Power Conditioning Using the STS and SVR

By:

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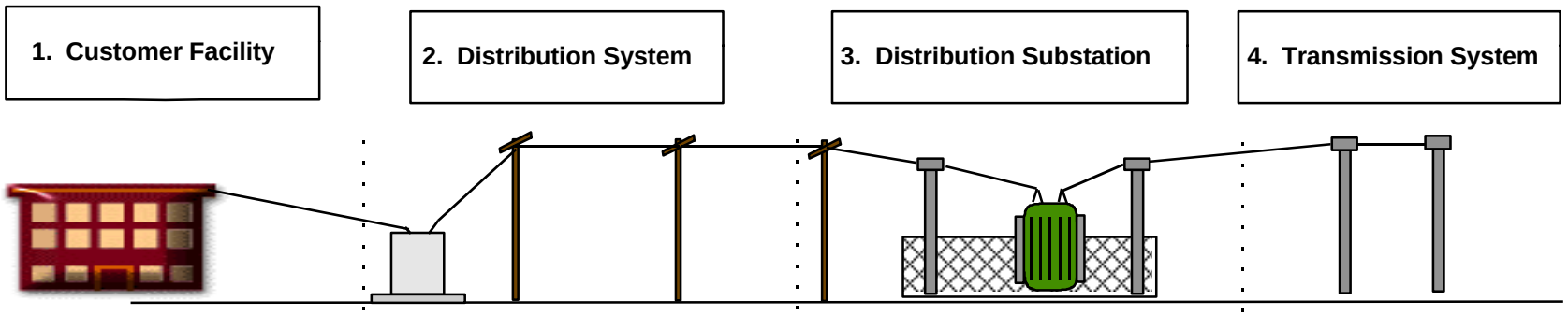
Complete System Management



Uninterruptible Power Supplies
Back-up Generators
Voltage Regulators
Harmonic Filters
Surge Suppressers
PQ Monitoring

Static Transfer Switch
Static Voltage Regulator
Dedicated Feeders
Networked Distribution

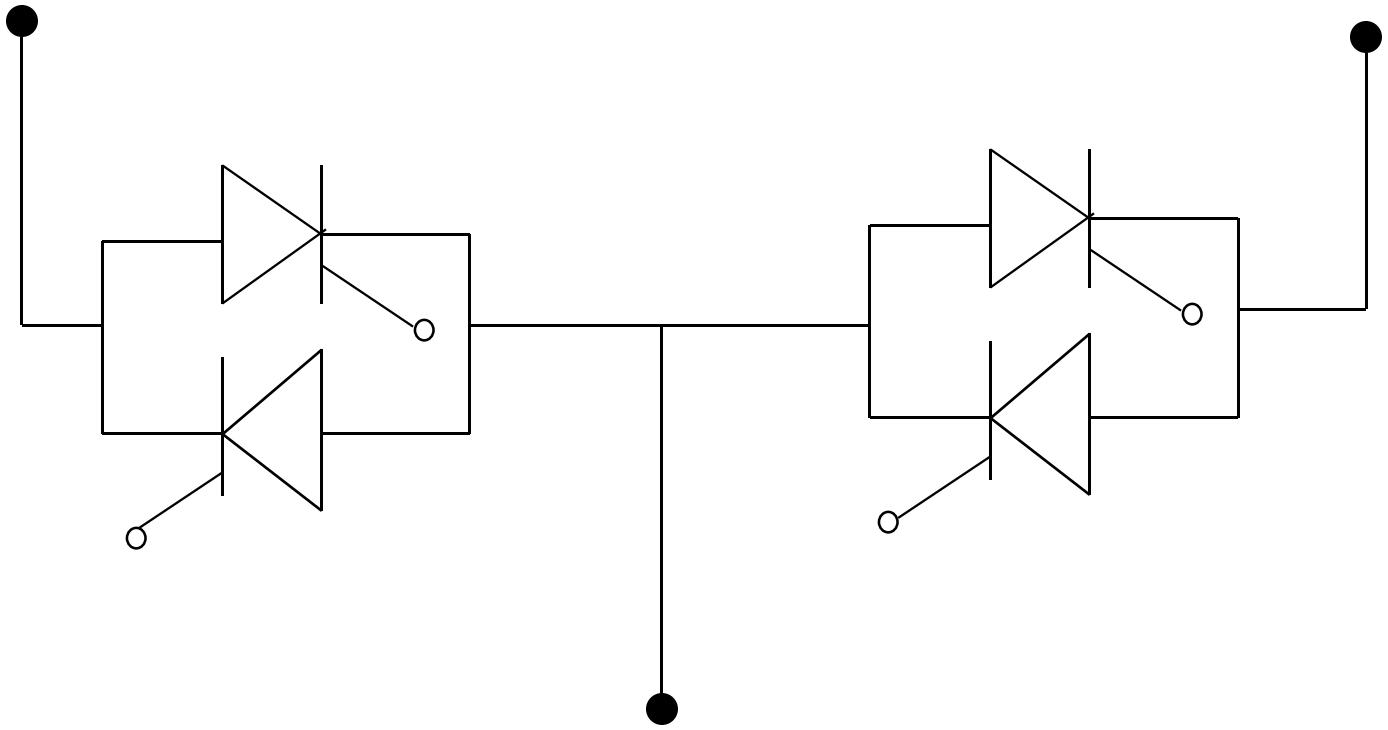
Static Voltage Regulator
Dedicated Substation
Looped Substation

