INSTRUCTION MANUAL
TC953/TC954
HIGH VOLTAGE
POWER SUPPLY

WARRANTY

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

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

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

1.0 INTRODUCTION

The TENNELEC TC 953 DUAL and TC 954 single HIGH VOLTAGE POWER SUPPLY (HVPS) provide a well regulated, low-noise, dc voltage source capable of supplying up to 100uA load current in a single-width NIM module. The TC 953 / TC 954 offers two output voltage ranges, 0 to ±100 volts or 0 to ±1000 volts at 0 to 100uA load current with a digital multimeter (DMM) for display of either current or voltage. The TC 953 dual supply has totally independent controls and displays for each channel. The load current can be displayed in three full-scale ranges of 1.000, 10.00, or 100.0uA. This is especially useful in alpha spectroscopy work as it allows for easy compensation of the voltage drop in the bias network due to detector leakage current.

Several features have been incorporated in the TC 953 / TC 954 to provide protection of fragile detectors. The TC 953 / TC 954 incorporates overvoltage protection at a level of 2 volts over the front-panel control on the 100 volt range and 20 volts over the front-panel control on the 1000 volt range. The rate of increase in the output voltage is limited to 30 volts per second on the 100 volt range and 300 volts per second on the 1000 volt range. The current limit is adjustable from 10% to 120% of the full-scale current range by a front-panel control. In the event of a failure due to an overvoltage or overcurrent condition, the TC 953/TC 954 will be disabled and the output voltage will decay to zero. The output voltage will be reset every 7 seconds until the fault is cleared or after the TC 953 / TC 954 VOLTAGE switch is cycled off and on. The mode of output voltage reset is user selectable.

The output voltage of the TC 953 / TC 954 may be controlled by a remote input. A 0 to +10 volt dc signal will produce a full scale output on the TC 953 / TC 954. A remote disable input is available to reduce the output voltage to zero regardless of the front-panel control settings.

2.0 SPECIFICATIONS

2.1 PERFORMANCE

OUTPUT VOLTAGE 0 to ±100V or 0 to ±1000V.

OUTPUT CURRENT 0 to 100uA.

OUTPUT POLARITY Positive or negative, selectable through left side shield.

OUTPUT RIPPLE ≤ 1.0mV peak to peak, 5Hz to 50 MHz; typically < 300uV at full load.

OUTPUT REGULATION ≤ 0.001% or 1mV (whichever is greater) variation in output voltage for load and bin supply variations within operating range (0 to 100uA output current and ±1% variation in bin supply voltages).

OUTPUT INACCURACY ≤ ±0.25% of full scale due to nonlinearity of potentiometer; typically ≤ ± 0.1% of setting.

TEMPERATURE INSTABILITY ≤ ± 30ppm/°C, 0 to 50°C; typically ≤ ± 10ppm/°C.

LONG-TERM INSTABILITY ≤ 0.001% per 24 hour period at constant line, load, and temperature.

RESOLUTION 0.5V or better on 1000 volt range; 0.05V or better on 100 volt range.

RESETTABILITY Resettable to within 1V on 1000 volt range; resettable to within 0.1V on 100 volt range.

DISPLAY INACCURACY ≤ ± .05% ± 1 least significant digit for current and voltage.

DISPLAY TEMPERATURE INSTABILITY ≤ ± 50ppm/°C, typically ≤ ± 30ppm/°C.

OPERATING TEMPERATURE 0 to 50°C.

2.2 CONTROLS

2.2.1 FRONT-PANEL CONTROLS

DISPLAY Two-position toggle switch selects V (output voltage) or uA (output current) for display on DMM.

VOLTAGE Ten-turn precision potentiometer with linear calibration from 0.0 to 1000 corresponding to output voltages of 0 to 1000 volts or 0 to 100 volts depending on range selected.

RANGE Two-position locking toggle switch selects either 1000V or 100V full scale.

CURRENT LIMIT Single-turn potentiometer sets current limit from 10 to 120 percent of selected full scale current range.

CURRENT RANGE Three-position toggle switch (locking toggle on the TC 954) selects 100.0, 10.00, or 1.000uA full scale current range for display on DMM and CURRENT LIMIT range.

VOLTAGE Two-position toggle switch (locking toggle on TC 954) enables or disables the high voltage output. When in the OFF position, the high voltage circuit is disabled but power is applied to the low voltage section allowing the precision voltage reference to remain at a stable operating temperature. When the VOLTAGE switch is set to ON, the high voltage section is enabled.

