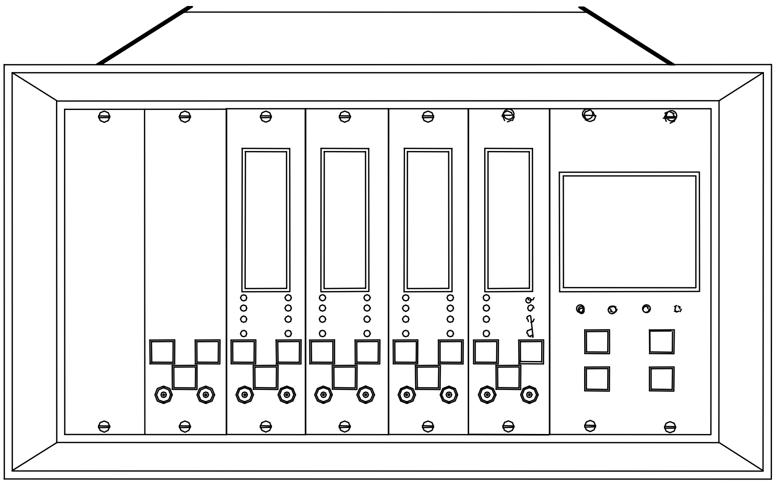
Operation Manual

Bently Nevada™ Asset Condition Monitoring



3300/25 Dual Accelerometer Input Monitor

imagination at work

Part Number 80181-01
Rev. AA (08/07)

Contact Information

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Additional Information

Notice:

This manual does not contain all the information required to operate and maintain the product. Refer to the following manuals for other required information.

3300 System Overview (Part Number 80171-01)

3300 System Installation Instructions (Part Number 80172-01)

3300 System Troubleshooting (Part Number 80173-01)

3300/12 Power Supply (AC supply) (Part Number 89602-01)

3300/14 Power Supply (DC supply) (Part Number 101256-01)

3300/03 System Monitor (Part Number 89604-01)

3300 Internal Barriers, Installation Manual (Part Number 88837-01)

RELATED PARTS

3300/25 Field Wiring Diagram Packet (Part Number 100317-01)

3300/25 Data Sheet (Part Number 141501-01)

3300/25 Meter Scales (Part Number 84113-25)

Product Disposal Statement

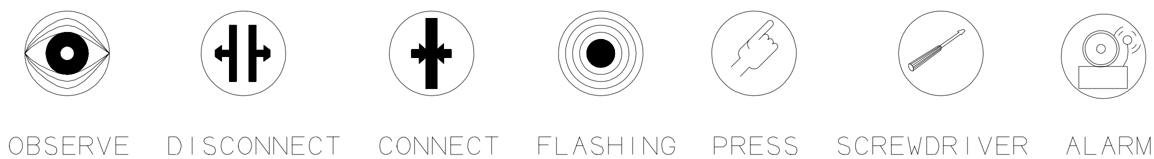
Customers and third parties, who are not member states of the European Union, who are in control of the product at the end of its life or at the end of its use, are solely responsible for the proper disposal of the product. No person, firm, corporation, association or agency that is in control of product shall dispose of it in a manner that is in violation of any applicable federal, state, local or international law. Bently Nevada LLC is not responsible for the disposal of the product at the end of its life or at the end of its use.

In this document procedures are given only for channel A. Procedures for channel B are similar except for the obvious substitutions of corresponding switches, terminals, and indicators.

NOTE: The information in this manual pertains to monitor main boards with part number 105513-xx and 79552-xx (all revisions) and filter boards with part numbers 148921-01 (all revisions), 105521-01 (all revisions and 79562-01 revision J and later. Exceptions are noted in the appropriate sections.

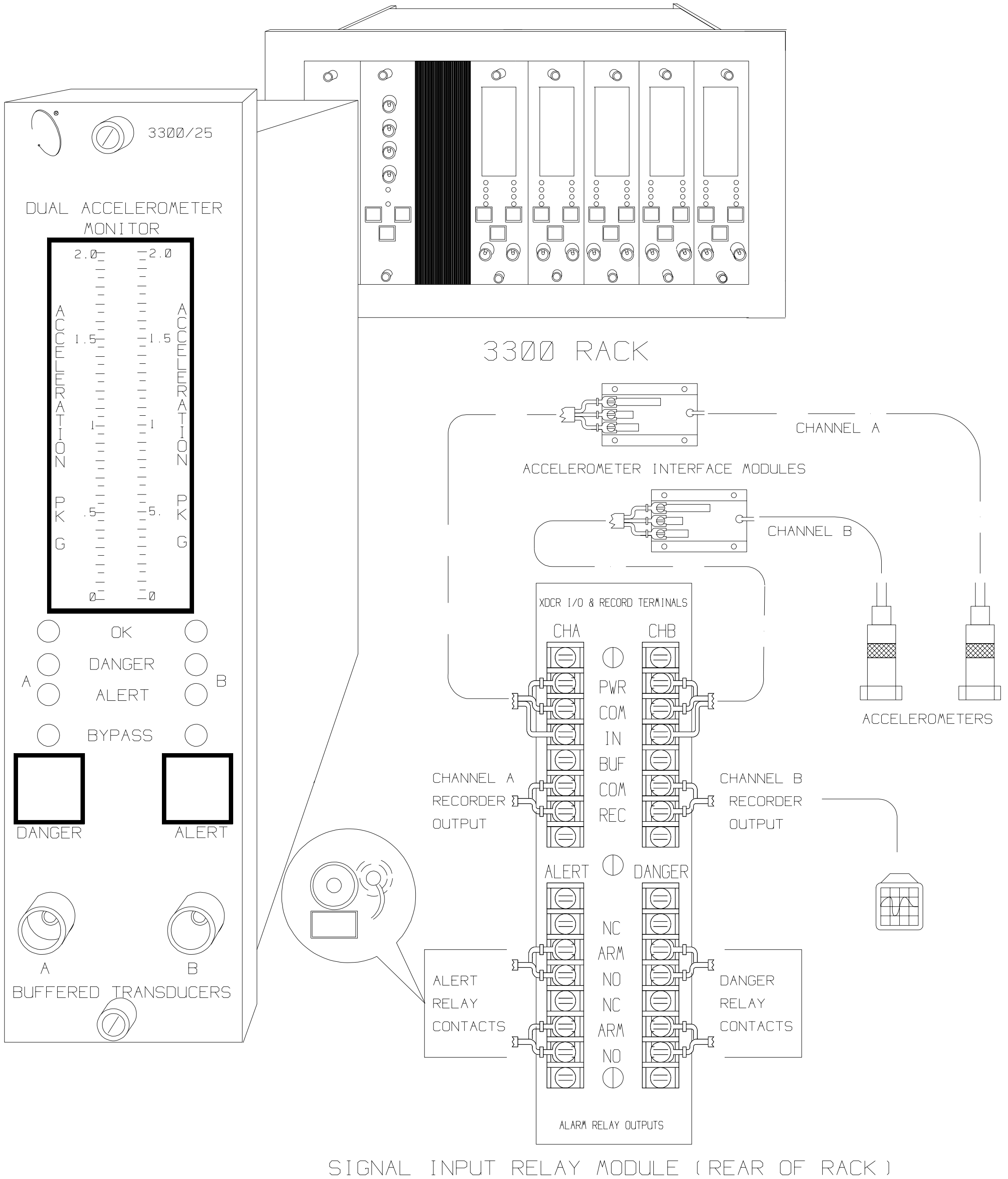
SYMBOLS

Special symbols are used in the manual to illustrate specifics in the step-by-step processes.



Contents

1. Dual Accelerometer Monitor System



Do not use this figure as a wiring diagram. Refer to 3300/25 Field Wiring Packet.

2. Monitor Functions

DUAL ACCELEROMETER INPUT - The 3300/25 Dual Accelerometer Input Monitor provides two independent channels of on-line machine monitoring using accelerometers for the transducer inputs. Accelerometers are generally used for high frequency measurements on machines such as turbines, gear boxes, compressors, and pumps. The monitor has filtering capabilities (high-pass, low-pass, band pass) that are programmable for selected frequency components or ranges.

SINGLE ACCELEROMETER INPUT - The 3300/25 Dual Accelerometer Input Monitor can also be used with a single transducer input. In this mode you can use both channels to monitor the same transducer but using different signal processing on each channel. You can choose to have channel A display in acceleration units and channel B in velocity units. You can also use different filter configurations on each channel.

OK - When the transducer output voltage is within the upper and lower OK limits of the monitor, the transducer is defined as OK. The detection circuit controls the channel OK and the monitor relay drive to the System OK Relay. If the monitor has the latching OK option enabled, a system reset is required to reset the OK function.

TIMED OK/CHANNEL DEFEAT - Timed OK/Channel Defeat minimizes false alarms due to faulty transducer wiring. If the input signal level on a given channel is not within the upper and lower OK limits, the following events occur:

the **OK** LED for the channel goes off,
the **BYPASS** LED for the channel comes on,
the channel is disabled, and
the System OK Relay de-energizes.

If the channel input signal level is restored within the upper and lower OK limits for 30 seconds, the channel **OK** LED starts flashing at 1 Hz to indicate that the OK state is restored, the **BYPASS** LED goes off, and monitoring is enabled. Press the **RESET** switch on the front of the System Monitor to stop the **OK** LED from flashing (it will remain on and steady after you press the **RESET** switch).

If the channel remains not OK, you can put the channel out of service by setting a channel bypass switch on the monitor circuit board. The monitor can then be operated as a single channel monitor. Without this feature the OK Relay could not be reactivated when faulty transducer wiring causes a not OK condition. In the Timed OK/Channel Defeat and Channel Bypass modes the recorder output is clamped to bottom scale and the meter registers zero. If you select Timed OK/Channel Defeat, you must also set the OK mode to nonlatching.

OK RELAY - The System OK Relay is mounted on the Power Input Module. Every channel in the rack must be OK or bypassed to energize the OK Relay.

ALARM - Pressing the **ALERT** or **DANGER** switches on the monitor front panel causes the corresponding Alert (first level alarm) or Danger (second level alarm) setpoints to be displayed on the front panel meter. **ALERT** and **DANGER** LEDs come on when the signal level exceeds preset levels for the selected time delay. The appropriate Alert and Danger relay contacts are then activated. AND and OR voting logic options determine when the Danger relay contacts are activated.

FIRST OUT - Separate First Out circuits exist for Alert and Danger alarms. A monitor with the First Out option selected flashes a channel alarm LED if that channel was the first channel in the rack to go into alarm since the last rack power up or reset. Pressing the **RESET** switch on the System Monitor acknowledges the First Out (the LED stops flashing and remains on steady).

DANGER BYPASS - When maintaining the monitor, you can set the Danger Bypass switch on the monitor circuit board to inhibit the Danger relay drive. This function turns on the **BYPASS** LEDs. Other front panel functions are not affected. You can enable this function by installing a jumper on the monitor circuit board.

ALARM RELAYS - You can program monitor alarms for either latching or nonlatching mode. In the nonlatching mode, the alarm resets automatically when the alarm condition no longer exists. In the latching mode the alarm must be reset manually by pressing the **RESET** switch on the front panel of the System Monitor (or by closing external Reset contacts). The alarm will not reset if the alarm condition still exists.

BUFFERED OUTPUT - The monitor provides buffered signals from the transducers on the channel A and B coaxial cable connectors on the front panel of the monitor and on terminals on the Signal Input Relay Module. These connectors can be used to connect external equipment to the monitor. The buffered output signal is in the same units as the LCD display for that channel. For example, if a channel is displaying velocity units then the corresponding buffered output will be in velocity units. The buffered output can also be configured to output the filtered or unfiltered signal on a channel for which filters have been configured, except for a channel which displays velocity and has the filters before the integrator/gain stage.

RECORDER OUTPUT - The monitor provides a recorder output for each channel. The recorder output is proportional to the measured acceleration or vibration signal over the monitor full scale range. The output range is user selectable to be 0 to -10 Vdc, +1 to +5 Vdc, or +4 to +20 mA.

The recorder clamping option, available when the +4 to +20 mA recorder output is selected, allows the user to choose the recorder output level used to annunciate a transducer not OK condition. With this option, the recorder output will clamp to either +2mA or +4mA (user selectable) when a transducer is not OK.

TRIP MULTIPLY - The Trip Multiply function multiplies setpoints by 2X or 3X in response to an external contact closure through terminals on the Power Input Module. When Trip Multiply is active, the **BYPASS** LEDs flash and the **TRIP MULTIPLY** LED on the System Monitor is on. The front panel meter and recorder outputs could saturate in this mode.

Setpoints beyond 1/3 to 1/2 of full scale may exceed OK limits when used with trip multiply.

SELF TEST - The monitor has three levels of self test: Cyclic, Power-up, and User-invoked.

Power-up self test is performed automatically each time the monitor power is turned on. A series of basic tests and transducer OK tests are performed.

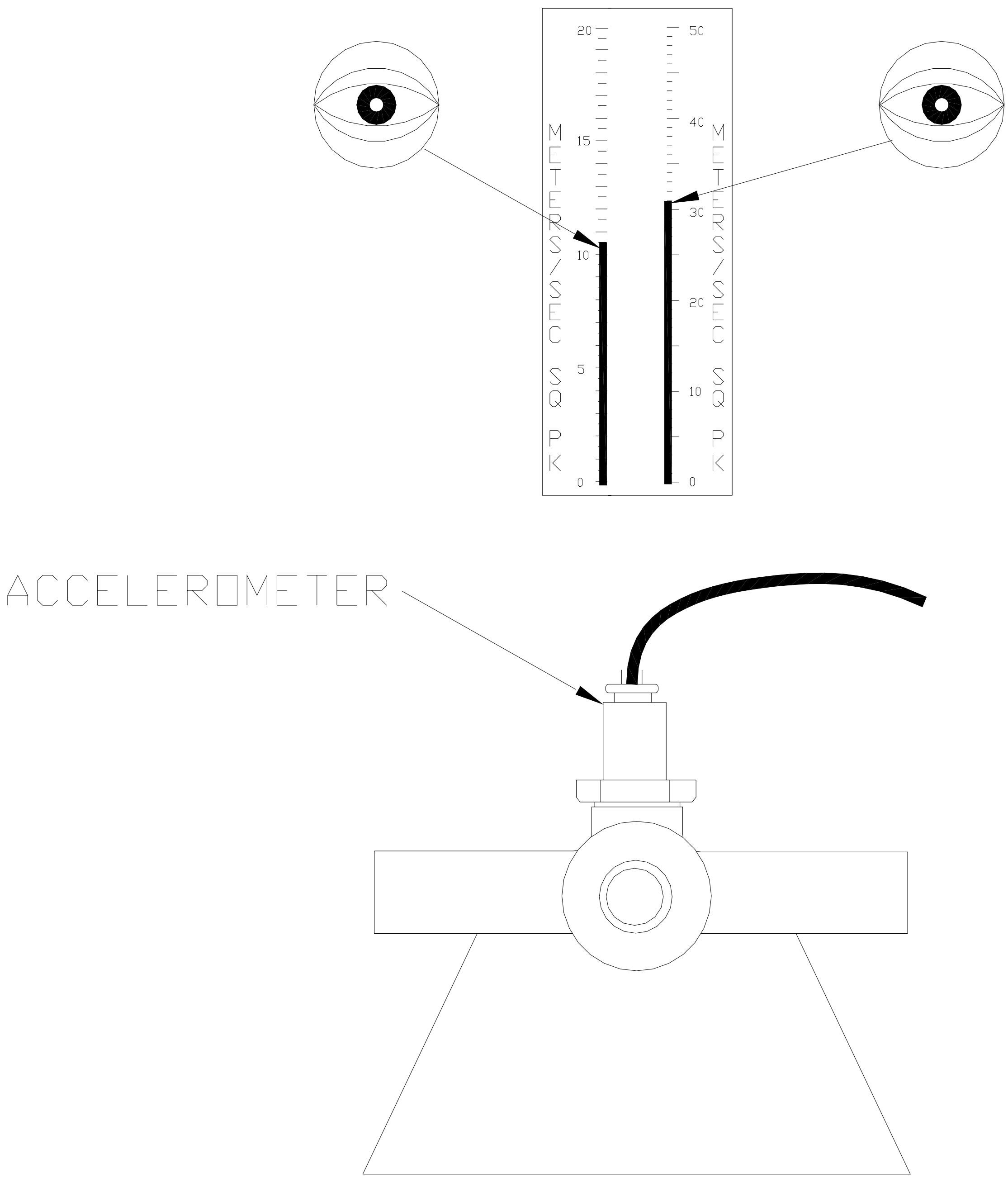
Cyclic self test is performed automatically during monitor operation. Errors encountered during cyclic tests disable the monitor and flash an error code on the LCD bargraph display. If the error is intermittent, the monitor will return to operation and the error codes will be stored for retrieval during User-invoked self tests. If the channel is OK, the monitor indicates that error codes have been stored by flashing the **OK** LED at 5 Hz.

User-invoked self test performs Power-up self test and lets you read and clear error messages that were stored during Cyclic self tests. Stored errors are annunciated by the **OK** LEDs flashing at 5 Hz and the error codes displayed on the front panel LCD bargraph.

Refer to the Self Test section in this manual for further details.

ERROR CODES - Error codes are displayed on the Monitor's LCD display. The error code display is distinguished from normal monitor operations by a fragmented scale representation. Refer to the Self Test and Error Codes sections of this manual for more details.

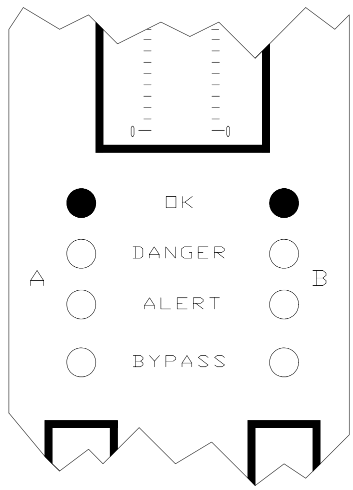
The monitor continuously indicates acceleration or velocity for Channels A and B.


20
15
10
5
0
50
40
30
20
10
0
METERS/SEC SQ PK
METERS/SEC SQ PK
ACCELEROMETER

3. LED Functionality

3.1 OK LEDs

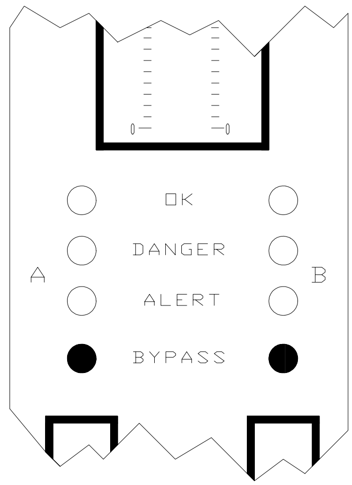
●	ON
○	OFF
◉	BLINK



LED DISPLAY A B	CONDITION	OK RELAY DRIVE*
● OK ●	Channel A and B are in operating range.	ON
○ OK ● ● OK ○	If a channel's **OK** LED goes off, that channel is not OK, has been latched not OK, or is bypassed.	OFF**
○ OK ○	The monitor is in self test, or both channels are not OK or bypassed. If an error code is displayed refer to the Error Code section in this manual.	OFF**
◉ OK ◉	An LED flashing at 5 Hz indicates that an error was encountered during Cyclic self test. Self Test, Section 16, describes how to read error messages.	ON
◉ OK ◉ ◉ OK ● ● OK ◉	An LED flashing at 1 Hz indicates that the channel's transducer has been not OK since the last reset. (This occurs only if Timed OK/Channel Defeat is selected).	ON

3.2 Bypass LEDs

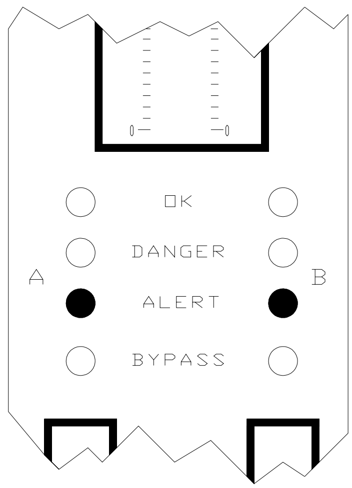
●	ON
○	OFF
◉	BLINK



LED DISPLAY A B	CONDITION
● BYPASS ●	The monitor is in the Danger Bypass mode. The system is in the Power-Up mode. User invoked Self Test is in progress. Timed OK/Channel Defeat is active. Both channels are bypassed. Rack Inhibit contacts at the back of the rack closed.
○ BYPASS ● ● BYPASS ○	If a channel's **BYPASS** LED comes on, that channel is bypassed, or Timed OK/Channel Defeat is active.
◉ BYPASS ◉ ◉ BYPASS ● ● BYPASS ◉	If one or both **BYPASS** LEDs are flashing, Trip Multiply is active. If only one LED is flashing, the other channel has the flashing overridden by: Channel bypass, or Timed OK/Channel Defeat, or Danger Bypass

3.3 Alert LEDs

●	ON
○	OFF
◉	BLINK

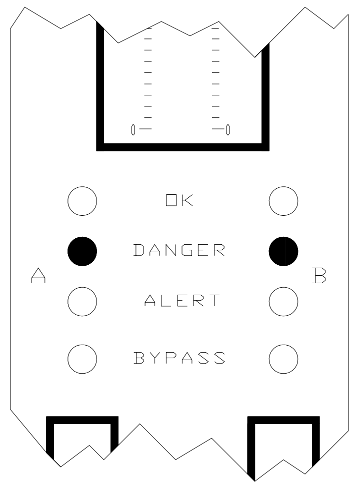


LED DISPLAY A B	CONDITION	ALERT RELAY DRIVE
● ALERT ○ ○ ALERT ● ● ALERT ●	If a channel **ALERT** LED comes on, that channel has exceeded its Alert setpoint level. Read Setpoint Levels, Section 5, describes how to read alarm setpoint levels.	ON
○ ALERT ◉ ◉ ALERT ○	A flashing **ALERT** LED indicates that the channel was the first in the rack to exceed its Alert setpoint since the last power up or reset. If two channel alert alarms occur within 50 milliseconds, both LEDs could flash.	ON

NOTE: The monitor will not annunciate an alert condition if the monitor is in the nonlatching mode and an alert condition existed but is no longer present.

3.4 Danger LEDs

●	ON
○	OFF
◉	BLINK



LED DISPLAY A		LED DISPLAY B	CONDITION	DANGER RELAY DRIVE OR Voting	DANGER RELAY DRIVE AND Voting *
●	DANGER	○	If a channel's **DANGER** LED comes on, that channel has exceeded its Danger setpoint level. Section 5 describes how to read setpoint levels.	ON	OFF
○	DANGER	●		ON	OFF
●	DANGER	●		ON	ON
○	DANGER	◉	A flashing **DANGER** LED indicates that the channel was the first in the rack to exceed its Danger setpoint since the last power up or reset. Two channels may indicate first out following self test. If two channel danger alarms occur within 50 milliseconds, both LEDs could flash.	ON	OFF
◉	DANGER	○		ON	OFF

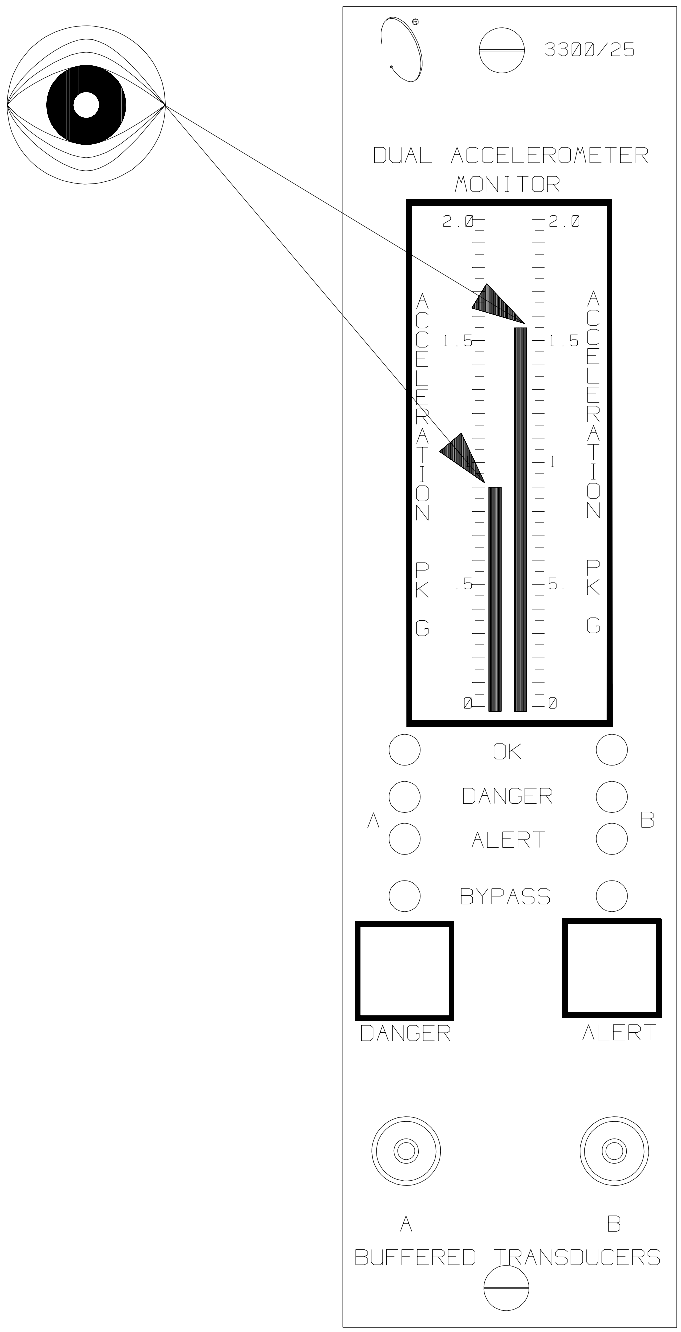
* If one channel in the monitor is bypassed or not OK and if the other channel then goes into Danger, the Danger relay will be activated.

NOTE: The monitor will not annunciate a danger condition if the monitor is in the nonlatching mode and a danger condition existed but is no longer present.

4. Read Channel Values

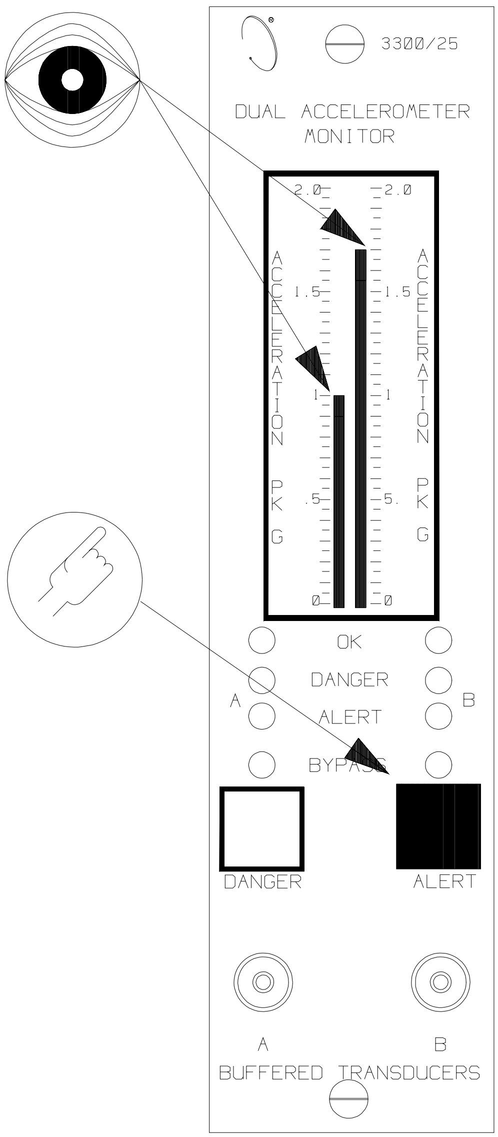
The monitor continuously indicates measured acceleration or velocity. The front panel below is indicating an acceleration of 0.9 g for channel A and 1.55 g for channel B.

Note: The meter scale units must be compatible with the full scale option configured in Section 18.6.

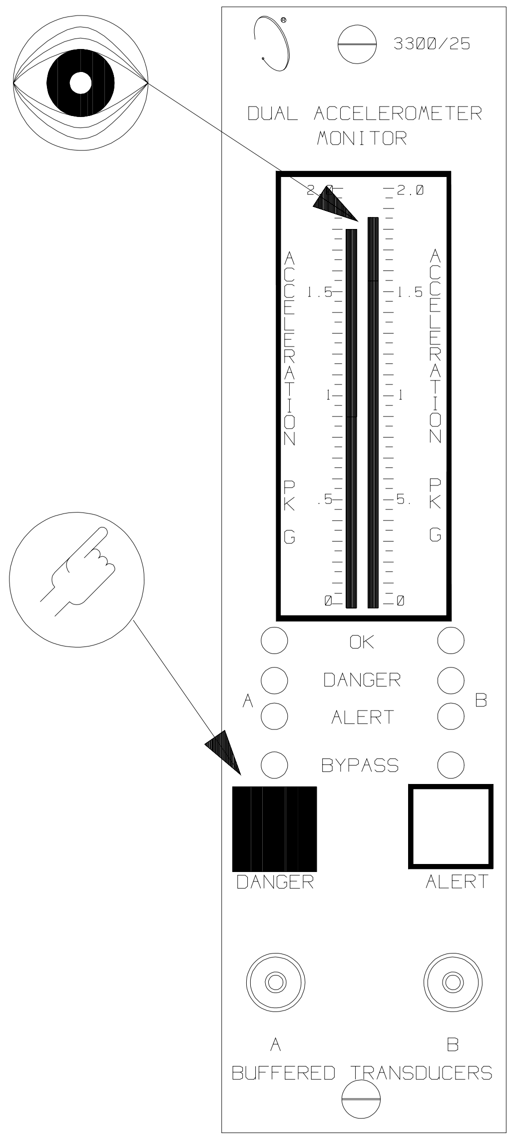


5. Read Setpoint Levels

Press the **ALERT** switch to read the Alert setpoints for both channel A and channel B on the meter scale. This example has an Alert setpoint of 1 g for channel A and 1.7 g for channel B.



Press the **DANGER** switch and read the Danger setpoints for both channel A and channel B on the meter scale. This example shows a Danger setpoint of 1.8 g for channel A and 1.85 g for channel B.



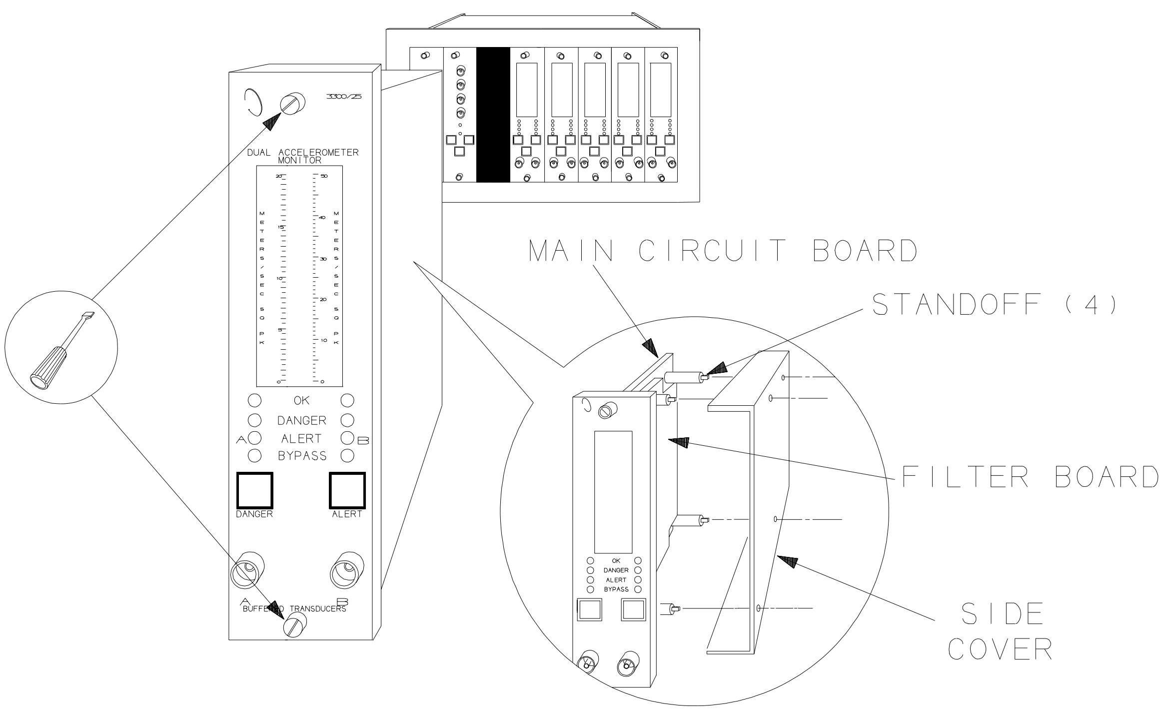
6. Monitor Removal and Disassembly

Caution

Improper rack operation may occur.

Power down rack or inhibit rack alarms when installing or removing a monitor.

- Loosen two monitor retaining screws on the front of the monitor.
- Pull the monitor from the rack.
- Remove side cover by pinching the protruding tip on each standoff.

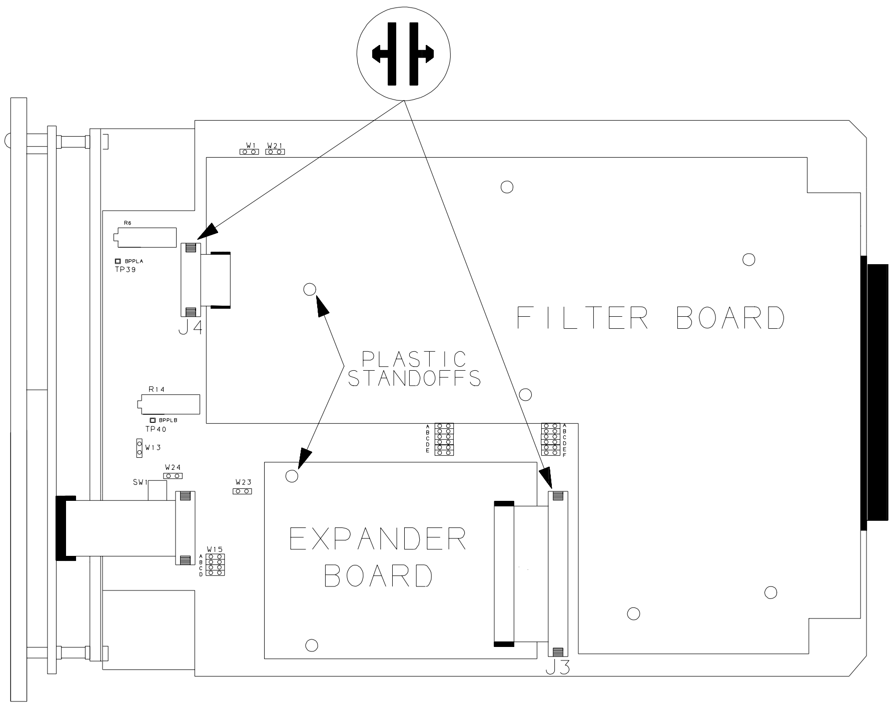


7. Monitor Disassembly

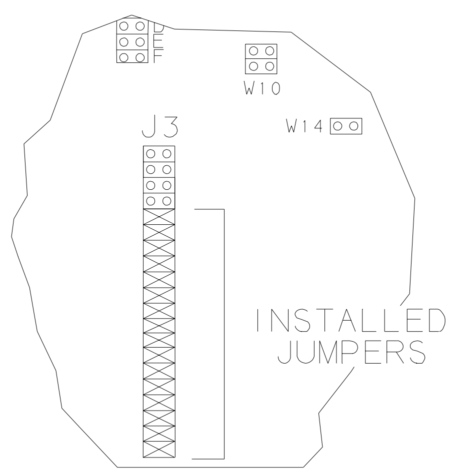
7.1 Filter and Expander Board Removal

Caution

Component damage may result from removing the filter or expander board while power is on.



Not all Dual Accelerometer Monitors contain the Expander Board. If this board does not exist, its functionality has been incorporated into the main board and connector J3 must be jumpered as shown



Caution

Component damage may result from removing the filter or expander board while power is on.

When performing the following instructions, refer to the drawing on the previous pages.

7.1.1 Filter Board Removal

1. Disconnect J4 by pressing the connector latches outward.
2. Release all six plastic standoffs by squeezing the retaining clip while gently pulling the filter board slightly away from the main board.
3. Remove the filter board.

7.1.2 Expander Board Removal

1. Disconnect J3 by pressing the connector latches outward.
2. Release all three plastic standoffs by squeezing the retaining clip while gently pulling the expander board slightly away from the main board.

NOTE: The third standoff is under the ribbon cable to the right of the expander board.

