HEATSAIL HGCB

ENGINEERING GUIDE

Version	Date		Author	Approved
1.0	12/3/24	Initial release	Jan Van Bogaert	Daniël Suykerbuyk

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DESCRIPTION

This document serves as reference for evaluating and using the HGCB.

HGCB stands for “HEATSAIL Generic Control Board” .

The main function of the HGCB is to serve as the controller of various HEATSAIL products in different configurations.

It’s basic function is to:

- control heating by means of relay switching and
- control lighting by means of trailing edge phase cut dimming.

The HGCB acts on commands received wirelessly over BLE, Bluetooth low energy or Bluetooth 5

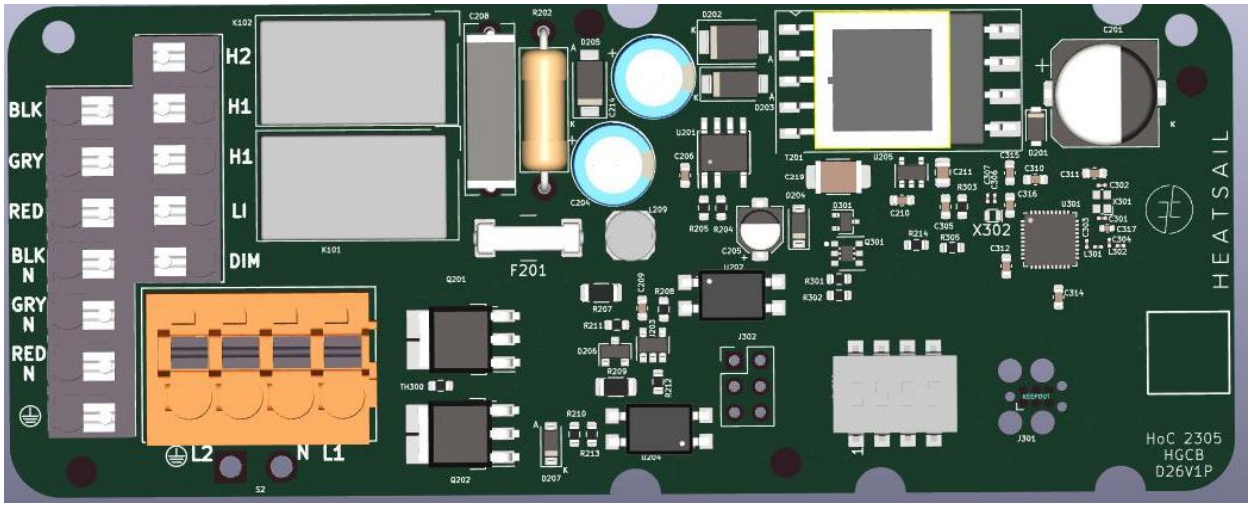

Figure 1 HGCB Overview

SYSTEM OVERVIEW

BLOCK DIAGRAM

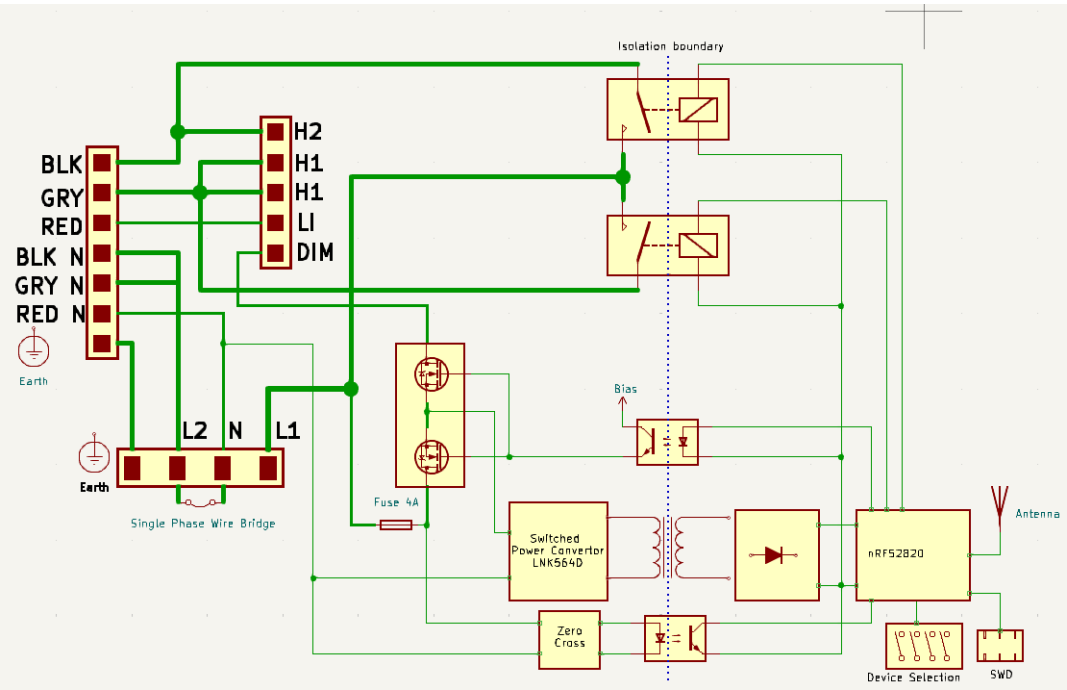

Figure 2 HGCB Block Diagram

SYSTEM DESCRIPTION

The HGCB has three power connectors for accommodating the HGCB into different Heatsail systems.

- Connector MAINS is used to connect the incoming power from home power grid. In a single phase power net (standard) the L2 power terminal is bridged with the N (Neutral). In case that a 2 -phased power system (240 – 120V - USA) is used, the Single Phase Wire Bridge needs to be removed.
- The connector on the left is used to connect the heating elements and the lighting system (lamp(s)).
- The middle connector is used in some configurations to by-pass the HGCB with external manual switches. In case by-passing is not used, the LI and DIM signal on this connector need to be bridged.

Heating is controlled by two relays, dimming is achieved by applying a PWM signal to a pair of High Voltage Power MOSFETS.

The system also has an isolated power supply for powering the nrf52820 microcontroller and its environment. Isolation from mains is implemented for having galvanic mains isolation which is convenient during programming and testing. But because all user interactions are done by wireless communication, there is no functional need for this isolation when the device is in the hands of the end-user.

