Model 5113
Pre-Amplifier

Instruction Manual

222144-A-MNL-C

FCC Notice

This equipment generates, uses, and can radiate radio-frequency energy and, if not installed and used in accordance with this manual, may cause interference to radio communications. As temporarily permitted by regulation, operation of this equipment in a residential area is likely to cause interference, in which case the user at his own facility will be required to take whatever measures may be required to correct the interference.

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Chapter 1
Characteristics

1.1 INTRODUCTION

The Model 5113 Low-Noise Preamplifier provides high gain, low-noise amplification of wideband signals from dc to 1 MHz. Adjustable high and low frequency rolloffs allow the bandwidth to be reduced. Two inputs, with switchable coupling, allow either differential or single-ended operation. Coarse gain is selectable from x5 to x50,000 in a 1-2-5 sequence with a fine gain control extending the range to xl to x10,000. An uncalibrated vernier allows finer adjustment of the gain.

The unit may be powered either from an external dc power supply or from its own batteries. The lead-acid batteries recharge automatically when a suitable external power supply is connected. Other features include an overload fast-recovery button, a front-panel dc zeroing screwdriver control, and battery test provisions. The Model 5113 is well suited for use as a preamplifier for other EG&G Princeton Applied Research signal processing instruments.

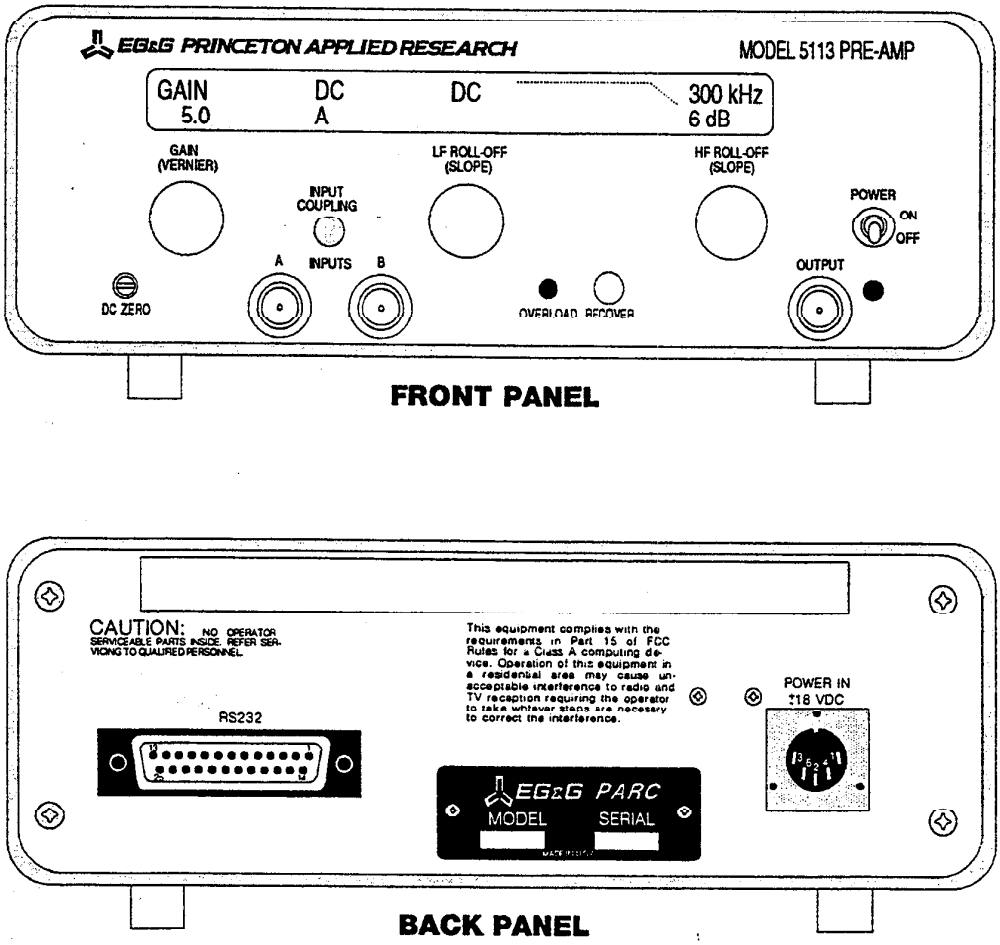


Figure 1-1. MODEL 5113 LOW-NOISE PREAMPLIFIER

1.2 SPECIFICATIONS

INPUTS
Two inputs, together with an input selection button, allow for four input modes providing dc or ac coupling and single-ended or differential operation. Input connectors are BNC type.

INPUT IMPEDANCE
Input impedance switchable via front-panel or computer control.

Ac coupled: either 10 MΩ or 100 MΩ in parallel with 25 pF, in series with 0.1 μF.

Dc coupled: either 10 MΩ or 100 MΩ in parallel with 25 pF.

MAXIMUM INPUT WITHOUT DAMAGE

Dc coupled: +10 V, -9 V

Ac coupled: Coupling capacitors can withstand 100 V. Transients that pass through coupling capacitors must not exceed dc coupled operation limits.

MAXIMUM INPUT SIGNAL CONSISTENT WITH LINEAR OPERATION

Common mode: 1 V peak.

Differential mode: As listed below.

Coarse Gain	Maximum Peak Input	
	Low Filter Reserve	High Filter Reserve
5 to 25	1 V	1 V
50 to 500	100 mV	1 V
1000 to 5000	10 mV	100 mV
10000 to 50000	10 mV	10 mV

Table 1-1. MAXIMUM INPUT AS A FUNCTION OF FILTER RESERVE AND COARSE GAIN SETTING

COMMON MODE REJECTION

DC to 1 kHz: >120 dB

1 kHz to 1 MHz: - 6dB/octave

GAIN
Coarse gain of x5 to x50,000 in 1-2-5 sequence with an accuracy of ±1%. Fine gain extends range from x1 to x100,000 with an accuracy of ±2%. An uncalibrated vernier provides gain adjustment of +20% of coarse gain.

