M-LIB Low Impedance Bus Differential System

The M-LIB Bus Differential System is a scalable low impedance bus differential relay. The M-LIB system offers the following features:

- Low impedance bus differential protection that eliminates the need for the separate CTs required by high impedance bus differential relays.
- Any number and configuration of incoming lines, outgoing feeders and bus ties can be accommodated through plug in modules. Adjusting to new substation construction simply involves the plugging in of appropriate modules.
- Under 1 cycle trip times.
- Automatic reconfiguration of the differential based upon breaker and disconnect switch 52A/B inputs.
- Automatic CT saturation detection prevents false trips for external faults.
- Separate dual slope biased differential elements for single bus, dual bus, and overall bus zones.
- Completely redundant A/D conversion circuitry for each protection zone for maximum security.
- CT circuit fault indication.
- Time synch input.
- Two, externally triggerable, 16-cycle oscillographic captures.
- Simple five button man machine interface (MMI) allows access to all functions, settings, and stored data without the need for a computer.
- Draw-out design permits relay testing without disturbing connections to case.
- Modbus communication protocol and RS485 terminal on rear.
- Programmable reset characteristics.

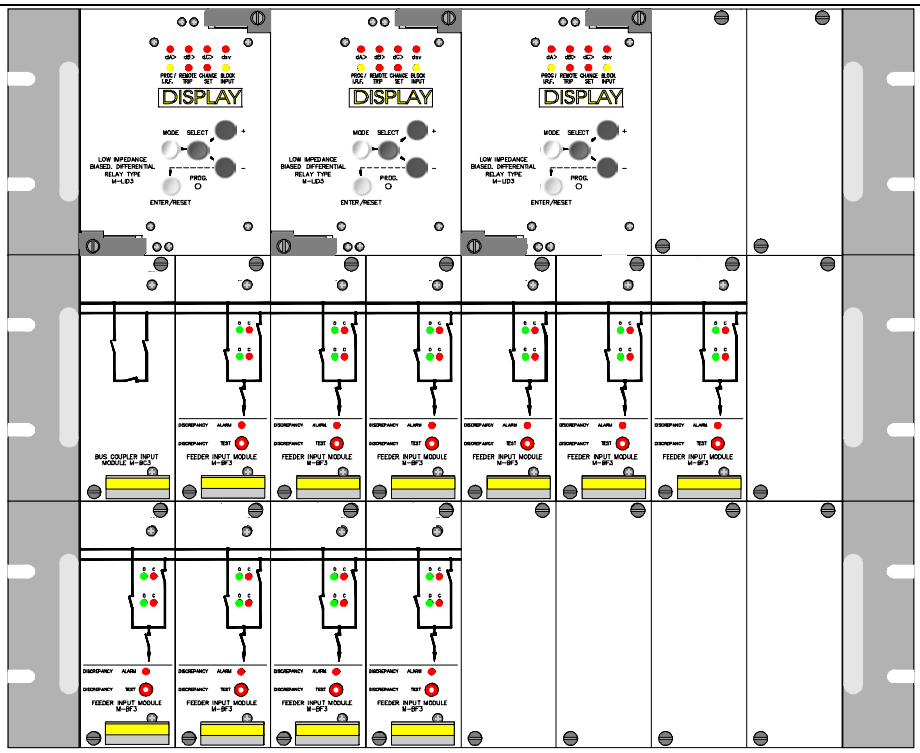

FIGURE 1
Typical Configuration of the M-LIB Low Impedance Bus Differential Relay

- Dedicated power supply/relay fail output contacts.
- Cumulative trip counters.
- Auto-ranging power supplies.

THE M-LIB SYSTEM

M-LIB systems consists of the M-BF3 Feeder Input Modules, the M-BC3 Bus Tie Modules, the M-LID3 Bus Differential Relays, and the 19” rack mount Model FC expansion chassis. All wiring between the various modules is accomplished either by circuit boards in the back of the FC chassis, or by special connecting cables which are part of the system.

THE FC EXPANSION CHASSIS

The FC Chassis holds up to 7 feeder or bus tie modules while providing a common power supply. All necessary circuitry to support the inter-connections of these modules is included in the FC Chassis. The FC chassis also provides connectors to allow for multiple FC chassis to be daisy-chained together for applications requiring more than 7 modules. See Figure 5.

