TC 241S ADDENDUM

This instrument has been modified to include a fast timing amplifier.

The following specifications/changes apply to the timing amplifier.

2.0A SPECIFICATIONS

2.1.A PERFORMANCE

INPUT AMPLITUDE RANGE 0 to ± 1 volt linear signal; 0 to ± 3.5 volts dc; maximum input (signal plus dc) ±4.5 volts.

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

RISE TIME -10 ns with minimum integration and maximum differentiation.

GAIN TEMPERATURE INSTABILITY <0.1%/°C, 0 to 50°C

2.2A CONTROLS

2.2.1A FRONT PANEL CONTROL

GAIN Six-position rotory switch selects gain factors from 5 to 250 in a 1-2.5-5 sequence.

2.2.2A INTERNAL CONTROLS

INPUT POLARITY Two-position slide switch selects either positive or negative polarity preamplifier signals for the timing amplifier input.

DIFFERENTIATOR TIME CONSTANT Four individual two-position slide switches select differentiator time constants of 10 ns, 20 ns, 50 ns and 100 ns. Switches may be used in combination to provide intermediate time constants, i.e., 50 ns and 100 ns IN to provide a 150 ns time constant. All switches OUT provides a 5 ns time constant.

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

2.3A CONNECTORS

2.3.1A FRONT-PANEL CONNECTORS

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. Rise time and decay time selected by the DIFFERENTIATOR and INTEGRATOR switch settings.

INPUT BNC type connector accepts either positive OK negative polarity input signals. The input impedance is 50 ohms dc-coupled, and the input is protected to ±4.5 volts absolute maximuni.

2.4A MTAL POWER REQUIREMENT (excluding preamplifier)

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

*** * * * * 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 PREAMP POWER ADAPTER must be used.

If there are any **questions** regarding the compatibility of the [PREAMP] connector of this instrument, **please contact** the TENNELEC Marketing Department for assistance.

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

Improper connection to the [PREAMP] connector may permanently da**mage the** amplifier **and/or** preamplifier. **TENNELEC** assumes no liability for ⬩◆♍♒ instrument damage.

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INSTRUCTION MANUAL

TC 241 AMPLIFIER

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1.0 INTRODUCTION

The TENNELEC TC 241 is a high perfotinance, economical spectroscopy amplifier in a single-width NIN module. Thi low noise and high countrate characteristics of the TC 241 are ideally suited for semiconductor detectors, proportional counters, and scintillation detectors.

The TC 241 incorporates four active integration networks which generate very symmetrical pseudo-gaussian unipolar signals. Switch selectable peaking times of 1, 3 and 6 usec allow the TC 241 to match the signal processing requirements of most detectors. The symmetry of the pulse-shaping network optimizes the signal'-to-noise ratio while allowing excellent countrate capability (See Fig. 1.1).

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

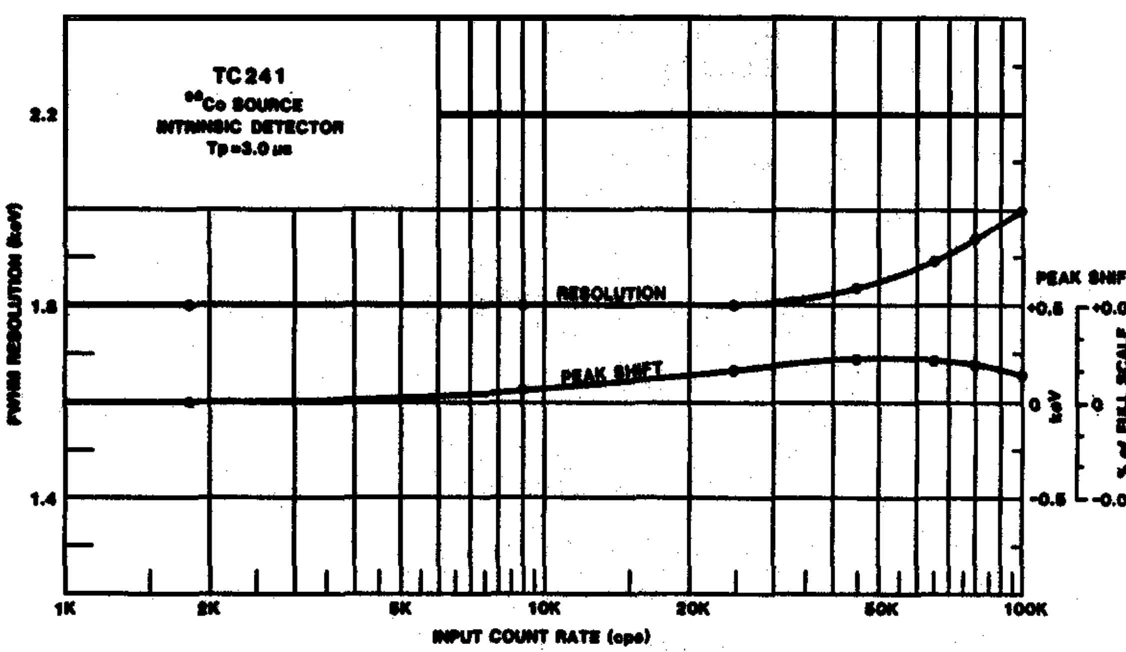


Fig. 1.1 Typical Resolution vs Countrate

The excellent **dc** stability of the TC 241 eliminates spectrum broadening caused by dc shift **of** the amplifier output and insures superior performance.

A unfpolar delay option allows the **unipolar** output to be delayed 2 **usec** for gating applications.

2.0 SPECIFICATIONS

2.1 PERFORMANCE

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** equals 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 **unipolar** peak.

GAIN RANGE Continuously variable **from** x5 to x750.

INTEGRAL NONLINEARITY **≤ ±0.05%** over 0 to **+10V** output range for 3 **usec** peaking time.

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

TEMPERATURE INSTABILITY

UNIPOLAR

Gain **≤ ±0.01%/°C,** 0 to **50°C**
DC Level **≤ ±10 uV/°C,** 0 to **50°C**

BIPOLAR

Gain **≤ ±0.01%/°C,** 0 to 5ooc
DC Level, **≤ ±30 uV/°C,** 0 **to 50°C**

WALK **≤ ±3** nsec over a 5011 dynamic range **for** 3 **usec** peaking time.

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

OVERLOAD RECOVERY Unipolar output recovers to within 2% of rated output from 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.

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.

SPECTRUM SHIFT (Unipolar) ** Peak position shifts typically less than 0.02% for a ^{60}Co 1.33 MeV gamma line at 05% of rated output, 3 usec peaking time and incoming rate of 1 to 100 kcps.

OPERATING TEMPERATURE 0 to 50°C

2.2 CONTROLS

2.2.1 FRONT PANEL CONTROLS

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.

POLE-ZERO (P/Z) 15-turn screwdriver adjustable control for cancellation of, preamplifier decay times from 35 usec to infinity.

POS-NEG Two-position toggle switch selects either positive 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/Z position disables the baseline restorer for accurate pole-iero cancellation adjustment.

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

2.2.2 INTERNAL CONTROLS

PEAKING TIRE Four individual three-position slide switches (accessible through the module's side ehield) selects 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 switches MUST be set to the ‘same position for proper operation of the amplifier.

UNIPOLAR DELAY OPTION When. installed, a two-position slide switch (accessible through the module’s side shield) selects 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 module’s 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.

2.3 CONNECTORS

2.3.1 FRONT PANEL CONNECTORS

INPUT BNC connector accepts either positive or negative polarity input signals. The input risetimes must be less than the selected peaking time with decay times of 35 usec to infinity. The input impedance is 1000 ohms dc-coupled (500 ohms pulse),’ and the input is protected to ±25V absolute maximum.

UNIPGLAR BNC connector provides dc-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 connectors are ehort circuit protected in either UNIPOLAR OUTPUT IMPEDANCE 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 hnd rear panel BIPOLAR output connectors. The total peak output current is limited to, 50 mA 'in the <1 ohm position. Both BIPOLAR connectors are ehort circuit protected in either BIPOLAR OUTPUT IMPEDANCE position.

2.3.2 REAR PANEL CONNECTORS

INPUT Refer to INPUT of Sec. 2.3.1.

