MAC 5000 Controller System

Ludl Electronic Products Ltd.

The New Standard of Automation

Practical

The modular MAC 5000 automation controller system with its stacking module concept combines the well known high performance of LEP systems and practical design in an all new generation of instrument controllers.

The LEP design philosophy makes the MAC 5000 system easy to integrate, simple enough for basic applictions, yet sophisticated and powerful enough for very advanced applications.

For basic operation the MAC 5000 accepts simple high level ASCII commands. This high level command line oriented protocol provides robust syntax checking and error detection. With little effort even a novice programmer can create applications using the MAC 5000 system.

For more demanding application the MAC 5000 supports a low level binary command set that provides advanced control of each module. Through the use of the low level communication mode throughput is increased and detailed parameters can be set for each module.

Applicable

All aspects of the MAC 5000 have been designed for simplicity. The stacking module concept, the flexible interfacing, the comprehensive array of component modules all make the MAC 5000 the choice for complete automation.

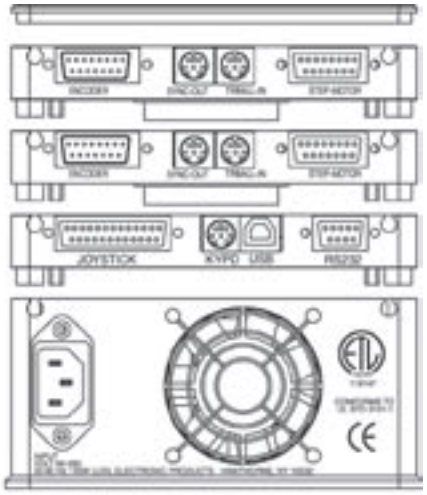
The ability to unify all the automation into a single controller dramatically simplifies system design, programming, implementation and troubleshooting. There are no boards to install into your computer; only a standard RS-232 or USB port is required. Each module is configurable either via hardware switches or by software override. Application software is also simplified through the use of common command structures across all the MAC 5000 modules.

The LEP philosophy makes basic operation and programming of the MAC 5000 system easy. The high level command set provides an intuitive, easy to use interface suitable for even novice programmers. While at the same time sophisticated low level commands are available that enable an application to fine tune the system for the vital performance edge.

Manual joystick control is always available. While it may seem mundane, this feature can save costs in terms of hardware integration and processing overhead. Each module supports either analog joystick or digital digipot control. In some cases both inputs are simultaneously supported.

Compatible

Building on its MAC 2000 legacy, the MAC 5000 retains the powerful features and efficient communications protocol. The connector pinouts for the stage and filter wheels conform to the standard LEP systems. This ensures that upgrading older, existing and future components will possible.



- Stacking module design for flexible configuration
- Easy access to all connections
- No complicated wiring harnesses
- Attractive polished aluminum finish
- Compact footprint
- RS-232 and USB interface standard
- CE compliant and ETL listed

Specifications

Input power ..... 90-250vAC, auto switching 150watts
Expansion module height 20mm
Base unit dimensions ..... 148mm x 200mm x 70mm (5.8” x 7.9” x 2.75”)
Base unit weight 1.4kg
Compliance ..... UL 3101-1, CE

Configured Systems

- **Configured systems simplify ordering**
- **Includes cables and documentation set**

The configured MAC 5000 systems bundle the necessary components into a single package. The packaged configurations ensure that each controller is suited exactly to the application; there are no unused components that may add to the cost of the system.

The preconfigured systems are fully expandable. The MAC 5000 architecture supports up to 20 addressable modules. The practical expansion is mostly limited by the power demand of the individual module and the ability of the power supply to meet that demand.

For example, the 995052 system supplies all the components for control an XY stage: base unit, XY drive modules, joystick, cables and documentation. Should there be a requirement for an XYZ system, the simple addition of third motor driver to a configured XY system would make a complete system.

Every system includes the minimum components:

- **System power supply**
- **RS-232 , USB interface**
- **Interface cable, RS-232**
- **Line cord (US Style)**
- **User documentation**

Base System Controller

The MAC 5000 base system is the foundation for all MAC 5000 configurations. The system includes the 73005001 system base, 73005042 interface/power supply, cables and documentation. This system should be used as a configuration starting piont when other more complete systems are not suitable. With the addition of any selected MAC 5000 modules this becomes a complete automation system.

995001 ..... MAC 5000 Base System

XY Stepper Motor Stage Controller

This XY stage controller system is ideal for LEP BioPrecision stepper motor stages. This system includes the components from the 995001 base system, with the addition of two 73005050 microstepping motor drive modules, and a 73000362 XY digipot joystick. This high performance controller is designed for maximum speed, resolution and flexibility.

995052 ..... XY Stepper Stage Controller

XY DC Servo Motor Stage Controller

For applications that use LEP DC servo motor stages this configuration is available. This system includes the 995001 base system, with the addition of two 73005051 DC servo motor drive modules, and a 73000362 XY digipot joystick. This high performance controller is designed for maximum speed, resolution and flexibility.

