

Camtech/2000/E/EMC/1.0

(FOR OFFICIAL USE ONLY)

**MAINTENANCE OF
ELECTROMAGNETIC CONTACTOR
ON
ELECTRIC LOCOMOTIVE
CAMTECH/2000/E/EMC/1.0**

Jan, 2000



Maharajpur, GWALIOR - 474 020

CHAPTER 1

INTRODUCTION

1.1 ELECTRO MAGNETIC CONTACTOR

This is a 3-phase, 380V, AC, 50Hz contactor with 3 poles and is used for operating the auxiliary machines in the locomotives. Operating coil is connected to 110V DC by switching “ON” the lever of BL key from driver desk. When coil get energised its armature is attracted then the fixed and moving contacts get closed. Accordingly the auxiliary machines starts with their respective time delay.

The following contactors are used in the locomotive.

S.No	Description	Abbreviation
1	Contactors for Traction Motor Blower Motors.	C105, C106
2	Contactors for Main Compressor Motors.	C101, C102, C103
3	Contactor for Transformer Oil Cooler Blower Motors	C107

S.No	Description	Abbreviation
4	Contactors for vacuum pump Motors	C111, C112, C121, C122
5	Contactors for starting Arno	C-118

Lay out of electromagnetic contactors is shown in figure 1.1. Each assembly consist of the following main parts

1. Yoke
2. Armature
3. Coil
4. Fixed Contact
5. Auxiliary Contacts
6. Arc Chutes
7. Pressure Adjusting Springs
8. Copper Shunts
9. Bearing
10. Bolts, Nuts, Screws, Washers
11. Timer

1.1.1 Construction

These contactors have a U-shaped fixed part (yoke), a fixed core and a U-shaped moving armature. The armature is attracted inside fixed yoke. The auxiliary contacts are fitted below the magnetic circuit. Dimensions of contactor type CBC-45-A-320Z are shown in figure 1.2

1.1.2 Magnetic Coil Characteristics

Resistance

Coil resistance should be $580 \pm 8\%$ ohms at 20°C.

Operating (pick up) Voltage

The minimum operating voltage should not be more than 57V at 20°C ambient temperature when the contactor picks up.

Releasing (drop out) Voltage

The voltage at which the contactor electrically opens out should be more than 10V and less than 20V at any ambient temperature.

1.2 IMPORTANT PARAMETERS OF ELECTRO MAGNETIC CONTACTOR TYPE I EMC/1:1968:64A: 3P

Main circuit rated voltage	:	500V AC, 50 HZ
Main circuit rated current	:	64A, AC 95 A, AC for high Capacity contactor
Rupturing capacity of Main contactors	:	Not less than 720V AC, 500A at 0.7 p.f.
Minimum pick up voltage	:	50V D.C.
Rating of operating coil		
Resistance at 20°C	:	580 ± 8% ohms
Nominal Voltage	:	110V D.C.
Operating Voltage	:	Between 68V to 136 V DC
Number of Auxiliary Contacts	:	3 N/C and 3 N/O
Rated voltage of auxiliary contacts	:	136V D.C.
Rated current of auxiliary contacts	:	5A D.C.
Rupturing capacity of auxiliary contacts	:	2A, 136V DC at L/R Ratio of 25/1000

1.3 TECHNICAL PARTICULARS OF CONTACTORS

CONTACTOR		FOR MAIN COMPRESSOR MOTOR	FOR OIL COOLER BLOWER MOTOR
References		C 101	C 107
Manufacturer		CLW	CLW
Type and number for one locomotive		EMC - 1 -1968 64A - 3P(1)	EMC -1-1968 64A-3P (1)
Voltage of Utilisation Circuit		380 V	380 V
Di- electric Test 50 C/S 1 min.	Between main circuit and Earth	2850V	2850V
	Between high and low voltage circuit	2850V	2850V
	Between low voltage circuit and Earth	1500V	1500V
	Between contacts opened	2250V	2250V

CONTACTOR		FOR MAIN COMPRESSOR MOTOR	FOR OIL COOLER BLOWER MOTOR
Minimum operating Voltage		68V	68V
Coil Resistance, 20°C in ohms		580 ± 8%	580 ± 8%
Contact Pressure in Kg /cm ²	Main contacts	> 0.65	>0.65
Contact gap in MM	Main contacts	22 ± 2	8.5 ± 1
Voltage Variation		68 to 136 V	68 to 136 V
Weight in Kg.		3	3
Auxiliary contacts		3 N/O 3 N/C	3 N/O 3 N/C
Observation		With magnet Valve type NC-4 (Modified)	-

