

ENNELEC

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# **INSTRUCTION MANUAL**

**TC 536**

**COUNTER & TIMER**

**31 AOUT 1988**

## WARRANTY

TENNELEC, INC. warrants that the products or components manufactured by it shall be free from defects in material or workmanship for a period of one year from the date of delivery to purchaser. If such product or component is determined to be defective by TENNELEC, its sole warranty obligation shall be limited to either replacing or repairing such defective product or component or allowing credit therefor, at TENNELEC's option. Such warranty is further conditioned upon the purchaser's giving prompt notice of any such defect and satisfactory proof thereof to TENNELEC's customer service manager, thereafter upon TENNELEC's approval, the purchaser shall return such defective product or component to TENNELEC's factory at Oak Ridge, Tennessee, all transportation charges prepaid. TENNELEC shall be responsible only for transportation charges incurred in returning such product or component to purchaser. All customs, brokerage and duty charges shall be at the expense of the purchaser. Damage in transit due to inadequate packaging will be repaired at purchaser's expense. Any repairs or replacements by the purchaser without TENNELEC's approval, any willful abuse or any evidence that the product or component was not properly used and maintained, would automatically void this warranty.

TENNELEC makes no warranty whatsoever in respect to products or components not manufactured by it but instead the applicable warranties, if any, of the respective manufacturers thereof shall apply. Likewise fuses, batteries and input transistors in ultra low-noise amplifiers are specifically excluded from this warranty.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, STATUTORY OR OTHERWISE, INCLUDING WARRANTY OF MERCHANTABILITY AND FITNESS.

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## 1.0 INTRODUCTION

The TENNELEC Model TC 536 is a high-performance counter and timer designed for high-speed data acquisition.

The counter section of the TC 536 will count negative input pulses at a rate of 100 million counts per second (100 MHz) and positive input pulses at a rate of 25 million counts per second (25 MHz).

The fast negative NIM pulse can be as narrow as 4 nsec with a pulse-pair resolution of 10 nsec and the positive pulse can be as narrow as 20 nsec with a pulse-pair resolution of 40 nsec.

A discriminator is provided for the positive input and is adjustable over the range of +0.1 to +10V. This design feature eliminates unwanted noise and allows either unipolar or bipolar signals to be accepted. A six-decade, seven-segment LED display is featured in the TC 536. Leading zero's are suppressed presenting only the data in an easily-read format. A front-panel TEST pushbutton is provided to verify that the LED'S are operational by displaying all "8's".

Counting can be electronically halted with the GATE input, or manually halted with a COUNT/STOP toggle switch.

The Timer section of the module is designed as an accurate timer for any counting experiment. The timebase for the TC 536 is crystal controlled which allows for less than 0.0005% inaccuracy. A front-panel INTERVAL LED illuminates during the timing interval. In addition to the standard inputs, a time gate has been provided. This input accepts standard NIM logic signals to gate the internal timebase oscillator off. By connecting a counting system busy signal to the Time Gate, a dead time correction is provided.

## 2.0 SPECIFICATIONS

### 2.1 Performance

COUNT CAPACITY: Six-decades (999,999).

COUNTING RATE: 100 MHz negative input; 25 MHz positive input.

PULSE PAIR RESOLUTION: Negative input 10 nsec; Positive input 40 nsec.

INPUT DISCRIMINATOR: Negative input fixed at -250 mV. Positive input variable from +0.1 to +10 volts.

TIMEBASE: 10 MHz crystal-controlled oscillator; inaccuracy <0.0005%; temperature instability <0.0002%/°C for 0 to 50°C.

TIME PRESETS: 0.01 to 900,000 sec; 0.01 to 900,000 min.

SYNCHRONIZING ERROR: <50 nsec.

OPERATING TEMPERATURE: 0 to 50°C.

## 2.2 Controls and Indicators

DISPLAY: Six-decades of seven-segment LED digits.