995053 ..... XY DC Servo Stage Controller

- **Designed specifically for LEP stages**
- **Complete XY stage control system including joystick**
- **Stacking module design for expansion**

- Complete controllers for LEP filter wheels
- Add filter wheel and mount and the system is complete
- Includes interface cable and line cord
- Manual front panel controls for shutters and position
- Visible LED indication of shutter status

Standard Stepper Filter Wheel Controller

This controller is configured for control of stepper motor filter wheels. This system includes the 73005080 filter/shutter control module and has the capability of controlling up to two single filter wheels or a single dual filter wheel. In addition, up to three shutters can also be controlled. Front panel toggle switches provide shutter and filter wheel position control.

995064 ..... Stepper Motor Filter Wheel Controller

High Speed DC Filter Wheel Controller

For demanding applications where high speed filter changing is required, the LEP DC filter wheels are the best choice. This controller adds a 73005081 DC filter wheel module to the standard base system. In this configuration any available DC filter wheel can be connected with front panel controls for each. The 73005081 module supports two single filter wheels or one dual filter wheel and up to three electronic shutters.

995066 ..... DC Servo Motor Filter Wheel Controller

Z-axis/Focus Controller

Single axis motor control for precision focus positioning is a simple but demanding application. This controller adds the 73005056 microstepping motor control module and 73000365 digipot control to the MAC 5000 base system to configure a system very well suited to this task. For a complete focus system add a drive motor and mounting bracket. The manual digipot focus control serves to enhance mechanical microscope focusing by providing finer and more comfortable control.

995062 ..... Z-axis Motor Controller

Video Autofocus Controller

The MAC 5000 autofocus is the most flexible video autofocus available. This system brings it together by combining precision 73005056 stepper motor drive module, the 73005085 video autofocus processor, 73000365 digipot and the MAC 5000 base system. Add a composite video source, a drive motor and mounting bracket and it becomes a complete system.

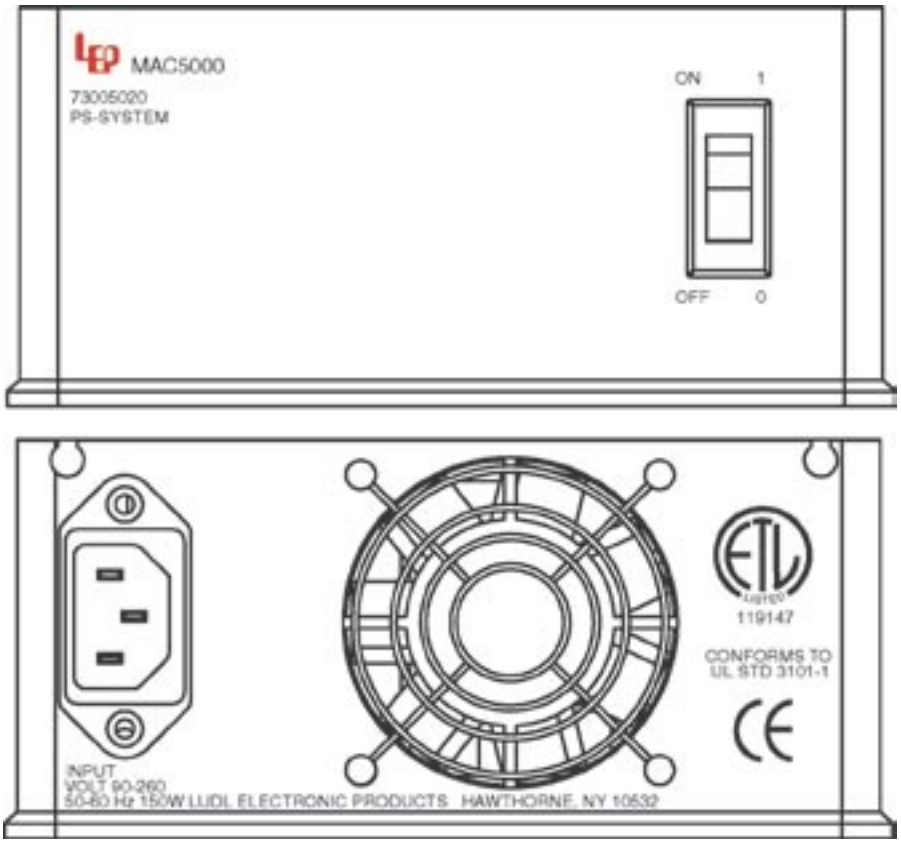
995061 ..... Video Autofocus Controller

- **Perfect for optical sectioning**
- **Add suitable drive motor or encoder option**
- **Includes interface cable and line cord**
- **Accepts high resolution encoder input**

MAC 5000

System Power Supply

- **Base unit required for all MAC 5000 systems**
- **Automatic switching 90-240v input**
- **Quiet cooling fan**
- **CE/ETLcompliant**



Overview

The foundation for the MAC 5000 is the system power supply. This module forms the physical base, supplies the raw DC power and the forced air cooling for the system.