UNIPOLAR Refer to UNIPOLAR of Sec. 2.3.1.

BIPOLAR Refer to BIPOLAR of Sec. 2.3.1.

PREAMP A 9-pin Amphenol 17-10090 type connector accepts signals from TENNELEC preamplifiers and provides power to TENNELEC~ or other commercially available preamplif iers.

*** * * * CAUTION * * * ***

The PREAMP connector on this instrument is directly compatible only with TENNELEC preamplif iers 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 (See Sec. 3.2.1).

If there are any questions regarding the compatibility of the PREAMP connector of this instrument, please contact the TENNELEC 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	DESCRIPTION
1	POWER GND
2	SIGNAL GND
3	PREAMP OUT
4	+12V
5	TEST
6	-24V
7	+24V
8	PHANTOM
9	-12v

2.4 POWER REQUIREMENTS (excluding preamplifier)

+24V, 40 mA; +12V, 65 mA
-24V, 30 mA; -12V, 75 mA

2.5 OTHER INFORMATION

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

DIMENSIONS Standard eingle-wide NIM module (1.35.x 8,714 in.) per TID 20893 (Rev).

INSTRUCTION MANUAL One provided with each instrument ordered.

ACCESSORY INCLUDED One model ADT 1 PREAMP POWER ADAPTER.

WARRANTY One year.

3.0 INSTALLATION

3.1 POWER CONNECTION

The TC 241 AMPLIFIER, requires a NIM-standard bin and power supply, such as the TENNELBC 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 deeigned so that it is not possible to overload the power supply, even with a full complement of modules in the bin. Since this may not be true when the bin contains modules other than those of TENNELEC design, the power eupply voltages should be checked after all modules have been inserted. The TENNELEC Bin and Power Supply provides power supply teet points on the bin control panel for monitoring the dc voltage levels.

3.2 PREAMPLIFIER CONNECTION

3.2.1 ORIGINAL TENNELEC PREAMPLIFIERS (Serial Number <2000)

The PREAMP connector of. this amplifier is NOT directly compatible with TENNELEC preamplifiers with serial numbers less than 2000. A model ADT 1 PREAMP POWER ADAPTER is required.

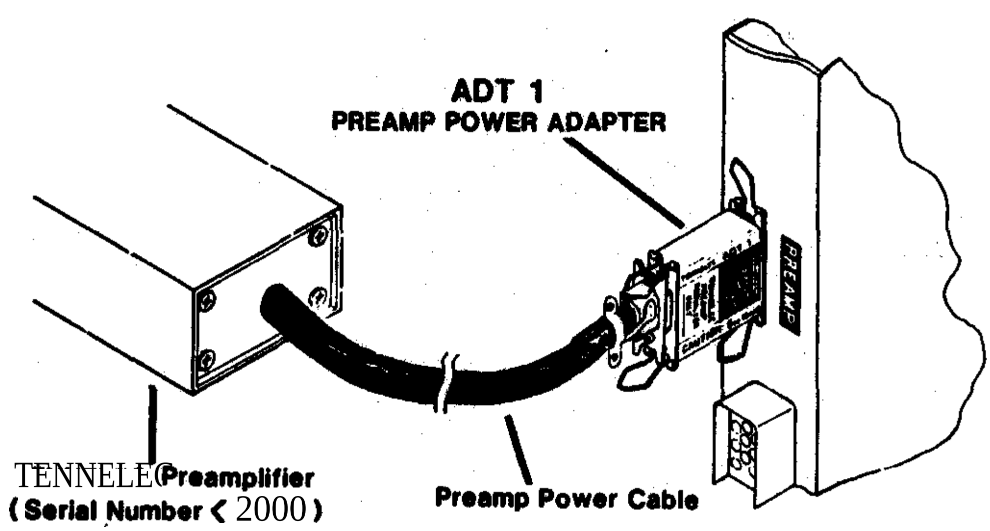


Fig. 3.1 Original TENNELEC Preamplifier Power Connections

The ADT 1 **PREAMP 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, th.e 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 PCS-NEG switch should be set to match the preamplifier's output signal polarity.

3.2.2 TENNELBC PREAMPLIFIERS (Serial Number >2000)

The PREAMP connector of this amplifier is directly compatible with TENWELEC 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 POS-NEG switch should be set to match the preamplifier's output signal polarity,

3.2.3 OTHER PREAMPLIFIERS

The PREAMP P connector of this amplifier is directly cornpatible 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 amplifier'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.

4.1.2 TEST SYSTEM SETUP

Set the TC 241 controls as follows, then insert into the NIM bin such that the internal controls are accessible.

COARSE GAIN	100
FINE GAIN	1.00
P/Z	Fully CCW
POS-NEG	POS
BLR-P/Z	P/Z
PEAKING TIME (PCB)	3 usec
UNIPOLAR DELAY (PCB)	OUT

Set the Tail Pulser controls as follows:

PULSE HEIGHT	10.0
RELAY	OFF
POL	+
DIRECT OUT/EXT IN	DIRECT OUT
OUTPUT	5V
ATTENUATION	5x10

Set the Oscilloscope controls as follows:

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

Connect the DIRECT OUTPUT of the TC 812 to the EXTERNAL TRIGGER INPUT of the oscilloscope with a BNC cable. Place a BNC tee on the front panel INPUT connector of the TC 241 and connect a 50 ohm terminator on one side of the tee. Connect a BNC cable between the TC 812 OUTPUT and the remaining side of the BNC tee.

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) test point of the NIM bin. Touch the DMM's positive lead to the center pin of the TC 241's UNIPOLAR connector; the DMM should indicate 0 ±5 mV. Repeat for BIPOLAR connector; the DMM should indicate 0 ±10 mV.

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. the characteristic impedance of the cable should match the impedance of the preamplifier output. All TENNELEC preamplifiers, contain 50 ohm series termination, therefore 50 ohm, RG-59 cable is recommended.

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 HIGH VOLTAGE DETECTOR BIAS

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

4.0 OPERATING PROCEDURES

4.1 FIRST-TIME OPERATIONS

Users will find it helpful to familiarize themselves with the TC 241 AMPLIFIER by conducting a few simple tests.

4.1.1 EQUIPMENT REQUIRED

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

Connect BNC cables from the UNIPOLAR and BIPOLAR output8 of the TC 241 to the Channel A and Channel B vertical inputs, respectively, of the oocilloecope. 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 241 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 Fig. 4.1). Note the time relationship of the unipolar peak to both the bipolar peak and bipolar zero-crossing. Switch the TC 241 BLR-P/Z control to the BLR position; the unipolar signal should not change,

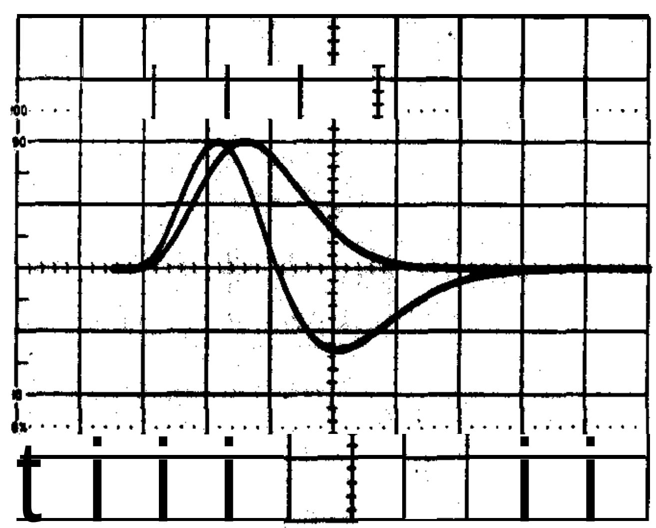


Fig. 4.1 TC 241 Linear Output Pulse Shapes

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 241 PEAKING TIME switches to the 6. usec position. The unipolar signal should now peak at 6 usec.

Reduce the TC 241's COARSE GAIN to 50. The maximum amplitude of both the unipolar and bipolar signals should decrease to 5.0 volts. Increase the TC 241's FINE GAIN control to 1.500 (fully CW). The maximum amplitude of both signals should increase to 7.5 volts.