2.2.2 INTERNAL CONTROLS

POLARITY Two-position switch (accessible through the module's left side shield) selects either positive (POS) or negative (NEG) high voltage polarity.**Refer to Section 3.2 for instructions on changing the high voltage polarity.** The TC 953 / TC 954 is shipped with the POLARITY switch in the POS position.

INT/EXT Two-position jumper selects either internal (INT) output voltage control or external (EXT) output voltage control. When the INT mode is selected, no external voltage control input is accepted. If the EXT

mode is selected, the output voltage is determined by the external control voltage. The front panel VOLTAGE control dial is not functional in the EXT mode. The TC 953 / TC 954 is shipped with the INT/EXT jumper in the INT position.

7s/PowOn Two-position jumper selects either 7 second (7s) or power on (PowOn) reset mode of operation. When in the 7s position, the TC 953 / TC 954 will recover from a fault condition and restore normal operation approximately 7 seconds after a fault condition was sensed. If the initial fault was not cleared, the TC 953 / TC 954 will continue resetting every 7 seconds until the fault is cleared. When the TC 953 / TC 954 is operated in the PowOn position, the TC 953 / TC 954 will not recover from a sensed fault condition until the VOLTAGE control is cycled from ON to OFF and back to ON. Note that the reset mode operates on sensed faults only and not on the DISABLE input. **The TC 953 / TC 954 is shipped with the 7s/PowOn jumper in the 7s position.**

2.3 CONNECTORS (Rear Panel)

OUTPUT SHV type connector provides 0 to ±100V or 0 to ±1000V output voltage. The connector is isolated from the TC 953 / TC 954 chassis to aid in the prevention of ground loops.

DISABLE BNC type connector accepts a NIM positive logic zero or a short to ground through a resistance of 100 ohms or less to disable the high voltage section. A NIM positive logic high, or an open circuit, is used to enable the high voltage section.

REMOTE BNC type connector accepts an external control signal to allow remote control of the TC 953 / TC 954 OUTPUT voltage. The external control voltage should not exceed +10.0V. The REMOTE input is protected for voltages exceeding +12V and negative voltages. The input impedance of the REMOTE input is 10k ohms. Note that only positive voltages are accepted and the OUTPUT polarity is controlled by the internal POLARITY switch.

2.4 INDICATORS

2.4.1 FRONT-PANEL INDICATORS

NEG Red LED indicator is illuminated when the TC 953 / TC 954 POLARITY switch is set to NEG.

POS Red LED indicator is illuminated when the TC 953 / TC 954 POLARITY switch is set to POS.

ON Red LED indicator is illuminated when the TC 953 / TC 954 VOLTAGE switch is set to ON.

DIS Red LED indicator is illuminated when the TC 953 / TC 954 high voltage section is disabled. The disable signal can be generated externally and applied to the DISABLE input or internally generated. The internal signal can be generated by an overvoltage condition, overcurrent condition, or by setting the VOLTAGE switch to OFF.

2.4.2 DIGITAL DISPLAY

The TC 953 / TC 954 digital display is a 3 1/2 digit multimeter (DMM) that monitors either the output voltage or the output current. The inaccuracy of the DMM is .05% of full scale ± 1 least significant digit. This results in a worse case error of ± 1.5V on the 1000V range and a worse case error of ± .15V on the 100V range. The temperature instability of the DMM is not as low as the temperature instability of the output voltage. Any drift in the output voltage as indicated by the DMM is probably due to the instability of the DMM. Typically, the TC 953 / TC 954 output voltage temperature instability is less than 10ppm/°C and the DMM is typically less than 30ppm/°C.

2.5 POWER REQUIREMENTS (TC 953, same load both channels)

TC 953 (1000V, 100uA),		TC 954 (1000V, 100uA)	
+24V, 70mA	+12V, 270mA	+24V, 35mA	+12V, 135mA
-24V, 40mA	-12V, 120mA	-24V, 20mA	-12V, 60mA

TC 953 (100V, 10uA)		TC 954 (100V, 10uA)	
+24V, 70mA	+12V, 120 mA	+24V, 35mA	+12V, 60mA
-24V, 40mA	-12V, 120 mA	-24V, 20mA	-12V, 60mA

2.6 OTHER INFORMATION

WEIGHT	TC 953	TC 954
Shipping	5.0 lbs. 2.3 kg.	4.5 lbs. 2.1 kg.

Net	3.0 lbs. 1.4 kg.	2.5 lbs 1.2 kg.

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

INSTRUCTION MANUAL One provided with each instrument ordered.

3.0 INSTALLATION

3.1 POWER CONNECTION

The TC 953 / TC 954 HVPS requires a bin and power supply, such as the TENNELEC TB3 / TC 911, for operation. The bin provides mechanical mounting and power supply distribution. Always turn the bin power supply OFF when inserting or removing any modules.

