

# Induction Heater Module 5 kW

Programmable Mains Powered Induction Coil Driver

**Model:** IHM-5K(e)

**Type:** Mains powered induction heater module



## Features and Specifications

- Up to 5000 W Heating Power \*
- Adjustable Heating Power (20% to 100%)
- Self-resonant 5kHz to 35kHz
- Overload Protection
- Optional PID control input
- Soft Start / Stop
- Optional Display / Controller
- Optional RS-232 Serial Control
- 220V AC Mains Input (100V – 260V)
- Dimensions: L193 x W120 x H98 mm

\* Power will depend on input voltage, coil design and magnetic coupling to workpiece.

## Example Applications

- Flameless Heating
- Plastic Melting
- Glass Melting
- Metal Casting
- Water Heaters
- Industrial Process

## Typical Usage

A powerful induction heating module designed for use in industrial heating processes.

The IHM-5K is designed for driving large induction coils such as those made from litz wire with a relatively high inductance. Ideal for industrial applications where large volumes of several litres are being heated. This will not directly drive small coils of a few turns like those used in metal hardening. For those applications an additional transformer would be required, or see our other induction heating products.

*This is not a consumer product and should only be installed / operated by suitably qualified personnel.*



*Mains voltages may be present throughout the circuit and heatsink. No part should be touched while power is connected. The output coil operates at mains voltages and higher so must be suitably insulated from the workpiece and also not touched while power is connected to the board.*

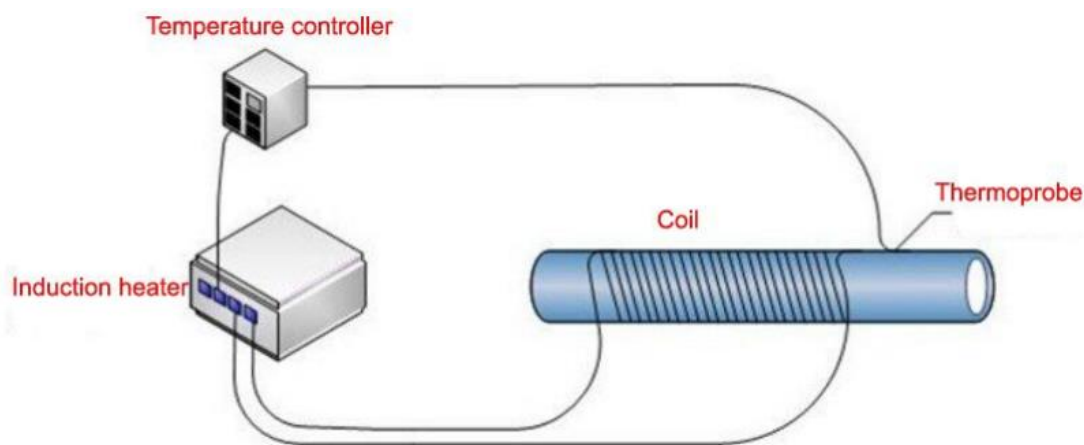


Figure 1: Typical Application

## ELECTRICAL CHARACTERISTICS

Symbol	Parameter	Min	Typical	Max
$V_{in}$	Input Supply Voltage (AC)	100 V	220 V	260 V
$P_{OUT}$	Operating Power Range	250 W*	-	5000 W*
$L_{COIL}$	Supported Coil Inductance	100uH**	-	300uH**
$V_{PID}$	PID Voltage input	0 V	-	5 V***
$T_{FB}$	Feedback Temperature (Workpiece)	0 C	-	150 C
$T_E$	Working Temperature (Environment)	-20 C	-	50 C
$F_{RES}$	Resonator Frequency	5kHz	15kHz	35kHz

Table 1: Electrical Characteristics

\* Adjustable range is 20% to 100%. Actual power will depend on loading conditions

\*\* Outside this range may still work, but may be less effective or lead to machine damage

\*\*\* Also supports 0-10V, and 4-20mA when configured

## Connections

The main connections are made using the screw terminals on the board. Optional connections are available using the small connectors. Locations and functions are in the table below.

