



VM20

MULTIFUNCTION AND MODULAR PROCESS MEASUREMENT AND CONTROL SYSTEM FOR GRINDING MACHINES

Characteristics

- Multifunction and modular:
 - Automatic wheel balancing (1 and/or 2 planes);
 - Wheel-workpiece and wheel-dresser contact detection;
 - Pre, In and Post-process size measurement;
 - Manual pre-balancing of wheel.
- Menu programmable.
- Operator panel:
 - local or remote graphic display, equipped with RS232 interface for hard copy function;
 - HMI Windows software package for PC-CNC terminal.
- Interfaces:
 - RS 232 serial interface for remote programming and data up/download;
 - Programmable parallel interface for remote programming, data up/download and digital I/O expansion;
 - DP PROFIBUS;
 - Analogue interfaces for measurement signals.
- Opto-insulated and protected digital interface.
- Analogue signals galvanically insulated.
- FFT vibrations analysis.
- Programmable measurement data acquisitions and storage.



Advantages

- Meets all the applications suitable to:
 - increase productivity;
 - ensure consistent product quality.
- Protection of the investment.
- Cost/performing in any application.
- Easy integration in any productive architecture.
- Remote assistance through tele-service.
- Reliable in workshops.
- Reduction of machine downtime thanks to failure prevention and diagnostic.
- Allows statistical process control.



THE REQUIREMENT

The manufacturing industry increasingly needs grinding machines able to produce parts with tight dimensional and geometric tolerances and an excellent surface finishing. Furthermore they shall ensure high productivity, flexibility and reliability. To meet these requirements, the grinding machine has to be equipped with a proper process measurement and control system.

VM20 SYSTEM

The VM20 system, with a limited number of basic and optional HW and SW components, can be easily configured and programmed by the user to meet virtually all the process measurement and control applications: from the simplest grinding machine to the most complex grinding center.

It is made up of sophisticated electronics, with bus architecture, which employs DSP components, microcontrollers and programmable logics. The result is an easy integration with the machine architecture and a wide availability of functions.

These functions range from grinding wheel balancing to the control of acoustic emission, power and force sensors, from the control of pre, in and post-process dimensional gauges for diameters, positions, taper and roundness of parts to the FFT vibrations analysis.

Different function modules manage all the essential variables to ensure machine productivity and quality of ground parts.

The modules' programming is simple and user-friendly. Modules can be programmed either from the systems' panel or through program down/uploading.

Each module can have one or more sections that operate concurrently. Each section can run a part program, associated to the same inputs or to separate inputs and to separate output channels. The acquired measurements can then be processed through formulas and the resulting logic actions timed.

Each section can contain more than one part program that can be launched manually or by CNC.

For the measurement of the different variables a series of control and alarm thresholds can be set and associated values and events can be stored: in this way VM20 is also a sophisticated monitoring and data acquisition system for the process statistic control. Each function module is equipped with a 15-pin connector for the logic I/O and with a 9-pin connector for the analogue I/O of measurements.

For a more extended integration with the CNC, the multilink I/O module is available.

The human interface is achieved both by a local or remote dedicated panel, equipped with backlighted graphic LCD display, and by HMI-Windows software panel that can be integrated on PC-CNC.

A panel can control more than one rack for a total of 4 balancing modules, 4 gap elimination modules, 2 gauging modules and 4 I/O multilink modules.

All the data are displayed both graphically and digitally in one of the standard languages selectable from the menu: English, French, German, Italian and Spanish and can be printed, as an option, as display hard copy, on a printer connected to the VM20 panel, through RS232. Other languages are available upon request.

The HMI package comprises both the complete emulation of the hardware panel and an OCX objects library. This OCX library allows the grinding machine manufacturer to integrate the VM20 visualizations in his own machining programs, thus easily achieving high quality custom-tailored applications.

The HMI software package can even be configured to operate on various PC stations connected to CNC, both via ethernet network and via modem. These PC stations, typically positioned in the development and assistance offices, are able to control the VM20 both in master mode and in echo mode for diagnostic and remote assistance purposes.

