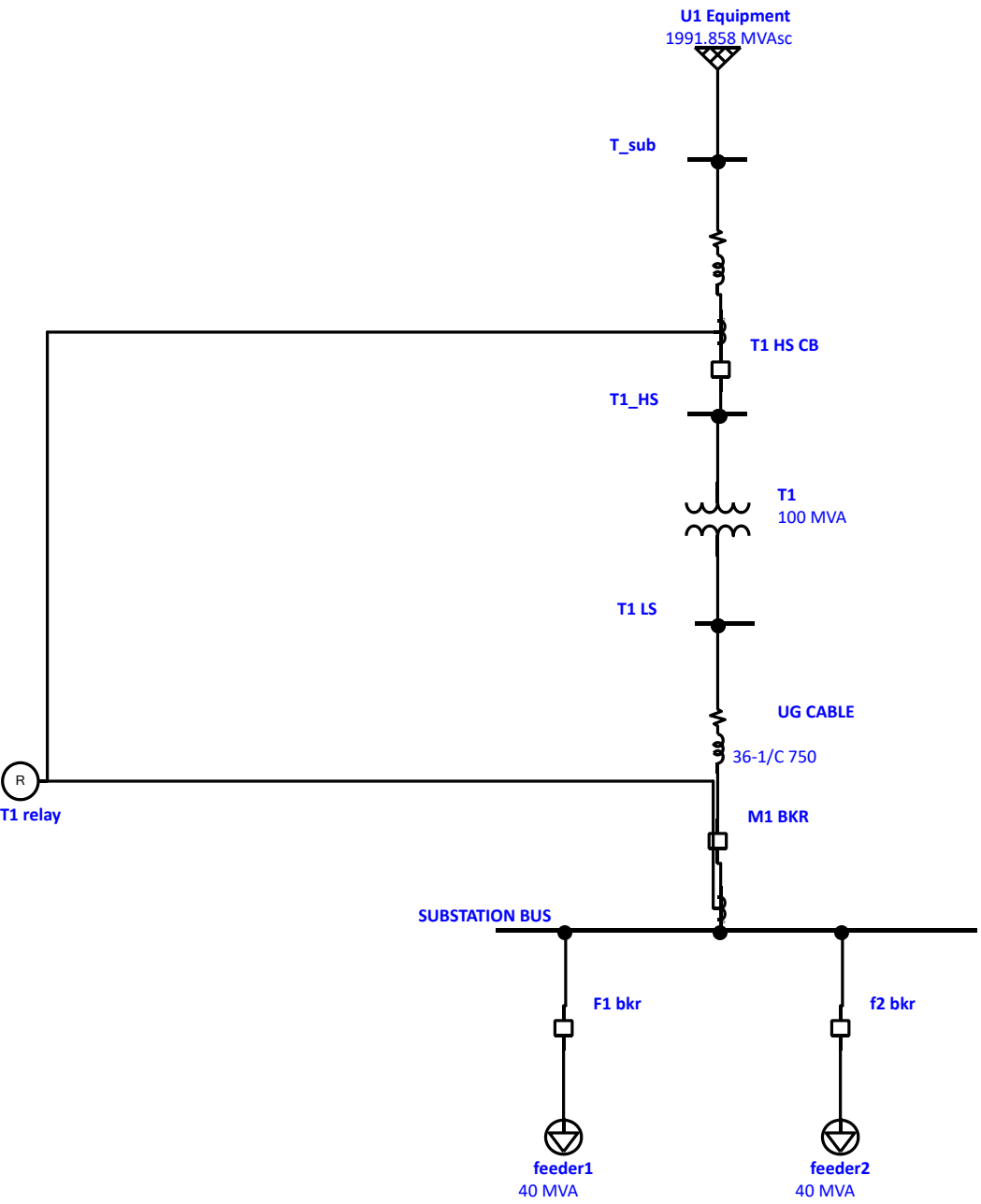
# One-Line Diagram - OLV1 (Star - Protection & Coordination)



| Utility Specifications | |
|---|---|
| Nominal Voltage | 230kV |
| 3LG fault current | 5000A , X/R=10 |
| SLG fault current | 7000A, X/R=12 |

| Transmission Line | |
|---|---|
| Length | 0.1miles |
| Type | Pelican |

| Transformers | |
|---|---|
| Primary nominal voltage | 230kV |
| Secondary Nominal Voltage | 13.8kV |
| Rated OA apparent power | 100 |
| impedance | 10% |
| X/R | 34.1 |
| High side tap | Nominal |
| Low side tap | Nominal |
| Connection | Dyn1 |

| Underground Cables | |
|---|---|
| Size | 230kV |
| Length | 13.8kV |
| Conductors per phase | 12 |
| Rated voltage | 15kV |
| Type | Aluminium |

| Feeder Loads | |
|---|---|
| Load nominal voltage | 13.8kV |
| Load power factor | 0.8 |
| connection | Delta |

## Electrical Transient Analyzer Program

## Load Flow Analysis

Loading Category (1): Design

Generation Category (1): Design

Load Diversity Factor: None

| | Swing | V-Control | Load | Total |
|---|---|---|---|---|
| Number of Buses: | 1 | 0 | 3 | 4 |

| | XFMR2 | XFMR3 | Reactor | Line/Cable/ Busway | Impedance | Tie PD | Total |
|---|---|---|---|---|---|---|---|
| Number of Branches: | 1 | 0 | 0 | 2 | 0 | 0 | 3 |

| | |
|---|---|
| Method of Solution: | Adaptive Newton-Raphson Method |
| Maximum No. of Iteration: | 99 |
| Precision of Solution: | 0.0001000 |
| System Frequency: | 60.00 Hz |
| Unit System: | English |
| Project Filename: | PSA_PBL |
| Output Filename: | C:\ETAP 1901\PSA_PBL\Untitled.lfr |

## Adjustments

| Tolerance | Apply Adjustments | Individual /Global | Percent |
|---|---|---|---|
| Transformer Impedance: | Yes | Individual | |
| Reactor Impedance: | Yes | Individual | |
| Overload Heater Resistance: | No | | |
| Transmission Line Length: | No | | |
| Cable / Busway Length: | No | | |

| Temperature Correction | Apply Adjustments | Individual /Global | Degree C |
|---|---|---|---|
| Transmission Line Resistance: | Yes | Individual | |
| Cable / Busway Resistance: | Yes | Individual | |

## Bus Input Data

| Bus | | | Initial Voltage | | Load | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Constant kVA | | Constant Z | | Constant I | | Generic | |
| ID | kV | Sub-sys | % Mag. | Ang. | MW | Mvar | MW | Mvar | MW | Mvar | MW | Mvar |
| SUBSTATION BUS | 13.800 | 1 | 100.0 | 0.0 | 51.200 | 38.400 | 12.800 | 9.600 | | | | |
| T1 LS | 13.800 | 1 | 100.0 | 0.0 | | | | | | | | |
| T1_HS | 230.000 | 1 | 100.0 | 0.0 | | | | | | | | |
| T_sub | 230.000 | 1 | 100.0 | 0.0 | | | | | | | | |
| Total Number of Buses: 4 | | | | | 51.200 | 38.400 | 12.800 | 9.600 | 0.000 | 0.000 | 0.000 | 0.000 |

| Generation Bus | | | | Voltage | | Generation | | | Mvar Limits | |
|---|---|---|---|---|---|---|---|---|---|---|
| ID | kV | Type | Sub-sys | % Mag. | Angle | MW | Mvar | % PF | Max | Min |
| T_sub | 230.000 | Swing | 1 | 100.0 | 0.0 | | | | | |
| | | | | | | 0.000 | 0.000 | | | |

## Line/Cable/Busway Input Data

**ohms or siemens/1000 ft per Conductor (Cable) or per Phase (Line/Busway)**

| Line/Cable/Busway ID | Library | Size | Length Adj. (ft) | % Tol. | #/Phase | T (°C) | R | X | Y |
|---|---|---|---|---|---|---|---|---|---|
| UG CABLE | 15MALS1 | 750 | 300.0 | 0.0 | 12 | 75 | 0.036570 | 0.049700 | |
| Line1 | | 477 | 528.0 | 0.0 | 1 | 75 | 0.044604 | 0.157749 | 0.0000010 |

Line / Cable / Busway resistances are listed at the specified temperatures.