NOISE
4 nV/Hz$^{1/2}$ at 1 kHz referred to input.

FREQUENCY RESPONSE
Without filters frequency response is DC to 1 MHz.

Two configurable filters allow 6 or 12 dB/octave low-pass response, 6 or 12 dB/octave high-pass response, or bandpass response.

Rolloff frequencies are switch and remotely selectable from 0.03 Hz to 300 kHz in a 1-3-10 sequence. Amplitude and Phase responses of HP and LP Filters are as follows.

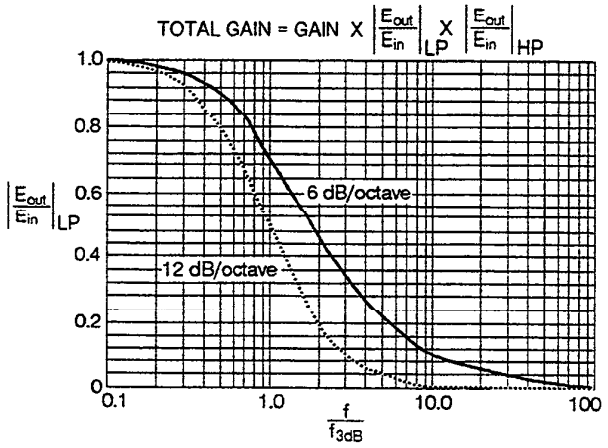


Figure 1-2. LOW-PASS FILTER AMPLITUDE vs NORMALIZED FREQ. RESPONSE

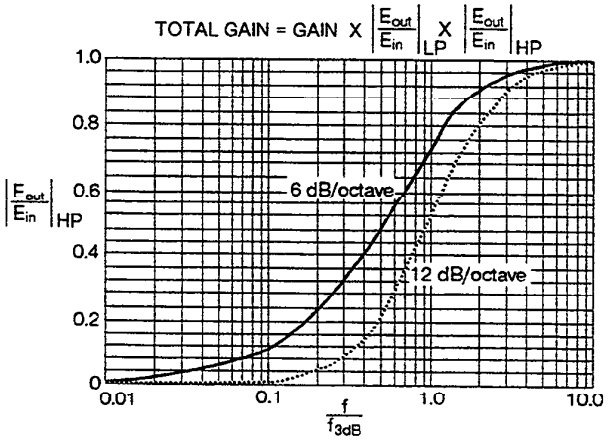


Figure 1-3. HI-PASS FILTER AMPLITUDE vs NORMALIZED FREQ. RESPONSE

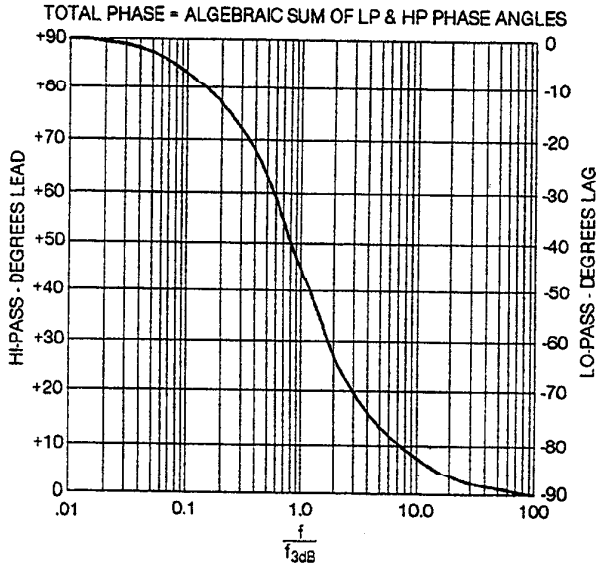


Figure 1-4. 6 dB FILTER
PHASE vs NORMALIZED FREQ. RESPONSE

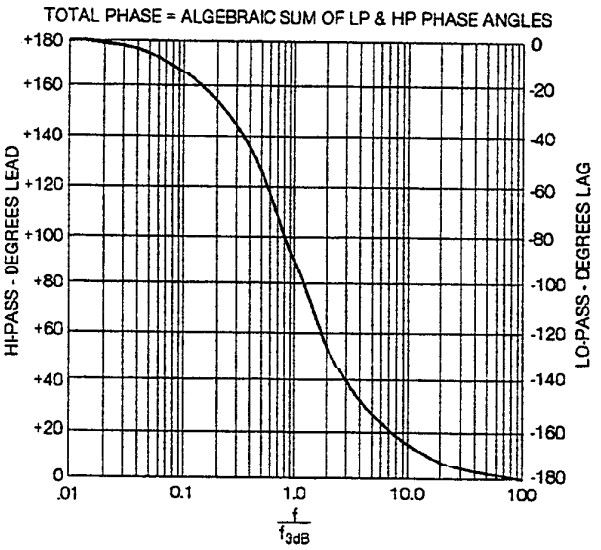


Figure 1-5. 12 dB FILTER
PHASE vs NORMALIZED FREQ. RESPONSE

DC DRIFT

Referred to Input (dc coupling): maximum 10 μV/°C or less than 10 μV per 24 hours at constant ambient temperature. A front-panel screwdriver control provides for dc zeroing.

Referred to Output (ac coupling):
Coarse gain only: 75 μV/°C
With Fine Gain: 250 μV/°C maximum

OUTPUT VOLTAGE
2 V pk-pk ahead of 50 Ω.

OUTPUT IMPEDANCE
50 Ω ±2%

OVERLOAD RECOVERY
Reset by front-panel push button or under computer control.

COMPUTER INTERFACE
Opto-isolated RS232 via DB25 25-pin connector. Communication rate selectable via front-panel display from 300 to 9600 baud. Fixed parameters are **no parity, eight data bits, and one stop bit.**

POWER REQUIREMENTS

Rechargeable lead-acid batteries: Provide approximately 30 hours operation between charges. A special page on the lcd display provides information on the state of the internal batteries.

