

## IN-PROCESS GAUGING SYSTEM FOR CRANKSHAFTS

The advances in grinding technology allow the machining of all ground features of a crankshaft in a single chucking operation. Where previously fixed grinding operations were required on machines dedicated to either grinding mains, pins, post and flywheel end diameters or the thrust faces, these single modern machines, thanks to their powerful CNC control systems, can grind all the features on a crankshaft in a sequenced cycle.

This new generation of grinding machine, providing increased productivity, under variable cutting and process conditions, involve the use of an in-process gauge to guarantee the continuous size of the workpiece being machined.

Marposs has developed such an in-process gauge, the Fenar L, which satisfies this demanding grinding application, having both the flexibility and precision that is required by this grinding process.



Measuring Heads

Electronic Units

Balancing Heads

Software

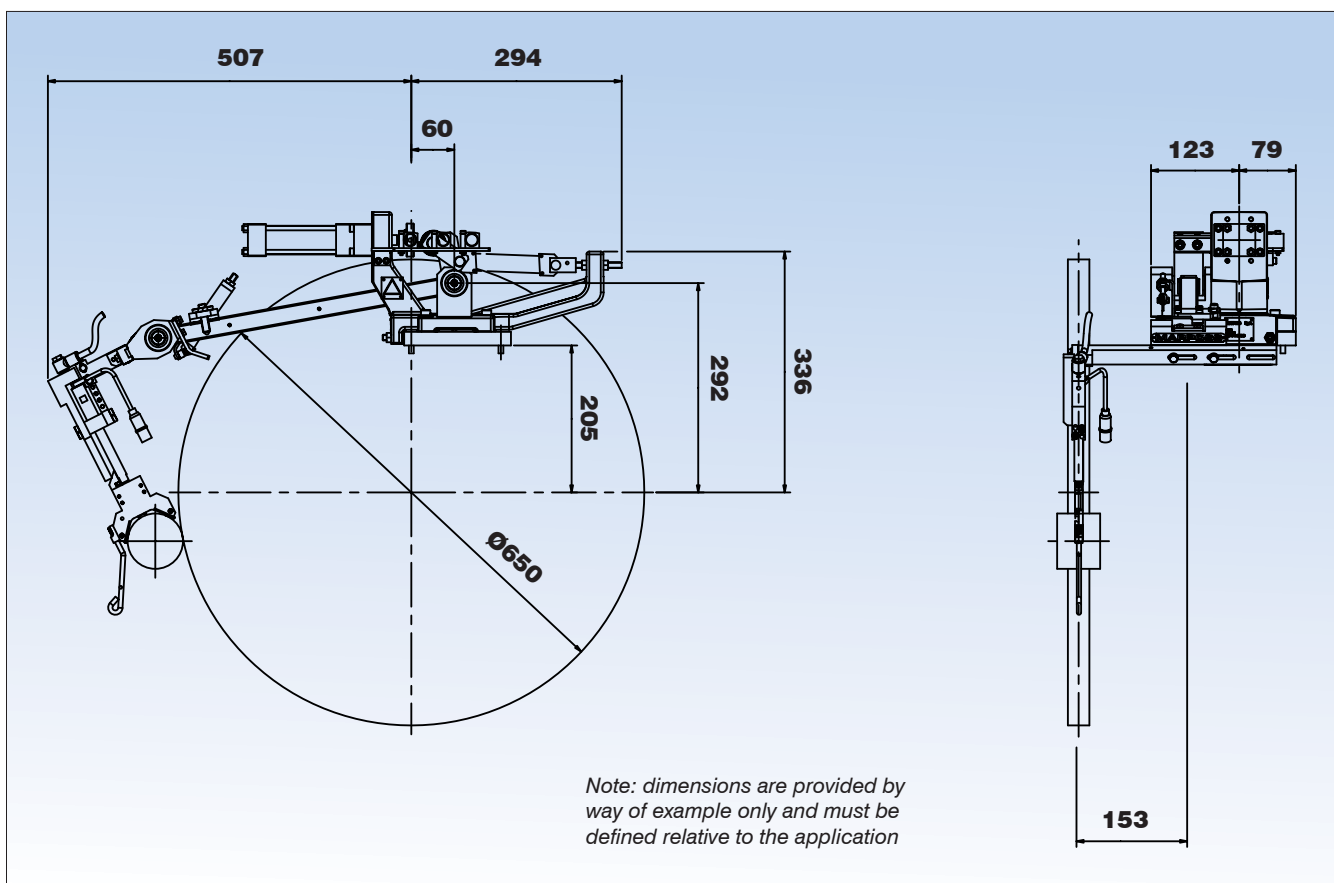
Sensors

Accessories

## Description of the system

The Fenar L gauge system, attached to the grinding wheel head(s) continuously follows stock removal and provides real time diameter measurement information until the final part size is achieved. The measuring head is automatically applied onto the diameter being machined without slowing the machining process. Measuring head engagement onto the workpiece is not affected by the angle of the pin journal.