BALANCING MODULE

The traditional grinding wheels, due to their non homogeneity, to coolant absorption and to wear, as well as the CBN ones, due to assembly tolerances and to wear, present a variable dynamic unbalance over time, which, if not eliminated through prompt balancing procedures, generates negative vibrations to the detriment of the machining quality and spindles lifetime.

The balancing can be performed by balancing heads mounted outside or inside the spindle- which, conveniently controlled by the VM20 balancing module, when necessary, automatically and in a few seconds, bring vibrations back to preset allowable limits.

A wide range of balancing heads without "dynamic torque" (patented by Balance Systems) standard or custom-tailored, with or without integrated touch sensor, eliminate traditional balancing heads torque and wobble, thus allowing to meet any specific application of the customer.

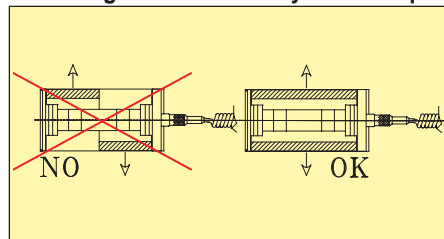
Various types of modules are available to handle balancing heads with contactless collector, with brush collectors, with brush collectors for balancing rings.

Thanks to the neutral position that can be reached by the compensation masses of these balancing heads, the VM20 allows to carry out a pre-balancing of the wheel in the machine, on one or two planes, by manually positioning a pair of weights placed on the wheel sides.

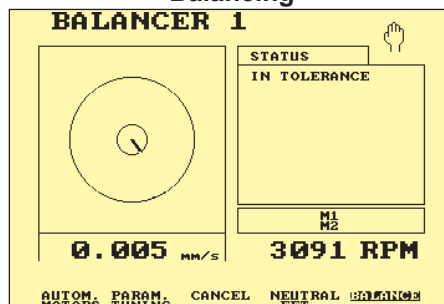
The wheel can be balanced on one plane with one balancing head for the individual wheel, and, on two planes, with two balancing heads, for large wheels or multiple wheels (centerless grinding machines or driving shaft grinding machines).

Each balancing module controls a balancing head and the vibration sensor. This last is employed for the measurement of balancing feedback and to monitor the behavior of the machine through FFT analysis.

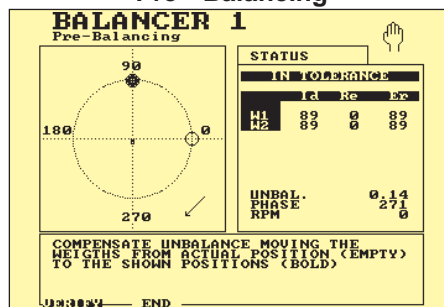
Balancing Head without "dynamic torque"



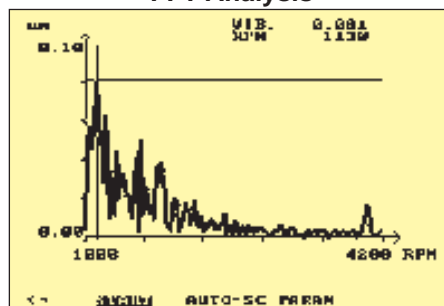
Balancing



Pre - Balancing



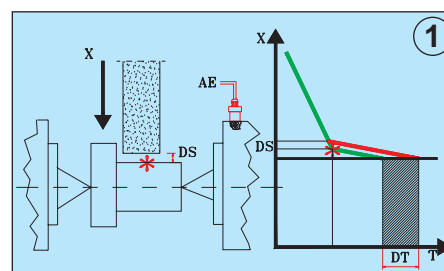
FFT Analysis



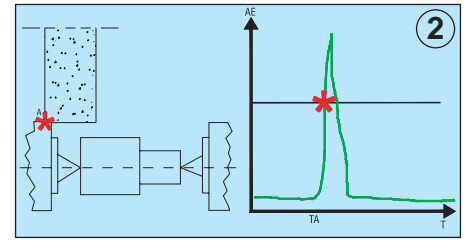
GAP ELIMINATION MODULE

Using measurement technologies for acoustic emission, absorbed power and force (or stress) that can be measured in the wheel-workpiece and wheel-dresser contact, the VM20 gap elimination module can satisfy, individually or contemporaneously, the following applications:

