

Proving Safe Isolation on AGL Primary Series Circuits

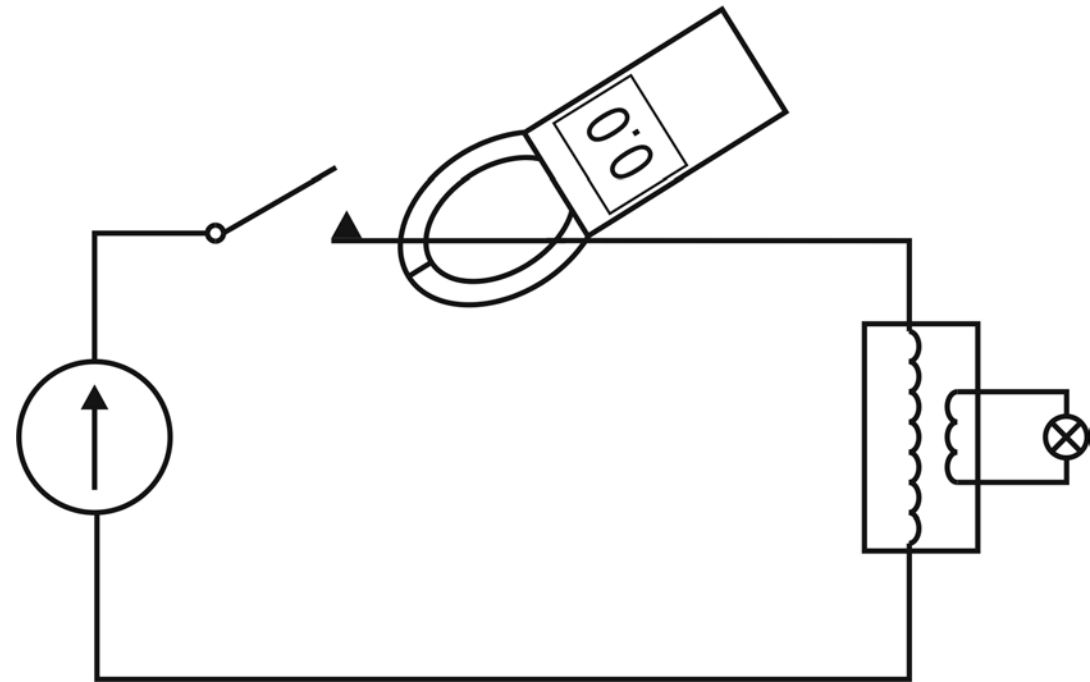
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Background

- Discussion with Andrew Dunn (Defence Estates) and Steve Martin (Develop Solutions) - how to prove safe isolation on AGL primary series circuits?
- AGL systems use a high voltage constant current source
- No protection against electric shock
- Capable of delivering a fatal electric shock
- Need to prove safe isolation on AGL systems before attempting maintenance work
- Is there a device that can be used to 'prove dead' on AGL primary series circuits?

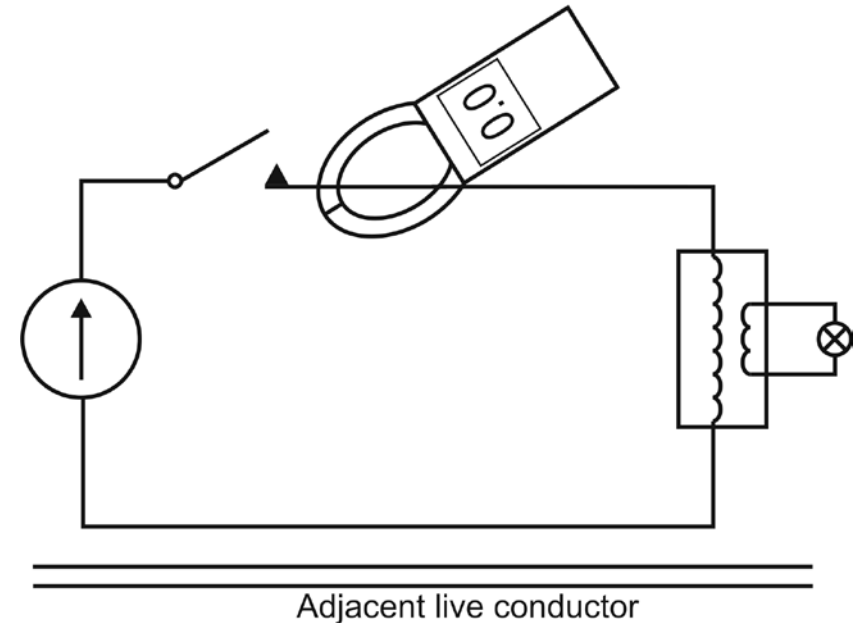
Possible solutions - current measurement method

