

ETAP[®]

PowerStation[®] 4.0

User Guide

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Chapter 16

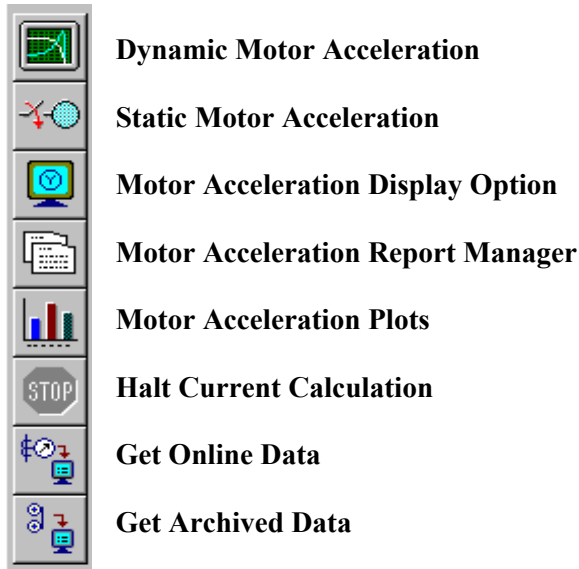
Motor Starting Analysis

During the motor starting period, the starting motor appears to the system as a small impedance connected to a bus. It draws a large current from the system, about six times the motor rated current, which therefore results in voltage drops in the system and poses disturbances to the normal operation of other system loads. Since the motor acceleration torque is dependent on motor terminal voltage, in some cases the starting motor may not be able to reach its rated speed due to extremely low terminal voltage. This makes it necessary to perform a motor starting analysis. The purpose of performing a motor starting study is twofold: to investigate whether the starting motor can be successfully started under the operating conditions, and to see if starting the motor will seriously impede the normal operation of other loads in the system.

PowerStation provides two types of motor starting calculations: Dynamic Motor Acceleration and Static Motor Starting. In the Dynamic Motor Acceleration calculation, the starting motors are represented by dynamic models and the program simulates the entire process of motor acceleration. This method can be used to determine if a motor can be started and how much time is needed for the motor to reach its rated speed, as well as to determine the effect of voltage dips on the system. In Static Motor Starting, the starting motors are modeled by the locked-rotor impedance during acceleration time, simulating the worst impact on normal operating loads. This method is suitable for checking the effect of motor starting on the system when the dynamic model is not available for starting motors.

The Motor Starting Toolbar section explains how to launch a motor starting calculation, to open and view an output report, or to select display options. The Motor Starting Study Case Editor section explains how you can create a new study case, what parameters are required to specify a study case, and how to set them. The Display Options section explains available options for displaying some key system parameters and the output results on the one-line diagram and how to set them. The Motor Starting Calculation Methods section describes calculation methods used by the program. The Required Data for Calculations section describes what data are necessary to perform motor starting studies and where to enter them. Finally, the last three sections describe how to view calculation results.

16.1 Motor Starting Toolbar



Dynamic Motor Acceleration

Click on this icon to perform a time-domain simulation for starting and/or switching off motors and static loads. For this study, accelerating motors are modeled dynamically; therefore, related motor parameters such as dynamic model (or LR model for synchronous motors), inertia, and starting load must be specified. Motors (induction and synchronous) and static loads can be switched off and on in any one of the 15 time events.

Static Motor Acceleration

Click on this icon to perform a time-domain simulation for starting and/or switching off motors and static loads. For this study, starting motors are modeled as constant impedance loads calculated from their locked-rotor currents with a user-defined acceleration time. Required parameters for this study include the locked-rotor current and power factor, acceleration time at no-load and full-load, and starting load.

Motors (induction and synchronous) and static loads can be switched off and on in any one of the 15 time events.

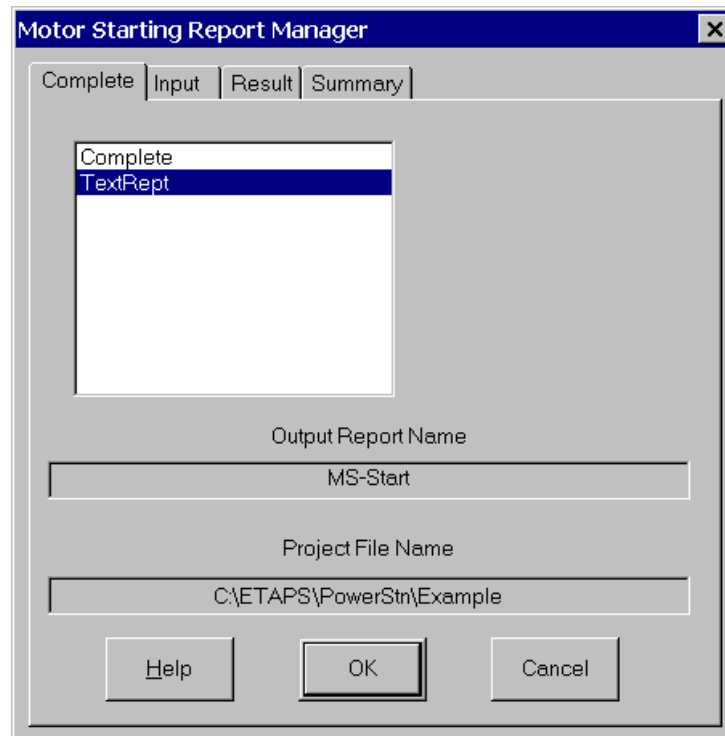
Display Option

Click on this icon to customize the information and results annotations displayed on the one-line diagram in Motor Starting mode.

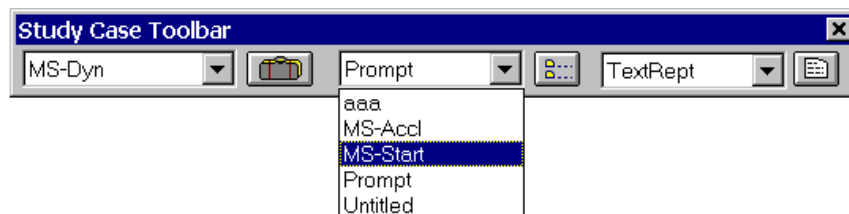
Motor Acceleration Report Manager

Motor acceleration output reports are provided in two forms: ASCII text files and Crystal Reports. The Report Manager provides four pages (Complete, Input, Result, and Summary) for viewing the different parts of the output report for both text and Crystal Reports. Available formats for Crystal Reports are displayed in each page of the Report Manager for motor starting (dynamic & static) studies.

The Crystal Reports is activated by choosing, in the Report Manager, any formats other than TextRept. You can open the whole study output report or only a part of it, depending on the format selection.



You can also view output reports by clicking on the View Output Report button on the Study Case Toolbar. A list of all output files in the selected project directory is provided for motor starting calculations. To view any of the listed output reports, click on the output report name, and then click on the View Output Report button.



Motor starting text output reports (with an **.msr** extension) can be viewed by any word processor such as Notepad, WordPad, and Microsoft Word. Currently, by default, the output reports are viewed by Notepad. You can change the default viewer in the ETAPS.INI file to the viewer of your preference (refer to Chapter 1).

The text output reports are 132 characters wide with 66 lines per page. For the correct formatting and pagination of output reports, you **MUST** modify the default settings of your word processor application. For Notepad, WordPad, and Microsoft Word applications we have recommend settings that are explained in the Printing & Plotting section.

Motor Acceleration Plots

To view plots of accelerated motors, click on this icon to bring up a dialog box to select motors from a drop-down list.

Halt Current Calculation

The Stop Sign button is normally disabled. When a motor acceleration calculation has been initiated, this button becomes enabled and shows a red stop sign. Clicking on this button will terminate the current calculation. One-line diagram display will not be available if you terminate the calculation before it completes; but the text output report and plots do store the calculation results up to the time instant when you terminates the calculation.

Get Online Data

If the ETAP key installed on your computer has the online feature (PSMS), you can copy the online (real-time) data to the current presentation.

Get Archived Data

If the ETAP key installed on your computer has the online feature (PSMS), you can copy the archived data to the current presentation.

16.2 Study Case Editor

The Motor Starting Study Case Editor contains solution control variables, pre-start loading conditions, motor starting events, and a variety of options for output reports. The study case is used for both dynamic and static motor acceleration studies.

PowerStation allows you to create and save an unlimited number of study cases. Motor starting calculations are conducted and reported in accordance with the settings of the study case selected in the toolbar. You can easily switch between study cases without resetting the options each time. This feature is designed to organize your study efforts and save you time.

As part of the multi-dimensional database concept of PowerStation, study cases can be used for any combination of the three major system toolbar components, i.e., for any configuration status, one-line diagram presentation, and Base/Revision Data.

The Motor Starting Study Case Editor can be accessed by first selecting the Motor Starting Analysis Mode from the Status/Mode toolbar, then clicking on the Study Case button from the Motor Starting Toolbar. You can also access this editor from the Project View by clicking on the Motor Starting Study Case folder.

To create a new study case, go to the Project View, right-click on the Motor Starting Study Case folder, and select Create New. The program will then create a new study case, which is a copy of the default study case, and adds it to the Motor Starting Study Case folder.

