COMMUNICATION NETWORKS

FOX615 OPIC2

IEEE C37.94 interface unit for differential protection.

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Enabling differential protection over packet-switched and TDM-based networks with guaranteed performance and a risk-free migration path.

01 OPIC2 IEEE C37.94 interface unit

As the most demanding application for any power utility, differential protection requires a highly robust and available communication infrastructure with well-defined deterministic behavior. In all circumstances, communication systems must guarantee uninterrupted exchange of information with the required performance to ensure proper operation of differential protection relays.

While this was proven successful with Synchronous Digital Hierarchy (SDH) technology, the same can no longer be guaranteed when migrating to packet-switched technology. This results in poor operation or, even worse, no operation of the protection system. As matter of fact, conventional circuit emulation (according to RFC specifications) for traditional TDM services over packet-switched networks can lead to non-deterministic behavior, which causes virtual fault currents in differential protection relays resulting in false tripping.

To fully protect the energy grid and valuable assets, the new OPIC2 interface provides specific circuit emulation functionality, which enables dependable communication for IEEE C37.94-based protection devices through packet-switched networks. With the new OPIC2 interface, TDM and packet-based transport technologies are available on a single unit with guaranteed performance as per most demanding requirements of the differential protection application.

OPIC2 key features

- Support of TDM and packet-based transport technologies for easy migration from SDH to MPLS-TP networks
- 4 x IEEE C37.94 interfaces are small form-factor pluggable-based (SFP) transceivers for direct connection with the protection device
- High-performance circuit emulation, specifically designed for differential protection over packet-switched networks
- Hitless redundancy for differential protection communication channel over packet networks
- Six electrical IRIG-B time code & PPS outputs for synchronization of end devices to GPS clock
- Enhanced traffic supervision functionalities
- Full integration in FOXMAN-UN (NMS)
- Guaranteed data integrity via authentication of data streams over packet-switched networks
- All optical interconnections provided from relay to relay, without any converter boxes

OPIC2: Integrated differential protection interface with unmatched performance.

High-performance circuit emulation for differential protection via packet-switched networks (PSN)
Differential protection relays usually calculate the delay times of the data channel by periodic round trip delay measurement. Therefore sudden latency changes, as well as asymmetrical delay times, cannot be detected and can potentially lead to incorrect tripping of power lines. OPIC2 solves this problem with a high-performance circuit emulation, which allows the transmission of differential protection data through a packet-switched wide area network (WAN).

Continuous channel supervision and enhanced alarm features supervise the quality of the communication channel, while hitless redundancy features ensure the highest availability of the communication channel. If the WAN quality is unavailable or in a critical stage, the protection relay is notified.

All about deterministic data channels
OPIC2 guarantees a highly deterministic data channel. The system is based on a configurable latency time of the communication link, which is adjustable in a range of 6-20 ms. This latency time needs to be adapted to the real conditions of the specific network configuration.

The combination of innovative features in OPIC2 and the FOX615 platform guarantees highly available, symmetrical real-time communication channels using wide area communication networks based on TDM and packet- switched technology. Thus it guarantees there is no wrong tripping of power lines due to communication problems. The solution also fully complies with the demanding requirements of harsh substation environments, and complies with standards such as IEEE 1613, EN 61000-6-2/3 and IEC 61850-3.

End-to-end smooth migration
Even during complex communication network modernization, halting the energy grid is not an option for a utility supplying power to homes and industries. Since a significant amount of protection applications still communicate on TDM, the migration needs to be planned carefully.

To smooth that process, the new OPIC2 interface further expands the FOX615 hybrid functionality to now support communication over TDM and packet-switched transport networks at the same time. No hardware change or rewiring of protection devices is longer needed at the substations. Migration of mission-critical differential protection services is simply done through service configuration in the network management system thus enabling a truly end-to-end smooth risk-free migration towards a packet-based infrastructure.

