
SafeGrid Earthing Software complies with IEEE Std 80 and IEC 60479.

Project:

QLD North 66 kV Substation

Scenario:

Scenario 1

Design Inputs

Table 1: Soil characteristics

Model	Determine values using soil modelling program (S-RES)
Top layer resistivity (Ohm.m)	15.453
Top layer depth (m)	3.059
Bottom layer resistivity (Ohm.m)	26.733

Refer to separate page for LM-RES soil modelling.

Table 2: Grid energisation

Units	Current (A)
Magnitude	1000

Table 3: Grid and rod conductor size

Method	Calculate grid conductor size
Conductor radius (mm)	3.372927

Refer to separate page for conductor size calculation.

Table 4: Measurement units

Units	Metric
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Table 5: System

Frequency (Hz)	50
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Levenberg-Marquardt Soil Resistivity (LM-RES) Modelling

Table 6: User Inputs

Soil model	Horizontal 2-Layer
Measurement method	Wenner
Measurement values	Resistivity (Ohm.m)
Account for probe depth? (True/False)	FALSE
Driven depth at short spacings (m)	-
Remove outliers? (True/False)	FALSE

Table 7: Field measurements

	Spacing (m)	Resistivity (Ohm.m)	Included? (True/False)
R1	2	15.7	TRUE
R2	4	19	TRUE
R3	8	21.2	TRUE
R4	16	24	TRUE
R5	32	26.5	TRUE

Table 8: Results

Top layer soil resistivity (Ohm.m)	15.452571
Top layer depth (m)	3.058878
Bottom layer soil resistivity (Ohm.m)	26.733267
Reflection factor, k	0.267405
Goodness of Fit (R-square)	0.976678

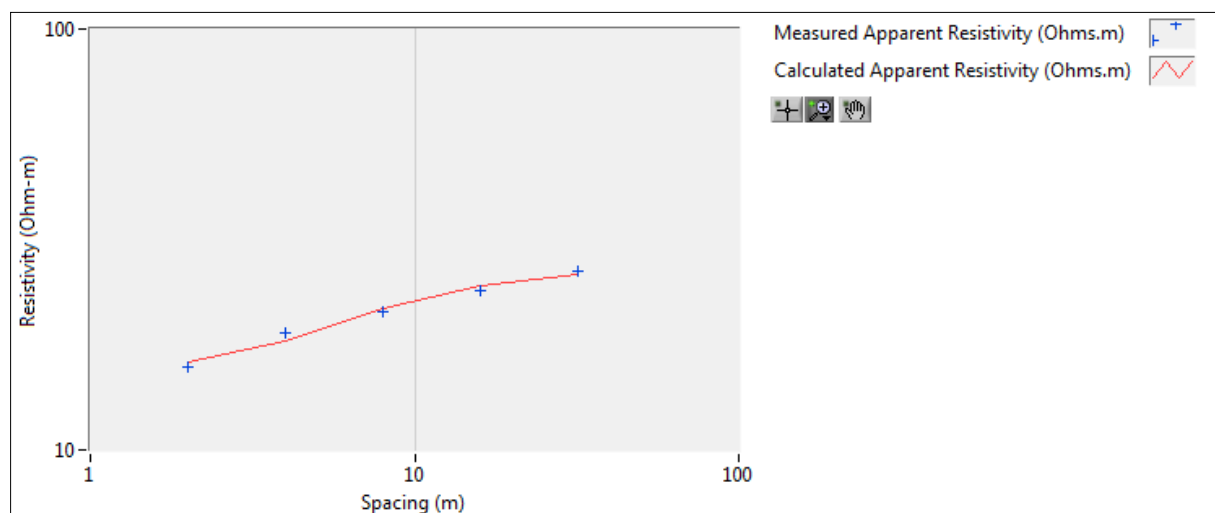


Figure 1: Non-linear model fit to field measurements

Conductor Ampacity Calculation in accordance with IEEE Std 80

Table 9: User Inputs

Conductor type	Copper, annealed soft-drawn (100% conductivity)
Symmetrical RMS current magnitude (kA)	10
Maximum fault duration (s)	1
Ambient temperature (deg.C)	20
Maximum allowable temperature	Fusing temperature
Maximum temperature (deg.C)	450
Decrement factor	Default
Decrement factor value	1.031
X/R ratio	20
System frequency (Hz)	50

Table 10: Material constants of conductor

Reference temperature for material constants (deg.C)	20
Thermal coefficient of resistivity at reference temperature (1/deg.C)	0.00393
Fusing temperature of conductor (deg.C)	1083
Resistivity of conductor at reference temperature (microOhms.cm)	1.72
Thermal capacity per unit volume (J/cm ³ .deg.C)	3.42

