



**THE CITY OF WINNIPEG**

# **BID OPPORTUNITY**

**BID OPPORTUNITY NO. 160-2006**

**SUPPLY AND DELIVERY OF TRAFFIC CONTROL SIGNAL EQUIPMENT**

## TABLE OF CONTENTS

### PART A - BID SUBMISSION

Form A: Bid	1
Form B: Prices	3

### PART B - BIDDING PROCEDURES

B1. Project Title	1
B2. Submission Deadline	1
B3. Enquiries	1
B4. Addenda	1
B5. Substitutes	2
B6. Bid Submission	2
B7. Bid	3
B8. Prices	4
B9. Qualification	4
B10. Opening of Bids and Release of Information	5
B11. Irrevocable Bid	5
B12. Withdrawal of Bids	5
B13. Evaluation of Bids	6
B14. Award of Contract	6

### PART C - GENERAL CONDITIONS

C1. General Conditions	1
------------------------	---

### PART D - SUPPLEMENTAL CONDITIONS

#### General

D1. General Conditions	1
D2. Scope of Work	1
D3. Definitions	1
D4. Contract Administrator	1
D5. Notices	2

#### Submissions

D6. Authority to Carry on Business	2
------------------------------------	---

#### Control of Work

D7. Commencement	3
D8. Orders	3
D9. Records	3

#### Measurement and Payment

D10. Invoices	3
D11. Payment	4

#### Warranty

D12. Warranty	4
---------------	---

### PART E - SPECIFICATIONS

GENERAL SPECIFICATIONS FOR TRAFFIC SIGNAL CONTROL EQUIPMENT	1
---	---

## **PART B - BIDDING PROCEDURES**

### **B1. PROJECT TITLE**

B1.1 SUPPLY AND DELIVERY OF TRAFFIC CONTROL SIGNAL EQUIPMENT

### **B2. SUBMISSION DEADLINE**

B2.1 The Submission Deadline is 4:00 p.m. Winnipeg time, June 28, 2006.

B2.2 Bid Submissions determined by the Manager of Materials to have been received later than the Submission Deadline will not be accepted and will be returned upon request.

B2.3 The Contract Administrator or the Manager of Materials may extend the Submission Deadline by issuing an addendum at any time prior to the time and date specified in B2.1.

### **B3. ENQUIRIES**

B3.1 All enquiries shall be directed to the Contract Administrator identified in D4.1.

B3.2 If the Bidder finds errors, discrepancies or omissions in the Bid Opportunity, or is unsure of the meaning or intent of any provision therein, the Bidder shall notify the Contract Administrator of the error, discrepancy or omission, or request a clarification as to the meaning or intent of the provision at least five (5) Business Days prior to the Submission Deadline.

B3.3 Responses to enquiries which, in the sole judgment of the Contract Administrator, require a correction to or a clarification of the Bid Opportunity will be provided by the Contract Administrator to all Bidders by issuing an addendum.

B3.4 Responses to enquiries which, in the sole judgment of the Contract Administrator, do not require a correction to or a clarification of the Bid Opportunity will be provided by the Contract Administrator only to the Bidder who made the enquiry.

B3.5 The Bidder shall not be entitled to rely on any response or interpretation received pursuant to B3 unless that response or interpretation is provided by the Contract Administrator in writing.

### **B4. ADDENDA**

B4.1 The Contract Administrator may, at any time prior to the Submission deadline, issue addenda correcting errors, discrepancies or omissions in the Bid Opportunity, or clarifying the meaning or intent of any provision therein.

B4.2 The Contract Administrator will issue each addendum at least two (2) Business Days prior to the Submission Deadline, or provide at least two (2) Business Days by extending the Submission Deadline.

B4.2.1 Addenda will be available on the Bid Opportunities page at The City of Winnipeg, Corporate Finance, Materials Management Branch internet site at <http://www.winnipeg.ca/matmgt>.

B4.2.2 The Bidder is responsible for ensuring that he has received all addenda and is advised to check the Materials Management Branch internet site for addenda shortly before submitting his Bid.

B4.3 The Bidder shall acknowledge receipt of each addendum in Paragraph 8 of Form A: Bid. Failure to acknowledge receipt of an addendum may render a Bid non-responsive.

## **B5. SUBSTITUTES**

- B5.1 The Work is based on the materials, equipment, methods and products specified in the Bid Opportunity.
- B5.2 Substitutions shall not be allowed unless application has been made to and prior approval has been granted by the Contract Administrator in writing.
- B5.3 Requests for approval of a substitute will not be considered unless received in writing by the Contract Administrator at least seven (7) Business Days prior to the Submission Deadline.
- B5.4 The Bidder shall ensure that any and all requests for approval of a substitute:
- (a) provide sufficient information and details to enable the Contract Administrator to determine the acceptability of the material, equipment, method or product as either an approved equal or alternative;
  - (b) identify any and all changes required in the applicable Work, and all changes to any other Work, which would become necessary to accommodate the substitute;
  - (c) identify any anticipated cost or time savings that may be associated with the substitute;
  - (d) certify that, in the case of a request for approval as an approved equal, the substitute will fully perform the functions called for by the general design, be of equal or superior substance to that specified, is suited to the same use and capable of performing the same function as that specified and can be incorporated into the Work, strictly in accordance with the Contract; and
  - (e) certify that, in the case of a request for approval as an approved alternative, the substitute will adequately perform the functions called for by the general design, be similar in substance to that specified, is suited to the same use and capable of performing the same function as that specified and can be incorporated into the Work, strictly in accordance with the Contract.
- B5.5 The Contract Administrator, after assessing the request for approval of a substitute, may in his sole discretion grant approval for the use of a substitute as an “approved equal” or as an “approved alternative”, or may refuse to grant approval of the substitute.
- B5.6 The Contract Administrator will provide a response in writing, at least two (2) Business Days prior to the Submission Deadline, only to the Bidder who requested approval of the substitute.
- B5.6.1 The Bidder requesting and obtaining the approval of a substitute shall be entirely responsible for disseminating information regarding the approval to any person or persons he wishes to inform.
- B5.7 If the Contract Administrator approves a substitute as an “approved equal”, any Bidder may use the approved equal in place of the specified item.
- B5.8 If the Contract Administrator approves a substitute as an “approved alternative”, any Bidder bidding that approved alternative shall base his Total Bid Price upon the specified item but may also indicate an alternative price based upon the approved alternative. Such alternatives will be evaluated in accordance with B13.
- B5.9 No later claim by the Contractor for an addition to the price(s) because of any other changes in the Work necessitated by the use of an approved equal or an approved alternative will be considered.

## **B6. BID SUBMISSION**

- B6.1 The Bid Submission consists of the following components:

- (a) Form A: Bid; and
- (b) Form B: Prices.

B6.2 All components of the Bid Submission shall be fully completed or provided, and submitted by the Bidder no later than the Submission Deadline, with all required entries made clearly and completely in ink, to constitute a responsive Bid.

B6.3 The Bid Submission may be submitted by mail, courier or personal delivery, or by facsimile transmission.

B6.4 If the Bid Submission is submitted by mail, courier or personal delivery, it shall be enclosed and sealed in an envelope clearly marked with the Bid Opportunity number and the Bidder's name and address, and shall be submitted to:

The City of Winnipeg  
Corporate Finance Department  
Materials Management Branch  
185 King Street, Main Floor  
Winnipeg, MB R3B 1J1

B6.4.1 Samples or other components of the Bid Submission which cannot reasonably be enclosed in the envelope may be packaged separately, but shall be clearly marked with the Bid Opportunity number, the Bidder's name and address, and an indication that the contents are part of the Bidder's Bid Submission.

B6.5 If the Bid Submission is submitted by facsimile transmission, it shall be submitted to (204) 949-1178.

B6.5.1 The Bidder is advised that the City cannot take responsibility for the availability of the facsimile machine at any time.

B6.6 Bid Submissions submitted by internet electronic mail (e-mail) will not be accepted.

## **B7. BID**

B7.1 The Bidder shall complete Form A: Bid, making all required entries.

B7.2 Paragraph 2 of Form A: Bid shall be completed in accordance with the following requirements:

- (a) if the Bidder is a sole proprietor carrying on business in his own name, his name shall be inserted;
- (b) if the Bidder is a partnership, the full name of the partnership shall be inserted;
- (c) if the Bidder is a corporation, the full name of the corporation shall be inserted; and
- (d) if the Bidder is carrying on business under a name other than his own, the business name and the name of every partner or corporation who is the owner of such business name shall be inserted.

B7.2.1 If a Bid is submitted jointly by two or more persons, each and all such persons shall identify themselves in accordance with B7.2.

B7.3 In Paragraph 3 of Form A: Bid, the Bidder shall identify a contact person who is authorized to represent the Bidder for purposes of the Bid.

B7.4 Paragraph 10 of Form A: Bid shall be signed in accordance with the following requirements:

- (a) if the Bidder is a sole proprietor carrying on business in his own name, it shall be signed by the Bidder;

- (b) if the Bidder is a partnership, it shall be signed by the partner or partners who have authority to sign for the partnership;
- (c) if the Bidder is a corporation, it shall be signed by its duly authorized officer or officers; and
- (d) if the Bidder is carrying on business under a name other than his own, it shall be signed by the registered owner of the business name, or by the registered owner's authorized officials if the owner is a partnership or a corporation.

B7.4.1 The name and official capacity of all individuals signing Form A: Bid shall be printed below such signatures.

B7.4.2 All signatures shall be original.

B7.5 If a Bid is submitted jointly by two or more persons, the word "Bidder" shall mean each and all such persons, and the undertakings, covenants and obligations of such joint Bidders in the Bid Submission and the Contract, when awarded, shall be both joint and several.

## **B8. PRICES**

B8.1 The Bidder shall state a price in Canadian funds for each item of the Work identified on Form B: Prices.

B8.1.1 Prices on Form B: Prices shall include:

- (a) duty;
- (b) freight and cartage;
- (c) Provincial and Federal taxes [except the Goods and Services Tax (GST) and Manitoba Retail Sales Tax (MRST, also known as PST), which shall be extra where applicable] and all charges governmental or otherwise paid; and
- (d) profit and all compensation which shall be due to the Contractor for the Work and all risks and contingencies connected therewith.

B8.2 The quantities listed on Form B: Prices are to be considered approximate only. The City will use said quantities for the purpose of comparing Bids.

B8.3 The quantities for which payment will be made to the Contractor are to be determined by the Work actually performed and completed by the Contractor, to be measured as specified in the applicable Specifications.

## **B9. QUALIFICATION**

B9.1 The Bidder shall:

- (a) undertake to be in good standing under The Corporations Act (Manitoba), or properly registered under The Business Names Registration Act (Manitoba), or otherwise properly registered, licensed or permitted by law to carry on business in Manitoba, or if the Bidder does not carry on business in Manitoba, in the jurisdiction where the Bidder does carry on business;
- (b) be responsible and not be suspended, debarred or in default of any obligation to the City;
- (c) be financially capable of carrying out the terms of the Contract;
- (d) have all the necessary experience, capital, organization, and equipment to perform the Work in strict accordance with the terms and provisions of the Contract;
- (e) have successfully carried out work, similar in nature, scope and value to the Work;
- (f) employ only Subcontractors who:

- (i) are responsible and not suspended, debarred or in default of any obligation to the City (a list of suspended or debarred individuals and companies is available on the Information Connection page at The City of Winnipeg, Corporate Finance, Materials Management Branch internet site at <http://www.winnipeg.ca/matmgt>); and
  - (ii) have successfully carried out work similar in nature, scope and value to the portion of the Work proposed to be subcontracted to them, and are fully capable of performing the Work required to be done in accordance with the terms of the Contract.
- (g) have a written workplace safety and health program in accordance with The Workplace Safety and Health Act (Manitoba).

B9.2 The Bidder shall be prepared to submit, within three (3) Business Days of a request by the Contract Administrator, proof satisfactory to the Contract Administrator of the qualifications of the Bidder and of any proposed Subcontractor.

B9.3 The Bidder shall provide, on the request of the Contract Administrator, full access to any of the Bidder's equipment and facilities to confirm, to the Contract Administrator's satisfaction, that the Bidder's equipment and facilities are adequate to perform the Work.

#### **B10. OPENING OF BIDS AND RELEASE OF INFORMATION**

B10.1 Bid Submissions will not be opened publicly.

B10.2 Following the Submission Deadline, the names of the Bidders and their Total Bid Prices (unevaluated, and pending review and verification of conformance with requirements) will be available on the Closed Bid Opportunities (or Public/Posted Opening & Award Results) page at The City of Winnipeg, Corporate Finance, Materials Management Branch internet site at <http://www.winnipeg.ca/matmgt>.

B10.3 After award of Contract, the name(s) of the successful Bidder(s) and the Contract Amount(s) will be available on the Closed Bid Opportunities (or Public/Posted Opening & Award Results) page at The City of Winnipeg, Corporate Finance, Materials Management Branch internet site at <http://www.winnipeg.ca/matmgt>.

B10.4 The Bidder is advised that any information contained in any Bid Submission may be released if required by City policy or procedures, by The Freedom of Information and Protection of Privacy Act (Manitoba), by other authorities having jurisdiction, or by law.

#### **B11. IRREVOCABLE BID**

B11.1 The Bid(s) submitted by the Bidder shall be irrevocable for the time period specified in Paragraph 9 of Form A: Bid.

B11.2 The acceptance by the City of any Bid shall not release the Bids of the next two lowest evaluated responsive Bidders and these Bidders shall be bound by their Bids on such Work for the time period specified in Paragraph 9 of Form A: Bid.

#### **B12. WITHDRAWAL OF BIDS**

B12.1 A Bidder may withdraw his Bid without penalty by giving written notice to the Manager of Materials at any time prior to the Submission Deadline.

B12.1.1 Notwithstanding GC.7.05(2), the time and date of receipt of any notice withdrawing a Bid shall be the time and date of receipt as determined by the Manager of Materials.

- B12.1.2 The City will assume that any one of the contact persons named in Paragraph 3 of Form A: Bid or the Bidder's authorized representatives named in Paragraph 10 of Form A: Bid, and only such person, has authority to give notice of withdrawal.
- B12.1.3 If a Bidder gives notice of withdrawal prior to the Submission Deadline, the Manager of Materials shall:
- (a) retain the Bid Submission until after the Submission Deadline has elapsed;
  - (b) open the Bid Submission to identify the contact person named in Paragraph 3 of Form A: Bid and the Bidder's authorized representatives named in Paragraph 10 of Form A: Bid; and
  - (c) if the notice has been given by any one of the persons specified in B12.1.3(b), declare the Bid withdrawn.
- B12.2 A Bidder who withdraws his Bid after the Submission Deadline but before his Bid has been released or has lapsed as provided for in B11.2 shall be liable for such damages as are imposed upon the Bidder by law and subject to such sanctions as the Chief Administrative Officer considers appropriate in the circumstances. The City, in such event, shall be entitled to all rights and remedies available to it at law.

### **B13. EVALUATION OF BIDS**

- B13.1 Award of the Contract shall be based on the following bid evaluation criteria:
- (a) compliance by the Bidder with the requirements of the Bid Opportunity (pass/fail);
  - (b) qualifications of the Bidder and the Subcontractors, if any, pursuant to B9 (pass/fail);
  - (c) Bid Price;
  - (d) economic analysis of any approved alternative pursuant to B5.
- B13.2 Further to B13.1(a), the Award Authority may reject a Bid as being non-responsive if the Bid Submission is incomplete, obscure or conditional, or contains additions, deletions, alterations or other irregularities. The Award Authority may reject all or any part of any Bid, or waive technical requirements if the interests of the City so require.
- B13.3 Further to B13.1(b), the Award Authority shall reject any Bid submitted by a Bidder who does not demonstrate, in his Bid Submission or in other information required to be submitted, that he is responsible and qualified.
- B13.4 Further to B13.1(c), the Bid Price shall be the sum of the quantities multiplied by the unit price for each year, for each item shown on Form B: Prices..
- B13.5 This Contract may be awarded by item as identified on Form B: Prices.
- B13.5.1 Notwithstanding B8.1, the Bidder may, but is not required to, bid on all items.

### **B14. AWARD OF CONTRACT**

- B14.1 The City will give notice of the award of the Contract or will give notice that no award will be made.
- B14.2 The City will have no obligation to award a Contract to a Bidder, even though one or all of the Bidders are determined to be responsible and qualified, and the Bids are determined to be responsive.
- B14.2.1 Without limiting the generality of B14.2, the City will have no obligation to award a Contract where:

- (a) the prices exceed the available City funds for the Work;
- (b) the prices are materially in excess of the prices received for similar work in the past;
- (c) the prices are materially in excess of the City's cost to perform the Work, or a significant portion thereof, with its own forces;
- (d) only one Bid is received; or
- (e) in the judgment of the Award Authority, the interests of the City would best be served by not awarding a Contract.

B14.3 Where an award of Contract is made by the City, the award shall be made to the responsible and qualified Bidder submitting the lowest evaluated responsive Bid.

B14.4 Notwithstanding GC.3.01 and GC.3.02, the City will issue a purchase order to the successful Bidder in lieu of the execution of a Contract.

B14.5 The Contract Documents, as defined in GC.1.01(7), in their entirety shall be deemed to be incorporated in and to form a part of the purchase order notwithstanding that they are not necessarily attached to or accompany said purchase order.

## **PART C - GENERAL CONDITIONS**

### **C1. GENERAL CONDITIONS**

C1.1 The *General Conditions for the Supply and Delivery of Goods* (Form 21: 88 03) are applicable to the Work of the Contract.

C1.1.1 The *General Conditions for the Supply and Delivery of Goods* are available on the Information Connection page at The City of Winnipeg, Corporate Finance, Materials Management Branch internet site at <http://www.winnipeg.ca/matmgt>.

## PART D - SUPPLEMENTAL CONDITIONS

### GENERAL

#### D1. GENERAL CONDITIONS

- D1.1 In addition to the *General Conditions for the Supply and Delivery of Goods*, these Supplemental Conditions are applicable to the Work of the Contract.
- D1.2 The General Conditions are amended by striking out "The City of Winnipeg Act" wherever it appears in the General Conditions and substituting "The City of Winnipeg Charter".
- D1.3 The General Conditions are amended by striking out "Board of Commissioners" or "Commissioner" wherever it appears in the General Conditions and substituting the "Chief Administrative Officer".
- D1.4 The General Conditions are amended by striking out "Tender Package" wherever it appears in the General Conditions and substituting "Bid Opportunity".
- D1.5 The General Conditions are amended by striking out "Tender Submission" wherever it appears in the General Conditions and substituting "Bid Submission".
- D1.6 The General Conditions are amended by striking out "Bidding Instructions" wherever it appears in the General Conditions and substituting "Bidding Procedures".

#### D2. SCOPE OF WORK

- D2.1 The Work to be done under the Contract shall consist of supply and delivery of traffic control signal equipment for the period of September 01, 2006 to August 31, 2009.
- D2.2 The Work shall be done on an "as required" basis during the term of the Contract.
- D2.2.1 The type and quantity of Work to be performed under this Contract shall be as authorized from time to time by the Contract Administrator and/or Users.
- D2.2.2 Subject to GC.4.08, the City shall have no obligation under the Contract to purchase any quantity of any item in excess of its actual operational requirements.

#### D3. DEFINITIONS

- D3.1 When used in this Bid Opportunity:
- (a) "**Business Day**" means any Calendar Day, other than a Saturday, Sunday, or a Statutory or Civic Holiday;
  - (b) "**Submission Deadline**" and "**Time and Date Set for the Final Receipt of Bids**" mean the time and date set out in the Bidding Procedures for final receipt of Bids;
  - (c) "**User**" means a person, department or other administrative unit of the City authorized by the Contract Administrator to order Work under this Contract;

#### D4. CONTRACT ADMINISTRATOR

- D4.1 The Contract Administrator is:  
Bill Woroby, P. Eng.  
Staff Engineer  
Public Works

103-1155 Pacific Avenue  
Winnipeg, MB R3E 3P1

Telephone No. (204) 986-5326  
Facsimile No. (204) 986-7358

## **D5. NOTICES**

- D5.1 GC.7.05 is hereby amended to delete reference to "registered mail" and to replace same with "ordinary mail".
- D5.2 GC.7.05 is further amended hereby to include delivery by facsimile transmission (fax) as an acceptable means of delivering notices, consents, approvals, statements, authorizations, documents or other communications required or permitted to be given under this Contract. Deliveries by fax will be deemed to have been received on the day of delivery, if a business day, or if not a business day, on the business day next following the day of delivery.
- D5.3 Further to GC.7.05, all notices, consents, approvals, statements, authorizations, documents or other communications to the City, except as expressly otherwise required in D5.4, D5.5 or elsewhere in the Contract, shall be sent to the attention of the Contract Administrator at the address or facsimile number identified in D4.1.
- D5.4 All notices of appeal to the Chief Administrative Officer shall be sent to the attention of the Chief Financial Officer at the following address or facsimile number:  
The City of Winnipeg  
Chief Administrative Officer Secretariat  
Administration Building, 3rd Floor  
510 Main Street  
Winnipeg, MB R3B 1B9  
Facsimile No.: (204) 949-1174
- D5.5 All notices, requests, nominations, proposals, consents, approvals, statements, authorizations, documents or other communications required to be submitted or returned to the City Solicitor shall be sent to the following address or facsimile number:  
The City of Winnipeg  
Corporate Services Department  
Legal Services Division  
185 King Street, 3rd Floor  
Winnipeg MB R3B 1J1  
Facsimile No.: (204) 947-9155

## **SUBMISSIONS**

### **D6. AUTHORITY TO CARRY ON BUSINESS**

- D6.1 The Contractor shall be in good standing under The Corporations Act (Manitoba), or properly registered under The Business Names Registration Act (Manitoba), or otherwise properly registered, licensed or permitted by law to carry on business in Manitoba, or if the Contractor does not carry on business in Manitoba, in the jurisdiction where the Contractor does carry on business, throughout the term of the Contract, and shall provide the Contract Administrator with evidence thereof upon request.

## **CONTROL OF WORK**

### **D7. COMMENCEMENT**

- D7.1 The Contractor shall not commence any Work until he is in receipt of a purchase order authorizing the commencement of the Work.
- D7.2 The Contractor shall not commence any Work on the Site until:
- (a) the Contract Administrator has confirmed receipt and approval of:
    - (i) evidence that the Contractor is in good standing under The Corporations Act (Manitoba), or properly registered under The Business Names Registration Act (Manitoba), or otherwise properly registered, licensed or permitted by law to carry on business in Manitoba.

### **D8. ORDERS**

- D8.1 The Contractor shall provide a local Winnipeg telephone number or a toll-free telephone number at which orders for delivery may be placed.

### **D9. RECORDS**

- D9.1 The Contractor shall keep detailed records of the goods supplied under the Contract.
- D9.2 The Contractor shall record, as a minimum, for each item listed on Form B: Prices:
- (a) User name(s) and addresses;
  - (b) order date(s);
  - (c) delivery date(s); and
  - (d) description and quantity of goods supplied.
- D9.3 The Contractor shall provide the Contract Administrator with a copy of the records for each year within fifteen (15) Calendar Days of the end of that year.

## **MEASUREMENT AND PAYMENT**

### **D10. INVOICES**

- D10.1 Further to GC.9.01 and notwithstanding GC.9.03, the Contractor shall submit an invoice for each order delivered.
- D10.2 Further to D5.3, the Contractor shall submit invoices to the locations designated at the time of ordering.
- D10.3 Invoices must clearly indicate, as a minimum:
- (a) the City's order number;
  - (b) date of delivery;
  - (c) delivery address;
  - (d) type and quantity of goods delivered;
  - (e) the amount payable with GST and MRST shown as separate amounts; and
  - (f) the Contractor's GST registration number.

D10.4 The City will bear no responsibility for delays in approval of invoices which are improperly submitted.

**D11. PAYMENT**

D11.1 Further to GC.9.01 and GC.9.03, payment shall be in Canadian funds net thirty (30) Calendar Days after receipt and approval of the Contractor's invoice.

**WARRANTY**

**D12. WARRANTY**

D12.1 Notwithstanding GC.10.01 and GC.10.02, the warranty period for each item of Work supplied shall begin on the date of successful delivery and shall expire one (1) year thereafter unless extended pursuant to D12.2, in which case it shall expire when provided for thereunder.

D12.2 If a defect or deficiency prevents the full and normal use or operation of the Work or any portion thereof, for purposes of calculating the warranty period, time shall be deemed to cease to elapse for the defective or deficient portion, and for any portion of the Work whose use or operation is prevented by such defect or deficiency, as of the date on which the defect or deficiency is observed or the use or operation is prevented and shall begin to run again when the defect or deficiency has been corrected or the Work may be used or operated to the satisfaction of the Contract Administrator.

D12.3 Notwithstanding GC.10.01, GC.10.02 and D12.2, if any law of Manitoba or of the jurisdiction in which the Work was manufactured requires, or if the manufacturer provides, a longer warranty period or a warranty which is more extensive in its nature, then the provisions of such law or manufacturer's warranty shall apply.

**PART E - SPECIFICATIONS**



**GENERAL SPECIFICATIONS FOR  
TRAFFIC SIGNAL CONTROL  
EQUIPMENT**

**APRIL 2006**

**The City of Winnipeg has been granted permission by California's Department of Transportation to duplicate CALTRANS TRAFFIC SIGNAL CONTROL EQUIPMENT SPECIFICATIONS.**

**The following technical specifications supplement the requirements of CALTRANS TRAFFIC SIGNAL CONTROL EQUIPMENT SPECIFICATIONS, dated January, 1989 and November, 1993.**

1. **PCB Circuit Reference Markings** - PCBs shall have circuit reference symbols clearly and legibly marked by silkscreen, circuit printing or similar permanent marking system on the circuit side, as nearby as practicable to the component referenced. PCB circuit reference symbols shall be identical to those depicted on the pictorial diagram within the manual which shows the physical locations and identification of each component.  
This component marking requirement shall apply to all PCBs **except** those within Model 200 Switchpacks and Model 204 Flasher Units. (Reference Item 1.3.11.4 on Page 14 "General Specifications").
2. **PCB Edge Connector Contacts** - all PCB edge connectors shall contain the maximum number of gold-plated contact fingers on both sides of the PCB, including contact fingers for spare and non-assigned connector positions, such that every bifurcated contact within the PCB receptacle (edge-connector) socket makes contact with plated contact fingers on the PCB. (Reference Item 1.2.5.3 on Page 11 "General Specifications").
3. **Sensed conflicting** field output **voltages** 25 VAC or greater for a **duration of 250 ms** or longer (**CALTRANS specifies 500 ms**) shall cause a FAILED state. (Reference Item 4.5.1.3 on Page 48 "Model 208/210 Monitors").
4. **Sensed conflicting** field output voltages between 15 and 25 VAC and for **durations between 200 ms and 250 ms** (**CALTRANS specifies 200 and 500 ms**) (Reference Item 4.5.1.5 on Page 49 "Model 208 and 210 Monitors").  
**The above two Conflict Monitor provisions (3. and 4.) are modified for *Winnipeg application* to permit the Monitor to properly sense flashing field output circuits which flash at a rate greater than 1 Hz, so as to be compatible with "Winnipeg Standard" Model 170E flash rate of **100 flashes per minute** (300 ms ON + 300 ms OFF).**
5. Model 336 Cabinets need not be supplied with a "BASE ADAPTER".

## TABLE of CONTENTS

<b>CHAPTER 1</b>	General Specifications for Traffic signal Control Equipment	4
<b>CHAPTER 2</b>	Specifications for Model 170E Controller Unit and Associated Model 412 Program Module	22
<b>CHAPTER 3</b>	Specifications for Model 200 Switch Pack and Model 204 Flasher Unit Modules	42
<b>CHAPTER 4</b>	Specifications for Model 208 210 Monitor Units	45
<b>CHAPTER 5</b>	Specifications for Sensor Units, Sensor Elements and Isolators Model 222 Two-Channel Loop Detector Sensor Unit Model 224 Four-Channel Loop Detector Sensor Unit Model 231 Magnetic Detector Sensing Element Model 232 Two-Channel Magnetic Detector Sensor Unit Model 242 Two-Channel DC Isolator Model 252 Two-Channel AC Isolator	49
<b>CHAPTER 6</b>	Specifications for Cabinet Models 332, 334 and 336	55
<b>CHAPTER 7</b>	Specifications for Model 400 MODEM Module	71
<b>CHAPTER 8</b>	Specifications for Model 402 Support Assembly	74
<b>APPENDIX A</b>	PLANS	76

### ITEMS SUPPLIED

Items supplied shall be new and unused.

### SPECIFICATION PRIORITIES

In case of conflict, the individual chapter shall govern over APPENDIX A and APPENDIX A shall govern over Chapter 1, General Requirements.

