



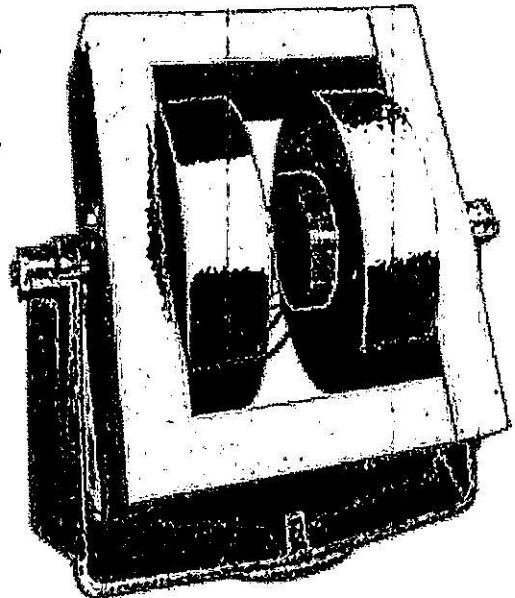
Laboratory Electromagnets

Advancing
the Science
of Magnetism

General:

All Walker Scientific, Inc. standard electromagnets are of the proven "H" frame, designed to provide superior homogeneity over a wide field range. With the use of our foil wound, water cooled coils, which have proven to produce the highest magnetic field per kilowatt, as compared with other methods of coil construction, we are able to provide extremely high fields at a moderate cost.

Our method of coil construction achieves a 40% greater fill factor over other methods of coil construction which results in greater accessibility to the working gap. It also enables more ampere turns to be condensed into a smaller volume nearer the magnet poles for minimized stray fields resulting in the highest magnetic field per kilowatt of power per cubic inch of coil volume for a given coil construction.



Our line of variable gap electromagnets offer added versatility while still offering the highest degree of rigidity for maximizing homogeneity.

Cast magnet iron frames are used in all of our variable gap electromagnets to enable us to provide the most uniform and field efficient variable gap electromagnets on the market by putting the iron where it is most needed.

The entire magnet yoke is cast from pure magnet iron of the same melt and the pole bores are finished by jig boring to insure precise alignment of the moving poles. In addition, a ramp locking mechanism is built into each movable pole to firmly lock each pole in position during operation so as to achieve fixed gap magnet performance.

All magnets are factory aligned and tested to specified field levels and homogeneity prior to shipment using NMR (Nuclear Magnetic Resonance) techniques where possible.

Applications:

- Magnetic hysteresis studies
- Magnetic susceptibility measurements
- Hall effect studies
- Magneto-optics experiments

- NMR (Nuclear Magnetic Resonance) studies
- EPR (Electron Paramagnetic Resonance) studies
- Quantum mechanics analysis
- Biological studies

Features:

- Proven "H" frame construction for high inherent homogeneity over a wide field range
- High efficiency tape wound coils for highest magnetic field per kilowatt input
- Pure magnet iron cast frames for all variable gap electromagnets
- Jig bored pole bores insure precise pole alignment for all variable gap electromagnets
- Positive ramp locking for all variable gap electromagnets
- NMR alignment, where possible for all electromagnets
- A wide selection of associated current and field regulated power supplies are also available

Specifications:

Size	Type			Electrical				Facility Requirements		Pl
	Model # Field Direction	Air Gap and Range	Intercoil Spacing	Input Power KW		Power Sources		Max Inlet Temp. and Press	Flow Rate	M (
				Recom-mended	Maximum	Recom-mended	Optional Maximum			
4	HV-4V Vertical	Variable .065- 3.25" .165- 8.26 cm	6.00" 15.24 cm	2.2	2.2	MH-1120	-	80°F 27°C 30-80 psi	1 gpm 4 lpm	3 1:
	HV-4H Horizontal	Variable .065- 4.00" .165- 10.16 cm	4.00" 10.16 cm	1.25	2.45	HS-525	HS-735	80°F 27°C 30-80 psi	1 gpm 4 lpm	4 1:

5	HF-5H Horizontal	Fixed 3" max. 7.62 cm	5.25" 13.34 cm	2.45	5.0	HS-735	HS-1050	80°F 27°C 30-100 psi	2-3 gpm 8-11 lpm	6' 2"
	HV-5H Horizontal	Variable .065- 5.25" .165- 13.34 cm	5.25" 13.34 cm	2.45	5.0	HS-735	HS-1050	80°F 27°C 30-100 psi	2-3 gpm 8-11 lpm	7' 3"
7	HF-7H Horizontal	Fixed 3.75" max. 9.53 cm	5.90" 14.99 cm	5.0	5.0	HS- 1050	-	80°F 27°C 30-100 psi	3 gpm 11 lpm	7' 3"
	HV-7V Vertical	Variable .065- 4.25" .165- 10.8 cm	7.25" 18.42 cm	5.0	8.5	HS- 1050	HS-1365	80°F 27°C 30-100 psi	3 gpm 11 lpm	12' 5"
	HV-7H Horizontal	Variable .065- 7.25" .165- 18.42 cm	7.25" 18.42 cm	5.0	8.5	HS- 1050	HS-1365	80°F 27°C 30-100 psi	3 gpm 11 lpm	12' 5"
9.5	HF-9H Horizontal	Fixed 4.75" max. 12.07 cm	6.5" 16.51 cm	8.5	11.25	HS- 1365	HS-1575	80°F 27°C 30-100 psi	4-5 gpm 15-19 lpm	25' 13"
10	HV-10V Vertical	Variable .065- 5.5" .165- 13.97 cm	8.25" 20.96 cm	11.25	14.5	HS- 1575	HS-1785	80°F 27°C 30-100 psi	5 gpm 19 lpm	28' 12"
	HV-10H Horizontal	Variable .065- 8.25" .165- 20.96 cm	8.25" 20.96 cm	11.25	14.5	HS- 1575	HS-1785	80°F 27°C 30-100 psi	5 gpm 19 lpm	28' 12"
12	HF-12H Horizontal	Fixed 6" max. 15.24 cm	7.60" 19.30 cm	8.5	14.5	HS- 1365	HS-1785	80°F 27°C 30-100 psi	4-6 gpm 15-23 lpm	58' 26"

15	HF-15H Horizontal	Fixed 6" max. 15.24 cm	7.90" 20.07 cm	22.0	24.2	HS- 20100	-	80°F 27°C 30-100 psi	8 gpm 30 lpm	1 53
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Note: The air gap for fixed electromagnets can be varied by interchanging pole caps.

The maximum air gap range for fixed gap electromagnets is based on using standard pole caps. Thinner pole caps can be provided on special order.

Accessories:

High-field tapered pole caps made from a high permeability iron cobalt, allow for optimum performance to meet specified gap and field strength requirements.

Cylindrical or tapered pole caps machined to customer specified gap and field strength requirements.

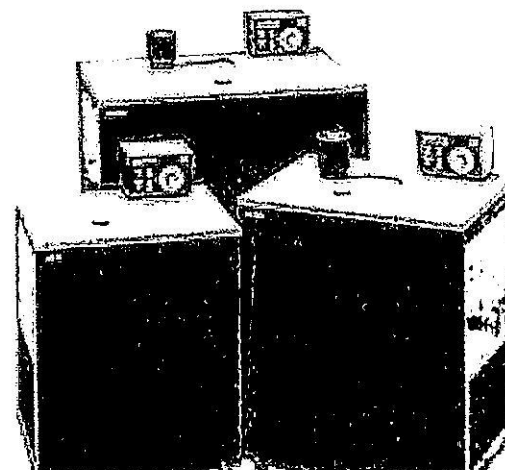
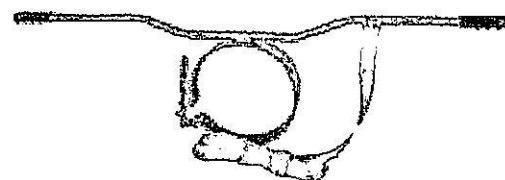
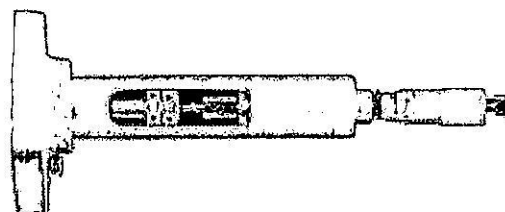
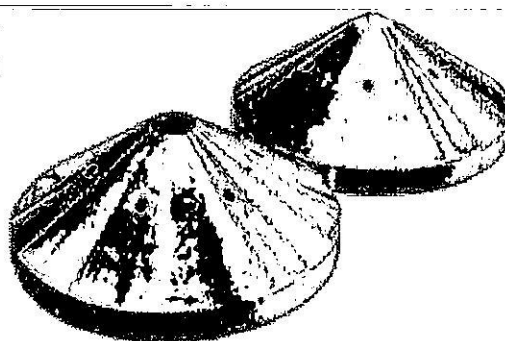
Ring shim pole caps use an adjustable ring at the periphery of the pole cap to increase field homogeneity at a given field level for a given air gap.