External power supply: Provides ±18 V power required by 5113. Supply is switchable between 110 V dc and 240 V dc, 50-60 Hz. Power connection is via DIN 5-pin connector.

DIMENSIONS
8.25" W x 3.5" H x 11" D (21.0 cm x 8.9 cm x 27.9 cm).

WEIGHT
Excluding external power supply: 8 pounds (3.7 kg)

ACCESSORIES
The Model 1901 or 1900 input transformer will increase gain by 100 or 1000 and reduce noise referred to the input down to a minimum of 0.03 nV/Hz^{½}.

Chapter 2
Initial Checks

2.1 INTRODUCTION

The following procedure is provided to facilitate initial performance checking of the Model 5113. In general, the procedure should be performed after inspecting the instrument for shipping damage (any noted to be reported to the carrier and to EG&G Princeton Applied Research Corporation), but before using it experimentally. Should any difficulty be encountered in carrying out these checks, contact the factory or one of its representatives.

2.2 EQUIPMENT NEEDED

1. General purpose laboratory oscilloscope.
2. Signal generator capable of providing a 0.2 V pk-pk sine wave at 10 Hz, 1 kHz, and 100 kHz.

2.3 PROCEDURE

1. Make sure that the voltage selector switch on the external power supply is in the position indicating the line voltage to be used (110 V ac or 240 V ac).
2. Plug the line cord into the external power supply and the external power supply into the instrument power socket.
3. Press the power switch upwards and release. The switch should spring back to the center position and the power indicator should remain lighted.
4. Make the following initial control settings:

   Gain: x10

   Input coupling:
   A Input: AC
   B Input: GND

   Displayed as A AC

   Filter mode: Bandpass

   Low Frequency Rolloff: 10 Hz

   High Frequency Rolloff: 100 kHz

5. Connect the oscilloscope to the output BNC connector.
6. Set the signal generator to 10 Hz, 0.2 V pk-pk, and connect it to the A Input. *Use the oscilloscope to make the signal generator amplitude settings so as to obtain consistency between input settings and output readings.*
7. Monitor the output; the output level should be 1.4 V pk-pk.
8. Set the signal generator to 1 kHz, 0.2 V pk-pk. Monitor the output; the output level should be 2 V pk-pk.
9. Set the signal generator to 100 kHz, 0.2 V pk-pk. Monitor the output; the output level should be 1.4 V pk-pk.
10. Press the power switch down and release. The switch should return to the center position and the power indicator should no longer be lighted.

This completes the initial checks. If the instrument performed as indicated, one can be reasonably sure that it is operating properly.

Chapter 3
Operating Instructions

3.1 FRONT PANEL CONTROLS AND DISPLAY

3.1A INTRODUCTION

The Model 5113 has been designed to be extremely easy to setup and use. With rotary and push button controls and an 80 character LCD (liquid crystal display), adjustments are quick to make and the display of information comprehensive. The display enables the operator to determine the instrument's status at a glance.

3.1B POWER SWITCH

The power switch has a momentary action, biased to the center. To turn the power on, press the switch up and release. The power indicator LED will light and the LCD will briefly display the start-up message. Once the start-up message disappears, the display will show the units configuration. All options are retained in non-volatile memory except for the backlight status. The backlight always defaults to *OFF* to conserve battery power and reduce battery charging time. To turn the power off, press the switch down and release. The power indicator LED will extinguish.

3.1C INPUTS

Input Connectors: There are two input connectors, A and B. The B input is used only in differential mode.

Input Selection: The input selector button, located above the two input connectors, cycles through four input modes. The mode selected is displayed on the LCD above the button. The four modes are:

A	**AC**
A	**DC**
A-B	**AC**
A-B	**DC**

When using AC coupling, the display will either show

AC-1 s or **AC-10 s**,

depending on the time constant selected. Refer to section 3.1H for information on how to change the time constant.

3.1D GAIN

The left hand knob controls all the gain functions. Pressing the knob cycles through three gain modes which are displayed on the LCD above the knob. These modes are:

COARSE GAIN *(displayed as COARSE)*

FINE GAIN *(displayed as FINE)*

GAIN VERNIER *(displayed as a bargraph)*

Rotating the knob in **COARSE** mode adjusts the calibrated gain displayed directly above the knob in a 1-2-5 sequence and removes any uncalibrated vernier. Rotating the knob in **FINE** mode also adjusts the calibrated gain displayed directly above the knob and removes any uncalibrated vernier. Rotating the knob in the vernier mode adjusts the uncalibrated vernier, shown by a moving bargraph. Whenever there is any uncalibrated vernier applied, the numerical value of the calibrated gain shows + after it to indicate that the gain is greater than that indicated by the numerical value. The + is the **UNCAL** indicator.

Note: The gain calibration is for no filters in.

3.1E FILTER MODES

The push action of the center and right hand knobs select the filter mode. The filter modes selectable by each knob are:

CENTER KNOB	RIGHT KNOB
Band pass	Band pass
High pass, 6 dB	Low pass, 6 dB
High pass, 12 dB	Low pass, 12 dB
High pass, 6/12 dB	Low pass, 6/12 dB
Flat	Flat

These filter modes are represented graphically on the LCD. The center knob controls the slope of the low frequency roll-off and the right hand knob controls the slope of the high frequency roll-off.

The 5113 contains two filters that can be independently switched in or out of circuit. The two filters can also be independently configured as either high or low pass with 6 dB/octave roll-off.

If, for example, both filters are switched into circuit, set up as low pass and tuned to the same frequency, then a low pass 12 dB per octave filter is formed. If the two filters are not tuned to the same frequency, then a (6/12 dB) per octave filter is formed. The filter starts to roll-off at 6 dB per octave at the lower of the two tuned frequencies. Above the higher of the two tuned frequencies the filters combine to produce 12 dB per octave roll-off.

