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TEST RESULTS ON SOME AMPLIFIER-DISCRIMINATOR CIRCUITS

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During the past few years there have been many amplifier-discriminator circuits developed for usage with drift chambers and proportional chambers. Each one may be the result of a specific need or for a specific reason. This internal report is about some measured characteristics of the circuits which we have obtained. It is our hope that the report will provide Fermilab users with some information on these amplifier-discriminators.

A pulse generator and a pulse shaping circuit shown in Figure 1 were used to inject a known charge of the shape shown in Figure 1 into the amplifier-discriminator being tested.

This circuit is chosen to provide a known quantity of charge to the input of the amplifier to obtain fair comparison between circuits of different input impedance. As shown in the figure, the pulse height and width are small enough that this procedure is justified. Using the results given in this report one can deduce current or voltage sensitivity for given configuration.

To provide reference pulses, the charge injector was connected to a standard termination and the pulse height adjusted at the pulser. Fixed attenuators were then inserted in the cable between the pulser and charge injector to control the amount of charge delievered by the charge injector.

To calculate the charge at the output of the charge injector the input voltage was reduced by the attenuation factor and multiplied by the capacitance. This gives the charge delievered to the amplifier-discriminator in coulombs.

The sensitivity was defined as the charge at which the amplifier-discriminator fires on 50% of the input pulses.

The amplifier-discriminators were all tested under as nearly identical conditions as could be achieved.

To plot the sensitivity versus threshold control voltage, the control voltage was set at a value that was just above the point where the amplifier-discriminators would fire on noise or oscillate. Attenuators were then inserted to find the 50% firing point. The attenuation was then reduced by six db and the control voltage raised to the 50% firing point, the control voltage and attenuation were then noted. The six db steps were repeated through the control range. Results of the test were plotted as sensitivity versus control voltage (Vth).

Slewing was checked by measuring the delay of the amplifier-discriminator. Scope triggering was supplied by the pulser. The delay to the amplifier-discriminator was noted on an oscilloscope, then delay to the output pulse could be read directly. This test was started at the maximum sensitivity as determined by the sensitivity test. The delay was noted and the attenuation decreased 6 db, the new delay was then noted. This procedure was repeated in 6 db steps to approximately twenty times the threshold. Results were plotted as charge versus delay at the control voltage given on the graph.

The crosstalk was determined by setting the amplifier-discriminator at its maximum sensitivity and raising the input charge level until the adjacent channel fired. The results are given as db over threshold.

Double pulse resolution is a measure of the total deadtime of the amplifier-discriminator. It was measured by using pulse pairs and decreasing the time between the pulses until the second no longer caused the amplifier-discriminator to fire. The double pulse resolution was determined for three input levels.

All the amplifier-discriminators were designed for negative pulses, although some were quite sensitive to positive pulses. To determine the positive response the amplifier-discriminators were tested as for negative response except that positive pulses were used.

Table I shows some of the test results. The circuit diagrams, time slewimg and sensitivity curves are shown in the following figures. The name of the designer associated with each circuit is indicated.

The authors would like to express their appreciation to those people who provided the circuits and to R. Shafer for discussions on the tests.

The authors apologize for any errors which may have escaped their attention.

TABLE I

Amplifier Designer	Crosstalk db Above Threshold	Sensitivity for Positive Input (Coulombs)	Double Pulse Resolution at Minimum Threshold (n sec) 1xth	2xth	4xth	Slewing for Inputs From 2xth to 10xth (n sec)	Sensitivity for Negative Input (Coulombs
C. Kerns	>54	4×10^{-15}	20	20	20	2.1	4×10^{-15}
W. Sippach (12 Channel Card)	37	3×10^{-15}	14	14	14	1.6	3×10^{-15}
W. Sippach (8 Channel Card)	30	12×10^{-15}	20	19	16	1.5	4×10^{-15}
W. Sippach (ECL 1035 Card)	24	23×10^{-15}	400	200	155	9.8	4×10^{-15}
T. Droege	52	4600×10^{-15}	800	600	400	3.2	5.8×10^{-15}
Nano Systems S-710 Feed back resistor 470Ω and	25	1900×10^{-15} (on adj. channel)	440*	400*	400*	3.5	37×10^{-15}
For 2KΩ	30	1500×10^{-15}	320	320	310	4	15×10^{-15}
LRS LD-604	54	52×10^{-15}	Input width	Input width	10	2.6	9×10^{-15}
LRS DC-200	54	5000×10^{-12}	70	55	22	4.75	9×10^{-15}

Amplifier Designer	Crosstalk db Above Threshold	Sensitivity for Positive Input (Coulombs)	Double Pulse Resolution at Minimum Threshold (n sec)			Slewing for Inputs From 2xth to 10xth (n sec)	Sensitivity for Negative Input (Coulombs
			1xth	2xth	4xth		
B. Wormington	54	**	90	120	110	10.5	7×10^{-15}

*Recovery time of the amplifier is 200n sec.
**This amp-disc triggers on positive when Vth is set below minimum threshold negative.

