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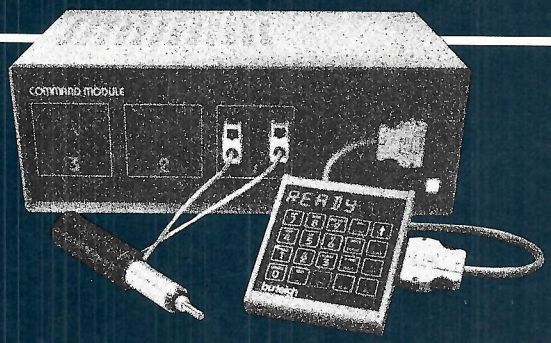
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burleigh

Intelligent Inchworm Translator Micropositioning Systems





INTELLIGENT INCHWORM TRANSLATOR MICROPOSITIONING SYSTEMS

FEATURES

- 10nm resolution capability
- Solid state piezoelectric motor
- Standard 25mm and 50mm travel
- Custom short or long travel designs
- Program multi-axis sequences
- Precision stages available
- Digital readout accurate to ± 1 micron
- Backlash free - no gears or threads
- 2mm/sec to 0.01μm/sec speed range
- Vacuum compatibility option
- Computer interface on RS-232C or optional IEEE-488
- Operation over a large temperature range
- Compact, lightweight, easy to mount
- Rack mount chassis
- STD Bus
- Pushes up to 1.5Kg loads
- Interface to laser interferometers
- Non-rotating spindle

APPLICATIONS

- X-ray or optical lithography
- Electrode positioning for the biosciences
- Position optical elements
- Scan interferometers
- Adaptive optics
- Operation in spacecraft
- Industrial process control
- Micro-machining and manufacturing
- Splice fiber optics
- Position read/write heads
- Fiber wetting measurements
- Robotics

Now you can get a new kind of versatility with our new piezoelectric Inchworm™ Translators.

These improved models give you ⩾ 2mm/sec speed with 10nm resolution capability. Units have 25 or 50mm travel with other travels on special order. Both models work with Burleigh's new X, X-Y or X-Y-Z stages.

The Inchworm Translators have an exclusive detachable measuring head that can be mounted on other moving elements or used with devices such as DC motors to give independent readout. Accuracy is ± 1μm.

New controllers are available to drive up to three Inchworm Translators. The microprocessor-based Command Module offers RUN, STEP or PROGRAM modes via a detachable keyboard or RS-232C port.

The Control Module allows a manual run mode only but can be upgraded to a Command Module.

Both controllers feature a 16-slot card cage with STD-Bus back plane board. This means you can get as much or as little "system" as you want.

The modular design lets you add future Burleigh options: higher resolution measuring head, DC or stepper motor interface, expanded memory with data hold and software packages.

The design is ideal for OEM precision positioning applications, for electrode and microscope stage positioning and high resolution requirements in the life sciences. Tell us what you need and if necessary we'll design it for you.

DESCRIPTION

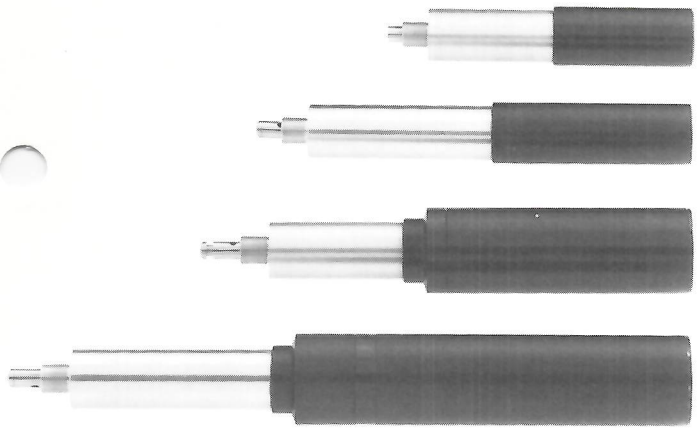
The Burleigh micropositioning systems perform three basic functions, and the hardware elements can be used individually or in combination. The functions are:

1. High resolution positioning
2. Precision measurement
3. Intelligent control

The complete product line can be broken down into three categories: 1) IW-Series Inchworm Translators and TS-Series Translation Stages for positioning, 2) EN-Series Encoders for measurement, and 3) CE-Series Microprocessor-based electronic systems for intelligent control.

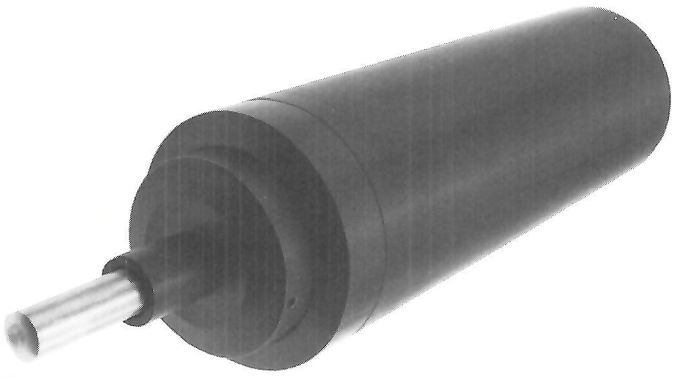
POSITIONING

Positioning is provided by the new IW-Series Inchworm Translators which have long life, high speed, long travels and modular, rugged construction. Precision X, X-Y and X-Y-Z TS-Series Translation Stage packages are also available. In the future other devices can be integrated into the system including DC motors and stepper motors.



MEASUREMENT

Measurement is provided with the new EN-Series Encoders having ± 1μm resolution and accuracy. The encoders are modular and are available in standard travels of 25mm or 50mm. Other travels are available on special request. The construction allows direct mounting of Encoder Bodies on the Inchworm Translators, independent mounting of Encoders with the same control interface, or independent mounting of Encoders for measurement and control of other positioning devices.