## 2-Winding Transformer Input Data

| Transformer | | Rating | | | | | Z Variation | | | % Tap Setting | | Adjusted | Phase Shift | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ID | Phase | MVA | Prim. kV | Sec. kV | % Z1 | X1/R1 | + 5% | - 5% | % Tol. | Prim. | Sec. | % Z | Type | Angle |
| T1 | 3-Phase | 100.000 | 230.000 | 13.800 | 10.00 | 34.10 | 0 | 0 | 0 | 0 | 0 | 10.0000 | Dyn | 0.000 |

## Branch Connections

| CKT/Branch | | Connected Bus ID | | % Impedance, Pos. Seq., 100 MVA Base | | | |
|---|---|---|---|---|---|---|---|
| ID | Type | From Bus | To Bus | R | X | Z | Y |
| T1 | 2W XFMR | T1_HS | T1 LS | 0.29 | 10.00 | 10.00 | |
| UG CABLE | Cable | T1 LS | SUBSTATION BUS | 0.05 | 0.07 | 0.08 | |
| Line1 | Line | T_sub | T1_HS | 0.00 | 0.02 | 0.02 | 0.0271987 |

## LOAD_FLOW_REPORT

| Bus | | Voltage | | Generation | | Load | | Load Flow | | | | | XFMR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ID | kV | % Mag. | Ang. | MW | Mvar | MW | Mvar | ID | MW | Mvar | Amp | %PF | %Tap |
| SUBSTATION BUS | 13.800 | 94.552 | -3.7 | 0.000 | 0.000 | 62.643 | 46.983 | T1 LS | -62.643 | -46.983 | 3464.8 | 80.0 | |
| T1 LS | 13.800 | 94.616 | -3.7 | 0.000 | 0.000 | 0.000 | 0.000 | SUBSTATION BUS | 62.676 | 47.027 | 3464.8 | 80.0 | |
| | | | | | | | | T1_HS | -62.676 | -47.027 | 3464.8 | 80.0 | |
| T1_HS | 230.000 | 99.989 | 0.0 | 0.000 | 0.000 | 0.000 | 0.000 | T_sub | -62.877 | -53.883 | 207.9 | 75.9 | |
| | | | | | | | | T1 LS | 62.877 | 53.883 | 207.9 | 75.9 | |
| * T_sub | 230.000 | 100.000 | 0.0 | 62.880 | 53.866 | 0.000 | 0.000 | T1_HS | 62.880 | 53.866 | 207.8 | 75.9 | |

* Indicates a voltage regulated bus ( voltage controlled or swing type machine connected to it)

\# Indicates a bus with a load mismatch of more than 0.1 MVA

## Bus Loading Summary Report

| Bus | | | Directly Connected Load | | | | | | | | Total Bus Load | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Constant kVA | | Constant Z | | Constant I | | Generic | | | | | Percent |
| ID | kV | Rated Amp | MW | Mvar | MW | Mvar | MW | Mvar | MW | Mvar | MVA | % PF | Amp | Loading |
| SUBSTATION BUS | 13.800 | | 51.200 | 38.400 | 11.443 | 8.583 | | | | | 78.304 | 80.0 | 3464.8 | |
| T1 LS | 13.800 | | | | | | | | | | 78.357 | 80.0 | 3464.8 | |
| T1_HS | 230.000 | | | | | | | | | | 82.806 | 75.9 | 207.9 | |
| T_sub | 230.000 | | | | | | | | | | 82.798 | 75.9 | 207.8 | |

* Indicates operating load of a bus exceeds the bus critical limit ( 100.0% of the Continuous Ampere rating).
# Indicates operating load of a bus exceeds the bus marginal limit (95.0% of the Continuous Ampere rating).

## Branch Loading Summary Report

| CKT / Branch | | Busway / Cable & Reactor | | | Transformer | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Ampacity (Amp) | Loading Amp | | Capability (MVA) | Loading (input) | | Loading (output) | |
| ID | Type | | | % | | MVA | % | MVA | % |
| UG CABLE | Cable | 6144.38 | 3464.76 | 56.39 | | | | | |
| T1 | Transformer | | | | 166.670 | 82.806 | 49.7 | 78.357 | 47.0 |

* Indicates a branch with operating load exceeding the branch capability.

## Branch Losses Summary Report

| Branch ID | From-To Bus Flow | | To-From Bus Flow | | Losses | | % Bus Voltage | | Vd % Drop |
|---|---|---|---|---|---|---|---|---|---|
| | MW | Mvar | MW | Mvar | kW | kvar | From | To | in Vmag |
| Line1 | -62.877 | -53.883 | 62.880 | 53.866 | 3.1 | -16.4 | 100.0 | 100.0 | 0.01 |
| T1 | -62.676 | -47.027 | 62.877 | 53.883 | 201.0 | 6855.5 | 94.6 | 100.0 | 5.37 |
| UG CABLE | -62.643 | -46.983 | 62.676 | 47.027 | 32.9 | 44.7 | 94.6 | 94.6 | 0.06 |
| | | | | | 237.0 | 6883.9 | | | |

* This Transmission Line includes Series Capacitor.

## Alert Summary Report

### % Alert Settings

| | Critical | Marginal |
|---|---|---|
| **Loading** | | |
| Bus | 100.0 | 95.0 |
| Cable / Busway | 100.0 | 95.0 |
| Reactor | 100.0 | 95.0 |
| Line | 100.0 | 95.0 |
| Transformer | 100.0 | 95.0 |
| Panel | 100.0 | 95.0 |
| Protective Device | 100.0 | 95.0 |
| Generator | 100.0 | 95.0 |
| Inverter/Charger | 100.0 | 95.0 |
| **Bus Voltage** | | |
| OverVoltage | 105.0 | 102.0 |
| UnderVoltage | 95.0 | 98.0 |
| **Generator Excitation** | | |
| OverExcited (Q Max.) | 100.0 | 95.0 |
| UnderExcited (Q Min.) | 100.0 | |

## Critical Report

| Device ID | Type | Condition | Rating/Limit | Unit | Operating | % Operating | Phase Type |
|---|---|---|---|---|---|---|---|
| SUBSTATION BUS | Bus | Under Voltage | 13.800 | kV | 13.048 | 94.6 | 3-Phase |
| T1 LS | Bus | Under Voltage | 13.800 | kV | 13.057 | 94.6 | 3-Phase |

