Acoustical Emission Monitoring System (AEMS)

L-4200-5

DYNAMIC BALANCE SYSTEM

OPERATION AND SPECIFICATION MANUAL ADDENDUM

Schmitt Industries, Inc.

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Operation and Specification Addendum
for the SBS
AEMS (Acoustical Emission Monitoring System)

Instruction addendum for use with the
SBS Balance System Operation Manual (Document L-4100-x)

Part# L-4200-5

Revision # 5.0 – Covers Rev. “I” Firmware Additions

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System Purpose

The SBS AEMS System has been developed to provide process control enhancement to grinding machine operators, including "Gap" elimination, Crash Monitoring, and Dressing Monitoring with the following objectives in mind:

- **Ease and Usefulness of Operation**
- **Maximum Grinding Machine Efficiency**
- **Close Integration with SBS Balance Systems**
- **Minimal Installation Requirements**
- **Attractive Purchase Price**

Operator Safety Summary

This summary contains safety information necessary for operation of the SBS AEMS System for grinding machines. Specific warnings and cautions are found throughout the Manual where they apply, but may not appear in this summary. Before installing and operating the SBS AEMS System, it is necessary to read and understand the entirety of this manual. After reading the Operation Manual, contact Schmitt Industries Inc. for any additional technical assistance required.

Warning
Observe all safety precautions for operation of your grinding machinery. Do not operate your equipment beyond safe balance limits.

Warning
Never operate a grinding machine without all proper safety guarding in place.

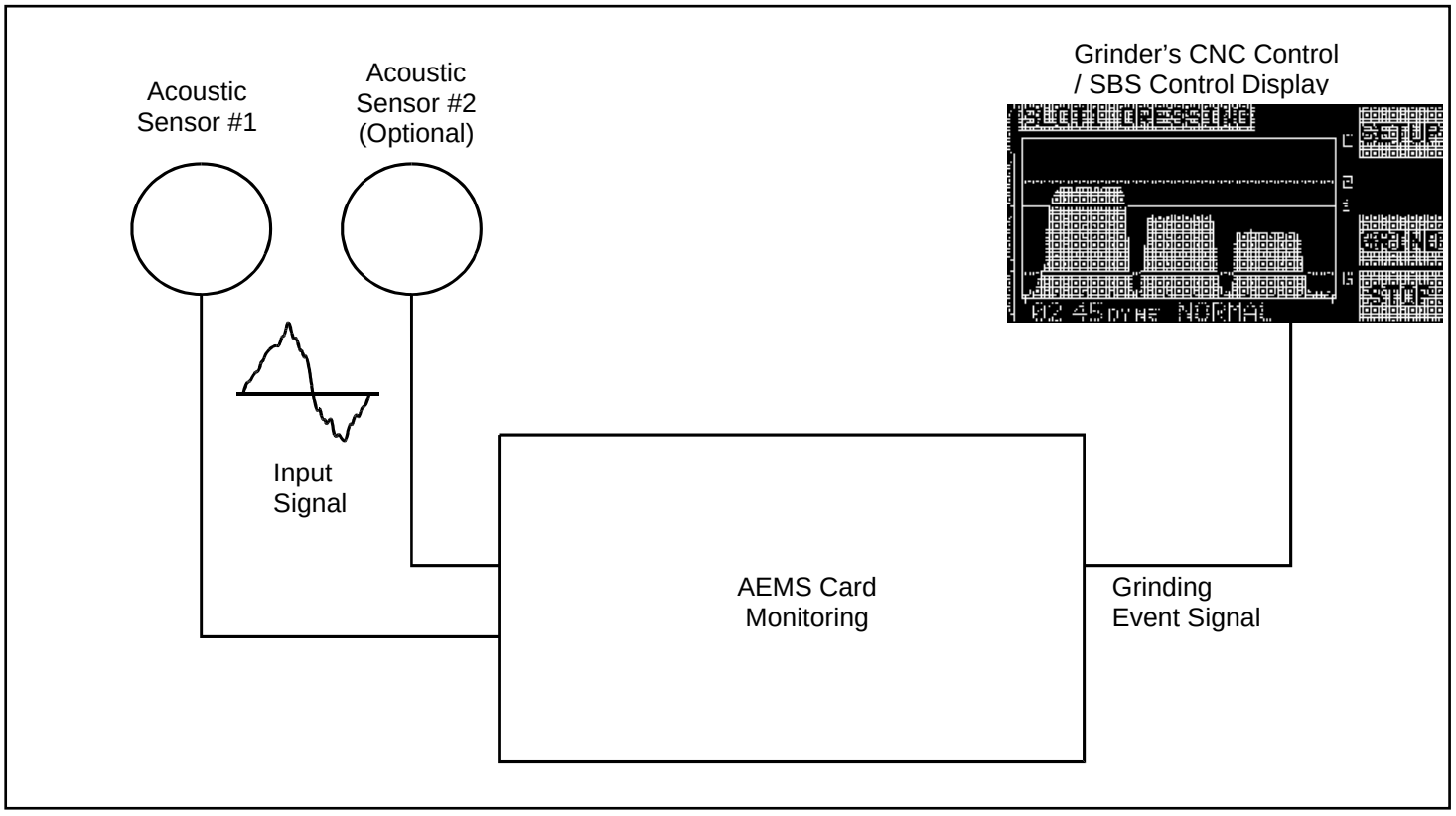
Caution
To avoid equipment damage, do not drop or mistreat.

Caution
Only qualified service technicians should attempt to perform service on SBS equipment. To avoid electric shock, do not remove the cover of the Control Unit, or remove cables, with power connected.

Caution
To avoid equipment damage, make sure the line voltage is within the range specified for the system.

System Theory and Connection

The AEMS system consists of a custom designed electronic control system, and depending on the installation, either one or two custom designed acoustic sensors. This electronic control is packaged as a separate electronic board to be inserted in SB-4400 or SB-4500 series Control units. The acoustic sensors are mounted on the grinding machine, and located to detect high frequency acoustic emissions generated in the machine structure resulting from the grinding or grinding process. By monitoring the level of these emissions, referenced against known background levels at the same frequency, key events can be automatically and quickly detected on the grinding machine as they occur. These events include: Initial contact of the grinding wheel to the dresser or work-piece, abnormal or severe contact between the wheel and these parts (crash), and contact with the dresser unit. The occurrence of these events is then reported via both the CNC port and the Control unit's main display. Machine CNC controls can be programmed to use this additional information to eliminate Gap dwell time, protect against damage resulting from part crash, and monitor the quality of the dressing process.

