IPSS	**SPECIFICATION FOR MOTOR CONTROL CENTRES (MCCs)** *(First Revision)*	**IPSS:1- 04- 040- 99** Formerly : IPSS:1-03-006-85
	Based on IS 8623(Pt 1) : 1993, IS 13947(Pt 1) & (Pt 4/Sec 1) : 1993	

0. FOREWORD

0.1 This Interplant Standard has been prepared by the Standards Committee on Switchgears and Controlgears, IPSS 1:4, with the active participation of the representatives of the steel plants, major consulting organizations and established manufacturers of motor control centres (MCCs) and was adopted in March 1999.

0.2 Interplant Standards for steel industry primarily aim at achieving rationalization and unification of parts and sub-assemblies used in steel plant equipment and accessories, and provide guidance in indenting stores or equipment for existing or new installations by individual steel plants. For exercising effective control on inventories, it is advisable to select a fewer number of sizes (or types) from among those mentioned in this standard for the purpose of company standards of individual steel plants. It is not desirable to make deviations in technical requirements.

0.3 This Interplant Standard covers motor control centres (MCCs) for medium voltage ac induction motors and has been prepared with a view to catering to the specific needs of steel industry.

0.4 All materials and components used in the manufacture of the motor control centres shall conform to relevant IPSS Standards wherever these exist, and in their absence, to the relevant Indian Standard Specification.

0.5 Indian Electricity Rules, 1956 and statutory regulations of the Government of India and the State Governments shall be complied with, wherever applicable.

0.6 The standard is generally based on the following ISs:

1) IS 8623 (Part 1) : 1993 'Low voltage switchgear and controlgear assemblies : Part 1 Requirements for type tested and partially type tested assemblies (*first revision*)'.

2) IS 13947 (Part 1) : 1993 'Low voltage switchgear and controlgear : (Part 1) General Rules (*superseding IS 2147 and IS 4237*)'.

3) IS 13947 (Part 4/Sec 1) : 1993 'Specification for low voltage switchgear and controlgear : Part 4 Contactors and motor starters, Sec 1 Electromechanical contactors and motor starters [*superseding IS 2959 and IS 8544 (all parts)*]'.

1. **SCOPE** – This Interplant Standard covers the requirements of motor control centres (MCCs) for main circuit voltage not exceeding 1000 V ac and control circuit voltage upto 415 V ac and 230 V dc, principally meant for direct-on-line contactor control of medium voltage ac induction motors.

1.1 Although this standard applies primarily to enclosed MCCs, this will also apply to open type MCCs to the extent relevant.

1.2 This Standard does not apply to MCCs intended for explosion hazardous areas in steel plants and also does not apply to such installations on moving mechanisms like overhead cranes.

2. **TERMINOLOGY** – For the purpose of this standard, the following definitions in addition to those given in IS 1885 (Part 17) : 1979 'Electrotechnical vocabulary : Part 17 Switchgear and controlgear (*first revision*)' shall apply.

2.1 **Motor Control Centre (MCC)** – It is a LT switchgear and controlgear assembly of one or more vertical sections having a horizontal common power bus and principally containing motor control units. These units are mounted one above the other in the vertical sections. The vertical sections may incorporate vertical buses connected to the common horizontal power bus thus extending the common power supply to the individual units.

NOTE 1 : In addition to motor control units, a MCC may include feeder tap units, incoming/sectionalizing switchgear and other auxiliary functional units.

NOTE 2 : A MCC comprising a single vertical section may not have a horizontal power bus.

NOTE 3 : A motor control unit may also exist as a part of MCC with the power circuit fed from a separate source rather than from the common power bus.

2.2 **Motor Control Unit** – It is a functional unit which includes:

a) Power circuit isolation device, the operating handle of which is available on the door,

b) Short circuit protection device for the circuit,

c) Motor and circuit overload and single phasing protection device,

d) Magnetic contactors,

e) Control circuit with its isolation and short circuit protection device, and

f) Indication, metering device whenever necessary.

2.3 **Functional Unit** – An assembly comprising all the elements in the main circuits and auxiliary circuits of a MCC that contribute to the fulfilment of the same function.

Typical examples : Incoming unit, motor control unit, control supply unit, relay unit, feeder tap unit, etc.

2.4 **Feeder Tap Unit** – A functional unit which includes externally operable circuit disconnecting means and branch circuit over current protection, principally used for non-motor loads.

2.5 **Vertical Section (Panel)** – A constructional unit of a MCC between two successive verticle delineations.

2.6 **Connected (Service) Position** – The position of a removable part in which it is fully connected for its normally intended function.

2.7 **Test Position** – A position of a withdrawable part in which an isolating distance is established in main circuits while auxiliary circuits are connected, allowing tests of the operation of the withdrawable part, that part remaining mechanically attached to the MCC.

2.8 **Disconnected (Isolated) Position** – The position of a withdrawable part in which an isolating distance is established in main and auxiliary circuits, the withdrawable part remaining mechanically attached to the MCC.

3. **SERVICE CONDITIONS** – Normal service conditions for the purpose of this standard are given below in 3.1 to 3.4:

3.1 **Ambient Temperature** – The reference ambient temperature shall be 40 deg C unless otherwise specified.

3.2 **Altitude** – The altitude shall not exceed 1000 m.

3.3 **Ambient Air** – The ambient air may contain a fair amount of conductive dust.

3.4 **Humidity** – The maximum relative humidity shall be 100%. However, both maximum ambient temperature and maximum relative humidity are not likely to occur simultaneously.

4. ELECTRICAL CHARACTERISTICS AND RATINGS (*see also 11*)

4.1 Preferred rated operational voltage are:

4.1.1 *Main Circuit* – 240 and 415 V ac; and

4.1.2 *Control and Auxiliary Circuits* – 110, 240 V ac or 24, 48, 110, 220 V dc.

4.2 Rated frequency shall be 50 Hz for ac.

4.3 All equipment of the MCC shall be suitable for the supply circuit of 415/240 V, 3-phase, 3 or 4 wire ac system with solidly earthed neutral or unearthed system.

ac and dc control supply shall be obtained through control transformers and rectifier sets respectively. These conversion equipment shall be included in the MCC itself unless otherwise specified.

