Special Specification 6336
Bridge Lighting DMX Control System

1. DESCRIPTION

Furnish, fabricate and install bridge lighting DMX 512 (digital multiplex) control system. A bridge lighting DMX control system is the complete assembly of central and remote electronic controllers, interfaces, wiring, DMX field wiring, all fixture connections, control cables, converters, communications equipment, enclosures, brackets, power supplies, mounting hardware, mounting supports, foundations, components, software, hardware and programming constituting a complete and operational lighting control system.

2. MATERIALS

Provide all new materials that comply with the details shown on the plans, the requirements of this Item and the requirements of the following items:
- Item 616, "Performance Testing of Lighting Systems,"
- Item 618, "Conduit,"
- Item 620, "Electrical Conductors," and
- Special Specification, "LED Decorative Bridge Column Lighting."

The lighting DMX control system must be fully compatible and operational with the LED Decorative Bridge Column Lighting fixtures. The DMX controlled system must offer web-based control of light intensity as detailed in the control intent and product performance specifications below.

2.1. Definitions.
- System - the configuration of one or more show controllers.
- Fixture - a controllable entity with one or more attributes.
- Attribute - a parameter of control such as Intensity, Pan or Gobo select.
- Group - a selection of Fixtures that can be stored and recalled.
- Trigger - a single point of control to the System (e.g. contact closure, serial command, etc.)
- Actions - items of functionality that can occur within a running system in response to events (e.g. Start Timeline, Set Intensity, etc.)
- Timeline - a series of connected steps referencing control with timing information.
- Effects - Attribute settings that result in continually varying levels following a specified curve and using additional timing parameters (e.g. period, offset, etc.)

2.2. Control Intent.

The basis of all lighting control fixture communication is ANSI E1.11 – USITT DMX512-A: Asynchronous Serial Digital Data Transmission Standard for Controlling Lighting Equipment and Accessories. System design and cable installation must conform to the published ANSI E1.11 standard requirements.

Each "Universe" includes 512 control addresses, may have a maximum of 32 devices which must be in line, and must be terminated end of line. Refer to ANSI Standard E1.11 for more detailed information.

The system design allows for 1 address per controlled fixture. All fixtures will be addressed individually to allow for control of each fixture independently. The system design allows for 2 universes of control (1024 addresses) in the complete system.

The system must be expandable to control additional fixtures and more universes of control with the addition of more show controllers.
2.3. **Performance.**

Control devices must be web based, with capability for scheduling, programming, and firmware updates. All components of the lighting control system will use Remote Device Management (RDM) throughout the entire control system design. The lighting control system will be capable of remotely addressing each fixture without physically going to each fixture location on the bridge. It is the responsibility of the fixture manufacturer and provider to ensure that the fixtures are RDM compatible to the industry standard.

Scheduling must be available as a 7 day, 365 day yr. real time and astronomic time clock, adjusted for local longitude/latitude, and automatically adjusts times for daylight savings. Scheduler must be available for individual days with a 365 day capability, with the option to schedule events on a specific day, or on a repeating schedule of daily, weekly, or monthly, as well as for specific times or as related to sunrise/sunset. Multiple timelines and trigger events and inputs must be possible with advanced logic (if/then command structure) as an absolute requirement. Schedule clock must be able to be updated over the internet using Network Time Protocol (NTP), and continue to operate when external power is absent.

Enclosures provided by the Lighting Control System Integrator (LCSI) must be NEMA 4 rated. LCSI is required to provide at a minimum at 400BTU thermoelectric solid state industrial quality heating/cooling device to provide a minimum 20°F difference in ambient temperature.

All electronic components in the lighting control system must be ruggedized industrial quality solid state as much as possible for high reliability in a harsh environment. Operating software will be stored in a dedicated non-removable non-volatile solid state memory. Show Data will be stored in non-volatile solid state memory which is removable for purposes of backup or disaster recovery.

2.4. **Programming Requirements.**

It is understood that programming will take place at night, after hours, to be able to see results of the lighting programming. The Electrical Contractor will have personnel available if requested in advance during any time programming is scheduled.

Network installation with connectivity and assigned IP addresses must be completed prior to entire system completion and design programming.

2.5. **Control Hardware.**

2.5.1. **General.**

The Controller must be a microprocessor-based system specifically designed for control of lighting and other related systems in an architectural or entertainment application. A personal computer running emulation software will not be acceptable.

The Controller will store show data in non-volatile solid-state memory. This memory must be removable for purposes of backup or disaster-recovery.

Show data may be downloaded from a personal computer over an Ethernet or USB connection.

