

- 5.16.5. In the case of miniature substations, the whole underbase shall be abrasive blasted and then hot dip galvanised and coated with black epoxy tar paint. All holes made in the underbase prior to galvanising shall be suitably sealed before painting.
- 5.16.6. All 3CR12, galvanised or zinc sprayed components shall be painted with an approved and appropriate primer and with two coats of an approved polyurethane-based heat fused epoxy powder coating in accordance with SANS 780:2021 (edition 5.1). Suitable steps shall have been taken to ensure a satisfactory bond between the protected surfaces and the paint to prevent peeling.
- 5.16.7. The colour of the outer coat of paint shall be an acceptable match to Colour C12 "Avocado" of SANS 1091.
- 5.16.8. The interior of all enclosures, except cable boxes, shall be painted white ("Arc Free White").
- 5.16.9. The painting and corrosion protection measures detailed in this section shall also apply to the gland plates and gland cut-out cover plates, whether supplied with the transformers or as separate loose items.
- 5.16.10. Alternative proven corrosion protection systems will be considered. Manufacturers shall submit their proposed corrosion protection specifications to the Engineer for approval.

#### **5.17. Warning Signs, Safety Notices and Labels**

- 5.17.1. Warning signs, safety notices and labels shall be provided in accordance with the requirements of SANS 780:2021 (edition 5.1) for distribution transformers and pole mounted transformers, and in accordance with the requirements of SANS 1029 for miniature substations.
- 5.17.2. A metallic corrosion resistant 150 mm x 150 mm Type WW7 warning sign in accordance with SANS 1186-1 shall be riveted with stainless steel blind pop rivets to the outside of all MV and LV compartment doors. In the case of the transformer MV enclosure the warning sign shall be affixed by alternative means, to approval.
- 5.17.3. The hinged metal cover covering live components within the LV switch compartment shall be fitted with a Type WW7 warning sign in accordance with SANS 1186-1.
- 5.17.4. The interior side of MV and LV compartment doors shall be indelibly marked MV/S and LV/S as applicable. Such markings shall have lettering of 150 mm height.
- 5.17.5. All equipment within the MV and LV compartments shall be labelled by means of Traffolyte-type identification labels.
- 5.17.6. A sign depicting electric shock treatment and full first aid instructions and information in case of fires shall be permanently attached to the interior of the LV compartment doors on distribution transformers and the MV and LV compartment doors on miniature substations.
- 5.17.7. For miniature substations fitted with top-oil temperature-based shunt tripping, a label stating "CHECK THERMOMETER POCKET FILLED WITH OIL BEFORE COMMISSIONING" shall be placed adjacent to the thermometer pocket.
- 5.17.8. The total mass of the distribution transformers, pole mounted transformers and miniature substations (in kilograms) shall be clearly stencilled on the side or rear of the unit in white lettering with a minimum font size of 50 mm (e.g. "TOTAL MASS: 500 kg").
- 5.17.9. Where the distribution transformer, pole mounted transformer or miniature substation supplier is not the manufacturer, the supplier shall provide and affix in an approved manner and position a label detailing the supplier's name or trademark.
- 5.17.10. Labels and markings on the miniature substation's ring main unit shall comply with the requirements of Section 8 of this specification.

#### **5.18. Transformer and Miniature Substation Rating Plates**

- 5.18.1. A rating plate shall be provided on the outside of the transformer tank detailing all the relevant information in metric form as stipulated in SANS 60076-1.
- 5.18.2. Rating plates on miniature substations shall be in accordance with the requirements of SANS 1029.
- 5.18.3. Rating plates shall include an oil PCB free declaration as specified in Section 5.10 of the Specification and shall in addition detail the brand and type of oil and confirmation of compliance to SANS 555-2.
- 5.18.4. Rating Plates shall include a Vector Diagram for the standard Dyn11 or Dyn7 transformer connections (for the particular tender Item) as per the requirements of SANS 60076-1, with the MV terminals being named A B C (left to right) and the LV terminals being named yn a b c (left to right).
- 5.18.5. There shall be no reference to phase colours on the rating plate, simply the terminal names A, B, C, a, b, c or yn as per the requirements of SANS 60076-1.
- 5.18.6. Winding terminal and tapping numbers per winding shall be depicted on the rating plate with the highest number connected to the bushing terminal, as indicated in Figure 5 of SANS 780:2021 (edition 5.1).
- 5.18.7. The phase rotation standard as per the rating plate shall be A B C.

