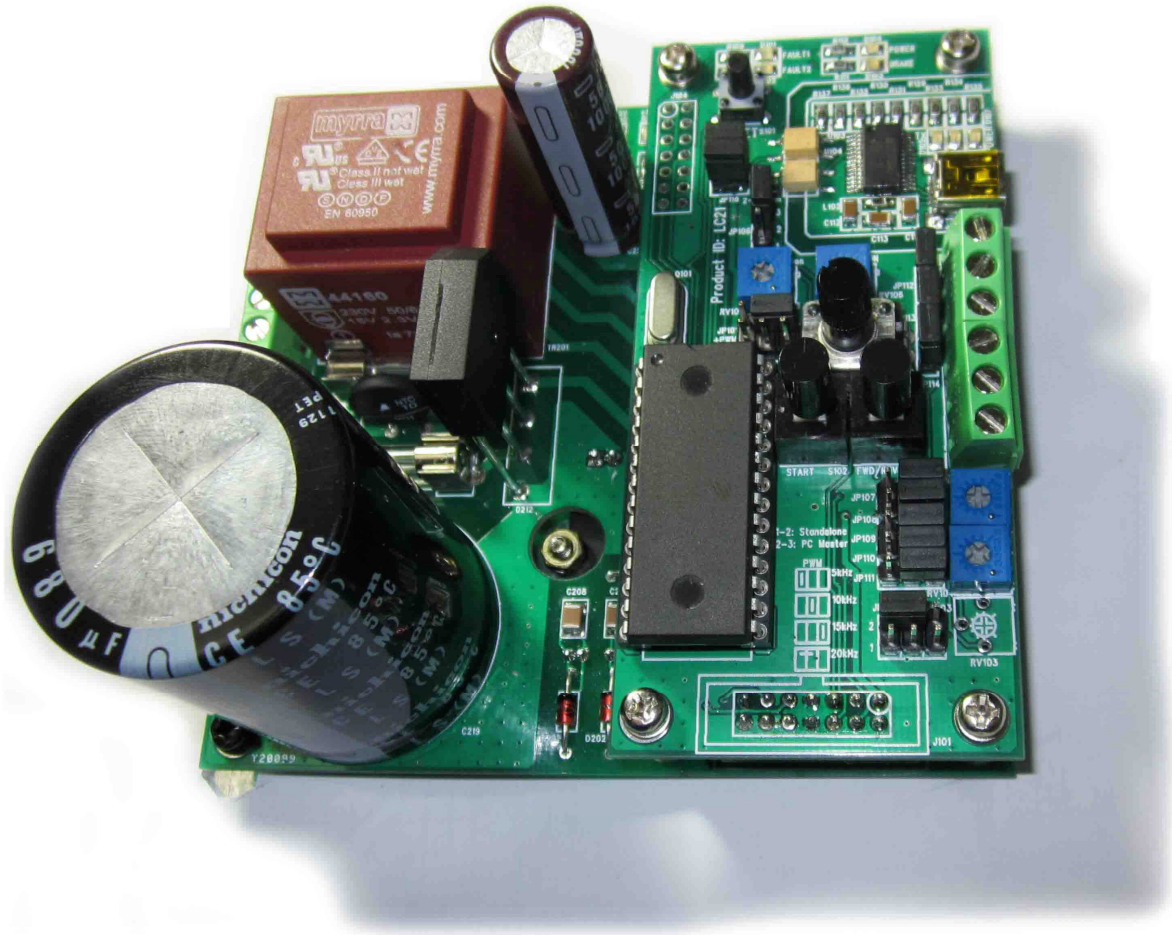
Three-Phase
Induction Motor Drive
Starter Kit MC3PHAC (Ver.2)



MJ-IMD-LC20-LC21

http://www.motorjock.com/

The 220 Volts 3 Amperes Three-Phase Induction Motor Drive, developed with a particular focus on reliability, robustness and low cost.

Features

- Complete 220V-3A power inverter solution
- V/f Control method implemented by MP3PHAC from Freescale
- Independent motor supply: 0 to 250V AC or direct DC at 0 to 350V DC
- Output current up to 3A
- Input inrush limiter based on 3.5A NTC resistor
- Overtemperature, overvoltage and overcurrent protection
- Compact design
- Test points available to test and further evaluation
- Available for Personal Computer and Stand-Alone operation mode
- Opto-isolated USB connection to host computer for control and monitoring
- Implemented as a two independent PCB: Control Board and Power Stage
- Two board implementation allow further evaluation
- Presetting for PWM frequency 5, 10, 15 and 20 kHz

Applications

- Washing machine
- Air conditioner
- Fan
- Pump

Functions:

- Sensorless Speed Control

Description

The purpose of the MJ-IMC-LC20-LC21 demonstration board is to present a universal, fully-tested design consisting of a 3-phase inverter bridge based on the small intelligent smart power module FNB41560 and the MP3PHAC MCU.

The MJ-ACMC-LC20-LC21 consists of two boards: Power Stage Board (LC20) and Control Board (LC21). The Power Stage Board LC20 can be used with different (compatible) Control Boards and Control Board LC21 can be used with different Power Stage Boards. It can be helpful for new design equipment debugging and testing.

The Power Stage Board LC20 consists of short-circuit rugged IGBT's with negative temperature coefficient. Additional auxiliary functions are undervoltage lockout and smart shut-down.

The Control Board LC21 can operate in standalone mode (control buttons, the «Start / Stop» «Forward / Reverse») and can be connected to personal computer via opto-isolated USB port.

