



ADVANCED POWER  
TECHNOLOGIES

# AC Balance of Plant Power Distribution Systems



## APS Engineered Power Systems Solutions Brochure

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**SAFE SMART SERVICEABLE SWITCHGEAR &  
ENGINEERED POWER SYSTEM SOLUTIONS**



ALN: 565 Rev. 05

# Power System Equipment



Figure 1: Low & Medium Voltage Power System Switchgear & Control Systems\*

## Engineered Equipment & Assistance Services

- ⊙ APT has the resources and expertise to provide safe, reliable, and cost-effective solutions for **All** Power System applications.
- ⊙ No matter how large or small, simple or complex the site is, APT has you covered from the incoming utility down to distribution and all of the redundancy in between:
  - Power System Site Planning, One-Line Diagram Development, Engineering and Design Review
  - Outdoor Walk-In Automatic Transfer & Distribution Switchgear Modules with sheltered working and maintenance rooms
  - Remote Monitoring SCADA systems
  - Pole Mounted or Pad Mounted Low and Medium Voltage Gang-Operated Disconnect Switches, Fuses, Surge Arresters, and Cut-Outs
  - Low and Medium Voltage Utility Intertie Switchgear according to IEEE 1547 and Utility Company requirements
  - Transient Voltage Surge Suppression
  - Outdoor NEMA 3R Non-Walk-In
  - Advanced controls for peak shaving, paralleling with utilities, generators, & islanding
  - Valve Regulated Lead Acid Energy Control Power Systems
  - Low to Medium Voltage Step-up & Step-Down Transformers
  - On-site Commissioning Assistance, Training, Troubleshooting & more!

# Master Control Panel (MCP)

**Compartments are configurable for incoming/ outgoing utilities, generator sources, and motor drives/starters for the ultimate in flexibility**



Figure 2: APT Master Control Panels with 20" Touchscreen Operator Interface & APTView SCADA System\*

## Advanced Logic Master Control Interface

- ⊙ Human Machine Interface (HMI)
  - Advanced Industrial Personal Computer (AiPC)
  - 20" Full Color Touchscreen
  - Windows 10
  - Provides power system monitoring & control via graphical interface
- ⊙ Local SCADA:
  - Graphical displays:
    - System One Line
    - Detailed genset electrical information
    - Genset loading controls
    - Alarm annunciation
    - Storage of all the monitored data every minute with date and time stamp
    - Remote monitoring and remote-control software
    - Capability of remote system troubleshooting
- ⊙ Uninterruptable Power Supply keeps unit powered during unplanned outages
- ⊙ Each generator electrical data:
  - Line to line voltages: Vab, Vbc, Vca
  - Generator frequency, Hz
  - Phase currents: Ia, Ib, Ic
  - 3Ø power: kW, PF, kVAR, kVA
  - 3Ø energy: kWh import, kWh export, kVARh import, kVARh export
- ⊙ Generator bus electrical data:
  - Line to line voltages; Vab, Vbc, Vca
  - Bus Frequency, Hz
- ⊙ System Status Information (alarm and events log):
  - Generator and Feeder circuit breakers position
  - Circuit breaker control switch in Trip position

# APT Metal Clad Construction



Figure 3: 15kV Max Auxiliary Transformer Cubicle over Vacuum Circuit Breaker Metal-Clad Section\*



Figure 4: 15kV Max Vacuum Circuit Breaker over Vacuum Circuit Breaker Metal-Clad Section\*



Figure 5: 15kV Max Controls Cubicle over Vacuum Circuit Breaker Metal-Clad Section\*

## Medium Voltage Metal-Clad Switchgear

- ⊙ Smart Switchgear for the High Demands of Tomorrow!
- ⊙ Designed & built to:
  - ANSI/IEEE C37.20.2
  - NEMA SG-5
- ⊙ Applications:
  - Utility Paralleling & Generator Paralleling Switchgear
  - Main-Tie-Main Automatic or Manual Transfer Switchgear
  - Distribution Feeder Switchgear
- ⊙ Main Bus:
  - Steel Enclosed Compartmentalized
  - 1200A, 2000A, 3000A
  - Durable Industrial Vinyl Mimic Bus
- ⊙ Infrared (IR) Viewing Windows
- ⊙ Symmetrical Interrupting Capacity:
  - 2.4kV-15kV: 40kA, 50kA, 63kA
- ⊙ Enclosure Environment Rating Options:
  - NEMA 1 (indoor)
    - Note: Circuit breakers in lower sections can be rolled out directly on the floor without the need for a ramp or lifting device without a housekeeping pad
  - NEMA 3R (outdoor) Non-Walk-In
  - Integrated onto APT PwrSkid Outdoor Non-Walk-In Switchgear Skid
  - Integrated into APT PwrHouse Outdoor Walk-In Switchgear Enclosure
  - NEMA 3R hardware is stainless steel
  - NEMA 3R Doors are Padlockable
  - Carbon Steel Powder coated ANSI 61 Gray



# APT MV FAC ATS Construction



Figure 6: APT FAC-Series Ultra Compact Vacuum Circuit Breaker Based ATS External Construction NEMA 3R\*



Figure 7: Up to 15kV Maximum Vacuum Circuit Breaker\*



Figure 8: Optional 24VDC Control Power Batteries & Rack for Optional Remote Indoor Mounting for Convenience of Maintenance Keep the Controls On-line Even if the Power is out!\*

## 2.4kV-15kV Ultra-compact ATS Space Saving Switchgear

- ⊙ Ultra-Compact Automated Switchgear for the High Demands of Tomorrow!
- ⊙ APT Open or Closed Transition Automatic Transfer Switchgear Applications:
  - One Utility Source & One Generator Source
  - Two Utility Sources
  - Two Generator Sources
- ⊙ Main Bus:
  - Steel Enclosed Compartmentalized
  - 1200A, 2000A, 3000A
  - Durable Industrial Vinyl Mimic Bus
- ⊙ Infrared (IR) Viewing Windows
- ⊙ Symmetrical Interrupting Capacity:
  - 2.4kV-15kV:
    - 12kA, 25kA, 31.5kA, 40kA, 50kA
- ⊙ Additional configurations:
  - 3-way transfer
  - Load Feeders
  - Tie circuit breakers
- ⊙ Enclosure Environment Rating Options:
  - NEMA 1 (indoor)
  - NEMA 3R (outdoor) Non-Walk-In
  - Integrated onto APT PwrSkid Outdoor Non-Walk-In Switchgear Skid
  - Integrated into APT PwrContainer ISO Container Based Outdoor Walk-In Switchgear Enclosure Module
  - NEMA 3R hardware is stainless steel
  - NEMA 3R Doors are Padlockable
  - Carbon Steel Powder coated ANSI 61 Gray

# MV ATS Details & Features



Figure 9: 5kV ATS Line-up\*



Figure 11: Optional Bus PT Drawer\*

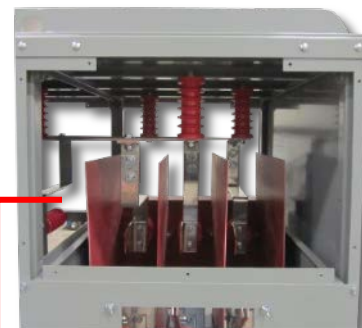


Figure 13: Close-up of Main Bus Compartment\*

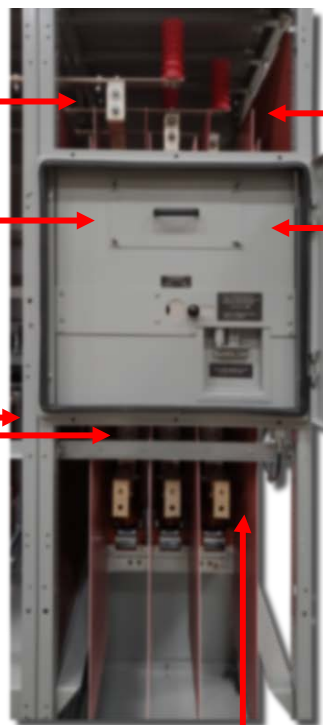


Figure 12: 5kV ATS Typical Generator Section Configuration\*



Figure 14: 15kV Max Vacuum Circuit Breaker over Vacuum Circuit\*



Figure 10: Rear Vacuum interrupters\*



Figure 15: Close-up of Vacuum Interrupters from the front of the section\*

# SBU-Series Switchboards



Figure 16: Front-Access Only Switchgear\*



Figure 17: UL891 with Metal Barriers Between Compartments & Top Mounted Lift Truck\*

