

INFORMATION BROCHURE

ON

PowerApps



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1 Introduction

PowerApps is a consortium of experienced professionals in the field of Power Systems Analysis & Simulation with an established reputation for customer responsiveness and technical expertise. PowerApps offers an extensive line of Power System Engineering Software that feature some of the most advanced analysis tools for transmission, distribution and industrial power systems. We offer comprehensive services in order for our customers to fully benefit from the PowerApps applications in their specific IT environment and to address their engineering analysis needs. This includes engineering studies, assistance to integration and comprehensive training.

Starting from August 2008, PowerApps is associated with Kalkitech for wider marketing and service possibilities. For more information please refer the web page <http://www.powerapps.org/PowerAppsKalkitech.aspx>

1.1 About KALKITECH

KALKI Communication Technologies Limited [KALKITECH] is an ISO 9001:2000 certified Technology Company incorporated in 1998 with the vision of becoming the leading provider of Computing, Communication and Control solutions to the energy, power generation, transmission, distribution, oil & gas, renewable energy and automation industry. Over the years KALKITECH has successfully designed, implemented and commissioned products and solutions to OEM's and end-customers in these industries. Continuous innovation through research and development is at the core of KALKITECH's corporate philosophy. More information about the company may be had from the web site <http://www.kalkitech.com>. sales@kalkitech.com. Further information on the company can be obtained by contacting KALKITECH has its corporate office in Bangalore, India with additional offices in the US, Middle East and regional offices in India.

2 Solution by KALKITECH

2.1 PowerApps - A Suite of Power System Analysis Software

PowerApps is an integrated Power Systems Analysis Software & Simulation package that includes the Graphic User Interface, Data Base Manager, and Electrical Equipment Parameter Estimation for creating the Network one-line diagram and associated database. PowerApps offers both graphical and tabular data entry modes, user-preferred single-line diagram drawing options and sophisticated facilities for reporting, plotting and customizing the simulation reports. The design of PowerApps recognizes the fact that there is no memory restriction in present day computers. Consequently PowerApps has no built in dimensioned variables. The needed memory for analysis of any system is allocated dynamically during execution time.

2.1.1 General Features of PowerApps

- Multiple study cases of load flow/short circuit/stability/protection/and other analytical procedures cases for all the network islands in one single execution.
- A single master database for all the study cases and outputs for easier maintenance of project database.
- Facilities for interactive single line diagram creation using a Windows based GUI.
- Automatic network model construction based on breaker statuses using an inbuilt Network topology processor. The Network topology processor algorithm is suitable for real time applications.
- Multiple study cases due to changes in breaker statuses, changes in load power specifications, changes in generator schedules, changes in transformer taps, changes in number circuits, changes in compensation etc. are handled in single program execution without creating additional databases and the results are stored in the same single database for post processing (e.g. Report generation). All other analysis which needs load flow base case as input are automatically executed after each load flow base case (e.g. Transient stability analysis with different disturbance scenarios) and the results are stored for post processing.
- Derived study cases from any given study base case with necessary data changes.
- No in built restriction on system size or components. The size of the system can vary between the barest minimum to maximum permissible by the memory available in the computer. It is the opinion of this author the entire Indian grid network can be represented for the analysis.
- Multiple stability study cases on the same load flow base case, with different disturbance scenarios.
- Input data in the format of ASCII, Excel, Access databases.
- OLE support
- Object oriented programming approach with Power Foundation Classes (PFC) to build analytical algorithms. The concept is similar to using MFC for MS windows programming in VC++.
- Standard library facilities for all common electrical elements.
- Validated algorithms (documents) with standard bench mark examples.

