




| | |
|---------------------------|--------------------------------|
| Title | Home 7 Plus Design Webinar |
| Project no. | 4521 |
| Operation scenario | |
| Client | Apprentice 121 |
| Date | 30/08/2023 |
| Company | Richard Harvey and Craig Buist |
| Designer | Richard Harvey and Craig Buist |

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|---------------------------|---|---|
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| Supply details | | |
| Description | Supply | |
| Supply method | User defined source @23kVA | |
| Phase/Voltage | Single-phase 230V 50Hz | |
| Earthing system | TN-C-S | |
| Voltage drop limit | Public supply: Lighting 3%, other uses 5% | |

| Prospective symmetrical 3Ph fault | | Prospective Ph to N fault | |
|-----------------------------------|--------|---|------|
| Isc-3ph (kA) | - | Isc-1ph (kA) | 1.64 |
| Zp-p (Ω) | - | Zp-n (Ω) | 0.14 |
| cos φ | - | cos φ | 0.9 |
| Prospective earth fault | | Earthing arrangements | |
| Ief (kA) | 1.62 | Earthing conductor (mm ²) | 1x16 |
| Ze (Ω) | 0.1421 | Earthing electrode resistance (Ω) | 0 |
| | | Main bonding conductor (mm ²) | 10 |

| Min/Max Fault levels | | | | | | | |
|------------------------|--------|------|---|------------------------|--------|------|---|
| Isc-max (kA) | 1.6429 | Cmax | 1 | Isc-min (kA) | 1.6429 | Cmin | 1 |
| Protection by supplier | | | | Main protective device | | | |
| Fuse 1P 100A/33kA | | | | | | | |

| Load calculations | | | | |
|--|--------------|----------|----------|--------------|
| Phase | L1 | L2 | L3 | N |
| Connected load (A) | 32.17 | 0 | 0 | 32.17 |
| Diversified load (A) | 32.17 | 0 | 0 | 32.17 |
| Spare load (A) | 0 (0%) | 0 | 0 | - |
| Design load (A) (Diversified + Spare) | 32.17 | 0 | 0 | 32.17 |

| Design load power calculations | | | | |
|--------------------------------|-----|----|----|-------|
| Phase | L1 | L2 | L3 | Total |
| kVA | 7.4 | 0 | 0 | 7.4 |
| kW | 7.4 | 0 | 0 | 7.4 |
| kVAr | 0 | 0 | 0 | 0 |
| cos φ | 1 | 1 | 1 | 1 |

| | |
|-----------------------|---|
| Main conductor | 2x1Cx25mm ² + 1x16mm ² E PVC70/S/Cu Length: 1m |
|-----------------------|---|

Circuits schedule report : DB1



| | |
|-----------------|---------------------------------------|
| Company | Richard Harvey and Craig Buist |
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| Description | Voltage | Phase | Total circuit ways | Spare load | Spare ways | Empty ways | | | |
|-----------------|---------------|-------------------|--------------------|--------------------|------------|--|-------------------------|-----------|--|
| DB1 | 230V AC | SP&N | 4 | 0% | 0 | 1Ph: 3 (75%) | | | |
| | | | | | | L1 | L2 | L3 | |
| Location: | | Mounting: | Surface | Reference No.: | | Connected load (A) Diversified load (A) Diversified+Spare load (A) | 32.17 32.17 32.17 | | |
| Connected from: | Supply | IP Rating: | IP 4X | Isolator Rating: | 100 | | | | |
| Zs (Ω): | 0.1442 | Board Rating (A): | | Fault Rating (kA): | | | | | |
| Incomer device | Isolator 100A | | | | | | | | |

| Way | Phase | Description | Conductor | Protective devices | Power factor Diversity factor 3rd Harmonics % | | | Connected load (A) Diversified load (A) Diversified+Spare load (A) | | |
|-----|-------|-------------------------------|---|--|---|----|----|--|----|----|
| | | | | | L1 | L2 | L3 | L1 | L2 | L3 |
| 1 | L1 | EVSE-Home Plus 7 charge point | 3Cx10mm ² + E(cable core and armour) SWA/XLPE90(70)/Cu Length: 26m | RCBO B 2P/40A/6kA/30mA/Class B (Inst) Generic BS EN 61009 6kA RCBO 30mA Type B | 1 1 0 | | | 32.17 32.17 | | |
| 2 | L1 | empty | | | | | | | | |
| 3 | L1 | empty | | | | | | | | |
| 4 | L1 | empty | | | | | | | | |
| L1 | | DB1 | 2x1Cx25mm ² + 1x16mm ² E PVC70/S/Cu Length: 1m | | 1 1 0 | | | 32.17 32.17 32.17 | | |