The HGCB is controlled by the nRF52820 microcontroller from Nordic Semiconductors. This controller includes a Bluetooth Low Energy transceiver. Based on the commands received over BLE, the microcontroller will:

1. Activate / deactivate the relays for heating control.
2. Drive a pulse width modulated signal towards the power MOSFETS to set the right dimming level. Dimming is achieved by cutting the power early during each mains power cycle. The zero crossing of the net is detected by the zero cross circuit and communicated through an optocoupler to the microcontroller. After each zero crossing the MOSFETS are switched on, and switched-off again

depending on the desired light intensity. “No light” is achieved by switching-off the MOSFETS immediately after switching-on at the zero crossing. 100% light is achieved in case the MOSFETS are left on util the end of the power cycle. This dimming principle is called trailing-edge dimming. In order to achieve the right dimming, the PWM signal is different for 50Hz and 60HZ power systems. The lamp types that are to be applied are mains driven halogen. LED’s can be accommodated using an appropriate power convertor.

The microcontroller of the HGCB automatically detects the net frequency (50 or 60 Hz) and adapts the PWM signal accordingly.

The HGCB also monitors the temperature of the HGCB with a sensor that is positioned close to the MOSFETS. When the temperature threshold is exceeded, power is reduced by dimming the light lower.

The HGCB communicates with outside world using Bluetooth Low Energy. The HGCB acts as a BLE peripheral that advertises a Complete Local Name. The Complete Local Name in the advertisement data has the form: “HEATSAIL xxxx yyyy” where xxxx represents the product type that hosts the HGCB (see table below) . yyyy is a 4 character identifier which the microcontroller generates from its own serial number, and is therefore unique.

The HGCB is used in various Heatsail products. The hosting product is identified by reading the 4 dipswitches. The switch positions are mapped on product types by the software. The following table gives the current programmed settings.