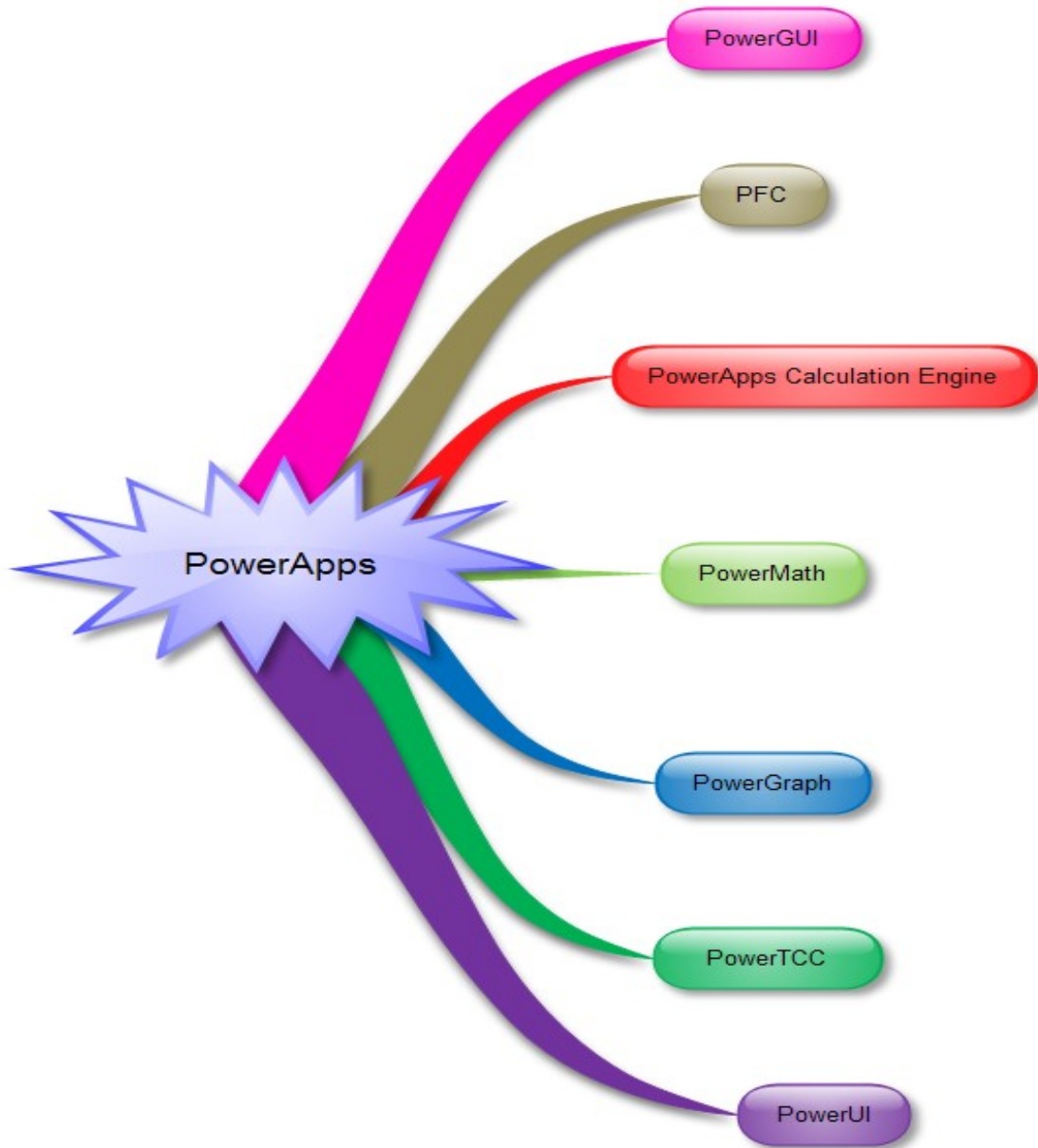


Figure-1 PowerApps Overview

2.1.2 PFC

Power Foundation Classes [PFC] is a collection of C++ classes for various electrical equipments, mathematical functions and power system analysis algorithms. PowerApps software is built using these class library functions. These functions may be provided to end users/industries/academics on license basis for academic/research/industrial/consulting applications

2.1.3 PowerGUI

PowerGUI is a general purpose single line diagram tool for construction of single line diagrams, taking data inputs for various power system analysis modules, execution, report generation.

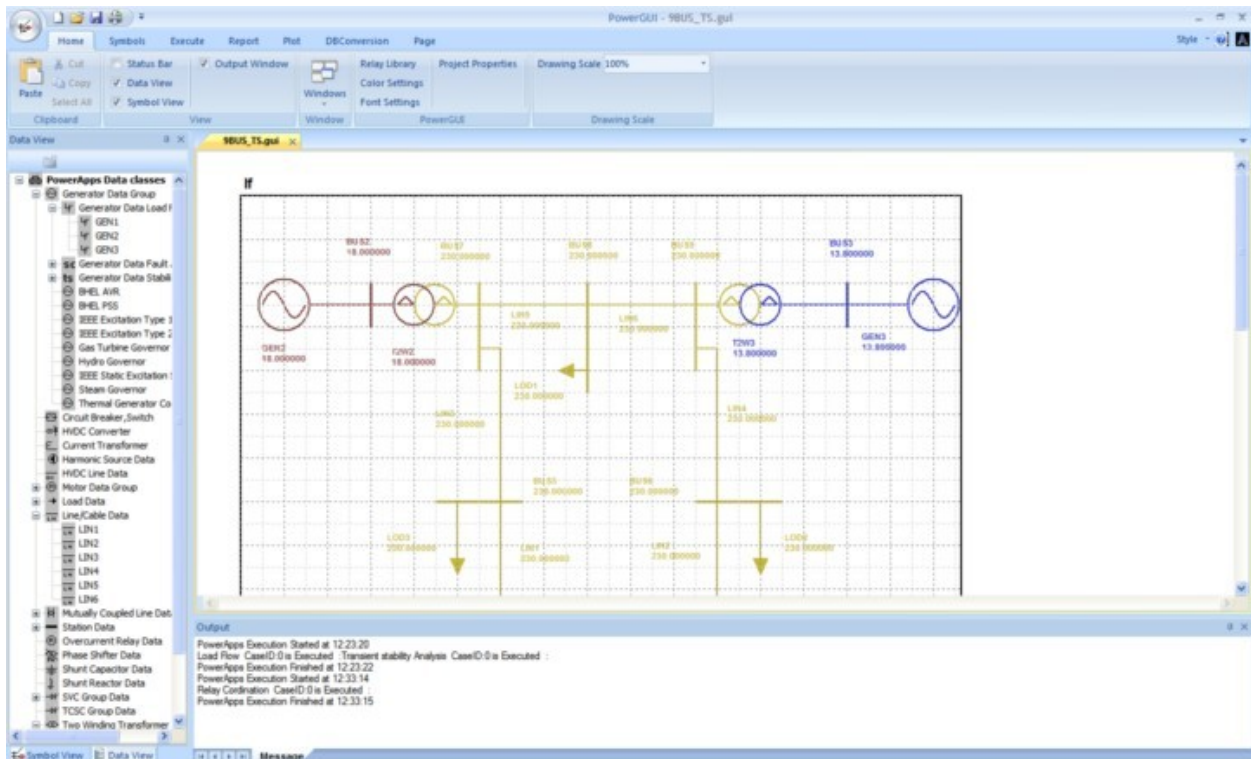


Figure-2 PowerGUI

2.1.4 PowerGraph

PowerGraph is a post processing utility used for XY plots of types , linear-linear, linear-log, log-linear, log-log. Typical examples of usage are transient stability plots, Motor starting studies, Driving point impedance plots in Harmonic studies.