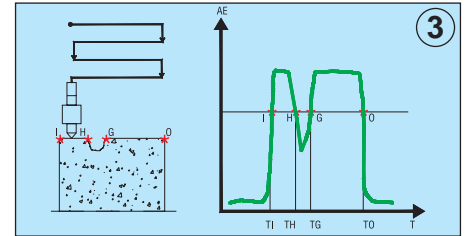
1. Gap elimination. In CNC machines, the switching from the rapid approach to the working feedrate speed has to be done in a position off size and off positioning tolerances of the workpiece. If the switching takes place when the wheel touches the workpiece, event that is detected by an acoustic emission and/or power sensor, there can be significant saving in machining cycle time of each part (an average of more than 60%).



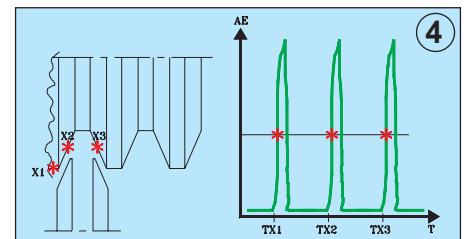
2. Wheel crash control. During movements the wheel can meet unexpected obstacles with consequent breaking, rejected parts and machine downtime. Acoustic and power sensors can immediately stop the machine, before irreparable breaking may take place, as soon as the signal level exceeds the alarm threshold.



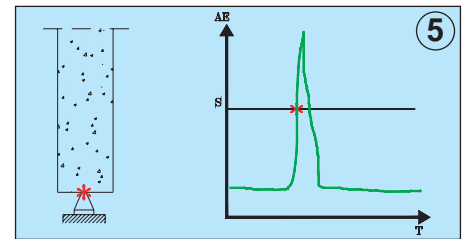
3. Dressing cycle control. The dressing pass depth, if performed with opened loop, shall be preset in such a quantity in order to recover the wheel consumption and to ensure a sufficient removal to uncover new cutting edges. This process can lead to excessive wheel consumption with non-negligible costs especially in case of CBN wheels. The acoustic emission detector allows to determine the wheel contact with the dresser in order to set the correct depth and control that the acoustic emission level remains, along the whole wheel profile, above a preset threshold, to indicate the absence of discontinuity and therefore of grinding accuracy.



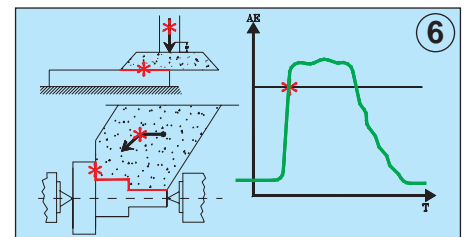
4. Wheel dressing with diamond-coated disc. When diamond-coated discs are used to dress the wheel, with the help of an acoustic emission sensor, this makes it possible to detect more than one wheel touch position, in order to identify the actual wheel size and center the dresser so that the profiling pass can be uniformly distributed and the material removal from the wheel can be minimized.



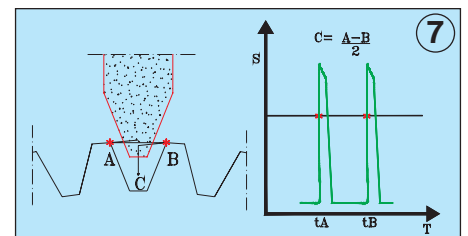
5. Machine zero determination. An acoustic emission sensor can determine the wheel contact with respect to a machine fixed point and therefore allow the CNC to determine the machine zero regardless of the wheel consumption.



