Matching Network for the Mex. IPS Array - New Development

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Technical Note : MxA/TR/2k2 – 02

1 Introduction :

This report is in sequence to the first one: MxA/TR/2k2 – 01. As repeated measurements through a network-designed as per this (1st) report, failed to tune the array to 138 MHz, doubts were raised about the R and X measurements by the Network Analyser. Repeat measurements of R and X by the Analyser showed widely varying values, when compared to the first. An alternate method by employing the Reflection/Transmission set (HP 87512A) along with the Vector Voltmeter (HP 8508A) yielded the stable and reliable set of R and X values. Hence a new network was designed, constructed and tested at the array. Postive results were shown by this network and this report gives it along with an Appendix outlining the operating procedures of the Vector Voltmeter. Future measurements for the complete array can be quickly done using this section as a test–manual.

2 The New Matching Network :

R and X of dipoles spanning from Row 1 to Row 6 of the array were measured at the four balun-ports, and Table 1 gives the measured R and X of the array(accurate and reliable set of data).

Table-1

`Vector Voltmeter -- HP 8508A & Refl./Trans.Test Set HP 87512A`
`All values are in Ω`

Dipole	Balun-1		Balun-2		Balun-3		Balun-4	
Row	R	X	R	X	R	X	R	X
1	44.2	-2.40	43.4	-2.84	43.8	-0.12	42.9	-1.30
2	44.1	-2.35	43.2	-2.63	42.3	-1.43	44.9	-0.92
3	42.5	-2.05	42.8	-3.72	42.7	-1.64	42.1	-1.39
4	41.2	-2.45	41.6	-3.25	41.6	-1.99	41.3	-1.55
5	42.0	-2.68	42.0	-4.10	41.0	-0.95	41.8	-0.69
6	40.5	-2.28	41.0	-2.20	40.6	-0.51	41.7	-0.30

The average of this 24 sets, $R = 42.3\Omega$ and $X = -1.906\Omega$. The normalized values are: $R_d = 0.846$ and $X_d = -0.038$
This again is similar to the location of R and X in the Smith's chart, as discussed in 1st report and hence the matching network configuration is the same (series inductance and a shunt capacitance).

Then Eq.(1.11)[1] becomes,

$$t^2 - 0.07624t - 0.12883 = 0 \qquad (1)$$

This equation does not have any real roots.Checking through the inequality of Eq.(1.16), a solution is obtained after iterative steps (as given in the Table at p.6 of the 1st report), as $s = 2.3$ and the corresponding $t = 0.4092$. So $C_1 = 10$ pF and $L_1 = 23.6$ nH.

3 Results :

A network with the above values was incorporated at the balun and the array's tuning was checked. Fig.1 shows the plot with and without the network. It is clear from the plot that the 138 MHz tuning has been accomplished, though the 115 MHz band is still present. This could be easily filtered off as the SWR at 138 MHz is lower than that of 115 MHz. More precise wiring and housing the balun + network inside the enclosure is bound to improve the frequency response of the array.

4 Acknowledgement :

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[1] The prefix to the Eqn.no. is added to signify the 1st report's Eqns.

Appendix –A
Measurement Procedures

The following equipments are required for the measurement of R and X as well as the frequency response of the dipole array:

1. Signal Generator (1MHz to 500 MHz.)

2. Vector Voltmeter – HP 8508A

3. Transmission/ Reflection Test set – HP 87512A

4. Standard loads,shorts and approx.10m. length of RG 223 cable

Fig.A1 illustrates the test set–up.

- Connect the units as shown in Fig.A1. Two short coaxial cables (of **equal electrical length**) are required to connect the `Incident` and `Reflected` ports of 87512A to Ch.A and Ch.B of the Vector Voltmeter. (*Direct coupling could also be done, exercising caution while engaging the threads of both A and B.*)

- Choose the middle of the frequency band of interest and set it at the Sig.Gen. Power level can be around -20 to 0 dBm. (Pl.see Note-2)

- Connect the long cable (RG 223). Do the calibration using this cable.With a short connected first (after presetting the VVM, selecting `UNITS` as dB and `REF SELECT` as **SHORT**...), press the `SAVE REF`.. VVM should now read a return loss of 0 dB and -180 deg. If the test frequency is changed re-calibration will be needed (Pl.see Note-1)

- Connect now the 50 - ohm Load. At `Z` being selected in the `REFLECTION B/A` key, it should read 50.0 $\pm$ j0.0.

- Connect the Test device/Antenna now to the test-port and measurements are commenced, To measure the freq. response (within the chosen band and calibration done at centre-of-the-band), vary the freq. at the Sig.Gen.in steps, and record the VVM display.

Note-1 :

For about 100 MHz. range, a single calibration at the centre-of-the band would be adequate enough. Anyhow one can check the accuracy of calibration by measuring the Std. Load's impedance at both ends of the band; If the reactances are appreciable, select a two freq.calibration: roughly one-third and two-third of the band can be set as the calib. frequencies.

Note-2 :

If the test-device includes an amplifier please ensure proper power levels at the Sig.Gen. Always choose a negative dBm level (approx. -30 or -40 dBm). VVM will display a NO LOCK if the input at Ch.A falls below -50 dBm. So a diligent choice is required at fixing the power levels.

Do **not** exceed the safe power levels marked at 87512A.

