Technical Manual

For The

Model 7620 Wideband

Transconductance Amplifier

www.guildline.com

NOTICE

TM7620-G-00
February 04, 2014

HAZARDS WARNING!

CURRENT AND VOLTAGE SOURCE INSTRUMENTS

READ THESE SAFETY PRECAUTIONS BEFORE SETTING UP OR USING THIS INSTRUMENT!

IMPROPER SETUP OR OPERATION OF THIS INSTRUMENT CAN RESULT IN PERSONAL INJURY, BURNS OR ELECTRICAL SHOCK!

Precautions, Safety and Preparation for Use

1. **Thoroughly read the set up and operating procedures in this manual before installing or using this instrument.**
2. Select the proper line voltage on the back panel and use only the proper fuse type and rating specified for this product.
3. The line power connection must have an earth ground conductor and must be connected to the instrument only with the line cord supplied or a proper line cord specified for the country of use.
   Operating this instrument without a proper grounded line connection can result in electrical shock hazard.
4. Observe all connector and terminal markings and ratings to avoid any possible shock, or other hazard to the user of this instrument.
5. Under no circumstances should unqualified personnel operate or service this instrument.
6. Do not connect the line power or operate this instrument with the covers removed.
7. Do not touch exposed terminal connections or make or break terminal connections with the instrument operating.
8. Operate this instrument only in a well ventilated and dry environment.
9. **Do not touch or make any type of connection to the CURRENT OR VOLTAGE OUTPUT connections while the instrument is in operation, to avoid POSSIBLE ELECTRICAL SHOCK HAZARD.**

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INTRODUCTION

1.1 SCOPE

This manual contains technical specifications, detailed description and maintenance information, and diagrams for the Guildline Instruments Model 7620 WIDEBAND TRANSCONDUCTANCE AMPLIFIER.

1.2 GENERAL DESCRIPTION

The 7620 WIDEBAND TRANSCONDUCTANCE AMPLIFIER is a high accuracy wideband transconductance amplifier with excellent long term and short term stability. The 7620 works over a specified range of DC to 100 kHz with degraded output above 100 kHz to 1 MHz. The two input voltage ranges accept 1 V (rms) and 10 V (rms) full scale to produce the full scale output of the selected range. The six output current ranges source currents from 200 μA (rms) to 20 A (rms) full scale with a compliance voltage of 10 V peak at dc and at least 7 V peak at 100 kHz. All instrument controls are available over the GPIB except Power ON/OFF. The 7620 operates on line power of 100 V (ac), 120 V (ac), 220 V (ac) and 240 V (ac) (all ±10%) at either 50 Hz or 60 Hz. Power line voltage is selectable on the back panel.

Uses for the 7620 WIDEBAND TRANSCONDUCTANCE AMPLIFIER include:

- Calibration of alternating and direct current shunts and resistors up to 20 A and 100 kHz
- Calibration of alternating and direct current ranges on analogue and digital multimeters

1.3 GENERAL THEORY OF OPERATION

A transconductance amplifier is a device that produces an output (I_{OUT}) proportional to the input voltage V_{IN} as follows:

$$I_{OUT} = T\,V_{IN}$$

For the 7620

$$T = \frac{R_2}{R * R_1}$$

where

T	is the traneconductance
R	is the input stage resistor used to convert the input voltage to a current used to drive the output stage (See Figure 1.3)
R_1	is the output current sensing resistor in the output stage (See Figure 1.4)
R_2	is the drive current sensing resistor in the output stage (See Figure 1.4)

The three resistors which determine the transconductance are selected for their frequency characteristics and stability.

A block diagram of the Model 7620 WIDEBAND TRANSCONDUCTANCE AMPLIFIER is shown in Figure 1.1.

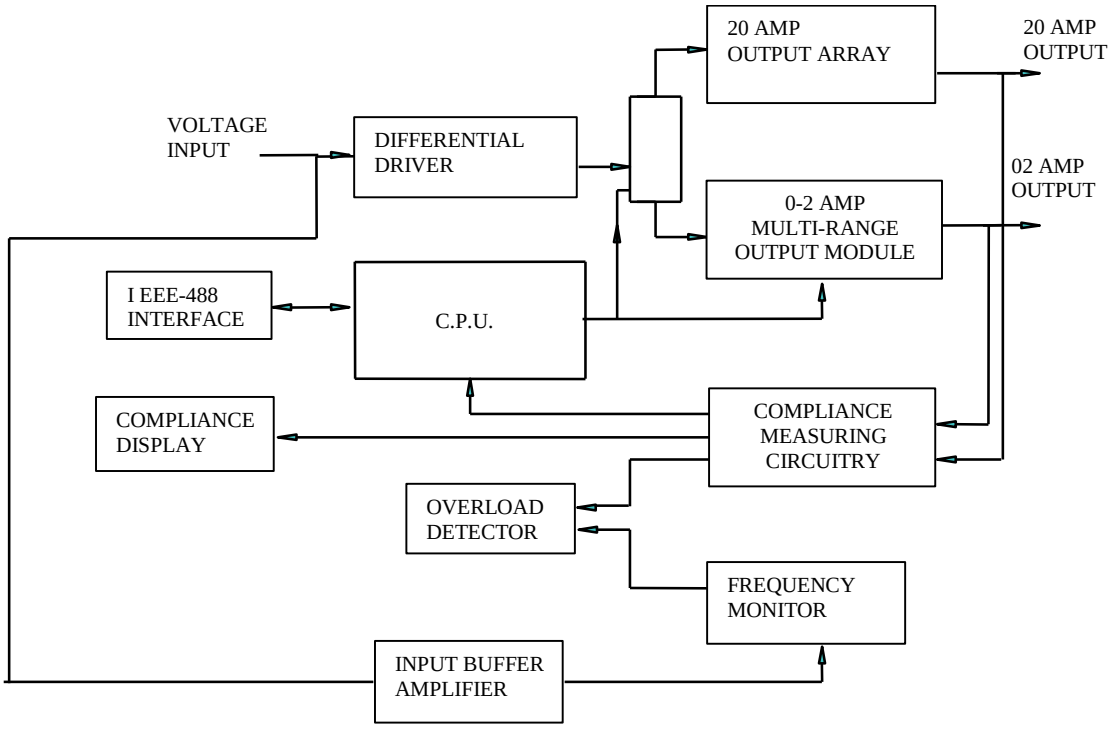


Figure 1.1
Model 7620 Block Diagram

1.3.1 GENERAL DESIGN APPROACH

The approach used for the 7620 WIDEBAND TRANSCONDUCTANCE AMPLIFIER is a cell-based design based on the work of Owen Laug [1] of the National Institute of Standards and Technology. A simplified diagram of the cell-based design is shown in Figure 1.2.

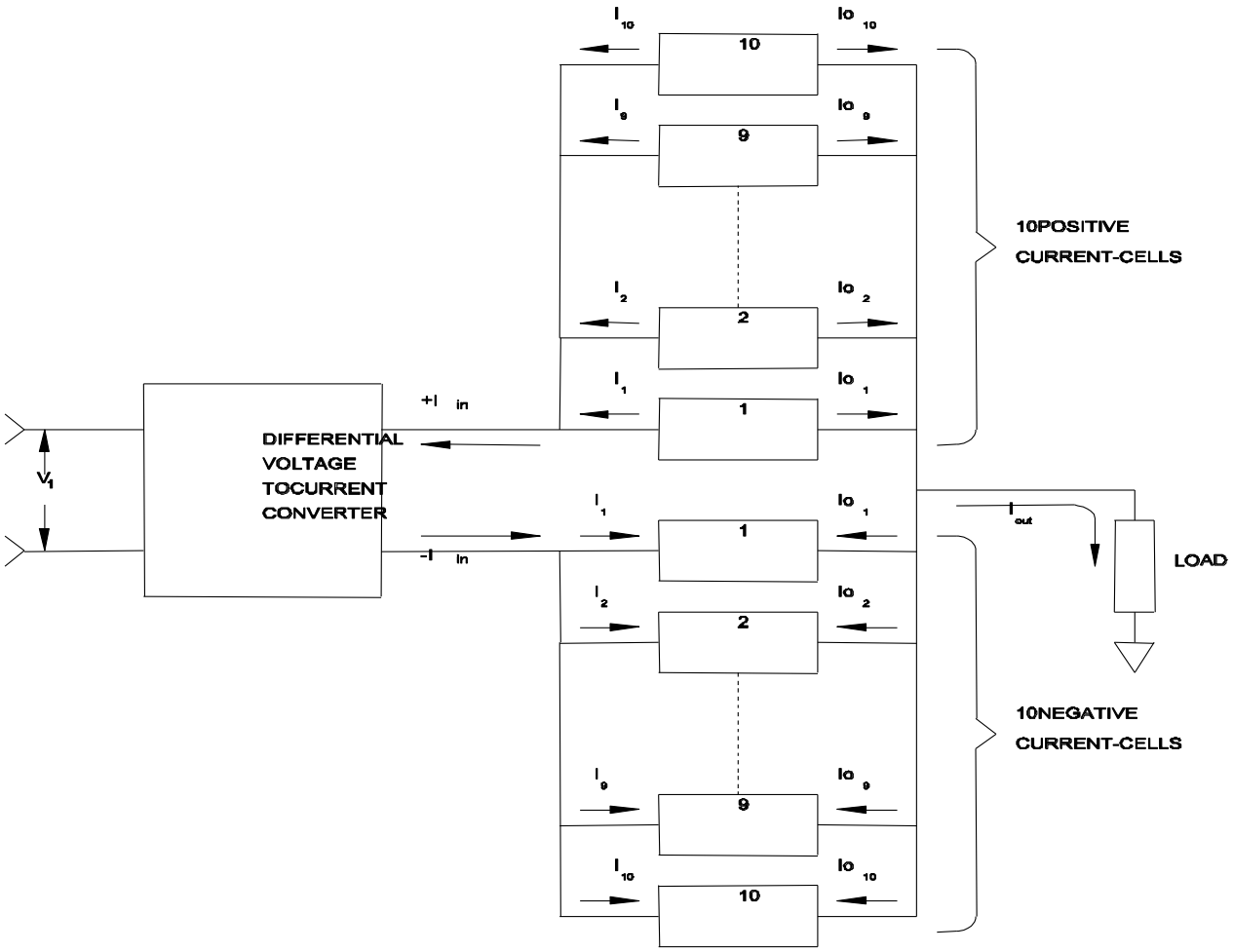


Figure 1.2
Multiple Cell Approach

[1] **LAUG, OWEN B.** A High-Current, Very-Wide-Band Transconductance Amplifier; IEEE Trans. Inst. & Meas. Vol. No.1 Feb. 1990.

The modular design of the high-current output stage of the 7620 allows each of the ten modules making up the positive and the ten modules making up the negative current arrays to operate at one tenth of the total current required from the unit. This in turn allows the use of a higher value resistor for use as the shunt in the output circuit to sense the current. Using a higher resistor value facilitates the use of bulk metal-foil resistor technology to minimise temperature coefficients and drift with time, as well as keeping the reactive component of the shunt to a minimum, thus allowing use of the amplifier to extended high frequencies.

As shown in Figure 1.2 a differential voltage-to-current convertor circuit converts an input voltage to a current which is then split into separate positive and negative lines to drive the two polarity-separated output arrays. The two polarities are also driven with a small quiescent current (300 μA) to lessen non-linearities and crossover distortion as the signal changes polarity. The overall current gain of this configuration is independent of the number of cells, but the maximum output current is (n) times the maximum current capability of a single cell , where (n) is the number of current-cell pairs (n=10 in the 7620 high-current output array, where each cell has a maximum capability of 2 A).

The differential input stage is shown diagrammatically in Figure 1.3. Operation of this stage is described in the paper by Laug.

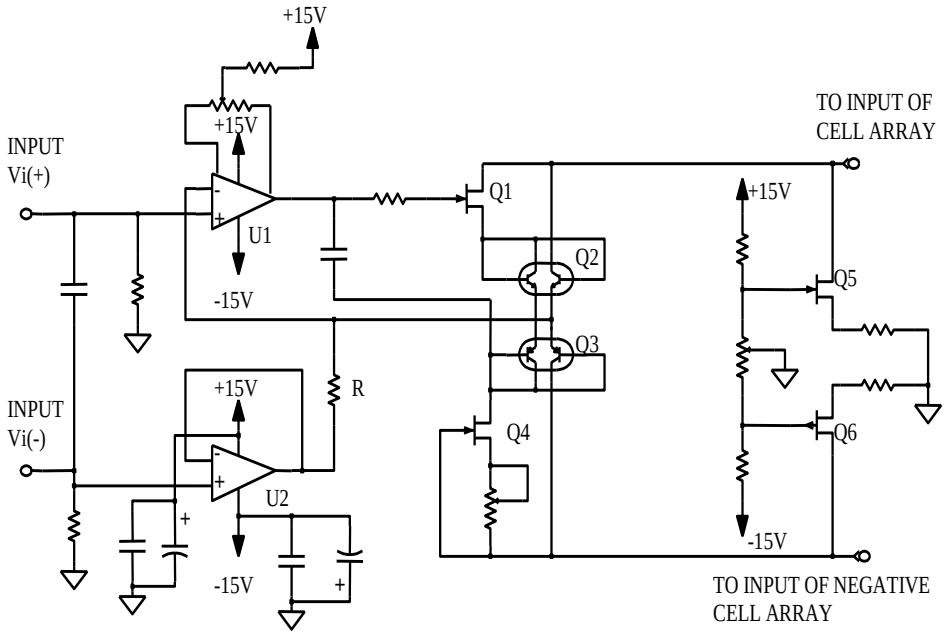


Figure 1.3
Differential Driver

The two operational amplifiers, U1 and U2 are each connected as unity gain amplifiers. An input voltage V_i, applied to the input terminals is forced across the resistor R, resulting in a current equal to V_i/R. Depending on the polarity of the input voltage, the current through

R is steered by Q2 and Q3 either to the negative-cell or out of the positive-cell input. Q4 serves as a dc current source to provide a fixed level of equal quiescent current for positive and negative cells. This feature effectively separates the input-voltage terminal from the common side of the output load-current terminal and interrupts possible ground loops when dealing with high output currents at high frequencies.

The output current-cell array consists of pairs of positive and negative current-cells. Figure 1.4 shows the basic version of a positive current-mirror cell used in the output array. The negative current-cell has the same configuration but uses complementary devices and reversed power supply voltage polarities.

