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PREPARED BY : DESIGN DEPT

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3 PHASE MASTER CONTROLLER

TECHNICAL MANUAL

As per CLW Specification No: CLW Specification No: CLW/ES/3/0031 ALT-I

THE FIRST AND ONLY
TOTALLY INDEGINOUSLY DESIGNED MASTER CONTROLLER
FOR
3 PHASE ELECTRIC LOCOMOTIVES

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Doc Name: 3PMC – TECHNICAL MANUAL

05/05/2020



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1. Introduction

The 3 Phase Master Controller is designed as per CLW Specification No: CLW/ES/3/0031 ALT-I. It is used in WAG9,WAP7 & WAP 5 class of 3 Phase electrical locomotive. The Master Controller is the heart of the locomotive and allows the loco pilot

- a. To select the drive direction of the locomotive i.e. forward or reverse
- b. Regulate the tractive & breaking effort of the locomotive.

The master controller has been designed indigenously by using the latest angle position transmitter along with field proven cam switches. The 3 phase master controller complies with IEC 60571 & 60077.

2. Mode of operation

There are three major functional components in the Master Controller

- a. Drive Direction Selector
- b. Drive Break Handle
- c. Angular Position Transmitter.

a. Drive Direction Selector / Reverser :

The drive direction selector has three positions **F – 0 – R**.

0(Neutral) – In the 0 position the locomotive is stand still. In this condition switches 201,202,203&204 are in open condition.

F (Forward) – In the F position the locomotive gets driven in Forward direction. In this condition switches 201 & 202 are in closed condition & forward signal is sent to VCU (Vehicle Control Unit)

R (Reverse) – In the R position the locomotive gets driven in Reverse Direction. In this condition switches 203 & 204 are in closed condition & reverse signal is sent to the VCU (Vehicle Control Unit)

b. Drive Brake Handle / Throttle Handle :

The drive brake handle has 3 regions of operation:

1. **Zero Position.**
2. **Traction Region / Traction Side**

3. Breaking Region / Breaking Side

If the drive break handle is moved from the zero position to the traction region tractive effort is generated & if moved from zero to the breaking region braking effort is generated. The tractive & breaking efforts are proportionally varied with respect to the position of drive break handle. The position of the drive break handle is read by the angle position transmitter by sensing the angle of rotation of drive brake handle from the 0 position & gives out corresponding current output w.r.t to the position of the shaft. Further the current output is read by VCU (Vehicle Control Unit) which in turn controls the tractive effort and braking effort. The drive break handle position is also sensed by using cam switches at pre-defined position which act as a feedback mechanism to cross check the functioning of the angle position transmitter.

The various positions of drive break handle and their corresponding outputs are detailed below .

<u>Traction Region</u>			<u>Drive Break Handle Position</u>	<u>Braking Region</u>		
<u>Switch Open/Close</u>	<u>Switch ID</u>	<u>Current Output</u>	<u>0</u>	<u>Current Output</u>	<u>Switch ID</u>	<u>Switch Open/Close</u>
Open	101,102, 103,104	2mA	0	2mA	101,102, 103,104	Open
Closed	101	3.9 mA - 4.9 mA	15 th Position	3.4 mA - 4.4 mA	102	Closed
Closed	101,103	8.6 mA - 9.6 mA	1/3 rd Position	8.2 mA - 9.2 mA	102,103	Closed
Closed	101,103, 104	14.6 mA - 15.6 mA	2/3 rd Position	14.2 mA - 15.2 mA	102,103, 104	Closed
Closed	101,103, 104	19.75 mA - 20.25 mA	Traction Max(TEmax) or Breaking Max (BE max)	19.75 mA - 20.25 mA	102,103, 104	Closed

The Traction Max (TE max)& Breaking Max (BE max) are limited by mechanical stoppers & hence the drive break handle does not go beyond these regions.

c. Angular Position Transmitter :

The angular position transmitter (sensor) is the heart of the Master Controller. It sense the rotation of the drive break handle and gives out a precise current output corresponding to the position of the drive break handle, w.r.t to the zero position, either in traction or breaking side. The angular position transmitter used in Saitronix make master controller is our proprietary which incorporates the latest Hall Effect sensing technology to measure the angle. Further the output can be configured as per the customer requirement.

