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Circulator Test Results

By
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Circulator Test Stage 1

- The purpose of performing this test was to prove and confirm results of performance of the circulator in terms of circulating, directing and reflection performance of the ports.
- The Manufacturer results are considered to confirm performance and provide comparison.
- Initial test results from the first Boxes/Antennas showed a fair performance (-15 to -18dB) as a start point.
- New antennas Version 2 were used to optimise reflection results within the boxes tests.
- Results of the new antennas with a direct connection to a straight line waveguide showed an average of -24dB at the 324MHz of the 6 possible combinations of PORTinPORTout (port1Port2, Port1Port3, Port2Port1,Port 2Port3, and Port3Port1, Port3Port2).
- Next step was to connect the termination boxes with new antennas to the circulator's ports as numbered accordingly (Port1-to-Port1, Port2-to-Port2, Port3-to-Port3).

Circulator Test Stage 2

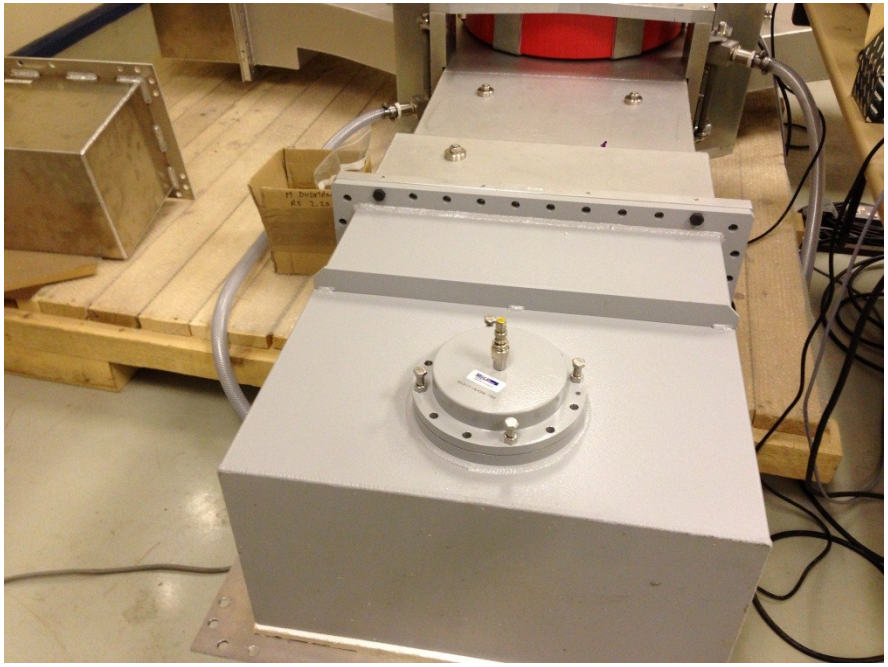
- **The results are shown below in graphs (Old and New) to compare, in conclusion:**

1. **First set of results with old antennas were done briefly as there was no stability in the antennas.**
2. **The new antennas Version 2 results shows a good match with the manufacturer results in terms of response and shape of the curves as well as the values of reflection and transmission (S11, S21) of the ports considering matching the VNA span to the manufacturer results, in numbers; Manufacturer reported (a range of -0.16dB S21 and -26dB S11) while we managed to get (a range of -0.2dB S21 and -20.7dB S11) .**
3. **Within the setup, I have tried to optimise the antennas again in order to match the results.**
4. **I found that altering the input or even the output port's antennas had minimal or almost no effect to the performance of these parameters.**
5. **The dominant factor of change in performance happened when I altered the matching load antenna !**
6. **I have managed to achieve around S11 of -22dB with moving the matching antenna a bit out.**
7. **The peak frequency point were around 326MHz in all results including the manufacturer results.**
8. **I have found that making the antenna a bit longer can shift back the frequency closer to 324MHz which would result in better performance.**