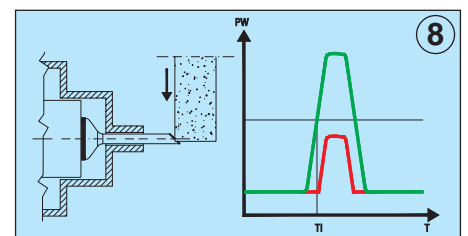
6. Part position detection. An acoustic emission sensor can identify the wheel contact with a part reference surface and therefore allow the CNC to remove a preset material quantity, regardless of the part positioning changes and wheel consumption, with consequent time saving in the cycle time compared to the solution provided with touch trigger (an average of more than 20%).



7. Overstock distribution. In case of part reworking or finishing with very little overstock, it is essential to be able to position the wheel so that the removal is uniformly distributed regardless of the position changes of the part in the machine and of the available overstock. An acoustic emission sensor can detect more than one wheel-part contact thus allowing the CNC to determine centering and correct wheel movements.



8. Overstock completeness checking. A power sensor can detect whether the set overstock minimum quantity has been removed in order to have a complete finishing.



The possibility to meet, in each specific application, the machining quality, the cycle time and the reliability requirements is strongly affected by the available equipment performances.

The VM20 gap elimination module, thanks to its sophisticated acquisition and processing system, allows having a response time of 1ms with acoustic emission sensors, and of 4ms with power sensors. This means, for instance, controlling, with the acoustic emission sensor, grinding depths of 0.5 μm and position the wheel, with respect to the part, with a penetration lower than 1 μm . The match of acoustic emission and power sensors is particularly suitable to warn collisions.

The wide acoustic emission sensor range, as per shapes and sizes, allows selecting the more efficient layout to control the specific application.

Each gap elimination module can handle up to two independent detecting sections that can be employed at the same time for different purposes such as double head grinding machine or grinding and dressing control. Each section supports four part programs that can be enabled one at a time, manually or by CNC, and each of them dedicated to different threshold settings as to touch, burnout and alarm.

Peculiar graphic functions allow to analyze transients that led to warnings and to monitor acoustic emission sensor signals with no load or during machining.

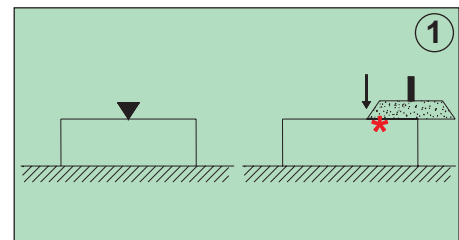
One module, in its maximum configuration, handles two AE sensor inputs, one optical fiber input for power sensors (up to 8 daisy chained sensors) and a force sensor input.

GAUGING MODULE

The wheel wear and machine and part temperature changes, especially in transients, do not allow to keep the parts size within close tolerance limits.

The constant production quality together with the cycle time improvement can be achieved with proper closed loop automatic measurement solutions:

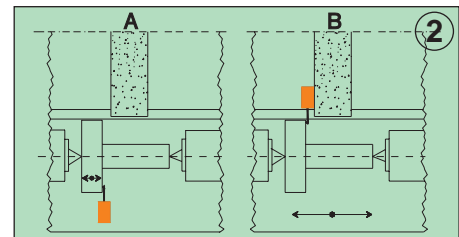
1. Pre-process part measurement and surface finding. Each part is measured with a gauge before the loading in the machine, the overstock is calculated and the removal is started from the wheel touching the part.



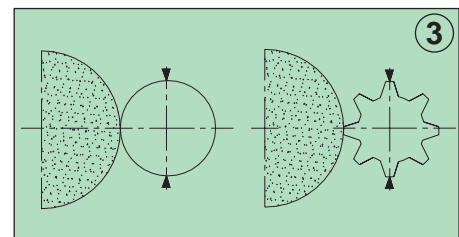
2. Part position detection. The part axial positioning errors are recovered:

A-by detecting, with a fixed gauge on the part-holder table, the position change of a part reference shoulder and correcting the zero (passive positioning).

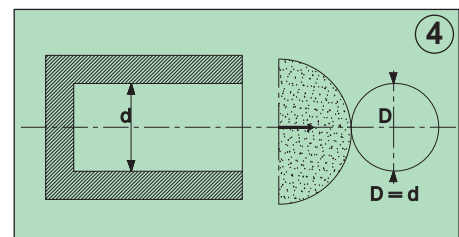
B-by detecting, with an approaching cycle controlled by CNC, through a gauge or a touch trigger assembled on the wheel-holder, the position of a part reference shoulder, which is assumed as zero (active positioning).



