# Ardent Concepts

Contactor 0.5 mm

Measurement Results

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5/17/03

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## *Objective*

The objective of these measurements is to determine the rf performance of the Ardent Concepts contactor in 0.5 mm configuration.  A signal pin surrounded by grounded pins is selected for the signal transmission configuration.  Measurements in both frequency and time domain form the basis for the evaluation.  Parameters to be determined are pin capacitance and inductance of the signal pin, the propagation delay, and the attenuation in the frequency range from 50 MHz to 30 GHz.

## *Methodology*

Capacitance and inductance for the equivalent circuits were determined through a combination of measurements in time and frequency domain.  Frequency domain measurements were acquired with a network analyzer (HP8722C).  The instrument was calibrated up to the end of the 0.020" diameter coax probe. The probe was then connected to the fixture and the response measured from one side of the array.  When the pins terminate into anopen circuit compression plate, a capacitance measurement results.  When a short circuit compression plate is used, inductance can be determined.

Time domain measurements are obtained via Fourier transform from VNA tests. These measurements reveal the type of discontinuities at the interfaces plus contacts and establish bounds for digital system risetime and clock speeds.

## Test procedures

To establish capacitance of the signal pin with respect to the rest of the array, a return loss calibration is performed. Phase angle information for S11 is selected and displayed. When the array is connected, a change of phase angle with frequency can be observed. It is recorded and will be used for determining the pin capacitance.

The self inductance of a pin is found in the same way, except the contactor pin array is compressed by a metal plate instead of an insulator. Thus a short circuit at the far end of the pin array results. Again, the analyzer is calibrated and S11 is recorded. The inductance of the pin can be derived from this measurement.

## Setup

Testing was performed with a test setup that consists of two brass plates with holes for the coaxial probes. One plate is mounted on the PCB side of the contactor, the other on the DUT side. Holes in the blocks receive semirigid coaxial cables. Fig. 1 shows this fixture and its components.

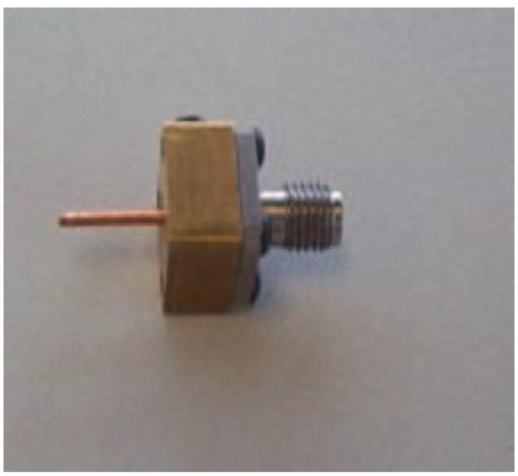

Fig. 1 Contactor test probe

The contactor is held in a fixture (Fig. 2):

Fig. 2 Probe plate with socket

Connections to the VNA are made with high quality coaxial cables with SMA 3.5 or K connectors.

## *Measurements*

### Time domain

The time domain measurements will be presented first because of their significance for digital signal integrity. TDR reflection measurements are shown in Figs. 3 to 5.

