Product Brochure

Pulsed Field Magnetometer (PFM) 8th generation – PFM08 revision 3 MH

The PFM08 range of magnet characterisation magnetometer can rapidly and accurately measure the magnetic hysteresis loop and extract key values for all high-grade permanent magnetic materials such as NdFeB, SmCo, Ferrite and all coated magnets. With a maximum field of 10.5T (8356 kA/m / 105 kOe) even the most coercive materials and highest grades of NdFeB or SmCo can be measured, while traditional permeameters cannot measure these high coercivity materials due to pole piece saturation limitations. The 8th generation of PFMs from Hirst uniquely feature the eddy current correction (patented F-2F algorithm), Self-Demagnetisation Field (SDF) correction function (to allow accurate measurement of a wide range of samples from cylinders, cuboids and arbitrary sample shapes), and Hirst proprietary Self De-magnetisation Field Function SDFF™ (patented) which accurately generates an open to closed circuit mapping (O2C™). The first generation of Hirst industrial PFM was launched in 1998 and the company won an Institute of Physics business award for the SDFF™ technology in 2020. Thus generation 8 PFMs give permeameter-like measurements for the highest grades of magnets to within 1% on permeameter reference measurements. HirstLab v2 software and Hirst proprietary SDFF™ technology has been implemented in collaboration with the National Institute of Metrology (NIM), Beijing, as part of a contract for the first 8th generation PFM placed by NIM. This is the third revision of the PFM08 Manual Handling (MH) hardware platform.

PFM08-10 AT MH / PFM08-40 AT MH

Key benefits

- All high-grade permanent magnets can be fully characterised such as NdFeB (inc AH), SmCo, hard Ferrites and coated magnets
- Any shape sample can be tested
- Fast full 4 quadrant measurement of magnetic hysteresis loops
- The PFM contains an integral capacitive discharge magnetiser (and demagnetiser) producing a field of over 10T meaning the highest grades of permanent magnetic material can be tested (which is not possible on traditional permeameters) thus can test samples that are magnetised or unmagnetised and return them demagnetised.
- Measurement repeatability better than ±0.5% at ambient temperature for H_{cJ} and B_r on standard test samples
- User friendly HirstLab v2 software for fast precise measurements
    - HirstLab v2 software automatically extracts critical parameters: Remanence: B_r, Coercivity: H_{cJ}, H_{cB}, Maximum energy product: $(BH)_{Max}$, Saturation values: H_{sat}, J_{sat}, Squareness Coefficients: H_k, H_k/H_{cJ}, H_{dx}(H_{d2}, H_{d5}, H_{d10}) and S_a are all automatically extracted from every measurement and displayed separately alongside JH and BH loops.
    - Eddy Current correction for larger samples using Hirsts proprietary F-2F approach
    - Any shape: cylinders, cuboid, and arbitrary shapes with built-in Self-Demagnetisation Field (SDF) shape correction function.
    - Unique Self Demagnetisation Field Function SDFF™ in HirstLab v2 which accurately generates an open-to-closed circuit mapping (O2C™) for the magnet sample giving accurate closed loop magnet parameters. Generation 8 PFMs give permeameter-like measurements for the highest grades of magnets

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  - Initial Magnetisation curves (HirstLab version v2.1 or higher)
  - English, Chinese and Korean language support (HirstLab version v2.1 or higher)
- Options
  - External Sample Heater Oven allowing samples to be heated up to 180°C and thermally stabilised prior to the measurement process.
  - External Sample Cooler for sample testing down to -40 °C and thermally stabilised prior to the measurement process.
  - Optional high temperature sample holder allowing samples to be tested up to 220 °C
  - Optional SC-05 small sample kit for testing samples down to 1x1x1mm^3 and up to 150°C
- Meets IEC (International Electrotechnical Commission) TR-62331 specifications for permanent magnets which is a non-destructive testing method.