Circulator Test Stage 3

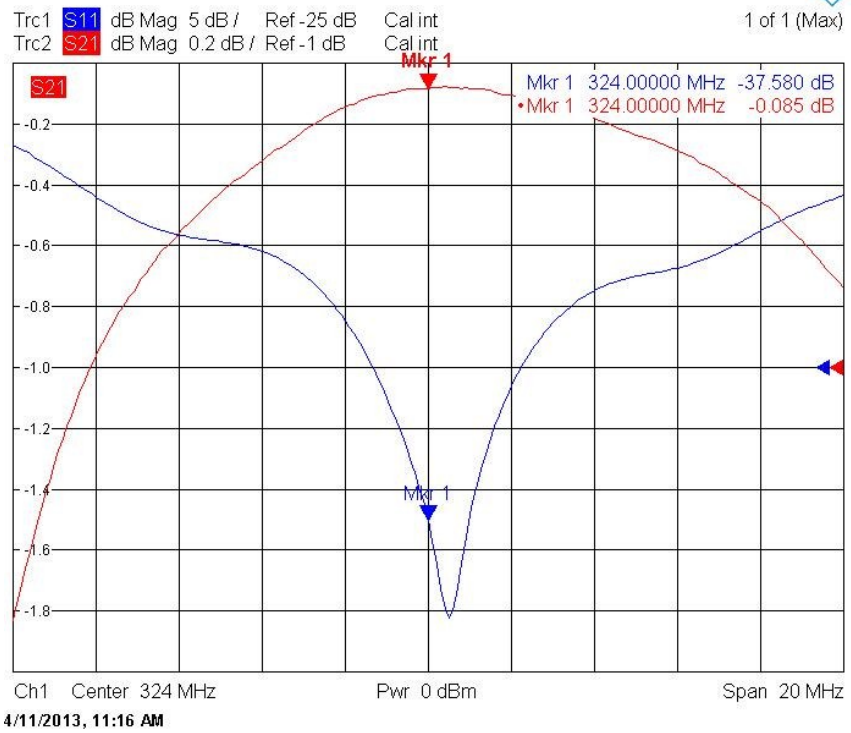
1. As the results with Version 2 antennas was not fully satisfying, we decided to try again to match the results and enhance the readings, therefore, Version 3 antennas been produced as (194.3mm) 5mm longer than Version 2 to try to enhance matching the input and output ports performance.

2. We have used Type-N flange from MEGA for the termination port with 50 Ohm Load to guarantee a better matching at 324MHz with the proper termination flange from MEGA.