I/O Connections

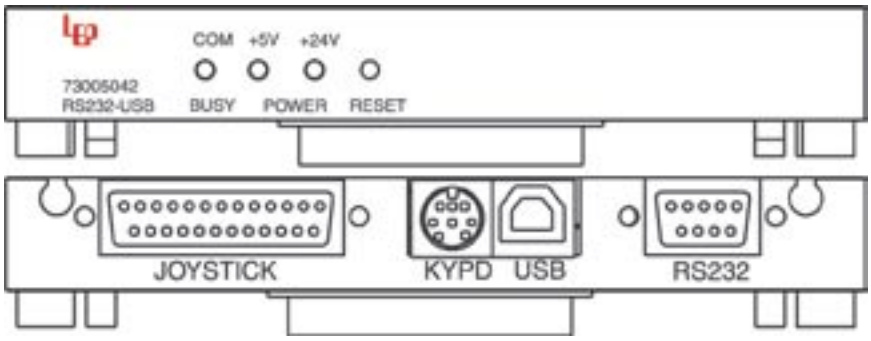
The mains connection to the system is via the IEC receptacle located on the rear panel. Internally a connector is supplied which connects to the 73005042 module supplying the regulated DC power for the system.

Specifications

Weight 1.4kg
Input requirements 90-240VAC, 50/60Hz, 150watts
Fan Noise 20dB

Ordering Information

73005001 ..... MAC 5000 Power supply module



- **Compatible with LEP standard communication protocol**
- **Rich command set including easy to use ASCII intuitive commands**
- **High throughput USB interface standard**
- **Required in every MAC 5000 system**

Overview

The MAC 5000 host computer interface serves a dual role. First the RS-232 and USB interfaces provide the means for the host computer to communicate with the MAC 5000 controller. In addition this module supplies regulated power for system expansion modules.

The interface supports two modes of communication: an ASCII mode and a binary mode. The ASCII mode processes recognizable commands such as "MOVE X=1000" . The binary mode provides a lower level of communication providing higher throughput and universal adaptability.

73005042 .....MAC 5000 Interface with RS-232 port, USB port

I/O Connections

Joystick input is by the DB-25 connector. The input is compatible with any LEP joysticks supporting up to three axes with digipot. Standard RS-232 port supports baud rates up to 115.2k baud. The USB interface complies with the USB standard 1.3. A separate mini-din connector is available for RS-232 communication for the 73005046 operator console.

Specifications

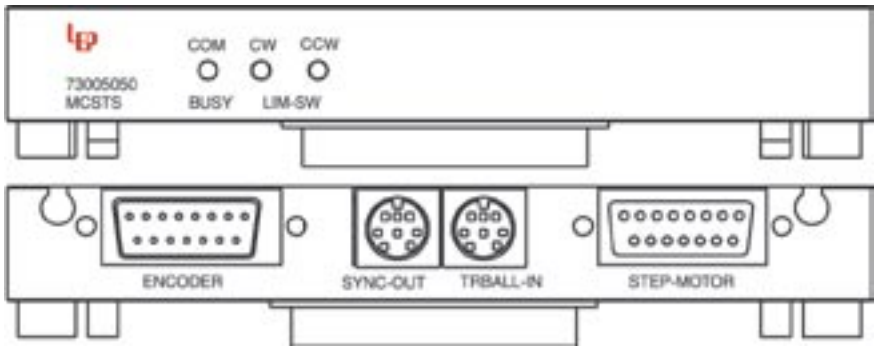
RS-232 ..... up to 115.2k baud, no handshaking
Joystick .....multi-axis analog/digital input
Operator console port.....9600 baud RS-232
Power requirements 24vDC
USB ..... USB 1.3 compatible with type B receptacle

Ordering Information

73A00031 ..... RS-232 cable 9-9pin
73A00043 .....RS-232 cable 9pin - Macintosh Mini-DIN
73005042 .....MAC 5000 Interface with RS-232 port, USB port
73A00056 ..... USB cable
73005046 ..... RS-232 MAC 5000 operator console
99M022 .....USB kit: cable and driver on CD-ROM

MAC 5000 Microstepping Motor Module

- High performance control and drive in a single unit
- Compatible with MAC 2002 and MAC 5000 commands
- Flexible open/ closed loop configurations
- Versatile external sync options
- Dedicated joystick or trackball input for easy manual control
- Processor controlled motor voltage for low current idle mode
- Linear microstepping drive for low noise and stability
- Command set compatible with DC servo drive



Overview

For high performance stepper motor control the MAC 5000 MCSTS module is unequalled. This module is a self-contained microprocessor motor controller with high performance regulated linear microstepping driver. The linear driver provides the highest accuracy without excessive motor heating or EMI radiation that can sometimes be a problem with conventional chopper type drives. All functions are built-in to the module: analog joystick control, digital joystick control, limit switches, pre-limit input, open or closed loop stepper motor control. Motor step rates are programmable from 0.8Hz up to 5mHz. A rich command set is compatible with all MAC 2002 and MAC 5000 modules.

