Operating Instructions

Brownlee Precision Model 440 ver. 4
Four-Channel Amplifier and Signal Conditioner

Power:

The Model 440's power requirements are 120 VAC, 60 Hz unless otherwise indicated on the back panel near the power connector. Run an IEC line cord from a wall socket to the back panel power connector. The 2 Amp, 5x 20 mm type fuse is located in the back panel power connector.

Turn on the power using the front panel power switch. The "ON" will illuminate and, after a pause, the LED alphanumeric displays will spell the startup message. After another pause, the displays will spell out the amplifier settings and the amplifier is ready for operation.

Troubleshooting: If the "ON" indicator does not light up, check the fuse and power connection.

Signal Connections:

Each of the four channels is an independent voltage amplifier with a non-inverting (A) input, an inverting (B) input and an output, all with BNC connectors. The input and output voltage ranges are +/- 10 Volts. Each output is capable of driving +/- 100 mA.

Amplifier Settings:

There are 5 main parameters, which can be adjusted on each amplifier channel: Gain, Lowpass Filter cutoff frequency, Highpass Filter cutoff frequency, Output Offset voltage, and Input Selection. There is a button corresponding to each one of these parameters. Pushing one of these buttons puts that parameter's value on the alphanumeric display. The knob can be used to adjust that parameter.

To set the gain, for example, push the 'Gain' button and then turn the knob until the desired value is displayed.

To completely configure a channel of the amplifier, all 5 parameters must be set using the buttons and the knob. The parameters may be set in any order.

It is important to remember that pushing a parameter button once does not change the amplifier settings; it simply changes the alphanumeric display. Turning the knob is the way to change the amplifier's internal settings.

The amplifier's output is not affected by which parameter happens to be displayed. You may want to leave the most frequently adjusted parameter on the display. The amplifier will retain all the settings for each channel when power is turned off, even if the unit is unplugged.

Gain

To set the amplifier's gain, push the 'Gain' button and turn the knob until desired gain is displayed. The gain ranges from 0.1 to 10,000. Gains of 1000 to 10,000 are abbreviated 1 K to 10 K, etc.

The gain can be displayed either as a ratio or in decibels: Gain=100 or G=40 dB, for example. See "Setups" section for an explanation of switching between these two modes.

Lowpass Filter

The Lowpass Filter is useful to suppress noise at higher frequencies than the signal of interest.

To set the Lowpass filter's cutoff frequency, push the 'Lowpass Filter' button and turn the knob until desired value is displayed. The cutoff frequency ranges from 20 Hz to 150 kHz. There is also a wideband setting, (LP=WB) with a cutoff frequency of approximately 200 kHz.

The filter characteristic is an 8 pole Bessel function for all values from 20 Hz to 50 kHz. The filter is an 8 pole elliptic function for values from 60 kHz to 150 kHz.

Highpass Filter (Input Coupling)

The Highpass Filter is useful when you need to amplify a small signal whose average voltage (or DC level) is not at 0 Volts, or may be slowly drifting relative to ground.

To set the Highpass Filter cutoff frequency, push the ‘Highpass Filter’ button and turn the knob until the desired value is displayed. The cutoff frequency of the single-pole Highpass filter can be varied from 0.01 Hz to 1 kHz.

In addition, the inputs can be true-DC-coupled (HP=DC) or DC-coupled with Autozero capability (HP=AZ DC). See Autozero section for an explanation of this feature.

If the Gain is ≤ 100 the Highpass Filter can remove DC input offset voltages up to +/- 10 Volts. If the Gain > 100, the Highpass Filter can remove DC input offset voltages up to +/- 100 mV. If you need both Gain > 100 AND common mode voltage > +/- 100 mV, you will need to cascade two channels. The first channel should have G < 100 and the Highpass filter ON; the second channel should perform the additional amplification.

Output Offset

To set the output offset voltage, push the ‘Output Offset’ button and turn the knob until the desired value is displayed. Output offset is abbreviated “OS”. The offset voltage may be varied from – 10 Volts to + 10 Volts.

Example: if your output signal is +/-2 Volts centered on 0 Volts, but you want to feed this signal to an ADC board with range 0-5 V, you may want to set the Output Offset to +2.5 V.

