

## Section 26 23 00

### ABB ReliaGear Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear

#### Part 1 GENERAL

##### 1.01 SUMMARY

- A. This specification defines low voltage metal-enclosed dead front switchgear assemblies rated 635V and below, utilizing ABB type Emax 2 draw out power circuit breakers built to construction methods as defined by the IEEE C37.20.1 and labeled to UL 1558 standards, as specified herein and shown on the contract drawings.

##### 1.02 REFERENCES

- A. Switchgear shall be designed, manufactured and tested in accordance with the following standards and guidelines. These documents are references only and shown by basic designation. The edition/revision of the referenced documents shall be the latest as of the date of the contract documents, unless otherwise specified.
  - 1. IEEE C37.20.1 – Metal-Enclosed Low Voltage Power Circuit Breaker Switchgear
  - 2. ANSI C37.51 – Conformance Testing of Metal-Enclosed Low Voltage AC Power Circuit Breaker Switchgear Assemblies
  - 3. NEMA 250 – Enclosures for Electrical Equipment
  - 4. UL 1558 – Metal-Enclosed Low Voltage Power Circuit Breaker Switchgear
  - 5. UL 50 – Enclosures for Electrical Equipment
  - 6. CSA C22.2 No.31 - Switchgear Assemblies
- B. Main and Feeder Circuit Breakers used in ABB Low Voltage Metal-Enclosed Switchgear shall be designed, manufactured and tested in accordance with the following:
  - 1. IEEE C37.13 — Low Voltage AC Power Circuit Breakers Used in Enclosures
  - 2. IEEE C37.17 — Trip Devices for AC and General Purpose DC Low-Voltage Power Circuit Breakers
  - 3. ANSI C37.50 — Test Procedure for Low Voltage AC Power Circuit Breakers Used in Enclosures
  - 4. UL1066 – Low Voltage AC & DC Power Circuit Breakers Used in Enclosures
  - 5. American Bureau of Shipping
  - 6. Electromagnetic compatibility ANSI C37.90.1 and C37.90.2.
- C. Related Specifications [apply as required]
  - 1. [26 28 00 – Low Voltage Power Circuit Breakers]
  - 2. [26 09 13 – Electrical Power Monitoring]
  - 3. [26 43 13 – Surge Protection for Low Voltage Electrical Power Circuits]
  - 4. [26 05 73 – Coordination and/or Arc Flash Studies]
  - 5. [26 05 06 – High Resistance Grounding]
  - 6. [26 12 00 – Medium Voltage Transformers]
  - 7. [26 13 00 – Medium Voltage Switchgear]
- D. Manufacturer Seismic Qualification [ apply as required]
  - 1. [IBC 2015/2012 – International Building Code]
  - 2. [CBC 2015/2013 – California Building Code]
  - 3. [ASCE 7-10 – American Society of Civil Engineers]
  - 4. [ICC-ES-AC156 – International Code Council – Seismic Qualification by shake table testing of non-structural components and systems]

### 1.03 SUBMITTALS (Approval/Record)

- A. General: Submit detailed drawings and product data for approval and final documentation in the quantities listed according to the conditions of the contract. Customer name, customer location and order number shall be identified on all transmittals.
- B. Documents for Approval: General arrangement drawings showing dimensioned elevation, floor plan, side view, foundation/anchoring details, approximate weights, one line diagram showing major features, nameplate legends, schematic diagrams and bill of material.
- C. Final Documents: Record documentation must include those in 1.03.B and wiring diagrams, list of recommended spare parts, installation and maintenance manuals [and certified test reports]
- D. Product Data: Include features, characteristics and ratings of individual circuit breakers and other components. Also, time-current characteristic curves for over current protective devices, including circuit-breaker trip devices. Breaker and assembly ratings including short circuit ratings, voltage ratings, and continuous current.
- E. Cable terminal sizes.
- F. Manufacturer's mounting and Installation guidelines shall be met in addition to the following:
  - a. The contractor shall provide equipment anchorage details, coordinated with equipment mounting provision, prepared and stamped by licensed civil engineer in the subject State.
- G. The switchgear shall bear a UL listing

### 1.04 QUALIFICATIONS

- A. The manufacturer of the UL labeled switchgear design shall be the same manufacturer of the major components contained within the switchgear sub-assembly, such as the low voltage power breakers.
- B. The manufacturer of this equipment shall be ISO 9001.
- C. The manufacturer shall have certification to ISO 14001.

### 1.05 DELIVERY, STORAGE, AND HANDLING

- A. Equipment shall be properly packed for delivery and shipped in original factory labeled wrapping and packaging, clearly marked on the outside wrapping for site identification.
- B. E1.2, E.2 and E4.2 circuit breakers shall be shipped installed inside their respective cells in which they were tested. E6.2 breakers shall be shipped in a separate package.
- C. Equipment shall be received, stored and handled in strict compliance with manufacturer's instructions and recommendations and protected from potential damage from weather and construction operations. Equipment shall be stored so condensation will not form on or in the switchgear; power shall be applied to space heaters where required to obtain suitable storage conditions. Instructions shall be included with each shipping split of switchgear.