3. Construction

The master controller has 4 major mechanical modules 1. Drive Direction Selector 2. Cam shaft 3. Drive break handle 4. Locking lever along with front & rear bearing plates. All these modules are bolted to a common plate which is called top cover.

The drive direction selector(reverser) comprises of the following parts:

The drive direction selector switch is designed using filed proven cam switches.

The drive direction selector switch is fixed to a support plate which is bolted, on 4 spacers, to the plate. The spindle of the switch which houses an oscillator controls the interlocking between the drive direction selector & drive break handle. It also has two MS cam which operate the cam switches. There are two switches provided for redundancy for each direction which are as follows.

<u>Cam Switch ID</u>	<u>Drive Direction</u>
CS ID : 201 & 202	Forward Direction
CS ID : 203&204	Reverse Direction

The Center Shaft& Switch Mounting Beam Consists of Following:

The Center shaft is mounted between partition wall & transducer mounting plates on either sides. The bearing plates are fixed on to the top plate. It has 4 equally spaced MS cams press fitted & locked on shaft. The cam switches are mounted on the switch mounting beam which is in turn mounted on to the top plate. Each switch corresponds 15,1/3 ,2/3 position of the center shaft in both traction & braking side. The switch details are as follows

<u>Cam Switch ID</u>	<u>Center Shaft Position</u>
CS ID : 101	15 th Position In traction side.
CS ID : 102	15 th Position In Breaking Side

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CS ID : 103	1/3 rd Position in Traction & Breaking Side
CS ID : 104	2/3 rd Position in Traction & breaking Side

The Transducer Mounting Plate consists of :

The Transducer mounting plate consists of shaft clutch holder & angle position transmitter. The clutch holds the shaft and prevents it from skidding during vibration. The transducer mounting plate also consists of the circular connector & sub-d connector mounting plate.

The Drive Break Handle(Throttle Handle) consists of :

The drive break handle is located in the partition wall and is in a separate bearing carrier. On this shaft are the control lever and the locking disc. The drive break handle is linked to the center shaft by a spur gear transmission (1:3 ratio).

