# OREGON MICRO SYSTEMS, INC.

PC34
INTELLIGENT MOTOR CONTROLLERS
FOR PC/XT/AT AND COMPATIBLE COMPUTERS

FEATURES

- LOW COST precision motion control

- Functions as an intelligent peripheral to PC/XT/AT or compatible computers

- Up to FOUR axes in ONE short (⅔ length)PC/XT/AT or compatible computer I/O slot

- 20 bits of user definable I/O

- Uniform pulse train for minimum torque ripple

- Minimal move latency

- Automatic conversion to user defined units, i.e. inches or revolutions, simplifies software

- Smooth, high resolution, resonance free motion

- Compatible with any stepping, servo or linear motor drive that accepts digital step and direction commands

- Synchronized or independent motion

- Software disk supplied

- Watchdog timer

- Can interrupt host when sequence is complete, limit encountered or error condition occurs

- Crystal controlled pulse rates from 0 to 524,000 steps per second

- Independent limit and home switches for each axis

- 68008 microprocessor for velocity profile synthesis and high level command interpretation

- Supports resolution of 0.0072 degrees per step (0.126 milliradians per step) or 50,000 steps per revolution (function of motor and driver)

- Position range of 134 million pulses on each axis

- Done flags available to host for each axis

- All data and commands are programmed in ASCII command strings

- 1 year limited warranty
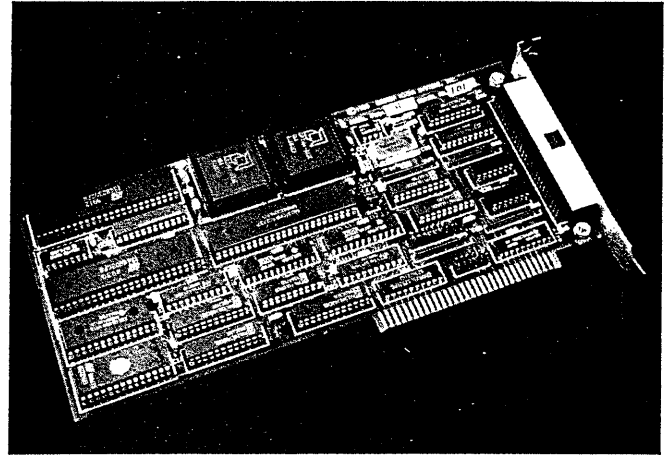
PC34-4 Four axes controller for PC/XT/AT computers

DESCRIPTION

The PC34 intelligent motion control allows control of up to 4 axes in one I/O slot of a PC/XT/AT or compatible computer. All axes are controlled through 4 I/O ports for control, status feedback, data and commands. Each axis has a separate command queue allowing the computer to transfer a command string then proceed with other tasks, while the PC34 manages the motion process. The computer can be interrupted at any point in the command stream to coordinate the motion process with other activities. Each axis can perform individual unrelated moves or they can be coordinated as required by the application.

The PC34 generates step and direction pulses for control of most popular step motor drivers. It also supports servo or linear motor controllers which accept step and direction inputs. The PC34 supports high resolution microstepping of 50,000 steps per revolution with a standard 200 step per revolution (1.8 degree per step) stepping motor and a microstepping driver by developing the high pulse rates required for theses applications. This high resolution allows the stepping motor to run smoothly at all speeds and minimizes low speed torque loss due to mechanical resonance effects.

Simple ASCII commands can be easily programmed from any high level language which allows input and output to an I/O device. This includes Basic, Pascal and C. Additional user

definable input and output lines can be used to monitor or initiate other events and are under the control of the host computer. Complex move sequences, time delays, status checks and control of other external events can be programmed through the PC/XT/AT interface.

PROGRAMMING

The OMS motion controls are easily programmed with double character ASCII commands through an extensive command structure. These commands are combined into character strings to create sophisticated motion profiles. It includes a 200 command and parameter buffer for each axis and a command loop counter which allows multiple executions of any command string.

The following commands are available in the PC34 family of motion controls. Some of the commands expect a numerical operand to follow. These commands are identified with a '#' after the command. The '#' indicates a signed integer input parameter or a signed fixed point number of the format ##.# when user units are enabled. With user units defined, distances, velocity and acceleration parameters may be input in inches, revolutions, etc.

Synchronized moves may be made by entering the AA command. This command performs a context switch which allows entering commands of the format MRx#, y#, z#, t#;. Numbers are entered for each axis which is to be commanded to move. An axis may be skipped by entering the comma with no parameter. The command may be prematurely terminated with a ";", i.e. a move requiring only the X and Y axes would use the command MRx#, y#; followed by the GO command. Each axis programmed to move will start together upon executing the GO command. The PC34 can be switched back to the unsynchronized mode by entering the desired axis command such as AX.