Patented u-shim is a unique inhomogeneity compensator which compensates for radial field fall-off at high intensities. Patent No. 3258656.

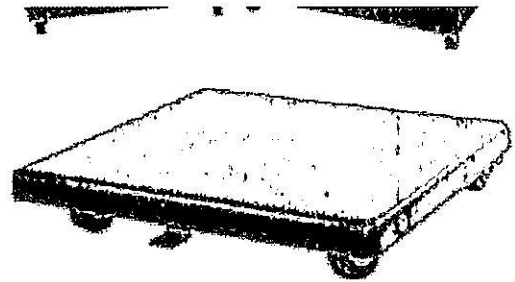
Pole cap remover allows safe, rapid interchange of different pole caps (9.5" thru 15").

Protection devices such as water flow interlocks and thermal interlocks are available to insure safety in case of facility interruption.

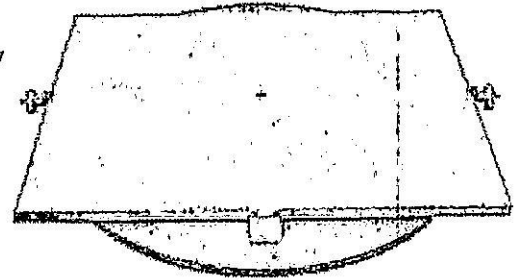
Closed loop chilled cooling systems are a reliable source of clean, cool water offering constant temperature and constant pressure to match any of our magnet/power supply systems.



Rolling rail truck is designed to allow one magnet to serve several different experimental stations. It enables precise relocation of the center of the magnetic field to avoid interference with pre-positioned experimental apparatus.



Rotating base is equipped with a ball bearing track to rotate the magnet 360° on the vertical axis. The axis of rotation may be adjusted for rotation about the air gap center. An indicator scale, readable to 0.1° is incorporated for accurate repositioning.



Beam Handling Electromagnets:

A broad range of dipole electromagnets are available with either solid or laminated core construction for particle beam handling.

Analyzing, switching, deflecting and steering magnets are produced with different features depending on application - pole roots and yokes are proportioned to operate at moderate flux densities to provide near linear response to excitation current in order to facilitate tracking or control.

Several other features are incorporated into the design when application and magnet size dictate:

Pole edges, contoured to approximate the Rogowski profile in order to minimize edge saturation effects for precision magnets operating at moderate to high fields.

Field clamps to better define field boundaries at the entrance and exit of the poles.

An easily accessible uniform field region within the poles to insert a measuring probe such as an NMR probe or Hall Probe for field measurement and/or control.

Dutchman dowels for ease and accuracy of assembly and disassembly.

When required, magnets are designed with second and higher order correction.

