



**MTS Proposal and Quotation
for
Components to support the development of a mutiaxial seismic table
at
EUCENTRE Pavia**



Quotation Number:	DGT01102016
Quotation Date:	January 14, 2016
Valid Until:	March 30th 2016
Customer:	EUCENTRE Pavia
Customer Contact:	Dr. Alberto Pavese
Inquiry Number:	
MTS Contact:	Dewey Tinderholm
	Application Engineer
	Email: dewey.tinderholm@mts.com Tel: 952-937-4202
Shipment Schedule:	Ship 8 months after order
Shipment Terms:	FCA Eden Prairie, MN per Incoterms® 2010
	(per Incoterms, 2010)
Payment Terms:	40% on order, 60% on shipment, Net 30 days
Equipment Packed For:	Ocean Transport

Prepared by: Dewey Tinderholm
Application Engineer

Forward MTS System Corp.
P.O. to: 14000 Technology Drive
Eden Prairie, Minnesota
55344

The parties expressly agree that the purchase and use of Material and/or Services from MTS are subject to MTS' Terms and Conditions, in effect as of the date of this document, which are located at <http://www.mts.com/en/about/terms/> and are incorporated by reference into this and any ensuing contract. Printed Terms and Conditions can be provided upon request by emailing MTST&C@MTS.com

PLEASE NOTE: PRIOR TO PLACING AN ORDER, YOU MUST FIRST NOTIFY MTS IF THIS ORDER IS: (A) FOR ULTIMATE END-USE BY THE U.S. GOVERNMENT OR (B) BEING PAID FOR WITH U.S. GOVERNMENT FUNDING.



Introduction

MTS is pleased to offer the following proposal and quotation for components to be integrated by the EUCENTRE Pavia.

It is assumed that MTS is supplying components only to EUCENTRE requirements and is not proactively involved in the Systems Engineering. Systems Engineering refers to the overall system design, interaction between sub-systems, final system control and operation.

There are several system level activities that will need to be considered but are not included in this offer. Please note some of the examples below:

- System Layout
- Facility interface drawings
- System Hydraulic Schematic
- System Control Schematic
- Actuator Interface design evaluation
- System Hazard Analysis
- Design and manufacture of circuitry necessary to interface with hydraulic power supply
- Installation planning
- Field Service participation in system integration
- System Controls Set-up
- Control mode tuning
- System operation
- Trouble shooting of system performance

As system integration is a core competency MTS would be happy to help EUCENTRE in this area. At this point, MTS and EUCENTRE have agreed to address this with a time and material solution to allow EUCENTRE to manage this content. The Assumption and Responsibilities matrix included in Appendix 1 is meant to clarify roles and responsibilities.

It is assumed that the EUCENTRE will procure the components from MTS in two phases; Phase 1 will include:

- MTS will provide modification drawings to EUCENTRE Pavia so they can rework their two existing 200 Ton vertical actuator assemblies. MTS will also provide the servo valve manifolds and servo valves for these two actuators. EUCENTRE Pavia will do the appropriate machining, procure and install the displacement transducer, assemble and test the re-worked actuators.
- MTS will provide two additional 200 Ton vertical actuators of the new design. It is important that all four of the actuators perform the same.
- Hold Down Actuators (quantity 2) and a remote control manifold that provides for servo control to adjust the hold down pressure. EUCENTRE Pavia will provide accumulation required and hoses as necessary to connect these actuators.
- Control Electronics and MTS Seismic Simulation Control Software

It is MTS' Understanding that EUCENTRE will incorporate these components to achieve a configuration similar to that shown in the following figure.

Phase 1

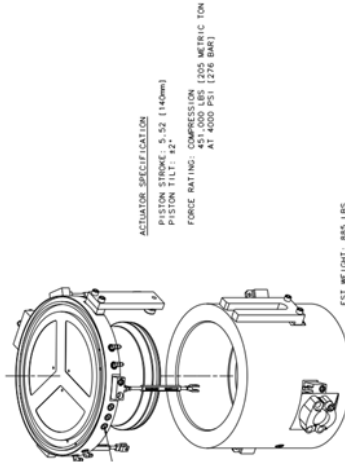
Hold Down Actuators

2 actuators with swivels will be supplied. These will be gas over design with a nominal length of 2.6 meters at mid stroke. Each is rated at 1250 kN downforce (tension). EUCENTRE will provide accumulation.

Shake Table designed and manufactured by EUCENTRE

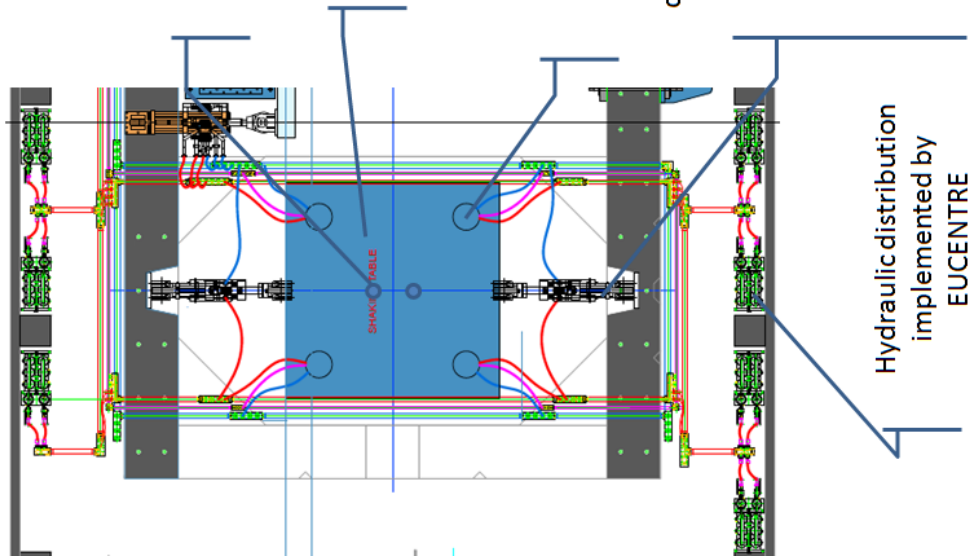
Vertical Actuators:

EUCENTRE will Re-work 2 existing actuators to add S/V and displacement measurement per MTS supplied documentation. MTS will design and build 2 new actuators

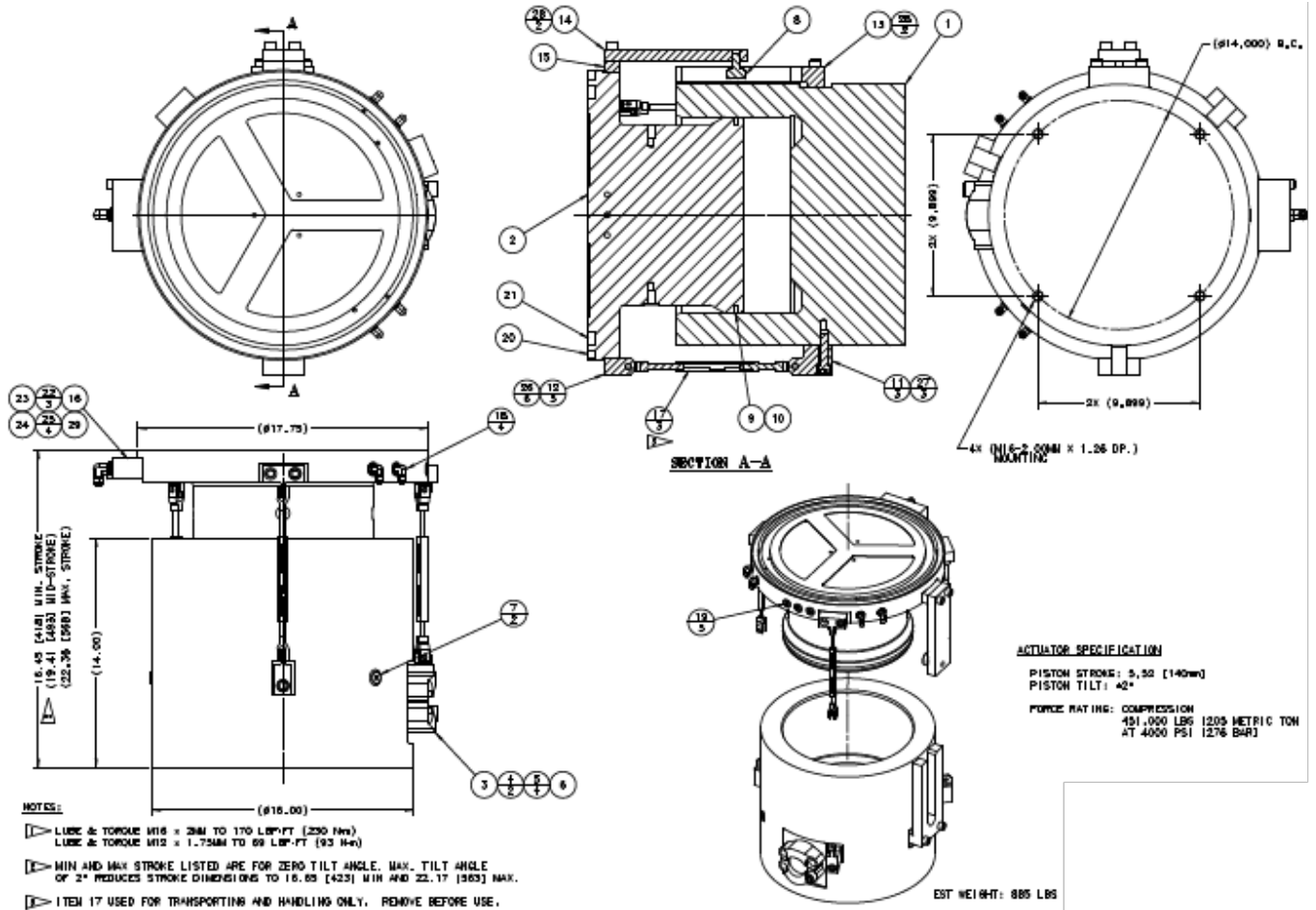


Horizontal Actuators to be provided by EUCENTRE

Note: These actuators are rated for 3000 psi. EUCENTRE will also implement the yaw and y displacement restraint



1. Vertical Actuators



EUCENTRE owns 2 vertical actuators that are configured as shown in the drawing above (MTS Part Number: 100-160-710. MTS will redesign the actuators to add a center mounted displacement transducer and a servo valve (256.250).

