Advanced Induction Heater Circuit

A Powerful and Versatile Induction Heating Control System

Model: CRO-2
Type: High performance induction heating coil driver

Features and Specifications

- Up to 3,000 W Heating Power*
- Ultra-high heating frequency Up to 2.0 MHz**
- Optional advanced controller for display and automation
- Customisation available
- Wide supply voltage range (12 V – 30 V)
- Coil voltage 0 V – 100 V up to 30 A DC
- High Efficiency ZVS operation
- I/O connections for logic interfacing & External controls
- Highly compact design
- High quality four layer, 2oz Copper PCB
- Dimensions: L100 x W100 x H44 mm (less than 4 inches)

** Peak power. Max continuous power supported will depend on operating conditions*
** For frequencies over 200 kHz, some customisation may be required. We recommend you contact us to discuss your application.

Example Applications

- Induction Heat Treatment
- Flameless Heating
- Melting Metals
- Jewellery Casting
- Annealing & Hardening
- Ammunition Cartridge Annealing
- Nanoparticle Research
- Wireless Power
- Tesla Coils
- Power Inverters

Typical Usage

Designed for use as a general induction heating controller, its versatility makes it highly suitable for a wide range of applications.

High frequency and power capability makes the CRO-2 is ideal for both scientific work and industrial applications.

With the PWM-4808 addon you can make an advanced induction heating system with automation options and more.

The ***CRO-2*** is a highly versatile **induction heating driver circuit** which uses high-performance components for precision and power in just a small 100 x 100 mm circuit board. The CRO-2 is designed for high power heating applications in scientific and industrial applications. With the optional addon controller (PWM-4808), this induction heater circuit has a huge range of advanced features and can be customised for your specific project.

The ZVS resonant system allows for automatic resonance of induction coils at high currents with minimal losses. Using this system means that you do not need to set or adjust the operating frequency as it is naturally determined by the inductance and capacitance of your work coil.

We designed this circuit so that it can be customised to meet the requirements of a wide range of projects. We can optimise the circuit for maximum power delivery at specific frequencies, or write custom control algorithms and interface with other machinery. Please contact us to discuss requirements. Call, email, or use the live chat on our website.

ELECTRICAL CHARACTERISTICS

NB: Figures may vary under different loading conditions and environments.

Symbol	Parameter	Min	Typical	Max
V_{in}	Input Supply Voltage	12V [1]	15 V	30 V
HV_{in}	Load Supply Voltage	0 V	15 V	80 V
I_{sup}	Supply Current (no load)	25 mA	30mA	100 mA
I_{out}	Continuous Output Current	0 A	-	30 A [3]
I_{pulse}	Pulse Current [2]	-	-	70 A
V_{logic}	Logic (High) Voltage	3.3 V	5 V	5 V
T_{limit}	Thermal Protection Threshold	-	90 C	110 C

Table 1: Electrical Characteristics

[1] 12V is absolute minimum. 15 to 24V recommended. [2] Pulse current is transistors max rated DC current at 25°C.
[3] Max current depends significantly on operating frequency and cooling options.