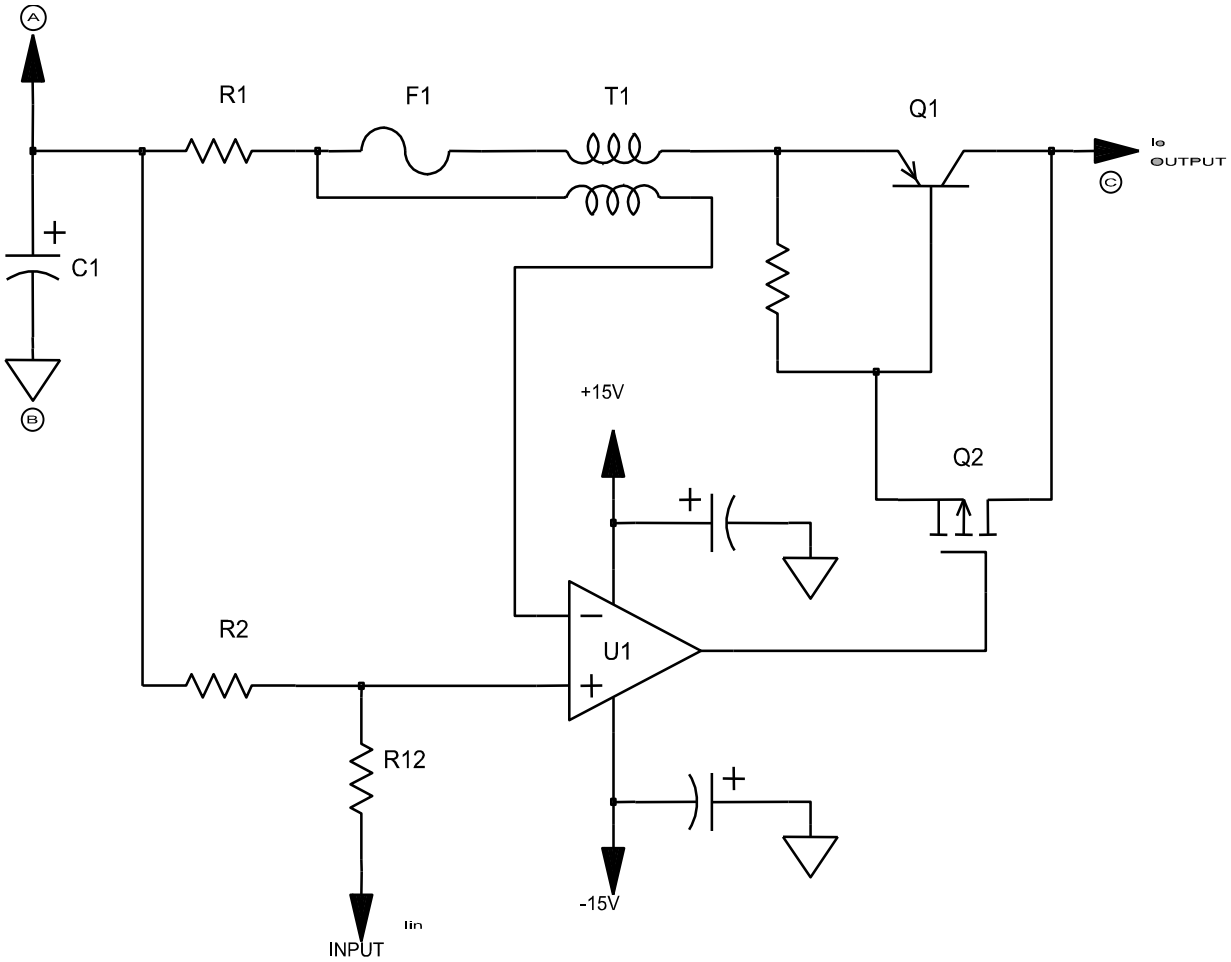


Figure 1.4
Positive Output Current-Mirror Cell

From Figure 1.4 it is seen that an input current I_{in} causes a voltage drop across resistor R2, which in turn causes the operational amplifier U1 to turn on the bipolar power transistor Q1. Output current I_{out} through R1 is regulated when the voltage drop across R1 equals the voltage drop across R2. Q1 is selected for a 7 A maximum continuous drain current rating. Transistor Q2 serves as a buffer for U1 in order to supply the current necessary to drive the large inter-electrode capacitances associated with Q1. The transformer in the source circuit provides stability and is designed to set the upper cut-off frequency of the cell's current gain. Output compliance voltage is determined primarily by the supply voltage at the (R1 - R2) node minus the voltage drop across Q1.

1.3.2 7620 FEATURES

1.3.2.1 COMPLIANCE VOLTAGE DISPLAY

The design of the 7620 includes a maximum output compliance voltage ranging from 10 volts at dc (and low frequencies) to 7 volts at 100 kHz. A 4-digit meter is fitted to the unit to indicate the compliance voltage level existing at the output connector. This is achieved by using a commercial rms-to-dc convertor integrated circuit and a single-chip a/d convertor/digital panel meter.

1.3.2.2 FREQUENCY MONITOR

Since the maximum available current and the compliance voltage are both dependent to some extent on the frequency of the input, a detector is included to inform the user of the 7620 of the frequency of operation. For convenience, the operating frequency spectrum is split into 3 bands: (0 to 100 kHz), (100 kHz to 750 kHz), and (750 kHz to 1 MHz). A commercial frequency-to-voltage convertor integrated circuit is used to produce an rms output voltage proportional to the input frequency. This voltage is fed into a voltage comparator circuit to produce 3 exclusive signals which drive three Light-Emitting Diodes (LED's) on the front panel and also to provide an input to the overload detector circuit so that the area of operation can be predicted.

1.3.2.3 4-WIRE INPUT BUFFER AMPLIFIER

The provision is added for a 4-wire input to the unit which allows the use of the 4-wire sensing available on most accurate voltage sources. This enables sensing of the input voltage directly at the input of the first amplifier in the driver circuitry of the 7620.

1.3.2.4 OUTPUT CURRENT-CELL ARRAY

The 7620 contains a high output current-cell array assembly that provides a 20 A output capability. The output current offset exhibited by the 20 A array is of the order of 2 mA total error which equates to 100 ppm of full scale. For lower value currents (up to 2 A) a single current-cell configuration is provided at a second output connector. This lower current-cell configuration includes switchable current shunts to provide decades of output currents (200 μA, 2 mA, 20 mA, 200 mA, 2 A) for the same drive from the differential driver assembly. When making measurements of current, one of the main sources of error is leakage between the "HI" and "LO" sides of the measurement system before the current reaches the shunt under test. To help alleviate this problem an "OUTPUT GUARD" terminal is added to the 7620. This output guard provides a buffered signal whose potential follows that of the output current "HI" terminal. This buffered guard signal can be used in a triaxial arrangement to prevent either capacitive or resistive leakage between the output-signal conductors.

1.3.2.5 IEEE-488 INTERFACE (CPU)

To allow use in automated testing and calibration configurations the 7620 is controllable via the IEEE-488 bus. A microprocessor-controlled IEEE-488 interface is included to handle the implementation of instructions and the reporting of instrument status. The microprocessor used is the Intel 80188 with the Texas Instruments TMS9914 integrated circuit.

1.3.2.6 OVERLOAD PROTECTION

An overload detection circuit block is included in the 7620 to give an indication over the IEEE-488 bus and on the front panel, of whether the instrument is being used within its specified operating limits. This function is achieved by using the microprocessor to monitor information from the frequency monitor, and compliance voltage display circuitry. The microprocessor block produces an output logic signal that is set when an operating point outside the designed area is selected. This signal causes :

- a lamp to light on the front panel
- the unit to disconnect the drive to the current-cell array
- a bit in the status byte to be set
- and an SRQ to be generated on the bus.

To allow use of the amplifier outside its specified operating area (but within its safe limits), an override overload switch on the front panel is provided. This switch will allow the user to have continued operation in the unspecified area without the unit tripping out. However, the status byte and the SRQ will still be generated. If an over limit situation occurs (110% of input) the 7620 will however disconnect the current-cell array drive independent of the override switch position.

SPECIFICATIONS

Specifications for Guildline Instruments 7620 WIDEBAND TRANSCONDUCTANCE AMPLIFIER		
Operating Temperature	18 -40 64 -104	°C °F
Operating Humidity non-condensing 18°C to 28°C 28°C to 40°C	 <70 <50	 % rh % rh
Storage Temperature	-20 to 60 -4 to 122	°C °F
Storage Humidity	15 to 80	% rh
Power Requirements	600	VA
Voltage Requirements	100, 120, 220, 240 ±10%	V (ac)
Line Frequency	50, 60	Hz
Dimensions	(H) 178 (W) 483 (D) 457 (H) 7 (W) 19 (D) 18	mm in
Weight	20.5 45.0	kg lbs

Table 2.1
Basic Instrument Specifications

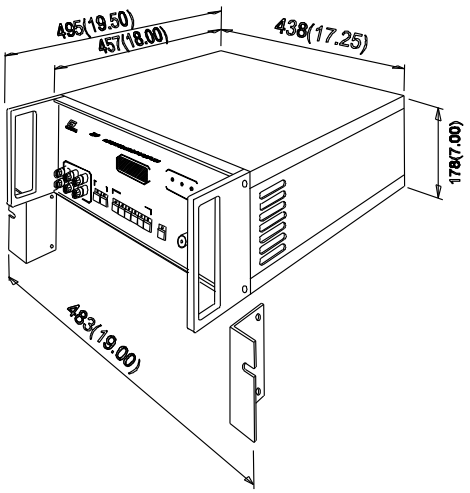


Figure 2.1
General Outline

Maximum Compliance Voltage:	10 V at dc 5 V (rms) at 100 kHz Peak Output Current (dc):35 A
Maximum Continuous Output Current (dc):	20 A
Maximum ACrms Output Current:	20 A at 100 kHz
Bandwidth:	DC to 100 kHz at 20 A Degraded performance above 100 kHz to 1 MHz
Settling Time:	1 s to full specification
Input Voltage:	1 V input max. = 1 V (rms) 10 V input max. = 10 V (rms) Offset Current:0.01% of range Input Impedance:100 kΩ Load Compliance:Resistive & Capacitive Loads Inductive Loads to 125 μH
Short Term DC Stability:	±100 ppm over a 30 minute period, where the absolute value is defined as 2 times the standard deviation of the measurement at full scale, excluding noise, at 10 samples maximum per second.

Gain Stability

Range	Temp Coeff. ppm/°C	Drift	
		@ 30 kHz ppm/hr	@ 100 kHz ppm/hr
200 µA	<10	<20	
2 mA	<10	<10	<100
20 mA	<15	<10	<40
200 mA	<25	<10	<40
2 A	<30	<10	<40
20 A	<50	<50	<50

Phase Input to Output

Range	Output Delay 5 kHz - 10 kHz (ns)	Output Jitter 10 Hz - 20 kHz (ns)
200 µA	2 000	
2 mA	300	1
20 mA	300	1
200 mA	300	1
2 A	300	1
20 A	500	5

Accuracy (24 hrs) @ 23°C ±2°C 1 V input ≤2 V output compliance

Range	±(% of reading + % of range)					
	Frequency Dc	Frequency dc - 1 kHz	Frequency 11 kHz - 5 kHz	Frequency 5 kHz - 10 kHz	Frequency 10 kHz - 20 kHz	Frequency 20 kHz - 100 kHz
200 µA	0.02 + 0.01	0.1 + 0.02	0.1 + 0.05	2.0 + 0.1		
2 mA	0.015 +0.01	0.07 + 0.01	0.08 + 0.05	0.15 + 0.1	0.3 + 0.1	2.0 + 0.4
20 mA	0.01 + 0.01	0.2 + 0.01	0.2 + 0.05	0.1 + 0.1	0.2 + 0.1	0.3 + 0.4
200 mA	0.01 + 0.01	0.1 + 0.01	0.1 + 0.05	0.1 + 0.1	0.1 + 0.1	0.2 + 0.2
2 A	0.01 + 0.01	0.07 + 0.01	0.11 + 0.05	0.1 + 0.1	0.1 + 0.1	0.2 + 0.2
20 A	0.01 + 0.01	0.1 + 0.01	0.1 + 0.1	0.1 + 0.1	0.1 + 0.25	2.5 + 0.5

Accuracy (24 hrs) @ 23°C ±2°C 1 V input ≤5 V output compliance

Range	±(% of reading + % of range)					
	Frequency Dc	Frequency dc - 1 kHz	Frequency 1 kHz - 5 kHz	Frequency 5 kHz - 10 kHz	Frequency 10 kHz - 20 kHz	Frequency 20 kHz - 100 kHz
200 µA	0.02 + 0.01	0.15 + 0.02	0.15 + 0.05	10.0 + 0.1		
2 mA	0.015 + 0.01	0.08 + 0.01	0.1 + 0.05	0.2 + 0.1	1.0 + 0.1	10.0 + 0.4
20 mA	0.01 + 0.01	0.2 + 0.01	0.2 + 0.05	0.15 + 0.1	0.3 + 0.1	1.0 + 0.4
200 mA	0.01 + 0.01	0.15 + 0.01	0.15 + 0.05	0.15 + 0.1	0.15 + 0.1	1.0 + 0.2
2 A	0.01 + 0.01	0.15 + 0.01	0.15 + 0.05	0.15 + 0.1	0.15 + 0.1	1.0 + 0.2
20 A	0.01 + 0.01	0.15 + 0.01	0.15 + 0.1	0.4 + 0.1	1.0 + 0.25	4 + 0.5

Accuracy (24 hrs) @ 23°C ±2°C 10 V input ≤2 V output compliance

Range	±(% of reading + % of range)					
	Frequency Dc	Frequency dc - 1 kHz	Frequency 1 kHz - 5 kHz	Frequency 5 kHz - 10 kHz	Frequency 10 kHz - 20 kHz	Frequency 20 kHz - 100 kHz
200 µA	0.06 + 0.01	0.1 + 0.02	0.1 + 0.05	2.0 + 0.1		
2 mA	0.04 + 0.01	0.1 + 0.01	0.1 + 0.05	0.2 + 0.1	0.6 + 0.1	4.0 + 0.4
20 mA	0.04 + 0.01	0.2 + 0.01	0.2 + 0.05	0.15 + 0.1	0.3 + 0.1	1.0 + 0.4
200 mA	0.04 + 0.01	0.1 + 0.01	0.1 + 0.05	0.15 + 0.1	0.3 + 0.1	1.0 + 0.2
2 A	0.04 + 0.01	0.1 + 0.01	0.11 + 0.05	0.15 + 0.1	0.4 + 0.1	1.5 + 0.2
20 A	0.1 + 0.01	0.1 + 0.01	0.1 + 0.1	0.15 + 0.1	0.5 + 0.25	3 + 0.5

