IEEE p802.4L

Through-the Air Physical Media, Radio

Statistic Analysis of Oshawa Measurements

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Attached is a submission to the IEEE p802.4L Task group.[1]

Please note that the attached diagrams are excerpts from the full set of analysis results.

[1] These charts were submitted to the IEEE p802.4L meeting held 5-7 November 1989 in Fort Lauderdale, FL. The temporary number was F.4L/6L.

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Summary of Attached Analysis

The attached drawings and calculations represent a more in depth analysis of the data obtained at the General Motors Car Body Assembly Plant in Oshawa, Ontario. The original analysis which consisted primarily of cataloging the data, and performing correlation on the data to obtain basic delay spread information has been enhanced with the addition of the following calculations:

- ◇ Instantaneous and average power
- ◇ Large scale fading characteristics
- ◇ Delay spread characteristics
- ◇ Temporal variance of the channel
- ◇ Analysis of noise samples
- ◇ Analysis of the impact of impulse noise on barker sequence correlation peaks

The data contained herein is basically self explanatory. It was produced using a combination of custom generated C language programs and the MATHEMATICA software package.

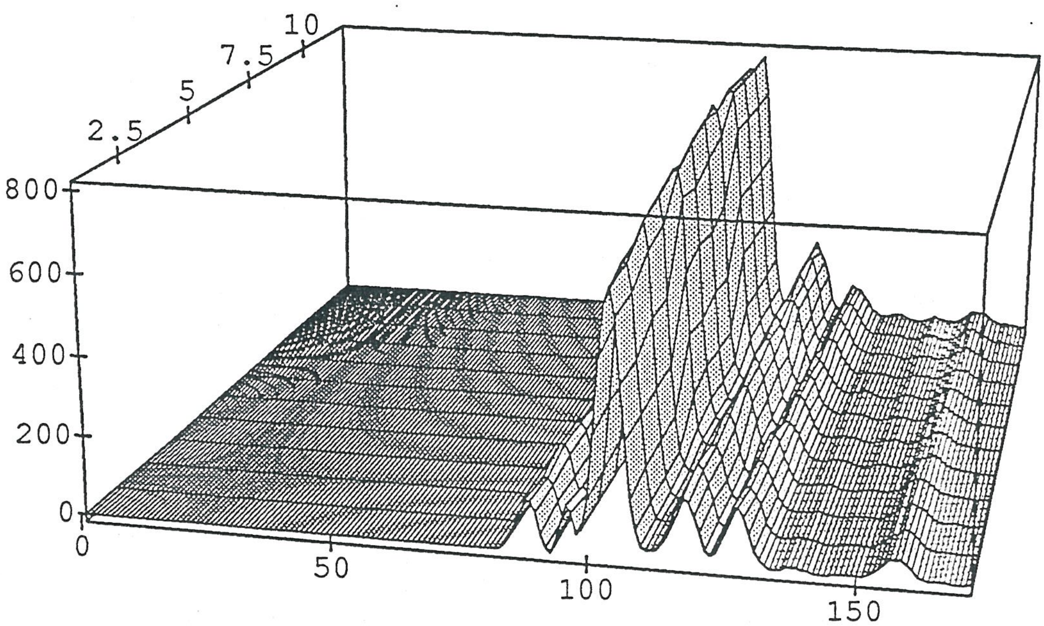
The large scale fading calculations were done by taking the I and Q voltage samples which were captured, scaling them according to the oscilloscope settings when they were captured, and forming a complex number I+iQ. This number was then multiplied by its complex conjugate to produce a value for instantaneous power. The instantaneous power was then summed over a number of samples and divided by the number of samples to provide an indication of average power. The average power from the measurments taken at a 10 wavelength distance at location J47 was used as a base for the generation of path loss numbers for the various locations. This data was also adjusted based on the level of transmitter modulation to a base level of 50 mv modulation. A least squares fit was done on the path loss versus distance data to provide a value for n. The square of the deviations of the actual values from the estimated values were then calculated to produce a deviation value. These were respectively, n = 2.204 and sigma = 9.53 dB. These values are in good agreement with values previously published.