OVERFLOW: Front-panel LED illuminates when counter overflow condition is met.

INTERVAL: Front-panel LED indicator is illuminated during the timing interval.

TEST: Front-panel push button lights all seven-segments of each LED when pressed, displaying 888888.

RESET: Front-panel push button resets display and internal registers to the initial zero condition.

0.01 MIN/0.01 SEC: Front-panel toggle switch selects the rate of timing markers.

COUNT/STOP: Toggle switch on the front panel selects counting (COUNT) or non-counting (STOP) condition.

DWELL: Front-panel single-turn control allows system recycling with an adjustable 0.1 to 10 sec dwell time between counting intervals. An OFF position is provided to inhibit the recycle operation.

DISCRIMINATOR: Single-turn potentiometer on the front panel sets the discriminator level for the positive input from +0.1 to +10V.

PRESET: Front-panel thumbwheel switches selects preset time interval in a  $N \times 10^M$  format. N selects the most significant digit of the preset as 0 through 9. M selects the power of 10 as 0 through 7.

## 2.3 Connectors

POS INPUT: Front and rear panel BNC connectors accept positive unipolar or bipolar input signals to  $\pm 25V$ . Input amplitude must exceed the adjustable threshold level for 20 nsec. Pulse-pair resolution  $\leq 40$  nsec; input impedance 1k ohm; dc-coupled.

**NEG INPUT:** Front and rear panel BNC connectors accept NIM standard fast negative logic signals, 14mA into 50 ohms. Minimum width 4 nsec at threshold. Threshold fixed at -250mV; pulse-pair resolution  $\leq 10$  nsec; input impedance 50 ohms; dc-coupled.

**GATE:** BNC connectors on front and rear panels accept NIM standard positive logic signals to control the counter gate. Open circuit or  $\geq +3$  volts to allow counting  $\leq +1.5$  volts to inhibit counting.

**INTERVAL:** Rear-panel BNC connector which provides a NIM standard positive logic signal that is true only during each preset counting interval,  $\geq +3$  during time interval,  $\leq +1.5$ V to inhibit counting during non-timing interval.

**RESET:** A rear-panel BNC connector accepts a NIM standard positive logic signal or a momentary ground to reset the counter to an initial zero condition. An internal programming pin (see Figure 2.0) allows the operator to select which condition is required for external reset. Active low:  $\leq +1.5$ V or short-to-ground for reset,  $\geq +3$ V or open circuit for non-reset. Active high:  $\geq +3$ V for reset,  $\leq +1.5$ V for non-reset.

**TIME GATE:** Rear-panel BNC connector accepts NIM standard positive logic signals to gate the internal 10 MHz timebase oscillator off,  $\geq +3$ V to gate timebase off,  $\leq +1.5$ V to gate timebase on; time resolution = 100 nsec; input impedance 10k ohms; dc-coupled. Connection of a system busy signal to the TIME GATE input provides for system dead time correction.

**OVERFLOW OUT:** Rear-panel BNC connector furnishes a 2usec wide NIM standard positive logic signal whenever the counter overflows (999,999). Output impedance  $\leq 10$  ohm, dc-coupled.

**HIGH/LOW:** Internal jumper pin selects the polarity of the reset output. Active high:  $> +3$ V for reset,  $< +1.5$ V for non-reset. Active low:  $< +1.5$ V for reset,  $> +3$ V for non-reset.

## 2.4 Ordering Information

**POWER REQUIREMENTS:** +24V, 65mA; +12V, 150mA  
-24V, 0mA; -12V, 100mA

**WEIGHT:** (SHIPPING) 4 lbs. (1.8 kg)  
(NET) 1 lb. 12 oz. (0.8 kg)

**DIMENSIONS:** Standard single-width NIM module (1.35 x 8.714) per TID-20893 (Rev.).

**WARRANTY:** One year.



INSTRUCTION MANUAL: One provided with each instrument ordered.

