NEC

User's Manual

Motor Control I/O Board

MC-IO Board For NEC Electronics Microcontrollers

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This is a Test- and Measurement equipment with possibility to be significantly altered by user through hardware enhancements/modifications and/or test or application software. Thus, with respect to Council Directive 89/336/EEC (Directive on compliance with the EMC protection requirements), this equipment has no autonomous function. Consequently this equipment is not marked by the CE-symbol.

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NOTES FOR CMOS DEVICES

① VOLTAGE APPLICATION WAVEFORM AT INPUT PIN

Waveform distortion due to input noise or a reflected wave may cause malfunction. If the input of the CMOS device stays in the area between V_{IL} (MAX) and V_{IH} (MIN) due to noise, etc., the device may malfunction. Take care to prevent chattering noise from entering the device when the input level is fixed, and also in the transition period when the input level passes through the area between V_{IL} (MAX) and V_{IH} (MIN).

② HANDLING OF UNUSED INPUT PINS

Unconnected CMOS device inputs can be cause of malfunction. If an input pin is unconnected, it is possible that an internal input level may be generated due to noise, etc., causing malfunction. CMOS devices behave differently than Bipolar or NMOS devices. Input levels of CMOS devices must be fixed high or low by using pull-up or pull-down circuitry. Each unused pin should be connected to V_{DD} or GND via a resistor if there is a possibility that it will be an output pin. All handling related to unused pins must be judged separately for each device and according to related specifications governing the device.

③ PRECAUTION AGAINST ESD

A strong electric field, when exposed to a MOS device, can cause destruction of the gate oxide and ultimately degrade the device operation. Steps must be taken to stop generation of static electricity as much as possible, and quickly dissipate it when it has occurred. Environmental control must be adequate. When it is dry, a humidifier should be used. It is recommended to avoid using insulators that easily build up static electricity. Semiconductor devices must be stored and transported in an anti-static container, static shielding bag or conductive material. All test and measurement tools including work benches and floors should be grounded. The operator should be grounded using a wrist strap. Semiconductor devices must not be touched with bare hands. Similar precautions need to be taken for PW boards with mounted semiconductor devices.

④ STATUS BEFORE INITIALIZATION

Power-on does not necessarily define the initial status of a MOS device. Immediately after the power source is turned ON, devices with reset functions have not yet been initialized. Hence, power-on does not guarantee output pin levels, I/O settings or contents of registers. A device is not initialized until the reset signal is received. A reset operation must be executed immediately after power-on for devices with reset functions.

⑤ POWER ON/OFF SEQUENCE

In the case of a device that uses different power supplies for the internal operation and external interface, as a rule, switch on the external power supply after switching on the internal power supply. When switching the power supply off, as a rule, switch off the external power supply and then the internal power supply. Use of the reverse power on/off sequences may result in the application of an overvoltage to the internal elements of the device, causing malfunction and degradation of internal elements due to the passage of an abnormal current.

The correct power on/off sequence must be judged separately for each device and according to related specifications governing the device.

⑥ INPUT OF SIGNAL DURING POWER OFF STATE

Do not input signals or an I/O pull-up power supply while the device is not powered. The current injection that results from input of such a signal or I/O pull-up power supply may cause malfunction and the abnormal current that passes in the device at this time may cause degradation of internal elements.

Input of signals during the power off state must be judged separately for each device and according to related specifications governing the device.

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[MEMO]

Preface

Readers

This manual is intended for users who want to understand the functions of the Motor Control IO Board for NEC Electronics Microcontrollers.

Purpose

This manual presents the hardware manual of the Motor Control IO Board for NEC Electronics Microcontrollers.

Organization

This system specification describes the following sections:

- Inverter module
- IGBT module
- Opto isolation
- Power supplies
- User connections

Legend

Symbols and notation are used as follows:

Weight in data notation	:	Left is high-order column, right is low order column
Active low notation	:	$\overline{xxx}$ (pin or signal name is over-scored) or /xxx (slash before signal name)
Memory map address:	:	High order at high stage and low order at low stage
Note	:	Explanation of (Note) in the text
Caution	:	Item deserving extra attention
Remark	:	Supplementary explanation to the text
Numeric notation	:	Binary... xxxx or xxxB Decimal... xxxx Hexadecimal... xxxxH or 0x xxxx

Prefixes representing powers of 2 (address space, memory capacity)