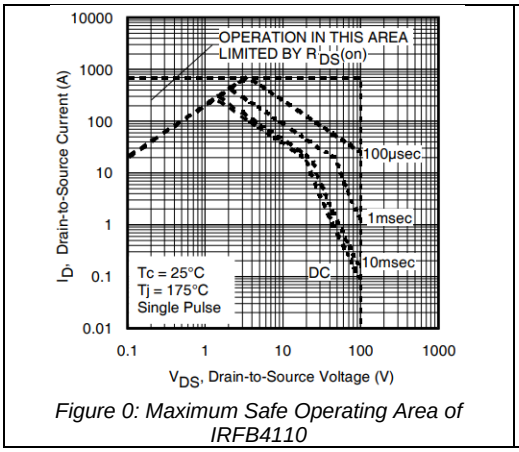


Figure 0: Maximum Safe Operating Area of IRFB4110

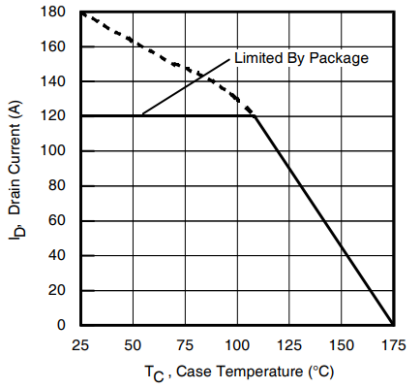
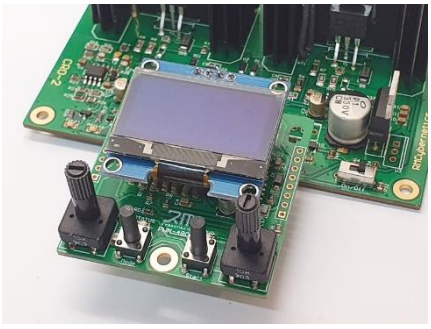


Figure 0: Maximum Current vs Temperature of IRFB4110

Optional Digital Controller – PWM-4808



With the PWM-4808 addon module, you will be able to see the resonant frequency, power levels and other settings. This module also adds a range of additional circuit protection features as it continuously monitors the system for current, voltage, and temperature. As standard the module comes with several operating modes such as PWM mode for adjusting average power, Timed mode for heating for a pre-set time of your choice, and a diagnostic mode for checking the internal parameters. With our customisation services, we can write specific firmware or interface with external hardware such as thermocouples, coolant flow sensors, electronic mechanisms, memory cards and more. See page 5 for instructions on using the addon module with the CRO-2.

Connections & Basic Usage

There are three power input and two power output connections on the CRO-2. The connections can be made using M4 bolts to fix suitable ring type connections in place, or to be screwed down to suitable connection posts. **Any bolts or connectors used on the output section must be made from a non-magnetic material** such as brass or stainless steel to reduce unwanted heating in the connectors due to the high frequency currents.

IMPORTANT: Do not power on or activate the circuit when no output coil is connected to T1/T2 as this could damage the power transistors.

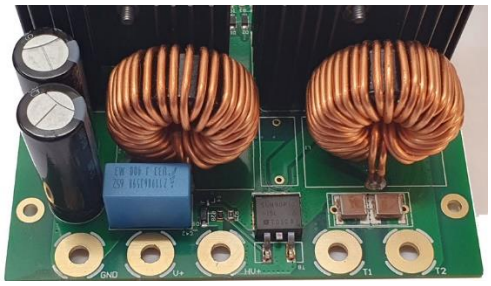


Figure 1: Power Connections

The circuit logic is powered from the GND and V+ inputs using a 12-to-30-volt DC PSU (15V recommended). This connection will power all the onboard electronics including the PWM-4808 addon module if used.

Power for the induction coil is supplied to HV+. If using a single supply rated between 12V and 30 V, you can simply link V+ and HV+ together. If using voltages outside this range, then you will need two separate PSUs or a PSU and suitable DC-DC convertor. Any PSU connected to HV+ must be suitably rated for high current.