When making a permanent installation, the following recommendations should be considered:

- The metal enclosure should be earthed using a dedicated earth connection.
- Install a noise filter that complies with European standards.
- The connection between the electromagnetic heater and the induction heating coil should be made using suitable cable and be shielded in suitable enclosure to reduce EMI
- A linear noise filter and ferrite core should be inserted in the power supply and control lines

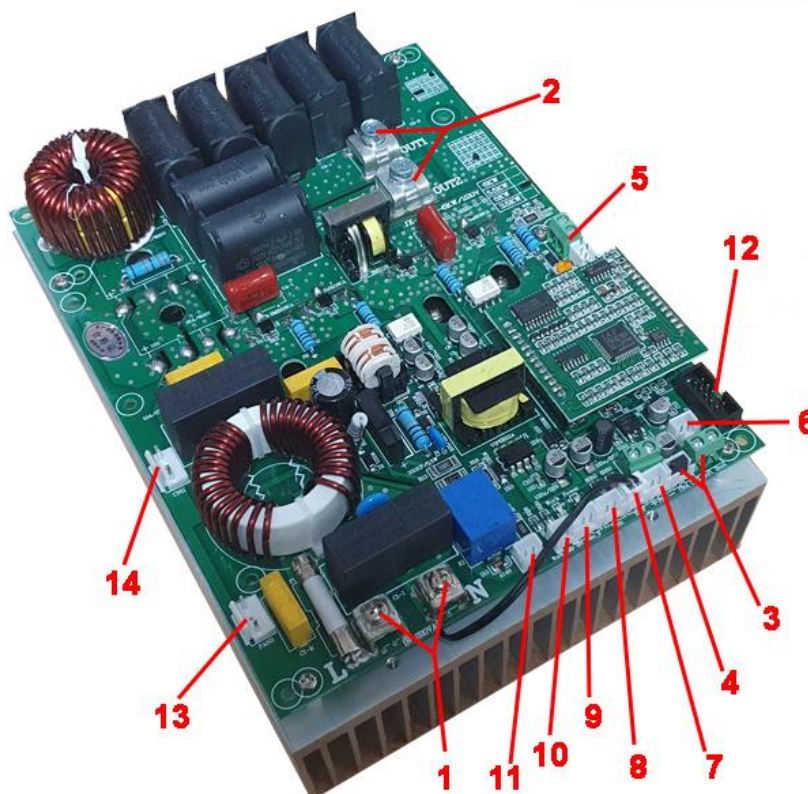


Figure 2: PCB Overview

No.	Function	Notes
1	Mains Input	220V AC Mains input
2	Coil Connection	
3	Start / Stop Switch – Connect a switch or relay here for on / off control of the output power.	Use a jumper link to short this for auto start when powered on
4	PID Input (power control)	Connect a 10k pot here for power level adjustment. Can also use a 0-5V, 0-10V, or 4-20mA signal when configured as described later.
5	RS-232 (MODBUS) interface	For connection to a serial port control system. Use the white JST header for MODBUS over RS-232.
6	SSR Connection	Not Used
7	IGBT Temperature Sensor	For monitoring the working temperature of the heatsink
8	External Temperature Sensor 1	Connect a 10k NTC thermistor for regulating temperatures up to 150 C
9	External Temperature Sensor 2	Connect a 10k NTC thermistor for regulating temperatures up to 150 C
10	External LED Indicator	Connect 12V LED indicator for output status
11	Thermocouple	Connection for Type-K thermocouple
12	External controller connection	Connection for the controller in the IHM-5Ke version
13	Main Heatsink cooling fan	For a 220V AC Fan
14	Secondary cooling fan	For a 220V AC Fan

Table 2: Circuit Connections

## Basic Operating Instructions

With a jumper link in place (3), the unit will power on automatically after receiving mains power. It will ramp up the power to the level set by the PID potentiometer (4) or the maximum value set by F-01. Alternatively, a switch or relay can be connected to input 3.

For the version with the enclosure and controller (IHM-5Ke), the system is activated using a switch or relay connected to the port marked RIS. Power level adjustment is made using the onboard potentiometer.

## Coil Design

A coil used with the IHM series heaters should typically be made from high current litz wire or specialised high temperature cable. The total winding length would typically be in the region of 20 meters with an inductance of around 150uH. The coil should be built such that it will typically resonate with the system at around 10kHz to 20kHz. The coil must also be designed with consideration of the workpiece material, dimensions, target temperature and heating time. RM Cybernetics offer coil design services, consultancy, and feasibility testing. Please contact us if you need assistance with this.



Figure 3: Typical Coil with multi-layer winding

When powered on, the IHM-5Ke can display useful information for developing your coil such as the resonating frequency, current, and phase. If the display shows the coil is working outside recommended ranges, the coil design should be adjusted accordingly.