CONTACTOR		FOR TM COOLER BLOWER MOTOR	FOR VACUUM PUMP MOTOR	FOR STARTING ARNO
References		C 105, C106	C-111-121 C-112-122	C-118
Manufacturer		CLW	CLW	M/s Plasto Industries
Type and number for one locomotive		EMC-1- 1968 64A-3P (2)	EMC-1- 1968 64A- 3P	-
Voltage of Utilisation Circuit		380V	380V	380 ± 22.5% V
Di- Electric Test 50 C/S 1 min.	Between Main Circuit and Earth	2850V	2850V	3.25KV
	Between High and low voltage circuit	2850V	2850V	3.25KV
	Between low voltage circuit and Earth	1500V	1500V	2 kV
	Between contacts opened	2250V	2250V	3.25KV

CONTACTOR		FOR TM COOLER BLOWER MOTOR	FOR VACUUM PUMP MOTOR	FOR STARTING ARNO
Minimum operating Voltage		68V	68V	68V
Coil resistance at 20°C		580 ± 8%	580 ± 8%	95 ± 8%
Contact Pressure in Kg/Cm ² .	Main contacts	> 0.65	> 0.65	7.5
	Auxiliary Contacts	-	-	0.08 ± 0.01
Contact gap in MM	Main contacts	8.5 ± 1	8.5 ± 1	17 ± 1
	Auxiliary contacts	-	-	5
Voltage Variation		68 to 136V	68 to 136V	60 to 136V
Weight in Kg.		3	3	30
Auxiliary contacts		3 N/O 3 N/C	3 N/O 3 N/C	2 N/O 1 N/C
Observation		-	With mechanical interlock	-

* * * * *

CHAPTER 2

INSPECTION SCHEDULES

Inspection schedules for electromagnetic contactors are described as under.

2.1 MINOR SCHEDULE - IA/IB/IC.

Following checks should be carried out.

1. Check condition of Arc-chutes for any overheating of EMC coil.
2. Check condition of fixed and mobile contacts and thickness etc.
3. Check free movement of contactors and auxiliary interlocks.
4. Check tightness of incoming and outgoing cables, coil connections and interlock connections.
5. Check contact gap ($8.5 \pm 1\text{mm}$), bedding and crushing of main and auxiliary contact ($8.3 \pm$ to 4.3mm).
6. Check main and auxiliary contact cleaning and polish if required.
7. Ensure provision of auxiliary interlock dust cover.

8. Check condition of cable lugs for any crackness, poor crimping etc.
9. Check function of C118 timer.
10. Clean the dust on the equipment.

2.2 MAJOR SCHEDULE (AOH/IOH)

In addition to above following checks to be carried out.

1. Check coil resistance.
2. Check coil for inter turn short.
3. Replace fixed and movable contacts.
4. Check pick up voltage as 65 ± 5 volt DC.
5. Check drop out voltage. It should be 20 to 10 volts DC.
6. Check IR value. It should be 10-mega ohm (minimum) with 500V megger.
7. Check main and auxiliary pressure. It should be 650 to 800 gms and 80-120gms respectively.
8. Check condition of blow out coil and flexible copper shunt.
9. Check working operation of EMC for double step/sluggish operation.

2.3 INSPECTION SCHEDULES AT A GLANCE

S. No	PART	INSPECTION DETAILS	I A	I B	I C	AO H	IO H
1.	Main Contacts	i. Clean main contact tips with dry clean rag. ii. Remove the flash marks. iii. Verify proper bedding. iv. Measure contact wear. v. Check the crushing. vi. Wash with petrol and replace, if necessary	*	*	*	*	*
			*	*	*	*	*
			-	*	*	*	*
			-	-	*	*	*
			-	-	*	*	*
			-	-	-	-	*
2.	Auxiliary Contacts	i. Check for proper fixation and operation ii. Clean contact tips. iii. Check for proper alignment. iv. Wash the contacts with petrol.	*	*	*	*	*
			-	-	*	*	*
			-	-	*	*	*
			-	-	-	-	*

