

## Two-channel Magnetic Field Probe System



**Features**

- Precision magnetic field measurements on one or two independent channels
- Very low drift, noise and temperature coefficients from state of the art precision Hall device.
- Probes designed for use in DC and AC fields up to +/- 2.5 T
- Probe tip slim yet rigid for stable field measurements
- Choice of signal cable lengths
- Fast analog outputs for real time field monitoring
- Field control servo option with input field target values delivered as analog voltages or as field values via the host computer
- Integrated temperature compensation and digitization,
- Fiber-optic data communications to host loop controller.

**Applications**

- Field measurement in DC and AC electromagnets.
- Control and monitoring of X-Y scan magnet systems
- Accelerator beamline magnet setting and monitoring
- General magnetic field measurements



**Specifications - H20 with MFP-30 probe***MFP-30*

Sensitive area	1 mm square (1 mm <sup>2</sup> )
Hall sensor position	7.5 mm from probe tip, 1.17 mm below probe top surface, position marked on casing.
Temperature sensor	Thermistor, calibrated measurement range 5C to 60C
Probe tip	< 2.3 mm (0.091"). See drawings.
AC field	Probe body materials non-conductive. Hall voltage and current leads small-pitch
Radiation resistance	Only passive components are located at the probe tip. Tested with 0.75 mC of 230 MeV protons delivered to a neutron producing target close to the probe, with no measurable change in performance. Corresponds to 1-2 years of typical particle therapy beamline dose.
Materials	Glass reinforced polycarbonate, polycarbonate, epoxy potting
Weight	40 g (1.4 oz)

*MFP-30 with H20*

Field polarity	Field vector entering the marker on the top surface of the probe gives a positive reading (with positive gain set)
Full scale	Not less than +/- 2.5 T (25000 Gauss)
Gain settings	x1, x4, x10, x40 ( 2.5 T, 0.625 T, 0.25 T, 0.0625 T)
External accuracy	0.05 % maximum deviation relative to full scale of any point from linear fit to at least 10 points over a 1 T span.
Temperature coefficient of gain	< 100 ppm C-1 within +10C / -5C of the calibration temperature. See example plot.
Temperature coefficient of offset	< 0.01 Gauss C-1 within +10C / -5C of the calibration temperature. See example plot.
Noise	< 0.1 Gauss rms with 1 msec averaging. See plot.
Step response	Better than 100 $\mu$ sec to within 0.1% of full scale deviation from target setting for any instantaneous field step. Observed step depends on selected downsampling.
Linearity	0.05 % maximum deviation relative to full scale of any point from linear fit to all points over full span.



**Specifications - H20 control unit***Input channels*

Hall probe inputs	Two Hall probe inputs to suit MFP-30 probes.
Analog inputs	Two general purpose analog inputs (+/- 10 V). Can be used for field target input if optional field control servo is in use.
Digitization	16 bits successive approximation over full span, fully parallel 250 kSa/s, with adjustable digital averaging
Downsampling	Averaging from 25 to 62,500 conversions per reading
Calibration	Field response gain and offset values for each analog signal and each range stored in EEPROM. Temperature coefficients for MFP-30 probe stored in EEPROM and linked to probe serial number.

*Output channels*

Analog outputs	Two multipurpose analog outputs. Used for fast field output (+/-10 V = +/- full scale). Used for monitor outputs in normal and fast monitor modes. Used for field control output if optional field control servo is in use.
Resolution	16 bit over +/-10 V
Update rate	250 kHz
Transition noise	<=25 mV typical at updates

Controls	16 position rotary switch for address selection.
Displays	Status LEDs green (power, processor status, comms status)
Power input	+24V (+/- 2V) DC, 350mA maximum. Probes get power from the H20 control unit.
Case Material	Stainless steel sheet (H20 control unit)
Weight	0.33 kg (0.72 lb) (H20 control unit)
Operating environment	15 to 35C, < 80% humidity, non-condensing, vibration < 0.2g all axes, 1 to 100Hz
Storage environment	0 to 50C, < 80% humidity, non-condensing, vibration < 2g all axes, 1 to 100Hz