16.2.1 Info Page

Study Case ID

Study case ID is shown in this entry field. You can rename a study case by simply deleting the old ID and entering the new ID. Study case ID can be up to 12 alphanumeric characters. Use the Navigator button at the bottom of the editor to go from one study case to the next existing study case.

Solution Parameters

This option allows you to choose solution control values for the load flow and motor starting solutions as well as the plot resolution.

Maximum Iteration

This value determines the maximum number of iterations PowerStation can make while solving the load flow equations. This means that the load flow should quit if it has not converged after the number of iterations you specify here. Since dynamic and static motor starting calculation methods use the Newton-Raphson algorithm, typical systems are solved within two to three iterations. We recommend choosing a minimum of five iterations. If the solution does not converge, you may want to increase this number, as well as decrease the value you have specified for precision.

Solution Precision

The load flow algorithm works by an iterating procedure until the motor loads it calculates for each bus match the motor loads which are scheduled for each bus. The difference is called system mismatch. Solution Precision tells PowerStation how many mismatches is allowed for a solution to be considered valid. When the mismatch for the motor MW and Mvar on each individual bus is below the value you enter for precision, PowerStation halts the load flow solution and declares that the solution has converged. Try using a value of 0.001 to begin with. If your system will not converge, try increasing this value to 0.005, etc.

Simulation Time Step

Enter the simulation time step for motor starting calculations. The recommended simulation time step is 0.001 second. If the simulation time step is too small, accumulation of the round off errors can cause inaccurate results. On the other hand, if this value is too large, calculation results may not capture the dynamic characteristics corresponding to very small time constants of the control equipment or system.

Plot Time Step

This value determines how often PowerStation should record the results of the simulation for plotting. For instance, if you specify 20 steps, PowerStation will plot points at every 20 X simulation time step, i.e. for a simulation time step of 0.001; plot time step will be .02 seconds. The smaller this number is, the smoother your plots will look, but also remember that the plot files on your hard disk may grow quite large. The main thing to keep in mind is that PowerStation records plot information at this interval throughout the simulation. So if you specified a simulation time step of 0.001 seconds, plot time step of 10, and a total time of 20 seconds, PowerStation will write $20 / (0.001 * 10) = 2000$ points to disk, which is a very large plot file.

Total Simulation Time

Total Simulation Time is the amount of time, in seconds, which you want the simulation to run. For instance, let's say you set up the following scenario:

t1 = 0.00 Nothing happens during this time event
t2 = 0.10 Start motor Mtr10 and switch on static load Stat2 on bus 20
t3 = 0.20 Switch off Mtr8 on bus 10

Total Simulation Time = 2.00

This simulation will go as follows: at time t1 = 0, PowerStation will run a load flow, using the pre-start loading you selected, to find the initial conditions of the system. At time t2 = 0.1 seconds, PowerStation will begin accelerating motor Mtr10 and switch on static load Stat2 on bus 20. At time t3 = 0.2 seconds, PowerStation will switch off the motor Mtr8 on bus 10. The simulation will continue for 1.8 more seconds, until time T = 2.0 seconds, when the simulation ends and the plots and summary reports are generated. As you can see, the total time MUST be greater than your last event time.

Apply XFMR Phase-Shift

Check this box to consider transformer phase-shift in load flow calculations. The phase-shift of a transformer can be found from the transformer editor.

Prestart Loading

This option allows you to specify how the system is loaded prior to starting any motors and/or switching on any static loads. You can select pre-starting loads by loading categories or from operating load.

Loading Category

Select one of the ten loading categories for pre-start loading in the motor starting study case. With the selection of any category, PowerStation uses the percent loading of all motors and other loads as specified for that category. Note that you can assign loading to each one of the ten categories from the Nameplate page of the Motor Editors and the Loading page of the Static Load Editors.

Operating Load

This check box shows up only if the key you used to run ETAP PowerStation has the online capability. When this box is checked, the operating load will be used as the pre-start load instead of the loading category.

Load Diversity Factor

This section allows you to specify load diversity factors to be applied on the loading category load. When the Operating Load is selected, no diversity factor is considered.

None

Select this option to use the percent loading of each load as entered for the selected Loading Category.

Bus Maximum

When this option is selected, all motors and other loads directly connected to each bus will be multiplied by the bus maximum diversity factor. Using this option, you can simulate load flow studies with each bus having a different maximum diversity factor.

This study option is helpful when the future loading of the electrical system has to be considered and each bus may be loaded at a different maximum value.

Bus Minimum

When this option is selected, all motors and other loads directly connected to each bus will be multiplied by the bus minimum diversity factor. Using this option, you can simulate load flow studies with each bus having a different minimum diversity factor.

Global

Enter the diversity factors for all constant kVA and constant Z loads. When you select this option, PowerStation will globally multiply all motor and static loads of the selected category with the entered motor and static load diversity factors. Using this option, you can simulate motor starting studies with fixed diversity factors for all operating loads.

Note that a motor load-multiplying factor of 125% implies that the motor loads of all buses are increased by 25 percent above their nominal values. This value can be smaller or greater than 100 percent.

Charger Prestart Loading

This section allows you to select the charger loading source.

Loading Category

When this option is selected, the load from the category specified in the Category field will be used to calculate the charger load for the pre-starting load flow.

Operating Load

When this option is selected, the charger operating load will be used for the pre-starting load flow. Note that the charger operating load is updated from DC load flow studies when the Updating Charger Load option has been selected in the DC Load Flow Study Case.

Alert

Motor starting report options include critical and marginal undervoltage and overvoltage buses, and the option for bus voltages to be printed in percent or kV.

Critical Voltage

Select this option and enter the minimum and maximum voltages that any bus may achieve before it is flagged and included in the critical undervoltage and overvoltage bus summary report. The flagged critical undervoltage and overvoltage buses will be displayed in red on the one-line diagram.

Marginal Voltage

Select this option and enter the minimum and maximum voltages that any bus may achieve before it is flagged and included in the marginal undervoltage and overvoltage bus summary report. The flagged critical undervoltage and overvoltage buses will be displayed in magenta on the one-line diagram.

Report**Bus Voltages**

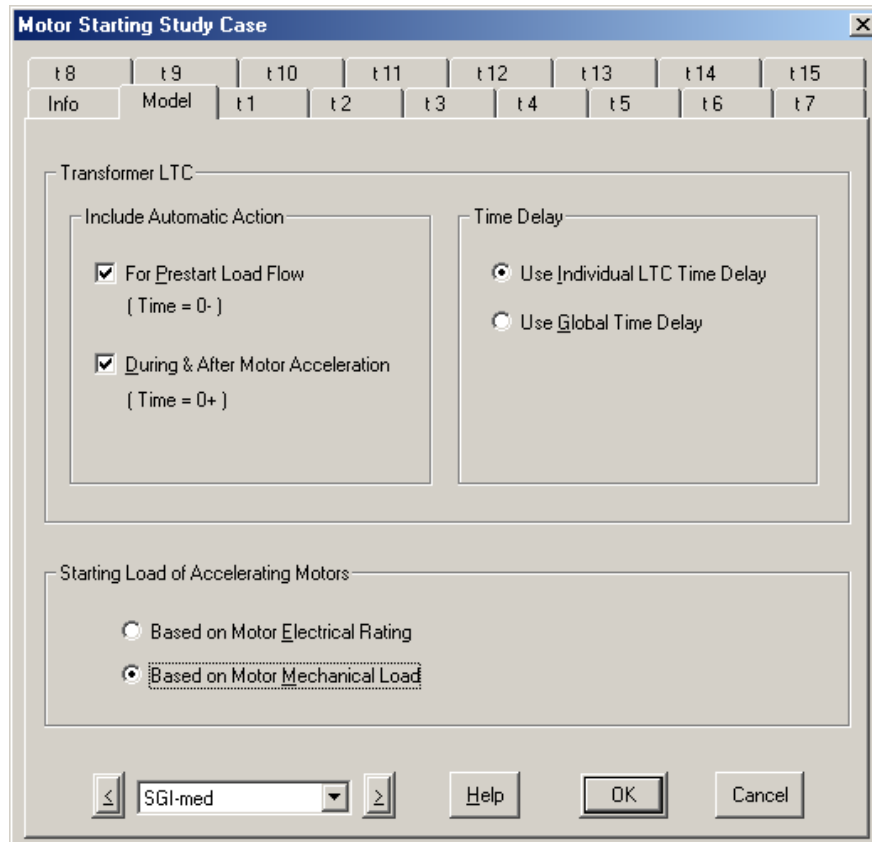
Calculated bus voltages seen in the output report can be printed in kV or as a percentage of the bus nominal voltages. Select your preference by clicking on in Percent or in kV. For graphical display of bus voltages see **Display Options – Motor Starting**.

Remarks 2nd Line

You can enter up to 120 alphanumeric characters in this remark box. Information entered here will be printed on the second line of every output report page header. These remarks can provide specific information regarding each study case. Note that the first line of the header information is global for all study cases and entered in the Project Information Editor.

16.2.2 Model Page

In the Model Page specify model information for transformer LTCs and motor loads.



Transformer LTC – Include Automatic Action

In this section you can specify the transformer LTC feature to be simulated in motor starting studies.

For Prestart Load Flow

If this option is checked, automatic voltage regulation actions and LTCs of transformers, if there are any, will be simulated in the pre-start load flow calculation.

During & After Motor Acceleration

If this option is checked, LTCs of transformers, if there are any, will be simulated in calculations after the pre-start load flow.