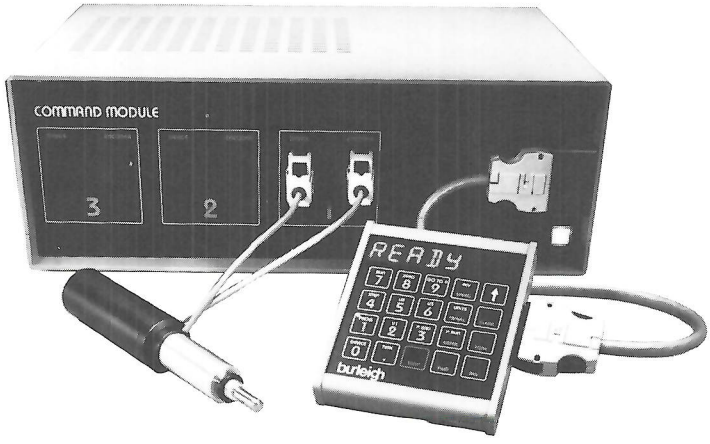


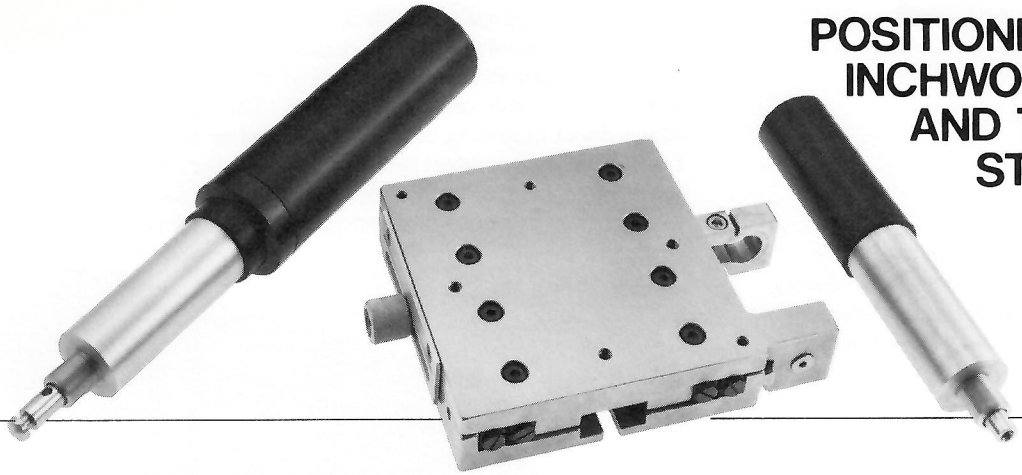
CONTROL

Intelligent electronic control is provided by the microprocessor-based CE-Series electronics. The CE-2000 Command Module is used for programmable control of up to three Inchworm Translators with Encoders. The user can choose between open loop or closed loop control. A card cage and STD Bus configuration allow the user to build as little or as much as needed. The individual cards can easily be integrated into existing STD Bus Systems.

A less sophisticated system, the CE-1000 Control Module, is also available and provides open loop control of up to three Inchworm Translators. With the Command upgrade kit the Control Module is converted to a Command Module.

This electronic system can be configured for measurement - only using the Encoders mentioned above. Cards are planned for DC motor drive and stepper motor control. OEM customers can buy cards only, the card cage and STD bus, or whatever components are required for specific applications. Custom software packages as well as specially designed Inchworm Translators or Encoders are also available. For quantity or OEM purchases substantial discounts are available.





POSITIONING WITH INCHWORM TRANSLATORS AND TRANSLATION STAGES

IW-500/600 SERIES INCHWORM TRANSLATORS

Burleigh's new IW Series Inchworm Translators have high resolution with almost complete absence of backlash. Consequently, the Inchworm Translator is particularly well suited in applications requiring high resolution positioning. The IW-600 Series Translators with the new fringe counting optical Encoders result in a positioning system with very smooth motion and absolute accuracy of $\pm$ 1μm regardless of direction of travel. Travels of 25mm and 50mm are now available as standard. Other travels, both longer and shorter are available as special order.

The life of the new Inchworm Translator is excellent. Customers have reported little or no degradation in motion for greater than 10^6 cycles over 2mm travel. Maximum speed now is $\geqslant$ 2mm/sec with a light load. This is a factor of 4 improvement over previous models. The maximum push (or pull) force is 1.5 Kg. Large masses can be accomodated with the TS Series Translation Stages.

Modular construction allows the addition of the EN-500 Series Encoder Body to the IW-500 Series Inchworm Translator. The Inchworm Translator can also be ordered as the Series IW-600 with the Encoder Body already attached. The TS Series Inchworm Translator powered Translation Stages are available in X, X-Y and X-Y-Z configurations. These stages use cross roller bearings, have a locking feature and offer the highest precision motion available in a mechanical stage. Maximum full travel deviation in any axis is $\leqslant$ 1μm. Maximum travel is 25mm or 50mm depending on package selection. Special Z-axis stages are available with 25mm travel and are adjustable to carry a weight of up to 1 Kg.

APPLICATIONS

The Inchworm Translator offers up to 50mm of intelligent electronically controlled travel with a resolution capability of 10nm, so it's an ideal positioning device for a wide range of applications. The unique mechanical construction allows reliable operation over a wide temperature range and in a variety of environments. The remote control aspects of the Inchworm Translator make it easy to work in tight, hard-to-get-at places or inaccessible locations such as a vacuum chamber. Common applications in the field of high resolution lithography include precision mask positioning in X-ray mask/wafer alignment, electron beam or laser beam lithography. Alignment and positioning problems of machine and micro-machine tools have been solved using the Inchworm Translator.

The new X-Y-Z configuration is useful in automated fiber splicing schemes for single-mode and multi-mode fibers. Hybrid circuit manufacture and alignment of micro-components in integrated optics can be easily performed in an automated manner with the Inchworm. Stringent space flight qualification has been met by Inchworm Translators that have performed precision alignment and positioning assignments on the space shuttle, satellites and defense applications. Use the Inchworm Translator or Translation Stages to position elements in laser cavities, vacuum chambers or X-ray monochrometers.

Use the Inchworm Translator to position optical elements such as gratings, detector arrays, beamsplitters and prisms.

In the field of neurophysiology and biophysics many applications are possible which eliminate the necessity for complicated hydraulic systems or noisy mechanical drives. Typical applications are chronic recording, specimen positioning in scanning electron microscopes as well as standard laboratory microscopes. Attach microelectrodes or cellular probes to the spindle for intracellular recording or mechanical stimulation of mechano receptors.

HOW IT WORKS

The Inchworm Translator uses three coupled PZT cylinders as active elements. The fit between the first and third piezoelectric element and the shaft is essentially zero. The center piezoelectric element is a clearance fit on the shaft. When a voltage is applied to the first piezoelectric element, it grips the shaft. Then a variable rate staircase voltage is applied to the center piezoelectric element, causing it to move in discrete steps of about 10nm. The staircase may be stopped at any step.

It takes 127 steps from its lower to its upper limit. The full range moves the third piezoelectric element with respect to the first approximately 1.25μm.

At the end of the staircase, a voltage is applied to the third piezoelectric element, causing it to grip the shaft. Then the voltage on the first piezoelectric element is removed, loosening its grip on the shaft. The staircase starts downward until it reaches its lower limit, at which point the first PZT element is activated again, the third PZT element released, and the staircase starts again. This process repeats over and over. See Figure 1.

The stepping rate for the staircase is variable to allow a maximum running speed of 2mm/sec and a minimum speed of about 0.01μm/sec at no load.

Loads on the Inchworm Translator spindle alter the maximum speed. At 1Kg load the maximum speed is 1.5mm/sec. At 1.5Kg it is 1.0mm/sec.

When the Inchworm Translator reaches either limit of travel an internal switch is contacted and the Controller automatically shuts off. This condition is indicated by either the FWD or REV LED flashing on the CE-1000 Control Module front panel or the words FWD LIM or REV LIM on the CE-2000 Command Module keyboard display.

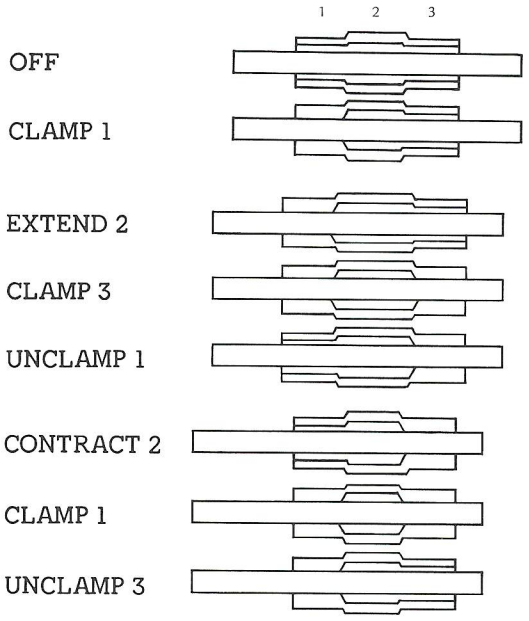


Figure 1

MOTION ACCURACY AND CHARACTERISTICS

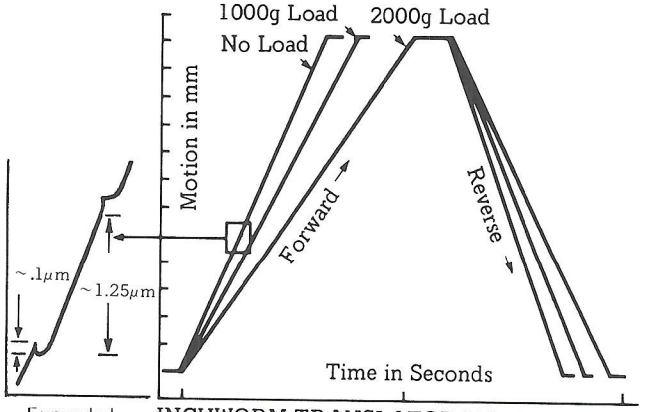
With the IW-601 or IW-602 Inchworm Translators the spindle position is always known to an absolute accuracy of ± 1μm. For applications requiring resolutions between 10nm and 1μm a careful examination of the motion characteristics is required.