## CHAPTER 1

### GENERAL SPECIFICATIONS FOR TRAFFIC SIGNAL CONTROL EQUIPMENT

#### TABLE OF CONTENTS

<b>SECTION 1</b>	GLOSSARY	5
<b>SECTION 2</b>	GENERAL	9
<b>SECTION 3</b>	COMPONENTS	12
<b>SECTION 4</b>	MECHANICAL	14
<b>SECTION 5</b>	ENGINEERING	15
<b>SECTION 6</b>	PRINTED CIRCUIT BOARDS	16
<b>SECTION 7</b>	QUALITY CONTROL	18
<b>SECTION 8</b>	ELECTRICAL, ENVIRONMENTAL AND TESTING REQUIREMENTS	18

**THIS CHAPTER CONTAINS GENERAL REQUIREMENTS APPLICABLE TO ALL EQUIPMENT SPECIFIED IN THIS DOCUMENT.**

**1.1 SECTION 1 – GLOSSARY**

1.1.1 Wherever the following terms or abbreviations are used, the intent and meaning shall be interpreted as follows:

**AC** - Alternating Current.

**AC+** - 120 Volts AC, 60 hertz ungrounded power source.

**AC-** - 120 Volts AC, 60 hertz grounded return to the power source.

**ACIA** - Asynchronous Communications Interface Adaptor Device, Motorola MC6850 or equal.

**ANSI** - American National Standards Institute.

**Assembly** - A complete machine, structure or unit of a machine that was manufactured by fitting together parts and/or modules.

**ASTM** - American Society for Testing and Materials.

**AWG** - American Wire Gauge.

**C** - Celsius

**Cabinet** - An outdoor enclosure for housing the controller unit and associated equipment.

**Caltrans** – California Department of Transportation

**Certificate of Compliance** - A certificate signed by the manufacturer of the material or the manufacturer of assembled materials stating that the materials involved comply in all respects with the requirements of the specifications.

**Channel** - An information path from a discrete input to a discrete output.

**CITY** - The City of Winnipeg, Province of Manitoba, Canada. The City of Winnipeg Public Works Department, Transportation Division, Traffic Signal Systems Branch.

**CMOS** - Complementary Metal Oxide Semiconductor.

**Component** - A component shall be identified as any electrical or electronic device.

**Contractor** - The person or persons, manufacturer, firm, partnership, corporation, vendor or combination thereof, who have entered into a contract with the CITY, as party or parties of the second part or his or their legal representative.

**Controller Unit** - That portion of the controller assembly devoted to the operational control of the logic decisions programmed into the assembly.

**CPU** - Central Processing Unit.

**CR** - ACIA Control Register.

**CSA** - Canadian Standards Association.

**DAT Program** - The State of California Department of Transportation's Diagnostic and Acceptance Test Program.

**DC** - Direct Current.

**DTA** - Down Time Accumulator.

**dB** - Decibel.

**dBa** - Decibels above reference noise, adjusted.

**deg** - Degrees.

**EG** - Equipment Ground.

**EIA** - Electronic Industries Association.

**Engineer** - The Manager of the Traffic Signal Systems Branch of the CITY of Winnipeg, acting either directly or through properly authorized agents, such agents acting within the scope of the particular duties delegated to them.

**EPROM** - Ultraviolet Erasable Programmable Read Only Memory Device.

**Equal** - Connectors: complying to physical dimensions, contact/pin material, plating and method of connection. Devices: conforming to function, pin out, electrical and operating parameter requirements, access times and interface parameters of the specified device. Interpretation shall be in the judgment of the Engineer.

**ETL** - Electrical Testing Laboratories, Inc.

**HEX** - Hexadecimal.

**Hz** - Hertz.

**I.D.** - Identification.

**Jumper** - A means of connecting/disconnecting two or more conductive points by soldering/desoldering a conductive wire jumper.

**Laboratory (Shop)** - The established Maintenance Shop of the City of Winnipeg Traffic Signals Assets Branch of the Transportation Division; or other laboratories authorized by the Department to test materials involved in the contract.

**LED** - Light Emitting Diode.

**ma** - Milliampere.

**MIC** - Hitachi HD6303X microprocessor device (or equal).

**MODEM** - Modulate/Demodulate Unit.

**Module** - A functional unit that plugs into an assembly.

**Motherboard** - A printed circuit connector interface board with no active or passive components.

**MOS** - Metal Oxide Semiconductor.

**MPU** - Motorola 6800 microprocessor device (or equal).

**ms** - Millisecond.

**mw** - Milliwatt.

**M/170E** - Program Module/Model 170E Controller Unit Connector.

**NA** - Presently Not Assigned. Cannot be used by the contractor for other purposes.

**NEMA** - National Electrical Manufacturer's Association.

**NETA** - National Electrical Testing Association, Inc.

**N.C.** - Normally closed contact.

**N.O.** - Normally open contact.

**ns** - Nanosecond.

**PLA/PAL** - Programmable Array Logic Device.

**PCB** - Printed Circuit Board.

**RDR** - ACIA Receiver Data Register.

**ROM** - Read Only Memory Device.

**RTC** - Model 170E Controller Unit Real Time Clock. This circuitry provides a 170E CPU IRQ interrupt pulse clocked off of the local power company's line frequency every 16.67 ms.

**RTCA** - Real Time Clock Adjustor Circuitry.

**RTS** - Request to Send.

**R/W** - Model 170E Controller Unit Read/Write Control Line.

**SCI** - Serial Communications Interface.

**Second Sourced** - Produced by more than one manufacturer.

**SR** - ACIA Status Register.

**SRAM** - Static Random Access Memory Device.

**STATE** - State of California

**SW** - Switch.

**TDR** - ACIA Transmit Data Register.

**Thumbscrew Device** - An 8-32 retractable screw fastener with projecting stainless steel screw, spring and natural aluminum knob finish (SOUTHCO #47-62-301-XX or equal).

**TTL** - Transistor-Transistor Logic.

**ua** - Microampere.

**UL** - Underwriter's Laboratories, Inc.

**us** - Microsecond.

**VAC** - Voltage Alternating Current.

**VDC** - Voltage Direct Current.

**VMA** - Valid Memory Address.

**Watchdog Timer (WDT)** - A monitoring circuit, external to the Controller Unit, which senses a Controller Unit Output Line.

**XX** - Manufacturer's Option.

## 1.2 SECTION 2 – GENERAL

1.2.1 All equipment furnished under these specifications shall be of the solid state design. Use of vacuum or gaseous tubes or electro-mechanical devices within the equipment is not acceptable unless otherwise indicated.

### 1.2.2 Documentation

1.2.2.1 Two manuals shall be supplied with each item up to a maximum of twenty (20) manuals.

1.2.2.2 Manuals shall be printed in a font of Gothic Legal 10 on 8.5 by 11 inch paper. Schematics, layouts, parts lists and plan details may be on 11 by 17 inch sheets, but the sheets must be neatly folded to 8.5 by 11 inch size. The manual shall be bound in durable covers.

1.2.2.3 Each manual shall include the following:

- General Description
- General Characteristics
- Installation
- Adjustments
- Theory of Operation
  - Systems Description (include block diagram).
  - Detailed Description of Circuit Operation.

#### -Maintenance

1. Preventative Maintenance.
2. Trouble Analysis.
3. Trouble Shooting Sequence Chart.
4. Wave Forms
5. Voltage Measurements.
6. Alignment Procedures.

Parts List (to include circuit and board designation, part type and class, power rating and component manufacturer and original manufacturer's part number).

Electrical Interconnection Drawing.

Schematic and Logic Diagram.

Assembly drawings and a pictorial diagram showing physical locations and identification of each component.

The serial numbers and revision numbers of equipment covered by manuals shall be printed on the front cover of the manuals.

1.2.2.4 Manuals for the Model 170E Controller Unit, Models 332, 334 and 336 Cabinets shall be furnished with the item and enclosed in the shipping container.

1.2.2.5 Prior to final printing, a preliminary draft of all manuals shall be submitted to the Engineer for approval.

1.2.3 Interchangeability - The following assemblies and their respective associated devices shall electrically and mechanically intermate and be compatible with each other:

ASSEMBLIES	ASSOCIATED DEVICES
Output File #1 and #2	Model 200 Switch Pack Model 210 Monitor Unit Model 430 Heavy Duty Relay
Input File	Models 222, 224 and 232 Detectors Models 242 and 252 Isolators
Power Distribution Assembly #1 and #2	Model 204 Flasher Unit Model 206 Power Supply Module Model 430 Heavy Duty Relay
Power Distribution Assembly #3	Model 200 Switch Pack Model 206 Power Supply Module Model 208 Monitor Unit Model 430 Heavy Duty Relay
Model 170E Controller Unit	Cabinet Models 332, 334 and 336 Model 400 MODEM Model 412C Program Module
Auxiliary Output File, Model 420	Model 200 Switch Pack Model 430 Heavy Duty Relay

1.2.4 Indicators and Character Displays

1.2.4.1 All indicators and character displays shall have a  $\pm 45$  degrees cone of visibility with its axis perpendicular to the front panel. All indicators and character displays shall be readily visible at a radius of up to 4 feet within the cone of visibility when the indicator is subjected to 9,000 foot candles of white light with the light source at  $45 (\pm 2)$  degrees to the front panel. If characters are not self-luminous, illumination shall be provided for viewing in low levels of ambient light. Indicators supplied on equipment requiring handles shall be mounted such that a horizontal clearance of 15 degrees minimum shall be provided for Models 208, 210, 222, 232, 242 and 252, and also a clearance of 30 degrees minimum shall be provided for Models 200, 204 and 206.

1.2.4.2 All indicators and character displays shall have a rated life of 100,000 hours, minimum.

1.2.4.3 Liquid Crystal Displays (LCD) shall operate at temperatures of -30 degrees to +70 degrees C without loss of visibility or bleeding.

1.2.5 Connectors

1.2.5.1 General

1.2.5.1.1 All connectors shall be keyed to prevent improper insertion of the wrong connector or PCB.

1.2.5.1.2 The TYPE 25 Connector shall be a 25 contact AMP HDP-20 Connector or equal with gold on nickel plated contacts. The female mating connector with socket contacts is designated TYPE 25S and the male mating connector with pin contacts is designated TYPE 25P. The TYPE 25P Connector shall be provided with lock spring clips for latching to its mating connector.

1.2.5.1.3 The TYPE T Connector shall be a single row, 10 position, feed through terminal block. The terminal block shall be a barrier type with 6-32, 0.25 inch, or longer, nickel plated brass binder head screws. Each terminal shall be permanently identified as to its function.

1.2.5.1.4 The mating connectors shall be designated as the connector number and male/female relationship such as C1P (plug or PCB edge connector) and C1S (socket).

#### 1.2.5.2 Connectors C1, C2, C4, C5 and C6

1.2.5.2.1 Pin and socket contacts for Connectors C1, C2, C4, C5 and C6 shall be beryllium copper construction subplated with 0.00005 inch nickel and plated with 0.00003 inch gold. Pin diameter shall be 0.062 inch. Connectors shall have the following number of contacts:

C1 - 104 contacts	C4 - 37 contacts
C2 - 14 contacts	C5 & C6 - 24 contacts

1.2.5.2.2 All pin and socket connectors of C1, C2, C4, C5 and C6 shall use the AMP #601105-1 or #91002-1 contact insertion tool, and the AMP #305183 contact extraction tool.

1.2.5.2.3 Connector C1 and C2 blocks shall be constructed of phenolic or equal and shall have an insulation resistance of 5000 megohms. The contacts shall be secured in the blocks with stainless steel springs.

1.2.5.2.4 Connector C1 and C2 corner guides shall be stainless steel. The guide pins shall be 1.097 inches in length and the guide sockets 0.625 inch in length.

1.2.5.2.5 Connector C4, C5 and C6 shall be circular plastic type with quick connect/disconnect capability and thread assist, positive detent coupling. The connectors shall be UL listed Glass Filled Nylon, 94 V-I Rated, heat stabilized, fire resistant.

#### 1.2.5.3 PCB Connectors

1.2.5.3.1 PCB edge connectors shall have bifurcated gold plated contacts.

1.2.5.3.2 The PCB connector shall meet or exceed the following:

Operating Voltage: 600 VAC (RMS) at sea level  
Current Rating: 5 amperes  
Insulation Resistance: 5,000 megohms  
Contact Material: Copper alloy plated with 0.00005 inch of nickel and 0.000015 inch of gold  
Contact Resistance: 0.006 ohm maximum

1.2.5.3.3 The PCB 22/44 Connector shall have 22 independent contacts per side, dual sided with 0.156 inch contact centres.

1.2.5.3.4 The PCB 28/56 Connector shall have 28 independent contacts per side, dual sided with 0.156 inch contact centres.

1.2.5.3.5 The PCB 36/72 Connector shall have 36 independent contacts per side, dual sided with 0.1 inch contact centres.

1.2.6 Packaging - Each item delivered shall be individually packed in its own shipping container. When loose styrofoam is used for packing, the item shall be sealed in a plastic bag to prevent direct contact with the styrofoam.

1.2.7 Delivery - Each item delivered for testing shall be complete, including manuals, and ready for testing.

## 1.2.8 Metals

### 1.2.8.1 Aluminum

1.2.8.1.1 Sheet shall be Type 5052-H32 ASTM Designation B209.

1.2.8.1.2 Rod, Bar and Extruded shall be Type 6061-T6, or equal.

1.2.8.2 Stainless Steel sheet shall be annealed or one-quarter-hard complying with the ASTM Designation: A666 for Type 304, Grades A or B, stainless steel sheet.

### 1.2.8.3 Cold Rolled Steel

1.2.8.3.1 Sheet, Rod, Bar and Extruded shall be Type 1018/1020.

1.2.8.3.2 Plating - All cold roll steel shall be plated. All plating shall be either cadmium plating meeting the requirements of U.S. Federal Specification QQ-P-416C, Type 2 Class 1 or zinc plating meeting the requirements of Federal Specification QQ-Z-325B, Type 2 Class 1.

1.2.8.4 All sharp edges and corners shall be rounded.

## 1.3 SECTION 3 – COMPONENTS

1.3.1 All components shall be second sourced and shall be of such design, fabrication, nomenclature, or other identification as to be purchased from a wholesale electronics distributor, or from the component manufacturer, except as follows:

1.3.1.1 When a component is of such special design that it precludes the purchase of identical components from any wholesale electronics distributor or component manufacturer, one spare duplicate component shall be furnished with each 20, or fraction thereof, components used.

1.3.1.2 Circuit design shall be such that all components of the same generic type, regardless of manufacturer, shall function equally in accordance with the specifications.

1.3.2 Only Memory, MPU, MIC and ACIA devices shall be socket mounted on the PCB's.

1.3.3 No component shall be operated above 80% of its maximum rated voltage, current or power ratings. Digital components shall not be operated above 3% over their nominal voltage, current or power ratings.

1.3.4 No component shall be provided where the manufactured date is 2 years older than the contract award date. The design life of all components, operating for 24 hours a day operating in their circuit application, shall be 10 years or longer.

1.3.5 Encapsulation of 2 or more discrete components into circuit modules is prohibited, except for transient suppression circuits, resistor networks, diode arrays, solid state switches, optical isolators and transistor arrays.

1.3.6 Except as specified in 1.3.5, all discrete components, such as resistors, capacitors, diodes, transistors, and integrated circuits shall be individually replaceable. Components shall be arranged so they are easily accessible for testing and maintenance.

1.3.7 The Contractor shall submit detailed engineering technical data on all components at the request of the Engineer. A letter from the component manufacturer shall be submitted with the detailed engineering data when the proposed application of the component alters the technical data. The letter shall certify that the component application meets specification requirements.

#### 1.3.8 Capacitors

1.3.8.1 The DC and AC voltage ratings as well as the dissipation factor of a capacitor shall exceed the worst case design parameters of the circuitry by 150%.

1.3.8.2 A capacitor which may be damaged by shock or vibration shall be supported mechanically by a clamp or fastener.

1.3.8.3 Capacitor encasements shall be resistant to cracking, peeling and discolouration.

1.3.8.4 All capacitors shall be insulated and shall be marked with their capacitance value and working voltage.

1.3.8.5 Electrolytic capacitors shall not be used for capacitance values of less than 1.0 microfarad and shall be marked with polarity.

#### 1.3.9 Potentiometers

1.3.9.1 Potentiometers with ratings from 1 to 2 watts shall be equivalent to U.S. Military Type RV4.

1.3.9.2 No potentiometers less than 1 watt rating shall be used (except for trimmer type function).

1.3.9.3 The power rating of any potentiometer shall be at least 100% greater than the maximum power requirements of the circuit.

#### 1.3.10 Resistors

1.3.10.1 Fixed carbon film, deposited carbon, or composition insulated resistors shall conform to the performance requirement of U.S. Military Specifications: MIL-R-11F or MIL-R-22684.

1.3.10.2 All resistors shall be insulated and shall be marked with their resistance value. Resistance values shall be indicated by the EIA colour codes.

1.3.10.3 Resistors shall be 10% or less tolerance.

1.3.10.4 The value of the resistors shall not vary by more than 5% between -37 degrees C and +74 degrees C.

1.3.10.5 Resistors that have a rating exceeding 2 watts shall not be used unless special ventilation or heat sinking is provided. They shall be insulated from the PCB.

#### 1.3.11 Semiconductor Devices

1.3.11.1 All solid state devices, except LED's, shall be of the silicon type.

1.3.11.2 All transistors, integrated circuits, and diodes shall be a standard type listed by EIA and clearly identifiable.

1.3.11.3 All metal oxide semiconductor components shall contain circuitry to protect their inputs and outputs against damage due to high static voltages or electrical fields.

1.3.11.4 The device pin "1" location shall be properly marked on the PCB adjacent to each pin.

### 1.3.12 Transformers and Inductors

- 1.3.12.1 All power transformers and inductors shall have the manufacturer's name or logo and part number clearly and legibly printed on the case or laminations.
- 1.3.12.2 All transformers and inductors shall have their windings insulated and shall be protected to exclude moisture.
- 1.3.12.3 All transformer and inductor leads shall be color coded with an approved EIA color or identified such to facilitate proper installation.

### 1.3.13 Circuit Breakers (10 amperes or greater)

- 1.3.13.1 Circuit breakers shall be listed by UL or ETL. The trip and frame sizes shall be plainly marked (marked on the breaker by the manufacturer), and the ampere rating shall be visible from the front of the breaker. All circuit breakers (30 amperes or greater) shall be quick-break on either automatic or manual operation. Contacts shall be silver alloy and enclosed in an arc quenching chamber. Overload tripping shall not be influenced by an ambient air temperature range of from -18 to 50 degrees C. Minimum interrupting capacity shall be 5,000 amperes, RMS.
- 1.3.13.2 Circuit breakers shall be the trip-free type.
- 1.3.13.3 Multi-pole breakers shall be the common-trip type.

### 1.3.14 Switches

- 1.3.14.1 DIP - Dual-in-package, quick snap switch(es) shall be rated for a minimum of 30,000 operations per position at 50 ma, 30 VDC. The switch contact resistance shall be 100 milliohms maximum at 2 ma, 30 VDC. The contacts shall be gold over brass (or silver).
- 1.3.14.2 LOGIC - The switch contacts shall be rated for a minimum of one ampere resistive load at 120 VAC or 28 VDC and shall be silver over brass (or equal). The switch shall be rated for a minimum of 40,000 operations.
- 1.3.14.3 CONTROL - The switch contacts shall be rated for a minimum of five amperes resistive load at 120 VAC or 28 VDC and shall be gold over brass (or equal). The switch shall be rated for a minimum of 40,000 operations.
- 1.3.14.4 POWER - Ratings shall be same as CONTROL except that the contact rating shall be a minimum of ten amperes at 125 VAC.

## 1.4 SECTION 4 – MECHANICAL

### 1.4.1 Assemblies and PCB Design

- 1.4.1.1 Assemblies (including Controller Unit) -- All assemblies shall be easily replaceable and incorporate plug-in capability for their associated devices or PCB's with the following exceptions:

The cabinet power supply. Mother board assemblies. The power supply for the Model 170E may be a plug-in assembly.

- 1.4.1.2 Assemblies shall be provided with 2 guides for each plug-in PCB or associated device (except relays). The guides shall extend to within 0.75 inch from the face of either the socket or connector and front edge of the assembly. If Nylon guides are used, the guides shall be securely attached to the file or assembly chassis. All printed circuit boards shall be mounted vertically.

1.4.1.3 PCB -- No components, traces, brackets or obstructions shall be within 0.125 inch of the board edge (guide edges).

1.4.1.4 The manufacturer's name or logo, model number, serial number, and circuit issue or revision number shall appear and be readily visible on all items. Placement of this information for modules such as the Model 208 or 210 Monitor Units, Model 400 MODEM, Model 412C Program Module and Model 414 Program Module shall be on the PCB.

1.4.2 Workmanship - Workmanship shall be in accordance with the highest industry standards.

1.4.3 Model Numbers

1.4.3.1 The manufacturer's model number, serial number and circuit issue or revision number shall appear on the rear panel of all equipment and modules supplied.

1.4.3.2 In addition to any assignment of model numbers by the manufacturer, a model number assigned in the table below shall be displayed on the front panel in bold type, at least 0.25 inch high.

<b>MODEL#</b>	<b>TITLE</b>
170E	CONTROLLER UNIT
200	SWITCHPACK
204	FLASHER UNIT
206	POWER SUPPLY MODULE
208	MONITOR UNIT
210	MONITOR UNIT
222	LOOP SENSOR UNIT
224	LOOP SENSOR UNIT
231	MAGNETIC ELEMENT
232	MAGNETIC SENSOR UNIT
242DC	ISOLATOR
252AC	ISOLATOR
402	SUPPORT ASSEMBLY
412C	PROGRAM MODULE

1.4.4 All PCB connectors mounted to the motherboard shall be mechanically secured to the chassis or frame of the unit.

1.4.5 All screw type fasteners shall utilize locking devices or locking compounds except for finger screws which shall be captive.

1.4.6 Tolerances - The following tolerances shall apply, except as specifically shown on the plans or in these specifications:

Sheet Metal  $\pm$  0.0525 inch / PCB + 0, -0.10 inch / Edge Guides  $\pm$  0.015 inch

## 1.5 SECTION 5 – ENGINEERING

1.5.1 Human Engineering

1.5.1.1 To the highest practicable degree, the unit shall be engineered for simplicity and ease of operation and maintenance. This shall include the following:

1.5.1.1.1 No more than 2 potentiometers, controls or switches may be mounted concentrically. Knobs for such devices shall have diameters in a ratio of 2:1 outer to inner. The outer knob shall have a diameter of at least one inch.

- 1.5.1.1.2 Knobs shall be of large enough diameter (at least 0.5 inch diameter) and of great enough separation (at least 0.5 inch edge to edge) to assure ease of adjustment without disturbance of adjacent knobs.
- 1.5.1.1.3 All fuses shall be easily accessible and shall be replaceable without the use of any tools.
- 1.5.1.1.4 PCB's shall slide smoothly in their guides while being inserted into or removed from the frame and shall fit snugly into the plug-in PCB connectors.
- 1.5.1.1.5 PCB's shall require a force no less than 5 pounds or greater than 50 pounds for insertion or removal.

## 1.5.2 Design Engineering

1.5.2.1 The following practices shall be employed in the design of solid state equipment circuitry:

- 1.5.2.1.1 The design shall be inherently temperature compensated to prevent abnormal operation. The circuit design shall include such compensation as is necessary to overcome adverse effects due to temperature in the specified environmental range.
- 1.5.2.1.2 For reasons of personal safety, personnel shall be protected from all dangerous voltages.

1.5.3 Generated Noise - No item, component or subassembly shall emit a noise level exceeding the peak level of 55 dBa when measured at a distance of one meter away from its surface.

## 1.6 SECTION 6 - PRINTED CIRCUIT BOARDS

### 1.6.1 Design, Fabrication and Mounting

- 1.6.1.1 All contacts on PCB's shall be plated with a minimum thickness of 0.000030 inch gold over a minimum thickness of 0.000075 inch nickel.
- 1.6.1.2 PCB design shall be such that components may be removed and replaced without damage to boards, traces or tracks.
- 1.6.1.3 Fabrication of PCB's shall be in compliance with U.S. Military Specification: MIL-P-13949, except as follows:
  - 1.6.1.3.1 Only NEMA glass cloth base epoxy resin copper clad laminates 0.0626 inch minimum thickness shall be used. Intercomponent wiring shall be by laminated copper clad track having a minimum weight of 2 ounces per square foot with adequate cross section for current to be carried. All copper track shall be plated or soldered to provide complete coverage of all exposed copper track. Jumper wires will not be permitted, except from plated-through padded holes to an external component or for designed function selection with the jumper insulated and as short as possible.
  - 1.6.1.3.2 Section 3.3.3 of U.S. Military Specification: MIL-P-13949E shall read "Pits and Dents. Grade of Pits and Dents shall be of Grade B quality (3.3.3.2) or better."
  - 1.6.1.3.3 Section 3.3 of Military Specification: MIL-P-13949 shall be omitted.
  - 1.6.1.3.4 Section 3.4 of Military Specification: MIL-P-13949 shall read "Warp or Twist. Class of permissible warp or twist shall be Class A (Table II) or better."

- 1.6.1.3.5 Sections 4.2 through 6.6 of Military Specification: MIL-P-13949 (inclusive) shall be omitted except as referenced in previous sections of this specification.
- 1.6.1.4 The fabrication of PCB's and the mounting of parts and assemblies thereon shall conform to U.S. Military Specification: MIL-STD-275E, except as follows:
  - 1.6.1.4.1 All semiconductor devices required to dissipate more than 250 mw or any case temperature that is 10 degrees C above ambient shall be mounted with spacers or transipads to prevent direct contact with the PCB. When completed all residual flux shall be removed from PCB.
  - 1.6.1.4.2 The resistance between any 2 isolated, independent conductor paths shall be at least 100 megohms when a 500 VDC potential is applied.
  - 1.6.1.4.3 All PCB's shall be coated with a moisture resistant coating.
  - 1.6.1.4.4 Where less than 0.25 inch lateral separation is provided between the PCB (or the components of a PCB) and any metal surface, a 0.03125 (-0.0 to +0.0156) inch thick Mylar (polyester) plastic cover shall be provided on the metal to protect the PCB.
- 1.6.1.5 Each PCB connector edge shall be chamfered at 30 degrees from board side planes. The key slots shall also be chamfered so that the connector keys are not extracted upon removal of board or jammed upon insertion. The key slots shall be 0.045 ( $\pm 0.005$ ) inch for 0.1 inch spacing and 0.055 ( $\pm 0.005$ ) inch for 0.156 inch spacing.
- 1.6.2 Soldering
  - 1.6.2.1 Hand soldering shall comply with Military Specification: MIL-P-55110.
  - 1.6.2.2 Automatic flow soldering shall conform to the following conditions:
    - 1.6.2.2.1 Constant speed conveyor system.
    - 1.6.2.2.2 Conveyor speed shall be the optimum to minimize solder peaks or points which form at component terminals.
    - 1.6.2.2.3 Temperature shall be controlled to within  $\pm 8$  degrees C of the optimum temperature.
    - 1.6.2.2.4 The soldering process shall result in the complete coverage of all solder runs, joints and terminals with solder except that which is covered by an electroplating process.
    - 1.6.2.2.5 Whenever clinching is not used, a method of holding the components in the proper position for the flow process shall be provided.
    - 1.6.2.2.6 If exposure to the temperature bath is of such a time-temperature duration, as to come within 80% of any component's maximum specified time-temperature exposure, that component shall be hand soldered to the PCB after the flow process has been completed.
- 1.6.3 Printed circuit board mounting. All printed circuit boards shall be mounted vertically (the copper clad surfaces shall be oriented vertically).
- 1.6.4 Definitions - Definitions for the purpose of this section on PCB's shall be taken from MIL-STD-429 and any current addendum.

## 1.7 SECTION 7 - QUALITY CONTROL

The following measures shall be taken by the Contractor during the production process to ensure a high standard of quality.

- 1.7.1 Components - All components shall be lot sampled to assure a consistent high conformance standard to the design specification of the unit.
- 1.7.2 Subassembly or module
  - 1.7.2.1 Visual inspection shall be performed on all modules, printed circuits and subassemblies to determine any physical defects such as cracking, scaling, poor fastening, incorrect component values and etc.
  - 1.7.2.2 Complete electrical testing shall be performed on each module, printed circuit board or subassembly to determine its compliance to the manufacturer's design function.
  - 1.7.2.3 Housing, chassis, and connection terminals shall be inspected for mechanical sturdiness, and harnessing to sockets shall be electrically tested for proper wiring sequence.
- 1.7.3 Units
  - 1.7.3.1 The completely assembled unit shall be subjected to a full environmental cycling and timing test.
  - 1.7.3.2 The unit shall be visually and physically inspected to assure proper placement, mounting and compatibility of subassemblies.
- 1.7.4 Predelivery Repair
  - 1.7.4.1 The procedures listed below shall be followed in repair of equipment before shipment.
    - 1.7.4.1.1 Any defects or deficiencies found by the inspection system involving mechanical structure or wiring shall be returned through the manufacturing process or special repair process for correction.
    - 1.7.4.1.2 Defects in PCB's or electronic circuit components shall be specially treated as follows:
      - 1.7.4.1.2.1 A PCB may be flow soldered a second time if copper runs and joints are not satisfactorily coated on the first run.
      - 1.7.4.1.2.2 Under no circumstances shall a PCB be flow soldered more than twice.
      - 1.7.4.1.2.3 Hand soldering may be used for printed circuit repair.

