INSTRUCTION MANUAL

TC 248 FAST/SLOW AMPLIFIER

WARRANTY

TENNELBC, INC. warrants that the products or components manufactured by it shall be free from defects in material or workmanship for a period of two years 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 sucn 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.

TBNNELEC 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.

* * * * * CAUTION * * * * *

The PREAMP connector on this instrument is directly compatible only with TENNELEC preamplifiers with serial numbers greater than 2000. It is also directly compatible with standard Aptec, Canberra, EG&G Ortec and PGT preamplifiers.

If a TENNELEC preamplifier with serial number less than 2000 is used, then a model ADT 1 PREAWP POWER ADAPTER must be used.

If there are any questions regarding the compatibility of the PREAMP connector of this instrument, please contact the TRNNELEC Warketing Department for assistance.

* * * * * * * * * WARNING * * * * * * * * * *

Improper connection to the PREAMP connector may permanently damage the amplifier and/or preamplifier. TENNELEC assumes no liability for such instrument damage.

* *

TABLE OF CONTENTS

TABLE OF CONTENTS

TABLE OF FIGURES

1.0 INTROWCTION

The TENNELEC Node1 TC 246 'combines a high perf ormance spectroscopy (SLOW) amplifier with a general purpose timing (FAST) amplifier in a single-width NIM module. The FAST/SLOW AHPLIFIER is ideally suited for applications which require both timing and energy information from the detector: signals.

The SLOW AMPLIFIER incorporates a five-pole (two complex-con jugate-pair and one real) active filter network to generate a near-gaussian shaped unipolar pulse which optimizes the signal-to-noise ratio while allowing excellent count rate capability. Switch-selectable peaking times of 1, 3 and 6 usec allows the TC 248 spectroscopy amplifier to be matched to the signal processing requirements of most detectors.

A gated baseline restorer (BLR) with automatic threshold and restorer rate circuits provides superb high count rate performance without degrading ultimate resolution.

The excellent dc stability of the TC 248 spectroscopy amplifier eliminates spectrum broadening caused by dc shift of the amplifier output.

A unipolar delay option allows the slow unipolar output to be delayed 2 usec for gating applications. A convenient slide-switch allows a normal (prompt) unipolar output when the delay is not required.

The FAST AMPLIFIER incorporates. CR-RC shaping to produce a high initial slope unipolar pulse for accurate timing measurements at low constant f ractions. Independent differentiator and integrator time constant switches allow the pulse decay time and risetime to be custom-tailored to the experiment.,

2.0 SPECIFICATIONS

2.1 PERFORMANCE

2.1.1 SPECTROSCOPY AMPLIFIER

PULSE SHAPING Active shaping networks produce pseudo-gaussian shaped unipolar pulses with selectable peaking times* (t_p) of 1, 3 or 6 usec. Unipolar pulse width at the 1.0% level eguals 2.8 t_p. Bipolar pulse peaks* at 0.78 t_p and crossover* occurs at 1.36 t_p. Bipolar crossover is delayed by 0.32 t_p from the prompt unipolar peak.;

GAIN RANGE Continuously variable f rom x5 to x750.

INTEGRAL NONLINEARITY $\leq$ ±0.05% over 0 to +10V output range for 3 usec peaking time.

NOISB Less than, 3.0 uV rms referred to the input for 6 usec peaking time, unipolar shaping and maximum gain; typically less than 3.2 uV rms for gain greater than 100. Bipolar typically less than 5.0 uV rms for gain greater than 100.

TEMPERATURE INSTABILITY

UNIPOLAR

Gain	$\leq$ ±0.01%/°C, 0 to 50°C
DC Level	$\leq$ ±10 uV/°C, 0 to 50°C

BIPOLAR

Gain	$\leq$ ±0.01%/°C, 0 to 5ooc
UC Level	$\leq$ ±30 uV/°C, 0 to 50°C

WALK $\leq$ ±3 nsec over a 50:1 dynamic range for 3 usec peaking time.

OVERLOAD RECOVERY Unipolar output recovers to within 2% of rated output f rom x300 overload in less than 2.5 non-overloaded pulse widths at maximum gain. Bipolar output recovers to within 2% of rated output from x300 overload in less than 2.0 non-overloaded pulse widths at maximum gain.

*Measured from the leading 1.0% ‘of maximum signal amplitude.

SPECTRUM BROADENING (Unipolar)** Typically less than 10% FWHM for a ^{60}Co 1.33 MeV gamma line at 85% of rated output, 3 usec peaking time and incoming rate of 1 to 100 kcps.

SPECTRUB SHIFT (Unipolar)** Peak position 'shifts typically less than 0.02% for a ^{60}Co 1.33 MeV gamma line at 85% of rated output, 3 usec peaking time and incoming rate of 1 to 100 kcps.

2.1.2 TIRING AMPLIFIER

PULSE SHAPING CR-RC shaping networks produce high initial slope unfpolar 'pulses with independently selectable differentiation and integration time constants of 5, 10, 20, 50 and 100 nsec.

RISETIME -10 nsec with minimum integration and maximum differentiation.

GAIN RANGE Variable from 5 to 250 in a l-2.5-5 sequence.

TEMPERATURE INSTABILITY

Gain $\leq \pm 0.1\%/^{\circ}C$, 0 to 50°C

OUTPUT AMPLITUDE RANGE 0 to -5 volts linear into a 50 ohm load.

2.2 CONTROLS

2.2.1 FRONT-PANEL CONTROLS

2.2.1.1 SPECTROSCOPY MPLIFIER

COARSE GAIN Six-position rotary switch selects gain factors from 10 to 500 in a l-2-5 sequence.

FINE GAIN Ten-turn precision potentiometer with linear calibration from 500 to 1500. The dial numbers should be considered as multipliers operating on the COARSE GAIN setting, with 500 and 1500 corresponding to multipliers of 0.5 and 1.5 respectively. The FINE GAIN control extends the total gain range from 5 to 750.

**Results may not be reproducible if measurements are made with a detector which exhibits a larger number of slow-risetime signal components.

POLE-XERO (P/E) 15-turn **screwdriver adjustable** control for cancellation **of preamplifier decay** tines from 35 **usec** to **infinity.**

POS-NEG Two-position toggle switch eelects either poeitive or negative polarity preamplifier **signals** for the amplifier 'input.

BLR-P/Z **Two-position** toggle **switch** enables the **baseline** restorer in the BLR position. The P/E position **disables the baseline** restorer for accurate pole-zero cancellation adjustment.

2.2.1.2 TIWING AWPLIFIER

GAIN Six-position **rotory** switch selects gain factors **from** 5 to 250 in a l-2.5-5 **sequence.**

2.2.2 INTERNAL CONTROLS

2.2.2.1 SPECTROSCOPY AWPLIFIER

PEAKING TIME **Four** individual **three-position** elide switches (accessible through the **side** shield) relectr unipolar peaking **time of 1,** 3 or 6 **usec.** Bipolar **peaking** time equals 0.78 of selected unipolar peaking **time.**

> NOTE: All four PEAKING TIME ewitches MUST be eet to the **same** position for proper operation of the amplifier.

UNIPOLAR DELAY OPTION **When installed,** a two-position slide **switch** (accessible **through** tbe side shield) select8 either prompt (OUT) or a 2 **usec** delay (IN) for the unipolar output. **The bipolar** output **is** unaffected by the unipolar delay **selection.**

OUTPUT **IMPEDANCE Individual two-position** slide **switches (accessible through the side** shield) **selects an output impedance of either <1 ohm or 50** ohms for the **UNIPOLAR** and **BIPOLAR outputs.** The **total peak** output current **is limited to 50 mA, for either** the UNIPOLAR and BIPOLAR **outputs, when** operated in the **<1** ohm position. **All outputs** are **short** circuit protected in either OUTPUT **IMPEDANCE position.**

2.2.2.2 **TIMING AMPLIFIER**

INPUT POLARITY Two-position slide switch (accessible through the side shield) selects either positiveor negative input polarity for the timing amplifier.

DIPPERENTIATOR TIME CONSTANT Four individual two-position slide switches (accessible through the side shield) select differentiator time constants of 10, 20, 50 and 100 nsec. Switches may be used in combination to provide intermediate values, i.e., 50 and 100 nsec IN to provide a 150 nsec time constant. All switches OUT provide a 5 nsec time constant.

INTEGRATOR TIME CONSTANT Four individual two-position slide switches (accessible through the side shield) select integrator time constants of 10, 20, 50 and 100 nsec. Switches may be used in combination to provide intermediate values, i.e., 50 and 100 nsec IN to provide a 150 nsec time constant. All switches OUT provides a 5 nsec time constant. The risetime is approximately 2.2 times the selected time constant.

