CMU-24VDC-ITL

Low Voltage DC Cabinet Monitor Unit

Operations Manual

THIS MANUAL CONTAINS TECHNICAL INFORMATION FOR THE **CMU-24VDC-ITL** SERIES ITS CABINET MONITOR UNIT.

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THE CMU-24VDC SERIES CABINET MONITOR UNIT IS DESIGNED AND MANUFACTURED IN THE USA BY
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AN ISO 9001:2008 REGISTERED COMPANY

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MAINTENANCE NOTE

THIS EBERLE DESIGN INC. CABINET MONITOR UNIT HAS BEEN CAREFULLY INSPECTED AND TESTED TO ENSURE PROPER OPERATION. IT IS RECOMMENDED THAT THE CABINET MONITOR UNIT BE TESTED AT LEAST ANNUALLY TO ENSURE PROPER OPERATION AND COMPLIANCE WITH FACTORY SPECIFICATIONS.

- WARNING -

LED SIGNALS MUST MEET THE REQUIREMENTS OF SECTION 3.2

CARE MUST BE TAKEN AT EACH INSTALLATION TO ENSURE THAT THE TOTAL VOLTAGE DROP DUE TO SIGNAL LOAD CURRENT IN BOTH THE FIELD WIRE AND FIELD RETURN WIRE DOES NOT EXCEED 4 VOLTS TOTAL.

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Section 1
GENERAL

1.1 OVERVIEW

The model CMU-24VDC Cabinet Monitor Unit (CMU-24VDC) is the principle part of the ITS Traffic Control Cabinet Monitoring System. It is resident in the Power Distribution Assembly and communicates with an Auxiliary Monitor Unit (AMU) located in each Output Assembly via Serial Bus #3. The role of the CMU-24VDC is to query various cabinet conditions and, if the application requires action, the CMU-24VDC will transfer control from the Advanced Traffic Controller (ATC) to a flashing control mode. Applications include the detection of, and response to, improper and conflicting signals and improper operating voltages in a cabinet assembly caused by malfunctions of the (ATC), load switches, or miss wiring of the cabinet.

The communications between the ATC and the CMU-24VDC via Serial Bus #1 plays an integral role in ensuring safe and proper operation of the cabinet equipment as well as providing important diagnostic functions used for trouble shooting malfunctioning equipment.

The Eberle Design CMU-24VDC meets with or exceeds all appropriate specifications outlined the ASHTO/ITE/NEMA ***Intelligent Transportation System (ITS) Standard Specification for Roadside Cabinets Version 01.02.17b***.

The Eberle Design CMU-24VDC is functionally interchangeable with a standard CMU-212 but is specially configured for low voltage (24Vdc) DC signal loads.

1.2 CHANNEL CONFIGURATION

The CMU-24VDC can be configured to monitor up to 28 physical load switch channels of three inputs per channel. An additional four virtual channels can be programmed to provide a total of 32 logical channels. Each channel is comprised of a Red / Don't Walk input, a Yellow input, and a Green / Walk input.

1.3 AUXILIARY MONITOR UNIT

The Auxiliary Monitor Unit (AMU-24VDC) provides the CMU-24VDC with voltage and current measurements from each installed Output Assembly. The AMU-24VDC has the capability to measure and report field terminal voltages for fourteen channels of three inputs per channel and load currents for fourteen channels. The AMU-24VDC is also compatible with a six position Output Assembly. The AMU is configured by its output assembly address. This address is set by a jumper plug located on the rear of the output assembly. For further information concerning the AMU-24VDC, see the Eberle Design ***AMU-24VDC Operations Manual***.

The AMU-24VDC address assignment specifies the physical arrangement of the Output Assemblies. This defines the number of contiguous channels that the CMU-24VDC is monitoring. An AMU-24VDC assigned as a 14 channel unit must be addressed as AMU #1 with AMU #2 reserved, or as AMU #3 with AMU #4 reserved. The following table shows the ten possible cabinet configurations:

AMU #1	AMU #2	AMU #3	AMU #4	Monitored Channels
14	reserved	none	None	1 thru 14
14	reserved	14	reserved	1 thru 28
14	reserved	6	None	1 thru 20
14	reserved	6	6	1 thru 26
6	none	none	None	1 thru 6

AMU #1	AMU #2	AMU #3	AMU #4	Monitored Channels
6	6	none	None	1 thru 12
6	6	6	None	1 thru 18
6	6	6	6	1 thru 24
6	none	14	reserved	1 thru 20
6	6	14	reserved	1 thru 26

The ATC must verify that all output assemblies being driven by a Serial Interface Unit (SIU) are being monitored by an AMU-24VDC and that the AMU-24VDC is enabled by the programming in the CMU-24VDC. Failure to provide this check may result in unmonitored load switch outputs. This could occur as a result of improper configuration of the cabinet, improper address assignment for one or more AMU-24VDC units, improper address assignment for one or more SIU units, or improper programming of the ATC.

1.4 CMU-24VDC PROGRAMMING

The CMU-24VDC is individually configured using a removable nonvolatile memory device called a Datakey[tm] (Datakey is a registered trademark of Datakey Electronics, Inc.). The Datakey replaces the mechanical jumper or diode based program card used in conventional signal monitors and provides an electronic method of programming the CMU-24VDC. The Datakey contains a nonvolatile prom device that is read by the CMU-24VDC. The Datakey itself is programmed by a separate programming device using a Personal Computer program such as the Eberle Design MonitorKey product. See the Eberle Design ***MonitorKey Operations Manual*** for further details.

The Datakey is interoperable with any CMU-24VDC meeting the requirements of the ASHTO/ITE/NEMA ***Intelligent Transportation System (ITS) Standard Specification for Roadside Cabinets Version 01.02.17b***.

1.5 ECCOM SOFTWARE INTERFACE

The front panel display of the CMU-24VDC provides limited operational status. This status includes real time indicators for Power, Serial Bus #1 activity, Serial Bus #3 activity, and eleven latched indicators for fault conditions. Detailed status is obtained through the front panel port using Eberle Design *ECcom* software running on a personal computer. The ECcom software provides access to real time monitor data such as current field signal status, field terminal voltages, cabinet control voltages, channel load current status, temperature, and fault status. Historical event logs and signal sequence logs are also provided. See the Eberle Design ***ECcom Operations Manual*** for further details.

