Output Rate Measurements for LeCroy Sixteen Channel Discriminator Models 2313 and 4413

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June 22, 1997

1 OVERVIEW

Two models of LeCroy discriminators were tested in order to measure output rates as a function of
1) the input signal amplitude and
2) the input signal width.

The results of these measurements indicate that the LeCroy Model 4413 discriminator has a greater, more stable output rate at similar input signal amplitudes than the newer LeCroy Model 2313 discriminator.

2 INTRODUCTION TO THE DISCRIMINATORS

2.1 The LeCroy Model 4413 Discriminator

The LeCroy Model 4413 discriminator is a sixteen channel CAMAC interface module with both updating and non-updating versions. The sixteen channels accept NIM level inputs and provide ECL level output signals. The output signals feature adjustable widths between 10 and 100 nanoseconds, and a front panel potentiometer allows threshold adjustments between -10 mV and -1.034 V. A **TEST** input, which when presented with a NIM level input signal via a 50Ω Lemo cable triggers all enabled channels, is located on the rear panel of the 4413.

2.2 The LeCroy Model 2313 Discriminator

The LeCroy Model 2313 discriminator is a sixteen channel non-updating CAMAC interface module. Each of the sixteen channels accepts NIM level inputs with a manufacturer's specified maximum input signal frequency of 100 MHz. The sixteen channels output ECL level signals with adjustable widths between 10 and 100 nanoseconds. Additionally, the sixteen channels have a common threshold (-10 mV to -1.034 V) which is adjustable via a front-panel potentiometer.

The 2313 utilizes a front-panel **TEST** input. An input signal delivered to the **TEST** input via a 50Ω Lemo cable triggers all enabled channels. The **TEST** input signal must be a NIM level signal with a minimum width of 6 nanoseconds, a maximum rate of 20 MHz, and a rise time less than 2 nanoseconds.

2.3 Differences between the LeCroy Models

Because the 4413 is the older of the two LeCroy models tested in this study, some of the Model 4413's features are less accessible than corresponding 2313 functions. However, given that both discriminators are CAMAC modules designed to be operated by remote interface, the most important difference between the two models is the location of the **TEST** input: the 4413 offers a rear-panel **TEST** junction while the 2313 uses a front-panel **TEST** input.

3 DESCRIPTION OF THE TESTS

3.1 Purpose

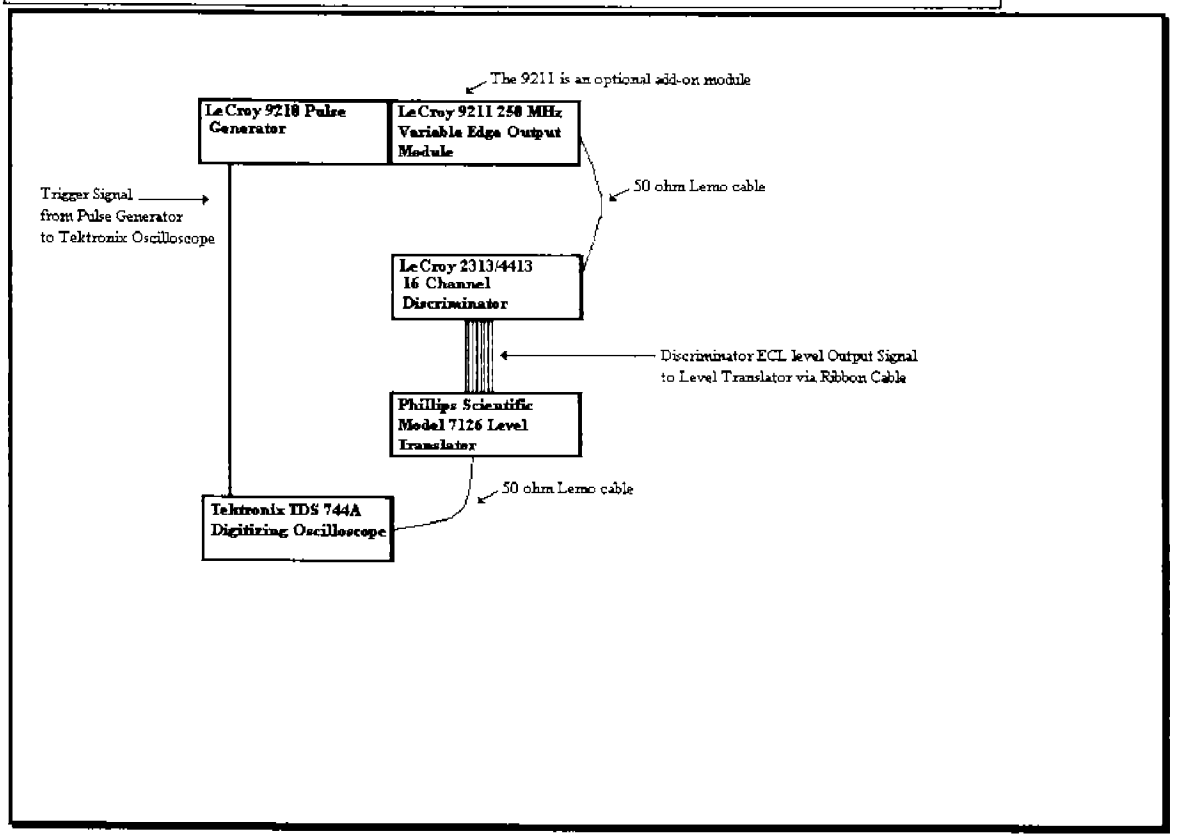
The purpose of the tests was to determine the maximum stable output rates of the LeCroy discriminators in response to varying input signal amplitudes and input signal widths.

3.2 Equipment and Experimental Setup

The discriminator tests utilized several components. The input signals which were distributed to the discriminator channels were generated by a LeCroy Model 9210 Pulse Generator with a LeCroy Model 9211 250 MHz Variable Edge Output Module. This particular pulse generator allows control over signal amplitude, width, rise time, fall time, and frequency. The generated input signals were delivered to the particular LeCroy discriminator under test via Lemo 50Ω cables. The ECL level output signals produced by the LeCroy discriminators were transmitted to a Phillips Scientific Model 7126 Level Translator via a thirty-two strand ribbon cable. Both the discriminator and level translator are CAMAC modules, and power for these modules was supplied by a BiRa Model 6700 CAMAC Crate. Both the Phillips Scientific Level Translator and the LeCroy Discriminators are capable of remote interface with CAMAC software controllers; however, the simplicity of these tests made manual (local) control of these modules efficient and practical.