- Clip on ammeter is placed around conductor while circuit is live
- Isolate circuit and confirm current is now zero
- If current is zero, it is assumed that the system is de-energised
- Always prove the operation of ammeter before and after use

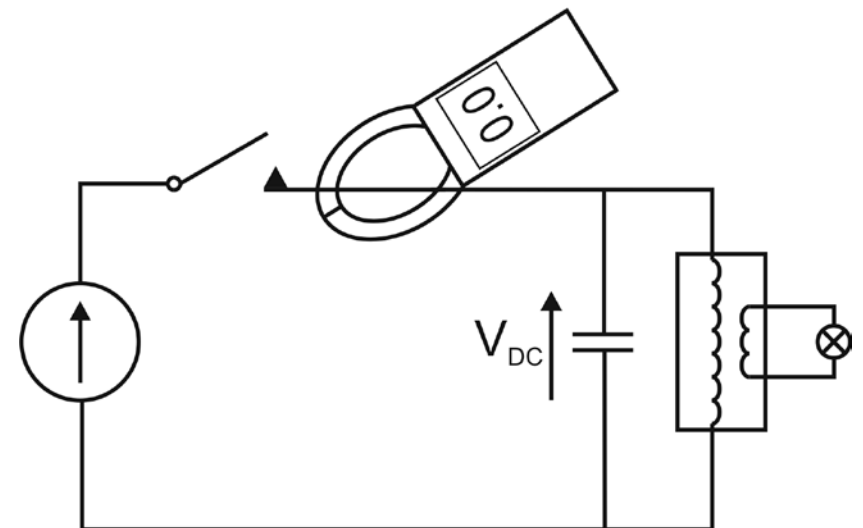


Potential problems

- Supply is isolated
- Measured current is zero
- Voltage maybe induced from an adjacent live conductor

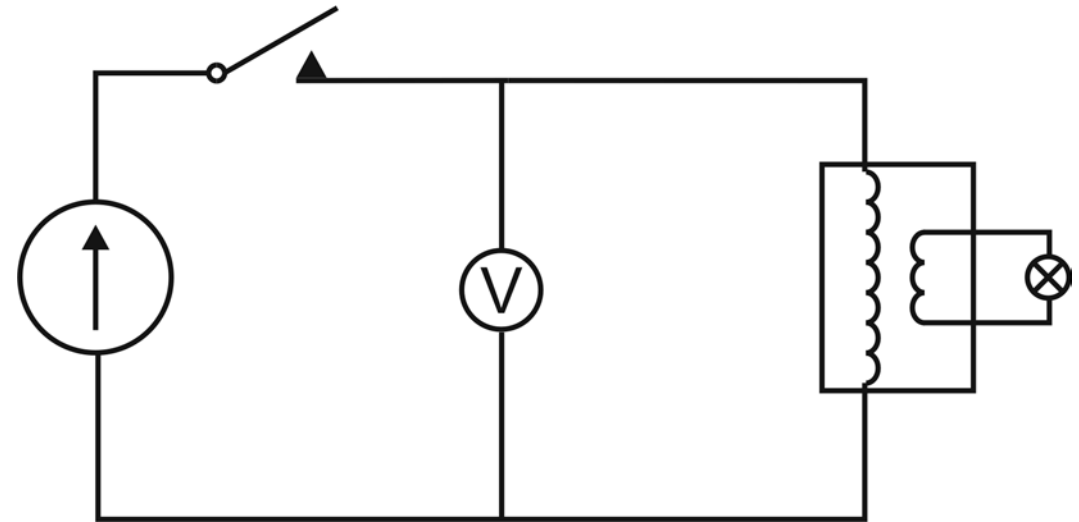


- Supply is disconnected
- Measured current is zero
- Hazard may be present due to energy stored in capacitance