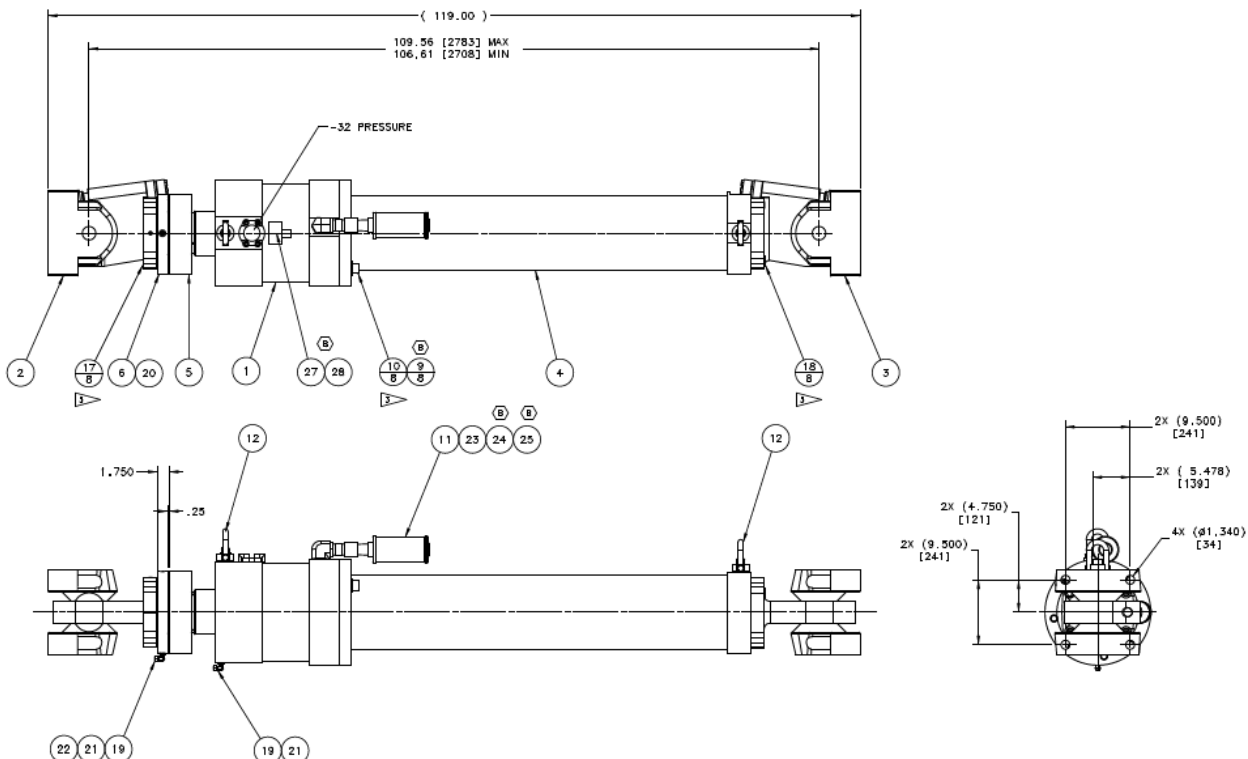
MTS will provide revised component drawings for the portions of the actuator which will need to be modified to convert the original actuator to the new configuration. EUCENTRE will be responsible for modifying the existing components to the new configurations. MTS will provide new 256.250 servo-valves which EUCENTRE will install on the existing actuators.

MTS will provide two (2) new additional actuators of the same configuration for the system. The new actuators will be configured with the center displacement transducer and the servo-valve as the modified actuators.

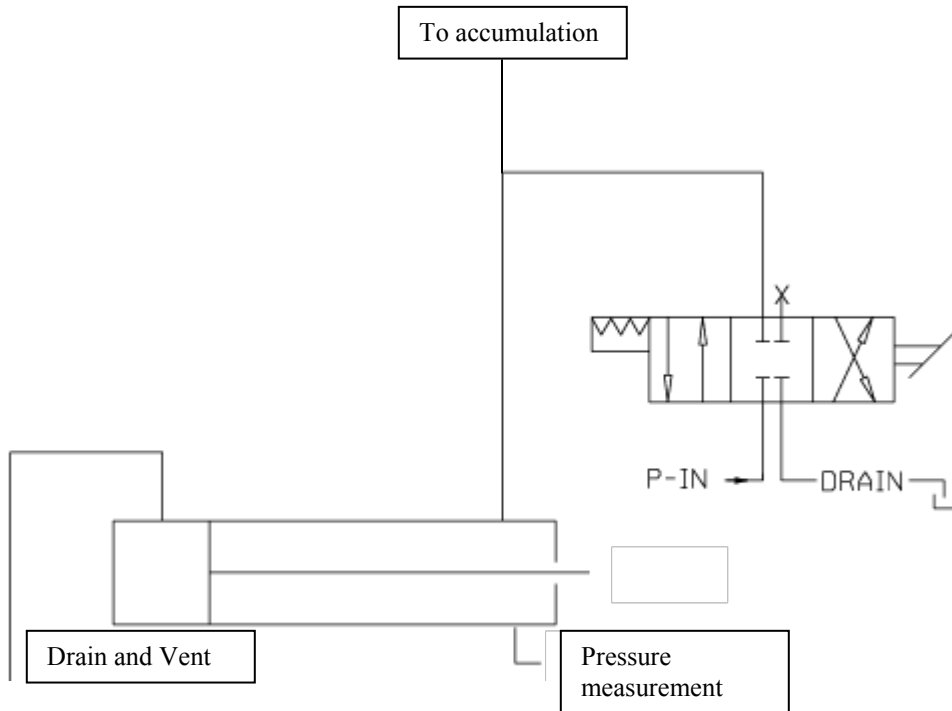
2. Hold-Down Actuators

MTS will provide quantity two (2) gas over oil hold down actuators similar to the configuration shown in the following figure. EUCENTRE has specified that each actuator must have a tension force capacity of 1250 kN, an actuator length such that the pin to pin distance is 2600 mm at the mid stroke position, and a displacement range of +/-125 mm (minimum). The oil pressure and compensation for leakage in the hold down actuators is managed via a remote servo valve. MTS will supply this servo valve and associated manifold which will need to be integrated by EUCENTRE.

