MINDSPEED™

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ZipWirePlus™ Single Span Regenerator Application Note

Introduction

This application note describes the implementation of a single span regenerator using Mindspeed's Enhanced EVM.

Repeater Overview

In order to achieve data transmission over greater distances than are achievable over a single SHDSL segment, one or more signal regenerators (SRUs or REGs) may be employed.

ITU G.991.2 Reference Diagram

The figure below has been extracted from the G.991.2 specification. It is a reference diagram of a SHDSL span containing two regenerators. Up to eight (8) regenerators per span are supported within the EOC addressing scheme, and no further limitation is intended herein.

Each SRU shall consist of two parts: an SRU-R for interfacing with the

STU-C (or a separate SRU-C), and an SRU-C for interfacing with the STU-R (or a separate SRU-R). An internal connection between the SRU-R and SRU-C shall provide the communication between the two parts during start-up and normal operation.

An SHDSL span containing X regenerators shall contain X + 1 separated SHDSL segments, designated TR1 (STU-C to SRU_1), TR2 (SRU_X-C to STU-R), and RRn (SRUn-C to SRU_{n+1}-R, where $1 \le n \le X-1$).

Figure 1-1. Block Diagram of a SHDSL Span with Two Signal Regenerators

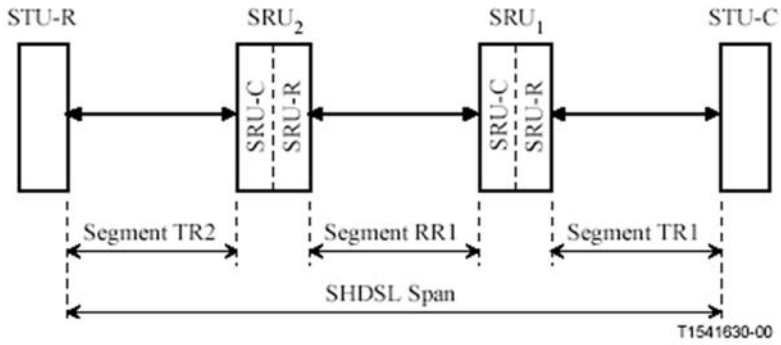


Figure D.1/G.991.2 – Block diagram of a SHDSL span with two signal regenerators

ETSI 101 524 Reference Diagram

The figure below has been extracted from the ETSI 101 524 Specification. It is a reference diagram of a SDSL span containing two regenerators. Up to eight (8) regenerators per span are supported within the EOC addressing scheme, and no further limitation is intended herein. Each REG shall consist of two parts: an REG-R for interfacing with the LTU (or a separate REG-C), and an REG-C for interfacing with the NTU (or a separate REG-R). An internal connection between the REG-R and REG-C shall provide the communication between the two parts during start-up and normal operation. An SDSL span containing X regenerators shall contain X+1 separated SDSL segments, designated TR_1 (LTU to REG_1), TR_2 (REG_X-C to NTU), and RRn (REGn-C to REG_{n+1}-R, where $1 \le n \le X-1$).

Figure 1-2. Block Diagram of a SDSL Span with Two Signal Regenerators

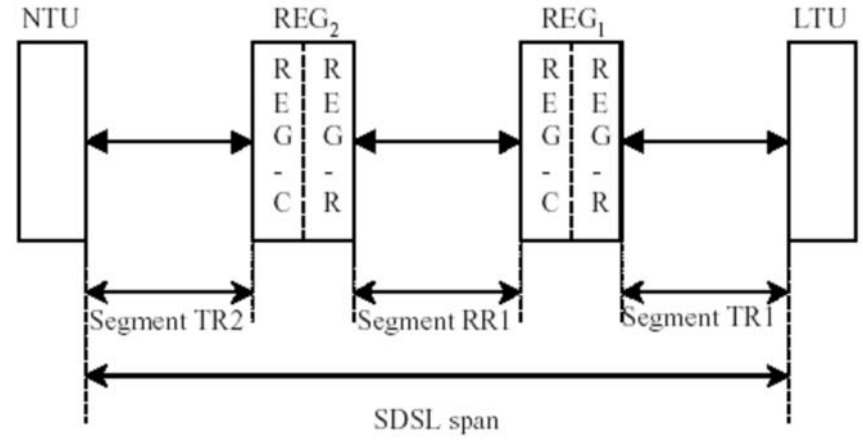


Figure C-1: Block Diagram of a SDSL Span with Two Signal Regenerators

ZipWirePlus Enhanced EVM Implementation

The Mindspeed implementation on the Enhanced EVM is a one regenerator span in fixed rate mode with the same DSL rates on both sides of the regenerator.