Direct measurement of voltage

- Voltage is measured directly using a suitable device
- Absence of voltage proves safe isolation
- Always prove the operation of voltage detector before and after use



Instrument Requirements

- Compliant with relevant IEC standards
- Compliant with MOD JSP 375 Safety Rules and Procedures
 - Detection threshold of 50V
 - A multimeter or a Clip On Ammeter is not to be used to prove Equipment dead
- Clear indication
- Suitable for AGL systems up to 5kV
- Compatible with standard AGL terminal blocks

Regulatory requirements

- IEC 61243-3 Live working. Voltage detectors. Two pole low voltage type
 - Only applicable for devices up to 1000V ac / 1500V dc

- IEC 61243-2 Live working. Voltage detectors. Resistive type to be used for voltages of 1kV to 36kV
 - Dielectric withstand 6kV (1.2 times maximum rated voltage)
 - Maximum circuit current <3.5mA
 - Minimum of 525mm of insulation between limit mark and handle

Voltage detector for AGL primary series circuits

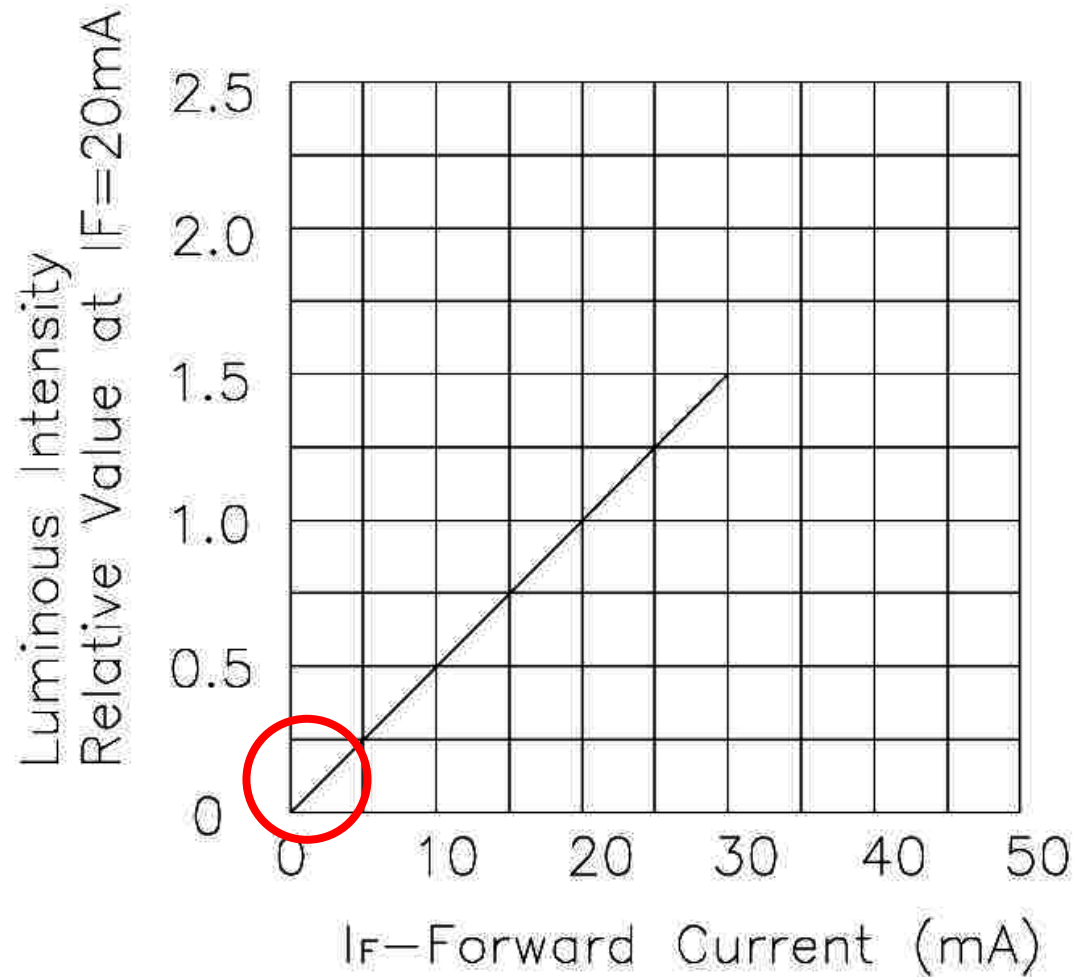
- No off-the-shelf solution
- Conventional test lamps rated for 690Vac
- Conventional resistive type hotsticks don't give reliable indication below 200V - 300V



