INSTRUCTION MANUAL

TC 455 QUAD CF DISCRIMINATOR

CORRIGENDUM

Due to circumstances beyond our control, certain ECL integrated circuits are not presently available. The substitution of a **10116L** line receiver in place of a **10H116L** was required. THIS SUBSTITUTION WILL **HAVE** NO AFFECT ON THE **WALK** SPECIFICATION OR **TYPICAL** WALK PERFORMANCE. The use of the **10116L in place** of the **10H116L** will limit the maximum input/output rate to the 180 to 190 MHz range.

The TC 455 will be upgraded **free** of charge at the customers request when the **10H116L** becomes available. Present information from the manufacturer indicates availability by January or February of 1984.

We regret any inconvience this may cause, However, since the compromise in performance is minor and the unit still retains the extremely low walk characteristics, the decision was made to continue shipments instead of delaying availability until early 1984.

If you have any questions on returning this unit for the upgrade, please contact the TENNELEC Customer Service Manager.

10/83

TC 455

TABLE OP CONTENTS

TC 455

TABLE OF CONTENTS

TABLE OF FIGURES

1.0 INTRODUCTION

The TC 455 Quad Constant Fraction 200 MHz Discriminator is a single-width NIM that includes four independent constant fraction discriminators. Each section of the TC 455 accepts negative input signals and generates three NIM-otandard fast negative logic signals for each input signal that exceeds the adjustable lower level threshold.

The constant fraction technique allows optimum timing with signals from photomultiplier tubes, channeltrons, surface barrier detectors and large solid-state detectors. The input signal is split into two parts. One portion of the signal is delayed and subtracted from a fraction of the input signal. The resulting zero-crossing point is fixed in time and is used to provide a precisely-timed logic pulse ‘for an input signal that spans a wide dynamic range.

Bach channel of the TC 455 includes independent lower level threshold (-5 mV minimum) controls to prevent triggering on low-level input signals or noise. The TC 455 has a 50 ohm input impedance and is protected against overload. The input signal cable and the delay cable should be 50 ohm coaxial cable to ensure proper termination and minimize reflections.

The constant-fraction shaping delay for each discriminator is determined by the length of 50 ohm coaxial cable connected between the two front-panel DELAY connectors. The shaping delay required is dependent upon the signal characteristics at the input of the TC 455.

The TC 455 requires the use of a bin and power supply that includes distribution of dc power at ±24V, ±12V, and ±6V. The TENNELEC TB3/TC 911-6 or equivalent is recommended. By using the recommended bin and power supply, a full complement of 12 TC 455 modules can be operated in the bin providing a total capacity of 48 channels of constant fraction discrimination.

2.0 SPECIPICATIONS

2.1 PERFORMANCE

NUMBER OF CHANNELS	'Pour, completely independent
INPUT/OUTPUT RATE	≥200 MHz (typically >240 MHz), limited by blocking width setting.
PULSE PAIR RESOLVING TIME	Less than 5 nsec for input signals with risetime <2 nsec, blocking width set at minimum.
INPUT PULSE CHARACTERISTICS	Accepts negative inputs from 0 to -2.5V or 0 to -5.0V in two selectable ranges. Maximum input without saturation is -4.75V for the 0 to -2.5V range and -9.5V for the 0 to -5.0V range. Input protected against overload; reflections ≤10% for risetimes ≥1 nsec.
MINIMUM INPUT PULSE WIDTH	Typically <700 psec.
LOWER LEVEL DISCRIMINATOR RANGE	Dependent upon input range selected. -5mV to -1.OV for the 0 to -2.5V range and -10mV to -2.OV for the 0 to -5.OV range.
THRESHOLD INSTABILITY	≤0.02%/°C of full scale, 0 to 50°C; referenced to -12V supply.
WALK* 0 to -2.5V RANGE CONSTANT FRACTION MODE (0.2 Fraction)	≤ ±100 psec (typically ≤ ±30 psec) for the range from -25 mV to -2.5V, (typically& ±160 psec for the range from -45 mV to -4.5V). See Pigure 2.1.

---

*Measured with a 1 nsec risetime input signal and pulse width of 10 nsec.

0 to -5.0V RANGE CONSTANT FRACTION MODE (0.2 Fraction)	≤± 100 psec (typically ≤ ±30 psec) for the range from -50 mV to -5.0V, (typically ≤ ±160 psec for the range from -95 mV to -9.5V). See Figure 2.1.
LEADING EDGE MODE (REQUIRES OPTIONAL LEADING EDGE. MODULE)	Depends on input signal risetime. For 1 nsec t_r, ≤ ±400 psec typical for a 10:1 dynamic range (X2 to X20 of threshold). ≤ ±500 psec typical for a 100:1 dynamic range (X2 to X200 of threshold).
TIME SLEWING	≤500 psec from half-fire, measured with t_r = 1.0 nsec, t_{pw} = 3.0 nsec at half height, $t_{d(tot)}$ = 1.5 nsec, threshold = -10 mV.
PROPAGATION DELAY	Nominally 10 nsec with a 1.5 nsec external delay cable.
PROPAGATION DELAY INSTABILITY	≤ 10 psec/°C, 0 to 50°C
BLOCKING WIDTH	Variable from <5 nsec to >500 nsec in two ranges. One range covers from <5 nsec to >100 nsec. The second range covers from <10 nsec to >500 nsec.
OPERATING TEMPERATURE 'RANGE	0 to 50%

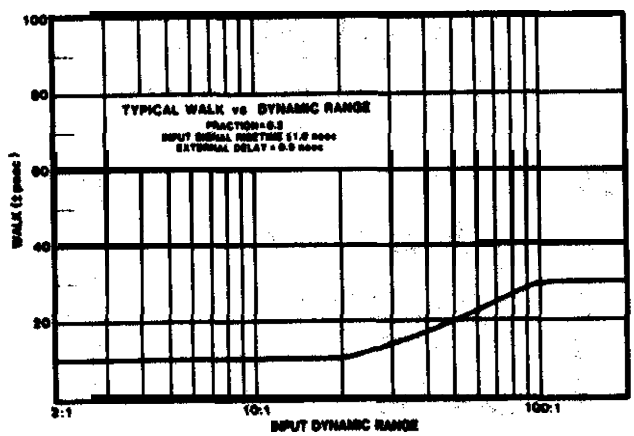


Figure 2.1.