THE M-BF3 FEEDER INPUT MODULES

The M-BF3 Feeder Input module is shown in Figure 2. One M-BF3 is required for each incoming or outgoing feeder on the protected bus.

Three bus CT inputs are supplied to the M-BF3. For dual bus substation construction, a pair of inputs is provided to allow for the indication of the status of the tie disconnects. See Figure 4. The M-BF3 uses these inputs to provide signals to the rest of the system for automatic reconfiguration of the differential summation based on which bus the feeder is connected.

Each M-BF3 is equipped with automatic CT saturation detectors.

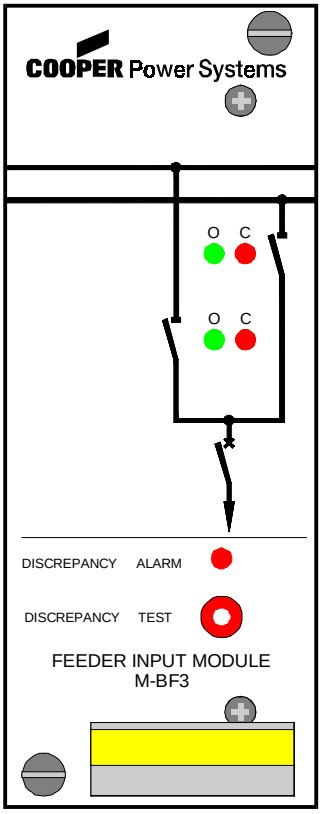

FIGURE 2: Feeder Input Module M-BF3

When CT saturation is detected (indicating a close-in external fault), the M-BF3 sends a signal to block the operation of the bus differential system.

The feeder's breaker trip signal is provided on each module. The connection of the system ensures that all breakers receive the trip command simultaneously.

THE M-BC3 BUS COUPLER MODULE

One M-BC3 bus coupler module is required for each bus tie breaker/switch. Two sets of 3-phase CT inputs are required, one on each side of the tie breaker. The M-BC3 automatically adjusts the summation of the differential current based on any inter-bus current flows. Any differential trip will cause the M-BC3 to trip its tie breaker.

See Figures 3 and 4.

THE M-LID3 BUS DIFFERENTIAL RELAY

The M-LID3 is a microprocessor based relay and is a part of the Edison line of protective relays. See Figure 6. The M-LID3 is specifically designed to work with the rest of the M-LIB system. Each M-LID3 relay provides for one zone of differential protection. For single bus systems, one M-LID3 is required. For two bus systems, two M-LID3's are required. A third M-LID3 can be added to dual bus systems to provide an overall check zone encompassing both busses.

Each M-LID3 measures the bus differential current (I_d) computed as the vector summation of all currents in the protected zone. The relay also calculates a bias current (I_R) proportional to the arithmetic summation of the currents in the zone.

The M-LID3 provides a dual slope differential element with adjustable breakpoints. The restraint characteristic is shown in Figure 7.

For close-in faults, the CT saturation detection circuitry in the affected M-BF3 module will pass a blocking signal to the respective M-LID3 relay via the FC Expansion Chassis. This will prevent mis-operation of the differential element.

The M-LID3 also provides CT supervision where opens in any zone may be detected.

Measurements

Each M-LID3 provides the following real time measurements:

- RMS value of each phase's differential current.
- Through current of each phase encompassing the entire zone of protection.

The maximum values of these measurements is also recorded. All of this information is accessible on the relay's front display and via Modbus.

Trip Counters

A counter is maintained for each protective element which tallies the cumulative total number of trips each element has experienced.

