Special Specification 6099
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, control cables, converters, communications equipment, enclosures, brackets, power supplies, mounting hardware, mounting supports, foundations, components and hardware 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"
- Special Specification 6104, "LED Bridge Pedestrian Pole Lighting Assembly"
- Special Specification 6105, "LED Bridge Arch Lighting Assembly"
- Special Specification 6106, "LED Bridge Flood Lighting Assembly"

2.1. **Design.**

2.1.1. **Option 1:** Electronic Theatre Controls Mosaic Control System;

2.1.2. **Option 2:** Traxon Butler Control System; or

2.1.3. **Option 3:** Approved equivalent according to the following specifications:

The lighting DMX control system offers web-based remote control of color-changing, DMX controlled bridge lighting fixtures as detailed in the control intent and product performance specifications below.

2.1.3.1. **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.)

2.1.3.2. **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, is limited to 1000 ft. cable length, 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 3 addresses per controlled fixture (red, green, and blue). Fixtures may have duplicate addresses and so be controlled together.

The system design allows for 2 universes of control (1024 addresses) per bridge, with a total of 14 universes (7168 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.

The system will have the ability to independently control each bridge so that color effects may be placed to “roll” over the whole length of the highway.

Each fixture mounted on a bridge strut will be independently controlled.

Fixtures on the bridge arches must be independently addressed on a fixture by fixture basis giving discrete control approximately every 18 in.

The inside facing fixtures on each bridge arch must be controlled together, approximately every 18 in. for a total of approximately 101 fixtures each run and 303 addresses.

The outside facing fixtures on each bridge arch must be controlled together, approximately every 18 in. for a total of approximately 101 fixtures each run and 303 addresses.

2.1.3.3. **Performance.**

Control devices must be website based, with remote internet upload capability for scheduling, programming, and firmware updates. Web-based integration for system troubleshooting and remote error reporting is required. It will not be necessary to travel physically to each bridge location for programming changes; except in cases of failure of the internet connection or electronics failure, tampering, or vandalism.

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.

The lighting control system will use 1 master controller to contain the scheduler. The master controller will trigger individual controllers at each bridge location via wireless radio. If the wireless radio link is lost and an individual bridge does not receive the daily scheduled control trigger, each individual controller will have the capability to run a default program instead.

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.

2.1.3.4. **Programming Requirements.**

Initial programming will be for 1 calendar yr., with default and special event days provided by owner's rep for the entire calendar yr. Event timing will be provided by the owner's rep: sunset to sunrise, or specific time of day events.

Programmer will provide a total of (4) Default Seasonal Timelines, (5) Sports Event Timelines, (12) Holiday/Special Event Timelines, and (4) Additional Special Events TBD by owner's rep at time of programming. LCSI will also program 16 static colors which may be scheduled.

Each timeline may be scheduled only once (for example Halloween, occurring only on the day of), or multiple times (for example "Patriotic," occurring on Memorial Day, Flag Day, Veteran's Day, and 4th of July), or for a defined period of time (for example Breast Cancer Awareness Month). The owner's rep is responsible for defining the schedule calendar, and which events are to happen at which times. In case of no input from the owner within 1 week of the scheduled programming, LCSI must submit a suggested calendar for approval by owner. Lacking information about city festivals and sports events, the suggested calendar will contain only standard known holiday events.

Default Seasonal Timelines will play daily absent any other special scheduled event.

Defined Default Seasons: Spring, Summer, Fall, Winter.

Defined Sports Events: Texans, Astros, Rockets, Dynamo, Dash.

Defined Holiday/Special Events: Valentine's Day, St. Patrick's Day, Earth Day, Halloween, Thanksgiving, Christmas, Go Texas/Rodeo, Patriotic, Breast Cancer Awareness, Autism Awareness, LBGT Pride, International Festival.

Four (4) Additional special event timelines may be used for additional events that the owner desires (for example the Super Bowl in 2017). Owner is responsible for supplying the system integrator with all information about the additional special event programming: color, any moving effects, timing, and any details about the finished desired effect.

The Lighting Consultant will work with the Owner to provide the LCSI with the design information needed to program all Event Timelines: what each scene should look like on each bridge. Renderings are extremely helpful, as well as sketches, written descriptions, or any other information to convey design intent.

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.

LCSI will attempt to program ahead of time as much as possible the Event Timelines. Given sufficient input from the Lighting Consultant and owner, it is possible to rough in quite a bit of programming in advance of onsite time, at the least setting up the defined timelines. LCSI is responsible for budgeting sufficient time on site to accomplish the programming of all defined event timelines.

As each bridge is finished, LCSI will test and verify complete and working installation and upload a default program to run until such time as the installation is completed and the entire system is commissioned and connected together.

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

2.1.3.5. **Control Hardware.**

2.1.3.5.1. **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 remote 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 remote 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 playback of video media with individual pixels mapped to lighting fixtures in an array.

The Controller must support a full-duplex RS232 Serial Port and 8 local contact closures.

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 support multiple streams of timecode and audio data within a single networked system.

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.

2.1.3.5.2. **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.

2.1.3.5.3. **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.

2.1.3.5.4. **Thermal.**

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

2.1.3.5.5. **Software.**

The Controller will be supported by programming software running on either a PC or Mac 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,
- Export TSV reports for all aspects of programming.

