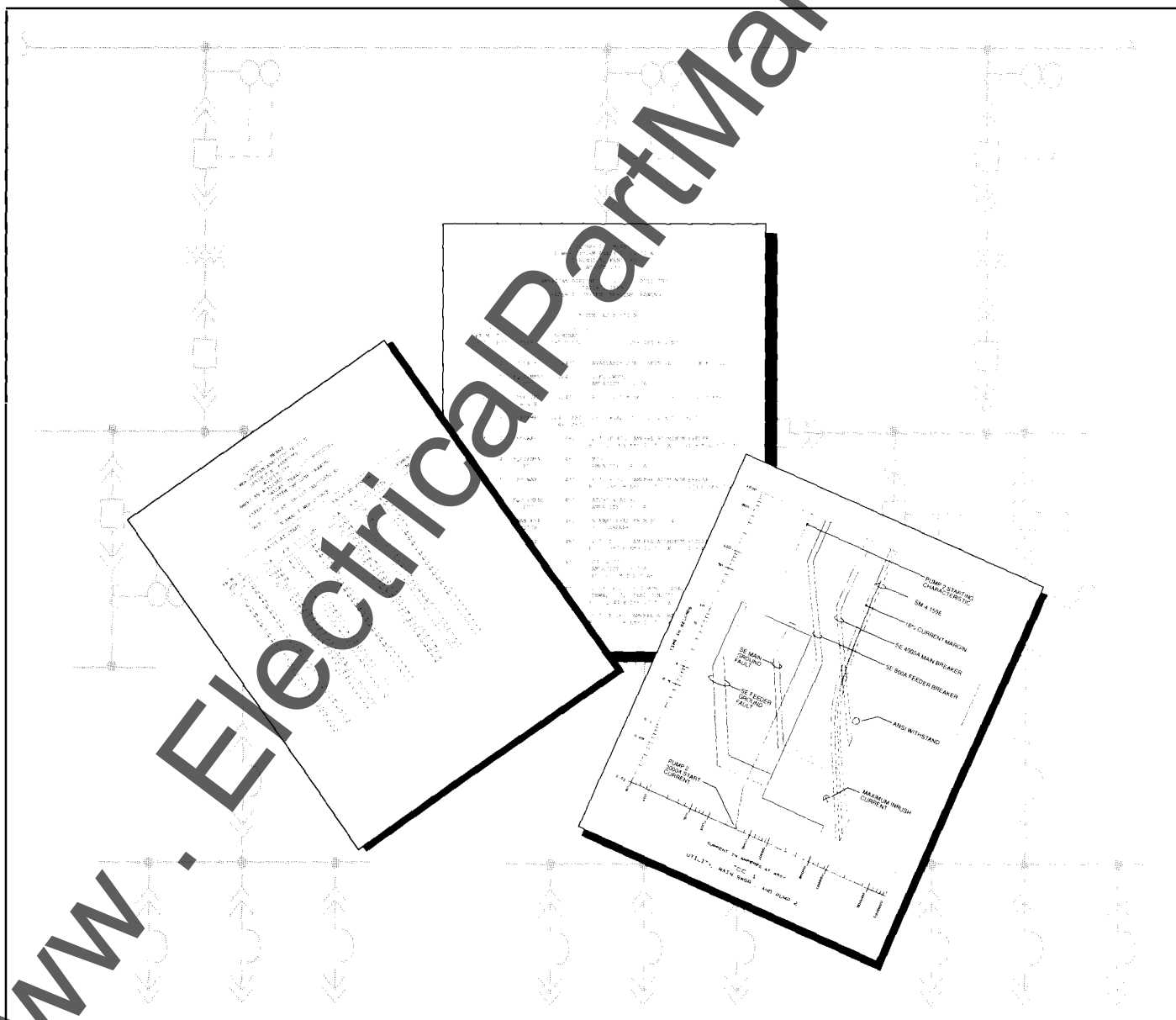


Square D Company Power System Studies



Electrical Power Distribution System - The Heart of the Business

From small commercial office buildings to large industrial manufacturing plants, the electrical power distribution system is the heart of all types of business. It is an extremely complex system which can be highly reliable over many years of continuous and sometimes abusive operation. And in today's competitive climates, it is being viewed as one if not the most integral part of any business. Without it's reliable operation, manufacturing stops, production is lost, and delivery schedules are missed. Adding to the economic loss, is the potential for injury to personnel or even loss of life.

