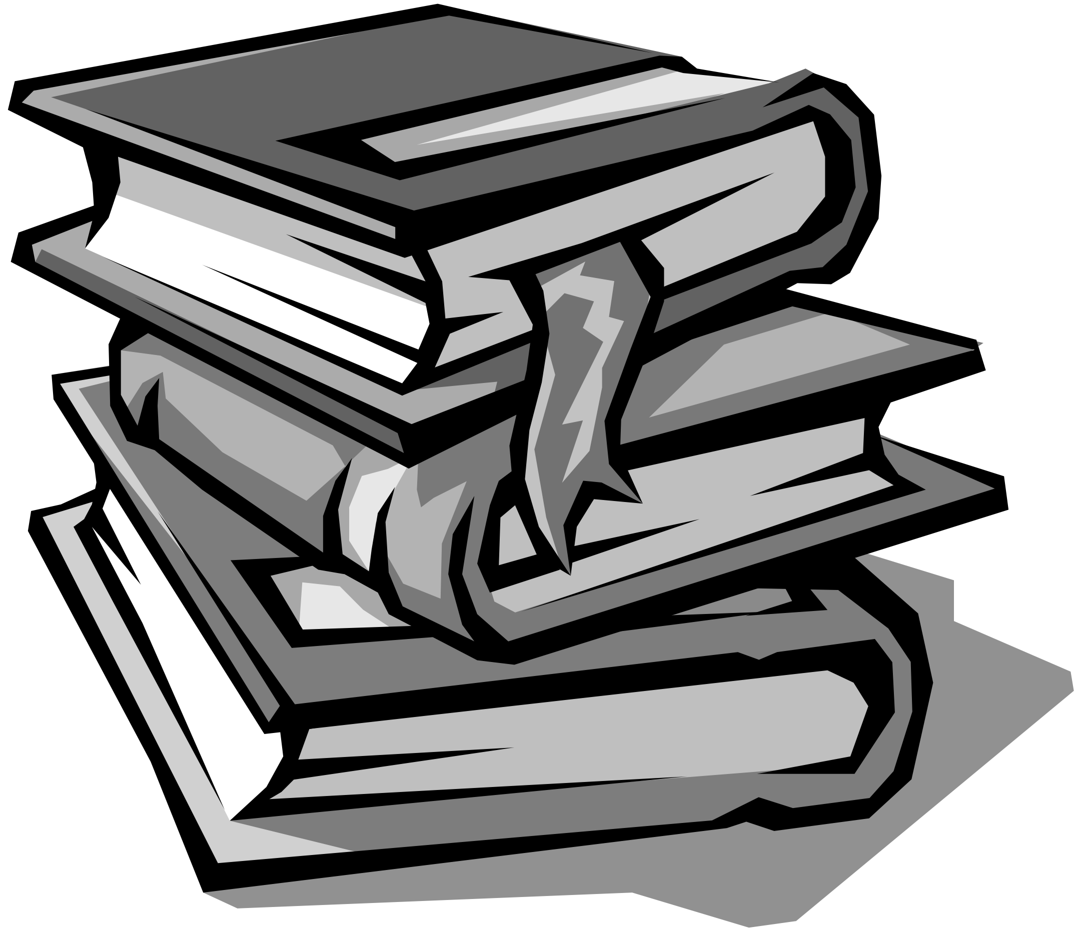
APTRANSCO



LBB & BUSBAR PROTECTION

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400KV

LBB/BFR

PROTECTION

NOMINICLATURE

LBB : Local Breaker Backup Relay.

BFR : Breaker Failure Relay.

CBF : Circuit Breaker Failure Relay.

ANSI Code : 50Z or 50BF.

This is Current Operated Relay.

BASICS OF LBB/BFR PROTECTION

LOCAL BREAKER BACKUP PROTECTION

A PROTECTION WHICH IS DESIGNED TO CLEAR A SYSTEM FAULTY BY INITIATING TRIPPING OTHER CIRCUIT BREAKER(S) IN THE CASE OF FAILURE TO TRIP OF THE APPROPRIATE CIRCUIT BREAKER.

IN MODERN NETWORKS THE CRITICAL FAULT CLEARING TIME MAY BE LESS THAN 200ms. HENCE, IF THE FAULT IS NOT CLEARED DUE TO FAILURE OF THE PRIMARY PROTECTIVE RELAYS OR THEIR ASSOCIATED CIRCUIT BREAKER, A FAST ACTING BACK-UP PROTECTIVE RELAY MUST CLEAR THE FAULT.

THERE ARE TWO BASIC FORMS.

REMOTE BACK-UP.

LOCAL BACK-UP.

REMOTE BACK-UP

PROVIDES BACK-UP PROTECTION FOR THE BOTH THE RELAYS (MAIN-1 & MAIN-2) AND BREAKERS AT REMOTE SUBSTATION.

LOCAL BACK-UP

LOCAL BACK-UP PROTECTION CAN BE DEVIDED INTO TWO CATAGORIES.

RELAY BACK-UP

BREAKER BACK-UP

RELAY BACK-UP

DUPLICATE PRIMARY PROTECTION. i.e ONE IS NON SWITCHED DISTANCE PROTECTION AND ANOTHER IS SWITCHED DISTANCE SCHEME OR OTHER WISE BOTH SCHEMES CHARECTERSTICS ARE DIFFERENT (QUADRALATERAL, MHO CIRCULAR, TAMOTO & OPTICAL) OR DIFFERENT MANUFACTURERS(ABB, ALSTOM, SIEMENS, EASUN REYROLL, SEL, GE, NXT PHASE OR BASLER) OR DIFFERENT METHODS (i.e ELECTROMECHANICAL, STATIC, NUMERICAL{MICROPROCESSOR &DSP}).

IF MAIN-1 & MAIN-2 ARE NUMERICAL RELAYS BOTH SHOULD BE SEPARATE CHARECTERESTICS AND SEPARATE MODELS AND ALL FEATURES SHOULD BE AVAILABLE IN BOTH SCHEMES AND BOTH RELAYS SHOULD BE 100% REDENDENCY IN ALL ASPECTS.

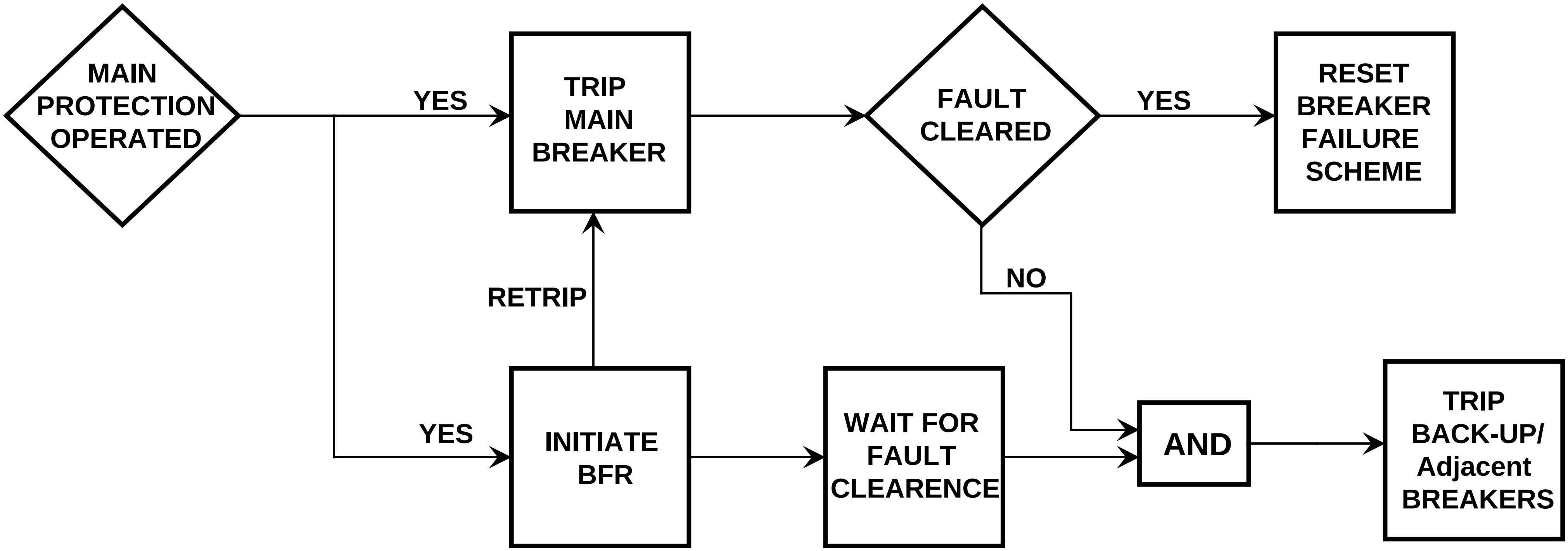
TO INCREASE THE SECURITY, THE CIRCUIT BREAKER HAS TWO TRIP COILS, ONE IS CONNECTED TO MAIN-1 PROTECTION AND ANOTHER IS CONNECTED TO MAIN-2 PROTECTION.

BREAKER BACK-UP

BECAUSE OF THE HIGH COST OF HIGH VOLTAGE CIRCUIT BREAKERS, IT IS NOT FEASIBLE TO DUPLICATE THEM.

IN CASE OF A BREAKER FAILURE THE OTHER CIRCUIT BREAKERS CONNECTED TO THE SAME BUS AS THE FAULTED BREAKER MUST THERE FORE BE TRIPPED.

LBB/BFR FLOW CHART

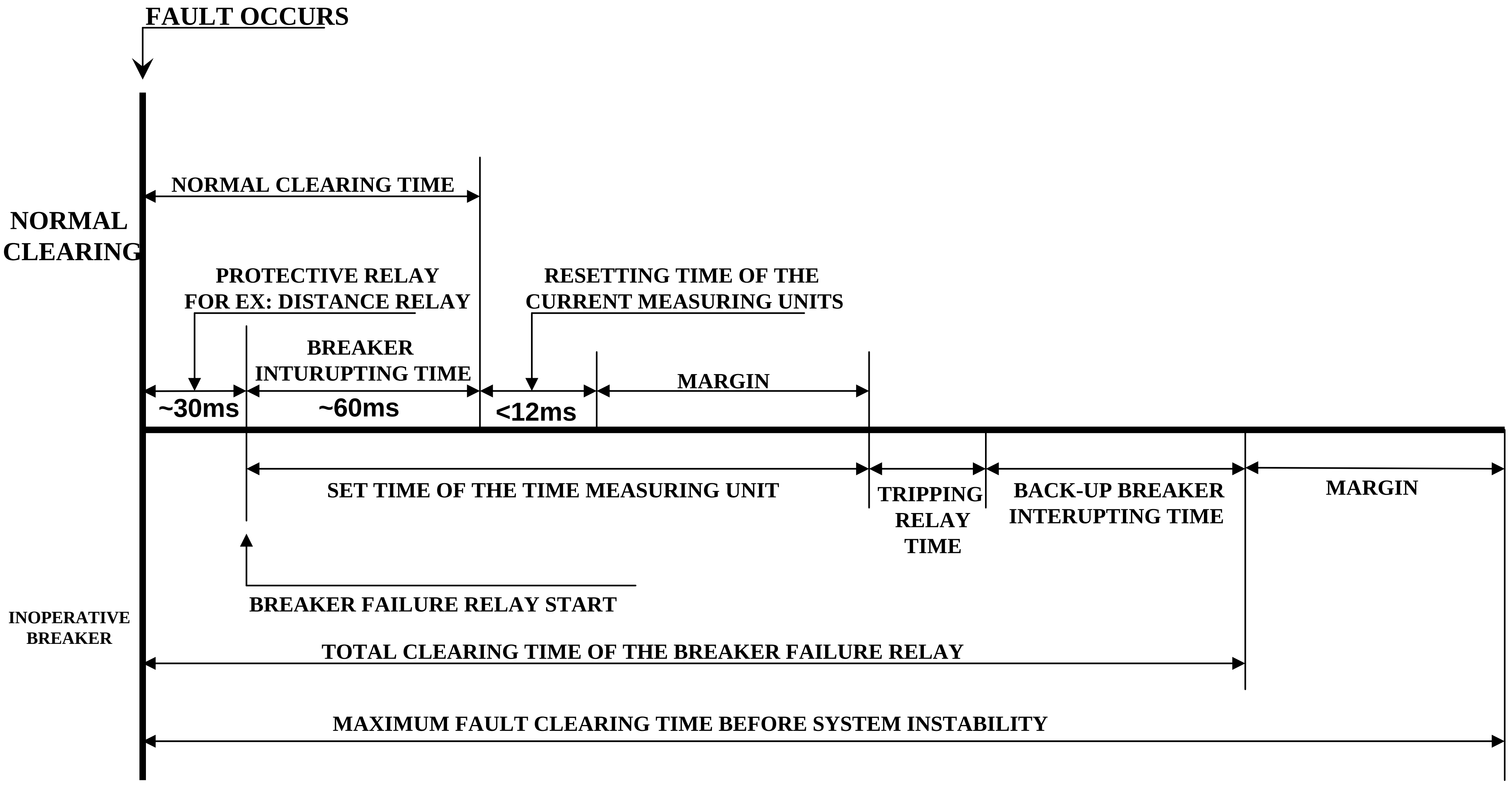


The Breaker Failure Protection (LBB/BFR) can operate single-stage/two-stage.

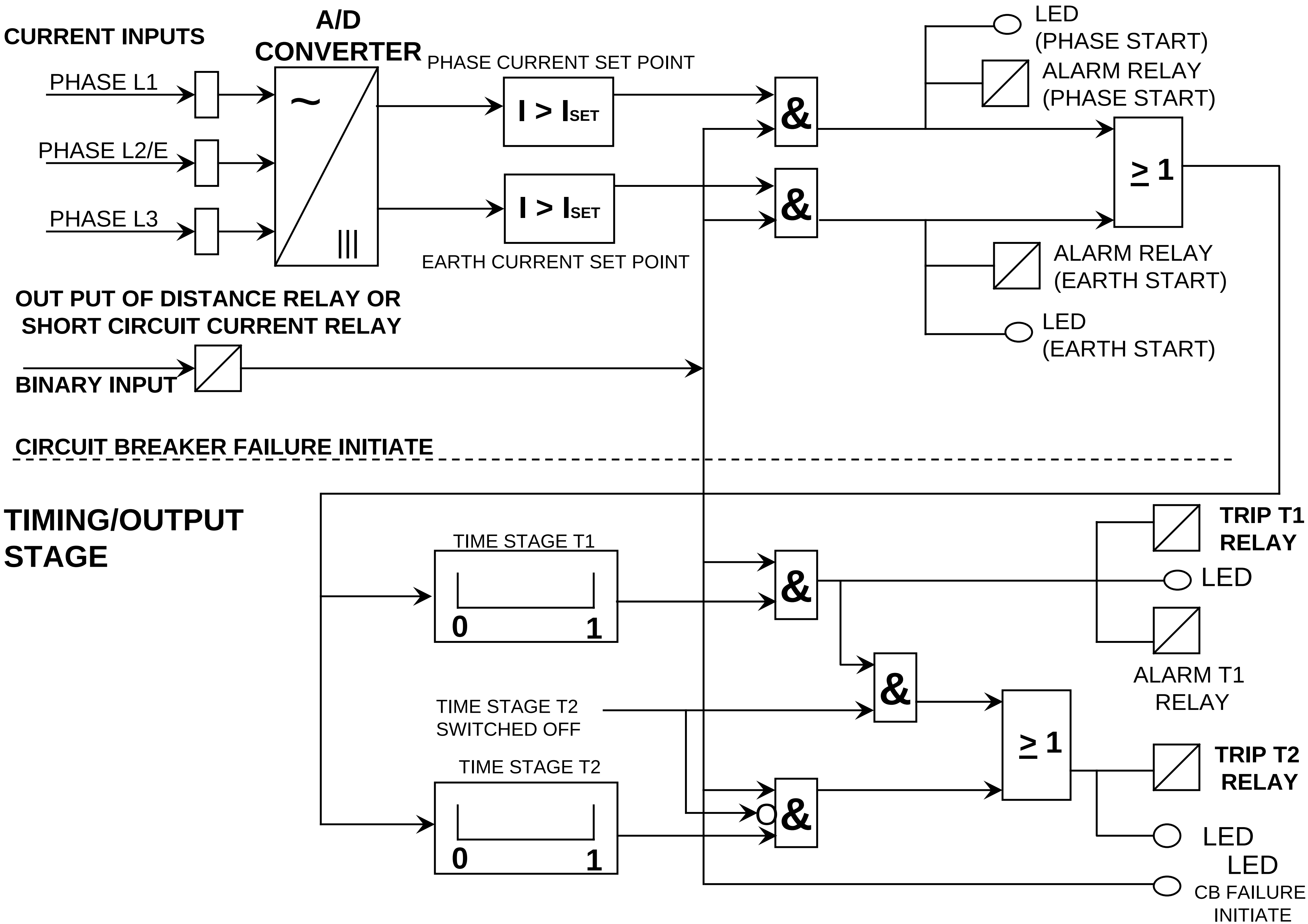
When used as single-stage protection, the Bus trip command is given to the adjacent Circuit Breakers if the protected feeder Breaker fails.

When used as two-stage protection, the first stage can be used to repeat the trip command to the relevant feeder Breaker, normally on a different trip coil, if the initial trip command from the feeder protection is not successful. The second stage will result in a Bus trip to the adjacent Breakers, if the command of the first stage is not successful.

LBB/BFR TIME CO-ORDINATION CHART



LBB/BFR LOGIC



CBIP Guidelines on Protection

LBB/ BFR PROTECTION COMMENTS

GENERAL

In the event of any CB fails to trip on receipt of command from Protection relays, all CBs connected to the Bus section to which the faulty circuit Breaker is connected are required to be tripped with minimum possibly delay through LBB Protection.

This Protection also Provides coverage for faults between CB and CT which are not cleared by other protections.

CBIP Guidelines on Protection

RECOMMENDATIONS FOR LBB/BFR PROTECTION

i) In all new 400KV and 220KV Substations as well as Generating Stations Switch Yard, it must be provided for each Circuit Breaker.

ii) For existing Switch Yards, it is considered a must at 400KV level and also 220KV Switch Yards having multiple feed.

iii) In case of radially fed 220KV Substations, Provision of LBB Protection is desirable but not essential.

CBIP Guidelines on Protection

LBB/BFR REQUIREMENTS

i) Have Short Operation and Drop off times.

ii) Have 3 Phase Current elements with facility for Phase wise initiation.

iii) have current setting range such that these can be set minimum 200mA for Line and 50mA for generators (for 1A CT for secondary).

iv) Have one common associated timer with adjustable setting.

REQUIREMENTS OF CIRCUIT BREAKERS

- Operating Time
- Breaking Capacity
- Stuck Breaker Probability
- Operating Sequence / Duty cycle

CBIP Guidelines on Protection

LBB/BFR OPERATION

- The Breaker Failure Protection (LBB/BFR) can operate single-stage/two-stage.

- When used as single-stage protection, the Bus trip command is given to the adjacent Circuit Breakers if the protected feeder Breaker fails.

- When used as two-stage protection, the first stage can be used to repeat the trip command to the relevant feeder Breaker, normally on a different trip coil, if the initial trip command from the feeder protection is not successful. The second stage will result in a Bus trip to the adjacent Breakers, if the command of the first stage is not successful. (This is More recommended)

CBIP Guidelines on Protection

LBB/BFR SPECIAL COMMENTS

(i) The relay is separate for each breaker and is to be connected in the secondary circuit of the CTs associated with that particular breaker.

(ii) For line breakers, direct tripping of remote end breaker(s) should be arranged on operation of LBB protection.

For transformer breakers, direct tripping of breaker(s) on the other side of the transformer should be arranged on operation of LBB protection

(iii) For lines employing single phase auto reclosing, the LBB relays should be started on a single phase basis from the trip relays.

CBIP Guidelines on Protection

LBB/BFR SPECIAL COMMENTS

(iv) The CT sec core may be separate core, if available. Other wise it shall be Clubbed (in series) with Main-1 or Main-2 protection.

(v) It is considered a good practice to have DC circuits of Gr.A and Gr. B protections and relay independent.

(vi) LBB cannot operate without proper initiation. It is good practice to provide redundant trip output and breaker fail input where other forms of redundancy does not exist.

(vii) Separation should be maintained between protective relay and CB trip coil DC circuit so that short circuit or blown fuse in the CB circuit will not prevent the protective relay from energizing the LBB scheme.

CBIP Guidelines on Protection

LBB/BFR SPECIAL COMMENTS

(viii) In addition to other fault sensing relays the LBB relay should be initiated by Bus bar protection, since failure of CB to clear a bus fault would result in the loss of entire station if BFP relay is not initiated

(ix) Tripping logic of the bus bar protection scheme shall be used for LBB protection also.

(x) For breaker-fail relaying for low energy faults like buchholz operation, special considerations may have to be given to ensure proper scheme operation by using C.B. contact logic in addition to current detectors.

CBIP Guidelines on Protection

LBB/BFR SETTING CRITERIA

(i) Current level detectors should be set as sensitive as the main protections

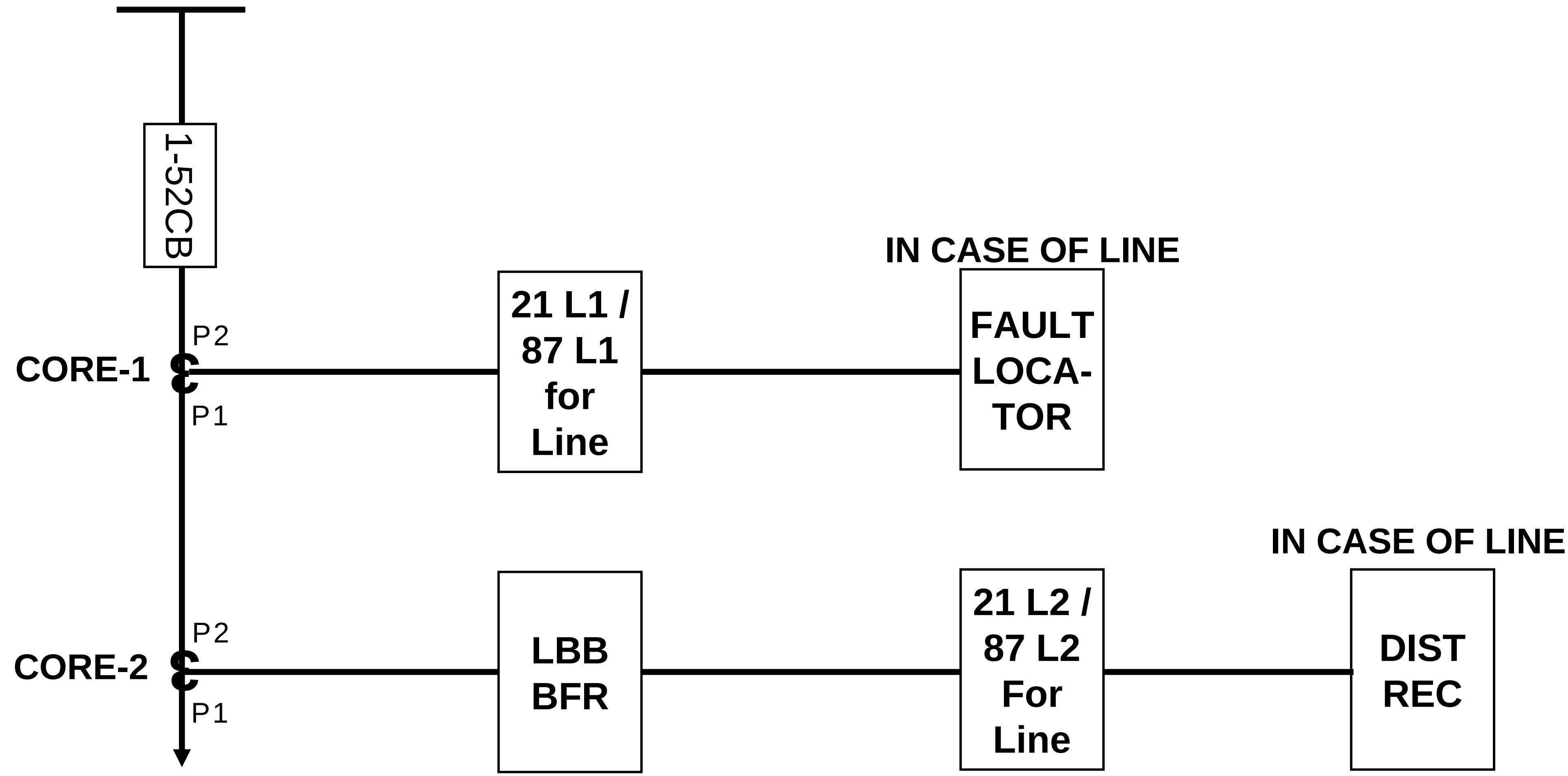
A general setting of 0.2 A is commonly practiced for Lines and Transformers

(ii) Timer setting should be set considering breaker interrupting time, current detector reset time and a margin. Generally a timer setting of 200 ms has been found to be adequate.

LBB/BFR connections during STATIC Relays

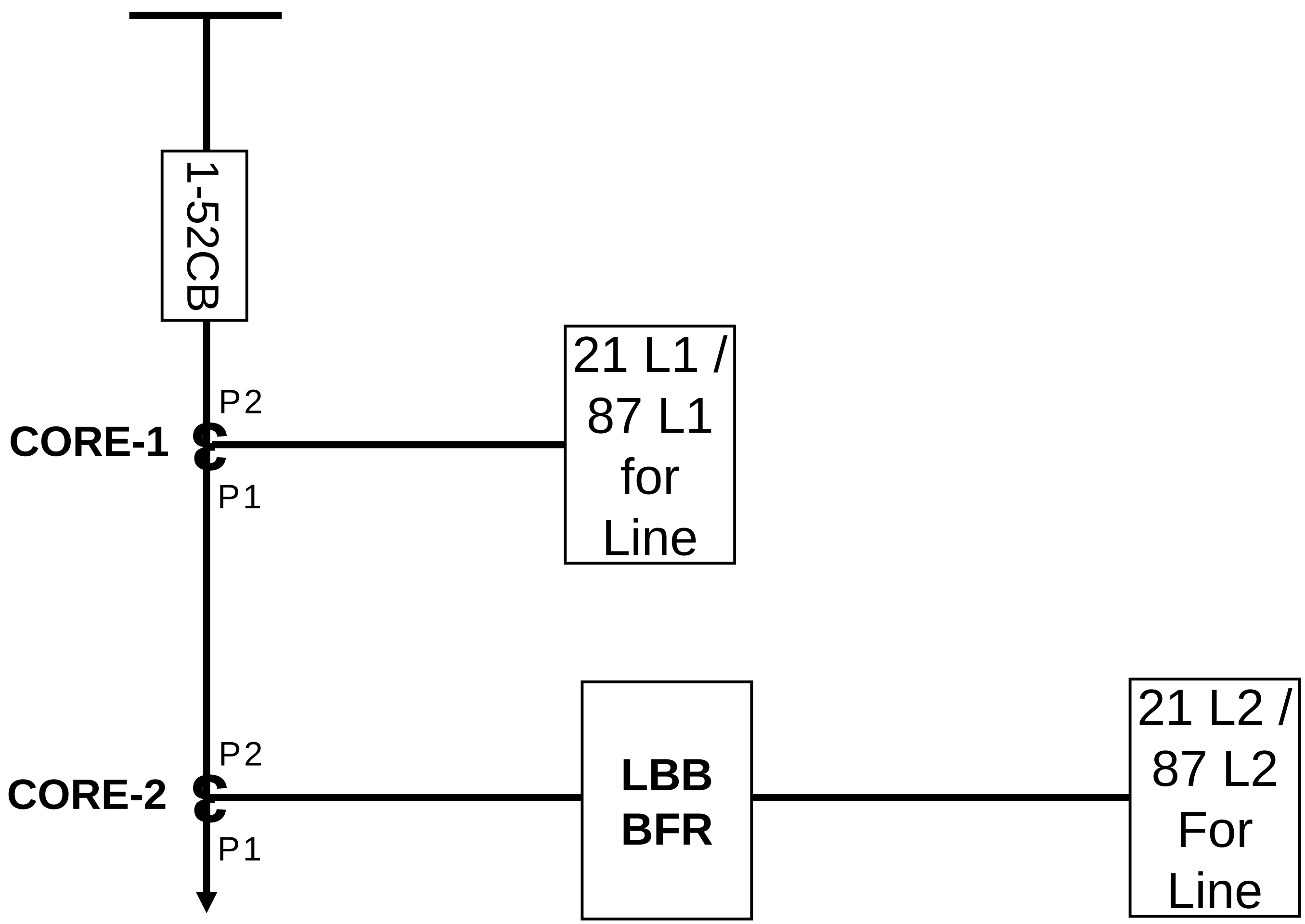
CT CORE-1: Main-1 Distance Relay & Fault Locator are in series.

CT CORE-2: Main-2 / Backup Relay, LBB/BFR & Disturbance Recorder are in series.

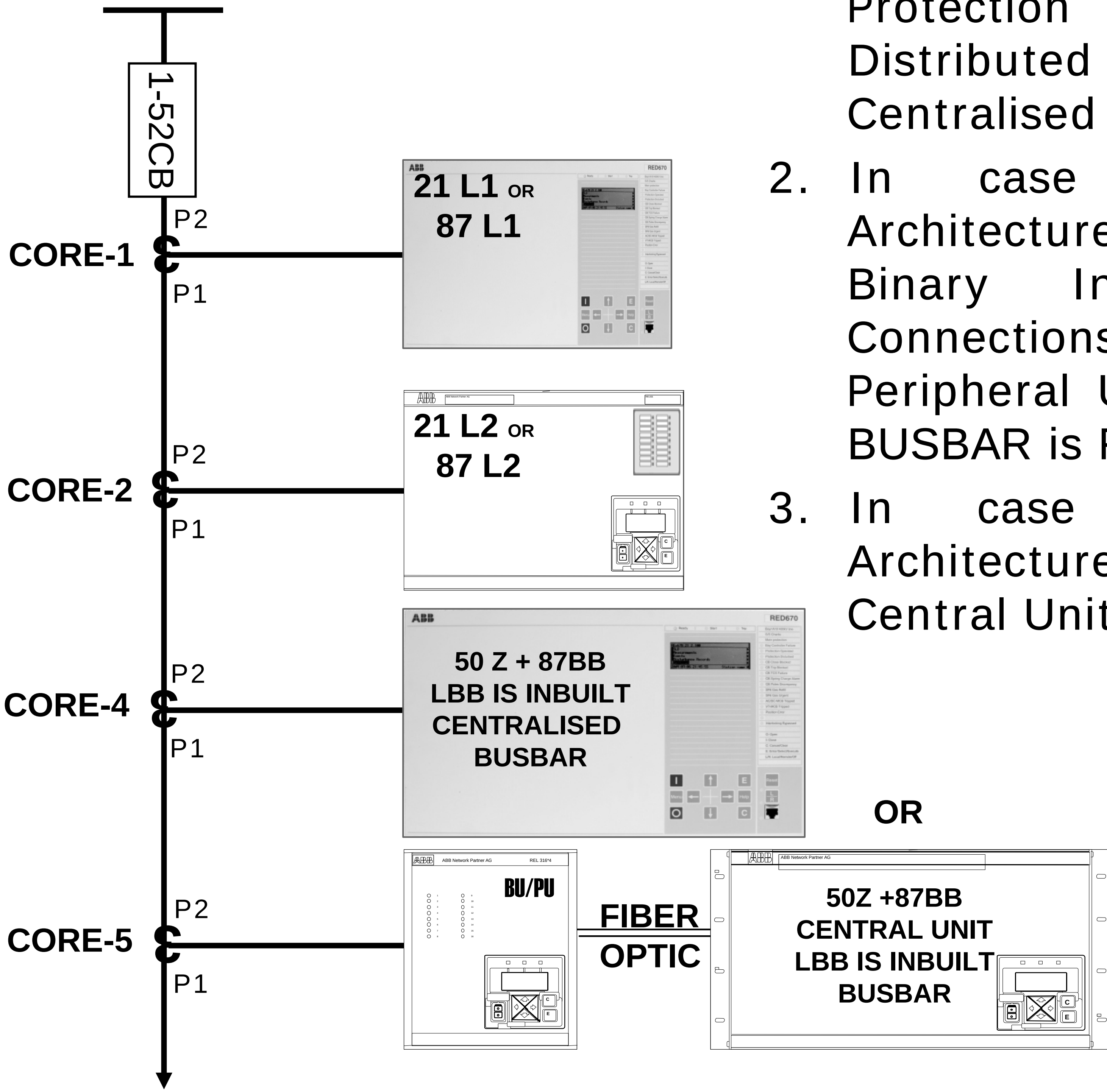


LBB/BFR connections during NUMERICAL Relays

1. Fault Locator is inbuilt feature in both Distance Schemes.
2. Disturbance Recorder is also inbuilt feature in both Distance Schemes.
3. Most of the Utilities are not accepting the LBB is Inbuilt feature of Main-1 or Main-2/ BU Protection. But Accepting Inbuilt feature of BUSBAR Protection.