### 1.06 OPERATION AND MAINTENANCE MANUAL

- A. Equipment operation and maintenance manuals shall be provided with each switchgear line up and shall include the following:
  - a. Provide documentation of [UL], [CUL], [CSA] compliance.
  - b. General Information (Recommendations, Instruction Manual, and LV Switchgear Features)
  - c. As-Built Drawings (general arrangement drawings, single line diagram, nameplate schematic diagrams, breaker control schematic diagrams, and interconnections and wiring diagrams)

- d. Electrical Bill of Material
- e. Datasheets and Catalogs from each of the components specific to this switchgear project
- f. Measurement equipment calibrations and torque settings
- g. Low Voltage power breaker operation and maintenance manuals
- h. Certified Production Test Reports
- i. Factory Acceptance Test Reports

## **Part 2 PRODUCTS**

### **2.01 MANUFACTURER**

- A. Metal-Enclosed switchgear assembly containing Low Voltage Power Circuit Breakers shall be ABB ReliaGear LV Switchgear using ABB Emax 2 type Low Voltage Power Circuit Breakers.

### **2.02 RATINGS**

- A. The system shall be rated for a maximum voltage rating of 635VAC.
- B. The horizontal bus ampacity of the Low Voltage Switchgear shall be fully rated to the following: [1600A], [2000A], [3200A], [4000A], [5000A].
- C. The system ampacity of the vertical bus in feeder breaker sections of the Low Voltage Switchgear shall be rated to [the total ampacity of the feeder breakers and prepared spaces within the given vertical structure per IEEE C37.20.1] [the total system ampacity equivalent to the horizontal bus].
- D. The system shall be designed for use on [60Hz] , [50 Hz] electrical systems.
- E. The systems shall be able to be used in [3-Phase 3-Wire] or [3-Phase 4-Wire] electrical systems.
- F. The switchgear assembly shall be rated to withstand mechanical forces during short-circuit conditions when connected to a direct power source having an available fault current of [42kA], [50kA], [65kA], [85kA], [100kA]
- G. The short circuit current rating of the system shall be determined by the available fault current at the Low Voltage Switchgear. All interrupting ratings shall be accomplished without the use of current limiting fuses.
- H. The switchgear assembly shall be braced to have a short time bus withstand rating of [85kA], [100kA] for 1 second (60 cycles).
- I. All circuit breakers shall have a minimum short circuit interrupting capacity of: [42kA], [50kA], [65kA], [85kA], [100kA].

### **2.03 CONSTRUCTION**

- A. Switchgear shall be factory assembled, tested and comply with applicable industry standards. It shall be a coordinated design so that shipping groups are easily connected together at the site into a continuous line-up.
- B. Each vertical section shall contain up to four individually enclosed Emax 2 power circuit breakers spaced uniformly vertically within the section. Sections shall have instrumentation compartments where shown on the drawings. Switchgear shall have a breaker compartment, bus compartment, and cable compartment all conforming to the standards required per this specification.

#### **1. Dimensions**

- a. Sections should be [18"] [22"] [30"] [38"] wide, respectively, dependent on the circuit breaker frame size being installed. Total switchgear depth shall not exceed [72"] [84"]. For depths less than listed consult the factory. The enclosure height for NEMA 1 enclosures shall be no more than 92" and a maximum of 102" including overhead lifting device. Conduit entrance area at a minimum shall be provided as listed in the table below for top or bottom entry based on section type specified on the contract drawings:

Table 1

Section Width	Section Depth	
	72"	84"
18"	14.00" W x 20.75" D	14.00" W x 32.75" D
22"	18.00" W x 20.75" D	18.00" W x 32.75" D
30"	26.00" W x 20.75" D	26.00" W x 32.75" D
38"	34.00" W x 20.75" D	34.00" W x 32.75" D

- b. The assembly shall be provided with removable 10 ga lifting straps at each corner of the shipping splits and shall be capable of being moved into installation position and bolted directly to [Contractor supplied floor sills to be set level in concrete per manufacturer's recommendations] [the floor without the use of floor sills providing the floor is level to 1/8 inch per 3-foot distance in any direction]. Provisions shall be made for jacking of shipping groups, for removal of skids or insertion of equipment rollers. The base shall be equipped with slots in the base frame members to accommodate the use of pry bars for moving the equipment to its final position. [Each structure shall contain bottom plates].
2. Barriers
    - a. Each individual circuit breaker compartment, or cell, shall be segregated from adjacent compartments and sections by means of steel barriers to the maximum extent possible.
    - b. Circuit breaker compartments are to be segregated from the bus compartment by grounded steel barriers.
    - c. Bus sectionalizing barriers shall be arranged to isolate the buses on either side of tie circuit breaker from each other.
    - d. Bus/cable compartment barriers shall be supplied to isolate the rear cable area from the main bus area.
    - e. Incoming line isolation barriers shall be arranged to isolate the incoming line connections from the horizontal and vertical bus in main sections rated for service entrance.
    - f. Bus compartment barriers shall be supplied to isolate the bus compartment from adjacent bus compartments.
    - g. [Option] Cable compartment barriers shall be supplied to isolate the rear cable area from each adjacent cable area. -
  3. Doors and Covers
    - a. [Option] Infrared (IR) viewing windows shall be installed on rear panels [hinged doors] to permit the use of infrared camera to inspect electrical connections

without requiring the opening of panels [doors]. Sufficient quantity of viewports shall be provided to scan all cable terminations in the cable compartment.