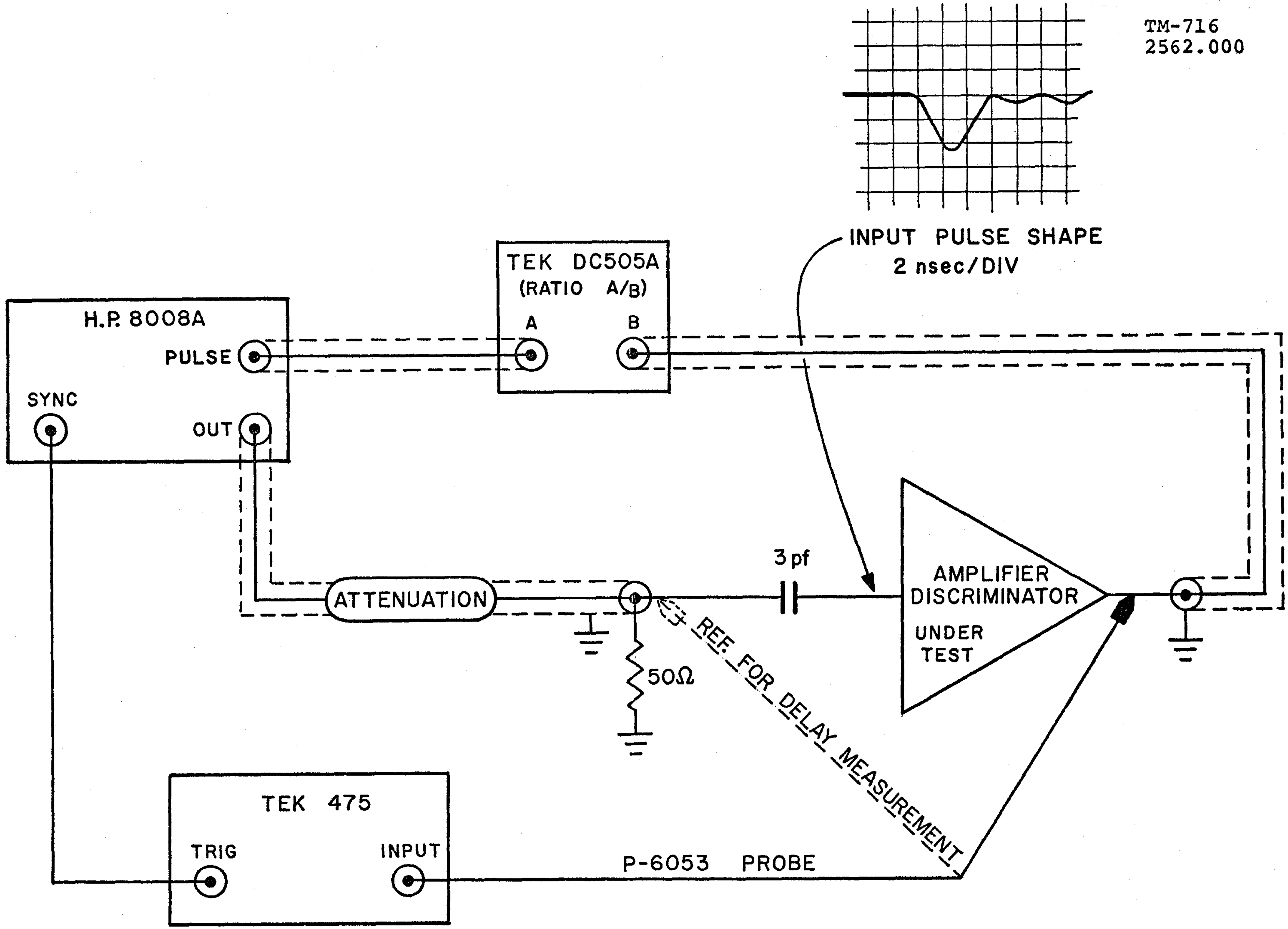
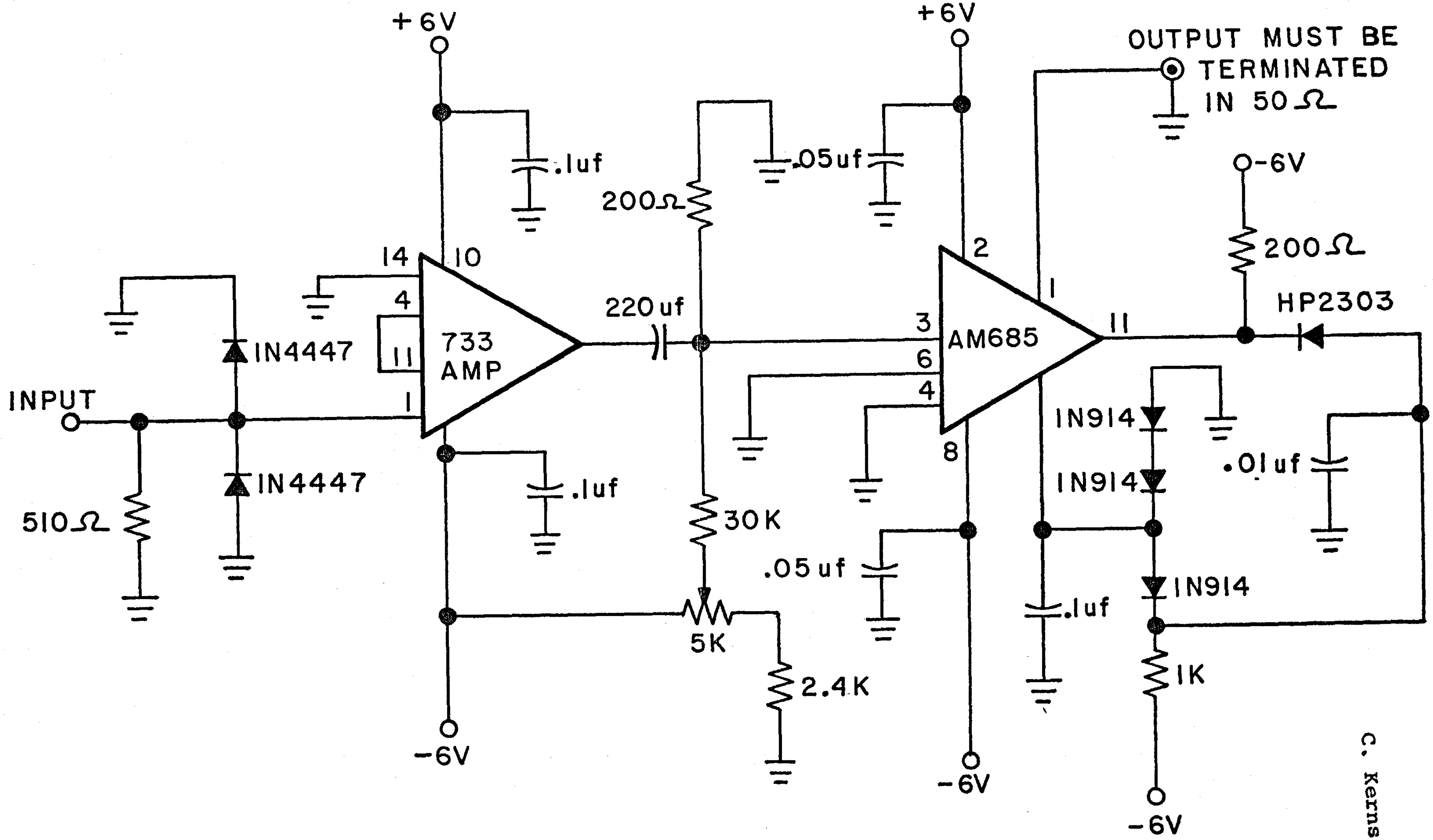
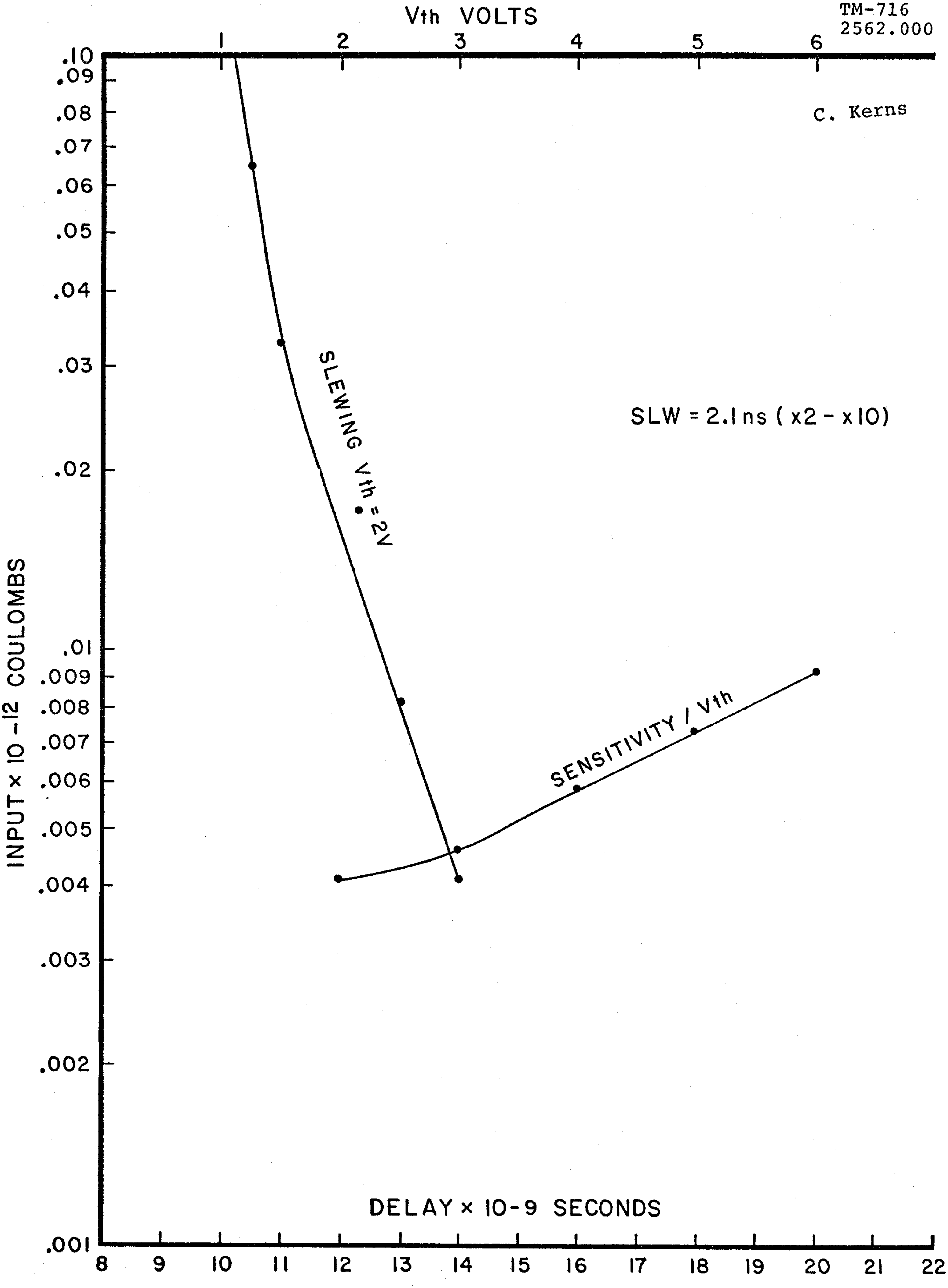
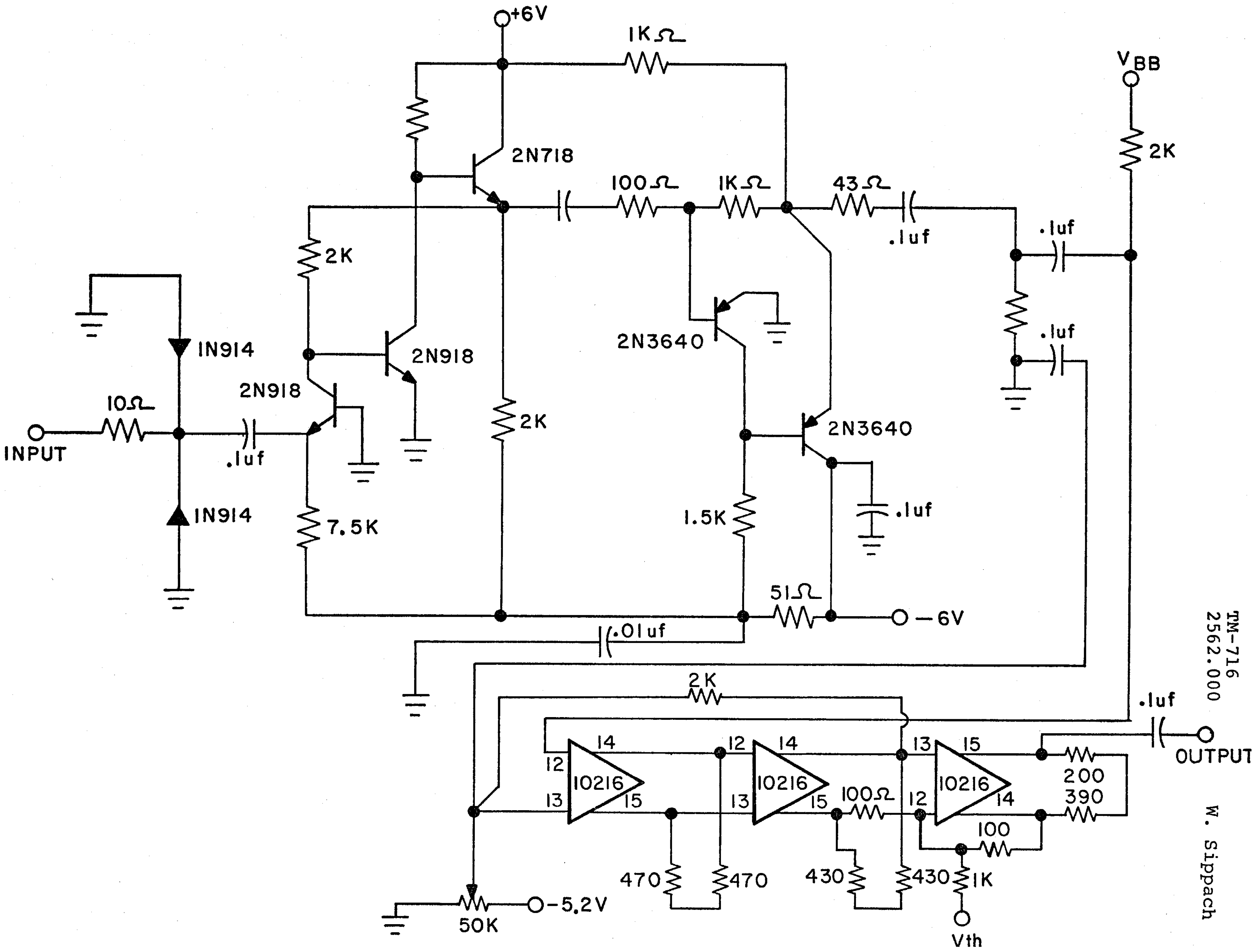

INPUT PULSE SHAPE
2 nsec/DIV
TEK DC505A
(RATIO A/B)
A
B
H.P. 8008A
PULSE
SYNC
OUT
ATTENUATION
3 pf
AMPLIFIER
DISCRIMINATOR
UNDER
TEST
50Ω
REF. FOR DELAY MEASUREMENT
TEK 475
TRIG
INPUT
P-6053 PROBE

