TECHNICAL NOTE

DATE :October 9, 1996

FROM : Venkatasubramani. T. L.

SUB : Shielding Effectiveness of GMRT Electronic Cabinets.

1.0 The Shielding effectiveness of the 19" wide 42U tall electronic cabinets, designed and developed for GMRT by M/s Stellar Modular Systems Pvt Ltd, Mumbai was independantly checked at Research Centre Imarat (RCI), Vignyanakancha, Hyderabad. The cabinet submitted to RCI had the additional feature of a conductive aluminium tape fixed along the periphery of the doors. Otherwise, it was similar to the one currently used in GMRT for housing ABR electronics at antenna shells and for Base-band, LO and Optical fiber electronics in the CEB.

2.0 A copy of the set of 12 posters, presented by me during the International Conference on EMI and EMC at Madras during Dec 6-8, 1995 is enclosed along with this note, to give sufficient information regarding our efforts (Pages 2 to 13).

3.0 The Test Report by RCI is also enclosed (Pages 14 to 16) with this note.

4.0 The results obtained at RCI are more or less consistent with measurements done at NCRA, atleast in the range of 200 to 600 Mhz. It appears from RCI data that there is an anti-resonance in the cabinet at around 900 Mhz (See Page 16), to give an increased shielding. This was not noticed in NCRA measurements (See page 12) due to inadequate sampling across the frequency band.

INDIGENOUS DEVELOPMENT OF A RFI SHIELDED CABINET FOR ELECTRONIC ASSEMBLIES

T. L. VENKATASUBRAMANI

Abstract:

A low-cost RFI-shielded all-aluminium cabinet has been indigenously designed and developed to house the electronic sub-assemblies of the Giant meterwave Radio telescope (GMRT) receiver. The cabinet is about 600 mm wide, 750 mm deep and 2100 mm high. It is internally designed to take standard 19" wide sub-racks, totally measuring 42U (1U=1.75") in height. The cabinet provides a shielding effectiveness of around 50 dB at 300 MHz, which drops down to 40 dB at 1000 MHz.

The cabinet was specially fabricated for the GMRT project by M/s Stellar Modular Pvt. Ltd., Bombay.

National Centre for Radio Astrophysics, GMRT Project,
Tata Institute of Fundamental Research,
Poona University Campus, Pune 411 007, INDIA.

1.0 Introduction:

The designer of the receiver system for a Radio Telescope operating in VHF and UHF bands has to not only consider the effects of external RFI sources but also the "Self-Produced RFI" by the receiver being built. This can be minimised by:

- Avoiding high-speed digital electronics close to the antenna, especially near the Feed and in the Front-end receiver;
- Using lowest speed devices, sufficient to meet the design requirements;
- Switching off sub-systems with high-speed digital electronics whenever not required;
- Following appropriate shielding practices at the location of the source of self-produced RFI;
- Using independant clocks of needed accuracy and not tying them to a single source to result in phase-coherent RFI;
- Locating the electronics in a shielded cabinet, which is in turn located inside a shielded room.

The results of the design and development efforts of the RFI-shielded cabinet to house the GMRT receiver is presented here.

2.0 Estimation of Shielding Effectiveness specification:

The worst-case effect of Self-produced RFI occurs when a locally generated signal, either by itself or as an inter-modulation product with other self-produced/ external RFI signal falls with in the RF band under use and is radiated and picked up by the feeds of nearby antennas. A thumb-rule normally followed is that such interfering signal should not result in degradation of the receiver sensitivity for 1 hour integration by more than 1%.

The First-order specification for the shielding effectiveness of the cabinet may be estimated as under:

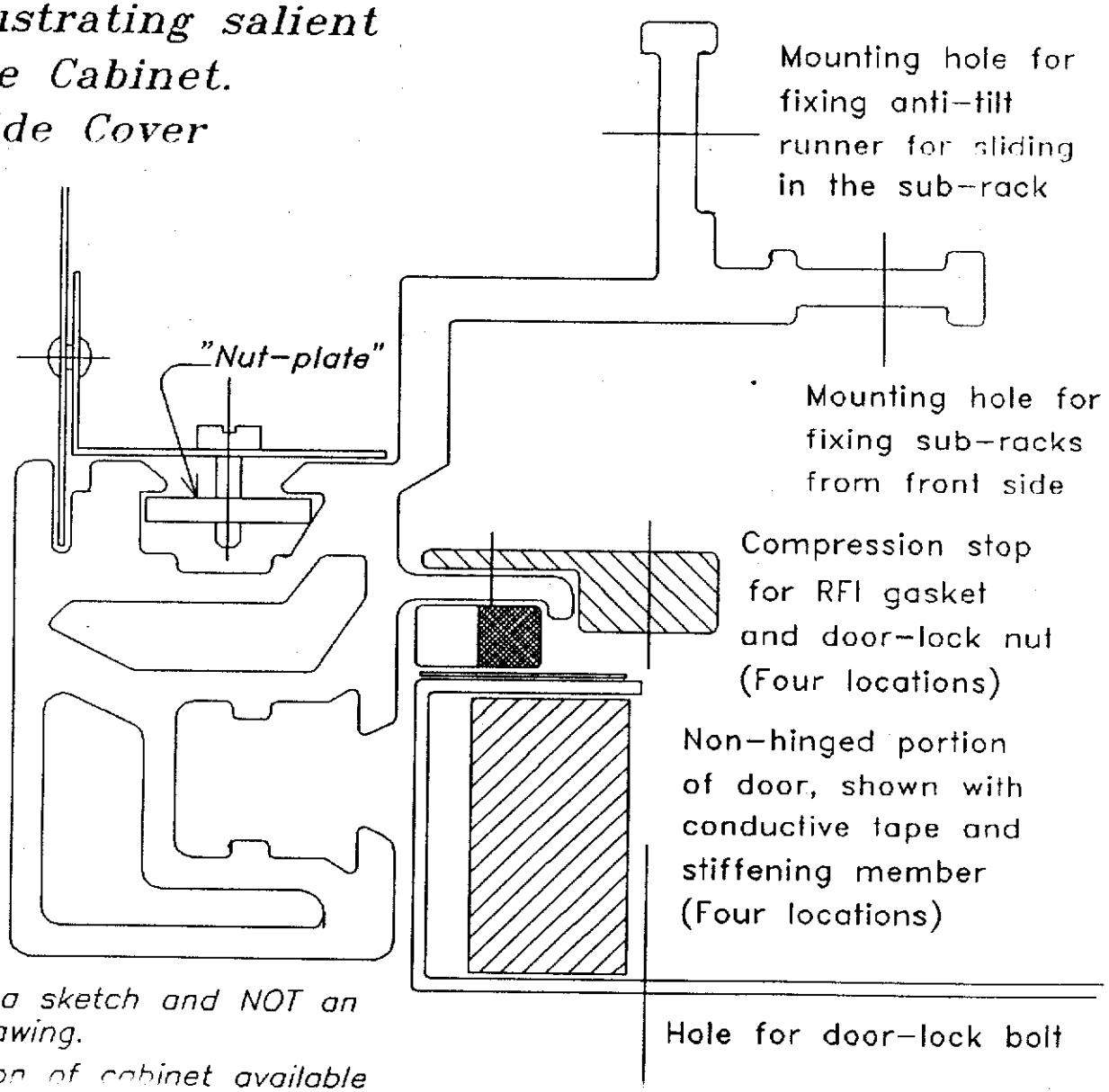
- Power of self-produced RFI is -60 dBW, which is radiated by an isotropic radiator from inside the cabinet
- Shielding effectiveness of the room where the cabinet is housed; Typically 60 dB
- Distance between closest antennas of the array; Around 100m
- Gain of the near-by antennas in the direction of the source of self-produced RFI is 0 dB.
- Typical Radio Astronomy receiver has a bandwidth of 1 MHz and a system temperature of 100 deg. K.

Using the above parameters, it could be calculated that a shielding effectiveness of the order of 40 dB is needed.