If one filter is configured as high pass the other as low pass, then a bandpass filter is formed. It is important to refer to the filter response figures in Chapter 2 to calculate the gain for any particular frequency. If both filters are tuned to the same frequency, then the gain of the filter at the tuned frequency is 0.707 * 0.707 = 0.5 (-6 dB). The overall gain of the 5113 at this frequency is therefore half the displayed gain value. It is important to note that the displayed gain is for no filters switched in.

When the filters are switched in the gain should be calculated with reference to the figures in Chapter 2.

3.1F FILTER ROLL-OFF

The rotary action of the center and right hand knobs control the filter roll-off frequencies. The roll-off frequency is displayed on the LCD next to the appropriate section of the graphical representation of the filter mode. In 6/12 dB mode, the low frequency roll-off is constrained to always be less than the high frequency roll-off, when adjusted by the center knob. Corres-pondingly, the high frequency roll-off is constrained to be greater than the low frequency roll-off, when adjusted by the right hand knob.

When adjusting the roll-off frequencies in band-pass mode, the low frequency roll-off can be adjusted to be the same as the high frequency roll-off. If the low frequency roll-off is then adjusted upwards, the high frequency roll-off will track, and if the high frequency roll-off is adjusted downwards, the low frequency roll-off will track.

3.1G OVERLOAD RECOVER/SLEEP

The push button located below the center and right hand knobs has two functions.

Overload Recover: When an overload is indicated by the LED located next to it, pushing the button initiates an overload recover. At low filter setting frequencies the time to recover from an overload condition can be decreased by the use of this button. At higher filter setting frequencies the unit recovers so fast that the use of this button is unnecesssary.

Sleep: When an overload is not indicated by the LED, pushing and releasing this button removes power from the LCD and puts the processor into a low power mode. This stops all internal clocks and oscillators, preventing any digital pick-up. The amplifier continues to work with all the previous settings still valid. The processor can be reactivated, in order to view the display or change the settings, by pressing any of the five front panel push buttons. *The processor can also be reactivated by sending a character via the RS232 port, refer to Chapter 5, Commands.*

3.1H SPECIAL PAGES

In order not to clutter the display, further settings are made on the **SPECIAL PAGES**. These are:

LCD contrast
Backlight
Automatic quiet mode
Dynamic reserve
RS232 baud rate
Time constant
Firmware version number
Battery state
Start-up message

To enter the special pages, press the center and right-hand knob. Once in the special pages mode, the left-hand knob acts as the exit button. Pressing the right-hand knob advances the display to the next page. A description of each special page follows.

LCD Contrast: Rotating or pressing the center knob adjusts the LCD contrast in 16 steps.

Backlight: Rotating or pressing the center knob turns the LCD backlight on or off. The backlight will not cause any noise pick-up because it consists of an array of LEDs rather than an electro-luminescent panel.

Automatic Quiet Mode: The processor can be made to go to sleep automatically a preset number of seconds after the last front-panel adjustment. The range is 1 to 60 seconds. Alternatively it can be set to **OFF** and the **SLEEP** button can be used when required.

Dynamic Reserve: Rotating or pressing the center knob adjusts the filter reserve between high and low (see Table 1-1 on page 2).

Baud Rate: Rotating or pressing the center knob adjusts the RS232 baud rate. The options are:

9600 baud
4800 baud
2400 baud
1200 baud
600 baud
300 baud

The other RS323 parameters are always no parity, 8 data bits and 1 stop bit.

Input and Coupling Time Constants: Rotating or pressing the center knob adjusts the input and two coupling time constants between **1 s** and **10 s**.

Firmware Version: This page displays the firmware version number for information only.

Battery State: Information is displayed on the state of the batteries.

Start-Up Message: When the Model 5113 is turned on, a start-up message appears briefly on the LCD. This message can be edited from the front panel in order to label the unit as belonging to a particular person, laboratory, etc.

When entering this page, the unit start-up message is displayed with a cursor under the top left hand character. By rotating the right hand knob, the cursor can be moved to any desired character position. Rotating the center knob then changes the character at the cursor location. The display can be quickly cleared by pressing the center knob for three seconds. Note that a greater variety of characters is available using the **LINE** command over the

RS232 bus.

3.2 OPERATING THE MODEL 5113

3.2A INTRODUCTION

The instrument is powered as required either from the self-contained batteries or from the external power supply, and the signal to be amplified is applied to the input connector(s); the amplified signal is available at the OUTPUT BNC connector through a resistance of 50 Ω.

Note: Before operating from the external power supply, make sure the external power supply voltage selector switch is in the position indicating the line voltage to be used, and be sure the proper size line fuse is installed (200 mA for 110 V operation or 100 mA for 240 V operation). Operating from too high a line voltage will blow the line fuse and possibly damage the power transformer and circuit components.

3.2B GROUNDING

The signal ground side of the input connectors is connected to chassis ground through a 47 Ω resistor.

Caution: The power rating of the 47 Ω resistor is ½ watt. Avoid excessive ground-to-ground current to avoid burning out this resistor. When the signal is applied to the input via a transformer, operate the amplifier single-ended. That is, repeatedly press the input select button until **A AC** is displayed on the LCD and connect the transformer to the A Input; connect one transformer lead to the outer shell of the BNC connector and connect the other transformer lead to the center conductor of the connector. Connecting this way avoids the problem of static charge build-up at the inputs due to no ground return.

3.2C SIGNAL VOLTAGE AND GAIN

With the variable gain control in the calibrated position, the gain selector accurately sets the gain to the indicated level. Intermediate levels of gain may be obtained by use of the vernier gain control. **Note:** The gain calibration is for no filters in.

The maximum output that the amplifier can provide is 2 V peak-to-peak (through 50 Ω into an open circuit). For maximum input voltages, refer to the specifications.

3.2D DC ZERO ADJUSTMENT

When the instrument is operated in the dc coupled mode, the dc zero trimmer may need to be adjusted as the gain is changed.