**Connectors**

Probe connection (on H20 and MFP-30)	Two 10 way Lemo EXG.1B.310 socket on H20, one on MFP-30. <table border="1"> <tr> <td>1</td> <td>Shield</td> <td>6</td> <td>Analog ground</td> </tr> <tr> <td>2</td> <td>Analog ground</td> <td>7</td> <td>Temperature signal</td> </tr> <tr> <td>3</td> <td>Hall probe signal</td> <td>8</td> <td>Analog ground</td> </tr> <tr> <td>4</td> <td>Hall probe gain select</td> <td>9</td> <td>+12 VDC</td> </tr> <tr> <td>5</td> <td>Digital 1 (not used)</td> <td>10</td> <td>- 12 VDC</td> </tr> </table>	1	Shield	6	Analog ground	2	Analog ground	7	Temperature signal	3	Hall probe signal	8	Analog ground	4	Hall probe gain select	9	+12 VDC	5	Digital 1 (not used)	10	- 12 VDC
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5	Digital 1 (not used)	10	- 12 VDC																		
Analog in	Two Lemo coaxial size 00.																				
Analog out	Two Lemo coaxial size 00.																				
Fiber optics	Two 1mm Avago ST bayonet. To suit 1 mm plastic fiber or 200 um HCS glass fiber.																				
Power in	2.1mm threaded jack. Mates with Switchcraft S761K or equivalent.																				

**Probe cable**

Type	Supplied cable multiway screened terminated in Lemo connector at each end.
Length options	9' (2.67 m), 15' (4.57 m) and 22' (6.27 m) standard. Other lengths available on request to special order. Maximum recommended length 50' (15.24 m)

**Interfacing and control**

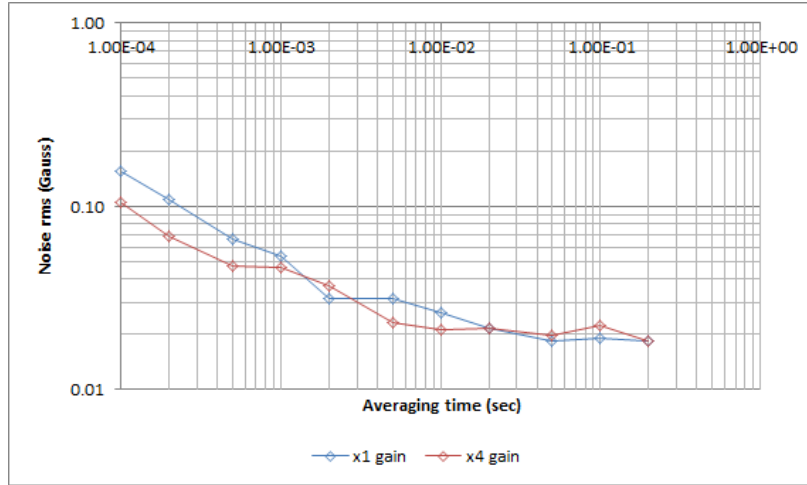
Interfaces	Fiber-optic loop, 10 Mbit/sec serial, 9 bit asynchronous binary.
Data rate	Typical read/write rate $\geq 1$ kHz, depending upon loop configuration. Rate to A500 host memory (special applications) $\geq 10$ kHz.
	Fibre-optic loop to host system interfacing available using loop controllers: A360 (Ethernet adaptor), A500 / A560 (Real-time controllers)
Host computer	PTC DiagnosticG2 host program provided for Windows PC. Version available for Linux distributions (enquire). IG2 program available which provides data distribution to EPICS. Client interfaces are available for C/C++, C#, Python, Java, Labview <sup>TM</sup> , Perl and others.



Performance

Noise

Measured standard deviation of 256 contiguous readings of a 0.62 T permanent magnet field as a function of averaging time. X1 and x4 gain setting.

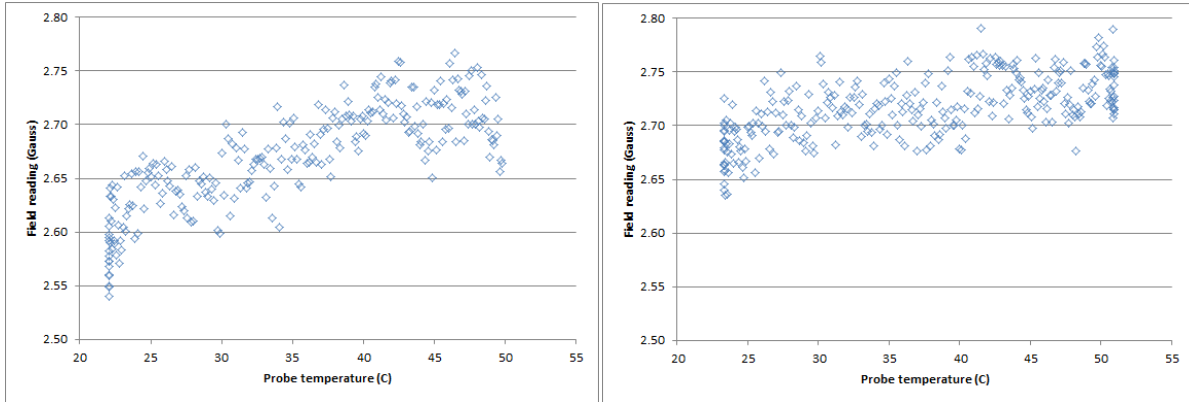


Temperature coefficient

Measured temperature coefficient of offset (affects readings close to zero).