## Designed to Meet UL® 891 Requirements

- ⊙ UL 891 Listed & Labeled
- ⊙ Voltage:
  - 208V – 690V, 3Ø
- ⊙ Frequency:
  - 60Hz or 50Hz
- ⊙ Silver plated copper bus
- ⊙ Standard bus ampacity up to 4000A
- ⊙ Bus Access & Cable Entry
  - Front or Rear Access for either top or bottom cable entry
- ⊙ Insulated Case Circuit Breakers
  - See page 15 (Feeder Sections) for more information
- ⊙ Molded Case Circuit Breakers
  - See page 15 (Feeder Sections) for more information
- ⊙ Intelligent close prevents simultaneous connection of multiple generators to dead bus with the addition of APT Generator Paralleling Modules to generator circuit breaker sections
- ⊙ Busbar connections with NEMA standard hole pattern
- ⊙ Enclosure Environment Rating Options:
  - NEMA 1 (indoor)
  - NEMA 3R (outdoor) Non-Walk-In
  - Integrated onto APT PwrSkid Outdoor Non-Walk-In Switchgear Skid
  - Integrated into APT PwrContainer ISO Container Based Outdoor Walk-In Switchgear Enclosure Module
  - NEMA 3R hardware is stainless steel
  - NEMA 3R Doors are Padlockable
  - Carbon Steel Powder coated ANSI 61 Gray
  - Optional Power System Mimic Bus
- ⊙ Surge Protection Device:
  - Type 1 & Type II Available
- ⊙ No Limits on Optional Features!
  - Pick as many options from the latest APT Part Number Selection Options Available List Available from an APT Power Solutions Development Engineer

# Outdoor Walk-In & Skid Modules



Figure 18: PwrContainer - Pre-wired Outdoor Walk-In ISO Container Based Power System Substation\*



Figure 19: PwrSkid - 2.5MW Pre-wired Outdoor Skid-mounted Medium to Low Voltage Unit Substation\*

## PwrContainer & PwrSkid for Power System Rapid Deployment

- ⊙ Fully integrated Power System power module (fully enclosed walk-in equipment enclosure) or open skid, come with equipment pre-installed and pre-wired from the factory and only external connections need to be made upon installation
- ⊙ Fast and clean installation allows for less installation time and more generation time
- ⊙ The following system components can be integrated in the power module or on the open skid:
  - Medium voltage and low voltage utility intertie switchgear
  - Power Distribution Switchboards and Panelboards
  - Power transformers
  - Utility Company metering and RTU
  - System control panels
  - Automatic Transfer Switchboards and Switchgear
  - Diesel and Natural Gas generators
  - Control and Maintenance rooms
- ⊙ Use of the PwrContainer & PwrSkid systems shifts large part of the installation from on-site to the controlled, factory environment, increasing the quality of the installation and allowing for the rapid deployment of the Power System balance of plant equipment



# Outdoor Walk-In Switchgear House



Figure 20: Outdoor Walk-In Low Voltage Utility & Generator Paralleling Switchgear PwrHouse\*



Figure 21: Outdoor Walk-In Medium Voltage Utility & Generator Paralleling Switchgear PwrHouse\*

## Low & Medium Voltage Outdoor Walk-In e-Houses

- ⊙ Packaged in a custom equipment enclosure to meet your exact needs
- ⊙ Walk-in switchgear aisle is constructed as one piece of custom enclosure to simplify onsite installation
- ⊙ All Equipment inside is factory installed and wired
- ⊙ Available with insulated walls, floor, and ceiling
- ⊙ Optional aluminum diamond plate provides a safe, long lasting, easy to clean floor
- ⊙ Complete with internal lighting (AC and/or DC) and convenience receptacles
- ⊙ Heating and/or cooling units designed for its operating environment
- ⊙ Separate rooms when appropriate for the application (transformer compartment, etc.)
- ⊙ Rugged, durable, weather resistant construction for the worlds harshest environments
- ⊙ Long life, no maintenance aluminum, insulated walls, and ceiling
- ⊙ For operator safety and a finished look and feel, all internal wiring is run in enclosed ducts, or conduit
- ⊙ Utility metering compartments can be integrated in the switchgear
- ⊙ Configurable for a wide range of applications:
  - Automatic and/or manual generator paralleling switchgear
  - AC or DC variable speed motor control
  - Power distribution switchgear
- ⊙ Side, top, or bottom cable entry and exit
  - Power and control quick connect receptacles are available
- ⊙ Optional site control and monitoring:
  - Modbus serial or Ethernet communications
  - APTView SCADA & computer systems
  - Switchgear Master Control

# Automatic Source Transfer



Figure 22: Automatic Transfer Controls\*



Figure 23: Automatic Transfer Controls & Protection NEMA 3R\*



Figure 24: Inside Automatic Transfer Sections\*

## Automatic Transfer Control with Open & Closed Transition Options

- ⊙ (ATO) – APT Automatic Standby Open Transfer Control Module provided functionality shall be as follows:
  - Automatic Open Transition (Utility - Generator) – automatically transfers power between the utility and generator in a “break-before-make” fashion.
    - “Break-before-make” disconnects one power source before it contacts another.
  - This operation produces two brief power outages – one outage per transfer.
  - Upon sensing of the utility failure (utility voltage is not within undervoltage setpoint) the Time Delay Engine Start timer shall start timing. If utility failure condition remains upon expiration of the Time Delay Engine Start timer the generator set shall be automatically started and brought up to speed and voltage. At that time utility circuit breaker shall open and generator circuit breaker shall close (after an adjustable time delay neutral). At this time the generator is supplying power to the site load. Upon sensing of utility return (utility voltage is within set undervoltage tolerance) the Time Delay Emergency to Normal timer shall start timing. If utility power remains healthy (utility voltage is within set undervoltage tolerance) upon expiration of the Time Delay Emergency to Normal timer the generator circuit breaker shall open and the utility circuit breaker shall close (after adjustable time delay neutral). At this time the generator set shall be put in the cooldown mode of operation.
  - Time Delay Neutral shall determine the minimum time period the load will be deenergized before the load is energized from the alternative source (normal or emergency).

## APT Transfer Control System Modules



Figure 25: ATC & SL (selectable) Control System Local Operator Interface\*



Figure 26: Control System Local Operator Interface with ATC Control Unit\*

## Multi-source Open & Closed Transition Transfer Control Modules

- ⊙ (ATC) – APT Automatic Standby Closed Transfer - Active Sync Control Module provided functionality:
  - Closed Transition – Power can be transferred between utility and generator in a “make-before-break” fashion by utilizing active generator synchronizing. After the end of the utility outage, power is transferred back from generator to utility using “make-before-break” sequence. This mode of operation can also provide a method of testing the back-up system without producing a power outage. This mode can also be used as an effective means of “peakshaving” facility loads to reduce utility demand charges.
  - This mode can be also initiated remotely by a utility RTU or facility energy control system.
  - If utility failure condition remains upon expiration of the Time Delay Engine Start timer the generator set shall be automatically started and brought up to speed and voltage. At that time utility circuit breaker shall be automatically open and generator circuit breaker shall close (after adjustable time delay). At this time the generator is supplying power to the site load.
  - Upon sensing of utility return (utility voltage and frequency are within set tolerances) the Time Delay Emergency to Normal timer shall start timing. If utility power remains healthy (utility voltage and frequency are within set tolerances) upon expiration of the Time Delay Emergency to Normal timer the transition of the load to the utility shall begin.
  - The generator shall be synchronized with the utility source and when in synchronism (as determined by the synchronizing check relay), close the utility circuit breaker. At this time the generator breaker shall be tripped immediately. The load is now powered by the utility.