1.6 SERIAL BUS #1

Serial Bus #1 provides a communication path between the CMU-24VDC to the ATC. The communications between the ATC and the CMU-24VDC plays an integral role in ensuring safe and proper operation of the cabinet equipment as well as providing important diagnostic functions used for trouble shooting malfunctioning equipment. Standardized communications can be broken into three categories; real time and latched fault status, configuration verification, and malfunction detection and diagnosis.

Messages are defined that allow the ATC and the CMU-24VDC to perform redundant checks on each other. The ATC has access to all CMU-24VDC information including field signal input status, permissive programming, and fault status. This gives the ATC the capability to provide a backup monitoring function and make enhanced event logging, remote intersection monitoring, and remote diagnostics feasible. Similarly, the CMU-24VDC receives information from the ATC that corresponds to the output commands to the load switches. This data allows the CMU-24VDC to better respond to and diagnose fault situations.

1.6.1 SERIAL BUS #1 MESSAGE TYPES

The CMU-24VDC is compatible with the following message types:

Type 60 Module Identification Command / Type 188 Module Identification Response

Type 61 Load Switch Drivers Command / Type 189 CMU Status Response

Type 62 Set FSA Command / Type 190 FSA Response

Type 65 Get CMU Configuration Command / Type 193 CMU Configuration Response

Type 66 Time and Date Broadcast Command

Type 67 Load Switch Drivers Command / Type 195 CMU Short Status Response

1.7 SERIAL BUS #3

Serial Bus #3 is used to transfer data from a maximum of four AMU-24VDC units to the CMU-24VDC. The CMU-24VDC then maps the retrieved data to the proper logical channel and evaluates the state of the field signals for fault conditions. The CMU-24VDC is compatible with AMU-24VDC units configured for 6-channel operation or 14-channel operation.

1.7.1 SERIAL BUS #3 MESSAGE TYPES

The CMU-24VDC is compatible with the following message types:

Type 1 AMU 6 Status Command / Type 129 AMU 6 Status Response

Type 2 AMU 14 Status Command / Type 130 AMU 14 Status Response

Type 128 Negative Acknowledge Response

1.8 FAILED STATE ACTION (LFSA, LFSA-R, NFSA)

When triggered by the detection of a fault condition that exists longer than the minimum defined period, the CMU-24VDC will enter the Failed State Action (fault) mode causing the OUTPUT relay to de-energize and the contacts on the OUTPUT NO pins to open. The cabinet assembly should be wired such that the opening of the OUTPUT NO relay contacts will cause an automatic switching of the field signal outputs from normal operation to flashing operation.

Only Unit Reset from the Reset Button or EXTERNAL RESET TEST input will reset the CMU-24VDC from a LATCHED FAILED STATE ACTION (LFSA). Only a Unit Reset from the Reset Button or EXTERNAL RESET TEST input or a CMU-24VDC Power Fail will reset a LATCHED RESETTABLE FAILED STATE ACTION (LFSA-R).

A NONLATCHED FAILED STATE ACTION (NFSA) will be reset if the fault conditions causing the NFSA have been removed. An NFSA will last for the programmed Minimum Flash time at a minimum.

Only one LFSA, LFSA-R or NFSA fault state will be set at any time.

1.8.1 EXIT FROM FSA

Prior to the CMU-24VDC transferring the OUTPUT NO contacts from the FSA state to the No Fault state, a transition period of 500 milliseconds will occur. During the transition period the OUTPUT NO contacts will be in the FSA state and the CMU-24VDC will set the Start-Up Flash Call bit in the Type 189 Frame to 1**.** At all other times the Start-Up Flash Call bit of the Type 189 Frame will be set to 0. This provides an early indication to the ATC that exit from the FSA state is occurring and the start-up phases should be set.

Section 2
MONITOR FUNCTIONS

2.1 CABINET POWER SUPPLY MONITOR

The CMU-24VDC will sense the Cabinet +24VDC MONITOR and +12VDC MONITOR power supply sources. The CMU-24VDC will also sense the Cabinet +24VDC MONITOR state in each Output Assembly as reported by each AMU. Voltages equal to or greater than +22 Vdc and +11 Vdc respectively will not cause a LFSA. Voltages at or less than +18 Vdc and +9 Vdc for 500ms or longer will cause a LFSA. If the sensed voltage is less than +22 Vdc or +11 VDC for 200 ms or less, the CMU-24VDC will not cause a LFSA. All other timing or voltage conditions may or may not cause LFSA. A +24VDC failure or +12VDC failure during the programmed Minimum Flash time or during a CMU-24VDC Power Failure will not cause a LFSA. The CMU-24VDC will report the value of the +24 VDC MONITOR and +12 VDC power MONITOR supply sources in the Type 189 response frame.

There is programming in the Datakey to disable +12 VDC power supply monitoring.

NOTE: The Cabinet PDA +24VDC MONITOR function is disabled in the CMU-24VDC-ITL firmware. The AMU 24VDC monitoring function is still active.

2.2 CONFLICTING CHANNELS MONITOR

For purpose of conflict determination, an active signal on either of the Green/Walk or Yellow inputs associated with any of the 32 channels will be considered as that channel being active. The Datakey will contain the permissive channel pair programming.

When any conflicting channels are detected as concurrently active for less than 200 milliseconds the CMU-24VDC will not cause a LFSA. When any conflicting channels are detected as concurrently active for 500 milliseconds or more, the CMU-24VDC will cause a LFSA. When any conflicting channels are detected as concurrently active for more than 200 milliseconds but less than 500 milliseconds, the CMU-24VDC may or may not cause a LFSA.

