

When an earth fault occurs in the filter circuit, earth fault relay 89.6 picks up and its contacts between potential 2801A & 2869 close and the message goes to central electronics (ADDRESS 05G13)

8.6 Monitoring of battery charger MCB {100 }

Battery charger is fed by aux converter. With aux converter switched on and MCB 100 closed supply goes to battery charger. (ADDRESS 04A01)

When the MCB trips then its aux. contacts close between potential 5092 & 2822, 5093 & 2823 respectively and the message goes to aux. converter electronics 426/2, 426/3.

(For detailed description on battery charger see clause 1)

9. Contactors for harmonic filters

9.1 Contactor filter ON / OFF {8.1 }

This contactor is used to switch ON or OFF filter circuit. (ADDRESS 01A10)

Contactor coil (ADDRESS 05H 01) is energised through converter control electronics {415 }

With key switch in DRIVING position, control electronics contactor 218 closes and supply comes to potential 5101A,B through MCB 127.1 [2095 - 2096 - 5101A,B]

Supply comes to coil of contactor 8.1 through converter control electronics 415 and NC contact of contactor discharging resistor {8.41 } [5101A,B - 2864 - 2865]
Control electronics controls the closing of filter ON/ OFF contactor in the following manner :

With VCB closed and reverser position selected, the filter ON/OFF contactor {8.1 } will close when TE/BE throttle is moved from zero position to any position. Afterwards whenever throttle is brought to zero with VCB closed the filter contactor will remain close. If this situation persists for more than 5 minutes, then filter contactor opens and discharge contactor {8.41 } closes for 120 msec. Filter contactor {8.1 } will remain open and will close when TE/BE throttle is again moved.

With contactor energised, its aux contact 8.1 connected between potential 2801A and 2861A,B closes and this message is taken by converter control electronics connected at potential 2861A ,B.

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This contactor is closed when both the bogies are in operation. It is open when one bogie is isolated (ADDRESS 01A11).

Contactor coil (ADDRESS 05H03) is energised through converter control electronics {415 }

With key switch in DRIVING position, control electronics contactor 218 closes and supply comes to potential 5101A,B through MCB 127.1 [2095 - 2096 - 5101A,B]

Supply comes to coil of contactor 8.2 through converter control electronics 415 [5101A,B - 2866] Control electronics will allow supply to the contactor coil only when one traction converter is isolated.

With contactor energised, its aux contact 8.2 connected between potential 2801A and 2862A,B closes and this message is taken by control electronics connected at potential 2862A,B.

9.3 Contactor discharging resistor {8.41 }

~~This contactor is closed to discharge harmonic filter capacitors {8.4 } through discharge resistor {8.42 } and is controlled by control electronics as explained above.~~

Supply comes to coil of contactor 8.41 through control electronics 415 and normally closed contact of contactor 8.1. This ensures that contactor 8.41 is closed only when contactor 8.1 is open [5101A,B - 2867 - 2868].

With contactor energised, its aux contact 8.41 connected between potential 2801A and 2863A,B , closes and this message is taken by control electronics connected at potential 2863A,B .

10. Aux converter contactors

There are five aux converter contactors {52 / * } electrically interlocked and controlled by aux. converter electronics, used to switch load from one aux converter to another, should any converter fail(ADDRESS 02Z).

(ADDRESS : 05I,K,L)

The aux. converter electronics { 426 } controls the aux. converter contactors { 52 / 1..5 }. Under normal conditions with all three aux. converters working ,contactors 52/1,3,5 will close and contacors 52/2,4 will remain open. 110 V DC supply is fed to to the respective aux. contactors {52.3/1,3,5 } through potential 5092. The normally

open contacts of aux. contactors close and in turn the main contactors { 52/1,3,5 } close.

In case of fault in aux. converter 1, contactor 52/5 is open by aux. converter electronics by cutting off supply to aux. contactor 52.3/5. Also contactor 52/4 is closed once 52/5 is open (ADDRESS : 05L 06) through normally close contact of 52/5 through potential 2801A.. Now aux. converter 2 feeds loads of both aux. converter 1 & 2.

Similarly in case of failure of aux. converter 2, aux. converter 1 will feed loads of both aux. converter 1 & 2 by opening of contactor 52/1 and closing of 52/4.

