



Features

- 18-60Vdc Input voltage
- Up to 600/1000W output power
- High temperature – 85degC
- Hall and Resolver Interface
- Support Sensorless Running
- 2 x Digital or Analog inputs (5V)
- Open Drain Output
- Compact and rugged aluminum housing
- CANbus and RS485 Interface
- Field Oriented Control
- High shock and vibration resistance



Product Description

The NSE LT 60V Brushless DC Motor Controller is a high performance, industrial temperature motor controller designed for applications that require a compact and ruggedized full featured controller. It is targeted for subsea and other industrial and automotive applications.

The LT 60V Brushless DC Motor Controller comes with an embedded firmware that allows sophisticated control of a wide variety of motors. An open interface protocol combined with NSE or 3rd party/customer software allow easy setup and configuration to most available Brushless DC motors. The controller can also be set up to have autonomous- and/or customer defined behavior.

The LT 60V Brushless DC Motor Controller has all the sensors and algorithms required to run closed loop control of RPM, input power and output current (torque). The controller has integrated both resolver and hall encoder interface integrated. The desired interface can be selected through the communication interface. This feature, combined with its other easily configurable settings, increases the flexibility of the controller and allows the same controller to be used in a wide range of applications and tools.

In order to operate reliably the controller has high efficiency, reducing the dissipated power to a minimum. The logic and control section has low current consumption in order to further increase operational time in cases where the controller is run from battery.

The PCB layout is designed with ruggedness in mind. A CNC machined aluminum chassis provides maximum mechanical support to allow the board to operate in an environment where very high shock and vibration may occur. The board has rugged high temperature connectors.

1 Product Specification

1.1 Electrical Specifications

Parameter	Conditions / Comments	Min	Typ	Max	Unit
SUPPLY VOLTAGE					
Input Voltage	<i>Specified operational range - A/B Version</i>	18		60	Vdc
Input Current to driver stage	<i>Note de-rating @ temperature - A Version - B Version</i>			10 16.6	Adc Adc
Current consumption (excluding motor current)	<i>Standby @ 28Vdc Input Running @ 28Vdc Input *Depend on connected resolver</i>	30	40	60 80*	mA mA
DRIVE SECTION					
Commutation Mode	<i>Resolver – Ref. fw. section Sensorless – Ref. fw. section Hall Feedback</i>		FOC FOC Trapez.		
Speed Range	<i>2 pole motor – Resolver 2 pole motor - Hall Encoder 2 pole motor – Sensorless *Depend on motor characteristics</i>	0 0 700*		16.000 16.000 16.000*	RPM RPM RPM
Output Motor Current	<i>- A Version - B Version</i>	0		10 16.6	A A
Input Current Sensor Range	<i>- A Version - B Version</i>	0		10 20	Adc Adc
Motor Current Sensor Range	<i>- A Version - B Version</i>	0		+/-10 +/-20	A A
PWM Switching Frequency range		16		48	kHz
FEEDBACK INTERFACE					
Motor Position Feedback	<i>Firmware Selectable</i>	Hall /	Resolver /	Sensorless	
Hall Excitation Voltage		4	5	5.5	Vdc
Hall Excitation Current				20	mA
Resolver Excitation Voltage		3.5	4	5	Vp-p
Resolver Excitation Current				20	mA rms
Resolver Excitation Frequency	<i>Firmware Selectable</i>	10		20	kHz
ANALOG/DIGITAL INPUT					
Number of channels	<i>Configurable Analog or Digital</i>		2		
Input impedance			9.4		kΩ
Input voltage range	<i>Configured as Analog Input</i>	0		5	V
Input High Voltage	<i>Configured as Digital Input</i>	4.8			V
Input Low Voltage	<i>Configured as Digital Input</i>			0.2	V