K (kilo): $2^{10} = 1024$

M (mega): $2^{20} = 1024^2 = 1,048,576$

G (giga): $2^{30} = 1024^3 = 1,073,741,824$

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Chapter 1 Introduction

The motor control I/O board (MC-IO-GENERAL) is a board interface designed to be used between an NEC Electronics motor control power module and micro-board.
Micro-boards are used to demonstrate and evaluate CPU and on-chip peripheral functions of NEC Electronics microcontrollers (MCUs). When connected to an MC-IO board and motor control power module, a micro-board can be used to demonstrate and evaluate CPU and motor control functions of the NEC Electronics MCUs designed for 3-phase asynchronous current induction motor (ASIC) and permanent magnet asynchronous current (PMAC) motor control applications. (Contact your local NEC Electronics representative for a list of micro-boards supported.)
The power module is available in two types: a high-voltage module (MC-PWR-HV) designed to drive 100-, 120- and 220-volt motors or a low-voltage module (MC-LV-INVERTER) that can drive motors up to 24 volts.
The MC-IO board serves as the user interface for operational control and signal conditioning between the MCU and the power module. With this modular approach, a user can easily evaluate several NEC Electronic 8- and 32-bit motor control MCUs. (Contact your local NEC Electronics representative for a list of devices supported.)