I/O Connections

The MCSTS module step-motor connector supports two phase stepper motors with CW and CCW limits, home position signalling, encoder inputs and a single pre-limit. A SYNC-OUT 8 pin mini-din connector has step/direction output as well as inputs for TTL gating and triggering. Stand-alone trackball control is available via the TRBALL-IN connector. The separate encoder connection is for the use of a second positioning encoder for dual encoder systems. In a dual encoder system the primary encoder input is used for motor servo and the secondary input is the actual position.

Specifications

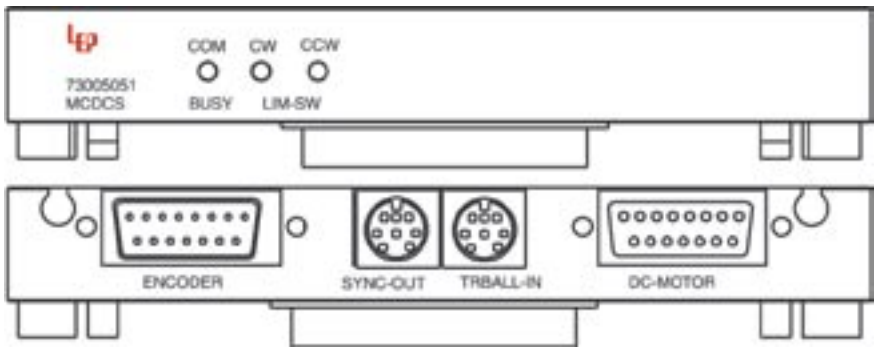
Step rate (min/max)	84Hz /5mHz
Motor current (min/max)	0.2A / 1.0A per phase
Limit switch input	rising or falling edge selectable
Encoder input	TTL quadrature , incremental
Encoder frequency (max)	400kHz
Microstepping ranges	5x, 10x, 25x, 50x, 100x and 200x

Ordering Information

73005050	Microstepping motor controller/driver

DC Servo Motor Module

MAC 5000



- **High performance control and drive in a single unit**
- **Compatible with MAC 2002 and MAC 5000 commands**
- **Dedicated joystick or trackball input for easy manual control**
- **Servo parameters are stored on-board in EEPROM**
- **Versatile external sync options**
- **Command set compatible with stepper motor drive**

Overview

High speed motion applications frequently demand high performance DC servo motor drives. The MAC 5000 MCDCS DC servo motor controller/driver offers the highest performance while still providing precision positioning control. Like its stepper motor cousin, this module is a totally integrated motion controller/driver with a full set of control inputs. A full compatible command set provides access to all motion parameters. Presets for 7 common applications are embedded to make implementation quick and easy. Full featured command set enables access to "state based" servo parameters for no compromise servo tuning.

I/O Connections

Motor connection includes motor output and inputs for the servo encoder, limit switches, home position and pre-limits. Special sync inputs and outputs are available on the 8 pin SYNC-OUT mini-din connector. A unique step/direction output is available to enable external data collection "on the fly". An auxiliary trackball input is also included. Support for a second incremental encoder input is included for systems with separate linear encoders or external positioning feedback devices.

Specifications

Position accuracy	±1 encoder count
Motor current (max)	3A
Limit switch input	rising or falling edge selectable
Encoder input	TTL quadrature , incremental
Encoder frequency (max)	400kHz

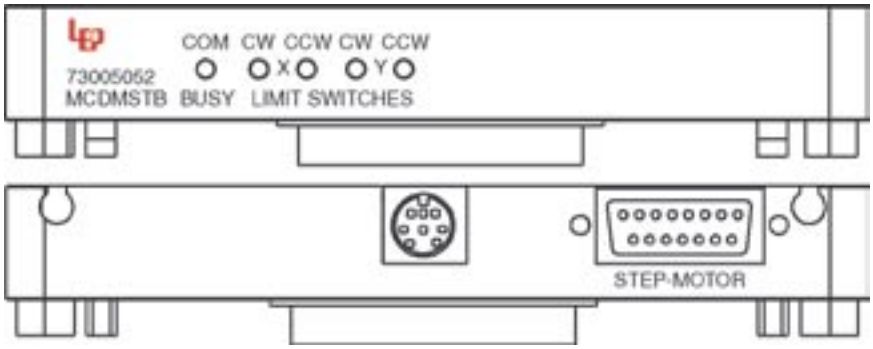
Ordering Information

73005051	DC Servo motor controller/driver

MAC 5000

BioPoint Stage Module

- Economical two axis motor control solution
- High resolution microstepping control
- Analog two axis joystick supported
- Compatible with single axis modules



Overview

Specifically intended to both drive and complement the LEP BioPoint stages, this module is a value priced two axis motor controller. Using the proprietary BioPoint stage connection full XY joystick control is enabled as well as software compatibility with single axis modules. Encoder input is not available with this module. This simplified microstep module supports dual stepper motors in open loop mode.

