

Special Specification 6073

Model 170E Series Traffic Signal Controller, Cabinets and Related Equipment



1. DESCRIPTION

Furnish traffic signal control equipment.

2. MATERIALS

Furnish materials conforming to the pertinent requirements of the following Standard and Special Specification Items.

- Item 680, "Highway Traffic Signals"
- SS 6005, "Testing, Training, Documentation, Final Acceptance, and Warranty"
- SS 6006, "Electronic Components"

Ensure electrical materials and construction methods conform to the current National Electric Code (NEC) and additional local utility requirements. Ensure all materials and construction methods conform to the requirements of this Item and the following pertinent requirements:

- "Traffic Signal Control Equipment Specifications" published by the State of California, Business, Transportation & Housing Agency; Department of Transportation (CALTRANS), dated January, 1989, and all current addenda and Revisions. Department specifications will govern in case of conflict.
- The Underwriter's Laboratory Incorporated (UL)
- Electronic Industries Association (EIA)
- National Electric Code (NEC); the American Society for Testing and Materials (ASTM)
- American National Standards Institute (ANSI)
- NEMA Standard TS2-1992, or the latest revision

Provide cabinet assemblies and separate 170E Controllers from one single manufacturer listed on the most current CALTRANS "QUALIFIED PRODUCTS LIST" (QPL).

Provide a CALTRANS certification stating that the equipment is included on the most current CALTRANS QPL. Department specific equipment not defined in the CALTRANS Specification is exempt from the QPL requirement.

Provide Cabinet Verification Test Program and Controller Diagnostic Test Program.

3. EQUIPMENT

3.1. **332A Traffic Signal Controller Assembly.** Provide the following components:

- Model 332A Cabinet, 1 each
- P Base Adapter, 1 per cabinet
- Model 170E Controller Unit, 1 per cabinet (Modified with HC-11 CPU)
- Power Distribution Assembly 2 (PDA 2)
- Model 200 Load Switch, 16 per cabinet
- Model 204 Flasher, 6 per cabinet
- Conflict Monitor, 1 per cabinet

- Model 242 DC Isolator, 5 per cabinet
- Model 252 AC Isolator, 1 per cabinet
- Model 430 Flash Transfer Relays, 8 per cabinet (2 as power relays)
- Voice Modem, 1 per cabinet
- Fiber Modem, 1 per cabinet
- C40/RS-232 Cable, 3 per cabinet
- P20 Connector Cable, 1 per cabinet
- EDCO SHA-1210 Surge Protector, 1 per cabinet
- EDCO PC 642-008D Surge Protector, 2 per cabinet
- C2 and C20 Wiring Harnesses for Surge Protection

- 3.2. **Integrated Circuits (IC).** Provide plug-in type, fully socketed integrated circuit devices (chips), having 14 or more pins (not including resistor packs) in the Controller and Program Module. Do not solder chips or any other components to the pins. Use low insertion/ withdrawal LIF lock type sockets for PROMS, EPROMS, and EEPROMS. Solder in place integrated circuits of fewer pins.

Provide IC sockets in accordance with the following:

- MIL-S-83734
- Machined, not stamped
- Inner contact of Gold over Nickel-plated Beryllium-Copper
- Outer sleeve of Gold, over Nickel-plated, or Tin over Copper-plated-Brass
- Under Writers Laboratory rating of 94V-O
- AUGAT-800 (or approved equal)

- 3.3. **Cabinet Requirements.**

- 3.3.1. **Model 332A Basic Cabinet (66 in. X 24 in. X 30 in.).** Provide smooth and natural aluminum finish. Use CALTRANS Specifications. Incorporate a lower input termination panel.

Provide base mounted cabinet with an 8 phase, 4 pedestrian, and 4 overlap operations. Use CALTRANS Specification (TSCES-5) for base mounting anchor-bolt pattern.

Provide Auxiliary Model 420 Output File with a receptacle that receives its input power via a disconnect plug.

Supply wiring to the Conflict Monitor with a single unit, quick disconnect (such as a 15-pin Molex unit) within the auxiliary output file, with the female end of the quick disconnect on the auxiliary output file side.

Provide rear access panel of the auxiliary output file that aligns and reattaches properly after each removal.

Configure cabinet interior to accommodate 170E Traffic Controller equipment as the top mounted equipment in the rack.