Figure 1-1: MC-IO Board

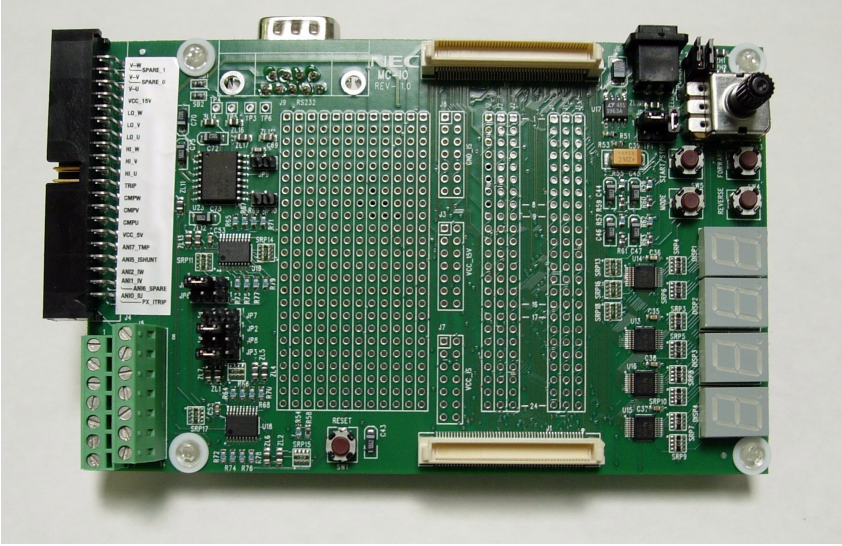


Figure 1-2: Typical Motor Control Application

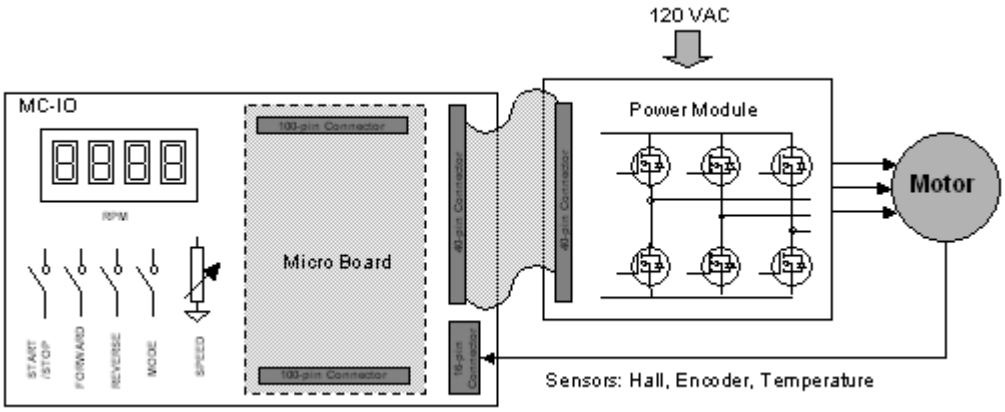


Figure 1-3: Board Block Diagram

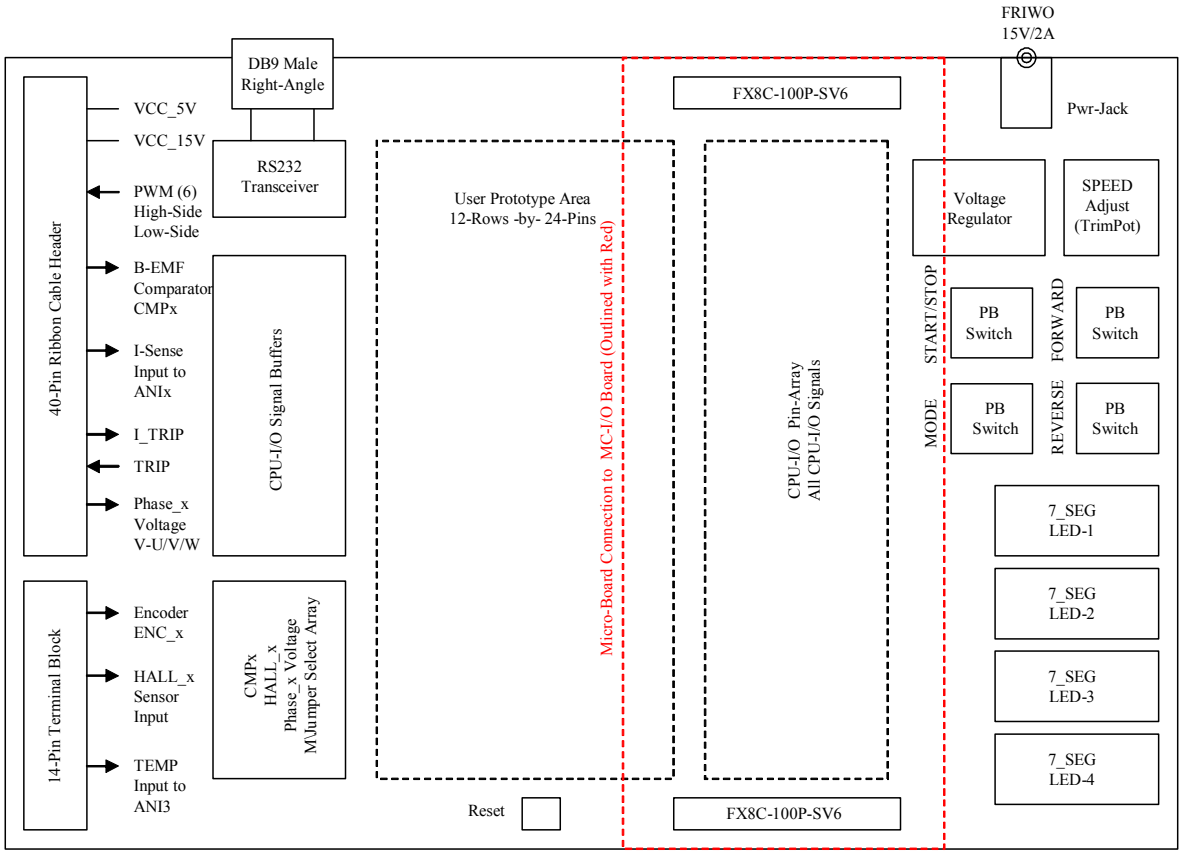


Table 1-1: Pin Signals

Type	Names	Description
System power signals	VCC_15 V	Power input to the MC-IO board
	VCC_5 V	Regulated 5 V power
PWM signals	HI_U, HI_V, HIW (high-side FET drive)	PWM signals from the CPU
	LO_U, LO_V, LO_W (low-side FET drive)	
Back-EMF zero-cross detection signals	CMPU, CMPV, CMPW	Back-EMF comparator signals from power module
		Connected to interrupt inputs of the CPU
Current sense signals	ANI0_IU, ANI1_IV, ANI2_IW	Motor phase current; low-side current detect
	ISHUNT	Motor common shunt current; low-side current detect; connected to A/D converter inputs of the CPU
Safety control signals	PX_ITRIP	Over-current detection signal from the power module; connected to port *x* of the CPU for further action
	TRIP	CPU-generated signal that turns off power to the power MOSFET
Phase voltage	V-U, V-V, V-W	Motor phase voltage monitoring signals; connected to A/D converter inputs of the CPU
Power module temperature	ANI7_TMP	Power module temperature sense signal; connected to A/D converter input of the CPU

Table 1-2: Terminal Block Signals

Category	Signal Names	Description
Motor shaft encoder	ENC_A, ENC_B, ENC_Z	Motor speed and direction signals; connected to encoder inputs of the CPU
HALL effect sensor signal	HALL_1, HALL_2, HALL_3	HALL effect sensor input; connected to interrupt inputs of the CPU
Motor temperature input	ANI3_TEMP	Motor temperature input; connected to A/D converter input of the CPU

Chapter 2 System Specifications

The MC-IO board has on-board user interface hardware for controlling and operating motor units.

