Foil Thickness Gauge

VBF 1000

Operating- & Service Instructions
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Subject to change without prior notice

Please order spares referring to the part number and drawing number of the enclosed documentation drawings
Safety Precautions, please read carefully!

Stand clear of the gauge while the strip is under tension or when it is running.

During the installation, fasten the slidebase to the gauge before carrying the gauge. Otherwise your fingers might get crushed in the slidebase, or the gauge or the slidebase might fall down while the arrangement is carried.

**WARNING , CRUSHING HAZARD !** The gauge has a separate, pneumatically operated guide roller. For safety reasons it is not allowed to work on the gauge unless the compressed air supply for the roller (at the rear side of the gauge) is disconnected.

This manual must be given to the machine operator, and one copy must be permanently available to operator and service personnel.

Nobody is allowed to work on or with the gauge, before he has read and understood this manual. Feel free to call the Vollmer company in case of any questions (phone +49 2334 507 0).

**WARNING , CRUSHING HAZARD !** In some applications this gauge has a hydraulic or a pneumatic traverse cylinder. The gauge operating mode has to be switched to the mode 'Service I', before anybody enters the danger zone. When operating in the standard mode ('Service 0') the gauge might rush back or forward unexpectedly and uncontrollably.

If a warning sign "Crushing Hazard ...." was sent with the gauge, it must be installed on an easy visible position after the machine has been installed. Contact the manager in charge of safety in the production department for installation of the sign. The sign 'Somebody is working on the gauge...' must lay in the electronic cabinet, so that it is always at hand to be hung up onto the service switch or close to it.

The gauge head might get hot without radiating much heat before it is actually touched. Therefore check the temperature carefully before trying to handle the gauge head.

If the gauge head is operated automatically or semiautomatically, the documentation contains a description of the control program for this application. Nobody is allowed to work on the gauge unless he knows the control program sequences. For your own safety, please make sure to get familiar with the control program sequences before you start to work on the gauge!
Spares

Please order spare parts referring to the part number and the drawing number of the large construction drawings which were sent with the documentation. In addition, the Vollmer service needs the project number (e.g. P 00/12345) which is stamped on the ID-plate at the gauge.

Intended use of this machine

This gauge must be used exclusively for the measurement of cold strip as specified in the Vollmer order confirmation. It must be firmly installed in its intended position and electrically, electronically, hydraulically and pneumatically connected as intended by the Vollmer company. Any alteration might cause severe damage or even personal injury.
Operation mode selector switch 'Service I/0'

If the gauge is traversed pneumatically or hydraulically (i.e. if it is not manually pulled on strip and pushed off strip), the electronic cabinet for this gauge contains a selector switch labelled 'Service I/0'.

'Service 0' is the position for the normal operation mode in which the gauge is traversed back and forward automatically. In case of strip tension loss or lateral strip movement, the gauge head is traversed off the strip into its rear limit position at double speed. Danger: Crushing Hazard! Nobody is allowed in the danger zone as long as the system in the 'Service 0' mode.

When switching to 'Service 1', hang up the warning sign 'Somebody is working on the gauge...' onto the service switch or close to it.

'Service 1' is the position for service operation. The gauge head can only be traversed in a "jog" by manual controls in the operator's desk. The automatic traverse control is switched off, so that the gauge will not rush back or forward automatically. Caution: There remains a crushing hazard for hands and fingers! Do not put hands or fingers into the slidebase!
Design and Function

The Vollmer thickness gauge VBF 1000 is made for measuring foils or very thin strip on fast running cold rolling mills or on inspection tables. The gauge measures the strip continuously in its measurement mouth which has a depth of 200 mm.

A C-shaped thickness measurement frame inside the gauge head carries two thickness transducers which stand exactly perpendicular to the strip, measuring it simultaneously from the top and from the bottom. Strip thickness changes push the transducer tips apart or allow them to come closer. The transducer tips are crowned and polished diamonds, which do not mark the strip.

At its base each LVDT transducer contains a differential transformer. The movable core of this transformer is connected to the measurement tip sliding on the strip surface. In this way, any movement of the measurement tip is measured inductively.

