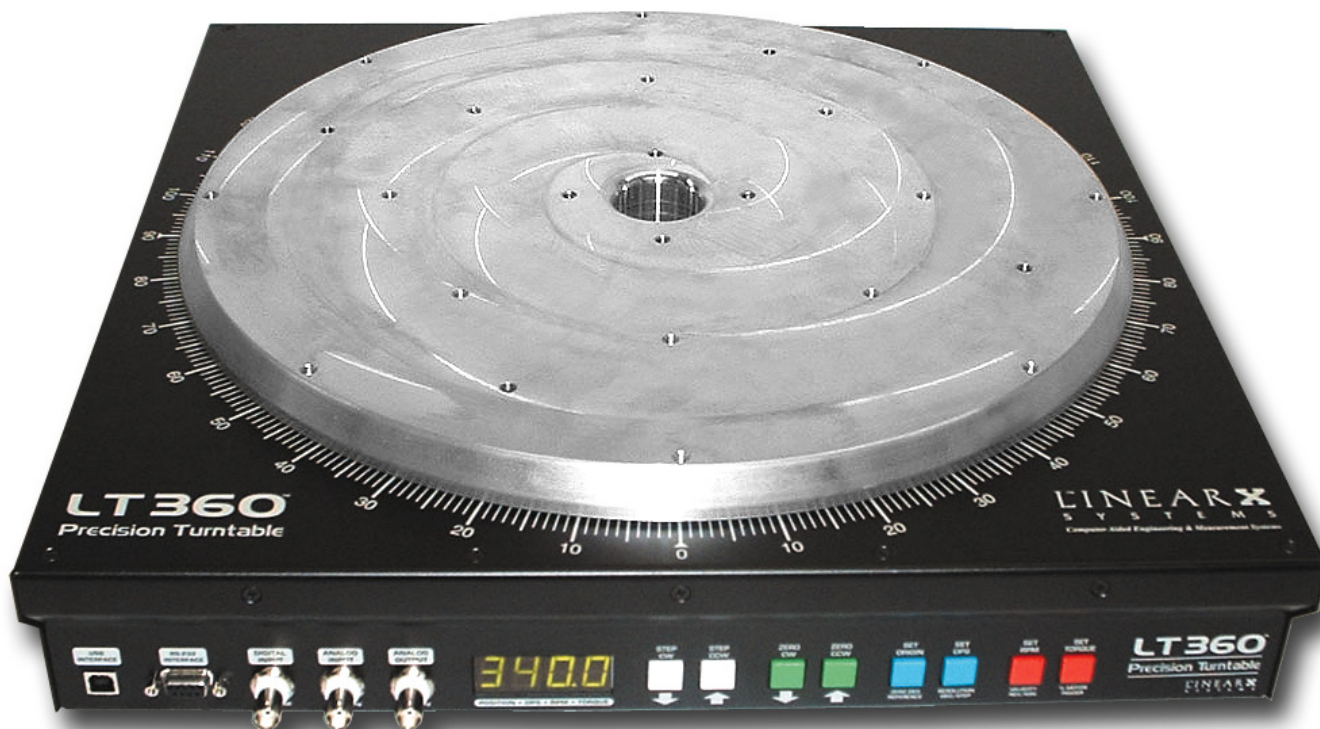


LT360 EXTM

Precision Turntable

LINEARTM X
S Y S T E M S
Computer Aided Engineering & Measurement Systems



Applications

- Polar Field Acoustic Measurements
Loudspeakers, Microphones, Enclosures
- Polar Field EM & RF Measurements
Antennas, Radiated EMI Testing
- 3D Model Scanning, Photography
- Industrial Automation & Process Control
- Sales/Marketing & Trade Show Displays

Features

- Heavy Duty, Rugged, Construction
- Precise, Repeatable, Rotational Control
- High Rotational Resolution of 0.1°
- Computer, Digital, Analog Control Methods
- Operation in Any Position or Orientation
- High Torque with Programmable Capability
- Center Through Hole for Cable Run
- Irreversible Drive, Platter Position Locked
- Programmable Velocity 0.1RPM - 12RPM
- Controlled Acceleration/Deceleration
- Precision Worm Gear Drive System
- Microstepping Stepper Motor Control

High Performance Turntable

The LT360EX is a rugged precision turntable designed for professional applications. It offers high precision, high strength, advanced interface and control capabilities, all at an affordable price. Multiple pre-tapped mount points are provided both on the platter and base for attachment of brackets, flanges, jigs, and other rigging. The LT360EX can be mounted in any orientation for maximum flexibility.

The load handling system is comprised of machined aluminum castings for both the platter and base. The central support hub utilizes a 125mm sealed ball bearing rated for 8,000 lbs. Large bidirectional axial thrust loads are easily handled along with substantial radial or unbalanced loads.

The drive system features a steel worm gear for precision rotational control and maximum torque. The system is driven by a microprocessor controlled stepper motor yielding internal resolution of 0.0015625 degrees. Controlled acceleration and deceleration is provided automatically via microstepping to yield smooth movement with minimal load disturbance.

Multiple control methods are supported which enable universal application. The LT360EX may be easily incorporated into almost any industrial automation environment by using one of the computer, digital, or analog interfaces. Advanced user control is conveniently achieved by using RS-232 or USB communication. A general purpose Win32 application program is provided, or the user can quickly create their own custom applications providing detailed operational control.

Front Panel Features

The front panel contains all of the connectors for the various interfaces including: USB (Type-B), RS-232 (DB-9F), TTL Pulse Input (BNC), Analog Input (BNC), Analog Output (BNC), and the LR360 Remote (MiniDIN-6).

The front panel also provides 8 pushbutton switches arranged in four color coded groups which are used for manual control of the turntable. A multi-function 4 digit LED display is also provided.



The controls are recessed under the surface edge of the turntable to help prevent damage due to objects which might be dropped from above, since the turntable is often located on a floor surface. Most of the functions are self explanatory. The LT360EX supports both Unipolar (0 to 360 degree) and Bipolar (0 to ± 180 degree) formats.

■ USB Interface

This is a standard type-B connector providing connection to a USB bus. The USB interface of the LT360EX uses only Low-Speed connection speed. This is more than adequate for control of the turntable.

■ RS-232 Interface

The DB-9F connector is wired as a DCE device, so only a straight-through cable connection is required to the DTE host (computer). The LT360 does not require any handshaking, so only the RX and TX signals are used in addition to Ground.

■ Pulse Input

This BNC connector provides a means to step the turntable via a TTL pulse. Each pulse will cause the turntable to rotate by the current step size, and in the direction of either CCW or CW. Triggering based on the Rising or Falling edge can be selected.

■ Analog Input

This BNC connector provides a means to control the location of the platter by analog voltage. The scale factor is 10mV/deg, and the resolution of the LT360EX is 0.1 degree.

■ Analog Output

This BNC connector provides a means to obtain an analog control voltage from the LT360EX. This can be useful if driving some other display, chart recorder, or other plotting device. The scale factor is 10mV/deg, and the resolution is 0.1 degree.

■ LED Display

The four digit LED display is used primarily to give the current position of the platter. The readout can be either Unipolar or Bipolar as selected through the Win32 software or commands. However the display has many other purposes. When various switches are pressed the display will show Position (Degree), Step Size (DegPerStep), Velocity (RPM), Torque (%), or the Accel Function (#).