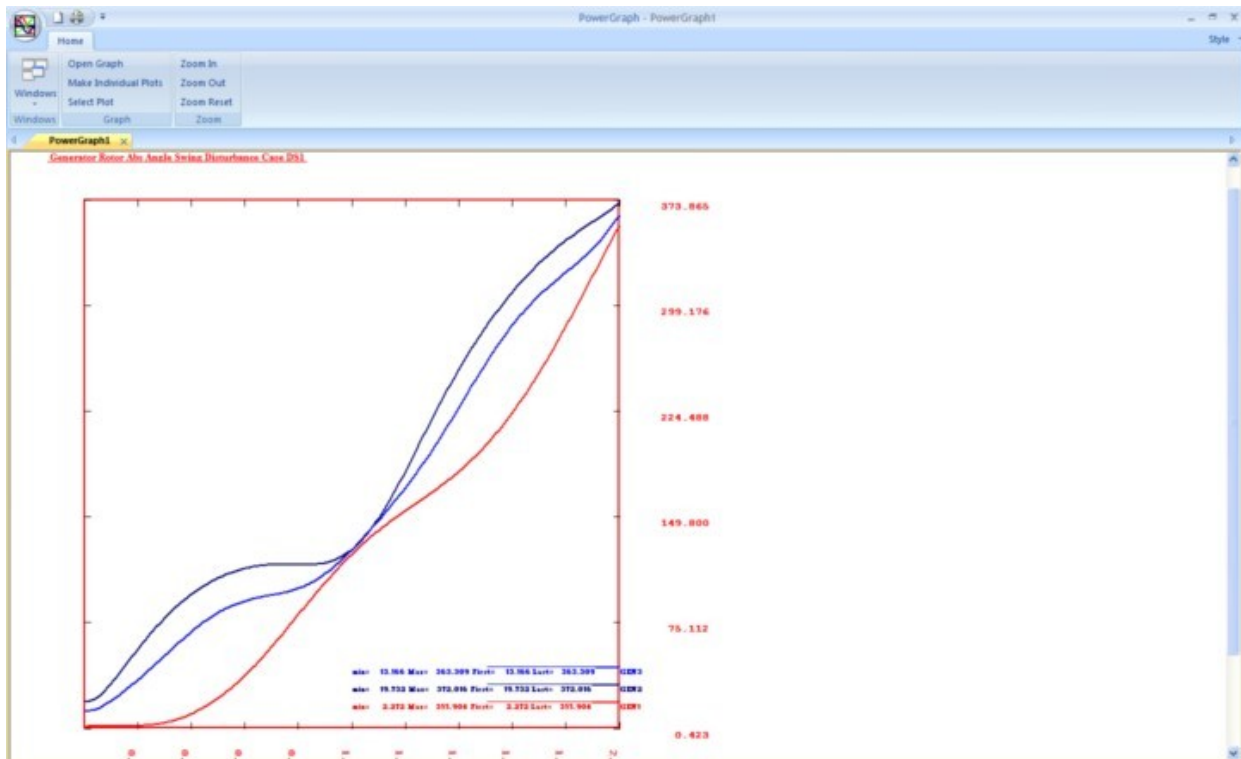


Figure-3 PowerGraph

2.1.5 PowerTCC

PowerTCC is a time current characteristic modeling tool that draws the TCC of protective devices and shows the discrimination in relay operating times. User can modify relay settings and try to achieve better coordination between protective devices. The utility can also plot TCC's for the PowerApps relay coordination module.

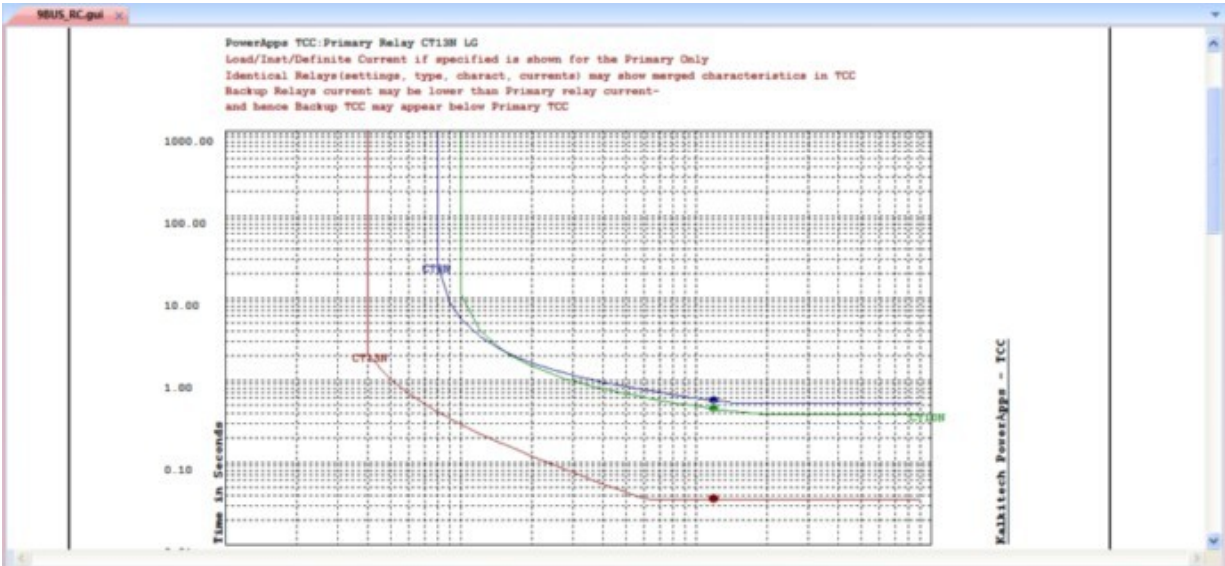


Figure-4 PowerTCC

2.1.6 PowerMath

PowerMath is a collection of generic mathematical functions used to develop the power system analysis software modules. These include matrix routines, sparse matrix techniques, curve fitting techniques, statistical analysis tools, optimization techniques, numerical integration routines and so on. There are specific routines for both complex numbers and Real numbers. The methods are general and are applicable to any field. These modules can be provided to end users on license basis with specific documentation and support via email.

2.1.7 PowerUI

PowerUI is a general purpose user interface with context sensitive help for preparing the database for power system studies using PowerApps. The database structure is generalized and can be used for any other specific applications where similar user interface requirements exist.

2.2 Licenses

The solution offered by KALKITECH can be handled either on a single desk top PC or a Laptop using Windows XP Professional or Windows Vista OS. In this case each single PC or Laptop will be loaded with the software and the functioning of software needs a USB hardware lock.

Alternatively, software solutions can be loaded into as many client PC's [Desktop or Laptop] as required [subject to a maximum of 30 users], which are connected to a same LAN and a server. A single USB hardware lock will be needed on the server on LAN for the functioning of the software modules. The number students who can use the software can be controlled by software on the server to which the hardware lock is connected.

2.3 Minimum Hardware Configuration

The following minimum hardware/software configurations are recommended and higher configurations can be used wherever possible.

- Microsoft Windows XP Professional, Version 2002, Service Pack 2 or above
- Intel Core 2 DUO CPU, 1.83 GHz or above, 1 GB RAM and above.

The software solution by KALKITECH will be loaded in each individual PC's and can have local or server based hardware locks depending on choice of licensing. KALKITECH's software solutions will use any standard printer, plotter available on the LAN.

