TMR Magnetic Stirrer with fault indicating system for the stirring staff combines the advantage of the magnetic drive with the safety of a mechanically coupled stirring unit.

Compact Magnetic Stirrer
TMR-102-SK
Operation via front panel or remote control
TMR-102-FSKV
7 x TMR-102-FSKV separated under a water bath

System Magnetic Stirrer
MAGNETRONIC DSZ-5010
Control unit and magnetic stirring unit separated
MAGNETRONIC DSS-50
TMR-102-S

Magnetic stirrer system on a mobile undercarriage
MAGNETRONIC DSS-50 with TMR-102-S and TUW-DSS11
DSS-50 VA with TMR-102-S on TUW-DSS11

TMR-102-SK: Magnetic drive field Ø 100 mm for stirring volumes up to 300 litre
TMR-202-…: Magnetic drive field Ø 200 mm for stirring volumes up to 1000 litre
Subject to technical modifications
06.2009
The TMR magnetic stirrer was developed for the pharmaceutical industry and biotechnology to thoroughly mix sensitive products in a sterile and gentle way, and to make the FDA and GMP-conform documentation of the stirring process possible.

Further applications can be found increasingly in industrial branches where sterile or toxic liquids are stirred e.g. in glass vessels.

For this purpose, the devices have been designed without compromise for permanent use in the production process and work maintenance-free for years even under difficult environmental conditions.

The integrated fault indicating system for the stirring staff combines the advantage of the magnetic drive with the safety of a mechanically coupled stirring unit:

- Sterility, since no shafts are routed through the product space.
- Universal use of a wide range of different container types made of non-magnetic materials, such as various stainless steels, plastics or glass.
- Easy cleaning and sterilising of the stirrer staff, no complicated storage geometry as with impeller stirring units. CIP and SIP-friendly design. Sterile containers can be sterilised with stirring staff in the autoclave.
- One magnetic stirring system can be used for several batching tanks, since the drive unit is not connected to the container. With mobile containers, for example, batching can be carried out in a different production area.
- Powerful and centring magnetic drive field, so that distances of a few centimetres between the stirring unit and the magnetic staff can be realised.
- Fault message when the magnetic force closure between drive and stirring staff breaks down, which can happen with magnetic stirrers on account of the system and leads to uncontrolled standstill of the stirring function despite rotating stirring unit. "Automatic stirring staff catch" for the automatic reestablishment of the stirring function.
- Time sequence control for the linear speed reduction at filling stations for e.g. vaccines containing adjuvants in order to avoid foam forming when the filling level in the product container drops.
- Clear documentation of the stirring process according to FDA and GMP guidelines through recording of speed curves and fault message voltage by means of a recorder.

Sterile can with centrally running stirring staff on the lifter tube.

500 litre glass container with freewheeling Teflon-coated special stirring staff.

R = 400mm
TMR magnetic stirrers produce a 2-pole permanently magnetic stirring field with a diameter of 100 mm (TMR-102-...) respectively 200 mm (TMR-202-...).

The magnetic field lines are bundled by special pole shoes and project almost vertically from the work surface.

There is a magnetic staff in the product container that aligns itself in the drive field on account of the magnetic attractive force and is rotated synchronously by this field.
This allows stirring unit and magnetic staff to rotate at the same speed in uninterrupted operation.

In contrast to the directly driven stirring unit, however, the forced closure between the drive and stirring staff can break off with the magnetic stirrer, so that the stirring process is interrupted despite the fact that the stirring unit is still rotating and thus producing a speed indication.

This operational problem cannot be detected without visual inspection and requires the use of supervisory personnel as well as containers with optical control possibilities.

Since the stirring staff cannot synchronise itself automatically after a break in connection, the stirring process remains interrupted until the speed has been reduced manually.

In sensitive areas of chemical-pharmaceutical laboratory and production technology, automatic monitoring and documentation of the stirring function is an absolute must.

For this purpose, the units are equipped with a complex fault indicating and self-monitoring system, whereby the magnetic staff sensor necessary for this has been able to be integrated fully in the drive housing so that no sensors are necessary in or on the container.

With all permissible stirring staffs, a break in forced closure, a lack of or blocked stirring staff as well as a tumbling stirring staff due to damage or wear are safely detected.

An "automatic catch" tries to catch the stirring staff automatically by reducing the speed in the event of a problem, so that the stirring process is only interrupted for a short time.

In addition, internal drive problems, e.g. motor switching off due to excess temperature, are also detected.