EUCENTRE will provide the accumulation required to minimize the force variation within the range of motion of the table and all hoses or hydraulic distribution to install and operate these actuators.



The Schematic in the following diagram shows how the hold down actuator is intended to function.



3 Electronic Control System

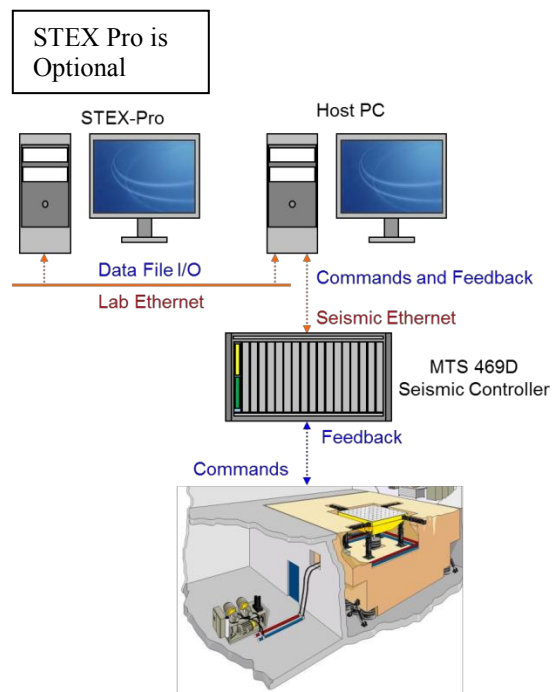
3.1 MTS Seismic Controller

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Model 494 / 469D Seismic Controller

Controls architecture





Control Electronics

The control architecture will be configured to control the 10 possible channels:

- 4 vertical actuators
- 4 horizontal actuators
- 2 hold down actuators (pressure control not dynamic force control)

The MTS 494 controls will include:

PC Hardware (with latest commercial options tested by MTS)
Windows 7 operating system with Microsoft Office

MTS 494 Digital Controller Electronics Hardware

MTS 494 electronics chassis

Dual Digital Universal Conditioners for Actuator Stroke
Digital Valve Drivers for Actuator Servo valves
Dual Digital Universal Conditioners for Actuator Delta-P
Dual Digital Universal Conditioners for Table Acceleration

Cables

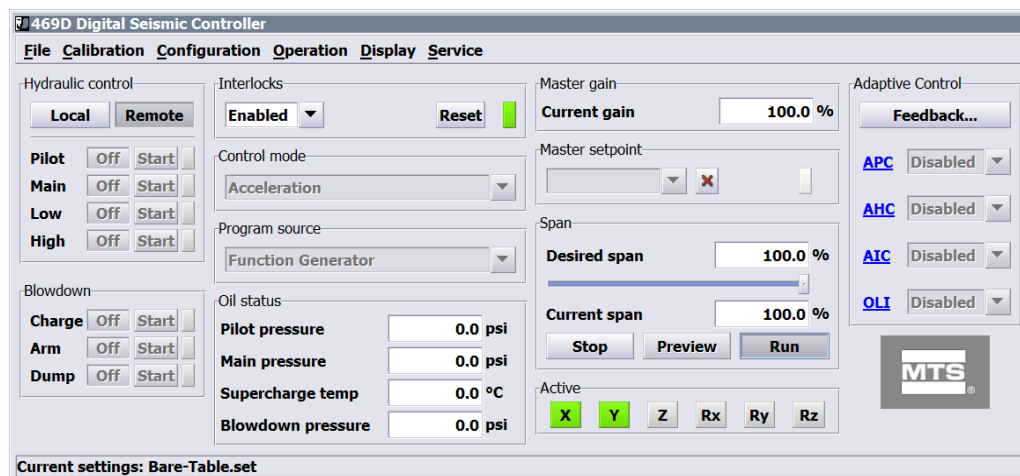
Actuator cables (10 sets 30 meter cable length)

Note: The MTS offer includes cabling for the actuators only. The customer is to provide cabling for any other system transducers, or for interfacing to emergency stop or hydraulic distribution functions for the system.

UPS module

MTS 469D Seismic Digital Controller Software

MTS Seismic Digital Control software provides an advanced graphical user interface (GUI) with full functionality provided for system tuning, test set up and operation, table data acquisition, and advanced high level adaptive control for high fidelity earthquake waveform reproduction.



Main Control Panel

The control software includes the following set of high level control techniques:

Command Function Generation, test wave forms that can be generated by the internal function generators include:

Cyclic: Square, triangle, and sine with adjustable amplitude and frequency. Sine sweep and dwell capability is also provided. Sine step programming with frequency or time specification.

Random: Bandlimited and shaped noise with adjustable RMS amplitude. Shapes include flat, $(1/f)^2$, $(1/f)$, f , $(f)^2$.

File: Any file of arbitrary points can be played out. Quadratic interpolation is used to upsample to the control update rate. The file can be generated using MTS STEX-Pro Software (see below), other commercially available data analysis packages or selected from the many thousands of earthquake time histories available in the research community. MTS supplies file player data format interfaces to MATLAB; therefore, allowing the use of many complex function generation operations, such as sine beat, mixed sine and random, decaying sine, multiple sinusoids, etc.