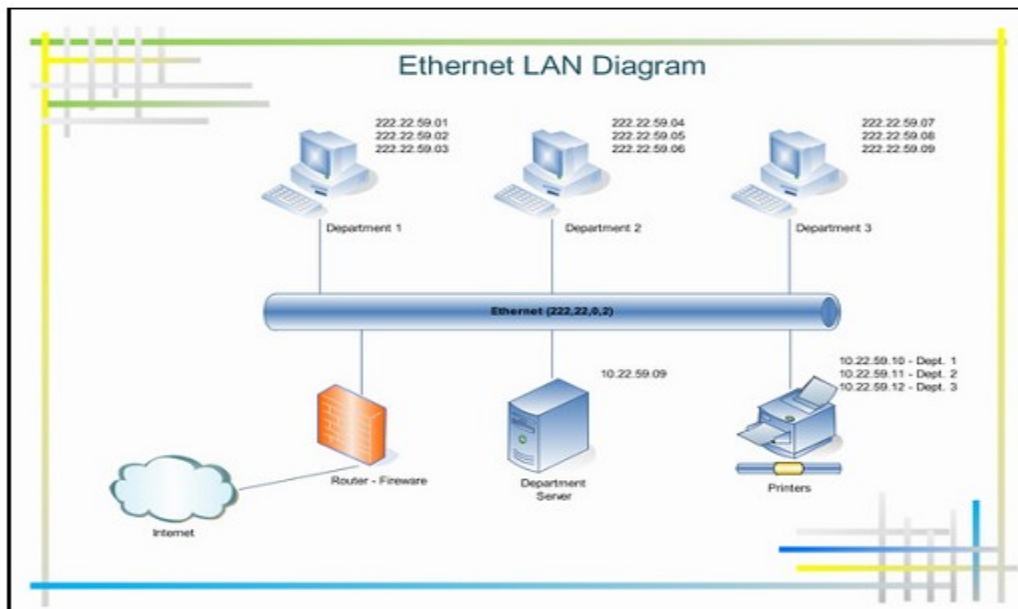


Figure-5 Server based License

3 Software Solution Features

This section summarizes the features of KALKITECH's software solution for Power System Analysis

3.1 Single Line Diagram Creation Module, GUI, Database Manager, General Features

- Supports multiple drawing pages, of any standard sizes and orientation
- Supports OLE features to import images and data from other OLE servers
- Provides unrestricted number of Undo and Redo facilities for the drawing
- Zoom Facility
- Standard drawing symbols like, bus, nodes, breakers, relays, lines, bus-sections, transformers (2 winding, 3 winding), neutral impedances [resistances, reactances, NGT's], CT's, PT's, generators, motors, constant power loads, harmonic current injections, SVC's, fuses shunt capacitors, shunt reactors, series capacitors, series reactors, HVDC links HVDC converters, Harmonic Filters, FACTS devices, Mutually coupled lines.
- Interactive data entry through symbols for various analysis
- Execution of analysis modules using the GUI and report generation – report manager
Tabular reports – Reports on Single Line Diagrams – Plot form reports [X-Y plots linear – linear plots, linear – log plots, log – log plots, Bar charts]
- Selection of single or multiple elements
- Copy and paste facility for single or multiple elements to reduce drawing effort
- Single database for all study cases and for all analysis. Single report database file for all analysis and study cases for easier maintenance.
- Single or Batch mode execution of all study cases and report generations
- Solution for networks with multiple network islands
- Combination of XY Plots and One Line Diagram portions for report purposes
- Standard Library Facilities for equipments for technical data and technical performance curves [cables, overhead conductors, motors, transformers, generators generator controls, relays].

- Built in Network Topology Processor in the analysis modules that construct equivalent network mathematical model based on the breaker/switch statuses, blow fuses, outage of elements etc.
- Facilities for Base Case Study and derived case studies [where derived cases reflect changes in parameters of the base case]

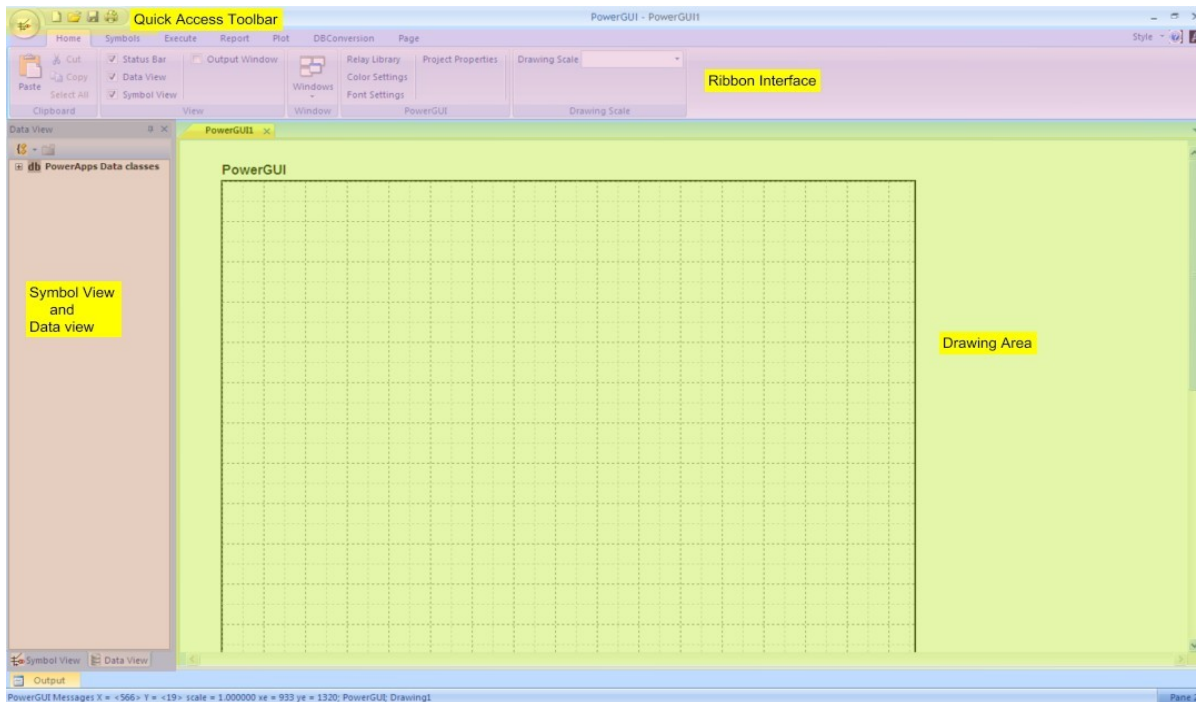


Figure-6 PowerGUI

3.2 Power Flow / Load Flow Solution Module

Power flow calculations provide active and reactive power flows and bus voltage magnitude and their phase angle at all the buses for a specified power system and operating condition subject to the regulating capability of generators, synchronous condensers, static var compensators, HVDC controls, FACTS controllers, tap changing under load transformers and specified net interchange between individual operating systems (utilities). This information is essential for the continuous evaluation of the current performance of a power system and for analyzing the effectiveness of alternative plans for system expansion to meet increased load demand. These analyses require the calculation of numerous power flow cases for both normal, and emergency (contingency) operating conditions.

