CCB-25 / DCMB
HARDWARE MANUAL

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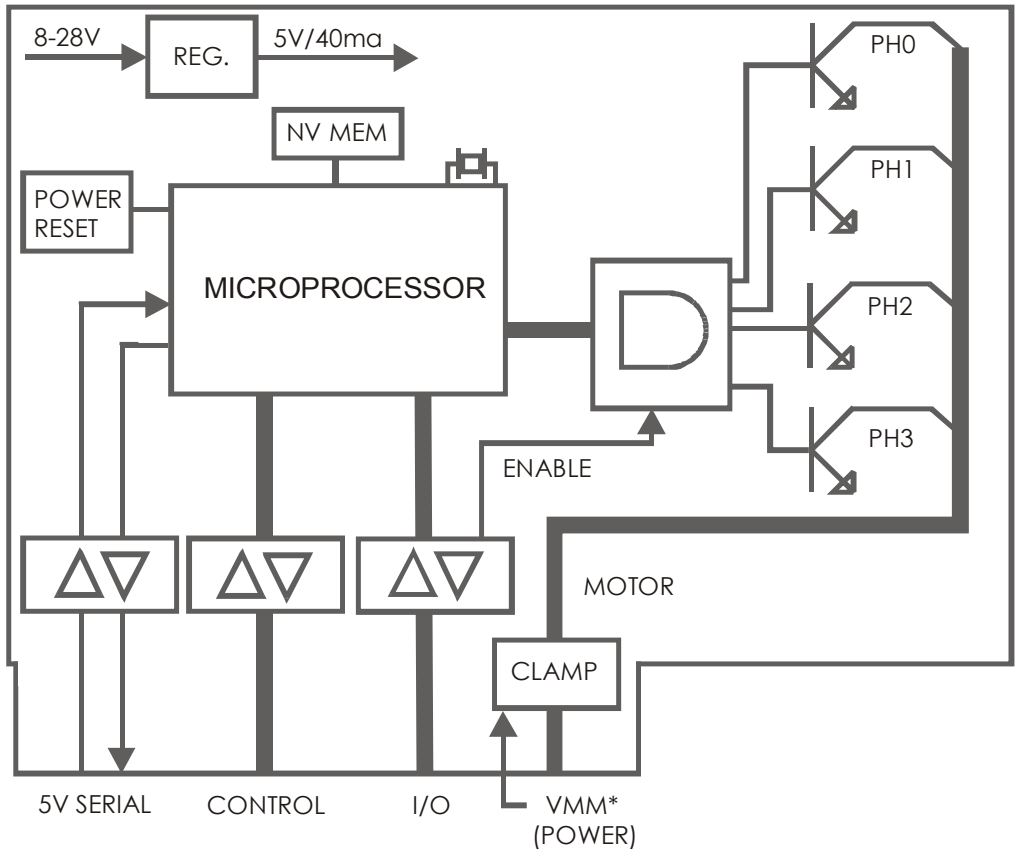
Overview

This document covers the hardware implementation of the CCB-25 and companion DCMB, an accessory dual-slot interface card. The heart of the credit card sized CCB-25 is a powerful controller chip called the SMC-25, a result of 20 years evolution of high performance motion control technology. The SMC-25 is a complete microcomputer with integral UART and program. It can produce step rates in excess of 20,000 steps per second. The extensive software communication protocol is covered in the SMC-25 Software Manual.

CCB-25

The CCB-25 is a low cost driver and smart controller board suitable for operating small stepper motors. The ASCII serial protocol may be interfaced to a standard RS-232 port on your computer. Because the CCB-25 is a self-contained microcomputer with program memory, many applications can be developed to operate without an additional "host" computer.



(Block Diagram: CCB-25 Driver and Intelligent Controller Board)

The CCB-25 utilizes a flexible phase sequence generator and unipolar power drivers with ratings up to 2 amps per phase. This all-in-one package is designed for OEM applications using high volume production linear actuators, rotary steppers and solenoid or valve drivers. Built in phase step sequences include Full, Half, and Wave drives. A custom user sequence capability provides a means to sequence 8 states with up to four devices.

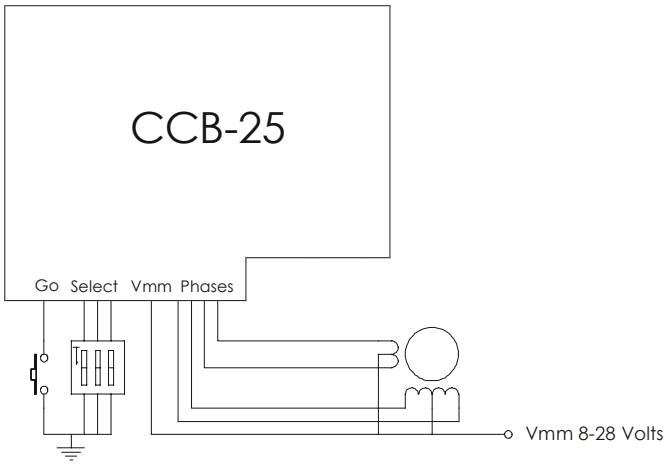
Features

- Small in size
- 3 amp current output
- User I.O. ports; 4 inputs and 3 outputs
- Limit and home switch inputs
- 2k non-volatile memory
- Programmable trip point
- Selectable "Party Line" serial communication

The controller logic implements low power C-MOS logic. All inputs and outputs are buffered with series resistors that afford some degree of protection against abuse that can occur, such as shorts to grounds or moderate voltages. ***WARNING: NEVER apply voltages in excess of 5.5 volts on any pin except the motor or Vmm supply, as damage not covered by the warranty will occur.***

Applications

In addition to driving small stepper motors, the CCB-25 can be used for other applications:



1. As a master step-direction control for high power step drives. The logic step and direction can be combined with the “drive” outputs to create sophisticated control signals for various motor drivers.