Transformer LTC – Time Delay

During motor starting, the program will check the voltages of the LTC regulated buses and set up an internal clock with a time delay. If a voltage is out-of-range and stays out-of-range, at the end of the initial delay time (T_i), the program will check the voltage again and decide whether to reset the clock or initiate an LTC tap adjustment. In the latter case, it will take a time duration equal to the operating time (T_c) to complete the LTC tap change. This process will continue until the final voltage falls within the regulating range or the LTC has reached its limits.

In this section you specify the LTC time delay used in the calculation. The information in this section is applied in the study only when the During & After Motor Acceleration option is checked.

Use Individual LTC Time Delay

If this option is checked, the initial time delay and the operating time entered in the individual transformer editor will be used in the calculation.

Use Global Time Delay

When this option is checked, the values entered in the Initial Time Delay and Operating Time fields will be used in the calculation. This means that all of the LTCs in the system will assume the same initial time delay and operating time.

Initial Time Delay

In this field you can enter the global initial time delay in seconds.

Operating Time

In this field you can enter the operating time in seconds.

Starting Load of Accelerating Motors

In the motor acceleration calculations, the difference between the motor torque and the load torque changes the motor speed. In ETAP PowerStation, the load torque model is specified as torque in percent as a function of normalized motor speed. This load torque may be based on motor electrical rating or on mechanical load. In this section, you indicate to the program which base you want to use.

Based on Motor Electrical Rating

When this option is checked, it is assumed that the load torque model you selected in the Motor Editor only represents the shape of the load as a function of speed. The load torque values will be adjusted so that at the synchronous speed the torque is equal to 100%. This means that, with the modified load curve, the motor will consume the rated electrical power at 100% starting load, under the rated voltage, and at the rated speed.

Based on Motor Mechanical Load

When this option is checked, it is assumed that the load torque model you selected in the Motor Editor represents the actual load based on rated output. The load curve will be applied as it is without any adjustments.

To illustrate the implication of this selection, consider a motor that has a start load of 50%. On the Start Dev page of the motor, the load torque curve is such that at rated speed the load torque is 67%.

Case 1: Load Model Based on Motor Electrical Loading

In this case, the load torque curve will be shifted so that the torque at rated speed is 100% of the motor rated torque. This means that the torque at each point on the load curve will be multiplied by a factor of 1.5 (equal to $1/0.67$). This modified the curve will be used as the load torque curve for the study.

Since the starting load is 50%, the actual load will be 50% of the load based on the modified curve as described above.

Case 2: Load Model Based on Motor Mechanical Load

In this case, the load torque curve will not be shifted because it is assumed to represent the actual load. However, since the starting load is 50%, the load torque curve will be adjusted so that the torque at each point of the curve is multiplied by 0.5.

16.2.3 Time Event Page

PowerStation provides 15 time events to simulate switching actions. Time Event pages t1 to t15 allow you to specify unlimited actions for each time event, i.e., you can start or switch off individual loads or categorized motor groups with the Action by Load and Action by Starting Category features, respectively. You can also change the operating load by clicking on the Load Transitioning option to change from one loading category to another.

Motor Starting Study Case

t8 t9 t10 t11 t12 t13 t14 t15
Info Model t1 t2 t3 t4 t5 t6 t7

Event
Name: Time:

Action by Load

Action	Load ID	St Category	Rating	kV	Bus ID
Switch On	LTG Load	N/A	200 kVA	0.48 kV	MCC1
Start	Pump 1	Design	500 HP	4 kV	Sub3 Swgr

Add Edit Delete

Action by Starting Category

Action	Starting Categories	Bus ID
Start	Normal	Bus3

Add Edit Delete

Action by Load Transitioning

☒ Active ☒ Include MV Loads Below kVA
Loading Category: ☐ Include LV Loads Below kVA

< MS > Help OK Cancel

Each time event (1 to 15) starts at a specific time and must occur in a forward order (e.g., Time Event 4 must occur at a later time than Time Event 3). PowerStation ignores the actions that are out of order from previous time events.

You must enter a value for the total simulation time in the Info page.

You can start or switch off multiple loads by starting category and/or by individual load. Note that the program assumes that all In Service loads are operating, except for the loads that are started or switched off in time events.

If you start an already running load, PowerStation will ignore the second starting action. If you switch off an already switched off load, PowerStation will ignore the second switch off action.

Note that it is possible to specify conflicting actions on a motor during the same time event by using the Action by Starting Category and Action by Load options. In such an event, the program checks the action specified by Action by Load first, and then checks the Action by Category event. The first valid action gets executed in the simulation and the rest are ignored.

Event

Name

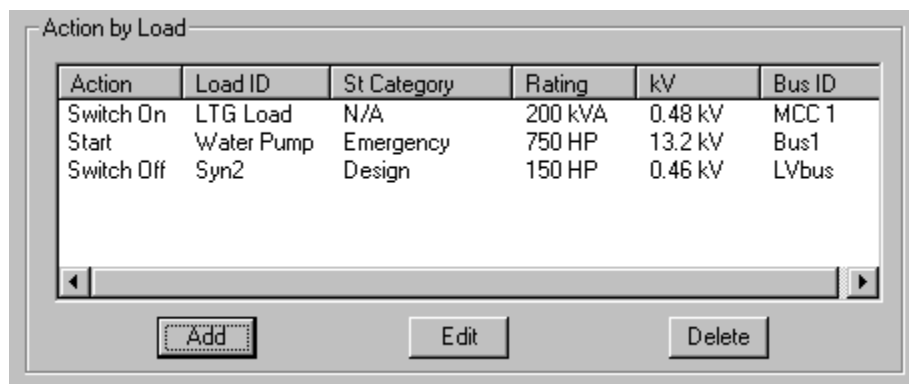
Enter up to 12 alphanumeric characters for the time event ID. This field is for user information only.

Time

Enter the time for each time event in seconds. Each time event must be placed per Time Event page. Time events must occur in a forward order (e.g., Time Event 4 must occur at a later time than Time Event 3). PowerStation ignores the actions of the out of order time events.

Action by Load

This feature allows you to switch on/off any existing motor or static load in a time event. The list of loads that have been selected is displayed in the Action by Load list box.



Add

To add a switching action for a motor, MOV, or static load, click on the Add button to open the Add Action By Load Editor. Select a motor, MOV, or static load and choose Start/Stop or Switch On/Off.

Edit

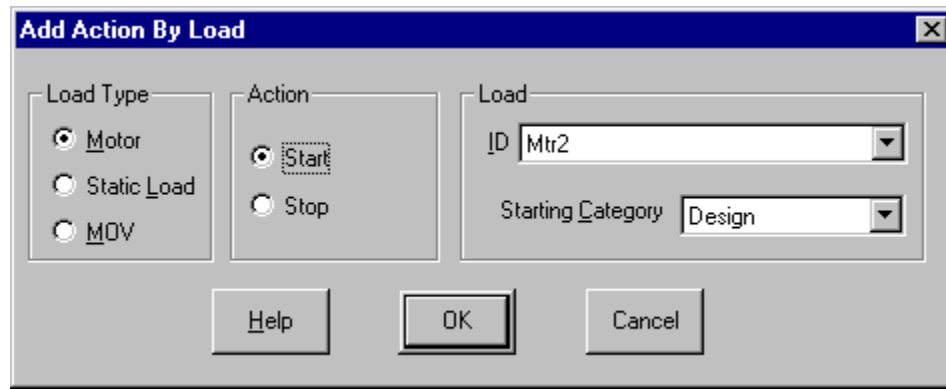
To edit a load, click on its action item and then click on the Edit button. The Edit button opens the Edit Action By Load Editor. This editor allows you to modify the data. For more information see **Add Action By Load**.

Delete

To delete a load from the Action by Load list, select the load by clicking on its action item and then click on the Delete button. The selected load will be removed from the action list.

Add Action by Load

This option allows you to add and/or modify a motor, MOV, or static load specifications, such as start/switch off, starting categories and connected bus IDs. Click on the OK button and the specifications of the selected loads will be displayed in the Action by Load list box.



The screenshot shows a dialog box titled "Add Action By Load". It contains three main sections: "Load Type" with radio buttons for "Motor" (selected), "Static Load", and "MOV"; "Action" with radio buttons for "Start" (selected) and "Stop"; and "Load" with a dropdown menu for "ID" (showing "Mtr2") and a dropdown menu for "Starting Category" (showing "Design"). At the bottom are buttons for "Help", "OK", and "Cancel".

Load Type

Motor Starting studies simulate switching of three types of loads: induction/synchronous motor, static load and capacitor, and MOV.

Action

Select this option to switch/stop motor, switch on/off a static load or a capacitor, or start an MOV. If you start an already running load, PowerStation will ignore the second starting action. If you switch off an already switched off load, PowerStation will ignore the second switch off action. Note that PowerStation assumes that all In Service loads are operating, except for the loads that are started or switched off in time events.

