Model 2002
Spectroscopy
Preamplifier

User's Manual

9231793B

ISO 9001
SYSTEM
CERTIFIED

CE

Canberra Industries, 800 Research Parkway, Meriden, CT 06450
Tel: 203-238-2351 FAX: 203-235-1347 http://www.canberra.com

Printed in the United States of America.

Table of Contents

Notes

1. Introduction

The Canberra Model 2002 Ge Detector Preamplifier is a low noise, high speed preamplifier designed for high resolution gamma spectroscopy and timing measurements using cooled germanium detectors. The 2002 converts the ionization charge developed in the detector during each absorbed nuclear event to a step-function output pulse whose amplitude is proportional to the total charge accumulated in the event. The pulse decays exponentially with a time constant of 50 µs (nominal) to segregate successive events in high count rate applications.

The preamplifier includes a low noise FET input circuit optimized for the ultra-high source impedance of germanium detectors. A protection network prevents damage to the amplifier input from high voltage transients. The charge amplifier and buffer stages have been designed for both the low noise and high speed performance needed for precise energy and timing spectroscopy. In addition, special circuits monitor both the temperature and activity of the detector, and warn when improper operating conditions exist. A high voltage filter insures a noise-free power source for the detector.

The block diagrams in Figures 1 and 2 show a functional breakdown of the preamplifier. The first stage serves as an integrator yielding an output voltage proportional to the accumulated charge from the detector. A differentiator follows the first stage and includes a calibrated pole/zero network to provide the unipolar signal with an accurate return to baseline. The second amplifier serves as an output buffer and allows preamp conversion factors of 100 mV/MeV or 500 mV/MeV, jumper selectable. Separately terminated Energy and Timing outputs are available. A calibrated offset adjustment insures a nominal quiescent dc output of zero volts.

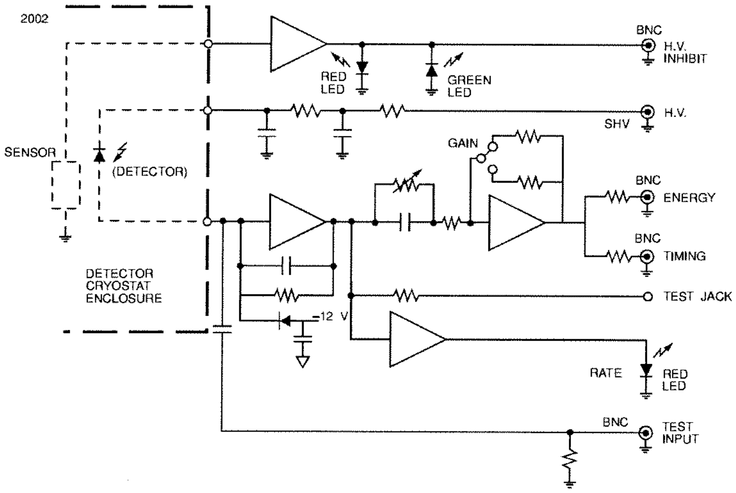


Figure 1 Model 2002 Block Diagram

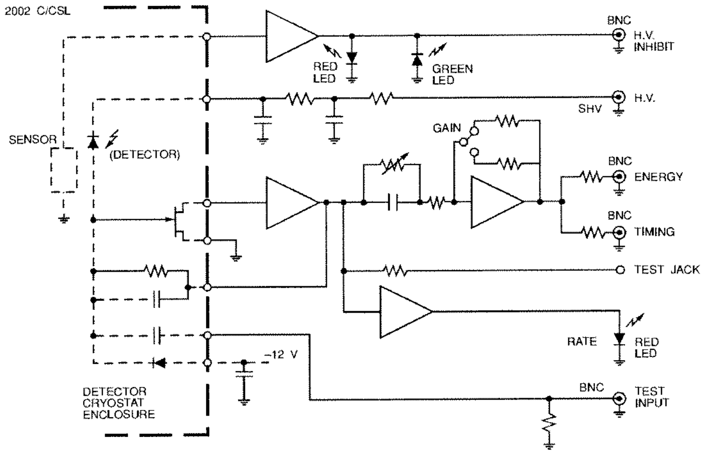


Figure 2 Model 2002C/CC/CSL Block Diagram

To reduce noise, the Model 2002C/CC/CSL's input circuits are cooled by mounting them inside the cryostat, creating an integral detector/preamp assembly. For installations requiring more flexibility, the standard Model 2002 includes all input circuits for coupling direct to the detector.

The low noise performance of the Model 2002 is the current state-of-the-art for room temperature (non-cooled) preamps. The noise level for the room temperature Model 2002 (direct coupled) is equivalent to less than 500 eV FWHM (Ge) with a source capacitance of 0 pF, using 4 µs near-Gaussian pulse shaping, and degrades at less than 17 eV/pF. Typical noise performance with other pulse shaping time constants can be seen in Figure 8 on page 17. In order to optimize the signal-to-noise ratio for low energy sources, the gain can be switched to the higher setting.

The fast rise time of the 2002 is maintained over a wide range of detector capacitances, making the preamp an excellent choice for timing measurements. Timing analysis can be done using Canberra Timing-Filter Amplifiers. Constant Fraction Discriminators and Time to Amplitude Converters as required.

The count rate capability of the Model 2002 has been demonstrated in excess of 200 000 counts per second using a ^{60}Co gamma energy source (1.33 MeV peak). In order to take advantage of the high-count-rate capability of the 2002, a Canberra high-count-rate main shaping amplifier is recommended.

A source which is too active may lead to detector-preamp overload. As the maximum rate-energy product is approached, the preamp may operate intermittently, producing excessive peak shift and resolution degradation. When the maximum rate-energy product is reached, the preamp will shut down. The Model 2002 includes a yellow High Rate warning LED which glows when the high rate condition is approached.

Germanium detectors operate properly only when cooled to liquid nitrogen temperatures. The Model 2002 preamp includes a monitoring circuit which operates in conjunction with a temperature probe thermally connected to the detector. If the detector temperature is correct, the green LED will glow. If the temperature of the detector rises beyond the normal operating range, the yellow High Voltage Inhibit LED will turn on. The Inhibit signal available on the rear panel BNC connector is used to disable the high voltage supply under these conditions.

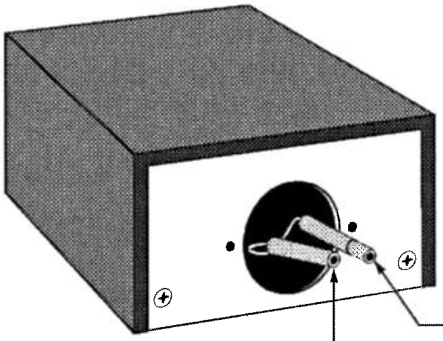
A test input is provided to assist system setup and as a diagnostic aid. The nominal voltage gain through the preamplifier test input is 1X for the output scale factor of 100 mV/MeV and 5X for the output scale factor of 500 mV/MeV.