3. Remove the expander board.

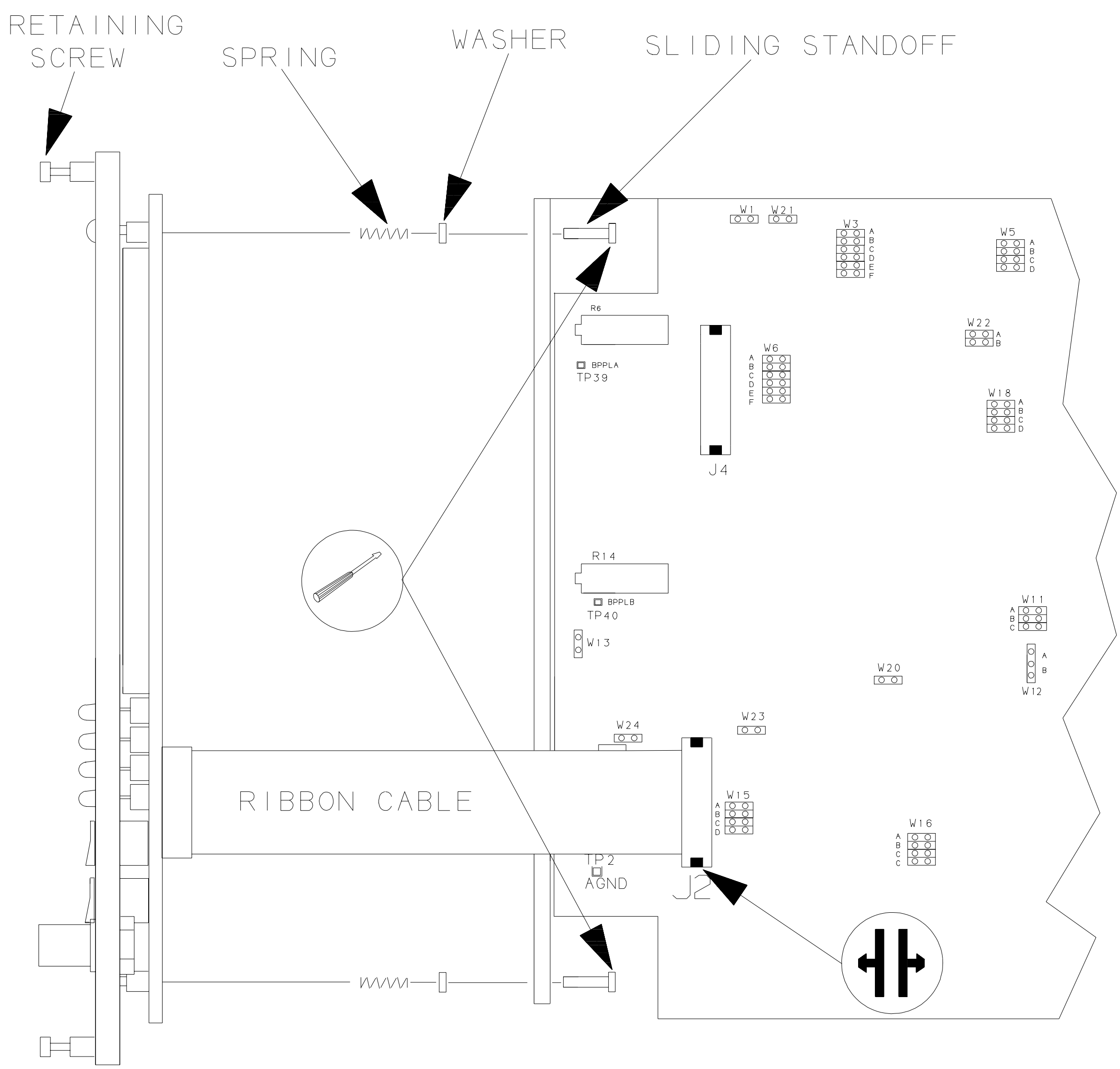
7.2 Front Panel Removal

Caution

Component damage may result from removing the filter or expander board while power is on.

1. Disconnect J2 by pressing the connector latches outward.

2. Unscrew two sliding standoffs.



7.3 Signal Input Relay Module Removal

WARNING

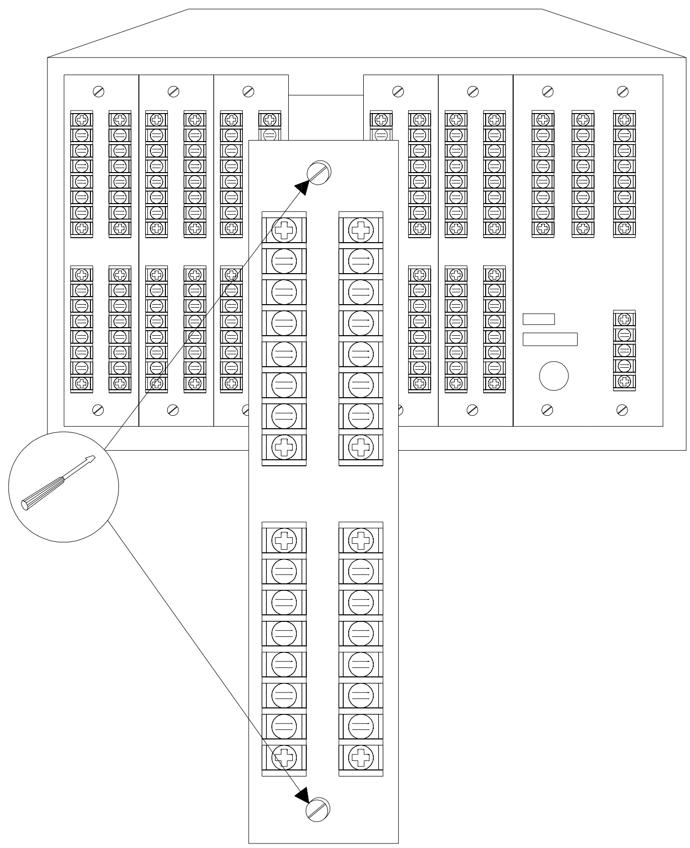
High voltage present. Contact could cause shock, burns, or death.

Do not touch exposed wires or terminals.

Caution

Machine protection provided by this monitor will be lost while the Signal Input Relay Module is removed from the rack.

The Signal Input Relay Module is on the back of the rack. For relay configuration, see the System Installation Instructions manual. For field wiring, refer to 3300/25 Field Wiring Diagram Packet.

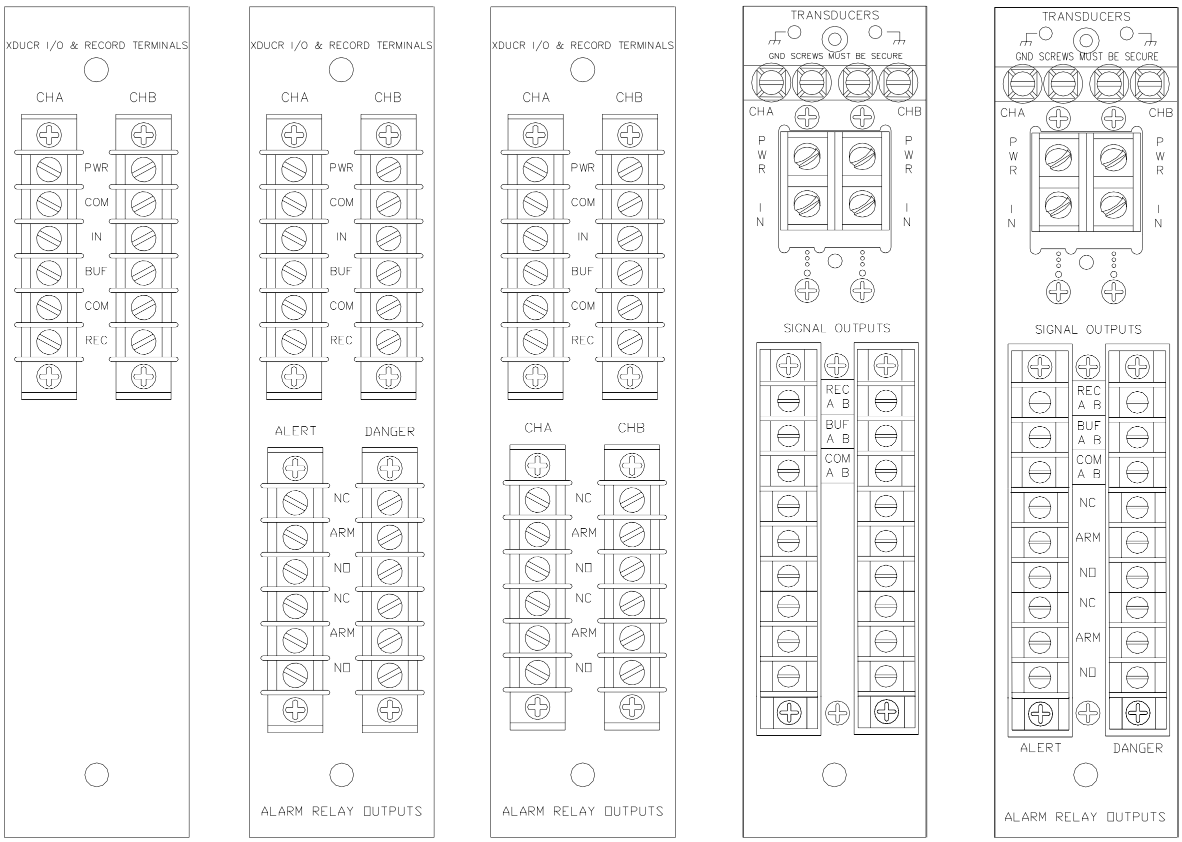


Module Removal

Loosen two screws and remove the module.

7.4 Signal Input Relay Modules (SIRM)

A monitor can be configured with the Signal Input Relay Modules shown below. Refer to options EE & FF in Monitor Ordering Options, Section 8.2 of this manual.



NO ALARM RELAYS	DUAL ALARM RELAYS	QUAD ALARM RELAYS	INTERNAL BARRIERS NO RELAYS	INTERNAL BARRIERS DUAL RELAYS

7.5 No Relay and Dual Relay SIRM

WARNING

High voltage present. Contact could cause shock, burns, or death.

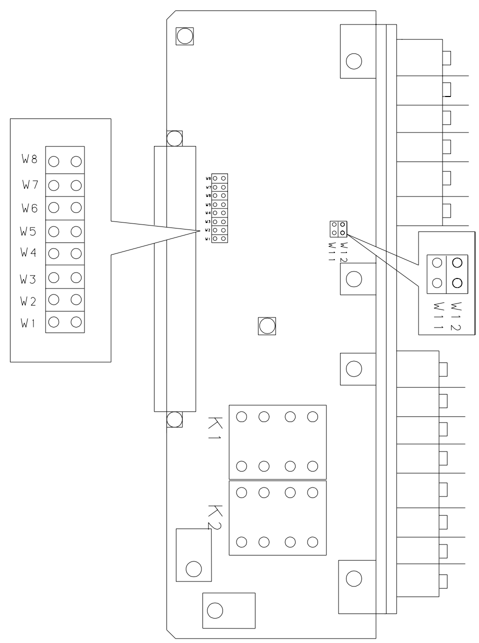
Do not touch exposed wires or terminals.

NOTE: For relay configuration of monitors with Internal Safety Barriers, refer to 3300 Internal Barriers, Installation

Remove the Signal Input Relay Module from the rack before changing option jumpers.

The entire configuration table applies to the Dual Relay SIRM.

ALERT RELAYS	JUMPERS	
	INSTALL	**REMOVE**
Normally Energized	W3	W4, W11
Normally De-	W4, W11	W3
DANGER RELAYS		
Normally Energized	W2	W1, W12
Normally De-	W1, W12	W2
OR Bus		
No Options*	-----------	W5-W8
Alert & Danger Bus 1	W6,W8	W5,W7
Alert & Danger Bus 2	W5,W7	W6,W8



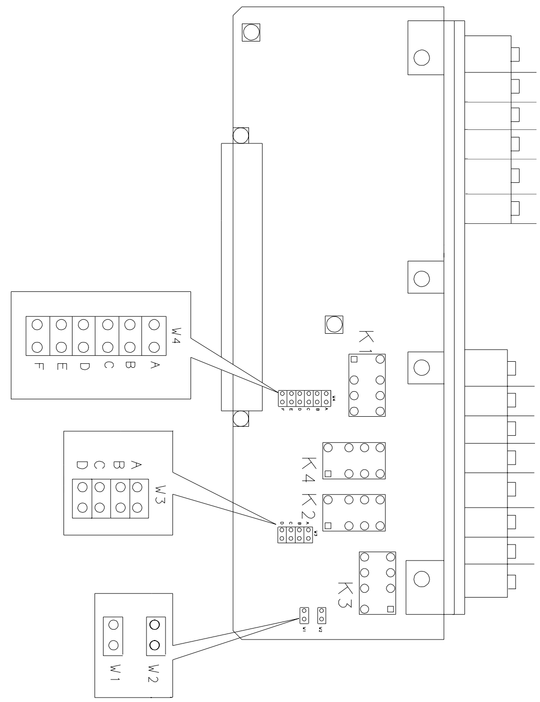
NOTE: * Denotes standard configuration.

7.6 Quad Relay Signal Input Module Options

WARNING

High voltage present. Contact could cause shock, burns, or death.

Do not touch exposed wires or terminals.



Remove the Signal Input Relay Module from the rack before changing option jumpers.

Note: AND voting logic must be done externally by wiring the contacts in series. The OR bus option is not available with quad relays. See 3300 System Installation Instructions.

ALERT RELAYS	JUMPERS	
	INSTALL	REMOVE
Normally Energized	W3A,W4C	W2, W3C, W3D, W4D
Normally De-energized*	W2, W3C, W3D, W4D	W3A, W4C
DANGER RELAYS		
Normally Energized	W4B, W4F	W1, W3B, W4A, W4E
Normally De-energized*	W1, W3B, W4A, W4E	W4B, W4F

NOTE: * Denotes standard configuration.

7.7 Internal Barrier Options SIRM

For relay configuration of monitors with internal safety barriers, refer to the 3300 Internal Barriers, Installation Manual (88837) or the 3300 System Installation Instructions (80172).

The Alert Relays and Danger Relays sections of the table below do not apply to the No Relay SIRM. Only the OR Bus section of the table below applies to the No Relay SIM.

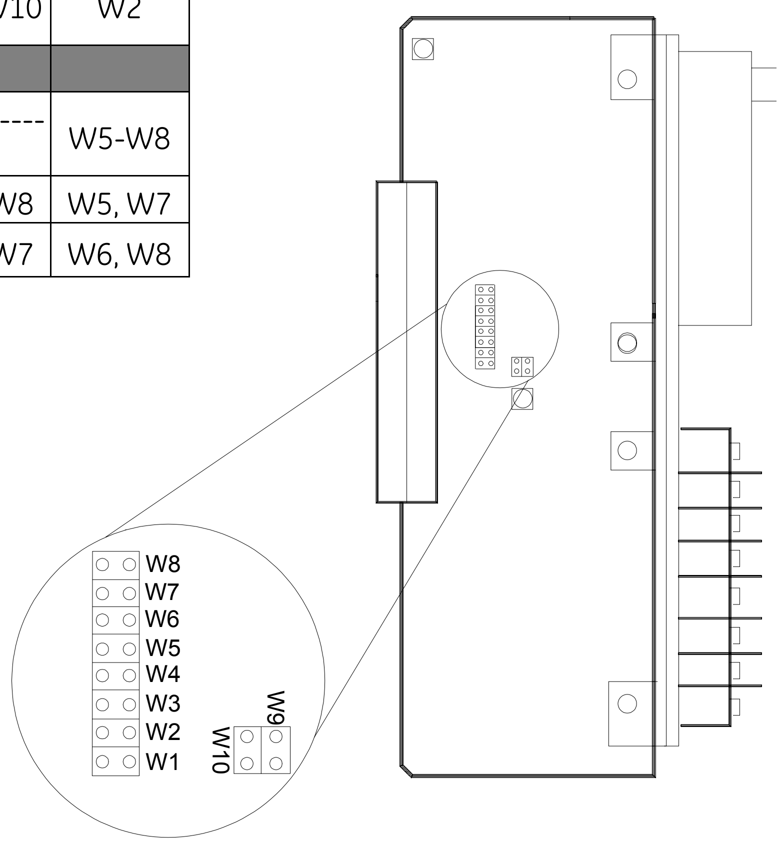
Dual Relay with Internal Barrier Options		
Alert Relays	Jumper In	Out
Normally Energized	W3	W4, W9
Normally De-energized*	W4, W9	W3
Danger Relays	Jumper In	Out
Normally Energized	W2	W1, W10
Normally De-energized*	W1, W10	W2
OR Bus		
No Options*	------------	W5-W8
Alert & Danger Bus 1	W6, W8	W5, W7
Alert & Danger Bus 2	W5, W7	W6, W8

WARNING

High voltage present. Contact could cause shock, burns, or death.

Do not touch exposed wires or terminals.

NOTE: * Denotes standard configuration.



8. Monitor Options

8.1 Field Programmable Options

First Out Enabled * Disabled	Alert Mode Latching * Nonlatching	Timed OK/Channel Defeat ** Enabled * Disabled
Alarm Delays 0.1 Second 1 Second 3 Seconds * 6 Seconds	Danger Mode Latching * Nonlatching	Danger Relay Voting ++ OR voting for relay drive * AND voting for relay drive
OK Mode ** Latching Nonlatching *	Recorder Outputs +4 to +20 mA * +1 to +5 Vdc 0 to -10 Vdc	Danger Bypass Enabled Disabled *
	+4 to +20 mA Recorder NOT OK output (+2 mA clamp) + Enabled Disabled*	

The following options are **independently** selected for both channel A and channel B.

High-pass Filter None* 1 of 499 possible frequencies from 3.7 to 3008 Hz (222 to 180,480 cpm)	Low-pass Filter None* 1 of 384 possible frequencies from 24 to 22,372 Hz (1440 to 1,342,320 cpm) (**79562-01** and 105521-01 filter boards) 1 of 433 possible frequencies from 23 to 22,441 Hz (1,380 to 1,346,460 cpm) (148921-01 filter board)
Buffered Transducer Filtering *** No Filtering * Filtered	Integrator/Filter Positioning Filter **before** Integrator/gain stage. Filter **after** Integrator/gain stage. High-pass filter, then integrator/gain stage, then low-pass filter.

* Denotes standard configuration.

** Nonlatching OK Mode must be selected if Timed OK/Channel Defeat is enabled.

*** If a channel is displaying velocity and you want the buffered output to be unfiltered then the filter must be **after** the integrator/gain.

\+ Only available with main PWA 105513-xx **and** Timed/OK Channel Defeat **must** be enabled.

++ With Quad Relays, AND voting logic must be done externally by wiring contacts in series.

8.2 Monitor Ordering Options

AA	BB	CC
*TRANSDUCER INPUT, CHANNEL UNITS	CHANNEL A FULL SCALE RANGE	CHANNEL B FULL SCALE RANGE
01 Dual accelerometer inputs; both channels indicate in acceleration units.	**01** 0 to 2 g pk	**01** 0 to 2 g pk
	02 0 to 5 g pk	**02** 0 to 5 g pk
02 ** Dual accelerometer inputs; channel A indicates in acceleration units, channel B indicates in velocity units.	**03** 0 to 10 g pk	**03** 0 to 10 g pk
	04 0 to 20 g pk	**04** 0 to 20 g pk
03 ** Dual accelerometer inputs; both channels indicate in velocity units.	**05** 0 to 1 in/s pk	**05** 0 to 1 in/s pk
	06 0 to 2 in/s pk	**06** 0 to 2 in/s pk
04 Single accelerometer input; both channels indicate in acceleration units.	**11** 0 to 20 m/s^2 pk	**11** 0 to 20 m/s^2 pk
	12 0 to 50 m/s^2 pk	**12** 0 to 50 m/s^2 pk
05 ** Single accelerometer input; channel A indicates in acceleration units, channel B indicates in velocity units.	**13** 0 to 100 m/s^2 pk	**13** 0 to 100 m/s^2 pk
	14 0 to 200 m/s^2 pk	**14** 0 to 200 m/s^2 pk
06 ** Single accelerometer input; both channels indicate in velocity units.	**15** 0 to 25 mm/s pk	**15** 0 to 25 mm/s pk
	16 0 to 50 mm/s pk	**16** 0 to 50 mm/s pk
	17 0 to 100 mm/s pk	**17** 0 to 100 mm/s pk

*This monitor is designed for accelerometer inputs of 100 mV/g ($10mV/m/sec^2$).

****** When integrated, low frequency signals can cause the monitor to saturate.

Monitor Ordering Options (Continued)

DD	EE	FF	GG
AGENCY APPROVAL	BARRIERS USED	ALARM RELAY	TRIP MULTIPLY
00 None **01** CSA/NRTL/C **02** BASEEFA	**00** None **01** External **02*** Internal	**00** None **01** Dual Relays, Epoxy Sealed **02** Dual Relays, Hermetically Sealed **03*** Quad relays, Epoxy Sealed	**00** None **01** 2X trip multiply **02** 3X trip multiply

*** Quad relays are not available with internal barriers.**

9. Meter Scale Replacement

The monitor meter scales can be replaced for operation with different full scale ranges. The replacement meter scales are located in the back of this manual.

1. Set the monitor full scale range. (See the Appendix A, Main Board Options.)

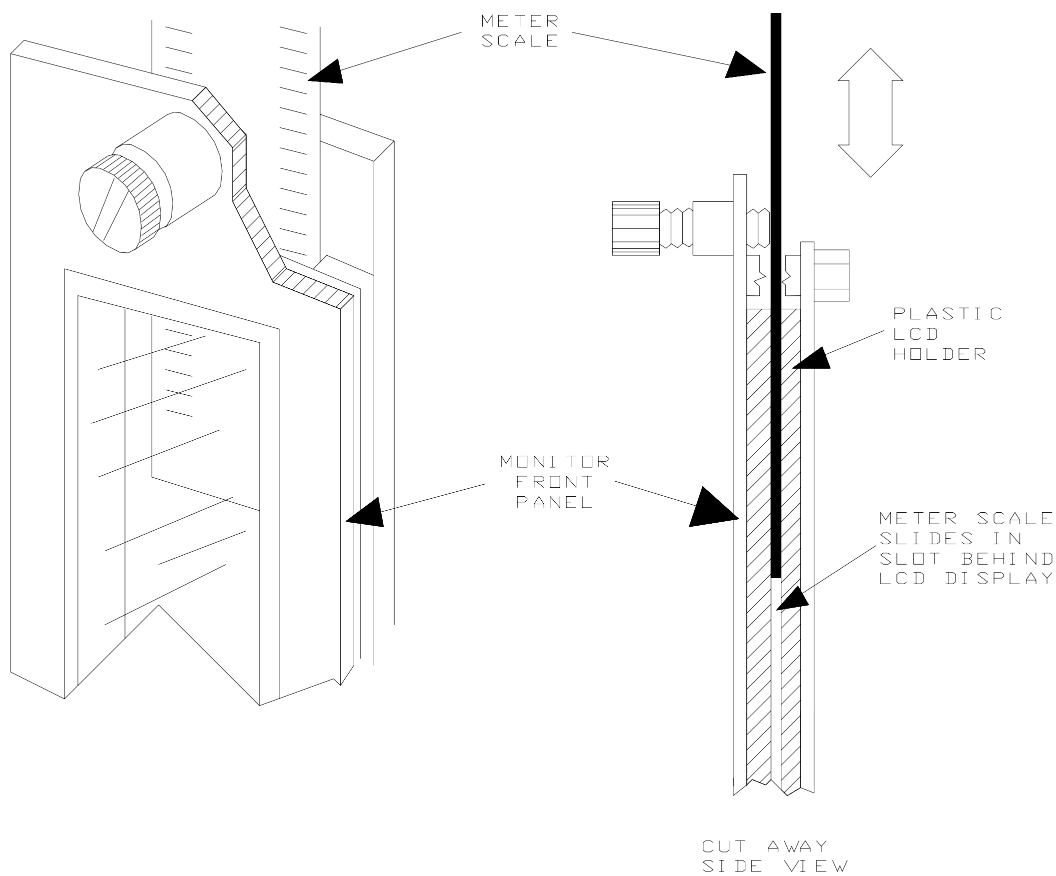
2. Cut the meter scale from the back of this manual. Be sure to cut along the marked outline so the meter scale will fit properly.

3. Open the front panel by loosening the two monitor retaining screws and sliding the front panel to the right.

4. Remove the old meter scale.

5. Insert the new meter scale in the front panel.

6. Close the front panel.

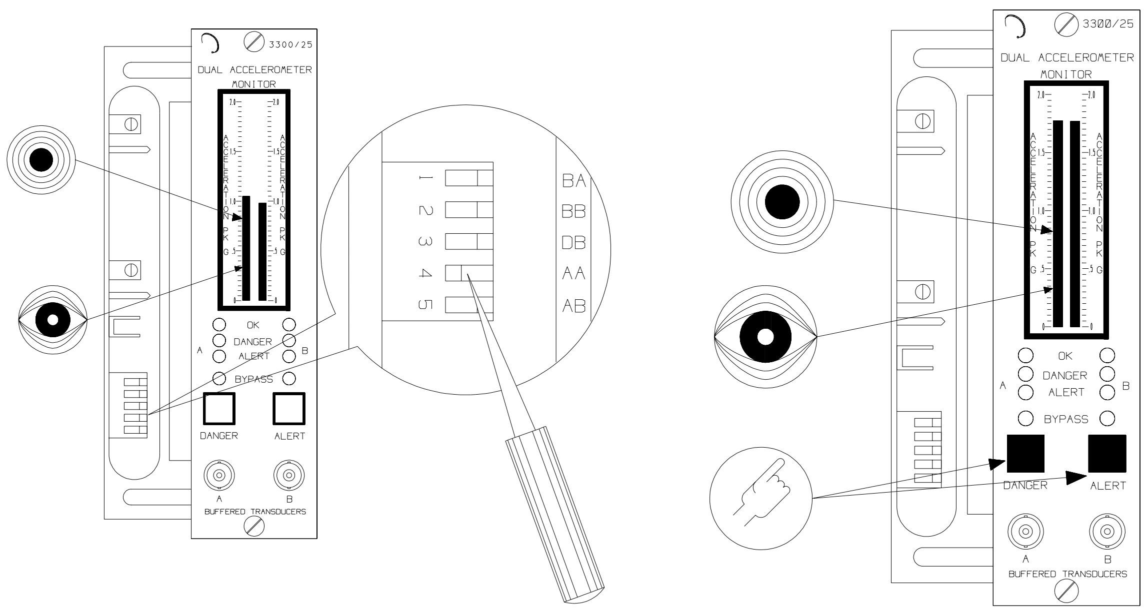


10. Alarm Setpoint Adjustment

Setpoints cannot be adjusted if trip multiply is installed and active. Trip multiply is active when the trip multiply contacts are closed.

1. Open the front panel by loosening the two monitor retaining screws and sliding the front panel to the right.

2. Select the channel to be adjusted by setting either switch **AA** (Adjust channel **A**) or **AB** (Adjust channel **B**) to the left (ON). The selected bargraph will start flashing.



3. To adjust the Alert or Danger setpoints, press and hold the **ALERT** or **DANGER** button on front panel and then press the (↑) or (↓) buttons on the System Monitor to adjust setpoint value up or down.

4. Reset the selected channel adjust **AA** or **AB** switches to the right (OFF).

NOTE: The monitor responds to the previous setpoint until the option adjust switch is turned off.

11. Channel Bypass

Caution

Machine protection provided by this monitor will be lost while Channel Bypass is on.

You can use Channel Bypass to take a Not OK or unconnected channel off line. This will restore the OK Relay to the OK state. The OK Relay will de-energize (go Not OK) if any channel in the rack is in a Not OK condition.

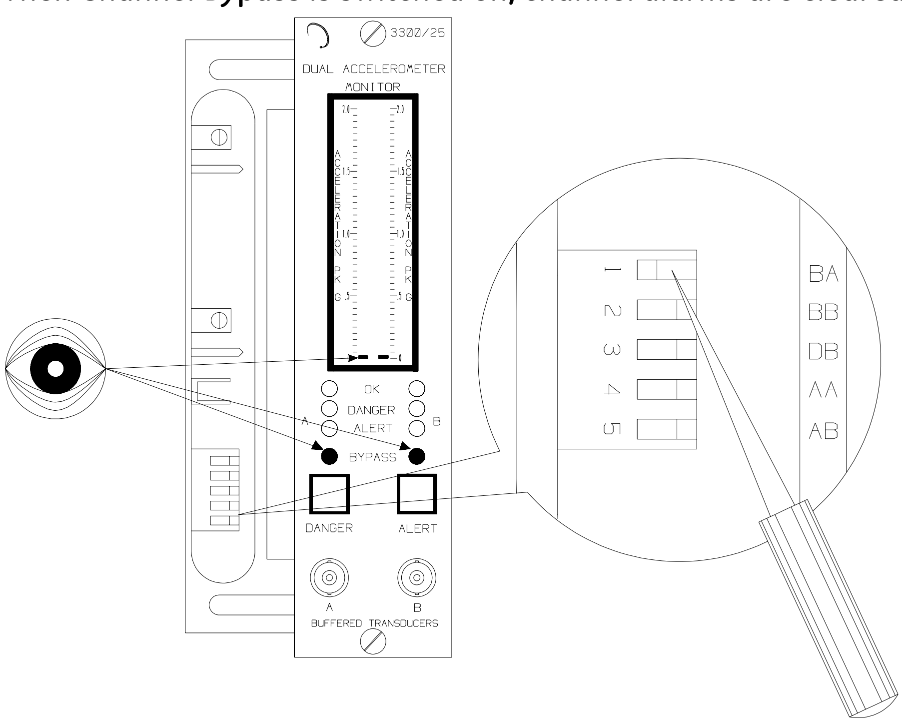
1. Open the front panel by loosening the two monitor retaining screws and sliding the front panel to the right.

2. Set **BA** (**B**ypass Channel **A**) or **BB** (**B**ypass Channel **B**) switch to the left (ON). The corresponding **BYPASS** LED comes on, the **OK** LED goes off, and the channel reading is clamped to zero.

3. Close the front panel.

NOTE

When Channel Bypass is switched on, channel alarms are cleared.



12. Danger Bypass

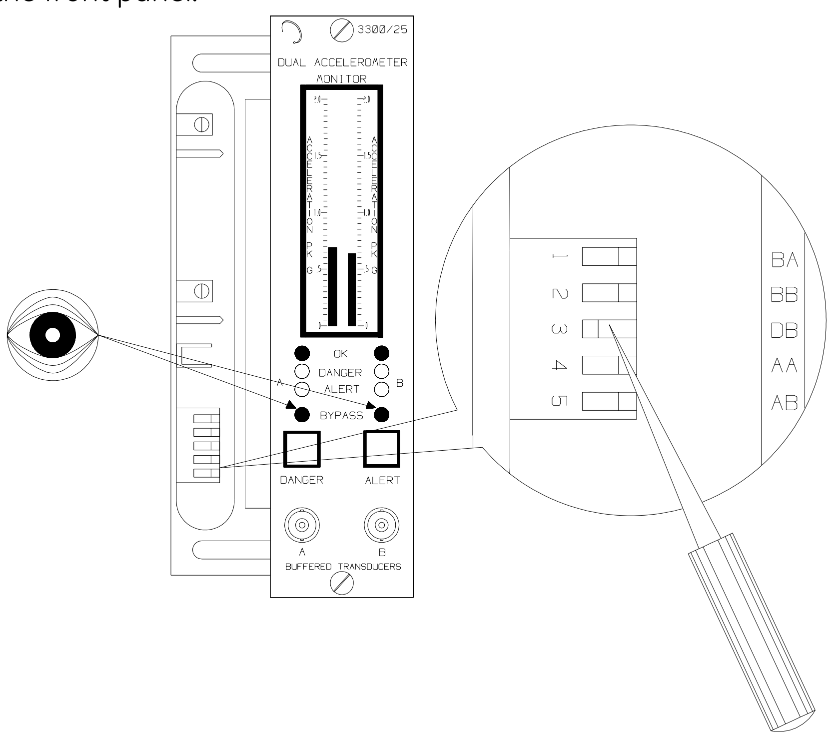
Caution

Machine protection provided by this monitor will be lost while Danger Bypass is on.

1. Open the front panel by loosening the two monitor retaining screws and sliding the front panel to the right.

2. Set **DB** (**D**anger **B**ypass) switch to the left (ON). Both channel **BYPASS** LEDs come on. The **DANGER** LEDs on the front panel can come on, but the danger relay drive will not be activated if a Danger setpoint is exceeded. The Danger Bypass switch can only be turned on if Danger Bypass is enabled. To enable the Danger Bypass switch refer to the Setting Field Programmable Options section of this manual.

3. Close the front panel.



13. Test Alarms

Use this procedure to test the alarm setpoints that you set in the Alarm Setpoint Procedure Section. The test uses a function generator to exceed the setpoint levels so that you can verify that the appropriate LEDs come on.

Use this procedure to test the alarms for both channels.

Testing the channel alarms involves these main steps:

- Connect and adjust the test instruments
- Test the Alert setpoint level
- Test the Danger setpoint level
- Prepare to bring the monitor on line

NOTE: If your monitor is configured for a single transducer input then you should bypass the channel which is not under test (see Section 11) so that you can verify that the channel under test is controlling the relays. Be sure to remove Channel Bypass at the end of this procedure.

13.1 Connect and Adjust the Test Instruments

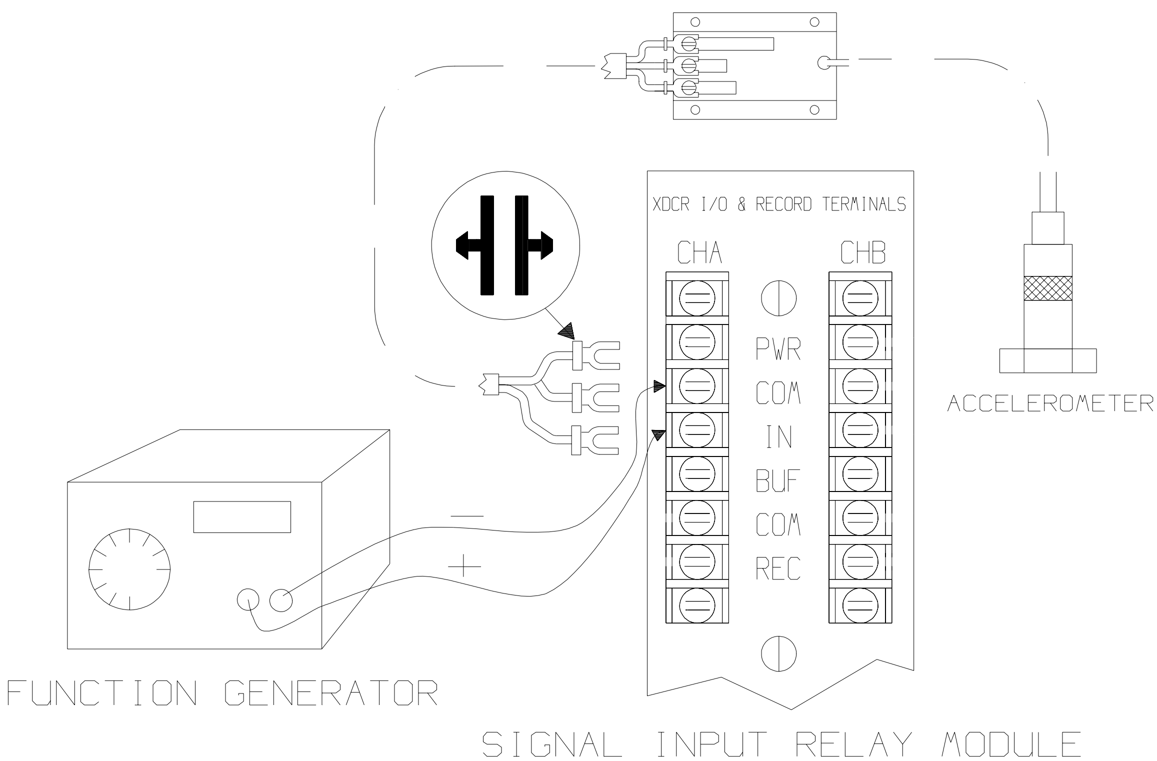
WARNING

High voltage present. Contact could cause shock, burns, or death.

Do not touch exposed wires or terminals.

Caution

Tests will exceed alarm setpoint levels causing alarms to activate. This could result in relay contacts changing state. See Danger Bypass, Section 12.



1. Disconnect all transducer wiring from the channel A terminals on the Signal input Relay Module.
2. Connect the function generator as shown in the figure above.

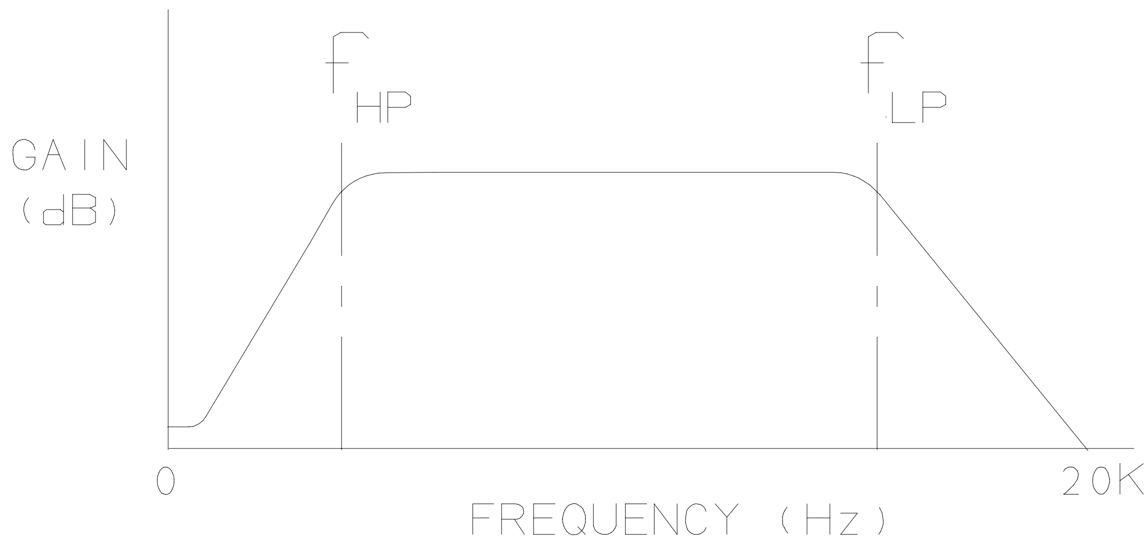
3. Adjust the input frequency of the function generator according to this equation:

$$\text{frequency} = \sqrt{(f_{HP} \times f_{LP})}$$

where:

f_{HP} = high-pass corner frequency.