2.2 CONTROLS

2.2.1 FRONT-PANEL CONTROLS

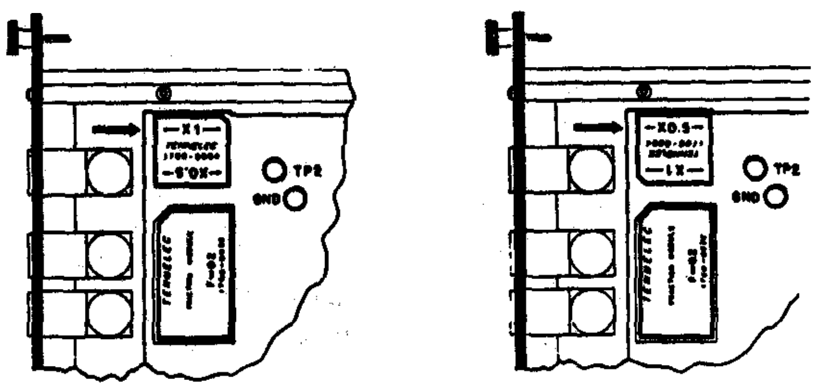
THRESHOLD (T) Front-panel multiturn screwdriver-adjustable potentiometer for each discriminator channel. The adjustment range is -5mV to -1.0V in the 0 to -2.5V *range* or -lOmV to -2.OV (effective threshold setting) when operating: in the 0 to -5.0V range. Note that in the 0 to -5.0V range, the input signal is divided by two before being routed to the lower level discriminator. This has the effect of doubling the lower level discriminator limits. The THRESHOLD teat point voltage is ten times the actual threshold (i.e. a -5mV threshold results in a -5UmV voltage at the Front-panel monitor).

WALK(Z) Front-panel multiturn screwdriver-adjustable potentiometer in each channel for precise aetting of walk compensation for each application.

BLOCKING WIDTH(W) Front-panel multiturn screwdriver-adjustable potentiometer in each channel for setting the minimum deadtime during pulse processing. The blocking width has two *ranger* internally jumper selectable. The two ranger provide blocking widths of <5 nsec to >100 nsec and <10 nsec to >500 nsec for each channel. Additionally, 'the blocking width controls the width of the negative-output signals.

2.2.2 INTERNAL CONTROLS.

ATTENUATOR MODULE Input ranges of 0 to -2.5V and 0 to -5.0V are selected, by a' PCB mounted attenuation. module. The correct orientation of the attenuation module for each range is shown in Figure 2.2~.



0 to -2.5V　　　　0 to -5.0V

Figure 2.2

FRACTION MODULE The TC 455 offers selection of the constant fraction attenuation fraction by use of a plug-in module for each channel. The standard fraction supplied is 0.2. Additional fractions are available as options. The LEADING EDGE node of operation can be eelected by use of the LEADING EDGE module in place of a constant fraction module. The LEADING EDGE module (TENNELEC part #1700-0040) is available as 'an option.

CF/SRT A printed circuit board mounted jumper (J1) allows selection of either constant fraction (CF) or constant fraction with slow risetime reject (SRT) operating mode for each channel. In the SRT mode, any input eignal that does not, cross th'e lower' level threshold before the constant fraction zero crossing occurs will be rejected. 'The CF mode is the normal mode of operation when timing with fast pulses such as those from a photomultiplier or channeltron. The TC 455 is shipped with J1 in the CF mode for all four channels.

BLOCKING WIDTH RANGE A printed circuit board mounted jumper (J2) allows selection of the blocking width range for each channel. Position 1 provides, a blocking width adjustment range of <10 nsec to >500 nsec. Position 2 provides a blocking width adjustment range of <5 nsec to >100 nsec. The TC 455 is shipped with J2 in the'number 2 position (<5 nsec to >100 nsec), consistent with a greater than 200 MHz operation rate.

2.3 CONNECTORS

INPUT Front-panel LEMO connector for each channel accepts negative signals in the range of 0 to -2.5V or 0 to -5.0V depending upon the position of the internal module. The input is dc coupled, has an input impedance of 50 ohms, is protected against input overloads and 'has ≤10% reflections for input risetimes ≥1 nsec. In the 0 to -2.5V range the maximum input without saturation is 5.0V and in the 0 to -5.OV range the maximum is -10.0V.

DELAY Two front-panel LEMO connectors for each channel, between which a delay cable (50 ohms impedance) is connected to form the internal constant fraction signal. The total delay consists of the delay time of the external cable plus an internal delay of approximately 0.3 nsec. The length of the delay cable used depends upon the risetime of the input signal and the propagation delay time of the cable (1.6 nsec per foot for commonly-used cables).

a/c MON Front-panel LEMO connector for each channel provides a constant fraction zero crossing monitor. The width of the pulse depends upon input signal level, delay time, and walk adjust setting; Characteristics when terminated by 50' ohms: dc offset of -200 mV, 100 mV positive going pulse at constant fraction zero crossing.

OUT Three independent front-panel LEMO connectors, for each channel, provide rimultaneoue NIM-standard fast negative logic signals. The output amplitude is nominally -800 mV into a 50 ohm load. The OUT signal width is controlled by the BLOCKING WIDTH (W) control and is adjustable over a range of <5 nsec to >500 nsec in two ranges as defined in Section 2.2.1. Rise and fall times of the OUT signals are typically <1 nsec.