2. A sequenced control to operate up to four valves, lights, or other devices in a programmable order. Valves or solenoids could be sequenced to create an electronic “cam.”

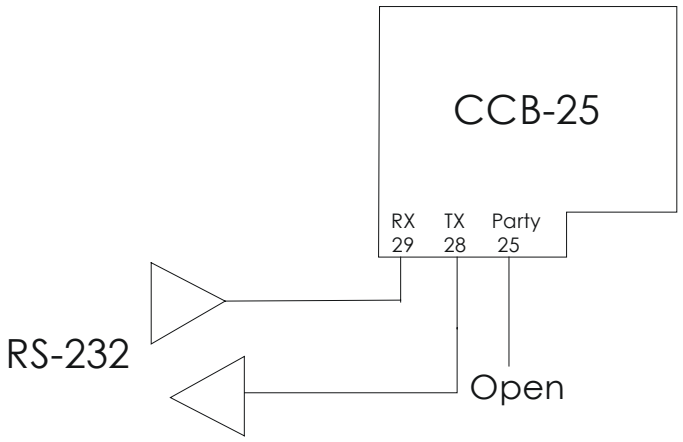
3. A basic stand-alone application. One of up to eight previously stored sequences may be chosen, using three “select” switches, then triggered with the go push-button. The 12 volts need not be regulated.

Terminal Interface

The serial interface is used for either a full time communication to a host computer or a temporary means to test and load parameters or programs for future execution. The serial communication input is 5-volt logic. The baud rate is fixed at 9600.

Several semiconductor manufactures supply RS-232, RS-422 or RS-485 line receivers. The older RS-232 devices require ±12-volt power while more recent buffers such as the MAX-232 from Maxim or Linear Technology contain integral voltage generators.

Once converted to 5-volt levels, multiple axes may be connected in parallel and operated in Party Line mode. The output serial line is open drain with a 10k pull-up. These outputs are connected in parallel, and then buffered with the appropriate line driver for connection to the host.



(Single axis, dumb terminal connection for name assignment)

RS-422 and Party Line

Communication is via RS-422 protocol and may operate in either Single or Party Line mode. Each unit monitors the host and responds when receiving a matching Name character. Communication to each individual axis in Single mode is performed to assign the unique Name (s) for each slave axis.

The Single mode provides User friendly, one axis communication for setup and debug functions. Setup usually involves optimizing operational parameters, writing and storing programs and assigning a unique Name for Party Line operation.

"Party Line" products have a 4 wire RS-422/485 interface. Differential line drivers and receivers are used to provide reliable communication in noisy environments. This design allows a single Master (or Host) computer and up to 32 Slave controllers. The hybrid design retains all the desirable characteristics of both EIA RS-422 and RS-485 specifications. In general, the hardware implementation follows the extended RS-485 standard with higher voltage and receiver capacity. Rather than half duplex protocol however, a full duplex Party Line communication is provided.

Slaves

Each Slave system contains the following:

1. RS-485 line receiver; always active.
2. RS-485 tri-state line driver; activated on receipt of "address received."

The line driver is always enabled when Single mode operation is selected.

Master
The Master interface, consists of:
1. RS-485 line receiver; always active
2. RS-485 line driver; always active

Note: The RS-485/422 is rated for a maximum cable length of 4,000 feet. It is recommended that a second terminator (120 ohms) be used if runs exceed 15 feet or if operated in an electrically noisy environment. DO NOT bundle signal wires and motor wires together. The high current and frequencies generated by chopper drivers will couple, even if shielded wire is used (unless 100% shielding can be guaranteed). Avoid proximity to relays, motors and other RFI sources.

Moving
The Moving signal is an open collector buffered output on all AMS motion control products. The AMS model SIN-8, serial adapter module, converts this signal to an RS-232 level and supplies it to Pin 8 "Carrier Detect" of the 25 Pin "D" connector.

Non-volatile Memory

2048 bytes of non-volatile memory is available to store user programs. Many programs may coexist, limited only by the available memory space. The custom parameters, necessary to match controller capability to motor and system are determined and stored as your defaults. These include initial velocity, ramping slope, step mode, etc. Once the desired settings are determined the “S” command stores them in NV memory and will be used as your defaults. These parameters may also be temporally modified during program execution, or by the host terminal.

Reset

A special control circuit performs the power up reset function. A reset is then forced if the 5-volt logic power falls below approximately 4.3Vdc, protecting against unwanted operations. Upon hardware reset all parameters (set by commands B,D,E,H,I,K,T,V) most recently saved are downloaded into the working registers of the controller. Both Jog and Go inputs are then active. During reset all outputs are off. That is, they are at a 5-volt level because of the integral pull-up resistors. The “boot up” process takes several hundred milliseconds.

The final function after reset is to execute any instructions found at location 1600 in the NV memory. At this point the serial port is functional and an “Esc” character will abort the executing program.

