1. INSTALLATION

The SPLCBL Relay chassis should be mounted on switchboard panels, or their equivalent, in a location free from dirt, moisture, corrosive fumes, excessive vibration and heat. Mount the chassis by means of the slotted holes on the front of the case. See Figure 2 for mounting dimensions.

The inputs and outputs are surge-protected in order to reduce the possibility of false signals induced between the leads and from external sources. Refer to “Silent Sentinels” publication RPL 79-2 for additional recommended protection practices, if desired. All chassis should be grounded with 14 AWG (or larger diameter) copper wire to an appropriate stud or frame.

All equipment should be operated within an ambient temperature range of -20°C to + 65°C. Ventilation may be required to insure that ambient temperature of 65°C is not exceeded within the enclosure in which the equipment is mounted.

2. APPLICATION

The segregated phase current differential LCB-II protective system is composed of three standard LCB-II relays and a UIO logic package (SPLCBL) for the single pole tripping logic.

The LCB-II units, for phases A, B and C are standard LCB-II relays that are usually applied to three phase transmission lines by themselves. The use of one LCB-II relay per phase provides the application of the current differential principle to all the phases of the power system.

The UIO logic package gathers the information of the LCB-II relays and combines them to develop the logic necessary to provide the signals for recloser initiation and breaker failure logic.

The segregated phase current differential LCB-II system has been designed for applications in which segregated monitoring of the power system phase currents is required and the power system breakers have been designed for single pole tripping.

When single pole tripping is required, the operation of the system is such that the system will trip a single pole for all phase to ground faults. The pole will be reclosed after a reasonable time delay by a reclosing relay using the SRI output from the UIO logic package. The trip mode is three pole for other types of faults.

Standard LCB-II systems that are normally applied to three phase transmission lines are used in the design. Each of the units is assigned to a particular phase of the power system, i.e., A, B or C; and, will be monitoring the differential current in the line. It is understood that in a two terminal application there will be an equal system in the other terminal.

The input to the standard LCB-II is done through terminal TB4-1 and the return through terminal TB4-2 in all the LCB-II systems. The LCB-II sub-systems will inherently have greater sensitivity to faults than if they were used by themselves as will be shown in a latter section of this instruction book.

The UIO package receives the trip outputs of the LCB-II systems (LCB-A, LCB-B and LCB-C) and implements the logic to initiate reclosing (SRI and 3RI) for single phase to ground and multiphase faults. The user can select the blocking of the reclosing relay with a jumper link on the LM-3 module for three phase faults only, for multiphase faults or none using the RB (Reclose Block) output.

The communication media used by the LCB-II subsystems is an audio-tone output. Each phase requires its own communication channel and each will detect a channel failure in its own phase but not in the other two sub-systems. The user should weight the consequences of allowing the device to become a non-directional overcurrent device or block it. If the overcurrent option is selected, the sensitivity should be greater than load current.

The current differential principle is inherently unaffected by mutual effects, voltage reversals, CCVT transient response an power swings. The system is essentially measuring the current flowing into the line and the current flowing out of the transmission line.

3. CONSTRUCTION

The SPLCBL relay chassis is 5.202 inches 132.1mm) high, 3 rack units, with edge slots for mounting on a standard rack or panel. For outline and drilling plan, refer to Figure 2.

The removable front cover has a smoked plexiglass front for viewing the LED indicators on the various enclosed modules. The front cover is removable with two thumb screws.

Output terminals are connected to surge capacitors connected from terminal to ground, for protection from external surges. These terminals are mounted horizontally across the back of the assembly.

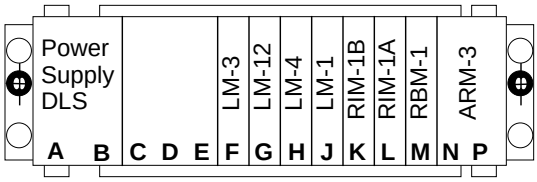


Figure 1. SPLCBL Assembly

All of the circuitry associated with the SPLCBL operation is contained in the enclosure behind the front cover. The printed circuit modules slide into position in slotted guides at the top and bottom of the enclosure and engage a printed circuit connector at the rear of the compartment. Each module and connector are keyed, so that they cannot be accidentally inserted into the wrong slot location.

Handles and a front plate on the modules are used for identification of the module name and location, for module removal and insertion, and as a bumper with the front cover to prevent the terminals from accidentally becoming disconnected from the terminal connector. The modules may be removed for replacement purposes or for use in conjunction with module extender type UME-3 which permits access to the modules test points and terminals for making measurements while the relay is energized.

4. MODULES DESCRIPTION

NOTE: Module assemblies carry the style of the assembly and the sub per which the module was assembled and Internal Schematic Reference and its sub per which the module electrically functions.

4.1. DLS Power Supply Module (1349D85A06) Location A-B

The DLS Power Supply module (See Figure 3) isolates the relay system logic and sensing circuits from the station battery. It also provides a source of + 15 Vdc needed by the operational amplifier and digital logic circuits, when switch on the front panel is in the ON position. Also mounted on the front panel are:

- Fuses (2)
- Test Jacks (+ 15 V POS, COM)
- LEDs (dc OUTPUT, dc INPUT)
- Potentiometer (OUTPUT ADJUST)

For a detailed description of the DLS Power Supply, refer to I.L. 41-830.11 (Section B).

4.2. LM-3 Logic Module (1586C93A01) Location F

The LM-3 Module (see Figure 4), developed for other UIO applications, is utilized in the SPLCBL assembly to provide RB (Reclose Block) logic. The module can be programmed for three phase reclose block or multiphase reclose block through the setting of a three position Link (L1). Refer to I.L. 41-847.14 (Section C) for a detailed description of the LM-3 Module.

In the special application of this module with LCB-II relays it was found that, due to the long resettime of the LCB-II relays, the Reclose Block (RB) output is obtained for all multiphase faults regardless of the (LI) Link Settings. Therefore, the (LI) Link should always be set in the MØRB position.

4.3. LM-12 Module (1614C67A01) Location G

The LM-12 Contact Converter module (see Figure 5) converts the dc voltages from 52b contacts, external resets, etc., to integrated circuit logic levels. The module contains six identical contact buffering circuits which provide isolation of the inputs. Each circuit is input voltage selectable (15, 48, 125, or 250 V dc) through Links L1 to L6.

Refer to I.L. 41-847.28 (Section D) for a detailed description of the LM-12 Module.

4.4. LM-4 Logic Module (1586C94A01) Location H

The LM-4 Logic Module (see Figure 6) provides four sets of logic.

1. The single phase fault detection logic will cause a 1 phase trip (1PT) output upon the occurrence of a single phase to ground fault. An additional output (1ØF) permits three phase trip if link “L1” is in the “3PT” position.
2. The single phasing interval fault detection logic will cause a 3 pole trip 1 (3PT1) output if a fault occurs on any phase while either of the other phases is open.

3. The close/reclose into a fault detection logic will cause a 3 pole trip 1 (3PT1) output if a fault appears on any phase within 500 milliseconds of the closing/reclosing of the breaker pole unit for that phase. The logic is reset by the opening of the breaker pole unit with a 100 millisecond delay to prevent a 3 pole trip following a single pole trip and reclose operation where the fault is cleared.

4. The pole position disagreement detection logic will cause a 3 pole trip 1 (3PT1) output if all three breaker poles are not in the same position. An adjustable time delay, 0.5 to 5.0 seconds, is provided to override the single phasing interval following a single phase to ground fault.

The detailed description of the LM-4 module is covered in I.L. 847.15 (Section E).

4.5. LM-1 Logic Module (1582C99G01) Location J

The LM-1 Logic Module (see Figure 7) is an INPUT/OUTOUT module containing various “AND”, “OR”, and timing logic configurations. The LM-1 is used in the SPLCBL unit to provide the additional “AND” and “OR” logic required by the UIO system.

Refer to I.L. 41-847.12 (Section F) for a detailed description of the LM--1 Module.