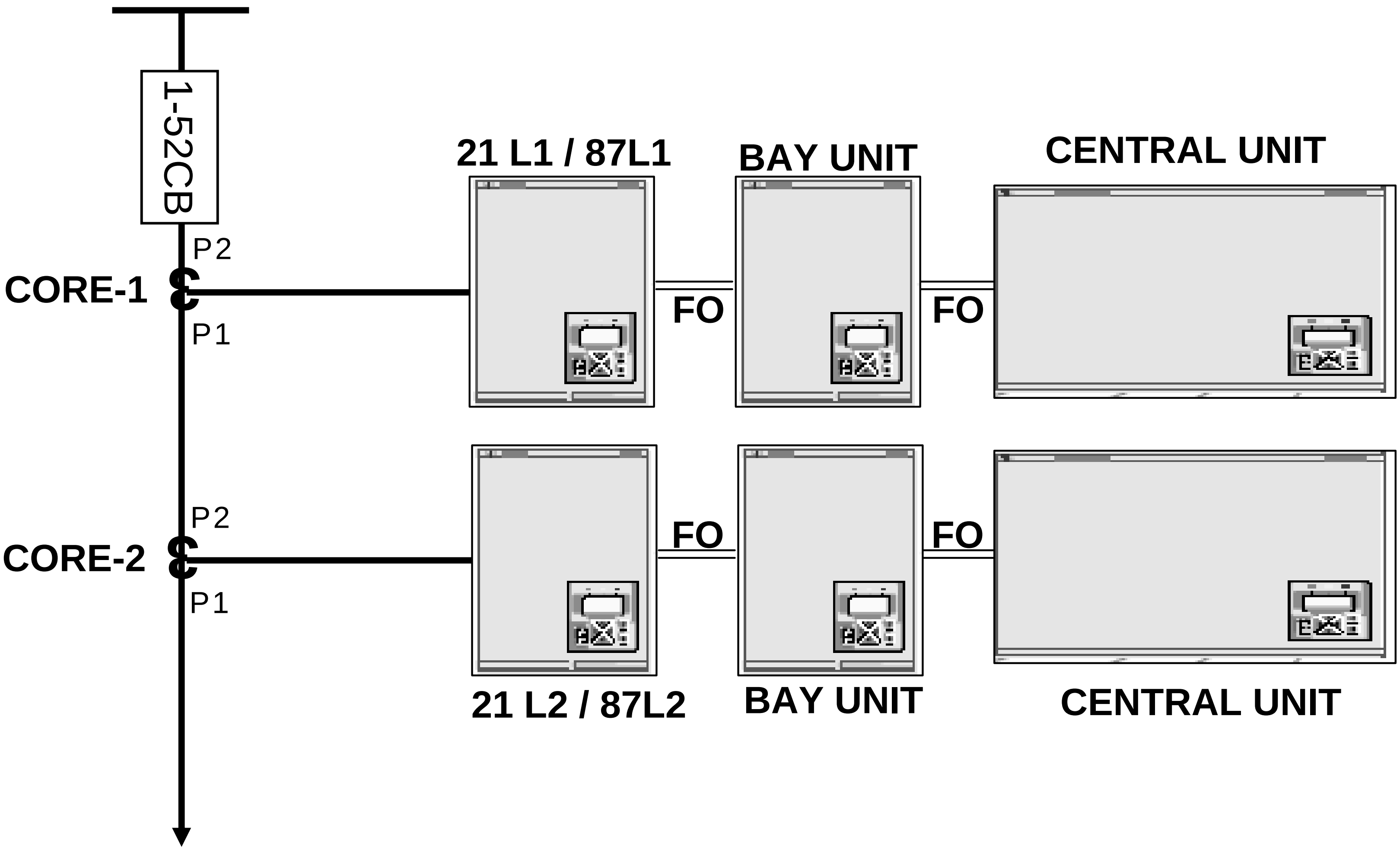
NEXT DEVELOPMENT



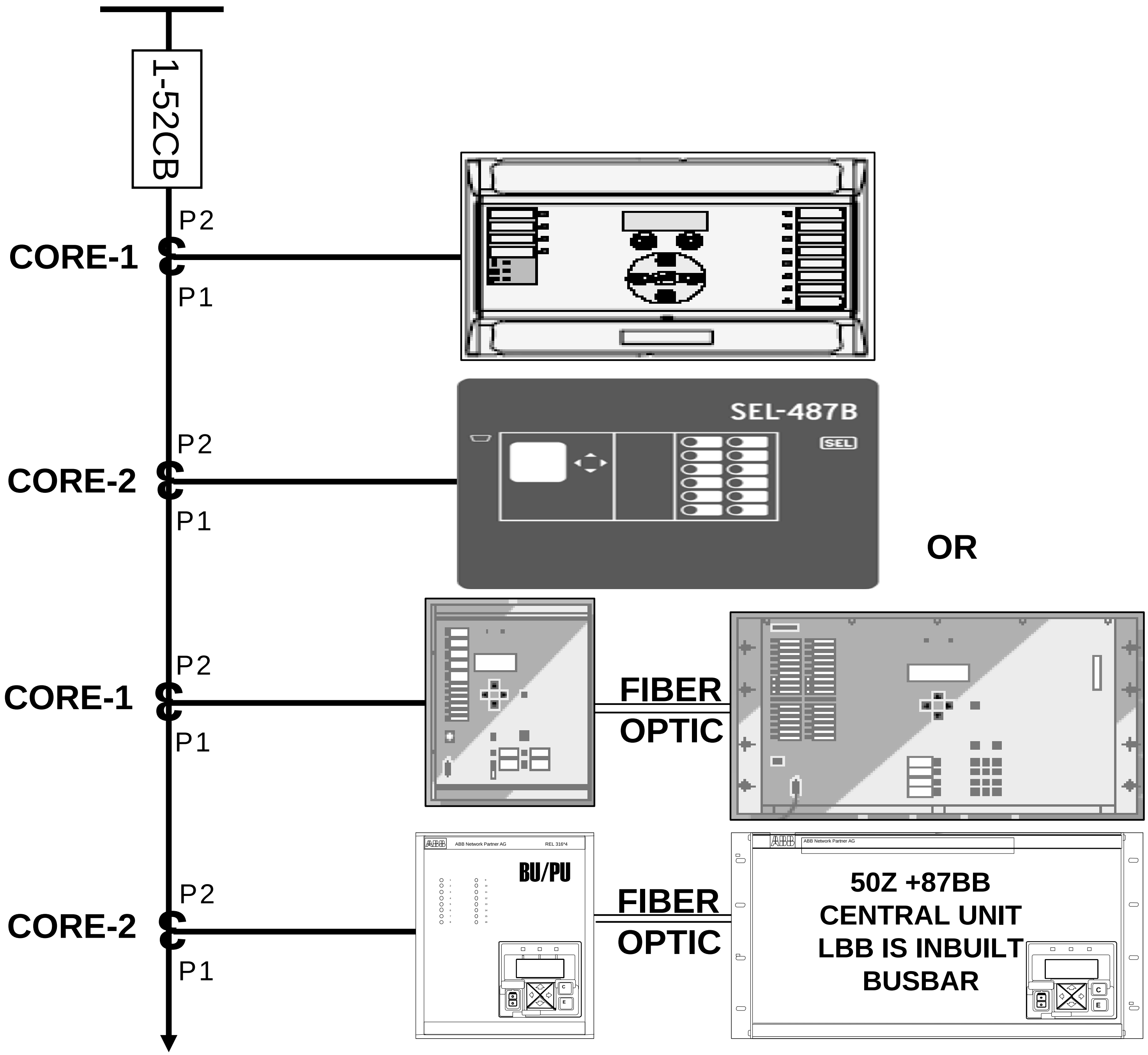
1. LBB is now Part of BUSBAR Protection Relay, For Distributed Architecture or Centralised Architecture.
2. In case of Distributed Architecture, CT connections, Binary Input & Output Connections are up to BAY / Peripheral Unit and BU/PU to BUSBAR is Fiber Optic Link
3. In case of Centralised Architecture I,V,BI & BO to Central Unit.

NEXT DEVELOPMENT

1. ABB is developed the New Concept i.e
2. CT connections are up to Main-1 Protection & Main-1 to Bay Unit and BAY UNIT to BUSBAR is Fiber Optic Link. (Numerical Distributed Architecture) and
3. Similarly for Main-2 Protection.

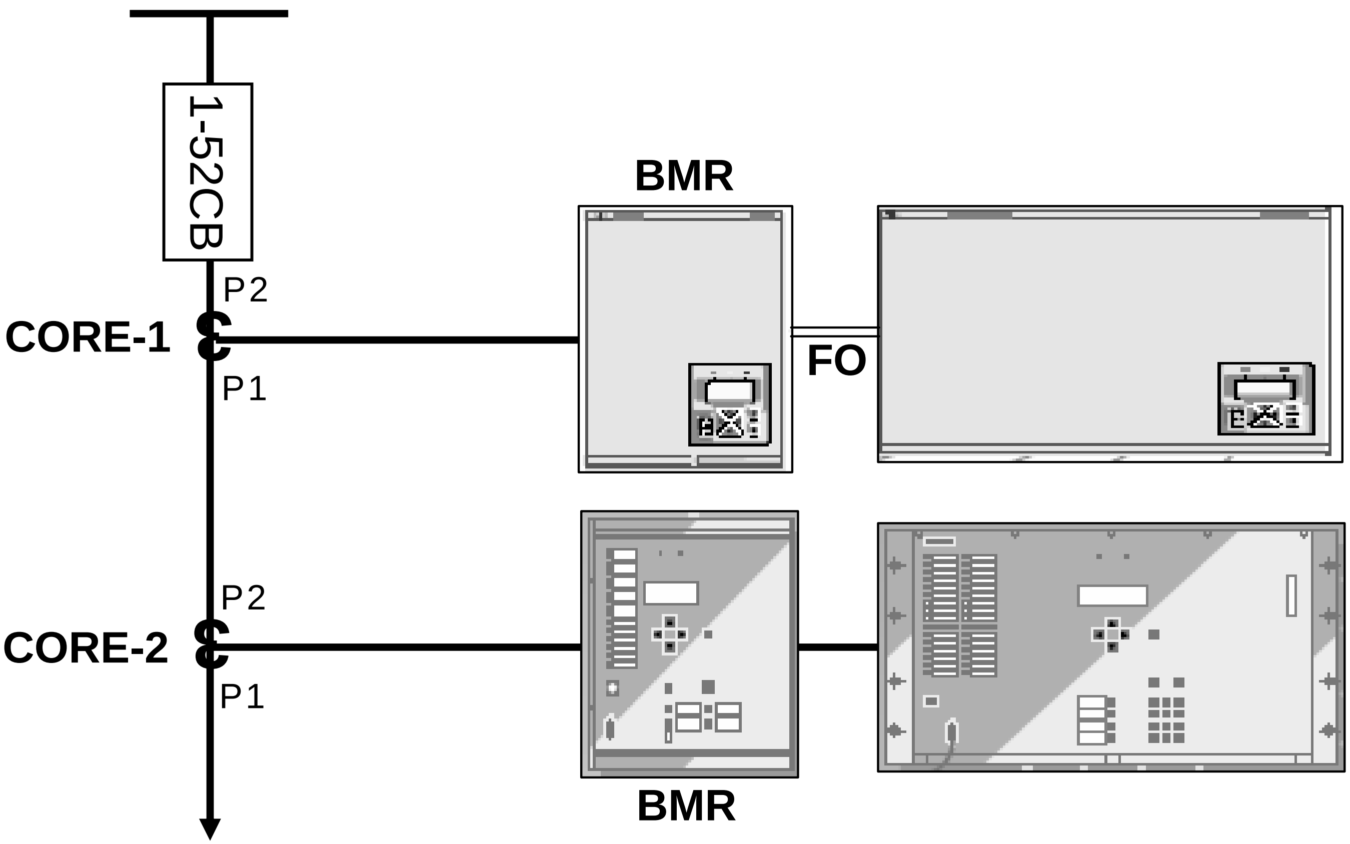


NEXT DEVELOPMENT FOR DUPLICATE BUSBAR PROTECTION FOR DISTRIBUTED OR CENTRALISED ARCHITECTURE



RECENT DEVELOPMENT

1. New Relay Introduced i.e Breaker Management Relay.
2. In this LBB (50Z) + A/R (79) + Check Syn (25) are Inbuilt features.
3. This is connected to Centralised Unit Through Fiber Optic or CT Connections are in Series to BUSBAR.



INITIATION TO LBB / BFR

1. 21L1 & 21L2 Operation will operate 1-Ph Trip Relays (186-R,Y,B & 286-R,Y,B). These Relays will energise the trip coils of the Circuit Breaker and initiate the LBB Relay.
2. 87T1 & 87T2 & Other Relays will operate Master Trip Relays / High Speed Trip Relays (86Gr-A, 86Gr-B). These Relays will energise the trip coils of the Circuit Breaker and initiate the LBB Relay.
3. BUSBAR Relays will operate Master Trip Relays / High Speed Trip Relays (96-BB). These Relays will energise the trip coils of the Circuit Breaker and initiate the LBB Relay.
4. Incase of Transfer Bus System or Bypass Isolator System initiation of LBB is selection of Normal / Transfer switch Position.

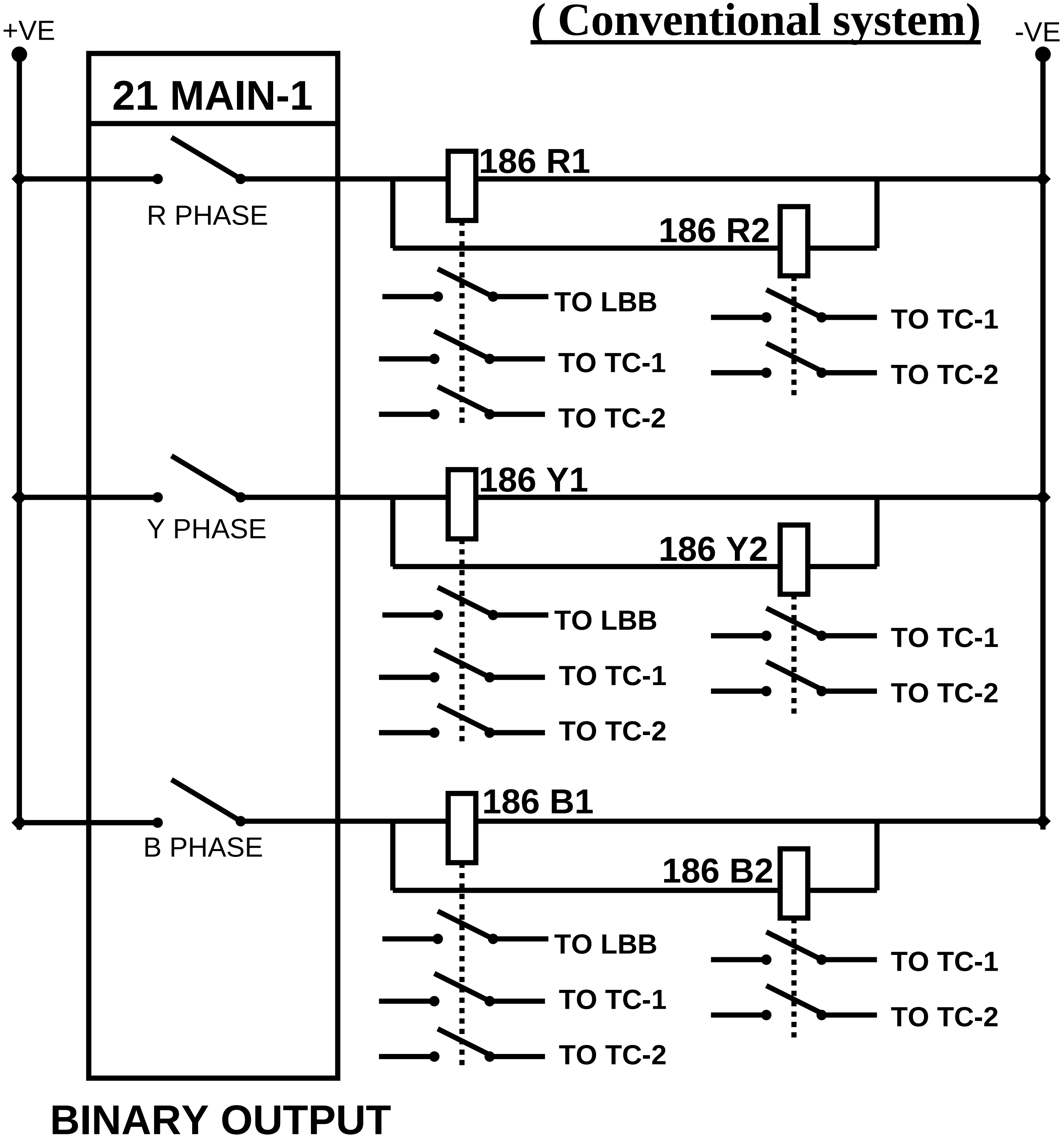
LBB / BFR Tripping Logic

When LBB Operated following Output Operations will Taken Place.

- To Main-1 Disturbance Recorder.
- To Main-2 Disturbance Recorder.
- To 86 Gr-A Bi-Stable relay.
- To 86 Gr-B Bi-Stable relay.
- To 87BUSBAR Output Relays (96BB1 and/or 96BB2).
- Direct Trip Ch-1 to Other end.
- Direct Trip Ch-2 to Other end.
- To Annunciation.
- To SER / RTU.
- Incase of ONE & HALF CB System, Central/ Tie LBB Having Duplicate Tripping Logics for 2 sides of Main Bays.

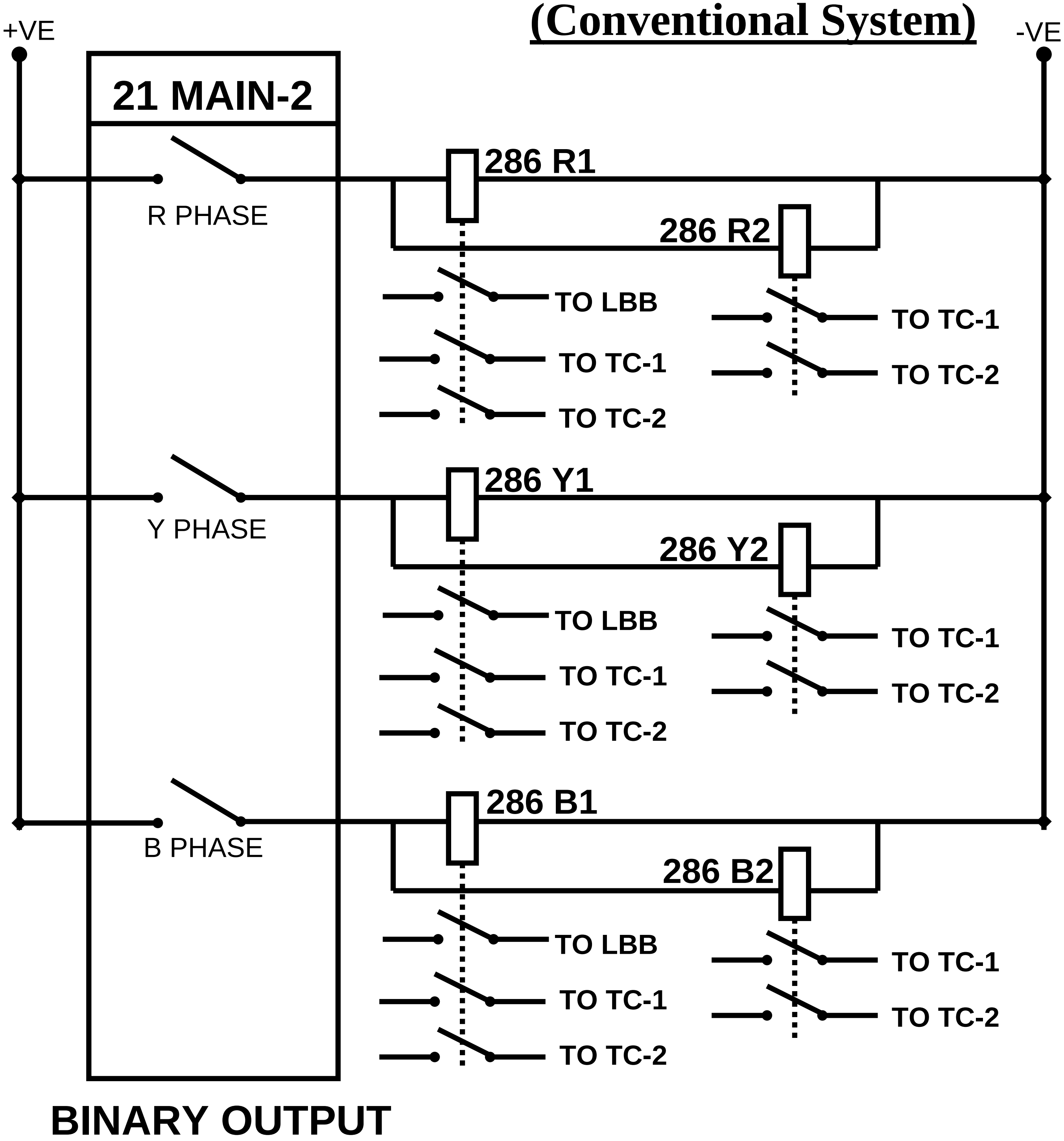
MAIN-1 (21L1) PROTECTION OPERATED

(Conventional system)



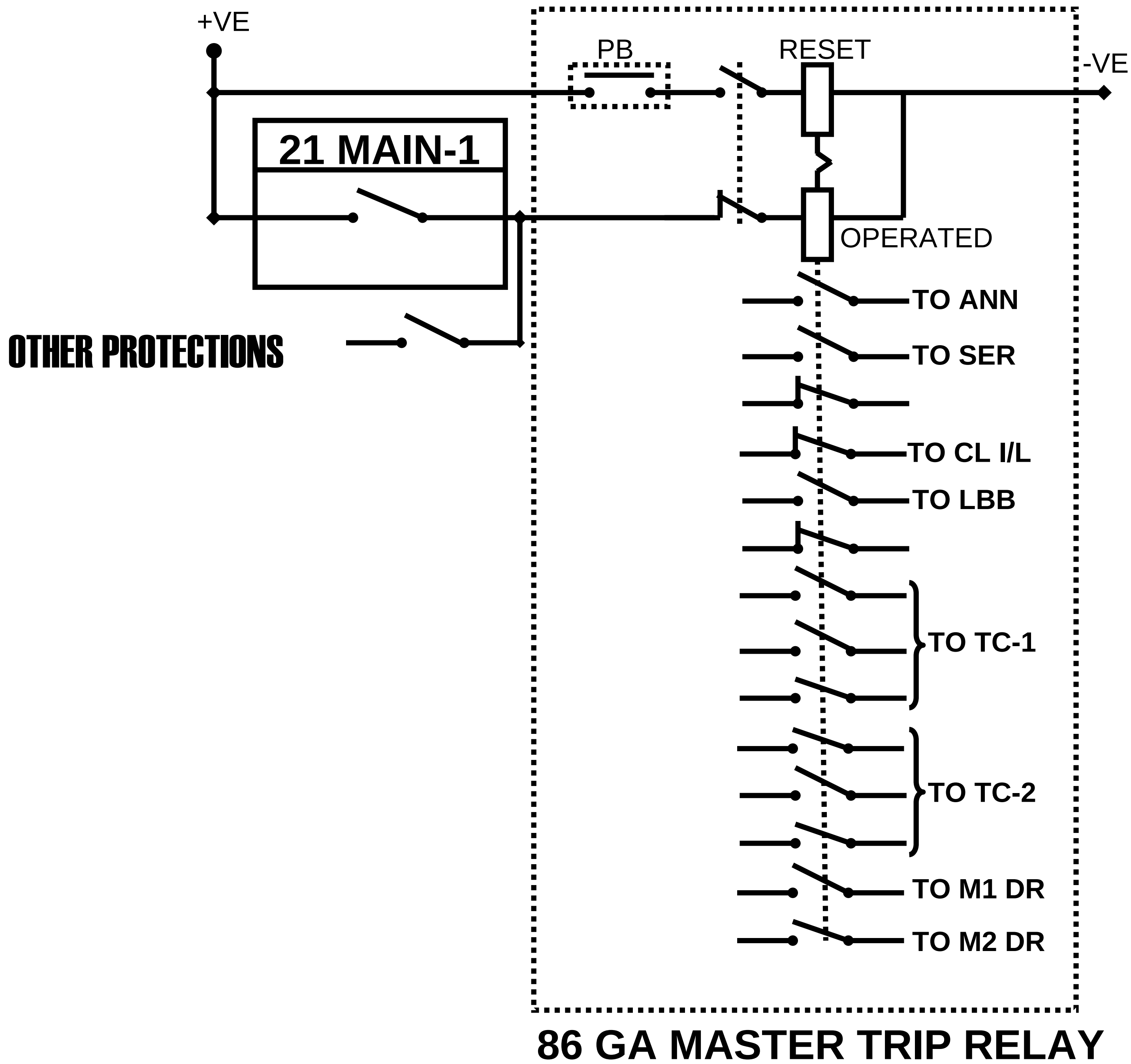
MAIN-2 (21L2) PROTECTION OPERATED

(Conventional System)



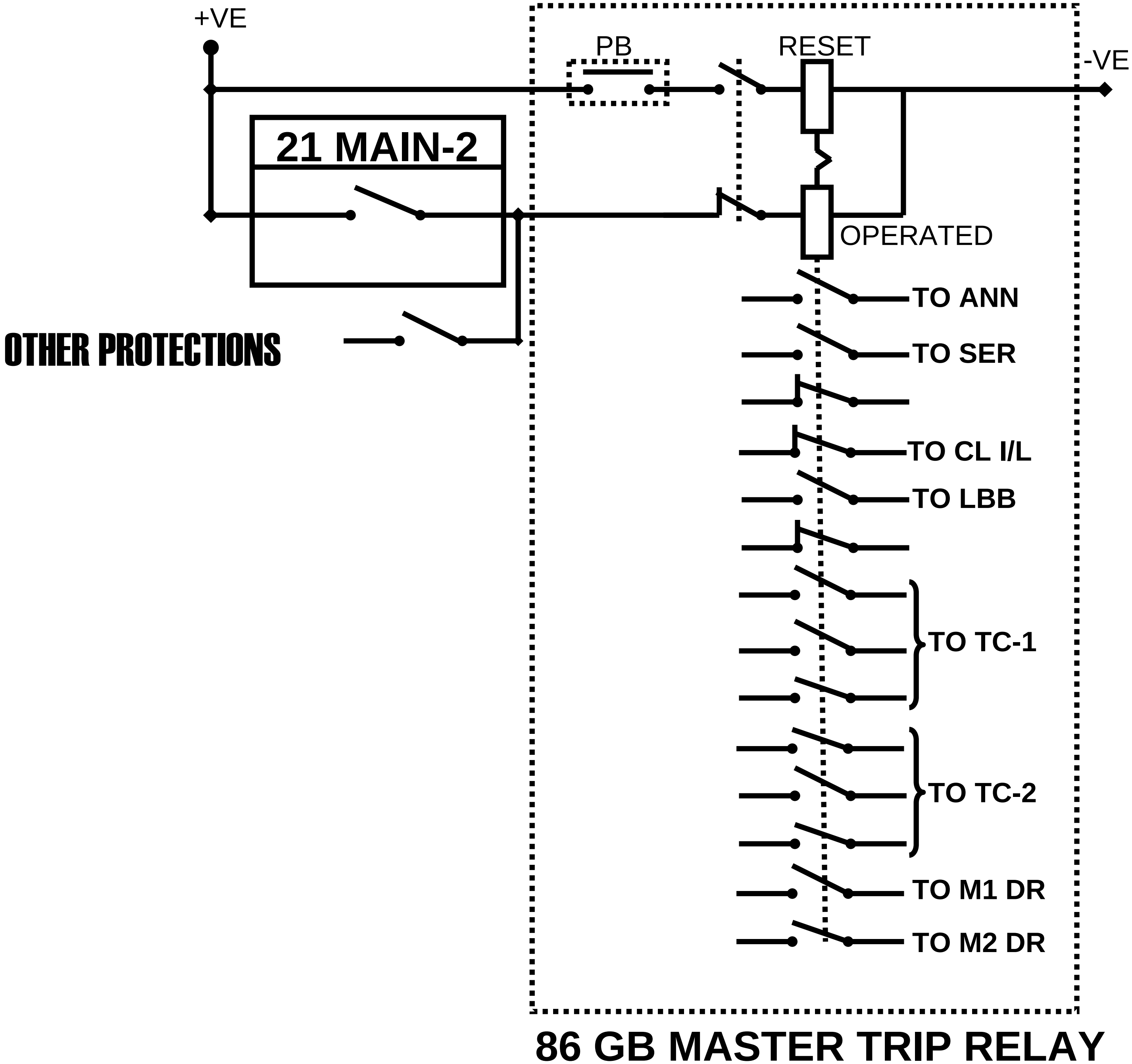
86 GA (MASTER TRIP RELAY) OPERATION

(CONVENTIONAL SYSTEM)

