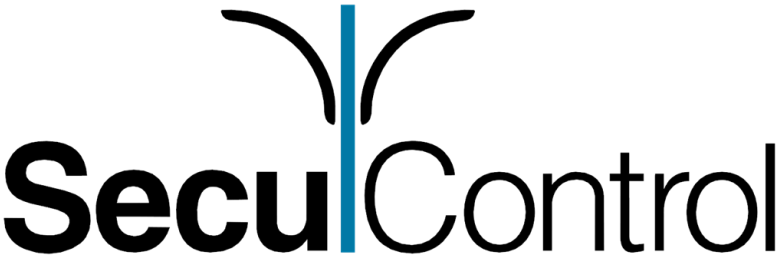

Testing Solutions for Electric Power

Considerations for the Implementation of Test Access Points – A Best Practice Guide

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Overview

- Introduction
- Type and Amount of Test Access Points
- Choice of Hardware and Associated Benefits
- Configuration of Test Access Points
  & Benefits of Standardization
  - Showcase practices from different countries
- Conclusion

Introduction

- NERC PRC-005: periodical testing required in fixed intervals (for time based maintenance)
  - Unmonitored relays: 6 years
  - Self-monitoring microprocessor relays with alarm: 12 years
  - Firmware updates may require additional testing
- Test access points are important elements to fulfill testing requirements

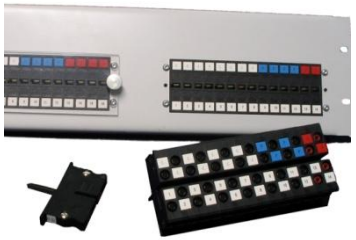
Type and Amount of Test Access Points

- Usage time of a panel – up to 30 years
- Long lasting consequences of design decisions
- Different approaches for new designs / retrofits
  - New designs: determine how many C’s, V’s, T’s need to be available for individual disconnect / test access
  - Retrofits: replicate an existing setup
- Some tests access points newly required due to regulations, e.g. for lockout switches

Choice of Hardware and Associated Benefits

- Hardware choices influenced by historical practice in the region, company, and individual usage preference
- United States and other world regions:
  - Ten-pole test block (knife-blade design and finger-safe design) prevalent
  - Individualized approach to testing

- Europe and other world regions:
  - Test block / test plug approach most common
  - Approach to open all contacts with plug, with integrated sequence



Choice of Hardware and Associated Benefits

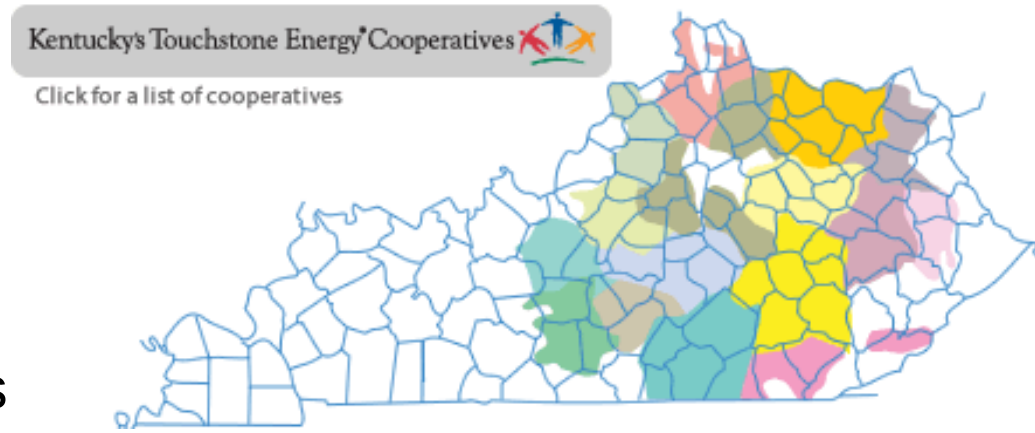
- Each hardware choice has particular benefits:
  - Test switch / test block (individualized approach):
    - flexible disconnect & testing without need of a plug
  - Test block/plug systems:
    - Automatic sequence of operation, preventing unintended trips
    - Well suited for standardized approaches to testing
- Many companies have used a particular design for a long time
- An evaluation of various different hardware options may be beneficial

Determining the Configuration of Test Access Points & Benefits of Standardization