Data Display: A number of internal and external signals are available for display for monitoring and diagnostic purposes. These include table command and feedback in displacement, velocity, and acceleration. Signals can be observed in the following manner;

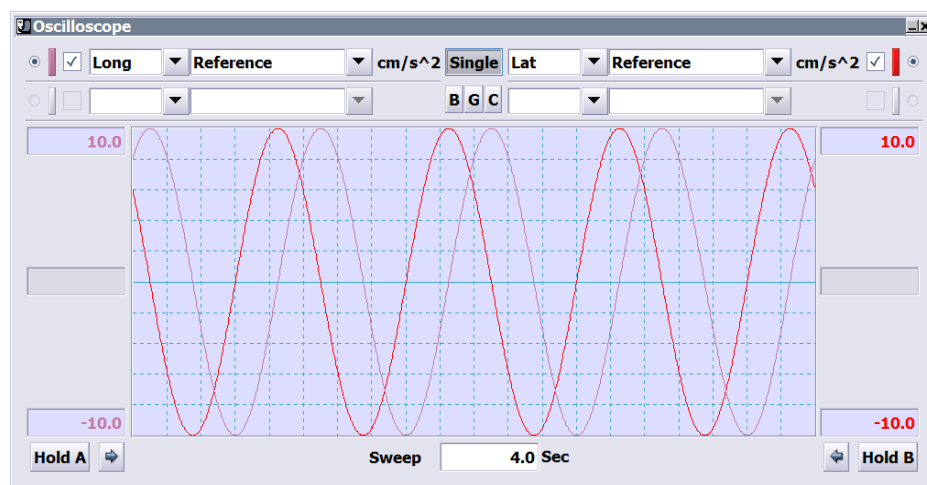
Digital oscilloscope: Displays two signals simultaneously on the computer screen in real time.

Signals can be shown in time, frequency, or phase (X-Y) domains.

Digital meter: Displays the current value of a signal, its maximum and minimum achieved values, and its peak and valley achieved values.

Digital Frequency Response Function Plotter: Used to display one or two transfer functions in phase or amplitude versus frequency. This display is extremely useful for test setup.

In addition, a time- & date-stamped status log is maintained of all machine operations limit detector trips, etc. The log is maintained on disk and can be examined at any time.



Oscilloscope – Data Display



Additional functionality: The control system software and Graphical User Interface provide the user with the ability to perform a number of very important functions.

Data acquisition of all internal and external signals to a digital file is provided. A file translator is also provided to convert from the acquired binary format to a text format suitable for transfer to many other analysis packages. There is a special interface function supplied for MATLAB that allows MATLAB to read these specific data files.

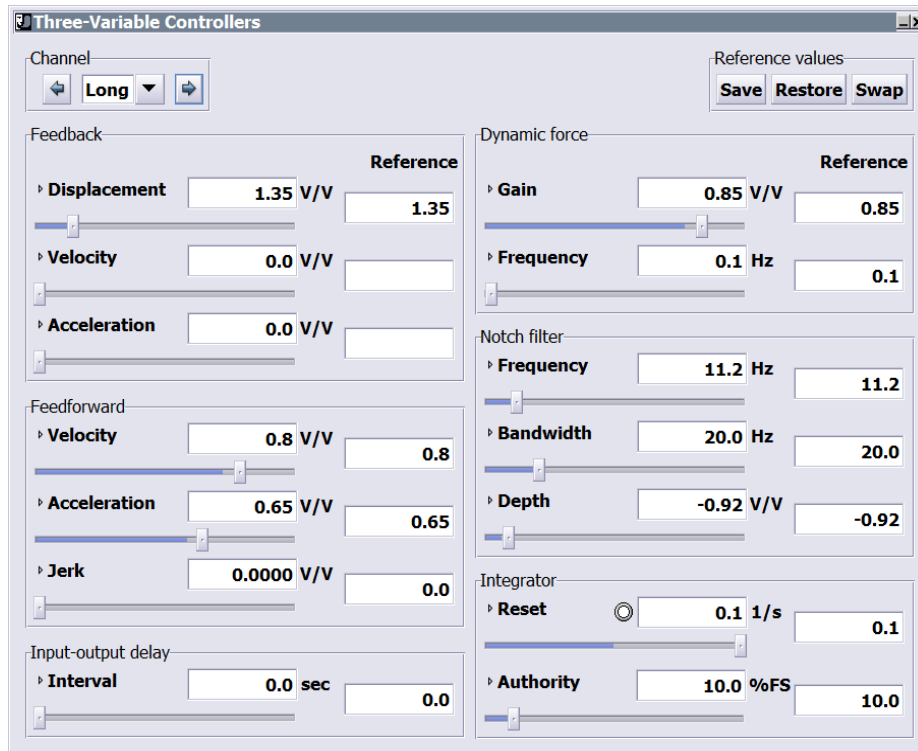
All electronic hardware is accessed through the graphical user interface for purposes of calibration. All calibration parameters can be stored to a digital file.

A test parameter file can be created to record the test specific settings for a given test. These may include settings of the function generator, system gain, TVC settings, among others. Multiple test parameter files can be stored.

Any internal or external signal can be used for limit detection purposes. The signal, action to be taken, upper and lower limits, and persistence are selected through the GUI.

An access protection password system allows only qualified operators to change critical system parameters to protect the system from unwanted changes.