4.4 Rated main circuit installation voltage shall be as per IS 13947 (Part 4/Sec 1) : 1993.

4.5 Short Circuit Currents

4.5.1 Rated short time (1 second) rms withstand current shall at least be equal to the 3-phase symmetrical fault level at the point of installation to be specified by the purchaser. Preferred values are 20 kA, 30 kA, 40 kA and 50 kA.

4.5.2 Rated peak withstand current of the MCC shall correspond to the peak value of the system fault to be indicated by the purchaser.

4.5.2.1 In the absence of suitable information, the peak value may be computed from the rms value specified, in accordance with 7.5.3 of IS 8623(Part 1) : 1993.

4.6 Short Circuit Strength

4.6.1 The main horizontal and vertical bus bars shall be designed, fabricated and supported to withstand the thermal and dynamic stresses corresponding to the rated short time and peak withstand currents (see 4.5.1 and 4.5.2).

4.6.2 The incoming (and sectionalizing, if any) switchgear and connections shall have a rated short time withstand current in accordance with 4.5.

NOTE : If the short circuit protective device (SCPD) is a fuse, then it may be considered satisfactory if the conditions of 4.6.3 are met.

4.6.3 The outgoing functional units shall be so designed that the components and wiring shall withstand the stresses arising out of a bolted short circuit at the outgoing terminals till such time that the SCPD clears the fault. The protection coordination shall be type "2" as given in 7.2.5.1 of IS 13947 (Part 4/Sec 1) : 1993.

4.6.4 The short circuit protection shall be so graded that a fault occurring in any outgoing branch circuit is cleared by the short circuit protective device in the faulted branch without affecting the other outgoing branch circuits.

5. GENERAL ARRANGEMENT

5.1 **General** – MCC shall be assembled by suitable combinations of panels arranged side by side and shall be easily extensible by the addition of more panels on either side. A typical MCC arrangement is illustrated in *Fig.1*.

5.1.1 Each panel shall have:

a) compartments housing drawout/non-drawout functional units,

b) horizontal chamber at top accommodating power control and auxiliary buses,

c) vertical bus bars (droppers) to feed functional units,

d) vertical cable alley to permit cable entry to each compartment, and

e) horizontal chamber at bottom

5.1.2 Each panel shall be fully separated from the adjacent panels by sheet steel partitions except for the openings in the horizontal chambers at the top and bottom to enable buses and cables/wires to pass through.

5.1.3 The MCC shall be of single front design. All components except the bus bars shall be accessible and capable of being removed from the front. All wiring shall be from the front. However, rear cover shall also be removable.

NOTE : Double front MCCs incorporating two sets of vertical buses, may also be specified in particular cases.

5.1.4 The MCC shall have uniform height and preferably uniform depth also, throughout its length.

5.1.5 The top horizontal chamber housing bus bars, etc shall have separate properly removable cover at the front and the top.

5.1.6 Cable entry shall generally be from bottom only. However, when specified, the arrangement shall be suitable for busduct/cable entry from top. Limiting dimensions for cable entry are given in *Fig-2* for MCCs with incomer rating upto 800 A (similar diagram for MCCs having incomer above 800 A is under consideration).

5.1.7 Vertical cable alley and bottom cable chamber shall have suitable and adequate number of supports for cabling. The bottom cable chamber shall have separate cover(s). The vertical cable alley shall be provided with single-flap detachable hinged doors.

5.1.8 Danger name-plates in accordance with IS 2551:1982 'Danger notice plates (*first revision*)' and IS 8923:1978 'Warning symbol for dangerous voltages'.

5.2 Feeder Arrangement

5.2.1 All the basic elements of a functional unit shall be accommodated in one compartment.

5.2.1.1 For the purpose of standardization, like components in a MCC shall be identical and interchangeable.

5.2.2 Each compartment shall be effectively partitioned from top, bottom and sides, except to the extent of space required for cable entries and ventilation, if required.

5.2.3 Compartment/withdrawable part sizes shall be integral multiples of basic sizes.

5.2.4 The disposition of components, wiring, etc, shall be identical for similar units.

5.2.5 Each compartment shall have individual sheet steel flanged doors, with concealed hinges. The door should be on the side opposite to the terminals to prevent obstruction to their access. The door shall open up to 100 degree (minimum).

5.2.5.1 For drawout units the door shall not form part of the withdrawable part and it shall not be possible to close the door until the unit is fully plugged-in.

5.2.5.2 The power circuit isolation device shall be operable from outside without opening the door. The coupling shall have the same mechanical life as the device itself.

5.2.5.3 The power circuit isolation device shall have facility for padlocking in the OFF position with the door closed. The direction of rotation of the handle should be according to 7.1.4.2 of IS 13947 (Part 1):1993.

5.2.5.4 The reset button for thermal relay, operating push buttons, control switches, etc shall be operable and meters and signal lamps visible without opening the door. The test push button, however, shall be accessible only after opening the door.

5.2.6 The control transformer/rectification equipment of control supply shall be mounted in one of the lowermost compartments.

5.3 Withdrawable Part

5.3.1 Each withdrawable part shall have three fixed functional positions in accordance with 2.6, 2.7 and 2.8, namely:

a) Service (connected) position,
b) Test position, and
c) Isolated (disconnected) position

The separation between the fixed and the drawout power contacts shall be minimum 25 mm in the isolated position.

5.3.2 Service, test and isolated positions shall be positive and identifiable.

NOTE : In some arrangements, it may be possible to have the isolated and test positions in the same position of mechanical travel by removing or connecting the control circuit connections.

5.3.3 Mechanical locking/latching facility shall be provided such that the withdrawable part can be locked/latched in any of the fixed positions and it shall not be possible for it to move out from the fixed position without human intervention.

5.3.4 The control contacts shall be of pull-apart type plug socket or self-aligning, sliding type drawout design. For plug socket design, the following features shall be provided:

a) Built-in mechanical interlock shall be provided to ensure the connection of right terminals of a plug and socket.

b) Locking features shall be provided in the plug-socket, which is to be disengaged manually for disconnection. Both insertion and disconnection shall be smooth and safe.

5.3.4.1 The control contacts shall be rated for minimum 10 A under the stipulated conditions.

5.3.5 Withdrawable parts for similar functional units of the same rating and circuits shall be interchangeable.

5.3.6 Power to the individual withdrawable parts shall be available from the vertical bus bars provided at the back through male and female plug-in contacts. The minimum rating of plug-in power contacts shall be 63 A. However, the rating shall be commensurate with the specified short-circuit rating.