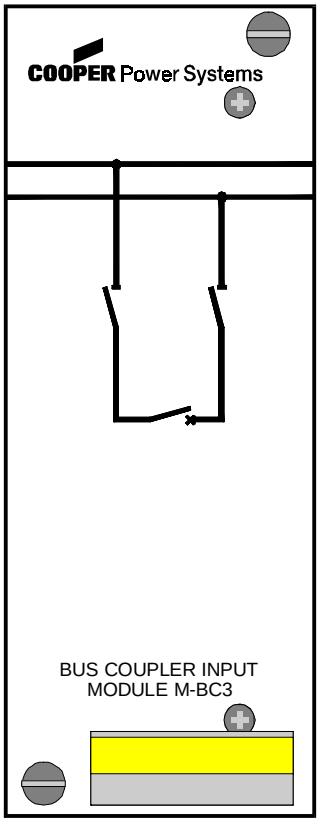

FIGURE 3: Bus Tie Input Module M-BC3

Targets

Eight bright LED targets are provided as follows:

- One for each phase differential element.
- One for the CT supervision element.
- To indicate the external time synch is active and operating.
- One to indicate remote oscillographic trigger.
- One to indicate if the relay is receiving an external blocking signal.
- An LED to indicate when the relay is in programming mode (flashing) and relay or power supply failure (ON).

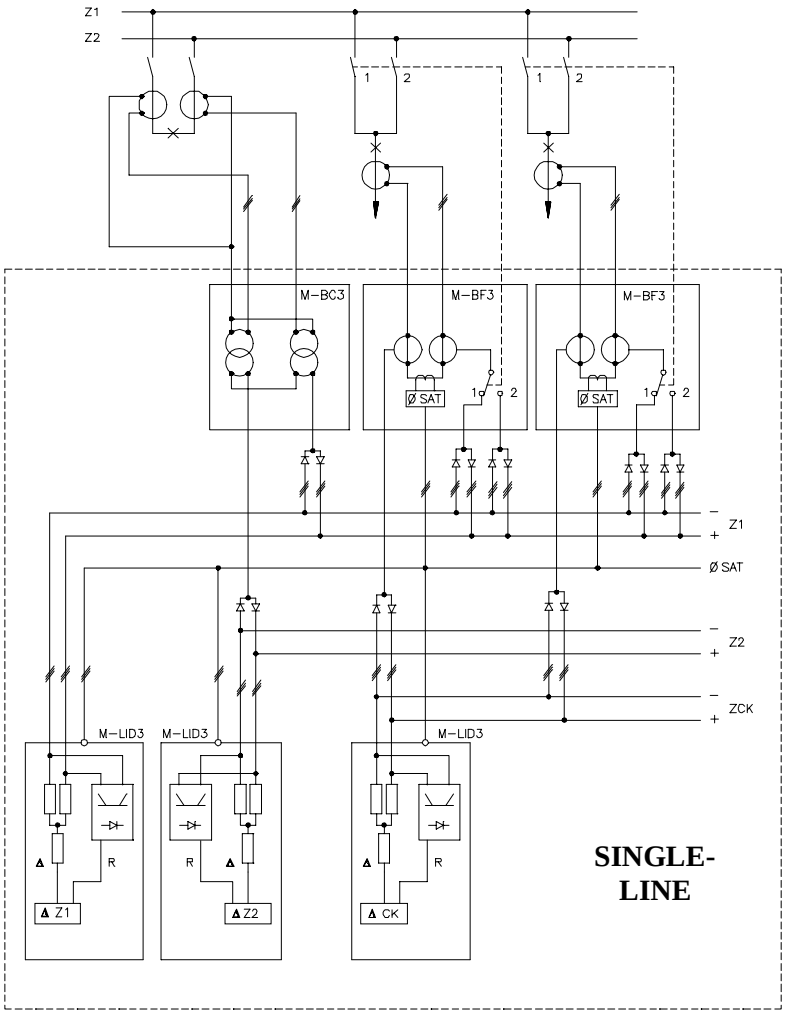

FIGURE 4: M-LIB System One-Line showing the Inter-relationship between the M-BF3, M-BC3, and M-LID3 Modules