## **1.8 SECTION 8 - ELECTRICAL, ENVIRONMENTAL AND TESTING REQUIREMENTS**

- 1.8.1 General
  - 1.8.1.1 The General procedures and equipment used in the evaluation of the controller unit, cabinet and auxiliary equipment are a minimum guide and should not limit the testing and inspection to ensure compliance of the equipment with these specifications.
  - 1.8.1.2 These test procedures shall be followed by the Contractor who shall certify that he has conducted inspection and testing in accordance with these specifications.
- 1.8.2. Inspection - A visual and physical inspection shall include mechanical, dimensional and assembly conformance of all parts of these specifications which can be checked visually or manually with simple measuring devices.

1.8.3 Environmental - All components shall properly operate within the following limits:

1.8.3.1 Ambient Temperature: -37 degrees C to 74 degrees C

1.8.3.2 Humidity: 5 to 95 percent

1.8.3.3 The relative humidity and ambient temperature values in the following table shall not be exceeded.

AMBIENT TEMPERATURE VERSUS RELATIVE  
HUMIDITY AT BAROMETRIC PRESSURES (29.92 in. Hg.)

Ambient Temperature/ Dry Bulb (in deg C)	Relative Humidity (in percent)	Ambient Temperature/ Wet Bulb (in deg C)	
-37 to 1.1		10	-17.2 to 42.7
1.1 to 46.0		95	42.7
48.8		70	42.7
54.4		50	42.7
60.0		38	42.7
65.4		28	42.7
71.2		21	42.7
74		18	42.7

1.8.3.4 Shock Test - per Military Specification: MIL-STD-810D Method 516.1.

1.8.3.5 Vibration - per Military Specification: MIL-STD-810D Method 514.1, equipment class G (Common Carrier).

1.8.3.6 Cabinets shall comply with the requirements of UL Bulletin of Research No. 23, "Rain Tests of Electrical Equipment".

1.8.3.7 All equipment shall continue normal operation when subjected to the following:

1.8.3.7.1 Low Temperature Test - With the item functioning at a line voltage of 90 VAC in its intended operation, the ambient temperature shall be lowered from 20 degrees C to -37 degrees C at a rate of not more than 18 degrees C per hour. The item shall be cycled at -37 degrees C for a minimum of 5 hours and then returned to 20 degrees C at the same rate. The test shall be repeated with the line voltage at 135 VAC.

1.8.3.7.2 High Temperature Test - With the item functioning at a line voltage of 90 VAC in its intended operation, the ambient temperature shall be raised from 20 degrees C to 70 degrees C at a rate of not more than 18 degrees C per hour. The item shall be cycled at 70 degrees C for a minimum of 5 hours and then returned to 20 degrees C at the same rate. The test shall be repeated with the line voltage at 135 VAC.

1.8.4 Electrical - All components shall operate properly within the following limits:

1.8.4.1 Applied Line Voltage: 90 to 135 VAC

1.8.4.2 Frequency: 60 ( $\pm 3.0$ ) Hertz

1.8.4.3 All circuits unless otherwise noted, shall commence operation at or below 90 VAC as the applied voltage is raised from 50 VAC to 90 VAC at a rate of 2 ( $\pm 0.5$ ) volts per second.

1.8.4.4 All equipment, when housed within its associated cabinet, shall be unaffected by transient voltages normally experienced on commercial power lines. Equipment purchased separately from cabinet will be tested for compliance with the equipment housed within a City of

Winnipeg Accepted Model 332 Cabinet and the cabinet connected to the commercial power lines.

- 1.8.4.4.1 The power line surge protection, (including the cabinet's and that internal to the equipment) shall enable the equipment being tested to withstand (nondestructive) and operate normally following the discharge of a 25 microfarad capacitor, charged to plus and minus 2,000 volts, applied directly across the AC line (applied at Cabinet Service Terminal Block) at a rate of once every 10 seconds for a maximum of 50 occurrences per test. The unit under test will be operated at 20 degrees ( $\pm 5$  degrees) C and at 120 ( $\pm 12$ ) VAC.
  - 1.8.4.4.2 The Model 400 MODEM will be housed in a City Accepted Model 170E Controller Unit which in turn is housed in the cabinet during the test described above.
  - 1.8.4.5 All equipment shall be unaffected by transient voltages normally experienced on commercial power lines. Equipment purchased separately from the cabinet will be tested for compliance as follows:
    - 1.8.4.5.1 Power from commercial power lines applied at Cabinet Service Terminal Block.
    - 1.8.4.5.2 Equipment properly housed and connected within a City of Winnipeg Accepted Model 332 Cabinet.
    - 1.8.4.5.3 The Cabinet Power Surge Protectors deactivated or removed.
    - 1.8.4.5.4 The equipment shall withstand (nondestructive) and operate normally when one discharge pulse of plus or minus 300 volts is synchronously added to the AC power at the Cabinet Service Terminal Block and moved uniformly over the full wave across 360 degrees or stay at any point of Line Cycle once every second. Peak noise power shall be 5 kilowatts with a pulse rise time of 500 ns. The unit under test will be operated at 20 (+/-5) degrees C and at 120 ( $\pm 12$ ) VAC.
      - 1.8.4.5.4.1 The Model 400 MODEM shall comply to the above conditions when housed in a City Accepted Model 170E Controller Unit and with DAT Program operating, and tested under the above conditions.
      - 1.8.4.5.4.2 Within the circuit of any device, module or PCB, electrical isolation shall be provided between DC logic ground, equipment ground and the AC grounded conductor. The DC logic ground and equipment ground shall be electrically isolated from the AC grounded conductor and from each other by 500 megohms, minimum, when tested at the input terminals with 500 VDC.
  - 1.8.4.6 All equipment shall be capable of normal operation following opening and closing of contacts in series with the applied voltage to the cabinet at a rate of 30 openings and closings per minute for a period of 2 minutes in duration.
  - 1.8.4.7 All equipment shall resume normal operation following a period of at least 5 hours at -37 degrees C and less than 10% humidity, when 90 VAC is applied to the input terminals of the cabinet.
- 1.8.5 Contractor's Testing Certification
- 1.8.5.1 The Contractor shall supply with each shipment a full test report of the quality control and final test conducted on each item. The test report shall indicate the name of the tester and shall be signed by a responsible manager.
  - 1.8.5.2 The Contractor shall submit his quality control procedure and format of test reports to the Engineer for approval within 15 working days following the approval of the contract.

1.8.5.3 The quality control procedure shall include the following:

- 1.8.5.3.1 Acceptance testing of all supplied components.
- 1.8.5.3.2 Physical and functional testing of all modules.
- 1.8.5.3.3 A minimum 100-hour burn-in of all modules.
- 1.8.5.3.4 Physical and functional testing of all items.
- 1.8.5.3.5 A minimum 24 hour operation of all controller units and cabinets.

## CHAPTER 2

### SPECIFICATIONS FOR MODEL 170 ENHANCED CONTROLLER UNIT AND ASSOCIATED MODEL 412C AND MODEL 172 MODULES

#### TABLE of CONTENTS

<b>SECTION 1</b>	- GENERAL	23
<b>SECTION 2</b>	- MODEL 170E CONTROLLER UNIT	25
<b>SECTION 3</b>	- MODEL 412C PROGRAM MODULE	30
<b>SECTION 4</b>	- MODEL 172 CONTROLLER MODULE	33
<b>SECTION 5</b>	- CHAPTER DETAILS	34

**2.1 SECTION 1 – GENERAL**

- 2.1.1 Power Failure - A power failure is said to have occurred when the incoming line voltage falls below 92 (+/-2) VAC for 50 ms. The determination of the 50 ms interval shall be completed within 67 ms of the time the voltage falls below 92 (+/-2) VAC.
- 2.1.2 Power Restoration - Power is said to be restored when the incoming line voltage equals or exceeds 97 (+/-2) VAC for 50 ms. The determination of the 50 ms interval shall be completed within 67 ms of the time the voltage first reaches 97 (+/-2) VAC.
- 2.1.3 The hysteresis between power failure and power restoration voltage settings shall be a minimum of 5 Volts with a threshold drift of no more than 0.2 VAC.
- 2.1.4 System READ Access Time - With Model 412C Module Resident in the Controller Unit, valid data shall be present at the MPU at least 100 ns prior to the end of the machine cycle.
- 2.1.5 The Diagnostic and Acceptance Test (DAT) Programs.

2.4.5.1 ***The DAT-170E Program shall be provided resident on the Model 412C Program Module U1 memory device and on the CPU U6 memory device.***

2.4.5.2 A copy of the DAT Programs will be available to the contractor at no charge.

- 2.1.6 If a PAL, EPROM, or ROM device is used in address decoding and timing algorithms, the device code listing together with data sheet(s) and any specific coding requirements shall be included in the unit or module documentation. The device coding shall be delivered in the same form that the Contractor uses to directly reproduce the device.
- 2.1.7 The system address organization of the Model 170E shall consist of two addressing configurations. The Decoder Input shall be furnished jumpered in address configuration 1. The internal module address organization shall be as specified in the appropriate module section.
  - 2.1.7.1 The two addressing configurations shall be selectable by use of one post jumper. The jumper shall control the logic state of one Decoder Circuit Input. The logic line shall be a three post type with the two logic levels on the outer posts. The following input line state conditions shall cause the Decoder circuit to provide the associated address configurations:

CONFIGURATION	LINE	FUNCTION
1	+5 VDC	170E/412C
2	DC GND	170E Internal/170

2.1.7.2 CONFIGURATION 1 Address Organization

FUNCTION	ADDRESS RANGE	COMMENTS
CPU SRAM	0000 - 0FFF	
U4 Memory	1000 - 3FFF	412C
Reserved	4000 - 4FFF	
DTA Minutes	5000 - READ	
DTA Reset	5000 - WRITE	
INPUT/OUTPUT	5001 - 5008	
	5009 - 500A WRITE	
RESTART State	5004 - BIT 1 READ	
DTA Seconds	500F - READ	
Reserve	5009 - 500E READ	
	500B - 500F WRITE	
	5010 - 5FFE	

CPU STATUS	5FFF - READ	Bit 1 - ACIA #1 IRQ Bit 2 - ACIA #2 IRQ Bit 3 - ACIA #3 IRQ Bit 4 - ACIA #4 IRQ Bit 5 - Reserved Bit 6 - Address Configuration Bit 7 - DTA Timeout Bit 8 - RTC IRQ
RTC Reset	5FFF - WRITE	
ACIA #1	6000	WRITE CR, READ SR
ACIA #1	6001	WRITE TDR, READ RDR
ACIA #2	6002	WRITE CR, READ SR
ACIA #2	6003	WRITE TDR, READ RDR
ACIA #3	6004	WRITE CR, READ SR
ACIA #3	6005	WRITE TDR, READ RDR
ACIA #4	6006	WRITE CR, READ SR
ACIA #4	6007	WRITE TDR, READ RDR
Reserve	6008 - 600F	
CPU SRAM	6010 - 6FFF	
PROGRAM MODULE		
Memory Write Protect	7000 - WRITE	
I.D. Feature	7000 - READ	
I.D. Location	7001 - READ	
	7001 - WRITE Reserve	
Reserve	7002 - 7009	
	700B - 700E WRITE	
	700F - READ	
RTCA Valid/ Reset	700A	
RTCA Counters 1 to 4	700B - 700E READ	
U3 Memory	7010 - 7FFF	
U1 & U2 Memory	8000 - FFFF	

NOTE -- Address locations noted as "Reserve" are assignable by the State only and shall not be used.  
**CPU STATUS Bit 6: "0" equals Address Configuration 1 and "1" equals Address Configuration 2.**

2.1.7.3 CONFIGURATION 2 Address Organization - This configuration provides all Model 412C Program Module features internal to the controller unit. The address organization is the same as CONFIGURATION 1 with the following exceptions:

CPU SRAM	0000 - 3FFF	U3 & U4 Memory internal
	6010 - 6FFF	
	7010 - 7FFF	
U6 EPROM	8000 - FFFF	U1 & U2 Memory internal

2.1.8 Each memory device shall stabilize to normal operation within 10 ms following Power Restoration and shall be in standby until addressed. Each device shall have the following maximum power drain at +5 VDC in its various states:

MEMORY	ACTIVE	STANDBY	POWERDOWN
EPROM	100 ma	40 ma	
SRAM	85 ma	20 ma	100 us (non-internal power)

2.1.9 CPU EPROM memory sockets shall be a 28 pin AMP Diplomat LF #64184-2, or equal. The MPU, ACIA and other memory sockets shall be an AUGAT #500/800 series AG10DPC or equal. Each socket number shall be permanently marked on the PCB adjacent to its Pin 1. Should the "... or equal MPU" pin/package be other than the 40 pin package, the MPU socket used shall match the above specified socket features.

## 2.2 SECTION 2 - MODEL 170E CONTROLLER UNIT

### 2.2.1 Unit Composition

2.2.1.1 The Model 170E Controller Unit shall consist of the following:

- Central Processing Unit (CPU)
- Input/Output Interface
- Unit Chassis
- M170E Auxiliary Board**
- Model 412C Program Module
- Unit Power Supply with external power connection
- Unit Standby Power
- Front Panel Assembly
- Internal System Interface
- Connectors C1S, C2S, C20S, C30S, C40S, and T-1
- Communications System Interface

2.2.1.2 The 170E shall be delivered pinned for Configuration 1 Addressing.

2.2.1.3 The composition weight shall not exceed 25 pounds.

### 2.2.2 Central Processing Unit (CPU)

2.2.2.1 The CPU shall be provided with an MPU and shall properly execute object programs developed to operate on the MPU. The MPU Interrupt requirements shall be as follows:

2.2.2.1.1 Non-Maskable Interrupt (NMI) - The NMI is exclusively assigned to the Power Failure Function. A Power Failure shall cause the MPU NMI line to immediately go LOW. The line shall be held LOW until the RES goes LOW to prevent multiple NMI issuance.

2.2.2.1.2 Reset Interrupt (RES) - The RES is exclusively assigned to Power Restoration and MPU Startup. The RES line shall go LOW 3 (+/-1) ms following the NMI going LOW. The line shall remain LOW until 150 (+/-75) ms after Power Restoration.

2.2.2.1.3 Interrupt Request (IRQ) - The IRQ Line shall be jointly used by the RTC and the four ACIA's to initiate IRQ to the MPU

2.2.2.1.3.1 Real Time Clock (RTC) - Real Time Clock circuitry shall be provided to trigger an interrupt to the MPU on the IRQ line once every 1/60 of a second during the 270 to 330 degree portion of the AC Sine Wave. The AC Sine Wave shall be derived from the local power company's 120 VAC 60 Hz frequency. The RTC shall be

READ at Bit 8, Address 5FFF (STATUS) and reset by a WRITE to Address 5FFF.

2.2.2.1.3.2 ACIA - Four ACIA's shall be provided, each capable of receiving and transmitting up to eight-bits of parallel data from the MPU for serial data communications. The ACIA shall have 4 registers which are addressable by the MPU. The MPU shall be capable of reading the Status Register (SR) and the Receiver Data Register (RDR), and writing in the Transmit Data Register (TDR) and in the Control Register (CR).

2.2.2.1.3.3 Each ACIA shall be provided with a 2 post type jumper between its IRQ output and the MPU IRQ input. The 170E shall be delivered with these jumpers installed.

2.2.2.2 CPU Clock Timing - The CPU clock circuitry shall be provided to generate the MPU clock timing. The clock circuitry and the MPU shall provide two selectable MPU machine cycle times of 0.651 and 1.302 (+/-0.0015) us. The machine cycle time selection shall be by Post Jumper (Three Post Type) with jumper in for 1.302 us. The CPU clock circuitry shall be located no further than 2 inches from the MPU clock pin inputs.

2.2.2.3 SRAM Memory, DALLAS 1235Y or equal, shall be provided.

2.2.2.4 A EPROM Memory, INTEL 27256A or equal, shall be provided in socket U6.

2.2.2.5 Restart Timer - A Restart Timer Circuitry shall be provided to react to the duration of power outage. The Restart Timer output is normally HIGH. When the NMI line goes LOW, the Restart Timer shall begin timing. If the timer reaches 1.75 (+/-0.25) seconds, its output state shall go to LOW and remain in that state for 50 (+/-24) ms after the RES line goes HIGH. If power is restored prior to the timer timing out, the output shall remain HIGH and the timer shall be reset to "0".

### 2.2.3 Downtime Accumulator (DTA)

2.2.3.1 A DTA shall be provided to accumulate time between Power Failure and Restoration. The DTA shall start counting immediately upon Power Failure and continue counting until the RES line goes HIGH following Power Restoration.

2.2.3.2 The DTA shall have 2 eight-bit binary registers counting the number of minutes and seconds. DTA accuracy shall be +/- 1 second over the 255 minute range. The DTA shall stop counting when the Minutes register equals 255 decimal. The DTA registers shall reset to 0 by a WRITE to address 5000. The DTA shall READ Minutes at Address 5000 and Seconds at Address 500F. The Seconds Register shall count 0 to 59 seconds decimal in 1 second increments. At 60 seconds, the Minutes Register shall be incremented and the Seconds Register reset to "0".

2.2.4 Total current drain for DTA and Restart Timer Circuitry (powerdown mode) shall not exceed 400 ua at 5 VDC, 35 degrees C while timing and 100 ua at 5 VDC when timeout is latched.

### 2.2.5 Input/Output Interface

2.2.5.1 Input/Output Interface shall utilize a ground true logic. The transfer of data between interface and working registers within the MPU shall be in eight-bit word increments, minimum. The steering of data from inputs or outputs for a given address shall be controlled by the state of MPU read/write command at the time the given address is valid.

2.2.5.2. Output Interface - The output interface shall consist of a minimum of 80 bits of buffered storage. Output data shall be latched at the time of writing from the MPU. This interface shall provide an NPN open collector output capable of driving up to 40 VDC and sinking up to

100 ma. A "1" from the MPU shall be presented as a grounded collector, and a "0" presented as an open circuit. Once a port is written into, the data shall remain present and stable until either another word is written into it or until the power is turned off. The state of these output ports at the time of power up or below power failure threshold shall be an open circuit.

2.2.5.3 Input Interface - The input interface shall consist of a minimum of 64 bits of gated inputs from external devices. Each logic level input shall be turned ON (true) when the input voltage is less than 3.5 VDC, shall be turned OFF (false) when the input current is less than 100 ua or the input voltage exceeds 8.5 VDC, shall pull up to 12 VDC, and shall not deliver in excess of 20 ma to a short circuit to logic level common. When the appropriate input address is impressed upon the input interface, the interface shall place its data on the data bus, which will be read by the MPU. Ground on any input shall be interpreted by the MPU as a "1" and an open on any input or the presence of a voltage greater than 8.5 VDC shall be interpreted as a "0" by the MPU when that input is read.

2.2.6 Unit Chassis - The controller unit shall be housed in a compact, portable metal enclosure suitably protected against corrosion. The controller unit shall mount in a standard EIA 19 inch rack. The enclosure shall be designed for convenient removal of PCBs without use of tools.

#### 2.2.7 Unit Power Supply

2.2.7.1 A power supply shall be provided to produce all DC power necessary to operate the controller unit. In addition, the supply shall provide the following voltages and current:

1000 ma at +12 VDC  
300 ma at -12 VDC  
500 ma at + 5 VDC  
400 ma at - 5 VDC

2.2.7.2 The DC ground shall not be connected to equipment ground.

2.2.7.3 Controller unit power shall be held up (DC logic voltages at normal operating levels) for a minimum of 50 +/- 17 ms beyond the NMI line going LOW.

2.2.7.4 The maximum DC voltage generated shall not exceed 45 volts.

2.2.7.5 The Power Supply shall be so designed that no further filtering regulation is needed for the required DC voltages.

2.2.7.6 Radio frequency suppressors shall be provided on the AC+ and AC- power lines. The part shall be a COR COM 3VS1 or equal.

#### 2.2.8 Unit Standby Power

2.2.8.1 A standby power shall be provided to retain power (minimum of 72 hours) to the CPU Restart Timer, DTA and Internal RTCA during power failure in the controller unit. The supply shall consist of holdup Capacitors, capacitor charging circuitry and power sense/transfer circuitry.

2.2.8.2 The power sense/transfer circuitry shall sense power loss and transfer capacitor power immediately to the required circuits. The transfer circuitry shall isolate the capacitors by transistor or relay until power loss transfer. The circuitry shall sense power restoration and transfer back to the normal isolation mode.

2.2.8.3 A charging circuit which shall, under normal operating conditions, fully charge and float the standby capacitors consistent with manufacturer's recommendations.

### 2.9 Front Panel Assembly

- 2.2.9.1 The front panel shall be securely fastened to the chassis and removable without the need for tools. A continuous hinge shall be provided on the left side of the unit to permit opening of the front panel and ready access to the interior of the controller unit.
- 2.2.9.2 The front panel shall be electrically connected by means of Connector C3. The front panel shall be connected to equipment ground through Connector C3.
- 2.2.9.3 The character displays shall be hexadecimal with circuits to accept, store, and display four-bit binary data. The characters shall be 0.40 inches high, minimum. Each character shall have latch strobe and blanking inputs. The second character from the right (lower row) shall have a decimal point. The face of the character display shall be scratch and solvent-resistant. The transfer of data from the MPU through the output interface to the display shall result in the display of each character in its non-inverted state.
- 2.2.9.4 The front panel shall be provided with 10 LED CALL/ACTIVE indicators.
- 2.2.9.5 A keyboard shall be provided. The transfer of data from the keyboard by way of the input interface to the MPU shall result in each character being received in its non-inverted state. The character shall consist of 4 bits of binary data, while the character control shall consist of 1 bit. A low state on the character control to the interface shall indicate the presence of a valid character. Each key shall be engraved or embossed with its function character, shall have a minimum surface area of 0.075 square inch and shall be mounted on a minimum of 0.50 inch centers, shall have an actuation force between 50 and 100 grams, and shall provide a positive tactile indication of contact. Key contacts shall have a design life of over one million operations, shall be rated for the current and voltage levels used, and shall stabilize within 5 ms following contact opening.
- 2.2.9.6 The front panel shall be provided with a toggle LOGIC switch to enable the stop timing function and shall be labelled "STOP TIMING".
- 2.2.9.7 An ON-OFF toggle CONTROL switch and fuse shall be provided for AC power. The switch and fuse shall protrude through the front panel, but shall remain with the controller unit chassis when the front panel is removed. The fuse shall be a 3AG Slow Blow type, rated at either 1 or 2 amperes, dependent upon the controller unit power requirements.
- 2.2.9.8 The front panel, under the legend "OPERATING INSTRUCTIONS", shall include a framework to retain a card, 4 inches wide by 6 inches high by 0.0625 inch thick.

#### 2.2.10 Internal System Interface

- 2.2.10.1 PCB to PCB Connector spacing shall be a minimum of 1.0 inch. Continuous nylon card guides (permanent locking type) shall be provided for the modules and all internal PCBs.
- 2.2.10.2 Two PCB 22/44S Connectors shall be provided for the MODEM Modules MC1 and MC2, and two PCB 36/72S Connectors shall be provided for the M170 Connector/Program Module and the M170E Connector/M170E Auxiliary Board.
- 2.2.10.3 The depth placement of the vertical M170 Connector shall be such that the Program Module Front Panel shall be flush with the Model 170E Controller Unit Front Panel when the module is connected.

#### 2.2.11 Data and Address Bus Requirements

- 2.2.11.1 All Data Bus Buffers and Data Bus Drivers shall be tri-state buffered devices enabling them to drive a load consisting of 10 TTL gates and 200 picofarads. The propagation delay time shall be less than 30 ns.

2.2.11.2 All Address Bus Inputs shall be buffered and shall load the bus by 1 TTL gate load and 100 picofarads.

#### 2.2.12 Connector Requirements

2.2.12.1 Connector C1S shall be mounted on the controller unit providing 44 inputs and 56 outputs of control interface to and from external devices or files.

2.2.12.2 The Model 400 MODEM and ACIA connections into and out of the controller unit shall be made through Connector C2S, C20S, C30S, C40S, and Terminal Block T-1 (Type T Connector). The control and data transmission lines for ACIA 1 shall be paralleled through C2S and T-1 connectors. ACIA 2 lines shall be routed to C20S connector, ACIA 3 to C30S, and ACIA 4 to C40S.

2.2.12.3 ACIA 4 RS-232 Signal Lines and Buffered mirrored signals NMI, RES and ROT Shall be internally routed to M170 and M170E as noted in Pin Assignments under Section 5 Details.

#### 2.2.13 Communication System Interface

2.2.13.1 The communication system shall consist of the CPU, ACIAs, motherboard connectors and lines, MODEM module connectors MC1 and MC2 and interfaces between ACIA and MODEM and both MODEM and ACIA to C2S, C20S, C30S, C40S, and Connector/T-1 terminal. **The interface between the ACIA and MODEM shall comply with EIA RS-232-C Standards and all functions under T-1, C2, C20S, C30S, and C40S connectors are referenced to the ACIA. AUDIO IN and AUDIO OUT are referenced to the MODEM.** The RTS and TX data lines to the MODEM shall have MARK and SPACE voltages of -12 and 12 VDC respectively.

2.2.13.2 C20S, C30S, and C40S connectors shall meet the requirements for the C2S connector.

2.2.13.3 A minimum of four baud rate frequencies, 19.2 kHz, 38.4 kHz, 76.8 kHz and 153.6 kHz shall be provided at the ACIA Rx/Tx clock inputs (pins 3 & 4). The frequency selection shall be by post type jumpers. Each ACIA shall have independent baud rate selection with jumpers delivered pinned for 19.2 kHz.

#### 2.2.14 Electrical Requirements

2.2.14.1 The front panel and chassis shall be connected to equipment ground.

2.2.14.2 A surge arrestor shall be provided between the AC+ and AC- for protection against powerline noise transients. The surge arrestor shall meet the following requirements:

Recurrent Peak Voltage:	212 volts
Energy Rating Maximum:	20 Joules
Power Dissipation, Average:	0.85 Watt
Peak Current for Pules less than 6 us:	200 Amperes
Standby Currents:	less than 1 ma

2.2.14.3 Two 0.5 ohm, 10 watt wire-wound power resistors with a 0.2 uH inductance shall be provided (1 on the AC+ power line and 1 on the AC- line). Three surge arresters rated for 20 Joules shall be supplied between AC+ and ground, AC- and ground, and between AC+ and AC-. A 0.68 uF capacitor shall be added between AC+ and AC- coming off the 0.5 Ohm resistor going to the surge arresters.

2.2.14.4 The AC power to the controller unit shall be supplied by a three conductor cable at least three feet in length. The cable shall terminate in a NEMA Type 5-15P grounding type plug.

- 2.2.14.5 Test points shall be provided for monitoring all power supply voltages. All test points shall be readily accessible when the front panel is opened. Any provided test point shall be isolated such that attaching a test probe shall not impact the operation of the controller unit. The test points shall be post type, 0.0625 inch diameter and 0.1875 inch high, minimum. The clearance between test points and other components shall be 0.25 inch, minimum.

### **2.2.15 M170E Auxiliary Board**

- 2.2.15.1 The M170E Auxiliary Board shall contain the RTCA circuitry and the identification switches. (See Section 3 for the RTCA circuitry and the identification switch requirements). The RTCA circuitry and the identification switches on the M170E Auxiliary Board shall be disabled when a Model 412C is installed. The M170 connector pins 71 and/or 72 shall provide a DC ground path via the Model 412C module (pins 69 & 70) to M170E connector (pins 71 & 72). A ground true present shall cause board feature disablement.
- 2.2.15.2 The M170E Auxiliary Board's PCB dimensions shall be identical to the Model 400 Modem except for the PCB edge connector dimensions.
- 2.2.15.3 The M170E Auxiliary Board's PCB connector shall be a PCB 36/72P and shall mate with the M170E connector.

## **2.3 SECTION 3 - MODEL 412C PROGRAM MODULE**

### **2.3.1 General Requirements**

- 2.3.1.1 A device shall be provided to prevent the module, when inserted upside down, from making contact with the module's mating connector within the controller unit.
- 2.3.1.2 The module PCB connector shall be provided with electrostatic charge protection to prevent CMOS device damage.
- 2.3.1.3 The VMA/Phase 2 (E) Clock Signal (M170 Pin 25) shall not be used in a memory device READ operation.
- 2.3.1.4 The total module current requirements shall not exceed 450 ma at +12 VDC and 100 ma at +5 VDC.
- 2.3.1.5 Address 700E, Bit 8 shall permanently read as "1". This bit state is used to differentiate between past delivered Model 412/64 modules (Bit 8 decoded "0") and the Model 412 module.
- 2.3.1.6 The module PCB connector shall be a PCB 36/72P.
- 2.3.1.7 The module front panel shall be connected to equipment ground at M170 Pin 34.
- 2.3.1.8 All addressable devices shall be fully decoded.
- 2.3.1.9 All memory sockets shall be a 28 pin AUGAT #528/828 series AG10DPC or equal.

### **2.3.2 Feature Requirements**

#### **2.3.2.1 Bus Inputs and Outputs**

- 2.3.2.1.1 All data lines shall be tri-state buffered on the module enabling them to drive a load consisting of 10 TTL gates and 200 picofarads. When this module is not being

addressed, the data output shall be disabled into a high impedance state and the data lines shall not source or sink more than 100 ua.

- 2.3.2.1.2 All addressed input lines shall load the bus by 1 TTL gate load and 100 picofarads. The propagation delay time shall be less than 30 ns.