S. No	PART	INSPECTION DETAILS	I A	I B	I C	AO H	IO H
03.	Copper Shunts	i. Check for damage or loose connection. ii. Check for flexibility. iii. Renew, if cut or worn out. iv. Change, if shunt is discoloured.	*	*	*	*	*
			-	*	*	*	*
			-	*	*	*	*
			-	-	*	*	*
04.	Bearing	Clean the journal bearing with petrol.	-	-	-	*	*
05.	Arc Chute	i. Check for tightness. ii. Clean the carbon and copper deposits. iii. Dismantle into two halves and clean. Replace, if more than half thickness effected with crater.	*	*	*	*	*
			-	-	*	*	*
			-	-	-	*	*
06.	Blow out coil	i. Tighten connection. ii. Check for overheating marks and damage. iii. Check for cracks on insulating support. iv. Dismantle & clean with petrol.	-	*	*	*	*
			-	*	*	*	*
			-	-	*	*	*
			-	-	-	*	*

S. No	PART	INSPECTION DETAILS	I A	I B	I C	AO H	IO H
07.	Operating mechanism	i. Check the play of insulated shaft. ii. Check free motion of armature. iii. Verify armature not fouling with parts. iv. Rotate the core. v. Renew armature, if deformed.	-	*	*	*	*
08.	Magnetic Circuit	i. Clean the coil with petrol. ii. Paint with air drying varnish, if insulation is deteriorating.	-	-	-	-	*
09.	Economy resistance	Clean and check for cracks.	-	*	*	*	*
10.	Cronometric relay	Overhaul and lubricate	-	-	*	*	*
11.	Bolts, nuts and screw	Tighten the nuts and fixing screws.	-	*	*	*	*
12.	Dusting.	Clean the dust with compressed air from all parts of the coil.	-	*	*	*	*
13.	Lubrication	Lubricate shaft bearing	-	-	-	*	*

2.4 CHECK SHEET FOR TESTING OF C118 CONTACTOR

S. No	ITEM	STANDARD VALUE	OBSERVED VALUE
01.	Resistance of magnetic coil at 20°C	95 ± 8% ohms	
02.	Closing Voltage of operating coil	Minimum 57 Volts	
03.	Check for 1. Dusting. 2. Cleaning of insulating parts and contacts. 3. Maintenance of arc chutes of blow out coil. 4. Free operation of mobile contact. 5. Free movement of armature. 6. Simultaneous operation of auxiliary contacts and main contacts.	To be done To be done To be done To be checked To be checked To be checked	

S. No	ITEM	STANDARD VALUE	OBSERVED VALUE
04.	Mechanical pressure of contacts 1. Main contact 2. Aux. Contact	5 to 6.75 kg 80 ± 25% grams	
05.	Endurance test to check corrects operation for 20 closings per minute by applying voltage from 68 to 136 Volts.	To be done by varying voltage each time.	
06.	Working of time lag contact.	To be checked for 3 seconds	
07.	Lubrication of moving parts with "Mobil oil A".	To be done	

CHAPTER 3

MAINTENANCE

3.1 REASONS OF FAILURES

Excess heat, switching surge voltages, discontinuity/ Poor continuity in electrical circuit and vibrations are the main reasons of contactor failures. This can be due to poor workmanship/ incorrect maintenance practices/ wrong operation. Therefore special attention should be paid towards following points.

3.1.1 Cleanliness

Clean all apparatus enclosed in dust proof boxes and cupboards by wiping them over with a brush or a soft clean non-fluffy cloth. Ensure that no particles of cloth remain on contacts, which might cause electrical failure.

When applying lubricant to apparatus, wipe off any oil that may have inadvertently got on to insulation surfaces.

3.1.2 Tightness of bolts, screws and nuts

Before the equipment is placed in service for the first time, ensure that all bolts, screws, nuts on terminals and contacts are tight. Repeat this check at the end of one week and at the end of 3,6,9 and 12 months service operation, because there is a tendency for connections and contacts to “settle” and loosen, due to the heating and cooling cycles to which they are subjected.

3.1.3 Contactors

Operate all contactors manually or by the normal electrical control. Ensure that there is no sluggishness in the operation or in the knuckling device. Ensure that there is no weakening of the knuckling spring. If there is any difficulty in restoring a contactor to normal, it should be replaced by a new or reconditioned contactor. Ensure that the correct combination of electric interlocks is fitted. Ensure that the correct bore diameter are used for the magnet valve.