# SBU-ATO-BI Transfer Switchboards



Figure 27: UPS Bypass/Isolation Maintenance Switchboard\*

## Automatic Transfer Switchgear with Bypass Isolation

- ⦿ Provide independent electrical fault protection for all sources:
  - 27/59 – Three-phase under/over voltage
  - 81O/U – Over/under frequency (Optional)
- ⦿ Automatic Transfer – Overview:
  - If there is a total loss of utility power, this mode of operation will cause the generator to automatically start, come on-line, and assume site load.
  - After utility power returns, a sequence of functions may be executed to return the breakers to their normal positions in an open transition.
  - After the return to normal, the generator(s) automatically come off-line, cools down, and is ready for the next start.
- ⦿ Manual Control – Overview:
  - Designed to control the power system in a very simplified and automated manner.
  - Should higher levels of functionality fail, or should the power system not have been properly set up for automatic operation, lower levels of manual control are available.
- The manual controls allow an operator to accomplish the following:
  - Manually trip/close the breakers as required with breaker status indication
- ⦿ HMI provides a means of programming setpoints and diagnosing fault conditions. Touchscreen HMI allows operators to select the following features:
  - Alarms – Shows all monitored alarm and fault conditions
  - Event Log – Provides event log
  - Metering – Provides simultaneous metering of generator and bus/utility
  - Normal Source Setpoints – Provides protection setpoints (under/overvoltage, etc.)
  - Emergency Source Setpoints – Provides protection setpoints (under/overvoltage, etc.)
  - Automatic Standby Setpoints – Provides time delays for operation of auto standby
  - Testing Status / Setpoints – Provides controls for operation of generator testing
  - Advanced Setpoints – Password protected menu of higher level functionality setpoints



## SBU-BI & SBU-SK Transfer Switchboards



Figure 28: APT SBU-Series Switchboard with (BI) – UPS Maintenance Bypass/Isolation with Manual, Non-electric Kirk Key Operation\*



Figure 29: APT SBU-Series Switchboard with (SK) – UPS Maintenance Bypass/Isolation with Manual, Electric Solenoid Key Release Unit (SKRU) Operation\*

## UPS Maintenance Bypass Manual Transfer Switchboards

- ⦿ (BI) – APT UPS Maintenance Bypass/Isolation with Manual, Non-electric Kirk Key Operation:
  - Three (3) identical Kirk Key locks with Two (2) identical Kirk Keys allow for only two circuit breakers to be closed at the same time. Remove key from source 1 and insert into the bypass circuit breaker to enable source 2 to provide power to the load normally served by source 1.
- ⦿ (SK) – APT UPS Bypass/Isolation with Solenoid Key Release Unit (SKRU):
  - Solenoid Key Release Unit (SKRU) with A-1 Key held captive. UPS output breaker A is closed supplying the critical load through the UPS. Key B-1 is held captive in the L-O interlock on breaker A. Maintenance bypass breaker B cannot be closed until the UPS is placed in bypass mode, sending a signal to the SKRU allowing release of key A-1. The SKRU has an apartment lock that will accept either key A-1 or B-1.
  - To supply critical load through the maintenance bypass breaker, proceed as follows:
    1. Place the UPS in bypass mode.
    2. Upon receipt of the proper signal, key A-1 in SKRU can be turned changing status of SKRU internal contacts and releasing key A-1.
    3. Insert key A-1 in L-O interlock on maintenance bypass breaker B and turn to unlock.
    4. Close maintenance bypass breaker B. Key A-1 is now held.
    5. Open UPS output breaker A.
    6. Turn key B-1 in interlock on UPS output breaker A to lock open. Key B-1 is now free.
    7. Insert key B-1 in SKRU and turn to return the SKRU internal contacts to the original position. Key B-1 is now held in the SKRU.

# Generator Paralleling & Control



Figure 30: Front Access Section Generator Protection & Control Door Open\*



Figure 31: Generator Protection Circuit Breaker behind door & Door Mounted Generator Paralleling Control\*



Figure 32: Close-Up of APT GP – Generator Paralleling Advanced Control Module Powered Up\*

## Advanced Generator Paralleling & Control Sections

- ⊙ Behind door mounted generator protection circuit breaker provides an added layer of operator protection
- ⊙ Provide ability to automatically parallel multiple generators in the same or multiple sections:
- ⊙ Complete Manual Paralleling Facilities
  - Synch Check Relay
  - Synch Lights
- ⊙ Complete 3Ø Generator Protection
  - Under/overvoltage, under/over frequency
  - Reverse Power (two setpoints)
  - Reverse VARs (two setpoints)
  - Current balance (two setpoints)
- ⊙ Optional 3Ø Bus Protection
  - Under/overvoltage and under/over frequency
- ⊙ Remote Start/Stop Interface
- ⊙ Prevention of Closing of Multiple Generators to a Dead Bus Simultaneously
- ⊙ First Up – First On logic Connects First Available genset to a Dead Bus
- ⊙ Uninterruptable Power Supply to trip the generator circuit breaker when main control power battery source fails
- ⊙ Insulated Case Circuit Breaker
- ⊙ Backlit 3.5" Color HMI:
  - Provides control & viewing of all the switchgear protective, process control, and configuration setpoints
  - Displays generator set operating parameters, real time system status, and historical list of events/alarms
- ⊙ Complete 3Ø Generator & Bus Metering:
  - True RMS Digital metering with accuracy within 0.3% for voltage & current 0.6% for power & energy
  - Direct 3Ø voltage sensing
  - 0-5 Amp sensing from generator or switchgear CTs
  - Generator metering includes:
    - A, V, Hz, kW, PF, kVAR, kWh, kVARh
  - Bus metering:
    - V, Hz

# Protection for Facility Main/Feeders

**Circuit Breaker  
Position  
Indicating Lights  
& Control Switch**



Figure 33: Door Mounted Circuit Breaker  
Position Indication & Control Switch\*

**Insulated Case  
Circuit Breaker**



Figure 34: Inside Feeder Section\*

## Large & Small Branch Circuit Protection Sections

- ⊙ High visibility, LED type indicating lights with lenses of 1" outside diameter and a service life of 100,000 hours at 77°F
- ⊙ See page 9 for available circuit breaker ratings
- ⊙ Your Choice of Circuit Breakers:
  - Molded Case Circuit Breakers:
    - UL® 489 Listed
    - Available up to 3000A
    - Manually Operated
    - Electrically Operated with Motor Operator Add-on
    - 80% or 100% Rated
    - Fixed Mounted
    - Interrupting Rating:
      - 18kA – 200kA @ 480V<sub>AC</sub>
    - Circuit breaker position Aux Contacts ("a" and "b")
  - Insulated Case Circuit Breakers:
    - UL® 489 Listed
    - Available from 800A up to 4000A
    - Electrically or Manually Operated
    - 100% Rated
    - Fixed Mounted or Drawout
    - Interrupting Rating:
      - 65kAIC (800 – 2000A)
      - 100kAIC (over 2000A)
    - Circuit breaker position Aux Contacts ("a" and "b")
  - Circuit Breaker Trip Units:
    - LI – Adjustable long time, instantaneous trip settings
    - LSI – Adjustable long & short time, instantaneous trip settings
    - LSIG – Adjustable long & short time, instantaneous trip settings, with ground fault trip settings