Information From System Studies

The reliability, efficiency, continued operations, safety and other critical aspects of electrical power distribution systems can be maximized through proper system studies. System studies provide comprehensive information about the electrical system under normal and abnormal operating conditions, describe how and where energy is being used, whether protective devices in the system are properly rated and set, the effects of harmonics, potential problem areas and much more. This information enables plant operations and plant engineers to make better, more informed decisions when managing their electrical distribution systems.

Electrical Systems Change

Electric utilities systems constantly undergo change to accommodate larger and more electric customers, switched capacitor banks to reduce line losses, increased generating capacity, connections to other utilities for wheeling of power, and the associated changes to transmission and distribution lines. Industrial and commercial systems frequently undergo similar changes within their own facilities. Often these changes have serious effects on electrical equipment in both new and existing facilities. With increased capacity comes higher and higher short-circuit levels which may exceed equipment ratings placing the equipment and personnel at a higher risk. Adding equipment or modifying the system configuration without consideration of the effects can result in equipment misoperation or failure, unnecessary down time, and other costs effecting the profitability of the business.

Cost Benefits From System Studies

The information provided by system studies helps users identify many cost benefits. Insurance companies sometimes offer reduced premiums for facilities which have had undergone a Short-Circuit Analysis. A Harmonic Analysis identifies equipment exposed to destructive harmonics and provides solutions to increase product life and avoid damage or failure. System studies can provide economic benefits for small and large electrical systems, whether new or existing.

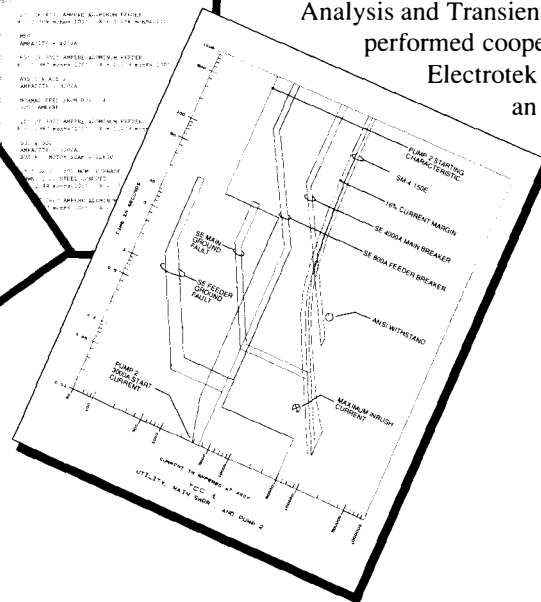
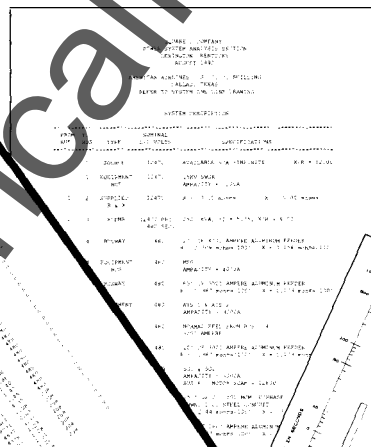
Types of System Studies

Square D offers customers extensive system study services including:

- Short-Circuit Analysis
- Load Flow
- Time-Current Coordination
- Motor Starting / Voltage Drop
- Power Factor Correction Analysis
- Harmonic Analysis
- Transient Analysis
- Others

Each of these studies provides comprehensive information with specific cost benefits to the customer. The Power Factor Correction Analysis, Harmonic Analysis and Transient Analysis are performed cooperatively with

Electrotek Concepts, Inc., an industry leader in the area of industrial power quality analysis.