Product Type (xxxx)	SW1	SW2	SW3	SW4
DOFS	U	U	U	U
DOPT	D	U	U	U
DIFS	U	D	U	U
DIPT	D	D	U	U
BEEM	U	U	D	U
LEAF	D	U	D	U
GLOW	U	D	D	U

SPECIFICATION

Item	Min	Max	Unit	Condition
Input Voltage Range	90	240	V	50 or 60 Hz
Power Consumption		400	mW	Dimming and Heating off
DIM Load Power		150	W	No cooling on MOSFETs
		300	W	MOSFETs equipped with heat sink
HEAT Load		10	A	Per relay
		20	A	Both relays active
Operating temperature	-40	80	^{0}C	Ambient air temperature
	-40	100	^{0}C	PCB temperature
Bluetooth 5.3 radio TX power		0	dBm	BLE Advertising
RX sensitivity		-90	dBm	Connected as peripheral
Isolation	1000		V	Mains N vs microcontroller ground

ENVIRONMENTAL COATING

The HGCB is intended for outdoor use. In order to protect the electronic components, the PCB and the solder joint against the environment, a conformal coating is applied.

CRITICAL COMPONENTS

Following components are critical in accomplishing the safety and regulatory requirements.

Assembly Reference(s)	Function	Part_Number	Manufacturer
F201	Fuse 4A	3403.0172	schurter
J1	Connector for Mains	1330200000	Weidmuller
J2	Connector for Heating, Lighting	1826010000	Weidmuller
J3	Connector for external switch	1825990000	Weidmuller
K101, K102	Relays for heating	OJT-SS-105HM	TE Connectivity
Q201, Q202	MOSFETS for dimming	IPD60R280P7ATMA1	Infineon
T201	Transformer	750817014	WE
U201	Power conversion chip	LNK564DG-TL	Power Integrations
U202, U204	Optocouplers	FOD817DSD	ONSEMI
U301	Microcontroller with BLE	NRF52820-QDAA-R7	Nordic Semiconductors

The HGCB pcb also features an antenna that is tuned on the ISM band used for Bluetooth (2.5GHz) . The antenna is of type monopole λ/4 and is build using PCB traces. Its design and tuning has been verified by Nordic Semiconductors.

USAGE

The following pictures indicate how the HGCB can be applies in various Heatsail product configurations.

