

## Product Note 48

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# 2 to 40 GHz Coaxial Programmable Tuner, Model 4002-2C

The coaxial programmable tuners, model 4002-2C operate from 2 to 40 GHz using precision 2.92 mm connectors (K®). The tuners use a dual axis mechanism, first introduced to 0.8 to 18 GHz units. The tuners are built in a rugged chassis and use three 1.8° stepper motors for moving the RF probes in a precise slabline, manufactured out of a single aluminium block using EDM, with a cut-off frequency beyond 45 GHz (figure 1). Two slotted and polished Beryllium Copper RF probes are permanently fixed on teflon stabilised vertical axes and ensure minimum loss, high phase tuning stability and instantaneous coverage of the 2 to 40 GHz frequency range ( $\approx 5$  octaves).

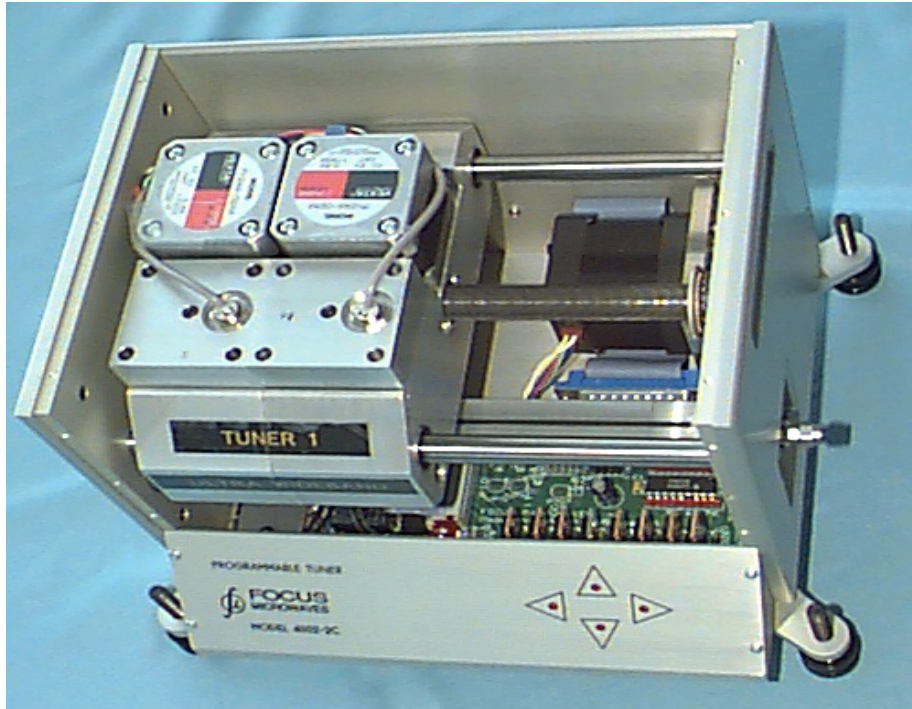
The RF probes are moved in, out and along the slabline to generate controllable  $\Gamma$  and phase. The probe's horizontal play during vertical movement is less than  $\pm 1\mu\text{m}$  in total. The slugs are sliding on the walls of the slabline for perfect ground contact and negligible microphonism (i.e. sensitivity of the RF parameters to mechanical vibrations).

The 4002-2C tuners are fully compatible with the IBM®-PC based CCMT control and measurement software for Calibration, Noise and Load Pull measurements. Obtainable VSWR exceeds 10:1 (Return Loss = 1.74 dB), and reaches up to 15:1 (RL = 1.16 dB) in most parts of the band ( figure 2 ).

The 4002-2C tuners can be used beyond 40 GHz, with reduced performance in respect to maximum VSWR. They can also be equipped with 2.4 mm connectors and optimised for 50 GHz operation.

### 4002-2C Tuner Characteristics

Frequency Range	2.0 - 40.0 GHz (option 50 GHz)
VSWR min	1.15:1
VSWR max	10:1 (15:1)
Insertion Loss	1.0 dB max @ VSWR min, @40 GHz
RF resetability	38 dB min @ 40 GHz
Tuning Resolution	0.29°/step @ 40 GHz
Max Tunable points	>1,900,000 @ 40 GHz
Mechanical - Accuracy	$\pm 1$ step
Step Size	Vertical 1.5 $\mu\text{m}$ , Horizontal 2.95 $\mu\text{m}$ ( higher resolution optional )
RF Connectors	GPC-2.92 mm (K®), (option 2.4 mm)
Overall Size	8.0 x 5.75 x 7.0 inches
Weight	5.4 kg
Power Handling	20 W CW ( connector limitation @ VSWR=10:1 )
Operation	Automatic - Manual - Mouse Tuning for test fixture or 'on wafer' probe stations.