3.1.4 Relays

Operate all relays manually or by the normal electrical control and ensure that there is no sluggishness in operation. If there is any difficulty in restoring, it should be replaced by a new or reconditioned relay. In case of replacement, care should be taken to ensure that the correct combination of contacts is fitted, and that it is identical in all other respects with the relay that it replaces.

3.1.5 **Contactors Contacts**

- Remove copper beads that may have formed during arc rupture with a smooth file.
- Clean the contact surface and file, if necessary.
- When any contact is worn to half its original thickness, it should be replaced with new contact.

3.1.6 **Silver Contacts**

- Contact surfaces with a black tarnish, caused by the formation of silver sulphide should not be disturbed since the tarnish is not detrimental.
- If appreciable transference of silver from one contact to the other has taken place, the contacts may be lightly filed to restore the normal surface. Do not use emery or glass paper because small particles may cause electrical failure.

3.1.7 **Control Contact Fingers**

- Check the contact pressure and ensure that it is within the specified limit.
- Renew the pressure spring if, tension is found less.
- Check that there is adequate over travel to ensure positive contact.
- Check that the contact gaps are not less than the specified minimum values.

3.1.8 Flexible Copper Braid

- Check that the braids are free of kinks, and there is no restriction to their normal movement.
- Examine carefully for any cuts or any loose strands. Replace braids, which are badly cut or damaged.

3.1.9 Arc Chutes

- Ensure that there is adequate clearance between the moving contact and the side of the arc chute.
- Remove any copper braid inside of the arc chute with a smooth file and clean the same.
- Replace the arc chute, which is badly eroded.
- Check that it is in its correct position and securely fixed.

3.1.10 Verification of contactors

Contacts

Observe free operation of main contacts. There should be no infringement of movable contacts with arc chutes.

Armature

Ensure that the armature moves freely and is properly secured and does not foul with any part of the magnet assembly.

Auxiliary contacts

Simultaneous operation of auxiliary and main contacts to be checked and adjusted, if necessary.

3.1.11 Couplers

Check that jumper, cables and coupler, contacts are in sound condition. Check that the interior of the coupler is free from any foreign material, and that the coupler castings are not damaged.

3.1.12 Resistors

- Clean either by vacuum method or blow out by dry compressed air. Clean insulated parts with a dry cloth.
- Inspect resistors and associated terminals for damage and overheating. Replace parts, if necessary.

3.1.13 Lubrication of End Support Assemblies

Assemblies should be lubricated with 'Mobil Oil A' during thorough inspection as well as during each overhaul.

3.2 CHECKS DURING REMOVAL AND REMOUNTING

Verify that alignment of the main moving contact with respect to the fixed contact. It should not be out by more than 1.5mm. Distance between main pole centre of main contacts of the contactor (Alsthom contactors three-pole type) should be 40.00 mm.

Allowable slackness diametrical	:	0.5mm
Allowable slackness Laterally	:	0.2 to 0.5 mm

The air gap of the auxiliary contacts should be approximately 2mm in open position. The main contacts should be opened, when clearance between core and armature becomes 2mm. Tolerance may be given as -0.5, + 0.0.3.2

3.3 TIME LAG CONTACTS TYPE DI 1622V

Main parts of this contactor are shown in figure 3.1. Time lag of this auxiliary contact is very effective during the opening of the contactor. The bolt must be adjusted in such a way that, with the auxiliary contacts completely loaded, the indicator is brought to the time lag required.

Loosen the lock nut of the roller-carrying lever when the indicator is on the required time lag. Adjust the position of lever by means of its teeth in such a way that the contactor is properly closed. The elastic control lever must slightly move from its support. Once the adjustment is completed, nut of the roller-carrying lever must be tightened and locked.

3.4 TESTING OF ELECTROMAGNETIC CONTACTOR

3.4.1 Mechanical Tests

(a) **Main contact**

The actual pressure of main contact should be 1000 ± 100 gms.

(b) **Auxiliary contact**

The contact pressure of auxiliary contacts either at normally open or normally close should be $80 \pm 10\%$ gms.

3.4.2 Electrical tests

(a) Coil resistance at 20°C should be $580 \pm 8\%$ ohms when measured with an instrument of accuracy $\pm 0.5\%$.

(b) **Verification of mechanical working**

The correct operation of each contactor should be checked at ambient temperature for 20 closing per minute working in succession within the voltage range of 68 to 136 V.