Noise and Distortion

Range	Frequency ≤100 Hz		Frequency 100 Hz - 1 kHz		Frequency 1 kHz – 5 kHz		Frequency 5 kHz - 10 kHz		Frequency 10 kHz - 20 kHz		Frequency 20 kHz - 100 kHz	
	Noise dB of full scale	Distortion % rdg	Noise dB of full scale	Distortion % rdg.	Noise dB of full scale	Distortion % rdg.	Noise dB of full scale	Distortion % rdg.	Noise dB of full scale	Distortion % rdg.	Noise dB of full scale	Distortion % rdg.
200 µA	-50	0.15	-50	0.3	-50	0.3	-25	5.0				
2 mA	-60	0.06	-60	0.06	-60	0.06	-60	0.1	-50	0.3	-30	4.0
20 mA	-70	0.03	-70	0.03	-60	0.1	-50	0.3	-40	1.0	-30	2.0
200 mA	-70	0.03	-70	0.03	-60	0.05	-60	0.3	-50	1.0	-45	2.0
2 A	-70	0.03	-70	0.03	-60	0.08	-50	0.3	-40	1.0	-30	3.0
20 A	-60	0.15	-60	0.1	-50	0.2	-50	0.3	-50	0.3	-40	0.7

Accuracy (90 Day) @ 23°C ±2°C 1 V input ≤2 V output compliance

Range	±(% of reading + % of range)					
	Frequency Dc	Frequency dc - 1 kHz	Frequency 1 kHz - 5 kHz	Frequency 5 kHz - 10 kHz	Frequency 10 kHz - 20 kHz	Frequency 20 kHz - 100 kHz
200 µA	0.02 + 0.01	0.1 + 0.02	0.1 + 0.05	2.0 + 0.1		
2 mA	0.02 + 0.01	0.07 + 0.01	0.08 + 0.05	0.15 + 0.1	0.3 + 0.1	2.0 + 0.4
20 mA	0.015 + 0.01	0.2 + 0.01	0.2 + 0.05	0.1 + 0.1	0.2 + 0.1	0.3 + 0.4
200 mA	0.015 + 0.01	0.1 + 0.01	0.1 + 0.05	0.1 + 0.1	0.1 + 0.1	0.2 + 0.2
2 A	0.015 + 0.01	0.07 + 0.01	0.11 + 0.05	0.1 + 0.1	0.1 + 0.1	0.2 + 0.2
20 A	0.015 + 0.01	0.1 + 0.01	0.1 + 0.1	0.1 + 0.1	0.1 + 0.25	2.5 + 0.5

Accuracy (90 Day) @ 23°C ±2°C 1 V input ≤5 V output compliance

Range	±(% of reading + % of range)					
	Frequency Dc	Frequency dc - 1 kHz	Frequency 1 kHz - 5 kHz	Frequency 5 kHz - 10 kHz	Frequency 10 kHz - 20 kHz	Frequency 20 kHz - 100 kHz
200 µA	0.02 + 0.01	0.15 + 0.02	0.15 + 0.05	10.0 + 0.1		
2 mA	0.02 + 0.01	0.08 + 0.01	0.1 + 0.05	0.2 + 0.1	1.0 + 0.1	10.0 + 0.4
20 mA	0.015 + 0.01	0.2 + 0.01	0.2 + 0.05	0.15 + 0.1	0.3 + 0.1	1.0 + 0.4
200 mA	0.015 + 0.01	0.15 + 0.01	0.15 + 0.05	0.15 + 0.1	0.15 + 0.1	1.0 + 0.2
2 A	0.015 + 0.01	0.15 + 0.01	0.15 + 0.05	0.15 + 0.1	0.15 + 0.1	1.0 + 0.2
20 A	0.015 + 0.01	0.15 + 0.01	0.15 + 0.1	0.4 + 0.1	1.0 + 0.25	4 + 0.5

Accuracy (90 Day) @ 23°C ±2°C 10 V input ≤2 V output compliance

Range	±(% of reading + % of range)					
	Frequency dc	Frequency dc - 1 kHz	Frequency 1 kHz - 5 kHz	Frequency 5 kHz - 10 kHz	Frequency 10 kHz - 20 kHz	Frequency 20 kHz - 100 kHz
200 µA	0.06 + 0.01	0.1 + 0.02	0.1 + 0.05	2.0 + 0.1		
2 mA	0.04 + 0.01	0.1 + 0.01	0.1 + 0.05	0.2 + 0.1	0.6 + 0.1	4.0 + 0.4
20 mA	0.04 + 0.01	0.2 + 0.01	0.2 + 0.05	0.15 + 0.1	0.3 + 0.1	1.0 + 0.4
200 mA	0.04 + 0.01	0.1 + 0.01	0.1 + 0.05	0.15 + 0.1	0.3 + 0.1	1.0 + 0.2
2 A	0.04 + 0.01	0.1 + 0.01	0.11 + 0.05	0.15 + 0.1	0.4 + 0.1	1.5 + 0.2
20 A	0.1 + 0.01	0.1 + 0.01	0.1 + 0.1	0.15 + 0.1	0.5 + 0.25	3 + 0.5

Accuracy (1 Year) @ 23°C ±2°C 1 V input ≤2 V output compliance

Range	±(% of reading + % of range)					
	Frequency dc	Frequency dc - 1 kHz	Frequency 1 kHz - 5 kHz	Frequency 5 kHz - 10 kHz	Frequency 10 kHz - 20 kHz	Frequency 20 kHz - 100 kHz
200 µA	0.03 + 0.01	0.1 + 0.02	0.1 + 0.05	2.0 + 0.1		
2 mA	0.025 + 0.01	0.07 + 0.01	0.08 + 0.05	0.15 + 0.1	0.3 + 0.1	2.0 + 0.4
20 mA	0.02 + 0.01	0.2 + 0.01	0.2 + 0.05	0.1 + 0.1	0.2 + 0.1	0.3 + 0.4
200 mA	0.02 + 0.01	0.1 + 0.01	0.1 + 0.05	0.1 + 0.1	0.1 + 0.1	0.2 + 0.2
2 A	0.02 + 0.01	0.07 + 0.01	0.11 + 0.05	0.1 + 0.1	0.1 + 0.1	0.2 + 0.2
20 A	0.02 + 0.01	0.1 + 0.01	0.1 + 0.1	0.1 + 0.1	0.1 + 0.25	2.5 + 0.5

Accuracy (1 Year) @ 23°C ±2°C 1 V input ≤5 V output compliance

Range	±(% of reading + % of range)					
	Frequency Dc	Frequency dc - 1 kHz	Frequency 1 kHz - 5 kHz	Frequency 5 kHz - 10 kHz	Frequency 10 kHz - 20 kHz	Frequency 20 kHz - 100 kHz
200 µA	0.03 + 0.01	0.15 + 0.02	0.15 + 0.05	10.0 + 0.1		
2 mA	0.025 + 0.01	0.08 + 0.01	0.1 + 0.05	0.2 + 0.1	1.0 + 0.1	10.0 + 0.4
20 mA	0.02 + 0.01	0.2 + 0.01	0.2 + 0.05	0.15 + 0.1	0.3 + 0.1	1.0 + 0.4
200 mA	0.02 + 0.01	0.15 + 0.01	0.15 + 0.05	0.15 + 0.1	0.15 + 0.1	1.0 + 0.2
2 A	0.02 + 0.01	0.15 + 0.01	0.15 + 0.05	0.15 + 0.1	0.15 + 0.1	1.0 + 0.2
20 A	0.02 + 0.01	0.15 + 0.01	0.15 + 0.1	0.4 + 0.1	1.0 + 0.25	4 + 0.5

Accuracy (1 Year) @ 23°C ±2°C 10 V input ≤2 V output compliance

Range	±(% of reading + % of range)					
	Frequency Dc	Frequency dc - 1 kHz	Frequency 1 kHz - 5 kHz	Frequency 5 kHz - 10 kHz	Frequency 10 kHz - 20 kHz	Frequency 20 kHz - 100 kHz
200 µA	0.07 + 0.01	0.1 + 0.02	0.1 + 0.05	2.0 + 0.1		
2 mA	0.05 + 0.01	0.1 + 0.01	0.1 + 0.05	0.2 + 0.1	0.6 + 0.1	4.0 + 0.4
20 mA	0.05 + 0.01	0.2 + 0.01	0.2 + 0.05	0.15 + 0.1	0.3 + 0.1	1.0 + 0.4
200 mA	0.05 + 0.01	0.1 + 0.01	0.1 + 0.05	0.15 + 0.1	0.3 + 0.1	1.0 + 0.2
2 A	0.05 + 0.01	0.1 + 0.01	0.11 + 0.05	0.15 + 0.1	0.4 + 0.1	1.5 + 0.2
20 A	0.1 + 0.01	0.1 + 0.01	0.1 + 0.1	0.15 + 0.1	0.5 + 0.25	3 + 0.5

OPERATING INSTRUCTIONS

3.1 INSTALLATION

Place the 7620 WIDEBAND TRANSCONDUCTANCE AMPLIFIER on a solid bench. Check that the proper fuse is installed and the proper line voltage is selected (See Section 3.4).

Connect a shunt to the 2 A output connector. (Typical current shunt valves are listed in Table 5.1).

Connect the line cord to an electrical outlet. Press POWER push-button and observe that the display shows zero 0.0 ± 0.1 V.

A warm-up time of 4 hours should be allowed before use.

Connect the input cable to the front panel and the voltage source to be used, select the input voltage range and select the current output range appropriate for the current shunt attached.

3.1.1 RACKMOUNT FEATURE

Brackets are supplied for rackmounting the 7620. It is recommended that support plates are used under the 7620 to avoid any damage. See Fig. 2-1.

3.1.2 RECOMMENDED PRACTICE

The 7620 has protection circuitry on its input and outputs, and is therefore quite robust. However, the following practice is recommended to reduce the likelihood of damaging the instrument.

Reduce the input to zero before doing the following:

- powering the instrument ON or OFF
- changing input voltage range
- changing output current range
- removing or attaching a load to the output. Note that inductive loads require particular care in that any change in current (i.e. removing an inductive load under power) creates a back EMF. Similarly a discontinuous inductive load, such as applying a clamp-on current meter or changing ranges on an inductive meter, will create a back EMF.

3.2 FRONT PANEL INDICATORS

There are numerous visual indicators on the front panel of the 7620. These indicators display the value of the output compliance voltage, the status of the front panel selectable ranges and functions, and the status of the remote interface. Front panel indicators and controls are shown in Figure 3.1.

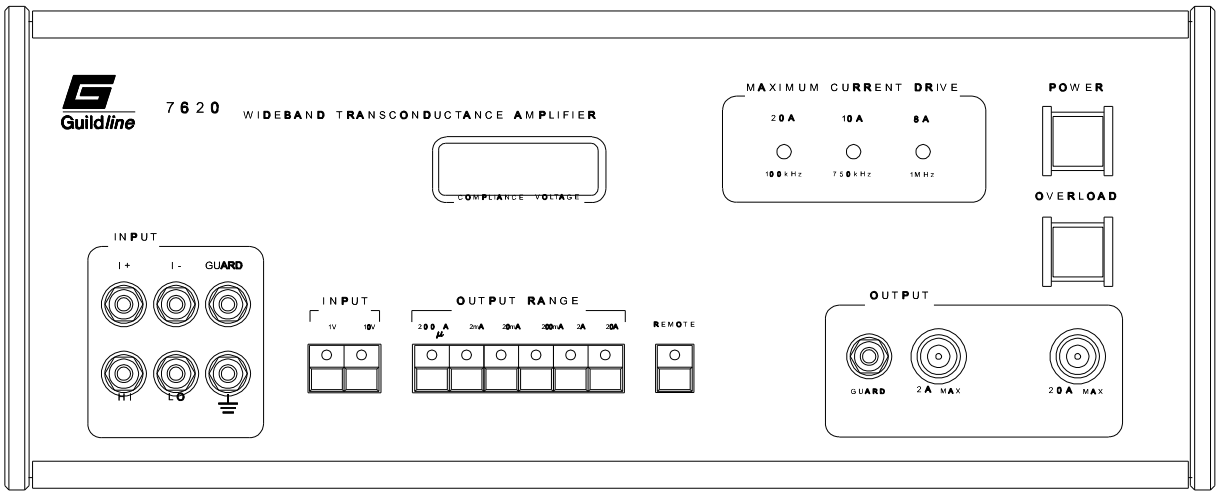


Figure 3.1
Front Panel Controls

3.2.1 DISPLAY WINDOW

A 4-digit, seven-segment Light-Emitting Diode (LED) display shows the rms value of the compliance voltage at the output terminals.

3.2.2 100 kHz INDICATOR

This LED indicates that the detected frequency of operation is less than 100 kHz and therefore currents up to 20 A can be output by the 7620. The maximum operating current is 20 A when this indicator is on.

3.2.3 750 kHz INDICATOR

This LED indicates that the detected frequency of operation is in the range 100 kHz to 750 kHz.

3.2.4 1 MHz INDICATOR

This LED indicates that the detected frequency of operation is greater than 750 kHz.

3.3 FRONT PANEL CONTROLS

The controls on the front panel include two alternate action switches, the POWER switch and the OVERLOAD switch with nine momentary push-button switches. Each push-button has an integral LED indicator.

3.3.1 POWER SWITCH

Connects ac power to the 7620 when depressed.

3.3.2 OVERLOAD SWITCH

Used to override the overload trip operation. When this switch is depressed the 7620 will NOT TRIP its overload relay, allowing the output to continue when an overload condition is reached (the overload switch does not override an input voltage overload above 110% of input voltage range). When this switch is not in the depressed position the 7620 will reduce the output current to zero when an overload condition is reached. The indicator in the OVERLOAD SWITCH is illuminated when the 7620 is working outside its maximum specified limits. The output compliance voltage, selected operating current range, input voltage, and operating frequency are parameters monitored for detection of the overload limit.

3.3.3 1 V MOMENTARY SWITCH

When pushed this switch configures the 7620 input to give full scale output current with 1 V input. The integrated LED indicator is illuminated when this function is active. Pressing this switch de-activates the 10 V input.