# Temporary Generator / Load Bank

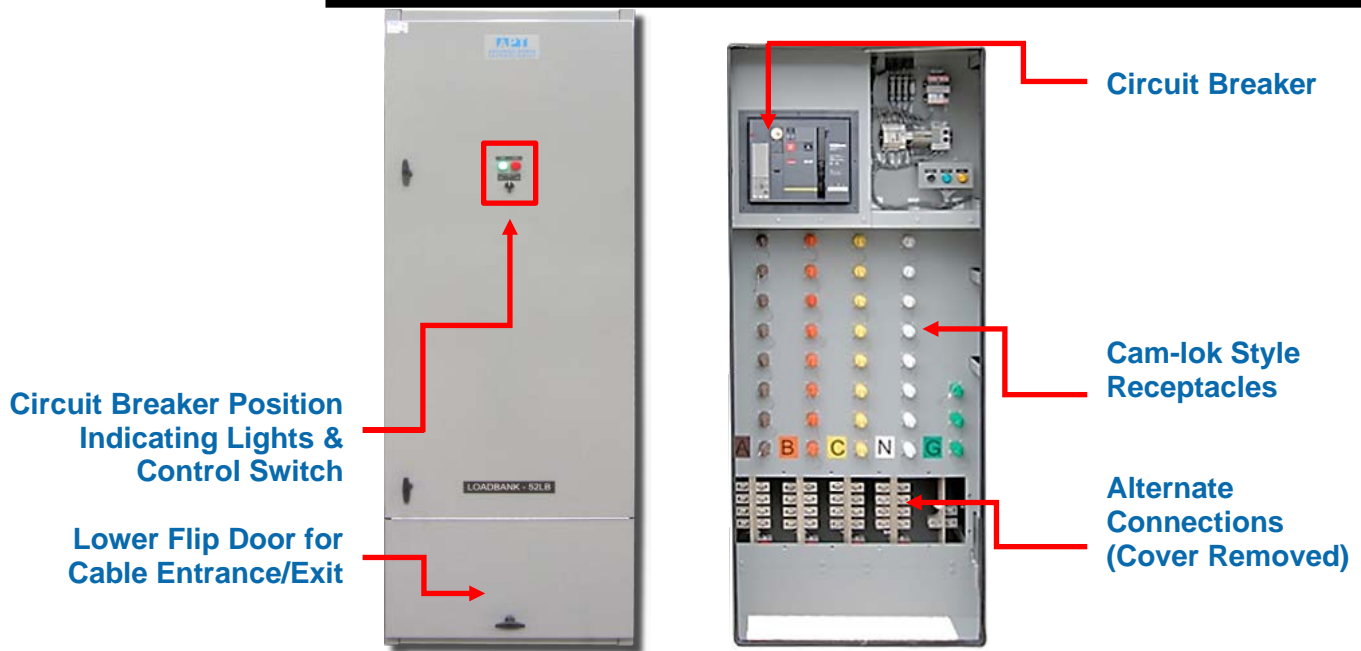


Figure 35: Quick Connect Section\*

Figure 36: Inside GQC Section\*

## Integrated Generator / Load Bank Quick Connection Section

- ⊙ Per NEC 700.3, temporary generator connection applications require either mechanical or electrical interlocking of the power sources to safely prevent the inadvertent paralleling of the normal & emergency power sources:
  - Service Entrance Rated Manual Transfer Switchboard (two integrated keys)
    - Utility service entrance circuit breaker with mechanical key interlock
    - Temporary generator circuit breaker with mechanical key interlock
  - Temporary Generator Connection Only
    - External service main no temporary generator circuit breaker protection
    - One integrated mechanical key interlock, one ship loose with mechanical key interlock for installation on facility service main
  - Multiple generators or feeders circuit breaker sections (multiple mechanical key interlocks, transfer block)
- ⊙ Operation sequence without the interlocking of sources is available for systems that achieve NEC 700.3 source interlocking externally
- ⊙ Loadbank connection only applications
  - Easily connects a temporary loadbank to a facility's permanent generator(s)
  - Utilizes female cam-lok type receptacles
  - Does not require the use of interlocking
  - Circuit breaker and monitoring options available
- ⊙ Integrated Generator & Loadbank Quick Connection
  - Integrates male & female cam-loks into one unit for all your temporary connection needs in one location
  - Dual-purpose termination cabinet allows for safe and clean connection of a portable temporary generator or loadbank
- ⊙ Alternatively, cam-lok gender changeover adapters are available to convert Generator Quick Connection into Loadbank Quick Connection\*

\*Subject to implemented options



## MV Available VCB Ratings



Figure 37: 2.4-15kV Max Vacuum Circuit Breakers\*

Table 1: Standard Vacuum Circuit Breaker Ratings\*

MVA Rating (reference only)	Actual MVA @ Maximum Rated Voltage	Rated Continuous Current	Voltage		Dielectric Ratings		Short Circuit Current					Mechanical Endurance
			Max Rated Voltage	Range Factor	Power Frequency	Impulse 1.2 x 50μs	System Interrupting	Close and Latch Rating	Short-Time Current Rating	Short-Time Current Duration	Interrupting Time	No Load Mechanical Operations
		A RMS	kV RMS	K	kV RMS	kV peak		kA peak	kA RMS	s	Cycles	
250	330	1200	4.76	1.24	19	60	40	104	40	2	3	10,000
500	572	1200	8.25	1.24	36	95	40	104	40	2	3	10,000
750	1039	1200	15	1.24	36	95	40	104	40	2	3	10,000
200	207	1200	4.76		19	60	25	81.9	31.5	2	3	10,000
		1200	4.76		19	60	31.5	81.9	31.5	2	3	10,000
		2000	4.76		19	60	31.5	81.9	31.5	2	3	10,000
		1200	15		95	95	25	81.9	31.5	2	3	10,000
		1200	15		95	95	31.5	81.9	31.5	2	3	10,000
		2000	15		95	95	31.5	81.9	31.5	2	3	10,000

# LV Circuit Breaker Ratings

Table 2: Available Circuit Breaker Ratings*					
Breaker Type	Frame Rating (A)	Interrupting Rating (kA)			Sensor Plug (A)
		240V	480V	600V	
Drawout	800	65	65	50	100, 250, 400, 600, 800
		100	100	85	
		200	150	100	
		200	150	100	
	1200	65	65	50	600, 800, 1000, 1200
		100	100	85	
		200	150	100	
		200	150	100	
	1600	65	65	50	800, 1000, 1200, 1600
		100	100	85	
		200	150	100	
		200	150	100	
	2000	65	65	50	1000, 1200, 1600, 2000
		100	100	85	
		200	150	100	
		200	150	100	
	2500	100	100	85	1200, 1600, 2000, 2500
		200	150	100	
	3000	100	100	85	1600, 2000, 2500, 3000
		200	150	100	
	4000	100	100	85	2000, 2500, 3000, 4000
		200	150	100	
	5000	100	100	85	2500, 3000, 4000, 5000
		200	150	100	
	6000	100	100	85	3000, 4000, 5000, 6000
		200	150	100	
Fixed	800	65	65	50	100, 250, 400, 600, 800
		100	100	85	
	1200	65	65	50	600, 800, 1000, 1200
		100	100	85	
	1600	65	65	50	800, 1000, 1200, 1600
		100	100	85	
	2000	65	65	50	1000, 1200, 1600, 2000
		100	100	85	
	2500	100	100	85	1200, 1600, 2000, 2500
	3000	100	100	85	1600, 2000, 2500, 3000
	4000	100	100	85	2000, 2500, 3000, 4000
	5000	100	100	85	2500, 3000, 4000, 5000
	6000	100	100	85	3000, 4000, 5000, 6000

# Power Quality Metering & Utility Intertie

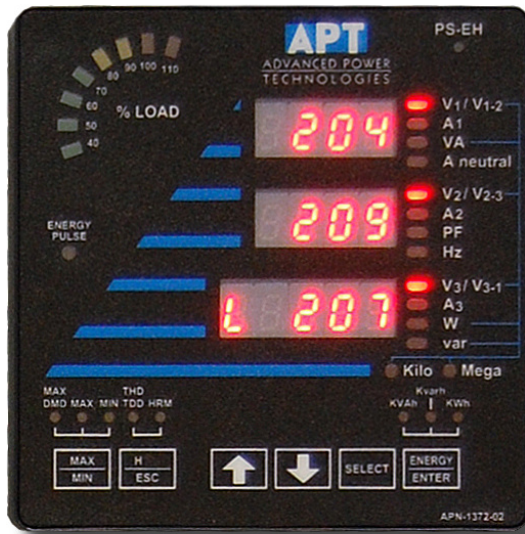


Figure 38: APT PS-EH - APT Multi-Function Power Meter Energized\*

Measurement Specifications Parameters				
Parameter	Full Scale @ Input Range	Accuracy		Range
		% Reading	% FS Conditions	
Voltage	120VxPT @ 120V 400VxPT @ 690V	0.2	0.02 10% to 120% FS	0 to 1,150,000 V Starting voltage 1.5-5.0% FS (selectable)
Line current	CT	0.2	0.02 For In = 5A 1% to 200% FS For In = 1A 5% to 200% FS	0 to 50,000 A Starting current 0.1% FS
Active power	0.36xPTxCT @ 120V 1.2xPTxCT @ 690V	0.3	0.02  PF  ≥ 0.5 <sup>1</sup>	-10,000,000 kW to +10,000,000 kW
Reactive power	0.36xPTxCT @ 120V 1.2xPTxCT @ 690V	0.3	0.04  PF  ≤ 0.9 <sup>1</sup>	-10,000,000 kVAR to +10,000,000 kVAR
Apparent power	0.36xPTxCT @ 120V 1.2xPTxCT @ 690V	0.3	0.02  PF  ≥ 0.5 <sup>1</sup>	0 to 10,000,000 kVA
Power factor	1.000		0.2  PF  ≥ 0.5, 1 ≥ 2% FSI	-0.999 to +1.000
Frequency	50/60 Hz 25 Hz, 400 Hz	0.02 0.04	VL-N > 25V	40 Hz to 70 Hz 15 Hz to 40 Hz 320 Hz to 480 Hz
Total Harmonic Distortion, THD V (I), %Vr (%Ir)	999.9	1.5	THD ≥ 1%, V ≥ 10% FSV and VL-N > 25V, 1 ≥ 10% FSI	0 to 999.9
Total Demand Distortion, TDD, %	100		TDD ≥ 1%, 1 ≥ 10% FSI, VL-N > 25V	0 to 100
Active energy Import & Export			Class 0.5S under conditions as per IEC 62053-22:2003	0 to 999,999,999 kWh
Reactive energy Import & Export			Class 0.5S under conditions as per IEC 62053-22:2003,  PF  ≤ 0.9	0 to 999,999,999 kVARh
Apparent energy			Class 0.5S under conditions as per IEC 62053-22:2003	0 to 999,999,999 kVAh