2.3.2.2. Memory

- 2.3.2.2.1 Four numbered memory sockets shall be provided and fully decoded using the following method. The module shall be delivered with MEMORY SELECT #3 Configuration designated memory devices (or equal), address decoders and jumpers.

- 2.3.2.2.2 Device manufacturer is designated as INT-Intel, D-Dallas and HD-Hitachi. The sockets shall be decoded by block jumper selection as follows:

	MEMORY	SOCKET	ADDRESS RANGE	AND DEVICE	JUMPER PATTERN		
SELECT	U1	U2	U3	U4	1	2	3
1.	E000-FFFF INT2764A	C000-DFFF INT2764A	7010-7FFF DAL1225	1000-4FFF HD6264 or HD62256	IN	IN	OUT
2.	C000-FFFF INT128A	8000-BFFF INT128A	SAME	SAME	OUT	IN	IN
3.	8000-FFFF	NOT ADRS	SAME	SAME*	OUT	IN	IN
4.	8000-FFFF INT27256A	3000-4FFF DAL1225	SAME	1000-2FFF SAME*	OUT	OUT	OUT

\*The Pin #26 jumper pattern shall provide either address line 13 for the HD62256 device or tied HIGH for CS2 function in HD6264. Pin 27 shall be assigned to WE function.

- 2.3.2.2.3 Jumper positions for Sockets U2 and U4 shall be provided to convert the sockets from an EPROM socket to a SRAM socket or vice versa. Jumper positions for Sockets U2, U3 and U4 shall be provided to convert the socket from a nonstandby power socket to a standby power socket or vice versa. Sockets U2 and U3 shall be jumpered for nonstandby power. Socket U4 shall be jumpered for standby power.

- 2.3.2.2.4 A Write Protect Circuit (WPC) shall be provided to prevent writing to SRAM memory during the controller unit MPU RESET interrupt line in a LOW state. A WRITE to ADDRESS 7000 shall be decoded and shall activate the WPC to place the R/W in a READ ONLY state. A subsequent WRITE to ADDRESS 7000 shall be decoded and shall deactivate the WPC allowing R/W function. The WPC state shall be brought out to Address 700E, Bit 7 ("1" State means "active"). The WPC power drain shall not exceed 40 ua at +5 VDC.

2.3.2.3 Module Power Supply

- 2.3.2.3.1 A power supply shall be provided onboard the module consisting of a DC Regulation Circuit, standby power and all necessary support circuitry.

- 2.3.2.3.2 A DC Regulator device with its circuitry shall be provided to reduce the +12 VDC to +5 VDC for module use. The Regulator shall have a minimum efficiency of 75% and provide +5 +/-0.25 VDC from no load to full load with a maximum of 2% ripple.
- 2.3.2.3.3 Standby power shall be provided to holdup WPC, SRAM and RTCA circuits during a Model 170E controller unit power failure. A circuit shall be provided to sense the +12 VDC M170 power line and switch to standby power when the line falls below +9 VDC. The standby power circuit shall switch off when the power line is greater than +11 VDC. The standby power shall be a standard "AA" cap terminal cell battery rated at a minimum of 1.6 ampere-hours at 3.7 +/-0.2 VDC. All module circuitry and devices shall not exceed a maximum power drain of 2 ma at 3.7 VDC on the Standby Battery.
- 2.3.2.3.4 The battery shall be delivered separate from the module. It shall not be used except for test loading check by the Contractor.
- 2.3.2.3.5 A battery holder for "AA" battery shall be provided securely mounted to the back of the front panel. The holder shall have a TAB header type connector attached to the battery pus mounting terminal.

2.3.2.4 Identification Switch Circuitry

- 2.3.2.4.1 Two identification switch packages and associated circuitry shall be provided. The switch packages shall be decoded at Address 7000 (features) and 7001 (locations). Each package shall have 8 SPST switch positions with each switch associated to a DATA Bit (Switch 1 to Bit 1 and so on). Switch ON shall denote bit state "1" to the 170 CPU and switch OFF shall denote bit state "0" to the 170 CPU.
- 2.3.2.4.2 The switch package shall be a DIP slide type and shall have recessed switches to prevent accidental switching.

2.3.2.5 Real Time Clock Adjuster (RTCA)

- 2.3.2.5.1 A RTCA shall be provided to adjust for missing RTC timing interrupts.
- 2.3.2.5.2 The RTCA shall be continuously powered and not affected by a controller unit power failure. RTCA accuracy shall be +/-10 ppm at 25 degrees C. Integral devices incorporating RTCA features and functions may be used in lieu of individual components. The RTCA current drain shall not exceed 1.0 ma at +3.7 VDC.
- 2.3.2.5.3 The RTCA shall include a free running 60 Hz Pulse PG, a 24 bit binary counter counting 60 Hz pulses, 4 eight-bit buffer ports and port decode/PG interrupt logic. The PG shall trigger binary counter to increment on every input pulse, counting continuously until reset to 0 by its reset line. Bits 21, 22, 23 and 24 in an all "1"'s state shall cause that PG to be disabled (Binary Counter Bit 1 is the least significant bit).
- 2.3.2.5.4 The counter bits shall be continuously read out to four 8 bit buffer ports. The ports shall be addressed and bits assigned as follows:

CPU ADDRESS	PORT BITS	COUNTER BITS	COMMENTS
700A			This address shall normally READ (decode) "55 HEX". If the standby power supply fails or is removed, it shall decode "54 HEX". A WRITE to this address will RESET the RTCA Binary Counter.

700B	1-6	1-6	READ only
700C	1-6	7-12	READ only
700D	1-6	13-18	READ only
700E	1-6	19-24	READ only

- 2.3.2.5.5 A SPST finger throw LOGIC switch shall be provided on the board to activate/deactivate standby power to the RTCA circuitry. With the switch in deactivated state the RTCA circuitry shall present NO power drain to the standby power supply.

## 2.4 SECTION 4 - MODEL 172 CONTROLLER MODULE

### 2.4.1 (FUTURE)

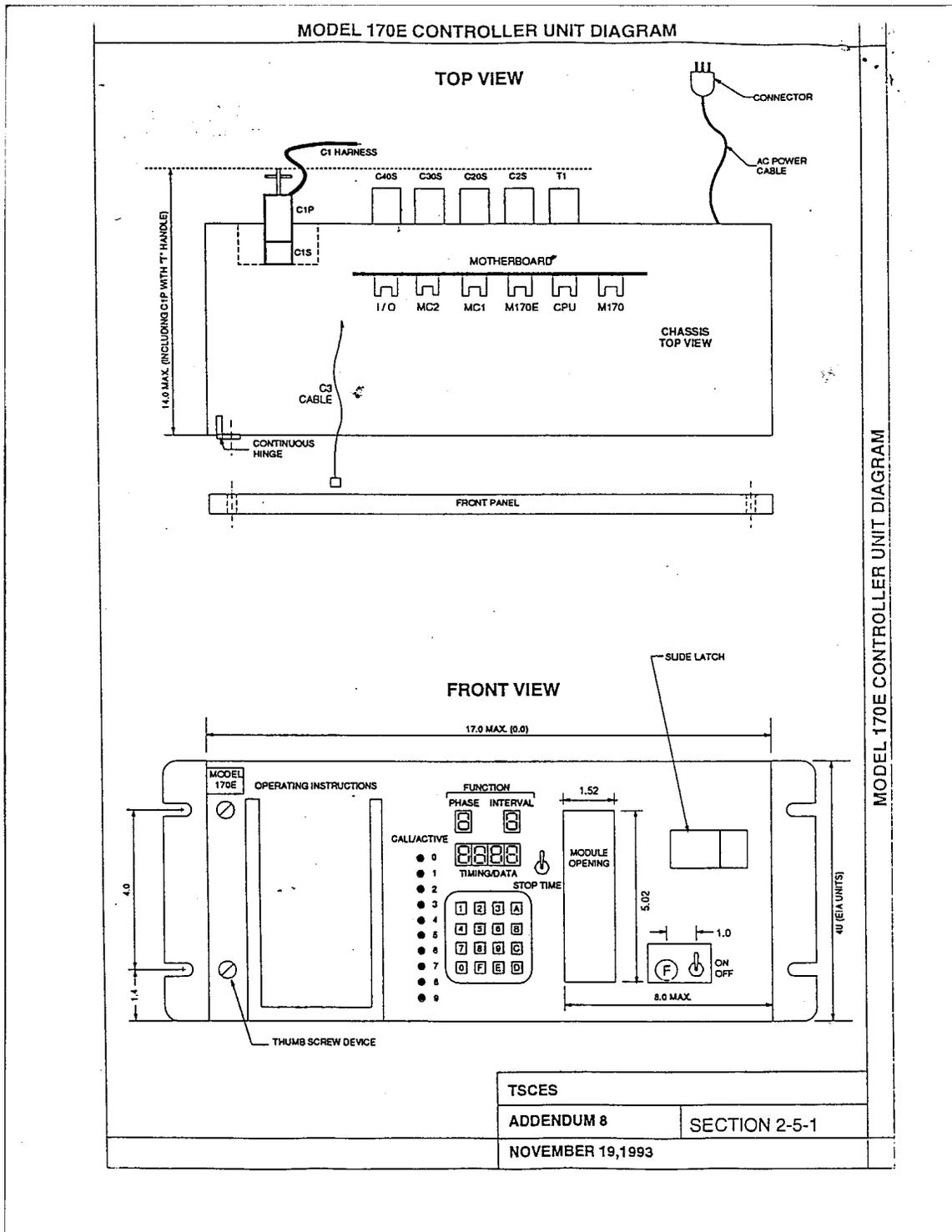
## 2.5 SECTION 5 - CHAPTER DETAILS

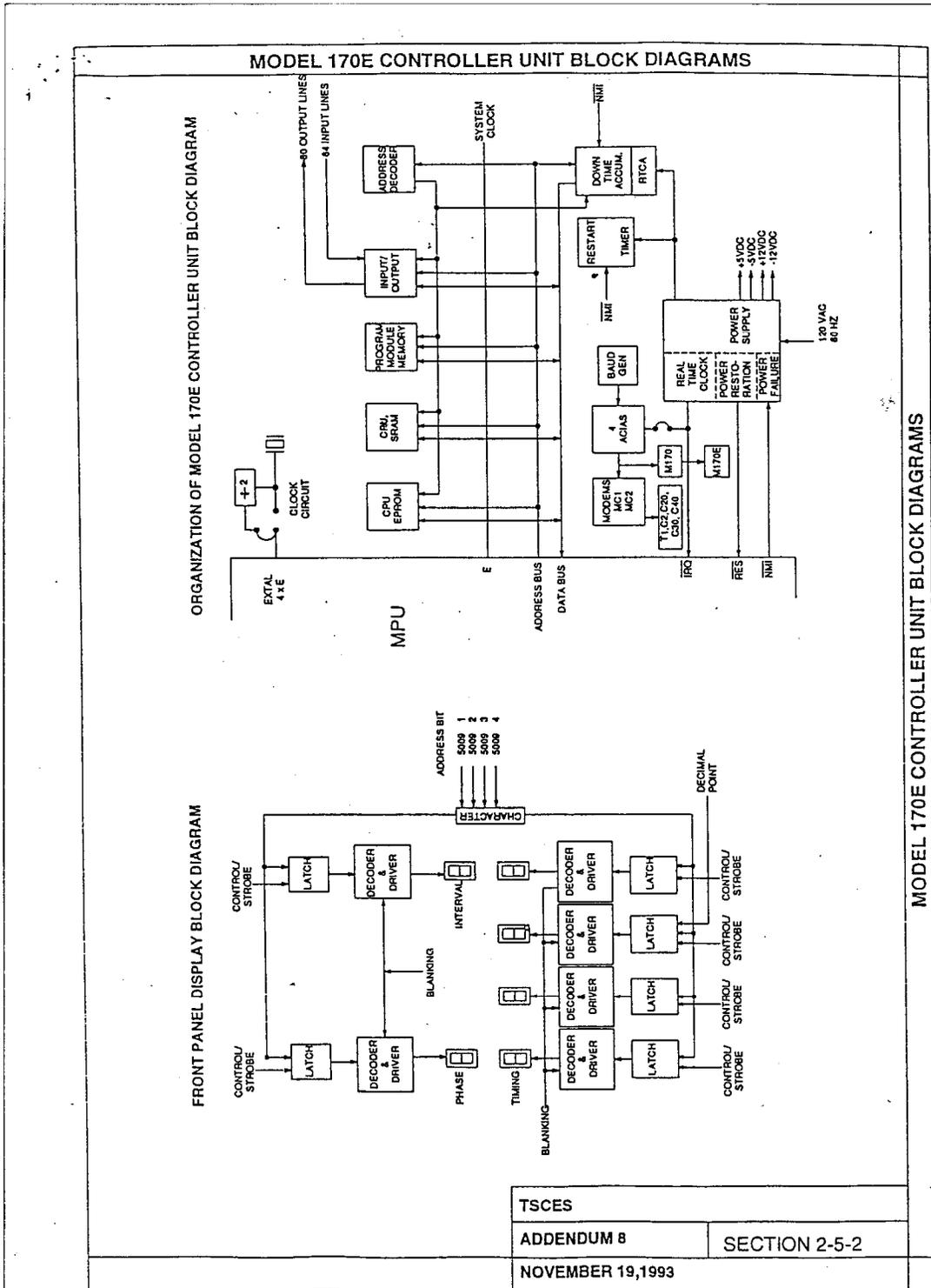
### SECTION

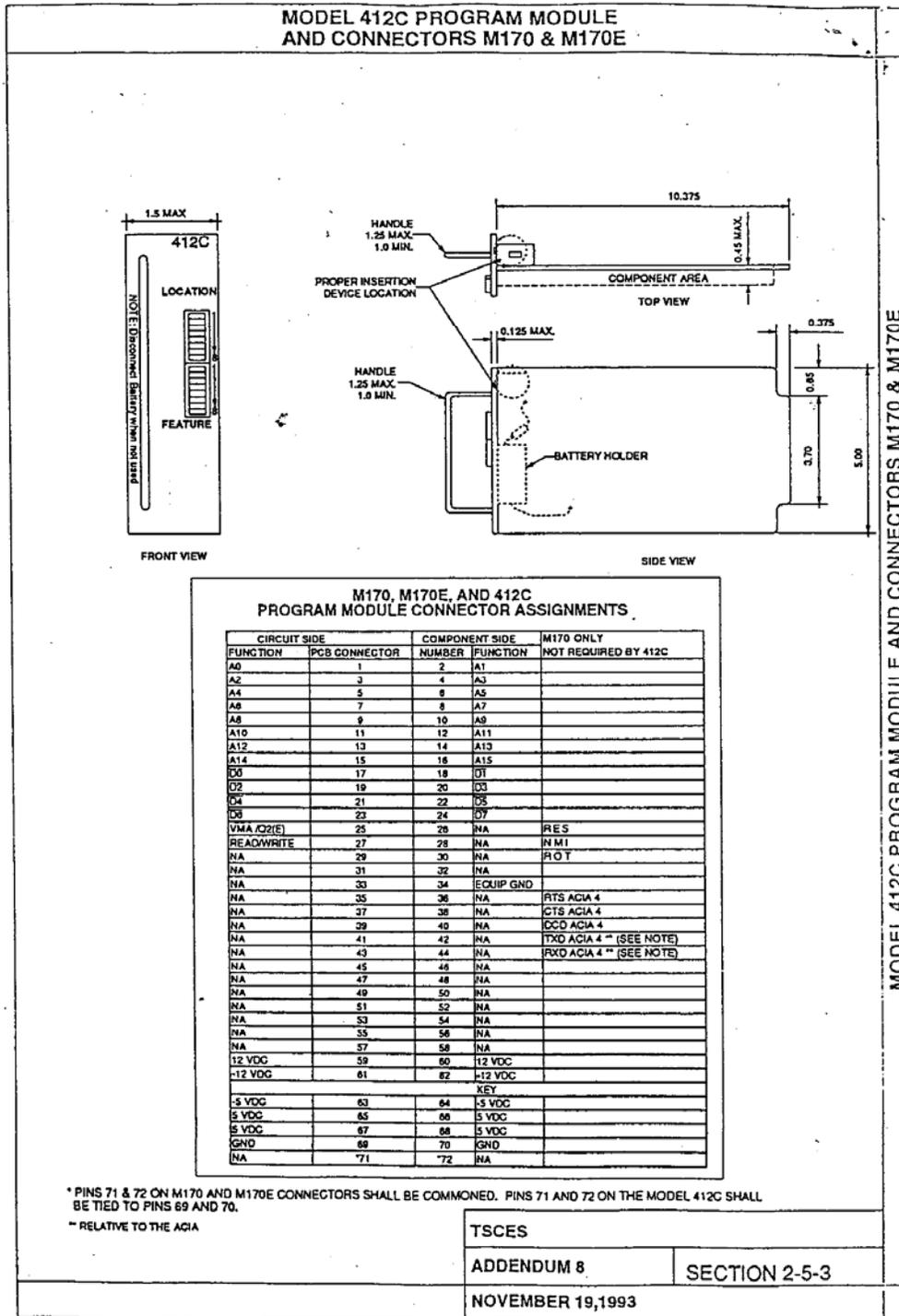
MODEL 170E CONTROLLER UNIT DIAGRAM	35
MODEL 170E CONTROLLER UNIT BLOCK DIAGRAMS	36
MODEL 412C PROGRAM MODULE AND CONNECTORS M170 & M170E	37
C1 CONNECTOR DETAIL	38
C1 AND C3 CONNECTOR ADDRESS ASSIGNMENTS	39
C2, C20, C30, AND C40 CONNECTOR DETAIL	40
MC1, MC2, AND BACKPLANE COMMUNICATION CONNECTORS	41

### NOTES for these sections:

1. All dimensions are in inches unless otherwise noted.
2. Pins not assigned can not be used by the Contractor for other purposes.









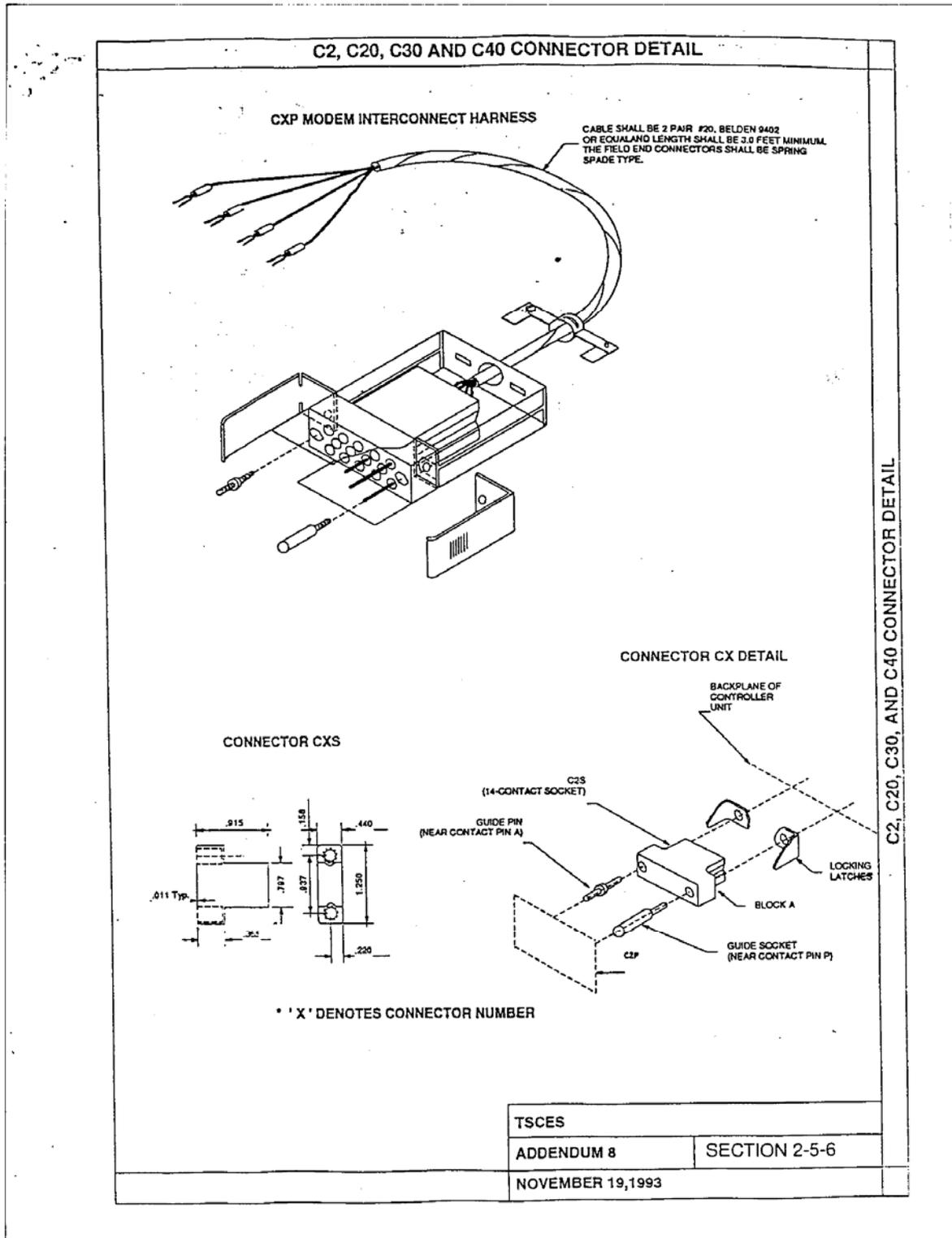
C1 AND C3 CONNECTOR ADDRESS ASSIGNMENTS

**INPUT PORT ADDRESS ASSIGNMENTS  
 FOR CONNECTORS C1 AND C3**

INPUT PORT ADDRESS	CONNECTOR C1	CONNECTOR C3	BIT	SOCKET CONTACTS	ADDRESS	BIT	SOCKET CONTACTS
5001	1	39	1	39	5005	1	87
5001	2	40	2	40	5005	2	88
5001	3	41	3	41	5005	3	89
5001	4	42	4	42	5005	4	90
5001	5	43	5	43	5005	5	91
5001	6	44	6	44	5005	6	92
5001	7	45	7	45	5005	7	93
5001	8	46	8	46	5005	8	94
5002	1	47	1	47	5009	1	75
5002	2	48	2	48	5009	2	76
5002	3	49	3	49	5009	3	77
5002	4	50	4	50	5009	4	78
5002	5	51	5	51	5009	5	79
5002	6	52	6	52	5009	6	80
5002	7	53	7	53	5009	7	81
5002	8	54	8	54	5009	8	82
5003	1	55	1	55	5009	1	83
5003	2	56	2	56	5009	2	84
5003	3	57	3	57	5009	3	85
5003	4	58	4	58	5009	4	86
5003	5	59	5	59	5009	5	87
5003	6	60	6	60	5009	6	88
5003	7	61	7	61	5009	7	89
5003	8	62	8	62	5009	8	90
5004	1	NA	1	NA	5004	1	NA
5004	2	NA	2	NA	5004	2	NA
5004	3	NA	3	NA	5004	3	NA
5004	4	NA	4	NA	5004	4	NA
5004	5	NA	5	NA	5004	5	NA
5004	6	NA	6	NA	5004	6	NA
5004	7	NA	7	NA	5004	7	NA
5004	8	NA	8	NA	5004	8	NA

**OUTPUT PORT ADDRESS ASSIGNMENTS  
 FOR CONNECTORS C1 AND C3**

OUTPUT PORT ADDRESS	CONNECTOR C1	CONNECTOR C3	BIT	SOCKET CONTACTS	ADDRESS	BIT	SOCKET CONTACTS
5001	1	43	1	43	5004	1	83
5001	2	44	2	44	5004	2	84
5001	3	45	3	45	5004	3	85
5001	4	46	4	46	5004	4	86
5001	5	47	5	47	5004	5	87
5001	6	48	6	48	5004	6	88
5001	7	49	7	49	5004	7	89
5001	8	50	8	50	5004	8	90
5002	1	10	1	10	5007	1	81
5002	2	11	2	11	5007	2	82
5002	3	12	3	12	5007	3	83
5002	4	13	4	13	5007	4	84
5002	5	14	5	14	5007	5	85
5002	6	15	6	15	5007	6	86
5002	7	16	7	16	5007	7	87
5002	8	17	8	17	5007	8	88
5003	1	18	1	18	5007	1	89
5003	2	19	2	19	5007	2	90
5003	3	20	3	20	5007	3	91
5003	4	21	4	21	5007	4	92
5003	5	22	5	22	5007	5	93
5003	6	23	6	23	5007	6	94
5003	7	24	7	24	5007	7	95
5003	8	25	8	25	5007	8	96
5004	1	26	1	26	5007	1	97
5004	2	27	2	27	5007	2	98
5004	3	28	3	28	5007	3	99
5004	4	29	4	29	5007	4	100
5004	5	30	5	30	5007	5	101
5004	6	31	6	31	5007	6	102
5004	7	32	7	32	5007	7	103
5004	8	33	8	33	5007	8	104
5004	1	34	1	34	5007	1	105
5004	2	35	2	35	5007	2	106
5004	3	36	3	36	5007	3	107
5004	4	37	4	37	5007	4	108
5004	5	38	5	38	5007	5	109
5004	6	39	6	39	5007	6	110
5004	7	40	7	40	5007	7	111
5004	8	41	8	41	5007	8	112
5004	1	42	1	42	5007	1	113
5004	2	43	2	43	5007	2	114
5004	3	44	3	44	5007	3	115
5004	4	45	4	45	5007	4	116
5004	5	46	5	46	5007	5	117
5004	6	47	6	47	5007	6	118
5004	7	48	7	48	5007	7	119
5004	8	49	8	49	5007	8	120
5004	1	50	1	50	5007	1	121
5004	2	51	2	51	5007	2	122
5004	3	52	3	52	5007	3	123
5004	4	53	4	53	5007	4	124
5004	5	54	5	54	5007	5	125
5004	6	55	6	55	5007	6	126
5004	7	56	7	56	5007	7	127
5004	8	57	8	57	5007	8	128
5004	1	58	1	58	5007	1	129
5004	2	59	2	59	5007	2	130
5004	3	60	3	60	5007	3	131
5004	4	61	4	61	5007	4	132
5004	5	62	5	62	5007	5	133
5004	6	63	6	63	5007	6	134
5004	7	64	7	64	5007	7	135
5004	8	65	8	65	5007	8	136
5004	1	66	1	66	5007	1	137
5004	2	67	2	67	5007	2	138
5004	3	68	3	68	5007	3	139
5004	4	69	4	69	5007	4	140
5004	5	70	5	70	5007	5	141
5004	6	71	6	71	5007	6	142
5004	7	72	7	72	5007	7	143
5004	8	73	8	73	5007	8	144
5004	1	74	1	74	5007	1	145
5004	2	75	2	75	5007	2	146
5004	3	76	3	76	5007	3	147
5004	4	77	4	77	5007	4	148
5004	5	78	5	78	5007	5	149
5004	6	79	6	79	5007	6	150
5004	7	80	7	80	5007	7	151
5004	8	81	8	81	5007	8	152
5004	1	82	1	82	5007	1	153
5004	2	83	2	83	5007	2	154
5004	3	84	3	84	5007	3	155
5004	4	85	4	85	5007	4	156
5004	5	86	5	86	5007	5	157
5004	6	87	6	87	5007	6	158
5004	7	88	7	88	5007	7	159
5004	8	89	8	89	5007	8	160
5004	1	90	1	90	5007	1	161
5004	2	91	2	91	5007	2	162
5004	3	92	3	92	5007	3	163
5004	4	93	4	93	5007	4	164
5004	5	94	5	94	5007	5	165
5004	6	95	6	95	5007	6	166
5004	7	96	7	96	5007	7	167
5004	8	97	8	97	5007	8	168
5004	1	98	1	98	5007	1	169
5004	2	99	2	99	5007	2	170
5004	3	100	3	100	5007	3	171
5004	4	101	4	101	5007	4	172
5004	5	102	5	102	5007	5	173
5004	6	103	6	103	5007	6	174
5004	7	104	7	104	5007	7	175
5004	8	105	8	105	5007	8	176
5004	1	106	1	106	5007	1	177
5004	2	107	2	107	5007	2	178
5004	3	108	3	108	5007	3	179
5004	4	109	4	109	5007	4	180
5004	5	110	5	110	5007	5	181
5004	6	111	6	111	5007	6	182
5004	7	112	7	112	5007	7	183
5004	8	113	8	113	5007	8	184
5004	1	114	1	114	5007	1	185
5004	2	115	2	115	5007	2	186
5004	3	116	3	116	5007	3	187
5004	4	117	4	117	5007	4	188
5004	5	118	5	118	5007	5	189
5004	6	119	6	119	5007	6	190
5004	7	120	7	120	5007	7	191
5004	8	121	8	121	5007	8	192
5004	1	122	1	122	5007	1	193
5004	2	123	2	123	5007	2	194
5004	3	124	3	124	5007	3	195
5004	4	125	4	125	5007	4	196
5004	5	126	5	126	5007	5	197
5004	6	127	6	127	5007	6	198
5004	7	128	7	128	5007	7	199
5004	8	129	8	129	5007	8	200
5004	1	130	1	130	5007	1	201
5004	2	131	2	131	5007	2	202
5004	3	132	3	132	5007	3	203
5004	4	133	4	133	5007	4	204
5004	5	134	5	134	5007	5	205
5004	6	135	6	135	5007	6	206
5004	7	136	7	136	5007	7	207
5004	8	137	8	137	5007	8	208
5004	1	138	1	138	5007	1	209
5004	2	139	2	139	5007	2	210
5004	3	140	3	140	5007	3	211
5004	4	141	4	141	5007	4	212
5004	5	142	5	142	5007	5	213
5004	6	143	6	143	5007	6	214
5004	7	144	7	144	5007	7	215
5004	8	145	8	145	5007	8	216
5004	1	146	1	146	5007	1	217
5004	2	147	2	147	5007	2	218
5004	3	148	3	148	5007	3	219
5004	4	149	4	149	5007	4	220
5004	5	150	5	150	5007	5	221
5004	6	151	6	151	5007	6	222
5004	7	152	7	152	5007	7	223
5004	8	153	8	153	5007	8	224
5004	1	154	1	154	5007	1	225
5004	2	155	2	155	5007	2	226
5004	3	156	3	156	5007	3	227
5004	4	157	4	157	5007	4	228
5004	5	158	5				