3.3.4 10 V MOMENTARY SWITCH

When pushed this switch configures the 7620 input to give full scale output current with 10 V input. The integrated LED indicator is illuminated when this function is active. Pressing this switch de-activates the 1 V input.

3.3.5 200 µA MOMENTARY SWITCH

When pushed this switch configures the 7620 output to give a full scale output current of 200 µA with full scale input voltage. The integral LED indicator is illuminated when this function is active. Pressing this switch de-activates all other output current selections.

3.3.6 2 mA MOMENTARY SWITCH

When pushed this switch configures the 7620 output to give a full scale output current of 2 mA with full scale input voltage. The integral LED indicator is illuminated when this function is active. Pressing this switch de-activates all other output current selections.

3.3.7 20 mA MOMENTARY SWITCH

When pushed this switch configures the 7620 output to give a full scale output current of 20 mA with full scale input voltage. The integral LED indicator is illuminated when this function is active. Pressing this switch de-activates all other output current selections.

3.3.8 200 mA MOMENTARY SWITCH

When pushed this switch configures the 7620 output to give a full scale output current of 200 mA with full scale input voltage. The integral LED indicator is illuminated when this function is active. Pressing this switch de-activates all other output current selections.

3.3.9 2 A MOMENTARY SWITCH

When pushed this switch configures the 7620 output to give a full scale output current of 2 A with full scale input voltage. The integral LED indicator is illuminated when this function is active. Pressing this switch de-activates all other output current selections.

3.3.10 20 A MOMENTARY SWITCH

When pushed this switch configures the 7620 output to give a full scale output current of 20 A with full scale input voltage. The integral LED indicator is illuminated when this function is active. Pressing this switch de-activates all other output current selections.

3.3.11 REMOTE MOMENTARY SWITCH

Pressing this switch will cause the 7620 to go to local front panel operation if the unit has previously been put into remote mode. This switch will be ignored if the remote controller sent the "local lockout command."

The integral red LED when lit, indicates that the 7620 is being controlled by the remote GPIB controller. All front panel functions will be disabled except for the POWER switch and the REMOTE switch in the remote mode of operation.

3.4 REAR PANEL CONTROLS

The rear panel of the instrument has controls which are used to configure the input line voltage, and to set the GPIB interface bus address.

3.4.1 LINE VOLTAGE SELECTION SWITCH

This rear panel mounted switch allows the 7620 operator to select the input voltage of the instrument (see Figure 3.2). It is important that the correct input voltage be selected before any attempt is made to operate the instrument. Only change the selected input voltage, after removing the line cord from the receptacle. Using a suitable slot-screwdriver, rotate the line voltage switch to align the pointer to the correct line operating voltage.

NOTE

The voltage selector settings of 130 and 150 are identical configurations inside the 7620 and are appropriate for an input voltage of 120 V (ac) ±10%. The 110 setting is appropriate for an input voltage of 100 V (ac) ±10%. The voltage selector settings of 240 and 260 are identical configurations inside the 7620 and are appropriate for input voltage of 240 V (ac) ±10%. The 220 setting is appropriate for input voltage of 220 V (ac) ±10%.

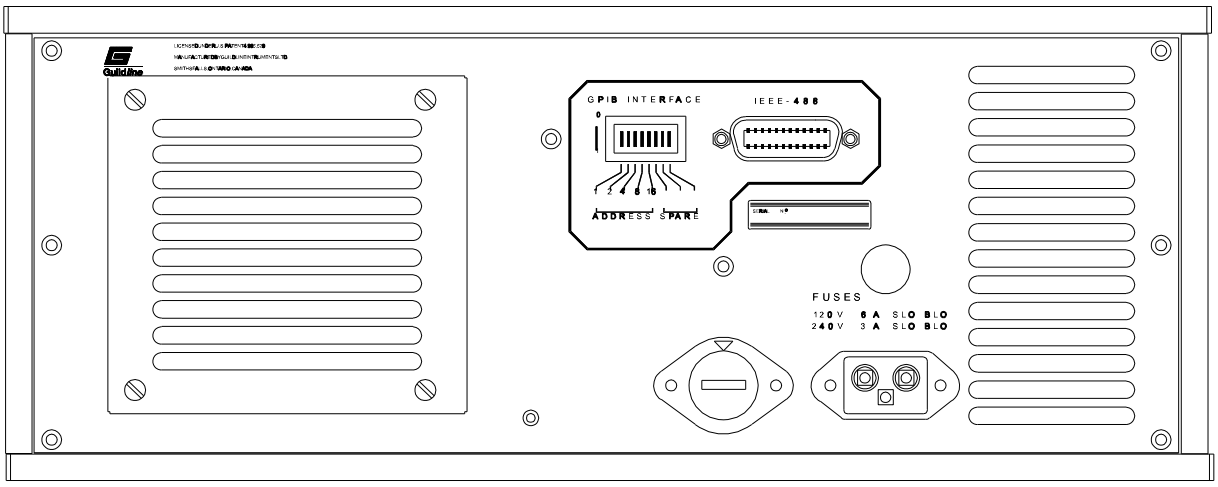


Figure 3.2
Rear Panel

Check to see that the fuses inserted in the line input fuse receptacle correspond to the type specified in Table 3.1. Only fuses of the specified type should be used.

Line Voltage	Fuse Type Required
110 V 130 V	6 A Slo-Blo (MDL-6, 250 V)
220 V 240 V	3 A Slo-Blo (MDL-3, 250 V)

Table 3.1
Recommended Fuses

Where the supplied line cord does not match the power outlet receptacle, the plug may be removed from the line cord and replaced with a grounded plug of the correct type. The plug should be wired as shown in Table 3.2.

Cord Wire Colour	Potential Voltage
Brown	Line
Blue	Neutral
Green/Yellow	Ground (Earth)

Table 3.2
Line Cord Wiring

3.4.2 GPIB ADDRESS SELECTION SWITCH

A group of eight switches mounted on the rear of the 7620 are used to set the GPIB address of the instrument. Switches 1 through 5 allow for an IEEE-488 address between 0 and 31 to be selected. Switch 6, 7 and 8 are UNUSED. The 7620 defaults to Talk/Listen mode. Talk Only and Listen only modes are not supported.

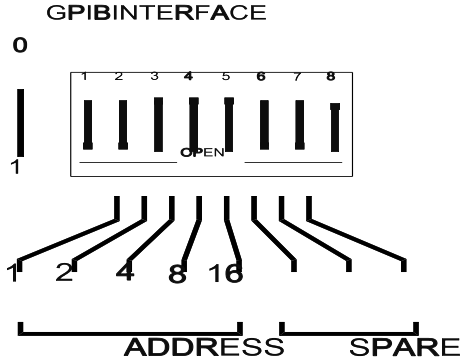


Figure 3.3
GPIB Address Switch

3.5 FRONT PANEL INPUT CONNECTORS

The 7620 provides for a four-terminal input connection using four binding posts located on the Front Panel. A buffered Output Guard terminal is also provided in the output section of 7620, with two RF coaxial output current connectors. A typical input terminal setup is shown in `.

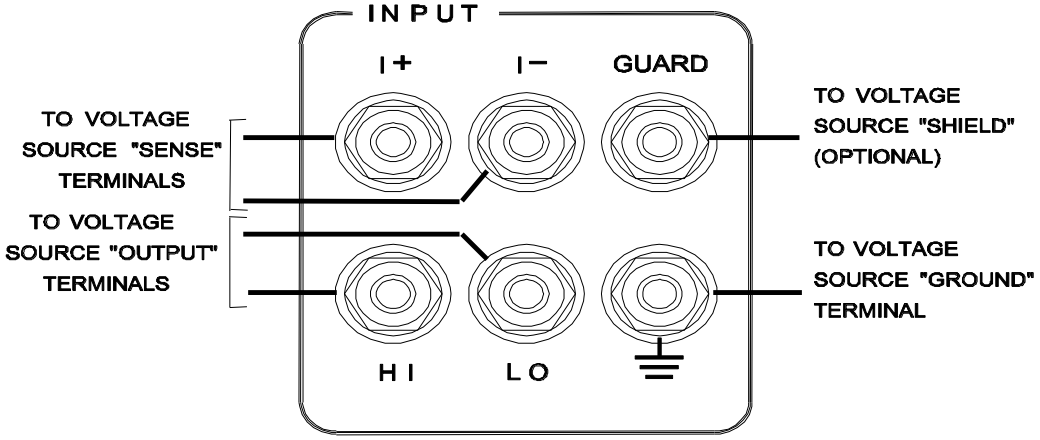


Figure 3.4
Typical Input Terminal Connections

3.5.1 HI INPUT TERMINAL

This input terminal provides the source input "Power +" or "+" voltage connection.

3.5.2 LO INPUT TERMINAL

This input terminal provides the source input "Power -" or "-" voltage connection.

3.5.3 I+ INPUT TERMINAL

This input terminal provides the source input "Sense +" connection.

3.5.4 I- INPUT TERMINAL

This input terminal provides the source input "Sense -" connection.

CAUTION

The Lo input terminal of the 7620 may be linked directly to the Ground terminal. With no link installed between input Lo and the ground terminal, the sum of the common mode voltage (the voltage between the Lo input terminal and the Ground terminal) and the normal mode voltage (the voltage between the Hi input terminal and the Lo input terminal) must not exceed 10 V.

3.5.5 INPUT GUARD TERMINAL

The Input Guard terminal provides a buffered output voltage signal that has the same magnitude and phase as the input source voltage. The Input Guard terminal can be used to drive the guard or shield conductor in the interconnect cable from the input voltage source.

3.5.6 GROUND TERMINAL

The Ground terminal provides direct access to instruments signal measurement ground. This point may be used as a measurement system reference point. As well it may be desirable to use Ground as the Guard potential on the input cable shield.

CAUTION

The ground potential at the Ground terminal is common with the return connections of the two front panel UHF output connectors. It is therefore important to consider the grounding of the source (connected to the 7620 input), and the load (connected to the 7620 output). If more than one of these components connects safety ground to the 7620 a ground loop will be created. This can adversely affect the measurement system and should be avoided. A single connection to safety ground at any one of the input, or output should not adversely affect the measurement system. The ground terminal must not be floated beyond ±50 V from safety ground to prevent damage to the 7620 circuit.

3.6 FRONT PANEL OUTPUT CONNECTORS

The 7620 provides a buffered Output Guard terminal and two RF coaxial output current connectors.

3.6.1 OUTPUT GUARD TERMINAL

The Output Guard terminal provides a buffered output voltage signal that has the same magnitude and phase as the output current "+" signal. The Output Guard terminal can be used to drive the guard or shield conductor in the interconnect cable from the output of the 7620.

3.6.2 2 A OUTPUT CONNECTOR

The 2 A Output connector provides the low current output capability of the 7620. Output currents up to 2 A can be supplied from this connector.

3.6.3 20 A OUTPUT CONNECTOR

The 20 A Output connector provides the high-current output capability of the 7620. Output currents up to 20 A can be supplied from this connector.

3.7 REAR PANEL CONNECTORS

There are two connectors on the rear panel of the 7620. These connectors are for ac line power and for computer communications (GPIB).

3.7.1 GPIB DATA CONNECTOR

The signals at the GPIB data connector are described in detail in Section 4. This connector is used for connecting the instrument to other devices/controllers on the common General Purpose Interface Bus (GPIB), IEEE-488.2.

3.7.2 POWER INLET CONNECTOR

The signals at the power inlet connector are described in detail in Section 3.4.1. This connector accepts a standard three wire moulded line cord.

REMOTE CONTROL

The 7620 WIDEBAND TRANSCONDUCTANCE AMPLIFIER operates directly from the front panel or under remote control of an instrument controller, computer, or terminal. Remote control can be interactive, with the user controlling each step from a terminal, or under the control of a computer running the 7620 in an automated system.

The 7620 has a remote control interface (GPIB). This chapter describes the interface and the commands to which the 7620 will respond.
In a system containing more than one controller, only one controller can exercise control while the other stays in dormant state until control is handed over.

4.1 IEEE-488/1978 (GPIB) INTERFACE

The 7620 is fully programmable for use on the IEEE standard 488.1 interface bus (IEEE-488 bus). The interface is also designed in compliance with the supplemental standard IEEE-488.2. Devices connected to the bus in a system are designated as talkers, listeners, talker/listeners, or controllers. The 7620 can only be operated on the IEEE-488 bus as a talker/listener under the control of an instrument controller.

This manual assumes that the user is familiar with the basics of the IEEE-488 interface bus.

The IEEE-488 interfacing standard applies to interface of instrumentation systems or portions of them, in which:

(1) Data exchanged among the interconnected apparatus is digital.
(2) Number of devices that may be interconnected by one contiguous bus does not exceed 15.
(3) Total transmission path lengths over interconnecting cables does not exceed the lesser of either 20 meters or 2-times the number of devices on the bus.
(4) Data rate across the interface on any signal line does not exceed 1MB/S.

4.2 CONTROLLER

There can be only one designated controller in charge on the GPIB bus. This device exercises overall bus control and is capable of both receiving and sending data. The rest of the devices can be designated as listener, talker or talker/listener.

The controller can address other devices and command them to listen, address one device to talk and wait till the data is sent. Data routes are set by the controller but it need not take part in the data interchange.

4.3 GPIB RESPONSES

The reply to any GPIB query command will be a sequence of ASCII characters followed by a line-feed character (0x0A). The line-feed character may also be expressed as $0A_{16}$ or 10_{10} or 12_8 or control-J, throughout this document we will use the `C' programming language notation for expressing numbers in base 16, specifically 0x0A indicates that 0A is to be interpreted in base 16 (hex).

4.4 INTERCONNECTING CABLE AND GPIB CONNECTOR

The interconnecting cable of IEEE-488 1978 consists of 24 conductors, 16 conductors are for carrying signals and 8 for grounding. Individual cable assemblies should be up to 4 meters long and should have both a plug and a receptacle connector type at each end of the cable. Each connector assembly is fitted with a pack of captive locking screws.

4.5 TYPICAL SYSTEM

Data Input/Output Lines - The 8 data I/O lines form the data bus over which data between the various devices is transmitted under the supervision of the controller. The message bytes are carried on data I/O signal lines in a bit parallel byte serial form, asynchronously and generally in a bidirectional manner.