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 operation 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 prodedure is as follows:

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

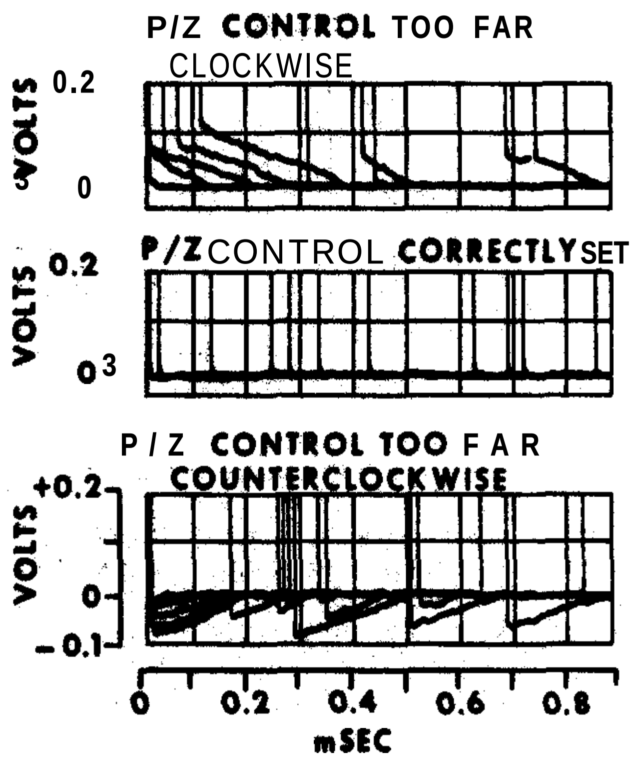


Fig. 4.2 P/2 Control Adjustment

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/X control for flattest possible' baseline (See Fig. 4.2).

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

NOTE: Oscilloscopes such as the TEKTRONIX Model 465 and 475 will overload with a 10 volt input signal when the vertical sensitivity is set for 100 mV/Div or less. The Resistor Bridge/Diode. Limiter shown in Fig. 4.3 is recommended to prevent overloading the, oscilloscope (this bridge/limiter is also used for amplifier linearity measurement). The FROM GENERATOR OUTPUT connector is not used when connected as an qscilloacope overload limiter.

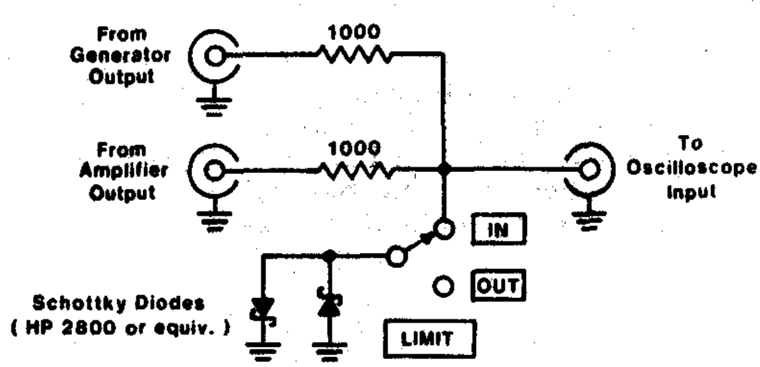


Fig. 4.3 Resistor Bridge/Diode Limiter

4.3 AMPLIFIER NOISE

The typical equivalent noise referred to the input vs amplifier, gain for, unipolar ‘and bipolar shaping is shown in Fig. 4.4 and Fig. 4.5 respectively.

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 FINS 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 FINS’ GAIN of 1,500, although still producing an overall gain of 75, result in an equivalent input noise of 6.2 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 requirements is presented below; consult the detector manufacturer for specific shaping requirements,

4.4.1 GASPROPORTIONALDETECTOR

The, required peaking time for a gas proportional detector depends on the. charge collection time of the detector, which is related to’the physical size (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 haped signal. Bipolar shaping is recommended because it reduces this effect without degrading detector resolution.