Communication is configured so that this single module appears as two separate modules for the purpose of programming. This feature allows this module to maintain software compatibility with standard MAC 2002/ MAC 5000 single axis modules.

I/O Connections

A single connector supplies the signals for the BioPoint XY stage. Inputs are provided for CW and CCW limits for each axis as well as the motor phases. Two axis joystick input, power supply and communication is via the internal stacking bus.

Specifications

Step rate (min/max) ..... 84Hz / 200kHz
MIcrostep size ..... 5x, 10x ,25x, 50x, 100x, 200x
Motor current (min/max) ..... 0.8 Amp per phase

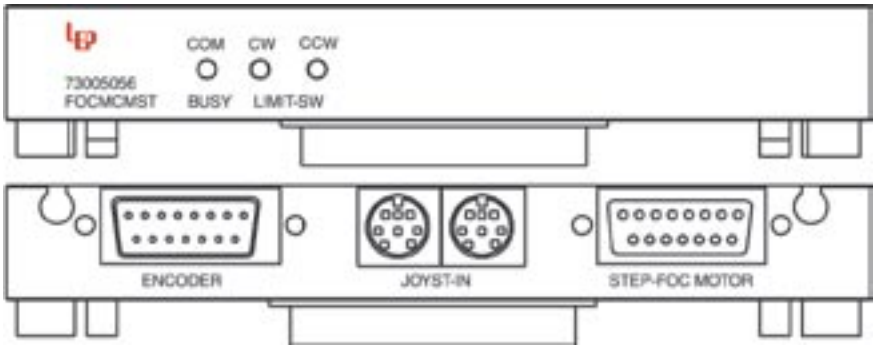
Ordering Information

73005052 ..... MAC 5000 BioPoint dual microstep module
99S201 ..... BioPoint 3”x2” upright XY stage
99S209 ..... BioPoint inverted XY stage

Focus Drive Microstepper Module

MAC 5000

- **Economical single axis motor control solution**
- **High resolution microstepping control**
- **Analog joystick and digipot supported**



Overview

Focus control presents different requirements for motor control; precise, high resolution positioning with a high throughput requirement. This module supports all LEP focus drive motors in either open or closed loop configurations. Digipot and joystick input is available for manual control.

I/O Connections

A standard LEP pinout DB-15 female connector supplies the stepper motor control signals. Also provided is a DB-15 connector for encoder input.

An auxiliary internal communication port for inter-module connection with the 73005085 Autofocus Processor module is available.

Inputs for dedicated analog and digital joystick are provided on a mini-DIN connector.

Specifications

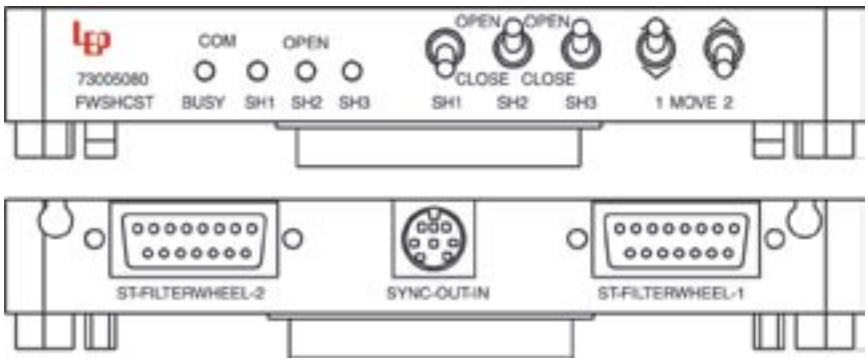
Step rate (min/max)	84Hz /5mHz
Motor current (min/max)	0.2A / 1.0A per phase
Limit switch input	rising or falling edge selectable
Encoder input	TTL quadrature , incremental
Encoder frequency (max)	400kHz
Microstepping ranges	5x, 10x, 25x, 50x, 100x and 200x

Ordering Information

73005056	MAC 5000 focus drive microstep module
99A400	Focus drive motor and adapter ring
99A402	Focus drive motor for Zeiss Axio microscopes
99A420	Linear encoder for focus, requires bracket.
99A421	Focus limit sensor, requires bracket

MAC 5000 Standard Filter Wheel Module

- Supports two filter wheels either as two independent singles or a single dual filter wheel
- Operates up to three electronic shutters
- Electronic synchronization features
- Front panel controls for manual operation
- LED indication of shutter state



Overview

The standard LEP filter wheel systems are based on a reliable stepper motor drive technology. Each module can support two six position filter wheels, either as two separate filter wheel units or a single dual filter wheel device. Additionally, this module can operate up to three electronic shutters. Sophisticated interface options allow for programmed electronic synchronization of the filter and shutter operation. For example a gating signal can be generated when the filter wheel is in position to trigger a camera or strobe.