- b. [Option] Document holders shall be provided on the inside of each instrument compartment door for manuals, drawings or other documents related to the equipment.
  - c. All edges of covers or hinged panels shall be formed.
  - d. [Option] Front hinged doors shall be provided with provisions for padlocking.
  - e. [Option] Hinged doors shall be provided with gaskets
  - f. [Option] Rear hinged doors shall be provided with provisions for padlocking.
  - g. The end sides of the lineup shall be covered with removable bolt-on covers.
  - h. The rear bolt-on covers shall be fabricated in two (2) pieces for ease of handling and shall be mounted using thread rolling hardware or [full-height hinged rear doors].
  - i. Rear covers [hinged doors] shall have vents to ensure adequate ventilation within the enclosure.
  - j. The circuit breaker door design shall be such that the following functions may be performed without the need to open the circuit breaker door, move circuit breaker between positions, operate manual charging system, close and open circuit breaker, examine and adjust trip unit settings, and read circuit breaker ratings nameplate.
  - k. Each circuit breaker or metering compartment shall be provided with a hinged front door secured with hand operated [key-lock] [tool-lock] rotary latches.
  - l. Breaker doors to be compliant to [IP30 - NEMA 2] [IP54] protection (door escutcheon).
  - m. [Option] An interlock shall be provided to prevent opening of the breaker compartment door unless the breaker is in the disconnect position.
  - n. [Option] An interlock shall be provided to prevent the breaker to be racked-in or out unless the breaker compartment door is closed.
4. Finish
- a. All exterior and interior steel surfaces of the switchgear will be properly cleaned and provided with a rust-inhibiting phosphatized coating and painted using a UL approved paint process.
  - b. The switchgear shall have a smooth finished gray-baked enamel electrodeposited over cleaned phosphatized steel ANSI 61 light gray in accordance with ASTM D1535 (Munsell notation 8.3 G6.10/0.54).
  - c. [Optional] Additional custom paint colors can be provided in order to meet special customer requirements such as matching other equipment].
5. [Option] Continuous mimic bus applied to front of switchgear using plastic laminate, set in single-line diagram format to indicate the arrangement of the circuit breakers in the power circuit.
6. [Option] Mimic diagram engraved on an 11" x 17" plastic laminate sheet mounted on the front of an instrument compartment door in the lineup.

#### C. Enclosure

- 1. [Indoor NEMA 1 Enclosure] shall consist of indoor switchgear assemblies to provide a degree of protection against contact with the enclosed equipment.

- A. Main bus shall connect free-standing vertical sections and shall not be tapered for the entire length of the assembly.
- B. All busses shall be [silver] [tin] plated copper.
- C. Bussing shall be braced to withstand the instantaneous interrupting rating of the main breakers or [85kA] [100kA] minimum RMS symmetrical.
- D. Buses and connections within the switchgear are based on UL and ANSI temperature rise of 65°C above a maximum ambient air temperature of 40°C.
- E. All bus joints shall utilize grade 5 hardware and conical washers for maximum joint integrity. Horizontal bus joints shall have a minimum NEMA 2-hole bolt connections.
- F. Neutral bus rated at 100% of the main bus rating as standard.
- G. All bus is standard with silver plated copper bars:
  - 1. [Option] Tin-plated
  - 2. [Option] Silver with epoxy insulation.
  - 3. [Option] Tin-plated with epoxy insulation.
- H. Supply Phase / Ground bus splice kits in all bus coating materials and bus ampacity ratings.
- I. Access to the rear cable termination area shall be feasible without reaching over the main and vertical bus.
- J. Bus shall be 98% minimum conductivity copper [silver-plated][tin-plated] over the entire length of the bus bar
- K. Ground bus shall be 98% minimum conductivity copper, minimum size ¼ by 4".
  - a. [Option] Ground ball studs and covers.
- L. [Option] Bus bar Insulation may be insulated with one or more of the following:
  - a. R/C (OCDT2), model Resicoat EL Gray PB with a minimum thickness of 10mils, insulating devices and materials, miscellaneous manufactured by AK20 Nobel known as Cornel.
  - b. Removable bus boots required for all joints.
- M. [Option] Main breaker section shall have a line side bus tap or line side circuit breaker to be used for fire pump applications. This fire pump circuit breaker or bus tap should be rated with the following continuous current ratings; [800A], [1200A], [1600A], [2000A], [3200A], [4000A], [5000A].

## 2.05 WIRING AND TERMINATIONS

- A. Control wiring, fuse blocks and terminal blocks within the switchgear shall be furnished as required. Manufacturer wiring diagrams to include control components mounted within the assembly shall be identified corresponding to the appropriate designations.
- B. Provide front accessible, horizontal wireways are to be included in the top and bottom of the enclosure with grommet protected cutouts passing from one vertical section to another. Top and bottom wireway height shall be a minimum of 4" and run the length of the entire switchgear.
- C. All control wire shall be type SIS. Control wiring shall be [16 ga] [14 ga] for control circuits and [14 ga] [12 ga] for current transformer circuits. Wire bundles shall be secured with nylon ties and anchored to the assembly without the use of adhesive backed wire anchors. All current transformer secondary leads shall be connected to [shorting terminal blocks], [ABB FT test switches] prior to connecting to any other device. Terminal blocks provided for all field connections. . Provide wire markers at each end of all control wiring within the switchgear.
- D. [Option] NEMA 2-hole [mechanical-] [crimp-] type lugs shall be provided for all line and load terminations suitable for copper or aluminum cable rated for 75°C size as indicated on drawings.

- E. A mechanical lug shall be provided in the incoming line section for connection of the main grounding conductor. [Option] Additional lugs for connection of other grounding conductors shall be provided as indicated on the drawings.
- F. [Option] Reusable insulating boots shall be provided to cover all power cable terminations.