5.3.7 The design of plug-in contacts shall be such as to increase contact pressure during short-circuit conditions. Proper contact pressure for all parting contacts shall be ensured.

5.3.8 A positive guiding system shall be provided to ensure proper engagement of the drawout contacts. The drawout control contacts shall be able to tolerate a mismatch up to $\pm$2 mm.

5.3.9 The side play of the withdrawable part shall be limited to 1.5 mm to prevent skewing.

5.4 Mounting of Components

5.4.1 The lowermost point of any electrical component shall not be less than 300 mm from bottom level of the MCC to facilitate inspection and maintenance.

5.4.2 Indicating instruments shall not be located higher than 2000 mm from the bottom of the MCC to facilitate reading. However, operating height of any component shall not be more than 1800 mm from MCC bottom.

5.4.3 All components of a non-drawout module shall be mounted in such a manner as to facilitate easy accessibility.

6. BUS BARS AND BUS CONNECTIONS

6.1 **General** – The bus bar arrangement shall generally conform to IS 11353:1985 'Guide for uniform system of marking and identification of conductors and apparatus terminals'.

6.2 Material

6.2.1 Power buses shall be of EC grade aluminium alloy equivalent to E 63401-WP (E 91 E) conforming to IS 5082:1988 'Wrought aluminium and aluminium alloy bars, rods, tubes, sections, plates and sheets for electrical application (second *revision*)' or high conductivity electrolytic grade copper conforming to IS 613:1984 'Copper rods and bars for electrical purposes (*second revision*)'.

6.2.2 Control and auxiliary bus, wherever provided, shall be of copper.

6.3 Size and Rating

6.3.1 The rated current at continuous operation of the main horizontal and auxiliary buses shall be as specified by the purchaser, notwithstanding the requirements imposed and to be met in accordance with 4.6.1 and 6.3.2.

6.3.2 Minimum continuous rating of bus bars shall be as follows:

a) Horizontal and vertical power buses (droppers) – 400 A,
b) Neutral bus – 50% of the phase buses, and
c) Control bus – 63 A.

6.3.3 The sizes of bus bars and bus connerctions shall be so selected that the total operating temperature does not exceed 90 deg.C for continuous operation at rated current (*see also 4.6.1*).

6.3.4 The cross-section shall be uniform throughout the length.

6.3.5 Allowance shall be made for reduction in section by bolt holes and stab-in-holes, if provided in the vertical buses.

6.3.6 The vertical bus bars (droppers) of different outgoing feeders of a MCC shall be of the same size.

6.4 Mechanical Arrangement

6.4.1 All power bus joints shall be designed to prevent over-heating.

6.4.2 The drawout connections shall be between silver plated copper and silver plated copper except for the incoming power connections where the drawout contacts may engage to silver plated copper/copper alloy or tin plated aluminium/copper. For bolted copper/aluminium connections, corrosion inhibitive compounds shall be provided.

6.4.3 Bus bars shall be supported on tough, non-hygroscopic, self-extinguishing and fire retardant insulators with anti-tracking contour and rigidly held to the framework of the chamber independent of any switch, circuit breaker or the like that is connected to it. Cut ends of insulators shall be made non-hygroscopic. Horizontal support insulators shall be provided with ribs to increase the creepage distance. Provision shall be made in the design to ensure that a continuous film of dust does not form on the surface of the insulator.

6.4.4 Bus bar connecting fish plates, zinc bichromated bolts, nuts and washers shall be provided at each end of a transport unit to facilitate connection at site. The MCC shall be freely extendable on either side.

6.4.5 The horizontal power bus and control buses shall run for the full length of the transport unit. Similarly, the vertical bus shall run for the full height of the panel excluding the bottom horizontal cable chambers.

6.4.6 More than one set of control buses may be required for MCCs involving more than one control voltage.

6.4.7 Both the power and control buses shall be sectionalized if stipulated.

6.4.8 The clearance between bare phase buses and between phase to earth in air shall be not less than 25 and 19 mm respectively. Abnormal conditions, such as short circuits shall not permanently reduce the distance between bus bars and connections below the minimum acceptable values. In case such clearance is not possible to provide, suitably insulated barriers shall be put.

6.4.9 Bus bars shall be phase identified by colour at intervals. The colour code shall be according to IS 11353:1985.

7. WIRING AND TERMINATIONS

7.1 MCCs shall be completely factory assembled and wired. If required, it may be split into a number of sections for ease of transport in which case each transport unit shall be fully wired up. Length of transport unit shall not exceed 3.2 meters.

The selection of Power Components for the MCC feeders shall be as per the guidelines given in the Table below:

Sl.No.	Motor Rating (kW) at S1 duty	Minimum rating of MCCB	Minimum rating of Contactor (Amps) AC 3 Duty
1.	Upto 3.7 kW	-	25
2.	5.5	100	40
3.	7.5	100	40
4.	11	100	40
5.	15	100	63
6.	18.5	100	63
7.	22	100	63
8.	30	100	160
9.	37	100	160
10.	45	100	160
11.	55	125	160
12.	75	250	250
13.	90	250	250

The selection of Power Components for the Motor feeder from the LT switchboard shall be as per the guidelines given in the table below:

Sl.No.	Motor Rating (kW) at S1 duty	Minimum rating of MCCB	Minimum rating of Contactor (Amps) AC 3 Duty
1.	110	400	400
2.	125	400	400
3.	135	400	400
4.	160	400	400
5.	200	400	600

7.2 Power connections shall be done by single core PVC insulated copper cable or copper/aluminium flats (*see also 4.6.2 and 4.6.3*). The minimum sizes for different feeder ratings of continuous duty cage motors shall be as indicated in *Table 1.*

7.3 Control wiring shall be done by 1100 V grade PVC insulated single core multistrand copper conductor of minimum cross-section 1.5 mm2 according to IS 694:1990 'PVC insulated cables for working voltages upto and including 1100 volts (*third revision*)(*amendment 1*)'. For CT, however, 2.5 mm2 cable shall be used.

7.4 All wires shall be run and fixed neatly and shall allow clear access to all components. Control wires shall be bunched.