- Maximum safety. Devices built into the support and the insertion device prevent any collision with the crankshaft and the grinding wheel. The control device avoids collision with the wheel even when the part is missing. If conventional wheels, rather than CBN ones are used, position sensors indicate the maximum wheel wear (minimum wheel diameter) allowed by the application and prevent collisions with the gauge system.
- Maximum flexibility. Automated re-tooling in a 25 mm range for flexible machining of main journals or pin bearings with different diameters for flexible machining of various types of crankshafts:
  - ▶ Unaffected by variations in the crank throw in a defined application range, and related to the selected wheel dimensions or wheel wear parameters.
  - ▶ Check of crankshaft main journal and pin bearing machined in succession with the same grinding wheel.
- Maximum precision. The movable measuring range within the overall operating range maintains the high measuring precision on the individual diameter. The sampling frequency, filters and electronic processing in the amplifier allow gauging with a speed compatible with an optimum machining process.
- Maximum processing speed. In-process measurement sampling at 0.5 msec intervals allows a measurement processing speed suited to the cutting speed from the initial roughing stages. Subsequent processing and filtering enables the user to predict the actual part value by performing adaptive cycles.
- Maximum durability. The gauge has a seal rating suitable for machine operating conditions and characterised by high coolant volume and pressure. The materials used minimise the effects of the coolant temperature range and/or those due to interruption of the machining. The gauge dimensions allow the gauge to be applied onto small diameters even with the steady rest present.
- Maximum reliability. The hundreds of operating applications which have been on the market for years confirm R&M design calculations for MCBF of more than 3 million cycles



Application diagram

## System technical specifications

Fenar L is the ideal solution for all diameter checking applications on modern crankshaft grinders. Designed to satisfy the requirements of gauging systems integrated in the machining process, it combines:

- Excellent metrological performance. Thanks to its auto-reference gauging system, the gauge is very accurate and has a large diameter measuring range.
- Total flexibility. The simplicity of the design and applicability confirmed by results in the field guarantee Fenar L absolute flexibility for use on orbital grinding of crankshafts.
- Reliability. The materials used in the Fenar L gauge are the result of over fifty years Marposs experience as the leader in the sector for gauges on grinders. The materials chosen reduce the effect of pressure, temperature and aggressiveness of the coolants used on this type of machining.



Double application



### Fenar L range of application

|   |                    |
|---|--------------------|
| <b>Diameter</b><br><i>larger diameters upon request</i>                     | 35 mm ≤ Ø ≤ 160 mm |
| <b>Stroke</b><br><i>larger strokes upon request</i>                         | ≤ 100 mm           |
| <b>Repeatability</b><br><i>with 0.1 μm resolution in machine conditions</i> | < 0,8 μm           |
| <b>Speed of rotation</b>  | < 70 rpm           |
| <b>Degree of protection</b><br><i>IEC 60529</i>                             | IP66 - IP67        |

### Fenar L range of application

|   |   |
|---|---|
| <b>Range 25 mm</b><br><i>snap gauge for checking main journals and pin journals with a single gauge with automatic zero-setting on the master part for any single diameter to be ground which is within the operating range</i>   | resolution 1 μm<br>measuring range 1000 μm  |
| <b>Range 12,5 mm</b><br><i>snap gauge for checking on machines with a double wheel carriage, one snap gauge dedicated to main journals and one for pin journals; automatic zero-setting on the master part for any single diameter to be ground which is within the operating range</i> | resolution 0,1 μm<br>measuring range 500 μm |

### Electronic part specifications

|                           |   |
|---------------------------|---|
| <b>Measurement output</b> | up to 7 cycle control commands<br>instantaneous measurement<br>measurement processed (mean) |
| <b>Sampling</b>           | 2000 S/s  |
| <b>Machine interface</b>  | logic I/Os<br>field bus<br>serial<br>Ethernet   |
| <b>Operator interface</b> | using dedicated panel or integrated in machine display                                      |