Any position change of the two transducer tips is passed to a VMF measurement amplifier, where they are added. The amplifier indicates a measurement result as deviation from zero, i.e. the difference from the preset nominal.
size. Depending on the type of the gauge, there are several ways for electronic nominal size setting. But no matter which kind of nominal size setting is used, the measurement amplifier indicates 0 when the measured strip thickness matches the nominal thickness.

The C-shaped measurement frame in the gauge has an extremely low temperature coefficient. This leads to a very high repeatability of the measurement results. The measurement frame is held by a special spring bearing in the gauge head.

Two flat springs lift the transducer tips off the strip as long as the gauge head is being traversed in its slidebase. This prevents the tips from hitting the strip edge. During measurement, the flat springs are pneumatically pushed towards the middle of the C-frame, so that the transducer rams come out and their tips can measure the strip.

In order to compensate for temperature influences on the measurement, each of the two transducer tips can be cooled by a jet of air.

Left: Lateral view on a double gauge arrangement of VBF gauges: The Gauge heads M are installed on the slidebase S. They are traversed on the slidebase by the hydraulic cylinders H between the rear limit position (shown here) and the measurement position on strip B, which is in this application supported by two guide rollers.

As an option, the VBF gauge can be equipped with a third guide roller R, which is pivoted down onto the strip by a pneumatic cylinder P. This roller is designed to dampen strip vibration.
The gauge head's slidebase is installed in such a position that the gauge head is at the strip passline height. The height of the gauge head can be fine-adjusted separately. Two rollers guide the strip in passline height from below, and (as an option) a third roller that can be pivoted up and down to dampen strip vibration.

Amplifier measurement data can be put out for controlling and for quality monitoring documentation according to ISO 9000. It is available on analog outputs and some VMF amplifiers additionally provide digital data output.
System

The VBF gauge is always installed with a VMF measurement amplifier. This measurement amplifier indicates the difference between measured strip thickness and selected nominal size. The documentation includes an extra instruction manual on the VMF amplifier.

Measurement amplifier VMF 311 with electronic classifier 2S (top) and nominal size selector FS4 (bottom).

The measurement amplifier continuously indicates the difference between nominal and actual strip thickness. The operator can select the resolution of the analogue indicator by the measurement range selector MB. Full deflection can indicate from 1000 microns (.030") down to 10 microns (.0003"). The zero potentiometer NP allows to eliminate small deviations of the gauge zero.

Tolerance limits can be set by the two-digit switches DK of the electronic classifier. Coloured control lamps indicate whether the measurement value is in, over or below tolerance. Such classifiers are optional equipment, their operation is described in a separate manual.

The (optional) nominal size selector FS4 shows the selected nominal size in microns (or steps of 0.0001", depending on the FS4 type).

The amplifier VMF 2000 includes all components described above. It puts out the measurement data with statistic evaluation ready for quality control documentation according to ISO 9000. Its internal automatic adjustment provides the best possible measurement accuracy at any time.

The VMF 2000 amplifier is capable of processing transducer signals of overall 4 mm measurement stroke (instead of 2 mm like the VMF 3/11 and 3/22 types). Such transducers and the VMF 2000 amplifier can be used to upgrade nearly all Vollmer gauges.
Types

According to individual requirements of our customers, Vollmer gauges are produced in many different types. The gauge card in the documentation shows the type of your gauge. The following list is a general overview about the available optional items:

VBF 1000 E/Su/VMF 2000/FS4/K/DAV-A/A0/Hwst 600.

Meaning of the abbreviations:

**VBF 1000 E:**
Electronic thickness gauge for very thin strip, on fast cold rolling mills, working with two electronic transducers, measuring depth 200 mm.

**Su:**
Measurement by 2 transducers in sum; accurate measurement values even in case of strip vibration.

**VMF 2000:**
fully digital measurement amplifier

**FS4:**
4 digit remote selection of nominal size by a thumb wheel switch; optional parallel decades have a nominal size output e.g. for control inputs. The amplifier is indicating zero when the strip has the nominal thickness.

**K:**
Air cooling of the transducer's measurement tips, against short-term drift if the measurement tips are heated by the strip.

**A0:**
optional electronic adjustment system, which works when the gauge is in its rear limit position. There the gauge system is automatically set to zero. Depending on the application. This procedure is started either by pressing a key or it is on automatically as long as the gauge is in the rear limit position (Only with VMF 3/22 or VMF 2000).