7.5 All wiring shall be arranged and supported in such a manner that there shall be no strain on termination.

7.6 Wiring. between two devices shall have no splices or soldered joints. Connections shall be made at fixed terminals only. Not more than two wires shall be terminated at one control terminal.

7.7 Each wire shall be identified at each end in accordance with the schematic diagram in an indelible manner. Ferrules shall be of interlocked type.

7.8 The following colour coding shall be adopted for identification of control wiring:

ac – light grey
dc – black

7.9 Each withdrawable part shall be self-contained, complete with internal wiring between the components.

7.10 For non-drawout modules, where wiring may be led to the door, it shall be done by flexible cable and so installed that no mechanical damage can occur to the wiring as a result of movement of the door.

7.11 Wire ways shall be smooth and entirely free from sharp edges, burrs, fins, etc that may cause abrasion of the insulation on conductors.

7.12 Wires shall not, as far as possible, be connected in parallel. However, if necessary, this should be done after taking extra precautions of keeping the same length, same conductor material, same cross-section, same insulation type and terminated in the same manner.

7.13 All connections external to the module shall be brought to acessible terminals. For drawout units, they shall be terminated on drawout terminals on the outgoing unit which will engage to corresponding stationary terminals on the compartment for the outgoing connections and on to vertical bus bars for the incoming connections.

7.14 All terminations shall be of adequate current rating to suit individual feeder/control circuit requirement.

7.15 All power and control terminals shall be properly separated and shall be suitably identified.

7.15.1 Terminals having connections from other modules shall be marked with red ferrules.

7.16 Each control terminal block shall have 10% spare terminals with a minimum of four numbers. However, in particular cases where this calls for increase in module size, the number of spare terminals may be reduced to 2.

7.17 Outgoing power terminations shall be designed for connecting aluminium cable according to IS 1554 (Part 1):1988 'PVC insulated (heavy duty) electric cables: Part 1 For working voltages upto and including 1100 volts (*third revision*)(*amendment 1*)'. The minimum termination sizes for different feeder ratings of continuous duty cage motors shall be as indicated in *Table 1.*

7.17.1 Suitable provision shall be made for terminating cable of size 120 mm2 and above to overcome cable bending problems, for example by extension links.

7.18 Inter-module wiring in the same panel shall be through the vertical cable alley.

7.19 Inter-panel wiring shall be carried out through the horizontal chamber at bottom/top. The wire way shall be properly separated from power to bus-bars.

7.19.1 Provisions shall be kept to carrying out wiring between different transport units. The wires shall be connected at one end and the other end properly labelled for connecting at site.

8. MECHANICAL DESIGN

8.1 MCC shall be sheet steel enclosed of floor mounting and free standing design.

8.2 Sheet steel used shall be of 2 mm thickness (minimum) for all members except:

a) doors and covers where it may be 1.6 mm (minimum), and
b) partitions with no component mounted thereon and having no structural function where it may be 1 mm (minimum).

8.2.1 For doors and covers, the sheet steel shall be cold rolled only.

8.3 Unless otherwise specified, the degree of protection provided by the enclosure shall not be inferior to IP 52 conforming to Table CI/CII of IS 13947 (Part 1):1993 considering that majority of such equipment are installed in enclosed premises. When it is not intended to install the MCC in enclosed premises, a degree of protection of IP 54 or better may be specified.

8.4 Durable gaskets shall be provided for all doors and covers and for all partitions between adjacent units. The gaskets shall be of sponge rubber/synthetic rubber.

8.4.1 Gaskets shall be adequately secured.

8.5 A base channel/frame of minimum 50 mm height and 2.5 mm thickness shall be provided to prevent corrosion of sheet and to facilitate cleaning of floors.

8.6 Removable cable gland plates shall be provided at the bottom of the MCC. The plates shall be undrilled unless otherwise specified.

8.7 All fasteners shall be zinc bichromated and passivated. All bolts shall be with spring washers.

8.8 Labels

8.8.1 An identification name-plate indicating the designation of the MCC shall be affixed at approximately the centre of the MCC (lengthwise) with letters not less than 25 mm high.

8.8.2 Identification/designation numbers shall be suitably indicated on each vertical section.

8.8.3 An inscription plate bearing the description of the functional unit shall be provided on the door of the compartment. Inscriptions shall also be provided on the signal lamps, operating handles of switches/breakers,

push button, etc which are available on the front of the door indicating its purpose of operation.

8.8.4 Each component shall be clearly labelled on the base plate according to the schematic diagram by durable marking; PVC/paper stickers are not acceptable.

8.8.5 All inscriptions on inscription plates shall be in English with characters of equal height on contrasting background.

8.8.6 Each character shall be not less than 3 mm high and shall be in sizes suited to the items to which they refer.

8.9 Provisions shall be made for lifting and handling of each transport unit, for example, by eye-bolts.

8.10 Sheet steel surfaces shall be free from dents and hammer marks. All openings and cut-outs shall be machine made and shall be free from burrs.

8.11 A removable cover shall be secured by at least four fasteners, with no fasterner spaced more than 600 mm and at least one fastener not more than 150 mm from each corner. However, cover sizes not exceeding 150x150 mm may have only two fasteners, one in each of two opposite sides.

8.12 At least two hinges shall be provided for each hinged door.

8.13 The minimum clear width of the vertical cable alloy and bottom cable chamber shall be 250 mm between the inner walls for single front MCCs.

8.14 All sheet steel work shall undergo a process of degreasing, pickling in acid, cold rinsing and phosphatising and then sprayed with a corrosion resistant primer followed by stove enamelling. Two coats of final paint shall be given thereafter and shall be further stove enamelled. Any other process of metal treatment may also be accepted subject to specific agreement with the purchaser. Thickness of coating shall be not less than 30 microns.

9. SAFETY FEATURES AND EARTHING

9.1 Protective measures shall be taken against electric shock in normal service as well as in the case of fault. Relevant clauses of Indian Electricity Rules, 1956 shall be complied with and the design shall generally conform to IS 8623 (Part 1):1993. Specific features are indicated below in 9.2 to 9.7.2.

9.2 The door of a functional unit shall be so interlocked with the associated power isolation device that the door can be opened only when the disconnecting device is OFF and it can not be switched on when the door is open.