EXTERNAL TEMPERATURE SENSOR Sensor Type	<i>RTD - firmware selectable.</i>	PT100 / PT1000			
Temperature Range		-20	200	°C	
OPEN DRAIN OUTPUT Voltage rating			60	Vdc	
Current rating			1	A	
PWM Switching Frequency	<i>Output can be set in 10% steps</i>	1		kHz	
MECHANICAL DIMENSIONS Chassis Length Chassis Width Chassis Height		160 51,5 20.5		mm mm mm	
CANBUS INTERFACE Baud Rate		83.3	125	250	kbits/s
RS485 INTERFACE Baud Rate		38.4	38.4	250	kbits/s
ENVIRONMENTAL AND THERMAL <i>Ambient temperature</i>	<i>Min and Max temperature on the surface of the outer housing given that thermal resistance is within the specification</i>	-20		85	°C
<i>Thermal Resistance</i>	<i>Surface of OUTER HOUSING to NSE UNIT</i> <i>*Refer to the Section "Thermal properties" for further definition</i>			0.5	°C/W
OPERATIONAL LIFETIME <i>Expected Lifetime</i>		T.B.D			Hours

1.2 Thermal properties

The NSE LT 60V BLDC Motor Controller is designed to operate in an environment up to 85°C.

In a typical assembly, the **NSE UNIT** is mounted to a **MOUNTING PROFILE** that is located inside an **OUTER HOUSING**.

The **OUTER HOUSING** surface temperature should not rise above the specified maximum ambient temperature, and the mechanical design and interface between the **OUTER HOUSING**, **MOUNTING PROFILE** and the **NSE UNIT** should be such that the thermal resistance specification is achieved.



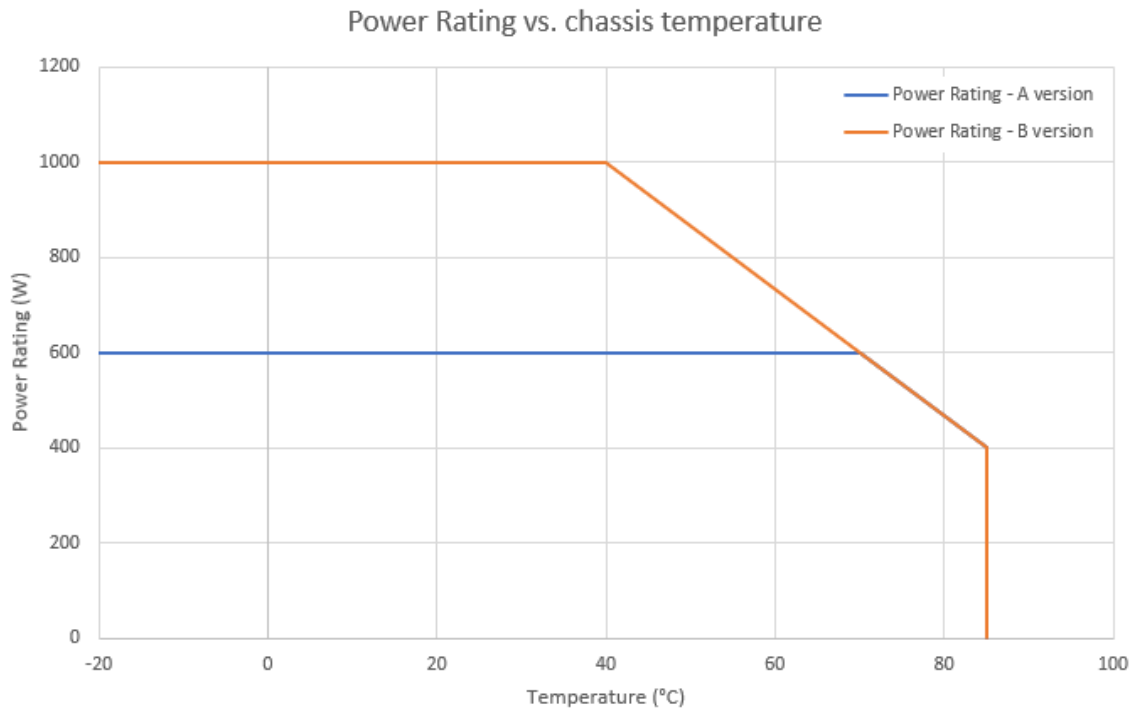
1.3 Conformal Coating

This product is delivered with no conformal coating.

