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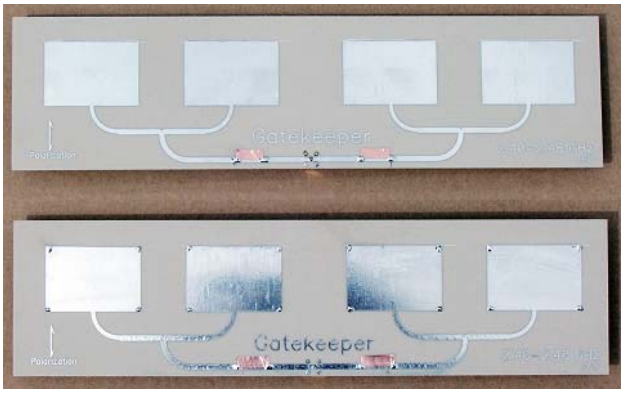
Introduction

360° Antenna has been retained to create a prototype 2.4 GHz ISM band patch antenna array with the following target specifications:

Style: Patch Antenna Array
Frequency Peak Response: 2.4 GHz ISM optimized for preferred spot frequency
Polarization: Vertical
Gain: ~13 dBi
Horizontal Beam Width: ~25° / strive to keep sidelobes -15 dB <, possibly -20 dB
Vertical Beam Width: ~120° / varies w/ placement & mounting, etc.
Power: ~10 watts CW
Impedance: 50-Ohms
VSWR: < 1.5
Connectors: SMA, N, or coax pig tail [1]
Construction: PC Board +/- Arlon 25N
Dimensions: ~ 3 x 10"
Deployment: Outdoors on pole



The prototypes created and tested for this application are shown above.

Measurements – *VSWR*

The prototypes originally resonated at 2395 MHz. The effective dielectric constant (E_r) of this particular Arlon low loss material seems to be about 2% low of their advertised value. Thus, the top edge of each patch was trimmed to bring the antennas up to 2440 MHz. Trimming of the phasing lines was not practical; thus tuning tabs were used to improve the return loss/SWR of the antennas. ***Figure 1*** on the following page shows the return loss curve of the prototype before trimming; ***Figure 2*** shows the effect of trimming the prototype to center the frequency around 2440 MHz.

