Allowable Operating Ranges for the HTRP

Mark M. McKinnon

March 21, 1990

The following is a summary of tests I conducted on March 19, 1990 to determine the allowable operating ranges of the HTRP. I was particularly interested to find out if the HTRP detector output was linear with input power. I also wanted to see if the phase determined from the detected cross products was constant with input power.

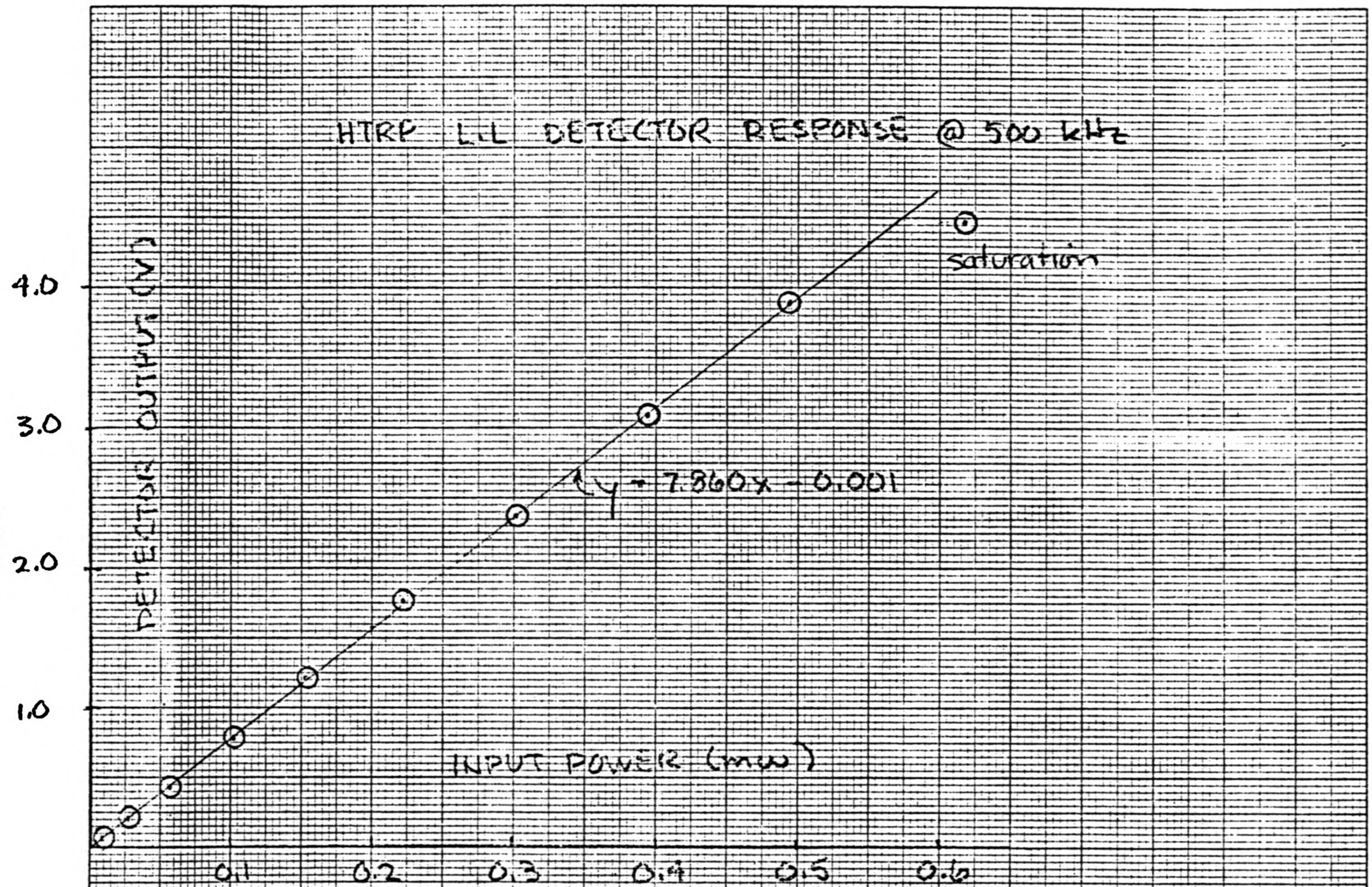
The testing was done by connecting the output of a signal generator to a power splitter. The two outputs of the power splitter were connected to the RCP and LCP inputs of the HTRP. The prototype phase-shift and detector cards were used in the test. The output of each detector (RR, LL, RL, and LR) was measured for different values of the signal generator sinusoid amplitude. The input power was measured with a power meter at one of the outputs of the power splitter. The test was conducted for sinusoid frequencies of 0.5, 1.0, 2.0, and 4.0 MHz. With this test configuration, the RCP and LCP inputs are exactly in phase. Therefore, the RL output should ideally be zero ($\sin 0 = 0$). I treated any signal in RL as a phase error, and computed the phase error as arctan(RL/LR).

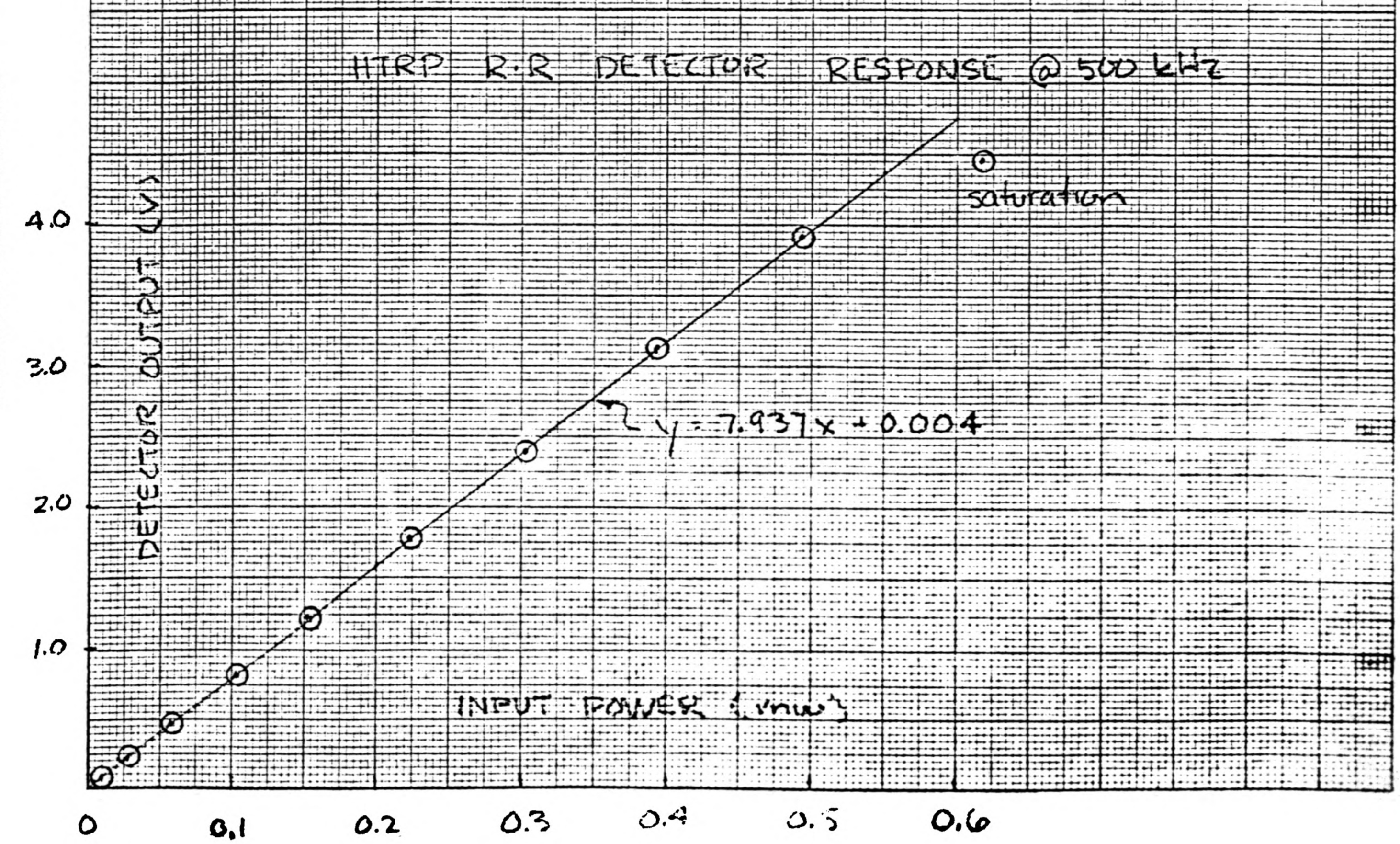
My results are plotted in the attached figures. The parallel product detector outputs (RR and LL) are wonderfully linear over the input power range I used. At all frequencies the detector outputs saturate at about 4.0 volts. The least squares fits to the straight lines are annotated on each graph. The slopes of the lines are approximately constant with frequency for a single detector, but the slopes increase slightly with decreasing frequency. This means the low frequency components of a broad band noise source will be weighted more than the high frequency components. This verifies the results I found during tests conducted on August 13, 1989 (figures also attached). The good results from recent tests of total flux calibration of VLA HTRP data indicate that this frequency dependence is not a major concern.