*Figures 1 and 2:* CCMT-4002-2C wideband programmable tuner, outside and inside view. One can recognise the double carriage horizontal mechanism and the 2.92 mm slabline, compatible with K connectors and operational up to 50 GHz.

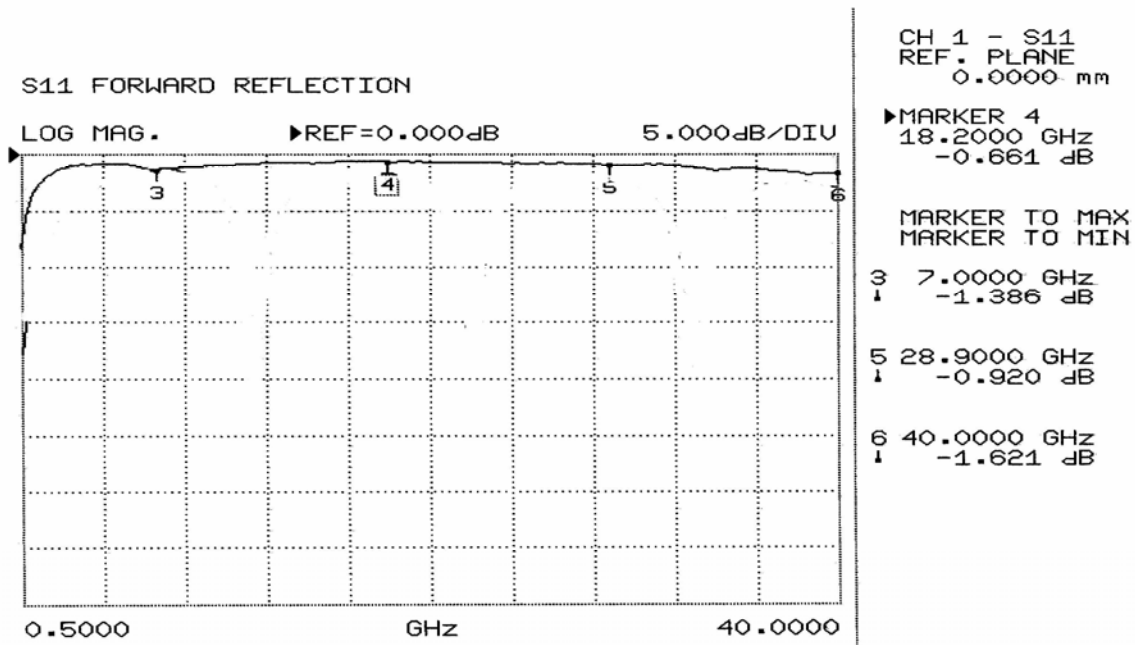


Figure 3: Maximum reflection factor of 4002-2C tuner. The plot shows the envelope reflection of the two RF probes; one best suited below 7 GHz (marker 3) and the other above 7 GHz.