Figure 1


+6V
.luf
200Ω
.05uf
+6V
OUTPUT MUST BE TERMINATED IN 50Ω
-6V
200Ω
HP2303
14
10
4
11
1
733 AMP
220uf
2
1
3
6
4
8
11
AM685
IN4447
IN4447
INPUT
510Ω
.luf
30K
5K
2.4K
.05 uf
IN914
IN914
IN914
.luf
.01uf
1K
-6V
-6V
-6V

C. Kerns


Vth VOLTS
1
2
3
4
5
6
C. Kerns
SLW = 2.1ns (x2 - x10)
SLEWING Vth = 2V
SENSITIVITY / Vth
INPUT × 10 -12 COULOMBS
.10
.09
.08
.07
.06
.05
.04
.03
.02
.01
.009
.008
.007
.006
.005
.004
.003
.002
.001
DELAY × 10-9 SECONDS
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22



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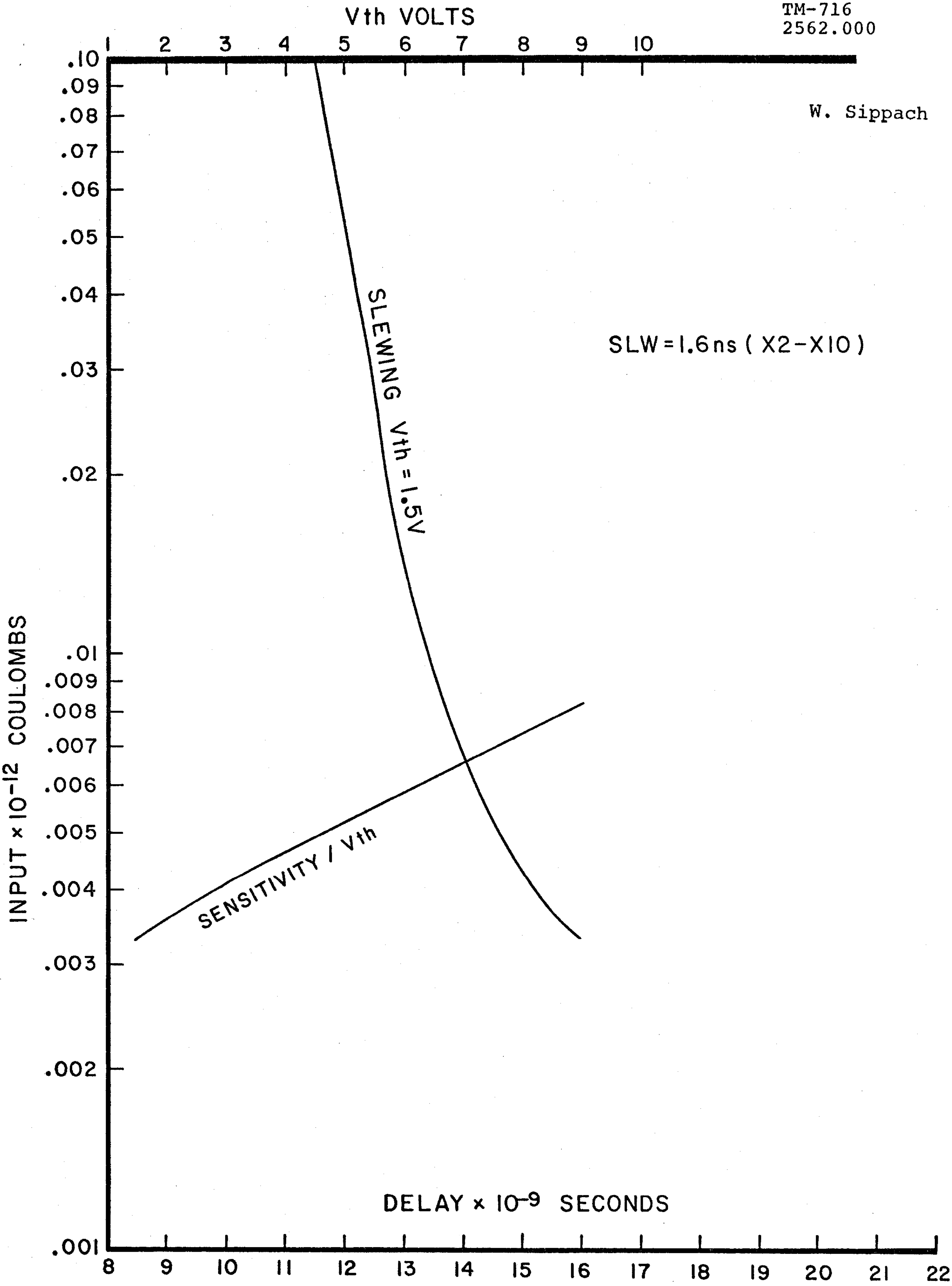
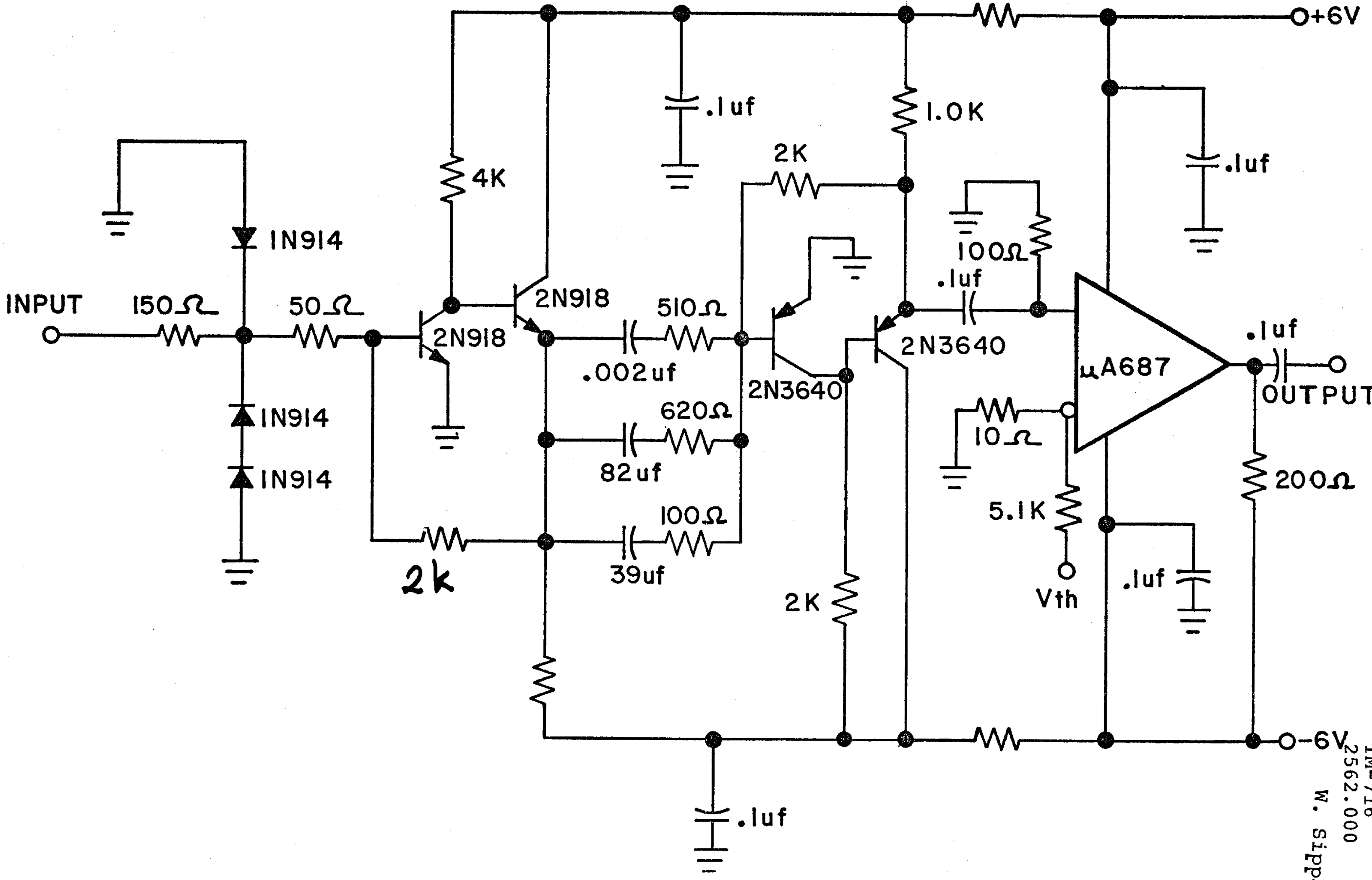
W. Sippach

W. Sippach


Vth VOLTS
1
2
3
4
5
6
7
8
9
10
.10
.09
.08
.07
.06
.05
.04
.03
.02
.01
.009
.008
.007
.006
.005
.004
.003
.002
.001
INPUT × 10-12 COULOMBS
SLEWING Vth = 1.5V
SLW = 1.6 ns (X2-X10)
SENSITIVITY / Vth
DELAY × 10-9 SECONDS
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22



