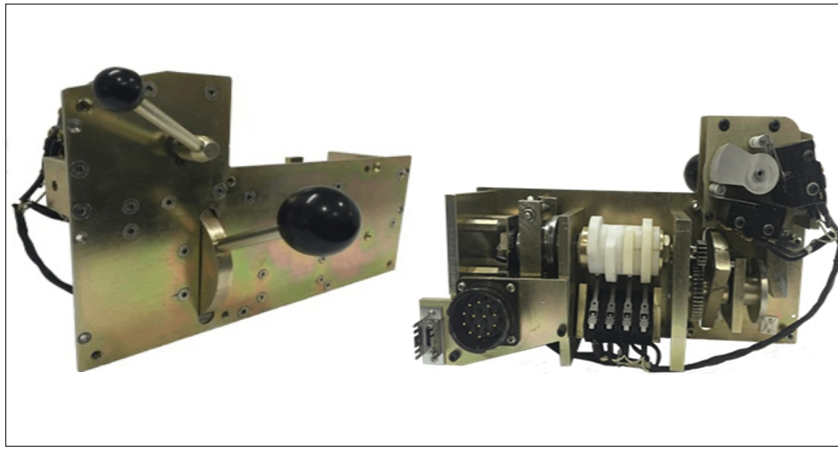
MASTER CONTROLLER FOR 3-PHASE LOCOMOTIVES

ARC/MCU/V1.0

USER MANUAL

Release V.1.0

January, 2019



ADVANCED RAIL CONTROLS PRIVATE LIMITED

#59/1-2, 1 & 2 FLOOR (ABOVE BANK OF INDIA), G-BLOCK,

80 FEET MAIN ROAD,SAHAKARANAGAR

BANGALORE-560092

INDEX

IMPORTANT NOTICE

This is a sophisticated microprocessor based equipment and can be serviced only by trained skilled personnel. Opening the equipment by any unauthorized person will make the warranty null and void

1.0 Introduction

Master controller used in three phase locomotives class WAG9, WAP5 & WAP7 Locomotives provides tractive effort & braking effort reference (TE/BE Demand) to the traction converter. This equipment is also referred as Throttle. The TE/BE Demand is generated by the driver by moving the handle up or down smoothly. While moving in 'UP' direction, TE demand is generated and while moving in 'DOWN' direction, BE demand is generated. The TE/BE demand is generated in the form of 4-20 mA current signal, which is sent to control electronics (VCU1 and VCU2) through Analog I/O interface viz Analog I/O card and signal routing printed circuit boards. This current signal is further converted into digital data and sent to converter control after conditioning and processing, based on the locomotive operating status.

There are 3 main functions in the Master controller which are mentioned below:

(a) TE/BE Reference signals Generation (4-20mA)
(b) CAM output Signals(Boolean 110VDC:TE, BE, 1/3, 2/3TE/BE)
(c) Forward & Reverse direction selection (Boolean 110VDC: For X2: REVX2)

1.1 TE/BE Reference Signal

The TE/BE reference is 4-20 mA current loop, both during traction & braking. The mode viz. traction or braking, is determined within the VCU by the Boolean signal depending upon whether the throttle handle is in traction region or braking region. The output signal variation with respect to the CAM shaft angle is illustrated in Fig-1 for reference.

The throttle handle movement is converted into encoder shaft through gear train. Hence, the throttle angle and encoder shaft angle will be at a ratio corresponding to the gear ratio.
When the throttle is at zero position, the signal is 2 mA, which is the active zero. Between 0˚ and 135˚, the signal varies linearly. At 15˚(TE) & at 15˚(BE), the signal is 4 mA, which is mapped in the vehicle software as 0%. When the signal is 20 mA, the TE/BE reference is mapped as 100% in the vehicle software.