In order to observe the temporal variance of the channel, the correlated data for M-sequences from each location was taken. Again, I and Q were combined through multipilcation of I+iQ by its complex conjugate and the results plotted. Successive peaks were located and displayed as 3 dimensional surface plots. Of particular interest were the plots of MSEQ1 through MSEQ6 which illustrate not only time variance but also the variance of the channel with small (approximately 1-2") micromovements. In general the duration of time which is represented in the plots is about 180 μs.

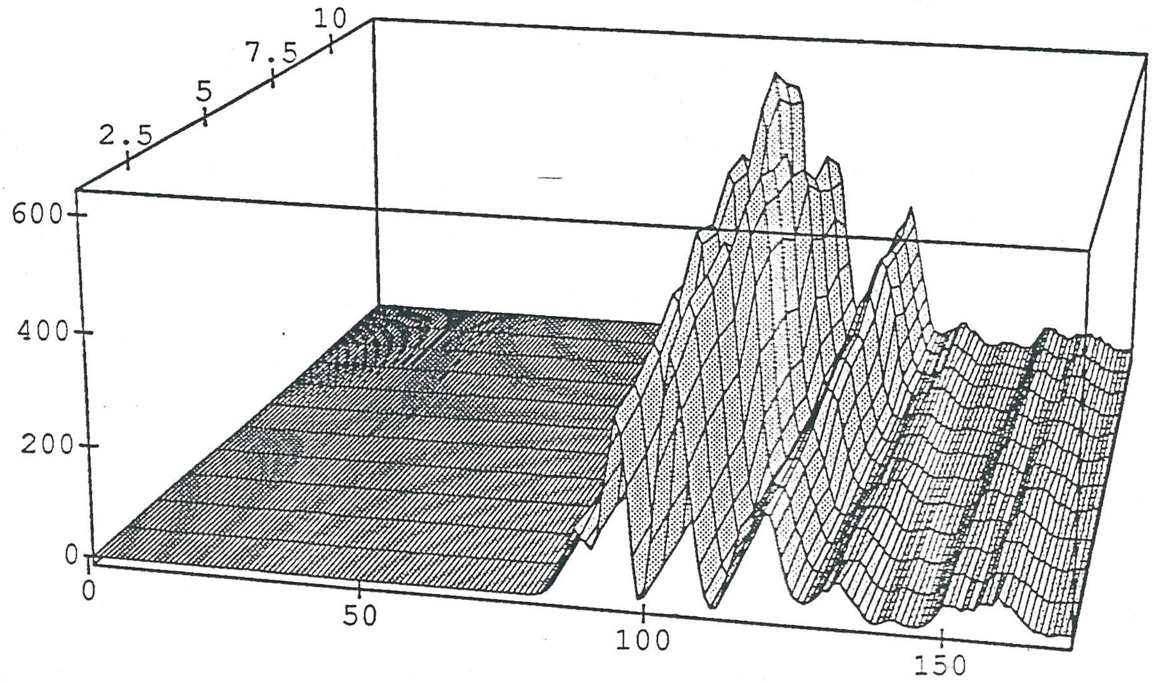
The delay spread was estimated by looking at each temporal variance plot and assigning a value of delay to it. These values were then processed to determine mean and standard deviation. In this calculation the mean of the delay spread was estimated to be 286.84 ns and the Standard deviation of this value was 99.72 ns. As has been previously reported there did not seem to be a correlation between delay spread and distance of transmission.

Finally, noise samples were taken and the amount of noise present in bins of 2 μs and 20 μs was examined. This examination indicated that impulse noise could cause the amount of power present in a bin to vary substantially from the mean value. In the sample BARK17, on an arbitrary scale the received power was 800 per bin under non impulse situations, and this increased to 1600 under impulse situations. Also provided is data regarding the impact of this impulse noise on the correlation peaks derived from the sample.