2.3 SERIAL BUS MONITOR

The CMU-24VDC communicates with both Serial Bus (SB) #1 and #3. In SB #1 the CMU-24VDC is a Secondary device, polled by the ATC Primary device. On SB #1, the CMU-24VDC will respond to the Serial Bus #1 Address defined by the ADDRESS 0 and ADDRESS 1 pins. On SB #3 the CMU-24VDC is the Primary device, polling each AMU-24VDC Secondary device.

2.3.1 SERIAL BUS #1 ERROR

The CMU-24VDC will cause a FSA when a Type 61 or Type 67 Frame has not been received from the ATC for greater than 1000 milliseconds. The first and second failures in a 24-hour period will be a NFSA. The third failure in a 24-hour period will be a LFSA-R. If a CMU-24VDC Power Fail resets the LFSA-R, the SB #1 failure count will be reset to two, such that the next SB #1 timeout results in a LFSA-R.

A SB #1 timeout failure during the programmed Minimum Flash time or during a CMU-24VDC Power Failure will not cause a FSA. The SB #1 Timeout function will be disabled if the SB #1 DISABLE input is at a True (Low) state

2.3.2 SERIAL BUS #3 ERROR

The CMU-24VDC will cause a FSA when a Type 129 or Type 130 Frame has not been received from each AMU for greater than 300 milliseconds. The first and second failures in a 24-hour period will be a NFSA. The third failure in a 24-hour period will be a LFSA-R. If a

CMU-24VDC Power Fail resets the LFSA-R, the SB #3 timeout count will be reset to two, such that the next SB #3 timeout results in a LFSA-R.

A SB #3 timeout failure during the programmed Minimum Flash time or during a CMU-24VDC Power Failure will not cause a FSA.

2.4 TYPE 62 FSA MESSAGE

If the “N” bit is set in a Type 62 message, the CMU-24VDC will react by causing a NFSA. The NFSA will remain until the receipt of a Message 62 with the “N” bit cleared or until the CMU-24VDC is reset by a Unit Reset or CMU-24VDC Power Fail. The NFSA will last for the programmed Minimum Flash time at a minimum.

If the “L” bit is set in a Type 62 message, the CMU-24VDC will react by causing a LFSA.

2.5 LACK OF SIGNAL INPUTS MONITOR

The CMU-24VDC will detect the absence of a required signal voltage on all the inputs of a channel OR the absence of any required channel load current. For voltage purposes a required signal on the Green OR Yellow OR Red inputs associated with a channel will be considered as that channel being Voltage Active. For load current purposes a total channel load current above the programmed threshold for a channel will be considered as that channel being Current Active. When a channel is not Voltage Active OR Current Active for less than 700 milliseconds, the CMU-24VDC will not cause a LFSA. When a channel is not Voltage Active OR Current Active for greater than 1000 milliseconds, the CMU-24VDC will cause a LFSA. When a channel is not Voltage Active OR Current Active for more than 700 milliseconds but less than 1000 milliseconds, the CMU-24VDC may or may not cause a LFSA.

The Current Sense Unit (CSU) monitor function is hardwired to the maximum of 28 physical channels, thus Virtual Channels do not have CSU monitoring capability. The CSU monitor function must be disabled for any physical channel that has an input remapped to a Virtual Channel.

Lack of Signal Input monitoring will be disabled for all channels when the MC COIL STATUS input is not active. There is programming in the Datakey to disable Lack of Signal Input monitoring on a per channel basis.

Lack of Signal Input monitoring will also be disabled for any channel which has the DARK CHANNEL MAP bit set to "1" in the Datakey programming for the DARK CHANNEL MAP addressed by the DARK CHANNEL MAP SELECT bits in a Type 61 message.

2.6 MULTIPLE INPUT MONITOR

The CMU-24VDC will detect the presence of an active signal on two or more inputs of a channel. When the presence of an active signal on two or more inputs of a channel is detected for less than 200 milliseconds, the CMU-24VDC will not cause a LFSA. When the presence of an active signal on two or more inputs to a channel is detected for 450 milliseconds or more, the CMU-24VDC will cause a LFSA. When the presence of an active signal on two or more inputs to a channel is detected for more than 200 milliseconds but less than 450 milliseconds, the CMU-24VDC may or may not cause a LFSA.

Multiple Input monitoring may anticipate and prevent a possible conflicting signal display in the intersection in the event that a proceed signal on the current phase hangs up and is constantly detected as active. An open or no load condition (i.e., burned-out bulb) may be also detected as an active signal depending on the output impedance characteristics of the load switch (i.e. load switch leakage current), and may cause a Multiple Input Fault.

Multiple Input monitoring will be disabled when the MC COIL STATUS input is not active. There is programming in the Datakey to disable Multiple Indication monitoring on a color combination basis (G+Y, Y+R, G+R) for each channel.

2.7 YELLOW CLEARANCE MONITOR

The CMU-24VDC will verify that the Yellow Change interval is at least 2.7 +/-0.1 seconds. The Yellow Change interval consists of the duration of time in which the Yellow field signal input is active in a sequence from Green to Yellow to Red. When the minimum Yellow Change interval is not satisfied, the CMU-24VDC will cause a LFSA. The CMU-24VDC will report a Skipped Yellow Clearance when the Yellow Change interval is less than 100 milliseconds. The CMU-24VDC will report a Short Yellow Clearance when the Yellow Change interval is less than 2.7 +/- 0.1 seconds and greater than 100 milliseconds.

Minimum Yellow Change interval monitoring will be disabled when the MC COIL STATUS input is not active. There is programming in the Datakey to disable Minimum Yellow Change interval monitoring on a per channel basis.

2.8 YELLOW PLUS RED CLEARANCE MONITOR

The CMU-24VDC will verify that the Yellow Change plus Red Clearance interval between the end of an active Green/Walk signal and the beginning of the next conflicting Green/Walk signal is at least 2.7 +/-0.1 seconds. When the minimum Yellow Change plus Red Clearance interval is not satisfied, the CMU-24VDC will cause a LFSA.

Minimum Yellow Change plus Red Clearance monitoring will be disabled when the MC COIL STATUS input is not active. There is programming in the Datakey to disable Minimum Yellow Change plus Red Clearance interval monitoring on a per channel basis.