4.6. RIM-1A Module (1603C10A11) Position L RIM-1B Module (1603C10A10) Position K RBM-1 Module (1603C10A12) Position M

The RIM-1A, RIM-1B, and RBM-1 Modules (see Figures 8, 9, & 10) use the same printed circuit board and are identical in construction except for the values of the timing capacitors.

The RIM-1A module supplies the 3RI output contacts to initiate the reclosing of the three phases. The contact output has a nominal “ON” time delay of 28 ms and an “OFF” time delay of 220 ms.

The RIM-1B module is identical to the RIM-1A module except is used to supply the SRI output contacts to initiate the reclosing of the single phase that is open. The “ON/OFF” time delays are the same as for the RIM-1A module.

The RBM-1 module supplies the RB output contacts to control the reclosing relay. The contact output has no intentional “ON” time delay and has an “OFF” delay of 375 ms.

All three modules contain LED indicators. The RIM-1A module has indication for phase trip operation (LCB-A, LCB-B, LCB-C) and 3RI

The RIM-B Module has indication for SRI.

The RMB-1 module has indication for RB and DTT.

The detailed descriptions for all three modules are covered in I.L. 41-847.23 (Section G).

4.7. ARM-3 Trip Module (1581C41A02) Position N - P

The ARM-3 Module (see Figure 11) provides contact trip outputs, trip indication, contact breaker failure outputs, system reset, and power up trip block. In the SPLCBL package, the ARM-3 module is used to provide the necessary contacts to trip all the breaker poles for multiphase faults.

Refer to I.L. 41-847.11 (Section H) for the detailed description of the ARM-3 module.

5. OPERATION

For the detailed operation of the LCB-II units, please, refer to ***I.L. 40-219 and 40-220, Type LCB-II Current Differential Line Protection Relay System and Type LCB-II Relay Modules***. The operating principle of the LCB-II sub-systems is explained thoroughly.

In the segregated current differential system three standard LCB-II relays are used to monitor the differential current in each phase (A, B, & C).

Only one current input is used per LCB-II (TB4-1 and TB4-2) which transforms the basic equation to:

VF = (14.14/3T) (C1 + C2 + C0) Ix

where:

VF = Filter output

C1, C2 and C0 = filter output constants.

T: Ampere tap setting of the relay.

In the settings section, the above equation is developed further.

The trip outputs of the standard LCB-II should be used to trip the respective breaker(s). The output contacts are TB7-4, 3 and TB7-2, 1.

Referring to the Internal Schematic (Figure 12) of the

SPLCBL logic assembly, one of the output contacts from each LCB-II is used to feed the UIO package. The dry contacts are connected to the inputs of the LM-3 and LM-4 modules where the single pole logic is developed. An active LCB-II signal indicates the trip of one of the subsystems.

The LM-3 module was designed to control the programming of the Reclose Block (RB) output through the setting of (LI) Link in the 3ØRB, NORB, or MØRB positions. However, due to the long reset time of the LCB-II relays, an input from the LM-4 module causes an RB operation regardless of the (LI) Link setting. The (LI) Link should always be set in the MØRB position.

The LM-4 module develops the Sound Phase Fault (SPFT) logic that opens the other two phases if there is an internal fault during single phasing. Reclose Into Fault (RIFT) logic is also included. Three pole tripping will be issued if a fault is detected in the same phase within 500 milliseconds of a reclosed breaker. Permanent three phase tripping for single line to ground faults can be achieved by the selection of jumper L1 that needs to be set to 3pT. Otherwise the system will trip a single pole for single line to ground faults. A single phasing timer is provided to allow a maximum time for a single pole open before tripping the other two poles. The timer is settable from 0.5 to 5 seconds.

The logic in the LM-4 module requires signals from the auxiliary 52b contacts (52b-A, 52b-B, 52b-C) from the breaker. The LM-4 receives these signals through the LM-12 module which transforms the contact voltages to digital signals as well as providing isolation through the use of optical isolators.

The single pole trip bypass is an input, from the LM-12 module, that bypasses single pole trip operation, allowing the system to trip three pole for single line to ground faults when this signal is active. The operation of this signal can be achieved by the use of an external control switch connected to the LM-12 module. A system reset is provided that will simultaneously reset all the indications in the LCB-II relays as well as in the UIO package.

Breaker failure initiate (BFI) contacts are provided in the following way:

Each LCB-II relay provides one (TB7-6, 5) Breaker Failure Initiate contact. If more contacts than one are required, an auxiliary relay should be applied.

A three phase BFI contact. (3-BFI) is provided in the ARM-3 module. There are two of these contacts.

The LCB-II relays have the capability of sending a DTT (Direct Transfer Trip) signal to the other end to trip the remote breaker. Since standard LCB-II relays are used, there are three channels that can be used. If a DTT trip is received at the local terminal, the logic in the UIO package will trip the three phases simultaneously.

6. SETTINGS

Please refer to ***I.L. 40-219 Type LCB-II Current Differential Line Protection Relay System*** for complete information of the operation and settings procedure for an LCB-II relaying system.

The segregated current differential LCB-II system is a variation of the three phase single unit and since only one current is being monitored it follows that:

$VF = (14.14/3T)(C1 + C2 + C0)\,Ix$

where:

VF = Voltage output of the sequence filter network.

T = The ampere tap setting of the relay.

C1, C2 and C0 = Filter network constants.

Ix = Either Ia, Ib or Ic.

The operation of the unit occurs when VF = 0.6526 volts, therefore:

$(C1 + C2 + C0)\,Ix = 0.1385T$

or the minimum sensitivity of the relaying system is:

$Ix = (0.1385T) / (C1 + C2 + C0)$

The combination of C1 + C2 + C0 can be chosen from Table 1, page 17 of the I.L. 40-219.

If C2 = C0 = 0 (OFF for N and Z) and C1 = -0.1, then the minimum sensitivity of the relay is:

$IX = 0.1385T$

T can be adjusted using the front panel potentiometer and has a range from 2 to 20 amps.

The most sensitive setting for the relaying system would be:

Ix = 0.1385T / (0.0 + .23 + (2.45))

Ix = .0517T

Using C1 = 0, C2 = 0.23 and C0 = 2.45

If the most sensitive setting is necessary for the application; then, the settings have to be chosen such that the sensitivity of the relaying system is at least 1.75 Ich, where Ich is the line charging current.

6.1. Loss of Channel

On the Loss-of-Channel option due to the relay monitoring a single phase current, and the effect of load flow on the sensitivity of the relay it is recommended that:

The option LC-BLK should be used if the sensitivity of the relay is below load flow.

If the fault current level allows a setting above maximum load current, then the other loss of channel options could be used; as explained in the I.L. 219.

6.2. Setting Example:

A 345 Transmission line has Ich = 0.38 Amps and maximum load flow of 5 Amps secondary. The Segregated Current Differential LCB-II system will be used to protect the system and should be set for maximum sensitivity.

Maximum Sensitivity for the system means that the C1, C2 and C0 constants should be chosen such that the minimum pick up is 1.75 larger than the charging current of the line:

Ix = 1.75 (0.38)

Ix = 0.665

There are many combinations of C1, C2 or C0 that could be chosen. For example:

C1 = - 0.05, C2 = 0.2 and C0 = 1.25

then:

T = Ix (C1 + C2 + C0) /0.1385
= 0.665 (1.4) /0.1385
= 6.722

Using the formula for the front dial setting (DS):

DS = 1082.5 - 2000 /T

then:

DS = 785

Since the relay is set for maximum sensitivity the LC option should be set to LC-BLK.

7. ACCEPTANCE TEST

7.1. Recommended Test Equipment

The following is recommended test equipment and associated test devices:

- dc voltage source
- Shorting Switches for input quantities to the SPLCBL logic unit
- Oscilloscope and/or electronic timer for “ON/OFF” time delays at the outputs of the SPLCBL logic unit.
- Style 1447C86G01 type UME-3 Extender Card for 3 rack unit chassis.

WARNING

WARNING: ALWAYS TURN POWER SUPPLIES “OFF’ WHENEVER A PC BOARD IS WITHDRAWN OR INSERTED.

7.2. SPLCBL Logic Unit

The proper operation of the UIO logic unit is determined by performing the test checks as detailed in Table 1.