3.0 Salient Features of the Cabinet:

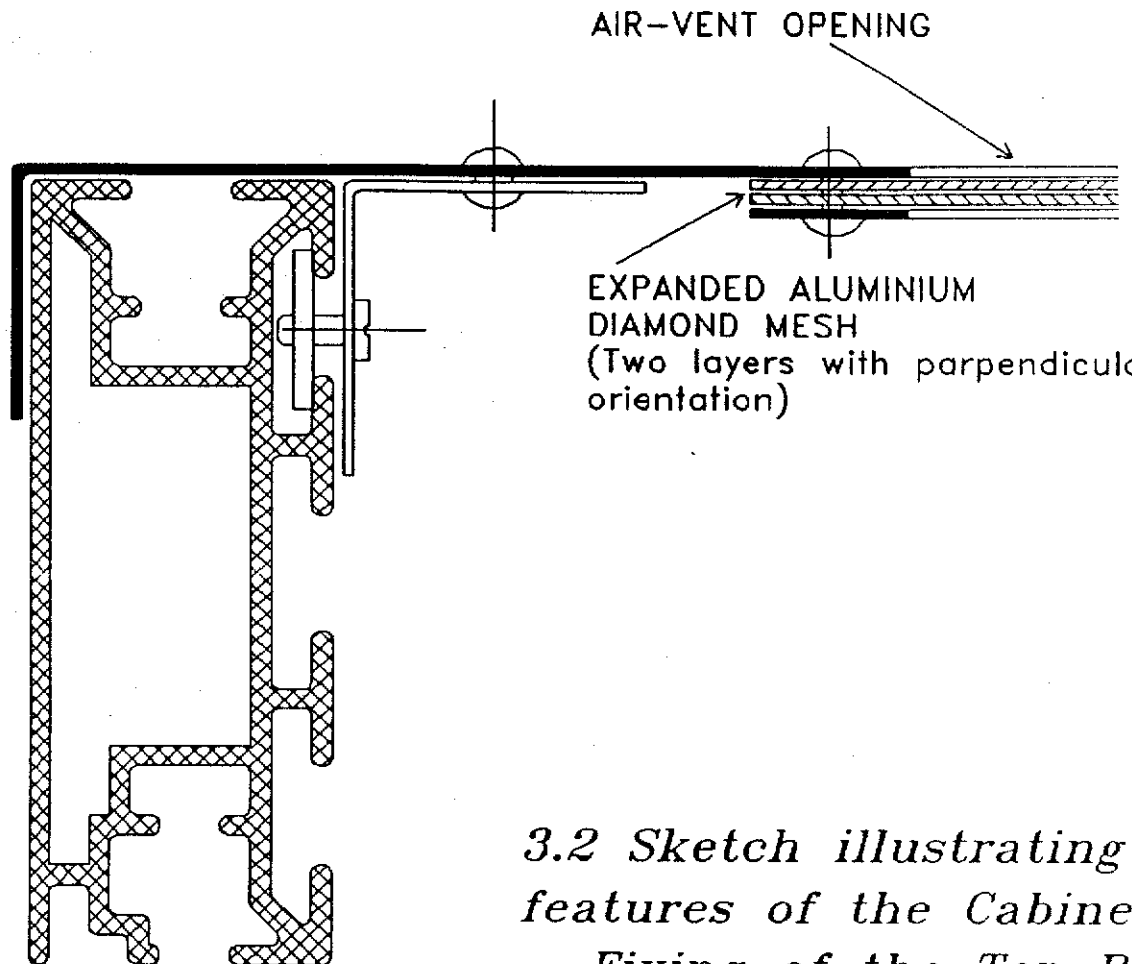
- Overall size 600 mm x 750 mm x 2100 mm.
- Uses specially developed extrusions in a "Bolt Plus Rivet" assembly with minimal welding. All mating surfaces are chromatised. Construction of the cabinet ensures that the self-produced RFI encounters atleast two perpandicular obstructions before it can leak to the outside world. Length of any thin slit is limited to 50 mm and the larger dimension of any slot, 5 mm.
- Incorporates facility to plug in and mount standard 482.6 mm (19") wide sub-racks with a simple "Anti-tilt" mechanism for a total height of 42U (1866.9 mm) from both front and rear.
- A simple design for air vent at the top and bottom of the cabinet using double layer of Aluminium diamond wire mesh.
- Front and rear doors fixed using full height piano hinges with an opening angle of about 130 degrees. A knitted wire mesh gasket around comprssible neoprene former is fixed on the other three sides of the door frame in specially formed grooves of the extrusion. Conductive tape is struck to the mating surface on the moving door. Stops are provided to prevent over-compression of the gasket. A simple 4-point locking mechanism using knobs has been adopted.

3.1 Sketch illustrating salient features of the Cabinet. – Door and Side Cover



Note: This is only a sketch and NOT an Engineering drawing.

Corner section of cabinet available with author.