The TC 953 exceeds the maximum allowable per-module power limit of the +12V power supply when the TC 953 is heavily loaded. The +12V current requirements of each module should be totaled to ensure that the total current requirements do not exceed the capability of the bin. The TENNELEC bin provides power supply test points on the control panel for monitoring the dc voltage levels.

3.2 POLARITY SELECTION

The polarity of the output voltage is selected by a pushbutton switch accessible through the left side shield. The switch positions are labeled on the side shield and the printed circuit board. When changing the output polarity always follow the procedure below. Failure to do so is potentially dangerous and may damage the TC 953 / TC 954.

TO CHANGE THE OUTPUT POLARITY:

1) REDUCE DIAL SETTING TO ZERO.
2) SET VOLTAGE SWITCH TO OFF.
3) **VERIFY OUTPUT VOLTAGE IS ZERO AS INDICATED BY THE FRONT PANEL DISPLAY.**
4) REMOVE MODULE FROM NIM BIN and NIM BIN POWER.
5) SET HIGH VOLTAGE POLARITY SWITCH TO CORRECT POSITION.

3.3 CURRENT RANGE SELECTION

Current range selection will depend upon the detector leakage current. For normal operation, set the CURRENT RANGE control to the range covering the maximum expected operating current for your detector. Remember that the leakage current will vary as a function of temperature and could exceed the CURRENT RANGE limits if temperature variations are extreme.

3.4 CURRENT LIMIT

Unless a current limit of other than 120% of CURRENT RANGE is desired, it is recommended to operate the CURRENT LIMIT control at the 120% position as this will allow maximum utilization of the selected CURRENT RANGE.

3.5 OUTPUT CONNECTIONS

The TC 953 / TC 954 HVPS is compatible with all TENNELEC preamplifiers that include provisions to accept the high voltage bias for the detector. The output cables will require SHV type connectors at each end (For example, TENNELEC model NC-595-12 cable).

4.0 OPERATION

4.1 FIRST TIME OPERATION

Users will find it helpful to familiarize themselves with the TC 953 / TC 954 HVPS by conducting a few simple tests.

4.1.1 CONTROL SETTINGS

Set the TC 953 / TC 954 controls as follows:

FRONT PANEL

VOLTAGE SWITCH	OFF
VOLTAGE RANGE	100V
CURRENT RANGE	100uA
CURRENT LIMIT	120% (FULLY CLOCKWISE)
VOLTAGE DIAL	0.0 (FULLY COUNTER CLOCKWISE)
DISPLAY	V

INTERNAL CONTROLS (Factory Settings)

POLARITY	POS
INT/EXT	INT
7s/PowOn	7s

4.1.2 POWER SUPPLY OPERATION

Install the TC 953 / TC 954 in the bin and apply power. The digital display should momentarily indicate 88888 and then indicate 000.0 ±.2V. The 88888 indication is the **POWER ON DISPLAY TEST.** Upon application of bin power, the display will indicate 88888 in the 100V range and 8888 when in the 1000V range. Verify that the POS and DIS LED's are illuminated.

Set the VOLTAGE switch to ON. Verify that the DIS LED is not illuminated and the ON LED is illuminated. Increase the VOLTAGE dial to the desired value and observe the increase in output voltage indicated by the display. Set the DISPLAY switch to uA. The display should indicate 000.0 ±.1uA.

To verify operation of the 7 second delay for a fault condition, rapidly reduce the VOLTAGE dial setting until the DIS LED is illuminated. The DIS LED should remain illuminated for approximately 7 seconds and then extinguish. The output voltage should recover to the setting on the VOLTAGE dial. Note: this also verifies operation of the overvoltage protection mode.

To verify operation of the power on reset mode requires removal of the left side shield for access to the 7s/PowOn jumper. Place the jumper in the PowOn position and rapidly reduce the VOLTAGE dial setting as in the previous paragraph. The DIS LED should illuminate and the output should decay to zero. Wait at least 10 seconds to verify that the output does not recover and the DIS LED remains illuminated. To initiate reset, set the VOLTAGE switch to OFF, wait 2 seconds or longer, and return the VOLTAGE switch to ON. The DIS LED should extinguish and the output voltage should recover to the VOLTAGE dial setting. Return the 7s/PowOn jumper to the 7s position.

4.1.3 EXTERNAL CONTROL

Verification of operation using an external voltage source requires a stable, low-ripple, dc voltage source. Any low frequency noise present in the external control voltage will be amplified by a factor of 100 when operating the TC 953 / TC 954 on the 1000V range and by 10 when operating on the 100V range.