The cross product detector outputs (RL and LR) have essentially constant phase offsets for input power levels of 0.15 to 0.5 milliwatts at all frequencies. This input power range corresponds to parallel product detector outputs of 1.2 to 4.0 volts, respectively. The phase offset seems to be constant with frequency to about 1.0 MHz, but increases by a factor of three at 4.0 MHz. Again, the increase in phase offset with increasing frequency confirms the results found on August 13. The phase offset below 1.0 MHz can be compensated for with appropriate polarization calibration. From the results of recent polarization calibration test runs (memorandum dated March 12, 1990), I expected a much stronger dependence of phase error on input power. The relatively stable phase error now suggests there is an error in either my polarization calibration scheme or the VLA polarization scheme. The two methods were compared in the March 12 memo.

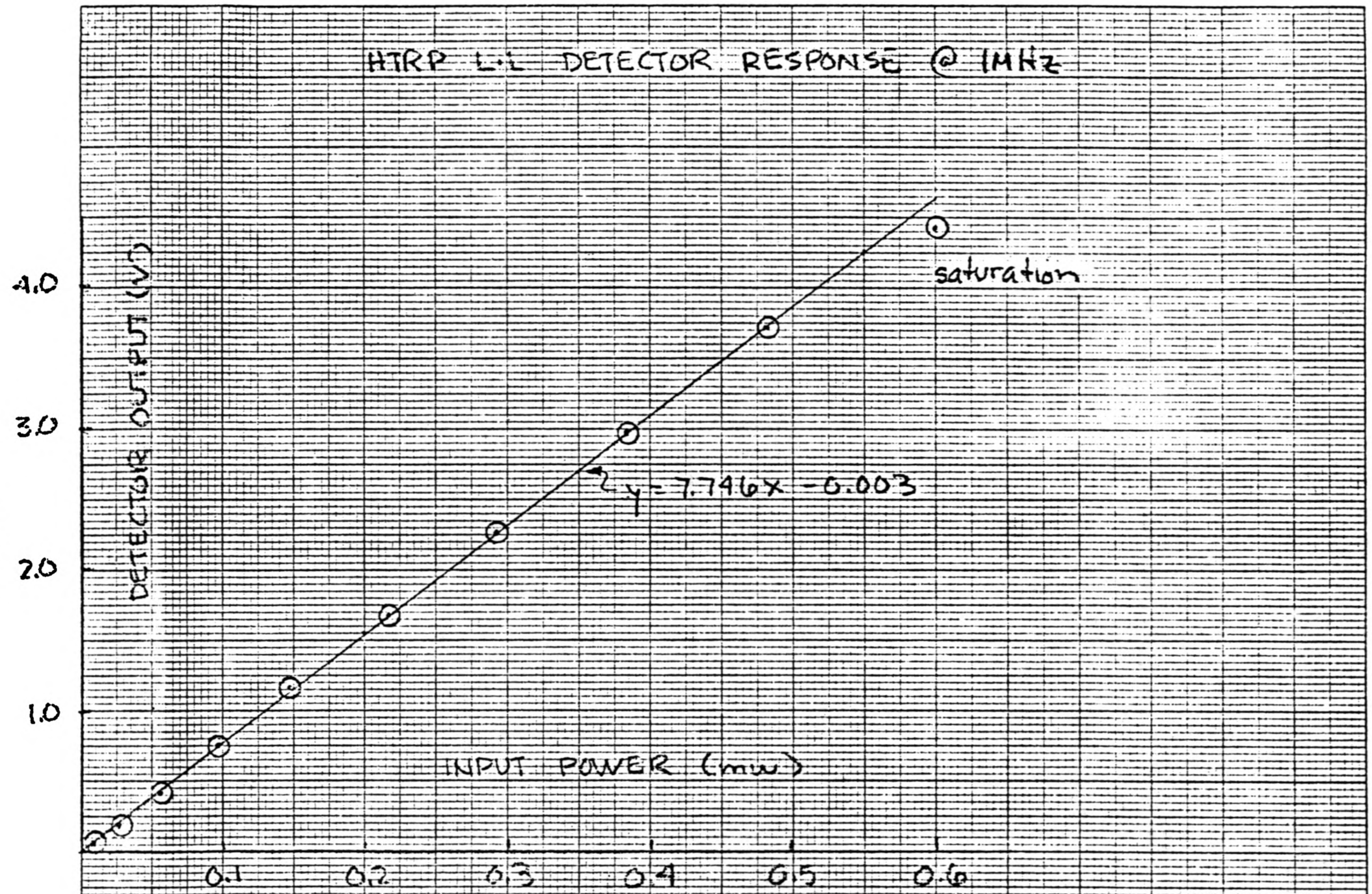
So, what are the observational consequences of these tests? One may use the HTRP over all videoconverter bandwidths for total power measurements (those involving only RR and LL) for detector output voltages up to 4.0 volts. The measurable flux will be determined by the attenuation set at the videoconverters. For example, suppose the attenuators are set such that a blank sky measurement produces a one volt signal, and the measurement of a 5.0 Jy calibration source produces a 1.2 volt signal. The maximum flux one could measure before detector saturation would be 5*3/0.2 = 75 Jy. Polarization measurements should be restricted to videoconverter bandwidths of 2.0 MHz and parallel product detector output voltages of 1.2 to 4.0 volts. One can probably use the 2.0 MHz filters since the signal at 2.0 MHz in the band is 10dB down. Conservative polarization observations should be restricted to 1.0 MHz bandwidth filters. Recall that all videoconverters have 2.0 and 4.0 MHz filters in both the upper and lower sidebands, but only four videoconverters have bandwidths below 2.0 MHz in the upper sideband only.