P-Base Adapter. Provide P-Base Adapter constructed of the same materials and same finish as the cabinet in accordance with the following requirements:

- Foundation opening (bottom of the adapter) - 20 in. x 34 in.
- Cabinet opening (top of the adapter) - 15 in. x 21 in.
- Height - 8 in.
- Withstand a 100-lb. horizontal loading applied to the top of an installed 332A cabinet with less than 0.5 in. deflection measured at the top of the controller
- Drill bolt holes to accommodate the 332A cabinet. Provide bolt hole with a 1 in. x 2 in. slotted hole parallel to the side of the cabinet.
- Mount P-Base Adapter to the foundation using anchor bolt assemblies through flanges that are attached to the outside of the adapter.

- Supply all appropriate mounting hardware for each P-Base Adapter.
- Submit 6 sets of shop drawings for approval prior to manufacturing.

Police panel. Provide police panel placed in the top rear of the right side panel of the cabinet. Include a standard 1/4 in. phone plug jack and three switches labeled AUTO/FLASH, SIGNALS ON/OFF, and AUTO/MANUAL. Provide a manual police push button on a 6 ft. rubber cord that inserts to a standard 1/4 in. phone plug jack and is stored in the police panel. Apply "manual control enable" to the Controller and "recall" to all phases when push button is placed in the manual position. "Advance" Controller when push button is activated. Hardwire manual control enable to the C1 pin number 53. Prohibit manual advancement in the minimum green, yellow, and red timing intervals.

Provide 2 cabinet keys and 2 master police keys with a long shank.

Hardwire all output files. Do not use printed circuit boards except in the P20 board (red monitor) and conflict monitor unit. Align and reattach Output File rear access panel properly after each removal.

Drawer. Provide an aluminum shelf with integral storage compartment in the rack directly below the 170E Local Controller with telescoping drawer guides for full extension and permanently attach plastic laminate to compartment top. Do not use silicon adhesive.

Loads. Provide "Pedestrian-Yellows", along with 4 additional spare terminals, with "dummy loads" consisting of 1 K ohm resistors, each rated at a minimum of 10 watts. Mount "dummy loads" on a terminal block in the rear of the output file, inside the output file enclosure, and behind the back panel. Do not mount "dummy loads" on the field output wiring terminal strips located on the back panel. Do not mount AC return banks on the back panel. Wire 1 side of each "dummy load" to AC return. Provide easy method to jumper the outputs from the selected load switches.

Cabinet Fan Controls. Meet the following requirements:

- Provide cabinet fan control assemblies with a 2 position toggle switch that enables bypass of the fan's thermostatic control in addition to the requirements for manually adjustable thermostatic control and a fuse for fan circuit protection. Energize the fan independent of the thermostatic control on 1 position. Use the other position to utilize the thermostatic control to energize the fan. Provide easy access to the fan control assemblies with protection from provided hot leads.
- Mount the fan control assembly inside the top of the cabinet, on the rear cabinet side of the fan. Place the manual thermostatic control, fuse, and toggle switch assembly facing the rear of the cabinet and provide easy access with the open rear cabinet door.
- Provide rear light fixture with no interference when accessing the fan control assembly. Provide 2 fluorescent lighting fixtures, with lens covers, mounted on the underside of the top portion of the cabinet and 1 extra replacement bulb. Provide fluorescent fixtures that adequately illuminate the front and rear portions of the inside cabinet when either door is open. Provide cabinet lights that do not interfere with access to the cabinet fan's thermostatic control, fuse and bypass toggle switch assembly. Wire cabinet lights to the same breakers as the ground fault interrupter.
- Install door actuated switches to turn on the cabinet lights when either the front or rear door is opened.

Doors. Provide front and rear door catches that do not come in contact with, nor otherwise interfere with access to or operation of fluorescent lighting fixtures, door actuated switches for the lighting fixtures, and fan control assembly (toggle switch, thermostatic control and fuse).

Provide louvered vents in the front door with a removable disposable air filter for ventilation. Design and construct louvered vents such that a stream of water from a pressure head, such as a Rainbird or other type sprinkler, does not enter the cabinet. Provide four pleated media type air filters that pass a minimum of 60 cu.ft. of air per minute. Provide air filters that completely cover the vents and do not allow incoming air through the vents to bypass the filter. Secure one filter with bottom and side brackets and a spring-loaded upper clamp. Form bottom filter bracket into a water-proof sump with drain holes to the outside.