Load

Load ID

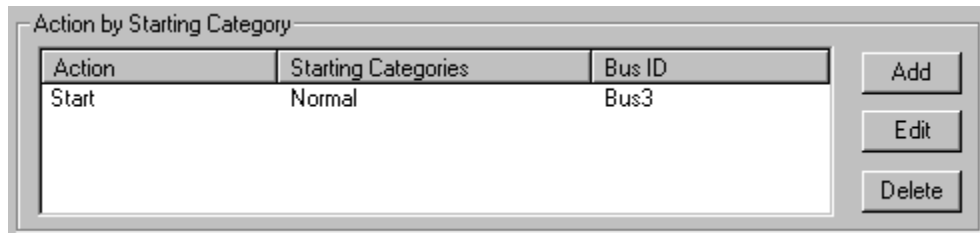
Select a load ID from the list box. The content in this list varies according to load type selected. For motor load, it contains all induction and synchronous motors; for static load, it contains all static loads and capacitors, and for MOV, it contains all the MOVs in the system.

Starting Category

Select a predefined starting category from the list box. This list box contains all ten motor starting categories. Motor starting categories can be defined in the Start Cat page of Induction and Synchronous Motor Editors. Note that the starting category is not applicable to static loads.

Action by Starting Category

This feature allows you to start motors by predefined motor starting categories. Note that motor starting categories can be defined in the Start Cat page of Induction Motor, Synchronous Motor, and MOV Editors. The selected motor groups are displayed in the Action by Starting Category list box.



Add

To start or switch off a predefined group of motors, click on the Add button to open the Add Action By Starting Category Editor. Then select a group of motors and choose Start or Switch Off.

Edit

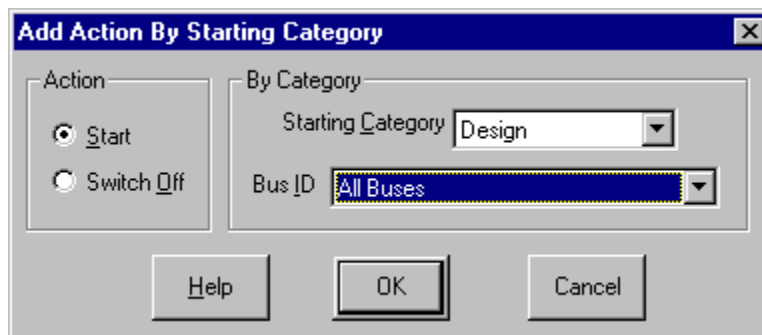
To edit a selected group of motors, click on its action item and then click on the Edit button. The Edit button opens the Add Action By Starting Category Editor. This editor allows you to modify the data.

Delete

To delete a motor group from the Action by Starting Category listing, select the motor group by clicking on its action item, then click on the Delete button. The selected motor group will be removed from the action list.

Add Action by Starting Category

This editor allows you to add and/or modify motor group specifications, such as start/switch off, starting categories, and connected bus IDs. Click on the OK button and the specifications of the motor groups selected in this editor will be displayed in the Action by Starting Category list box.



Action

Select Start/Stop or Switch On/Off for the selected motor group. If you start an already running load, PowerStation will ignore the second starting action. If you switch off an already switched off load, PowerStation will ignore the second switch off action. Note that PowerStation assumes that all In Service loads are operating, except for the loads that are started or switched off in time events.

Starting Category

Category


Select a predefined starting category from the list box. This list box contains all ten motor starting categories. Motor starting categories can be defined in the Start Cat page of Induction and Synchronous Motor Editors.

Bus ID

Select a bus ID to define the motor starting group from the list box. This list box contains all bus IDs created for the electrical system under study. In addition, you can choose Start or Switch Off for all buses defined by a starting category by selecting All Buses from the Bus ID list box.

Action by Load Transition

This feature allows you to change operating load from one loading category to another. In changing the loading category, if a motor load is changed from a zero percent to a non-zero percent load, it will create an action to start the motor. However, once a motor is started by an action from load transition, the Load Transition option will not apply to the motor anymore. Furthermore, once a load, including motors, static loads, and capacitors, has been switched on or off through Action by Load or Action by Starting Category, the Load Transition option will not apply to this load from that point on.



The screenshot shows a dialog box titled "Action by Load Transitioning". It has four main controls: a checked checkbox labeled "Active", a dropdown menu labeled "Loading Category" with "Design" selected, a checked checkbox labeled "Include MV Loads Below" with a text field containing "500" and "kVA" to its right, and an unchecked checkbox labeled "Include LV Loads Below" with a text field containing "0" and "kVA" to its right.

Active

Check this box to flag that a load transition will take place in this event.

Loading Category

Select from the list a loading category as the new loading category, which you want to change to.

Include MV Loads Below

Check this box to enable the kVA field at right. You can enter an upper limit of kVA in the field for medium voltage loads to be involved in the load transition. If this box is not checked, medium voltage loads of all sizes will be considered in the load transition. Loads with rated voltage higher than 1 kV are treated as medium voltage loads.

Include LV Loads Below

Check this box to enable the kVA field at right. You can enter an upper limit of kVA in the field for low voltage loads to be involved in the load transition. If this box is not checked, low voltage loads of all sizes will be considered in the load transition. Loads with rated voltage not higher than 1 kV are treated as low voltage loads.

kVA

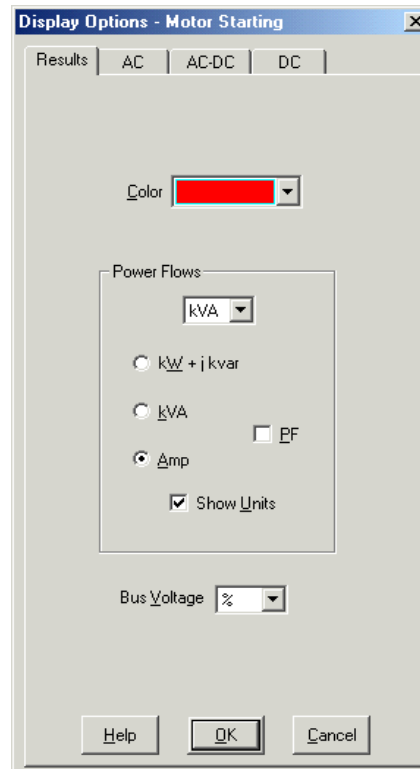
Once enabled, you can enter an upper limit for load capacity rating in this field. Note that a value of zero means that no loads are considered in the Load Transition.

16.3 Display Options

The Motor Starting Analysis Display Options consist of a Results page and three pages for AC, AC-DC, and DC info annotations. Note that the colors and displayed annotations selected for each study are specific to that study.

16.3.1 Results Page

Select the result information to be displayed on the one-line diagram.



Color

Select the color for information annotations to be displayed on the one-line diagram.

Power Flow Units

Select this option to display units for power flow or current flow on the one-line diagram.

kW + j kvar

Click on the kW + j kvar button to display power flow in kW and kvar.

kVA

Click on the kVA button to display power flow in kVA.

Amp

Click on the Amp button to display current flow in amperes.

Power Factor - PF

The PF check box is enabled when the kVA or Amp options are selected.

Bus Voltage

Select a unit for voltage display from the list.

16.3.2 AC Page

This page includes options for displaying info annotations for AC elements.

Color

Select the color for information annotations to be displayed on the one-line diagram.

ID

Select the check boxes under this heading to display the ID of the selected AC elements on the one-line diagram.


Rating

Select the check boxes under this heading to display the ratings of the selected AC elements on the one-line diagram.

Device Type	Rating
Gen. (Generator)	kW / MW
Power Grid (Utility)	MVA _{sc}
Motor	HP / kW
Load	kVA / MVA
Panel	Connection Type (# of Phases - # of Wires)
Transformer	kVA / MVA
Branch, Impedance	Base MVA
Branch, Reactor	Continuous Amps
Cable / Line	# of Cables - # of Conductor / Cable - Size
Bus	kA Bracing
Node	Bus Bracing (kA)
CB	Rated Interrupting (kA)
Fuse	Interrupting (ka)
Relay	50/51 for Overcurrent Relays
PT & CT	Transformer Rated Turn Ratio


kV

Select the check boxes under this heading to display the rated or nominal voltages of the selected elements on the one-line diagram.

For cables/lines, the kV check box is replaced by the  button. Click on this button to display the cable/line conductor type on the one-line diagram.

A

Select the check boxes under this heading to display the ampere ratings (continuous or full-load ampere) of the selected elements on the one-line diagram.

For cables/lines, the Amp check box is replaced by the  button. Click on this button to display the cable/line length on the one-line diagram.

Z

Select the check boxes under this heading to display the rated impedance of the selected AC elements on the one-line diagram.

Device Type	Impedance
Generator	Subtransient reactance X_d''
Power Grid (Utility)	Positive Sequence Impedance in % of 100 MVA ($R + j X$)
Motor	% LRC
Transformer	Positive Sequence Impedance ($R + j X$ per unit length)
Branch, Impedance	Impedance in ohms or %
Branch, Reactor	Impedance in ohms
Cable / Line	Positive Sequence Impedance ($R + j X$ in ohms or per unit length)

D-Y

Select the check boxes under this heading to display the connection types of the selected elements on the one-line diagram. For transformers, the operating tap setting for primary, secondary, and tertiary windings are also displayed. The operating tap setting consists of the fixed taps plus the tap position of the LTC.

Composite Motor

Click on this check box to display the AC composite motor IDs on the one-line diagram, then select the color in which the IDs will be displayed.

Use Default Options

Click on this check box to use PowerStation's default display options.

16.3.3 AC-DC Page

This page includes options for displaying info annotations for AC-DC elements and composite networks.