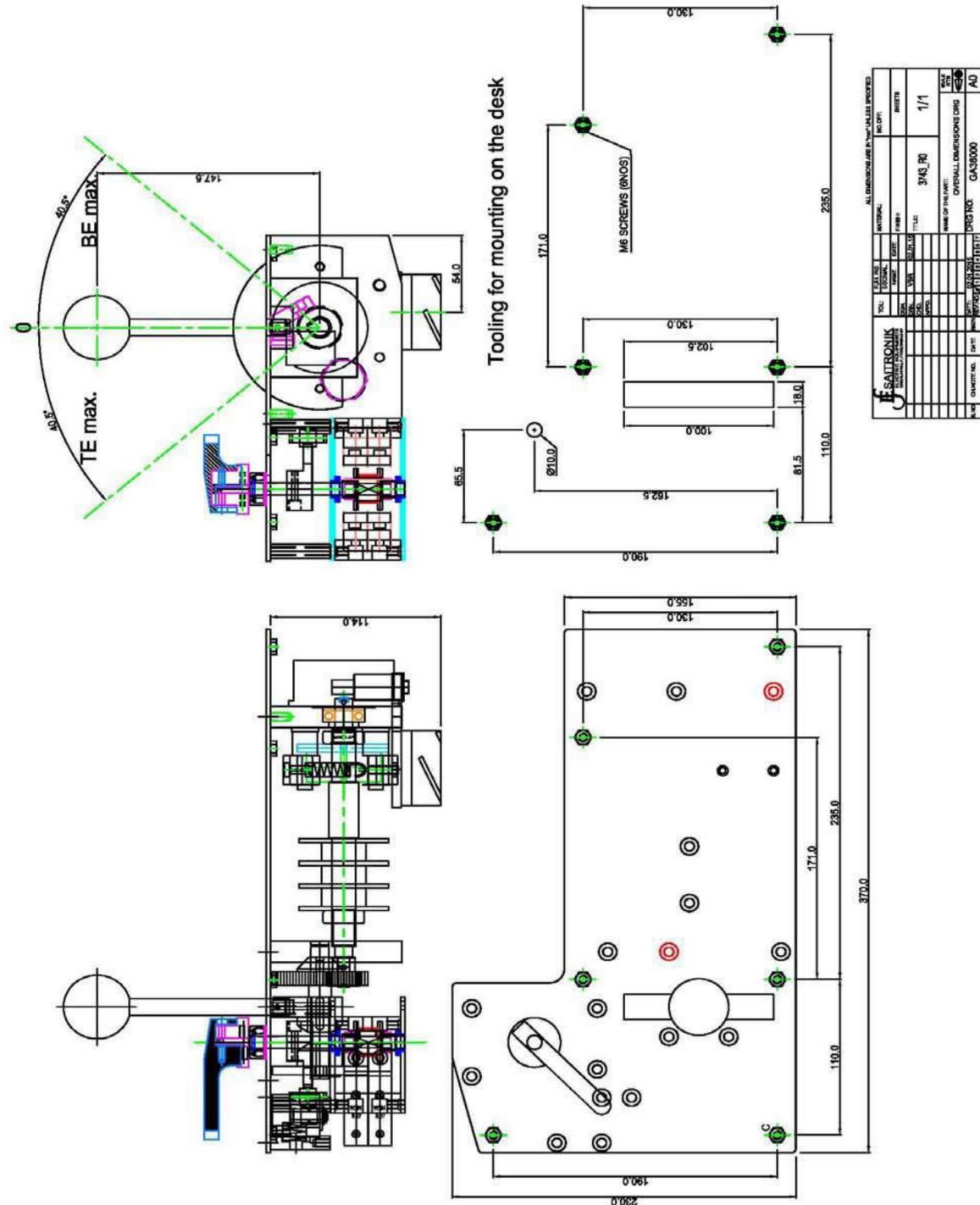
4. Technical data

Handle/selector	Position	Nº of auxiliary contacts	Angle converter
Drive direction selector	R, 0, F	4	No
Drive/brake handle	BE...0...TE	4	Yes

- | | | | |
|--|--------------------------|---------------------|---------|
| 1) F&R Switch Contacts | As per CLW Specification | 3TWD.101.138. | 4units |
| 2) Contact element | As per CLW Specification | 3TWD.101.138. | 4 units |
| 3) Angle converter type AT-36
Standard angular position transmitter | | AT-36 1 unit | |
| -Power supply | | 24 V DC / 50 mA | |
| -Output | | 20-2-20 mA (3 Wire) | |

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5. Dimensional Drawing



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6. Routine Inspection Procedure & Report

Tested By:

Verified By:

FINAL INSPECTION REPORT						
Visual, Electrical & Functional Testing Sheet of 3 Phase Master Controller				Pg:2 of 3		
REF: SPEC No - CLW/ES/3/0031/I		Model No:-3PMC-36-R0		Doc No : 36-FIR_01		
Customer:		PO No:	PO Dt:	Date of Inspection :		
Sl no	Type of test	Unit Sl Nos →				
3	Dimensional (Sl.No. 2 of Test Programme in sheet 7A of Specification)	Parameters	Specified Values	Measured Values to be noted as ↓		
		Length	370 mm ± 1.0mm			
		Over All Width-1	230mm ±1.0mm			
		Over All Width -2	155±1.0mm			
		Bottom Side -Mounting Hole CD Length wise	110mm± 0.5mm			
			235mm ± 0.5mm			
		Top Side -Mounting Hole CD Length wise	171mm ± 0.5mm			
		RHS Side - Mounting Hole CD Width wise	130mm ± 0.5mm			
		LHS Side - Mounting Hole CD Width wise	190± 0.5mm			
4	Contact elements and driving and Braking Drum Test (Sl.No. 2 of Test Programme in sheet 7A of Specification)	Contact force	1.6 N (163gms) -2.6 N (265gms)	Measured Ranges should be note		
		Contact opening	2.5mm - 4.5 mm			