## **5.19. Transformer Terminal Markings**

- 5.19.1. All terminals of the MV and LV windings shall be legibly and indelibly marked with the appropriate terminal name assigned to that terminal in accordance with SANS 60076-1 and SANS 780:2021 (edition 5.1).
- 5.19.2. Terminal naming and markings shall be in accordance with Figure 6 of SANS 780:2021 (edition 5.1), marked A B C as viewed from the MV side of the transformer, and **c b a yn** as viewed from the LV side of the transformer.
- 5.19.3. The markings shall be on brass or anodized aluminium and shall be permanently secured in a position adjacent to the bushings so as to clearly indicate the sequence of the terminals with which they are associated. The terminal markings shall be clearly visible when the covers are fitted.
- 5.19.4. Terminal markings for the MV terminals of distribution transformers shall be adjacent to the bushings inside the MV cable compartment.
- 5.19.5. Terminals shall in addition be marked with the phase designation, one of R, W, B, r, w, b or yn, to indicate the intended phase connections to the transformer's terminals for the particular tender Item, as detailed below.
- 5.19.6. Vector group Dyn7 transformers shall be marked for B W R phase connection to terminals A B C (as per Figure 6 of SANS 780:2021 (edition 5.1)) on the MV side of the transformer and r w b yn phase connection to terminals **c b a yn** (as per Figure 6 of SANS 780:2021 (edition 5.1)) on the LV side.
- 5.19.7. Vector Group Dyn11 transformers shall be marked for R W B phase connection to terminals A B C (as per Figure 6 of SANS 780:2021 (edition 5.1)) on the MV side of the transformer and b w r yn phase connection to terminals **c b a yn** (as per Figure 6 of SANS 780:2021 (edition 5.1)) on the LV side.
- 5.19.8. All LV busbars shall be colour-coded red, white, blue or black by means of a clearly visible painted spot of at least 20 mm in diameter.
- 5.19.9. All busbars shall be made from Bimetallic Busbars (CCAA or Al Alloy etc). All busbar and earth bar components shall be clearly marked with "CCT" at approved intervals by permanent embossing or punching.

## **5.20. Clearances**

- 5.20.1. Air clearances and specific creepage distances on the MV side of the transformers and miniature substations and within the miniature substation MV compartment shall comply with SANS 876.

compartments shall be fitted with an approved 15 A round pin switched socket outlet and a pair of 15 A terminals protected by type "NS" HRC 20 A and 4 A fuse links, respectively.

- 6.13.10. The supply to the "NS" HRC fuse links shall be by means of an approved insulated copper conductor securely supported below busbar level.

#### **6.14. Busbars - General Requirements**

- 6.14.1. The phase neutral and earth busbars shall be tinned Bimetallic Busbars (CCAA or Al Alloy etc)
- 6.14.2. Electroplated materials shall not be acceptable for Bimetallic Busbars (CCAA or Al Alloy etc) bus bars.
- 6.14.3. Tinned Bimetallic Busbars (CCAA or Al Alloy etc) busbars shall be tinned to the same standard as specified for copper busbars.
- 6.14.4. Copper busbar nominal ratings are as detailed in table 1 below. Tinned Bimetallic Busbars (CCAA or Al Alloy etc) busbars shall be sized to achieve minimum load and fault ratings equivalent to the copper busbar sizes.

<b>Tx Rating</b>	<b>Copper Busbar Dimensions</b>	<b>Nominal Rated Current (A)</b>
200kVA	25 x 6 mm	275
315kVA	30 x 10 mm	433
500kVA	50 x 10 mm	688
800kVA	50 x 12.5 mm	1100
1000kVA	80 x 10 mm	1375

- 6.14.5. Tenderers shall provide detailed technical data sheets and test certificate documenting and proven such equivalence.
- 6.14.6. Tenders shall detail standard equivalent Bimetallic Busbars (CCAA or Al Alloy etc) bus bar dimensions where indicated by item in Schedule 13B
- 6.14.7. The neutral bar shall have the same cross-sectional area as the phase busbars.
- 6.14.8. The earth bar, phase and neutral busbar dimensions shall be appropriate for the transformer KVA rating and number of outgoing feeder circuits as described in this specification.
- 6.14.9. The earth bar dimensions, and the phase and neutral busbars of Pole Mounted Transformers and Distribution Transformers up to 1000 kVA rating, shall be made from Tinned Bimetallic Busbars (CCAA or Al Alloy etc) (CCAA) material.
- 6.14.10. Phase busbars on 100 kVA and 200 kVA units shall be pre-drilled with 12,5 mm holes suitably positioned for connections to 3 x J25S or equivalent moulded case circuit breakers (MCCB's).
- 6.14.11. Phase busbars on 315 kVA to 1000 kVA units shall be pre-drilled with 12,5 mm holes suitably positioned for connections to either 3 x large frame MCCB's or 5 x J25S or equivalent MCCB's.
- 6.14.12. The neutral bar and earth bar on Pole Mounted Transformers shall have a minimum of six predrilled 12,5 mm connection holes.