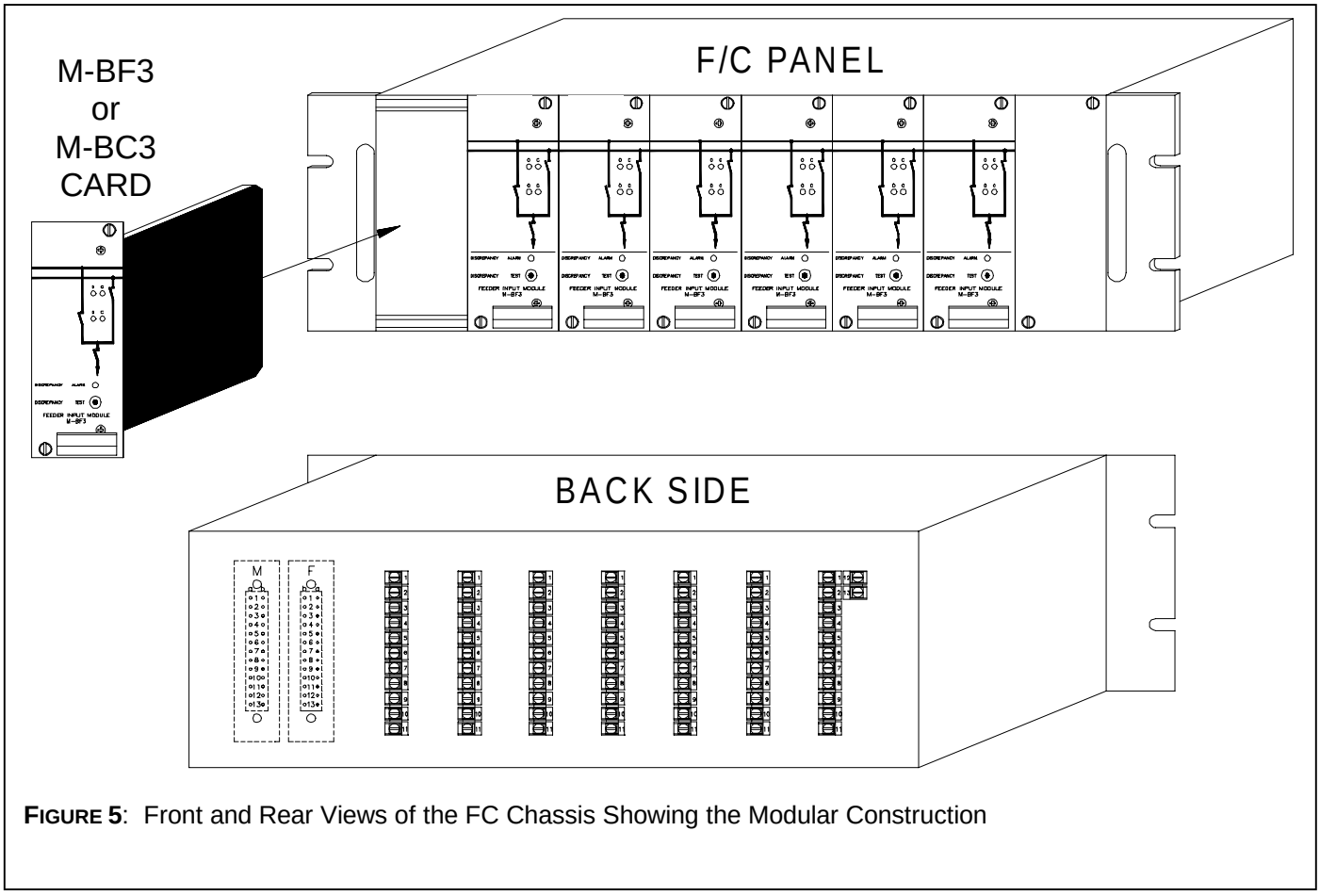

FIGURE 5: Front and Rear Views of the FC Chassis Showing the Modular Construction

FIGURE 6: Front Panel View of the M-LID3 Dual Slope Bias Differential Relay

Reset Characteristics

The output relays may be programmed to reset in one of two manners.

- Instantaneously upon the input or calculated quantities dropping below the pickup value.
- Manual reset (by front panel or computer command) only.

Event Records

The M-LID3 records for the five most recent protective element trip the values of the three phase differential, the three phase through currents, and the cause of the trip.

Triggered Oscillographic Capture

Each M-LID3 will capture two 16 cycle[1] oscillographic records of the differential current waveforms. The record is triggeres by the trip of any protective elements, by external signal (dry input) or by Modbus command. This data must be retrieved by Modbus. The Edison relay interface software, EdisonCOM, provides such a retrieval facility.

Time Synchronization

The M-LID3's clock can be set manually, via IRIG-B, or by an external synchronization pulse. The pulse may be set to arrive at 5, 10, 15, 30, or 60 minute intervals. Time clock resolution is 10msec. The time clock feature may also be disabled.