Color

Select the color for information annotations to be displayed on the one-line diagram.

ID

Select the check boxes under this heading to display the IDs of the selected AC-DC elements on the one-line diagram.

Rating

Select the check boxes under this heading to display the ratings of the selected AC-DC elements on the one-line diagram.

Device Type	Rating
Charger	AC kVA & DC kW (or MVA / MW)
Inverter	DC kW & AC kVA (or MW / MVA)
UPS	kVA
VFD	HP / kW

kV

Click on the check boxes under this heading to display the rated or nominal voltages of the selected elements on the one-line diagram.

A

Click on the check boxes under this heading to display the ampere ratings of the selected elements on the one-line diagram.

Device Type	Amp
Charger	AC FLA & DC FLA
Inverter	DC FLA & AC FLA
UPS	Input, output, & DC FLA

Composite Network

Click on this check box to display the composite network IDs on the one-line diagram, then select the color in which the IDs will be displayed.

Use Default Options

Click on this check box to use PowerStation's default display options.

16.3.4 DC Page

This page includes options for displaying info annotations for DC elements.

Color

Select the color for information annotations to be displayed on the one-line diagram.

ID

Select the check boxes under this heading to display the IDs of the selected DC elements on the one-line diagram.


Rating

Select the check boxes under this heading to display the ratings of the selected DC elements on the one-line diagram.

Device Type	Rating
Battery	Ampere Hour
Motor	HP / kW
Load	kW / MW
Elementary Diagram	kW / MW
Converter	kW / MW
Cable	# of Cables - # of Conductor / Cable - Size


kV

Select the check boxes under this heading to display the rated or nominal voltages of the selected elements on the one-line diagram.

For cables, the kV check box is replaced by the  button. Click on this button to display the conductor type on the one-line diagram.

A

Select the check boxes under this heading to display the ampere ratings of the selected elements on the one-line diagram.

For cables, the Amp check box is replaced by the  button. Click on this button to display the cable length (one way) on the one-line diagram.

Z

Select the check boxes under this heading to display the impedance values of the cables and impedance branches on the one-line diagram.

Composite Motor

Click on this check box to display the DC composite motor IDs on the one-line diagram, then select the color in which the IDs will be displayed.

Use Default Options

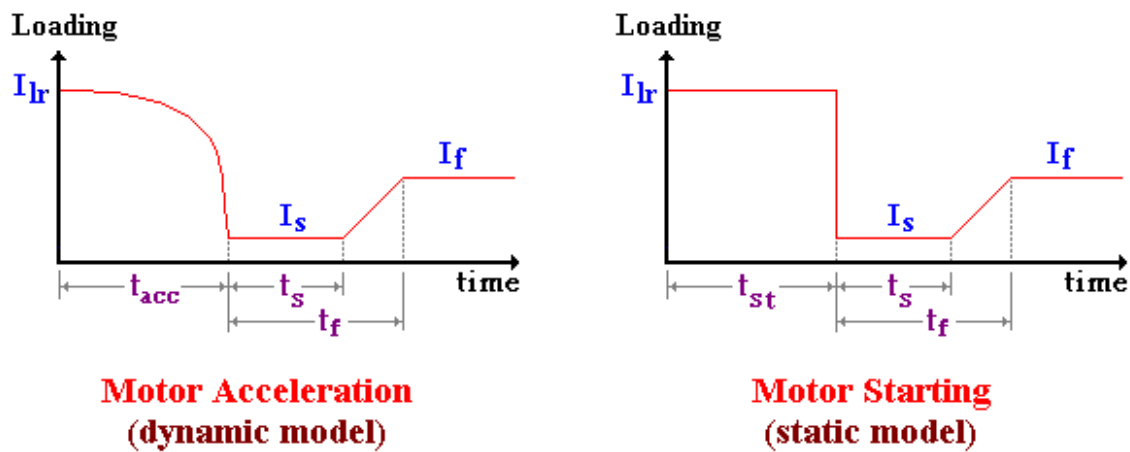
Click on this check box to use PowerStation's default display options.

16.4 Calculation Methods

PowerStation provides two methods for motor starting: Dynamic Motor Acceleration and Static Motor Starting. Both methods perform time-domain simulations and report results in both text report and plot formats.

The purpose of performing a motor starting study is twofold: to investigate whether the starting motor can be successfully started under the operating conditions and to see if starting the motor will seriously impede the normal operation of other loads in the system.

The Dynamic Motor Acceleration and Static Motor Starting differ in the way the starting motors are modeled.



I_{Lr} = Locked Rotor Current (%)	t_{acc} = Acceleration Time (dynamically calculated)
I_s = Starting Load (%)	t_{st} = Starting Time (fixed)
I_f = Final Load (%)	t_s = Beginning of Load Change after acceleration
	t_f = End time for motor Load Change

16.4.1 Dynamic Motor Acceleration

In Dynamic Motor Acceleration, a dynamic model through out the whole simulation models the accelerating motor. For this study, you also need to specify a load torque model for the load that the motor is driving.

From the Model page for induction motor, or the LR Model page for synchronous motor, you can specify motor dynamic model from one of the five different types:

- **Single1** - Equivalent (Thevenin) circuit model with constant rotor resistance and reactance
- **Single2** - Circuit model with deep-bar effect, rotor resistance and reactance change with speed
- **DBL1** - Double cage circuit model, with integrated rotor cages
- **DBL2** - Double cage circuit model, with independent rotor cages
- **TSC** - Torque slip characteristic curve model

While the Single1, Single2, DBL1, and DBL2 models are all based on an electrical circuit representation of the motor, the TSC model allows you to model a starting motor directly from the manufacturer's performance curves. You can choose one of the existing library models or create your own motor model in the **Motor Library**.

PowerStation also allows you to model the load torque curve for each individual motor. You can choose one of the existing library models or create your own motor model in the **Load Library**.

Due to the difference in modeling of starting motors, you may perform the static motor starting study if you are more concerned with the effect of motor starting on other operating loads in the system or if information on dynamic model for the starting motor is not available. On the other hand, if you are concerned with the actual acceleration time or whether the starting motor can be successfully started, a dynamic motor acceleration study should be performed.

16.4.2 Static Motor Starting

In the Static Motor Starting method, it is assumed that the starting motor can always be started. You specify from the **Motor Editor** motor acceleration time at 0% and 100% of the load, and the program interpolates the acceleration time for the motor load based on these two values.

During the acceleration period, the motor is represented by its locked-rotor impedance, which draws the maximum possible current from the system and has the most severe effect on other loads in the system. Once the acceleration period has passed, the starting motor is changed to a constant kVA load and PowerStation simulates the load ramping process according to the starting and final loads specified in the motor editor. Refer to Motor Starting Category page in **Motor Editor** for more information.

16.4.3 Load Transition

In an event, you can specify a load transition to transfer system operating load from one loading category to another. This allows you to globally adjust the system load during motor starting studies. You may apply a load transition to all operating loads or to a group of loads by setting an upper limit of capacity on loads to be involved in the load transition. Additionally, you can start motors through load transition if the load percent is changed from zero to a non-zero value.

Due to the complexity involved in the interaction between normal motor starting actions and load transition, the following rules are implemented to resolve conflicts in motor starting action preparation.

1. If, in an event, both action by load or starting category and action by load transition call for change of status or loading of a load, the action by load or starting category takes priority.
2. If a load, whether a motor, an MOV, a static load, or a capacitor, is switched on/off through actions by load or starting category in one event, the load transition will not apply to this load from that point on.
3. If, in a load transition, the load percent of a motor is changed from zero percent to a non-zero value, this motor will be started at the new load percent (non-zero value). And from this point on, the load transition will not apply on this motor any more.
4. In calculating load for a load transition, it takes into consideration the options for load diversity factors entered in the Motor Study Case Editor for pre-start load flow.

16.4.4 MOV Motor Starting

MOVs are specially designed motors that have different operational characteristics from regular motors. Since these motors behave close to constant impedance load during operation, they are modeled as constant impedance load in motor starting calculations.

The operation mode of an MOV may be opening or closing a valve, depending upon its initial status. In order to start an MOV motor, its status has to be either open or closed. If the initial status of an MOV is open, its operation mode will be closed and if the initial status is closed, its operation mode will be open. Both modes involve several stages of operation as defined in the Characteristic section of the Nameplate page in MOV editor. For each stage, the impedance to represent the MOV is calculated based on the current and power factor for the stage and the rated voltage.

Due to infrequent operations of MOV, for one motor starting simulation, a MOV is allowed to start only once.