2.4 POWER REQUIREMENTS

+24V, 83 mA; +12V, 167 mA; +6V, 416 mA 117VAC, 46 mA
-24V, 83 mA; -12V, 167 mA; -6V, 416 mA

2.5 OTHER INWRWATION

WEIGHT	
(SHIPPING)	5.0 lbs. (2.28 kg)
(NET)	3.0 lbs. (1.37 kg)
DIMENSIONS	Standard single-width NIM (1.35 x 8.714 in;) per TID 20893 (Rev).
INSTRUCTION MANUAL	One provided with each instrument ordered.
WARRANTY	One year
OPTIONS AVAILABLE	0.1, 0.3, 0.4 and 0.5 fraction modules, or leading edge module. Other fraction modules available on special order.

output pulse width is determined by the front panel W control associated with that channel. Bach output. connection should be made through a mating, LEMO connector and a 50 ohm coaxial cable to a 50 ohm terminating impedance. Termination is not necessary for unused outputs or unused channels,

The TC 455 is capable of operating in excess of 200 MHz. Operation at such frequencies requires an output signal width of less than 5' nsec. The typical output width at the -250 mV level (when adjusted for minimum width) is 3.0 nsec. Some instruments may not respond to a signal this narrow. If an instrument connected to the TC 455 wjll not respond to the minimum width output signal, adjust the W control to produce a pulse of adequate width. This situation could occur *when* interfacing the TC 455 to slower instruments such as ratemeters, counters, etc. This will limit the maximum rate capability of the effected channel.

3.2.3 DELAY CABLE

The shaping delay for each channel is adjusted by selecting the length of 50 ohm coaxial cable connected between the two DELAY LEMO connectors (NOTE: the constant fraction time derivation circuit is not complete until the delay cable is installed). The total delay is equal to the external delay (t_{EXT}) plus the internal delay of approximately 0.3 nsec. The amount of delay required is dependent upon the input signal risetime, the fraction selected, and whether the TC 455 is, operating in the true-constant-fraction (TCF) mode or the amplitude-risetime-compensated (ABC) mode. Compute cable length at 0.63 feet per nsec (19 cm/nsec).

When the TC 455 is used in fast timing or counting experiments with scintillators and pbotomultiplier tubes (PMT's), the delay ehould be selected to place the unit in the True Constant Fraction (TCF) mode. To operate the TC 455 in this mode requires the delay be selected such that the time of zero-crossing occurs at the peak of the attenuated signal. This method of operation (TCF) is useful when 'timing with pulses having. a narrow range of risetimes and a wide range of amplitudes, thus producing a, time pickoff which is insensitive to pulse height variation. Selection of the optimum constant fraction delay is usually accomplished experimentally. However, a useful starting point is given by

$$t_{EXT} = [t_r(1-f) - 0.31 \text{ nsec}$$

where tr is the 10% to 90% risetime of the input pulse and f is the selected fraction (0.2 is standard).

When using the TC 455 with large volume semiconductor detectors, such as germanium, the risetime of the input signal will vary from a few tens to several hundred nanoseconds. To provide the least walk, the TC 455 delay cable should be selected to place the unit in the Amplitude Risetime Compensated (ARC) mode of operation. In this mode, the delay cable is selected to have the time of zero crossing occur before the attenuated input reaches its maximum. This mode of operation will minimize the, risetime dependence of the zero crossing time. Selection of the constant fraction delay is usually accomplished experimentally. However, a useful starting point is given-by

$$t_{EXT} < [t_{r(MIN)} (1-f) - 0.3] \text{ nsec}$$

where $t_{r(MIN)}$ is the minimum expected risetime for any input signal.

3 . 3 OPERATING MODES

3.3.1 CONSTANT PRACTION

The object of any time pickoff instrument is to generate a logic pulse which has a constant time relationship to the event which caused it and which is invariant with the amplitude of the. initiating event.

The undesired time dependence on the amplitude is known as "walk", and the random variation due to inetrument noise is known as “jitter”. Walk and jitter are independent of each other.

One of the best known timing techniques is the constant fraction (CF) method. This technique is particularly useful with large volume germanium detectors in which the collection time varies according to the location of the initial ionieation in the detector. The CF technique operates as follows: An incoming unipolar signal is split into two, paths. In one, the signal is attenuate'd. In the other, the signal is not attenuated, but delayed. The attenuated and delayed signals are then combined in a differential amplifier stage resulting in a subtraction process. The difference signal is bipolar, with the baseline crossing being the locus. (or image) of a particular point on the leading edge of the incoming signal. This point is at a fraction of the amplitude of the incoming signal, and that fraction is invariant in amplitude. The fraction is chosen for beet performance with a particular detector and can be fixed by the attenuation factor and delay in the respective paths of the processed signal. A crossover pickoff circuit generates a logic pulse time-correlated to the desired leading-edge f raction.

The TC 455 is delivered with the 0.2 fraction modules installed. The effective fraction can be changed by replacing the 0.2 module with optional fraction modules. By use of the selectable fraction, the TC 455 can be optimized to suit the particular experiment.

3.3.2 LEADING EDGE

The TC 455 can be converted to a 200 MHz leading edge discriminator by replacing the fraction module with the optional leading edge module. When operating in the leading edge mode, the SRT/CF switch must be in the CF mode or signals will not be processed. The leading edge mode of operation should be used only with signals having a very short risetime and/or a very narrow range of amplitudes because a change in amplitude will cause walk.

4.0 OPERATION

Each channel of the TC 455 has an input connection, a zero-crossing monitor and three outputs. The discriminator threshold, the blocking width and the walk characteristics are all adjustable independently in each channel as required by the application.

The TC 455 accepts negative input signals over two ranges as outlined in Section 2.2.2. The input range selected should accept the largest amplitude signal that will be used for timing. The 0 to' -2.5V range provides optimum timing for input signals with amplitudes between -5 mV and -2.5V. The 0 to -2.5V range can be used with input signal amplitudes as high as -5.0V. Above approximately -5.0V, the input protection network clips input signal 'to protect the input section of the TC '455.

The 0 to -5.0V range provide8 optimum timing for input signals with amplitudes between -10 mV and -5.0W. The 0 to -5.0V ran' e can be used with input signal amplitudes a8 h4gh a8 -10.0V. Above approximately -10.0V, the input' protection network clips the input signal to protect 'the input section of the TC 455.

For each input pulse that satisfies the TC 455 logic requirements for that channel, three logic pulses are generated 8imultaneouely. Additionally, an indicator LED is illuminated to indicate the channel is processing pulses.

The threshold level of the TC 455 should always be set above the noise level of the input signal. The noise can be minimised by proper selection of the integration and differentiation time constants of the timing-filter amplifier if one is used. For most systems, this requirement will result in a lower-level setting of at least -20 mV to ensure noise free triggering. The LED is used to provide a visual indication for each input pulse that produces an output pulse and can be used to determine the minimum threshold level above system noise.