- Once a hardware decision has been made, the configuration of the test access points can be determined
- Benefits of standardization should be considered
- Case studies from different geographic areas:
  - East Kentucky Power Cooperative 
  - Texas New Mexico Power 
  - 50Hertz Transmission GmbH 
  - Companhia Paranaense de Energia 

East Kentucky Power Cooperative (EKPC)

- EKPC:
  - One of the largest US G & T cooperatives
  - Operating over 2,800 miles of high-voltage transmission lines
  - Serving 520,000 homes & businesses across Kentucky



- Hardware choice: individualized ten-pole test block
  - Wanted to keep individualized approach of the test switch
  - Chose finger-safe design to avoid exposed voltages
- Test access points for every current, voltage and trip contact, except for connectorized relays

East Kentucky Power Cooperative (EKPC)

- Standardization on three configurations:
  - Transmission relays

    A- -B C- -D E- -F G H I J

    white currents, blue voltages

  - Bus differential relays

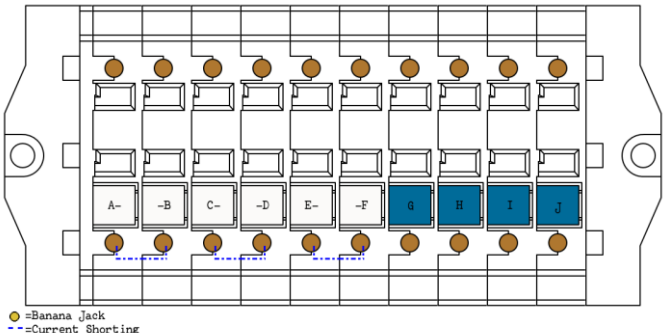
    A- -B C- -D E- -F G H I J

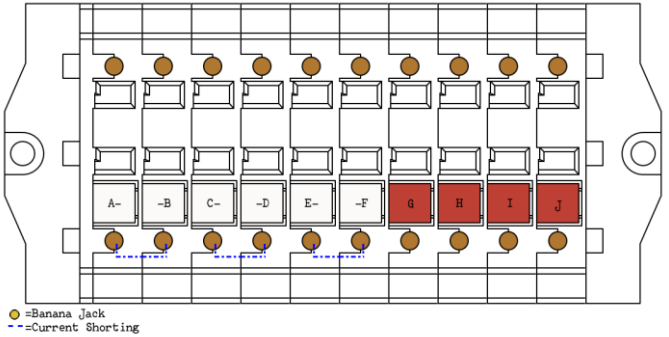
    white currents, red trips

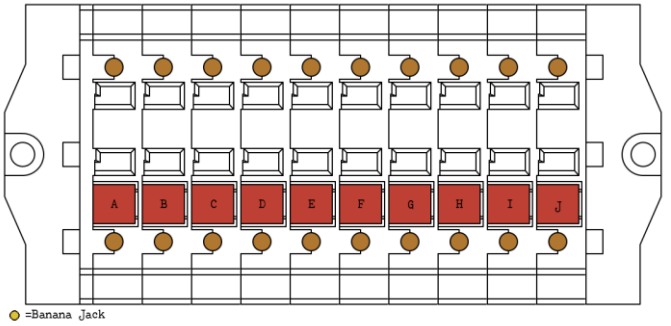
  - Trips

    A B C D E F G H I J

    red trips







East Kentucky Power Cooperative (EKPC)

- Two configurations are electrically identical, but have different labeling:
  - 311L and 487E relays required voltage indication, disconnect contacts are labeled as voltages (blue V labels)
  - 587Z and 387A relays did not require voltage inputs, disconnect contacts are labeled as trips (red T labels)
- Third configuration: all-purpose test block for trips (all red labels)

East Kentucky Power Cooperative (EKPC)

- Depending on the application, one or more standard configurations are used:
  - 387A relays: two CT winding inputs - two current test blocks
  - 311L and 587Z relays: one CT, one current test block
- Amounts of trip contacts was known from previous standards – one or more trip test blocks / relay
- Each test block is assigned to only one device

East Kentucky Power Cooperative (EKPC)

- Standardization on 3 configurations:
  - Fewer different test blocks across the system makes testing easier
  - The same test blocks can be used on different relays and panels
  - Minimizes amount of part numbers
  - Keeps stock numbers low
- Standardized label colors & inscriptions of test blocks
- A document clearly defines standard designs