Three Variable Control (TVC) for high fidelity reproduction across a wide band width. TVC includes a reference generator and velocity computer for deriving command and feedback signals in displacement, velocity, and acceleration. TVC is necessary due to the wide bandwidth associated with seismic time histories.



Degree of Freedom Control (DOF) for controlling the table motion in the coordinate domain rather than the actuator domain. The table motion is a result of eight (8) independent actuators which must be time synchronized to achieve the desired motion. DOF Control accomplishes this synchronization by transforming all individual actuator feedback signals into a DOF feedback signal. Each degree of freedom composite error signal is then transformed into individual actuator commands. Stability and tuning are greatly improved for systems operating in the coordinate domain as compared to the actuator domain.

Delta Pressure Stabilization (DPS) for effectively dampening oil column compliance to allow for higher gain settings across a wider bandwidth. The ability to maintain high gain settings without decreased stability is critical for high fidelity seismic waveform reproduction.

The following set of patented MTS Adaptive Control Techniques is included with the system controls:

Depending on the signal being optimized, different techniques are more effective.

PROGRAM SHAPE	SYSTEM LINEARITY	
	LINEAR	NONLINEAR
SINUSOIDAL	Amplitude-Phase Control (APC)	Adaptive Harmonic Cancellation (AHC)
NON-SINUSOIDAL	Adaptive Inverse Control (AIC)	Online Iteration (OLI) or STEX

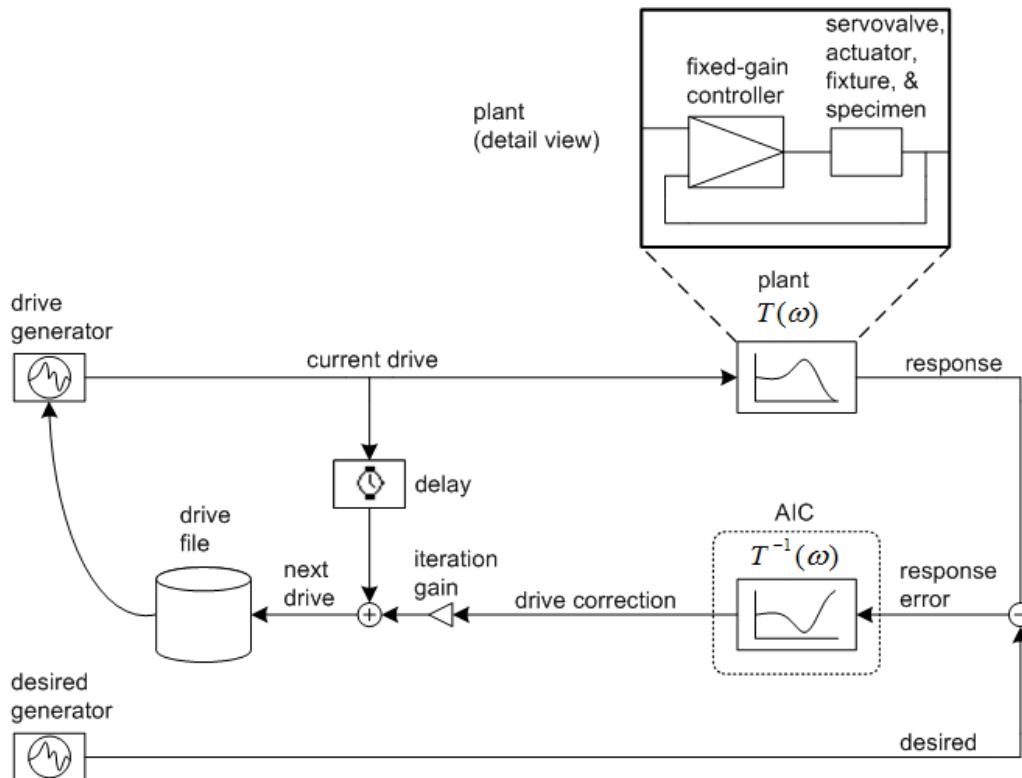
Amplitude Phase Control (APC) for automatic correction of amplitude and phase errors during sine wave testing. A network of time domain digital filters measures the system input and output to detect errors in amplitude and phase. The input signal is then automatically scaled by the inverse of the amplitude error and shifted by the negative of the phase error. APC quickly reacts to changes in the system to maintain minimal error in amplitude and phase even when changing system dynamics are present.

Adaptive Harmonic Cancellation (AHC) for control and elimination of harmonic distortions during sine wave testing. AHC is based upon the technologies developed in the science of active noise cancellation. AHC automatically eliminates unwanted harmonics by adding a signal with exactly the right phase and amplitude such that the harmonic is canceled. AHC automatically adjusts to changes in the system or specimen response.

Note: Amplitude Phase Control and Adaptive Harmonic Cancellation can be used simultaneously for reducing linear and non-linear errors when performing sine wave testing.

Adaptive Inverse Control (AIC) for reducing linear distortions during random wave form testing. AIC uses a digital filter to measure the frequency response function of the system. The command signal is then scaled by the inverse of this function so that the overall frequency response is closer to unity. AIC automatically adjusts to changes in the system or specimen response.

On-line iteration (OLI) On-line iteration corrects the command to achieve the desired response in real time. It is particularly useful in very nonlinear situations.



