SBS Hydrokompenser
Balance System

Operation Manual

with SB-5500 Series Control

LL-5300 Rev 1.2

Productivity through Precision™

DYNAMIC BALANCE SYSTEM
A Product Line of Schmitt Industries, Inc.

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Operation and Specification Manual

for the

SBS Hydrokompenser Balance System

Covering Systems with Model 5500 series Control Unit

LL- 5300

Manual Revision # 1.2

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Benefits of SBS System with SB-5500 Control:

- Increases throughput by saving setup time
- Improves part quality by automatically balancing to 0.02 micron
- All-digital electronic design increases operating life and reliability
- Easy to install and operate
- Longer life for grinding wheels, dressing wheels and spindle bearing
- Works with existing SBS installations
- Profibus, Ethernet and USB 2.0 communication
- International adaptability: voltage, frequency, communication, and display language
- Four-channel capability reduces costs by permitting balancing of multiple machines
- Backed by world-class SBS customer service

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General Instructions

System Purpose

In order for the wheel of a grinding machine to accurately cut, produce smooth surface finishes, and generate correct part geometry, it is necessary to prevent vibration in the grinding process. A primary cause of vibration during grinding is the existence of imbalance in the grinding wheel. This is often due to the heterogeneous nature of the grinding wheel, which contains great numbers of unevenly distributed grains, causing intrinsic imbalance. This imbalance can be compounded by eccentric mounting of the wheel, varying width of the wheel, imbalance in the arbor, and coolant absorption into the wheel. Considering all these factors, even a carefully established initial balance will not last long. Furthermore, due to wear and dressing, the rotational dynamics of a grinding wheel are always changing. For these reasons, dynamic balancing of grinding wheels has long been recognized as an important step in the production process.

The SBS Balance System has been developed to provide dynamic balancing for grinding machine operators with the following objectives in mind:

- **Ease and Usefulness of Operation**
- **Maximum Grinding Machine Efficiency**
- **Minimal Installation Requirements**
- **Minimal Maintenance Requirements**
- **Attractive Purchase Price**

Operator Safety Summary

This summary contains safety information necessary for operation of the SBS Balance System for grinding machines. Specific warnings and cautions are found throughout the Operation Manual where they apply, but may not appear in this summary. Before installing and operating the SBS Balance 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: Failure to properly attach SBS Balance System components to the grinding machine spindle will result in safety hazard during machine operation.

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

Caution: To avoid equipment damage, make sure the line voltage is within the range specified for the system (see specification section).

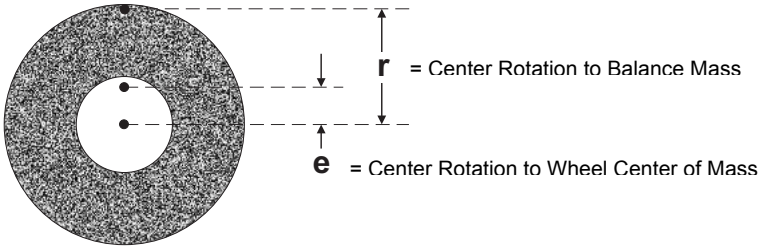
Caution: Only qualified service technicians should attempt to service the SBS Balance System. To avoid electric shock, do not remove the cover of the Control Unit, or remove cables, with power connected.

System Theory and Connection

The SBS Balance System operates on the principle of mass compensation for any given grinding wheel's imbalance. The Intrinsic Imbalance of a grinding wheel is equal to its mass multiplied by "**e**", the distance between the wheel's center of mass and the wheel's center of rotation.

Intrinsic Imbalance = **e** (**Wheel Mass**)

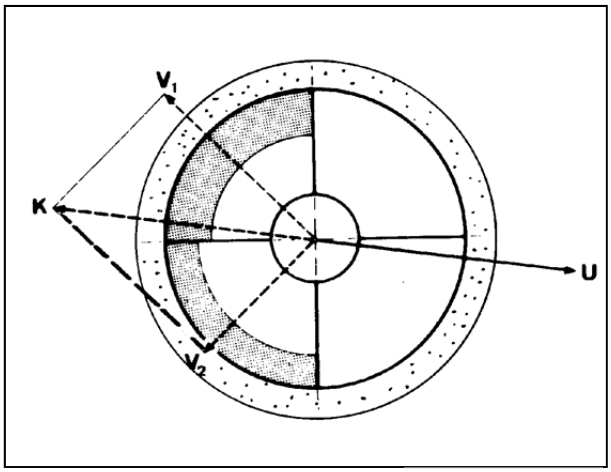
Measured Imbalance = **r** (**Balance Weight Mass**)



The imbalance of a grinding wheel is determined in practice by use of the Measured Imbalance of the wheel. The Measured Imbalance is equal to the product of the mass of an attached balance weight, located to balance the grinding wheel, multiplied by "**r**" the distance between that weight's center of mass and the grinding wheel's center of rotation. In both cases, the imbalance is given in terms of a mass multiplied by a distance, with (grams)(centimeters) being the units used for reference by the system.