To adjust the discriminator threshold level, monitor the dc voltage from the front-panel T monitor to ground for the active channel. The nominal range of adjustment is -50 mV to -10.0V. The actual threshold level is 10% of the test point voltage, corresponding to a threshold range of -5.0 mV to -1.00V when the input range is set for 0 to -2.5V. When Operating with the input range eat for 0 to -5.0V, the actual threshold 'is 20% Of the test point voltage, corresponding to a threshold range Of -10.0 mV to -2.00V.

TO adjust the blocking width (W), drive the appropriate channel with input pulses having a rate of 1 MHZ Or less. Observe the width of either of the three OUT signals and adjust the blocking width for the desired setting. The range of adjustment is from <5 nsec to >500 nsec in two ranges as outlined in Section 2.2.2.

The optimum walk control setting will vary depending upon the type of detector, used. The adjustment is made by observing the Z/C MON output on a fast oscilloscope (500 MHz) which is triggered externally by the negative output of the appropriate channel of the TC 455.

The Z potentiometer should be set to produce minimum walk on the leading edge of the Z/C MON output, where walk in this instance will be characterized by horizontal jitter.. A typical waveform from the Z/C WON monitor is shown in Figure 1.1. This signal was generated using the TC 455 with a PMT and with the oscilloscope triggered externally as outlined above. Improper walk adjustment will result in a broader trace than shown in Figure, 4.1.

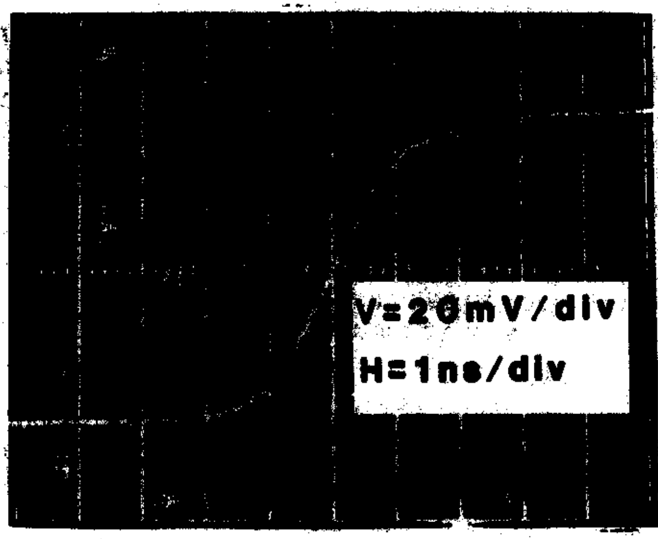


Figure 4.1 Z/C MON

Selection of the proper length of delay cable' will depend upon th.e detector type and detector characteristics. See Section 3.2.3. for details on selection of the delay cable length.

The slow-risetime reject (SRT) timing mode can be used to reduce leading-edge walk. This reduction results from rejection of slow-risetime signals in which the CF zero crossing occurs before the signal has crossed the discriminator threshold. Unfortunately, the counting efficiency is reduced. because of the rejected signals, but the improvement in FW.1M and FW.01M resolution is a compensating factor. The amount of improvement is dependent upon the. lower-level threshold as more slow pulses are rejected for higher thresholds.

If the TC 455 is to be operated in the leading edge mode, the fraction module must. be replaced by the optional leading edge module. In this mode, the delay connectors are unused (no connection required): the SRT/CF jumper (J1) must be in the CF mode.

5.0 CIRCUIT DESCRIPTION

A complete schematic of the TC 455 is included at the back of this manual. A simplified block diagram of the TC 455 is shown in Figure 5.1 and is used as a reference to describe its operation.