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Tested By:

Date:

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Date:

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7. Calibration Procedure for Angle Transmitter

How to Calibrate Angle Transmitter

- To Calibrate Angle Transmitter make sure that **Drive Brake Handle/Throttle Handle is in Zero position.**



- Remove the **Magnet Holder** from the Master Controller as shown below using 12-13 D-Spanner or suitable screwdriver



- After removing the Magnet Holder Insert the **Magnet Holder in Magnet Holder Groove** of Angle Transmitter



Magnet Holder Groove Before Inserting Magnet Holder

After Inserting Magnet Holder into Magnet Holder Groove

d. Connect the Sub-D connector and Power ON the unit. The LED in Angle Transducer will glow in the Following sequence

- Green LED blinks one time



- Blue LED blinks 2 times



- Green LED blinks 6 times



After the 6th time remove the magnet holder from magnet holder groove.

e. After removal of magnet holder from the magnet holder groove then only successful calibration will happen. After successful calibration **GREEN LED** will be ON continually and the current meter will showing 2mA at drive break handle zero position.



f. Note: Cares During Calibration :

1. Magnet Holder shall be **firmly inserted in the Magnet Holder Groove.** Ensure that **during the entire calibration process Magnet Holder is not removed or moved from the Magnet Holder Groove.**
2. Drive Break Handle Shall be **constant at zero position.** Ensure that **Drive Break Handle is not moved due to vibration or manually during the entire calibration process.**
Above point 2 & 3 shall be followed from Step "a to e"
3. **At step "d" after 6th time green blinking has been completed - the magnet holder from magnet holder groove shall be removed.**

If Any of the above cares are not observed during the calibration process , the calibration process will fail. **Failure of Calibration process will be indicated by BLUE & RED LED Blinking.** If the calibration process fails the entire calibration process has to be restarted

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8. Maintenance Schedule

MAINTAINANCE SCHEDULE		
Period	Interval	Inspection/Maintenance Work
P1	1Month	No Inspection
P2	3Month	No Inspection
P3	12Month	1. Inspection & Cleaning of Auxiliary contacts. 2. Lubricating of Rotating/Sliding/friction parts. 3. Inspection &Tightening of screws, nuts & bolts if loosed Note: Special attention shall be given to rollers/springs / cam switches/nylon clutch to check
R1	3Years	<p>General Overhaul:</p> 1. Cleaning & lubrication of Parts 2. Parts Inspection for <ul style="list-style-type: none"> - Wear /deformation - Cracks - Plays - Corrosion - Surface Damage,Cracks - Cam switches and spring force. 3. - Inspection &Tightening of screws, nuts & bolts if loosed Note: Special attention shall be given to rollers/springs / cam switches/nylon clutch to check for any worn out/damage / carbonization and be replaced if necessary.
R2	6Years	<p>General Overhaul:</p> 1. Cleaning of Parts 2. Parts Inspection for <ul style="list-style-type: none"> - Wear /deformation - Cracks - Plays - Corrosion - Surface Damage,Cracks - Cam switches and spring force. 3. - Check Electrical wiring. 4. - Inspection &Tightening of screws, nuts & bolts if loosed Note: Special attention shall be given to rollers/springs / cam switches to check for any worn out/damage/carbonization and be replaced if necessary.
R3	10Years	<p>General Overhaul:</p> 1. Cleaning of Parts 2. Parts Inspection for <ul style="list-style-type: none"> - Wear /deformation - Cracks - Plays - Corrosion - Surface Damage - Cracks, Cam switch and spring force. 3. - Check Electrical wiring. 4. - Inspection &Tightening of screws, nuts & bolts if loosed Note: Special attention shall be given to rollers/springs / cam switches to check for any worn out/damage/carbonization and be replaced if necessary.