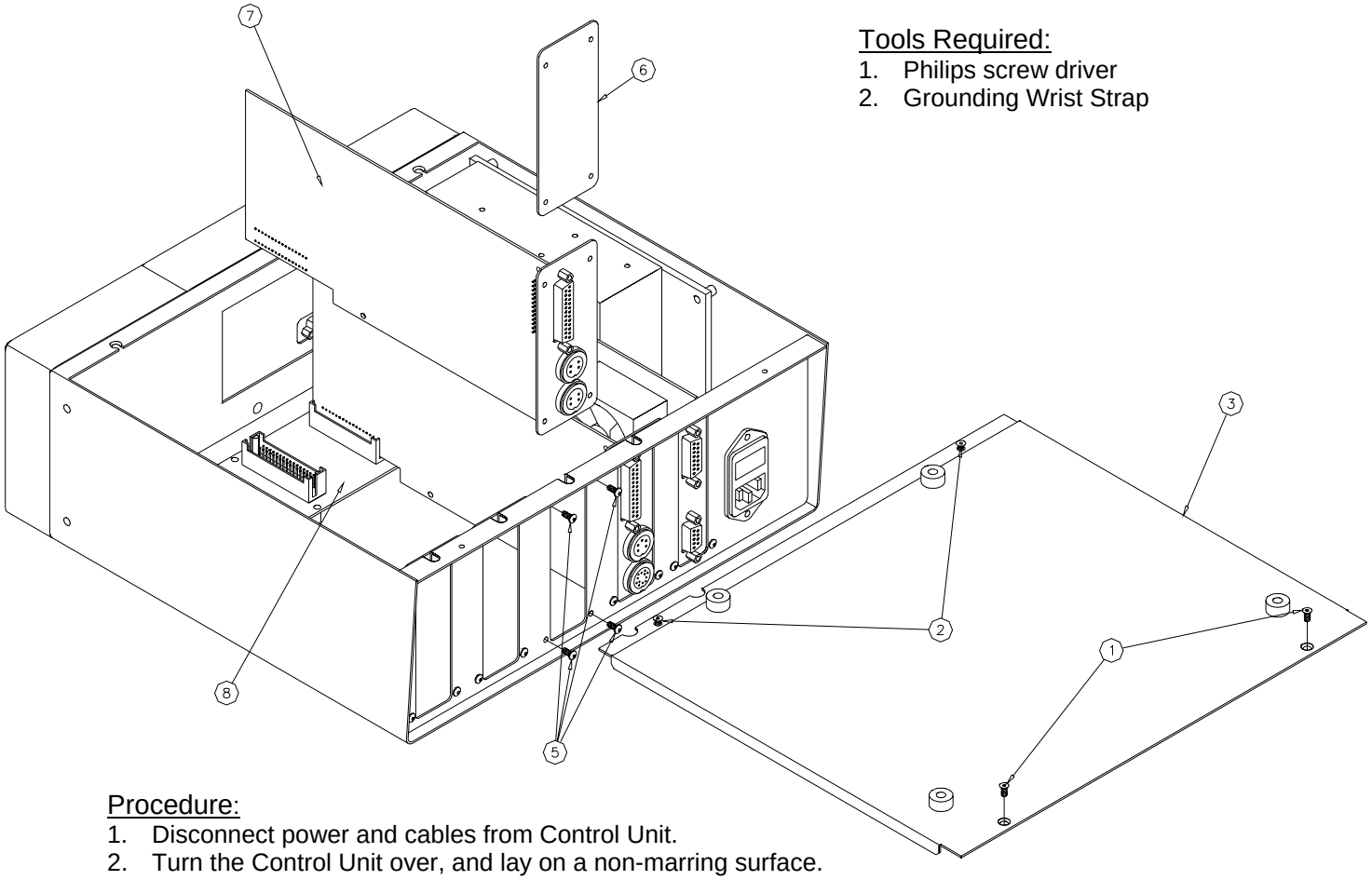


System Installation

The SBS AEMS System is easily installed in a short period of time. This section provides instructions for mounting of the system hardware on the grinding machine. Included are sections covering installation of the AEMS Card in the SBS Control Unit, making system connections, and installing the acoustic sensor(s).

Installation of the AEMS Card in the SBS Control Unit

If the AEMS Card was factory installed, proceed to the next section. If the AEMS Card is being added to an existing SBS Control Unit, use the following procedure and diagram to install the card in any open and available numbered slot in the Control Unit (slot 1-4 for SB-4500 series, slot 1-2 for SB-4400 series).



Tools Required:

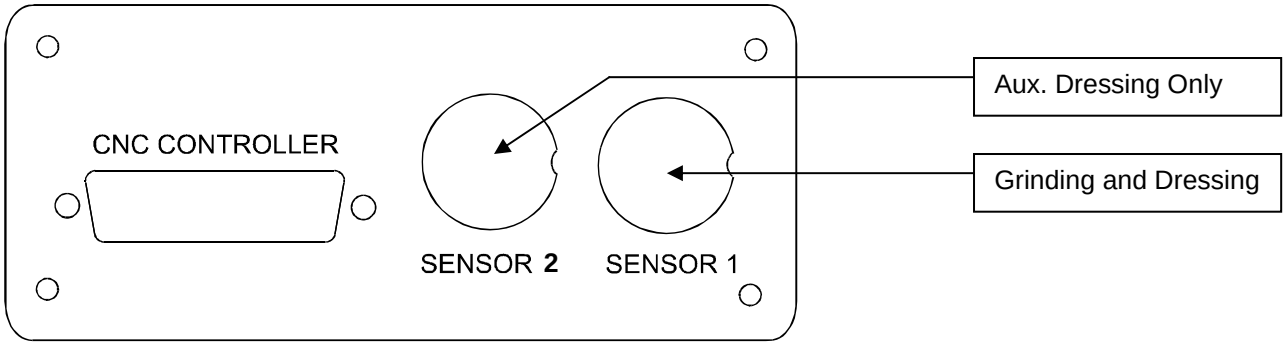
1. Philips screw driver
2. Grounding Wrist Strap

Procedure:

1. Disconnect power and cables from Control Unit.
2. Turn the Control Unit over, and lay on a non-marring surface.
3. Remove the four Cover Screws (1) and (2).
4. Remove Bottom Cover (3) and attach Grounding Wrist Strap (4) to rear lip of panel.
5. Remove Slot Cover Screws (5) and Slot Cover (6).
6. Plug AEMS Card (7) into Back Plane Board (8).
7. Install Slot Cover Screws (5) into AEMS Card (7) and tighten in place.
8. Remove Grounding Wrist Strap (4).
9. Install Cover (3) and tighten Cover Screws (1 & 2).
10. Reconnect power and cables for operation.

System Connections

The Back panel of the AEMS card is shown below. The device can be identified by the two four (4) pin circular connectors, for connecting the acoustic sensor(s). The first sensor position (SENSOR 1) can be used to monitor both Dressing and Grinding, while the second (optional) sensor connector (SENSOR 2) can only be used to monitor Dressing. In cases where one sensor is to be used, connect to SENSOR 1.



SB-4522 AEMS Gap/Crash Card

Acoustic Sensor Location

Choose an appropriate sensor location on the grinder for testing. The Sensor must be mounted by drilling and tapping a fastener hole in the machine casting or other rigid machine structure. Use a M6 or 1/4-20 machine cap screw to firmly bolt the AEMS sensor to the machine. The mounting spot should be reasonable flat, and must be free of foreign matter such as swarf. Paint removal is advisable but not required.