3.2E OVERLOAD FAST RECOVERY

Pressing the overload recover button when the overload indicator is lighted causes fast discharge of the capacitors so that normal operation can be resumed immediately. Note this button has the secondary function of putting the processor to sleep if pressed when no overload is indicated.

3.2F LOW-PASS AND HIGH-PASS FILTERS

Two filters, configurable as either low-pass or high-pass, provide seven filter modes plus flat response. The seven filter modes are:

low-pass with 6 dB roll-off,
low-pass with 12 dB roll-off,
low-pass with 6/12 dB roll-off,
bandpass,
high-pass with 6 dB roll-off,
high-pass with 12 dB roll-off,
high-pass with 6/12 dB roll-off.

3.2G SINGLE-ENDED VS DIFFERENTIAL OPERATION

The amplifier may be operated differentially or single-ended. For single-ended operation, repeatedly press the input selector button until either **A AC** or **A DC** appears on the display, as appropriate. For differential operation, repeatedly press the input selector button until either **A-B AC** or **A-B DC** appear on the display, as appropriate.

Remember that the two signal grounds (tied together internally) are connected to chassis ground through a 47 Ω resistor. For maximum ground-loop rejection, avoid shorting the signal ground to chassis ground.

3.2H BATTERY OPERATION, TEST, AND CHARGING

The Model 5113 has rechargeable batteries good for up to 30 hours of operation when fully charged. If they are not fully charged, or if the Model 5113 is driving a load having an impedance of less than 10 Ω, a shorter operating period will result. To operate from battery power, lift and release the Power switch, but do not plug in the external power supply. When the period of battery powered operation is completed, be sure to turn the power off by pressing the Power switch down and releasing it, to prevent running down the batteries. The Model 5113 contains circuitry to increase battery life and reduce charge time. The state of the batteries is continuously monitored and once they fall below the voltage at which the amplifier no longer performs as specified, the unit automatically turns off. It is also possible to turn the unit off remotely, via the RS232 link, once an experiment has been completed.

To check the batteries, push the center and right hand knobs simultaneously to enter the special page mode. Repeatedly press the right hand knob until the battery page appears where the state of the batteries is indicated. Battery charging takes place whenever a suitable external power supply is connected. Beginning from the fully discharged state, it takes anywhere from 24 to 36 hours to fully recharge the batteries. In general, one should follow each period of battery operation with a charging period of equal or greater duration.

Note: When the unit is switched on, with an external

power supply connected, the batteries "trickle charge" at a rate very much lower than that obtained when the unit is switched off.

The batteries used in the Model 5113, should they require replacement, can be ordered from EG&G PARC. The part number is 231872.

When the batteries are being recharged (instrument plugged into external power supply but with the unit switched off), there is no time limit, that is, there is no possibility of overcharge with subsequent battery damage due to the charging being maintained for too long a time.

Chapter 4
Circuit Description

4.1 BLOCK DIAGRAM DISCUSSION
As can be seen from the block diagram in Figure 4-2, the Model 5113 comprises four gain stages plus vernier control with two interstage LP/HP filter circuits and an overload detection circuit. There are also battery charging and test circuits with full microprocessor control of all functions.

4.1A INPUT COUPLING CIRCUIT
The input coupling relays select the inputs directly or through dc blocking capacitors and apply the selected inputs to the corresponding FET buffers. Further dc blocking capacitors occur after two of the three switchable attenuators. There is a choice of two input impedances or time constants. A relay selects between 10 MΩ and 100 MΩ resistors at the input and semiconductor switches select between 1 MΩ and 10 MΩ resistors before two of the gain stages.

When using the amplifier single-ended, the input relay for the B input selects the outer shell of the A input BNC connector.

4.1B GAIN DETERMINATION
The firmware selects the appropriate gain stages to achieve the required gain displayed on the front panel LCD. The gain is allocated in one of two ways, depending on whether the low noise option or the high dynamic reserve option has been selected. These options are set by entering the special pages mode and pressing the right hand knob repeatedly until the relevant page appears. Alternatively the option can be set via the RS232 link using the DR command.

The low noise option tends to put the gain ahead of the filters, whereas the high dynamic reserve option tends to put the gain after the filters.

4.1C FILTERS
Two identical configurable filter circuits are cascaded to provide the eight filter modes. In each filter block, three analog switches allow the filter to be configured as low-pass, high-pass or flat response. The R component of the RC filter is provided by one fixed and four switchable resistors, while the C component is provided by one of four switchable capac-itors. The transfer curves for these filters are given in Chapter 1.

4.1D COARSE GAIN
There are four separate coarse gain stages. The first gain stage, before the filters, has three switchable gains. The other three gain stages occur after the filter and are fixed at x5. The three fixed gain stages are preceded by switchable attenuators. Overall gain is calibrated by a trimmer, R318, located in the feedback of the output amplifier. This is adjusted only when the fine gain is set to x1.

4.1E FINE GAIN
Fine gain control is achieved by the appropriate selection of four binary-weighted resistors connected to the summing junction of the output amplifier. The maximum range of the fine gain is x0.2 to x3.

4.1F VERNIER
A 4-bit vernier feeds into the summing junction of the output amplifier. When in use, the gain is uncalibrated.

4.1H OVERLOAD DETECTION
The overload detection circuit is connected to three points in the circuit. The first is before the filters and indicates an overload with a signal level greater than 4 V peak. The second detection point is located before the vernier and the third on the output but before the 50 Ω output resistor. These last two detection points indicate an overload when the signal level is greater than 1 V peak.

4.2 OVERLOAD FAST-RECOVERY
There are no extra components required to implement overload recovery except for the button. The overload recover button, when pressed, instructs the processor to close all the switches connected to the R's and C's in the RC filter. This allows the capacitors to discharge, thereby providing fast overload recovery. The switches return to their previous state after 0.5 s. Note that if no overload exists when the button is pressed, its secondary function of putting the processor to sleep takes place. If when an overload occurs the processor is already asleep, the button will need to be pressed twice, once to wake the processor and once to perform the overload recovery.