2.3 CONNECTORS

2.3.1 FRONT-PANEL CONNECTORS

2.3.1.1 COMMON

INPUT BNC connector accepts either positive or negative polarity input signals which are applied to both the spectroscopy and timing amplifiers. The input signal risetimes should be less than the selected timing channel integrator time 'constant and the decay time should be within the range of 35 usec to infinity. The input impedance is 50 ohms dc-coupled, and the input is protected to f3.5 volts dc absolute maximum.

2.3.1.2 SPECTROSCOPY ANPLIFIER

UNIPOLAR BNC connector provides ,&-restored (0 ±5 mV) unipolar shaped output pulses with' a full-scale range of 0 to +10V (+11.5V maximum). The UNIPOLAR OUTPUT IMPEDANCE switch selects an output impedance of either <1 ohm or 50 ohms for both front- and rear-panel UNIPOLAR output' connectors. The total peak output current is limited to 50 mA in the <1 ohm position. Both UNIPOLAR connector,6 are short circuit protected in either UNIWLAR OUTPUT IWPEDANCE position.

BIPOLAR BNC connector provides ground referenced (0 ±10 mV) bipolar shaped output pulses with a full-scale range of 0 to +10V (+11.5V maximum). The BIPOLAR OUTPUT IMPEDANCE switch selects an output impedance of either <1 ohm or 50 ohms 'for both front- and rear-panel BIPOLAR output connectors. The total peak output current is limitedto 50 mA in the <1 ohm position. Both BIPOLAR connectors are short circuit protected in either BIPOLAR OUTPUT IMPEDANCE position.

2.3.1.3 TIMING AMPLIFIER

OUTPUT Lemo type connector provides shaped timing output pulses with a full-scale linear range of 0 to -5 volts (-7 volts maximum) when terminated into a, 50 ohm load. Risetime and decay time selected by the INTEGRATOR and DIFFERENTIATOR switch settings.

2.3.2 REAR-PANEL CONNECTORS

2.3.2.1 COMMON

INPUT Refer to INPUT of Sec. 2.3.1.1.

PREAMP A O-pin Amphenol 17-10090 type connector accepts signals from TENNELEC preamplif iers and provides power to TENNELEC or other commercially available preamplif iers.

• * • • CAUTION • • • • *

The PREAMP connector on this instrument is directlycompitible only with TENNELEC preamplif iers with serial numbers greater than 2000. It is also directly compatible with standard Aptec, [illegible] EGCG Ortec and FGT preamplifiers.

If a TENNELEC preamplifier. with serial number less than 2000 is used, then a model ADT 1 PREAMP POWER ADAPTER must be used (See Sec. 3.2.1).

If there are any. quttions regarding the compatibility of the PREAMP connector of this instrument, please contact the TBNNELEC Marketing Department for assistance.

WARNING

Improper connection to the **PREAMP** connector may permanently **damage the** amplifier and/or preamplifier. **TENNELEC assumes** no **liability for** such instrument damage.

PREAMPLIFIER PIN ASSIGNMENT

PIN	DBSCRIPTION
1	**POWER GND**
2	SIGNAL GRD
3	**PREAMP** OUT
4	**+12V**
5	TEST
6	**-24V**
7	**+24V**
8	**PHANTOM**
9	**-12V**

2.3.2.2 SPECTROSCOPY **AMPLIFIER**

UNIPULAR Refer to **UNIPOLAR of** Sec. **2.3.1.2.**

BIPOLAR **Refer** to **BIPOLAR of** Sec. 2.3.1.2.

2.4 POWER **REQUIREMENTS** (excluding preamplifier)

+24V, 45 **mA; +12V,** 135 **mA**
-24V, 45 **mA; -12V,** 115 **mA**

2.5 **OTHER INFORMATION**

OPERATING **TEMPERATURE 0 to 50°C**

WEIGHT	**Shipping**	**5.0 lbs (2.3 kg)**
	(Net)	**2.5 lbs (1.2 kg)**

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

INSTRUCTION **MANUAL** One provided with each instrument ordered.

WARRANTY One year.

3.9 INSTALLATION

3.1 POWER CONNECTION

The TC 248 FAST/SLOW, AMPLIFIER requires a NIM-standard bin and power supply, such as the TENNELEC TB3/TC 911, for operation. The bin provides mechanical mounting and power supply distribution. Always turn OFF the bin power supply when inserting or removing any modules.

All TENNELEC NIM modules are designed sothatit is not poesible to overload the power supply, even with a full complement of modules in the bin. Since this maynotbe true when the bin contains modules other than those of TENNELEC design, the power euppl voltages should be checked after all modules have been inserted. The TENNELEC Bin and Power Supply provides power supply test points on the bin control panel for monitoring the dc voltage levels.

3.2 PREABPLIFIER CONNECTION

3.2.1 ORIGINAL TENNELEC PREAMPLIFIERS (Serial Number <2000)

The PREAMP connector of this amplifier is NOT direclvYccompatiblewith TENNELEC preamplifiers with serial numbers less than 2000. An optional model ADT 1 PREAMP POWER ADAPTER is required.

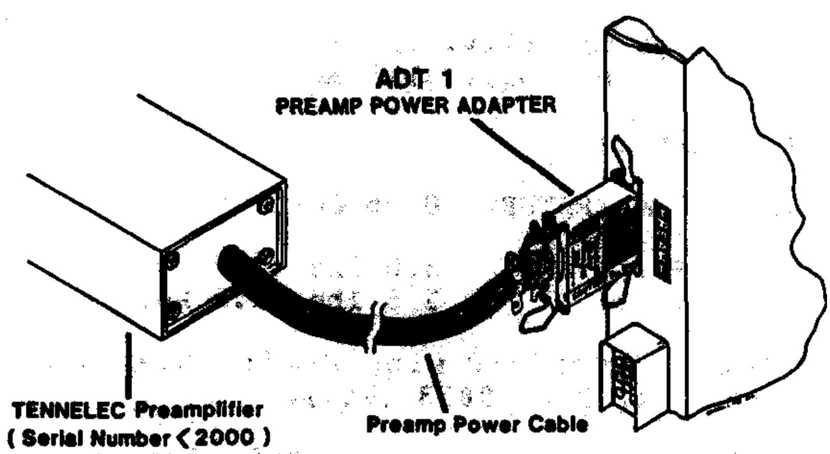


Fig. 3.1 Original TENNELEC Preamplifier Power Connections

The ADT 1 PREAUP POWER ADAPTER should be physically mounted to the amplifier's rear-panel PREAMP connector (See Fig. 3.1).

The.' preamplifier's power cable is then connected to the ADT 1 adapter. As with the original TENNELEC configuration, the preamplifier's output signal is present in the power cable and no external BNC cable is required from the preamplifier's output to the amplifier's input. The amplifier's front-panel PDS-NEG switch should be set to match the preamplifier's output signal polarity.,

3.2.2 TRNNELBC PREAMPLIFIERS (Serial Number >2000)

The PREAMP connector of this amplifier is directly compatible with TENNELEC preamplifiers with serial numbers greater than 2000.

The preamplifier's power cable is directly connected to the amplifier's PREAMP connector. The preamplifier's output signal is present in the power cable and no external BNC cable is required from the preamplifier's output to the amplifier's input. The amplifier's front- panel PGS-NEG switch should be set to match the preamplifier's output signal polarity.

3.2.3 OTHER PRBAWPLIFIERS

'The PREAMP connector of this amplifier is directly compatible with standard Aptec, Canberra, EG&G Ortec and PGT preamplifiers.

The preamplifier's power cable is directly connected to the amplifier's PREAMP connector. The, preamplifier's output signal should be connected to the hmplifier's rear-panel INPUT connector with a BNC cable. The BNC cable should be' spirally wrapped with the preamp power cable to reduce noise pickup.,,

3.2.4 GENERAL PRECAUTIONS

When an external BNC cable longer 'than. ten feet is used to'connect the preamplifier output to the amplifier input, tbe characteristic impedance of the cable should match the impedance of the preamplifier output. All TEWNELEC preamplif iers contain 50 ohm series termination, therefore 50 ohm RG-58' cable is recommenced.

To minimize electrical noise pickup when external BNC signal and/or high voltage cables are connected between the preamplifier and NIM bin (containing the amplifier and high voltage. power supply), the cable lengths should 'match the preamp power cable length and be spirally wrapped with the preamp power cable.

3.2.5 RICE VOLTAGE DETECTOR BIAS

It is recommended; that the detector high-voltage power supply be mounted in the same NIM bin as tha amplifier to reduce ground,-loop noise pickup. The high-voltage cable between the H.V. supply and the preamplif ier should be spirally wrapped with the, preamp power 'cable.

4.0 OPERATING PROCEDURES

4.1 FIRST-TIN% OPERATIONS

Users will find. it helpful to familiarize themeelves with the TC 248 FAST/SLOW AMPLIFIER by conducting .a few simple tests.