Detector Test Panel. Mount a plate, maximum 1-3/4 in. high with 12, 2 position, on-off switches, to the top of the EIA channel. Place NORMAL in the up position and CALL in the down position. Provide switch that will input a call to designated input file slots in accordance with BI-Tran 233 detector arrangement for 8 vehicular and 4 pedestrian phases. Provide C1 pin numbers for the vehicular and pedestrian phases as shown on Table 1:

Table1
C1 Pin Numbers

PHASE	PIN NO
1	56
2	39
3	58
4	41
5	55
6	40
7	57
8	42
P2	67
P6	68
P4	69
P8	70

Anchor Bolt Assemblies: Provide four assemblies, type RAWL, Size 3/4 in. x 4-1/4 in., Carbon Steel, Drill-3/4 in. or approved equal.

AC service input. Provide one MARATHON CAT NO. 1423307 assembly or approved equal for AC service input with terminal capability of accepting up to 1/0 gage wires.

3.3.2.

Surge Protection.

Provide devices to protect equipment from surges and over voltages. Place AC isolation terminals on the same side of the cabinet as the AC service inputs.

Provide capacity of the internal wiring and printed circuit board traces greater than or equal to the protecting threshold of circuit breakers and surge protectors provided for use during normal operation or short-circuit condition.

Provide two EDCO PC 642-008D surge protectors for the audio in and audio out communications pairs connecting to the Model 170E ACIA post-modem communications lines (for use with C2 and C20 ports).

Supply 2 wiring harnesses to connect each of the C-2 and C20 connectors to independent 12 wire, terminal strips on the side of the cabinet (i.e., a separate wiring harness and terminal strip for each of the C2 and C20 connectors). Include 4 conductors connecting the Audio In and Audio out pairs of the respective port to its (own) terminal strip with each harness.

Provide Power Distribution Assembly. Include a lightning/surge/transient protection unit on the AC Service Input that reduces the effect of lightning transient voltages applied to the AC line. Provide protector that is an EDCO SHA-1210 with external lugs and 2 stage series/parallel device. Mount protector on the lower side-wall of the cabinet positioned to minimize damage to other equipment should the unit explode. Minimize the lead lengths to the input power termination.

Provide protector with the following features and functions:

- Maximum AC Line voltage: 140 Volt AC.
- Twenty pulses of peak current, each of which will rise in 8 microseconds and fall in 20 microseconds to one-half the peak: 20,000 Amp.
- Epoxy-encapsulated in a flame retardant material
- Continuous service current: 10 Amps at 120 VAC RMS

Provide the following terminals:

- Main Line (AC Line first stage terminal)
- Main Neutral (AC Neutral input terminals)
- Equipment Line Out (AC Line second state output terminal, 10 Amps) to provide power to the Type 170E Controller, to the 24 VDC power supply, and to the conflict monitor
- Equipment Neutral Out (Neutral terminal to protected equipment)
- Ground (earth connection)

Separate the Main AC Line In and the Equipment Line Out terminals by a 200 micro-Henry (minimum) inductor rated to handle 10 Amp AC Service.

Place the first stage clamp between Main Line and Ground terminals; the second stage clamp between Equipment Line Out and Equipment Neutral.

Provide an MOV or similar solid state device, rated at 20 KA for the first and second stage clamp. Do not use gas discharge tubes.

Connect together internally the Main Neutral and Equipment Neutral Output. Provide an MOV (or similar solid state device, or gas discharge tubes) rated at 20 KA between Main Neutral and Ground terminal.

Provide peak clamp voltage of 250 Volts at 20 KA (Voltage measured between Equipment Line Out and Equipment Neutral Out terminals. Current applied between Main Line and Ground Terminals with Ground and Main Neutral terminals externally tied together).

Provide output voltage not to exceed 280 Volts.

3.4. **Controller Unit Model 170E.**

Provide a Model 170E Controller Unit as specified in CALTRANS Specification, with modifications as per this Specification.

Socket-mount all integrated circuits having 14 pins or more as described in Sub article 3.B "Integrated Circuits" of this Specification. Provide low insertion/withdrawal LIF lock type sockets for PROMS, EPROMS, and EEPROMS.

Do not use a battery in the 170E Controller.

Provide a HC-11 CPU with a 68HC11 microprocessor.