Applications

- Designed for characterisation of hard magnetic materials in both production control and research applications. for all permanent magnet materials (Ferrite, NdFeB, SmCo, AlNiCo) including high grade NdFeB coated samples
- These PFMs are ideal for high-speed production testing and quality control with users being able to achieve test times of less than a minute
- The optional small sample kits available on PFM08-10 and PFM08-40 to test samples down to 1x1x1mm for grain boundary diffusion (GBD) magnets testing
- Thin sample mode for accurate measurement of 1mm thick slices on PFM08-10 and PFM8-40 often used for GBD magnet development and testing
- The large sample PFM08-40 HT support quality control applications in EV manufacture with samples sizes up to 45mm diagonal

Hirst Pulsed-Field Magnetometry systems

Designed for industrial use, the PFM offers fast, accurate, full hysteresis loop measurements of all industrial magnets, with unparalleled speed and repeatability.

Full 4 quadrant loops can be generated in less than 1s and PFMs are a non-destructive testing and characterisation technique. The process needs no pre-magnetisation of magnets prior to sample insertion (unlike permeameters) and can deliver a magnetised or demagnetised magnet at the end of the cycle.

Manual Sample Handling – MH versions for production and quality control testing

The manual sample handling versions are for lab tests and production quality control aimed at standard test sample sizes. The latest PFM08-10 AT MH revision 3 is the most cost-effective PFM so far from Hirst supporting ambient and fast temperature compensated tests.

Above: PFM08-10 AT MH (on left) and PFM08-10 AT MH with optional sample heater (on right)

High Speed Measurement

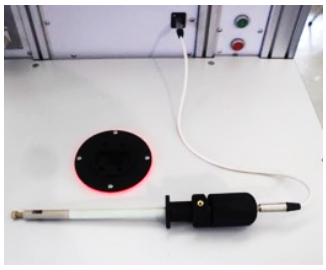
The measurement pulses on PFM08s are less than 1 second for a full 4 quadrant measurement with most of the rest of the test cycle time spent on sample loading and temperature stabilisation of the sample which is critical for accurate and repeatable measurements. The PFM system offers repeatability of measurements at speeds that are simply unattainable with other methods of measurement. The measurement process involves generating large pulsed magnetic fields. These pulsed magnetic fields drive the magnet around its major hysteresis loop. The pickup coils detect the applied field and the magnets response to the applied field. J and H signals are fed to the integrated PC where they are processed to form JH and BH loops representing the characteristics of the magnetic material. The PFM then automatically proceeds to measure the full loop characteristics and displays the results immediately with all critical parameters automatically extracted.

The PFM08 range have integral sample monitoring and features two methods for dealing with sample temperature: stabilised temperature and temperature corrected. Even in high precision sample temperature stabilised tests of a standard 10mm diameter block test sample a fully temperature stabilised measurement will only take 5 minutes. For faster tests a temperature corrected method can be used for rapid ambient testing, this test will take less than 1 minute including sample loading on the PFM. Temperature compensated measurements are quicker as the sample is measured at its current temperature and the values obtained are corrected to the desired ambient temperature point – this is often used in quality control applications where quicker measurements are required, and data needs to be compared at a specific temperature.

In magnet block testing applications for quality control users regularly test >60 samples per hour with a temperature compensated measurements on the PFM08-10 MH.

Sample temperature control

The MH revision 3 PFMs sample stick have a built -in temperature sensor (top) to allow the sample temperature to be measured at the time of measurement with an optional external sample heater oven allowing samples to be heated up to 180°C and thermally stabilised prior to the measurement process. Optional high temperature sample holders allow samples to be tested up to 220 °C. Below is the sample in the optional sample heater oven, the stick temperature sensor is plugged into the sample heater oven displaying the actual sample temperature below the set point for the oven (left) and with the sample holder stick plugged into the PFM ready to be put into the measurement port (right):-



Several of these sample heater ovens can be used to bring multiple samples up to specific test temperatures and soak at that temperature whilst a measurement happens in parallel in the PFM allowing high speed testing at similar speeds to that of an ambient test, with a high temperature test taking less than 1 minute.