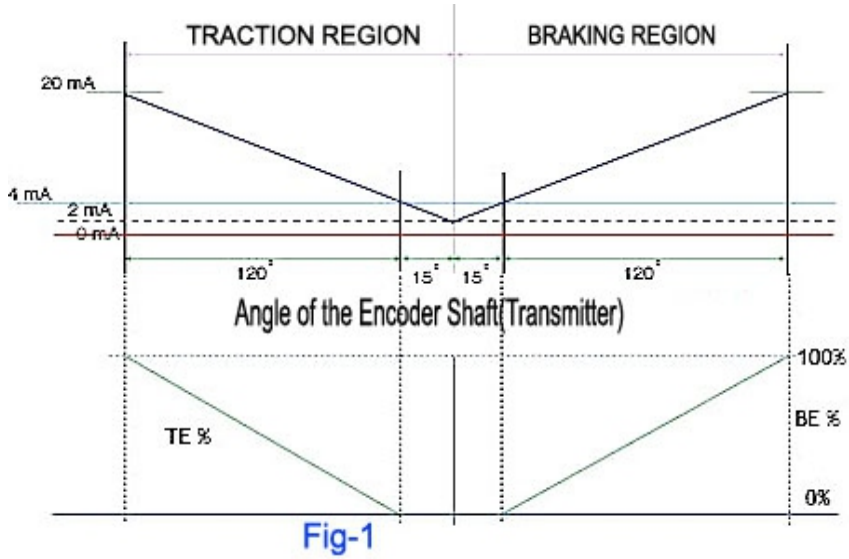


Fig-1

1.2 CAM Output Signals

CAM switches are needed to detect the position of Angle Transmitter (Throttle). Four cam switches are used to detect the position like TE region, BE region, ZERO position, 1/3 of Full TE/BE and 2/3 of Full TE/BE. ZERO position is sensed by sensing the combination of four CAMs. The position of CAM switches in different regimes are as follows:

When the throttle handle is at zero position, all the four switches are pressed, and all the contact outputs are open (i.e. outputs are zero). The CAM switch related to TE region gets released at 15˚ movement of the encoder shaft in TE region, and the contact will close. Similarly, the CAM switch related to BE will close when the encoder moves 15˚ into the BE region. Similar action will take place for the CAM switches corresponding to 1/3 & 2/3 of TE/BE maximum. The mechanical arrangement of the CAM and the corresponding angle is given in Fig-2.

The CAM switches used are of high durability suitable for lakhs of repeated ON/OFF operations during the lifetime, with load. The switch mechanism is totally enclosed type to avoid any dust ingress. The interface of Cam switches with vehicle control is given in Fig-3.

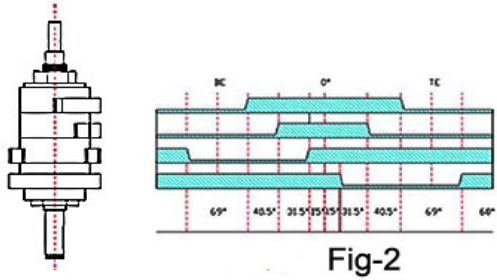


Fig-2

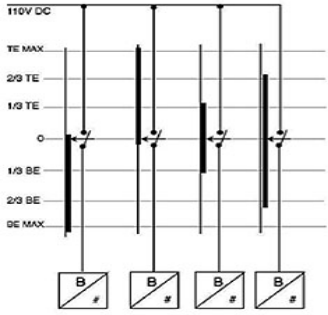
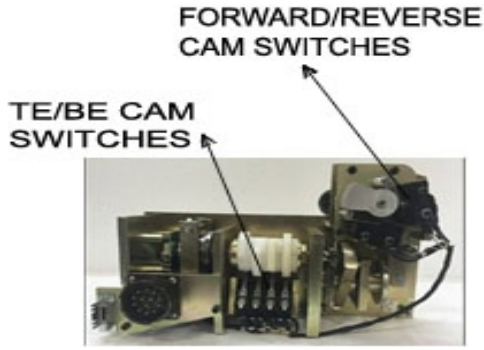


Fig-3



1.3 FORWARD/REVERSE Selector Switch

The master controller is integrated with a forward/reverse selector switch, which is used by the driver to select the travel direction. This selector switch is mechanically interlocked with the throttle handle, so that, throttle movement is possible only after selecting the direction. Also, once the direction is selected, it cannot be changed unless the throttle is brought back to zero position.