The Operating Software of the Controller will be stored in a dedicated non-removable non-volatile solid-state memory. It must be possible to update the Operating Software by download from a personal computer over an Ethernet or USB connection.

The Controller must commence show playback automatically on receiving power without additional external inputs.

The Controller must have an internal real-time clock that continues to operate when external power is absent. It must be capable of adjusting for Daylight Saving Time automatically and can be updated over the Internet using the Network Time Protocol (NTP).

The Controller must be able to calculate sunrise and sunset times based on longitude and latitude information, and use these as triggers for events.

The Controller must have a capacity of 1024 channels of DMX512 with RDM.
The Controller will output control data as ETCNet2, Philips KiNet, Pathway XDMX and Art-Net II protocols with one protocol active per output, in lieu of DMX512 output.

There must be visual indicators on the Controller showing status of the controller and its interfaces.

The Controller must operate a web server on its Ethernet interface. This will allow status information, control and configuration options to be accessed remotely.

The appearance and content of the web interface may be customized by the user.

The Controller must allow lighting to be programmed as separate zones, with independent triggering and manual intensity control.

The Controller must support multiple timelines, crossfades and effects running concurrently.

The Controller must support up to two expansion modules for support of other interfaces or protocols, including DALI, audio and linear timecode.

The Controller must support multiple remote modules connected via Ethernet for support of additional show control interfaces, such as contact closures, analog inputs, relay outputs and serial.

The Controller must have a recessed switch for resetting the unit without removal of power.

The Controller must have an internal security feature that will restart the unit in the event of program failure.

Multiple Controllers will automatically synchronize and share triggers when programmed as part of a single show and linked via Ethernet during playback.

The Controller must support conditional logic and execute user-defined Lua (multi-paradigm programming language) scripts to support advanced show control operations.

The Controller must be provided with a 5 yr. manufacturer warranty.

2.5.2. Mechanical.

Enclosure and mounting must comply with DIN43880 and EN60715(35/7.5) respectively.

The controller must be an 8 unit DIN enclosure (143.5mm x 90.0mm x 58.0mm).

The controller must be entirely solid-state with no moving parts, fans or hard disc drives.

2.5.3. Electrical.

The Controller must be able to receive power over Ethernet as an alternative to direct DC power (IEEE 802.3af PoE powered device).

The Controller must be designed to support the following wire terminations:

- 9V to 48V DC Power,
- Isolated DMX512 Out, RDM-compatible (2),
- Isolated Digital Inputs (8, tri-mode: active high, active low or contact closure), and
- Plug-in rising clamp terminals must be provided for all connections.

In addition there must be the following standard connectors:

- RJ45 socket for 10/100Base-TX Ethernet,
- USB-B Socket for USB 1.1,
- 9-pin D socket for isolated RS232 serial input/output 5-pin DIN socket for MIDI In,
- 5-pin DIN socket for MIDI Out, and
- 25-pin D socket for Expansion Modules.

2.5.4. Thermal.

The controller must operate in a temperature range from 0°C to 50°C (32°F to 122°F).
2.5.5. Software.

The Controller will be supported by programming software running on a PC platform.

Programming features must include:
- Comprehensive architectural and automated fixture library,
- Drag and drop placement of fixtures on plan,
- Drag and drop patching of fixtures to output addresses,
- Import of any media for mapping to fixture arrays,
- Timeline based programming and playback,
- Extensive range of editable effect presets,
- Drag and drop placement of effect presets and media on timeline,
- Variety of triggering options for firing system-wide events,
- Each trigger event may be configured to initiate one or more lighting or show control action,
- Each trigger event may be configured to test one or more conditions before executing its actions,
- Simulation of individual timelines, and entire project with triggers,
- Live output from software for programming verification purposes,
- Controller and network management tools,

2.6. Configuration and Control Software.

2.6.1. System Configuration.

The application interface must be based around (i) a tree-view; (ii) a workspace area; (iii) item selector.
There must be a 2-dimensional plan view that displays the layout of the project.
It must be possible to represent data about the workspace area graphically (plan) or in tabular form.
Items displayed on the plan may be arranged using drag-and-drop interaction.
Plan views must support zoom.
Plan views must support a layout grid with user-defined spacing and color with associated snap-to-grid functionality.
There must be an auto-backup feature.
It must be possible to add Fixtures by selecting a Fixture Template from the provided library and create custom Fixtures.
It must be possible to create a fixture layout based on data imported from a defined documentation format (e.g. CSV).
There must be provision for help functionality to be accessed from within the application.
It must be possible to import images as a background image to the plan view.