1.4 Environmental requirements

NSE boards must be installed in dry air at atmospheric pressure (1atm). Avoid humid atmosphere or under / overpressure. Refer to general NSE installation guidelines for more information.

1.5 Input power rating



2 Connections

2.1 Input Power



Motor Controller Connector: **M3 shanks**
 Mating connector: **M3 ring terminals. Max outer diameter = 7mm**
Suggested Phoenix contact 3240016 -
Terminals Ring cable lug red M3 0.5-1.5 mm² (16-20AWG)
 Mating torque: **0.5Nm**
 Cable kit: **5 x M3 ring terminals Included in NSE-5001-15-CON A/B**

Pin	Signal name	Description / Function	NSE Connector kit wire type	NSE Connector kit wire color
VIN	VIN	Supply Voltage Positive In	PTFE - 18AWG	ORANGE
GND	GND	Supply Voltage Ground	PTFE - 18AWG	GREEN

2.2 Motor Phase Outputs



Motor Controller Connector: **M3 shanks**
 Mating connector: **M3 ring terminals. Max outer diameter = 7mm**
Suggested Phoenix contact 3240016 -
Terminals Ring cable lug red M3 0.5-1.5 mm² (16-20AWG)
 Mating torque: **0.5Nm**
 Cable kit: **5 x M3 ring terminals Included in NSE-5001-15-CON A/B**

Pin	Signal name	Description / Function	NSE Connector kit wire type	NSE Connector kit wire color
A	PHASE A	Motor Phase A	PTFE - 18AWG	RED
B	PHASE B	Motor Phase B	PTFE - 18AWG	BLACK
C	PHASE C	Motor Phase C	PTFE - 18AWG	WHITE
GND*	GND	GND	PTFE - 18AWG	GREEN

*Note that ground wire from motor can be connected in parallel with the input ground

2.3 H1 - Resolver connector



Part Number	Description
M80-5000822	PCB Connector
M80-FC20868FC-0150L	Pre-wired cable – 150mm – 24AWG
Alt. 1 M80-4600842	Alternative 1 - Cable connection kit 22AWG
Alt. 2 M80-4610842	Alternative 2 - Cable connection kit 24-28AWG

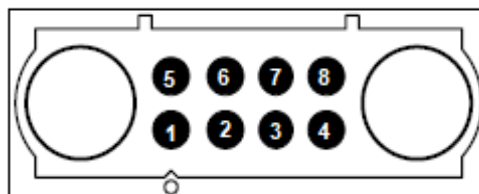


Figure 1 - M80-5000822 Top view
This is the PCB mounted connector on the driver

Pin	Signal name	Description / Function	NSE Connector kit wire type	NSE Connector kit wire color
1	EXEC+	Resolver excitation + Should be twisted with Pin 2 / EXEC-	24AWG - PTFE	Black
2	EXEC-	Resolver excitation – Should be twisted with Pin 1 / EXEC+	24AWG - PTFE	Brown
3	SIN+	Resolver SIN + Should be twisted with Pin 4 / SIN-	24AWG - PTFE	Red
4	SIN-	Resolver SIN – Should be twisted with Pin 3 / SIN+	24AWG - PTFE	Orange
5	COS+	Resolver COS + Should be twisted with Pin 6 / COS-	24AWG - PTFE	Yellow
6	COS-	Resolver COS – Should be twisted with Pin 5 / COS+	24AWG - PTFE	Green
7	RTD+	Motor RTD + Twist with Pin 8	24AWG - PTFE	Blue
8	RTD-	Motor RTD - Twist with Pin 7	24AWG - PTFE	Violet

2.4 H2 - Hall connector



Part Number	Description
M80-5000822	PCB Connector
M80-FC20868FC-0150L	Pre-wired cable – 150mm – 24AWG
Alt. 1 M80-4600842	Alternative 1 - Cable connection kit 22AWG
Alt. 2 M80-4610842	Alternative 2 - Cable connection kit 24-28AWG