A general distinction must be made between two variants of stirring staffs (see sketches on page 2):

- Teflon-coated stirring staffs freewheeling on the container base and
- Stainless steel-encapsulated stirring staffs that are centred with Teflon or ceramic bearing on a pin in the container base or are fixed to the lifter tube.

Freewheeling Teflon-coated stirring staffs are particularly advantageous since they can remain in the container during cleaning and sterilisation and no bearing spots need monitoring.
Any Teflon abrasion which occurs is usually within the tolerance level, since it does not change the product physiologically and is retained by intermediate filters during filling.

All stirring staffs can be adapted optimally to conditions in terms of both size and arrangement, so that gentle product mixing can take place even at low speeds.
The device is made up of a torsion-resistant, highly durable aluminium profile frame structure and a fixed axle as additional central support for the work surface, so that even heavy containers can be set up on it (150 kg with evenly distributed load).

The housing has the following dimensions:
- Work surface: 400 x 400 mm
- Device height: 170 mm + 25 ... 60 mm height of base adjustable
- Weight: ca. 19 kg
- Protecting rating: IP 43 (special version without ventilation slits IP 54).

The work surface is made of brush-finished special steel, material no. 1.4571. Paneling is made of patterned sheet metal „5 WL“, material no. 1.4301.

The ball-bearing stirring unit is driven by a special asynchronous squirrel-cage motor with a high torque. Digital speed recording and maintenance-free, highly efficient flat belt gear guarantee operational safety under tough environmental conditions.

A built-in external fan for the interior switches on automatically under extreme load in case the heat dissipation via the metal housing is no longer sufficient.

The air intake and discharge openings are on the bottom of the device and protected by special coarse filters so that no drops of water can penetrate the inside.

In addition, a reversible excess temperature protection feature is installed for the motor, including fault message. Thanks to special permanent magnets with pole shoes, an extremely powerful and centring drive field is generated.

The built-in highly sensitive magnetic staff sensor can detect a problem with the stirring staff within the following functional areas:

<table>
<thead>
<tr>
<th>Stirring staff type</th>
<th>Dimensions with collar</th>
<th>Distance stirring staff - Work surface</th>
</tr>
</thead>
<tbody>
<tr>
<td>B 07080</td>
<td>Ø 7 x 80 mm</td>
<td>0 – 20 mm</td>
</tr>
<tr>
<td>B 14100</td>
<td>Ø 14 x 100 mm</td>
<td>0 – 30 mm</td>
</tr>
<tr>
<td>B 25110</td>
<td>Ø 25 x 110 mm</td>
<td>0 – 40 mm</td>
</tr>
<tr>
<td>B 25155</td>
<td>Ø 25 x 155 mm</td>
<td>0 – 50 mm</td>
</tr>
<tr>
<td>B 35150</td>
<td>Ø 35 x 150 mm</td>
<td>0 – 60 mm</td>
</tr>
<tr>
<td>TER-4040210</td>
<td>Square 40 x 40 x 210 mm</td>
<td>Suitable to a limited extent 10 – 70 mm</td>
</tr>
</tbody>
</table>

The magnetic stirring unit can be used as a table-top device or as a built-in version under batching tanks, production lines, worktables, non-magnetic water baths etc.
The electronics are housed in a stainless steel housing with fold-out carrying handles, connection panel on the rear and cable bracket.

The built-in speed control works in the 25 - 500 rpm range and keeps the preselected reference value constant in the face of fluctuations in mains voltage, changes in load and temperature influences.

The current speed of the stirring unit can be read off on a 3-digit LED display and is recorded parallel to this on channel 2 of the recorder.

To prevent a premature break in forced closure between the stirring unit and magnetic staff in the acceleration phase, the run-up time can be preselected infinitely between 0,1 - 5 minutes.

The built-in "fault indicating system for the stirring staff" is used for comprehensive monitoring of the stirring function. A fault message is given in the event of

- Break in forced closure between the stirring unit and magnetic staff.
  Possible causes for this are ➢ Speed selected too high.
  ➢ Run-up time too short.
  ➢ Turbulences in the liquid.
  ➢ Too much distance between the stirring unit and the magnetic staff.

- Stirring staff missing or blocked.
- Wobbling stirring staff due to damage, poor magnetisation or wear
- Internal problem, e.g. excess temperature, mechanical or electrical drive defect etc.

The fault message is given through a flashing LED display and a warning buzzer with adjustable volume. In addition, an alarm relay is switched with 2 potential-free changeover contacts that are accessible via the connection panel on the back: Contact load AC 250 V / 5 A.