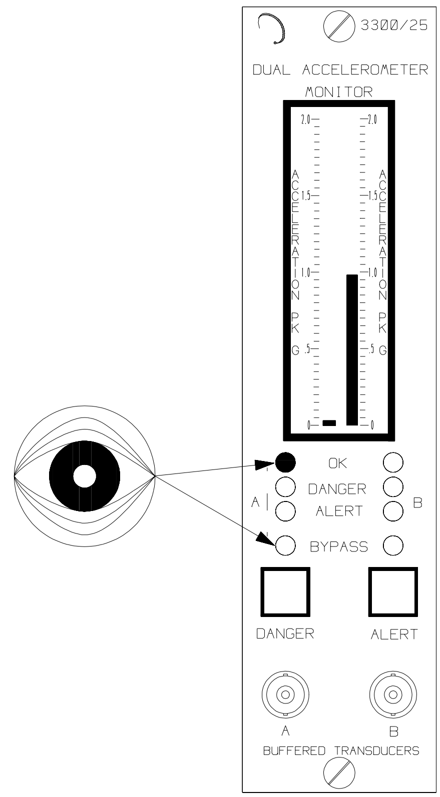
f_{LP} = low-pass corner frequency.



If you use..	then use these values to calculate the input frequency
low-pass filter only	f_{HP} = 240 CPM (4 Hz) *
high-pass filter only	f_{LP} = 1,200,000 CPM (20 kHz) *
no filters	input frequency = 6000 CPM (100 Hz)

* The values listed here for f_{HP} and f_{LP} are for calculating the function generator frequency only. They should not be used to configure the filter board.

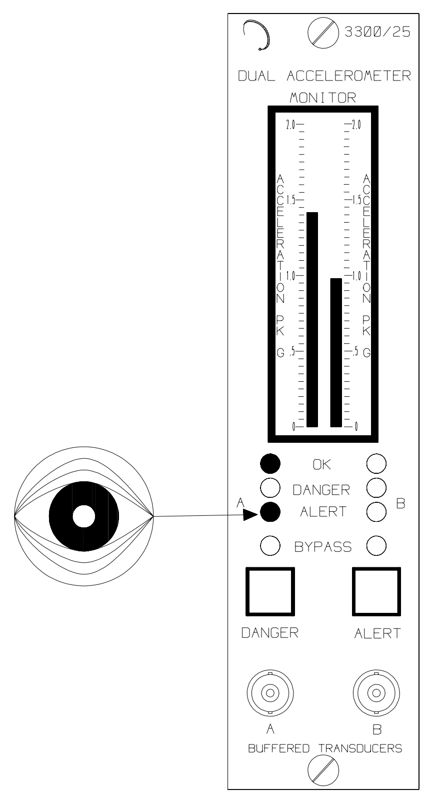
13.2 Test the Alert Setpoint Level



1. Adjust the function generator DC offset to -7.5 Vdc.

2. Wait 30 seconds for the completion of the Timed OK/Channel Defeat delay, then press the RESET switch on the System Monitor. Verify that the channel's OK LED is on and the ALERT, DANGER, and BYPASS LEDs are off.

3. Adjust the amplitude of the function generator sine wave so that the reading on the monitor front panel is below the alarm setpoint.

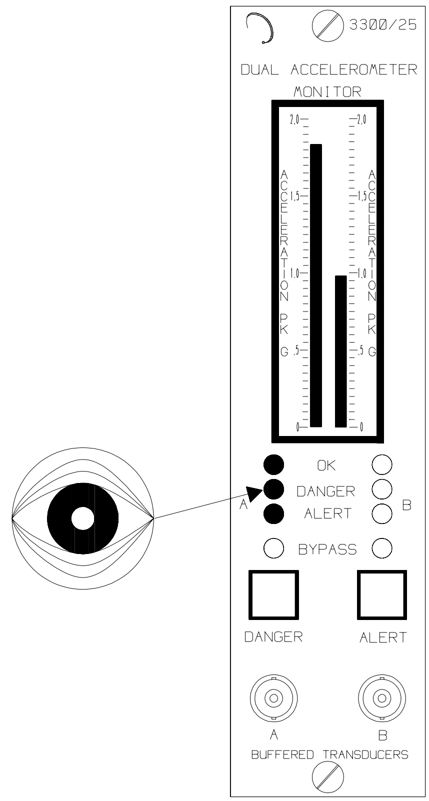


4. Adjust the function generator amplitude past the Alert setpoint level and verify that the **ALERT** LED comes on (flashing if the First Out option is selected).

5. Verify that the Alert relay changed state.

6. Press the **RESET** switch on the System Monitor and verify that the **ALERT** LED remains on steady.

13.3 Test the Danger Setpoint Level



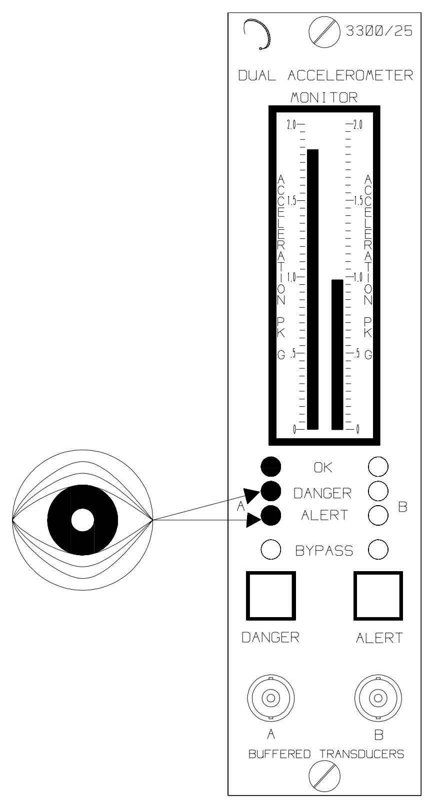
1. Adjust the function generator amplitude past the Danger setpoint level and verify that the **DANGER** LED comes on (flashing if the First Out option is selected).

2. Verify that the Danger Relay changed state.

NOTE: The Danger Relay will not change state if:

- Danger Bypass is on
- Danger AND voting logic is selected and only one channel exceeds its setpoint.

AND voting is not active if either channel is bypassed or not OK.



3. Press the **RESET** switch on the System Monitor.

4. Verify that the **ALERT** and **DANGER** LEDs remain on and steady.

13.4 Prepare to Bring the Monitor On Line

1. Reduce the function generator amplitude to below the alarm setpoints and observe that the **ALERT** and **DANGER** LEDs go off (if nonlatching alarm jumpers are installed).

2. Press the **RESET** switch on the System Monitor to reset latching alarms.

3. If Monitor Trip Multiply option (GG) is 01 or 02 (see Section 8.2), repeat this test with Trip Multiply activated. (See **Trip Multiply** Monitor Functions, Section 2). Alarm setpoint levels are multiplied by 2X or 3X when Trip Multiply is activated.

4. Disconnect the function generator and reconnect the transducer to channel A in accordance with the field wiring diagrams at the end of this manual. Verify that the **OK** LED comes on and the OK Relay energizes (if nonlatching OK mode is selected). Press the **RESET** switch on the System Monitor to reset latching not OKs.

5. If Danger Bypass or Channel Bypass was turned on at the beginning of this test, turn it off before monitoring resumes. (See the Danger Bypass and Channel Bypass sections of this manual).

NOTE: For a Single Transducer Input repeat the test for Alert and Danger setpoints for the
channel B alarms.

14. Test OK Limits

WARNING

High voltage present. Contact could cause shock, burns, or death.

Do not touch exposed wires or terminals.

Caution

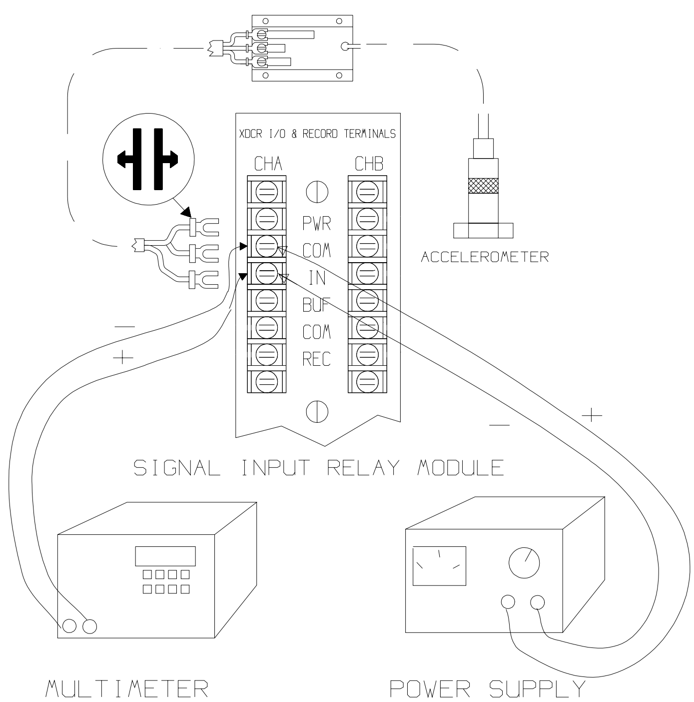
Tests will exceed alarm setpoint levels causing alarms to activate. This could result in relay contacts changing state. See Danger Bypass, Section 12.

Before bringing the monitor on line, use this procedure to check that the OK Limits for channels A and B are working properly. You will need a multimeter and a power supply.

NOTE: If your monitor is configured for a single transducer input then you should bypass the channel which is not under test (see section 11) so that you can verify that the channel under test is controlling the OK Relays. Be sure to remove Channel Bypass at the end of this procedure.

1. Disconnect Transducer input wiring from the channel A terminals on the Signal Input Relay Module.

2. Connect the multimeter and power supply as shown



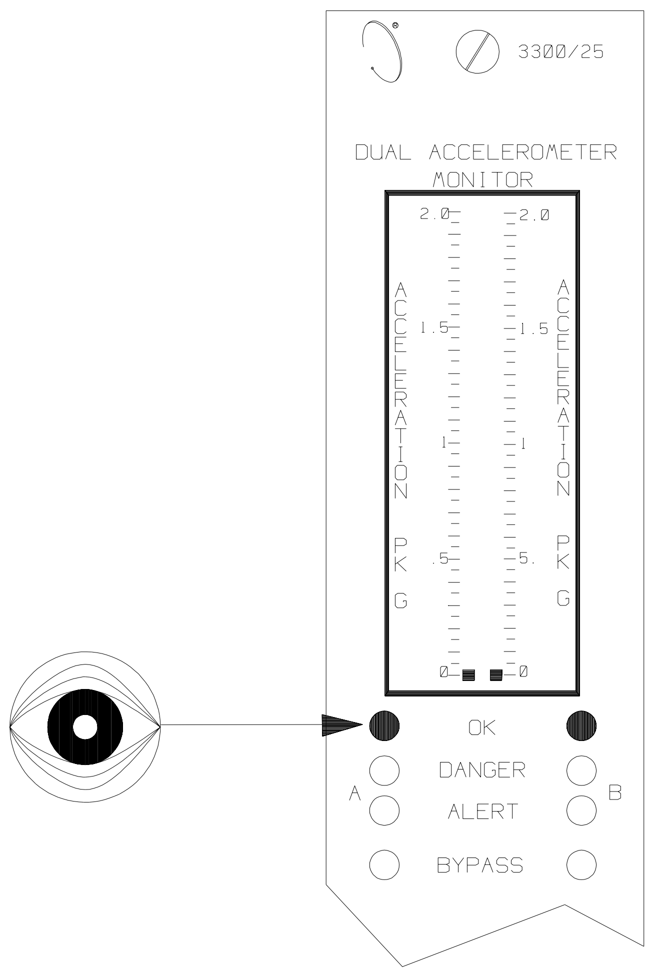
3. Adjust the power supply voltage for -7.5 Vdc with respect to common.

4. Wait 30 seconds for the completion of the Timed OK/Channel Defeat delay, then press the RESET switch on the System Monitor. Verify that the channel A OK LED is on.

5. Decrease the power supply voltage (more positive) until the OK LED goes off (lower limit). Verify that the lower OK limit is between -3.6 Vdc and -4.1 Vdc and that the OK Relay changes states (de-energized).

   Note: All other channels in the rack must be OK or bypassed in order for the relay to change states.

6. Return the power supply voltage to -7.5 Vdc and verify that the OK LED comes back on and the OK Relay energizes. If the not OK mode is latching it must be reset using the RESET button on the System Monitor. If Timed OK/Channel Defeat is enabled, the OK LED will be flashing when it comes on.



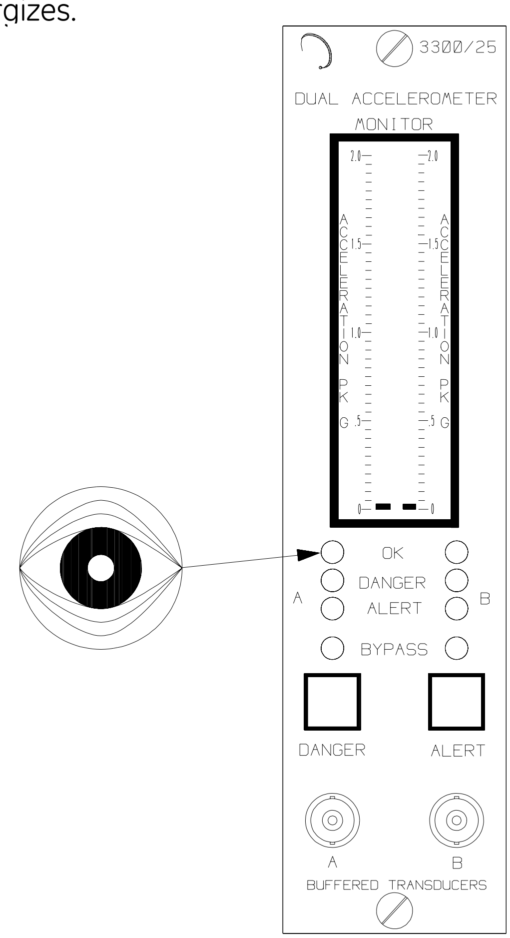
7. Gradually increase the power supply voltage (more negative) until the OK LED goes off (upper limit). Verify that the upper OK Limit is between -11.5 Vdc and -12.0 Vdc and that the OK Relay de-energizes.

8. Return the power supply voltage to -7.5 Vdc and verify that the OK LED comes back on and the OK Relay energizes.

9. For Dual Transducer Inputs, reconnect channel A wiring, and repeat the steps in this section for channel B.

10. For Single Transducer Input repeat steps 4 to 8 for channel B to test the channel B OK limits.

When finished, disconnect the power supply and multimeter and reconnect the wiring to the transducer input terminals on the Signal Input Relay Module. Verify that the OK LED comes on and the OK Relay energizes.



15. Calibrate Channels

Before you begin Channel Calibration, you must choose the full scale range and set the appropriate jumpers (See Section 18.6). Calibrate both channels of your monitor. To calibrate channels you will need these instruments and tools

- multimeter
- function generator
- screwdriver

Use this procedure to calibrate both channels.

Calibrating a channel involves these main steps:

- Set the filter option to No Filters
- Connect and adjust the test instruments
- Calibrate the channels
- Prepare to bring the monitor on line

15.1 Set the Filter Option to No Filters

NOTE: This procedure may alter your filter configuration.

WARNING

High voltage present. Contact could cause shock, burns, or death.

Do not touch exposed wires or terminals.

Caution

Tests will exceed alarm setpoint levels causing alarms to activate. This could result in relay contacts changing state. See the Danger Bypass section.

1. Disconnect the transducer input wiring from the channel A terminals on the Signal Input Relay Module. (Note: For a single transducer input the field wiring connects to the channel A field terminals. Therefore this step does not need to be repeated to calibrate channel B.)

2. Remove the monitor from the rack and disassemble it to allow access to the options on both the Main and Filter boards.

3. Remove the following jumpers from the filter board (PWA 105521-01 or 79562-01 or 148921-01):
   Channel A: W37, W78, W79, W83, W84
   Channel B: W41, W60, W61, W85, W86

4. Remove the following jumpers from the main board (PWA 105513-XX or 79552-XX):

   Channel A: W6D, W6F, W18A
   Channel B: W3A, W3C, W5A

5. Install the following jumpers on the main board (PWA 105513-XX or 79552-XX):

   Channel A: W6E, W18B, W18C
   Channel B: W3B, W5B, W5C

6. Reassemble the monitor and install it into the rack. Do not secure the front panel.

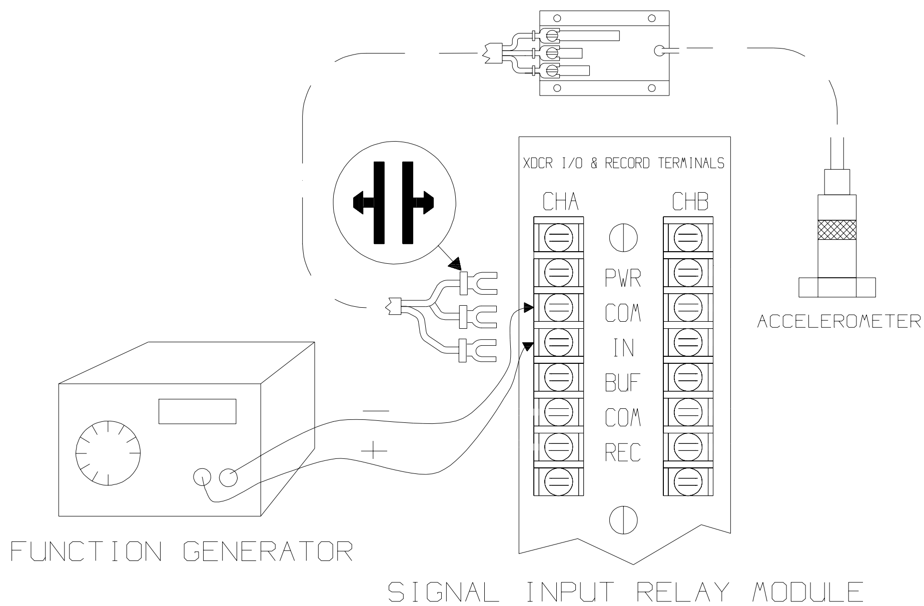
15.2 Connect and Adjust the Test Instruments

(Repeat for channels A and B.)

1. Connect the function generator to the channel A terminals as shown in the figure above.
   (Note: For a single transducer input system, do not repeat this step for channel B.)

2. Adjust the function generator sine wave to 307.5 ± 2 Hz with a -7.5 ± .3 Vdc offset.

3. Adjust the signal amplitude to the meter full scale according to Full Scale option (BB for Channel A, CC for Channel B) as shown in the table:



OPTION	SIGNAL AMPLITUDE (mV peak)	SIGNAL AMPLITUDE (mV RMS)	OPTION	SIGNAL AMPLITUDE (mV peak)	SIGNAL AMPLITUDE (mV RMS)
01	200	141	11	204	144
02	500	354	12	510	361
03	1000	707	13	1020	721
04	2000	1414	14	2039	1442
05	500	354	15	492	348
06	1000	707	16	985	697
			17	1970	1393

NOTE: If barriers are used, calibrate with barriers in place.

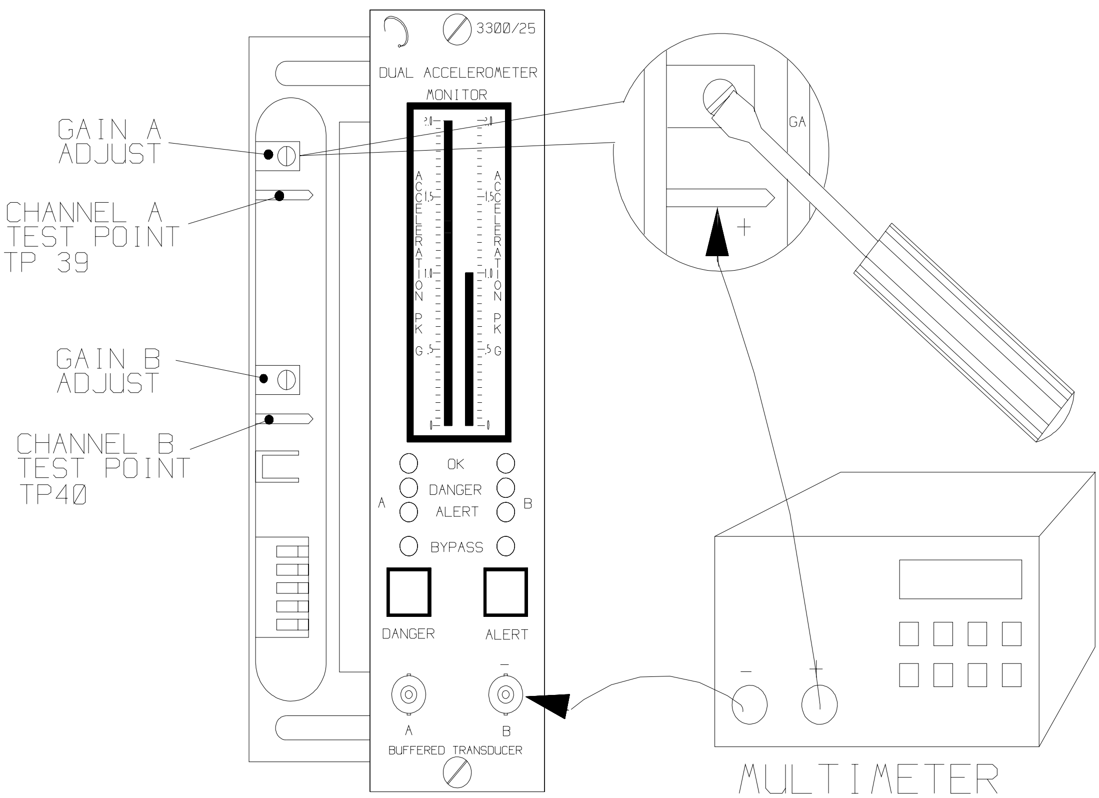
15.3 Calibrate the Channels

(Repeat for channels A and B)

1. Measure the proportional signal output at TP39 (BPPLA) for Channel A and TP40 (BPPLB) for Channel B. The testpoint locations are shown in the figure below. The voltages at these testpoints should match the voltages listed in the following table.

TRIP MULTIPLY OPTION	PROPORTIONAL OUTPUT (Vdc)
NONE	+5.000
2X	+2.500
3X	+1.670

2. Adjust potentiometer GA (gain adjust A) for Channel A, and GB for Channel B, to the appropriate Proportional Output (Vdc) shown above.



15.4 Prepare to Bring the Monitor On Line

(Repeat for channels A and B)

1. Disconnect the test equipment and reconnect the transducer wiring A to the channel A terminals. (Field wiring is shown the 3300/25 Field Wiring Diagram Packet.)

WARNING

High voltage present. Contact could cause shock, burns, or death.

Do not touch exposed wires or terminals.

2. Re-configure the filters, if necessary. At this point, the Filter Option is set to No Filters. See Appendices B or C.

3. Close the front panel.

4. Verify that the ALERT and DANGER LEDs go off if alarms are nonlatching.

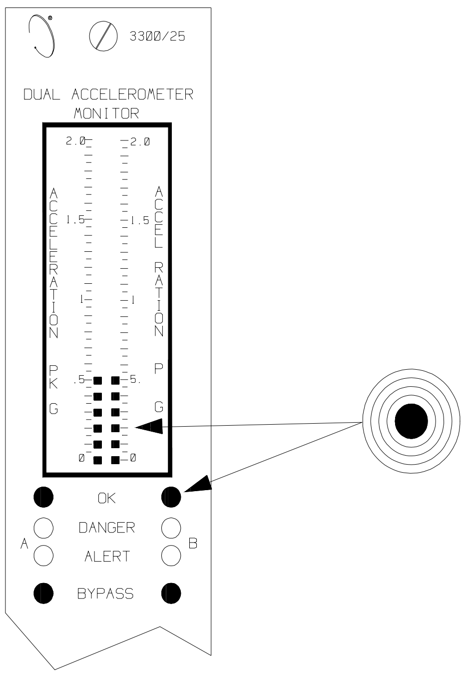
5. Press the RESET button on the System Monitor if Alarms are latching.

6. Verify that the OK LED is on. If Timed OK/Channel Defeat is enabled, the OK Mode must be nonlatching. In this case the OK LED will come on and flash. Pressing the system RESET button on the System Monitor will cause the OK LED to stop flashing and remain on.

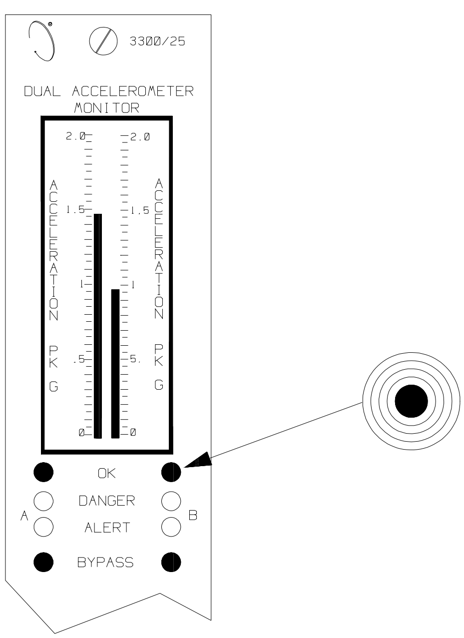
7. If the OK Mode is latching, the OK LED will remain off until you press the RESET switch on the System Monitor.

8. If Danger Bypass was enabled before starting the channel calibration procedure, it should be disabled before monitoring resumes (see Danger Bypass, Section 12 of this manual).

16. Self Test



Active Error Indication



Stored Error Indication

The monitor has three levels of self tests:

SELF TEST	PERFORMED
Power-up	When the monitor is turned on.
Cyclic	Continuous during monitoring operations.
User-invoked	When you initiate the self test by temporarily shorting the self-test pins.

When the monitor detects an error, it displays an error condition two ways depending on whether the error is active or stored. An active error is an error that currently exists. A stored error condition results from a storable error momentarily occurring after the last time all errors were cleared.

If the monitor detects an active error, the following events occur:

- Monitoring stops until the problem is resolved
- The error code is stored in memory and flashes on the LCD bargraph
- The **BYPASS** LEDs come on
- The **OK** LEDs flash at 5 Hz

Active errors that do not flash the **OK** LEDs require user-invoked self test or may require recycling power to clear them. If either of these actions fail to clear the error refer to the Error Codes section.

If the monitor no longer detects an active error and a stored error exists, the following events occur:

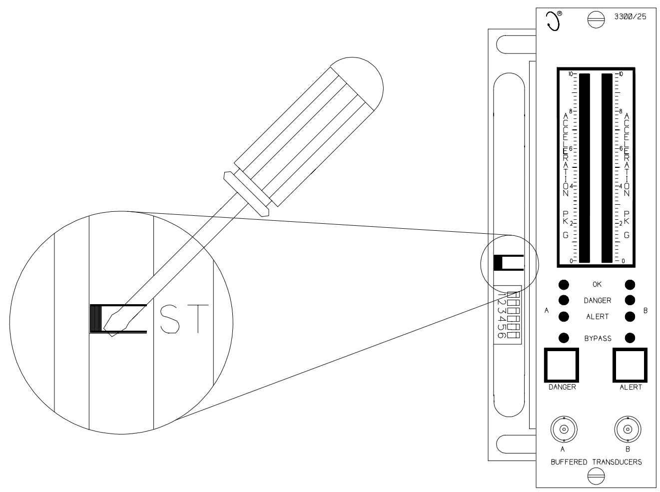
- Monitoring resumes

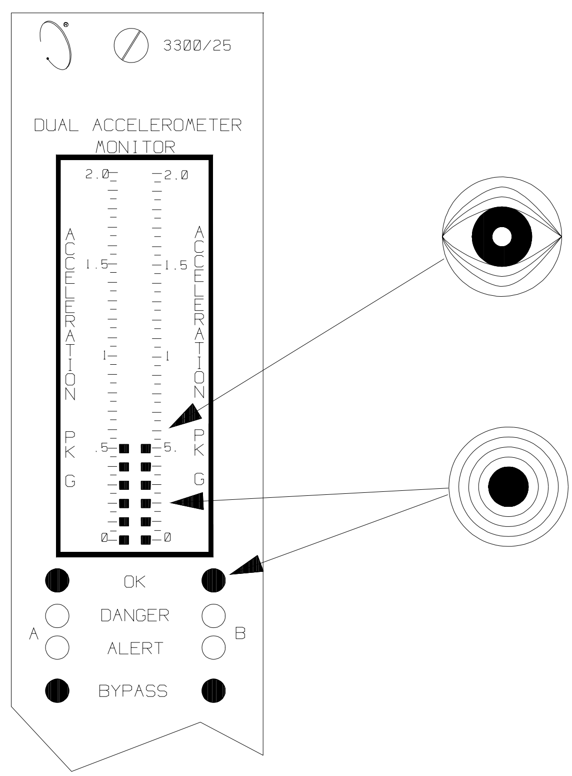
If the **OK** LED would otherwise be on, the **OK** LEDs flash at 5 Hz to indicate that an error code has been stored

Recall stored error codes by using the User-invoked self test. Use the following steps to run the User-invoked self test, read error codes, and clear stored error codes:

Caution

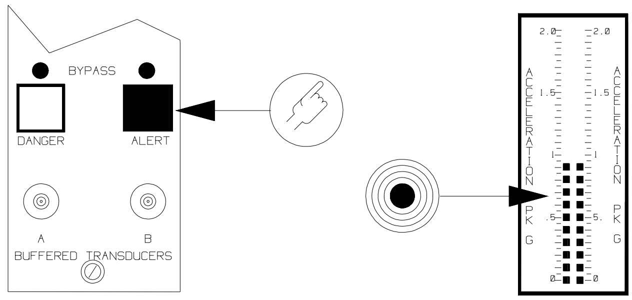
Machine protection provided by this monitor will be lost for the duration of the self test.





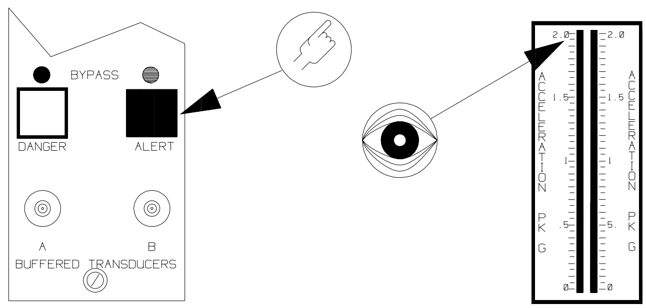
2. Read any other stored error codes by pressing and holding the **ALERT** switch for approximately one second.

   For example, the display to the far right contains a second stored error code - number 10.



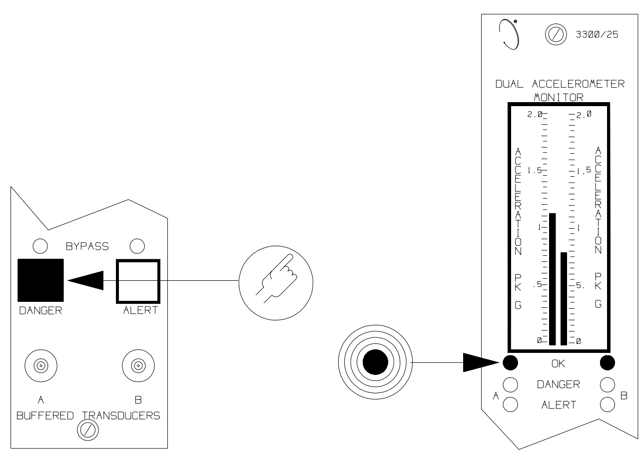
When you reach the end of the error code list, the LCD bargraph comes on at full scale range and the OK LEDs turn off.

You may read through the list again by continuing to press the **ALERT** switch.

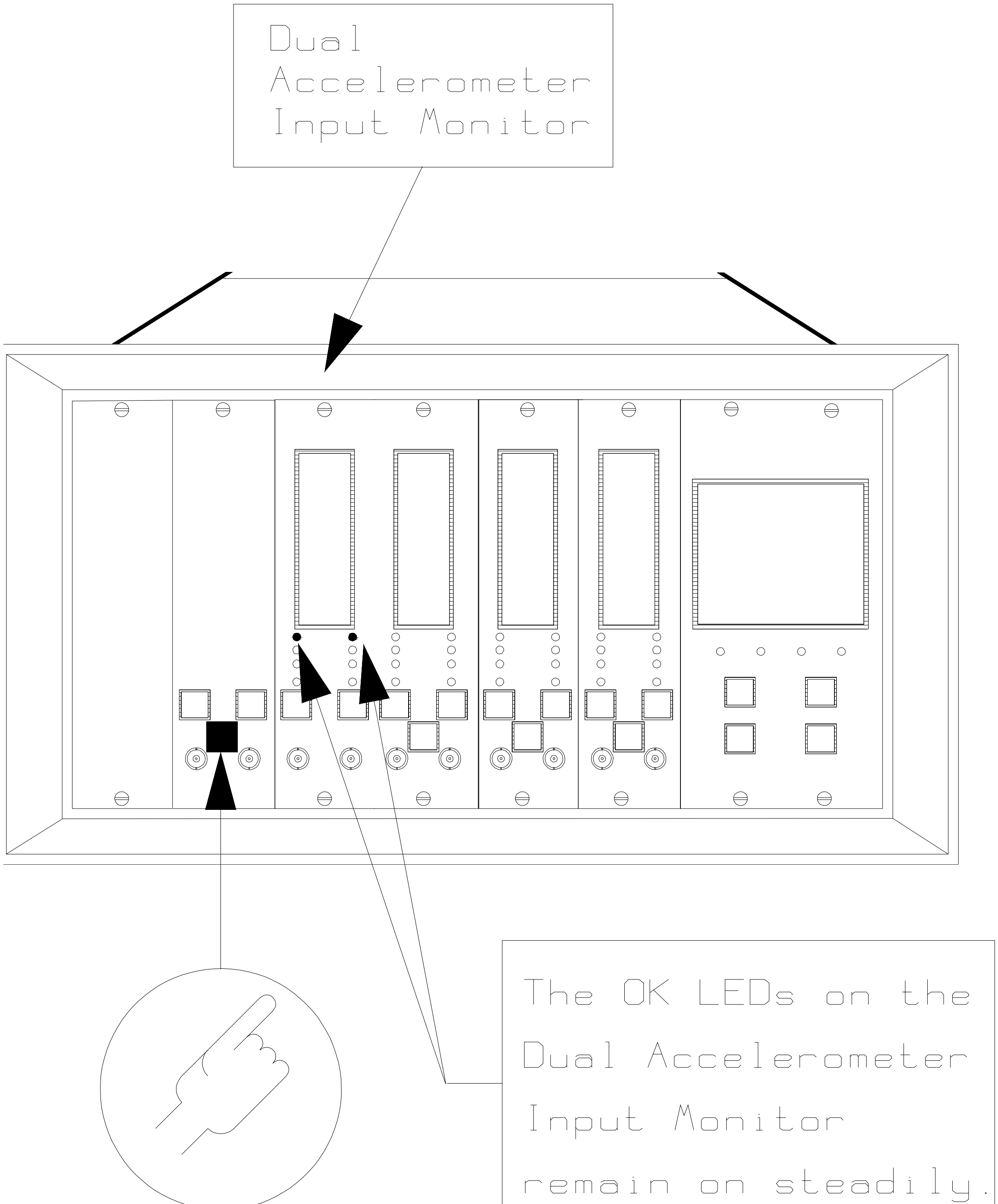


3. When the LCD bargraph is at full scale, clear error codes from memory by pressing and holding the **DANGER** switch for approximately one second.

   If Timed OK /Channel Defeat is selected, 30 seconds after you clear the error codes, the **OK** LEDs will flash at 1 Hz to indicate that the monitor has been not OK.



When you press the **RESET** switch on the System Monitor, the **OK** LEDs will stop flashing.