EAST KENTUCKY POWER COOPERATIVE

A Touchstone Energy Cooperative

Typical Test Switches

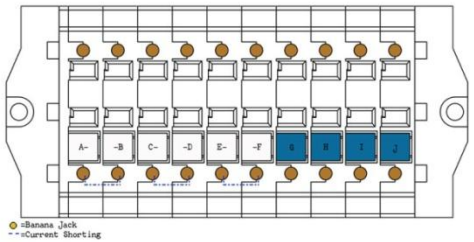
SecuControl – www.secucontrol.com

Transmission Relays (311Ls, for 487E use one of these with as many "BUS Diff Relay TS Part #" as needed)

PART #: FTLP10004AE

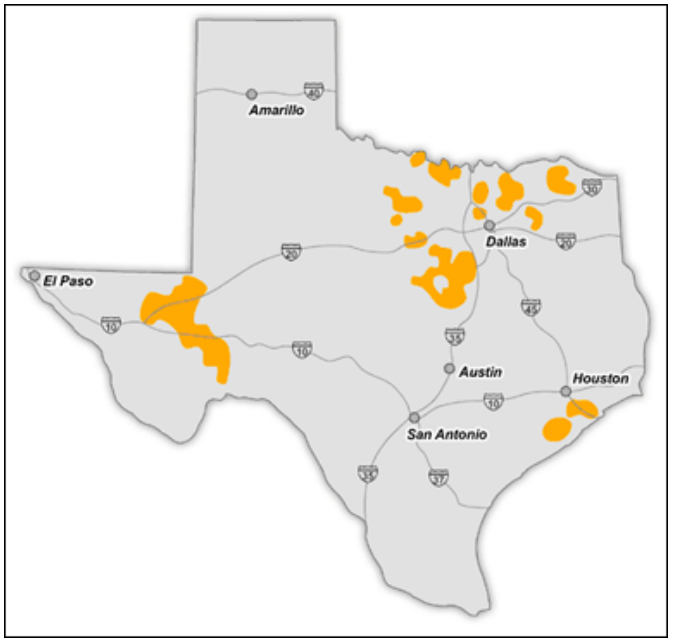
SecuControl FTL Test Block, 10-pole,
horizontal mount, dust cover and pins,
with integrated banana jacks,
configuration: C-C C-C C-C, V V V V
Labeling on Plugs connectors: C- -C, C- -C, C- -C, (all white), V_A, V_B, V_C, V_N (all V's blue),
Labeling Test Switch: A-, -B, C-, -D, E-, -F, (all I's white), G, H, I, J (all V's blue),

image:



Texas New Mexico Power (TNMP)

- TNMP:
  - Electricity T&D company
  - Serving 230,000 customers throughout Texas
- Hardware choice:
  test block / test plug solution
- Several phases of hardware use and standardization:
  - Knife-blade test switch
  - Test block / plug system in different sizes
  - Test block / plug system standardized on 10-pole sizes



Texas New Mexico Power (TNMP)

- Reasons for hardware choice:
  - Safety
    - finger-safe design
    - integrated CT shorting
  - Efficiency
    - technicians can concentrate on the testing procedure
    - usage of a pre-wired plug on multiple relays significantly reduced testing times (for one substation from one day to a few hours)
  - Reliability
    - Opening sequence of test plugs avoids inadvertent tripping

Texas New Mexico Power (TNMP)

- First standardization phase with new hardware:
  - Standard configurations closely aligned with relays
  - Safety, efficiency and panel space savings benefits

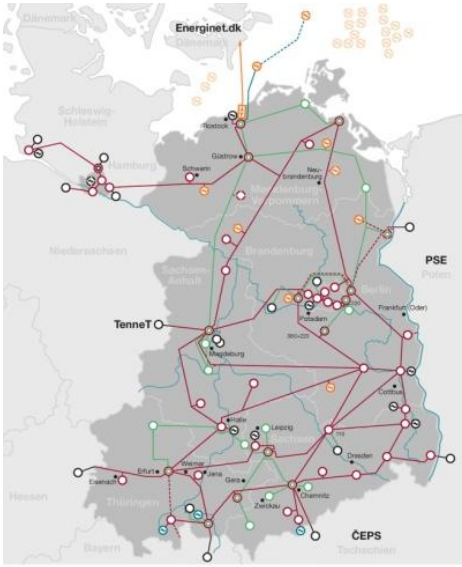
Texas New Mexico Power (TNMP)

- Second standardization phase:
  - Three ten-pole configurations used almost exclusively
  - Operation with ten-pole test plugs (or individual probes)
  - Two-step test procedure (trips first, then currents/voltages)

Texas New Mexico Power (TNMP)

- Benefits of standardization on fewer configurations:
  - Reduced amount of test plugs needed
  - Allowed using the same bundle of test equipment throughout the entire TNMP system
  - Test crews know exactly what they will see in the substation panel
  - Standardized panel design across the system increased the technicians understanding of the system and decreased need to double check wiring or connection drawings
  - Training of new technicians is quicker, and confidence of the technician is increased even when testing during service.