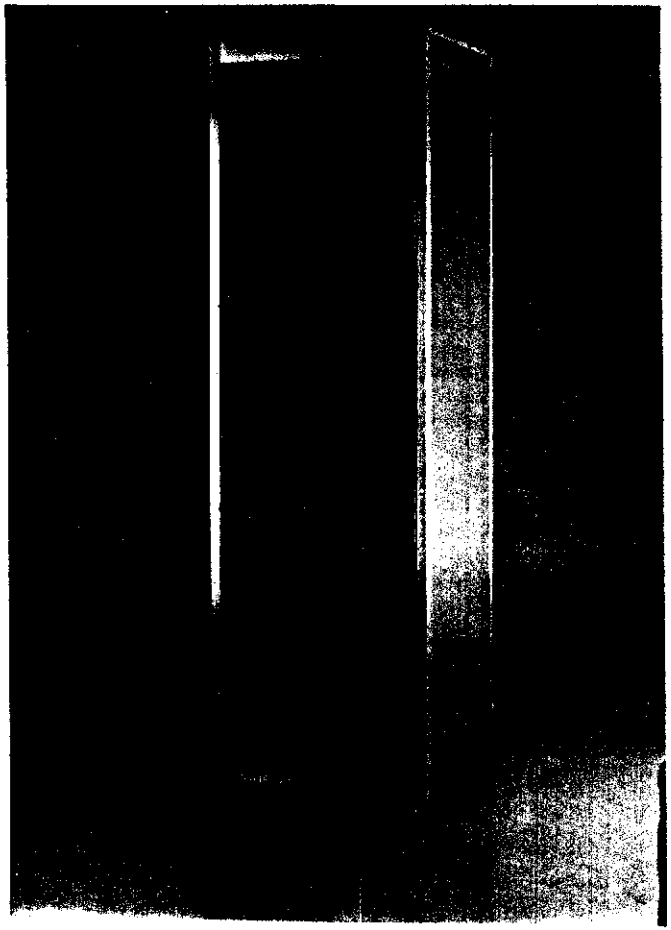


3.2 Sketch illustrating salient features of the Cabinet. – Fixing of the Top Plate

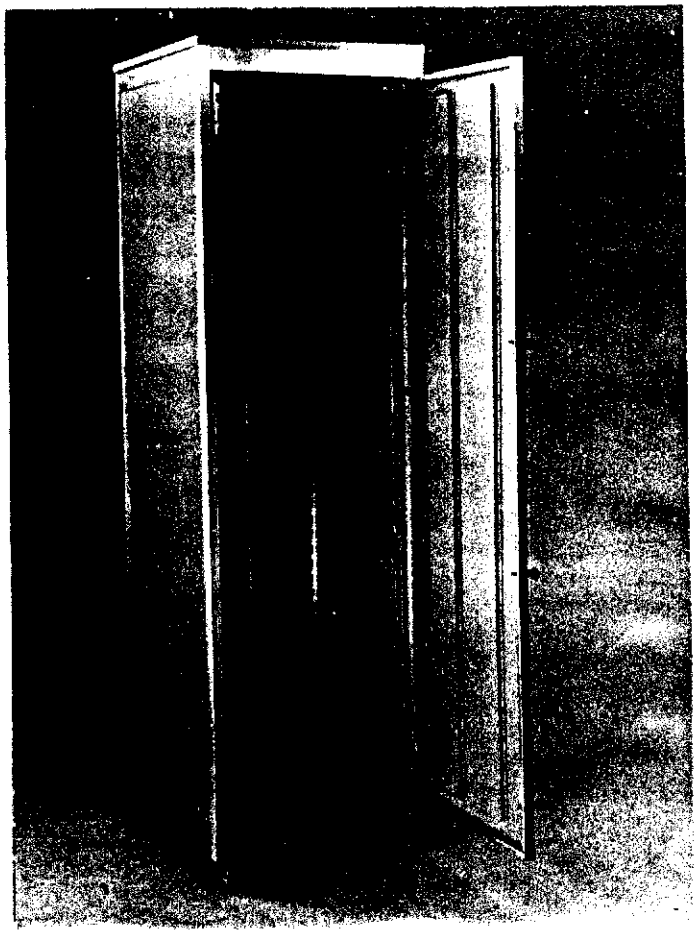
Note: This is only a sketch and NOT an Engineering drawing.

Corner section of cabinet available with author.