17. Error Codes

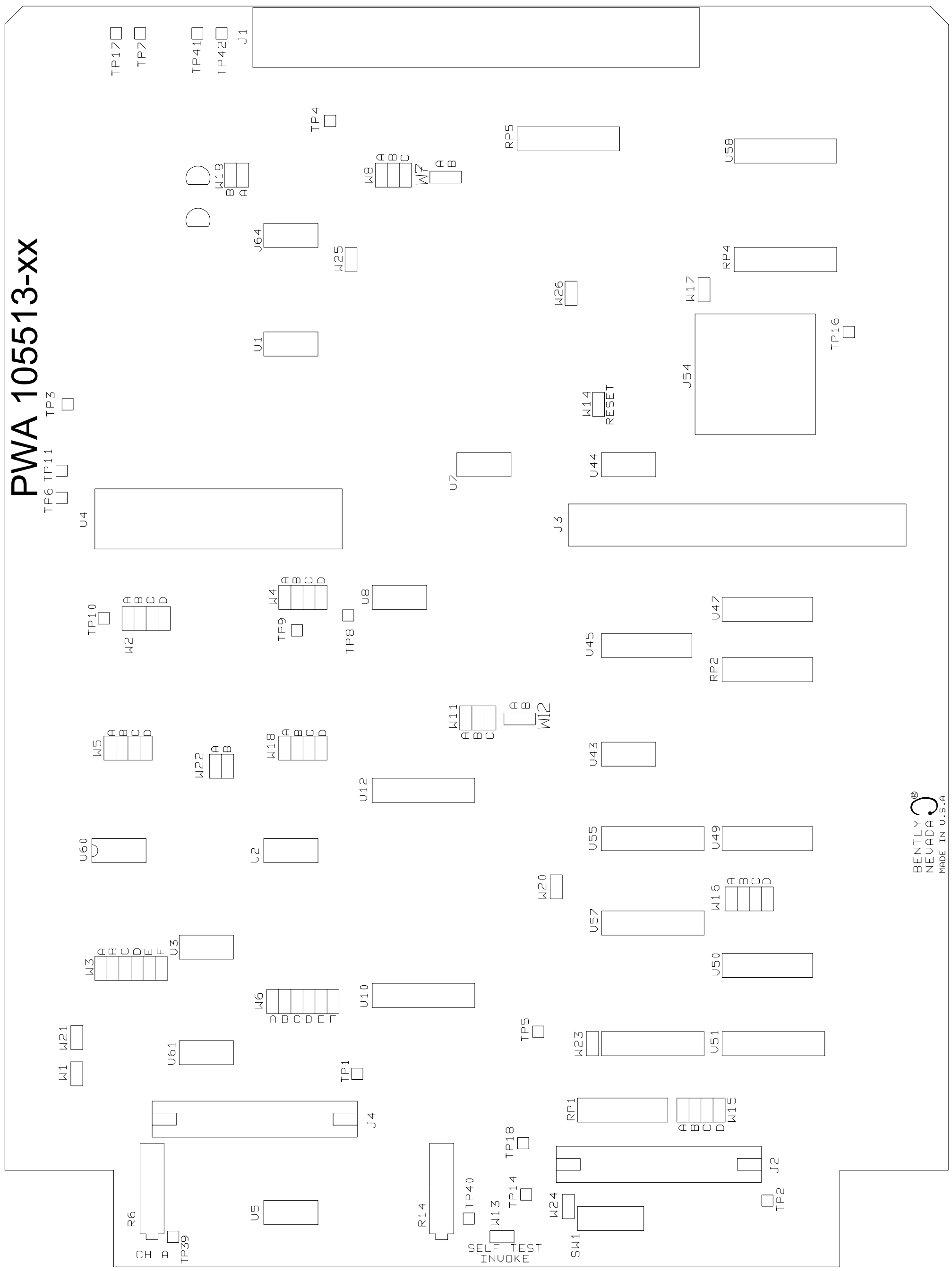
Refer to the Monitor Functions, Section 2 and Self Test, Section 16 for more information about displaying error codes. Refer to the Self Test section for information about clearing stored errors.

ERROR CODE	DESCRIPTION	EXPLANATION/RECOVERY
2	ROM checksum failed.	Tested at power up and User-invoked self test. This error is displayed on the front panel, but is not stored in memory. Install your spare monitor or contact your local Bently Nevada office for service.
3	Nonrecoverable EEPROM failure.	Tested only at Cyclic self test. Install your spare monitor or contact your local Bently Nevada office for service.
4	EEPROM failure.	May be corrected by adjusting alarm setpoints in the monitor (See section 10). If setpoint adjustment fails to correct this error, install your spare monitor or contact your local Bently Nevada office for service.
5	+7.5V/-VT node out of tolerance.	Tested cyclically. If it is a stored error, recall and clear the error codes as described in the Self Test, Section 16. If it is an active error, replace the monitor with a spare or contact your local Bently Nevada office for service.
6	+VRH node out of tolerance.	
7	+5V node out of tolerance.	
8	MVREF node out of tolerance.	
9	+7.5V node out of tolerance.	
10	+VRL node out of tolerance.	
11	MVREF/-6.5V node out of tolerance.	
12	+5V/-7.5V node out of tolerance.	
13	Clock OK voltage out of tolerance.	
14	RAM failure.	Tested only at Power-up or User-invoked self test. These errors are displayed on the front panel but not stored in memory. Install your spare monitor or contact your local Bently Nevada office for service.
17	COP watchdog not configured.	

NOTE: If the monitor experiences recurring stored errors contact your local Bently Nevada office for service.

18. Appendix A–Main Board Options

18.1 Jumper Locations for PWA 105513-xx



NOTE: This drawing applies to main boards with part number 105513-xx.

18.2 Shipped As Options

The monitor is shipped with the following configuration:

OPTION	SHIPPED SETTING
First Out	Enabled
OK Mode	Nonlatching
Timed OK/Channel Defeat	Enabled
Alert Mode	Latching
Recorder Outputs	+4 to +20 mA
+4 to +20mA Recorder Not OK Output (+2 mA clamp) *	Disabled
Filters	No filters
Buffered transducer filtering	Not filtered
Danger Mode	Latching
Danger Bypass	Disabled
Danger Relay Voting	OR voting for relay drive
Alarm Delays	3 Seconds

* Only available with main PWA 105513-xx **and** Timed OK /Channel Defeat **must** be enabled.

18.3 Main Board Option Settings

Use these and the tables on the following pages to configure main board options:

OPTION	SETTING	INSTALL	REMOVE
First Out	Enabled*	W16C	None
	Disabled	None	W16C
OK Mode	Latching	W20, W23**	None
	Nonlatching*	None	W23
Timed OK/Channel Defeat	Enabled*	None	W20, W23**
	Disabled	W20	None
Alert Mode	Latching*	W15D	None
	Nonlatching	None	W15D
Danger Mode	Latching*	W16B	None
	Nonlatching	None	W16B
Danger Bypass	Enabled	W24	None
	Disabled*	None	W24
Danger Relay Voting	OR voting for relay drive*	None	W16D
	AND voting for relay	W16D **++**	None
Alarm Delays	0.1 Second	None	W15B, W15C
	1 Second	W15C	W15B
	3 Seconds*	W15B	W15C
	6 Seconds	W15B, W15C	None

NOTES:

* Denotes standard configuration.

** Nonlatching OK mode MUST be selected if Timed OK/Channel Defeat is enabled. The table is setup with this dependency in mind.

OPTION	SETTING	INSTALL	REMOVE
Trip Multiply +	None	W19A,W19B	W15A,W16A,W21
	2X	W15A,W21*	W16A,W19A,W19B
	3X	W16A,W21*	W15A,W19A,W19B

*** W21 is used only with Transducer Input/Channel Units options 01, 02 or 03.

+ Trip multiply options require hardware component changes on the main board. Do not change the TM option unless corresponding hardware changes are made also. Consult your local sales representative for information.

++ Do not use AND voting with Quad Relays.

18.4 Recorder Options

Use the following table to configure Main Board 105513-xx.

OPTION	SETTING	INSTALL	REMOVE
RECORDER OUTPUTS	+4 to +20 mA *	W7A W8C W11C W12A	W7B W8A,B W11A,B W12B
	+1 to +5 V	W7B W8B W11B W12B	W7A W8A,C W11A,C W12A
	0 to -10 V	W7B, W8A,C W11A,C W12B	W7A W8B W11B W12A
+4 to 20mA Recorder Not OK Output (+2mA clamp)**	Enabled	W25, W26	None
	Disabled *	None	W25 W26

NOTES:

* Denotes standard configuration.

** Timed OK/Channel Defeat must be enabled.

The following recorder configuration information applies only to monitors with main board part number 79552-xx.

OPTION	SETTING	INSTALL	REMOVE
RECORDER OUTPUTS	+4 to +20 mA *	W7A,C,E,F W8B,C W10A,B W11B,C W12A,C,E,F	W7B,D, W8A,D,E,F W9A,B W11A,D,E,F W12B,D
	+1 to +5 Vdc	W7B,D W8A,E W10A,B W11A,E W12B,D	W7A,C,E,F W8B,C,D,F W9A,B W11B,C,D,F W12A,C,E,F
	0 to -10 Vdc	W7B,D W8D,F W9A,B W11D,F W12B,D	W7A,C,E,F W8A,B,C,E W10A,B W11A,B,C,E W12A,C,E,F

* Denotes standard configuration.

18.5 Channel Types

TRANSDUCER INPUT, CHANNEL UNITS	JUMPERS	
	INSTALL	REMOVE
Dual Accelerometer, Channel A Acceleration Channel B Acceleration	W3B,E W6B,E W22B	W1 W3F W6A W22A
**** Dual Accelerometer, Channel A Acceleration Channel B Velocity**	W3B,F W6B,E W22B	W1 W3E W6A W22A
**** Dual Accelerometer, Channel A Velocity Channel B Velocity**	W3B,F W6A,E W22B	W1 W3E W6B W22A
*** Single Accelerometer, Channel A Acceleration Channel B Acceleration**	W1 W3B,E W6B,E W22A	W3F W6A W22B
*** ** Single Accelerometer, Channel A Acceleration Channel B Velocity**	W1 W3B,F W6B,E W22A	W3E W6A W22B
*** ** Single Accelerometer, Channel A Velocity Channel B Velocity**	W1 W3B,F W6A,E W22A	W3E W6B W22B

NOTE: * Single accelerometer transducer must be connected to channel A. No connection is made to channel B. For Trip Multiply Monitors (option GG -01, -02), ensure that W21 is removed when a single transducer input is used.

** When integrated, low frequency signals can cause the monitor to saturate.

18.6 Full Scale Options

Caution

If you change full scale options, recalibrate both channels and replace the meter scale on the front panel.

MONITOR FULL SCALE OPTIONS	CHANNEL A JUMPERS		CHANNEL B JUMPERS	
	INSTALL	REMOVE	INSTALL	REMOVE
0 to 2 g pk or 0 to 20 m/s² pk	W4C W18D	W4A,B,D W6C	W2B W5D	W2A,C,D W3D
0 to 5 g pk or 0 to 50 m/s² pk	W4A,C W6C	W4B,D W18D	W2B,D W3D	W2A,C W5D
0 to 10 g pk or 0 to 100 m/s² pk	W4C W6C	W4A,B,D W18D	W2B W3D	W2A,C,D W5D
0 to 20 g pk or 0 to 200 m/s² pk	W4A W6C	W4B,C,D W18D	W2D W3D	W2A,B,C W5D
0 to 1 in/s pk or 0 to 25 mm/s pk	W4A,C	W4B,D W6C W18D	W2B,D	W2A,C W3D W5D
0 to 2 in/s pk or 0 to 50 mm/s pk	W4C	W4A,B,D W6C W18D	W2B	W2A,C,D W3D W5D
0 to 100 mm/s pk	W4A	W4B,C,D W6C W18D	W2D	W2A,B,C W3D W5D

18.7 Main Board Buffered Out and Filter Options

BUFFERED TRANSDUCER OUTPUT	CHANNEL A		CHANNEL B	
	INSTALL	REMOVE	INSTALL	REMOVE
* Buffered transducer output not filtered.	W18C	W18A	W5C	W5A
Buffered transducer output filtered	W18A	W18C	W5A	W5C

* Standard configuration.

When this option is selected, the buffered transducer output follows the Integrator/Gain Stage. For a true unfiltered output, all filters should be located after the Integrator/Gain Stage.

If any filters are located before the Integrator/Gain Stage, the buffered transducer output will be filtered by those filters. Refer to Figure 1 in Section 19.3 (duplicated in Section 20.3).

The table below shows the configuration of the Integrator/Gain stage. The configuration of the Integrator/Gain stage is described in Sections 19.6 and 20.6.

INTEGRATOR/GAIN STAGE LOCATION	**Main Board**			
	Channel A		**Channel B**	
	INSTALL	REMOVE	INSTALL	REMOVE
** Integrator/Gain Stage with **NO** Filtering	W18B W6E	W6D W6F	W5B W3B	W3A W3C
*** Filter **after** Integrator/Gain Stage	W6E	W6D W6F W18B	W3B	W3A W3C W5B
Filter **before** Integrator/Gain Stage	W6D W6F W18B	W6E	W3A W3C W5B	W3B
High Pass Filter **before** Integrator/Gain Stage and Low Pass Filter **after** the Integrator/Gain Stage	W6D W6F	W6E W18B	W3A W3C	W3B W5B

** Denotes standard configuration

*** When filtering without integration, set the filter **after** the Integrator/Gain Stage.

19. Appendix B–Filter Board Options PWA 79562-01 and PWA 105521-01

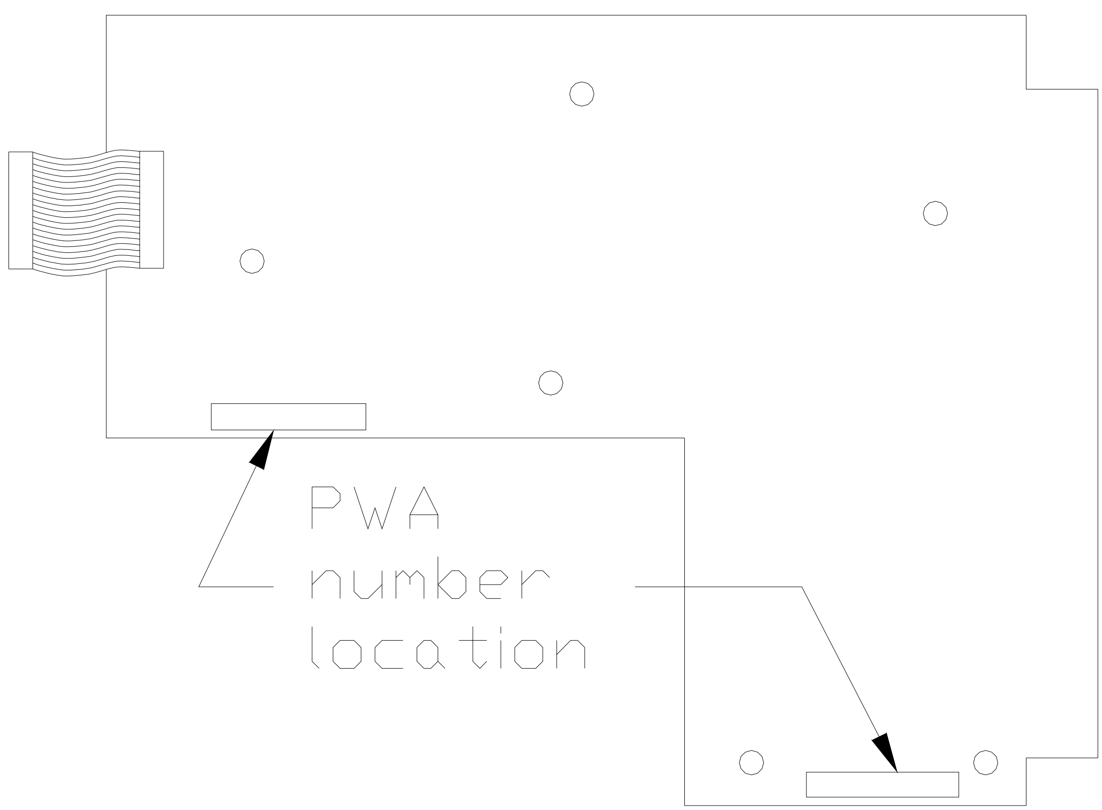
19.1 Identify Filter Board

The configuration of the low pass filter is depends upon which filter board is being used. The filter board can be identified by looking at the PWA (Printed Wiring Assembly) number that is silkscreened on the component side of the board.

The three possibilities are:

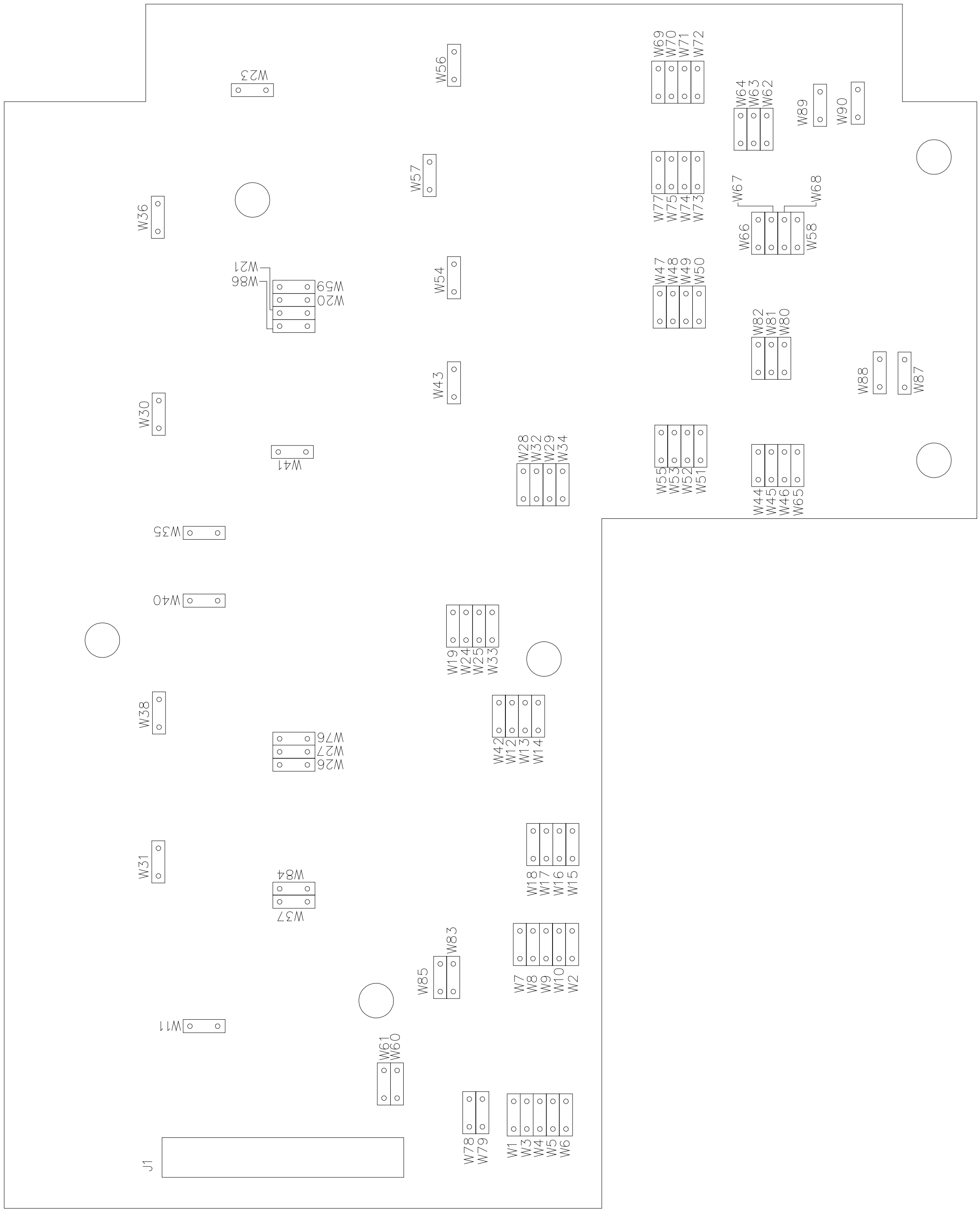
PWA 79562-01 **Refer to Appendix B**

PWA 105521-01 **Refer to Appendix B**



PWA 148921-01 **Refer to Appendix C**

19.2 Filter Board Jumper Locations



19.3 Integrator/Gain Stage Flow Path

This diagram is meant to illustrate the signal path through the Integrator/Gain Stage and the filters. It should not be used to determine jumper configurations. Follow the instructions in Section 19.4 determine the necessary jumper configuration.

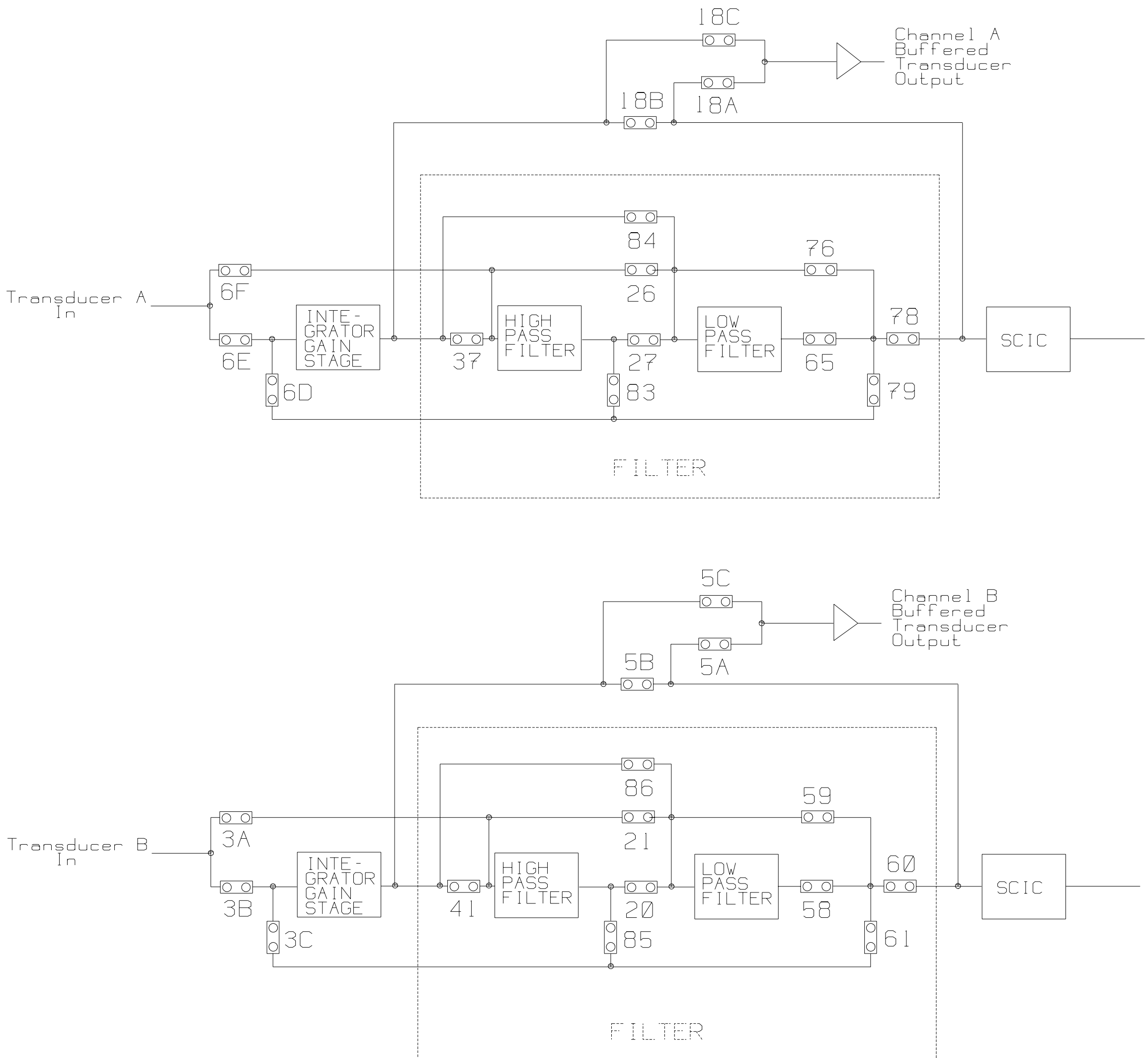


FIGURE 1. SIGNAL FLOW PATH

19.4 General Procedure

Follow these steps, in the order below, to program the monitor to operate with or without filters. After choosing the filter type and the location of the Integrator/Gain Stage you can check the signal flow path using figure 1 in section 19.3.

NOTE: Because the calibration procedure requires changing the filter settings, it is recommended that the monitor be calibrated before configuring the filter (See Section 15).

1. Remove the monitor from the rack and disassemble it to allow access to the jumpers on both the Main and Filter boards (See Section 6).

2. Choose the filter type (See Section 19.5). The options are
   - High-Pass (HP) filter
   - Low-Pass (LP) filter
   - Band-Pass (BP) filter
   - No filters

3. Set the Integrator/Gain Stage (See Section 19.6). The options are
   - Integrator/Gain Stage with NO filters
   - Filter after Integrator/Gain Stage
   - Filter before Integrator/Gain Stage
   - High Pass filter before Integrator/Gain Stage and Low Pass filter after Integrator/Gain Stage

4. Set the filter corner frequency.
   - High-Pass filter corner frequency (f_{HP}) (See Section 19.7)
   - Low-Pass filter corner frequency (f_{LP}) (See Section 19.10)
   - Band-Pass filter corner frequencies (f_{HP} and f_{LP}) (See Section 19.14)
   - If you have NO filters, go to step 5.

5. Reassemble the monitor and install it into the rack.

6. Test the filter settings by performing the tests described in Section 19.15.

19.5 Filter Board Options

Choose the filter type by installing and removing the jumpers on the filter board as shown in the table below. See Section 19.2 for the location of the jumpers on the Filter Board.

FILTER TYPE	CHANNEL A		CHANNEL B	
	INSTALL	REMOVE	INSTALL	REMOVE
High Pass (HP) Filter ONLY	W27,76	W26,65	W20,59	W21,58
Low Pass (LP) Filter ONLY	W26,65	W27,76	W21,58	W20,59
Band Pass (BP) Filter	W27,65	W26,76	W20,58	W21,59
High Pass Filter **before** Integrator/Gain Stage and Low Pass Filter **after** the Integrator/Gain Stage	W65,78 W83,84	W26,27 W37,76 W79	W58,60 W85,86	W20,21 W41,59 W61
*NO Filters		W26,27 W37,65,76 W78,79 W83,84		W20,21 W41,58,59 W60,61 W85,86

* Denotes standard configuration.

19.6 Integrator/Gain Stage Options

When measuring acceleration, configure the filter after the Integrator/Gain Stage.

When measuring velocity, configure:

the Low-Pass filter after the Integrator/Gain Stage and
the High-Pass filter before the Integrator/Gain Stage

1. Set the location of the Integrator/Gain Stage by installing or removing the jumpers on the main and filter boards as shown in the table below. Refer to Sections 18.1 and 19.2 for the location of jumpers. Figure 1 Section 19.3 illustrates the signal flow path for different jumper configurations.

2. See Section 18.7 for the configuration of the Buffered Outputs.

Channel A Integrator/Gain stage Location

INTEGRATOR/GAIN STAGE LOCATION	**CHANNEL A**			
	Main Board		**Filter Board**	
	INSTALL	REMOVE	INSTALL	REMOVE
*Integrator/Gain Stage with **NO** Filtering	W18B,6E	W6D,6F		W37,78 W79,83 W84
Filter **after Integrator/Gain Stage	W6E	W6D,6F W18B	W37,78	W79,83 W84
Filter **before** Integrator/Gain Stage	W6D,6F W18B	W6E	W79	W37,78 W83,84
High Pass Filter **before** Integrator/Gain Stage and Low Pass Filter **after** the Integrator/Gain Stage	W6D,6F	W6E,18B	W65,78 W83,84	W26,27 W37,76 W79

***** Denotes standard configuration

****** When filtering without integration, set the filter **after** the Integrator/Gain Stage.

Channel B Integrator/Gain Stage Location

INTEGRATOR/GAIN STAGE LOCATION	**CHANNEL B**			
	Main Board		**Filter Board**	
	INSTALL	REMOVE	INSTALL	REMOVE
***Integrator/Gain Stage with **NO** Filtering	W5B,3B	W3A,3C		W41,60 W61,85 W86
****Filter **after** the Integrator/Gain Stage	W3B	W3A,3C W5B	W41,60	W61,85 W86
Filter **before** the Integrator/Gain Stage	W3A,3C W5B	W3B	W61	W41,60 W85,86
High Pass Filter **before** the Integrator/Gain Stage and Low Pass Filter **after** the Integrator/Gain Stage	W3A,3C	W3B,5B	W58,60 W85,86	W20,21 W41,59 W61

***** Denotes standard configuration.

****** When filtering without integration, set the filter **after** the Integrator/Gain Stage.

NOTE: If you have chosen the **NO Filtering** option, then you have completed your filter Configuration.

When measuring velocity, low frequency signals can cause the monitor to saturate.

19.7 High Pass Filter Options

Install the jumpers on the filter board as shown in this table. Select frequencies not listed in this table by using the procedure in Section 19.8.

CHANNEL A- CHANNEL B-		W11 W23	W31 W30	W38 W35	W40 W36	W18 W19	W17 W24	W16 W25	W15 W33	W14 W34	W13 W29	W12 W32	W42 W28
Hz	CPM												
3.7	222	R	R	R	R	I	I	I	I	I	I	R	R
5.0	300	R	R	R	R	I	I	I	I	I	R	I	I
6.2	372	R	R	R	R	I	I	I	I	I	R	I	R
7.5	450	R	R	R	R	I	I	I	I	I	R	R	I
9.9	594	R	R	R	R	I	I	I	I	R	I	I	I
12.5	750	R	R	R	R	I	I	I	I	R	I	R	I
16.2	972	R	R	R	R	I	I	I	I	R	R	I	R
22.4	1344	R	R	R	R	I	I	I	R	I	I	R	I
24.9	1494	R	R	R	R	I	I	I	R	I	R	I	I
28.7	1722	R	R	R	R	I	I	I	R	I	R	R	R
33.7	2022	R	R	R	R	I	I	I	R	R	I	R	R
37.4	2244	R	R	R	R	I	I	I	R	R	R	R	I
42.4	2544	R	R	R	R	I	I	R	I	I	I	R	I
46.1	2766	R	R	R	R	I	I	R	I	I	R	I	R
49.8	2988	R	R	R	R	I	I	R	I	R	I	I	I
54.8	3288	R	R	R	R	I	I	R	I	R	R	I	I
58.6	3516	R	R	R	R	I	I	R	I	R	R	R	R
62.3	3738	R	R	R	R	I	I	R	R	I	I	R	I
67.3	4038	R	R	R	R	I	I	R	R	I	R	R	I
74.8	4488	R	R	R	R	I	I	R	R	R	R	I	I
83.5	5010	R	R	R	R	I	R	I	I	I	I	R	R
92.2	5532	R	R	R	R	I	R	I	I	R	I	R	I
101	6060	R	R	R	R	I	R	I	R	I	I	I	R
112	6720	R	R	R	R	I	R	I	R	R	I	R	I
117	7020	R	R	R	R	I	R	I	R	R	R	R	I
121	7260	R	R	R	R	I	R	R	I	I	I	I	R
126	7560	R	R	R	R	I	R	R	I	I	R	I	R
135	8100	R	R	R	R	I	R	R	I	R	R	I	I
142	8520	R	R	R	R	I	R	R	R	I	I	R	I
151	9060	R	R	R	R	I	R	R	R	R	I	I	R

R = REMOVE JUMPER, I = INSTALL JUMPER

This table is continued on the next page.

CHANNEL A -		W11	W31	W38	W40	W18	W17	W16	W15	W14	W13	W12	W42
CHANNEL B -		W23	W30	W35	W36	W19	W24	W25	W33	W34	W29	W32	W28
Hz	CPM												
167	10020	R	R	R	R	R	I	I	I	I	R	R	I
176	10560	R	R	R	R	R	I	I	I	R	R	I	R
183	10980	R	R	R	R	R	I	I	R	I	I	R	R
192	11520	R	R	R	R	R	I	I	R	R	I	R	I
201	12060	R	R	R	R	R	I	R	I	I	I	I	R
208	12480	R	R	R	R	R	I	R	I	I	R	R	R
217	13020	R	R	R	R	R	I	R	I	R	R	R	I
226	13560	R	R	R	R	R	I	R	R	I	R	I	R
234	14040	R	R	R	R	R	I	R	R	R	R	I	I
242	14520	R	R	R	R	R	R	I	I	I	I	R	I
251	15060	R	R	R	R	R	R	I	I	R	I	I	R
268	16080	R	R	R	R	R	R	I	R	I	R	R	R
275	16500	R	R	R	R	R	R	I	R	R	R	I	R
284	17040	R	R	R	R	R	R	R	I	I	R	I	I
292	17520	R	R	R	R	R	R	R	I	R	I	R	I
300	18000	R	R	R	R	R	R	R	R	I	I	I	R
309	18540	R	R	R	R	R	R	R	R	R	I	I	I
496	29760	I	I	I	I	I	I	R	I	R	I	R	I
755	45300	I	I	I	I	I	R	I	I	I	I	I	I
1003	60180	I	I	I	I	I	R	I	R	I	R	I	R
2006	120360	I	I	I	I	R	I	R	I	R	I	R	I
2996	179760	I	I	I	I	R	R	R	R	R	R	R	I

R = REMOVE JUMPER, I = INSTALL JUMPER

Use the procedure in the following section to set a high-pass corner frequency not listed in the table.

19.8 Non Standard High Pass Filter Options

Follow this procedure only if the desired high-pass corner frequency is not listed in the table in the previous section.

1. Select a high-pass corner frequency, f_{hp}, in the range 3.7 Hz to 3008 Hz.

2. Select a value, **K**, according to this table:

If your frequency is within this range,	Use this value for **K**
3.7 Hz to 318 Hz	1.246
319 Hz to 3008 Hz	11.797

3. Calculate the multiplier value, D, by using this formula:

$$D = \frac{f_{HP}}{K}$$

where

f_{HP} is the high-pass corner frequency from step 1
K is the constant selected in step 2
D is the multiplier value (D should be in the range 3 to 255)

4. Convert **D** to the closest 8 bit binary integer, D0 to D7.

5. Install/Remove jumpers according to the following table. The jumpers corresponding to values D0 to D7 are installed according to these rules:

an installed jumper = 0, D0 is the least significant bit (**LSB**)
a removed jumper = 1, D7 is the most significant bit (**MSB**)

CHANNEL	K = 1.246 **REMOVE**	K = 11.797 **INSTALL**	(MSB) D7	D6	D5	D4	D3	D2	D1	(LSB) D0
A	W11 W31 W38 W40	W11 W31 W38 W40	W18	W17	W16	W15	W14	W13	W12	W42
B	W23 W30 W35 W36	W23 W30 W35 W36	W19	W24	W25	W33	W34	W29	W32	W28

19.9 Example High-Pass Filter Configuration

This example shows how to configure channel A with a high-pass filter that has a corner frequency, f_{hp}, of 24000 CPM (400 Hz). The High Pass Filter is located after the Integrator/Gain Stage. (While working through this example you can refer to the procedure for setting the high-pass filter which is at the start of this section).

Follow the steps outlined in the Filter Configuration Section.

1. Set the type of filter as a High-Pass filter as shown in the table of Section 19.5. The table in Section 19.5 shows that for a High-Pass filter for channel A

Install: **W27 and W76**

Remove: **W26 and W65**

2. Set the High Pass Filter after the Integrator/Gain Stage as shown in the table for channel A in Section 19.6.

On the Main Board

Install: **W6E**

Remove: **W6D,W6F, and W18B**

On the Filter Board

Install: **W37,W78**

Remove: **W79,W83, and W84**

3. Set the high-pass filter corner frequency f_{hp}. Since the desired f_{hp} is not in the High-Pass Freq. Configuration Table Section, you will need to refer to the Non Standard High Pass Filter Options, Section 19.8 for the jumper configuration.

4. f_{hp} is between 319 Hz and 3008 Hz, so the value of K is 11.797. Set the following jumpers for K = 11.797 (shown in the table in Section 19.8).

Install: **W11,W31,W38,W40**

5. Use the formula in step 3 of Section 19.8 to obtain a value for the multiplier, **D**. In this case:

$$D = \frac{400}{11.797}$$

The result is **D** = 33.9

6. Step 4 of Section 19.8 requires that you convert **D** to the closest 8 bit binary integer. The closest integer to 33.9 is 34, and the 8 bit binary representation is 00100010. **D7** is the most significant bit **(MSB)**, and **D0** is the least significant bit **(LSB)**.

7. Complete the filter configuration by installing jumpers according to step 5 of Section 19.8. To configure the filter board for the high-pass corner frequency f_{hp} = 400 Hz

Install:	**W13,W14,W15,W17,W18, and W42**
Remove:	**W12 and W16**

8. Channel A of the filter board is now completely configured. Configure channel B as required and then verify the filter settings as described in Test Filter Options, Section 19.15.

19.10 Low-Pass Freq. Configuration Table

Use the tables on the next four pages to select the low-pass corner frequency f_{LP}. The -3dB frequency is 1.06 x f_{LP}. For frequencies not listed in this table, follow the procedure in the following section.