The CAM switch arrangement for the selector switch is given in Fig-4:

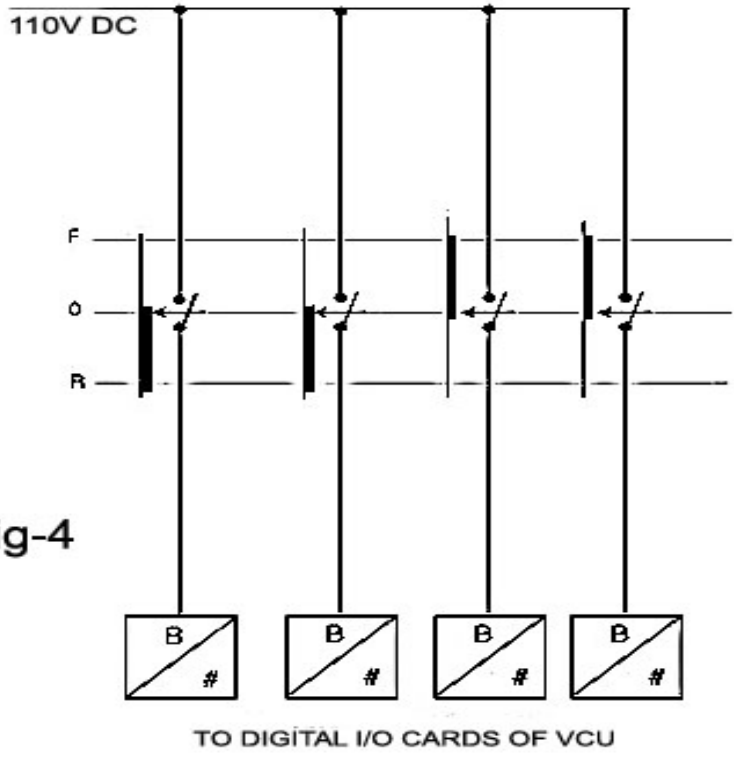


Fig-4

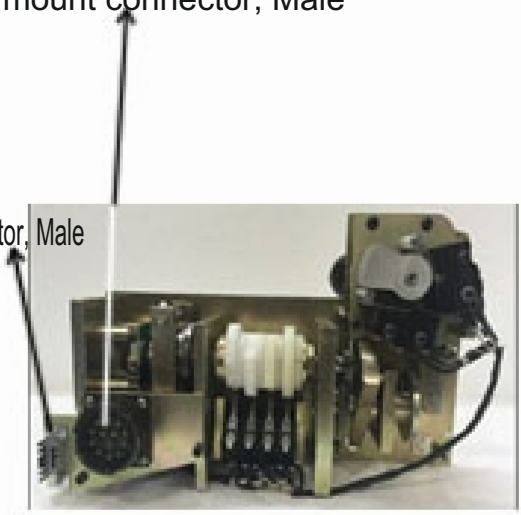
There are four switches in the direction selector. When the selector is thrown in forward direction (F), two switches gets pressed, thus establishing a contact and supplying 110V DC signal to the digital I/O cards of VCU. Similarly, another two switches gets pressed when the selector is thrown in the Reverse direction (R), thereby establishing contacts and extending 110V DC supply to the digital I/O cards of VCU. At zero position, all the switches gets released and the switches will be open, and hence, the digital I/O cards will sense a zero voltage. The switches used are similar to the ones used in conjunction with the throttle handle.

2.0 Pin assignment

There are two types of connectors used in the Master Controller.