Brief calculations report : DB1



| | |
|-----------------|---------------------------------------|
| Company | Richard Harvey and Craig Buist |
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| Circuit | | | Current inequalities check | | Breaking capacity check | Phase fault adiabatic check | CPC adiabatic check | Maximum Zs at earth fault | Earth fault disconnection time | Status |
|---------|-------|-------------|----------------------------|-------------------------|---------------------------|--------------------------------------|---|----------------------------------|--------------------------------|--------|
| Way | Phase | Description | $I_b \leq I_n/I_r$ (A) | $\min I_z \leq I_t$ (A) | $I_{sc} \leq I_{cu}$ (kA) | $I^2t \leq k^2s^2$ ($\times 10^3$) | $cpc \geq \sqrt{(I^2t)/k}$ (mm ²) | $Z_s \leq \max Z_s$ (Ω) | $disc \leq \max$ (s) | |
| L1 | | DB1 | $32.17 \leq 100$ | $100 \leq 114$ | $1.63 \leq 33$ | $348.9 \leq 8265.63$ | $16 \geq 5.25$ | $0.1442 \leq 0.3441$ | $0.16 \leq 5$ | OK |

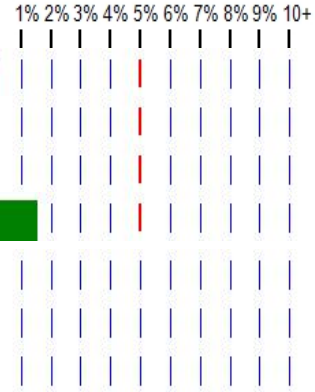
| | | | | | | | | | | |
|---|----|-------------------------------|-----------------|-----------------|---------------|--------------------|------------------|----------------------|-----------------|----|
| 1 | L1 | EVSE-Home Plus 7 charge point | $32.17 \leq 40$ | $50.47 \leq 60$ | $1.62 \leq 6$ | $8.42 \leq 1322.5$ | $25.6 \geq 0.81$ | $0.2351 \leq 1.0925$ | $0.01 \leq 0.4$ | OK |
| 2 | L1 | empty | - | - | - | - | - | - | - | - |
| 3 | L1 | empty | - | - | - | - | - | - | - | - |
| 4 | L1 | empty | - | - | - | - | - | - | - | - |

Voltage drop analysis report : DB1



| | |
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| Company | Richard Harvey and Craig Buist |
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| Way | Phase | Description | Conductor | Ib (A) | 1Ph AC or DC @ Operating temperature | | cosφ | Ct | Voltage drop (%)@ 230V | | | | |
|-----|-------|-------------------------------|--|--------|--------------------------------------|--------|------|------|------------------------|---------|-------|-------------|-----------|
| | | | | | R mΩ/m | X mΩ/m | | | Supply | Circuit | Total | Split Limit | Max Limit |
| L1 | | DB1 | 1m, 2x1Cx25mm ² + 1x16mm ² E PVC70/S/Cu | 32.17 | 0.88 | 0.1 | 1 | 0.87 | 0 | 0.02 | 0.02 | 1.5 | 5 |
| 1 | L1 | EVSE-Home Plus 7 charge point | 26m, 3Cx10mm ² + E(cable core and armour) SWA/XLPE90(70)/Cu | 32.17 | 2.2 | 0 | 1 | 0.94 | 0.02 | 1.5 | 1.52 | 3.5 | 5 |
| 2 | L1 | empty | - | - | - | - | - | - | - | - | - | - | - |
| 3 | L1 | empty | - | - | - | - | - | - | - | - | - | - | - |
| 4 | L1 | empty | - | - | - | - | - | - | - | - | - | - | - |