4.3 POWER SUPPLY
The two dc inputs from the external power supply are regulated to +13.8 V and -13.8 V. These voltages are set by R509 and R510 respectively. The 12 V sealed lead-acid batteries can be charged indefinitely at this voltage. FETs Q500 and Q501 prevent the batteries from discharging through the regulator voltage adjustment resistors when no external power supply is connected. Further regulation provides +10 V and -9 V rails for the analog circuits and +5 V for the digital circuits. Power is applied to these regulators through a bistable relay, K500. K500 is set to the on position by the momentary action of the front-panel power switch. K500 is set to the off position either by the front panel switch or under processor control using Q503. The processor turns the power off when the battery voltage fall to a level at which the amplifier no longer operates to specification or when the OFF command is sent over the RS232 link. For battery operation, the unit is simply not plugged into the external power supply, so that the batteries alone provide power to the dc lines. For convenience in checking the batteries, a test circuit is

provided.

4.4 BATTERY TEST CIRCUIT

When the processor is awake, the voltage on the positive battery is periodically measured by an analog to digital converter. If the voltage falls below approximately 10.8 V, a low battery warning is displayed on the LCD. Only the positive battery is monitored in this way since it has the larger power drain.

While the processor is asleep it is not possible to use the analog to digital converter. The batteries are monitored using two comparators which are able to wake-up the processor when either battery falls below the voltage required to operate the analog circuits. Since the unit will no longer be working to specification, the processor will then turn the unit off.

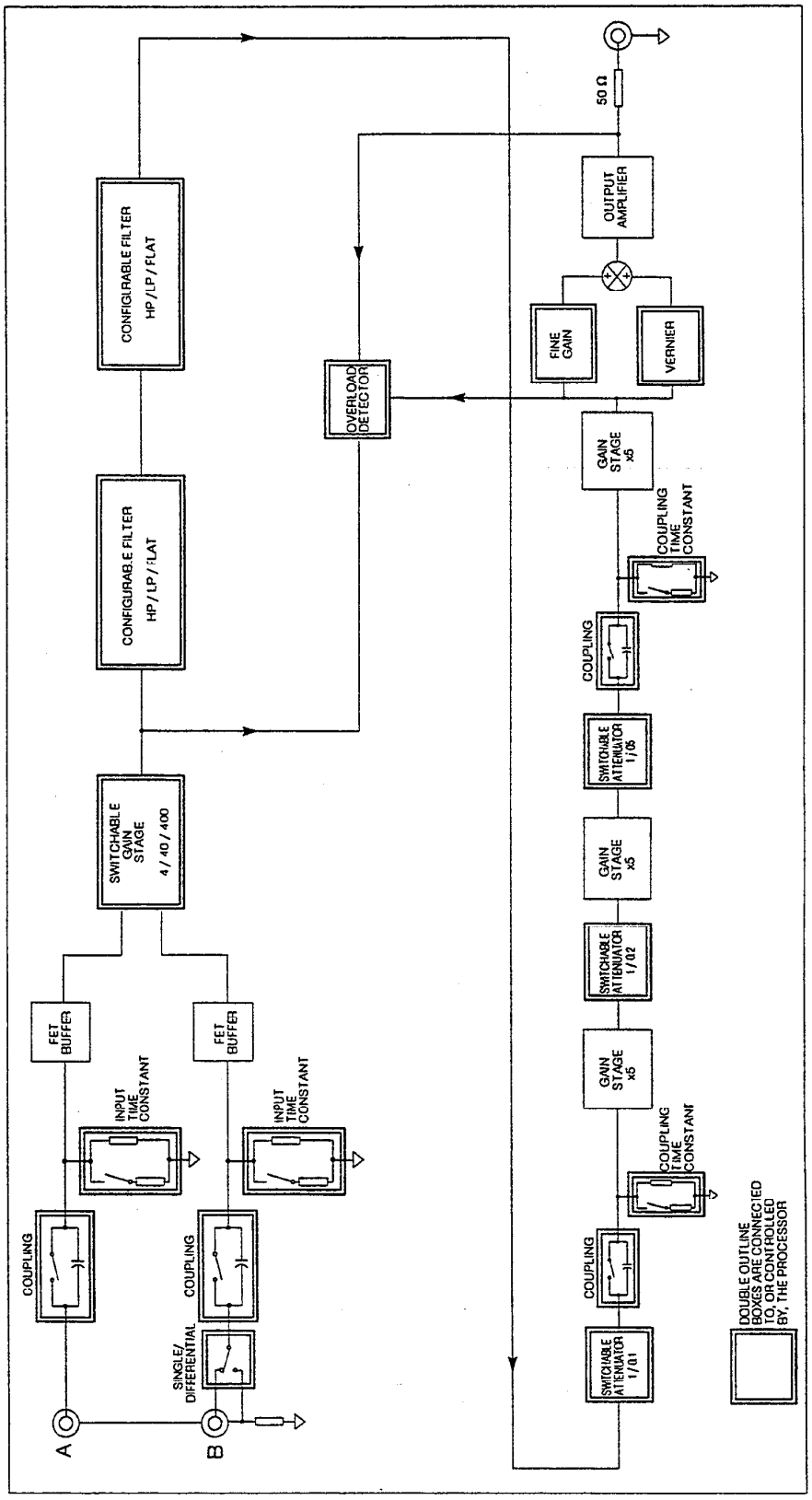


Figure 4-1. MODEL 5113 BLOCK DIAGRAM

Chapter 5
Commands

5.1 INTRODUCTION

A transmission to the Model 5113 consists of a command followed by its operand. Commands may be upper-case or lower-case. Each transmission must be followed by a carriage return terminator. Each command consists of one or more characters used to delineate the command plus one or two operands. If a command contains more than one operand, the operand must be separated by a space.

The 5113 always responds to a command with either an * or a ? prompt. An * (asterisk) response indicates that the command has been executed and the unit is ready to accept another command. A ? (question mark) response indicates that an error condition has occurred. There may have been something wrong with the command itself, or it may have caused an error condition such as overload in the 5113.