The output of the charge integrator is available at a rear panel test jack for detector/preamplifier troubleshooting. The VI characteristics of the detector can be readily checked by measuring the test-point voltage as a function of detector bias voltage.

Power for the Model 2002 is usually supplied from the associated Canberra pulse shaping amplifier. The power lines are filtered within the Model 2002 to provide high noise immunity. A 3 m (10 ft) power cable is provided with the preamp.

2. Controls and Connectors

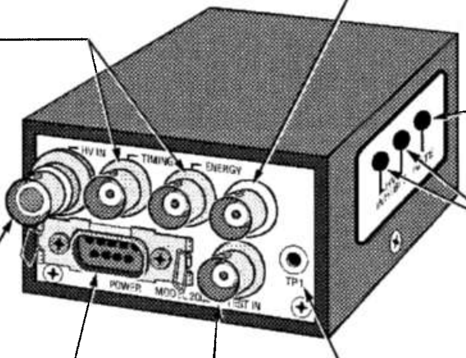
This is a brief description of the 2002's controls and connectors. For more detailed information, refer to Appendix A, *Specifications*. Note that the 2002CC and 2002CSL preamp enclosures are different than those shown for the 2002 and 2002C.



DETECTOR BIAS
To Anode if – HV
To Cathode if + HV
(Red sleeving).

DETECTOR INPUT
accepts charge pulse
from Detector
(Black sleeving).

Figure 3 Front Panel Connectors



HV INHIBIT OUPUT - Shuts off high voltage supply if detector is too warm Output at 12 V during normal operation, or ground when temperature is too high.

ENERGY & TIMING OUTPUTS - Output signals are identical (see specifications for details). Either or both outputs may be employed as desired since they are isolated from each other. Timing output is 50 ohms impedance. Energy output is 93 ohms impedance.

HIGH RATE INDICATOR LED glows red when preamp approaches maximum count rate.

HV INHIBIT INDICATORS indicate correct detector temperature and LN level when green LED is lit, fault condition when red LED is lit.

HV INPUT - Detector bias from supply such as Canberra Model 3106D. SHV connector, rated ± 5000 V dc.

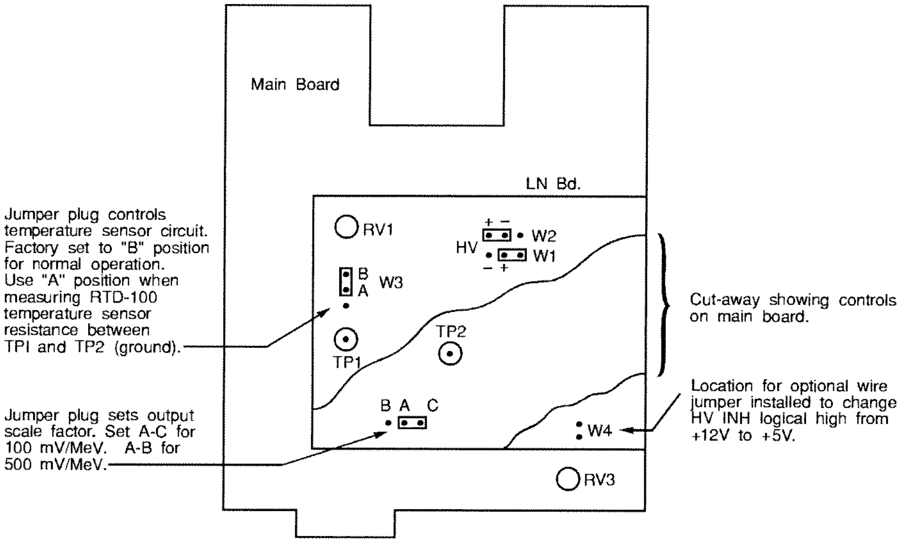
POWER - Accepts ± 12 and ± 24 V dc from main amplifier.

TEST INPUT - Charge coupled to preamp input at 0.5 pC/V. Input impedance 93 ohms.

TEST JACK - Used to monitor charge integrator output directly, or monitor detector leakage. Output impedance 10 kilohms.

Figure 4 Rear Panel Connectors

Internal Controls



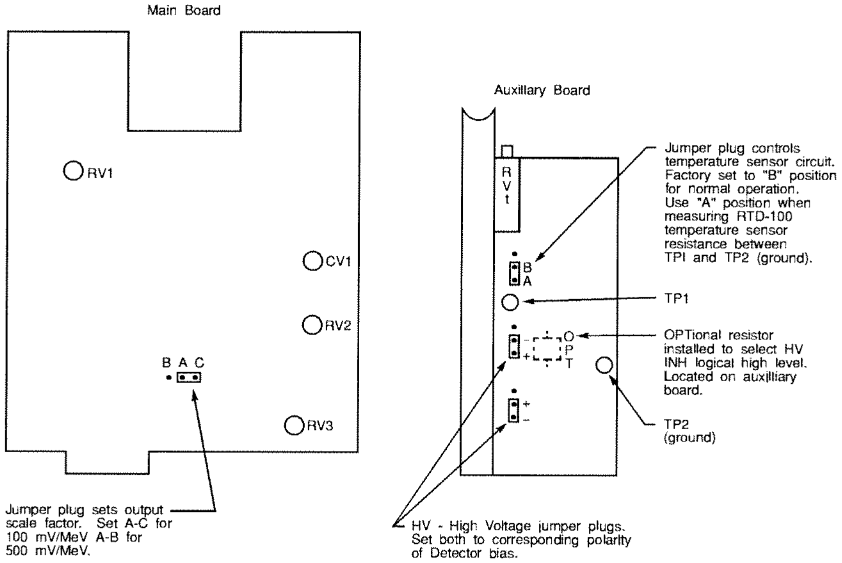
Jumper plug controls temperature sensor circuit. Factory set to "B" position for normal operation. Use "A" position when measuring RTD-100 temperature sensor resistance between TPI and TP2 (ground).

Jumper plug sets output scale factor. Set A-C for 100 mV/MeV. A-B for 500 mV/MeV.

Cut-away showing controls on main board.

Location for optional wire jumper installed to change HV INH logical high from +12V to +5V.

Figure 5 2002/C/CSL Internal Controls



Jumper plug sets output scale factor. Set A-C for 100 mV/MeV A-B for 500 mV/MeV.