9.2.1 In cases where the components of a functional unit cannot be accommodated in one compartment, the door of the compartment housing the power disconnecting device shall be interlocked as in 9.2 while the door of the other compartment shall be openable only when the former door is open. Alternatively, a common door, for the two compartments with interlocking as in 9.2 may be provided.

9.2.2 It shall be possible for an authorized person to defeat the interlock and open the door without having to switch-off the power disconnecting device for inspection and testing and for intentional application of power while the door is open.

9.2.2.1 The interlock shall be restored to normal on reclosing the door, preferably automatically. It shall not be possible to switch on the power disconnecting device without resetting the interlock to normal.

9.3 It shall not be possible to plug-in the withdrawable part to the vertical bus unless the power switch is in the OFF position (*under consideration*).

9.4 Adequate protection shall be provided to prevent accidental contact with live parts when a door of the MCC is open. The degree of protection shall correspond at least to IP 2LX conforming to Table CI of IS 13947 (Part 1):1993 and shall include the provisions of 9.4.1 to 9.4.3.

9.4.1 Barriers shall be provided to prevent accidental contact with vertical bus bars from the compartment. Suitable slots may be provided for connection to the vertical bus bars.

9.4.2 The live parts of the incoming side of the power switch/breaker which are not rendered dead by its switching off shall be suitable protected.

9.4.3 Cable terminations which project into the cabling chamber shall be properly shrouded.

9.5 A continuous earth bus shall be provided for the full length of the MCC running at the bottom with an earthing terminal at each end.

9.5.1 The earth bus shall be of minimum 50x6 mm copper or equivalent aluminium or GI section.

9.6 Provision shall be made to connect earth continuity conductors from incoming and outgoing cables.

9.7 For the earthing of the withdrawable part, a spring loaded scrapping earth shall be provided having an effective connection to the earth bus.

9.7.1 The earth contact shall be interrupted only after the live main power conduction has been interrupted and continuity established before the live conductors are reconnected.

9.7.2 The earth continuity shall remain effective from the service to the test position inclusively.

10. STANDARD CONTROL SCHEME

10.1 A typical control scheme for a reversible continuous duty cage motor drive is shown in *Fig 3*. (Standard schemes for intermittent duty and slipring motor drives as well as incoming/sectionalizing switchgear are under consideration.) It is recommended that this scheme should be used wherever possible with the required modifications/simplifications to take care of the requirements of the particular drive, for example, drives with only manual control, non-reversible drives, specific interlocking of a drive, etc.

The terminal numbers for the most common functions are standardized for ease of connection and maintenance, for example, forward start button is between terminals 11-12, external trip contact between 7-9, etc. For a particular drive, new numbers may be used for additional terminals when required.

The position of the standard terminal number in the terminal strip plan is also standardized. Additional terminal numbers wherever used shall not be interposed in the standard strip plan. The power circuit shows switch fuse unit as SCPD for illustration only. A fuse-switch or MCCB as SCPD may also be used.

11. **SELECTION OF COMPONENT RATINGS** – The specification of components are/shall be covered in the relevant IPSS Standards. The selection of component types and ratings only are covered here.

11.1 Motor Power Circuit Components

11.1.1 *General* – The selection of components for continuous duty cage motors only are covered (selection for intermittent duty and wound rotor motors are under consideration). The power circuit components shall be selected based on the following particulars of the drive to be indicated by the purchaser:

a) Motor's rated capacity in kW (and preferably rated current) together with reference ambient temperature; and

b) Preferably motor's starting current and starting time. In the absence of this information, a maximum starting current of 8 times the rated current at 40 deg.C and lasting a maximum period of 5 seconds may be assumed.

11.1.2 *Power contactors* – The minimum ratings for different motor feeders are indicated in *Table-1*. These ratings shall correspond to minimum 120 cycles per hour and a minimum contact life of 1 million cycles with 99% at ac 3 and 1% at ac 4 utilization category.

11.1.3 *Overload relay* – The tripping characteristics of the thermal overload relay shall be selected to provide protection to the motors under overload, single phasing and stalling. The relay shall not cause undue tripping while starting and shall be self-protecting through contactors upto 10 times its maximum setting. The setting range shall be so selected that the rated current of the motor is closer to the upper limit of the range. The relays shall be provided with auto/hand reset facility.

NOTE : The use of MCCB for overload protection may also be considered after taking due precautions.

11.1.4 *Short circuit protective device* (*SCPD*) – The SCPD may be either a fuse switch/switch-fuse unit (Alternative-I) or a MCCB motor circuit breaker (Alternative-II). The SCPD shall meet the following requirements:

a) The manufacturer shall state the take over current at which the SCPD takes over from the overload relay. While using instantaneous trip MCCBs as SCPD, due care shall be taken against any unprotected zone between the maximum current of the overload relay and the magnetic threshold;

b) The SCPD will meet the requirements of 4.6.3 from the take over current upto maximum stipulated fault current;

c) There shall be no undue tripping of the MCCB or blowing of fuse during DOL starting. Particular care should be taken to obviate the tripping of MCCBs due to the peak assymetrical current;

d) The switch/MCCB (if without an overload release) shall have a thermal withstand matching with the tripping characteristics of the overload relay so as to be protected by it upto the take over current;

e) The MCCB shall have a breaking capacity at performance category P1 in excess of or equal to the stipulated fault current; and

f) For Alternative-I, the switch shall have a minimum rating of utilization category AC 23 not less than the rating given in *Table 1* and not less than the rating of the associated fuse.

11.2 **Control Circuit Components** – Control circuit components like auxiliary contactors, control switches, etc as well as auxiliary contacts of power contactors, circuit breakers, switches, etc shall have a minimum continuous thermal rating of 10 A and an operational current of minimum 4 A at utilization category AC 11 for 240 V ac and 0.5 A at DC 11 for 220 V dc. However, the contacts of push button and thermal overload relay may have an AC 11 rating of 1.5 A.

11.3 **Incoming Sectionalizing and Feeder Tap Units** – The type of switchgear, namely ACB, MCCB, fuse-switch, etc as well as the rating and releases shall be as specified by the purchaser.

11.4 **Control Supply Units** – Unless otherwise specified, the following provisions shall apply :

a) One control supply unit per bus section will be provided;

b) For MCCs with two control bus sections, each control supply unit will have the rating to feed the complete control circuit of the MCC (through appropriate change-over switches);

c) The control supply switch for the individual feeders shall be minimum 16 A rating, unless otherwise specified; and

d) Voltmeter/indicating lamp shall be provided for control supply supervision.