3.4.3 Dielectric strength test

- (a) 1500V, 50Hz, AC to be applied for one minute between the operating coil/auxiliary switches and the earth body.
- (b) 2850V, 50 Hz, AC to be applied for one minute between all the main contacts shorted and the earthed auxiliary circuit & body.
- (c) 2250V, 50Hz, AC to be applied for one minute between the open main contacts, the arc-chute being in position.

3.5 CHECK SHEET FOR TESTING OF ELECTRO-MAGNETIC CONTACTORS

S.No.	Checks	Standard
1.	Check the defect reported by driver or maintenance staff.	
2.	Megger between phase, coil and shaft to earth.	10 M Ω
3.	Check visually for crack, damage and flashing.	No crack and damage.
4.	Check tightness of all connections	Perfect
5.	Check contact gap.	8.5 \pm 1mm
6.	Check crushing of contact.	4 \pm 3mm
7.	Check contact pressure.	600 to 850 gm
8.	Check contact bedding.	85 % min.
9.	Check pole to pole distance.	30 to 40 mm
10.	Check pick up voltage	68 volt.
11.	Check drop out voltage	20 to 10 volt.
12.	Check coil resistance	580 \pm 8% Ω

S.No.	Checks	Standard
13.	Inter-turn short circuit test to be done.	To be perfect.
14.	Surge testing to be done.	To be perfect
15.	Check auxiliary inter-lock contact pressure.	80 to 120gm.
16.	Check the thickness of contact tips.	New - 3mm Min. - 1.5 mm
17.	Check the play between armature and yoke.	1mm
18.	Check the distance between core and armature.	2 mm - 0.5 + 0 mm
19.	Check simultaneous closing of 3-phase contact by delay timer of Slazer Electronics as given in appendix-A.	Perfect
20.	Check humming during working condition.	No humming
21.	Check coil locking for play.	Perfect
22.	Check the condition of shunt.	Perfect

3.6 COMMON DEFECTS, CAUSES AND REMEDIES

S.No	DEFECT	CAUSES	REMEDIES
01.	Flashing and pitting of EMC tips.	1. Mostly accompanied with auxiliary motor failure. 2. Improper bedding.	1. Maintain proper bedding during IC, AOH and IOH 2. Replace worn out contact tips.
02	Auxiliary interlock not closing. Hence 6 th notch tripping in locomotive.	Poor contact in auxiliary interlock.	Check contact pressure and replace, if required.
03.	Coil burnt and opens circuited.	Inter-turn short circuit.	Change with new coil, which has with stood in burn-in-test.

S.No	DEFECT	CAUSES	REMEDIES
04.	Coil not picking, late picking or ageing.	Weak magnetism of coil due to ageing or jamming of mechanism.	<ol style="list-style-type: none"> 1. Check the smoothness of mechanism and lubricate, if required. 2. Check coil condition and replace if necessary
05.	Coils getting shorted	1. CCA melting	Measure coils resistance and replace defective coils.

3.7 DEFECTS AND REMEDIAL ACTION FOR C118 CONTACTOR

SR. NO	DEFECT	REMEDIAL ACTION
01.	QCVAR interlock on C118 branch getting flashed due to interruption of high current.	QCVAR inter lock to be cleaned with "OKS" contact cleaner.
02.	C118 chromatic switch nylon stem is getting dropped in service.	During over hauling & IC ₀ schedule arraldite to be applied between the stem & metal base.
03.	Auxiliary switch made of "Bakelite", material broken.	Replace with switch made of nylon during overhauling (AOH/IOH)

3.8 DO'S AND DON'TS

3.8.1 Do's

1. Do avoid short circuit by properly insulating the leads, coils etc to meet switching surge voltage.
2. Do use cleats to prevent rubbing of connecting cables/leads.
3. Do measure MV drop across crimped termination and joints.
4. Do keep equipment clean from inside & outside.
5. Do ensure desired-contact area, cleaning and contact pressure periodically of contactors, relays, interlocks etc.
6. Do prepare & follow correct methodology for crimping.
7. Do ensure safeguard against switching surges, vibrations and poor continuity of electric circuit to control earth faults and short circuits.
8. Do use correct part number for electronic components.