CHANNEL A - CHANNEL B -		W80 W62	W81 W63	W82 W64	W44 W66	W45 W67	W46 W68	W1 W7	W3 W8	W4 W9	W5 W10	W6 W2	W87 W89
Hz	CPM												
24	1440	I	I	I	I	I	I	I	R	R	R	R	R
33	1980	I	I	R	I	R	I	R	R	R	I	R	R
42	2520	I	I	I	I	R	R	R	R	I	R	R	R
49	2940	I	I	I	R	R	R	R	R	R	I	R	R
59	3540	I	R	I	R	R	R	R	R	R	R	I	R
66	3960	I	I	R	I	R	I	R	R	I	R	R	R
74	4440	I	I	R	R	R	I	R	R	R	I	R	R
84	5040	I	I	I	I	R	R	R	I	R	R	R	R
92	5520	R	I	I	R	R	I	R	R	R	R	I	R
98	5880	I	I	I	R	R	R	R	R	I	R	R	R
108	6480	I	R	R	I	R	R	R	R	R	I	R	R
116	6960	R	R	I	I	R	R	R	R	R	R	I	R
125	7500	I	R	R	I	I	I	R	R	R	I	R	R
133	7980	I	I	R	I	R	I	R	I	R	R	R	R
142	8520	I	R	R	R	R	I	R	R	R	I	R	R
152	9120	R	I	I	I	R	I	R	R	R	I	R	R
160	9600	I	I	R	R	R	R	R	R	I	R	R	R
168	10080	I	I	I	R	R	I	R	I	R	R	R	R
184	11040	R	I	I	R	R	I	R	R	R	I	R	R
202	12120	R	I	R	I	I	R	R	R	R	I	R	R
216	12960	I	R	R	I	R	R	R	R	I	R	R	R
236	14160	I	R	I	R	R	R	R	R	I	R	R	R
250	15000	I	R	R	I	I	I	R	R	I	R	R	R
266	15960	I	I	R	I	R	I	I	R	R	R	R	R
284	17040	I	R	R	R	R	I	R	R	I	R	R	R
305	18300	R	I	I	I	R	I	R	R	I	R	R	R
321	19260	I	I	R	R	R	R	R	I	R	R	R	R
336	20160	I	I	I	R	R	I	I	R	R	R	R	R
368	22080	R	I	I	R	R	I	R	R	I	R	R	R
403	24180	R	I	R	I	I	R	R	R	I	R	R	R

The -3 dB corner frequency occurs at 1.06 X the frequencies listed in this table.

R = REMOVE JUMPER, I = INSTALL JUMPER

This table is two pages wide.

W88 W90	W43 W56	W54 W57	W55 W77	W53 W75	W52 W74	W51 W73	W50 W72	W49 W71	W48 W70	W47 W69	CHANNEL A - CHANNEL B -	
											Hz	CPM
I	R	R	I	I	I		I	R	R	I	24	1440
I	R	R	I	I	I	I	R	I	I	R	33	1980
I	R	R	I	I	I	I	R	I	R	R	42	2520
I	R	R	I	I	I	I	R	R	I	R	49	2940
I	R	R	I	I	I	I	R	R	R	R	59	3540
I	R	R	I	I	I	R	I	I	I	R	66	3960
I	R	R	I	I	I	R	I	I	R	R	74	4440
I	R	R	I	I	I	R	I	R	R	I	84	5040
I	R	R	I	I	I	R	R	I	I	I	92	5520
I	R	R	I	I	I	R	R	I	R	I	98	5880
I	R	R	I	I	I	R	R	R	I	I	108	6480
I	R	R	I	I	I	R	R	R	R	I	116	6960
I	R	R	I	I	R	I	I	I	I	R	125	7500
I	R	R	I	I	R	I	I	I	R	R	133	7980
I	R	R	I	I	R	I	I	R	I	R	142	8520
I	R	R	I	I	R	I	R	I	I	I	152	9120
I	R	R	I	I	R	I	R	I	R	I	160	9600
I	R	R	I	I	R	I	R	R	I	I	168	10080
I	R	R	I	I	R	R	I	I	I	I	184	11040
I	R	R	I	I	R	R	I	R	I	R	202	12120
I	R	R	I	I	R	R	R	I	I	I	216	12960
I	R	R	I	I	R	R	R	R	I	R	236	14160
I	R	R	I	R	I	I	I	I	I	R	250	15000
I	R	R	I	R	I	I	I	R	I	R	266	15960
I	R	R	I	R	I	I	R	I	R	I	284	17040
I	R	R	I	R	I	I	R	R	R	R	305	18300
I	R	R	I	R	I	R	I	R	I	I	321	19260
I	R	R	I	R	I	R	R	I	I	I	336	20160
I	R	R	I	R	R	I	I	I	I	I	368	22080
I	R	R	I	R	R	I	R	I	I	R	403	24180

The -3 dB corner frequency occurs at 1.06 X the frequencies listed in this table.

R = REMOVE JUMPER, I = INSTALL JUMPER

Use the procedure in the following section to set a low-pass corner frequency not listed in the table.

CHANNEL A -		W80	W81	W82	W44	W45	W46	W1	W3	W4	W5	W6	W87
CHANNEL B -		W62	W63	W64	W66	W67	W68	W7	W8	W9	W10	W2	W89
Hz	CPM												
417	25020	I	R	I	R	I	R	R	I	R	R	R	R
463	27780	R	R	I	I	R	R	R	I	R	R	R	R
500	30000	I	R	R	I	I	I	R	I	R	R	R	R
543	32580	I	R	R	R	I	R	R	I	R	R	R	R
588	35280	I	I	R	R	R	I	I	R	R	R	R	R
625	37500	I	R	R	R	R	R	R	I	R	R	R	R
676	40560	R	I	I	R	I	I	R	I	R	R	R	R
758	45480	R	I	I	R	R	R	R	I	R	R	R	R
833	49980	R	R	I	I	I	I	R	I	R	R	R	R
926	55560	R	R	I	I	R	R	R	I	R	R	R	R
1000	60000	R	R	I	R	R	I	R	I	R	R	R	R
1087	65220	R	R	R	I	I	R	R	I	R	R	R	R
1163	69780	R	I	I	I	I	R	I	R	R	R	R	R
1250	75000	I	R	R	R	R	R	I	R	R	R	R	R
1351	81060	R	I	I	R	I	I	I	R	R	R	R	R
1515	90900	R	I	I	R	R	R	I	R	R	R	R	R
1667	100020	R	R	I	R	I	R	R	I	R	R	R	R
2083	124980	R	R	R	I	R	I	R	I	R	R	R	R
2500	150000	R	R	R	I	R	R	R	I	R	R	R	R
3333	199980	R	R	I	R	I	R	I	R	R	R	R	R
4167	250020	R	R	R	R	I	R	R	I	R	R	R	R
5000	300000	R	R	R	R	R	I	R	I	R	R	R	R
6250	375000	R	R	R	R	R	R	R	I	R	R	R	R
8333	499980	R	R	R	R	I	R	I	R	R	R	R	R
10000	600000	R	R	R	R	R	I	I	R	R	R	R	R
12500	750000	R	R	R	R	R	R	I	R	R	R	R	R
14915	894900	R	R	R	R	I	R	R	R	R	R	R	I
22372	1342320	R	R	R	R	R	R	R	R	R	R	R	I

The -3 dB corner frequency occurs at 1.06 X the frequencies listed in this table.

R = REMOVE JUMPER, I = INSTALL JUMPER

This table is two pages wide.

W88 W90	W43 W56	W54 W57	W55 W77	W53 W75	W52 W74	W51 W73	W50 W72	W49 W71	W48 W70	W47 W69	CHANNEL A - CHANNEL B - Hz	CPM
I	R	R	I	R	R	I	R	R	I	R	417	25020
I	R	R	I	R	R	R	R	I	I	R	463	27780
I	R	R	R	I	I	I	I	I	R	I	500	30000
I	R	R	R	I	I	I	R	R	I	R	543	32580
I	R	R	R	I	I	R	R	I	I	R	588	35280
I	R	R	R	I	R	I	I	I	R	R	625	37500
I	R	R	R	I	R	R	I	I	I	I	676	40560
I	R	R	R	R	I	I	I	R	I	R	758	45480
I	R	R	R	R	I	R	R	I	I	R	833	49980
I	R	R	R	R	R	R	I	I	I	R	926	55560
I	I	I	I	I	I	R	I	I	R	R	1000	60000
I	I	I	I	I	I	R	I	R	I	I	1087	65220
I	I	I	I	I	I	R	I	R	R	I	1163	69780
I	I	I	I	I	I	R	I	R	R	R	1250	75000
I	I	I	I	I	I	R	R	I	I	R	1351	81060
I	I	I	I	I	I	R	R	R	I	I	1515	90900
I	I	I	I	I	I	R	R	R	R	R	1667	100020
I	I	I	I	I	R	I	I	R	R	R	2083	124980
I	I	I	I	I	R	I	R	R	R	I	2500	150000
I	I	I	I	I	R	R	R	R	R	I	3333	199980
I	I	I	I	R	I	I	R	R	I	R	4167	250020
I	I	I	I	R	I	R	R	R	I	R	5000	300000
I	I	I	I	R	R	R	I	R	I	I	6250	375000
I	I	I	R	I	I	R	R	I	R	R	8333	499980
I	I	I	R	I	R	R	R	I	R	I	10000	600000
I	I	I	R	R	R	I	R	I	I	I	12500	750000
R	I	I	R	R	R	R	R	R	R	R	14915	894900
R	I	I	R	R	R	R	R	R	R	R	22372	1342320

The -3 dB corner frequency occurs at 1.06 X the frequencies listed in this table.

R = REMOVE JUMPER, I = INSTALL JUMPER

Use the procedure in the following section to set a low-pass corner frequency not listed in the table.

19.11 Non Standard Low Pass Filter Options

Use this procedure only if the desired low pass corner frequency is not listed in the table in the previous section. The procedure consists of these two parts:

- Set the anti-aliasing filter (f_{AA}).
- Set the low-pass corner frequency (f_{LP}).

Since the low-pass filter used on the filter board is a switched capacitor type, an anti-aliasing filter is required to band-limit the input signal. Configure the anti-aliasing filter to have a corner frequency, f_{AA}, five times that of the selected low-pass filter corner frequency, f_{LP}.

19.11.1 Setting the Anti-Aliasing Filter

1. Select the low-pass corner frequency you require, f_{LP}, in the range 24 Hz to 22.372 kHz.

   NOTE: the -3dB frequency is 1.06 x f_{LP}.

2. Calculate the necessary anti-aliasing corner frequency, f_{AA}, based on your required low-pass corner frequency, f_{LP}.

$$f_{AA} = 5 \times f_{LP}$$

If $f_{AA} \leq$ 68.57 kHZ, go to step 3.

If f_{AA} > 68.57 kHZ, go to step 5 and use a value of M=255 and K=268.9. This will set the anti-alias corner frequency to its highest value.

3. Select K according to this table:

Anti-Aliasing Corner Frequency, $\mathbf{f_{AA}}$, Range	Use this value for **K**
120 Hz to 4.81 kHz	19.188
>4.81 kHz to 68.57 kHz	268.9

4. Calculate the multiplier value, M, by using this formula:

$$M = \frac{f_{AA}}{K}$$

where f_{AA} is the anti-aliasing corner frequency (in Hz) from step 2

K is the constant selected in step 3

M is the multiplier value. (M should be in the range 6 to 255)

5. Convert **M** to the closest 8 bit binary integer **M0** to **M7**.

6. Set the anti-aliasing filter corner frequency, f_{AA}.
Install/Remove jumpers for the multiplier value **M** and constant **K**, according to the following table. The jumpers corresponding to values **M0** to **M7** are installed according to these rules:

an installed jumper	= 0,	M0 is the least significant bit **(LSB)**
a removed jumper	= 1,	M7 is the most significant bit **(MSB)**

FILTER BOARD
ANTI-ALIASING CORNER FREQUENCY JUMPER TABLE

CHANNEL	K = 19.188 **REMOVE**		K = 268.9 **INSTALL**		(MSB) M7	M6	M5	M4	M3	M2	M1	(LSB) M0
A	W43	W54	W43	W54	W55	W53	W52	W51	W50	W49	W48	W47
B	W56	W57	W56	W57	W77	W75	W74	W73	W72	W71	W70	W69

19.11.2 Setting the Low-Pass Corner Frequency

1) Select a value for clock frequency (fCLK) from this list. We recommend that you start with 3.58 MHZ.

2) Calculate the divider ratio **D** using this equation. is The clock frequency, f_{CLK}, (in Hz) is selected in step 1 and f_{LP} is the desired low pass corner frequency (in Hz).

MHZ	kHz
3.58	500
2	250
1	125

$$D = \frac{f_{CLK}}{40 \times f_{LP}}$$

3) Choose the value for the divider ratio in this list that is closest to the value for D that you calculated in step 2.

4	16	27	35	44	58	85	179
5	18	28	36	45	60	87	188
6	20	29	37	46	61	89	224
9	22	30	38	47	64	90	298
10	23	31	39	50	69	99	358
12	24	32	40	52	74	112	447
14	25	33	41	53	78	128	895
15	26	34	43	56	81	149	2048

CONDITION	ACTION
If the value for the divider ratio from the list in step 3 is...	
within ±1 of the value calculated in step 2	set the jumpers for the low pass corner frequency by continuing with steps 4 and 5.
not within ±1 of the value calculated in step 2	choose the next lower value for clock frequency in the table from step 1 and repeat steps 2 and 3.
If you cannot find values for f_{CLK} and D that give the low pass frequency you need...	use the clock frequency and divider ratio that gives a low-pass corner frequency that is closest to the corner frequency you need.

4. Set the jumpers for the input clock frequency (f_{CLK}) according to this table.

R = REMOVE JUMPER, I = INSTALL JUMPER

SWITCHED CAPACITOR FILTER INPUT CLOCK JUMPER TABLE							
CHANNEL A - CHANNEL B -	W1 W7	W3 W8	W4 W9	W5 W10	W6 W2	W87 W89	W88 W90
3.58 MHZ	R	R	R	R	R	I	R
2 MHZ	I	R	R	R	R	R	I
1 MHZ	R	I	R	R	R	R	I
500 kHz	R	R	I	R	R	R	I
250 kHz	R	R	R	I	R	R	I
125 kHz	R	R	R	R	I	R	I

5. Set the jumpers for the Divider ratio D according to the table on the following page.

19.12 Divider Ratio Table

CHANNEL A - / B -	W80 / W62	W81 / W63	W82 / W64	W44 / W66	W45 / W67	W46 / W68
DIVIDER RATIO **D**						
4	R	R	R	R	R	R
5	R	R	R	R	R	I
6	R	R	R	R	I	R
9	R	R	R	R	I	I
10	R	R	R	I	R	R
12	R	R	R	I	R	I
14	R	R	R	I	I	I
15	R	R	I	R	I	R
16	R	I	R	R	R	R
18	R	I	R	R	R	I
20	R	I	R	R	I	R
22	R	I	R	R	I	I
23	R	R	R	I	I	R
24	R	R	I	R	R	R
25	R	R	I	R	R	I
26	R	R	I	R	I	I
27	R	R	I	I	R	R
28	R	R	I	I	R	I
29	R	R	I	I	I	R
30	R	R	I	I	I	I
31	R	I	R	I	I	R
32	R	I	R	I	I	I
33	R	I	I	R	R	R
34	R	I	I	R	R	I
35	R	I	R	I	R	R
36	R	I	I	R	I	R
37	R	I	I	R	I	I
38	R	I	R	I	R	I
39	R	I	I	I	R	R
40	I	R	R	R	R	R
41	R	I	I	I	R	I
43	R	I	I	I	I	R
44	I	R	R	R	R	I
45	R	I	I	I	I	I
46	I	R	R	R	I	R

CHANNEL A - / B -	W80 / W62	W81 / W63	W82 / W64	W44 / W66	W45 / W67	W46 / W68
DIVIDER RATIO **D**						
47	I	R	R	I	I	R
50	I	R	R	I	I	I
52	I	R	R	R	I	I
53	I	R	I	R	R	R
56	I	R	I	R	R	I
58	I	R	R	I	R	R
60	I	R	I	R	I	R
61	I	R	R	I	R	I
64	I	R	I	R	I	I
69	I	R	I	I	R	R
74	I	R	I	I	R	I
78	I	I	R	R	R	R
81	I	R	I	I	I	R
85	I	I	R	R	R	I
87	I	I	R	R	I	R
89	I	R	I	I	I	I
90	I	I	R	R	I	I
99	I	I	R	I	I	R
112	I	I	R	I	I	I
128	I	I	I	R	R	R
149	I	I	I	R	R	I
179	I	I	I	R	I	R
188	I	I	R	I	R	I
224	I	I	I	R	I	I
298	I	I	I	I	R	R
358	I	I	R	I	R	R
447	I	I	I	I	R	I
895	I	I	I	I	I	R
2048	I	I	I	I	I	I

R = REMOVE JUMPER, I = INSTALL JUMPER

19.13 Example Low-Pass Filter Configuration

This example shows how to configure channel B with a low-pass filter that has a corner frequency, f_{LP}, of 7500 CPM (125 Hz). (The resulting -3dB point is at 1.06 x f_{LP} or 7950 CPM (132.5 Hz). The Low-Pass Filter is before the Integrator/Gain Stage.

NOTE: Since this corner frequency is listed in Section 19.10, you would normally configure the filter from the table. This example is meant to illustrate the calculation procedure used when the desired corner frequency is not given in the table.

Follow the steps outlined in the General Procedure, Section 19.4 for the following two steps.

1. Set the type of filter as a **Low-Pass** filter as shown in the table of Section 19.5. The table in Section 19.5 shows that for a **Low-Pass** filter for channel B

   On the Filter Board

   Install: **W21 and W58**

   Remove: **W20 and W59**

2. Set the Low-Pass Filter before the Integrator/Gain Stage as shown in the table for channel B in Section 19.6.

   On the Main Board

   Install: **W3A,W3C, and W5B**

   Remove: **W3B**

   On the Filter Board

   Install: **W61**

   Remove: **W41,W60,W85 and W86**

Follow the steps outlined in General Procedure, Section 19.4, to set the low-pass corner frequency, f_{LP}.

3. Set the anti-aliasing filter. Select the anti-aliasing corner frequency f_{AA} to band-limit the input signal.

$$f_{AA} = 5 \times 125 = 625$$

4. Select a value, **K**. In this case, f_{AA} is between 120 Hz and 4.81 kHz, so the value of **K** is 19.188.

5. Calculate the multiplier value **M**. In this case:

$$M = \frac{625}{19.188} = 32.57$$

6. Convert **M** to the closest 8 bit binary integer. The closest integer to 32.57 is 33, and the 8 bit binary representation is 00100001. **M7** is the most significant bit **(MSB)**, and **M0** is the least significant bit **(LSB)**.

7. Set the jumpers for the anti-aliasing corner frequency, f_{AA}, according to the Anti-Aliasing Corner Frequency Jumper Table shown earlier in this section.

   On the Filter Board

   Install: **W70,W71,W72,W73,W75, and W77**

   Remove: **W56,W57,W69, and W74**

8. Set the low-pass corner frequency. Step 1 tells you to select a value for clock frequency f_{CLK} beginning with f_{CLK} = 3.58 MHZ.

9. Calculate the divider ratio **D**.

$$D = \frac{3580000}{40 \times 125} = 716$$

10. Look at the Divider Ratio Table to find a match to the divider ratio **D** that was calculated above. There is not a match for **D** = 716 within ±1 in the Divider Ratio Table so select f_{CLK} = 2 MHZ.

11. Calculate **D** with f_{CLK} = 2 MHZ.

$$D = \frac{2000000}{40 \times 125} = 400$$

There is not a match for **D** = 400 within ±1 in the Divider Ratio Table so select f_{CLK} = 1 MHZ.

13. Calculate D with f_{CLK} = 1 MHZ.

$$D = \frac{1000000}{40 \times 125} = 200$$

There is not a match for **D** = 200 within ±1 in the Divider Ratio Table so select f_{CLK} = 500 kHz.

14. Calculate **D** with f_{CLK} = 500 kHz.

$$D = \frac{500000}{40 \times 125} = 100$$

There is a match for **D** = 99 in the Divider Ratio Table. This is within ±1, so select f_{CLK} = 500 kHz.

15. Set the divider ratio, **D**, jumpers that correspond to the divider ratio **D** = 99. Use the Divider Ratio Table to set **D**.

On the Filter Board
Install: **W62,W63,W66, and W67**
Remove: **W64 and W68**

16. Set the input clock frequency, f_{CLK}, jumpers that correspond f_{CLK} = 500 kHz. Use the Switched Capacitor Filter Input Clock Jumper Table to set f_{CLK}.

On the Filter Board
Install: **W9,W90**
Remove: **W2,W7,W8,W10,W89**

17. The filter for channel B is now completely configured. Configure channel A as required and then verify the filter settings as described in Section 19.15.

19.14 Band-Pass Filters

A band-pass filter consists of cascaded high-pass and low-pass filters. To configure the Band-Pass filter, follow the instructions for programming the high-pass and low-pass filters.

The center frequency of the bandpass filter is given by:

$$f_{BP} = \sqrt{f_{LP} \times f_{HP}}$$

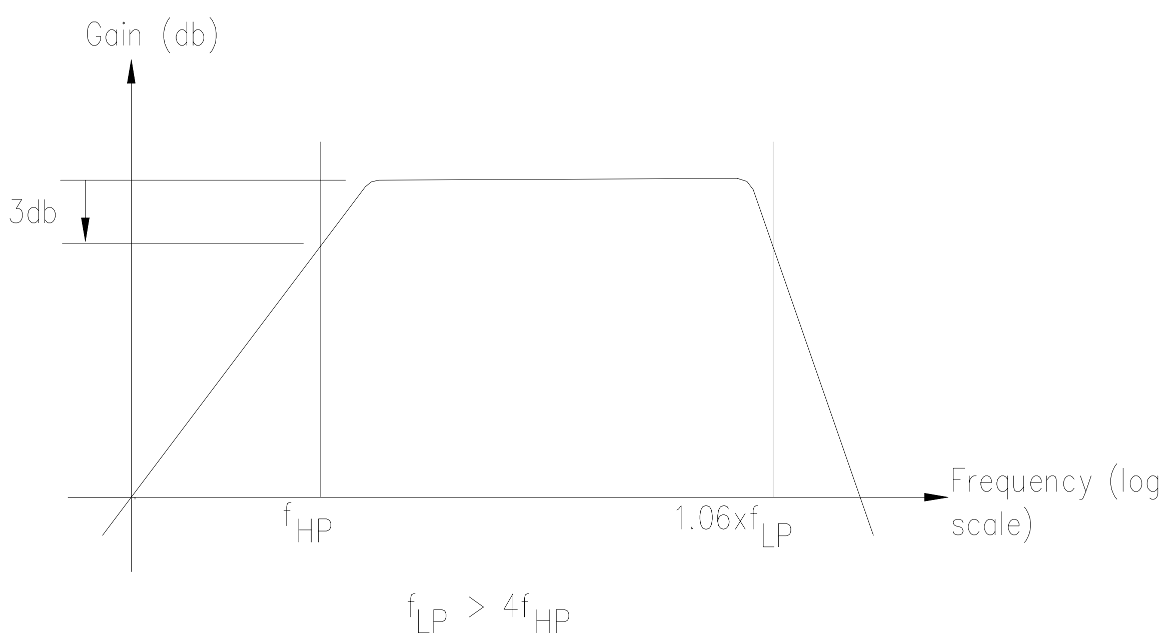
where

f_{BP} = Band-Pass filter center frequency

f_{LP} = Low-Pass filter corner frequency

f_{HP} = High-Pass filter corner frequency

NOTE: The low-pass corner frequency f_{LP} should be four times (or more) the high-pass corner frequency f_{HP}.



19.15 Test Filter Option

This procedure verifies filter settings by using a function generator to simulate a signal with an amplitude equal to full scale at the -3dB frequency. Since the filter attenuates a signal with this frequency by 3dB, the monitor output should be 65% to 75% of full scale.

For some full scale ranges such as those listed in step 5b, the function generator may not be able to output a signal with an amplitude great enough to match the full scale range of the monitor. In this case, use the alternate procedure in Section 19.16 to test the filter.

Channels A and B must be calibrated before doing this test. Refer to Section 15.

If barriers are used, test with barriers in place.

1. Disconnect the transducer input wires from the channel A terminals on the Signal Input Relay Module.
2. Connect a function generator to channel A input terminals as shown in this figure.

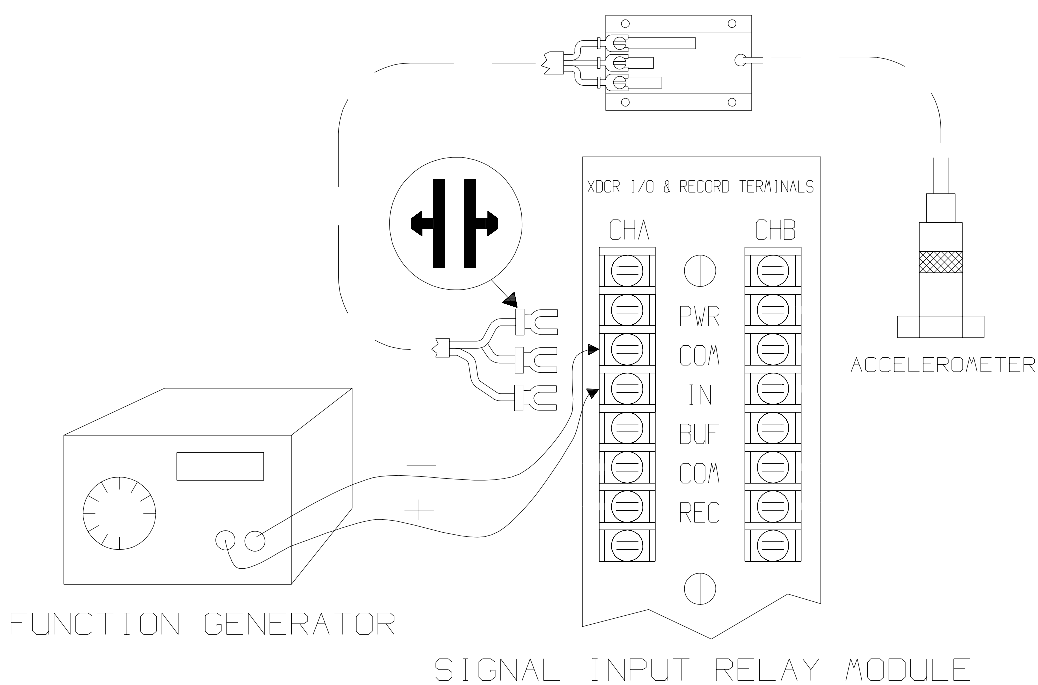
WARNING

High voltage present. Contact could cause shock, burns, or death.

Do not touch exposed wires or terminals.

Caution

Tests will exceed alarm setpoint levels causing alarms to activate. This could result in relay contacts changing state. See Danger Bypass, Section 12.



3. Adjust the settings on the function generator according to this table:

PARAMETER	SETTING
wave form	sine wave
DC offset	-7.5 Vdc
frequency to test high pass filters to test low pass filters	filter corner frequency, f_{HP} (1.06) x (f_{LP})
amplitude	See step 5

4. Determine the Full Scale Range option for your monitor by checking Section 8.2, Monitor Ordering Options.

For Full Scale Range options 01, 02, 03, 04, 11, 12, 13, 14

(Acceleration options)

5a. Set the amplitude of the function generator according to this table:

FULL SCALE OPTION	SIGNAL AMPLITUDE	
	$V_{0\text{-}pk}$ (mVpk)	V_{rms} (mVrms)
01	200	141
02	500	353
03	1000	707
04	2000	1414
11	204	144
12	510	360
13	1020	721
14	2040	1442

For Full Scale Range options 05, 06, 15, 16, 17

(Velocity options)

5b. Calculate the amplitude for the function generator using this formula:

Amplitude = K x corner frequency in Hz

Set the function generator to the calculated amplitude.

FULL SCALE OPTION	K	
	mVpk/Hz	mVrms/Hz
05	1.63	1.15
06	3.25	2.30
15	1.60	1.13
16	3.20	2.27
17	6.41	4.53

See Appendix D, Section 21.4, for derivation of K.

Step 5a continued:	Step 5b continued:
For Full Scale Range options 01, 02, 03, 04, 11, 12, 13, 14	For Full Scale Range options 05, 06, 15, 16, 17
For example, if the Full Scale Range option is 11, set the amplitude to 204 mVpk or 144 mVrms.	For example if the Full Scale Range option is 06 and the corner frequency is 53 Hz, calculate the amplitude like this: Amplitude (mVpk) = (3.25 mVpk/Hz) X (53 Hz) = 172 mVpk or Amplitude (mVrms)= (2.30 mVrms/Hz) X (53 Hz) = 122 mVrms **If the result of this calculation is greater than 3.5 Vpk or 2.47 Vrms or if the signal level is too small to accurately set on the function generator, use the alternate procedure in Section 19.16 to finish testing the filter options.**

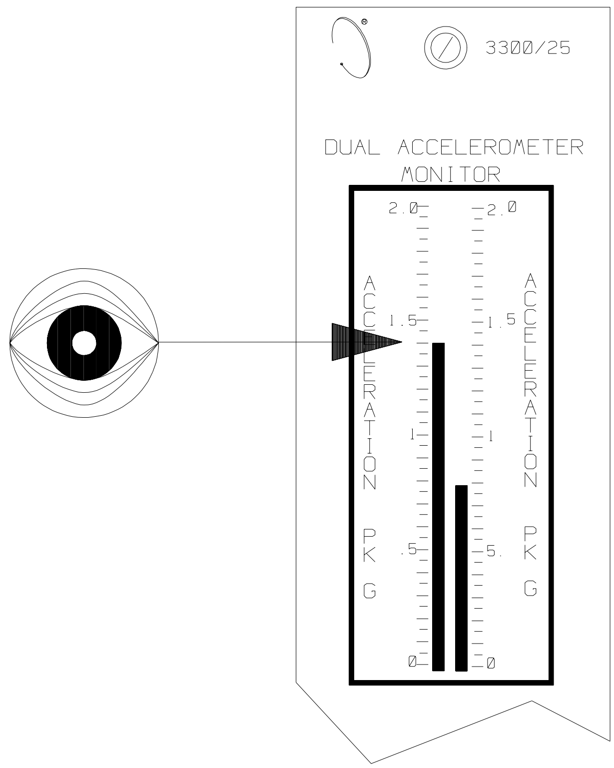
6. Verify that the bargraph for channel A reads 65% to 75% of full scale range, with the following exceptions:

A. The bargraph reading will be lower if you have a High Pass Filter with a corner frequency below 100 Hz and that channel is measuring velocity (Full Scale Range options 05, 06, 15, 16, or 17, see Section 8.2).

Some typical bargraph readings for this configuration are given below.

High Pass Filter corner frequency	Bargraph reading (% of full scale)
10 Hz	43% to 53%
30 Hz	61% to 71%
60 Hz	64% to 74%

B. The bargraph reading may be slightly lower if you have a Low Pass Filter with a corner frequency above 13.7 kHz. The reading will be lowest when the corner frequency is at its highest setting, 22.372 kHz. The bargraph reading for this setting should be 64% to 75% of full scale range.



7. Repeat the test for channel B.

8. Disconnect the test equipment
   and reconnect the transducer input wiring to channels A and B.

9. Turn Danger Bypass off if you turned it on at the beginning of this procedure.

19.16 Test Filter Option (Alternate Procedure)

This procedure should only be used when your Full Scale Range Option is 05, 06, 15, 16, or 17 (see Section 8.2) and the full scale amplitude calculated in step 5b of the main procedure (Section 19.15) is greater than 3.5V or too small to set up accurately on your function generator.

Note: Both channels A and B must be calibrated before performing this test (see Section 15). Test equipment should be set up as shown in step two of Section 19.15. If barriers are used, test with barriers in place.

1. Configure the main board as follows to change the Integrator Stage to a Gain Stage:

Channel A:	Install	**W6B,C**
	Remove	**W6A**
Channel B:	Install	**W3D,E**
	Remove	**W3F**

2. Adjust the frequency of the function generator to the -3dB frequency of the filter. For High Pass Filters, the -3dB frequency is the same as the corner frequency chosen in Section 19.7 or 19.8. For Low Pass Filters, the -3dB frequency is 1.06 times the corner frequency chosen in Section 19.10 or 19.11. Set the amplitude of the function generator for a full scale sine wave signal with a -7.5 Vdc offset:

Full Scale Option		Full Scale Input Voltage	
		Vpk	Vrms
05	0-1 in/s	0.500	0.354
06	0-2 in/s	1.00	0.707
15	0-25 mm/s	0.492	0.348
16	0-50 mm/s	0.984	0.696
17	0-100 mm/s	1.969	1.392

3. Verify that the front panel bargraph for the channel being tested reads 65% to 75% of full scale range.

4. If you are testing a Band Pass Filter, repeat steps two and three at the second -3dB frequency.

5. Configure the main board as follows to change the Gain Stage back to an Integrator Stage:

Channel A:	Install	**W6A**
	Remove	**W6B,C**
Channel B:	Install	**W3F**
	Remove	**W3D,E**

6. Choose an integrator test frequency according to the following criteria:
   A. The test frequency must be within the passband of the filter.
   B. The test frequency cannot be below 100 Hz or in the range 280 Hz to 335 Hz.
   C. The test frequency should be at least a decade away from the filter's -3dB frequency, if possible (i.e., at least ten times the high pass -3dB frequency or no more than one tenth the low pass -3dB frequency).

   If the test frequency is less than a decade away from a filter's -3dB frequency, the bargraph readings made in step eight may be lower than specified.

7. Adjust the function generator frequency to the test frequency. Set the amplitude for a sine wave signal with a -7.5Vdc offset, using the following equation:

$$\text{Amplitude} = K \times F$$

where:

K is found in the table below and f is the test frequency (chosen in step six) in Hertz.

Full Scale Option		K*	
		mV/Hz (peak)	mV/HZ (RMS)
05	0-1 in/s	1.46	1.04
06	0-2 in/s	2.93	2.07
15	0-25 mm/s	1.44	1.02
16	0-50 mm/s	2.89	2.04
17	0-100 mm/s	5.77	4.08

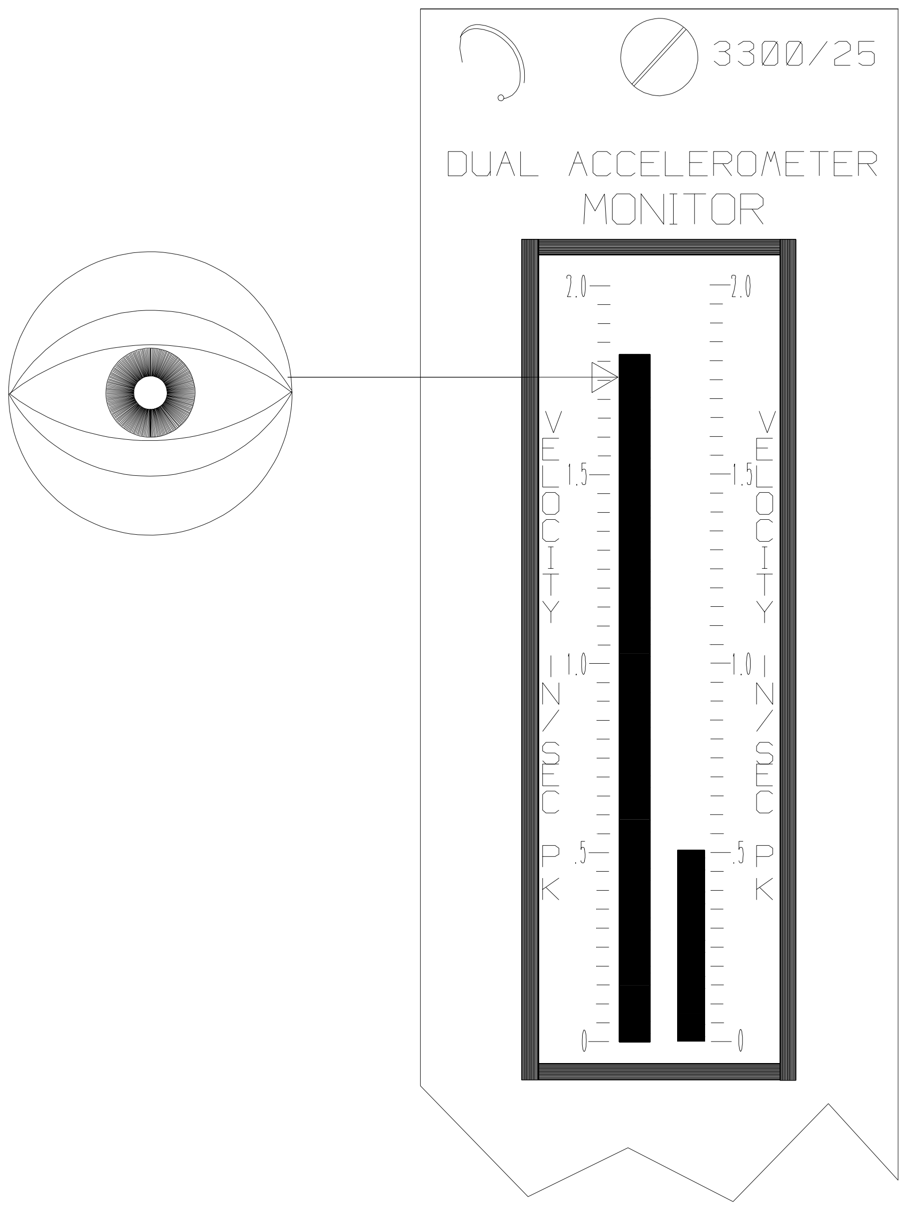
See Appendix D, Section 21.4 for derivation of K.

*K as used in this table is 90% of the calculated value.

8. Verify that the front panel bargraph reads 85% to 95% of full scale range.

The figure below shows a monitor bargraph reading 90% of full scale.