Handshake or Data Byte Control - The three interface signals are used to effect the transfer of each byte of data on the DIO signal lines from a talker or controller or one or more listeners.

(1) DAV (DATA VALID) is used to indicate the condition of (availability and validity) information on the DIO signal lines.
(2) NRFD (NOT READY FOR DATA) is used to indicate the condition of readiness of devices to accept data.
(3) SRQ (SERVICE REQUEST) is used by a device to indicate the need for attention and to request an interruption of the current sequence of events.
(4) REMOTE ENABLE (REN) is used (by a controller) in conjunction with other messages to select between two alternate sources of device programming data.
(5) EOI (END OR IDENTIFY) is used (by a talker) to indicate the end of a multiple byte transfer sequence or in conjunction with ATN (by a controller) to execute a polling sequence.
(6) Address and Talk/Listen Selection
On the rear panel the address can be set as desired.

4.6 GPIB INTERFACE

The 7620 meets the subsets of the GPIB interface specification IEEE-488.2 shown in Table 4.2. The pin connections on the GPIB interface connector are shown in Table 4.1.

SH1 the 7620 has complete source handshake capabilities.

AH1 the 7620 has complete acceptor handshake capabilities.

T5 the 7620 has talker capabilities with a single primary address in the range 0 to 30. Extended addressing is not implemented.

L3 the 7620 supports basic listener with unaddress if MTA (My Talk Address) is received. The talk and listen addresses will always be the same. The 7620 does not support extended listen addresses.

SR1 the 7620 has complete service request generation capabilities.

RL1 all functions (except POWER) on the front panel of the 7620 can be locked out by the GPIB controller. The 7620 does not have an indicator on the front panel to indicate when it is in the local lock out state.

PP0 the 7620 has no parallel poll capabilities.

DC1 the 7620 has full device clear capabilities.

DT1 the 7620 has full device trigger capabilities.

C0 the 7620 will never become the bus controller.

E2 the 7620 has all required electrical interface capability.

PIN	Name	Description
1	DIO1	Data Input Output Line 1
2	DIO2	Data Input Output Line 2
3	DIO3	Data Input Output Line 3
4	DIO4	Data Input Output Line 4
5	EOI	End or Identify
6	DAV	Data Valid
7	NRFD	Not Ready For Data
8	NDAC	Not Data Accepted
9	IFC	Interface Clear
10	SRQ	Service Request
11	ATN	Attention
12	SHEILD	Screening On Cable (connected to safety ground)
13	DIO5	Data Input Output Line 5
14	DIO6	Data Input Output Line 6
15	DIO7	Data Input Output Line 7
16	DIO8	Data Input Output Line 8
17	REN	Remote Enable
18	GND6	Ground wire of twisted pair with DAV
19	GND7	Ground wire of twisted pair with NRFD
20	GND8	Ground wire of twisted pair with NDAC
21	GND9	Ground wire of twisted pair with IFC
22	GND10	Ground wire of twisted pair with SRQ
23	GND11	Ground wire of twisted pair with ATN
24	GND	Logic Ground

Table 4.1
IEEE-488.1 Pin Designations

Source Handshake	SH1
Acceptor Handshake	AH1
Talker	T5
Listener	L3
Service Request	SR1
Remote Local	RL1
Parallel Poll	PP0
Device Clear	DC1
Device Trigger	DT1
Controller	C0
Electrical Interface	E2

Table 4.2
GPIB Device Capabilities

4.6.1 GPIB INPUT BUFFERING

The GPIB input buffer is 256-bytes long. The input full bit is set when the buffer is above 75% full (64 bytes remaining), hence if the operator limits messages sent to the 7620 to 32 bytes and checks the IFL bit in the status register before sending each message, then under normal operating conditions the buffer should never overflow. If the buffer is full and the operator sends more data, the 7620 will perform the necessary handshaking as per usual, but the data WILL be lost, this is done for two reasons:

1. If the buffer is full, the system operator is probably in error since the 7620 should never become full (the 7620 interprets most commands in under 150 milliseconds).

2. The 7620 will never lock up the GPIB bus.

4.6.2 GPIB OUTPUT BUFFERING

Output from query commands are placed into a 256-byte output buffer. When the controller reads data from the 7620 the responses will come from the output buffer in, first-in first-out order. If for some reason the controller does not read the responses from its query commands the output buffer will overflow, in this case the first data into the buffer will still be valid and the later data will be lost. When output data is lost the query error bit in the status register will be set. When the output buffer is not empty then the message available (MAV) bit will be set in the status register.

4.6.3 GPIB DEADLOCK

If the controller demands a byte of data from the 7620 and the buffer is empty and this condition persists for a period of 8 seconds, the 7620 will place the current voltage (see Voltage? command) into the output buffer and use this data to satisfy the controllers demand for data. The format of the data is set by the current state of the Terse/Verbose flag (see Terse and Verbose commands).

4.6.4 GPIB DEVICE CLEAR

The 7620 will assume the following state when it receives a Device Clear signal from the GPIB interface:

- 10 V input range is selected
- Overload Reset is selected
- 200 μA output range is selected
- Terse response is selected

4.7 COMMAND LANGUAGE

The commands for GPIB mainly correspond to the labels assigned to the front panel switches. Throughout this document when examples are given they apply to commands through the GPIB interface. The examples will not show the termination characters.

4.7.1 GENERAL SYNTAX FOR COMMANDS

The 7620 uses a sophisticated command parser which can usually determine which command was desired, even if the command is entered incorrectly. The commands **Voltage?** and **Volts?** will be considered by the command parser as identical. Some care should be taken when sending similar commands such as RAnge? and RomChecksum?. As well, the parser may not be able to decide which command was desired in the event of a gross misspelling (such as using Rance instead of RAnge).

No command used in the 7620 has an embedded space in its name; spaces (0x20) are used only to separate command names from their parameters, and to separate parameters from each other.

Throughout this description some of the command names will have an UPPER case portion and a lower case portion. The command may be shortened such that only the portion of the command name which was presented in UPPER case characters is present. The command parser of the 7620 is case insensitive (i.e. the letter case of commands sent to the 7620 does not matter), both UPPER case letters and lower case letters may be used.

4.7.2 GENERAL SYNTAX FOR NUMBERS

Numeric parameters may have up to 30 characters, and although the 7620 will accept numeric parameters in the range ±2.2E-308 through ±1.8E308, the useful range of numbers is between ±1.0E-8 and 1.0E5.

The portion of the command parser which interprets numeric input will correctly recognize most common forms of numeric input; for example the following are all valid methods of expressing the number 123.4:

123.4
123.4e00
0.1234E3
1234e-1
0000123.4

The following are examples of invalid forms of expressing a number:

123.4 e00	space between mantissa and exponent letter
1234D-1	exponent not e or E
n123.4	letter in front of the first digit
e34	missing mantissa

Multipliers (such as μ, m, k, and M) are not permitted on commands. All numbers must be entered in the base units; for example 100 mV can be expressed as 100e-3 or 0.100.

Expressions (for example 7 + 20 X 3) are not allowed as parameters.

4.8 REMOTE AND LOCAL OPERATION

The 7620 can be operated using the front panel switches or it can be operated remotely using a remote controller. In addition, the 7620 can be placed in a local lockout condition at any time by a command from the controller. When combined, the local, remote, and lockout conditions yield four possible operating states:

LOCAL The 7620 responds to local and remote commands. This is also called "Front Panel Operation". Only remote commands that do not affect the state of the 7620 are allowed to execute. (For example the command **Voltage?** is allowed to operate but the command **Range 20.0** which would change the instrument state is not allowed.) If the controller sends a command which would affect the instrument's state while in local, the command will be ignored, and no error indication will be given.

LOCAL WITH LOCKOUT Local with lockout is identical to Local except that the 7620 will go into remote with lockout instead of the remote state when the 7620 receives a remote command. The local with lockout state is entered by sending a IEEE-488 LLO+REN command from the controller to the 7620.

REMOTE When the Remote Enable (REN) line is asserted and the controller addresses the 7620 as a listener, the 7620 enters the remote state. The REMOTE LED on the front panel of the 7620 will be lit when the 7620 is in the remote state.

Front panel operation is restricted to the use of the Power switch and the REMOTE switch. Pressing the REMOTE switch or sending the GTL (Go To Local) interface message returns the 7620 to the local state.

REMOTE WITH LOCKOUT The remote with lockout state can be entered from remote or local with lockout, but not directly from local. Remote with lockout is similar to the remote state but restricted: the REMOTE switch will not return to the local state. To return the 7620 to the local with lockout state the controller must send a GTL interface command. To return the 7620 to the local state the controller must unassert the REN control line.

The possible Remote/Local state transitions are summarized in Table 4.3.

FROM	TO	IEEE-488 Interface Command
Local	Remote	MLA + REN
	Local/Lockout	LLO + REN
Remote	Local	GTL or LOCAL key
	Remote/Lockout	LLO + REN
Local/Lockout	Remote/Lockout	MLA + REN
Remote/Lockout	Local	REN
	Local/Lockout	GTL

Table 4.3
Remote/Local State Transitions

4.9 GPIB COMMANDS

4.9.1 *ESE - SET STATUS ENABLE REGISTER

This command sets the standard event status enable register bits. When the bits in the Event Status Enable (ESE) register are "ANDed" with the bits in the Event Status Register (ESR) if the result is non-zero then the Event Status Bit (ESB) in the Status Byte Register (STB) is set. The values accepted for the *ESE command are between 0 and 255, all other values are considered to be an error.

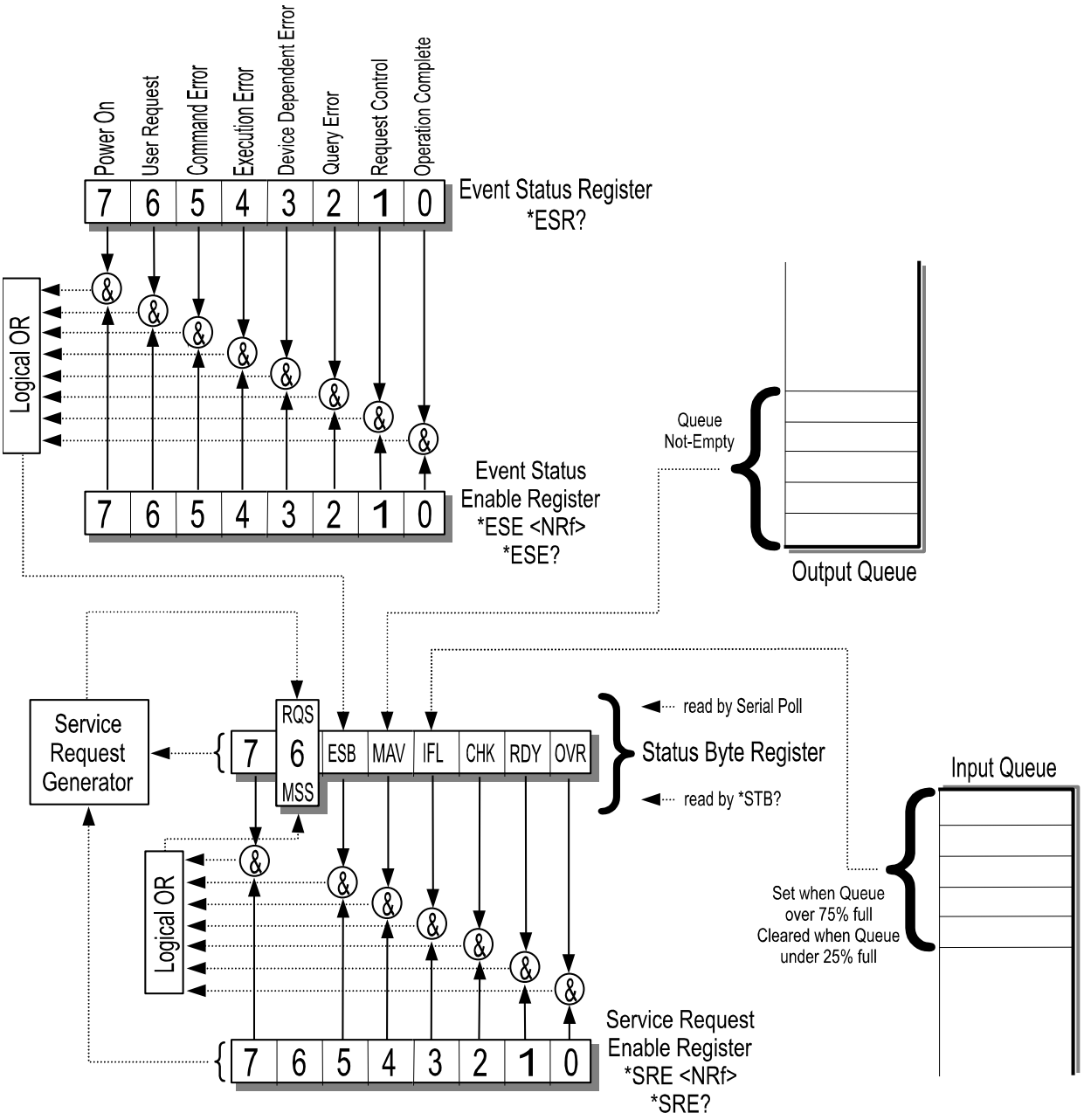


Figure 4.1
Event Status Bit Operation

4.9.2 *ESE? - EVENT STATUS ENABLE QUERY

This command reports the current value of the Event Status Enable Register. The value returned will be between 0 and 255.

4.9.3 *ESR? - EVENT STATUS REGISTER QUERY

This query allows the operator to determine the current contents of the event status register. Reading the Event Status Register clears it.

4.9.4 *IDN? - IDENTIFICATION QUERY

This command causes the 7620 to reply with an identification string. The identification string is built up of four (4) fields delimited by commas (,). The first field is the manufacturer (eg. Guildline Instruments), the second field is the model (eg. 7620), the third field is the serial number (eg. 55065), and the final field is the firmware revision (eg. A). A typical response might read:

Guildline Instruments, 7620, 55065,C

The reply string will be shorter than 73 characters.

4.9.5 *OPC - OPERATION COMPLETE

This command will cause the 7620 to set the Operation Complete bit (bit 0) in the Event Status Register. Since the 7620 processes all commands sequentially, the operation complete bit will be set as soon as the command is parsed.

4.9.6 *OPC? - OPERATION COMPLETE QUERY

This query will place a numeric 1 in the output buffer indicating that all pending operations are complete.