- 6.14.13. The neutral bar and earth bar on Distribution Transformers shall have a minimum of eight predrilled 12,5 mm connection holes.
- 6.14.14. All pre-drilled connection holes on phase busbars, neutral bar and earth bar shall be fitted with M12 stainless steel bolts, nuts and washers.
- 6.14.15. All busbars shall be arranged vertically like in the Type B miniature substation and shall be mounted on colour coded nylon stand-off insulators.
- 6.14.16. The neutral bar shall be mounted on black nylon stand-off insulators. The insulators shall be rated to withstand a working voltage of 600 V under normal and damp conditions and shall be rated to withstand a high voltage test of 2 kV for 5 minutes.
- 6.14.17. The neutral and earth bars shall be mounted using stainless steel torque shear bolts.
- 6.14.18. The neutral bar shall be connected to the earth bar with a removable solid tinned Bimetallic Busbars (CCAA or Al Alloy etc) earth strap.
- 6.14.19. It shall be ensured that the positioning of the earth bar and neutral bar relative to the predrilled cable gland holes on the gland plate are such that all gland holes can be utilised for the specified cable sizes without obstruction of cables by the earth and neutral bars. The design positions of the earth and neutral bars and the predrilled gland holes shall be to the Engineer's approval.
- 6.14.20. Busbars shall be color-coded according to the phase colors, i.e. r-w-b, b-w-r.

#### **6.15. Secondary (LV) Side – Bushings, Busbars and Connections**

- 6.15.1. The LV bushings of Pole Mounted Transformers and Distribution Transformers with 420 V secondary windings shall be of ceramic or other insulating material to the approval of the Engineer. DMC components or similar shall not be accepted.
- 6.15.2. All bushings shall be provided with individual or mono-block tinned aluminium alloy Palm flag type or similar, with suitable number of holes for fastening.
- 6.15.3. The Distribution Transformers of rating 1600 kVA and 2000 kVA with 420 V secondary windings shall be fitted with busbars / bushing flags suitable for connection of up to 4x single core cables per phase of cross-sectional area 500 mm<sup>2</sup> or 630 mm<sup>2</sup>.
- 6.15.4. The Pole Mounted Transformers and Distribution Transformers up to 1000 kVA rating shall be fitted with phase busbars and neutral bar as specified below.
- 6.15.5. All connections (LV bushings to Main MCCB, main MCCB to busbars and LV bushings to busbars) shall be solid tinned Bimetallic Busbars (CCAA or Al Alloy etc) conductors or flexible LV alternative Jumpers Conductor (CCAA or Al Alloy etc) conductors to approval and so designed that the circuit breakers may be independently removed for replacement. The neutral busbar connection shall be PVC insulated LV alternative Conductor (CCAA or Al Alloy etc).
- 6.15.6. The connections between the transformer LV bushings and the busbars or main MCCB shall be fitted with locknuts at each connection point.
- 6.15.7. All external earth connections on the units shall be of suitably sized Copper-Clad Steel or Aluminium Alloy.

#### **6.16. Secondary (LV) Side – MCCB's and MCCB Backing Plate**

- 6.16.1. Ground-mount Distribution Transformers shall be fitted with the main electronic adjustable MCCB and shall be positioned to the left (on opposite side of the neutral bushing). The width of the LV compartment door shall be suitably sized with a minimum door width of 1250 mm on all sizes.
- 6.16.2. The Main MCCB shall be connected between the LV bushings and the busbars.