4.1.1 EQUIPMENT REQUIRED

1. NIM Bin and Power Supply (TENNELEC TB3/TC 911 or equivalent).
2. Precision Tail Pulser (TENNELEC TC 812 or equivalent).
3. Oscilloscope (TEKTRONIX 465 or eguivalent) .
4. Digital Multimeter (FLUKE 8010A or eguivalent).
5. Shielded 50 ohm cables with BNC connectors.
6. BNC tee and 50 ohm terminator.
7. BNC to Lemo Adapter.

4.1.2 **TEST** SYSTEM SETUP

Set thh TC 240 **controls • e follows, then insert into the NIM bin such that** the **internal controls** are **accessible.**

COARSE GAIN	20
PINE GAIN	1.00
P/Z	Fully CCW
POS-NEG	POS
BLR-P/Z	P/Z
TIMING AMP GAIN	10
PEAKING TIME (PCB)	3 usec
UNIPOLAR DELAY (PCB)	OUT
TIMING AMP INPUT POLARITY (PCB)	POS
TIMING AMP DIFFERENTIATOR (PCB)	100 nsec
TIMING AMP INTEGRATOR (PCB)	100 nsec

Set the **Tail Pulser controls as follows:**

PULSE HEIGHT	10.0
RELAY	OFF
POL	+
DIRECT OUT/EXT IN	DIRECT OUT
OUTPUT	5V
ATTENUATION	10

Set the Oscilloscope controls as follows:

CH A VERT SENS	5 Volts/Div (dc-coupled)
CH B VERT SENS	5 Volts/Div (dc-coupled)
VERT DISPLAY MODE	CH A
HORIZ SWEEP	2 usec/Div
TRIGGERING	POS EXTERNAL

Connect the DIRECT **OUTPUT of the TC** 812 to the EXTERNAL TRIGGER **INPUT** of the orcflloecope with a BNC cable. Connect a BNC **cablebetween the** TC 812 **OUTPUT** and the **INPUT of the TC 248 amplifier.**

4.1.3 **TEST SYSTEM** OPERATION

Apply power **to the NIM bin and set** the Digital **Multimeter (DMM)** for 200 **mV** dc **full-scale.** Connect the **DMM's negative lead** to the **GND (ground)** teet point of **the NIM bin.** Touch **the DM"s positive lead to** the center **pin of** the **TC 248's UNIPOLAR** conhector; the DMM ehould **indicate** 0 **±5 mV. Repeat** tot **BIPOLAR connector;** the **DMM** ehouldindicate **0 ±10 mV.**

Connect BNC cables from the UNIPOLAR and BIPOLAR output6 af the TC 248 to the Channel A and Channel B vertical inputs, respectively, of, the, oscilloscope. Turn the RELAY power of the TC 812 to the ON position and adjust the oscilloscope trigger control for a stable display. Adjust the TC 248 P/Z control for proper compensation (refer to Sec. 4.2). Return the oscilloscope vertical and horizontal controls to their initial settings. Switch the oscilloscope to the alternate display mode. Positive unipolar '-and bipolar shaped pulses should be present (See Pig. 4.1). Note the time relationship of the unipolar peak to both the bipolar peak and bipolar zero-crossing. Switch the TC 248 BLR-P/Z control to the BLR position; the unipolar signal should not change.

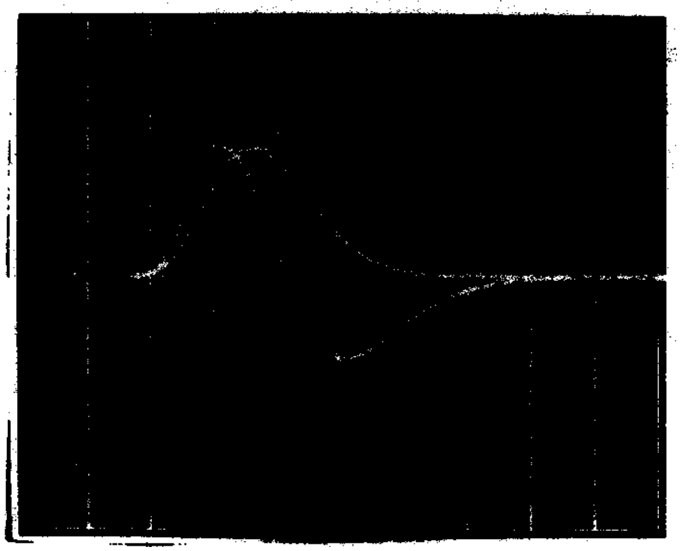


Fig. 4.1 TC 248 Slow Linear Output Pulse Shapes

For instruments with the UNIPOLAR DELAY OPTION, position the unipolar signal peak around "the, center vertical graticule line. "Switch the UNIPOLAR DELAY control to the IN position. Note that the unipolar signal is delayed by 2 usec, while the bipolar signal remains prompt,: Return the UNIPOLAR DELAY control to the OUT position.

Change all four of the TC 248 PEAKING TIME switches to the 6 usec position. The unipolar signal should now peak at 6 usec. .

Reduce the TC 248's COARSE GAIN to 10. The maximum amplitude of both the unipolar and bipolar signals should decrease to 5.0 volts. Increase the TC 248's FINE GAIN control to 1.500 (fully CW). The maximum amplitude of both signals should increase to 7.5 volts.

Remove both cables between the amplifier's outputs and the oscilloscope's inputs. Place a BNC tee on the CH B input of the oscilloscope and connect a 50 ohm terminator on one side of the tee. Connect a BNC cable to the remaining side of the BNC tee. Attach a BNC-to-Lemo adapter to the remaining end of the BNC cable and connect to the TC 248 TIMING AMP OUTPUT.

Set the Oscilloscope controls as follows:

CR B VERT SENS	0.5 Volt/Div (dc-coupled)
VRRT DISPLAY MODE	CH B
HORIZ SWEEP	0.2 usec/Div
TRIGGERING	POS EXTERNAL

Negative 2.0 volt fast-shaped pulses should be present (See Fig. 4.2). Reduce the TC 248's TIRING AWPGAIN to 5. The maximum amplitude of the timing signal should decrease to 1.0 volts.

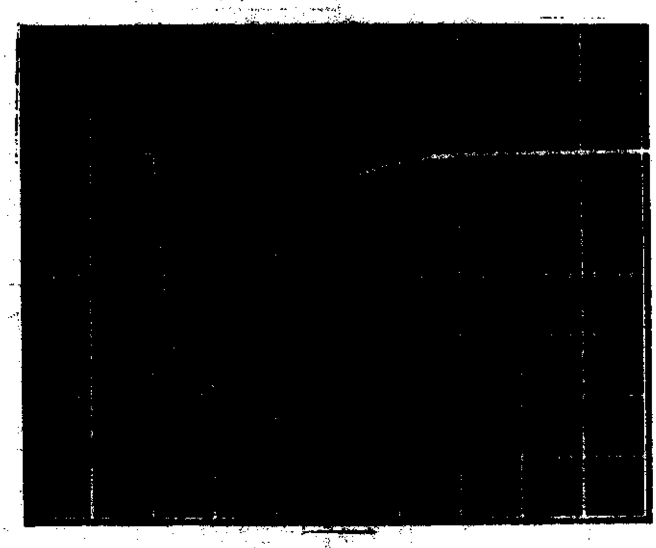


Fig. 4.2 TC 248 Fast Timing Output Pulee Shape

4.2 POLE-ZERO (P/Z) CANCELLATION

Accurate, setting of the' P/Z control is essential for good resolution at high count rates in unipolar operatfon and for correct operation of the BLR circuit. With bipolar operation, accurate setting is not important regarding resolution, but is important if quick recovery'- from heavily overloading signals is required. The adjustment procedure is as follows:

Using a detector, and a radioactive source as an input, observe the UNIPOLAR output signals of -the amplif ier on an oscilloscope with a triggered sweep. The oscilloscope MUST be dc-coupled to the amplifier.

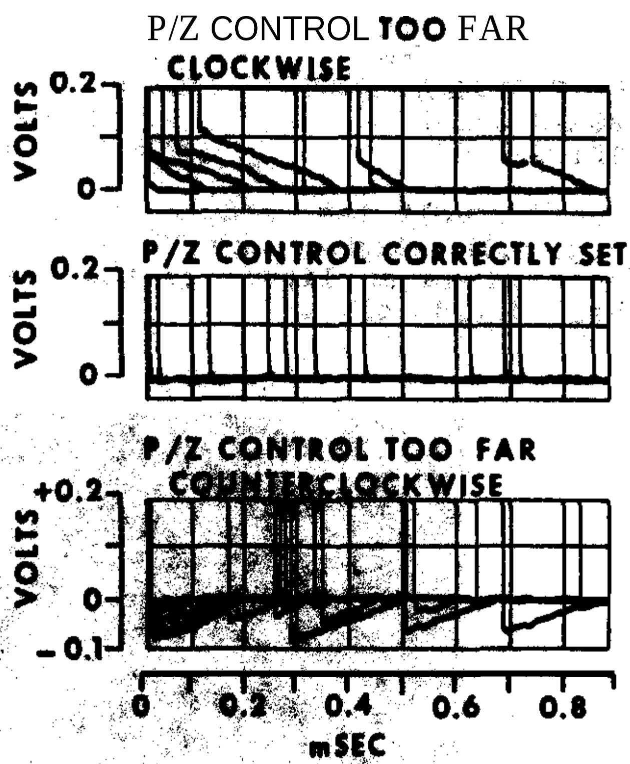


Fig. 4.3 P/Z Control Adjustment

Adjust the amplifier gain so that the highest energy peak produces an amplifier output of approximately 9 volts. Adjust the source strength and/or spacing from detector to provide a count rate between 2,000 and 10,000 cpe. Increase the oscilloscope vertical sensitivity to 100 mV/Div.