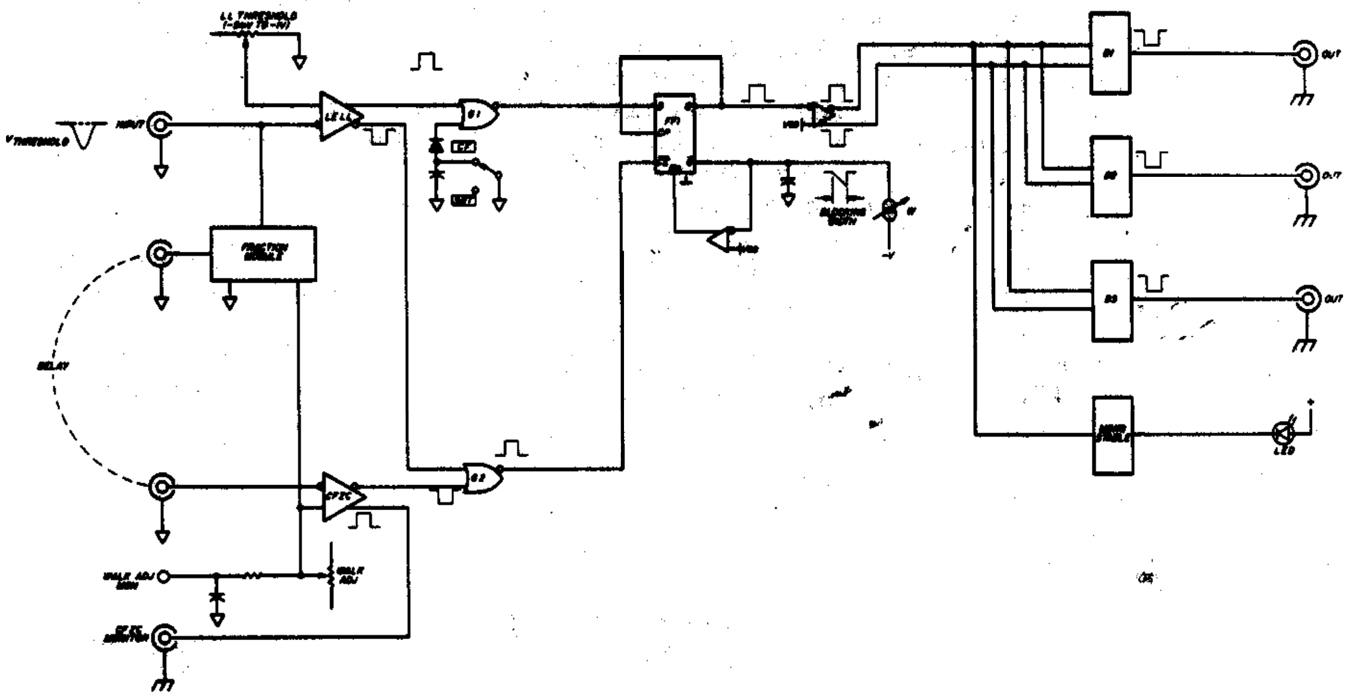


Figure 5.1 Simplified Block Diagram

An 'input in the range of 0 to -2.5V starts at time zero and is simultaneously applied to the leading 'edge lower level' (LELL) discriminator and the, constant fraction circuitry. The LELL discriminator has a threshold range from -5 mV to -1.0V. If the input signal exceeds the threshold, the comparator produces a logic pulse which arms the constant fraction zero crossing gate (G2). Note that in the CF mode G1 is armed regardless of the state of the lower level comparator. For the signal to be processed in the SRT mode, G1 must be armed by the LELL comparator before G2 generates an output pulse.

The signal applied to the constant fraction circuitry is attenuated and promptly applied to the constant fraction zero crossing (CFZC) comparator. The remaining portion of the signal is delayed (delay determined by external delay cable plus 0.3 nsec internal delay) and applied to the inverting terminal of the CFZC comparator. The CFZC comparator produces an output pulse when the two inputs are equal (internal sum of zero). This logic pulse is applied to G2 which must be armed to generate a response.

The logic pulse generated by G2 is applied to a fast one-shot consisting of an ECL D type master-slave flip flop (FF1). FF1 produces a fixed-width pulse set by the blocking-width-charging current. FF1 will not accept another input until the blocking-width output resets FF1 RD to the high state. At that time FF1 is reset and is prepared to accept new pulses.

The Q output of FF1 is routed to an ECL line receiver. The output from the ECL line receiver is used to drive the three current switches that generate the NIM negative logic signals. The front-panel indicator LED is driven by a monostable which is triggered from the ECL line receiver output.

6.0 TYPICAL APPLICATIONS

6.1 GENERAL

The TC 455 is a versatile instrument in that it can be used with very fast signals such as those generated by photomultipliers, channeltrons and thin, silicon charged-particle detectors. Additionally, the TC 455 can be used with system's which have a wide range, of charge collection times, typical of which are intrinsic Ge systems in which the timing signal has a risetime varying from a few tens to several hundred nanoseconds. The versatility is further enhanced by allowing the user to select the fraction used to generate the constant fraction zero crossing. Two typical applications are described in the Sections 6.2 and 6.3.

6.2 TIMING WITH SCINTILLATORS

A typical fast-timing coincidence system is shown in Figure 6.1. The TC 455 is used as the time mark generator in each channel. These time marks are used as the start and stop inputs to the time-to-amplitude converter (TAC). A separate energy channel is associated with each detector and consists of a preamplifier, a shaping amplifier and a single-channel analyzer (SCA). The range of energies for which timing information is processed is controlled by the SCA which strobe the TAC through a fast coincidence module. For two detected events to be processed, the events must fall into the selected energy range and into the resolving time of the fast coincidence unit. With a scintillator such as NaI(Tl), the long decay time (t_d =250 nsec) will require adjustment of the deadtime to prevent triggering on the individual photoelectron events near the trailing edge of the decaying signal.

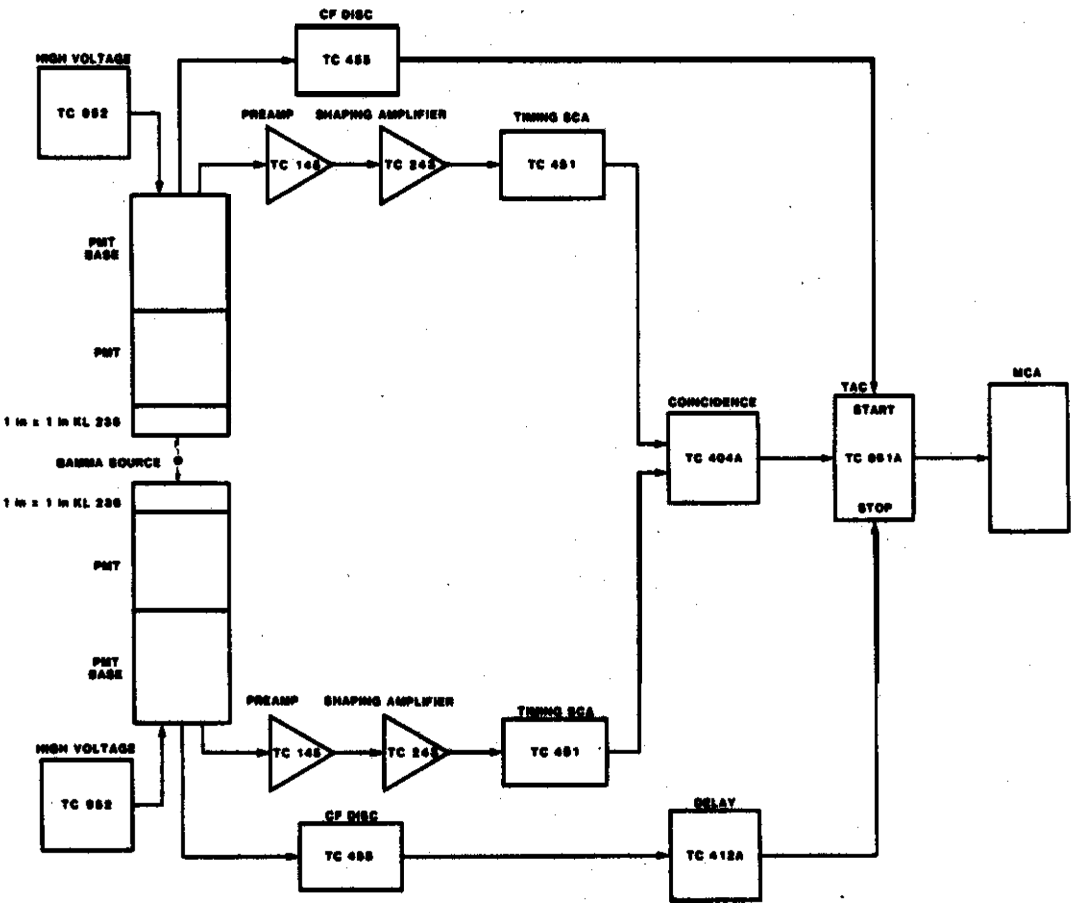


Figure 6.1 A Typical Gamma-Gamma Timing Coincidence System for Measurements with Scintillators and Photomultiplier Tubes