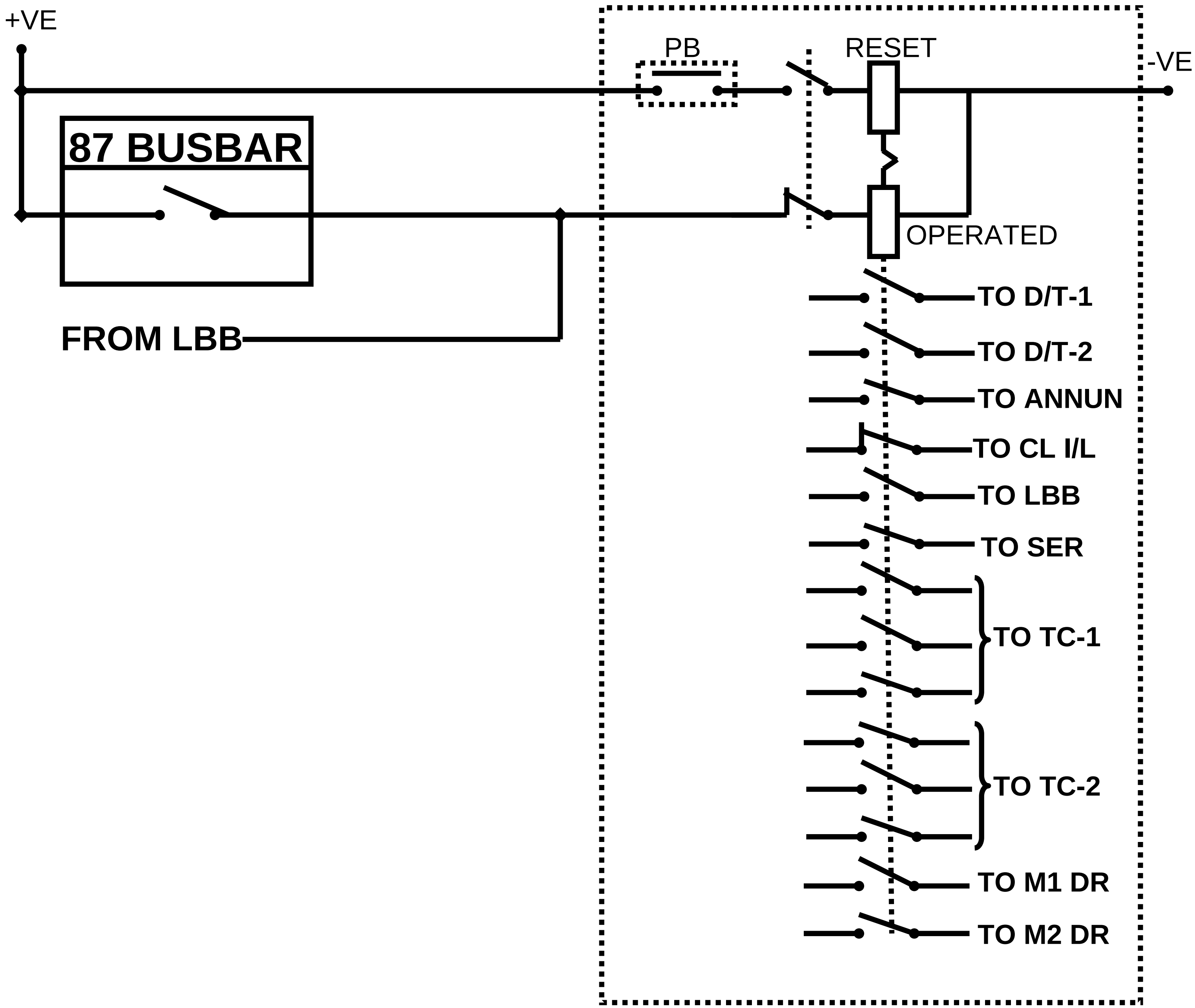


86 GB (MASTER TRIP RELAY) OPERATION

(CONVENTIONAL SYSTEM)



96 BB (MASTER TRIP RELAY) OPERATION

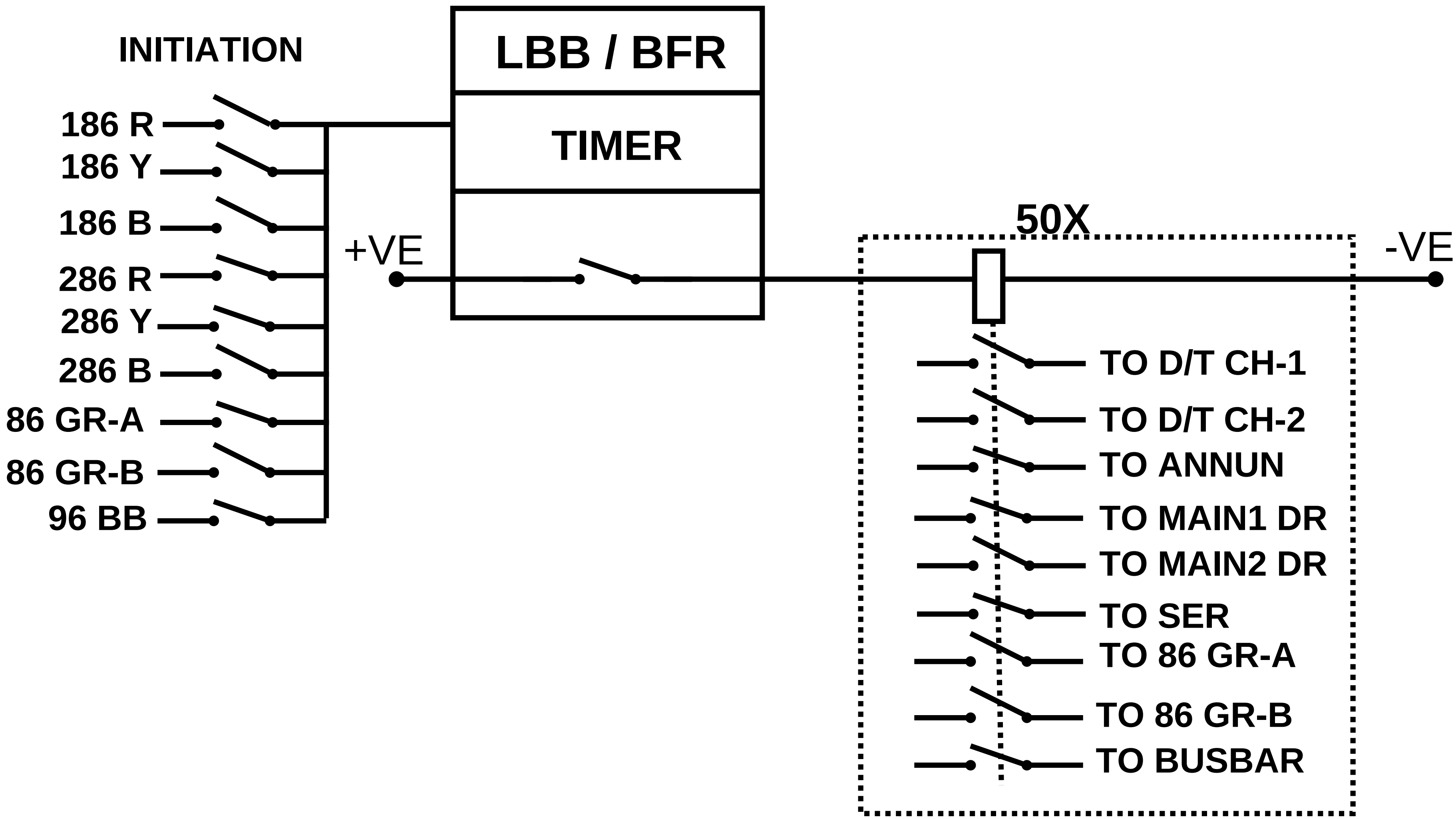


96 BB MASTER TRIP RELAY

FOR SINGLE BUS SYSTEM,
ONE & HALF CB SYSTEM,
DOUBLE CB & DOUBLE BUS SYSTEM
& RING MAIN BUS SYTEM

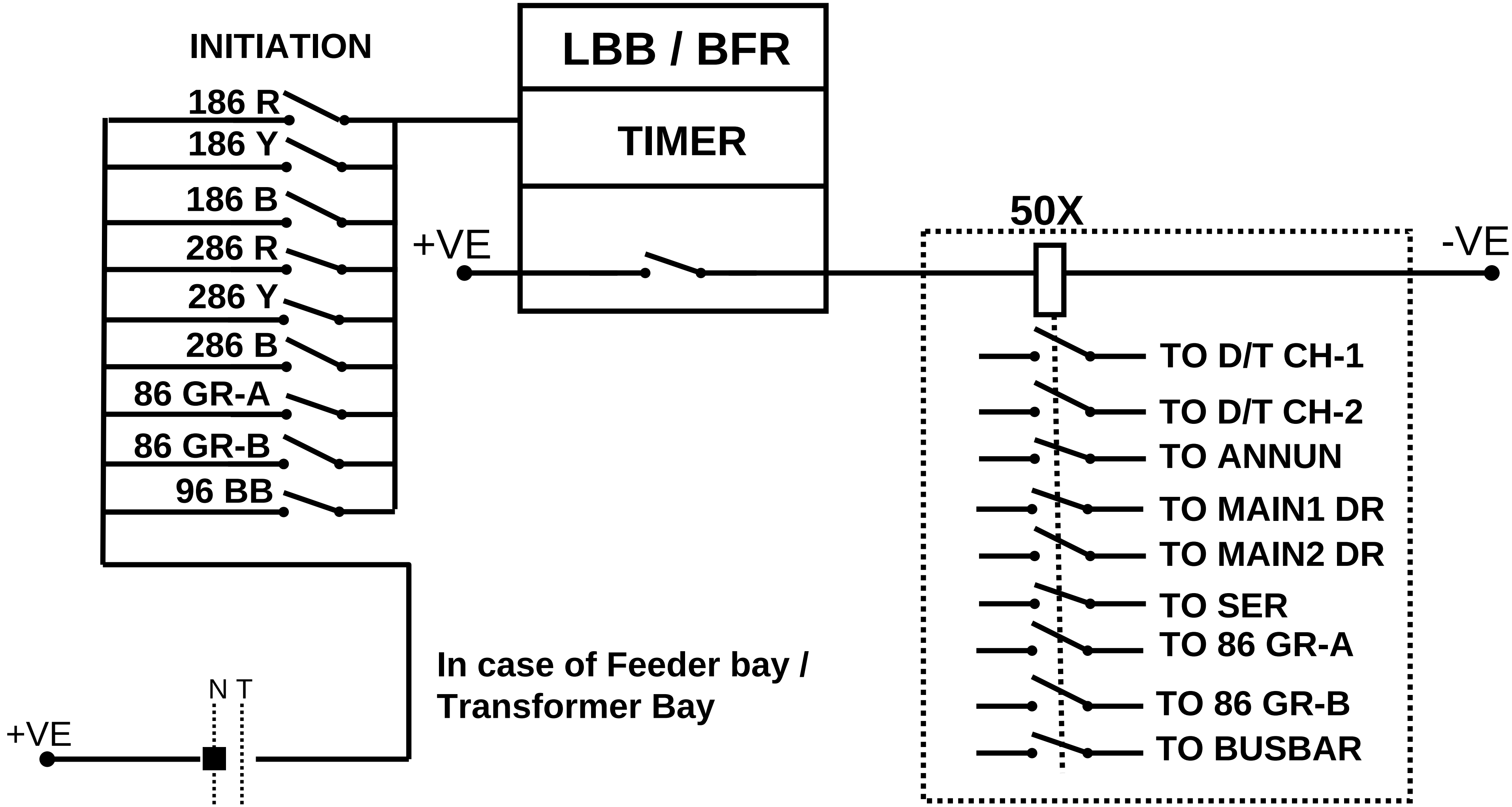
LBB Operation & Output

(SINGLE BUS / DOUBLE BUS / QUAD BUS SYSTEM)

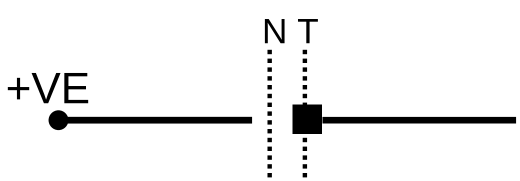


LBB Operation & Output

(TRANSFER BUS / BYPASS ISO SYSTEM)



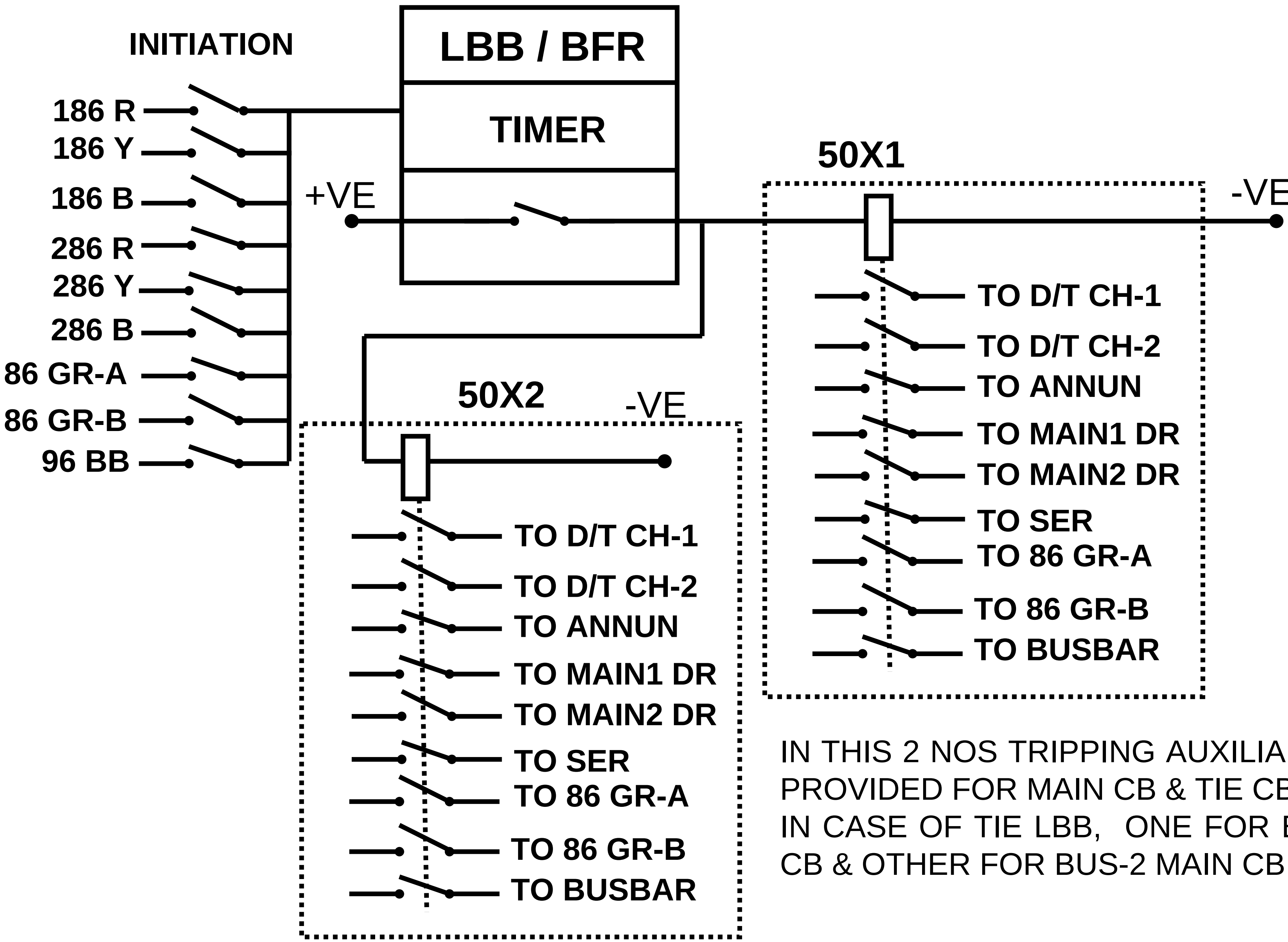
In case of Feeder bay / Transformer Bay



In case of Transfer bay / Bus Coupler Bay for Transfer Bus / Bypass ISO System initiation to that LBB

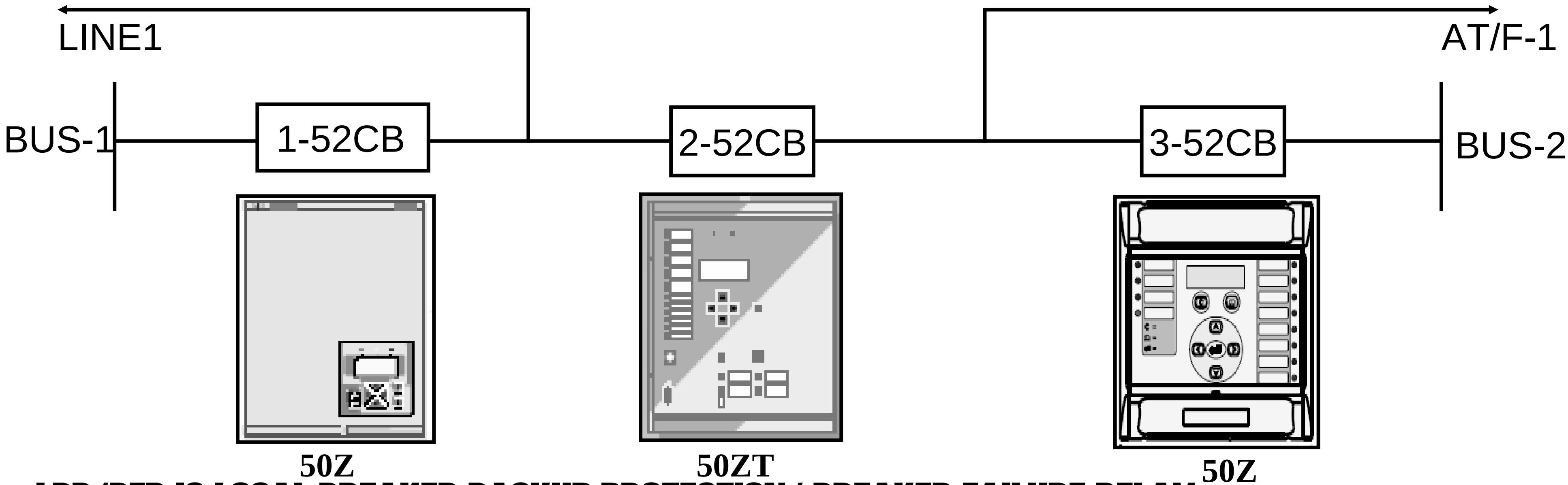
LBB Operation & Output

(ONE&HALF CB SYSTEM)



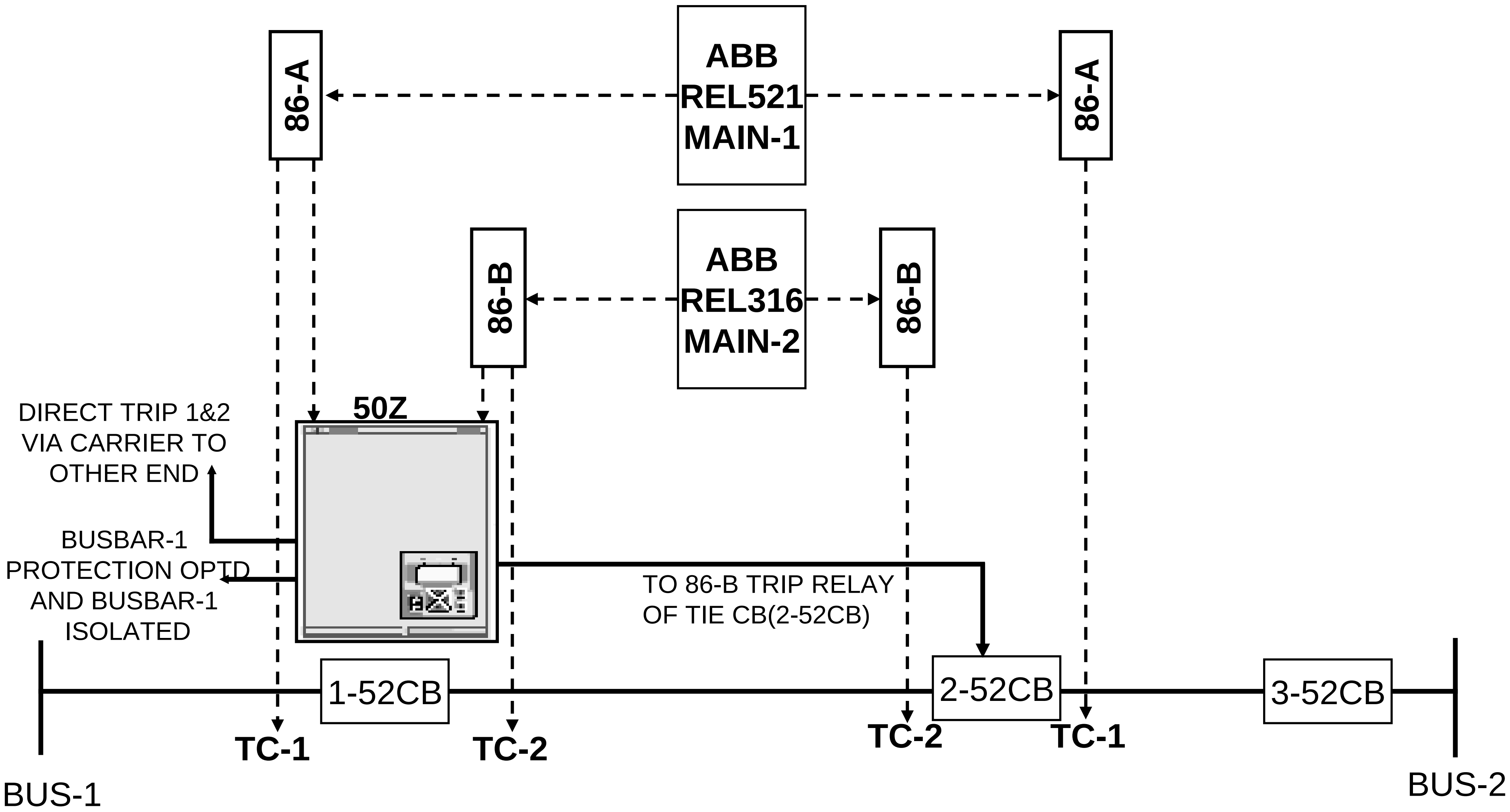
IN THIS 2 NOS TRIPPING AUXILIARY RELAYS PROVIDED FOR MAIN CB & TIE CB.
IN CASE OF TIE LBB, ONE FOR BUS-1 MAIN CB & OTHER FOR BUS-2 MAIN CB.

LBB/BFR PROTECTION



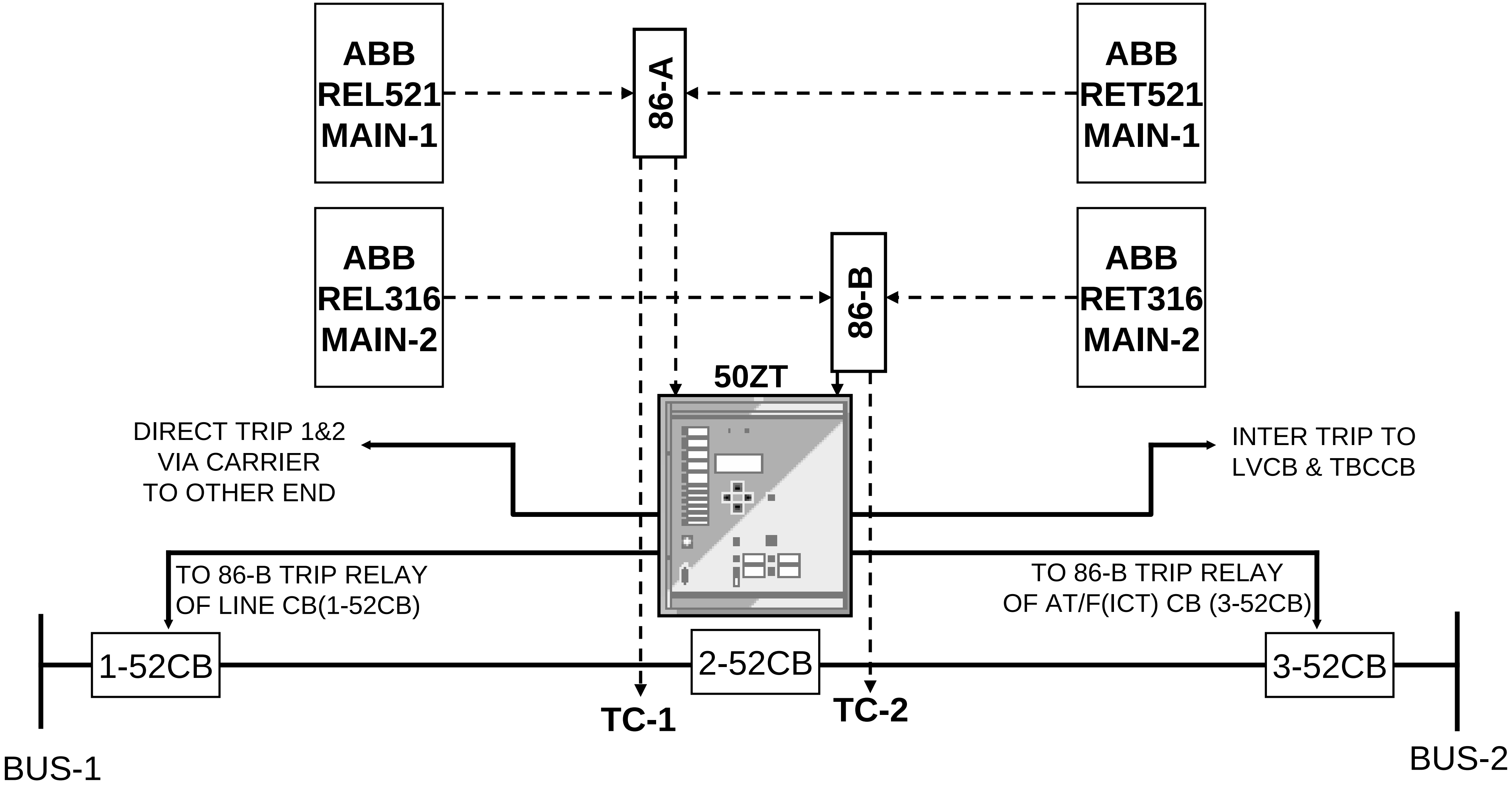
- LBB/BFR IS LOCAL BREAKER BACKUP PROTECTION/ BREAKER FAILURE RELAY.
- 1No RELAY IS PROVIDED FOR EACH BREAKER.
- THIS IS CURRENT OPERATED RELAY.
- THIS RELAY IS ENERGISED WHEN MASTER TRIP RELAY(86-A OR/AND 86-B) OPERATES OR SINGLE PHASE TRIP RELAYS OPERATES AND GIVEN SIGNAL TO BREAKER FOR TRIP.
- IN THIS RELAY TIME DELAY IS PROVIDED.
- THIS RELAY OPERATES WHEN THE BREAKER IS UNDER TROUBLE/ FAILS TO OPERATE.
- AFTER ENERGISED THE RELAY AND TIME DELAY COMPLETES, EVEN CURRENT IS THERE THIS THINKS BREAKER FAIL TO OPERATE AND GIVEN SIGNAL AS PER SCHEME DESCRIBED NEXT PRESENTATION.
- NEW CONCEPT: Normally the CT connections for LBB/BFR relay is in series with Main-2 Protection. In case of Numerical Distributed LBB/BFR and Centralized Bus-Bar System, the CT connections for Bus-Bar are terminated at LBB/BFR and Centralized Bus-Bar is interconnected by Fiber-Optic cable.

1-52 CB LBB/BFR OPERATION



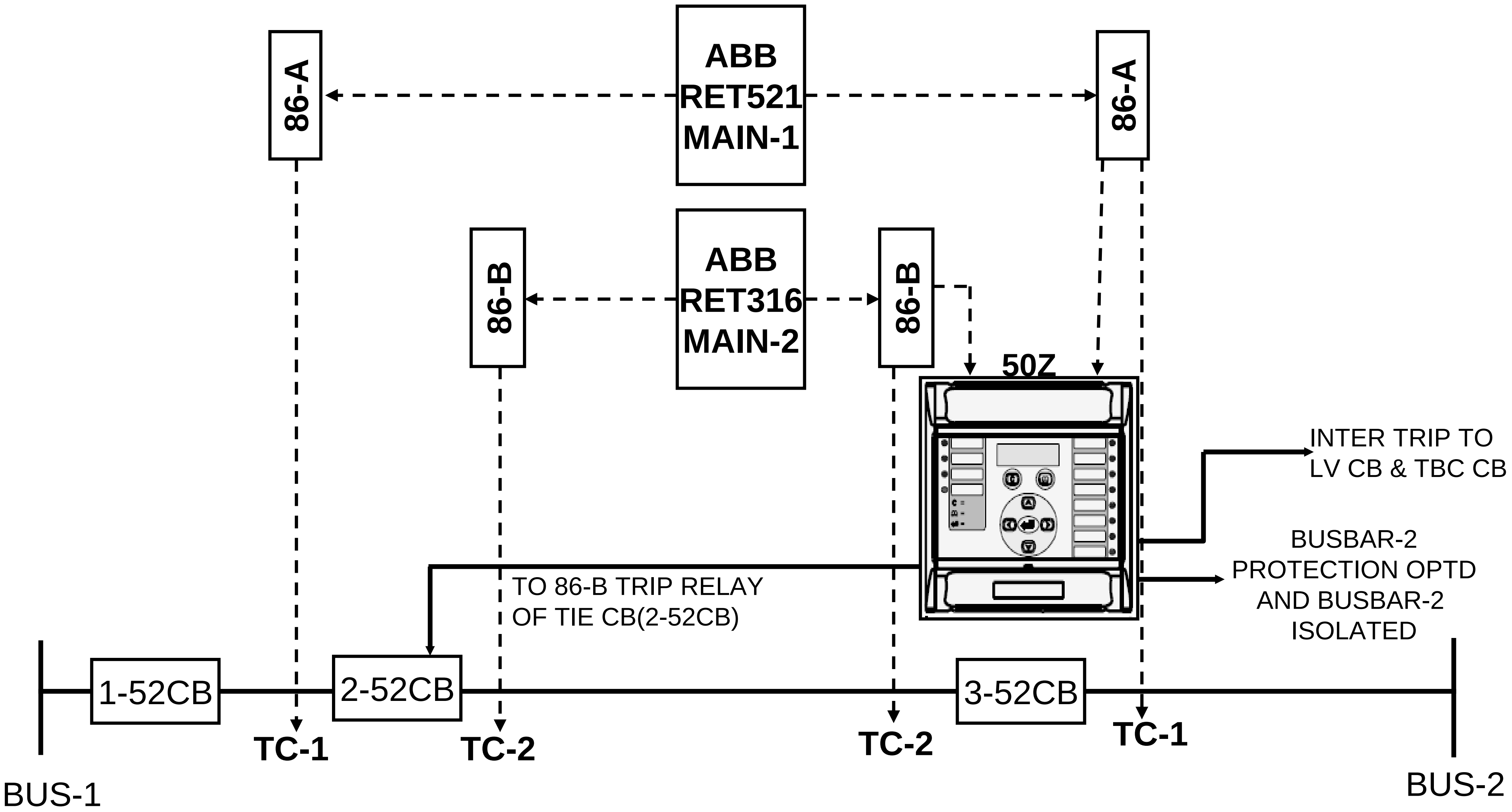
Breaker Failure Relay of the Main Circuit Breaker Trips the Connected Bus, Tie Circuit Breaker, and Remote End Circuit Breaker