Power Supplies

Two voltages are required in most applications. The logic supply is a normal +5-volts. The step motor ratings determine the value of Vmm. Ground (pins 1, 26 and 40) is common to all power supplies.

The CCB-25 implements a small 5-volt regulator (powered by Vmm) rated for 40ma, maximum. The regulator is suitable for Vmm ranges between 8 and 28 volts maximum. A small amount of user 5-volt power (less than 5ma) may be obtained from pin 27. External voltage regulators or power supplies are generally required for any serial interface I.C.’s or external circuitry.

The DCMB (mother board) comes with a 1 amp voltage regulator and heat sink. Vmm must be the same or higher as the voltage applied to the motor. Its main function is to supply an inductive spike clamp to protect the driver power transistors.

5-Volt Configuration
When a 5-volt drive output is used, Vmm and Vcc (pins 27 and 39) should both be connected to the external 5-volt power supply.

WARNING: NEVER apply voltages in excess of 5.5 volts on any pin except the motor or Vmm supply, as damage not covered by the warranty will occur.

Input Ports

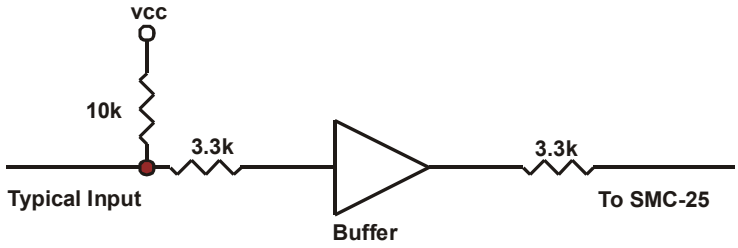
Pins 11, 15, 9 and 3; Four General-Purpose 5 Volt Input Ports are available for applications such as reading switches or other signals. The CMOS input ports P1 through P4 are protected with a 3.3k series resistor and a 10k pull-up to 5 volts. The input provides some degree of protection against accidental contacts with higher voltage sources. Depending on your design and environment, external buffers, isolation or filters may be implemented to protect against noise.

These inputs are usable with the following commands:

Command	Description
A 128	Read port
L	Loop on port
G 2048	Branch on port

It is important to realize that these ports are defined as inputs because of the direction of the buffers on the board. The SMC-25 microprocessor software allows the user ports (P1 through P6) to function as either input or outputs. The "A" command permits the output of a low on any combination of these six ports, thus creating an output. The A 128 command will read all six of these ports and report the binary value representing the states when sampled.

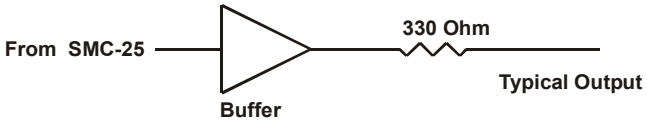
A built in resistor (below) between the buffer and SMC-25 is designed to protect against possible input/output conflicts.



(A typical input circuit)

Applying voltages above or below the maximum ratings can cause damage. This circuit also applies to the home input, limit inputs, go and soft stop.

Pins 7, 14, 18; Three General-Purpose 5-Volt Output Ports for applications such as valve control or logic signals.



(A typical output circuit)

Applying voltages above or below the maximum can cause damage. Note that the protection resistor will reduce the output drive capability and must be considered when designing loads.

The following outputs DO NOT include current limit protection resistors: TXD, Direction, Moving, and the 4 phase drivers**. (*Note; the built-in 5 volt regulator has a limited output current. The sum of multiple drive source currents may require a higher capacity external Vcc power):***

Pin 4; Home Input is used by the Find Home command. The homing sequence has a special routine that helps remove the effects of mechanical backlash. If the home function is not used, then the home input may be read by the host as a general-purpose input. The "]" command will return the home input state.

Pin 5; Moving Output is an open drain status output that is low while moving. It may be or'ed with the corresponding outputs of other axis for use by the system. When a "host" computer is used, then the preferred method is reading of the motion status with the software command ('^').

Pins 6, 8; **Limit Switch Inputs** are dedicated inputs that inhibit motion in one direction only. Prior to each motor step, the specific CW or CCW input is tested for an "on limit" state. When this happens, no more stepping is permitted in that direction, and the position counter does not change. The remainder of the index is terminated without ramping. A motion command in the opposite direction will be allowed, provided that the corresponding limit input allows it.

Pins 10, 12, 13; Jog Control provides a dual speed jog in both directions. Asserting a low level on pins 10 or 12 cause a "jog" or move at the speed specified in the first parameter (times 30) of the "B" command. When the level returns high, the stepping halts without any ramp. The direction CW or CCW is determined by which pin is asserted. A third pin (13) selects the second speed of jog specified by the 2nd parameter of the "B" command. If a jog input is held low and the "speed select" is asserted, ramping up that second speed occurs. Still holding the jog input and releasing the "speed" will cause ramping to the first speed. Releasing the jog input will cause termination without any ramping.

Pins 16, 17; Soft Stop and Go Inputs are used to control of pre-stored sequences. A low on the Go input will initiate the previously stored program, starting at NV location 00. This is comparable to the software "G 0" command. Program instructions can be a list of commands that are completed or can be constructed to run indefinitely. The Soft Stop input will cause deceleration (if the axis is moving) followed by termination. The internal SMC-25 software "polls" these inputs, hence they must be asserted for a minimum time (recommended 10ms). While the program is running the serial command input is locked out, but will respond to an "ESC" or "^C" Abort command character.

