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Dual-channel Filters

Series SR640

1290-D Reamwood Avenue, Sunnyvale, California 94089
e-mail: info@thinkSRS.com • www.thinkSRS.com
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Revision 2.6
(12/99)

SRS Stanford Research Systems

Notice: The information described in this manual pertains to the SR640 dual channel low-pass filter, the SR645 dual channel high-pass filter, and the SR650 low-pass high-pass filter. The manual refers to all three filter models as "SR640". Any differences between the three models are explicitly noted.

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SAFETY AND PREPARATION FOR USE

**** CAUTION ****

This instrument may be damaged if operated with the LINE VOLTAGE SELECTOR set for the wrong AC line voltage or if the wrong fuse is installed.

LINE VOLTAGE SELECTION

The SR640 operates from 100, 120, 220 or 240 Volts nominal AC power source with a line frequency of 50 or 60 Hz. Before connecting the power cord to a power source, verify that the LINE VOLTAGE SELECTOR card, located in the rear panel fuse holder,is set so that the correct AC input voltage is visible.

Conversion to other AC input voltages requires a change in the fuse holder voltage card position and fuse value. Disconnect the power cord, open the fuse holder cover door and rotate the fuse-pull lever to remove the fuse. Remove the small printed circuit board and select the operating voltage by orienting the printed circuit board to position the desired voltage to be visible when pushed firmly into its slot. Rotate the fuse-pull lever back into its normal position and insert the correct fuse into the fuse holder.

LINE FUSE

Verify that the correct line fuse is installed before connecting the line cord. For 100V/120V, use a 1 Amp fuse and for 220V/240V, use a 1/2 Amp fuse.

LINE CORD

The SR640 series uses a detachable, three-wire power cord for connection to the power source and to a protective ground. The exposed metal parts of the instrument are connected to the outlet ground to protect against electrical shock. Always use an outlet which has a properly connected protective ground.

GROUNDING

The SR640's BNC connector shields are NOT connected to the unit's chassis ground. This is done in order to provide the user with maximum flexibility in connecting the instrument's grounds for optimum noise-reduction. However, the user should be aware that improper connection of the SR640 to a hazardous voltage source could result in hazardous voltages present at the exposed BNC shield terminals. Please see the guide to operations for additional information concerning grounding.

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SR640 SPECIFICATIONS

GENERAL INFORMATION

The SR640 consists of two independent low-pass filter channels. Each filter is preceded by a low-noise preamplifier with selectable gain of 0 to 60 dB. The filters are an 8-pole, 6-zero elliptical design with 0.1 dB maximum passband ripple and 115 dB/octave attenuation slope. A variable gain output amplifier with gains of 0dB, 10dB, and 20dB follows each filter. The filter may be bypassed to allow each channel to be used simply as an amplifier.

The filters are controlled by a CMOS microprocessor which also handles the RS-232 and IEEE-488 interfaces. In addition, nonvolatile storage is provided for up to 9 complete instrument settings defined by the user.

No direct electrical connection exists between the microprocessor section of the SR640 and the filter channels. Filter and gain control is accomplished strictly through optoisolated interfaces. In addition, each channel's ground is isolated from the digital section's ground as well as from the other filter section. Each channel's isolated ground is made available to the user on a rear-panel BNC connector to provide maximum flexibility in connecting the SR640.

FILTER SPECIFICATIONS

Frequency Range	1Hz to 100 kHz with 3-digit resolution
Type	8-pole, 6-zero elliptic
Rolloff	115 dB/octave
Passband Ripple	0.1 dB pk-pk, typical
Stopband Attenuation	80 dB, typical

INPUT SPECIFICATIONS

Impedance	1 MΩ // 15 pF
Configuration	Single ended (A or B) or Differential (A-B)
Common Mode Rejection	>90 dB at 100 Hz
Coupling	AC or DC
Input Noise	10 nV/√Hz at 1 kHz with 60 dB input gain
Gain	0,10,20,30,40,50,60 dB ±0.2 dB
Maximum Input Signal	10 Volts pk-pk

