Memorandum

To: A. R. Kerr
S. -K. Pan
R. Groves

cc: J. Webber

From: J. Effland
K. Crady

Subject: Square Law Detector Upgrades

Revisions			
Version	**Date**	**Who**	**Notes**
1.1	2002-05-02	jee	Added A.R. Kerr's measured tunnel diode data
1.0	2000-02-17	jee & wkc	Original

Square law detectors convert IF noise power to a voltage as part of the system that measures receiver Y-Factors using the chopper wheel. Both square law detectors were upgraded to operate between 1 and 18 GHz by replacing the tunnel diode detector with a model ACTP-1715NC3 from Advanced Control Components, Inc. This memo presents measured linearity data for these detectors.

The square law detectors are a subsystem in the synchronous receiver chassis, and are housed in a Modpak box in that chassis. As defined in this memo, the square law detectors consist of the coaxial tunnel diode detector followed by two stages of amplification, that is, everything inside the Modpak box. The output voltage level is read *via* a front panel meter, and is also available on a coax connector below the meter.

The schematic is shown in Figure 1, which was taken from Tony Kerr's design as drawn by Don Stone in AutoCAD and dated 1997-11-21.

Figure 2 shows the setup used to measure the linearity of the square law detectors. The bandpass filter in the setup prevents sweep generator harmonics from causing power meter measurement errors, especially since the directional coupler can exacerbate power measurement errors from harmonics.

We found during testing of both units that a DC block is required to reduce the AC line noise on the detector's output voltage. With the DC block installed at the detector input, the peak-to-peak line noise is about 2 mV, and without it, the line noise is greater than 20 mV. The strong noise component occurs only when the detector input is terminated with 50 ohms. The reason for this is unknown, but it's interesting to note that the tunnel diode vendor offers the option of integrating a DC block into their product. DC blocks have been ordered and will be installed inside both chassis.

Measured transfer functions for the square law detectors are show in Figure 3 for unit SN 001 and in Figure 4 for unit SN 002. Operation at both 1.5 GHz and 14.9 GHz was measured, since couplers and filters were available for both of these frequencies. A.R. Kerr's 1978 measurements of tunnel diode detectors are included in the graphs to show the linearity achievable with careful circuit tuning. The curve marked "Linear Response" is simply a straight line passing through the lowest power point in the measured data and provides a means to compare the measured data to a perfectly linear detector. The residual voltage that is present with no input significantly influences the linearity at the low end. This can be manually adjusted to a few mV with the front panel zero adjust. The measurements also show that maximum dynamic range is achieved in an automated system by subtracting the residual zero-input voltage from the measured output voltage of the square law detector. This also makes the automated system independent of manual zero adjustments.

The gain differs by about 5 dB between the units, which doesn't reduce the dynamic range but does shift the operating range by that amount. In the future, we may want to readjust the gain of SN002 so that both units have similar gain, perhaps when the DC blocks are permanently installed in the units.