Analytical calculations Report



| | | | | | | | | | | | | | | |
|---------------------------------------|------------------------------------|---|-------------------------------|--|----|------------------------------|--|---------------------------------------|----------------------------------|--------------------------------------|--|---------------------------------|-------------|--------------|
| Analytical calculations Report | | | | | | | | | | | | | | |
| Company | | Richard Harvey and Craig Buist | | | | | | | | | | | | |
| Designer | | Richard Harvey and Craig Buist | | | | | | | | | | | | |
| Circuit Description | DB1 | | | Voltage / Phase | | | Single phase (230V E@230V) / L1 | | | | | | | |
| Supply from | Supply | | | Circuit type | | | DB - DIN Rail | | | | | | | |
| Remarks | | | | Cable ID Classification | | | c-d-1 | | | | | | | |
| Circuit design data | | Status: Pass - Calculated using ElectricalOM v.2023.6.21.4 - BS 7671:2018 + A2:2022 | | | | | | | | | | | | |
| Conductor type | | Single-core 70°C thermoplastic insulated non-armoured, 2x1Cx25mm ² + 1x16mm ² E, PVC70/S/Cu | | | | | | | Length (m) | 1 | | | | |
| | | Element | Copper (Cu) | Armour | No | Temp (°C) | Full loaded:70 / Actual:33.2 | | Reference | BS/4D1 | | | | |
| Installation method | | Clipped direct flat touching - Reference method C | | | | | Correction factors | | Ci:1 Cg:1 Ca:1 Ct:0.87 Cf:1 Ch:1 | | | | | |
| | | Settings | Ambient temperature (°C): 30. | | | | | | | | | | | |
| Protective conductor CPC | | Installation settings | | Separate conductor (separate cpc touching the phase conductor) | | | | | | | | | | |
| | | Separate conductor (mm²) | 16 | Other cpc (mm²) | 0 | | Total equivalent to Cu (mm²) | | 16 | | | | | |
| Protective devices | | Overcurrent | | Generic, Fuses BS1361 fuses Rating(A): 100 | | | | | Icu / Ics | 33kA / 33kA | | | | |
| | | RCD/Earth fault device | | No | | | | | mA | - | | | | |
| Circuit calculations | | | | | | | | | | | | | | |
| Currents (A) | | | | Impedances at full loaded temperature (Ω) | | | | | | | | | | |
| Design current I_b | Device rating I_n | Minimum effective conductor capacity - min I_z | | Tabulated conductor capacity I_t | | | | Phase conductor Z₁ | CPC Z₂ | Earth external | Phase external | | | |
| 32.17 | 100 | 100 | | 114 | | | | 0.00088 | 0.0014 | 0.1421 | 0.1408 | | | |
| Load factors | L1 | L2 | L3 | Design load | | L1 | L2 | L3 | N/Totals | Voltage drop | L1 % | L2 % | L3 % | Volts |
| Power factor | 1 | - | - | Current (A) | | 32.17 | - | - | 32.17 | Source | 0 | - | - | 0 |
| 3rd Harmonics (%) | 0 | - | - | Load (kVA) | | 7.4 | - | - | 7.4 | Circuit | 0.02 | - | - | 0.05 |
| Diversity factor | 1 | - | - | Resistive (kW) | | 7.4 | - | - | 7.4 | Total | 0.02 | - | - | 0.05 |
| Spare (%) | 0 | | | Reactive (kVAr) | | 0 | - | - | 0 | Limit | Public supply other uses:5% | | | 11.5 |
| Earth Fault Calculations | | Earth fault current (kA) | | Z_s (Ω) at fault conditions | | Max Z_s (Ω) | | Max Disconnection Time (s) | | Device Disconnection Time (s) | | Min CPC (mm²) | | |
| | | 1.5153 | | 0.1442 | | 0.3441 | | 5 | | 0.1589 | | 5.25 | | |
| Phase Fault Calculations | | Max at starting point (kA) | | Max at end point (kA) | | Min at end point (kA) | | Disconnection time of Fuse (s) | | | Conductors withstand duration (s) | | | |
| | | 1.6266 | | 1.6186 | | 1.6141 | | 0.13 | | | 3.17 | | | |

Analytical calculations Report



| | | | |
|-----------------|--------------------------------|--|--|
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| | | | | |
|----------------------------|-------------------------------|----------------------------------|-------------------------------------|--|
| Circuit Description | EVSE-Home Plus 7 charge point | Voltage / Phase | Single phase (230V E@230V) / L1 | |
| Supply from | DB1 (Way 1) | Circuit type | Electric Vehicle Charging Equipment | |
| Remarks | | Cable ID Classification | c-f-1 | |