Short-Circuit Analysis

Square D Power System Engineers perform computer-based short-circuit analyses on all types of industrial and commercial electrical systems by applying appropriate Standards including ANSI, IEEE, NEMA, and UL. A short-circuit analysis from Square D provides owners and plant management personnel with short-circuit levels throughout the electrical system. It discusses the ability of the protective devices, circuit breakers, relays, etc., to respond under short-circuit conditions and indicates whether the equipment can withstand the short-circuit effects. Where underrated equipment or equipment which has been misapplied is identified, a discussion of possible changes is provided to help customers adhere to requirements of the NFPA, NEC, and other electrical industry standards.

Some of the benefits customers can recognize from the results of a short-circuit analysis are:

- Avoid catastrophic failure due to short-circuits
- Reduced system downtime
- Increase equipment life
- Minimize liability from underrated or misapplied equipment
- Reduce or eliminate equipment damage
- Help avoid injury to personnel

Included in Square D's short-circuit analyses are clear tabular listings of system short-circuit levels, computer printouts of input data listing system impedances, tables comparing short-circuit levels to the ratings of the equipment, and a computer generated one-line diagram showing short-circuit levels, system and equipment information, and other important aspects of the distribution system. All Short-Circuit Analyses are presented in easy to understand format and provided in a bound report for the customer.

Protective Device Time-Current Coordination Study

A protective device time-current coordination study, or coordination study, is an evaluation of a system's protective devices, such as relays, fuses and circuit breakers, and the equipment to which they are applied. A coordination study compares the operating levels and times of the protective devices to the withstand levels and times which the equipment can sustain without damage or failure. Its goals are to provide power transformers, switchgear, substations, motor control centers, panelboards, and other electrical equipment with the required protection while selecting appropriate types, ampere ratings, and device settings to insure minimum service interruption under overload and short-circuit conditions.

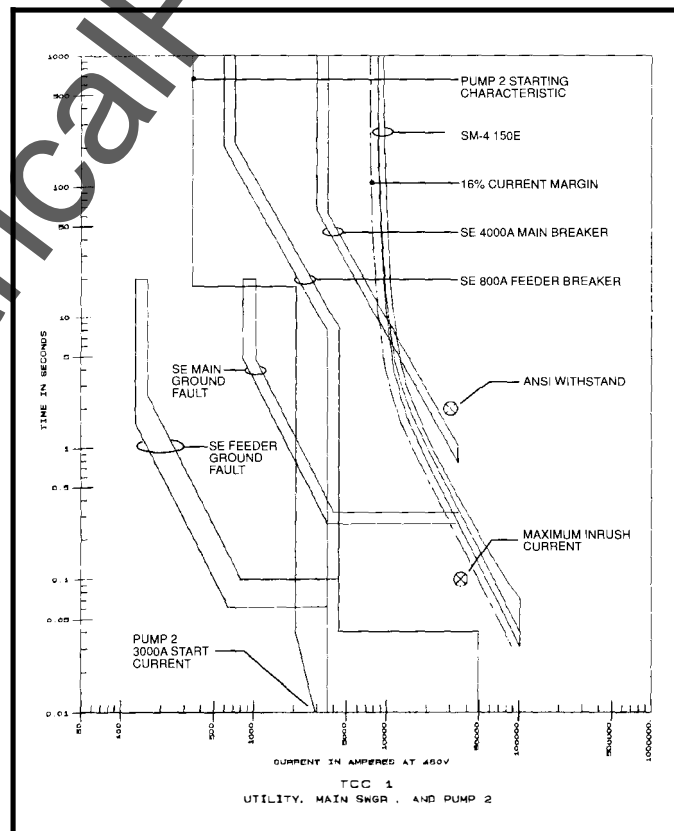
Some of the benefits customers can recognize from the results of a protective

device time-current coordination study are:

- Minimize system downtime and nuisance device operations
- Avoid equipment damage or failure through increased system protection
- Provide settings for all adjustable devices - relay, ground-fault equipment, etc.
- Isolate faulty circuits without loss of power to other parts of the system
- Identify and recommend corrective action for underprotected equipment
- Increase productivity and profitability
- Insure the safety of personnel

A Square D Coordination Study is a comprehensive computer-based analysis which includes clear tabular printouts of the suggested settings for all adjustable devices, composite log-log characteristic curves of the protective devices illustrating the resulting protection and coordination in the system,

a computer generated one-line diagram illustrating devices, equipment, system connections, and short-circuit levels when available. All materials are presented in an easy to understand format and provided in a bound report for the customer.