In case of failure of aux. converter 3 contactors 52/1,3 will open while contactors 52/2,4,5 will close. Now aux. converter 1 feeds loads of first and second converter and aux. converter 2 will feed aux. converter 3 loads.

Electrical interlocking through aux. contacts is provided to ensure correct operation. Contactor 52/4 will close only when either contactor 52/5 or 52/1 is open and vice-versa. Contactor 52/2 will close only when both 52/3 and 52/1 is open and vice-versa.

11. Drivers cab and machine room lighting circuit

In the following paragraphs, only lighting circuits from cab1 side are described. For cab2 side only potential numbers will change accordingly.

11.1 Drivers cab light { 325 / 1 }

110 V DC supply from battery is fed to potential 3054 through MCBs { 112 & 310.4 } (ADDRESS 04B08).

This supply is fed to the cab lamp { 325 / 1 } through switch { 324 / 1 } provided on the driver's desk { 3054 - 3512A - 2050 } (ADDRESS 07A01).

11.2 Drivers desk & asst drivers desk illumination { 325.21 / 1 & 325.22 / 1 }

24 V DC supply from DC to DC converters { 118.5 / 1 } comes to potential 2097A,B (ADDRESS 04F04)

This supply is fed to the desk illumination lamps through switches { 324.21 / 1 & 324.22 / 1 } provided on the drivers and asst driver desk respectively [2097A - 3080A - 2050] & [2097A - 3081A - 2050] (ADDRESS 07A 07,08).

11.3 Corridor lights { 330 / 1-5 }

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Description of control circuit

110 V DC supply from battery is fed to potential 3054 through MCBs { 112 & 310.4 } (ADDRESS 04B08).

This supply is fed to the five corridor lights { 330 / 1-5 } through latching push buttons { 327 / 1 & 2 } provided near the entrance to the machine room. Corridor lights can be switched on & off through either switch .

[3054 - 3532 - 3533] & [3054 - 3531 - 3533] (ADDRESS 07B01, 02)

11.4 Hand lamp sockets { 334.1 / 1, 2 }

(ADDRESS 07A05.06).

110 V DC supply can be obtained for hand lamps from sockets 334.1 / 1,2 provided on the drivers desk through switches { 337 / 1, 2 }. They are connected to potential 3054 which gets 110 V DC from battery through MCBs { 112 & 310.4 }(ADDRESS 04B 08).

Additional 2 sockets { 334.2 / 1, 2 } for 110V DC supply are provided in the machine room.

11.5 Head lights { 318 / 1, 2 }

(ADDRESS 07C 01)

Two head lights are provided on the exterior of each cab which can be operated from either cab one at a time, through headlight switch { 316 / 1 } provided on the driver's desk. Headlight intensity (dimmer) switch { 317 / 1 } is also provided to lower the intensity of headlights by inserting resistance { 332.3 / 1 } in the circuit.

110 V DC supply is fed to potential 3501A from battery through front lighting MCB{ 310.1} and contactor { 126.7 / 1 } [2094 - 2095 - 2101A - 3501A] (ADDRESS 04C04).

Headlight lamps get supply through headlight switch { 316 / 1 } & intensity (dimmer) switch { 317 / 1 } .

11.6 Marker lights { 318.1 / 1, 2 & 318.2 / 1, 2 }

ADDRESS 07C05,07

Two front marker lights (white) and two rear marker lights (red) are provided on the exterior of each cab.

110 V DC supply is fed to potential 3054 from battery through frontlighting MCB{ 310.1 } [3054 - 3545A, 3054 - 3546A] (ADDRESS 04C04).

Marker lamps get supply through marker light switches { 316.11 /1,2 & 316.12 /1,2 }

11.7 Emergency flash lights { 318.3 / 1 }

(ADDRESS 07D02)

One flasher light is provided on the exterior of each cab. 110 V DC supply is fed to the flasher control unit { 323.1 / 1 } directly from potential 3501 A through illuminated pushbutton { 316.2 / 1 }. The output of the control unit is fed to the flasher lamp { 318.3 / 1 }.

By pressing pushbutton flasher lamp the pushbutton lamp lights up to indicate that flasher light is ON. [2099A - 3554A].

11.9 Illumination of instruments

(ADDRESS : 07E02, 06)

By closing switches { 324.1 } lamps { 79.1, 79.2, 74, 116, 81.1, 81.2, 81.3, 81.4 } light up to provide illumination to the instruments.