Without temperature compensation (left): +0.004 Gauss C-1

With default compensation (right): +0.002 Gauss C-1



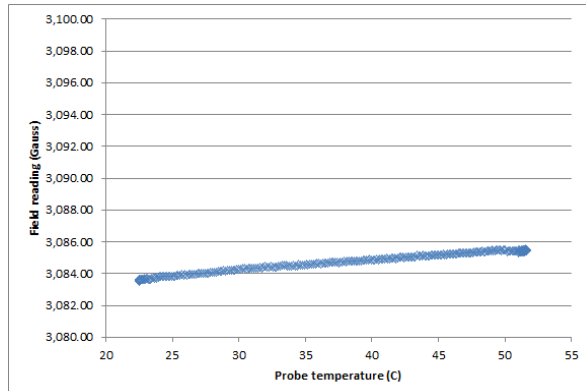
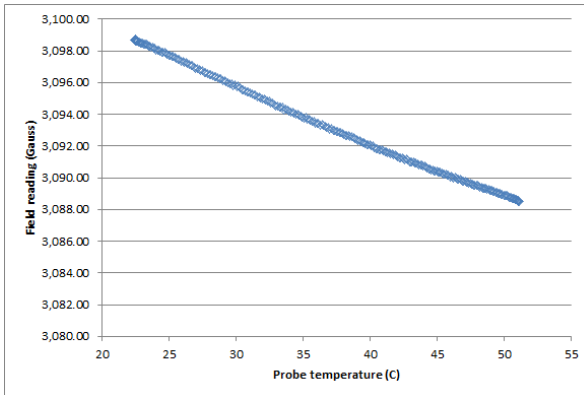
## Performance (continued)

### Temperature coefficient

Temperature coefficient of gain (affects high field readings), measured at 0.3 T

Without temperature compensation (left):  $-117 \text{ ppm C}^{-1}$

With default compensation (right):  $+21 \text{ ppm C}^{-1}$

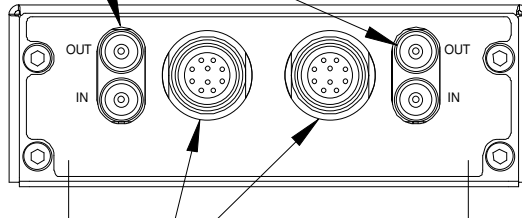


The H20 and MFP-30 are shipped as a matched pair that meets the specification. Users may further refine the temperature compensation parameters to suit particular operating field ranges and temperature ranges. User accessible settings are provided for offset coefficient, and first and second order coefficients of gain.