1) 13 pin Circular: Panel mount connector, Male

2) 9 pin D-Sub: Panel mount connector, Male with coding plate



2.1 13 pin Circular connector Pin assignment

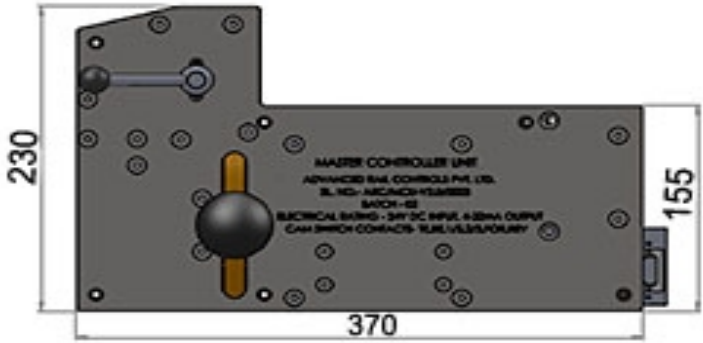
SL NO	Signal Name	13 pin Connector Pin number	CAM Switch Number
1	B+(110V DC)	1	All CAM common points
2	FORWARD	2	CAM2(NO)
3	FORWARD	3	CAM3(NO)
4	SPARE 1	-	CAM1
5	REVERSE	4	CAM4(NO)
6	REVERSE	5	CAM5(NO)
7	SPARE 2	-	CAM10
8	TE	6	CAM6(NC)
9	BE	7	CAM7(NC)
10	1/3 TE/BE	8	CAM8(NC)
11	2/3 TE/BE	9	CAM9(NC)

2.2 9 pin Sub-D connector Pin assignment

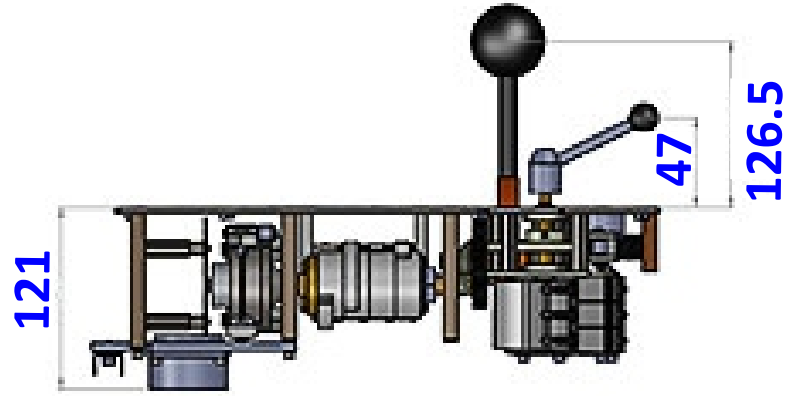
SL NO	Signal Name	9 pin Connector Pin number
1	+24 V	3
2	4-20 mA Signal	5
3	GND Signal	9
4	RX	2
5	TX	7
6	GND	4

3.0 Mechanical Dimensions

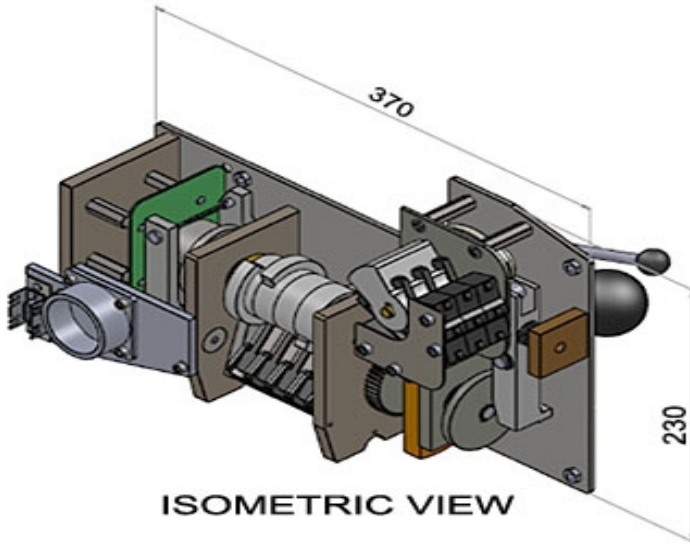
The master controller is made using components milled through CNC machines with high level of precision and accuracy. The assembly views are given below. The dimensions interfacing with the locomotive will be exactly as per CLW drawings & specifications.