Table 11: Results - minimum conductor size

Conductor cross-sectional area (mm ²)	35.740754
Conductor radius (mm)	3.372927

Buried Grid Model

Table 12: Segments

No. of segments accounting for intersections only	233
No. of segments after segmentation (for accuracy)	413
Fault location (segment no.)	1
Total length of conductor network (m)	600

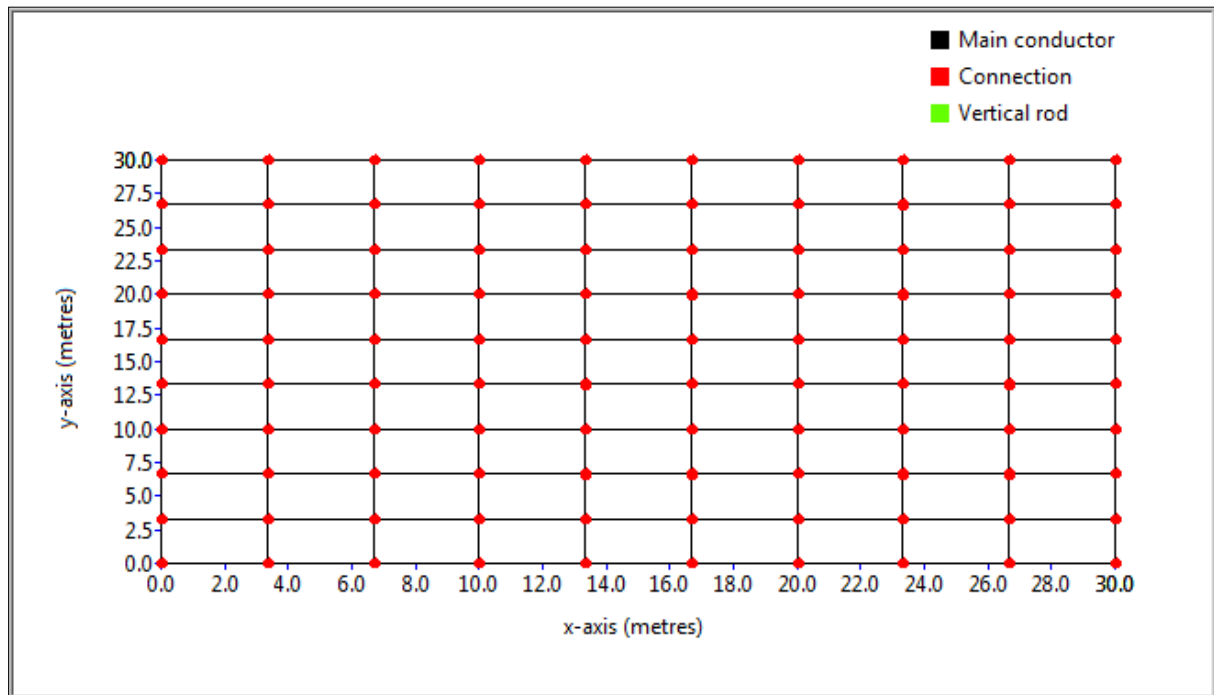


Figure 2: Buried grid preview

Safety Criteria (ISAFE) Calculation

Table 13: User Inputs

Safety standard (body resistance)	IEEE
Fibrillation current method	50kg - IEEE
Body resistance curve (IEC)	-
Conditions (IEC)	-
Foot resistance calculation method	IEEE80:2000
Additional series resistance (i.e. shoe or glove) (Ohms)	0
Fault clearing time (s)	0.5
System frequency (Hz)	50
System X/R ratio	20
Decrement factor	Default
Decrement factor value	1.061755

Sub-surface layer resistivity (Ohm.m)	100
Use top layer soil resistivity? (True/False)	TRUE
Surface material resistivity (Ohm.m)	500
Surface layer depth (m)	0.18

Table 14: Results

Allowable Touch Voltage Limit (V)	254.184869
Allowable Step Voltage Limit (V)	553.217983
Permissible body current (A)	0.164049
Body resistance (Ohms)	1000

Method of Images Grounding (MOI-GND) Modelling

Table 15: Results

Grid Impedance (Ohms)	0.338
Grid Potential Rise, GPR (V)	337.718

Table 16: Summary of Inputs

Top soil layer resistivity (Ohm.m)	15.45
Depth top soil layer (m)	3.06
Bottom soil layer resistivity (Ohm.m)	26.73
Excitation current (A)	1000
Faulted segment no.	1
Final no. of segments	413
Conductor radius (m)	0.003373
Conductivity of buried conductor (S/m)	57E+6
Frequency (Hz)	50
Calculation delta	0.001