<sup>1</sup> @ 80% to 120% of voltage FS, 1% to 200% of current FS and frequency 50/60 Hz

PT - external potential transformer ratio

CT - primary current rating of external current transformer

FSV - voltage full scale

FSI - current full scale

## PS-EH Advanced Multi-Function Power Metering & Utility Intertie

- ⊙ UL recognized for Advanced Power Metering
- ⊙ True RMS, 3 Element Power Quality Metering:
  - Metering accuracy shall be in accordance with ANSI C12.20-1998, rated an with accuracies as follows:
    - Class 10 0.5% for energy.
    - 0.2% of reading and 0.02% of full scale for voltages and currents.
    - 0.3% of reading and 0.02% of full scale for active and apparent power
  - Dedicated high-brightness digital LED displays are visible in the bright sun light or in the dark
- ⊙ Environmental Conditions
  - Operating temperature:
    - -20°C to 60°C (-4°F to 140°F)
  - Humidity:
    - 0 to 95% non-condensing
- ⊙ Service Entrance Utility Intertie Options
  - IEEE 1547 – IEEE Standard for Interconnecting Distributed Resources with Electric Power
  - Visible circuit disconnect with draw-out main circuit breaker
  - Utility Intertie Protective Relay Functions as required
  - Voltage & Current Test Switches per utility requirements
  - Potential Transformers (PTs):
    - Fused, revenue grade potential transformers connected in wye or delta configuration
  - Current Transformers (CTs):
    - Dedicated Revenue Grade CTs with 0.3% Accuracy @ B0.1 Burden for Revenue Grade Meters as required

# SBU-Series PDU Switchboards



Figure 39: SBU-Series – 2000A AC Power Distribution Switchboard\*

## SBU-Series 208-600V Power Distribution Unit Switchboard

- ⦿ Delivers power to multiple downstream distribution panelboards from up to 500kVA Uninterruptable Power Supply
- ⦿ System Voltage Range:
  - 480V – 600V, 60/50 Hz
- ⦿ Insulated case Main Circuit Breaker:
  - 1200A – 4000A
  - NEC 2017 - Energy Reduction Maintenance Switch Available Upon Request
- ⦿ UL 891 Listed Standard for Switchboards
- ⦿ Main bus:
  - Silver-plated copper bus (1000A/in<sup>2</sup>)
  - NEMA standard hole pattern
  - 65kAIC bracing min
- ⦿ Symmetrical Interrupting Capacity:
  - 35kA, 65kA or 100kA
- ⦿ Unit Mounted MCCBs offer the ultimate in flexibility, serviceability, and troubleshooting
  - Molded Case Power Distribution Sub-feed Circuit Breakers
- ⦿ Standard or 100% Rated Circuit Breakers
- ⦿ 100% Neutral Bus Standard, 200% Neutral Bus for customer connections available upon request
- ⦿ Emergency remote power-off available upon request
- ⦿ Branch breaker CTs and feeder monitoring available upon request



## PBU-Series Power Distribution Panels

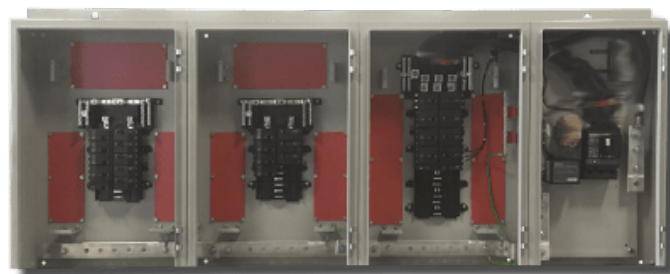


Figure 40: 800A Power Distribution Panelboard NEMA 3R\*



Figure 42: 600A Multi-section Power Distribution Panelboard

Figure 41: Interior of PBU Series Panel Lineup



## PBU-Series 480-600V Power Distribution Panels

- ⊙ Distributes Power to Facility Loads
- ⊙ Designed for supply applications
- ⊙ Available standards (based on ratings & options):
  - UL 67 Standard for Panelboards
  - UL 891 Standard for Switchboards
  - UL 508A Standard for Industrial Control Panels
- ⊙ Voltage:
  - 208V – 600V, 3Ø, 4 Wire
- ⊙ Frequency:
  - 60 / 50Hz
- ⊙ Symmetrical Interrupting Capacity:
  - 18kA, 35kA, or 65kA
- ⊙ Surface Mountable
- ⊙ Bus Options:
  - Tin-plated Aluminum
  - Silver-plated Aluminum
  - Silver-plated Copper
- ⊙ Available Main:
  - Molded Case Circuit Breaker
  - Molded Switch
  - Main Lugs Only
- ⊙ Feeder Breakers:
  - Up to Fourteen (14) 3-pole breakers maximum per section
- ⊙ Bottom & Side Entry for NEMA 1 & 3R
- ⊙ Top Entry for NEMA 1
- ⊙ Fuse Options Available Upon Request

## PTX-Series Utility Power Transformers



Figure 43: PTX-Series - 2000kVA Step Down Power Transformer NEMA 3R\*



Figure 44: PTX-Series - 1000kVA Step Down Power Transformer NEMA 3R\*

## PTX-Series Low to Medium Voltage Power Transformer

- ⊙ Built to all applicable IEEE C57.12.34
- ⊙ High Voltage Side:
  - Aluminum windings
  - 2.4kV - 34,500 V Delta or Wye Connected
  - BIL up to 200 kV
  - Tap changer:  $\pm 2, 2.5\%$
  - Live front
  - Radial feed
  - Optional Bushing wells
- ⊙ Low Voltage Side:
  - Aluminum windings
  - Single Low Voltage Winding
  - 208V - 1200 V Delta or Grounded Wye Connected
  - BIL up to 60 kV
  - Epoxy 2 piece-bushings with 4-holes blade
- ⊙ Cooling class: ONAN
- ⊙ Pad Mount, Step Down
- ⊙ Ratings:
  - 500kVA - 3,000 kVA
  - Frequency: 60 Hz
  - Impedance:  $5.75\% \pm 7.5\%$
  - Temperature rise:  $65^{\circ}\text{C}$
- ⊙ Options:
  - Dead front
  - Loop feed
- ⊙ Enclosure
  - Outdoor NEMA 3R
  - Mild steel tank & cabinet
  - Powder paint system; Color: ANSI 70 or Green Munsell 7GY 3.29/1.5
  - Weights: 7000 – 17500 lbs

# Utility-Utility Source Applications

## Sample Two Utility Source Only Configurations

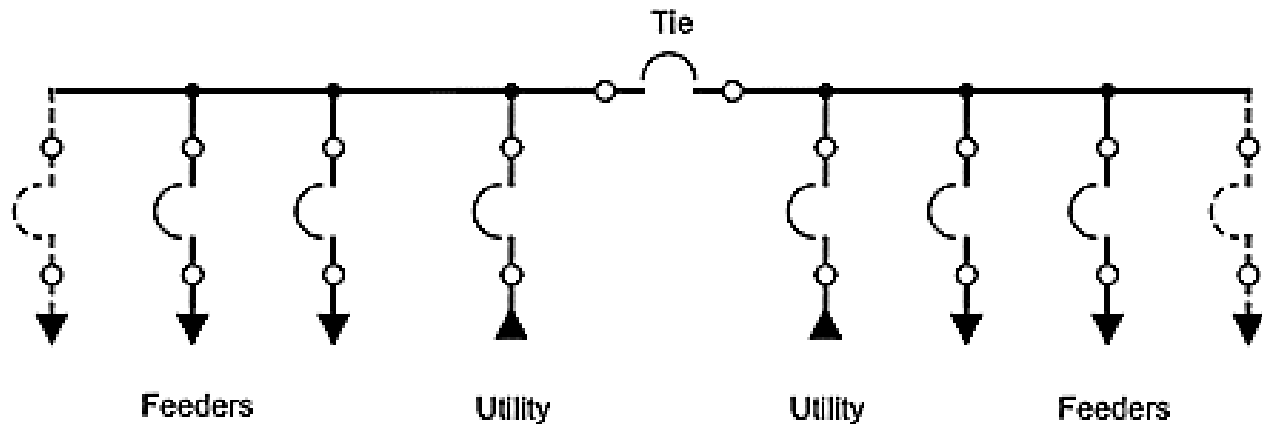


Figure 45: Two Utility Sources Main-Tie-Main with Feeders on Both Ends of the Tie\*