2.9 LOCAL FLASH STATUS

The CMU-24VDC will monitor the LF STATUS input. This input is used to indicate to the CMU-24VDC that the cabinet should be placed into NFSA as a result of the AUTO/FLASH switch being transferred to the FLASH postion. When this signal is sensed as not active for greater than 500 milliseconds the CMU-24VDC will cause a NFSA. When this signal is sensed as not active for less than 200 milliseconds the CMU-24VDC will not cause a NFSA.

2.9.1 LOCAL FLASH STATUS RECOVERY

Recovery from Local Flash Status NFSA will occur when this signal is sensed as active for greater than 500 milliseconds. When this signal is sensed as active for less than 200 milliseconds the CMU-24VDC will not cause recovery from Local Flash Status NFSA.

2.10 CIRCUIT BREAKER TRIP STATUS

The CMU-24VDC will monitor the CB TRIP STATUS input. When one or more circuit breakers have tripped, this input should go to the not active state. When this signal is sensed as not active for greater than 500 milliseconds the CMU-24VDC will cause a LFSA. When this signal is sensed as not active for less than 200 milliseconds the CMU-24VDC will not cause a LFSA.

2.11 FLASHER UNIT OUTPUT FAILED ALARM

The CMU-24VDC will monitor the FLASHER 1-1, FLASHER 1-2, FLASHER 2-1, FLASHER 2-2 voltage states reported by each AMU-24VDC. The AMU-24VDC reports the flasher state at the output assembly. Thus a failed state may indicate a malfunction of the connector system or flash voltage bus or flasher unit.

When a transition from the inactive state to the active state or a transition from the active state to the inactive state is absent for greater than 2500 milliseconds, the CMU-24VDC will set a status bit in the Type 189 frame. This alarm condition will not cause a FSA. It should cause the appropriate response in the ATC. This status is non-latching such that once a status bit has been set, the sensing of five valid transitions of the input will clear the status bit.

2.12 CMU POWER FAILURE

The CMU-24VDC will monitor the +24VDC POWER input and the NRESET and POWERDOWN cabinet control inputs to determine a CMU Power Failure response. The POWERDOWN signal in the False (low) state indicates loss of power in the ATC. A CMU Power Failure will be recognized when both the POWERDOWN and NRESET signals are False (low) for greater than 100 ms or the 24VDC POWER voltage is less than the DC Power Level Sense Dropout defined in 5.1.

2.12.1 24VDC POWER LEVEL SENSE

The CMU-24VDC will monitor the CMU 24VDC POWER input and AMU 24VDC POWER inputs reported by each AMU-24VDC. When any 24VDC POWER voltage is less than the DC Power Level Sense defined in 5.1 for greater than the DC Power Fail Monitor timing defined in 5.2, the CMU-24VDC will cause a NFSA. Once NFSA has been set, the POWERDOWN and NRESET signals will not be monitored until all DC voltages have exceeded the DC Power Level Sense Restore level defined in 5.1.

2.12.2 POWER INTERRUPT

The CMU-24VDC will disable monitoring of the +12VDC and +24VDC power supply inputs when either the POWERDOWN or NRESET input is False (low). When the POWERDOWN and NRESET signals are both False (low) the CMU-24VDC will cause a NFSA.

2.12.3 POWER RECOVERY

When the POWERDOWN input is True (high) and the NRESET signal goes from False (low) to True (high) the CMU-24VDC will begin timing the programmed Minimum Flash Interval. During the Minimum Flash Interval the CMU-24VDC will be in NFSA.

2.12.4 POWER UP

Following initial application of 24VDC voltage the CMU-24VDC will maintain a NFSA until the POWERDOWN input is True (high) and the NRESET signal goes from False (low) to True (high). The CMU-24VDC will then begin timing the programmed Minimum Flash Interval. During the Minimum Flash Interval the CMU will be in NFSA.

2.12.5 MINIMUM FLASH INTERVAL

During the Minimum Flash Interval the CMU-24VDC will be in NFSA. The Minimum Flash Interval will be programmed in the Datakey between the limits of 6 seconds to 16 seconds with an incremental adjustment of 1 second. The CMU-24VDC will not set a FSA during the Minimum Flash Interval.

2.13 FIELD OUTPUT CHECK

The Field Output Check is a continuous verification that the field signal output states set by the ATC are properly driven to the signal loads and correctly sensed by the AMU-24VDC and CMU-24VDC. It is an enhanced function made possible by the Serial Bus #1 communications between the ATC and CMU-24VDC. The CMU-24VDC will receive a Type 61 message from the ATC that contains an image of the controller output commands to the load switches. When a fault condition triggers the CMU-24VDC, the Type 61 message information received while the fault condition was being timed will be used by the CMU-24VDC to determine whether the sensed field signal input status corresponded to the ATC

output commands. This diagnostic information may then be used to isolate whether the fault condition was caused by an ATC malfunction or a failure in the load switch and/or field wiring.

The Field Output Check function is enabled for each channel input individually and provides two modes of operation, Field Check Mode and Field Check Status.

2.13.1 FIELD CHECK MODE

The CMU-24VDC will compare the active states of the field signals with the states reported by the ATC in the Type 61 frame. When a mismatch is detected for less than 700 milliseconds the CMU-24VDC will not cause a LFSA. When a mismatch is detected for 1000 milliseconds or more, the CMU-24VDC will cause a LFSA. When a mismatch is detected for more than 700 milliseconds but less than 1000 milliseconds, the CMU-24VDC may or may not cause a LFSA.

The Field Check Mode is typically caused by a miss-wired or improperly configured cabinet. When the Field Check Mode is detected the FIELD CHECK front panel indicator will be illuminated solid.

Field Output Check monitoring will be disabled when the MC COIL STATUS input is not active. There is programming in the Datakey to disable Field Output Check monitoring on a channel input basis.

2.13.2 FIELD CHECK STATUS

The CMU-24VDC will compare the active states of the field signals with the states reported by the CU in the Type 61 frame. When a mismatch is detected while a Conflict, Lack of Signal, or Multiple fault is timing, Field Check Status will be reported with the fault to indicate the faulty channel(s) and color(s).