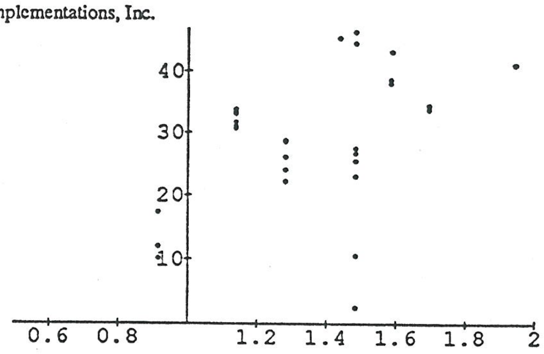
From a noise point of view the most serious problem seems to be with intentional radiators operating within the band we are dealing with. Although the magnitude of the noise from intentional radiators will vary from site to site, it appears from our collection of data at multiple sites that it is reasonable to expect that RADIOLAN's will be expected to operate in many situations in an environment characterized by negative signal to interference ratios and that existance of adequate jamming margin with the technique chosen to implement the system will be essential. This is true in both the 915 MHz and the 2.45 GHz band. In the higher frequency band the presence of substantial interference from microwave ovens is to be expected. In the lower frequency band, high levels of interference can be expected from emergency services radio, theft detection devices, and older microwave ovens.



Y56 Temporal Variance MSEQ1



Y56 Temporal Variance MSEQ3



In[20]:=

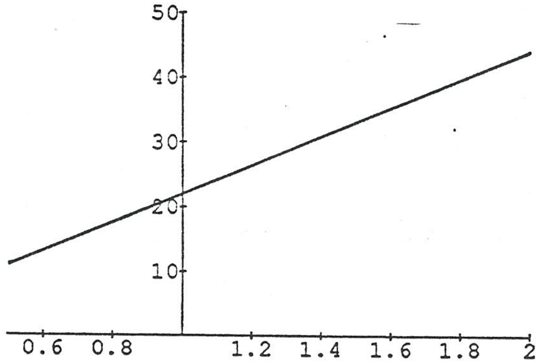
```
Fit[data1,{x},x]
```

Out[20]=

```
22.0439 x
```

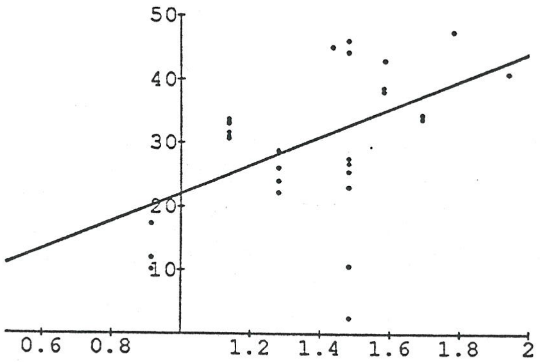
In[21]:=

```
Plot[%,{x,.5,2},PlotRange ->{{.5,2},{0,50}}]
```



In[22]:=

```
Show[%,%%%]
```




```
For[i=0;sigma=0,i<Length[data],sigma=sigma+
((data1[[i]][[2]]-First[Out[20]] data1[[i]][[1]])^2),i++]
```