Jumper plug controls temperature sensor circuit. Factory set to "B" position for normal operation. Use "A" position when measuring RTD-100 temperature sensor resistance between TPI and TP2 (ground).

TP1

OPTional resistor installed to select HV INH logical high level. Located on auxiliary board.

TP2 (ground)

HV - High Voltage jumper plugs. Set both to corresponding polarity of Detector bias.

Figure 6 2002CC Internal Controls

3. Installation

The Model 2002 preamp connects to the body of a detector cryostat which has accessible anode and cathode leads. It is direct coupled at the input for installations in which both terminals of the detector are electrically isolated from ground.

Mounting the Model 2002

The front panel of the Canberra Model 2002 is reversible to facilitate either end-mounting or side-mounting to the cryostat as desired. The panel provides a 25 by 35 mm opening for routing the input leads to the detector feed-through pins, and two number 4-40 tapped holes for mounting an adapter bracket for the particular cryostat body.

Mounting may be accomplished most readily and conveniently if the cover is removed from the preamplifier. However, the user must be very cautious not to touch the high voltage capacitors or high megohm resistors in the detector bias supply, otherwise fingerprints and residue will degrade noise performance. It is also suggested that the input leads be dressed away from each other and from the chassis to minimize the stray capacitances which aggravate noise.

Precautions

Strict attention must be paid to these precautions in order to insure optimum performance and reliability. Since the Model 2002 is a state of the art ultra-low noise preamplifier, field repairs are not recommended.

The user must be very cautious in inspecting or adjusting the Preamplifier, particularly in the area of the high voltage components as described above.

⚠ While the long filter time constant relieves restrictions on the rate of voltage applied to the HV INPUT, the user should never connect or disconnect the Preamplifier from a detector while the high voltage is ON. Always wait at least 5 minutes after the detector bias has been reduced to zero (allowing the filter to fully discharge back into the High Voltage Power supply), before disconnecting the preamplifier from the detector.

If the preamplifier is to be used in an environment of high relative humidity, special precautions, and possible special treatment at the factory, may be necessary to minimize extraneous noise or possible destruction of the FET due to high voltage leakage and discharges.

Connecting the Preamp

Rear panel connections are made as follows. The Energy output is used to connect to a spectroscopy amplifier such as the Canberra Model 2020. The Timing output, which has 50 Ω impedance, should be used for timing experiments. The High Voltage Bias connection should be made using a high voltage cable to the high voltage supply. If the High Voltage Inhibit feature is used, connection should be made to the bias supply's inhibit input. Power should be taken from the associated amplifier with the supplied power cable.

To prevent ground loop noise from entering the system, the H.V. Input and H.V. Inhibit Output grounds are isolated. To maintain this isolation on the 2002CC and 2002CSL preamps, slip the flexible sleeving included with the preamp over the BNC and SHV connector shells after connecting the cables.

Mounting Models 2002C, CC, and CSL

The Model 2002C, CC, and CSL preamps are normally mounted and connected to the detector at the factory.

Preventative Maintenance

Preventative maintenance is not required for this unit.

When needed, the front panel of the unit may be cleaned. Remove power from the unit before cleaning. Use only a soft cloth dampened with warm water and make sure the unit is fully dry before restoring power. *Do not* use any liquids directly on the preamp housing, front, or rear panels.

4. Operating Instructions

This chapter will acquaint you with the operating features of the Model 2002 family of preamplifiers and discuss system considerations.

Temperature Monitoring Circuit

Before applying power to the system, make sure the High Voltage Inhibit connection has been made to the inhibit input of the high voltage supply. When the preamp is turned on, the green LED will glow if the detector has already been cooled to LN temperatures.

If the HV INHIBIT feature is in use and the detector temperature is not correct, the HV Inhibit output will prevent high voltage from being applied and the yellow HV Inhibit LED will turn on. Remember that preamp power must be on for the High Voltage Inhibit output to function.

If the liquid nitrogen in the Dewar flask runs low, the yellow LED will light and the external high voltage power supply will be shut down. The Inhibit output is normally +12 V when detector temperature is correct and approximately +0.1 V during a fault condition. If you are using a high voltage supply not manufactured by Canberra, make sure the inhibit input is compatible with the preamp output.

Some high voltage supplies may require a logical high voltage of +5 V instead of +12 V. If it is necessary to change the Inhibit output swing of the 2002, 2002C or 2002CSL to +5 V, install and solder a wire jumper on the LN Monitor Board in the location marked W4. (See Figure 5) On the 2002CC, to change from +12 V to +5 V logical high, install and solder a 10 kΩ, ¼ W resistor on the Auxiliary Board in the space marked OPT. See Figure 6 on page 5.

High Rate Indicator

The High Rate warning indicator will light when the preamp is being overdriven by too active a source. Higher energy sources will cause preamp saturation at a lower count rate than lower energy sources. If the light flickers, the preamp is entering the overload region. If it glows steadily, it may be necessary to reduce the exposure of the detector to source activity by separating the detector and the source. The light will also glow if excessive leakage develops in the detector. When first powered up, the LED may turn on for several seconds due to transient conditions.

Common Operating Problems

The modern Ge gamma ray spectrometer is an extremely sensitive, state-of-the art system. Inexact performance of other than the grossest type is generally due to subtle factors. It is the ability to determine and correct these factors that constitutes the art in the science of gamma spectroscopy instrumentation.

All of the many possible contributors to less than optimum performance cannot be listed here. The purpose of this section is to note the usual causes of loss of resolution, and to suggest corrective steps.

Do not expect to diagnose problems with a detector, a preamplifier, a main amplifier, and a multichannel analyzer. To troubleshoot a spectroscopy system, a good modern, oscilloscope (Tektronix 465, 475, or equivalent) will be needed. Also, a high quality tail pulse generator (Canberra 1407 or equivalent) will be extremely useful.

The simplest test is, of course, to connect your detector, apply bias, present a source, and accumulate a spectrum. Be sure a pulser is not feeding the preamplifier while the spectrum is accumulating or resolution loss may result. If the results obtained are far different from what is expected, it then becomes necessary to troubleshoot the system.

First, observe the amplifier output on an oscilloscope at various time base and amplitude settings. Is the amplifier properly pole/zero canceled? If it is not, you will probably see output pulses causing undershoots that persist for longer than two or more main pulse widths. Set the main amplifier pole/zero cancellation by the procedure given in the amplifier manual.

The next step is to remove all sources and, with the detector still connected and bias applied, to apply a test pulse to the preamplifier's TEST input. Make sure the pulser polarity is correct. Set the amplitude of the pulser so that its peak occurs near the region of the peak of the source previously used.