## 2.06 LOW VOLTAGE POWER CIRCUIT BREAKER

### A. Summary

1. Shall be ABB Emax 2 low voltage power circuit breakers and shall be available up to 5000A and certified to ANSI C37 standards under UL 1066.
2. Power circuit breakers shall be draw out type ABB Emax 2® with Ekip® family of electronic trip units. Circuit breakers shall have interrupting ratings as follows [42kA] [50kA] [65kA] [85kA], [100kA] RMS amperes without fuses. Thirty-cycle withstand rating available up to 100 kA to provide maximum coordination with downstream circuit breakers.
3. Emax 2 circuit breakers shall be available in the following frame sizes: E1.2 [250-1200A], E2.2 [250-2000A], E4.2 [800-3200A] and E6.2 [4000-5000A].
4. The rated mechanical life of the circuit breaker shall be no less than:

Table 2

Frame Size	Amperage	Operations
E1.2	1200	20,000
E2.2	2000	25,000
E4.2	3200	20,000
E6.2	5000 & 6000	12,000

### B. Circuit Breaker

1. Circuit breaker shall be draw out type Emax 2 [manually] [electrically] operated as indicated on shop drawings. Electrically operated breakers shall be complete with [120 Vac] [240 Vac] [24 Vdc] [48 Vdc] [125 Vdc] motor operators. The charging time of the motor shall not exceed 8 seconds.
2. All circuit breaker operating mechanisms are to be two-step stored energy mechanism with a maximum of 50ms (3-cycle) closing time. With the breaker closed and the spring charged, the breaker shall complete an Open-Close-Open (O-C-O) cycle without recharging.
3. Current-carrying components shall be completely isolated from the accessory mounting area and double insulated from the operator with accessory cover in place.
4. Each phase inside the circuit breaker shall be completely isolated from other phases and ground by polyester thermoset material.
5. Circuit breaker must be equipped with an interlock to discharge the stored energy spring before the circuit breaker can be withdrawn from its cell. Circuit breaker must provide a positive ground connection.
6. The breaker control interface shall have color-coded visual indicators to indicate contact open or closed positions, as well as spring charged and discharged indication. Manual control pushbuttons [option] [tamper resistant cover] on the breaker face shall be provided for opening and closing the breaker. The power circuit breaker shall have a "Positive On" feature. The circuit breaker flag will always show the true contact position.
7. Circuit breaker element shall have the following indicators all of which shall be visible to the operator located on the faceplate of the breaker with the compartment door closed:



- a. Connected, test and disconnected position indicators
  - b. Spring charged (Yellow) /discharged (White) indicators
  - c. Circuit breaker open (Green) or closed (Red) status
8. Circuit breaker buttons shall not be isolated or covered, thereby requiring a tool to operate the breaker.
9. Provide interlocks to prevent racking the circuit breaker unless the breaker is open.
10. The circuit breaker racking handle storage location shall be integral to the breaker.
11. It shall be possible to rack the circuit breaker element from the connected to the disconnected position with the compartment door closed otherwise known as closed door racking.
12. Breaker shall have shutter locks standard for spare cells/compartments or when breakers are removed.
13. Breaker must have a fail-safe device to prevent removal of a circuit breaker when the springs are charged.
14. [Option] Ready-to-close contact must be available to indicate remotely that the circuit breaker is "ready to close." The circuit breaker is ready to close when it is open, spring mechanism is charged, a maintained closing order is not present, a maintained opening order is not present, and the circuit breaker is in an operational position.
15. A rating plug will offer indication of the rating on the front of the trip unit.
16. Secondary wiring shall be front accessible and available in spring terminal connections. Secondary wiring must not be accessible when switchgear door is closed. Push-in terminal blocks allows rapid secure, vibration resistant auxiliary connections.
17. Circuit breaker shall be equipped with contact wear indication, visible from the trip unit display or from a PC using a communication unit.
18. All circuit breakers shall have provisions for field interchangeable electrical accessories including shunt trip, closing coil, spring charging motor, auxiliary contacts, and trip unit.
19. Current-carrying components shall be completely isolated from the accessory mounting area and insulated from the operator with accessory cover in place.

## 2.07 TRIP UNITS

- A. Each low voltage power circuit breaker shall be equipped with an electronic trip device. Trip units for [power distribution] [generators] available in [LI], [LSI] and [LSIG] versions, suitable for all distribution systems.
- B. [Option] Power Controller module shall be included with the [Ekip Touch] [Ekip Hi-Touch] [Ekip G Touch] [Ekip G Hi-Touch] trip unit for controlling loads [generators] optimizing the power consumed, increasing the system's efficiency and providing power and energy measurements.
- C. Trip units shall be interchangeable from front of circuit breaker. The electronic modules shall be installed on terminal box without removing the electronic trip units and protection shield.
- D. Trip units shall incorporate 'true RMS sensing' and have LED long-time pickup indications.
- E. ABB Ekip® trip units shall be type: [Ekip Dip] [Ekip Touch] [Ekip Hi-Touch] [Ekip G Touch] [Ekip G Hi-Touch] with functionality and capabilities listed below:

Table 3

Models	Distribution	Generators
Ekip Dip	Protection	-
Ekip Touch	Protection, [Load control] & Measurement	-



Ekip Hi Touch	Protection, [Load control], Measurement & Network Analyzer	-
Ekip G Touch	-	Protection, [Load control] & Measurement
Ekip G Hi-Touch	-	Protection, [Load control], Measurement & Network Analyzer