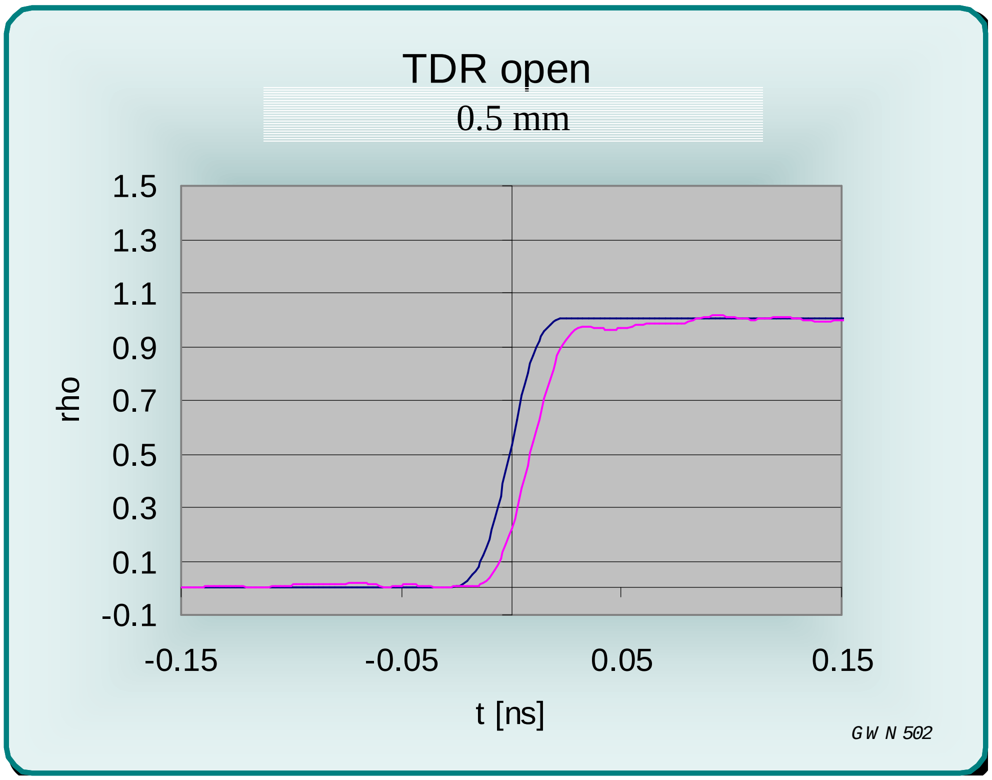


Fig. 3 TDR signal from an OPEN circuited contactor

The reflected signal from the contactor (rightmost trace) shows only a very small deviation in shape from the original waveform (leftmost trace). The risetime of 27.5 ps is nearly identical to that of the system with the open probe because the pins form a transmission line with a characteristic impedance near 56 Ohms. Electrical pin length is about 7.5 ps one way.

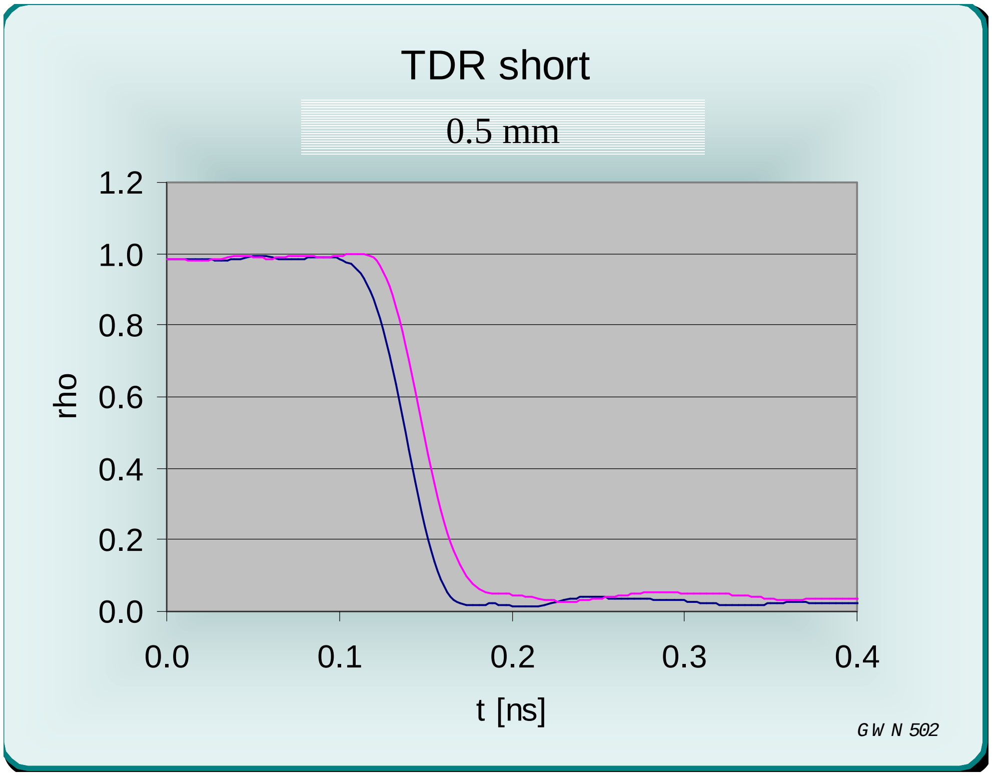


Fig. 4 TDR signal from SHORT at probe plus SHORT inclusive socket

For the short circuited contactor the fall time is about 37.5 ps.