11.10 Testing of indication lamps

(ADDRESS : 07E11, 13)

As soon as loco is put in driving mode, control electronics tests the indication lamps by providing supply for few seconds.

12. Master controller

(ADDRESS 08C)

Master controller { 150 } consists of 3 position rotary switch (Reverser) for selection of travel direction - FOR, NEUTRAL, REV and throttle for tractive & braking effort.

Throttle for TE/BE, except in zero position, interlocks the reverser through an electromagnet controlled by control electronics (ADDRESS 08C) [2111A - 2532A - 2151A - 2050] .

Each reverser has four contacts : (ADDRESS 08C03-06)

Two close during forward [2111A - 2524A, 2111A - 2525A] and two close during reverse [2111A - 2526A, 2111A - 2527A] and feedback goes to central electronics { 411 }.

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The demanded corresponding value for TE/BE is generated by means of an angle transmitter { 150.1 } and the output is fed to central electronics. (ADDRESS 08C09).

The TE/BE throttle has following aux. contacts :

Between potential 2111A & 2520A closed during TRACTION position of throttle handle.

Between potential 2111A & 2521A closed during BRAKING position of throttle handle.

Between potential 2111A & 2522A closed during TRACTION position of throttle between angle 13.5 and 40.5 degree i.e 1/3 TE to TE max and in BRAKING position from 1/3 BE to BE max .

Between potential 2111A & 2523A closed during TRACTION position of throttle between angle 27 and 40.5 degree i.e 2/3 TE to TE max and in BRAKING position from 2/3 BE to BE max .

The last two contacts are provided so that in case of failure of angle transmitter loco can be driven and braked in three steps (1/3, 2/3 & MAX TE / BE) through these contacts. A switch {152 } is provided in the machine room to change over from transmitter to manual stepped control. (ADDRESS 17A12).

The feedback is sent to control electronics { 411 }

The same description applies to scheme 08D with changes of potential and position numbers.

12.1 To limit maximum tractive effort during starting, a switch { 151.1 } is provided on driver's desk (ADDRESS 08E01). When this switch is closed, feed goes to central electronics which limits the tractive effort to 30 KN (for WAG - 9) only [2111A - 2540A].

12.2 For constant speed operation , a push button switch { 151.4 } is provided on driver's desk (ADDRESS 08E02). When this switch is closed, feed goes to central electronics, which accordingly adjusts TE / BE to maintain constant speed within available TE/BE range.[2111A - 2541A] Central electronics also gives supply to lamps { 151.4 } which light up to indicate constant speed operation.

12.3 To indicate wheel slip, an indication lamp{ 92/ 1 }is provided on the drivers desk which gets 24V DC supply through control electronics. Control electronics monitors all the axles speed and detects wheel slip [2099A - 2542A - 2151A]. (ADDRESS 08E03)

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12.4 Two tractive/ braking effort meters { 79.1, 79.2 } are provided on each desk, one for each bogie. Control electronics calculates tractive effort from traction motor parameters and accordingly feed the meters. (ADDRESS 08E05,11)

The same description applies to scheme 08F with changes to potential and position numbers.

13. Power supplies

(ADDRESS 09A - 09D)

DC / DC converters are used for power supply. The input battery voltage may vary between 77 to 137.5 V DC. The following output voltages are available : 5 V, ± 15 V, ± 24 V DC. Power supplies are located in central electronics rack 1 & 2 (CEL 1, 2) { 411, 412 } converter control electronics { 415 } and aux converter control electronics { 426 }.

110 V DC supply from battery is fed at the input. The output of the power supply is connected to the control electronic PCBs from the backside of the racks.

For cooling of control electronics in the above panels, fans are provided which run on 48 VDC supply through potential 2098A.

(ADDRESS 09E)

The two diagnostic terminals on each driver's cab { 435 } are connected to central electronics { 411 & 412 } via RS 422 serial data link [5060A,B to 5065 A,B]. The terminals are supplied through potential 3502A,4201 & 3502B,4203 respectively

Sheet 09Z shows the disposition of vehicle bus inside the locomotive. Fibre optics cables are connected between various controls for communication and data transfer.

14. Speedometer

(ADDRESS 10A)

MEMOTEL speedometer consists of an optical pulse generator { 94.1 } mounted on the axle box of the loco and driven by driving fork, one speedometer with recording and indicating (MEMOTEL master) { 94.2 } in cab2 and one speedometer with only indication (MEMOTEL slave) { 94.3 } in cab1.