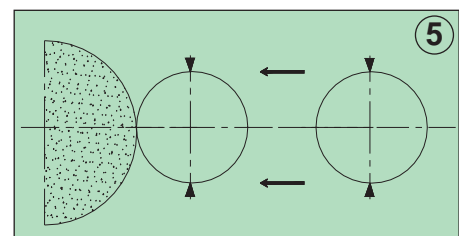
3. In-process diameter measurement. The diameter of the part being machined is continuously measured with a gauge, and the rough machining and finishing speeds are set according to the overstock actually available. The removal is stopped as soon as the nominal size is reached.



4. Match grinding. During machining of surfaces of parts that have to be closely coupled, the female outside the machine is measured, and the male machining is stopped when the same in-process size is reached.



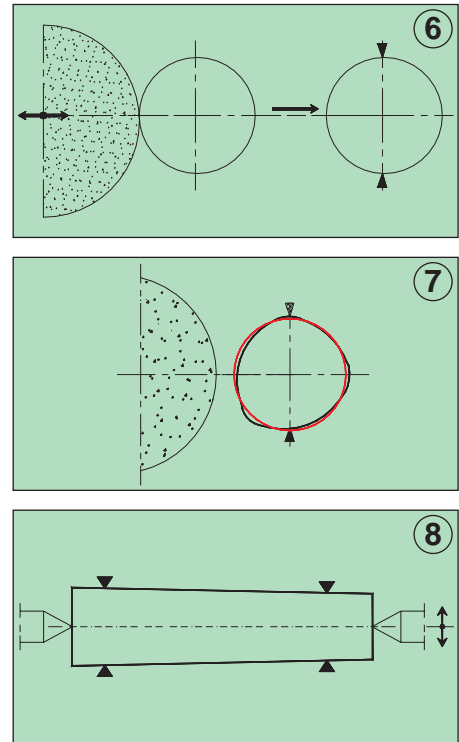
5. In-process gauge compensation. A number of machined parts are measured consecutively, outside the machine, in more stable temperature conditions, and the compensation signal is sent to the in-process gauge, which becomes effective on the following parts.



6. Post-process measurement. A number of machined parts are measured consecutively, outside the machine, in more stable temperature conditions, and the compensation signal is sent to the machine CNC, which becomes effective on the following parts.

7. Roundness check. The wheel edge loss and the vibrations of the wheel not perfectly balanced can cause roundness errors, which strongly spoil the quality of cylindrical couplings. Its control avoids the scrap production, promptly leading to balancing and dressing cycles.

8. Taper correction. The cylindrical shape is determined by the perfect parallelism of the part axis and the wheel axis during the corresponding movement, and, in plunge machining, by the wheel shape. The parallelism is kept within tolerance with measurement and compensation systems and with prompt wheel grinding.



The gauging module, through Top Gauge line, allows meeting any diameter and position comparative measurement application, with automatic zero on the master part, with small and wide measuring range, with continuous or interrupted surfaces.

The size displaying is analogue (bargraph) and digital with 0.0001 mm resolution in the International system or 0.00001 inches in the Imperial system.

A module handles up to 4 independent inputs for 4 transducers whose readings can be processed through formulas. The transducer actual mechanical position is also displayed.

Each gauging module is provided with two independent sections inside which, alternatively, up to 16 part programs can be enabled. Each part program is dedicated to a peculiar setting of 4 in-process size warning thresholds, five post-process size categories and to the combination of transducers that define the size. The sparkout time is programmable. The synchronism option enabled allows performing the 100% roundness automatic check directly in the machine, with the same in-process gauge and at the same time as the wheel retraction cycle, therefore without supplementary costs. The gauging module in "taper" configuration, as it handles two diameter gauges, calculates the taper value that is compared with pre-set control thresholds and sends compensation signals to the CNC to adjust the table system or wheel dressing requests.