9. Return to step 7 of the main procedure (Section 19.15).



20. Appendix C–Filter Board Options PWA 148921-01

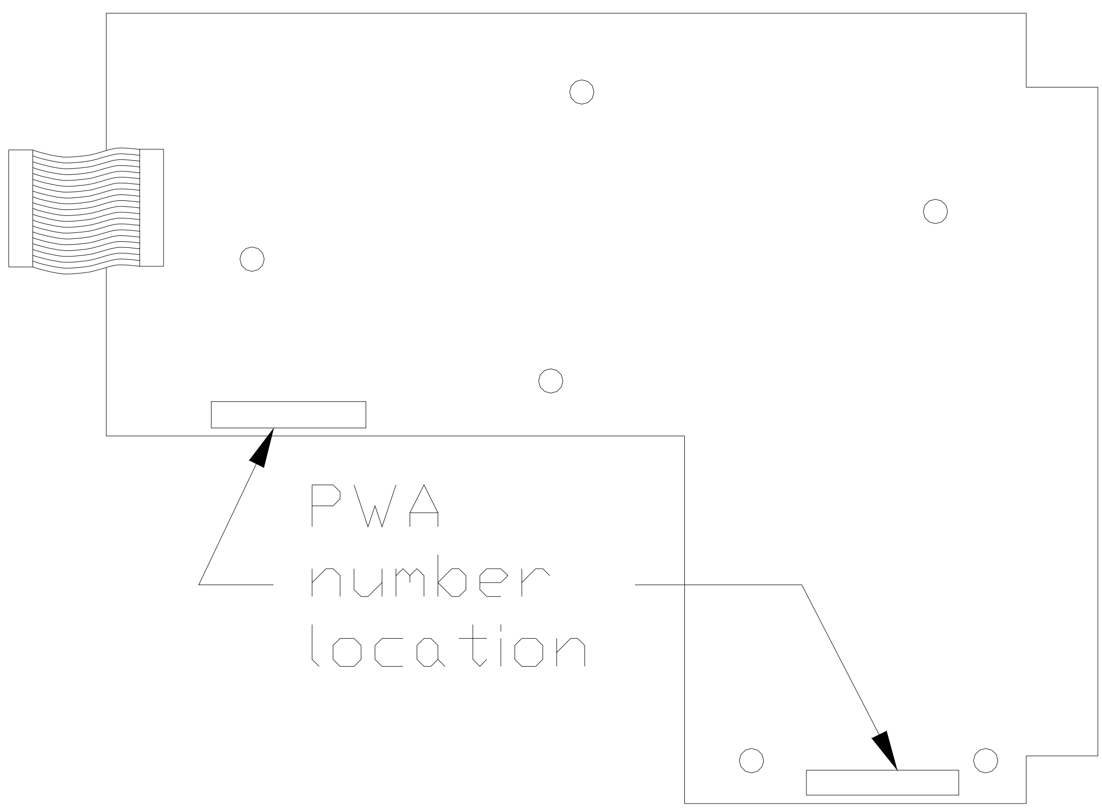
20.1 Identify Filter Board

The configuration of the low pass filter is depends upon which filter board is being used. The filter board can be identified by looking at the PWA (Printed Wiring Assembly) number that is silkscreened on the component side of the board.

The three possibilities are:

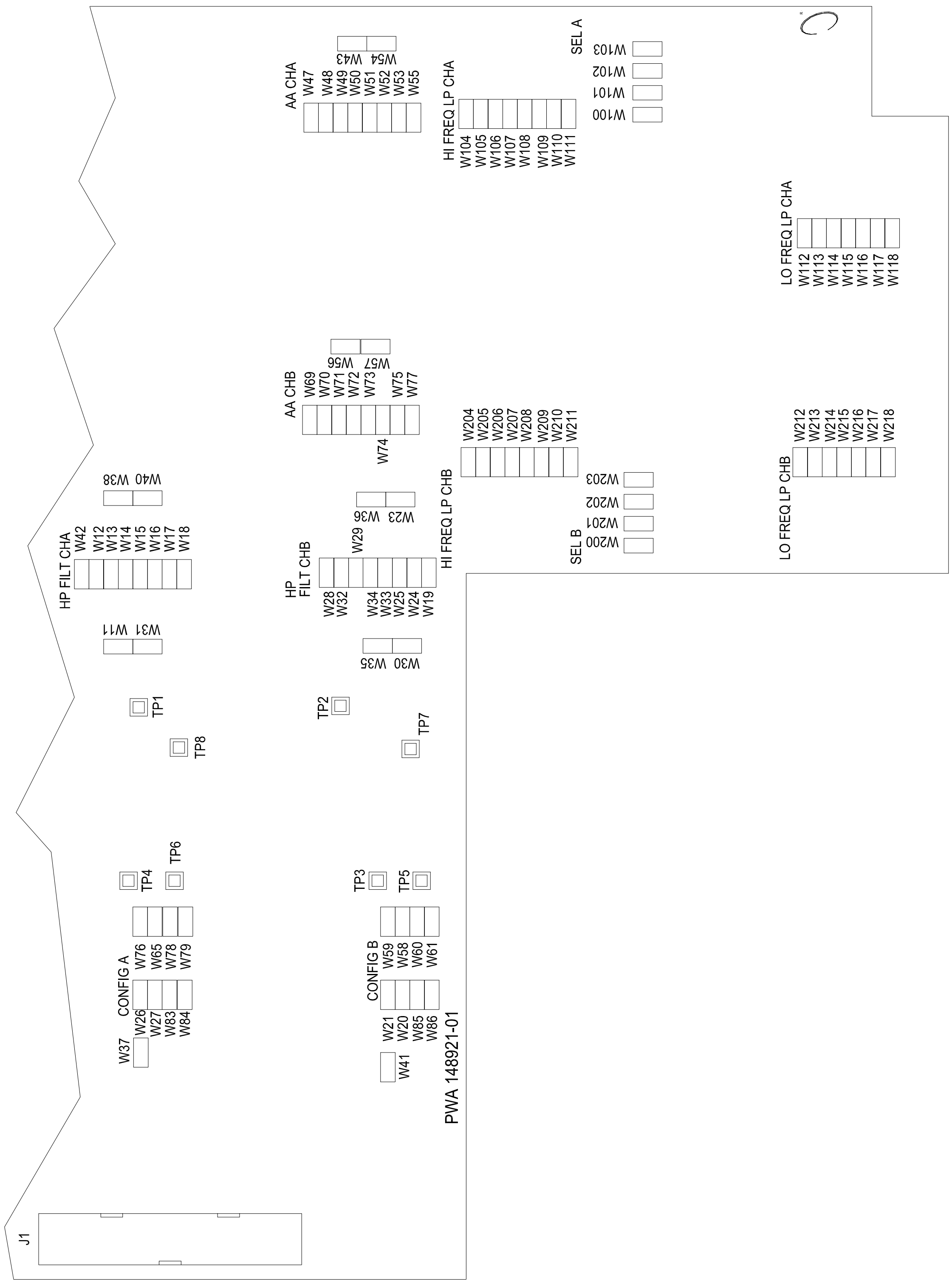
PWA 79562-01 **Refer to Appendix B**

PWA 105521-01 **Refer to Appendix B**



PWA 148921-01 **Refer to Appendix C**

20.2 Filter Board Jumper Locations



20.3 Integrator/Gain Stage Flow Path

This diagram is meant to illustrate the signal path through the Integrator/Gain Stage and the filters. It should not be used to determine jumper configurations. Follow the instructions in Section 20.4 to determine the necessary jumper configuration.

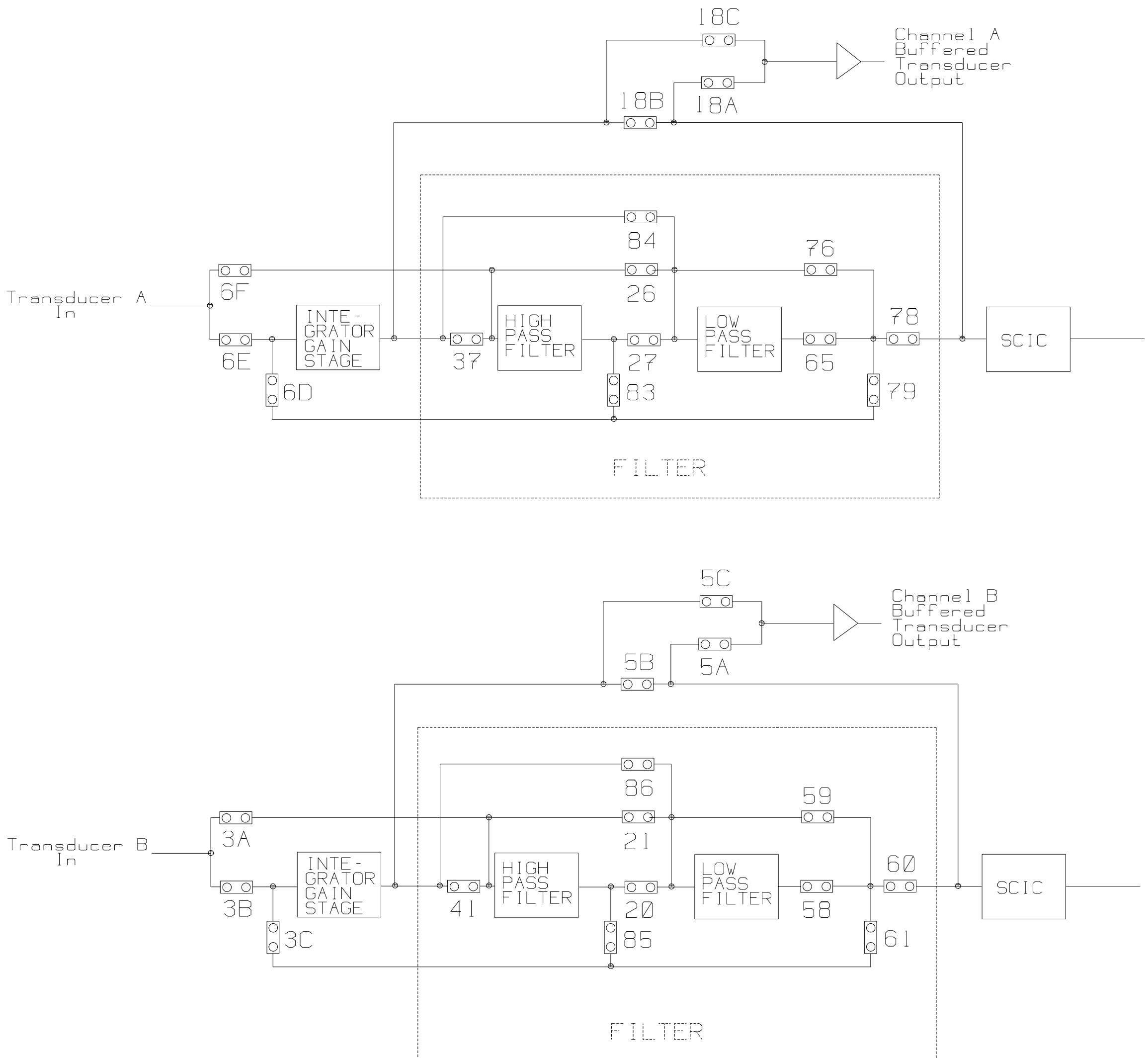


FIGURE 1. SIGNAL FLOW PATH

20.4 General Procedure

Follow these steps, in the order below, to program the monitor to operate with or without filters. After choosing the filter type and the location of the Integrator/Gain Stage you can check the signal flow path using Figure 1 in Section 20.3.

NOTE: Because the calibration procedure requires changing the filter settings, it is recommended that the monitor be calibrated before configuring the filter (See Section 15).

1. Remove the monitor from the rack and disassemble it to allow access to the jumpers on both the Main and Filter boards (See Section 6).

2. Choose the filter type (See Section 20.5). The options are

   - High-Pass (HP) filter
   - Low-Pass (LP) filter
   - Band-Pass (BP) filter
   - No filters

3. Set the Integrator/Gain Stage (See Section 20.6). The options are

   - Integrator/Gain Stage with NO filters
   - Filter after Integrator/Gain Stage
   - Filter before Integrator/Gain Stage
   - High Pass filter before Integrator/Gain Stage and Low Pass filter after Integrator/Gain Stage

4. Set the filter corner frequency.

   - High-Pass filter corner frequency (f_{HP}) (See Section 20.7 or 20.8)
   - Low-Pass filter corner frequency (f_{LP}) (See Section 20.10)
   - Band-Pass filter corner frequencies (f_{HP} and f_{LP}) (See Section 20.11)
   - If you have NO filters, go to step 5.

5. Reassemble the monitor and install it into the rack.

6. Test the filter settings by performing the tests described in Section 20.12.

20.5 Filter Board Options

Choose the filter type by installing and removing the jumpers on the filter board as shown in the table below. See Section 20.2 for the location of the jumpers on the Filter Board.

FILTER TYPE	CHANNEL A		CHANNEL B	
	INSTALL	REMOVE	INSTALL	REMOVE
High Pass (HP) Filter ONLY	W27,76	W26,65	W20,59	W21,58
Low Pass (LP) Filter ONLY	W26,65	W27,76	W21,58	W20,59
Band Pass (BP) Filter	W27,65	W26,76	W20,58	W21,59
High Pass Filter **before** Integrator/Gain Stage and Low Pass Filter **after** the Integrator/Gain Stage	W65,78 W83,84	W26,27 W37,76 W79	W58,60 W85,86	W20,21 W41,59 W61
***NO** Filters		W26,27 W37,65,76 W78,79 W83,84		W20,21 W41,58,59 W60,61 W85,86

***** Denotes standard configuration.

20.6 Integrator/Gain Stage Options

When measuring acceleration, configure the filter after the Integrator/Gain Stage.

When measuring velocity, configure:

the Low-Pass filter after the Integrator/Gain Stage and
the High-Pass filter before the Integrator/Gain Stage

1. Set the location of the Integrator/Gain Stage by installing or removing the jumpers on the main and filter boards as shown in the table below. Refer to Sections 18.1 and 20.2 for the location of jumpers. Figure 1 on page 88 illustrates the signal flow path for different jumper configurations.

2. See Section 18.7 for the configuration of the Buffered Outputs.

Channel A Integrator/Gain stage Location

INTEGRATOR/GAIN STAGE LOCATION	CHANNEL A			
	Main Board		**Filter Board**	
	INSTALL	REMOVE	INSTALL	REMOVE
*Integrator/Gain Stage with **NO** Filtering	W18B,6E	W6D,6F		W37,78 W79,83 W84
Filter **after Integrator/Gain Stage	W6E	W6D,6F W18B	W37,78	W79,83 W84
Filter **before** Integrator/Gain Stage	W6D,6F W18B	W6E	W79	W37,78 W83,84
High Pass Filter **before** Integrator/Gain Stage and Low Pass Filter **after** the Integrator/Gain Stage	W6D,6F	W6E,18B	W65,78 W83,84	W26,27 W37,76 W79

***** Denotes standard configuration

****** When filtering without integration, set the filter **after** the Integrator/Gain Stage.

Channel B Integrator/Gain Stage Location

INTEGRATOR/GAIN STAGE LOCATION	**CHANNEL B**			
	Main Board		**Filter Board**	
	INSTALL	REMOVE	INSTALL	REMOVE
***Integrator/Gain Stage with **NO** Filtering	W5B,3B	W3A,3C		W41,60 W61,85 W86
****Filter **after** the Integrator/Gain Stage	W3B	W3A,3C W5B	W41,60	W61,85 W86
Filter **before** the Integrator/Gain Stage	W3A,3C W5B	W3B	W61	W41,60 W85,86
High Pass Filter **before** the Integrator/Gain Stage and Low Pass Filter **after** the Integrator/Gain Stage	W3A,3C	W3B,5B	W58,60 W85,86	W20,21 W41,59 W61

***** Denotes standard configuration.
****** When filtering without integration, set the filter **after** the Integrator/Gain Stage.

NOTE: If you have chosen the **NO Filtering** option, then you have completed your filter Configuration.

When measuring velocity, low frequency signals can cause the monitor to saturate.

20.7 High Pass Filter Options

Install the jumpers on the filter board as shown in this table. Select frequencies not listed in this table by using the procedure in Section 20.7.

CHANNEL A- CHANNEL B-		W11 W23	W31 W30	W38 W35	W40 W36	W18 W19	W17 W24	W16 W25	W15 W33	W14 W34	W13 W29	W12 W32	W42 W28
Hz	CPM												
3.7	222	R	R	R	R	I	I	I	I	I	I	R	R
5.0	300	R	R	R	R	I	I	I	I	I	R	I	I
6.2	372	R	R	R	R	I	I	I	I	I	R	I	R
7.5	450	R	R	R	R	I	I	I	I	I	R	R	I
9.9	594	R	R	R	R	I	I	I	I	R	I	I	I
12.5	750	R	R	R	R	I	I	I	I	R	I	R	I
16.2	972	R	R	R	R	I	I	I	I	R	R	I	R
22.4	1344	R	R	R	R	I	I	I	R	I	I	R	I
24.9	1494	R	R	R	R	I	I	I	R	I	R	I	I
28.7	1722	R	R	R	R	I	I	I	R	I	R	R	R
33.7	2022	R	R	R	R	I	I	I	R	R	I	R	R
37.4	2244	R	R	R	R	I	I	I	R	R	R	R	I
42.4	2544	R	R	R	R	I	I	R	I	I	I	R	I
46.1	2766	R	R	R	R	I	I	R	I	I	R	I	R
49.8	2988	R	R	R	R	I	I	R	I	R	I	I	I
54.8	3288	R	R	R	R	I	I	R	I	R	R	I	I
58.6	3516	R	R	R	R	I	I	R	I	R	R	R	R
62.3	3738	R	R	R	R	I	I	R	R	I	I	R	I
67.3	4038	R	R	R	R	I	I	R	R	I	R	R	I
74.8	4488	R	R	R	R	I	I	R	R	R	R	I	I
83.5	5010	R	R	R	R	I	R	I	I	I	I	R	R
92.2	5532	R	R	R	R	I	R	I	I	R	I	R	I
101	6060	R	R	R	R	I	R	I	R	I	I	I	R
112	6720	R	R	R	R	I	R	I	R	R	I	R	I
117	7020	R	R	R	R	I	R	I	R	R	R	R	I
121	7260	R	R	R	R	I	R	R	I	I	I	I	R
126	7560	R	R	R	R	I	R	R	I	I	R	I	R
135	8100	R	R	R	R	I	R	R	I	R	R	I	I
142	8520	R	R	R	R	I	R	R	R	I	I	R	I
151	9060	R	R	R	R	I	R	R	R	R	I	I	R

R = REMOVE JUMPER, I = INSTALL JUMPER

This table is continued on the next page.

CHANNEL A - CHANNEL B -		W11 W23	W31 W30	W38 W35	W40 W36	W18 W19	W17 W24	W16 W25	W15 W33	W14 W34	W13 W29	W12 W32	W42 W28
Hz	CPM												
167	10020	R	R	R	R	R	I	I	I	I	R	R	I
176	10560	R	R	R	R	R	I	I	I	R	R	I	R
183	10980	R	R	R	R	R	I	I	R	I	I	R	R
192	11520	R	R	R	R	R	I	I	R	R	I	R	I
201	12060	R	R	R	R	R	I	R	I	I	I	I	R
208	12480	R	R	R	R	R	I	R	I	I	R	R	R
217	13020	R	R	R	R	R	I	R	I	R	R	R	I
226	13560	R	R	R	R	R	I	R	R	I	R	I	R
234	14040	R	R	R	R	R	I	R	R	R	R	I	I
242	14520	R	R	R	R	R	R	I	I	I	I	R	I
251	15060	R	R	R	R	R	R	I	I	R	I	I	R
268	16080	R	R	R	R	R	R	I	R	I	R	R	R
275	16500	R	R	R	R	R	R	I	R	R	R	I	R
284	17040	R	R	R	R	R	R	R	I	I	R	I	I
292	17520	R	R	R	R	R	R	R	I	R	I	R	I
300	18000	R	R	R	R	R	R	R	R	I	I	I	R
309	18540	R	R	R	R	R	R	R	R	R	I	I	I
496	29760	I	I	I	I	I	I	R	I	R	I	R	I
755	45300	I	I	I	I	I	R	I	I	I	I	I	I
1003	60180	I	I	I	I	I	R	I	R	I	R	I	R
2006	120360	I	I	I	I	R	I	R	I	R	I	R	I
2996	179760	I	I	I	I	R	R	R	R	R	R	R	I

R = REMOVE JUMPER, I = INSTALL JUMPER

Use the procedure in the following section to set a high-pass corner frequency not listed in the table.

20.8 Non Standard High Pass Filter Options

Follow this procedure only if the desired high-pass corner frequency is not listed in the table in the previous section.

1. Select a high-pass corner frequency, f_{hp}, in the range 3.7 Hz to 3008 Hz.

2. Select a value, **K**, according to this table:

If your frequency is within this range,	Use this value for **K**
3.7 Hz to 318 Hz	1.246
319 Hz to 3008 Hz	11.797

3. Calculate the multiplier value, D, by using this formula:

$$D = \frac{f_{HP}}{K}$$

where

f_{HP} is the high-pass corner frequency from step 1
K is the constant selected in step 2
D is the multiplier value (D should be in the range 3 to 255)

4. Convert **D** to the closest 8 bit binary integer, D0 to D7.

5. Install/Remove jumpers according to the following table. The jumpers corresponding to values D0 to D7 are installed according to these rules:

an installed jumper = 0, D0 is the least significant bit (**LSB**)
a removed jumper = 1, D7 is the most significant bit (**MSB**)

CHANNEL	K = 1.246 **REMOVE**	K = 11.797 **INSTALL**	(MSB) D7	D6	D5	D4	D3	D2	D1	(LSB) D0
A	W11 W31 W38 W40	W11 W31 W38 W40	W18	W17	W16	W15	W14	W13	W12	W42
B	W23 W30 W35 W36	W23 W30 W35 W36	W19	W24	W25	W33	W34	W29	W32	W28

20.9 Example High-Pass Filter Configuration

This example shows how to configure channel A with a high-pass filter that has a corner frequency, f_{hp}, of 24000 CPM (400 Hz). The High Pass Filter is located after the Integrator/Gain Stage. (While working through this example you can refer to the procedure for setting the high-pass filter which is at the start of this section).

Follow the steps outlined in the Filter Configuration Section.

1. Set the type of filter as a High-Pass filter as shown in the table of Section 20.5. The table in Section 20.5 shows that for a High-Pass filter for channel A

   Install: **W27 and W76**
   Remove: **W26 and W65**

2. Set the High Pass Filter after the Integrator/Gain Stage as shown in the table for channel A in Section 20.6.

   On the Main Board
   Install: **W6E**
   Remove: **W6D,W6F, and W18B**

   On the Filter Board
   Install: **W37,W78**
   Remove: **W79,W83, and W84**

3. Set the high-pass filter corner frequency f_{hp}. Since the desired f_{hp} is not in the High-Pass Freq. Configuration Table Section, you will need to refer to the Non Standard High Filter Options, Section 20.8, for the jumper configuration.

4. f_{hp} is between 319 Hz and 3008 Hz, so the value of K is 11.797. Set the following jumpers for K = 11.797 (shown in the table in Section 27.5).

   Install: **W11,W31,W38,W40**

8. Use the formula in step 3 of Section 20.8 to obtain a value for the multiplier, **D**. In this case:

$$D = \frac{400}{11.797}$$

The result is **D** = 33.9

9. Step 4 of Section 20.8 requires that you convert **D** to the closest 8 bit binary integer. The closest integer to 33.9 is 34, and the 8 bit binary representation is 00100010. **D7** is the most significant bit **(MSB)**, and **D0** is the least significant bit **(LSB)**.

10. Complete the filter configuration by installing jumpers according to step 5 of Section 20.8. To configure the filter board for the high-pass corner frequency f_{hp} = 400 Hz

Install:	**W13,W14,W15,W17,W18, and W42**
Remove:	**W12 and W16**

9. Channel A of the filter board is now completely configured. Configure channel B as required and then verify the filter settings as described in the Test Filter Option, Section 20.12.

20.10 Low Pass Filter Options

Configure the low pass filters using the following tables. The jumper settings at the tops of the pages apply to all frequencies (rotational speeds) on their respective pages.

All possible cutoff frequencies are listed. There is no formula for calculating other cutoff frequencies.

The -3dB frequency occurs at the frequencies listed in the following tables. This is different from the older filter boards (PWA 79562-01 and PWA 105521-01) that have their corners occurring at a slightly different frequency.

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Low Pass Filter Options

W43 W56	W54 W57	W100 W200	W101 W201	W102 W202	W103 W203	Ch. A Ch. B
R	R	I	R	R	I	

	Ch. A Ch. B	W47 W69	W48 W70	W49 W71	W50 W72	W51 W73	W52 W74	W53 W75	W55 W77
Hz	CPM								
23	1380	R	R	R	I	I	I	I	I
31	1860	R	I	I	R	I	I	I	I
39	2340	R	R	I	R	I	I	I	I
47	2820	R	I	R	R	I	I	I	I
55	3300	R	R	R	R	I	I	I	I
63	3780	R	I	I	I	R	I	I	I
71	4260	R	R	I	I	R	I	I	I
78	4680	R	I	R	I	R	I	I	I
86	5160	R	R	R	I	R	I	I	I
94	5640	R	I	I	R	R	I	I	I
102	6120	R	R	I	R	R	I	I	I
110	6600	R	I	R	R	R	I	I	I
117	7020	R	R	R	R	R	I	I	I
126	7560	R	I	I	I	I	R	I	I
133	7980	R	R	I	I	I	R	I	I
141	8460	R	I	R	I	I	R	I	I
149	8940	R	R	R	I	I	R	I	I
157	9420	R	I	I	R	I	R	I	I
165	9900	R	R	I	R	I	R	I	I
172	10320	R	I	R	R	I	R	I	I
180	10800	R	R	R	R	I	R	I	I
188	11280	I	R	I	I	R	R	I	I
196	11760	I	I	R	I	R	R	I	I
204	12240	I	R	R	I	R	R	I	I
212	12720	I	I	I	R	R	R	I	I
220	13200	I	R	I	R	R	R	I	I
227	13620	I	I	R	R	R	R	I	I
235	14100	I	R	R	R	R	R	I	I
243	14580	I	I	I	I	I	I	R	I
250	15000	I	R	I	I	I	I	R	I
258	15480	I	I	R	I	I	I	R	I
266	15960	I	R	R	I	I	I	R	I

R = REMOVE JUMPER, I = INSTALL JUMPER. This table is two pages wide.

Low Pass Filter Options (Continued)

Ch. A Ch. B	W104 W204	W105 W205	W106 W206	W107 W207	W108 W208	W109 W209	W110 W210	W111 W211
	R	R	R	R	R	R	R	R

W112 W212	W113 W213	W114 W214	W115 W215	W116 W216	W117 W217	W118 W218	Ch. A Ch. B	
							Hz	CPM
I	I	R	R	R	R	R	23	1380
R	R	I	R	R	R	R	31	1860
I	R	I	R	R	R	R	39	2340
R	I	I	R	R	R	R	47	2820
I	I	I	R	R	R	R	55	3300
R	R	R	I	R	R	R	63	3780
I	R	R	I	R	R	R	71	4260
R	I	R	I	R	R	R	78	4680
I	I	R	I	R	R	R	86	5160
R	R	I	I	R	R	R	94	5640
I	R	I	I	R	R	R	102	6120
R	I	I	I	R	R	R	110	6600
I	I	I	I	R	R	R	117	7020
R	R	R	R	I	R	R	126	7560
I	R	R	R	I	R	R	133	7980
R	I	R	R	I	R	R	141	8460
I	I	R	R	I	R	R	149	8940
R	R	I	R	I	R	R	157	9420
I	R	I	R	I	R	R	165	9900
R	I	I	R	I	R	R	172	10320
I	I	I	R	I	R	R	180	10800
R	R	R	I	I	R	R	188	11280
I	R	R	I	I	R	R	196	11760
R	I	R	I	I	R	R	204	12240
I	I	R	I	I	R	R	212	12720
R	R	I	I	I	R	R	220	13200
I	R	I	I	I	R	R	227	13620
R	I	I	I	I	R	R	235	14100
I	I	I	I	I	R	R	243	14580
R	R	R	R	R	I	R	250	15000
I	R	R	R	R	I	R	258	15480
R	I	R	R	R	I	R	266	15960

R = REMOVE JUMPER, I = INSTALL JUMPER. This table continues on the next page.

Low Pass Filter Options (Continued)

W43 W56	W54 W57	W100 W200	W101 W201	W102 W202	W103 W203	Ch. A Ch. B
R	R	I	R	R	I	

	Ch. A Ch. B	W47 W69	W48 W70	W49 W71	W50 W72	W51 W73	W52 W74	W53 W75	W55 W77
Hz	CPM								
274	16440	I	I	I	R	I	I	R	I
282	16920	I	R	I	R	I	I	R	I
289	17340	I	I	R	R	I	I	R	I
297	17820	I	R	R	R	I	I	R	I
305	18300	I	I	I	I	R	I	R	I
313	18780	I	R	I	I	R	I	R	I
321	19260	I	I	R	I	R	I	R	I
329	19740	R	I	R	I	R	I	R	I
337	20220	I	I	I	R	R	I	R	I
344	20640	I	R	I	R	R	I	R	I
360	21600	I	R	R	R	R	I	R	I
368	22080	I	I	I	I	I	R	R	I
376	22560	I	R	I	I	I	R	R	I
384	23040	I	I	R	I	I	R	R	I
392	23520	I	R	R	I	I	R	R	I
399	23940	I	I	I	R	I	R	R	I
407	24420	I	R	I	R	I	R	R	I
415	24900	R	I	R	R	I	R	R	I
423	25380	R	R	R	R	I	R	R	I
431	25860	R	I	I	I	R	R	R	I
439	26340	R	R	I	I	R	R	R	I
446	26760	R	I	R	I	R	R	R	I
454	27240	R	R	R	I	R	R	R	I
462	27720	R	I	I	R	R	R	R	I
470	28200	R	R	I	R	R	R	R	I
478	28680	R	I	R	R	R	R	R	I
486	29160	R	R	R	R	R	R	R	I
493	29580	R	I	I	I	I	I	I	R
501	30060	R	R	I	I	I	I	I	R
509	30540	R	I	R	I	I	I	I	R
516	30960	R	R	R	I	I	I	I	R

R = REMOVE JUMPER, I = INSTALL JUMPER. This table is two pages wide.

Low Pass Filter Options (Continued)

Ch. A Ch. B	W104 W204	W105 W205	W106 W206	W107 W207	W108 W208	W109 W209	W110 W210	W111 W211
	R	R	R	R	R	R	R	R

W112 W212	W113 W213	W114 W214	W115 W215	W116 W216	W117 W217	W118 W218	Ch. A Ch. B	
							Hz	CPM
I	I	R	R	R	I	R	274	16440
R	R	I	R	R	I	R	282	16920
I	R	I	R	R	I	R	289	17340
R	I	I	R	R	I	R	297	17820
I	I	I	R	R	I	R	305	18300
R	R	R	I	R	I	R	313	18780
I	R	R	I	R	I	R	321	19260
R	I	R	I	R	I	R	329	19740
I	I	R	I	R	I	R	337	20220
R	R	I	I	R	I	R	344	20640
I	R	I	I	R	I	R	352	21120
R	I	I	I	R	I	R	360	21600
I	I	I	I	R	I	R	368	22080
R	R	R	R	I	I	R	376	22560
I	R	R	R	I	I	R	384	23040
R	I	R	R	I	I	R	392	23520
I	I	R	R	I	I	R	399	23940
R	R	I	R	I	I	R	407	24420
I	R	I	R	I	I	R	415	24900
R	I	I	R	I	I	R	423	25380
I	I	I	R	I	I	R	431	25860
R	R	R	I	I	I	R	439	26340
I	R	R	I	I	I	R	446	26760
R	I	R	I	I	I	R	454	27240
I	I	R	I	I	I	R	462	27720
R	R	I	I	I	I	R	470	28200
I	R	I	I	I	I	R	478	28680
R	I	I	I	I	I	R	486	29160
I	I	I	I	I	I	R	493	29580
R	R	R	R	R	R	I	501	30060
I	R	R	R	R	R	I	509	30540
R	I	R	R	R	R	I	516	30960

R = REMOVE JUMPER, I = INSTALL JUMPER. This table continues on the next page.

Low Pass Filter Options (Continued)

W43 W56	W54 W57	W100 W200	W101 W201	W102 W202	W103 W203	Ch. A Ch. B
R	R	I	R	R	I	

	Ch. A Ch. B	W47 W69	W48 W70	W49 W71	W50 W72	W51 W73	W52 W74	W53 W75	W55 W77
Hz	CPM								
524	31440	R	I	I	R	I	I	I	R
532	31920	R	R	I	R	I	I	I	R
540	32400	R	I	R	R	I	I	I	R
548	32880	R	R	R	R	I	I	I	R
555	33300	R	I	I	I	R	I	I	R
564	33840	R	R	I	I	R	I	I	R
571	34260	R	I	R	I	R	I	I	R
579	34740	R	R	R	I	R	I	I	R
587	35220	R	I	I	R	R	I	I	R
595	35700	R	R	I	R	R	I	I	R
603	36180	R	I	R	R	R	I	I	R
610	36600	R	R	R	R	R	I	I	R
618	37080	R	I	I	I	I	R	I	R
626	37560	I	I	R	I	I	R	I	R
634	38040	I	R	R	I	I	R	I	R
642	38520	I	I	I	R	I	R	I	R
650	39000	I	R	I	R	I	R	I	R
658	39480	I	I	R	R	I	R	I	R
665	39900	I	R	R	R	I	R	I	R
673	40380	I	I	I	I	R	R	I	R
681	40860	I	R	I	I	R	R	I	R
689	41340	I	I	R	I	R	R	I	R
697	41820	I	R	R	I	R	R	I	R
705	42300	I	I	I	R	R	R	I	R
712	42720	I	R	I	R	R	R	I	R
720	43200	I	I	R	R	R	R	I	R
728	43680	I	R	R	R	R	R	I	R
736	44160	I	I	I	I	I	I	R	R
744	44640	I	R	I	I	I	I	R	R
751	45060	I	I	R	I	I	I	R	R

R = REMOVE JUMPER, I = INSTALL JUMPER. This table is two pages wide.

Low Pass Filter Options (Continued)

Ch. A Ch. B	W104 W204	W105 W205	W106 W206	W107 W207	W108 W208	W109 W209	W110 W210	W111 W211
	R	R	R	R	R	R	R	R

W112 W212	W113 W213	W114 W214	W115 W215	W116 W216	W117 W217	W118 W218	Ch. A Ch. B	
							Hz	CPM
I	I	R	R	R	R	I	524	31440
R	R	I	R	R	R	I	532	31920
I	R	I	R	R	R	I	540	32400
R	I	I	R	R	R	I	548	32880
I	I	I	R	R	R	I	555	33300
R	R	R	I	R	R	I	564	33840
I	R	R	I	R	R	I	571	34260
R	I	R	I	R	R	I	579	34740
I	I	R	I	R	R	I	587	35220
R	R	I	I	R	R	I	595	35700
I	R	I	I	R	R	I	603	36180
R	I	I	I	R	R	I	610	36600
I	I	I	I	R	R	I	618	37080
R	R	R	R	I	R	I	626	37560
I	R	R	R	I	R	I	634	38040
R	I	R	R	I	R	I	642	38520
I	I	R	R	I	R	I	650	39000
R	R	I	R	I	R	I	658	39480
I	R	I	R	I	R	I	665	39900
R	I	I	R	I	R	I	673	40380
I	I	I	R	I	R	I	681	40860
R	R	R	I	I	R	I	689	41340
I	R	R	I	I	R	I	697	41820
R	I	R	I	I	R	I	705	42300
I	I	R	I	I	R	I	712	42720
R	R	I	I	I	R	I	720	43200
I	R	I	I	I	R	I	728	43680
R	I	I	I	I	R	I	736	44160
I	I	I	I	I	R	I	744	44640
R	R	R	R	R	I	I	751	45060

R = REMOVE JUMPER, I = INSTALL JUMPER. This table continues on the next page.

Low Pass Filter Options (Continued)

W43 W56	W54 W57	W100 W200	W101 W201	W102 W202	W103 W203	Ch. A Ch. B
R	R	I	R	R	I	

Hz	Ch. A Ch. B CPM	W47 W69	W48 W70	W49 W71	W50 W72	W51 W73	W52 W74	W53 W75	W55 W77
759	45540	I	R	R	I	I	I	R	R
767	46020	I	I	I	R	I	I	R	R
775	46500	I	R	I	R	I	I	R	R
782	46920	I	I	R	R	I	I	R	R
790	47400	I	R	R	R	I	I	R	R
798	47880	I	I	I	I	R	I	R	R
806	48360	I	R	I	I	R	I	R	R
814	48840	I	I	R	I	R	I	R	R
822	49320	R	R	R	I	R	I	R	R
830	49800	R	I	I	R	R	I	R	R
837	50220	R	R	I	R	R	I	R	R
845	50700	R	I	R	R	R	I	R	R
853	51180	R	R	R	R	R	I	R	R
861	51660	R	I	I	I	I	R	R	R
869	52140	R	R	I	I	I	R	R	R
877	52620	R	I	R	I	I	R	R	R
885	53100	R	R	R	I	I	R	R	R
892	53520	R	I	I	R	I	R	R	R
900	54000	R	R	I	R	I	R	R	R
908	54480	R	I	R	R	I	R	R	R
916	54960	R	R	R	R	I	R	R	R
924	55440	R	I	I	I	R	R	R	R
931	55860	R	R	I	I	R	R	R	R
939	56340	R	I	R	I	R	R	R	R
947	56820	R	R	R	I	R	R	R	R
955	57300	R	I	I	R	R	R	R	R
963	57780	R	R	I	R	R	R	R	R
971	58260	R	I	R	R	R	R	R	R
979	58740	R	R	R	R	R	R	R	R

R = REMOVE JUMPER, I = INSTALL JUMPER. This table is two pages wide.