The acceptance tests for the individual modules are covered by their respective instruction leaflets included in this manual.

7.3. LCB-II Relays

The acceptance test for the LCB-II relay is detailed in L-682A29, IL 40-219, and IL-40-220.

8. SPECIFICATION

8.1. General

Rated Current
1 or 5 amperes

Rated Frequency
50 or 60 Hz

dc Battery

Nominal	Range
48/60 Vdc	38/70 Vdc
110/125 Vdc	72/145 Vdc
220/250 Vdc	170/290 Vdc

Ambient Temperature Range
For Operation — - 20 to + 65 degrees C
For Storage — - 40 to + 80 degrees C

Insulation Test Voltage
2kV, 50/60 Hz, 1 minute (IEC255-5)

Impulse Voltage Withstand
5k V peak, 1.2/50 us,
0.5 joule, (IEC 255-5)

Surge Withstand Voltage
2.5, 1MHz
(ANSI-C37.90a, IEC 255-6)

Fast Transient Voltage Withstand
5k V, 10/100 ns
(Proposed ANSI-C37.90a)

EMI Volts/Meter Withstand
25 MHz-1 GHz
V/m (Proposed ANSI-C37.90.2)

Control and Monitoring

Signal Output (Pickup Time 2.5 ms)
Maximum switching of 3 amperes
or 250 volts or 50 watts

Power Supply alarm Output

(Drop out time 1.5 ms)
Make and carry continuous 1 amp
or 50 watts

External Connections
Terminal blocks located on the rear
of the chassis

8.1.1. Dimensions

132.56 mm High (5.219 inches) (3R.U.)
483 mm Wide (19.0 inches) (standard
19-inch rack)

360.43 mm Deep (14.19 inches) (including
terminal blocks)

8.1.2. Outputs

Contact Outputs (for Control)

Designation	Function	Location on Module
RB	Reclose Block	RBM-1
3RI	3P Reclose Initiate	RIM-1A
SRI	1P Reclose Initiate	RIM-1B
3PT	3P Trip	ARM-3
3BFI	3P Breaker Failure Initiate	ARM-3
Contact Outputs (for Monitoring)		
Designation	Function	Location on Module

Contact Outputs (for Control)

Designation	Function	Location on Module
PSA	Power Supply Failure Alarm	DLS

9. ROUTINE MAINTENANCE

Periodic checks of the SPLCBL Logic Relay are advisable to verify the settings or to indicate component degradation. These checks will allow corrective action to be taken before components actually fail. any accumulated dust should be removed at regular maintenance intervals.

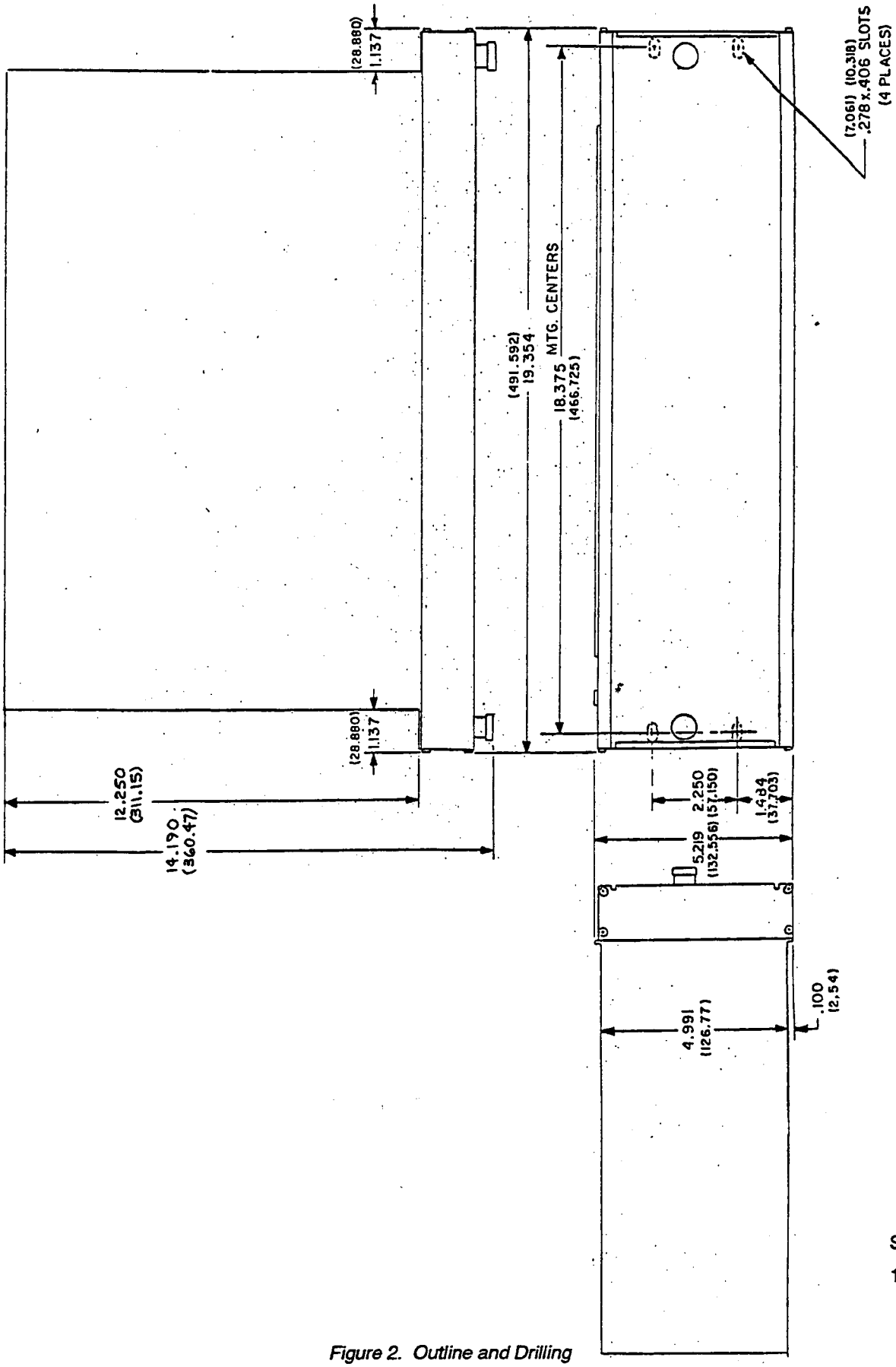
10. RENEWAL PARTS

Repair work can be done most satisfactorily at the factory. However, interchangeable spare modules or components can be furnished to the customers who are equipped for doing repair work. When ordering parts (components, modules, etc.), always give the complete catalog number and appropriate factory style number(s).

TABLE 1

TEST	LM-3 LINK "L1" POS.	LM-4 LINK "L1" POS.	Applied Input	LED STATUS								OBSERVED OUTPUT	REMARKS
			Short Terminals	LCB A	LCB B	LCB C	3RI	5RI	RB	DTT	3PT	TERMINALS SHORTED	
1	"M0RB"	"1PT"	TB1-1 & 2	ON				ON				TB3-9 To 12	FOR ALL TESTS Set Links "L1" to "L6" on LM-12 Module to 250 Vdc Position. Set P1 on LM-4 Module to max. CCW. **Reset LED's after each test. Note: Reset PB is on ARM-3 Module.** Reset P1 to the desired Timer setting after completion of tests.
2	↓	↓	TB1-3 & 4		ON			ON				↓	
3	↓	↓	TB1-5 & 6			ON		ON				↓	
4	↓	↓	TB1-1,2,3, & 4	ON	ON			ON *	ON		ON	TB3 - 1 to 8 & 13 to 20	
5	↓	↓	TB1-1,2,5, & 6	ON		ON		ON *	ON		ON	↓	
6	↓	↓	TB1- 3, 4, 5, & 6		ON	ON		ON *	ON		ON	↓	
7	↓	↓	TB1-7 & 8							ON	ON	TB3 - 1 to 4 & 13 to 20	
8	↓	↓	TB1- 9 & 10							ON	ON	↓	
9	↓	↓	TB1- 11 & 12							ON	ON	↓	
10	↓	↓	TB1 - 1 & 2 and 250 Vdc TO TB2-4(+) & TB2-14	ON			ON		ON		ON	TB3 - 1 to 8 & 13 to 20	
11	↓	↓	TB1- 3 & 4 and 250Vdc to TB2-2(+) & TB2-14		ON		ON		ON		ON	↓	
12	↓	↓	TB1-1 & 2 and 250Vdc to TB2-4(+) & TB2-14			ON	ON		ON		ON	↓	
13	↓	↓	TB1-1 & 2 and 250Vdc to TB2-2(+) & tb2-14	ON			ON	ON	ON		ON	TB3 - 1 to 20	
14	↓	↓	250Vdc to TB3-8(+) & TB3-14 then short TB1-1 & 2	ON			ON	ON			ON	TB3 - 8 to 20	