Output Elements

The following functions may be programmed to operate one or more of the output relays.

- Biased differential trip.
- Un-biased differential trip.
- Time delayed CT supervision element.

Diagnostics

For maximum security, the differential currents are measured by two parallel and completely independent A/D circuits. These circuits must be in agreement with each other or else a relay fail condition is indicated.

Complete memory and circuit diagnostics are run upon powering the relay. The revision level of the firmware is displayed at this time.

The relay provides two manual test routines which may be run at any time. The first routine performs the same 15 minute test an in addition checks the target LEDs and the control circuitry to the output relays without operating the output relays.. The second test is identical but also operates the output relays.

During normal operation the relay suspends operation every 15 minutes for 10 msec and runs a comprehensive set of diagnostics that includes memory checksum, test of the A/D converters by injection of an internally generated reference voltage, and a check of the ALU.

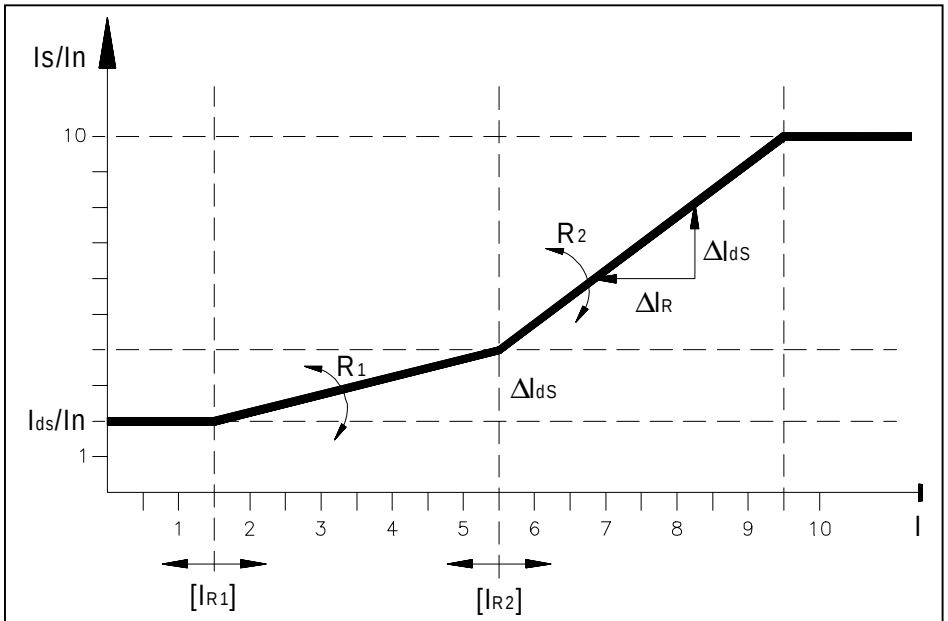

FIGURE 7: Dual Slope Bias Characteristic of the M-LID3 Differential relay

[1] 8 pre-fault and 8-post fault cycles.

Table 1: Functional Specifications

Nominal system frequency setting range	50 or 60 Hz
Basic minimum pick-up level	2 - 200% of rated CT current in 1% steps
First zone bias slope	0.40 – 1.00 pu in 0.01 pu steps
First slope breakpoint	0.5 – 2.0 pu of rated current in 0.1 pu steps
Second zone bias slope	0.40 – 1.00 pu in 0.01 pu steps
Second slope breakpoint	3.0 – 8.0 pu of rated current in 0.1 pu steps
Minimum pick-up level for CT supervision element	0.1 – 1.0 pu in 0.01 pu steps or Disable