If a Conflict, Lack of Signal, or Multiple fault has triggered the CMU-24VDC to the fault mode and the CMU-24VDC indicates that there is no Field Check Status, the ATC or ATC programming is the most likely cause. The lack of Field Check Status indicates the ATC drove the signals to an improper state. If a Conflict, Lack of Signal, or Multiple fault has triggered the CMU-24VDC to the fault mode and the CMU-24VDC indicates that there is Field Check Status, then cause of the malfunction can be isolated to the SIU, load switch, field wiring, or signal load.

When Field Check Status is detected the FIELD CHECK front panel indicator will be flash at a 2Hz rate.

Field Output Check monitoring will be disabled when the MC COIL STATUS input is not active. There is programming in the Datakey to disable Field Output Check monitoring on a channel input basis.

2.14 DIAGNOSTIC ERROR

The CMU-24VDC is provided with a resident series of self-check diagnostic capabilities. When a Diagnostic fault is detected, a LFSA-R will be set and the DIAGNOSTIC indicator illuminated. Should a Diagnostic error occur, other fault indicators that may be concurrently displayed with the DIAGNOSTIC indicator may not be valid due to the nature of these hardware and/or firmware failures.

2.14.1 RAM MEMORY DIAGNOSTIC

This test will verify that all RAM elements are operating correctly at power-up or following a Unit Reset.

2.14.2 NONVOLATILE MEMORY DIAGNOSTIC

This test will verify that the nonvolatile flash ROM and event log eeprom contain the proper data. The routine will perform a check on each ROM device and make a comparison with a check value. This test is performed at power-up and at a minimum rate of 1024 bytes per second during operation

2.14.3 DATAKEY MEMORY DIAGNOSTIC

This test will verify whether the non-volatile Datakey contains valid data. The routine will perform a check on each nonvolatile memory element at power-up and whenever read and make a comparison with a 16 bit Frame Check Sequence (FCS) procedure defined in clause 4.6.2 of ISO/IEC 3309. Invalid data may result from corrupted Datakey contents, an invalid FCS calculation, invalid parameter values, or a Datakey Protocol Version incompatibility.

The Datakey not present will cause a LFSA and illuminate the DIAGNOSTIC indicator if the DOOR SWITCH FRONT input is sensed as not active (door closed). The DIAGNOSTIC indicator will flash at a rate of 2Hz if the Datakey is not present when the DOOR SWITCH FRONT input is sensed as active (door open).

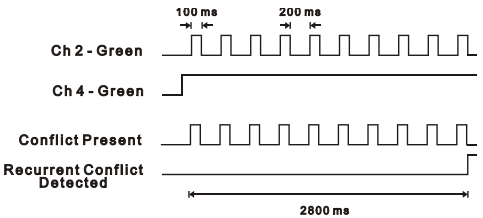
2.14.4 INTERNAL MPU MONITOR

The CMU-24VDC will monitor the operation of its microprocessor with an independent circuit. At a minimum, the monitoring circuit will receive logic state transitions at least once every 50 milliseconds from the microprocessor. When the logic state transition is not received for 500 milliseconds the monitor circuit will force a LFSA-R and illuminate the DIAGNOSTIC indicator.

2.15 RECURRENT PULSE DETECTION

This error detection function supplements the normal Conflict, Multiple, and Lack of Signal monitoring algorithms for sensing faults that are intermittent or pulsing in nature. The RMS signal detection algorithm is designed to filter out short term transients commonly found on the electrical service and provide noise immunity against false signal detections. The Recurrent Pulse detection function is designed to respond to fault conditions that are intermittent in nature and do not meet the continuous timing requirements of the normal detection algorithms, yet may still produce improper signal displays. These input conditions are differentiated by their longer time constant and fault response times.

The figure below shows a simple example of a recurrent Conflict fault. Channel 2 Green is detected active due to a malfunction of the load switch that caused the output to “flicker” On for 100 ms approximately every 200 ms. Because normal Conflict detection requires a continuous fault of at least 350 ms duration, this event could go undetected. The Recurrent Pulse detection algorithm will combine these pulses into one event and trigger a Conflict fault once the longer recurrent timing threshold is exceeded.



When triggered by a recurrent fault condition, the Signal Monitor will enter the fault mode, transfer the Output relay contacts to the Fault position, and illuminate the appropriate CONFLICT, MULTIPLE, or LACK OF SIGNAL indicator. The unit will remain in the fault mode until reset by the Reset button or the External Reset input. Fault response times will

vary depending on the pulse width and frequency of the recurrent inputs, but will range from 1000 ms minimum to 10.4 seconds maximum. Recurrent Pulse detection can be disabled with the SEL1 option jumper, see Section 2.15.1.

2.15.1 RECURRENT PULSE DETECTION DISABLE

The Recurrent Pulse Detection function can be disabled by soldering a 0-ohm jumper into position SEL1 on the CMU-24VDC printed circuit board. When the jumper is inserted, Recurrent Pulse Detection is disabled. When the jumper is removed, Recurrent Pulse Detection is enabled.

Section 3
INPUT SIGNALS

3.1 FIELD SIGNAL INPUTS (*LEDGUARD*)

The Eberle Design CMU-24VDC uses a technique designed to better monitor the characteristics of LED based signal loads called *LEDguard*. Each field signal input is measured and compared to both a high threshold and a low threshold value to determine On / Off status. This differs from conventional AC signal monitors where the active threshold is picked according to the color of the signal. Once the high and low On / Off thresholds have been determined using the input RMS voltage, the individual fault monitor functions use the appropriate threshold to determine if a fault condition exists.

LEDguard		Green/Walk	Yellow	Red/Don't Walk
Conflict		Low	Low	---
Red Fail		High	High	High
Dual Indication		Low	Low	Low
Clearance	Low	Low	High	

All unused RED (DON'T WALK) field signal inputs must be terminated to the 24VDC supply.