## SUMMARY OF TOTAL GENERATION , LOADING & DEMAND

| | MW | Mvar | MVA | % PF |
|---|---|---|---|---|
| Source (Swing Buses): | 62.880 | 53.866 | 82.798 | 75.94 Lagging |
| Source (Non-Swing Buses): | 0.000 | 0.000 | 0.000 | |
| Total Demand: | 62.880 | 53.866 | 82.798 | 75.94 Lagging |
| Total Motor Load: | 51.200 | 38.400 | 64.000 | 80.00 Lagging |
| Total Static Load: | 11.443 | 8.583 | 14.304 | 80.00 Lagging |
| Total Constant I Load: | 0.000 | 0.000 | 0.000 | |
| Total Generic Load: | 0.000 | 0.000 | 0.000 | |
| Apparent Losses: | 0.237 | 6.884 | | |
| System Mismatch: | 0.000 | 0.000 | | |

Number of Iterations: 4

# Electrical Transient Analyzer Program

## Short-Circuit Analysis

### ANSI Standard

### 3-Phase, LG, LL, & LLG Fault Currents

### 1/2 Cycle Network

| | Swing | V-Control | Load | Total |
|---|---|---|---|---|
| Number of Buses: | 1 | 0 | 3 | 4 |

| | XFMR2 | XFMR3 | Reactor | Line/Cable/ Busway | Impedance | Tie PD | Total |
|---|---|---|---|---|---|---|---|
| Number of Branches: | 1 | 0 | 0 | 2 | 0 | 0 | 3 |

| | Synchronous Generator | Power Grid | Synchronous Motor | Induction Machines | Lumped Load | Total |
|---|---|---|---|---|---|---|
| Number of Machines: | 0 | 1 | 0 | 0 | 2 | 3 |

| | |
|---|---|
| System Frequency: | 60.00 |
| Unit System: | English |
| Project Filename: | PSA_PBL |
| Output Filename: | C:\ETAP 1901\PSA_PBL\Untitled.SA2S |

## Adjustments

| Tolerance | Apply Adjustments | Individual /Global | Percent |
|---|---|---|---|
| Transformer Impedance: | Yes | Individual | |
| Reactor Impedance: | Yes | Individual | |
| Overload Heater Resistance: | No | | |
| Transmission Line Length: | No | | |
| Cable / Busway Length: | No | | |

| Temperature Correction | Apply Adjustments | Individual /Global | Degree C |
|---|---|---|---|
| Transmission Line Resistance: | Yes | Individual | |
| Cable / Busway Resistance: | Yes | Individual | |

## Bus Input Data

| Bus | | | | | Initial Voltage | |
|---|---|---|---|---|---|---|
| ID | Type | Nom. kV | Base kV | Sub-sys | %Mag. | Ang. |
| SUBSTATION BUS | Load | 13.800 | 13.800 | 1 | 100.00 | -30.00 |
| T1 LS | Load | 13.800 | 13.800 | 1 | 100.00 | -30.00 |
| T1_HS | Load | 230.000 | 230.000 | 1 | 100.00 | 0.00 |
| T_sub | SWNG | 230.000 | 230.000 | 1 | 100.00 | 0.00 |

4 Buses Total

All voltages reported by ETAP are in % of bus Nominal kV.
Base kV values of buses are calculated and used internally by ETAP.

## Line/Cable/Busway Input Data

**ohms or siemens per 1000 ft per Conductor (Cable) or per Phase (Line/Busway)**

| Line/Cable/Busway | | | Length | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ID | Library | Size | Adj. (ft) | % Tol. | #/Phase | T (°C) | R1 | X1 | Y1 | R0 | X0 | Y0 |
| UG CABLE | 15MALS1 | 750 | 300.0 | 0.0 | 12 | 75 | 0.03657 | 0.0497 | | 0.11519 | 0.12226 | |
| Line1 | | 477 | 528.0 | 0.0 | 1 | 75 | 0.0446045 | 0.1577493 | 0.000001 | 0.0956523 | 0.4853866 | 0.0000005 |

Line / Cable / Busway resistances are listed at the specified temperatures.

## 2-Winding Transformer Input Data

| Transformer | Rating | | | | | Z Variation | | | % Tap Setting | | Adjusted | Phase Shift | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ID | MVA | Prim. kV | Sec. kV | % Z | X/R | + 5% | - 5% | % Tol. | Prim. | Sec. | % Z | Type | Angle |
| T1 | 100.000 | 230.000 | 13.800 | 10.00 | 34.10 | 0 | 0 | 0 | 0 | 0 | 10.00 | Dyn | 30.00 |

## 2-Winding Transformer Grounding Input Data

| Transformer | Rating | | | Grounding | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Conn. | Primary | | | | Secondary | | | |
| ID | MVA | Prim. kV | Sec. kV | Type | Type | kV | Amp | ohm | Type | kV | Amp | ohm |
| T1 | 100.000 | 230.000 | 13.800 | D/Y | | | | | Solid | | | |

## Branch Connections

| CKT/Branch | | Connected Bus ID | | % Impedance, Pos. Seq., 100 MVAb | | | |
|---|---|---|---|---|---|---|---|
| ID | Type | From Bus | To Bus | R | X | Z | Y |
| T1 | 2W XFMR | T1_HS | T1 LS | 0.29 | 10.00 | 10.00 | |
| UG CABLE | Cable | T1 LS | SUBSTATION BUS | 0.05 | 0.07 | 0.08 | |
| Line1 | Line | T_sub | T1_HS | 0.00 | 0.02 | 0.02 | 0.0271987 |

## Power Grid Input Data

| Power Grid | Connected Bus | Rating | | % Positive Seq. Impedance 100 MVA Base | | | Grounding | % Zero Seq. Impedance 100 MVA Base | | |
|---|---|---|---|---|---|---|---|---|---|---|
| ID | ID | MVASC | kV | X/R | R | X | Type | X/R | R0 | X0 |
| U1 Equipment | T_sub | 1991.858 | 230.000 | 10.00 | 0.49955 | 4.99552 | Wye - Solid | 12.00 | 0.059568 | 0.71482 |

Total Power Grids (= 1 ) 1991.858 MVA

## Lumped Load Input Data

| Lumped Load | Lumped Load | | | | Motor Loads | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Rating | | % Load | | Loading | | X/R Ratio | | Impedance (Machine Base) | | | Grounding | | |
| ID | kVA | kV | MTR | STAT | kW | kvar | X"/R | X'/R | % R | % X" | % X' | Conn. | Type | Amp. |
| feeder1 | 40000.0 | 13.800 | 80 | 20 | 25600.0 | 19200.0 | 10.00 | 10.00 | 1.538 | 15.38 | 23.08 | Delta | | |
| feeder2 | 40000.0 | 13.800 | 80 | 20 | 25600.0 | 19200.0 | 10.00 | 10.00 | 1.538 | 15.38 | 23.08 | Delta | | |