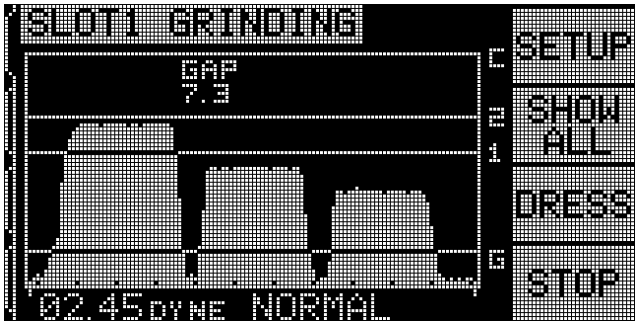
The vital issue to be considered in placing the sensor is acoustic transmission quality. The sensor should be location on a rigid part of the grinder so that the high frequency noise resulting from contact between the wheel and work part, or between the wheel and dresser unit, will travel to the sensor with minimal loss of signal. Signal loss will occur both with distance traveled through the machine structure, and with each part to part mating junction in the machine. What is desired is a short path of travel for the acoustic signal, through as few parts of the machine as possible, with all parts of this travel path being rigid, solid, and firmly mated portions of the machine structure.

It may be possible to mount one AEMS sensor on the spindle housing, near where the balancer sensor would be located, and use this location for monitoring both Dressing and Grinding. If this does not work on a particular machine structure, the alternative is to mount one sensor on the dresser structure for dressing monitoring, and another sensor on the tailstock, or other rigid portion of the part holding structure of the machine, for grinding monitoring. Two sensors can be used simultaneously by the AEMS system.

NOTE: **Do Not** mount acoustic sensors on thin or loosely attached machine components such as wheel guards. The main casting of the machine close to the grinding wheel produces the best acoustic signal.

Operating Instructions

Go to the SHOW ALL menu for the control unit, by pressing the SHOW ALL button from any card main screen. Select the AEMS card to be displayed.



Main Screen Operation

This is the main screen of the AEMS system. The unit has two separate monitoring modes, with corresponding screens “Dressing”, and “Grinding”.

The mode is selectable from this main screen, by using the DRESS/GRIND toggle button, third from the top. The currently selected mode is always shown in the upper screen label, along with the current channel name assigned to the AEMS card.

The SHOW ALL button simply returns the user to the system wide menu screen, for monitoring all card channels installed in the SBS control unit, or to select another channel for detailed interface. This button is only available on control units with more than one function card installed.

The START/STOP toggle button on the bottom right of the screen, starts and stops the display from scrolling real-time acoustical signal levels currently being monitored. It is possible to stop or freeze the display, so that target levels can be adjusted against recent signal levels, or for review of an event by the operator. Even when the screen is not scrolling, the unit will continue to monitor for gap and crash events, and provide their status via the CNC Connector, and by the color of the front panel channel status LED.

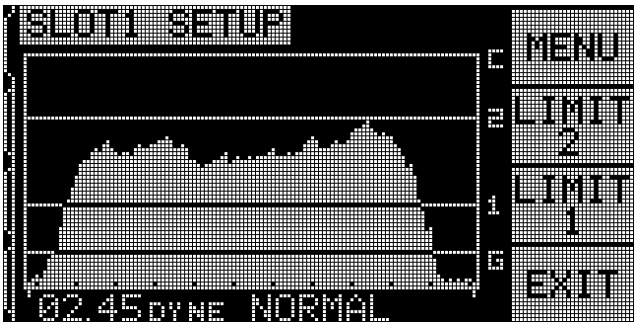
Measured Gap and Dress Times

While GRINDING mode is running, each elapsed time interval that the signal falls **below** the G level is displayed on screen as GAP time. This time, in seconds, is displayed above the measured GAP.

While DRESSING mode is running, each elapsed time interval that the signal rises **above** the G level is displayed on screen as DRESS time. This time, in seconds, is displayed above the measured DRESS.

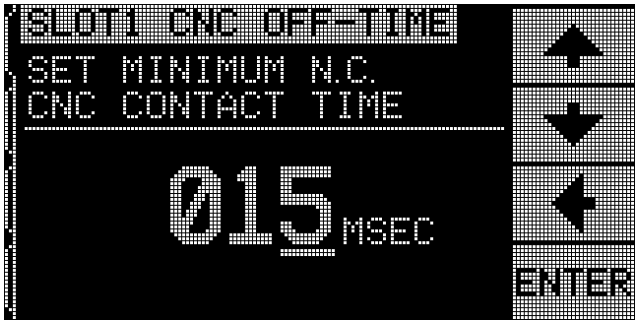
SETUP

Pressing the SETUP button from the main screen allows the operator to access the system setup screen. On this screen the user can adjust the **1** (LIMIT 1) and **2** (LIMIT 2) levels or continue into the setup menu by pressing MENU. To change the limits, select which Limit to change from the SETUP screen, and then use the up and down arrows on the resulting screen to move the limit line, relative to the graph.



MENU

The Menu contains the user selectable operation settings for the AEMS system. Many parameters are stored independently for the two separate monitoring modes under GRIND PARAMETERS and DRESS PARAMETERS. These parameters will be discussed in detail later. The other following menu items listed are general settings for the operation of the AEMS card as a whole.



CNC Signal Time

Sets the minimum hold time, in milliseconds (msec.), that relay contacts are opened or closed to indicate an event signal. **Important – The purpose is to make an event's signal last long enough to assure signal detection by the machine control used.** The factory default settings are 1 msec, but PLCs or similar devices typically will monitor at timed intervals of about 5 msec. In such cases the signal time must be set to exceed the polling cycle time. Affects GAP, LIM1, LIM2, and (if not latched) CRASH signals of the CNC interface.

To change settings, select SETUP from the Main screen. From the Setup screen, select MENU with the corresponding button, then select CNC SIGNAL TIME from the menu. The two screens that follow control the ON and OFF contact hold times. Times can be set from 1 to 999 msec.

To set the desired time for the N.O. contact closed time, use the left arrow button to select digits, and the up and down arrow buttons to change the selected digit. Press ENTER to accept the entry and proceed to the OFF-TIME screen.

In the same manner, set the time that the N.C. contact will be closed and press ENTER.

CNC Crash Latch

This menu option sets how the CRASH output signals will react to crash conditions. Use the up and down arrow buttons to toggle the cursor between the OFF or ON selections. Press ENTER to have the entry accepted.

OFF Crash not latched, subject to ON/OFF times like GAP, LIM1, LIM2.

ON Crash condition closes the CRASH N.O. contact until it is reset by: (1) RESET CNC input (2) RS232 error clear (3) Clear button when Crash error screen is displayed.

CNC Function – Stop/Start

Menu option activates or deactivates optional CNC control of the screen STOP and START functions. Screen STOP, freezes the data display screen, and START will begin the data screen scrolling again, showing current data. This function is always controllable via. The front panel screen and menu buttons (MENU) and by the RS-232 port. When this option is set to MENU+RS232+CNC, the function of two inputs on the CNC port is modified to allow control of screen STOP and START. The inputs used for this control are the GRIND and DRESS inputs (see CNC input section for details).

Channel Name

Selecting the CHANNEL NAME menu item will display an entry screen. Use the right arrow button to select cursor position, and the up and down arrow buttons to toggle through the alphanumeric list to label the AEMS card device. Custom labels can be used to identify each card device installed in the SBS control unit with this feature. Up to Five characters can be used to label the AEMS card. Press ENTER to accept the entry.