### 3.0 OPERATING PROCEDURES

#### 3.1 First-time Operation

Every instrument from TENNELEC, Inc. is thoroughly tested before it leaves our facility. However, it is possible for damage to occur during shipping and it is advised that a few tests be run before the instrument is put into actual operation.

Visually check the Model TC 536 upon receipt for possible external damage. If it appears to be damaged, proceed according to the instructions given in the SHIPPING DAMAGE section of this manual.

It is recommended that the power supply of the bin be OFF when the module is inserted.

##### 3.1.1 Equipment Recommended

The following equipment is recommended for conducting a few tests so that the operator may familiarize themselves with the TC 536 controls:

1. NIM bin and Power Supply (such as the TENNELEC TB3/TC911)
2. Tail Pulse Generator (such as the TENNELEC TC 812)

##### 3.1.2 Test System Set-up

Insert the TC 536 into the NIM bin and set the controls as follows:

COUNT/STOP	STOP
DWELL	OFF
0.01 sec/0.01 Min.	0.01 sec
N PRESET	1
M PRESET	3
POS DISC	2 Volts
RESET HIGH/LOW	LOW

Connect the pulser output to the front panel POS INPUT of the TC 536. Adjust the pulser for a +5 volt, 60 Hz synchronous output when terminated into its characteristic impedance.

Apply power to the bin. Move the COUNT/STOP switch to the count position. The timer should gate on for 10 seconds and then gate off. Press the reset pushbutton. The timer section of the TC 536 will reset and a new counting interval will begin.

Turn the DWELL control to mid-range. The module should now count for 10 seconds, stop for a few seconds (DWELL time) displaying the accumulated counts, reset and then count again.

### 3.2 Connection to Power

Turn off the Bin Power Supply when inserting or removing any modules. The TENNELEC modules are designed so that it is not possible to overload the Power Supply with even a full complement of modules to the Bin. Since, however, this may not be true when the Bin contains modules other than those of TENNELEC design, the Power Supply voltages should be checked after all modules have been inserted.

### 3.3 Operation in a System

If the TC 536 is used in a non-printing system with non-printing data acquisition modules then the INTERVAL and RESET signals of the TC 536 can be used for system control. The rear panel INTERVAL and RESET outputs of the TC 536 are connected to the GATE and RESET inputs, respectively, of each non-printing counter in the system as shown in Figure 1.0. Set the internal RESET HIGH/LOW select pin (See Figure 2.0) of the TC 536 and each counter to the appropriate position (NOTE: most counters that do not have a RESET HIGH/LOW select pin require a HIGH for reset).

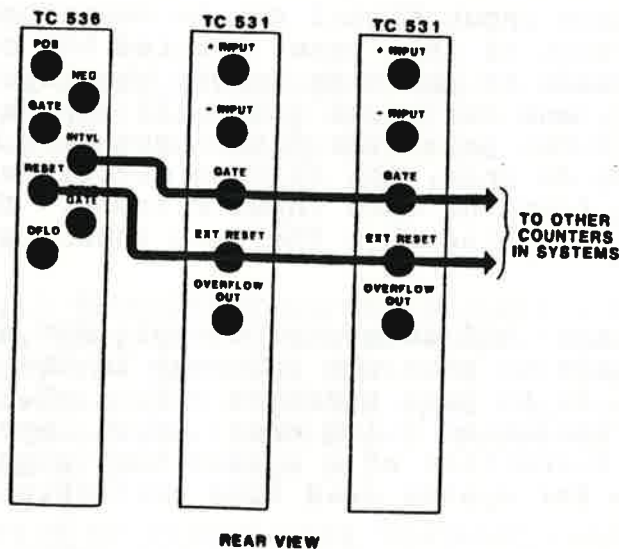


Figure 1.0 Non-Printing Module Interconnection for Non-Printing Operation



### 3.4 Signal Connections

**Counts Inputs:** The TC 536 accepts and counts either fast negative logic pulses or slow positive logic pulses. It can also accept positive analog pulses. Determine the type of input pulses that will be furnished and use the appropriate input.