** = SRI LED turns on during this test because the 2 inputs cannot be shorted exactly simultaneously. However, the 5RI does not appear at the output.*



Sub 1

1614C81

Figure 2. Outline and Drilling

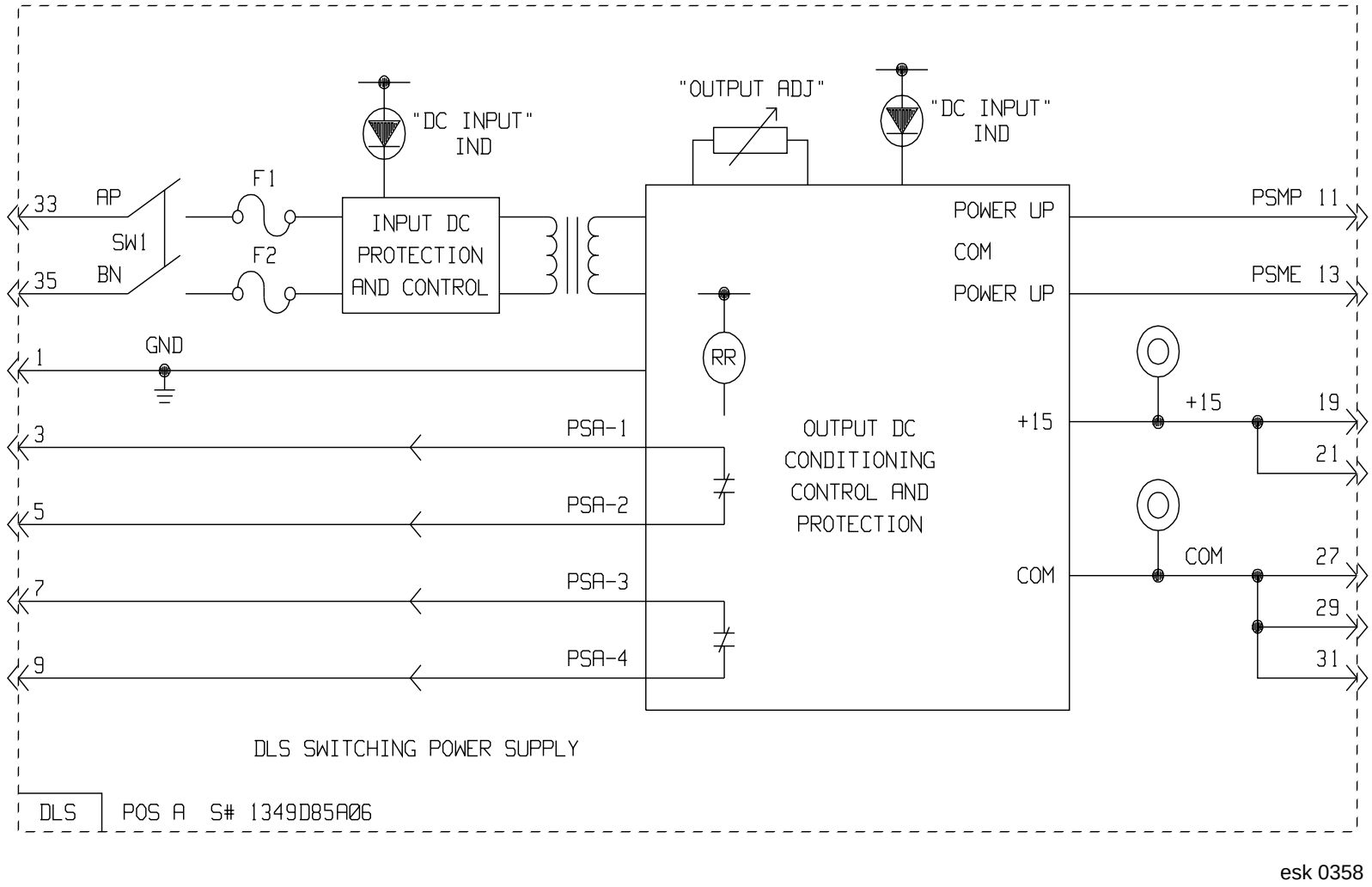
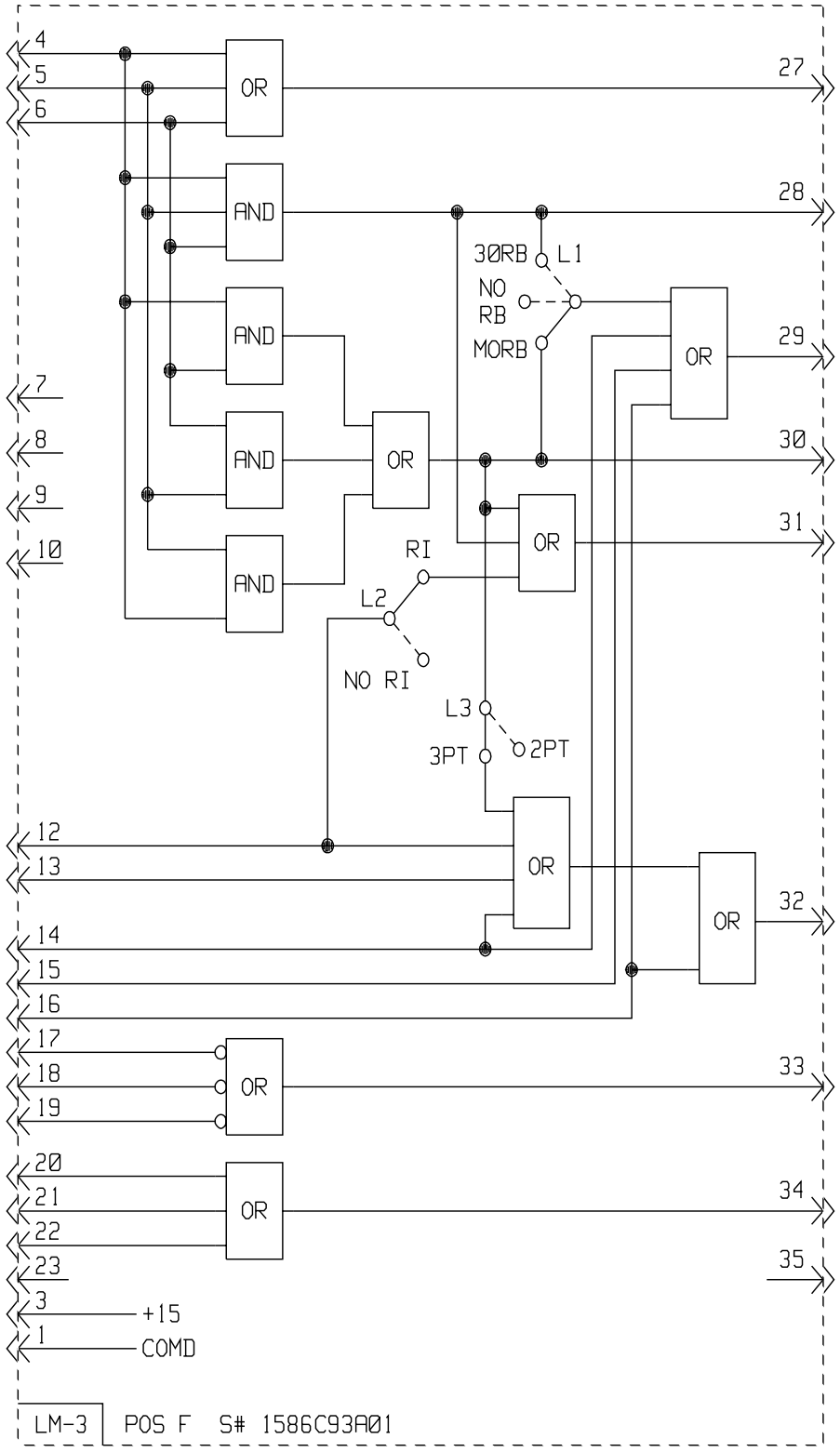