On a sub-micron scale, the smoothness of the motion of the Inchworm Translator is influenced by the discontinuity in the clamping and unclamping process. This discontinuity will vary from unit to unit and typically will not exceed 0.1μm. The discontinuity is repeatable under a given set of conditions. Actual measured motion of a typical Inchworm Translator under several load conditions is shown in Figure 2. One section of the trace was expanded to look at motion in more detail. The discontinuity is evident as is the very smooth motion between discontinuities.

It is extremely important to differentiate between the 10nm resolution of the basic Inchworm Translator and the 1μm resolution of the optical interferometer.

The interferometer is a fringe counting system which splits the fringes electronically so a determination of position can be made to 1μm. The interferometer does not count steps on the PZT staircase. Any motion of the Inchworm spindle will be measured by the interferometer. It is therefore a monitor of absolute position. The staircase applied to the center PZT element of the Inchworm Translator always results in a series of 10nm steps which can be observed if a higher resolution position measuring device is used.

Laser interferometers, LVDT or outboard linear encoders can be readily interfaced to allow positioning accuracy to 0.05μm. Please consult the factory for specific information.



INCHWORM TRANSLATOR MOTION VS. TIME AT TOP SPEED FOR VARIOUS LOADS

Figure 2

CLEARANCE COMPENSATION

The fit between the clamp tubes and shaft in the Inchworm Translator varies slightly with temperature. This fit can be electronically adjusted with the Clearance Compensation feature, which can also be used to compensate for wear. This adjustment is made on a trim pot on the Inchworm HV Drive Card.

SPECIFICATIONS

IW-501, IW-502, IW-601, IW-602 INCHWORM TRANSLATORS

Travel:	IW-501, IW-601	0-25mm
	IW-502, IW-602	0-50mm
Resolution:		10nm
Speed:	no load	0.01μm/sec to $\geqslant$ 2mm/sec
	1Kg load	0.01μm/sec to $\geqslant$ 1.5mm/sec
	1.5Kg load	0.01μm/sec to $\geqslant$ 1.0mm/sec
Axial load, maximum:		1.5Kg
Lateral Spindle Displacement:		1-2μm (typical)
Construction:		Non-magnetic materials
Electrical Connector:		TRW-Cinch TE9P
Temperature Range:		0^{o} to +50^{o}C standard
Temperature Rise of housing for prolonged operation at top speed:		+20^{o}C in air

IW-601/602 INCHWORM TRANSLATORS ONLY

Display Resolution:	1μm
Display Accuracy:	$\pm$ 1μm
Measurement Method:	Optical fringe counting interferometer

NOTE: IW-501 or IW-502 are upgradable to the IW-601 or IW-602 by addition of the appropriate EN Series Encoder.

TEMPERATURE RANGE

The Inchworm Translator uses materials with closely matching thermal coefficients of expansion to allow operation from 0 to +50^{o}C. The calculated and empirical coefficient of expansion of the IW-600 Series Translator from spindle tip to readerhead point is approximately 1μm/^{o}C. Special order Inchworms are available to substantially reduce this error. NOTE: mounting of the Encoder to the moving piece is better in applications requiring the Inchworm Translator to operate for extended periods ($\geqslant$ 15 minutes) at top speed.

GROUNDING

The body of the Inchworm Translator is grounded to the Command or Control Module and chassis ground through shielded cables. It is recommended that a separate ground lead be attached to the Inchworm Translator spindle to ensure complete grounding, especially in neurological applications. The AC power plug should then have its ground lifted through the use of a 3 pin adapter plug to prevent a ground loop. With this precaution noise generated by the Inchworm Translator when running is less than the noise level in most high impedance electrode sensing systems. It is further reduced when the Inchworm Translator is not running. For full grounding details consult Burleigh or your local representative.

MOUNTING

Use of the Inchworm Translator is straightforward. It mounts in a 1/2" diameter clearance hole. See Figure 3. The spindle moves relative to the housing, is keyed to prevent rotation, has a removable spherical tip and works best with minimal load. The tip is used when pushing against a spring load. With the tip off, elements can be mounted directly into the 6-32 tapped hole in the end of the spindle. Magnetic coupling can be used if a magnetic tip is used. Burleigh can construct custom adapters for interfacing the Inchworm Translator with many different systems (i.e. translation tables, sterotaxic devices, mirror mounts, etc). Contact the factory or your nearest representative for details.

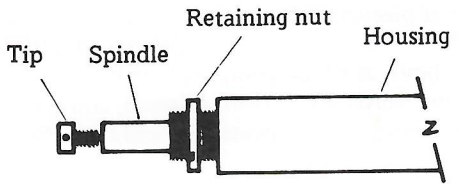


Figure 3

IW-470 LATERAL STABILITY OPTION

The IW Series Inchworm Translator has a typical lateral motion (side to side) on the order of 1-2μm at the tip of the spindle. For critical applications such as fiber splicing, hybrid assembly or intracellular recording of cells smaller than 10μm it may be desirable to have the IW-470 Lateral Stability Option installed on the translator at the time of purchase. With the IW-470 lateral motion is reduced to approximately 0.1μm.

IW-471 LATERAL STABILITY RETROFIT

A field IW Series Inchworm Translator (without IW-470) can be returned to the factory at any time for retrofit of the IW-471 Lateral Stability Retrofit Option.

IW-475 ELECTRODE MOUNTING KIT

This kit provides three adapters to be used in mounting and connecting electrodes for extracellular recording. The electrode carrier attaches directly to the non-rotating spindle of the Inchworm Translator and can be used with single or multiple barrel micropipettes or electrodes. Using one of the two adapters shown in the outline dimension section, the WPI Probes M-707 and F-23B/223A can be attached.

IW-490 VACUUM OPTION

The standard Inchworm Translators are not meant for vacuum operation unless one of the two standard vacuum option packages are ordered.

The IW-490 option allows the IW-500 Series Inchworm Translator to be operated in a vacuum of $\leqslant 10^{-6}$ Torr. It includes a special teflon multipin cable for use inside a vacuum chamber.

The cable mates with an O-ring vacuum feedthrough which can be threaded into a ¾-16 tapped hole or mounted in a ¾" clearance hole in a plate with a maximum thickness of ¼". Special cleaning and packaging of the Inchworm Translator is also observed in the construction and shipping procedures.