Project flow and Deliverables:

Upon completion of design of the component, MTS will submit drawings showing the external dimensions and interface details (Hole patterns, flatness specifications, etc.) to EUCENTRE Pavia. EUCENTRE Pavia will approve this information and MTS will begin manufacture. Expediting this process is critical in meeting the delivery schedule. The components will be then be manufactured and delivered to EUCENTRE Pavia for integration by EUCENTRE into the system.

Phase 1 Price:

740,000 USD

FCA Eden Prairie, MN per Incoterms® 2010

Payment terms: 40% on order 60% on Delivery - Net 30 days.

Delivery: MTS will have the equipment available for shipment 8 months after receipt of order.

This proposal is based on the following statement with regard to terms and conditions.

The parties expressly agree that any subsequent proposal and purchase order for use of Material and/or Services from MTS are subject to MTS' Terms and Conditions, in effect as of the date of this document, which are located at <http://www.mts.com/en/about/terms/> and are incorporated by reference into this and any ensuing contract. Printed Terms and Conditions can be provided upon request by emailing MTST&C@MTS.com



Options:

Option 1: MTS STEX-Pro Base Package

15,000 USD

The base package allows the user to import an ASCII earthquake file, edit the length, calculate the ASD and Statistics to determine the bandwidth of control necessary and to measure an FRF and do iterations to reproduce the earthquake on a seismic simulator.

Table Programming

STEX-Pro supplements the real time MTS 469D Digital Controller by providing additional table programming capabilities. The researcher can work from a single package which has been designed with input from seismic researchers over the past 3 decades. Tests can be programmed for data acquisition only, system frequency response measurement, and the execution of time history and compensated test waveforms.

Off Line Iterative Compensation

STEX -Pro provides an off line iterative test compensation method for reducing nonlinear distortion during earthquake time history and random wave form testing. A low level random signal is used to excite the table/specimen system and measure the frequency response function. The frequency response function is then used to modify the original drive file. The modified drive file is then executed and the achieved motion is compared to the desired. The process of measuring the frequency response function and modifying the drive file is repeated until the required level of matching between desired and achieved motions is attained.

Base STEX Pro includes the following tools:

STEX Pro Tools
ASCII conversion
Channel Extract
Cut
Header Modification
Import
Sequential Excitation
SimulateDG
SimulateRA
Spectrums
Statistics



Option 2: STEX PRO Premier Package

35,000 USD
Must purchase Base STEX Pro

The STEX Pro - Premier Package provides a comprehensive set of common application tools for seismic testing. These tool sets support enterprise-wide activities by providing better integration and easier sharing of simulation information across analytical and experimental activities. Advanced editing, analysis and simulation tools are included in this package.

STEX Pro Premier extends the capability to include the assessment of seismic events in the form of Shock Response Spectra and allows the creation of Seismic test waveforms from published Shock response spectra used in Seismic qualification testing. In addition, included are a comprehensive set of time and frequency domain tools for capturing a much greater understanding of both the seismic waveforms as well as responses of the test specimen. One particular tool that is very valuable is the Time History Motion Conversion tool that will compute the missing derivatives or integrals of Newtonian motion. For example if one has an earthquake time history in an acceleration format, this tool will compute the velocity and displacement waves associated. This allows one to compare the test rig capability in terms of velocity and displacement to the demand of the seismic event to make sure it will fit.

Other tools like channel FRF can be useful to measure transmissibility from table to specimen for example.

STEX Pro Premier includes the following tools:

STEX Pro Premier Tools	STEX Pro Premier Tools (Cont.)
Amplitude Spectrum	Message Tool
Ascii conversion	Plotter Utility
ASD Prediction	Rainflow
Batch Processor	Random TH Generation
Channel Extract	Region Scale and Offset
Channel FRF	Remove Mean
Channel Transformation	Remove Offset
Coherence	Resample
Compress	Save Project
Control Band Calculator	Sequence Editor
Control Band Estimator	Sequence Reporting
Convolution	Sequential Excitation
Copy, Rename, or Delete	Shape
Cut	Shock Response Spectrum
DOF Transformation	Signal Processing Calculator
Edit Time History Data Flags	SimulateDG
Export	SimulateRA
File History Viewer	Simultaneous Excitation
Filter	Sine Wave Generation
FRF	Single Probability Density
Header Modification	Spectrums
Import	SRS Conversion
Impulse Response	Statistical Editor
Inv. Shock Response Spectrum	Statistical Region Selection
Inverse	Statistics
Joint Probability Density	SVD
Levelcross	Taper
MATLAB Interface	Template Management
Matrix Editor	Time History Concatenation
Matrix Math	Time History Math
Matrix Normalization	Time History Motion Conv.
Matrix Smoothing	Time History Report
Merge or Append	Time Shifting



Option 3 PC for STEX PRO

4,500 USD

MTS will supply the current MTS Tested Version of PC to host the STEX Pro Software. The PC loaded with the STEX Software. It will also include a 24 inch monitor.

Option 4 System Services

MTS has offered the components specified by EUCENTRE. Per EUCENTRE's request, MTS has not included a broad range of system services in this proposal such as System design; System Assembly, Start-up, operation and troubleshooting are available at MTS Standard pricing. It was agreed that this content would be managed in a time and material fashion to allow EUCENTRE Pavia to manage the content of these services to maximize value. MTS will offer a 10% discount on labor if EUCENTRE orders a block of 100 hours of consulting time.