12. **TESTS** – These tests are applicable for the MCC only. The individual devices and self-contained components incorporated in the MCC need not be tested once these have been tested according to the relevant specifications.

12.1 **Type Tests** – Tests specified in 12.1.1 to 12.1.5 constitute type tests and may be carried out in any sequence and on different samples.

12.1.1 *Verification of temperature rise limits* – According to 8.2.1 of IS 8623 (Part 1):1993, the limits of temperature shall be as given in Table-III of IS 8623 (Part 1):1993. However, the temperature for buses shall not exceed 90 deg.C as specified in 6.3.3.

12.1.2 *Verification of short circuit strength* – This test shall be conducted to verify conformity with 4.6. A representative number of types and sizes shall be tested to adequately determine satisfactory performance. The tests shall be conducted generally in accordance with 8.2.3 of IS 8623 (Part 1):1993. However, the following shall also be applicable:

a) No unit shall be plugged in or bolted to the vertical bus during the test on bus bars;

b) The vertical bus system being tested shall be short circuited at its end farthest from the horizontal bus;

c) Outgoing functional units shall be tested while installed in the MCC in a compartment as close as possible to the incoming line terminals and the short circuit applied at the load terminals;

d) Immediately after the short circuit test, a di-electric test in accordance with 10.1.5 shall be withstood. For the outgoing functional units, the test shall be on the line side of the short circuit protective device which shall be left as it is after the test; and

e) For drawout MCCs, a tray shall be plugged into the vertical bus after the test on the vertical buses and any deformity which impairs normal imsertion of the tray shall be considered a failure. Also after the test on an outgoing drawout unit, the plug-in contacts and vertical buses shall be essentially in the same mechanical and electrical condition as those before the test.

12.1.3 Verification of degree of protection

a) The degree of protection for the enclosure (see 8.3) shall be verified according to 8.2.7 of IS 8623 (Part 1):1993, and

b) The degree of protection for the insulating barriers (see 9.4) shall be tested according to C7 of IS 13947 (Part 1):1993 as indicated against first characteristic numeral.

12.1.4 Verification of di-electric properties, continuity of protective circuits, clearances and creepage distances, mechanical operation shall be according to relevant clauses of IS 8623 (Part 1):1993.

12.2 **Routine Tests** – Tests specified in 12.2.1 to 12.2.5 shall constitute routine tests, to be carried out on each MCC or transport unit and may be carried out in any sequence.

12.2.1 *Di-electric test* – According to 8.3.2 of IS 8623 (Part 1):1993.

12.2.2 *Checking of protective measures and electrical continuity of protective circuits* – Generally according to 8.3.3 of IS 8623 (Part 1):1993. In particular, conformity with 9.6 and 9.7 shall be verified.

12.2.3 *Physical inspection* – Generally according to 8.3.1 of IS 8623 (Part 1):1993 and shall include the following:

a) Checking with respect to general arrangement like feeder arrangement, mounting of components, termination arrangement, buses, wiring and connections, etc;

b) Tests to ensure the proper functioning of mechanical interlocks, for example, door interlocks (see 9.2), tray interlocks (see 5.3.3), mechanically interlocked contactors, etc;

c) Tests to show the interchangeability of withdrawable parts (see 5.3.5) for drawout MCCs only; and

d) Checking of mechanical work, for example; fixing of doors and covers, gaskets, surface finish, movement and engagement of withdrawable part, latching of withdrawable part when fully racked in, etc.

12.2.4 Checking with respect to schematic diagram including technical data, ratings and setting of components.

12.2.5 Electrical functional test for each functional unit to show that the desired function is achieved and also the interlocking and sequence circuits are operating correctly.

13. INFORMATION TO BE GIVEN BY THE PURCHASER

13.1 **Single Line Schematic Diagram** – This diagram will indicate the schematic power and control supply distribution arrangement of the different incoming and outgoing feeders and will include the following:

a) Supply voltage and frequency;
b) System fault level at the point of installation;
c) Continuous current rating of power buses;
d) Details of control and auxiliary buses, if any;
e) Bus sectionalization, if any;
f) Type of switchgear for incomer/sectionalizer and feeder tap units with ratings and proposed cable sizes;
g) Motor data according to 11.1.1; and
h) Feeder designation and reference for control schematic diagram for each feeder (reference 13.2).

13.2 Control Schematic Diagram of Feeders

13.2.1 Each feeder shall have a corresponding control schematic diagram (one diagram may apply to several feeders) indicating the power, control, protection, interlocking, circuits, etc. These diagrams shall conform to the typical circuit given in *Fig.3* as closely as possible. Wherever applicable, a reference to *Fig.3* shall be considered sufficient in lieu of a control schematic diagram.

13.2.2 The diagram shall include ratings for control components as required.

13.2.3 The components/signals which are external to the MCC shall be identified.

13.2.4 The terminals which are to be wired to the terminal strip shall be identified.

13.3 **Execution Required** – Drawout or non-drawout

13.4 The following information is also to be included by the purchaser if the requirement is different from the standard:

a) Ambient temperature is different from 40 deg.C (*reference 3.1*),
b) Degree of protection provided by the enclosure if different from IP 5X (*reference 3.3*),
c) Requirement of double front execution (*reference 5.1.3*),
d) Cable/bus entry from top (*reference 5.1.6*), and
e) Broad specification of components for which IPSS standards do not exist.