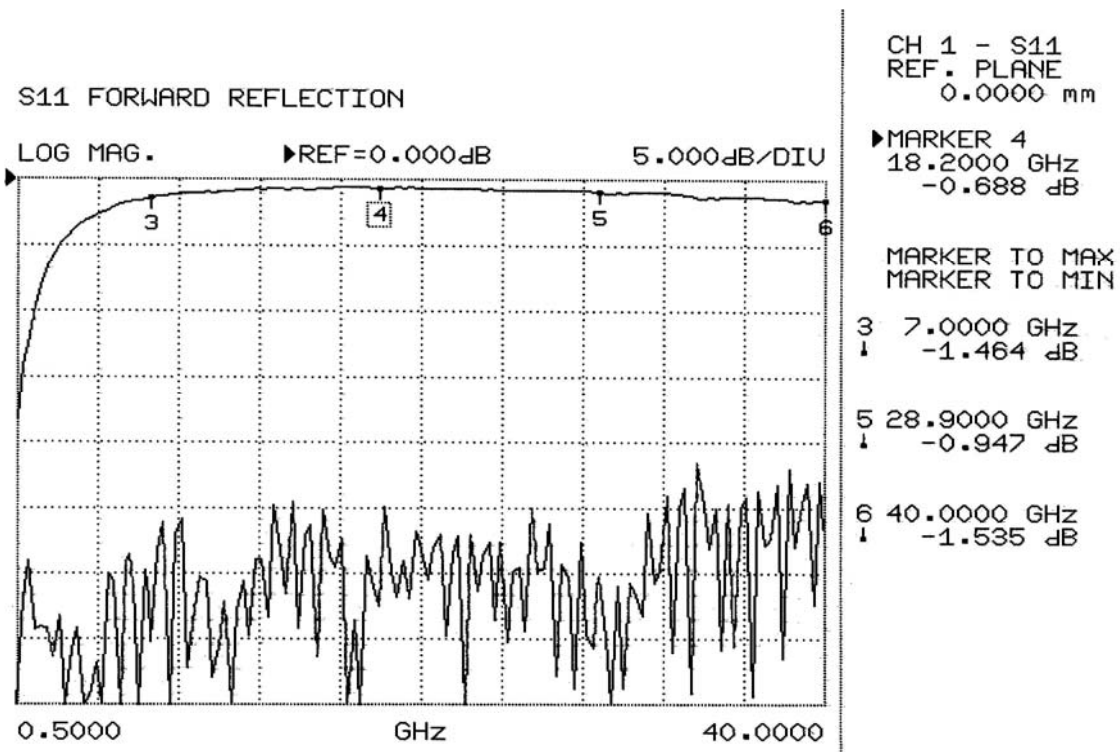


Figure 4: Tuning capability of high-end probe and residual reflections of the 4002-2C tuner.

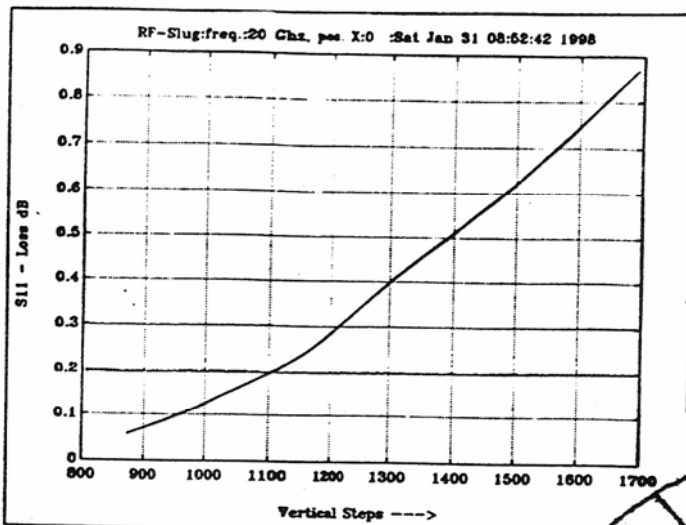
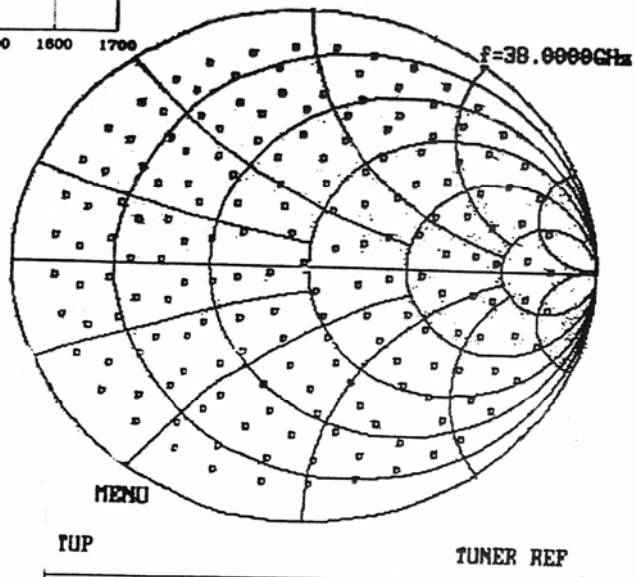


Figure 5: Reflection factor as function of probe depth (in steps)

Figure 6: Distribution of 181 calibration points at 38 GHz. Using these points only the CCMT software can tune accurately to over 2 million impedances within the tuning range of the tuner at this frequency



PERFORMANCE VERIFICATION

Date of Test = Sat Jan 24 16:03:11 1998  
 File name = C:\CCMT\DATA\335\_0.PRF -  
 CAL comment = sn:335 VLF, Sa: Jan 24 15:19:05 19

Calibrated at 181 points

Cycle Tuning Error [dB] over 25 points per Frequency.

GHz	1	2	3	4	5	Aver
2.0	-54.3	-52.3	-53.4	-52.2	-51.3	-52.7
3.0	-53.2	-53.8	-53.9	-52.7	-52.1	-53.2
4.0	-56.0	-53.9	-55.2	-54.5	-53.3	-54.6
19.0	-53.8	-52.0	-49.3	-48.9	-51.7	-49.6
20.0	-51.2	-49.2	-48.1	-48.9	-50.4	-50.9
21.0	-49.9	-50.1	-50.9	-51.3	-49.8	-50.2
39.0	-45.8	-46.0	-45.8	-45.5	-45.6	-45.8
40.0	-44.2	-45.3	-43.7	-42.9	-44.2	-43.4

Figure 7: Tuning Accuracy of 4002-2C tuner. The shown values correspond to arbitrarily tuned points, not calibrated points, and include both tuner and interpolation errors.