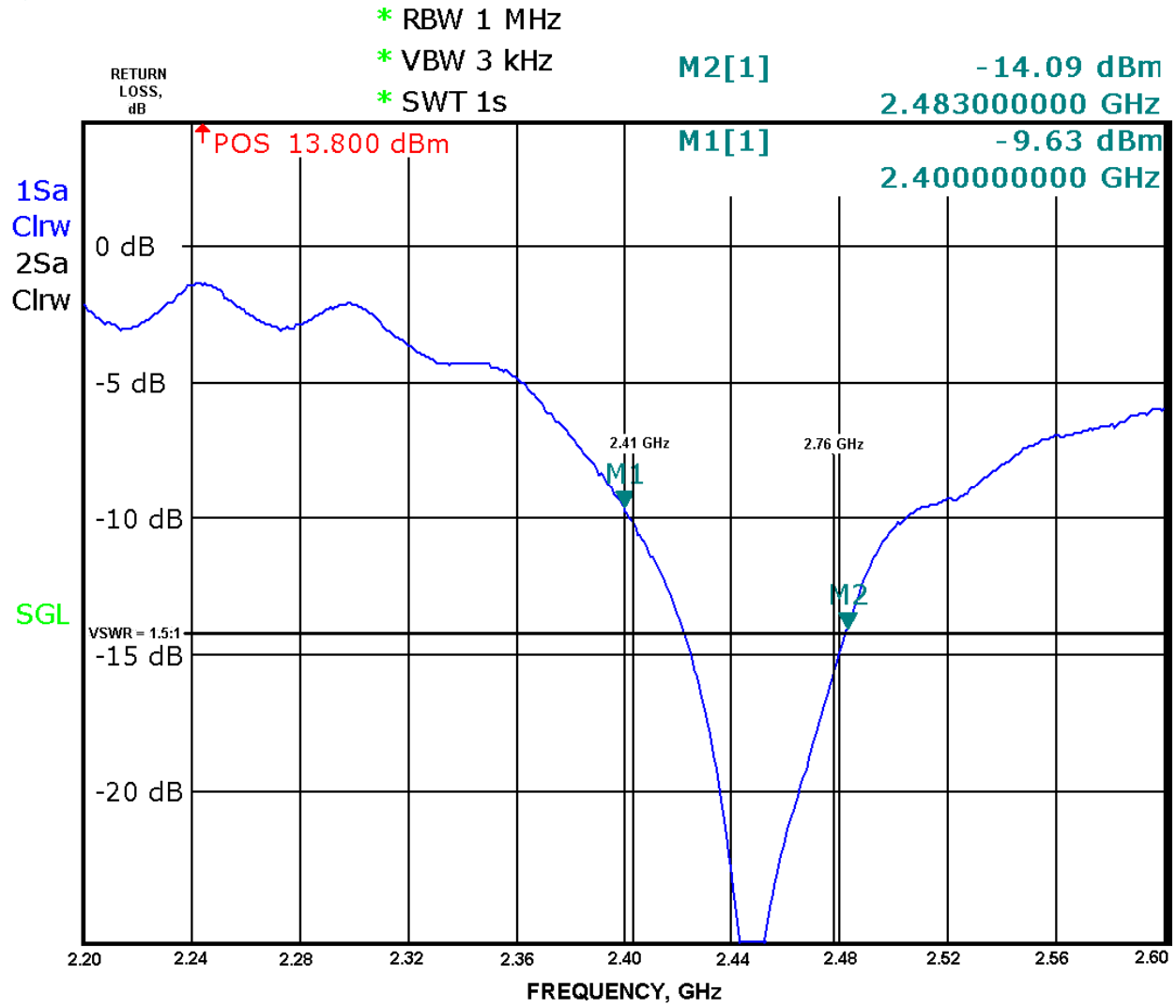


Figure 1: Return loss plot of prototype array before trimming to center at 2440 MHz.