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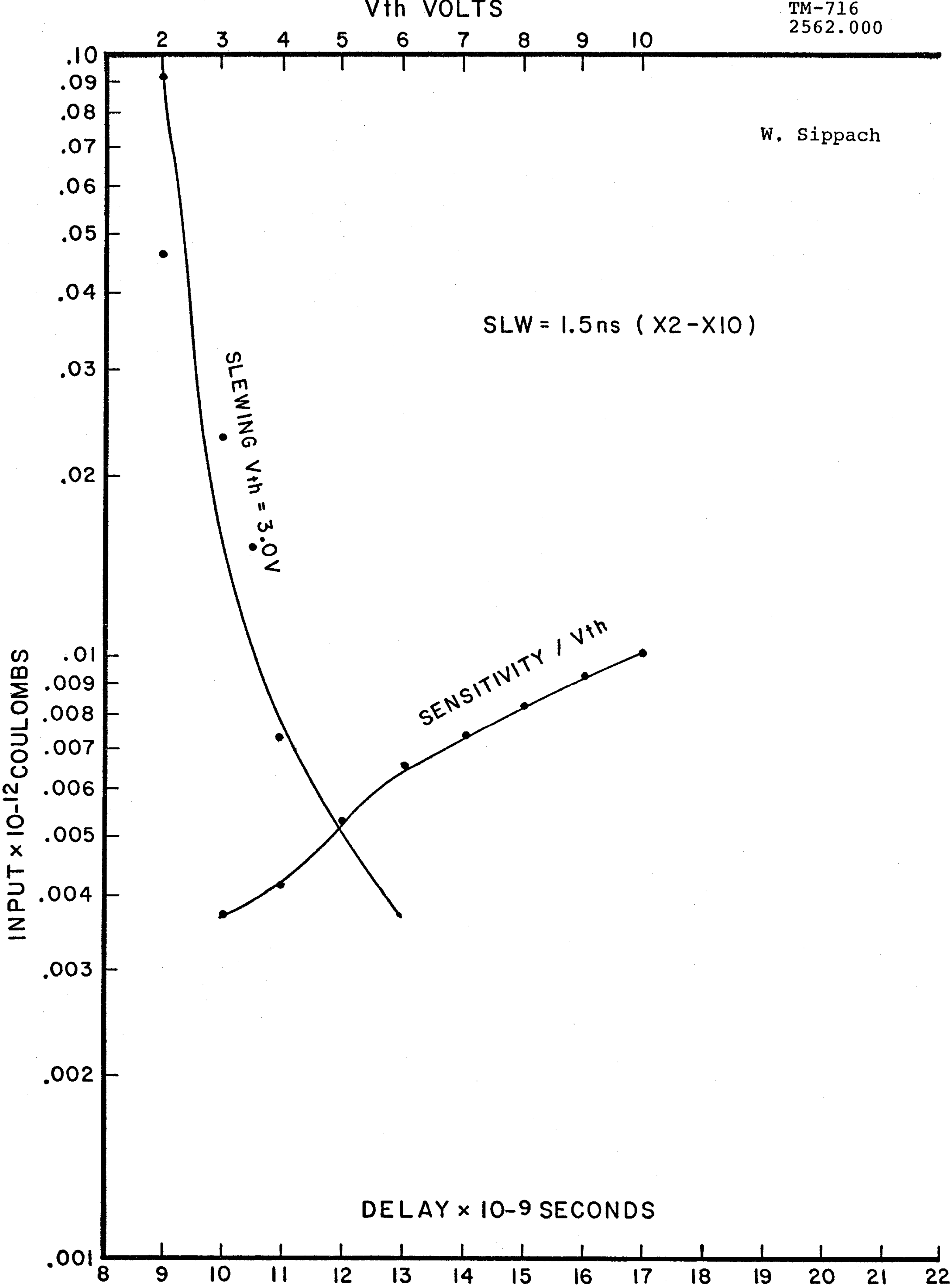
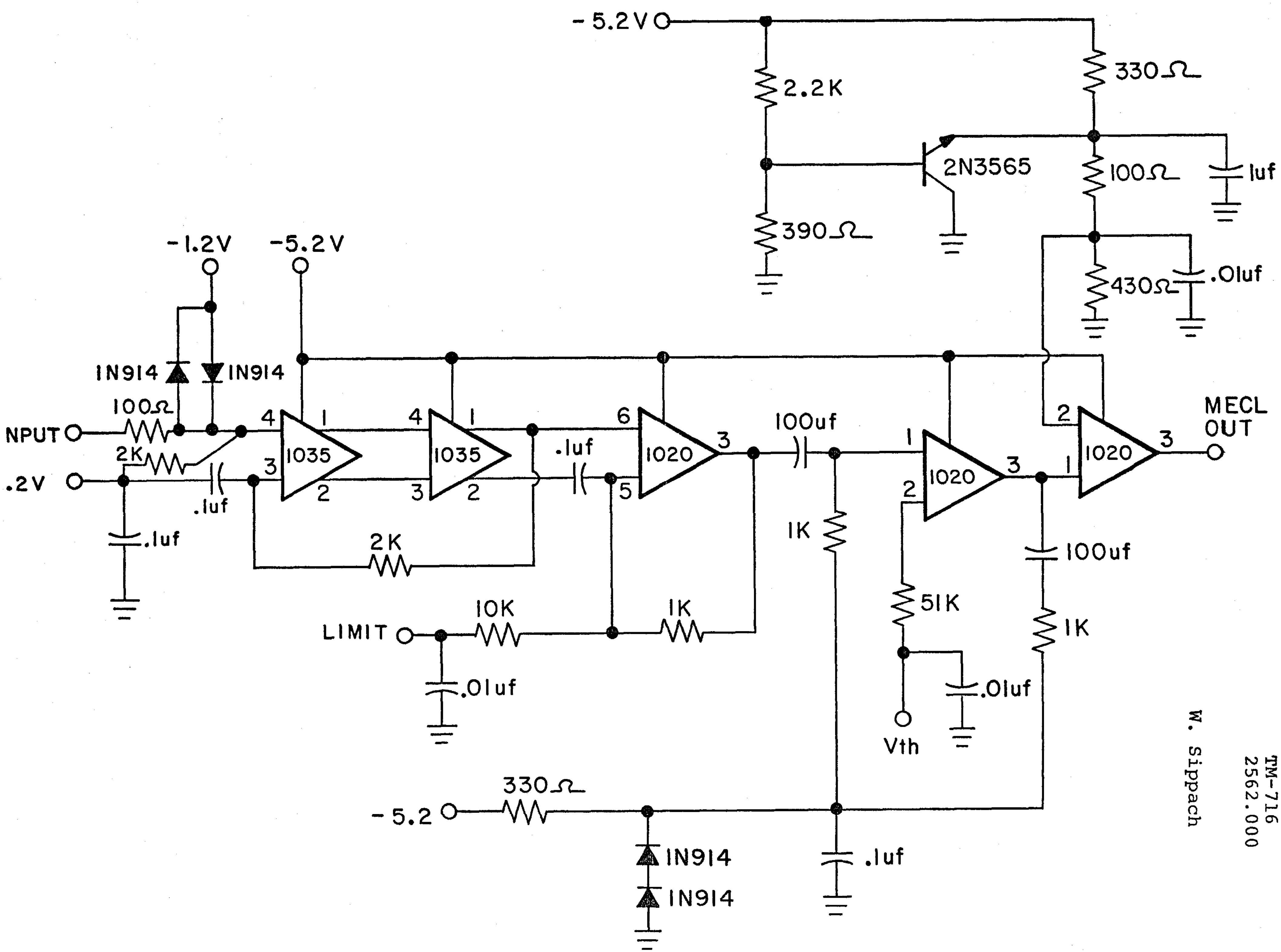
W. Sippach


Vth VOLTS
2 3 4 5 6 7 8 9 10
W. Sippach
SLW = 1.5ns (X2-X10)
SLEWING Vth = 3.0V
SENSITIVITY / Vth
INPUT × 10-12 COULOMBS
.10 .09 .08 .07 .06 .05 .04 .03 .02 .01 .009 .008 .007 .006 .005 .004 .003 .002 .001
DELAY × 10-9 SECONDS
8 9 10 11 12 13 14 15 16 17 18 19 20 21 22



W. Sippach

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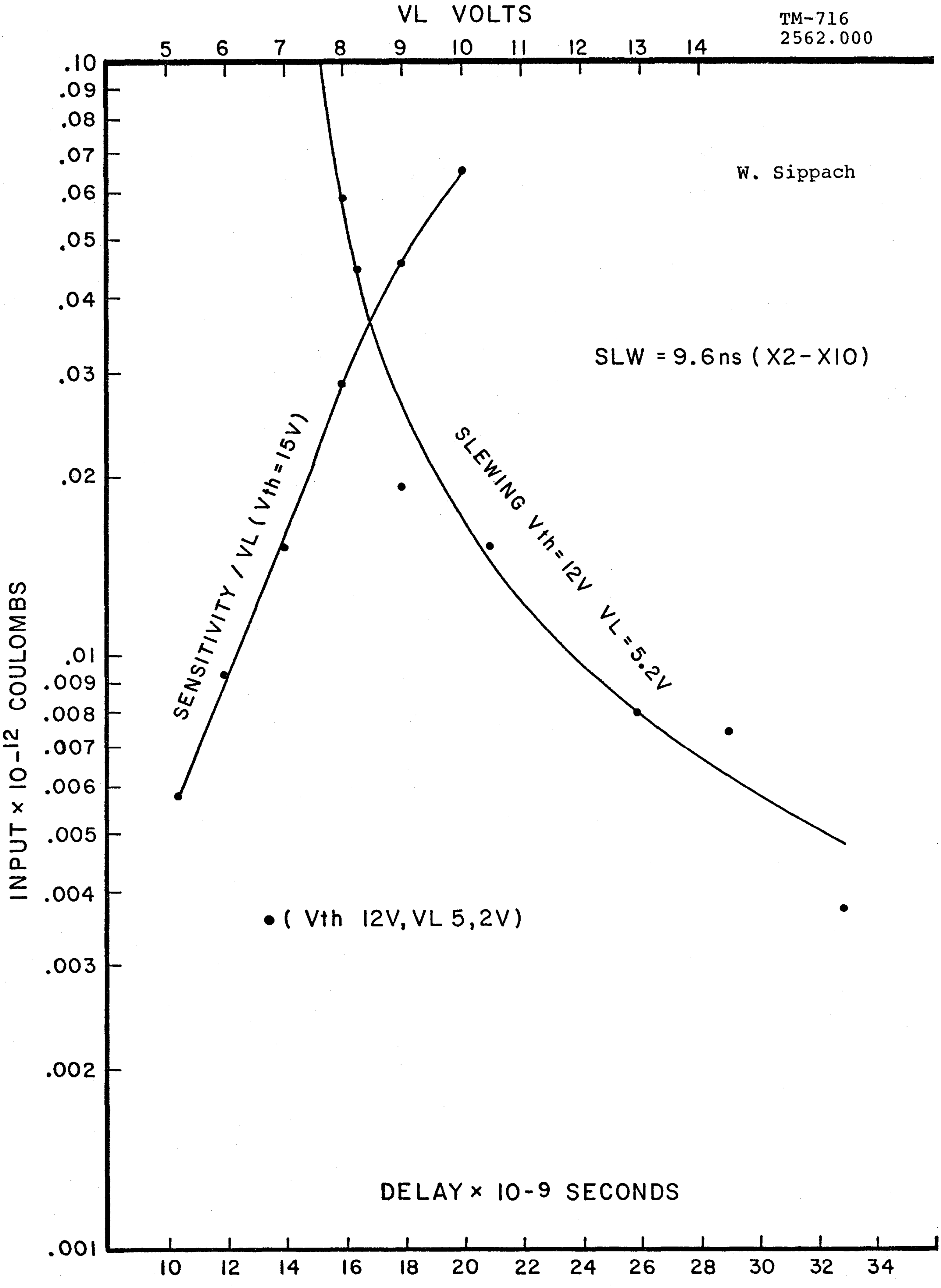
VL VOLTS
5
6
7
8
9
10
11
12
13
14
.10
.09
.08
.07
.06
.05
.04
.03
.02
.01
.009
.008
.007
.006
.005
.004
.003
.002
.001
W. Sippach
SLW = 9.6 ns (X2-X10)
SENSITIVITY / VL (Vth = 15V)
SLEWING Vth = 12V VL = 5.2V
INPUT × 10-12 COULOMBS
• (Vth 12V, VL 5,2V)
DELAY × 10-9 SECONDS
10
12
14
16
18
20
22
24
26
28
30
32
34