16.4.5 Motor Starting vs. Transient Stability Studies

The motor starting calculation is intentionally directed to investigate the behavior of a starting motor and its effect on system operations, facilitated by starting devices, etc. The transient stability calculation can also simulate the motor starting process, with emphasis on the dynamic behavior of the whole system under the impact of motor starting. The differences in objectives of the two types of calculation lead to different modeling of system elements, as shown in the following table:

Comparison of System Element Models			
<u>Element</u>	<u>Transient Stability</u>	<u>Dynamic Motor Acceleration</u>	<u>Static Motor Starting</u>
Generators	Dynamically Modeled	Constant Voltage Behind X_d'	Constant Voltage Behind X_d'
Exciter/Governors	Dynamically Modeled	Not Modeled	Not Modeled
Utility Ties	Constant Voltage Behind X''	Constant Voltage Behind X''	Constant Voltage Behind X''
Operating Motors	Modeled Dynamically or Constant kVA	Constant kVA	Constant kVA
Starting Motors	Single1, Single2, DBL1, & DBL2 Models	Single1, Single2, DBL1, DBL2, & TSC Models	Locked-Rotor Z and Power Factor
Starters	Not Modeled	Modeled	Modeled

16.4.6 Other Features of Motor Starting Study

Many features are included in the motor starting study to facilitate system design and analysis, some of which are listed here:

- A static load can be switched on and off repeatedly at any time during a simulation.
- A motor can be started and switched off repeatedly at any time during a simulation.
- The motor switching can be specified by an individual load or by bus and starting category.
- In static motor starting, after the acceleration period is passed, it will be modeled as a constant power load. The load level can vary at a rate specified by the user. Please see the **Motor Starting Category** page for a detailed description on the model for load changes.
- An MOV can be started at any time during the simulation.

16.5 Required Data

Bus Data

Required data for motor starting calculations for buses includes:

- Bus ID
- Nominal kV
- %V and Angle (when Initial Condition is set to use Bus Voltages)
- Load Diversity Factor (if the Loading option is set to use the Maximum or Minimum load)

Branch Data

Branch data is entered into the Branch Editors, i.e., 3-Winding Transformer Editor, 2-Winding Transformer Editor, Transmission Line Editor, Cable Editor, Reactor Editor, and Impedance Editor. Required data for motor starting calculations for branches includes:

- Branch ID
- Branch Z, R, X, or X/R values and units, tolerance, and temperatures, if applicable
- Cable and transmission line length and unit
- Transformer rated kV and kVA/MVA, tap and LTC settings
- Impedance base kV and base kVA/MVA

Power Grid Data

Required data for motor starting calculations for power grids includes:

- Utility ID
- Mode (Swing, Voltage Control or Mvar Control)
- Rated kV, and short-circuit MVA and power factor
- %V and Vangle

Synchronous Generator Data

Required data for motor starting calculations for synchronous generators includes:

- Synchronous Generator ID
- Mode (Swing, Voltage Control or Mvar Control)
- Rated kW, kV, and power factor
- X_d' and X/R ratio

Synchronous Motor Data

Required data for motor starting calculations for synchronous motors includes:

- Synchronous Motor ID
- Rated kW/hp and kV
- Power factors and efficiencies at 100%, 75%, and 50% loading for operating motors
- Loading Category IDs and % Loading for operating motors
- Equipment cable data

Induction Motor Data

Required data for motor starting calculations for induction motors includes:

- Induction Motor ID
- Rated kW/hp and kV
- Power factors and efficiencies at 100%, 75%, and 50% loading
- Loading Category ID and % Loading
- Equipment cable data

Static Load Data

Required data for motor starting calculation for static loads includes:

- Static Load ID
- Rated kVA/MVA and kV
- Power factors at 100%, 75%, and 50% loading
- Loading Category ID and % Loading
- Equipment cable data

MOV Data

Required data for motor starting calculation for MOV includes:

- MOV ID
- Rated kW/hp and kV
- Current, PF, and time for each operation stage
- Equipment cable data

Capacitor Data

Required data for motor starting calculation for capacitor includes:

- Capacitor ID
- Rated kV, kvar/bank and number of banks
- Loading category ID and % Loading
- Equipment cable data

Lumped Load Data

Required data for motor starting calculation for lumped load includes:

- Load ID
- Rated kV, MVA, power factor, and % for motor load
- Loading category ID and % Loading

Additional Data for Starting Motors

For Static Motor Starting studies, the additional data includes:

- Motor locked-rotor impedance and power factor
- Motor acceleration time at no load and full load
- Start and final percent loading and begin and end of load change time
- Starting device data when needed
- No load and full load accelerated time (for static motor starting)

For Dynamic Motor Acceleration studies, the additional data includes:

- Dynamic motor model for induction motors
- LR model for synchronous motors
- Load torque model
- Motor inertia

Study Case Data

There are some study case related data, which must also be provided. This data includes:

- Study Case ID
- Maximum number of iteration
- Precision of solution
- Total simulation time, simulation time step, and plot time step
- Prestart loading (loading category)
- Initial Condition
- Transformer LTC data
- Report (report format)

The study case related data is entered into the Motor Starting Study Case Editor.

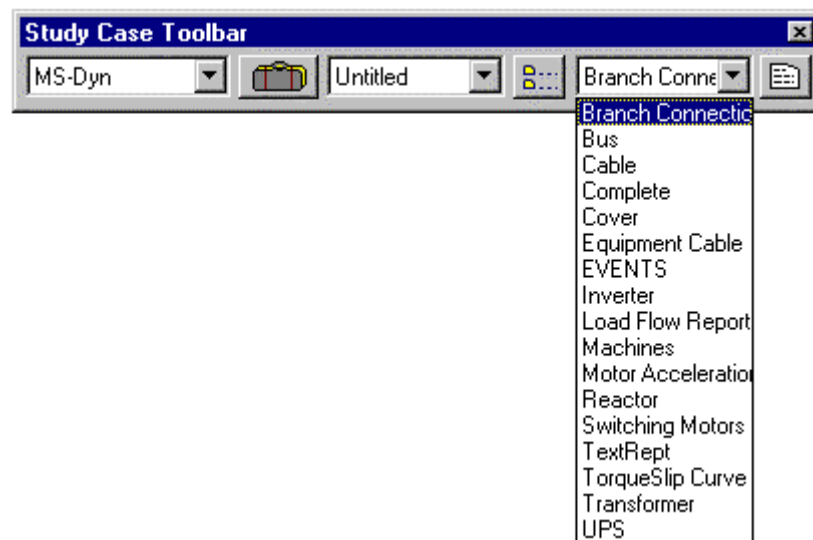
16.6 Output Reports

The motor starting calculation results are reported in four different formats: a text output report, Crystal Reports, a one-line view display, and plots. You can use the Display Options Editor to specify the content to be displayed.

The Crystal Reports format provides you with detailed information for a motor acceleration analysis. You can utilize the Report Manager to help you view the output report.

16.6.1 View Output Reports From Study Case Toolbar

This is a shortcut for the Report Manager. When you click on the View Output Report button, PowerStation automatically opens the output report, which is listed in the Study Case Toolbar with the selected format. In the picture shown below, the output report name is Untitled and the selected format is Complete.



16.6.2 Motor Starting Report Manager

To open the Report Manager, simply click on the View Report Manager button on the Motor Acceleration Toolbar. The editor includes four pages (Complete, Input, Result, and Summary) representing different sections of the output report. The Report Manager allows you to select formats available for different portions of the report and view it via Crystal Reports. There are several fields and buttons common to every page, as described below.

Output Report Name

This field displays the name of the output report you want to view.

Project File Name

This field displays the name of the project file based on which report was generated, along with the directory where the project file is located.

Help

Click on this button to access Help.

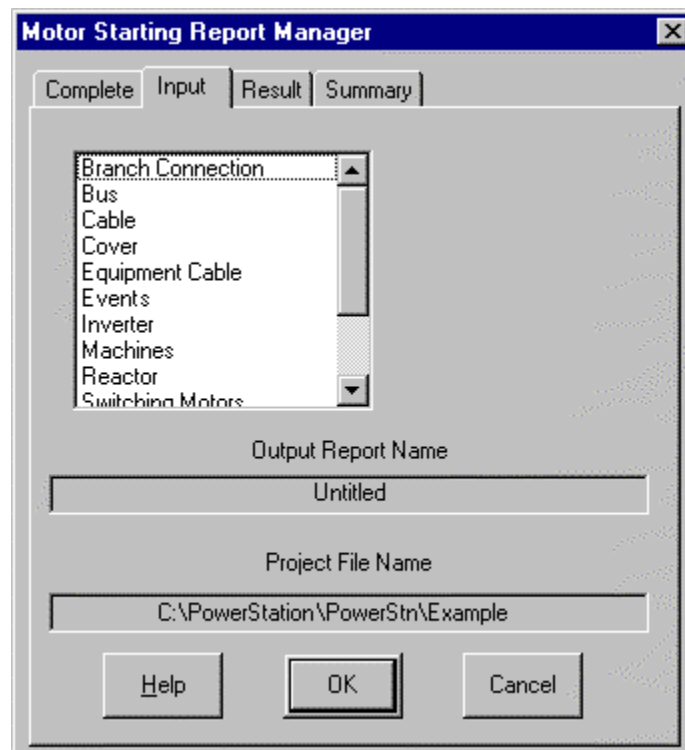
OK / Cancel

Click on the OK button to dismiss the editor and bring up the Crystal Reports view to show the selected portion of the output report. If no selection is made, it will simply dismiss the editor. Click on the Cancel button to dismiss the editor without viewing the report.

