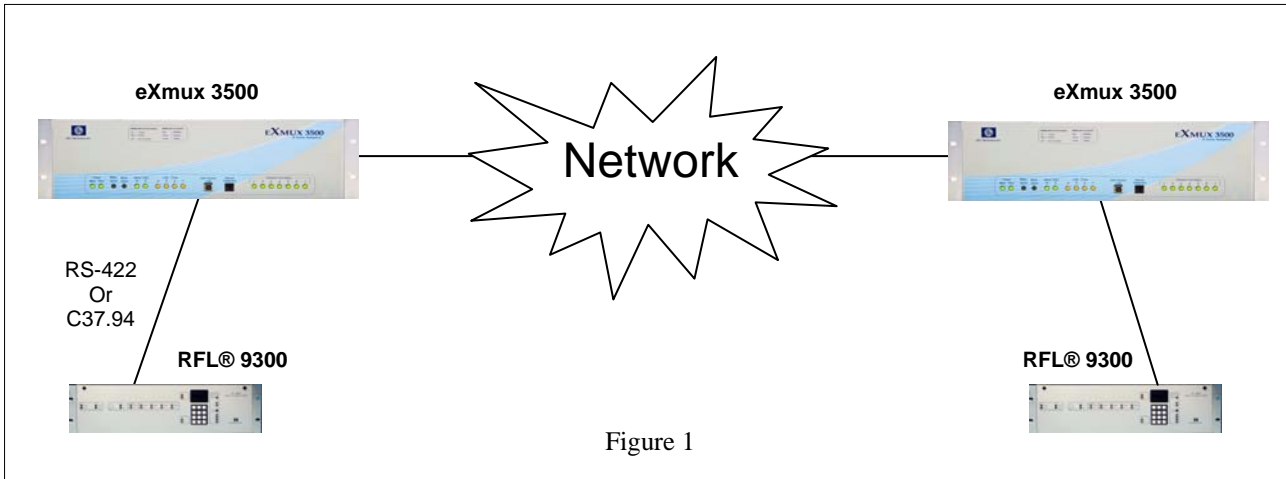


**RFL® 9300 Current Differential Relay over the RFL eXmux 3500 IP Access Multiplexer**

The RFL eXmux 3500 is a hardened IP Access Multiplexer engineered for mission critical infrastructures that seamlessly transport voice, serial, video and Ethernet data communications over Ethernet/IP or MPLS networks. The eXmux 3500 is a Layer 2 device with an integrated managed Ethernet switch which allows the eXmux 3500 to be used either in a private network with other eXmux 3500's or as part of a larger Ethernet/IP/MPLS network. Both fiber (using SFPs) and RJ-45 connections are available for the eXmux 3500; uplink speeds of up to a Gigabit are possible.

Figure 1 below depicts the eXmux 3500 as the communications system providing a point-to-point communications circuit between a pair of RFL® 9300 Current Differential Relays. The network cloud is a general representation of an IP network and does not imply a direct point-to-point connection. The communications protocol interface options for the RFL® 9300 over the eXmux 3500 are C37.94 Short Haul Fiber or synchronous RS-422/449. Refer to the following table for the correct eXmux 3500 Interface Unit (IU) required for the appropriate 9300 protocol interface.

<b>RFL® 9300 Communications Interface</b>	<b>eXmux 3500 Interface Unit (IU)</b>
C37.94 SHF	4-Port C37.94 IU
RS-422/449	4-Port Synch. Multi-Protocol IU



**Network Performance Consideration**

Current Differential Relays by nature are sensitive to communication channel delays which affects performance. Latency issues should always be considered when installing a current differential relay over any kind of multiplexer. The eXmux 3500 when applied over direct fiber connection with minimum jitter buffer delay settings (also referred to as Packet Delay Variation (PDV)) of 1-2ms, will yield a back-to-back communication channel delay of <5ms. The total delay including the RFL® 9300 inherent delay (4ms) would be <10ms. In addition to the low latency, when setup in a redundant path configuration the eXmux 3500 has a unique Hitless Switching feature that guarantees no data is lost during any single path failure. For a network with anticipated traffic usage beyond 90% of bandwidth capacity, Quality of Service (QoS) features can always be used to ensure that TDM data has the highest priority.

When connecting eXmux 3500's over an IP network, the following information can be used as part of the overall network design to determine communication channel delays. The network topology should be designed with a minimum number of nodes between the two ends of any current differential relay channel to minimize the Packet Delay Variation (PDV) setting; this will minimize the overall latency. By using the VLAN capability of the eXmux 3500, a secure and direct bidirectional communications channel can be created for the 9300 circuit.

**Product Latency:**

- The digital RFL® 9300 can tolerate up to 21ms of channel delay.
- RFL® 9300 inherent delay – 4ms
- RFL® 9300 asymmetric delay tolerance – 4ms
- eXmux 3500 C37.94 and RS-422 interface inherent back to back channel delay – 2.5ms
- eXmux 3500 C37.94 and RS-422 asymmetric back to back channel delay – 0.2ms
- eXmux 3500 through node delay – 0.02ms
- eXmux 3500 programmable packet-delay variation (PDV) settings – 1 to 500ms

**eXmux 3500 Interface Unit Settings:**

This application note assumes familiarity with the operation of the eXmux 3500 and the RFL® 9300. The appropriate eXmux 3500 Interface Unit to be used for this circuit should be programmed before mapping. Refer to the eXmux 3500 manual for mapping procedures and specific interface wiring information for each of these IU's.

***eXmux 3500 C37.94 IU settings***

1. On desired Port tab, set RX Data-Out Polarity to **NORMAL** and TX Data-In Polarity to **INVERT**.
2. On Bandwidth tab, set desired Port Bandwidth to **1** (64kbps).

A multimode fiber cable with ST connector is used to connect the RFL® 9300 C37.94 I/O to the eXmux 3500 C37.94 IU.

***eXmux 3500 Multi-Protocol Synch IU settings***

1. On General tab, set choose RS-422 Protocol.
2. On desired Port tab, set P(x) Interface Mode to **DCE**. Handshaking Delay **Disable**. RX Data-Out Polarity and TX Data-In Polarity to **NORMAL**. RX Clock Polarity and TX Clock Polarity to **NORMAL**.
3. On Bandwidth tab, set desired Port Bandwidth to **1** (64kbps).

A DB-37F to DB-25M cable is used to connect the RFL® 9300 Direct Digital I/O to the eXmux 3500 Synch IU. Refer to the chart below and the 9300/eXmux 3500 manuals for cabling pin out information. RFL can provide the following cable if desired.

<b>RFL 9300 RS-449 DB-37F</b>	<b>eXmux 3500 Sync IU DB-25M</b>	<b>RFL 9300 Signal</b>
1	1	Chassis Gnd
4	2	TX Data Out +
22	14	TX Data Out -
5	15	Send Timing +
23	12	Send Timing _
6	3	RX Data In +
24	16	RX Data In -
8	17	Receive Timing +
26	9	Receive Timing -

This application note may not apply to other vendors of Current Different Relays as some settings may be different. Check with the vendor of the relay you are using to determine the required eXmux 3500 settings. Contact RFL at 973-334-3100 for further assistance.