When the "automatic stirring staff catch" is switched on (green LED display on the control panel), the speed of the magnetic stirring unit is automatically reduced to 25 rpm in the event of a problem, so that the stirring staff is pulled back into the drive field. When the forced closure has been made again, the stirring staff "caught", the drive unit runs up again to the originally set speed during the set run-up time. This means the stirring process was only interrupted briefly.

The fault message remains activated until it is acknowledged by means of the built-in key button. (Automatic reset after an adjustable delay can be preset on the electronic plug-in card.)

In the "OFF" switch position, there is no reduction in speed after a fault message, so that the stirring staff is not automatically pulled back into the drive field at higher speeds and the stirring process remains interrupted despite the stirring unit rotating. The fault message remains active in this case.

A yellow LED display flashes as a warning in this operating mode.

The "automatic stirring staff catch" should only be switched off in exceptional cases if, for example, work has to take place with unsuitable stirring staffs under visual inspection.
Within the circuit, a fault indication voltage is generated that is proportional to the forced closure between the stirring unit and magnetic staff and is recorded on channel 1 of the built-in recorder.

At the same time, a 12-segment bar display serves the visual evaluation of force transmission and / or as an adjustment aid for aligning the stirring unit under one container.

Below 50 % of the indicated range the stirring process is interrupted: Fault message.

The higher the amplitude is above 50 %, the better the magnetic coupling.

This way, an imminent drive interruption can be predicted and the maximum safe speed can be determined for a certain stirring process.

The built-in time lapse control has been developed especially for filling stations in order to avoid air pockets caused by surface turbulence when the filling level is falling, and thus foam formation.

For this purpose, the speed is reduced linearly and automatically down to 50 rpm within an adjustable time range (filling time) from 10 minutes to 10 hours.

Here a computer stores the selected initial speed and then determines the required speed reduction per minute from the time entered.

The remaining time till the end of the lowest speed is displayed digitally in hours / minutes.

Time lapse and speed reduction can be interrupted using the break switch.

The time lapse control is switched on using the START pushbutton and then controls the speed curve.

The built-in two-channel recorder serves for documentation of the speed curve and the fault indication voltage. The recorder has its own mains switch behind the front door that should always remain switched on.

For documentation of the stirring process in accordance with FDA and GMP guidelines it is essential to record the speed curve on one channel and the fault indication voltage parallel to this on a second channel, since this is the only way a fault during the stirring process can be recognised absolutely certainly.

Since the speed is not automatically reduced when there is a break in forced closure between the stirring unit and magnetic staff when the automatic stirring staff catch is switched off, the stirring process grinds to a halt despite the stirring unit continuing to rotate and thus despite a speed indication, since the stirring staff is no longer automatically synchronised.

As a result, this fault cannot be detected on the basis of the recorded speed, but rather only on the basis of the sensor voltage of the fault indication system recorded parallel to this, which in the case described falls to under 50 %.

A detailed description of the recorder documentation can be found on page 7 and 8.
The speed is reduced to 50 rpm in order to prevent air entering the product when the filling level is low. This makes pulsations of the fault indication voltage increase, since the stirring staff makes more and more wobbling movements.

The selected reference speed happens to be near the resonance speed of the stirring staff used, so that rotating vibrations occur sporadically. These lead to fluctuations in the fault indication voltage, but are not relevant for the stirring process.

The "automatic stirring staff catch" is switched on again and a lower reference speed of 200 rpm is chosen. This automatically reduces the stirring unit speed to 25 rpm, so that the stirring staff is synchronised and the stirring process is continued.

The automatic stirring staff catch is switched off for test purposes and the reference speed increased to 350 rpm. At about 320 rpm the forced closure between stirring staff and drive is broken. This makes the stirring staff get “out of step” and the stirring effect stops: Fault message 3.

When the automatic stirring staff catch is switched off, the stirring unit runs up to its reference speed, however, so that it is no longer synchronised and the stirring effect remains interrupted. This means that the stirring process fault cannot be detected on the basis of the speed curve, but rather only on the basis of the recording of the fault indication voltage, which remains under 50 %.

For this reason, the speed and the fault indication voltage must both be recorded for a definite documentation of the stirring process.

Another batching tank with stirring staff is added, so that the fault indication voltage increases to more than 50 % and the magnetic stirrer runs up to the preselected reference value of 200 rpm during the set run-up time.

The magnetic stirring unit is pushed under the container so that the speed block is automatically cancelled and the stirring unit runs up to catch speed of 25 rpm:

Fault indication volt. ca. 19 % = Fault message 2.
Fault diagnosis: No stirring staff in the container.