3.3 Photographs of the Overall Cabinet

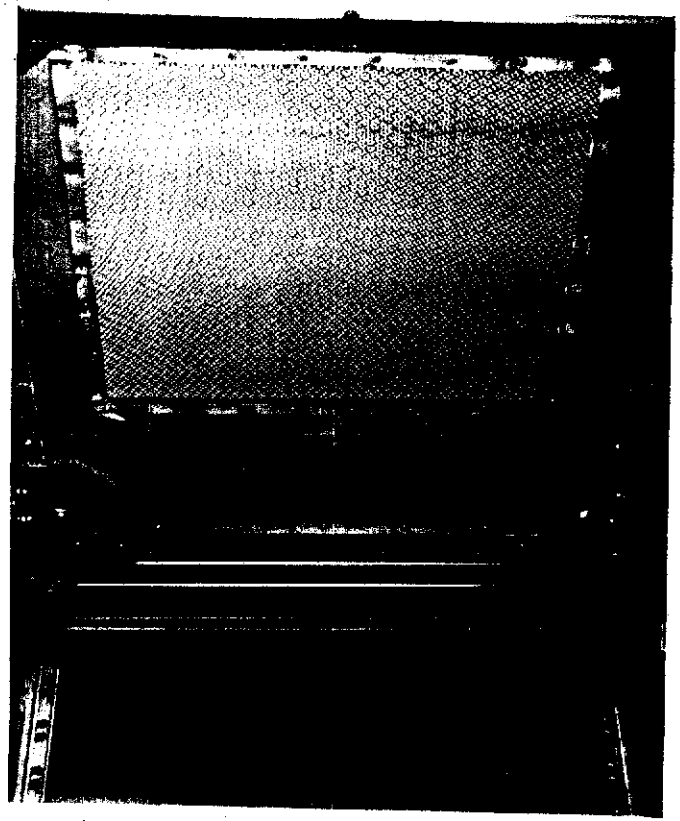


View to highlight Door-lock, castor wheels and arresting bolts.

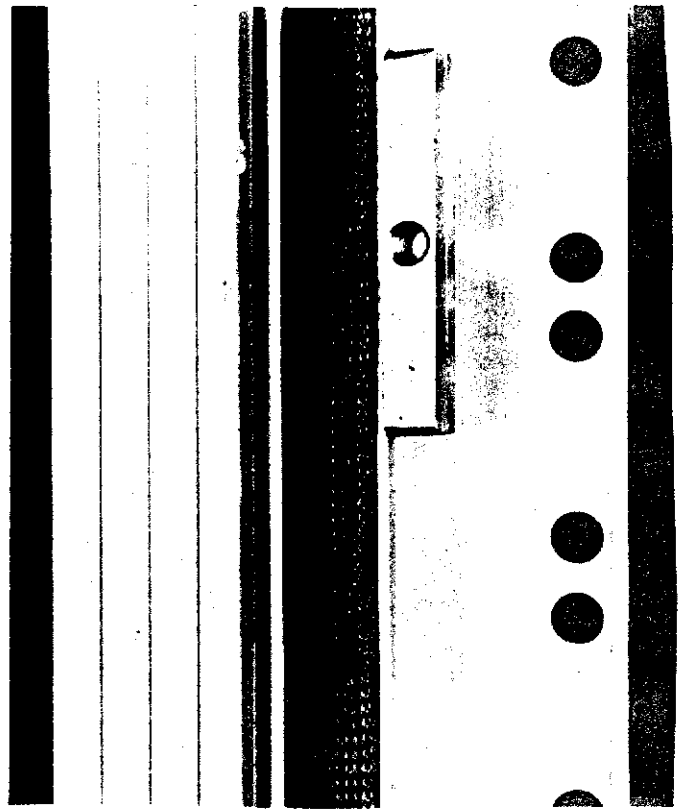


View to highlight piano-hinge, door-stiffener, side covers and the bottom plate with air-vent.