- 15 V system power at power input (voltage regulator is used to generate VCC = 5 V)
- Two 100-pin FX8C-100P-SV6 connectors for connecting a micro-board with motor control MCU to the MC-IO board
- 40-pin ribbon cable that carries signals to and from the motor control power module
- 14-pin terminal block to connect sensor signals from the motor unit in use
- Potentiometer connected to ANI4 input of the CPU to adjust speed
- Push button switches that can be reprogrammed by the user

  - START/STOP
  - MODE
  - FORWARD
  - REVERSE

- Four-digit, seven-segment light-emitting diode (LED) to display motor speed in revolutions per minute (RPM) and other status information
- RS-232 transceiver and optional DB9 connector (connected to a UART of the selected CPU)
- User prototype area

  - Twelve rows of 24-pin, 100-mil centered pin array for user prototyping
  - Required CPU signals connected to CPU I/O pin array
  - Board size of 3.5 (W) × 5.5 (L) inches

Chapter 3 Hardware

Figure 3-1: Physical Placement of Components on MC-IO Board

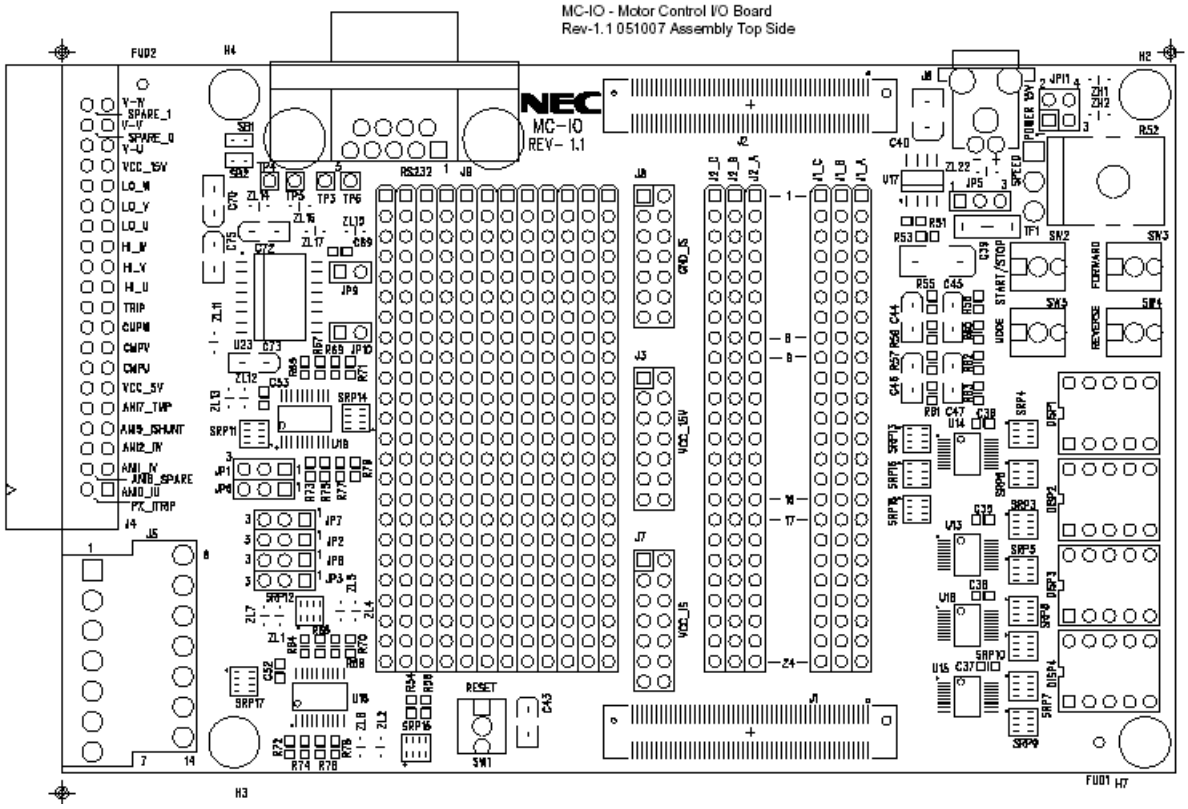


Table 3-1: Factory Settings

Jumper	Setting	Function	Description
JP1	1–2	INTP1_PX to JP6.2	Sensor inputs to INTP1
JP2	1–2	INTP2_PY to JP7.2	Sensor inputs to INTP2
JP3	1–2	INTP3_PZ to JP8.2	Sensor inputs to INTP3
JP4			Not used
JP5	1–2		Voltage regulator output = VCC_IS
JP6	1–2	CMPU_IS to JP6.2	B-EMF comparator output
JP7	1–2	CMPV_IS to JP7.2	
JP8	1–2	CMPW_IS to JP8.2	
JP9	Open		Transmit and receive loop-back
JP10	Open		RTS and CTS loop-back
JP11	1–2		System power supplied by MC-IO board, not power module