4.9.7 *OPT? - REPORT AVAILABLE OPTIONS

This query command reports the presence or absence of various options. The format of the reply is a series of arbitrary ASCII response fields separated by commas. The 7620 currents reports "0" to indicate no options installed.

4.9.8 *RST - DEVICE RESET

This command is intended to return the 7620 to a known state, specifically a return to terse mode. This command will not affect the following:

1. The Output Queue.
2. The state of the IEEE-488 interface.
3. The selected address of the 7620.
4. The *SRE setting.
5. The *ESE setting.

The ***RST** command will perform the following actions:

1. Select the 10 V input range.
2. Select the 200 µA current output range.

BIT LOCATION		NAME	DESCRIPTION
0	LSB	OPC	OPeration Complete - This event bit is generated in response to the *OPC or *OPC? command. It indicates that the 7620 has completed any pending operations and that the parser is ready to accept more program messages.
1		RQC	ReQuest Control - This event bit indicates to the GPIB controller that the 7620 is requesting permission to become the controller in charge. The 7620 will NEVER set this bit.
2		QYE	QuerY Error – This bit indicates that an attempt is being made to read data from the output queue when no output is either present or pending, or that data in the output queue has been lost (queue overflow). See also GPIB Deadlock.
3		DDE	Device Dependent Error - Not used.
4		EXE	EXecutive Error – Set when 1) a program data element is evaluated to be outside the legal input range or is inconsistent with the 7620's capabilities, 2) a valid program message could not be properly processed.
5		CME	CoMmand Error - Set when 1) a syntax error has been detected by the parser, 2) a semantic error has occurred indicating that an unrecognized header has been received, 3) a Group Execute Trigger was entered into the input buffer inside of a program message.
6		URG	User Request - Set when any key is depressed on the 7620 keyboard.
7	MSB	PON	Power On - This bit is set after the 7620 is powered up.

Table 4.4
Event Status Register

BIT LOCATION		NAME	DESCRIPTION
0	LSB	TIME	System Time has Changed - This bit is set once each second as the real time clock ticks, and is cleared by the execution of the TIme? command.
1		OLD	OverLoaD - This bit is set when operation of the unit is attempted outside its limits.
2		CHK	Checksum Computation Complete - This bit is set once, after instrument power on and the completion of the computation of the ROM checksum and is cleared by the RomChecksum? command.
3		IFL	Input full - This bit is set when the input queue is over 75% full and cleared when the queue drops below 25% full.
4		MAV	Message AVailable - This bit is set when the output queue is not empty.
5		ESB	Event Status Bit – This bit is set when the result of a bitwise AND of the Event Status Register and the Event Status Enable Register is not zero.
6		RQS	Request for Service - This bit is set when the result of a bitwise and of the Status Byte Register and the Service Request Enable Register is not zero.
7	MSB	FRC	Frequency Range Change - This bit is set to indicate that the 7620 has entered a new frequency range.

Table 4.5
Status Byte Register

4.9.9 *SRE - SERVICE REQUEST ENABLE COMMAND

The service request enable command allows the 7620 to generate a service request on the GPIB interface under a limited set of conditions. The limitations on the conditions are defined by the numeric parameter following the *SRE command. The numeric parameter is an integer in the range 0-255. The numeric parameter when expressed in base 2 (binary) represents the bit values of the Service Request Enable Register.

For all bits (except bit 6) a bit value of one (1) indicates an enabled condition and a bit value of zero (0) represents a disabled condition. *SRE? is the companion query command.

4.9.10 *SRE? - SERVICE REQUEST ENABLE QUERY

This command allows an operator to determine the current contents of the Service Request Enable Register. A number between 0 and 63 or between 128 and 191 will be returned.

4.9.11 *STB? - READ STATUS BYTE QUERY

This command allows the operator to read the status byte and master summary bits (shown in Figure 4.1).

The response from this command is an integer in the range 0-255. This integer when expressed in base 2 (binary) represents the bit values in the Status Byte Register. Note that the Master Summary Status bit and Not RSQ is reported in bit 6. The Status Byte Register can also be read with the Read Serial Poll hardware command on the GPIB interface.

This Register can be read by Serial Poll or by the *STB? command.

4.9.12 *TRG - GROUP EXECUTE TRIGGER

This command performs the same action as a group execute trigger on the GPIB interface. Since the 7620 is not capable of starting any action on command, this command will set the execution error bit in the event status register (bit 4).

4.9.13 *TST? - QUERY RESULTS OF SELFTEST

This command is intended to report the status of any self-tests performed by the 7620. If the 7620 passes all of its self-tests then the reply will be :

0

If any failures are detected then the result will be a number (between -32768 and 32767) indicating which test failed.

4.9.14 Date - SET THE SYSTEM DATE

The date command allows the operator to set the real time clock date registers (see also the Time command). The format of a valid Date command is:

Date YYYY/MM/DD

Where YYYY, MM and DD are the year, month and day of the month respectively.

The format of showing the year in the most significant location was selected over possible formats, such as MM/DD/YYYY or DD/MM/YYYY, (formats preferred in other countries) because this format has the largest units (years) first and the smallest units (days) last.

4.9.15 Date? - DISPLAY THE 7620 INTERNAL DATE

This command will report the date maintained in the system real time clock in the terse format:

YYYY/MM/DD

or if verbose mode is enabled:

Date YYYY/MM/DD

Where YYYY, MM and DD are the year, month and day respectively.

4.9.16 DER? - DEVICE ERROR REGISTER

This command will report the status of the Device Error Register. The meaning of the bits in the Device Error Register are shown in Table 4.6.

In verbose mode the response will be :

Device Error Register 2

and in terse mode the response will be :

2

where the number (2) will change to reflect the actual contents of the Device Error Register.

BIT LOCATION		NAME	DESCRIPTION
0	LSB	ALO	AnaLogue Overload - This bit is set to indicate that the 7620 has detected an analogue overload condition. (Input voltage >110% fsc)
1		COV	Compliance Over Voltage - This bit is set when the amplifier compliance voltage capability has been exceeded.
2		OLB	OverLoad Bypass - This bit is set when the overload bypass switch is engaged by the operator of the 7620.
3		OLR	OverLoad Relay – This bit is set when the overload relay is engaged by the 7620.
4		Spare	reserved for future expansion.
5		Spare	reserved for future expansion.
6		Spare	reserved for future expansion.
7	MSB	Spare	reserved for future expansion.

Table 4.6

Device Error Register

4.9.17 DFR? - DEVICE FREQUENCY REGISTER

This command will report the status of the Device Frequency Register. The meaning of the bits in the Device Frequency Register are shown in Table 4.7.

In verbose mode the response will be :

Device Frequency Register 2

and in terse mode the response will be :

2

where the value (2) will change to reflect the actual contents of the Device Frequency Register.

BIT LOCATION		NAME	DESCRIPTION
0	LSB	LOW	Low frequency range - This bit is set to indicate that the 7620 has detected an input range dc-100 kHz.
1		MED	MEDium frequency range - This bit is set to indicate that the 7620 has detected an input frequency range 100 kHz - 750 kHz.
2		HIGH	High frequency range - This bit is set to indicate that the 7620 has detected an input in the frequency range 750 kHz - 1 MHz.
3		Spare	reserved for future expansion.
4		Spare	reserved for future expansion.
5		Spare	reserved for future expansion.
6		Spare	reserved for future expansion.
7	MSB	Spare	reserved for future expansion.

Table 4.7
Device Frequency Register

4.9.18 Key? - REPORT LAST KEY PRESSED

This query command will report the value of the key most recently pressed on the front panel. In terse mode the response will be one of:

A, B, 1, 2, 3, 4, 5, 6, R, ?

where ? indicates that no keys have been pressed since the 7620 was last RESET. The verbose mode reply will be preceded with "KEY". The meanings of the various key characters are shown in Table 4.8.

Character	Key Name
A	1 V Range
B	10 V Range
1	200 μA Range
2	2 mA Range
3	20 mA Range
4	200 mA Range
5	2 A Range
6	20 A Range
O	Overload
R	Remote

Table 4.8
Front Panel Switch Character Designations

4.9.19 Key <keyname> - ENTER A KEYSTROKE

The Key command causes the 7620 to perform actions similar to the acti.....ons performed when a front panel key is pressed. Allowable values for <keyname> are:

A, B, 1, 2, 3, 4, 5, 6, O, R

where each of these is a single ASCII character. Multiple <keynames> may be placed on the key command line and they will be processed in the order given.

For example the command:

Key B6

will select the 10 V input range and the 20 A output range.

4.9.20 Range - SELECT OUTPUT CURRENT RANGE

This command changes the currently selected output range. For example the command :

RAnge 20.0

will select the 20 A output current range where the value 20.0 is dependant on the range desired.

Almost any value can be specified, however the instrument has only a limited set of ranges available :

(200 µA, 2 mA, 20 mA, 200 mA, 2 A, 20 A)

Therefore the closest range will be selected.

After a RAnge command has been executed care should be taken to ensure that the range desired has actually been selected.

If the numeric parameter to the command is missing or not recognised, the CME (CoMmand Error) bit in the Event Status Register will be set. If the numeric value is out of range (i.e. > 20 A) then the EXE (EXecution Error) error bit will be set for a program data element out of range.

4.9.21 Range? - DISPLAY THE CURRENTLY SELECTED RANGE

This query command displays the value of the currently selected range. In verbose mode the reply will be:

Range 20.0 Amps

or in terse mode the reply will be:

20.0

where the value 20.0 is dependant upon the current range selected.

4.9.22 RomChecksum? - DISPLAY THE ROM CHECKSUM

This query command will give the checksum of the ROM. Since the checksum algorithm is quite involved, the processor computes the checksum in its "spare" time. Depending upon the bus activity, this takes about 30 seconds after power up (or a reset).

In order to determine if the computation of the checksum is complete, the operator may either poll the checksum until the value is no longer -1 or wait for the CHK bit in the Status Byte Register to be set to one (1). It should be noted that the CHK bit will only be set once after the 7620 is powered on, hence simply waiting for the CHK bit to become set may not always work if the RomChecksum has been previously read. Normally this command is only used for diagnostic purposes. The verbose reply to the RomChecksum command will be:

RomChecksum 1234

The terse reply will be:

1234

where the value 1234 will depend on the checksum computed.

4.9.23 SInce? - DISPLAY THE TIME THE 7620 WAS LAST RESET

This query command will display the date and time at which the 7620 was last powered up (or reset). The verbose reply will be:

SInce Thurs June 2, 10:55:22 1988

or in terse mode:

Thurs June 2, 10:55:22 1988

where the date displayed will depend upon the startup date. Under normal conditions the 7620 should be able to operate for months or years without a reset, therefore this command reflects when the last power failure occurred.

4.9.24 Serial Number - SET THE 7620 SERIAL NUMBER

This command accepts an integer in the range 0 to +200 000, this number will be reported in the serial number field of the *IDN? command.

4.9.25 TErse - TURN OFF VERBOSE MODE

This is the default mode for the 7620 after reset. Typically query commands will return very little extraneous information in terse mode.

For example the command :

TErse

will place the 7620 into terse mode.

4.9.26 TIme - SET THE SYSTEM TIME

This command will set both internal clocks in the 7620. The format of the time command is:

TIme HH:MM:SS

where HH, MM and SS are the hours, minutes and seconds respectively. The hours should be expressed in 24 hour format.

4.9.27 TIme? - DISPLAY THE SYSTEM TIME

This command will report the time maintained in the system real time clock in the terse format:

HH:MM:SS

or the verbose format:

Time HH:MM:SS TimeZone

where HH, MM and SS are the hours, minutes and seconds in 24 hour format, and TimeZone is the current time zone (see TimeZone command).

It should be noted that the 7620 maintains two real time clocks, one is battery backed up and is read only once after power up, the other clock counts periodic interrupts.

4.9.28 TimeZone - SET THE OPERATIONAL TIME ZONE

Internally the 7620 maintains all times as a 32-bit integer representing the number of seconds since January 1st 1970 Greenwich Mean Time (GMT). When a time is input or displayed it is converted either to or from local time. In order for the 7620 to be able to perform this conversion the instrument must know the current time zone.

The TimeZone command has the form:

TimeZone aaabbbccc

where **aaa** is the 3 letter abbreviation for the local standard time zone (e.g. CST) and **bbb** is a number from -23 to +24 indicating the value that is subtracted from GMT in order to obtain local standard time. Both **aaa** and **bbb** are required but **ccc** is the abbreviation for the local daylight savings time zone (e.g. CDT) and it should be present only if daylight savings time is currently in effect.

4.9.29 UPtime? - DISPLAY HOW LONG THE 7620 HAS BEEN RUNNING

This query command will reply with the number of seconds since the last power failure (or reset). In verbose mode the response will be:

UPTIME 234 61 SECONDS

and in the terse mode the response will be:

234 61

where the number 234 61 will change to reflect the actual up time. Note: The number of seconds can get quite large, as large as $2^{31} - 1 = 214\ 748\ 364\ 7$, however the number of seconds in a year is only 31,557,600 hence it will take nearly 70 years to overflow this number.

4.9.30 VErbose - SET VERBOSE MODE

The VErbose command causes the output of all subsequent commands to contain additional information, this mode should be used for determining problems with programs and when the instrument is being used interactively.

For example the command :

VErbose

will place the 7620 into verbose mode.

4.9.31 Voltage - SELECT THE INPUT VOLTAGE RANGE

This command changes the currently selected input voltage range. For example the command :

Voltage 10.0

will select the 10 V input range where the value 10.0 is dependant on the range desired. Almost any value can be specified, however the instrument has only a limited set of ranges available : (1 V , 10 V). Therefore the closest range will be selected.

After a Voltage command has been executed care should be taken to ensure that the range desired has actually been selected.

If the numeric parameter to the command is missing or not recognised, the CME (CoMmand Error) bit in the Event Status Register will be set. If the numeric value is out of range (i.e. > 55 V) then the EXE (EXecution Error) error bit will be set for a program data element out of range error.

4.9.32 Voltage? - DISPLAY THE CURRENT INPUT VOLTAGE RANGE

The Voltage? command will report the currently selected voltage range. In verbose mode the response will be:

1.0 Volts

and in the terse mode the response will be:

1.0

where the number will change to reflect the actual input voltage range.

4.10 PROGRAMMING HINTS

In general, a simple way to get this instrument to respond is to select a voltage range, or to set an output range, by using the KEY command (see Section 4.9.19) and sending the same keystrokes that would be used from the front panel. This technique allows the system operator to easily try out the command sequences from the front panel before coding the necessary controller routines.