FRONT VIEW



SIDE VIEW



ISOMETRIC VIEW

4.0 Functional Test

Master Controller Functional test to be followed as per Specification:(Ref: CLW approved test Protocol No. 71/16/1075/(4t)/10999. Dated 28-02-17)

(a) Throttle Movement test
(b) Direction Movement test
(c) Mechanical inter-lock test between direction handle and throttle
(d) Angle transmitter output (4-20mA) test proportional to the angle position of the throttle handle with direction set

4.1 Throttle Movement Test

Throttle must move smoothly in TE and BE region without any obstruction.

4.2 Direction Movement Test

Direction handle must rotate in forward and reverse.

4.3 Mechanical inter-lock test between Direction and Throttle Handles

Throttle should not move if direction switch is in Zero Position. If direction is selected in forward, throttle must move in TE and BE region. If we want to change the direction to Reverse, then throttle handle should be brought back to Zero position.

4.4 Angle Transmitter Output (4-20mA) Test

The TE/BE reference is 4-20 mA current loop, both during traction & braking. The mode viz. traction or braking, is determined within the VCU by the Boolean signal depending upon whether the throttle handle is in traction region or braking region.

The output signal variation with respect to the CAM shaft is to be followed as per the process mentioned below : CURRENT

Process Stage	Process	OUTPUT (observation using Digital Multimeter)	
		CURRENT (in mA)	CAM position
1	Output Current and CAM position measurement when throttle at zero position and direction in forward/Reverse condition	1.75~2.25	Only Forward CAM should be ON. Continuity between 13 pin connector pin no. 1&2, 3 is to be observed.
2	To test Current and CAM positions at 15 Degree position in TE region	3.9~4.9	Along with the Forward CAM, TE CAM also should be ON. Continuity between 13 pin connector pin no. 1&2, 3, 6 is to be observed.
3	To test Current and CAM positions at 1/3 position in TE region	8.6~9.6	Forward CAM, TE CAM and 1/3 CAM should be ON. Continuity between 13 pin connector pin no. 1&2, 3, 6, 8 is to be observed.

Process Stage	Process	CURRENT (in mA)	CAM position
4	To test Current and CAM positions at 2/3 position in TE region	14.6~15.6	Forward CAM, TE CAM, 1/3 CAM and 2/3 CAM should be ON. Continuity between 13 pin connector pin no. 1&2, 3, 6, 8, 9 is to be observed.
5	To test Current and CAM positions at maximum position in TE region	19.75~20.25	Forward CAM, TE CAM, 1/3 CAM and 2/3 CAM should be ON. Continuity between 13 pin connector pin no. 1&2, 3, 6, 8, 9 is to be observed.
6	To test Current and CAM positions at 15 Degree position in BE region	3.4~4.4	Along with the Forward CAM, BE CAM also should be ON. Continuity between 13 pin connector pin no. 1&2, 3, 7 is to be observed.
7	To test Current and CAM positions at 1/3 position in BE region	8.2~9.2	Forward CAM, BE CAM and 1/3 CAM should be ON. Continuity between 13 pin connector pin no. 1&2, 3, 7, 8 is to be observed.
8	To test Current and CAM positions at 2/3 position in BE region	14.2~15.2	Forward CAM, BE CAM, 1/3 CAM and 2/3 CAM should be ON. Continuity between 13 pin connector pin no. 1&2, 3, 7, 8, 9 is to be observed.
9	To test Current and CAM positions at maximum position in BE region	19.75~20.25	Forward CAM, BE CAM, 1/3 CAM and 2/3 CAM should be ON. Continuity between 13 pin connector pin no. 1&2, 3, 7, 8, 9 is to be observed.