Low Pass Filter Options (Continued)

Ch. A Ch. B	W104 W204	W105 W205	W106 W206	W107 W207	W108 W208	W109 W209	W110 W210	W111 W211
	R	R	R	R	R	R	R	R

W112 W212	W113 W213	W114 W214	W115 W215	W116 W216	W117 W217	W118 W218	Ch. A Ch. B	
							Hz	CPM
I	R	R	R	R	I	I	759	45540
R	I	R	R	R	I	I	767	46020
I	I	R	R	R	I	I	775	46500
R	R	I	R	R	I	I	782	46920
I	R	I	R	R	I	I	790	47400
R	I	I	R	R	I	I	798	47880
I	I	I	R	R	I	I	806	48360
R	R	R	I	R	I	I	814	48840
I	R	R	I	R	I	I	822	49320
R	I	R	I	R	I	I	830	49800
I	I	R	I	R	I	I	837	50220
R	R	I	I	R	I	I	845	50700
I	R	I	I	R	I	I	853	51180
R	I	I	I	R	I	I	861	51660
I	I	I	I	R	I	I	869	52140
R	R	R	R	I	I	I	877	52620
I	R	R	R	I	I	I	885	53100
R	I	R	R	I	I	I	892	53520
I	I	R	R	I	I	I	900	54000
R	R	I	R	I	I	I	908	54480
I	R	I	R	I	I	I	916	54960
R	I	I	R	I	I	I	924	55440
I	I	I	R	I	I	I	931	55860
R	R	R	I	I	I	I	939	56340
I	R	R	I	I	I	I	947	56820
R	I	R	I	I	I	I	955	57300
I	I	R	I	I	I	I	963	57780
R	R	I	I	I	I	I	971	58260
I	R	I	I	I	I	I	979	58740

R = REMOVE JUMPER, I = INSTALL JUMPER. This table continues on the next page.

Low Pass Filter Options (Continued)

W43 W56	W54 W57	W100 W200	W101 W201	W102 W202	W103 W203	Ch. A Ch. B
I	I	I	R	R	I	

	Ch. A Ch. B	W47 W69	W48 W70	W49 W71	W50 W72	W51 W73	W52 W74	W53 W75	W55 W77
Hz	CPM								
986	59160	R	R	I	I	R	I	I	I
994	59640	R	R	I	I	R	I	I	I

R = REMOVE JUMPER, I = INSTALL JUMPER. This table is two pages wide.

Low Pass Filter Options (Continued)

Ch. A Ch. B	W104 W204	W105 W205	W106 W206	W107 W207	W108 W208	W109 W209	W110 W210	W111 W211
	R	R	R	R	R	R	R	R

W112 W212	W113 W213	W114 W214	W115 W215	W116 W216	W117 W217	W118 W218	Ch. A Ch. B	
							Hz	CPM
R	I	I	I	I	I	I	986	59160
I	I	I	I	I	I	I	994	59640

R = REMOVE JUMPER, I = INSTALL JUMPER.

Low Pass Filter Options (Continued)

W43 W56	W54 W57	W100 W200	W101 W201	W102 W202	W103 W203	Ch. A Ch. B
I	I	R	R	I	R	

	Ch. A Ch. B	W47 W69	W48 W70	W49 W71	W50 W72	W51 W73	W52 W74	W53 W75	W55 W77
Hz	CPM								
1002	60120	R	R	I	I	R	I	I	I
1042	62520	I	I	R	I	R	I	I	I
1082	64920	R	I	R	I	R	I	I	I
1123	67380	R	I	R	I	R	I	I	I
1163	69780	I	R	R	I	R	I	I	I
1203	72180	R	R	R	I	R	I	I	I
1243	74580	I	I	I	R	R	I	I	I
1282	76920	I	I	I	R	R	I	I	I
1322	79320	R	I	I	R	R	I	I	I
1362	81720	I	R	I	R	R	I	I	I
1402	84120	R	R	I	R	R	I	I	I
1443	86580	R	R	I	R	R	I	I	I
1483	88980	I	I	R	R	R	I	I	I
1523	91380	R	I	R	R	R	I	I	I
1563	93780	I	R	R	R	R	I	I	I
1603	96180	I	R	R	R	R	I	I	I
1643	98580	R	R	R	R	R	I	I	I
1683	100980	I	I	I	I	I	R	I	I
1723	103380	R	I	I	I	I	R	I	I
1764	105840	R	I	I	I	I	R	I	I
1804	108240	I	R	I	I	I	R	I	I
1844	110640	R	R	I	I	I	R	I	I
1884	113040	I	I	R	I	I	R	I	I
1923	115380	I	I	R	I	I	R	I	I
1963	117780	R	I	R	I	I	R	I	I
2003	120180	I	R	R	I	I	R	I	I
2043	122580	I	R	R	I	I	R	I	I
2084	125040	R	R	R	I	I	R	I	I
2124	127440	I	I	I	R	I	R	I	I
2164	129840	R	I	I	R	I	R	I	I
2204	132240	R	I	I	R	I	R	I	I
2244	134640	I	R	I	R	I	R	I	I
2284	137040	R	R	I	R	I	R	I	I
2324	139440	I	I	R	R	I	R	I	I
2364	141840	I	I	R	R	I	R	I	I

R = REMOVE JUMPER, I = INSTALL JUMPER. This table is two pages wide.

Low Pass Filter Options (Continued)

Ch. A Ch. B	W112 W212	W113 W213	W114 W214	W115 W215	W116 W216	W117 W217	W118 W218
	I	I	R	R	R	R	R

W104 W204	W105 W205	W106 W206	W107 W207	W108 W208	W109 W209	W110 W210	W111 W211	Ch. A Ch. B Hz	CPM
I	R	R	I	I	R	R	R	1002	60120
R	I	R	I	I	R	R	R	1042	62520
I	I	R	I	I	R	R	R	1082	64920
R	R	I	I	I	R	R	R	1123	67380
I	R	I	I	I	R	R	R	1163	69780
R	I	I	I	I	R	R	R	1203	72180
I	I	I	I	I	R	R	R	1243	74580
R	R	R	R	R	I	R	R	1282	76920
I	R	R	R	R	I	R	R	1322	79320
R	I	R	R	R	I	R	R	1362	81720
I	I	R	R	R	I	R	R	1402	84120
R	R	I	R	R	I	R	R	1443	86580
I	R	I	R	R	I	R	R	1483	88980
R	I	I	R	R	I	R	R	1523	91380
I	I	I	R	R	I	R	R	1563	93780
R	R	R	I	R	I	R	R	1603	96180
I	R	R	I	R	I	R	R	1643	98580
R	I	R	I	R	I	R	R	1683	100980
I	I	R	I	R	I	R	R	1723	103380
R	R	I	I	R	I	R	R	1764	105840
I	R	I	I	R	I	R	R	1804	108240
R	I	I	I	R	I	R	R	1844	110640
I	I	I	I	R	I	R	R	1884	113040
R	R	R	R	I	I	R	R	1923	115380
I	R	R	R	I	I	R	R	1963	117780
R	I	R	R	I	I	R	R	2003	120180
I	I	R	R	I	I	R	R	2043	122580
R	R	I	R	I	I	R	R	2084	125040
I	R	I	R	I	I	R	R	2124	127440
R	I	I	R	I	I	R	R	2164	129840
I	I	I	R	I	I	R	R	2204	132240
R	R	R	I	I	I	R	R	2244	134640
I	R	R	I	I	I	R	R	2284	137040
R	I	R	I	I	I	R	R	2324	139440
I	I	R	I	I	I	R	R	2364	141840

R = REMOVE JUMPER, I = INSTALL JUMPER. This table continues on the next page.

Low Pass Filter Options (Continued)

W43 W56	W54 W57	W100 W200	W101 W201	W102 W202	W103 W203	Ch. A Ch. B
I	I	R	R	I	R	

	Ch. A Ch. B	W47 W69	W48 W70	W49 W71	W50 W72	W51 W73	W52 W74	W53 W75	W55 W77
Hz	CPM								
2405	144300	R	I	R	R	I	R	I	I
2445	146700	I	R	R	R	I	R	I	I
2485	149100	R	R	R	R	I	R	I	I
2525	151500	R	R	R	R	I	R	I	I
2564	153840	I	I	I	I	R	R	I	I
2604	156240	R	I	I	I	R	R	I	I
2644	158640	I	R	I	I	R	R	I	I
2684	161040	I	R	I	I	R	R	I	I
2725	163500	R	R	I	I	R	R	I	I
2765	165900	I	I	R	I	R	R	I	I
2805	168300	R	I	R	I	R	R	I	I
2845	170700	R	I	R	I	R	R	I	I
2885	173100	I	R	R	I	R	R	I	I
2925	175500	R	R	R	I	R	R	I	I
2965	177900	I	I	I	R	R	R	I	I
3005	180300	I	I	I	R	R	R	I	I
3046	182760	R	I	I	R	R	R	I	I
3086	185160	I	R	I	R	R	R	I	I
3126	187560	R	R	I	R	R	R	I	I
3166	189960	R	R	I	R	R	R	I	I
3205	192300	I	I	R	R	R	R	I	I
3245	194700	R	I	R	R	R	R	I	I
3285	197100	I	R	R	R	R	R	I	I
3325	199500	I	R	R	R	R	R	I	I
3366	201960	R	R	R	R	R	R	I	I
3406	204360	I	I	I	I	I	I	R	I
3446	206760	R	I	I	I	I	I	R	I
3486	209160	R	I	I	I	I	I	R	I
3526	211560	I	R	I	I	I	I	R	I
3566	213960	R	R	I	I	I	I	R	I
3606	216360	I	I	R	I	I	I	R	I
3646	218760	I	I	R	I	I	I	R	I
3687	221220	R	I	R	I	I	I	R	I
3727	223620	I	R	R	I	I	I	R	I
3767	226020	R	R	R	I	I	I	R	I

R = REMOVE JUMPER, I = INSTALL JUMPER. This table is two pages wide.

Low Pass Filter Options (Continued)

Ch. A Ch. B	W112 W212	W113 W213	W114 W214	W115 W215	W116 W216	W117 W217	W118 W218
	I	I	R	R	R	R	R

W104 W204	W105 W205	W106 W206	W107 W207	W108 W208	W109 W209	W110 W210	W111 W211	Ch. A Ch. B Hz	 CPM
R	R	I	I	I	I	R	R	2405	144300
I	R	I	I	I	I	R	R	2445	146700
R	I	I	I	I	I	R	R	2485	149100
I	I	I	I	I	I	R	R	2525	151500
R	R	R	R	R	R	I	R	2564	153840
I	R	R	R	R	R	I	R	2604	156240
R	I	R	R	R	R	I	R	2644	158640
I	I	R	R	R	R	I	R	2684	161040
R	R	I	R	R	R	I	R	2725	163500
I	R	I	R	R	R	I	R	2765	165900
R	I	I	R	R	R	I	R	2805	168300
I	I	I	R	R	R	I	R	2845	170700
R	R	R	I	R	R	I	R	2885	173100
I	R	R	I	R	R	I	R	2925	175500
R	I	R	I	R	R	I	R	2965	177900
I	I	R	I	R	R	I	R	3005	180300
R	R	I	I	R	R	I	R	3046	182760
I	R	I	I	R	R	I	R	3086	185160
R	I	I	I	R	R	I	R	3126	187560
I	I	I	I	R	R	I	R	3166	189960
R	R	R	R	I	R	I	R	3205	192300
I	R	R	R	I	R	I	R	3245	194700
R	I	R	R	I	R	I	R	3285	197100
I	I	R	R	I	R	I	R	3325	199500
R	R	I	R	I	R	I	R	3366	201960
I	R	I	R	I	R	I	R	3406	204360
R	I	I	R	I	R	I	R	3446	206760
I	I	I	R	I	R	I	R	3486	209160
R	R	R	I	I	R	I	R	3526	211560
I	R	R	I	I	R	I	R	3566	213960
R	I	R	I	I	R	I	R	3606	216360
I	I	R	I	I	R	I	R	3646	218760
R	R	I	I	I	R	I	R	3687	221220
I	R	I	I	I	R	I	R	3727	223620
R	I	I	I	I	R	I	R	3767	226020

R = REMOVE JUMPER, I = INSTALL JUMPER. This table continues on the next page.

Low Pass Filter Options (Continued)

W43 W56	W54 W57	W100 W200	W101 W201	W102 W202	W103 W203	Ch. A Ch. B
I	I	R	R	I	R	

	Ch. A Ch. B	W47 W69	W48 W70	W49 W71	W50 W72	W51 W73	W52 W74	W53 W75	W55 W77
Hz	CPM								
3807	228420	R	R	R	I	I	I	R	I
3846	230760	I	I	I	R	I	I	R	I
3886	233160	R	I	I	R	I	I	R	I
3926	235560	R	I	I	R	I	I	R	I
3966	237960	I	R	I	R	I	I	R	I
4007	240420	R	R	I	R	I	I	R	I
4047	242820	I	I	R	R	I	I	R	I
4087	245220	I	I	R	R	I	I	R	I
4127	247620	R	I	R	R	I	I	R	I
4167	250020	I	R	R	R	I	I	R	I
4207	252420	R	R	R	R	I	I	R	I
4247	254820	R	R	R	R	I	I	R	I
4287	257220	I	I	I	I	R	I	R	I
4328	259680	R	I	I	I	R	I	R	I
4368	262080	I	R	I	I	R	I	R	I
4408	264480	I	R	I	I	R	I	R	I
4448	266880	R	R	I	I	R	I	R	I
4487	269220	I	I	R	I	R	I	R	I
4527	271620	R	I	R	I	R	I	R	I
4567	274020	R	I	R	I	R	I	R	I
4607	276420	I	R	R	I	R	I	R	I
4648	278880	R	R	R	I	R	I	R	I
4688	281280	I	I	I	R	R	I	R	I
4728	283680	I	I	I	R	R	I	R	I
4768	286080	R	I	I	R	R	I	R	I
4808	288480	I	R	I	R	R	I	R	I
4848	290880	R	R	I	R	R	I	R	I
4888	293280	R	R	I	R	R	I	R	I
4928	295680	I	I	R	R	R	I	R	I
4969	298140	R	I	R	R	R	I	R	I
5009	300540	I	R	R	R	R	I	R	I
5049	302940	I	R	R	R	R	I	R	I
5089	305340	R	R	R	R	R	I	R	I
5128	307680	I	I	I	I	I	R	R	I
5168	310080	R	I	I	I	I	R	R	I

R = REMOVE JUMPER, I = INSTALL JUMPER. This table is two pages wide.

Low Pass Filter Options (Continued)

Ch. A	W112	W113	W114	W115	W116	W117	W118
Ch. B	W212	W213	W214	W215	W216	W217	W218
	I	I	R	R	R	R	R

W104	W105	W106	W107	W108	W109	W110	W111	Ch. A	
W204	W205	W206	W207	W208	W209	W210	W211	Ch. B	
								Hz	CPM
I	I	I	I	I	R	I	R	3807	228420
R	R	R	R	R	I	I	R	3846	230760
I	R	R	R	R	I	I	R	3886	233160
R	I	R	R	R	I	I	R	3926	235560
I	I	R	R	R	I	I	R	3966	237960
R	R	I	R	R	I	I	R	4007	240420
I	R	I	R	R	I	I	R	4047	242820
R	I	I	R	R	I	I	R	4087	245220
I	I	I	R	R	I	I	R	4127	247620
R	R	R	I	R	I	I	R	4167	250020
I	R	R	I	R	I	I	R	4207	252420
R	I	R	I	R	I	I	R	4247	254820
I	I	R	I	R	I	I	R	4287	257220
R	R	I	I	R	I	I	R	4328	259680
I	R	I	I	R	I	I	R	4368	262080
R	I	I	I	R	I	I	R	4408	264480
I	I	I	I	R	I	I	R	4448	266880
R	R	R	R	I	I	I	R	4487	269220
I	R	R	R	I	I	I	R	4527	271620
R	I	R	R	I	I	I	R	4567	274020
I	I	R	R	I	I	I	R	4607	276420
R	R	I	R	I	I	I	R	4648	278880
I	R	I	R	I	I	I	R	4688	281280
R	I	I	R	I	I	I	R	4728	283680
I	I	I	R	I	I	I	R	4768	286080
R	R	R	I	I	I	I	R	4808	288480
I	R	R	I	I	I	I	R	4848	290880
R	I	R	I	I	I	I	R	4888	293280
I	I	R	I	I	I	I	R	4928	295680
R	R	I	I	I	I	I	R	4969	298140
I	R	I	I	I	I	I	R	5009	300540
R	I	I	I	I	I	I	R	5049	302940
I	I	I	I	I	I	I	R	5089	305340
R	R	R	R	R	R	R	I	5128	307680
I	R	R	R	R	R	R	I	5168	310080

R = REMOVE JUMPER, I = INSTALL JUMPER. This table continues on the next page.

Low Pass Filter Options (Continued)

W43 W56	W54 W57	W100 W200	W101 W201	W102 W202	W103 W203	Ch. A Ch. B
I	I	R	R	I	R	

	Ch. A Ch. B	W47 W69	W48 W70	W49 W71	W50 W72	W51 W73	W52 W74	W53 W75	W55 W77
Hz	CPM								
5208	312480	R	I	I	I	I	R	R	I
5248	314880	I	R	I	I	I	R	R	I
5289	317340	R	R	I	I	I	R	R	I
5329	319740	I	I	R	I	I	R	R	I
5369	322140	I	I	R	I	I	R	R	I
5409	324540	R	I	R	I	I	R	R	I
5449	326940	I	R	R	I	I	R	R	I
5489	329340	R	R	R	I	I	R	R	I
5529	331740	R	R	R	I	I	R	R	I
5569	334140	I	I	I	R	I	R	R	I
5610	336600	R	I	I	R	I	R	R	I
5650	339000	I	R	I	R	I	R	R	I
5690	341400	I	R	I	R	I	R	R	I
5730	343800	R	R	I	R	I	R	R	I
5769	346140	I	I	R	R	I	R	R	I
5809	348540	I	I	R	R	I	R	R	I
5849	350940	R	I	R	R	I	R	R	I
5889	353340	I	R	R	R	I	R	R	I
5930	355800	R	R	R	R	I	R	R	I
5970	358200	R	R	R	R	I	R	R	I
6010	360600	I	I	I	I	R	R	R	I
6050	363000	R	I	I	I	R	R	R	I
6091	365460	I	R	I	I	R	R	R	I
6131	367860	I	R	I	I	R	R	R	I
6171	370260	R	R	I	I	R	R	R	I
6211	372660	I	I	R	I	R	R	R	I
6251	375060	R	I	R	I	R	R	R	I
6291	377460	R	I	R	I	R	R	R	I
6331	379860	I	R	R	I	R	R	R	I
6371	382260	R	R	R	I	R	R	R	I
6410	384600	I	I	I	R	R	R	R	I
6450	387000	I	I	I	R	R	R	R	I
6490	389400	R	I	I	R	R	R	R	I
6530	391800	I	R	I	R	R	R	R	I
6571	394260	R	R	I	R	R	R	R	I

R = REMOVE JUMPER, I = INSTALL JUMPER. This table is two pages wide.

Low Pass Filter Options (Continued)

Ch. A Ch. B	W112 W212	W113 W213	W114 W214	W115 W215	W116 W216	W117 W217	W118 W218
	I	I	R	R	R	R	R

W104 W204	W105 W205	W106 W206	W107 W207	W108 W208	W109 W209	W110 W210	W111 W211	Ch. A Ch. B Hz	CPM
R	I	R	R	R	R	R	I	5208	312480
I	I	R	R	R	R	R	I	5248	314880
R	R	I	R	R	R	R	I	5289	317340
I	R	I	R	R	R	R	I	5329	319740
R	I	I	R	R	R	R	I	5369	322140
I	I	I	R	R	R	R	I	5409	324540
R	R	R	I	R	R	R	I	5449	326940
I	R	R	I	R	R	R	I	5489	329340
R	I	R	I	R	R	R	I	5529	331740
I	I	R	I	R	R	R	I	5569	334140
R	R	I	I	R	R	R	I	5610	336600
I	R	I	I	R	R	R	I	5650	339000
R	I	I	I	R	R	R	I	5690	341400
I	I	I	I	R	R	R	I	5730	343800
R	R	R	R	I	R	R	I	5769	346140
I	R	R	R	I	R	R	I	5809	348540
R	I	R	R	I	R	R	I	5849	350940
I	I	R	R	I	R	R	I	5889	353340
R	R	I	R	I	R	R	I	5930	355800
I	R	I	R	I	R	R	I	5970	358200
R	I	I	R	I	R	R	I	6010	360600
I	I	I	R	I	R	R	I	6050	363000
R	R	R	I	I	R	R	I	6091	365460
I	R	R	I	I	R	R	I	6131	367860
R	I	R	I	I	R	R	I	6171	370260
I	I	R	I	I	R	R	I	6211	372660
R	R	I	I	I	R	R	I	6251	375060
I	R	I	I	I	R	R	I	6291	377460
R	I	I	I	I	R	R	I	6331	379860
I	I	I	I	I	R	R	I	6371	382260
R	R	R	R	R	I	R	I	6410	384600
I	R	R	R	R	I	R	I	6450	387000
R	I	R	R	R	I	R	I	6490	389400
I	I	R	R	R	I	R	I	6530	391800
R	R	I	R	R	I	R	I	6571	394260

R = REMOVE JUMPER, I = INSTALL JUMPER. This table continues on the next page.

Low Pass Filter Options (Continued)

W43 W56	W54 W57	W100 W200	W101 W201	W102 W202	W103 W203	Ch. A Ch. B
I	I	R	R	I	R	

	Ch. A Ch. B	W47 W69	W48 W70	W49 W71	W50 W72	W51 W73	W52 W74	W53 W75	W55 W77
Hz	CPM								
6611	396660	R	R	I	R	R	R	R	I
6651	399060	I	I	R	R	R	R	R	I
6691	401460	R	I	R	R	R	R	R	I
6732	403920	I	R	R	R	R	R	R	I
6772	406320	I	R	R	R	R	R	R	I
6812	408720	R	R	R	R	R	R	R	I
6852	411120	I	I	I	I	I	I	I	R
6892	413520	R	I	I	I	I	I	I	R
6932	415920	R	I	I	I	I	I	I	R
6972	418320	I	R	I	I	I	I	I	R
7012	420720	R	R	I	I	I	I	I	R
7051	423060	I	I	R	I	I	I	I	R
7091	425460	I	I	R	I	I	I	I	R
7131	427860	R	I	R	I	I	I	I	R
7171	430260	I	R	R	I	I	I	I	R
7212	432720	I	R	R	I	I	I	I	R
7252	435120	R	R	R	I	I	I	I	R
7292	437520	I	I	I	R	I	I	I	R
7332	439920	R	I	I	R	I	I	I	R
7373	442380	I	R	I	R	I	I	I	R
7413	444780	I	R	I	R	I	I	I	R
7453	447180	R	R	I	R	I	I	I	R
7493	449580	I	I	R	R	I	I	I	R
7533	451980	R	I	R	R	I	I	I	R
7573	454380	R	I	R	R	I	I	I	R
7613	456780	I	R	R	R	I	I	I	R
7653	459180	R	R	R	R	I	I	I	R
7692	461520	I	I	I	I	R	I	I	R
7732	463920	I	I	I	I	R	I	I	R
7772	466320	R	I	I	I	R	I	I	R
7812	468720	I	R	I	I	R	I	I	R
7853	471180	I	R	I	I	R	I	I	R
7893	473580	R	R	I	I	R	I	I	R
7933	475980	I	I	R	I	R	I	I	R
7973	478380	R	I	R	I	R	I	I	R

R = REMOVE JUMPER, I = INSTALL JUMPER. This table is two pages wide.

Low Pass Filter Options (Continued)

Ch. A	W112	W113	W114	W115	W116	W117	W118
Ch. B	W212	W213	W214	W215	W216	W217	W218
	I	I	R	R	R	R	R

W104	W105	W106	W107	W108	W109	W110	W111	Ch. A	
W204	W205	W206	W207	W208	W209	W210	W211	Ch. B	
								Hz	CPM
I	R	I	R	R	I	R	I	6611	396660
R	I	I	R	R	I	R	I	6651	399060
I	I	I	R	R	I	R	I	6691	401460
R	R	R	I	R	I	R	I	6732	403920
I	R	R	I	R	I	R	I	6772	406320
R	I	R	I	R	I	R	I	6812	408720
I	I	R	I	R	I	R	I	6852	411120
R	R	I	I	R	I	R	I	6892	413520
I	R	I	I	R	I	R	I	6932	415920
R	I	I	I	R	I	R	I	6972	418320
I	I	I	I	R	I	R	I	7012	420720
R	R	R	R	I	I	R	I	7051	423060
I	R	R	R	I	I	R	I	7091	425460
R	I	R	R	I	I	R	I	7131	427860
I	I	R	R	I	I	R	I	7171	430260
R	R	I	R	I	I	R	I	7212	432720
I	R	I	R	I	I	R	I	7252	435120
R	I	I	R	I	I	R	I	7292	437520
I	I	I	R	I	I	R	I	7332	439920
R	R	R	I	I	I	R	I	7373	442380
I	R	R	I	I	I	R	I	7413	444780
R	I	R	I	I	I	R	I	7453	447180
I	I	R	I	I	I	R	I	7493	449580
R	R	I	I	I	I	R	I	7533	451980
I	R	I	I	I	I	R	I	7573	454380
R	I	I	I	I	I	R	I	7613	456780
I	I	I	I	I	I	R	I	7653	459180
R	R	R	R	R	R	I	I	7692	461520
I	R	R	R	R	R	I	I	7732	463920
R	I	R	R	R	R	I	I	7772	466320
I	I	R	R	R	R	I	I	7812	468720
R	R	I	R	R	R	I	I	7853	471180
I	R	I	R	R	R	I	I	7893	473580
R	I	I	R	R	R	I	I	7933	475980
I	I	I	R	R	R	I	I	7973	478380

R = REMOVE JUMPER, I = INSTALL JUMPER. This table continues on the next page.

Low Pass Filter Options (Continued)

W43 W56	W54 W57	W100 W200	W101 W201	W102 W202	W103 W203	Ch. A Ch. B
I	I	R	R	I	R	

Ch. A	Ch. B	W47 W69	W48 W70	W49 W71	W50 W72	W51 W73	W52 W74	W53 W75	W55 W77
Hz	CPM								
8014	480840	R	I	R	I	R	I	I	R
8054	483240	I	R	R	I	R	I	I	R
8094	485640	R	R	R	I	R	I	I	R
8134	488040	I	I	I	R	R	I	I	R
8174	490440	R	I	I	R	R	I	I	R
8214	492840	R	I	I	R	R	I	I	R
8254	495240	I	R	I	R	R	I	I	R
8294	497640	R	R	I	R	R	I	I	R
8333	499980	R	R	I	R	R	I	I	R
8373	502380	I	I	R	R	R	I	I	R
8413	504780	R	I	R	R	R	I	I	R
8453	507180	I	R	R	R	R	I	I	R
8494	509640	I	R	R	R	R	I	I	R
8534	512040	R	R	R	R	R	I	I	R
8574	514440	I	I	I	I	I	R	I	R
8614	516840	R	I	I	I	I	R	I	R
8655	519300	R	I	I	I	I	R	I	R
8695	521700	I	R	I	I	I	R	I	R
8735	524100	R	R	I	I	I	R	I	R
8775	526500	I	I	R	I	I	R	I	R
8815	528900	R	I	R	I	I	R	I	R
8855	531300	R	I	R	I	I	R	I	R
8895	533700	I	R	R	I	I	R	I	R
8935	536100	R	R	R	I	I	R	I	R
8974	538440	R	R	R	I	I	R	I	R
9014	540840	I	I	I	R	I	R	I	R
9054	543240	R	I	I	R	I	R	I	R
9094	545640	I	R	I	R	I	R	I	R
9135	548100	I	R	I	R	I	R	I	R
9175	550500	R	R	I	R	I	R	I	R
9215	552900	I	I	R	R	I	R	I	R
9255	555300	R	I	R	R	I	R	I	R
9296	557760	R	I	R	R	I	R	I	R
9336	560160	I	R	R	R	I	R	I	R
9376	562560	R	R	R	R	I	R	I	R

R = REMOVE JUMPER, I = INSTALL JUMPER. This table is two pages wide.

Low Pass Filter Options (Continued)

Ch. A Ch. B	W112 W212	W113 W213	W114 W214	W115 W215	W116 W216	W117 W217	W118 W218
	I	I	R	R	R	R	R

W104 W204	W105 W205	W106 W206	W107 W207	W108 W208	W109 W209	W110 W210	W111 W211	Ch. A Ch. B Hz	CPM
R	R	R	I	R	R	I	I	8014	480840
I	R	R	I	R	R	I	I	8054	483240
R	I	R	I	R	R	I	I	8094	485640
I	I	R	I	R	R	I	I	8134	488040
R	R	I	I	R	R	I	I	8174	490440
I	R	I	I	R	R	I	I	8214	492840
R	I	I	I	R	R	I	I	8254	495240
I	I	I	I	R	R	I	I	8294	497640
R	R	R	R	I	R	I	I	8333	499980
I	R	R	R	I	R	I	I	8373	502380
R	I	R	R	I	R	I	I	8413	504780
I	I	R	R	I	R	I	I	8453	507180
R	R	I	R	I	R	I	I	8494	509640
I	R	I	R	I	R	I	I	8534	512040
R	I	I	R	I	R	I	I	8574	514440
I	I	I	R	I	R	I	I	8614	516840
R	R	R	I	I	R	I	I	8655	519300
I	R	R	I	I	R	I	I	8695	521700
R	I	R	I	I	R	I	I	8735	524100
I	I	R	I	I	R	I	I	8775	526500
R	R	I	I	I	R	I	I	8815	528900
I	R	I	I	I	R	I	I	8855	531300
R	I	I	I	I	R	I	I	8895	533700
I	I	I	I	I	R	I	I	8935	536100
R	R	R	R	R	I	I	I	8974	538440
I	R	R	R	R	I	I	I	9014	540840
R	I	R	R	R	I	I	I	9054	543240
I	I	R	R	R	I	I	I	9094	545640
R	R	I	R	R	I	I	I	9135	548100
I	R	I	R	R	I	I	I	9175	550500
R	I	I	R	R	I	I	I	9215	552900
I	I	I	R	R	I	I	I	9255	555300
R	R	R	I	R	I	I	I	9296	557760
I	R	R	I	R	I	I	I	9336	560160
R	I	R	I	R	I	I	I	9376	562560

R = REMOVE JUMPER, I = INSTALL JUMPER. This table continues on the next page.

Low Pass Filter Options (Continued)

W43 W56	W54 W57	W100 W200	W101 W201	W102 W202	W103 W203	Ch. A Ch. B
I	I	R	R	I	R	

	Ch. A Ch. B	W47 W69	W48 W70	W49 71	W50 W72	W51 W73	W52 W74	W53 W75	W55 W77
Hz	CPM								
9416	564960	I	I	I	I	R	R	I	R
9456	567360	R	I	I	I	R	R	I	R
9496	569760	R	I	I	I	R	R	I	R
9536	572160	I	R	I	I	R	R	I	R
9576	574560	R	R	I	I	R	R	I	R
9615	576900	R	R	I	I	R	R	I	R
9655	579300	I	I	R	I	R	R	I	R
9695	581700	R	I	R	I	R	R	I	R
9735	584100	R	I	R	I	R	R	I	R
9776	586560	I	R	R	I	R	R	I	R
9816	588960	R	R	R	I	R	R	I	R
9856	591360	I	I	I	R	R	R	I	R
9896	593760	I	I	I	R	R	R	I	R
9937	596220	R	I	I	R	R	R	I	R
9977	598620	I	R	I	R	R	R	I	R
10017	601020	R	R	I	R	R	R	I	R
10057	603420	R	R	I	R	R	R	I	R
10097	605820	I	I	R	R	R	R	I	R
10137	608220	R	I	R	R	R	R	I	R
10177	610620	I	R	R	R	R	R	I	R
10217	613020	I	R	R	R	R	R	I	R

R = REMOVE JUMPER, I = INSTALL JUMPER. This table is two pages wide.

Low Pass Filter Options (Continued)

Ch. A Ch. B	W112 W212	W113 W213	W114 W214	W115 W215	W116 W216	W117 W217	W118 W218
	I	I	R	R	R	R	R

W104 W204	W105 W205	W106 W206	W107 W207	W108 W208	W109 W209	W110 W210	W111 W211	Ch. A Ch. B	
								Hz	CPM
I	I	R	I	R	I	I	I	9416	564960
R	R	I	I	R	I	I	I	9456	567360
I	R	I	I	R	I	I	I	9496	569760
R	I	I	I	R	I	I	I	9536	572160
I	I	I	I	R	I	I	I	9576	574560
R	R	R	R	I	I	I	I	9615	576900
I	R	R	R	I	I	I	I	9655	579300
R	I	R	R	I	I	I	I	9695	581700
I	I	R	R	I	I	I	I	9735	584100
R	R	I	R	I	I	I	I	9776	586560
I	R	I	R	I	I	I	I	9816	588960
R	I	I	R	I	I	I	I	9856	591360
I	I	I	R	I	I	I	I	9896	593760
R	R	R	I	I	I	I	I	9937	596220
I	R	R	I	I	I	I	I	9977	598620
R	I	R	I	I	I	I	I	10017	601020
I	I	R	I	I	I	I	I	10057	603420
R	R	I	I	I	I	I	I	10097	605820
I	R	I	I	I	I	I	I	10137	608220
R	I	I	I	I	I	I	I	10177	610620
I	I	I	I	I	I	I	I	10217	613020

R = REMOVE JUMPER, I = INSTALL JUMPER.

Low Pass Filter Options (Continued)

W43 W56	W54 W57	W100 W200	W101 W201	W102 W202	W103 W203	Ch. A Ch. B
I	I	R	I	R	R	

	Ch. A Ch. B	W47 W69	W48 W70	W49 W71	W50 W72	W51 W73	W52 W74	W53 W75	W55 W77
Hz	CPM								
10256	615360	R	R	R	R	R	R	I	R
10416	624960	I	R	I	I	I	I	R	R
10576	634560	R	I	R	I	I	I	R	R
10736	644160	I	I	I	R	I	I	R	R
10899	653940	R	R	I	R	I	I	R	R
11059	663540	I	R	R	R	I	I	R	R
11219	673140	R	I	I	I	R	I	R	R
11379	682740	I	I	R	I	R	I	R	R
11542	692520	R	R	R	I	R	I	R	R
11702	702120	I	R	I	R	R	I	R	R
11862	711720	R	I	R	R	R	I	R	R
12022	721320	I	I	I	I	I	R	R	R
12184	731040	R	R	I	I	I	R	R	R
12344	740640	I	R	R	I	I	R	R	R
12504	750240	R	I	I	R	I	R	R	R
12664	759840	I	I	R	R	I	R	R	R
12821	769260	R	R	R	R	I	R	R	R
12981	778860	I	R	I	I	R	R	R	R
13141	788460	R	I	R	I	R	R	R	R
13301	798060	I	I	I	R	R	R	R	R
13463	807780	R	R	I	R	R	R	R	R
13623	817380	I	R	R	R	R	R	R	R
13783	826980	R	R	R	R	R	R	R	R
13943	836580	R	R	R	R	R	R	R	R
14106	846360	R	R	R	R	R	R	R	R
14266	855960	R	R	R	R	R	R	R	R
14426	865560	R	R	R	R	R	R	R	R
14586	875160	R	R	R	R	R	R	R	R
14748	884880	R	R	R	R	R	R	R	R
14908	894480	R	R	R	R	R	R	R	R
15068	904080	R	R	R	R	R	R	R	R
15228	913680	R	R	R	R	R	R	R	R
15385	923100	R	R	R	R	R	R	R	R
15545	932700	R	R	R	R	R	R	R	R
15705	942300	R	R	R	R	R	R	R	R
15865	951900	R	R	R	R	R	R	R	R
16027	961620	R	R	R	R	R	R	R	R
16187	971220	R	R	R	R	R	R	R	R

R = REMOVE JUMPER, I = INSTALL JUMPER. This table is two pages wide.