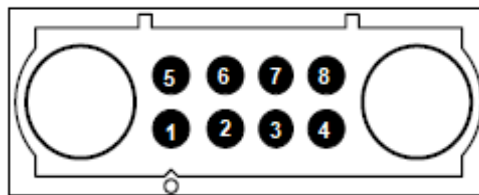
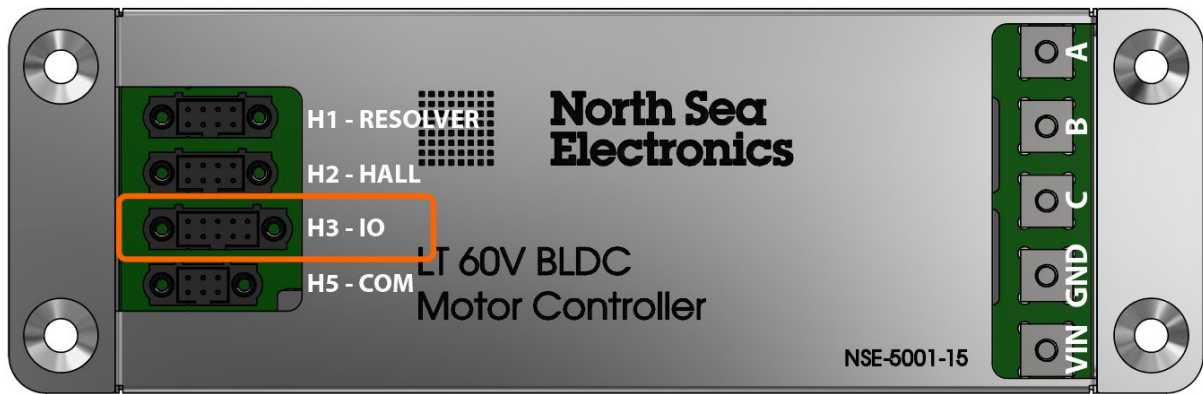


Figure 2 - M80-5000822 Top view
This is the PCB mounted connector on the driver

Pin	Signal name	Description / Function	NSE Connector kit wire type	NSE Connector kit wire color
1			24AWG - PTFE	Black
2	5VHALL	Motor Hall Sensor Supply	24AWG - PTFE	Brown
3	HALL A	Hall Sensor A	24AWG - PTFE	Red
4	HALL B	Hall Sensor B	24AWG - PTFE	Orange
5	HALL C	Hall Sensor C	24AWG - PTFE	Yellow
6	GND	Motor Hall sensor ground	24AWG - PTFE	Green
7	RTD+	Motor RTD +	24AWG - PTFE	Blue
8	RTD-	Motor RTD -	24AWG - PTFE	Violet

2.5 H3 – IO Connector



Part Number	Description
M80-5001042	PCB Connector
M80-FE21068F2-0450L	Pre-wired cable – 5mm mold - 450mm – 24AWG
Alt. M80-FF21068F2-0450L	Alternative - Pre-wired cable – 1mm mold - 450mm – 24AWG
Alt. M80-4611042	Alternative - Cable connection kit 24-28AWG

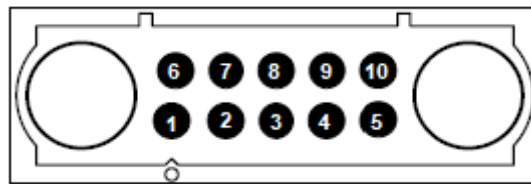
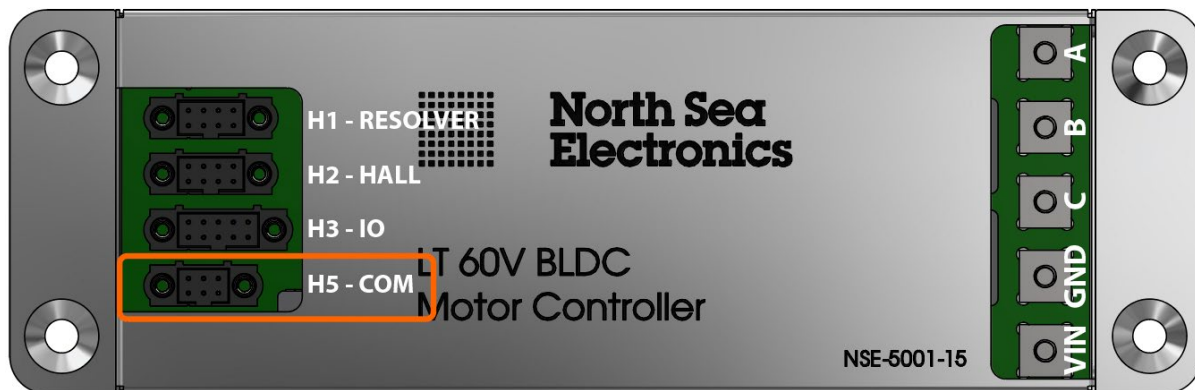