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[How to choose a magnet system](#)

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	TYPE			ELECTRICAL				FACILITY REQUIREMENTS		PHYSICAL	
	Model # Field Direction	Air Gap & Range	Intercoil Spacing	Input Power KW		Power Sources		Max. Inlet Temp. & Press	Flow Rate	Weight lbs.	
				Recom- mended	Maximum	Recom- mended	Optional Maximum			Magnet Only	Shipping
4	HV-4V Vertical	Variable .065-3.25" .165-8.26 cm	6.00" 15.24 cm	2.2	2.2	MH-1120	---	80°F 27°C 30-80 psi	1 gpm 4 lpm	350 lb 159 kg	425 lb 193 kg
	HV-4H Horizontal	Variable .065-4.00" .165-10.16 cm	4.00" 10.16 cm	1.25	2.45	HS-525	HS-735	80°F 27°C 30-80 psi	1 gpm 4 lpm	400 lb 181 kg	425 lb 192 kg
5	HF-5H Horizontal	Fixed 3" max. 7.62 cm	5.25" 13.34 cm	2.45	5.0	HS-735	HS-1050	80°F 27°C 30-100 psi	2-3 gpm 8-11 lpm	600 lb 272 kg	725 lb 329 kg
	HV-5H Horizontal	Variable .065-5.25" .165-13.34 cm	5.25" 13.34 cm	2.45	5.0	HS-735	HS-1050	80°F 27°C 30-100 psi	2-3 gpm 8-11 lpm	750 lb 340 kg	875 lb 397 kg
7	HF-7H Horizontal	Fixed 3.75" max. 9.53 cm	5.90" 14.99 cm	5.0	5.0	HS-1050	---	80°F 27°C 30-100 psi	3 gpm 11 lpm	750 lb 340 kg	875 lb 397 kg
	HV-7V Vertical	Variable .065-4.25" .165-10.8 cm	7.25" 18.42 cm	5.0	8.5	MS-1050	HS-1365	80°F 27°C 30-100 psi	3 gpm 11 lpm	1200 lb 544 kg	1350 lb 612 kg
	HV-7H Horizontal	Variable .065-7.25" .165-18.42 cm	7.25" 18.42 cm	5.0	8.5	HS-1050	HS-1365	80°F 27°C 30-100 psi	3 gpm 11 lpm	1225 lb 556 kg	1375 lb 624 kg
9.5	HF-9H Horizontal	Fixed 4.75" max. 12.07 cm	6.5" 16.51 cm	8.5	11.25	HS-1365	HS-1575	80°F 27°C 30-100 psi	4-5 gpm 15-19 lpm	2900 lb 1315 kg	3100 lb 1406 kg
10	HV-10V Vertical	Variable .065-5.5" .165-13.97 cm	8.25" 20.96 cm	11.25	14.5	HS-1575	HS-1785	80°F 27°C 30-100 psi	5 gpm 19 lpm	2800 lb 1270 kg	3000 lb 1361 kg
	HV-10H Horizontal	Variable .065-8.25" .165-20.96 cm	8.25" 20.96 cm	11.25	14.5	HS-1575	HS-1785	80°F 27°C 30-100 psi	5 gpm 19 lpm	2850 lb 1293 kg	3050 lb 1383 kg
12	HF-12H Horizontal	Fixed 6" max. 15.24 cm	7.60" 19.30 cm	8.5	14.5	HS-1365	HS-1785	80°F 27°C 30-100 psi	4-6 gpm 15-23 lpm	5800 lb 2631 kg	6050 lb 2744 kg
15	HF-15H Horizontal	Fixed 6" max. 15.24 cm	7.90" 20.07 cm	22.0	24.2	HS-20100	---	80°F 27°C 30-100 psi	8 gpm 30 lpm	11900 lb 5398 kg	12200 lb 5534 kg

Note: The air gap for fixed electromagnets can be varied by interchanging pole caps.

The maximum air gap range for fixed gap electromagnets is based on using standard pole caps. Thinner pole caps can be provided on special order.