OUTPUT SPECIFICATIONS

Impedance	<1 Ω
Full Scale Output Signal	10 Volts pk-pk into >300 Ω
DC Offset	Adjustable to 0 Volts DC
Gain	0,10,20 dB ±0.2 dB
Harmonic Distortion	No greater than 80 dB below full scale at 100 Hz signal
Spurious Components	No greater than 80 dB below full scale with input source <50 Ω
Crosstalk Between Channels	No greater than 80 dB below full scale with input source <50 Ω
Phase Match Between Channels	±2°, DC to cutoff frequency

GENERAL

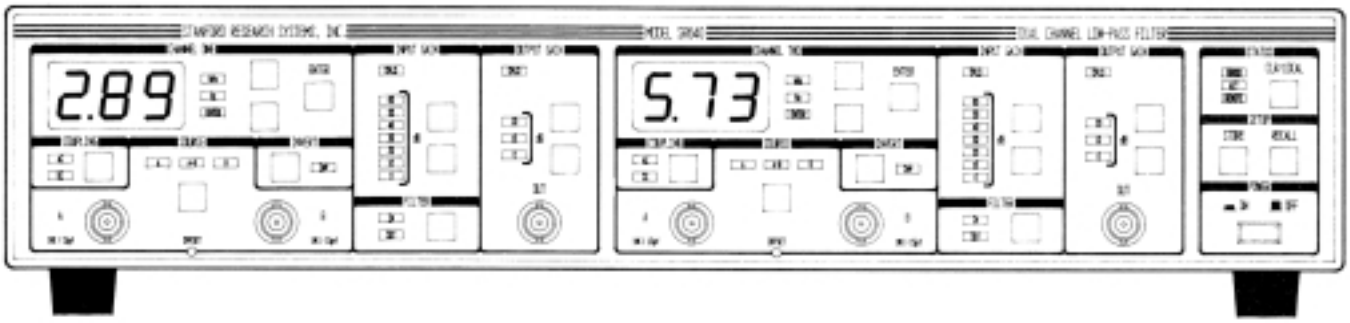
Interfaces	IEEE-488 and RS-232 standard. All instrument functions can be controlled and read through the interface.
Stored Settings	9 complete 2 channel instrument configurations may be stored in nonvolatile memory.
Power	100/120/220/240 VAC, 50/60 Hz
Dimensions	15.7"W X 3.0"H X 14.0"L
Warranty	One year parts and labor on materials and workmanship

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INSTRUMENT OVERVIEW

FRONT PANEL SUMMARY



FRONT PANEL OPERATION

The front panel has been designed to be nearly self-explanatory. The effect of each keypress is usually reflected by a change in the state of a nearby LED.The front panel controls for each filter channel are identical. The following discussion of the front panel controls applies to both channel 1 and channel 2.

POWER BUTTON

The SR640 is turned on by depressing the POWER button. When the unit is turned on, the model number, serial number and firmware version number will appear briefly on the LED displays. When the unit is powered off, all instrument settings are stored in non-volatile memory. Upon power up, the SR640 checks the consistency of the stored settings. If an error appears on power up, the instrument is returned to its default state. The default state for each filter channel is:

Cutoff Frequency:	5 kHz
Coupling:	DC
Source:	A
Invert:	Off
InputGain:	0 dB
Output Gain:	0 dB
Filter:	In

FREQUENCY DISPLAY

The three digit LED displays indicate the cutoff frequency of each filter. The adjacent unit LEDs indicate whether the displayed frequency is in Hz or kHz. The cutoff frequency for either channel may be changed using the frequency increment and decrement buttons to the right of the display. When one of these buttons is pressed, the displayed frequency will begin scrolling up or down. Note, however, that the actual filter cutoff frequency does NOT change until the ENTER button is pressed. The ENTER LED will light to indicate that the displayed frequency does not match the actual filter cutoff frequency. When the ENTER button is pressed, the ENTER LED will turn off and the filter frequency will change to match the displayed frequency. If the frequency display has been changed but it is not desired to change the actual filter cutoff frequency, pressing the CLR/LOCAL button will reset the display to the actual filter frequency.