The sample holder has a simple and easy to use sample hight adjuster build into the handle. Once the sample is clamped into the sample holder using the lower adjustment screw the user can then select the sample height. This allows the user to select the correct sample height between 1 and 15mm (graduations are at 2, 5, 10, 15mm) and this ensures the sample is located in the centre of the PFM measurement coils when inserted into the PFM for maximum measurement accuracy. A 08-10 sample holder is shown below.

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An optional external sample cooler allows sample testing down to -40 °C with the samples thermally stabilised prior to putting them in the PFM for measurement.

Small Sample kits

One of the major improvements in the revision 3 hardware platform for the generation 8 PFMs is that it allows user interchangeable pick-up coils of different diameters and sensitivities for optimum measurements of samples of differing sizes. In addition, the measurement noise levels have been dramatically reduced in revision 2 and further improved in revision 3 hardware compared to previous generations of Hirst PFMs. The combination allows the highest level of measurement repeatability over a wide range of sample sizes with optional small sample kits (SC-05) allow testing of samples down to 1x1x1mm^3 at ambient or at up to 150 °C with the sample heater oven.

Eddy Current Correction

A PFM08's applied field is a single period sine-wave pulse with a maximum amplitude in excess of 10 T. As such the PFM captures the full 4 quadrant hysteresis loop. It is in the nature of pulsed-field measurements that rate dependent features are present in the hysteresis loop, due to Eddy-Current effects. These rate dependent effects can be calculated out of the result by the PFM applying two pulses at different frequencies for each measurement using Hirst's patented F-2F algorithm to calculate the hysteresis loop that would be obtained from a zero-frequency measurement. F-2F has been verified to produce the same results as a static measurement obtained from a vibrating sample magnetometer and permeameter. Eddy currents are not significant on smaller samples of NdFeB below 10mm.

Any Shape

The PFM can measure any shape of magnet and as standard cylinders, cuboids are included in HirstLab v2 with a look up table with the built in Self-Demagnetisation Field (SDF) shape correction function. For more complex and arbitrary shapes this can be calculated with FEM although HirstLab v2 app by simply loading the shape into the app and copying over the SDF value.

Unique SDFF™ technology

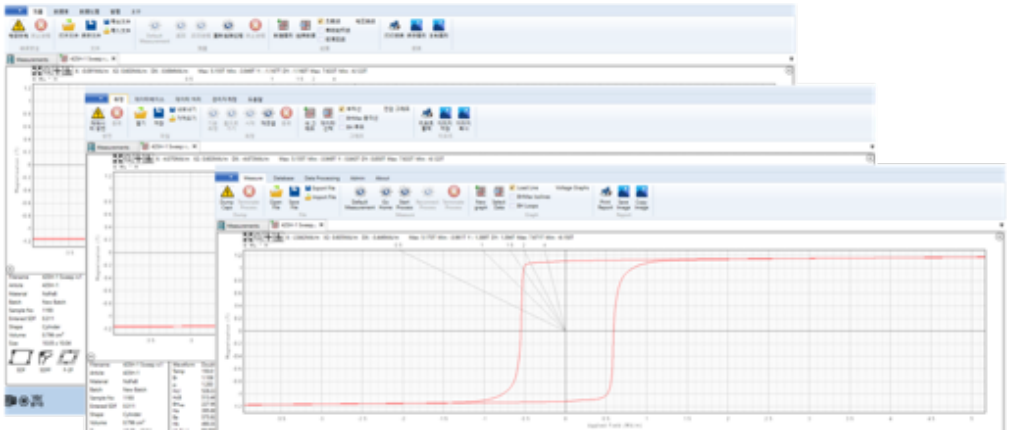
In addition, HirstLab v2 has a unique Self Demagnetisation Field Function SDFF™ which accurately generates an open-to-closed circuit mapping (O2C™) for the magnet sample generating accurate closed loop magnet parameters as a permeameter would. Use of SDFF correction does not change the B_r or H_{cJ} measurements for the sample. The use of SDFF™ improves H_{cB}, BH_{Max} and H_k/H_{cJ} with respect to the permeameter and reduces the BH_{Max}, H_{cB} error which would naturally increase for low coercivity samples due to open circuit rounding without the SDFF™ correction. SDFF is optional and can be enabled/disabled in HirstLab v2 by user and gives the same results as the original HirstLab v1. With this technology the generation 8 PFMs give permeameter-like measurements for the highest grades of magnets to typically within 1% on permeameter reference sample measurements from NIM.