The following summarizes the PC34 command set:

AXIS SPECIFICATION COMMANDS

The following commands specify the axis to which the following commands are to be directed. They remain in effect until replaced by another command of the same type.

AA   AXES ALL
The AA command will perform a context switch to the synchronized mode.

AM   AXES MULTITASKING
The AM command will perform a context switch to the multitasking mode. This mode is optimized for a multitasking operating system environment where the host operating system manages several simultaneous processes.

AX   AXIS X
The AX command directs all the following commands to the X axis.

AY   AXIS Y
The AY command directs all the following commands to the Y axis.

AZ   AXIS Z
The AZ command directs all the following commands to the Z axis.

AT   AXIS T
The AT command directs all the following commands to the T axis.

SYSTEM CONTROL COMMANDS

These commands allow control of various system parameters and operating modes. This allows the user to optimize the response of his/her system for his/her application needs.

EN   ECHO ON
The EN commands enables echoing of commands.

EF   ECHO OFF
The EF command disables echoing.

HH   HOME HIGH
The HH command sets the sense of the home switches to active high.

HL   HOME LOW
The HL command sets the sense of the home switches to active low.

CN   COSINE ON
The CN command enables Cosine ramps, i.e. half sinusoid acceleration and cosine velocity profiles.

PN#   PARABOLIC ON
The PN command enables parabolic ramps. The parameter selects the point of truncation.

PF   PARABOLIC OFF
The PF command restores linear acceleration and deceleration ramps.

RS   RESET
The RS command is a software reset which causes the PC34 microprocessor to reset.

MOVE SPECIFICATION COMMANDS

These commands allow specification of move parameters to the user's system requirements.

AC#   ACCELERATION
The AC command sets the acceleration/deceleration value. This value is used to establish the rate of acceleration and deceleration when a move command is envoked.

VL#   VELOCITY
The VL command sets the maximum velocity value of the axis being programmed. This value is used to establish the maximum number of pulses per second sent to the motor driver from the PC34 board when one of the move execution commands is envoked.

VB#   VELOCITY BASE
The VB command allows the velocity ramp to start at the specified velocity. This allows faster acceleration and the ability to pass through resonance quickly in some applications.

LP#   LOAD POSITION
The LP command will immediately load the position supplied as a parameter into the absolute position register of the axis.

MA#   MOVE ABSOLUTE
The MA command will set up the axis to move to the absolute position supplied as a parameter.

MR#   MOVE RELATIVE
The MR command will set up the axis to move relative from the current position at the time the move is executed.

MT#   MOVE TO
The MT command uses linear interpolation to perform a straight line move to the specified absolute position. Up to 4 axes may be moved together in the AA or the AM mode.

ML#   MOVE LINEAR
The ML command uses linear interpolation to perform a straight line relative move to the new location. Up to 4 axes may be moved together in the AA or the AM mode mode.

MOVE EXECUTION COMMANDS

These commands allow execution of the moves which have been previously specified.

GO   GO
The GO command will initiate the move which has been previously programmed.

GD   GO AND RESET DONE FLAG
The GD command resets the done flags on the active axes then proceeds with the move identical to the GO command.

JG#   JOG
The JG command is a velocity command and will jog the axis at the velocity supplied as a parameter. The velocity may be changed without stopping by entering another JG command.

MOVE TERMINATION COMMANDS

The following commands allow termination of move sequences in process.

ST   STOP
The ST command flushes the queue for the currently addressed axis only and causes the axis to decelerate to a stop at the rate previously specified in an AC command.

SA   STOP ALL
The SA command flushes all queues and causes all axes to decelerate to a stop at the rate previously specified in an AC command.

KL   KILL
The KL command will flush the command queue and terminate pulse generation of all axes immediately.

LOOP CONTROL COMMANDS

These commands allow move sequences to be repeated within loops. Loops can be nested up to four levels deep on each axis.

LS#   LOOP START
The LS command sets the loop counter for the axis being programmed. The parameter specifies the number of times the loop will be executed. Loops may be nested up to 4 levels deep.

LE   LOOP END
The LE command terminates the most recent LS command.

WS#   WHILE SYNC TRUE
The WS command will execute the commands between the WS and WD commands as a loop while the selected input bit is true. The test is at the bottom of the loop and thus will always be executed at least once.

WD   WHILE END
The WD command serves as the loop terminator for the WS commands.

WH   WHILE
The WH command will execute all commands until the terminating WG command as a loop until terminated by a CW command. This allows indefinate loops to be terminated by the host computer.

WG   WHILE FLAG END
The WG command serves as the terminator for the WH command.