SOURCE SELECT

There are two input BNC connectors provided for each filter channel. When source LED 'A' is on, the input signal is measured between the center conductor of the 'A' BNC connector and its shield. When the 'B' LED is on, the signal is measured between the center conductor of the 'B' BNC connector and its shield. When the 'A-B' LED is on, the signal is taken between the center conductor of the 'A' connector and the center conductor of the 'B' connector. In all cases, the shields of the 'A' and 'B' BNC connectors are connected to

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each other and to the filter ground. The filter ground is NOT connected to the unit's chassis ground.

Filter ground for each channel is available at a rear panel BNC connector. With this connector, the user can connect filter ground to chassis ground or to any other desired point.

COUPLING AND INVERT

The COUPLING button selects either AC or DC input coupling for both the 'A' and 'B' input connectors. The AC coupling has a nominal -3dB point of 0.1Hz. Selecting INVERT on the front panel simply inverts the sign of the output signal with respect to the input.

INPUT AND OUTPUT GAIN

The input and output gain indicators display the amount of gain present before and after the filter. Changing the gain is accomplished with the up and down buttons to the right of the respective indicators. The gain can be changed in 10 dB increments up to a maximum of 60 dB of input gain (prefilter) and 20 dB of output gain (postfilter).

FILTER IN/OUT

Selecting filter IN on the front panel puts the filter in the signal path. Selecting filter OUT leaves the input and output amplifiers in the signal path but bypasses the filter. The -3dB point for the input and output amplifiers with the filter bypassed is approximately 450 kHz.

OFFSET ADJUST

The front panel offset adjust allows the user to dial in approximately ±150 mV of input offset voltage. Note that this is a true input offset and the actual output offset voltage will depend on the selected gain.

CLR/LOCAL

The CLR/LOCAL button has two functions. If the displayed frequency for either filter channel has been changed, pressing the CLR/LOCAL button resets the display to the actual filter frequency. If the SR640 has been placed in the REMOTE mode by a command from the computer interface, pressing the CLR/LOCAL button will return the unit to the LOCAL mode and enable front panel control. Note that the CLR/LOCAL button will not return the unit to local operation if the unit has been placed in the LOCAL LOCKOUT mode.

STORE AND RECALL

The SR640 can store and recall up to 9 complete instrument setups. To store the current instrument configuration, press the STORE button. The setup number (1-9) will appear in the channel 2 frequency display. To change the setup number, use the channel 2 frequency up and down buttons. When the setup number is correct, press the channel 2 ENTER button to store the setup. Recalling previously stored setups is done in the same manner. Recalling setup '0' places the instrument in its default configuration. Pressing the CLR/LOCAL button while storing or recalling a setup aborts the operation and returns the display to its normal mode. If an attempt is made to recall a setup which has not been previously stored, the display will indicate an error. In this case, the CLR/LOCAL button should be pressed to resume normal operation.

ERROR, ACTIVITY, and REMOTE LEDs

The ACT LED lights to indicate any activity over the interface, such as the receipt of a command. The ERROR LED will light when a bad command is received over the computer interface. The REMOTE LED lights to indicate the SR640 is either in the REMOTE or LOCAL LOCKOUT mode of operation. In either of these modes, the front panel buttons are not operational. Only in the REMOTE mode can front panel operation be regained by pressing the CLR/LOCAL button.

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GUIDE TO PROGRAMMING

The SR640 dual channel low-pass filter is remotely programmable via both RS-232 and GPIB interfaces. All front panel features (except offset adjustment) may be controlled and read via the computer interfaces.

Communicating with the SR640

Before using either the RS-232 or GPIB interface, the appropriate configuration switches must be set. The configuration switch is located on the rear panel and label 'SW1'. Bit 8 of the switch selects GPIB or RS-232 operation. If bit 8 is 'on', GPIB operation is selected, if it is 'off', the RS-232 interface is enabled. The other bits of the switch take their meaning depending upon whether RS-232 or GPIB operation has been selected.

When a bit is 'on', it is in the DOWN position.