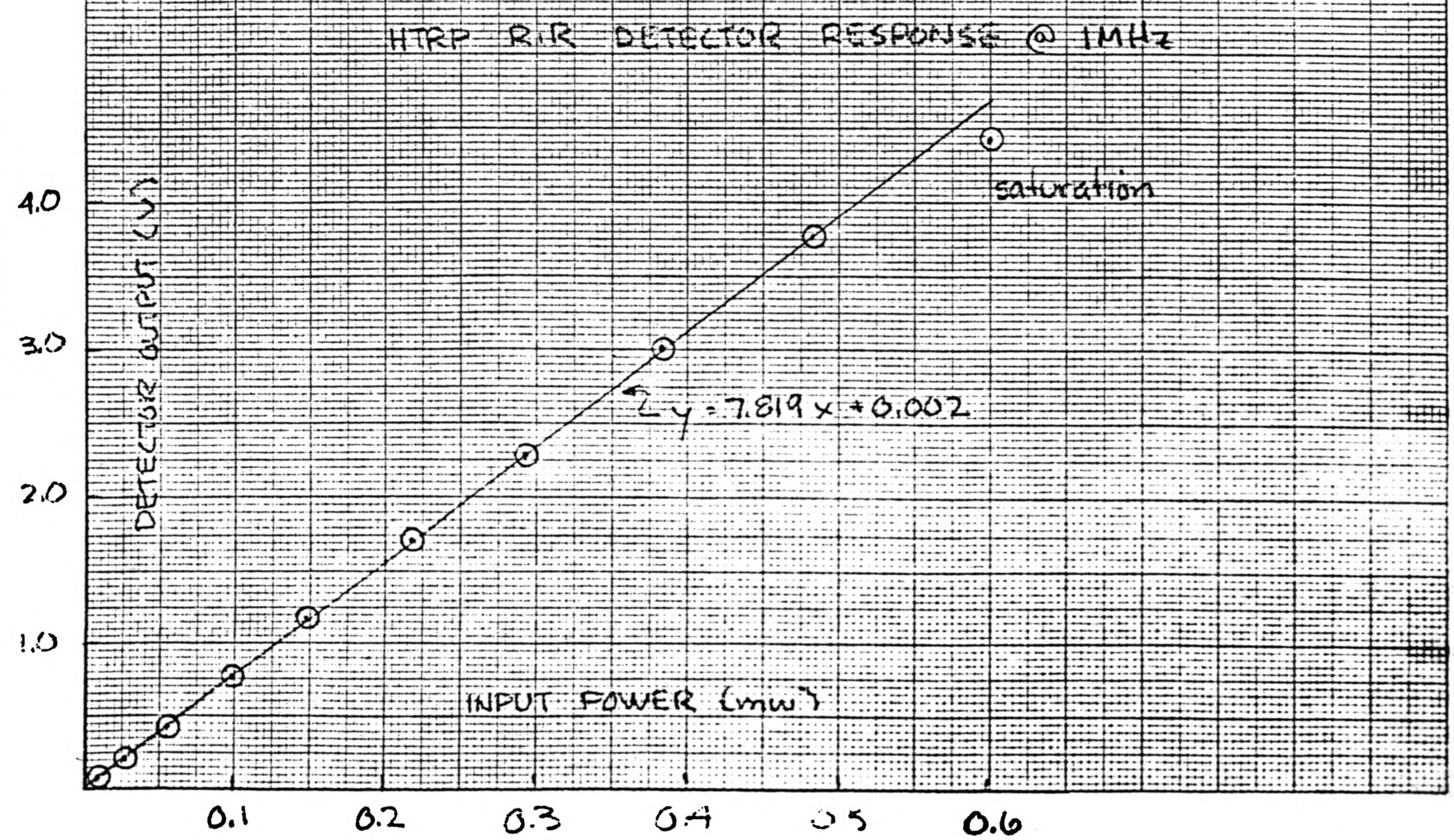
HMM
3-20-90


HTRP L.L DETECTOR RESPONSE @ 500 kHz
saturation
DETECTOR OUTPUT (V)
4.0
3.0
2.0
1.0
y = 7.860x - 0.001
INPUT POWER (mw)
0.1
0.2
0.3
0.4
0.5
0.6

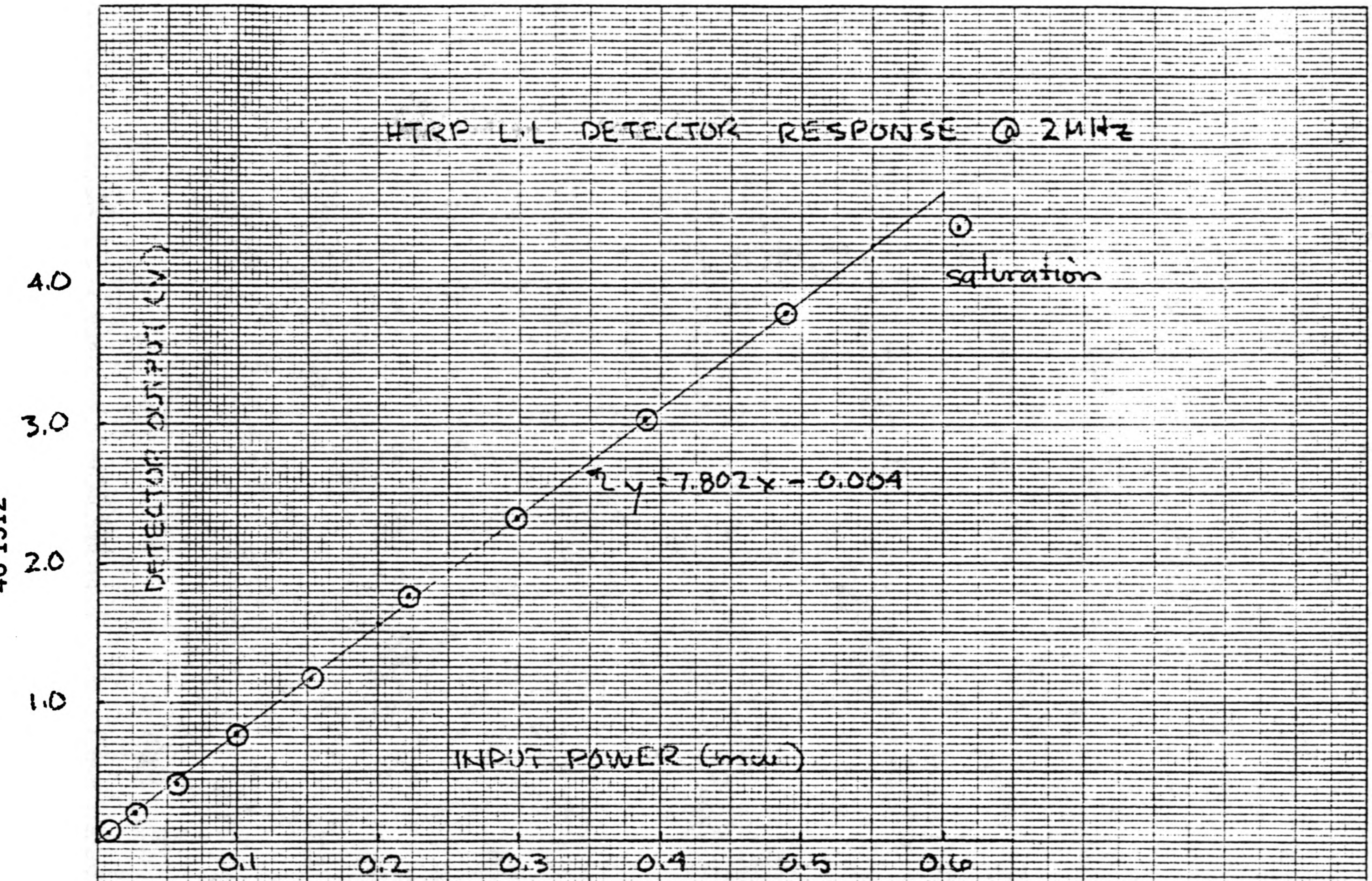

HTRP R.R DETECTOR RESPONSE @ 500 kHz
saturation
DETECTOR OUTPUT (V)
4.0
3.0
2.0
1.0
y = 7.937x + 0.004
INPUT POWER (mw)
0
0.1
0.2
0.3
0.4
0.5
0.6