Technical challenges

- Voltage range covering all AGL primary circuit voltages
- Indication down to 50V ac/dc
- For compliance with IEC 61243-2
 - Circuit current = 3.5mA maximum
 - For a maximum voltage of 5kV, internal impedance > 1.43Mohm
 - Therefore, circuit current at 50V = 35uA
- Neon wont strike at 50V
- LED not visible at 35uA
- 525mm (21") of insulation means a physically large device

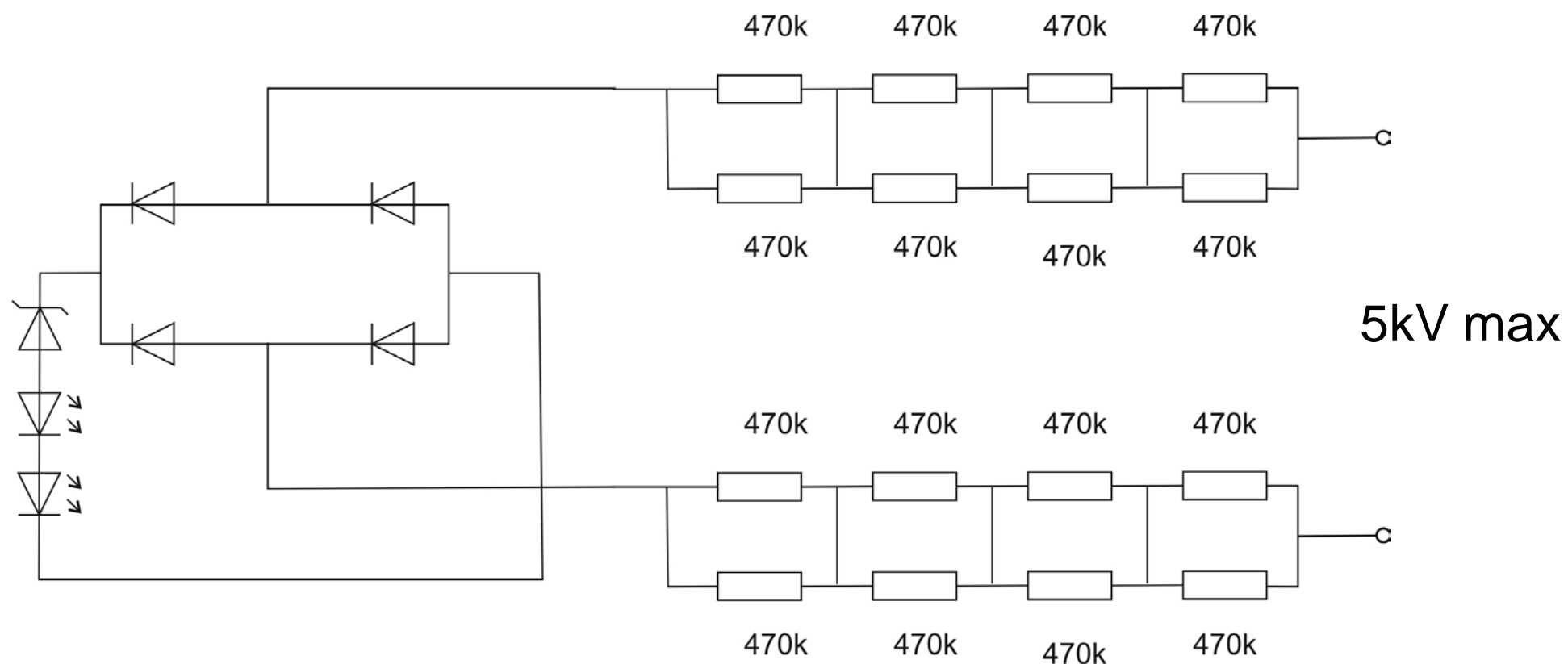
Could high intensity LED work?