3.1 Operation

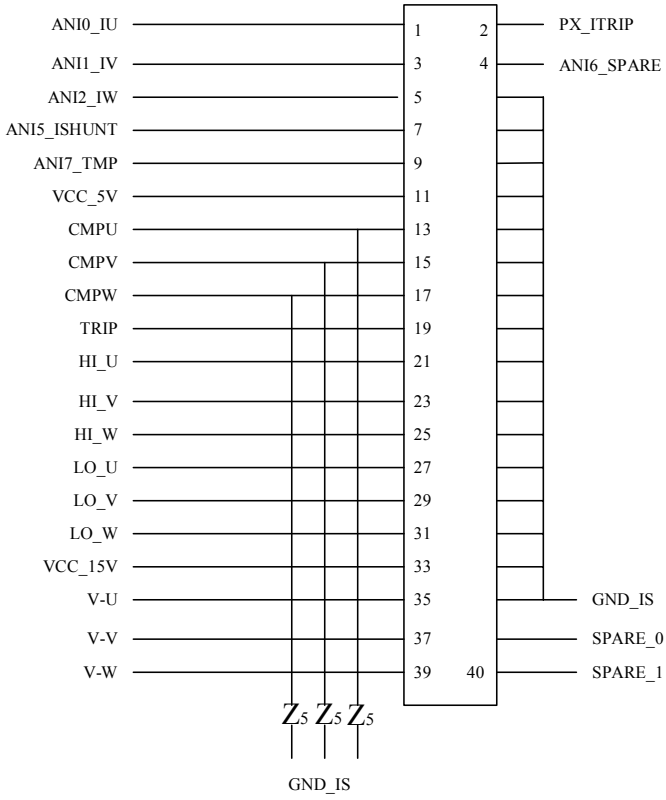
When connected to a micro-board and power module to drive the selected motor, the MC-IO board can be used to demonstrate a selected CPU's motor control functions.
The unit can operate in standalone mode or be connected to a host computer through the MC-IO board's RS-232 port. In standalone mode, a user can control the motor from the MC-IO board's push buttons and speed potentiometer. To operate from a computer, special GUI software is needed.
(Contact your NEC Electronics representative for information.)

3.2 On-Board Components

3.2.1 J4 - 40-Pin Ribbon Cable

The 40-pin ribbon cable is used to connect motor control signals and motor position sensor signals between the motor control power module and MC-IO board.

Figure 3-2: Pin Configuration

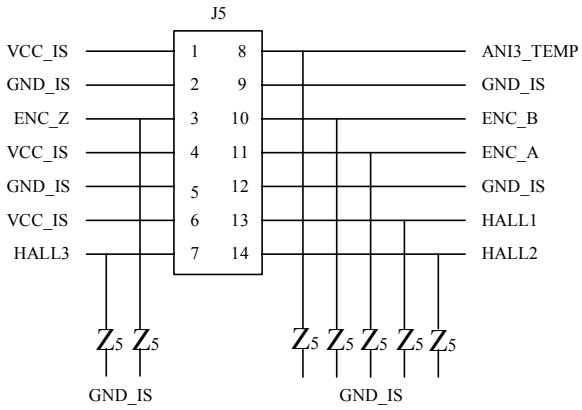


Note: Clamped transient voltage suppressors (Zs) protect critical digital motor control signals.

3.2.2 14-Pin Terminal Block

The 14-pin terminal block is used for connecting motor sensor signals to the MC-IO board.

Figure 3-3: Terminal Block Pin Configuration



Note: Clamped transient voltage suppressors (Zs) protect critical digital motor control signals.