Menu Entry

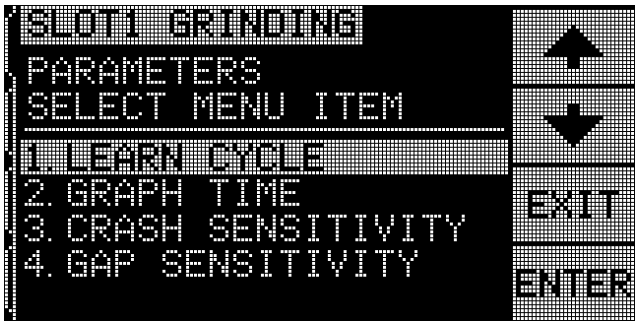
This selection on the menu list provides for use of a standard access code for menu protection. Setting the channel to the protected mode denies access to the menu list unless the access code is entered. This setting ensures that system settings will not be accidentally compromised. The screen displays ENABLED when Menu access is available, and PROTECTED when menu access is controlled by the access code. Function buttons are assigned the numbers 1, 2, 3, and ENTER, which are used to input the access code. The standard access code is **232123.** Once the code has been entered and the ENTER button has been pressed the MENU selection is protected. Re-entry to the menu list will now require entry of this code. The message MENU ACCESS PROTECTED will be displayed notifying the user that the menu is password protected, and the user will be given the opportunity to enter the code. Entering a code other than the correct number will produce a message INCORRECT CODE ENTERED TRY AGAIN/ CANCEL.

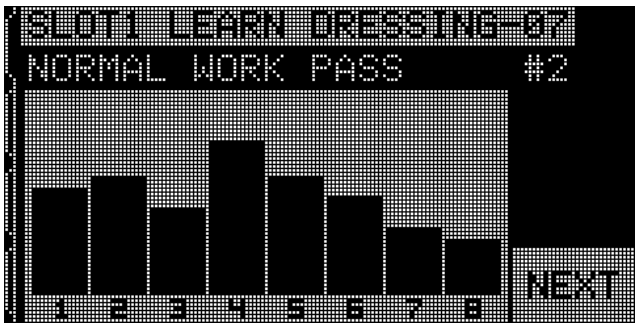
To disable menu protection, enter the correct code to access the menu, select the MENU ENTRY item from the menu, and enter the code again to turn off the protection. The display for MENU ENTRY will display ENABLED when protection has been disabled.

Grind and Dress Parameters

Learn Cycle

The system needs to be set for proper operation by first initiating a learning cycle, which will compare the background acoustical emission levels at various frequencies with the levels that occur during normal dressing or grinding. A separate learning cycle must be run for both the grinding and dressing modes, as resulting parameters are stored separately for each mode, but the process is the same in both cases. The learning cycle will properly set up the gain and other parameters needed for correct operation in the selected monitoring mode. After pressing SETUP to enter the setup menu, press the MENU button, followed by selecting either DRESSING PARAMETERS or GRINDING PARAMETERS, depending on the current monitoring mode. Next select LEARN CYCLE to activate the learning cycle for the mode selected.

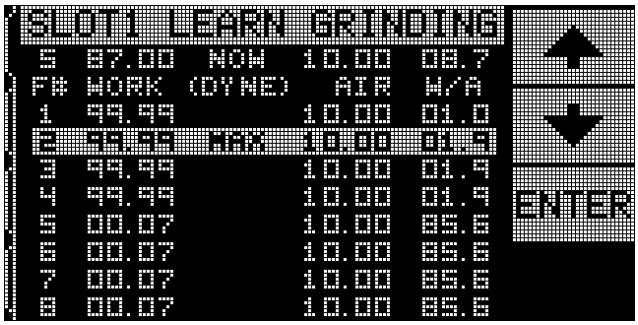




The first window will show eight bar graphs, representing the real time signal levels occurring in each of the separate frequency bands covered by the unit. The graph is titled AIR PASS. The bar graphs will rise and fall as signal levels change. The VIEW DATA button allows the user the view the results of the last learning cycle ran, and choose an alternate frequency band based on those results. To perform a learning cycle, the first step is to "learn the background levels". To do this, the machine should be operational, with all systems running, but **without** wheel contact with the part or dresser. Once the graph has settled, press START to begin learning. Move the wheel though a mock grind or dress movement, without wheel contact (the bar graphs may rise a little during this process). When finished, press NEXT to store the maximum background levels recorded in each frequency band, and to move to the next phase of learning.

The screen should now be reversed in color from the previous screen, and titled NORMAL WORK PASS. The operator should initiate wheel contact with the dresser or part, and complete one or more cycles, until the bar graph is stable. This process records the maximum signal levels during normal grinding or dressing, so the bar graphs will always show the highest levels recorded during this current learning cycle. Once the bar graph has stabilized, press NEXT to store this information, and display the resulting data screen.

The data screen will show acoustic levels recorded for all eight filter bands, during the air pass and the work pass. The resulting ratio between background and work levels is displayed, and the filter band selected by the control system for optimal monitoring is highlighted. Press ENTER to accept this choice, or override the AEMS system selection by choosing another filter band, and then pressing ENTER. Press EXIT twice to exit the setup menu, and return to the Main Screen.



Verify Normal Operation

The Main Screen can be stopped or started by toggling the lower right hand button. When running, the screen will display real time acoustic level information, as it occurs. When stopped, the screen shows the last time period recorded. Always verify that the heading for the screen reads either DRESSING or GRINDING and that the mode selected is correct. When the wheel is not making contact, the screen should show signal levels below the G (GAP) limit line, and the screen should read "Idle" on the bottom. **If the signal level is above the G limit at this point, you must repeat the learning cycle to achieve proper results.** The G (Gap) and C (Crash) limit levels are set automatically during the learning cycle and vary according to the results of the learning process and the sensitivity setting selected by the operator (see: Gap sensitivity and Crash sensitivity settings under the Setup Menu). The Gap and Crash trip levels can be manually adjusted by changing the sensitivity setting.

Initiate wheel contact with the dresser or work-piece (depending on the selected mode), and observe the running display. You should see the acoustic levels falling between the 1 (LIMIT 1) and 2 (LIMIT 2) levels during full contact, and dropping off below the G level between passes. The 1 and 2 levels indicate the normal minimum and maximum levels for grinding or dressing. Using the SETUP screen, these levels can be adjusted by the operator as needed in order to bracket the normal operation range. If results are not as described, then one of two things should be tried.

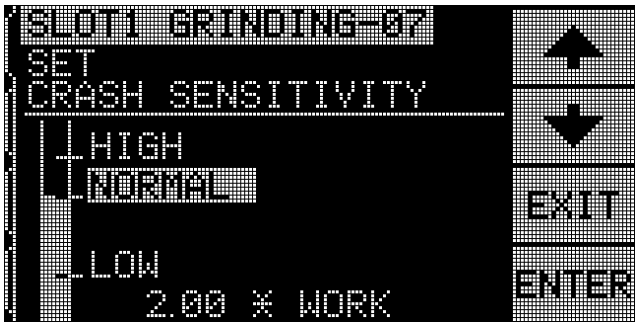
a) Try adjusting the sensitivity level parameters under the Menu. Learning again is not required. Note that higher sensitivity selections are more sensitive to noise as well as signal.

b) Try an alternate Sensor location, and re-run the LEARN cycle. Try moving the sensor closer on the machine structure to the point of wheel contact, as described in the Acoustic Sensor Location section.

