The ‘Universal Relay’ Family

“The engine for substation automation”
The Challenges of the ‘Universal Relay’

Performance

Cost ($)

Universal Relay

Busbar

Diagnostics

Monitoring

Metering

Control

Protection

Feeder

Transformer

Generator

Transmission Line
Hardware Architecture Overview
Universal Relay Architecture - ‘Modularity’

Six Basic Modules
Physical Realization

19” Chassis
(4RU high)

Modules

High-Speed Data Bus

Modular HMI
Modularity...

Power Supply

- HALT/HAST limits
  - -40 - 130°C
- High Efficiency SMPS
  - > 80%

CPU

- High-speed 32-Bit RISC CPU
  - > 50 MIPS, up to 120 MIPS
- FLASH memory
- Easy firmware upgrades
- High-Speed Comms support
  - 10/100Mbps Ethernet LAN
  - Redundant Fiber

DSP + CT/VT

- Modular CT/VT configurations
  - up to 8 CT/VTs
- High-speed digital sampling
  - >16 Bit A/D
  - > 64 samples / power cycle
- High-speed 16-Bit DSP
  - > 32 MIPS, up to 80 MIPS
Modularity...!

**Digital I/O**
- Control outputs
  - Solid State
  - Electromechanical - multiple types
  - Fast activation speeds (< 4ms)
- Status inputs
  - Dry and Wet contacts
  - 18 - 300 VDC
  - Fast detection speeds (< 4ms)

**Analog I/O**
- Transducer type inputs
  - ± dcmA
  - ±Voltage
  - Resistive
- Outputs for Legacy SCADA
  - ± dcmA
- Support multiple I/O configurations

**Communications**
- High-speed Serial
  - Asynchronous (9600 - 115K Baud)
  - Synchronous (56K - 256K Bps)
- Fiber Optical (Single/Multi mode)
- Channel Redundancy
Inter-Module Communications

High-Speed Data Bus

- High-Speed Parallel Data Bus: 80 - 100 Mbytes/sec
- High-Speed Serial Communications Bus: 10Mbps
- High-Speed Inter-Processor Serial Data Bus: 16Mbps

Multiple buses allow for high-performance:
  - Protection and communications without bottlenecks
Scalability

Minimum

Maximum
‘Box’ Capacity

CT/VT (I & V) inputs
up to 3 modules

Status (Binary) inputs
up to 6 modules

Control (contact) outputs
up to 6 modules

Analog (Transducer) I/O
up to 3 modules

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CT/VT (I & V) inputs
up to 3 modules
24 (max)
8/module

Status (Binary) inputs
up to 6 modules
96 (max)
16/module

Control (contact) outputs
up to 6 modules
48 (max)
8/module

Analog (Transducer) I/O
up to 3 modules
24 (max)
8/module
Configuration/Flexibility

Sub-Modules
Sub-Module Types

**Current & Voltage**
- Current & Voltage
- Future
- CT, VT
- Optical, Digital

**Control and Status I/O**
- Control and Status I/O
- Future
- Form-A
- Form-C
- Solid-State
- Wet/Dry Input
- Customer

**Analog (Transducer) I/O**
- Analog (Transducer) I/O
- Future
- ±1mA, 4-20mA, 0-5mA
- RTD (Pt, Ni, Cu)
- ±5V, Resistive
- Customer
‘Upgradeability’/Serviceability

‘Plug n Play’

- Easy Module Draw-out
- Field Wiring Undisturbed
- Module Keying
- CT Shorting ‘Clips’
Software Architecture Overview
Modular, flexible hardware architecture requires software to support it.

**Major functional elements required:**

- Protection Elements
- Metering Elements
- Monitoring Elements
- Programmable Logic and I/O control
- Data and Event capture/storage
- HMI programmability
- Communications
Modular Software: ‘Object Oriented’ Design

Protection

- TOC
- IOC
- Distance - Mho
- Distance - Quad
- Distance - Lens
- Differential - Xfrmr
- Differential - Bus
- Differential - Line
- Frequency - df/dt
- Frequency - Under
- Volts/Hz

Class

Objects of the Class
Building Applications: ‘Object Oriented’ Design

Classes

Protection  Metering  Control  Monitoring  HMI  Comms

Common Core Software

Application Software
A Common Platform: Modular H/W and S/W

Application Software

- Feeder
- Line
- Transformer
- Generator
- Busbar
- Control
- Monitoring
- Diagnostic
- Power Quality
Communications Capabilities Overview
The UCA Substation