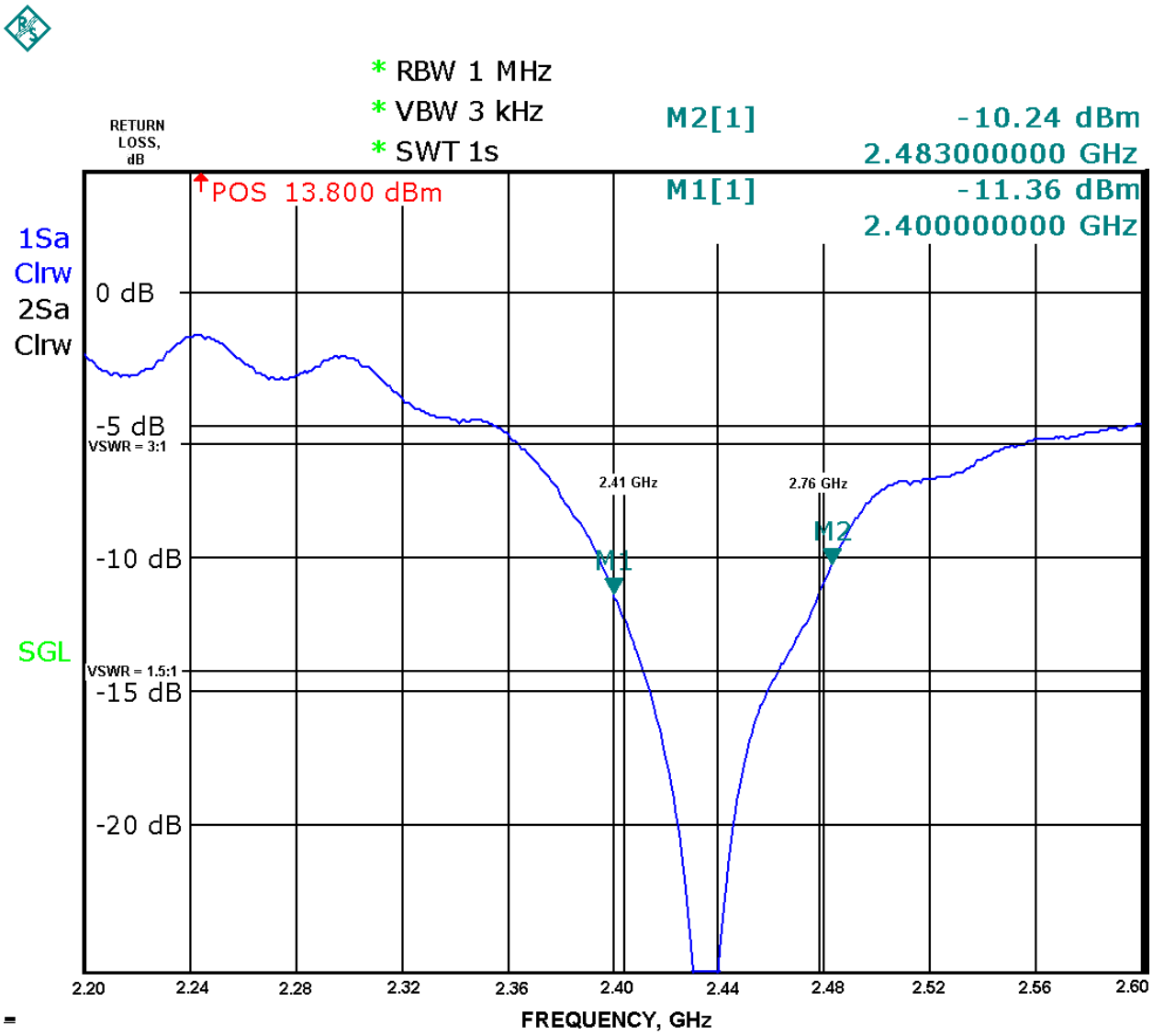


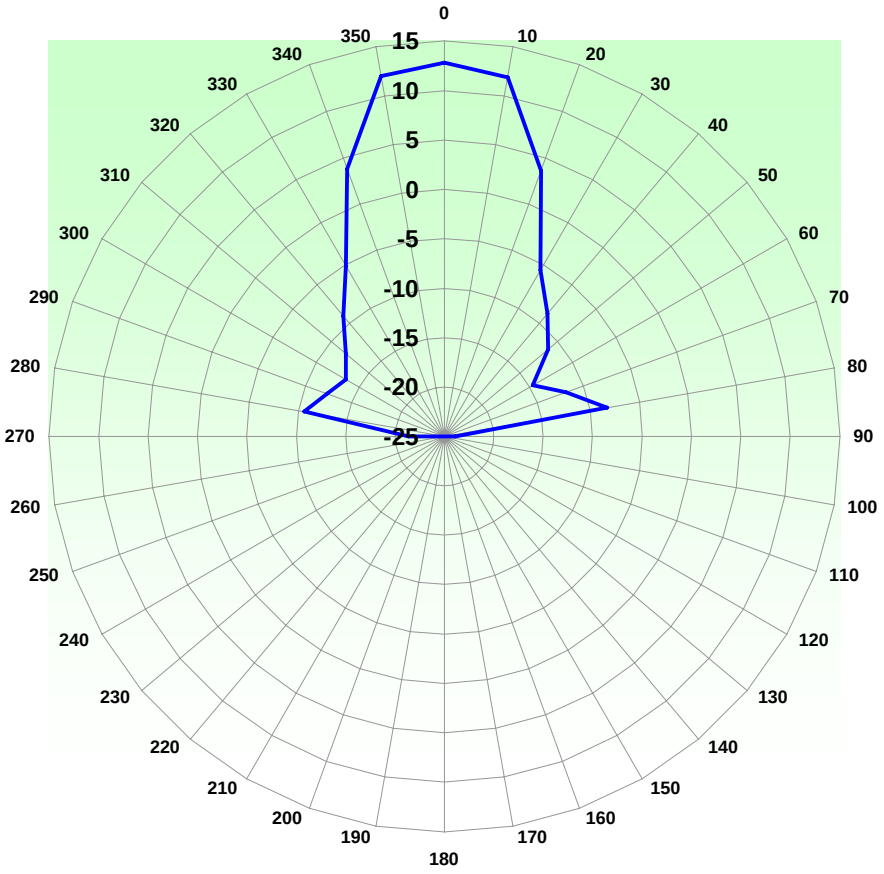
Figure 2: Return loss plot after trimming to center the array around 2440 MHz.