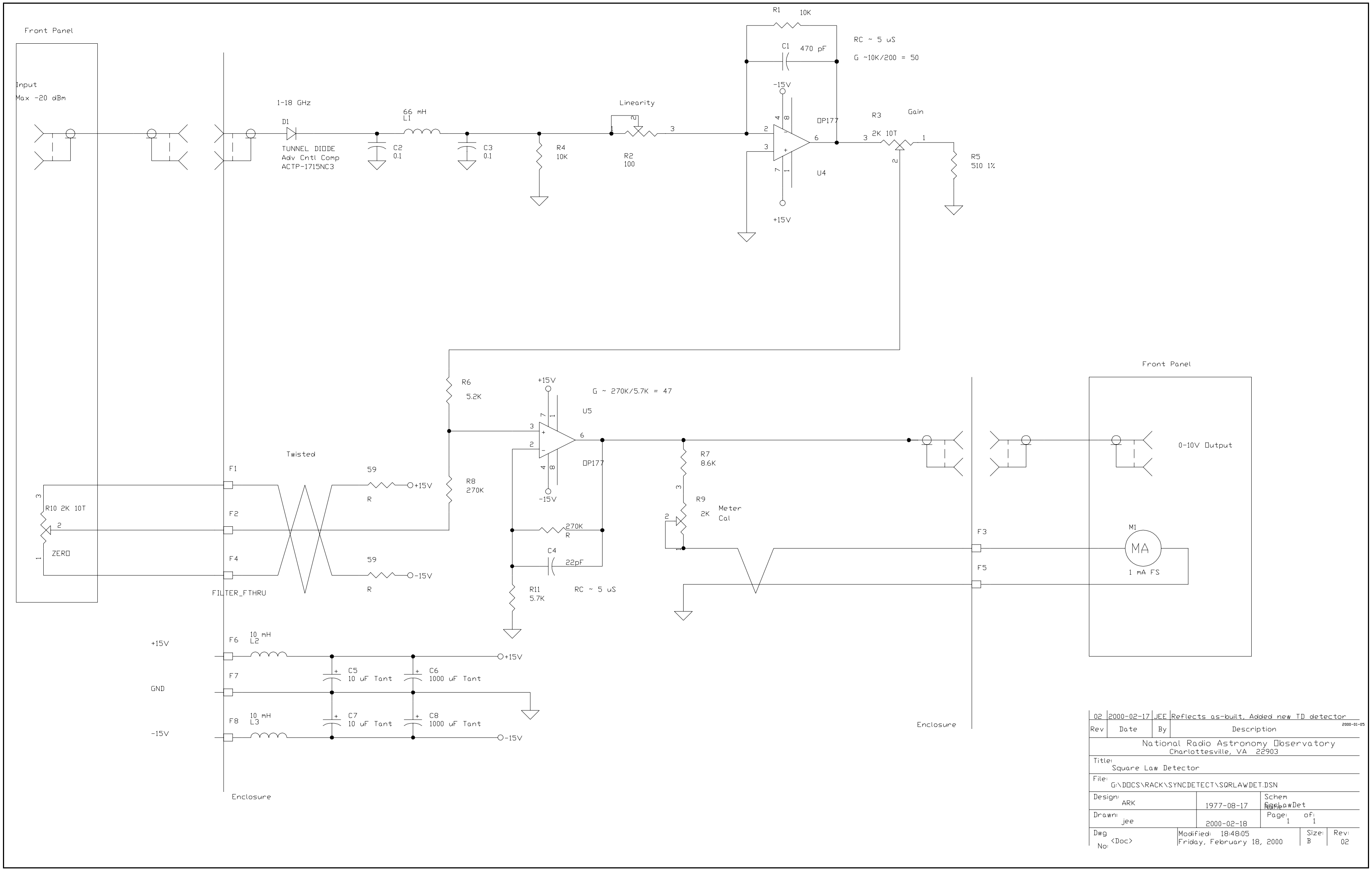

Figure 1: Square Law Detector Schematic

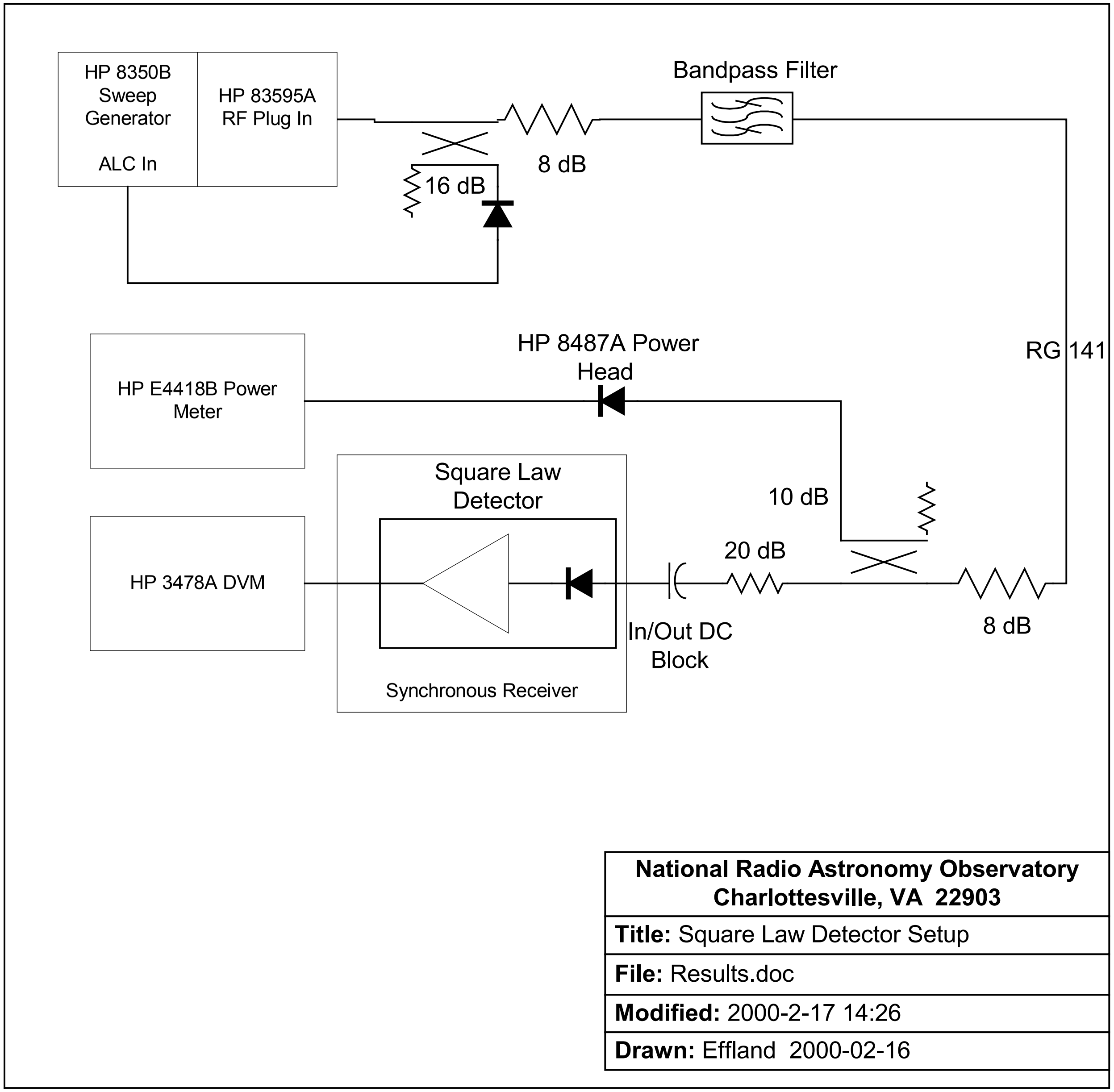