3.4.1 Photograph of Internal Details

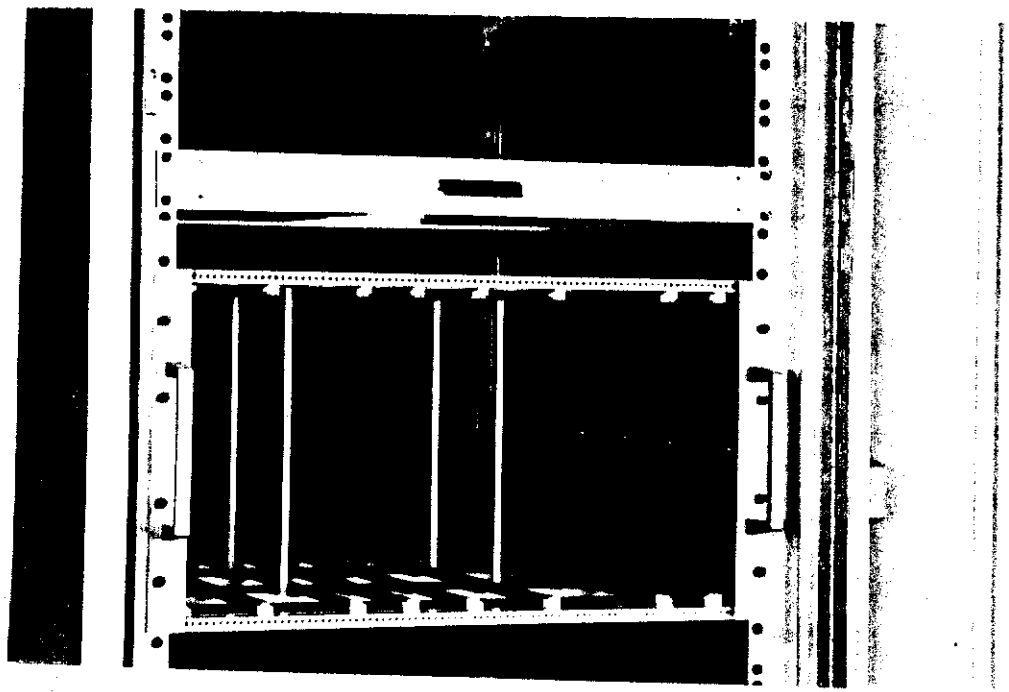


View to highlight top cover assembly and the air-vent.



View to highlight compression stop, door-lock nut and the RFI gasket.

3.4.2 Photograph of Internal Details



View to highlight Anti-tilt runner, piano hinge, c-bend stiffening member, typical sub-rack and typical fan tray.

4.0 Measurement Procedure:

(a) The DC resistance between a "Grounding Bolt" on one of the side covers and all points of the rack was measured using a sensitive milliohm meter.

The maximum resistance recorded in a typical rack was 100 milliohms.

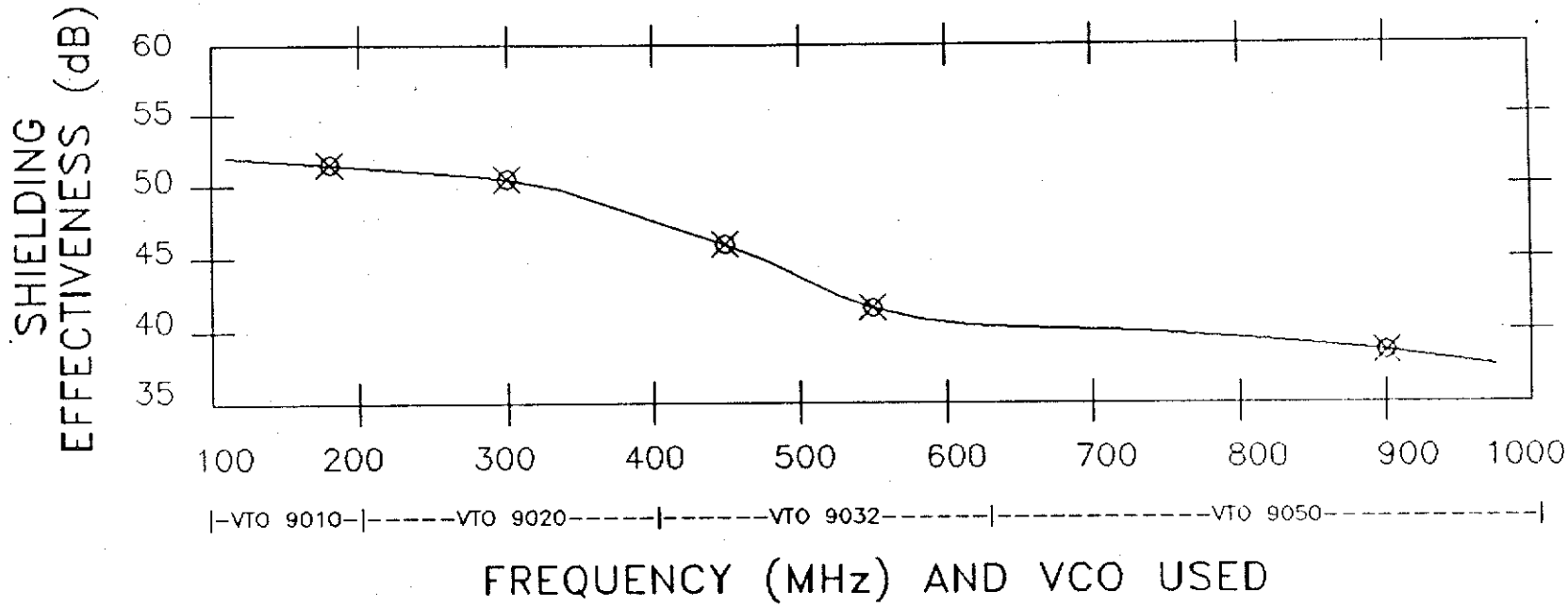
(b) The RF shielding effectiveness was measured by Insertion method in the terrace of the NCRA building at Pune. A battery powered VCO and a whip aerial with ground plane, form the transmitter. The receiver comprises of a similar antenna located 5 m. away, an amplifier and a Spectrum Analyser.