Measurements – *Pattern*

The measured azimuthal pattern plot at 2440 MHz is shown on the following page in ***Figure 3***. The peak gain was measured at about 12.8 dBi. Each -3 dB point was found to be at about ±15°, while the -10 dB point is at about ±24°; the pattern of the prototype antenna appeared to be very symmetrical; compare the measured pattern with the modeled pattern, shown as Figure 4. The -3 dB point on the elevation plot was measured at about +/- 60° degrees, very broad.

An array optimized for gain typically has a -17 dB first sidelobe. This 4-patch array exhibits a -16 dB sidelobe at 75° degrees as seen in ***Figure 3***'s accompanying table. Further reduction of this sidelobe would probably require a larger footprint for the antenna or a reduction in gain.

Angle°	dBi Gain 2440 MHz Azimuth	
0	12.8	
10	11.9	
15.3	9.8	-3 dB Angle
20	3.6	
23.8	2.8	-10 dB Angle
30	-5.6	
40	-8.8	
50	-11.3	
60	-14.7	
70	-11.9	
75	-3.7	
80	-8.3	
90	-23.9	
100	-25.0	
110	-25.0	
120	-25.0	
130	-25.0	
140	-25.0	
150	-25.0	
160	-25.0	
170	-25.0	
180	-25.0	
190	-25.0	
200	-25.0	
210	-25.0	
220	-25.0	
230	-25.0	
240	-25.0	
250	-25.0	
260	-25.0	
270	-21.4	
280	-10.6	
285	-4.1	
290	-12.4	
300	-13.5	
310	-12.0	
320	-9.1	
330	-5.1	
336.1	2.8	-10 dB Angle
340	3.8	
346	9.8	-3 dB Angle
350	12.0	



Notes:

* Yellow shaded data cells denote that dBi reading was below the listed measurement.

Fig. 3: Measured azimuthal pattern at 2440 MHz.