Recommended Operating Range	Solution
Frequency: 10 – 20 kHz	High frequency indicates the coil should have a longer winding length or more turns. Low frequency indicates the coil should have a shorter winding length or fewer turns.
Phase: 03 - 15	If the phase value is too high, the coil should have more turns

Table 3: Frequency & Phase

## Advanced Features

Many additional features are accessible through the controller interface included in the IHM-5Ke version or through the serial interface. The display can show basic parameters such as operating current, resonant frequency, error codes and more. Additionally, there are many registers that can be changed using the display controller or through the RS-232 interface. The table below lists all the main parameters.

## Parameter Adjustments

Using the controller, press PRG (7) to enter the F-Code menu. Using the up/down keys (5/10) it is possible to scroll through the 32 available settings. Pressing ENTER (6) will select the displayed F-Code and change the display to show its current value. The value can be adjusted up or down using the arrow keys followed by ENTER to save the value to memory. To return to the main display mode, simply press the back key.

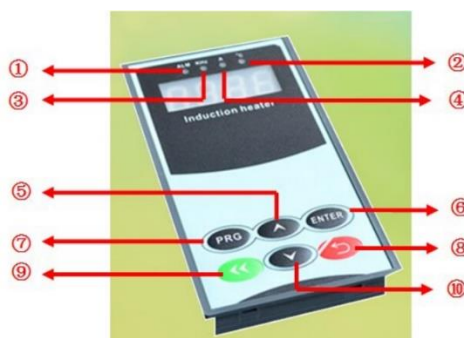


Figure 4: IHM Series controller

Key / Indicator	Function
1	Warning or Fault indicator
2	Heatsink Temperature Indicator
3	Operating Frequency Indicator
4	Operating Current Indicator
5	Next / Increment
6	OK / ENTER
7	Programming Mode
8	Back / Exit
9	Select Display Value
10	Previous / Decrement

Table 4: Controller Layout

F/D-Codes below refer to the types of variables for the machine. F-Codes are user adjustable parameters for changing the way the machine operates available using the controller in the IHM-5Ke. D-Codes are read-only codes that tell the user about the internal functioning of the machine. If using the controller, pressing the << key will cycle through the main operating parameters (D-Codes). To reset the machine to factory defaults, hold ENTER for about 15 seconds until the display goes blank and resets.



The table below lists the available settings for the IHM-5K. Most parameters can be read or adjusted using the optional digital display which is included with version IHM-5Ke. For many of the parameters, the F-Code available in the display corresponds to the Modbus address where the value can be read or modified. Note that some values are read only. The factory default value is shown in bold square brackets **[X]**. Some registers will only return 0 when read using MODBUS as these are unavailable for use in this way. Some of the unavailable registers may show random values when read using third party MODBUS software.

Using the controller, it is possible to view or modify up to 32 functional parameters.

**WARNING: Incorrect configuration could lead to machine damage.**

Address	F/D-Code	Parameter	Description
1	F-01	Output Power (20-100 %) <b>[90]</b>	Power will ramp up to this value when powered on. In adjustable modes, this will be the maximum value an adjustment will reach. Range: [20 - 100]
2	F-02	Power Mode <b>[1]</b>	0: On/Off Setting 1-6 for adjustable power 1: 10k pot connected to PID 2: 0-5V connected to PID 3: 0-10V connected to PID 4: 4-20mA connected to PID with 250 ohm, 1W resistor in parallel 5: Power control by RS-232 Range: [0 - 5]
3	F-03	Shutdown voltage setting <b>[0]</b>	Range: [0 - 255]
UNAVAILABLE	F-04	Input current correction	Used for calibration. Power the coil, and then adjust the displayed value to match a value measured using a suitable clamp meter.
UNAVAILABLE	F-05	Output current correction	As above
UNAVAILABLE	F-06	Display Mode <b>[0]</b>	<b>0: Input Current</b> 1: External Temp. 1 2: External Temp. 2 3: External Temp. 3 (type-k) 4: External Temp. 4 (type-k)
7	F-07	External Temp 1 Max (Water out) <b>[140]</b>	Alarm Threshold °C Range: [0 - 255]
8	F-08	External Temp 1 Min <b>[130]</b>	Alarm Threshold °C Range: [0 - 255]
9	F-09	External Temp 2 Max (Water In) <b>[80]</b>	Alarm Threshold °C Range: [0 - 255]
10	F-10	External Temp 2 Min <b>[70]</b>	Alarm Threshold °C Range: [0 - 255]
11	F-11	External Temp 3 Max <b>[160]</b>	Alarm Threshold °C Range: [0 - 255]
12	F-12	External Temp 3 Min <b>[150]</b>	Alarm Threshold °C Range: [0 - 255]
13	F-13	External Temp 4 Max	Alarm Threshold °C Range: [0 - 255]
14	F-14	External Temp 4 Min	Alarm Threshold °C Range: [0 - 255]
UNAVAILABLE	F-15	Phase difference remote heating setting <b>[20]</b>	Range: [5 - 100]
16	F-16	Countdown days	Range: [0 - 255]
UNAVAILABLE	F-17	Cancel countdown set	Range: [0 - 9999]
18	F-18	Custom password	Range: [0000 - 9999]
19	F-19	Coil starting current threshold setting <b>[002]</b>	Range: [000 - 100]
20	F-20	Coil sustaining current threshold setting <b>[002]</b>	Range: [000 - 100]
21	F-21	Output current protection value setting <b>[100]</b>	Range: [75 - 250]
22	F-22	Start delay setting <b>[0]</b>	Range: [000 - 255]
23	F-23	Off delay setting <b>[0]</b>	Range: [000 - 255]
24	F-24	Internal temperature protection setting <b>[80]</b>	Range: [60 - 90]
25	F-25	Rs485 communication address setting <b>[001]</b>	Range: [001 - 240]