Handy tip: double-clicking the Output Offset button will immediately reset the output offset voltage to zero.

Input Select

To select which input is to be amplified, push the 'Input Select' button and turn the knob until desired configuration is displayed. "Gnd" ignores both input lines and internally ties the inputs to 0 Volts for equipment setup and testing.

The "A" setting amplifies the single-ended signal on the A input. The "-B" setting amplifies and inverts the single-ended signal on the –B input. The "A-B" setting amplifies the difference between the A and –B inputs.

Handy tip: Once the input Select button has been pushed, your input choice may be made by either turning the knob, or by repeatedly pushing the Input Select button. For example, the first time you push Input Select, the present input setting is written to the alphanumeric display without changing it. Each additional push of the button, however, will advance the amplifier through its four options:,A, -B, A-B, and Gnd

Special Functions of the Model 440:

Line Notch Filter

Pushing this button toggles the notch filter on and off. When on, this filter removes sinusoidal interferences at the line frequency. It is factory set for 50 Hz or 60 Hz.

Notch filters will distort square waves of frequencies lower than the center frequency of the notch. For this reason, you should generally keep the notch filter OFF, and only use it when line noise is excessive.

Autozero

If the Highpass Filter is set to any value *except* HP=DC, then pushing the "Autozero" button resets the centerline level of the output to 0 Volts (plus or minus the Output Offset setting). Pushing Autozero turns off the output for approximately 100-250 milliseconds.

Digital Voltmeter

Pushing the DVM button on the channel 1 or 2 will put the DC level *of the output* on the alphanumeric display. The displayed value is post-gain and post-filtering.

To read the DC level of the input, you must first set:

Gain = 1
Highpass Filter = DC
Output Offset = 0 Volts

Turning on the DVM does not affect the amplifier settings or the output signal.

Memory

There are two modes for the amplifier memory: **Single Memory Mode** is easy to use, and **Multiple Memory Mode** offers more memory options. See "Setups" section for instructions on how to switch between these two modes.

Single Memory Mode: Pushing the "Memory STO" button saves this channel's settings to this channel's memory. Pushing the "Memory RCL" button reconfigures this channel to the settings in this channel's memory.

ALL six amplifier settings are stored to memory, and all six recalled from memory: Gain, Lowpass Filter, Highpass Filter, Output Offset, Input Select, and Line Notch Filter.

Multiple Memory Mode: In this mode, there is a choice of 7 memory locations for each channel. Four of these locations are unique to the channel. They are numbered 1.1, 1.2, and 1.3 on channel one; 2.1, 2.2, 2.3, on channel two, etc. In addition, there

are 4 memory locations which are common to all channels. These are designated A, B, C, and D.

In Multiple Memory Mode, storing the current settings to memory is done in three steps:

1. Push the memory STO button. The display will show: STO 2.1? , for example.

2. Turn the knob until the desired memory location is displayed: STO C? , for example.

3. Push the Memory STO button a second time to confirm. The display will briefly show: STORED!

In Multiple Memory Mode, recalling the settings from memory is done the same way:

1. Push the Memory RCL button.
   The display will show: RCL A? , for example.

2. Turn the knob until the desired memory location is displayed: RCL 1.3? , for example.

3. Push the Memory RCL button a second time to confirm. The display will briefly show: RECALLED

If you wish to cancel the memory command after step 1 or 2, simply stop and wait 3 seconds, the memory command will time out without executing anything.

The common memory locations, A, B, C, and D are useful to transfer settings from one channel to another. For example, to make channel 4's setting identical to channel 3's, follow these steps:

- On channel 3, store to location B
- On channel 4, recall from location B

(Location A, C, or D could also have been used.)

You may switch between single-memory and multiple-memory modes without losing the data in memory. In single-memory mode, you are actually using memory location 1.1 on channel one, location 2.1 on channel two, etc.

Setups

Pushing the "Setups" button puts certain amplifier setup choices on the alphanumeric displays. Turn the knob beneath the display to change its setting. Push the "Setups" button a second time to exit this mode. Under Setups:

Mems/ch: switches between single-memory and multiple-memory modes.