Numbers must be ASCII decimal with the most significant digit transmitted first. Any number of leading spaces are permitted before a command or parameter sent to the Model 5113 as long as the entire command including terminator does not exceed 16 characters.

In the event of a command error or parameter error, the 5113 sets bit 1 (invalid command) or bit 2 (parameter error) of the Status Byte. If correct command mnemonics followed by meaningless characters in place of the operand are applied, the 5113 will implement the correct part of the command and ignore the rest.

5.2 MODEL 5113 COMMANDS

Detailed descriptions of the 5113 commands follow. Where there is only one operand, it is designated "n". Where there are two operands, the first is designated "n_1" and the second "n_2". If sent with operands, the command sets the value of the corresponding parameters. If sent without operands, it requests that the 5113 report the values.

BL n: BACKLIGHT: This command sets or reads the LCD backlight status.

n	Significance
0	LCD backlight off
1	LCD backlight on

CG n: COARSE GAIN: This command sets or reads the coarse gain in a 1-2-5 sequence.

n	Gain
0	5
1	10
2	25
3	50
4	100
5	250
6	500
7	1000
8	2500
9	5000
10	10000
11	25000
12	50000

CP n: COUPLING: This command sets or reads the input coupling.

n	Significance
0	AC
1	DC

DR n: DYNAMIC RESERVE: This command sets or reads the filter reserve setting. The low filter reserve setting has the advantage of lower noise.

n	Significance
0	Low noise
1	High filter reserve

FF n_1 n_2: FILTER FREQUENCY: Sets or reads the roll-off frequency setting of filter n_1.

n_1	Significance
0	Low frequency roll-off
1	High frequency roll-off

n_2	Frequency
1	0.03 Hz
2	0.1 Hz
3	0.3 Hz
4	1.0 Hz
5	3.0 Hz
6	10 Hz
7	30 Hz
8	100 Hz
9	300 Hz
10	1.0 kHz
11	3.0 kHz
12	10 kHz
13	30 kHz
14	100 kHz
15	300 kHz

When changing the filter frequencies using the FF command, there is no protection against setting the low frequency roll-off to be greater than the high frequency roll-off. This is to allow the frequencies to be updated in either order by the controlling program. The lcd display will show whatever frequencies have been set up, but if an attempt is made to adjust an "illegal" setting

from the front panel, then one of the frequencies will be automatically "corrected".

FG n: FINE GAIN: On all but the maximum coarse gain, the fine gain extends the coarse gain from x1 to x3 in 0.2 increments, i.e. 1.0, 1.2, 1.4, 1.6, etc. On the maximum coarse gain setting of 50,000, the fine gain extends the coarse gain by a maximum of x2. On the minimum coarse gain setting of x5 the fine gain has an additional under-range to bring the total gain down to x1.

n	Significance	Valid Gain
-4	x0.2	x5 only
-3	x0.4	x5 only
-2	x0.6	x5 only
-1	x0.8	x5 only
0	x1.0	all gains
1	x1.2	all gains
2	x1.4	all gains
3	x1.6	all gains
4	x1.8	all gains
5	x2.0	all gains
6	x2.2	not x50000
7	X2.4	not x50000
8	x2.6	not x50000
9	X2.8	not x50000
10	x3.0	not x50000

FLT n: FILTER: This command sets or reads the filter mode.

n	Filter
0	Flat
1	Bandpass
2	Low pass, 6 dB roll-off
3	Low pass, 12 dB roll-off
4	Low pass, 6/12 dB roll-off
5	High pass, 6 dB roll-off
6	High pass, 12 dB roll-off
7	High pass, 6/12 dB roll-off

GV n: GAIN VERNIER: This command sets or reads the vernier value. The uncalibrated vernier increases the gain by a maximum of 20% in 15 steps. When the vernier is on (and therefore the gain is uncalibrated) it is indicated on the LCD display by a + after the gain figure.

The range of n is 0 to 15. To turn the vernier off, set n to 0.

HELP: HELP: This command causes the 5113 to output on the RS232 a brief list of the available commands.

ID: INSTRUMENT IDENTIFICATION: This command causes the 5113 to echo the response **5113.**

IN n: INPUT: Sets or reads the input mode.

n	Input mode
0	A
1	A-B

LCD n: LCD CONTRAST: This command sets or reads the parameter that controls the LCD contrast or viewing angle and must be in the range of 0 to 15 inclusive.

LINE n CR text: STARTUP MESSAGE: This command can be used to change the message that is displayed briefly on power-up. This is a two-stage command. The first stage is to send either LINE 1 or LINE 2 followed by the carriage return terminator. This causes the unit to automatically lock out the front panel until the second part of the command is complete. The second part of the command consists of text followed by a carriage return terminator. A maximum of 40 characters is allowed. If 40 characters are sent then the terminator is not required. While the text is being transmitted it is displayed on the LCD display on the relevant line. Once transmission of the text is complete the display reverts to whatever was previously displayed.

OFF: OFF: This command turns off power to all but the battery charging circuit. If the external power supply is connected, the battery will continue to charge. If the external power supply is not connected, then no power is taken from the battery. This is equivalent to pressing down and releasing the front-panel power switch. This command is useful in preventing unnecessary discharge of the battery. After a computer has completed an unattended experiment, it can turn the instrumnet off. Note that the complementary command, ON, does not exist.

OR: OVERLOAD RECOVER: This command causes the unit to perform an overload recover in the same way as pressing the front panel overload recover button.

REMOTE n: REMOTE: This command sets or reads the front panel status.

n	Front Panel Status
0	Locked out
1	Normal

SLEEP: SLEEP: This command causes the Model 5113 to turn off all the digital oscillators and turn off power to the LCD.

This is equivalent to the front-panel sleep push button.

ST: STATUS: This command requests that the Model 5113 report its status to the host controller. The

number reported is the decimal equivalent of the Status Byte and refers to the previously applied command.