- 6.16.3. The tripping and holding (non-tripping) currents and maximum tripping time under overload conditions shall be in accordance with SANS 60947-2.
- 6.16.4. The MCCB operating characteristics for electronic release MCCBs shall not be affected by changes in ambient temperature.
- 6.16.5. The MCCB must be locked, and a proof of testing be provided.
- 6.16.6. Include the Electronic Tripping unit (for the curve), on both the spec and the schedules
- 6.16.7. The ratings shall be suitably chosen for each transformer size. The protection settings shall be applied to account for inrush current, overloading and harmonics. These ratings and settings shall be provided in schedule 13B.
- 6.16.8. The moulded case circuit breakers for feeders will be provided and fitted by others.
- 6.16.9. The MCCB backing plate for 100 kVA, 200 kVA and 315 kVA Pole Mounted Transformers shall be pre-drilled for the fitting of 3 x J25S or equivalent 25kA MCCB's of rating up to 250 A, arranged in accordance with Drawing DR 2399/C Sheet 3 Rev 2.
- 6.16.10. The MCCB backing plate for 50 kVA Pole Mounted Transformers shall be pre-drilled for the fitting of 2 x G15D or F15D or equivalent 15kA MCCB's of rating up to 100 A.
- 6.16.11. The backing plate (and accordingly the MCCBs) shall be positioned relative to the busbars such that the required separations from earthed and live busbars and conductive parts and minimum arc venting spaces specified by the MCCB manufacturers are maintained. MCCB's currently utilized are the CBI Hy-Mag L40B, J25S, F15D and M35B types.
- 6.16.12. A hinged metal cover, to approval, shall be provided to shield the busbars, the connectors to the MCCB's and the MCCB incoming terminals to prevent inadvertent contact.
- 6.16.13. A further, separate hinged metal cover, to approval, shall be provided to shield the MCCB outgoing terminals and cable droppers and lugs to prevent inadvertent contact.
- 6.16.14. The hinged metal cover shall be so positioned that the access to the operating toggles of the moulded case circuit breakers is not inhibited in any way, and that these toggles can be operated safely.
- 6.16.15. Provision shall be made for the circuit breakers to be mounted in a single row. Staggered arrangements of the MCCB's will not be accepted.
- 6.16.16. It shall be ensured that the positions of the MCCB's relative to the busbars and relative to each other are such that the required separations and minimum arc venting spaces specified by the manufacturers of the MCCB's are maintained

#### **6.17. Secondary (LV) Side – Gland Plate and Glands**

- 6.17.1. The LV switch compartment gland plate on the Pole Mounted and Distribution Transformers shall be predrilled as specified and fitted with removable gasketed 3CR12 steel coverplates.
- 6.17.2. The quantity and position of gland holes for the 50 kVA, 100 kVA and 200 kVA Pole Mounted Transformers shall be as detailed in Drawing DR 2399/B Rev 2, suitable for 2 x four core LV cables of up to 120 mm<sup>2</sup> nominal section.
- 6.17.3. The 315 kVA Pole Mounted Transformers shall have gland plates predrilled with 5 x 50 mm gland holes, suitable for 5 x four core LV cables of up to 120 mm<sup>2</sup> nominal section.
- 6.17.4. The Distribution Transformers Items B1 to B5 and Water and sanitation transformers Items E1 to 25 shall be fitted as standard with Split Gland Plates complete with Blanking Cover plates, as depicted in Drawings SK 5242 Sheets 1 & 2.
- 6.17.5. The Distribution Transformers Items B6 to B8 of ratings 200 kVA to 500 kVA shall be fitted with a non-ferrous gland plate having 50 mm diameter gland holes suitable to make off 4 x 500 mm<sup>2</sup> single core armoured cables using No 5 adjustable glands.
- 6.17.6. The Distribution Transformers Items B9 to B10 of ratings 800 kVA and 1000 kVA shall be fitted with a non-ferrous gland plate having 50 mm diameter gland holes suitable to make off 8 x 500 mm<sup>2</sup> single

## 7. Requirements Specific to Miniature Substations

### 7.1. General Construction

7.1.1. The miniature substations shall be suitable for outdoor use and shall be divided into following compartments where applicable, namely:

7.1.1.1. MV

7.1.1.2. Transformer

7.1.1.3. LV

7.1.1.4. Communication (differs according to the type of mini)

7.1.2. The miniature substations shall be manufactured from materials as detailed below with the following minimum thicknesses:

Channel Underbase	:	6 mm hot dip galvanised mild steel
Transformer Bottom	:	4,5 mm 3CR12 stainless steel
Transformer Tank	:	4,5 mm 3CR12 stainless steel
Tank Cover	:	4,5 mm 3CR12 stainless steel
Radiator Tubes	:	1,6 mm hot dip galvanised mild steel / stainless steel
Walls and Roof	:	3 mm 3CR12 stainless steel
Doors	:	3 mm 3CR12 stainless steel
Door Lock Box	:	3 mm 3CR12 stainless steel