GPIB:

Bit	Explanation
8	Always on for GPIB
7	not used
6	not used
5	high order bit of GPIB address
4	GPIB address (on = 1 off = 0)
3	GPIB address
2	GPIB address
1	low order bit of GPIB address

RS-232:

Bit	Explanation	
8	Always off for RS-232	
7	on = echo	off = no echo (normally off)
6	on = 8 bit word	off =7 bit word
5	on = even parity	off = odd parity
4	on = parity enabled	off = disabled
3	baud rate select	
2	baud rate select	
1	baud rate select	

Bit 3	2	1	Baud Rate
on	on	on	19200
on	on	off	9600
on	off	on	7200
on	off	off	4800
off	on	on	3600
off	on	off	2400
off	off	on	2000
off	off	off	1800

Note that the configuration switch is only read on power-up. If a setting needs to be changed, the unit must be turned off and turned on again for the change to be recognized.

Command Syntax

Communication with the SR640 is accomplished by sending and receiving strings of ASCII characters. Characters sent to the SR640 may be sent in either UPPER or lower case.

A command to the SR640 consists of 4 ASCII characters followed by an optional question mark '?' character, followed by a list of arguments separated by commas, followed by a line-feed (<lf>) character. If spaces are included in the command string, they are ignored by the SR640. The SR640 interprets the GPIB EOI message sent with the last character of a string as equivalent to a <lf> terminator. Examples of commands are:

FREQ1,23600.<lf> set the channel 1 filter frequency to 23.6 kHz.
FREQ?2<lf> read the channel 2 filter frequency
*CLS<lf> clear the status byte

Multiple commands may be sent on a single line. The commands must be separated by semicolon characters. An example of a multiple command would be:

FREQ1,23.6E3;FREQ2,100<lf>

The presence of a question mark character in a command indicates that the command is a request to the SR640 to send back a value. Values returned by the SR640 are terminated with a carriage return <cr> and a linefeed <lf>. If the GPIB interface is used, the <lf> is accompanied by the EOI message.

RS-232 Echo and No Echo Operation

In order to allow the SR640 to be operated from a terminal, an echo feature has been included which causes the unit to echo back characters received over the RS-232 port. This feature is enabled by setting bit 7 of the configuration switch on. When using the unit with a computer, this feature should be disabled to prevent spurious characters from being sent to the computer. The echo feature is not operational when the unit is being used with the GPIB interface.

Tips on Using National Instruments GPIB cards

To successfully interface the SR640 to a PC via the GPIB, the instrument, interface card, and inter-

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face driver must all be configured properly. To configure theSR640, the GPIB address must be properly set using the DIP switch on the back panel. The SR640 is shipped with the GPIB address set to 23.

Make sure that you follow all the instructions for installing the GPIB card. The National Instruments card **cannot** simply be unpacked and put into your computer. To configure the card you must first set jumpers and switches to set interrupt levels and I/O addresses. You must then run the program IBCONF to configure the DOS resident GPIB driver. Please refer to the National Instruments manuals for complete details.

Once all the hardware and software has been configured properly, try using the IBIC program supplied with the National Instruments card to send commands and receive data from the SR640. If you cannot talk to the SR640 with the IBIC program, there is no point in trying to write a program.

Although the National Instruments language contains many commands, to avoid confusion it is best to start with a few simple ones. Use IBWRT and IBRD to write and read from the SR640. After you are familiar with the simple commands you can explore other, more complex, programming commands.

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COMMAND LIST

The command list of the SR640 is detailed below. Commands that may be queried have a question mark ? in parentheses (?) after the four character command mnemonic. Commands that may ONLY be queried have a ? after the mnemonic. Parameters shown in brackets {} should be omitted if the command is used as a query. Do not send () or {} as part of the command. The variable i used in many of the commands indicates which filter channel the command will operate on. This variable can only be 1 (for channel 1) or 2 (for channel 2). The variable n is an integer variable, and must be sent as an integer, i.e. no decimal points or exponents. The variable x is a real number and may be expressed in fixed or floating point format, with or without a decimal point.