Observe the output of the amplifier. Note that the output is not properly pole/zero canceled for the pulser feeding the preamp (due to the extra time constant of the pulser). This is of no consequence for a pure pulser input. Are the baseline fluctuations of one or two times ac line frequency? A ground loop is indicated. Insert all system line plugs into the same outlet. Or, are the baseline fluctuations of random frequency between 10 Hz and 15 000 Hz? If so, clap your hands near the detector and look for increased noise of this type. The area may be too noisy, causing microphonic problems.

Isolate the detector as much as possible by setting it on a foam rubber base and place a foam rubber collar between the bottom of the cryostat head and the Dewar neck. The bubbling of the liquid nitrogen in the Dewar is a frequent, hard-to-cure cause of microphonics.

If high frequency noise is observed, is it random or periodic? Periodic noise may be a sign of electronics failure: isolate the cause by observing the preamplifier output. Is the same pattern observed, or is the problem in the main amplifier? Does the noise amplitude change if the connecting cables are moved? If so, locate the source of the interference and separate it from the cabling. Random high frequency noise may be detector load resistor or input capacitor breakdown.

Low level periodic system noise may be difficult to detect using an oscilloscope, but still produce significant resolution degradation. The offending periodic noise may be masked by the normal composite of detector signals and system noise making it almost impossible for the scope to synchronize with it. The cause may again be cable pickup since cable loops are capable of picking up magnetically transmitted noise (EMI). The noise source can be a TV monitor or other piece of equipment capable of producing strong fields.

To test for the presence of low level EMI, connect the preamp power cable, then connect a BNC cable from the shaping amplifier input to the preamplifier test input (see Figure 7). No detector signals will be transferred, but the cable will continue to pick up the magnetically transmitted noise. Observe the output of the shaping amp with an oscilloscope. If periodic noise is observed, move the signal and preamp power lines away from the interfering equipment.

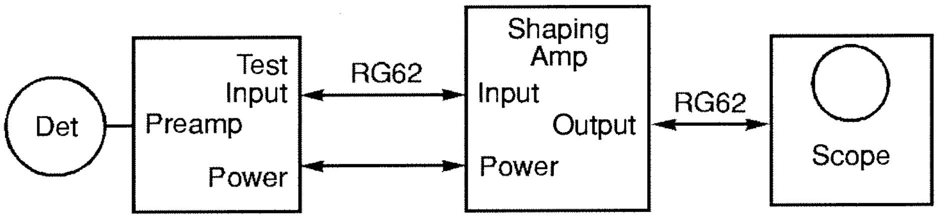


Figure 7 Test Setup for Magnetically Induced Noise

If the lines cannot be moved far enough from the interfering source to remove the noise, install a cable transformer (Canberra Model LB1500) at the preamp output before reconnecting it to the shaping amp, and a ground-loop-eliminator preamp power cable (Canberra Model LB1501).

In order to reduce the effect of ground-loop induced noise, the grounds of the HV Input and HV Inhibit connectors are isolated from the analog signal ground. Some preamps are equipped with an external wiring harness, which creates a potential for the connector shells to touch, negating the ground isolation. If a 2002CSL Preamp is being used which includes insulating sleeves for the HV and HV Inhibit connectors, the sleeves should be slipped over the BNC and SHV connectors after they have been attached to the HV power supply wiring.

For further information refer to Canberra application note "System Considerations with High Resolution Detectors", included in the Germanium Detectors User's Manual, and available separately from the factory.

If low frequency noise still is a serious problem, the user should experiment with different baseline restorer settings to minimize the noise.

Next, accumulate a pulser peak on the analyzer. Calculate its resolution. If you are using a 2002 with room temperature FET, repeat with the detector removed and the input connector of the preamplifier shielded. Wait five minutes to remove the preamplifier from the detector after switching off the detector bias. You now have three resolution figures available for essentially equal energy peaks: source (R_S), pulser and biased detector connected (R_D), and pulser without detector connected (R_E).

If R_E is not less than 0.65 keV for a 2 µs unipolar Gaussian shaping time constant, the problem is in the electronics and probably in the preamplifier.

If R_E is acceptable, but R_D is greater than 0.65 keV plus 0.017 keV/pF detector and connection capacitance, then the problem is either in the detector (microphonics, excess leakage current noise, breakdown due to moisture or grime on the detector output connector), or in the preamplifier (leaky input capacitor, dirty or moist detector load resistor, dirty or moist detector input connector).

If R_E and R_D are acceptable, but the live spectrum (R_S) is not as good as expected, the problem is probably in the detector (bad detector, poor charge collection, insufficient bias) or in the electronics following the preamplifier (count rate too high, improper amplifier pole/zero cancellation, wrong main amplifier time constant, wrong position of restore switches, wrong amplifier shaping - bipolar vs. unipolar, improper amplifier shaping for the ADC being used, ADC cannot take the count rate, amplifier or ADC drift).

These many alternatives are not easy to check. Substituting, one by one, other detectors, preamplifiers, amplifiers, and multichannel analyzers may help pinpoint the problem. Checking the above common problems will aid in spotting the source of trouble.

The Test Pulser Input

Besides being useful for troubleshooting system noise, the Test Input can be used to check system gains, pulse shapes, and rise times. To check the intrinsic preamp rise time, connect a square wave or pulse generator with a fast rise time leading edge, preferably 5 ns or less rise time, to the Test Pulser input. Connect the Timing Output to a fast rise time oscilloscope using 50 Ω cable and terminate the cable at the oscilloscope end with 50 Ω. The rise time will show the performance of the preamp and the effect of any added detector capacitance. Fastest rise time will be seen with gain set in the low ("A-C") position.

Gain

The charge gain of the preamplifier is set by the position of a jumper plug in the approximate center of the printed circuit board. The preamp is shipped with the jumper set from "A" to "B", giving a nominal charge gain of 10 V/pC, equivalent to approximately 500 mV/MeV, and the nominal voltage gain between TEST input and ENERGY (or TIMING) outputs is 5. With the jumper set from "A" to "C", the nominal charge gain is 2 V/pC, equivalent to approximately 100 mV/MeV, and the nominal voltage gain between TEST input and ENERGY (or TIMING) outputs is 1. Set the jumper to the scale factor desired before use.

5. Circuit Description

The Model 2002/C/CC/CSL Spectroscopy Preamplifier contains two printed circuit boards. The larger main board contains two amplifiers, an input charge sensitive section (integrator) and an output differentiator/buffer. On the 2002/C/CC/CSL the input FET and associated components are mounted inside the cryostat. The 2002/C/CSL main board also has mounted on it components for the high voltage decoupling network while the 2002/CC contains a separate HV filter assembly. The smaller auxiliary (LN Monitor) board contains circuits to monitor the output of the temperature and rate sensors.