### 7.2. Miniature Substation Type C:

7.2.1. The design and construction of the Dyn7 Type C miniature substations shall be generally in accordance with the arrangement for a Type A-long unitary design substation as specified in SANS 1029 and shall comply with SANS 1029 where applicable. The miniature substations shall have a transverse mounted transformer and shall be dimensioned to fit on a Type CS concrete plinth as shown on Drawing SK 5180 Rev 1. The miniature substation base frame shall not exceed the dimensions of the Type CS concrete plinth and shall be in full compliance with cable cut-out dimensions and specified internal arc classification. The width of the substation is to be kept to a minimum. The width of the LV compartment door shall be maximized, and the door opening shall have a door width of a minimum of 1250 mm. The positioning of the LV cable feeders shall be positioned above the plinth opening (900mm).

7.2.2. The front side of the Type C miniature substation shall be deemed to be the side on the long axis that faces the road. Type C miniature substations shall have the LV compartment on the left-hand side of the transformer (facing in the direction of the long axis) and the MV (RMU) compartment on the right-hand side of the transformer when the miniature substation is viewed from the front side. The tap changer compartment and MV (RMU) compartment doors shall open to the front side and the LV compartment door shall be hinged such that it opens towards the rear of the miniature substation and provide unobstructed egress towards the front.

each LV switch compartment.

- 7.14.1.3. The "NS" HRC 4 A fused link shall be used as the connection to supply the resetting voltage for the earth fault indicator equipment.
- 7.14.1.4. The supply to the fuse links for the SSO, 15A terminals and shunt tripping installation shall be by means of approved insulated copper conductors securely supported below busbar level.
- 7.14.1.5. Means shall be provided for carrying vermin proof earth fault indicator leads from the MV compartment to the LV compartment in an approved manner.
- 7.14.1.6. The hinged metal cover shall be provided and installed to close the bottom of the LV compartment to reduce the occurrence of condensation in the compartment during storage and prior to commissioning of the miniature substations.

#### 7.14.2. Type C Miniature substations – Bushings, Busbars and Connections

- 7.14.2.1. All LV bushings shall be of porcelain or other insulating material to the approval of the Engineer. DMC components or similar will not be accepted.
- 7.14.2.2. All bushings shall be provided with individual or mono-block tinned aluminium alloy Palm flag type or similar, with suitable number of holes for fastening.
- 7.14.2.3. All busbars, neutral bars, and earth bars shall be made of tinned Bimetallic Busbars (CCAA or Al Alloy etc), color-coded, and dimensioned such that, at full load, the current density shall not exceed an equivalent to that of copper busbars, i.e., 1.8 A/mm<sup>2</sup>.
- 7.14.2.4. The neutral bar shall have the same cross-sectional area as the phase busbars.
- 7.14.2.5. The earth bar, phase and neutral busbar dimensions shall be appropriate for the transformer kVA rating and number of outgoing feeder circuits as described in this specification.
- 7.14.2.6. The connection from the transformer LV bushings to the main MCCB and from main MCCB to the busbars shall be solid tinned LV alternative Conductor (CCAA or Al Alloy etc) or flexible tinned LV alternative Conductor (CCAA or Al Alloy etc) or aluminium alloy conductors to approval and designed such that the main MCCB may be independently removed for replacement.
- 7.14.2.7. All connections to the transformer LV bushings and the busbars and the connections of the bushing flags shall be fitted with locknuts at each connection point.
- 7.14.2.8. Phase busbars shall be pre-drilled with 12,5 mm holes suitably positioned for connections to either 3 x large frame MCCB's or 5 x J25S or equivalent MCCB's.
- 7.14.2.9. The neutral bar and earth bar shall have a minimum of eight predrilled 12,5 mm connection holes.
- 7.14.2.10. All pre-drilled connection holes on phase busbars, neutral bar and earth bar shall be fitted with M12 stainless steel bolts, nuts and washers.
- 7.14.2.11. The neutral bar shall be mounted on black nylon stand-off insulators. The insulators shall be rated to withstand a working voltage of 600 V under normal and damp conditions and shall be rated to withstand a high voltage test of 2 kV for 5 minutes.
- 7.14.2.12. The neutral and earth bars shall be mounted using stainless steel torque shear bolts.
- 7.14.2.13. The neutral bar shall be connected to the earth bar with a removable solid tinned LV alternative Conductor (CCAA or Al Alloy etc) earth strap.
- 7.14.2.14. Terminal markings **c b a yn** (and phase colour indication as specified for the Items), shall be positioned above the LV bushings.
- 7.14.2.15. All external earth connections on the units shall be of Copper-Clad Steel or Aluminium Alloy. Aluminium conductors are not an acceptable alternative.
- 7.14.2.16. All busbars shall be arranged vertically like in the Type B miniature substation and shall

be mounted on colour coded nylon stand-off insulators.