■ Step CW / CCW (White switches)

These two switches are mainly used to step the platter by the current step size, either clockwise (CW) or counter clockwise (CCW). When the switch is pressed, the platter will rotate by the current step size. These switches are also used with other switches to increment/decrement parameter values.

■ Zero CW / CCW (Green switches)

These two switches are used to move the platter to the origin (0.0) either by clockwise (CW) or counter clockwise (CCW) rotation.

■ Set Origin (Blue switch)

This switch is used to reset the origin to the current platter position. No platter movement occurs.

■ Set Step Size DPS (Blue switch)

This switch is used to change the step size. When this switch is pressed, the display will show the current step size. The step size can then be changed up/dn by pressing the White buttons. The minimum step size is 0.1 degree.

■ Set Velocity RPM (Red switch)

This switch is used to change the velocity in revolutions per minute. When this switch is pressed, the display will show the current RPM setting. The RPM can be changed up/dn by pressing the White buttons. The minimum RPM is 0.1 and the maximum is 12.00.

■ Set Torque % (Red switch)

This switch is used to change the motor torque in percent. When this switch is pressed, the display will show the current torque setting in percent. The torque can then be changed up/dn by pressing the White buttons. The max value is 100% and the min is 10%.

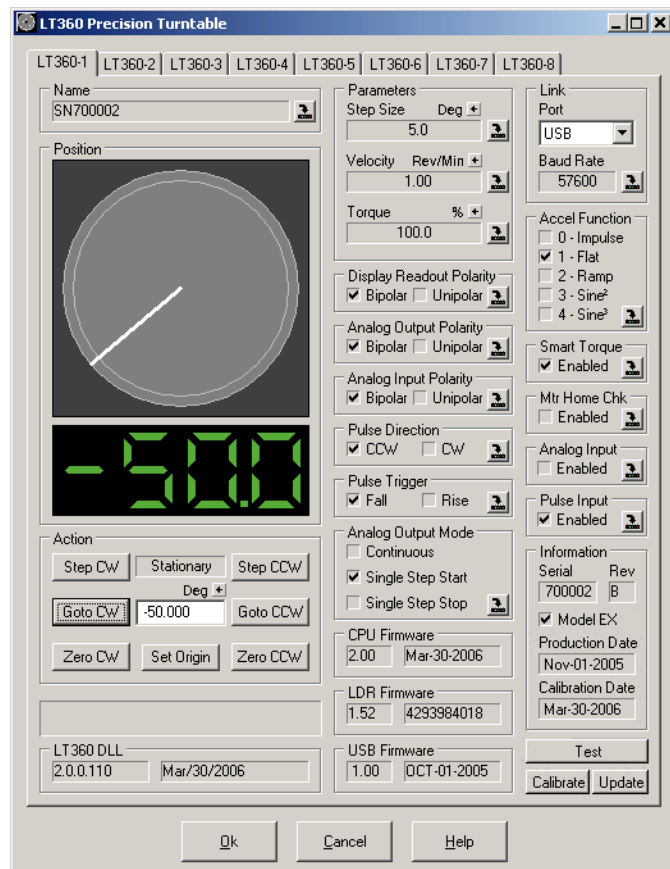
Application Software

The application program provides full control over all of the LT360EX functions and features. Up to eight (8) units can be managed simultaneously, either linked by USB or RS-232. The main window of the program is shown below. Fields are grayed out when unlinked.

Each LT360EX unit is assigned to a tab. Changing between tabs will load the parameters of that unit into the controls and parameter fields. The LT360EX can be connected to a USB or COM serial port on the computer. The Link group box has selections for: USB, NONE, COM1, COM2, etc.

If an LT360EX unit is found on the port, the link will be activated and the contents read from the LT360EX into the parameter fields and controls. If the baud rate does not match the LT360EX, or the unit is not on the selected COM port, an RX error message will be shown. The Port list box will then be forced back to the NONE selection. For USB links, the Port list box will be forced back to the NONE selection without any message if an LT360 is not found.

Two methods of displaying current turntable position are used: the analog platter display, and the digital readout. Clicking on the platter graphic will Abort/Stop a move. Clicking on the digital readout will update the display.



Custom User Programming

■ Win32 DLL Programming

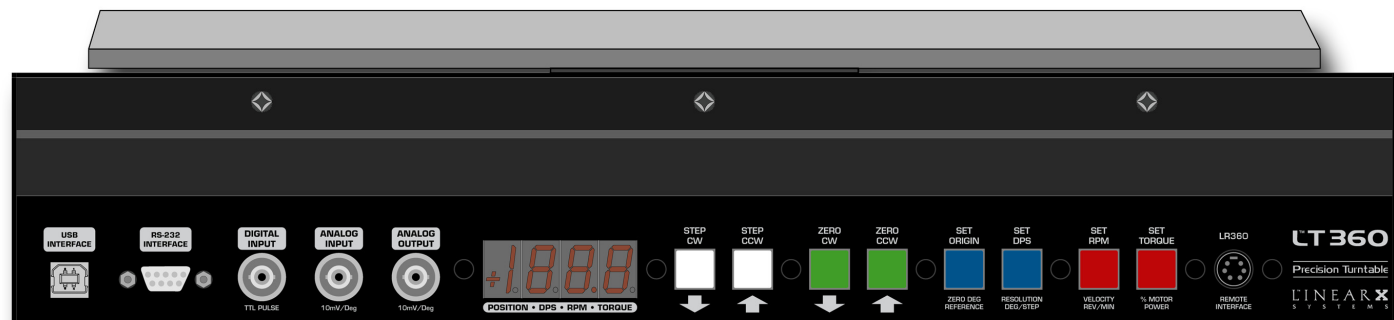
A DLL (Dynamic Link Library) is provided for use by user application programs to allow direct control of the LT360EX Precision Turntable. The DLL supports the Win32 OS environments. For other operating system environments, the universal RS-232 programming method should be used.

The DLL supports both methods of linking to LT360EX turntables either via serial RS-232 connections or the USB (Universal Serial Bus). Multiple LT360 units can be managed by the DLL simultaneously, from 1 to 128 units. The DLL handles all of the management details necessary for easy serial communications over either the PC's COM ports or USB. The application program needs only to place calls to the DLL through 4 simple functions. The DLL functions are 32 bit code and can be called by any Win32 application written in any language. An appropriate header file is all that is required for the exported functions for linking.

■ RS-232 Programming

The RS-232 industry standard serial interface provides a universal means to control the LT360EX by any program in any operating system environment. RS-232 still has many advantages over the newer bus formats such as USB. The length of a cable run for RS-232 is not restricted, and the commands can be sent to the LT360EX from any program, device, or operating system.

All commands sent to the LT360EX can be either upper or lower case. Numeric parameters when needed for Set commands are contained in the string at the end, and then followed by a termination character. There must be a [space] delimiter between the Set or Get word and the command name, and again between the parameter if used. The final termination character must follow to inform the LT360EX that the command string is now complete and can be processed. *Note: See LT360EX manual for further details.*



Load Handling

Probably the most common question asked by many customers is: *how much weight can it handle?* While this question may at first appear quite simple, the answer is actually more complex than most may initially realize. Loading conditions are determined by many factors including: horizontal or vertical orientation, rotational velocity, mass of load, the acceleration function used, distance from rotational center, and perhaps resistance or torque loads of external customer rigging or structures.

