRC (IR A350- 10) fuse is fitted on the PCB.

FS4 Two 5A, A/S, 20x5mm

**MANUFACTURE
AND
SALES****RHOPOINT INSTRUMENTATION LTD**

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