Figure 3. DLS Power Supply Block Diagram



esk 0359

Figure 4. LM-3 Logic Diagram

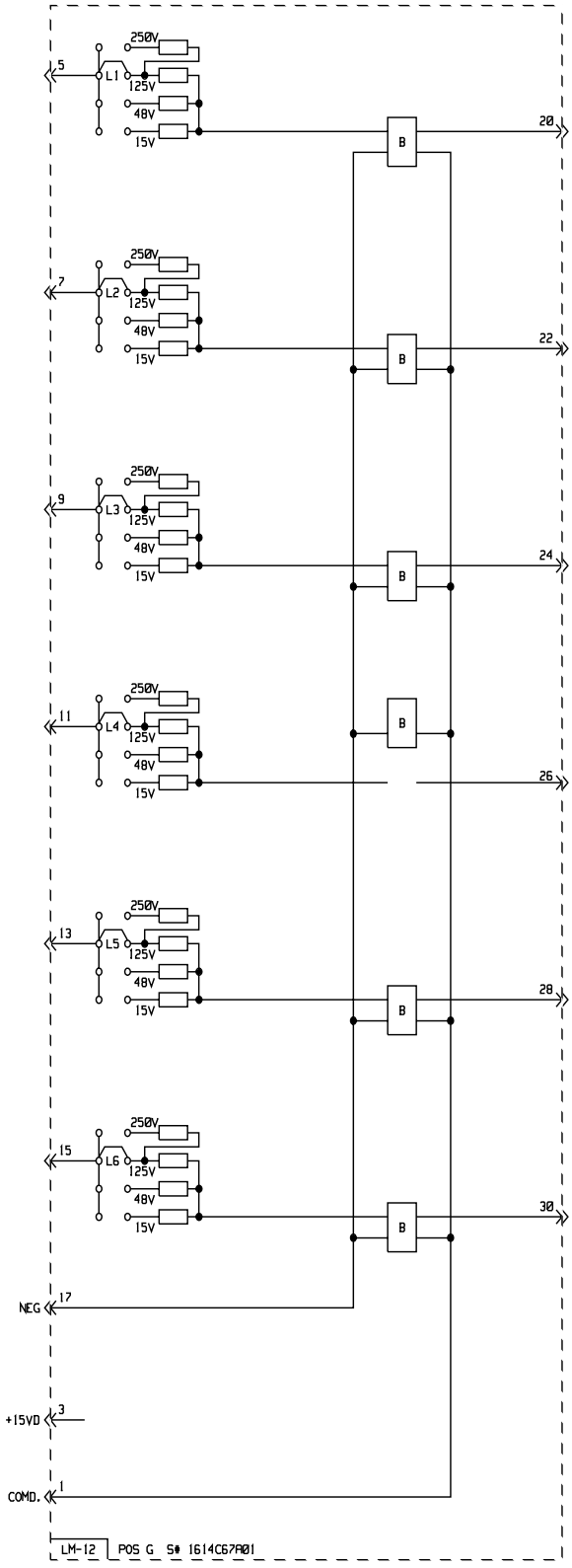


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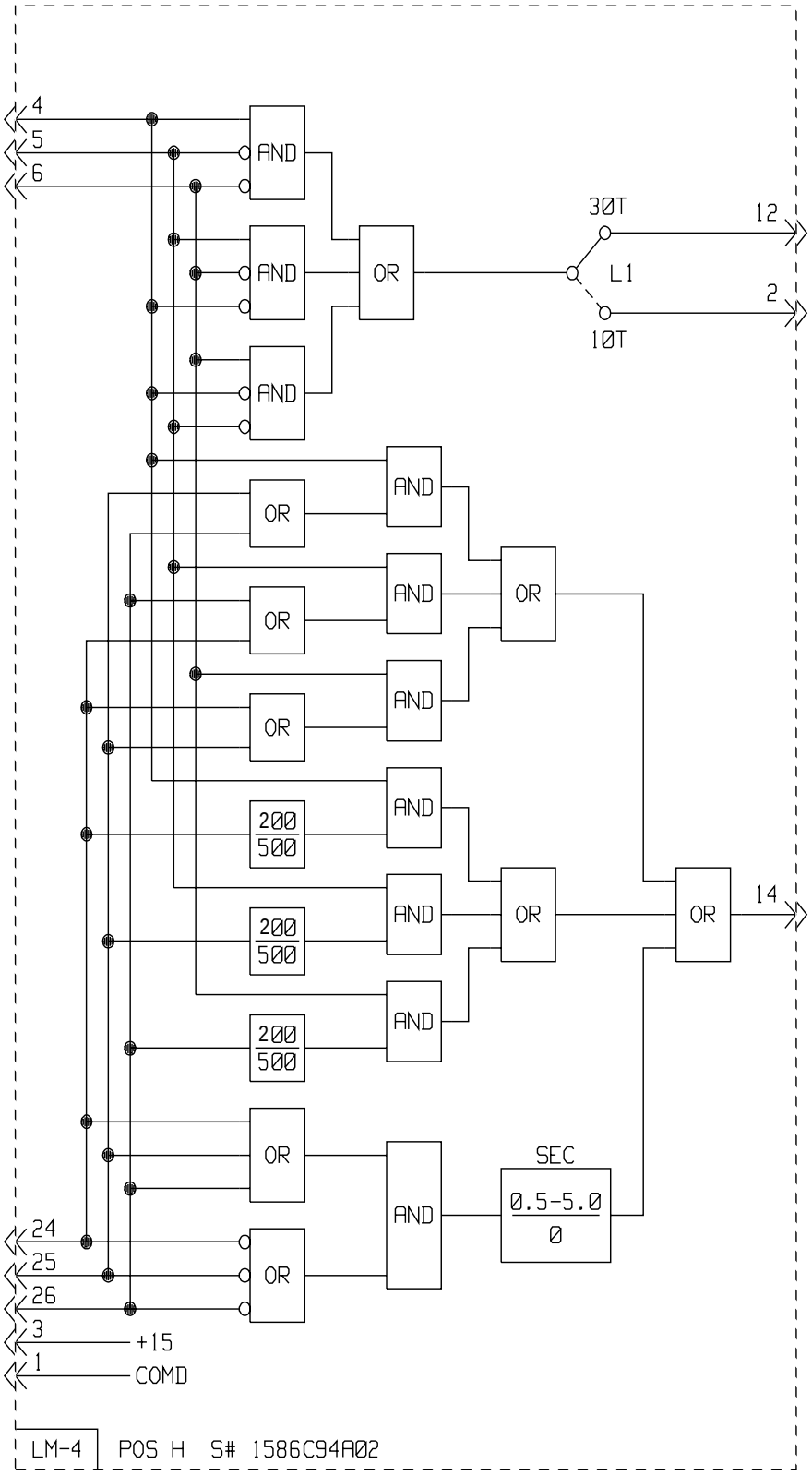
Figure 5. LM-12 Logic Diagram