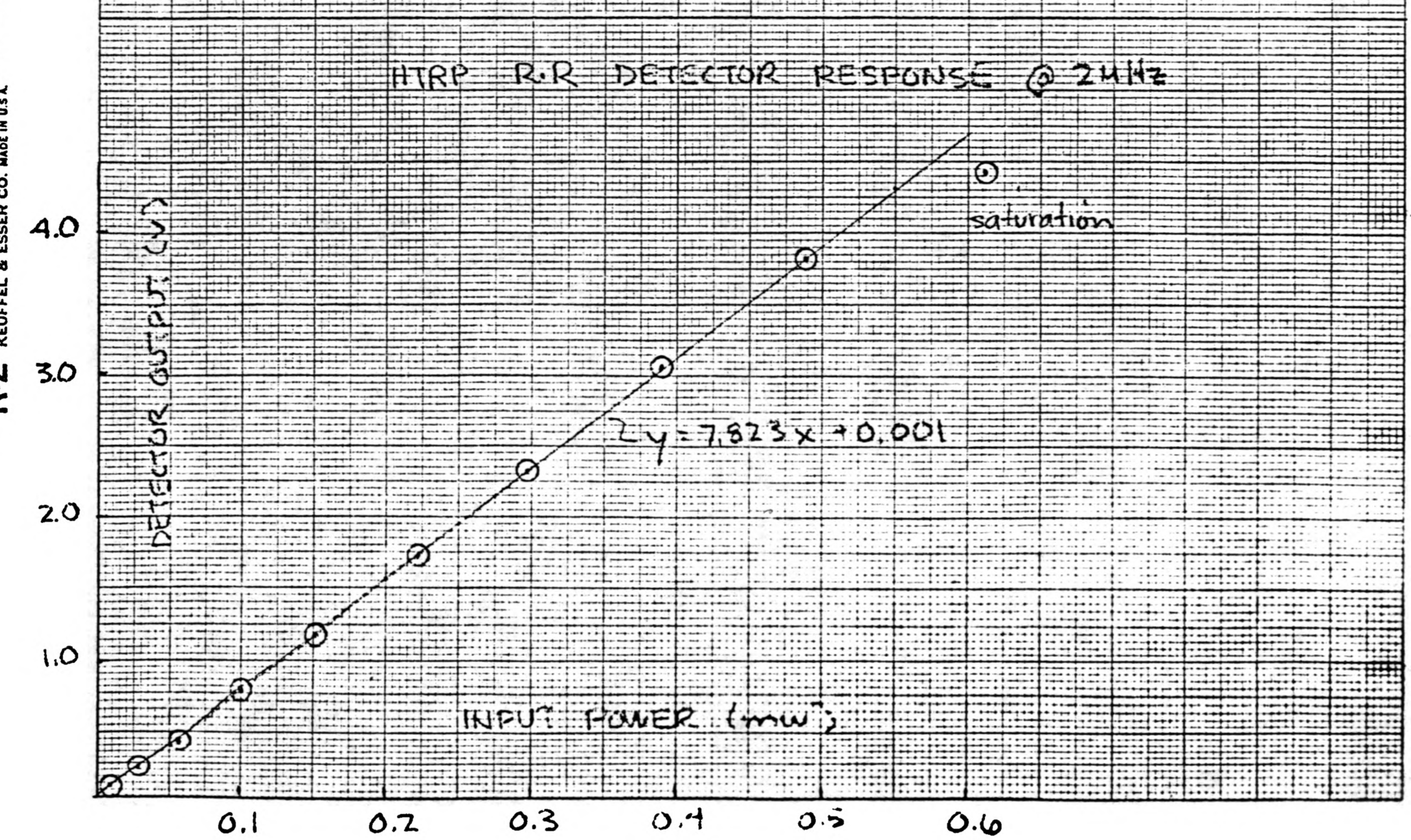
MMM
3-20-90


HTRP L·L DETECTOR RESPONSE @ 1MHz
DETECTOR OUTPUT (V)
INPUT POWER (mw)
y = 7.746x − 0.003
saturation
1.0
2.0
3.0
4.0
0.1
0.2
0.3
0.4
0.5
0.6

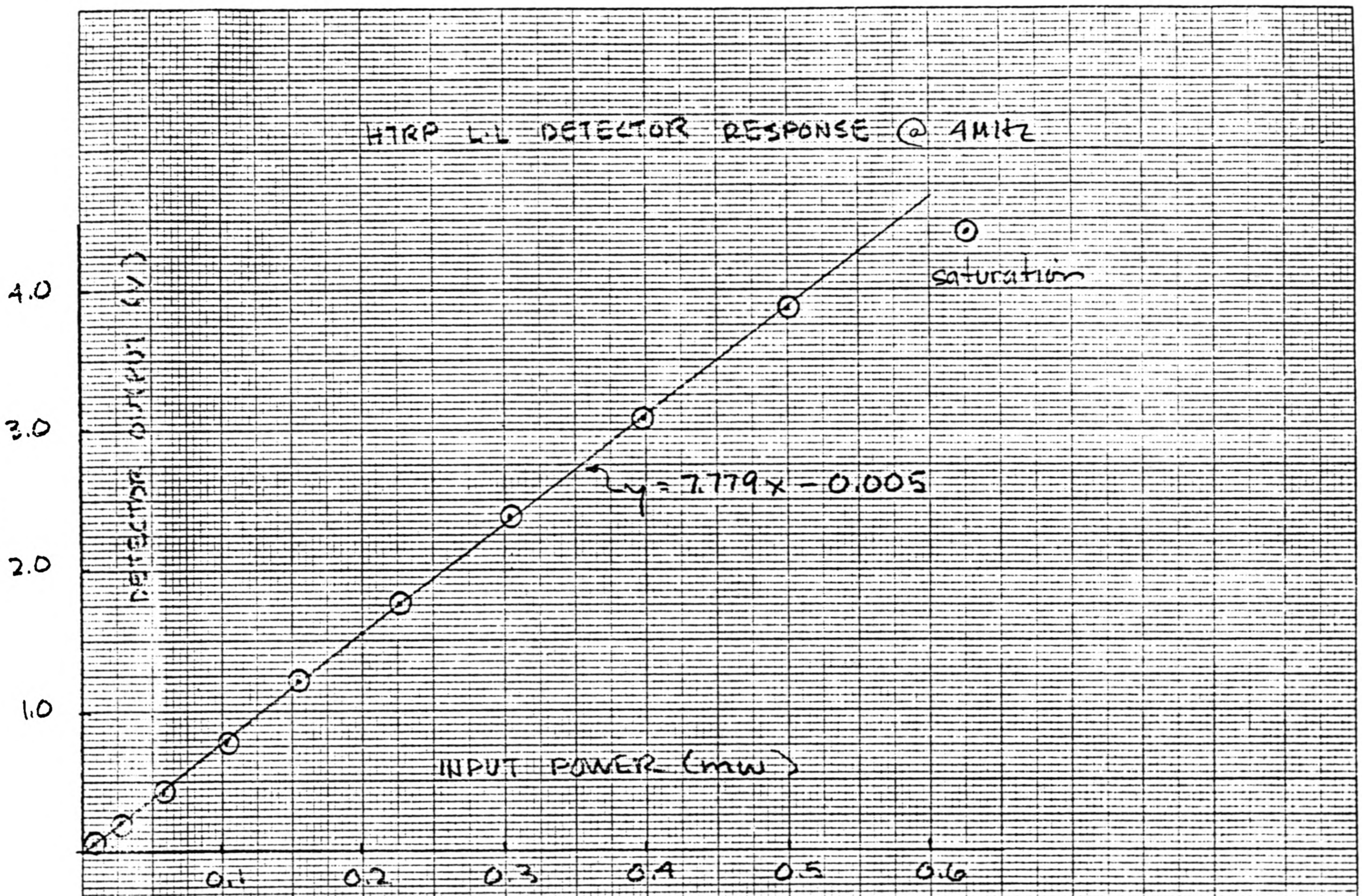

HTRP R·R DETECTOR RESPONSE @ 1MHz
DETECTOR OUTPUT (V)
INPUT POWER (mw)
y = 7.819 x + 0.002
saturation
1.0
2.0
3.0
4.0
0.1
0.2
0.3
0.4
0.5
0.6