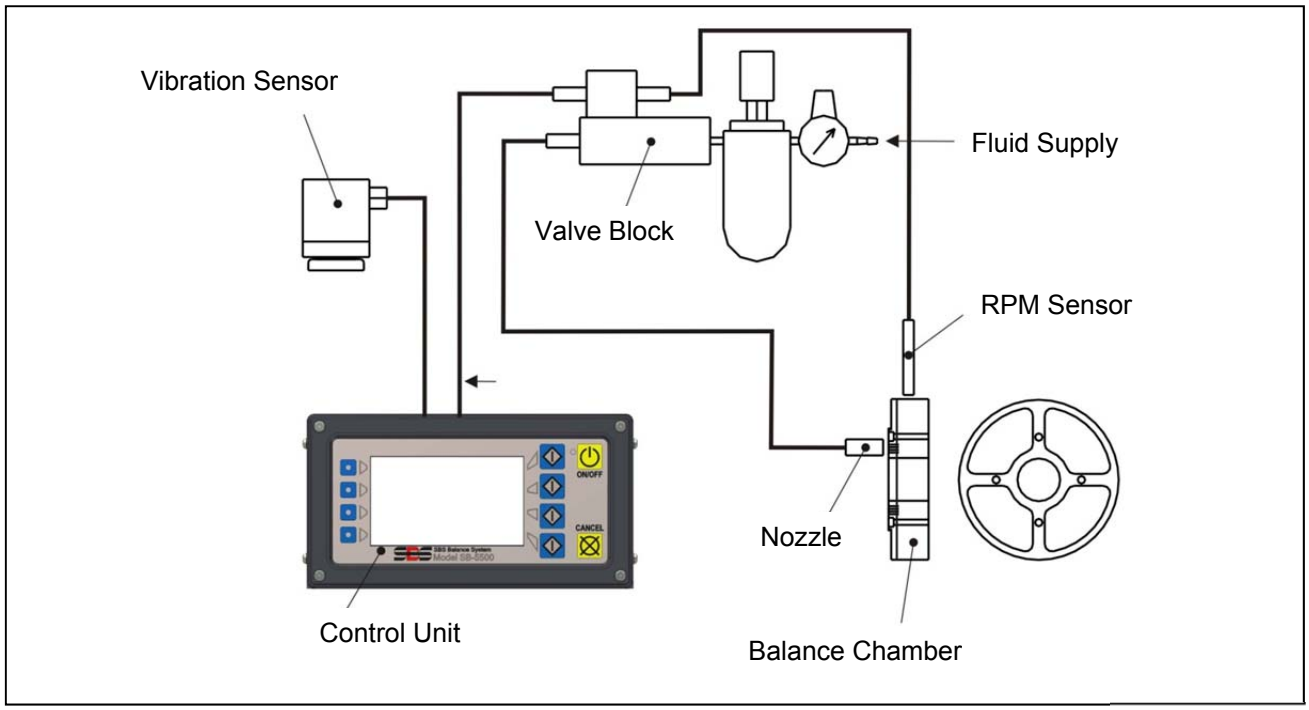
Compensation of imbalance in the Hydrokompenser system is by means of liquid (coolant or oil) which is injected into four quadrants inside the rotating balancing Chamber. The Balance Chamber is secured to the grinding wheel holder. The injected liquid is distributed and retained in each individual quadrant of the Chamber by centrifugal force.

This diagram explains the basic balance method of the Hydrokompenser system, where U is the vector of imbalance, V_1 and V_2 are the vectors produced by fluid injected into each chamber quadrant, and K is the compensation vector resulting from the sum of V_1 and V_2.



The system consists of a Balance Chamber (for addition and location of the balance fluid), a four port Nozzle (for delivery of balance fluid to each quadrant of the Chamber), a Valve Block (for filtering and control of fluid to the Nozzle), an RPM Sensor (some models of Nozzle include the RPM sensor), a Vibration Sensor, and the SBS Control Unit. Imbalance is expressed as spindle movement or vibration detected from the grinding machine by the sensor. The vibration signal from the sensor is transmitted to the control unit, which filters the signal by RPM. When an Auto-balance cycle is initiated, the control unit actuates the Valve Block to inject fluid through the Nozzle in the Chamber quadrant(s) that reduces the amplitude of the incoming vibration signal.

The vibration sensor determines the amount of unbalance, while the RPM sensor detects the position of unbalance. The required correction vector is determined by the Control unit and individual quadrant fill amounts are calculated (V_1 + V_2) accordingly. The individual valves in the Valve Block open as commanded by the Control unit and the liquid balance medium is allowed to pass out the corresponding port in the Nozzle under pressure. The Nozzle injects the coolant into the required quadrant(s) in the ring Chamber as a continuous stream. The Chamber grooves help collect the liquid and insure it enters the required quadrant.



Environmental Considerations

The SBS Balance System is designed to dynamically correct for the detrimental effects of grinding wheel imbalance on quality of surface finish, part geometry, as well as wheel and machine bearing life. The system cannot correct for other environmental problems. This section is intended as a discussion of some common environmental problems which may influence grinding quality.

Other sources of vibration

A most common source of vibration is adjacent machinery. Grinding machines should be properly isolation mounted if vibration-producing machinery is operating nearby. Other sources of vibration may be components mounted on the machine, such as pumps, motors, drives, etc.

The SBS Balance System may not operate efficiently under the influence of some external vibrations. The system filters the vibration signal it detects from the grinding machine at the frequency of the spindle RPM. This means that vibrations occurring at frequencies other than that of the rotating wheel will be ignored by the system. For adjacent machinery operating at the same frequency, or in phase with that frequency, the system will not distinguish between vibrations occurring from wheel imbalance and those originating in the adjacent machine.