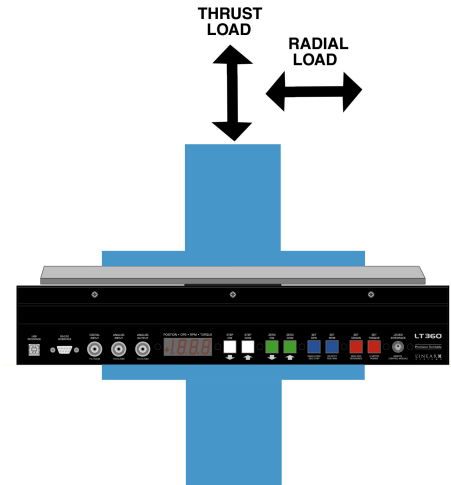
To illustrate the complex dynamics of this mix of variables, one could say that a well setup and balanced 1000lb load could be more easily driven than a poorly setup 100lb load. Therefore the load handling capabilities are very much a function of how well the user constructs, mounts, and supports the loads with the LT360EX.

■ Thrust & Radial Static Loading

The drive assembly of the LT360EX is robust and consists of two heavy aluminum castings mounted between a 125mm (5 Inch) ball bearing. The axial static thrust load rating for the bearing is 8000 lbs (4000kg). The thrust load rating is bidirectional, and can be either pulling or pushing. Radial or side loading of bearings is always much less, probably on the order of several hundred pounds.

The load capability for the two castings depends greatly on how evenly the load is attached to the castings. If the load is bolted properly and rigidly to the surfaces, with the weight concentrated in the center region, the castings should easily handle 1000 lbs or more.

If the load is not attached to the platter and base properly, than the castings could fracture with smaller load stress. Therefore it is critically important that any jigs being mounted to the platter and base provide their own rigid surface strength to avoid excess stress at the outside edges of the castings. The LT360EX chassis should *never* be used as a primary support structure for load handling. All loading should be applied to the castings with the provided mounting points.



■ Horizontal Torque Loading

The case of horizontal torque is shown in the pictorial here. This is probably the most common configuration for setup. In this case the LT360EX is located on a horizontal surface, or on a ceiling, and the load is rotated in a horizontal plane with no change in the vertical axis.

The torque load is equal to the product of radial distance and force, where force is the product of mass and acceleration.

$$F = M \cdot A \quad T = R \cdot F = R \cdot M \cdot A \quad M = T / (R \cdot A)$$

Since there is no change in vertical position, gravity is not a factor. The only acceleration acting on the load is due to the LT360EX. For the LT360EX model the maximum platter driving torque is 100 NM (Newton•Meters). We will assume that the rotational velocity is set to 1 RPM, and that the Flat acceleration function is in use.

With these operating conditions the average acceleration for the Flat acceleration function is about 0.21M/S^2 at 1 RPM and 1M. Therefore the maximum mass load which can be rotated is:

LT360EX, 1Meter, 1RPM, Flat Accel Profile

$$M = T / (R \cdot A) = 100 / (1.0 \cdot 0.21) = 476\text{kg} = 1047\text{ lbs}$$

The mass load capability for other operating conditions can also be calculated as easily. Reducing the centroid load distance by half will double the mass load capability. It should be noted that the acceleration is proportional to the square of RPM. Reducing the RPM by a factor of 2, reduces the acceleration by a factor of 4. The greatest load handling ability with chopper current drive is provided for RPM values less than about 2 RPM. At higher RPM velocities the torque is greatly reduced. This is due to the inductance of the motor limiting the current. High velocities such as the maximum 12 RPM will only be suitable for driving minimal light torque loads.

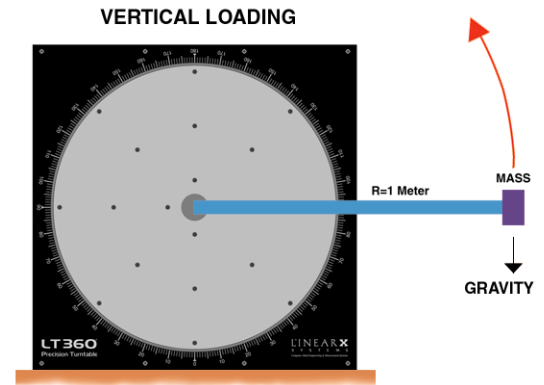


■ Vertical Torque Loading

The case of vertical torque is shown in the pictorial here. In this case the LT360EX is located vertically relative to the ground surface. In this configuration the mass load is being acted upon by the acceleration of gravity. The acceleration of gravity is 9.8M/S^2 , generally much larger than the rotational acceleration of the LT360EX. For this reason the mass load capability will be greatly reduced.

The torque load is equal to the product of radial distance and force, where force is the product of mass and acceleration.

$$F = M \cdot A \quad T = R \cdot F = R \cdot M \cdot A \quad M = T / (R \cdot A)$$



Since the vertical position is changing, gravity is a factor. Depending on the position of the load, or the rotational direction, the acceleration due to gravity will add or subtract from the rotational acceleration of the LT360EX. Based on typical operating parameters of 1 RPM, 1 Meter, and a Flat acceleration function, the acceleration is about 0.21M/S^2 . However the acceleration due to gravity is 9.8M/S^2 about 50X larger. The actual acceleration due to gravity changes around the circle from zero at the bottom or top, to the maximum at the sides. Since the rotational acceleration is so much smaller than the effects of gravity, we will simply assume the worst case acceleration as equal to gravity. Therefore the maximum mass load which can be rotated is:

LT360EX (100NM), 1 Meter

$$M = T / (R \cdot A) = 100 / (1.0 \cdot 9.8) = 10.2\text{kg} = 22\text{ lbs}$$

Note that the mass load capability in the vertical configuration is not a function of the RPM or acceleration functions of the LT360EX. Gravity dominates the acceleration entirely. Larger mass loads can be handled by reducing the radial distance. Reducing the distance by half will double the mass load capability. This configuration is not very useful for load rotation due to the limits of gravity. It is commonly used to rotate a lighter weight boom and microphone for this axis.

From these calculations it should be clear that the centroid of the mass load must be fairly lightweight or located fairly close to the rotational center, to avoid creating large torque requirements. In the vertical configuration acceleration due to gravity is the limiting factor.

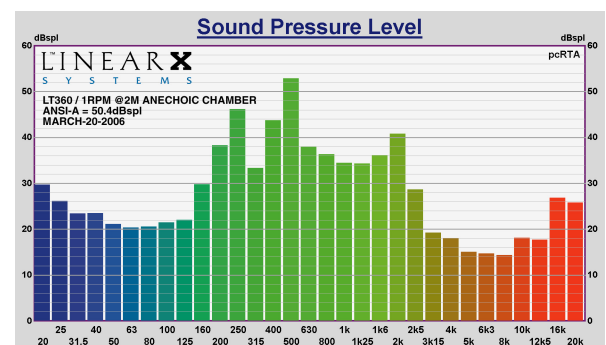
Acoustical Noise

In most applications where acoustic measurements are to be performed, the LT360EX will be used to rotate the device under test to a specific position, and then the measurement taken while stopped. In this application the LT360EX is not rotating while the measurement is in progress, and noise is not a factor. The LT360EX produces virtually no noise when it is not rotating.