3.2 LED SIGNAL LOAD ELECTRICAL REQUIREMENTS

LED Signal loads shall meet the following requirements under all conditions of temperature, time, etc:

1) the signal shall emit NO light when the terminal voltage is less than 6 Vrms, And

2) the signal shall emit light when the terminal voltage is greater than 16 Vrms, And

3) between the terminal voltages of 6 Vrms and 16 Vrms the signal may or may not emit light.

- WARNING -

LED SIGNALS MUST MEET THE REQUIREMENTS OF SECTION 3.2

CARE MUST BE TAKEN AT EACH INSTALLATION TO ENSURE THAT THE TOTAL VOLTAGE DROP DUE TO SIGNAL LOAD CURRENT IN BOTH THE FIELD WIRE AND FIELD RETURN WIRE DOES NOT EXCEED 4 VOLTS TOTAL.

3.3 LOAD SWITCH CURRENT

Load current is sensed by the AMU-24VDC based on total load current to all colors of a channel. Total load current is an indication that a signal load is present. Lack of adequate load current indicates no active load (i.e. burned out lamps) or an open field wire condition. Load current monitoring is used by the Lack of Signal monitoring function (see 2.5) to detect the loss of signal load while the load switch is in the On state.

A channel will be sensed active when the load current exceeds 105% of the Channel Current Sense Threshold programmed for that channel in the Datakey. A channel will not be sensed active when the load current is less than 95% of the Channel Current Sense Threshold programmed for that channel in the Datakey. A load current value between 95% and 105% of the Channel Current Sense Threshold may or may not be sensed active. This provides a hysterisis value of +/- 5% of the Channel Current Sense Threshold.

The Channel Current Sense Threshold should be programmed for each monitored channel based on the minimum signal load under all worst case conditions.

3.4 PDA CONTROL SIGNAL INPUTS

3.4.1 LOCAL FLASH STATUS

The cabinet should be wired such that operation of the cabinet in AUTO mode will place 24VDC on the LF STATUS pin. Operation of the cabinet in FLASH mode should be open circuit on this input. This input will be considered active when the input voltage exceeds the Active threshold defined in Cabinet Control 5.1. This input will not be considered active when the input voltage is less than the Not Active threshold defined in Cabinet Control 5.1. The CMU-24VDC will report the state of this input in the Type 189 frame. See section 2.9.

3.4.2 MAIN CONTACTOR (MC) COIL STATUS

The cabinet should be wired such that the MC COIL STATUS input is connected to the 24VDC side of the main contactor signal bus relay coil. An active signal on this input indicates the Signal Bus should be powering the load switches. This input will be considered active when the input voltage exceeds the Active threshold defined in Cabinet Control 5.1. This input will not be considered active when the input voltage is less than the Not Active threshold defined in Cabinet Control 5.1. The CMU-24VDC will report the state of this input in the Type 189 frame.

3.4.3 MAIN CONTACTOR (MC) SECONDARY STATUS

The cabinet should be wired such that the MC SECONDARY STATUS input will be connected to the output side of the main contactor signal bus relay. An active signal on this input indicates the Signal Bus is powering the load switches. This input will be considered active when the input voltage exceeds the Active threshold defined in Cabinet Control 5.1. This input will not be considered active when the input voltage is less than the Not Active threshold defined in Cabinet Control 5.1. The CMU-24VDC will report the state of this input in the Type 189 frame.

3.4.4 FTR COIL DRIVE STATUS

The cabinet should be wired such that the FTR COIL DRIVE STATUS input is connected to the FTR COIL DRIVE signal in the DC SIGNAL POWER BUS. An active signal on this input indicates the flash transfer relays are energized and the field signals are driven from the load switch outputs. This input will be considered active when the input voltage exceeds the Active threshold defined in Cabinet Control 5.1. This input will not be considered active when the input voltage is less than the Not Active threshold defined in Cabinet Control 5.1. The CMU-24VDC will report the state of this input in the Type 189 frame.

3.4.5 CIRCUIT BREAKER (CB) TRIP STATUS

The cabinet should be wired such that the CB TRIP STATUS input will be connected to the Auxiliary Switch output of the circuit breaker unit. The active state of this input indicates that the circuit breaker unit is not in the tripped state. This input will be considered active when the input voltage exceeds the Active threshold defined in Cabinet Control 5.1. This input will not be considered active when the input voltage is less than the Not Active threshold defined in Cabinet Control 5.1. The CMU-24VDC will report the state of this input in the Type 189 frame.

3.4.6 FRONT / REAR DOOR SWITCH

The cabinet should be wired such that +24VDC is applied to the DOOR SWITCH FRONT or DOOR SWITCH REAR inputs when the respective door is Open. These inputs will be considered active when the input voltage exceeds the Active threshold defined in Cabinet Control 5.1. These inputs will not be considered active when the input voltage is less than the Not Active threshold defined in Cabinet Control 5.1. The CMU-24VDC will report the state of these inputs in the Type 189 frame.

The Datakey not present will cause a LFSA if the DOOR SWITCH FRONT input is sensed as not active (door closed). See section 2.14.3.

3.5 MONITOR INTERLOCK

The MONITOR INTERLOCK input is connected to VDC GROUND within the CMU-24VDC. The cabinet should be wired such that the lack of VDC GROUND on this pin forces the cabinet to the flash mode. This prevents a cabinet from operating without a CMU-24VDC installed.

3.6 EXTERNAL TEST RESET INPUT

The EXTERNAL TEST RESET input is used to reset the CMU-24VDC from the FSA condition. When the EXTERNAL TEST RESET input is connected to VDC GROUND (True) all front panel indicators will be illuminated for 100 msec and the OUTPUT relay energized. Continuously activating the input will not affect CMU-24VDC operation.

The EXTERNAL TEST RESET input is intended for use in testing the CMU-24VDC and should not be connected in the cabinet.

3.7 SERIAL BUS #1 ADDRESS INPUTS

The Address Select input pins ADDRESS 0 and ADDRESS 1 define the Serial Bus #1 address of the CMU. The pins are left open for a logical False, and are connected to VDC GROUND for a logical True.