Detailed Circuit Description

The input amplifier on the main board consists of an operational amplifier using Q1 through Q6, and feedback components R2 and C2. C2 turns the op-amp into a charge amplifier or integrator. The output of the integrator is a voltage proportional to the charge collected in the detector. R2 provides a dc bias path around the loop. Diode D1, which is normally reverse biased, protects the FET from high voltage transients. The input FET is operated at a low voltage (+4 V nominal) and high current (15 to 20 mA), the optimum conditions for low noise and high gain. RV1 provides current adjustment as necessary. L1 provides a high ac impedance, blocking noise from entering the amplifier loop via the FET current supply. Q2 biases the drain of Q1, which with Q2 forms a cascade section which injects signal current into common base amplifier Q3.

Q3 provides a high voltage gain, since it is buffered by current source Q4 and emitter follower Q5. Q3 bias current is approximately 1 mA. Current source Q6 allows the amplifier to swing effectively to the negative rail.

In order to boost high speed performance, NPN transistors Q2 and Q4 were chosen for their low capacitance. CV1 compensates for remaining parasitic capacitance. C6 adjusts amplifier response to the fixed range of CV1.

The dc voltage at the output of the integrator is brought out to the rear panel test jack for monitoring purposes. Without detector HV bias present, this dc level is the negative bias required on the gate of the FET to allow it to conduct the current demanded by RV1, etc. This voltage is nominally –1 V dc, but should never be more positive than 0, or more negative than –2.5 V dc. The output of the charge amplifier drives the rate monitoring circuit.

To provide proper preamp output over a wide range of rates, the RC network connecting the first and second stages provides pole-zero cancellation. The 2 ms time constant of the first stage is canceled by RV2, R15, and C10. R14, R16, and C10 combine to differentiate the pulse and provide a nominal 50 ms fall time. Current from this network is fed to the output amplifier. When RV2 is precisely adjusted, the output pulse will be unipolar, allowing the best resolution at high count rates and optimizing overload recovery.

The output amplifier uses Q7 through Q11 and is configured as an operational amplifier. Feedback is provides by either R21 and C12, or R22. Adjustable resistor RV3 and resistors R13 and R18 provide offset compensation for the output.

Q8 is a common emitter stage, driving the common base Q7 directly. The latter provides the voltage gain in the loop, and level translates the bias levels for an output voltage swing capability of up to ±10 V. Q10 is a current source, providing a nominal 4 mA sink to Q9. D2 and D5 provide the static forward bias for the push-pull emitter follower outputs Q9 and Q11. D3 and D4 act with D2 and D5, respectively, to limit the voltage that can be developed between the output driving point and the bases of the push-pull transistors, and thereby provide short circuit current limiting through R25 and R26. R28 and R29 provide the coax terminations for the Energy and Timing outputs respectively. C12 is the frequency compensation element for the selected gain of the buffer.

The auxiliary or LN board contains High Rate Indicator and High Voltage Inhibit circuits. To produce the High Rate indication, the varying dc output of the charge amplifier is reduced then buffered by unity gain amplifier A1A which drives an LED through a Zener diode. The Zener diode conducts to indicate count rate overload. Polarities of the LED and Zener diode are reversible by J1 and J2 to accommodate both N and P type detectors.

The Model 2002/C/CSL High Voltage Inhibit circuit measures the resistance of the platinum resistance temperature detector (PRTD) which is thermally connected to the detector. The PRTD and resistor R6 form a voltage divider at one input of comparator A1B. When the output of the divider crosses the threshold voltage set by RV1 at the other input of the comparator, the comparator changes state, turning on the other LED and switching logic driver Q1. The optional jumper W4 may be installed to reduce the logic high output level from +12 V to +5 V. The temperature sensor is an RTD-100 with a temperature coefficient of 0.41Ω/°C.

Standard LC decoupling of the ±12 V and ±24 V dc supplies is used to minimize problems due to noise pickup and induction in the power cable external to the preamp. High voltage bias to the detector is filtered by a two-stage RC filter. High voltage ground is isolated from signal ground by R30 to prevent a ground loop from occurring. R36 isolates analog ground from the High Voltage Inhibit signal ground.

A. Specifications

Inputs

DETECTOR INPUT – Charge pulse from a cooled Ge detector.

TEST INPUT – Charge coupled to preamp input at 0.5 pC/V minimal; voltage gain to outputs 1X or 5X (as selected), ±30%. Input impedance is 93 Ω.

HV INPUT – Detector bias voltage, 0 to ±5 kV dc; no limit to the rate at which bias may be applied; series resistance to detector bias point is 2000 MΩ nominal; filter time constant is 6 seconds, nominal. High voltage ground is isolated from signal ground by 470 Ω.

Outputs and Indicators

ENERGY OUTPUT – Provides unipolar pulses with peak amplitude linearly proportional to the charge input, non-inverting. Decay time constant is 50 µs (±10%). Output swing range is ±10 V open circuit. Output impedance is 93 Ω, series connected, dc coupled. Output dc offset is 0 ±75 mV dc (at gain of 100 mV/MeV), or 0 ±100 mV dc (at gain of 500 mV/MeV).

TIMING OUTPUT – Unipolar pulse for each input event; signal parameters same as above, except 50 Ω output.

HV INHIBIT OUTPUT (Requires cryostat with temperature sensor) – Provides a logic signal to turn off High Voltage Power Supply when detector temperature exceeds level which causes detector leakage. Output is +12 V when temperature is correct and <+0.5 V under fault condition; capable of sinking 10 mA. Installing optional 10 kΩ resistor changes high level from +12 V to +5 V. High voltage inhibit ground is isolated from signal ground by a 1 mH, approximately 30 Ω, inductor to prevent introduction of ground loop noise.

HV INHIBIT INDICATORS (Requires cryostat with temperature sensor) – Green LED glows when detector is at normal operating temperature. Yellow LED glows if temperature exceeds level which causes detector leakage.

HIGH RATE INDICATOR – Provides a visual indication of count rate overload. Yellow LED begins to glow at nominal 75% of max count rate and brightens as max rate is reached.

Performance

INTEGRAL NONLINEARITY – <±0.05% for an output swing of ±8 V (unterminated).

GAIN STABILITY – ≤±0.005%/°C (±50 ppm/°C) over a range of 0 to +50 °C; ≤±0.01% over 24 hours at constant temperature after 1 hour stabilization.

CHARGE SENSITIVITY – 2V/pC, or 10 V/pC, corresponding to 100 mV/MeV, or 500 mV/keV (Ge) equivalent, as selected by internal jumper plug. Shipped in the 500 mV/MeV position. Gain tolerance is ±25%.