16.6.3 Input Data Page

This page allows you to select different formats for viewing input data, grouped according to type. They include:

- Branch
- Bus
- Cable
- Cover
- Equipment Cable
- Events
- Inverter
- Machines
- Reactor
- Switching Motors
- Torque Slip curve
- Transformer
- UPS



Project:	Example	ETAP PowerStation	Page:	1
Location:	Lake Forest, California	4.0.0C	Date:	12-17-2001
Contract:	OTI-12345678		SN:	850TI30125
Engineer:	Operation Technology, Inc.	Study Case: MS-Dyn	Revision:	Base
Filename:	EXAMPLE		Config:	Normal

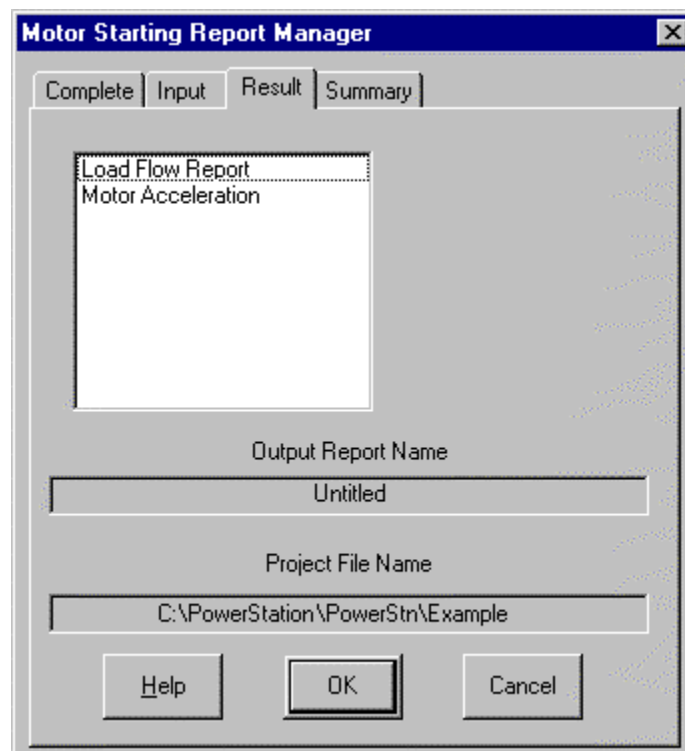
This info is printed on top of every output report, 1st remark line. (120 characters)
 Second line of remarks for "MS Dyn" study case.

BRANCH CONNECTIONS

CKT/Branch		Connected Bus ID		% Impedance, Pos. Seq., 100 MVAh			
ID	Type	From Bus	To Bus	R	X	Z	Y
T2	2W XFMR	Main Bus	Sub 2A	2.95	67.92	67.98	
T3	2W XFMR	Sub 3 Swgr	LV Bus	48.07	865.33	866.67	
T4	2W XFMR	Sub 3	Bus 1	53.46	379.59	383.33	
T5	2W XFMR	Sub 23	Bus 23A	127.22	736.59	747.50	
T22	2W XFMR	Bus 7	Sub 22	10.67	129.56	130.00	
T23	2W XFMR	Bus 6	Sub 23	10.67	129.56	130.00	
XFMR 3	2W XFMR	Sub 3 Swgr	MCC 1	25.06	701.55	702.00	
T1	3W XFMR	Main Bus	Sub 2B	1.18	47.98	47.99	
	3W XFMR	Main Bus	Sub 3	1.17	48.66	48.68	
	3W XFMR	Sub 2B	Sub 3	324.12	3383.37	3398.86	
Cable 2	Cable	Sub 3	Sub 3 Swgr	4.35	5.71	7.18	
Cable 14	Cable	Bus 1	Bus 2	119.79	82.25	145.31	
Cable 22	Cable	Sub 2A	Bus 7	0.82	0.78	1.13	
Cable 23	Cable	Sub 2B	Bus 6	0.82	0.78	1.13	

16.6.4 Result Page

This page allows you to select formats to view the result portion of the output report.

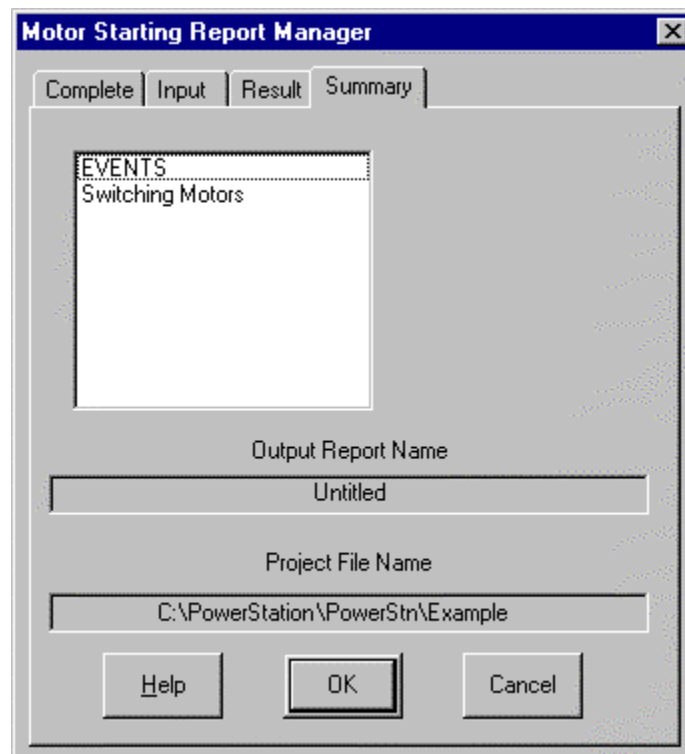


LOAD FLOW REPORT @ T = 0.00-

Bus		Voltage			Generation		Motor Load		Static Load		Load Flow				XFMR	
ID	kV	%Mag.	Ang.	MW	Mvar	MW	Mvar	MW	Mvar	ID	MW	Mvar	Amp	%PF	% Tap	
Bus1	0.480	97.858	-1.9	0	0	0	0	0	0	Bus2	0.65	0.38	927	86.74		
										Sub 3	-0.65	-0.38	927	86.74		
Bus2	0.480	96.742	-2.0	0	0	0.65	0.37	0	0	Bus1	-0.65	-0.37	927	86.79		
Bus6	13.800	99.993	1.6	0	0	0	0	0	0	Sub2B	-0.54	-0.34	27	84.17		
										Sub23	0.54	0.34	27	84.17		
Bus7	13.800	100.080	-2.2	0	0	0	0	0	0	Sub2A	-3.03	-2.04	153	82.93		
										Sub22	3.03	2.04	153	82.93		
Bus23A	0.400	98.907	-0.9	0	0	0.41	0.23	0.12	0.08	Sub23	-0.53	-0.31	898	86.39		
LVBus	0.480	96.208	-4.6	0	0	0.43	0.11	0.36	0.19	Sub3 Swgr	-0.79	-0.31	1057	93.20		
* Main Bus	34.500	100.000	0.0	0	0	0	0	0	0	Sub2A	5.82	3.45	113	86.00	-2.500	
										Utility	-2.22	-4.25	80	46.29		
										Sub2B	-3.60	0.80	62	-97.64		
										Sub 3						

16.6.5 Summary Page

This page allows you to select formats to view summary reports of the output report.



MOTOR STARTING EVENTS

Time Event		Switching Load				% Loading		Load Change Time		Motor Load		Static Load	
Name	Time	ID	Type	Action	St. Category	Start	Final	Begin	End	MW	Mvar	MW	Mvar
Event 1	0.10	Pump 1	Ind. MTR	Switch On	Design	0.0	0.0	0.00	0.00				
		Syn1	Syn. MTR	Switch On	Design	27.0	86.0	0.30	1.00				

16.6.6 Complete Page

In this page there is only one format available, Complete, which brings up the complete report for a motor acceleration study. The complete report includes input data, results, and summary reports.

The image shows a Windows-style dialog box titled "Motor Starting Report Manager". It has four tabs: "Complete", "Input", "Result", and "Summary". The "Complete" tab is selected. Inside the dialog, there is a large text area labeled "Complete TextRept" which is currently empty. Below the text area, there are two input fields: "Output Report Name" with the text "Untitled" and "Project File Name" with the text "C:\PowerStation\PowerStrn\Example". At the bottom of the dialog are three buttons: "Help", "OK", and "Cancel".

Electrical Transient Analyzer ProgramETAP PowerStationMotor Starting Analysis**Dynamic Acceleration**

	<u>Swing</u>	<u>Generator</u>	<u>Load</u>	<u>Total</u>			
Number of Buses:	1	1	12	14			
	<u>XFMR2</u>	<u>XFMR3</u>	<u>Reactor</u>	<u>Line/Cable</u>	<u>Impedance</u>	<u>Tie PD</u>	<u>Total</u>
Number of Branches:	7	1	0	4	0	0	12
	<u>Synchronous Generator</u>	<u>Power Grid</u>	<u>Synchronous Motor</u>	<u>Induction Machines</u>	<u>Total</u>		
Number of Machines:	1	1	1	1	4		
Prestart Loading:	Design Category, Normal Loading						
Method of Solution:	Newton-Raphson						
Max. No. of Iterations:	5						
Precision of Solution:	0.00100 MW and Mvar						
System Frequency:	60						
Unit System :	English						
Project Filename:	EXAMPLE						
Output Filename:	F:\ETAPS 40\PowerStation\Example\MS-Acc1MS1						

16.6.7 Text Report

The output report consists of several sections, as summarized below:

System Input Data

The beginning of the output report prints the system input data that is used in the motor starting study, including bus input data with the operating load connected to each bus, system branch data, branch connection summary, and generator and utility machine data.

Initial Load Flow Report

An initial load flow study is performed with the specified pre-starting load. This load flow calculation is carried out using the Newton-Raphson method. The load flow result is printed for you to inspect system operating conditions.