ADDRESS 1	ADDRESS 0	SB #1 ADDRESS
False	False	0x0F
False	True	0x10
True	False	0x11
True	True	0x12

The default address for the CMU is 0x0F. If multiple CMU units are not installed on Serial Bus #1 these inputs should be left in the False (open) state.

3.8 SERIAL BUS #1 DISABLE INPUT

The SERIAL BUS #1 DISABLE input is used to prevent a Serial Bus #1 Error when communications from the ATC is not active. When the SERIAL BUS #1 DISABLE input is connected to VDC GROUND (True) The CMU-24VDC will not communicate on Serial Bus #1 or set a FSA condition if communications from the ATC is not present. See section 2.3.1.

The SERIAL BUS #1 DISABLE input is intended for use in testing the CMU-24VDC and should not be connected in the cabinet.

3.9 PDA TEMPERATURE

The CMU-24VDC will measure the ambient temperature in the PDA and report this value in the Type 182 frame. This temperature indication may be used to analyze malfunctions that could be related to over heating or cold conditions.

Section 4
FRONT PANEL DESCRIPTION

4.1 INDICATORS

4.1.1 POWER INDICATOR

A green POWER indicator will illuminate to indicate 24VDC POWER voltage is proper. It will flash at a 2 Hz rate when the 24VDC POWER input of the CMU or AMUs are less than the DC Power Level Sense (see section 5.1).

It will remain Off when the 24VDC POWER voltage is less than 15 +/- 2 Vrms. See section 2.12.

4.1.2 24VDC FAIL INDICATOR

A red 24VDC FAIL indicator will illuminate when the CMU-24VDC is in FSA as a result of a 24VDC MONITOR cabinet power supply fault. See section 2.1.

4.1.3 12VDC FAIL INDICATOR

A red 12VDC FAIL indicator will illuminate when the CMU-24VDC is in FSA as a result of a 12VDC MONITOR cabinet power supply fault. The 12VDC FAIL indicator will pulse at a 2 Hz rate when the 12VDC monitor function is disabled. See section 2.1.

4.1.4 CONFLICT INDICATOR

A red CONFLICT indicator will illuminate when the CMU-24VDC is in FSA as a result of a Conflicting Channels fault. See section 2.2.

4.1.5 LACK OF SIGNAL INDICATOR

A red LACK OF SIGNAL indicator will illuminate when the CMU-24VDC is in FSA as a result of a Lack of Signal Inputs fault. See section 2.5.

4.1.6 MULTIPLE INDICATOR

A red MULTIPLE indicator will illuminate when the CMU-24VDC is in FSA as a result of a Multiple Inputs fault. See section 2.6.

4.1.7 CU / LOCAL FLASH INDICATOR

A red CU / LOCAL FLASH indicator will illuminate when the CMU-24VDC is in FSA as a result of a Type 62 command from the ATC (see section 2.4), the LOCAL FLASH STATUS input is inactive (see section 2.9), or CB TRIP STATUS is inactive (see section 2.10).

4.1.8 CLEARANCE INDICATOR

A red CLEARANCE indicator will illuminate when the CMU-24VDC is in FSA as a result of a Yellow Clearance or Yellow Plus Red Clearance fault. See section 2.7 and 2.8.

4.1.9 FIELD CHECK INDICATOR

A red FIELD CHECK indicator will illuminate when the CMU-24VDC is in FSA as a result of a Field Check Mode fault. The indicator will flash at a 2Hz rate when the CMU-24VDC is in FSA with Field Check Status as a result of Conflict, Lack of Signal, or Multiple fault. See section 2.13.

4.1.10 SB #1 ERROR INDICATOR

A red SB #1 ERROR indicator will illuminate when the CMU-24VDC is in FSA as a result of a Serial Bus #1 fault. See section 2.3.1. The SB #1 ERROR indicator will pulse at a 2 Hz rate when the SERIAL BUS #1 DISABLE input is True. See section 3.8.

4.1.11 SB #3 ERROR INDICATOR

A red SB #3 ERROR indicator will illuminate when the CMU-24VDC is in FSA as a result of a Serial Bus #3 fault. See section 2.3.2.

4.1.12 DIAGNOSTIC INDICATOR

A red DIAGNOSTIC indicator will illuminate when the CMU-24VDC is in FSA as a result of a Diagnostic fault. See section 2.14.

The DIAGNOSTIC indicator will flash at a 4 Hz rate if the Datakey is not present and a FSA state does not exist. See section 2.14.3.

4.1.13 SB #1 RX INDICATOR

A yellow SB #1 RX indicator will pulse On each time the CMU-24VDC correctly receives a frame on Serial Bus #1.

4.1.14 SB #3 RX INDICATOR

A yellow SB #3 RX indicator will pulse On each time the CMU-24VDC correctly receives a frame on Serial Bus #3.

4.2 TERMINAL PORT

An EIA-232-E Data Terminal Equipment (DTE) interface is provided for interconnecting to a personal computer using the EDI ECcom Signal Monitor Communications software package. See the Eberle Design ***ECcom Operations Manual*** for further details. This port is electrically isolated from the main CMU-24VDC power supply and 48VDC Ground.

A **Null Modem** cable is required for connection to a standard PC port.

4.3 RESET BUTTON

Depressing the RESET button resets the CMU-24VDC from the FSA condition after it has been triggered by a fault. When the RESET button is depressed all front panel indicators will be illuminated for 500 msec and the OUTPUT relay energized. Continuously depressing the Reset button will not affect CMU-24VDC operation.

4.4 DATAKEY

The front panel mounted Keycepticle^{tm} is used to receive the Datakey serial memory device. To install a Datakey, insert the key and rotate clockwise 90 degrees to the vertical orientation. When a Datakey is installed while the power is applied to the CMU-24VDC, the CMU-24VDC will load and verify the parameters and begin using the new configuration immediately.

When a Datakey is removed while the power is applied to the CMU-24VDC, the CMU-24VDC will continue to use the parameters from the removed Datakey until Reset is applied, a new Datakey is installed, or a power-up cycle occurs.