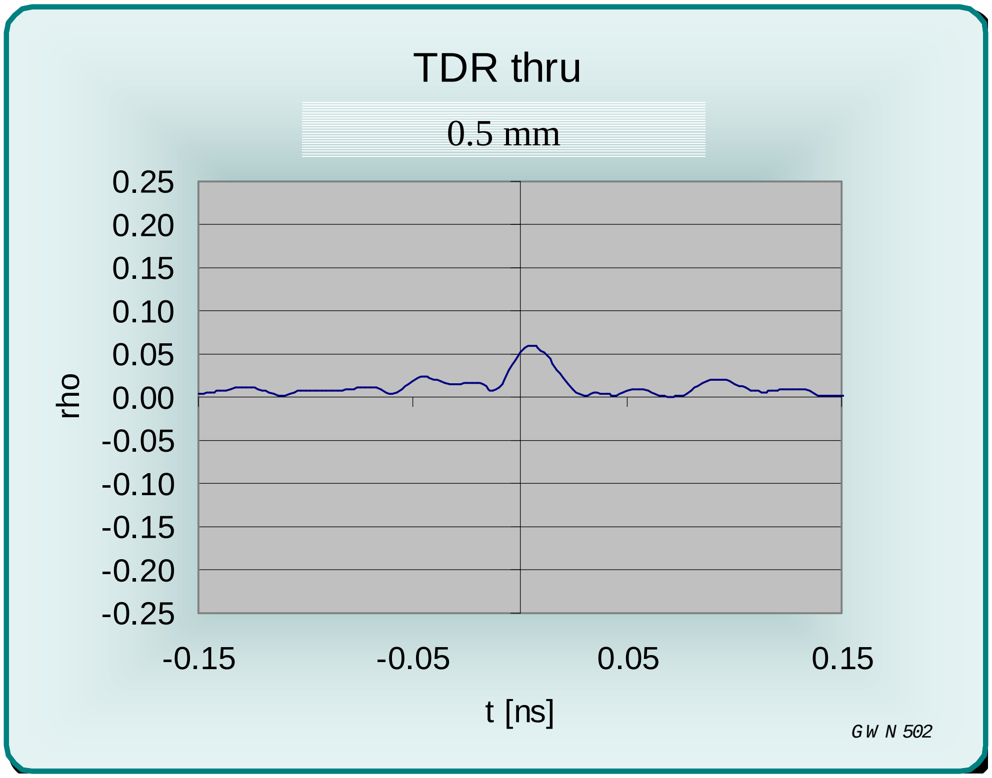


Fig. 5 TDR measurement into a 50 Ohm probe

The thru TDR response shows only a small inductive component. It corresponds to an impedance value of about 56 Ohms.

The TDT performance for a step propagating through the pin arrangement was also recorded (see Fig. 6).