Low outgassing materials and epoxies are used throughout. Burleigh guarantees vacuum performance to the conditions under which the Inchworm Translator was tested at the factory. The Inchworm Translator is mounted in a clean vacuum chamber which has a volume of $1ft^3$ and using a special liquid nitrogen cold trapped oil diffusion pump (pumping speed approximately 100 liters/sec) a vacuum of $< 10^{-6}$ Torr is achieved with no visible depositions on a polished plate at about $77^{o}K$ mounted near the Inchworm Translator. The standard IW-500 Series is not guaranteed for vacuum operation unless the vacuum package is ordered. The Inchworm Controller must be turned off while pumping through the corona region (0.1 - 100 Torr) to prevent arcing. For requirements below 10^{-6} Torr, consult the factory.

IW-491 VACUUM OPTION

This is identical to the IW-490 except that it is for the IW-600 Series Inchworm Translator. The optical measuring head inside the Inchworm is modified and treated to reduce outgassing. Teflon wires are used and no grease or labels are applied to the body of the instrument. Two feedthroughs are used. One is identical to the IW-490 and is for the high voltage. A second teflon jacketed cable and feedthrough is supplied for the low voltage optical interferometer signals. The Inchworm Controller must be turned off while pumping through the corona region (0.1 - 100 Torr) to prevent arcing. For requirements exceeding 10^{-6} Torr, consult the factory.

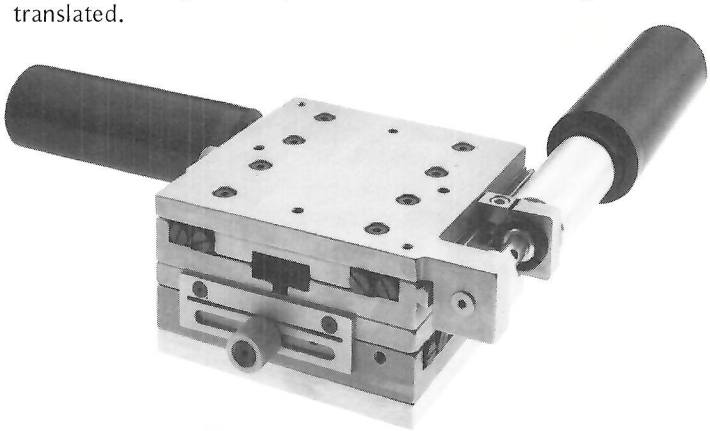
TS SERIES INCHWORM POWERED TRANSLATION STAGES: TS-101/102/201/202

These stages use crossed roller bearings, have a locking feature and offer the highest precision of motion available in mechanical stages. When powered by the Inchworm Translators, travel is available to 50mm depending on the package selected. A special Z axis stage and mounting adapter is available to provide balanced backlash-free vertical motion. Similar to other fine quality commercially available stages the TS Series Stages include a specially designed high rigidity mount for the Inchworm Translator and a unique shake-free, high-force coupling between spindle and stage top which eliminates axial load on the spindle.

Complete X, X-Y and X-Y-Z Translation Stage/Inchworm Translator packages are available. All TS-100 Series Stages will stack with precision location pins for X-Y motion.

HOLE OPTION

A TS-050 Hole Option is available for the TS Series Stages which provides a 44mm through hole in the top and bottom sections of a stage. The aperture is reduced as the stage is translated.

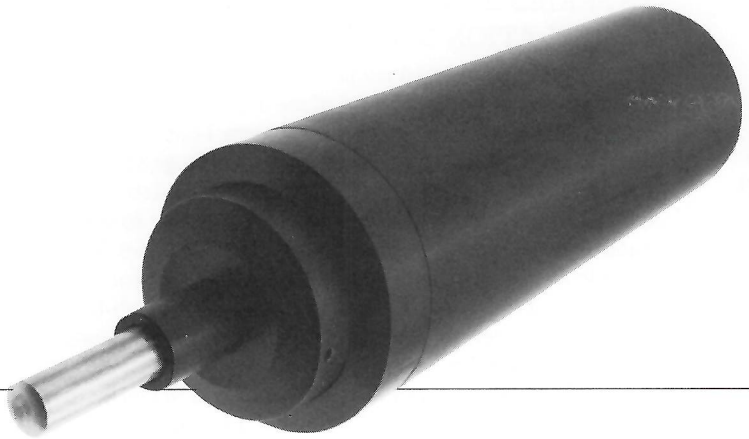


TS TRANSLATION STAGES

Travel:	
TS-101	25mm with IW-501
TS-102	50mm with IW-502
TS-201	25mm with IW-601
TS-202	50mm with IW-602
TS-100	50mm travel, no Inchworm Translator
Maximum deviation in any axis:	Approx. 1μm

TS-351, TS-361 Z AXIS STAGES

The Z-axis balanced stage has 25mm of travel and will carry a weight of up to one kilogram. This Inchworm Translator powered vertical motion stage can be used alone, with one Translation Stage for X-Z, or with two Translation Stages for X-Y-Z. This precision stage assembly includes a variable force, backlash free, balanced and adjustable torsion spring to provide a counter balance for mounted experiments with up to 1Kg maximum weight as well as the weight of the top portion of the stage itself. The TS-351 is powered with an IW-501 Inchworm Translator and the TS-361 is powered with an IW-601 Inchworm Translator with Encoder.



PRECISION MEASUREMENT WITH OPTICAL ENCODERS

EN SERIES ENCODERS

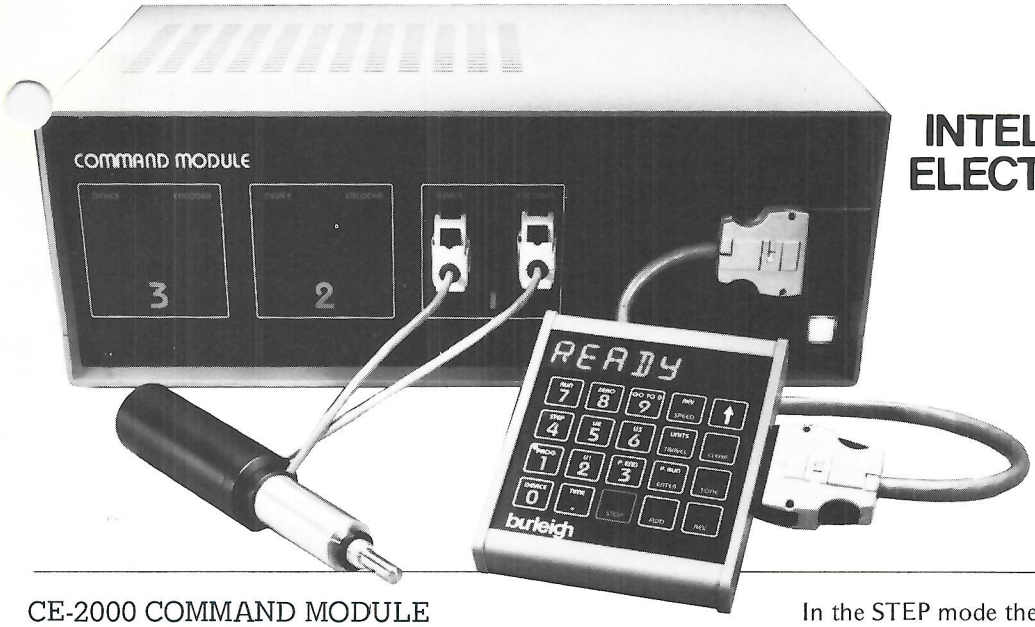
Burleigh's EN Series Encoders use an optical fringe counting system to provide an absolute measurement accuracy of ± 1μm and a display resolution of 1μm. Travels of 25mm or 50mm are standard. The EN-501 and EN-502 Encoder Bodies attach directly to the appropriate Inchworm Translator. The EN-371 and EN-372 Encoders include a spindle and independent mounting shank for direct measurement applications. In this case, the sliding spindle contacts the experiment and the measurement is made directly. Since the Encoder operates independently of the Inchworm Translator, the closed-loop control system works equally well whether the Encoder Body is attached directly to the Inchworm Translator or the Encoder is mounted separately. Separate mounting may be helpful if the Inchworm Translator is likely to be operated at top speed for long periods. The Inchworm Translator will generate some heat in this mode which may be a source of undesirable thermal expansion errors. The Encoders can be used by themselves for precision measurement and control in other systems.