Graph Time

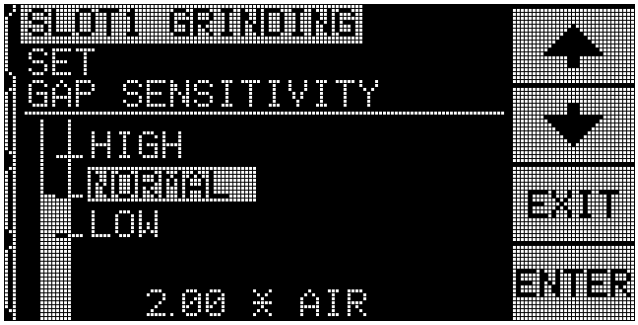
Graph Time adjusts the time scale the AEMS system uses to display data on the screen. The Graph time set represents the number of seconds taken to scroll across the display screen, so the width of the screen then reflects the data taken in this same time period. The default time is 11.4 seconds and can be set up to 365 seconds. A longer Graph Time will display data over a longer period of time, but at a lower resolution.

Crash Sensitivity



Can be set as needed on the scale provided. This setting determines the C (Crash) limit, based on a fixed multiple of the maximum work level recorded during the last learning cycle. A higher Sensitivity setting means the Crash limit will be set nearer the work level (more sensitive), while a lower Sensitivity setting will move the Crash limit further above the work level (less sensitive). Sensitivity changes are easily made by pushing the up and down arrows to achieve the proper sensitivity for your job requirements.

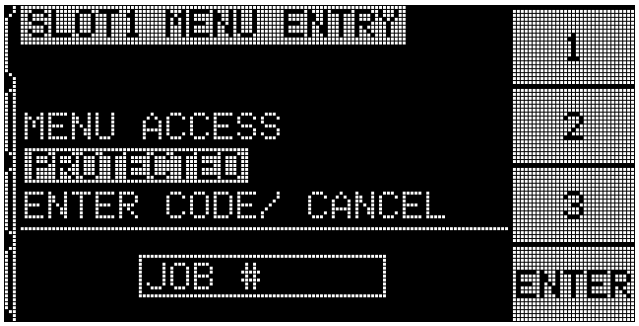
Gap Sensitivity



Can be set as needed on the scale provided. This setting determines the G (Gap) limit, based on a fixed multiple of the maximum Air Pass level recorded during the last learning cycle. A higher Sensitivity setting means the Gap limit will be set nearer the Air Pass level (more sensitive), while a lower Sensitivity setting will move the Gap limit further above the Air Pass level (less sensitive). Sensitivity changes are easily made by pushing the up and down arrows to achieve the proper sensitivity for your job requirements.

Sensitivity and Gain Control

Changing the sensitivity settings will change the effective signal gain of the unit. To ensure ease of setup, the signal gain is set automatically, based on the current results of the last learning cycle, and the current sensitivity settings. By increasing the sensitivity settings, the Gap or Crash Limit affected will be assigned a lower value, and screen scale will be recalculated to compensate, producing higher displayed signal levels. By lowering the sensitivity settings, the Limits will be assigned a higher value, the new screen scale will then produce lower displayed signal levels. **Important - the screen scale of the AEMS system is logarithmic, not linear**. This allows fairly large changes in signal level to be displayed on screen, without overrunning the screen limits.



Multiple Parameter Sets – Job #

This menu item allows multiple job settings to be stored for future reference and easy retrieval. This is useful in cases where changes in the workpiece, grinding wheels, or other job setup variables on the grinding machine, change the AEMS system settings required to correctly monitor different jobs.

The Job # setting is optional, and is by default set to "OFF". In this condition only two sets of parameters are stored, one each for the GRINDING mode and the DRESSING mode. By Selecting the MENU option, JOB #, the user will be able to access separate memory storage for up to 16 separate pairs of stored job parameters, one GRINDING and one DRESSING setup for each job number, providing a total memory storage of 32 separate setups.

After selecting the JOB # option from the MENU screen, the user simply enters the desired reference job number on the following screen, using the up and down arrows to select the job number desired, and ENTER to make the selected job # setup parameters active. Setup for each job would proceed normally with a LEARN cycle, and setup of limits as required for this particular job. Important – all separate JOB # memory sets will initially include factory default settings, and must be individually setup before use.

Once a user has selected an individual JOB # from this menu, it will remain the active parameter set until changed from the same menu. If any individual JOB # is currently selected (JOB # is not set to OFF), then the active JOB # will be appended to the descriptive label at the top of all control screens related to operation of the individual job. This added text is in the form of –XX, indicating the current job number selected. In addition, the JOB # menu item will move to the top of the MENU list, making selection of various job numbers more convenient.

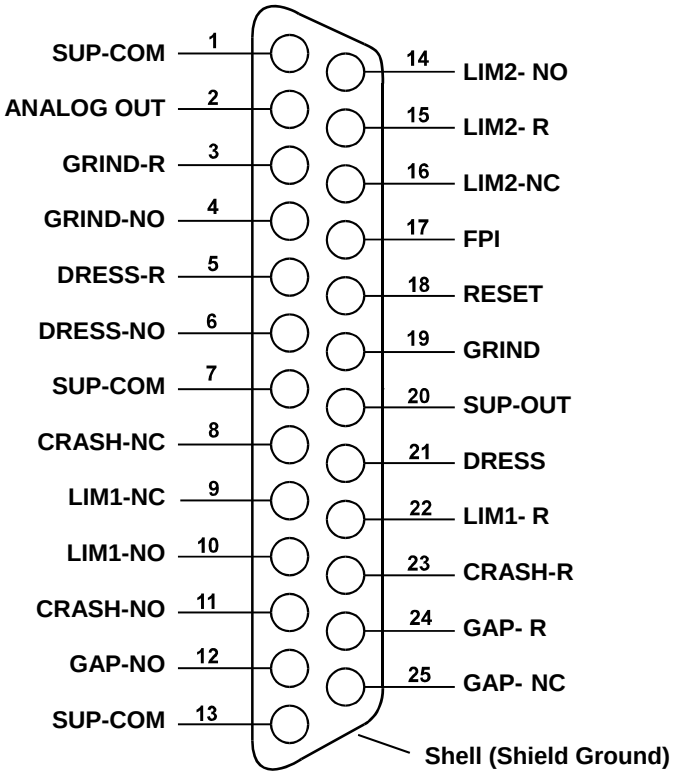
When Job # is not set to OFF, the function of the AEMS system MENU ENTRY is altered. The ability to switch between JOB # settings is still allowed, even when system MENU ENTRY is protected. A default entry of "JOB #" is initially displayed on the menu entry password screen, as shown. Entry of a number will overwrite this initial entry, and allow the user to operate the password screen normally, and by entering the access code, enable full menu entry. By pressing ENTER to accept the "JOB #" code initially displayed, the user will have access to the JOB # selection screen only.