As with any high-speed, low-hysteresis discriminator, care should be taken as to the quality of the pulses applied to the input. Any ringing or excess noise in the region of the discriminator threshold will very likely result in multiple triggering. When counting fixed-amplitude pulses, it is a good idea to set the threshold to approximately one-half the input pulse height. Please check your pulse source and threshold before reporting your instrument defective due to multiple triggering.

Positive logic or analog signals can be connected to either the front or rear panel BNC connector. These two connectors are not isolated from each other; so signals from two sources should not be connected simultaneously to the two Positive Input connectors. The input circuit in the TC536 is dc-coupled to eliminate baseline shifts associated with changing counting rates.

Negative logic signals can be connected to either the front or rear panel Negative Input connector. The input impedance in this circuit is 50 ohm, dc-coupled, the standard impedance for which the fast negative logic pulse is defined. There is a fixed threshold level of -250 mV in this input circuit, and the input pulse needs to exceed this level for only 4 nsec to be counted.

**Gate Input:** The Gate Input signal can be connected to the TC 536 by either the front or rear panel mounted BNC connector. With no connection made to the Gate Input, the input voltage level is about +5 V, and the count gate will permit the unit to operate. To cut off the gate, the Gate input must be pulled down to below +1.5 V. To do this, the driving circuit must be capable of absorbing 0.5 mA from the Gate Input circuit. The gate circuit will permit counting when the Gate input is at +3V or greater.

**Time Gate:** Rear-panel BNC connector accepts NIM standard positive logic signals to gate the internal 10 MHz timebase oscillator off,  $\geq +3V$  to gate timebase off,  $\leq +1.5V$  to gate timebase on; time resolution = 100 nsec; input impedance 10k ohms; dc-coupled. Connection of a system busy signal to the TIME GATE input provides for system dead time correction.

**Reset:** A bidirectional reset signal is available through a rear panel mounted BNC connector. The connector will accept a NIM standard slow positive logic signal that will reset both the time and counter sections of the TC 536. The connector will also provide a NIM standard slow positive logic signal output whenever

the TC 536 internally generates a reset, whether from the RESET pushbutton or a recycle operation. The RESET signal can be either active HIGH or active LOW to initiate reset to zero.

An internal programming pin (See Component Layout Figure) allows the operator to select which condition is required for an external reset (See Schematic). LOW:  $\leq 1.5V$  or short-to-ground for reset,  $\geq + 3V$  or open circuit for non-reset. HIGH:  $\geq + 3V$  for reset,  $\leq + 1.5V$  for non-reset.

Interval: Rear-panel BNC connector which provides a NIM standard slow positive logic signal that is true only during each preset counting interval,  $\geq + 3V$  during timing interval,  $\leq 1.5V$  to inhibit counting.

Overflow Output: The overflow signal is available through a rear panel mounted BNC connector. A positive 5V signal appears at the output each time the contents of the counter change from 999,999 to 0. The output signal is 2 usec wide;  $Z_o$  is  $\leq 10$  ohm, dc-coupled.

#### 4.0 SHIPPING DAMAGE

Upon receipt of the instrument, examine it for shipping damage. Damage claims should be filed with the carrier. The claims agent should receive a full report; a copy of that report should be sent to TENNELEC, Inc., P.O. Box D, Oak Ridge, Tennessee 37830. The model number and serial number of the instrument must be included in the report. Any remedial action taken by TENNELEC, Inc. will be based on the information contained in this report.

#### 5.0 SERVICING

In the event of a component failure, replacement may be done in the field or the instrument may be returned to our plant for repair. There will be no charge for repairs that fall within the warranty.

#### 6.0 WARRANTY

In connection with TENNELEC's warranty (inside front cover), TENNELEC suggests that if a fault develops, the customer should immediately notify the TENNELEC Customer Service Manager. He may be able to prescribe repairs and to send replacement parts which will enable you to get the instrument operating sooner and at less expense than if you return it.