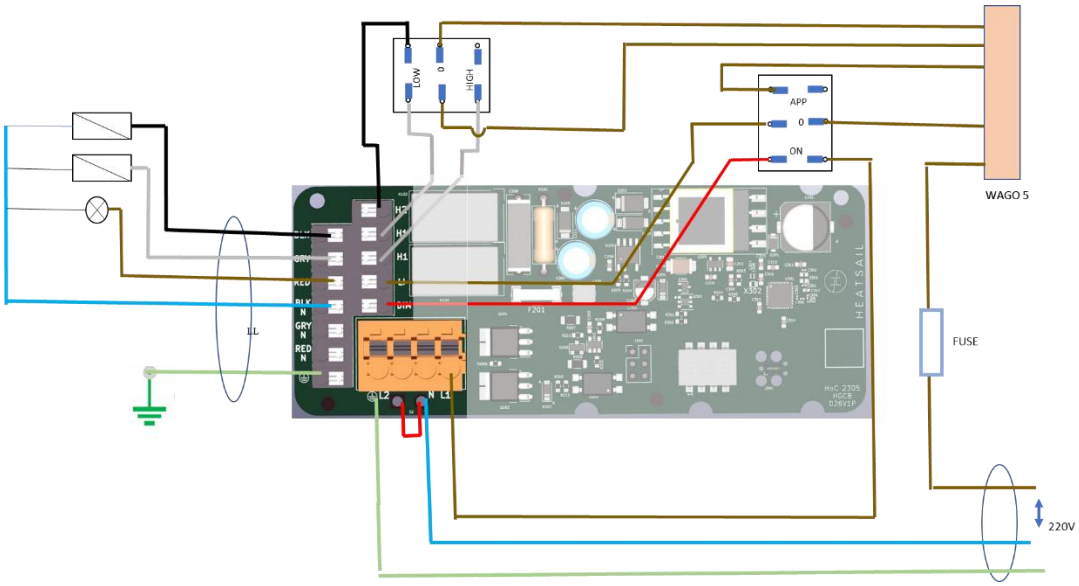

Figure 3 HGCB applied single phase with extra switches

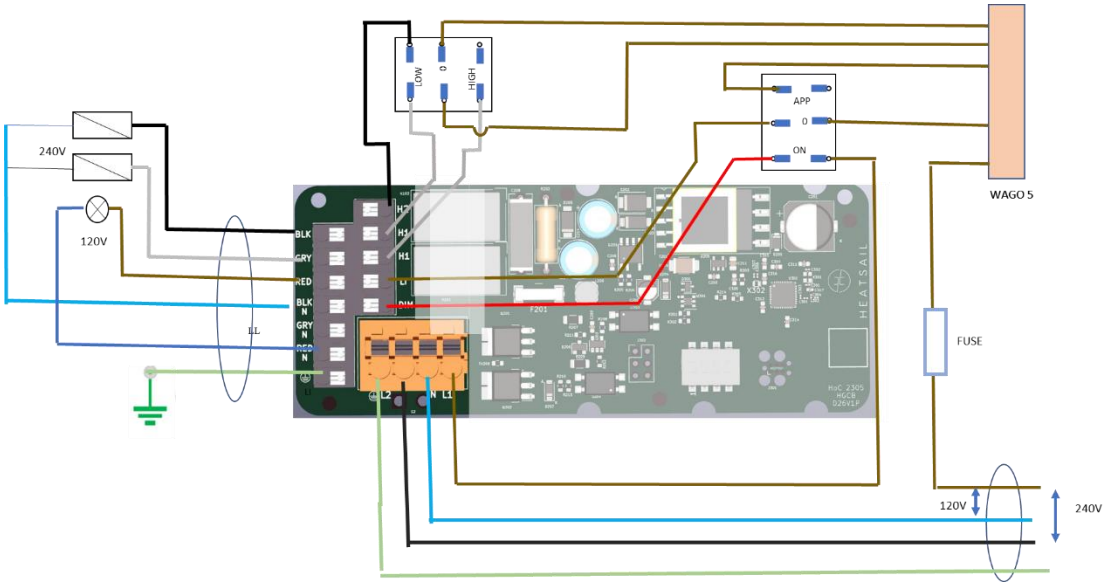

Figure 4 HGCB applied in two-phase system with extra switches

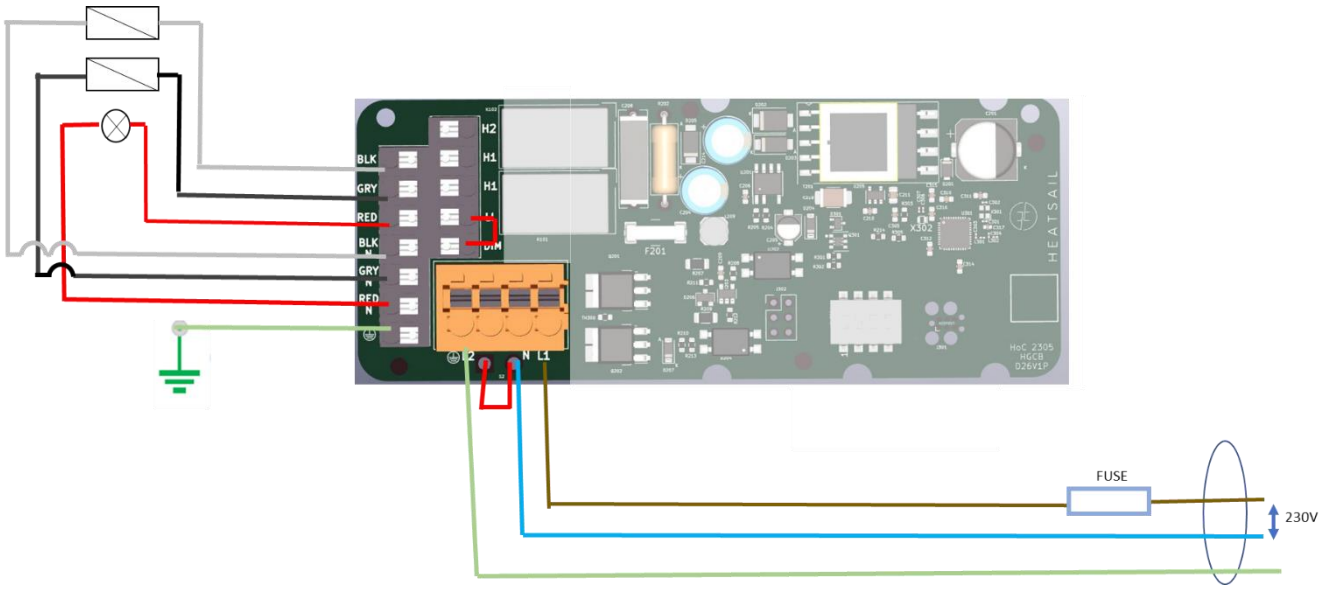

Figure 5 HGCB applied in single phase system - no extra switches

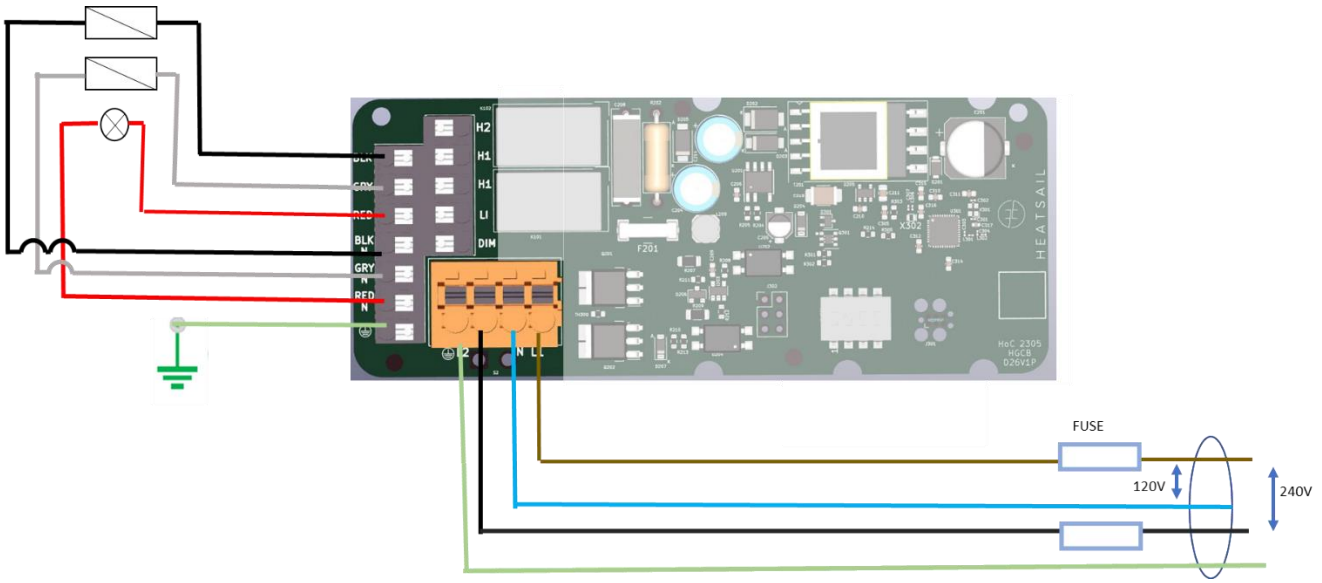

Figure 6 HGCB applies in two phase system - no extra switches

FCC Caution:

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation.If this equipment does cause harmful interference to radio or television reception,which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

-- Reorient or relocate the receiving antenna.

-- Increase the separation between the equipment and receiver.

-- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

-- Consult the dealer or an experienced radio/TV technician for help.

To maintain compliance with FCC ’ s RF Exposure guidelines, This equipment should be installed and operated with minimum distance between 20cm the radiator your body: Use only the supplied antenna.