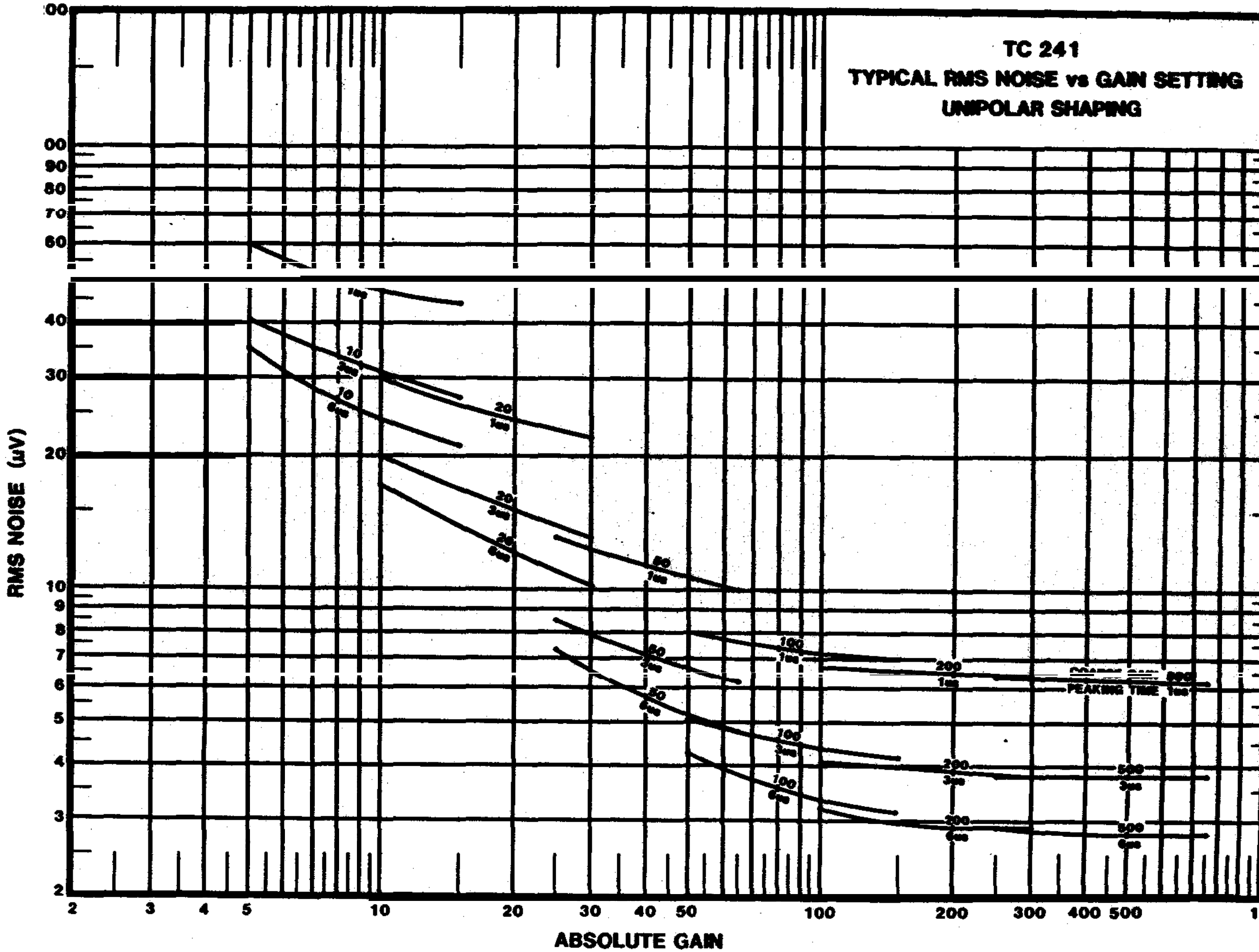


Fig. 4.4 Unipolar Noise vs Gain and Peaking Time

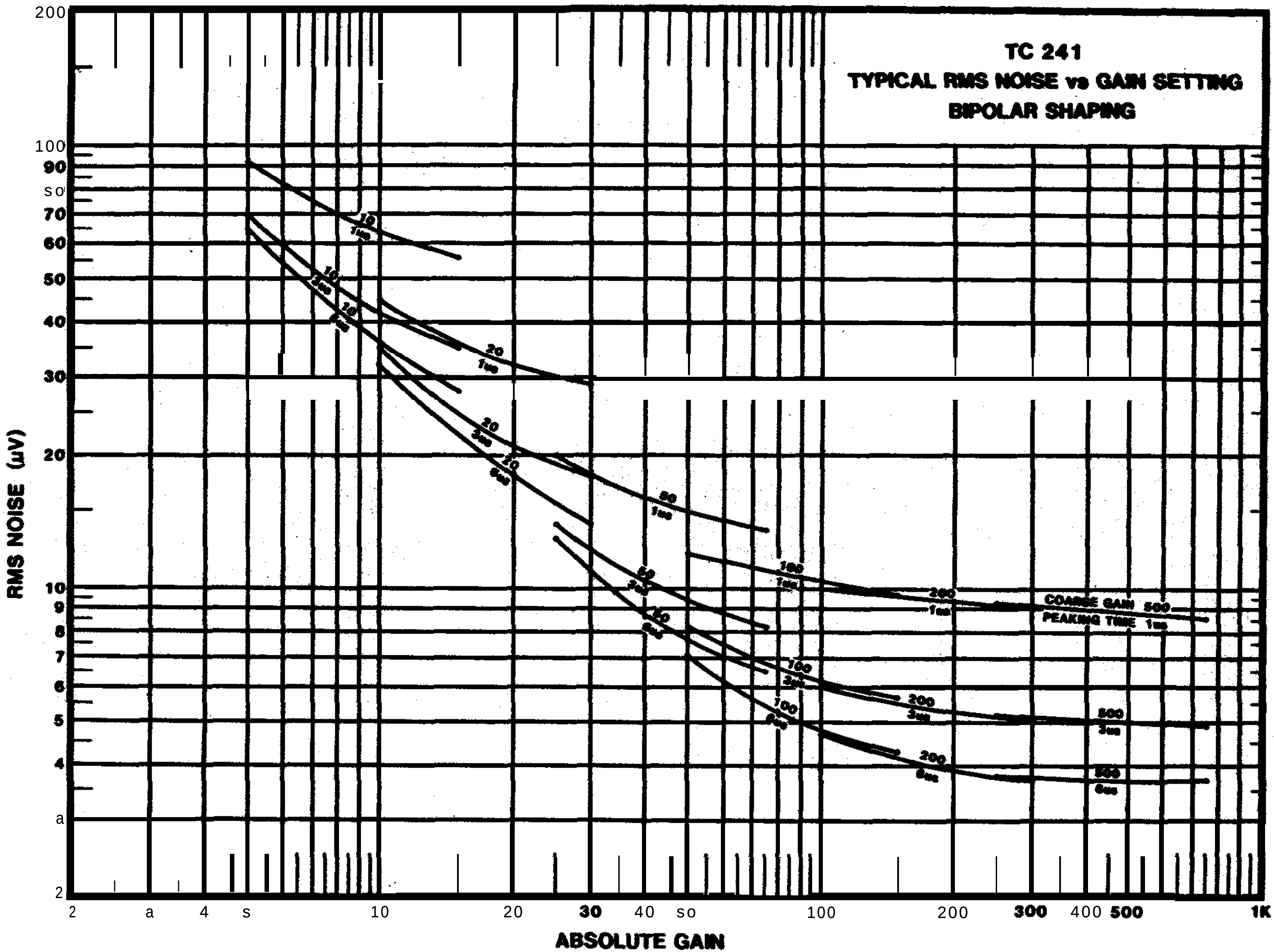


Fig. 4.5 Bipolar Noise vs Gain and Peaking Time

4.4.2 GERMANIUM DETECTOR

Unipolar shaping, an& a peaking time of 3 or 6 usec generally will give best' results for germanium detectors, depending en 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 shown in Fig. 4.6. A performance crossover occurs above 80 Kcps with 3 usec peaking time providing better resolution.

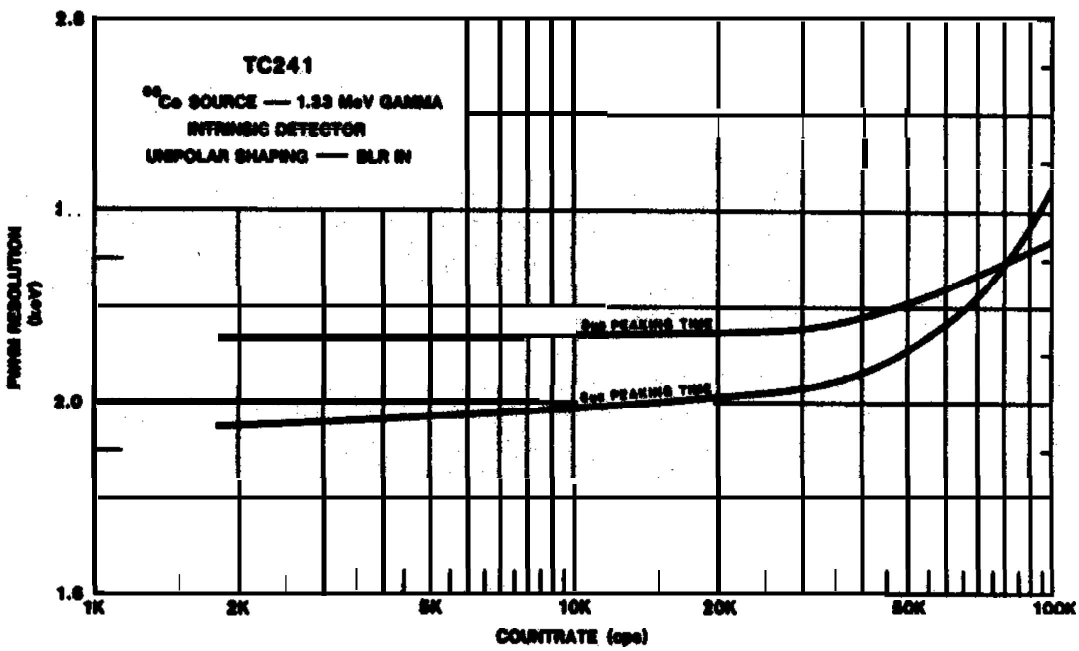


Fig. 4.6 Resolution vs Countrate

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 NaI scintillators). Bipolar shaping is preferred because it reduces the effect of overload and detector microphonics without degrading resolution.

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 detectors are resolution-limited by their high capacitance, thus benefit from a longer peaking time. Small detectors are resolution-limited by their leakage current; which implies a shorter peaking time?

4.5 OUTPUT TERMINATION CONSIDERATIONS

The TC 241 allows individually switchable output terminations of either <1 ohm or 50 ohms for both the UNIPOLAR and BIPOLAR outputs. The TC 241 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 50% 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 several instruments from the same amplifier output connector. The output signal amplitude will be relatively independent of the load impedanoe, which is not the case with series 50 ohm termination. However, the amplifier may oscillate when driven into overload.

5.0 AMPLIFIER TEST

5.1 NOISE TEST

5.1.1 EQUIPMENT REQUIRBD

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 equivalent).
4. AC Voltmeter (HP400, HP3400A or equivalent).
5. Shielded 50 ohm cables with BBC connectors.
6. BNC tee and 50 ohm terminator.

5.1.2 NOISE TEST SETUP

Set the TC 241 controls as fellows, then insert into the NIM Bin.

COARSE GAIN	500
FINE GAIN	1.500
P/Z	Fully CCW
POS-NEG	POS
BLR-P/Z	P/Z
PEAKING TIME (PCB)	6 usec

Set the Tail Pulser controls as follows:

PULSE HEIGHT	1.33
POL	+
DIRECT OUT-EXT IN	DIRECT-OUT
OUTPUT	1V
ATTENUATION	10

Set the Oscilloscope controls as follows:

VERT SENS	2 Volts/Div (do-coupled)
HORIZ SWEEP	1 usec/Div
TRIGGERING	POS EXTERNAL

Connect the system shown in Fig. 5.1.