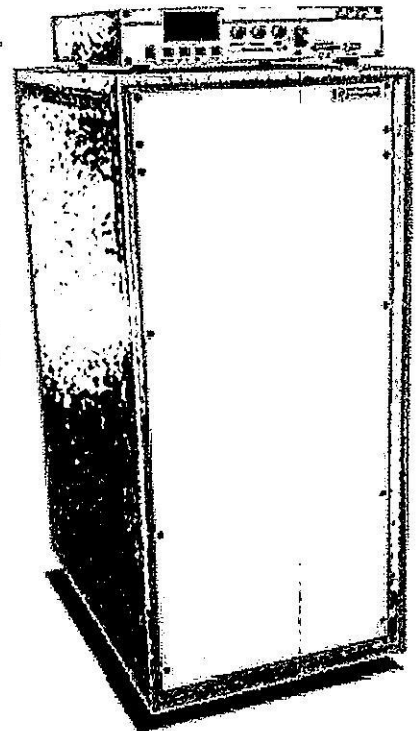
*Advancing
the Science
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Regulated Power Supplies

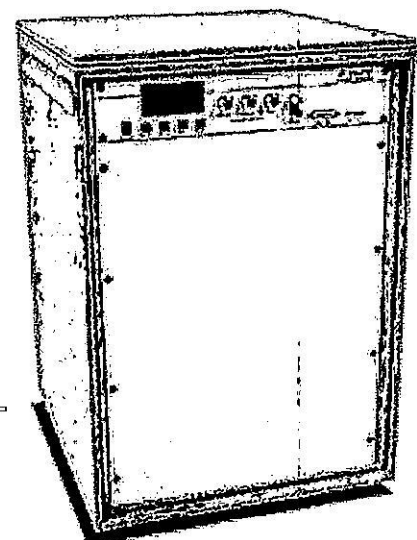
Precision Current Regulated Laboratory D.C. Power Supplies

Standard Features:

- **CONTROL MODULE** - All power supply controls and visual indicators are located in a 19" wide control module which can be mounted in the main power supply cabinet. It is also available for remote rack mounting, or in a separate enclosure for remote bench top mounting.
- **ANALOG INPUT** - A 0 - 10V analog voltage is applied to the EXT INPUT providing for remote control of the power supply output current.
- **COARSE, MEDIUM AND FINE CURRENT CONTROL** - All three current controls afford an easy and accurate way of setting the load current from one part in 10^3 to one part in 10^6 (-4SS).
- **OVERLOAD PROTECTION** - Current limiting prevents the power supply from exceeding maximum rated current output by automatically turning the DC power OFF.
- **CURRENT METER** - The total output current flowing through the output load is indicated on the 4 1/2 digit meter display.
- **FLOW SWITCH INTERLOCK** - Prevents DC power from being applied unless adequate water flow is established.
- **CASTER MOUNTED** - All power supplies above 2.45kW are mounted on casters to facilitate movement from one location to another when required.



**Remote Control Console
Option**



Panel Mounted Control

General:

Walker Scientific, Inc., manufactures a broad range of high stability, current regulated DC power supplies. The built-in controls are designed to provide an output of continuously regulated DC current to a variety of output loads. The solid state regulator elements are capable of providing current stability of 0.0003% (3ppm) to 0.001% depending upon the regulation option. Current regulation is accomplished by a solid state transistorized series regulator. A wide range of standard and non-standard output configurations are available from 1.25kW to well over 100kW. Numerous standard and optional features afford the

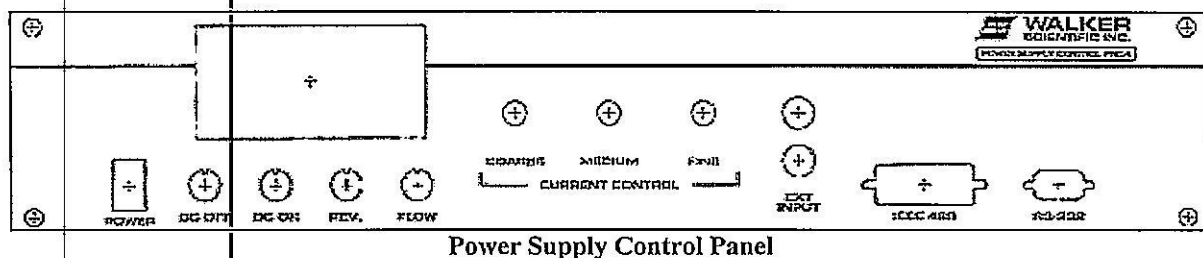
versatility required to adapt to almost any current regulated power supply application.