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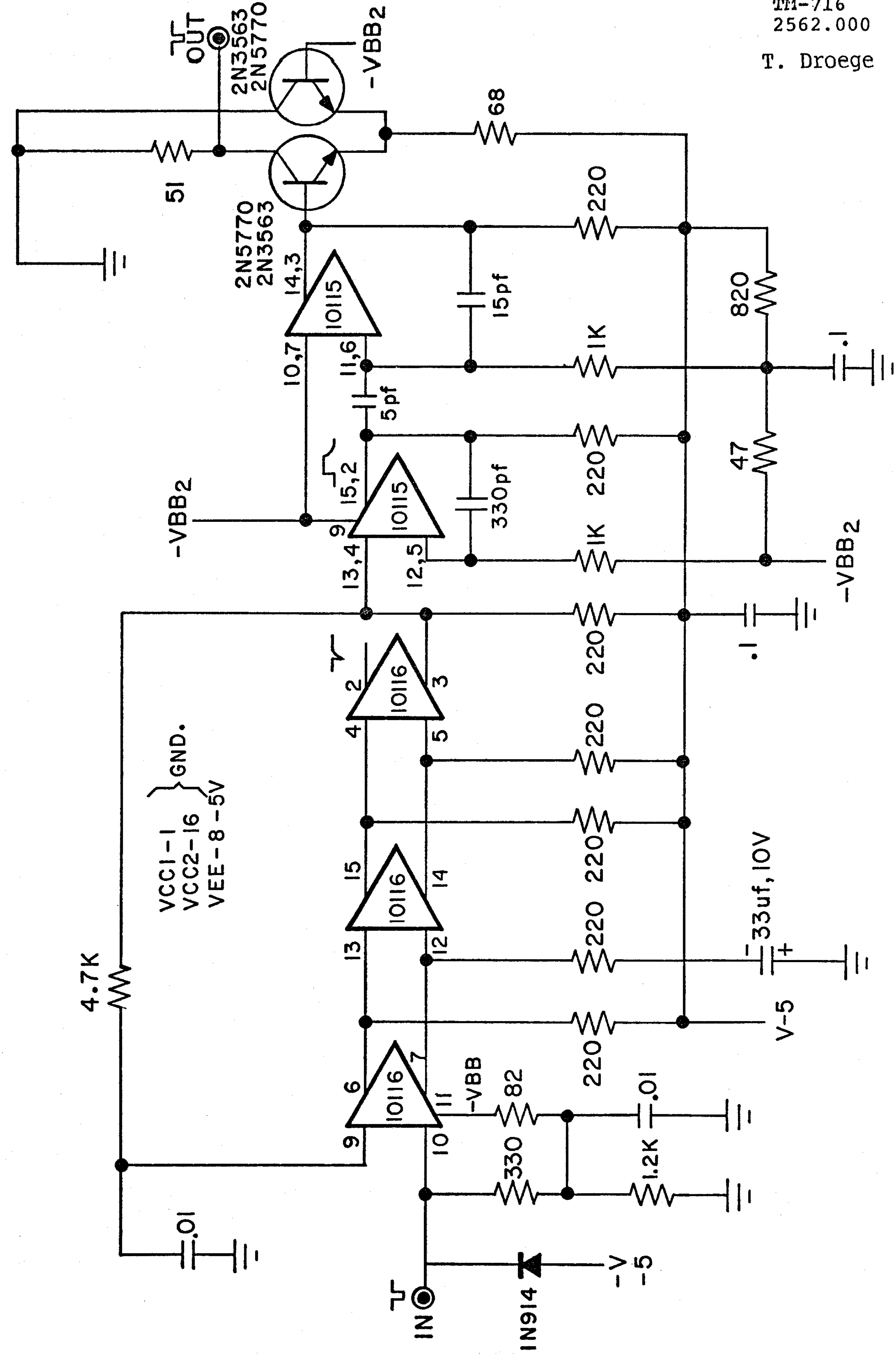
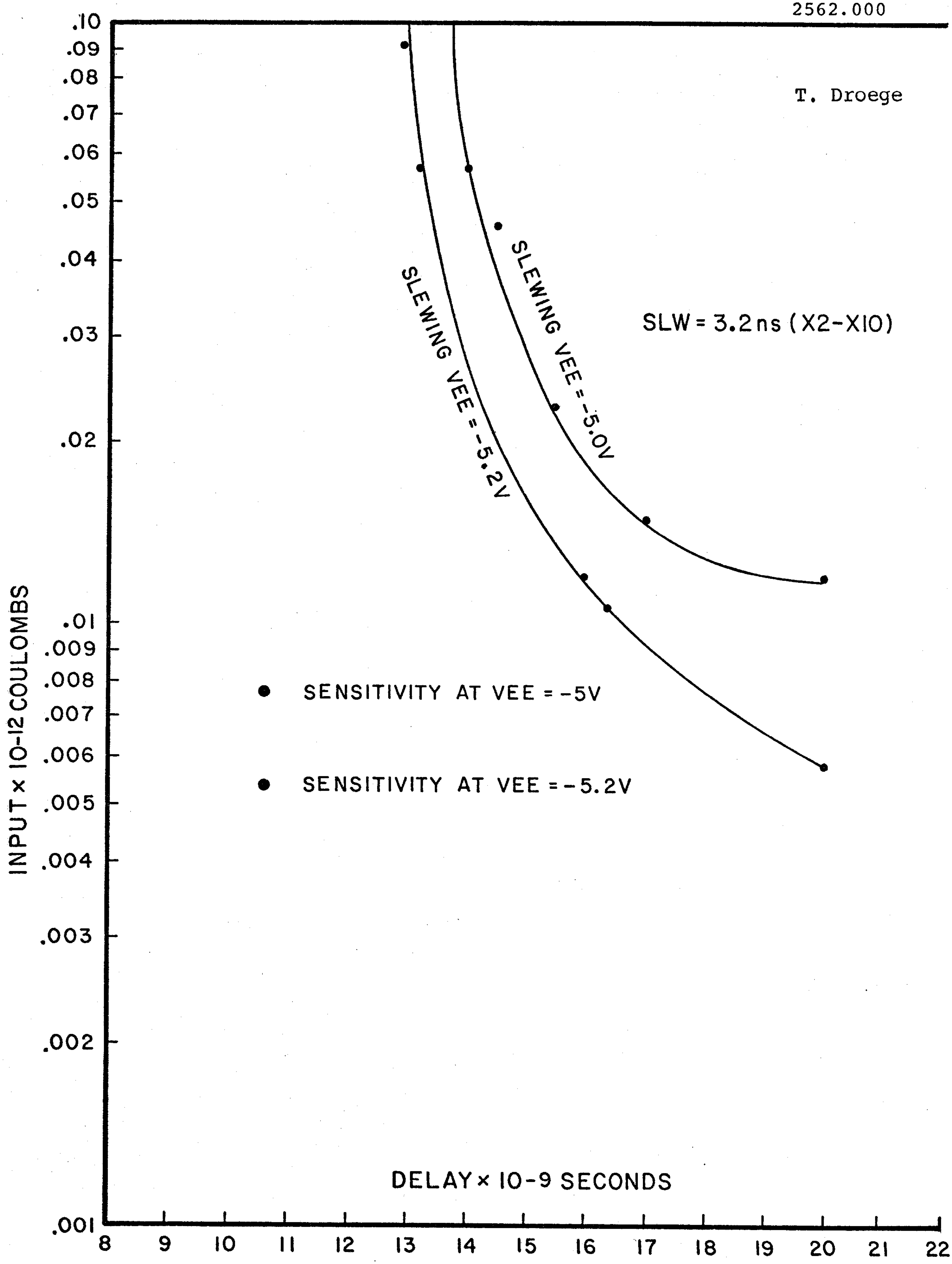
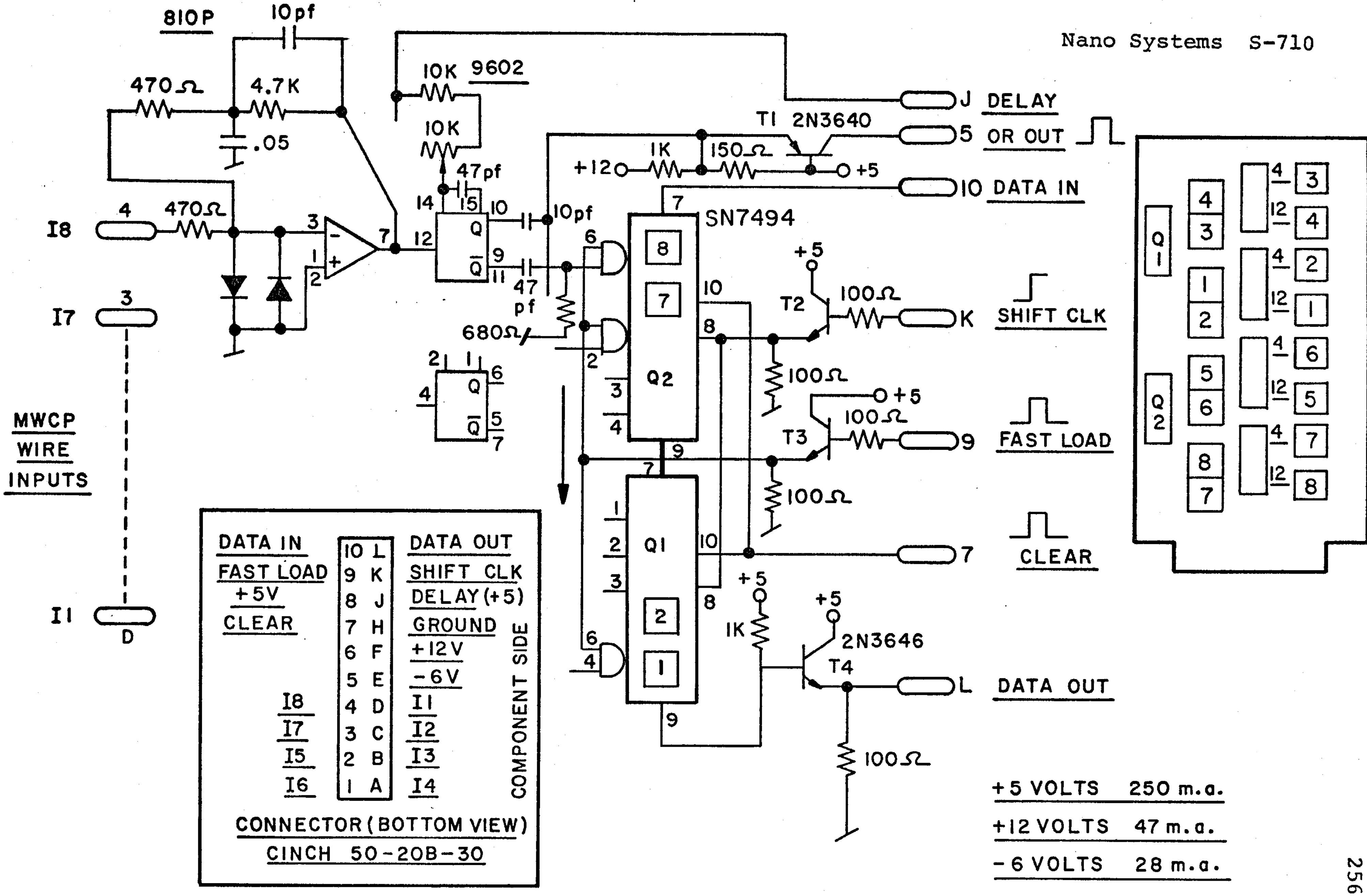
T. Droege