Mains switch “ON”
Automatic stirring staff catch „ON”

The speed block (special feature) triggers, since the carriage with the magnetic stirrer is not placed under the container yet:

Fault indication volt. ca. 1 % = Fault message 1.
Fault diagnosis: The stirrer does not move.

Device data and setting values

<table>
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<tbody>
<tr>
<td><strong>Product container</strong>: Batching tank 150 litre</td>
</tr>
<tr>
<td><strong>Teflon stirring staff</strong>: Ø 25 x 110 mm, freewheeling</td>
</tr>
<tr>
<td><strong>Speed preselection</strong>: 250, 350, 200 and 50 rpm</td>
</tr>
<tr>
<td><strong>Run-up time</strong>: 3 minutes</td>
</tr>
<tr>
<td><strong>Fault message 1</strong>: Speed block, since the magnetic stirrer system has not been pushed under the transport carriage of the batching tank yet.</td>
</tr>
<tr>
<td><strong>Fault message 2</strong>: Missing stirring staff in the container.</td>
</tr>
<tr>
<td><strong>Fault message 3</strong>: Excessive speed and the “automatic stirring staff catch” is switched off</td>
</tr>
</tbody>
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Fault messages:
- **1**: Speed block, since the magnetic stirrer system has not been pushed under the transport carriage of the batching tank yet.
- **2**: Missing stirring staff in the container.
- **3**: Excessive speed and the “automatic stirring staff catch” is switched off.

Fault diagnosis:
- Fault message 1: The stirrer does not move.
- Fault message 2: No stirring staff in the container.
- Fault message 3: Excessive speed.

Channel 1: Force closure stirring unit ➔ magnetic staff
Channel 2: Speed stirring unit

Recorder printout as an example for the FDA-conform documentation of a stirring process with faults.
Pulsations of fault indication voltage increase at low speeds for reasons inherent in the system, but this is not important for the monitoring function.

G) 14°°: End of filling process.
The minimum speed of 50 rpm is reached after 5 hours of filling time and 1 hour of break time.

F) Slight fluctuations in the fault indication voltage are normal and are caused by rotary oscillations of the stirring staff at certain resonance speeds.

E) 11°°: The break circuit is cancelled and the filling process continued.

D) 10°°: The break circuit has been activated. This makes the speed "freeze" at the current value and stops the "time left" display.

C) The container is moved by mistake so that the bearing pin of the stirring staff is no longer aligned to the axle of the stirring unit axle and the forced closure breaks: Fault message.

Then the speed is increased automatically during the set run-up time to the original value so that the stirring process was only interrupted briefly.

B) 8°°: The stack tank is set onto the auxiliary frame with the stirring unit and the time lapse control is started up:
The stirring unit runs up to its reference value of 250 rpm during the set run-up time. After this, linear speed reduction begins according to the automatic program.

A) Mains switch „ON“
Automatic stirring staff catch „ON“
The stirring unit runs without container and thus without stirring staff to catch speed 25 rpm.
Fault indication volt. ca. 20 % = Fault message.
7. Flow diagram of all alarms with the respective reactions.

**Connect mains cable!**

- Mains switch switched on?
  - YES: Fault indication relay dropped out = Electric fault message.
  - NO: Mains switch switched on?

- Acoustic and optical fault message active?
  - YES: Smooth operation.
    - Stirring unit running at reference speed.
    - Fault indication relay is activated.
    - Bar display for forced closure > 50%.
  - NO: Speed n = 0 rpm?

- Speed n = 0 rpm?
  - YES: Fault indication relay is activated.
    - Warning buzzer switches off.
    - Automatic transition to smooth operation.
    - Stirring unit runs up to reference speed.
    - Fault indicator lamp goes off.
    - Warning buzzer switches off.
    - Fault indication relay is activated.
  - NO: IMPORTANT NOTE!
    - Check ventilation openings on the base of the magnetic stirring unit for free access!

- Motor cooled down to operating temperature?
  - YES: Normal operation is indicated by a green indicator lamp.
  - NO: Speed n = 25 rpm?

- Speed n = 25 rpm?
  - YES: Automatic stirring staff catch is switched on.
    - Automatic stirring staff catch if possible!
  - NO: Fault message stirring staff?

- Fault message stirring staff?
  - YES: Fault indication relay dropped out.
    - Fault indicator lamp flashing in acknowledge button.
    - Warning buzzer is active.
    - Bar display for forced closure > 50%.
  - NO: Speed n > 0 rpm?