Power Flow is the analysis module of PowerApps dedicated to power flow analysis in three-phase electric power networks. It is equipped with powerful analytical options and alternative solution techniques.

3.2.1 General Features of Power Flow Software

- Gauss-Seidel.
- Newton-Raphson.
- Fast-Decoupled.
- Load flow solution of multiple-islanded systems. The solution is available for each of the islands having a reference (slack) node. The reference node is automatically identified by the algorithm as the largest generator node in each island.
- Shunt compensations, series compensations, phase shifters, transformer taps.
- No limits on the number of study cases and related reports in a single execution of the program

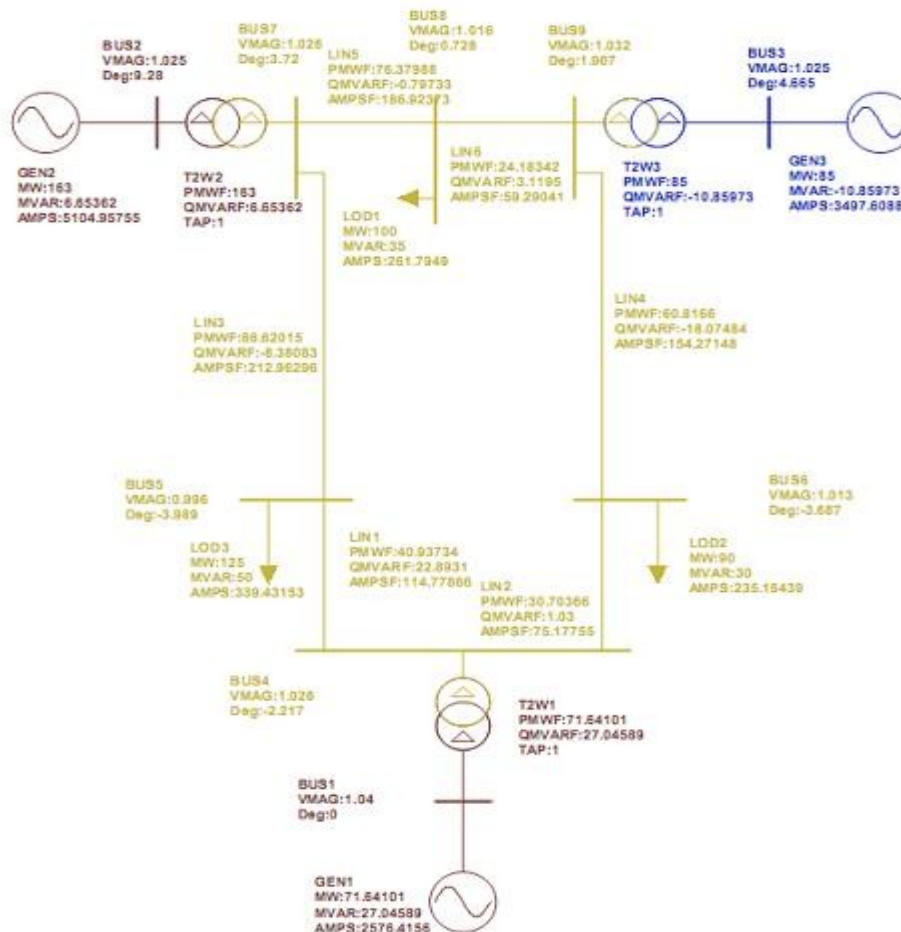


Figure-7 PowerApps Load Flow Results

3.3 Short Circuit Analysis

Short circuit calculations provide currents and voltages on a power system during fault conditions. This information is required to design an adequate protective relaying system and to determine interrupting requirements for circuit breakers at each switching location. Fault conditions can be balanced or un-balanced shunt faults or series (open conductor) faults. Often information about contributions to a fault from rotating machines such synchronous machines, large motors would be required as a function of time to determine making and breaking requirements. Fault calculations may consider or ignore pre-fault power flow conditions. Short Circuit is the PowerApps analysis module dedicated to simulating fault conditions in three-phase electric power systems. User friendly data entry, a multitude of reports and flexibility in applying all industry-accepted standards are features that make it an Indispensable tool for these very common and important system studies. PowerApps Short Circuit Module adheres to North American ANSI C37.5, ANSI C37.010, ANSI C37.13 and International IEC-60909 guidelines. It also supports conventional short-circuit studies without reference to any particular standards.

3.3.1 General Features of Short Circuit Software

- Fault levels for asymmetrical and symmetrical faults including bolted faults.
- ANSI/IEEE standards.
- IEC standards including 363 and 909.
- G74 British standard, a computer algorithm based standard for IEC 909 standard. IEC
- 909 standard specified multiplication factors based on hand calculation procedures and simplifying assumptions.
- Short circuit analysis of multiple-islanded systems with solution for each of the islands.
- Default flat 1.0 pu positive sequence bus voltage based calculations.
- Option to consider pre-fault bus voltages from load flow along with the sequence impedances for loads.
- Multiple case studies in single execution of the program for different network configurations and/or different source impedances or ratings.
- Automatic generation of reports for all the specified study cases on the single line diagram.
- Induction motor models.
- Fault calculations for network with multiple islands with sources in each island.
- Detailed system wide post fault bus voltages and flows for specified bus faults along with impedance seen at each relay locations.

- Output contains, detailed phase quantities, sequence quantities of voltages, currents, driving point impedances, transfer impedances, contribution from sources, and contribution from adjacent buses.
- Results of fault calculations with mutual coupling matches perfectly with published examples.