Provide the front face of the controller with a flush mounted 9-pin female, RS-232 connector that is connected to the C40 port for PC communication (modified controller mother board).

3.5. **Power Distribution Assembly No. 2 (PDA No.2).**

Provide a Power Distribution Assembly No. 2 as specified in the CALTRANS Specification for Assembly and modified as follows:

- Provide dual flash transfer relays mounted on the back, fold down panel of the PDA No. 2, next to the Controller Unit Receptacle instead of a mercury contact relay rated at 60 amp.
- Provide individual flash transfer relays as specified in Section 3.12 "Model 430 Flash Transfer Relay"
- Provide easy access for maintenance purposes. Provide rear access panel fold down panel of the PDA No. 2 that aligns and reattaches properly after each removal.

Provide 2 sets of shop drawings showing the configuration of the flash transfer relays for this function.

- 3.6. **Model 200 Load Switch.** Provide a MODEL 200 LOAD SWITCH meeting or exceeding the CALTRANS Specification.
- 3.7. **Model 204 Flasher.** Provide MODEL 204 FLASHER, meeting or exceeding the CALTRANS Specification. Provide cabinet with slots for 2 flashers that blink alternately even when the powered up cabinet is not in flash mode in order to indicate that they are operational.
- 3.8. **Conflict Monitor.**

Provide conflict monitor that meets or is fully downward compatible with the CALTRANS 210 specification and monitors the following:

- Red, Yellow, and Green status of at least 16 channels
- Provide the red channel into the monitor through a 20-pin connector (P20 Connector) on the front panel to provide compatibility with existing City of El Paso conflict monitors. Provide remaining signals into monitor through its 56 pin card edge connector as defined by CALTRANS Specifications.
- 16 channels and ability to display the status of each channel
- Watchdog Timer signal from the 170E Controller
- 24 volt cabinet power and displays an error if the 24 volt supply is below 18 volts
- Allows the BND, Green/Yellow, Polarity, and Yellow Time (1, 2 and 3) functions to be set via hardware switches

Provide one P20 connector for each conflict monitor. Provide protection on the P20 connector pins to prevent shorting the monitor when inserting it into the cabinet.

Provide capability to continuously scan a diode card for allowing compatible channels and identify the channels causing a failure and type of failure after the intersection has been placed on flash by the monitor.

Provide monitor that is equal to, fully downward compatible and supports all the features of the EBERLE 210E CL conflict monitor unit currently in use by City of El Paso.

Provide Watchdog Timer (WDT) with: an indicator that lights the face of the monitor when a failure occurs; an operator-selected, 1 second or 1.5 second time out; a disable switch to disable monitoring the WDT signal from the 170E controller; and a flash WDT indicator when the display switch is activated.

Detect a Multiple Output Error if any channel has more than one indication on and generate a flash condition that is selected (on or off) on a per channel basis.

Detect a Red Enable error and display the appropriate channel and type of failure if the red enable is active and the channel that does not show any lights.

Detect and display sequence errors if a channel sequences improperly.

Detect a Short Yellow error if a yellow time is shorter than programmed into the monitor or is missing entirely. Select minimum yellow times by channel.

Omit the yellow segment of monitoring when the channel is used for pedestrian signals.

Record and store a log history of several different types of events. An event is any kind of an error or change in programming. Store 100 events with the most recent first and oldest last. Each event will contain the time of the event, the power line voltage, and the cabinet temperature as measured at the monitor, and the status of the field wire signal indications (i.e., R,Y, or G) for all 16 channels.

Communicate status and alarm functions to the 170E Local Controller. Provide a connector cable for communications between the monitor and the 170E Local Controller with the following requirements:

- 9 pin, male, RS-232 connector on one end that inserts securely into the monitor and the other end inserts securely into the 170E Local Controller's C30 port
- Attach cable internally to the cabinet in a manner that will not interfere with access to or the operation of any other equipment within the cabinet. Do not use adhesive, stick-on tie plates to attach cable.
- Provide three sets of cables, CDs, 3-1/2 in. high density diskettes and/or any other items necessary to communicate and program the conflict monitor (to include accessing the Log History, as per Sub article H.12 of this specification) using a standard IBM compatible PC. Provide hard copy of all software documentation.