Figure 3-4: Signal Positions on the Terminal Block

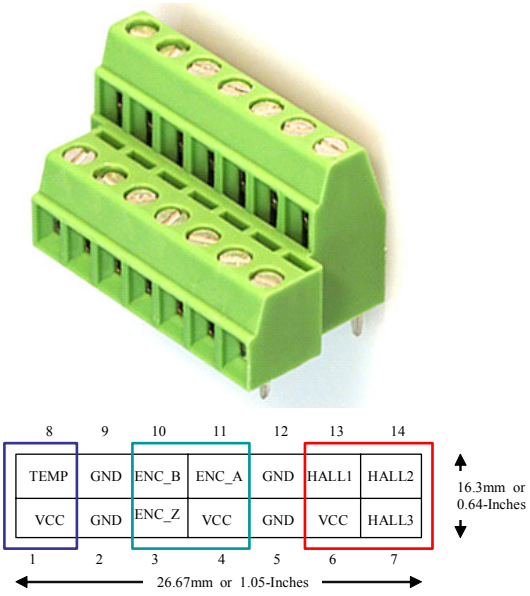
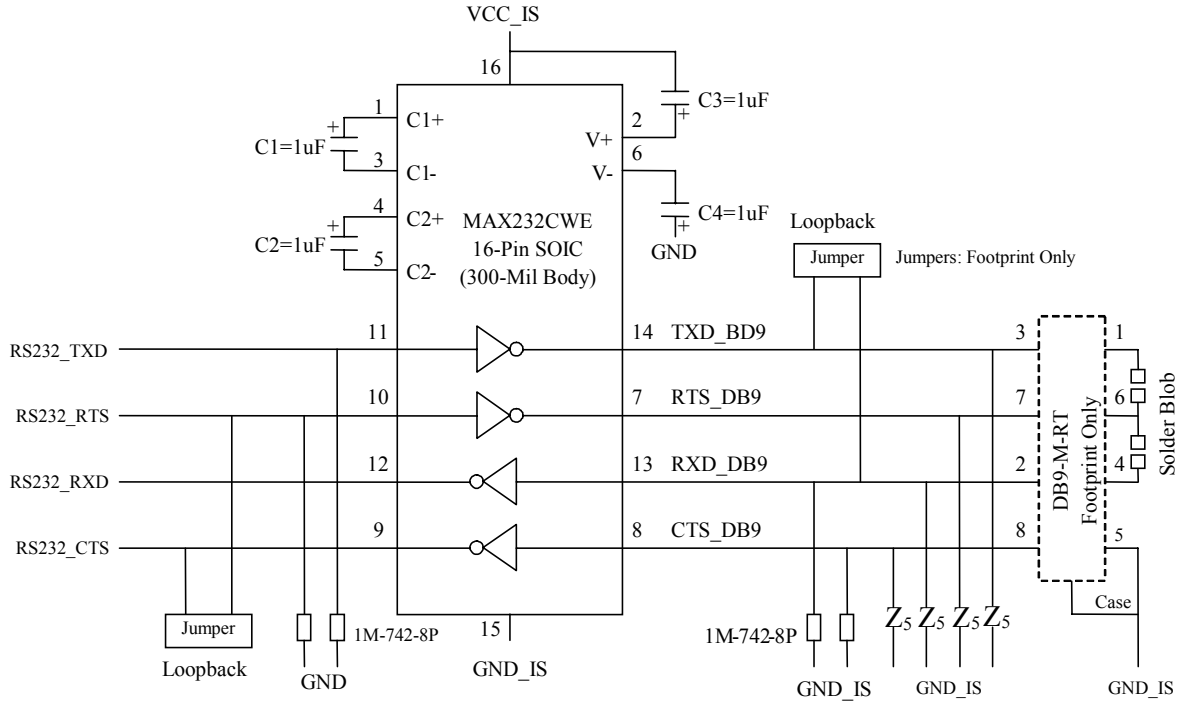
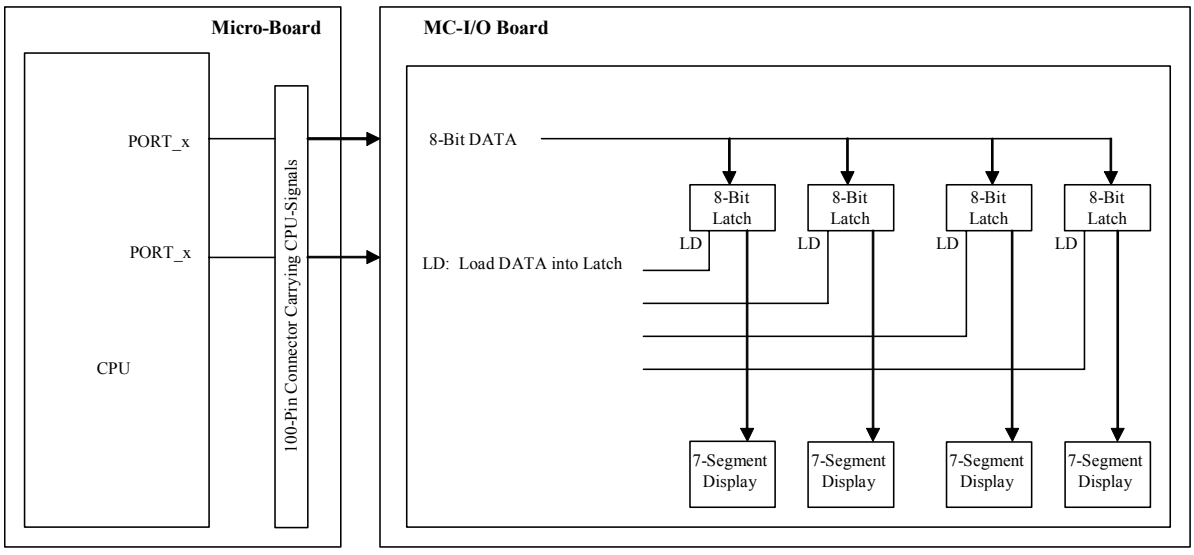


Figure 3-5: RS-232 Transceiver and Optional DB9 Connector



Remark: RS232_TXD and RS232_RXD: Transmit and receive signals of CPU
RS232_RTS and RS232_CTS: Port signals of CPU

Figure 3-6: Four-Digit, Seven-Segment LED



The 7-segment LED data is latched one digit at a time. The ports used for the data and Latch Enable (LD) signal differs from CPU to CPU, depending on the micro-board used. Refer to the associated user's manual to determine which ports to use for the 7-segment LED.