50Hertz Transmission GmbH (50Hertz)



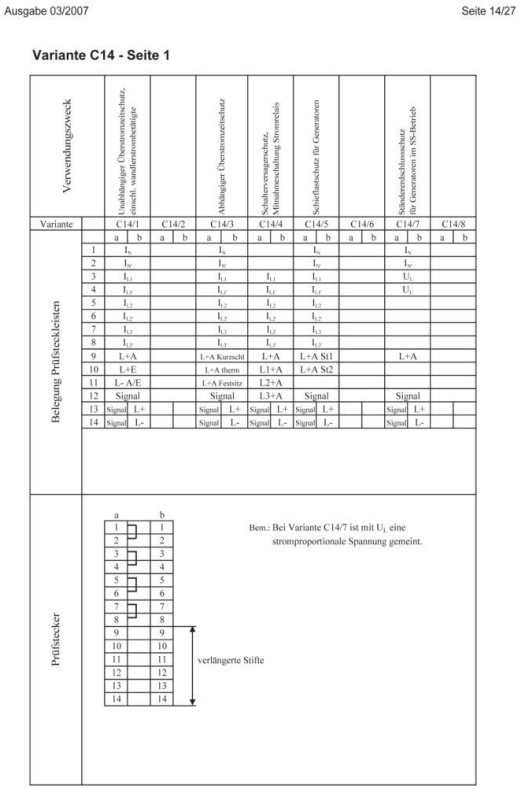
- 50Hertz:
  - German transmission utility, over 10,000 km HV lines
  - Supplying power for 18 million people
- Hardware choice: test block / test plug solution
- Standard based on VDE technical specification:
  - 7-, 14- and 19-pole test blocks and plugs
  - Configurations include currents, voltages and trips, matching relay testing requirements
  - Many configurations are used for different applications
  - Standard dates back to 1970s, later digital protection applications were added

50Hertz Transmission GmbH (50Hertz)

- Examples for typical configurations and uses:
  - “A7” – configuration: C-C V V T T T
    - Single system current-, voltage- and power relays
    - Wattmetric ground fault detection
    - Transient earth fault relays
  - “B14” – configuration: C-C-C-C V V V V T T T T T T
    - Overcurrent time protection
    - Directional overcurrent time protection
    - Distance protection and directional overcurrent protection
  - “C19” – configuration: C-C C-C C-C C-C V T T T T T T T T T T
    - Digital overcurrent time protection
    - Busbar protection

50Hertz Transmission GmbH (50Hertz)

- Standard Test Access Points
  - In use in almost all substations, and with every digital relay
  - Main applications: distance protection, differential protection, transformer protection and line differential protection
  - Testing usually performed by 50Hertz, if contractors the testing details and software are specified
  - 50Hertz performs testing only if cabinets are built according to their standard
  - Test intervals: digital line & transformer protection max 4 years, some types of digital protection max 2 years, electromechanical protection: twice as often or more



Ausgabe 03/2007 Seite 14/27

Variante C14 - Seite 1

Verwendungszweck		Unabhängiger Überstromzeitschutz, einschl. wanderstromabhängige			Abhängiger Überstromzeitschutz		Schalterversagerschutz, Mitnahmeschaltung Stromrelais		Schiefhalteschutz für Generatoren			Ständererdschlussschutz für Generatoren im SS-Betrieb		
Variante		C14/1		C14/2		C14/3		C14/4		C14/5		C14/6		C14/7		C14/8
		a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b
Belegung Prüfsteckleisten	1	I_{L1}				I_{L1}				I_{L1}				U_{L1}			
	2	I_{L2}				I_{L2}				I_{L2}				U_{L2}			
	3	I_{L3}				I_{L3}		I_{L1}		I_{L3}				U_{L3}			
	4	$I_{L1'}$				$I_{L1'}$		$I_{L1'}$		$I_{L1'}$							
	5	I_{L2}				I_{L2}		I_{L2}		I_{L2}							
	6	$I_{L2'}$				$I_{L2'}$		$I_{L2'}$		$I_{L2'}$							
	7	I_{L3}				I_{L3}		I_{L3}		I_{L3}							
	8	$I_{L3'}$				$I_{L3'}$		$I_{L3'}$		$I_{L3'}$							
	9	L+A				L+A Kurzschl		L+A		L+A St1				L+A			
	10	L+E				L+A therm.		L1+A		L+A St2							
	11	L- A/E				L+A Festsitz		L2+A									
	12	Signal				Signal		L3+A		Signal				Signal			
	13	Signal	L+			Signal	L+	Signal	L+	Signal	L+			Signal	L+		
	14	Signal	L-			Signal	L-	Signal	L-	Signal	L-			Signal	L-		