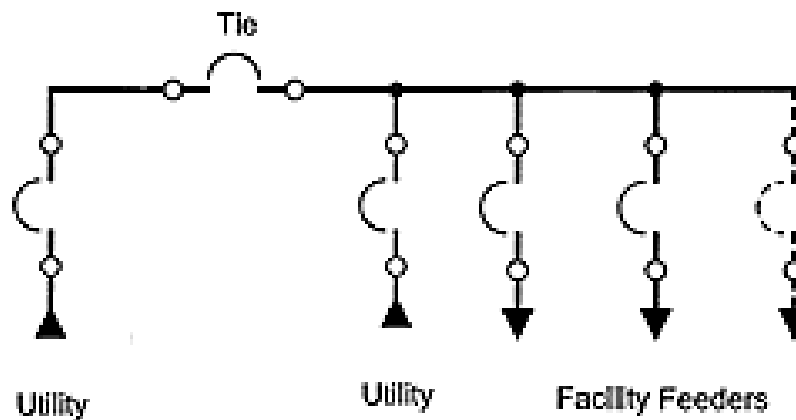


Figure 46: Backup Utility Source Main-Tie-Main with Feeders on One End of the Tie\*

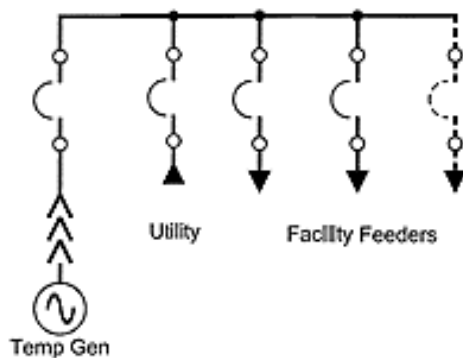


Figure 47: Utility with Temporary Generator Back Up\*

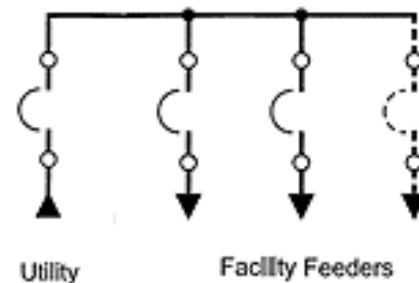


Figure 48: Single Utility with Distribution Feeders\*

## Sample Utility & Generator Configurations

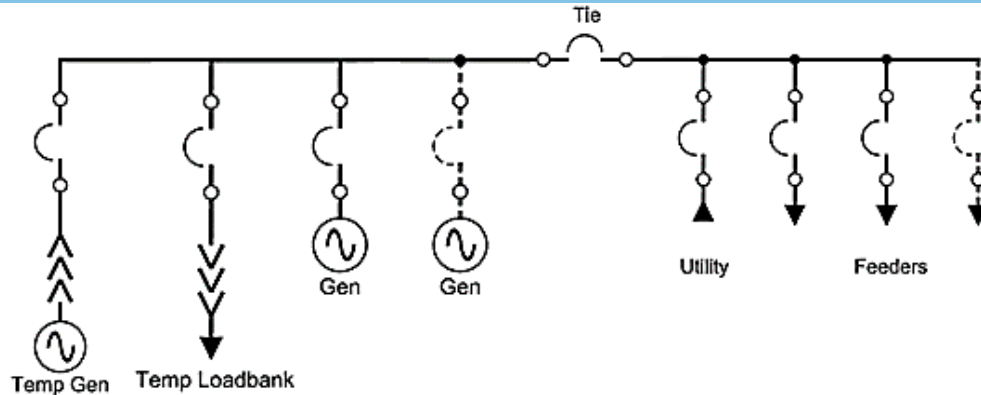


Figure 49: Generator Paralleling with Temporary Generator & Load Bank Quick Connection, Gen Bus Tie, Normal Utility & Distribution Feeders\*

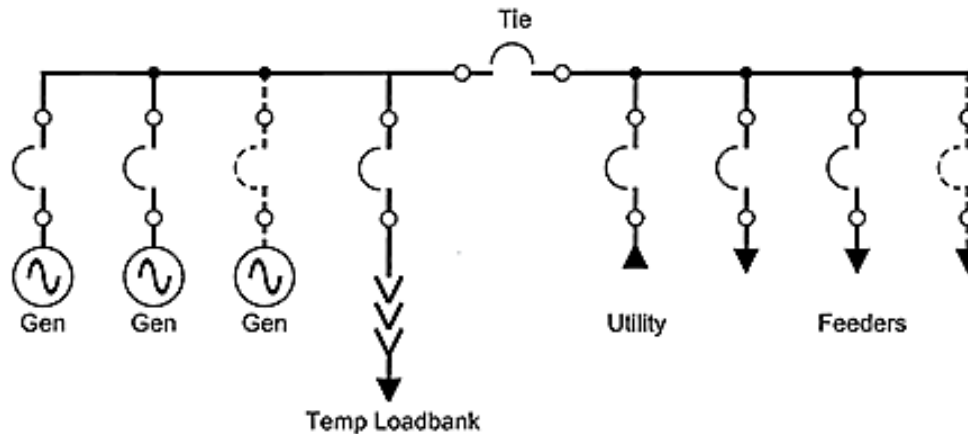


Figure 50: Generator Paralleling with Temporary Generator & Load Bank Quick Connection, Gen Bus Tie, Normal Utility & Distribution Feeders\*

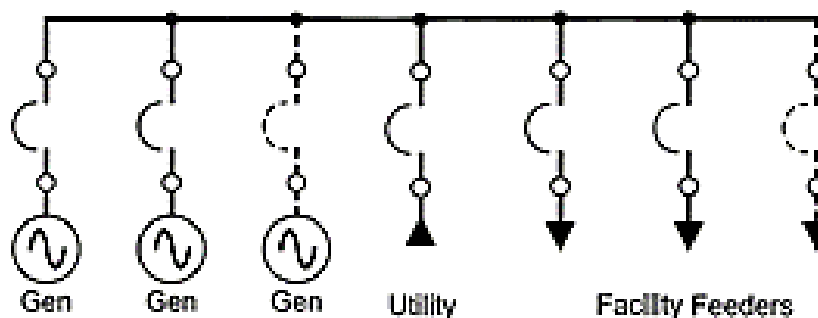


Figure 51: Generator Paralleling Peak Shaving with Normal Utility & Distribution Feeders\*



## Generator Only Configurations

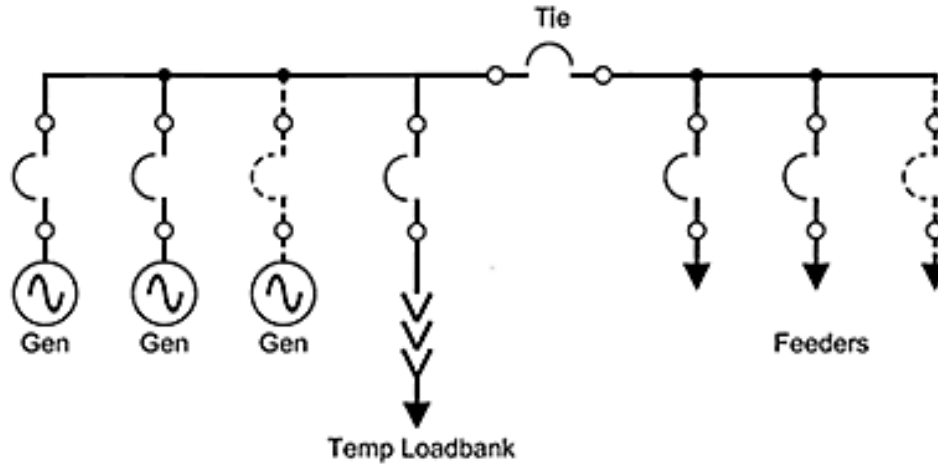


Figure 52: Generator Paralleling with Temporary Loadbank Quick Connection, Gen Bus Tie & Distribution Feeders