Compensation is accomplished by turning the P/2 control for flattest possible baseline (See Fig. 4.3).

A second method of setting the control is to increase the sweep speed 80 that the pulse duration occupies approximately 2 cm of sweep. Then; looking at the baeeline (which will be fuzzy) about one pulse width from the end of the pulse, adjust the P/K control for minimum baseline smear.

NOTE: Oscilloscopes such as the TBKTRONIX Model 465 and 475 will overload with a 10 volt input signal when the vertical sensitivity is eet for 100 mV/Div or less. The Resistor Bridge/Diode Limiter shown in Fig. 4.4 is recommended to prevent overloading the oscilloscope (this bridge/limiter is also used for amplifier linearity measurement),,, The FROM GENERATOR OUTPUT ‘connector is not uied when connected as an oscilloscope overload limiter.

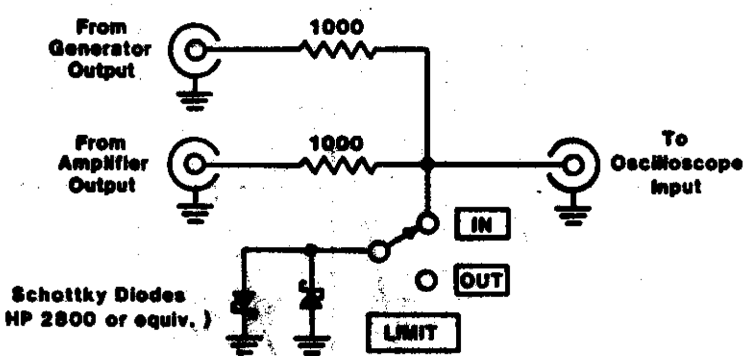


Fig. 4.4 Resistor Bridge/Diode Limiter

4.3 ARPLIFIBRNOISE

The typical equivalent noise referred to the input vs amplifier gain for unipolar and: bipolar rhaping is shown in Fig. 4.5 and Fig. 4.6 respectively.