The Level Translator converted the ECL signals into NIM signals, and these NIM signals were conveyed to a Tektronix TDS 744A Digitizing Oscilloscope. The Tektronix Oscilloscope was triggered by the trigger output of the LeCroy 9210 Pulse Generator. The Tektronix 744A Digitizing Oscilloscope has many signal measurement capabilities, the most important for this experiment being frequency, width, and amplitude measurement options. The equipment layout is displayed in Diagram 1.

Diagram 1: Experimental Equipment Layout



3.3 Experimental Method

The LeCroy 2313 and 4413 Discriminators were tested separately. Each discriminator was first examined for physical defect and wear. This is a true concern since the delicate electronics which constitute the discriminators need protection from excessive dust, extreme temperature changes, and physical shock caused by forceful handling or excessive vibration.

Secondly, the output signal width and threshold were set by means of the front-panel screws. The threshold for these tests was set at -100 mV and the output width was set at a minimum, approximately 5 ns.

After inserting the discriminator into the CAMAC crate, the input signal from the LeCroy Pulse Generator was connected to channel one of the discriminator. Output signals from the level translator were sent to the oscilloscope for measurement.

The oscilloscope monitored the discriminator output signals's frequency as well as the output signal's amplitude. As the pulse generator's input signal frequency was increased from the initial value of 10 MHz, the output signal was monitored for stability. When the digital oscilloscope was not able to sample enough points from the translated discriminator output signal, the resulting output signal frequency was labeled the maximum output rate for the quantity under study, namely input signal amplitude or input signal width.

This process was repeated five times for each discriminator model. Tests one and two varied input signal amplitude with constant input signal widths for **Channel 1** discriminator input. Test three varied input signal amplitude with a constant input signal width for the **TEST** input. Test four varied input signal width with a constant input signal amplitude for the single **Channel 1** input. Finally, test five varied input signal width with a constant signal amplitude for the **TEST** input. Regardless of the test number, the output signals were drawn from **Channel 1** of the discriminators. Certain samplings of other channels were taken to ensure the accuracy of the readings; however, the signals from these other channels were so similar to **Channel 1** that **Channel 1** can be taken to be a true representative of the discriminator performance.

4 RESULTS

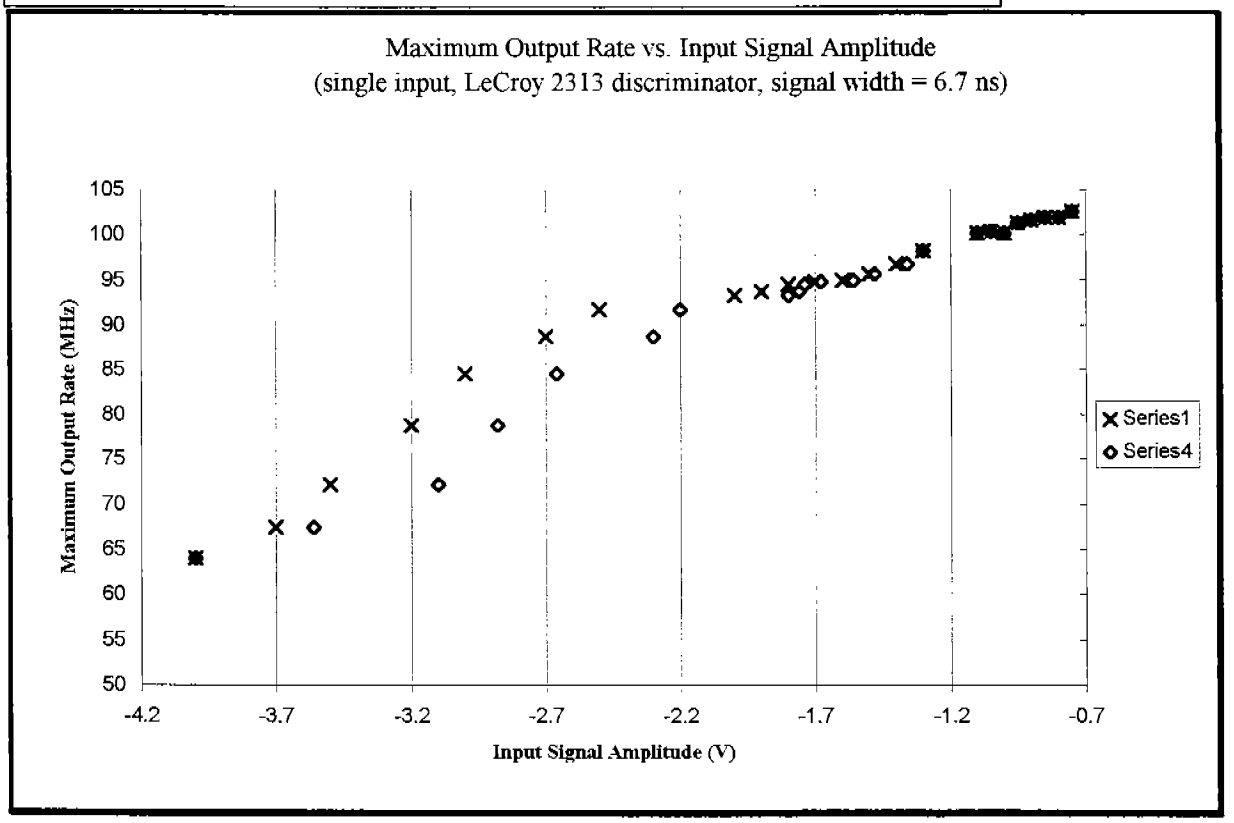
The results of the tests are displayed in the following graphs. The data were graphed using Microsoft Excel version 5.0.