Components

MCU: MC3PHAC
(Manual and Communication software available at http://www.freescale.com/)

USB: FT232R
(Manual and Virtual COM driver available at http://www.ftdichip.com/)

POWER: FNB41560
(Manual and Mounting Guidance available at http://www.fairchildsemi.com/)

Connector Description

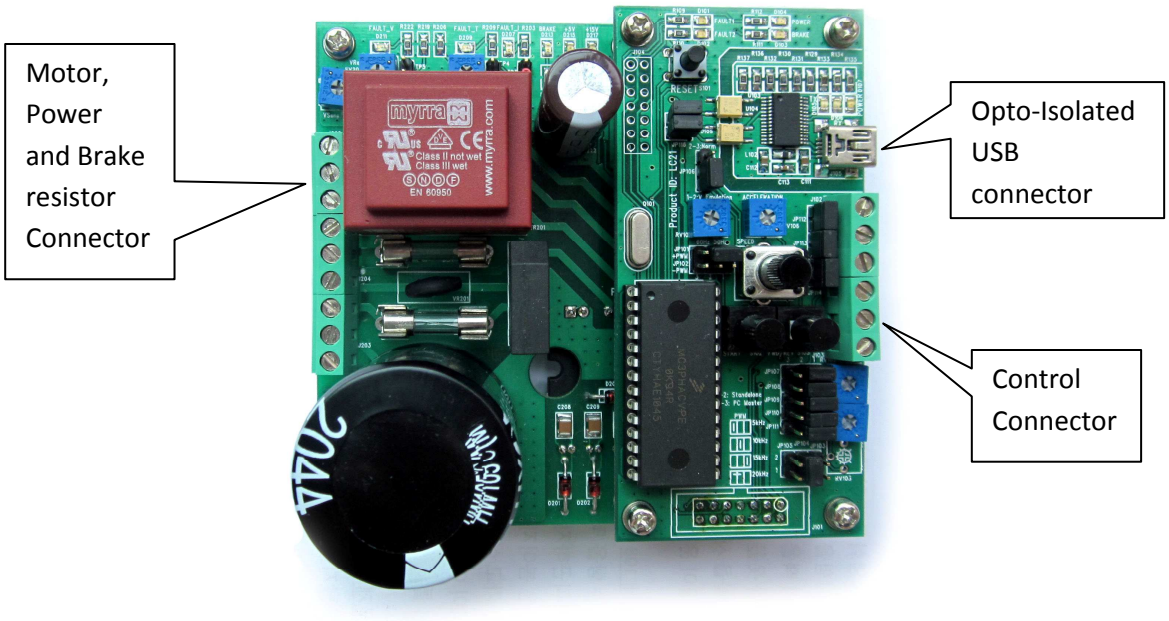


Fig. 1. Connector description

Wiring

Wiring diagram represents at fig. 2.

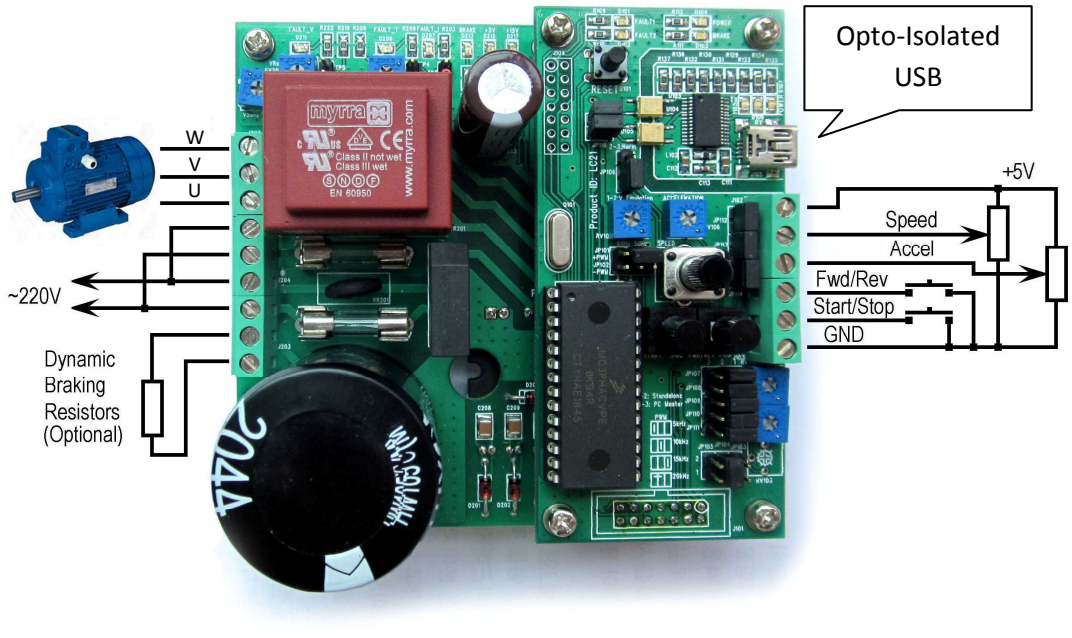


Fig. 2. Wiring

The Power Stage Board LC20 contains the 9-pin screw connector for Motor, Power and Braking resistor connection. The Control Board LC21 contains the 6-pin screw connector for External Control panel connection (which include just two variable resistors 10 kOhm and two push buttons) and standard mini-USB connector for Personal Computer connection.

Motor connection

Motor have to be connected to corresponding pin **[U V W]** on the Power Stage Board LC20 (refer silk screen in the bottom of the board)

Power Connection

Power Stage Board LC20 has two independent power input for motor **[MOTOR POWER]** and control circuit **[AC220]** (refer silk screen in the bottom of the board).

Braking resistor connection

If Motor operate at hard Start-stop mode important to use Braking resistor to avoid overvoltage alarm during motor deceleration. The Resistor have to be connected to corresponding pin **[Brake]** on the Power Stage Board LC20 (refer silk screen in the bottom of the board). Value and Power of Braking resistor have to be select due to application requirements.
Note. For operating show it is possible to use incandescent lamp (about 60..200 Watt) as a Braking resistor

External pushbuttons and variable resistors connection

It is possible to use internal variable resistors (RV105: “Speed” and RV106: “Acceleration”) and buttons (S102: “START/STOP”, S103: “FORWARD/RESERVE”) for control motor speed, acceleration, On/Off status and motor direction or connect external pushbuttons and variable resistors 10 kOhm to the Control Board LC21 via 6 pin screw connector (refer Fig. 2). If external pushbuttons and variable resistors are used, the jumpers JP113 and JP114 are must be remove.

Personal Computer connection

Connection to PC is available via opto-isolated USB port which located at Control Board LC21 (Fig. 2). It is possible to use 'USB type A to Mini-B' standard cable.

Using MJ-IMD-LC20-LC21 with personal computer

The MJ-IMD-LC20-LC21 can be used in “Standalone Mode” or can be connected to Personal Computer and operate in “PC master Software Mode”.
To switch mode necessary to set jumpers JP108, JP109, JP110, JP111 as:
1-2: “Standalone Mode”
2-3: “PC master Software Mode”
Jumper JP107 make switching analog signal "A_Speed" and "A_Temperature" (Refer Circuit diagram)
1-2: “Speed” (measure analog signal from Speed set variable resistor)
2-3: “Temperature” (measure analog signal from temperature sensor inside IGBT module U203)
It is recommended to set jumper JP107 to 1-2: “Speed” position when used “Standalone Mode” for motor speed control from variable resistor RV105, and to set jumper JP107 to 2-3: “Temperature” position when used “PC master Software Mode” for real time IGBT module U203 temperature monitoring via analog input SPEED (MC3PHAC, pin 26).
Switching of jumpers in “Standalone Mode” and “PC master Software Mode” represents at fig.3 and fig.4.