110 V DC supply through potential 4206 (& 2050) is fed to the master speedometer at terminals 35 & 34 . The output of the pulsegenerator, which gives a frequency

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signal proportional to speed, is fed at terminals 4,8,3 (from first optical sensor) and terminals 7,5 (from second sensor). From the master speedometer in cab2 signals go to speedometer in cab1 through screened cables from terminals 50, 17 using RS422/485A serial data link. 110 V DC supply is fed to cab1 speedometer through potential 4206.

Alarm relay is provided which operates to indicate a general MEMOTEL error. On closing of this relay its contacts between potential 4206 & 4207 (terminals 25 & 9) close and the feed goes to central electronics { 411 }.

An output relay is provided with speed dependent contact. When speed reaches 105% of the maximum permissible speed, contact between potential 4206 & 4208 close and feed goes to buzzer { 238 }(ADDRESS 11B09).

When speed reaches 110% of the maximum permissible speed, contact between potential 3097 & 4240 open and the supply to EP valve for emergency brakes is cut off which results in application of emergency brakes. (ADDRESS : 11A11) The message goes to the control electronics through potential 4244.

Two transistor outputs are configured to give distance dependent control signals which are used for operating wheel flange lubricator. After every fixed distance (which is settable) contacts between potential 4206 & 4209 and between potential 4206 & 4210 close and feed goes to flange lubrication EP valves { 300.3/ 1 & 2 }.

15. Vigilance control

(ADDRESS 11A)

Vigilance control system consists of Main control unit { 237 }, warning buzzer { 238.1 } one in each cab, spring loaded pushbutton { 236 } and footswitch { 235 } and spring loaded reset push button { 237.5 } and pressure switch { 269.5 }.

Vigilance system is ON only when loco is in DRIVING mode and speed is above 1.5 Km/h. In DRIVING mode supply comes through potential 2516A or 2516B to terminals K or J of control unit to switch on the system. Main supply to the system comes through potential 4236 to terminal A. On slave loco, in multiple loco operation, since both cab activating switches are in zero position, no supply is available on either terminals K or J which results in isolation of vigilance unit . When supply is available on both terminals K & J i.e two cabs activated, vigilance control is isolated.

Vigilance system is OFF when loco brakes are fully applied .Pressure switch { 269.5 } monitors the brake cylinder pressure, and when pressure is more than 1.5 bars the contacts between potential 3090 & 3049 open and supply at terminal U is disturbed which results in switching OFF of vigilance system. When pressure is less than 1.0 bars the contacts close and reactivate the vigilance control system.

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The system operates on the principle that normal operations performed by driver (such as master controller operation or application of brakes through auto brake handle) are accepted by the system as an indication of drivers fitness . This information to the vigilance control unit comes through control electronics, connected at terminal V and through contacts of brake controller { 293 }(ADDRESS 06F).

When driver is not doing any of the above operations then within 60 sec (settable) he has to release pedal switch / pushbutton and repress it . This has to be repeated after every 60 sec. Otherwise the buzzer 238.1 will sound (supply comes at terminal G) and lamp { 242.1 } lights up and after 8 sec (settable) emergency brakes will apply. This works in the following way :

Normally EP valve for emergency braking { 243 } is energised through supply from terminal E of control unit. [3000 - 3108B - 3108A - 3097 - 4240 - 4241] When vigilance system operates the emergency brakes, then supply at terminal E is cut off which results in de-energisation of EP valve for emergency braking { 243 } and emergency brakes are applied on the locomotive. Once emergency brake is applied they cannot be released for next 2 minutes (settable).

By pressing emergency push button { 244 }, from the occupied cab, supply to the EP valve of emergency brakes is cut-off and emergency brakes are applied.

To isolate vigilance system , switch { 237.1 } is operated. When this switch is off supply to vigilance control unit is cutoff through potential 4236. Supply to emergency brake valve { 243 } is maintained through potential 3000 by closing of contacts of switch 237.1 (in its off position) between potential 4200 & 3000.