Figure 2: Measurement Setup

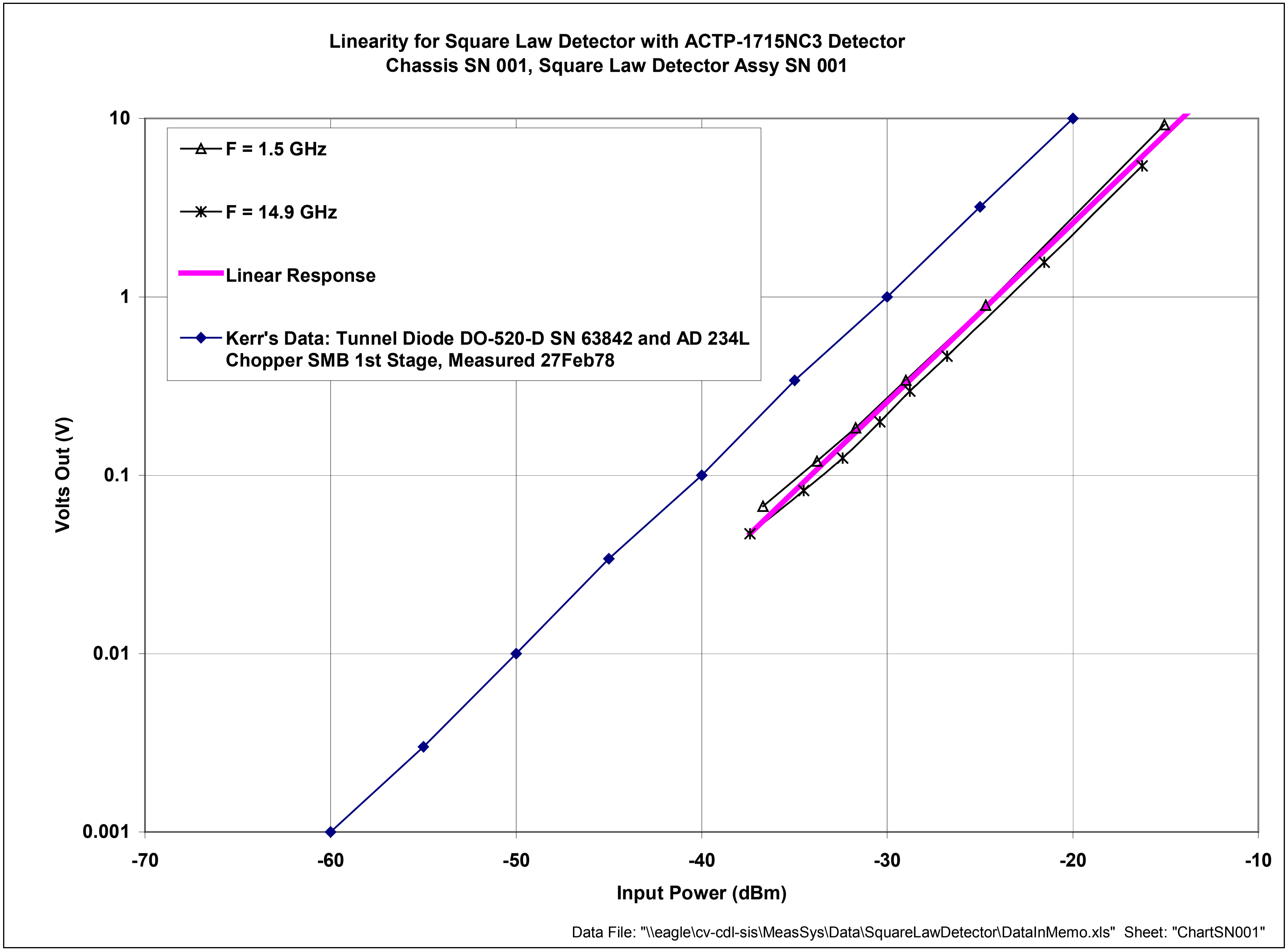