However in some acoustic measurement applications it may be necessary or desirable to perform measurements while the device is being rotated. In this situation noise from the LT360EX may or may not be an issue, depending on the background noise sensitivity.

Noise is generated by the stepper motor and drive assembly when the LT360EX is actively rotating the load. The 1/3 octave noise spectrum is given in the graph above. The broad spectrum noise is:

50dBspl @ 2M, 1 RPM, ANSI-A Weighted



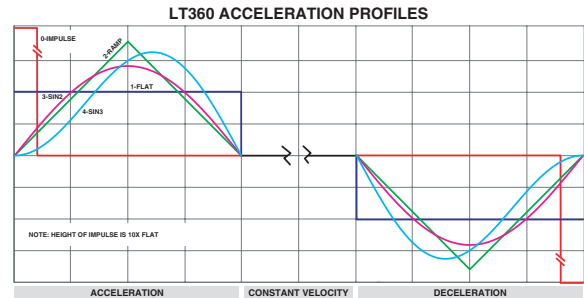
It should also be noted that a user mounting structure and/or rigging can also produce noise when in motion. This can arise from many sources including: bearing or wheel squeaks, joint interface squeaking, etc. To minimize all noise sources bearings should be well lubricated and bolted joints may need special treatment of rubber pads or similar between the members. The self noise of the LT360EX itself can be reduced by using an isolation box surrounding it or similar means if that is an issue.

Controlled Acceleration

Moving a load mass from one stationary position to another requires acceleration and deceleration. Simple brute force drive methods provide only constant velocity travel which produce substantial spikes of acceleration and deceleration as the motion starts and stops. This acceleration/deceleration impulse is generally undesirable often causing the load to jerk violently, sometimes producing oscillation of the mounting structure or load itself. The LT360EX utilizes an advanced method of microprocessor stepper motor control which provides *shaped* acceleration and deceleration for smooth movement of the load without abrupt transitions. The LT360EX precisely controls the acceleration automatically while executing the movement to the desired position with 0.1 degree accuracy. Controlled acceleration also permits far greater loads to be rotated.

The LT360EX provides several different acceleration functions or *profiles* that control how the platter accelerates and decelerates from a stationary position to the constant velocity rotation. Five different acceleration profiles are provided as shown in the graph:

- 0 - Impulse
- 1 - Flat
- 2 - Ramp
- 3 - SIN2
- 4 - SIN3



■ 0 - Impulse

The Impulse function provides the fastest rise time from zero to constant velocity. However it also greatly reduces the maximum load which the LT360EX can rotate, due to its higher acceleration. The acceleration of this function is about 10X that of the others. The Impulse function is useful for light loads where a fast response time is desired. However for most typical applications where a heavy load is being rotated, this function is probably the least desirable. Using a softer acceleration function is preferable.

■ 1 - Flat

The Flat function provides constant acceleration until the platter reaches the constant velocity rotational rate, as set by the RPM value. This is probably a good general purpose profile for most typical applications. The load is accelerated under a constant value which provides maximum torque handling and relatively little load disturbance.

■ 2 - Ramp

The Ramp function provides a more gradual acceleration profile, beginning at zero, ramping to a maximum, then decreasing to zero again as the constant velocity speed is reached. This acceleration profile is based on a parabolic velocity function.

■ 3 - SIN2

The Sin² function provides a more gradual acceleration profile, beginning at zero, increasing to a maximum, then decreasing to zero again as the constant velocity speed is reached. This acceleration profile is based on a Sin² velocity function.

■ 4 - SIN3

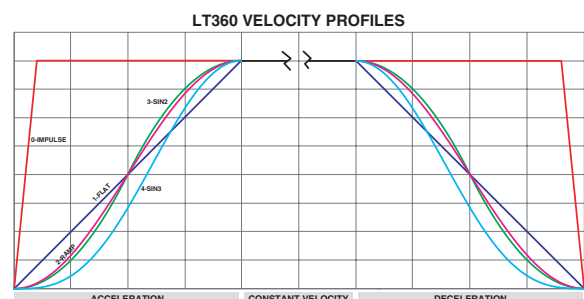
The Sin³ function provides a more gradual acceleration profile, beginning at zero, increasing to a maximum, then decreasing to zero again as the constant velocity speed is reached. This acceleration profile is based on a Sin³ velocity function.

In theory each increasing index of the acceleration functions provides a softer acceleration method. However in many cases the practical differences between functions 1-4 will be very small.

If there is additional rigging and/or a fixture attached to the LT360EX, the rigidity and mass of the additional hardware will play an important factor in the overall motional system response. No mechanical structure is perfectly rigid. When the LT360EX platter begins to rotate, not all portions of the attached rigging will instantly follow this same motion. The fixture will bend, and can behave with its own time constant and perhaps ringing to the rotational motion. The ringing motion or vibration will be controlled by the damping in the fixture. Proper design of fixtures often requires damping elements such as rubber pads placed between joints to increase damping.

■ Velocity Profiles

Each of the acceleration functions has an associated velocity function. These are shown here in the graph. The Impulse function reaches full velocity very quickly, much faster than any of the other functions. The other four functions all provide a much more gradual acceleration.

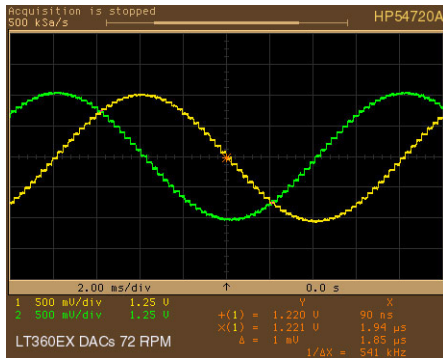


Electrical Features

The system controller module is the brains of the LT360EX and contains all of the analog and digital processing circuitry. Three microcontrollers are employed: the Main System Controller, the USB Interface Controller, and the Stepper Motor Controller. The main MCU is an ARM-7 32-bit processor operating at 48MHz.

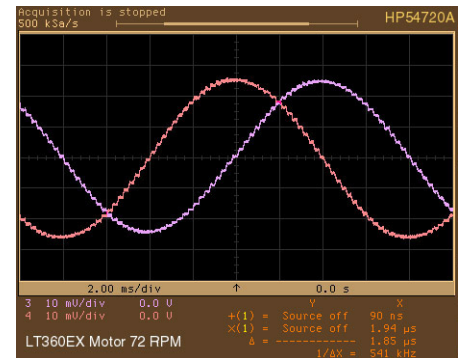
■ Advanced Microstepping Controller

Due to the high resolution, programmable torque, controlled acceleration/deceleration, and variable velocity operation; very demanding requirements are placed on the motor control drive system. The EX model utilizes a highly advanced proprietary custom microstepping controller with unique *bidirectional* PWM high frequency current regulation. This innovative design enables the control of both positive and negative motor coil currents, all within a locked feedback control loop.



The microstepping controller must first generate precise dual sine waves in quadrature, with the required stepping resolution of 16 microsteps. This is handled by two very accurate 16 bit DACs as shown on the *left*. The true motor coil current is sensed by precision differential amplifiers. The motor current is then compared against these waveforms and regulated in a bidirectional PWM feedback loop to match these two DAC staircase waveforms.