9. Trouble Shooting Guide.

<u>Sl.No.</u>	<u>Type of Problem</u>	<u>Probable Cause for Problem</u>	<u>Troubleshooting Procedure Steps</u>	<u>Result of Trouble Shooting</u>	<u>Corrective action</u>
DRIVE DIRECTION SELECTOR HANDLE OR REVERSER HANDLE PROBLEMS					
1.	Forward "F" Signal Not coming in VCU/DDU when reverse is kept in Forward Direction	1.Continuity across circular connector pin 1&2 , 1&3 is not coming	<p>1. Check Continuity on Master Controller 13 pin Male circular connector pin 1&2 ,1&3 either using continuity tester .</p> <p>2. Check wiring through continuity tester as per schematic between circular connector & auxiliary switches 201 & 202 .</p> <p>3. Check continuity across switch terminals .</p>	<p>If Continuity is ok</p> <p>If continuity is not ok</p> <p>If wiring is ok</p> <p>If continuity is not ok</p>	<p>Check signal continuity at VCU END (i.e. Digital IO card)</p> <p>Got to Step 2</p> <p>1.Check if Lug is broken. if Yes replace Lug 2.Check if wiring is interchanged correct the wiring as per schematic 3.If wiring cannot be interchanged replace circular connector</p> <p>Go to step 3</p> <p>Replace the switch.</p> <p>Enlarge the reverser hole on the driver desk by fileing or drilling.</p>
	2.Reverser switch is rubbing on the driver desk	Open the Top engraved Label and observer for any interference / obstruction of the driver desk on the free movement of the reverser key.		If it is rubbing on the driver desk	2)Go to Step 1
	3.If continuity is ok & 110V DC supply is not coming.	Open the Female connector coming from the loco & check between pin no. 1 & loco ground using tests lamp or DMM.		If 110 VDC is coming.	Check the loco battery supply voltage.
2.	Reverse "R" Signal Not coming in VCU/DDU when reverse is kept in Forward Direction	1.Continuity across circular connector pin 1&4 , 1&5 is not coming	<p>1. Check Continuity on Master Controller Male circular connector pin 1&4 ,1&5 using continuity tester</p>	<p>If Continuity is ok</p> <p>If continuity is not ok</p>	<p>Check signal continuity at VCU END (i.e. Digital IO card)</p> <p>Got to Step 2</p>

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			2. Check wiring through continuity tester as per schematic between circular connector & auxiliary switches 201 & 202 .	If Wringing is not ok	1.Check if Lug is broken. if Yes replace Lug 2.Check if wiring is interchanged correct the wiring as per schematic 3.If wiring cannot be interchanged replace circular connector.
				If wiring is ok	Go to step 3
			3. Check continuity across switch terminals .	If continuity is not ok	Replace the switch.
		2.Reverser switch is rubbing on the driver desk	Open the Top Engraved Label and observe for any interference of the driver desk on the free movement of the reverser key.	If it is rubbing on the driver desk	Enlarge the reverser hole on the driver desk by fileing or drilling.
		3. If continuity is ok & 110 V DC supply is not coming.	Open the Female connector coming from the loco & check between pin no. 1 & loco ground using test lamp or DMM	If 110 VDC is coming	Go to Step 1.
				If 110 VDC is not coming	Check the loco battery supply voltage

DRIVE BREAK HANDLE / THROTTLE HANDLE

3.	15 Position Signal is not coming in VCU /DDU	1.Continuity across circular connector pin For 15 Position :- (a) 1 to 6 (Traction Side) (b) 1 to 7 (Breaking Side)	1. Check Continuity on Master Controller Male circular connector pin 1&6(Traction side) or 1&7(Breaking Sid) using continuity tester.	If Continuity is ok	Check signal continuity at VCU END (i.e. Digital IO card)
				If continuity is not ok	Got to Step 2