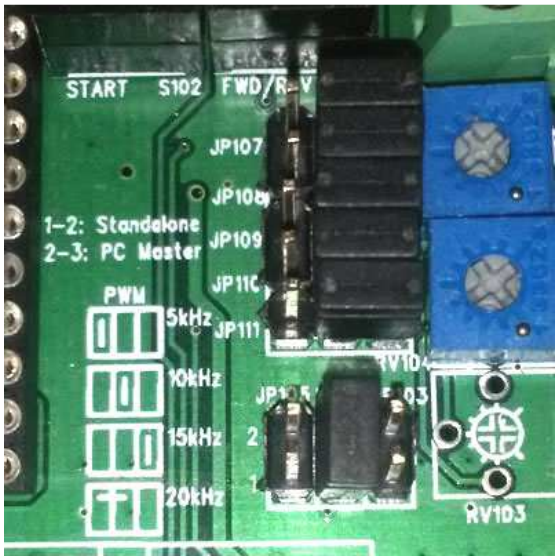


Fig. 3. 1-2: “Standalone Mode”

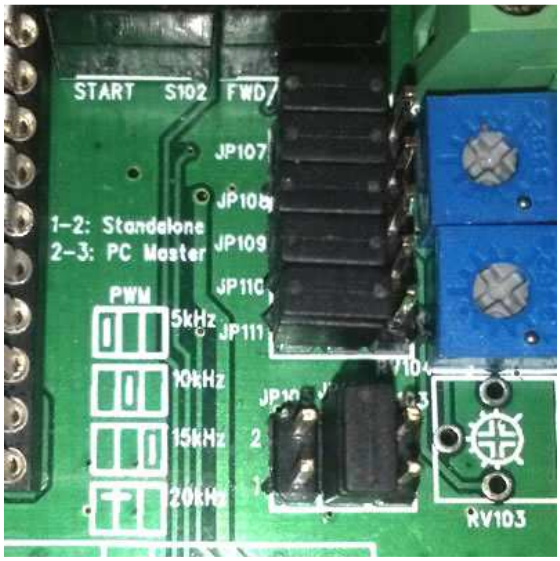


Fig. 4. 2-3: “PC master Software Mode”

By default jumpers JP107, JP108, JP109, JP110, JP111 set in position 1-2: “Standalone Mode” (Fig. 3). To use MJ-IMD-LC20-LC21 with personal computer jumpers must be switch to position 2-3: “PC master Software Mode” (Fig. 4).

Software

Before plugging USB cable to PC important to install Virtual COM Port (VCP) driver from FTDI website http://www.ftdichip.com/
For control and manage Control Board LC21 from personal computer possible to use FreeMASTER (refer “FreeMASTER Application Installation” on Freescale website http://www.freescale.com/) .
Demo MC3PHAC FreeMASTER (also known as PC-Master) application software is available at http://www.freescale.com/ (refer AN2202: “Creating a Graphical User Interface (GUI) for the MC3PHAC” and AN2202SW software zip-file)

Virtual COM port setup installation

The Starter Kit MC3PHAC (Ver.2) connect to personal computer via USB. The Starter Kit use IC FT232RL - USB UART from FTDI, therefore it is necessary to install drivers of the virtual COM port (VCP Driver) or D2XX Driver, if user will use port via Windows USB Stack and DLL. last version of drivers it is possible to download from www.ftdichip.com.

After VCP drivers installation will complete a new virtual COM port will appear in Windows Device Manager (Fig. 5).

Fig. 5. FTDI VCP at Device Manager.

It is possible to use this port (for example COM5 as a represent at Fig.5)to connect Starter Kit to any PC application.

"FreeMASTER" installation

Freescale company, as a manufacturer of IC MC3PHAC at the www.Freescale.com/FreeMASTER web site represents software: "FreeMASTER", well known before as a "PCmaster".

Fig. 6. FreeMASTER main window.

It is possible to download "FreeMASTER" description and help files for free from www.Freescale.com after registration.

The "MC3PHAC_PCMasterSoftware_Demo" project

FreeMASTER is a user-friendly real-time debug monitor and data visualization tool that you can use for any application development and information management. FreeMASTER supports completely non-intrusive monitoring of variables on a running system. You can display multiple variables changing over time on an oscilloscope-like display, or view the data in text form. As well, FreeMASTER supports additional capabilities and targets with an on-target driver for transmitting data from the target to the host computer.

Freescale company at website www.Freescale.com also represents a demo-project for FreeMASTER: "MC3PHAC_PCMasterSoftware_Demo", refer to "Creating a Graphical User Interface (GUI) for the MC3 PHAC": AN2202.pdf.

Important to note MC3PHAC_PCMasterSoftware_Demo needs to set the PWM polarity signal parameters and Dead Time value. If this parameters will set wring, the Starter Kit MC3PHAC (Ver.2) can be damage. To avoid this problem use the customized version of MC3PHAC_PCMasterSoftware_Demo.
In customized version possible to found file "MotorInitParm.cfg", where parameters of the PWM polarity signals preset:

```
PWM Polarity B+ T+ 0x1000 0x50 1
Dead Time 0x0036 2000 ns
```

These lines are set the PWM polarity signal parameters "B+ T+" and Dead Time value "2000 ns" Other parameters can be different, depend configuration.
It is not recommended to manually edit file "MotorInitParm.cfg". Parameters in this file saved from the project.