There are several electronic options available. The CE-2000 Command Module (see the next section) can be used with up to three Encoders. It can also be used without the detachable keyboard and the position information transmitted to a computer, one axis at a time, via the standard RS-232C port. Separate Encoder cards can be purchased for integration into other electronic control systems with a STD Bus. Encoders will track at rates of up to a meter per second.

SPECIFICATIONS

EN SERIES ENCODERS: EN-371/372/501/502

Measurement Method:	Optical fringe counting
Resolution:	1μm
Accuracy:	± 1μm
Range:	
EN-371, EN-501	25mm
EN-372, EN-502	50mm
Maximum tracking speed:	1m/sec
Mounting:	
EN-371	Mount in 0.375" diameter clamp ring
EN-372	Mount in 0.375" diameter clamp ring
EN-501	Mounts to IW-501 to create IW-601
EN-502	Mounts to IW-502 to create IW-602



INTELLIGENT ELECTRONIC CONTROL

CE-2000 COMMAND MODULE

The heart of Burleigh's new CE Series micropositioning system is the CE-2000 Command Module, a complete microprocessor based control system which allows programmable operation of up to three Inchworm Translators with or without Encoders. The Command Module consists of a chassis with power supply, STD Bus, 16 slot card cage, break-away front panel, detachable keyboard, CPU card, Inchworm Cards and Encoder Cards. The basic system controls one Inchworm Translator with Encoder, but with additional cards up to three Inchworm Translators with Encoders can be controlled. The Command Module's detachable keyboard can be mounted directly to the front panel or can be detached and reconnected with a two meter cable. The keyboard includes an eight digit full alpha-numeric display with 13.7mm high characters. This detachable keyboard is used to operate Inchworm Translators with Encoders in RUN, STEP or in a full PROGRAM mode, or Inchworm Translators without Encoders in the RUN mode only. The display shows the positions in mm to an accuracy of 1μm. And it provides prompts to help the user program a desired motion sequence. The RS-232C Port can also be used for remote computer control and IEEE-488 is available as an option.

OPERATION

On power-up, the CE-2000 performs a self test and indicates via the keyboard display that this test is being performed. When the test is complete the unit is operational in either the RUN or STEP mode. The user can preselect what mode the unit is first available in and the speed range desired. These selections are set with hardware switches located on the central processor card and control cards. In the RUN mode the detachable keyboard controls are used to manually command an Inchworm Translator to run either FORWARD or REVERSE at one of 1000 digitally selectable speeds. The keyboard allows the selection of one of the three Inchworm devices available. On power-up, device # 1 is always selected as the first available.

The display on the keyboard indicates if a device is running and shows which device is under control. This display can be zeroed at any position. It also informs the user if the Inchworm Translator has reached a limit of travel and automatically shuts down.

In the STEP mode the user chooses a step size (for example 10μm), the speed and the direction. Each time the FWD or REV key is touched the Inchworm Translator takes that step in the appropriate direction. The display indicates and accumulates the absolute position. The user can command the Inchworm to return to zero at any point and the user determines the zero point.

In the PROGRAM mode the user can program simple or complex sequences of motion choosing different speeds, steps and directions for each sequence. Pauses of 1ms to 60 sec can be programmed at the end of each sequence and up to three Inchworm Translators with Encoders can be programmed for sequential multiple axis movements.

An example of a program to control an X-Y stage might involve advancing 100μm on the X axis at top speed, then moving 70μm on the Y axis at slower speed, pausing for 700ms then advancing another 100μm along the X axis at a slower speed, pausing again and so on. Up to 30 sequences can be programmed for each of the three devices and the sequences can be repeated up to 65,000 times. The user can program the following parameters.

1. Device (or axis)
2. Direction (forward or reverse)
3. Speed
4. Distance
5. Pause between motion
6. Motion repetitions
7. Loops or subroutines

In closed-loop operation the system "seeks" and holds the correct position even if there is creep or backlash in the user system, overshoot due to large inertial loads or system vibration. For some applications, such as neuroscience, the closed-loop "seek" mode is undesirable and can be switched off.

INTERFACING

The CE-2000 Command Module can be interfaced for external computer control through the rear panel RS-232C serial port or the optional CE-430 Card can be plugged in for an IEEE-488 Interface. RS-232C is a standard of the Electronics Industries Association (EIA) that was specifically designed to interface data communications equipment (DCE) and data terminal equipment (DTE). This widely accepted 25 pin standard is used in laboratory and industrial data communications systems and is capable of long distance error free transmission. Opto-isolated current loop configurations are available. Baud rate is selectable from 50 to 19.2K baud.

IEEE-488, commonly referred to as GPIB, is an electrical mechanical interfacing standard. GPIB allows connection of the CE-2000 Command Module to external mini or micro computers with compatibility via a 24 pin plug. This standard is widely accepted by laboratories requiring high data rates, with multiple instruments over relatively short paths.

CE-2000 SPECIFICATIONS

Maximum number of axes:	Drives up to three Inchworm Translators with Encoders
CPU:	
Type	8 bit 6809 Microprocessor
Processor clock freq.:	1.2 MHz
Processor clock period:	.91μsec
ROM	8K
RAM	1K
User programmable RAM:	0.5K
Serial Communications Port:	RS-232C
Baud rate:	Switch selectable from 50 - 19.2K baud
Detection/Generation:	Odd, Even, or no parity
Start/Stop Bit Selection:	1,1 1,2 2
Mode:	Half Duplex
Keyboard:	Membrane, 20 key
Display:	LED 8 digit, 14 segments alpha-numeric
AC power requirements:	100-120/200-240 VAC (selectable)
Line frequency:	50-60Hz
Line current:	.75 amps, max.
Line power:	90 watts
Clamp voltage:	0-700 volts
Staircase voltage:	0-600 volts

STD BUS

The CE-2000/1000 and all CE Control Cards are compatible with other STD based systems. The STD bus was conceived as a simple bus structure for 8-bit microprocessors. This 56 pin bus is sufficiently flexible to work with all industry standard 8-bit microprocessors and to be used in both dedicated control and data processing applications. We believe the STD bus to be a solid format for future systems development.

CE-1000 CONTROL MODULE

The CE-1000 Control Module is a less sophisticated version of the Command Module. It provides open-loop control of an Inchworm Translator and can also be expanded to control up to three Inchworm Translators by the addition of the Inchworm Translator cards. It uses the same chassis, card cage, STD Bus and Inchworm Translator cards as the Command Module and has a special break-away front panel with integral keypad. Front panel controls allow selection of the device, speed and direction. A variable speed control allows fine tuning of the speed range from 0.01μm/sec to ⩾ 2mm/sec. Using the rear panel I/O Port the user can remotely control all functions with TTL logic level signals. These functions include RUN, FAST/SLOW, FORWARD or REVERSE. This port will provide a status check and with an external clock input will provide variable speed control. The Control Module can be upgraded to a Command Module with the addition of the CE-190 Command Upgrade Kit. This kit consists of the CPU card, detachable keyboard, cable, Command panel and Encoder cards.