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			2. Check wiring through continuity tester as per schematic between circular connector & auxiliary switches 101 for Traction or 102 for Breaking.	If Wringing is not ok	1.Check if Lug is broken. if Yes replace Lug 2.Check if wiring is interchanged correct the wiring as per schematic 3.If wiring cannot be interchanged replace circular connector.
				If wiring is ok	Go to step 3
			3. Check continuity across switch terminals 101(Traction) or 102(Breaking)	If continuity is not ok	Replace the switch.
		2. 110 V DC supply is not coming.	4. Open the Female connector coming from the loco & check between pin no. 1 & loco ground using tests lamp or DMM	If 110 VDC is coming	Go to Step 1.
				If 110 VDC is not coming	Check loco battery voltage.
4.	1/3 RD Position Signal is not coming it VCU /DDU	1. Continuity across circular connector pin 1/3 RD Position :- 1 to 8 (Traction/Breaking Side)	1. Check Continuity on Master Controller Male circular connector pin 1&8 either using continuity tester or test lamp.	If Continuity is ok	Check signal continuity at VCU END (i.e. Digital IO card)
				If continuity is not ok	Got to Step 2
			2. Check wiring through continuity tester as per schematic between circular connector & auxiliary switches 103(Traction/Breaking).	If Wringing is not ok	1.Check if Lug broken if Yes replace Lug 2.Check if wiring is interchanged . Correct the wiring as per schematic 3.If wiring cannot be interchanged replace circular connector.
				If wiring is ok	Go to step 3
			3. Check continuity across switch terminals 103 (Traction/Breaking)	If continuity is not ok	Replace the switch.

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5.	2/3 RD Position Signal is not coming it VCU /DDU	1. Continuity across circular connector pin 2/3 RD :- 1 to 9 (Traction/Breaking Side)	1. Check Continuity on Master Controller Male circular connector pin 1&9 either using continuity tester or test lamp. 2. Check wiring through continuity tester as per schematic between circular connector & axillary switches 104(Traction/Breaking). 3. Check continuity across switch terminals 104 (Traction/Breaking)	If 110 VDC is coming	Go to Step 1.
				If 110 VDC is not coming	Check loco battery voltage.
				If Continuity is ok	Check signal continuity at VCU END (i.e. Digital IO card)
		2.110 V DC supply is not coming.	Open the Female connector coming from the loco & check between pin no. 1 & loco ground using tests lamp or DMM	If continuity is not ok	Got to Step 2
				If Wrapping is not ok	1. Check if Lug is broken if Yes replace Lug 2. Check if wiring is interchanged . Correct the wiring as per schematic 3. If wiring cannot be interchanged replace circular connector.
				If wiring is ok	Go to step 3
6.	2mA current is not available at throttle handle zero position.	1.Either Calibration is not done.	1.Check if continuous Red & Blue color LED is blinking on Angle Transmitter or current meter is showing 2mA and current is not varying in traction and breaking side..	If continuity is not ok	Replace the switch.
				If 110 VDC is coming	Go to Step 1.
				If 110 VDC is not coming	Check loco battery voltage.
		1.Either Calibration is not done.	1.Check if continuous Red & Blue color LED is blinking on Angle Transmitter or current meter is showing 2mA and current is not varying in traction and breaking side..	Calibration is not done	Complete the calibration processes as detailed in the manual.
ANGLE TRANSMITTER PROBLEM					
6.	2mA current is not available at throttle handle zero position.	1.Either Calibration is not done.	1.Check if continuous Red & Blue color LED is blinking on Angle Transmitter or current meter is showing 2mA and current is not varying in traction and breaking side..	Calibration is not done	Complete the calibration processes as detailed in the manual.