Open the project MC3PHAC_PCMasterSoftware_Demo: **File -> Open Project**:

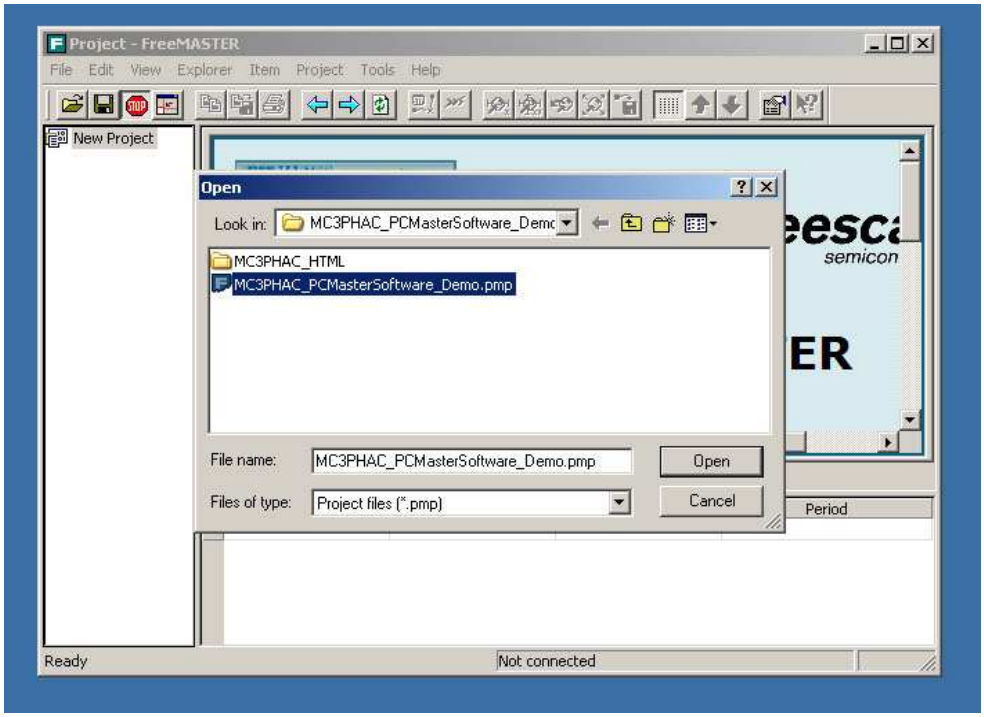


Fig. 7. **File -> Open Project** window

The open project is represents at fig. 8.

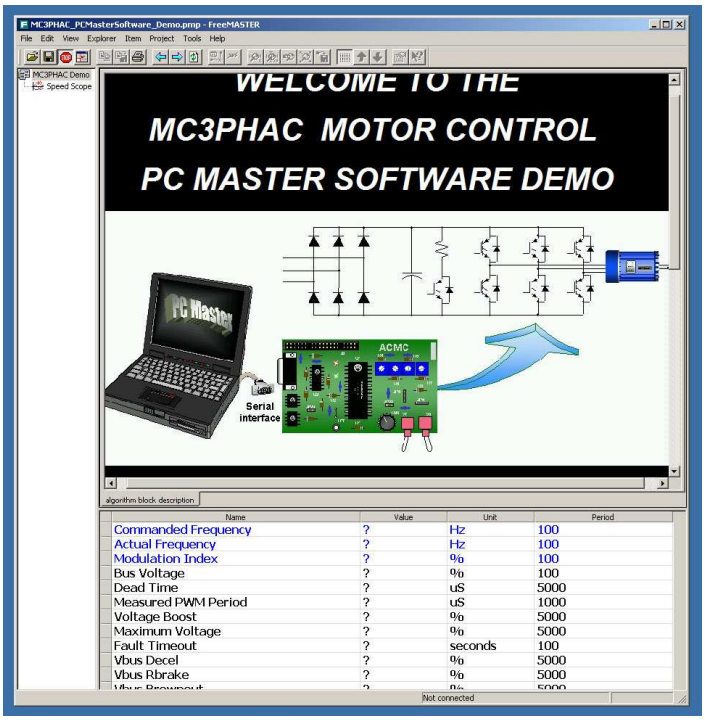


Fig. 8. MC3PHAC_PCMasterSoftware_Demo main window

At the next stage it is necessary to set COM port number for communication (Fig. 9). To set port those: **Project -> Options...**

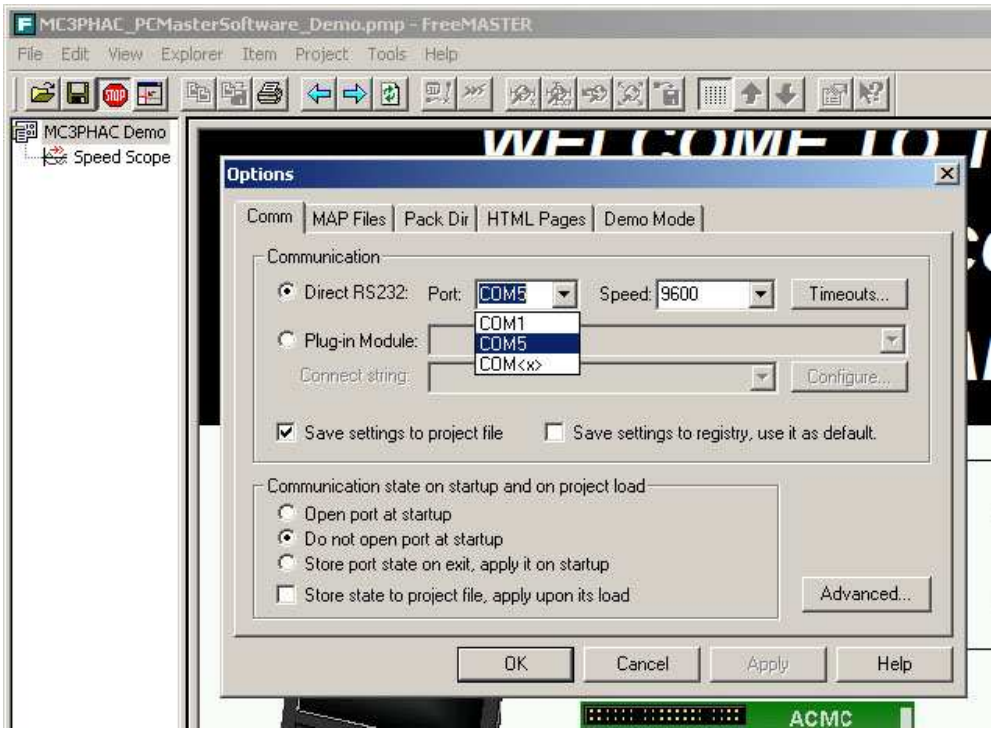


Fig. 9. COM port setting

If COM port is change it is necessary to Save project by **File -> Save Project**.
Now it is possible to connect to MC3PHAC by pushing red STOP Button. in the result in the bottom of the application data from MC3PHAC will appear (fig. 10):