Total Connected Lumped Loads ( = 2 ): 80000.0 kVA

## SHORT- CIRCUIT REPORT

Fault at bus: **SUBSTATION BUS**

Prefault voltage = 13.800 kV = 100.00 % of nominal bus kV ( 13.800 kV)
= 100.00 % of base kV ( 13.800 kV)

| Contribution | | 3-Phase Fault | | Line-To-Ground Fault | | | | | Positive & Zero Sequence Impedances Looking into "From Bus" | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| From Bus ID | To Bus ID | % V From Bus | kA Symm. rms | % Voltage at From Bus Va | Vb | Vc | kA Symm. rms Ia | 3I0 | % Impedance on 100 MVA base R1 | X1 | R0 | X0 |
| SUBSTATION BUS | Total | 0.00 | 45.022 | 0.00 | 102.40 | 100.70 | 43.658 | 43.658 | 6.76E-001 | 9.27E+000 | 4.44E-001 | 1.02E+001 |
| T1 LS | SUBSTATION BUS | 0.54 | 27.714 | 1.11 | 102.51 | 100.13 | 32.468 | 43.658 | 8.45E-001 | 1.51E+001 | 4.44E-001 | 1.02E+001 |
| feeder1 | SUBSTATION BUS | 100.00 | 8.659 | 100.00 | 100.00 | 100.00 | 5.598 | 0.000 | 4.81E+000 | 4.81E+001 | | |
| feeder2 | SUBSTATION BUS | 100.00 | 8.659 | 100.00 | 100.00 | 100.00 | 5.598 | 0.000 | 4.81E+000 | 4.81E+001 | | |

\# Indicates fault current contribution is from three-winding transformers
* Indicates a zero sequence fault current contribution (3I0) from a grounded Delta- Y transformer

## Short-Circuit Summary Report

1/2 Cycle - 3-Phase, LG, LL, & LLG Fault Currents

Prefault Voltage = 100 % of the Bus Nominal Voltage

| Bus | | 3-Phase Fault | | | Line-to-Ground Fault | | | Line-to-Line Fault | | | *Line-to-Line-to-Ground | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ID | kV | Real | Imag. | Mag. | Real | Imag. | Mag. | Real | Imag. | Mag. | Real | Imag. | Mag. |
| SUBSTATION BUS | 13.800 | 3.275 | -44.903 | 45.022 | 2.728 | -43.573 | 43.658 | 38.887 | 2.836 | 38.990 | 37.768 | 23.992 | 44.744 |

All fault currents are symmetrical (1/2 Cycle network) values in rms kA.
* LLG fault current is the larger of the two faulted line currents.