Figure 3 - M80-5001042 Top view
This is the PCB mounted connector on the driver

Pin	Signal name	Description / Function	NSE Connector kit wire type	NSE Connector kit wire color
1	RXD	UART RX – 3.3V Level	24AWG - PTFE	Black
2	TXD	UART TX – 3.3V Level	24AWG - PTFE	Brown
3	DIN1	Digital Input – 3.3V to 5V level – Internal 10k pull-up to 3.3V	24AWG - PTFE	Red
4	DIN2	Digital Input – 3.3V to 5V level – Internal 10k pull-up to 3.3V	24AWG - PTFE	Orange
5	AIN1	0-5V or 4-20mA analog input	24AWG - PTFE	Yellow
6	AIN2	0-5V or 4-20mA analog input	24AWG - PTFE	Green
7	5VEXT	+5V supply for external sensors	24AWG - PTFE	Blue
8	OPEN_DRAIN	Open drain for relay/solenoid	24AWG - PTFE	Violet
9	GND	Ground	24AWG - PTFE	Grey
10	GND	Ground	24AWG - PTFE	White

2.6 H5 – Communication Connector



Part Number	Description
M80-5000642	PCB Connector
M80-FE20668F2-0450L	Pre-wired cable – 5mm mold - 450mm – 24AWG
Alt. M80-FF20668F2-0450L	Alternative - Pre-wired cable – 1mm mold - 450mm – 24AWG
Alt. M80-4610642	Alternative - Cable connection kit 24-28AWG

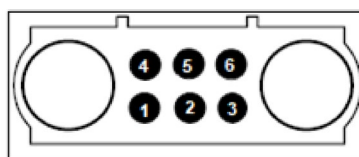
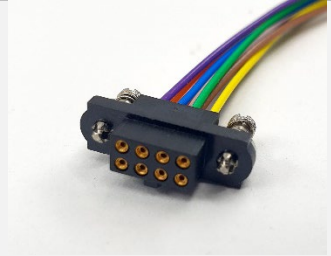
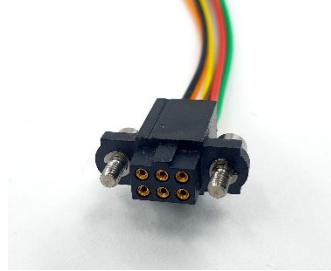


Figure 4 - M80-5000642 Top view
This is the PCB mounted connector on the driver

Pin	Signal name	Description / Function	NSE Connector kit wire type	NSE Connector kit wire color
1	CANH	CAN High (Should be twisted with Pin 2 / CANL)	24AWG - PTFE	Black
2	CANL	CAN Low (Should be twisted with Pin 1 / CANH)	24AWG - PTFE	Brown
3	GND	Ground	24AWG - PTFE	Red
4	GND	Ground	24AWG - PTFE	Orange
5	RS485-A	RS485 A (Should be twisted with Pin 6 / B)	24AWG - PTFE	Yellow
6	RS485-B	RS485 B (Should be twisted with Pin 5 / C)	24AWG - PTFE	Green