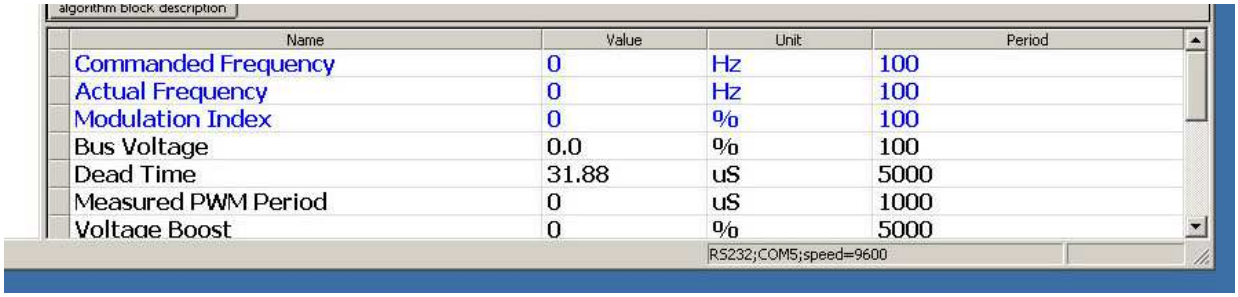


Fig. 10. Data from MC3PHAC.

Next, press the button **"Press Here to Continue"** and note window will appear (fig. 10). Just close it by pressing **OK**.

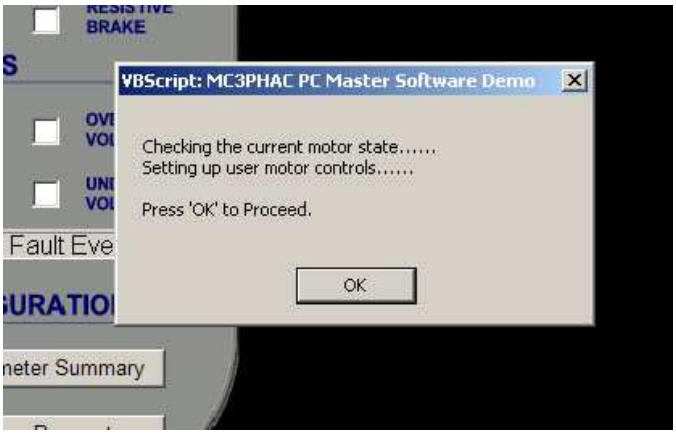


Fig. 11. Note window

Next, system will show permission to execute ActiveX, click **"Yes"**:

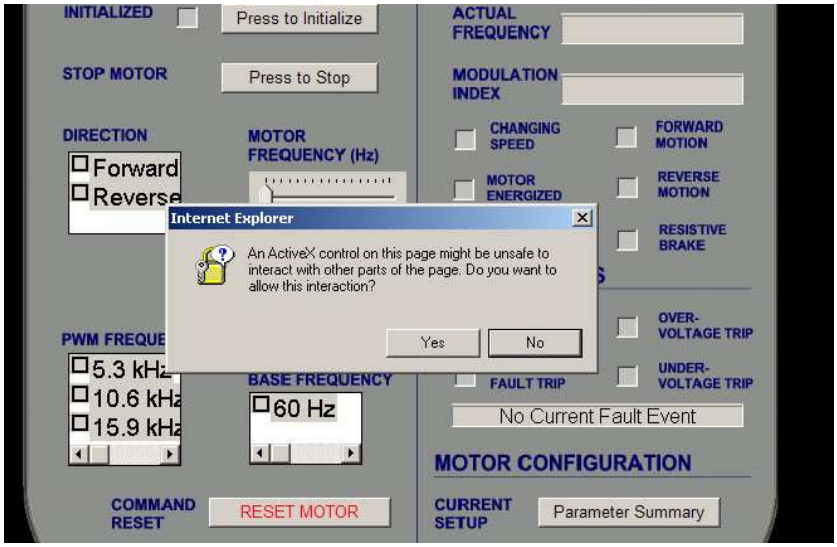


Fig. 12. Permission to execute ActiveX

Before start the system will show one more time all parameters. It is important to check "PWM Polarity: B+ T+" and "Deadtime: 2000 ns" (Fig. 13):

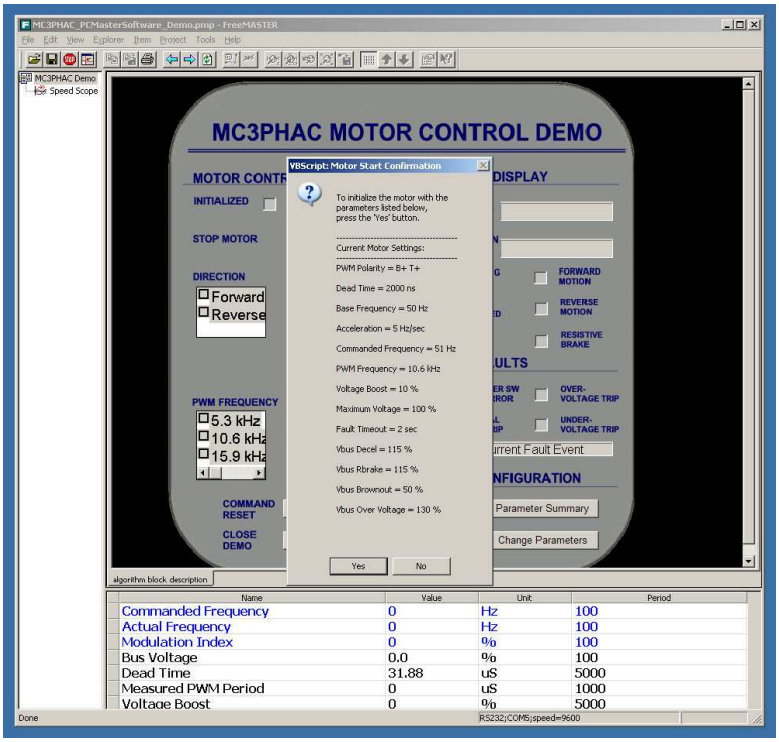


Fig. 13. Parameters window

If parameters are different with described above, it is important to cancel by pressing "No" and set correspond value. Set parameters window represents at Fig. 14.