## Sequence Impedance Summary Report

| Bus | | Positive Seq. Imp. (ohm) | | | Negative Seq. Imp. (ohm) | | | Zero Seq. Imp. (ohm) | | | Fault Zf (ohm) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ID | kV | Resistance | Reactance | Impedance | Resistance | Reactance | Impedance | Resistance | Reactance | Impedance | Resistance | Reactance | Impedance |
| SUBSTATION BUS | 13.800 | 0.01287 | 0.17650 | 0.17697 | 0.01287 | 0.17650 | 0.17697 | 0.00846 | 0.19341 | 0.19360 | 0.00000 | 0.00000 | 0.00000 |

```
function microgrid_dashboard()

    fig = uifigure('Name', 'Microgrid Load Flow and Fault Analysis Dashboard', ...
                   'Position', [100, 100, 1400, 900], ...
                   'Color', [0.94, 0.94, 0.94]);


    tabgroup = uitabgroup(fig, 'Position', [10, 10, 1380, 880]);

    % Tab 1: System Overview
    tab1 = uitab(tabgroup, 'Title', 'System Overview');
    create_system_overview(tab1);

    % Tab 2: Load Flow Analysis
    tab2 = uitab(tabgroup, 'Title', 'Load Flow Analysis');
    create_load_flow_tab(tab2);

    % Tab 3: Fault Analysis
    tab3 = uitab(tabgroup, 'Title', 'Short Circuit Analysis');
    create_fault_analysis_tab(tab3);

    % Tab 4: Real-time Monitoring
    tab4 = uitab(tabgroup, 'Title', 'Real-time Monitoring');
    create_monitoring_tab(tab4);
end

function create_system_overview(parent)

    title_label = uilabel(parent, 'Text', 'Microgrid System Overview', ...
                          'Position', [20, 820, 300, 30], ...
                          'FontSize', 18, 'FontWeight', 'bold');


    specs_panel = uipanel(parent, 'Title', 'System Specifications', ...
                          'Position', [20, 500, 400, 300], ...
                          'FontSize', 12, 'FontWeight', 'bold');


    specs_text = {
        'Utility Specifications:'
        '• Nominal Voltage: 230 kV'
        '• 3LG Fault Current: 5000 A (X/R = 10)'
        '• SLG Fault Current: 7000 A (X/R = 12)'
        ''
        'Transformer (T1):'
        '• Rating: 100 MVA'
        '• Primary: 230 kV'
        '• Secondary: 13.8 kV'
        '• Impedance: 10%'
        '• Connection: Dyn1'
        ''
```

```
        'Underground Cable:'
        '• Type: 15MALS1'
        '• Size: 750 MCM'
        '• Length: 0.1 miles'
        '• Conductors per phase: 12'
        ''
        'Feeder Loads:'
        '• Feeder 1 & 2: 40 MVA each'
        '• Power Factor: 0.8 lagging'
        '• Connection: Delta'
    };

    uitextarea(specs_panel, 'Value', specs_text, ...
              'Position', [10, 10, 370, 270], ...
              'Editable', 'off');

    % Single-line diagram
    diagram_panel = uipanel(parent, 'Title', 'Single Line Diagram', ...
                            'Position', [450, 400, 900, 400], ...
                            'FontSize', 12, 'FontWeight', 'bold');


    ax = uiaxes(diagram_panel, 'Position', [20, 20, 860, 360]);
    draw_single_line_diagram(ax);

    bus_panel = uipanel(parent, 'Title', 'Bus Data Summary', ...
                        'Position', [20, 50, 1330, 330], ...
                        'FontSize', 12, 'FontWeight', 'bold');

    bus_data = {
        'T_sub', '230.0', '100.0', '0.0', '62.88', '53.87', 'Swing Bus'
        'T1_HS', '230.0', '100.0', '0.0', '-62.88', '-53.88', 'Load Bus'
        'T1_LS', '13.8', '94.6', '-3.7', '62.68', '47.03', 'Load Bus'
        'SUBSTATION BUS', '13.8', '94.6', '-3.7', '-62.64', '-46.98', 'Load Bus'
    };

    bus_table = uitable(bus_panel, 'Data', bus_data, ...
                        'ColumnName', {'Bus ID', 'Nominal kV', 'Voltage %', 'Angle °',↙
'MW', 'Mvar', 'Type'}, ...
                        'Position', [20, 20, 1290, 290]);
end

function create_load_flow_tab(parent)

    title_label = uilabel(parent, 'Text', 'Load Flow Analysis Results', ...
                          'Position', [20, 820, 300, 30], ...
                          'FontSize', 18, 'FontWeight', 'bold');

    voltage_panel = uipanel(parent, 'Title', 'Bus Voltage Profile', ...
                            'Position', [20, 550, 650, 250], ...
                            'FontSize', 12, 'FontWeight', 'bold');
```

```
    ax1 = uiaxes(voltage_panel, 'Position', [30, 30, 600, 200]);

    bus_names = {'T_sub', 'T1_HS', 'T1_LS', 'SUBSTATION BUS'};
    voltage_pu = [1.00, 1.00, 0.946, 0.946];
    voltage_angle = [0.0, 0.0, -3.7, -3.7];

    bar(ax1, voltage_pu);
    ax1.XTickLabel = bus_names;
    ax1.Title.String = 'Bus Voltage Magnitude (p.u.)';
    ax1.YLabel.String = 'Voltage (p.u.)';
    grid(ax1, 'on');

    power_panel = uipanel(parent, 'Title', 'Power Flow Distribution', ...
                          'Position', [690, 550, 650, 250], ...
                          'FontSize', 12, 'FontWeight', 'bold');

    ax2 = uiaxes(power_panel, 'Position', [30, 30, 600, 200]);

    mw_data = [62.88, -62.88, 62.68, -62.64];
    mvar_data = [53.87, -53.88, 47.03, -46.98];

    hold(ax2, 'on');
    bar(ax2, [mw_data', mvar_data']);
    ax2.XTickLabel = bus_names;
    ax2.Title.String = 'Active and Reactive Power Flow';
    ax2.YLabel.String = 'Power (MW/Mvar)';
    legend(ax2, 'MW', 'Mvar');
    grid(ax2, 'on');

    branch_panel = uipanel(parent, 'Title', 'Branch Loading Summary', ...
                           'Position', [20, 280, 1320, 250], ...
                           'FontSize', 12, 'FontWeight', 'bold');

    branch_data = {
        'T1 (Transformer)', '100 MVA', '82.81 MVA', '82.8%', '166.7 A', 'Normal'
        'UG CABLE', '6144 A', '3465 A', '56.4%', '3465 A', 'Normal'
        'Line1 (Transmission)', '—', '—', '—', '207.9 A', 'Normal'
    };

    branch_table = uitable(branch_panel, 'Data', branch_data, ...
                           'ColumnName', {'Branch', 'Capacity', 'Loading', 'Loading %',↙
'Current', 'Status'}, ...
                           'Position', [20, 20, 1280, 210]);

    summary_panel = uipanel(parent, 'Title', 'System Summary', ...
                            'Position', [20, 50, 1320, 210], ...
                            'FontSize', 12, 'FontWeight', 'bold');

    summary_text = {
        'Load Flow Convergence: 4 iterations'
```

```
        'System Mismatch: 0.000 MW, 0.000 Mvar'
        'Total Generation: 62.88 MW, 53.87 Mvar'
        'Total Load: 62.88 MW, 53.87 Mvar'
        'Total Losses: 0.237 MW, 6.884 Mvar'
        'System Power Factor: 75.9% Lagging'
        ''
        'Alerts:'
        '● SUBSTATION BUS: Under Voltage (94.6% < 95.0%)'
        '● T1_LS: Under Voltage (94.6% < 95.0%)'
    };

    uitextarea(summary_panel, 'Value', summary_text, ...
              'Position', [20, 20, 1280, 170], ...
              'Editable', 'off');
end

function create_fault_analysis_tab(parent)

    title_label = uilabel(parent, 'Text', 'Short Circuit Analysis Results', ...
                          'Position', [20, 820, 300, 30], ...
                          'FontSize', 18, 'FontWeight', 'bold');

    fault_panel = uipanel(parent, 'Title', 'Fault Current Analysis', ...
                          'Position', [20, 550, 650, 250], ...
                          'FontSize', 12, 'FontWeight', 'bold');

    ax1 = uiaxes(fault_panel, 'Position', [30, 30, 600, 200]);

    fault_types = {'3-Phase', 'Line-Ground', 'Line-Line', 'Line-Line-Ground'};
    fault_currents = [45.022, 43.658, 38.990, 44.744]; % kA

    bar(ax1, fault_currents);
    ax1.XTickLabel = fault_types;
    ax1.Title.String = 'Fault Currents at SUBSTATION BUS';
    ax1.YLabel.String = 'Fault Current (kA)';
    grid(ax1, 'on');

    impedance_panel = uipanel(parent, 'Title', 'Sequence Impedances', ...
                              'Position', [690, 550, 650, 250], ...
                              'FontSize', 12, 'FontWeight', 'bold');

    ax2 = uiaxes(impedance_panel, 'Position', [30, 30, 600, 200]);

    seq_types = {'Positive', 'Negative', 'Zero'};
    resistance = [0.01287, 0.01287, 0.00846];
    reactance = [0.17650, 0.17650, 0.19341];

    hold(ax2, 'on');
    bar(ax2, [resistance', reactance']);
    ax2.XTickLabel = seq_types;
    ax2.Title.String = 'Sequence Impedances (Ohms)';
```

```
    ax2.YLabel.String = 'Impedance (Ohms)';
    legend(ax2, 'Resistance', 'Reactance');
    grid(ax2, 'on');

    % Fault contribution table
    contrib_panel = uipanel(parent, 'Title', 'Fault Current Contributions', ...
                            'Position', [20, 280, 1320, 250], ...
                            'FontSize', 12, 'FontWeight', 'bold');

    contrib_data = {
        'Total System', '45.022', '43.658', '38.990', '44.744'
        'T1 Transformer', '27.714', '32.468', '—', '—'
        'Feeder 1 Load', '8.659', '5.598', '—', '—'
        'Feeder 2 Load', '8.659', '5.598', '—', '—'
    };

    contrib_table = uitable(contrib_panel, 'Data', contrib_data, ...
                            'ColumnName', {'Source', '3-Phase (kA)', 'L-G (kA)', 'L-L↙
(kA)', 'L-L-G (kA)'}, ...
                            'Position', [20, 20, 1280, 210]);

    % Fault analysis summary
    fault_summary_panel = uipanel(parent, 'Title', 'Analysis Summary', ...
                                  'Position', [20, 50, 1320, 210], ...
                                  'FontSize', 12, 'FontWeight', 'bold');

    fault_summary_text = {
        'Fault Analysis at SUBSTATION BUS (13.8 kV):'
        '• Pre-fault Voltage: 100% of nominal'
        '• Maximum Fault Current: 45.022 kA (3-Phase Fault)'
        '• Minimum Fault Current: 38.990 kA (Line-Line Fault)'
        ''
        'System Strength:'
        '• Utility Short Circuit Power: 1991.858 MVA'
        '• System X/R Ratio: 34.1 (Transformer), 10.0 (Utility)'
        ''
        'Protection Considerations:'
        '• Circuit breakers must be rated for minimum 45 kA'
        '• Coordination required between utility and feeder protection'
        '• Ground fault protection needed for Dyn transformer connection'
    };

    uitextarea(fault_summary_panel, 'Value', fault_summary_text, ...
              'Position', [20, 20, 1280, 170], ...
              'Editable', 'off');
end

function create_monitoring_tab(parent)

    title_label = uilabel(parent, 'Text', 'Real-time System Monitoring', ...