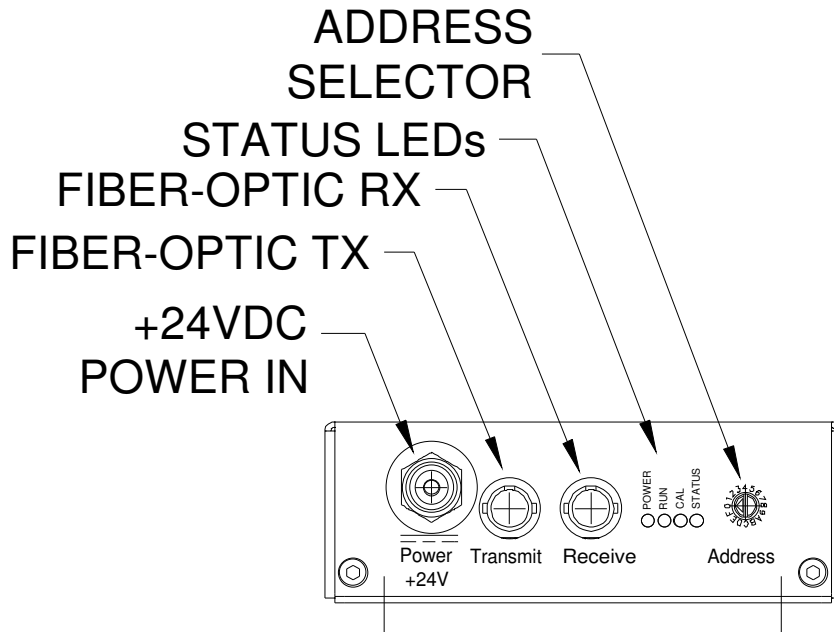


H20 control unit

ANALOG I/O  
Top: Out  
Bottom: In



HALL PROBE INPUTS



ADDRESS  
SELECTOR

STATUS LEDs

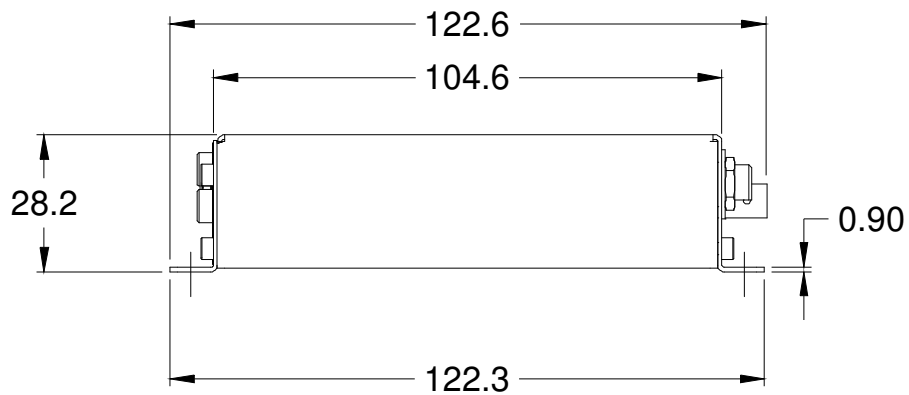
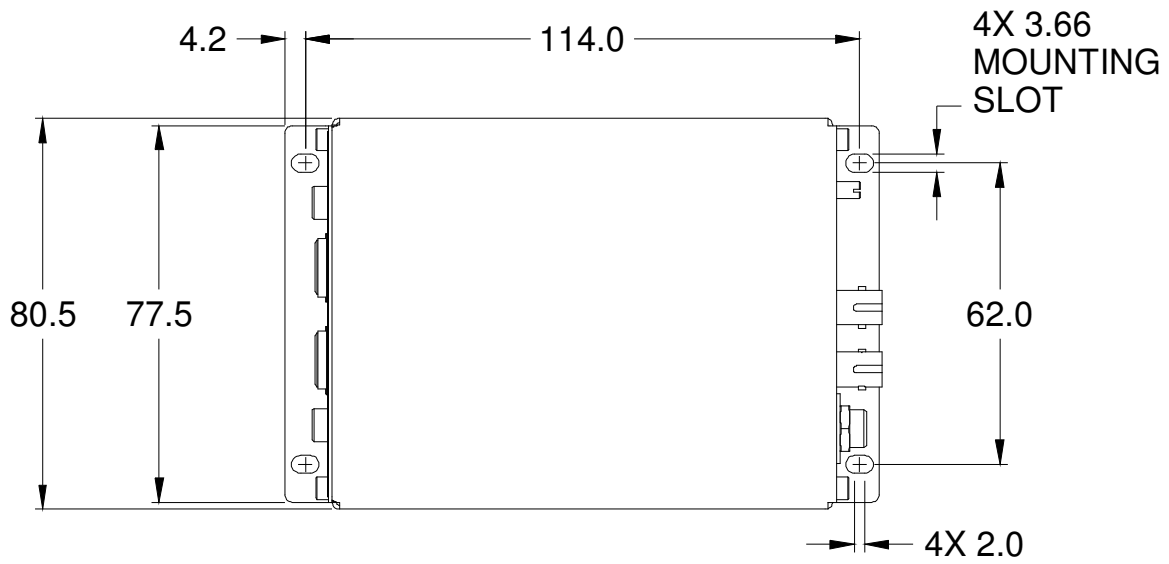
FIBER-OPTIC RX