Should return prove necessary, the TENNELEC Customer Service Manager must be informed in WRITING, BY CABLE or TWX of the nature of the fault and the model number and serial number of the instrument. Pack the instrument well and ship PREPAID and INSURED to TENNELEC, Inc., 601 Oak Ridge Turnpike, Oak Ridge,

Tennessee 37830. As stated in the warranty DAMAGE IN TRANSIENT WILL BE REPAIRED AT THE SENDERS EXPENSE as will damage that obviously resulted from abuse or misuse of the instrument.

Quotations for repair of such damage will be sent for your approval before repair is undertaken.

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*****
*
* TENNELEC's Quality Assurance Program
* requires that each and every instru-
* ment be fully aged, vibrated, and
* electronically checked.
*
* Should the user require a copy of the
* Quality Control Procedure and Test
* Record, please call the Customer Ser-
* vice Department of TENNELEC. Both
* model number and serial number are
* required.
*
*****
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MANUAL REV. 0

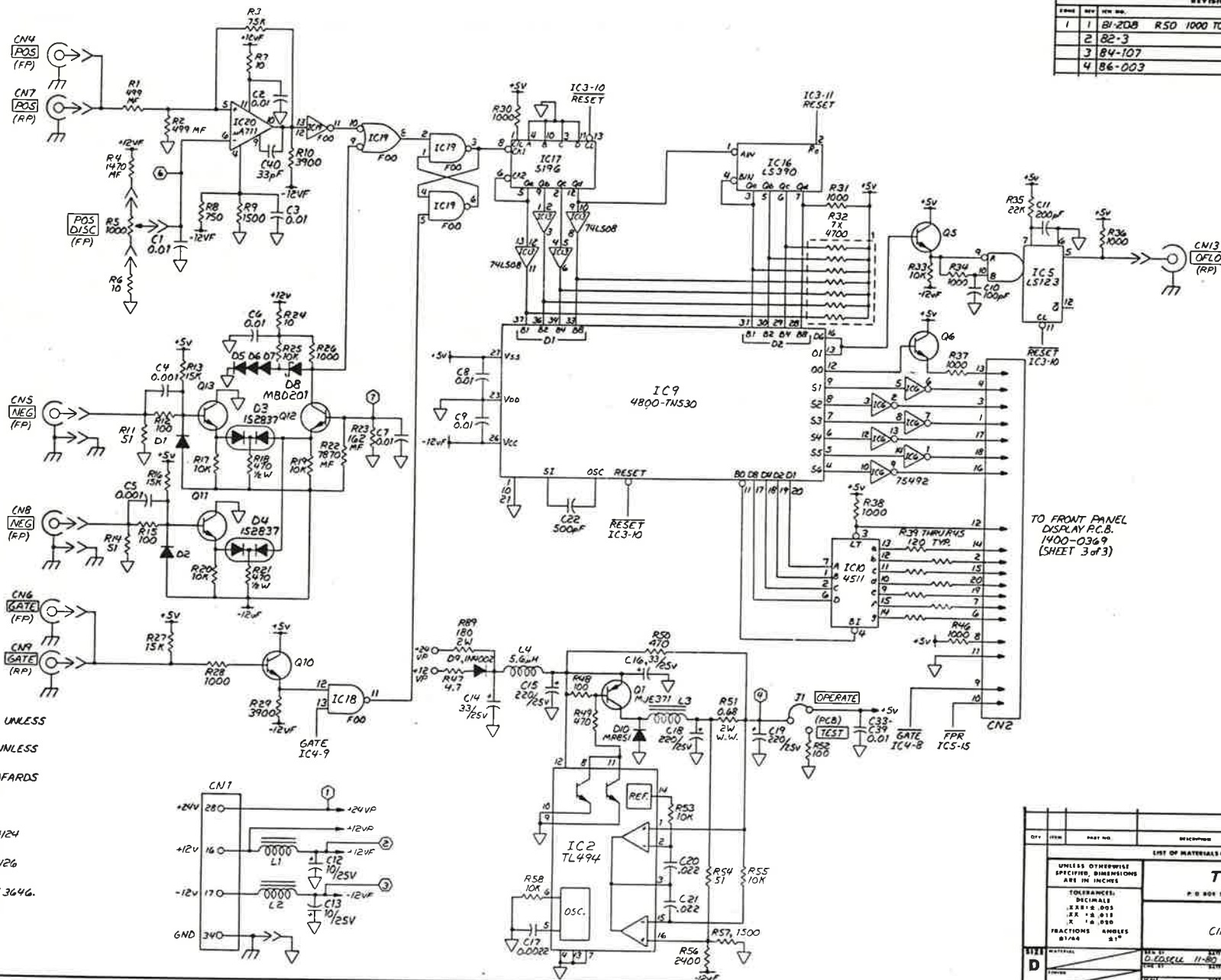
4/81 - Engineering and component improvements may be made after date of printing.