HirstLab v2 – Powerful and easy to use software

All new Hirst PFM systems are supplied with comprehensive software, HirstLab v2. The HirstLab v2 software combines all of Hirst's expertise and PFM technology into a single, easy-to-use package. The software manages the operation of the PFM and maintains a database with the history of all measurements. A flexible plotting tool provides multiple views of the measured data.

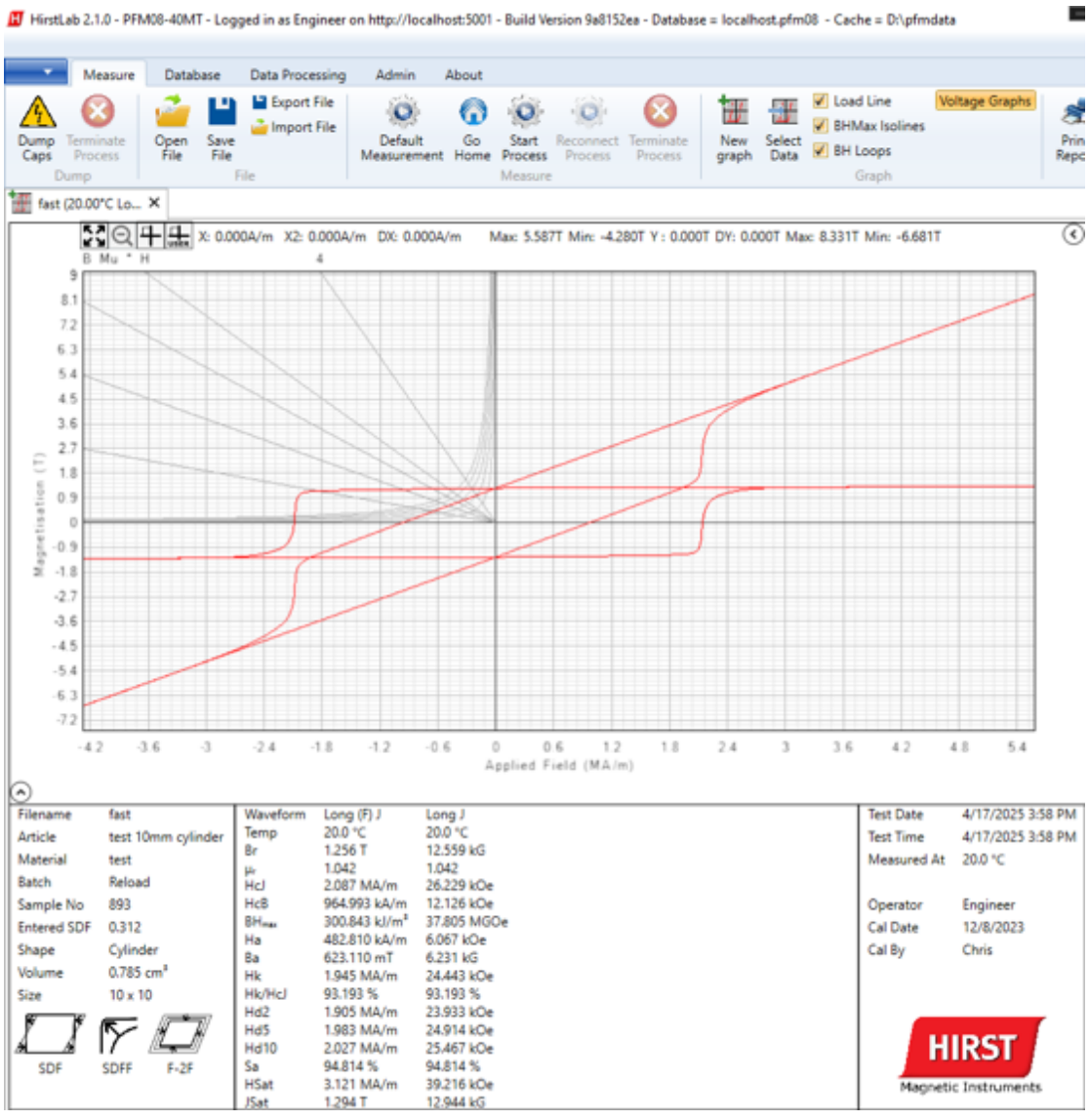
Language support options

In HirstLab v2.1 there is also support for Chinese and Korean alongside English to make the software as easy to use as possible.



Automatically extracts critical measurement parameters

Remanence: B_r, Coercivity: H_{cJ}, H_{cB}, Maximum energy product: $(BH)_{Max}$, Saturation values: H_{sat}, J_{sat}, Squareness Coefficients: H_k, H_k/H_{cJ},H_d (H_{d2}, H_{d5}, H_{d10}) and S_a are all automatically extracted from every measurement and displayed separately alongside JH and BH loops shown below



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Full graphical display

The software can simultaneously display multiple loops in either one or multiple windows for easy comparisons. A comparison function is available for the demagnetisation quadrant to highlight any differences between measurements. Data is also available as a hard copy via a printer and can be displayed with a choice of S.I. and/or c.g.s. Units and a fully customisable report format.

All the PFM's functions are accessible through the user interface including the extensive data processing and storage features. The software follows similar design to many other applications that run on Microsoft Windows™ creating a familiar environment and reducing the time to learn the software.

Measurement database for 100% traceability

A measurement database stores every measurement made on the system ensuring 100% traceability and making it impossible to lose a measurement. A more traditional system of entering filenames is also available but it is not a requirement to use it. Especially useful for industrial quality assurance (QA) and similar applications. The database can be stored on the built in PC or on a central server so that multiple PFM machines can be monitored from a central location. The SQL database supports filtering through a range of parameters such as operator name, sample data etc, which allows easy recollection of any previous data.

Along with a measurement database HirstLab v2 also provides a sample database. Details of sample properties, dimensions, and required measurement parameters can be stored. When a measurement of that sample is taken the measurement settings are automatically set-up based on the parameters stored in the sample database. The sample details are also used in the processing of data to produce JH and BH loops that are calibrated to unit volume.

Report generation

HirstLab v2 can produce a detailed report describing the characteristics of the measured sample or a summary report from a set of measurements. There are several easy to use and powerful report formats built-in, here is one example showing a sample re-load test at ambient :