4.1 LeCroy Model 2313 Discriminator Results

4.1.1 Results for Model 2313 Test One

Graph 1 plots data taken for a fixed input signal width of 6.7 ns. The amplitude was varied from -0.750 V to the pulse generator maximum amplitude setting of -4.00 V. The input signal was introduced via a Lemo cable to the **Channel 1** input of the LeCroy Discriminator. The data were collected from a ECL to NIM translation module as the LeCroy 2313 discriminator output signals are of ECL format. These translated **Channel 1** output signals were measured on the Tektronix Oscilloscope for rate (Series 1), and the original input signal's amplitude was rechecked at the maximum rate (Series 4). Often there was a decrease in input signal amplitude at the maximum rate.

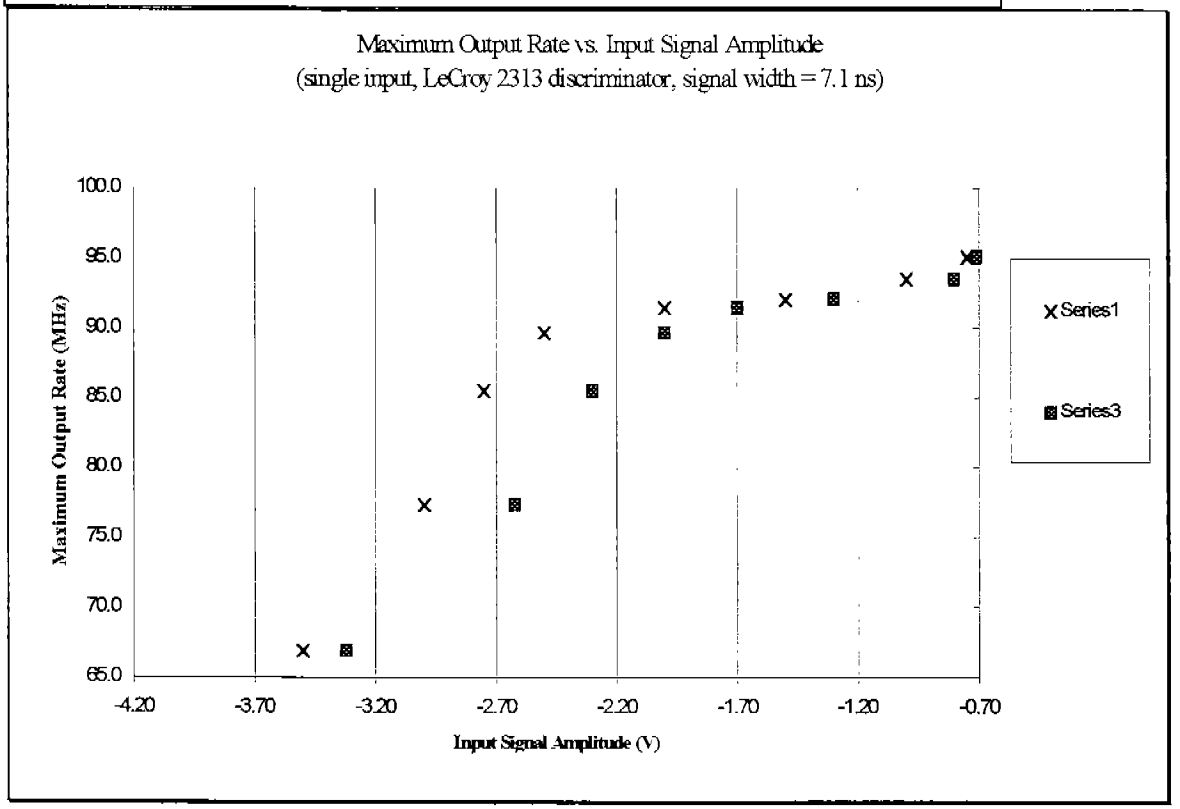
Graph 1: Input Signal to Discriminator Channel 1; fixed input signal width, varying input signal amplitude



4.1.2 Results for Model 2313 Test Two

Graph 2 plots data taken for a fixed input signal width of 7.1 ns. The amplitude was varied from -0.750 V to the pulse generator maximum amplitude setting of -4.00 V. The input signal was introduced via a Lemo cable to the **Channel 1** input of the LeCroy Discriminator. The data were collected from a ECL to NIM translation module as the LeCroy 2313 discriminator output signals are of ECL format. These translated **Channel 1** output signals were measured on the Tektronix Oscilloscope for rate (Series 1), and the original input signal's amplitude was rechecked at the maximum rate (Series 3). Often there was a decrease in input signal amplitude at the maximum rate.

Graph 2: Input Signal to Discriminator Channel 1; fixed input signal width, varying input signal amplitude



4.1.3 LeCroy Manufacturer Specification for Single Channel Inputs

The manufacturer's specifications[1] list a guaranteed maximum rate of 100 MHz for individual channel inputs. The individual channels must have an input signal of a minimum width of 3 ns. The input threshold is variable (-1.023 V - +0V) via a screw potentiometer on the discriminator's front panel.

4.1.4 Results for Model 2313 Test Three

Graph 3 plots data taken for a fixed input signal width of 7.3 ns. The amplitude was varied from -0.840 V to the pulse generator maximum amplitude setting of -4.00 V. The input signal was introduced via a Lemo cable to the **TEST** input of the LeCroy Discriminator. The **TEST** input, when used, creates an output pulse in each of the discriminators 32 channels. The data were collected from a ECL to NIM translation module as the LeCroy 2313 discriminator output signals are of ECL format. These translated **TEST** input-to- **Channel 1** output signals were measured on the Tektronix Oscilloscope for rate (Series 1), and the original input signal's amplitude was rechecked at the maximum rate. However, the signals produced by **TEST** input did not exhibit significant amplitude shifts at the maximum output rate as was observed from the output signals produced by single channel inputs.