2-52 CB LBB/BFR OPERATION



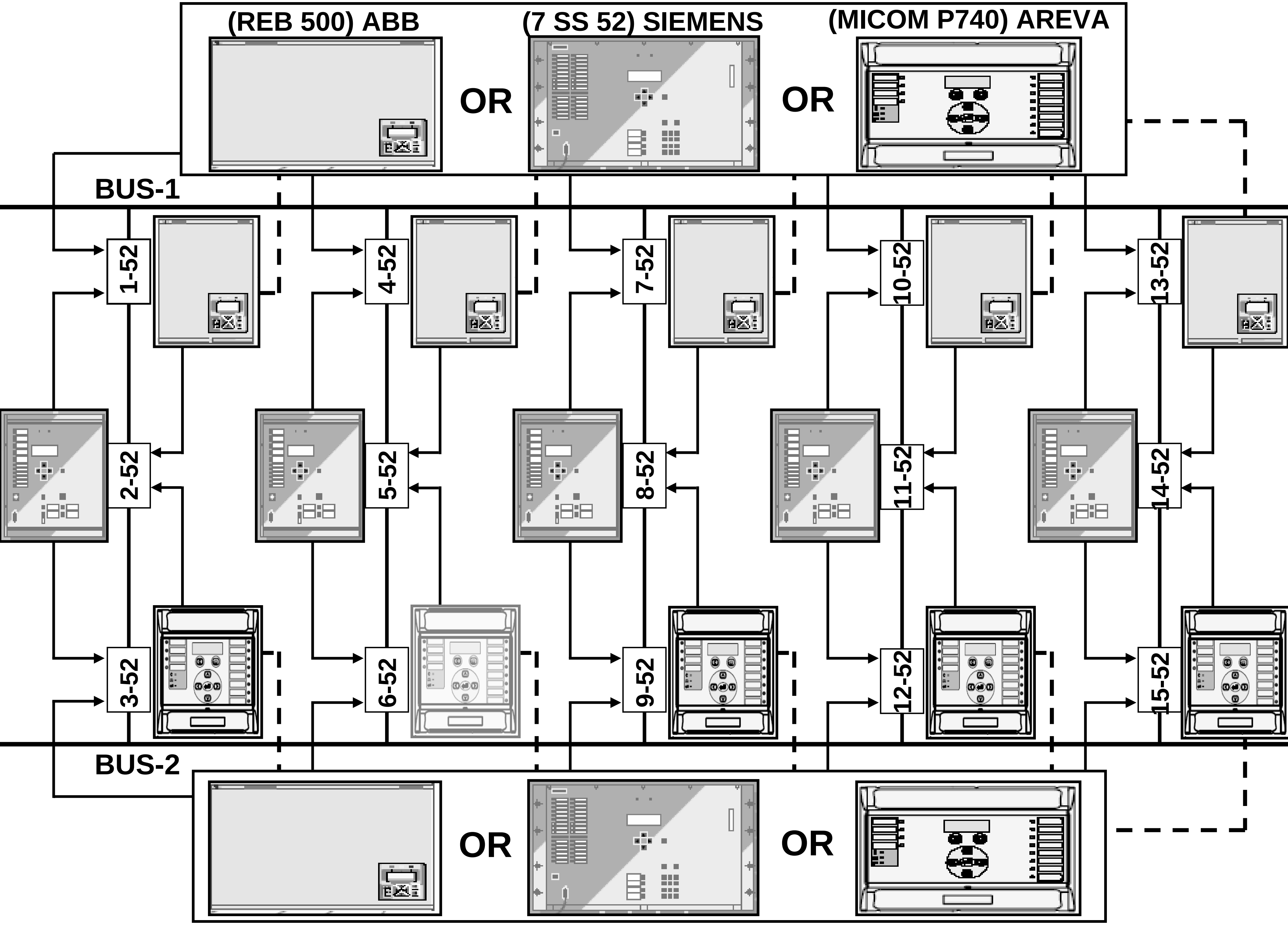
Breaker Failure Relay of the Tie Circuit Breaker Trips the Both Main Circuit Breakers and Remote End Circuit Breakers (In case of Transformer, LV Circuit Breaker)

3-52 CB LBB/BFR OPERATION

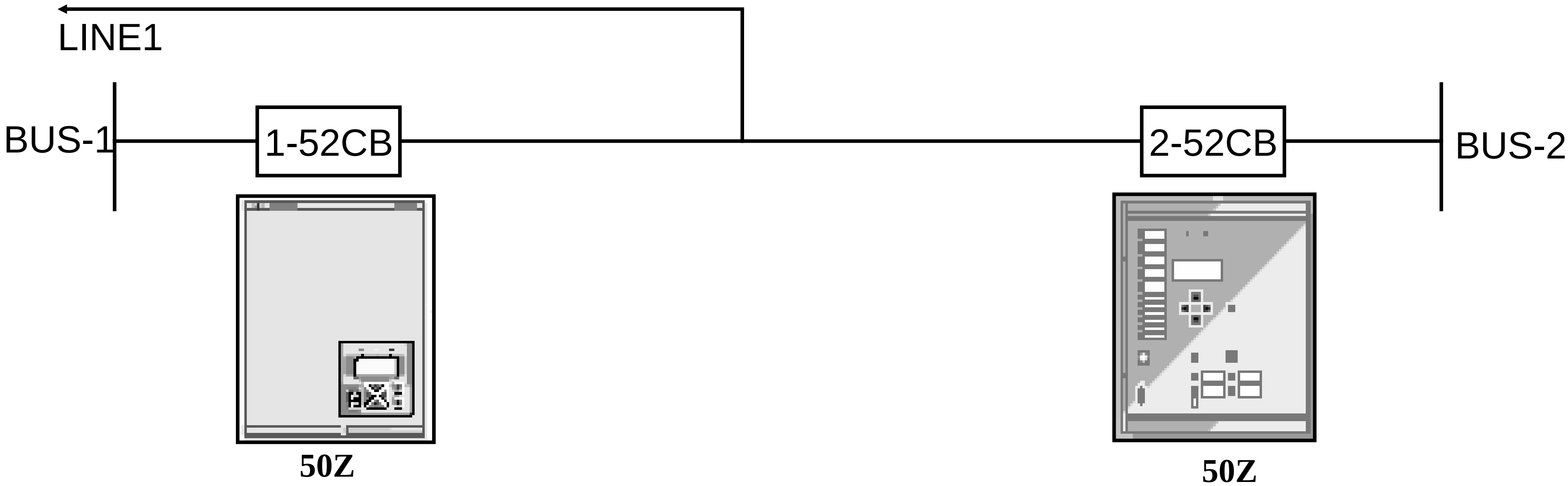


Breaker Failure Relay of the Main Circuit Breaker Trips the Connected Bus, Tie Circuit Breaker, and Remote End Circuit Breaker (In case of Transformer, LV Circuit Breaker)

DISTRIBUTED LBB & NUMERICAL CENTRALISED BUS BAR PROTECTION

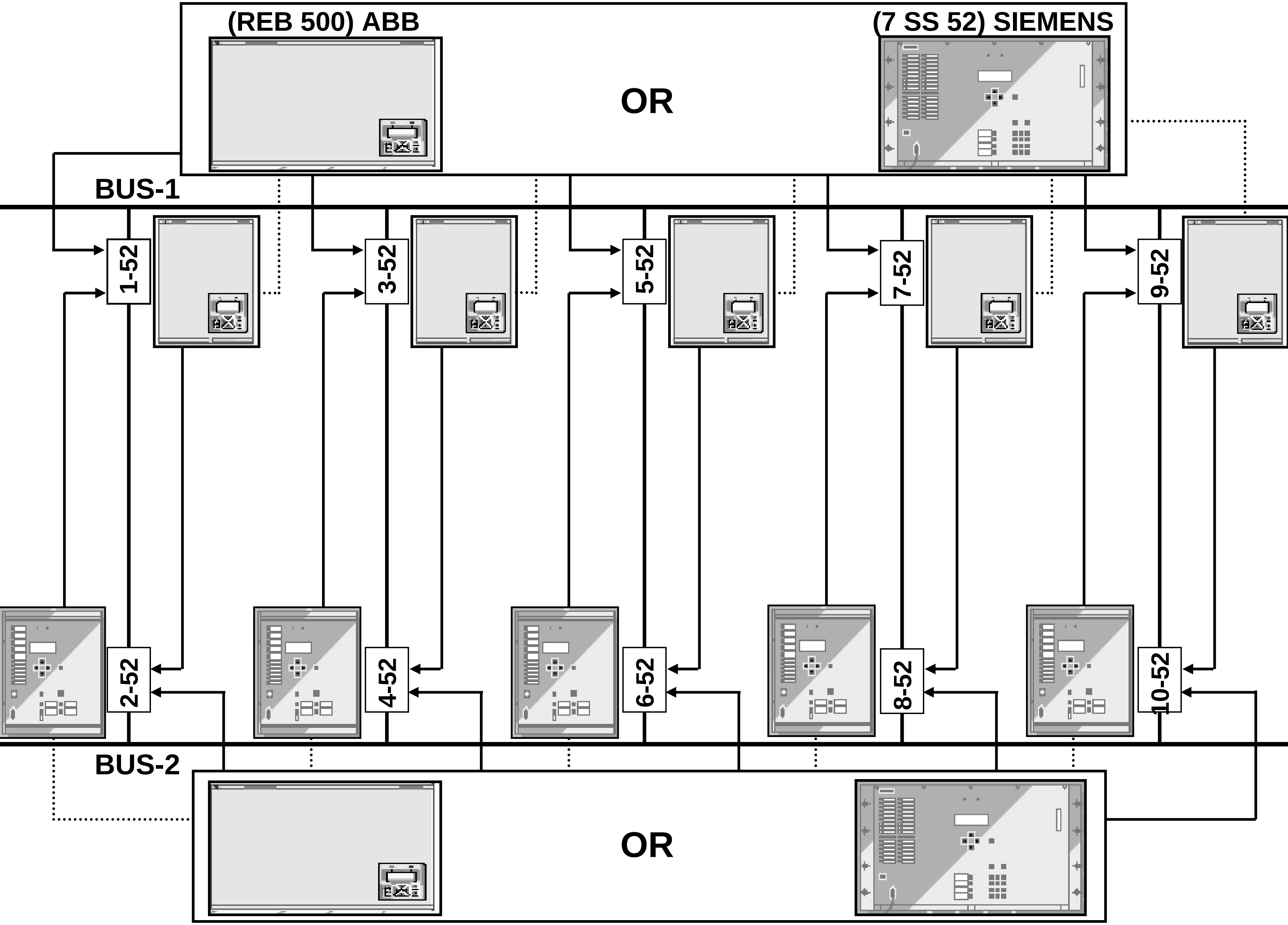


LBB/BFR PROTECTION



- THE ABOVE SYSTEM IS DOUBLE BUS AND DOUBLE BREAKER SYSTEM.
- THE ABOVE CONFIGUARATION IS UTILISED IN 765KV SYSTEM.
- IN THIS SYSTEM EACH CIRCUIT BREAKER HAVING SEPARATE LBB.
- BREAKER FAILURE RELAY OF THE 1-52 CIRCUIT BREAKER TRIPS THE CONNECTED BUS, 2-52 CIRCUIT BREAKER, AND REMOTE END CIRCUIT BREAKER.
- SIMILARLY BREAKER FAILURE RELAY OF THE 2-52 CIRCUIT BREAKER TRIPS THE CONNECTED BUS, 1-52 CIRCUIT BREAKER, AND REMOTE END CIRCUIT BREAKER.
- INCASE OF TRANSFORMER THE REMOTE END BREAKER MEANS IV CIRCUIT BREAKER.

DISTRIBUTED LBB & NUMERICAL CENTRALISED BUS BAR PROTECTION



400KV

BUSBAR

PROTECTION

NEED/NECESSICITY

- BUSBAR Protection is provided for high speed sensitive clearance of BUSBAR faults by tripping all the Circuit Breakers connected to faulty bus.
- A BUSBAR Protection is a Protection to protect BUSBARs at Short-Circuits and Earth-faults. In the “childhood” of electricity no separate Protection was used for the BUSBARs. Nearby line protection were used as back-up for BUSBAR Protection.
- In its absence fault clearance takes place in zone-II of Distance Relay by remote end tripping.
- With increasing Short-Circuit Power in the network separate BUSBAR Protections have to be installed to limit the damage at primary faults. A delayed tripping for BUSBAR faults can also lead to instability in nearby generators and total system collapse.

NEED/NECESSICITY

- The earliest form of BUS Protection was that provided by the relays of circuits (i.e. Lines , Transformers, Reactors & Capacitor Banks) over which current was supplied to a BUS. In other words the BUS was included within the back-up zone of these relays. This method was relatively slow speed, and loads tapped from the lines would be interrupted unnecessarily, but it was otherwise effective. Some preferred this method to one in which the inadvertent operation of a single relay would trip all the connections to the BUS.
- This Means Slow And Unselective Tripping And Wide Spread Black Out.

EFFECT OF DELAYED CLEARENCE

- Greater damage at fault point.
- Indirect shock to connected equipments like shafts of Generator and windings of Transformer.

PRINCIPLE OF OPERATION

- The Principle of Operation of Bus bar protection is Kirchoff’s Current Law. i.e. Sum of the Currents Entering in to the Node is equal to Sum of the Currents Leaving the node. Here Node Means BUSBAR.

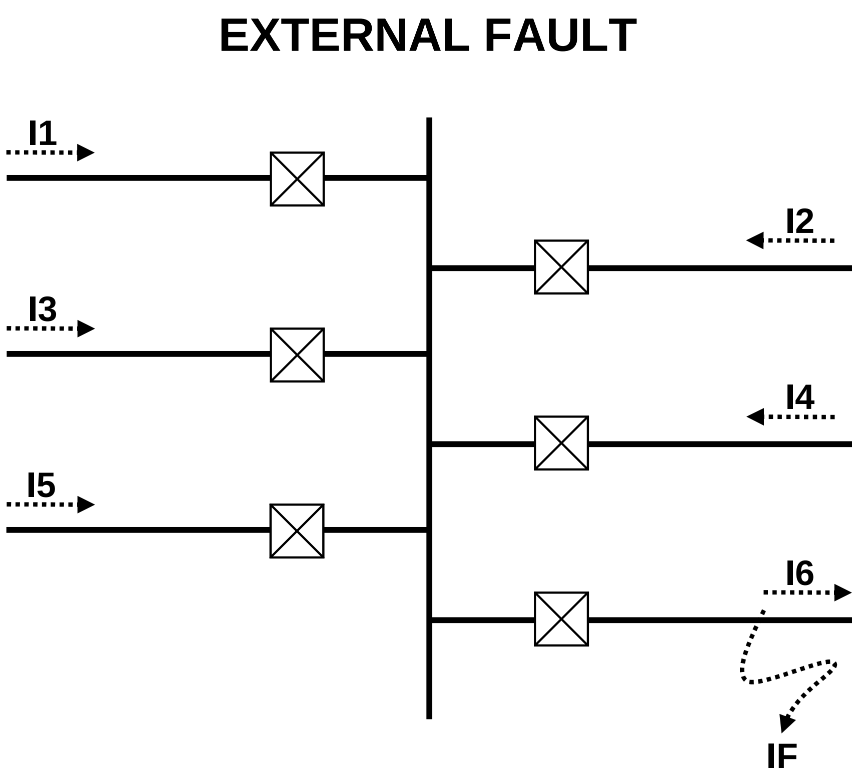
CAUSES OF BUS ZONE FAULTS

- Deterioration of Insulating Material.
- Flashover of insulators due to lightning or System Over Voltages.
- Wrong application of /or failure to remove temporary earth connections.
- Short circuits caused by birds, monkeys, vermin and the like.
- Short circuits caused by construction machinery.

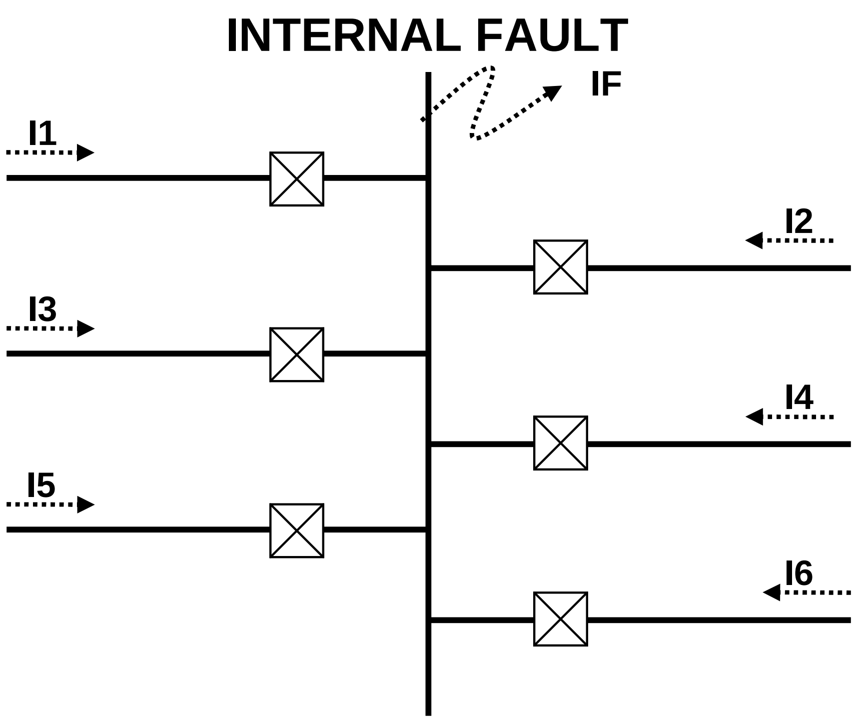
BASICS OF BUS BAR PROTECTION

BASIC THEORY

KIRCHOFF's CURENT LAW STATES THAT THE SUM OF THE CURRENTS ENTERING A GIVEN NODE MUST BE EQUAL TO THE CURRENTS LEAVING THAT NODE



IF= I6= I1+I2+I3+I4+I5



IF= I1+I2+I3+I4+I5+I6

RECOMMENDATIONS

- Must have as short tripping time as possible.
- Must be able to detect internal faults.
- Must be absolutely stable at external faults. External faults are much more common than internal faults. The magnitude of external faults can be equal to the stations maximum breaking capacity, while the function currents can go down to approximately 2% of the same. The stability factor there fore needs to be at least 50 times i.e. 20. CT-saturation at external faults must not lead to mal-operation of the BUSBAR Protection.
- Must be able to detect and trip only the faulty part of the BUSBAR system.
- Must be secure against mal-operation due to auxiliary contact failure, human mistakes and faults in the secondary circuits etc.

TYPES OF BUSBAR PROTECTION SCHEMES

- HIGH IMPEDENCE BUSBAR PROTECTION :

  High Impedance Differential Protection has traditionally been provided by Electromechanical Relays and associated stabilising resistances connected across the Current Transformer secondary bus wires of the Protected zone, i.e. the Measuring Circuit comprises a High impedance stabilising Resistor (Metrosil) connected across the circulating current arrangement of all the CT’s in parallel. The resulting Scheme is economical, simple in concept and easily extendable to cover additional circuits. It has an added advantage that low fault current settings can be achieved whilst retaining through fault stability. Application of this type of scheme can however sometimes be limited by the need for CTs on each circuit to be of the same ratio and by the knee point voltage required to achieve fast operating times. The Value of Stabilising Resistor chosen such that the voltage drop across the relay circuit is insufficient to operate the relay for faults outside the protection zone.

  The High-impedance protection scheme, on the other hand, is a good Solution for single BUSBAR arrangements, 1 ½ breaker systems or ring BUSBARS, providing that appropriate dedicated CT cores are available For this use alone.

TYPES OF BUSBAR PROTECTION SCHEMES

- MEDIUM/MODERATE IMPEDENCE BUSBAR PROTECTION:

  This is effectively combination of the normal plain circulating current High-Impedance and Stabilised percentage biased differential scheme. This relay acts as Medium Impedance Protection during internal faults & but Low Impedance Protection during load and external faults.

  Although heavy through fault currents may produce a different current that exceeds the differential pick-up setting, stabilizing current prevents tripping. The requirements made on the primary CT’s are subsequently less stringent than for a simple High-Impedance Scheme.

LOW IMPEDANCE PROTECTION

- PHASE COMPARISION BUSBAR PROTECTION:

  This operates on the principle that any BUSBAR fault will be characterised by all current flows towards the protected BUSBARS and phase coincidence and is checked for positive and negative half cycles. In addition the non coincidence is used for as a blocking signal.

  However under low fault level conditions, it is possible for some load flow to continue. To prevent this from stabilising the Protection, a fault load current of Highest rated outgoing circuit is normally selected i.e. pick-up level is set above the load current.

  The differential current can also be included in the phase comparison , there by further improving stability.

  The Main advantage of this scheme is that, it is not necessary for the current transformers on each circuit to be equal ratio. Also the current transformers may be lower output than those required for High-Impedance Schemes.

LOW IMPEDANCE BUSBAR PROTECTION

- PERCENTAGE BIASED DIFFERENTIAL PROTECTION:

  This Protection is known as current comparison with current restraint, biased or percentage differential relaying. The operating current is the Phasor sum of all feeder currents and the restraint current is the arithmetic sum. A trip command is given when operating current is greater than its pickup level and the stabilising factor the ratio of operating current to restraint current.

  in case of CTs ratios differ, the currents have to be balanced by using interposing CTs (Aux ratio matching CTs). In this load bias take care for any matching errors.

  where as High-Impedance protection the scheme is inherently stable during CT saturation, in this scheme special measures must be taken to ensure the protection remains stable during CT saturation. In this scheme check feature can be included.

  This type incorporates a stabilising resistor to ensure through fault stability at high fault levels. This can limit the minimum size of current transformer that will be required to ensure high speed performance.

VOLTAGE DIFFERENTIAL RELAY WITH LINEAR COUPLERS

The problem of CT saturation is eliminated at its source by air-core CTs called linear couplers. These CTs are like bushing CTs but they have no iron in their core, and the number of secondary turns is much greater. The secondary-excitation characteristic of these CTs is a straight line having a slope of about 5 volts per 1000 ampere-turns.

Contrasted with conventional CTs, linear couplers may be operated without damage with their secondaries open-circuited. In fact, very little current can be drawn from the secondary, because so much of the primary magneto-motive force is consumed in magnetizing the core.

The linear couplers are connected in a series of all CTs & to Voltage-Differential circuit. For normal load or external-fault conditions, the sum of the voltages induced in the secondaries is zero, except for the very small effects of manufacturing tolerances, and there is practically no tendency for current to flow in the Differential Relay.

When a BUS fault occurs, the Voltages of the CTs in all the source circuits add to cause current to flow through all the secondaries and the coil of the Differential Relay. The Differential Relay, necessarily requiring very little energy to operate, will provide high-speed Protection for a relatively small net voltage in the Differential Circuit.

SUMMATION CTs METHOD

In practical application of the schemes, Summation Current Transformers (one per main set of CTs) are normally used. These summation CTs have a tapped primary to which the three phases of the Main CTs are connected, the secondary of the summation CTs providing single-phase output.

The Advantages of summation CTs are.

1. Single Relay is used for all three phases.
2. A Definite bias is available for all types external faults.
3. Lead burden on Main CTs is less, provided these CTs are located Judiciously.
4. Secondary Cabling is reduced.
5. Aux switch requirement in Double BUSBAR arrangement is reduced.

The main Draw backs are

1. The setting for Various types of faults is different, needing careful analysis.
2. Bias effect is less for Phase faults than for Earth faults.

NUMERICAL BUSBAR PROTECTION

- In this two Models of BUSBAR Protections are offered.

  1. Centralised Architecture.

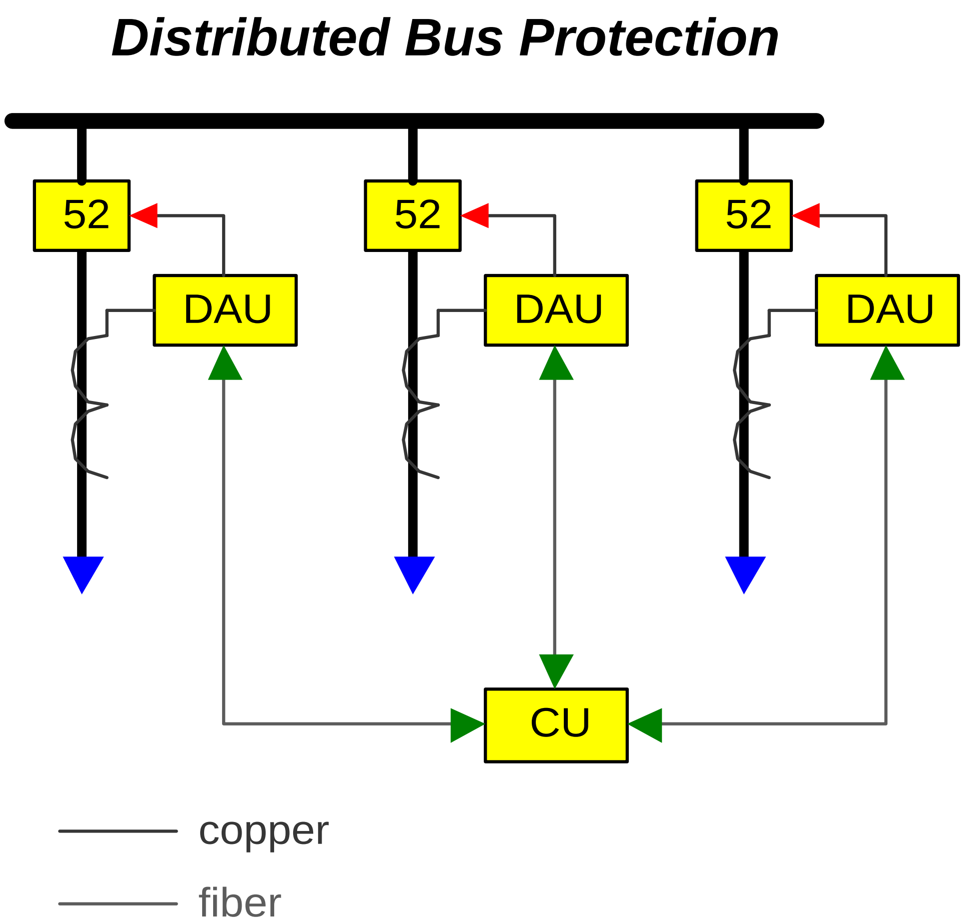
  2. Distributed Architecture.

- The following are the advantages in this Numerical BUSBAR Protection

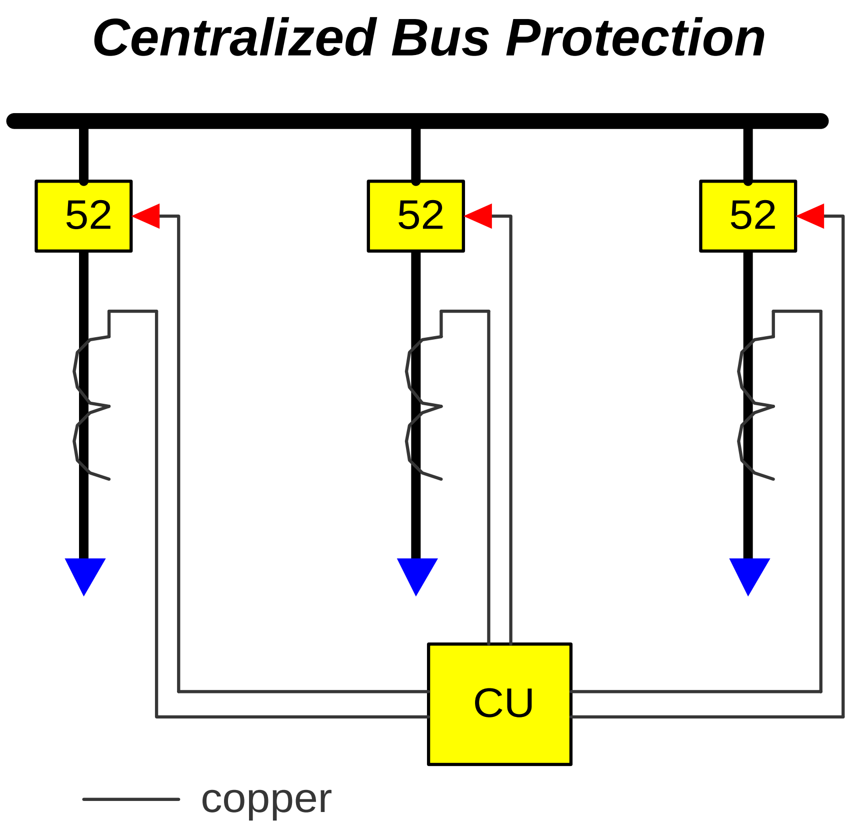
1. LBB, EFP and other Protections are inbuilt feature.
2. Ratio Matching Transformers are not required. They can be programmable.
3. Isolator selection is required & selection relays are not required for zone segregation.
4. One Unit is sufficient, for any no of Zones of BUSBAR Protection.
5. In Distributed Architecture Communication between Bay Unit to Central Unit is Fiber Optic connection.
6. Check Zone feature like Over-all Differential Protection & Over Current Starter Protection is in built function.
7. Current comparison, CT supervision, CT open circuit & CT Saturation Detection is also inbuilt feature.
8. Disturbance recorder and event recorders are inbuilt feature.
9. BUSBAR Tripping Relays are not required. This is can be configured in BUSBAR Relay/ Bay Unit Binary output contacts.
10. These can be configured either High or Low impedance BUSBAR Protection.

Traditionally Two Distinctive Architectures

(CENTRALISED & DECENTRALISED)



- Fits better new installations
- Perceived less reliable
- Slower



- *Fits better retrofit installations*
- *Perceived more reliable*
- *Potentially faster*

DIFFERENCE BETWEEN BUSBAR SCHEMES

DETAILS	HIGH IMPEDENCE BUSBAR PROTECTION	PERCENTAGE BIASED LOW IMPEDENCE BUS BAR PROTECTION
PRINCIPLE	THE CURRENTS ENTERING AND LEAVING THE BUSBAR ARE COMPARED CONTINUOSLY. IT INVOLVES CHOOSING OF IMPEDENCE HIGH ENOUGH STABLISE THE RELAY FOR HEAVY EXTERNAL FAULTS. THIS IS CIRCULATING CURRENT PRINCIPLE.	IT HAS DIFFERENTIAL AND BIAS SETTING. THE RESULTANT BIAS IS PROPOTIONAL TO ARITHMATIC SUM OF ALL CURRENTS, WHEREAS THE OPERATING CURRENT IS VECTOR SUM OF ALL CIRCUIT CURRENTS.
CTs	IT REQUIRES ALL IDENTICAL CT RATIO's & TURNS RATIO. LOW RESISTANCE OF SECONDARY WINDING. Class X for all CT Cores. MINIMUM KNEE POINT VOLTAGE OF 300-500V. LOW MAGNETISING CURRENT(FEW MILLIAMPS).	IT CAN WORK WITH CTs OF UNEQUAL RATIOS ALSO. FREE OF ANY NEED OF MATCHED CT CHARACTERESTIC OR RATIOs LOW LEAKAGE REACTANCE OR RESISTANCE. OTHER PROTECTIVE RELAYS CAN BE INCLUDED IN THE SAME CIRCUIT.
BURDEN	IMPOSES COMPARATIVELY HIGH BURDEN ON CTs. AUXILIARY CTs REDUCE THE PERFORMANCE OF THE SCHEME	IMPOSES LESS BURDEN ON CTs. AUXILIARY CTs HAVE NO EFFECT ON PERFORMANCE OF SCHEME.
CT SATURATION	OPERATION OF SCHEME EVEN WHEN CTs GET SATURATED DURING INTERNAL FAULTS.	OPERATION OF SCHEME EVEN WHEN CTs GET SATURATED DURING INTERNAL FAULTS. INSENSITIVE TO CT SATURATION.
UTILISATION	IT IS GOOD SOLUTION FOR SINGLE BUSBAR ARRANGEMENTS, ONE & HALF BREAKER SYSTEMS OR RING BUSBAR SYSTEMS.	MOST SUITABLE FOR DOUBLE AND MULTIPLE BUSBAR SYSTEMS (WITH OR WITHOUT TRANSFER BUS).
OPERATING TIME	BASIC OPERATING TIME EXCLUDING RELAY TIME IS 15 – 20 mS.	DETECTS FAULTS WITH IN 1 –2 mS AND INITIATES TRIPPING WITH IN 5-7 mS.
STABILITY	INABILITY TO COPE WITH INCREASING FAULT CURRENT.	STABLE FOR INFINITE FAULT LEVEL.
PERFORMANCE	HIGHLY SENSITIVE FOR INTERNAL FAULTS AND COMPLETELY STABLE FOR EXTERNAL FAULTS.	HIGHLY SENSITIVE FOR INTERNAL FAULTS AND COMPLETELY STABLE FOR EXTERNAL FAULTS.
ADDITIONAL PROTECTION	THIS RELAY REQUIRES CHECK ZONE FEATURE. THE TRIP COMMAND IS ONLY GIVEN WHEN BOTH A DISCRIMINATING & CHECK ZONE SYSTEM OPERATES.	THIS RELAY HAS IN BUILT CHECK ZONE FEATURE (NO SEPARATE CHECKZONE FEATURE) i.e OVER CURRENT STARTING RELAY PROVIDED.