- F. Main circuit breakers shall have [Ekip Dip] [Ekip Touch] [Ekip Hi Touch] [Ekip G Touch] [Ekip G Hi Touch] trip units with the key functions and protection settings as shown in the trip unit function selection table 4 below.
- G. Tie circuit breakers shall have [Ekip Dip] [Ekip Touch] [Ekip Hi Touch] [Ekip G Touch] [Ekip G Hi Touch] trip units with the key functions and protection settings as shown in the trip unit function selection table 4 below.
- H. Feeder circuit breakers shall have [Ekip Dip] [Ekip Touch] [Ekip Hi Touch] [Ekip G Touch] [Ekip G Hi Touch] trip units with the key functions and protection settings as shown in the trip unit function selection table 4 below.
- I. Generator circuit breakers shall have [Ekip G Touch] [Ekip G Hi Touch] trip units with the key functions and protection settings as shown in the trip unit function selection table 4 below.
- J. [EKIP DIP] [STANDARD]
1. Ekip Dip protection trip unit with high accuracy protection against overcurrent shall include dedicated LEDs allowing the fault that caused tripping to be determined. Ekip Dip does not come with a display.
  2. The trip unit shall measure phase and neutral current at 1% accuracy including the current transformers in the 0.2 ...1.2 in range.
  3. Trip unit shall record the characteristics of the circuit breaker, to enable a rapid analysis during troubleshooting or maintenance (the values shall be displayed on a PDA or PC by using the communication modules or Bluetooth):
    - i. Maximum and average current values per phase;
    - ii. Date, time, fault current per phase and type of protection tripped over the last 30 trips
    - iii. Date, time and type of operation of the last 200 events (for example: opening/closing of the circuit breaker, pre-alarms, editing settings)
    - iv. Number of mechanical and electric operations of the circuit breaker
    - v. Total operating time
    - vi. Contact wear (endurance)
    - vii. Date and time of the last maintenance carried out, in addition to the estimate of the next maintenance required
    - viii. Circuit-breaker identifying data: type, serial number, firmware version, name of the device as assigned by the user
  4. Trip unit shall include test port on the front. Circuit breaker tests as follows:
    - i. Run trip test, LED test and check absence of alarms detected by the watchdog function
    - ii. Run trip test, LED test, individual protection functions and save the report
    - iii. Run the battery test when the circuit breaker is disconnected
- K. [EKIP TOUCH] [Optional]
1. Ekip Touch provides protections and high accuracy measurements of all electric parameters and integrates common automation and supervision systems. Trip unit shall

include a UL touch screen interface enabling operator access for all information and settings.

2. Trip unit shall measure three phases (L1, L2, L3) and neutral (Ne) with 1% accuracy in the 0.2 to 1.2 In range. The complete range of measurement is from 0.03 to 16x In, where In is the value of the rating plug. The display to show the current of the most loaded phase both in numeric and analog format on an ammeter with a 0-125% In scale for rapid identification of the load of the breaker.
  3. The trip unit shall be used as a multi-meter to measure the values of:
    - i. Voltage: phase-phase, phase-neutral (accuracy 0.5%)
    - ii. Power: active, reactive, apparent (accuracy 2%)
    - iii. Energy: active, reactive, apparent (accuracy 2%)
    - iv. Frequency (accuracy 0.2%)
    - v. Power factor by phase and total
    - vi. Peak factor
  4. The trip unit shall include a data logger that stores with high sampling frequency the instantaneous values of all the measurements and is transferrable to a PC.
  5. The trip unit shall store all trip information:
    - i. Protection tripped
    - ii. Opening data (current, voltage or frequency)
    - iii. Time-stamping (data, time and consecutive opening number)
    - iv. The trip unit shall provide a complete set of maintenance indicators that can be seen from the display or a PC. The indicators shall include the following:
    - v. Date, time, fault current by phase and type of protection tripped over the last 30 trips
    - vi. Date, time and type of operation of the last 200 events (example: opening/closing of the circuit breaker, pre-alarms, editing of settings)
    - vii. Number of operations of the circuit breaker: divided into mechanical operations (no current), electrical operations (with current) and protection function (trip)
    - viii. Contact wear (endurance) estimated in function of the number and type of openings
    - ix. Total operating time of the circuit breaker with circulating current
    - x. Date and time of the last maintenance session, scheduling of the next maintenance session
    - xi. Circuit-breaker identifying data: type, serial number, firmware version, device name assigned by the user
  6. All the information shall be capable of being seen from the display and from a PDA or PC.
  7. Trip unit shall include a test port on the front with available functions:
    - i. trip test, test of the display and of the LEDs and check of absence of alarms shall be detected by the watchdog function
    - ii. test of the single protection functions and test of the display
    - iii. test of the battery with the circuit breaker switched off
- L. [EKIP HI-TOUCH] [Optional]
1. The Ekip Hi-Touch provides protection and high accuracy measurements, it shall be integrated with common automation and supervision systems. The trip unit includes directional protection, restricted ground fault and dual setting of the protections.