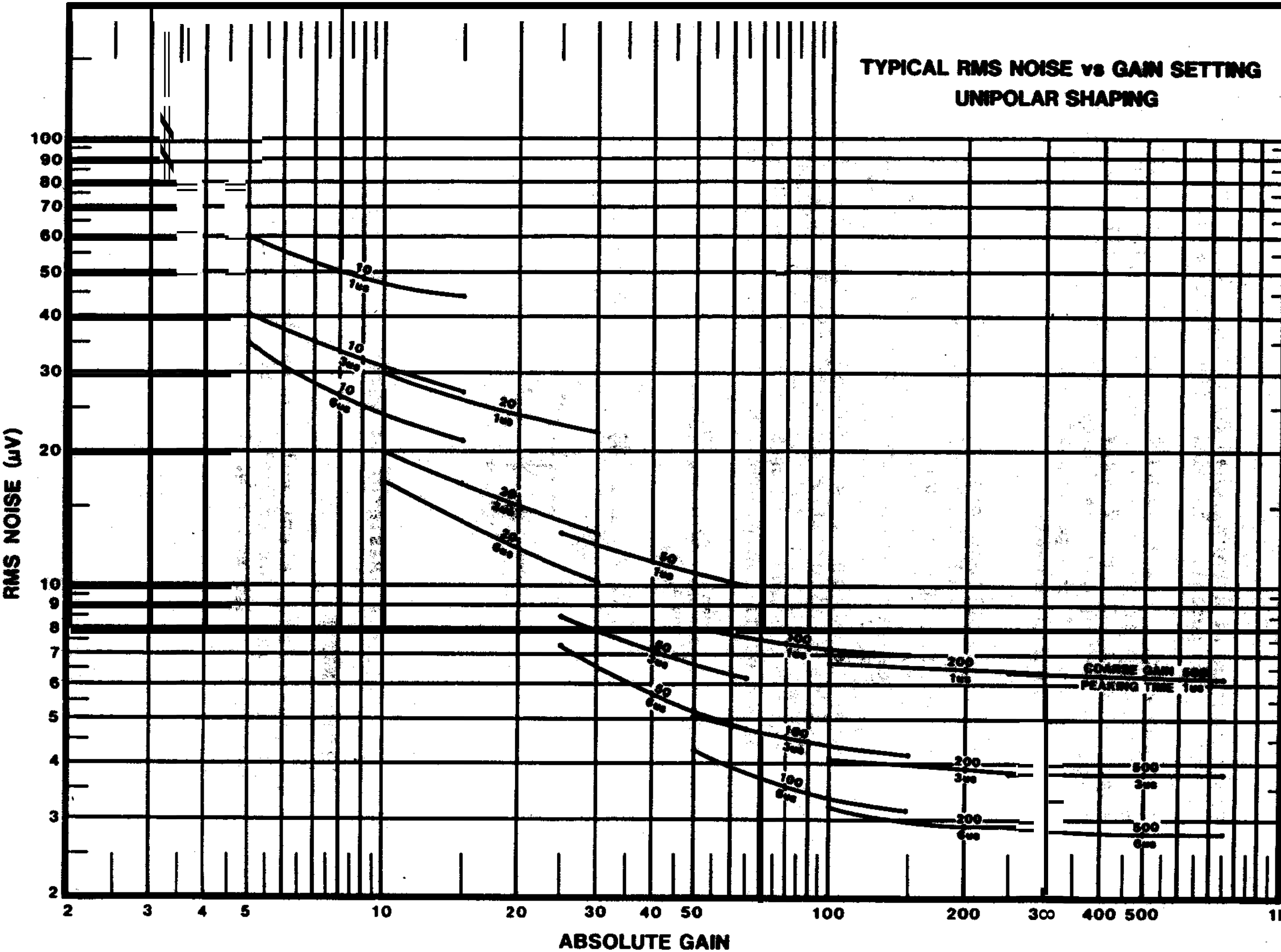


Fig. 4.5 UNIPOLAR NOISE vs GAIN and PEAKING TIME

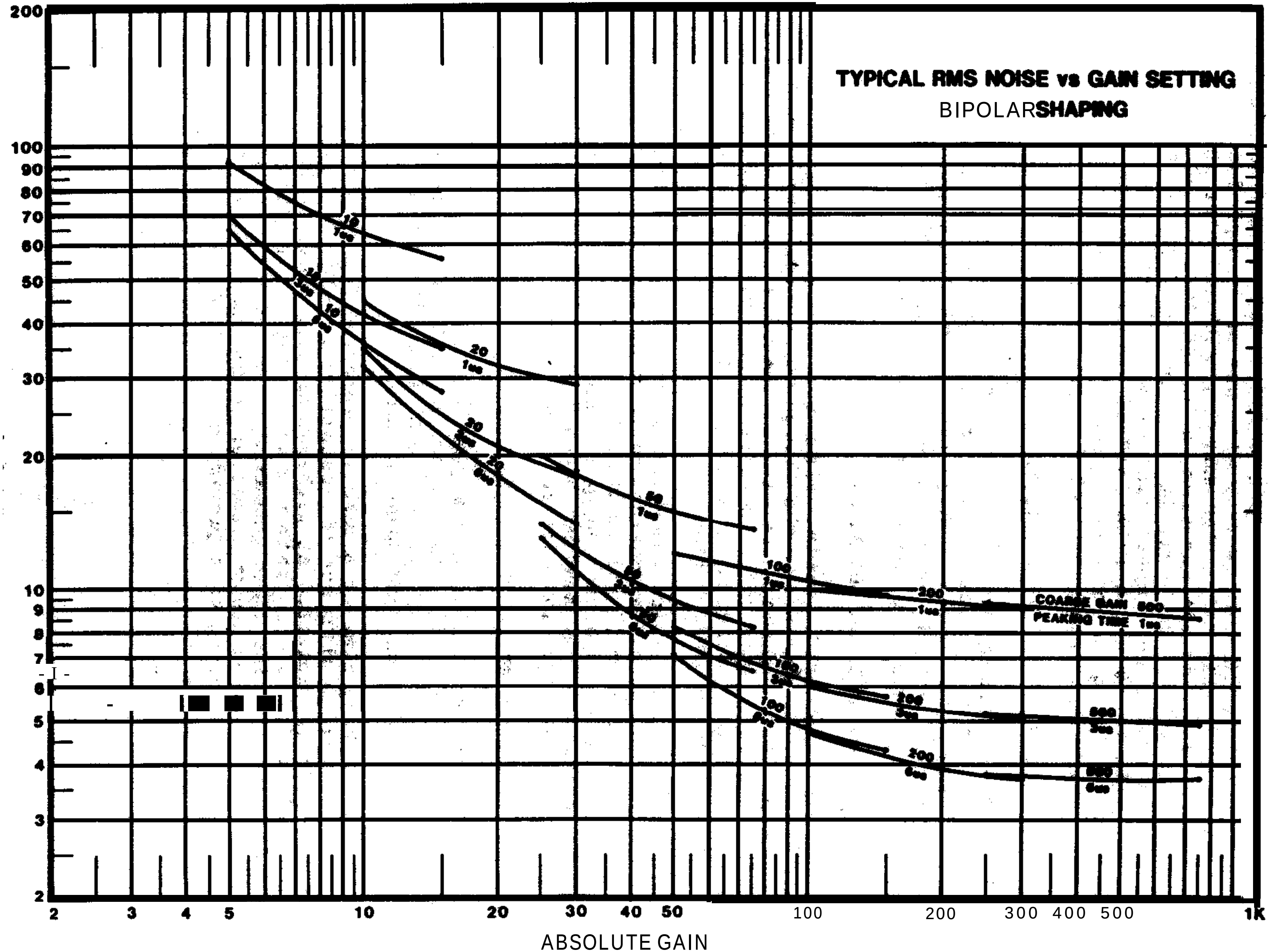


Fig. 4.6 BIPOLAR NOISE vs GAIN and PEAKING TIME

Lowest equivalent input noise results when a high COARSE GAIN and low FINE GAIN are used to produce the same overall gain. For example, with unipolar shaping and a 3 usec peaking time, a. COARSE GAIN of 100 and a FINE GAIN of 0.750 result in an overall gain of 75 with an' equivalent input noise of 4.8 uV, while a COARSE GAIN of 50 and a FINN GAIN of 1.500, although still producing an overall gain of 75, result in an equivalent input. noise of 8.2 uV.

4.4 PEAKING TIME CONSIDERATIONS

The optimum peaking time for a particular system depends on the detector characteristics and counting rate. A general discussion of peaking time requirement6 is presented below? consult the detector manufacturer for specific shaping requirements.

4.4.1 GASBROWRTIONAL DETECTOR

The required peaking time for a gas proportional detector depends on the charge collection time of the detector, which is related to the physical sire (both the outer electrode and center wire), fill gas and high voltage. Generally,, a larger detector will have a slower collection time.

Correct pole-zero compensation is not possible because of the peculiar charge collection characteristics, resulting in either an undershoot or back porch on the trailing-edge of a unipolar shaped signal. Bipolar shaping is recommended because it reduces thie effect without degrading detector reoolution.

4.4.2 GERMANIUM DETECTOR

Unipolar shaping and a peaking time of 3 or 6 usec generally will give best results for germanium detectors, depending on, the detector size, configuration, and counting rate.

A peaking time of 6 usec is preferred for applications requiring ultimate low-countrate resolution, while 3 usec is preferred at high-countrates. Resolution as a function of countrate at 3 and 6 usec peaking times for a typical intrinsic germanium detector is rhown in Fig. 4 7. A performance crossover occurs above 80 Kcps with 3' usec peaking time providing better resolution.

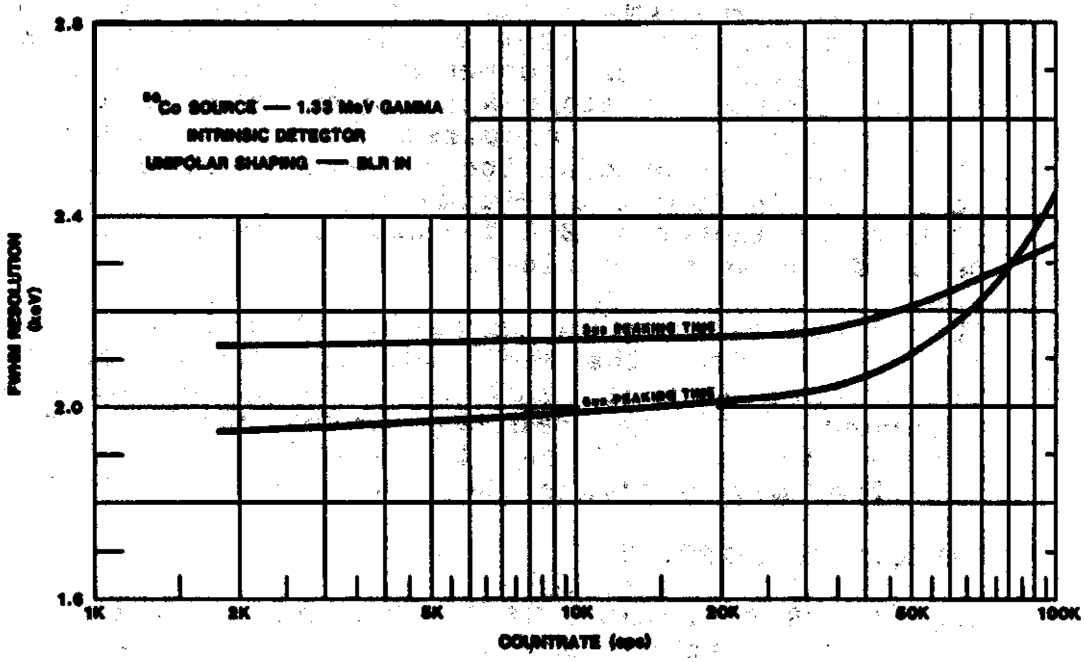


Fig. 4.7 Resolution vs Countrate

4.4.3 SCINTILLATION DETECTOR

Scintillation detectors require a peaking time of two to three times the decay time constant of the scintillator (a 1 usec peaking time is about optimum for Nal scintillators). Bipolar shaping is preferred because it reduces the effect of overload and detector microphonics without degrading rerolution.

4.4.4 SILICON SURFACE BARRIER DETECTOR

Unipolar shaping and a peaking time of 1 or'3 usec usually will give best results, depending on the detector capacitance and leakage current. Generally, large area detector&are resolution-limited by their high capacitance and thus benefit from a longer peaking time. Small detectors are resolutton-limited by their leakage current, which implies a shotter peaking time.

4.5 OUTPUT TERMINATION CONSIDERATIONS

The TC 248 allows individually switchable output terminations of either <1 ohm or 50 ohms for both the UNIPOLAR and BIPOLAR outputs. The TC 248 is shipped with both OUTPUT IMPEDANCE switches in the 50 ohm position.

Series 50-ohm, termination is recommended for general applications and is required for 'long cable lengths and/or high noise environments. In extreme situations series termination along with shunt termination at the receiving end may be required, however, this reduces the signal amplitude at the *receiving* end of the cable to ,501 of the non-shunt-termination value. An in-line 50, ohm terminator or BNC 'Tee and 50 ohm terminator may be used *for* shunt termination.

The <1 ohm termination is useful when driving eeveral instruments from the same amplifier "output connector. The output signaJamp litude will be relatively independent of the load impedance, which is not the case with series 50 ohm termination. However , the amplifier may oscillate when driven into overload.

5.0 CIRCUIT DBSCRIPTIOM

The TC 248 FAST/SLOW AMPLIFIER module contains a high performance spectroscopy amplifier and a general purpose timing amplifier which share a common input.

The spectroscopy amplifier consist *of* three gain stages, two active-filter stages, two output driver stages, and an active, baseline restorer, (BLR) with automatic threshold and restorer rate, circuits as ehown in the. TC 248 BLOCK DIAGRAM. The overall transfer function of the amplifier synthesize an $e^{-3t}\sin^4 t$ time response resulting in a pseudo-gaussian pulse shape.

Transistors Q1 through Q6 form a low-noise'input op-amp stage with switchnselectable gains *of* 20, 10, 4, or 2. Diodes D1 and D2 provide input protection, while diodes D3 through D5 provide biasing and overload limiting.

Input-polarity selection and additional gain is provided by IC1. Diode D8 provides overload limiting.

Fine-gain adjustment and additional switch selectable gain is provided by IC2. Diode D9 Provides overload limiting.

IC3 and ICI form a four-pole active 'integrator.:

The signal from the integrators is differentiated, then buffered by IC5 and transistors Q8 and Q9 to *provide* a high-current BIPOLAR output. Diodes D13 and D14 provide overload limiting.