Status: Pass - Calculated using ElectricalOM v.2023.6.21.4 - BS 7671:2018 + A2:2022

| | | | | |
|---------------------------------|---|--|--|------------------------------|
| Circuit design data | | | | |
| Conductor type | Multicore 90°C thermosetting insulated armoured, 3Cx10mm ² + E(cable core and armour), SWA/XLPE90(70)/Cu - Run to 70°C | | | |
| | Length (m) | 26 | | |
| Element | Copper (Cu) | Armour | Steel | Temp (°C) |
| | | | | Full loaded:70 / Actual:45.6 |
| Reference | BS/4D4 | | | |
| Installation method | Direct in ground - Reference method D | | | Correction factors |
| | Settings | Cc:0.9 Cd:1.03 Cs:0.9 Cg:1 Ca:0.95 Ct:0.94 Cf:1 Ch:1 | | |
| Protective conductor CPC | Ground temperature (°C): 25. Underground settings: Depth 0.5m. Soil thermal resistivity 3K.m/W. | | | |
| | Installation settings | Cable armour and integral conductor | | |
| Protective devices | Integral conductor (mm²) | 10 | Armour (mm²) | 39 |
| | | | Total equivalent to Cu (mm²) | 25.6 |
| Overcurrent | Generic, RCBOs BS EN 61009 6kA RCBO 30mA Type B Rating(A): 40 | | | Icu / Ics |
| | RCBO, 40A. Touch voltage = 0.01V (Maximum = 50V) | | | 6kA / 6kA |
| RCD/Earth fault device | | | | mA |
| | | | | 30 |

| | | | | | | | |
|-------------------------------------|------------------------------------|---|---|--|--------------------------|-----------------------|-----------------------|
| Circuit calculations | | | | | | | |
| Currents (A) | | | | Impedances at full loaded temperature (Ω) | | | |
| Design current I_b | Device rating I_n | Minimum effective conductor capacity - min I_z | Tabulated conductor capacity I_t | Phase conductor Z₁ | CPC Z₂ | Earth external | Phase external |
| 32.17 | 40 | 50.47 | 60 | 0.0572 | 0.03925 | 0.1442 | 0.1425 |

| | | | | | | | | | | | | | | | |
|---------------------|-----------|-----------|-----------|--------------------|------------------------|-----------|-----------|-----------------|---------------------|-------------|----------------|-----------------------------|--------------|---|------|
| Load factors | L1 | L2 | L3 | Design load | L1 | L2 | L3 | N/Totals | Voltage drop | L1 % | L2 % | L3 % | Volts | | |
| | 1 | - | - | | Current (A) | 32.17 | - | - | | 32.17 | Source | 0.02 | - | - | 0.05 |
| | 0 | - | - | | Load (kVA) | 7.4 | - | - | | 7.4 | Circuit | 1.5 | - | - | 3.45 |
| | 1 | - | - | | Resistive (kW) | 7.4 | - | - | | 7.4 | Total | 1.52 | - | - | 3.5 |
| | - | - | - | | Reactive (kVAr) | 0 | - | - | | 0 | Limit | Public supply other uses:5% | | | 11.5 |

| | | | | | | |
|---------------------------------|---------------------------------|--|------------------------------|-----------------------------------|--------------------------------------|---------------------------------|
| Earth Fault Calculations | Earth fault current (kA) | Z_s (Ω) at fault conditions | Max Z_s (Ω) | Max Disconnection Time (s) | Device Disconnection Time (s) | Min CPC (mm²) |
| | 0.9293 | 0.2351 | 1.0925 | 0.4 | 0.01 | 0.81 |

| | | | | | |
|---------------------------------|-----------------------------------|------------------------------|------------------------------|---------------------------------------|--|
| Phase Fault Calculations | Max at starting point (kA) | Max at end point (kA) | Min at end point (kA) | Disconnection time of RCBO (s) | Conductors withstand duration (s) |
| | 1.6186 | 0.9923 | 0.9176 | 0.01 | 1.57 |

Zs - Earth fault loop impedance report : DB1



| | |
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Uo - Nominal Line Voltage to Earth: 230V

| Way | Phase | Description | Conductor | Protective devices | Disc. time | Max Disc. time | Zs Calculated (Ω) | | Max Zs Calculated (Ω) | | R1+R2 Calculated (Ω) | |
|-----|-------|-------------------------------|--|--|------------|----------------|-------------------|--------|-----------------------|------------|----------------------|-----------|
| | | | | | sec | sec | Zs | Zs 80% | max Zs | max Zs 80% | R1+R2 | R1+R2 80% |
| L1 | | DB1 | 2x1Cx25mm ² 1x16mm ² E PVC70/S/Cu Length: 1m | | 0.16 | 5 | 0.14 | 0.12 | | | <0.01 | <0.01 |
| 1 | L1 | EVSE-Home Plus 7 charge point | 3Cx10mm ² E(cable core and armour) SWA/XLPE90(70)/Cu Length: 26m | RCBO B 2P/40A/6kA/30mA/Class B (Inst) Generic BS EN 61009 6kA RCBO 30mA Type B | 0.01 | 0.4 | 0.24 | 0.19 | 1.09 | 0.87 | 0.1 | 0.08 |
| 2 | L1 | empty | - | - | - | - | - | - | - | - | - | - |
| 3 | L1 | empty | - | - | - | - | - | - | - | - | - | - |
| 4 | L1 | empty | - | - | - | - | - | - | - | - | - | - |