Switching Motor and Static Load Data

The switching motor and static load data printed include the motor nameplate data, equivalent cable data, and the switching static load data.

For dynamic acceleration studies, the motor dynamic model and load model data are printed in this section.

Switching Event Data

This section of the output report lists, in the sequence of time events, every load-switching action. It provides you with a summary of all the actions that are to be simulated in the study.

Event Load Flow Report

For each specified time event, whether there are switching actions or not, the program will run a load flow calculation and report the result in this section. This feature provides you with a way to inspect system operating conditions at any time during motor starting simulation. The program also runs a load flow at the end of the total simulation time and prints the results in this section.

Tabulated Simulation Results

This section tabulates, for each switching motor, the simulation results as functions of time at the specified plot time step. The tabulated results include motor slip, motor terminal voltage, bus voltage, motor current, and motor real power input.

Sample Text Report

```

Project: Example
Location: Lake Forest, California
Contract: OTI-1234
Engineer: Operation Technology, Inc.

SYSTEM ANALYSIS
=====
PowerStation 4.0.0C
Study Case: MS-Dyn

Page: 1
Date: 05-17-2000
SN: 85OTI30125
File: EXAMPLE
-----

---
This info is printed on top of every output report, 1st remark line. (120 characters)
Second line of remarks for "MS Dyn" study case.

=====
Electrical Transient Analyzer Program
-----

MOTOR STARTING ANALYSIS

Dynamic Acceleration

Number of Buses:      Swing      Gen.      Load      Total
-----
1                    1          8         10

XFRM2  React. Line/Cable  Imp.  Tie PD  XFRM3  Total
-----
Number of Branches:      4          0          3          0          0          1          8

Number of Machines:      1          1
Prestart Loading:          Category 1 (Design ), Normal Loading
Method of Solution:        Newton-Raphson
Maximum Number of Iterations: 5

Precision of the Solution: .00100 MW and Mvar
System Frequency: 60.0 Hz

Unit System: English

Data Filename: EXAMPLE
Output Filename: C:\PowerStation 3.0\PowerStn\Example\Untitled.ms

```

Project: Example	BUS INPUT DATA	Page: 2
Location: Lake Forest, California	PowerStation 4.0.0C	Date: 05-17-2000
Contract: OTI-1234		SN: 85OTI30125
Engineer: Operation Technology, Inc.	Study Case: MS-Dyn	File: EXAMPLE

--- This info is printed on top of every output report, 1st remark line. (120 characters)
 Second line of remarks for "MS Dyn" study case.

Bus Information & Nominal kV				Init. Voltage		Generation		MTR Load @T=0-		Static Load		Mvar Limits	
ID	Type	kV	Description	% Mag.	Ang.	MW	Mvar	MW	Mvar	MW	Mvar	Max.	Min.
Bus1	Load	0.480		100.0	0.0			0.000	0.000	0.000	0.000		
Bus2	Load	0.480		100.0	0.0			0.647	0.370	0.000	0.000		
Bus3	Load	13.800		101.5	-1.2			3.239	1.355	0.000	0.000		
LVBUS	Load	0.480		97.1	-3.5			0.426	0.114	0.391	0.207		
Main Bus	SWNG	34.500		100.0	0.0			0.000	0.000	0.000	0.000		
MCC1	Load	0.480		97.9	-3.1			0.421	0.190	0.000	0.000		
Sub2A	Load	13.800		101.5	-1.2			0.000	0.000	0.000	0.000		
Sub2B	Gen.	13.800		100.0	1.4	6.300	0.000	0.000	0.000	0.000	0.000	4.650	-2.000
Sub 3	Load	4.160		99.8	-0.5			0.000	0.000	0.000	-0.450		
Sub3 Swgr	Load	4.160		99.6	-0.5			0.000	0.000	0.000	0.000		
10 Buses Total						6.300		4.733	2.029	0.391	-0.243		

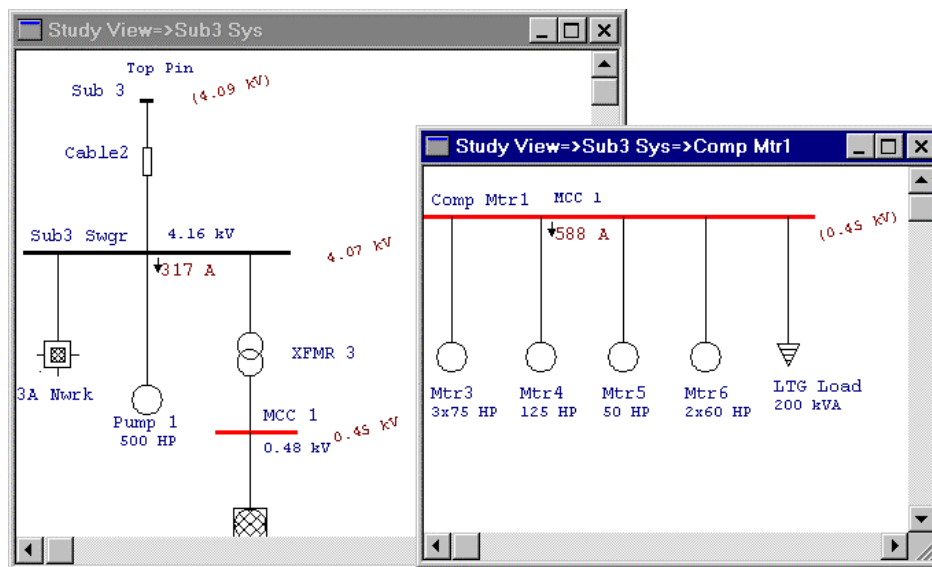
16.7 One-Line Diagram Displayed Results

In addition to the text report, PowerStation displays the calculation results on the one-line diagram. Once a motor starting study is finished, a Motor Starting Display Time ruler, as shown below, will appear in the toolbar. The ruler ranges from zero seconds to the final simulation time. Initially, the reference pointer is at the far left, corresponding to $t = 0$ second. You may click on either end of the ruler to move the pointer one grid at a time, or hold the mouse button down to move the pointer continuously. You may also click on the pointer, hold the mouse button down, and then drag the pointer to the desired position. The time corresponding to the pointer position is also displayed next to the ruler in seconds.



The one-line diagram displays the bus voltages and the current (or kW+jkvar or kVA) of the starting motors for the simulation time specified on the ruler. As you move the pointer along the ruler, the displayed results change accordingly, providing you with a quick way to examine the calculation results.

In the example one-line diagram shown below, the starting motors Pump 1 and Mtr4 are drawing 317 amperes and 588 amperes respectively, while the voltage of bus Sub3 Swgr is 4.07 kV.

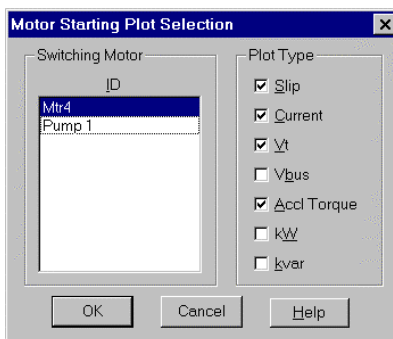


16.8 Plots

PowerStation also provides simulation plots for you to examine calculation results graphically. To view the simulation plots, click on the Motor Acceleration Plots button in the **Motor Starting Toolbar**. It will bring up a Motor Starting Plot Selection diagram, as shown here, where you can specify the motors and types of plots to view.

Motor ID

This list contains IDs of all the starting motors. Click on a motor to view its plots. Clicking again will deselect it. Plots for up to sixteen (16) motors can be displayed on one plot view. If more than sixteen motors have been selected, plots for the first sixteen motors will be displayed.

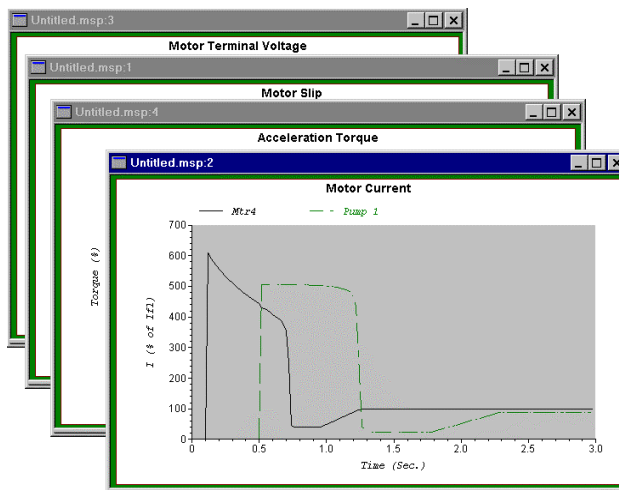


Plot Type

The types of plots available include slip, current, terminal voltage, acceleration torque, real input power, and reactive input power. Clicking on a check box will select/deselect the corresponding plot type.

Clicking on the OK button will open plot views for the selected plot types. PowerStation opens one plot view for each selected plot type to display the type of plots for the selected motors.

The Printing and Plotting Chapter, **Plot View**, describes features that will be helpful in viewing the plot.



Modifying Plot Parameters

Plot parameters such as plot line type, axis, legend, and text can be modified directly from the plot view. For example, to modify plot line type, double-click on the plot line and change the line type from the Plot Parameter Editor.