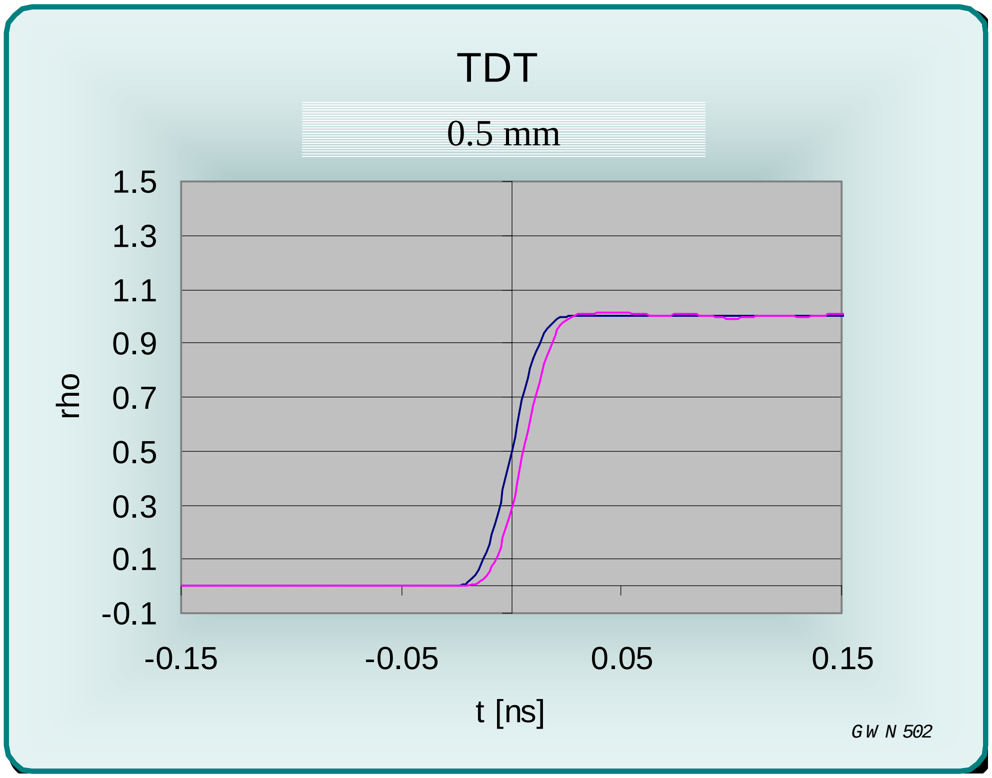


Fig. 6 TDT measurement

The TDT measurements for transmission show that very little contribution to risetime is due to the pin array (10-90% RT = 35 ps, the contribution of the socket is negligible compared to system risetime). The added delay at the 50% point is 7.5 ps.

**Frequency domain**

Network analyzer reflection measurements for a single sided drive of the signal pin with all other pins open circuited at the opposite end were performed to determine the pin capacitance . The analyzer was calibrated to the end of the probe and the phase of S11 was recorded (Fig. 7). From the curve the capacitance of the signal pin to ground can be determined (see Fig. 8).

