Utility Network Specialists

Traditional Techniques/Innovative Solutions
From RFL Communications plc

Power Line Carrier Application Brochure

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Introduction

RFL Communications is a successful system integrator, experienced in the supply of telecom product, systems and services for applications within the power industry.

Operating from offices in the UK and Dubai, it has supported numerous global projects and has a reputation for delivering quality solutions and providing high levels of technical support.

RFL Communications product portfolio includes DSP Powerline Carrier products, Line Traps, and Coupling equipment.

Customers have access to a full range of high performance Power Line Carrier equipment and accessories. Coupled to the supply of products RFL Communications offer a complete service, from design to supply, installation and support.

Power Line Carrier

Power Line Carrier is one of the most reliable and cost effective transmission systems currently deployed by power utilities.

PLC is the term used to denote the entire process of communication that uses the power lines as a medium.

A PLC channel includes the signal path from the transmitting equipment at one terminal, through tuning equipment at the receiving end, and into the receiving terminal. In duplex operation the signal is sent over the same path in opposite directions, on different frequencies. The frequencies typically used are between 30 and 500kHz.

In planning a PLC link, consideration is given to ensuring that there is sufficient RF power to overcome the line losses, as well as confining the signal to a defined path and excluding unwanted signals. Such functions are achieved through the use of line traps, coupling capacitors and tuners. These devices are tuned to provide low impedance paths for the frequencies being used, and high-impedance paths to block unwanted frequencies.

The types of systems available include On/Off, FSK, analogue SSB, and digital SSB.

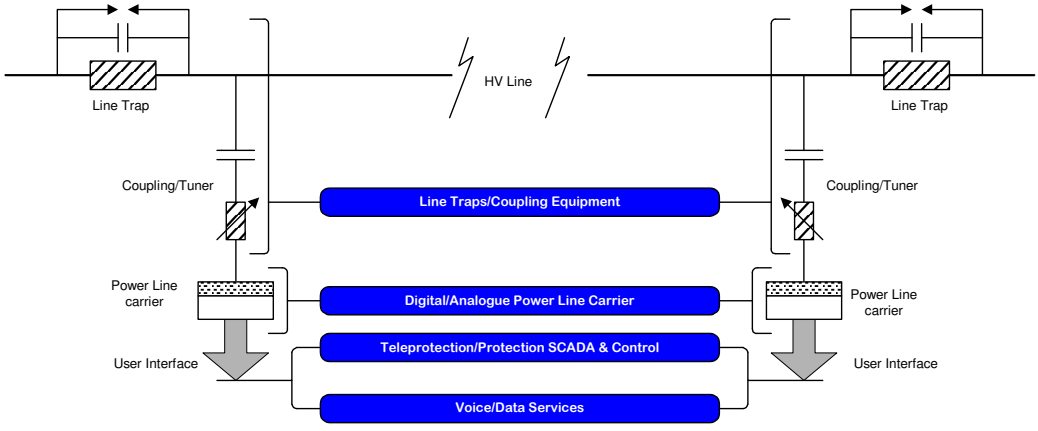

Diagram 1A – Basic PLC equipment block diagram

Line Traps

Line traps are used to confine the frequencies being used for the PLC application to a particular section of overhead line.

This isolation limits the transmission of unwanted frequencies into adjacent lines and prevents the RF signal from being lost due to faults on external line sections.

Typically after three bus sections, the line trap allows carrier frequencies to be re-used without fear of interference.

The traps are mounted in series with the power line and are designed to withstand high currents and have a low impedance at the power frequency. To this end they normally include a tuning device allowing them to be matched to the power line characteristics and PLC carrier frequencies.

Wide-band traps, tuned to a specific frequency band are used for most new applications. This type of trap includes a tuning device which allows a block to be selected against various frequency regions. The impedance can also be adjusted to match the local conditions.

The performance standards for line traps are defined within the IEC 353 recommendations.

Coupling Equipment

The coupling device and coupling capacitor provide the connection between the overhead line and PLC equipment. The coupling device needs to provide efficient transmission of the carrier frequency signals whilst offering protection from power frequency voltage and transient over-voltages.

Coupling techniques include Phase to Ground, Phase to Phase and Inter-phase systems. Whilst a single device is needed for Phase to ground applications, a second coupling device and HF hybrid transformer is used for phase to phase and inter-system coupling.

Whilst phase to ground coupling is the simplest method, utilising the least amount of equipment, phase to phase is more efficient and fault tolerant to a single phase fault.

The performance standards for coupling devices are defined within the IEC-481 recommendations.

PLC Equipment Types

Selecting the correct technology involves an understanding of the application and overall telecom strategy of the power utility. Whilst the On/Off and FSK solutions are focused on the support of protection relay applications, both the analogue and digital SSB products offer greater scope for voice and data communications. If co-ordinated, the PLC equipment can integrate and co-exist within an existing TDM or IP network.