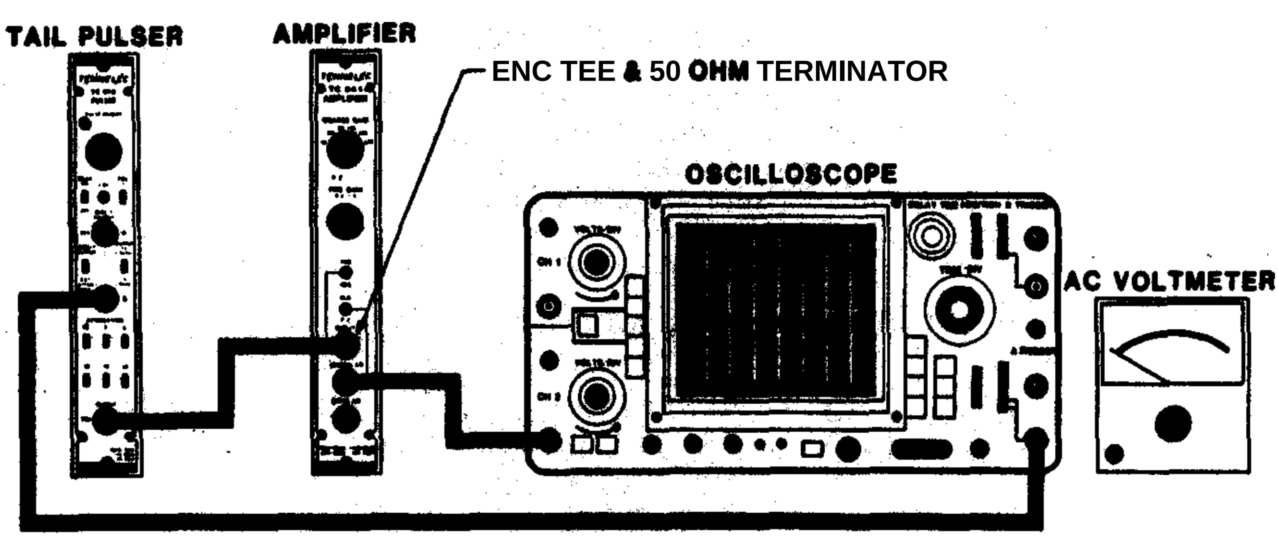


Fig. 5.1 Noise Test Setup

5.1.3 NOISE MEASUREMENT

Apply power to the NIM Bin and adjust the oscilloscope trigger control for a, stable display. Adjust the TC 812 PULSE HEIGHT control for an exact 10.0 volt signal from the TC 241 UNIPOLAR output. The overall amplifier gain (A_o) is calculated from

$$A_o = \frac{1000}{\text{PULSE HEIGHT Dial Setting}}$$

where the TC 812 PULSE HEIGBT dial setting reads direct. A typical PULSE HEIGHT dial setting of 1.33 would indicate an overall gain of 752.

Turn the TC 812 ‘RELAY switch to the OFF position. Remove the cable from the oscilloscope vertical input and reconnect to the ac-voltmeter input. Read the output noise (N_o) from the ac-voltmeter (for an average responding meter, such as the HP400 series, the reading must be multiplied by 1.135 to get the true rms value). The noise referred to the input (N_i) is obtained by dividing the output’ noise (N_o) by the overall amplifier gain (A_o).

5.2 NONLINEARITY

5.2.1 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 equivalent).
4. Resistor Bridge/Diode Limiter (See Fig. 4.3).
5. Shielded 50 ohm cables with BNC connectors.
6. BNC tee and 50 ohm terminator.

5.2.2 NONLINEARITY TEST SETUP

Set the TC 241 controls as follows, then insert into the NIM Bin.

COARSE GAIN	10
FINE GAIN	1.000
P/Z	Fully CCW
PGS-NEG	NEG
‘BLR-P/E	P/Z
PEAKING TIME (PCB)	3 usec

Set the Tail Pulser **controls** a6 f0l10W6:

PULSE **HEIGHT**	10.0
RELAY	ON
POL	
DIRECT OUT-EXT IN	DIRECT OUT
OUTPUT	5v
ATTENUATION	5

Set the **Oscilloscope** control6 a6 follows:

VERT SENS	2 **Volts/Div** (de-coupled)
HORIZ SWEEP	**1 usec/Div**
TRIGGERING	NEG EXTERNAL

Connect the **system** as **shown** in Fig. 5.2.

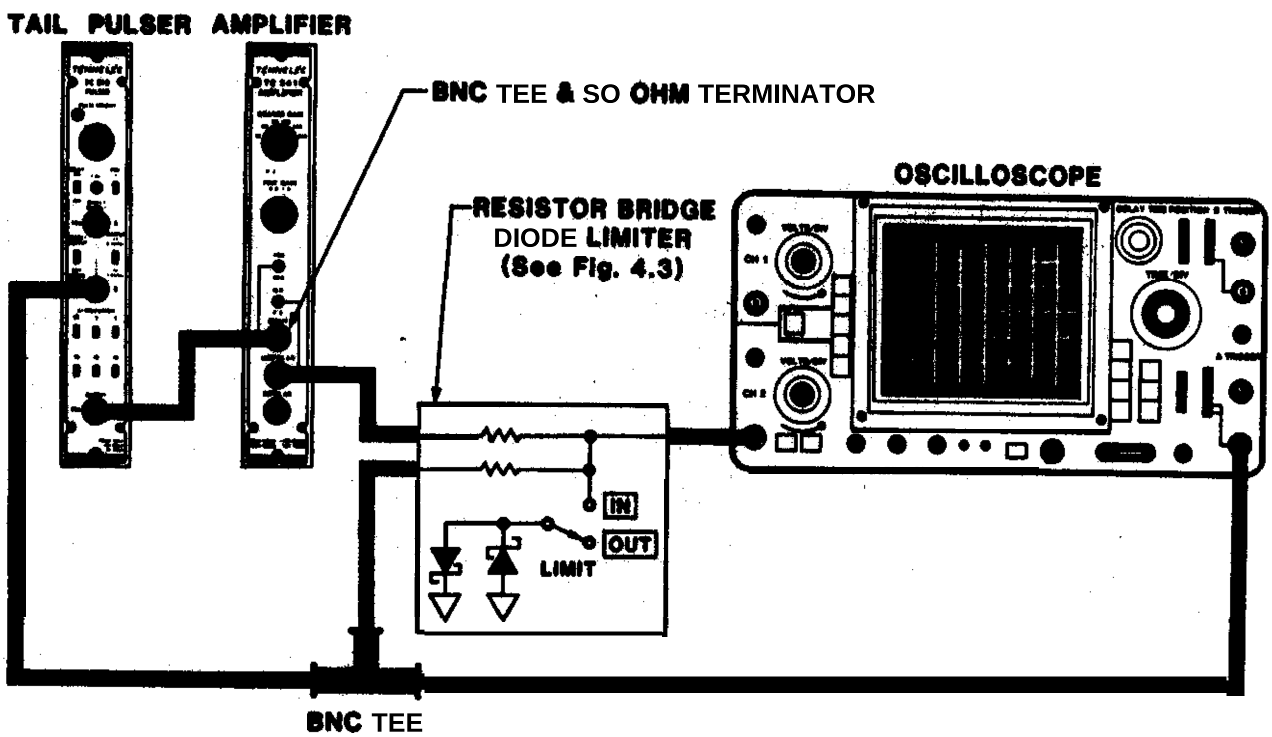


Fig. **5.2** Nonlinearity **Test** Setup

5.2.3 NONLINEARITY MEASUREMENT

Apply power to the NIM Bin and **adjust the oscilloscope** trigger control for a stable **display.** With the diode limiter OUT, **adjust** the FINE GAIN control for a null **signal** on the waveform in Fig. 5.3. Switch the limiter

IN and increase oscilloscope sensitivity to 5 mV/Div, if possible. As the sensitivity is increased; improve the null, using the FINE GAIN control as necessary. In traversing the last three steps of oscilloscope sensitivity, note that a. small null imbalance should increase proportionally as the sensitivity is increased. IF THIS DOES NUT OCCUR, IT INDICATES INADEQUATE OVERLOAD CAPABILITY OF TRE OSCILLOSCOPE. The maximum usable sensitivity is the last step before nonproportional response sets in.