It can also be isolated with isolating cock { 237.3 } in the pneumatic panel. (ADDRESS 06A06)

16. Fire detection system

(ADDRESS 11B)

The fire detection unit { 212 } detects any fire in the machine room by checking the machine room air at various locations for smoke. In case of fire the contact between terminals 18 & 19 and between 4 & 5 of the unit close. This results in sounding of the buzzer [2097B - 4238 - 4232A,B]. Message also goes to control electronics through potential 4227. To reset, the reset button on the unit is pressed. In case of any fault in the fire detection unit the contact between terminals 10 & 11 open and the message goes to the control electronics through potential 4229.

17. Pneumatic system

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(ADDRESS 06A)

17.1 Pressure switch of flow indicator { 269.41 } monitors the pressure in the main reservoir pipe. In case of train parting, the flow from main reservoirs to brake pipe is too high, which causes drop in main reservoir pressure, which is detected by the pressure switch and the message goes to central electronics { 412 } through brake electronics { 260 }.

17.2 Pressure switch emergency brakes { 269.1 } monitors the pressure in air brake pipe. In case of application of emergency brake pressure in air brake pipe falls to zero as it is vented to atmosphere which is detected by pressure switch and the message goes to central electronics { 412 } through brake electronics { 260 }. This information is mainly used for the control of emergency brakes in multiple operation.

17.3 Pressure switches of brake cylinder { 269.6 } monitor the pressure in the brake cylinders. During application of brakes, pressure in brake cylinders increase which is detected by these pressure switches and the messages go to central electronics through brake electronics { 260 }.

17.4 Pressure switch direct brake { 269.2 } monitors the pressure in direct brake pipe. Direct brake pipe is connected to other locos in multiple. In case of any parting of locos, main reservoir equalising pipe pressure falls which results in cutting off air to direct brake pipe, which is vented to atmosphere. This is sensed by pressure switch and feed back sent to central electronics through brake electronics { 260 }.

17.5 When brake control unit { 293.2 } is isolated its contacts between potential 3090 & 3095 close and the message goes to central electronics through brake electronics { 260 }.

ADDRESS 06B :

17.6 Parking brakes :

Parking brakes are controlled by central electronics. When main reservoir pressure falls below 3.5 bars, then pressure switch { 269.3 } operates and the feed goes to central electronics which energises parking brake EP valve { 270.3 } through brake electronics. Applied parking brake is indicated by illuminated pushbutton for application of parking brakes { 268 }

To manually apply parking brakes, push button { 268 } is pressed located in each cab. The feed goes to control electronics through potential 3060A,B . Control electronics sends message to brake electronics { 260 } through potential 3048 to potential 3058, which causes energisation of EP valve for parking brakes application { 270.3 }.

There is common pushbutton { 268 } for application and release of parking brakes.



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17.12 To unload compressors when pressure exceeds 10 bars , EP valve for unloading { 273.3 } is energised by central electronics which monitors the pressure [4204 - 3112 - 3040].

17.13 Air dryer { 284.5 } is provided at the outlet of the compressors. It contains two towers and a timer controls the switch over between both the towers. 110 V DC from battery is fed for timer operation through potential 3101 and 3042 through central electronics { 412 }. Central electronics checks if compressors are working and shuts the timer off in case compressors are OFF. Then both the towers will be dried.

(ADDRESS 06E)

17.14 Main compressor

Pressure switch {172.2 }monitors the main reservoir pressure and starts compressors alternatively till the pressure reaches 10 bars . Then the pressure switch contacts open which results in opening of compressor contactor through control electronics till the pressure falls below 8 bars

When pressure falls below 7.5 bars , pressure switch {172.3 } operates and both the compressors operate till pressure reaches 10 bars.

When pressure falls below 5.5 bars, pressure switch { 269.4 } operates and message goes to central electronics which cuts off tractive effort and gives low main reservoir pressure warning to the driver on the display till the pressure reaches 6.4 bars.

Compressors can be operated manually from the cab by operating compressor switch { 172 }. It has three positions : OFF, AUTO PRESSURE CONTROL, ON (MANUAL CONTROL) . In AUTO mode the compressors are controlled by the three pressure switches mentioned above. In the manual mode only a pneumatic over pressure relieve is used. In this position its contact between potential 2111A & 3035A close and feed goes to central electronics which then closes the compressor contactors. The status of this switch is monitored by central electronics through the contact between potential 2111A & 3034A which is closed in OFF position.

Pressure switch {269.42 } monitors the brake feed pipe pressure and gives feedback to central electronics { 412 } and brake electronics { 260 }.