7.14.3. Type C Miniature substations – LV Main MCCB

- 7.14.3.1. The LV compartment shall be fitted with the main electronic adjustable MCCB, and shall be positioned to the left (on opposite side of the neutral bushing)
- 7.14.3.2. The Main MCCB shall be connected between the LV bushings and the busbars.
- 7.14.3.3. The tripping and holding (non-tripping) currents and maximum tripping time under overload conditions shall be in accordance with SANS 60947-2.
- 7.14.3.4. The MCCB operating characteristics for electronic release MCCBs shall not be affected by changes in ambient temperature.
- 7.14.3.5. The ratings shall be suitably chosen for each transformer size. The protection settings shall be applied to account for inrush current, overloading and harmonics. These ratings and settings shall be provided in schedule 13B.

7.14.4. Type C Miniature substations – MCCB's and MCCB Backing Plate

- 7.14.4.1. The moulded case circuit breakers will be provided and fitted by others.
- 7.14.4.2. The miniature substations shall be fitted by the manufacturer with a 3CR12 corrosion resistant steel backing plate for subsequent mounting of the moulded case circuit breakers.
- 7.14.4.3. The MCCB backing plate shall be pre-drilled in accordance with Drawing SK 5191 Sheet 1 for the fitting of 3 x moulded case circuit breakers of rating 400 A, 600 A or 800 A arranged and for an alternative fitment of 5 x J25S MCCB's of rating up to 250 A.
- 7.14.4.4. The backing plate (and accordingly the MCCBs) shall be positioned relative to the busbars such that the required separations from earthed and live busbars and conductive parts and minimum arc venting spaces specified by the MCCB manufacturers are maintained. MCCB's currently utilized by the CCT are the CBi Hy-Mag L40B, J25S and M35B types.

7.14.5. Type C Miniature substations – MCCB and LV Busbar Hinged metal covers

- 7.14.5.1. A hinged metal cover, to approval, shall be provided to shield the busbars, the connectors to the MCCB's and the MCCB incoming terminals to prevent inadvertent contact.
- 7.14.5.2. A further, separate hinged metal cover, to approval, shall be provided to shield the MCCB outgoing terminals to prevent inadvertent contact.
- 7.14.5.3. Hinged metal cover shall be so positioned that the access to the operating toggles of the moulded case circuit breakers is not inhibited in any way, and such that these toggles can be operated safely.
- 7.14.5.4. Provision shall be made for the circuit breakers to be mounted in a single row. Staggered arrangements of the MCCB's will not be accepted.
- 7.14.5.5. It shall be ensured that the positions of the MCCB's relative to the busbars and relative to each other are such that the required separations and minimum arc venting spaces specified by the manufacturers of the MCCB's are maintained.

7.14.6. Type C Miniature substations – LV Cable Clamping

- 7.14.6.1. The LV compartment shall be provided with a hot dipped galvanised unistrut and suitable K-clamps to secure a maximum of five 4 core cables ranging in size between 120 mm<sup>2</sup> and 300 mm<sup>2</sup>. The minimum distance between the outgoing terminal droppers of the moulded-case circuit breakers and the bottom unistrut shall be 530 mm.

7.14.7. Type C Miniature substations – LV Metering

- 7.14.7.1. LV metering and LV switch compartment door meter windows are not required for the Type C miniature substations.

7.14.8. Smart Requirements - General



- 7.14.8.1. The RMUs on mini substations shall be fully SCADA ready, fitted as detailed hereunder. Specific details specified in this regard apply solely to these two equipment types.
- 7.14.8.2. It is the intention that the smart relay, the mini-remote terminal unit, ethernet switch, the radio communications unit and the AC power Supply Unit will be installed at a later stage.
- 7.14.8.3. All indications, alarms, trip and close coils, terminal strips, small wiring, fibre conduit, housings, equipment mounting boards and other parts and accessories necessary to fulfil the specified requirements shall be included in the tender and provided by the contractor.