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		2. Calibration position has been shifted.	2.Check by keeping throttle handle at zero position but current meter is showing other than 2mA & Green LED is continuous on.	Calibration is done but calibration position is shifted	Complete the calibration processes as detailed in the manual.	
7.	Current Output Is not available at VCU /DDU	1. Either Angle transmitter is problem.	1. Check for GREEN LED indication and current output Variation in traction and breaking side.	1.If no LED indications.	1.Check for Power Supply of 24V is available on pin no 3 & 9 . 2.If 24VDC is available then Replace Angle Transmitter & Do calibration	
		2.Either Cable connection is broken/Loose Contact.	1.Check for RED Blinking LED indication.	2.Current output is not varying from 2mA to 20mA in both traction and braking.	Do Calibration and if still current output is not varying from 2mA to 20mA , Replace Angle Transmitter & Do calibration	
		3. 24VDC Supply is not available.	1.Check if Green LED is ON.	Wiring on Sub-D pin no 5 or 9 is broken.	Change the loco wiring.	
		Master Controller Functionality problem.	1.Check Master Controller function with Test Jig.	Check for 24V DC supply on pin no. 3 to 9 using DMM	Check VCU Power Supply Card.	
8.	Angle Transmitter Failure Message on DDU.		1.Check Master Controller function with Test Jig.	IF Functional test Results ok	Check for Analog & Digital signals at VCU Digital & Analog Card.	
				IF Test Result is Not ok.	1. Got to SL.No. 3,4,5, if 15 or 1/3 rd or 2/3 rd signal is not coming. 2. Go to SL.No. 6,7 if angle transmitter is not working.	

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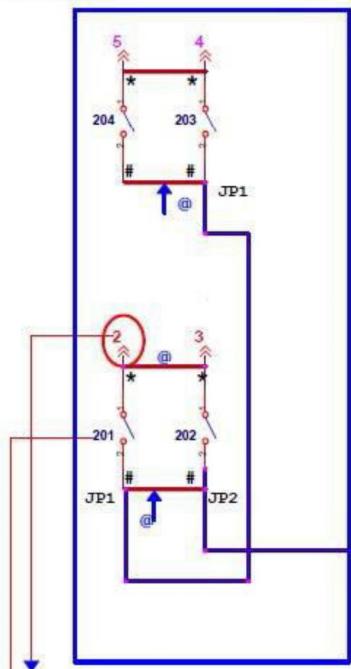
9.	Throttle Handle moves only in traction side or breaking side when reverser is at F or R position.	Reverser Handle is not fully placed in the Forward "F" or Reverser "R" side due to its rubbing on the driver desk.	Open the Top Label plate and observe for any interference/obstruction of the driver desk on the free movement of the reverser key handle.	If it is rubbing on the driver desk	Enlarge the reverser hole on the driver desk by filling or drilling.
		Rubber Gaskets hole is not as sufficient and obstructs the free movement of the Reverser Handle.	Open the Top Label plate and observe for any interference or obstruction by the gasket for the free movement of the reverser key handle.	If it is rubbing on the driver desk	Enlarge the rubber gasket hole being stucked on to the driver desk.

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10. Wiring Schematic

13 Pin circular connector wiring schematic:

DRIVE DIRECTION SELECTOR/REVERSER HANDLE

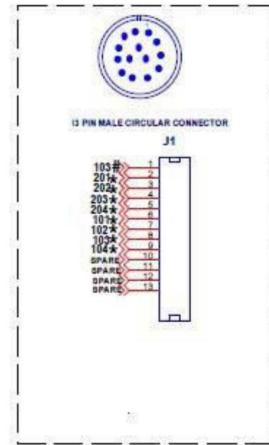
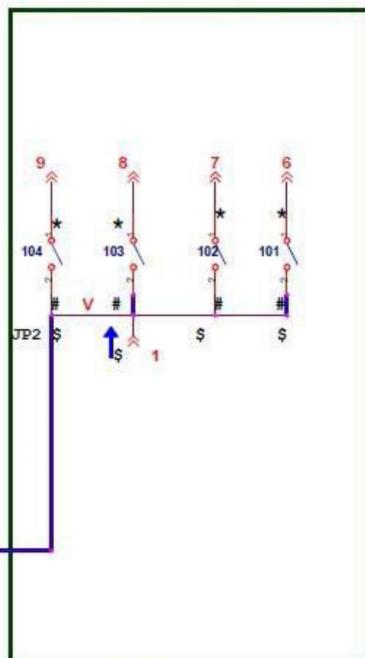


NOTE1: THE NUMBERS (2, 3, etc) WRITTEN FOR EACH SWITCH REPRESENTS THE PIN NUMBERS OF 13 PIN CIRCULAR CONNECTORS. REF. FIG J1.