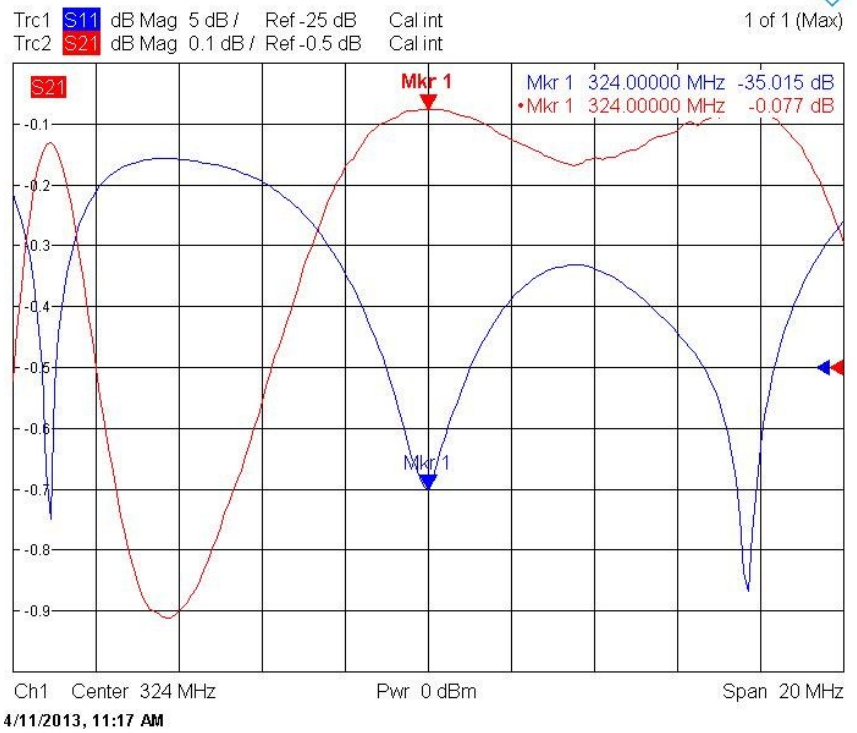


Test results with V3 antennas and MEGA Flange

Port 1 in Port 2 out
Port 3 matched 50 Ohms



Port 1 in Port 2 out
Port 3 Open

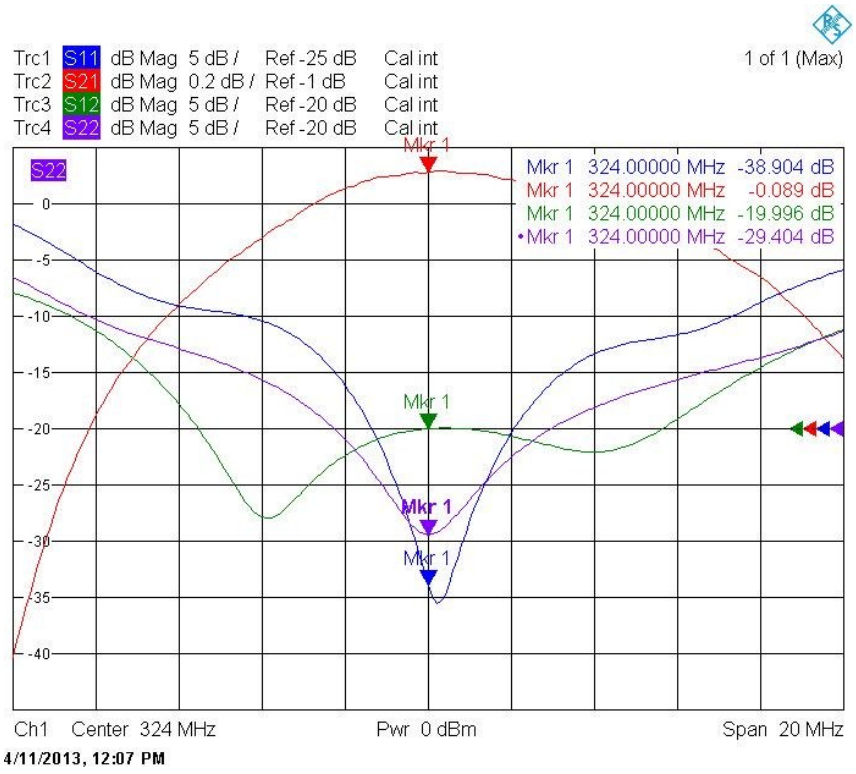


We can clearly see that we have matched and exceeded the manufacturer results of -31dB in the S11 and -0.150dB of S21

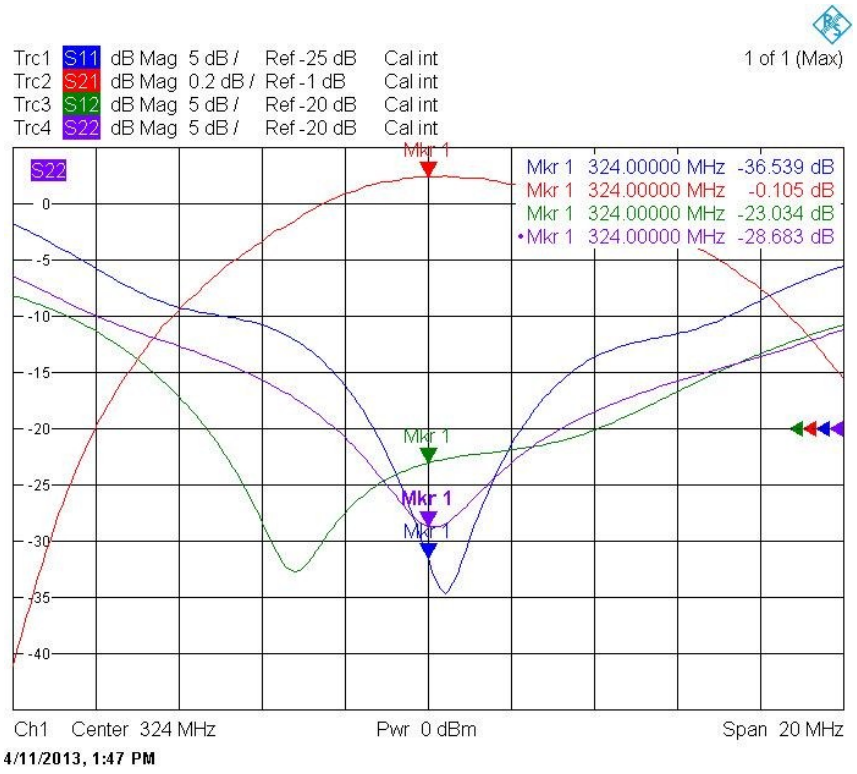
Test results with V3 antennas and MEGA Flange