CHECK ZONE FEATURE

Mal-operation of BUSBAR Protection can result in wide spread system failure. It is therefore considered judicious to monitor its operation by some form of check relay.

In case of High Impedance Relay the setting calculations is quite high and some times low settings can be adopted. In this factor of safety is more. This may be possibility for mal-operation from design point of view. The provision of a check feature is therefore purely a measure against mal-operation caused by external agencies.

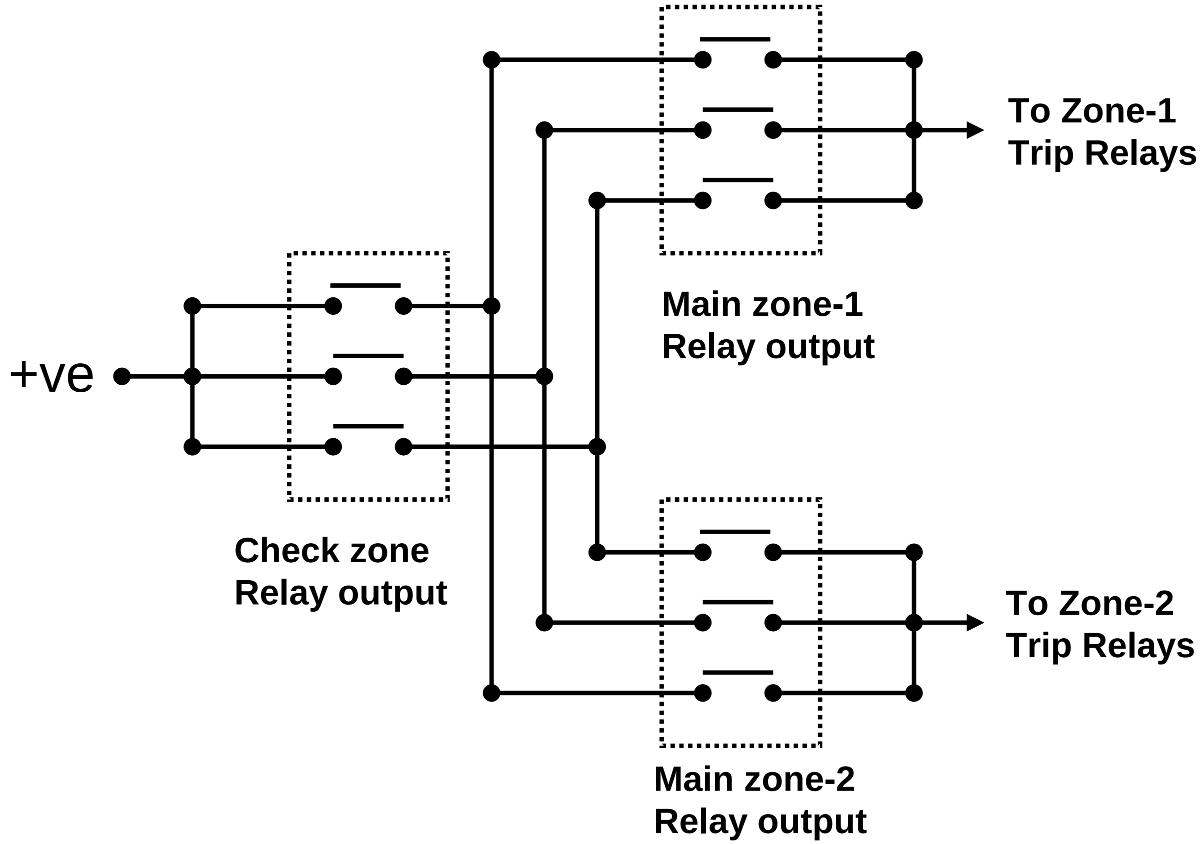
CHECK ZONE FEATURE

The ideal check feature should posses the following characteristics:

1. Check feature should be provided by a Relay which is physically different from the Main Relay.
2. It should pick-up for all types of faults that the Main Protection is capable of detecting.
3. The check feature should be at least as fast if not faster than Main Protection for given type of fault.
4. The source which feeds the Check Relay should be Physically Different from what feeds the Main Protection.
5. The Check feature should operate only for faults within the Main Zone/Zones of Protection and not for external faults.
6. A separate cores of CTs for Check Relay is added with the ratios same as for the Main Relay.
7. Check Relay can be connected irrespective of CT isolator selection in case of Double Bus, Triple Bus & Quad Bus for all circuits, this is called overall Check zone and in case Single Bus and 1-1/2 CB system same as Main Relay.

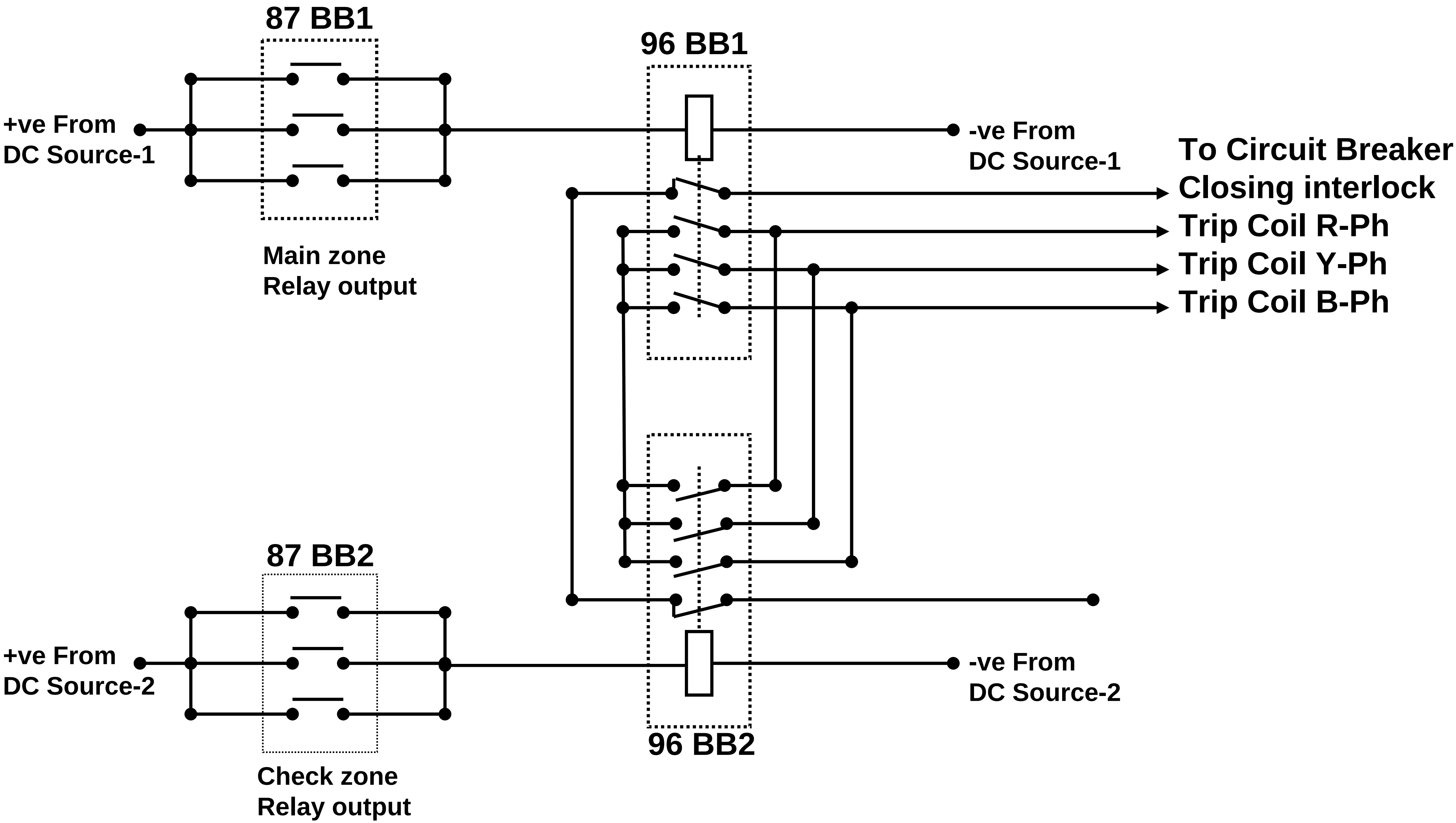
TRIPPING LOGIC

The TRIP command is only given when both a discriminating/Main Zone and Check-Zone system Operates.



TRIPPING LOGIC

incase of Single Bus System and One and Half Breaker system the output of Main Relay and Check Relay is transferring to Main Tripping Relays & check Tripping Relays respectively. The outputs of these Tripping Relays are parallel for Tripping and series incase of interlocks.



CBIP Guidelines on Protection

SPECIAL COMMENTS

i) DC Supply for Bus bar protection shall be independent from feeder.

ii) Faults between CB & CT shall be cleared from one side by opening of CB on Bus bar Protection Operation.

iii) However clearing of Fault from other side shall be through breaker failure protection.

iv) 3–ph trip relays shall be provided for each CB which shall also initiate LBB/BFR Protection.

v) in case of existing SS where CTs are different ratios, biased type differential protection/ Numerical Bus bar protection is recommended.

vi) Length of secondary leads should be kept as minimum as possible.

vii) Where lead runs are excessive, an increase in wire size or use of parallel conductors are meant to reduce lead resistance.

CBIP Guidelines on Protection

REQUIREMENTS

i. it shall be 3-ph type and operate selectively for each bus bar section.

ii. it shall operate on Differential Principle and provide independent zones of protection for each bus.

iii. it shall provide zone indication.

iv. it shall be stable for through fault conditions up to maximum 40KA fault level.

v. For applications where BUS Differential Protection sensitivity has to be set below load current, as may be a case with use of concrete structures, it is recommended that a separate check zone is provided, other wise separate check zone is not essential. Check zone, if provided, shall be of High Impedance type.

vi. it shall incorporate continuous supervision for CT secondary against any possible open circuits. In case of detection of open circuiting of CT secondary, after a time delay, the effected zone of protection shall be rendered inoperative and alarm initiated.

vii. it shall be include DC supply supervision.

viii. include adequate number of high speed tripping relays.

ix. whenever CT switching is involved the scheme shall include necessary CT switching relays and have provision for CT switching incomplete alarm.

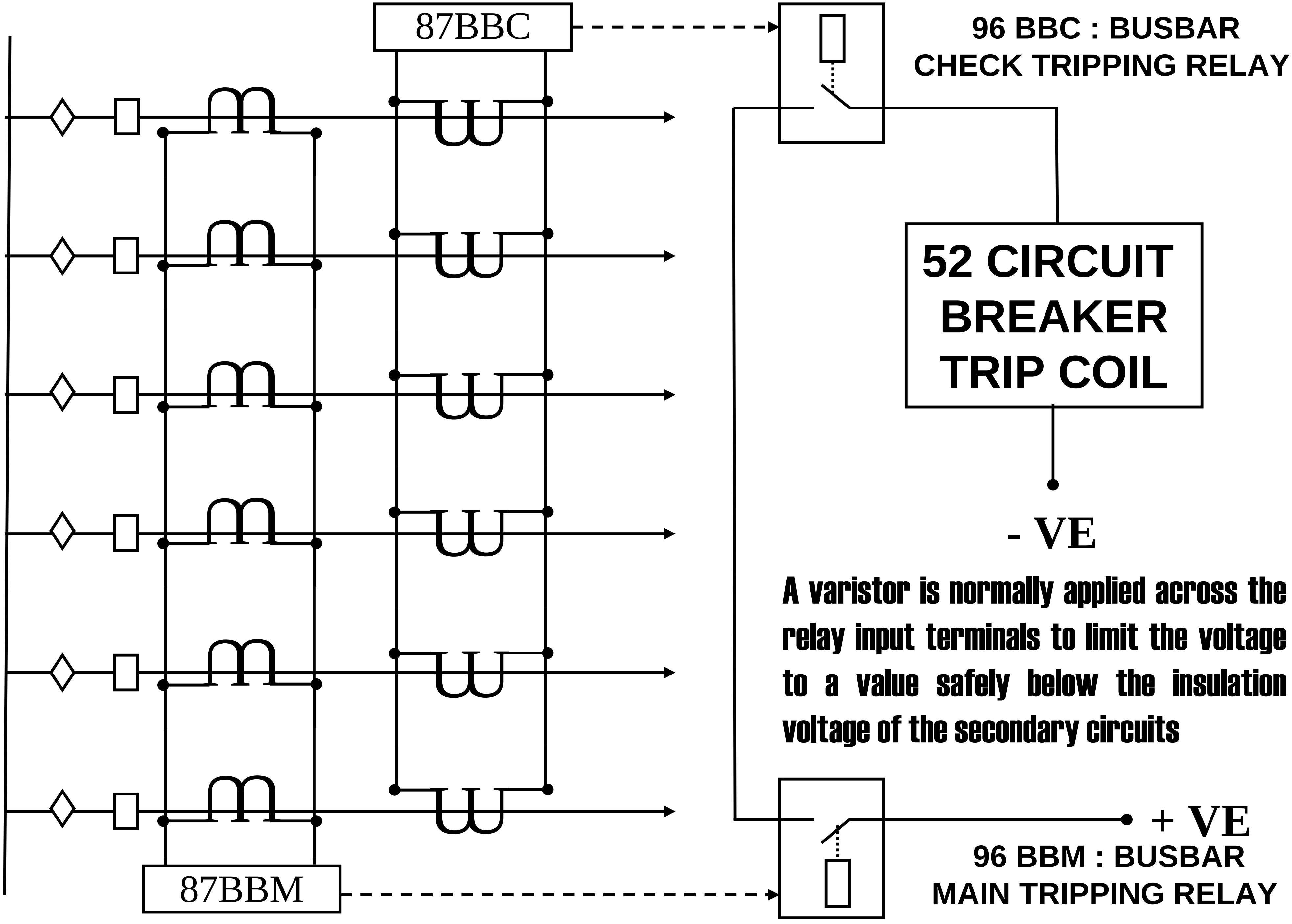
x. it shall be include IN/OUT switching facility for each zone..

CBIP Guidelines on Protection

SETTING CRITERIA

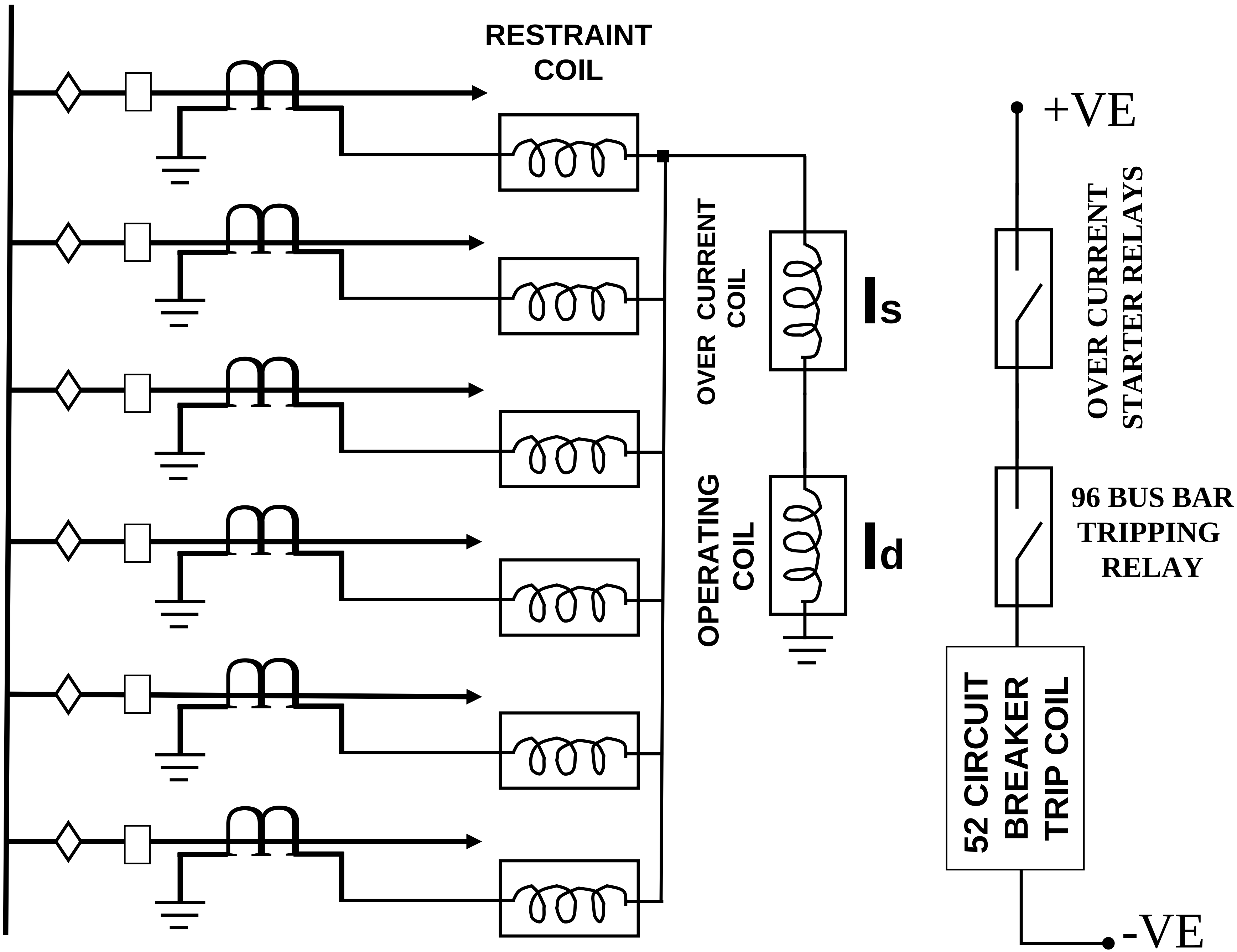
- C.T wire supervision relays should be set with a sensitivity such that they can detect C.T secondary open circuit even in case of least loaded feeder.
- BUSBAR Differential Protection should have overall sensitivity above heaviest loaded feeder current unless a separate check zone has been provided.
- In case where faults currents are expected to be low, the protection should be sensitive enough to take care of such expected low fault current.
- In case of voltage operated High Impedance type Protection, the voltage setting should be above expected voltage developed across the relay during maximum through fault current condition.
- In case of current operated relays for stability under through fault condition, external resistance is to be set such that voltage developed across relay and resistance combination is below the voltage required for forcing required relay operating current.

HIGH IMPEDENCE BUSBAR PROTECTION

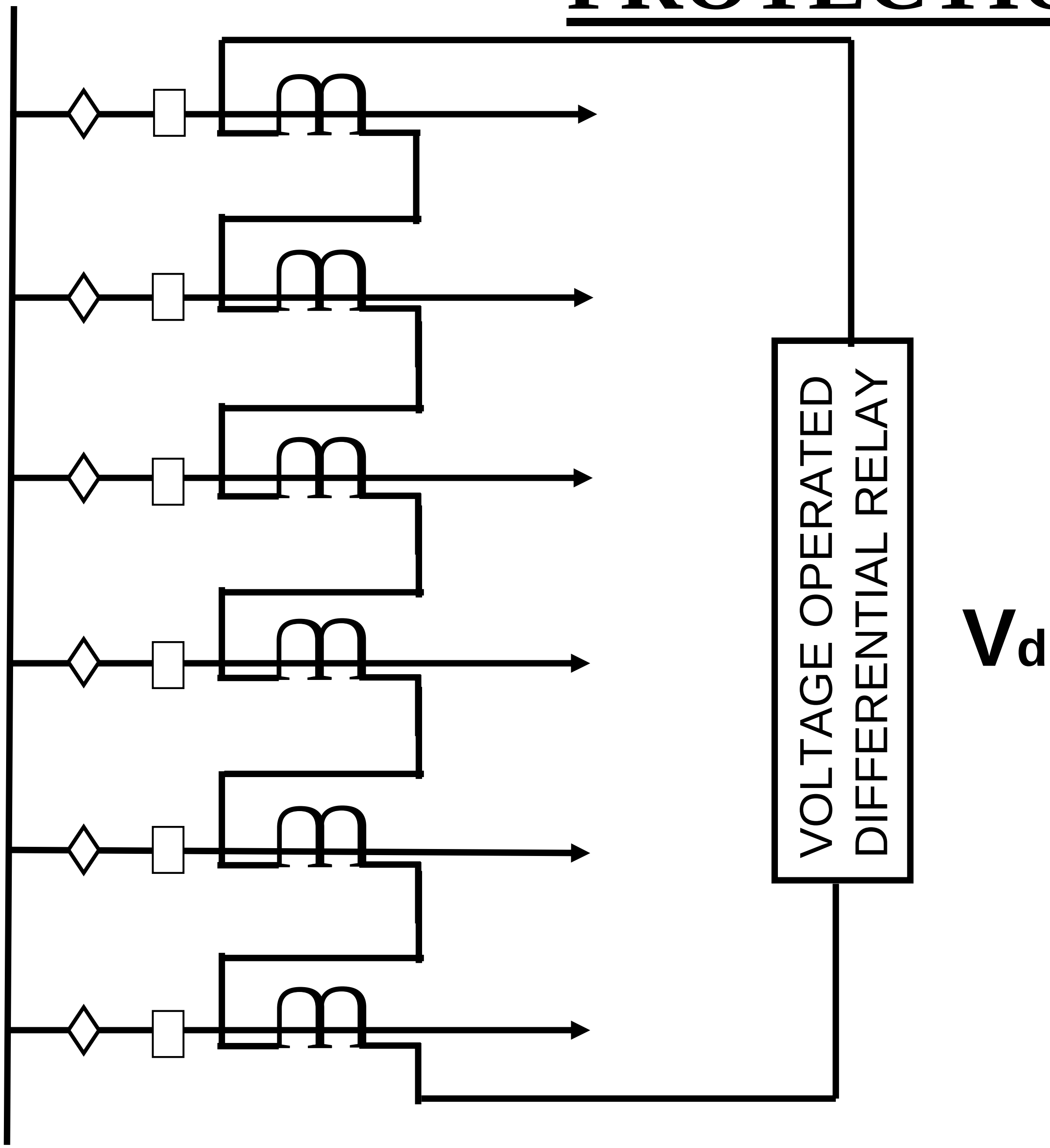


A varistor is normally applied across the relay input terminals to limit the voltage to a value safely below the insulation voltage of the secondary circuits