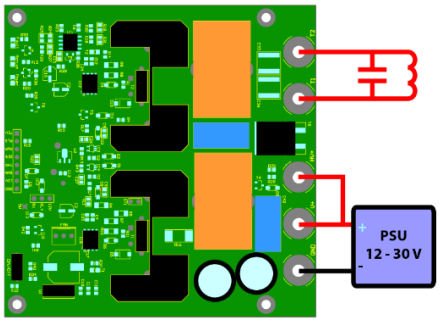


Figure 2 – Single PSU Connection

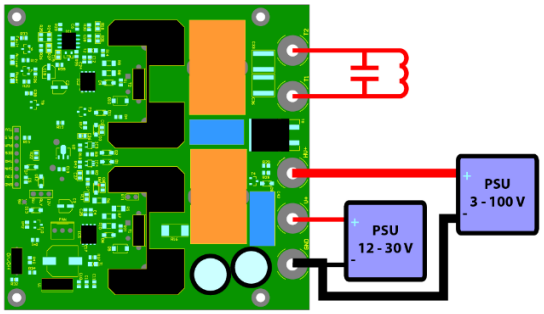


Figure 3 – Dual PSU Connection

Connection	Function
GND	Connect to PSU ground or negative terminal
V+	Connect to PSU positive terminal (12V to 30V)
HV+	Connect to PSU positive terminal (3V to 80V)
T1	Connect to coil
T2	Connect to coil

Table 2: Power and Load Connections

Without an external controller, the circuit has a simple on/off control using the small slide switch or logic inputs. When using any external controller, this switch should be kept in the OFF position to allow the external signals to be used. A full description of using the addon controller can be found later in this datasheet.

Figure 4: Other Connections, Indicators & Controls

Connection	I/O	Description
GND	-	Ground connection for logic and low power external interfaces
12V	OUT	12V power connection for external interfaces. 200mA Max [3]
SHN	OUT	Voltage from the built in 75uR shunt resistor, used to measure current.
THR	OUT	Voltage from the thermistor voltage divider mounted on the heatsink
DIS	IN/OUT	Hold high to disable the oscillator. NB: This may be overridden internally by the switch, external PWM, or the temperature protection circuit.
PWM	IN	Logic signal to enable or disable the oscillator output, HV+ input, and RLY.
PLS	OUT	Square wave signal matching the output oscillation frequency
T1V	OUT	Divided voltage from the coil terminal T1

Table 3: External interface connections

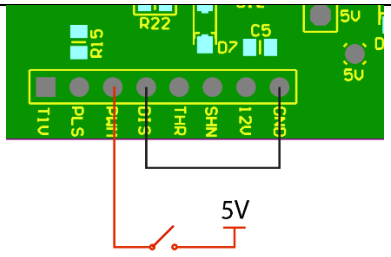


Figure 5: Using an external switch

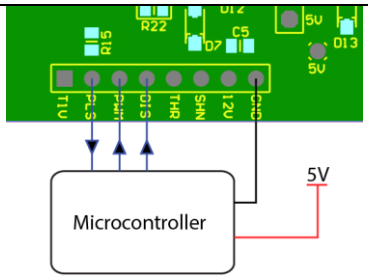


Figure 6: Using an external microcontroller

Connection	I/O	Description
12V	OUT	12V power connection for external relay [3]
RLY	OUT	Open collector output. Used for switching an external HV+ signal. Pulls low on activation, 50mA max.
5V	OUT	5V power connection for external relay [3]
FAN	OUT	Standard 12V Fan Header. 200mA max [3]

Table 4: Other connections

[3] Max 200mA combined output from all 12V and 5V connections.

LED Indicators

There are 5 LED indicators on the CRO-2 used to let you know the operational status of the unit as described in the table below

LED	Function When Lit
Power	Power is present between V+ and GND
Active	HV+ has been activated by the circuit and connected to the work coil.
Fault	Output has been disabled due to high system temperature
T1 & T2	Associated transistor is active. In normal operation, both these should appear to be lit at the same time. If only one is lit, or they are not of equal brightness, this would indicate a problem.

Table 5: LED Indicators

It is important to read and understand ALL these instructions carefully to ensure that the circuit will operate properly. If there is anything you are not sure about, please contact us for support.

Output Coil Considerations

The CRO-2 is a self-resonant system which relies on the integrity and stability of the work coil and tank capacitors to function. To allow the circuit to be used at a wide range of frequencies, the PCB design accounts for some parts being added or changed for optimisation in a particular application.

The work coils available on our website are optimised for use with our driver circuits. If you plan to use your own coil which is significantly different, we recommend contacting us for advice.