> IMPORTANT: `The HP 87512A Trans./Refl. set has a discrepancy in the port--marking shown on the top face to the side's marking: ALWAYS REFER THE MARKINGS ON THE SIDE for` *Incident* `and` *Reflected* `ports to be connected to the corresponding ports of VVm.`

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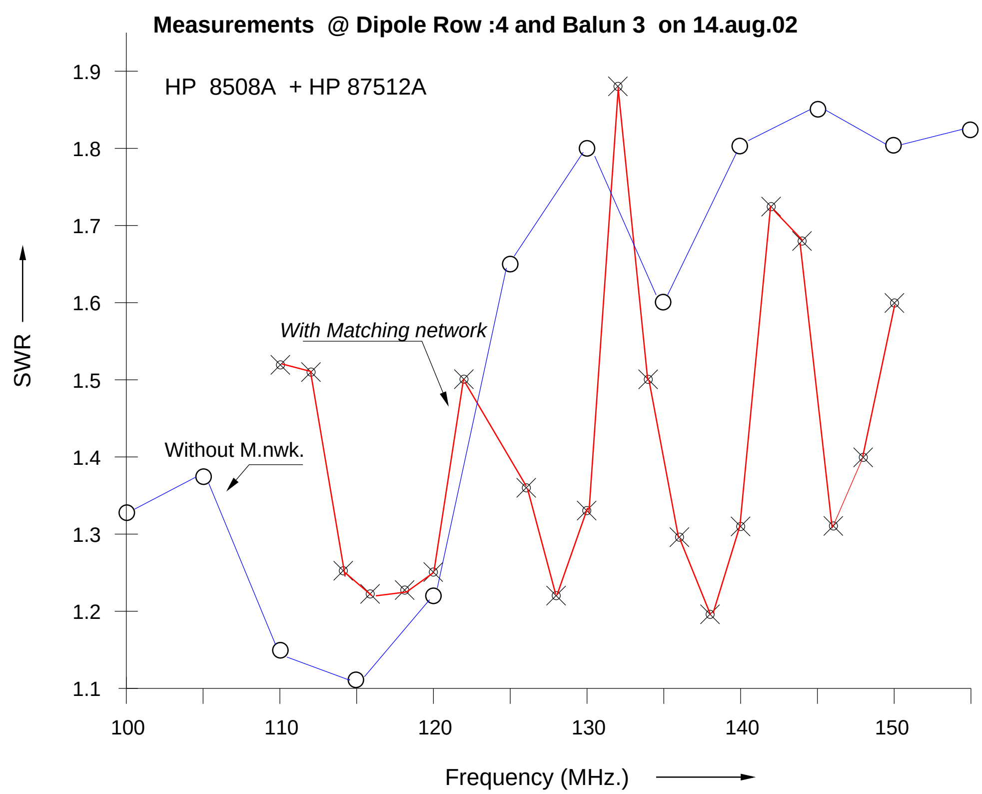

Fig. 1 [MxA/TR/2k2 − 02]

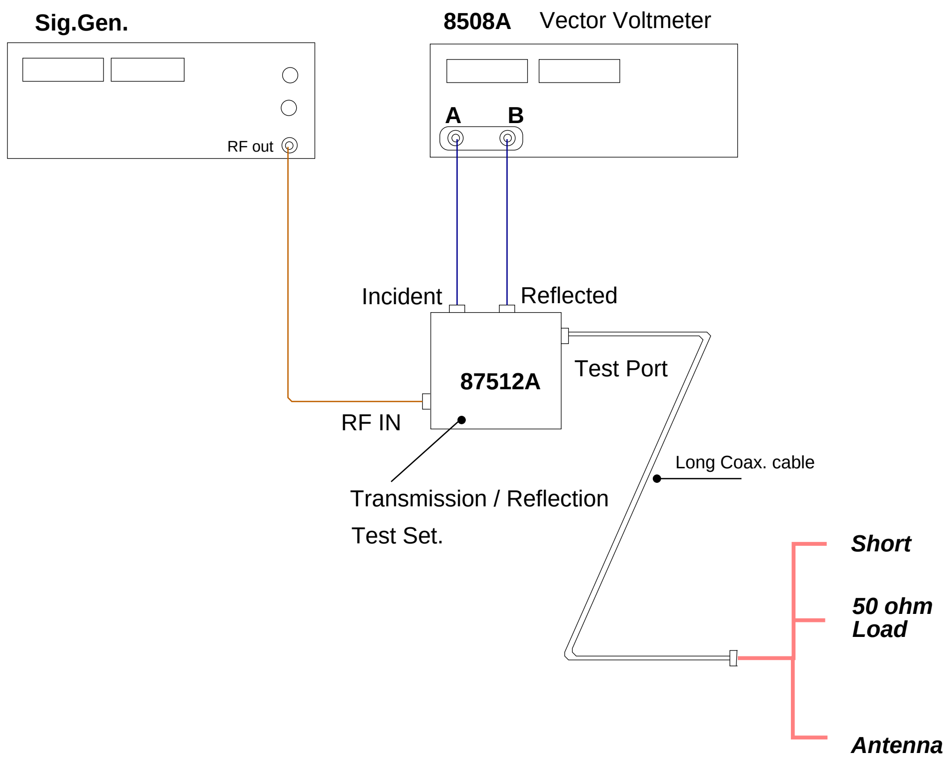

Fig. A1 [MxA/TR/2k2 − 02]