In[28]:=

```
sigma/(Length[data]-2)
```

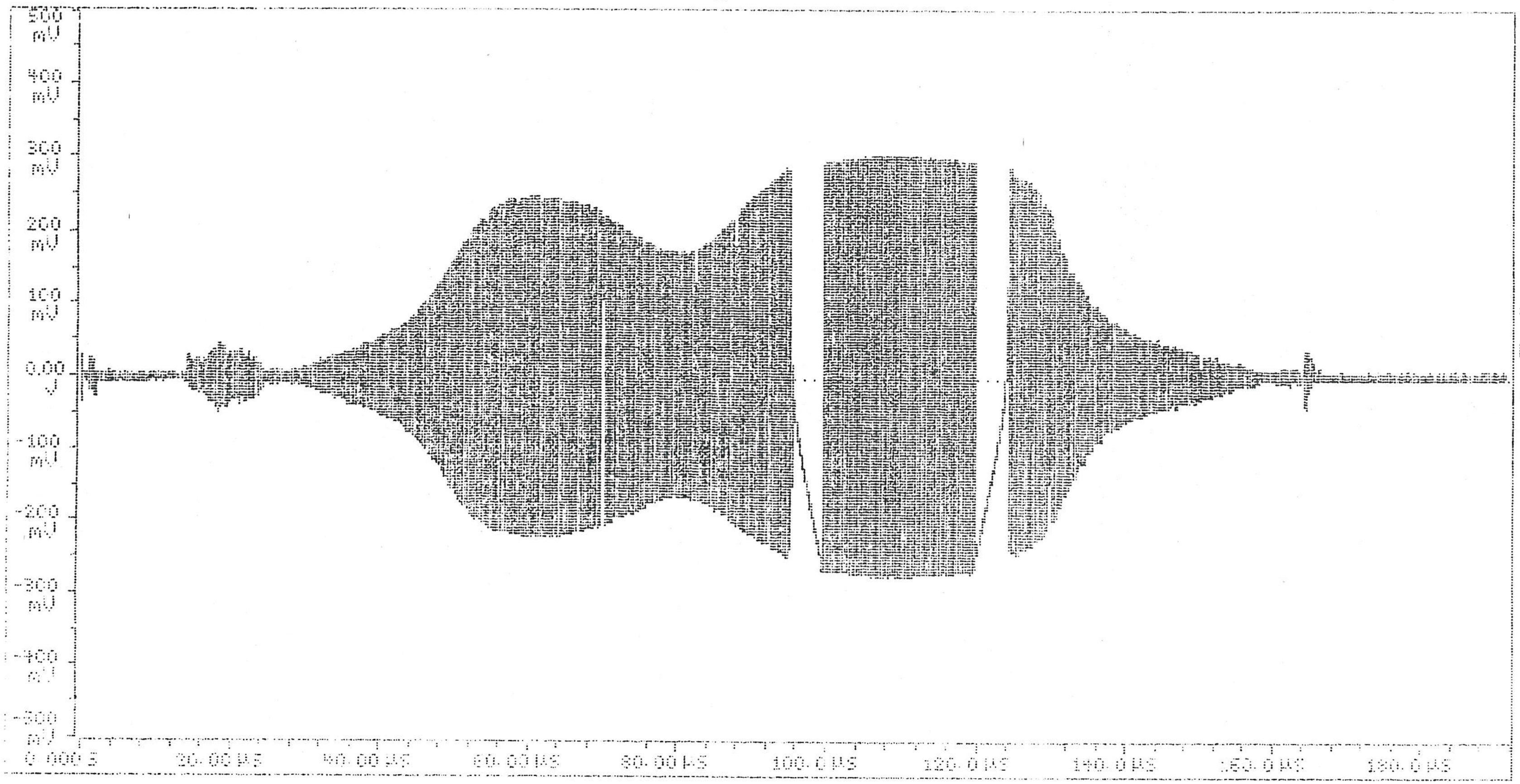
Out[28]=

```
95.3267
```

1 mS/DIV

1 VOLT/DIV.

File　　LeCroy EASYWAVE　　18:34:57



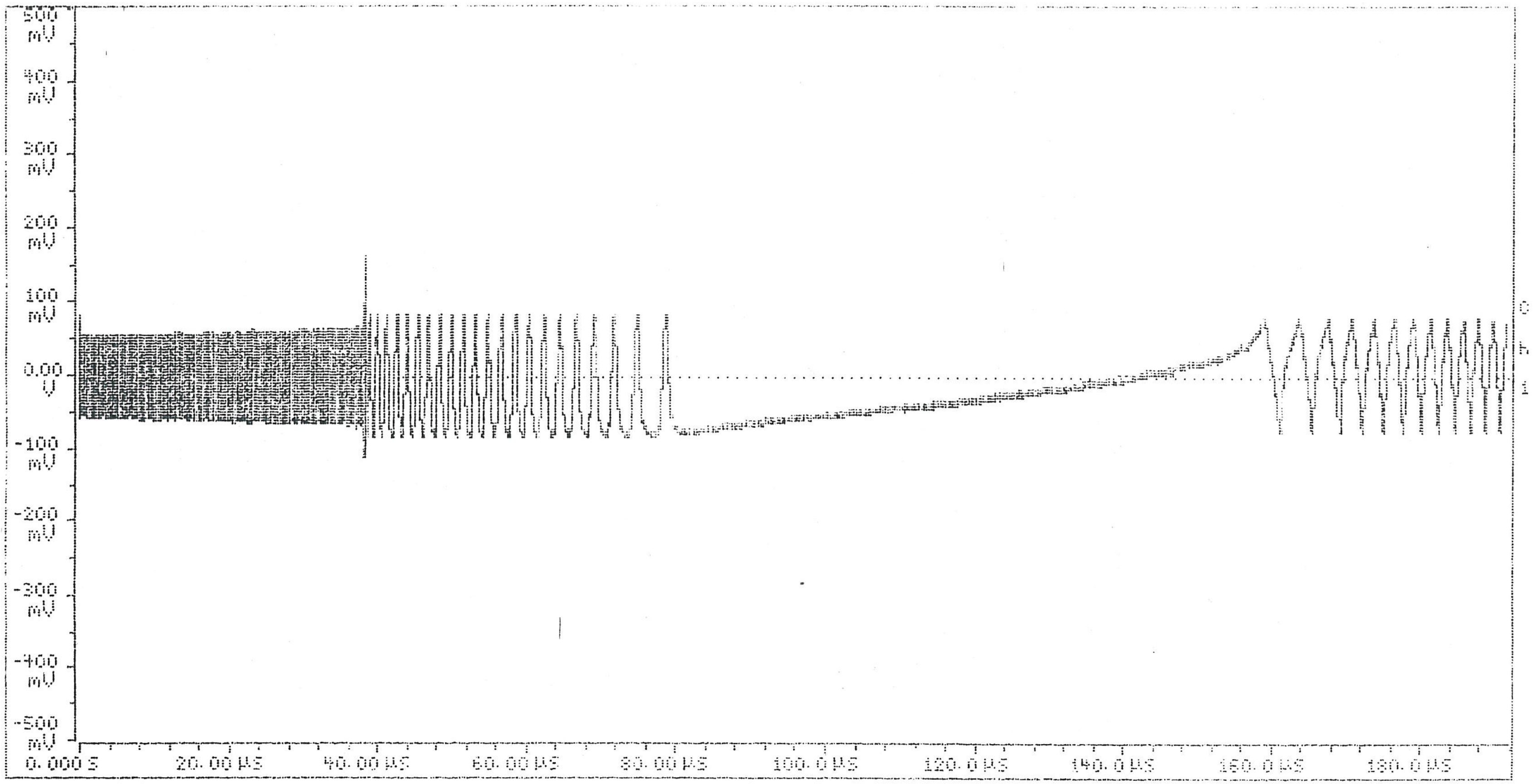
File transfer:	Disk to ew	dIsk to afg and ew	Ew to disk	eW to afg	Afg to disk and ew	aFg to ew	More

MICR19.WAV from disk to EW

5Ns/PT

1V/DIV

File LeCroy EASYWAVE 18:32:44



File transfer:	Disk to ew	dIsk to afg and ew	Ew to disk	eW to afg	Afg to disk and ew	aFg to ew	More

Cursor: 0 (0.000 s), 14 (2.9 mV)