T. Droege


INPUT × 10-12 COULOMBS
.10
.09
.08
.07
.06
.05
.04
.03
.02
.01
.009
.008
.007
.006
.005
.004
.003
.002
.001
SLEWING VEE = -5.0V
SLEWING VEE = -5.2V
SLW = 3.2 ns (X2-X10)
SENSITIVITY AT VEE = -5V
SENSITIVITY AT VEE = -5.2V
DELAY × 10-9 SECONDS
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22

Nano Systems S-710



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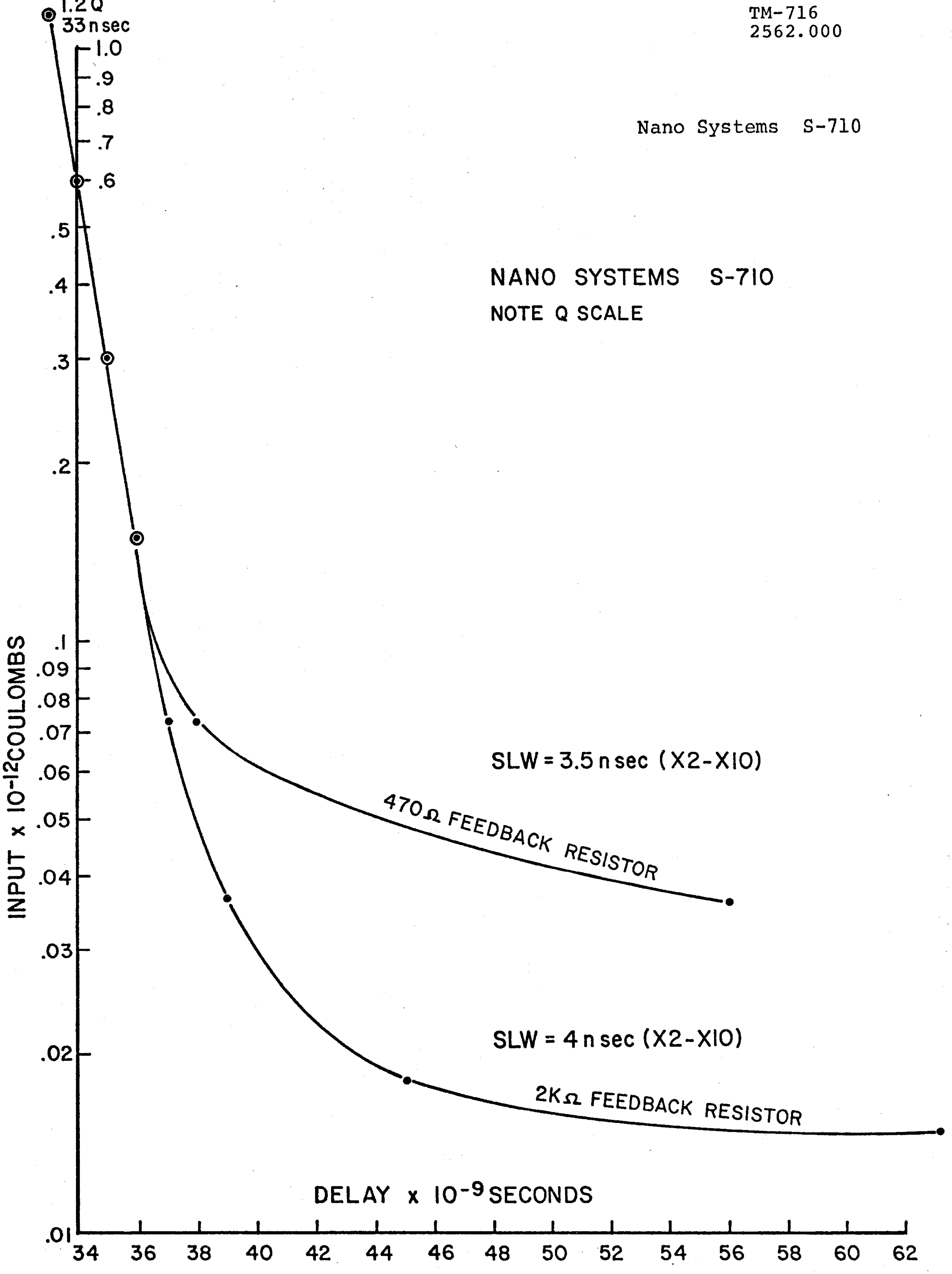
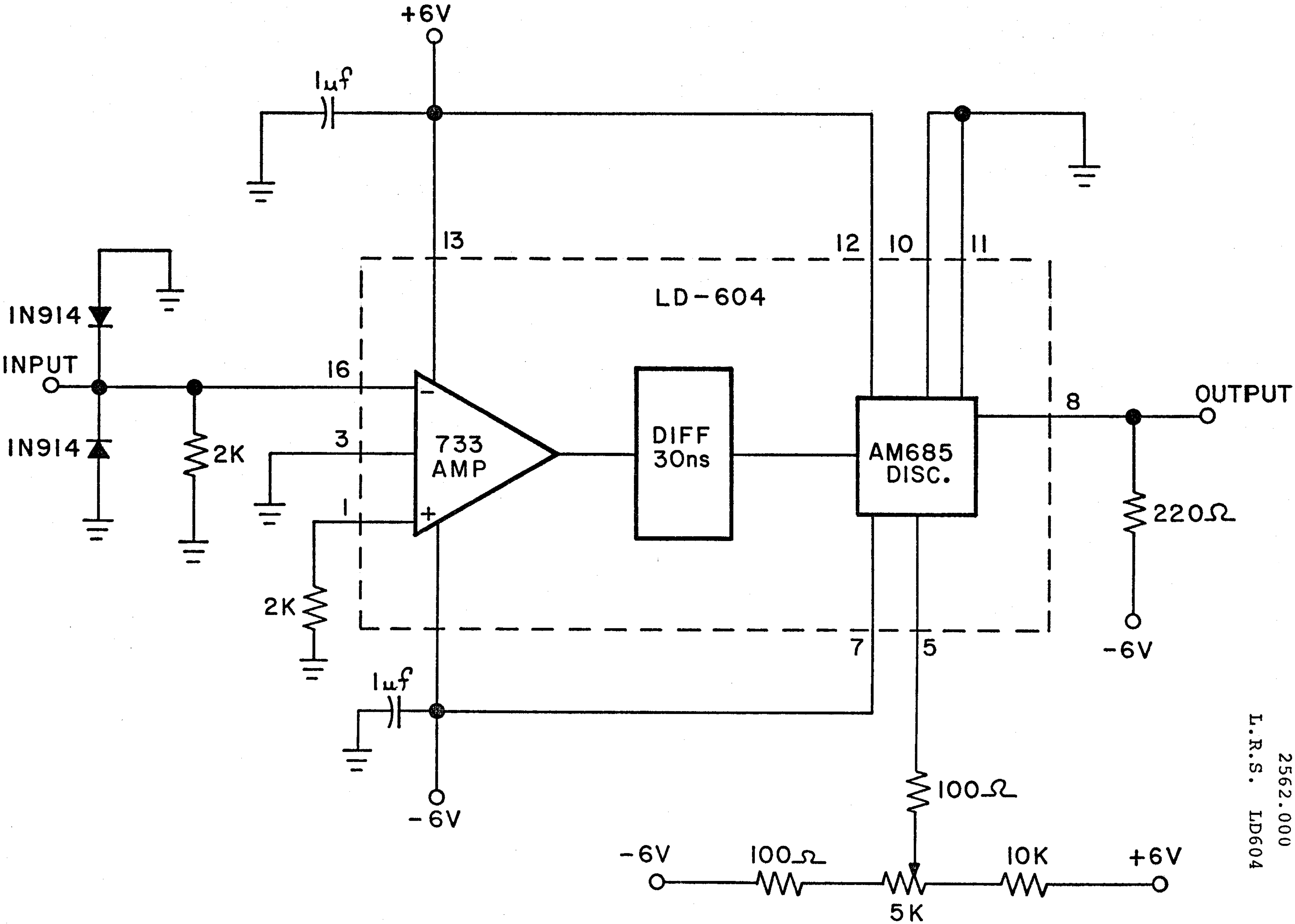
Nano Systems S-710