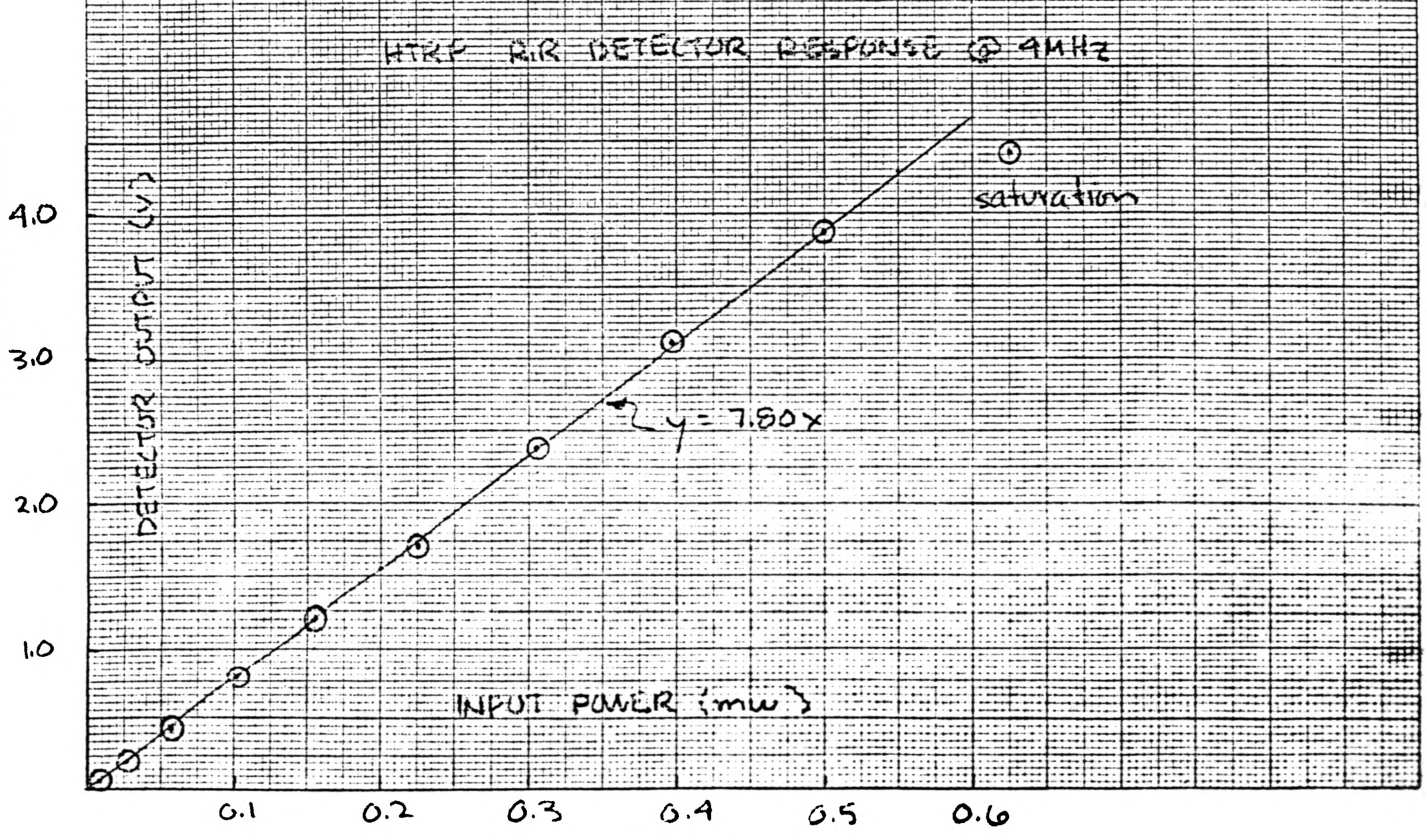
NMM
3-20-90


HTRP L.L DETECTOR RESPONSE @ 2MHz
DETECTOR OUTPUT (V)
4.0
3.0
2.0
1.0
saturation
y = 7.802x - 0.004
INPUT POWER (mw)
0.1
0.2
0.3
0.4
0.5
0.6