Having reached maximum usable sensitivity, complete the test by gradually reducing the pulser output to zero while observing the change in null voltage (do not touch the ATTENUATOR). The interpretation of the results are as follows:

Since the generator supplies bridge signal as well as amplifier input signal, varying the generator output should not affect the null if the amplifier is perfectly linear (this is very nearly the case with the TC 241).

The per-mV unbalance of the null corresponds to an amplifier nonlinearity of 1 mV/5V = 0.02% (a 5 mV unbalance would represent 5 x 0.02% = 0.1% nonlinearity). Typically, the null shift with a TC 241 is less than 1 mV.

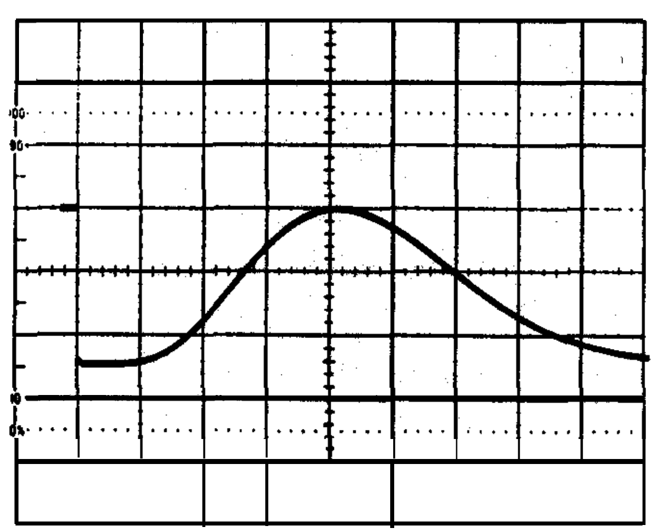


Fig. 5.3 Bridge-Balance Waveform.

6.0 CIRCUIT DESCRIPTION

The TC 241 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 a's shown in the TC 241 BLOCR DIAGRAM. The overall transfer function of the amplifier synthesize an $e^{-3t} \sin^4 t$ time response resulting in a pseudo-gaussian pulse shape.

Transistora Q1 through Q6 form a low-noise input op-amp stage with switch selectable 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 IC4 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 UNIPQLAR output., Diodes D20 and D21 provide overload limiting.

Baseline restoration of the UNIPQLAR output is provided by traneconductance amplifier IC7. capacitor C51 functions as an output' level memory. IC9 and IC10 form a peak detector for- the negative noise excursions at the UNIPOLAR output, which determines the BLR gate threshold. IC8 and transistor Q13 gate the restorer current whenever the UNIPQLAR 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 is disabled with switch S9 in the P/Z position for accurate pole-zero cancellation adjustment.

7.0 SSIPPING DAMAGE

Upon receipt of the instrument, examine it for shipping damage, Damage claims should be f iled with the carrier. The claims agent should receive a full report: a copy of that, report should be rent to TENNELEC, Inc., P.O. Box D, Oak Ridge, Tennessee 37830. The' model number and serial number of the inatrument 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 withinthe warranty.

9.0 WARRANTY

In connection with TENNELEC's warranty, (inside front cover), TENNELEC suggests that if a fault develops, the customer should immediately noyfy 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 aerial number of the instrument. Pack the instrument well and ship PREPAID and INSURED to TENNELEC, Inc., 601 Oak: Ridge Turnpike, Oak Ridge, Tennessee 37830 Asstated in thewarranty DAMAGE IN TRANSIT WILL BE' REPAIRED AT THE SENDER'S EXPENSE as will damage that obviously resulted from abuse or misuse of the instrument.

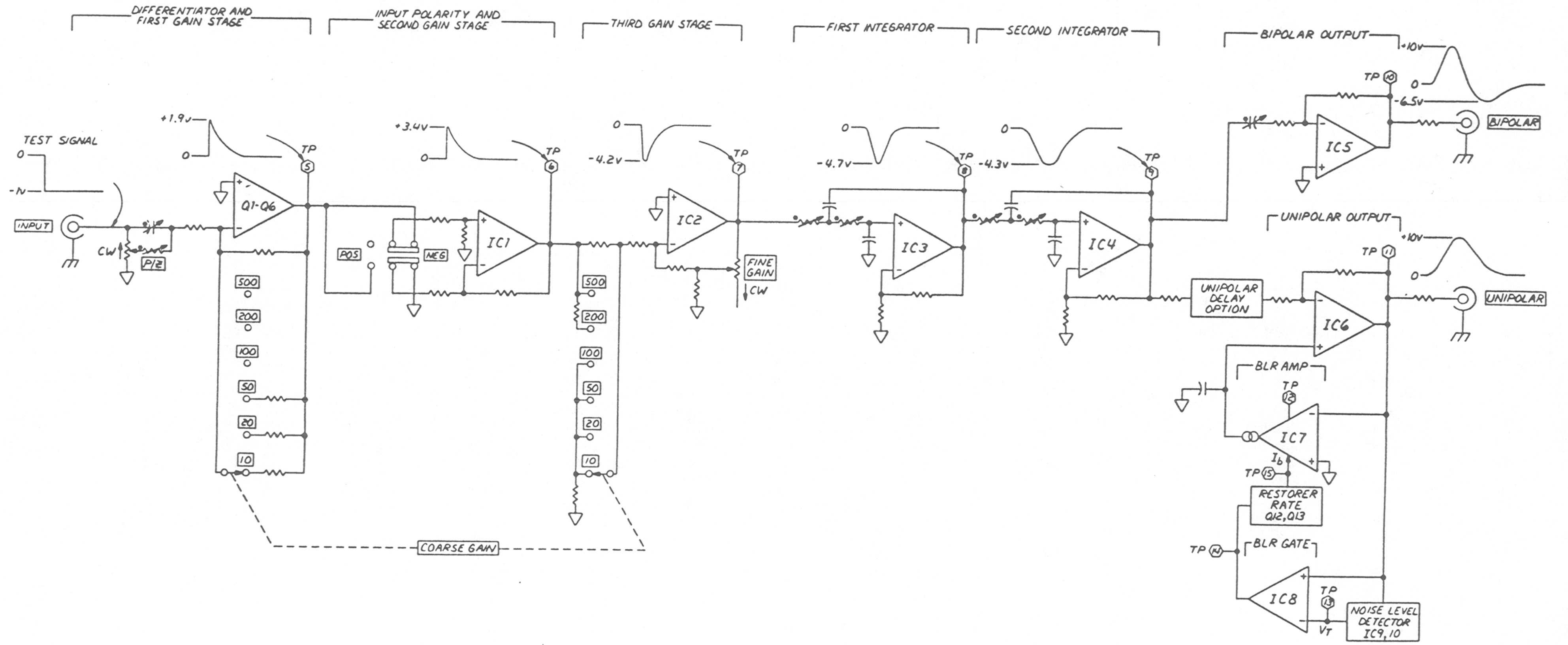
Quotations for repair of such damage will be sent for your approval before repair is undertaken.

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

8/81- Engineering and component improvements may be made after date of printing.