17.15 Aux compressor

Aux compressor { 48 } runs on 110 V DC supply from battery directly. As soon as battery and control circuit MCBs are closed supply goes to aux. compressor contactor { 48.2 } through NC contacts of pressure switch { 172.4 }. By the closing of contacts of the contactor the aux. compressor starts.

The actual electric braking effort value is transmitted from the central electronics to brake electronics { 260 } using terminals P & R through potential 3014 & 3015.

Brake pipe pressure is monitored by pressure transducers and the feedback is sent to central electronics from terminals M & N through potential 3009 & 3010.

Feedback on the status of brake electronics is sent to central electronics from terminal SM through potential 3008.

17.18 Direct brake EP valves { 270.2 } are controlled by brake electronics, through potential 3063A,B.

(ADDRESS : 06I)

Brake pipe control system (E70) and blending unit (EBCS)

Brake electronics { 260 } controls the operation of EP valves { 271.1,271.11,271.12, 271.2, 271.5, 271.6, 278 }. Detailed description will be provided later by D&M.

18. Actual value detection

18.1 Primary circuit

(ADDRESS 12A)

The output of the primary voltage transformer { 3 } is fed to transformer modules { 224.1/2 }, which are basically a transformer which converts 200 V AC output (corresponding to 25 KV) of primary voltage transformer to 4 V AC. These are fed to the main converter electronics { 415 / 1 & 2 } and provide information on catenary voltage amplitude and phase for generation of thyristor firing pulses.

Through another transformer module { 224.2 }, AC output voltage of primary voltage transformer is converted to DC voltage of 10 V (corresponding to 30 KV) which is fed to catenary voltmeters { 74 } provided in each cab.

The output of primary voltage transformer is fed directly to minimum voltage relay { 86 }. When the corresponding catenary voltage falls below 17.5 KV, this relay deenergises.

The output of primary current transformer { 6.1 } is fed to maximum current relay { 78 }. When the corresponding primary current increases beyond preset value, this relay picks up. In order to prevent pick up of maximum current relay when VCB is switched on, a resistor { 78.1 } is connected in parallel, controlled by a contact of

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time relay { 136.3 } which is already used for VCB control circuit. This increases the current setting during closing of VCB (ADDRESS 05B14).

Battery voltmeter { 116 } in each cab is connected to 110 V DC supply of the battery through potentials 2111A,B & 2151A,B.

(ADDRESS 12B,E)

The output of primary current sensor { 6.2 }, hotel load current sensor { 33 } (for **WAP5 ONLY**), aux converter current sensor { 42.3 }, harmonic filter current sensor { 8.5 } and current sensors of line converters { 18.2 } is fed to the main converter electronics { 415 }.

Self test for correctness of the circuit is done , every time before main circuit breaker is closed in driving mode, through supply of voltages + 24V & - 24 V in the test windings of the current sensors.

(ADDRESS 12C,F)

Voltage transducers { 15.6 / 1 & 2 } connected in the DC link circuit of the main converter feed the DC link voltage value to the main converter electronics { 415 }.

The outputs of the earth fault detection (voltage transducer) { 89.4 } and drive inverter current sensors { 18.5 / 1,2, 3 } are also fed to the main converter electronics { 415 }.

Sum of traction motor currents from converter 2 is fed to converter 1 and viceversa through connector 415.LA.

(ADDRESS 12D,G)

Speed sensors { 93.2 } and temperature sensors { 98 / 1 & 2 } located on the traction motors { 20 } measure the speed and temperature of the motors and send signals to the main converter electronics { 415 }.

Temperature sensors { 210.61 } and pressure sensors { 210.62 } monitor the temperature and flow (yes/no) of main converter oil cooling circuit and send signals to converter electronics { 415 }. Similarly temperature and flow (yes/no) of main transformer oil {210.5,213.5} is measured and signals sent to converter electronics.

19. Trainbus

(ADDRESS 13A,B)

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(ADDRESS : 16B)

The gate unit power supply { 219 } gets 110 V DC input from the battery and gives 48V DC output to the gate units.

With loco in driving mode and contactor for control electronics { 218 } closed supply comes to potential 2601A (ADDRESS : 04D). Through gate unit precharging resistance { 219.1/1 } supply goes to power supply of gate units { 219/1 } and charges the capacitors of the power supply.