ASG Service and Consulting Price List

For Services Performed in North America, Europe, and Asia

Effective January 5, 2015

Subject to change without notice All Prices in US Dollars

Service Description

Standard Service Rate

1. Service call by local MTS Advanced System Level Field Service Engineer

- Local MTS field service engineer on site time (4 hour first day minimum)

Monday - Friday 0800 to 1800 \$255 per Hour

Monday - Friday 1800-2400 + 25%

Monday - Friday after 2400 and Saturday + 50%

Sundays and Holidays + 100%

+Travel expense and Zone rates

2. System support call by MTS-Minneapolis based Systems Engineer

- MTS-Minneapolis engineer on site time (8 hour first day minimum)

Monday- Friday 0800-1800 \$275 per Hour

Monday - Friday 1800-2400 + 25%

Monday - Friday after 2400 and Saturday + 50%

Sundays and Holidays + 100%

+Travel expense and Zone rates

3. Engineering consulting at MTS-Minneapolis

Includes Mechanical Engineering, Electrical Engineering, Software Engineering, and Project Management.

- (1 hour minimum)

Monday- Friday 0800-1800 \$275 per Hour

Monday - Friday 1800-2400 + 25%

Monday - Friday after 2400 and Saturday + 50%



Sundays and Holidays + 100%

+Travel expense and Zone rates

4. Diagnosis, repair, or assembly technician labor performed at Customer Site

- MTS-Minneapolis technician on site time (8 hour first day minimum)

Monday - Friday 0800 to 1800 \$255 per Hour

Monday - Friday 1800-2400 + 25%

Monday - Friday after 2400 and Saturday + 50%

Sundays and Holidays + 100%

+Travel expense and Zone rates

5. Diagnosis, repair, or assembly technician labor at MTS-Minneapolis

Includes Mechanical, Electrical, and Transducer technician labor.

- (4 hour minimum)

Monday - Friday 0800 to 1800 \$205 per hour

Monday - Friday 1800-2400 + 25%

Monday - Friday after 2400 and Saturday + 50%

Sundays and Holidays + 100%

+Travel expense and Zone rates



Zone Charges

MTS uses a concept called zone charge to calculate travel charges for services rendered by Field Service Engineers (FSE) or Minneapolis based employees. A zone charge covers MTS employee travel time to and from the customer site and normal operating expenses (i.e., automobile, per diem, and lodging as required), excluding air, ferry, or train fares. MTS will make every effort to provide services from the closest service office and communicate the expected zone charges. However, MTS reserves the right to provide and charge for services from another zone to meet customer schedule requirements.

Travel Expense Rates

Zone Charges - Ground or Air

Zone	Distance	1st Day	Each Additional Day*
1	1/2 hour one way	\$191	\$191
2	1 hour one way	\$331	\$331
3	1.5 hours one way	\$518	\$518
4	2 hours one way	\$657	\$290
5	2.5 hours one way	\$818	\$290
6	3 hours one way	\$983	\$290
7	3.5 hours one way	\$1,139	\$290
8	4 hours or more one way + Airfare	\$1,304	\$290

Zone Charges - Ground or Air

Zone	Distance	1st Day	Each Additional Day*
9	To European Sites + Airfare	\$2,639	\$326
10	To Asian Sites + Airfare	\$3,581	\$326

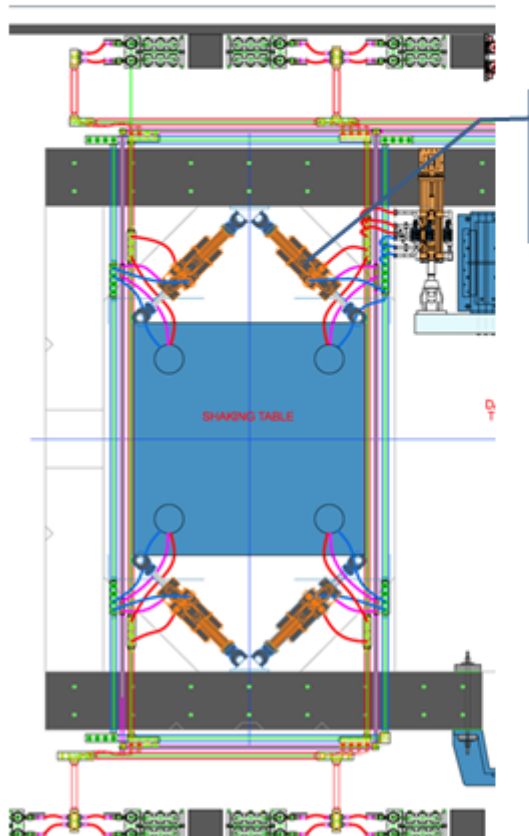
ASG Service and Consulting Price List

MTS will offer a 10% discount on labor if EUCENTRE orders a block of 100 hours of consulting time.

3. Phase 2

EUCENTRE plans to purchase future hardware change the horizontal actuator configuration. The purpose of this is to add the other horizontal (Y) axis of control. At this point the final configuration is envisioned to be configured as shown in the following figure.

Phase 2



Replace existing horizontal actuators with new design. This could be either the Bayonet Design or a double ended design based on a traditional model 244 actuator.

MTS will design and provide the actuators per EUCENTRE Specification. Currently EUCENTRE is evaluating whether a bayonet design actuator with shorter overall length will be required. The alternative is a horizontal actuator design based on MTS model 244 actuator design. The information below needs to be refined as the system design evolves.



Budgetary Guidance for Horizontal Actuators

This information was provided earlier and has not been refined since those discussions

Budgetary guidance for Actuators based on standard MTS 244 actuator design: Approximately 650,000 – 700,000 USD

Budgetary Guidance for Actuators based on bayonet design: Approximately 1 million USD