Gain: determines whether Gain is displayed as a ratio or in dB. Gain (dB) = 20 $\log_{10}$ Gain (ratio)

Coarse/Fine

When an amplifier parameter is adjusted using the knob, the values can be made to change in small incremental steps (FINE mode) or take larger jumps to the next "round" value (COARSE mode). Changing Coarse/Fine only affects future adjustments; the current settings do not get "rounded-off".

Input Resistance Switch

There is a small slide switch between the A and B input connectors. Its settings are as follows:

General Purpose: The input resistance of the amplifier is 1 MΩ. This is the recommended position for most users.

High Impedance: The input resistance of the amplifier is $>10^8$ Ω. This may be useful when high resistance probes are used as the input. The downside is increased noise, especially prevalent at high gain values.

Low Noise: This input resistance of the amplifier is 100 KΩ and the input bias current is typically 3 μA. At Gains > 100, the noise is slightly reduced with this setting.

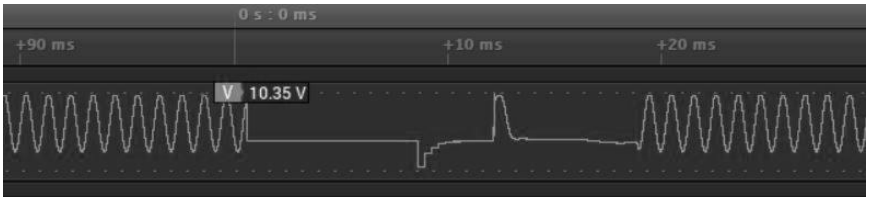
Self-Trimming

The electronic components at each stage of the amplifier have inherent offset voltages, which could cause a shift of the “zero” level of the output. The Brownlee Precision Model 440 has a self-trimming feature, which compensates for these errors automatically.

Every time an amplifier parameter is changed, the amplifier goes through a quick self-calibration routine. During this routine the output will be invalid for approximately 10-20 mS, or up to 250 mS if ‘Autozero’ is pressed.

The Self-trimming routine is only performed on the channel whose gain is being changed. The other three channels are unaffected.

If you notice the zero level of the output has drifted you can invoke the self-trimming feature by changing a parameter, or by pushing Autozero.



Example: Sine wave signal interrupted by self-trimming routine upon settings change.

Amplifier Specifications:

Gain Range	0.1 to 10,000
Gain Accuracy	< 2% error
Input Impedance, Gen. Purp. Mode	1 MΩ, 15 pF
Input Impedance, Low Noise Mode	100 KΩ, 15 pF
Input Impedance, High Imp. Mode	$>10^8$ Ω, 15 pF
Input Voltage Range, G ≤ 100	+/- 10 Volts
Input Voltage Range, G > 100	+/- 100 mV
Input Bias Current, Gen. Purp. Mode	< 50 pA
Input Bias Current, Low Noise Mode	< 12 µA
Input Offset Voltage	< 5 µV
Output Offset Voltage	< 15 mV
Common Mode Rejection Ratio	> 70 dB
Slew Rate (input and output)	10 V/µS
Lowpass filter characteristic: 20 Hz-50 kHz	8 pole Bessel
60 Khz-150 kHz	8 pole elliptic
Wideband Voltage Noise, ref. to input	< 20 μV_{p-p}
Wideband Voltage Noise, ref. to output	< 15 mV_{p-p}
Noise Spectrum. 1 kHz, ref. to input	10-nV/ √Hz

At low gains, the total output noise is approximately RTO noise. At high gains, the total output noise is approximately Gain x RTI noise.

Output Voltage Range	+/- 10 Volts
Output Current	+/- 100 mA
Output Offset Control Range	+/- 10 Volts
Cross-talk Rejections *	
No load on transmitting channel	130 dB
100 Ω load on transmitting channel	120 dB

* Low impedance signal or ground on receiving channel

These specifications are tested to be accurate as of 2021, but are subject to change without notice.

Warning: This instrument must not be used on human subjects.

Model number: 440

Serial number: _____

Firmware version: V_____

Custom Options: _____

Ship Date: _____

Warranty: 12 months, parts and labor

Instruction manual: 440 Rev. L Aug, 2022

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