**DAV:**
The diamond measuring tips are pneumatically lifted when the gauge is traversed - in order not to damage them at the strip edge.

**AS:**
Automatic symmetry adjustment; the transducer tips are moved up/down pneumatically instead of manual manipulation

**Hwst 600:**
Hydraulic traverse unit consisting of a control unit and a slidebase with roller bearings for the slidebase, stroke of the hydraulic cylinder is 600 mm, some optional items may vary (e.g. with or without hydraulic unit, or with/without valves).
Measurement

Zero setting

Set the gauge to nominal size zero and check the indication. It should be zero. If not, set the amplifier indication to zero in the 10µm measurement range (see separate manual for VMF measurement amplifier). Then actuate the DAV and check if the indication gets back to zero.

If the gauge was delivered with the optional A0 equipment, the system sets itself automatically to zero whenever the gauge is in its rear limit position. Alternatively, a button can be pressed during the rolling, that makes the gauge traverse to its rear limit position, perform the A0 setting, and then automatically moves forward onto the strip where it continues to measure with the previously set nominal size. During this zero setting procedure, the automatic thickness control is automatically disabled when the gauge is pulled back and enabled when the gauge returns to the strip.

Checking the measurement accuracy

If the gauge zero is constant, the gauge accuracy may be checked with a special test gauge plate (optional item). This test should be performed regularly. The tighter the thickness tolerance of the strip, the more often the gauge should be checked. The gauge must be in the on strip position (without strip on the mill) and must be set to the ‘Service I’ mode before somebody get close to the gauge.

First enter the thickness of the gauge plate as the nominal size. Then insert the plate into the measurement mouth so that it lies on the guide rollers as shown in the sketch. The indication must be close to zero (+/- 0.5 µm). If not, check the gauge.

VBF 1000 test gauge plate:
The plate is put onto the guide rollers so that the centre part (which is of an exactly defined thickness) is positioned between the measurement transducers.
Symmetry check

After zero setting, select nominal size 100 and insert a 100 µm slip gauge. Alternatively, we recommend to use a check gauge plate as described before (optional extra, available from Vollmer). The amplifier has to indicate near 0. If not, the symmetry and sensitivity need to be adjusted:

When the gauge is in its rear limit position, switch into the ‘Service I’ mode, set nominal size to 0, move both transducer tips up and down, (indication has to stay 0 µm +/-0.5 µm). In case of tight tolerances check daily, otherwise weekly). Gauges with AS do this procedure automatically. Both ways are described in a separate manual for the VMF amplifier.

Nominal size setting

Nominal size is set fed into the VMF amplifier by an external source of the mill control electronics, or it is set electronically by a thumb wheel switch (installed by Vollmer). The nominal size input compensates the measurement signal for the selected amount. If the required material thickness, e.g. 500 µm, is entered as nominal size. If then the measurement is 501 µm, the amplifier will indicate +1 µm (1 µm = 1 micron). This allows the operator, to read any thickness deviation directly from the indicator needle without having to perform a transformation.

Tolerances in microns are set either by decade switches such as the 2s or 4s (optional items, see separate instructions), by keys of the VMF 2000 amplifier or by serial ports on the VMF 2000.

Measurement start and end

Select nominal and move the gauge on strip by pressing the "on Strip" button (or by an automatic control command). If a DAV is installed, the diamond tips are lifted while the gauge is moved and the indicator needle is deflected fully to + until the gauge is in measurement position. There the diamond tips are released an touch the strip surface. Now the measurement amplifier indicates, how far the measurement result differs from the selected nominal size and the electronic classifier (if installed) indicates if the material thickness is in tolerance.
**Important note for manual gauge traversing**

The gauge head must be pulled off the strip before strip tension is off. The strip end must never run through the gauge! It would probably cause severe damage to the gauge.

**Cooling**

The tips of the transducers are cooled by a jet of air in order to prevent the gauge from short term drift of the zero point. Short term is caused by a temperature increase of the diamond tips due to high strip temperature. The drift occurs, when the gauge is pulled off the strip and adjusted to nominal size 0 (be sure to check with A0 off):

- if the indicator moves to minus -> increase cooling air pressure
- if the indicator moves to plus -> decrease cooling air pressure

The cooling can be adjusted separately for each edge by a proportional valve 0-10V. It can be set to cool the tips on both sides or on the ingoing side only.