FILTER COMMANDS

ACDC(?)i{,n}

The ACDC command sets the input coupling for channel i to AC (n=0) or DC (n=1).

FLTR(?)i{,n}

If n=1, the FLTR command puts the channel i filter into the signal path. If n=0, the filter is bypassed.

FREQ(?)i{,x}

The FREQ command sets the filter cutoff frequency for channel i to x. Allowed values are $1.0 \leq x \leq 99{,}900$ (Hz).

INVT(?)i{,n}

The INVT command inverts the output signal with respect to the input (n=1), or leaves it uninverted (n=0).

LOCL n

The LOCL command sets the local/remote mode of the instrument. Allowed values are:

n	mode
0	local
1	remote
2	remote with local lockout

OVLD?

The OVLD? command queries the overload status of the instrument. The result is returned as a decimal number (0-15) which represents a 4 bit binary number. The binary number is coded as follows:

bit	meaning
3 (msb)	channel 2 output overload
2	channel 2 input overload
1	channel 1 output overload
0 (lsb)	channel 1 input overload

PREG(?)i{,n}

The PREG command sets the input gain for channel i to the value specified by n. Allowed values of n are:

n	Input Gain
0	0 db
1	10 db
2	20 db
3	30 db
4	40 db
5	50 db
6	60 db

PSTG(?)i{,n}

The PSTG command sets the output gain for channel i to the value specified by n. Allowed values of n are:

n	Output Gain
0	0 db
1	10 db
2	20 db

SRCE(?)i{,n}

The SRCE command selects the input source for channel i. The permitted values for n are:

n	Input Source
0	A
1	A-B
2	B

STATUS AND INTERFACE COMMANDS

*IDN?

The *IDN? command returns the SR640's identification string. The string format is:

Stanford Research Systems,SR640,S/N0001,v

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1.01<cr><lf>

***RST**

The *RST command resets the instrument. It is equivalent to a RCL 0 command (recall default set-up).

***STB? {n}**

The *STB? command queries the value of the SR640's status byte. The byte is returned as a decimal number (0-255). The *STB? n command reads the value of bit n. The range of n is 0-7. The value returned is either 0 or 1. The various bits in the status byte have the following meanings:

bit	meaning
0	READY. Indicates unit has completed all pending commands.
1	OUTPUT FULL. Indicates the unit's output queue is full.
2	EXECUTION ERROR. Indicates an illegal value was encountered while executing a command.
3	SYNTAX ERROR. Indicates the SR640 could not interpret received characters as a command.
4	OUTPUT NOT EMPTY. Indicates the SR640 has characters waiting to be sent.
5	INPUT FULL. Input queue full. The user should send commands more slowly.
6	SRQ. Indicates the unit has requested service from the GPIB controller.
7	POWER ON. Indicates the SR640 has been powered on.

Each of the bits is set when the associated condition first becomes true. The status byte is only cleared after the *STB? or *CLS command.

***CLS**

The *CLS command clears the SR640's internal status byte. This status byte is the byte returned by the SR640 when it is serial polled via the GPIB interface. It may also be queried using the *STB? command.

***SRE(?){n}**

The *SRE command sets the service request enable byte to the value specified by n. Allowed values are 0 through 255. When a bit is set in the status byte, the byte is logically 'anded' with the service request enable byte. If the corresponding bit in the service request enable byte is set, the SR640 issues a SRQ (service request) to the GPIB controller. This command may only be used with the GPIB interface.

***RCL n**

The *RCL n command recalls the nth stored instrument settings. Allowed values for n are 0 through 9.

***SAV n**

The *SAV command saves the current instrument configuration as stored setting n. Values for n are 1 through 9.

***PSC (?)n**

The *PSC command sets the power-on status clear bit. If n=1, the service request enable byte is cleared upon power up. If n=0, the status byte and service request enable byte maintain their values when the unit is powered down. This allows the generation of a service request upon power up.

WAIT(?)n

The WAIT command sets the RS-232 transmission delay between characters. This is sometimes useful when interfacing with slower computers and terminals. The wait interval is set to about 2ms * n. Allowable values for n are 0 < n <255.