The Base Reading is first taken without the cabinet. Then the transmitter is mounted inside the cabinet and the doors closed. Readings are taken in the Eight compass directions by rotating the cabinet along it's vertical axis and the Average computed. The procedure is repeated at various spot frequencies.

Shielding Effectiveness of the cabinet is the difference between Base reading and Average reading.

(c) A cabinet has been submitted for characterisation at a premier RFI test facility in India and the results are expected shortly.

5.0 Response of a Typical Cabinet:



6.0 Furthur Work:

(1) To simplify and improve door-lock mechanism for better and operator-independant repeatability of results.

7.0 Conclusion:

A low-cost indigenous RFI-shielded cabinet has been successfully developed. The cabinet provides a shielding effectiveness of around 45 ± 6 dB over 100-1000 MHz range, which meets the requirement.

Acknowledgement:

Thanks are due to colleagues at NCRA, Pune, especially Mr. B. Ajith Kumar and Mr. M. N. Karthikeyan, for their contribution as the cabinet evolved from concept to reality.

Thanks are also due to Mr. Elias, Technical Director, M/s Stellar Modular Systems Pvt. Ltd., Bombay for his efforts in the iterations to bring the performance of the cabinet to the current level.

E.EL/A 5

EMI/EMC CENTRE

आर सि आई

No. RCI/EMI/EMC/ 736/1243
DATE : 17-06-96

This Report Contains 3 Pages.

TEST REPORT
ON

SHIELDING EFFECTIVENESS TEST ON ELECTRONIC CABINET OF M/s STELLAR MODULAR SYSTEMS FOR GMRT PROJECT - NCRA - TIFR, PUNE

TEST ENGINEERS

EMI/EMC TEAM	REPS. OF WORK CENTRE
K.SURYANARAYANA	T.L.VENKATA SUBRAMANI
DEVENDER	RAJIV BEHL
SMT.SHANTA SARVADE	

ISSUED BY

(K. NAGESWARA RAO, Sc. 'F')
MANAGER

JOB WORK UNDERTAKEN FOR

M/s STELLAR MODULAR SYSTEMS, BOMBAY

[illegible]
[illegible]
MINISTRY OF DEFENCE
RESEARCH & DEVELOPMENT ORGANISATION
HYDERABAD - 500 069
• TELEPHONE : 040-311942 • TELEX : 0425-2212/2342 • FAX : 040-242666, 311941

SHIELDING EFFECTIVENESS TEST RESULTS OF ELECTRONIC CABINET 19"

I FRONT SIDE:

FREQUENCY(MHz)	SHIELDING EFFECTIVENESS(dB)
100	37
200	57
300	42
400	39
500	35
600	37
700	16
800	18
900	29
1000	19

Results obtained above are the optimum test results. Test was repeated for three times and got the consistant results each time. Test set up is shown in Figure.