STS Power Conditioning Application

- For customers who need whole-facility power conditioning
- For facilities where a large portion of the load is power sensitive
- For facilities with loads above 3 MW

The Static Transfer Switch

Simplified Single-line diagram



Distribution Requirements

- Two feeders from different substations or from different banks in the same substation
- Distribution capacity reserved in the back-up feeder
- Distribution capacity reserved in substation
- Reliable and good power quality transmission

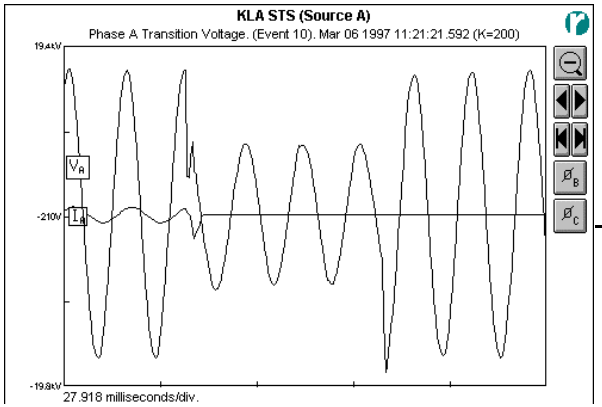
STS Characteristics

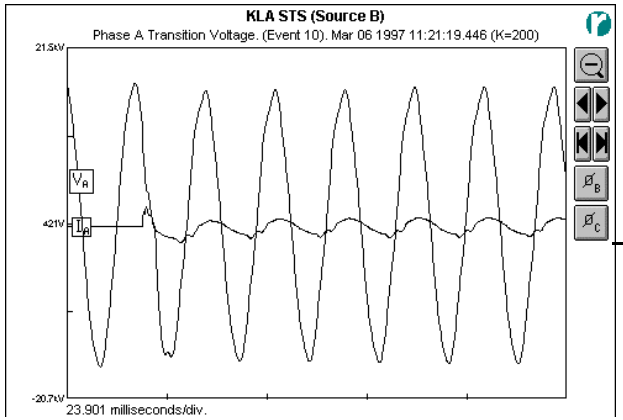
- The Static Transfer Switch (STS) is a three-phase, 25 kV class, static transfer system complete with bypass and isolation switches
- Rating:
  - Up to 600 Amps, 22 MVA at 21kV.
  - 12,000 Amp symmetric short circuit capacity.
  - 1/8 to 1/2 of a cycle detection and transfer time.

STS Advantages

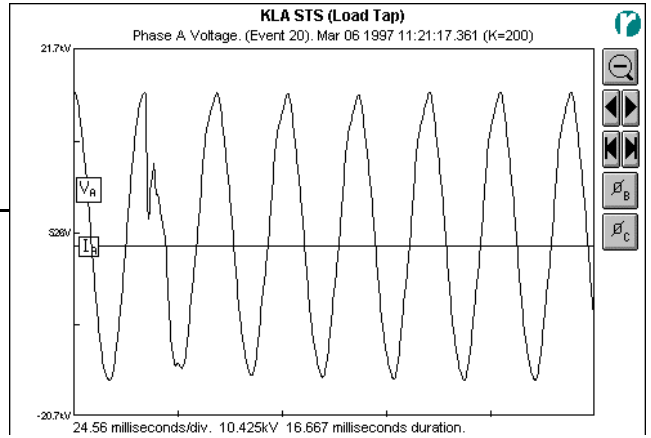
- Protects entire facility
- Small footprint and weight
- Can be installed outdoors
- Higher reliability and uptime
- Easier to maintain
- Lower cost