An excellent test for environmental vibration is to monitor the vibration level on the grinding machine while the spindle is not turning. The vibration level should be checked in various locations on the grinding machine, but in particular at the location the vibration sensor is to be mounted. All surrounding equipment, including any auxiliary pumps or attachments on the grinding machine should be operating during this test.

The SBS Balance System can help perform this test *(see: Background Vibration section)*, but cannot remove these vibrations.

Machine condition

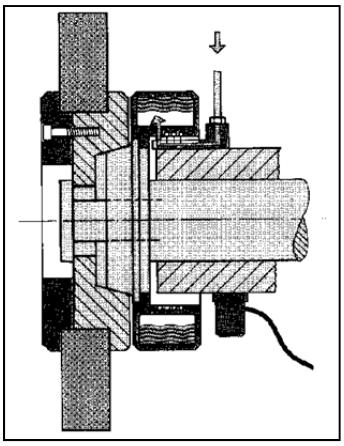
Grinding machine condition is an important factor in determining the minimum balance level that the SBS Balance System can achieve. The spindle should be balanced, as well as all components in the spindle drive train (i.e. belts, pulleys, motor, etc.). The balance system can be used to readily determine if any significant imbalance exists in the machine itself. Simply use the same method as described above for checking environmental vibration, except test with the spindle running and with no wheel mounted. The SBS Balance System cannot remove vibration resulting from machine condition problems.

System Installation

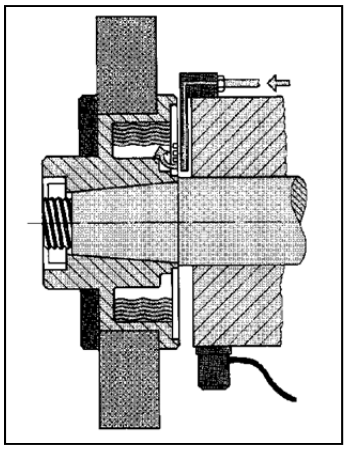
Balance Chamber

The Hydrokompenser System allows for a great variety of implementation, and supports machine operation at machine speeds up to 15,000 rpm in certain applications, which makes it the perfect solution for solving unbalance problems on machine types that mechanical balancers can't address as well. Individual Hydrokompenser Chambers are designed for specific applications, with maximum spindle rotational speeds for each design. **Caution: Exceeding the maximum spindle speed reported to Schmitt Industries, Inc. during application engineering, may result in dangerous part failure.**

A chamber can be designed for any application, and can be bolted to the grinder, or be built into the machine for OEM applications. This manual can therefore not possibly cover all methods of attachment of chambers to machines. However, they all have in common a simple installation on the grinder by several bolts and a pilot bore for precise alignment. Details will be provided in engineering drawings.