CNC Interface Protocol

There are two different options available for interfacing the SBS AEMS System with a CNC control. Either a hardwire interface or software interface is supported. The hardwire interface is supported via a standard DB-25 connector located on the rear panel of the AEMS Card, while the Software interface is supported via the DB-9 connector located on the rear panel of the SBS Control Unit's Main Card, which is common to the whole control unit. Because of the many possible variations and configurations of cabling required for such an interface, it is left to the operator to supply the necessary cable. **When designing a CNC interface for the SBS System, it is important to understand that it is intended that the grinding machine's CNC control operate the SBS System**. It is not possible, or advisable, for the SBS System to control the grinding machine. The following interface is provided as a means to connecting with the SBS control, using information provided by the system, to maintain the desired grinding parameters. The whole of the SBS Balance System Operation Manual, as well as this instruction addendum should be read before attempting to interface the SBS System with any CNC control.

CNC Interface Connector

Standard for SB-4400, and SB-4500



AEMS CNC connector wiring diagram

Hardwire Control Interface – AEMS Card

The CNC interface consists of three sections: the interface power supply, the inputs, and the outputs.

The interface power supply is provided exclusively for use with the inputs of the CNC interface. It consists of three common pins and an output pin. The common pins are internally connected to chassis and earth ground, while the output is intended to provide a maximum of 30 mA at approximately +15VDC.

The four inputs provide optical isolation between input signals and the rest of the controller circuitry. The inputs are activated by connection to the AEMS CNC interface power supply output, or by connection to a customer supplied signal. Activating the inputs requires at least 8 mA at a voltage between 10 and 26 volts, AC or +DC, referenced to the AEMS CNC interface power supply common. The common pins are internally connected to chassis and earth ground. The inputs are deactivated by removing the connection to the power or signal source.

The six primary outputs consist of optically isolated, solid state, SPDT and SPST relays. These relays may used to supply an output signal by connection to the AEMS CNC interface power supply output or by connection to a voltage source supplied by the customer. The relay contacts are electrically isolated from all other circuits and are rated for 120 Volts DC or AC, 50 mA maximum. Inductive loads must be protected against flyback greater than 180 volts. **Important** – Output signal duration is selectable, and may be critical to proper operation with machine controls using periodic polling of outputs (See CNC Signal Time section).

The ANALOG OUT is a 0-10V, 15ma max signal proportional to the acoustic emission signal. This output signal intensity is controlled by the CRASH SENSITIVITY (higher sensitivity gives higher voltage).

The contacts of a relay are often referred to as normally open (NO), normally closed (NC) and common. The term "common" in this sense does not imply connection to power supply common. The term "common return" (R) will be used below to indicate the "common" contact of the relay. Each input should be held active for 50ms minimum to allow the control to respond.

Input Pin Names and Functions

Pin	Name	Description
17	**FPI**	Front Panel Inhibit- While this input is held active, most operator actions at the front panel keypad are disallowed. Specifically, the SETUP button, the DRESS/GRIND button, and the START/STOP Button are disabled. Still enabled are the Power button and the SHOW ALL button. This affects the operation of this AEMS card only.
18	**RESET**	Crash Reset. The crash status latch will be reset following the rising edge of a voltage applied to this input. A crash that occurs while voltage is applied will not be reset. The voltage must be removed and reapplied. This input is ignored if the CNC Crash latch is set to OFF.
19	**GRIND**	Activate this Input to select GRIND mode and initiate AEMS operation using the Grind parameters. Selection will be made following the rising edge of a voltage being applied to this input. Option: When STOP/START CONTROL SOURCE is set via the menu to allow CNC control of the screen STOP and START functions, this input will provide control of this function also. When this mode is selected, the screen will continue to scroll (with new data being displayed) only while this input is held active. Following the removal of voltage from this input, the control card will STOP the display, until voltage is applied again.
21	**DRESS**	Activate this Input to select DRESS mode and initiate AEMS operation using the Dress parameters. Selection will be made following the rising edge of a voltage being applied to this input. Option: When STOP/START CONTROL SOURCE is set via the menu to allow CNC control of the screen STOP and START functions, this input will provide control of this function also. When this mode is selected, the screen will continue to scroll (with new data being displayed) only while this input is held active. Following the removal of voltage from this input, the control card will STOP the display, until voltage is applied again.

Output Pin Names and Functions

Pin	Name	Description
2	**ANALOG OUT**	Analog signal output (0-10V, 15mA max.) referenced to SUP-COM. See following section for further details.
4	**GRIND-NO**	Closed to indicate the GRIND parameters are in use.
3	**GRIND-R**	Common return connection for the GRIND contact.
6	**DRESS-NO**	Closed to indicate the DRESS parameters are in use.
5	**DRESS-R**	Common return connection for the DRESS contact.
11	**CRASH-NO**	Closed to indicate a crash condition. Latches if the CNC crash latch is on.

8	**CRASH-NC**	Closed whenever CRASH-NO is open (no error condition detected). It is also closed when power is off and during standby, initialization, self-test, and learn modes.
23	**CRASH-R**	Common return connection for the CRASH contacts.
12	**GAP-NO**	Closed whenever the AE is at least at the GAP setting (wheel contact detected).
25	**GAP-NC**	Closed whenever GAP-NO is open indicating that the AE is below the GAP setting (grinding air). It is also closed when power is off and during standby, initialization, self-test, and learn modes.
24	**GAP-R**	Common return connection for the GAP contacts.
10	**LIM1-NO**	Closed whenever the AE is at least at the level of the LIM1 setting.
9	**LIM1-NC**	Closed whenever LIM1-NO is open indicating that the AE is below the level of the LIM1 setting. It is also closed when power is off and during standby, initialization, self-test, and learn modes.
22	**LIM1-R**	Common return connection for the LIM1 contacts.
14	**LIM2-NO**	Closed when the AE is at least at the level of the LIM2 setting (excessive grinding pressure).
16	**LIM2-NC**	Closed whenever LIM2-NO is open indicating that the AE is below the LIM2 setting. It is also closed when power is off and during standby, initialization, self-test, and learn modes.
15	**LIM2-R**	Common return connection for the LIM2 contacts.
20	**SUP-OUT**	A protected supply referenced to the Supply Common connection. It will be adequate to operate any combination of the CNC inputs on the CNC connector.
1,7,13	**SUP-COM**	Common reference connection for the CNC input pins on all channels, connected to earth and chassis ground. This connection is for the common of the external supply, when one is used to activate the CNC input signals.

AEMS Analog Output

The voltage is presented at pin 2 of the 25 pin CNC connector of the SB-4522 card. Pin 1 is the ground reference for this voltage. The analog output on the AEMS system is not calibrated to a fixed level. The gain of the system is auto scaling, so that the analog signal output always falls in the 0-10 VDC range. This auto scaling gain is needed to accommodate the huge variation in signal level, which can be measured on various types of grinders with different applications, and sensor placements. This auto scaling gain corresponds to the gain used for the display of AE level on the front panel. This scale is reset every time a learning cycle is run, or the Crash sensitivity setting is changed.