2.6.2. Channel Configuration.

There must be functionality to patch channels to DMX and/ or Ethernet Protocols including ETCNet2, Philips KiNet, Pathway XDMX and ARTNET.
There must be support for Channels with split patches (e.g. VL5).
It must be possible to swap pan and tilt axes for a moving-light Fixture.
It must be possible to invert pan and tilt axes for a moving-light Fixture.
It must be possible to specify a minimum and maximum value for an Attribute.
It must be possible to specify a default value for an Attribute.
2.6.3. **Design and Simulation.**

There must be independent control of every Attribute of a channel or fixture.

It must be possible to create Groups as a selection shortcut.

The plan must show simulation feedback for Channels in a graphical form. It must be possible to simulate control events.

The simulation may be linked to the actual online System to synchronize playback and inject control events.

2.6.4. **Timelines.**

Timelines may be displayed and modified in linear form.

Timelines may be set on an individual Attribute basis.

All timelines may include split timing.

Timelines will be applied based on priority.

It will be possible for all timelines to include effects.

The end state of a timeline must be user configurable.

2.6.4.1. **Triggers.**

It must be possible to trigger actions using external trigger or individual events; set conditions for each trigger; specify timed events, including repeat intervals such as daily, weekly etc.; and specify astronomical timed events.

Serial input data must be treated as a trigger and must be handled as a standard or custom action.

2.6.5. **Actions.**

There must be standard Actions:

- for starting, stopping, pausing and resuming timelines;
- to set timeline intensity;
- to set timeline position;
- for working with external triggers connected to Expansion Modules.

It must be possible to initiate custom scripts as Actions.

2.6.6. **Local Network.**

Must report status of Processors and Stations.

Must allow for configuration of network properties (IP) of Show Controllers.

Must allow for upload of configuration data to all or individual Show Controllers.

Must allow for download of configuration data from Show Controllers.

Must allow for download of logging data from Show Controllers.

Must provide for performing firmware upgrades to Show Controllers.

Must allow for discovery of connected Show Controllers.

Must support an integrated web server for connectivity and control of programmed timelines.

2.7. **Management Software.**

The Lighting Control System must include dedicated software for managing multi-controller installations with the following features:

- Allow for updates to configuration files and media content.
- Support scheduled configuration upload allowing automatic updates outside normal operating hours.
- Automatically reconnect and resume file upload if connection is lost.
- Retain existing project for automatic restoration if upload is unsuccessful, maintaining system operation.
- Support alerts and password management.
- Allow access to controller web based interface.

2.8. DMX Repeater.

The eDIN DMX/RDM Repeater Module must permit star-wiring and repeating of DMX512 and RDM signals over the connected DMX cabling.

The Module must fully isolate and protect DMX transmitters and receivers, and RDM controllers and responders from high common mode voltages, ground loop currents and other potentially damaging or disrupting electrical faults.

The Module must have one input port, one pass-thru port and four output ports. All ports must be bidirectional.

There must be no in-line processing of the input signal, to ensure that all output signals are exact duplicates of the input signal with no processing delays.

The Module must be designed to mount on standard 35mm DIN rail.

LED indicators must be provided for Power, Data-In and CPU status, as well as for DMX/RDM activity on each of the four output ports.

The Module must be capable of regenerating four (4) exact duplicates of the original source input signal. Each regenerated output signal must have the same characteristics and capabilities of the input signal.

Each output must be capable of driving up to 32 DMX/RDM responding devices over a maximum 300-meter (1000-ft.) length of cable.

One (1) DMX/RDM pass-thru port must be provided. The pass-thru port must be active, i.e. electrically repeated.

The Module itself must act as an RDM responder.

It must be possible to field-update the module firmware via the DMX/RDM input port.

Multiple modules, up to the RDM-specified limitation of four (4), may be cascaded (looped) on the same DMX/RDM input data line using the pass-thru port or any output port.

All DMX/RDM input and output ports must be capable of withstanding short-term application of up to 250V without damage to internal components.

Port protection must be self-healing, rated for 250V. Replaceable fuses will not be acceptable.

The DMX input port must provide 1500-volt optical isolation between the input signal wiring and output signal wiring.

DMX output ports must be fully optically isolated from each other. The DMX/RDM Repeater module must be designed to snap on to 35mm DIN rail without the use of tools.

The ambient operating temperature must be -10°C to 50°C (14°F to 122°F). The operating humidity must be 5% - 95% non-condensing.

The DMX/RDM Repeater Module must meet the requirements of USITT DMX512 (1990), ANSI E1.11 DMX512-A and ANSI E1.20 RDM.

The DMX/RDM Repeater Module must be compliant with the EU RoHS (2002/95/EC) directive. The DMX/RDM Repeater Module must conform to all FCC and CE requirements.