Bolted on



Built in

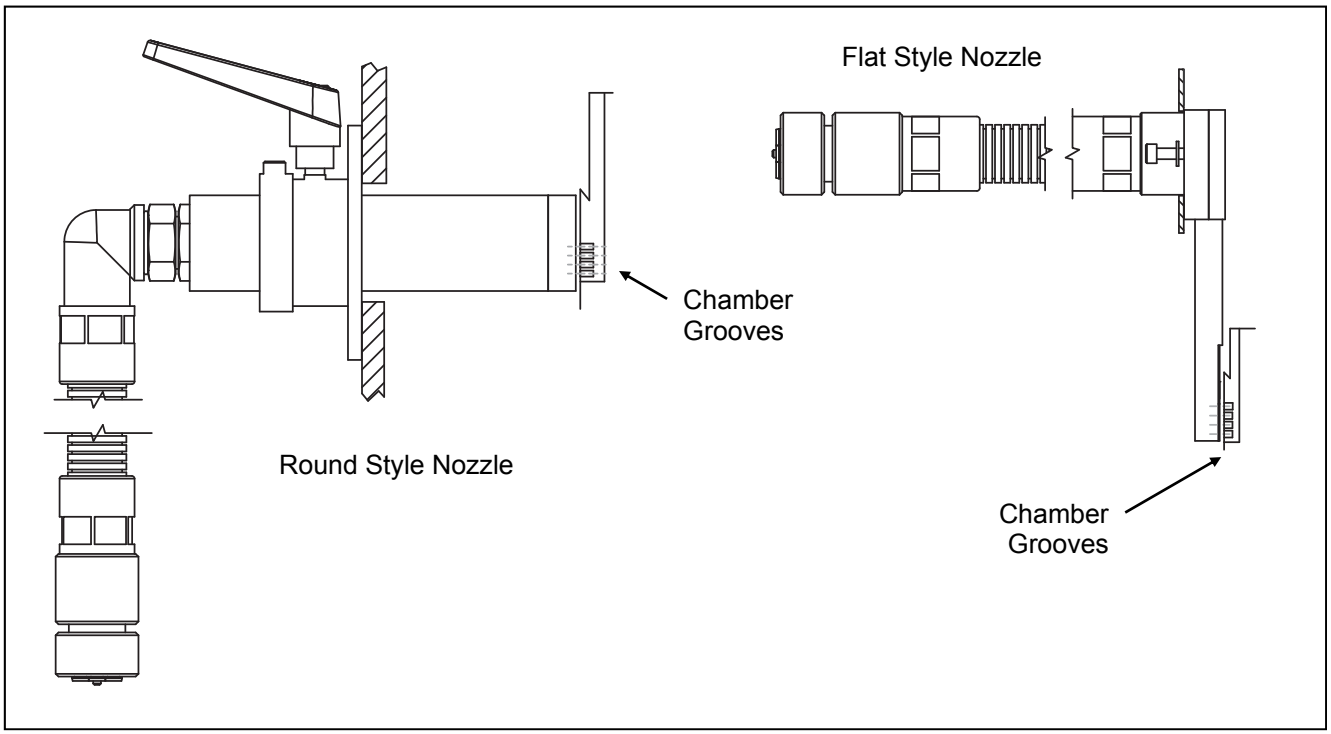
Valve Block

The Valve Block should be mounted in a clean part of the machine outside the coolant spray zone, and as close as possible to the Nozzle, typically at a distance of 2.5 meters (8 feet). This corresponds to the standard length of hose attached to the Nozzle. Special lengths are available on request. Details will be provided in engineering drawings. The Valve Block includes a fluid pressure regulator, as well as a fluid filter to remove particles from the coolant or other fluid to be used as a balance medium.

Nozzle installation and alignment

The Nozzle must be mounted on a non-rotating part of the machine so that the four nozzle ports align with and are directly facing the four fluid grooves on the Balance Chamber. Round style Nozzles come with an alignment feature to assist with finding the correct position, while the flat style (rectangular) Nozzles rely on careful measurement to achieve position. Details will be provided in engineering drawings.

The alignment of the nozzles is critical, as it determines the speed and accuracy of the balancing process. For proper operation, the nozzles must be located within a maximum distance from the Chamber face of 1-3 mm.



Attachment to the machine is best accomplished by a simple bracket of proper dimension to hold the Nozzle Block in the required position during machine operation. Where necessary, the ability to make finish adjustments in distance and alignment of the Nozzle should be provided for in the bracket design. Because the requirements for mounting are dependent on individual machine design and customer preference, the customer should provide the required hardware or bracket for attachment of the Nozzle. SBS will provide design and fabrication services for customers who so desire.

Once the nozzle block is installed and connected properly to the valve block, set the pressure using the pressure regulator on the valve block. Adjust the coolant jet exiting the nozzles in a way that it is deflected after 0.5 m (1.5 ft). If a water-based coolant is used, this should correspond to a pressure of 0.5-1.5 bars (7-21 psi), depending on the distance between valve block and nozzle block. If oil is used, this should correspond to a pressure of 1-4 bars (14-58 psi).

RPM sensor

The RPM sensor is a proximity sensor which is triggered off a rotating feature on the machine. Some Nozzles are design to incorporate the RPM sensor, and are triggered off a small hole provided in the Balance Chamber. Other applications require a separate RPM sensor, which may be located at the drive end, or the wheel end of the spindle. A small drilled hole 5mm dia. And 3mm deep is suggested for triggering the RPM sensor.

SBS Control unit

The SBS Control unit should be mounted in a location allowing observation of the display by the machine operator outside the coolant spray zone of the grinder. A variety of mounting hardware is available for installation on horizontal surfaces or for rack mounting. Cabling connections to the control unit include the Vibration Sensor, RPM Sensor, and Valve Block cables, the power cord, and the selected machine controller interface cable *(see: System Connection diagram).*

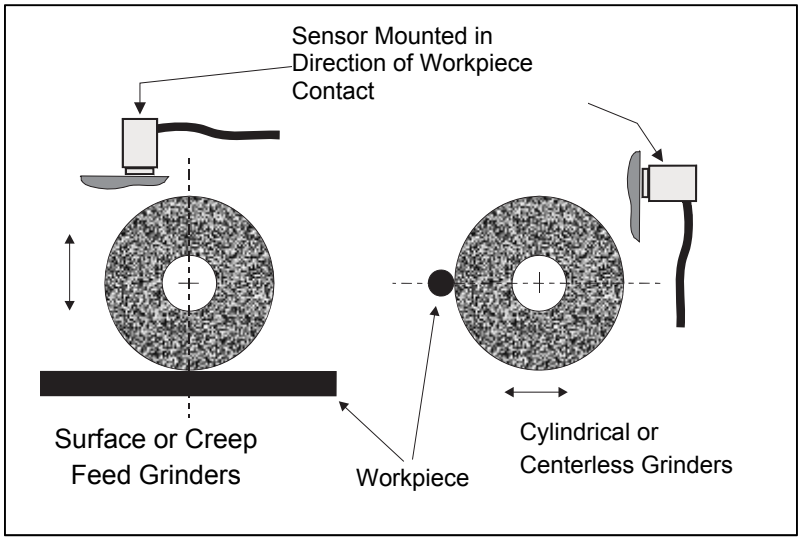
Vibration sensor location

The Vibration Sensor can be mounted on the grinding machine using the magnetic mount provided, or permanent stud mount. The magnetic mount should be used during initial system start up until a good permanent location is found on the grinding machine for the sensor. The sensor can then be permanently stud mounted at that location. A machined flat should be supplied at the mounting location when stud mounting the sensor.

The location and installation of the sensor are critical for successful operation of the SBS Balance System. Because of differing machine characteristics, Vibration Sensor location is specific to the machine model. There are two general principles that should assist in finding a proper sensor location for your grinding machine.