MULTILINK I/O AND DATA ACQUISITION MODULE

The performance, for each specific automation application, is influenced by the efficient integration of the control auxiliary unit with the machine CNC and with the company software environment architectures.

VM 20 system, with the multilink I/O module, in its different configurations, offers a wide range of interfaces and communication protocols to exchange logic signals, data and programs.

The module is available in communication release and communication plus data collection (data logger).

The module maximum configuration is equipped with:

- serial interface used to integrate the CNC (parameters and part-programs up-down loading) or for collected data download on external device;

- parallel interface with 37-pin cannon connector destined to:

- a) system logic I/O expansion,
- b) inputs that can be associated to process external events,
- c) parameters and part-programs up/down loading.

- PROFIBUS DP interface to handle, through field bus, logic I/O, remote programming and monitoring.

The data collection module can store, through push-pull buffer, more than 22,000 records containing measurement data, internal and external events, data and time.

Data reading can be performed through a PC connected via RS232 interface, which, upon a reading command, receives data strings in ASCII format.

The obtained file can be processed with electronic sheet or database management system.

VM20 SYSTEM ARCHITECTURE

Modular-Multifunction

Local/remote 19" panel



19" built-in, shelf rack



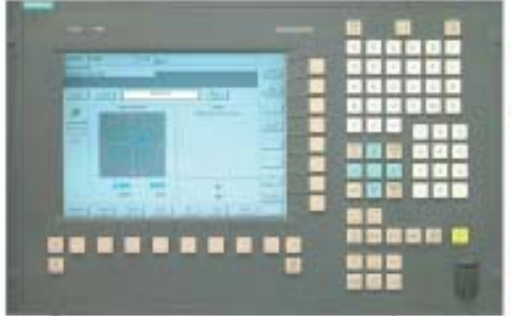
Local/remote 19"/2 panel



19"/2 built-in, shelf rack



Software panel



RS 232
OR
RS 485
OR
RS 232

Profibus:
Logic I/O; up - download
RS232 serial interface:
Up - download; data collection

Parallel interface:
Logic I/O; up - download
Logic I/O
Analogue
interface

Programming office
ocx / master / eco

LAN



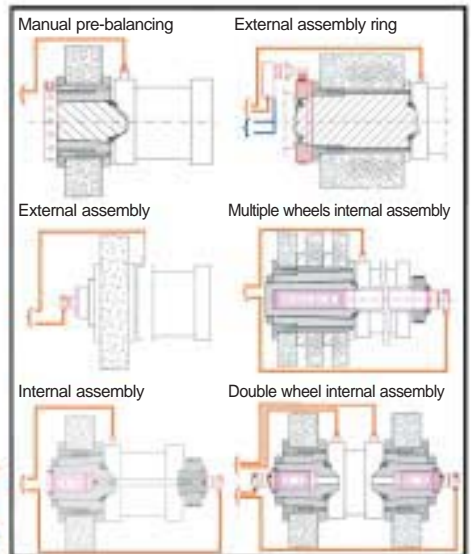
WAN

Teleservice office
master / eco

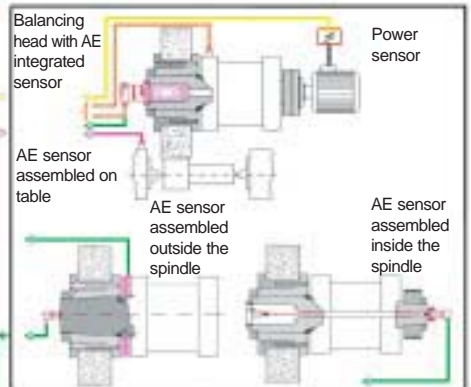
LAN



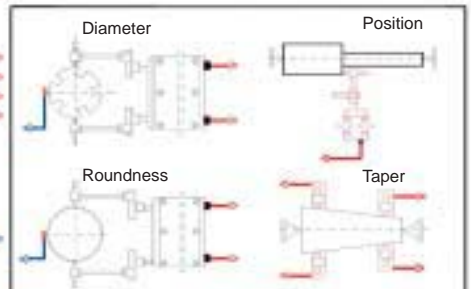
WHEEL BALANCING



TOUCH SENSING



IN-PROCESS GAUGING



TECHNICAL DATA

Rack

Size	Format	Capacity
19"	Built-in, shelf, remote.	6 Modules + 1 Multilink I/O Module
19"/2	Built-in, shelf, remote.	2 Modules + 1 Multilink I/O Module