Pins 21, 22; Step and Direction Outputs are used with external power drivers or devices such as position display. These 5-volt outputs will operate in accordance with all motion commands. The designer should be aware that the width of the low going step pulse is short (5-10uS). This is important when selecting opto isolators or specifying drives. If the drive to be interfaced has inputs with slow response, then one of the phase outputs may be used with a binary step sequence. Remember that the actual step rates will be divided by 2, 4 or 8 but the waveform will be a 50-50 square wave.

These two inputs permit use as an intelligent translator, accepting a user direction signal and step pulse.

The following features are available:

1. The bi-directional position counter will track the position.
2. The limit switch inputs will function.
3. The step, direction, and phase outputs sequence.
4. If enabled, the Trip function will operate.
5. The hold current (power down) will function.

The input step rate is not buffered and caution must be exercised to avoid motor "stalls."

Pin 24; Driver Chop Input has a built in pull-down resistor. The input must SOURCE a 5-volt high to shut off all output transistors. The circuit bypasses the micro controller, gating off the base drive into the output transistors. Applications for this function include power reduction, simple regulation, or current control via duty cycle. Motor performance is not generally increased with this method (as compared to a bi-polar chopper).

Pin 25; Party Line Select Input is used to select the serial protocol between Single and Party Line communications mode. Single mode is a user-friendly communication that is intended for use during debug and familiarization with the operation. It is also necessary to assign and store the single character axis "name" that will be used in Party Line mode. A low will place the pre-addressed axis into the Party Line mode. This mode should be used when communicating via application software, even if only one axis is used.

Pins 28, 29; TXD Out and RXD In: These 5-volt serial signals are used for communications. The RXD input is driven by an external RS-232 receiver. Most line receivers will drive many CCB-25 cards. The serial output is open-drain and should be connected (wire or'ed) in parallel before sending to a RS-232 driver. The optional dual axis motherboard (DCMB) includes an RS-232 interface and serial Party Line expansion connections.

Phase Outputs

Pins 31, 32; Phase 3 Drive Out: *
Pins 33, 34; Phase 2 Drive Out: *
Pins 35, 36; Phase 1 Drive Out: *
Pins 37, 38; Phase 0 Drive Out: *

*These outputs use high power FET transistors. They can also be used to drive solenoids or high current opto isolators.

The step switch sequence is determined by an 8-byte table within the controller. One of several standard built-in tables may be selected, or a custom state table may be placed in the non-volatile memory.

Phase Sequence

The H command sets the phase switching sequence:

Sequence	1	2	3	4	5	6	7	8
Full (H0)	1010	1001	0101	0110	1010	1001	0101	0110
Half (H1)	1010	1000	1001	0001	0101	0100	0110	0010
Wave (H2)	1000	0001	0100	0010	1000	0001	0100	0010
Binary (H3)	0000	1000	0100	1100	0010	1010	0100	1110
Res. 0 (H4)	0010	0010	0010	0010	0010	0010	0010	0010
Res. 1 (H5)	0011	0011	0011	0011	0011	0011	0011	0011
Res. 2 (H6)	1010	1010	1010	1010	1010	1010	1010	1010
Res. 3 (H7)	0110	0110	0110	0110	0110	0110	0110	0110

Signal Pin Descriptions

Input Hardware

Unless otherwise stated, all inputs are 0-5 volt logic, with 10k pull-up resistors to Vcc. A 3.3k series resistor affords some protection from input surges to the CMOS series input buffers.

Output Hardware

Unless otherwise stated, all outputs are 0-5 volt logic. Open drain outputs have 10k pull-up resistors to Vcc.

P1 (40 Pin Edge Connector Signals)

Pin	Name	Function	Signal	Pin	Name	Function	Signal
1	Gnd	Power	Com	2	N/C		
3	Port 4	Input	5-volt	4	Home	Input	5-volt
5	Moving	Output	OD	6	Limit A	Input	5-volt
7	Port 5	Output	5-volt	8	Limit B	Input	5-volt
9	Port 3	Input	5-volt	10	Jog 2 In	Input	5-volt
11	Port 1	Input	5-volt	12	Jog 1 In	Input	5-volt
13	Jog Speed	Input	5-volt	14	Port 6	Output	5-volt
15	Port 2	Input	5-volt	16	Soft Stop	Input	5-volt
17	Go	Input	5-volt	18	Port 4	Output	5-volt
19	Vcc 5-volt	In/Out	5-volt	20	Ext. Dir.	Input	OD
21	Dir.	Output	OD	22	Step Pulse	Output	5-volt
23	Ext Step	Input	5-volt	24	Enable	Input	5-volt
25	Party Line	Input	5-volt	26	Gnd	Power	Com
27	Vcc 5-volt	In/Out	5-volt	28	TXD	Output	5-volt
29	RXD	Input	5-volt	30	N/C		
31	Ph 3 Drive	Output		32	Ph 3 Drive	Output	
33	Ph 2 Drive	Output		34	Ph 2 Drive	Output	
35	Ph 1 Drive	Output		36	Ph 1 Drive	Output	
37	Ph 0 Drive	Output		38	Ph 0 Drive	Output	
39	Vmm	Power		40	Gnd	Power	Com