CALIBRATION

5.1 CALIBRATION EQUIPMENT

The following equipment is required to calibrate the 7620 WIDEBAND TRANSCONDUCTANCE AMPLIFIER:

1) An accurate ac/dc voltage source. (Fluke 5700A is appropriate)

2) A set of ac current shunts

3) A dc voltmeter (Guildline 4880A is recommended)

4) A wide band ac voltmeter (Guildline 7130 is recommended)

5.2 DC CALIBRATION

5.2.1 EQUIPMENT SET-UP

Connect the appropriate shunt to the input of the 4880A. With the 4880A on the 2 V range check the voltmeter reads zero within ±30 μV or better. Press the zero key if required to remove any offsets. Connect the remaining equipment as illustrated in Figure 5.1.

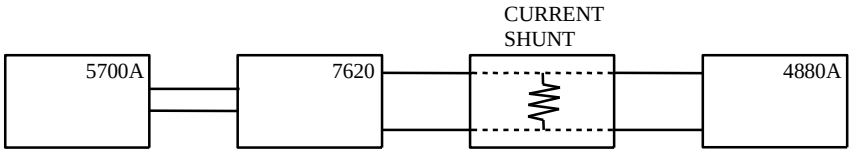
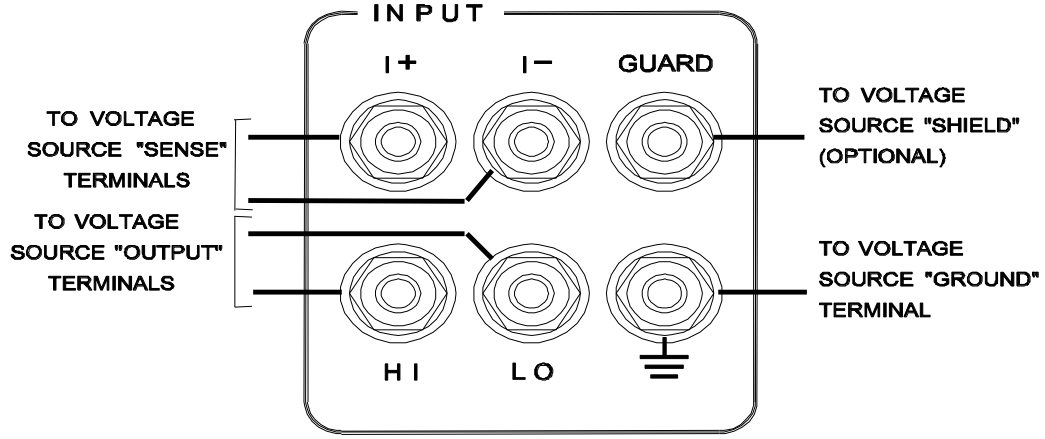


Figure 5.1
D/C Calibration Test Set-up

NOTE

For proper calibration results the input must be configured in the "4-wire" mode. All four terminals must be taken independently to the calibrator.



Other input termination configurations can give calibration errors of up to 200 ppm. For example, in the 4-wire input configuration shown, if terminal I+ is linked to terminal HI at the 7620 front panel, the resulting output signal from the 7620 would be reduced by 100 ppm. Also, if only a 2-wire configuration is used, where, the sense terminals (I+, I-) are not connected, the output signal would be reduced by 200 ppm.

5.2.2 DC OFF-SET CURRENT CHECK

Select the 1 V input range and the appropriate output current range on the 7620. Apply zero volts ±10 μV or better to the input of the 7620. The 4880A voltmeter should read less than ±200 μV for a shunt with a compliance of 2 V at full scale current (0.01% of range).

Follow the above procedure to check each of the 7620 current ranges.

5.2.2.1 DC OFF-SET CURRENT ADJUSTMENT

DC offset current adjustments are made on the 2 A and 20 A outputs. With a suitable shunt (See Table 5.1) attached to the 2 A output adjust R201 until the voltage across the shunt is zero with no input voltage.

Adjustment of the 20 A output offset is achieved by first attaching a 0.1 Ω shunt to a dc voltmeter and nulling the voltmeter. The shunt voltmeter arrangement should then be connected to the 20 A output connector and the 20 A range selected with zero volts input. Two variable resistors on the 20 A array printed circuit board set the offset current. Initially both variable resistors should be one turn from fully counter clockwise. Adjustment of either (or both) potentiometers is made to zero the voltmeter reading.

5.2.3 DC GAIN CHECK

Select the 1 V input range and the appropriate output current range on the 7620. Apply zero volts to the input and zero the voltmeter to ±10 μV or better.

Apply +0.5 V to the input and record the voltage measured on the output. Apply -0.5 V to the input, the output should agree in magnitude with the positive output to within the limits shown in Table 5.1 (for a shunt with a compliance of 2 V at full scale current).

Follow the above procedure to check each of the 7620 current ranges.

NOMINAL SHUNT VALUE (OHMS)	CURRENT RANGE	GAIN ERROR (± μV)	TRANSCONDUCTANCE ERROR
10 k	200 μA	400	0.04%
1 k	2 mA	400	0.04%
100	20 mA	300	0.035%
10	200 mA	300	0.035%
1	2 A	300	0.035%
0.1	20 A	300	0.035%

Table 5.1
DC Gain Tolerance

5.2.3.1 DC GAIN ADJUSTMENT

DC gain is adjusted by use of select-on-test resistors used to shunt the gain set resistor for each range each range (R_1 in Figure 1.4, also see Section 1.3). Equations for the calculation of these select-on-test resistors are given in the following Table. (See also Section 5.2 and Figure 5.1 for setup).

RANGE	VARIABLE		CALCULATION
200 μA	(A)	$(V_{CAL} - V_O)$ 200 μA	R_{SOT} 200 μA = $[(1/(A - 0.1B - 0.01C)) \times (0.9\ V_{CAL})^2 \times R_1/V_O]$
2 mA	(B)	$(V_{CAL} - V_O)$ 2 mA	R_{SOT} 2 mA = $[(1/(B - 0.1C - 0.01D)) \times (0.9\ V_{CAL})^2 \times R_1/V_O]$
20 mA	(C)	$(V_{CAL} - V_O)$ 20 mA	R_{SOT} 20 mA = $[(1/(C – 0.1D - 0.01E)) \times (0.9\ V_{CAL})^2 \times R_1/V_O]$
200 mA	(D)	$(V_{CAL} - V_O)$ 200 mA	R_{SOT} 200 mA = $[(1/(D - 0.1E)) \times (V_{CAL})^2 \times R_1/V_O]$
2 A	(E)	$(V_{CAL} - V_O)$ 2 A	R_{SOT} 2 A = $[(1/E) \times V_{CAL} \times R_1]$

20 A	(F)	(V_{CAL} - V_O) 20 A	R_{SOT} 20 A = [(1/F) x V_{CAL} x R_1]

Where V_{CAL} for a range is the voltage that is expected across the calibrating shunt at the calibrating current
.... V_O for a range is the measured voltage across the calibrating shunt
.... R_I is 1 kΩ for 200 μA; 100 Ω for 2 mA; 10 Ω for 20 mA; 1 Ω for 200 mA; 0.1 Ω for 2 A; 0.01 Ω for 20 A;

NOTE

V_{CAL} and V_O must not include an offset voltage which may be present due to an offset current other measurement system offsets.

Also see front panel pcb schematic 18927.01.04.

RT500 - 504 are R_{SOT} for the current ranges +2 A to +200 μA respectively
RT600 - 604 are R_{SOT} for the current ranges -2 A to -200 μA respectively.

5.2.4 TRANSCONDUCTANCE

If the absolute value of the current shunt is known the transconductance of each range can be determined as follows:

$$T = \frac{I_{out}}{V_{in}} \quad 3$$

where T is transconductance
..... I_{out} is the output current
..... V_{in} is the input voltage

$$I_{out} = \frac{V_{SHUNT}}{R_{SHUNT}} \quad 4$$

where V_{SHUNT} is the voltage measure across the shunt
..... R_{SHUNT} is the resistance of the current shunt

then

$$T = \frac{V_{SHUNT}}{V_{in} \times R_{SHUNT}} \quad 5$$

The absolute value of the transconductance should be within values given in Table 5.1.

5.3 FREQUENCY RESPONSE

5.3.1 EQUIPMENT SET-UP

Connect the equipment as illustrated in Figure 5.2.

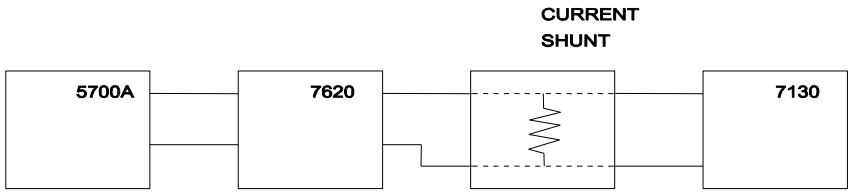


Figure 5.2
A/C Calibration Test Set-up

5.3.2 PROCEDURE

The frequency response of the 7620 is checked by applying inputs of the same rms value in the following manner.

1) Apply a positive dc voltage to the input of the 7620 and measure the voltage across the output current shunt.

2) Apply an ac voltage to the input of the 7620 and measure the voltage across the output current shunt.

3) Apply a negative dc voltage to the input of the 7620 and measure the voltage across the output current shunt.

The difference between the ac signal and the average of the positive dc and negative dc signals is used to measure the ac response.

$$\text{AC/DC Difference} = \text{AC} - \frac{+\text{DC} + \text{abs}(-\text{DC})}{2} \quad 6$$

The above procedure is repeated for the ac frequency points of interest. Results should meet the specifications given in the Tables in Section 2 of this manual to within the errors and uncertainties of the test setup equipment used.

PRINCIPLES OF OPERATION

6.1 INTRODUCTION

The 7620 consists of the following functional blocks:

a) Dual Linear Power Supply -
generates ±5 volts, ±24 volts, ±16 volts, and ±12 volts.

b) Dual High-Current Switching Power Supply -
generates ±12 volts.

c) CPU Assembly -
consisting of a microprocessor with its input/output latches, random access memory, read only memory, GPIB interface and Front Panel logic interface.

d) Front Panel Assembly -
with operator control switches, voltage display unit and low output current drive electronics (to 2 A).

e) High-Current Output Drive Assembly -
with ten positive 2 A current-cells and ten 2 A negative current-cells.

f) Software - the operating software in read only memory.

The functional blocks are described below.

6.2 DUAL LINEAR POWER SUPPLY

The dual linear power supply is shown in the schematic drawing Number 19198.01.04 (sheet 1 of 1).

A single transformer with three secondary windings drives three standard series-pass regulated supplies. The supplies are connected in a conventional configuration and have an associated rectifier, filter, three terminal monolithic regulator and output filter.

Linear regulator U5 (LM317N) is biased with resistors R9 and R10 to generate +24 V at pcb connector J5-8 (+A3). Similarly, regulator U7 (LM337N) is biased with resistors R11 and R12 to generate -24 V at pcb connector J5-6 (-A3). The ±24 V is used to power the operational amplifiers on the positive and negative current-cells of the front panel pcb assembly.

Linear regulator U6 (LM340T) generates +16 V at pcb connector J5-3 (+B3). Similarly, regulator U8 (LM320T) generates -l6 V at pcb connector J5-5 (-B3). The ±l6 V is used to power the front panel pcb and operational amplifiers on the 20 A Current-Cell Array pcb.

Linear regulator U2 (LT1084CT) generates +12 V at pcb connector J2-8 (+C2). Similarly regulator U3 (LT1033CT) generates -12 V at pcb connector J2-6 (-C2). The ±12 V, 2 A, supplies provide the power for the output current for the ranges of 2 A and below.

The linear regulator at U1 (LM323K) provides a +5 V power supply at J2-2 (+D1). This +5 V supply is further filtered by an inductive filter network mounted off the linear power supply assembly and is used to power the digital logic circuitry on the CPU and front panel pcb assemblies.

Linear regulator U4 (LM320T5) provides a -5 V power supply at J2-5. The -5 V is used by the panel meter U703 (ICL7107) on the front panel pcb.

6.3 DUAL HIGH-CURRENT SWITCHING POWER SUPPLY

A high-current switching power supply provides the ±12 V, 30 A required for the current-cell array assembly. (Guildline part number 320-00360).

6.4 CPU ASSEMBLY

The CPU assembly used in the 7620 is shown in schematic drawing number 19427.01.04 (sheets 1 to 5).

The CPU assembly contains a microprocessor, memory and input/output devices. The input/output devices interface to the front panel switch and display assembly and the GPIB (IEEE-488) control bus connector. Not all of the circuitry included in the RS232 SCHEMATIC (sheet 4 of 8) of drawing no.19427.01.04 is installed for the 7620. For a complete list of all components not installed, refer to the CPU GENERAL ASSEMBLY dwg. no. 19427.01.02 and parts list PL19427.01.02.

6.4.1 CENTRAL PROCESSING UNIT

The CPU is an Intel 80188 processor and the design is similar to most 80188 CPU designs. The following sections describe the major functional blocks, however a detailed timing analysis is far beyond the scope of this manual. If a problem is suspected in this section then checking the subsystems in the order which they are presented is recommended.

6.4.1.1 CLOCK GENERATION

Crystal X1 provides 4.9152 MHz signal to the processor U100, which generates the system clock (CLK) pin 56.

6.4.1.2 CONTROL SIGNAL GENERATION

The 80188 CPU (U100) contains the required logic to generate, read, and write strobes for the memory and input/output devices. During normal system operation the RD signal (Pin 62) should show the most activity, since the processor should be continually fetching instructions from the program ROM. The WR signal (Pin 63) should toggle at a rate less than the RD signal and show a reasonable amount of activity as the processor writes to RAM.

6.4.1.3 ADDRESS AND DATA BUFFERS

Addresses from the CPU cluster are latched by the 2 octal latches U101, and U102. This latching operation demultiplexes the address/data bus of the CPU cluster into separate address and data busses for the peripherals components. U103 is the data transceiver.

6.4.1.4 MEMORY AND IO ADDRESS DECODING

The CPU (U100) performs all memory and address decoding internally. The memory chip selects are UCS (for the ROM), LCS (for the RAM), and the MCS0-3 for other memory devices. The IO chip selects are PCS0-6 for the various IO devices.