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PROGRAMMING EXAMPLES

The following are examples of programs which communicate with the SR640 in a variety of languages over both RS232 and GPIB. In each case, the program does the same thing: Set the channel 1 pregain to 10 db, the Channel 2 postgain to 20 db, and read the value of the channel 1 cutoff frequency. Once the basics of writing to and reading from the SR640 are mastered, the task of programming is reduced to simply finding the appropriate command from the command list.

Program Example 1
IBM PC, BASIC, via RS232

In this example, the IBM PC's COM2: serial port is used to communicate with the SR640. Note that a "straight through" RS232 cable (NOT a null modem cable) should be used to connect the PC to the SR640. The SR640 should be set to operate at 9600 baud, 8 bits, no parity.

```
10'Example program for the SR640 filter using IBM BASIC over the COM2: port
20'
30'Open the COM2: port for 9600, 8 bits, no parity, ignore handshake
40 OPEN "COM2:9600,N,8,2,CS,DS,CD" AS #1
50'
60' Clear COM2 port
70 PRINT #1,"  "
80' Set channel 1 pregain and postgain
90 PRINT #1,"PREG1,1;PSTG2,2"
100 'Now read channel 1 cutoff frequency
110 PRINT #1, "FREQ?1"
120 INPUT #1, FREQ        'read answer
130 PRINT "frequency = ",FREQ
140 STOP
```

Program Example 2
IBM PC, Microsoft FORTRAN, National Instruments GPIB Card

Please refer to the "Guide to Programming" section for additional information on using the National Instruments GPIB card. The GPIB.COM driver must be configured with IBCONF before using the National Instruments cards.

```
c example program for the SR620 using Microsoft FORTRAN and National Instruments GPIB
card
c compile with /FPa /AL and link with MFIBL.OBJ (supplied by National Instruments)

$storage:2

c this line must be in the source file
      common /ibglob/ibsta,iberr,ibcnt
      integer sr640
```


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```
      character *80 string
      real*4answer


c initialize gpib card

      call ibinit(ibsta)

c get device id for sr640

      sr640 = ibfind('sr640 ')

c set pregain and postgain

      call ibwrt (sr640,'PREG1,1;PSTG2,2',15)

c now query stage 1 filter cutoff

      call ibwrt (sr640,'FREQ?1',6)
      call ibrd (sr640,string,30)
      read (string,1000) answer

1000   format (bn,f14.0)

      write (*,*) answer
      stop
      end
```

Program Example 3
IBM PC, Microsoft C, National Instruments GPIB card

```
/* Program to test SR640 communication using National Instruments GPIB card and
Microsoft C. Compile with /AL /FPa /c and link with the CIBL.OBJ module supplied
by National Instruments  */

#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <math.h>

/* function prototypes */

void main(void);

/* variables defined in CIBL module */
```


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```
extern int ibsta;
extern int iberr;
extern int ibcnt;


void main (void)
{
        int sr640;
        char string[30];
        float answer;

        sr640 = ibinit("SR640");     /* locate device */
        if (sr640<0)
                error();

        ibwrt (sr640,"PREG1,1;PREG2,2",15);  /* set gain */

        ibwrt (sr640, "FREQ?1",6);

        /* query frequency */
        ibrd (sr640,string,30);


        /* and get answer */

        sscanf(string,"%f",&answer);
        printf("answer = %f",answer);
}
```


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Circuit Description

INTRODUCTION

Schematics for the SR640 series dual-channel filters are shown on the following pages. They include the following: Preamplifier, filter stage, output amplifier, optoisolated interface, microprocessor section, communications section, front panel interface, power supplies, and front panel. The preamplifer, filter stages (4/channel), output amplifer, and optoisolated interface are located on the individual filter boards (2/instrument). The microprocessor and commuinication components are located on the digital board at the rear of the instrument.