Electrical Specifications

D.C. Characteristics: (Vcc= 5V ±10%)

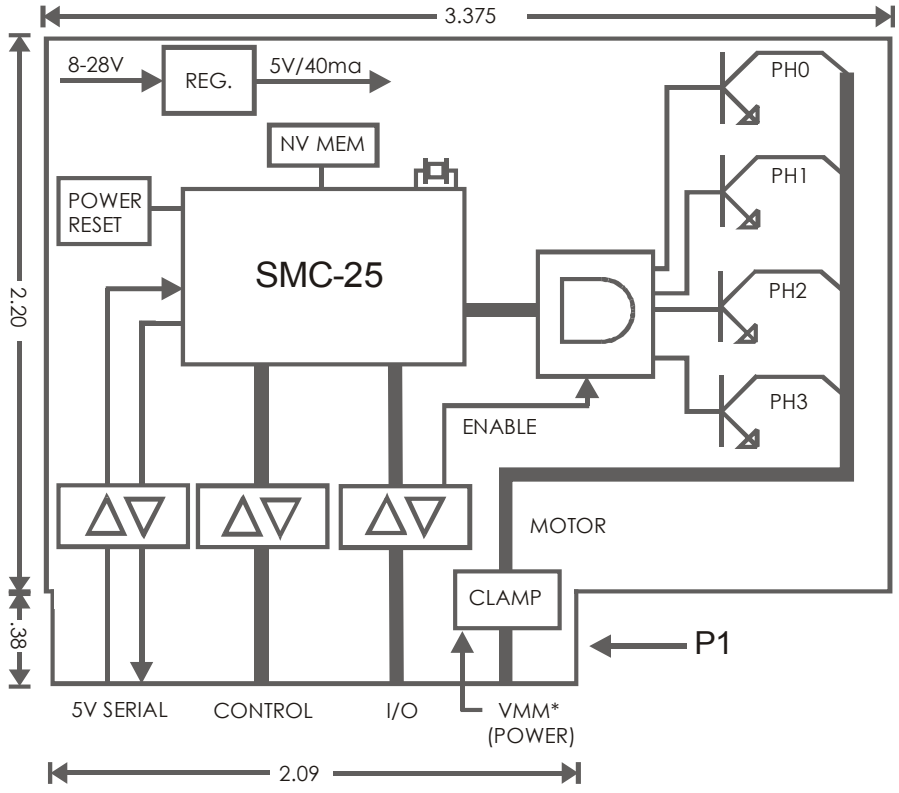
Description	Condition	Min	Max	Unit
Icc: Supply current			40.0	Ma
Vil: Input low voltage		-.05	0.8	V
IiI: Input low current	Vil=0.45V		-500.0	µa
Vih: Input high voltage		2.0	Vcc+0.555	V
Vol: Output low voltage	IoI=1.6ma		0.45	V
Voh: Output high voltage	Ioh= -80µa		2.4	V

Drive Outputs

Description	Min	Max	Unit
4 unipolar transistors (continuous)		3.0	Amp
Motor power supply (Vmm)	8	28	Vdc

Physical Specifications

Size: 3.375 x 2.580 (in.), 20-pin edge connector mount.

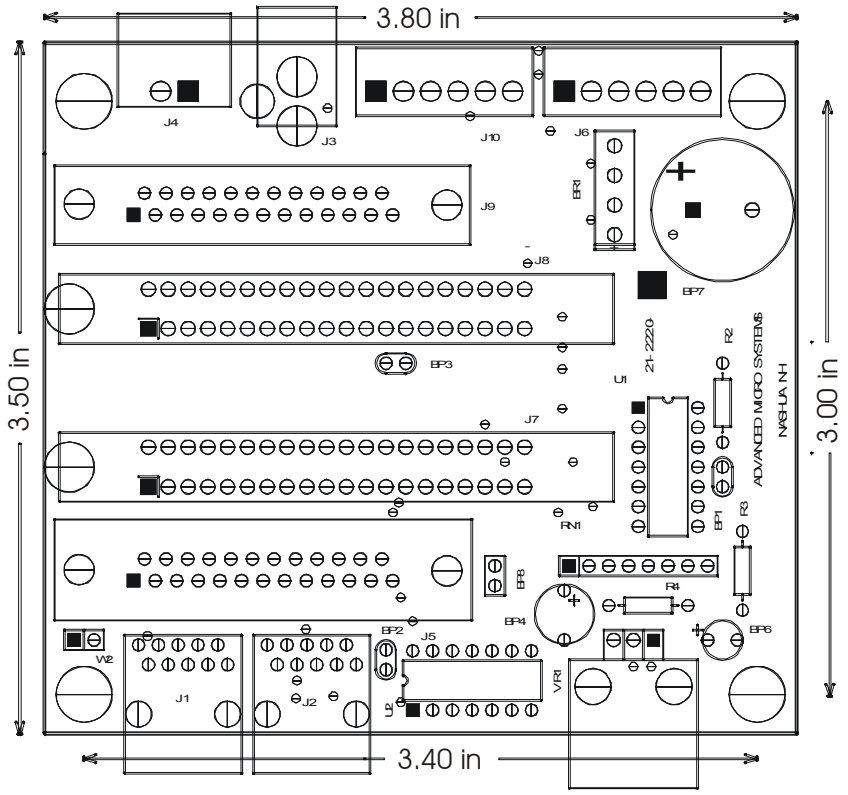


DCMB
2 AXIS MOTHER BOARD

Two Axis Mother Board (Model DCMB)

The DCMB is an accessory to the CCB-25. It contains the interface for one or two axis of motion control. The expansion connector provides the ability to add more axes in a microprocessor-based system.