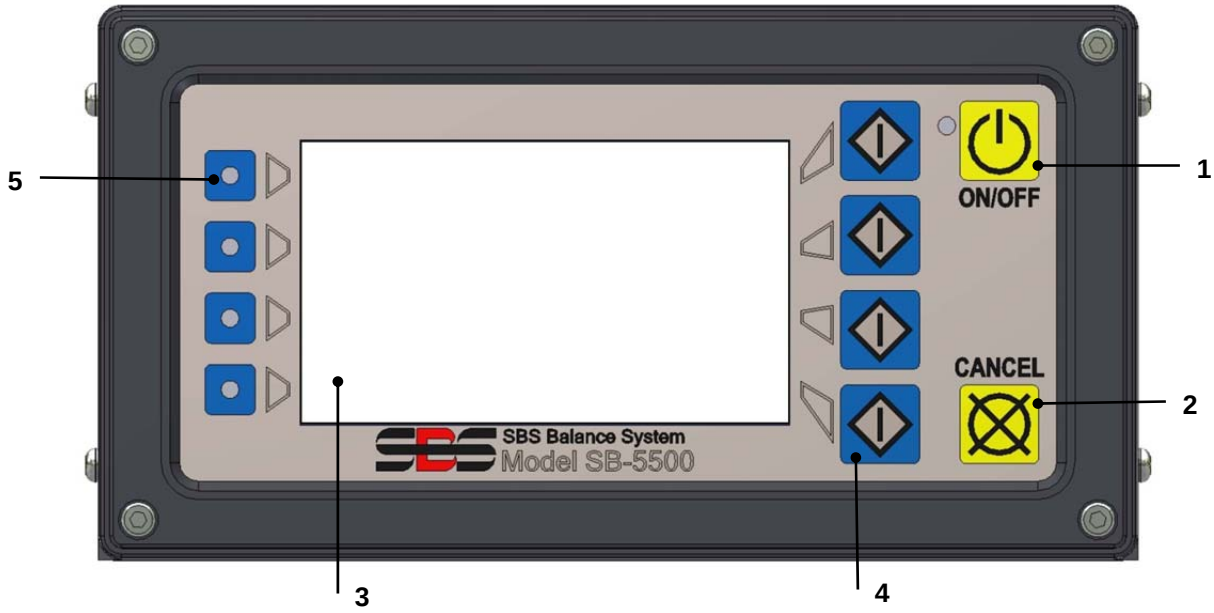
1. **Locate the Sensor in the same direction as the centerline between the grinding wheel and the workpiece**. The best place to start is a flat machined surface on the spindle housing over the bearing closest to the wheel and perpendicular to the spindle's centerline. A vertical mounting surface is preferable on most cylindrical grinding machines because the sensor is in line with the grinding wheel and the workpiece. For this same reason on surface grinders and creep feed grinders, a horizontal mounting surface is generally best. Although the balance Chamber itself may be mounted either on the wheel or pulley end of the machine, the Sensor should always be aligned at the wheel end of the machine.

2. **Locate the sensor on a rigid part of the machine structure, where vibration from the spindle will be accurately transmitted.** On some machines the wheel guard can be a good location to mount the sensor, if it is heavy enough and rigidly attached to the spindle housing. The balance system relies on vibration signals received from the Vibration Sensor to accurately display the current vibration level in peak-to-peak units, and to balance the grinding wheel. The system employs narrow bandwidth filters that prevent vibration at non-spindle frequencies from being detected. However, in applications where the motor or other machine components are running at the same speed or frequency as the spindle, interfering vibrations may result. Careful experimentation with the sensor's location minimizes sources of interference.



Control Unit Operating Instructions

The SBS Balance System is easily configured to the particular needs of your grinding setup. Following is an overview of the control and interface features of the SBS Balance System Control Unit.



Front panel controls

The Figure above illustrates the controls and indicators on the front panel of the Balance Control Unit. The following is a description of these features:

1) ON/OFF. This button turns on the operating power for the system. When the system is turned on the unit initiates a Power-On Display, and the green LED to the left of the button will be illuminated. When turned OFF the unit is in the stand-by mode, and the green LED is blinking. This indicates power is connected to the unit, but the control is inactive.

2) CANCEL BUTTON. Pressing this button will cancel the operation in progress, or the last selection or entry made. Also clears any displayed error message.

3) LCD DISPLAY. **The display is not a touch screen. Do not press on the display screen**. The screen is used to display data and assign functions to the function buttons.

4) FUNCTION BUTTONS. Operation of the Control unit is accomplished via the four function buttons to the right of the display. The menu bar area of the display, to the left of these buttons, assigns the current function to each button. Use these buttons to make all operational selections.

5) SLOT STATUS LED. A three color LED on the left side of the display shows the operational status of the balancer card or other device cards installed in each of the four corresponding card slots.

Power-on display

The Front Panel of the control can be removed and remotely mounted using a SB-43xx series cable. When switched on in either configuration the Control Unit performs self-analysis which defines its status, and the setting of operating parameters. Operator information is then shown on the LCD display following the startup sequence described below:

1) The company logo screen is displayed and lights on the front panel are illuminated to verify their operation. During this short time, the SETUP button is available. Pressing this button will enter setup mode for the control.

2) After four seconds, the unit displays information about each balancer or device card installed, indicating type of device and identifying information. To extend the time that this information is displayed, press any one of the function buttons while the slot information is on the screen. Each button press will add six seconds to the display time, giving additional time to read the information.