SHIELDING EFFECTIVENESS TEST RESULTS OF ELECTRONIC CABINET 19"

I FRONT SIDE:

FREQUENCY(MHz)	SHIELDING EFFECTIVENESS(dB)
100	37
200	57
300	42
400	39
500	35
600	37
700	16
800	18
900	29
1000	19

Results obtained above are the optimum test results. Test was repeated for three times and got the consistant results each time. Test set up is shown in Figure.

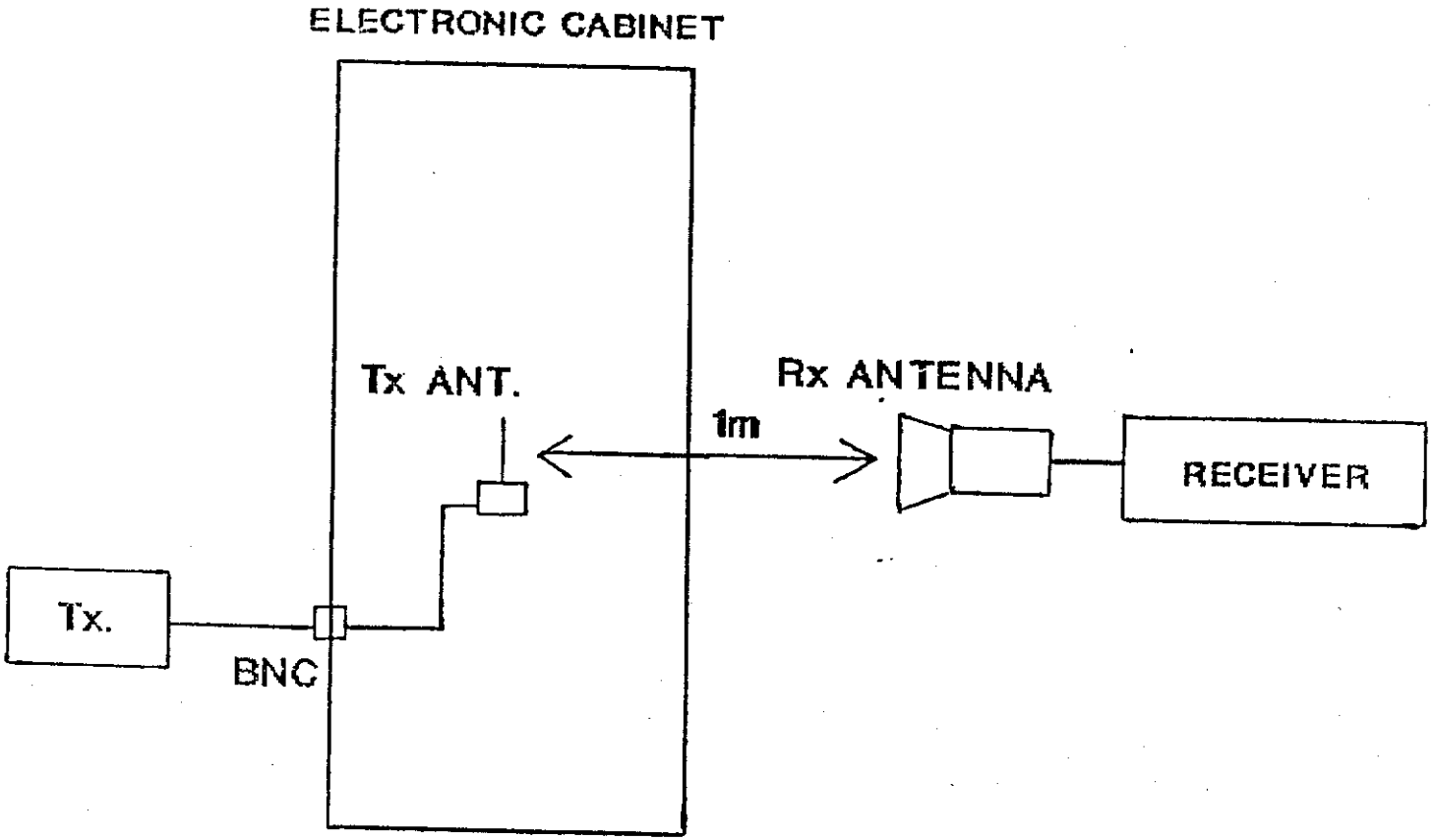


Fig: TEST SET-UP