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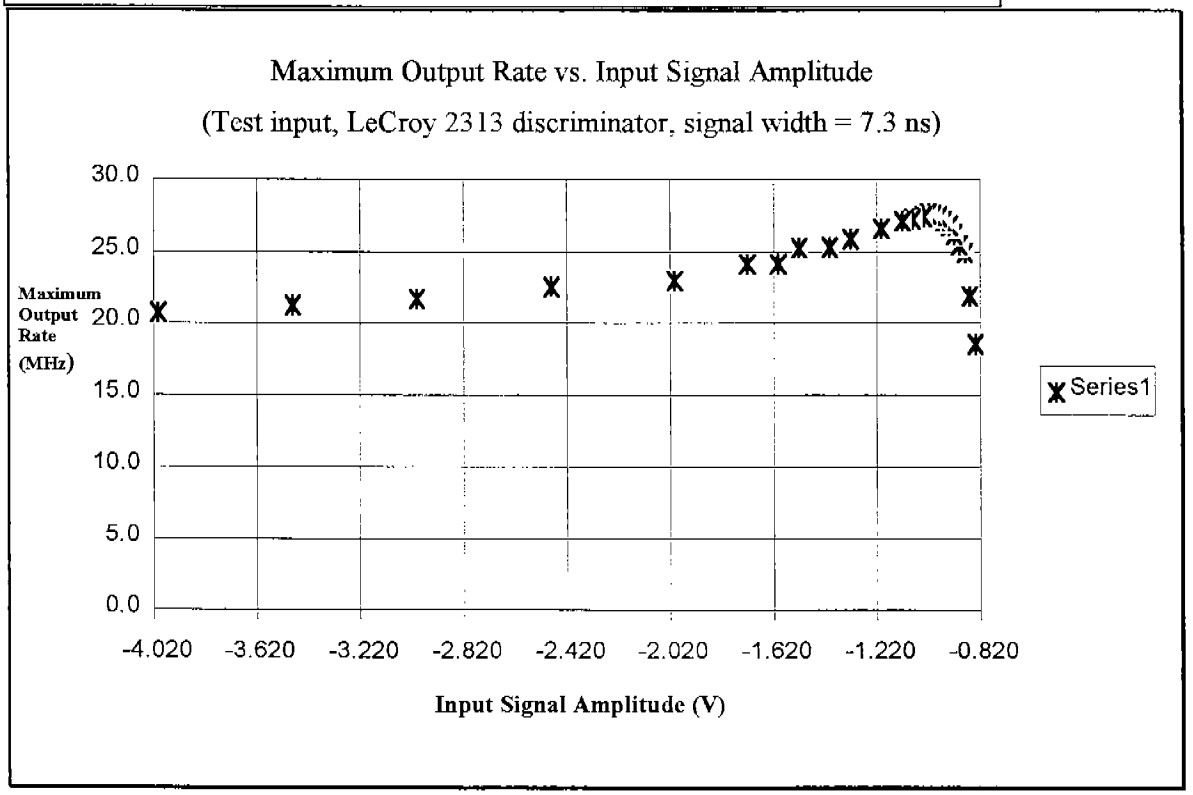
[1] *LeCroy Model 2313 Discriminator Operator's Manual* (New York: LeCroy Corporation, April 1995), p. 3.

Graph 3: Input Signal to Discriminator TEST Input; fixed input signal width, varying input signal amplitude



4.1.5 LeCroy Manufacturer Specification for the TEST Input

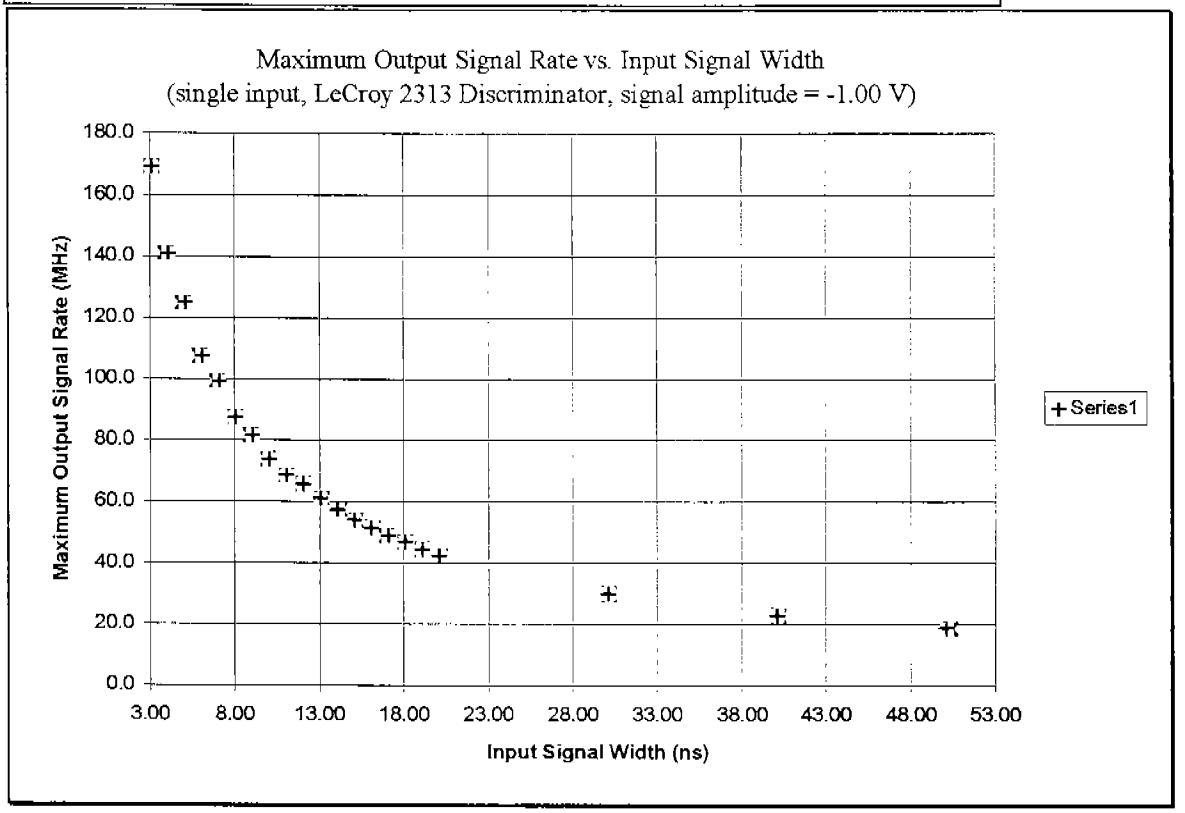
The manufacturer's specifications list a maximum rate of 20 MHz for the **TEST** inputs[2]. The **TEST** input must have an input signal of a minimum width of 6 ns, a rise time of < 2 ns, and a minimum input signal amplitude of -0.700 V. The input threshold is variable (-1.023 V - +0V) via a screw potentiometer on the discriminator's front panel.