Figure 3 Linearity for Detector SN 001

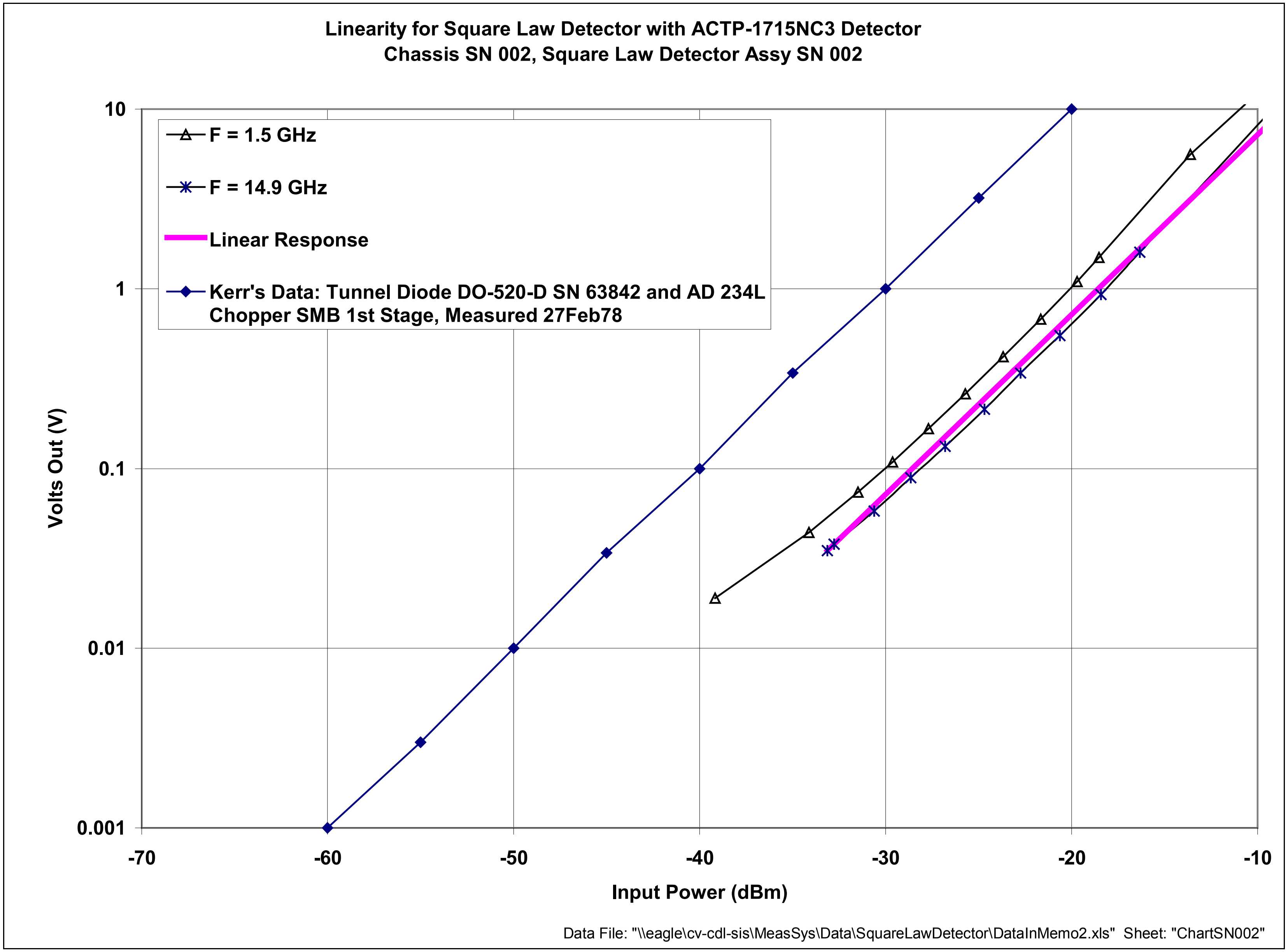

Figure 4 Linearity for Detector SN 002