3) After two more seconds, the unit displays the initial operational screen for the control unit. The unit will display either the SHOW ALL monitor screen, or one card slot's main operating screen, whichever was selected when the unit was last switched off.

4) Any error conditions detected by the self-analysis are displayed as "ERROR - *code*" where *code* lists the reference code of the error detected. For detailed description of error codes, see the "Displayed Error Messages" section of this manual, or additional product instruction addendum manuals.

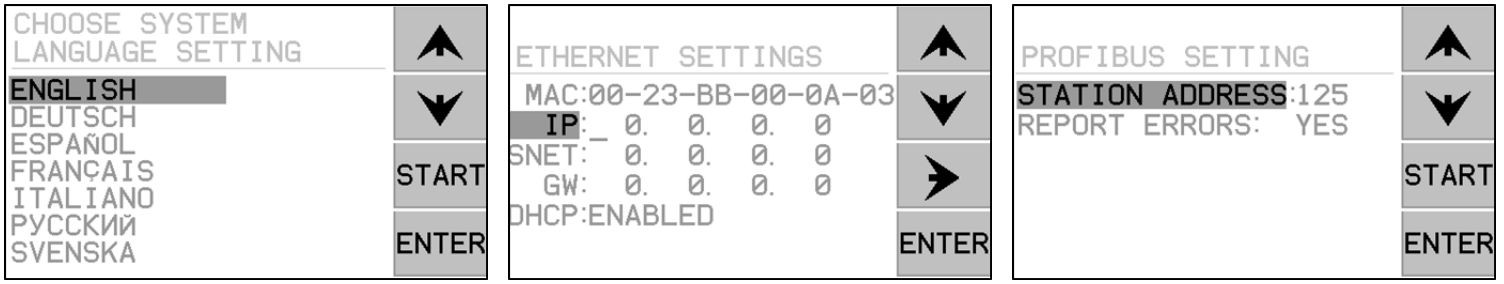
SETUP

At Power-on, press the SETUP button to enter this mode. The Setup screens allow the user to select:

1. Operational language
2. Ethernet settings
3. Profibus Station ID (if installed)

While in Setup mode:

- Press ENTER to save current settings on the screen and/or proceed to the next Setup screen
- Press CANCEL to cancel unsaved settings on the screen and/or proceed to the next screen
- Press START to cancel unsaved settings, exit Setup mode, and start operation.



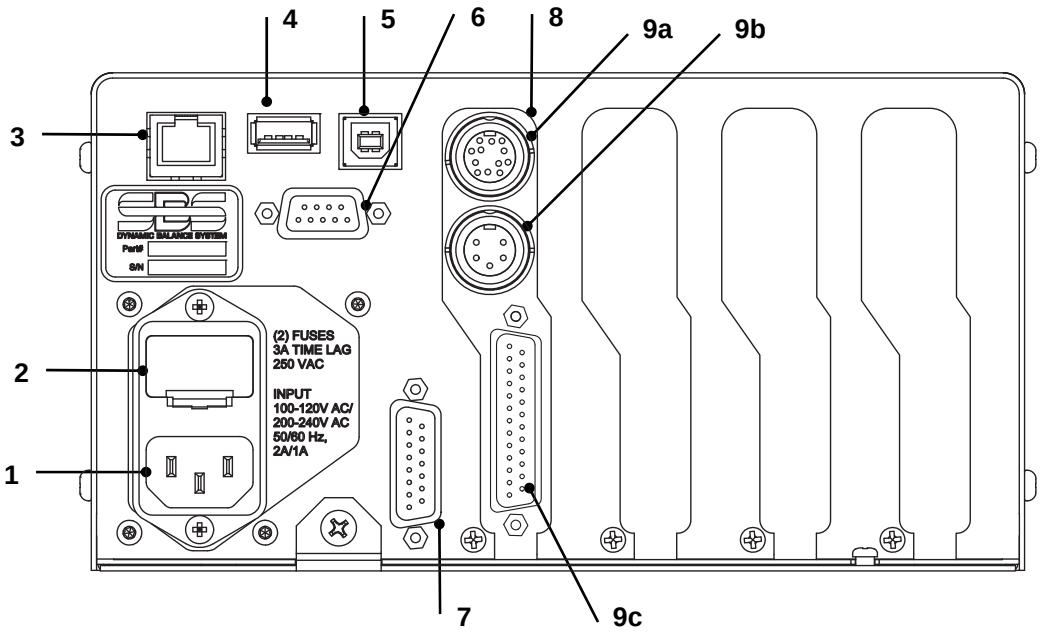
The first Setup screen selects the language used by the control. Use the arrow buttons to scroll through the available languages. The second Setup screen allows Ethernet settings. Manual settings can be made or DHCP can be enabled for automatic assignment. Use the arrow buttons to scroll through all the available Ethernet settings and use the up and down arrows to change digits. The third screen allows selection of Profibus Station ID (if installed) and the option to turn off Profibus Error reporting.

Control unit without front panel connected

The control unit can be operated without a physical keypad/display assembly attached. SBS provides a Windows software program which acts as a virtual keypad/display. The only power-on indication for the unit with no physical front panel attached is the standard Software Interface menu and command prompt. *(see: Software Interface section).*

Rear panel connections

The figure following shows the rear of the control. The following connections are located on the rear panel of the Control Unit, and are common to any cards installed in the control.