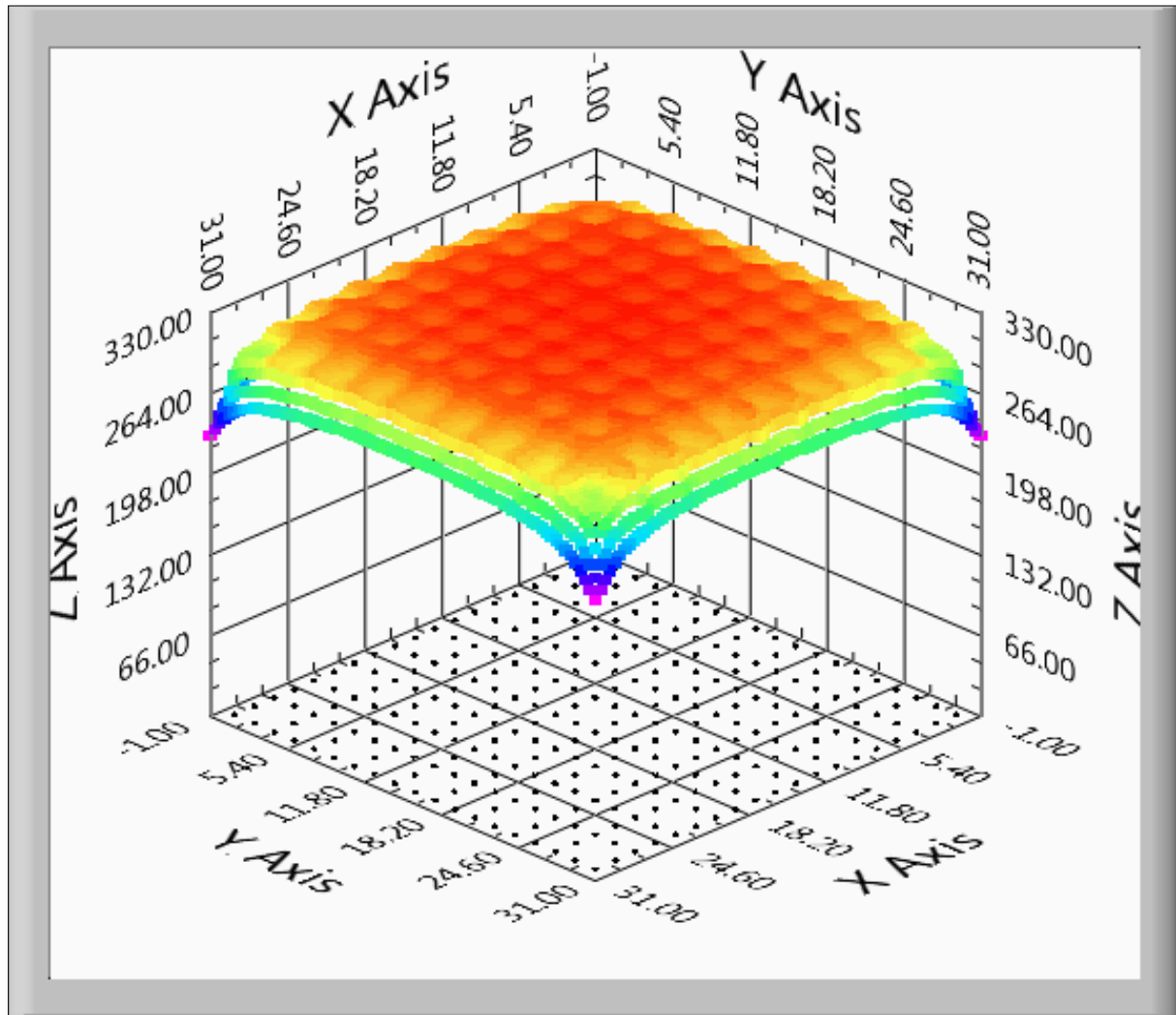


Figure 3: Surface potentials (V) - 3D view

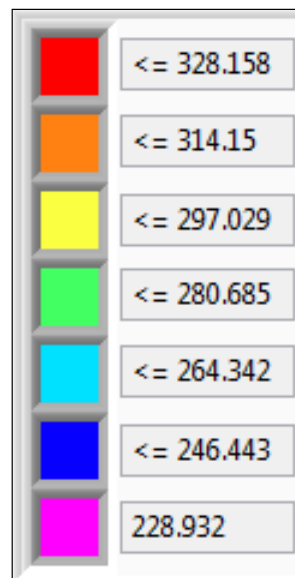


Figure 4: Surface potentials - Colour map