## Roundness check (optional)

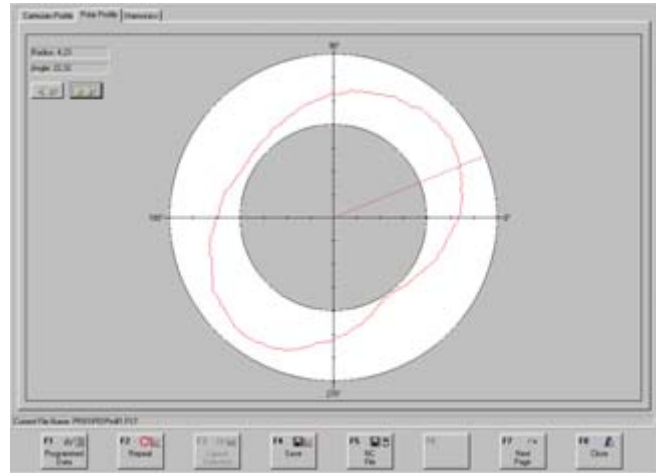
Checking the material to be removed before beginning the grinding cycle allows the grinding cycle to be adjusted to the measurement taken. Excessive out-of-round detected during finishing indicates abnormal bending on the part, steady rest pressure failure or a deterioration in grinding wheel cutting. The real time check of measurement value detected during the cycle allows for intermediate spark-outs and/or wheel speed adjustment until the part is completely finished. This provides an economical method for maintaining high quality standards and reducing waste, making the process more efficient and productive.

If we exclude the shape error due to residual wheel imbalance, what remains is the systematic roundness error. The wheel imbalance can be corrected by using an automatic balancing system either integrated into the in-process gauge system or in an independent unit. The systematic errors must be measured and analysed in a metrology room to define their magnitude, origin and how to correct them. This takes time, since the parts must be studied off-line and involves unplanned machine down time if the cause of the error requires adjustment of the grinding machine.

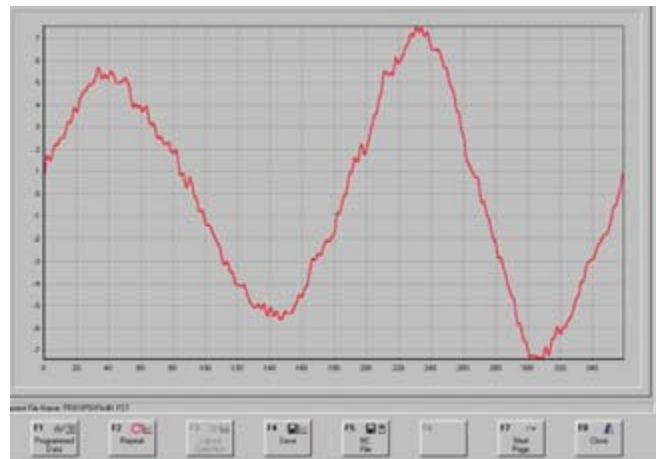
Use of the Fenar L gauge in the machining process and the consequent sampling of measurements in a complete part revolution allows the diameter shape to be processed at the end of machining. This "save and process" part shape option lets you carry out a real time check on the development of the shape of parts being ground and make the necessary correction to the process.

This optional check further reduces the time needed to see a return on investment since, as well as the advantages typical of real type machining cycle checks, it significantly reduces shape error check times. Taking the measurement directly on the grinder, without affecting overall process productivity, immediately provides information about the roundness of the part machined, information that would otherwise have to be obtained by taking the part to a metrological room.

The shape check on the part(s) being ground can be carried out on the grinding machines processor or on a remote quality control work station. The system is easily integrated for automatic adjustment providing compensation data to the axis interpolation system according to the methods used by the machine CNC.



Polar diagram



Cartesian diagram

### Roundness check technical specifications

|   |   |
|---|---|
| Profile   | 3600 points (0,1°)  |
| Accuracy  | 0,5 µm  |
| Profile construction                                  | up to 150 harmonics for machine compensation (programmable up to 150) |
| Selectable filters                                    | gaussian type programmable  |
| Speed of rotation                                     | 60 rpm  |
| Multiple archive management by part type and diameter | yes   |



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