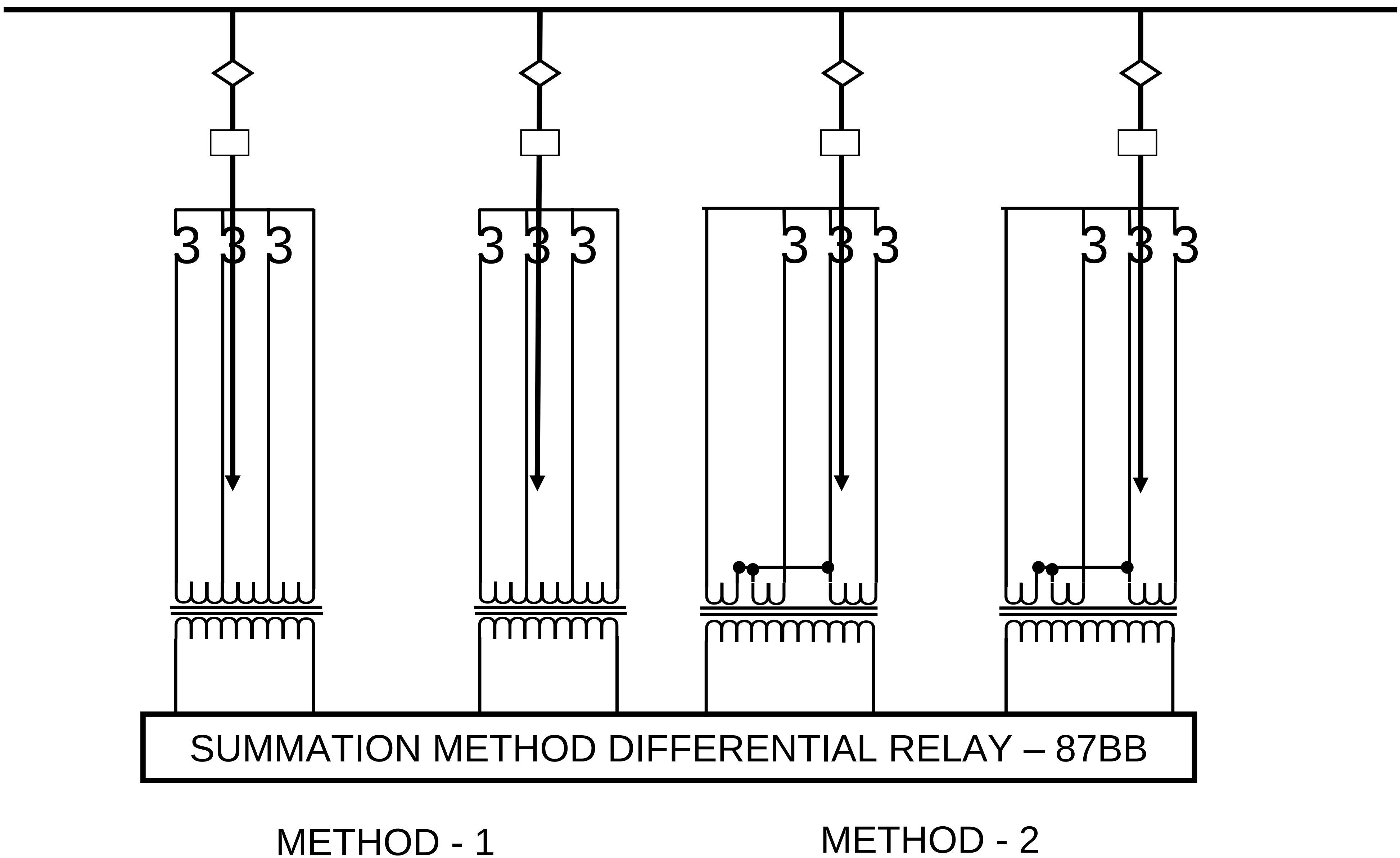
LOW IMPEDENCE BUSBAR PROTECTION



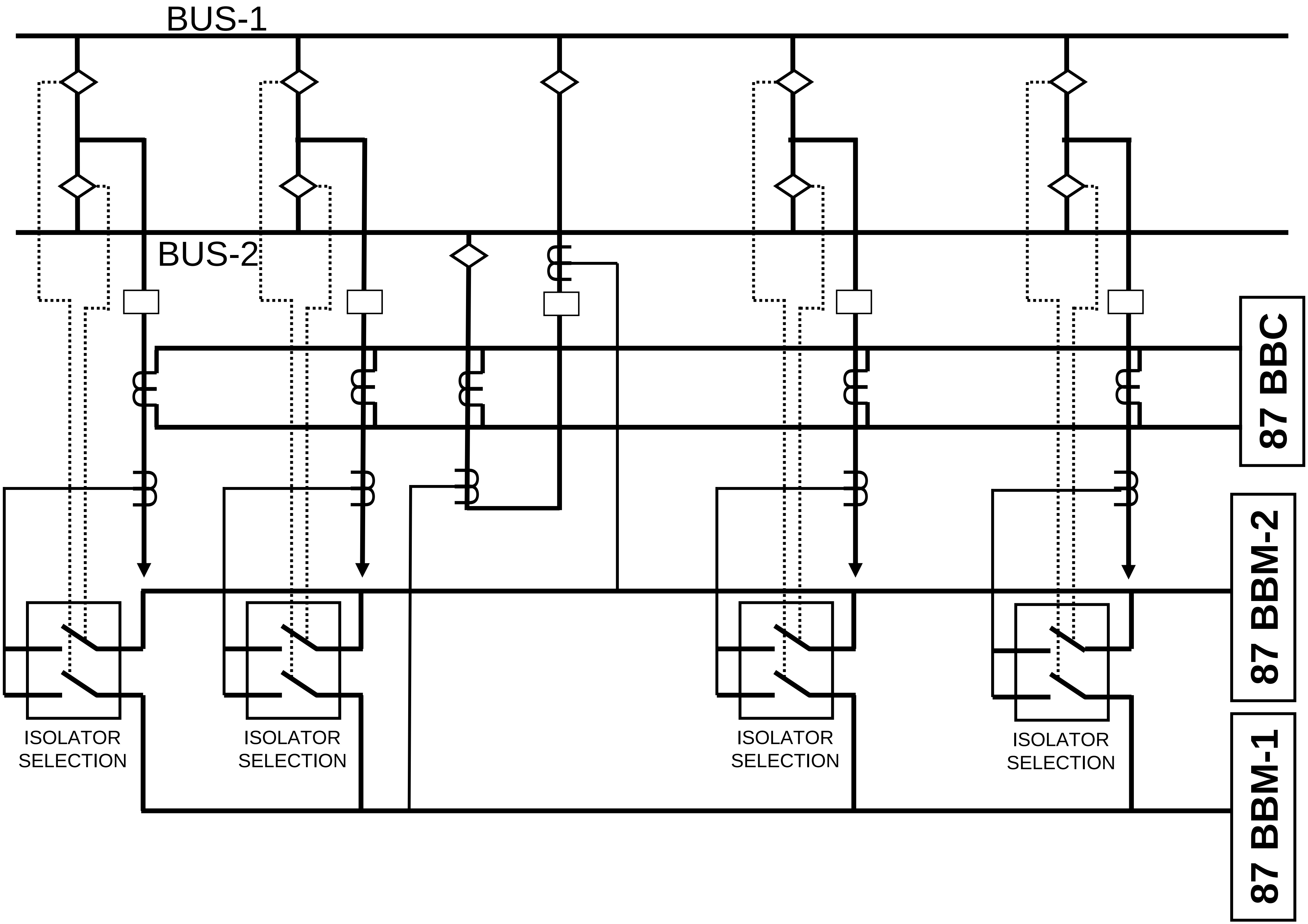
VOLTAGE-DIFFERENTIAL BUSBAR PROTECTION



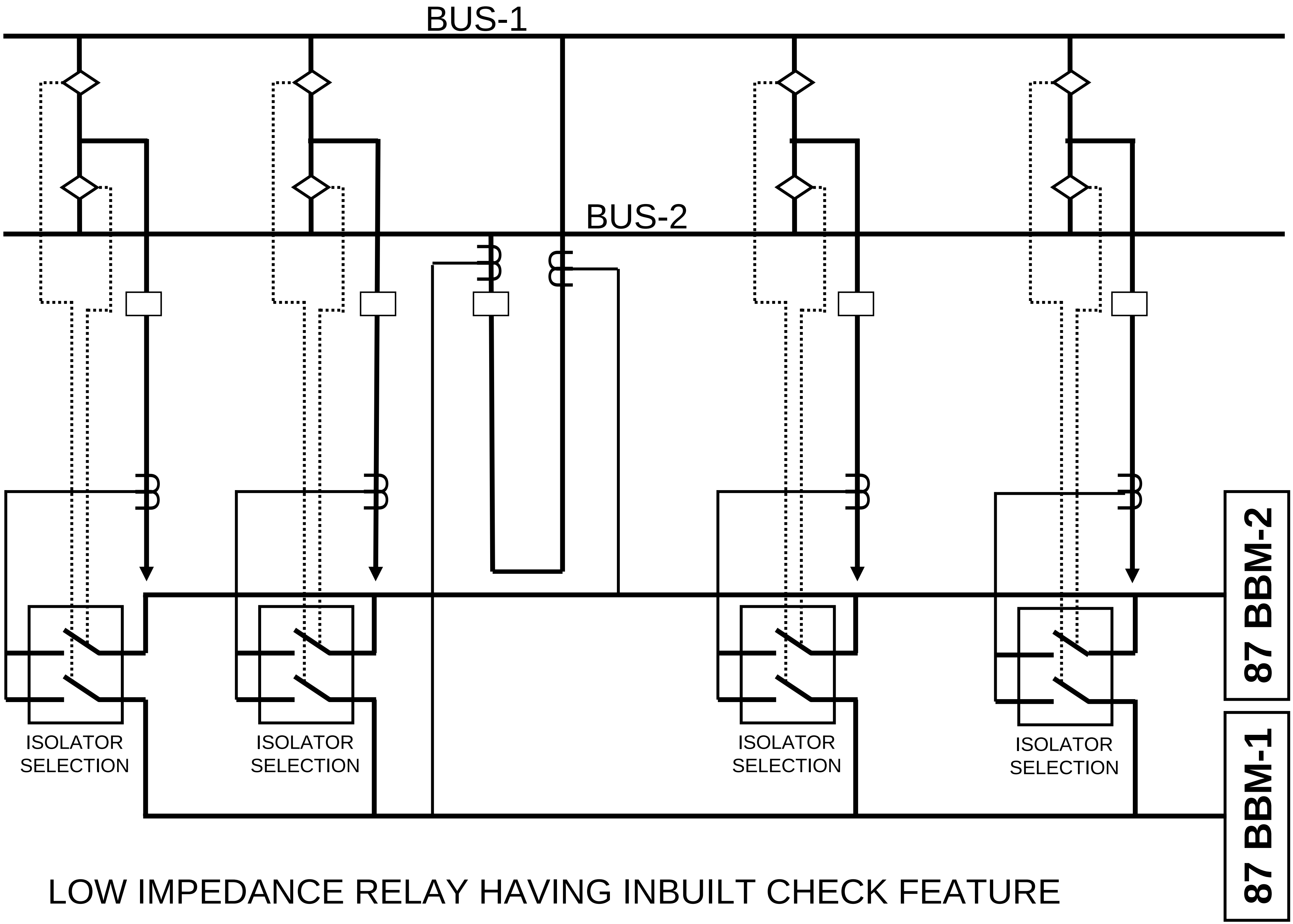
SUMMATION CT METHOD



DOUBLE BUS- HIGH IMPEDENCE

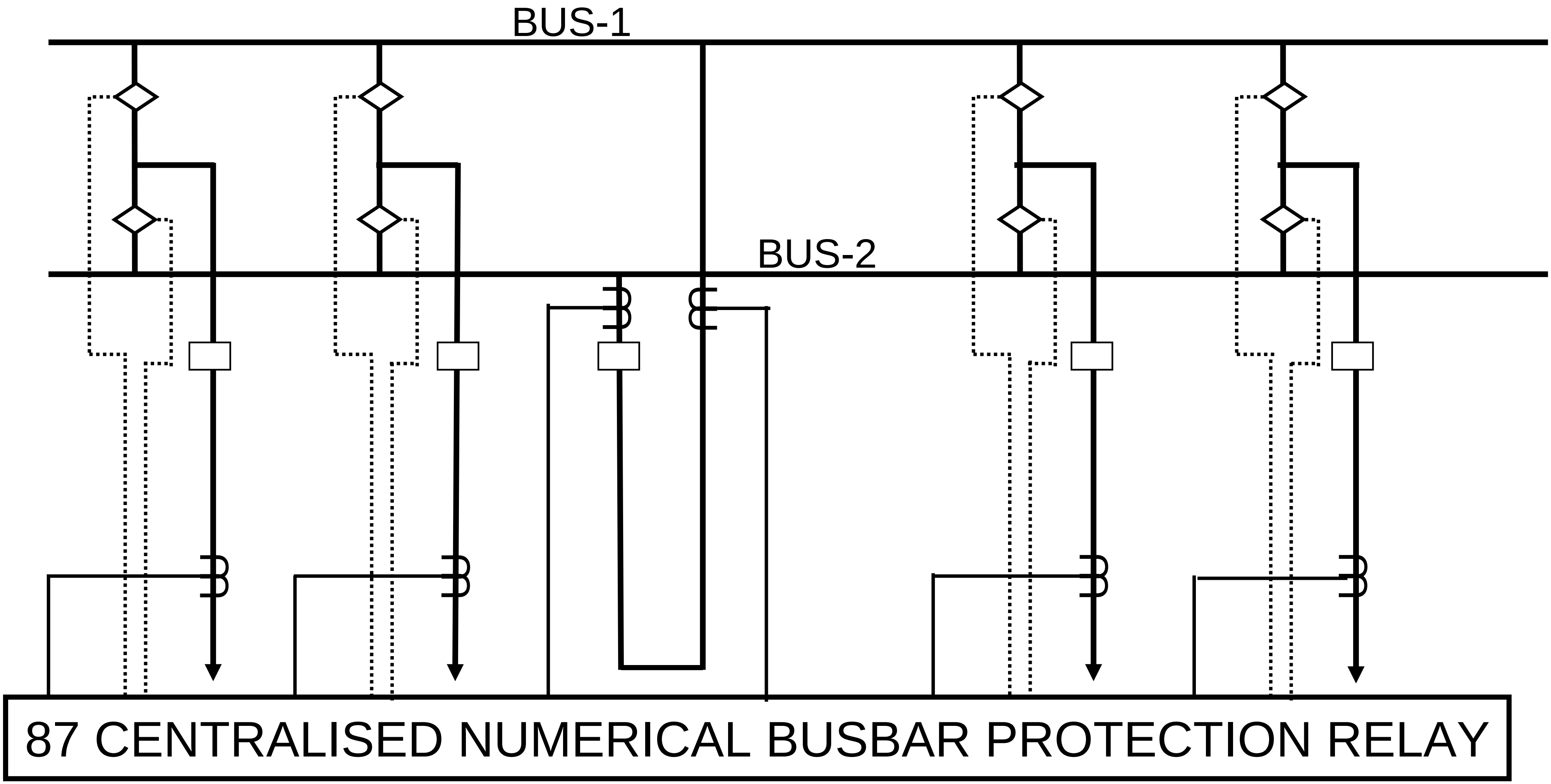


DOUBLE BUS- LOW IMPEDENCE



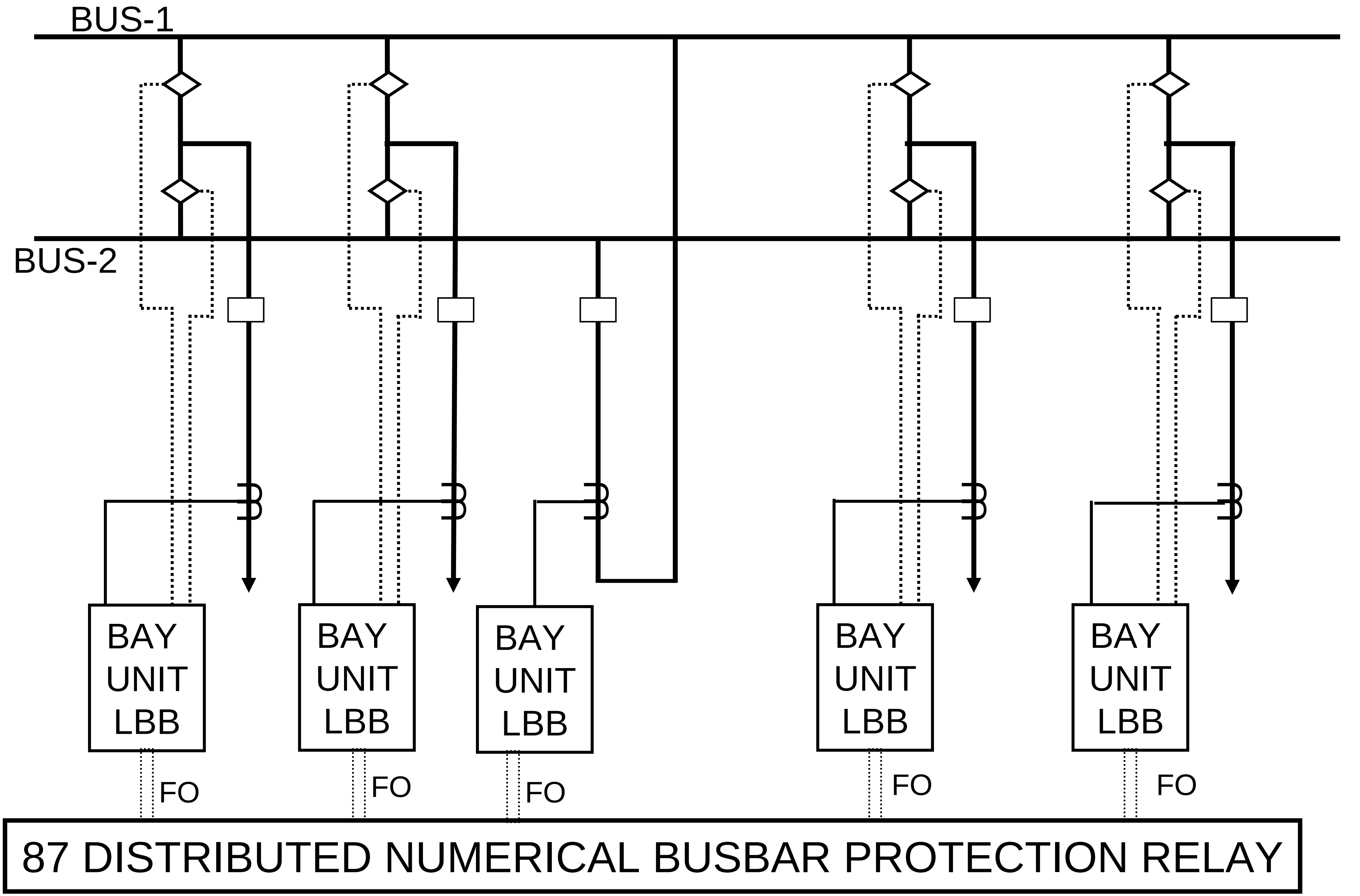
LOW IMPEDANCE RELAY HAVING INBUILT CHECK FEATURE

DOUBLE BUS- NUMERICAL CENTRALISED

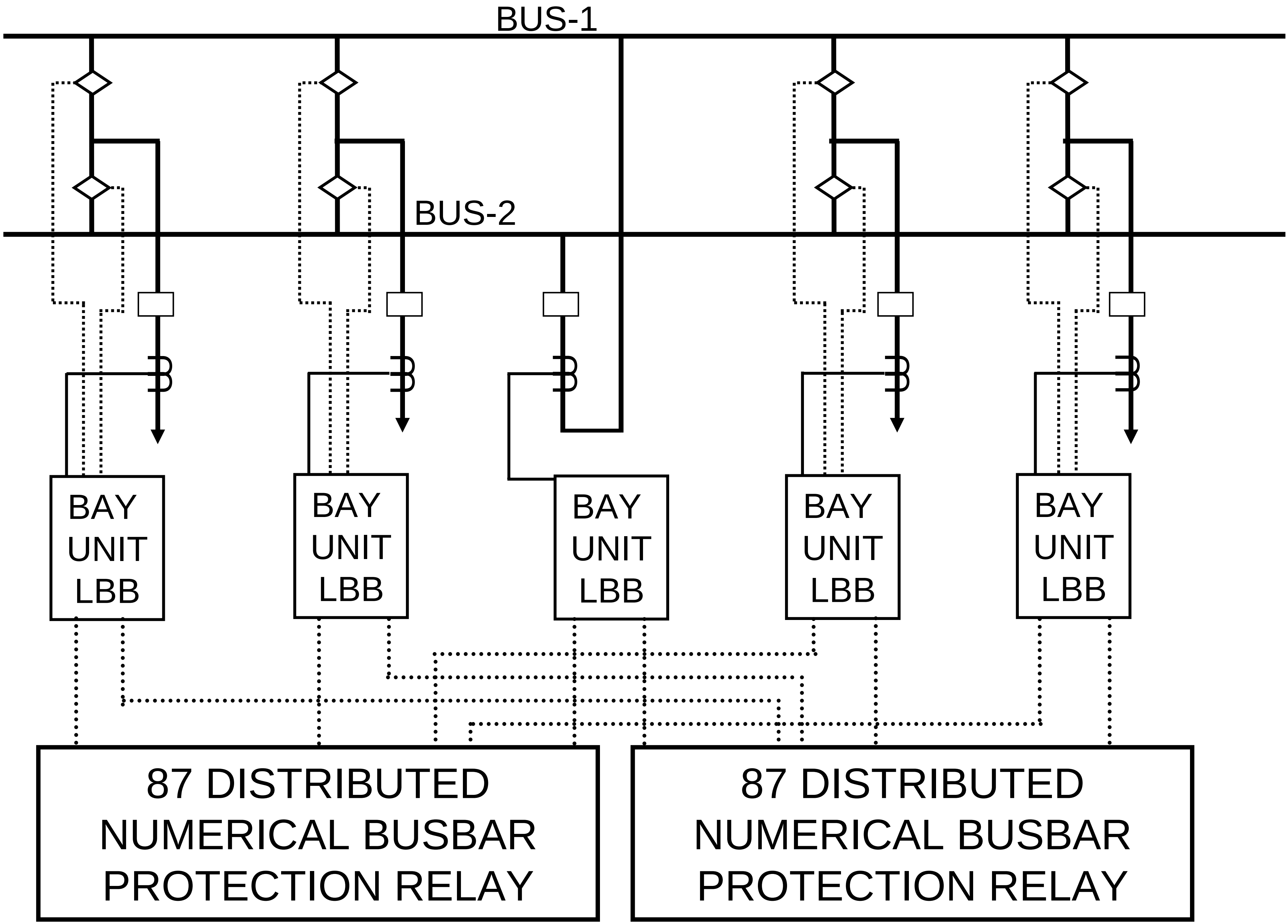


CENTRALISED NUMERICAL BUSBAR HAVING NUMERICAL ALGORITHAM FOR ISOLATOR SELECTION, ZONE SELECTION, OVER ALL DIFFERENTAIL PROTECTION AS CHECK ZONE, OVER CURRENT STARTER AS CHECK ZONE, CT SUPERVISION, CT OPEN CIRCUIT & CT SATURATION ETC FEATURES ARE INBUILT.