- 3.9. **Model 222 Loop Detectors Amplifiers.** Provide Model 222 Loop Detector Amplifier Unit as specified in the CALTRANS Specifications. Provide 2 channel detectors.
- 3.10. **Model 242 DC Isolator.** Provide MODEL 242 DC Isolator unit as specified in the CALTRANS Specifications.
- 3.11. **Model 252 AC Isolator.** Provide a MODEL 252 AC Isolator unit as specified in the CALTRANS Specification. Provide each isolator with a test switch that operates properly in either the normal or reverse logic mode.
- 3.12. **Model 430 Flash Transfer Relay.** Provide a Model 430 Flash Transfer Relay unit as specified in the CALTRANS Specifications.
- 3.13. **Diagnostic Test Program.**
- Provide the cabinet and controller diagnostic test program on a separate set of EPROMS and installed on a program module. Provide 3 sets of EPROMS (6 total) and 1 set of program modules (2 total).
- 3.13.1.1. **Controller Test.** Provide features specified by the CALTRANS Specifications. Provide program that operates with Standard IBM compatible PC, Controller keypad entries and displays and tests the operation of the Model 170E Controller unit, including but not limited to, internal memory, the Program Module, the real-time clock, the 4 input-output ports and their circuitry, the display, and the keyboard.
- 3.13.1.2. **Cabinet Test.** Provide program to test cabinet wiring related to the output file, input file, police panel, and flash switches and verifies the operation of Cabinet.
- 3.13.1.3. **Fiber Modem Test.** Comply with Special Specification 6005, "Testing, Training, Documentation, Final Acceptance, and Warranty". Include the following testing for digital data performance.
- All necessary tests to ensure compliance with all of the requirements of EIA Standard 232. At a minimum, demonstrate data communications between each of the data channel units in the control center and the corresponding data channel units in the field.
 - Using a loopback plug at each EIA-232 channel terminating at a field location, conduct a 24 hour bit error rate test (BERT) for each channel using a data communications test set in the control center.
 - Certify that the EIA-232 channels can operate at a sustained rate of 9600 bits/sec (bps) for a 24 hour period with the error free seconds (EFS) no less than 99.98%. Use the 511-bit CCITT standard pseudo-random pattern for testing.
 - Correct problems if BER is exceeded on any channel. Restart BERT from beginning as if no previous BERT had been conducted. Prepare and deliver a report prior to re-testing if a component has been modified as a result of the subsystem test failure.
- 3.14. **Voice Modem.**
- Provide a voice modem in the internal modem slot for the C2 port for traffic controller network communications that is fully compatible with existing 496 GDI modems. Provide 2-wire half duplex and 4-wire full duplex communications that are switch selected between full and half duplex. Provide indicators on

the front of the voice modem to indicate Carrier Detect, Data Transmit, Request to Send, Clear to Send, and Data Receiver that meets or exceeds the following requirements.

- Operational at a distance of up to 20 miles with copper, 19 AWG, twisted pair, communication lines
- Data Rate: 0 to 9,600 baud modulation
- Modulation: Phase Coherent Frequency Shift Keying
- Data Format: Asynchronous, serial by bit
- Serial Interface: EIA RS-232-C and CCITT V.24 standards
- Frequencies: 11,200 Hz (MARK), 17,600 Hz (SPACE), and 7,800 Hz (Soft Carrier)
- Transmitting Output Signal Level: 0, -2, -4, -6, and -8 dBm; switch selected or adjustable
- Carrier Detect Threshold: +3 to -42 dBm
- Receiver Bandpass Filter that meets the error rate requirement specified below, and provides 20 dB/Octave, minimum active attenuation outside of the specified frequency range
- Clear-to-Send (CTS) Delay: Switch selected 6 or 12 milliseconds (+/- 2 milliseconds)
- Receive Line Signal Detect Time: Switch selected 4 or 8 milliseconds (+/- 2 milliseconds)
- Receiver Squelch: Switch selected, 3 or 6.5 milliseconds (+/- 2 milliseconds)
- Soft Carrier (7800 Hz) Turn Off Time: Switch selected 5 or 10 milliseconds (+/- 2 milliseconds)
- Modem Recovery Time: Receives data within 22 milliseconds after completion of transmission
- Error Rate: Not to exceed 1 bit in 100,000 bits, with a signal-to-noise ratio of 16 dBm, measured in the 9,900 to 18,900 Hz frequency range
- Anti-Streaming: Switch selected, Enable or Disable
- Power Requirements: Input Voltages Maximum Current Consumption
- +12 Volts DC: 75 milliamperes and -12 Volts DC: 75 milliamperes
- Environmental Operating Ranges to operate without failure between the temperatures of -35°F to + 165°F, with humidity to 95% (non-condensing)

3.15. **Fiber Modem.**

Provide and install a Fiber Optic RS-232 Data Modem (OTR) in field nodes and hubs as shown on the plans that meet or exceed the following requirements.