4.1.6 Results for Model 2313 Test Four

Graph 4 plots data taken for a fixed input signal amplitude of -1.00 V. The input signal width was varied from 3.10 ns to 50.10 ns. The rise time and the fall time of the input signal were both 0.90 ns. The input signal was introduced via a Lemo cable to the **Channel 1** input of the LeCroy Discriminator. The data were collected from a ECL to NIM translation module as the LeCroy 2313 discriminator output signals are of ECL format. These translated **Channel 1** output signals were measured on the Tektronix Oscilloscope for rate (Series 1), and the original input signal's width was rechecked at the maximum rate.

[2] Ibid.

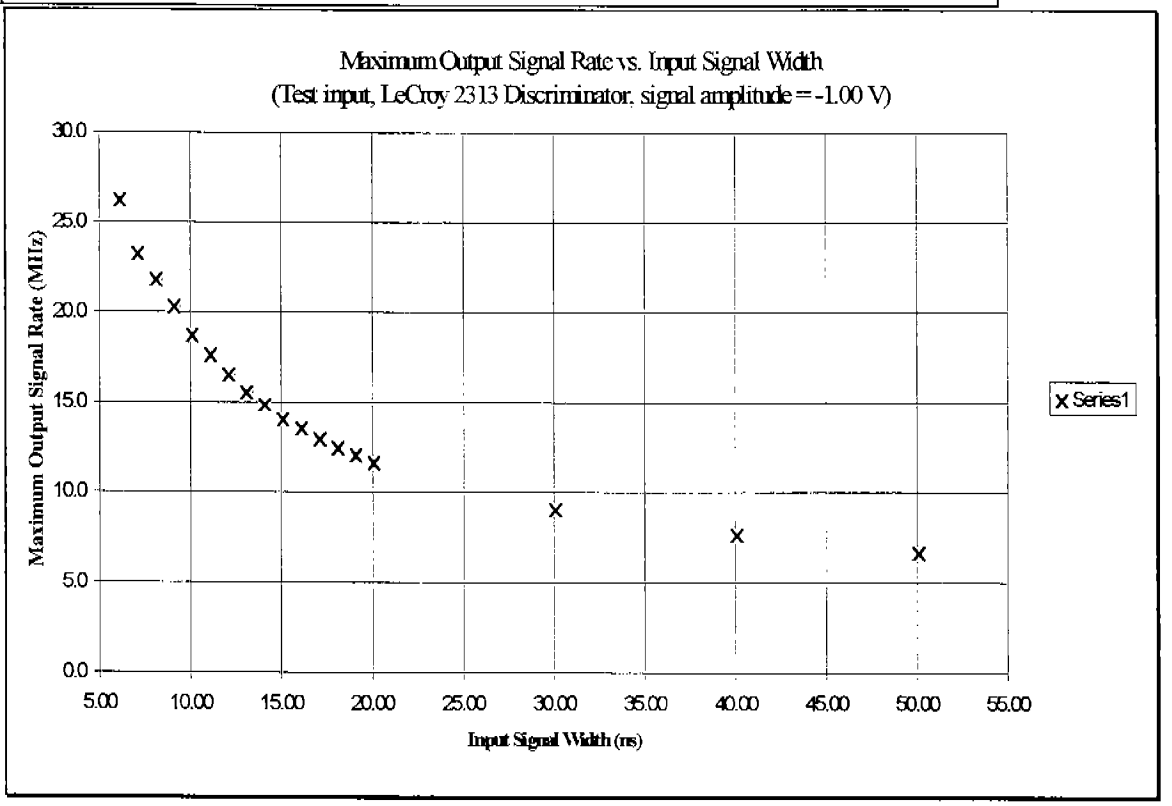
Graph 4: Input Signal to Discriminator Channel 1; fixed input signal amplitude, varying input signal width



4.1.7 Results for Model 2313 Test Five

Graph 5 plots data taken for a fixed input signal amplitude of -1.00 V. The input signal width was varied from 3.10 ns to 50.10 ns. The rise time and the fall time of the input signal were both 0.90 ns. The input signal was introduced via a Lemo cable to the **TEST** input of the LeCroy Discriminator. The data were collected from a ECL to NIM translation module as the LeCroy 2313 discriminator output signals are of ECL format. These translated **TEST** input-to-**Channel 1** output signals were measured on the Tektronix Oscilloscope for rate, and the original input signal's width was rechecked at the maximum rate.

Graph 5: Input Signal to Discriminator TEST Input; fixed input signal amplitude, varying input signal width