14. LABEL

14.1 Each MCC shall have a name plate/label indicating the following:

a) Reference to the IPSS standard i.e. IPSS:1-04-040-99
b) Manufacturer's name and trade mark
c) Serial Number
d) Year of manufacture
e) Weight

APPENDIX-A (Sheet 1 of 2)

(Clause 0.6)

COMPARATIVE STUDY OF IPSS:1-04-040-99 'SPECIFICATION FOR MOTOR CONTROL CENTRES (MCCs) (*FIRST REVISION*) AND IS 8623 (PART 1):1993, IS 13947 (PART 1):1993 & IS 13947 (PART 4/SEC 1):1993

	Requirement	Clause Reference in IPSS	Clause Reference in ISs
Requirements which are identical between IPSS & ISs	Certain nomenclature	2.3, 2.5 to 2.8	2.1.5, 2.2.1, 2.2.9, 2.2.10, 2.2.11 of IS 8623 (Part 1):1993
	Main circuit voltage	4.1.1	4.3.1.1 of IS 13947 (Part 1):1993
	Door interlocking	9.2, 9.2.2	7.4.2.2.3(b) of IS 8623 (Part 1):1993 (in essence)
	Certain tests	12.1.1 and 12.1.2 (partly), 12.1.4, 12.1.3, 12.2.1, 12.2.2	As mentioned in the test
Requirements selected out of choice given in ISs	Control circuit voltage	4.1.2	4.5 of IS 13947 (Part 1):1993
	Short circuit strength of functional units	4.6.3	4.3.6.4 of IS 13947 (Part 1): 1993
	Gradation of ac protection	4.6.4	7.4 of IS 8623 (Part 1):1993
	Bus material	6.2	IS 5082:1981 and IS 613:1984
	Degree of protection for enclosure	8.3	7.1.11 of IS 13947 (Part 1):1993
Supplementary requirements not contradicting ISs	Certain nomenclature	2.1, 2.2, 2.4	

APPENDIX-A (Sheet 2 of 2)

	Requirement	Clause Reference in IPSS	Clause Reference in ISs
	Derivation of voltage other than main circuit voltage	4.3	
	Rated insulation voltage	4.4	
	General ar ngement	5.0	
	Bus size and mechanical arrangement	6.3, 6.4	
	Wiring & terminations	7.0	
	Mechanical design Aspects	8.0	
	Door interlocking	9.2.1	
	Barriers for live parts	9.4.1 to 9.4.3	
	Standard control scheme	10.0	
	Selection of component ratings	11.0	
	Certain tests	12.1.1 and 12.1.2 (partly), 12.2.3, 12.2.4, 12.2.5	
	Information to be given by the purchaser	13.0	
Deviations from ISs	Earthing of withdrawable part	9.7	IS 8623 (Part 1):1993
	Degree of protection for barriers	9.4	7.4.2.2 of IS 8623 (Part 1):1993