**MC1, MC2, AND BACKPLANE COMMUNICATION CONNECTIONS**

**C2P, C20P, C30P, AND C40P CONNECTOR ASSIGNMENT**

PIN	FUNCTION	WIRE COLOR
A	AUDIO IN	WHITE
B	AUDIO IN	BLACK
C	AUDIO OUT	RED
E	AUDIO OUT	GREEN

**MC1 AND MC2 CONNECTOR PIN ASSIGNMENTS \***

MC1		MC2	
PIN	FUNCTION	PIN	FUNCTION
2	MODEM 1 AUDIO IN	A	DC GROUND
3	MODEM 1 AUDIO IN	B	DC GROUND
9	ACIA 2 DCD**	C	+12 VDC
10	ACIA 2 RTS**	D	+12 VDC
11	ACIA 2 TXD**	E	-12 VDC
12	ACIA 2 CTS**	F	-12 VDC
13	ACIA 2 RXD**	K	ACIA 1 DCD**
19	MODEM 2 AUDIO OUT	L	ACIA 1 RTS**
20	MODEM 2 AUDIO OUT	M	ACIA 1 TXD**
21	MODEM 2 AUDIO OUT	N	ACIA 1 CTS**
22	MODEM 2 AUDIO IN	P	ACIA 1 RXD**
		X	MODEM 3 AUDIO OUT
		Y	MODEM 1 AUDIO OUT

**BACKPLANE COMMUNICATIONS CONNECTIONS\***

T1 (ACIA1/MODEM 1)		C2S		C20S	
PIN	FUNCTION	PIN	FUNCTION	PIN	FUNCTION
1	AUDIO IN	A	MODEM 1 AUDIO IN	A	MODEM 2 AUDIO IN
2	AUDIO IN	B	MODEM 1 AUDIO IN	B	MODEM 2 AUDIO IN
3	DCD**	C	MODEM 1 AUDIO OUT	C	MODEM 2 AUDIO OUT
4	RTS**	D	+5 VDC	D	+5 VDC
5	TXD**	E	MODEM 1 AUDIO OUT	E	MODEM 2 AUDIO OUT
6	CTS**	F	-5 VDC	F	-5 VDC
7	RXD**	H	ACIA 1 DCD**	H	ACIA 2 DCD**
8	AUDIO OUT	J	ACIA 1 RTS**	J	ACIA 2 RTS**
9	AUDIO OUT	K	ACIA 1 TXD**	K	ACIA 2 TXD**
10	DC GND	L	ACIA 1 RXD**	L	ACIA 2 RXD**
		M	ACIA 1 CTS**	M	ACIA 2 CTS**
		N	DC GND	N	DC GND
		P	+12 VDC	P	+12 VDC
		R	-12 VDC	R	-12 VDC

C30S		C40S	
PIN	FUNCTION	PIN	FUNCTION
A	MODEM 3 AUDIO IN	A	MODEM 4 AUDIO IN
B	MODEM 3 AUDIO IN	B	MODEM 4 AUDIO IN
C	MODEM 3 AUDIO OUT	C	MODEM 4 AUDIO OUT
D	+5 VDC	D	+5 VDC
E	MODEM 3 AUDIO OUT	E	MODEM 4 AUDIO OUT
F	-5 VDC	F	-5 VDC
H	ACIA 3 DCD**	H	ACIA 4 DCD**
J	ACIA 3 RTS**	J	ACIA 4 RTS**
K	ACIA 3 TXD**	K	ACIA 4 TXD**
L	ACIA 3 RXD**	L	ACIA 4 RXD**
M	ACIA 3 CTS**	M	ACIA 4 CTS**
N	DC GND	N	DC GND
P	+12 VDC	P	+12 VDC
R	-12 VDC	R	-12 VDC

DEFINITIONS:  
 TXD: TRANSMIT DATA LINE  
 RXD: RECEIVE DATA LINE

- ACIA 1 - C2S/MODEM #1
- ACIA 2 - C20S/MODEM #2
- ACIA 3 - C30S/MODEM #3
- ACIA 4 - C40S/M170/M170E/MODEM #4

\* PINS NOT ASSIGNED SHALL NOT BE USED BY THE CONTRACTOR FOR OTHER PURPOSES.  
 \*\* RELATIVE TO THE ACIA

TSCS

ADDENDUM 8

SECTION 2-5-7

NOVEMBER 19, 1993

MC1, MC2, AND BACKPLANE COMMUNICATION CONNECTIONS

## CHAPTER 3

### SPECIFICATIONS FOR MODEL 200 SWITCH PACK AND MODEL 204 FLASHER UNIT MODULES

#### TABLE of CONTENTS

<b>SECTION 1 - GENERAL REQUIREMENTS</b>	43
<b>SECTION 2 - MODEL 200 REQUIREMENTS</b>	43
<b>SECTION 3 - MODEL 204 REQUIREMENTS</b>	44

### **3.1 SECTION 1 - GENERAL REQUIREMENTS**

- 3.1.1 The module chassis providing rigid unit support (for connector mounting, PCB support, module alignment and insertion/removal) and Triac heat sinking shall be made of metal suitable to meet support and environmental requirements. Where electrical isolation protection is the only requirement, plastic insulation material may be used in lieu of metal.
- 3.1.2. Module control circuitry and switches shall be readily accessible by the use of a screwdriver or wrench. Only one type of screw head end (slotted or Phillips) shall be used throughout.
- 3.1.3. Each module shall be so constructed that persons inserting or removing the module will not be exposed to any parts having live voltage. A handle shall be attached to the front of each module to facilitate the module insertion or removal from its mating connector.
- 3.1.4 The module shall be so constructed that its lower surface will be no more than 2.10 inches below the centreline of the connector and that no part will extend more than 0.90 inch to the left or 1.10 inches to the right of the centreline of the connector pin array.
- 3.1.5 Continuous edge guides shall be provided on the module.
- 3.1.6 The front panel of the module shall be provided with one indicator per switch. The indicators shall be vertically centred on the front panel with top and bottom indicators no more than one inch from the panel vertical centre.
- 3.1.7 Each switch shall have the capability of switching any current from 0.05 to 10 amperes (AC) of tungsten lamp load or 10 amperes (AC) at a power factor of 0.85.
- 3.1.8 Each switch shall turn ON within  $\pm 5$  degrees of the zero voltage point of the AC sinusoidal line, and shall turn OFF within  $\pm 5$  degrees of the zero current point of the alternating current sinusoidal line. After power restoration, the zero voltage turn ON may be within  $\pm 10$  degrees of the zero voltage point only during the first half cycle of line voltage during which an input signal is applied. Turn ON and OFF shall be within 8.33 ms following application or removal of the logic signal, respectively.
- 3.1.9 Each switch shall be designed for a minimum of 300 million operations while switching a tungsten filament load of 1,000 watts at 70o C.
- 3.1.10 Each switch shall have isolation between input DC control and AC to lights output circuit of at least 2,000 VDC and 10,000 megohms DC.
- 3.1.11 Each switch shall have a one cycle surge rating of 175 amperes RMS and a one second surge rating of 40 amperes RMS.
- 3.1.12 Each switch shall be capable of withstanding a peak inverse voltage of 500 volts at 70 degrees C and no more than 20 ma leakage.
- 3.1.13 The connector plug contact tails shall be solder hook or eye styles only. PCB (soldered to the PCB) and quick connect connections styles are not allowed.

### **3.2 SECTION 2 - MODEL 200 REQUIREMENTS**

- 3.2.1 The Model 200 Solid State Switch Pack shall be a modular plug-in device containing 3 solid state switches to be used for opening and closing connections between the applied power and an external load.

- 3.2.2 A LOW state input (negative true logic) from the controller unit (saturated NPN transistor, 0 to 6 VDC) shall cause the switch to be energized. A HIGH state input (cut-off NPN transistor, 16 VDC or greater) shall cause the switch to de-energize. The state transition (conducting to nonconducting or vice versa) shall occur between 6 and 16 VDC.
- 3.2.3 The incoming logic signal shall not sink more than 20 ma nor be subjected to more than 30 VDC.
- 3.2.4 The module shall not draw more than 60 ma at +16 VDC or greater from the cabinet power supply with all switches ON.
- 3.2.5 Each switch shall have a OFF state dv/dt rating of 100 volts per us or greater.
- 3.2.6 The indicators shall be labeled or colour coded from top to bottom "Red", "Yellow" and "Green". Each indicator shall indicate a controller unit output circuit.
- 3.2.7 The input circuit of each switch shall have reverse polarity protection.
- 3.2.8 The resistance between the AC+ input terminal and the AC+ output terminal of each switch shall be 15,000 ohms, minimum, when the switch is in the open position. The output current from the switch through the load when the load switch is in the OFF state shall not exceed 20 ma peak.
- 3.2.9 Each switch shall be isolated so that line transients or switch failure will not adversely affect the controller unit.
- 3.2.10 The Plug Connector shall be a BEAU P-5412-LAB or equal.

### **3.3 SECTION 3 - MODEL 204 REQUIREMENTS**

- 3.3.1 The Model 204 Flasher Unit shall be a modular plug-in device containing a flasher control circuit and 2 solid state switches. The module's function is to alternately open and close connections between the applied power and an external lamp load during flashing operation.
- 3.3.2 The module shall generate its own internal DC power for logic and control from the AC Line.
- 3.3.3 The module shall commence flashing operation when AC power is applied to the module.
- 3.3.4 The circuit shall provide 50 to 60 flashes per minute with a 50% duty cycle.
- 3.3.5 A surge arrestor shall be provided between AC+ (pin 11) and Flasher Out (pins 7 & 8). The surge arrestor shall be capable of reducing the effects of a transient voltage applied to the field signal circuits, and shall have the following ratings:

Recurrent peak voltage	212 Volts
Energy rating, maximum	50 Joules
Power dissipation, average	0.85 Watt
Standby current for pulses less than 6 us:	2000 Amperes
Standby current: less than	1 ma
- 3.3.6 Each switch shall have an OFF state dv/dt rating of 200 volts per us or greater.
- 3.3.7 The indicators shall indicate the output state of the switches.
- 3.3.8 The Plug Connector shall be a BEAU P-5406-LAB or equal.
- 3.3.9 Each circuit shall be designed to operate in an open circuit (without load) condition for 10 years or greater.

**CHAPTER 4**  
**SPECIFICATIONS FOR MODEL 208**  
**AND 210 MONITOR UNITS**

TABLE OF CONTENTS

<b>SECTION 1 -</b>	GENERAL REQUIREMENTS	47
<b>SECTION 2 -</b>	POWER SUPPLY MONITOR REQUIREMENT	47
<b>SECTION 3 -</b>	WATCHDOG TIMER MONITOR REQUIREMENTS	48
<b>SECTION 4 -</b>	MODEL 208 REQUIREMENTS	48
<b>SECTION 5</b>	MODEL 210 REQUIREMENTS	48

#### **4.1 SECTION 1 - GENERAL REQUIREMENTS**

4.1.1 The Monitor Unit shall render reliable detection and cause a relay output contact condition (FAILED state) when sensing the following:

4.1.1.1 MODEL 208 MONITOR UNIT

1. The +24 VDC Power Supply Voltage below specified threshold
2. A WDT Timeout Condition

4.1.1.2 MODEL 210 MONITOR UNIT

1. The +24 VDC Power Supply Voltage below specified threshold
2. A WDT Timeout Condition
3. Conflicting Field Output Circuits ON together

4.1.2 FAILED State Output Circuits

4.1.2.1 An electro-mechanical relay shall be provided to switch an output circuit during a FAILED state. The relay coil shall be energized in a NON FAILED state.

4.1.2.2 The relay contacts shall be rated for a minimum of 3 amperes at 120 VAC and 100,000 operations. Contact opening/closing time shall be 30 ms or less.

4.1.2.3 Monitor Unit Reset

4.1.2.3.1 A momentary SPST CONTROL switch labeled "RESET" shall be provided on the unit front panel to reset the monitor unit circuitry to a NON FAILED state. The switch shall be so positioned on the front panel that the switch can be operated while gripping the front panel handle.

4.1.2.3.2 A reset issuance (Unit Reset) shall be a onetime input to prevent the monitor from constant reset.

4.1.2.4 All monitor logic and driver power shall be generated from an internal unit power supply except for WDT and +24 VDC cabinet voltage sense circuits. The WDT sense circuit power may be derived from either power supply. Circuits on the monitor that are "powered" by the +24 VDC cabinet power supply shall be optically isolated from those deriving their power from the monitor unit internal supply. The monitor shall not draw more than 500 ma from the +24 VDC cabinet power supply. Failure to provide reliable operating voltage levels shall cause a FAILED state.

#### **4.2 SECTION 2 - POWER SUPPLY MONITOR REQUIREMENTS**

4.2.1 The monitor unit shall sense an external +24 VDC power supply output voltage.

4.2.2 Voltages sensed at +18 VDC or below for a duration of 500 ms or longer shall cause a FAILED state.

4.2.3 Voltages sensed at +22 VDC or above shall NOT cause a FAILED state.

4.2.4 Voltages sensed below +22 VDC for a duration of 200 ms or less shall NOT cause a FAILED state.

4.2.5 All timing and voltage conditions other than those specified above may or may not cause a FAILED state.

4.2.6 A FAILED state caused by sensing the power supply shall illuminate a front panel indicator light labeled "VDC FAILED". The indicator light shall remain ON until Unit Reset.

4.2.7 Only Unit Reset shall reset the power supply sense circuitry from a FAILED state.

### 4.3 SECTION 3 - WATCHDOG TIMER MONITOR REQUIREMENTS

4.3.1 WDT Circuitry shall be provided to monitor a controller unit output line state routed to the monitor unit at its assigned pin. The WDT Circuitry shall sense any line state change and the time between the last change. No state change for 1.5 ( $\pm$  0.1) seconds shall cause a FAILED state. The timer shall reset at each state change in a NON FAILED state.

4.3.2 Only the Unit Reset or a WDT inactive due to the voltage sense shall reset the WDT from a FAILED state.

4.3.3 A FAILED state caused by the WDT shall illuminate a front panel indicator light labelled "WDT ERROR". The indicator shall remain ON until Unit Reset issuance.

4.3.4 The WDT Circuitry shall sense the incoming VAC Line and when the voltage falls below 98 ( $\pm$  2) VAC for 50 ( $\pm$  17) ms shall inhibit the WDT Function. When the WDT Circuitry senses the incoming VAC Line rise above 103 ( $\pm$  2) VAC for 50 ( $\pm$  2) ms the WDT shall become active. A hysteresis between the Voltage Inhibit and the Voltage Active Settings shall be a minimum of 3 volts.

### 4.4 SECTION 4 - MODEL 208 REQUIREMENTS

4.4.1 Provision to drive an external NE2H Neon light through a 56 KOhm, 1/2 watt series resistor (resident on unit) from the unit shall be supplied.

4.4.2 The PDA #3 WDT Reset Input shall not be sensed by the unit. It exists only for downward compatibility reset of past WDT plug-in boards.

4.4.3 The output relay contact for FAILED state shall be "OPEN".

### 4.5 SECTION 5 - MODEL 210 REQUIREMENTS

4.5.1 Conflicting Field Output Circuits

4.5.1.1 The monitor unit shall monitor up to 32 field output circuits using a 16 conflicting channel (green and yellow outputs logically OR'd internally together) comparison setup. The specified associated cabinet output file assignment or operator selected output switches will determine channel assignment.

4.5.1.2 All monitored field output voltages shall be measured as true RMS responsive (up to 3 KHz) to both positive and negative alternations of the sine wave and the full cycle. The calculated value shall be averaged over a minimum of 2 cycles. If digital means are used in calculating RMS, a minimum of 2 samples shall be taken per alternation.

4.5.1.3 \*Sensed conflicting field output voltages 25 VAC or greater for a duration of **250 ms or longer** shall cause a FAILED state. (\* This provision varies from CALTRANS to properly sense flashing field output circuits which flash at a rate greater than 1 Hz.)

4.5.1.4 Sensed conflicting field output voltages 15 VAC or less OR any voltage having a duration of 200 ms or less shall NOT cause a FAILED state.

- 4.5.1.5 \*Sensed conflicting field output voltages between 15 and 25 VAC and for durations between **200 ms and 250 ms** may or may not cause a FAILED state. (\* This provision varies from CALTRANS to properly sense flashing field output circuits which flash at a rate greater than 1 Hz.)
- 4.5.1.6 The conflict monitoring circuitry shall be capable of detecting both a positive and negative half-wave failure under the foregoing conditions.
- 4.5.1.7 A FAILED state caused by sensing voltage conflicts shall be reset only by the Unit Reset.
- 4.5.1.8 Sixteen indicators shall be provided on the unit front panel to indicate if the channel output is sensed ON. The indicators shall remain ON in a latched state during a FAILED state unless unlatched by a Unit Reset or a unit loss of power during said FAILED state.
- 4.5.2 Conflict Programming Card
- 4.5.2.1 A plug-in PCB Programming Card shall be provided in the monitor unit. The card shall plug into the unit through a slot in the unit front panel. The card shall contain 120 diodes (#1N4148 or equal). Each diode shall match 1 through 16 channels of possible conflict. The programming card shall be logically labeled and laid out for easy identification of the diodes by channel. With diodes in place all output channels being monitored shall be in conflict. When the diode (anode to numerical pins and cathode to alphabetical pins) has been removed the channels shall be defined as non-conflict.
- 4.5.2.2 A pad for 16 yellow inhibit jumpers shall be provided. Placement of the associated channel jumper between the channel yellow pin and the yellow inhibit common shall disable sensing the said channel yellow.
- 4.5.2.3 The programming card shall intermate with a PCB 28/56S Connector. The card shall be provided with card ejectors. The monitor unit shall provide a mechanically sound card and connector support including continuous card guides. When the programming card is resident in the unit, the card's front end shall be flush with the unit's front panel.
- 4.5.2.4 Pins 16 and T shall be connected together on the programming card. Removal of the card shall be sensed as a conflicting FAILED state.
- 4.5.3 A front panel indicator labeled "CONFLICT" shall be provided. The indicator shall illuminate when there is a FAILED state caused by conflicting channels and go off only by Unit Reset issuance.
- 4.5.4 The output relay contact for FAILED state shall be "CLOSED".
- 4.5.5 A second output circuit (STOPTIME controller input) shall be provided to sink a NPN Open Collector Transistor upon FAILED state. The transistor shall be rated to sink a minimum of 50 ma at up to 30 VDC. A blocking diode shall be provided on the transistor output to prevent it from sourcing power into the controller unit.
- 4.5.6 An internal SPST LOGIC toggle switch shall be provided on the Model 210 Monitor Unit to activate the WDT function. When the switch is ON the WDT circuitry shall be active. The switch shall be mounted on the module PCB in a readily accessible location.
- 4.5.7 The Front Panel RESET switch shall be tied to the External Test Reset Input Line (Pin Z). The External Line shall be optically isolated from internal circuitry.

## CHAPTER 5

### SPECIFICATIONS FOR DETECTOR SENSOR UNITS, ELEMENTS AND ISOLATORS

**MODEL 222 TWO-CHANNEL LOOP DETECTOR SENSOR UNIT**

**MODEL 224 FOUR-CHANNEL LOOP DETECTOR SENSOR UNIT**

**MODEL 231 MAGNETIC DETECTOR SENSING ELEMENT**

**MODEL 232 TWO-CHANNEL MAGNETIC DETECTOR SENSOR UNIT**

**MODEL 242 TWO-CHANNEL DC ISOLATOR**

**MODEL 252 TWO-CHANNEL AC ISOLATOR**

#### TABLE of CONTENTS

SECTION 1- GENERAL REQUIREMENTS	50
SECTION 2- MODEL 222 & 224 REQUIREMENTS	50
SECTION 3- MODEL 231 REQUIREMENTS	53
SECTION 4- MODEL 232 REQUIREMENTS	53
SECTION 5- MODEL 242 REQUIREMENTS	53
SECTION 6- MODEL 252 REQUIREMENTS	54

## **5.1 SECTION 1 - GENERAL REQUIREMENTS**

- 5.1.1 The sensor unit and isolator channels shall be operationally independent from each other.
- 5.1.2 Each sensor unit or AC isolator channel shall draw no more than 100 ma from the +24 VDC cabinet power supply and shall be insensitive to 700 millivolts RMS ripple on the incoming +24 VDC line.
- 5.1.3 The sensor unit or isolator front panel shall be provided with a hand pull to facilitate insertion and removal from the input file.
- 5.1.4 All control switches, gain dials and channel indicators shall be mounted on the front panel. Each sensor unit or isolator channel shall have an indicator to provide visual indication of detection or incoming signal.
- 5.1.5 Each sensor unit or isolated channel output shall be an opto-isolated N Open Collector capable of sinking 50 ma at 30 VDC. The output shall be compatible with the controller unit inputs.
- 5.1.6 A valid channel input shall cause a channel ground true output to the controller unit of a minimum 100 ms in duration. An onboard jumper shall be provided to bypass the above minimum timing requirement.
- 5.1.7 The sensor unit or sensing element shall operate and interface successfully with an associate CALTRANS Standard Sensing Unit or Element.
- 5.1.8 The output transistor shall switch from the OFF state to the ON state in a period equal to or less than 20 us. The transistor shall switch from the ON state to the OFF state in a period equal to or less than 20 us.
- 5.1.9 The numbered and lettered sides of the PCB connector shall be commonly assigned.

## **5.2 SECTION 2 - MODEL 222 & 224 LOOP DETECTOR SENSOR UNIT REQUIREMENTS**

- 5.2.1 The sensor unit channel shall produce an output signal when a vehicle passes over or remains over wire loops embedded in the roadway. The method of detection shall be based upon a design that renders the output signal when a metallic mass (vehicle) enters the detection zone causing a change of 0.02% minimum decrease in inductance of the circuit measured at the input terminals of the sensor unit. The detector zone shall include all configurations listed in paragraph 5.2.9.
- 5.2.2 An open loop shall cause the sensor unit channel to output a signal.
- 5.2.3 Each sensor unit channel shall be capable of detecting all types of Manitoba licensed motor vehicles when connected to the loop configuration/lead-in requirements of 5.2.9.
- 5.2.4 The sensor unit shall comply with all performance requirements when connected to an inductance (loop plus lead-in) from 50 to 700 micro henries with a Q-parameter as low as 5 at the sensor unit operating frequency.
- 5.2.5 Loop inputs to each channel shall be transformer isolated.
- 5.2.6 Each individual channel shall have a minimum of 3 switch selectable operating frequencies.

5.2.7 The sensor unit channel tuning circuits shall be automatic and shall be so designed that drift, caused by environmental changes, or changes in applied power shall not cause an actuation.

#### 5.2.8 Mode Selection Requirements

5.2.8.1 Each sensor unit channel shall have Pulse and Presence selectable modes.

##### 5.2.8.1.1 Pulse Mode

5.2.8.1.1.1 In the pulse mode, each new vehicle presence within the detection zone shall initiate a sensor unit channel output pulse of 125 ( $\pm 25$ ) ms in duration.

5.2.8.1.1.2 Should a vehicle remain in a portion of the detection zone for a period in excess of 2 seconds, the sensor unit channel shall automatically "tune out" the presence of said vehicle. The sensor unit channel shall then be capable of detecting another vehicle entering the same detection zone. The recovery time between the first vehicle pulse and channel capability to detect another vehicle shall be 3 seconds maximum.

##### 5.2.8.1.2 Presence Mode

5.2.8.1.2.1 In the presence mode, the sensor unit channel shall recover to normal sensitivity within 1 second after termination of vehicle presence in the detection zone regardless of the duration of the presence.

5.2.8.1.2.2 The channel sensitivity settings shall be provided that detect the presence of a vehicle in the detection zone for a specified time period and inductance change(s). The conditions are as follows:

	Minimum time duration in minutes	Detector Input inductance change
5.2.8.1.2.2.1 Setting 1	3 10	0.02% or more 0.06% or more
5.2.8.1.2.2.2 Setting 2 (OCC)	4	1.00% or more

#### 5.2.9 Sensitivity

5.2.9.1 Each sensor unit channel shall be equipped with a front panel selectable sensitivity settings(s) in presence and pulse modes to accomplish the following under operational and environmental requirements of this specification:

5.2.9.1.1 Each sensor unit channel shall respond to an inductance change of 0.02% while connected to the following California Standard Plan ES-5A & B Loop Configurations. (California Department of Transportation Standard Plans)

5.2.9.1.1.1 Single Type A, B or Q Loop with a 250 foot lead-in cable.

5.2.9.1.1.2 Single Type A, B or Q Loop with a 1000 foot lead-in cable.

5.2.9.1.1.3 Four Type A, B or Q Loops connected in series/parallel with a 250 foot lead-in cable.

- 5.2.9.1.1.4 Four Type A, B or Q Loops connected in series with a 1000 foot lead-in cable.
- 5.2.9.1.1.5 One 50 foot Type C Loop with 250 foot lead-in cable.
- 5.2.9.2 Each sensor unit channel shall respond while in Setting 2 (OCC) to a nominal change in inductance between 0.15% to 0.4% while connected to the above loop configurations. This setting shall not respond to an inductance change of less than 0.1%.
- 5.2.9.3 The sensor unit channel shall not detect vehicles, moving or stopped, at distances of 3 feet or more from any loop perimeter, in all configurations listed in paragraph 5.2.9.
- 5.2.9.4 All sensitivity settings shall not differ  $\pm 40\%$  from the nominal value chosen.
- 5.2.9.5 There shall be a minimum of 7 selectable sensitivity settings including specified sensitivity settings.
- 5.2.10 Response time of the sensor unit channel for the OCC setting shall be less than 20 ms. That is, for any decreased inductive change which exceeds its sensitivity threshold, the channel shall output a ground true logic level within 20 ms. When such change is removed, the output shall become an open circuit within 20 ms.
- 5.2.11 The sensor unit channels shall begin normal operation within 2 seconds after the application of power or after a reset signal of 15  $\mu$ s.
- 5.2.12 Lightning protection shall be installed within the sensor unit.
  - 5.2.12.1 The protection shall enable the sensor unit to withstand the discharge of a 10 microfarad capacitor charged to  $\pm 1000$  volts directly across the sensor unit input pins with no loop load present.
  - 5.2.12.2 The protection shall enable the sensor unit to withstand the discharge of a 10 microfarad capacitor charged to  $\pm 2000$  volts directly across either the sensor unit input inductance pins or from either side of the sensor unit input inductance pins to equipment ground. The sensor unit input pins shall have a dummy resistive load attached equal to 5.0 ohms.
- 5.2.13. Tracking rate - The sensor unit shall be capable of compensating or tracking for an environmental change up to 0.001% change in inductance per second.
- 5.2.14 Tracking Range
  - 5.2.14.1 The sensor unit shall be capable of normal operation as the input inductance is changed  $\pm 5.0\%$  from the quiescent tuning point regardless of internal circuit drift.
  - 5.2.14.2 The sensor unit shall be capable of normal operation as the input resistance is changed  $\pm 0.5\%$  from the quiescent tuning point regardless of internal circuit drift.
- 5.2.15 Temperature Change - The operation of the sensor unit shall not be affected by changes in the inductance and/or capacitance of the loop caused by environmental changes with the rate of temperature change not exceeding 1 degrees C per 3 minutes. The opening or closing of the controller cabinet door with a temperature differential of up to 18 degrees C between the inside and outside air shall not affect the proper operation of the sensor unit.
- 5.2.16 A switch or switch position shall be provided on the front panel to disable each channel output.

### **5.3 SECTION 3 - MODEL 231 MAGNETIC SENSING ELEMENT REQUIREMENTS**

- 5.3.1 Each sensing element shall be designed for ease of installation, repositioning, and removal. It shall be no larger than 2.25 inches in diameter and shall have no sharp edges along its length. The overall length shall not exceed 21 inches.
- 5.3.2 Each sensing element including lead-in shall have a DC resistance of less than 3500 ohms.
- 5.3.3 The sensing element shall be constructed of nonferrous material and shall be moisture proof. The element shall contain no moving parts or active components. The element shall have a minimum of 50 feet lead-in cable. Leakage resistance shall be a minimum of 10 megohms when tested with 400 VDC between lead wire, including lead wire entrance, and the fluid of a salt water bath after the device has been entirely immersed in the bath for a period of 24 hours at 20 degrees (+3 degrees) C. The salt water bath concentrate shall be one fourth ounce of salt per gallon of water.