CE-1000 SPECIFICATIONS

Maximum number of axes:	Drives up to three Inchworm Translators
AC power requirements:	100-120/200-240 VAC (selectable)
Line frequency:	50-60 Hz
Line current:	.75 amps, max.
Line power:	90 watts
Clamp voltage:	0-700 volts
Staircase voltage:	0-600 volts

REMOTE CONTROL

The CE-1000 Control Module rear panel 25 pin I/O port is used for control signal input as well as output monitor. TTL compatible inputs can be used to command the Inchworm Translator to run forward or reverse and travel fast or slow. An external clock input will provide speed control determined by the clock rate with 514KHz corresponding to maximum speed.

NOTE: All control I/O lines have internal pull-up to 5 volts through 3.3 Kohm. A "LO" input is required to set an operating mode ("HI" is 5 volts. "LO" is 0 volts).

CARDS, OPTIONS AND ACCESSORIES

CE-210 INCHWORM CARD PAIR

Consists of a HV Drive Card and a Logic Card. The Card Pair can be used in the Command or Control Module to drive additional Inchworm Translators.

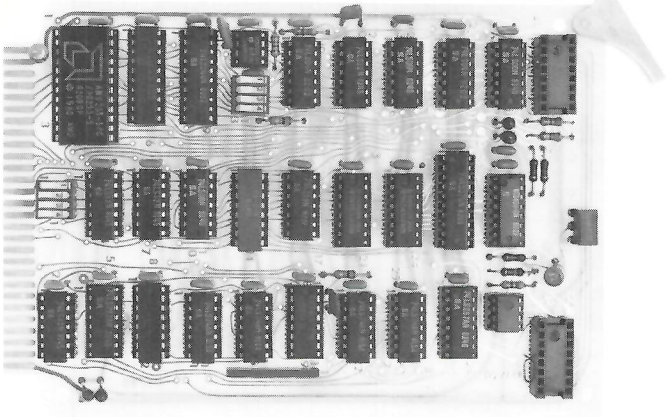
The Logic Card can be operated by an external clock, by direction commands or addressed through the STD bus.

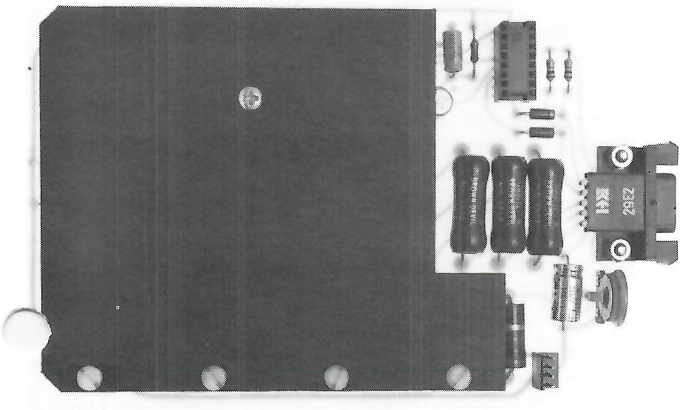
Power requirements:	+ 5 VDC @ 300ma + 12 VDC @ 10ma
Input:	Forward/Reverse/Limit TTL low going pulse or processor command, 500 KHz max.
Input address:	4 switch selectable with I/O request
Output:	Staircase current output, 127 steps 1.5ma max. Clamp logic 5v, 1.5ma max.

The HV Drive Card is STD compatible and provides HV logic control for driving the IW Series Inchworm Translators.

Power requirements:	+700 VDC @ 40ma +12 VDC @ 6ma
Inputs:	Staircase current control, 127 steps 1.5ma Current clamp drive, 1.5ma
Output:	0-600 VDC staircase 0-700 VDC clamp drive 0-180 VDC clearance compensation

Either of the CE-210 cards may be purchased separately. Contact the factory for details.





CE-310 ENCODER CARD PAIR

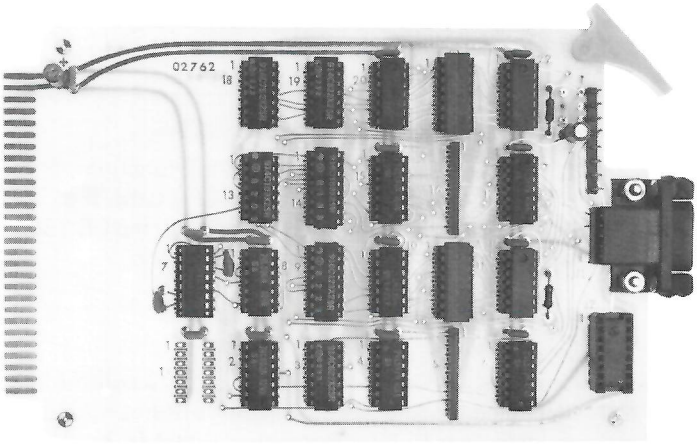
Consists of a TTL Upcount/Downcount Card and a 24 bit Counter Card. This Card Pair will allow a separate Encoder for a 600 Series Inchworm to be plugged into a CE-2000 Command Module.

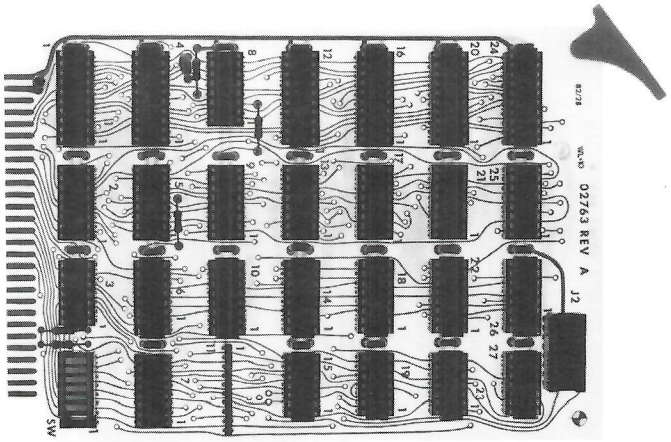
The Upcount/Downcount Card produces TTL level output from the encoder input.

Power requirement:	+5 VDC @ 70ma
Input	
Reference level:	2.5 VDC
Waveform:	S1, S2 with 90° phase separation, 2 volts p-p centered at 2.5 VDC
Output:	TTL upcount/downcount 1 pulse = 1μm High going pulses
Function:	Used with IW-600 series translators and encoders. Provides A to D by fringe division. Divide by 16.

The Counter Card is a 24 bit counter to interface with the Upcount/Downcount Card or other compatible measurement devices.