3.2.3 Speed Adjustment Potentiometer

A 10 kΩ-potentiometer is connected to ANI4 of the analog-to-digital (A/D) converter input of CPU.

3.2.4 Push button Switches

There are four push button switches for motor control operation:

- START/STOP
- MODE
- FORWARD
- REVERSE

Push button functions can be reprogrammed by the user. In addition, there is a push button switch for $\overline{\text{RESET}}$.

3.3 Jumper Settings

3.3.1 JP1–JP3 and JP6–JP

The settings of JP6–JP8 select back-EMF zero-cross detection signals or phase-voltage signals. By default, JP6–JP8 are configured to select the back-EMF detection signals. The phase-voltage signals are analog signals that are reserved for future use.

The setting of JP1–JP2 select back-EMF zero-cross or HALL sensor signals for BLDC rotor position detection. The outputs of the selected signals are connected to interrupt inputs of CPU.

Figure 3-7: Jumper Configurations

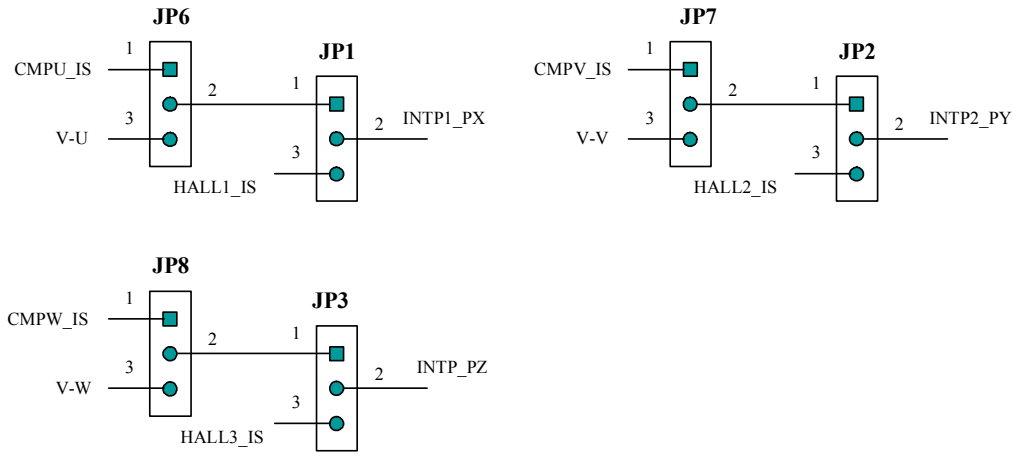


Table 3-2: JP Settings

Setting	Selected Power Source	Status
JP6.1 to JP6.2	CMPU_IS as sensor input	Default
JP6.3 to JP6.2	Phase voltage V-U	Future use
JP7.1 to JP7.2	CMPV_IS as sensor input	Default
JP7.3 to JP7.2	Phase voltage V-V	Future use
JP8.1 to JP8.2	CMPW_IS as sensor input	Default
JP8.3 to JP8.2	Phase voltage V-W	Future use

Table 3-3: JP1 Settings

Setting	Description	Status
JP1.1 to JP1.2	JP6.2: output of JP6	
JP1.3 to JP1.2	HALL1_IS as sensor input	Default
JP2.1 to JP2.2	JP7.2: output of JP7	
JP2.3 to JP2.2	HALL2_IS as sensor input	Default
JP3.1 to JP3.2	JP8.2: output of JP8	
JP3.3 to JP3.2	HALL3_IS as sensor input	Default

3.3.2 Power Supply Jumper Selections

The MC-IO board can be powered from the 15-volt power supply through the J11 power jack or from the power module by configuring jumper JP11. The 5-volt power for the digital circuits can be derived from the on-board regulator or from the power module, as specified by the configuration of jumper JP5.

When used with the low-voltage power module, the MC-IO board can supply 15 volts and up to 2 A power to the power module. A low-voltage, 12-volt brushless DC motor can be operated for limited loads that require less than 2 A.

3.3.3 JP5 - VCC 5 V Selection

An option is provided to supply VCC_5 V to the power module by connecting a jumper between pin 3 of the TF1 filter and pin 3 of JP5 when the JP4 1–2 jumpers are connected. The TF1 filter is installed on the bottom of the MC-IO board. The power module also can supply 5 volts DC to the MC-IO module when JP5 2–3 are connected.