- Two axis interface
- Expansion connector for multi-axis
- 1 amp, 5-volt regulator for additional load
- DB-25 connector for input/output signals
- DC or 8-40 VAC input for low cost power
- Separate motor and power supply inputs
- RJ45 connector for RS-422 input



(Dual axis motherboard with 8-40 VAC input, 5-volt regulator, RS-422 interface and Party Line expansion)

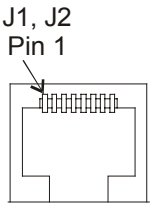
An RS-422 input converts standard serial voltages to TTL levels to drive up to 32 axes. The open drain TXD outputs from each axis are wire-or'd, providing "Party Line" communication.

DCMB Connectors

J1- RS-422 Interface

The J1 modular RJ45 connector serves as an RS-422 interface. The receiver and transmitter signals meet EIA specifications. Available serial adapter modules (SIN-8 and SIN-10) allow convenient plug-in compatibility to the host computer.

Pin	Signal	Type	Pin	Signal	Type
1	Moving	Output	5	TXD+	Output
2	Gnd	Logic	6	RXD+	Input
3	RXD-	Input	7	+5-volt	Logic
4	TXD-	Output	8	Party Enable	Input



J2- Party Line Extension

J2 allows convenient "Party Line" connection to the next axis.

Pin	Signal	Type	Pin	Signal	Type
1	Moving	Output	5	TXD+	Output
2	Gnd	Logic	6	RXD+	Input
3	RXD-	Input	7	N/C	
4	TXD-	Output	8	Party Enable	Input

J3- AC Input

A standard 5.5 mm jack provides input options for low cost AC power transformers. A 9V (1 amp or higher) AC transformer can be used for typical 12Vdc motors. A DC supply may also be applied but approximately 1.5 volts will be lost in the 1 amp rectifier. The unregulated voltage (approximately 12Vdc) is available on J4.

J4- Vmm Input Power

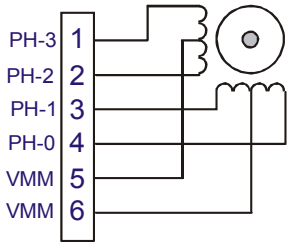
This input can be used as a power input in place of J3.

Pin	Signal
1	Vmm (8-40 Vdc)
2	Gnd (0 volts)

J6, J10 Motor Connector

A six-pin power connector is designed to accept each wire from a six-conductor motor.

Pin	Signal
1	Ph 3
2	Ph2
3	Ph1
4	Ph0
5	Vmm (center tap Ph2 and Ph3)
6	Vmm (center tap Ph0 and Ph1)



I/O 1, and I/O 2 Input/Output Signals

Two convenient DB25 connectors provide access to all input and output signals. All signals are 5-volt logic levels, rated at 1 ma source or sink. Inputs have a 10k pull-up resistor.

Pin	Name	Function	Signal	Pin	Name	Function	Signal
1	Port 2	Input	5-volt	14	Vcc	Power	5-volt
2	Port 4	Input	5-volt	15	Home	Input	5-volt
3	Moving	Out	OD	16	Limit A	Input	5-volt
4	Port 5	Out	5-volt	17	Limit B	Input	5-volt
5	Port 3	Input	5-volt	18	Jog 1	Input	5-volt
6	Port 1	Input	5-volt	19	Jog 2	Input	5-volt
7	Jog Speed	Input	5-volt	20	Port 6	Output	5-volt
8	Gnd	Power	Com	21	Soft Stop	Input	5-volt
9	Go	Input	5-volt	22	Port 4	Output	5-volt
10	Ext Dir.	Input	5-volt	23	Dir.	Output	OD
11	Step	Output	5-volt	24	Gnd	Power	Com
12	Ext Step	Input	5-volt	25	Gnd	Power	Com
13	Chop	Input	5-volt				

Naming Axis Procedure

To communicate with the CCB-25 and/or CCB-26 one of the following serial adapters are necessary:

Single Axis

1. SIN-7 (25 pin) or SIN-9 (9 pin), RS-232 to RS-232 serial adapter and cable used for communication with one axis in single axis mode.