#### 7.14.9. Smart Requirements - Housing

- 7.14.9.1. A Smart Compartment, as specified, shall be provided between the LV and the RMU compartments and shall be suitably sized to accommodate the communications related devices and facilities specified hereunder, including the Power Supply Unit, Remote Terminal Unit, Radio Communications Unit, Ethernet Switch, AC Mains and trunking.
- 7.14.9.2. The Smart Compartment shall be a dedicated compartment mounted internal to the mini-sub enclosure.
- 7.14.9.3. The communication compartment shall be fitted with a removable wooden backing board (20 mm Blockboard or equivalent to approval) which shall be sized and laid out for the comms. The minimum internal dimensions of the Smart Compartment shall be as detailed in the Technical Schedules.
- 7.14.9.3.1. The SCADA compartment shall be provided with an Antenna Conduit as specified for the Radio Communications Unit.

#### 7.14.10. Smart Requirements – Wiring

- 7.14.10.1. Small wiring for all alarms, statuses, indications and auxiliary supply for each of the devices shall be wired from the coils, contacts and switches to a dedicated terminal strip(s).
- 7.14.10.2. The compartment housing the smart relay shall be fitted with terminal strip(s) marshalling all controls, alarms, statuses and indications from RMU terminals detailed above, and all controls, alarms, statuses, indications shall be wired through to these terminal strips.
- 7.14.10.3. The smart compartment housing shall further be fitted with AC Mains Supply for communication devices, with a circuit breaker for the clamping and terminating of the incoming AC Mains Cable, of maximum size 10mm<sup>2</sup> Cu 2-core PVC SWA PVC.
- 7.14.10.4. Mains Supply wiring from the terminal strip in the Circuit Breaker Module MV cable compartment to the AC Mains Supply terminal strip in the Smart compartment is to be supplied and installed by the contractor. AC Mains Supply wiring is to be of minimum size 4mm<sup>2</sup>. Wireways between the MV Cable compartments and the Smart compartment shall be grommetted and fully IAC compliant in accordance with the IAC classification and testing.
- 7.14.10.5. All small wiring shall be fully wired, ferruled and trunked to the relevant sources / destinations.

#### 7.14.11. Smart Requirements – Controls, Indications and Alarms

- 7.14.11.1. The RMU unit shall be equipped with status indication as follows (in addition to the standard fitment specified within this document):
  - 7.14.11.1.1. Switch-disconnector module shall be supplied with auxiliary switches as below:
    - Disconnector position (2x NO, 2x NC) (*NO: Normally Open; NC: Normally Closed*)
    - Earthing switch position (2x NO, 2x NC)
  - 7.14.11.1.2. The ring main unit shall be designed for future retrofitting of motors for remote operation.
  - 7.14.11.1.3. Circuit breaker module: motorised spring charge, trip and close trip coils, auxiliary switches for:

- Circuit breaker position (2x NO, 2x NC)
- Disconnecter position (2x NO, 2x NC)
- Earthing switch position (2x NO, 2x NC)
- Circuit breaker tripped

7.14.11.2. The RMUs units shall be equipped with alarms as follows:

#### 7.14.12. Low SF6 gas density

7.14.12.1.1. Door open

7.14.12.1.2. “Close not healthy”, for switch-disconnectors

7.14.12.1.3. “Circuit-breaker not healthy”, for circuit breakers

7.14.12.1.4. “Stored energy mechanism not charged”, for all modules

7.14.12.2. The RMU gas pressure sensor shall be provided with low gas pressure auxiliary contacts and wired to the Communications compartment terminal strip for alarm purposes.

#### 7.14.13. Door Status Monitoring Device

7.14.13.1. A robust door status monitoring device will be installed to monitor the open/close status of mini-substation doors. The device will relay this information to the central SCADA system via a modem to be installed in the smart compartment.

7.14.13.2. The device must include reliable sensors to detect the open/close status of doors.

7.14.13.3. The sensors must work seamlessly with the communication unit to transmit status updates.

7.14.13.4. The device must be capable of connecting to a modem using standard communication protocols (e.g., RS485, Ethernet, or Modbus).

7.14.13.5. Provision for real-time data transmission to SCADA.

7.14.13.6. The device shall operate on 220V AC power. No battery or DC power options are acceptable.

7.14.13.7. The device and its enclosures must comply with SANS 60529 standards and have an ingress protection rating of at least IP66, ensuring protection against dust and high-pressure water jets.