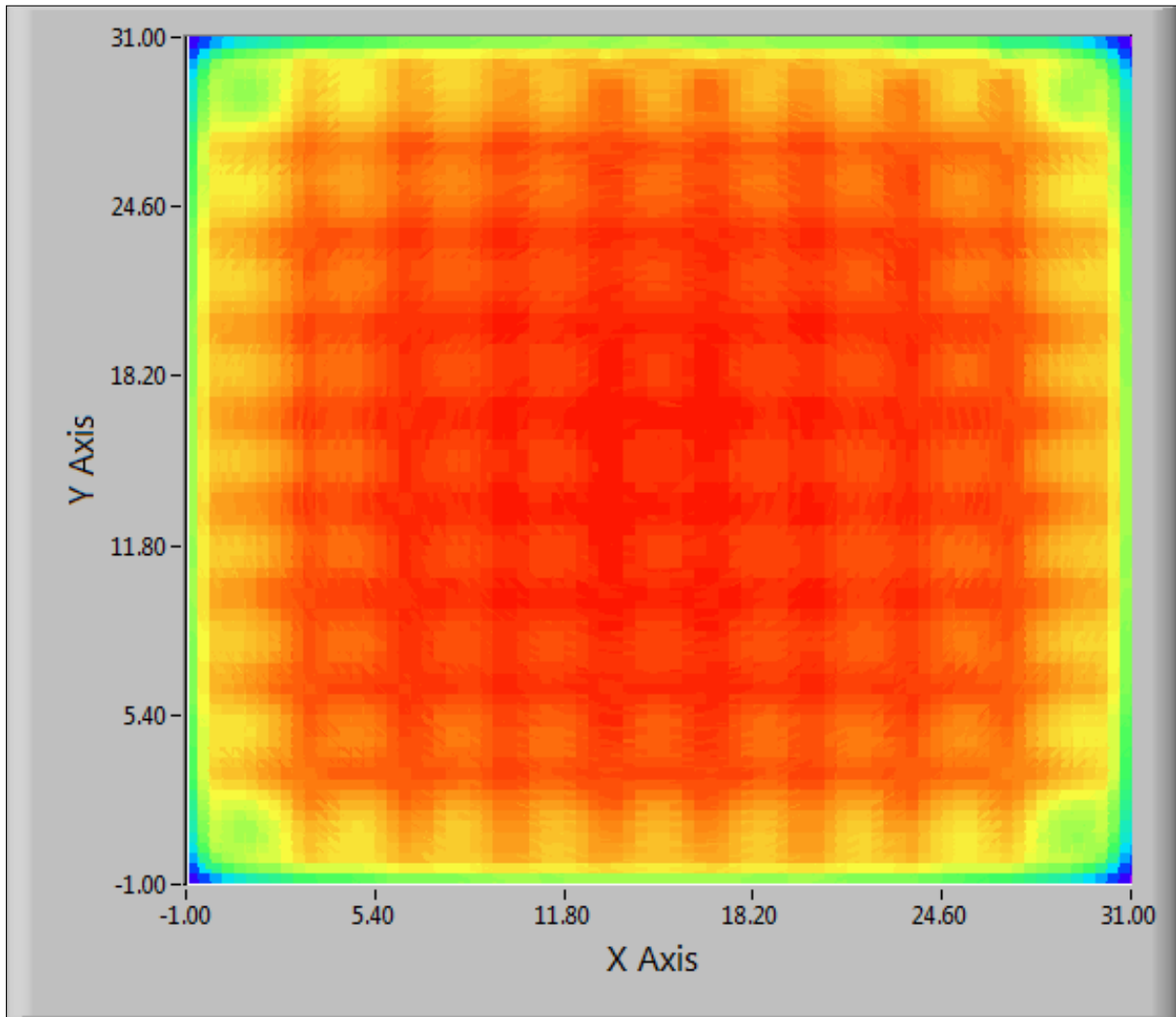


Figure 5: Surface potentials (V) - X-Y view

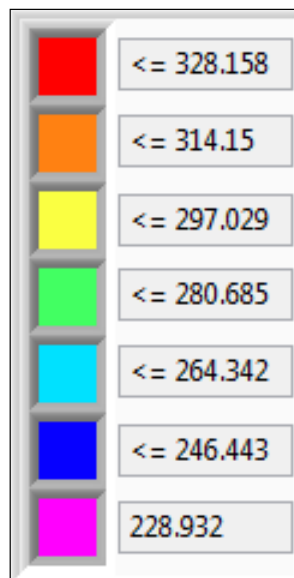


Figure 6: Surface potentials - Colour map