When the gauge head is pulled off the strip, a gust of compressed air is blown through all of the cooling air outlets in order to keep them clean.

**Compressed air supply/Flow Control**

Air pressure for the diamond lifting device (DAV) is adjusted at the pneumatic cabinet. It is set OK. when the transducer tips are lifted quickly off the strip without the rams hitting unnecessary hard against their limit stop.

The chokes D at the rear of the gauge head should be set so that the indicator does not show sudden peaks during automatic symmetry checking. Such peaks indicate that the damping by the chokes needs to be slowed down by closing the flow control.

The transducers need dry air without oil.

**Guide roller check**

Guide rollers should run easily and have only a small amount of lateral clearance. Put the test plate that came with the gauge onto the rollers and check if they are parallel.
Maintenance

The gauge does not need much maintenance as long as it is not too dirty and the diamond tips of the transducers are not worn.

Remove the transducers only if the rams have too much friction or if the diamonds are worn. However - when the gauge measures strip with an even surface in a clean environment, the diamonds will last a very long time.

To disassemble the gauge

First undo all plugs and the flexible air supply tubing from the front side of the connector plate and from the valves (press ring towards the plate and pull the air tube off).

Now lift the whole gauge head with the cables off its mount.

Installation may vary on different applications.
To open the gauge head

Lay the gauge head on its left side and unscrew the six Allen bolts.

To remove the transducers

Note: Do not swap the upper and lower transducer! The lower transducer has a spring suspended measurement ram, but the upper transducer has none or (depending on the application) one with less spring force.

Then turn the gauge head onto the opposite side and screw out the two screws 49.

Note: Do not bend or deform the C-frame when removing or installing the transducers. This would result in measurement errors.
Lift the C-frame with its bearing block F and the two transducers out of the housing. Now the transducers can be removed after the clamp screws K in the C-frame were turned loose.

**To service the transducers**

The servicing of the transducers (cleaning, diamond changing etc.) is described in a separate Transducer Service Manual.

**To install the transducers**

Insert both transducers into their clamps in the C-frame. The one with the softer ram spring should be installed into the top arm.

Turn the transducers into such a position where the inner edges of flat spring B do not scrape at their protection cover. The flat sides of the cover must stand exactly parallel to the outer edges of the flat spring.
Do not fasten the clamp screws at this point. Carefully insert the C-frame into the housing. The C-frame must not fall down or get any hard hits. Put the transducer cables carefully into their original position and insert and tighten the two screws 49 to fasten the bearing block. Check for the 90°-position of the C-frame (see following section).

Disconnect both transducers from the VMF measurement amplifier. Set nominal size selector to 000 and adjust the VMF indicator to 0 (see VMF manual for details).

**Note**

*During transducer installation, the flat spring must be set to neutral position where it does not lift the transducer tip. That means, either the two pneumatic cylinders in the measurement frame must be supplied with compressed air, or the 5mm thick spacers which came with the gauge should be put between C-frame and flat spring.*

Connect the bottom transducer to its extension cable X2 and select measurement range 1000 µm on the VMF (only on VMF 3/11 or 3/22, on all digital amplifiers the digital indicator can be watched to find the correct transducer position). Adjust the position of the bottom transducer as explained below:

- set nominal size to 000
- push the upper transducer up, so that it is out of way
- insert a 1,5 mm thick adjustment plate into the measurement mouth
- push the bottom transducer against the adjustment plate until the amplifier indicates +1000 µm (when using transducers with 2 mm stroke)
- check the transducer's rotational position (flat spring) and tighten clamp screw moderately
- connect the upper transducer to the measurement amplifier (X3), the bottom transducer remains connected
- set the sensitivity range selector to the most sensitive measurement range (3µm or 10µm)
- take out the adjustment plate
- push the upper transducer down against the lower one until the measurement amplifier indicates nearly zero
- check the transducer's rotational position (flat spring) and tighten clamp screw moderately
- set the amplifier to zero (see VMF manual)
- check for transducer symmetry!
- check for input sensitivity!

Then reassemble the housing and insert the gauge head into its holding.