Next step was to check the other S parameters of the test (S12 & S22), first, we found that it's lower than expected at 324MHz due to the 50 Ohm load matching at Port 3….
I have tried different techniques to improve the match as shown below till I managed to get the best match at the last reading by changing the load cable length to be at 50 Ohm

Reading 1

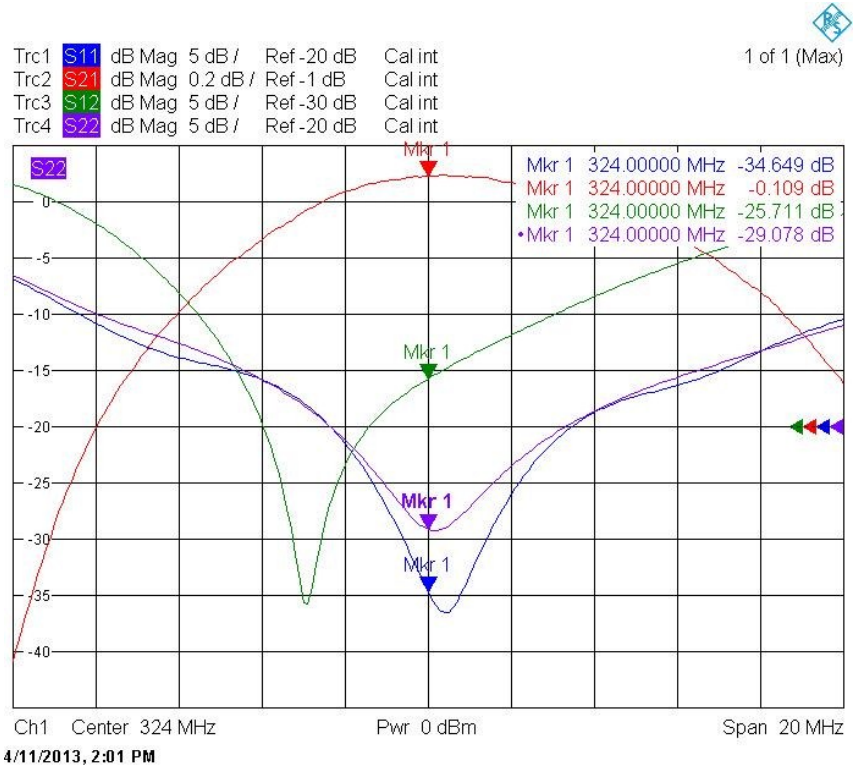


Reading 2

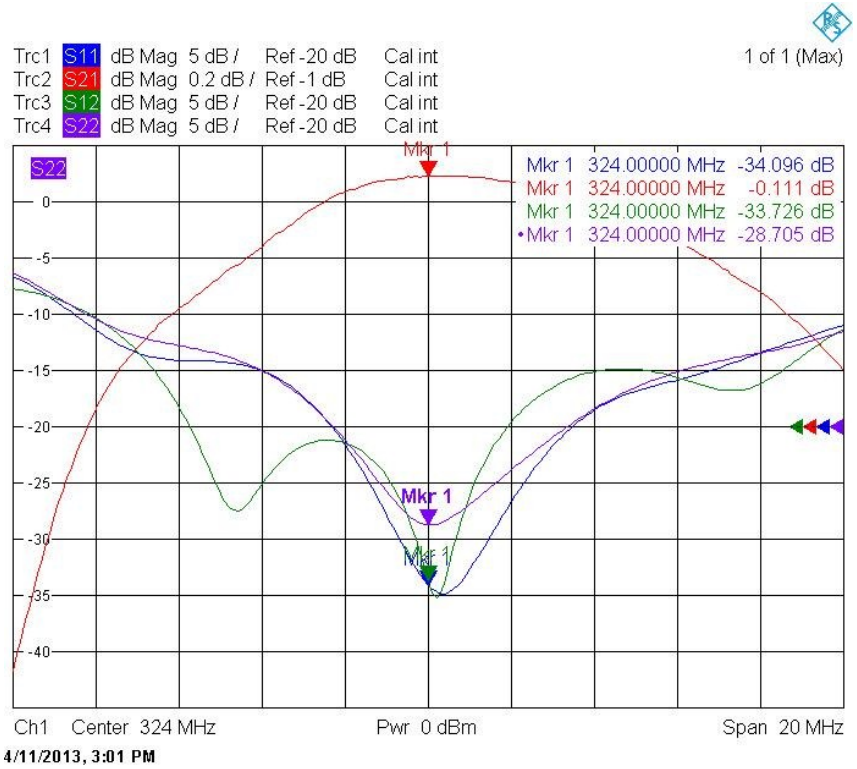


Test results with V3 antennas and MEGA Flange

Reading 3

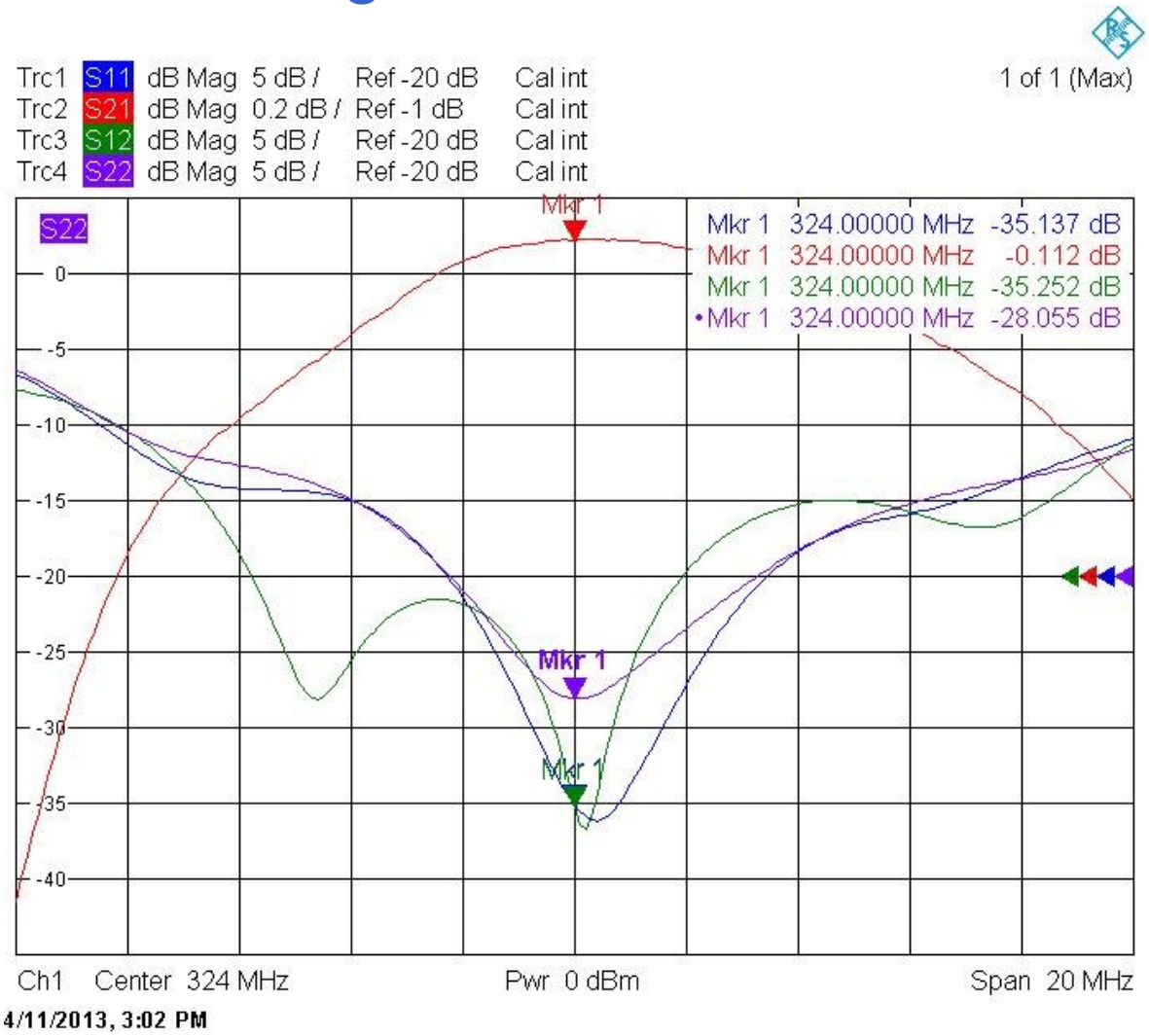


Reading 4



Final Test results with V3 antennas and MEGA Flange

Final Reading



9. Termination boxes connected to the three ports of the circulator