FIBER-OPTIC TX

+24VDC  
POWER IN



H20 control unit

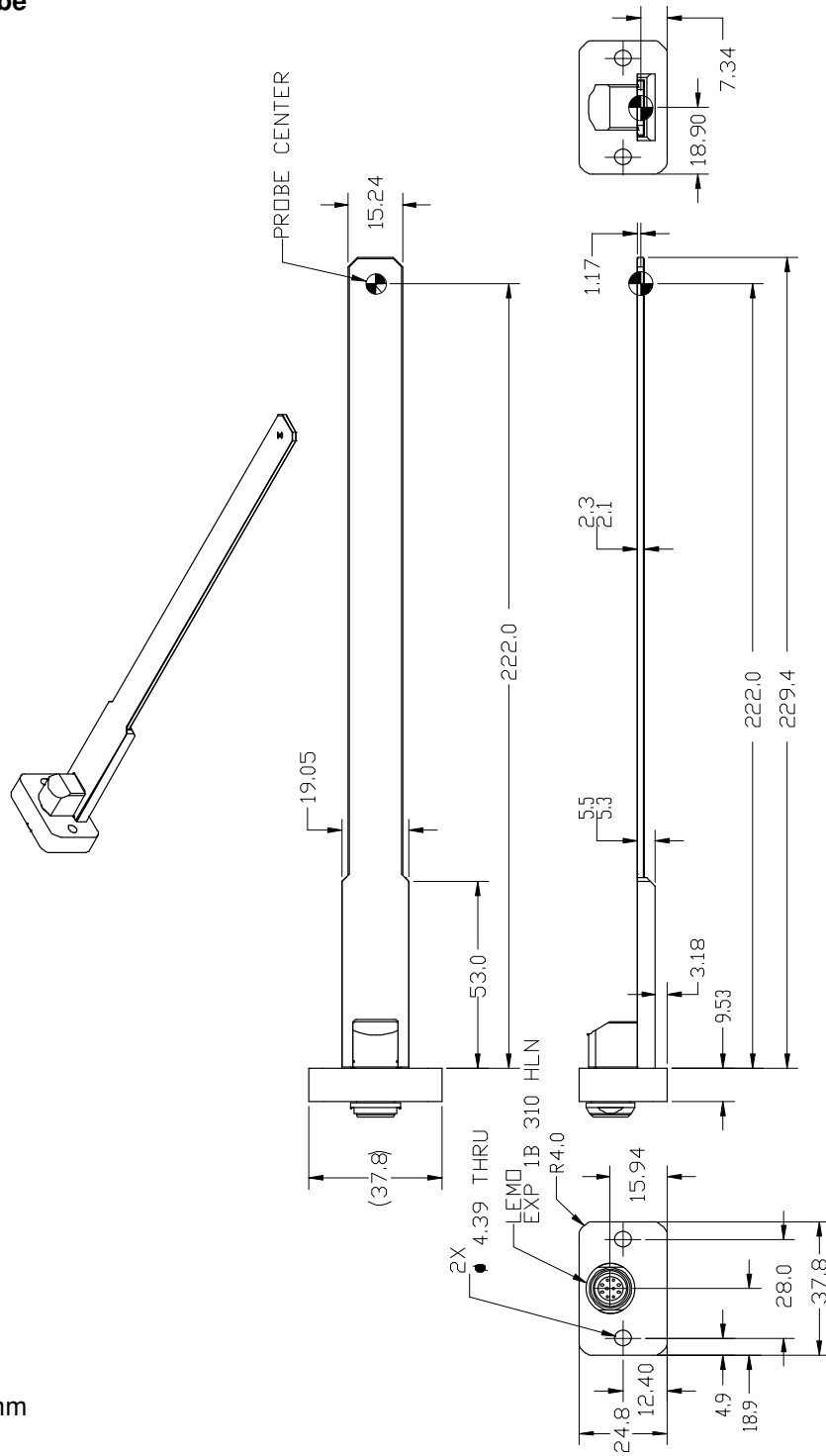


Dims mm





MFP-30 probe



Dims mm

Positive (N to S) field vector into marker gives positive reading (for positive gain)



**Ordering information**

H20-CTRL	H20 control unit
H20-CTRL-S2	H20 control unit with field control servo feature
MFP-30	MFP-30 field probe
PSU24-40-1	Power supply, 24 VDC, 40W for H20
CAB-H10-9	Connection cable between H20 and MFP-30, 9' (2.7 m)
CAB-H10-15	Connection cable between H20 and MFP-30, 15' (4.6 m)
CAB-H10-22	Connection cable between H20 and MFP-30, 22' (6.7 m)

*Preconfigured and calibrated system examples*

H20-SYS1-9	H20 system comprising H20 control unit, one MFP-30 magnetic field probe and 9' (2.7 m) cable, PSU24-40-1 power supply.
H20-SYS1-22	H20 system comprising H20 control unit, one MFP-30 magnetic field probe and 22' (6.7 m) cable, PSU24-40-1 power supply.
H20-SYS2-9	H20 system comprising H20 control unit, two MFP-30 magnetic field probes and two 9' (2.7 m) cables, PSU24-40-1 power supply.
H20-SYS2-22	H20 system comprising H20 control unit, two MFP-30 magnetic field probes and two 22' (6.7 m) cables, PSU24-40-1 power supply.
H20-SYS2-S2-22	H20 system comprising H20 control unit with field control feature, two MFP-30 magnetic field probes and two 22' (6.7 m) cables, PSU24-40-1 power supply.

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