Following is an explanation of the process that sets this voltage and the effects of that process on other event threshold settings in the system. During the LEARN process, the WORK value is measured. This WORK value, along with the CRASH SENSITIVITY setting, are then used to compute the system's Crash Event level. The CRASH SENSITIVITY (CS) selects a multiplier for the measured WORK level that, when applied, yields the Crash Event level (CRASH).

$$(CRASH) = (WORK)(CS)$$

At appropriate times the processor sets the internal amplifier gains such that a Crash Event would generate a voltage between 4.5 and 9.0 volts at the analog output. The values selectable for CRASH

SENSITIVITY (CS) produce multipliers ranging from 3.55 to 1.05 (with LOW=3.0 and HIGH=1.5). This multiplier is applied to the WORK level to set the amplifier gains. Note that there is no correlation between the gain set, and the corresponding voltage levels for the separate GRINDING and DRESSING modes.

(VCRASH) = 4.5 – 9.0 VDC = (VWORK)(CS)

In an example where sensitivity is set higher (e.g. CS = HIGH), the incoming AE signal needs only to rise to 50% higher than the normal WORK level to trigger a crash event. With the system set to a lower sensitivity setting (e.g. CS = LOW), a signal increase of 200% is needed to generate the event.

The analog output voltage representing WORK level can be approximated using the following table:

Crash Sensitivity	Low	Medium	High
Min. WORK Voltage	1.50	2.25	3.00
Max. WORK Voltage	3.00	4.50	6.00

The voltage levels representing AIR and GAP levels are much lower than the WORK level. On the same voltage scale, the WORK voltage will be W/A (from the LEARN screen) times the AIR voltage. The GAP voltage will be AIR voltage times the GAP SENSITIVITY (GS) level selected. The range of GS settings correspond to multipliers from 3.55 to 1.05 (with LOW=2.5 and HIGH =1.5).

(VWORK) = (W/A)(VAIR) (VGap) = (VAIR)(GS)

Software (RS-232) Interface

The SBS Balance System provides an alternate CNC interface using the RS-232 signal lines on the DB-9 connector on the rear of the SBS control unit. The RS-232 interface allows the same control capability as the hardwire CNC interface, plus allows additional monitoring capability. The following description applies to all SB-4500 and SB-4400 series models of SBS Control Units. The RS-232 interface is a subset of the complete RS-232 specification. Please see the Operations Manual for details, including pin descriptions, setting Baud rate, and general interface information.

RS-232 Commands and Responses

When the Control unit is first powered up, the following messages are transmitted out the RS-232 Port. The first two lines are from the System Controller, the first is identifying text and the second is the firmware version. The remaining lines identify the functions plugged into the Slot Card positions and the firmware revision associated with each. The last five messages may be transmitted in any order:

/SB-4500, Copyright (c) 1998, Schmitt Industries, Inc.<CR>
V0.02<CR>
2X3.00V0.09[GR1]/GAP / CRASH<CR>
1X0/No Card<CR>
3X0/No Card<CR>
4X0/No Card<CR>

Commands - A message preceded with the digit ‘1’ through ‘4’ will be a command or response referring to Slot Cards 1 through 4, respectively. A message starting with any other character refers to the System Controller. The following commands and responses are available to control an installed AEMS card.

AEMS Card Commands (Cards are Individually Controlled)		
Command	Response	Meaning/ **Example**:
C		Control Panel Status Inquiry. **<Esc>C<CR>**
	CI	Control Panel is Inhibited **CI<CR>**
	CE	Control Panel is Enabled **CE<CR>**
	CX	Control Panel is not installed **CX<CR>**
CE		Control Panel Enable. **<Esc>CE<CR>**
	K	Command Acknowledged **K<CR>**
	CX	Control Panel is not installed **CX<CR>**
CI		Control Panel Inhibit. **<Esc>CI<CR>**
	K	Command Acknowledged **K<CR>**
	Q	Command Not Accepted (Panel in use?) **Q<CR>**
	CX	Control Panel is not installed
V		Version Request (main board firmware). **<Esc>V<CR>**
	Vn.nn	Firmware Version **V1.00<CR>**
X		Type (of slot card) Request. **< Esc >1X<CR>** Start Slot 1 Info Request.
	X3.xxVv.vv [sss]/text	Slot info response. 3 is Gap/Crash type. xx is specific model type. v.vv is gap firmware revision. sss is the user specified name for this card. Text briefly explains the card type. **1X3.00V1.00[GAP1]/Gap / Crash<CR>**
S[C]		Status Request command. If 'C' present then previously reported errors conditions will be cleared before the status is reported. **<Esc>1S<CR>** Report Slot 1 Status.
	S{D|G}aaaa [,CIP][,FPI] [,GAP] [,LIM1] [,LIM2] [,CRASH], ERR=eee	Status response. D or G indicates current mode, Dress or Grind, aaaa is AE level (dynes). CIP is Cycle In Progress. FPI is Front Panel Inhibit. GAP, LIM1, LIM2, and CRASH the corresponding relay output is closed, eee represent individual error letters representing error conditions. If the first character is '@' then an error condition requires clearing (use SC command or press clear on front panel). **1SD2.905,CRASH,ERR=@AB<CR>** **<ESC>1SC<CR>** Report Slot 1 Status. **1SD2.912,ERR=B<CR>**
C[D|G|S|A|nn]		Cycle Command: If D or G, will change to the corresponding mode (Dress or Grind). If nn will change to corresponding Job# parameter set (nn range 0-16, 0 turns Job# OFF). If S or A then will Start or Abort the measurement process, correspondingly. No response to D, G, A or nn. **<ESC>1C7<CR>** Set Job# to 7. **<ESC>1CS<CR>** Start Cycle.

AEMS Card Commands (Cards are Individually Controlled)		
Command	Response	Meaning/ **Example**:
	{D|G}dddd	Cycle data. D or G indicates Dress or Grind value. dddd is AE level in dynes. These will be sent whenever a cycle is running. There will be no response if the command is not allowed. **1G0.023<CR>** Grind Cycle data. **1G0.120<CR>** Grind Cycle data. **1G0.134<CR>** Grind Cycle data. **<ESC>1CA<CR>** Abort Cycle. (no response)
L		Level request: **<ESC>1L<CR>** Request Current Levels.
	Lnn{D|G}gggg, aaaa,bbbb,cccc	Level response. nn indicates current Job# parameter set. Nn=0 for OFF, nn=1-16 for current Job#. D or G indicates current mode, Dress or Grind. Levels (dynes) are gggg for Gap, aaaa for Lim1, bbbb for Lim2, and cccc for Crash. Levels are different for each mode (Dress or Grind). **1L7G0.023,0.145,1.056,3.112<CR>** Grind mode levels.

Displayed Error Messages

Self-diagnostic software has been incorporated into the SBS AEMS Card. If a problem ever occurs, It is quickly reported on the front panel display of the control unit in the form of an error code. Below is a listing of these codes, a description of when each test automatically runs, how each error is cleared, the definition of each error, as well as the prescribed action to be taken by the user of the system. To further isolate defective components a series of test operations accompany some of the error codes.