26	F-26	Baud rate setting <b>[9600]</b>	Range: [1200 - 38400] (Displays last four digits only)
UNAVAILABLE	F-27	Frequency Mode <b>[0]</b>	0: High Frequency (Default) 1: Low Frequency Transformer Range: [0 - 1]
UNAVAILABLE	F-28	Full bridge / half bridge setting <b>[0]</b>	0: Full Bridge 1: Half Bridge Range: [0 - 1]
29	F-29	Check the power-on heating time (days)	Read Only
30	F-30	View heating timing (days)	Read Only
31	F-31	Check the power-on heating time (hour, minutes)	Read Only
32	F-32	Check software version	Read Only
33			
34			
35			
36			
37	D-02	Working Frequency	
38	D-03	Phase Difference	
39	D-04	Input Current	
40	D-05	Output Current	
41	D-06	Heatsink Temperature	
42		Fault Code	0: A-01 (See error table) 1: A-02 2: A-03 3: E-01 4: E-02 5: E-03 6: E-04 7: E-05 8: E-06
43		External Temp 1	
44		External Temp 2	

Table 5: F/D-Codes, MODBUS addresses and parameters

## Error Codes

Warning and error codes will show on the main display. When a warning code shows, the machine will still operate but it is recommended that adjustments be made. Error codes will stop the machine operating. The table below lists the warning and error codes with their meaning and possible solutions.

Code	Description	Troubleshooting
A-01	Poor workpiece coupling	The coil is too far from the workpiece or the winding configuration is not working well.
A-02	Current limit	Workpiece too large, or coil configuration problem
A-03	High Frequency	Coil inductance or winding length is too low.
E-01	Low Current	Coil not connected or inductance too high
E-02	Peak Overcurrent	Coil short-circuit, or IGBT failure
E-03	Heatsink Sensor Missing	Heatsink sensor not plugged in or damaged.
E-04	Heatsink overheating	Better cooling required
E-05	External Temp. Sensor Fail	Custom function only
E-06	External Temp. Sensor Fail	Custom function only
E-07	Coil Current High	Coil configuration problem or wiring problem.
E-08	High Frequency	Coil inductance is too low or windings too short
END	Scheduled work time ended	

Table 6: Error and Warning Codes

## RS-232 Serial Interface

Communication with the IHM-5K is possible using MODBUS over RS-232 interface. For use with a PC, it is possible to use a simple USB serial convertor. For use with RS-485, you will need a suitable 485/232 adaptor. The interface is galvanically isolated, though it is recommended to use your own isolator for added protection. The connection is made using the small header (5) on the PCB. The pinout is Rx, Tx, GND, 5V. The 5V is an output and can be used to power a USB isolator if required. The GND of this interface is floating as it uses an isolated supply, therefore you should make sure this GND is common with the GND of whatever device you interface it with.

Communication protocol uses a MODBUS based system and most registers can be read/written using MODBUS software such as QModMaster or Modbus Poll.

<https://sourceforge.net/projects/qmodmaster/>

[https://www.modbustools.com/modbus\\_poll.html](https://www.modbustools.com/modbus_poll.html)

Most common use would be to use the MODBUS Read holding Register (0x03) and Write Single Register (0x06)

The screenshot shows the Modbus Poll software interface. The main window displays a list of registers with their addresses and values. A 'Test Center' dialog box is open, showing a hex input field with the value '01 03 00 25 00 01'. The dialog also includes buttons for 'Open list', 'Save list', 'Clear', 'Add to list', 'Send', 'Exit', and 'Copy'. Below these buttons, there are radio buttons for 'Add Check', 'CRC', and 'LRC'. The dialog also displays the hex data for the selected register: '046-Tx: 01 03 00 25 00 01 95 C1' and '047-Rx: 01 03 02 0D AC BC A9'.