Load Flow / Voltage Drop Analysis

Square D's Power System Engineers also perform Load Flow / Voltage Drop Analyses for electrical distribution systems. These studies typically examine the incoming utility service down to and including the utilization equipment. This type of system study provides plant engineers and plant facilitators needed information on where, how much, and how efficiently energy is being used throughout the system. It also provides the associated losses, and the resulting voltage levels at the individual distribution buses. Equipped with this information, additions or modifications to the system can be made such that starting a motor, a welder, or other type of electrical apparatus will not result in contactor drop-out, dimming lights, flicker, or other undesirable effects.

Some of the benefits which can be recognized from the results of a Load Flow / Voltage Drop Analysis are:

- System planning and modification is based on information not guesswork
- Reduced flicker
- Identifies problems and recommends solutions

A Square D Load Flow / Voltage Drop Analysis is a comprehensive computer-based analysis which includes clear tabular printouts of the load flows of each circuit in the system, resulting losses, voltage drops for each feeder and voltage level at each distribution bus in the system. Also included is a computer generated one-line diagram identifying equipment and voltage present under the load conditions with the direction and value of power flow. All materials are presented in an easy to understand format and provided in a bound report for the customer.

Power Factor Analysis

Power factor correction capacitors have become a very economical means for many customers to reduce demand charges and power factor penalties. A power factor correction analysis determines the amount of capacitors that are required at each of the distribution buses in the system to achieve the desired power factor level. The power factor characteristics of the plant loads can be

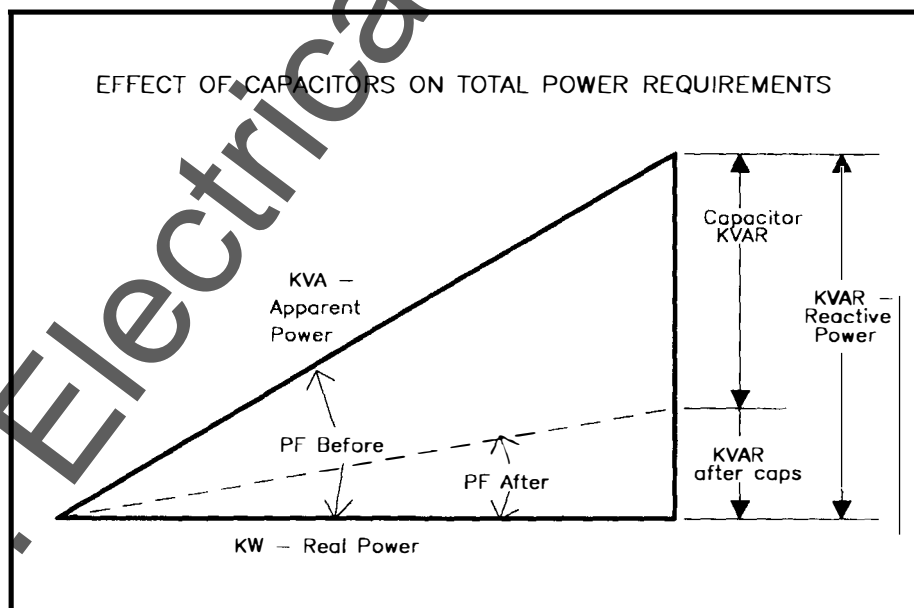
determined from billing information or by site survey as required. Applying appropriate controls, power factor correction can be designed to maintain a desired power factor over a wide range of load variations.

Some of the benefits of a Power Factor Analysis are:

- Reduced demand and demand charges
- Reduction or avoidance of power factor penalties
- Reduced stress on equipment
- Better equipment utilization

Despite the significant benefits which can be realized using power factor correction capacitors, there are two important concerns which should be considered when the capacitors are applied. The first of these concerns is harmonic distortion resulting from nonlinear loads proliferating electrical systems today. The second is the high susceptibility of these capacitors and other devices to transient overvoltages.