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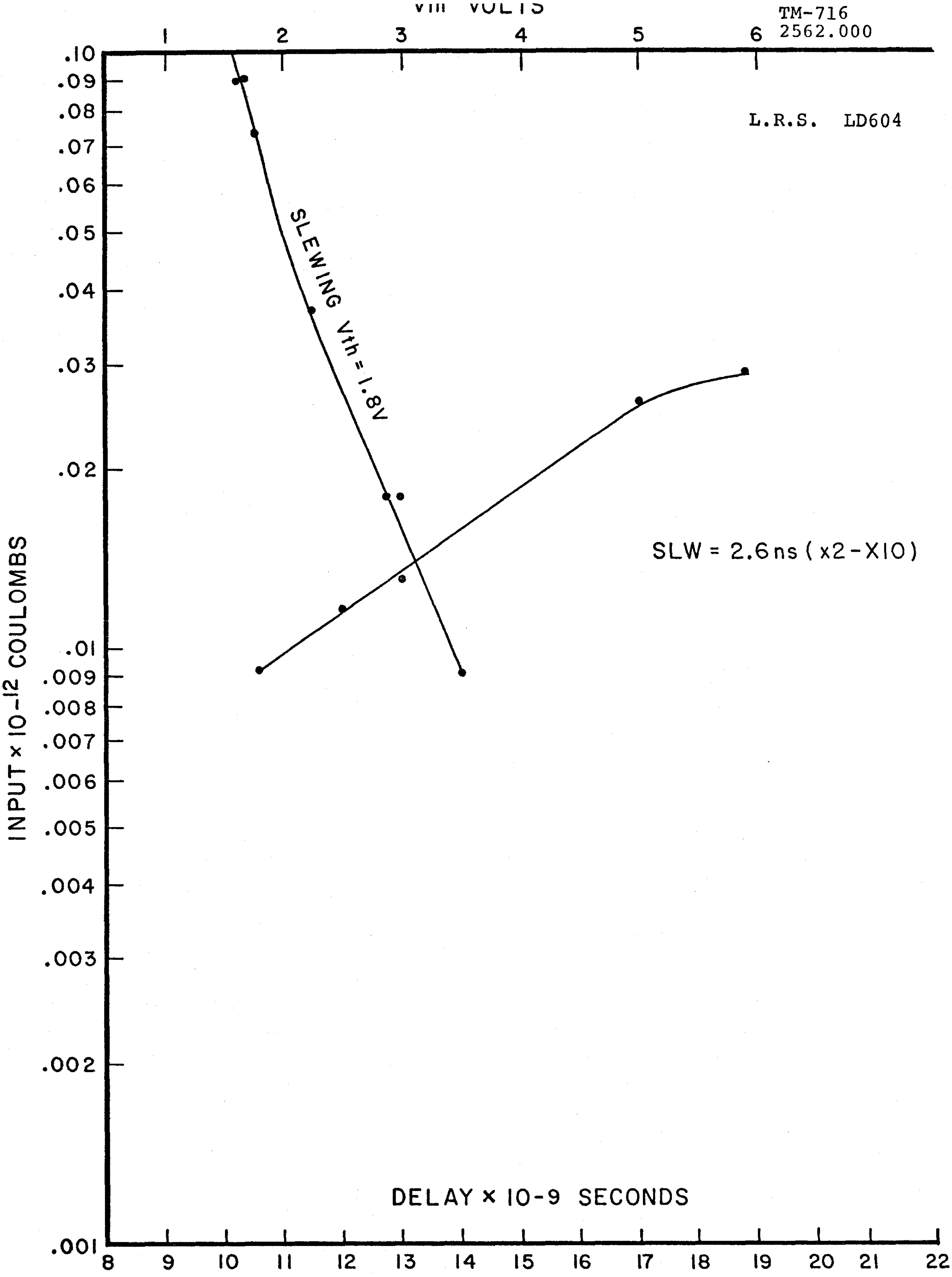
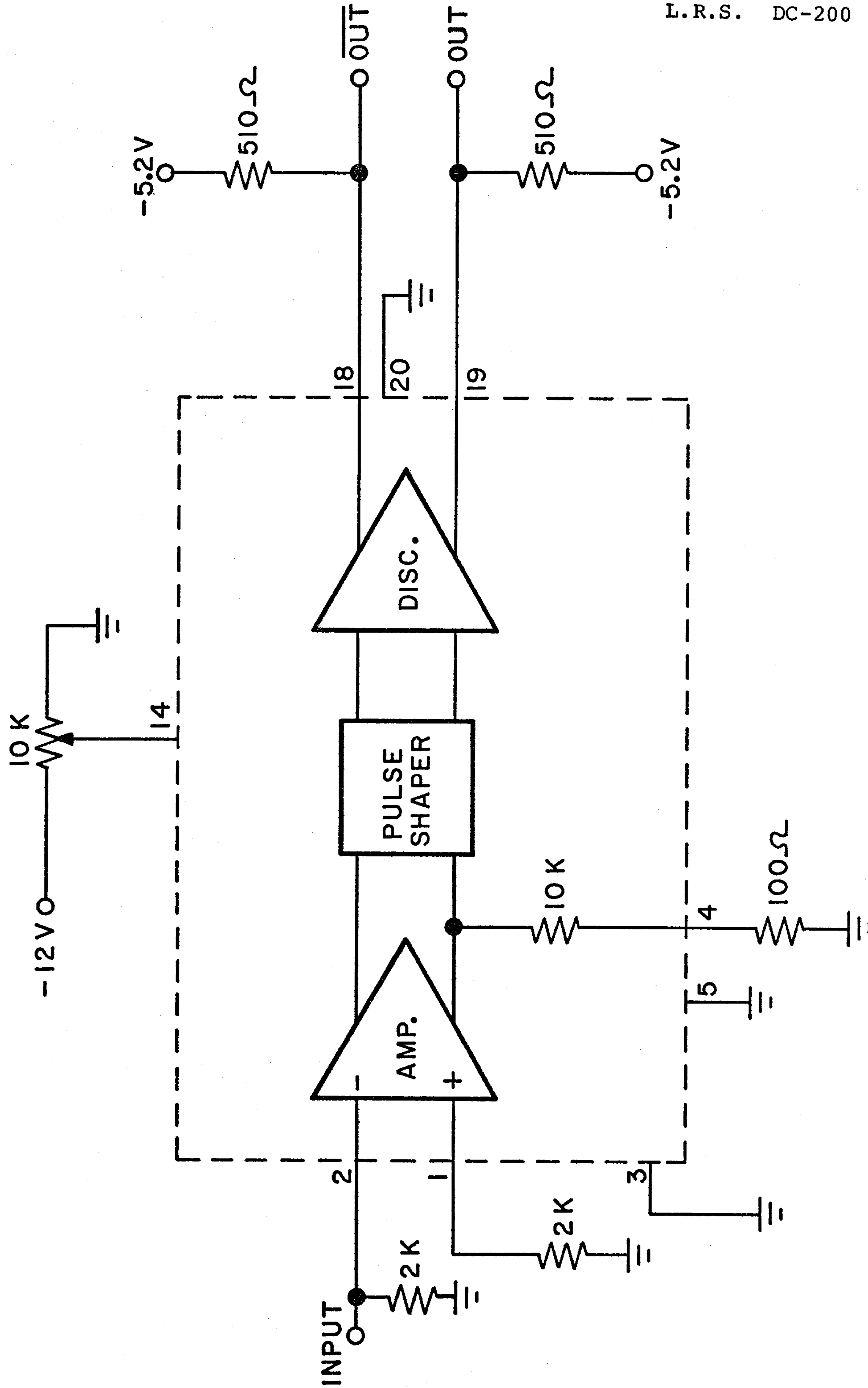
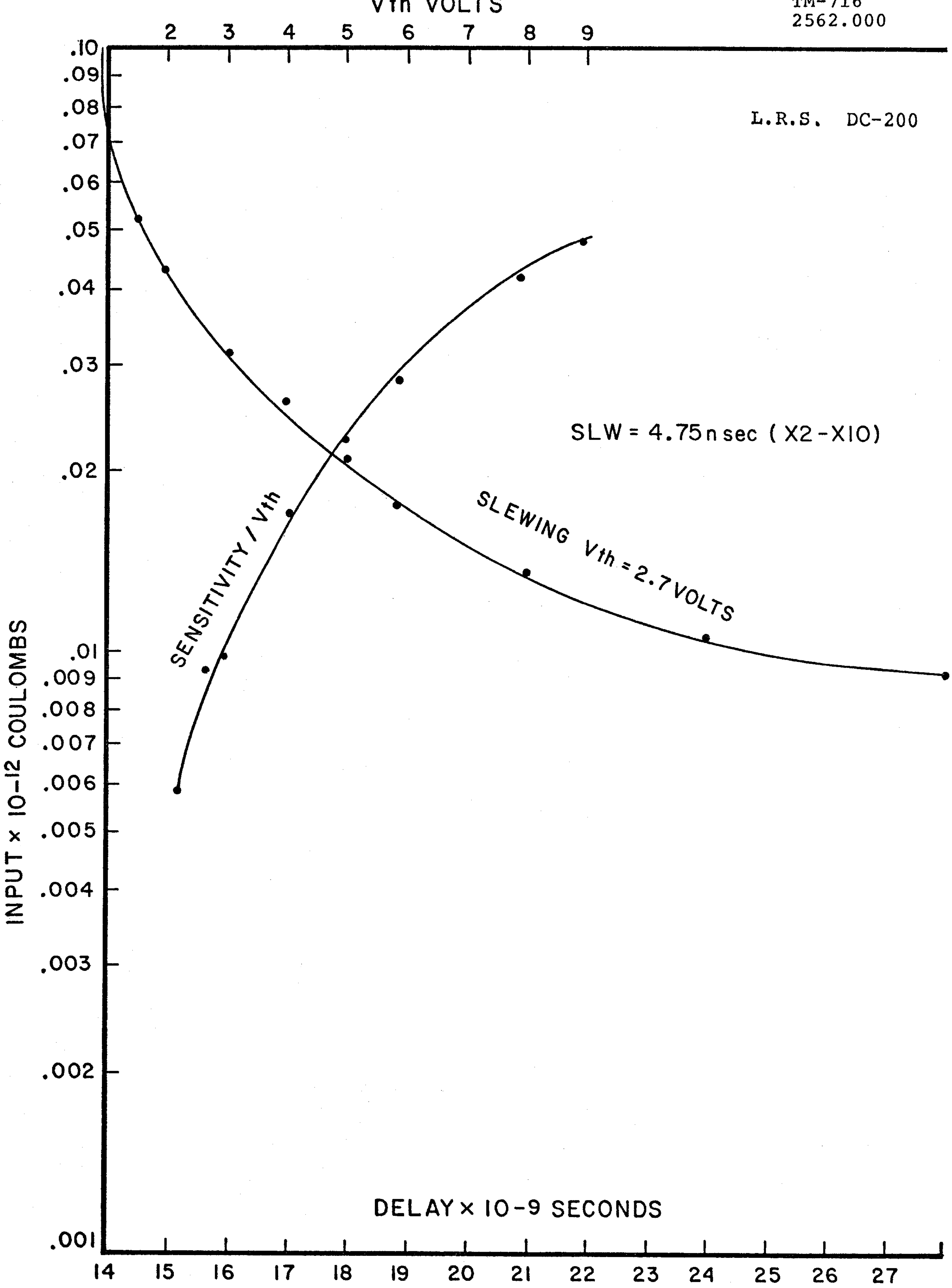
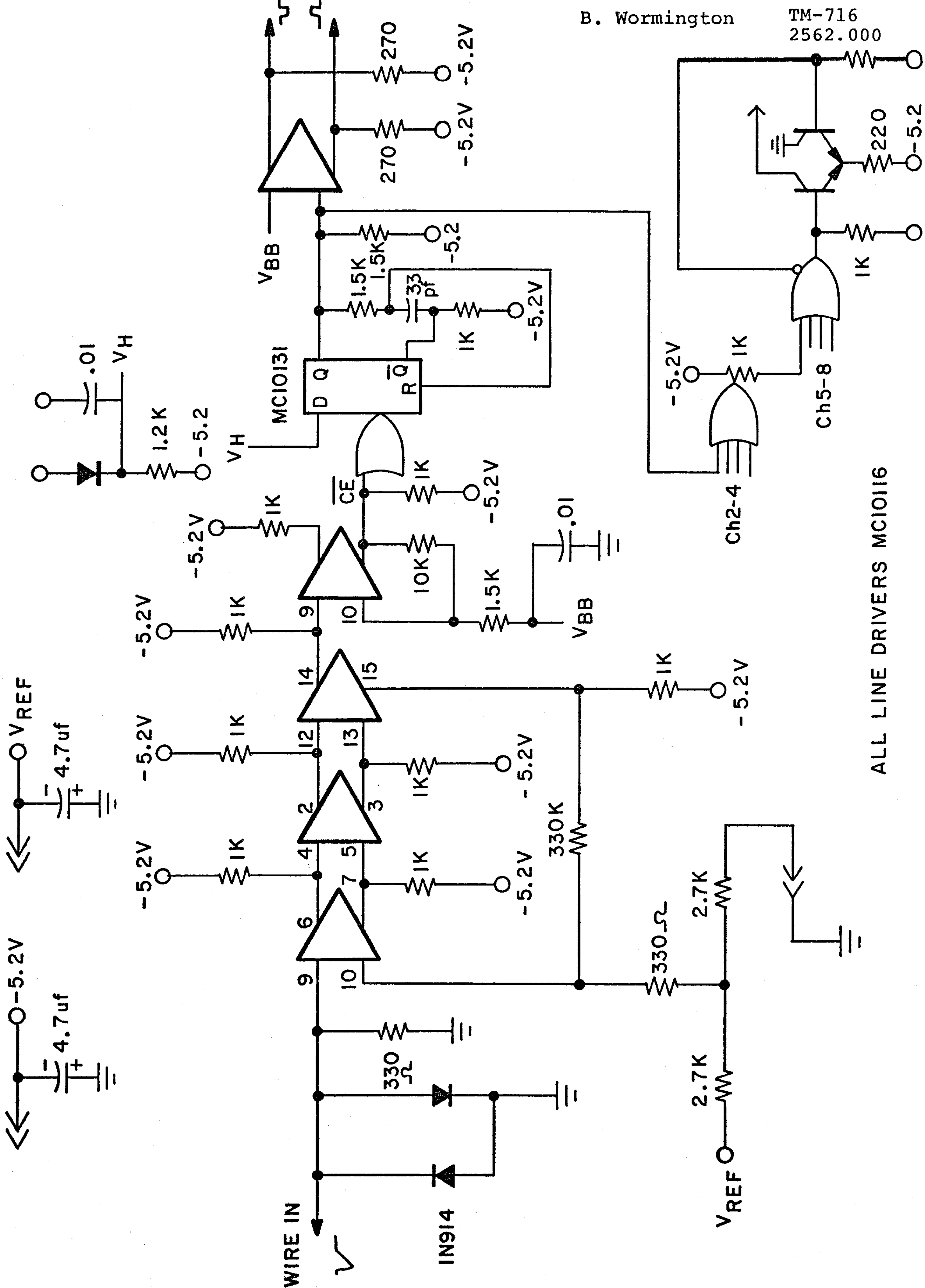
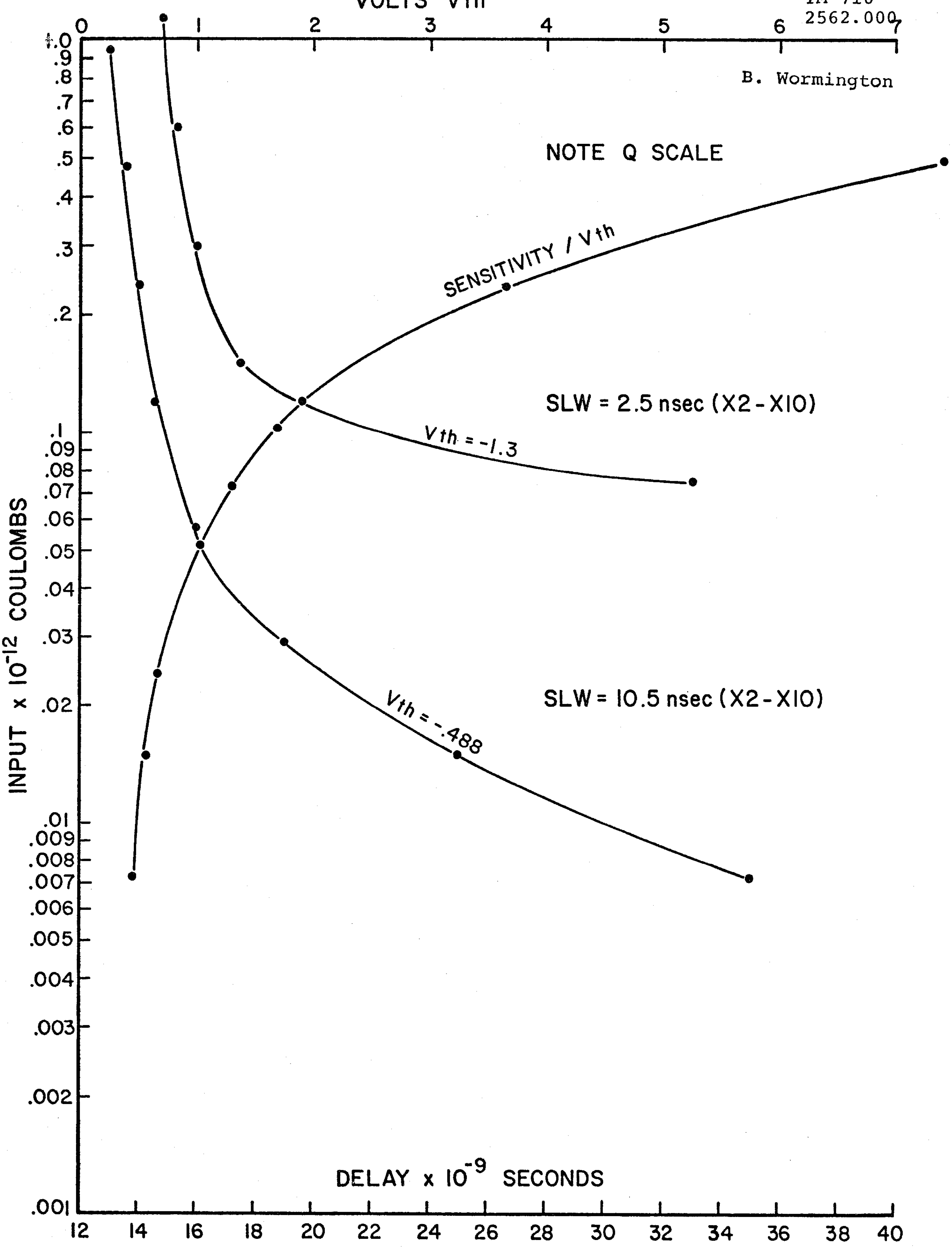
L.R.S. LD604