NOTES:

(1) • DENOTES SWITCHED 'PEAKING TIME' 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/Z: P/Z

(E) PEAKING TIME: 3 μs

(F) -1 VOLT STEP INPUT

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 ± .030 FRACTIONS ±1/64 ANGLES ±1°

TENNELEC

P O BOX D, OAK RIDGE, TENNESSEE 37830

TC 241

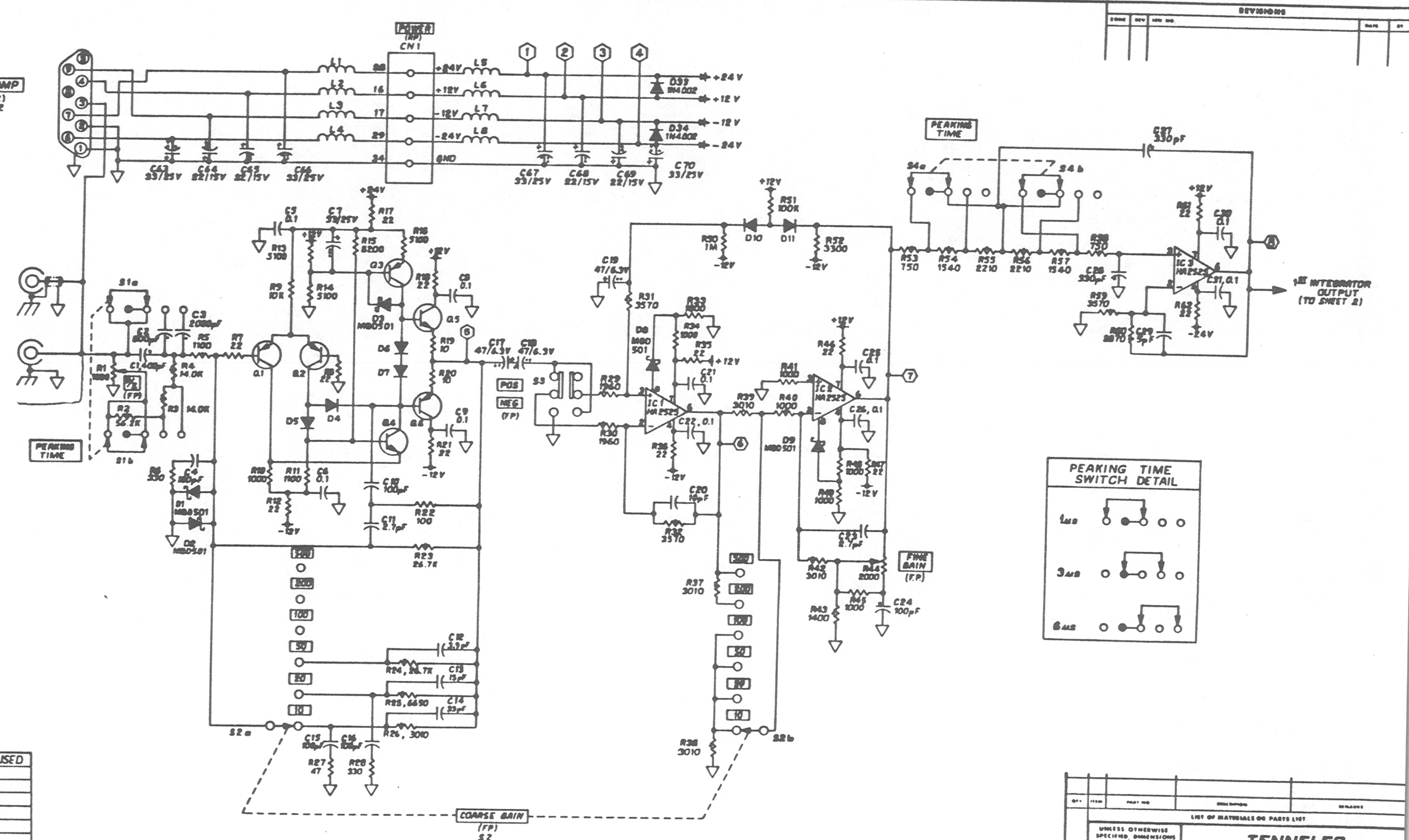
BLOCK DIAGRAM

SIZE D

D. EOSELL 9-19-81

TC 241

SCALE NONE



LAST USED	NOT USED
R142	
C70	
D34	
Q14	
IC10	
S10	
L8	
CN8	
TP15	

LIST OF MATERIALS OR PARTS LIST

UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN INCHES

TENNELEC

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

TC 241 SCHEMATIC DIAGRAM

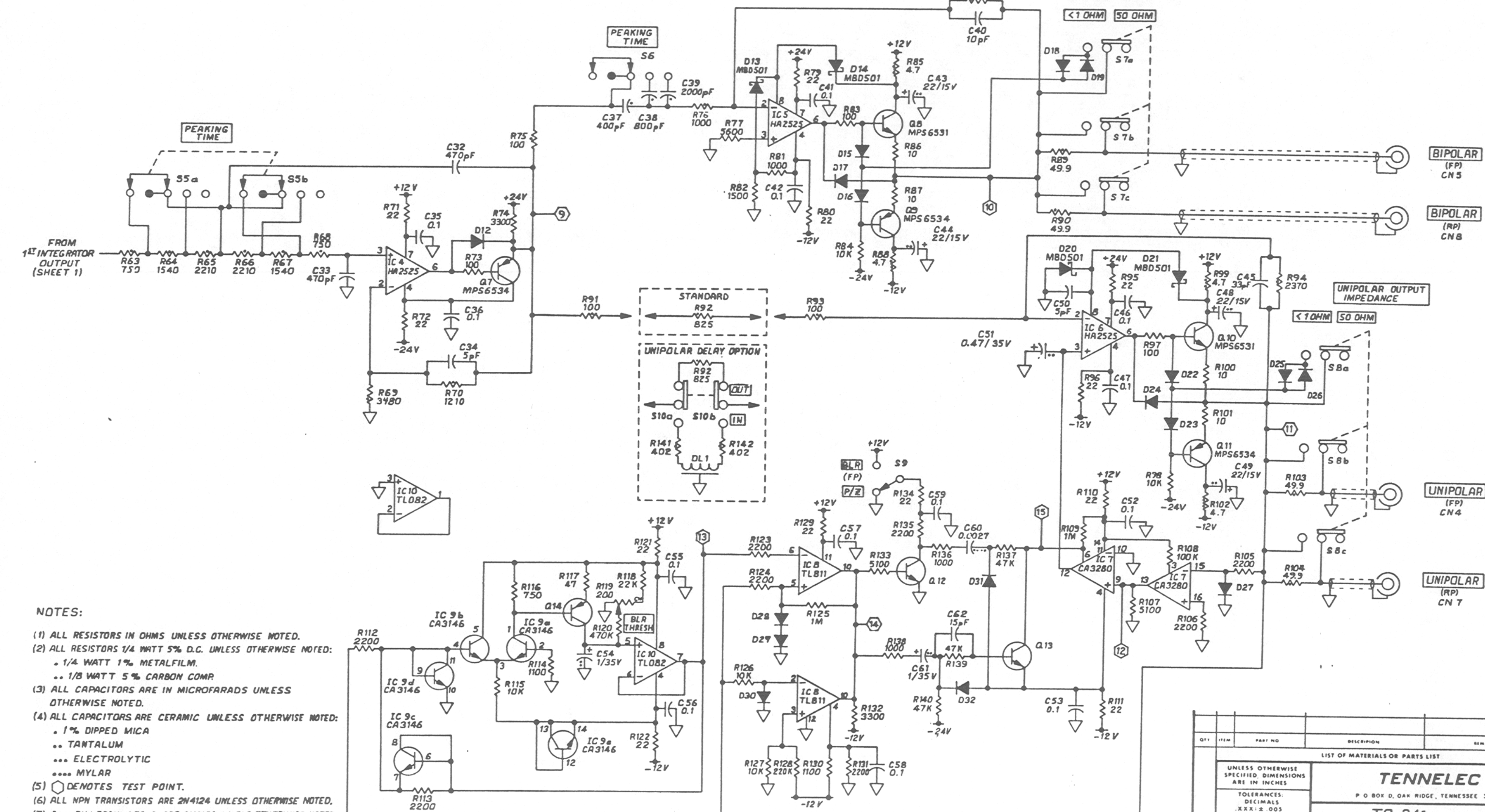
SIZE D

S. HINSHAW

SHEET 1 of 3

REVISIONS

ZONE	REV	ECN NO.		DATE	BY
	1	83-63			DG/...H



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% METALFILM.
- •• 1/8 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
- ••• ELECTROLYTIC
- •••• MYLAR

(5) ⬡ DENOTES TEST POINT.
(6) ALL NPN TRANSISTORS ARE 2N4124 UNLESS OTHERWISE NOTED.
(7) ALL PNP TRANSISTORS ARE 2N4126 UNLESS OTHERWISE NOTED.
(8) ALL DIODES ARE 1N4154 UNLESS OTHERWISE NOTED.