Example of an Actual Transfer

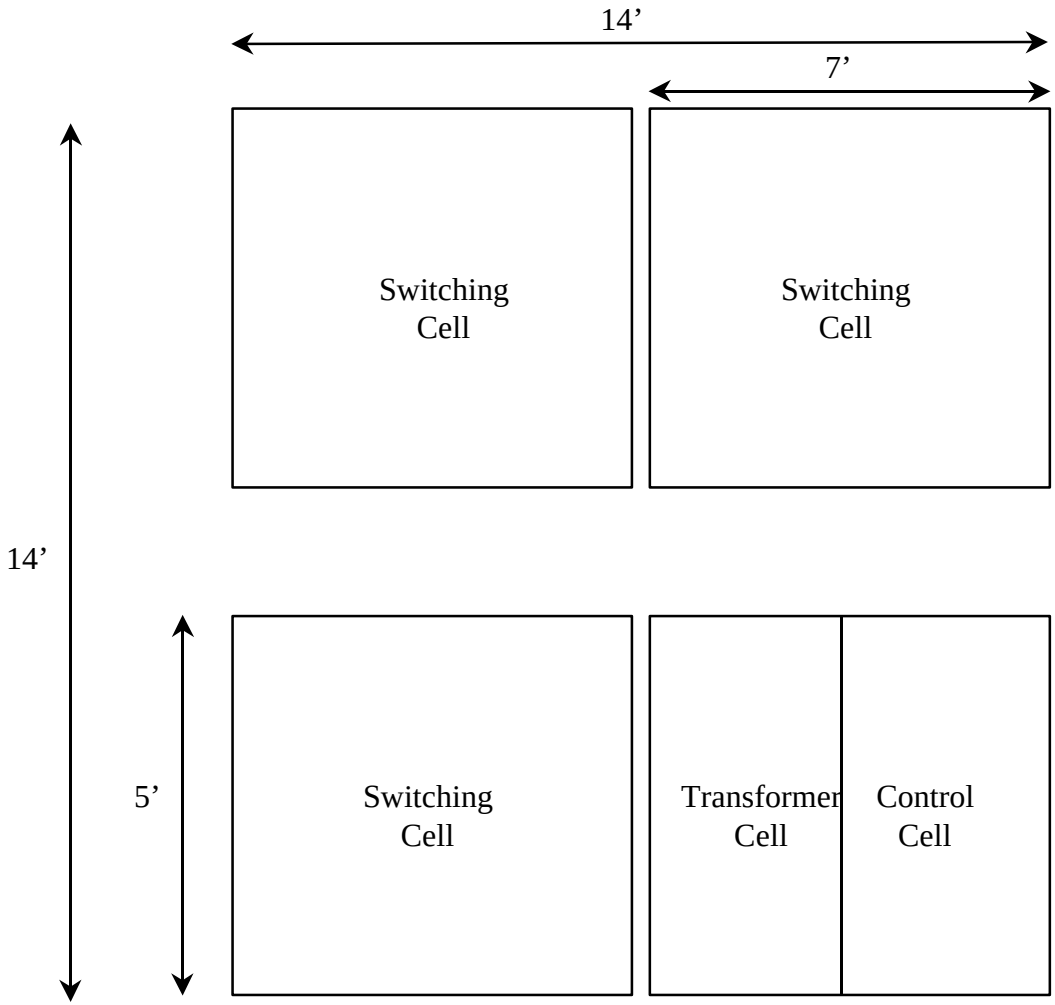




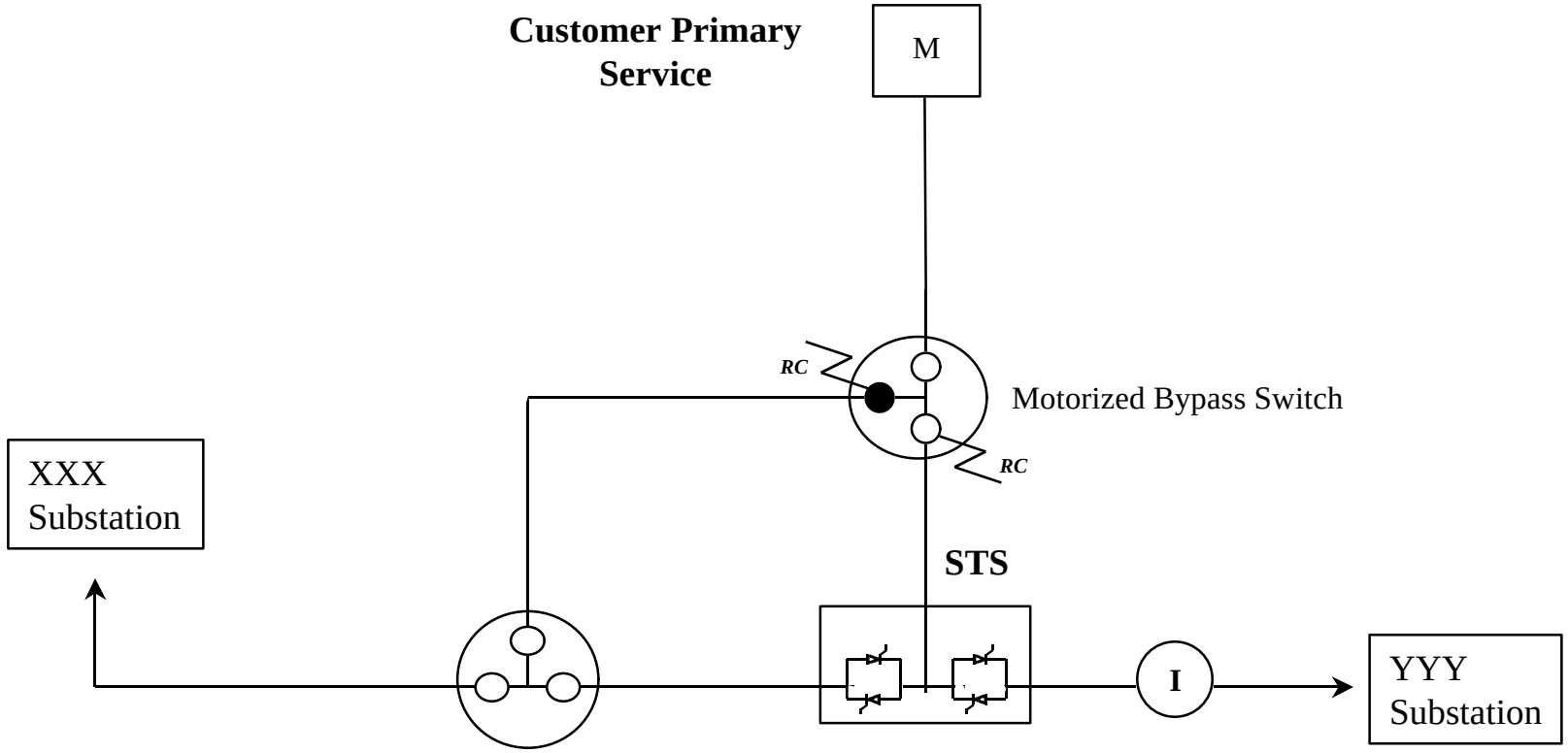
STS



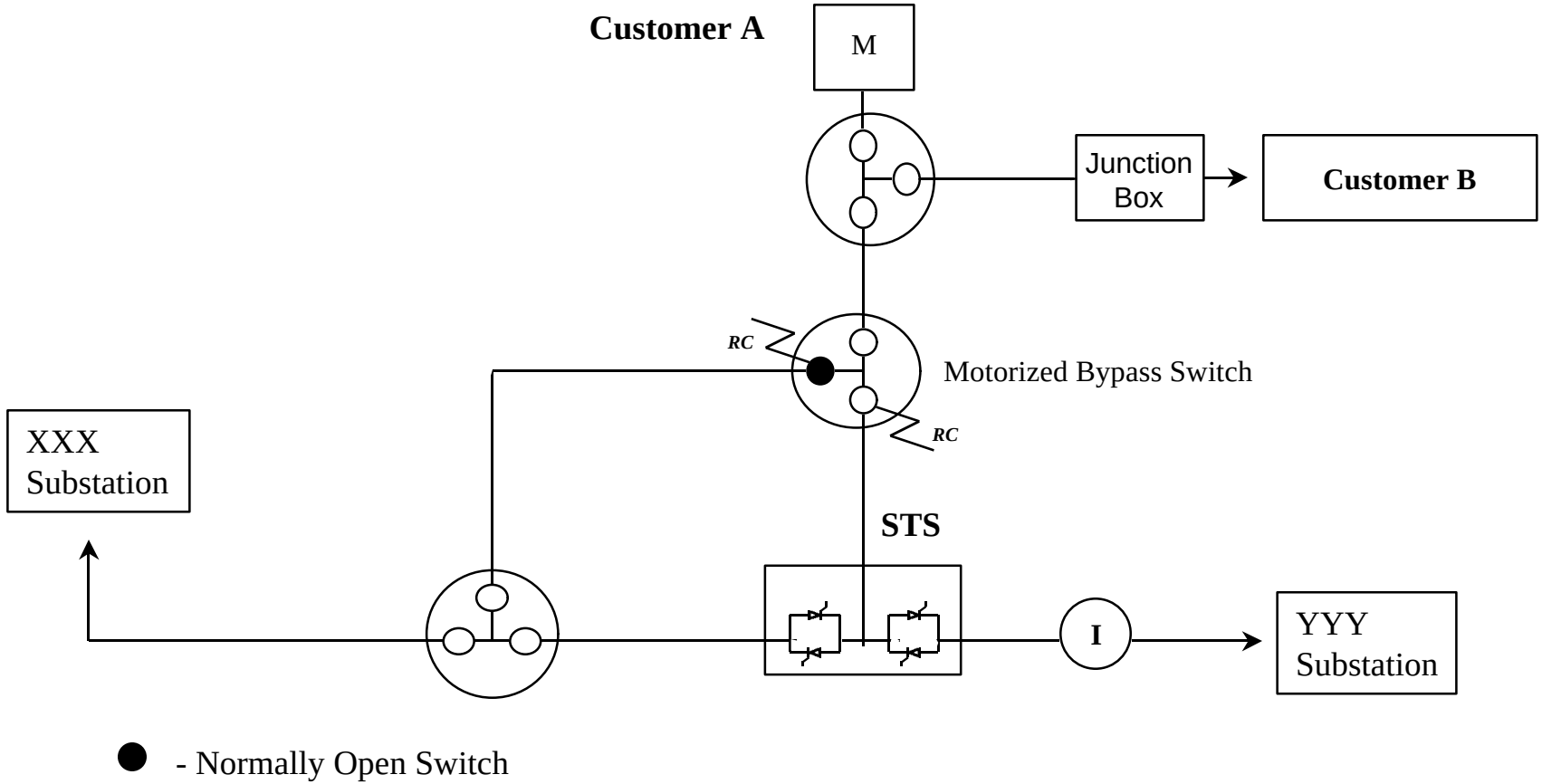