10Mbps Dual Ethernet Fiber Hubs

Interoperable IEDs

Access to:
- Enterprise
- Internet

Slower Legacy Devices use Gateway

UCA2 COMPLIANT UR FAMILY

PROPRIETARY PROTOCOLS LEGACY DEVICES
UCA - ‘Peer-to-Peer’

**Response time**
- UCA 10/100Mbps LAN: 4 ms
- UR Relay 1: Response time = 2 ms
- UR Relay 2: Response time = 2 ms
- UR Relay 3: Response time = 8 ms
Universal Relay - ‘Peer-to-Peer’ performance

< 8ms, Event-to-Output

GOOSE Message

FlexLogic™
RELAY #1
Trip Message

FlexLogic™
RELAY #2
Trip Output

FlexLogic™
RELAY #3
Blocking Message
Inter Substation Communications

FSC
(Fiber Optic System Communications)

- SONET Technology: 51/155 Mbps
- Ethernet LAN ‘Bridging’ capability
- Creates single Ethernet WAN
- Redundant channels ensure reliability
Configuration Tools & Capabilities:
• FlexLogic™
• ‘Sources’
• URPC
UR Functional Architecture
UR FlexLogic™ Architecture
UR FlexLogic™ Example

Voting Logic Schematic
UR FlexLogic™ Example
UR FlexLogic™ Example

Time Overcurrent Acceleration
UR FlexLogic™ Example

Example Using FlexLogic in UR Relay

Flexlogic can be used to implement various protection and control schemes. Shown here is a simple yet effective 4-step load shedding system restoration prepared using Flexlogic. For Under Frequency (UF) protection elements having 1 different set point s have been used. The load shedding scheme is accomplished using only two of the 30 "Virtual Inputs" available in Haxlogic.
Concept of ‘Sources’

‘Sources’ is a concept used in the Universal Relay to:

• Simplify the configuration and usage of multiple 3Ø I & V inputs (up to 24)

• Group 3Ø I & V inputs into a ‘source’ to be used by Metering and Protection elements

• Numerically sum 3Ø currents from different CTs on the power system

• Perform Synch-Check by grouping appropriate VT inputs for comparison
Breaker-and-a-Half Scheme
Traditional Relay Application

CT1

VT1

CT2

50BF RELAY

50BF RELAY

External Summation

VOLT

AMPS

50P

W

67P

Protective Relay
Universal Relay Solution Using Sources

Universal Relay 'box'

High-Speed Data Bus

COMMUNICATIONS (Ethernet, HDLC, UART)

DSP & Magnetics
DSP processor + CT/VTs

Power Supply

CPU

Main Processor

VT1

CT1

CT2

CT1

CT2
Multiple Feeder + Busbar
Universal Relay Solution using 'Sources',

Universal Relay 'box',
‘Sources’ Configuration

Physical 3-phase I & V Inputs

Configure Sources (done via settings)

Source #1

Source #2

Source #3

Source #4

Source #5

Source #6

Universal Relay
F35 Multiple Feeder Relay

F35 Multiple Feeder Management Relay™
URPC - One common tool for the UR Family

Settings
Metering
FlexLogic™

Oscillography
Single-Line
Future Development
UR + UCA + Internet = New Possibilities
Internet Communications NOW!

Test a UR F60 Feeder Management Relay over the Internet

View/Retrieve:
- Metering
- Events
- Oscillography
The UR Family - One common Architecture

**TRANSMISSION**
- L60 (Transmission Line: Phase Comparison)
- L90 (Transmission Line: Current Differential)
- D60 (Transmission Line: Distance)

**DISTRIBUTION**
- F60 (Feeder: Comprehensive w Hi-Z)
- T60 (Transformer: Comprehensive)
- C30 (Control IED)
- C60 (Breaker Management IED)

**SYSTEMS SOFTWARE**
- URPC (Entry Level HMI, Engineering Tool)
- PMCS (Full Featured Systems HMI)

**GENERATION**
- G60 (Generator: Comprehensive > 100MVA)
- B30 (Busbar: Basic 6 Feeder)
- B90 (Busbar: Comprehensive - up to 30 Feeders)