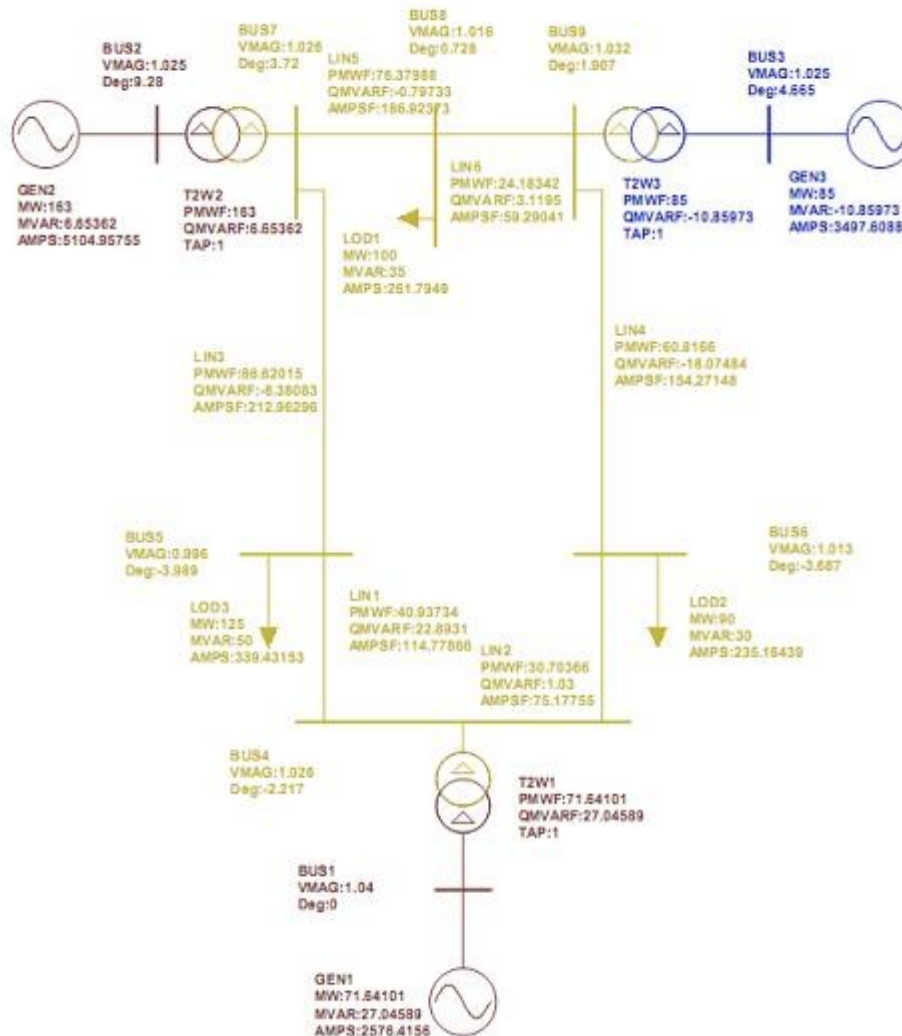


Figure-8 PowerApps Short Circuit Analysis Results

3.4 Transient Stability Analysis

The recovery of a power system subjected to a severe large disturbance is of interest to system planners and operators. Typically the system must be designed and operated in such a way that a specified number of credible contingencies do not result in failure of quality and continuity of power supply to the loads. This calls for accurate calculation of the system dynamic behavior, which includes the dynamic characteristics of the rotating machines, generator controls, static var compensators, loads, protective systems and other controls. Transient stability analysis can be used for dynamic analysis over time periods from few seconds to few minutes. Transient Stability Analysis is the PowerApps simulation module dedicated to simulating electromechanical transients in three phase electric power systems. It features an extensive library of equipment and controller models, the capability to include user-defined controls, a very flexible user-interface and powerful graphics. Transient Stability Analysis module utilizes the simultaneous implicit trapezoidal integration solution technique for network, machine and controller equations. The program supports the capability to test the step response of controllers and User Defined Modeling for system equipment and controllers.