Address	Name	Value
0		00000
1	Power %	90
2	Power Mode	1
3	Shutdown Voltage	0
4	Input Current Correction [X]	0
5	Output Current Correction [X]	0
6	Display Mode [X]	0
7	Ext. Temp. 1 Max	140
8	Ext. Temp. 1 Min	130
9	Ext. Temp. 2 Max	80
10	Ext. Temp. 2 Min	70
11	Ext. Temp. 3 Max	160
12	Ext. Temp. 4 Min	1536
13	Ext. Temp. 4 Max	150
14	Ext. Temp. 4 Min	512
15	Phase difference Limit [X]	512
16	Countdown Days	0
17	Cancel countdown set [?]	9898
18	Custom Password	0
19	Coil Starting Current Threshold	2
20	Coil Sustaining Current Thres...	2
21	Output Current Protection	280
22	Start Delay	0
23	Stop Delay	0
24	Heatsink Temperature Limit	80
25	RS-485 Address	1
26	Baud Rate	9600
27	Frequency mode [X]	9600
28	Full / Half Bridge mode [X]	9600
29	Power On Heating days	-1
30	Heating Time Days	0
31	Power ON Heating hour	0
32	Software Version	0
33		0
34		0
35		0
36		0
37	Working Frequency	3500
38	Phase Difference	0
39	Input Current	9
40	Output Current	3
41	Heatsink Temperature	27
42	Fault Code	0
43	Ext. Temp. 1	0

For Help, press F1.

Figure 5: Modbus Poll Screenshot

## RS-232 / MODBUS Data Format

Modbus:           Base Address: 0  
                       Write Single Register 0x06  
                       Read Registers: 0x03

Depending on the software used for MODBUS RTU, there may be variation in the way the addressing should be used. For example; Register 01 (Power Percentage) may need to be addressed as 40002. When using tools such as QModMaster or Modbus Poll, some register values may not be reliable if scanned in large blocks as it assumes all blocks contain the same datatype. When debugging it can be useful to just scan a single register of interest. It is possible to overrun the data buffer on the machine, this may cause it to become unresponsive and you will see the yellow "Work" LED on the PCB flashing quickly.

Port Setting:

Baud	Data Bits	Stop Bits	Parity	Endian
9600	8	1	None	Little

### MODBUS Packet Format

Device Address	Function Code	Parameter Address	Parameter Value	CRC-16
1-byte	1-byte	2-byte	2-byte	2-byte

A typical data packet will be in the form of a series of bytes represented as hexadecimal values. When setting an address, or value, it is important to make sure to convert to hexadecimal values. When receiving packets, the value should also then be converted to a 16-bit decimal. The 16-bit CRC check code can be calculated using online tools like linked below. Note that when using the tool below, remember to swap the order of the two bytes for your data packet. E.g. if the tool returns a CRC check code of 0xDF59, enter 59DF in the packet.

<https://crccalc.com/?crc=010600150032&method=CRC-16/MODBUS&datatype=hex&outtype=0>

### Function Codes follow common MODBUS types:

Code	Function
0x05	Write parameter (1-bit)
0x01	Read Parameter (1-bit)
0x03	Read Parameter (2-bytes)
0x06	Write Parameter (2-bytes)

### Example Data Packet - Update a Parameter

This example shows updating the output power to 50%. Remember to convert any decimal values to hexadecimal for the data packet. (Decimal 50 in hex is 0x32)

Device Address	Function Code	Parameter Address	Parameter Value	CRC-16
01	06	00 01	00 32	59 DF

Send the command: 01 06 00 01 00 32 59 DF

### Example Data Packet - Read a Parameter

This example shows reading the current operating frequency. Remember that returned values are hexadecimal bytes and may need converting to decimal in your application. When requesting data, the parameter value represents the number of values requested. Typically, this would be just 0001. If this is set to a higher number, additional bytes will be returned which will may represent the next registers in the series.

Device Address	Function Code	Parameter Address	Values Requested	CRC-16
01	03	00 25	00 01	95 C1



Send the command: 01 03 00 25 00 01 95 C1

After the command is sent, you will receive 7 bytes: 01 03 02 0D AC BC A9

Device Address	Function Code	No. of bytes for value	Parameter Value	CRC-16
01	03	02	0D AC	D5 CA

0D AC = 3500 = 35kHz