I/O Connections

Two connectors are designated to connect to filter wheel 1 and 2. They are similar with the exception of the shutter connections. Filter wheel 1 has connections for shutter 1 and 3, while filter wheel 2 has connections for 2 and 3.

The SYNC-OUT-IN mini-din connector supports the filter wheel sychronization control signals.

Specifications

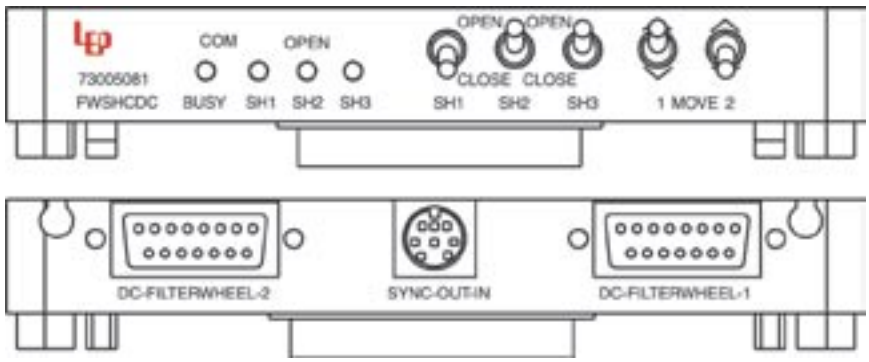
Speed ..... selectable and programmable, up to 100 ms between adjacent filters
Change algorithm ..... computed shortest path to selected filter
Shutter Speed .....6ms open, 5ms close (shutter dependent)
Shutter modes .....timed, automatic or manual exposure

Ordering Information

73005080 ..... Stepper filter/shutter control module
99A042 .....Single six position 25mm stepper motor filter wheel
99A142 .....Single six position 32 mm stepper motor filter wheel
99A045 ..... Dual six position 25mm stepper motor filter wheel
99A145 ..... Dual six position 32mm stepper motor filter wheel
99A041 ... Single six position 25mm stepper motor filter wheel w/o shutter for emission applications

High Speed Filter Wheel Module

MAC 5000



- **Supports two filter wheels either as two independent singles or a single dual filter wheel**
- **Operates up to three electronic shutters**
- **Electronic synchronization features**
- **Front panel controls for manual operation**
- **LED indication of shutter state**

Overview

The DCFWSHC DC servo filter changer module offers high performance, reliable filter changing. Software compatible with STFWSHC stepper motor filter changer module, two six position filter wheels and up to three electronic shutters are supported The high speed controller utilizes DSP processor to control the closed loop DC servo motor. The result is a high speed filter change with a carefully controlled acceleration profile to minimize vibration.

I/O Connections

Two connectors are designated to connect to filter wheel 1 and 2. They are similar with the exception of the shutter connections. Filter wheel 1 has connections for shutter 1 and 3, while filter wheel 2 has connections for 2 and 3.

The SYNC-OUT-IN mini-din connector supports the filter wheel sychronization control signals. The open collector synchronization output is available to gate external devices when the filter wheel has reached its target position. The TTL synchronization input can be used to sequence the filter wheel through a list of pre-defined filter positions without host computer interaction. By using a combination of the input and output synchronization signals the filter wheel can be effectively slaved to other data acquisition equipment.

Specifications

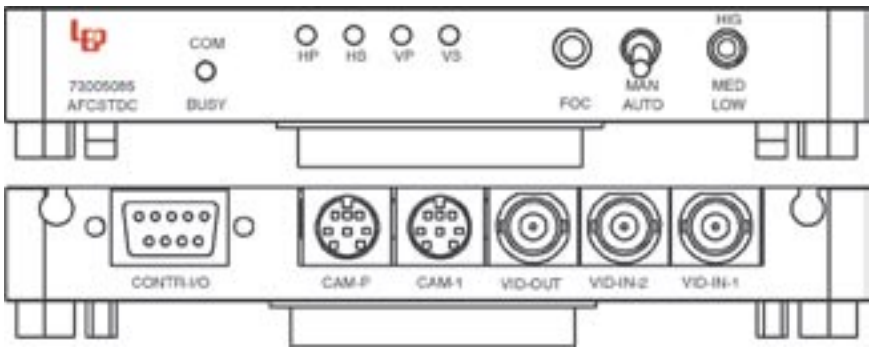
Speed ..... selectable and programmable, up to 30ms between adjacent filters
Change algorithm ..... computed shortest path to selected filter
Shutter Speed ..... 6ms open, 5ms close
Shutter modes ..... timed, automatic or manual exposure