The DMX/RDM Repeater Module must be a Class 2 Low Voltage device.
2.9. **Enclosures.**

Provide prewired NEMA 4 enclosure which will be completely exposed to the elements. Enclosure is to contain all lighting control system components required for a complete lighting control solution, including but not limited to: show controller, DMX repeaters, router, and Ethernet switch. Each enclosure to be tamper resistant. Each Enclosure to include surge suppression for all lighting control equipment. Each Enclosure to be heated/cooled with an industrial quality solid state thermoelectric cooler with a minimum 400BTU rating. Enclosures must be lockable and tamper resistant. Electrical contractor must coordinate any additional equipment which will need to reside in the LCSI provided enclosure to ensure sufficient space is available: specifically, any network equipment requiring protection and cooling. Provide 4 sets of submittals of fixtures, controls, and mounting provisions to the TxDOT Area Office at 7479 Bagby Ave, Waco Texas 76712. Obtain all pertinent approvals on the submittals before purchasing materials and beginning work. Provide manufacturer's warranty for each DMX Control System that will replace failed components or parts for a period of five years from the purchase date. Meet EIA-485 industry standard. Provide a minimum 2 universe DMX control system. Provide software and software licenses necessary to implement the scenes shown on the plans. Provide optical isolation for each universe. Isolation may be in gateways, opto-isolation amplifiers, or other electronic devices. Furnish and install enclosures as shown on the plans. Alternate arrangement and supports may be approved by the TxDOT Area Office. Furnish enclosures and auxiliary equipment such as insulation, ventilation, air conditioning, and heating strips, that provide the environmental requirements of the equipment and electronic components installed. Provide enclosure drain. Submit shop drawings on enclosure and auxiliary components to the TxDOT Area Office for approval.

3. **CONSTRUCTION**

Perform work in accordance with the details shown on the plans and the requirements of this Item. Use established industry and utility safety practices when installing equipment located near overhead or underground utilities. Consult with the proper utility company before beginning work. Coordinate conduit layout and mounting design with the respective fabricator. Replace damaged components.

3.1. **Installation.**

Furnish and install Bridge Lighting DMX Control and connect each lighting assembly to the DMX Controller as shown on the plans. The Department may shift an assembly's location, if necessary to secure a more desirable location or to avoid conflict with utilities. Install cables, conduit, j-boxes and other equipment necessary for fixture connection in a manner that minimizes visibility from pedestrian and roadway traffic. Contractor is to ensure that all parts and pieces are installed to make a complete and functional Bridge Lighting DMX Control System that is in full communication with all components of Special Specification 6XXX LED Decorative Bridge Column Lighting. Program controls initially will be for solid colors with additional scenes as directed by the Engineer. Control manufacturer’s representative will conduct a minimum two (2) hours on-site preconstruction meeting with the contractor and the Engineer to review data wiring, installation, and integration of LED fixtures with the control system components. Manufacturer’s representative will provide on-site programming and commissioning of the system. Commissioning will include verification and approval of environmental features in place for the purpose of
controller manufacturer’s warranty enforcement. Commissioning will verify that fixture channel assignments match the plans and that each fixture or fixture segment is operational. Ensure that control system provided properly operates all fixtures provided.

Provide a minimum of four (4) hours on-site training at each cabinet location by manufacturer’s representative for Department maintenance personnel. Training will cover DMX512 controller programming and maintenance issues to the satisfaction of the Engineer. Test installed DMX lighting controls in accordance with Item 616, “Performance Testing of Lighting Systems.”

4. MEASUREMENT

This Item will be measured as each Bridge Lighting DMX Control System is complete and in place.

5. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” will be paid for at the unit price bid for “Bridge Lighting DMX Control System.” This price is full compensation for furnishing, installing, DMX controls to each and all fixtures shown in the aesthetic lighting plans; Fixture connections, DMX cables, terminators, splices, and splitters; central and remote electronic controllers, interfaces, wiring, control cables, converters, communications equipment (including internet access and fees), enclosures, brackets, power supplies, mounting hardware, mounting supports, foundations, components and hardware constituting a complete and operational lighting control system; training; meetings; coordination with bridge fabricators; programming and any initial support. Internet access and fees will be paid for by the City of Waco.

New conduit will be paid for under Item 618, “Conduit.” New electrical conductors will be paid for under Item 620, “Electrical Conductors.” New ground boxes will be paid for under Item 624, “Ground Boxes.” New electrical services will be paid for under Item 628, “Electrical Services”. New decorative light assemblies; j-boxes, and brackets will be paid for under Special Specification “LED Decorative Bridge Column Lighting.”