STS Footprint



Typical Installation



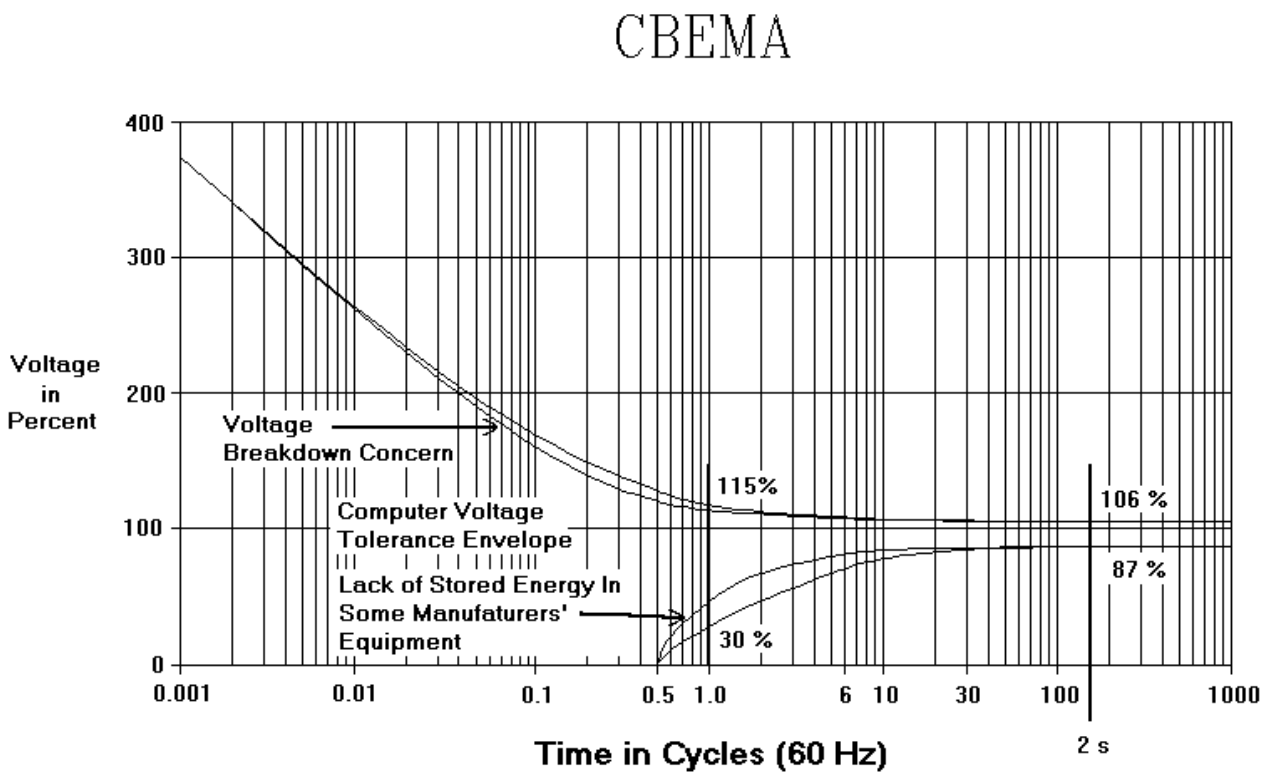
Shared STS Installation



Quality of Service for STS Customers

- Similar to transmission customers with looped service
- One voltage sag outside CBEMA a year depending on the transmission power quality
- One interruption every four to six years