NOISE – Using a Canberra Model 2020 Spectroscopy Amplifier set at 4 µs unipolar semi-Gaussian shaping, noise behavior is summarized in Table 1. Noise performance for other shaping time constants and source capacitances is shown in Figure 8.

Table 1 Noise vs. C_{source}

C_{source} in picofarads		Noise in Coulombs (RMS)	Noise in eV, FWHM*
0	typical	1.3×10^{-17}	570
	maximum	1.4×10^{-17}	600
100	typical	5.0×10^{-17}	2200
	maximum	5.2×10^{-17}	2300

*Based on 2.98 eV/ion-pair in Ge at 77 °K

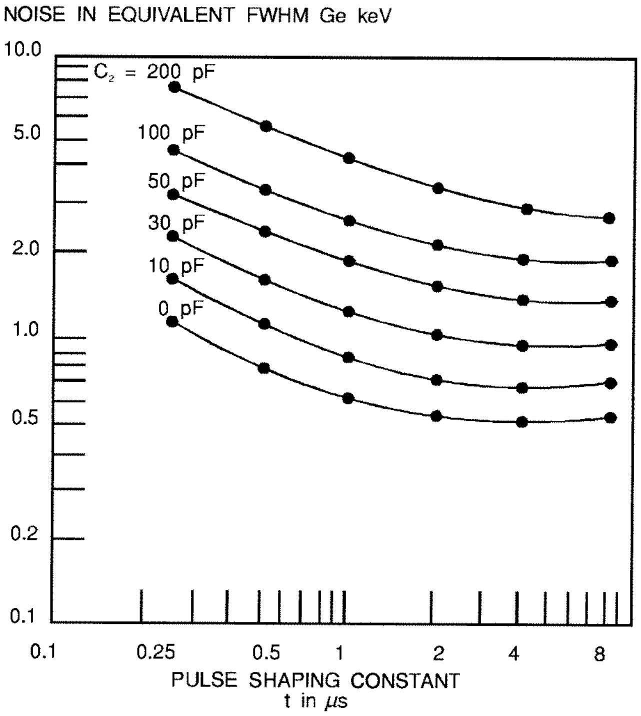


Figure 8 Pulse Shaping vs. Noise Equivalent

COUNT RATE – Count rate performance has been demonstrated at beyond 200 000 counts per second for ^{60}Co source (1.33 MeV).

RISE TIME – Measured at low gain setting.

<15 ns with C_{source} = 0 pF

<20 ns with C_{source} = 30 pF

<30 ns with C_{source} = 100 pF

Connector Types

DETECTOR INPUT – On 2002, 25 mm (1 in.), nominal, leads with Augat LSG-3CG1-1 sockets (fit 1 mm [0.040 in.] dia. pins), for direct mounting to common feedthroughs on detector cryostats. The 2002C/CC/CSL preamp is an integral part of the detector assembly.

HV INPUT – SHV

TEST INPUT – BNC UG-1094/U

ENERGY OUTPUT – BNC UG-1094/U

TIMING OUTPUT – BNC UG-1094/U

HV INHIBIT OUTPUT – BNC UG-1094/U

POWER – Amphenol 17-20090

Accessories

CABLE – One 3 m (10 ft) power cable is supplied with the preamplifier.

Power Requirements

+24 V dc – 18 mA +12 V dc – 21 mA

–24 V dc – 8 mA –12 V dc – 7 mA

Physical

SIZE – 2002 and 2002C: 7.6 x 10.2 x 4.4 cm (3 x 4 x 1.75 in.);
2002CC and 2002CSL: cylindrical, 12.7 x 7.9 cm (5 x 3.1 in.) (l x d)

NET WEIGHT – 0.40 kg (0.88 lb)

SHIPPING WEIGHT – 0.86 kg (1.9 lb)

Environmental

OPERATING TEMPERATURE – 0 to 50 °C.

OPERATING HUMIDITY – 0-80% relative, non-condensing.

Tested to the environmental conditions specified by EN 61010, Installation Category I, Pollution Degree 2.

B. Installation Considerations

This unit complies with all applicable European Union requirements.

Compliance testing was performed with application configurations commonly used for this module; i.e. a CE compliant NIM Bin and Power Supply with additional CE compliant application-specific NIM were racked in a floor cabinet to support the module under test.

During the design and assembly of the module, reasonable precautions were taken by the manufacturer to minimize the effects of RFI and EMC on the system. However, care should be taken to maintain full compliance. These considerations include:

- A rack or tabletop enclosure fully closed on all sides with rear door access
- Single point external cable access
- Blank panels to cover open front panel Bin area
- Compliant grounding and safety precautions for any internal power distribution
- The use of CE compliant accessories such as fans, UPS, etc.

Any repairs or maintenance should be performed by a qualified Canberra service representative. Failure to use exact replacement components, or failure to reassemble the unit as delivered, may affect the unit's compliance with the specified EU requirements.

Notes

Warranty

Canberra (we, us, our) warrants to the customer (you, your) that for a period of ninety (90) days from the date of shipment, software provided by us in connection with equipment manufactured by us shall operate in accordance with applicable specifications when used with equipment manufactured by us and that the media on which the software is provided shall be free from defects. We also warrant that (A) equipment manufactured by us shall be free from defects in materials and workmanship for a period of one (1) year from the date of shipment of such equipment, and (B) services performed by us in connection with such equipment, such as site supervision and installation services relating to the equipment, shall be free from defects for a period of one (1) year from the date of performance of such services.

If defects in materials or workmanship are discovered within the applicable warranty period as set forth above, we shall, at our option and cost, (A) in the case of defective software or equipment, either repair or replace the software or equipment, or (B) in the case of defective services, reperform such services.

LIMITATIONS

EXCEPT AS SET FORTH HEREIN, NO OTHER WARRANTIES OR REMEDIES, WHETHER STATUTORY, WRITTEN, ORAL, EXPRESSED, IMPLIED (INCLUDING WITHOUT LIMITATION, THE WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE) OR OTHERWISE, SHALL APPLY. IN NO EVENT SHALL CANBERRA HAVE ANY LIABILITY FOR ANY SPECIAL, EXEMPLARY, PUNITIVE, INDIRECT OR CONSEQUENTIAL LOSSES OR DAMAGES OF ANY NATURE WHATSOEVER, WHETHER AS A RESULT OF BREACH OF CONTRACT, TORT LIABILITY (INCLUDING NEGLIGENCE), STRICT LIABILITY OR OTHERWISE. REPAIR OR REPLACEMENT OF THE SOFTWARE OR EQUIPMENT DURING THE APPLICABLE WARRANTY PERIOD AT CANBERRA'S COST, OR, IN THE CASE OF DEFECTIVE SERVICES, REPERFORMANCE AT CANBERRA'S COST, IS YOUR SOLE AND EXCLUSIVE REMEDY UNDER THIS WARRANTY.