1) POWER SUPPLY. Connection for line power input (AC input model shown)
Caution: Before applying power to the Control, make sure the supply voltage is within specified range.
AC Input Models: 100-120V AC, 200-240V AC, 50-60 Hz
DC Input Models: 21 VDC to 28 VDC. 5.5A max at 21 VDC.

2) FUSE HOLDER. Contains the line fuses. AC Input Controls use (2) 5x20 3A time lag, DC Input Controls use (1) 5x20 6.3A.

3) ETHERNET. Provides TCP/IP Connection to host device, such as CNC Controller.

4) USB CONTROLLER. Allows USB flash drive to be connected for Firmware update. Latest firmware for the control and update instructions are available on the SBS website.

5) USB DEVICE. Provides connection to another USB 2.0 host, such as a CNC Control.

6) PROFIBUS. Provides connection to Profibus DP host device, such as CNC Control (option).

7) REMOTE. This DB-15 connector receptacle is a duplicate of the connector on the font side of the box, used to connect the optional cable for remote front panel installation.

8) DEVICE SLOTS. Numbered Slots are available for installation of balancer cards or other device cards supplied by SBS. Unused Slots are covered with blank panels.

Balancer card rear panel connections

The control comes standard with one card, and others can be purchased and added to the control unit as required. Each card has three connections on the rear panel of the control.

9a) BALANCE CONNECTION. Connects to the Valve Block.

9b) SENSOR CONNECTION. Connects to the Vibration Sensor.

9c) HARDWIRE INTERFACE. Standard DB-25 connector for connecting the individual balancer card in the control to a grinding machine controller. A complete description of this interface is given in the “Hardwire Interface” section.

Balancer Operation

Balancer slot status LED

The status indication for installed Balancer card is as follow:

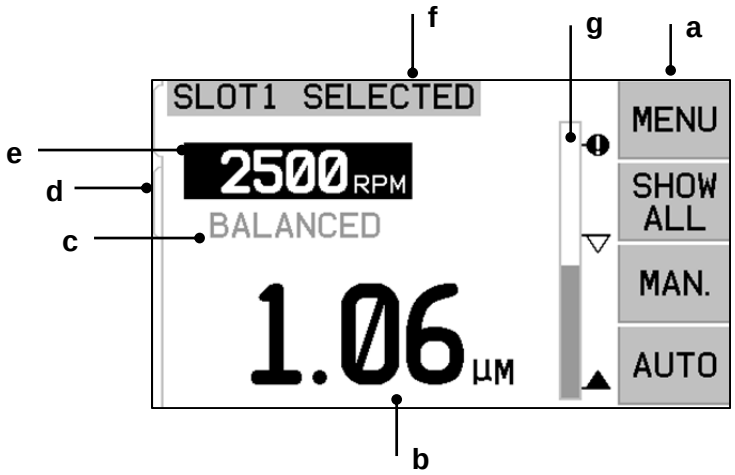
BALANCE **ABOVE CRITICAL**. The LED is lit **RED** when the measured vibration is above the user set CRITICAL limit, or if the RPM level exceeds the user set Critical Max. RPM limit. The LED will blink while the system is performing an auto-balance.

BALANCE **ABOVE TOLERANCE**. The LED is lit **YELLOW** when the measured vibration is above the TOLERANCE level selected by the user. The LED will blink while the system is performing an auto-balance.

BALANCE **BELOW TOLERANCE**. The LED is lit **GREEN** when the measured vibration is at or below the selected TOLERANCE level. The LED will blink while the system is performing an auto-balance.

Balancer main screen elements

The following elements are displayed on the Balancer Card Main Screen.



a) MENU BAR. The right side of the display is used to assign current functions to the four corresponding Function Buttons to the right of the display. An animated hourglass appears in this display area during the balance and plotting cycles to indicate progress.

Function Buttons are defined as follows for the main screen of each balancer card. See Function Button Map for an overview.

MENU – Pressing this button displays a menu listing with selectable operating parameters and other functions for the control unit.

SHOW ALL – Displays the status of all balancer or other installed cards on one screen.

Pressing CANCEL from the SHOW ALL screen will display a "System Status" screen showing all current Ethernet settings for the control. Pressing any button from this screen will then display a "Firmware Versions" screen showing version details of all installed devices in the control unit. Pressing any button from this screen will return to the SHOW ALL screen.

MAN. – Enters Manual Balance mode allowing manual injection of fluid into each of the four Chamber quadrants (C1 through C4). Fluid is dispensed for the duration of each button press. These buttons are available only in Manual Balance mode.

AUTO - Initiates an auto-balance cycle. Pressing CANCEL will halt the auto-balance cycle. *(see: Automatic Balancing section).*

b) VIBRATION DISPLAY. Indicates the measured vibration level of the grinding machine in either microns or mils displacement, or in millimeters/second or mils/second velocity. Displayed units are selectable from the Menu.

c) STATUS. Indicates the current status of the selected balancer card.

d) SCREEN TAB. Tabs are shown on the left side of the display for each installed device card. The open tab indicates which device card is currently selected. In the figure the card in device slot #1 is selected, and a closed tab indicates another card installed in slot#2. These tabs align with the four device card status LEDs to the left of the display.

e) RPM DISPLAY. Displays Spindle RPM measured by the balancer. The display also indicates RPM frequency during a Manual Filter vibration test.

f) IDENTIFICATION TAG. The upper edge of the display identifies the user selectable name of the device card currently selected, and the current position in the menu structure.

g) BAR GRAPH. The bar graph shows the measured vibration level compared with the LIMIT, TOLERANCE, and CRITICAL levels.