3.0 INSTALLATION

3.1 POWER CONNECTION

The TC 455 power requirements must be furnished from a NIM-standard bin and power supply that includes ±6V power distribution, such a8 the TENNELEC TB3/TC 911-6 Bin and Power Supply. The bin provides mechanical mounting and power supply distribution;

The TC 455 is designed so that it is not possible to overload the power supply, even with a fu-11 complement of modules in the bin. Since this may not be true when the bin contain8 modules other than-those of TENNELEC design, the power supply voltage8 should be checked after all modules have been inserted. The TENNELEC Bin and Power Supply provide8 power supplytedt points on the bin 'control panel for monitor-ing the dc voltage levels.

Calibration of the lower level threshold (T) depend8 on the -12V NIM Bin voltage. Before using the TC 455, verify that the -12V supply is properly adjusted. The bin power supply is furnished with trimming control8 for precisely setting the voltages. In TENNELEC bin supplies, all buss voltages are of instrument-grade quality (highly regulated and very stable).

3.2 CONNECTIONS

3.2.1 INPUT SIGNAL

Each discriminator channel includes an input connector on the front panel. The TC 455 input is internally terminated in SO ohms and is protected against overloads. The Tc 455 requires negative input signals and should be connected to the source of the input signals by a 50 ohm coaxial cable with a mating LEMO connector. The input, signal can be supplied to any of the four channels as the channels operate independently.

3.2.2 OUTPUT

Each discriminator channel of the TC 455 ha6 three output connectors labeled OUT. These three connectors furnish NIM-standard fast negative logic signals. The three signals are generated simultaneously but are independent of each other with regard to loading. The

6.3 TIMING WITS SOLID STATE DETECTORS

A block diagram of a typical gamma-gamma coincidence system used with a germanium detector is shown in Figure 6.2. The TAC start signal is generated by a fast plastic scintillator and the TAC stop signal is from a coaxial germanium detector. The TC 455 in the stop channel will improve the FW.1M and FW.01M resolution when operated in the SRT mode, especially if the dynamic range of energies as set by the SCA is large.

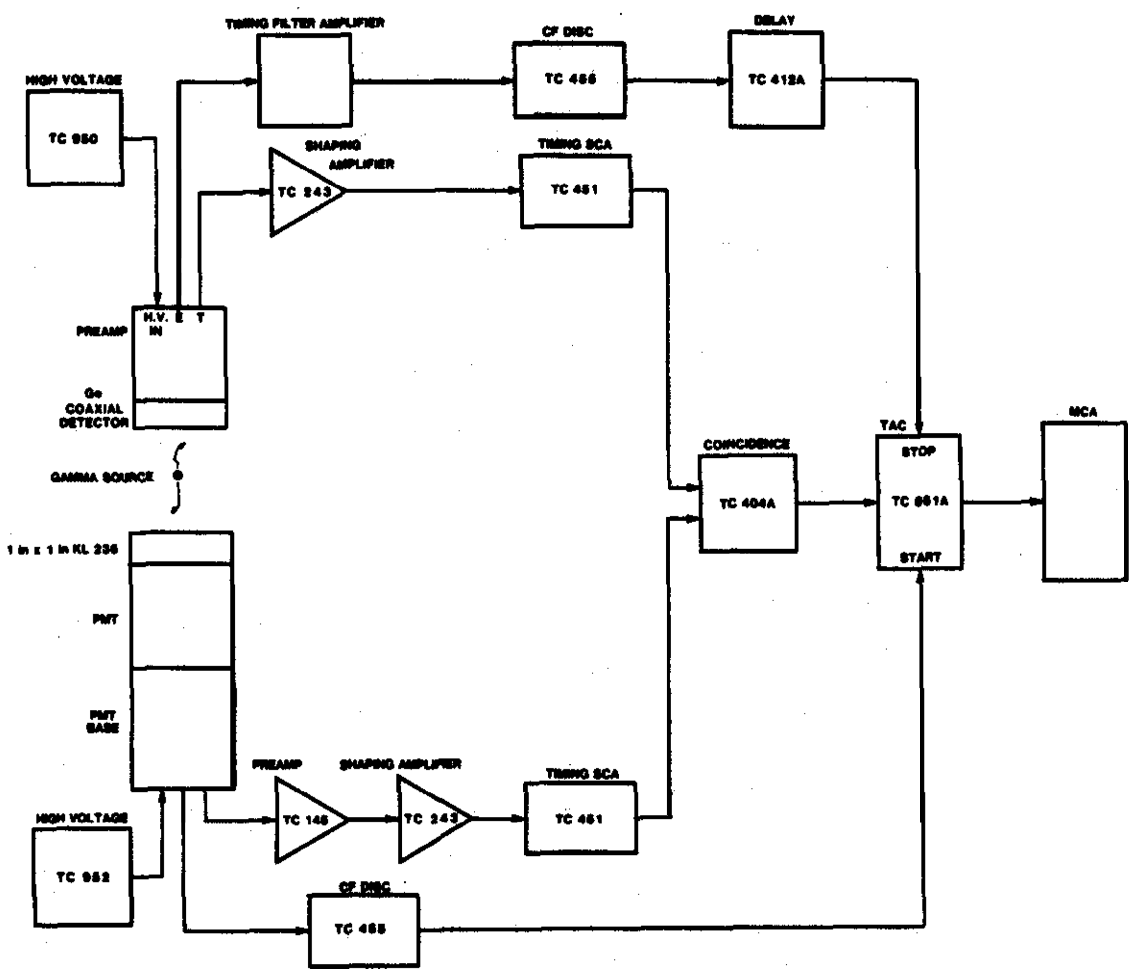


Figure 6.2 A Typical Gamma-Gamma Timing Coincidence System for Measurements with a Scintillator and a Large Ge Coaxial Detector

7.0 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 2560, Oak Ridge, Tennessee 37830-2560. 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.