                          'Position', [20, 820, 300, 30], ...
```

```
                    'FontSize', 18, 'FontWeight', 'bold');

    control_panel = uipanel(parent, 'Title', 'Control Panel', ...
                        'Position', [20, 700, 1320, 100], ...
                        'FontSize', 12, 'FontWeight', 'bold');

    start_btn = uibutton(control_panel, 'Text', 'Start Monitoring', ...
                       'Position', [20, 40, 120, 30], ...
                       'ButtonPushedFcn', @start_monitoring);

    stop_btn = uibutton(control_panel, 'Text', 'Stop Monitoring', ...
                      'Position', [160, 40, 120, 30], ...
                      'ButtonPushedFcn', @stop_monitoring);

    load_label = uilabel(control_panel, 'Text', 'Load Factor:', ...
                       'Position', [300, 45, 80, 20]);

    load_slider = uislider(control_panel, 'Position', [390, 50, 200, 3], ...
                        'Limits', [0.5, 1.5], 'Value', 1.0, ...
                        'ValueChangedFcn', @adjust_load);

    load_value = uilabel(control_panel, 'Text', '1.00', ...
                       'Position', [600, 45, 40, 20]);

    status_panel = uipanel(parent, 'Title', 'System Status', ...
                        'Position', [20, 550, 400, 130], ...
                        'FontSize', 12, 'FontWeight', 'bold');

    voltage_lamp = uilamp(status_panel, 'Position', [20, 80, 20, 20], ...
                        'Color', 'green');
    voltage_status = uilabel(status_panel, 'Text', 'Voltage: Normal', ...
                           'Position', [50, 80, 120, 20]);

    frequency_lamp = uilamp(status_panel, 'Position', [20, 50, 20, 20], ...
                          'Color', 'green');
    frequency_status = uilabel(status_panel, 'Text', 'Frequency: 60.0 Hz', ...
                             'Position', [50, 50, 120, 20]);

    loading_lamp = uilamp(status_panel, 'Position', [20, 20, 20, 20], ...
                        'Color', 'yellow');
    loading_status = uilabel(status_panel, 'Text', 'Loading: 82.8%', ...
                           'Position', [50, 20, 120, 20]);

    voltage_trend_panel = uipanel(parent, 'Title', 'Voltage Trend', ...
                                'Position', [440, 400, 440, 280], ...
                                'FontSize', 12, 'FontWeight', 'bold');

    ax_voltage = uiaxes(voltage_trend_panel, 'Position', [20, 20, 400, 240]);
    ax_voltage.Title.String = 'Bus Voltage Monitoring';
    ax_voltage.XLabel.String = 'Time (s)';
    ax_voltage.YLabel.String = 'Voltage (p.u.)';
```

```
    grid(ax_voltage, 'on');

    power_trend_panel = uipanel(parent, 'Title', 'Power Flow Trend', ...
                                'Position', [900, 400, 440, 280], ...
                                'FontSize', 12, 'FontWeight', 'bold');

    ax_power = uiaxes(power_trend_panel, 'Position', [20, 20, 400, 240]);
    ax_power.Title.String = 'Power Flow Monitoring';
    ax_power.XLabel.String = 'Time (s)';
    ax_power.YLabel.String = 'Power (MW)';
    grid(ax_power, 'on');

    alarm_panel = uipanel(parent, 'Title', 'Alarms & Events', ...
                          'Position', [20, 50, 1320, 330], ...
                          'FontSize', 12, 'FontWeight', 'bold');

    alarm_text = {
        '[06-07-2025 22:29:31] System initialized'
        '[06-07-2025 22:29:32] Load flow analysis completed - 4 iterations'
        '[06-07-2025 22:29:33] Warning: Under voltage at SUBSTATION BUS (94.6%)'
        '[06-07-2025 22:29:33] Warning: Under voltage at T1_LS (94.6%)'
        '[06-07-2025 22:29:34] Transformer T1 loading: 82.8% (Normal)'
        '[06-07-2025 22:29:35] Cable loading: 56.4% (Normal)'
        '[06-07-2025 22:29:36] System stable - All parameters within limits'
    };

    alarm_display = uitextarea(alarm_panel, 'Value', alarm_text, ...
                               'Position', [20, 20, 1280, 290], ...
                               'Editable', 'off');

    setappdata(parent, 'start_btn', start_btn);
    setappdata(parent, 'stop_btn', stop_btn);
    setappdata(parent, 'load_slider', load_slider);
    setappdata(parent, 'load_value', load_value);
    setappdata(parent, 'ax_voltage', ax_voltage);
    setappdata(parent, 'ax_power', ax_power);
    setappdata(parent, 'alarm_display', alarm_display);
    setappdata(parent, 'voltage_lamp', voltage_lamp);
    setappdata(parent, 'frequency_lamp', frequency_lamp);
    setappdata(parent, 'loading_lamp', loading_lamp);
    setappdata(parent, 'voltage_status', voltage_status);
    setappdata(parent, 'frequency_status', frequency_status);
    setappdata(parent, 'loading_status', loading_status);
end

function draw_single_line_diagram(ax)
    cla(ax);
    hold(ax, 'on');

    % Bus positions
    buses = struct();
```

```
    buses.T_sub = [1, 5];
    buses.T1_HS = [3, 5];
    buses.T1_LS = [5, 3];
    buses.SUBSTATION_BUS = [7, 3];

    % Buses
    bus_names = fieldnames(buses);
    for i = 1:length(bus_names)
        pos = buses.(bus_names{i});
        plot(ax, pos(1), pos(2), 'ks', 'MarkerSize', 8, 'MarkerFaceColor', 'black');
        text(ax, pos(1), pos(2)+0.2, bus_names{i}, 'HorizontalAlignment', 'center',↙
'FontSize', 8);
    end

    % Transmission line (T_sub to T1_HS)
    plot(ax, [buses.T_sub(1), buses.T1_HS(1)], [buses.T_sub(2), buses.T1_HS(2)], 'b-',↙
'LineWidth', 2);
    text(ax, 2, 5.2, 'Line1', 'HorizontalAlignment', 'center', 'FontSize', 8);

    % Transformer (T1_HS to T1_LS)
    plot(ax, [buses.T1_HS(1), buses.T1_LS(1)], [buses.T1_HS(2), buses.T1_LS(2)], 'r-',↙
'LineWidth', 2);
    plot(ax, 4, 4, 'ro', 'MarkerSize', 15, 'MarkerFaceColor', 'red');
    text(ax, 4, 4.3, 'T1', 'HorizontalAlignment', 'center', 'FontSize', 8, 'FontWeight',↙
'bold');
    text(ax, 4, 3.7, '100MVA', 'HorizontalAlignment', 'center', 'FontSize', 7);

    % Underground cable (T1_LS to SUBSTATION_BUS)
    plot(ax, [buses.T1_LS(1), buses.SUBSTATION_BUS(1)], [buses.T1_LS(2), buses.↙
SUBSTATION_BUS(2)], 'g-', 'LineWidth', 2);
    text(ax, 6, 3.2, 'UG CABLE', 'HorizontalAlignment', 'center', 'FontSize', 8);

    % Loads
    % Feeder 1
    plot(ax, [buses.SUBSTATION_BUS(1), buses.SUBSTATION_BUS(1)+0.5], [buses.↙
SUBSTATION_BUS(2), buses.SUBSTATION_BUS(2)-0.5], 'k-', 'LineWidth', 1);
    plot(ax, buses.SUBSTATION_BUS(1)+0.5, buses.SUBSTATION_BUS(2)-0.5, 'mo',↙
'MarkerSize', 10, 'MarkerFaceColor', 'magenta');
    text(ax, buses.SUBSTATION_BUS(1)+0.5, buses.SUBSTATION_BUS(2)-0.8, 'Feeder1',↙
'HorizontalAlignment', 'center', 'FontSize', 7);
    text(ax, buses.SUBSTATION_BUS(1)+0.5, buses.SUBSTATION_BUS(2)-1.0, '40MVA',↙
'HorizontalAlignment', 'center', 'FontSize', 7);

    % Feeder 2
    plot(ax, [buses.SUBSTATION_BUS(1), buses.SUBSTATION_BUS(1)+0.5], [buses.↙
SUBSTATION_BUS(2), buses.SUBSTATION_BUS(2)+0.5], 'k-', 'LineWidth', 1);
    plot(ax, buses.SUBSTATION_BUS(1)+0.5, buses.SUBSTATION_BUS(2)+0.5, 'mo',↙
'MarkerSize', 10, 'MarkerFaceColor', 'magenta');
    text(ax, buses.SUBSTATION_BUS(1)+0.5, buses.SUBSTATION_BUS(2)+0.8, 'Feeder2',↙
'HorizontalAlignment', 'center', 'FontSize', 7);
    text(ax, buses.SUBSTATION_BUS(1)+0.5, buses.SUBSTATION_BUS(2)+1.0, '40MVA',↙
```

```
'HorizontalAlignment', 'center', 'FontSize', 7);

    % Utility source
    plot(ax, buses.T_sub(1)-0.5, buses.T_sub(2), 'ko', 'MarkerSize', 15,↙
'MarkerFaceColor', 'cyan');
    text(ax, buses.T_sub(1)-0.5, buses.T_sub(2)+0.3, 'Utility', 'HorizontalAlignment',↙
'center', 'FontSize', 8, 'FontWeight', 'bold');
    text(ax, buses.T_sub(1)-0.5, buses.T_sub(2)-0.3, '230kV', 'HorizontalAlignment',↙
'center', 'FontSize', 7);

    % Voltage levels
    text(ax, buses.T_sub(1), buses.T_sub(2)-0.3, '230kV', 'HorizontalAlignment',↙
'center', 'FontSize', 7, 'Color', 'blue');
    text(ax, buses.T1_HS(1), buses.T1_HS(2)-0.3, '230kV', 'HorizontalAlignment',↙
'center', 'FontSize', 7, 'Color', 'blue');
    text(ax, buses.T1_LS(1), buses.T1_LS(2)-0.3, '13.8kV', 'HorizontalAlignment',↙
'center', 'FontSize', 7, 'Color', 'blue');
    text(ax, buses.SUBSTATION_BUS(1), buses.SUBSTATION_BUS(2)-0.3, '13.8kV',↙
'HorizontalAlignment', 'center', 'FontSize', 7, 'Color', 'blue');


    ax.XLim = [0, 8.5];
    ax.YLim = [1.5, 6];
    ax.XTick = [];
    ax.YTick = [];
    ax.Title.String = 'Microgrid Single Line Diagram';
    grid(ax, 'off');
    axis(ax, 'equal');
end

function start_monitoring(src, event)
    parent = src.Parent.Parent;
    ax_voltage = getappdata(parent, 'ax_voltage');
    ax_power = getappdata(parent, 'ax_power');

    t = 0:0.1:30;

    voltage_base = 0.946;
    voltage_variation = voltage_base + 0.02*sin(2*pi*0.1*t) + 0.01*randn(size(t));

    power_base = 62.64;
    power_variation = power_base + 5*sin(2*pi*0.05*t) + 2*randn(size(t));

    plot(ax_voltage, t, voltage_variation, 'b-', 'LineWidth', 1.5);
    ax_voltage.YLim = [0.9, 1.0];

    plot(ax_power, t, power_variation, 'r-', 'LineWidth', 1.5);
    ax_power.YLim = [50, 75];

    voltage_lamp = getappdata(parent, 'voltage_lamp');
    if min(voltage_variation) < 0.95
```

```
        voltage_lamp.Color = 'red';
    else
        voltage_lamp.Color = 'green';
    end
end

function stop_monitoring(src, event)
    parent = src.Parent.Parent;
    ax_voltage = getappdata(parent, 'ax_voltage');
    ax_power = getappdata(parent, 'ax_power');

    cla(ax_voltage);
    cla(ax_power);

    ax_voltage.Title.String = 'Bus Voltage Monitoring - Stopped';
    ax_power.Title.String = 'Power Flow Monitoring - Stopped';
end

function adjust_load(src, event)
    parent = src.Parent.Parent;
    load_value = getappdata(parent, 'load_value');
    loading_status = getappdata(parent, 'loading_status');
    loading_lamp = getappdata(parent, 'loading_lamp');

    load_factor = src.Value;
    load_value.Text = sprintf('%.2f', load_factor);

    base_loading = 82.8;
    new_loading = base_loading * load_factor;
    loading_status.Text = sprintf('Loading: %.1f%%', new_loading);

    if new_loading > 95
        loading_lamp.Color = 'red';
    elseif new_loading > 85
        loading_lamp.Color = 'yellow';
    else
        loading_lamp.Color = 'green';
    end
end

microgrid_dashboard();
```