The CBEMA Curve



ANSI/IEEE – Std 446-1987
Typical Design Goals of
Power-Conscious Computer Manufacturers

Lessons Learned

- Mild transmission sags are more frequent than expected
- Mild transmission sags are not a problem
- Initial transfer settings were too sensitive
- With adjusted settings STS transfers approximately once a month

Transmission PQ in the Silicon Valley

- One transmission sag outside CBEMA at a high tech company in 13 months
- No sags outside CBEMA at a major Chip Manufacturer in 10 months

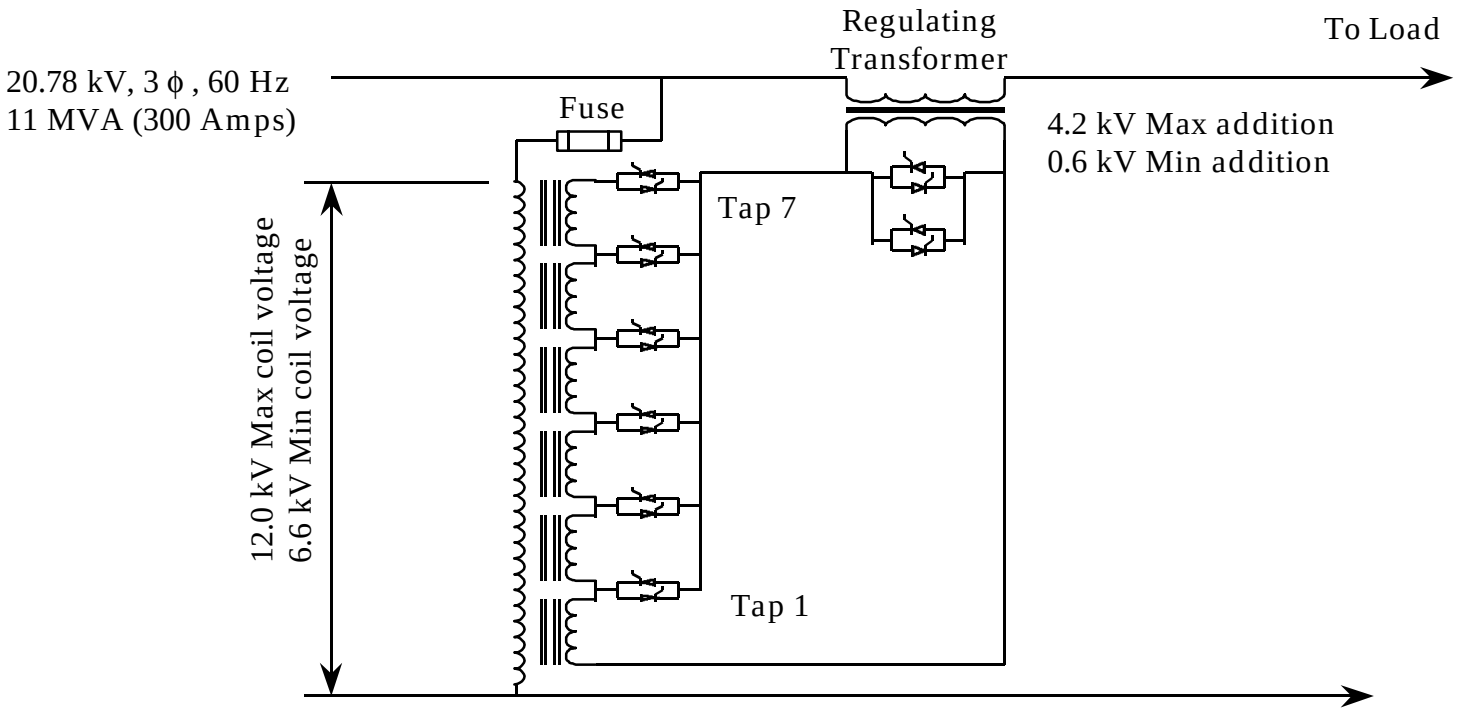
If Transmission Quality Is Not Adequate

- Static Voltage Regulator (SVR) downstream from the STS
- 4 millisecond voltage regulation typical
- 90% of nominal output voltage with 55% of nominal input voltage