3.15.1. **General Requirements.** Utilize the latest available techniques with a minimum number of parts, subassemblies, circuits, cards, and modules to maximize standardization and commonality. Design equipment for ease of maintenance and provide component parts that are readily accessible for inspection and maintenance. Provide test points for checking essential voltages and waveforms.

- Electronic components. Comply with SS 6006, "Electronic Components".
- Mechanical Components. Use stainless steel for all external screws, nuts, and locking washers. Do not use self-tapping screws without approval. Provide parts made of corrosion resistant material, such as plastic, stainless steel, anodized aluminum, or brass. Protect all materials used in construction from fungus growth and moisture deterioration. Separate dissimilar metals by an inert dielectric material.

3.15.2. **Functional Requirements.** Provide a fault tolerant, self-healing, high reliability device, Electronic Industries Association (EIA) Compatible RS-232 data communications via a fiber optic communications link to and from multidrop interconnected field devices and host distribution nodes such as NEMA or Type-170 controllers, closed-circuit television pan-tilt controllers, dynamic message sign controllers and other similar controllers which may be associated with Traffic Management Systems.

- Support uplink and downlink communications via fiber optic cables in a self-healing ring configuration. Employ two uplink fibers (one transmit and one receive), and two downlink fibers (one transmit and one receive), for a total of four fibers per each modem
- Optically communicate with other modem units interconnected to an overall host node, using compatible optical modulation

- Include a repeating function, either uplink or downlink, depending on the source direction of the received signal
- Capable of receiving electrical RS-232 transmission and control signals from a field device connected to the unit and converting these RS-232 electrical signals to optically modulated signals in the uplink or downlink direction
- Capable of receiving optically modulated signals from either uplink or downlink devices, converting these optical signals to RS-232 electrical transmission and control signals and providing these signals to the distribution node connected
- Capable of receiver inputs from an uplink modem to be repeated downlink and received inputs from a downlink modem to be repeated uplink
- Support near instant recovery from a broken fiber optic interconnect cable between all controller locations on a given ring
- Capable to encompass all standard data rates up to 38.4 kbps without any baud rate adjustments to the transmitted and received data, accommodating full duplex asynchronous data transmission including capability to change the transmitted and received data rate, at any time, within the above range without any mechanical adjustments to the modem
- Provide an anti-streaming (anti-babbling) logic control over electrical to optical signal transmission that includes:
 - A user changeable time-out range that changes to four seconds, eight seconds, sixteen seconds, thirty-two seconds, sixty-four seconds or infinity (disabled)
 - Detects the presence of an RTS signal and data applied to the transmitted data port, inhibits the CTS control signal and blocks the transmitted data port should the maximum selected transmission time be exceeded
 - Provide a manual reset button and a failure indicator light on the modem that keeps the CTS control signal inhibited and the transmitted data port blocked when the anti-streaming logic has been activated until the manual reset button is depressed
- Provide fiber optic transmitting and receiving devices that operate at a single optical wavelength of 1300 nm nominally. Do not use dual wavelength or WDM techniques
- Provide two independent RS-232 channels, designated as "A" and "B" channels

3.15.3.

Electrical/Optical Requirements:

- Transmitting Device. Provide Transmitting Device capable of operating over singlemode fiber optic cable.
- Transmitter Optical Output. Provide output power to 8/125 singlemode dual window glass fiber at wavelengths of 1300 nm/1550 nm, sufficient to accommodate a link loss budget of 12 dB or more at each wavelength. Provide the optical coupled power value and tolerance after design is tested and approved.
- Optical Detector. Provide pin diode optical detector.
- Receiver Optical Input. Provide receiver optical input with a minimum sensitivity of 12 dB, at each wavelength, below the transmitter output level and operates within the parameters of this specification.
- Receiver Automatic Gain Control (AGC). Provide AGC circuitry to provide the receiver with the required dynamic range from transmitter- receiver spacing of 0 to 12 dB at each wavelength. Use of external optical attenuators to meet the dynamic range requirements must be approved prior to installation.
- Transmitting/Receiving Devices with the following:
 - Mean Time Between Failure (MTBF) of 100,000 hours at 122°F ambient
 - FM Modulation
 - Asynchronous, full duplex operating mode
 - RS-232 Input/Output Impedance
 - DC to 38.4 Kbaud minimum system bandwidth
 - Mean time between failure (MTBF) of 100,000 hours at 122°F ambient