8.0 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.

9.0 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 send replacement parts which will enable you to get the instrument operating sooner and at less expense than if you returned 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 37830-2560. As stated in the warranty DAMAGE IN TRANSIT WILL BE REPAIRED AT THE SENDER’s EXPENSE as will damage that obviously resulted from abuse or misuse of the instrument.

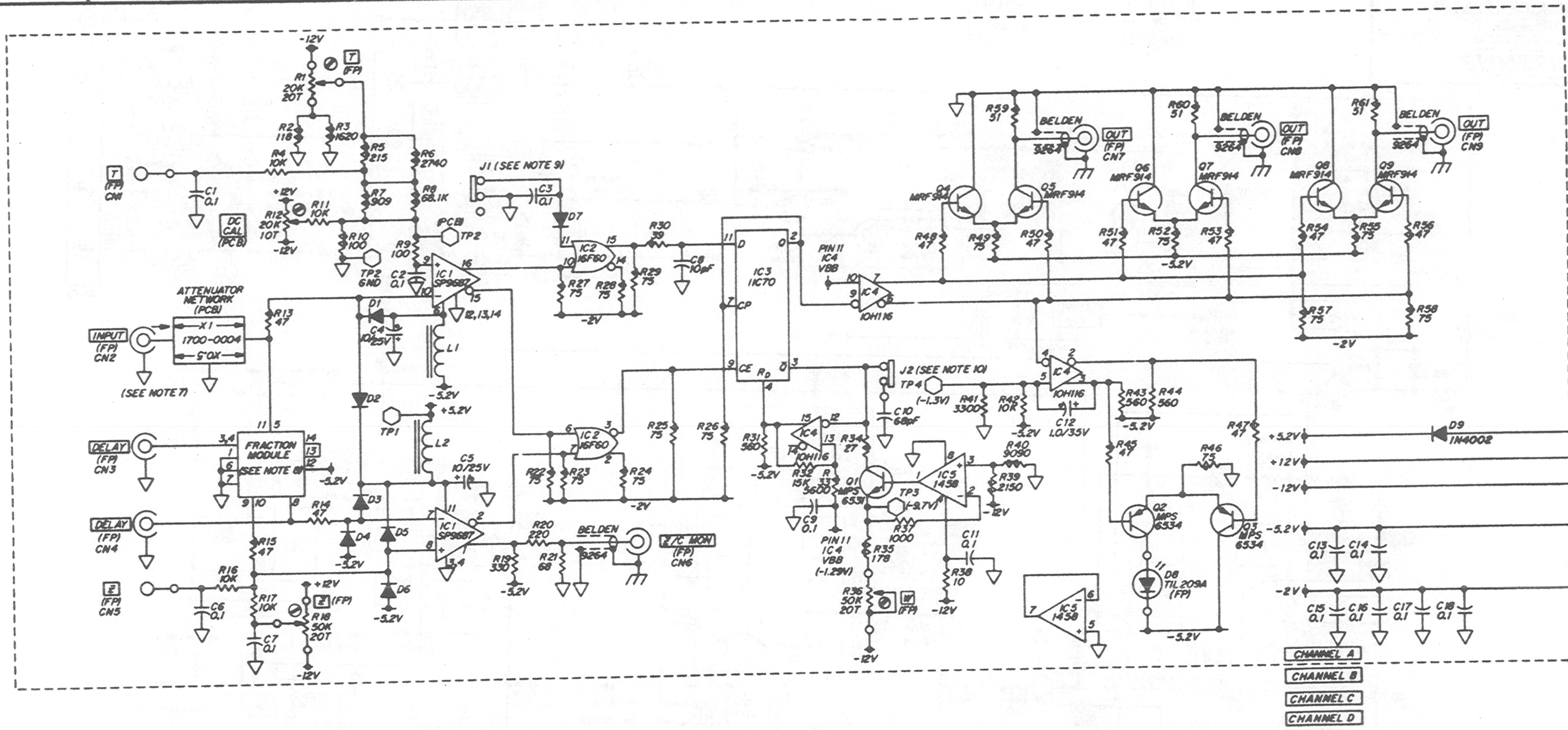
Quotations for repair of such damage will be sent for your approval before repair is undertaken.

TENNELEC'S Quality Assurance Program requires that each and every instrument 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 Service Department of TENNELEC. Both model number and Serial number are required.

MANUAL REV. 0

8/83 - Engineering and component improvements may be made after date of printing,



NOTES:

1) ALL RESISTORS ARE IN OHMS UNLESS OTHERWISE NOTED
2) ALL RESISTORS ARE ¼ WATT 5% D.C UNLESS OTHERWISE NOTED:
   - • ⅛ W 5% CARBON COMP.
   - •• ¼ W 1% METAL FILM
   - ••• 2 W 5% WIRE WOUND
3) ALL CAPACITORS ARE IN MICROFARADS UNLESS OTHERWISE NOTED.
4) ALL CAPACITORS ARE CERAMIC UNLESS OTHERWISE NOTED:
   - • TANTALUM
   - •• ALUMINIUM ELECTROLYTIC
5) ALL DIODES ARE 1N4154 UNLESS OTHERWISE NOTED.
6) ⬡ DENOTES TEST POINT.
7) THE ATTENUATOR MODULE, 1700-0004, SELECTS THE INPUT VOLTAGE RANGE.
   X1 POSITION 0 ⟶ −2.5V NOMINAL, −5.0V MAXIMUM.
   X0.5 POSITION 0 ⟶ −5.0V NOMINAL, −10.0V MAXIMUM.
   FOR FURTHER INFORMATION, SEE MANUAL.
8) THE FRACTION MODULE IS REMOVABLE, ALLOWING SELECTION OF VARIOUS FRACTIONS. THE TC 455 IS SUPPLIED WITH 0.2 FRACTION MODULE (P/N 1700-0032) AS STANDARD. FOR FURTHER INFORMATION, SEE MANUAL.
9) THIS JUMPER SELECTS EITHER THE CF OR SRT MODE.
   UPPER POSITION IS CF.
   LOWER POSITION IS SRT.
10) THIS JUMPER SELECTS BLOCKING WIDTH RANGE. UPPER POSITION IS FROM <10nsec TO >500nsec.
   LOWER POSITION IS FROM <4.5nsec TO >100nsec.
11) COMPONENT DESIGNATORS LESS THAN 100 ARE REPEATED FOR EACH CHANNEL. (THE TC 455 HAS 4 CHANNELS).
12) COMPONENT DESIGNATORS GREATER THAN 100 ARE INDEPENDENT OF EACH CHANNEL.