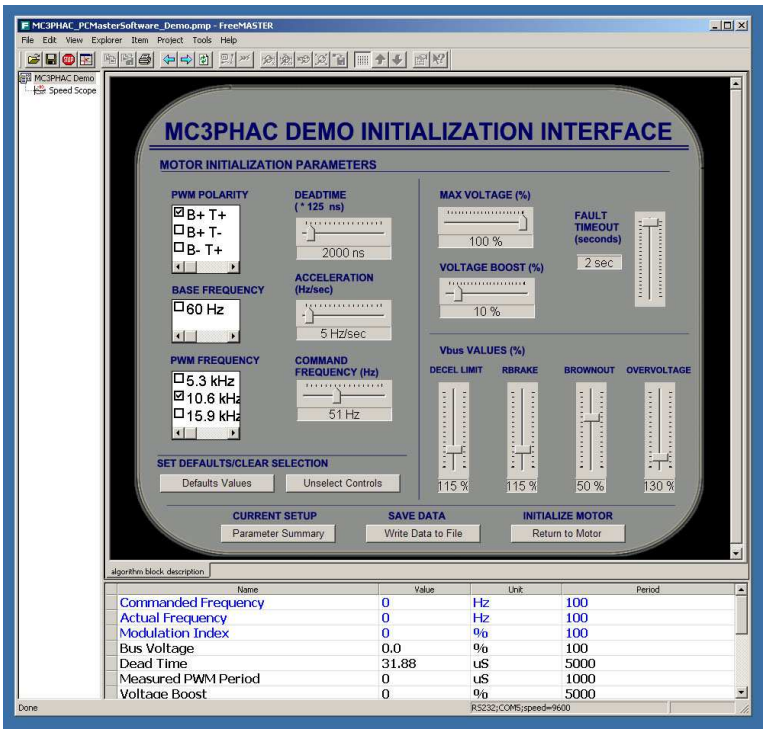


Fig. 14. Set parameters window

Set the corresponded parameters (most important to set **PWM Polarity: B+ T+** and **Deadtime: 2000 ns**) and press **"Write Data to File"** in the result this data will write to file "MotorInitParm.cfg" and system will represents resume of all data which sawed in file (Fig. 15).

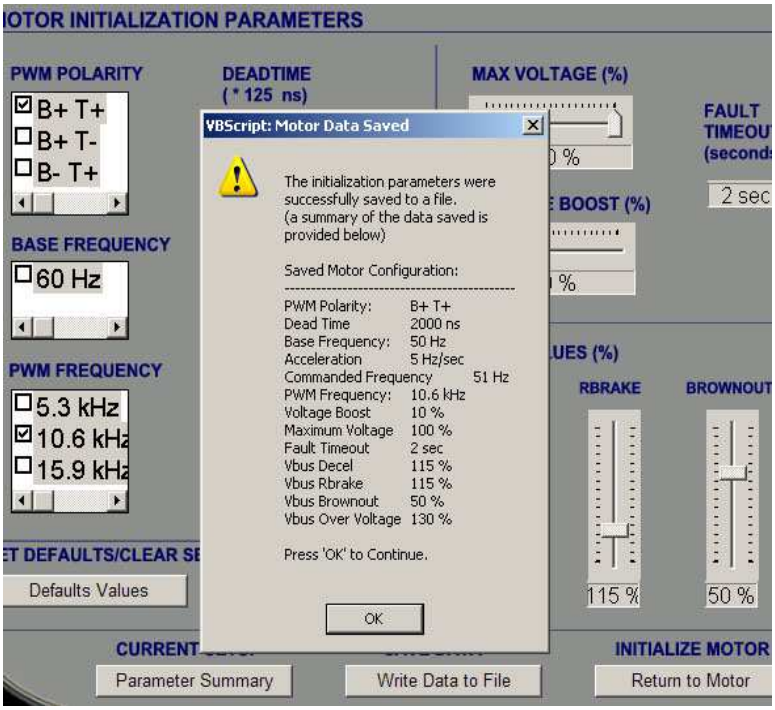


Fig. 15. Saved Data Resume.

Window after data downloading to MC3PHAC represents below (Fig.16):

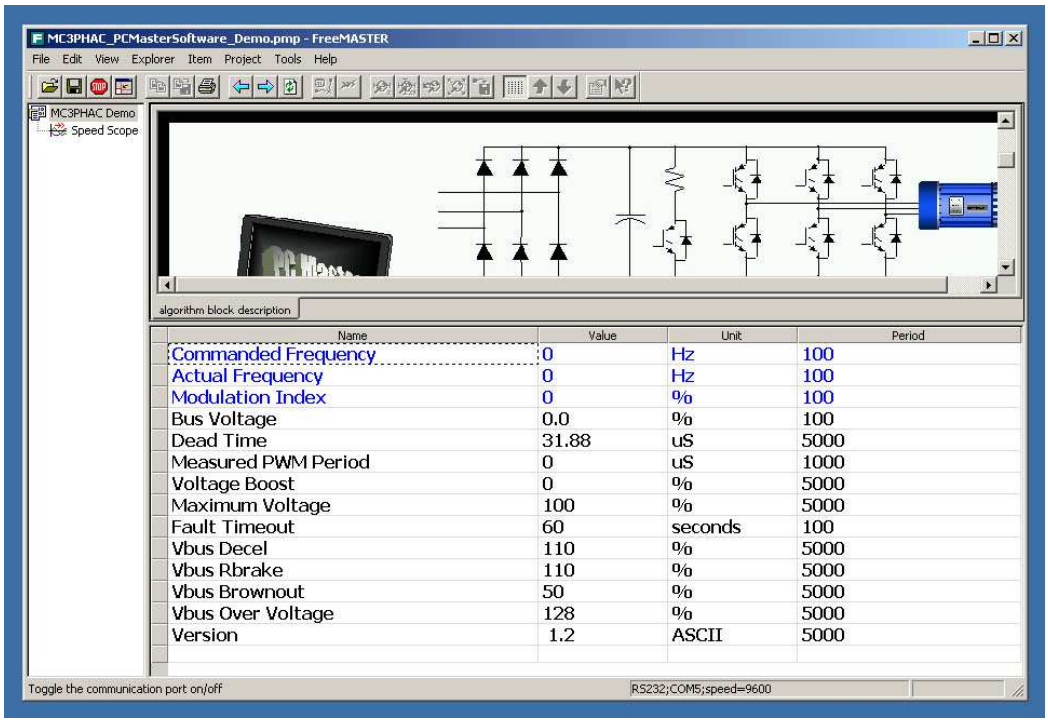


Fig. 16. Connect.