6.4.1.5 INTERRUPT CONTROLLER

The system interrupt controller is within the CPU IC (U100) and interrupt priorities are set by software.

6.4.1.6 POWER SUPPLIES

The linear regulator U104 produces the +5V power supply designated +5VD. This supply powers the microprocessor memory, communications and interface circuitry to the opto-isolator U505. Additional interface circuitry (pages 6 through 8 of 19427.01.04) and opto-isolator U500 are powered by the +5V power supply designated +5V which is produced on the Dual Power Supply PCB and shared with the Front Panel PCB.

6.4.2 MEMORY

The Memory section of the CPU pcb consists of 3 general purpose 28 pin sockets which will allow up to 192 kbytes of ROM with 32 kbytes of RAM, or 96 kbytes of RAM with 64 kbytes of ROM, or a number of intermediate compromises.

Memory socket U201 contains a Smart Watch (which has a real time clock and battery backup for the RAM). I.C. U202 is configured to be ROM since the processor performs its boot from location 0xFFFF0, and U200 is configured as RAM.

6.4.3 GPIB INTERFACE

The GPIB interface is built up from a Texas Instruments TMS9914 IC (U300) and two buffers (U301 and U302). U303 converts the polarity of the interrupt output for the system interrupt controller.

GPIB address switches at switch bank SW1 contains 8 switches mounted remotely but connected with a wiring harness to the CPU pcb assembly. The positions of each of the 8 switches can be read (through the 74HC373 bus driver at U304), by the 80188 microprocessor when the processor reads the appropriate input/output port number assigned to the Texas Instruments TMS9914 integrated circuit at U300. The relative position of these switches determine the GPIB ADDRESS for the 7620.

6.4.4 OPTICAL INTERFACE

Communications between the microprocessor writes control bits to the front panel PCB and reads the front panel PCB switches and status bits over a serial optical interface. reading and writing are done simultaneously, two 18 bit bytes in succession. The PAL (U504) and the counter (U503) generate the communication clock and latch signals. The shift register (U502) sends the outgoing control data through the opto coupler (U505) while the shift register (U501) receives the incoming switch and status data from the opto coupler (U500). Mono stables (U600) and U601) monitor communications clock (SERCLK) and generating latching and control signals.

The shift registers (U702 and U703) receive the outgoing control while the shift register (U700 and U701) send the switch and status data to the microprocessor.

The eight bit comparator (U800) and the eight bit latch (U801) monitor the status lines for a change of state. The eight bit NOR gate (U802) monitor the switches for a key press. When a change in a status bit or a key press is detected an interupt is generated and sent to the microprocessor requesting service. The mono stable (U601) debounces the interupt.

The input and output signals on J800 are described in Tables 6.1 and 6.2.

Signal Name	J800 pin	Active	Function
DB15	21	Hi	1 V switch has been pressed.
DB14	23	Hi	10 V switch has been pressed.
DB13	25	Hi	200 μA switch has been pressed.
DB12	27	Hi	2 mA switch has been pressed.
DB11	29	Hi	20 mA switch has been pressed.
DB10	31	Hi	200 mA switch has been pressed.
DB9	33	Hi	2 A switch has been pressed.
DB8	35	Hi	20 A switch has been pressed.
DB7	10	Hi	O/LOAD – indicates an overload condition.
DB6	12	Hi	COMP - indicates a compliance overload.
DB5	14	Lo	$\overline{100\ K}$ – indicates input frequency <100 KHz.
DB4	16	Lo	$\overline{750\ K}$ – indicates input frequency >100 KHz, <750 KHz
DB3	18	Lo	$\overline{1\ M}$ – indicates input frequency >750 KHz
DB2	20	Hi	BPb BPASS – indicates overload switch is depressed
DB1	19	Hi	INOL – indicates input >110%
DB0	17	Hi	REMOTE SWITCH has been pressed.

Table 6.1
Switches and Status Bits

Signal Name	J800pin	Active	Function
DA15	22,5	Hi	Turns on K501, K601, 200μA switch LED
DA14	24,7	Hi	Turns on K502, K602, 2mA switch LED
DA13	26,9	Hi	Turns on K503,K603, 20mA switch LED
DA12	28,11	Hi	Turns on K504, K604, 200mA switch LED
DA11	30,13	Hi	Turns on K505, K605, 2A switch LED
DA10	32,15	Hi	Turns on 1K1-20K1, K200, 20A switch LED - Turns off K500,K600
DA9	37		Not Used
DA8	36,1	Hi	Turns on K100, 1V switch LED
DA8	3	Hi	Turns on 10V switch LED
DA7	38	Hi	Turns on K201
DA6	39	Hi	Turns on Overload lamp
DA5	40	Hi	Turns on remote switch LED

Table 6.2
Control Bits

6.5 FRONT PANEL

The front panel display assembly is shown schematically in drawing number 18927.01.04 (8 sheets). This assembly connects to the CPU card assembly at connector J1 and is mounted on one single printed circuit card. Several functional blocks are built into this assembly:

a) Input Buffer Amplifier and Differential Driver
b) Input Frequency Range Detector
c) Overload Detect Circuitry
d) Positive 200 μA to 2 A Current-Cell
e) Negative 200 μA to 2 A Current-Cell
f) Compliance Voltage Measuring Circuit and Display
g) Digital Interface to CPU and Operator Switches.

The following sections describe the major functional blocks of the front panel display assembly.

6.5.1 INPUT BUFFER AND DIFFERENTIAL DRIVER

The input amplifier is comprised of operational amplifiers U100 (LF356H) and U102 (LF356H) configured as a unity gain buffer amplifiers. Input protection is provided by the diode network of CR100,CR101,CR102,CR103 and CR104. Operational amplifier U101 (LF356H) is configured as a differential input instrumentation amplifier.

A differential current drive circuit is also driven directly from the input. The differential drive amplifier input comprises U200 (AD845KN) and U201 (AD845KN). These two operational amplifiers are each connected as unity gain amplifiers. The voltage at the input to the differential driver terminals is forced across the resistor R206.

The resulting current through R206 is equal to :

(input voltage)/R)

where R = 500 ohms for R206

and input voltage = (VinHI - VinLO))

This current is steered by Q201 (MAT01) and Q202 (2N3810), depending on the polarity of the input, to either the negative-cell (at LK201) or out of the positive-cell input (at LK200). Q203 (2N4222) serves as a dc current source to provide a fixed level of equal quiescent current, set by R211, for each cell array. Relay K201 switches the current drive output from the differential stage, either to the inputs of the high-current-cell array (20 A output) or the low-current-cell array (2 A output).

6.5.2 INPUT FREQUENCY RANGE DETECTOR

U300 (LF356) is a zero-crossing detector which translates the signal from the input differential amplifier to 0 V and + 5 V levels required for CMOS logic. The input signal frequency is divided by U304 in order to match the range of the frequency to voltage convertor U301 (AD650). Offset null of the frequency to voltage convertor is provided by R305, while R301 scales the output voltage. Comparators U302 (LM339) monitor the output of the F-to-V Convertor and generate the frequency bank of operation signals (1 M, 750 k, 100 k) and drive the corresponding front panel indicators DS300, DS301, DS302.

6.5.3 OVERLOAD DETECT CIRCUIT

The signal from the input differential amplifier is rectified and then monitored by U400 (LM339) to generate three current bank of operation signals (0-8 A, 8 A-10 A, 10 A-20 A). Logic circuits of U401 (74HC04), U402 (74HC08) and U403 (74HC32) combine the current-band-of-operation signals with the frequency-band-of-operation signals and the current-limit signal to generate the overload signal at U403-8. This signal is read by the microprocessor from parallel port U801-PB4. Software logic drives an output to energise/de-energise overload relay at K200 depending on status of the overload logic signal.

6.5.4 POSITIVE 200 µA TO 2 A CURRENT-CELL

The +12 V power supply is connected to the positive current-cell by K500 which is switched by Q500. The driver current (+2 A signal) is drawn through R516 and sensed by the operational amplifier U500 (AD845). The operational amplifier U500 drives the pair of transistors Q501 and Q502 to allow an appropriate current to flow to the output current sensing resistors R502-R515. The signals 200 µA, 2 mA, 20 mA, 200 mA and 2 A energize relays K501 to K505 respectively to select output current sensing resistor and therefore the output current range. Over-current protection of the output transistor Q501 is provided by fuse F500. DS500 is illuminated if F500 has blown.

6.5.5 NEGATIVE 200 µA TO 2 A CURRENT-CELL

The -12 V power supply is connected to the negative current-cell by K600 which is switched by Q500. The driver current (-2 A signal) is drawn through R616 and sensed by the operational amplifier U600 (AD845). The operational amplifier U600 drives the pair of transistors Q601 and Q602 to allow an appropriate current to flow to the output-current sensing resistors R602-R615. The signals 200 µA, 2 mA, 20 mA, 200 mA and 2 A energize

relays K601 to K605 respectively to select output-current sensing resistor and therefore the output current range. Over-current protection of the output transistor Q601 is provided by fuse F600. DS600 is illuminated if F600 has blown.

6.5.6 COMPLIANCE VOLTAGE MEASUREMENT AND DISPLAY

The relay K700 selects the 2 A connector or the 20 A connector at which the compliance voltage is to be measured. The operational amplifier U700 buffers the output signal and U701 provides current drive required to drive the output "GUARD" terminal. Resistor R708 scales the input to the rms to dc convertor U702 (AD536A). Resistor R700 scales the output of the rms to dc convertor U702. The output of U702 is monitored by comparator U704 (LM339), which generates the compliance over voltage signal (COMP) and by the panel meter U703 (ICL7107). The panel meter drives the four front panel displays DS700-DS703. The panel meters reference is trimmed by resistor R703.

6.6 20 A CURRENT-CELL ARRAY

The 20 A current-cell array is shown schematically in drawing number 18926.01.04 (20 sheets). This assembly is made up of ten identical positive current-cells and ten identical negative current-cells. Each cell is capable of delivering 2 A output current. The outputs of all current-cells are connected to a common point at the 20 A output connector. The following sections describe the function of a positive current-cell and of a negative current-cell.

6.6.1 POSITIVE CURRENT-CELL

The +12 V power supply is connected to the positive current-cell by 1K1 which is switched by 1Q3. The driver current (+20ADRV) is drawn through 1R11 and is sensed by the operational amplifier 1U1 (OP37). The operational amplifier 1U1 drives the pair of transistors 1Q1 and 1Q2 to allow an appropriate current to flow through the output sensing resistors 1R1 to 1R10. Over-current protection of the output transistor 1Q1 is provided by Fuse 1F1. The LED 1DS1 is illuminated if 1F1 has blown.

6.6.2 NEGATIVE CURRENT-CELL

The -12 V power supply is connected to the negative current-cell by 11K1 which is switched by 11Q3. The driver current (-20ADRV) is drawn through 11R11 and is sensed by the operational amplifier 11U1 (OP37). The operational amplifier 11U1 drives the pair of transistors 11Q1 and 11Q2 to allow an appropriate current to flow through the output sensing resistors 11R1 to 11R10. Over-current protection of the output transistor 11Q1 is provided by Fuse 11F1. The LED 11DS1 is illuminated if 11F1 has blown.

6.7 SOFTWARE

The control program within the 7620 is the "glue" which joins the interfaces and the microprocessor together. The major interfaces to the microprocessor are the FRONT PANEL SWITCHES and DISPLAY (and ultimately the user), and the REMOTE computer interface (IEEE-488).

The 7620 control program is approximately 65 000 bytes long. It is written in the "C" programming language and stored as binary numbers in the 27C512 read-only memory.

TROUBLESHOOTING AND MAINTENANCE

7.1 TROUBLESHOOTING

SYMPTOM AND POSSIBLE CAUSE AND CURE

NO DISPLAY - Instrument not plugged in. Instrument not switched on. Power supply not operating correctly. Faulty FRONT PANEL pcb.

DISPLAY ON (but switches do not respond) - Front panel locked out by remote controller. Cable from CPU to front panel not connected. Faulty FRONT PANEL pcb. Faulty CPU pcb.

DISPLAY ON (most keys operative with some exceptions) - Cable from CPU to front panel not connected properly. Faulty FRONT PANEL pcb.

GPIB BUS DOES NOT RESPOND - Incorrect Bus address. GPIB cable not connected to instrument correctly. Internal GPIB cables not connected correctly. Faulty CPU pcb.

NO POWER TO CPU pcb - Instrument not plugged in. Instrument not switched on. Incorrect voltage range selected at power inlet connector. Blown fuse. Faulty power supply module. Power cable not plugged into CPU pcb.

7.2 PREVENTATIVE MAINTENANCE

Preventative maintenance consists of cleaning, visual inspection. When it is performed on a regular basis it may prevent instrument breakdown and will improve the reliability of this instrument. The severity of the environment to which the 7620 is subjected determines the frequency of maintenance. A convenient time to perform preventative maintenance is preceding recalibration of the instrument.

The 7620 should be cleaned as often as operating conditions require. Accumulation of dirt in the instrument can cause overheating and component breakdown. Dirt on components acts as an insulating blanket and prevents efficient heat dissipation. It also provides an electrical conduction path which may result in instrument failure. The dress skins provide protection against dust in the interior of the instrument. Operation without these panels in place necessitates more frequent cleaning.

CAUTION

Avoid the use of chemical cleaning agents which might damage the plastics used in this instrument. In particular, avoid chemicals which contain benzene, toluene, xylene, or similar solvents.

Periodically inspect the instrument for general cleanliness. Remove the cover and clean out any accumulated dust with a soft brush; at the same time check for discoloured or damaged wiring. Check all screws and hardware for tightness.

PARTS LISTS (can be ordered from Guildline)

MODEL 7620

PL18985.01.02	7620 General Assembly
PL19427.01.02	7620 CPU pcb
PL18927.01.02	Front Panel pcb
PL18926.01.02	High-Current-Cell Array pcb
PL19198.01.02	Dual Power Supply pcb

DRAWINGS (can be ordered from Guildline)

MODEL 7620

18924.01.04 7620 General Schematic
18985.01.02 7620 General Assembly
19427.01.04 7620 CPU pcb Schematic
19427.01.02 7620 CPU pcb Assembly
18926.01.04 High-Current Array pcb Schematic
18926.01.02 High-Current Array pcb Assembly
18927.01.04 Front Panel pcb Schematic
18927.01.02 Front Panel pcb Assembly
19198.01.04 Dual Power Supply pcb Schematic
19198.01.02 Dual Power Supply pcb Assembly