5.0 Master Controller overall Specification

MASTER CONTROLLER	
Power Supply	+24V DC supply (from VCU1 and VCU2 Rack)
Max. Load Current	100mA @ 24V DC
Output Signal Interface	Analog 4-20mA
CAM Switches	Fully sealed Omron Switches
Estimated Life of **CAM** Switches	**10,00,000 Operations**
Connectors	9 pin Sub-D Connector (P/N: TRACHDOP09C06S, Mfd: Gimota) for Supply and 4-20mA interface. 13 pin Circular Connector (P/N:GB260B32-013PN-EAC, Mfd :Gimota) for CAM output signal
Enclosure	Mild steel, Stainless steel, Delrin, Nylon & Aluminium
Operating Temperature	-40 °C to +85 °C
Dimensions	370 x 230 x 124 mm
Approvals	Complies with IEC - 60571 : 2012 (IEC 61373:2010, Category 1, Body Mounted)

6.0 Scope of supply (per Unit)

SL.No.	Item name	Unit	Quantity /unit
1	Master controller unit	No.	1
2	M6X20mm CSK screw	No.	6
3	Name Plate	No.	1

7.0 Spare items and accessories (for Ordering)

SL.No.	Item name	ARC UID Number	Quantity Required (per Unit)
1	Controller Board	3310131048	1
2	CAM Switches	1128121617	10
3	Spring	2228231001	2
4	13 pin circular Connector Male	22121526AJ	1
5	9 pin Sub-D connector Male	221215166K	1

8.0 Contact Details

For any warranty/service related queries, please contact:

Mr. M Mariappa.
Head, Service Department,
Advanced Rail Controls Private Limited,
 # 59/1&2, Above Bank of India,
G- Block, Sahakara Nagar,
Bangalore- 560092.
Phone: +91 80 42401212, +91 80 42401226
Fax : +91 80 42401213
Cell: +91 9743715600
E-Mail : *mail@arc.net.in, mariappa@arc.net.in*
Website: www.arc.net.in

***Contact Details of service Personnel*:**

Lallaguda / Vishakhapatnam / Kazipet / Vijayawada
Chaitanya M (Base station : Kazipet) **Cell: +91 7989247708**
Chaitanya S (Base station : Lallaguda) **Cell : + 91 9177368723**
CLW / Dankuni
Rahul Deo Sharma [Base Station : Chittaranjan] **Cell : + 91 9334804107**
Piyush Prasad [Base Station : Chittaranjan] **Cell : + 91 9386203249**

For any warranty / service related queries, please contact :

Ajni / Itarsi / Bhusawal / Bhopal / New Katni
Pankaj Rameshrao Hedau [Base Station : Nagpur] **Cell : + 91 9021090829**
Ghaziabad / Tuglakabad / RDSO
Subhash Kumar (Base Station : New Delhi) **Cell : + 91 9212846380**
Tatanagar / Bandamunda
Vivek Kumar Mukhi [Base Station : Tatanagar] **Cell : + 91 7762905971**
Gomoh / Howrah / Kancharapara
Ravikumar Vishwakarma (Base station : Gomoh) Cell : +91 7050029319 **Anchal Kumar Cell: +91 8092793337**

ADVANCED RAIL CONTROLS PRIVATE LIMITED
#59/1-2, II FLOOR (ABOVE BANK OF INDIA)
G-BLOCK, SAHAKARANAGAR
BANGALORE-560 092
Tel: 080-42401212 Fax: 080-42401213
E-mail: mail@arc.net.in