Sub 1
esk 0361

Figure 6. LM-4 Logic Diagram

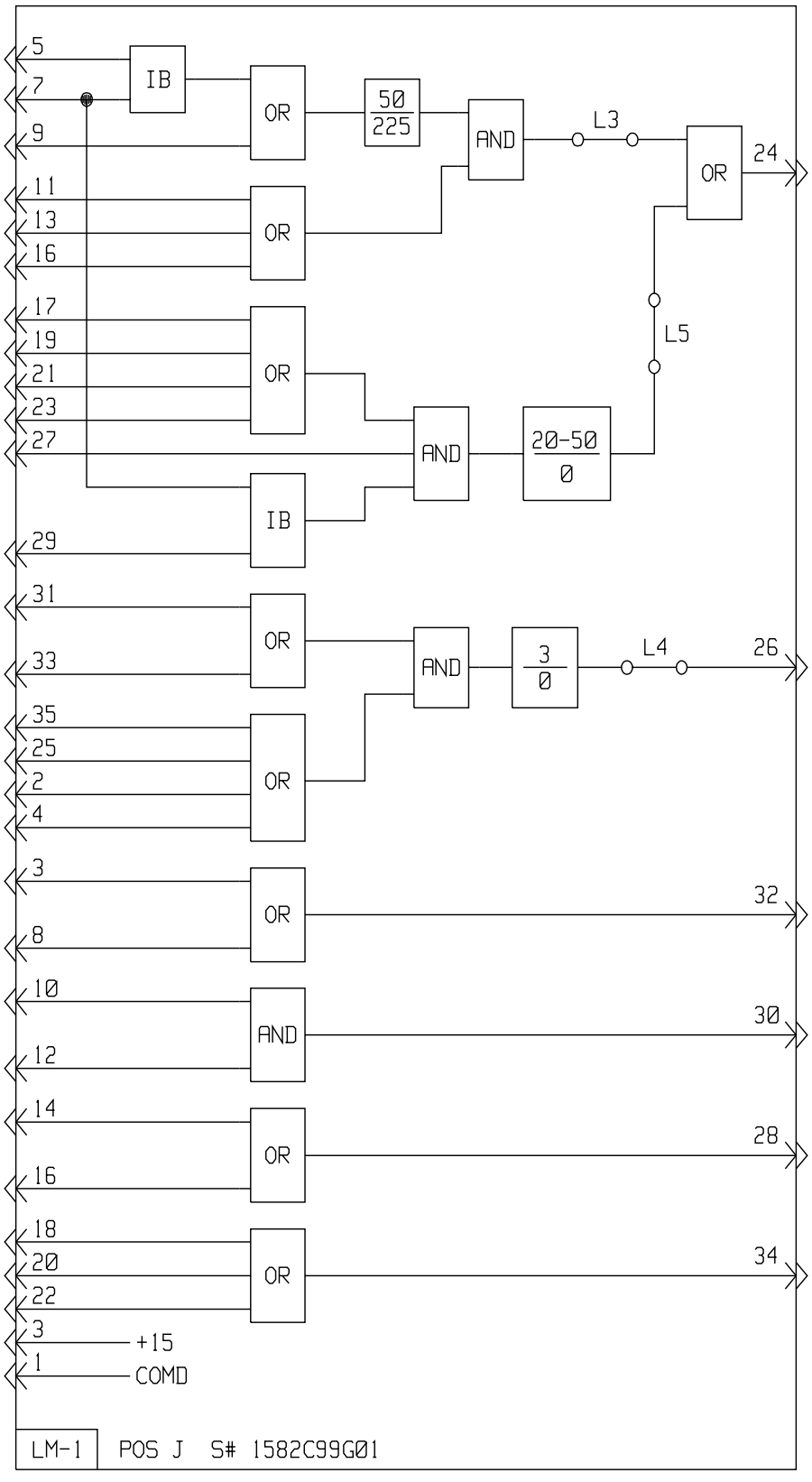
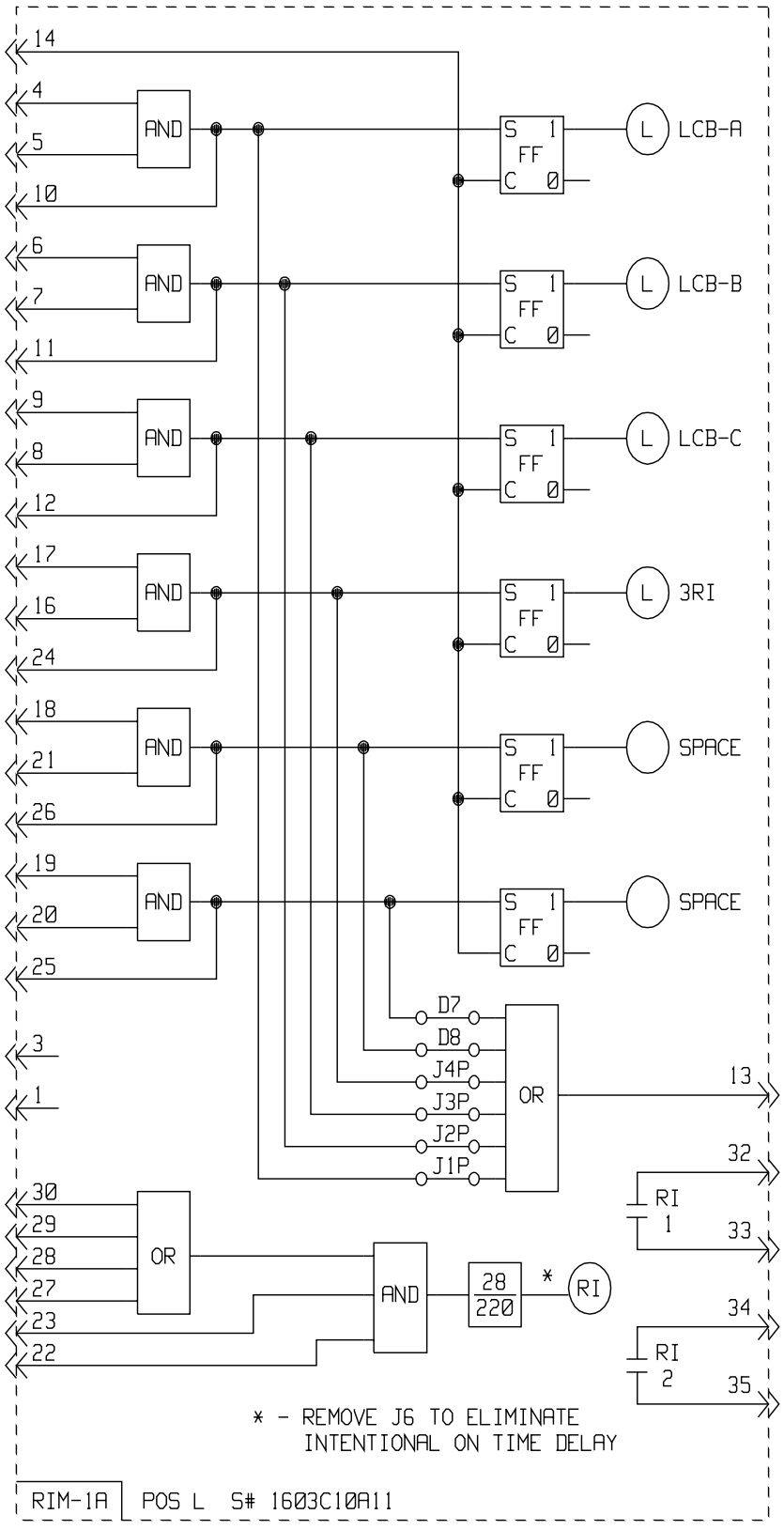