EXCLUSIONS

Our warranty does not cover damage to equipment which has been altered or modified without our written permission or damage which has been caused by abuse, misuse, accident, neglect or unusual physical or electrical stress, as determined by our Service Personnel.

We are under no obligation to provide warranty service if adjustment or repair is required because of damage caused by other than ordinary use or if the equipment is serviced or repaired, or if an attempt is made to service or repair the equipment, by other than our Service Personnel without our prior approval.

Our warranty does not cover detector damage due to neutrons or heavy charged particles. Failure of beryllium, carbon composite, or polymer windows, or of windowless detectors caused by physical or chemical damage from the environment is not covered by warranty.

We are not responsible for damage sustained in transit. You should examine shipments upon receipt for evidence of damage caused in transit. If damage is found, notify us and the carrier immediately. Keep all packages, materials and documents, including the freight bill, invoice and packing list.

Software License

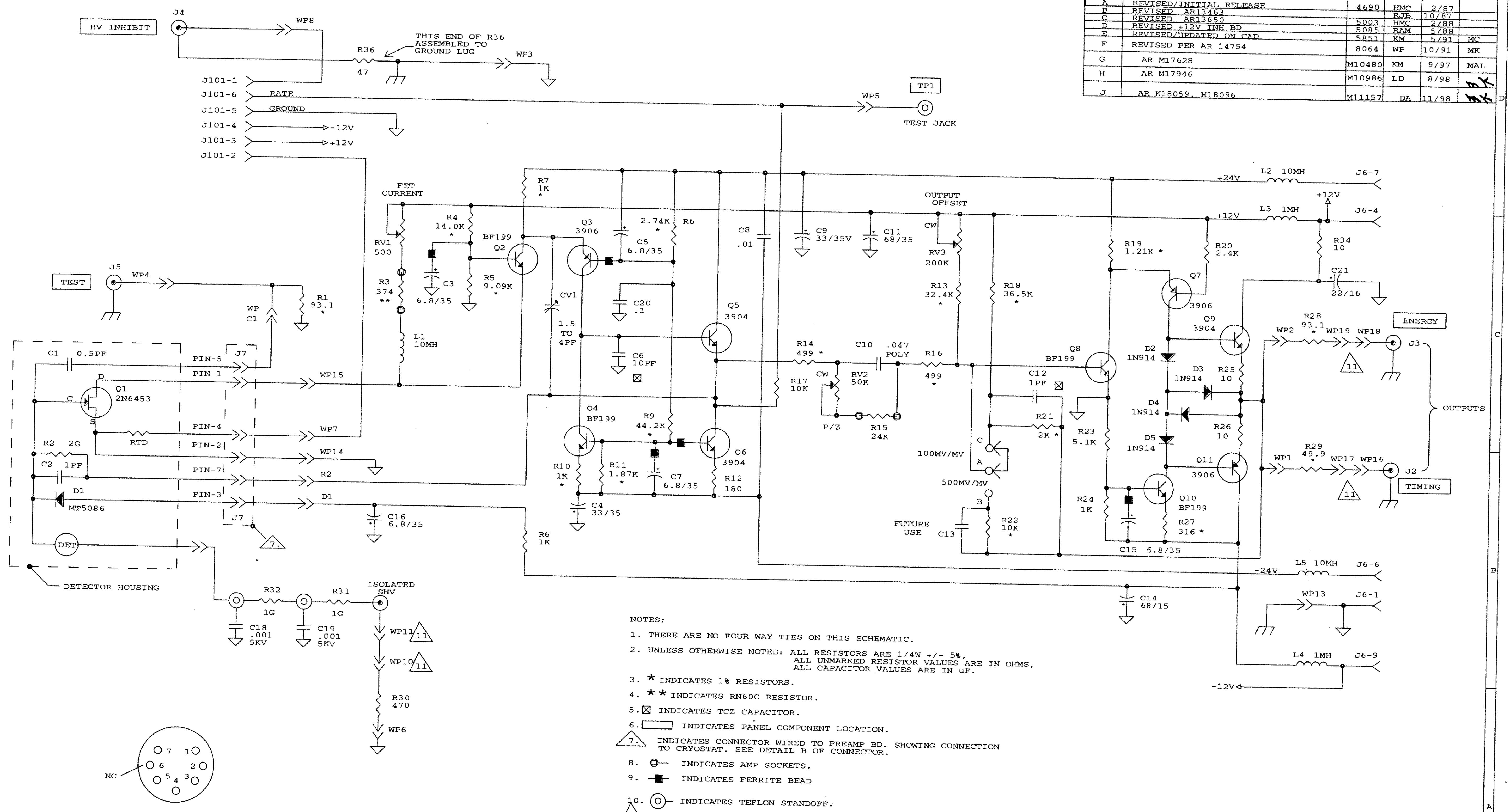
When purchasing our software, you have purchased a license to use the software, not the software itself. Because title to the software remains with us, you may not sell, distribute or otherwise transfer the software. This license allows you to use the software on only one computer at a time. You must get our written permission for any exception to this limited license.

BACKUP COPIES

Our software is protected by United States Copyright Law and by International Copyright Treaties. You have our express permission to make one archival copy of the software for backup protection. You may not copy our software or any part of it for any other purpose.

Revised 1 Apr 03

REV	CHANGE	ECN	BY	DATE	APPD
A	REVISED/INITIAL RELEASE	4690	HMC	2/87	
B	REVISED AR13463		RJB	10/87	
C	REVISED AR13650	5003	HMC	2/88	
D	REVISED +12V INH BD	5085	RAM	5/88	
E	REVISED/UPDATED ON CAD	5851	KM	5/91	MC
F	REVISED PER AR 14754	8064	WP	10/91	MK
G	AR M17628	M10480	KM	9/97	MAL
H	AR M17946	M10986	LD	8/98	MK
J	AR K18059, M18096	M11157	DA	11/98	MK



DETAIL B

LAYOUT OF J7 CONNECTOR WIRING SIDE

NOTES;

1. THERE ARE NO FOUR WAY TIES ON THIS SCHEMATIC.
2. UNLESS OTHERWISE NOTED: ALL RESISTORS ARE 1/4W +/- 5%,
ALL UNMARKED RESISTOR VALUES ARE IN OHMS,
ALL CAPACITOR VALUES ARE IN uF.
3. * INDICATES 1% RESISTORS.
4. ** INDICATES RN60C RESISTOR.
5. ☒ INDICATES TCZ CAPACITOR.
6. ☐ INDICATES PANEL COMPONENT LOCATION.
7. INDICATES CONNECTOR WIRED TO PREAMP BD. SHOWING CONNECTION TO CRYOSTAT. SEE DETAIL B OF CONNECTOR.
8. INDICATES AMP SOCKETS.
9. INDICATES FERRITE BEAD
10. INDICATES TEFLON STANDOFF.
11. ON MODEL 2002C, WIRING IS DIRECT TO BNC'S WITHOUT USE OF WIRE POINTS.