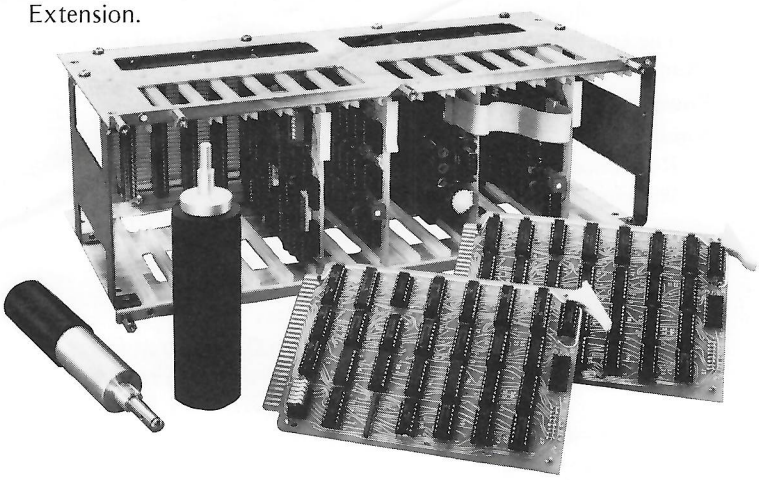
Power requirements:	+5 VDC @ 250ma
Input:	TTL high going upcount/downcount 24 bit comparison count
Max. data rate:	15 MHz
Counter:	24 bit
Outputs:	FIRQ, SIGN, <, >, = 24 bit accumulated count





CE-100 CARD CAGE

This light weight rugged card cage has 16 card slots and a 7 connector STD bus back plane. Expansion to a 14 connector STD bus back plane requires addition of the CE-101 STD Bus Extension.



CE-101 STD BUS EXTENSION

This extension must be added to the Command Module to enable the addition of a 2nd or 3rd Inchworm Translator and/or Encoder. This kit includes all necessary hardware and fasteners.

CE-105 CHASSIS MODULE

This module includes the complete chassis with power supply, top and bottom covers and rear panel.

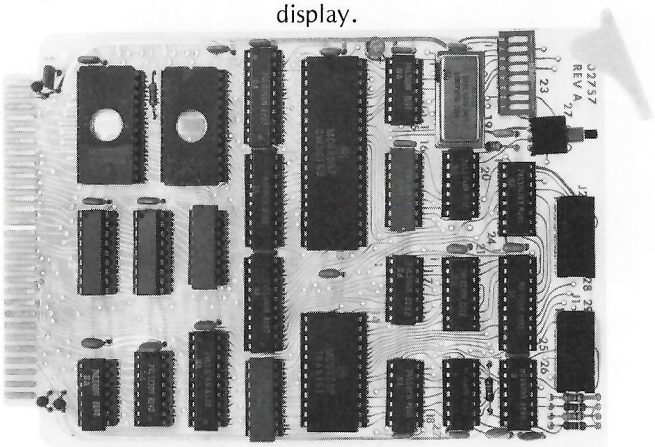
CE-190 COMMAND UPGRADE KIT

This kit will convert a Control Module to a full function Command Module. It includes the CE-130 CPU Card, the CE-125 Detachable Keyboard, the CE-126 Cable, the CE-120 Command Panel and the CE-310 Encoder Card Pair.

CE-130 CPU CARD

This processor uses a 6809 8 bit microprocessor to control the CE-2000 Command Module. This processor features novel I/O and memory map, two 16 bit index registers, two 16 bit stack pointers and two 8 bit accumulators. This card will find use in a wide variety of machine control applications.

Power requirements:	+ 12 VDC, 30ma + 5 VDC, 750ma
Output:	Burleigh STD Bus and keyboard display.



CE-400 ANALOG I/O

This Analog Input/Output Card allows up to three axis control with CE-440 three axis joy stick or any compatible analog input.

Power requirements:	+ 5 VDC @ 20ma
Input:	3 channel
Output:	STD Bus data

CE-410 EXPANSION ROM

This card allows ROM expansion of the CE-2000 to 12K byte.

Power requirements:	+ 5 VDC, 500ma
Capacity:	12K byte
Input:	TTL level data
Output:	TTL level data

CE-420 EXPANSION RAM

Allows RAM expansion to 16K byte; use two CE-420 for a maximum expansion to 32K byte.

Power requirements:	+ 5 VDC @ 500ma
Capacity:	16K
Input:	TTL level data
Output:	TTL level data

CE-430 IEEE INTERFACE CARD

This Bus interface card, when plugged into the CE-2000 Command Module, will allow interface of all CPU functions and translator control to an external computer or a GPIB. With this card the CE-2000 functions as a listener-talker.

Power requirements:	+ 5 VDC @ 1 amp
Input:	STD standard
Input address:	User selectable
Output:	IEEE-488 1980 standard

CE-440 THREE AXIS JOY STICK CONTROL

This three axis joy stick allows tactile control of up to three Inchworm Translators from CE-1000 or CE-2000.

FUTURE OPTIONS

It is anticipated that optional plug-in cards will be developed to provide a host of additional features. Custom software development for special requirements is available in ROM and inquiries are invited. The following options are presently scheduled for development.

1. Custom software programs
2. Data hold to maintain position and program information in case of loss of power
3. DC motor drive with encoder interface for programmable operation
4. Stepper motor drive for direct interface with CPU for programmable operation

Note that it should be possible to use the Command Module with appropriate option cards to control a hybrid system (e.g. Inchworm Translator with Encoder, DC motor drive with Encoder and a stepper motor drive rotational stage).

SYSTEMS AND COMBINATIONS

To assist in the selection of the appropriate components to assemble a custom Inchworm micropositioning system, we have prepared the following examples:

Example 1

Assume you have to perform automated inspection of hybrid semiconductor devices. Your inventory includes 10 different components in lots of 1000. Your inspectors view the components through a microscope and manually move the microscope stage about to predetermined inspection points. In order to eliminate operator error, reduce tedium and increase productivity it would be desirable to automate inspection with a programmable Inchworm powered 2" travel X-Y microscope stage. An inspection program would be written for each circuit and called up on the keyboard by pushing the program load and the corresponding number.

The proper Inchworm system would include:

1	CE-2000	Command Module
2	TS-202	Translation Stage with IW-602, 50mm travel
1	CE-210	Inchworm Card Pair
1	CE-310	Encoder Card Pair
1	CE-101	STD Bus extension

For a third axis, to be used to zoom or focus the microscope, the following additions could be chosen:

1	TS-361	Z-axis Translation Stage with IW-601, 25mm travel
1	CE-210	Inchworm Card Pair
	CE-310	Encoder Card Pair

Example 2

The researcher interested in doing intracellular recording in tissue slices under a microscope might want his Inchworm system to include:

1	CE-2000	Command Module
1	IW-601	Inchworm Translator with Encoder, 25mm travel
1	IW-470	Lateral Stability Option
1	IW-475	Electrode Mounting Kit

Please consult the factory for assistance in selection of the appropriate components.

CUSTOM APPLICATIONS

For custom applications Burleigh offers other systems such as Inchworm Translators which lock when the power is shut off, short travel miniature translators, long travel Inchworm Translators and stage drives, low lateral motion systems, adaptive arrays and space flight qualified systems. We even offer a special Inchworm Translator System which can be used for electrode positioning in chronic implant research with primates. New data sheets, Tech Memos and applications bulletins are continually being printed so please contact the factory for further details.

WARRANTY

The Burleigh Inchworm Translator and Inchworm Controllers are warranted against defects in material and workmanship for a period of one year after date of delivery and the return of Burleigh's warranty card. The Inchworm Translator is designed to operate in a vacuum with the addition of the IW-490, IW-491 Vacuum Option. However, vacuum operation is not guaranteed for operation in the corona region (0.1 - 100 Torr) even with the vacuum option. During the warranty period, Burleigh will repair, or at its option, replace parts which prove to be defective when the instrument is returned prepaid to Burleigh Instruments, Inc. The warranty will not apply if the instruments have been damaged by accident, misuse, or as a result of modifications by persons other than Burleigh personnel. Contact the factory before returning any instrument for repair.

DELIVERY INFORMATION

Delivery is in most cases stock to four weeks. However, demand sometimes exceeds supply. In these instances delivery will be somewhat longer.