- Optical Fiber Compatibility. Provide 8/125 micron singlemode with availability at 62.5/125 micron (graded index) dual window multimode glass fiber.
- Data Performance Requirements. Conform to all EIA Standard RS-232 requirements for digital data transmitted and received by the OTR.
- Data Rate. Support data transmission rates from 0 bits/sec up to and including 38,400 bits/sec.
- Bit Error Rate (BER). Do not exceed 10 to the -9 power within optical budget for each data channel.
- Power Requirements. Operate at 12 to 24 VAC or VDC from a separate power supply and does not draw more than 5 watts of power each. Operate the separate power supply from 115 VAC (+/- 10%), 60 Hz (+/-3 Hz). Do not affect the equipment operation by the transient voltages, surges and sags normally experienced on commercial power lines. Confirm with the local power service to determine if any special design is needed for the equipment. Extra cost, if required, is subsidiary to Item 680.
- Power Service Transients. Meet Section 2.1.6, "Transients, Power Service" of the NEMA Standard TS2-1992, or the latest revision, requirements for power service transient equipment.
- Wiring. Meet the wiring requirements of the NEC. Cut all wires to proper length. Provide cable slacks to facilitate removal and replacement of assemblies, panels, and modules. Do not double back wire to take up slack. Neatly lace cable with nylon lacing or plastic straps and secure with clamps.
- Transient Protection. Provide diodes or other protective devices across the coils for transient suppression for all DC relays, solenoids, and holding coils.
- Power Service Protection. Provide readily accessible, manually resettable or replaceable circuit protection devices (such as circuit breakers or fuses) for equipment and power source protection.
- Fail Safe Provision. Design equipment such that failures of the equipment do not cause the failure of any other equipment unit.

3.15.4.

Mechanical Requirements.

- Modular Design. Provide a modular design that allows major components to be readily replaced in the field. Mechanically key modules of unlike functions to prevent insertion into the wrong socket or connector. Clearly identify all modules and assemblies with name, model number, serial number, and any other pertinent information required to facilitate equipment maintenance.
- Connectors and Harnesses. Provide connectors for all external connections. Key connectors to preclude improper hookups. Color code and/or appropriately mark all wires to and from the connectors. Plate each and every conductive contact surface or pin with a minimum of 20 microns of gold. Provide connecting harness of appropriate length and terminated with matching connectors for interconnection with the terminal equipment shown on the plans or as directed. Use FC type connectors.
- Housing. Provide standard compact serviceable OTR modules that do not exceed 4.0 in D x 7.1 in W x 2.0 in H. Provide rack mountable modems in a compatible card cage at the remote hub locations.

3.15.5.

Environmental Design Requirements.

- Ambient temperature range of 1.4 to 158°F
- Relative humidity from 0% to 95%

4.**QUALITY ASSURANCE**

Furnish new equipment of current production and utilize Manufacturer's standard models as applicable to this Specification.

4.1.

CALTRANS/QA Certificate of Compliance. All applicable items must meet the electrical, environmental, and testing requirements as specified in the CALTRANS Specification. Supply each shipment with a full test report of the quality control and the final test of each item. Attach the "CALTRANS/QA Certificate of Compliance" with the name of the tester and signature of the responsible manager to the Packing List.

- 4.2. **Diagnostic Testing Certificate of Compliance.** Provide controller diagnostic and cabinet verification tests for all equipment as specified in this Specification. Supply verification with each shipment that these tests were performed and that all equipment passed the tests. Attach "Diagnostic Testing Certificate of Compliance" with the name of the tester and signature of responsible manager to the Packing List.
- 4.3. **CALTRANS Qualified Products List (QPL).** Furnish all CALTRANS standard items only by a Manufacturer on the latest CALTRANS QPL.