9. Do check good condition of joints with the help of its colour.
10. Do open relays, interlocks etc., in the test rooms only.
11. Do provide knobs in relays for wedging by drivers.
12. Do maintain minimum 1mm gap between dust cover and moving contact.
13. Do set contact forces to maximum and use special tools at the time of maintenance.
14. Do over stretch test carried out on spring during AOH/IOH/POH.
15. Do use sleeves or sockets at the end of each FLEXIBLE to prevent rubbing.
16. Do use correct size and dimensions of parts, bolts/screws, fixing insulators etc.
17. Do use specified oils and lubricants periodically.
18. Do carry out failure/defect analysis.
19. Do replace rubber seals/ gaskets, split pins etc. in every overhaul and periodic schedule.
20. Do replace components/equipment on life basis.

21. Do repair equipment if economical.
22. Do you know that a repaired equipment has less reliability and less life as compared to new equipment.
23. Do maintain statistics in failure analysis of particular loco. i.e. detecting repetition of failures, details of failure, design, make, speed at the time of failure, date of failure, details of last maintenance done, name of artisan staff, relation with modification suggested & implementation, name of the driver, particular location, manufacture year of equipment.
24. Do advise to manufacturer for first year failure as feed back for improving manufacturing process, design etc.
25. Do read details of maintenance practices suggested by manufacturer.
26. Do train the staff about the use of tools and instruments for job, which they are doing.
27. Do motivate the staff.
28. Do promote positive attitude.
29. Do improve working environment by providing sufficient light, space, cleanliness, and ventilation.
30. Do follow laid down maintenance procedures.

31. Do maintain tolerance and clearances within permissible limits.
32. Do review followed maintenance practices and staff skills.
33. Do arrange inspection of work by independent agency.
34. Do prepare the boards of perfect drawings by carefully indicating tolerance/clearances, material specification, testing procedures, trade mark marking on the components, new and condemning sizes, date of manufacture etc.
35. Do update description and annual average consumption of stock items regularly.
36. Do make use of user code.
37. Do inspect the materials as per drawings and specification.
38. Do store rubber material in a place, which is well ventilated, free from dust, moisture & sunlight.
39. Do sprinkle chalk powder on rubber material, seal in polythene bag.
40. Do use rubber material on first in first out basis.

41. Do use improve communication system while issuing instructions.
42. Do increase availability of good tools, equipment, and genuine spare parts.
43. Do review type of equipment used in material handling and the procedures adopted.
44. Do use quality circles, brain storming, and reliability engineering and other management techniques.
45. Do meet officers/supervisors to give feed back.
46. Do plan your work and time.

3.8.2 Don'ts

1. Don't lubricate contactor, pivots or relay mechanism except as scheduled.
2. Don't use sand paper/emery cloth for cleaning of contacts as emery dust can remain between contacts.
3. Don't touch the contacts either by hand or clothe after final cleaning.
4. Don't use bolts/screws of normal diameter less than 10mm made of steel of CLASS lower than 8.8 because they can get over stressed during tightening.
5. Don't mix lubricants of different makes.
6. Don't disturb contact surfaces, which are bright but may be rough and pitted.

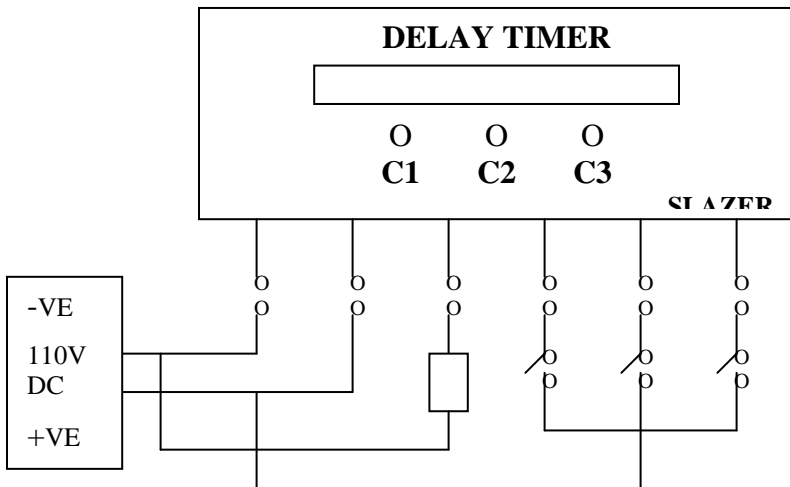
Appendix-A

Slazer Electronics Delay Timer for testing Electromagnetic Contactor

SPECIFICATION

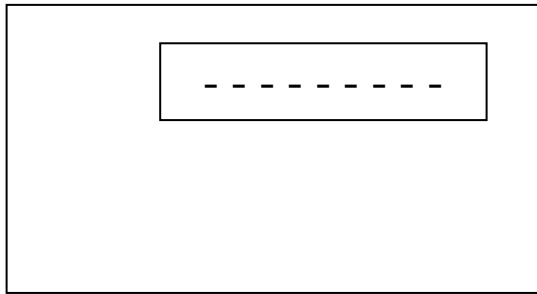
1. Supply 110 volt DC, 50 milli-ampere(Maximum).
2. Display of ON/OFF/ in milli-seconds.
3. Four digit seven segment display for time.
4. LED indication of display for three contactors C1, C2, C3.