The actual power and frequency delivered to the work coil will depend on its dimensions, tank capacitor, and any workpiece in the coil. For more information about this, we suggest reading our ***Guide to Induction Heating***

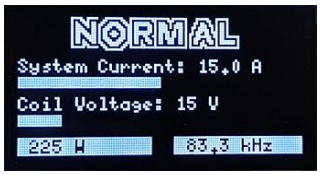
PWM-4808 Controller Usage Instructions

With the PWM-4808 addon module, there are a range of operating modes that can be used. The exact layout and operation may change as we update the firmware. Check our website for details and the latest firmware updates.

Controls
There are four controls on the PWM-4808. Two potentiometers (pots) and two push buttons. The function of each will vary depending on the selected mode, though generally, the left button will be for changing mode and the right one to toggle on and off. It is important to consider that the pot controls position will take effect when changing modes. The driver will be deactivated whenever the mode is changed. Full details are outlined below.

Operating Modes

NORMAL – Simple Start/Stop Operation



BUTTON L:	Next mode
BUTTON R:	On / Off
POT L:	UNUSED
POT R:	UNUSED

This is the mode that loads by default. Pressing the *Start* button will toggle on/off the resonator. Information about the power and frequency will be displayed on the screen.

AUTO - Automatic power activation mode

BUTTON L:	Next mode
BUTTON R:	On / Off
POT L:	Hysteresis
POT R:	Hold Current

When activated, the driver will briefly pulse the coil approximately every second in order to test for the presence of a workpiece. The presence of a workpiece is determined by the measured current exceeding the *hold current* set by the user. If during a pulse, this current (or higher) is detected, the driver will stay on until either deactivated, or the current falls below the threshold. An additional setting for *hysteresis* is available to improve stability. Once the *hold*

current is reached, automatic deactivation will not occur unless the current falls below the *hold current* minus *hysteresis*.

TIMED – On / Off with Timer

BUTTON L: Next mode
BUTTON R: On / Off
POT L: UNUSED
POT R: Time

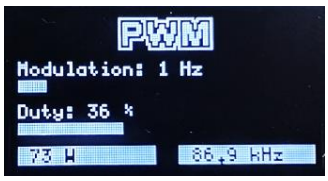
Press the button to activate the driver for a user defined amount of time. By default, this can be up to 60 seconds. Longer times can be achieved with custom firmware.

AUX – Automatic temperature control

BUTTON L: Next mode
BUTTON R: On / Off
POT L: UNUSED
POT R: Target Temperature

Automatic workpiece temperature regulation can be achieved by using an external sensor. When activated the driver will stay on until the target temperature is reached. When reached it will deactivate, automatically activating again when the workpiece temperature drops.
The temperature sensor used must output a voltage in the range 0-5V proportional to the measured temperature.

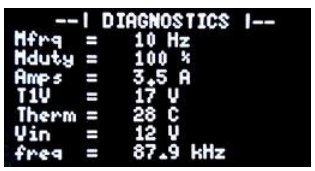
PWM – Pulse Width Modulation



BUTTON L: Next mode
BUTTON R: On / Off
POT L: Frequency
POT R: Duty

The output driver will be pulsed in order to adjust the average heating power delivered to a workpiece. For example, setting the *duty* to 50% and *frequency* to 1Hz will activate the driver for 0.5s, then deactivate for 0.5s, thus delivering an average power of 50% compared to normal mode. This pulsed mode can be hard on the driver components (and could cause them to fail) so we suggest only using it if you have a good stable setup and at low power levels. The lowest *frequency* setting is the most reliable. If you are unsure about using this mode or anything else, please contact us for assistance. Note that in PWM mode, the pulsing output will mean that the display for power and frequency may be unstable.

DIAGNOSTICS – Display diagnostic information



BUTTON L: Next mode
BUTTON R: On / Off
POT L: Frequency
POT R: Duty

The output will operate in the same way as PWM mode described above. On the screen will be additional information about the internal readings which can help when diagnosing problems or developing your system.