If a CMU-24VDC is Reset or powered-up with the Front Door in the open position without a Datakey installed or with an invalid Datakey, the CMU-24VDC will assume a default Datakey configuration according to the Datakey Protocol Version.

Section 5
SPECIFICATIONS

5.1 ELECTRICAL

Power Requirements
Operating Voltage ..... 15 to 32 Vdc
Power Consumption (maximum)..... 10 Watts

Voltage Monitors
Field Signals High Threshold
- Active..... greater than 18.5 Vrms
- Not Active ..... less than 17.5 Vrms

Field Signals Low Threshold
- Active..... greater than 4.0 Vrms
- Not Active ..... less than 3.0 Vrms

Cabinet Control (Local Flash Status, MC Coil Status, MC Secondary Status, FTR Coil Drive, CB Trip Status, Front / Rear Door Switch)
- Active..... greater than 20.5 Vrms
- Not Active ..... less than 19.5 Vrms

DC Power Fail Monitor
DC Power Level Sense Restore ..... greater than 22 Vrms
DC Power Level Sense Dropout..... less than 21.5 Vrms

DC Voltage Monitors
+24 Volt Monitor
- Active..... greater than 22 Vdc
- Not Active ..... less than 18 Vdc

+12 Volt Monitor
- Active..... greater than 11 Vdc
- Not Active ..... less than 9 Vdc

Logic Inputs
External Test Reset, Serial Bus #1 Disable, Address 0, Address 1
- Not Active (False) ..... greater than 16 Vdc
- Active (True) ..... less than 8 Vdc

CMU Temperature
Accuracy .....± 6 ^{o}C

5.2 TIMING

Cabinet Power Supplies (+24VDC, +12VDC)
- Fault ..... greater than 500 ms
- No Fault..... less than 200 ms
- Typical ..... 350 ms

Conflict
- Fault ..... greater than 500 ms
- No Fault..... less than 200 ms
- Typical ..... 350 ms

Serial Bus #1 Error
- Fault ..... greater than 1000 ms

Serial Bus #3 Error
- Fault ..... greater than 300 ms

Multiple
- Fault ..... greater than 450 ms
- No Fault ..... less than 200 ms
- Typical ..... 350 ms

Lack of Signal Inputs
- Fault ..... greater than 1000 ms
- No Fault ..... less than 700 ms
- Typical ..... 850 ms

Yellow Clearance
- Fault ..... less than 2600 ms
- No Fault ..... greater than 2800 ms
- Typical ..... 2700 ms

Yellow Plus Red Clearance
- Fault ..... less than 2600 ms
- No Fault ..... greater than 2800 ms
- Typical ..... 2700 ms

Field Check
- Fault ..... greater than 1000 ms
- No Fault ..... less than 700 ms
- Typical ..... 850 ms

Local Flash Status, Circuit Breaker Trip
- Fault ..... greater than 450 ms
- No Fault ..... less than 200 ms
- Typical ..... 350 ms

DC Power Fail Monitor
- Fault ..... greater than 225 ms
- No Fault ..... less than 175 ms
- Typical ..... 200 ms

NRESET, POWERDOWN
- Active ..... greater than 120 ms
- Not Active ..... less than 80 ms
- Typical ..... 100 ms

5.3 MECHANICAL

Height ..... 4.166 inches
Width ..... 2.340 inches
Depth (front panel to rear edge of DIN connector) ..... 7.682 inches

5.4 ENVIRONMENTAL

Storage Temperature Range ..... -45 to +85 ^{o}C
Operating Temperature Range ..... -34 to +74 ^{o}C
Humidity (non-condensing) ..... 0 to 95% Relative

Section 6
CONNECTOR ASSIGNMENTS

6.1 MAIN DIN CONNECTOR

The CMU-24VDC main connector is a two row DIN 4161264 Header Type:

Pin	Function	Pin	Function
A1	+24VDC Monitor	**B1**	Reserved
A2	+12VDC Monitor	**B2**	External Test Reset
A3	VDC Ground	**B3**	Serial Bus #1 Disable
A4	Monitor Interlock	**B4**	Reserved
A5	Address 0	**B5**	Address 1
A6	Reserved	**B6**	Reserved
A7	SB1 TxData +	**B7**	SB1 TxData -
A8	SB1 RxData +	**B8**	SB1 RxData -
A9	SB1 TxClock +	**B9**	SB1 TxClock -
A10	SB1 RxClock +	**B10**	SB1 RxClock -
A11	Reserved	**B11**	Reserved
A12	Reserved	**B12**	Reserved
A13	Reserved	**B13**	Reserved
A14	Reserved	**B14**	Reserved
A15	Line Sync +	**B15**	Line Sync -
A16	Nreset +	**B16**	Nreset -
A17	PowerDown +	**B17**	PowerDown -
A18	SB3 TxData +	**B18**	SB3 TxData -
A19	SB3 RxData +	**B19**	SB3 RxData -
A20	SB3 Clock+	**B20**	SB3 Clock-
A21	LF Status	**B21**	LF Status
A22	Output Relay NO	**B22**	Output Relay NO
A23	CB Trip Status	**B23**	Reserved
A24	MC Coil Status	**B24**	Reserved
A25	MC Secondary Status	**B25**	Reserved
A26	FTR Coil Drive Status	**B26**	Reserved
A27	Door Switch Front	**B27**	Reserved
A28	Door Switch Rear	**B28**	Reserved
A29	Reserved	**B29**	Reserved
A30	Reserved	**B30**	24VDC Power
A31	Equipment Ground	**B31**	Reserved
A32	Reserved	**B32**	24VDC Ground

Note: Output Relay NO is open during FSA (de-energized).

6.2 EIA-232 CONNECTOR

The front panel EIA-232 connector is a 9 pin metal shell “DB9S” female subminiature type connector. Because the port is configured as a DTE device, a null modem cable is required to connect directly to a personal computer COMM port.

Pin #	Function	I/O
1	Reserved	-
2	Receive data	I
3	Transmit Data	O
4	Reserved	-

Pin #	Function	I/O
5	Signal Ground	-
6	Reserved	-
7	Reserved	-
8	Reserved	-
9	Reserved	-