To operate under external voltage control, the TC 953 / TC 954 POLARITY switch must be set for the desired output polarity and the INT/EXT jumper set to EXT. The control voltage must be positive. The TC 953 / TC 954 is basically an operational amplifier with a gain of 10V/V or 100V/V. Note that the front panel VOLTAGE dial is disabled when operating in the EXT mode; however, setting the VOLTAGE dial to 0.0 is recommended. Setting the dial to zero will help prevent accidental application of bias when returning to INT control.

4.1.4 REMOTE DISABLE

The TC 953 / TC 954 rear-panel DISABLE input is designed to provide normal operation for a NIM positive logic one or an open input. The DISABLE input will inhibit operation of the TC 953 / TC 954 for a short to ground or a NIM positive logic zero. Operation of the DISABLE input can be verified by shorting the DISABLE input to ground using a BNC terminator such as a 50 ohm or 100 ohm terminator.

4.2 DETECTOR CONNECTION

ALWAYS VERIFY THAT THE TC 953 / TC 954 OUTPUT VOLTAGE, AS INDICATED ON THE DMM, IS ZERO BEFORE CONNECTING THE HIGH VOLTAGE OUTPUT TO A PREAMPLIFIER OR CONNECTING THE DETECTOR TO THE PREAMPLIFIER. CONSULT THE PREAMPLIFIER MANUAL FOR ANY NECESSARY PRECAUTIONS AND THE DETECTOR DATA SHEET FOR THE PROPER POLARITY, LEVEL OF BIAS VOLTAGE, AND ANY SPECIAL PRECAUTIONS FOR APPLYING BIAS AND HANDLING PROCEDURES.

For initial application of bias voltage, it is recommended that the VOLTAGE dial be set to 0.0 and the voltage gradually increased until the proper operating point is reached. The TC 953 / TC 954 has a maximum rate of increase in the output voltage of 30 volts per second in the 100V range and 300 volts per second in the 1000V range. The ramp feature should prove useful when removing bias from a detector and reapplying bias to the same detector as the VOLTAGE dial can be set to the proper voltage and the output controlled by the VOLTAGE switch. The ramp feature will reapply bias at a controlled rate which should be safe for the preamplifier and detector combination. The ramp feature is active on all output voltage increases including recovery from fault conditions.

4.3 DETECTOR LEAKAGE CURRENT MEASUREMENT

When initially applying bias voltage to a detector, operate the TC 953 / TC 954 with the CURRENT RANGE control in the range covering the maximum expected leakage current and with the CURRENT LIMIT control set to 120%. The DMM resolution is 0.1uA in the 100uA range, .01uA in the 10uA range and .001uA in the 1uA range. For most applications, operation on the 100uA or the 10uA range will give adequate resolution. When operating in the 1uA range, adequate time must be given for all capacitors in the preamplifier high voltage filter network to properly form at the operating voltage to obtain an accurate leakage current reading. Additionally, the final high voltage filter capacitor in the TC 953 / TC 954 must be allowed to form properly. This time will vary with applied voltage and is usually less than 2 minutes for voltages less than 500V. The typical error generated by not allowing for the current to settle to zero is less than .002uA.

4.4 LOADING EFFECTS

The TC 953 / TC 954 is, in effect, a noninverting operational amplifier and has a low output impedance. The feedback signal is taken directly at the output and the output impedance is approximately zero. The output voltage is essentially independent of load, with less than .001% variation (typically less than .0003%) for a 0 to 100 uA change in output current.

To determine the actual voltage on a detector, the resistance between the output of the TC 953 / TC 954 and the detector itself must be identified. Since the bias voltage is usually supplied through a detector load resistor in the preamplifier and then to the detector, the resistance can usually be determined from the preamplifier schematic diagram. The actual detector voltage (V_{DET}) can be determined by

$$V_{DET} = V_{HVPS} - I_{DET}R_L$$

where V_{HVPS} is the TC 953 / TC 954 output voltage, I_{DET} is the detector leakage current as indicated by the TC 953 / TC 954 display in the uA mode, and R_L is the detector load resistance. The TC 953 / TC 954 provides a direct reading of the detector leakage current down to the nanoampere level.

5.0 MAINTENANCE

The TC 953 / TC 954 is a highly stable and precision power supply. Periodic calibration or adjustment is not necessary and is not recommended as a routine procedure. Precise measurement of the TC 953 / TC 954's performance requires specialized and expensive test equipment. If trouble should arise, it is strongly recommended that the unit be returned to TENNELEC for repair. If it is impossible to return the unit to TENNELEC for repair, a detailed Test Procedure is available upon request. Observe the following procedure before removing the TC 953 / TC 954 side shields.