The coil of contactor { 218.2 } also gets energised through main converter control electronics { 415/1 } and bypasses the precharging resistance, but after a time delay to allow precharging of gate supply to be completed.

20.4 Gate units 4Q converter and main converter

(ADDRESS : 16C, D)

Gate units of 4Q converter { 227 }, drive inverter { 228 } and MUB { 229 } get 48 V DC supply through their respective power supplies {219}The main converter electronics { 415 } gives control signals to the gate units and accordingly the GTOs { 12, 13 } are triggeed ON or OFF.

The same description applies to sheets 16E & F for bogie 2.

21. Fault acknowledge

21.1 Failure mode operation

(ADDRESS : 17A12)

In case of failure of angle transmitter loco can be driven and braked in three steps (1/3, 2/3 & MAX TE / BE) through aux. contacts of master controller. A rotary switch for failure mode operation {152 } is provided in the machine room to change over from transmitter to manual stepped control.

21.2 Simulation

(ADDRESS : 17A14)

Key switch {179 } for simulation of ciruits during commissioing is provided in the machine room. In simulation position of the switch, supply goes to the control electronics which activates the simulation circuit.

21.3 Fault acknowledge

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(ADDRESS : 17A02)

On occurrence of any fault the illuminated pushbutton {163.1 } will light up. On pressing the pushbutton the lamp goes off.

In case of priority 1 fault, fault indication lamp {163 } starts blinking. On pressing pushbutton this lamp will go off unless there is some isolation performed in which case the fault indication lamp will continue to glow.

21.4 Bogie cutout

(ADDRESS : 17B03)

To isolate any one of the bogies or both the bogies rotary switch {154 } is provided. In normal condition supply to control electronics {411 } through potential 2401 & 2402 is maintained by the switch. When bogie 1 alone or both the bogies are isolated supply through potential 2401 is interrupted and when bogie 2 alone or both the bogies are isolated supply through potential 2402 is isolated, which is detected by control electronics.

21.5 Configuration

Spare rotary switch { 160 } and illuminated push button { 161 } are provided for future use.

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Protective Functions

Specification of ABB Protective Functions

IR WAP-5/WAG-9

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1. INTRODUCTION

The purpose of the protective functions is to detect and evaluate faults or impermissible deviations in the traction circuit and to initiate the necessary protective measures.

Description title : Protective functions

Customer : Indian Railway

Contract number : 1 - 361250

Processors : ABB processors that have been programmed in FUPLA

1.1. Reference Documents

[1] Vehicle Control System Software Specification (Revision F)	3EHP 541 681
[2] Certificate Of Type Test IR WAP-5	3EHX 410 115
[3] Signal Values And Tolerances Of The Bus Station Converter Equipment	3EHL 421 088
[4] Routine Test Sensor And Converter Test	3EHX 610 282

2. FUNCTION

Protective functions in ABB circuits

3. PROCESSORS CONCERNED

All ABB processors that have been programmed in FUPLA.

4. BRIEF DESCRIPTION

The specification describes the protective functions which are monitoring the traction circuits. It describes which values are monitored and how they are measured (types of transformers or sensors and input to the control system). Furthermore, the protective actions are specified which must happen if a limit value is exceeded or a fault is occurred.

Limit value indications

All indicated values shall be considered as setting values and shall be checked and/or optimised when the vehicle is in commissioning stage.

All values defined in this document, release H, correspond to the software release 1.20 for WAP5/WAG9 as delivered in December 99. Updates for release I are requested by Bombardier Transportation India due to reviewing the documents.

Fault messages and diagnostic data sets (DDS)

A diagnostic data set (DDS) is generated whenever a protective action takes place. If useful, a corresponding fault message is displayed on the fault indication system.

Abbreviations

VCB	= Vacuum Circuit Breaker, AC main circuit breaker
TE	= Tractive Effort
BE	= Braking Effort
SLG,FLG,STB,HBB	= Processor names

Connector designations:

"Transformer 224.1/1 to BA 5/6 SLG1" means

"Transformer 224.1/1 is connected to Pin 5 and Pin 6 of the connector BA of the processor SLG1".

Description of limits and triggered actions (e.g. 5.3. harmonic filter current):

"I >= 600 A(RMS) / t_{filt}=100 ms : VCB off, contactor harmonic filter off" means