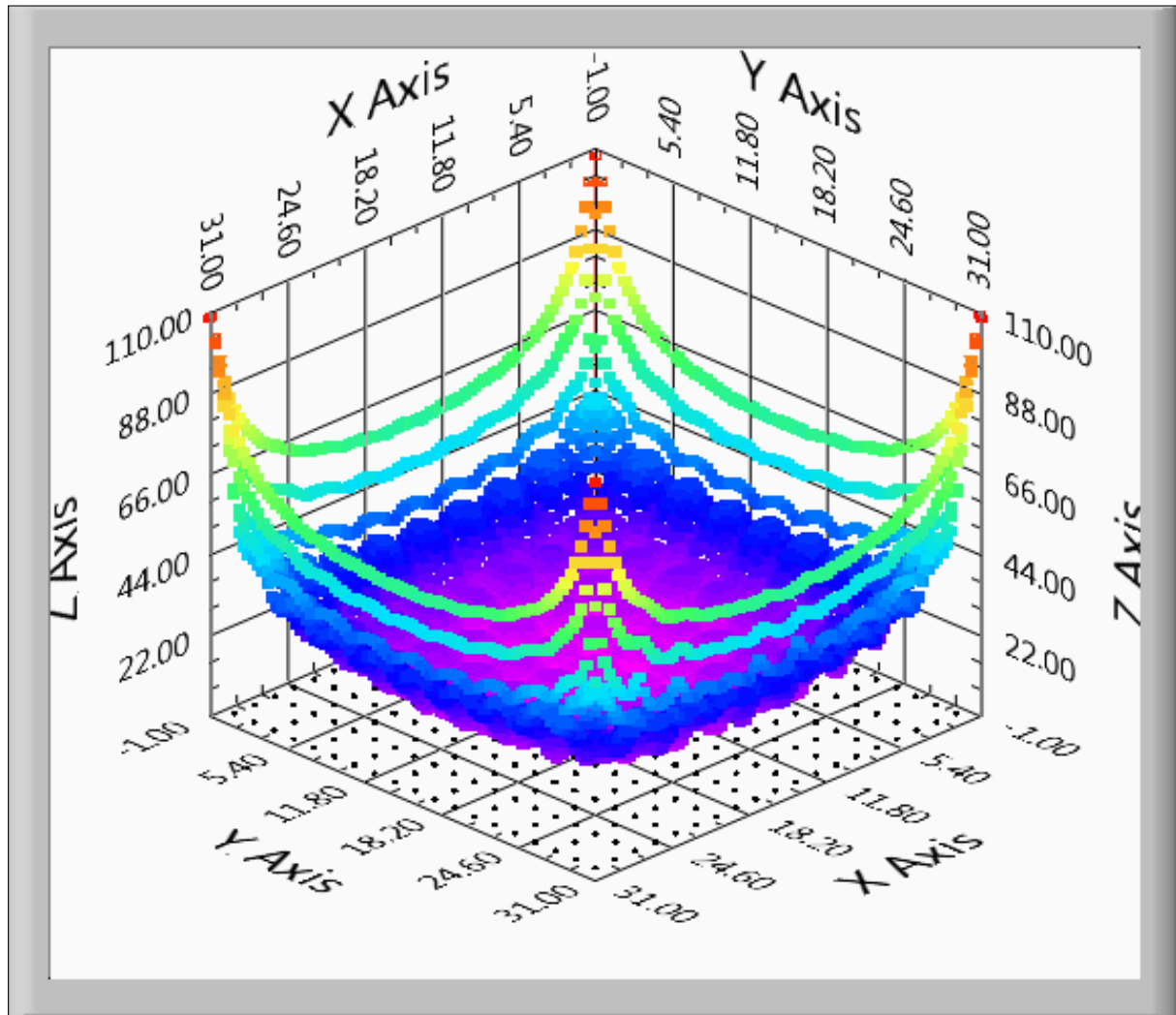


Figure 7: Touch potentials (V) - 3D view

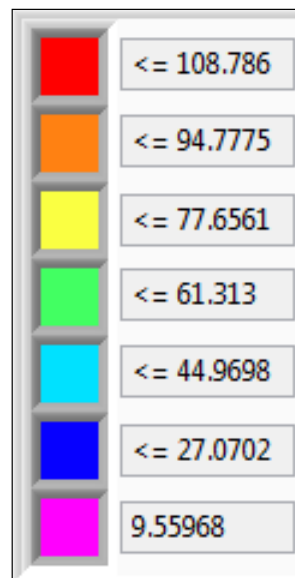


Figure 8: Touch potentials - Colour map