Batch	Filename	Article	Operator	Date	Time	Description	Temperature	Br	HcJ	HcB	BHMax	HkHcJ
reload	42SH2-Y I	42SH2-Y	Jack	2/14/2024	6:08:36 PM		20.4°C	1.320 T	1.698 MA/m	1.017 MA/m	336.292 kJ/m³	93.521 %
reload	42SH2-Y II	42SH2-Y	Jack	2/14/2024	6:12:32 PM		20.4°C	1.321 T	1.698 MA/m	1.016 MA/m	336.440 kJ/m³	93.484 %
reload	42SH2-Y III	42SH2-Y	Jack	2/14/2024	6:18:06 PM		20.4°C	1.321 T	1.699 MA/m	1.016 MA/m	336.384 kJ/m³	93.484 %
reload	42SH2-Y IV	42SH2-Y	Jack	2/14/2024	6:22:54 PM		20.4°C	1.321 T	1.698 MA/m	1.017 MA/m	336.682 kJ/m³	93.524 %
reload	42SH2-Y V	42SH2-Y	Jack	2/14/2024	6:28:59 PM		20.4°C	1.322 T	1.701 MA/m	1.017 MA/m	337.010 kJ/m³	93.525 %
reload	42SH2-Y V	42SH2-Y	Jack	2/14/2024	6:33:36 PM		20.4°C	1.321 T	1.697 MA/m	1.017 MA/m	336.542 kJ/m³	93.536 %
reload	42SH2-Y VI	42SH2-Y	Jack	2/14/2024	6:39:34 PM		20.4°C	1.322 T	1.700 MA/m	1.018 MA/m	337.159 kJ/m³	93.510 %
reload	42SH2-Y VII	42SH2-Y	Jack	2/14/2024	6:44:01 PM		20.4°C	1.322 T	1.700 MA/m	1.018 MA/m	336.908 kJ/m³	93.499 %
reload	42SH2-Y VIII	42SH2-Y	Jack	2/14/2024	6:48:32 PM		20.4°C	1.322 T	1.701 MA/m	1.017 MA/m	336.878 kJ/m³	93.490 %
reload	42SH2-Y IX	42SH2-Y	Jack	2/14/2024	6:53:52 PM		20.4°C	1.322 T	1.700 MA/m	1.018 MA/m	337.015 kJ/m³	93.500 %
Mean								1.321 T	1.699 MA/m	1.017 MA/m	336.731 kJ/m³	93.507 %
Max								1.322 T	1.701 MA/m	1.018 MA/m	337.159 kJ/m³	93.536 %
Min								1.320 T	1.697 MA/m	1.016 MA/m	336.292 kJ/m³	93.484 %
Peak error +/- %								0.063 %	0.138 %	0.098 %	0.129 %	0.028 %
Standard deviation								0.042 %	0.079 %	0.057 %	0.086 %	0.019 %

Data export facilities

Comprehensive data export facilities allow data to be easily migrated to other software applications including exporting to .csv, .JSON, .nc formats.

Hirst Generation 8 PFMs run a full SQL database and users can extract data directly the database in network connected PFMs.

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Range overview

Part Number	Magnetiser & Coil Set	Max Sample Size	Testing Temperature	Min sample volume
PFM08-10 AT MH	9kJ, SC-10	10.5 diameter, 15mm (h)	Ambient only	15mm3
PFM08-40 AT MH	50kJ, SC-40	45mm diagonal, 30mm (h)	Ambient only	100mm3

Options

SHS-HT180 kit - External Sample Oven for high temperature testing
SHS-HT220 High Temperature Sample holder for sample testing to 220DegC
SHS-MT kit External Sample Cooler for -40DegC testing
SC-05 kit - Small sample kit for samples down to 1x1x1mm

Technical data

Magnetisation pulse	Full period sine wave
Magnetiser Energy, Voltage and Peak field	PFM08-10: 9kJ, 3000V, 10T peak (7958kA/m / 100k Oe) PFM08-40: 50kJ, 3000V, 10.5T peak (8356 kA/m / 105k Oe)
Eddy current removal	Compensation for linear and non-linear rate dependant effects via Hirst proprietary F-2F algorithm important on larger samples
Shape correction	Built in Self-Demagnetisation Field (SDF) shape correction function
Permeameter equivalent curve	Hirst proprietary Self De-magnetisation Field Function SDFF™ which accurately generates an open to closed circuit mapping (O2C™) for the magnet sample giving accurate closed loop magnet parameters
Standard Sample sizes +	PFM08-10 samples 5-10.5mm diameter (up to 14.5 mm diagonal), 1-15mm height (optional small sample kit down to 1x1x1mm) PFM08-40 samples 5-40.5mm diameter (up to 45mm diagonal), 1-30mm height (optional small sample kit down to 1x1x1mm)
Sample shapes	Any shape via SDF correction – with built in standard shape look up including cylinder and cuboids. A powerful SDF calculator app is included for all other shapes
Repeatability*	B_r and H_{cJ} ±0.5 % for Manual Handling machines (ambient measurement, standard 10mm samples)
Display and controls	Windows 11 computer, intuitive software with simple test initiation controls and full database system, min 24" HD colour monitor, wireless keyboard and mouse (supplied)
Colours and materials	Steel and Aluminium case
Dimensions / Weight	PFM08-10 - 800mm x 1400mm x 1345mm / 350kg PFM08-40 - 800mm x 1400mm x 1345mm / 350kg plus Additional Capacitor bank - 1000mm x 1000mm x 850mm / 350kg (located and connected at the back of the PFM08)
Connectivity	Ethernet via RJ45, WIFI and USB
Recommended Machine Operating Range	+18 °C to +23 °C
Power Supply	PFM08-10: Single Phase 220/240VAC 50-60Hz 16A or 110VAC option Max 3m cable length PFM08-40: Single Phase 220/240VAC 50-60Hz 32A or 110VAC option Max 3m cable length Additional single phase 220/240VAC 50-60Hz 16A or 110VAC option for external chiller power connection is required