Figure 7. LM-1 Logic Diagram



esk 0363

Figure 8. RIM-1A Logic Diagram

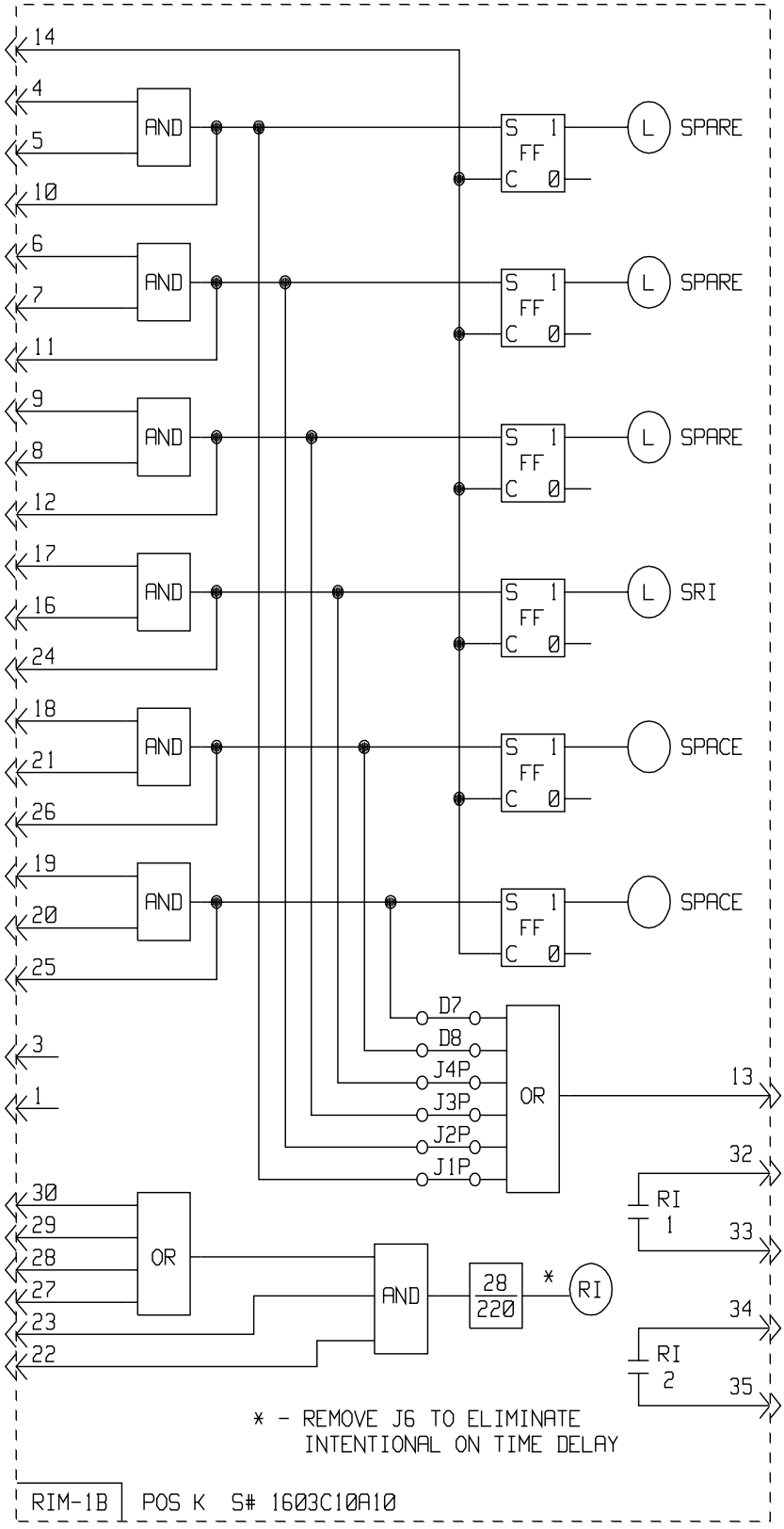


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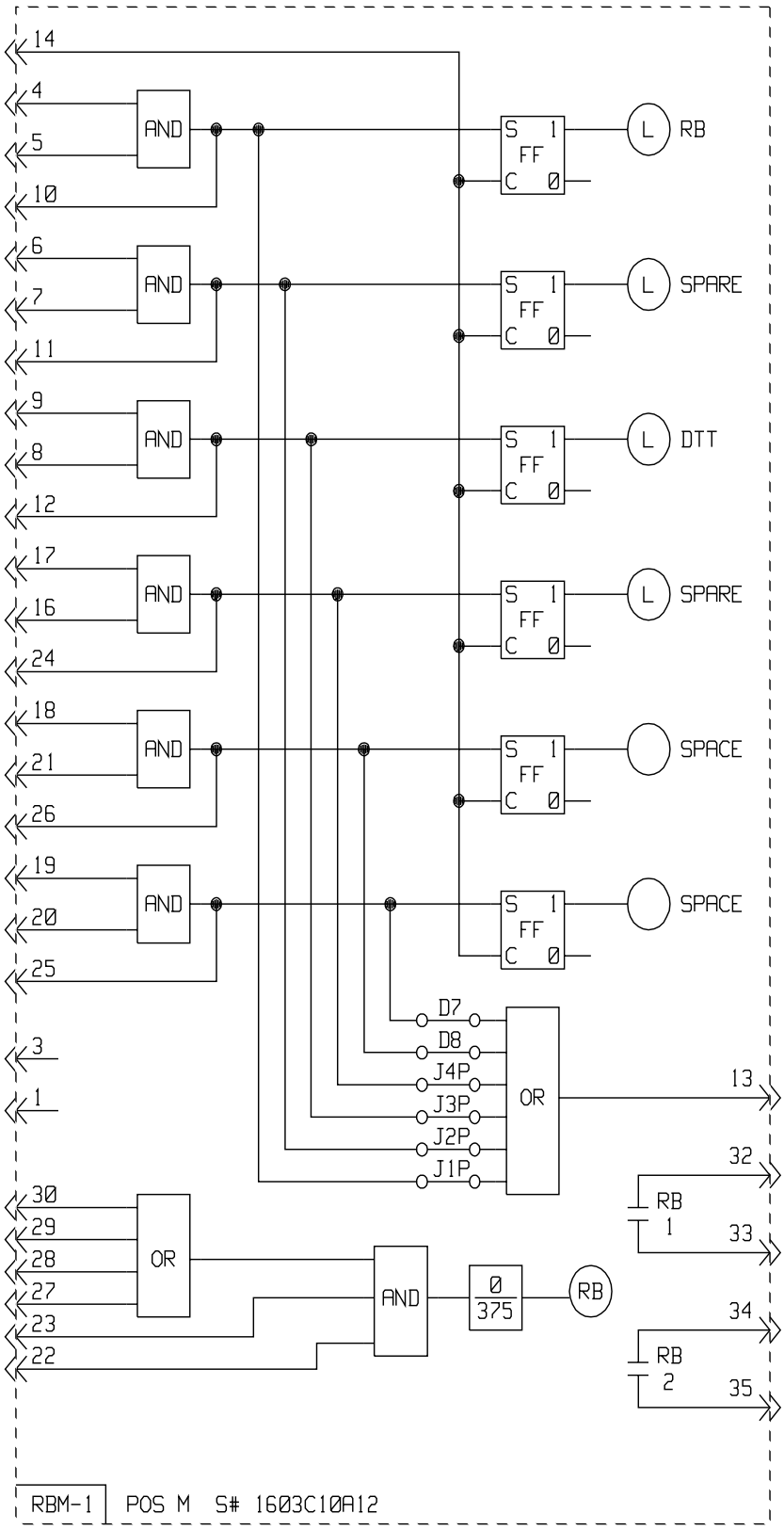
Figure 9. RIM-1B Logic Diagram



