Insulation Monitors in Energy Storage

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Why you need insulation monitoring

Energy storage system

Application

- Energy storage systems (ESSs) utilize ungrounded battery banks to hold power for later use
- **NEC 706.30(D)** For BESS greater than 100V between conductors, circuits can be ungrounded if a ground fault detector is installed.
- **UL 9540:2020 Section 14.8** For BESS greater than 100V between conductors, circuits can be ungrounded if ground fault detector is installed.

Ground fault issue

- Since they are ungrounded, ESSs have lessened protection against ground faults
- Ground fault = lower performance
- Ground fault = safety/ fire risk

Insulation monitoring

- Insulation monitoring devices (IMDs) help enhance safety by monitoring earth leakage
- Detect unwanted leakage values before a fault occurs
- Detect insulation deterioration in real time
How it works
Energy storage system

Operating principle

- IMDs superimpose a test signal which measures the resistance to ground
- A resistance threshold is determined
- IMDs detect values outside the threshold

Diagram:

- Inverter (AC to DC)
- Battery
- Ground
- CM-IWN

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September 23, 2021  |  Slide 3

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**Product Selection**

Insulation monitoring relays

**General Purpose (CM-IWS and CM-IWN)**

**Performance**
- Up 0-400V AC or 0-600 V DC
- Up to 20μf Ce
- 1 SPDT contact each for pre-warning and warning
- Coupling unit CM-IVN allows monitoring at 690V AC or 1000V DC

**Dimension**
- 45mm width (90mm with CM-IVN)

**Features**
- LED status indication
- Adjustment/ DIP switches via front panel

**Advanced Applications (CM-IWM)**

**Performance**
- Up to 1500V DC or 1100V AC network voltage
- Up to 3000μf Ce
- High adjustable range up to 250kΩ
- 1 SPDT contact each for pre-warning and warning

**Dimension**
- 90mm width

**Features**
- LED status indication
- LED indication for R
- Auto self test
Why Insulation Monitoring and not Residual Current Devices?

**Principle**

- A floating delta system cannot create the fault current magnitude needed for low impedance ground return path
- The system charging current is lower than the operating point of most RCDs
- The RCD device will never trip, not even if a bolted fault* existed for multiple days

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*Bolted fault: a very low impedance connection between a phase and ground

\[ I_F = \frac{V_{SG}}{R_{GR} + R_{QR} + R_{NG}} \]

- \( I_F \): Fault Current, in amperes
- \( V_{SG} \): Voltage between faulted phase and ground, in volts
- \( R_{GR} \): Resistance of the ground fault, in ohms
- \( R_{QR} \): Resistance of the ground-return path
- \( R_{NG} \): Resistance of neutral-to-ground bonding jumper
Why Insulation Monitoring and not Residual Current Devices?

### Principle

- Ground fault detection in ungrounded arrays is typically achieved by measuring the insulation resistance of each pole relative to ground.
- Resistance values are measured in hundreds or thousands of kilo-ohms.
- Ground fault is detected when the impedance to ground of either pole drops to a low level (pre-warning and warning settings on IMDs).