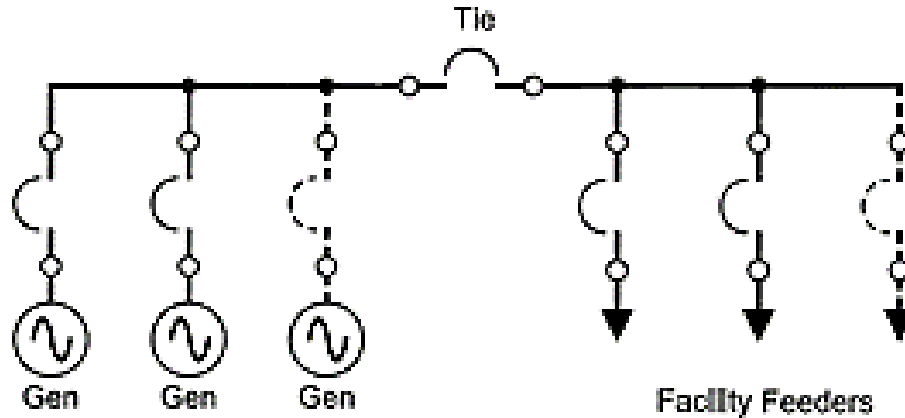


Figure 53: Generator Paralleling with Gen Bus Tie & Distribution Feeders

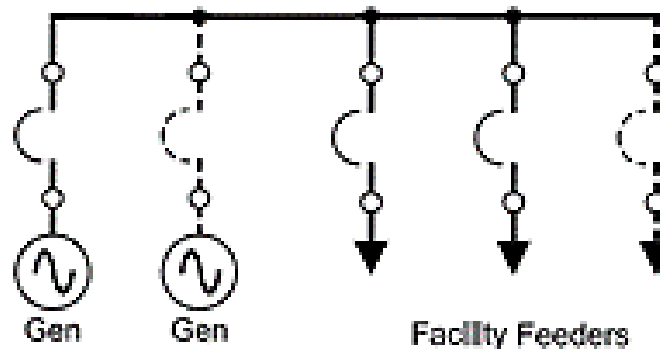


Figure 54: Single Generator or Generator Paralleling with Distribution Feeders

# ATS Application One-Line Diagrams

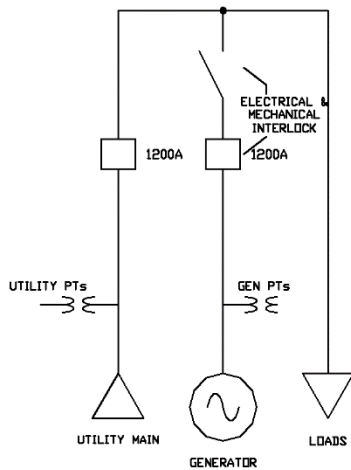


Figure 55: One Utility, One Generator Source Automatic Transfer Switchgear

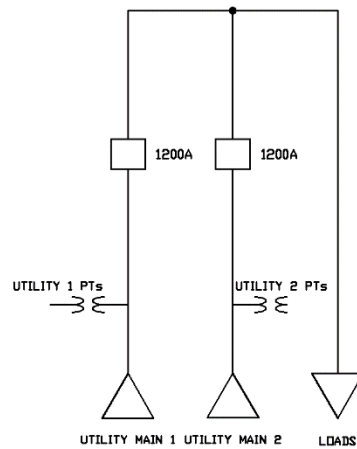


Figure 56: Two Utility Sources Automatic Transfer Switchgear

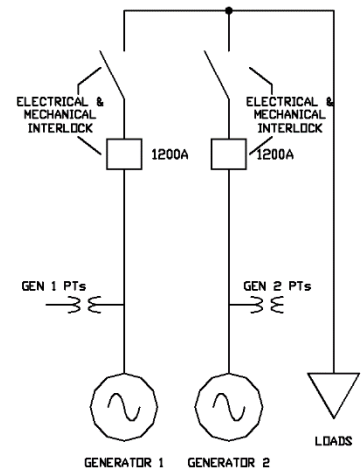


Figure 57: Two Generator Sources Automatic Transfer Switchgear

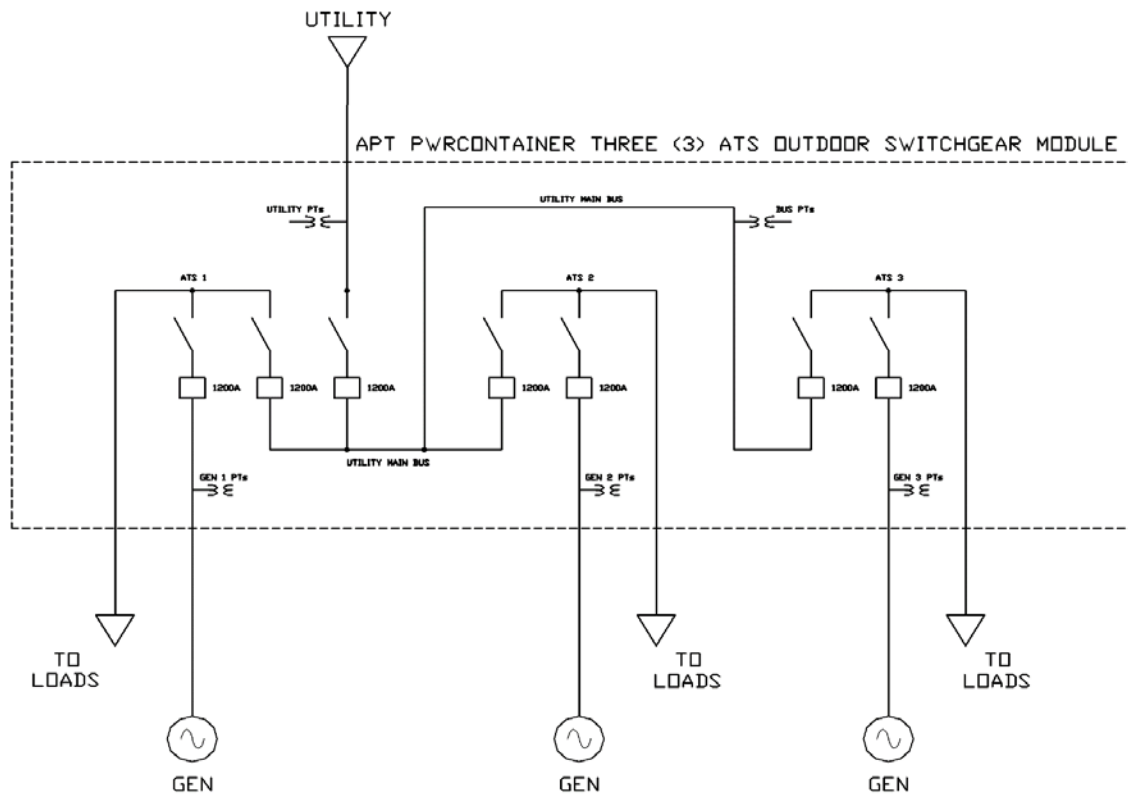


Figure 58: PwrContainer with Three (3) ATS Line-up

# Temp Gen/Load Bank QC Applications

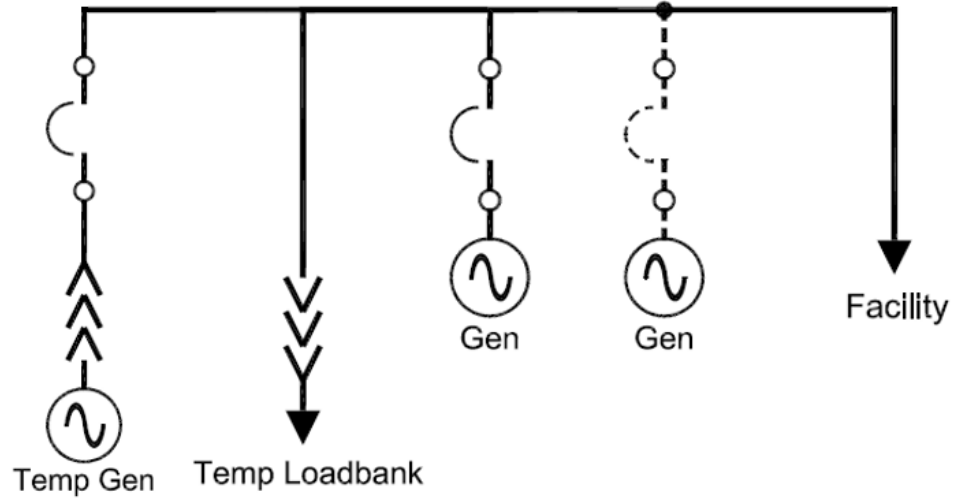


Figure 59: Generator & Loadbank Quick Connection Switchboard with Temporary Generator Circuit Breaker Only