The traces on the *right* show the actual motor coil currents of 7.5 Amps Peak as measured by dual Tektronix A6302 current probes. They perfectly track both the positive and negative slopes of the DAC waveforms.



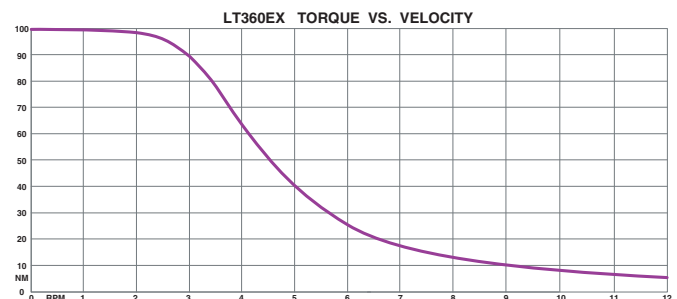
Conventional stepper drives use a fixed combination of fast/slow decay which cannot adapt to variations in motor speed and produce asymmetrical behavior. The bidirectional PWM drive utilized in the EX dynamically adjusts for optimum drive at any motor speed producing textbook perfect current waveforms, maximum square wave drive power at high motor speed, and minimal current ripple at zero motor speed.

■ SmartTorque

The *SmartTorque* feature of the LT360EX automatically reduces motor power when the platter is not in motion. Since the worm drive is irreversible it is not necessary to maintain full drive power to the motor merely to hold its position. The worm drive locks the position automatically. Motor power is reduced to half when the drive is not active. This increases motor life and reduces unnecessary power consumption and heating both in the drive electronics and the motor.

■ Variable Speed Operation

The EX model enables variable speed operation from 0.1RPM to 12 RPM. The very wide 100:1 range provides the ability to handle heavy loads at lower RPM, and lighter loads at higher RPM. As the RPM increases the motor current decreases, thus reducing torque as shown here in the graph. This is the common result of all electrical motor drives. Maximum torque is produced for platter velocities below about 3 RPM. The higher RPM range can be used for lighter loads which may require more speed and less torque.

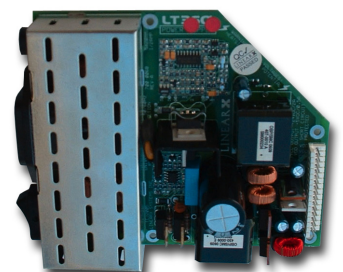
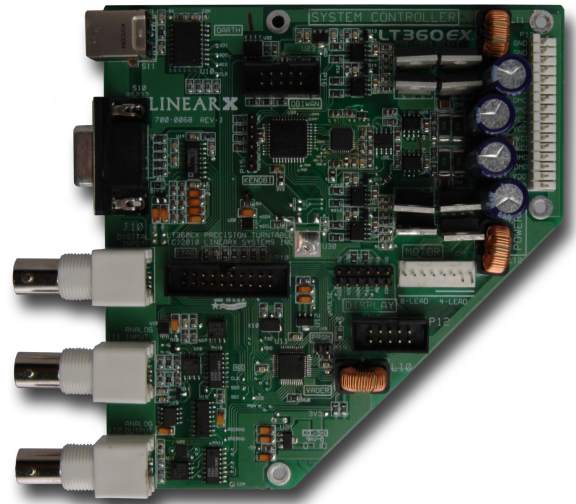


■ Analog Interface & Calibration

The analog control system uses both ADC and DAC components of 16 bit resolution, as well as computer corrected linearity. Custom thin-film resistor networks are employed to meet the temperature tracking and stability requirements. Each LT360EX unit requires 90 minutes of automated calibration and performance verification.

■ Universal Power Supply

The LT360EX utilizes a high frequency power supply with power factor correction. This provides universal world-wide voltage support, from 85-265VAC without user changes. The LT360EX is shipped with an IEC-US power cord, but other types can be obtained from local retail stores.



Mechanical Features

The LT360EX drive assembly consists of two A713 Aluminum castings, platter and base, joined through a 125mm ball bearing. The drive assembly provides both high strength and high precision. A 1.5 In (38mm) clearance hole is provided through the center of the assembly for cable routing.

Powerful Worm Drive

A powerful right angle worm drive system is utilized. The worm is cold formed hardened steel, and the helical gear is cast iron. This type of drive system is irreversible providing automatic locking of the platter position. Lubrication of the gears can be applied externally by the user via an access hole in the bottom of the chassis if required.

A large 100mm powerful hybrid stepper motor drives the gear system controlled by the microstepping controller. Microstepping is utilized to provide an internal resolution of 0.0015625 degrees. This enables precise control of position as well as acceleration and deceleration.



Precision Bearing

Standard commercial bearings are produced with a CN or C3 tolerance specification. The EX model utilizes a custom C2 tolerance bearing which provides exceptional tighter tolerance than standard bearings. This enables the platter to be held in tighter position and improves gear alignment under a wide range of loading.

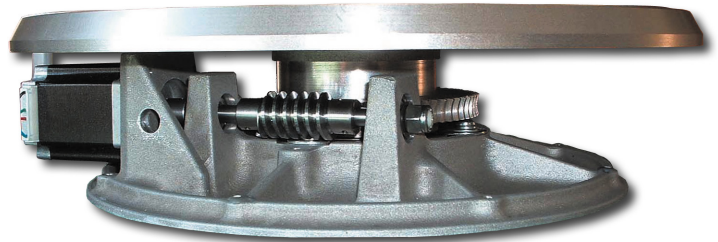
Convenient User Mounting Access

Both the base and platter castings provide pre-tapped 1/4-20 mounting holes for easy user attachment of the LT360EX to jigs and/or other external structures. A through hole down the center of the platter and base is also provided for cable runs.

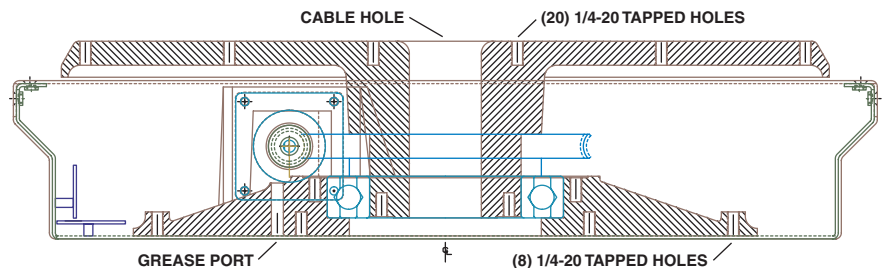
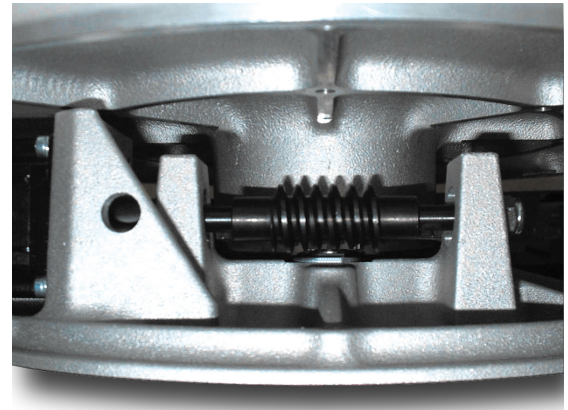
Note: Never use the chassis as structural support. Its purpose is only to contain the internal electronics and system components.