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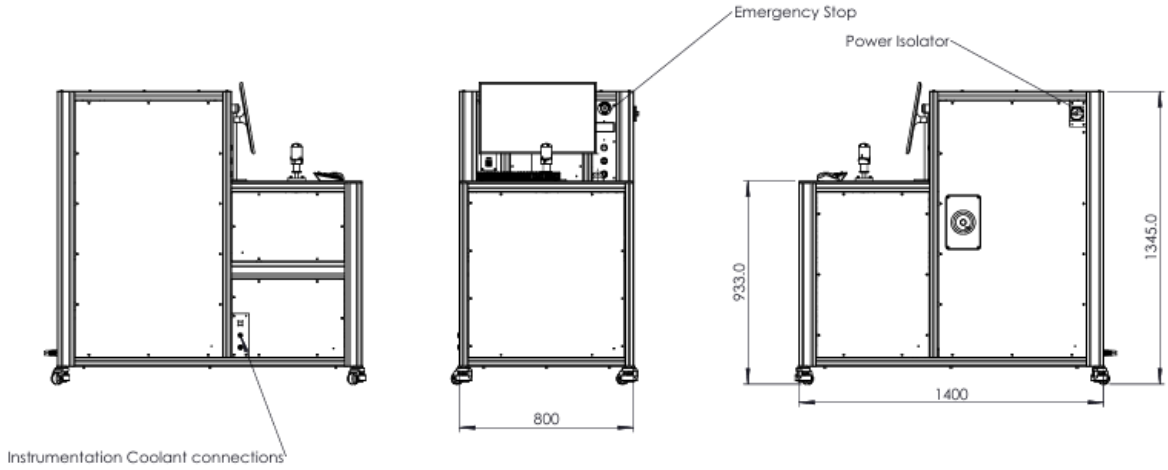
[+] where height is specified in relation to a sample this is along the direction of magnetisation of the sample. The sample under test must have the direction of magnetisation orientated vertically in the PFM
[*] For specific sample performance data, see detailed specifications for each machine



PFM08-10 AT – MH, Manual Sample Handling version (above), chiller and optional sample ovens not shown.

Warranty and Calibration

Supplied calibrated with 1 year warranty. A calibration is required every year to maintain the highest levels of performance – Hirst has a dedicated team of installation and service engineers, available to travel worldwide to install and support equipment, service contracts are available. Contact your local distributor for details.

Accessories

Basic reference magnet sample packs:-

- **RM-AT** - Ambient N40H, N42SH samples with NIM certification
- **RM-HT** - contains RM-AT samples plus 100°C and 150 °C samples with NIM certification
- **RM-HT+** - contains RM-HT samples plus 180 °C sample with NIM certification

Hirst Magnetic Instruments has been active in providing solutions for 60 years in magnetics and magnetic measurement. Hirst manufactures precision hand-held gaussmeters, fluxmeters, demagnetisers, bench top & workstation industrial magnetisers, industrial production-line magnetisers, pulsed field magnetometers (PFMs) for characterising magnetic materials.

PFM08 MH product range brochure v5.0 April 2026

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