Microgrid Load Flow and Fault Analysis Dashboard

System Overview | Load Flow Analysis | Short Circuit Analysis | Real-time Monitoring

# Microgrid System Overview

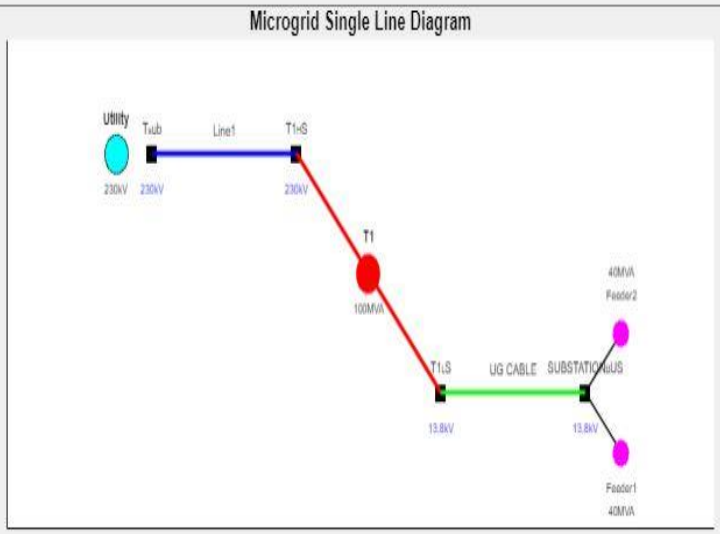
## System Specifications

Utility Specifications:
- Nominal Voltage: 230 kV
- 3LG Fault Current: 5000 A (X/R = 10)
- SLG Fault Current: 7000 A (X/R = 12)

Transformer (T1):
- Rating: 100 MVA
- Primary: 230 kV
- Secondary: 13.8 kV
- Impedance: 10%
- Connection: Dyn1

Underground Cable:
- Type: 15MALS1

## Single Line Diagram




## Bus Data Summary

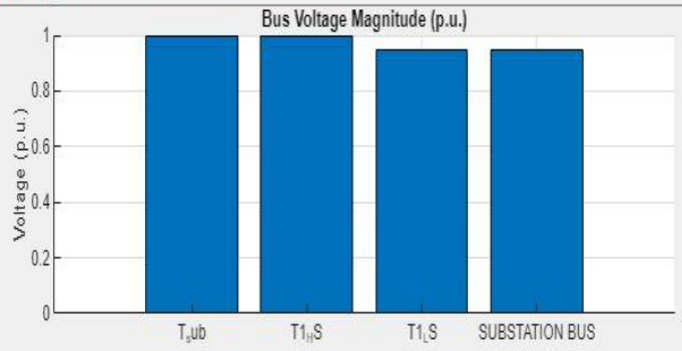
| | Bus ID | Nominal kV | Voltage % | Angle ° | MW | Mvar | Type |
|---|---|---|---|---|---|---|---|
| 1 | T_sub | 230.0 | 100.0 | 0.0 | 62.88 | 53.87 | Swing Bus |
| 2 | T1_HS | 230.0 | 100.0 | 0.0 | -62.88 | -53.88 | Load Bus |
| 3 | T1_LS | 13.8 | 94.6 | -3.7 | 62.68 | 47.03 | Load Bus |
| 4 | SUBSTATION BUS | 13.8 | 94.6 | -3.7 | -62.64 | -46.98 | Load Bus |