Torque Measurement Jig



LT360EX Drive Assembly



Backlash

Backlash is a term used to describe the tolerance or *play* between a set of gears. All gears have backlash. The LT360EX typically has a backlash of 0.07 degrees peak, but may be as high as 0.20 degrees due to variations in gear production. However this is largely irrelevant for most applications, since backlash can always be driven out by rotating to a given position from a single direction.

Calibration

Calibration is performed originally at the factory, and in most cases will be permanent and not be required again. However if your application requires recalibration for NIST compliance, you will probably need to send in your unit to the factory for recalibration on a periodic basis. Calibration is possible by other labs, but only if the required equipment and jigs are available.

The calibration of each LT360EX requires 90 minutes of time and involves both the electronics and the mechanical system. A GPIB instrumentation system is utilized, and all operations are performed by automation. An example calibration certificate is shown on the next page.

CERTIFICATE OF TRACEABLE CALIBRATION

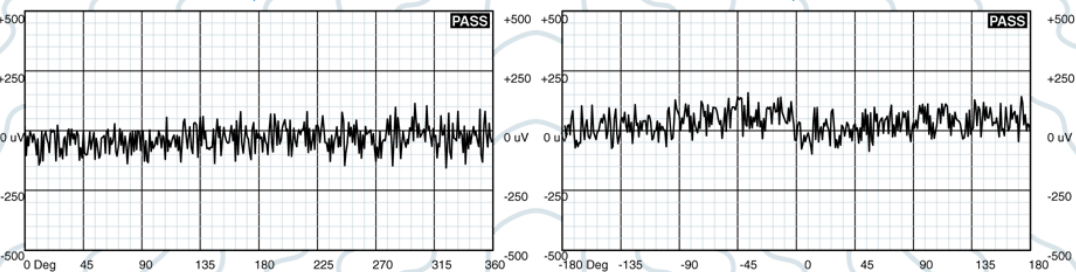
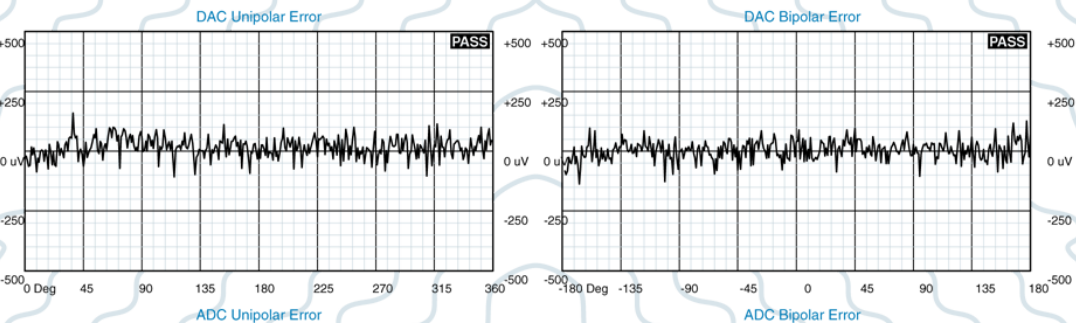
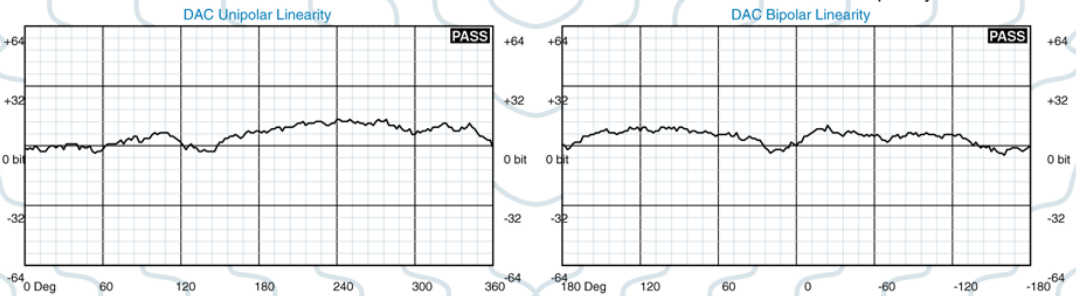
INSTRUMENT

Description	Precision Turntable	Firmware Version	1.50	DAC Unipolar Offset	3FF2
Model Number	LT360	Firmware Date	Mar-17-2006	DAC Unipolar Scale	D220
Serial Number	700002	Unit Name	SN700002	DAC Bipolar Offset	7FF0
Manufacturer	LinearX	Torque	49.00 N-M	DAC Bipolar Scale	D210
Technician	C. Strahm	Backlash	±0.067 Deg	ADC Unipolar Offset	3FC2
Production Date	Nov-01-2005	Output Noise	22.12 μ V RMS	ADC Unipolar Scale	D1B8
Calibration Date	Mar-18-2006	DAC Vhi	3.665747 VDC	ADC Bipolar Offset	7FAE
Calibration Due	Mar-19-2007	DAC Vlo	-1.246498 VDC	ADC Bipolar Scale	D1B7

STANDARDS

Description	Manufacturer	Model No	Serial No	Asset No	Cal Due	Ambient Temp	0.0 C
Torque Meter	SnapOn	TER100FU	2119	LX1005	Nov-23-2007	Relative Humidity	0.0 %
Dial Indicator	Mitutoyo	ID-S1012E	38727	LX1006	Feb-17-2007	Barometric Pres	0.0 mmHg
Multimeter	HewlettPackard	34401A	3146A10031	LX1017	Oct-12-2006	Line Volt age	117.11 VAC
Multimeter	HewlettPackard	34401A	US36049845	LX1019	Oct-12-2006	Line Frequency	60.01 Hz

ENVIRONMENT



This certifies the listed instrument meets or exceeds the published specifications. It has been calibrated using standards whose accuracies are traceable to the National Institute of Standards and Technology. Alternatively, accuracies have been derived from natural physical constants or by ratio type self-calibration techniques. ©2006 LinearX Systems Inc.