2.1.3.6. **Configuration and Control Software.**

2.1.3.6.1. **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.

2.1.3.6.2. **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.

2.1.3.6.3. **Design and Simulation.**

There must be control of LED arrays supporting pixel mapping of static or video media in any Apple® QuickTime® supported file format.

There must be control of moving lights (as a type of Fixture).

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

Appropriate graphical controls must be provided for non-intensity Attributes (e.g. color picker).

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.

2.1.3.6.4. **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.

2.1.3.6.4.1. **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.

2.1.3.6.5. **Actions.**

There must be standard Actions:

- for starting, stopping, pausing and resuming timelines;

- to set timeline intensity;
- to set timeline position;
- for setting fixture color; and
- for working with external triggers connected to Expansion Modules.

It must be possible to initiate custom scripts as Actions.

2.1.3.6.6. **Network.**

Must report online 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 remote connectivity and control of programmed timelines.

2.1.3.6.7. **Reports.**

It must be possible to generate tabular reports; customize their layout and appearance; and to print reports.

2.1.3.6.8. **Resources.**

Effect Curves and Fade Profiles must use a common format and allow custom variants to be generated by the user; additional Fixture Templates may be defined by the user (custom Fixtures).

2.1.3.7. **Remote Management Software.**

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

- Allow for remote 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 remote connection is lost.
- Retain existing project for automatic restoration if upload is unsuccessful, maintaining system operation.
- Support email confirmation and alerts and password management.
- Allow access to controller web interface.

2.1.3.8. **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 bi-directional.

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.

2.1.3.9. **Radio Control System.**

Provide radio control modems and antennae suitable for transmitting trigger information from one master schedule show controller to each receiving show controller.

Radio Modem must be specifically designed for Serial-to-Serial (RS232/422/485) connectivity.

Radio Modem must be IP67 rated.

Radio Modem must be 900 MHz.

Radio Modem RF Properties: Physical Standard – 802.15.4

Frequency: 900 MHz ISM (902-928 MHz)

Transmit Power: 10,16, 25, 30, or 63 mW, software selectable

Receiver sensitivity: -100dBm

Over the air data rate: 250 kbps

Outdoor Range, Supplied Antenna: 1.5 mi

Outdoor Range, High Gain Antenna: 10mi

Transmission method: DSSS

Modulation: FSK

Channel Capacity: 12 Direct Sequence Channels

Network Topologies: Peer-to-Peer, Point-to-Point, Point-to-Multi Point

Encryption: 128bit AES

Supplied Antenna: 50ohm impedance, 3dBi gain, vertical polarization, 4.38 in. long

2.1.3.9.1. **Radio Modem Serial Properties.**

Data rate: 1.2 to 115.2 kbps

Data Bits: 8

Parity: None, even, odd, mark, space Stop Bits: 1 or 2

Flow Control: None or Software. Operating temperature: -40°F to 165°F

Operating Humidity: 0-95% non-condensing.

All Antenna must be supplied with Lightning Arrestor.

Transmitting antenna at master control location must be 50 ohm impedance, 900MHz directional with a minimum nominal gain of 6 dBd.

LCSI is responsible for providing antenna appropriate suited for reliable communication between master controller and receiving controllers.

2.1.3.10. **Enclosures.**

Provide prewired NEMA 3R enclosures to fit inside all steel bollard bridge locations.

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 radio transceiver.

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.

Provide two (2) Enclosures per typical single bridge location.

The Montrose double bridge location will require one additional enclosure, NEMA 4, which will be installed in the center of the 2 bridges and completely exposed to the elements.

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 for the data connection to the internet service provider.

Provide 2 sets of submittals of fixtures, controls, and mounting provisions to the Lighting Designer at Gandy2 Lighting Design,1824 Spring Street, Studio 201, Houston, Texas 77007. Provide an additional 2 sets of submittals to the TxDOT District Engineer at 7600 Washington Avenue, Houston, Texas 77007. Obtain all pertinent approvals on the submittals before purchasing materials and beginning work.

Provide manufacturer's warranty for each bridge lighting assembly that will replace failed components or parts for a period of two yr. from the purchase date.

Meet EIA-485 industry standard. Provide a minimum 8 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 Lighting Designer and TxDOT District Engineer. 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 Lighting Designer and TxDOT District Engineer 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. Prevent scarring or marring of fixtures. Replace damaged components. Repair damaged painted areas of lighting assemblies.

3.1. **Installation.**

Furnish and install Bridge Lighting DMX Control. 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.

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 6104 LED Bridge Pedestrian Pole Lighting Assembly, Special Specification 6105 LED Bridge Arch Lighting Assembly, and Special Specification 6016 LED Bridge Flood Lighting Assembly.

Program controls initially as shown on the plans for review. Program additional scenes as directed by the Engineer.

Control manufacturer’s representative will conduct a minimum two (2) hrs. 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) hr. on-site training 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 a lump sum for Bridge Lighting DMX Control System.

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; DMX cable, terminators, splices, and splitters; conduit and j-boxes for DMX cables; central and remote electronic controllers, interfaces, wiring, control cables, converters, communications equipment, enclosures, brackets, power supplies, mounting hardware, mounting supports, foundations, components and hardware constituting a complete and operational lighting control system; training; meetings; programming and any initial support.