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

TC 241 SCHEMATIC DIAGRAM

SIZE D

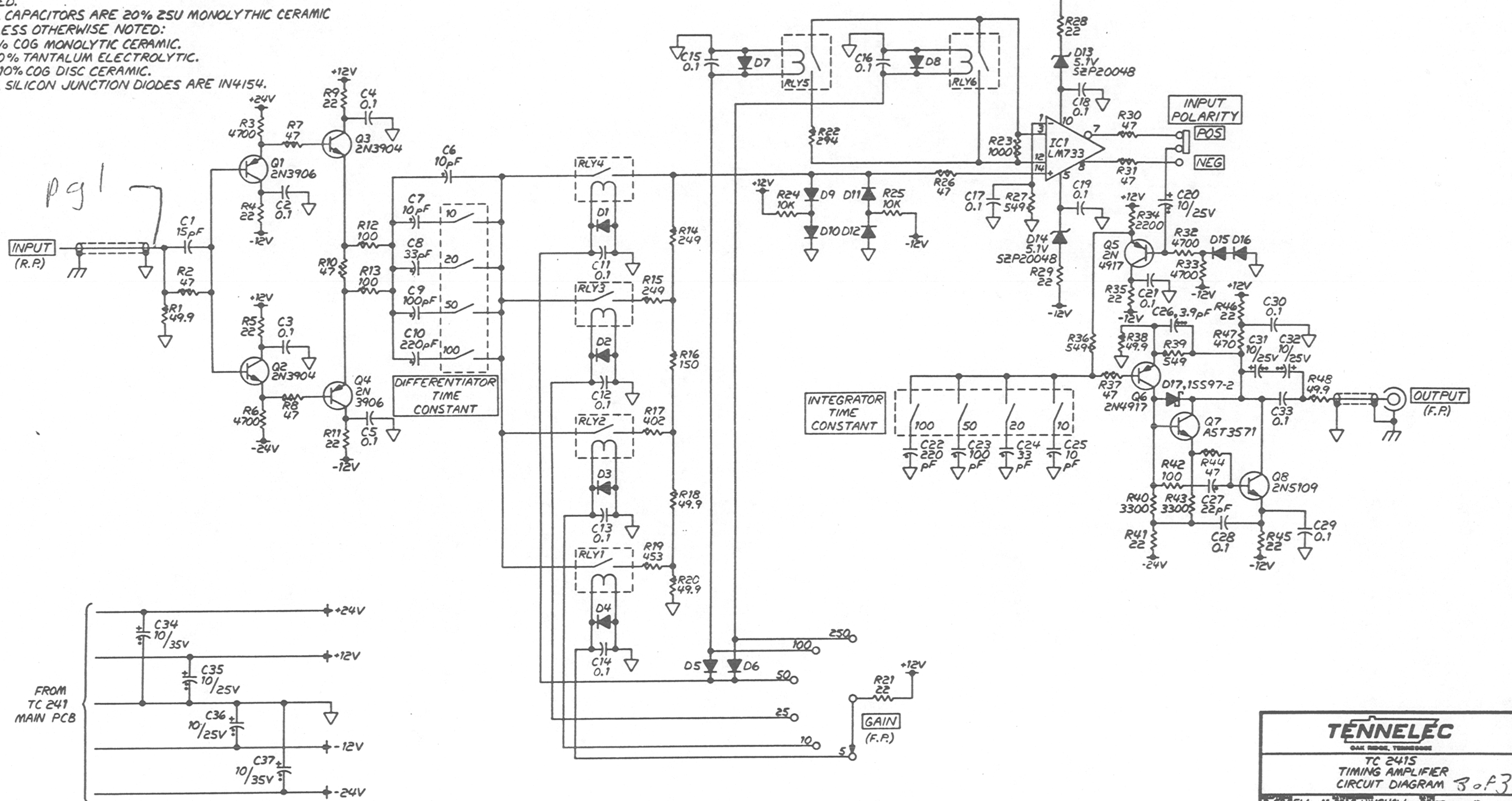
DRN BY WX BYRNE 8/81 — ENGINEER S. HINSHAW 8/81

SHEET 2 of 3

NOTES:
(1) ALL RESISTORS IN OHMS UNLESS OTHERWISE NOTED.
(2) ALL RESISTORS ARE 1/4 WATT 5% DEPOSITED CARBON UNLESS OTHERWISE NOTED:
- • 1/4 WATT 1% METAL FILM (RN 55C).
- •• 1/8 WATT 5% DEPOSITED CARBON.
- ••• 1/8 WATT 1% METAL FILM (RN50C).

(3) ALL CAPACITORS IN MICROFARADS UNLESS OTHERWISE NOTED.
(4) ALL CAPACITORS ARE 20% Z5U MONOLYTHIC CERAMIC UNLESS OTHERWISE NOTED:
- • 5% COG MONOLYTIC CERAMIC.
- •• 10% TANTALUM ELECTROLYTIC.
- ••• 10% COG DISC CERAMIC.

(5) ALL SILICON JUNCTION DIODES ARE IN4154.



REV	ECN	DESCRIPTION	INC BY	APP BY	DATE

TENNELEC

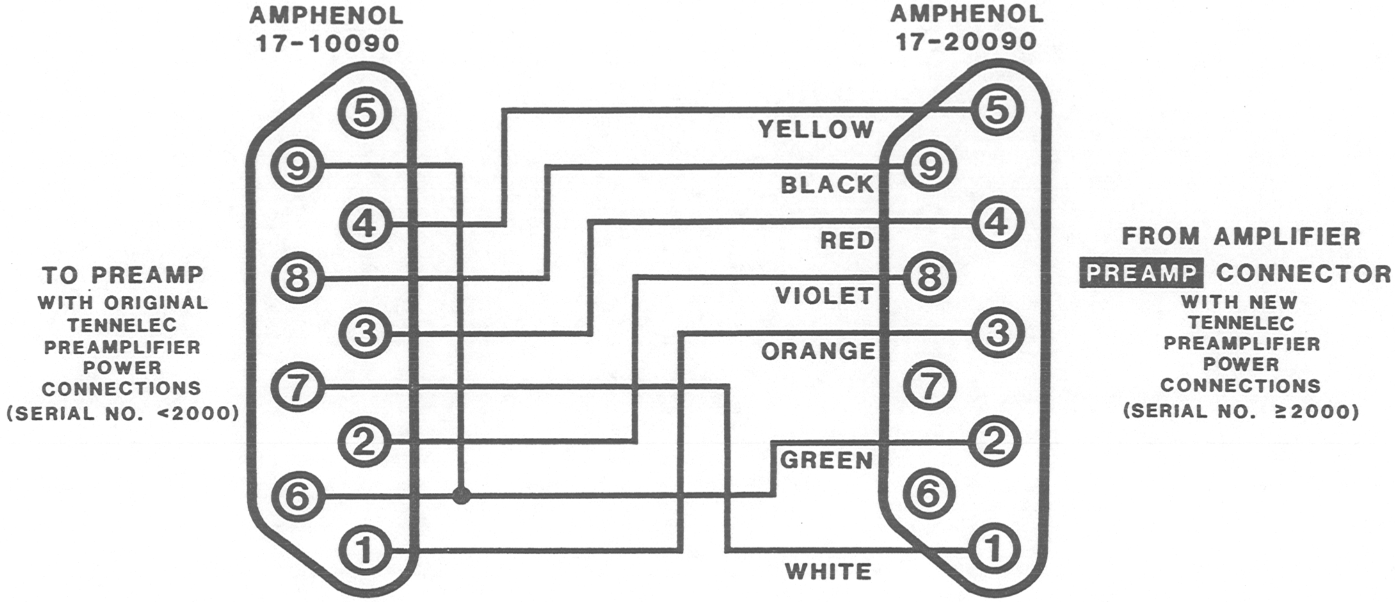
OAK RIDGE, TENNESSEE

TC 241S
TIMING AMPLIFIER
CIRCUIT DIAGRAM 3 of 3

D. EDSELL 11-83 | S. HINSHAW

TC 241S

NOTES
(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 1-7-81
CHK BY W.K.BYRNE 1-7-81
SCALE NONE
ENGINEER S.HINSHAW 1-81
ENG APP S.Hinshaw 1/8/81
MFG APP
MODEL NO.
DRAWING NO. ADT-1