**Figure 2.0 Printed Circuit Mounted Jumper Pin**

NOTES

- (1) ALL RESISTORS ARE 1/4 W DC UNLESS OTHERWISE NOTED.
- (2) RESISTORS ARE IN OHMS UNLESS OTHERWISE NOTED.
- (3) CAPACITORS ARE IN MICROFARADS UNLESS OTHERWISE NOTED.
- (4) DIODES ARE IN4154 UNLESS OTHERWISE NOTED.
- (5) NPN TRANSISTORS ARE 2N4124 UNLESS OTHERWISE NOTED.
- (6) PNP TRANSISTORS ARE 2N4126 UNLESS OTHERWISE NOTED.
- (7) Q11-Q13 ARE SELECTED MPS 3646.
- (8) ○ DENOTES TEST POINT (TP)



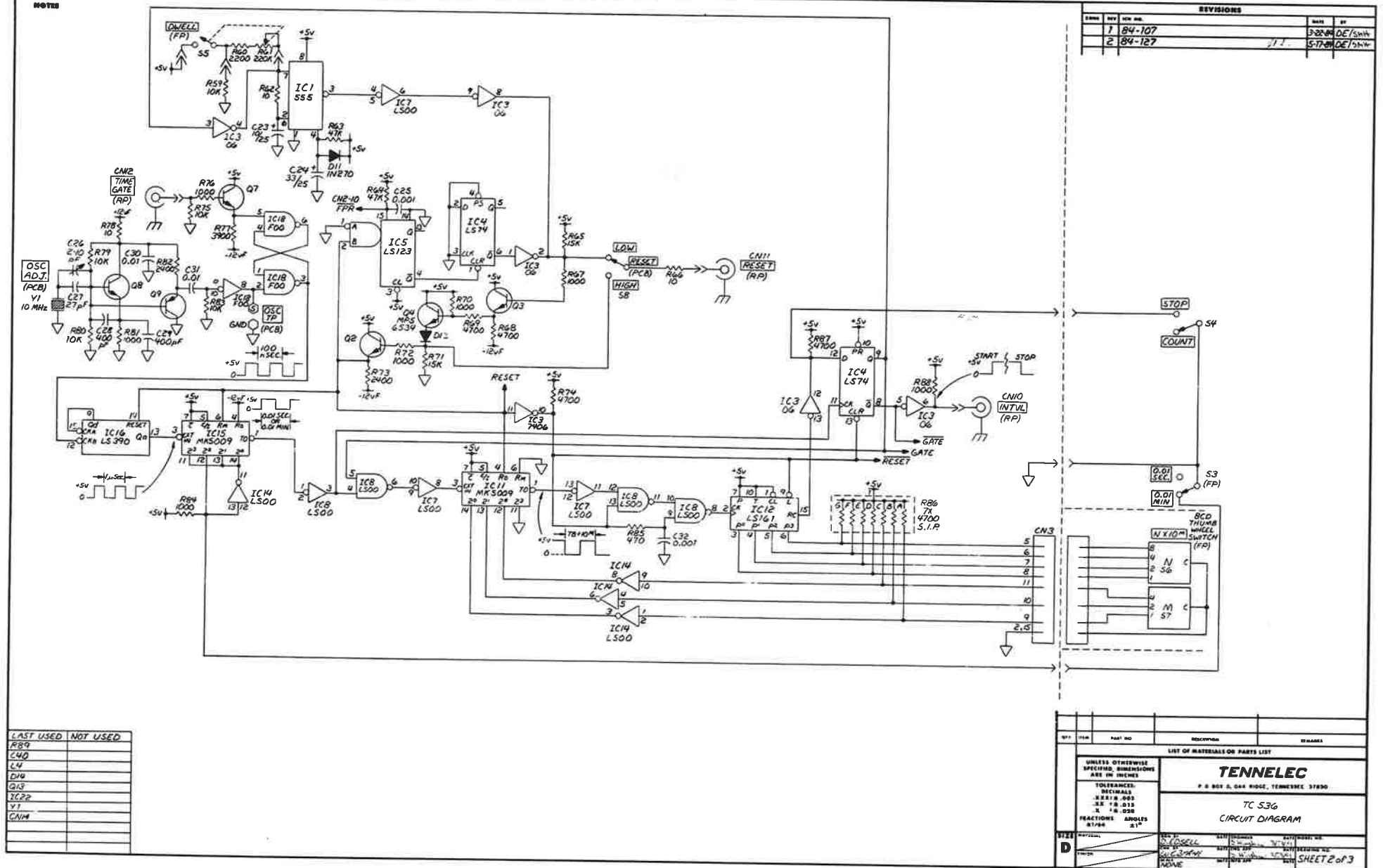
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2	82-3		4-8-76	DE/SMH
3	84-107		3-22-77	DE/SMH
4	86-003		1-15-78	DE/SMH

TO FRONT PANEL  
DISPLAY P.C.B.  
1400-036.9  
(SHEET 3 of 3)

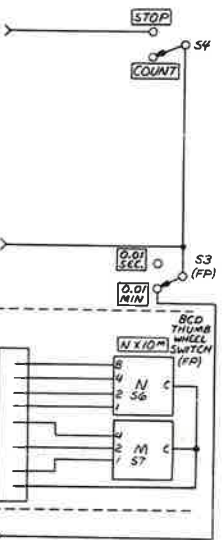
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DECIMALS				
XXX.XX .005				
XX.X .010				
X .050				
FRACTIONS				
ANGLES				
.1"				
MATERIAL				
D				
DRAWN BY: D. ECKEL 11-80				
CHECKED BY: J. H. HARRIS 11-80				
DATE: 11-80				
SHEET 1 of 3				