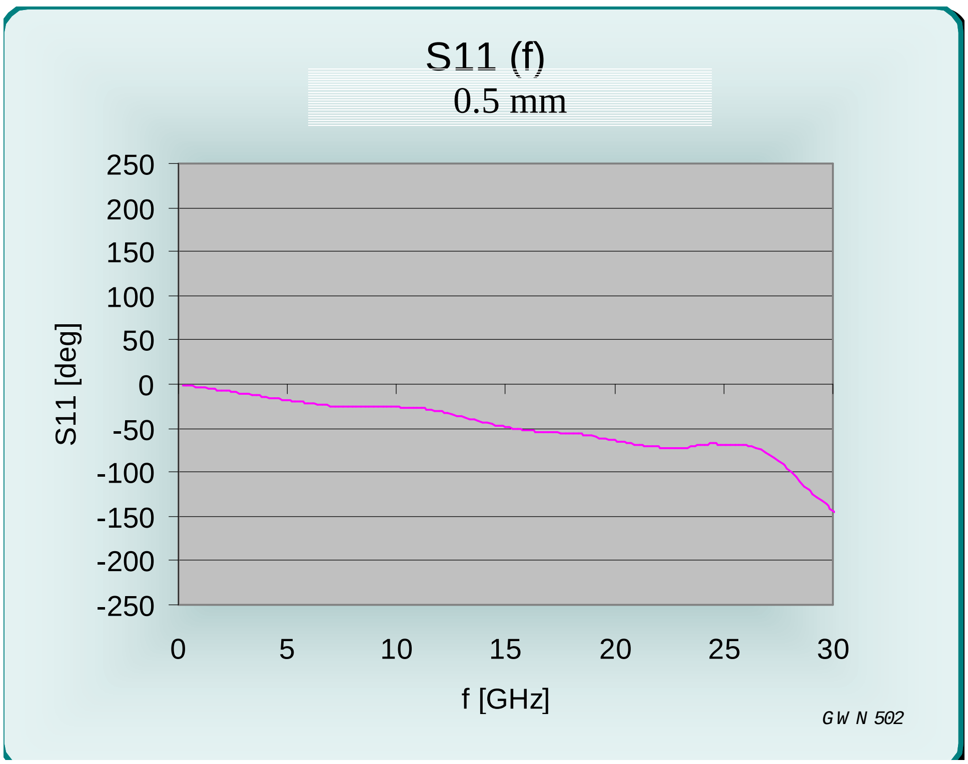


Fig. 7 S11 (f) for the open circuited signal pin

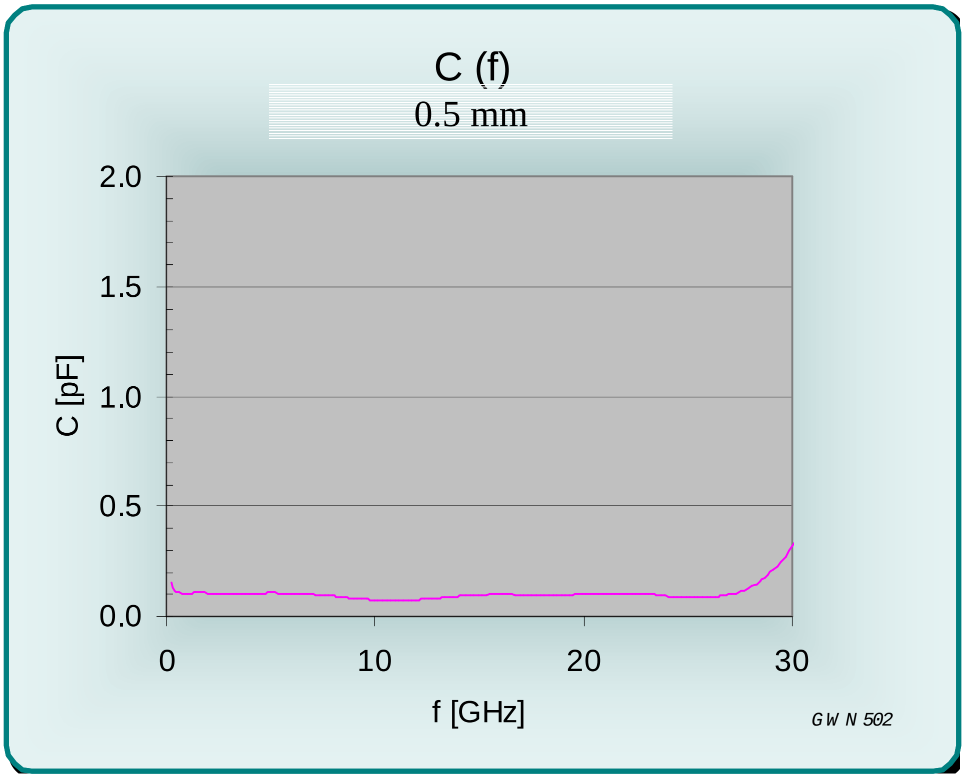


Fig. 8  C(f) for the open circuited signal pin

Capacitance is 0.1  pF to  28 GHz.  The rise in capacitance to values above 0.1 pF at the end of the frequency range is due to the fact that the pins form a transmission line with a length that has become a noticeable fraction of the signal wavelength.  The lumped element representation of the transmission environment as a capacitor begins to become invalid at these frequencies.

The Smith chart measurement for the open circuit shows that there are no undue resonances or distortion in the response (Fig. 9):

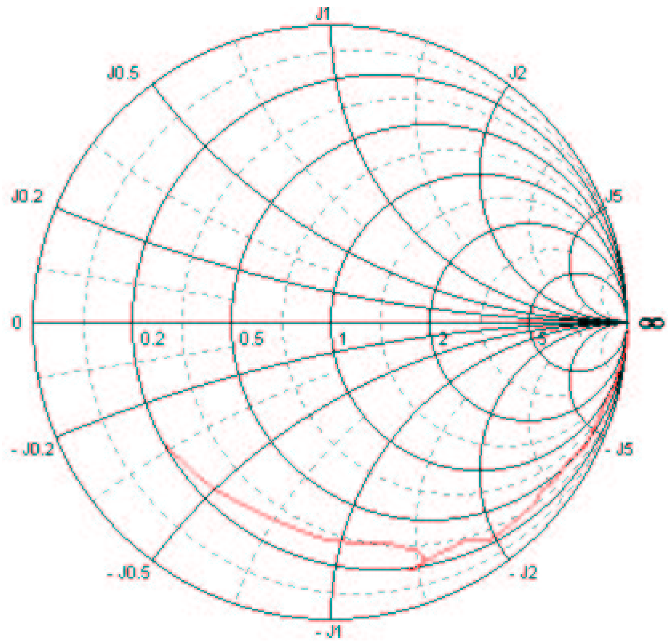


Fig. 9 Reflections from an open circuited contactor

To extract the pin inductance, the same types of measurements were performed with a shorted pin array. Fig. 10 shows the change in reflections from the contactor. Calibration was established with a short placed at the end of the feed coax.