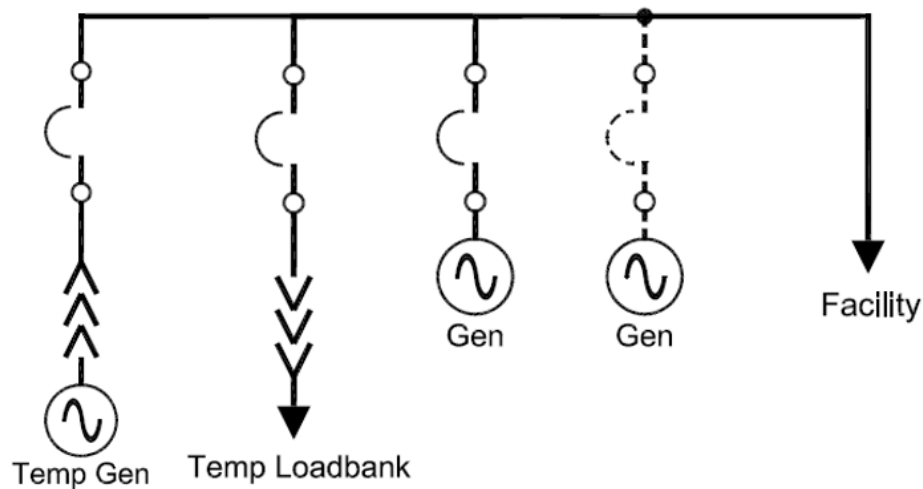


Figure 60: Generator & Loadbank Quick Connection Switchboard with Temporary Generator & Loadbank Circuit Breakers

# Typical Applications for GQC & LQC

## Generator Only Configurations

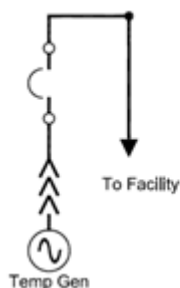


Figure 61: Single Circuit Breaker Option

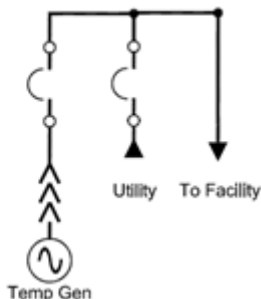


Figure 62: Dual Circuit Breaker Option with Utility & Gen Breaker

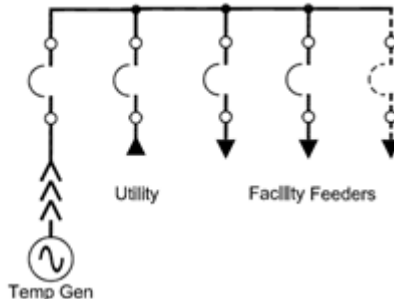


Figure 63: Multiple Circuit Breakers Option

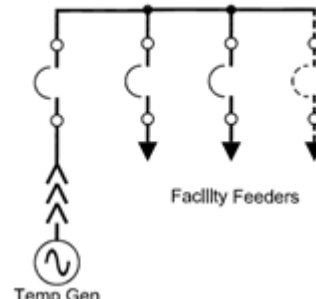


Figure 64: Feeder Circuit Breakers Option

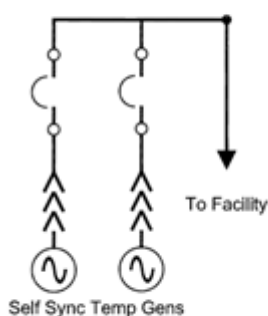


Figure 65: Two Self Sync Temp Gensets into two sets of Cam-locks

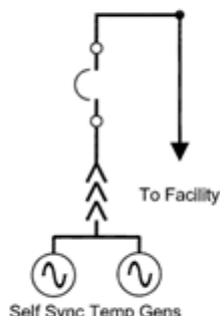


Figure 66: Two Self Sync Temp Gensets into one set of Cam-locks

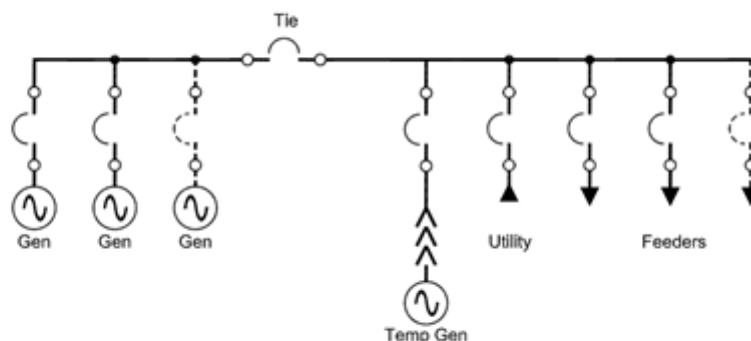


Figure 67: GQC integrated into Low Voltage Switchgear

## Loadbank Only Configurations

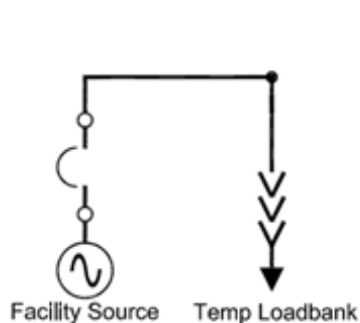


Figure 68: LQC Single Circuit Breaker Option

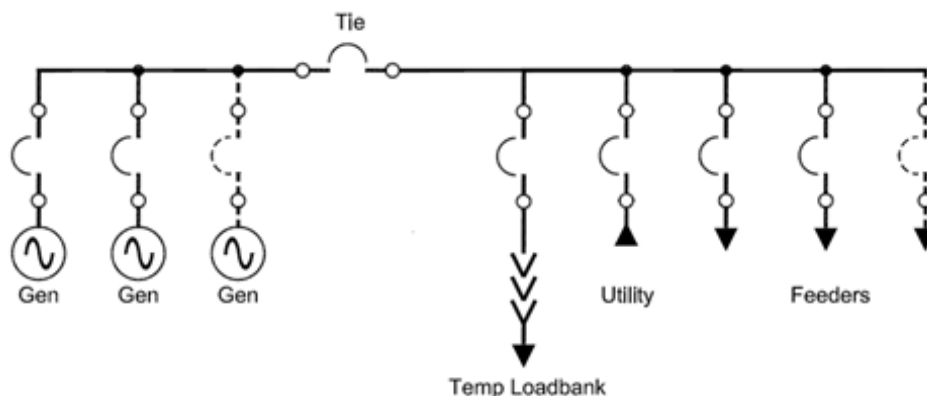


Figure 69: LQC integrated into Low Voltage Switchgear for annual Genset Testing



# About Advanced Power Technologies



Advanced Power Technologies (APT) is on the cutting edge of the latest engineered power system smart technologies, as it relates to microgrid & storage management, renewable & conventional energy source deployment, demand peak shaving, and facility back-up and co-generation power systems. Located in the central United States and headquartered in Lafayette, Indiana with solutions development engineers around the country, APT provides domestic and international products and services to industry leading companies from around the world. APT engineers have decades of power system experience from working with some of the largest companies in industry. Over the last two decades, we have produced successful solutions for hundreds of large-scale electric power projects involving utility/generator paralleling, transfer, peak shaving, and distribution. We pride ourselves in providing electrical power systems that are engineered and custom built, utilizing state-of-the-art technologies to fit our customer's exact needs. The core of our business is low & medium voltage engineered power systems for a wide range of indoor & outdoor applications, such as:

- ⦿ Utility(ies) and Generator(s) Paralleling/Transfer/Peak Shaving/Distribution Switchgear
- ⦿ Microgrids, Microgrid Master Control Panels, SCADA systems
- ⦿ Containerized Battery Energy Storage Systems (BESS)
- ⦿ Photovoltaic (PV) Solar Power Collection/Distribution & Renewable Energy Storage Systems
- ⦿ Low & High Resistance Grounding Systems, Grounding Systems for Photovoltaic Effective Grounding
- ⦿ High Efficiency Combined Heat and Power Switchgear & Control Systems (CHP, Co-generation)
- ⦿ Outdoor Walk-In Electrical Houses (E-Houses) & Skid-Mounted Switchgear
- ⦿ Motor Control Centers & Motor Control Switchgear
- ⦿ Automatic & Manual Load Transfer Switchgear
- ⦿ Bypass/Isolation & Power Distribution Circuit Breaker Switchboards
- ⦿ Generator/Loadbank Quick Connection Switchgear, Switchboards, & Tap Boxes
- ⦿ Industrial Control Panels

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APT cares and understands that each power system is different. We will evaluate various solutions to develop the best solution for a site. APT focuses on our ability to combine several traditional pieces of equipment/functionality into as little of a footprint possible. This saves on space, the cost of equipment, cost of installation, and accomplishes the most optimal/state-of-the-art design your facilities. APT's desires to foster and grow a culture of continued open communication with each customer. Let APT be your source to provide fully engineered power system equipment solutions for the full customer facility on time, on or under budget, and in the smallest footprint possible. We are always available to assist customers and engineers representing customers in the development of complex power solutions for all facility types.