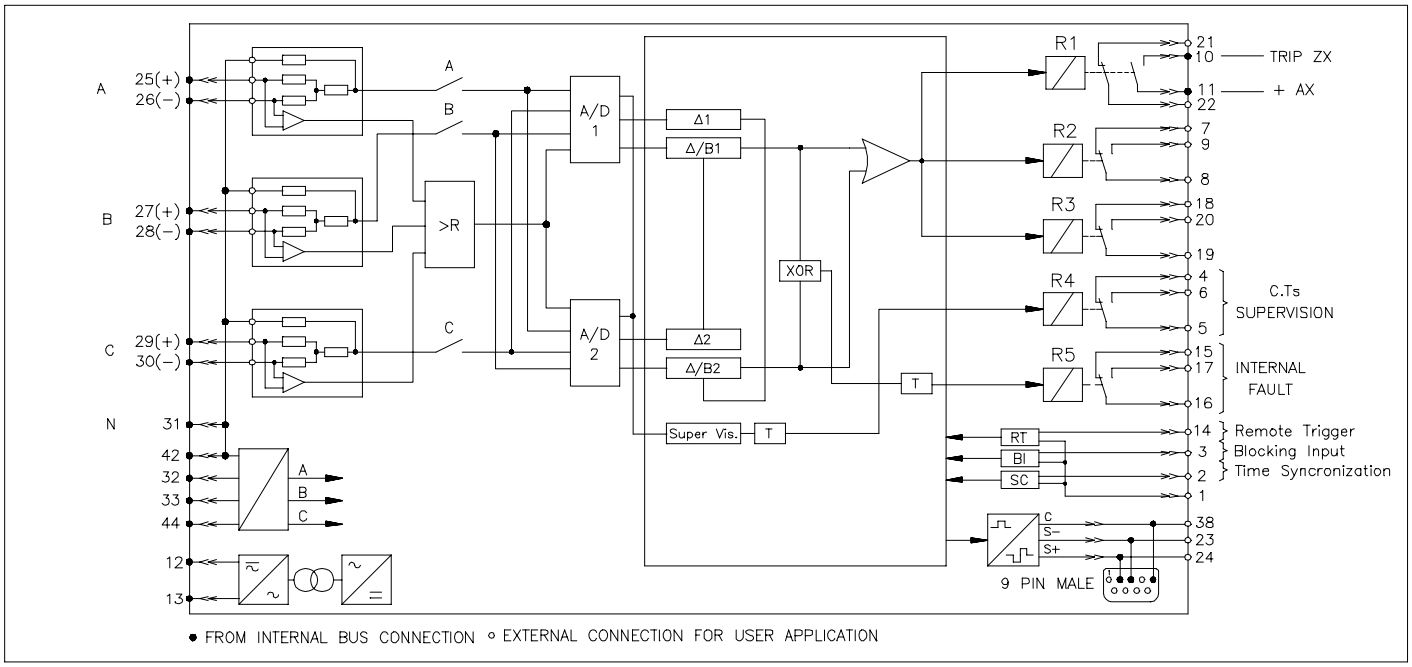

FIGURE 8 - Wiring Diagram for the M-LID3 Relay

ORDERING INFORMATION

The M-LIB system consists of the following parts, the quantity of which must be specified separately at the time of order. The relationship between these parts may be seen in Figure 9.

M-BF3 Feeder modules: One required per incoming or outgoing feeder.

M-BC3 Bus Coupler modules: One required per bus tie for two bus systems.

FC Chassis: One required for every seven M-BF3 or M-BC3 modules. M-BF3 and M-BC3 modules may be mixed in an FC chassis. A power supply auxiliary voltage must be specified for the FC chassis. This supplies the power to all M-BF3 and M-BC3 modules mounted in the FC chassis.

M-LID3 Differential relays: One required for each zone of protection desired (3 maximum). The M-LID3 relays are supplied in a common 19" rack mount case that matches the FC chassis.

Cables: One CF1 cable is required to attach the FC Chassis to the M-LID3 differential relays. If more than one FC chassis is used, then one each CFM cable is required to interconnect the chassis in a daisy chain manner.

Construct the catalog numbers from the following table:

Base Relay Model	**Description**	**Power Supply[2]**		**Other Options**	
		Code	**Description**	**Code**	**Description**
PRFC	FC Chassis	L	24-110V AC/DC		
		H	90-220V AC/DC		
PRMBF3	Feeder Module				
PRMBC3	Bus Coupler Module				
PRMLIB3J	Differential relay	L	24-110V AC/DC	1	One Zone of protection (one relay)
		H	90-220V AC/DC	2	Two Zones of protection (two relays)
				3	Thee zones of protection (three relays)
PRCF1	CF1 cable				
PRCFM	CFM cable				

Example: PRFCL is an FC chassis with a 24-110V power supply. A PRMLIB3JL3 is three M-LID3 relays with 24-110V power supplies in a 19" rack mount case.