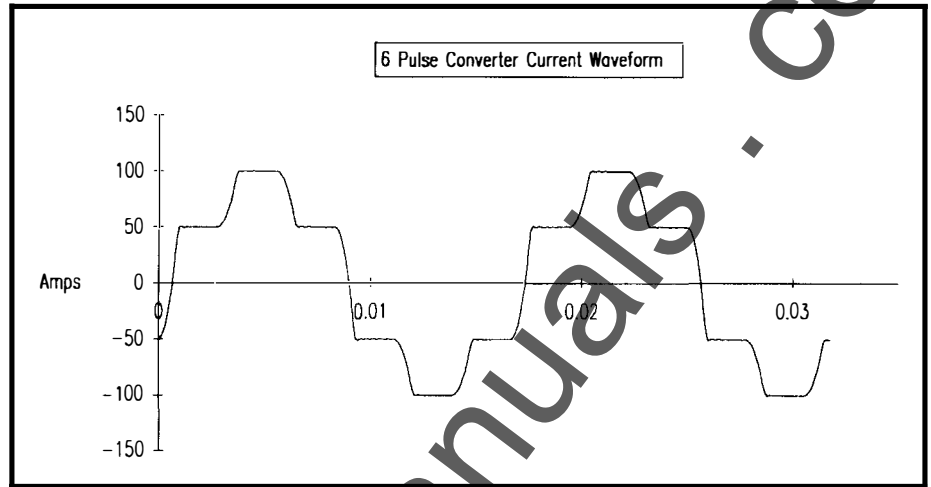
In either case, computer analysis of the specific conditions leading to these problems is available. All materials are presented in an easy to understand format and provided in a bound report for the customer.



Harmonic Analysis

Today many facilities utilize nonlinear or harmonic producing loads including adjustable speed motor drives, solid-state ballast lighting, welding equipment, computers, UPS systems, and others. These harmonic producing devices cause distortion of the voltage and current waveforms which can result in equipment misoperation or failure. To compound the problem, it is common for many installations to utilize shunt power factor correction capacitors to avoid excessive power factor penalties. This combination often results in significant problems including harmonic resonance conditions in which extremely high levels of current and/or voltage appear in the system.

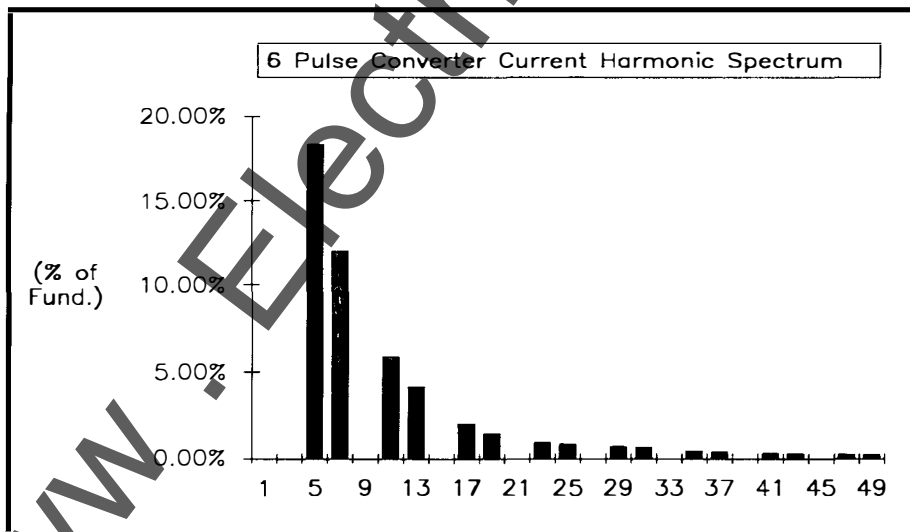
A harmonic analysis determines harmonic current flow and voltage distortion levels throughout the electrical distribution system. The analysis is made utilizing a digital computer programmed to accept the required system information including the significant loads in the system which produce or are effected by harmonics. The resulting analysis provides an evaluation of harmonic current flow and bus voltage distortion levels throughout the system.