CAUTION

DANGEROUS VOLTAGES & CURRENTS EXIST INSIDE THIS INSTRUMENT. BEFORE REMOVING SIDE SHIELD:

1) REDUCE DIAL SETTING TO ZERO.
2) SET VOLTAGE SWITCH TO OFF.
3) VERIFY OUTPUT VOLTAGE IS ZERO AS INDICATED BY THE FRONT PANEL DISPLAY.
4) REMOVE FROM NIM BIN AND NIM BIN POWER.
5) WAIT 10 SECONDS BEFORE REMOVING SIDE SHIELDS.

THE HIGH VOLTAGES PRESENT IN THIS INSTRUMENT ARE HAZARDOUS. DO NOT ATTEMPT ANY ADJUSTMENTS OR MAINTENANCE UNLESS YOU ARE EXPERIENCED WITH HIGH VOLTAGE CIRCUITS.

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 contained in that 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.

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. 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 return it.

Should return prove necessary, the TENNELEC Customer Service Manager must be informed in WRITING, BY CABLE OR TWX of the nature of the fault and the model number and serial number of the instrument. Pack the instrument well and ship PREPAID and INSURED to TENNELEC, Inc., 601 Oak Ridge Turnpike, Oak Ridge, Tennessee 37830. As stated in the warranty DAMAGE IN 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.

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* TENNELEC'S Quality Assurance Program requires *
* that each and every instrument be fully aged, *
* vibrated, and electronically tested. *
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* 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. *
*
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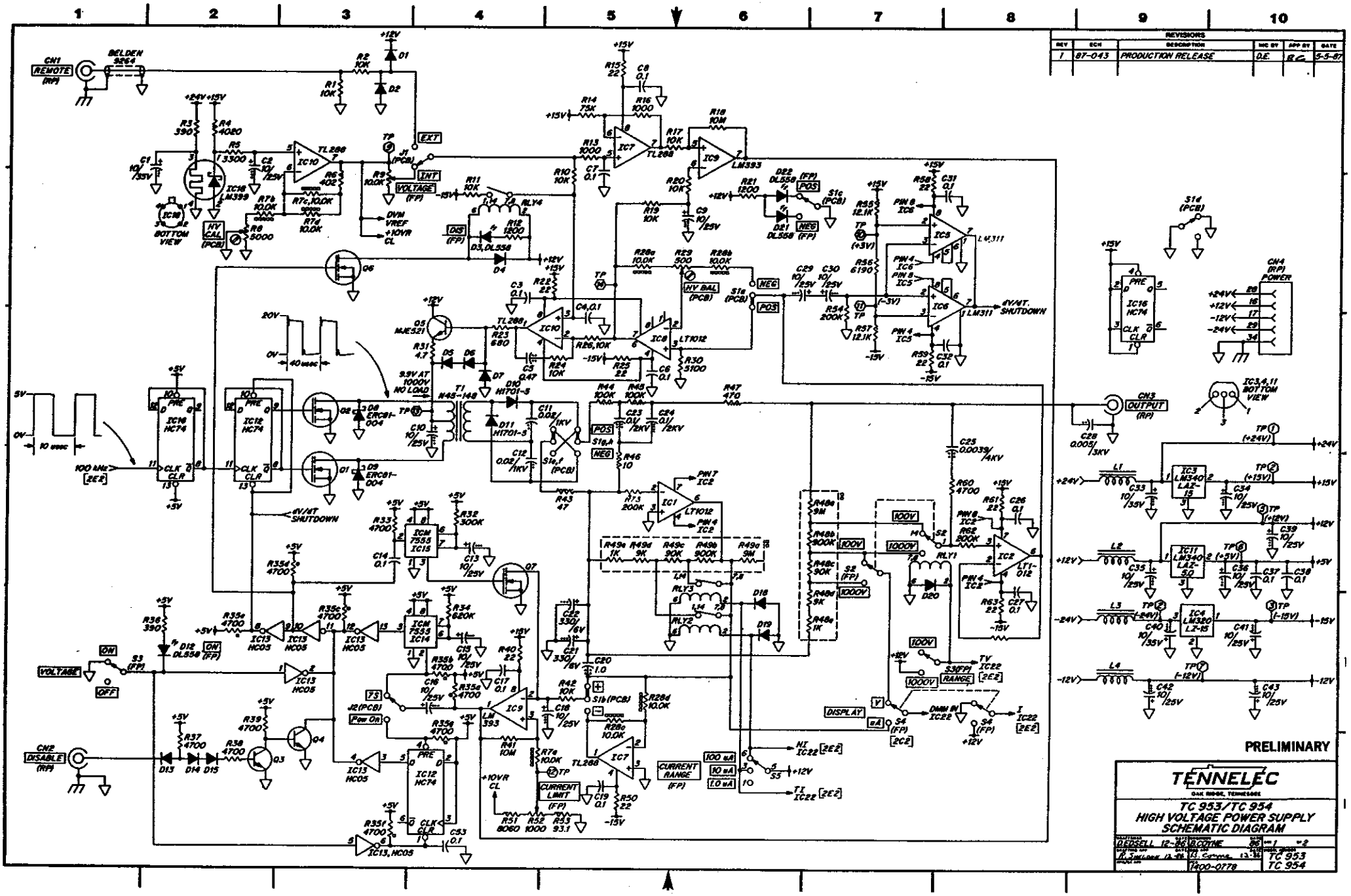
MANUAL REV. 0