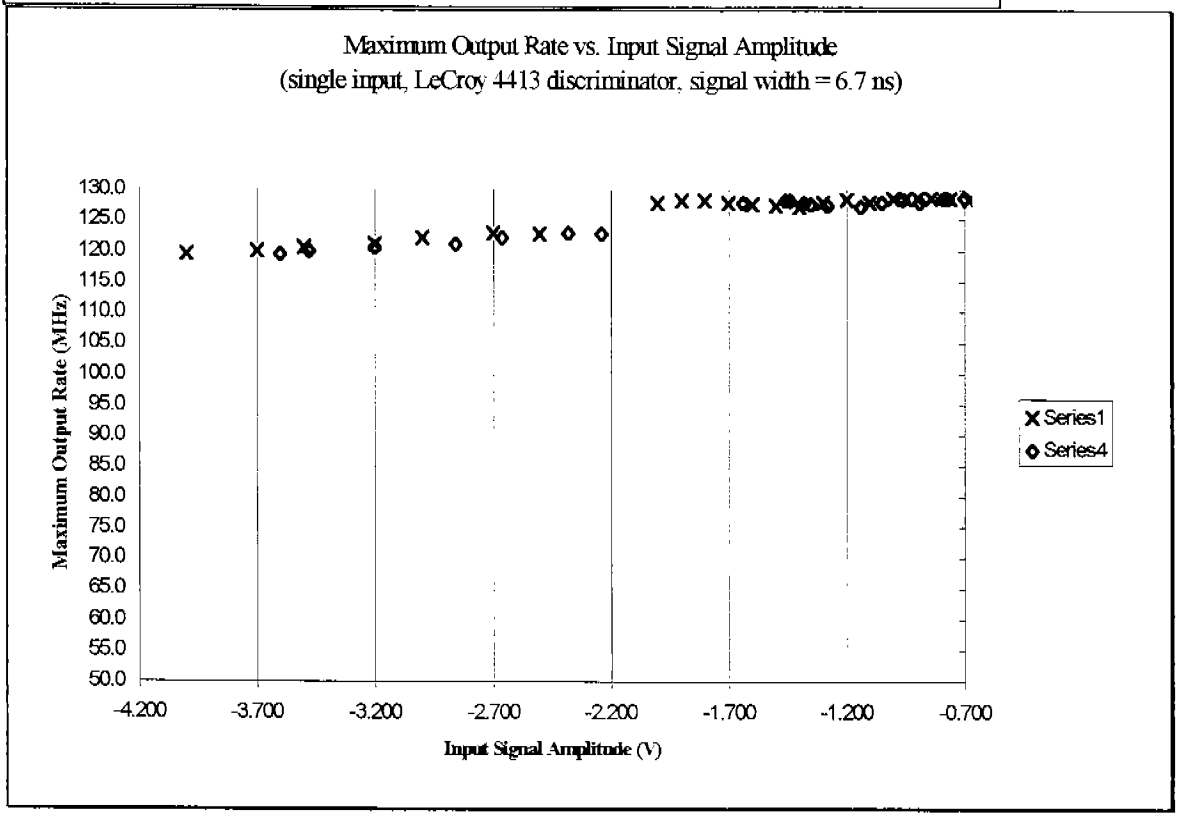


4.2 LeCroy Model 4413 Discriminator Results

4.2.1 Results for Model 4413 Test One

Graph 6 plots data taken for a fixed input signal width of 6.7 ns. The amplitude was varied from -0.750 V to the pulse generator maximum amplitude setting of -4.00 V. The input signal was introduced via a Lemo cable to the **Channel 1** input of the LeCroy Discriminator. The data were collected from a ECL to NIM translation module as the LeCroy 4413 discriminator output signals are of ECL format. These translated **Channel 1** output signals were measured on the Tektronix Oscilloscope for rate (Series 1), and the original input signal's amplitude was rechecked at the maximum rate (Series 4). Often there was a decrease in input signal amplitude at the maximum rate.

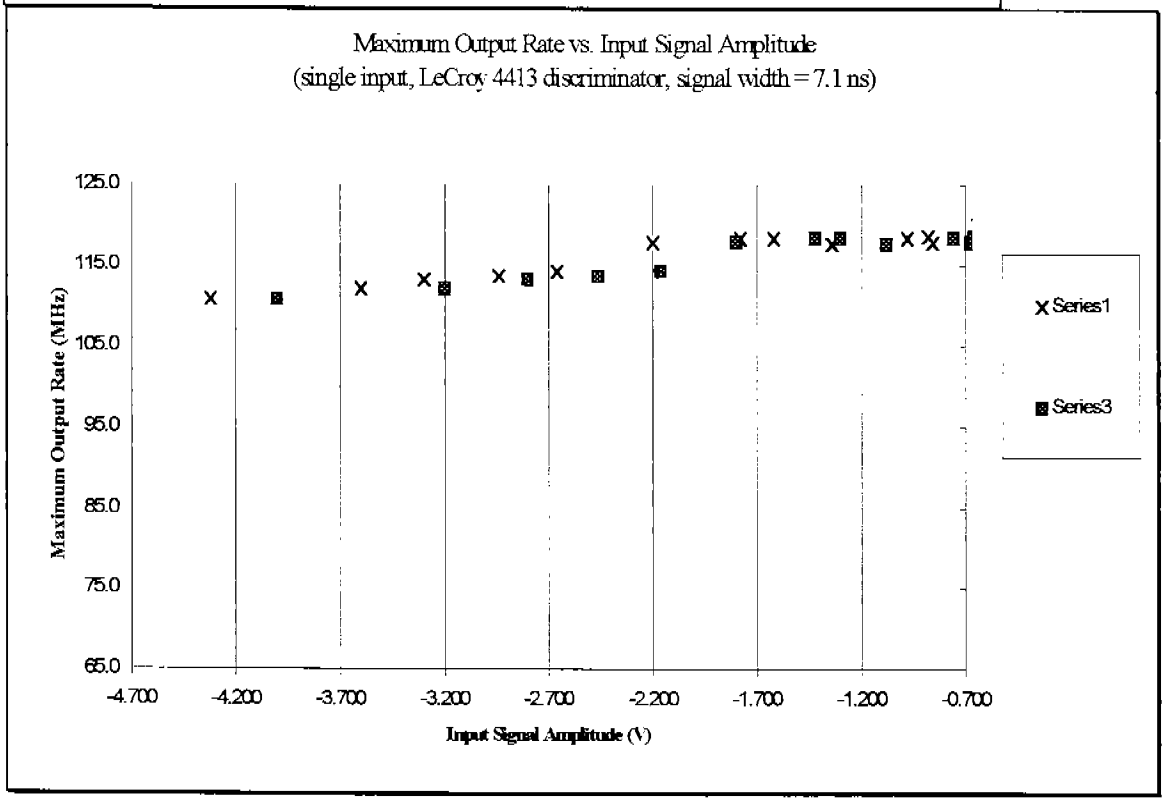
Graph 6: Input Signal to Discriminator Channel 1; fixed input signal width, varying input signal amplitude



4.2.2 Results for Model 4413 Test Two

Graph 7 plots data taken for a fixed input signal width of 7.1 ns. The amplitude was varied from -0.750 V to the pulse generator maximum amplitude setting of -4.00 V. The input signal was introduced via a Lemo cable to the **Channel 1** input of the LeCroy Discriminator. The data were collected from a ECL to NIM translation module as the LeCroy 4413 discriminator output signals are of ECL format. These translated **Channel 1** output signals were measured on the Tektronix Oscilloscope for rate (Series 1), and the original input signal's amplitude was rechecked at the maximum rate (Series 3). Often there was a decrease in input signal amplitude at the maximum rate.