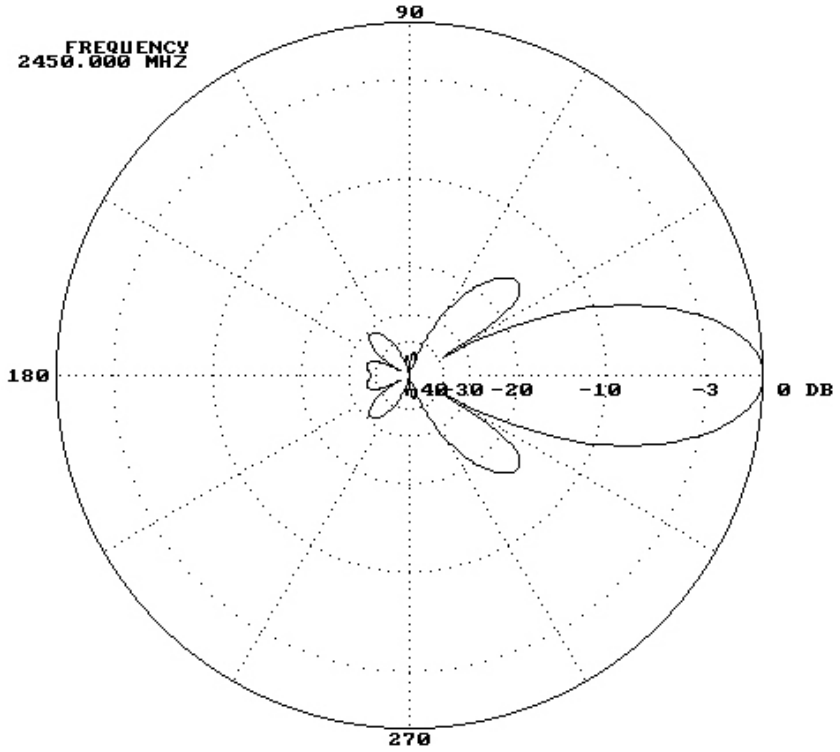


Fig. 4: Modeled azimuthal pattern; note the similarity, including the front sidelobe levels. The rear lobes should be greater than -30 dB; the measured rear lobe level on our prototypes was at least -30 dB.

Printed Circuit Board Antenna

Figure 5 shows a graphic of the Gerber file for the antenna array. Note that this design is based on Arlon 25N material, 0.100" thick. The revised size of the array PC board is 2.9" x 11". As the antenna is not designed to be mounted by itself, we suggest that the board be mounted within an RF-transparent, weather-resistant plastic case with the feedline exiting the case directly away from the backplane. If the plastic in front of the antenna is fairly thin (1/16 inch or so), and the antenna PC board is mounted from 1/8 to 1/4 inch from the case face, the effect of the housing should be negligible; however, such a mounting system would have to be tested.

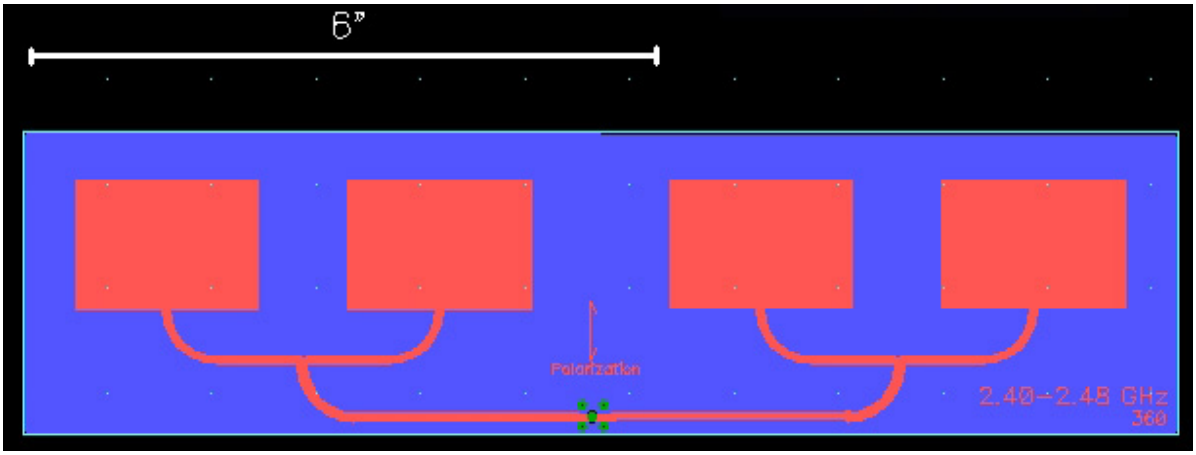


Figure 5: Graphic of the Gerber file for the revised prototype antenna array. Other connector types can be accommodated, if desired.