[2] The power supplies are user replaceable and interchangeable. See catalog section 150-99.

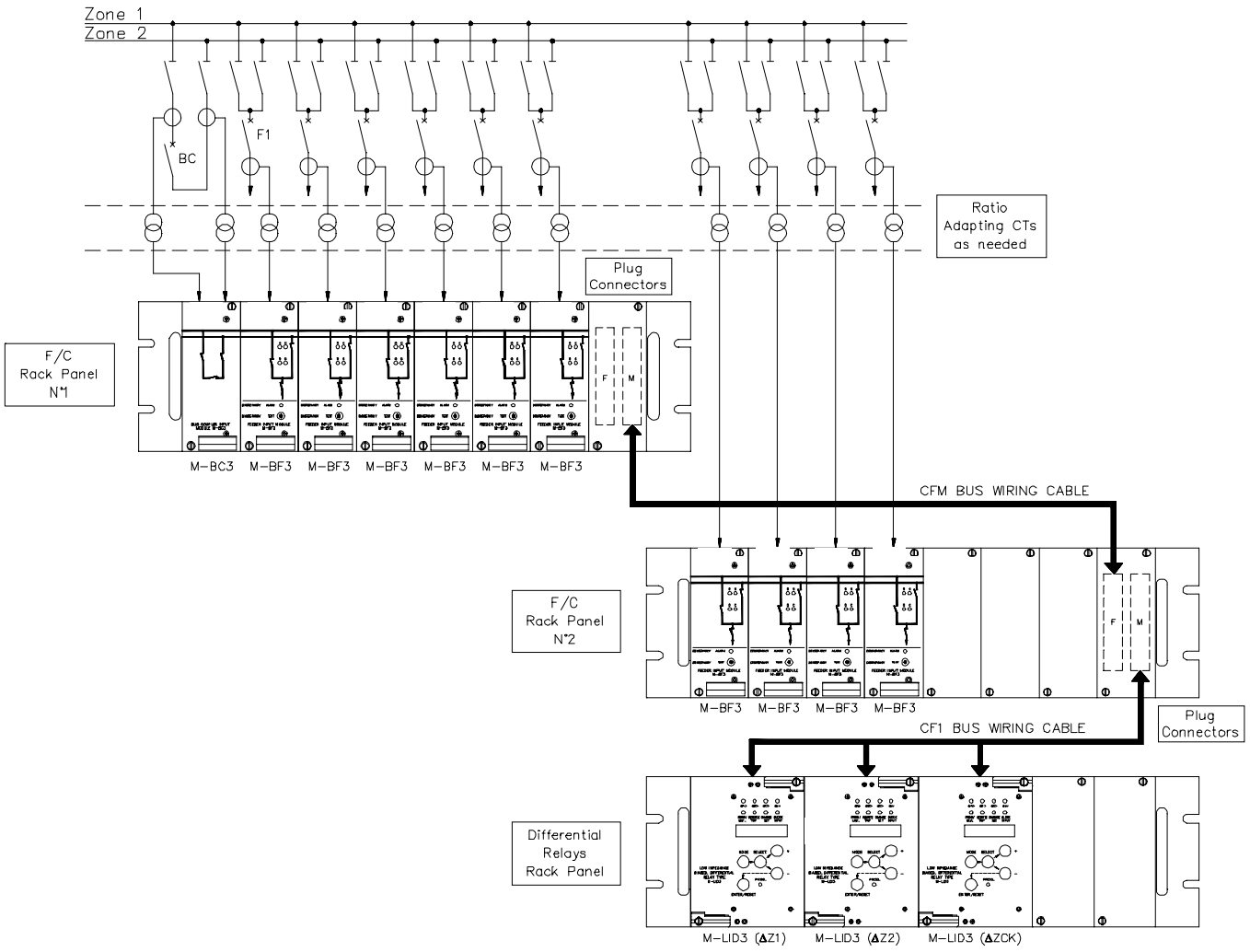

FIGURE 9: Example Configuration of the M-LIB System

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