(Available in 2000)
Universal Relay Protection Highlights & Benefits
The Universal Relay Family - Protection Highlights

Common to entire family:

- **High-speed power system current and voltage sampling:**
  - 64 samples per cycle (e.g. 3.84 KHz @ 60Hz)

- **High speed Protection:**
  - Elements calculated 8 x per cycle (e.g. every 2ms @)

- **High accuracy metering:**
  - 0.25% of reading from 0.1xCT to 2.0xCT

- **Oscillography:**
  - Up to 128 cycles (up to 1024 cycles available with memory expansion)

- **Sequence of Events Recorder:**
  - Up to 1024 event records, time stamped to **microsecond** precision

- **High speed peer-to-peer UCA2 communications:**
  - 10Mbps UCA2 LAN, Fast ‘GOOSE’ control messaging

- **FlexLogic™ for customization of schemes utilizes ‘virtual’ (remote) I/O:**
  - Allows for distributed programmable scheme logic via LAN **across entire substation**

- **‘Sources’ concept simplifies the configuration of multiple 3Ø I & V inputs**
  - Numerically sum 3Ø currents from different CTs on the power system
The Universal Relay Family - Protection Highlights

**DISTRIBUTION**

- **F60** (Feeder Management Relay)
  - Comprehensive feeder protection with high-speed, sub-cycle fault clearance
  - Multiple high-speed bus transfer trip schemes
  - Improved ‘Hi-Z’ downed conductor detection (2x sensitivity)

- **F35** (Multiple Feeder Management Relay)
  - 5 Feeders with busbar voltage, 6 Feeders without busbar voltage
  - IOC, TOC, Underfrequency, Undervoltage, 4-shot configurable recloser

- **T60** (Transformer Management Relay)
  - High-speed, dual-slope, % differential protection (up to 6 windings)
  - ‘Dynamic Inrush Restraint’ - proper operation for inrush OR energizing onto fault
  - ‘Loss-of-Life’ management

- **C60** (Breaker Management Relay)
  - Breaker failure + synch-check + reclose for dual breakers
  - Breaker monitoring and diagnostics

- **C30** (Controller IED)
  - Utility ‘hardened’ programmable logic controller and sensor concentrator
  - Discrete I/O and transducer I/O (e.g. dcmA -1 to 20mA, RTDs)
The Universal Relay Family - Protection Highlights

**TRANSMISSION**

- **L60** (Line Phase Comparison Relay)
  - New algorithm digitally mimics traditional analog approach with improvements
  - Support for multiple schemes (7 currently defined)
  - Support for new and legacy power line carrier equipment (CSxx, RFL)

- **L90** (Line Current Differential Relay)
  - High-speed, sub-cycle fault clearance
  - ‘Adaptive Elliptical Restraint’ - improved sensitivity without compromising security
  - ‘Self-Synchronizing’ algorithm - does not require common external clock source

- **D60** (Line Distance Relay)
  - State-of-the-art digital filtering adapted to deal specifically with CCVT transients
  - Excellent transient overreach control (< 5%) for lines with CCVTs and high SIRs
The Universal Relay Family - Benefits
Common to entire family:

• No more stranded relay investments:
  • Upgradeable to future technology,
  • Scalable and configurable to changing requirements
  • Easy ‘serviceability’ via plug-n-play modules

• Reduced integration and learning costs:
  • Reduced system integration cycle time due to common platform for all devices
  • Reduced learning curve cycle because of common “look & feel” across family
  • Reduced wiring costs by utilizing high-speed UCA2 LAN communications
  • Protection, control, metering & monitoring in one ‘box’

• Substation automation ready:
  • Supports multiple high-speed 10Mbps LAN options - UCA2, Modbus/TCP/IP, DNP3.0
  • Supports communication via WAN or via Internet.
  • Supports high-speed legacy serial communications - (i.e. RS485 up to 115Kbps)
  • Supports multiple telecom multiplexer (i.e. SONET) interfaces: G.703, RS422, Fiber

• Support for continuous monitoring and diagnostics:
  • Interfaces directly to transducers for Breaker, Transformer and LTC ‘health’ monitoring
  • Platform for future built-in diagnostics capability
  • Provides continuous data retrieval capability via LAN, WAN or Internet
The *Universal Relay™* Family

www.ge.com/indsys/pm