Bit	Meaning
0	Command Done
1	Invalid command
2	Parameter error
3	Overload
4	Low battery
5	Not used
6	Not used
7	Not used

TC n: TIME CONSTANT: This command sets or reads the input time constant.

n	Time constant
0	1 second
1	10 seconds

VER: VERSION: This command requests that the Model 5113 report its firmware version number.

5.3 MODEL 5113 DIAGNOSTIC COMMANDS

The following three commands can be used for testing the front panel controls and display.

SET: This command causes the Model 5113 to set all the LCD pixels to on. This can be used to check that the LCD has no pixels that are permanently off.

BLANK: This command causes the Model 5113 to clear the LCD display. This can be used to check that the LCD has no pixels that are permanently on.

TEST: This command initiates a test of the front panel controls. The step by step instructions are displayed on the LCD. If the test passes the Model 5113 replies with **1**. If the test fails the reply is **0**.

5.4 RS232 PARAMETERS

The baud rate for the RS232 interface is selected from within the special pages as described in section 3.1H. The other RS232 parameters are

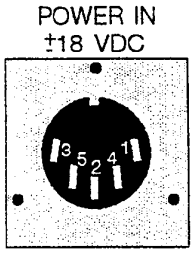
No Parity
8 Data Bits
1 Stop Bit

Appendix A
Pinouts

A.1 POWER INPUT PINOUT

PIN	FUNCTION
1	No Connection
2	Ground/Earth
3	No Connection
4	-18 V
5	+18 V

Note: Mating connector is SWITCHCRAFT[R] type 05BL5M or equivalent (EG&G PARC #2102-0171).

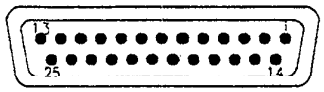


A.2 RS232C CONNECTOR PINOUT

Note: On the rear panel is a female, 25 pin, optically isolated RS232 connector.

The connections are:

PIN	FUNCTION
2	Data receive
3	Data transmit
4	RTS (must be high)
7	Ground



RS232 CONNECTOR

All other pins are unconnected.

No hardware handshaking is implemented but RTS must be connected and be permanently high in order to power the opto isolator. If RTS is not available, then a 9V battery connected between pin 4 (+ve) and pin 7 (-ve) will enable the circuit to operate and also maintain isolation.

Appendix B
Power Supply

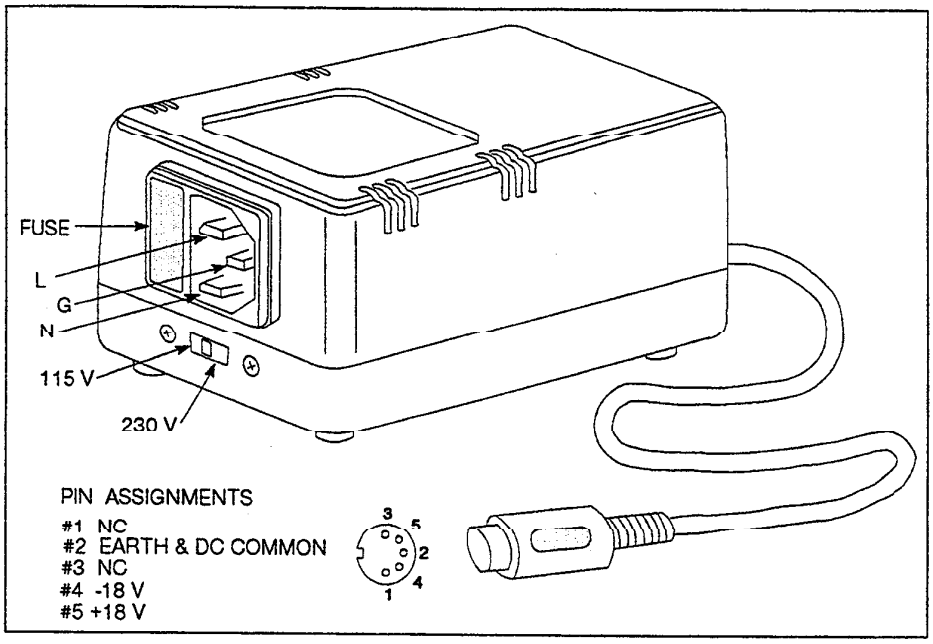


Figure B-1. EXTERNAL POWER SUPPLY

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WARRANTY

EG&G Instruments Corporation warrants each instrument of its own manufacture to be free of defects in material and workmanship. Obligations under this Warranty shall be limited to replacing, repairing or giving credit for the purchase price, at our option, of any instrument returned, shipment prepaid, to our Service Department for that purpose within **ONE** year of delivery to the original purchaser, provided prior authorization for such return has been given by an authorized representative of EG&G Instruments Corporation.

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SHOULD YOUR EQUIPMENT REQUIRE SERVICE

A. Contact the Service Department (609-530-1000) or your local representative to discuss the problem. In many cases it will be possible to expedite servicing by localizing the problem to a particular plug-in circuit board.

B. If it is necessary to send any equipment back for service, we need the following information.

1. Model number and serial number.
2. Your name (instrument user).
3. Your address.
4. Address to which the instrument should be returned.
5. Your telephone number and extension.
6. Symptoms (in detail, including control settings).
7. Your purchase order number for repair charges (does not apply to repairs in warranty).
8. Shipping instructions (if you wish to authorize shipment by any method other than normal surface transportation.)

C. **U.S. CUSTOMERS** - Ship the equipment being returned to:

EG&G Instruments
375 Phillips Blvd.
Trenton, NJ 08618

D. **CUSTOMERS OUTSIDE OF U.S.A.** - To avoid delay in customs clearance of equipment being returned, please contact the factory or the nearest factory distributor for complete shipping information.

E. Address correspondence to:

EG&G Instruments
P.O. Box 2565
Princeton, New Jersey 08543-2565

Phone: (609) 530-1000
TELEX: 84-3409
FAX: 883-7259