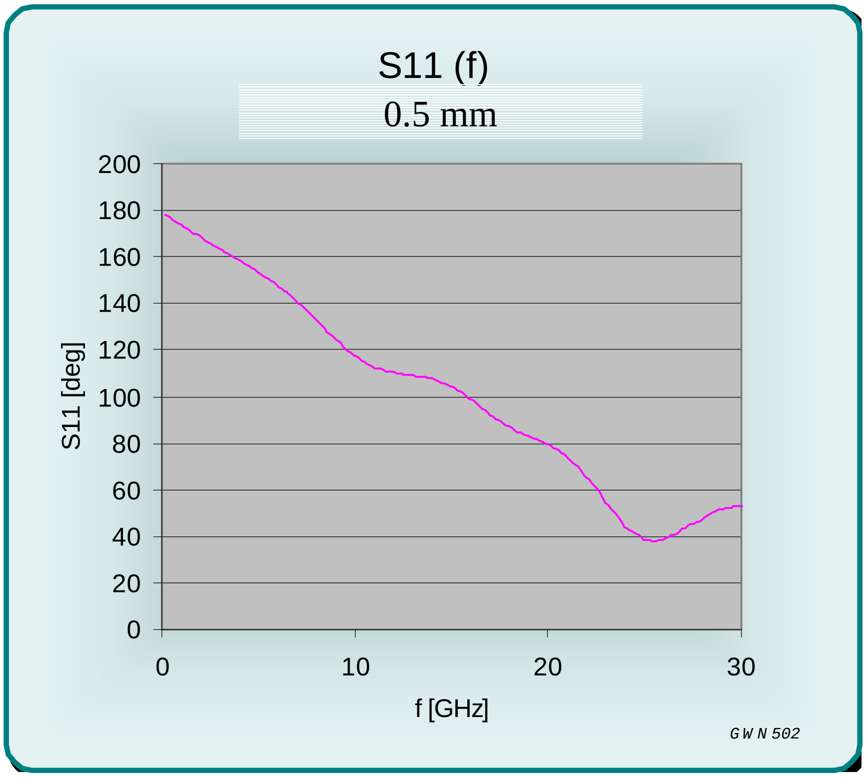


Fig. 10 S11 (f) for the short circuited case

The phase change corresponds to an inductance of about 0.5 nH (see Fig. 11). This value is true at frequencies to approximately 20 GHz. Above this frequency the inductance increases. At these frequencies, the transmission line nature of the arrangement must be taken into account.