Safety note

Nobody must work on the gauge unless it was switched to the 'Service I' mode before! Only in this mode, the gauge head will not rush back or forward automatically.

Warning, Crushing Hazard! The gauge must not be traversed as long as somebody is in the danger zone close to the slidebase. The hydraulic cylinder which is traversing the gauge, is very powerful and might traverse the gauge all the way to its limit position.
90°-position of the measurement frame

After the measurement frame was put back into the housing, its 90°-position must be checked.

The measurement frame is pushed into the 90°-position by its own weight and by the spring bearing F. It is in the so-called 90°-position when the distances 1, measured between the upper edge of the measurement frame and the upper side of the gauge’s housing are the same at the front and at the rear. Set screw O forms the mechanical limit stop for the 90° position. Set screw U needs to be set to such a position where it allows the measurement frame to be lifted for about 0.2mm at its front end.
Trouble shooting

If the gauge measures incorrectly

- Wrong location compared to gauge reading?
  Cross profile strip thickness varies in many cases. If the gauge is checked, strip thickness must be measured in the same distance from the edge as the transducers have measured.
  \(\Rightarrow\) check the strip thickness at correct edge distance

- Roller or gauge head position wrong?
  If the guide rollers are not parallel, or if the gauge head is inclined to one side, the transducers are not perpendicular to the strip. The gauge will indicate too much thickness.
  \(\Rightarrow\) check the gauge head adjustment by the delivered adjustment plate (see under "Installation") or check the gauge by the (optional) adjustment plate with integrated slip gauge (see under "Symmetry check").

- Gauge head suspension or C-frame bent?
  After strip breaking or after the strip end passed through the measurement mouth, the C-frame or the gauge head suspension might be bent, so that the transducers are not perpendicular to the strip.
  \(\Rightarrow\) check gauge head position using the adjustment plate
  \(\Rightarrow\) check C-frame with a 20mm inspection pin (available from Vollmer). It has to slide easily through transducer clamp holes. If not, the C-frame can possibly be repaired by Vollmer.

- Transducers dirty?
  In a very dirty environment, the rams of two transducers sometimes get too sticky, so that they do not shut completely. If the gauge is then set to zero, the indication of a following measurement is too low. After cleaning the transducer ram should slide easy in its bushing or bearing for a quite long period of time.
  \(\Rightarrow\) increase cleaning frequency

- Transducer tips dirty?
  Dirt deposits at the transducer tips cause wrong measurement results.
  \(\Rightarrow\) increase cleaning frequency or increase air cleaning purge pressure.

- Transducers clamped too hard?
  If the clamp screws in the C-frame are clamped too hard, they possibly distort the transducer housing which increases the friction in the ram guiding.
  \(\Rightarrow\) loosen the clamp screw and re-tighten them with moderate force

- Flat spring is scraping at the transducer's protection cover
  If the rotational position of the transducer is wrong, the flat spring might scrape at the protection cover causing measurement errors.
  \(\Rightarrow\) realign the transducer more exactly (see under "To install the transducers")

- Gauge zero not constant?
  If the screws, which connect the measurement ram with the guide ram, are not tight, the measurement ram might move against the guide ram.
If, for example, DAV was activated or material was placed between the transducers and then removed, the zero point changes. The indication is incorrect even if the symmetry is correct.

- Fasten the set screws in the guide ram (see transducer manual)

- Short-term drift of the gauge zero?
  Can be noticed, if the rolling has been finished and the gauge in its rear position is directly set to zero (without A0). If the display drifts away to + or -, the diamond cooling does not work correctly.
  - Readjust the cooling at the pressure valve "cooling" in the pneumatic cabinet
    (if the indication drifts away to minus -> increase the cooling, if the indication drifts away to plus -> reduce cooling)

- Indication too low?
  If the transducers in the C-frame are clamped not tight enough, they might be shifted in their bore. Gauge zero is then shifted too.