Preamplifier

The preamplifier is a low-noise fully differential amplifier with gains from 0 to 60 db. Relays K1 and K2 select the input source and coupling, while K4 switches in a X10 attenuator used at the three lowest gain settings. The Dual FET U2, along with low-noise op-amps U3 and U4 form the feedback stabilized differential pair at the heart of the premplifier. U6 and U8 provide additional amplification. The output of the preamplifier is switched by U9 to the first filter stage or directly to the output amplifier if the filter has been bypassed.

Filter Stages

Each of the four filter stages is derived from a 3 op-amp biquadratic filter with a low pass transfer function of:

$$T(s) = \frac{s^2 + \omega_z^2}{s^2 + \frac{\omega_p}{Q}s + \omega_p^2}$$

Stage paramaters for the low pass filter are:

Stg	ω_p	Q	ω_z/ω_p
1	.6347	.5493	-
2	.8060	.9507	2.0793
3	.9850	2.095	1.9653
4	1.076	7.375	2.6776

For the high pass filter, the parameters are simply related by the lowpass to high-pass transformation.

Component designations for the filter stage will be refered to as UnXX where n designates the stage number. Un14A, C, and D form the actual filter section. The tuning capacitors Cn20-Cn27 are switched by relays Kn05 and Kn06 according the the decade. Fine tuning within a decade is accomplished by the 10 bit parallel resistor networks composed of Rn40 through Rn59. Switching of the resistors is done with the FET switches Qn00 through Qn19 and their associated driver diodes.

The dual 8 bit DAC Un12 and its related output op-amps along with Un13A and differential amp Un13D allow the pole frequency and Q of the circuit to be fine tuned by adjusting the values sent to the dual DAC. This is how the unit is calibrated. The magnitude of the 'fine tuning' is set by Rn60 and Rn61.

The zero frequency of the circuit is not digitally adjustable but is instead set by resistors Rn71 and Rn72. Jumpers JPn05-n07 allow the zero-forming network to be removed from the circuit in stages that do not have zeros. The single op-amp Un15 forms the output buffer for the stage.

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Output Amplifier

Un16A and B select the filter output or bypassed output from the preamplifier. The 8-bit DAC U17 provides output gain adjustment. The actual output amplifier is U119 which has its gain selected by switch U21. Output inversion is accomplished with U22 in conjunction with the switches U16C and U16D. The optional component U23 provides a high current output buffer. Dual Comparator U20 takes care of output overload detection.

Optoisolated Interface

No direct electrical connection exists between the microprocessor section and the filter boards. Control signals for the filter boards originate from the two 32 bit latched serial input shift registers U25 and U26. These shift registers are in turn controlled by the output of optoisolator U24. Optoisolator U11 provides output isolation for the overload signals which are read by the processor section. Shift register U26 is run between -15V and ground so that its open collector outputs may be pulled up to +15V. These ±15V signals control the FET switches which determine the filter stage frequencies.

Microprocessor and Communications

The microprocessor U4 is a Z80, clocked at 3.6864 MHz by U3. U6 is an 8K ROM, while U7 provides 2K of battery backed up RAM. U1 is a 64K ROM which contains the calibration information for the filter channels. The calibration ROM is mapped as I/O, requiring flip-flop U5B to switch between the normal I/O space and the calibration ROM. U9A gates the clock to the processor enabling the processor clock to be removed during quiescent operation. The clock is restored by a control signal from flip-flop U5A in response to a keyboard or communication interrupt. Communication is accomplished with the UART U15 and GPIB chip U12.

Power Supplies

Regulators U101 provides 5V power to the microprocessor and communications circuits, while regulators U102-105 provide ±15V power to the filter sections. Note that the 5V power supply is the only one referenced to the chassis ground. Note also that each filter power supply is taken from a separate transformer secondary for maximum isolation.

Note: The SR645 and SR650 units contain additional regulators (U27 and U28) on the high-pass filter boards to provide ± 5V to the VTC4706 op-amps.

Front Panel

Shift Registers U201-U206 provide control signals for the front panel LEDs. Switches SW301-SW324 comprise the switch matrix which is read by the processor via input port U 301. LED digits DS101-DS106 are controlled via output ports U18-U25.

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