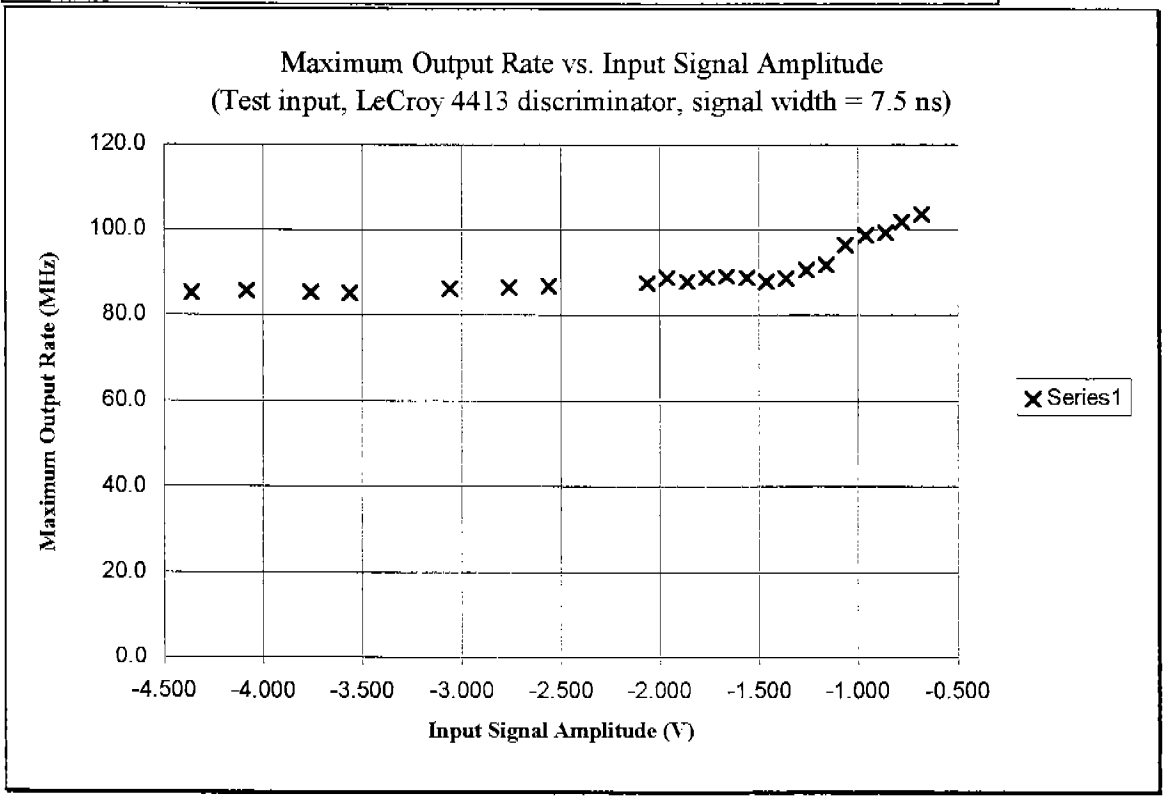
Graph 7: Input Signal to Discriminator Channel 1; fixed input signal width, varying input signal amplitude



4.1.4 Results for Model 4413 Test Three

Graph 8 plots data taken for a fixed input signal width of 7.3 ns. The amplitude was varied from -0.840 V to the pulse generator maximum amplitude setting of -4.00 V. The input signal was introduced via a Lemo cable to the **TEST** input of the LeCroy Discriminator. The **TEST** input, when used, creates an output pulse in each of the discriminators 32 channels. The data were collected from a ECL to NIM translation module as the LeCroy 4413 discriminator output signals are of ECL format. These translated **TEST** input-to- **Channel 1** output signals were measured on the Tektronix Oscilloscope for rate (Series 1), and the original input signal's amplitude was rechecked at the maximum rate.

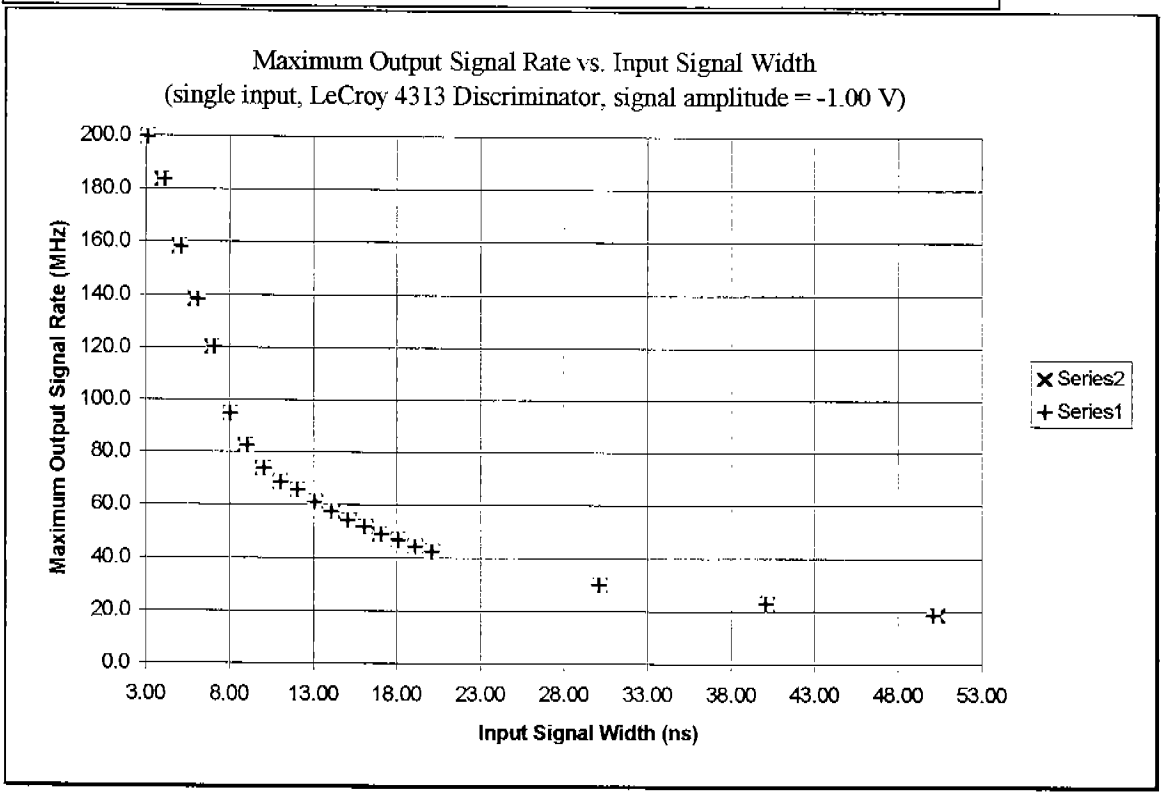
Graph 8: Input Signal to Discriminator TEST Input; fixed input signal width, varying input signal amplitude