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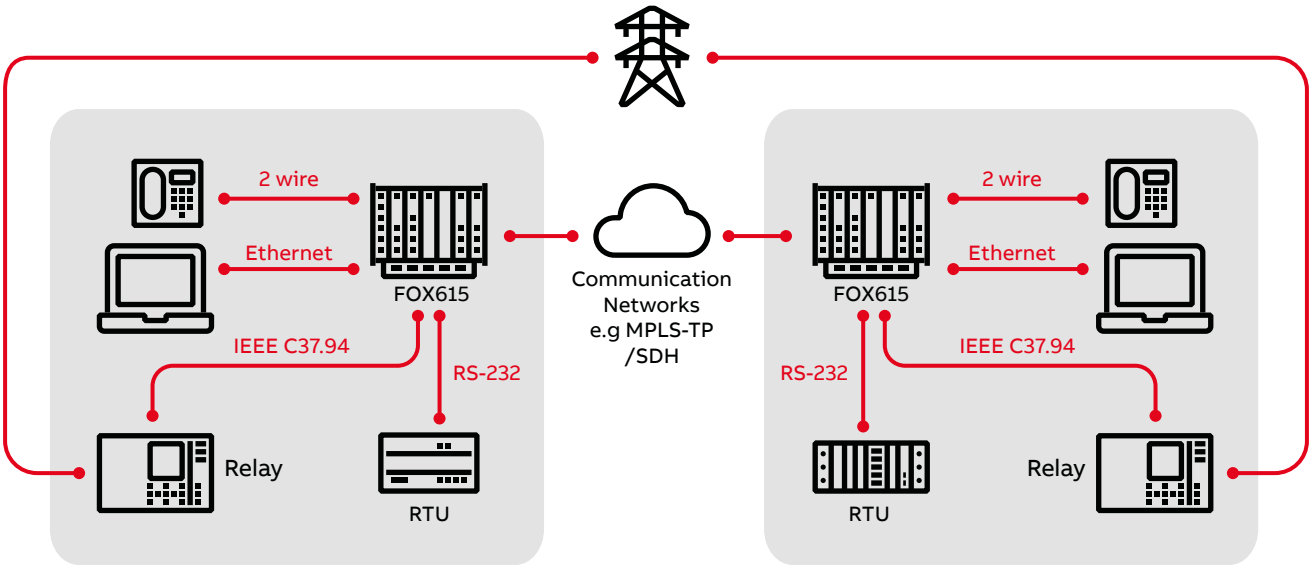

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Increased performance.
Less effort.

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03 Integration of electrical interfaces

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04 Real time distribution from cenral time server to end devices using IEEE 1588v2 (One way Communication)

OPIC2 architecture
With FOX615 and OPIC2, differential protection is just one application of many. OPIC2 WAN interface supports TDM-Bus and packet-switched access enabling operation of differential protection systems over SDH or MPLS-TP networks at the same time. Distinct measures such as special channel routing, network over-dimensioning and complex configuration or dedicated fibers are not necessary anymore to guarantee precise systems operation.

The 4 x 2 Mbit TDM bus access can be used to integrate older differential protection relay types using electrical interfaces instead of the standardized IEEE C37.94 optical interface. Such older relays would be connected to the corresponding data interface on FOX615 (e.g., LEDS1 for X.21, or LECO1 for G.703 64 kbit/s) and use the high-performance circuit emulation functionality of OPIC2 to enable communication through a packet-switched WAN, with guaranteed performance.

Real time information is the key for future applications
Fault recorders, event recorders, differential protection relays and also wide area protection schemes using synchrophasors need very accurate time of day information to ensure precise operation, or to provide statistical analysis at a later stage. FOX615 supports IEEE 1588v2 Precision Time Protocol (PTP) as well as synchronous Ethernet. This enables the distribution of time-of-day information from a central time server through the WAN to substations and end devices. With its IRIG-B outputs, OPIC2 enables the distribution of this information to end devices, making local GPS installations void and increasing the system's overall availability.

Management system
All modules of FOX615, including a variety of services and applications, are managed centrally by the FOXMAN management system, the network management system for the complete communications portfolio.

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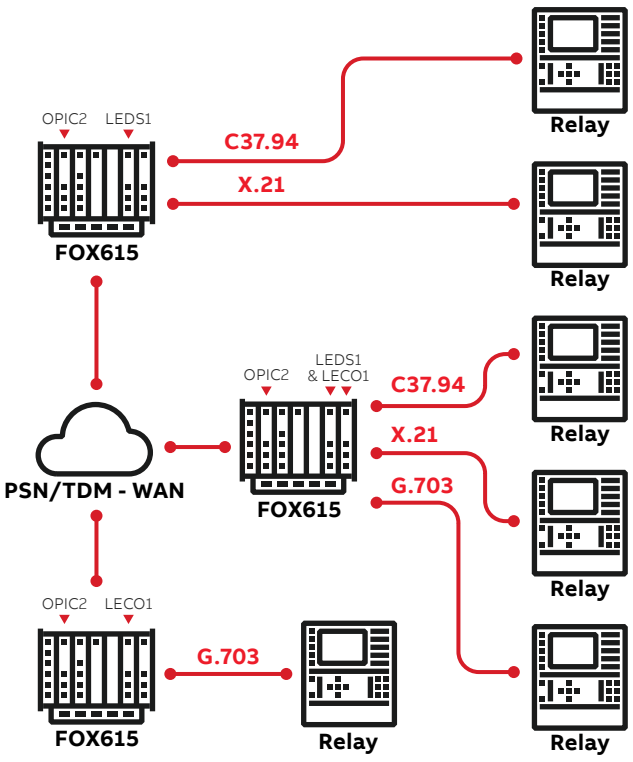