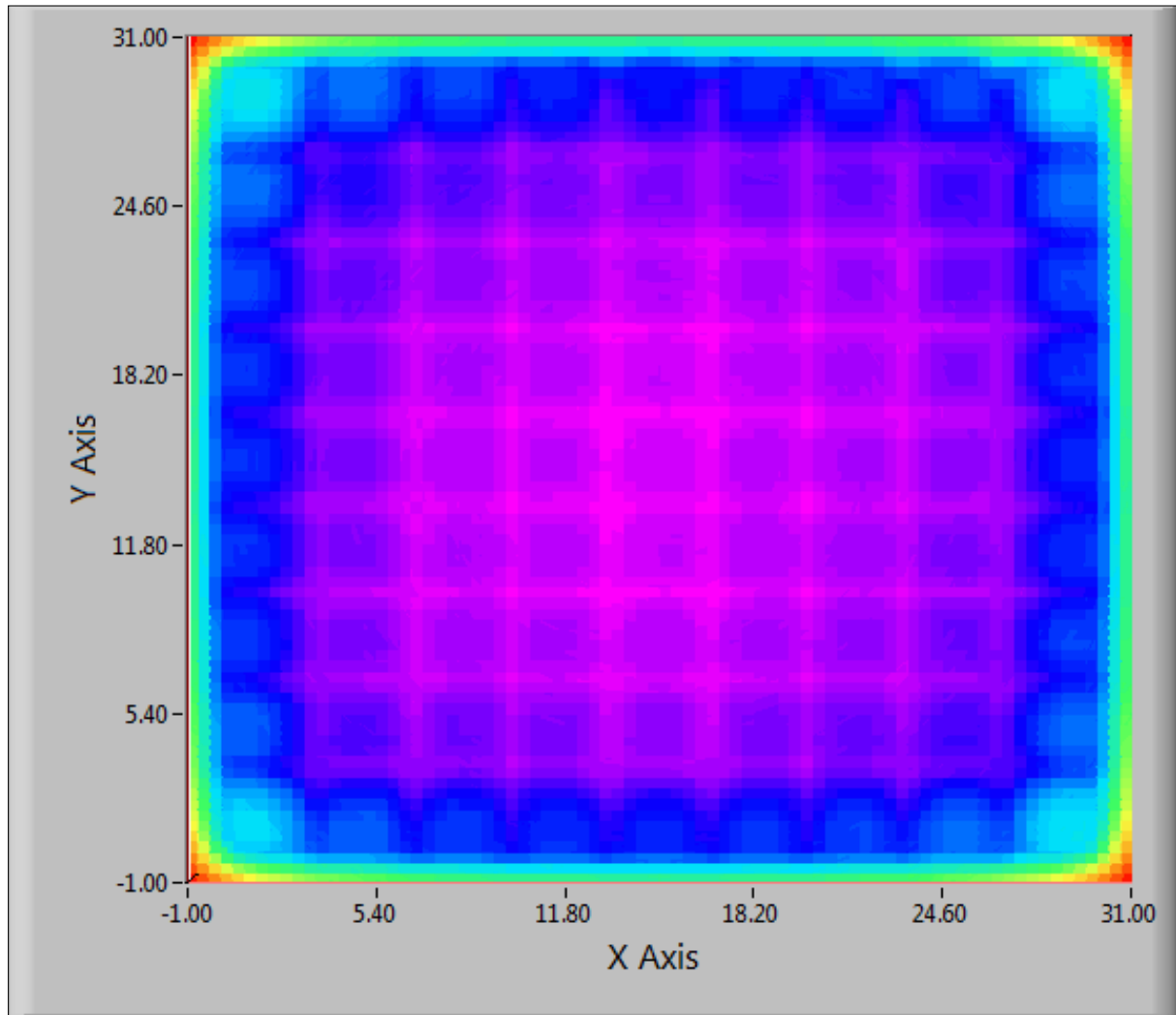


Figure 9: Touch potentials (V) - X-Y view

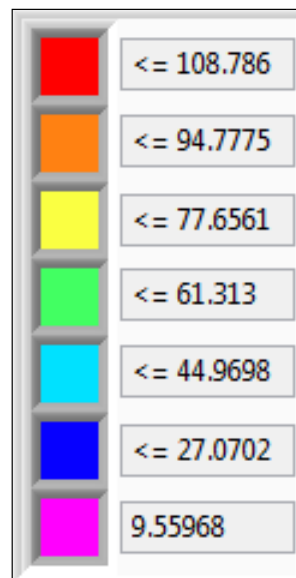


Figure 10: Touch potentials - Colour map