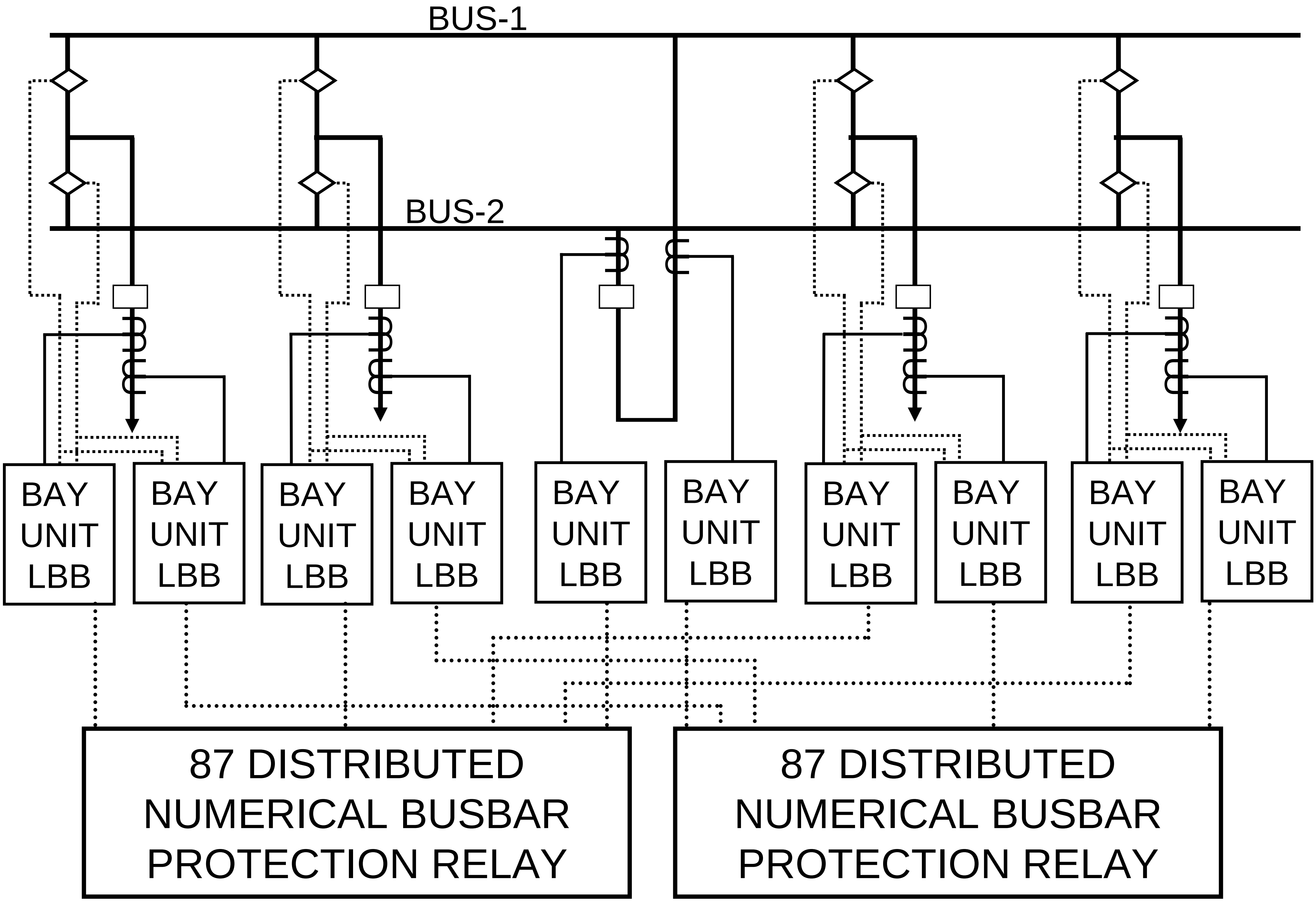
DOUBLE BUS- NUMERICAL DISTRIBUTED



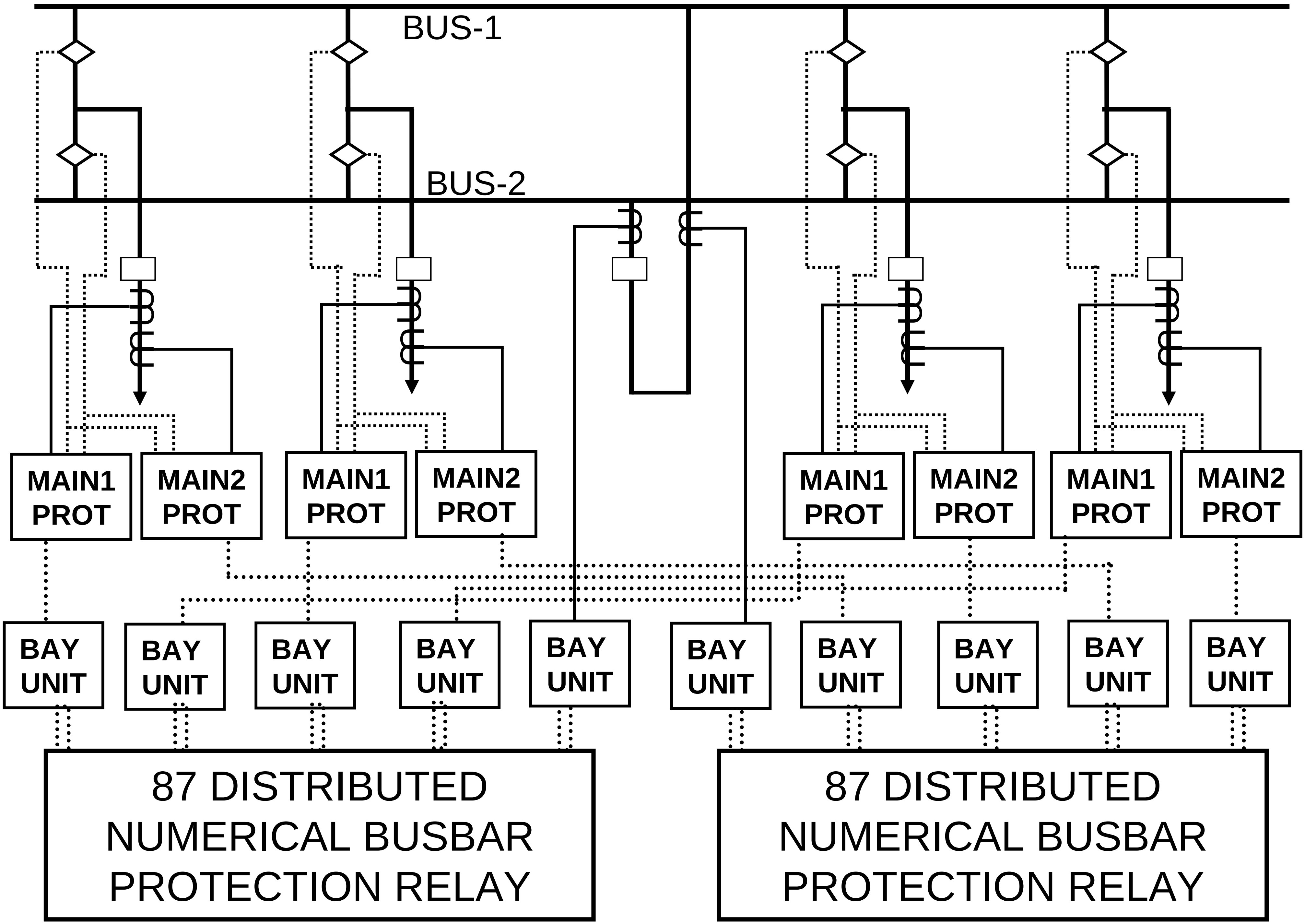
DOUBLE BUS- DUPLICATE PROTECTION



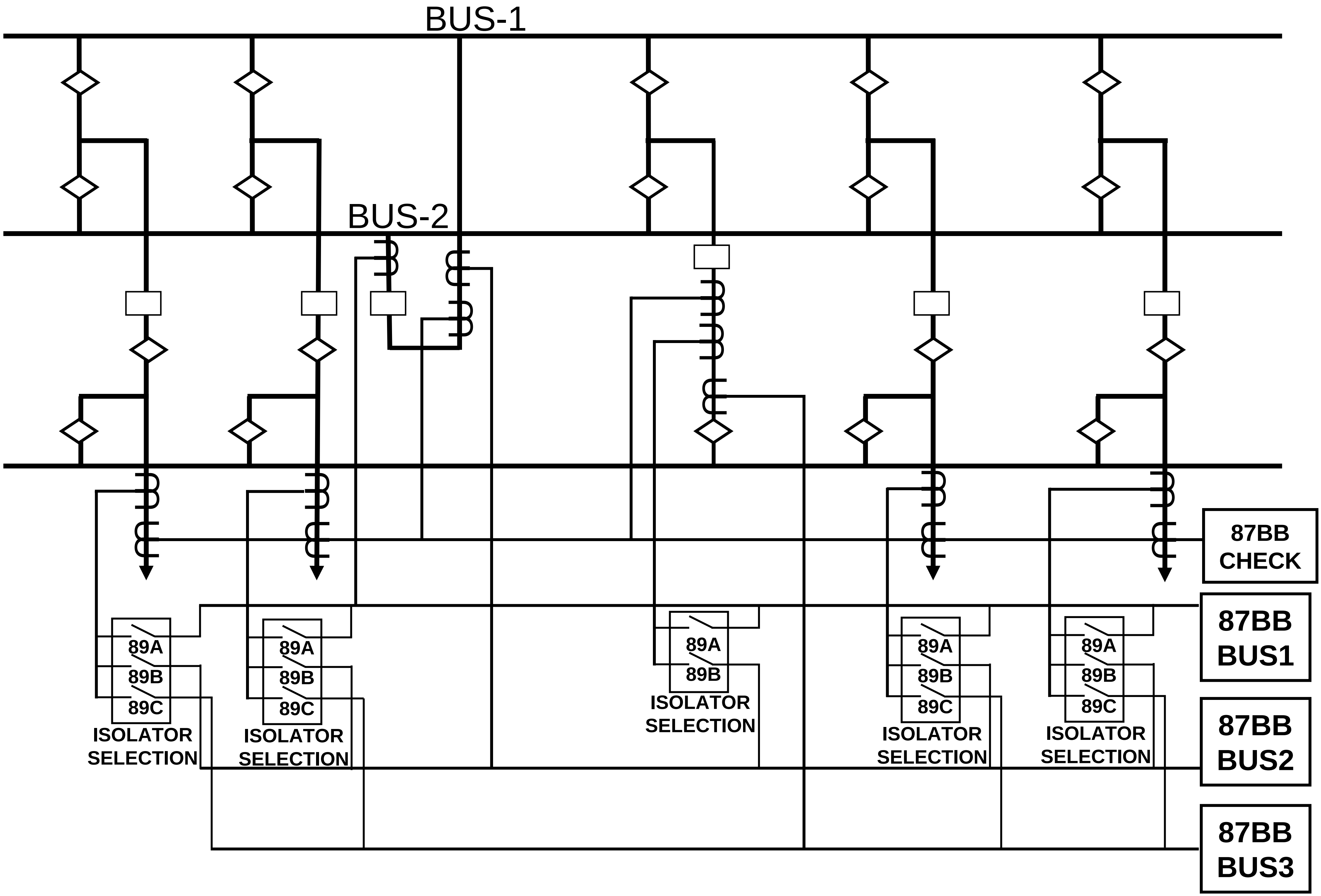
DOUBLE BUS- DUPLICATE PROTECTION



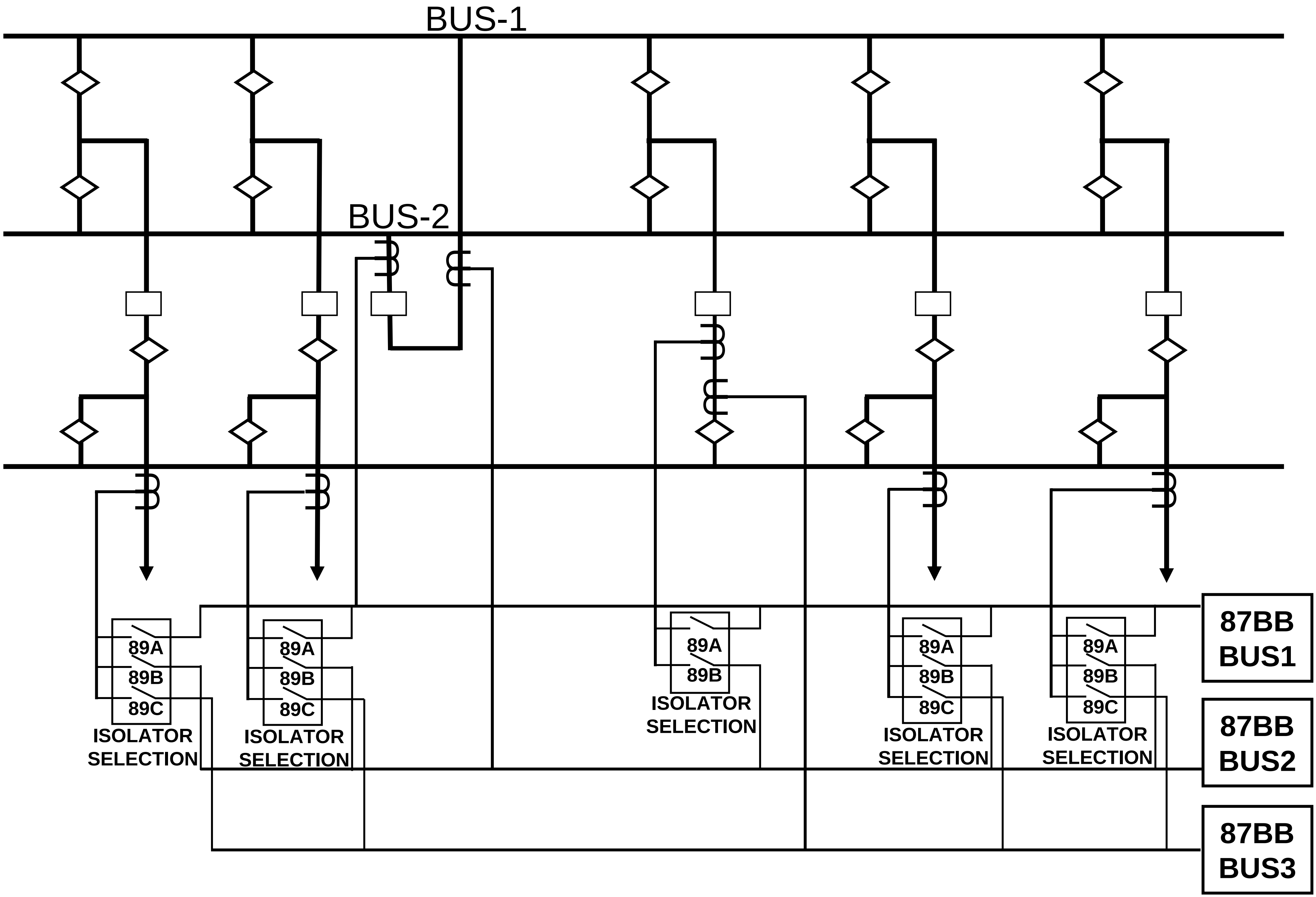
DOUBLE BUS- DUPLICATE PROTECTION



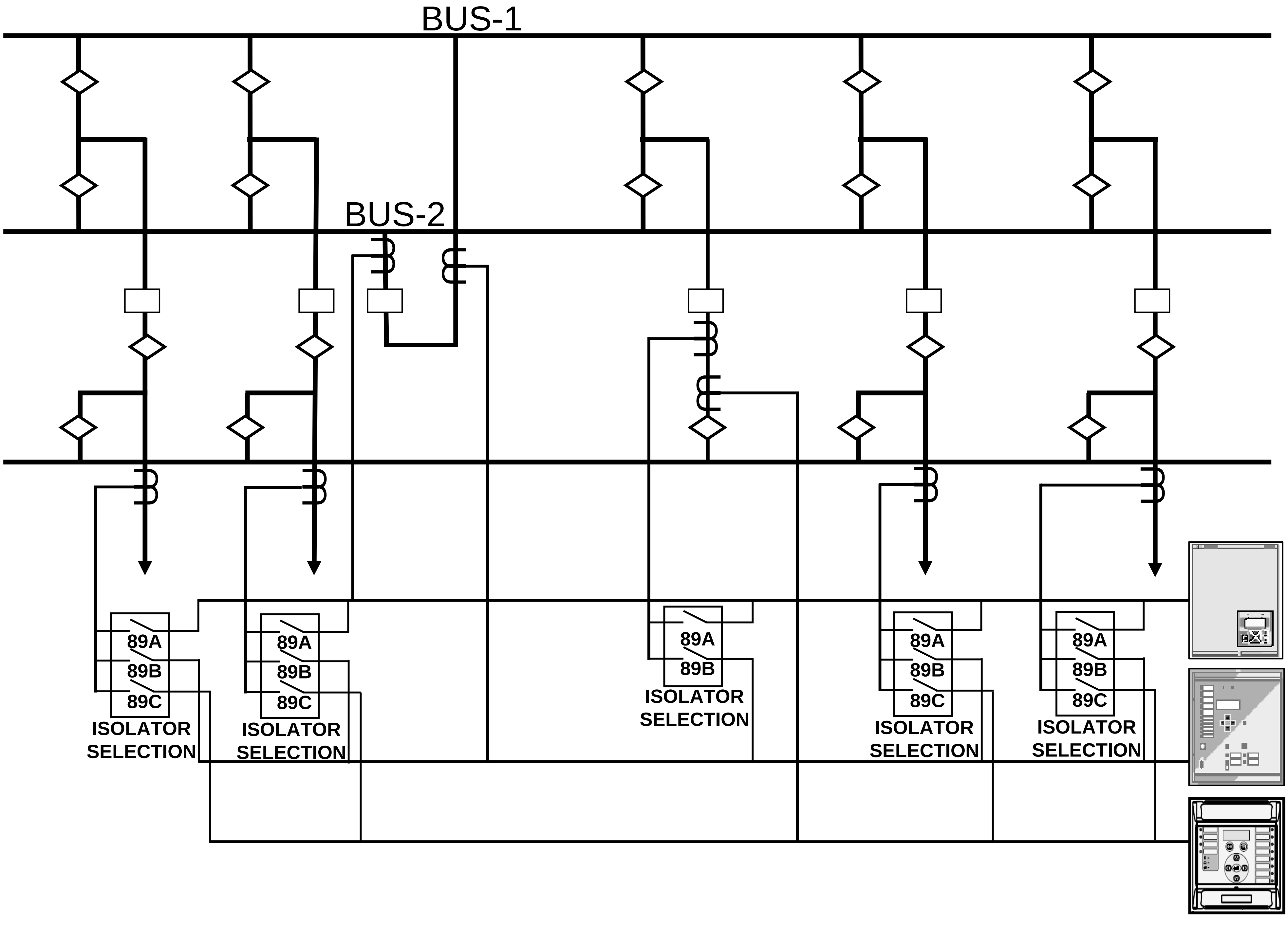
DOUBLE BUS WITH TB- HIGH IMPEDENCE



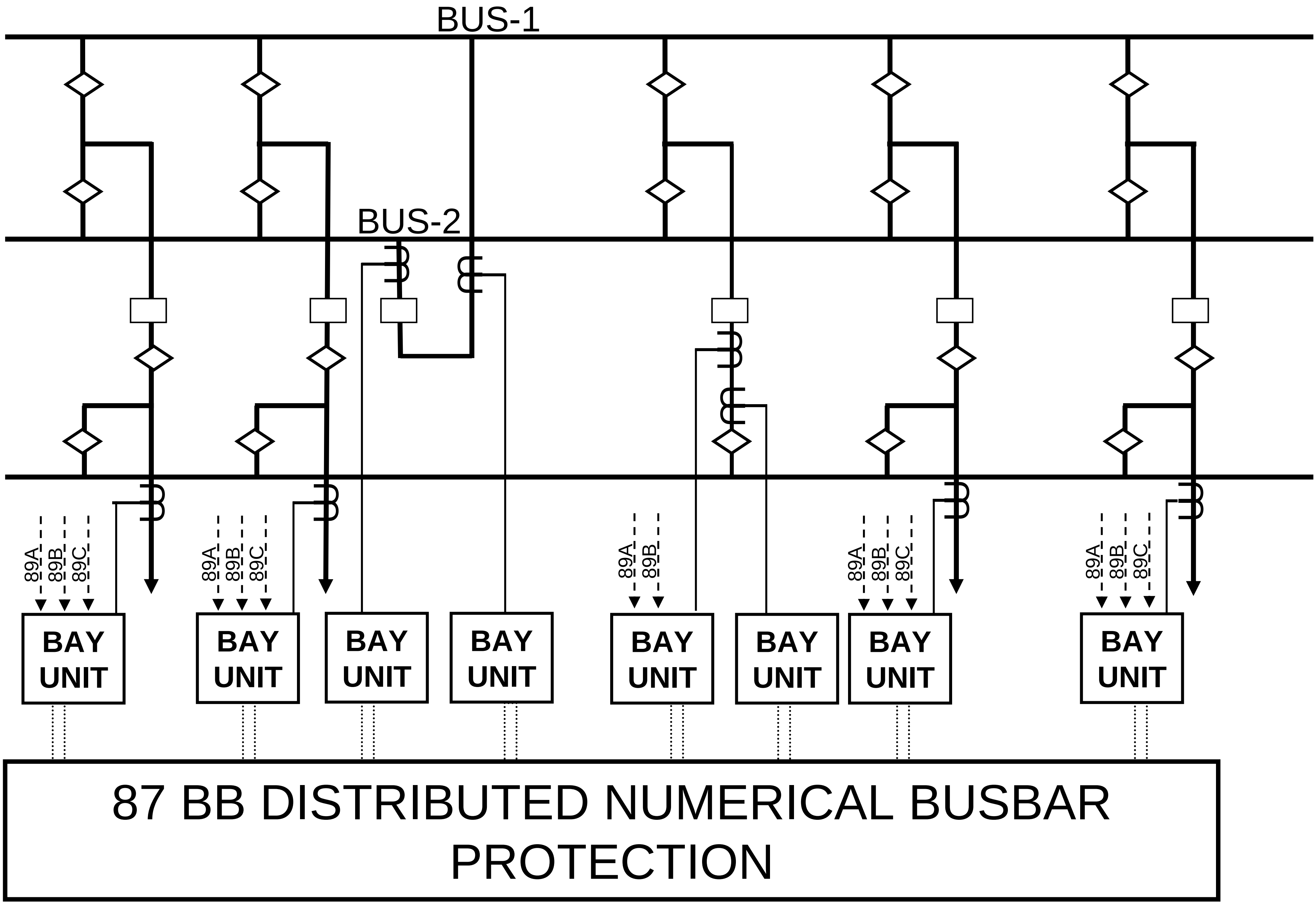
DOUBLE BUS WITH TB- LOW IMPEDENCE



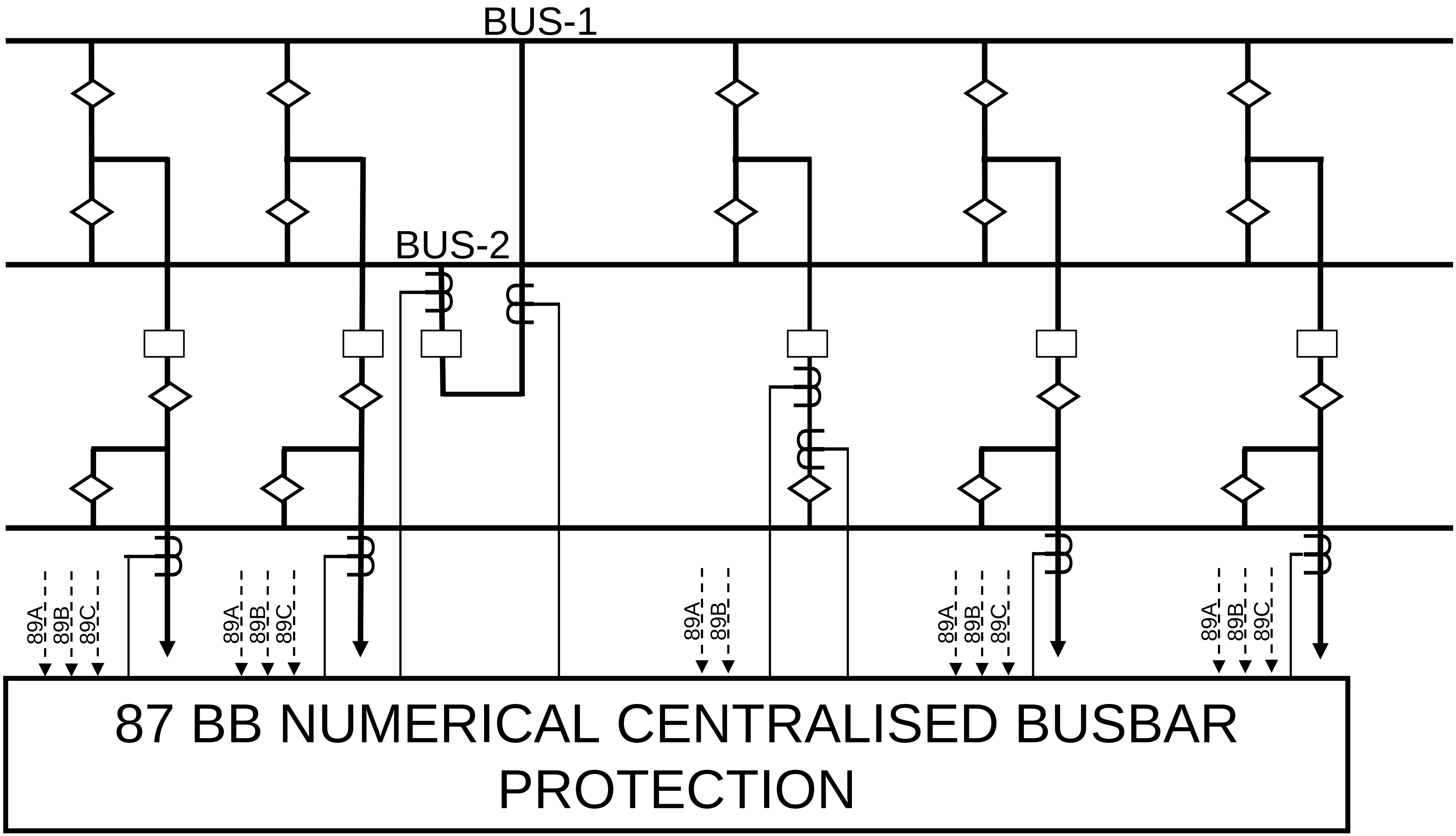
DOUBLE BUS WITH TB- NUMERIC(1)



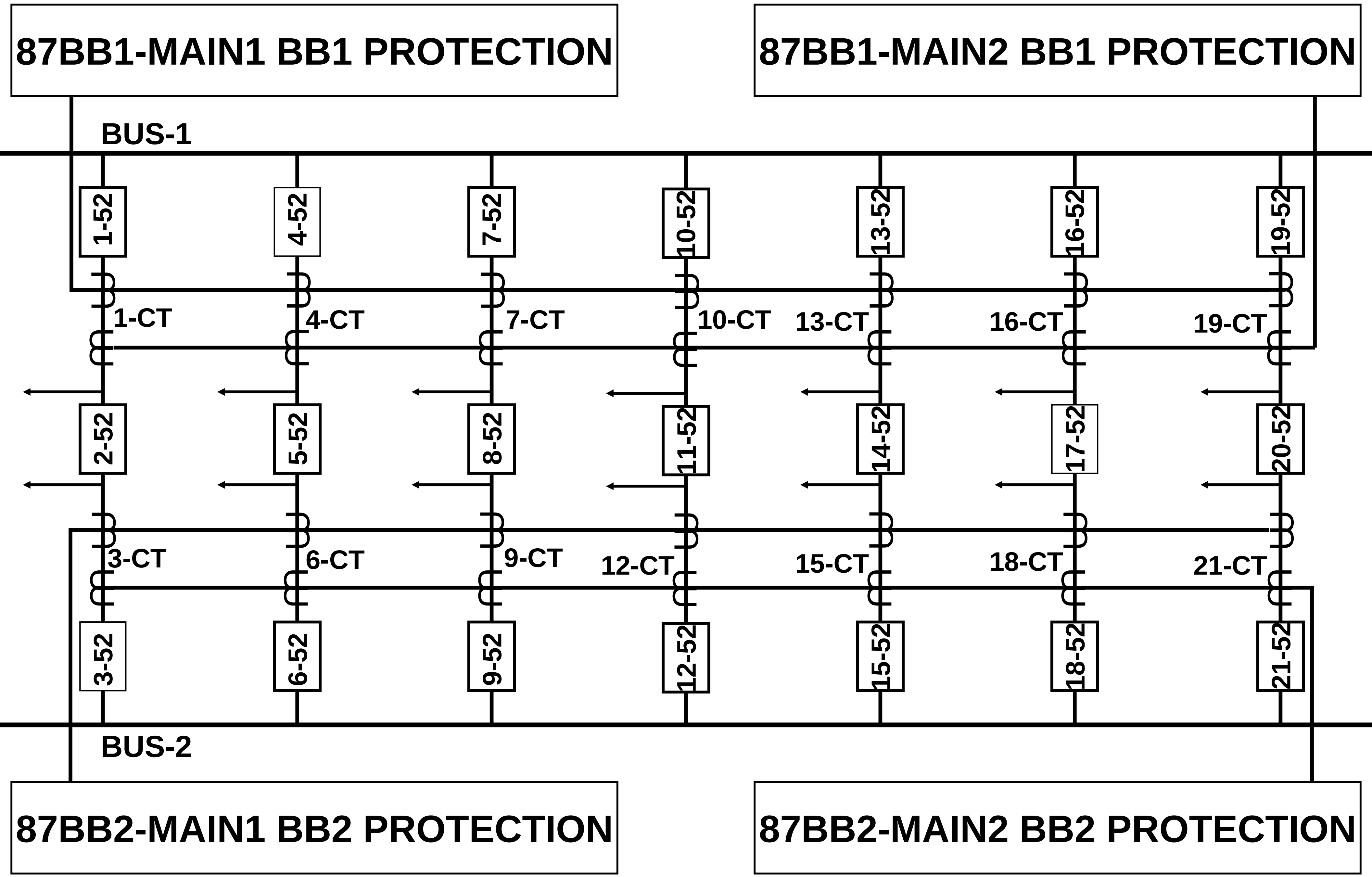
DOUBLE BUS WITH TB- NUMERIC(2)



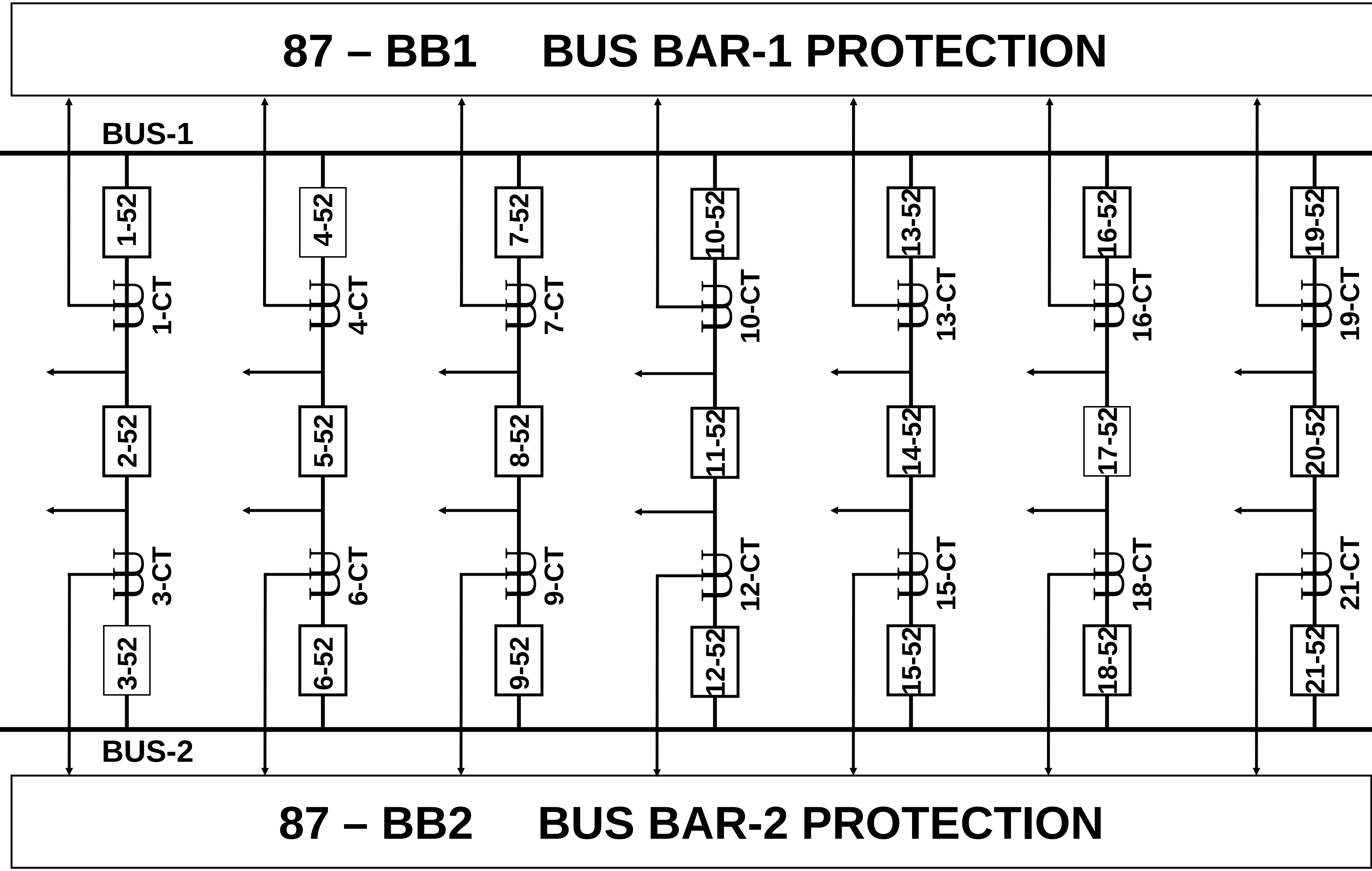
DOUBLE BUS WITH TB- NUMERIC(3)



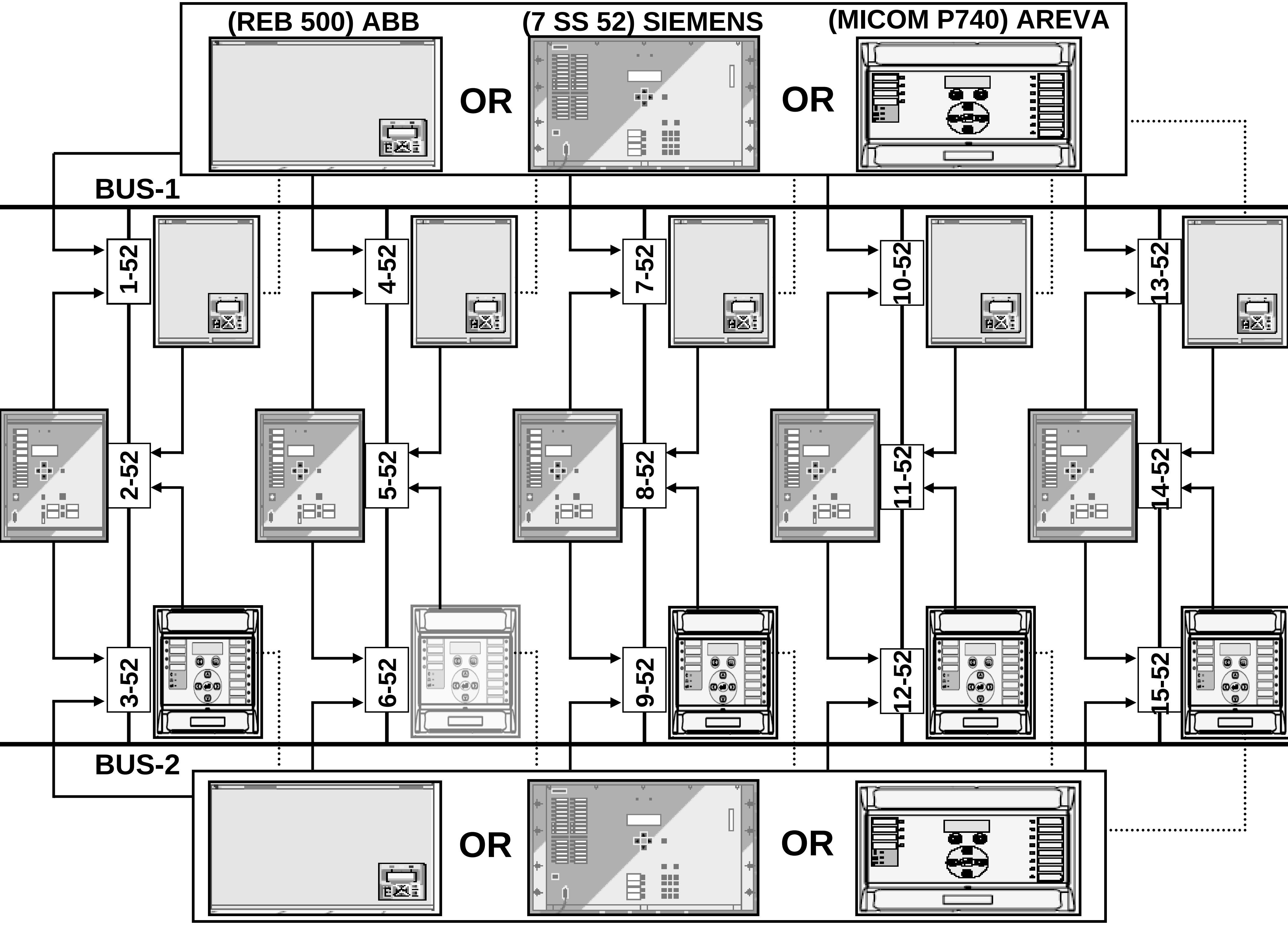
ONE AND HALF CB SYSTEM – HIGH IMPEDANCE



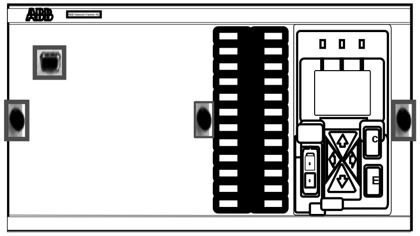
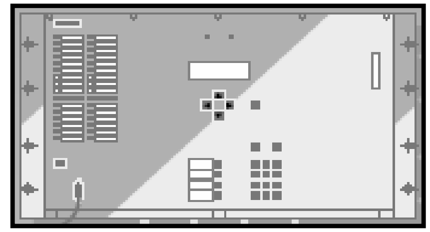
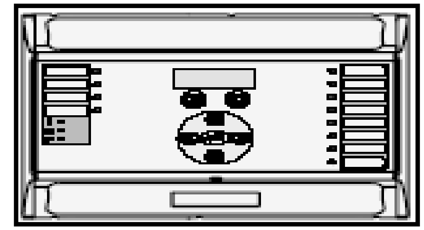
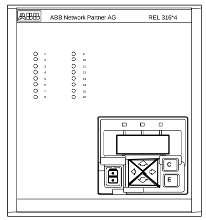
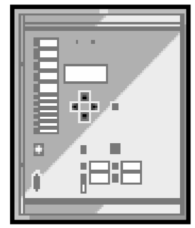
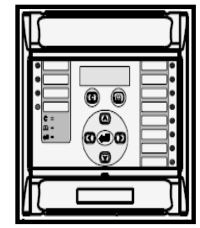
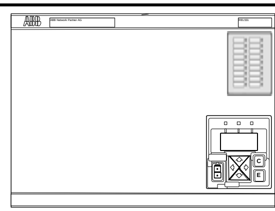
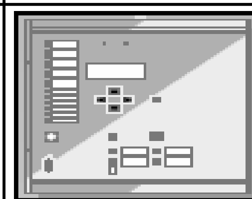
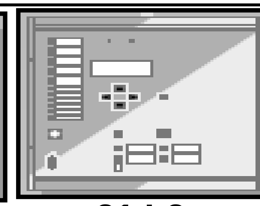
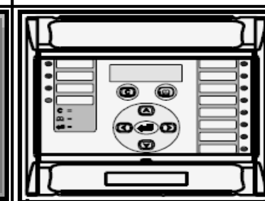
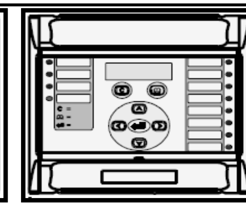
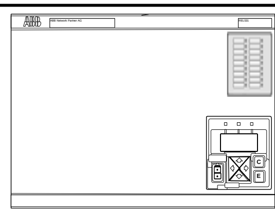
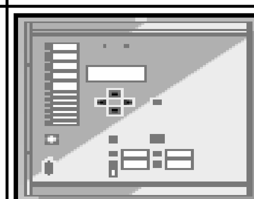
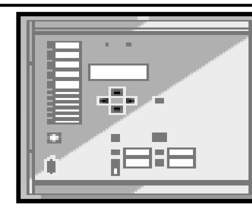
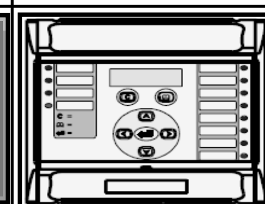
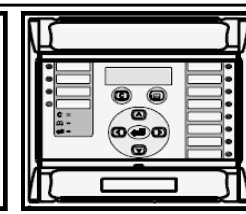
ONE AND HALF CB SYSTEM – LOW IMPEDANCE



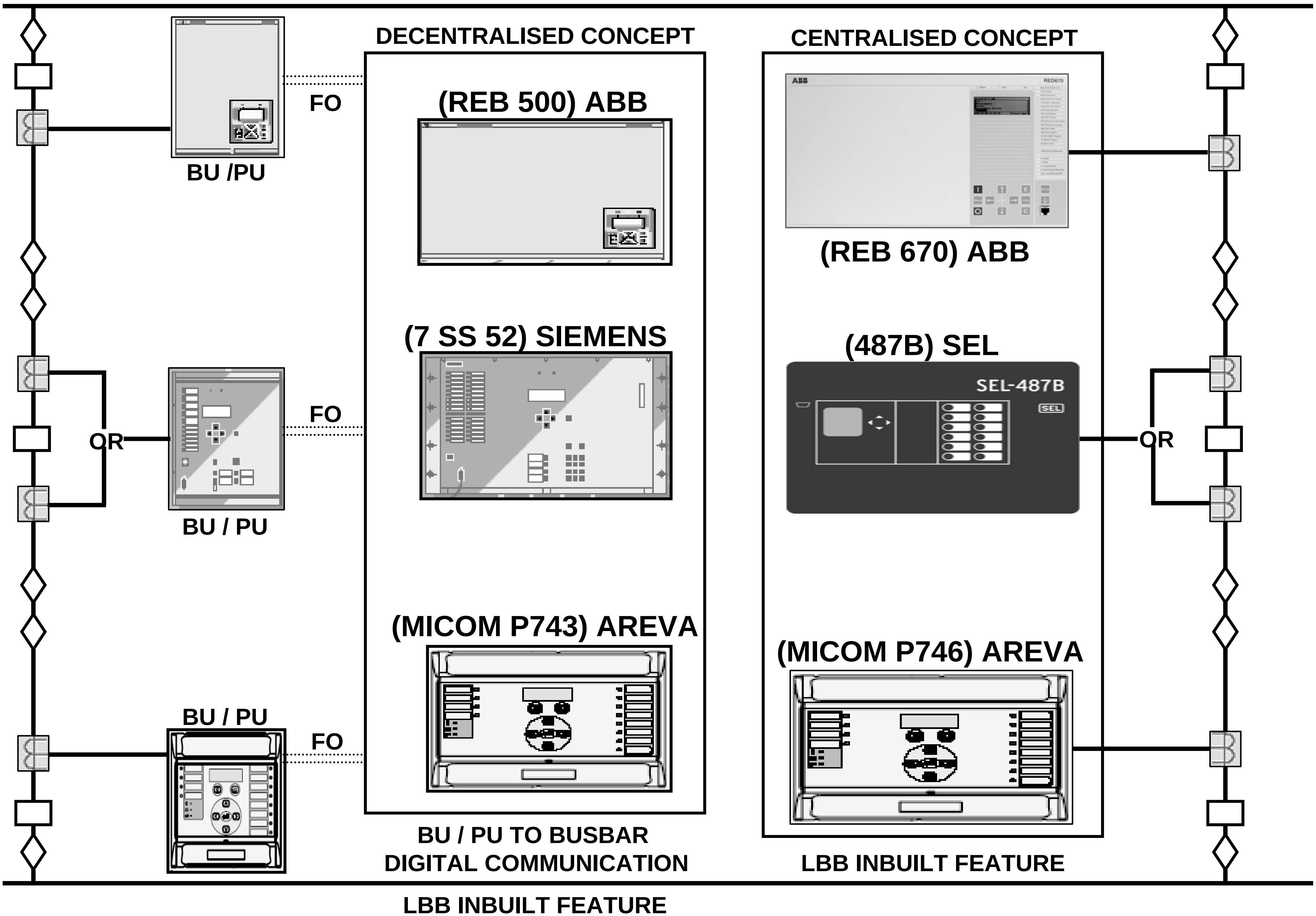
DISTRIBUTED LBB & NUMERICAL CENTRALISED BUS BAR PROTECTION



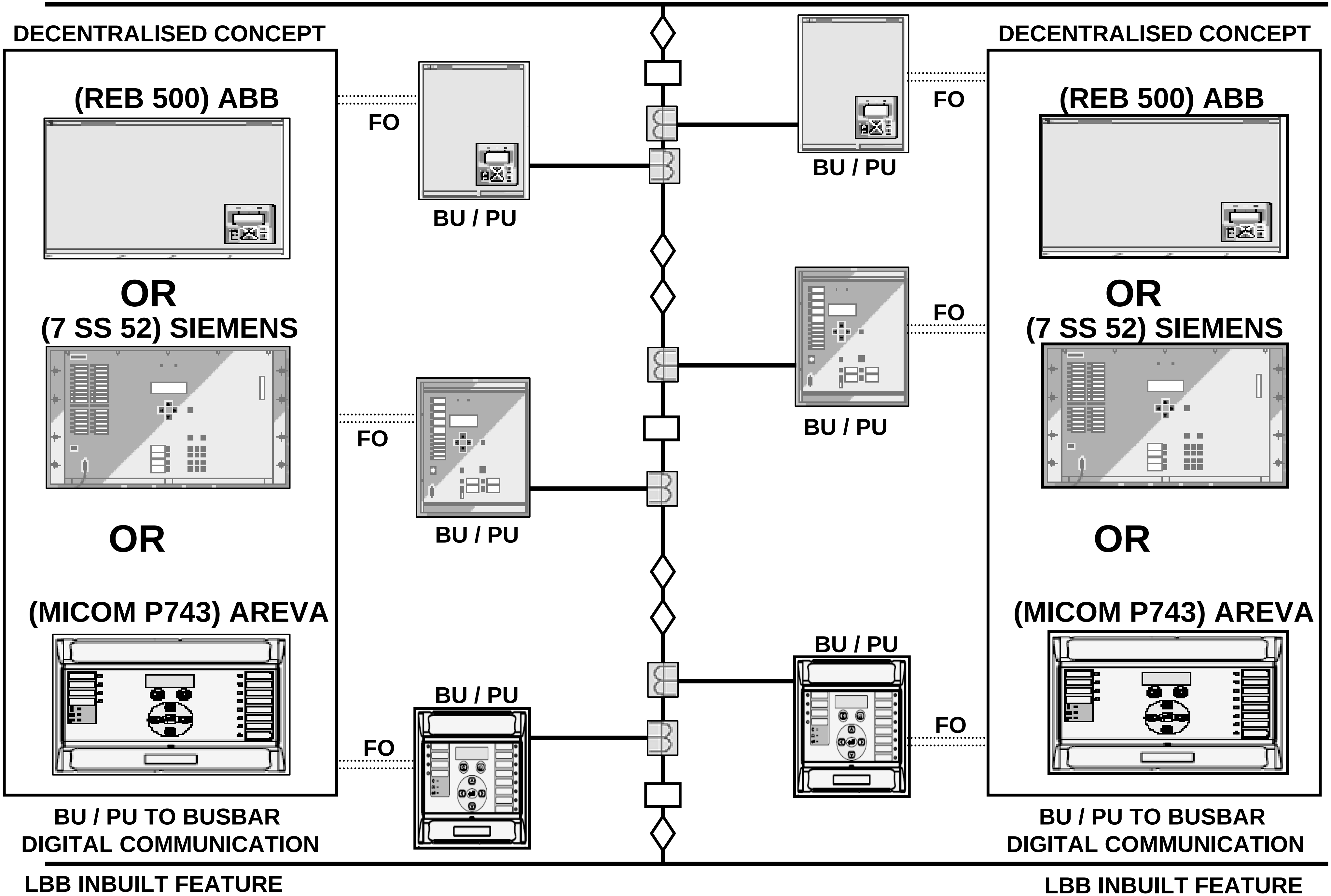
LATEST DEVELOPMENT IN NUMERICAL CENTRALISED BUS BAR PROTECTION

	ABB	SIEMENS	AREVA
BUSBAR PROTECTION CENTRAL UNIT			
BAY UNIT			
LINE PROTECTION	  21 L1 21 L2	  21 L1 21 L2	  21 L1 21 L2
TRANSFORMER PROTECTION	  87 T1 87 T2	  87 T1 64 T2	  87 T1 64 T2
DESCRIPTION	1. IN THIS NO SEPARATE CORE IS REQUIRED FOR EITHER BUSBAR PROTECTION OR LBB / BFR. 2. CENTRALISED BUSBAR IS CONNECTED FROM BAY UNIT OR LBB OR BFR THROUGH FIBRE OPTIC. 3. BAY UNIT / BFR / LBB IS CONNECTED FROM MAIN-1 & MAIN-2 OF LINE PROTECTION <u>OR</u> MAIN & BACKUP PROTECTION OF TRANSFORMER THROUGH FIBRE OPTIC FOR REDUNDANCY TO BAY UNIT. 4. THE CURRENT DATA IS TRANSFERED TO BAY UNIT TO BUSBAR CENTRAL UNIT FROM LINE / TRANSFORMER PROTECTIONS FOR NUMIRICAL ALGORITHAM OF LBB & BUSBAR CENTRAL UNIT AND IT WILL OPERATE FOR INTERNAL FAULTS AND DOES NOT OPERATE FOR THROUGH / EXTERNAL FAULTS.		