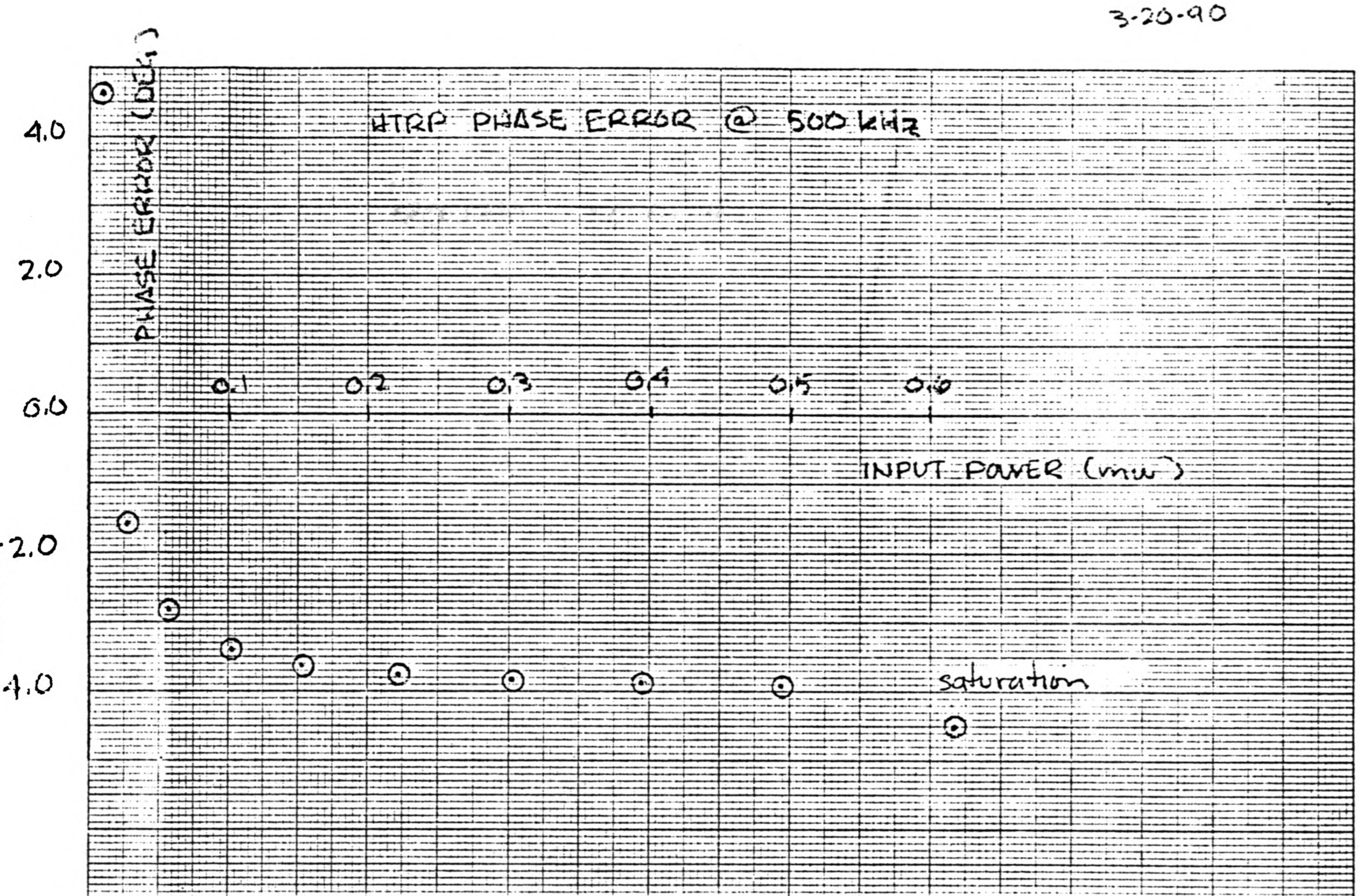

HTRP R.R DETECTOR RESPONSE @ 2MHz
DETECTOR OUTPUT (V)
4.0
3.0
2.0
1.0
saturation
y = 7.823x + 0.001
INPUT POWER (mw)
0.1
0.2
0.3
0.4
0.5
0.6

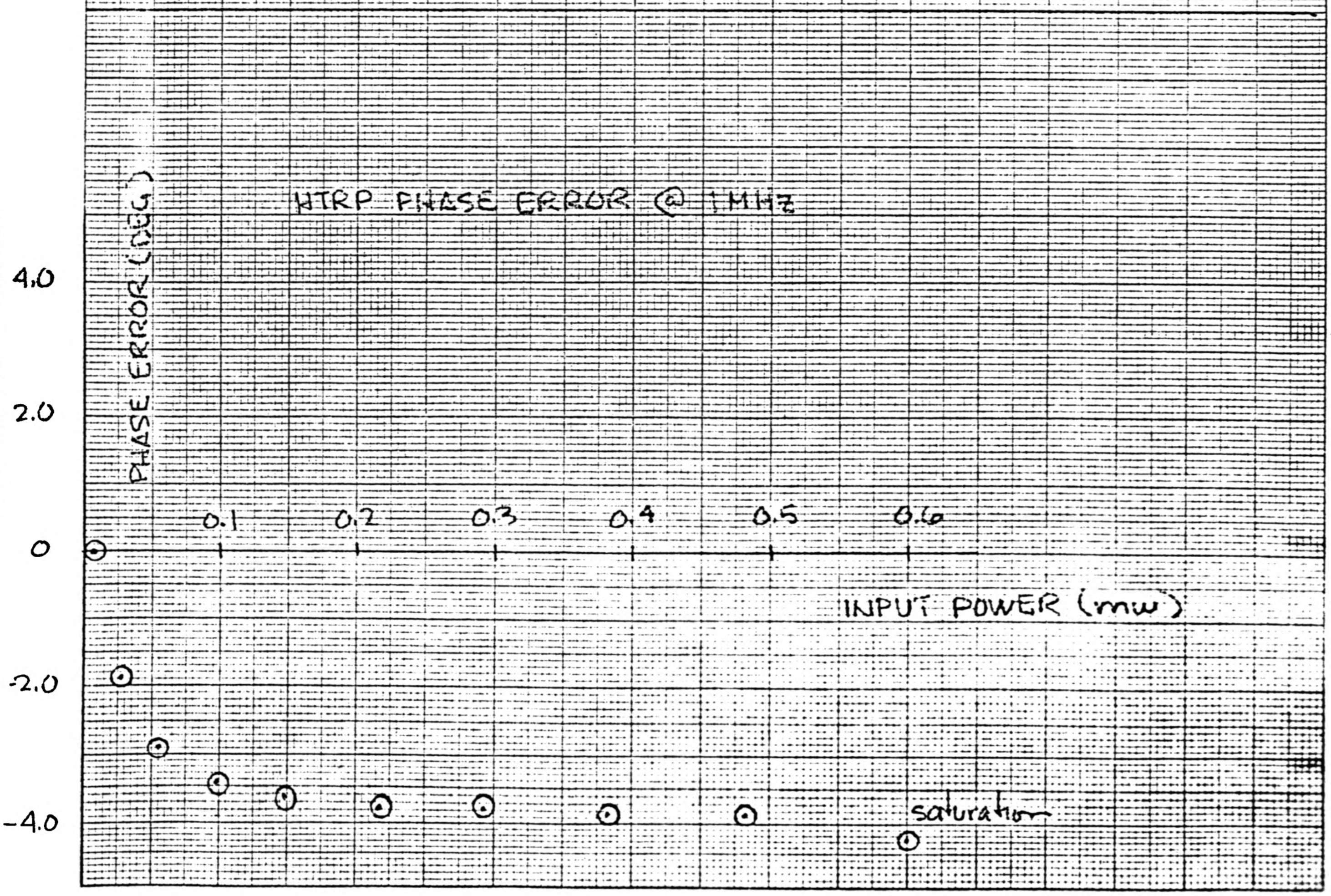
HMM
3-20-90


HTRP L.L DETECTOR RESPONSE @ 4MHz
saturation
y = 7.779x − 0.005
DETECTOR OUTPUT (V)
INPUT POWER (mw)
4.0
3.0
2.0
1.0
0.1
0.2
0.3
0.4
0.5
0.6