CW   CLEAR WHILE
The CW command terminates the WH command sequence upon execution of the WG instruction. This loop is always executed at least once.

HOME OR INITIALIZATION CONTROL COMMANDS

These commands allow the coordination of the physical stage home position with the PC34 position register.

HM#   HOME COMMAND
The HM command will find home and initialize the position counter to the position supplied as a parameter.

HR#   HOME REVERSE
The HR command will find home in the reverse direction and initialize the position counter to the position supplied as a parameter.

KM   HOME AND KILL
The KM command will find home and stop generating pulses immediately, i.e. no deceleration ramp will be generated. The position counter is not affected.

KR   HOME REVERSE AND KILL
The KR command will find home in reverse and stop generating pulses immediately, i.e. no deceleration ramp will be generated. The position counter is not affected.

MOVE SYNCHRONIZATION COMMANDS

These commands allow the synchronization of moves with external events or multiple axes sequences.

ID   INTERRUPT DONE
The ID command will return the done flag to the host and interrupt the host if the interrupt has been enabled.

IC   INTERRUPT CLEAR
The IC command will clear the done and error flags.

WT#   WAIT TIME
The WT command will wait for the specified number of milliseconds before proceeding with the next command.

SYSTEM STATUS REQUEST COMMANDS

These commands allow the host to request the status of various move parameters including the status of limit and home switches.

WY   WHO ARE YOU
The WY command returns the model and firmware revision of the board or system being addressed.

RP   RETURN POSITION
The RP command requests the current position.

RQ   RETURN QUEUE STATUS
The RQ command returns the number of entries available in the command queue.

RA   RETURN AXIS INTERRUPT STATUS
The RA command returns the state of the limit, home switches and done/error flag for the currently addressed axis.

RI   RETURN INTERRUPT STATUS
The RI command returns the state of the limit, home switches and done/error flags for each axis.

QA   QUERY AXIS
The QA command returns the status of the addressed axis like the RA command except the status register and flags are not affected.

QI   QUERY INTERRUPT STATUS
The QI command returns the status of each axes like the the RI command, except the status register and flags are not affected.

COMMANDS FOR USER UNITS

The following commands allow redefinition of move specification command parameters to user defined units. The OMS controls will automatically convert all move parameters to these units once they have been defined.

UU#   USER UNITS
The UU command converts all move velocities, distances, etc. to user specified units by multiplying by the parameter given in this command.

UF   USER UNITS OFF
The UF command turns off user units and causes the PC34 board to use it's default units.

USER I/O CONTROL COMMANDS

AF   AUXILIARY OFF
The AF command sets the auxiliary output to the low level. The open collector driver is turned on pulling the output to near ground. It may be used to change power level on driver modules so equipped or as a user definable output.

AN   AUXILIARY ON
The AN commands sets the auxiliary output to the high level. The open collector driver is turned off allowing a pull-up resistor to pull the output high. It may be used to change power level on driver modules so equipped or as a user definable output.

PA#   POWER AUTOMATIC
The PA command will perform a AN command at the beginning of each move and perform an AF after the move. See the AN and AF commands.

BL#   BIT LOW
The BL command sets the selected output bit to active (TTL) low.

BH#   BIT HIGH
The BH command sets the selected output bit to TTL high (off).

BX   BIT REQUEST IN HEX
The BX command returns the state of the input bits in hex format.

SW#   SYNC WAIT
The SW command may be used to synchronize multiple PC34 boards or synchronize to external events by commanding the controller to wait for the selected input to go high.

PROGRAMMING EXAMPLES

In a typical move requirement involving both X and Y axes the following will demonstrate the programming:

- Move a distance of 1,000,000 pulses on the X axis with a velocity of 400,000 pulses per second and a peak acceleration of 500,000 pulses per second per second.

- Wait for the X axis to finish its motion, then move the Y axis to an absolute position of 1,000,000 with the same velocity and acceleration parameters.

With these assumed conditions, the following is input from the host computer:

```
AA
VL400000,400000; AC500000,500000;
MR1000000; GO
MA,1000000; GO
```
↑ don't move X any more.