- Indication correct at zero but wrong at other values?
  Check the transducer symmetry by moving up and down both transducer tips. If the indication does not stay 0
  - readjust the transducer symmetry

- Indication too high?
  If the strip breaks or a strip end passes through the gauge, the C-frame is possibly bent. The indication is too high. Check as before and
  - check the alignment of transducer clamping bores with a 20 mm inspection pin and the condition of the diamond contacts

**If the gauge marks the strip?**

- Diamond with small cracks?
  If hit too hard, the diamonds in the transducer measurement tips might get tiny ring-shaped cracks, which are hardly visible. Sometimes such crackles mark the strip
  - replace the measurement tip

- Diamond broken out?
  In case of strip breaking the diamonds might break out of the measurement tips.
  - replace the measurement tip

- Roller blocked?
  - Replace roller. If the roller surface is not damaged, replace only the bearings.
Measurement head adjustment

Installation

When the gauge is installed into an inspection line, installation height and levelling of the gauge are derived from the inspection table. If the gauge was removed from its position, take care to reinstall the slidebase exactly angular to the passline.

In rolling mills the gauge should be installed as described in the following sketch:

If possible, the gauge should be positioned between the roll gap \( \text{mill} = W \) and the deflector roll \( U \). Base and the bracket \( K \) are so high that they lie under the strip by the "passline height" \( H \) (see data drawing in the documentation).

Additional conditions are:
- base parallel to roll axes in the mill
- slidebase parallel to the strip
- gauge must be able to traverse towards roll middle of the strip

The VBF gauges have two devices for setting the gauge's inclination and tilt. First the entire unit (i.e. gauge head with guide rollers) is adjusted to a position where the guide rollers stand correctly (see under "Guide rollers levelling and passline adjustment"). In addition, if necessary e.g. after a strip breaking, the gauge head can be aligned to the guide rollers (see under "Gauge head alignment").
Guide rollers levelling and passline adjustment

The gauge needs to stand exactly parallel to the passline, so that the strip just drives the guide rollers but is not lifted or deformed by them.

Set the side inclination and the height of the entire gauge (head + guide rollers) by the four set screws L1 and L2.

Gauge head adjustment

The gauge's measuring mouth has to stand exactly in the passline. The height of the gauge head (but not of the guide rollers) is adjusted by the four set screws G1 and G2. However, the gauge was already adjusted at Vollmer to meet the passline formed by the two VBF guide rollers, so that usually there is no need to readjust G1 and G2.

For adjustment of the gauge head's position relative to the guide rollers, first move the gauge head in measurement position without a strip in the mill.

Then put the delivered 1.5mm thick, flat adjustment plate (this is not the check gauge plate described under "To check the measurement result" onto the two rollers and into the measurement mouth between the transducers. Now adjust G1 and G2 in such a way, that:
1. the lower transducer protection device (TS) is about 0.2 mm below the adjustment plate lying on the guide rollers R. To achieve this, disconnect the upper transducer from the VMF amplifier and check the indication of the bottom transducer. The gauge head's height is OK when it measures +800µm (if the transducer was installed at +1000µm as recommended on page 17).

2. the front side V of the gauge head stands perpendicular to the adjustment plate (check with a square which is put on the side of the adjustment plate).

3. the sides F of the gauge head stand perpendicular to the adjustment plate (check with a square which is put on the side of the adjustment plate).
**Light barriers**

The light barriers LV and LH detect the strip edge when the gauge head is traversed on the strip and while the gauge is measuring.

They may be removed for servicing after the plastic covers K (covering their wiring) were removed off the gauge head.

The steel covers S protect the cooling air tubing.
Adjustment of the upper guide rollers

As an option, the VBF gauge can be equipped with a third guide R roller, which is pneumatically pivoted. This roller is designed to dampen strip vibration.

The upper guide roller is pivoted down onto the strip an up to their resting position by the pneumatic cylinder P. The working pressure of this cylinders should be set in such a way that the roller is moved up and down with an even motion without hitting too hard against the limit stops. When the roller is down, it should rest firmly against the limit stop.

Safety precautions

Never work on the gauge or stand close to it as long as strip tension is on. Do not adjust the upper roller before the lower rollers are adjusted. Decrease or increase the gap between upper and lower rollers as required in a step by step approach, but only when the rolling mill is in a safe operation mode and when the gauge is set to the service mode (Service I). Stick to the Safety Precautions on page 3!

- The upper roller must be set to a position slightly above the strip, without touching it. The roller may touch the strip only momentarily to hold it down when it lifts off the lower guide rollers due to vibration.
- Set the height of the upper roller appropriately by the knurled set screw K, but follow the safety precautions!