Selectivity study results report



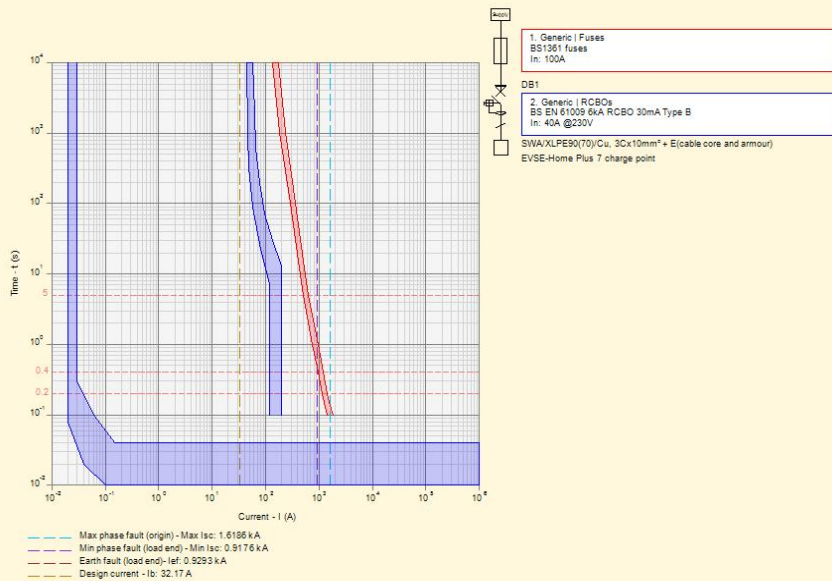
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| Upstream | Downstream | Over-current | Energy based | Earth fault |
|--|--|---------------------|---------------------|--------------------|
| Supply Generic BS1361 fuses In (A): 100 | EVSE-Home Plus 7 charge point Generic BS EN 61009 6kA RCBO 30mA Type B In (A): 40 | ✓ | ✓ | ✓ |

Selectivity study analysis report

| | | |
|-----------------|--------------------------------|--|
| Company | Richard Harvey and Craig Buist | |
| Designer | Richard Harvey and Craig Buist | |

| | Upstream | Downstream |
|---------------------|--------------|----------------------------------|
| Circuit | Supply | EVSE-Home Plus 7 charge point |
| Device ID | | |
| Manufacturer | Generic | Generic |
| Type | Fuses | RCBOs |
| Family | BS1361 fuses | BS EN 61009 6kA RCBO 30mA Type B |
| Rating | In (A): 100 | In (A): 40 |
| RCD | - | - |
| Settings | - | - |



Downstream Circuit Calculations

| Ib (A) | Max Isc (origin) (kA) | Min Isc (incomer/load-end) (kA) | Ief (kA) |
|--------|-----------------------|---------------------------------|----------|
| 32.174 | 1.6186 | 0.9176 | 0.9293 |

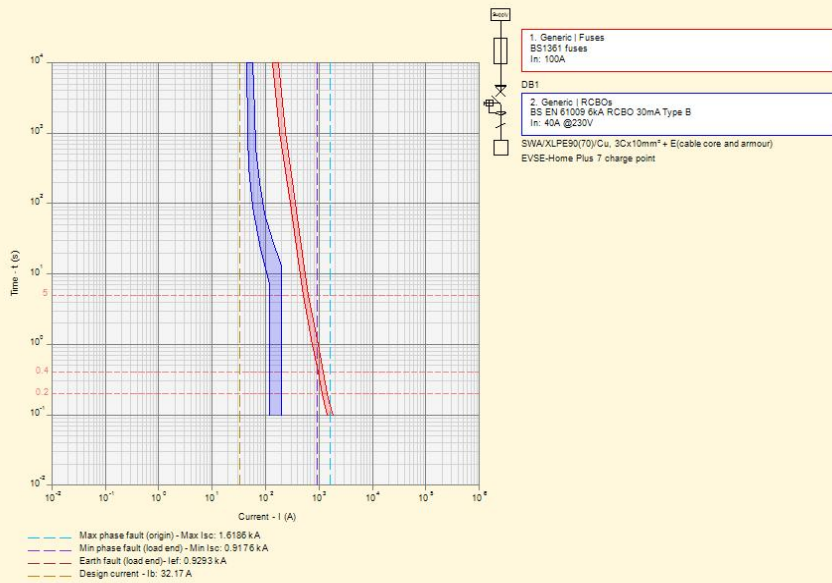
Selectivity checks between Upstream and Downstream devices