### **5.4 SECTION 4 - MODEL 232 TWO-CHANNEL MAGNETIC DETECTOR SENSOR UNIT REQUIREMENTS**

- 5.4.1 The Model 232 Two-Channel Magnetic Detector Sensor Unit contains 2 channels of detection. When resident in a energized cabinet Input File and each channel connected to its associated Model 231 Magnetic Detector Sensing Element(s), the channel shall produce an output signal to the controller unit when a voltage is induced in the sensing element by a vehicle passing over the sensing element.
- 5.4.2 Each channel shall detect all Manitoba licensed vehicles passing within 6 feet of the Model 231 Sensing Element with a 1000 foot lead-in cable at all speeds between 3 and 80 miles per hour.
- 5.4.3 A single control knob for adjusting the sensitivity of each channel shall be readily adjustable without use of tools and shall be mounted on the front panel.
- 5.4.4 A momentary switch or switch position shall be provided to place a call on each channel on an individual basis.

### **5.5 SECTION 5 - MODEL 242 TWO-CHANNEL DC ISOLATOR REQUIREMENTS**

- 5.5.1 The Model 242 Two-Channel DC Isolator shall contain 2 isolation channels which provide isolation between electrical contacts external to the module and the controller unit input. The method of isolation shall be based upon a design which shall provide reliable operation.
- 5.5.2 Each isolation channel shall have front panel-mounted test switch to simulate valid input. The test switch shall be a single pole-double throw, three-position CONTROL test switch: The position assignment shall be UP - constant ON; MIDDLE - OFF; and DOWN - momentary ON.
- 5.5.3 The isolator shall have an internal power supply which shall supply 20 ±4 VDC to the field input side of the isolation channels. The Isolator shall not draw more than 2.5 watts of AC power. No current shall be drawn from the cabinet power supply.
- 5.5.4 A channel contact closure input of 5 ms or less shall not cause an out (ground true) to the controller. An input of 25 ms or greater shall cause an output to the controller. An input of duration between 5 and 25 ms may or may not cause an output to the controller. The channel circuitry shall be able to react to a new input closure within 25 ms of an input opening.

- 5.5.5 Each isolation channel field input shall be turned on (true) when a contact closure causes an input voltage of less than 8 VDC, and shall be turned off (false) when the contact opening causes the input voltage to exceed 12 VDC. Each input shall deliver no less than 15 ma nor more than 40 ma to an electrical contact closure or short from the power supply.
- 5.5.6 The minimum isolation shall be 1000 megohms and 2,500 VDC measured between the input and output of the same channel.
- 5.5.7 Lightning protection shall be installed inside the Isolator.
  - 5.5.7.1 The protection shall enable the isolator to withstand the discharge of a 10 microfarad capacitor charged to  $\pm$  1000 volts directly across the input pins with no load present.
  - 5.5.7.2 The protection shall enable the isolator to withstand the discharge of a 10 microfarad capacitor charged to  $\pm$  2000 volts directly across either the input pins or from either side of the input pins to equipment ground. The input pins shall have a dummy resistive load attached equal to 5.0 ohms.

## **5.6 SECTION 6 - MODEL 252 TWO-CHANNEL AC ISOLATOR REQUIREMENTS**

- 5.6.1 The Model 252 Two-Channel AC Isolator shall contain 2 isolation channels which provide isolation between external 120 VAC input circuits and the controller unit input circuits. The method of isolation shall be based upon a design which provides reliable operation.
- 5.6.2 A channel input voltage ( $V_{on}$ ) of 80 ( $\pm$  5) VAC applied for a minimum duration of 100 ms shall cause an output (ground true) to the controller.
- 5.6.3 A channel input voltage of  $V_{on}$  minus 10 VAC applied for a minimum duration of 100 ms shall cause an output (False) to the controller.
- 5.6.4 Each channel input circuit shall have a input impedance of between 6000 to 15000 Ohms at 60 Hz.
- 5.6.5 Circuitry switching to invert inputs to read ground false logic (by jumpers) shall be provided.
- 5.6.6 The transistor shall be capable of sinking 50 ma at 30 VDC.
- 5.6.7 The minimum isolation shall be 1000 megohms between the input and output terminals at 500 VAC applied voltage.
- 5.6.8 Each channel input shall withstand, without damage, the discharge of a 10 microfarad capacitor charged to  $\pm$  1000 volts, when connected directly to the open input pins. Each channel shall withstand, without damage, the discharge of a 10 microfarad capacitor charged to  $\pm$  2000 volts, when connected between either input pin and equipment ground.

**CHAPTER 6**  
**SPECIFICATIONS FOR CABINET MODELS 332, 334 & 336**

**TABLE OF CONTENTS**

<b>SECTION 1</b> GENERAL REQUIREMENTS and CABINET MODEL COMPOSITION	<b>56</b>
<b>SECTION 2</b> HOUSING REQUIREMENTS	<b>57</b>
<b>SECTION 3</b> CABINET CAGE REQUIREMENTS	<b>60</b>
<b>SECTION 4</b> CABINET ASSEMBLIES	<b>60</b>
<b>SECTION 5</b> CABINET WIRING	<b>68</b>
<b>SECTION 6</b> POWER LINE SURGE PROTECTORS	<b>70</b>

## 6.1 SECTION 1 - GENERAL REQUIREMENTS AND CABINET MODEL COMPOSITION

6.1.1 Unless otherwise specified the model shall be furnished, ready for operation with the following composition.

6.1.1.1 Model 332A Cabinet (Panel Termination) shall consist of:

Housing 1 A or B	Output File	#1
Mounting Cage 1	C1 Harness	#1
Power Distribution Assembly #1*	Service Panel	#1
Input Files I & J	Input Panel	#1
Power Supply Assembly *		

6.1.1.2 Model 332B Cabinet (Pan Duct) shall consist of:

Housing 1 A or B	Output File	#1
Mounting Cage 1	C1 Harness	#1
Power Distribution Assembly #1*	Service Panel	#1
Input Files I & J	Input Panel	#2
Power Supply Assembly *		

6.1.1.3 Model 334 Cabinet (Ramp Meter) shall consist of:

Housing 1 A or B	PDA Assembly	#3
Mounting Cage 1	C1 Harness	#2
Input File I	Service Panel	#1
Input Panel #3		

6.1.1.4 Model 336A Cabinet (2 to 8 Phase) shall consist of:

Housing 2	Output File	#1
Mounting Cage 2	C1 Harness	#3
Power Distribution Assembly #2	Service Panel	#2
Input File I	Input Panel	#4

6.1.1.5 Model 336B Cabinet (2 to 4 Phase) shall consist of:

Housing 2	Output File	#2**
Mounting Cage 2	C1 Harness	#3
Power Distribution Assembly #2	Service Panel	#2
Input File I	Input Panel	#4
Monitor Unit Assembly		

\*The Contractor has the option to supply the Power Distribution Assembly #2 in lieu of the Power Supply and Power Distribution #1 Assemblies.

\*\*A C1 Harness #3/Output File #2 Adaptor shall be provided.

6.1.1.6 All assemblies and files shall be mounted on the cage mounting rails per cabinet model detail. Cabinet model interface wiring shall be per specified C1 harness, detailed wiring lists and required One Line Wiring.

6.1.2 Cabinet Shipping Requirements - The cabinet shall be delivered mounted on a plywood shipping pallet. The pallet shall be bolted to the cabinet base. The cabinet shall be enclosed in a slipcover cardboard packing shell. The housing doors shall be blocked to prevent movement during transportation.

- 6.1.3 Cabinet Adaptors - When specified, adaptors shall be provided. The adaptors shall be fabricated of the same material and finish as the cabinet housing.
- 6.1.4 All bolts, nuts, washers, screws (size 8 or larger), hinges and hinge pins shall be stainless steel unless otherwise specified.
- 6.1.5 A cage mounting clear area for the controller unit shall be provided. The area shall extend 1.5 inches in front of and 16 inches behind the front EIA mounting angles.
- 6.1.6 All conductors, terminals and parts which could be hazardous to maintenance personnel shall be protected with suitable insulating material.

## 6.2 SECTION 2 - HOUSING REQUIREMENTS

- 6.2.1 The housing shall include, but not be limited to, the following:

Enclosure	Police Panel
Doors	Ventilization
Latches/Locks	Gasketing
Hinges and Door Catches	Cage Supports and Mounting

- 6.2.2 Housing Construction

- 6.2.2.1 The housing shall be rainproof with the top of the enclosure crowned to prevent standing water. It shall have single front and rear doors, each equipped with a lock.
- 6.2.2.2 The enclosure doors, lifting eyes, gasket channels, police panel and all supports welded to the enclosure and doors shall be fabricated of 0.125 inch minimum thickness aluminum sheet. Bolted on supports shall be either the same material and thickness as the enclosure or 0.105 inch minimum thickness steel. The side panels and filter shell shall be fabricated of 0.080 inch minimum thickness aluminum sheet.
- 6.2.2.3 All exterior seams for enclosure and doors shall be continuously welded. All exterior welds shall be smooth. All edges shall be filed to a radius of 0.03125 inch minimum. Exterior cabinet welds shall be done by gas tungsten arc (TIG) process only. ER5356 aluminum alloy bare welding electrodes conforming to AWS A5.10 requirements shall be used for welding on aluminum. Procedures, welders and welding operators shall conform to the requirements and practices in AWS B3.0 and C5.6 for aluminum. Internal cabinet welds shall be done by either gas metal arc (MIG) process or gas tungsten arc (TIG) process.
- 6.2.2.4 Aluminum surfaces shall conform to the following:
  - 6.2.2.4.1 An anodic coating shall be applied to the aluminum surface after the surface has been cleaned and etched. The cleaning and etching procedure shall be to immerse in inhibited alkaline cleaner at 71 degrees C for 5 minutes (Oakite 61A, Diversey 909 or equivalent in mix of 6 to 8 ounces per gallon of distilled water). Rinse in cold water. Etch in a sodium solution at 66 degrees C for 5 minutes (0.5 ounce sodium fluoride plus 5 ounces of sodium hydroxide mix per gallon of distilled water). Rinse in cold water. Desmut in a 50% by volume nitric acid solution at 20 degrees C for 2 minutes. Rinse in cold water.
  - 6.2.2.4.2 The anodic coating shall conform to MIL-A-8625C (Anodic Coatings for Aluminum and Aluminum Alloys) for Type II, Class I Coating except the outer housing surface

coating shall have a 0.0007 inch minimum thickness and a 27 milligrams per square inch minimum coating weight. The anodic coating shall be sealed in a 5% aqueous solution of nickel acetate (PH 5.0 to 6.5) for 15 minutes at 99 degrees C.

- 6.2.2.5 The enclosure door frames shall be double flanged out on all 4 sides and shall have strikers to hold tension on and form a firm seal between the door gasketing and the frame. The dimension between the door edge and the enclosure external surface when the door is closed and locked shall be 0.156 ( $\pm 0.08$ ) inch.
- 6.2.2.6 Gasketing shall be provided on all door openings and shall be dust-tight. Gaskets shall be 0.25 inch minimum thickness closed cell neoprene or silicone (BOYD R-10480 or equal) and shall be permanently bonded to the metal. If neoprene is used, the mating surface of the gasketing shall be covered with a silicone lubricant to prevent sticking to the mating metal surface. A Gasket Top Channel shall be provided to support the top gasket on the door (prevent gasket gravitational fatigue).
- 6.2.2.7 Cage bottom support mounting angles shall be provided on either side, level with the bottom edge of the door opening, for horizontal support and bolt attachment. In addition, side cage supports shall be provided for the upper cage bolt attachments. Spacer brackets between the side cage supports and the cage shall be a minimum thickness of either 0.188 inch aluminum or 0.105 inch steel.
- 6.2.2.8 The housing shall be provided with 2 lifting eyes for placing the cabinet on its foundation. Each eye opening shall have a minimum diameter of 0.75 inch. Each eye shall be able to support a weight load of 1000 pounds.
- 6.2.2.9 All exterior bolt heads shall be tamperproof type.

### 6.2.3 Door Latches and Locks

- 6.2.3.1 The latching handles shall have provision for padlocking in the closed position. Each handle shall be 0.75 inch minimum diameter stainless steel with a minimum 0.5 inch shank. The padlocking attachment shall be placed at 4.0 inches from the handle shank centre to clear the lock and key. An additional 4.0 inches minimum gripping length shall be provided.
- 6.2.3.2 The latching mechanism shall be a three-point draw roller type. The pushrods shall be turned edgewise at the outer supports and have a cross section of 0.25 inch thick by 0.75 inch wide, minimum.
- 6.2.3.3 When the door is closed and latched, the door shall be locked. The locks and handles shall be on the left side of the front door and right side of the rear door. The lock and lock support shall be rigidly mounted on the door. In the locked position, the bolt throw shall extend a minimum of 0.25 ( $\pm 0.03125$ ) in. into the latch cam area. A seal shall be provided to prevent dust or water entry through the lock opening.
- 6.2.3.4 The locks shall be Corbin 2 type, or equal. One key shall be supplied with each lock. The keys shall be removable in the locked position only.
- 6.2.3.5 The locks shall have rectangular, spring loaded bolts. The bolts shall have a 0.281 inch throw and shall be 0.75 inch wide by 0.375 inch thick (tolerance is  $\pm 0.035$  inch).
- 6.2.3.6 The centre latch cam shall be fabricated of a minimum thickness 0.1875 in. steel or aluminum. The bolt surface shall horizontally cover the cam thickness. The cam shall be structured to only allow the door to open when the handle is moved toward the centre of the door.

6.2.3.7 Rollers shall have a minimum diameter of 0.875 inch with nylon wheels and steel ball bearings.

6.2.4 The housing ventilation including intake, exhaust, filtration, fan assembly and environmental control are as follows:

6.2.4.1 The front door shall be provided with louvered vents. The louvered vent depth shall be a maximum of 0.25 inches. A removable and reusable air filter shall be housed behind the door vents. The filter filtration area shall cover the vent opening area. A filter shell shall be provided that fits over the filter providing mechanical support for the filter. The shell shall be louvered to direct the incoming air downward. The shell sides shall be bent over a minimum of 0.25 inches to house the filter. The filter resident in its shell shall be held firmly in place with a bottom bracket and a spring loaded upper clamp. No incoming air shall bypass the filter. The bottom filter bracket shall be formed into a waterproof sump with drain holes to the outside housing.

6.2.4.2 The intake (including filter with shell) and exhaust areas shall pass a minimum of 60 cubic feet of air per minute for housing #1 and 26 cubic feet of air per minute for housing #2.

6.2.4.3 The housing shall be equipped with an electric fan with ball or roller bearings and a capacity of at least 100 cubic feet of free air delivery per minute. The fan shall be mounted within the housing and vented.

6.2.4.4 The fan shall be thermostatically controlled and shall be manually adjustable to turn on between 33 degrees C and 65 degrees C with a differential of not more than 6 degrees C between automatic turn on and off. The fan circuit shall be protected at 125% of the fan motor ampacity. The manual adjustment shall be graded in 10 degrees C increment scale. Technical documentation of the fan performance characteristics shall be supplied with the first "Evaluation" model.

6.2.4.5 The filter shall be 16 inches wide by 12 inches high by 0.875 inch thick. The filter shall be an ECO-AIR Products E35S or equal.

6.2.5 Hinges and Door Catches

6.2.5.1 Two-bolt per leave hinges shall be provided to bolt the enclosure to the door. Housing 1 shall have 4 hinges and Housing 2 three hinges. Each hinge shall be 3.5 inches minimum length and have a fixed pin. The pin ends shall be welded to the hinge and ground smooth. The pins and bolts shall be covered by the door edge and not accessible when the door is closed.

6.2.5.2 Front and rear doors shall be provided with catches to hold the door open at both 90 and 180 ( $\pm$  10) degrees. The catch minimum diameter shall be either 0.375 inch for plated steel or aluminum rods or 0.25 inch for stainless steel. The catches shall be capable of holding the door open at 90 degrees in a 60 mph wind acting at an angle perpendicular to the plane of the door.

6.2.6 Police Panel

6.2.6.1 A police panel assembly shall be provided to allow the police officers limited access to intersection control. The police panel assembly including switches shall not extend into the cabinet more than 1.5 inches.

6.2.6.2 The police panel door shall be equipped with a lock. The lock shall be keyed for a master police key. One key shall be furnished with each police lock. Each police key shall have a shaft at least 1.75 inches in length.

6.2.6.3 The police panel shall contain 2 DPST toggle POWER switches.

6.2.6.3.1 Model 334 - One switch shall be labeled "ON-OFF LIGHTS" and the other "POLICE CONTROL ON-OFF".

6.2.6.3.2 Models 332 and 336 - One switch shall be labeled "ON-OFF" and the other "FLASH/AUTOMATIC".

6.2.6.4 The front and back of the panel shall be enclosed with a rigid metal covering so that no parts having line voltage are exposed.

6.2.6.5 The panel assembly shall have a drain to prevent water collecting within the assembly. The drain shall be channeled to the outside.

### **6.3 SECTION 3 - CABINET CAGE REQUIREMENTS**

6.3.1 A standard EIA 19-inch rack cage shall be installed inside the housing for mounting of the controller unit and cabinet assemblies.

6.3.2 The EIA rack portion of the cage shall consist of 2 pairs of continuous, adjustable equipment mounting angles. The angle nominal thickness shall be either 0.1345 inch plated steel or 0.105 stainless steel. The angles shall be tapped with 10-32 threads with EIA universal spacing. The angle shall comply with Standard EIA RS-310-B and shall be supported at the top and bottom by either welded or bolted support angles to form a cage.

6.3.3 Clearance between rails for mounting assemblies shall be 17.75 inches.

6.3.4 Two steel supporting angles extending from the front to the back rails shall be supplied to support the controller unit. The angles shall be designed to support a minimum of 50 pounds each. The horizontal side of each angle shall be a minimum of 3 inches. The angles shall be mounted 17.5 inches from the top of the mounting area for Models 332 and 334 and 7.25 inches for the Model 336 Cabinet. The angles shall be vertically adjustable.

6.3.5 The cage shall be bolted to the cabinet at 4 points, via the housing cage supports and associated spacer brackets, 2 at the top and 2 at the bottom of the rails.

6.3.6 The cage shall be centered within the cabinet.

### **6.4 SECTION 4 - CABINET ASSEMBLIES**

#### **6.4.1 General**

6.4.1.1 The following equipment shall be completely removable from the cabinet without removing any other equipment and using only a slotted or Phillips screw driver:

Power Supply Assembly  
Power Distribution Assembly  
Input File  
Output File  
Monitor Unit Assembly

- 6.4.1.2 All fuses, circuit breakers, switches (except Police Panel Switches and Fan Fuse) and indicators shall be readily visible and accessible when the cabinet front door is open.
- 6.4.1.3 All equipment in the cabinet, when required, shall be clearly and permanently labelled. The marker strips shall be made of material that can be easily and legibly written on using a pencil or ballpoint pen. Marker strips shall be located immediately below the item they are to identify and must be clearly visible with the items installed.
- 6.4.1.4 Resistor-capacitor transient suppression shall be provided at all AC relay sockets (across relay coil), except for the Flash Transfer Relays (FTR) in the output files where one suppression device may be common for all.
- 6.4.1.5 A leakage resistor, which permits a small amount of current to pass through the heavy duty relay coil, shall be installed across the terminals of relay sockets to overcome the residual magnetism.
- 6.4.1.6 Assembly or file depth dimension shall include terminal blocks.
- 6.4.1.7 All assemblies and files shall allow air circulation through its top and bottom unless specifically called out otherwise.
- 6.4.1.8 Socket types (or equal) for the following equipment shall be:

Switch Pack	BEAU S-5412-XX (or equal)
Heavy Duty Relay	BEAU S-5408-XX (or equal)
Flasher Unit & Power Supply Module	BEAU S-5406-XX (or equal)
208 Monitor Unit	PCB 22/44S
210 Monitor Unit	PCB 28/56S

- 6.4.1.9 Connector sockets for Flasher Unit, Power Supply, and Switch Pack modules shall be mounted with their front face 7.5 inches deep from assembly or file front panel. (Note Output File exception).
- 6.4.1.10 Guides (top and bottom) shall be provided for Switch Pack Modules, Flasher Units, Monitor Unit, Watchdog Timer Module, Detector and Isolator Modules and Power Supply Module (bottom only). The guides shall begin 1.0 ( $\pm$  0.5) inches in from the front panel surface and extend to within 0.5 inches from the connector socket face.
- 6.4.1.11 Assemblies and Files shall be fabricated of 0.060 inch minimum thickness aluminum or stainless steel sheet. The metal surface shall be treated with clear chromate.

#### 6.4.2 Power Supply Assembly

- 6.4.2.1 A power supply shall be provided to supply +24 VDC to the Input and Output Files for use by their associated devices. The power supply shall be of ferro-resonant design having no active components and conform to the following requirements.
  - 6.4.2.1.1 Line Regulation - 2% from 90 to 135 VAC at 60 Hz, plus an additional 1.6% for each additional 1.0% frequency change.
  - 6.4.2.1.2 Load Regulation - 5% from 1 ampere to 5 amperes with a maximum temperature rise of 30 degrees C above ambient.

- 6.4.2.1.3 Design Voltage - +24 ( $\pm$  0.5) VDC at full load, 30 degrees C, 115 VAC incoming after a 30 minute warm up period.
- 6.4.2.1.4 Full Load Current - 5 amperes, minimum.
- 6.4.2.1.5 Ripple Noise - 2 volts peak-to-peak and 500 millivolts RMS at full load.
- 6.4.2.1.6 Line Voltage - 90 to 135 VAC.
- 6.4.2.1.7 Efficiency - 70% minimum.
- 6.4.2.1.8 Minimum Voltage - +22.8 VDC.
- 6.4.2.1.9 Circuit capacitors shall be rated for 40 volts, minimum.
- 6.4.2.2 The assembly shall have a maximum depth of 5.5 inches.
- 6.4.2.3 The front panel shall include AC and DC fuses, power ON light and test points for monitoring the output voltages.
- 6.4.2.4 The assembly including terminals shall be protected to prevent accidental contact with energized parts.
- 6.4.2.5 The power supply cage and transformer shall be securely braced to prevent damage in transit.
- 6.4.3 Power Distribution Assembly
  - 6.4.3.1 The following equipment shall be provided with the Power Distribution Assemblies:
    - 6.4.3.1.1 PDA #1
      - 1 --Duplex NEMA 5-15R Controller Receptacle
      - 2 --Duplex NEMA 5-15R Equipment Receptacles, (one with GFI)
      - 1 --1 Pole 50 Amperes minimum, 120 VAC Main Circuit Breaker
      - 1 --1 Pole 15 Amperes, 120 VAC Equipment Circuit Breaker
      - 1 --6 Pole Ganged, 15 Amperes, 120 VAC Signal Bus Circuit Breaker
      - 1 --2 Pole Ganged, 20 Amperes, 120 VAC Flash Bus Circuit Breaker
      - 1 --Mercury Contactor - rated minimum 60 Amperes, 120 VAC
      - 2 --Model 204 Flasher Units and Sockets
      - 1 --AUTO/FLASH Control Switch
      - 1 --FLASH Indicator Light
      - 1 --Model 430 Heavy Duty Relay (Transfer Relay) and Socket
      - 2 --10 Position Terminal Blocks (TBK) T1 and T2
    - 6.4.3.1.2 PDA #2
      - 1 --Duplex NEMA 5-15R Controller Receptacle
      - 2 --Duplex NEMA 5-15R Equipment Receptacles, (one with GFI)
      - 1 --1 Pole 50 Amperes minimum, 120 VAC Main Circuit Breaker
      - 1 --1 Pole 15 Amperes, 120 VAC Equipment Circuit Breaker
      - 1 --6 Pole Ganged, 15 Amperes, 120 VAC Signal Bus Circuit Breaker\*
      - 1 --2 Pole Ganged, 20 Amperes, 120 VAC Flash Bus Circuit Breaker
      - 1 --Mercury Contactor - rated minimum 60 Amperes, 120 VAC
      - 2 --Model 204 Flasher Units and Sockets
      - 1 --Model 206 Power Supply Module and Socket

- 1 --Model 430 Heavy Duty Relay and Socket (Transfer Relay)\*
- 1 --AUTO/FLASH Control Switch
- 1 --FLASH ON Indicator Light
- 3 --10 Position Terminal Blocks (TBK) T1, T2 and T4
- 1 --4 Position Terminal Block (TBK) T3
- OR \* Circuit Breaker Option

#### 6.4.3.1.3 PDA #3

- 1 --Duplex NEMA 5-15R Controller Receptacle
- 2 --Duplex NEMA 5-15R Equipment Receptacles, (one with GFI)
- 1 --1 Pole 30 Amperes, 120 VAC Main Circuit Breaker
- 3 --1 Pole 15 Amperes, 120 VAC Circuit Breakers, (Equipment and Field)
- 1 --Model 206 Power Supply Module and Socket
- 1 --Model 208 Monitor Unit and Socket
- 1 --Model 430 Heavy Duty Relay and Socket (Transfer Relay)\*
- 1 --Watchdog Timer ON/OFF-RESET Control Switch
- 3 --Model 200 Switch Pack Sockets
- 3 --10 Position Terminal Blocks (TBK) T1, T2 and T4
- 1 --4 Position Terminal Block (TBK) T3

6.4.3.2 Rating of breakers shall be shown on face of breaker or handle. Breaker function shall be labeled below breakers on front panel.

6.4.3.3. The first equipment receptacle in the circuit shall have ground-fault circuit interruption as defined in the National Electrical Code. Circuit interruption shall occur on 6 ma of ground-fault current and shall not occur on less than 4 ma of ground-fault current.

6.4.3.4 The "AUTO/FLASH" switch, when placed in "FLASH" position (down), shall energize the Mercury Contactor (MC) coil. When the switch is placed in the "AUTO" position (up) the switch packs shall control the signal indications. The switch shall be a SPST toggle Control switch.

6.4.3.5 The FLASH Indicator Light labeled "Flash On" shall be mounted on the PDA front panel. The lamp shall be driven by Flasher Unit/ Output through Flash Relay Circuit No. 1 or per Circuit Breaker Option.

6.4.3.6 All conductors from the power distribution assembly routed to the cabinet wiring shall be connected to the terminal block on the common side, except for the AC power conductor between the service terminal block and main circuit breaker. All internal conductors terminating at the blocks shall be connected to the other side of the blocks.

6.4.3.7 Ganged Circuit Breakers shall be certified by the circuit breaker manufacturer that their circuit breakers shall gang trip.

6.4.3.8 The Monitor Unit ON/OFF-RESET Switch shall be a DPST Toggle Control switch mounted on the PDA #3 front panel. When placed in DOWN position, (OFF-RESET), a grounded input shall be presented at the Monitor Unit pin 22 (resetting the WDT Circuitry) and the other side switch circuit shall close bypassing the Monitor Unit.

#### 6.4.3.9 Circuit Breaker Option

- 6.4.3.9.1 Six Single Pole 15 Ampere Circuit Breakers with Auxiliary Switch feature and Medium Trip Delay characteristics shall be provided.

6.4.3.9.2 The six breakers shall be wired and routed per the Option One Line Diagram. The breaker auxiliary switch circuit shall be open when the breaker is in the ON position. The auxiliary circuits shall be wired in parallel so that any tripped breaker shall energize the Mercury Contactor Coil, Flash Transfer Relay Coils and the "FLASH ON" Indicator. The Auxiliary Contacts shall be rated at 5 Amperes, 120 VAC minimum ("fast on" type connection).

#### 6.4.3.10 Model 206 Power Supply Module

6.4.3.10.1 The module shall meet requirements specified in 6.4.2.1 and 6.4.2.3.

6.4.3.10.2 The module chassis shall be vented. Its top and sides shall be open except for unit supports.

6.4.3.10.3 When resident in the PDA assembly the module shall be held firmly in place by its stud screw, assembly connector support panel and a wingnut.

6.4.3.10.4 Two 0.5 ohm, 10 watt minimum wire wound power resistors with a 0.2uH inductance shall be provided (1 on the AC+ power line and 1 on the AC- line). Three MOV surge arrestors rated for 20 Joules minimum shall be supplied between AC+ and EG, AC- and EG, and between AC+ and AC-. A 0.68 uF capacitor shall be placed across AC+ and AC- between the two power resistors and the MOV's.

6.4.3.11 Terminal screw size shall be 10-32 for Terminal Blocks (TBK) T1, T2 and T4 and 6-32 for Terminal Block (TBK) T3.

#### 6.4.4 Input File

6.4.4.1 The file shall have a maximum depth of 8.5 inches and shall inter mate with and support 14 two-channel detector sensor or isolator units.

6.4.4.2 The file shall provide a PCB 22/44S connector centered vertically for each two-channel detector. The associated number and letter side connectors shall be shorted internally. Pins D, E, F, J, K, L and W shall be brought out to an 8 position terminal block on the back of the file. The output emitters shall be common grounded with the ground terminating at TB 15, Position 4. Position 8 of the terminal block is assigned to Equipment Ground and is used to terminate lead in shields.