Figure 3-8: JP5, TF1 Configuration

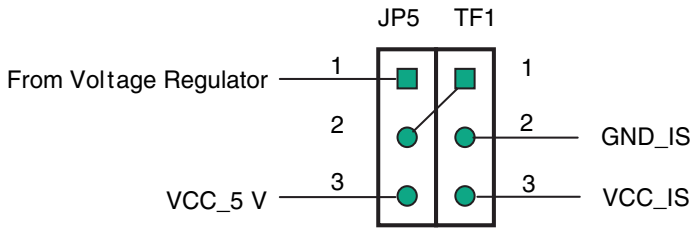


Table 3-4: JP5, TF1 Settings

Setting	Selected Power Source	Status
JP5–1 to JP5–2	Voltage regulator output to MC-IO board	Default
JP5–1 to JP5–2 and JP5–3 to TF1–3	VCC_S (5 V_{DC}) to power module	
JP5–2 to JP5–3	VCC_5 V from power module (system is powered by power module)	

3.3.4 JP11 - VCC 15 V Selection

The MC-IO board can be powered from the power module by connecting JP11 2–4.

Figure 3-9: JP11 Configuration

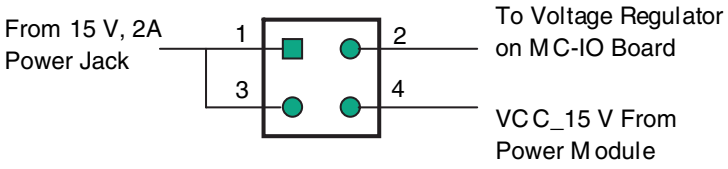
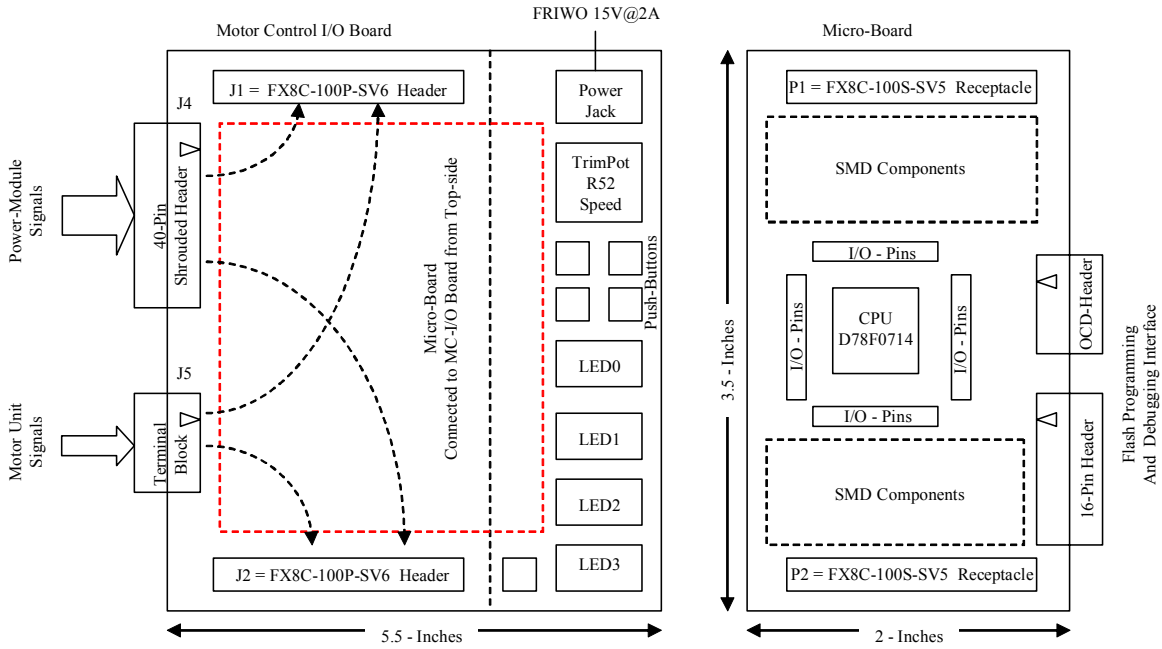


Table 3-5: JP11 Settings

JP11 Setting	Selected Main Clock Source	Status
1–2 3–4	Power input from the MC-IO board power jack	
2–4	VCC_15 V from power module; system powered by power module	

Chapter 4 Micro-Board and Power Module

Figure 4-1: Micro-Board and Power Module Block Diagram



4.1 Interface with Micro-Board

The micro-board with NEC Electronics MCU can be connected to the MC-IO board from the top, through J1–P1 and J2–P2 connectors. All CPU signals are available for the MC-IO board.

4.2 Interface with Power Module

The MC-IO board and power module are connected through a 40-pin ribbon cable. The signals from the power module are directed to the CPU through 100-pin connectors.

4.3 Interface with Motor Unit Sensors

J5 is used to connect motor sensor signals such as hall, motor temperature and shaft encoder to the MC-IO and CPU boards.