On/Off Power Line Carrier

Designed for Directional Comparison Blocking (DCB) applications within high speed protective relaying schemes. This equipment uses amplitude modulation to communicate between line terminal ends. At one of the terminals, the carrier transmitter will be turned on, whenever an external fault to the protected line is detected. The receiver, at the remote terminal, upon detecting this signal, will prevent that terminal from over tripping.

Frequency Shift Keyed Power Line Carrier

This equipment is typically used for Direct Transfer Trip (DTT), Permissive (PTT), Directional Comparison Unblocking (DCU), and dual phase comparison applications.
Frequency Shift power line carrier provides channel, and equipment monitoring, via the continuous guard signal that is always present.
Upon detection of an internal line fault, the transmitter is frequency shifted to a trip frequency, and simultaneously increased in power to insure detection at the remote terminal.

Analogue Single Side Band (SSB) Power Line Carrier

Analogue SSB equipment provides a consistent, reliable 4kHz voice channel between equipments. This speech band is frequency sub-divided using filter arrangements allowing it to support voice plus low speed data. Teleprotection signals use a command guard tone programmed above the speech band. This can co-exist with voice and data traffic whilst in it's quiescent state. During a trip condition the teleprotection commands frequency shift to an in band frequency and the voice and data services are temporarily squelched.

The bandwidth can be increased by adding a second carrier system on the same link, dual analogue carrier. This doubles the bandwidth (8KHz) and services supported.

Digital Single Side Band (SSB) Power Line Carrier

Higher bandwidth data connections have driven the need for an alternative to the traditional analogue SSB solution. Digital SSB carrier equipment incorporates advanced modem techniques and compression algorithms to provide an increased data throughput, typically 64Kbit/s. This increases the number of potential independent channels, see table below.

Digital PLC equipment needs more bandwidth that analogue. This is partially offset as the Tx and Rx signals are often superimposed. Typically whilst an analogue carrier needs 4kHz in each direction (8kHz total), a digital equivalent uses either 8 or 16kHz for both Tx and Rx. These figures don't include frequency spacing.

The table below details configuration possibilities for both analogue and digital solutions.

	Digital SSB PLC		Analogue SSB	
Bandwidth	16kHz	8kHz	4kHz	8kHz
Voice Only Configuration	6 channels	3 channels	1 channels	2 channel
Voice + Data	5 voice + 4 x 2,400Bit/s data	2 voice + 4 x2,400Bit/s data	1 voice + 4 async 200Bit/s data	1 voice + 4 async data 600 bit/s
Data	2 x 19,200bit/s + 1 x 9,600bit/s	1 x 19,200bit/s + 1 x 4,800bit/s	1 x async 1200 bit/s + 1 x async 600 data	2 x async 1,200bit/s data

Digital PLC Techniques

Increased bandwidth end to end is only one advantage with digital PLC.

Digital equipment includes a multiplexer function that facilitates interfacing of a number of asyn/sync data channels and voice. Clearly bandwidth (64kbit/s) remains an issue, hence voice compression is used to increase the number of audio channels available. Most products use the ITU-T G.729 standard that compresses voice into an 8Kbit/s signal.

By incorporating a multiplexer the digital PLC offers terminal end and add drop functionality. For applications that consider multi-hop links with voice and data channels passing through intermediate equipment, the complexity of the overall system design is reduced.

Teleprotection is interfaced at the HF level so it avoids any fixed and/or fault induced delays introduced by the mux/modem. This is vital as during fault conditions the modem deployed within digital PLC equipment may loose sync and have to effectively “retrain” with the remote end. This will introduce a delay exceeding the ms operate times required by protection schemes.

Request for Quotation Form

This form can be used to help you provide the information needed for RFL Communications to provide you with a budget costing for your project.

Once submitted an RFL engineer will review your requirement and send you technical details on the equipment that best suits your application along with a budget price.

To: RFL Sales

1. Contact/Project Information

Name		Utility/Company	
Telephone		Email Address	
Project Name		New/Upgrade (specify)	

2. Sub-Station Interface Requirements

	Interface Requirements			
	Teleprotection	**Voice**	**Data**	**Relay**
Number of Channels				
Type of Interface				
Data Rate/s				

3. Frequency Restrictions

End A				End B			
Bandwidth				Bandwidth			
TX		Rx		Tx		Rx	

* Add Information for three ended schemes or projects with multiple links

4. Installation Information

Line Distance		Line Voltage	
Tower Type		Number of Transitions	
Traps Installed Y/N		Coupling Device Y/N	
Coupling Required (delete as required)	Phase to Ground	Phase to Phase	Inter-System

5. Diagram

Product Focus – Analogue Carrier

RFL 9508 Analogue SSB Powerline Carrier

RFL 9508 is a DSP analogue SSB carrier system based on the IMUX 2000 E1 multiplexer. The equipment has the ability to transmit two E1 time slots (2 x 64Kbit/s) over a powerline using either a bandwidth of 2.5 or 4kHz..