2. The front interface of the unit shall be touchscreen color display and show measurements, bar graphs and sine curves.
3. Trip unit shall be provided with the following protection functions as shown on the selection table 4 shown below.
4. Trip unit shall provide a complete series of measurements; Measurements and counters: currents, voltage, power, energy; Maximum values and value log; Data logger; Information on the trip and opening data and Maintenance indicators.
5. Trip unit shall include a Network Analyzer function, which analyzes the quality of energy consumed in accordance IEEE 1159 and IEEE 1250.
6. Network Analyzer function shall perform continuous monitoring of the quality of energy, and shall show all results through a display or communication module such as; hourly average voltage value, interruptions / short dips in voltage (voltage interruptions / voltage dip), short voltage spikes (voltage transients, spikes), slow voltage sags and swells (voltage sag / voltage swell), voltage imbalances and harmonic analysis.
7. [EKIP G TOUCH] Trip unit is similar to Ekip Touch with added features described below.
  - a. Ekip G Touch shall be designed for use in applications with generators, cogeneration and marine applications, in conformity to IEEE C37.102. It shall provide protection and high accuracy measurements of all electrical parameters and [integrated with the automation and supervision systems]. All protection functions shall be individually tested before commissioning.
  - b. The front interface of the trip unit shall provide a wide, high-resolution touchscreen display for measurements and alarms.
  - c. Trip unit includes protection functions as shown on the selection table 4 below.
  - d. Trip unit shall offer a complete series of measurements; Measurements and meters: currents, voltage, power, energy; Maximum values and value log; Data logger; Information on the trip and opening data and Maintenance indicators.

M. [EKIP G HI-TOUCH]

1. Ekip G Hi-Touch is designed for use in applications with generators, cogeneration and marine applications, in conformity to IEEE C37.102. It provides optimum protection against frequency creep and maximum directional current. It shall provide protection and high accuracy measurements of all electrical parameters and [integrated with the automation and supervision system]. All protection functions shall be individually tested before commissioning.
2. It shall be supplied measuring and protection module and enables an independent second set of protections to be set. Network Analyzer function provided to enable monitoring quality of the power delivered by the generator.
3. Trip unit shall be provided with the following protection functions as shown on the selection table 4 shown below.
4. Trip unit shall offer a complete series of measurements and meters: currents, voltage, power, energy; maximum values and value log; data logger; information on the trip and opening data and maintenance indicators. Measurement range to the 50<sup>th</sup> Harmonic.

N. Table 4 - Trip Unit Function Selection Table

Protection Functions & Key Features	Ekip Dip	Ekip Touch	Ekip Hi Touch	Ekip G Touch	Ekip G Hi Touch
Dip switches for setting the network frequency and neutral protection device	X				
Dip switches for setting the protective functions	X				
LED for alarm signaling of L, S, I & G protective function and diagnostics	X				

LI Functions	X	X			
LSI Functions	X	X	X		
LSIG Function	X	X	X	X	X
Ground fault (G – ANSI 51N & 50NTD);	X	X	X	X	X
Instantaneous overcurrent (I – ANSI 50);	X	X	X	X	X
Neutral protection;	X	X	X	X	X
Overload (L – ANSI 49);	X	X	X	X	X
Power-on LED for signaling correct operation (watchdog)	X	X	X	X	X
Push button for test and for indicating the cause of tripping	X	X	X	X	X
Test and programming connector	X	X	X	X	X
Thermal memory;	X	X	X	X	X
Time-delayed overcurrent (S – ANSI 51 & 50TD);	X	X	X	X	X
Alarm LED		X	X	X	X
Closing on short-circuit (MCR);		X	X	X	X
Current imbalance (IU – ANSI 46);		X	X	X	X
Current thresholds;		X	X	X	X
Ground fault on toroid (Gext – ANSI 51G & 50GTD)		X	X	X	X
Home push button to return to home page		X	X	X	X
Instantaneous ground fault (G - ANSI 50N);		X	X	X	X
Pre-alarm LED		X	X	X	X
Second protection, instantaneous overcurrent (2I).		X	X	X	X
Start-up function;		X	X	X	X
Wide high-resolution color touch screen display		X	X	X	X
Zone selectivity for functions S and G (ANSI 68);		X	X	X	X
Password system is used to manage “Read” or “Edit” modes.		X	X	X	X
Cyclical direction of the phases (ANSI 47);		O	X	X	X
Ekip Measuring Pro measuring & protection module		O	X	X	X
Overfrequency (OF – ANSI 81H);		O	X	X	X
Overvoltage (OV – ANSI 59);		O	X	X	X
Power factor (ANSI 78);		O	X	X	X
Reverse active power (RP – ANSI 32R);		O	X	X	X
Underfrequency (UF – ANSI 81L);		O	X	X	X
Undervoltage (UV – ANSI 27);		O	X	X	X
Voltage imbalance (VU – ANSI 47);		O	X	X	X
Directional Overcurrent (D - ANSI 67)			X	X	X
Dual settings of protections			X	X	X
Ekip Measuring Pro Module, with relative LED power on			X	X	X
Second Protection, ground fault (ANSI 50TD/51G & 64REF)			X	X	X
Second protection, under & over frequency (UF2 - OF2 - ANSI 81L & 87H)			X	X	X
Second protection, under & over voltage (UV2 & OV2 - ANSI 27 & 59)			X	X	X
Second time-delayed overcurrent protection (S2 - ANSI 50TD)			X	X	X
Start-up function for protection D			X	X	X
Zone selectivity for protection (D ANSI - 68)			X	X	X
Active overpower (OP - ANSI 32OF)				X	X
Active underpower (UP - ANSI 32LF)				X	X
Differential ground fault (RC- ANSI 87N)				X	X
Loss of field or reverse active power (RQ - ANSI 40 or 32RQ)				X	X
Reactive overpower (OQ - ANSI 32OF)				X	X
Residual overvoltage (RV - ANSI 59N)				X	X
Voltage controlled overcurrent protection (S(V) - ANSI 51V)				X	X
Rate of change of frequency (ROCOF - ANSI 81R)					X
Second protection, loss of field or reverse reactive power (RQ - ANSI 40 or 32R)					X
Second protection, voltage controlled overcurrent protection (S2(V) - ANSI 51V)					X
Power Controller function (optional);		O	O	O	O
Synchro check (SC – ANSI 25, optional);		O	O	O	O
Residual current (Rc – ANSI 64 & 50NTD);		O	X	X	