Description:

The basic enclosure of every power supply contains all electrical/electronic components, a control panel, connections for AC input power, DC output terminals and standard hose couplings for water cooling requirements.

The standard rack mounted control module (see options for remote control console) is located in the top front section of the power supply. The panel includes COARSE, MEDIUM and FINE (-4SS only) CURRENT CONTROLS, a panel meter to display the output current, switches for power ON/OFF, DC ON, DC OFF with indicator lights for power ON, DC ON and water FLOW. Power supplies equipped with the current REVERSAL option will include a REVERSAL switch and indicator light. An EXT INPUT is provided for connection to an external sweep generator or controller.

Each power supply ordered with computer compatible interfaces will include both RS232 and IEEE 488 ports located on the front panel. Only one port is active at any one time. See options sections for detailed description.

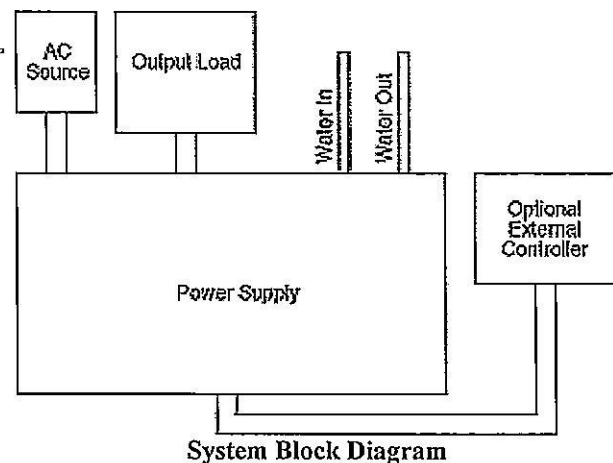


Operation:

The HS series power supply uses a precision closed loop regulator which consists of a phase angle controlled voltage pre-regulator (above 50V), precision voltage reference, precision current shunt, DC amplifier and series regulating transistor bank assembly. The phase angle controlled pre-regulator circuitry provides a constant voltage across the current regulating transistor assembly. This is accomplished by monitoring the collector to emitter voltage of the transistors and maintaining it at a constant level. This serves to keep the power dissipation in the transistors at an optimum level.

The current regulator functions by monitoring the voltage drop across the precision current shunt which is in series with the output load, therefore, proportional to the output current. This voltage is then amplified and compared to the precision voltage reference at the level derived from the current control potentiometers. The resultant error signal is then amplified and fed into a series amplifier circuit which in turn drives the series regulating transistor assembly.

The circuit obtains highly stable operation by temperature controlling the current regulator circuits, using an extremely stable reference voltage and also through the use of a specially constructed, highly stable reference resistor. The combination of these factors along with precision electronic circuit design allows the HS power supply to operate with such a high degree of current regulation and



stability.

Optional Features:

- **CURRENT REVERSAL** - The current reversal option is incorporated into the main power supply enclosure for the purpose of reversing the current polarity automatically at any setting. The current reversal is initiated by the pushbutton switch located on the front panel of the power supply. Depressing the REVERSAL switch will automatically set the output current to zero, reverse polarity, then ramp back up to the previous setting. The electronic circuitry automatically pauses at zero current to allow for the dissipation of any back EMF that may be generated from an inductive load. The reversal time is dependent upon the power supply, load impedance, and current setting.
- **RELAY CONTROL PACKAGE** - This option is used to operate the AC ON, DC ON, DC OFF, and REVERSAL (if so equipped) from a remote source.
- **BACK BIAS** - Power supplies equipped with the back bias option have the capability to overcome a typical residual field that would be found when driving an ironcore electromagnet. This is accomplished by a bias current, opposite in polarity to the normal current output of the supply.
- **ANALOG OUTPUT** - The power supply can be equipped with a current monitor. This output is a 0 to +10 VDC signal that is proportional to the output current where 10 volts is equal to 100% current. This output can source any device with an input impedance greater than 5 kOhm.
- **REMOTE CONTROL CONSOLE OPTION** - A separate, remote control console can be provided in place of the standard panel mounted unit when required. The console measures 3.5"H x 19"W x 18"D. Refer to the power supply control panel description section for details.
- **IEEE/RS-232 COMMUNICATIONS PORTS** - Complete control of any Walker Scientific HS power supply is achieved through either an IEEE488 GPIB parallel interface or an RS-232 serial interface. The RS-232 interface allows complete control with a standard PC RS-232 serial port, eliminating the requirement for any additional PC I/O cards for communicating with the power supply. The IEEE488 GPIB interface permits operation of the power supply on the same interface bus as other GPIB compatible equipment (each device on the bus must be set to a different address). The GPIB address can be set via a dipswitch setting to allow the interface to be controlled independently of other equipment on the same bus. Both interface options enable full computer control of all power supply functions, including power on/off, polarity reversal, and the setting of the output current level with up to 20 bits of resolution (1 ppm). The user can also monitor water coolant flow status (go/no go) and actual output current with up to 16 bits of resolution (15 ppm).