PRICE AND TERMS

Current price and information on associated shipping and insurance charges can be found in the price list. Prices are subject to change without notice and are slightly higher outside of Canada and the United States.

DESCRIPTION

INCHWORM POSITIONERS AND TRANSLATION STAGES

IW-501	Inchworm Translator, 25mm travel
IW-502	Inchworm Translator, 50mm travel
IW-601	Inchworm Translator/Encoder, 25mm travel
IW-602	Inchworm Translator/Encoder, 50mm travel
IW-470	Lateral Stability Option
IW-471	Lateral Stability Retrofit
IW-475	Electrode Mounting Kit
IW-490	Vacuum Option for IW-500 Series Translators
IW-491	Vacuum Option for IW-600 Series Translators
TS-101	Translation Stage with IW-501, 25mm travel
TS-102	Translation Stage with IW-502, 50mm travel
TS-201	Translation Stage with IW-601, 25mm travel
TS-202	Translation Stage with IW-602, 50mm travel
TS-100	Translation Stage, 50mm travel, no Inchworm
TS-351	Z-axis balanced stage assembly (IW-501)
TS-361	Z-axis balanced stage assembly (IW-601)
TS-050	Hole Option

ENCODERS FOR PRECISION MEASUREMENT

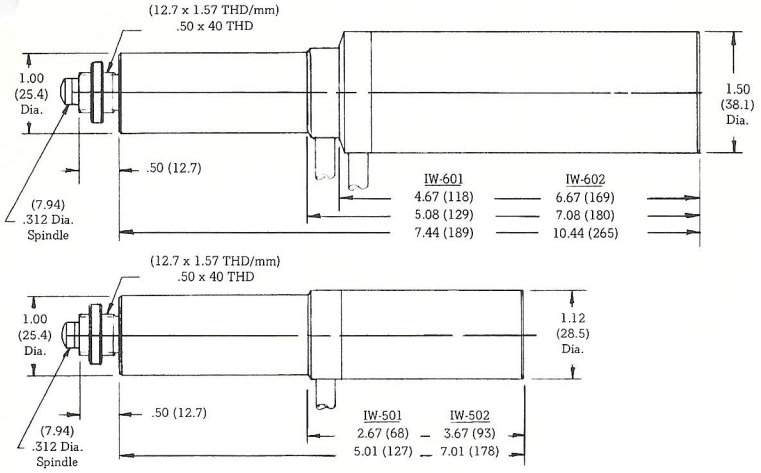
EN-371	Encoder, 25mm travel, for independent mounting
EN-372	Encoder, 50mm travel, for independent mounting
EN-501	Encoder Body, 25mm travel; add to IW-501
EN-502	Encoder Body, 50mm travel; add to IW-502

INTELLIGENT ELECTRONIC CONTROL

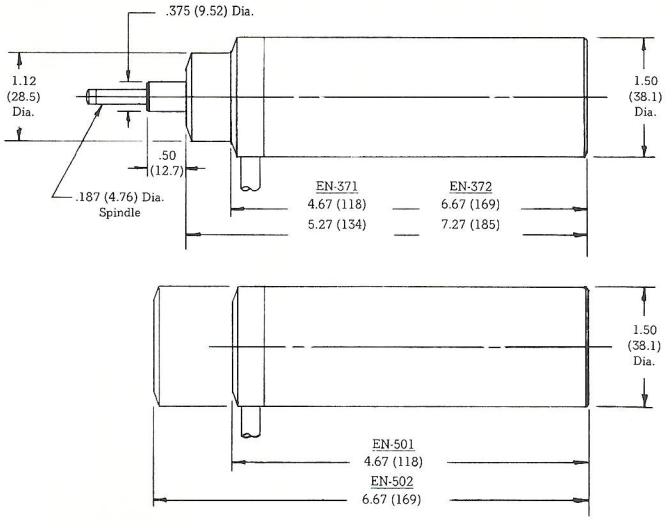
CE-2000	Command Module. Expandable to drive three Inchworm Translators with Encoders
CE-1000	Control Module, to control Inchworm Translator in RUN mode. Expandable to drive three Inchworm Translators
CE-210	Inchworm Card Pair
CE-310	Encoder Card Pair
CE-100	Card cage, 16 slots
CE-101	STD Bus Extension
CE-105	Chassis Module
CE-190	Command Upgrade Kit
CE-130	CPU Card
CE-400	Analog I/O
CE-410	Expansion ROM
CE-420	Expansion RAM
CE-430	IEEE Interface Card
CE-440	Three axis joy stick

NOTES:

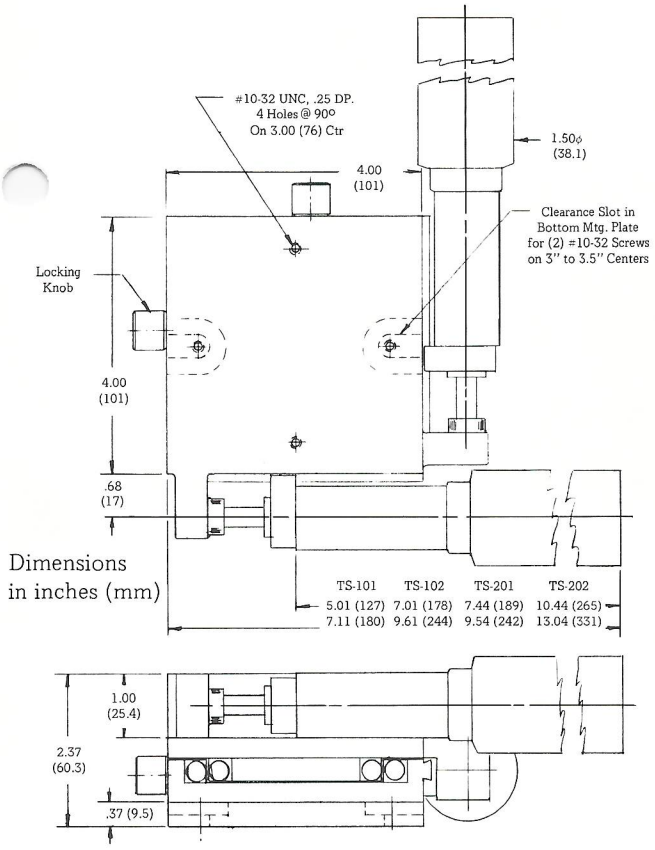
OUTLINE DIMENSIONS



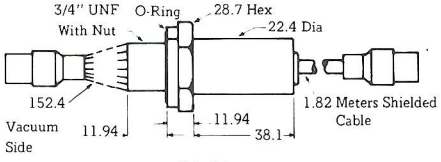
Dimensions in inches (mm)



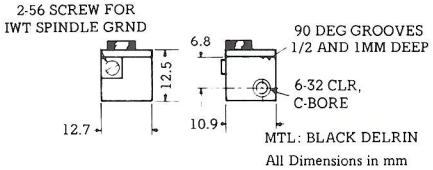
Dimensions in inches (mm)



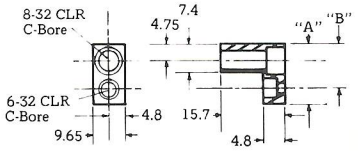
Dimensions
in inches (mm)



IW-490 All Dimensions in mm



All Dimensions in mm



IW-475

A	B
16.5	12.1
18.8	14.2

All Dimensions in mm

REPRESENTATIVES

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Holland, Belgium, Luxembourg, Denmark

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Optilas, C.E. nº. 1422-91019 Evry Cedex, France Tel (6) 077-40-63 Tlx 842 600019

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