NOTE2: THE NUMBERS 201, 202 REPRESENTS THE AUXILIARY SWITCH IDENTITY

@: TWO TERMINAL COPPER SHORTING LINK -4
 NOSS: FOUR TERMINAL COPPER SHORTING LINK -
 1NO

DRIVE BRAKE HANDLE/THROTTLE

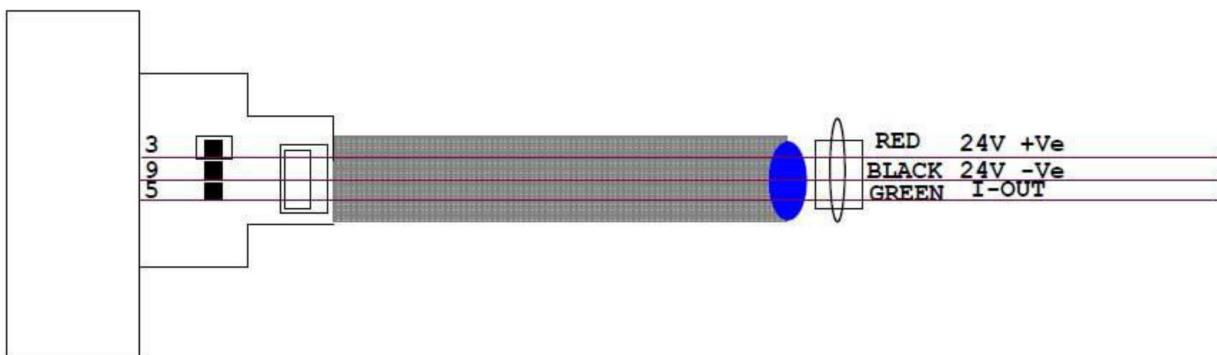


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3PHASE MASTER CONTROLLER

Size	Document Number	Rev
Custom	WIRING DIAGRAM OF 3PMC-36	0
Date	21-04-2016	Sheet

9 pin sub-d connector wiring schematic.



11.Loco Fitment/Mounting Cares to be exercised.

- Ensure that the driver desk cut out for Reverser Handle and Throttle Handle Drum shall be maintained sufficiently such that the Reverser handle and Throttle handle do not rub on the driver desk after mounting. If Reverser / Throttle Handle are rubbing on driver desk ensure to increase the diameter & width of cutout either through filing or drilling.
- The hole on the rubber gasket shall be sufficient so that it does not obstruct the movement of the reverser handle.
- Ensure that the Master Controller is earthed properly through earthing cable.
- While removing the master controller ensure that earthing cable is first removed , before removing the master controller.
- Ensure that all the mounting holes are matched before tightening the mounting screws of the master controller.

12.Tools

Sl. No.	Operation	Tools Required
1	To remove M4 grub or pan head screw of F&R Handle	Screw driver(-),Ellen key 2mm
2	To remove M6 CSK ellen screws of engraved lable.	Ellen key 4mm
3	To remove magnet holder	12-13 d-spanner
4	To remove M6 CSK Ellen mounting screws	Ellen key 4mm
5	To remove M6 socket head screws of circular connector.	Ellen key 5mm
6	To remove M4 socket head ellen screws of angle transmitter.	Ellen key 3mm
7	To remove M3 sub-d connector.	Ellen key 2.5mm
8	To remove M10 Earthing lug.	10-11 d-spanner
9	To tighten or removing Auxiliary switch terminal nuts.	M5 nut driver / 8-9 d spanner
10	To check functionality of master controller	Test jig
11	to check continuity across circular connector pins or switch terminals	Continuity tester.