NOTES



REVISIONS			
REV	REV NO	DATE	BY
1	84-107	3-20-84	DE/SHW
2	84-127	5-17-84	DE/SHW



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2	84-127	CIRCUIT DIAGRAM	

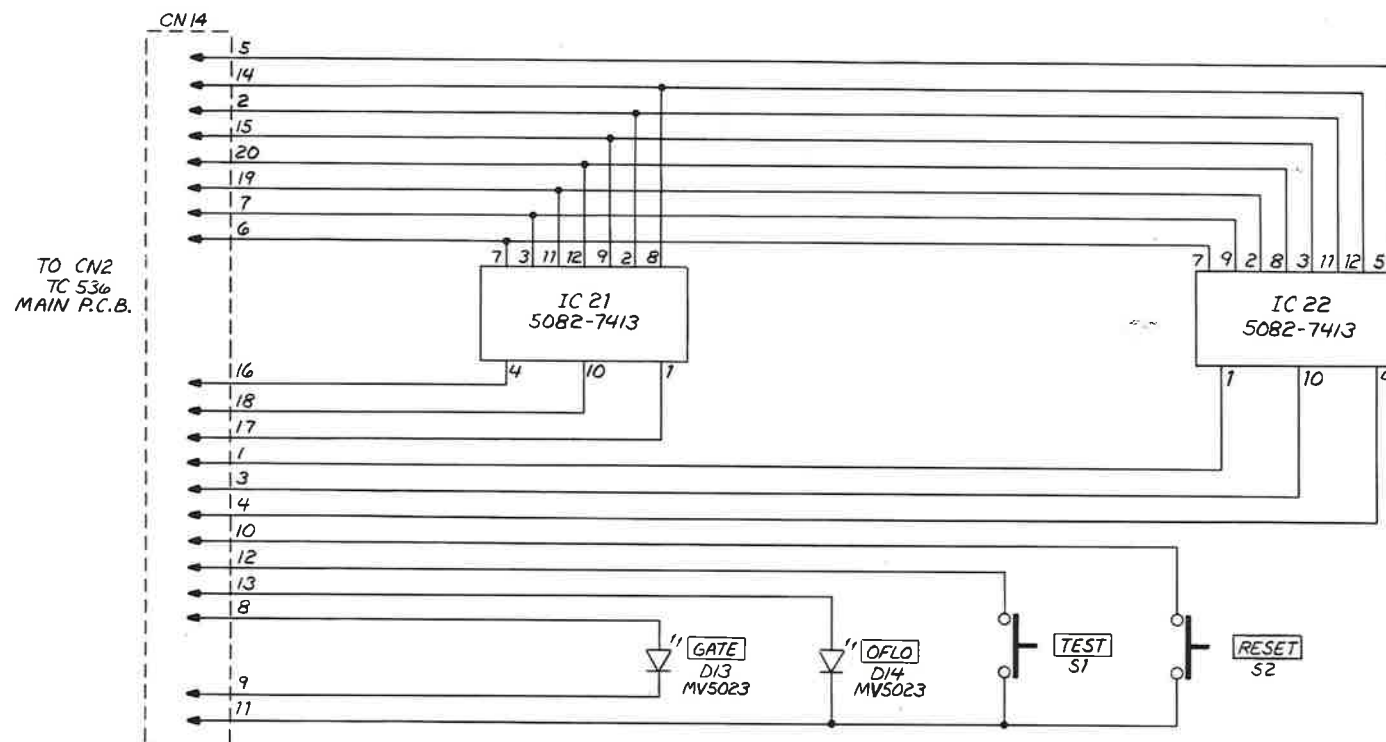
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TENNELEC			
P.O. BOX 2, SAN WIG, TENNESSEE 37080			
TC 536			
CIRCUIT DIAGRAM			

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1	84-107	TC 536	
2	84-127	CIRCUIT DIAGRAM	

NOTES

REV.	ECN NO.	REVISIONS		DATE	BY



(P.C.B. PART #1400-0369)

QTY	ITEM	PART NO.	DESCRIPTION	REMARKS
LIST OF MATERIALS OR PARTS LIST				
UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN INCHES			<b>TENNELEC</b> P. O. BOX 4, OAK RIDGE, TENNESSEE 37830	
TOLERANCES: DECIMALS .XXX ± .005 .XX ± .015 .X ± .020 FRACTIONS ANGLES ± 1/64 ± 1°				
SIZE	MATERIAL	FINISH	TC 536 DISPLAY BOARD SCHEMATIC	
C	DATE	BY	DATE	BY
	12/2/80	D. EDSELL	12/1/80	S. H. HARRIS
DATE	BY	DATE	BY	DATE
12/1/80	S. H. HARRIS	12/1/80	S. H. HARRIS	12/1/80
SCALE	NONE	DATE	BY	DATE
				TC 536