- Speed n > 0 rpm?
  - YES: Fault indication relay is activated.
    - Bar display for forced closure > 50%.
    - Stirring unit running at reference speed.
    - Smooth operation.
  - NO: Excess motor temperature, stirring unit at a standstill.
    - Fault indication relay dropped out.
    - Fault indicator lamp flashing in acknowledge button.
    - Warning buzzer is active.
    - Bar display for forced closure < 10%.
    - All segments dark.

- IMPORTANT NOTE!
  - Check ventilation openings on the base of the magnetic stirring unit for free access!

- Motor cooled down to operating temperature?
  - YES: Normal operation is indicated by a green indicator lamp.
  - NO: Speed n > 25 rpm?

- Speed n > 25 rpm?
  - YES: Excess motor temperature, stirring unit at a standstill.
    - Stirring staff cannot be synchronised automatically.
  - NO: IMPORTANT NOTE!
    - Motor cooled down to operating temperature?

- Mains switch switched on?
  - YES: Excess motor temperature, stirring unit at a standstill.
    - Fault indication relay dropped out.
    - Fault indicator lamp flashing in acknowledge button.
    - Warning buzzer is active.
    - Bar display for forced closure > 50%.
  - NO: Fault message stirring staff?

- Fault message stirring staff?
  - YES: Fault indication relay is activated.
    - Bar display for forced closure > 50%.
    - Stirring unit running at reference speed.
    - Smooth operation.
  - NO: Electric fault message.

- Electric fault message.
  - YES: Mains switch switched on?
  - NO:Acoustic and optical fault message active?

- Acoustic and optical fault message active?
  - YES: Fault indication relay is activated.
    - Warning buzzer switches off.
    - Automatic transition to smooth operation.
    - Stirring unit runs up to reference speed.
    - Fault indicator lamp goes off.
    - Warning buzzer switches off.
    - Fault indication relay is activated.
  - NO: IMPORTANT NOTE!
    - Switch on automatic stirring staff catch if possible!

- IMPORTANT NOTE!
  - Stirring staff cannot be synchronised automatically.

- Press the acknowledgement button!
  - Acknowledgement given?
    - YES: Smooth operation.
      - Fault indicator lamp goes off.
      - Warning buzzer switches off.
      - Fault indication relay is activated.
    - NO: IMPORTANT NOTE!
      - Check ventilation openings on the base of the magnetic stirring unit for free access!

- IMPORTANT NOTE!
  - Check ventilation openings on the base of the magnetic stirring unit for free access!

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  - Check ventilation openings on the base of the magnetic stirring unit for free access!
HAZARD WARNING!
Always heed the "safety instructions" before use!

- **WARNING** of magnetic field, even with the stirring unit switched off!
- Do not place any sensitive devices e.g. watches/clocks, monitors, measuring instruments etc. near or on the magnetic stirrer!
- People with pacemakers or other sensitive life-sustaining devices have to keep at an appropriate safe distance! Ask your doctor or device manufacturer whether functional problems can be excluded!
- Do not place any magnetic objects such as screwdrivers on the work surface of the magnetic stirrer! **THE PARTS CAN BE FLUNG OFF! DANGER OF INJURY!**
- Only operate the stirring staffs in closed containers, do not leave open!
- **BE CAREFUL WITH GLASS VESSELS: DANGER OF BREAKING!**
  Do not let the stirring staffs fall through the bottle neck when inserting them into the vessel!
  Choose the speed so low that the stirring staff cannot be flung out of the rotating field and/or use a correspondingly small and lightweight stirring staff.
- Centrally running stirring staffs (bearing pin in the base of the vessel) have to be aligned centrally to the work surface of the magnetic stirrer! Once set up, containers must be secured against displacement through respective retention fittings!
  If the stirring staff’s bearing pin is no longer aligned to the stirring unit axle, dangerous malfunctions can occur with the stirring staff fault indication system so that a break in forced closure is no longer detected reliably and the stirring process comes to an uncontrolled halt! Maximum permissible alignment fault: ± 20 mm
- In cases of damage, particularly to the mains or connection cable to the stirring unit, the unit must be switched off immediately and disconnected from the mains supply. **Otherwise danger of FATAL INJURY through electric shock!**
Application examples

9. Control unit DSS-50 VA on an undercarriage TUW-DSS11

Top photo: Display and operating panel
Lower photo: Connection panel on the rear

Subject to technical modifications
06.2009
Application examples

10. Glass vessel 50 litre on a mobile magnetic stirrer system
Application examples

11. Final-Bulk container 150 litre, made by BINDER, on a transport carriage
Application examples

12. Product space of different containers with freewheeling Teflon stirring staff.