The system is configurable with standard 4-wire voice cards, 2W FXS, 2W FXO, and orderwire modules along with a modular 4 or 8 function transfer trip system, housed internally or externally depending on the application requirements.

The RFL 9508 features include the ability to operate as an add drop E1 multiplexer that can be integrated into existing networks with electrical or optical interfaces. The system is available with 1,2, 3, or 4 channels in one compact system.

An optional plug in TCP/IP SNMP interface is available to allow the RFL 9508 to be used on LAN and managed networks.

Technical Specifications:

RF Band

Frequency Range:	20 to 500kHz
Full duplex Channels:	1, 2, 3 or 4 SSB Channels
Channel Bandwidth:	2.5 kHz, 4kHz

Selectivity

Overall (4kHz from Bandedge):	<=-75 dBmO
Channel (0.3 kHz from Bandedge):	<=-65 dBmO

AF Band

AGC dynamic range:	+14 to –26dB, or +20dB
Background Noise:	<= -55dBmOp (IEC 495 Recommendation)
Harmonic Distortion:	<=-40dBmO F=400 Hz (IEC 495 Recommendation)
Group Delay:	300/3,400Hz (IEC 495 Recommendation)
Frequency Stability:	±0.5Hz at 250kHz (± 2ppm)
Tx Line Filters:	Adjustable from 20 to 500 KHz (with no additional parts required)
Rx Line Filters:	Adjustable from 20 to 500 KHz (with no additional parts required)
Minimum Sensitivity:	-30dBm

Signalling

Frequency:	3825 Hz, optional in-band
Type of Modulation:	FSK
Frequency Shift:	± 30Hz from channel centre frequency

Environmental Conditions:

Ambient Temperature Range:	-20 to +65^{0}C
Relative Humidity:	0 to 95% non condensing

Product Focus – Digital Carrier

STED Digital SSB Power Line Carrier

STED is a new generation of high performance PLC equipment utilising Digital Processing Technology (DSP).

These advanced digital PLC systems are able to transmit 64 or 32Kbit/s within a 16 or 8kHz band.

The equipment superimposes the Tx/Rx signals using echo cancellation techniques. Trellis code modulation allows the transmission of 64Kbit/s with a 24dB Signal to Noise Ratio.

The equipment is fully configurable and can support the following functions:

Integrated Multiplexer with drop and insert function allows the STED to be integrated into a TDM network.

Integrated Router allows the STED to be used in IP networks

Dedicated interface for teleprotection signalling allows the STED to be used for protection applications.

Technical Specifications

Transmission

Data Rate:	64 (32) kBit/s
Bandwidth:	16 (8) KHz superimposed Tx/Rx
Modulation Type:	64 TCM (Trellis Code Modulation)
Frequency Range:	40 to 500kHz
Carrier Frequency :	Programmable with a 4kHz step
Crossing delay:	<60ms
Bit Error Rate:	<10E-7 with SNR = 24dB
Maximum Line Attenuation:	
	From 30dB to 40dB (with noise)
User Interface:	X.21/V.11 and ITU-T G.703 co-directional
Line Connection:	Balanced/Unbalanced
Nominal Impedance:	50, 75 Ohm (unbalanced)/ 124, 150 Ohm (balanced)
Return Loss:	≥ 14dB

Fully Compatibility with analogue transmission systems
Configuration and monitoring of local and remote equipment
Teleprotection Interface
Integrated Multiplexer and Drop/Insert function
Integrated Router Function

Multiplexer and Drop/Insert function

Multiplexer and Drop/Insert functions
Data Interface
data rates from 1.2Kbit/s to 19.2Kbit/s
Voice Interfaces
2/4 wire + E&M, FXS/FXO

Point to Point and Point to Multipoint connections
Voice Compression:
ITU-T G.729A (8Kbit/s)
FXS/FXO and FXS/FXS (direct call) integrated ring generator

Router Function

Ethernet 10BaseT interface
TDM and IP on the same carrier

Power Supply

Input Voltage range:
48Vdc (+20%, -15%)
Power Consumption:
≤150Watt (fully equipped)

Output Power (PEP)
2/10/20/40 Watt

Environment Characteristic

Temperature range: -5 to 55°C
Relatively humidity: ≤93% at 40°C
(Compliant with IEC 721-3-3)

Mechanical Characteristics

ETSI subrack 16 (10+6) RU
483 x 400 x 280mm
Weight 14kg fully equipped

Contact Details

Address:	UK Head Office RFL Communications plc Connect 17 Avon Way Langley Park Chippenham Wiltshire SN15 1GG United Kingdom	Middle East Office RFL Communications plc (Middle East) 132 Al Habtoor Building Metropolitan Complex PO BOX 25647 Dubai U.A.E
Telephone:	(01249) 446500	
Fax:	(01249) 446506	
Website:	www.rflcomms.co.uk