3 Cable kit

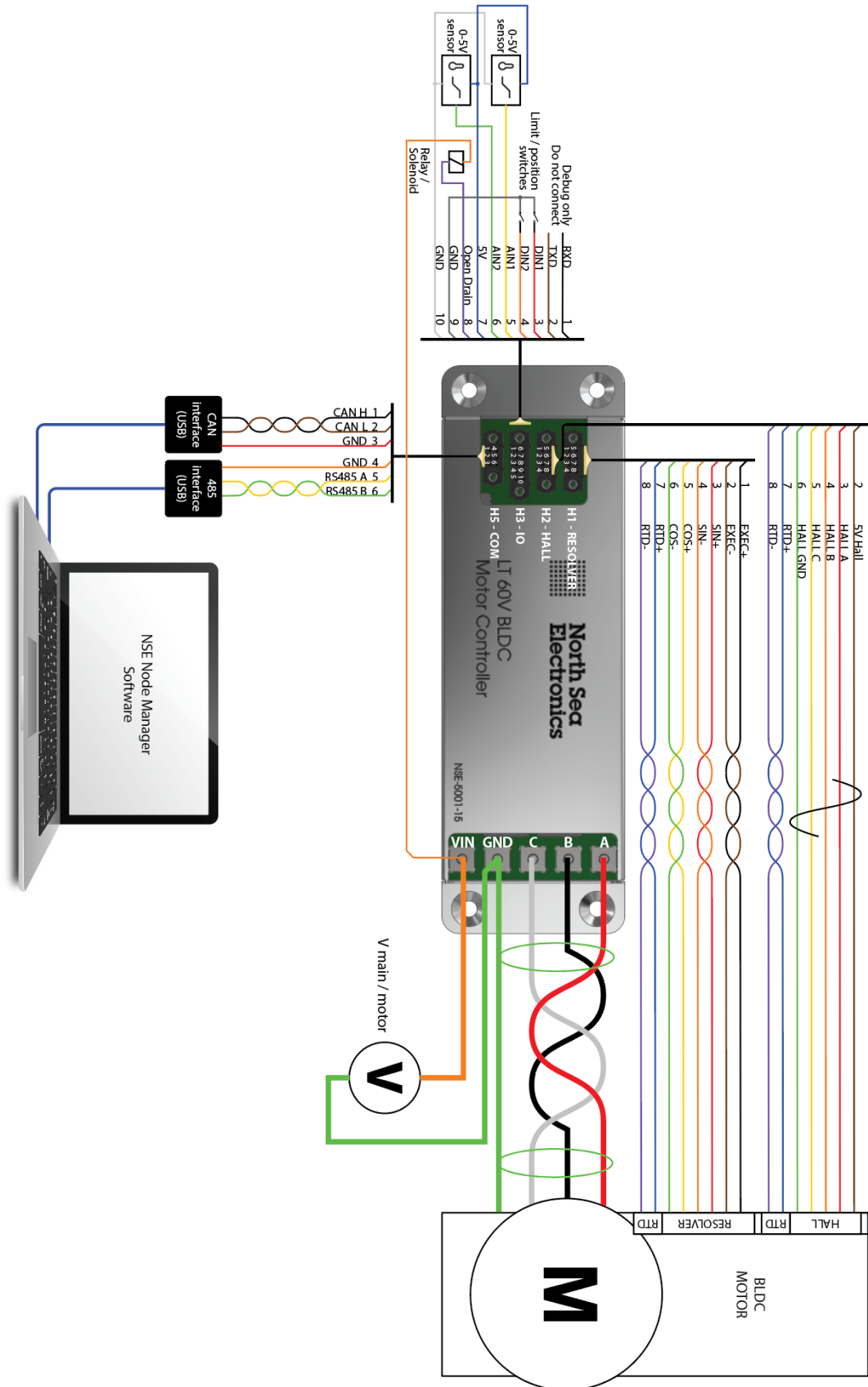
3.1 NSE-5001-15-CON-A

Item #	Description	Specification	Photo
1	Resolver or Hall Cable	M80-FC20868FC-0150L 8 pin Pre-wired cable – 150mm – 24AWG	
2	Communication Cable	M80-FE20668F2-0450L Pre-wired cable – 5mm mold - 450mm – 24AWG	
3	Power Ring terminals	M3 ring terminal x 5	