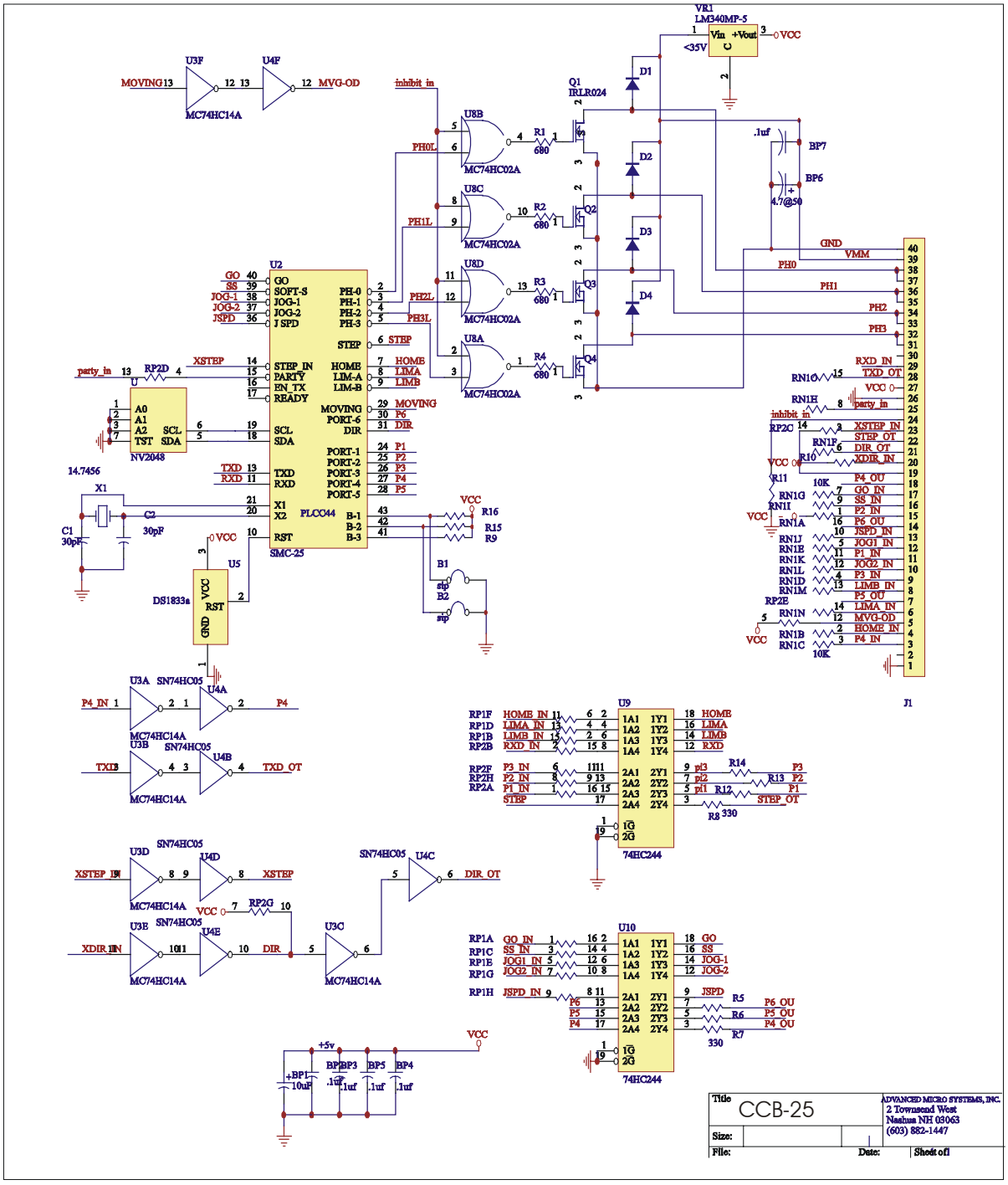
Multi-Axis

2. SIN-8, RS-232 to RS-422 serial adapter and cable. It permits addressing of up to 32 axes from a single serial port.
3. SIN-10 and SIN-11, Intelligent serial line converters. Theses adapters are used with operating systems that are difficult to interface with, such as Windows 2000 and Windows NT.

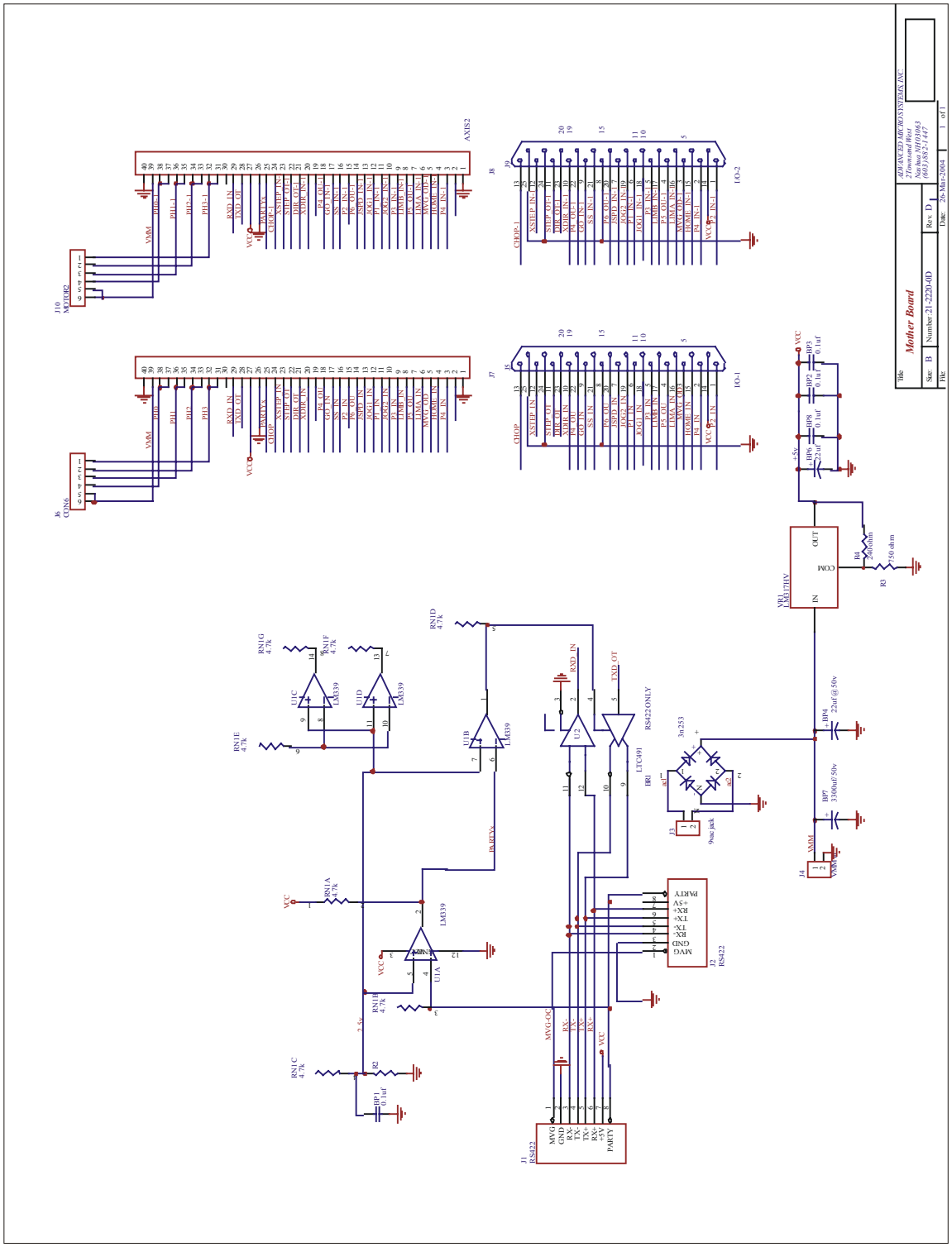
The following procedure is used for multi-axis "Party Line' applications to assign an axis "Name" to the CCB-26/CCB-26 using the DCMB motherboard:

1. Turn the power "OFF."
2. Connect the serial adapter from your serial port to J1 on the DCMB.
   SIN-8: Move the red selector switch to the "S" (single line) position.
   SIN-10: Move the Party Line switch (S8) to the "off" position.
   SIN-11: Ready as is.
3. Remove all CCB-25/CCB-26's from the DCMB.
4. Install the first CCB-25/CCB-26 in the DCMB (either slot).
5. Turn the power "ON."
6. Enter the "Name" character: (A-Z, a-z) followed by a space bar. The CCB-25/CCB-26 will sign on.
7. Verify by entering the "X" (Examine) command <CR>. The last "n" value should be the Name assignment.
8. Enter the "S" (Save) command <CR>. The Name is now stored in the NV memory.
9. Turn the power "OFF."
10. Remove the first CCB-25/CCB-26.
11. Install the second CCB-25/CCB-26.
12. Repeat steps 5 through 11 for each CCB-25/CCB-26.
13. Prior to programming, if you are using a:
    SIN-8: Move the red selector switch to the "P" (Party Line) position.
    SIN-10: Move the Party Line switch (S8) to the "on" position.
    SIN-11: Enter the Amper (&) sign.

CCB-25 Schematic



DCMB Schematic



ADDENDUM

Naming Axis Procedure V1.10

SMC-25 V1.10 incorporates ^N and ^P commands for an alternate way of naming an axis. In this instance, using the DCMB, any AMS serial adapter can be used for single or Party Line connection.

The following procedure is used for multi-axis "Party Line' applications to assign an axis "Name" to the CCB-26/CCB-26 using the DCMB motherboard:

1. Turn the power "OFF."
2. Connect the serial adapter from your serial port to J1 on the DCMB.
3. Remove all CCB-25/CCB-26's from the DCMB.
4. Install the first CCB-25/CCB-26 in the DCMB (either slot).
5. Turn the power "ON."

Assign the controller name:

6. Enter control N (^N). – "name ?" is displayed.
7. Type the single (case sensitive) name character. "Save" is displayed.
8. Type "y" (lower case Y).
9. Hit the spacebar key.

Note: The controller will accept any character as a name, including control characters. Two common error characters show up as either a space ' ' or ♥ (heart symbol).

The unit is ready to operate in the current single controller mode or be switched over to party line mode. It is suggested that the operator use single mode first to become familiar with command input. The single controller mode can be used with any "dumb" terminal device and is not dependant on using the AMS software.

10. Remove the first CCB-25/CCB-26.
11. Install the second CCB-25/CCB-26.
12. Repeat steps 5 through 9 for each CCB-25/CCB-26.

Controller Name Assignment

Whenever the application is controlled via a "host" computer the proper protocol (handshake) MUST be used. Either the programmer must write the necessary serial, echoed character-by-character software (driver), or implement a SIN-11 for the proper handshake.

In any case, a unique name must be assigned.
EVEN A SINGLE CONTROLLER APPLICATION REQUIRES PARTY LINE PROTOCOL.

AMS software searches for controller names starting with A, B, C, …. x, y, or z.

Recommended names are as follows:

Recommended Names: (Upper case A through Z) (Lower case a through z)		Non-valid Names:	
ASCII	HEX	ASCII	HEX
[	5B	^C	03
\	5C	CR	0D
]	5D	LF	0A
^	5E	@	40
-	5F		
‘	60		