Benefits which can be derived from a harmonic analysis are:

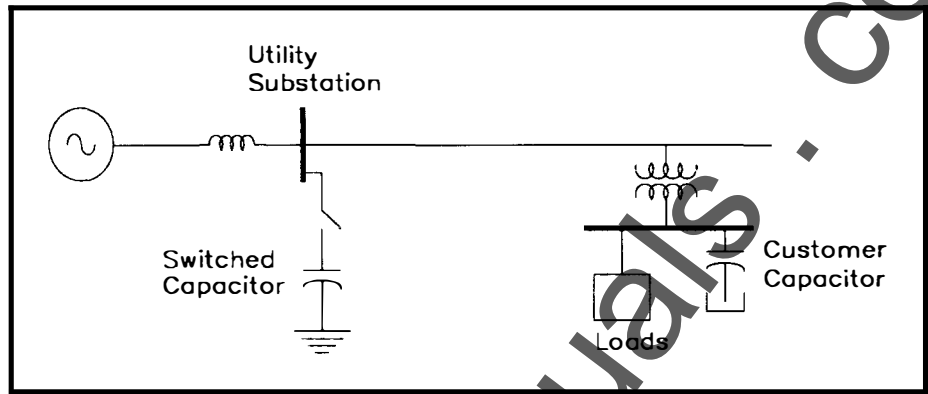
- Appropriate transformer derating due to third, fifth, seventh, and higher harmonics
- Avoid neutral conductor "burn-outs" due to non-canceling triplen harmonics, and others
- Calculate harmonic levels of current and voltage in power factor correction capacitors
- Provide harmonic filter design specifications

The results of a harmonic analysis identify specific system conditions related to harmonic problems and provide detailed specifications for harmonic filters. Harmonic filters can be provided by Square D based on the reactive power requirements of the customer. These filter designs can incorporate existing capacitor banks, wherever possible. For buses where power factor correction is not critical, a minimum size filter can be specified which meets power factor requirements and assures adequate harmonic control. All materials are presented in an easy to understand format and provided in a bound report for the customer.



On-line System Studies Via PowerLogic™

For some installations it is not possible to perform an accurate harmonic analysis prior to construction due to lack of exact loading information. In other facilities, an increasing percentage of loads produce harmonic currents and voltages, often resulting in power quality problems. The Waveform Capture feature available with Square D's PowerLogic™ Circuit Monitors provides an ideal means for customers to obtain an on-line power quality analysis or harmonic analysis. Through data communications to a personal computer equipped with waveform analysis software, the digitized waveform data captured by PowerLogic™ Circuit Monitors, including harmonic information through the 31st harmonic (1860 Hz), can provide a wealth of harmonic information. PowerLogic™ can provide the necessary information to help solve power quality problems.