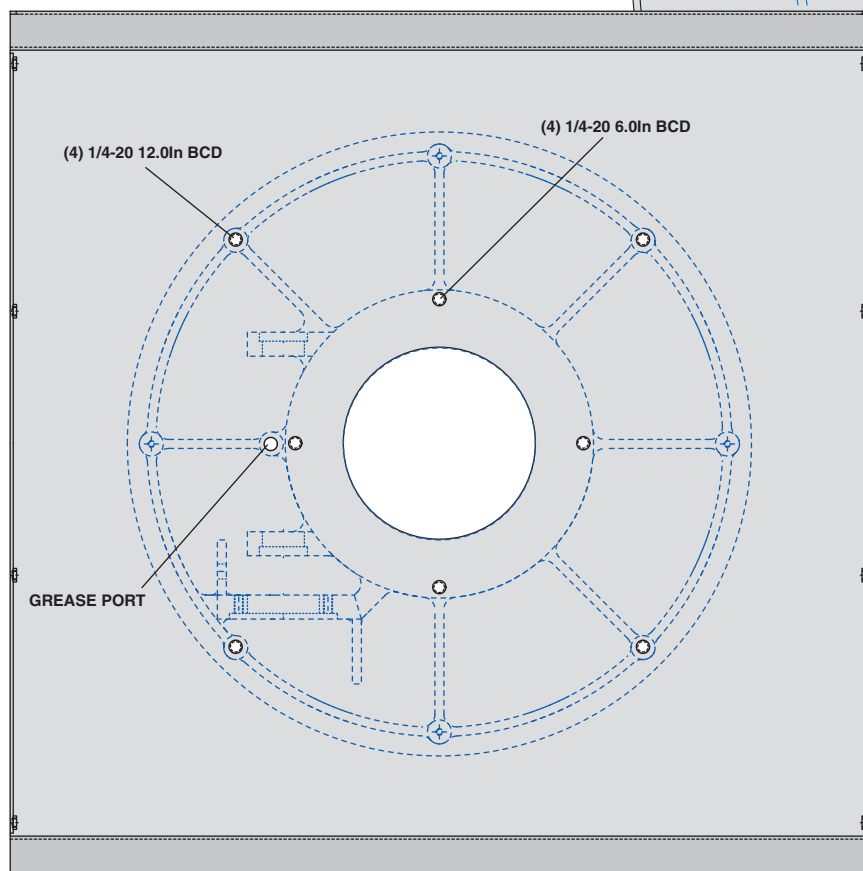
LINEARX
SYSTEMS

LinearX Systems Inc 9500 S W Tualatin-S herwood Road Tualatin, OR 97062-8586 US A

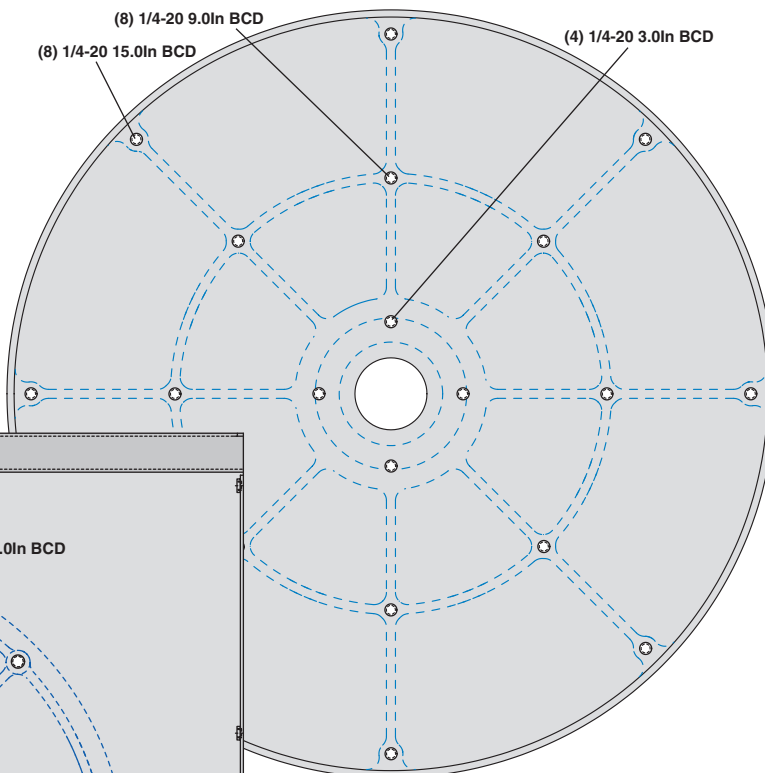
Mounting

The platter and base both have pre-tapped 1/4-20 machine screw holes for mounting customer fixtures and jigs. The thread depth is 0.5 In (12mm) minimum. When attaching screws to these tapped holes, please make sure the screw length entering the platter or base castings does not exceed about 1/2 Inch.

Note: Never use the chassis as structural support.



Bottom view of Chassis/Base



Top view of Platter

■ Mounting to the Base

The base casting is 13 Inches (330mm) in diameter and is located inside the chassis under the bottom panel. It contains (8) 1/4-20 tapped holes for mounting, located on bolt circle diameters of:

- (4) - 12.0 Inch BCD
- (4) - 6.0 Inch BCD
- (Each set offset 45 degrees.)

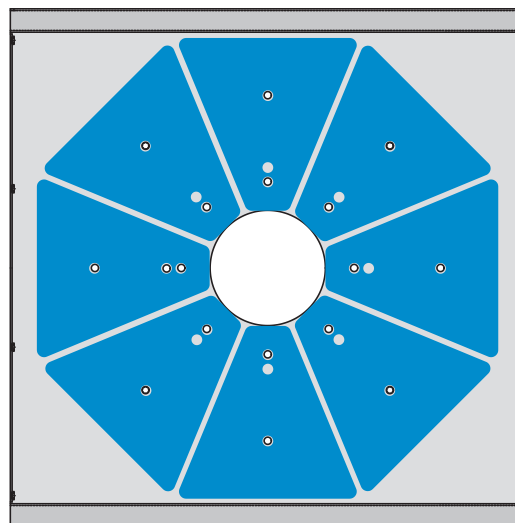
The 13 Inch diameter area of the base is the true load bearing surface. None of the other exterior portions of the chassis should be used for mounting to jigs or fixtures.

■ Rubber Pads

A package of 8 triangular rubber foot pads are provided with the LT360EX. Depending on how you intend to mount the LT360EX, you may or may not wish to use the optional pads.

If you intend to bolt the LT360EX directly to other rigging or fixtures, it is probably best not to use the feet. This will allow you to bolt the base of the LT360EX directly to your fixture without the rubber pads between the interface. This will make the joint more rigid.

If you will be using the LT360EX on the floor, then the rubber feet can be applied to the bottom of the unit.



Accessories

■ LR360 Remote

The LR360 remote provides a means to control the LT360EX turntable manually from a remote location. It provides a duplication of the front panel switches and display which can be useful if the LT360EX is located in a difficult to see or operate location. In most cases the user will likely be operating the LT360EX via computer. However the LR360 provides a backup control method if necessary for certain applications. The LR360 interface uses a standard PS2 cable (Mini-DIN6), a standard 50ft cable is supplied.