X: Standard; O: Optional

## 2.08 COMMUNICATIONS

- A. The following Protocols shall be Supported by Ekip Touch series:
- B. [Choose as required] [IEC61850] [Modbus RTU] [Modbus TCP/IP] [Profibus-DP] [DeviceNet] [ProfiNet] [EtherNet / IP] communication modules and shall be integrated within the trip unit without the need for any external communication devices.
- C. Redundant communication modules shall be available [and shall be provided when indicated], or two different communication protocols may be used on the same breaker including blue tooth capability.

## 2.09 BREAKER ACCESSORIES

- A. Breaker shall be equipped with accessories shown on the shop drawings.
- B. All accessories shall be UL listed as field-installable and shall be interchangeable between frame sizes.
- C. Accessories shall not be limited to the following:
  - 1. [Option] Shunt Trip
  - 2. [Option] Closing coil
  - 3. [Option] Under voltage release
  - 4. [Option] Spring charging motor
  - 5. [Option] Bell alarm with remote reset
  - 6. [Option] Shutter lock
  - 7. [Option] Anti-insertion lock
  - 8. [Option] Mechanical operator counter
  - 9. [Option] IP30 protection (door escutcheon)
  - 10. [Option] IP54 protection (breaker cover on door)
  - 11. [Option] Ready to close contact
  - 12. [Option] Communication modules

## 2.10 AUTOMATIC TRANSFER SYSTEM

- A. Automatic transfer systems minimize power interruption by transferring the load from the normal source to an alternate source when the normal source is temporarily unavailable. Provide an Automatic Transfer scheme as described in the specification herein, and as shown on the projects drawings. Provide sequence of operation with submittals for engineer approval. System programming shall be completed at the factory after approval by the engineer. Supply system type based on following available options.
  - 1. [option] Trip unit based
  - 2. [option] PLC Based
  - 3. [option] Relay system, "hard wired based", and provided with ABB Relion series as required

## 2.11 MISCELLANEOUS DEVICES

- A. [Option] Kirk Key Interlocks: Key interlocks shall be provided as indicated and shall operate in the sequence as indicated on the drawings.
- B. [Option] Space Heaters: Each section of the switchgear shall be provided with thermostatically controlled a space heater. Power for the space heaters shall be obtained [from a control power transformer within the switchgear] [from a source as indicated on the drawings]. Supply voltage shall be 120 Vac.
- C. [Option] CPTs: Fused control power transformers shall be provided as indicated on the drawings or as required for proper operation of the installed equipment and miscellaneous devices. A

fusible disconnect switch shall provide circuit protection ahead of the transformer. [Control power transformers that supply power to the transformer cooling fans shall be sized as indicated by the transformer manufacturer].

- D. [Option] Voltage transformers (PT) shall be provided for metering or relaying applications with 120V fused secondary winding. Primary side shall be protected by disconnecting-type current-limiting fuses. Fuse holders shall be labeled to indicate size and type of fuse and to identify the transformer. [door mounted ABB Flexitest switch shall be provided].
- E. [Option] Current transformers (CT) shall be rated accordingly for metering or relaying applications as needed. Secondary side of current transformers shall be grounded on one side through a removable link [door mounted ABB Flexitest switch shall be provided].
- F. [Option] Surge Protection Device: Provide surge protective devices as specified in Section 26 41 23. Surge protective devices shall be Type 1 or Type 2 per NEC and UL 1449.

## 2.12 METERING

- A. [Optional] Measurements shall be available from the Ekip touch or Hi-Touch trip units.

## 2.13 ARC ENERGY REDUCTION

- A. [Option] Switchgear shall utilize Zone Select Interlock (ZSI), interconnecting wiring with the Ekip Touch trip unit with no additional external components and meeting 2014 NEC article 240.87.
- B. [Option] Maintenance Switch: The circuit breakers shall have the capability of a maintenance mode protective settings when equipped with the Ekip Touch or Ekip Hi-Touch trip units. A second instantaneous overcurrent setting (2I) shall be available from the standard operation value instantaneous setting (1I) "ANSI 50". This 2nd I protective setting can be set lower than the standard operation setting for a temporary amount of time and can be activated via an external command. Circuit breakers must be equipped with either an Ekip Touch or Ekip Hi-Touch trip unit and the required accessories for this function.
- C. Arc Flash Detection System ABB Arc Guard TVOC2 [Option 1]
  - 1. The arc detection system shall use light as the main condition for tripping. Detectors shall cover the bus compartment, cable compartment and in other places where the designer of the switchgear considers a risk for an arc. The detectors shall be made of optical fiber in order to avoid EMC disturbances. Without any extra calibration from the user the system shall not react for a light intensity lower than 3000 lux in order to avoid nuisance tripping. The light intensity for tripping shall also be constant regardless of the length of the detector.
  - 2. The trip signal must be sent within less than 1 ms to the circuit breaker in an event of an arc. The arc monitoring unit shall provide at least three high speed solid state tripping outputs to the circuit breaker. It shall be possible to configure the detectors to trip different circuit breakers depending on which sensor detector detects the arc.
  - 3. The system shall have the possibility to mount up to 30 detectors in the space of the main unit in order to avoid space issues if the system would be extended.
- D. Arc Flash Detection System ABB REA [Option 2]
  - 1. The switchgear shall have an independent Arc Fault mitigation system utilizing light detection fibers optics.
  - 2. The main module of the REA arc fault protection system, can operate as a stand-alone device or in combination with other modules depending on the level of protection.
  - 3. The system can utilize a loop or radial type fiber-optic sensor, or a lens-type sensor for light detection.