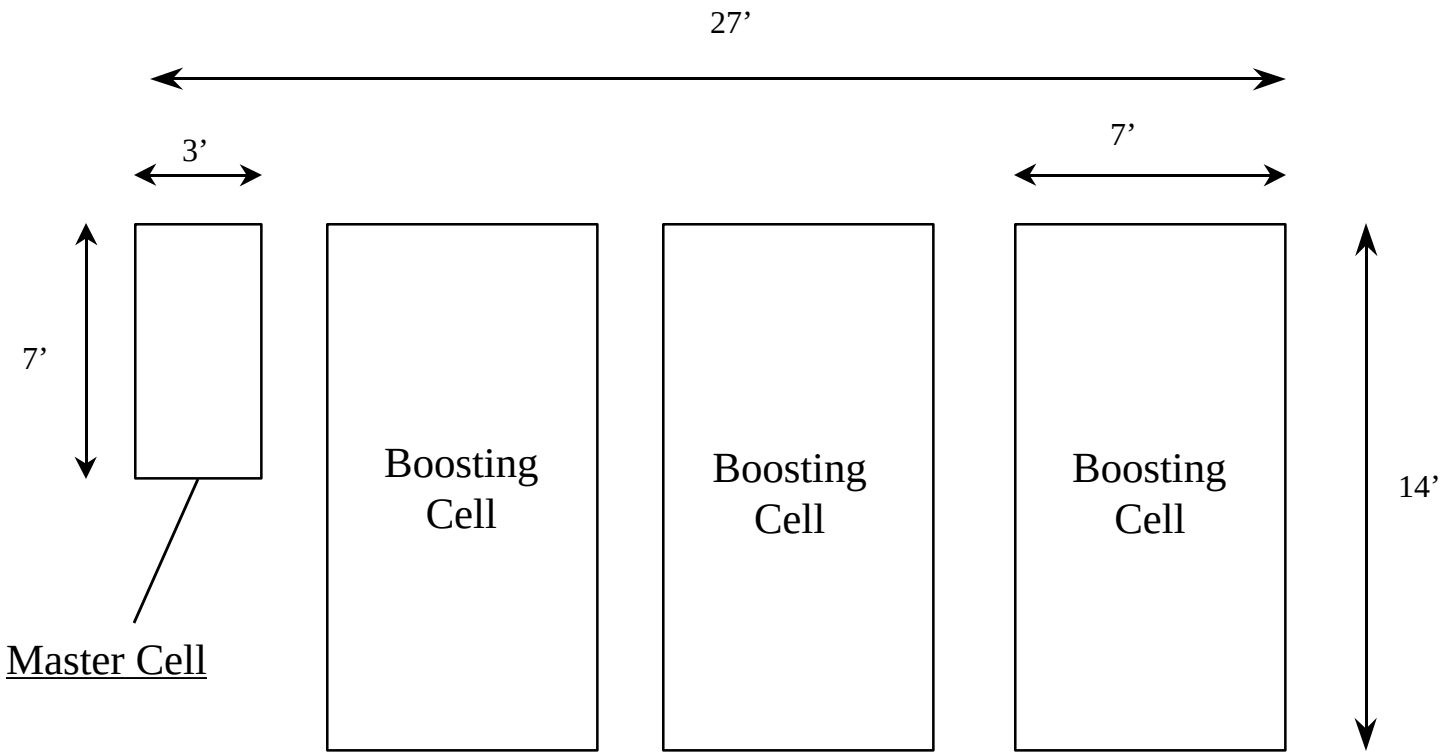
SVR Characteristics

- The Static Voltage Regulator (SVR) is a three-phase, 25 kV class, static tap changing regulator, complete with bypass and isolation switches.
- Rating:
  - Up to 600 Amps, 22 MVA at 21 kV.
  - 12,000 Amp symmetric short circuit capacity.
  - 65% maximum voltage boost in 1/4 to 1/2 cycle.
  - For voltage sags down to 55% of nominal, will maintain voltage between 90% and 100% of nominal. For voltage sags below 55% of nominal, will provide maximum boost.