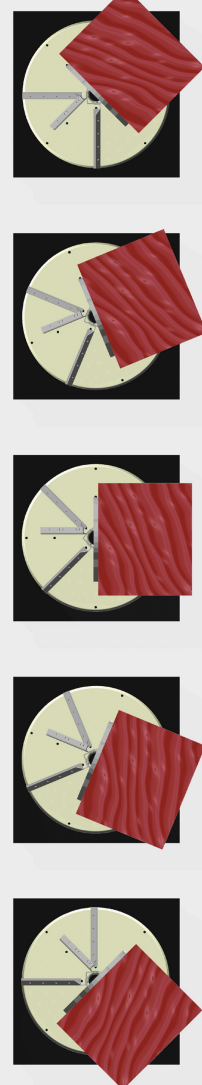
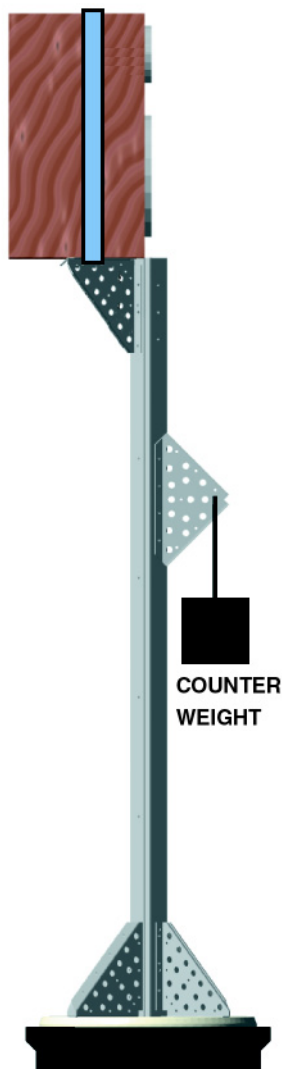
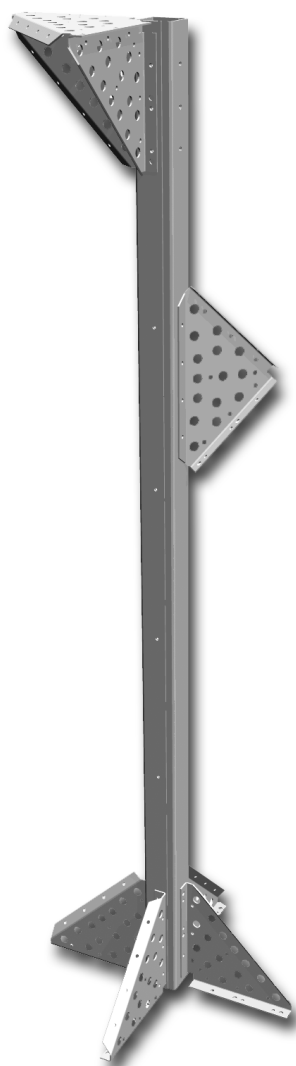
■ TS360 Stand

The TS360 turntable stand mounts directly on the LT360EX Precision Turntable. It provides a quick and convenient means for obtaining polar acoustic field data on loudspeakers, horns, enclosures and other similar devices.



The TS360 was specifically designed to enable offset rotation, thereby permitting rotation relative to the center of the baffle board, rather than the center of the enclosure. This is a common requirement as measurements are often related to the front surface of the enclosure or device.

Gated or time windowed measurements can be used to produce quasi anechoic data typically down to 200Hz. Polar measurements on small and medium size devices generally do not have much significance below these low frequencies, since the polar response becomes omnidirectional.



LT360EX Electrical Specifications

Control Panel

Switches	(8) Momentary Push Buttons
Display	4 Digit, 7-Segment, 0.56 Inch
Memory	Nonvolatile, retention >40 years
Microprocessor	48MHz, ARM-7, 32-Bit MCU

USB Interface

Class/Rev	Low Speed, 1.5Mbps, USB-1.1
Connector	Type-B

RS-232 Interface

Baud Rate	9600 default, 57600 max
Configuration	DCE (use straight thru cable)
Connector	Sub-D 9 Pin Female

Digital Input

Input Impedance	100k Ω
Pulse Polarity	Pos or Neg
Threshold	TTL, LVTTTL, 1.5V, Vth 0.75V
Pulse Width	2us Min
Connector	BNC Jack

Analog Input

Input Impedance	1M Ω
Scale Factor	10mV / Degree
Unipolar Range	0 to +3.600V for 0 to 360°
Bipolar Range	-1.800 to +1.800V for -180° to +180°
Pull-up Current	5uA
Driving Source Z	200 Ω Max Recommended
Connector	BNC Jack

Analog Output

Output Impedance	< 1 Ω
Scale Factor	10mV / Degree
Unipolar Range	0 to +3.600V for 0 to 360°
Bipolar Range	-1.800 to +1.800V for -180° to +180°
Output Current	40mA Max
Short Duration	Unlimited
Connector	BNC Jack

Microstepping Controller

Drive	High Frequency Bidirectional PWM
Frequency	20kHz Switching Regulation
Power Stage	Discrete, Dual H-Bridge
Microstepping	16 Microsteps with controlled Accel
Coil Current Max	7.5A Peak / 5.3A RMS (per coil)

Power Supply

Power/Type	50W, Universal PFC SMPS
Line Voltage	World-Wide 85-265VAC, 50/60Hz
Line Current	Sinusoidal, Power Factor > 0.9
Switching Freq	Multiphase Flyback, 300kHz
Standards	IEC 60950/61010, UL-1950
	CISPR-22, FCC Class-B,
Connector	IEC-320 Universal Inlet

LT360EX Mechanical Specifications

Main System

Operation	Mount any orientation, Ta 0° to 40°C
Platter	Cast & Machined Aluminum, A713
Base	Cast & Machined Aluminum, A713
Bearing	125mm Ball Bearing, C2 Clearance
Hub	80mm Diameter, 20mm Wall
Axial Load	1,000 lbs (450 kg) Max, Bidirectional
Radial Load	300 lbs (136 kg) Max
Drive System	Irreversible Worm Drive
Scale	Accurate Screen Printed 1 Degree
Chassis	16ga Steel, Black Textured Polane

Drive System

Motor	NEMA-23 100mm Stepper Motor
Controller	Bipolar Microprocessor Microstepping
Direction	Either Counterclockwise or Clockwise
Shaft	0.375 Inch Dia, Steel 1040
Worm	0.75 Inch SAE 4340 Hardened Steel
Worm Gear	5.75 Inch SAE 65 Cast Iron
Bearing	Sealed Ball Bearings ABEC-1
Torque	100 Newton•Meters (74 Foot•Pounds)
Velocity	0.1 to 12 RPM, Programmable
Acceleration	Shaped, controlled by Microprocessor
Resolution	0.0015625 Degree
Step Size	0.1 Degree Min
Backlash	0.07 Degrees Typ, 0.20 Degrees Max
Origin	User Resettable

Center Through Hole

Diameter	1.5 Inches (38mm)
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Platter Dimensions

Height	0.75 Inches (19mm)
Diameter	16.0 Inches (406mm)
Mounting Holes	(4) 1/4-20 on 3.0 Inch BCD (76.2mm)
Mounting Holes	(8) 1/4-20 on 9.0 Inch BCD (228.6mm)
Mounting Holes	(8) 1/4-20 on 15.0 Inch BCD (381.0mm)

Chassis Dimensions

Height	3.3 Inches (84mm)
Width	18.0 Inches (457mm)
Length	18.0 Inches (457mm)
Base Diameter	13.0 Inches (330mm)
Mounting Holes	(8) 1/4-20 on 6.0 Inch BCD (152.4mm)
Mounting Holes	(4) 1/4-20 on 12.0 Inch BCD (304.8mm)

Overall Dimensions

Height	4.1 Inches (104mm)
Width	18.0 Inches (457mm)
Length	18.0 Inches (457mm)
Weight	40 lbs (18 kg)



Contact factory or visit our web site for a list of International Dealers.

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Supplied Software

- LT360 USB device driver (SYS)
- LT360 USB user interface (DLL)
- LT360 Application Program (Win32)

Computer Interface Requirements

- Windows® 9X, 2000, XP, Vista, W7
- 10MB free Hard Drive space
- 32MB RAM Memory or more
- Pentium-III / 100 or equivalent
- USB port for control interface, or
- COM serial port for control interface, or
- Generic USB or RS-232 host system.