9/24/86 - Engineering and component improvements may be made after date of printing.


REVISIONS
REV | ECN | DESCRIPTION | MFG BY | APP BY | DATE
1 | 87-043 | PRODUCTION RELEASE | D.E. | | 5-5-87
CN1 REMOTE (RP)
BELDEN 9264
CN2 DISABLE (RP)
CN3 OUTPUT (RP)
CN4 (RP) POWER
+12V
+15V
+24V
-12V
-15V
+5V
-24V
D1
D2
R1 10K
R2 10K
R3 390
R4 402Ω
R5 13300
R6 402
R7a,10.0K
R7b 10.0K
R7c,10.0K
R8 5000
R9 10.0K
R10 10K
R11 10K
R12 1200
R13 1000
R14 75K
R15 22
R16 1000
R17 10K
R18 10M
R19 10K
R20 10K
R21 1200
R22 22
R23 680
R24 10K
R25 22
R26,10K
R28a 10.0K
R28b 10.0K
R29 500
R30 5100
R31 4.7
R32 300K
R33 4700
R34 620K
R35a 4700
R35b 4700
R35c 4700
R35d 4700
R35e 4700
R35f 4700
R36 390
R37 4700
R38 4700
R39 4700
R40 22
R41 10M
R42 10K
R43 47
R44 100K
R45 100K
R46 10
R47 470
R48a 9M
R48b 900K
R48c 90K
R48d 9K
R48e 1K
R49a 1K
R49b 900K
R49c 90K
R49d 9K
R49e 9M
R50 22
R51 8060
R52 1000
R53 93.1
R54 200K
R55 12.1K
R56 6190
R57 12.1K
R59 22
R60 4700
R61 22
R62 200K
R63 22
R64 10.0K
C1 10/35V
C2 10/25V
C3 0.1
C4,0.1
C5 0.47
C6 0.1
C7 0.1
C8 0.1
C9 10/25V
C10 10/25V
C11 0.02/1KV
C12 0.02/1KV
C13 10/25V
C14 0.1
C15 10/25V
C16 10/25V
C17 0.1
C18 10/25V
C19 0.1
C20 1.0
C21 330/6V
C22 330/6V
C23 0.1/2KV
C24 0.1/2KV
C25 0.0039/4KV
C26 0.1
C27 0.1
C28 0.005/3KV