| Overcurrent | Energy based | Earth fault |
|-------------|---|-------------|
| OK | OK - Downstream Let-through energy < Upstream Fuse pre-arcing energy (4.59 x 10 ³ A ² s < 50.31 x 10 ³ A ² s) | OK |

Selectivity study analysis (Overcurrent) report

| | | |
|-----------------|--------------------------------|--|
| Company | Richard Harvey and Craig Buist | |
| Designer | Richard Harvey and Craig Buist | |

| | Upstream | Downstream |
|---------------------|--------------|----------------------------------|
| Circuit | Supply | EVSE-Home Plus 7 charge point |
| Device ID | | |
| Manufacturer | Generic | Generic |
| Type | Fuses | RCBOs |
| Family | BS1361 fuses | BS EN 61009 6kA RCBO 30mA Type B |
| Rating | In (A): 100 | In (A): 40 |
| RCD | - | - |
| Settings | - | - |



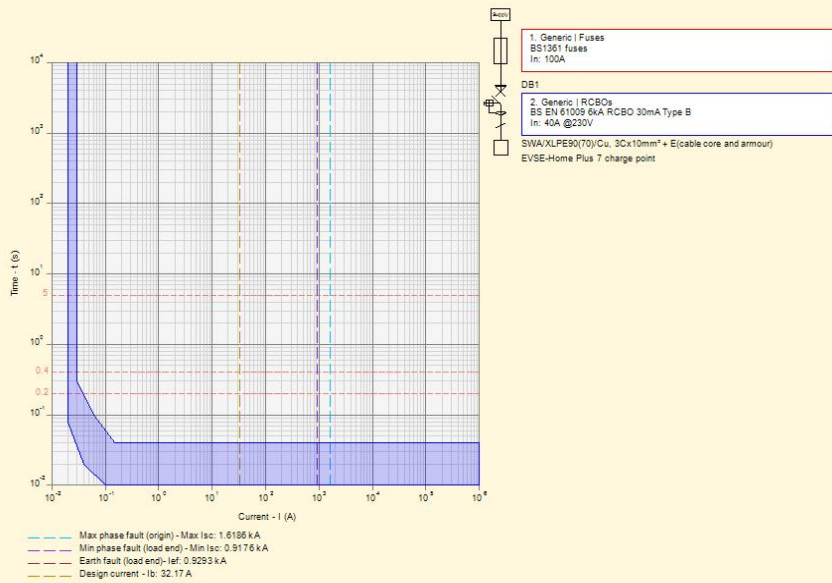
| Downstream Circuit Calculations | | |
|---------------------------------|-----------------------|---------------------------------|
| Ib (A) | Max Isc (origin) (kA) | Min Isc (incomer/load-end) (kA) |
| 32.174 | 1.6186 | 0.9176 |

| Selectivity checks between Upstream and Downstream devices | |
|--|---|
| Overcurrent | Energy based |
| OK | OK - Downstream Let-through energy < Upstream Fuse pre-arcing energy (4.59 x 10 ³ A ² s < 50.31 x 10 ³ A ² s) |

Selectivity study analysis (Earth fault) report

| | | |
|-----------------|--------------------------------|--|
| Company | Richard Harvey and Craig Buist | |
| Designer | Richard Harvey and Craig Buist | |

| | Upstream | Downstream |
|---------------------|--------------|----------------------------------|
| Circuit | Supply | EVSE-Home Plus 7 charge point |
| Device ID | | |
| Manufacturer | Generic | Generic |
| Type | Fuses | RCBOs |
| Family | BS1361 fuses | BS EN 61009 6kA RCBO 30mA Type B |
| Rating | In (A): 100 | In (A): 40 |
| RCD | - | - |
| Settings | - | - |



Downstream Circuit Calculations

I_{ef} (kA)

0.9293

Selectivity checks between Upstream and Downstream devices

Earth fault

OK