Prüfstecker

a	b
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
10	10
11	11
12	12
13	13
14	14

verlängerte Stifte

Bem.: Bei Variante C14/7 ist mit U_L eine stromproportionale Spannung gemeint.

50Hertz Transmission GmbH (50Hertz)

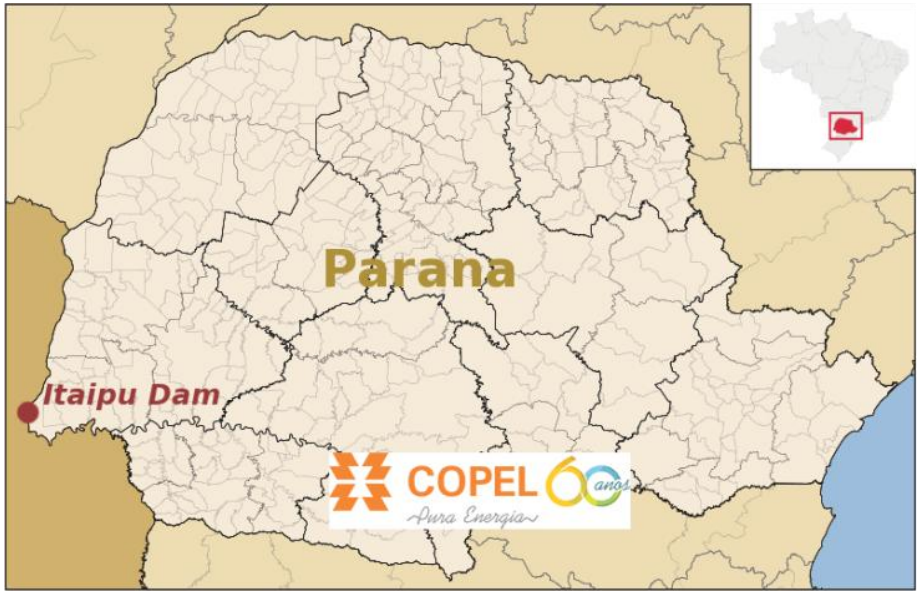
- 50Hertz standardized protection panels for transformer protection (left) and line differential protection (right)

50Hertz Transmission GmbH (50Hertz)

- Benefits of standardized approach:
  - High work safety for technicians
  - Protection from unintended trips
  - Possibility to test during operation
  - Test efficiency and time savings
    - Low numbers of qualified personnel – highly standardized process
    - Standardized test access points, panel designs, test templates and automated settings for test routines
    - All test blocks are wired in the same way for the same function
    - Currently high investments in HV transmission grid – more commissioning and functional testing, increasing need for efficiency
  - Stocking, reordering, working with contractors

Companhia Paranaense de Energia (Copel)

- Copel:
  - Serves 4.1 million customers in the Brazilian state of Paraná
  - Operates 2,174 km of transmission lines and 187,310 km of distribution lines
- Hardware choice: ten-pole test block



Companhia Paranaense de Energia (Copel)

- Stayed with the individualized approach to testing
- Change to finger-safe style motivated by concerns about electrical exposure
- Continued using existing standard configurations (3 ten-pole test blocks)
- Standard configurations are used in new projects as well as retrofits
- No changes to existing designs or the test process

Conclusion

- Well designed test access points are an important element to help fulfill testing requirements (NERC PRC-005, …)
- Different hardware choices with respective benefits are available and should be considered
  - Individualized opening/closing of poles
  - Predefined opening/closing sequence with test plug
- Real-world examples show different approaches - all experience benefits through thoughtful standardization, e.g. safety, test efficiency, test during operation, labeling, stocking, …
- A first installation in a test environment or limited project may be useful to improve the design, and aid training

Questions

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