SVR - One Line Diagram



SVR Footprint



SVR Performance

- Provides voltage to its output/load terminals for any load from 0 - 100% of rating from 0.7 lagging to 0.7 leading power factor
- Boosts the source/line voltage from 55% to over 90% within 8 - 12 milliseconds from start of the voltage sag, including sensing time
- On recovery of source voltage the SVR limits, its output/load terminal voltage to less than 1.5 per unit peak value for one half cycle
- Senses the downstream fault and prevents the voltage being boosted into a downstream fault

Design (Type) Tests

SVR Testing

No.	Standard	STS Applicable Requirement
1.	ANSI/IEEE C37.34/4.1.1	Power Frequency. 60 Hz Voltage Withstand
2.	ANSI/IEEE C37.8.6	Partial Discharge, Corona
3.	ANSI/IEEE C57.20.2	Lightning Impulse Withstand (120kV, Base Level BIL)
4.	ANSI/IEEE C37.12.00	Through Fault Current Withstand

The SVR Control Logic compliance with following standards will be through subsequent tests on July/August 1997

5.	ANSI/IEEE C37.90.1/2.2/2.3	Surge Withstand Capability (SWC)
6.	ANSI C62.41	Powerline Surge Voltage and Current Withstand Capability
7.	MIL STD.DOD - HDBK-263	Electrostatic Discharge Insensitivity (Non-susceptibility)
8.	SAMA PMC 33.1	Electromagnetic Field Insensitivity (Non-susceptibility)
9.	FCC Part 15 Class B	Electromagnetic Interference below Class B Emission Level
10.	ANSI/IEEE C37.12.90	Audible Noise, 70dBa at 6 feet

SVR Standard Ratings

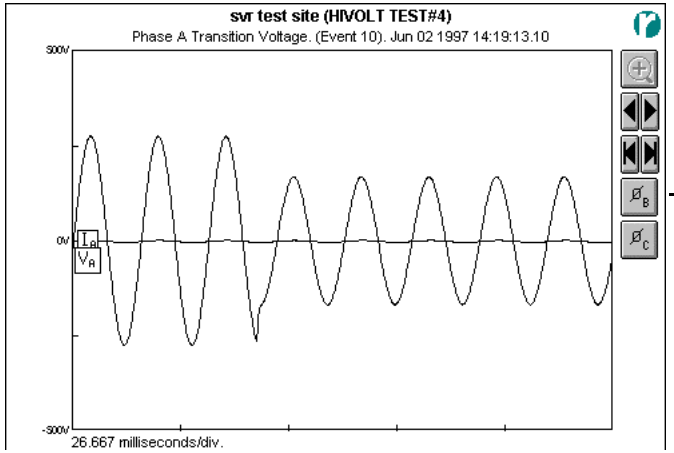
- 300 Amps
  - 15 kV, 125 kV BIL, 35% Boost Capacity
  - 25 kV, 125 kV BIL, 35% Boost Capacity
- Other ratings under consideration.

SVR Design Basics

- **High Reliability**
  - **Estimated MTBF of 80,000 hours (power disruption)**
  - **Detailed FMEA**
  - **Low stress industrial components utilized**
  - **SCRs utilized in SVR low voltage circuit section only, transformer isolated for 125kV BIL**
  - **MOVs across each SCR for vacuum breaker generated transients protection**
  - **Crowbar SCR redundant (double) gate drivers**
  - **Comprehensive logic and gate drivers diagnostics**
  - **Fully SCADA compatible and compliment with ANSI/IEEE standards and utility practices.**
- **Circuit simulation and scaled down prototype testing has been completed for essentially all line-load conditions**

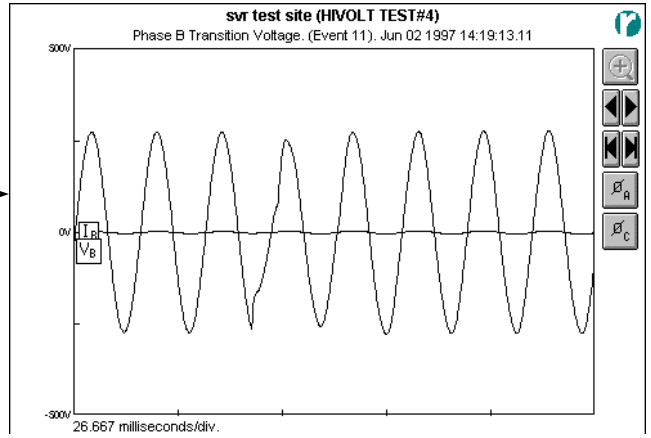
Example of a Boosting Operation

Input V & I



SVR

Output V & I



SVR Key Benefits

- Ensures Load Voltages above 90% for up to 55% Deep Voltage Sags
- Protects the Entire Facility against most Utility Distribution System Power Quality problems
- Provides a Reliable (no battery) Low Cost UPS Alternative
- Reduces Business Interruptions with Paybacks in some Applications in Less Than Five (5) Transfers