In a typical application where an X/Y plotter is being controlled, the auxiliary output of the X axis causes the pen to contact the surface of the paper when it is high (Auxiliary on). Using appropriate motors and drivers, the platform will move 1 inch when the OMS motion controller produces 10,000 pulses. The following commands will plot the leter "W" three times across the stage 0.125 inches apart. Each letter should be 3 inches tall and 2 inches wide. The following OMS controller commands will perform the task:

```
AX UU10000 AF
AY UU10000
AA AC2,2; VL1,1;
MA0,0; GO
LS3
AX AN AA
MR0,3; GO ML1,-3; GO
ML2,3; GO MR0,-3; GO
AX AF AA
MR.125,0; GO
LE
```

OPERATING PRINCIPLE

The PC34 family of motion controls provides acceleration to an optimum speed followed by a constant velocity and a controlled deceleration to a stop. The velocity profile is achieved by calculating the optimum velocity 1024 (2048 on two axes versions) times each second providing a very smooth acceleration curve. The calculation is used to control a variable frequency pulse train which is derived from a crystal oscillator thus providing very accurate pulse rates. Linear as well as parabolic and cosine velocity ramps can be generated to fit a variety of system requirements. The following figure shows a typical acceleration and constant velocity followed by the deceleration using a linear velocity profile.
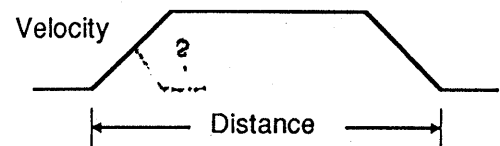
Linear Velocity Profile

Moves may be chained together to provide a more complex pattern. An internal queue can store up to 200 command parameters in an input queue for each axis as well as 124 characters in an input character buffer. This allows a complicated move sequence to be performed without host intervention. A flag can be passed to the host on the completion of a sequence or at any intermediate point in the command stream.

SPECIFICATIONS

Velocity
0 to 524,000 pulses per second simultaneous on each axis

Acceleration
0 to 8,000,000 pulses per second per second

Position range
PC34-2   67,000,000 pulses (±33,500,000)
PC34-4   134,000,000 pulses (±67,000,000)

Accuracy
Position accuracy and repeatability ±0 counts
Velocity accuracy ±0.01% of peak velocity in jog mode

Environmental
Operating temperature range 0 to 50 degrees centigrade
Storage temperature range -20 to 85 degrees centigrade

Humidity 0 to 90% non-condensing

Power

+5 volts at 1.75 amps (from PX/XT/AT backplane)

Dimensions

4.2 x 9.0 x 0.5 inches high

PC/XT/AT interface

Meets all IBM I/O channel signal specifications and definitions

Limit switch inputs

TTL input levels with on board 2.2K pull up resistor, requires only external switch closure to ground or TTL level input signal. Input sense (low or high true) selectable by on board jumper for each axis.

Home switch inputs

TTL input levels with on board 2.2K pull up resistor, requires only external switch closure to ground or TTL level input signal. Input sense (low or high true) selectable under software control for each axis.

User definable inputs

8 user definable TTL level inputs with on board 2.2K pull up resistor, requires only external switch closure to ground or TTL level input signal.

User definable outputs

8 user definable TTL level outputs.

Step pulse output

Pulse width 50% duty cycle. Open collector TTL level signal. Step, direction and auxiliary outputs can be changed to TTL totem pole output in axis pairs with option T (7404).

Direction output

Same as step pulse output

Auxiliary output

Same as step pulse output

PC/XT/AT interrupt vector

Interrupt vector user selectable levels 2 through 7. The factory default is level 5.

PC/XT/AT registers

The I/O address block is user selectable. The factory default is 300 hex.

OFFSET	FUNCTION	I/O
0	Data	I/O
1	Done status	I
2	Control	I/O
3	Status	I

Connector pin list

Pins are shown in their actual relative position as viewed from the connector.

CONNECTOR PIN ASSIGNMENTS			
FUNCTION	PINS		FUNCTION
User input 0	50	1	+5 volts
User input 2	49	2	User input 1
User input 4	48	3	User input 3
User input 6	47	4	User input 5
User output 0	46	5	User input 7
User output 2	45	6	User output 1
User output 4	44	7	User output 3
User output 6	43	8	User output 5
Ground	42	9	User output 7
X step output	41	10	+5 volts
X auxiliary output	40	11	X direction output
X CW limit switch	39	12	Ground
X home switch	38	13	X CCW limit switch
Y step output	37	14	+5 volts
Y auxiliary output	36	15	Y direction output
Y CW limit switch	35	16	Ground
Y home switch	34	17	Y CCW limit switch
Z step output	33	18	+5 volts
Z auxiliary output	32	19	Z direction output
Z CW limit switch	31	20	Ground
Z home switch	30	21	Z CCW limit switch
T step output	29	22	+5 volts
T auxiliary output	28	23	T direction output
T CW limit switch	27	24	Ground
T home switch	26	25	T CCW limit switch

The mating connector is an Amp, Inc. 2-102398-3 with a 2-102536-3 and 2-102681-0 hood and strain relief. These are supplied with each PC34 purchased at quantity 1-4 pricing.

ORDERING INFORMATION

MODEL	DESCRIPTION
PC34-2	2 axes controller
PC34-4	4 axes controller

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