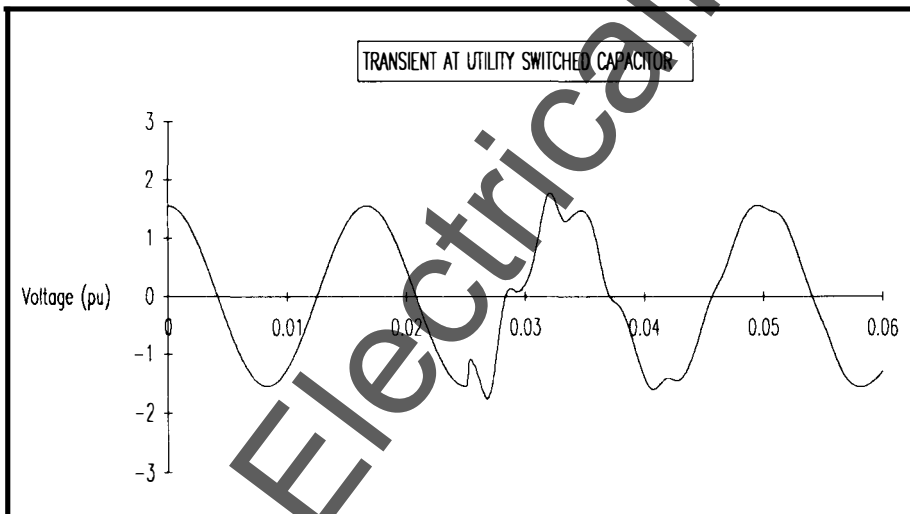


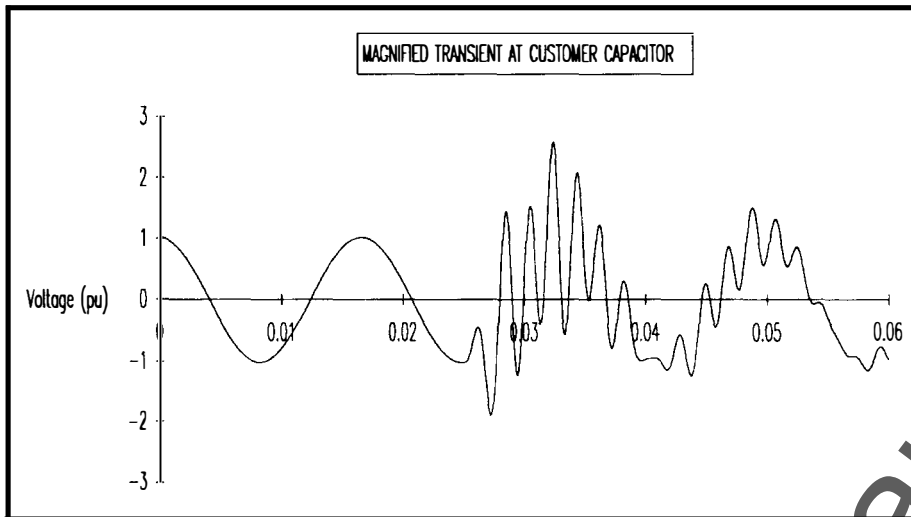
Transients Study

Transient disturbances are becoming an increasing problem in modern industrial environments. The most important transient concern which needs to be evaluated involves the potential for magnified transient overvoltages during utility capacitor switching events. This is a particular concern if the utility has capacitors on the primary system that supplies the facility.

It is not uncommon for magnified transients at the low voltage capacitors to be 3 to 4 times the nominal system voltage. These transients have significant energy associated with them and are likely to cause failure of protective devices, electronic equipment, capacitors, and other devices.

Computer simulations and field measurements are usually required to resolve switching transient problems. The transient study must be closely coordinated with a harmonic analysis, since solutions to harmonic distortion problems (filters) can change the system response and increase or decrease transient problems.





customer requirements. For customers who require the ability to perform their own maintenance, Square D can provide the customer's portions of the database and the computer generated system one-line diagrams.

Square D Technical Services Division

In addition to Square D Company's Power System Analysis Group, customers can receive valuable assistance from our Technical Services Division. From data collection for system studies to equipment repair, maintenance and change-outs, Square D's Technical Services Division is ready to help.

Benefits which can be derived from a transient study are:

- Prolong capacitor life and other equipment
- Eliminate nuisance drop-out of voltage sensitive electronic equipment
- Provide solutions to transient problems
- Reduce equipment failure and downtime

The results of a transient study are used to recommend the optimum solutions to potential and existing transient overvoltage problems. Recommendations are included for any equipment required including capacitors, reactors, switching devices, controls, and/or surge arrestors. All materials are presented in an easy to understand format and provided in a bound report for the customer.

Other System Studies

In addition to the studies previously discussed, Square D can offer customers the following analyses:

- Motor-Starting / Voltage Drop Analysis
- Motor Torque-Speed Acceleration Analysis
- Safe Motor Re-energization

Continued Support

Square D System Studies are performed with powerful engineering software. Input data is stored in a database for future access. Once the system has been modeled in the computer, future system changes can be evaluated by Square D without excessive cost to the customer. Square D can provide continued support or maintenance contracts based on

For More Information

For additional information about Square D System Studies, contact your local Square D Field Office or call or write:

Square D Company, 2306 Harrodsburg Road, Lexington, Kentucky, 40504.
(606) 224-1914, (606) 224-1989 FAX.

or

Square D Company, PowerLogic, 200B Weakley Road, Smyrna, TN, 37167.
(615) 459-8500, (615) 459-0002 FAX.

For more information regarding Square D Technical Services, contact your local Square D Field Office or call:
(800) 634-2003.



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