7.14.13.8. The device must comply with SANS 62262 and achieve at least an IK10 impact protection rating.

7.14.13.9. It shall be suitable to operate on an ambient temperature range between -10°C to +55°C; humidity tolerance: Up to 95% non-condensing. It shall be UV-resistant materials to prevent degradation in outdoor installations.

7.14.13.10. The device shall have a minimum service life of 10 years. All components must be modular for easy replacement and maintenance.

### 7.15. **LV Compartment - Type B Miniature substations**

#### 7.15.1. Type B Miniature substations – LV Compartment and Fittings

7.15.1.1. The LV compartment of the Type B miniature substations shall be generally in accordance with Figure C.5 of Annexure C of SANS 1029, and shall be divided into an LV end compartment and an LV front compartment which between them shall house the transformer LV bushings, busbars, thermometer pocket, digital temperature monitor with over-temperature trip indication, the main electronic adjustable MCCB, 3 phase digital maximum power demand meter and associated fittings, moulded case circuit breakers, glands and other fittings as detailed.

7.15.1.2. The LV end compartment shall unless otherwise approved also house the transformer off-

circuit tapping switch and oil level gauge.

- 7.15.1.3. Each miniature substation shall be provided with a 3 phase digital maximum power demand meter, complete with single ratio current transformers.
- 7.15.1.4. Street lighting control circuitry is not required in the LV compartment of the Type B miniature substations.
- 7.15.1.5. A single-phase plug socket protected by 15 A circuit breaker earth leakage unit combination shall be provided.
- 7.15.1.6. All circuits shall be provided with blank Traffolyte-type designating labels.

#### 7.15.2. Type B Miniature substations – Bushings, Busbars and Connections

- 7.15.2.1. All LV bushings shall be of porcelain or other insulating material to the approval of the engineer. DMC components or similar will not be accepted.
- 7.15.2.2. All bushings shall be provided with individual or mono-block tinned aluminium alloy Palm flag type or similar, with suitable number of holes for fastening.
- 7.15.2.3. All busbars, neutral bar and earth bar shall be made tinned Bimetallic Busbars (CCAA or Al Alloy etc), colour coded and be so dimensioned that at full load the current density shall not exceed 1,8 A/mm<sup>2</sup>.
- 7.15.2.4. The neutral bar shall have the same cross-sectional area as the phase busbars.
- 7.15.2.5. A full length tinned Bimetallic Busbar (CCAA or Al Alloy etc) earth of dimensions equivalent to 31,5 mm x 6,3 mm copper bar and in compliance with SANS 1029 shall be mounted above the gland plate. This shall be connected to the transformer neutral, transformer tank, miniature substation metal works, LV distribution and MV switchgear, using a removable 70 mm<sup>2</sup> bare stranded tinned LV alternative Conductor (CCAA or Al Alloy etc) or aluminium alloy.
- 7.15.2.6. The busbar load current carrying capacity and fault current rating shall be in accordance with the transformer rating.
- 7.15.2.7. All connections to the transformer LV bushings and the busbars and the connections of the bushing flags shall be fitted with locknuts at each connection point.
- 7.15.2.8. The phase busbars, neutral bar and earth bar shall have a minimum of eight predrilled 12,5 mm connection holes.
- 7.15.2.9. All pre-drilled connection holes on phase busbars, neutral bar and earth bar shall be fitted with M12 stainless steel bolts, nuts and washers.
- 7.15.2.10. No terminations shall be connected on any of the busbar insulator mounting bolts.

#### 7.15.3. Type B Miniature substations – LV Main MCCB

- 7.15.4. The LV compartment shall be fitted with the main electronic adjustable MCCB.
- 7.15.5. The Main MCCB shall be connected between the LV bushings and the busbars.
- 7.15.6. The tripping and holding (non-tripping) currents and maximum tripping time under overload conditions shall be in accordance with SANS 60947-2.
- 7.15.7. The MCCB operating characteristics for electronic release MCCBs shall not be affected by changes in ambient temperature.
- 7.15.8. The ratings shall be suitably chosen for each transformer size. The protection settings shall be applied to account for inrush current, overloading and harmonics. These ratings and settings shall be provided in schedule 13B.

#### 7.15.9. Type B Miniature substations – LV Feeder MCCBs

- 7.15.9.1. The Type B miniature substations shall have mounted provision for six (6) CBi Hy-Mag