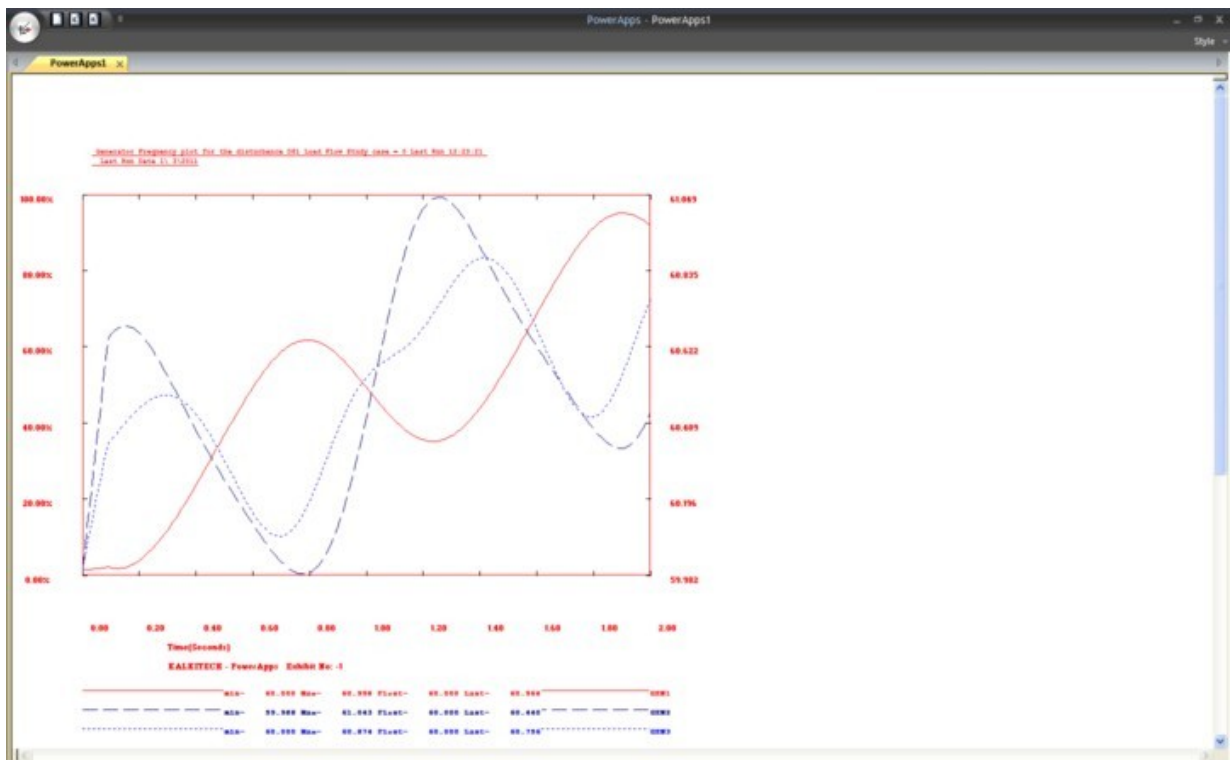


Figure-9 PowerAppsTransient Stability Plot

3.4.1 General Features of Transient Stability Analysis

- Transient models of excitation systems, turbine governors, static-var compensators and power system stabilizers.
- Load shedding / islanded operation.
- Transient stability analysis of multiple-islanded systems with solution for each of the islands.
- Choice of generator models. From simple classical generators with constant voltage behind transient reactance to modelling detailed synchronous machines with variable voltages behind sub-transient reactances.
- Standard IEEE excitation system models and turbine and governor models.
- Commercial excitation models and governor models.
- Models for power system stabilizers and different stabilizing signals.
- Modelling load characteristics similar to that in the load flow analysis.
- Modelling load characteristics as function of frequency.
- Dynamic models of Induction motor and its load.
- Motor starting studies. Motor modelling by their equivalent circuits or by the measured response during starting along with mathematical model for load torque as function of speed.
- Under frequency/Under Voltage relay operation simulation.
- Load shedding.
- Islanded operation.
- Element opening/closing.
- Loss of generators.
- Multiple transient stability disturbance scenarios for each base case load flow study. Note that, multiple load flow case studies can be performed followed by multiple transient stability simulations for each load flow study case.
- Plots of selected bus frequencies and bus voltages. Note bus frequencies are different from generator frequencies.

3.5 Relay Co-ordination and Protection Settings

Protective relays are to be designed to isolate the faulted portion of the system at the earliest with minimum system disruption. When the relays meant to protect specific equipments, transmission/distribution lines/feeders or zones do not operate backup relays must act to isolate the fault providing sufficient time discrimination for the operation of the primary relays. The relays must also be able to discriminate between faulted conditions, normal operating conditions and abnormal operating conditions. Relay coordination calculation module must consider the operating characteristics of the relays and must determine the optimum relay settings to achieve the objectives stated

3.5.1 General Features of Relay Co-ordination module

- Overcurrent phase fault relays.
- Overcurrent earth fault relays.
- Coordination with maximum load current.
- Coordination with fuse characteristics.
- Coordination with maximum motor starting current and time.
- Coordination with transformer inrush current.
- Coordination with primary-back up pairs.
- Coordination with thermal withstand capabilities ($I^2t = K$ characteristics).
- Coordination with safe stall limits for Motors.
- Automatic generation of TCCs showing all relevant coordination.
- Automatic identification of primary and back up relay pairs.
- Provision for user defined back up relays for specific primary relays.
- Solution for multiple island networks.
- Multiple study cases for different network and source configurations in a single execution of the program.
- Built in libraries of commercial relays, IEEE and IEC characteristics.