At the next window it is enough to press Forward check box for start motor rotation (Fig. 17)

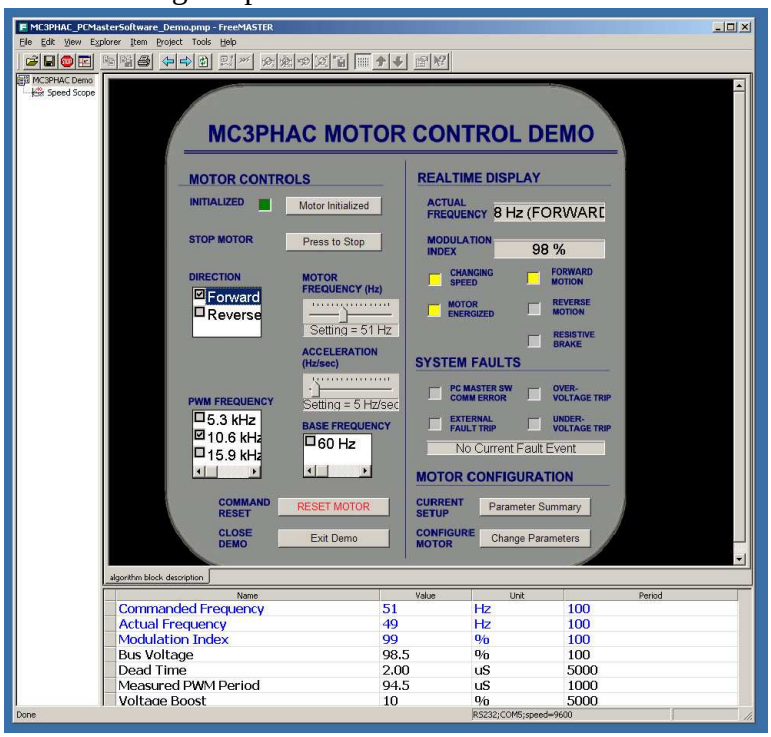


Fig. 17. Motor is Run Forward.

Using an independent Motor and Control Circuit power supply.

Particular feature if the Power Board LC20 is possibility to use independent Motor and Control Circuit power supply connection. It is possible to use same voltage for Control Circuit and Motor IGBT Bridge U203 (refer Fig. 2) or to use separate "AC/DC Motor Power" and "AC Control Power" connection as represents at (Fig. 5)

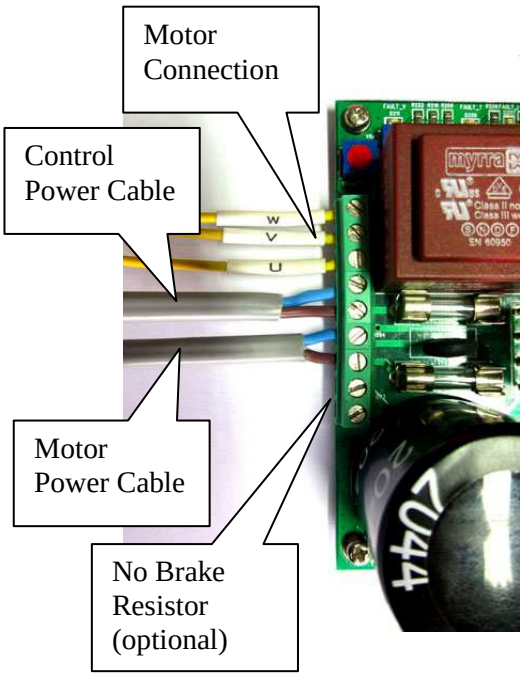


Fig. 5. Separate "Motor Power" and "Control Power".

"AC Control Power" must be AC voltage 50/60 Hz, 220V, ±10%.
"AC/DC Motor Power" can be AC voltage, in range 0 to 230V or DC voltage in range 0 to 330V. In case of DC voltage "Motor Power" wiring "+" and "-" can be arbitrary because of rectifier D212 is on the board. Variable "Motor Power" useful in case of using motor with operation less than 220 volts or safety during tests and non-standard motor operation modes (like low-speed operation).

The IC MC3PHAC measure Bus voltage "+V_MOTOR" at capacitor C219, via R210, R211, R212, R213, RV201, R214, R215, U202-A формируя аналоговый сигнал "A_VBUS". Signal "A_VBUS" going to IC MC3PHAC via jumper JP106 (position of jumper is 2-3: "Normal Operation"). In case of using low voltage "AC/DC Motor Power" it is necessary to set the jumper JP106 in position 1-2: "Voltage Sensor Emulation". In this case analog signal "A_VBUS" will be set by variable resistor RV101. For adjustment variable resistor RV101 it is recommended to connect Starter Kit MC3PHAC (Ver.2) to personal computer and check value of the "A_VBUS" signal by "Bus Voltage" data at the PC monitor (Fig. 6).

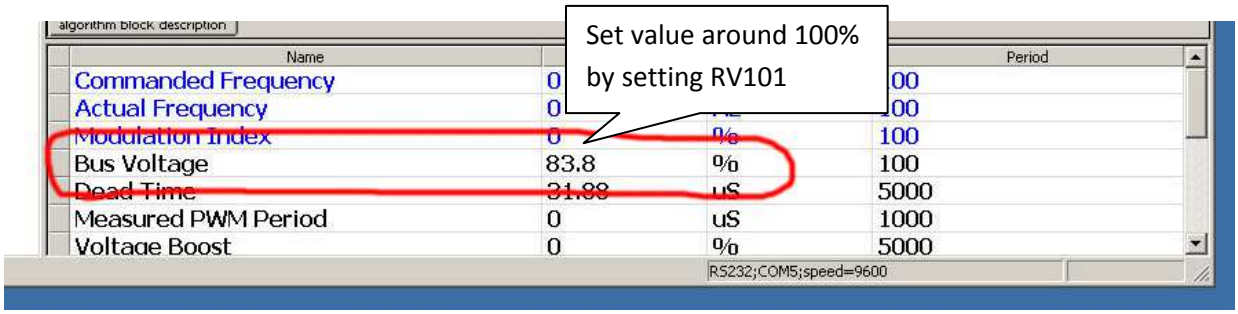


Fig. 6. Bus Voltage Setting.

Set the "Bus Voltage" using variable resistor RV101 around 100%. The adjustment of the variable resistor RV101 it is recommended to implement with disconnected "AC/DC Motor Power". Increasing of the "Bus Voltage" leads to the "BRAKE" signal appear, and further increasing leads to the "FAULT" signal appear. Value of "Bus Voltage" also influence to duty cycle of the PWM for make stable of actual motor voltage due to Bus Voltage changes or voltage ripple.