A simple command structure is used to execute each power supply function. The user can write software routines for controlling the power supply or use a commercially available software package such as National Instruments LabVIEW(TM), or we can provide the software support required for your application.

- **FIELD REGULATION** - A universal field control package consisting of a precision

gaussmeter, probe and power supply interface provides a system designed to allow full user control of the electromagnet through either current or field regulation.

When operating in the current control mode, the current to the electromagnet is sensed and fed back to the power supply control to maintain a constant current. Current to the electromagnet will remain constant with changing load impedance and over specified line voltage variations of $\pm 10\%$.

When the system is operated in the field control mode, the magnetic field in the electromagnet gap is sensed by a Hall effect sensor and gaussmeter. The signal from the gaussmeter is then fed to the power supply control to maintain a constant field in the electromagnet air gap. The field in the electromagnet will remain constant for variations in gap size or with the introduction of other objects into the air gap.

- FIELD CONTROL -**

Field set accuracy:

MG-3D Gaussmeter

$\pm 0.2\%$ of range with HP-93 probe (10X)

(Ranges: 0-10KG or 0-100KG)

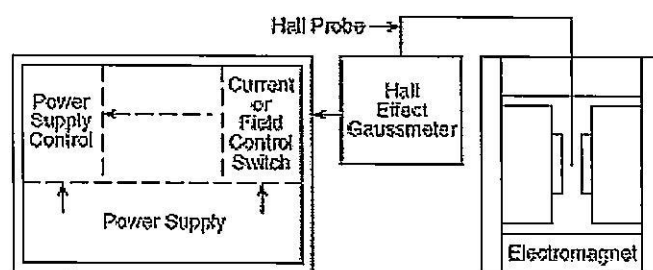
$\pm 0.35\%$ of range with HP-33 probe (1X)

(Ranges: 0-1KG or 0-10KG)

Field set resolution: 0.1% of range (0-1KG or 0-100KG)

Field Regulation: $\pm 0.02\%$ or 25 milligauss, whichever is greater.

Max. line voltage variation: $\pm 10\%$



Functional Diagram

DC Output Range:

A full range of Precision DC Current Regulated Power Supplies is available with output power in the range of 1.25kW to 100kW with either -3SS or -4SS regulation and input power to match any facility requirement. When requesting a quotation, please specify input and output requirements.

POWER	CURRENT	VOLTAGE
1.25kW - 100kW	0-10A to 0-500A	0-10V to 0-500V

Regulation Selection:

SUFFIX	SHORT TERM (30 min.)		LONG TERM (8 hrs.)		CURRENT CONTROL RESOLUTION		
	10-100%	1-10%	10-100%	1-10%	COARSE	MEDIUM	FINE
- 3SS	0.001%	0.01%	0.01%	0.1%	1 part in 10^3	5 parts in 10^5	N/A
- 4SS	0.0003%	0.001%	0.001%	0.01%	1 part in 10^3	5 parts in 10^5	1 part in 10^6

Typical Power Supplies:

Typical Precision DC Current Regulated Power Supplies between 1.25kW and 22kW.