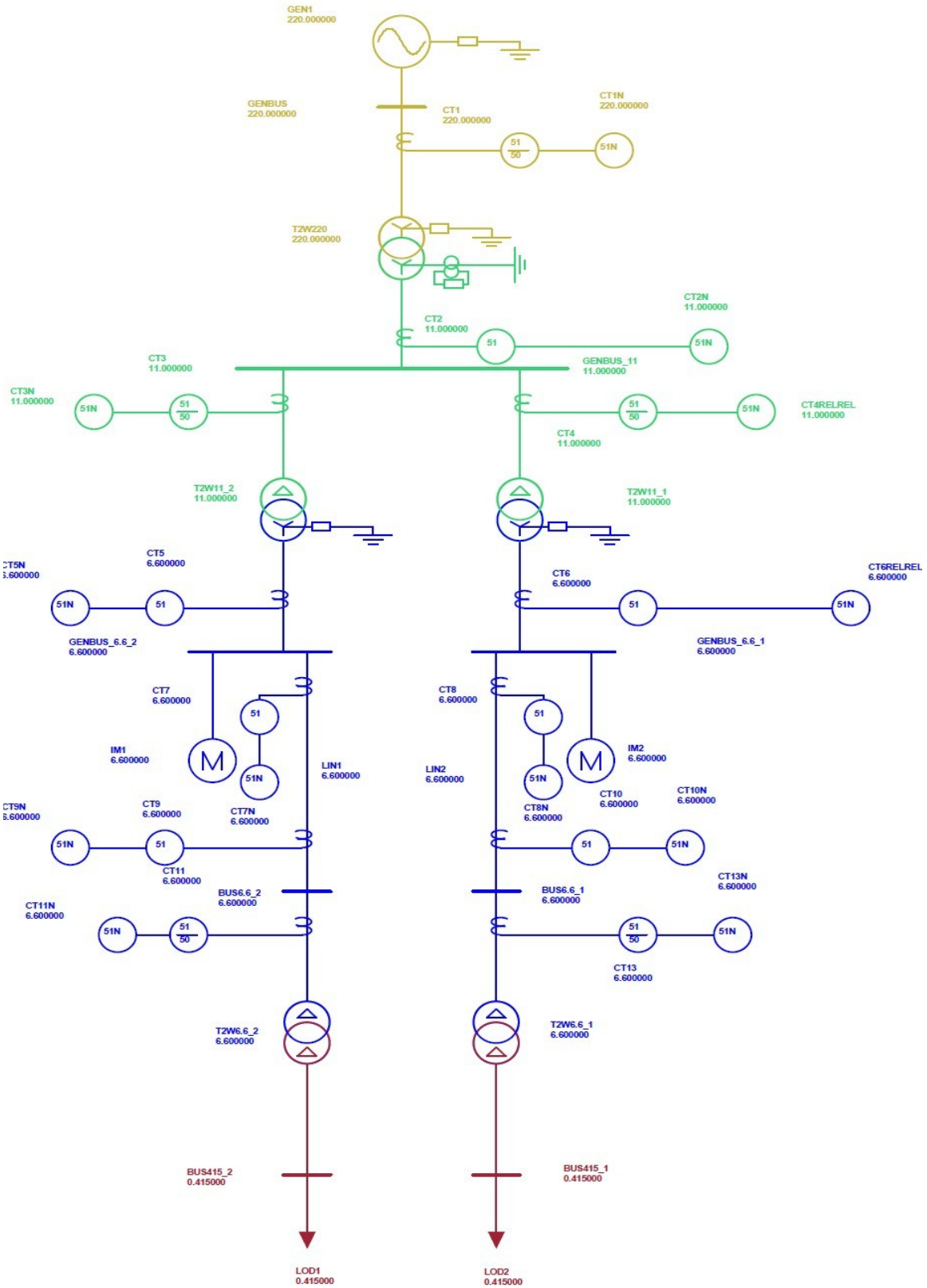


Figure-10 PowerApps Relay Co-ordination

3.6 Motor Starting Studies

Motor starting studies can help in the selection of best method of starting, the proper motor design, and the proper system design for minimizing the impact of the motor starting.

Analysis of motor starting methods can be performed by both static and dynamic simulation techniques as follows. These techniques have their own conveniences, advantages and drawbacks. We believe mainly in transient (dynamic) motor starting studies that reproduce observed (measured) motor starting conditions.

- Load flow type solution with the perceived starting impedance of the motor modeled as part of network modeling
- Short circuit method type of calculations considering pre-fault short circuit conditions and using voltage drop calculations considering motor starting currents. Alternatively
- Where accurate dynamic model of the motor electric circuit and load torque characteristics are available, dynamic model of the motor can be used in traditional transient stability algorithm to assess the impact of the motor starting.

In the absence of accurate model information, transient stability studies can be used where the observed (measured) starting current can be used as nodal injection at the motor bus as a dynamic event and the system response to this dynamic event can be evaluated.

The various methods described above can take into account all types of motor starting such as

- Direct on line
- With compensation
- Auto transformers
- Soft Starters
- Start Delta Start
- Performance curves supplied from manufacturer
- Variable frequency drives

3.7 Harmonic Measurements and Filter Design (optional)

Harmonics in power systems can result in undesirable influence such as Capacitor heating/failure, Telephone interference, Rotating equipment heating, Relay misoperation, Transformer heating, Switchgear failure, Fuse blowing. The main sources of harmonics in power system are static power converters, arc furnaces, discharge lighting and any other load that requires non-sinusoidal current. In order to limit the harmonic current propagation in to the network, harmonic filters are placed close to the source of the harmonic currents. Harmonic filters provide low impedance paths to harmonic currents and thus prevent them from flowing into the power network. Harmonic analysis program computes indices such as total voltage harmonic distortion factor at system buses to evaluate the effect of the harmonic sources and to evaluate the effectiveness of the harmonic filters. Also, driving point impedance plots of the buses of interest are generated to identify whether series or parallel resonance phenomenon occurs at any harmonic frequency of interest.

3.7.1 General Features of Harmonic Measurements, Filter Design and Analysis

- Distortion Factor Calculations as per IEEE 519 Standard.
- Impedance Frequency Scans to identify parallel and series resonance points and bus locations.
- Modeling of harmonic sources and filters.
- Modeling of all electric circuits as function of frequency.
- Analysis using design data or Field measurements.
- Analysis for various network configurations, fault levels.
- Simultaneous solution of multiple islanded network.
- Single execution and report generation for multiple study cases.
- Calculation of harmonic current flows in specified circuit elements.
- Display of computed harmonic distortion factors, harmonic bus voltages, harmonic currents on single line diagram for all study cases.
- Evaluation of adequacy of filter design.
- Design of filters considering the harmonic currents to be filtered and reactive power compensation needed at fundamental frequency.
- Field measurements of power flows, harmonics and reports on the same.

Harmonic Analysis

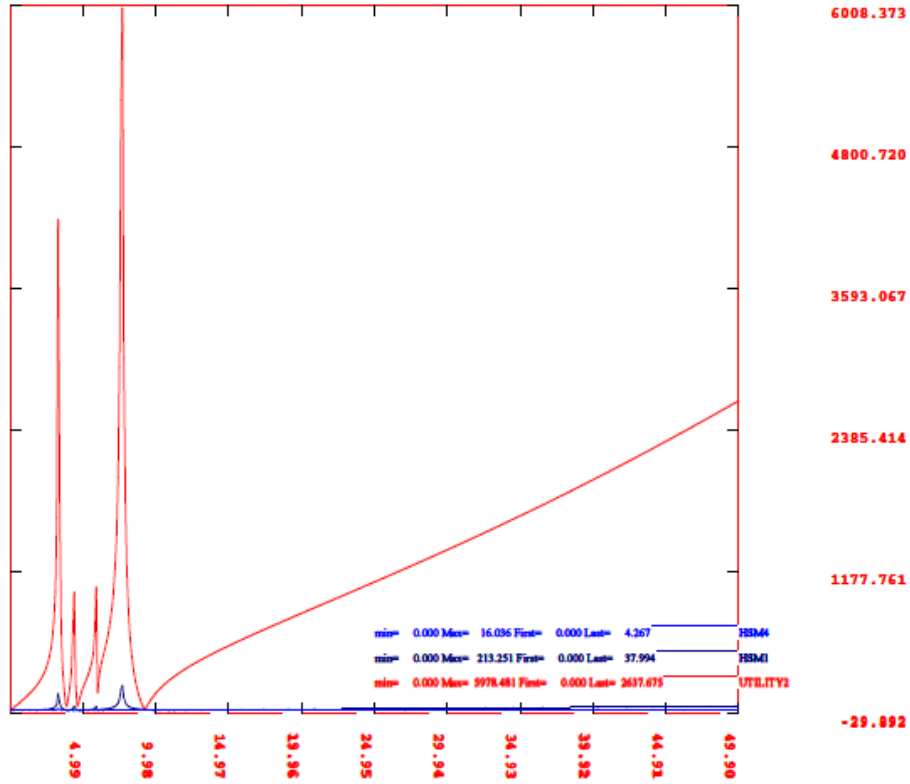


Figure-11 PowerApps Harmonic analysis Plot

4 List of Annexure

The following documents are enclosed as part of this technical proposal.

1. PowerApps Brochure
2. Validation Documents of PowerApps software
3. Certificates of Satisfactory Performance