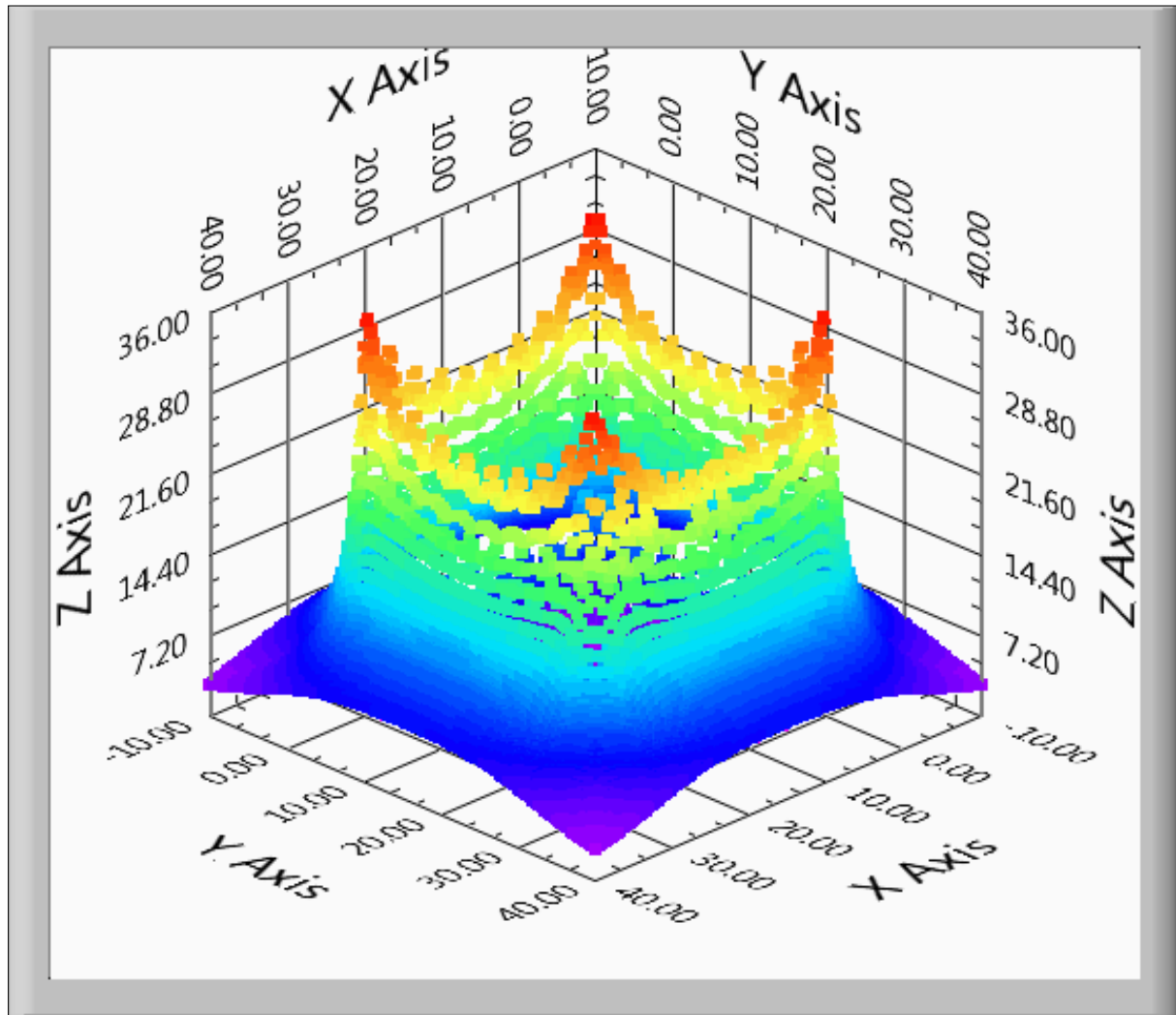


Figure 11: Step potentials (V) - 3D view

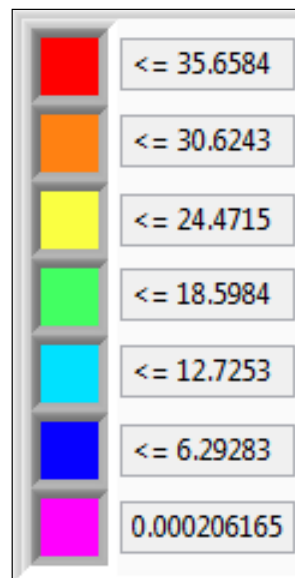


Figure 12: Step potentials - Colour map