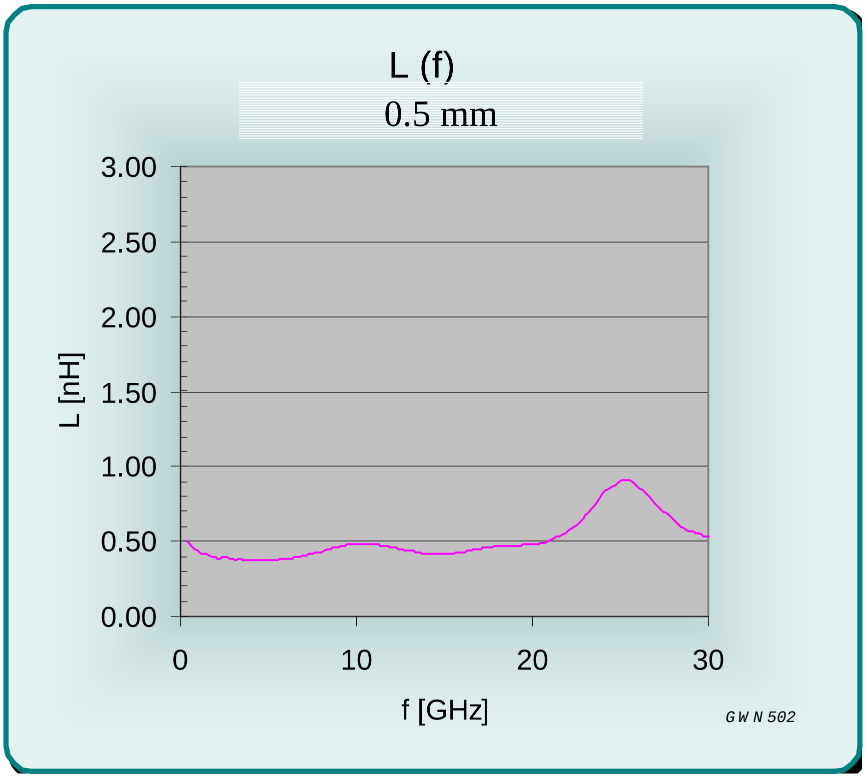


Fig. 11 L(f) for the short circuited contactor

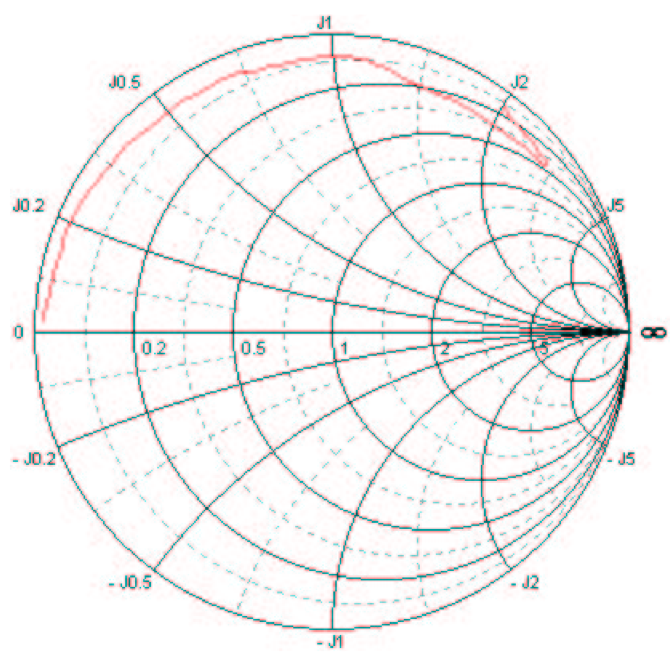


Fig. 12 Short circuit response in the Smith chart

Like the open circuited case there are no aberrations or resonances noticeable in the Smith chart for the short circuit condition.

An insertion loss measurement is shown in Fig. 13 for the frequency range of 50 MHz to 30 GHz. Insertion loss is less than 1 dB to 24 GHz.

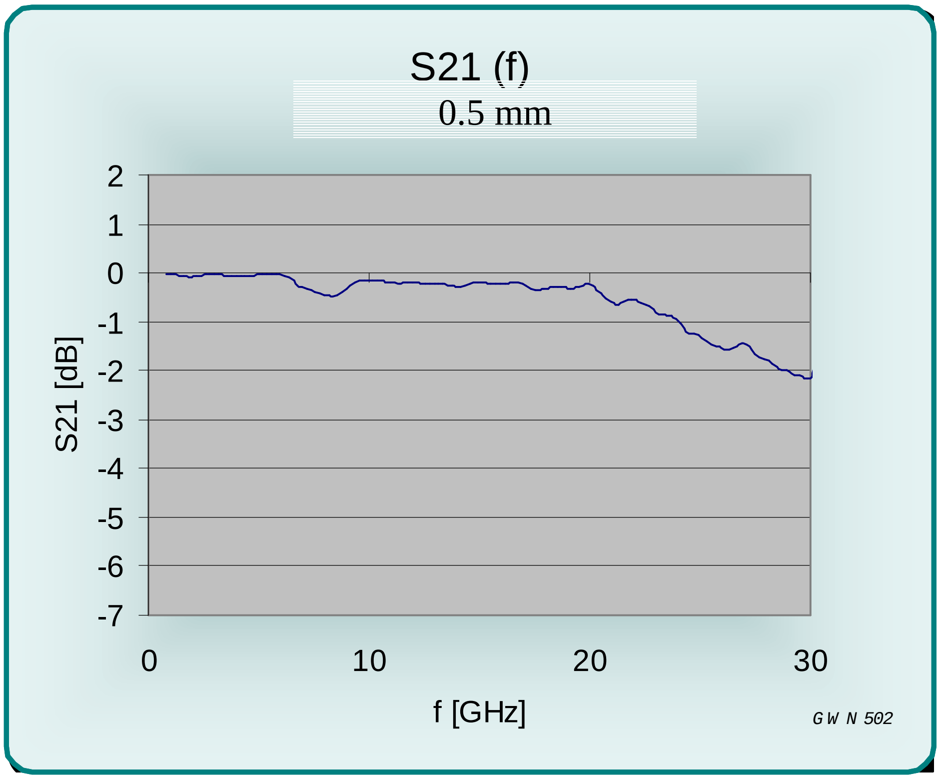


Fig. 13 Insertion loss S21 (f)

The Smith chart for the thru measurement shows a good match:

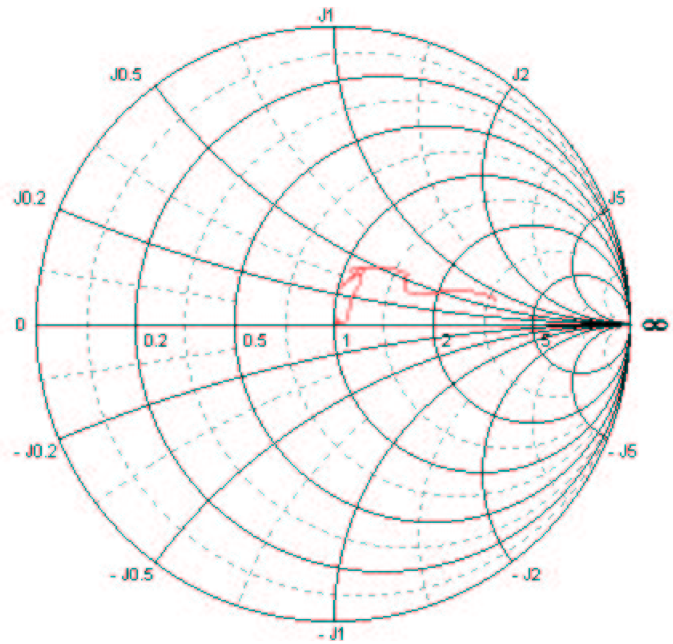


Fig. 14  Smith chart for the thru measurement into a 50 Ohm probe

Fig. 15 shows the VSWR as a function of frequency:

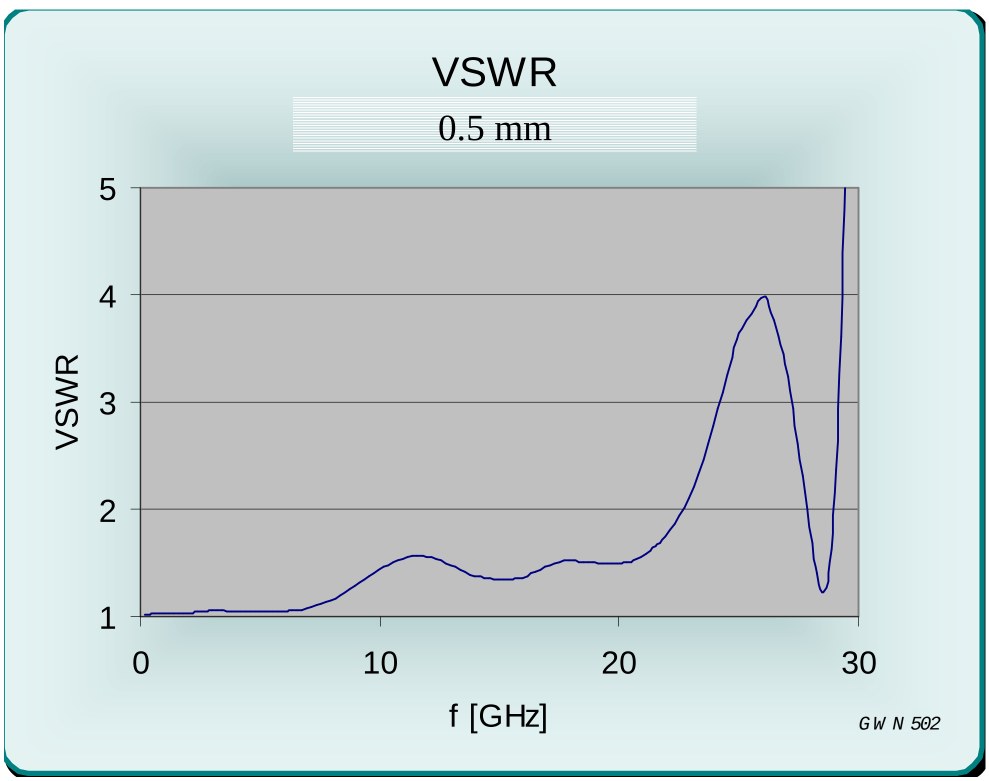


Fig. 15 Standing wave ratio VSWR (f) [1 / div.]

The VSWR remains below 2 : 1  to a frequency of 22 GHz.

## *Conclusions*

The Ardent Concepts contactor was characterized in a 0.5 mm pitch array configuration with a signal pin surrounded by ground pins. The DUT was an arrangement of 4 x 4 contacts in an array.

Interfaces to the HP8722C network analyzer were established through semirigid coaxial cable probes with K connectors. The frequency range of the tests was 50 MHz to 30 GHz.

The pin to ground capacitance was found to be 0.1 pF. The inductance was determined to be 0.5 nH.

Electrical length (signal delay) is 7.5 ps. Risetime contributions of the arrangement to the overall system risetime were small.

The insertion loss S21 for the through configuration was below 1 dB to 24 GHz. VSWR is below 2 : 1 to 22 GHz.