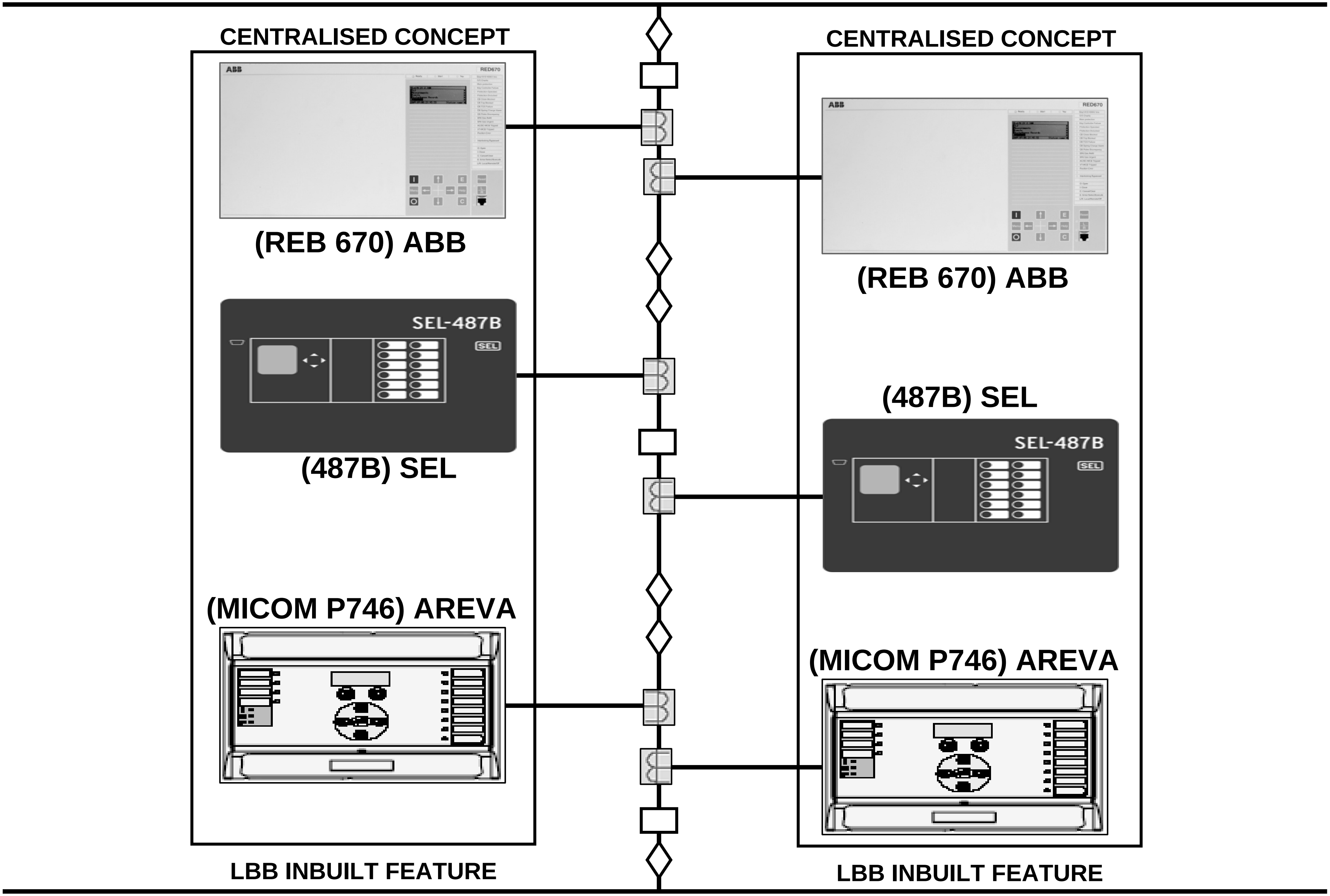
NUMERICAL BUSBAR SCHEME INCL LBB/BFR/CBF (DECENTRALISED & CENTRALISED ARCHITECTURE)



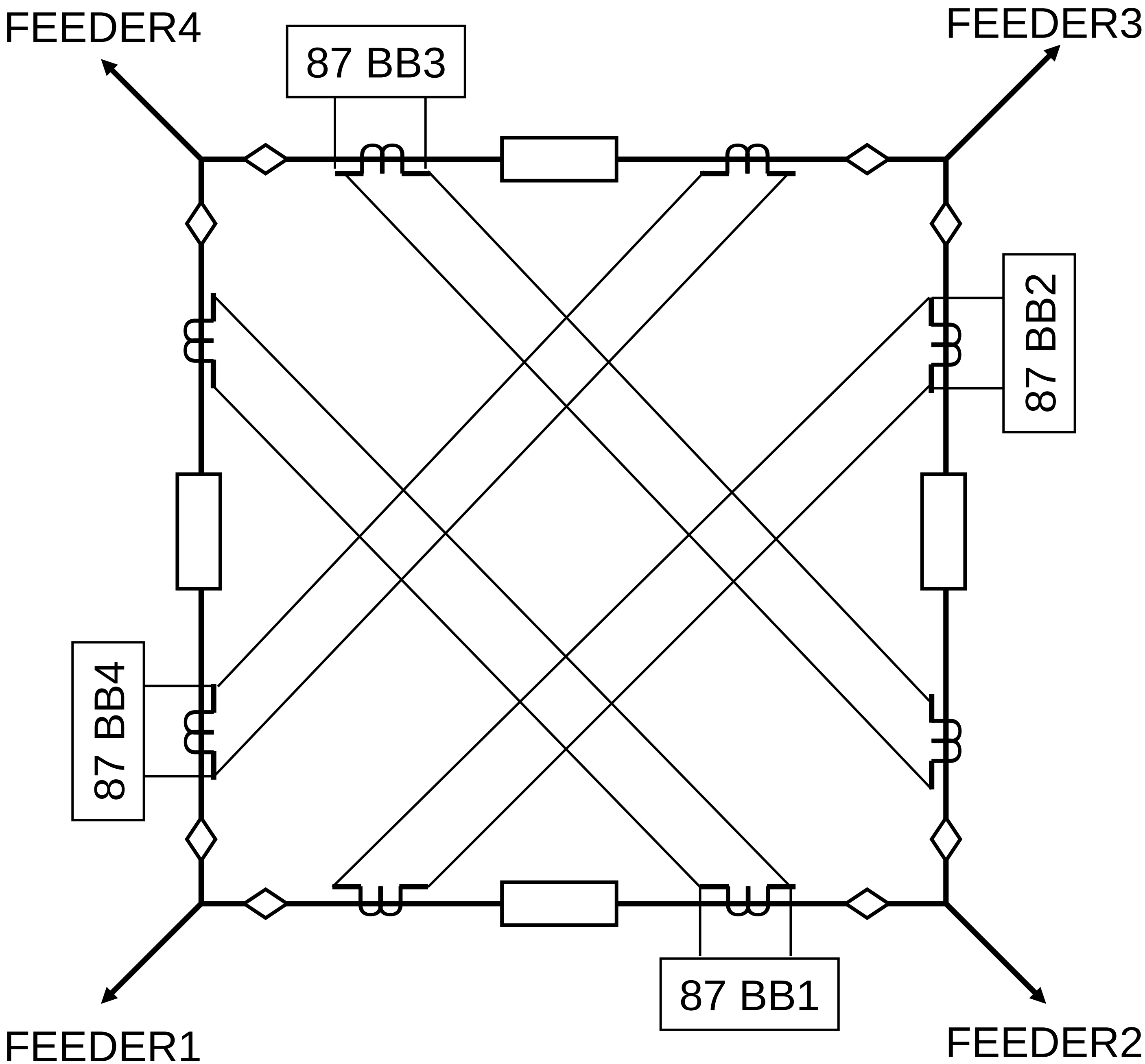
NUMERICAL BUSBAR SCHEME INCL LBB/BFR/CBF (DECENTRALISED CONCEPT- DUPLICATE)



NUMERICAL BUSBAR SCHEME INCL LBB/BFR/CBF
(CENTRALISED CONCEPT - DUPLICATE)



PROTECTION OF RING BUS SYSTEM

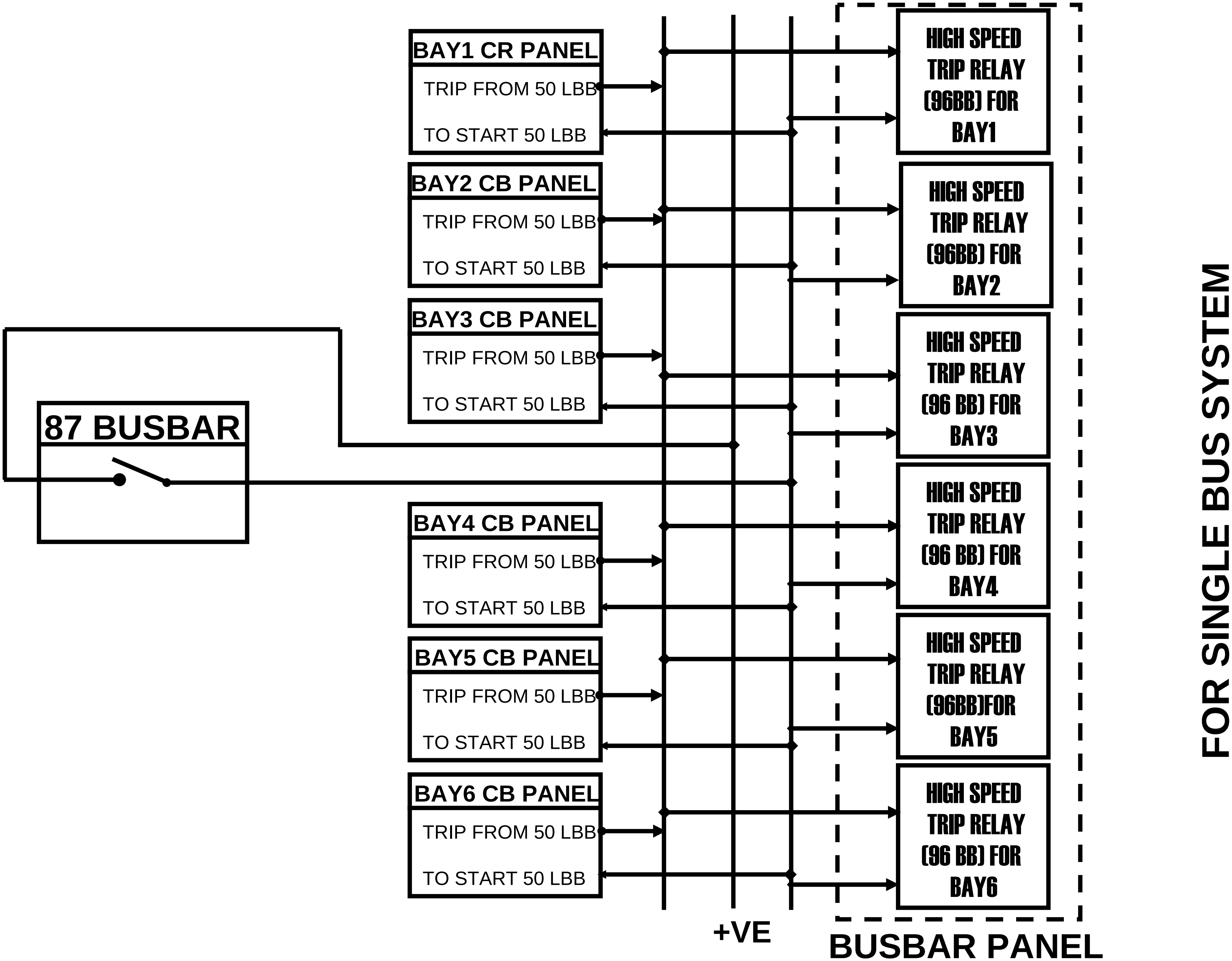


BUS BAR PROTECTION

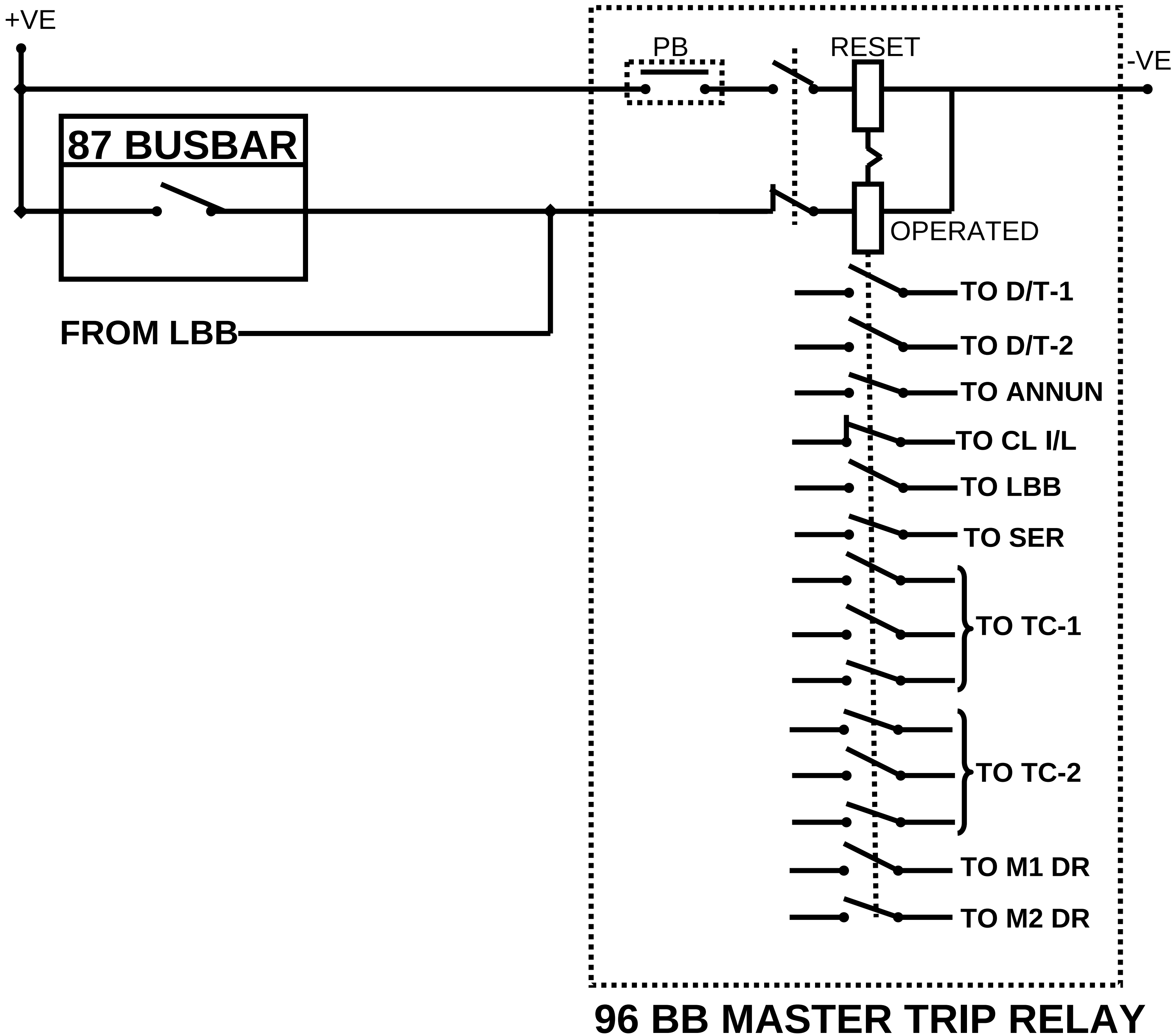
- INITIATE ALL CBs TRIP UNITS CONNECTED TO THIS BUS AND OPERATE.
- TO TRIP COIL-1 CONCERNED BAY CB
- TO TRIP COIL-2 CONCERNED BAY CB
- TO CLOSE CIRCUIT INTERLOCK OF CONCERN CB
- DIRECT TRIP SEND CHANNEL-1 TO OTHER END
- DIRECT TRIP SEND CHANNEL-2 TO OTHER END
- TO LBB/BFR INITIATION
- FROM LBB/BFR TO BUS BAR TRIPPING
- TO DISTURBANCE RECORDER OF MAIN-1
- TO DISTURBANCE RECORDER OF MAIN-2
- TO EVENT RECORDER (SOE/ SCADA)
- INITIATE ALARM (ANNUNCIATION COME)

- INITIATE ALL CBs TRIP UNITS CONNECTED TO THIS BUS AND OPERATE.
- TO TRIP COIL-1 CONCERNED BAY CB
- TO TRIP COIL-2 CONCERNED BAY CB
- TO CLOSE CIRCUIT INTERLOCK OF CONCERN CB
- DIRECT TRIP SEND CHANNEL-1 TO OTHER END
- DIRECT TRIP SEND CHANNEL-2 TO OTHER END
- TO LBB/BFR INITIATION
- FROM LBB/BFR TO BUS BAR TRIPPING
- TO DISTURBANCE RECORDER OF MAIN-1
- TO DISTURBANCE RECORDER OF MAIN-2
- TO EVENT RECORDER (SOE/ SCADA)
- INITIATE ALARM (ANNUNCIATION COME)

87 BUSBAR PROTECTION TRIPPING SCHEME

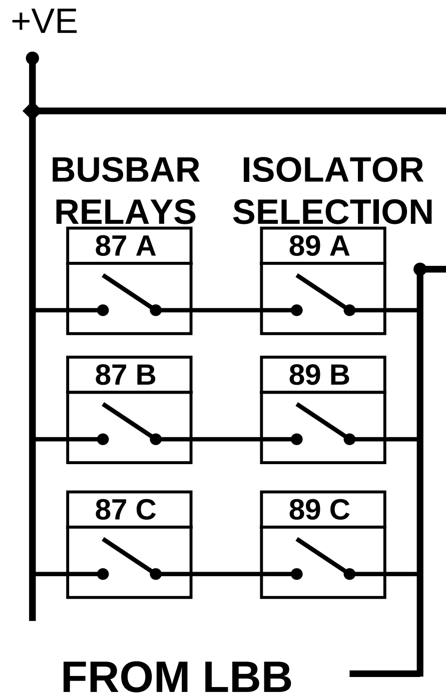


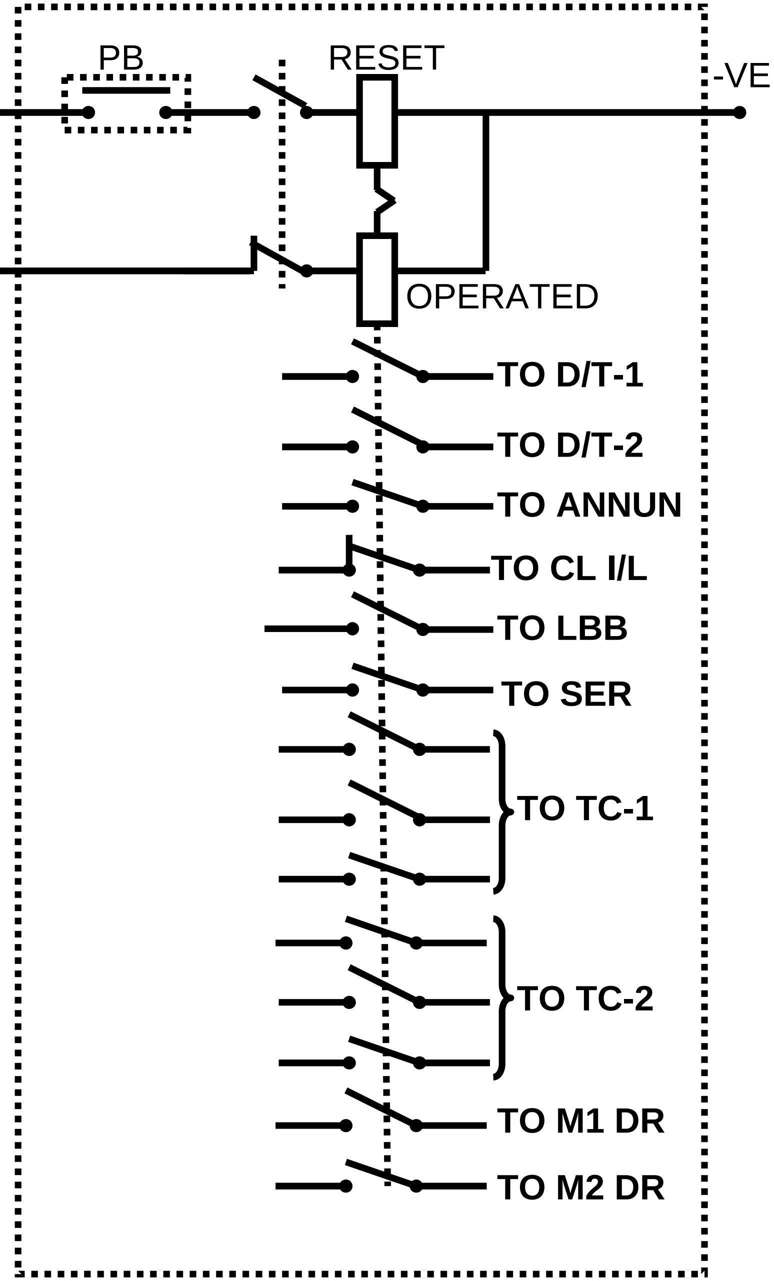
96 BB (MASTER TRIP RELAY) OPERATION



FOR SINGLE BUS SYSTEM,
ONE & HALF CB SYSTEM,
DOUBLE CB & DOUBLE BUS SYSTEM
& RING MAIN BUS SYTEM

96 BB (MASTER TRIP RELAY) OPERATION



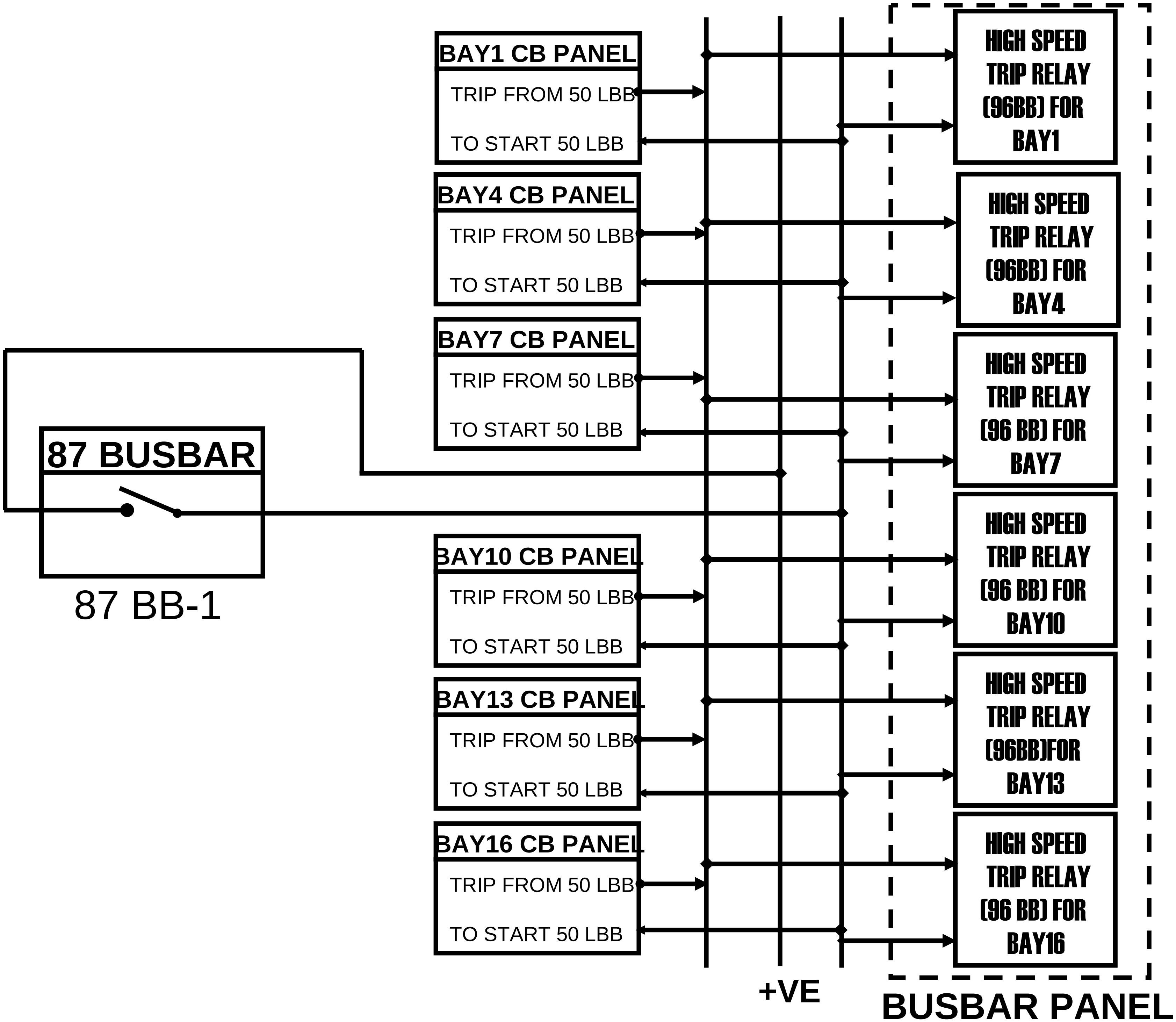


96 BB MASTER TRIP RELAY

IF BUS-1 IS OPERATED THE FEEDERS CONNECTED TO BUS BAR-1WILL BE OPTD BASED ON THE ISOLATOR SELECTION. SIMILARLY FOR BUS-2 & BUS-3 & ANY NO OF BUSES ONLY, EXPECT ONE AND HALF CB SYSTEM, DOUBLE CB SYSTEM & RING BUS SYTEM.

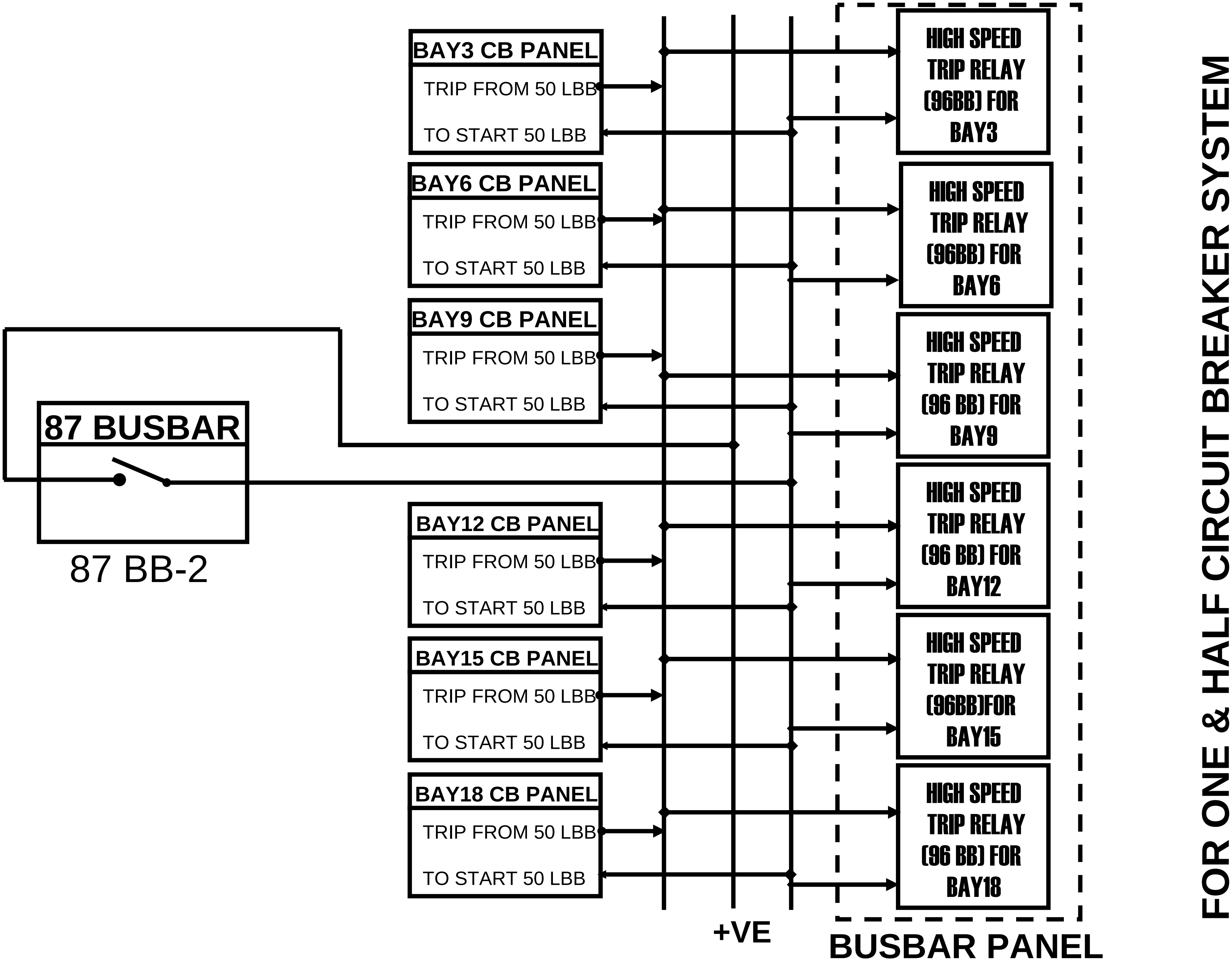
FOR SINLE BUS AND TRANSFER BUS SYSTEM
FOR DOUBLE BUS SYSTEM
FOR DOUBLE BUS & BYPASS ISO SYSTEM
DOUBLE BUS & TRANSFER BUS SYSTEM
TRIPPLE BUS SYTEM
TRIPPLE BUS & TRANSFER BUS SYSTEM &
QUAD BUS SYTEM
(DOUBLE BUS WITH CB SECTIONALISER)

87BB-1 BUSBAR PROTECTION TRIPPING SCHEME



FOR ONE & HALF CIRCUIT BREAKER SYSTEM

87BB-2 BUSBAR PROTECTION TRIPPING SCHEME



UTILISATION RECOMMENDATIONS

- BUSBAR protection must be provided in all new 400kV and 220kV Substations as well as Generating Station Switchyards.
- For existing Substations, provision of BUSBAR Protection is must & considered at 400kV level and at 220kV level.
- In case of radially fed 220kV Substations, having more than one bus it is desirable to have BUSBAR Protection, but it is an Option.
- For Substations of High strategic importance i.e. 765KV or 400KV Systems, the complete Bus bar protection can be fully duplicated for Back-up Protection/Redundancy.
- Dedicated Protections invariably employ separate DC circuits and CT cores. They send trip impulses to separate trip coils and use separate isolator position auxiliary contacts. Cross tripping of both trip coils is also done.

THANK YOU