The integrated signal is directly applied to IC6 and transistors Q10 and Qll to provide a high-current UNIPOLAR output. Diode8 D20 and D21 provide overload limiting.

Baeeline restoration of the UNIPOLAR output is ptovided by transconductance amplif ier IC7. Capacitor C51 functions as an output level memory. IC9 and IC10 form a peak detector fox the negative noise eicureions at the UNIPOLAR output, whichdetermines the BLR gate threshold. IC8 and transistor Q13 gate the restorer current whenever the UNIPOLAR output exceeds the BLR gate threshold. An additional, exponentially decaying restoration current is provided when switch S9 is in the BLR position. This additional current ie disabled with switch S9 in the P/Z position for accurate pole-zero cancellation adjustment.

The timing amplifier conoiet of an input buffer, monolithic amplifier with differential outputs, and gain of x10 output driver stage.

Transistors Q15 through Q18 form a high input impedance, low output impedance buffer amplifier which isolates the timing amplifiet differentiator from the input signal.

Reed Relays RLY1 through RLY4 select an input attenuation factor of x1, x2, x5 or x10 depending on the setting of the timing amplifier GAIN switch.

Monolithic video amplif ier- IC11 amplifies the differentiated signal and provides both inverted and non-inverted outputs. Relays RLY5 and RLY6 select the gain of, the video amplifier IC by changing the emitter resistance of the differential input stage.

Input polarity selection is accomplished by choosing the proper output rignal from the video amplifier.

Transistors Q19 through Q22 form a gain of x10 non-inverting output driver stage.

6.0 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 37831-2560. 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 cont ained in this report.

7.0 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 period.

8.0 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. Se 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. 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.

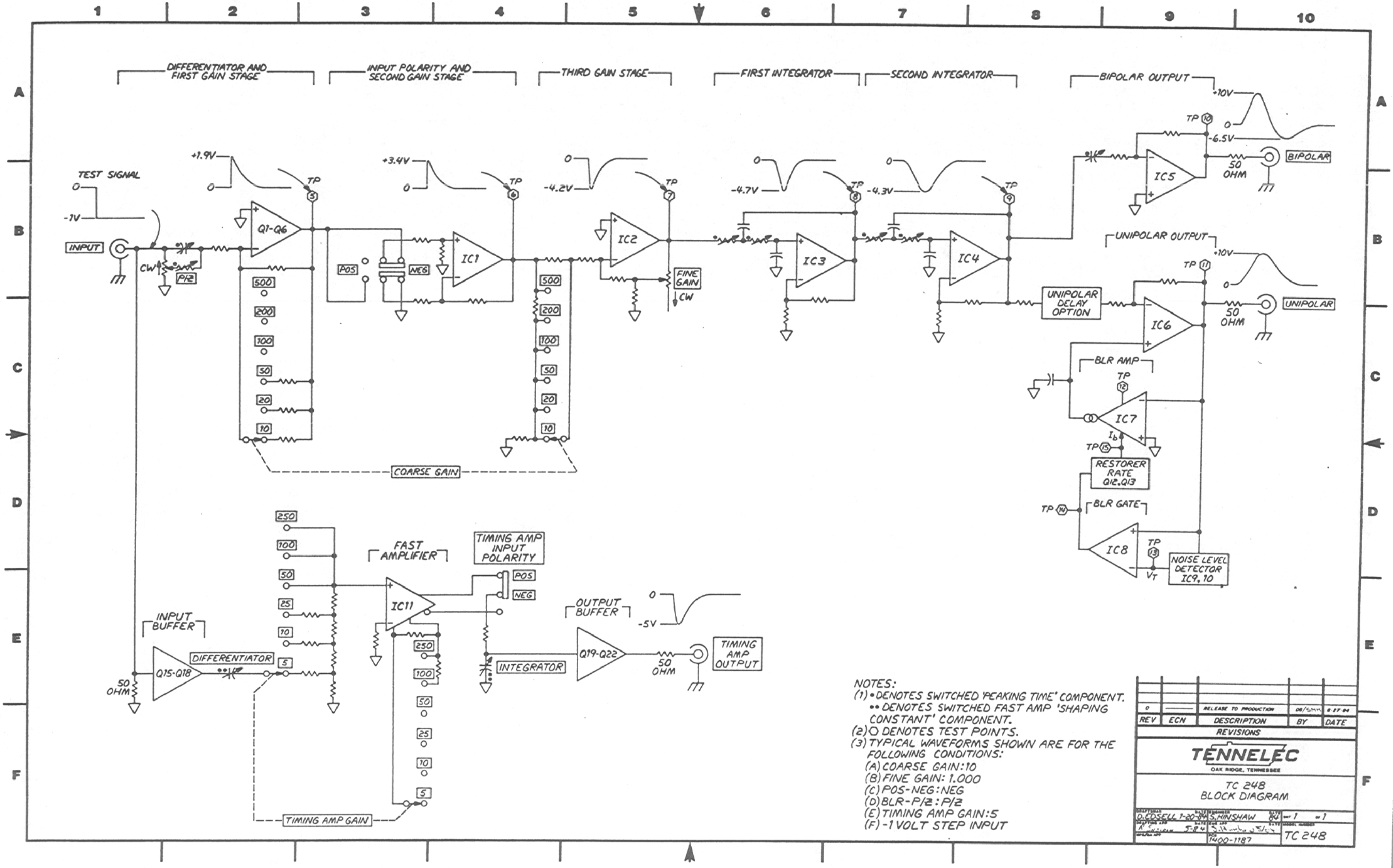
Quotations for repair of such damage will be sent for your approval before repair is undertaken.

TENNELEC'S Quality Assurance Program requires that each and every instrument be fully aged, vibrated, and electronically checked.

Should the ◆⬧♏❒ 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.

☠✌☠✞✌☹ ☼☜✞✍ ◻

3/84 - Engineering and component improvements may be made after date of printing.



NOTES:
(1) • DENOTES SWITCHED 'PEAKING TIME' COMPONENT.
•• DENOTES SWITCHED FAST AMP 'SHAPING CONSTANT' COMPONENT.
(2) ○ DENOTES TEST POINTS.
(3) TYPICAL WAVEFORMS SHOWN ARE FOR THE FOLLOWING CONDITIONS:
(A) COARSE GAIN: 10
(B) FINE GAIN: 1.000
(C) POS-NEG: NEG
(D) BLR-P/2: P/2
(E) TIMING AMP GAIN: 5
(F) -1 VOLT STEP INPUT

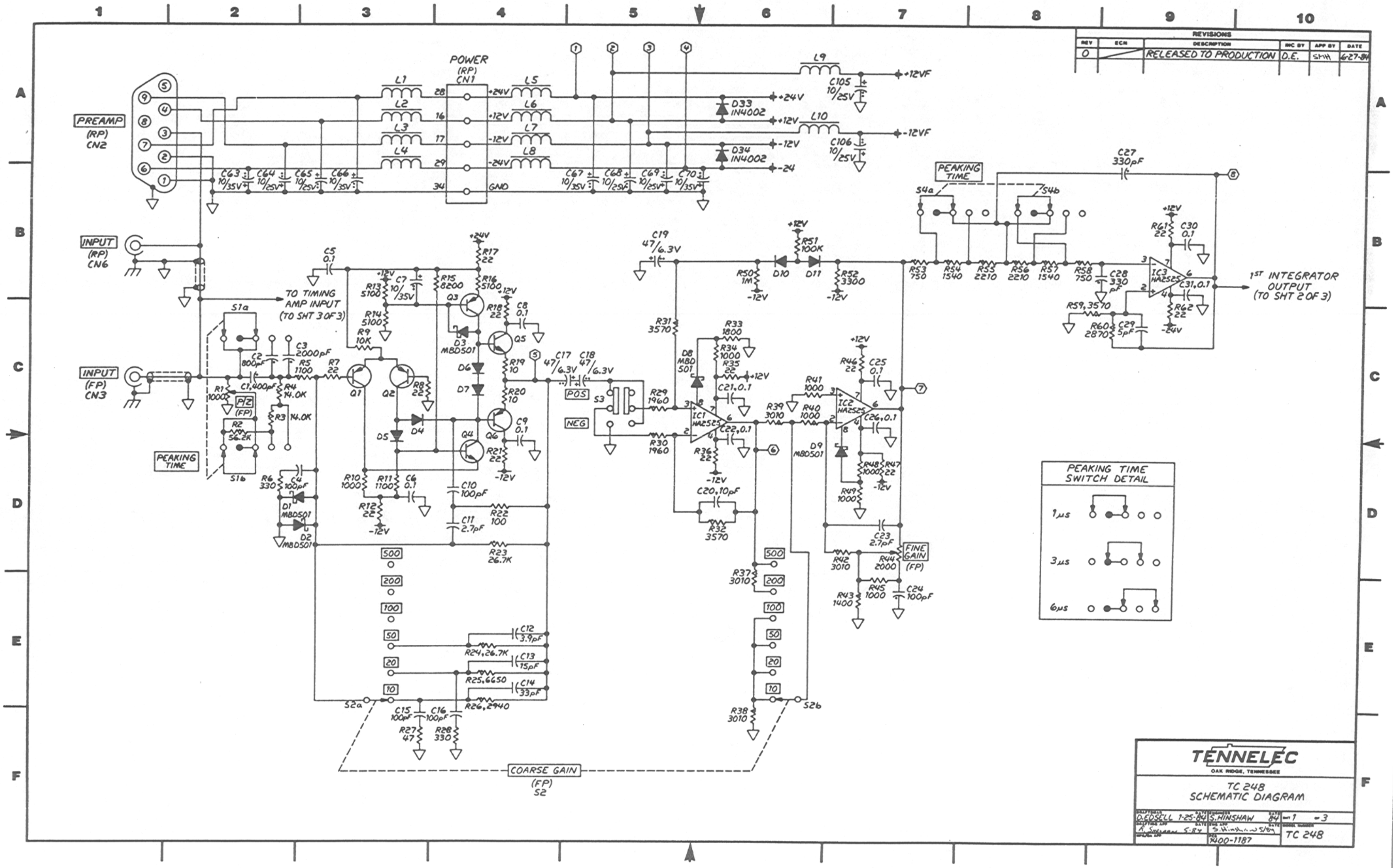
REV	ECN	DESCRIPTION	BY	DATE
0		RELEASE TO PRODUCTION		