1— Checked continuously.....

message: **SENSOR 1 DEFECT**
OPEN – CHECK CABLE
AND CONNECTORS
SEE MANUAL

Clears automatically.

definition: Acoustic Sensor 1 presence not detected. This could be caused by a defective sensor or by no sensor being connected.

action: Check sensor connections and try Power-On again. Continued error messages indicate the need for repairs to the Sensor.

2— Checked Continuously.....

message: **SENSOR 1 DEFECT**
SHORT – CHECK CABLE
AND CONNECTORS
SEE MANUAL

Clears automatically.

definition: Acoustic Sensor 1 short circuit detected.

action: Disconnect the balancer from AC power before checking cables and connectors, and sensor for shorts. If the problem can not be isolated, the sensor, cable, and/or Control Unit should be returned for repair.

3— Checked Continuously.....

message: **SENSOR 2 DEFECT**
OPEN – CHECK CABLE
AND CONNECTORS
SEE MANUAL

Clears automatically.

definition: Acoustic Sensor 2 presence not detected. This could be caused by a defective sensor or by no sensor being connected.

action: Check sensor connections and try Power-On again. Continued error messages indicate the need for repairs to the Sensor.

4— Checked Continuously .....

message: **SENSOR 2 DEFECT**
SHORT – CHECK CABLE
AND CONNECTORS
SEE MANUAL

Clears automatically.
definition: Acoustic Sensor 2 short circuit detected.
action: Disconnect the balancer from AC power before checking cables and connectors, and sensor for shorts. If the problem can not be isolated, the sensor, cable, and/or Control Unit should be returned for repair.

5— Checked Continuously .....

message: **+15V POWER DEFECT**
SHORT – CHECK CABLE
AND CONNECTORS –
SEE MANUAL

Cleared automatically.
definition: 15V Auxiliary supply low – fuse open
action: Check for shorts in Sensor and CNC cables and connectors and re-initialize the system. If the error persists return Control Unit and cables for repair. If you have the SBS system cabled to your CNC controller, verify that the CNC cable is free of electrical shorts. The CNC cable is not supplied with the SBS system, and repair is the responsibility of the user.

6— Checked Continuously .....

message: **CRASH CONDITION**

Cleared manually.
Cleared by pressing "Clear" button, or by CNC initiated RESET command.
definition: Unit has measured acoustic levels exceeding the Crash limit set.
action: Check for part crash. Reset Error.

7— Checked continuously .....

message: **CIRCUIT FAILURE**
UNABLE TO MEASURE
VIBRATION
SEE MANUAL

Clears automatically.
definition: Signal acquisition circuit failed.
action: No action required other than clearing manually from the Balancing screen. If the problem persists, the Control Unit should be returned for repair.

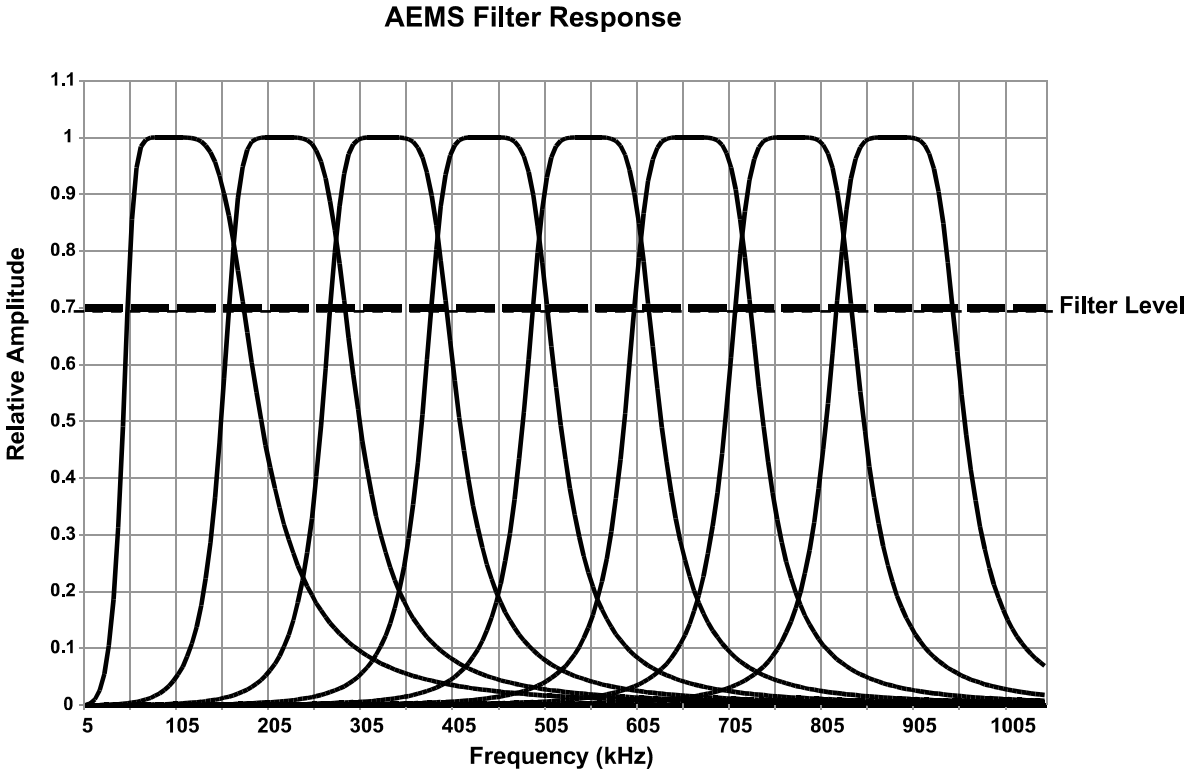
Appendix A: Electronic Specifications

Sensor(s)

Sensors:	One of two sensor signal inputs are available for the AE monitor operation, selectable as a function of the operating mode (grind/dress).
Frequency Range:	50 kHz to 950 kHz
Responsivity:	1.8 mV/dyne (f = 100 kHz) 0.2 mV/dyne (f = 900 kHz)
Dynamic Range:	140 db (f = 100 kHz) 120 db (f = 900 kHz)

Electronics

Acoustic Range:	>120 db
Frequency Range:	50 kHz to 950 kHz, in several filter ranges. Only one filter is selected at any one time.



Filter Staging:	(6th order Butterworth bandpass)

1) 50 – 180 kHz
2) 160 – 290 kHz
3) 270 – 400 kHz
4) 380 – 510 kHz
5) 490 – 620 kHz
6) 600 – 734 kHz
7) 710 – 840 kHz
8) 820 – 950 kHz

AE Repeatability	±2% @ 50:1 signal to noise
AE Reproducibility	±5% @ 50:1 signal to noise

Appendix B: Replacement Parts List

Part#	Description
SB-4522	AEMS (Gap/Crash) Card
SB-42xx	Acoustic Sensor w/ cable

1) xx = cable length in feet - standard options 11, 20, or 40 at standard price

Appendix C: System Connection Diagram