4. The main detection module shall have two high-speed, galvanically isolated, insulated gate bipolar transistor (IGBT) outputs (HSO1 and HSO2) for CB tripping purposes. In addition, one heavy-duty relay output (TRIP3) used for additional tripping.
5. On detection of an arc fault, the REA arc fault protection system delivers trip commands in less than 2.5 ms to all circuit breakers that feed the fault zone
6. The system shall have an adjustable three-phase overcurrent or two-phase and neutral overcurrent condition monitoring function, which enhances the reliability of the arc fault detection by eliminating unwanted CB tripping caused by light not related to any arc fault, e.g. flash light used in photography.
7. The built-in self-supervision system of the main module shall continuously monitor the operating voltages, the integrity of the cabling between the main module and the extension modules (if used), and the fiber-optic link connections between the main modules (if used). Any fault or malfunction detected by the self-supervision system will be used to alert the operator.
8. A detected fault will block the module to prevent incorrect operation.
9. The system shall have the following features:
  - i. Loop or radial type fibre sensor, or lens-type sensor for light detection
  - ii. Two high-speed IGBT outputs for direct CB trip
  - iii. Two opto-connectors for fast signal transfer of light/current/trip signals between the main modules, also over long distances
  - iv. Relay output for circuit-breaker failure protection or as an alarm output
  - v. Two RJ45-type ports for chaining max. 5 extension modules per port
  - vi. Selective tripping schemes by additional extension modules

## 2.15 ACCESSORIES

- A. [Optional] - An overhead lift device, track mounted at top of front of switchgear complete with a lifting hoist and lifting yoke shall be provided.
- B. [Optional] - A portable floor-supported, roller-based, elevating lift truck for moving circuit breakers in and out of compartments shall be provided.
- C. [Optional] – Ekip T&P portable test unit shall be provided for testing all trip unit functions of the circuit breaker without removal from the switchgear.
- D. [Optional] – Breaker Test Cabinet: A wall-mounted or free-standing cabinet used for testing of electrically operated breakers and other circuit breaker related functions shall be provided.
- E. [Optional] – Portable remote racking mechanism to allow racking in and out of breaker cell compartment shall be provided.
- F. [Optional] – Wall mounted remote control panel for electrically operated circuit breakers with Ekip Panel for monitoring and control shall be provided.

## 2.16 NAMEPLATES & LABELS

- A. Nameplates shall meet all standards listed in IEEE C37.20.1.
- B. Precautionary labels meet ANSI Z53.4. Standard nameplates for devices shall be white background with black lettering phenolic type attached with stainless steel screws. [Optional nameplate colors, black background with white lettering]
- C. The main system nameplate shall be stainless steel screwed on type with self-tapping screws. All lettering is engraved. The following information is available on the switchgear assembly rating nameplate:
  1. Manufacturer's name and address



2. Manufacturer's type designations
3. Manufacturer's identification reference
4. Rated maximum voltage (where applicable)
5. Rated power frequency (where applicable)
6. Rated continuous current (main bus)
7. Rated short-circuit withstand current
8. Date of manufacture
9. Instruction manual number

### **PART 3 EXECUTION**

#### **3.01 FACTORY ACCEPTANCE TESTING**

- A. The switchgear shall be completely assembled, wired, adjusted and tested at the factory. After assembly, the complete switchgear shall be tested to ensure the accuracy of the wiring and the functionality of all equipment. The main bus system along with the wiring and control circuits shall be given a dielectric test in accordance with IEEE C37.20.1.
- B. A certified test report of all standard production tests shall be shipped with each assembly.
- C. Factory acceptance tests as outlined above and written by an independent commissioning agent shall be witnessed by the owner's representative. All cost associated with travel and lodging for the factory witness tests shall be the responsibility of the owner and/or contractors. (Note that for safety reasons the owner's representative will not be allowed inside the test cell when power is applied.)
- D. The manufacturer shall notify the owner two (2) weeks prior to all test dates.

#### **3.02 FIELD TESTING**

- A. Provide the services of a qualified factory-trained manufacturer's representative to provide start-up assistance and/or supervision of the equipment specified under this section for a period of [two working days] per lineup.
- B. The Contractor shall provide three (3) copies of the field startup report.
- C. [Option] [Manufacturer shall provide an on-site field engineer for start-up and testing of the installed equipment. Quote as a separate line item including time for commissioning]

#### **3.03 TRAINING**

- A. The Contractor shall provide a training session for owner's representatives for [(1) 8 hour work normal day] at the job site location.
- B. The training session shall be conducted by a manufacturer's qualified representative. The training program shall consist of the instruction on the operation of the assembly, circuit breakers, and major components within the assembly.

#### **3.04 INSTALLATION**

- A. The successful contractors must install all equipment per the manufacturer's recommendations and per the contract drawings.
- B. All necessary hardware to secure the assembly in place shall be provided by the contractor.
- C. All equipment under this contract shall be installed and checked in strict accordance with the manufacturer's recommendations as documented in the operation and maintenance manuals.