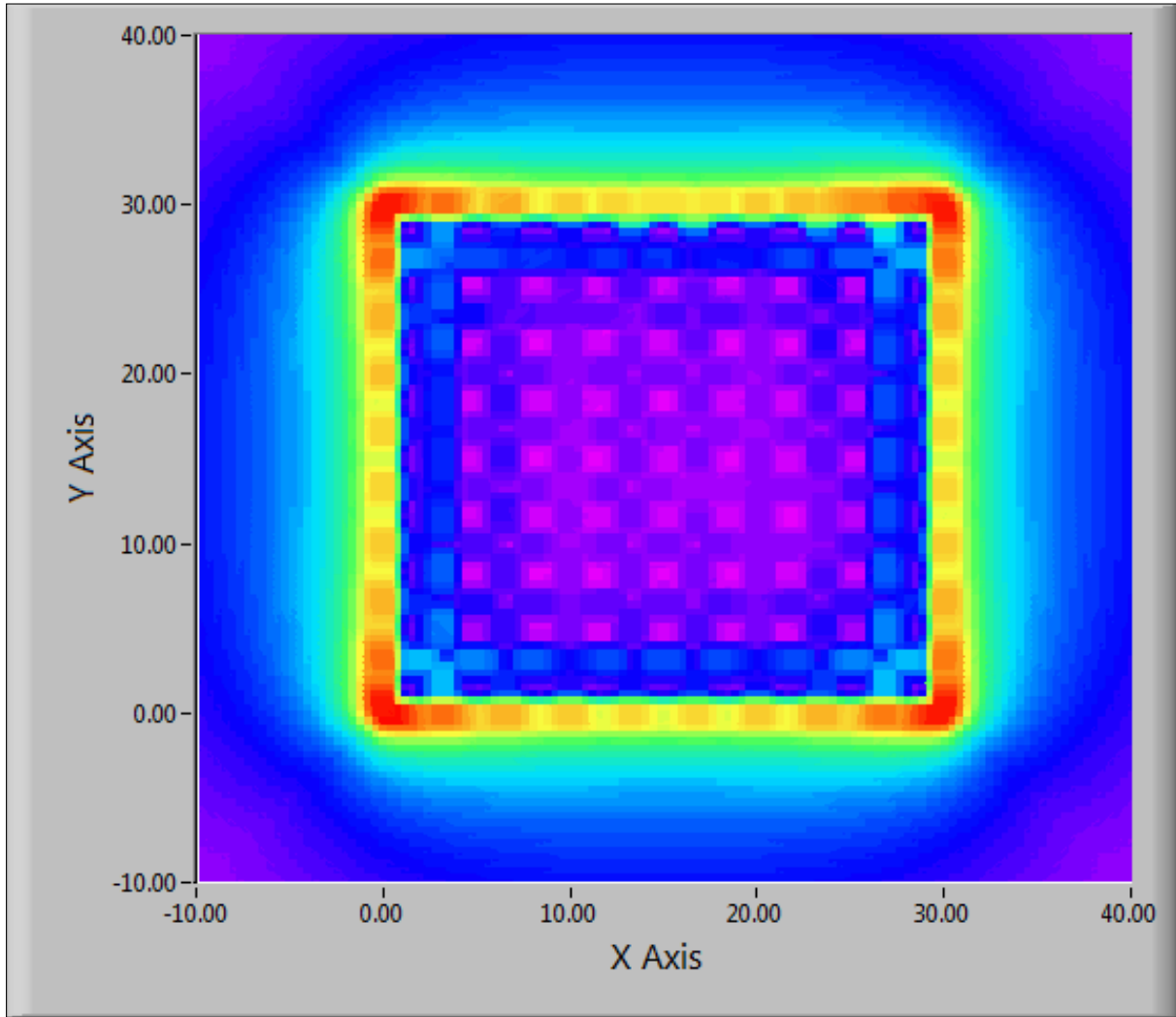


Figure 13: Step potentials (V) - X-Y view

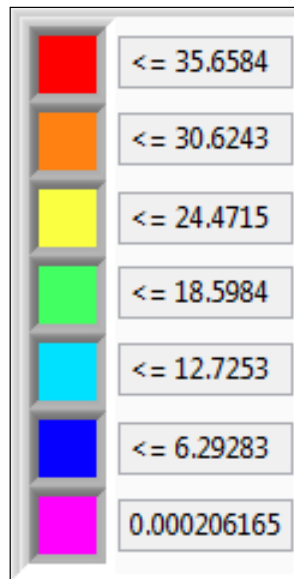


Figure 14: Step potentials - Colour map