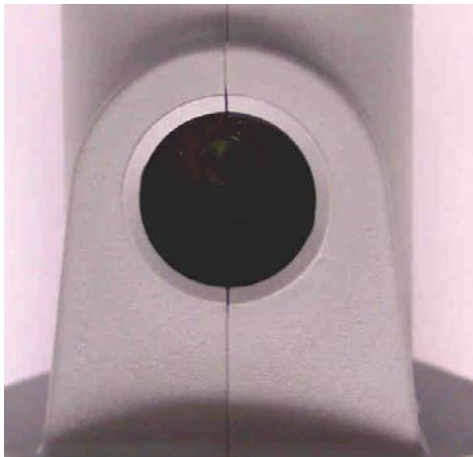
polarizer



Schematic for passive device



Results



0V



50V

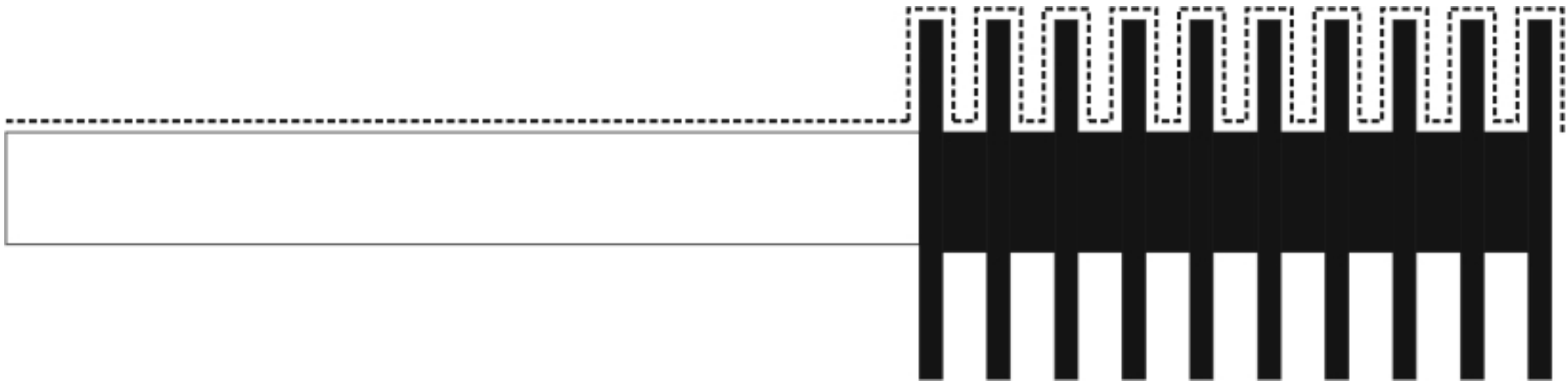


500V



1000V

Achieving 525mm of creepage



- By creating a raised barrier, the overall length can be reduced by the distance across the surface of the barrier whilst maintaining creepage distance
- Must be a complete seal between the barrier and the resistive element

Effect on overall length



Dielectric withstand test

- Handles fully submersed
- 6kV (1.2 x maximum rated voltage) applied to both contact electrodes
- Total leakage current = 490uA



Conclusions

- Current measurement alone cannot **prove** safe isolation
- Voltage measurement can **prove** safe isolation
- High intensity LED with polarizing lens can provide good indication from 50V to 5000V
- A simple but effective engineering design can provide a compact device, compliant with IEC Standards, which can prove safe isolation on AGL primary series circuit