Important to note, that setting of the jumper JP106 in position 1-2: "Voltage Sensor Emulation" in fact disconnect bus voltage checking by IC MC3PHAC and it is important to be carefully in using of the motor and board. It is recommended to use additional current limiters of fuses in the "AC/DC Motor Power".

Heatsink Mounting

PCB size 100x105 mm

Board must be installed on the Heatsink. Mounting holes location and dimension represents at Fig. 3, Side view represents at Fig. 4.

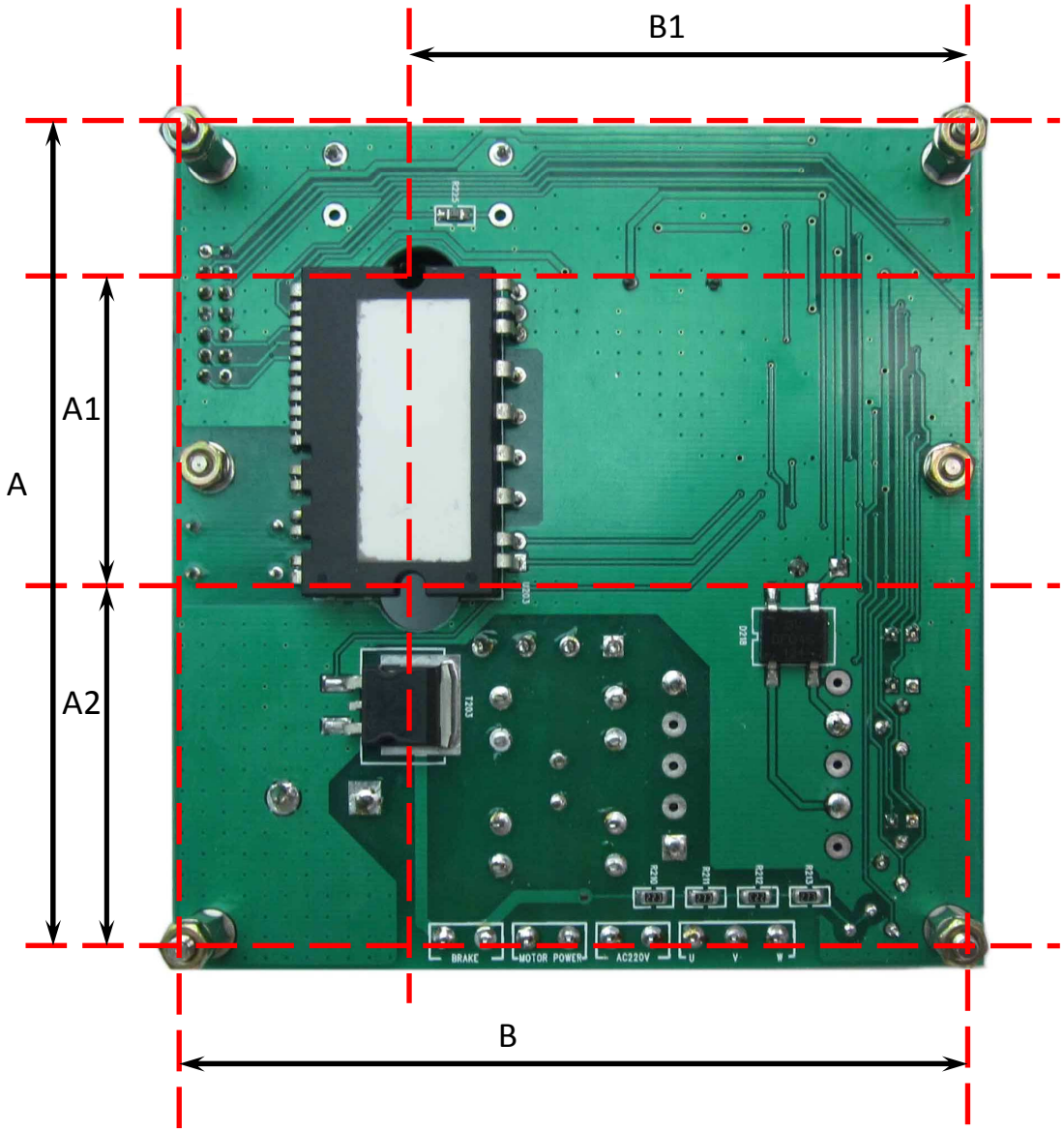


Fig. 3. Mounting holes location

A = 94.615mm

A1 = 36.7

A2 = 41.975

B = 90.17mm

B1 = 64.54mm

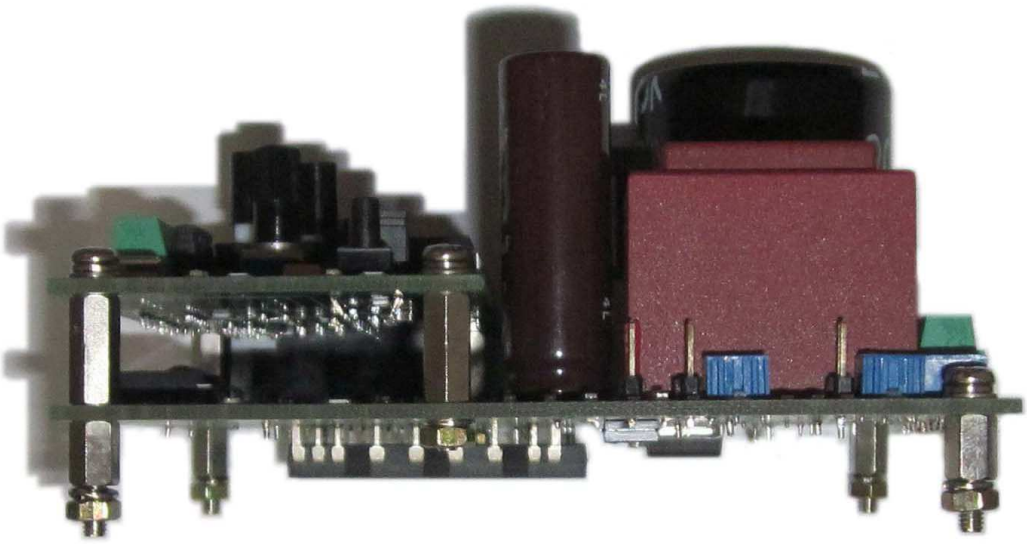


Fig. 4. Side view