MENU Settings

Note: All menu items are set independently for each installed balancer card, or other device.

Press the MENU button to display the menu items detailed below. The menu provides access to system settings for individual balancer cards, and to perform certain optional functions. Use the up and down arrows buttons to move through the menu items. Press ENTER to access the selected menu item. Press EXIT or CANCEL to exit the Menu and return to the Main Screen for the card.

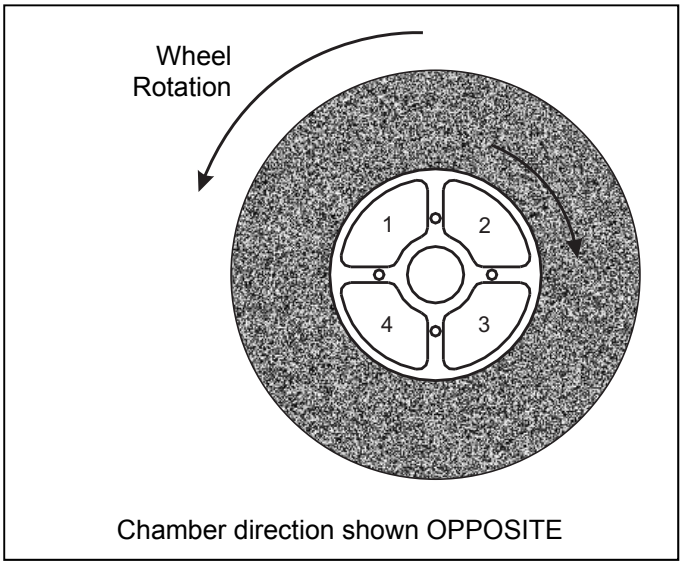
Balance settings

Use the backward arrow button to move the cursor from one digit to the next. Use the up and down arrow buttons to increase or decrease the value of the selected digit. Press the ENTER button to save any changes and move to the next balance setting. Pressing CANCEL will return to the Menu. Each of the following three balance settings are presented consecutively.

1. **LIMIT** target level. This is the lower limit that the balancer will try to achieve during an Auto-balance cycle. This value should be set 0.2 microns higher than the background vibration level.
2. **TOLERANCE** level. This level sets the high end of the acceptable balance range. When this level is exceeded a Balance Out of Tolerance (BOT) error condition is reported. This error signals the operator or machine controller to re-balance the machine. This level needs to be determined by process considerations. It should rarely be less than 1 micron above the Limit.
3. **CRITICAL** level. This level can be set at a value providing a secondary warning of extreme out of balance condition that may be damaging to the grinding machine or process. When this level is exceeded a Critical Balance out of Tolerance (BOT2) error is reported. This signals the operator or machine controller to shut down the machine. This same error can also be triggered by excessive RPM *(see: Critical RPM).*
4. **WHEEL ROTATION/ CHAMBER DIRECTION** – Sets the relative direction that the chamber quadrants increase in number on the machine relative to the direction of rotation of the wheel. The Chamber quadrants are numbered from 1 to 4, with 1 being the quadrant connected to the smallest diameter chamber lid groove, and 4 the quadrant connected to the largest diameter chamber lid groove. The system must know if the direction that these quadrants increment upwards is the **same** as or **opposite**

to the direction of the wheel rotation. The system can determine this automatically, but to do so requires extra injections of fluid. Because chamber capacity is fixed and once the chamber is full it must be emptied before further balancing can be performed, automatic direction identification may not be desired in situations where this direction relationship remains constant. The following four settings are available.

- Automatic Always – With every balance operation, the direction will be determined automatically by injection into each chamber quadrant. This can be useful where the spindle swivels or otherwise changes directions.
- Automatic Once – On the first balance cycle after selecting this option, the system will automatically determine the direction by injection into each chamber quadrant, and will store the result.
- Same – This setting allows the operator to set the direction as SAME, without running the auto-determination cycle.
- Opposite – This setting allows the operator to set the direction as OPPOSITE, without running the auto-determination cycle.



Chamber direction shown OPPOSITE

Vibration units

Press the corresponding button to select from the available vibration units, available in displacement or velocity, as well as english or metric units. The currently selected units are highlighted on the screen. Once selected, the display changes allowing the up and down arrows to be used to set the resolution. Press ENTER to save the selection. Changing vibration units between metric and english will convert the numerical value set for the Limit, Tolerance, or Critical Levels. **Caution -** Changing between displacement and velocity units will not change these numerical values, as no direct conversion is possible. In this case the user must review and edit the limit settings to an appropriate number.

Balance speed

This setting will affect the time taken to perform an Auto-balance cycle. Normal is the correct setting for most applications. Factory default is Cautious, to ensure successful balance on all machines.

- CAUTIOUS – Setting 1. This setting controls the balance weights in a slower progressive balance mode. It is most useful on high speed grinders, or other machines where slight changes in the balance weight produces dramatic change in vibration level.
- AGGRESSIVE – Setting 2. This setting operates the balancer in the fastest balancing mode. It is most useful on machines with slower speeds and large wheels.
- NORMAL – Setting 3. This setting uses a combination of a fast balancing routine until the vibration level reaches 1.0 micron, then switches automatically to a slower routine for accurate balancing.