3.2 NSE-5001-15-CON-B

Item #	Description	Specification	Photo
1	Resolver or Hall Cable	M80-FC20868FC-0150L 8 pin Pre-wired cable – 150mm – 24AWG	
2	IO Cable	M80-FE21068F2-0450L Pre-wired cable – 5mm mold - 450mm – 24AWG	
3	Communication Cable	M80-FE20668F2-0450L Pre-wired cable – 5mm mold - 450mm – 24AWG	
4	Power Ring terminals	M3 ring terminal x 5	

4 Block diagram



5 Features

Feature	Description
Communication Interface	The controller is delivered with both RS485 or CAN bus communication interface. The unit has no CAN termination resistor.
Input power filter	The controller has a power filter in order to reduce radiated noise from the driver during operation. Note however that this filter will not remove all ripple currents and voltages, so depending on the application – further power line filtering may be required. Consult NSE for more information on the power filter and noise characteristics
Hall and resolver interface	The controller has both resolver and hall interface integrated.
Voltage and current sensing	The controller has embedded sensors for both input voltage and current, and phase currents. In addition, it can sense the phase voltages and back EMF.
Temperature sensing	There are two embedded temperature sensors (logic section and transistor temperature). These can both be read out through the CAN communication interface. There is an external interface to an RTD sensor – either PT100 or PT1000. The choice of sensor is selectable through the communication interface. Typically, this sensor is used to monitor motor temperatures.
0-5V Analog Input	The controller has 2 x 0-5V analog input that can be used for analog voltage control of speed or other functions. Consult NSE for implementation of this feature.
Open Drain Output	The controller has 1 x Open Drain output than can be used for general purpose switching. The output can be PWM controlled in steps of 10%.

6 Firmware

The embedded firmware features all the necessary functions to set up and run most available Brushless DC motors. Setup of the controller is stored in a non-volatile memory that can also easily be down- and uploaded to a computer in order to save and restore defined configurations.

6.1 Control parameters

Parameter(s)	Setting(s)
Run Control	Start / Stop
Drive/Feedback Mode	Resolver / Hall-Encoder / Sensorless
Motor Configurations	Pole Pair, Resolver settings, PWM frequency
Sensorless Configurations	Senorless characteristics
Speed	Speed (RPM) setpoint
Input Current	Input current setpoint (correlate with input power for a fixed voltage input)
Phase Current	Phase current setpoint (correlate with torque)
Position setpoint	Position setpoint (if run in position control)
PID parameters	PID regulation settings
Startup parameters	Configuration for auto- start and stop at defined voltages
Alarm parameters	Configuration of alarm parameters
Communication	CAN Address, baud rate, node ID
Other Parameters	Other control and configuration parameters. Refer to register description for a full overview of parameters

6.2 Feedback parameters

Parameter(s)	Readout
Drive state	Drive state (Resolver / Hall / Sensorless), Regulation mode
RPM	Motor RPM
Currents	Input (power) and output (torque) currents
Voltages	Input voltage and internally measured voltages (for diagnostics)
Position	Position step counter
Temperatures	Internal and external (RTD) temperatures
Alarm	Alarm status
Other Parameters	Other feedback parameters. Refer to register description for a full overview of parameters

6.3 Alarm parameters

Parameter	Function
Under Voltage	Under voltage shutdown
Over Voltage	Over voltage shutdown
Input current	Shutdown if input current exceeds the defined limit
Phase current	Shutdown if the phase current (torque) exceeds the defined limit
Temperature	Shutdown if the transistor temperature exceeds the defined limit
Under RPM	Shutdown if the RPM drops below threshold
Sensorless Stall	Shutdown if the sensorless algorithm detect stall of motor

6.4 Field Oriented Control

When running in resolver- or sensorless mode the controller will use field oriented control with space vector modulation of the PWM in order to control the motor. In short this means that the control of the motor is done by regulating the phase current as an inner regulation loop, allowing the controller to respond immediately to any load changes on the motor.