CONNECTION DIAGRAM

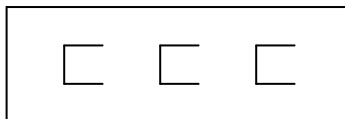


DISPLAY SEQUENCE

1. Coil OFF or power ON



2. Coil ON: Display blank, all the three contactors ON
3. Time for contact C1
4. Time for contact C2
5. Time for contact C3
6. Display time for contact C1
7. Display time for contact C2
8. Display time for contact C3
9. Display time gap



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Southern Railway, Chennai - 600003
13. Chief Electrical Loco Engineer
S.C. Railway, Secunderabad - 500071
14. Chief Electrical Loco Engineer
Eastern Railway, Fairly Palace, Calcutta- 700 001
15. Chief Electrical Loco Engineer
South Eastern Railway, Garden Reach, Calcutta - 700
16. Chief Electrical Loco Engineer
Northern Railway, Baroda House New Delhi -110 001

Institutions

17. Principal,
Railway Staff College, Vadodara - 390 004The
18. Director,
IRIEEN, P.Box. No. 233, Nasik Road - 422 101.
19. Principal ,
C.E.T.I. Central Railway, Thakurli
20. Principal,
Electric Loco Training Centre, SE Railway, Tatanagar

Chief Works Managers

21. Central Railway Traction Motor Workshop, Nasik Road - 01
22. POH Workshop, Central Railway, Bhusawal - 425201
23. POH Workshop, Eastern Railway, Kancharapara.
24. Traction Motor Shop,
Northern Railway, Kanpur - 208001
25. POH Workshop,
Northern Railway, Charbagh, Lucknow.
26. POH Workshop,
South Eastern Railway, Perambur, Chennai.
27. POH Workshop,
South Eastern Railway, Karagpur (W.B.)
28. Chitaranjan Locomotive Works, Chitaranjan, (W.B.)

Sr. DEE/TRS, Electric Loco Sheds

29. Central Railway, Jhansi (U.P.)
30. Central Railway, Bhusawal - 425201.
31. Central Railway, Ajni, Nagpur - 44000
32. Central Railway, Itarsi (MP)
33. Central Railway, Katni (MP)
34. DCLS, Central Railway, Kalyan (Maharashtra)

35. South Eastern Railway, Tatanagar - 831002 (Bihar)
36. South Eastern Railway,
Bhilai Marshalling Yard, Bhilai-01
37. South Eastern Railway, Waltier - 530 001
38. South Eastern Railway, Bondamunda (Orissa)
39. Electric Loco Car Shed,
South Eastern Railway, Tikiapara.
40. Eastern Railway, Mugalsarai - 232 102
41. Eastern Railway, Asansole - 713 301
42. Eastern Railway, Gamoh (Bihar)
43. Northern Railway, Kanpur - 208 001
44. Northern Railway, Gaziabad - 201 001
45. South Central Railway, Vijayawada - 520 001
46. South Central Railway, Lallaguda, Secunderabad.
47. Western Railway, Varodara - 390 002
48. Western Railway, Valsad (Gujrat)
49. Western Railway, Tuglakabad , New Delhi - 110 044
50. Southern. Railway, Arakkonam (Tamil Nadu)
51. Documentation Centre/CAMTECH.
52. Library/CAMTECH.

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1. Maintenance Manual of CLW for WAM4, WAG5, WAP1 Locomotives.
2. Maintenance Manual of BHEL for WAG5 Locomotives.
3. AC Traction Manual.
4. Comments/Suggestions given by RDSO.
5. IRIEEN Journals.
6. Comments/Suggestions given by CETI/THK.
7. Comments/Suggestions given by various sheds during visit as well as during seminar.
8. Electric Locomotive POH check sheet.

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