Vin VOLTS
1
2
3
4
5
6
L.R.S. LD604
SLEWING Vth = 1.8V
SLW = 2.6ns (x2-X10)
INPUT × 10-12 COULOMBS
.10
.09
.08
.07
.06
.05
.04
.03
.02
.01
.009
.008
.007
.006
.005
.004
.003
.002
.001
DELAY × 10-9 SECONDS
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22


OUT
OUT
510Ω
510Ω
-5.2V
-5.2V
18
20
19
DISC.
PULSE SHAPER
AMP.
10 K
14
-12V
10 K
4
100Ω
5
2
1
3
2K
2K
INPUT


Vth VOLTS
2
3
4
5
6
7
8
9
L.R.S. DC-200
SLW = 4.75 n sec (X2 - X10)
SENSITIVITY / Vth
SLEWING Vth = 2.7 VOLTS
INPUT × 10-12 COULOMBS
.10
.09
.08
.07
.06
.05
.04
.03
.02
.01
.009
.008
.007
.006
.005
.004
.003
.002
.001
DELAY × 10-9 SECONDS
14
15
16
17
18
19
20
21
22
23
24
25
26
27


ALL LINE DRIVERS MC10116
MC10131
WIRE IN
IN914
Ch2-4
Ch5-8
VREF
VBB
VH
CE
-5.2V
1K
1.5K
10K
330K
330Ω
2.7K
270
220
33 pf
.01
4.7uf
1.2K


VOLTS Vth
0
1
2
3
4
5
6
7
B. Wormington
NOTE Q SCALE
SENSITIVITY / Vth
SLW = 2.5 nsec (X2-X10)
Vth = -1.3
SLW = 10.5 nsec (X2-X10)
Vth = -.488
INPUT x 10^-12 COULOMBS
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
.09
.08
.07
.06
.05
.04
.03
.02
.01
.009
.008
.007
.006
.005
.004
.003
.002
.001
DELAY x 10^-9 SECONDS
12
14
16
18
20
22
24
26
28
30
32
34
36
38
40