Microgrid Load Flow and Fault Analysis Dashboard

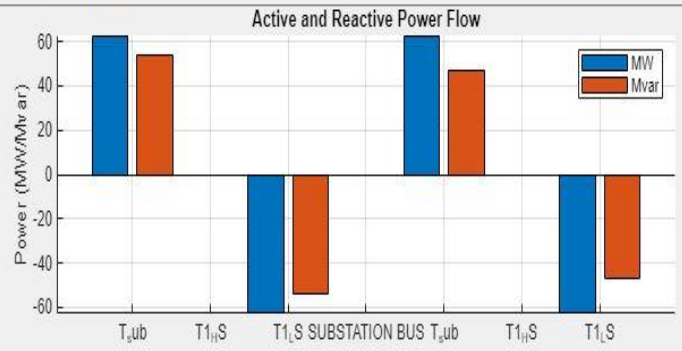
System Overview | Load Flow Analysis | Short Circuit Analysis | Real-time Monitoring

## Load Flow Analysis Results

### Bus Voltage Profile




### Power Flow Distribution




### Branch Loading Summary

| | Branch | Capacity | Loading | Loading % | Current | Status |
|---|---|---|---|---|---|---|
| 1 | T1 (Transformer) | 100 MVA | 82.81 MVA | 82.8% | 166.7 A | Normal |
| 2 | UG CABLE | 6144 A | 3465 A | 56.4% | 3465 A | Normal |
| 3 | Line1 (Transmission) | — | — | — | 207.9 A | Normal |

### System Summary

Load Flow Convergence: 4 iterations
System Mismatch: 0.000 MW, 0.000 Mvar
Total Generation: 62.88 MW, 53.87 Mvar
Total Load: 62.88 MW, 53.87 Mvar
Total Losses: 0.237 MW, 6.884 Mvar
System Power Factor: 75.9% Lagging

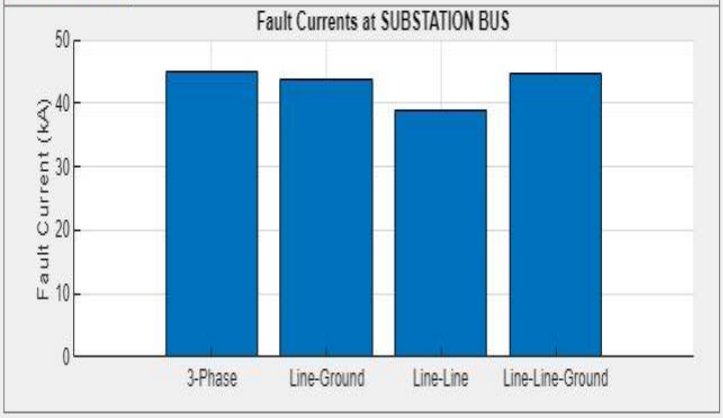
Alerts:

Microgrid Load Flow and Fault Analysis Dashboard

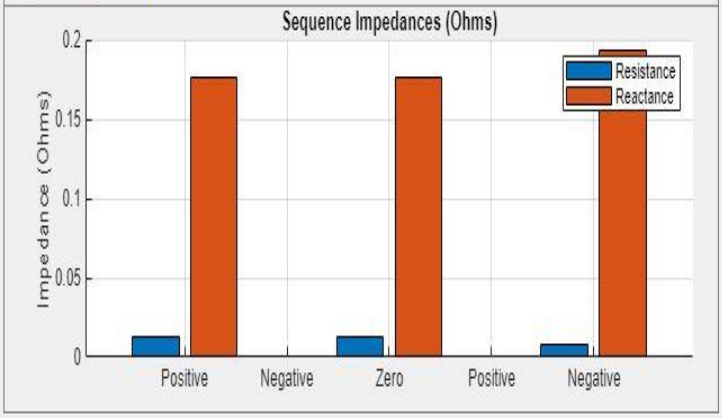
System Overview | Load Flow Analysis | Short Circuit Analysis | Real-time Monitoring

# Short Circuit Analysis Results

## Fault Current Analysis




## Sequence Impedances




## Fault Current Contributions

| | Source | 3-Phase (kA) | L-G (kA) | L-L (kA) | L-L-G (kA) |
|---|---|---|---|---|---|
| 1 | Total System | 45.022 | 43.658 | 38.990 | 44.744 |
| 2 | T1 Transformer | 27.714 | 32.468 | — | — |
| 3 | Feeder 1 Load | 8.659 | 5.598 | — | — |
| 4 | Feeder 2 Load | 8.659 | 5.598 | — | — |

## Analysis Summary

Fault Analysis at SUBSTATION BUS (13.8 kV):
- Pre-fault Voltage: 100% of nominal
- Maximum Fault Current: 45.022 kA (3-Phase Fault)
- Minimum Fault Current: 38.990 kA (Line-Line Fault)

System Strength:
- Utility Short Circuit Power: 1991.858 MVA
- System X/R Ratio: 34.1 (Transformer), 10.0 (Utility)

Microgrid Load Flow and Fault Analysis Dashboard

System Overview | Load Flow Analysis | Short Circuit Analysis | Real-time Monitoring

## Real-time System Monitoring

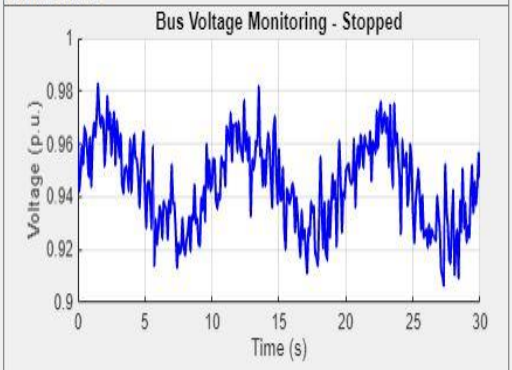
**Control Panel**

Start Monitoring | Stop Monitoring | Load Factor: 0.73 (0.5 0.7 0.9 1.1 1.3 1.5)

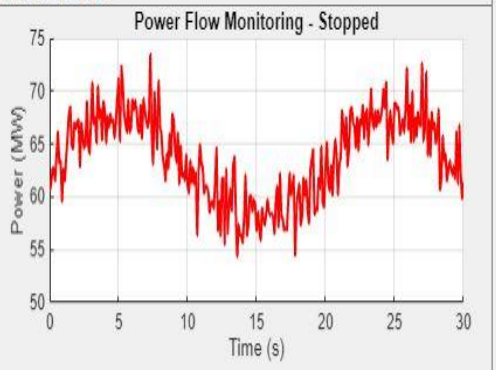
**System Status**

- Voltage: Normal
- Frequency: 60.0 Hz
- Loading: 60.4%

**Voltage Trend**




**Power Flow Trend**




**Alarms & Events**

[06-07-2025 22:29:31] System initialized
[06-07-2025 22:29:32] Load flow analysis completed - 4 iterations
[06-07-2025 22:29:33] Warning: Under voltage at SUBSTATION BUS (94.6%)
[06-07-2025 22:29:33] Warning: Under voltage at T1_LS (94.6%)
[06-07-2025 22:29:34] Transformer T1 loading: 82.8% (Normal)
[06-07-2025 22:29:35] Cable loading: 56.4% (Normal)
[06-07-2025 22:29:36] System stable - All parameters within limits