Ordering Information

73005081 ..... DC servo high speed filter/shutter control module
99A350 ..... Single ten position 25/32mm DC servo filter wheel
99A351 ..... Single six position 25 mm DC servo filter wheel w/o shutter

MAC 5000 Video Autofocus Processor

- Robust contrast based focus detection
- Selectable focus algorithms
- Dynamic focus mode
- On screen diagnostic information
- Front panel controls for immediate mode autofocus
- Fully programmable parameters



Overview

For precision measurements and image analysis, precision video autofocus is a necessity. The LEP MAC 5000 autofocus combines high performance with flexibility to operate on almost all types of images. The autofocus processor module works in conjunction with the 75005056 microstep motor controller/driver to make a complete autofocus sub-system . All parameters are accessible from the host computer affecting resolution, accuracy and speed. Software commands allow control of focus region, search and threshold parameters.

I/O Connection

The video input is supported by the module from either the mini-DIN CAM-*n* connector or the VID-IN-*n* connectors. Video output is supplied to the VID OUT connector and displays the original signal with the superimposed focus information.

The mini-DIN camera connections also can supply +12vDC for camera power.

Composite, either RS-170 or CCRIR, is compatible with the video inputs. Digital video is not supported.

Specifications

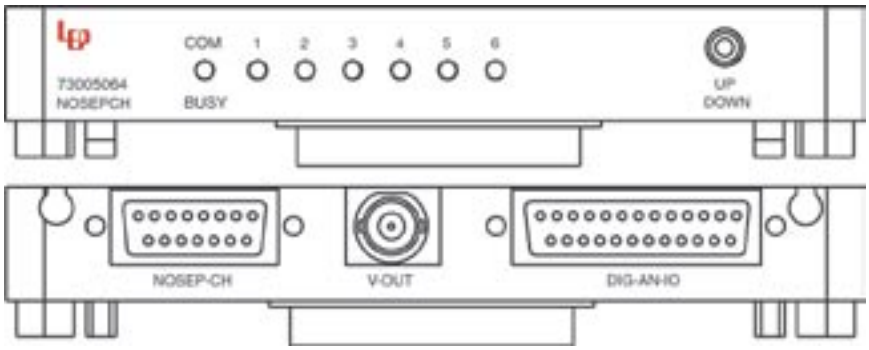
Video Compatibility ..... RS-170, CCIR(PAL)
Termination ..... 75ohm jumper selectable
Camera power supply 12vDC 1amp
Focus speed ..... < 1 sec at high magnification (sample dependent)

Ordering Information

73005085 ..... MAC 5000 Video Autofocus Processor
73005056 ..... MAC 5000 Microstep motor drive/controller

Objective Turret Changer

MAC 5000



- **Available for 5 or 6 position turrets**
- **Shortest path algorithm used**
- **Additional analog I/O connects available**
- **Front panel control for manual operation**
- **LED display of current position**

Overview

Frequently the final piece of the microscope automation puzzle concerns automating the microscope objective changer. The LEP MAC 5000 objective changer module both senses and drives the objective position. This module is specific for either five or six position turrets.

I/O Connection

The NOSEPCH module supports the LEP motorized turret components fitted to the microscope. Additionally, the module has a 16 bit 1-10v analog output supplied on a BNC connector which is suitable for use as a control signal for the LEP stabilized DC lamp power supply. Access to the control signals for the nosepiece changer are via the 25 pin DIG-AN-IO. Additional digital inputs and outputs are available for general purpose use. The NOSEP-CH connector supplies the turret position sensor connections and the drive signals for the motor.

Specifications

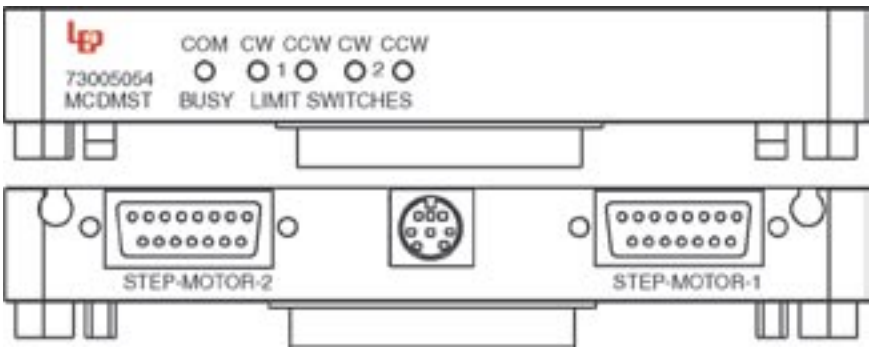
Turret capacity.....5 or 6 positions, automatically selectable
Analog output .....0-10v 16 bit DAC
Digital output ..... Open collector 24v 500mA max
Digital input..... 0-5v TTL

Ordering Information

73005064 ..... Motorized Nosepiece Changer
please call for specific microscope support or custom requirements

MAC 5000 Dual Microstepping Motor Controller

- Dual motor control
- High resolution microstepping
- Dedicated dual axis joystick input
- each axis independently addressable
- Separate end-limits for each axis
- Closed loop encoder supported



Overview

This module offers the ability to operate two independent stepper motors. Motor resolution is jumper and software configurable. Microstep resolutions can be set up to 200x, which yields 40,000 microsteps with a standard 1.8 degree stepper motor. The fixed motor current of 800mA is suitable for most LEP products including XY stages.