Property of
CANBERRA INDUSTRIES, INC.
COMPANY CONFIDENTIAL MATERIAL

Unauthorized Duplication of any or all of the material contained herein is strictly prohibited

DRAWN BY / DATE
KM 5/23/91

APPD ELEC / DATE
MC 5/91

NOT NETLIST COMPATIBLE

CANBERRA INDUSTRIES
800 RESEARCH PARKWAY
MERIDEN, CT 06450

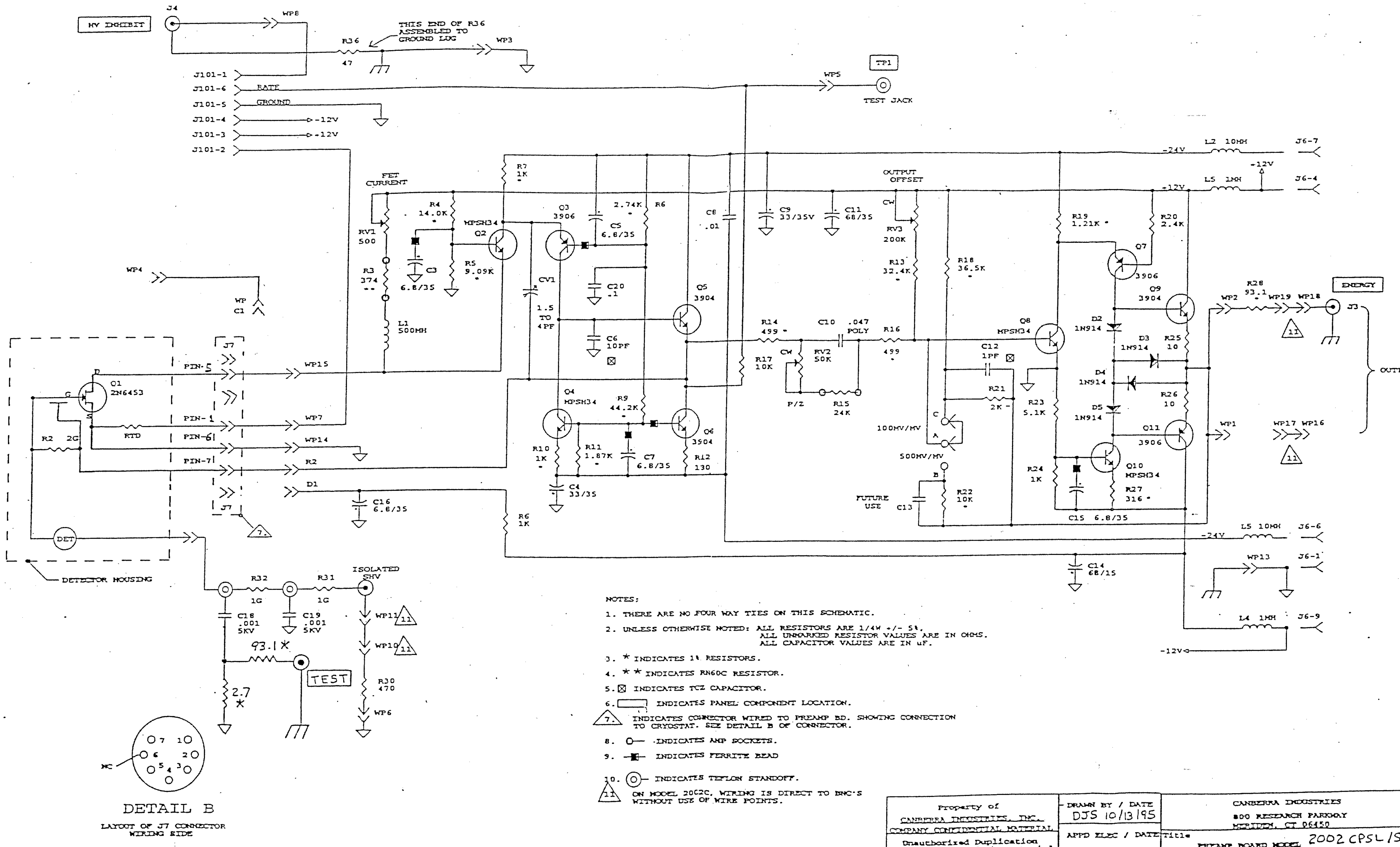
Title
PREAMP BOARD MODEL 2002C/2002CSL

Size B
Document Number B-21700
REV J

Date: November 13, 1998
Sheet 1 of 1

ORIGINAL

REV	CHANGE	ECN	BY	DATE	APPD
A	RELEASE	232	DJS	10/13	



NOTES;

1. THERE ARE NO FOUR WAY TIES ON THIS SCHEMATIC.
2. UNLESS OTHERWISE NOTED: ALL RESISTORS ARE 1/4W +/- 5%.
   ALL UNMARKED RESISTOR VALUES ARE IN OHMS.
   ALL CAPACITOR VALUES ARE IN uF.
3. * INDICATES 1% RESISTORS.
4. ** INDICATES RN60C RESISTOR.
5. ☒ INDICATES TCZ CAPACITOR.
6. ▭ INDICATES PANEL COMPONENT LOCATION.
7. △ INDICATES CONNECTOR WIRED TO PREAMP BD. SHOWING CONNECTION TO CRYOSTAT. SEE DETAIL B OF CONNECTOR.
8. O— INDICATES AMP SOCKETS.
9. —■— INDICATES FERRITE BEAD
10. ◎— INDICATES TEFLON STANDOFF.
11. △ ON MODEL 2002C, WIRING IS DIRECT TO BNC'S WITHOUT USE OF WIRE POINTS.

Property of
CANBERRA INDUSTRIES, INC.
COMPANY CONFIDENTIAL MATERIAL

Unauthorized Duplication of any or all of the material contained herein is strictly prohibited

DRAWN BY / DATE
DJS 10/13/95

APPD ELEC / DATE

PARTS LIST

CANBERRA INDUSTRIES
800 RESEARCH PARKWAY
MERIDEN, CT 06450

Title
PREAMP BOARD MODEL 2002 CPSL/S

Size B
Document Number B 201633
REV A

Date:
Sheet 1 of 1