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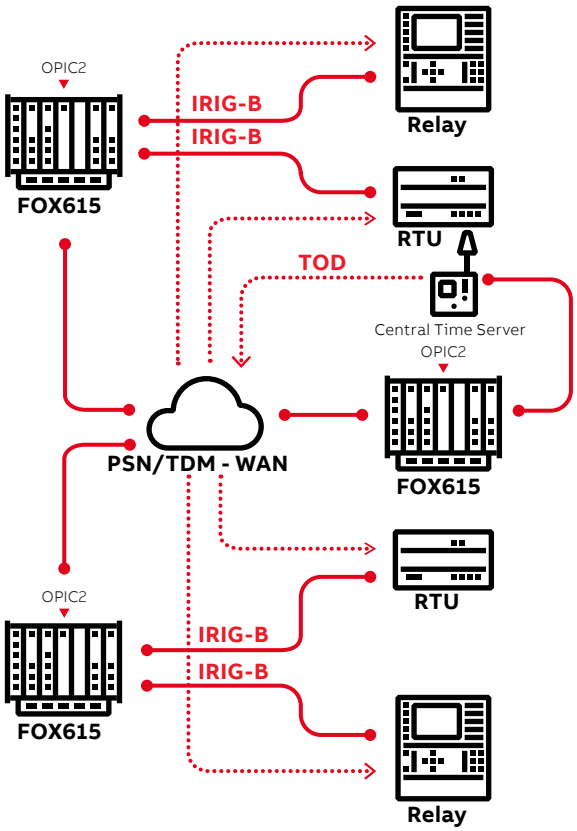

General WAN Interface Mode: Packet or TDM	
Designed for	FOX615/612, Packet-switched access and TDM-Bus access
Number of ports	4 SFP front ports, 4 x access to the FOX615 TDM bus All optical ports require SFP for: - 850 nm (multimode) or - 1310 nm (single-mode)
Circuit emulation over PSN - Configurable end-to-end latency time - Max. asymmetry, jitter & wander	4 high performance circuit emulation instances 1-20 ms 150 us
Operation mode	IEEE C37.94 or ABB TPE
IRIG-B/PPS outputs	6 x electrical as per IRIG-B002/006, 1 x optical MM 820 NM, ST connector
Module width	1 mechanical slot in FOX615
Environmental conditions	According to FOX615 specification
Configuration tool	FOXCST
Maintenance	Local and remote test loops available, traffic statistics
Channel redundancy	Packet mode: hitless traffic redundancy TDM mode: Typical 1+1 switchover time ≤ 25 ms
Standard compliance	IEEE C37.94, IEC 62843, IEEE 1613, IEC 61850-3, EN 61000-6-3/2, IEC 61000-4-2/3/4/5/6/8/16/18/29, EN 60950-1, IEC 60255-5
MTBF	> 100 years

Interfaces		
Interface type	**IEEE C37.94**	**ABB type**
Max. port number	4	4
Type of port (connector)	Optical SFP (LC-PC)	Optical SFP (LC-PC)
Framing compliant to	ANSI/IEEE C37.94	ABB SFC protocol
Data transmission	N x 64 kbit/s (N = 1 ... 12) 64 kbits/s – 768 kbit/s	N x 64 kbit/s (N = 1 ... 3) [Ch1, Ch2, RemAlm]
Transmission bit rate	2,048 kbit/s optical	4,096 kbit/s optical
Signal bit rate	2,048 kbit/s	2,048 kbit/s
Optical line coding	NRZ	MCMI

SFP transceivers

The optical parameters are subject to the selected SFP transceiver module. The following table shows the characteristics of the SFP transceiver modules approved for these applications:

Optical parameters	IEEE C37.94 compliant (1KHW001871R0005)	ABB SFC protocol
Application example	RED670 NSD570/G1LOa	REL316, REL551, REL561 NSD570/G1LO
Wavelength	850 nm	1310 nm
Fiber type	Multimode	Single-mode
Optical output power (Tx)	-19 ... -11 dBm*	-15 ... -8 dBm
Max allowed optical input power	-3 dBm	-3 dBm
Optical power budget, min	13 dB	19 dB
Receiver sensitivity	-32 dBm	-34 dBm
Maximum distance (depending on total link attenuation)	2 km**	30 ... 50 km**

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