This module supports two motion axes, as such it is addressable as two separate modules with independently selectable addresses. The software command set is a subset of the 73005050 microstep drive for compatibility.

I/O Connection

Motor connection is via the standard LEP DB-15 female connector. Encoder signals, end-limit and motor drive signals are present on each connector.

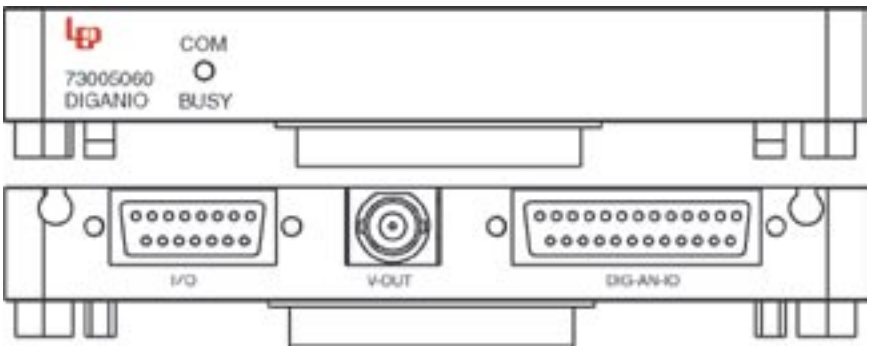
Joystick input is selectable from the internal MAC 5000 joystick bus or externally from the rear mounted mini-DIN connector. This module does not support digital control input (digipot).

Specifications

Step rate (min/max)	84Hz / 200kHz
MIcrostep size	5x, 10x ,25x, 50x, 100x, 200x
Motor current	0.8 Amp per phase
Encoder input	TTL quadrature , incremental
Encoder frequency (max)	400kHz

Ordering Information

73005054	Dual microstepping motor controller



- General purpose analog and digital I/O
- Flexible port arrangement
- Interfaces to LEP 990034 power supply

Overview

Frequently there are applications that have a unique control requirement not met by standard automation components. For these applications the MAC 5000 DIGANIO module is available. Whether its a matter of sensing a safety switch, reading a temperature or controlling a solenoid, this module completes the system.

I/O Connection

The female DB-25 pin connector breaks out the I/O connections. Also present on the DB-25 are the signal and chassis ground as well as +5, +24vDC. The DB-15 female connector is for analog I/O support. The BNC connector provides for a single analog output.

Specifications

Analog Channels ..... 4 or 2 depending on configuration
Analog Resolution ..... 8 bit 4 channel / 16bit 2 channel mode
Analog output 0-10v
Analog input ..... 4 channel / 0-5 VDC
Digital Output Channels 8
Digital output ..... Open collector 35v 500mA max
Digital Input Channels 8
Digital input ..... TTL level 1k ohm impedance

Ordering Information

73005060 ..... General purpose digital/analog I/O module

- Interface directly with MAC 5000
- No computer required
- Accurate and repeatable control
- Programmable features

XY Joysticks

The joystick input devices are available in several different configurations. Three axis joysticks (XYZ) have the conventional XY function with a twist knob on the stick to provide the third axis control. The LEP MAC 2000/5000 systems are configured to route the joystick inputs to the appropriate drive axis. Certain joysticks also feature an integrated digipot for precise focus control

Ordering Information

73000360 ..... XY joystick
73000361 ..... XYZ joystick
73000362 ..... XY digipot joystick
73000366 ..... XYZ digipot joystick

Digipot Control

The LEP digipot control is a smooth continuously turning device for single axis control.

This is a displacement type control. That is when the knob is rotated by a certain amount, the motor till turn a corresponding amount. The velocity of the movement is based on how fast the knob is turned.

The digipot control is constructed with a heavy solid anodized aluminum base for stability. The digipot base can be oriented vertically or horizontally based on personal preference.

A three position gain switch is provided for coarse, medium and fine position control.

Ordering Information

73000365 ..... Single axis (Z-axis) digipot control

Other MAC 5000 components

73A00031 ..... DB-9 to DB-9 RS-232 interface cable
73A00043 ..... DB9 to Macintosh mini-DIN interface cable
74-C50015 ..... MAC 5000 system cover
73A00056 ..... USB to MAC 5000 cable
73A00011 ..... 115 v line cord
90M027 ..... MAC 5000 configuration manual
90M026 ..... MAC 5000 programming manual