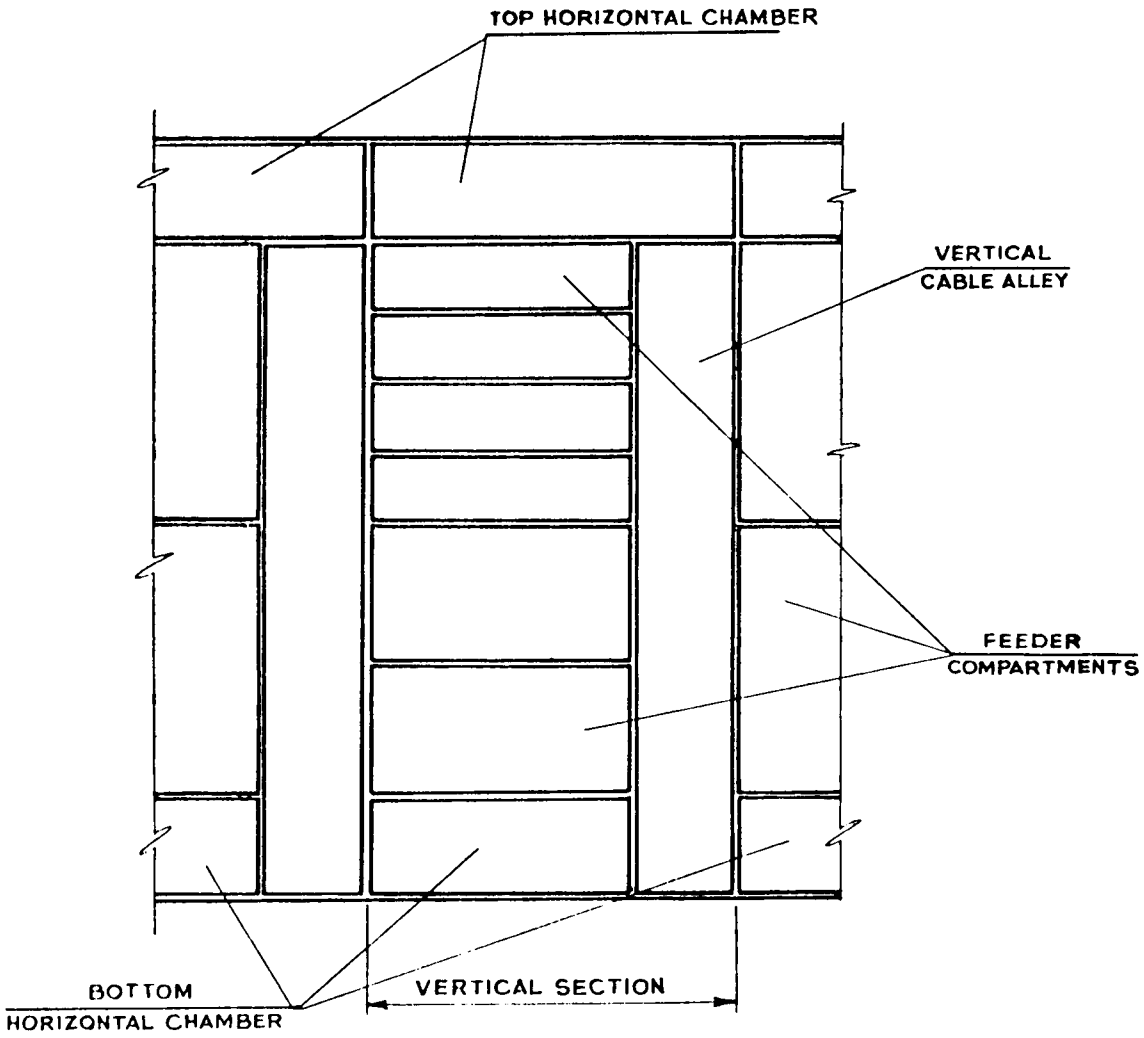


FIG. 1 TYPICAL FRONT VIEW OF MCC

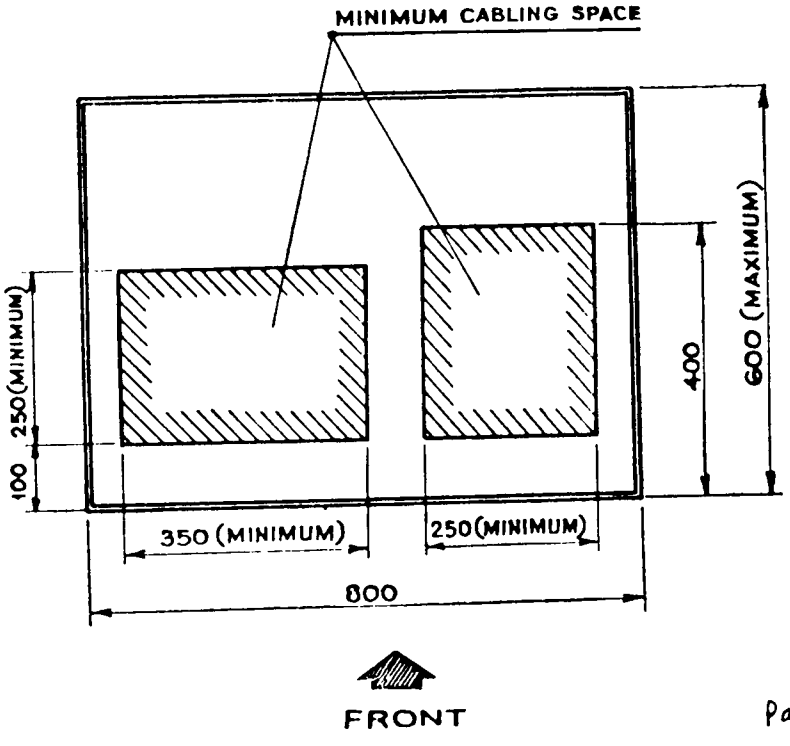
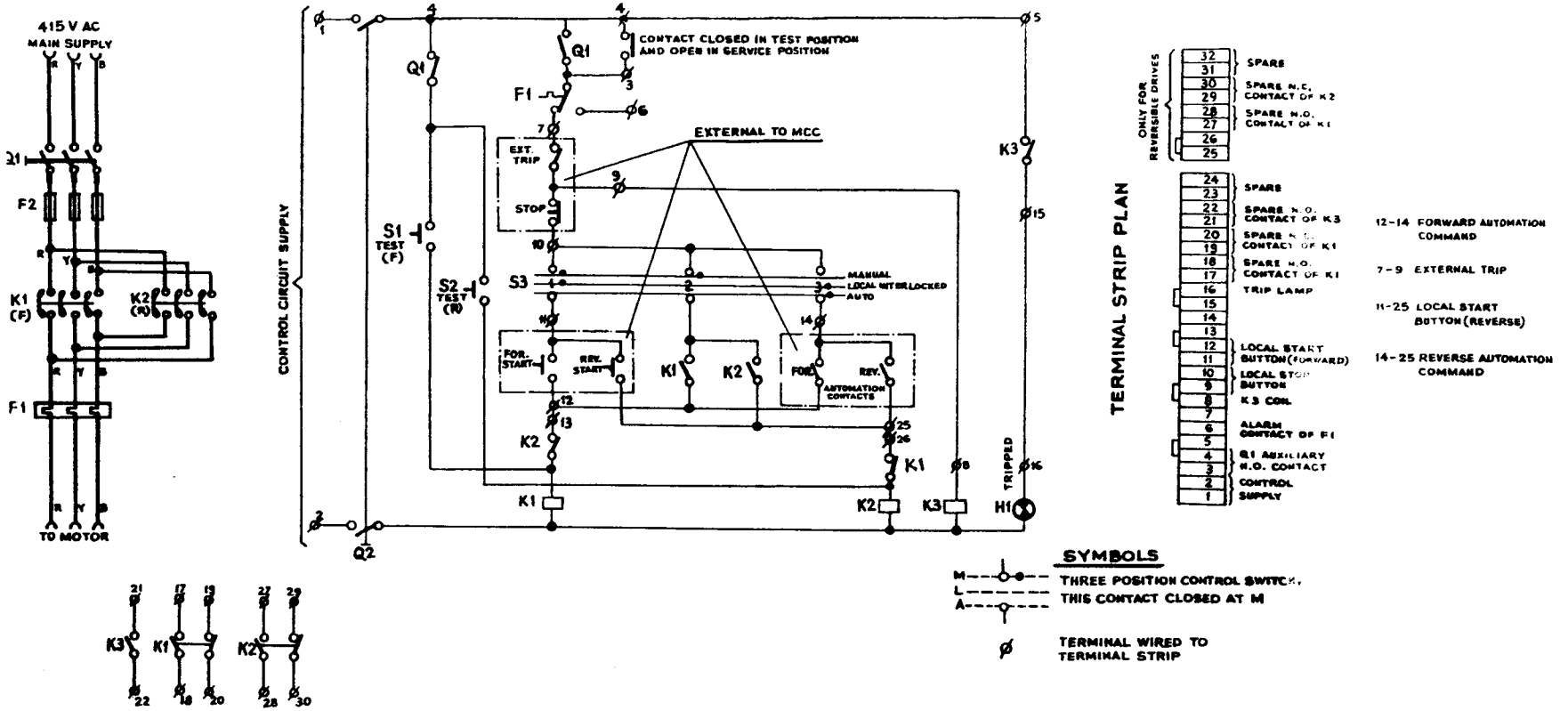


FIG. 2 LIMITING DIMENSIONS FOR CABLE ENTRY



K1 — Forward contactor
K2 — Reverse contactor
K3 — Auxiliary contactor
(Other auxiliary contactors when used will be designated *K4*, *K5*, etc)
Q1 — Main isolator (may be the switch of the switch fuse unit or MCCB, etc)
Q2 — Control circuit isolator
F1 — Overload relay
F2 — Main fuses (only for switch fuse/fuse switch versions)
S1 — Test button for forward contactor (*K1*)
S2 — Test button for reverse contactor (*K2*)
S3 — Control selector switch (push button/switches for other purposes when used will be designated *S4*, *S5*, etc)
H1 — Motor tripped signal lamp (other lamps when used will be designated *H2*, *H3*, etc)

FIG. 3 TYPICAL SCHEMATIC DIAGRAM FOR REVERSIBLE CONTINUOUS DUTY DRIVE