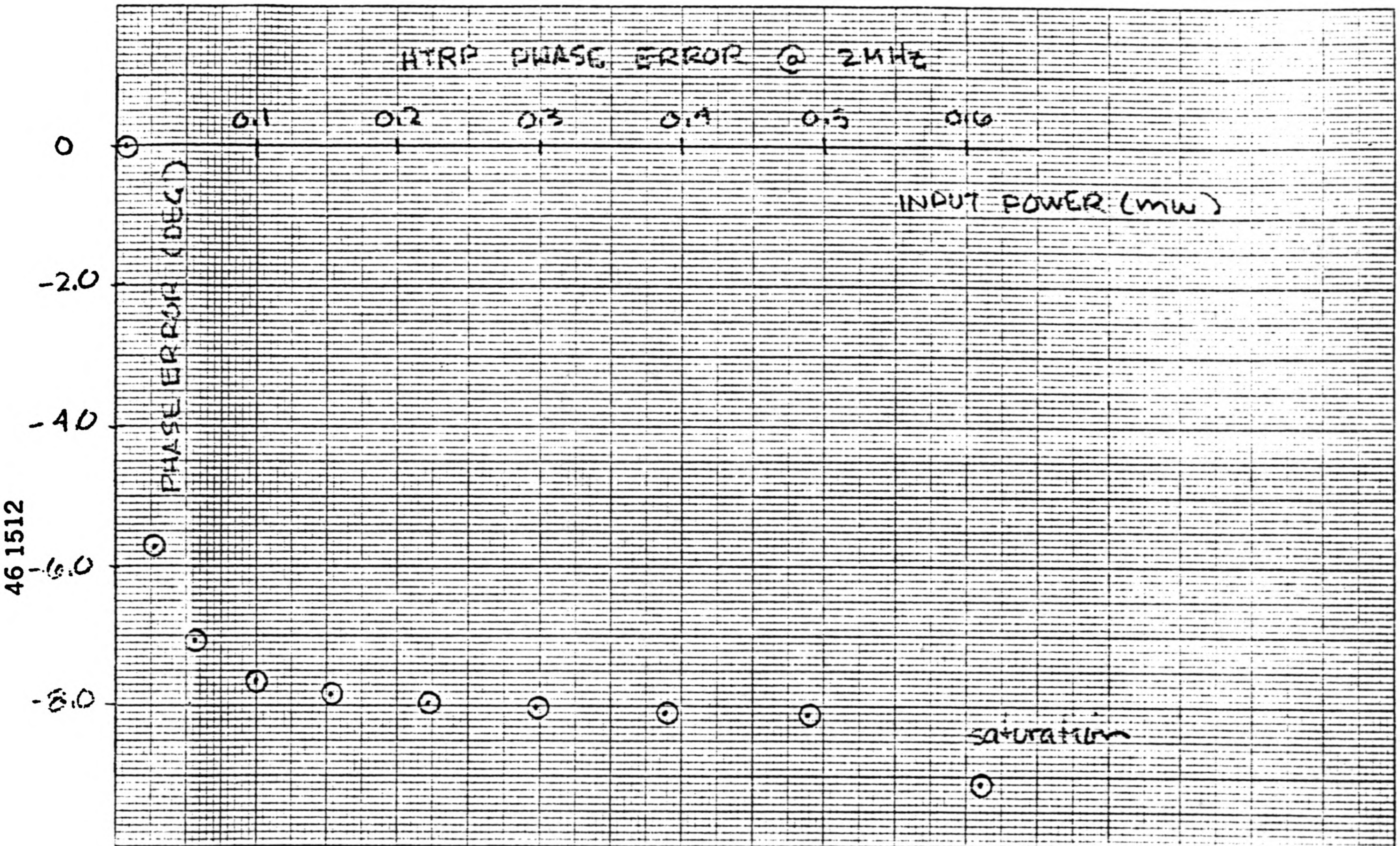

HTRP R.R DETECTOR RESPONSE @ 4MHz
saturation
y = 7.80x
DETECTOR OUTPUT (V)
INPUT POWER (mw)
4.0
3.0
2.0
1.0
0.1
0.2
0.3
0.4
0.5
0.6

MMM
3-20-90

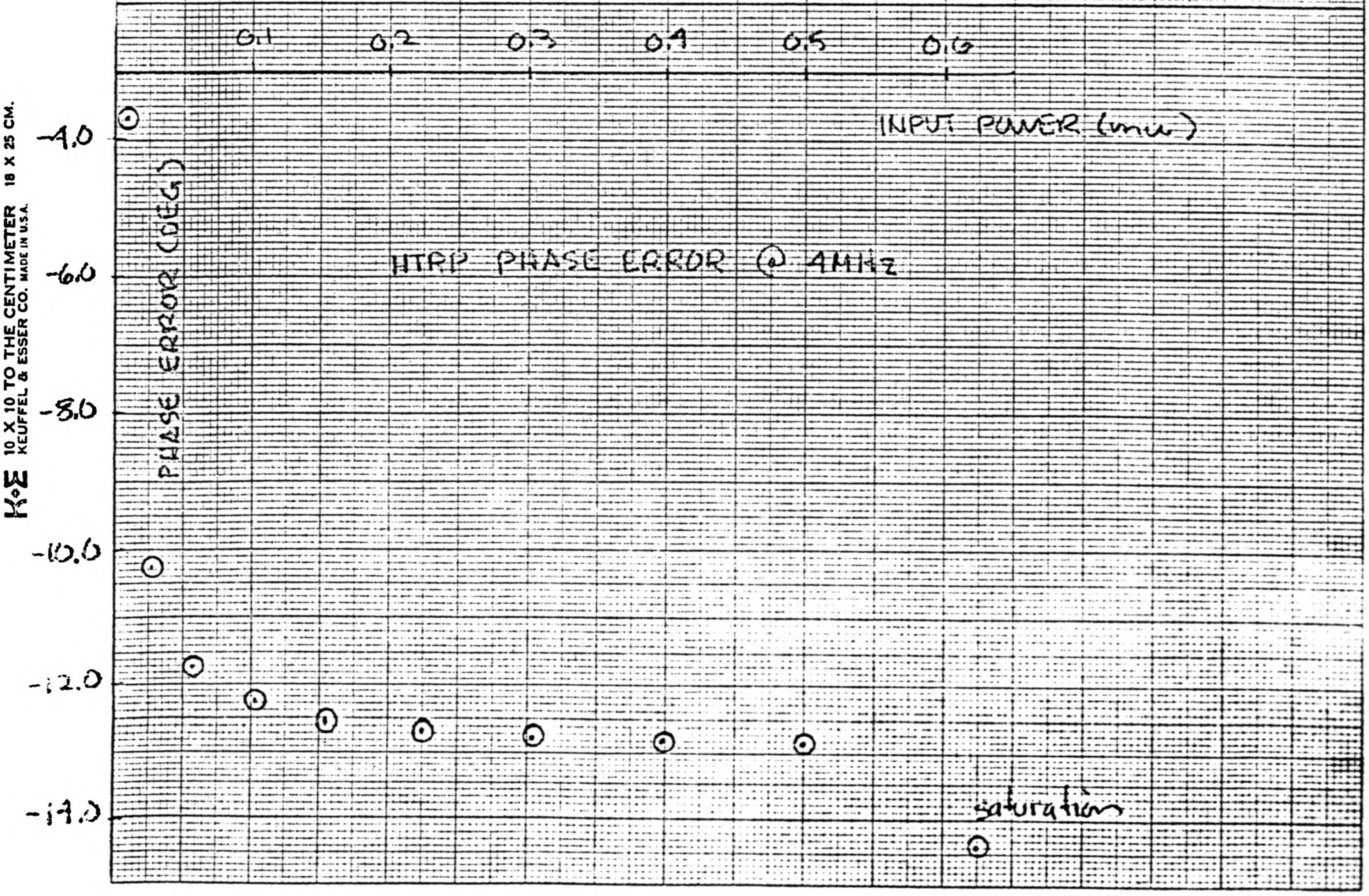

HTRP PHASE ERROR @ 500 kHz
PHASE ERROR (DEG)
4.0
2.0
0.0
-2.0
-4.0
0.1
0.2
0.3
0.4
0.5
0.6
INPUT POWER (mw)
saturation


HTRP PHASE ERROR @ 1 MHz
PHASE ERROR (DEG)
4.0
2.0
0
-2.0
-4.0
0.1
0.2
0.3
0.4
0.5
0.6
INPUT POWER (mw)
saturation