Power Supply

Type	Electric Characteristics	Compliance
Switching	90-250 Vac / 50-60Hz / 120W.	CE, CSA, UL.

Operator Panel

Type	Format/size	Characteristics
VM21	Built-in, shelf, remote 19".	LCD graphic display LCD 320x240 pixel, backlit. Industrial water-proof sandwich keyboard. RS232 serial interface (Optional).
VM24	Built-in, shelf, remote 19"/2.	(see above)
Type	Characteristics	
HMI Software	PC - Windows , hardware panel emulation; for instance for: - SIEMENS NCU 840D/Di with PCU50/70, - FANUC OPEN CNC 180i TA, - General PC. OCX libraries. PC-CNC / VM20 connection through RS232/RS485 converter.	

Balancing Module

Management	Characteristics
Vibration sensor	Wheel unbalance measurement. Unit of measurement: μm , mm/s. Measurement range 0..100 μm - 0..100 mm/s. Resolution 0.001 μm - 0.001 mm/s (peak value). Internal/external assembly, with no-link collector or brush collector. Without dynamic torque.
Balancing head	
Ring balancing head	Brush collector, synchronism, and collector descent actuator control.
Digital interface	Sink/source logic I/O. Main I/O are: balancing control input, neutral masses control input, wheel rotation control enabling input, balanced wheel / masses in neutral position output, wheel revs eco output, programmable alarms outputs.
Analogue interface	Speedometer dynamo control, revs potentiometer control, programmable 0..10V output (source and sink) to display the unbalance or wheel rotation speed.

Gap Elimination Module

Management	Characteristics
AE sensors	2 channels, FFT processing with programmable digital filtering.
Force sensors	1 channel for straining gauge.
Power sensors	1 digital channel in optical fiber and connection of a maximum of 8 daisy-chained sensors. Power instant measurement of any kind of direct current, single-phase, three-phase motor.
Digital interface	Sink/source logic I/O. The main I/O are: reset / enable input, part program selection input, touch warning output, burnout warning output, alarm warning output (anti-crash).
Analogue interface	2 0..10V programmable outputs (source and sink) to display AE, power, force measures.

Gauging Module

Management	Characteristics
Gauges	4 channels for LVDT sensor with small (1mm) and wide range (12,5mm). 0,1 μm resolution.
Digital interface	Sink/source logic I/O. The main I/O are: Measurement cycle start / enable input. Auto-zero input. Touch finger recharge input. Output connected to in-process machining stages of: rough machining , finishing, spark-out, cycle end or post-process of good, compensable, scrap. Programmable outputs of roundness and shape errors (ovality, triangularity, etc.); diagnostics programmable outputs on ongoing process.
Analogue interface	Programmable 0..10V output (source and sink) to display sizes or transducer actual position.

Multilink I/O Module

Management	Characteristics
Serial interface	RS232 for part-program and parameters up-download, data download on PC.
Digital interface	Sink/source I/O employable as system I/O expansion, I/O dedicated to external process, part-program and parameters up-download.
Field Bus interface	Profibus DP, up to 12Mbit/s for the system total management: I/O, programming, monitor.
Data collection	Storage up to 22,000 records programmables through push-pull buffer. Access to data via RS232 with ASCII text output format.

Specifications are subject to change without notice. © 2003 by Balance Systems. Printed in Italy. Cod M0200



Balance Systems s.p.a.
via Ruffilli, 2/4
20060 Pessano con Bornago
(Milano) Italy
Tel. +39.029 504 955
Fax +39.029 504 977
E-mail: info@balancesystems.it
www.balancesystems.com



Balance Systems