5. WARRANTIES AND SERVICE

- 5.1. **Warranty Period.** Provide full warranty on all items, equipment and materials provided under this contract. Use standards of the industry or a minimum period of 24 months from the date of shipment to Department. Mark each item with the date of shipment. Provide warranty coverage on all Original Equipment Manufacturer (OEM) defects, deficiencies, and latent defects including: Parts, labor, and shipping costs to include all necessary shipping and handling, for both return to the manufacturer and reshipment back to Department at no additional cost to Department. Any item found not in accordance with this Specification will be rejected, and returned for immediate replacement, at no cost to Department.
- 5.2. **Repair.** The Manufacturer will perform warranty repair or replacement, and shipment back to Department within 15 working days after receiving equipment.
- 5.3. **Extension.** Following warranty repair or replacement, the warranty period for the repaired or replaced item will be the remainder of the original warranty or 12 months from the date of shipment back to Department, whichever is greater. Mark each returned item with the date of shipment back to Department.

6. DOCUMENTATION

Provide one complete equipment documentation set for each cabinet assembly delivered and ten complete documentation sets for diagnostic test software.

- 6.1. **Cabinet Assembly Wiring Diagram.** Provide each complete cabinet assembly with two, 24 in. x 36 in. paper prints of the complete Cabinet Wiring Diagram. Information on the cabinet wiring diagram will consist of detailed equipment layout drawings and detailed wiring diagrams of all equipment installed in the cabinet. Department approval is required before final submission.
- 6.2. **Other Equipment.** Provide documentation for each controller and each auxiliary piece of equipment that is sufficient for operation and maintenance of the equipment to the satisfaction of the Department. Prepare required documentation in a clear, concise manner with appropriate illustrations, tables, and cut-away drawings, and voltage/wave form reference pictures. Equipment requiring documentation includes, but is not limited, to the following.
- Model 170E Controller Unit
 - Power Distribution Assembly No. 2 (PDA No. 2)
 - Model 206 Power Supply, 24 Volts
 - Model 200 Load Switch
 - Model 204 Flasher
 - Conflict Monitor
 - Model 242 DC Isolator
 - Model 430 Flash Transfer Relays
 - Voice Modem
 - Fiber Modem
- 6.3. **Binding.** Adequately bind documentation for protection and to prevent loss of pages. Use two heavy-duty staples, with binding tape, or plastic spiral binding. Use fonts and sizes per CALTRANS Specifications.

6.4. **Contents.** Documentation material will include, but is not limited to the following.

- General description
- Appropriate illustrations, table, cut-away drawings
- Installation and set-up procedures
- Operating procedures
- Theory of operation
- Voltage and wave form descriptions and reference pictures
- Maintenance and troubleshooting procedures
- Schematic diagrams of circuits and IC boards, which are in sufficient detail to enable City of El Paso maintenance personnel to trace signals at the component level
- Pictorial layout of IC board components
- Parts list including: Name of OEM, description, reference symbol, part number and location
- Software for each cabinet assembly delivered (hard bound copy of all operational, diagnostic, and test software documentation is required, even if provided on magnetic media)

7. GENERAL ACCEPTANCE TESTING

The City of El Paso will configure and test the controller assemblies for conformance to this Specification. A minimum of 30 working days for acceptance testing of each shipment is required. Final authority over acceptance or rejection of the equipment, with regard to the interpretation of this Specification resides with the Department. The Department reserves the right to reject any equipment that fails to meet specifications. Any and all expenses incurred as a result of rejection during the term of this contract are the responsibility of the Contractor. Controllers will not be required to conform to Test Methods specified in Item 680, "Installation of Highway Traffic Signals".

8. DELIVERY

Deliver Traffic Signal Controller Assemblies to TxDOT's El Paso District Warehouse at the following address:

TxDOT
Attn: Signal Shop Supervisor
13301 Gateway West Blvd
El Paso, TX 79928

Clearly mark the project number on all shipment documents. Ship Traffic Signal Cabinet Assemblies as completely assembled and "ready to be powered" units, and attach to pallets mounted in accordance with the CALTRANS'S "Cabinet Housing Details", TSCES-5.

Provide plastic sheeting or packing that inhibits the entry of dust during transport and subsequent temporary storage between the bottom of each cabinet and the pallet to which it is attached.

Ship all other equipment per standard industry practice.

9. MEASUREMENT AND PAYMENT

The work performed, materials furnished, equipment, labor, tools and incidentals will not be measured or paid for directly, but is considered subsidiary to Item 680, "Highway Traffic Signals".