IC NUMBER	POWER PINS		
	+5.2V	GND	-5.2V
IC 1	11	3, 14	6
IC 2,3,4		1, 16	8

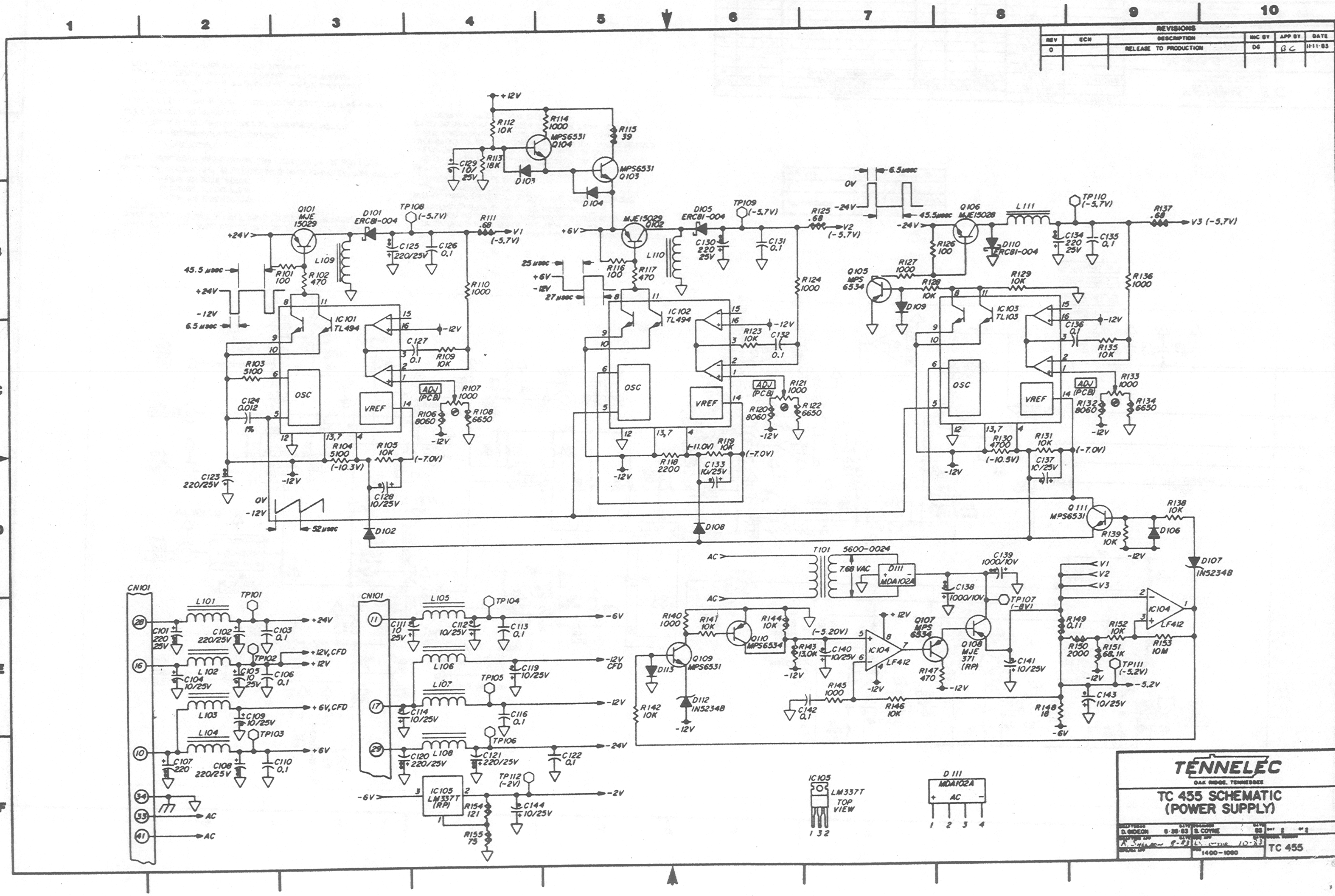
REVISIONS					
REV	ECN NO.	DESCRIPTION	INC. BY	APP. BY	DATE
0		RELEASE TO PRODUCTION	DG		11-11-83

LAST USED	NOT USED
R61,155	C 115,117,118
C18,144	
IC5,105	
Q9,111	
D9,113	
L2,111	
T101	
TP4,111	

TENNELEC
OAK RIDGE, TENNESSEE

TC 455 SCHEMATIC (CFD)

D. EDSELL / D. GIDEON | S. COYNE | 1 of 2
1400-1060
TC 455


REVISIONS
REV | ECN | DESCRIPTION | INC BY | APP BY | DATE
0 | | RELEASE TO PRODUCTION | DG | BC | 11-11-83
TENNELEC
OAK RIDGE, TENNESSEE
TC 455 SCHEMATIC
(POWER SUPPLY)
D. GIDEON
6-28-83
B. COYNE
1400-1080
TC 455
IC101 TL494
IC102 TL494
IC103 TL103
IC104 LF412
IC105 LM337T (RP)
T101 5600-0024
7.68 VAC
D111 MDA102A
Q101 MJE 15029
Q102 MJE15029
Q103 MPS6531
Q104 MPS6531
Q105 MPS 6534
Q106 MJE15028
Q107 MPS 6534
Q108 MJE 371 (RP)
Q109 MPS6531
Q110 MPS6534
Q111 MPS6531
D101 ERC81-004
D105 ERC81-004
D110 ERC81-004
D107 1N5234B
D112 1N5234B
V1 (-5.7V)
V2 (-5.7V)
V3 (-5.7V)
CN101
LM337T TOP VIEW
D111 MDA102A