esk 0365

Figure 10. RMB-1 Logic Diagram

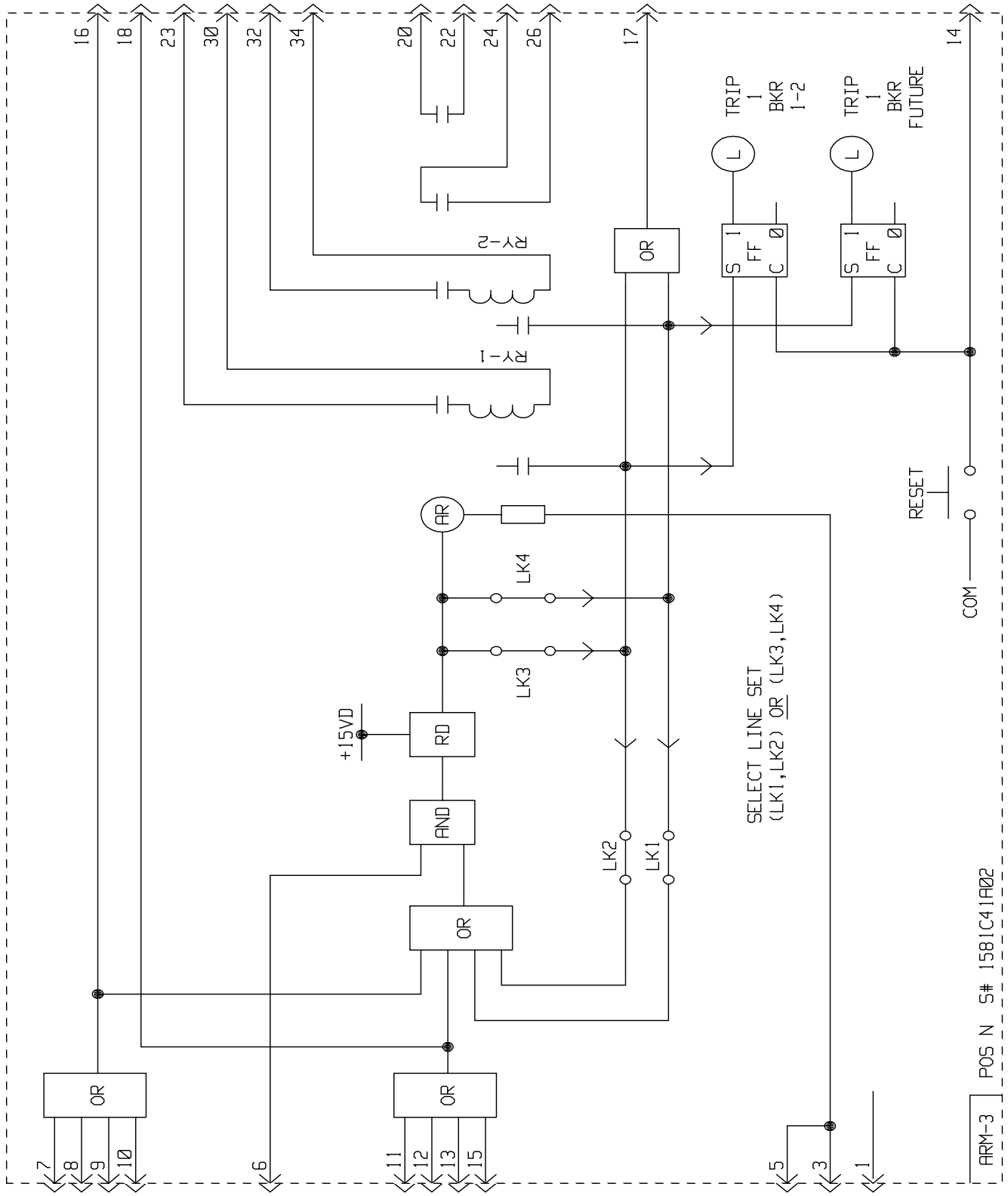


Figure 11. ARM-3 Logic Diagram

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Sub 4 1357D48

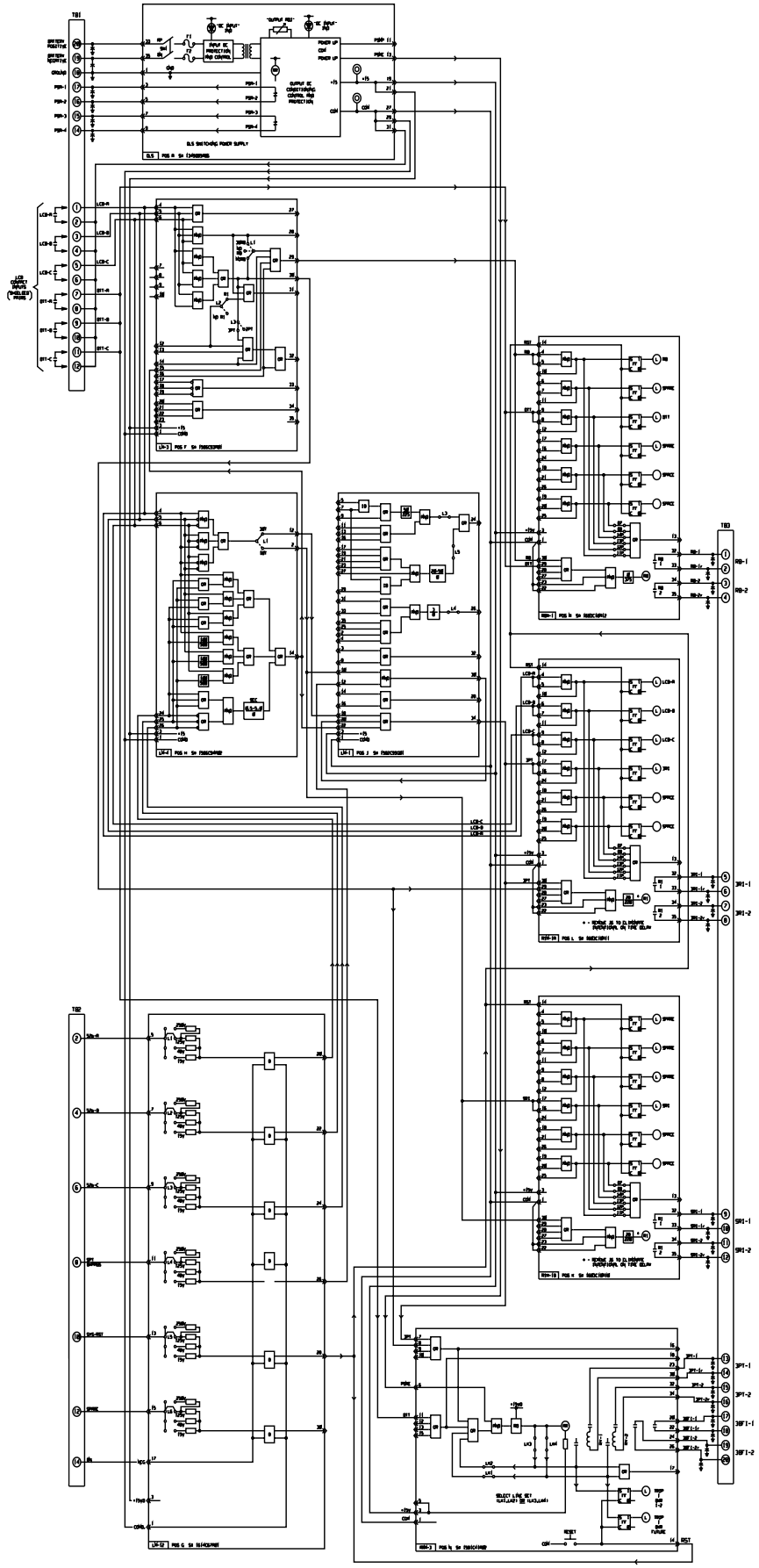

Figure 12. SPLCBL Internal Schematic

Type SPLCBL

Segregated Phase LCB Logic Relay

I.L. 40-388
NEW INFORMATION
(7/93)

ABB Power T&D Company Inc.
Relay Division
Coral Springs, FL 33065

305 752-6700
800 523-2620

Printed in Coral Springs, FL

It is recommended that the user of this equipment become acquainted with the information in this instruction leaflet before energizing the system. Failure to do so may result in injury to personnel or damage to the equipment, and may affect the equipment warranty. Printed circuit modules should not be removed or inserted while the relay is energized unless specific instructions elsewhere in this leaflet states that such action is permissible. Failure to observe this precaution can result in undesired tripping output and cause component damage. Electrostatic discharge precautions should be observed when handling modules or individual components.

Remove all blocking material that was used to secure the parts during shipment. Make sure that all moving parts operate freely, and inspect the contacts to see that they are clean and close properly.

All integrated circuits used on the modules are sensitive to and can be damaged by the discharge of static electricity. Electrostatic discharge precautions should be observed when handling modules or individual components.

ABB does not assume liability arising out of the application or use of any product or circuit described herein. ABB reserves the right to make changes to any products herein to improve reliability, function or design. Specifications and information herein are subject to change without notice. All possible contingencies which may arise during installation, operation, or maintenance, and all details and variations of this equipment do not purport to be covered by these instructions. If further information is desired by purchaser regarding a particular installation, operation or maintenance of equipment, the local ABB representative should be contacted.

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FIGURES

LIST OF RELATED DOCUMENTS