Low Pass Filter Options (Continued)

Ch. A Ch. B	W112 W212	W113 W213	W114 W214	W115 W215	W116 W216	W117 W217	W118 W218
	I	I	R	R	R	R	R

W104 W204	W105 W205	W106 W206	W107 W207	W108 W208	W109 W209	W110 W210	W111 W211	Ch. A Ch. B Hz	CPM
R	R	R	R	R	R	I	R	10256	615360
I	R	R	R	R	R	I	R	10416	624960
R	I	R	R	R	R	I	R	10576	634560
I	I	R	R	R	R	I	R	10736	644160
R	R	I	R	R	R	I	R	10899	653940
I	R	I	R	R	R	I	R	11059	663540
R	I	I	R	R	R	I	R	11219	673140
I	I	I	R	R	R	I	R	11379	682740
R	R	R	I	R	R	I	R	11542	692520
I	R	R	I	R	R	I	R	11702	702120
R	I	R	I	R	R	I	R	11862	711720
I	I	R	I	R	R	I	R	12022	721320
R	R	I	I	R	R	I	R	12184	731040
I	R	I	I	R	R	I	R	12344	740640
R	I	I	I	R	R	I	R	12504	750240
I	I	I	I	R	R	I	R	12664	759840
R	R	R	R	I	R	I	R	12821	769260
I	R	R	R	I	R	I	R	12981	778860
R	I	R	R	I	R	I	R	13141	788460
I	I	R	R	I	R	I	R	13301	798060
R	R	I	R	I	R	I	R	13463	807780
I	R	I	R	I	R	I	R	13623	817380
R	I	I	R	I	R	I	R	13783	826980
I	I	I	R	I	R	I	R	13943	836580
R	R	R	I	I	R	I	R	14106	846360
I	R	R	I	I	R	I	R	14266	855960
R	I	R	I	I	R	I	R	14426	865560
I	I	R	I	I	R	I	R	14586	875160
R	R	I	I	I	R	I	R	14748	884880
I	R	I	I	I	R	I	R	14908	894480
R	I	I	I	I	R	I	R	15068	904080
I	I	I	I	I	R	I	R	15228	913680
R	R	R	R	R	I	I	R	15385	923100
I	R	R	R	R	I	I	R	15545	932700
R	I	R	R	R	I	I	R	15705	942300
I	I	R	R	R	I	I	R	15865	951900
R	R	I	R	R	I	I	R	16027	961620
I	R	I	R	R	I	I	R	16187	971220

R = REMOVE JUMPER, I = INSTALL JUMPER. This table continues on the next page.

Low Pass Filter Options (Continued)

W43 W56	W54 W57	W100 W200	W101 W201	W102 W202	W103 W203	Ch. A Ch. B
I	I	R	I	R	R	

	Ch. A Ch. B	W47 W69	W48 W70	W49 W71	W50 W72	W51 W73	W52 W74	W53 W75	W55 W77
Hz	CPM								
16347	980820	R	R	R	R	R	R	R	R
16507	990420	R	R	R	R	R	R	R	R
16670	1000200	R	R	R	R	R	R	R	R
16830	1009800	R	R	R	R	R	R	R	R
16990	1019400	R	R	R	R	R	R	R	R
17150	1029000	R	R	R	R	R	R	R	R
17312	1038720	R	R	R	R	R	R	R	R
17472	1048320	R	R	R	R	R	R	R	R
17632	1057920	R	R	R	R	R	R	R	R
17792	1067520	R	R	R	R	R	R	R	R
17949	1076940	R	R	R	R	R	R	R	R
18109	1086540	R	R	R	R	R	R	R	R
18269	1096140	R	R	R	R	R	R	R	R
18429	1105740	R	R	R	R	R	R	R	R
18591	1115460	R	R	R	R	R	R	R	R
18751	1125060	R	R	R	R	R	R	R	R
18911	1134660	R	R	R	R	R	R	R	R
19071	1144260	R	R	R	R	R	R	R	R
19234	1154040	R	R	R	R	R	R	R	R
19394	1163640	R	R	R	R	R	R	R	R
19554	1173240	R	R	R	R	R	R	R	R
19714	1182840	R	R	R	R	R	R	R	R
19876	1192560	R	R	R	R	R	R	R	R
20036	1202160	R	R	R	R	R	R	R	R
20196	1211760	R	R	R	R	R	R	R	R
20356	1221360	R	R	R	R	R	R	R	R
20513	1230780	R	R	R	R	R	R	R	R
20673	1240380	R	R	R	R	R	R	R	R
20833	1249980	R	R	R	R	R	R	R	R
20993	1259580	R	R	R	R	R	R	R	R
21155	1269300	R	R	R	R	R	R	R	R
21315	1278900	R	R	R	R	R	R	R	R
21475	1288500	R	R	R	R	R	R	R	R
21635	1298100	R	R	R	R	R	R	R	R
21798	1307880	R	R	R	R	R	R	R	R
21958	1317480	R	R	R	R	R	R	R	R
22118	1327080	R	R	R	R	R	R	R	R
22278	1336680	R	R	R	R	R	R	R	R
22441	1346460	R	R	R	R	R	R	R	R

R = REMOVE JUMPER, I = INSTALL JUMPER. This table is two pages wide.

Low Pass Filter Options (Continued)

Ch. A Ch. B	W112 W212	W113 W213	W114 W214	W115 W215	W116 W216	W117 W217	W118 W218
	I	I	R	R	R	R	R

W104 W204	W105 W205	W106 W206	W107 W207	W108 W208	W109 W209	W110 W210	W111 W211	Ch. A Ch. B	
								Hz	CPM
R	I	I	R	R	I	I	R	16347	980820
I	I	I	R	R	I	I	R	16507	990420
R	R	R	I	R	I	I	R	16670	1000200
I	R	R	I	R	I	I	R	16830	1009800
R	I	R	I	R	I	I	R	16990	1019400
I	I	R	I	R	I	I	R	17150	1029000
R	R	I	I	R	I	I	R	17312	1038720
I	R	I	I	R	I	I	R	17472	1048320
R	I	I	I	R	I	I	R	17632	1057920
I	I	I	I	R	I	I	R	17792	1067520
R	R	R	R	I	I	I	R	17949	1076940
I	R	R	R	I	I	I	R	18109	1086540
R	I	R	R	I	I	I	R	18269	1096140
I	I	R	R	I	I	I	R	18429	1105740
R	R	I	R	I	I	I	R	18591	1115460
I	R	I	R	I	I	I	R	18751	1125060
R	I	I	R	I	I	I	R	18911	1134660
I	I	I	R	I	I	I	R	19071	1144260
R	R	R	I	I	I	I	R	19234	1154040
I	R	R	I	I	I	I	R	19394	1163640
R	I	R	I	I	I	I	R	19554	1173240
I	I	R	I	I	I	I	R	19714	1182840
R	R	I	I	I	I	I	R	19876	1192560
I	R	I	I	I	I	I	R	20036	1202160
R	I	I	I	I	I	I	R	20196	1211760
I	I	I	I	I	I	I	R	20356	1221360
R	R	R	R	R	R	R	I	20513	1230780
I	R	R	R	R	R	R	I	20673	1240380
R	I	R	R	R	R	R	I	20833	1249980
I	I	R	R	R	R	R	I	20993	1259580
R	R	I	R	R	R	R	I	21155	1269300
I	R	I	R	R	R	R	I	21315	1278900
R	I	I	R	R	R	R	I	21475	1288500
I	I	I	R	R	R	R	I	21635	1298100
R	R	R	I	R	R	R	I	21798	1307880
I	R	R	I	R	R	R	I	21958	1317480
R	I	R	I	R	R	R	I	22118	1327080
I	I	R	I	R	R	R	I	22278	1336680
R	R	I	I	R	R	R	I	22441	1346460

R = REMOVE JUMPER, I = INSTALL JUMPER.

20.11 Band-Pass Filters

A band-pass filter consists of cascaded high-pass and low-pass filters. To configure the Band-Pass filter, follow the instructions for programming the high-pass and low-pass filters.

The center frequency of the bandpass filter is given by:

$$f_{BP} = \sqrt{f_{LP} \times f_{HP}}$$

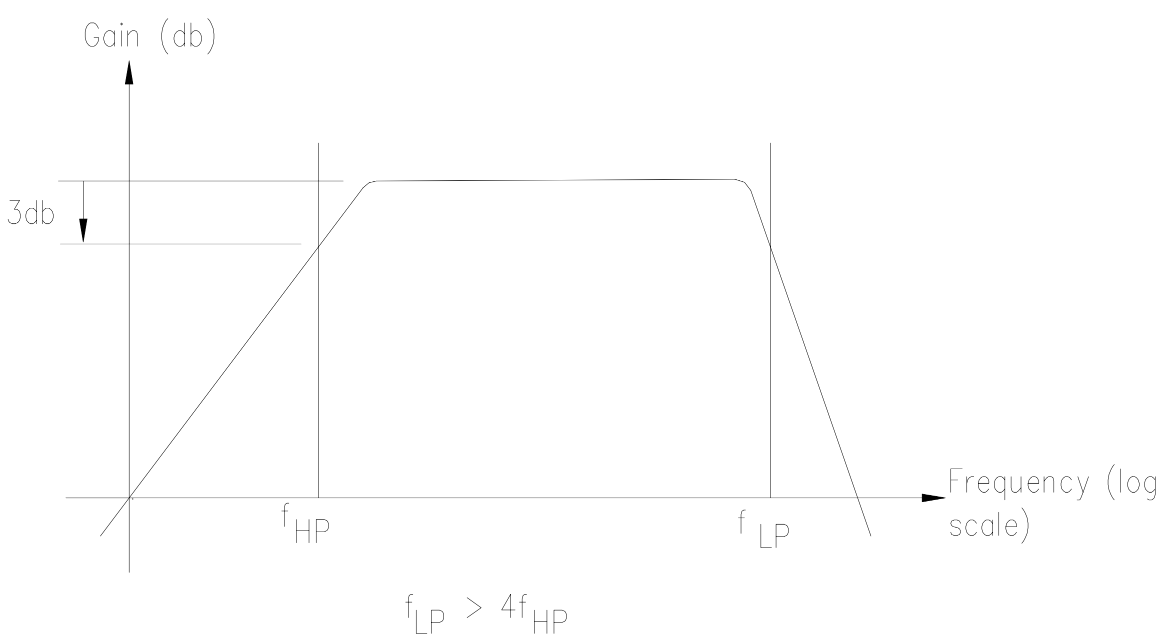
where

f_{BP} = Band-Pass filter center frequency

f_{LP} = Low-Pass filter corner frequency

f_{HP} = High-Pass filter corner frequency

NOTE: The low-pass corner frequency f_{LP} should be four times (or more) the high-pass corner frequency f_{HP}.



20.12 Test Filter Option

This procedure verifies filter settings by using a function generator to simulate a signal with an amplitude equal to full scale at the -3dB frequency. Since the filter attenuates a signal with this frequency by 3dB, the monitor output should be 65% to 75% of full scale.

For some full scale ranges such as those listed in step 5b, the function generator may not be able to output a signal with an amplitude great enough to match the full scale range of the monitor. In this case, use the alternate procedure in Section 20.13 to test the filter.

Channels A and B must be calibrated before doing this test. Refer to Section 15.

WARNING

High voltage present. Contact could cause shock, burns, or death.

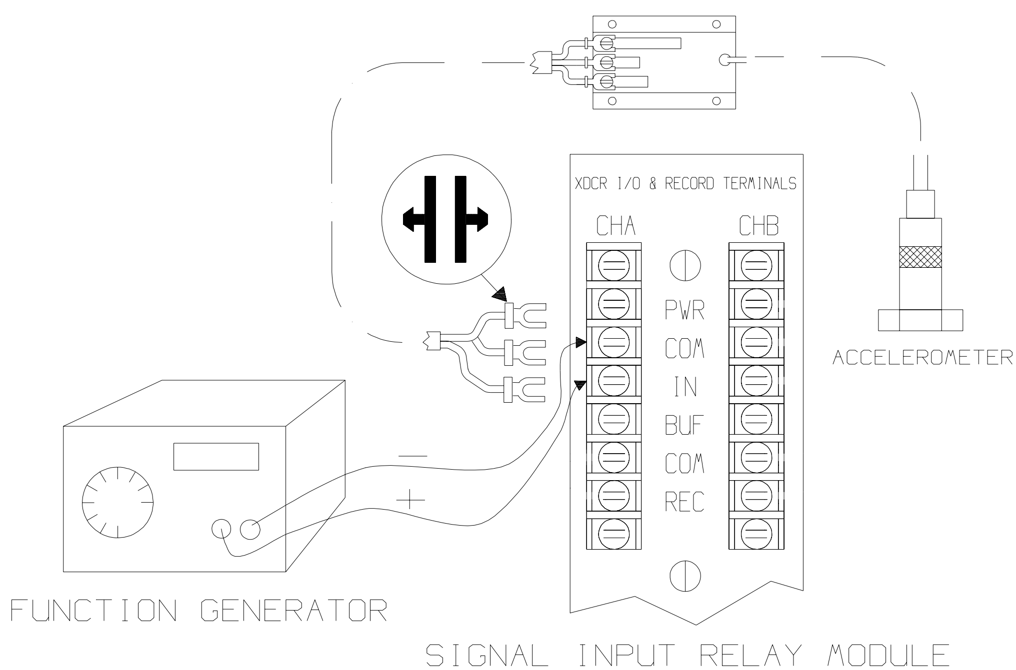
Do not touch exposed wires or terminals.

Caution

Tests will exceed alarm setpoint levels causing alarms to activate. This could result in relay contacts changing state. See the Danger Bypass section.

If barriers are used, test with barriers in place.

1. Disconnect the transducer input wires from the channel A terminals on the Signal Input Relay Module.
2. Connect a function generator to channel A input terminals as shown in this figure.



3. Adjust the settings on the function generator according to this table:

PARAMETER	SETTING
wave form	sine wave
DC offset	-7.5 Vdc
frequency to test high pass filters to test low pass filters	filter corner frequency, f_{HP} filter corner frequency, f_{LP}
amplitude	See step 5

4. Determine the Full Scale Range option for your monitor by checking Section 8.2, Monitor Ordering Options, in this manual.

For Full Scale Range options 01, 02, 03, 04, 11, 12, 13, 14
(Acceleration options)

5a. Set the amplitude of the function generator according to this table:

FULL SCALE OPTION	SIGNAL AMPLITUDE	
	$V_{0\text{-}pk}$ (mVpk)	V_{rms} (mVrms)
01	200	141
02	500	353
03	1000	707
04	2000	1414
11	204	144
12	510	360
13	1020	721
14	2040	1442

For Full Scale Range options 05, 06, 15, 16, 17
(Velocity options)

5b. Calculate the amplitude for the function generator using this formula:

Amplitude = K x corner frequency in Hz

Set the function generator to the calculated amplitude.

FULL SCALE OPTION	K	
	mVpk/Hz	mVrms/Hz
05	1.63	1.15
06	3.25	2.30
15	1.60	1.13
16	3.20	2.27
17	6.41	4.53

See Appendix D, Section 21.4, for derivation of K.

Step 5a continued:	Step 5b continued:
For Full Scale Range options 01, 02, 03, 04, 11, 12, 13, 14	For Full Scale Range options 05, 06, 15, 16, 17
For example, if the Full Scale Range option is 11, set the amplitude to 204 mVpk or 144 mVrms.	For example if the Full Scale Range option is 06 and the corner frequency is 53 Hz, calculate the amplitude like this: Amplitude (mVpk) =(3.25 mVpk/Hz)X(53 Hz) = 172 mVpk or Amplitude (mVrms) =(2.30 mVrms/Hz)X(53 Hz) = 122 mVrms **If the result of this calculation is greater than 3.5 Vpk or 2.47 Vrms or too small to set accurately on the function generator, use the alternate procedure in Section 20.13 to finish testing the filter options.**

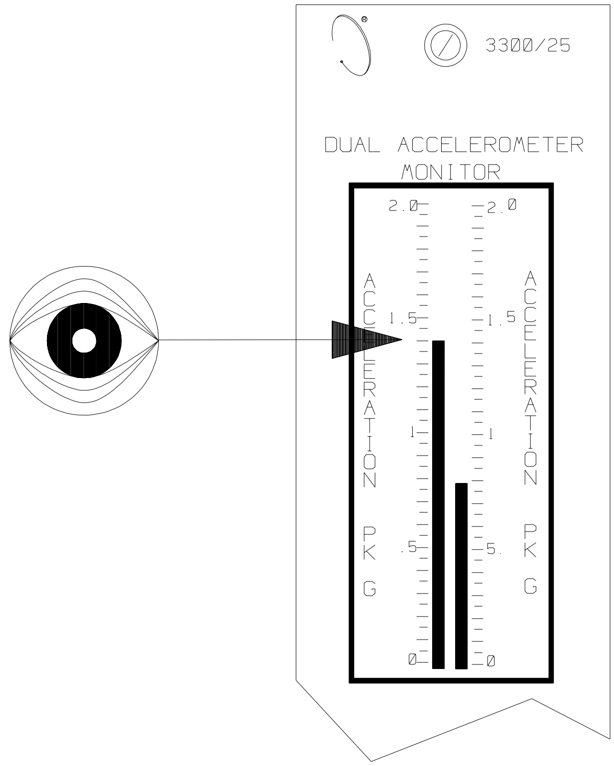
6. Verify that the bargraph for channel A reads 65% to 75% of full scale range, with the following exceptions:

A. The bargraph reading will be lower if you have a High Pass Filter with a corner frequency below 100 Hz and that channel is measuring velocity (Full Scale Range options 05, 06, 15, 16, or 17, see Section 3).

Some typical bargraph readings for this configuration are given below.

High Pass Filter corner frequency	Bargraph reading (% of full scale)
10 Hz	43% to 53%
30 Hz	61% to 71%
60 Hz	64% to 74%

B. The bargraph reading may be slightly lower if you have a Low Pass Filter with a corner frequency above 13.7 kHz. The reading will be lowest when the corner frequency is at its highest setting, 22.372 kHz. The bargraph reading for this setting should be 64% to 75% of full scale range.



7. Repeat the test for channel B.

8. Disconnect the test equipment and reconnect the transducer input wiring to channels A and B.

9. Turn Danger Bypass off if you turned it on at the beginning of this procedure.

20.13 Test Filter Option (Alternate Procedure)

This procedure should only be used when your Full Scale Range Option is 05, 06, 15, 16, or 17 (see Section 8.2) and the full scale amplitude calculated in step 5b of the main procedure (Section 20.12) is greater than 3.5V or too small to set up accurately on your function generator.

Note: Both channels A and B must be calibrated before performing this test (see Section 15). Test equipment should be set up as shown in step two of Section 20.12. If barriers are used, test with barriers in place.

1. Configure the main board as follows to change the Integrator Stage to a Gain Stage:

Channel A:	Install	**W6B,C**
	Remove	**W6A**
Channel B:	Install	**W3D,E**
	Remove	**W3F**

2. Adjust the frequency of the function generator to the -3dB frequency of the filter. For High Pass Filters, the -3dB frequency is the corner frequency chosen in Section 20.7 or 20.8. For Low Pass Filters, the -3dB frequency is the corner frequency chosen in Section 20.10. Set the amplitude of the function generator for a full scale sine wave signal with a -7.5 Vdc offset:

Full Scale Option		Full Scale Input Voltage	
		Vpk	Vrms
05	0-1 in/s	0.500	0.354
06	0-2 in/s	1.00	0.707
15	0-25 mm/s	0.492	0.348
16	0-50 mm/s	0.984	0.696
17	0-100 mm/s	1.969	1.392

3. Verify that the front panel bargraph for the channel being tested reads 65% to 75% of full scale range.

4. If you are testing a Band Pass Filter, repeat steps two and three at the second -3dB frequency.

5. Configure the main board as follows to change the Gain Stage back to an Integrator Stage:

Channel A:	Install	**W6A**
	Remove	**W6B,C**
Channel B:	Install	**W3F**
	Remove	**W3D,E**

6. Choose an integrator test frequency according to the following criteria:
   A. The test frequency must be within the passband of the filter.

   B. The test frequency cannot be below 100 Hz or in the range 280 Hz to 335 Hz.

   C. The test frequency should be at least a decade away from the filter's -3dB frequency, if possible (i.e., at least ten times the high pass -3dB frequency or no more than one tenth the low pass -3dB frequency).

   If the test frequency is less than a decade away from a filter's -3dB frequency, the bargraph readings made in step eight may be lower than specified.

7. Adjust the function generator frequency to the test frequency. Set the amplitude for a sine wave signal with a -7.5Vdc offset, using the following equation:

$$\text{Amplitude} = K \times F$$

where:

K is found in the table below and f is the test frequency (chosen in step six) in Hertz.

Full Scale Option		K*	
		mV/Hz (peak)	mV/HZ (RMS)
05	0-1 in/s	1.46	1.04
06	0-2 in/s	2.93	2.07
15	0-25 mm/s	1.44	1.02
16	0-50 mm/s	2.89	2.04
17	0-100 mm/s	5.77	4.08

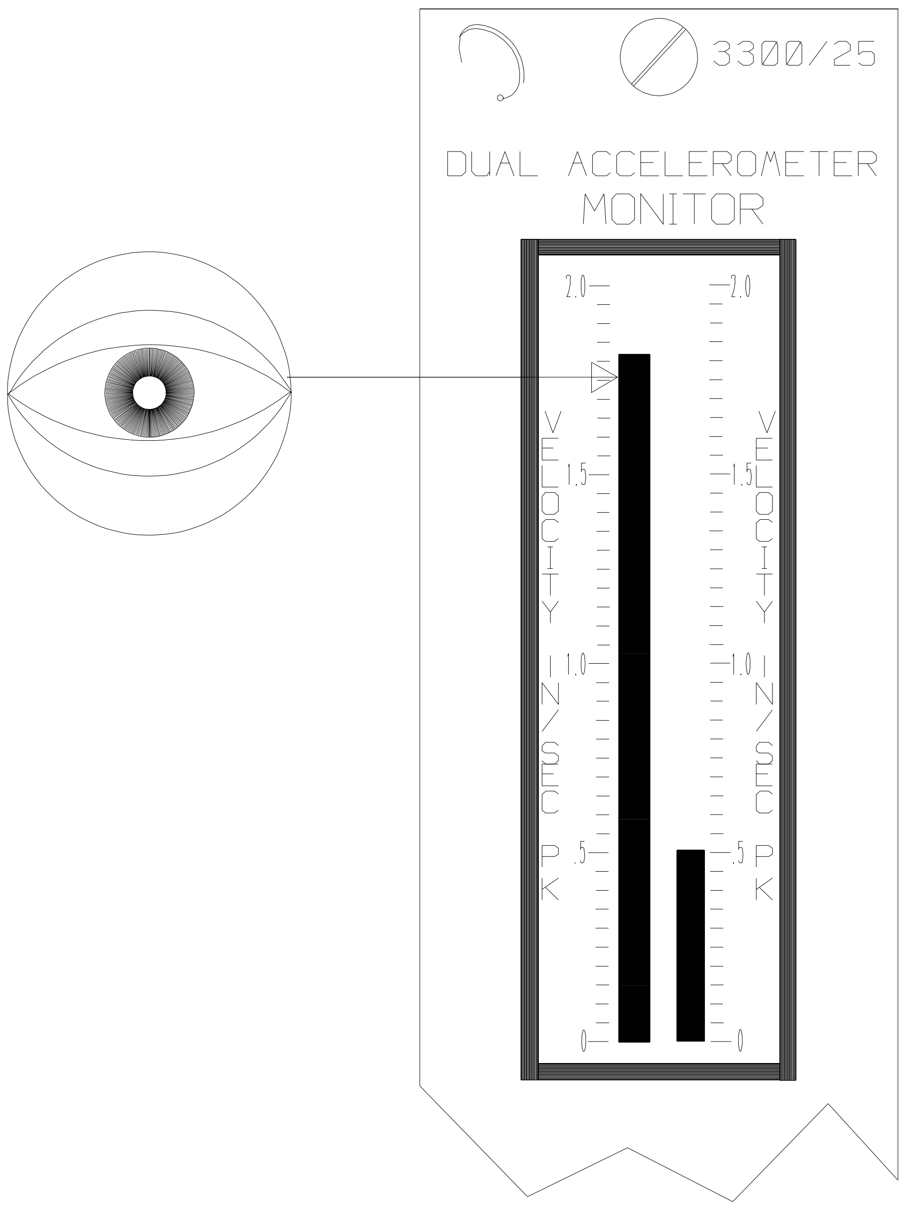
See Appendix D, Section 21.4 for derivation of K.

*K as used in this table is 90% of the calculated value.

8. Verify that the front panel bargraph reads 85% to 95% of full scale range.

The figure below shows a monitor bargraph reading 90% of full scale.

9. Return to step 7 of the main procedure (Section 20.12).



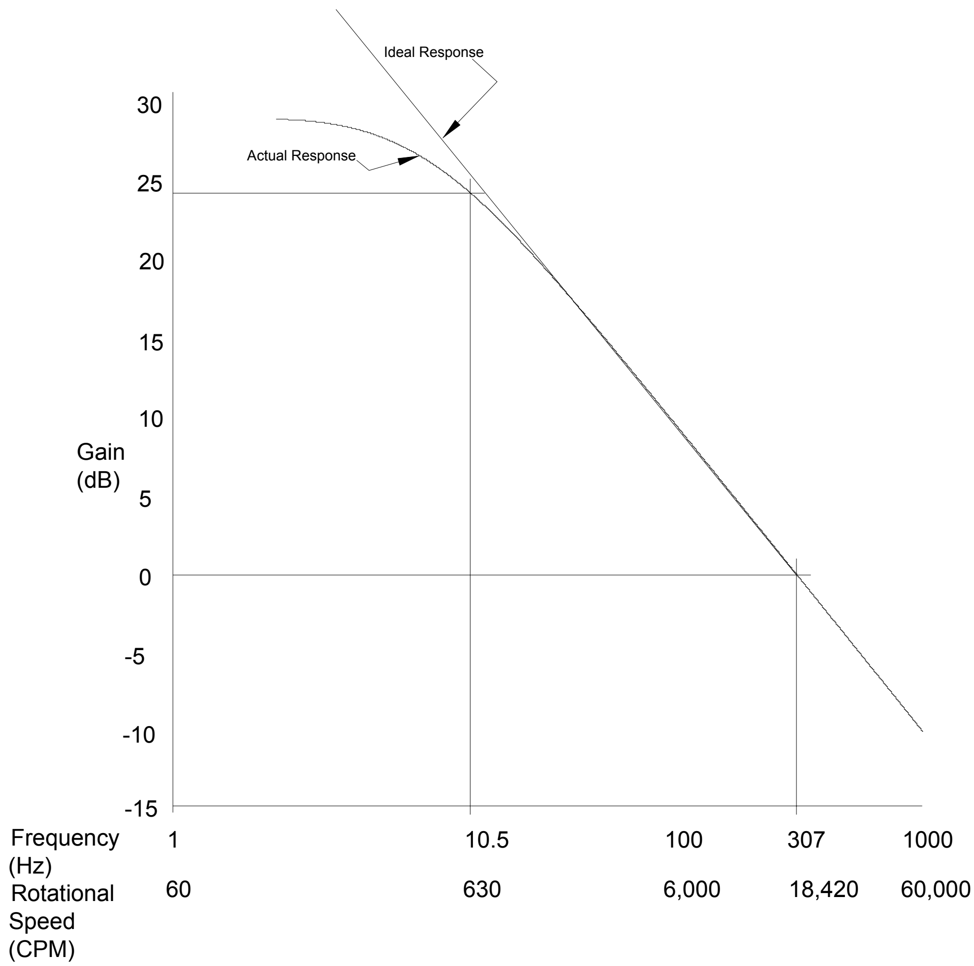
21. Appendix D–Integrated Signals

21.1 Integrator Response

The integrator circuit converts a 100 mV/g acceleration signal to a 500 mV/in/sec velocity signal. The 0 dB (unity gain) frequency of the integrator occurs at approximately 307 HZ. The 0 dB frequency is the frequency where the gain is equal to unity, that is, where the output voltage is the same as the input voltage. The integrated signal has the same frequency as the input frequency.

Since the integrator gain increases at lower frequencies, low frequency signals can cause the monitor to exceed full scale (saturate).

This is a graph of the response of the integrator / gain circuit:



21.2 Integrated Buffered Output Calculation

This section shows how to calculate the buffered output voltage for a transducer or function generator signal that is being integrated by the monitor.

The formula only applies when the unfiltered signal is at the buffered output. For an unfiltered buffered output, all filters should be located after the Integrator/Gain Stage. If any filters are located before the Integrator/Gain Stage, the buffered transducer output will be filtered by those filters.

1. Calculate the transducer output voltage:

$$\text{Vib} \times \text{SF} = \text{Vsig}$$

Where:

'Vib' is the level of mechanical vibration measured by the transducer, in g. This can be measured as g peak or g RMS.

'SF' is the scale factor of the transducer = 100 mV/g.

'Vsig' is the transducer output voltage that is applied to the monitor input. This voltage is measured in peak or RMS, the same as Vib.

2. Use this formula to calculate the buffered output voltage

$$\text{Vout} = \frac{\text{Vsig} \times 29.645}{\sqrt{(.009097 \times F^2) + 1}}$$

Where:

Vsig is the input voltage to the monitor.
Vout is the buffered output voltage.
F is the frequency of the signal.

Vout is measured in peak or RMS, the same as Vsig.

This formula is within 2% of the ideal value at frequencies of 50 Hz or greater.

21.2.1 Sample Calculation, Buffered Output

Monitor is configured as: BB or CC option 16 (50 mm/sec (peak))
Input vibration level is: 1g (peak)
Input signal frequency is: 100 Hz = 6000 CPM
Transducer scale factor is: 100 mV/g

Step 1. Calculate transducer output voltage.

Vib = 1g (peak)
SF = 100 mV/g

$$1g(peak) \times 0.1 V/g = 0.1 V = Vsig$$

Step 2.

$$Vout = \frac{0.1 \times 29.645}{\sqrt{(.009097 \times 100^2) + 1}} = 0.3091\ V(peak)$$

The signal at the buffered output is 0.3091 V (peak) or equivalently 0.2186 V (RMS).

21.2.2 Derivation of Integrated Signal Voltage

The transfer function of the integrator and the gain block is:

$$Y(S) = -\frac{Z_f}{Z_i} \times 4$$

Where:

Z_f is the feedback impedance: $Z_f = \dfrac{R_f \times \frac{1}{SC_f}}{R_f + \frac{1}{SC_f}}$

Z_i is the input impedance: $Z_I = R_I$

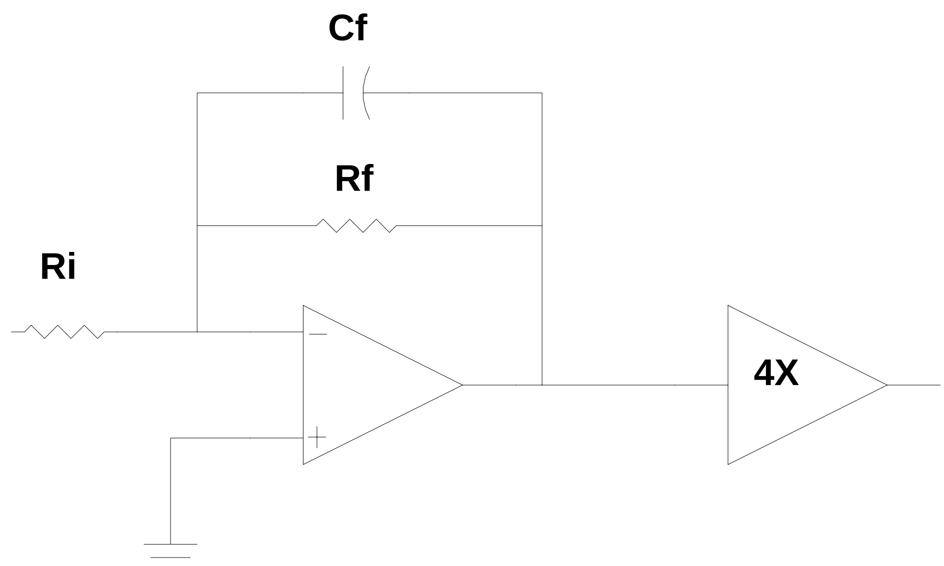
$$S = i \times \omega = i \times 2 \times \pi \times F$$

Entering component values and simplifying we get:

$$Y(S) = \frac{Vout}{Vin} = \frac{1.347 \times 10^9}{6.90 \times 10^5 \times S + 4.54 \times 10^7} = \frac{29.645}{1.518 \times 10^{-2} \times S + 1}$$

Taking the magnitude, we have:

$$\frac{Vout}{Vin} = \frac{29.645}{\sqrt{(.009097 \times F^2) + 1}}$$



21.3 Integrated Meter Reading Calculations

This section shows how to calculate the front panel meter reading for a transducer or function generator signal that is being integrated by the monitor.

This calculation does not include the effect of filtering.

1. Calculate the transducer output voltage:

$$Vib \times SF = Vsig$$

Where:

'Vib' is the level of mechanical vibration measured by the transducer, in g.

'SF' is the scale factor of the transducer = 100 mV/g.

'Vsig' is the transducer output signal that is applied to the monitor input. The voltage is measured in peak or RMS, the same as vib.

If the transducer signal is simulated by a function generator, Vsig is the peak or RMS signal level.

2. Calculate the front panel meter reading:

$$\text{Vsig} \times \frac{K}{F(Hz)} = \text{Front Panel Meter Reading}$$

Where:

'Vsig' is the input voltage to monitor.
'K' is the conversion factor is from the tables below.
'F' is the frequency of the input signal.
'Front Panel Meter Reading' is the value displayed on the front panel.

Scale Factor = 100 mV/g, BB and CC options 5,6,15,16 and 17.

Input measured in	Conversion factor for output measured in	Conversion factor for output measured in
	in/s (peak)	**mm/s (peak)**
peak	K = 614.48	K = 15,607.77
RMS	K = 869.00	K = 22,072.72

21.3.1 Conversion Factor Calculation

This is how the conversion factor, K, is calculated:

$$\{\text{peak to RMS}\} \times \{\text{units conversion}\} \times \frac{1}{2 \times \pi} = K$$

{Peak to RMS}:
= 1.414 if input is in RMS
= 1.0 if input is in pk

{Units Conversion}:
for 100 mV/g to in/sec (peak) output:

$$\frac{g}{0.100\,V} \times \frac{32.174\ ^{ft}\!/_{sec}}{g} \times \frac{12\,in}{ft}$$

for 100 mV/g to mm/sec (peak) output:

$$\frac{g}{0.100\,V} \times \frac{9806.7\ ^{mm}\!/_{sec}}{g}$$

21.3.2 Sample Calculation, Meter Output

Monitor is configured as: BB or CC option 16 (50 mm/sec (peak))

Input vibration level is: 1g (peak)

Input signal frequency is: 100 Hz = 6000 CPM

Transducer scale factor is: 100 mV/g

Step 1. Calculate transducer output voltage.

Vib = 1g (peak)

SF = 100 mV/g

$$1g(peak) \times 0.1 \tfrac{V}{g} = 0.1V$$

The transducer voltage that is applied to the input of the monitor is 0.1V peak. This signal can be simulated by applying a 0.1V peak (at 100 Hz) signal to the input of the monitor.

Step 2. Calculate the front panel meter reading:

Vsig = 0.1 V peak

F = 100 Hz

SF = 100 mV/g

The conversion factor, K, is found in the table in Section 21.3. The meter scale is measured in mm/sec and the input signal is measured in peak: K = 15,607.77

$$0.1V(peak) \times \frac{15{,}607.77}{100\ Hz} = 15.608\ \tfrac{mm}{sec}$$

The front panel meter will read 16 mm/sec (peak).

21.4 Calc. of Input for Full Scale Integrated Output

$$K(peak) = 2 \times \pi \times MFS \times F \times \frac{Accel\,SF}{g\,conversion}$$

Where:

K (peak) is the calculated input voltage, expressed in V peak.

F is the signal frequency in Cy/sec.

MFS is the peak full-scale meter reading, expressed in peak.

Accel SF is the accelerometer scale factor, 100mV/g.

g conversion is expressed as 9807 (mm/sec^2)/g or 386.09 (in/sec^2)/g.

If you wish to express **K** in RMS: $K\,RMS = \frac{K\ (peak)}{1.414}$

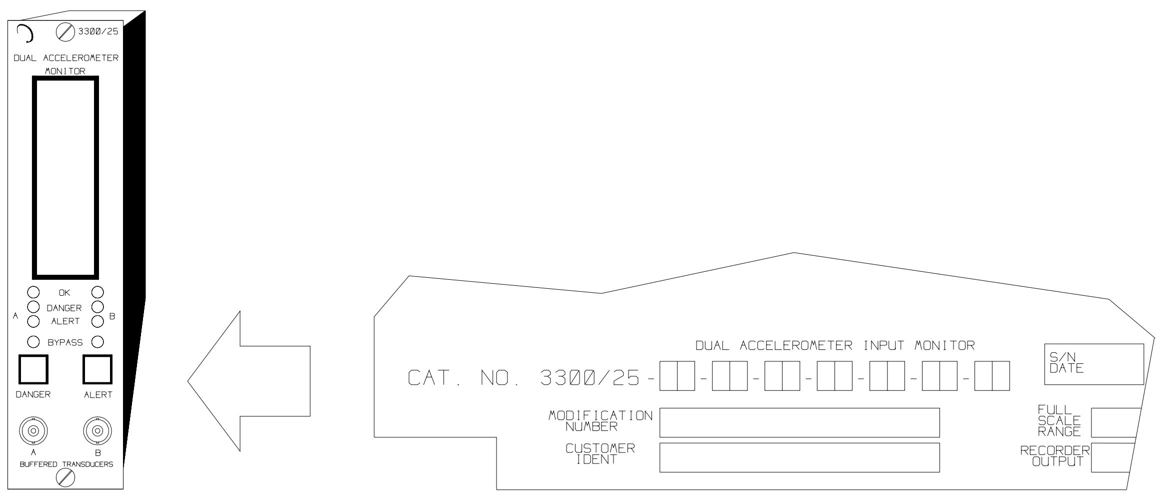
22. Recommended Spare Parts

To order replacement parts see the Specifications and Ordering Information section at the end this manual. The complete part number must be specified, as indicated on the identification decal. The part number is explained on page 22.

If you have a monitor that has been modified, the modification number must be specified on the parts order. The modification number (if any) will be shown on the identification decal.

If in doubt about the part number, call your Bently Nevada representative before ordering the part.

The customer programmable options on replacement parts will be set as shown in Section 18.2.



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