C29 10/25V
C30 10/25V
C31 0.1
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C36 10/25V
C37 0.1
C38 0.1
C39 10/25V
C40 10/35V
C41 10/25V
C42 10/25V
C43 10/25V
IC1 LT1012
IC2 LT1-012
IC3 LM340 LAZ-15
IC4 LM320 LZ-15
IC5 LM311
IC6 LM311
IC7 TL288
IC8 LT1012
IC9 LM393
IC10 TL288
IC11 LM340 LAZ-5.0
IC12 HC74
IC13 HC05
IC14 7555
IC15 7555
IC16 HC74
IC17 HC74
IC18 LM399
IC19 HC74
IC20 HC74
IC21 HC74
IC22 DVM
Q1 ERC81-004
Q2 ERC81-004
Q3
Q4
Q5 MJE521
Q6
Q7
Q8
D3,DL558
D4
D5
D6
D7
D8 ERC81-004
D9 ERC81-004
D10 HITF01-5
D11 HITF01-5
D12 DL558
D13
D14
D15
D16
D17
D18
D19
D20
D21 DL558
D22 DL558
T1 N45-1488
RLY1
RLY2
RLY3
RLY4
S1a (PCB) POS NEG
S1b (PCB)
S1c (PCB)
S2 (FP) 100V 1000V
S3 (FP) VOLTAGE OFF RANGE
S4 (FP) DISPLAY V mA
S5 CURRENT RANGE 100 mA 10 mA 1.0 mA
S6 (FP) EXT INT VOLTAGE
S7 (FP) OVERLOAD
S8 (FP) DISABLE
S14 (PCB)
TP1 (+24V)
TP2 (+15V)
TP3 (+12V)
TP4 (+5V)
TP5 (-5V)
TP6 (-12V)
TP7 (-15V)
TP8 (-24V)
TP9 (+3V)
TP10 (-3V)
TP11
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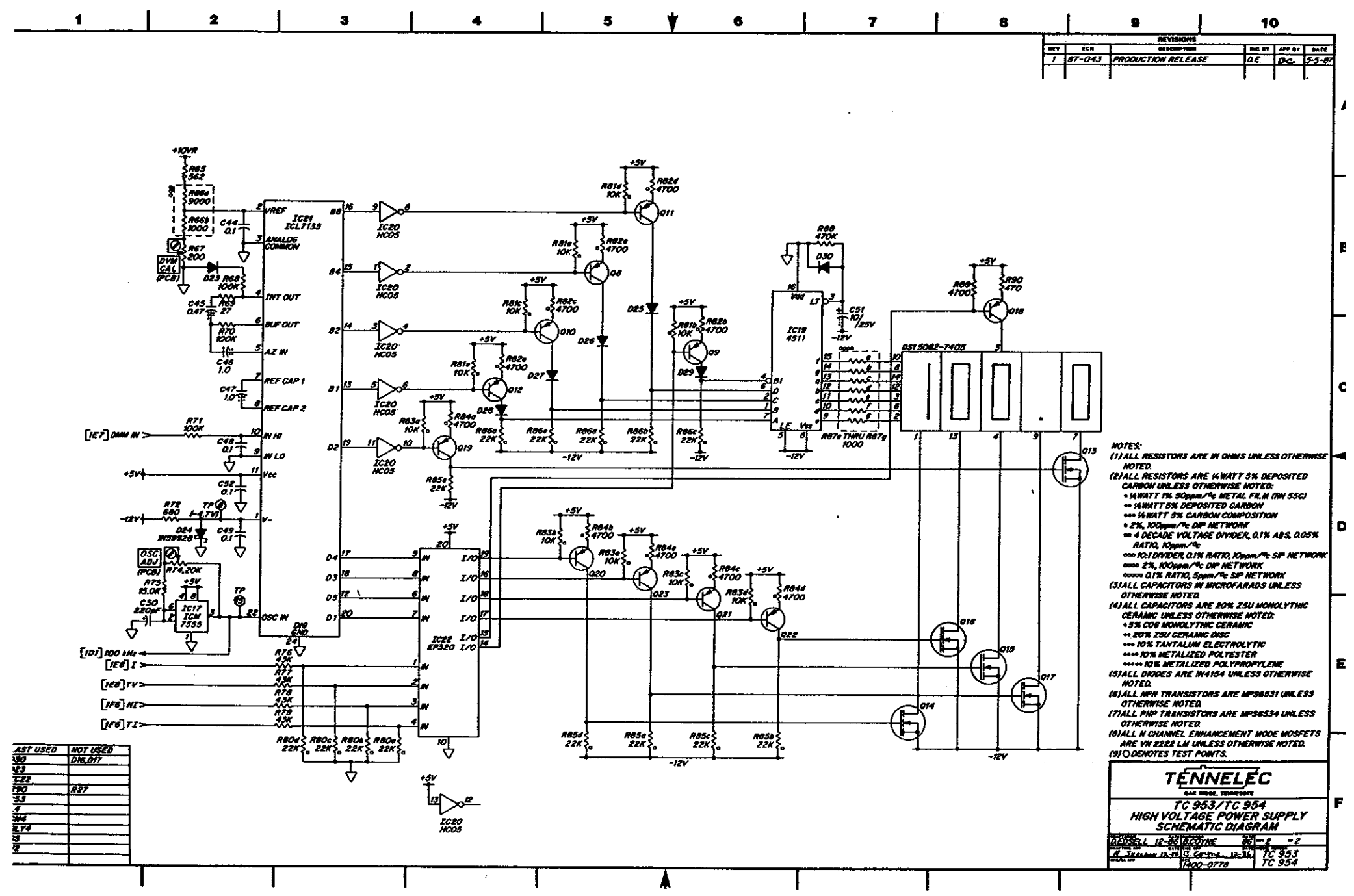
PRELIMINARY
TENNELEC
OAK RIDGE, TENNESSEE
TC 953/TC 954
HIGH VOLTAGE POWER SUPPLY
SCHEMATIC DIAGRAM
DRAWN REDSELL 12-86
TRACED CONE
SIZE D
SHEET 1 OF 2
APPROVED
DATE 12-15-86
TC 953
TC 954
100-0778