Space vector modulation is regarded as the most efficient way of running the motor, and ensure that the motor is running smooth with low torque ripple and wear of the bearings.

When running with hall encoder feedback, the controller will run standard trapezoidal control of the motor.

6.5 Closed loop regulation

The controller has the ability to run closed loop control of a motor. All the parameters have a control loop and they are run simultaneously – so that the controller can regulate the speed of a motor at a certain RPM and until the torque reaches a defined level in which the torque control loop will take over the regulation.

Parameter	Function
Speed	Regulate the speed of the motor to the desired setpoint
Phase current	Control the phase currents of the motor. This correlates with the motor torque.
Input current	Control the input current of the motor. For a steady input voltage, regulating the input current will regulate the input power.
Position	If in position mode, the motor will go to the position setpoint, using the internal position counter (number of motor steps)

6.6 Bootloader

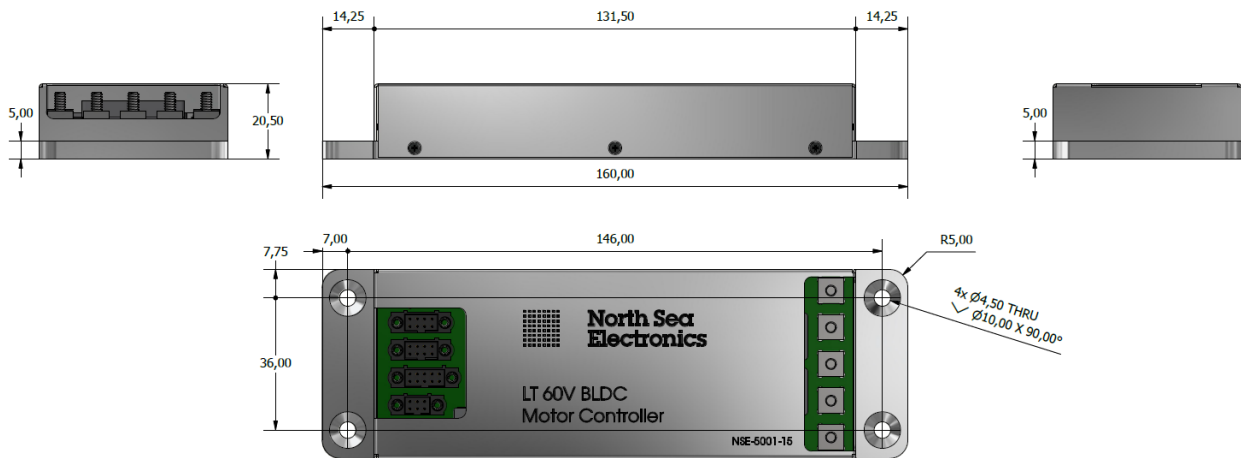
The controller is provided with a bootloader that allows for easy updates of the firmware. NSE is constantly making improvements and adding features to its firmware-base and the bootloader allows the customer to upgrade a controller if desired.

7 Graphical User Interface

The “NSE Node Manager” software (graphical user interface) is a free of charge software that can be used to set up and run the motors. This software uses the standard NSE protocol to communicate with the controller and allows the user to set up and run the system in a short time.

Using a USB to CANbus adapter and the “NSE Node Manager” software one can connect to the controller to control and set it up. Configuration profiles can easily be stored to the computer.

8 Mechanical Dimensions



9 Ordering

9.1 Order code

		Order code:	NSE-5001	-15	-X
Category	NSE-5001	= NSE Motor Controllers			
Model	-15	= 60V Industrial Temperature controller			
Rating	-A	= 18 – 60V / 0 – 10A			
	-B	= 18 – 60V / 0 – 16A			

9.2 Where to buy

Email: sales@nse.no
 Web: www.nse.no
 Phone: +47 406 48 400

10 Revision History

REV	DATE	DESCRIPTION	PREP	APPR
A	02.09.2022	Initial Release	RFY	