MMM
3-20-00

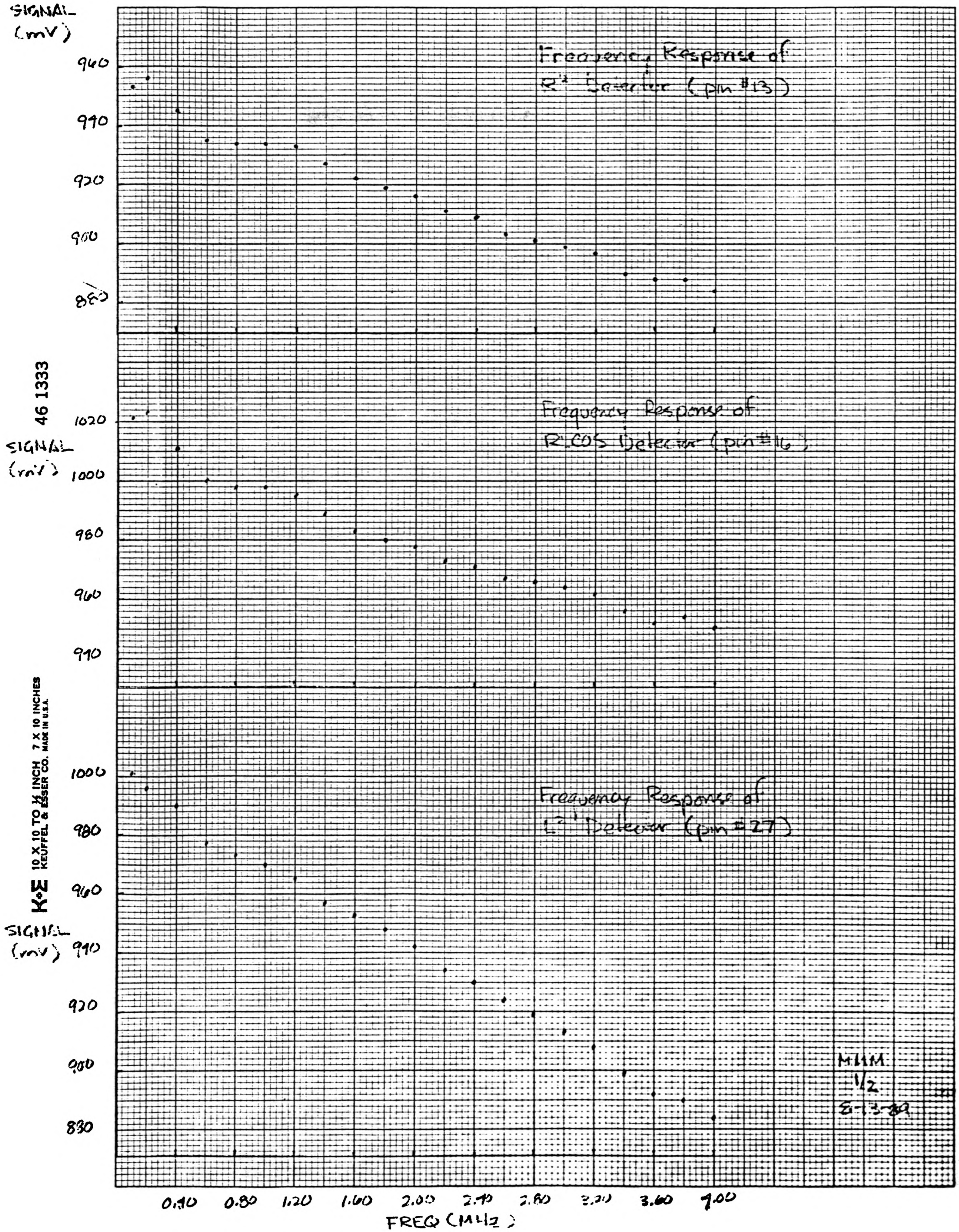


HTRP PHASE ERROR @ 2MHz
0.1
0.2
0.3
0.4
0.5
0.6
INPUT POWER (mw)
PHASE ERROR (DEG)
0
-2.0
-4.0
-6.0
-8.0
saturation

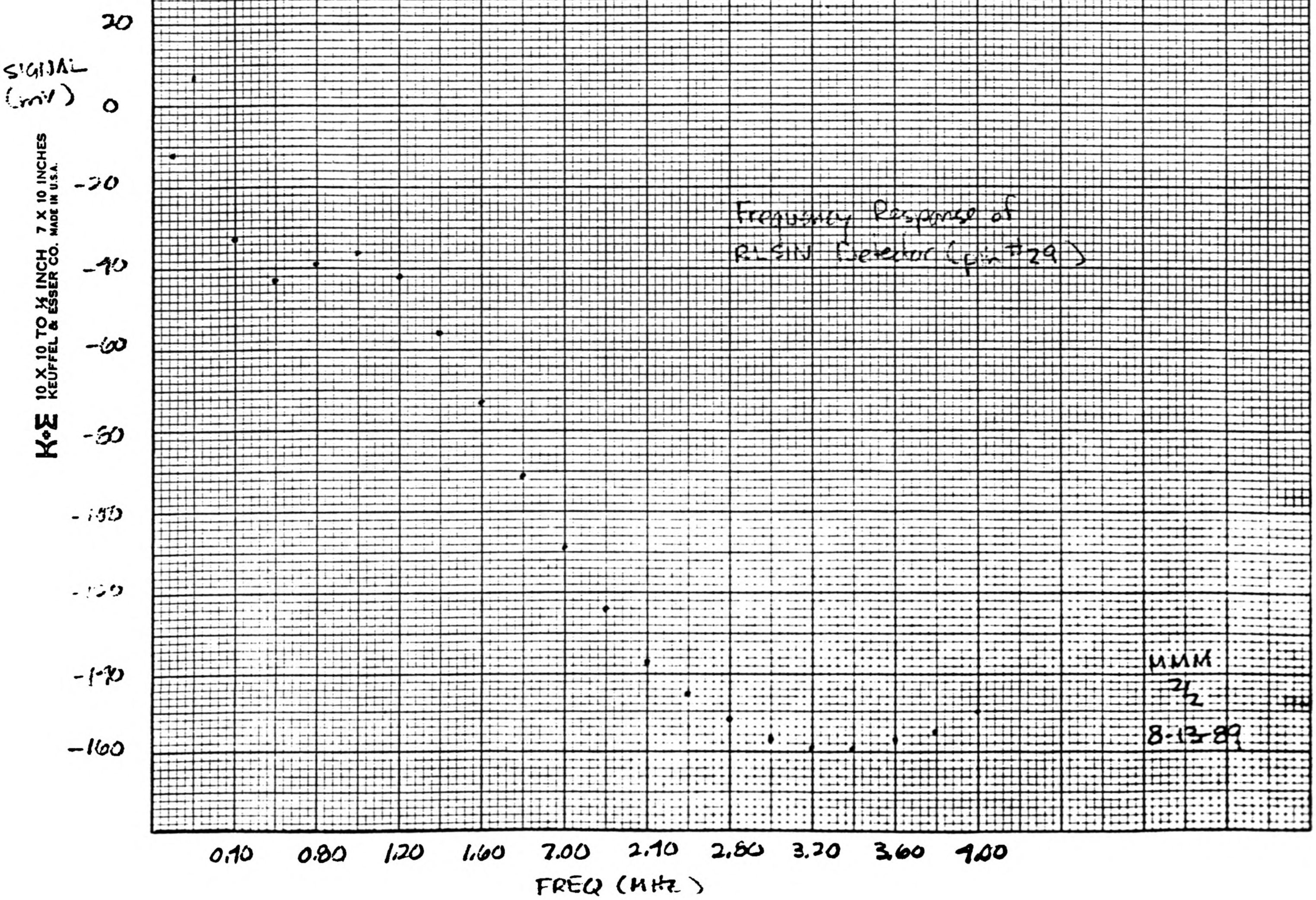


0.1
0.2
0.3
0.4
0.5
0.6
INPUT POWER (mw)
HTRP PHASE ERROR @ 4MHz
PHASE ERROR (DEG)
-4.0
-6.0
-8.0
-10.0
-12.0
-14.0
saturation

DETECTOR FREQUENCY [illegible]



Procedure:
1. Select frequency @ HP 8165A Signal Source
2. Adjust HP 435A Power Meter for probe efficiency @ selected frequency
3. Measure source power & force to -3dBm by varying amplitude
4. Connect source to power splitter @ detectors.
5. Measure voltage @ the desired detector card pin.
6. Repeat for different frequencies.



MMM
7/2
8-13-89