REVISIONS
REV | ECN | DESCRIPTION | ENG BY | APP BY | DATE
1 | 87-043 | PRODUCTION RELEASE | D.E. | pc. | 5-5-87
+10VR
R65 562
R66a 9000
R66b 1000
R67 200
DVM CAL (PCB)
D23 R68 100K
C44 0.1
C45 0.47
R69 27
R70 100K
C46 1.0
C47 1.0
IC21 ICL7135
VREF
ANALOG COMMON
INT OUT
BUF OUT
AZ IN
REF CAP 1
REF CAP 2
IN HI
IN LO
Vcc
V-
OSC IN
DIG GND
[IE7] DMM IN
R71 100K
C48 0.1
C52 0.1
C49 0.1
+5V
-12V
R72 680
TP 4.7V
D24 IN5932B
OSC ADJ (PCB)
R74 20K
R75 15.0K
C50 220pF
IC17 ICM 7555
TP
[ID1] 100 kHz
[IE6] I
[IE8] TV
[IF6] HI
[IF6] TI
R76 43K
R77 43K
R78 43K
R79 43K
R80d 22K
R80c 22K
R80b 2.2K
R80a 22K
IC20 HC05
IC22 EP320
R81d 10K
R82d 4700
Q11
R81a 10K
R82a 4700
Q8
R81c 10K
R82c 4700
Q10
R81b 10K
R82b 4700
Q9
R81e 10K
R82e 4700
Q12
R83a 10K
R84a 4700
Q19
R86a 22K
R86d 22K
R86b 22K
R86c 22K
R85a 22K
D25
D26
D27
D28
D29
D30
R88 470K
IC19 4511
C51 10/25V
R87a THRU R87g 1000
DSI 5082-7405
R89 4700
R90 470
Q18
Q13
R83b 10K
R84b 4700
Q20
R83c 10K
R84c 4700
Q23
R83d 10K
R84d 4700
Q21
Q22
Q16
Q15
Q17
Q14
R85d 22K
R85b 22K
R85c 22K
NOTES:
(1) ALL RESISTORS ARE IN OHMS UNLESS OTHERWISE NOTED.
(2) ALL RESISTORS ARE ¼WATT 5% DEPOSITED CARBON UNLESS OTHERWISE NOTED:
* ¼WATT 1% 50ppm/°C METAL FILM (MW 55C)
** ½WATT 5% DEPOSITED CARBON
*** ½WATT 5% CARBON COMPOSITION
* 2%, 100ppm/°C DIP NETWORK
** 4 DECADE VOLTAGE DIVIDER, 0.1% ABS, 0.05% RATIO, 10ppm/°C
*** 10:1 DIVIDER, 0.1% RATIO, 10ppm/°C SIP NETWORK
**** 2%, 100ppm/°C DIP NETWORK
***** 0.1% RATIO, 5ppm/°C SIP NETWORK
(3) ALL CAPACITORS IN MICROFARADS UNLESS OTHERWISE NOTED.
(4) ALL CAPACITORS ARE 20% Z5U MONOLYTHIC CERAMIC UNLESS OTHERWISE NOTED:
* 5% COG MONOLYTHIC CERAMIC
** 80% Z5U CERAMIC DISC
*** 10% TANTALUM ELECTROLYTIC
**** 10% METALIZED POLYESTER
***** 10% METALIZED POLYPROPYLENE
(5) ALL DIODES ARE IN4154 UNLESS OTHERWISE NOTED.
(6) ALL NPN TRANSISTORS ARE MPS6531 UNLESS OTHERWISE NOTED.
(7) ALL PNP TRANSISTORS ARE MPS6534 UNLESS OTHERWISE NOTED.
(8) ALL N CHANNEL ENHANCEMENT MODE MOSFETS ARE VN 2222 LM UNLESS OTHERWISE NOTED.
(9) ○ DENOTES TEST POINTS.
LAST USED | NOT USED
U30 | D16,D17
U31
U32
U22
U20 | R27
U33
U4
U34
U19
U5
U6
TENNELEC
OAK RIDGE, TENNESSEE
TC 953/TC 954
HIGH VOLTAGE POWER SUPPLY
SCHEMATIC DIAGRAM
DESIGNED | APPROVED | SIZE | REV
GRISELL 12-86 | BECKME 86 | D | 2
DRAWN | CHECKED | SCALE | SHEET
A. Tarleton 12-15 | D. Carter 12-16 | | 2
400-0778
TC 953
TC 954