4.2.5 Results for Model 4413 Test Four

Graph 9 plots data taken for a fixed input signal amplitude of -1.00 V. The input signal width was varied from 3.10 ns to 50.10 ns. The rise time and the fall time of the input signal were both 0.90 ns. The input signal was introduced via a Lemo cable to the **Channel 1** input of the LeCroy Discriminator. The data were collected from a ECL to NIM translation module as the LeCroy 4413 discriminator output signals are of ECL format. These translated **Channel** 1 output signals were measured on the Tektronix Oscilloscope for rate (Series 1), and the original input signal's width was rechecked at the maximum rate (Series 2). Often there was a slight decrease in width at the maximum rate.

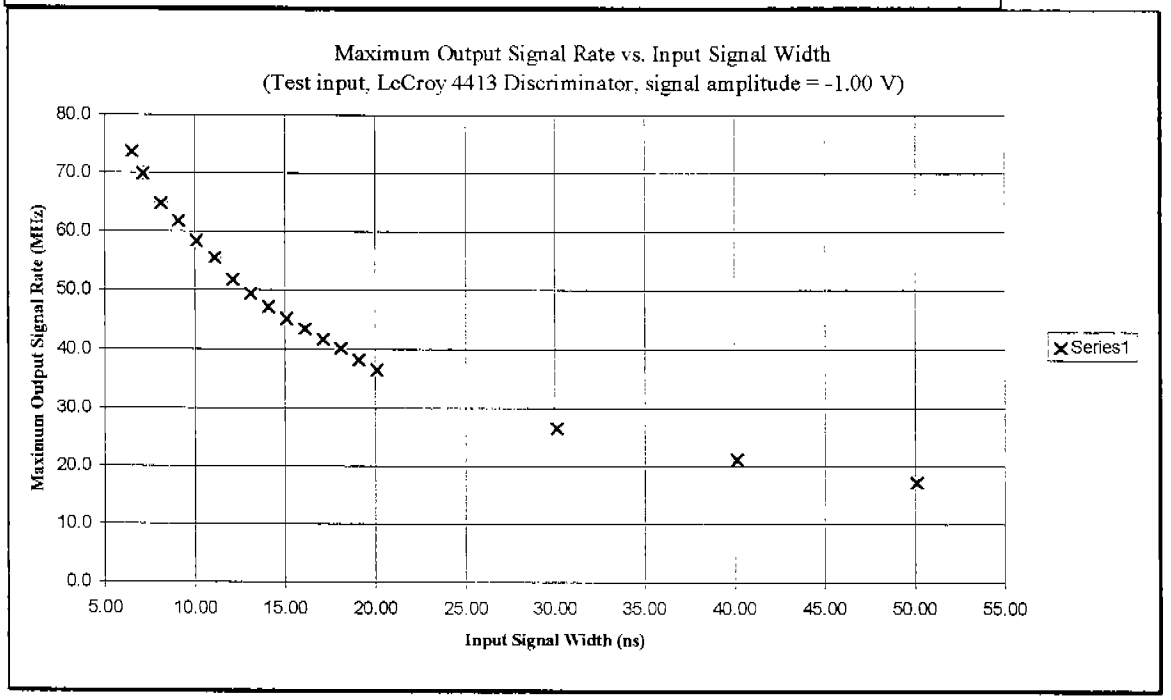
Graph 9: Input Signal to Discriminator Channel 1; fixed input signal amplitude, varying input signal width



4.2.6 Results for Model 4413 Test Five

Graph 10 plots data taken for a fixed input signal amplitude of -1.00 V. The input signal width was varied from 3.10 ns to 50.10 ns. The rise time and the fall time of the input signal were both 0.90 ns. The input signal was introduced via a Lemo cable to the **TEST** input of the LeCroy Discriminator. The data were collected from a ECL to NIM translation module as the LeCroy 4413 discriminator output signals are of ECL format. These translated **TEST** input-to-**Channel 1** output signals were measured on the Tektronix Oscilloscope for rate (Series 1), and the original input signal's width was rechecked at the maximum rate.

Graph 10: Input Signal to Discriminator TEST Input; fixed input signal amplitude, varying input signal width



5 CONCLUSIONS

Table 1 summarizes the results of the discriminator tests. A comparison of maximum output rate is offered for the two LeCroy discriminator models under study. The results are quoted for an input signal amplitude of -0.860 mV.

Table 1: Summary of Results for an Input Signal Amplitude of -0.860 mV

LeCroy Discriminator Model	Input Signal Amplitude (mV)	Input Signal Width (ns)	Maximum Output Rate (MHz)
2313 (single channel, **Channel 1**)	-0.860	6.7	101.9
2313 (single channel, **Channel 1**)	-0.860	7.5	101.9
2313 (**TEST** input)	-0.860	7.5	21.9
4413 (single channel, **Channel 1**)	-0.860	6.7	117.8
4413 (single channel, **Channel 1**)	-0.860	7.5	128.6
4413 (**TEST** input)	-0.860	7.5	99.4