6.4.4.3 The input file shall be provided with marker strips to identify isolators and detectors in the file.

6.4.4.4 Terminal Block screw size for Input File Terminals shall be 8-32.

#### 6.4.4.5 Output File

##### 6.4.4.5.1 General Requirements

6.4.4.5.1.1 The Output File shall be provided with marker strips to identify switch packs when mounted in the file.

6.4.4.5.1.2 Switch pack connectors, monitor unit connectors, flash transfer relay sockets and flash programming connectors shall be accessible from the back of the Output File without the use of tools or removal of any other equipment.

- 6.4.4.5.1.3 Terminal Blocks (TBK) 01 and 03 terminal positions shall be labelled functionally. A permanent label reading "Channels 9 and 10 Separated" shall be placed on the right side Output File mounting flange.
- 6.4.4.5.1.4 Field wire terminal blocks shall be mounted vertically on the back of the assembly. Output File #1 shall have 3 terminal blocks with 12 positions and Output File #2 shall have 3 terminal blocks with 6 positions. Terminal position screw size shall be 10-32.
- 6.4.4.5.1.5 The Flash Transfer Relays shall be Heavy Duty type. The coil of the relay shall be energized only when the signals are in flashing operation and the police panel ON/OFF switch is ON. The relay shall transfer the field outputs from switch pack output to flash control. The transfer shall not interrupt the controller unit operation.
- 6.4.4.5.1.6 The depth of the file shall not exceed 14.5 inches.
- 6.4.4.5.1.7 The flash programming connectors shall be Molex Type 1375 or equal. The receptacle shall be mounted on the file with a programmable plug connected. The plug connector, with programming jumpers, shall be furnished for each circuit to allow red or yellow flash programming. Plug pins shall be crimped and soldered.
- 6.4.4.5.1.8 Terminal Blocks (TBK) 01 and 03 terminal screw size shall be 8-32 and Terminal Blocks (TBK) 02 and 04 shall be 6-32.
- 6.4.4.5.2 Output File #1
  - 6.4.4.5.2.1 The output file shall be capable of containing 12 Model 200 Switch Packs, 4 Flash Transfer Relays, and the Model 210 Monitor Unit. 4 Flash Transfer Relays and 1 Model 210 Monitor Unit shall be furnished with each output file.
  - 6.4.4.5.2.2 The red and yellow output circuits of switch packs 1, 2, 3, 4, 5, 6, 7 and 8 shall be made available at individual Molex receptacle/plug connections for flash selectability. Eight "red" and 4 "yellow" Molex Plugs shall be provided.
  - 6.4.4.5.2.3 It shall be possible to remove the Model 210 Monitor Unit without causing the intersection to go into flashing operation. The cabinet shall be wired so that with the front cabinet door closed and with the monitor unit removed, the intersection shall go into flashing operation (see One Line Diagram). The cabinet shall contain a conspicuous warning against operation with the Model 210 Monitor Unit removed.
  - 6.4.4.5.2.4 The monitor unit compartment including the housed Model 210 Monitor Unit exclusive of handle shall extend no farther than 1.25 inches in front of the 19 inch rack front surface. The switch pack socket connector front surface shall be no more than 8.5 inches in depth from the front surface of the output file.
- 6.4.4.5.3 Output File #2 (Model 420)
  - 6.4.4.5.3.1 The Output File #2 shall be capable of containing 6 Model 200 Switch Packs and 2 Flash Transfer Relays. 2 Flash Transfer Relays shall be provided with the file.

6.4.4.5.3.2 The red and yellow output circuits of Switch Packs No. 1, 2, 4 and 5 shall be made available at a Molex receptacle/plug connection for flash selectability.

#### 6.4.4.6 Heavy Duty Relay (Model 430)

- 6.4.4.6.1 Heavy duty relays shall be the electromechanical type designed for continuous duty.
- 6.4.4.6.2 Each relay shall be enclosed in a removable, clear plastic cover. The manufacturer's name, electrical rating and part number shall be placed on the cover. They shall be permanent, durable and readily visible.
- 6.4.4.6.3 Each relay shall be provided with DPDT contacts. Contact points shall be of fine silver, silver alloy or superior alternative material. Contact points and arms shall be capable of switching a 20 ampere at 120 VAC tungsten load per contact once every 2 seconds with a 50% duty cycle for at least 250,000 operations without contact welding or excessive burning, pitting or cavitation.
- 6.4.4.6.4 The relay coil shall have a power consumption of 10 volt-amperes maximum.
- 6.4.4.6.5 Each relay shall withstand a potential of 1500 VAC at 60 Hz between insulated parts and between current carrying and noncarrying parts. Each relay shall have a 1 cycle surge rating of 175 amperes RMS.

#### 6.4.4.7 Side Panels

- 6.4.4.7.1 Two panels shall be provided and mounted on the cage parallel to the cabinet sides. In viewing from the back door, the left side panel shall be designated as the "Input Panel" and the right side panel shall be designated as the "Service Panel".

#### 6.4.4.8 Cabinet Harnesses

- 6.4.4.8.1 The C1 Harness shall be a minimum of 4 feet in length. The harness wire bundle shall be provided with external protection and routed on the Input Panel side of the cabinet. Adequate length shall be provided to allow the C1P Connector to properly connect any City Approved Model 170 Controller Unit mounted in the cabinet.
- 6.4.4.8.2 One end of the C1 Harness shall be the C1P Connector with pin contacts wired per the detail assignment. The other ends of the harnesses shall terminate as follows:

Harness #1 –  
C4S Connector (connected to C4P on Output File #1)  
C5S Connector (connected to C5P on either the Input Panel or Output File #2)  
Assigned Input Files I & J Positions and Logic Ground Bus

Harness #2 –  
C5S Connector (same as Harness #1)  
C6S Connector (connected to C6P on Output/PDA Assembly)  
Assigned Input File I Positions and Logic Ground Bus

Harness #3 –  
C4S Connector (same as Harness #1)  
Assigned Input File I Positions, Input Panel Terminal  
Block and Logic Ground Bus.

- 6.4.4.8.3 C1 Harness #3/Output File #2 Adaptor shall be comprised of a C4P Connector on one end and a C5S on the other. The adaptor shall interface the first 24 pins of C4 Connector to the 24 pins of C5.
- 6.4.4.8.4 Conductors between the C1 Connector and the Input File(s) shall be of adequate length to allow any conductor to be connected to any detector output terminal (Positions S, F, or W).
- 6.4.4.9 Monitor Unit Assembly (For Model 336B)
- 6.4.4.9.1 The monitor unit assembly shall be 1.75 inches high and a maximum of 17.0 inches wide. The assembly shall house the Model 210 Monitor Unit (horizontally). A Model 210 Monitor Unit shall be furnished with each assembly.
- 6.4.4.9.2 The assembly shall have a vertical opening of 1.5 inches on the front panel for Model 210 insertion/removal. PCB edge guides shall be provided for monitor unit support and to guide it into its mating connector socket.
- 6.4.4.9.3 A 10 position terminal block (M1) shall be provided on the backplane of the assembly. Position assignment, left to right, shall be as follows:
- Position 1 -- +24 VDC  
Position 2 -- DC Ground  
Position 3 -- External Reset  
Position 4 -- Watchdog Timer (WDT) Input  
Position 5 -- STOPTIME Output  
Position 6 -- Door Switch (Unit Resident)  
Position 7 -- Mercury Contactor Coil (To PDA)  
Position 8 -- AC+  
Position 9 -- AC-  
Position 10-- Equipment Ground
- 6.4.4.9.4 A 37 pin circular plastic connector, matching C4P requirements, shall be provided and mounted rigidly on the back of the assembly. Pin assignments shall be as follows:

	PIN CHANNEL /FUNCTION	PIN CHANNEL /FUNCTION	PIN CHANNEL /FUNCTION
1	1 GREEN	12 6 YELLOW	23 12 GREEN
2	1 YELLOW	13 7 GREEN	24 12 YELLOW

3	2 GREEN	14	7 YELLOW	25	13 GREEN
4	2 YELLOW	15	8 GREEN	26	13 YELLOW
5	3 GREEN	16	8 YELLOW	27	14 GREEN
6	3 YELLOW	17	9 GREEN	28	14 YELLOW
7	4 GREEN	18	9 YELLOW	29	15 GREEN
8	4 YELLOW	19	10 GREEN	30	15 YELLOW
9	5 GREEN	20	10 YELLOW	31	16 GREEN
10	5 YELLOW	21	11 GREEN	32	16 YELLOW
11	6 GREEN	22	11 YELLOW	33	AC-

NOTE: PINS 34 to 37 NOT ASSIGNED.

## 6.5 SECTION 5 - CABINET WIRING

### 6.5.1 Cabinet Wiring Diagram

6.5.1.1 Four sets of nonfading (comparable to Xerox 2080) cabinet wiring diagrams shall be supplied with each cabinet. The diagrams shall be nonproprietary. They shall identify all circuits in such a manner as to be readily interpreted. The cabinet drawing shall show the equipment layout in an elevation view as viewed from the rear of the cabinet with the left and right cabinet walls shown in their relative positions. The diagrams shall be placed in a heavy duty side opening clear plastic pouch and attached to the front cabinet door. The pouch shall be of such design and material that it provides adequate storage and access to the wiring diagram and manual.

6.5.1.2 Two cabinet manuals shall be provided in the pouch together with the cabinet wiring diagram sets. The pouch shall be of a size and strength to easily hold the documents and keys without tearing.

### 6.5.2 Conductors

6.5.2.1 All conductors used in cabinet wiring shall terminate with properly sized non-insulated (if used, for DC Logic only) or clear insulated spring-spade type terminals except when soldered to a through-panel solder lug on the rear side of the terminal block or as specified otherwise. All crimp-style connectors shall be applied with a power tool which prevents opening of the handles until the crimp is completed.

6.5.2.2 Conductors between the service terminal AC- and Equipment Ground and their associated bus, the equipment ground bus conductor to Power Distribution Assembly and cage rail, AC- Bus to Power Distribution Assembly shall be No. 8 or larger.

6.5.2.3 All conductors unless otherwise specified shall be No. 22, or larger, with a minimum of 19 copper strands. Conductors shall conform to Military Specification: MIL-W-16878D, Type B, or better. The insulation shall have a minimum thickness of 10 mils and shall be nylon jacketed polyvinyl chloride except that Conductors No. 14 and larger may have Type THHN insulation (without Nylon Jacket), and shall be stranded with a minimum of 7 copper strands.

6.5.2.4 All conductors, except those which can be readily traced, shall be labeled. Labels attached to each end of the conductor shall identify the destination of the other end of the conductor.

6.5.2.5 All conductors shall conform to the following colour-code requirements:

- 6.5.2.5.1 The grounded conductors of AC circuits shall be identified by a continuous white or grey colour.
  - 6.5.2.5.2 The equipment grounding conductors shall be identified by a solid green colour or by a continuous green colour with 1 or more yellow stripes.
  - 6.5.2.5.3 The DC logic ground conductors shall be identified by a solid white colour with a red stripe.
  - 6.5.2.5.4 The ungrounded AC+ conductors shall be identified by a solid black colour or black with coloured stripe.
  - 6.5.2.5.5 The ungrounded logic conductors shall be identified by any colour not specified above.
  - 6.5.2.6 All wiring harnesses shall be neat, firm and routed to minimize crosstalk and electrical interference. Printed circuit motherboards are to be used where possible to eliminate or reduce cabinet wiring.
    - 6.5.2.6.1 Wiring containing AC shall be routed and bundled separately or shielded separately from all logic voltage control circuits.
    - 6.5.2.6.2 Cabling shall be routed to prevent conductors from being in contact with metal edges. Cabling shall be arranged so that any removable assembly may be removed without disturbing conductors not associated with that assembly.
  - 6.5.2.7 Within the cabinet, the DC logic ground and equipment ground shall be electrically isolated from the AC grounded conductor and each other by 500 megohms when tested at 250 VDC, with the power line surge protector disconnected.
  - 6.5.2.8 The AC- copper terminal bus shall not be grounded to the cabinet nor connected to logic ground. Nylon screws with a minimum diameter of 0.25 inch shall be used for securing the bus to the service panel.
  - 6.5.2.9 The cabinet power supply DC Ground shall be connected to the DC logic ground bus using a No. 14, or larger, stranded copper wire.
  - 6.5.2.10 Each detector lead-in pair, from the field terminals in the cabinet to the sensor unit rack connector, shall be a cable of UL Type 2092 or better. The stranded tinned copper drain wire shall be connected to a terminal on the input file terminal block. This input terminal shall be connected to the equipment grounding bus through a single conductor.
- 6.5.3 Terminal Blocks
- 6.5.3.1 The terminal blocks shall be barrier type rated at 20 amperes, 600 volts RMS minimum. The terminal screws shall be 0.3125 inch minimum length nickel plated brass binder head type with screw inserts of same material. Screw size is called out under associated cabinet assembly, file or side panel.
  - 6.5.3.2 The terminals of the power line service terminal block shall be labeled "L1" and "AC-", and shall be covered with a clear insulating material to prevent inadvertent contact. Terminating lugs large enough to accommodate No. 2 conductors shall be furnished for the service terminal block. The terminal block shall be rated for 50 amperes at 600 volts peak, minimum. The block shall be either a double row, 3 position screw/insert with shorting bar (screws, inserts and shorting bars shall be nickel plated brass) or a Marathon #1423552 (or

equal). If the Marathon block is used, the surge protectors shall be terminated under a screw head (not common with AC+, AC- or Equipment Ground). The AC+, AC- and Equipment Ground conductors connecting to the service terminals and appropriate busses shall not be spade lugged.

## **6.6 SECTION 6 - POWER LINE SURGE PROTECTORS**

6.6.1 Two types of power line surge protectors shall be provided between both line conductors (AC+ and AC-) and equipment ground. The protectors shall be installed at the service terminal block.

6.6.2 One type of surge protector shall be the Three-Electrode Gas Tube type and shall have the following ratings:

6.6.2.1 IMPULSE BREAKDOWN: Less than 1,000 volts in less than 0.1 us at 10 kilovolts/us.

6.6.2.2 STANDBY CURRENT: Less than 1 ma.

6.6.2.3 STRIKING VOLTAGE: Greater than 212 VDC.

6.6.2.4 Capable of withstanding 15 pulses of peak current each of which will rise in 8 us and fall in 20 us to 0.5 of the peak voltage at 3 minute intervals. Peak current rating shall be 20,000 amperes.

6.6.3 The other type of surge protector shall be Metal Oxide Varistor (MOV). One shall be installed between AC+ and equipment ground and the other between AC- and equipment ground. The MOV shall have the following ratings:

6.6.3.1 RECURRENT PEAK VOLTAGE: 212 Volts.

6.6.3.2 ENERGY RATING MINIMUM: 50 Joules.

6.6.3.3 POWER DISSIPATION: Average 0.85 Watt.

6.6.3.4 PEAK CURRENT FOR PULSES: 2,000 Amperes for less than 6 us.

6.6.3.4 STANDBY CURRENT: Less than 1 ma.

**CHAPTER 7  
SPECIFICATIONS FOR MODEL 400 MODEM MODULE**

**TABLE of CONTENTS**

<b>SECTION 1 MODEL 400 MODEM MODULE</b>	<b>72</b>
---	-----------

## 7.1 SECTION 1 MODEL 400 MODEM MODULE

7.1.1 The MODEM shall provide two-wire half duplex and four-wire full duplex communications. It shall be switch selectable between half duplex and full duplex. In half duplex, pins X and Y shall be used for Audio IN/OUT.

7.1.2 The MODEM shall be compatible with Bell Standard 202S and comply with the following requirements:

7.1.2.1 Data Rate: 300 to 1200 baud modulation.

7.1.2.2 Modulation: Phase coherent frequency shift keying (FSK).

7.1.2.3 Data Format: Asynchronous, serial by bit.

7.1.2.4 Line and Signal Requirements: Type 3002 voice-grade, unconditioned.

7.1.2.5 ACIA and MODEM Interface: EIA RS-232-C standards.

7.1.2.6 Tone Carrier Frequencies (Transmit & Receive): 1200 Hz (MARK) and 2200Hz (SPACE) with  $\pm 1\%$  tolerance. The operating band shall be (half power, - 3dB) between 1000 and 2400 Hz.

7.1.2.7 Transmitting Output Signal Level: 0, -2, -4, -6 and -8 dB (at 1700 Hz) continuous or switch selectable.

7.1.2.8 Receiver Input Sensitivity: 0 to -40 dB.

7.1.2.9 Receiver Bandpass Filter: Shall meet the error rate requirement specified in Paragraph 7.1.2.15 and shall provide 20 dB/Octave, minimum active attenuation for all frequencies outside the operating band.

7.1.2.10 Clear-to-Send (CTS) Delay: 12 ( $\pm 2$ ) ms.

7.2.1.11 Receive Line Signal Detect Time: 8 ( $\pm 2$ ) ms mark frequency.

7.2.1.12 Receive Line Squelch: 6.5 ( $\pm 1$ ) ms, 0 ms (OUT).

7.2.1.13 Soft Carrier (900 Hz) Turn Off Time: 10 ( $\pm 2$ ) ms.

7.2.1.14 MODEM Recovery Timer: Capable of receiving data within 22 ms after completion of transmission.

7.2.1.15 Error Rate: Shall not exceed 1 bit in 100,000 bits, with a signal-to-noise ratio of 16 dB measured with flat-weight over a 300 to 3000 Hz band.

7.2.1.16 Transmit Noise: Less than -50 dB across 600 ohm resistive load within the frequency spectrum of 300 to 3000 Hz at maximum output.

7.1.3 The MODEM power requirements are as follows:

Input Voltages    Maximum Current Consumption

+12 VDC	75 milliamperes
-12 VDC	75 milliamperes

- 7.1.4 Indicators shall be provided on the front of the MODEM to indicate Carrier Detect, Transmit Data, and Receive Data.

**CHAPTER 8**  
**SPECIFICATIONS FOR MODEL 402 SUPPORT ASSEMBLY**

**TABLE of CONTENTS**

<b>SECTION 1 MODEL 402 SUPPORT ASSEMBLY</b>	<b>75</b>
---	-----------

## **8.1 SECTION 1 - MODEL 402 SUPPORT ASSEMBLY**

- 8.1.1 The Model 402 Support Assembly shall be constructed to mount in a standard EIA 19 inch rack.
- 8.1.2 The top of the Model 402 shall be covered. The sides and bottom shall be slotted for ventilation.
- 8.1.3 The front panel shall provide 2 openings for the insertion and removal of Model 400 Modem Modules. The openings shall allow for the proper use of PCB card ejectors. PCB edge guides shall be provided for each opening.
- 8.1.4 Connector SAC1 shall be a TYPE 25P connector with solder cup connectors on contact plug assembly. The connector shall be mounted on the assembly rear panel.
- 8.1.5 Connector SAC2 shall be a TYPE T connector.
- 8.1.6 Connectors SAC4 and SAC5 shall be PCB 22/44S connectors. The connectors shall intermate with Model 400 Modules. SAC4 Connector shall be wired for Model 400 Module only. SAC5 Connector is wired for either Model 400 or a future I/O Module.
- 8.1.7 Connector D25S shall be a TYPE 25S connector. The connector shall have a shield and mounting hardware to mate with the TYPE 25P connector on the Model 414 Module. The D25S connector shall have a 4 foot cable to interconnect it to the Model 402's other connectors. The cable shall also be provided with strain relief at entry to the Model 402's rear panel. The cable shall be Belden 9515 (or equal).

## APPENDIX A

### TABLE OF CONTENTS

MODELS 400, 402, 412C AND 414	81
<b>MODELS 200, 204, 208, 210, 222, 224, 232, 242, AND 252</b>	<b>77</b>
<b>CABINET HOUSING DETAILS</b>	<b>83</b>
<b>ONE LINE DIAGRAM AND EQUIPMENT MOUNTING</b>	<b>84</b>
<b>POWER DISTRIBUTION</b>	<b>85</b>
<b>INPUT AND OUTPUT FILES</b>	<b>86</b>
<b>SIDE PANELS</b>	<b>87</b>
<b>HARNESS WIRING LISTS</b>	<b>88</b>



STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION  
**Caltrans**

PROJECT ENGINEER  
 DESIGNED BY  
 CHECKED BY  
 DATE REVISION  
 DATE

### MODEL 210 MONITOR UNIT

**FRONT VIEW**

0.4375 WIDTH BY 3.375 LENGTH MONITOR PROGRAMMING CARD

NOTE 5

**BACK VIEW**

PROGRAMMING AREA  
 COMPONENT SIDE

**SIDE VIEW**

1.5 MAX.  
 1.50 MAX.  
 0.125 MAX. FRONT PANEL  
 3.50 MIN.  
 5.63  
 6.0  
 9.80 (0.001)  
 4.50  
 2.40  
 10.17

**END VIEW**

0.47  
 3.50  
 6.875  
 0.375  
 0.125 MAX.

**MODEL 210 MONITOR UNIT CONNECTOR WIRING ASSIGNMENTS**

PIN	JUNCTION	PIN	JUNCTION
1	Channel #2 Green	17	Channel #10 Yellow
2	Channel #3 Green	18	Channel #11 Green
3	Channel #4 Green	19	Channel #12 Green
4	Channel #5 Green	20	Channel #13 Green
5	Channel #6 Green	21	Channel #14 Green
6	Channel #7 Green	22	Channel #15 Green
7	Channel #8 Green	23	Channel #16 Yellow
8	Channel #9 Green	24	Channel #17 Yellow
9	Channel #10 Green	25	Channel #18 Yellow
10	Channel #11 Green	26	Channel #19 Yellow
11	Channel #12 Green	27	Channel #20 Yellow
12	Channel #13 Green	28	Channel #21 Yellow
13	Channel #14 Green		
14	Channel #15 Green		
15	Channel #16 Yellow		
16	Channel #17 Yellow		
17	Channel #18 Yellow		
18	Channel #19 Yellow		
19	Channel #20 Yellow		
20	Channel #21 Yellow		
21	Channel #22 Yellow		
22	Channel #23 Yellow		
23	Channel #24 Yellow		
24	Channel #25 Yellow		
25	Channel #26 Yellow		
26	Channel #27 Yellow		
27	Channel #28 Yellow		
28	Channel #29 Yellow		

DATE  
 REVISION  
 DATE  
 REVISION  
 DATE  
 REVISION

### MODEL 200 AND 204 CONNECTOR DETAIL

**MODEL 200**

PIN FUNCTION

1 AC+ Ground  
 2 AC- Ground  
 3 Red Output  
 4 Not Assigned  
 5 AC- Ground  
 6 Red Output  
 7 Green Output  
 8 Yellow Output  
 9 Yellow Output  
 10 Green Input  
 11 Not Assigned  
 12 Not Assigned

**MODEL 204**

PIN FUNCTION

1 Load Circuit #1  
 2 Load Circuit #2  
 3 Equip Ground  
 4 AC-  
 5 Not Assigned  
 6 Not Assigned

**CROSS SECTION A-A**

4.2 MAX.  
 1.75 MAX.  
 0.2 MAX.  
 7.375 1.0, 1.125  
 3.5 MIN.  
 2.0  
 0.0625  
 4.17 (10.01)

### MODEL 200 AND 204 PHYSICAL DETAILS

**SIDE VIEW**

0.125 MAX. FRONT PANEL  
 0.125 MAX.  
 1.50 MAX.  
 1.50 MAX.  
 0.125 MAX.

### MODEL 210 MONITOR UNIT

**SIDE VIEW**

0.125 MAX. FRONT PANEL  
 0.125 MAX.  
 1.50 MAX.  
 1.50 MAX.  
 0.125 MAX.

### MODEL 222, 224, 232, 242 AND 252

**SIDE VIEW**

0.125 MAX.  
 1.50 MAX.  
 1.50 MAX.  
 0.125 MAX.

### MODEL 222, 224, 232, 242 AND 252 CONNECTOR ASSIGNMENTS

PIN	FUNCTION	PIN	FUNCTION
A	DC Ground	W	#1 Input
B	+24 VDC	X	#2 Output (E)
C	Detector Reset	Y	#3 Output (E)
D	#1 Input	Z	#4 Output (E)
E	#1 Input		
F	#1 Output (C)		
G	#2 Input (E)		
H	#2 Output (E)		
I	#2 Input (E)		
J	#2 Output (E)		
K	#2 Input Common		
L	Equipment Ground		
M	AC-		
N	AC+		
O	#3 Input		
P	NA		
Q	#3 Output (C)		
R	NA		
S	#3 Output (E)		
T	NA		
U	#4 Input		
V	#4 Output (C)		
W	#4 Output (E)		
X	#4 Output (E)		
Y	#4 Output (E)		
Z	#4 Output (E)		

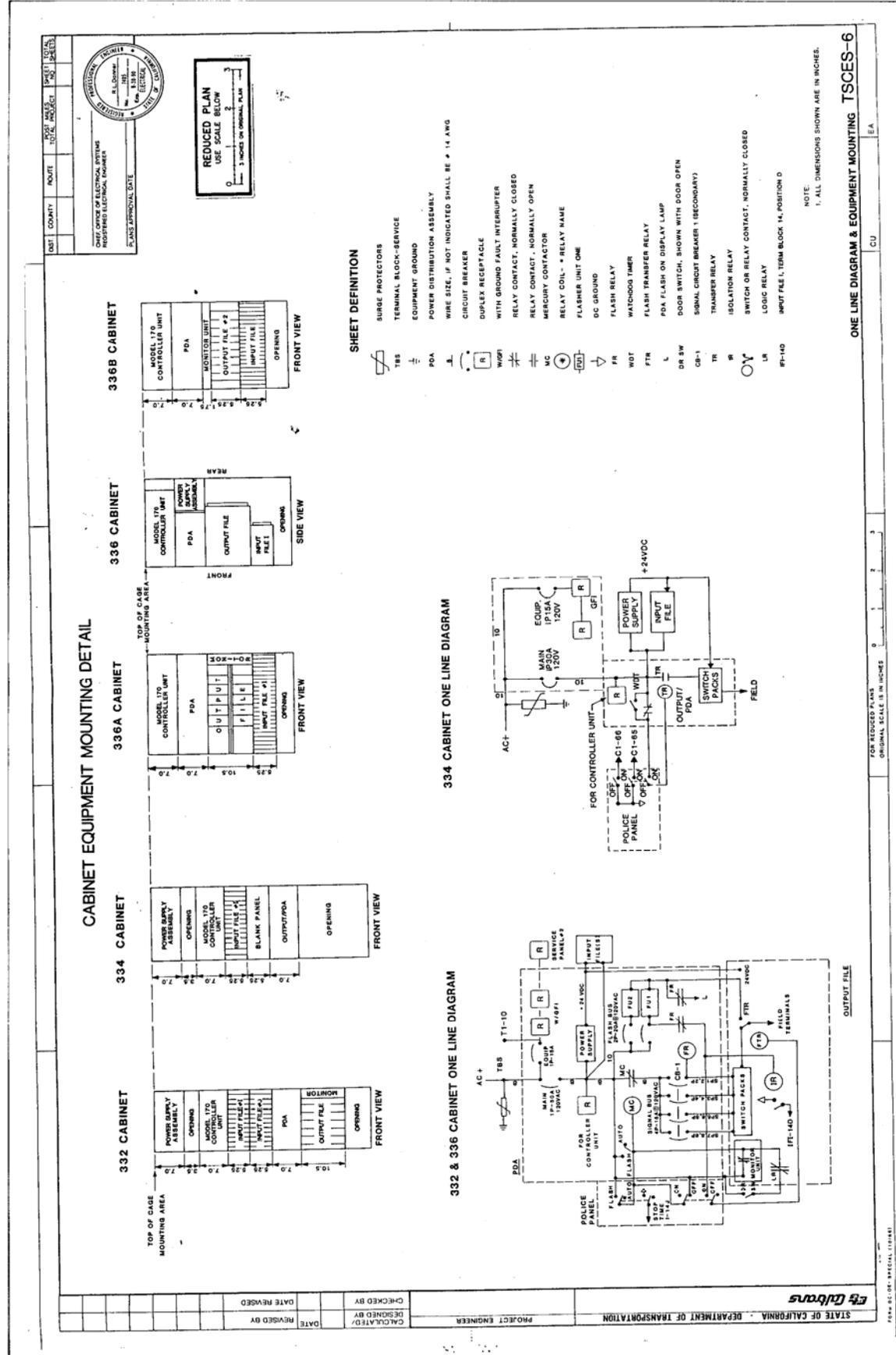
**NOTES:**

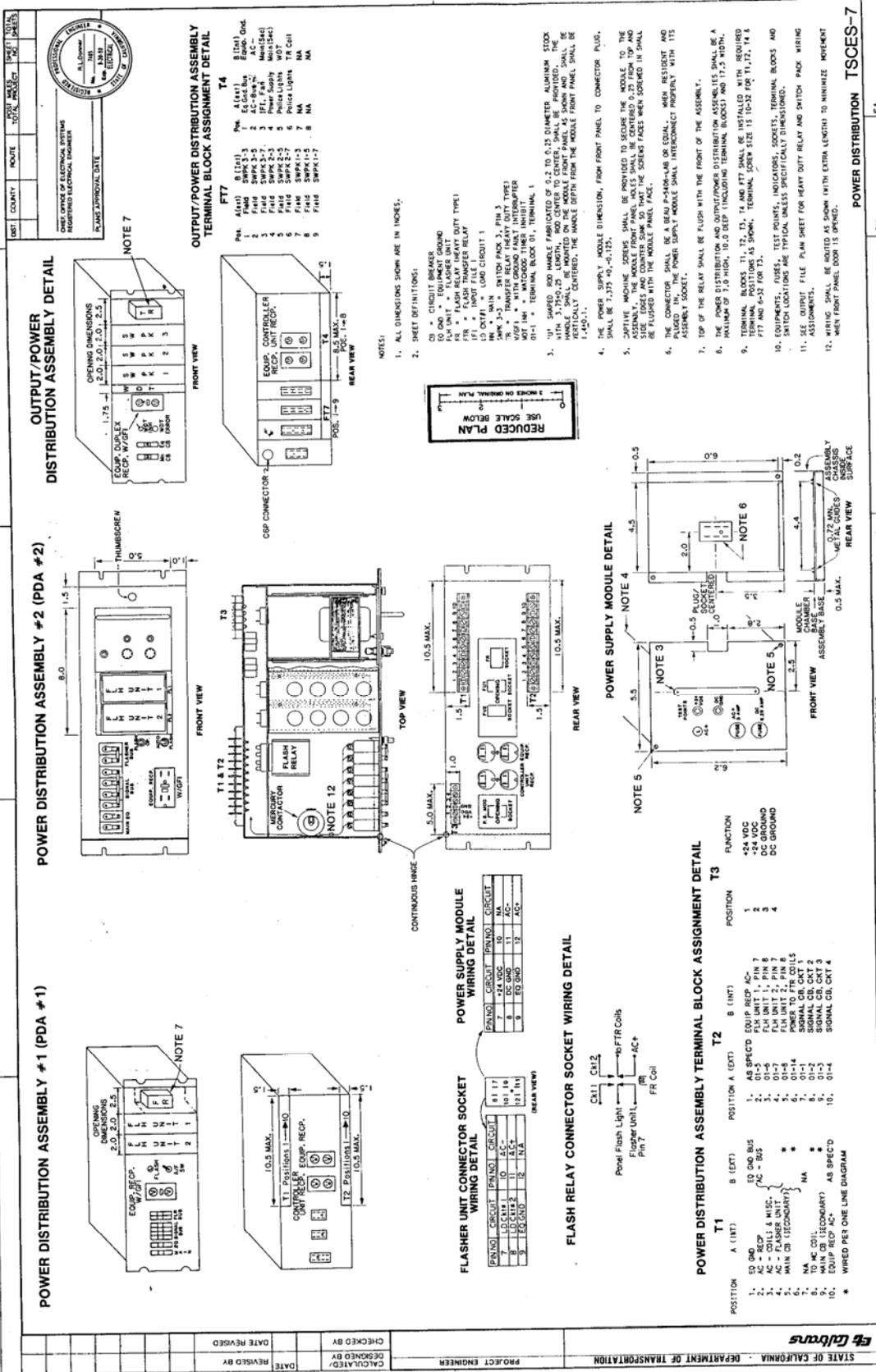
- ALL DIMENSIONS SHOWN ARE IN INCHES.
- MODELS 222, 224, 232, 242, AND 252 SHALL HAVE A WIDTH OF 1.125". MODEL 224 SHALL HAVE A WIDTH OF 2.0125".
- MODEL 210 TOLERANCE DIMENSIONS ARE ±0.02 INCH EX. CEPT AS NOTED.
- SHEET IDENTIFICATION KEYING  
 (C) - COLLECTOR  
 (E) - EQUIPMENT  
 (O) - OUTPUT  
 (I) - INPUT  
 (R) - RESISTOR  
 (S) - SWITCH  
 (T) - TERMINAL  
 (V) - VOLTAGE  
 (W) - WIRE  
 (X) - X-RAY  
 (Y) - YIELD  
 (Z) - ZINC
- "U" SHAPE ROD HANDLE SHALL BE FABRICATED ON MODEL 222 & MODEL 242 DIAMETER STOCK TO FORM A HANDLE.
- THE MODEL 200 CONNECTOR SHALL BE BEAN P-5412-LAB (OR EQUAL). THE MODEL 204 CONNECTOR SHALL BE BEAN P-5408-LAB (OR EQUAL).

STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION  
**Caltrans**

PROJECT ENGINEER  
 DESIGNED BY  
 CHECKED BY  
 DATE REVISION  
 DATE







STATE OF CALIFORNIA - DEPARTMENT OF TRANSPORTATION  
 PROJECT ENGINEER  
 CHECKED BY  
 DESIGNED BY  
 DATE REVISION BY  
 DATE REVISION

**INPUT FILE DETAIL**

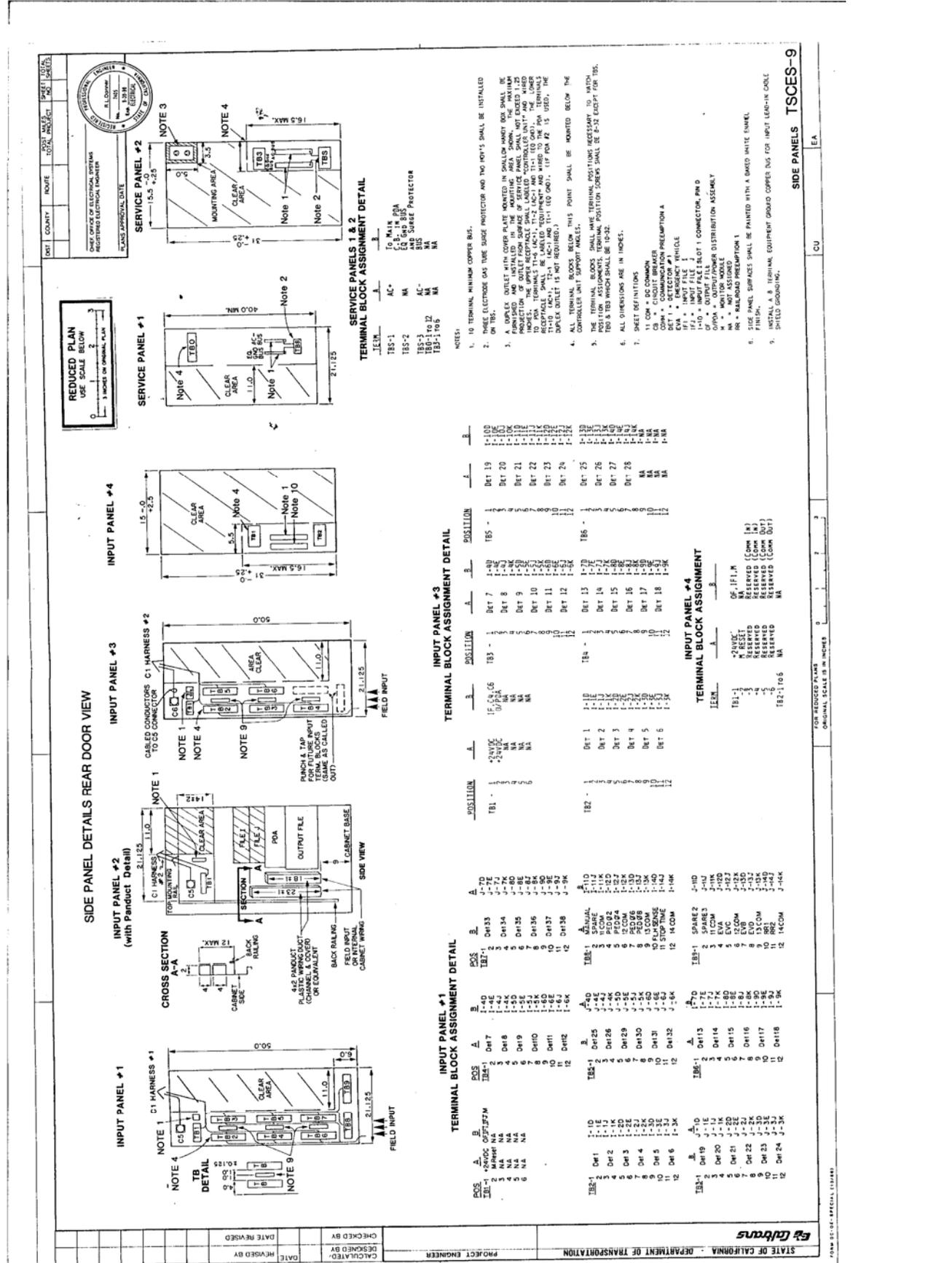
**INPUT FILE TERMINAL ASSIGNMENT DETAIL**

Term.	Pin	Function	Term.	Function
1	SP - Spare	1	AC*	AC*
2	W - Channel 1 Output	2	DC	Equip. Ground
3	D - Channel 1 Input	3	DC	Equip. Ground
4	E - Channel 2 Input	4	DC	Equip. Ground
5	X - Channel 2 Input	5	DC	Equip. Ground
6	L - Equip. Ground	6	DC	Equip. Ground

**OUTPUT FILE #1 DETAIL**

**OUTPUT FILE #1 TERMINAL ASSIGNMENT DETAIL**

Term.	Function	Term.	Function
1	DC VDC	11	SWK 2-RED
2	DC VDC	12	SWK 3-RED
3	DC VDC	13	SWK 4-RED
4	DC VDC	14	SWK 5-RED
5	DC VDC	15	SWK 6-RED
6	DC VDC	16	SWK 7-RED
7	DC VDC	17	SWK 8-RED
8	DC VDC	18	SWK 9-RED
9	DC VDC	19	SWK 10-RED
10	DC VDC	20	SWK 11-RED
11	DC VDC	21	SWK 12-RED
12	DC VDC	22	SWK 13-RED
13	DC VDC	23	SWK 14-RED
14	DC VDC	24	SWK 15-RED
15	DC VDC	25	SWK 16-RED
16	DC VDC	26	SWK 17-RED
17	DC VDC	27	SWK 18-RED
18	DC VDC	28	SWK 19-RED
19	DC VDC	29	SWK 20-RED
20	DC VDC	30	SWK 21-RED
21	DC VDC	31	SWK 22-RED
22	DC VDC	32	SWK 23-RED
23	DC VDC	33	SWK 24-RED
24	DC VDC	34	SWK 25-RED
25	DC VDC	35	SWK 26-RED
26	DC VDC	36	SWK 27-RED
27	DC VDC	37	SWK 28-RED
28	DC VDC	38	SWK 29-RED
29	DC VDC	39	SWK 30-RED
30	DC VDC	40	SWK 31-RED
31	DC VDC	41	SWK 32-RED
32	DC VDC	42	SWK 33-RED
33	DC VDC	43	SWK 34-RED
34	DC VDC	44	SWK 35-RED
35	DC VDC	45	SWK 36-RED
36	DC VDC	46	SWK 37-RED
37	DC VDC	47	SWK 38-RED
38	DC VDC	48	SWK 39-RED
39	DC VDC	49	SWK 40-RED
40	DC VDC	50	SWK 41-RED
41	DC VDC	51	SWK 42-RED
42	DC VDC	52	SWK 43-RED
43	DC VDC	53	SWK 44-RED
44	DC VDC	54	SWK 45-RED
45	DC VDC	55	SWK 46-RED
46	DC VDC	56	SWK 47-RED
47	DC VDC	57	SWK 48-RED
48	DC VDC	58	SWK 49-RED
49	DC VDC	59	SWK 50-RED
50	DC VDC	60	SWK 51-RED
51	DC VDC	61	SWK 52-RED
52	DC VDC	62	SWK 53-RED
53	DC VDC	63	SWK 54-RED
54	DC VDC	64	SWK 55-RED
55	DC VDC	65	SWK 56-RED
56	DC VDC	66	SWK 57-RED
57	DC VDC	67	SWK 58-RED
58	DC VDC	68	SWK 59-RED
59	DC VDC	69	SWK 60-RED
60	DC VDC	70	SWK 61-RED
61	DC VDC	71	SWK 62-RED
62	DC VDC	72	SWK 63-RED
63	DC VDC	73	SWK 64-RED
64	DC VDC	74	SWK 65-RED
65	DC VDC	75	SWK 66-RED
66	DC VDC	76	SWK 67-RED
67	DC VDC	77	SWK 68-RED
68	DC VDC	78	SWK 69-RED
69	DC VDC	79	SWK 70-RED
70	DC VDC	80	SWK 71-RED
71	DC VDC	81	SWK 72-RED
72	DC VDC	82	SWK 73-RED
73	DC VDC	83	SWK 74-RED
74	DC VDC	84	SWK 75-RED
75	DC VDC	85	SWK 76-RED
76	DC VDC	86	SWK 77-RED
77	DC VDC	87	SWK 78-RED
78	DC VDC	88	SWK 79-RED
79	DC VDC	89	SWK 80-RED
80	DC VDC	90	SWK 81-RED
81	DC VDC	91	SWK 82-RED
82	DC VDC	92	SWK 83-RED
83	DC VDC	93	SWK 84-RED
84	DC VDC	94	SWK 85-RED
85	DC VDC	95	SWK 86-RED
86	DC VDC	96	SWK 87-RED
87	DC VDC	97	SWK 88-RED
88	DC VDC	98	SWK 89-RED
89	DC VDC	99	SWK 90-RED
90	DC VDC	100	SWK 91-RED
91	DC VDC	101	SWK 92-RED
92	DC VDC	102	SWK 93-RED
93	DC VDC	103	SWK 94-RED
94	DC VDC	104	SWK 95-RED
95	DC VDC	105	SWK 96-RED
96	DC VDC	106	SWK 97-RED
97	DC VDC	107	SWK 98-RED
98	DC VDC	108	SWK 99-RED
99	DC VDC	109	SWK 100-RED
100	DC VDC	110	SWK 101-RED
101	DC VDC	111	SWK 102-RED
102	DC VDC	112	SWK 103-RED
103	DC VDC	113	SWK 104-RED
104	DC VDC	114	SWK 105-RED
105	DC VDC	115	SWK 106-RED
106	DC VDC	116	SWK 107-RED
107	DC VDC	117	SWK 108-RED
108	DC VDC	118	SWK 109-RED
109	DC VDC	119	SWK 110-RED
110	DC VDC	120	SWK 111-RED
111	DC VDC	121	SWK 112-RED
112	DC VDC	122	SWK 113-RED
113	DC VDC	123	SWK 114-RED
114	DC VDC	124	SWK 115-RED
115	DC VDC	125	SWK 116-RED
116	DC VDC	126	SWK 117-RED
117	DC VDC	127	SWK 118-RED
118	DC VDC	128	SWK 119-RED
119	DC VDC	129	SWK 120-RED
120	DC VDC	130	SWK 121-RED
121	DC VDC	131	SWK 122-RED
122	DC VDC	132	SWK 123-RED
123	DC VDC	133	SWK 124-RED
124	DC VDC	134	SWK 125-RED
125	DC VDC	135	SWK 126-RED
126	DC VDC	136	SWK 127-RED
127	DC VDC	137	SWK 128-RED
128	DC VDC	138	SWK 129-RED
129	DC VDC	139	SWK 130-RED
130	DC VDC	140	SWK 131-RED
131	DC VDC	141	SWK 132-RED
132	DC VDC	142	SWK 133-RED
133	DC VDC	143	SWK 134-RED
134	DC VDC	144	SWK 135-RED
135	DC VDC	145	SWK 136-RED
136	DC VDC	146	SWK 137-RED
137	DC VDC	147	SWK 138-RED
138	DC VDC	148	SWK 139-RED
139	DC VDC	149	SWK 140-RED
140	DC VDC	150	SWK 141-RED
141	DC VDC	151	SWK 142-RED
142	DC VDC	152	SWK 143-RED
143	DC VDC	153	SWK 144-RED
144	DC VDC	154	SWK 145-RED
145	DC VDC	155	SWK 146-RED
146	DC VDC	156	SWK 147-RED
147	DC VDC	157	SWK 148-RED
148	DC VDC	158	SWK 149-RED
149	DC VDC	159	SWK 150-RED
150	DC VDC	160	SWK 151-RED
151	DC VDC	161	SWK 152-RED
152	DC VDC	162	SWK 153-RED
153	DC VDC	163	SWK 154-RED
154	DC VDC	164	SWK 155-RED
155	DC VDC	165	SWK 156-RED
156	DC VDC	166	SWK 157-RED
157	DC VDC	167	SWK 158-RED
158	DC VDC	168	SWK 159-RED
159	DC VDC	169	SWK 160-RED
160	DC VDC	170	SWK 161-RED
161	DC VDC	171	SWK 162-RED
162	DC VDC	172	SWK 163-RED
163	DC VDC	173	SWK 164-RED
164	DC VDC	174	SWK 165-RED
165	DC VDC	175	SWK 166-RED
166	DC VDC	176	SWK 167-RED
167	DC VDC	177	SWK 168-RED
168	DC VDC	178	SWK 169-RED
169	DC VDC	179	SWK 170-RED
170	DC VDC	180	SWK 171-RED
171	DC VDC	181	SWK 172-RED
172	DC VDC	182	SWK 173-RED
173	DC VDC	183	SWK 174-RED
174	DC VDC	184	SWK 175-RED
175	DC VDC	185	SWK 176-RED
176	DC VDC	186	SWK 177-RED
177	DC VDC	187	SWK 178-RED
178	DC VDC	188	SWK 179-RED
179	DC VDC	189	SWK 180-RED
180	DC VDC	190	SWK 181-RED
181	DC VDC	191	SWK 182-RED
182	DC VDC	192	SWK 183-RED
183	DC VDC	193	SWK 184-RED
184	DC VDC	194	SWK 185-RED
185	DC VDC	195	SWK 186-RED
186	DC VDC	196	SWK 187-RED
187	DC VDC	197	SWK 188-RED
188	DC VDC	198	SWK 189-RED
189	DC VDC	199	SWK 190-RED
190	DC VDC	200	SWK 191-RED
191	DC VDC	201	SWK 192-RED
192	DC VDC	202	SWK 193-RED
193	DC VDC	203	SWK 194-RED
194	DC VDC	204	SWK 195-RED
195	DC VDC	205	SWK 196-RED
196	DC VDC	206	SWK 197-RED
197	DC VDC	207	SWK 198-RED
198	DC VDC	208	SWK 199-RED
199	DC VDC	209	SWK 200-RED
200	DC VDC	210	SWK 201-RED
201	DC VDC	211	SWK 202-RED
202	DC VDC	212	SWK 203-RED
203	DC VDC	213	SWK 204-RED
204	DC VDC	214	SWK 205-RED
205	DC VDC	215	SWK 206-RED
206	DC VDC	216	SWK 207-RED
207	DC VDC	217	SWK 208-RED
208	DC VDC	218	SWK 209-RED
209	DC VDC	219	SWK 210-RED
210	DC VDC	220	SWK 211-RED
211	DC VDC	221	SWK 212-RED
212	DC VDC	222	SWK 213-RED
213	DC VDC	223	SWK 214-RED
214	DC VDC	224	SWK 215-RED
215	DC VDC	225	SWK 216-RED
216	DC VDC	226	SWK 217-RED
217	DC VDC	227	SWK 218-RED
218	DC VDC	228	SWK 219-RED
219	DC VDC	229	SWK 220-RED
220	DC VDC	230	SWK 221-RED
221	DC VDC	231	SWK 222-RED
222	DC VDC	232	SWK 223-RED
223	DC VDC	233	SWK 224-RED
224	DC VDC	234	SWK 225-RED
225	DC VDC	235	SWK 226-RED
226	DC VDC	236	SWK 227-RED
227	DC VDC	237	SWK 228-RED
228	DC VDC	238	SWK 229-RED
229	DC VDC	239	SWK 230-RED
230	DC VDC	240	SWK 231-RED
231	DC VDC	241	SWK 232-RED
232	DC VDC	242	SWK 233-RED
233	DC VDC	243	SWK 234-RED
234	DC VDC	244	SWK 235-RED
235	DC VDC	245	SWK 236-RED
236	DC VDC	246	SWK 237-RED
237	DC VDC	247	SWK 238-RED
238	DC VDC	248	SWK 239-RED
239	DC VDC	249	SWK 240-RED
240	DC VDC	250	SWK 241-RED
241	DC VDC	251	SWK 242-RED
242	DC VDC	252	SWK 243-RED
243	DC VDC	253	SWK 244-RED
244	DC VDC	254	SWK 245-RED
245	DC VDC	255	SWK 246-RED
246	DC VDC	256	SWK 247-RED
247	DC VDC	257	SWK 248-RED
248	DC VDC</		



LAST COUNTY ROUTE TOTAL INCHES PART NUMBER PART NUMBER SHEETS

**REDUCED PLAN**  
 USE SCALE BELOW

**CHIEF OFFICE OF ELECTRICAL SYSTEMS**  
 REGISTERED ELECTRICAL ENGINEER

PLANS APPROVAL DATE

**C1 HARNESS #1 WIRING LIST**

PIN	SOURCE	DESTINATION	FUNCTION
1	DC DND	DC DND BUS	
2	DC DND	DC DND BUS	
3	DC DND	DC DND BUS	
4	DC DND	DC DND BUS	
5	DC DND	DC DND BUS	
6	DC DND	DC DND BUS	
7	DC DND	DC DND BUS	
8	DC DND	DC DND BUS	
9	DC DND	DC DND BUS	
10	DC DND	DC DND BUS	
11	DC DND	DC DND BUS	
12	DC DND	DC DND BUS	
13	DC DND	DC DND BUS	
14	DC DND	DC DND BUS	
15	DC DND	DC DND BUS	
16	DC DND	DC DND BUS	
17	DC DND	DC DND BUS	
18	DC DND	DC DND BUS	
19	DC DND	DC DND BUS	
20	DC DND	DC DND BUS	
21	DC DND	DC DND BUS	
22	DC DND	DC DND BUS	
23	DC DND	DC DND BUS	
24	DC DND	DC DND BUS	
25	DC DND	DC DND BUS	
26	DC DND	DC DND BUS	

**C2 HARNESS #1 AND #2 WIRING LIST**

PIN	SOURCE	DESTINATION	FUNCTION
1	DC DND	DC DND BUS	
2	DC DND	DC DND BUS	
3	DC DND	DC DND BUS	
4	DC DND	DC DND BUS	
5	DC DND	DC DND BUS	
6	DC DND	DC DND BUS	
7	DC DND	DC DND BUS	
8	DC DND	DC DND BUS	
9	DC DND	DC DND BUS	
10	DC DND	DC DND BUS	
11	DC DND	DC DND BUS	
12	DC DND	DC DND BUS	
13	DC DND	DC DND BUS	
14	DC DND	DC DND BUS	
15	DC DND	DC DND BUS	
16	DC DND	DC DND BUS	
17	DC DND	DC DND BUS	
18	DC DND	DC DND BUS	
19	DC DND	DC DND BUS	
20	DC DND	DC DND BUS	
21	DC DND	DC DND BUS	
22	DC DND	DC DND BUS	
23	DC DND	DC DND BUS	
24	DC DND	DC DND BUS	
25	DC DND	DC DND BUS	
26	DC DND	DC DND BUS	

**C3 HARNESS #1 AND #2 WIRING LIST**

PIN	SOURCE	DESTINATION	FUNCTION
1	DC DND	DC DND BUS	
2	DC DND	DC DND BUS	
3	DC DND	DC DND BUS	
4	DC DND	DC DND BUS	
5	DC DND	DC DND BUS	
6	DC DND	DC DND BUS	
7	DC DND	DC DND BUS	
8	DC DND	DC DND BUS	
9	DC DND	DC DND BUS	
10	DC DND	DC DND BUS	
11	DC DND	DC DND BUS	
12	DC DND	DC DND BUS	
13	DC DND	DC DND BUS	
14	DC DND	DC DND BUS	
15	DC DND	DC DND BUS	
16	DC DND	DC DND BUS	
17	DC DND	DC DND BUS	
18	DC DND	DC DND BUS	
19	DC DND	DC DND BUS	
20	DC DND	DC DND BUS	
21	DC DND	DC DND BUS	
22	DC DND	DC DND BUS	
23	DC DND	DC DND BUS	
24	DC DND	DC DND BUS	
25	DC DND	DC DND BUS	
26	DC DND	DC DND BUS	

**C4 HARNESS #1 AND #3 WIRING LIST**

PIN	SOURCE	DESTINATION	FUNCTION
1	DC DND	DC DND BUS	
2	DC DND	DC DND BUS	
3	DC DND	DC DND BUS	
4	DC DND	DC DND BUS	
5	DC DND	DC DND BUS	
6	DC DND	DC DND BUS	
7	DC DND	DC DND BUS	
8	DC DND	DC DND BUS	
9	DC DND	DC DND BUS	
10	DC DND	DC DND BUS	
11	DC DND	DC DND BUS	
12	DC DND	DC DND BUS	
13	DC DND	DC DND BUS	
14	DC DND	DC DND BUS	
15	DC DND	DC DND BUS	
16	DC DND	DC DND BUS	
17	DC DND	DC DND BUS	
18	DC DND	DC DND BUS	
19	DC DND	DC DND BUS	
20	DC DND	DC DND BUS	
21	DC DND	DC DND BUS	
22	DC DND	DC DND BUS	
23	DC DND	DC DND BUS	
24	DC DND	DC DND BUS	
25	DC DND	DC DND BUS	
26	DC DND	DC DND BUS	

**C5 HARNESS #1 AND #2 WIRING LIST**

PIN	SOURCE	DESTINATION	FUNCTION
1	DC DND	DC DND BUS	
2	DC DND	DC DND BUS	
3	DC DND	DC DND BUS	
4	DC DND	DC DND BUS	
5	DC DND	DC DND BUS	
6	DC DND	DC DND BUS	
7	DC DND	DC DND BUS	
8	DC DND	DC DND BUS	
9	DC DND	DC DND BUS	
10	DC DND	DC DND BUS	
11	DC DND	DC DND BUS	
12	DC DND	DC DND BUS	
13	DC DND	DC DND BUS	
14	DC DND	DC DND BUS	
15	DC DND	DC DND BUS	
16	DC DND	DC DND BUS	
17	DC DND	DC DND BUS	
18	DC DND	DC DND BUS	
19	DC DND	DC DND BUS	
20	DC DND	DC DND BUS	
21	DC DND	DC DND BUS	
22	DC DND	DC DND BUS	
23	DC DND	DC DND BUS	
24	DC DND	DC DND BUS	
25	DC DND	DC DND BUS	
26	DC DND	DC DND BUS	

**C6 HARNESS #2 WIRING LIST**

PIN	SOURCE	DESTINATION	FUNCTION
1	DC DND	DC DND BUS	
2	DC DND	DC DND BUS	
3	DC DND	DC DND BUS	
4	DC DND	DC DND BUS	
5	DC DND	DC DND BUS	
6	DC DND	DC DND BUS	
7	DC DND	DC DND BUS	
8	DC DND	DC DND BUS	
9	DC DND	DC DND BUS	
10	DC DND	DC DND BUS	
11	DC DND	DC DND BUS	
12	DC DND	DC DND BUS	
13	DC DND	DC DND BUS	
14	DC DND	DC DND BUS	
15	DC DND	DC DND BUS	
16	DC DND	DC DND BUS	
17	DC DND	DC DND BUS	
18	DC DND	DC DND BUS	
19	DC DND	DC DND BUS	
20	DC DND	DC DND BUS	
21	DC DND	DC DND BUS	
22	DC DND	DC DND BUS	
23	DC DND	DC DND BUS	
24	DC DND	DC DND BUS	
25	DC DND	DC DND BUS	
26	DC DND	DC DND BUS	

**C7 HARNESS #3 WIRING LIST**

PIN	SOURCE	DESTINATION	FUNCTION
1	DC DND	DC DND BUS	
2	DC DND	DC DND BUS	
3	DC DND	DC DND BUS	
4	DC DND	DC DND BUS	
5	DC DND	DC DND BUS	
6	DC DND	DC DND BUS	
7	DC DND	DC DND BUS	
8	DC DND	DC DND BUS	
9	DC DND	DC DND BUS	
10	DC DND	DC DND BUS	
11	DC DND	DC DND BUS	
12	DC DND	DC DND BUS	
13	DC DND	DC DND BUS	
14	DC DND	DC DND BUS	
15	DC DND	DC DND BUS	
16	DC DND	DC DND BUS	
17	DC DND	DC DND BUS	
18	DC DND	DC DND BUS	
19	DC DND	DC DND BUS	
20	DC DND	DC DND BUS	
21	DC DND	DC DND BUS	
22	DC DND	DC DND BUS	
23	DC DND	DC DND BUS	
24	DC DND	DC DND BUS	
25	DC DND	DC DND BUS	
26	DC DND	DC DND BUS	

**CONNECTORS C4, C5, AND C6**

**NOTE:**

- SHEET DEFINITIONS:  
 C1-2 = CONNECTOR C1, PIN 2  
 EVL = EVENT PORT 5001, BIT 1  
 IF1-2F, SP = INPUT FILE 1, TERMINAL DESIGNATION F  
 (CHANNEL 1 OUTPUT), SPARE  
 IF1-2M = INPUT FILE 2, TERMINAL DESIGNATION M  
 (CHANNEL 2 OUTPUT)  
 O1-1 = OUTPUT PORT 5001, BIT 1  
 SRI = RAILROAD 1 TRACK 2 ROESTERIAN, GREEN  
 SWK 2P-2SN = SWITCHBOARD TIMER, MONITOR UNIT  
 2 DC = PHASE 2 COUNT & EXTENSION

**HARNESS WIRING LISTS TSCE-10**