Power Supply Model Number	Use With Mag. Size	Standard Input Power	Output			Cooling Requirements				Physical		
			Amps	VDC	kW	BTU/Min Max Inlet Temp		Flow Rate		Weights		C Din
						Power Supply Only	Power Supply and Mag.	Power Supply Only	Power Supply and Mag.	Net Wt.	Ship Wt.	
HS-525-4SS	4"	120V / 50 or 60Hz Single Phase	0-25	0-50	1.25	15 BTU 80°F (27°C)	93 BTU 80°F (27°C)	1 GPM (4 LPM) 30-100 PSI	1 GPM (4 LPM) 30-100 PSI	Approx. 175lbs. (79kg)	Approx. 225lbs. (102kg)	22' D-2 H-3
HS-735-4SS	4" 5"	208, 220, 230, 240V 50 or 60Hz Single Phase	0-35	0-70	2.45	20 BTU 80°F (27°C)	170 BTU 80°F (27°C)	1 GPM (4 LPM) 30-100 PSI	1 GPM (4 LPM) 30-100 PSI	Approx. 200lbs. (90kg)	Approx. 250lbs. (113kg)	22' D-2 H-3
HS-1050-3SS HS-1050-4SS HS-50100-3SS HS-50100-4SS	5" 7"	120/208V 60Hz, 3 Phase 4 Wire	0-50 0-50 0-100 0-100	0-100 0-100 0-50 0-50	5.0	30 BTU 80°F (27°C)	350 BTU 80°F (27°C)	2 GPM (8 LPM) 30-100 PSI	2-3GPM (8-11 LPM) 30-100 PSI	Approx. 390lbs. (176kg)	Approx. 475lbs. (215kg)	22' D-3 H-3
HS-1365-3SS HS-1365-4SS HS-65130-3SS HS-65130-4SS	7" 9.5" 12"	120/208V 60Hz, 3 Phase 4 Wire	0-65 0-65 0-130 0-130	0-130 0-130 0-65 0-65	8.5	42 BTU 80°F (27°C)	590 BTU 80°F (27°C)	2 GPM (8 LPM) 30-100 PSI	3GPM (11 LPM) 30-100 PSI	Approx. 390lbs. (176kg)	Approx. 475lbs. (215kg)	22' D-3 H-3

HS-1575-3SS	9.5" 10"	120/208V 60Hz, 3 Phase 4 Wire	0-75	0-150	11.5	50 BTU 80°F (27°C)	750 BTU 80°F (27°C)	2 GPM (8 LPM) 30-100 PSI	4-5 GPM (15-19 LPM) 30-100 PSI	Approx. 580lbs. (263kg)	Approx. 700lbs. (317kg)	22' D-3 47"
HS-1575-4SS			0-75	0-								
HS-75150-3SS			0-150	150								
HS-75150-4SS			0-150	0-75								
HS-1785-3SS	12"	120/208V 60Hz, 3 Phase 4 Wire	0-85	0-170	14.5	60 BTU 80°F (27°C)	960 BTU 80°F (27°C)	2 GPM (8 LPM) 30-100 PSI	5 GPM (19 LPM) 30-100 PSI	Approx. 780lbs. (353kg)	Approx. 930lbs. (421kg)	22' D-3 47"
HS-1785-4SS			0-85	0-								
HS-85170-3SS			0-170	170								
HS-85170-4SS			0-170	0-85								
HS-20100-3SS	15"	120/208V 60Hz, 3 Phase 4 Wire	0-105	0-210	22	74 BTU 80°F (27°C)	1430 BTU 80°F (27°C)	2 GPM (8 LPM) 30-100 PSI	8 GPM (30 LPM) 30-100 PSI	Approx. 975lbs (442kg)	Approx. 1150lbs (521kg)	22' D-3 47"
HS-20100-4SS			0-105	210								
HS-10200-3SS			0-210	0-								
HS-10200-4SS			0-210	105								

See our line of electromagnets for use with these power supplies

Accessories:

- Hall Effect Gaussmeters
- Model UFC-5 Hall Field Controller
- Model WS-8-10D Digital Electronic Sweep