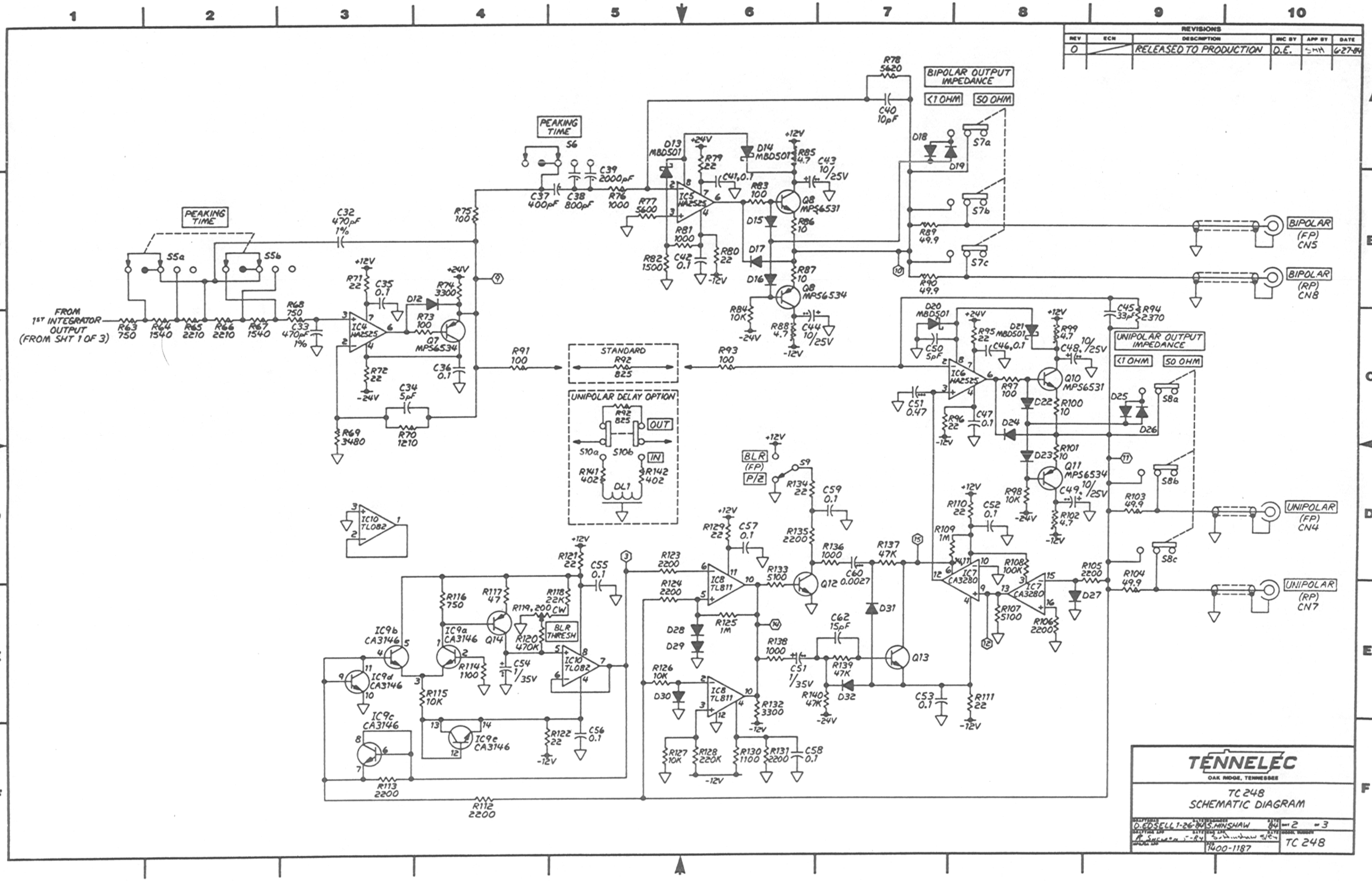
REVISIONS

TENNELEC
OAK RIDGE, TENNESSEE

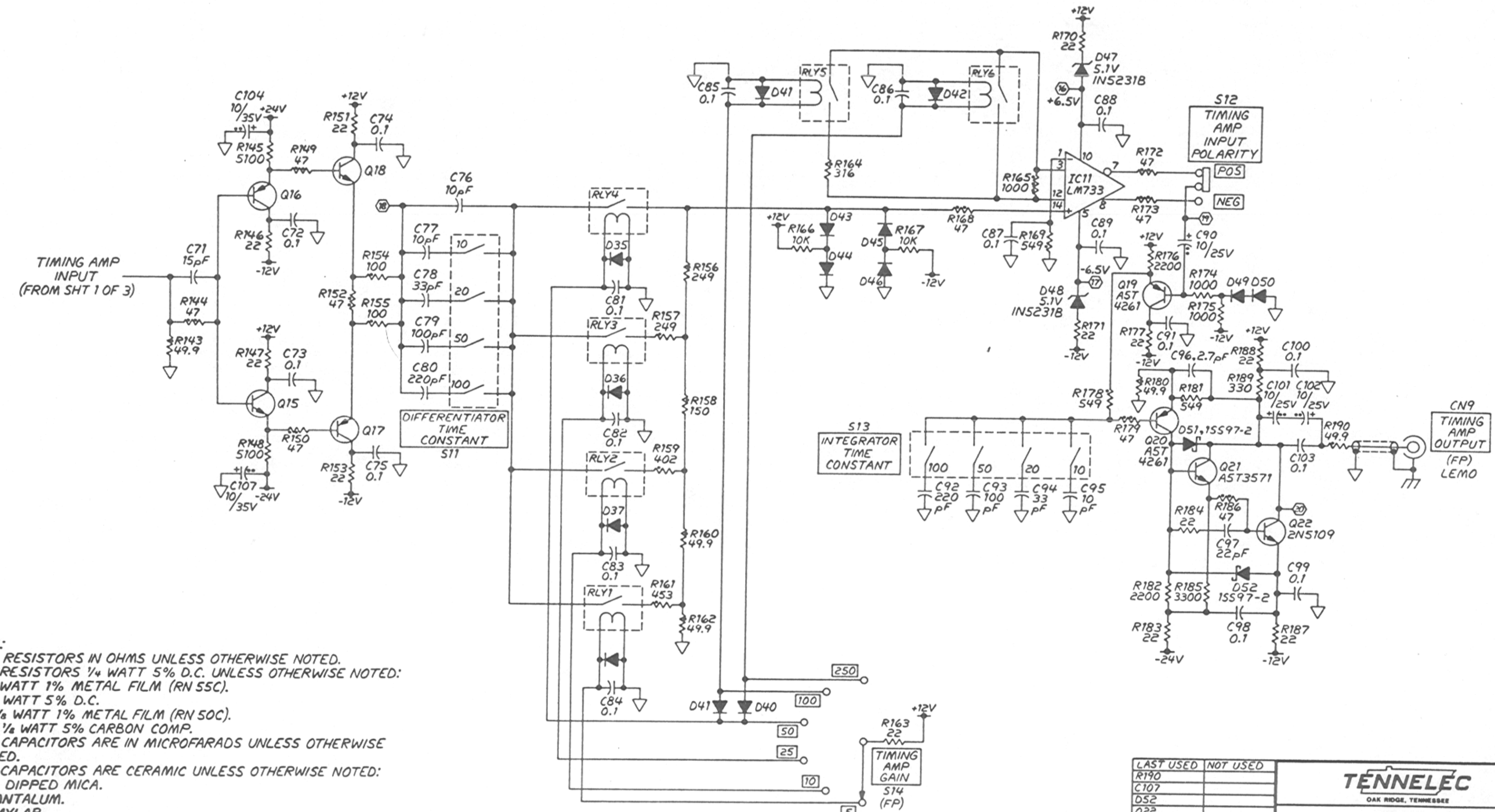
TC 248
BLOCK DIAGRAM

D. EDSELL 1-20-84 S. HINSHAW
1400-1187
TC 248


REVISIONS
REV | ECN | DESCRIPTION | INIC BY | APP BY | DATE
0 | RELEASED TO PRODUCTION | D.E. | SMH | 6-27-84
POWER (RP) CN1
PREAMP (RP) CN2
INPUT (RP) CN6
INPUT (FP) CN3
TO TIMING AMP INPUT (TO SHT 3 OF 3)
PEAKING TIME
P/Z (FP)
POS
NEG
COARSE GAIN (FP) S2
FINE GAIN (FP)
1ST INTEGRATOR OUTPUT (TO SHT 2 OF 3)
PEAKING TIME SWITCH DETAIL
1μs
3μs
6μs
TENNELEC
OAK RIDGE, TENNESSEE
TC 248 SCHEMATIC DIAGRAM
D.EDSELL 1-25-84
S.HINSHAW
1400-1187
TC 248


REVISIONS
REV | ECN | DESCRIPTION | INC BY | APP BY | DATE
0 | RELEASED TO PRODUCTION | D.E. | SMH | 6-27-84
FROM 1ST INTEGRATOR OUTPUT (FROM SHT 1 OF 3)
PEAKING TIME
S5a
S5b
S6
BIPOLAR OUTPUT IMPEDANCE
<1 OHM
50 OHM
S7a
S7b
S7c
BIPOLAR (FP) CN5
BIPOLAR (RP) CN8
STANDARD R92 825
UNIPOLAR DELAY OPTION
OUT
IN
DL1
UNIPOLAR OUTPUT IMPEDANCE
S8a
S8b
S8c
UNIPOLAR (FP) CN4
UNIPOLAR (RP) CN7
BLR (FP)
P/Z
S9
BLR THRESH
IC4 HA2525
IC5 HA2525
IC6 HA2525
IC7 CA3280
IC8 TL811
IC9 CA3146
IC10 TL082
Q7 MPS6534
Q8 MPS6531
Q10 MPS6531
Q11 MPS6534
TENNELEC
OAK RIDGE, TENNESSEE
TC 248
SCHEMATIC DIAGRAM
D. EDSELL 1-26-84
S. HINSHAW
2 of 3
1400-1187
TC 248

REV	ECN	DESCRIPTION	INC BY	APP BY	DATE
0		RELEASED TO PRODUCTION	D.E.	SMH	6-27-84



NOTES:
(1) ALL RESISTORS IN OHMS UNLESS OTHERWISE NOTED.
(2) ALL RESISTORS 1/4 WATT 5% D.C. UNLESS OTHERWISE NOTED:
- • 1/4 WATT 1% METAL FILM (RN 55C).
- •• 1/8 WATT 5% D.C.
- ••• 1/8 WATT 1% METAL FILM (RN 50C).
- •••• 1/2 WATT 5% CARBON COMP.

(3) ALL CAPACITORS ARE IN MICROFARADS UNLESS OTHERWISE NOTED.
(4) ALL CAPACITORS ARE CERAMIC UNLESS OTHERWISE NOTED:
- • 1% DIPPED MICA.
- •• TANTALUM.
- ••• MYLAR.

(5) ○ DENOTES TEST POINTS.
(6) ALL NPN TRANSISTORS ARE 2N3904 UNLESS OTHERWISE NOTED.
(7) ALL PNP TRANSISTORS ARE 2N3906 UNLESS OTHERWISE NOTED.
(8) ALL DIODES ARE 1N4154 UNLESS OTHERWISE NOTED.

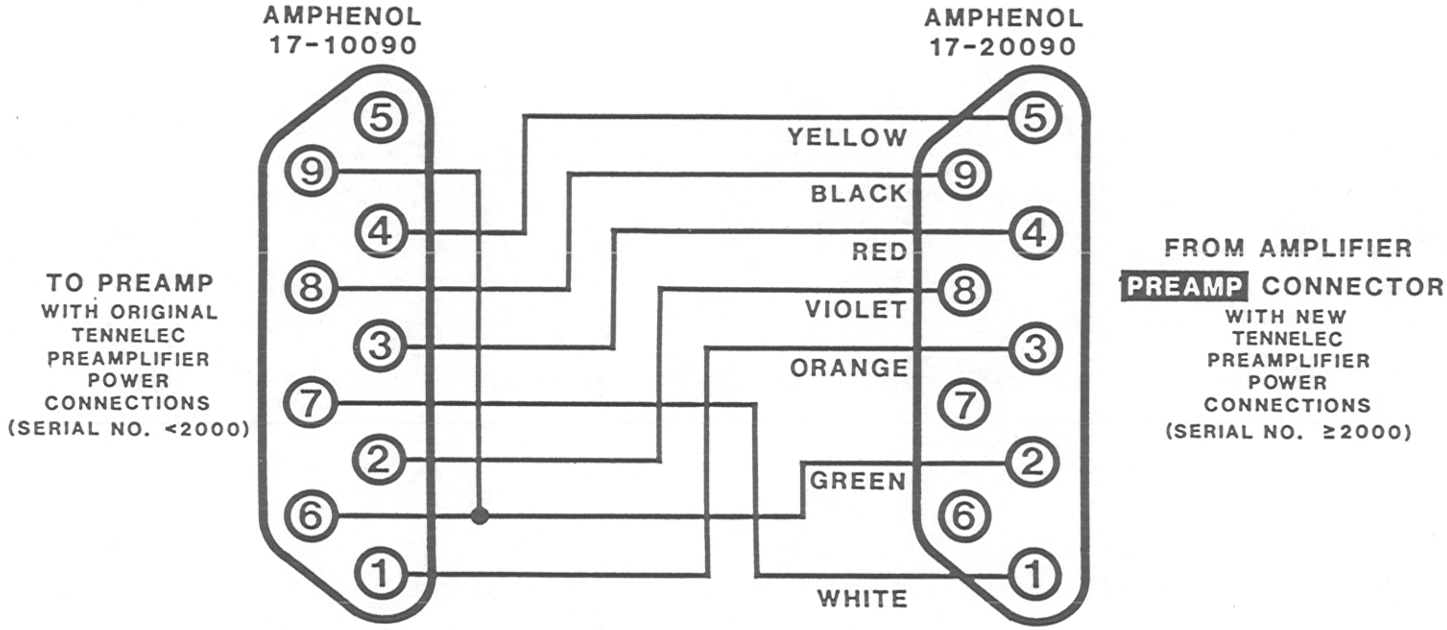
LAST USED	NOT USED
R190	
C107	
D52	
Q22	
IC11	
S14	
L10	
CN9	
TP20	
DL1	

TENNELEC
OAK RIDGE, TENNESSEE

TC 248
SCHEMATIC DIAGRAM

D.EDSELL 1-31-84 | S.HINSHAW 84 | SH 3 OF 3
1400-1187 | TC 248

(1) ADT-1 ADAPTER PHYSICALLY MOUNTED
AT AMPLIFIER **PREAMP** CONNECTOR.



PREAMPLIFIER PIN ASSIGNMENT		
PIN	ORIGINAL TENNELEC	NEW TENNELEC
1	PREAMP OUT	POWER GND
2	PHANTOM	SIGNAL GND
3	+12V	PREAMP OUT
4	TEST	+12V
5	HV BIAS	TEST
6	SIGNAL GND	-24V
7	POWER GND	+24V
8	-12V	PHANTOM
9	TEST GND	-12V

QTY	ITEM	PART NO.	DESCRIPTION	REMARKS

LIST OF MATERIALS OR PARTS LIST

UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN INCHES

TOLERANCES:
DECIMALS
.XXX ±.005
.XX ±.015
.X ±.020
FRACTIONS ±1/64
ANGLES ±1°

TENNELEC
P. O. BOX D, OAK RIDGE, TENNESSEE 37830

PREAMPLIFIER POWER ADAPTER

SIZE C
MATERIAL
FINISH
DRN BY D.EDSELL DATE 1-7-81
ENGINEER S.HINSHAW DATE 1-81
CHK BY W.C.BYRNE DATE 1-7-81
ENG APP S.Hinshaw DATE 1/8/81
SCALE NONE
MFG APP
MODEL NO.
DRAWING NO. ADT-1