System Architecture

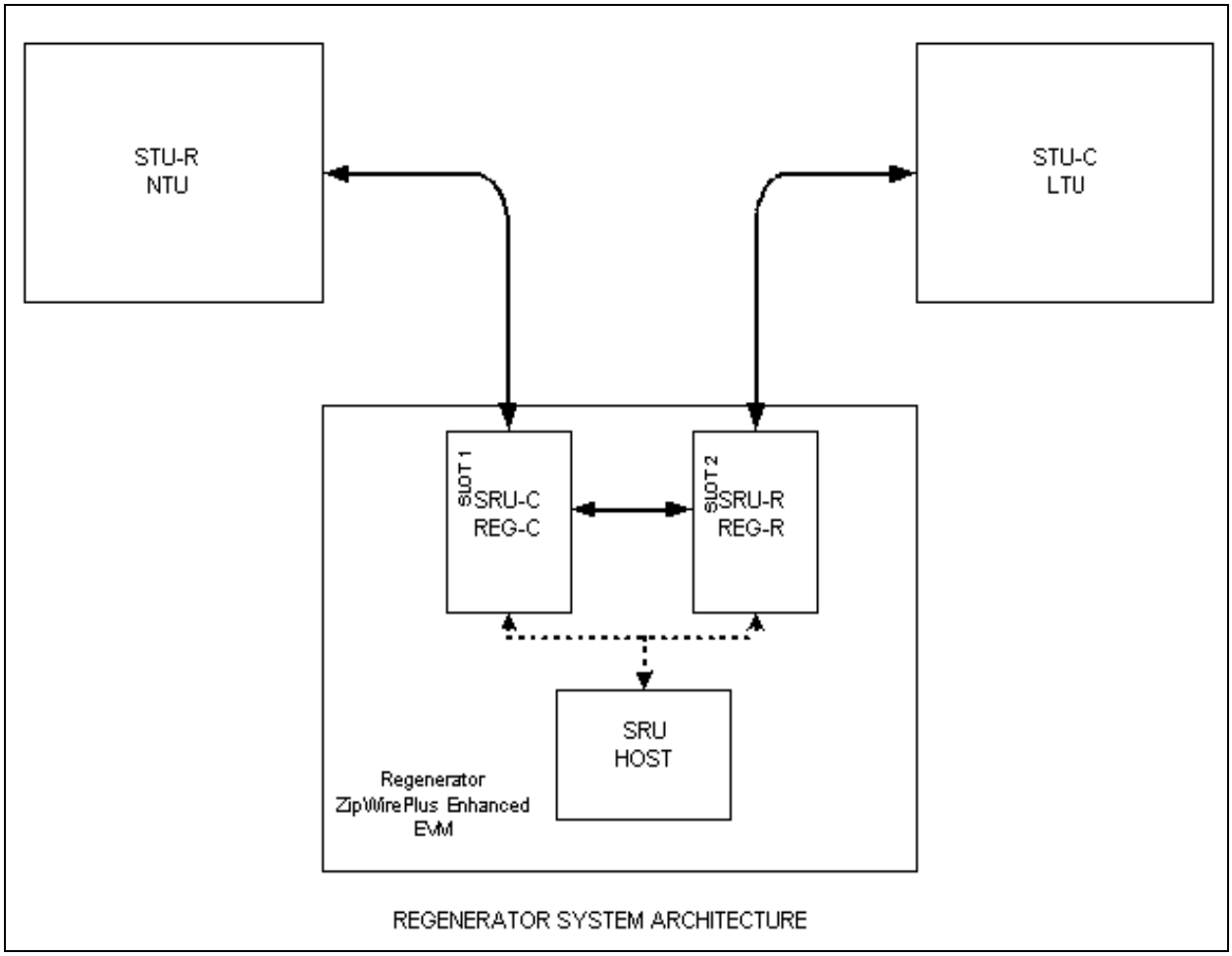
The regenerator consists of

- SRU-C / REG-C
- SRU-R / REG-R

In the Regenerator Enhanced EVM the ZipWirePlus LIC on slot 1 is the SRU-C. The ZipWirePlus LIC on slot 2 is the SRU-R.

The SRU-C & SRU-R are controlled by the Host Processor (MPC8260) located on the Elgin Microprocessor Board. The Host processor is called SRU Host.

Figure 1-3. Mindspeed Regenerator Enhanced EVM System Architecture



The SRU host controls the activation and deactivation of the links within the span. It also communicates information from SRU-R to SRU-C and viceversa..

Regenerator Host Software

Regenerator Host Software Overview

The Regenerator Host Software runs on the Host Microprocessor Board. It is responsible for the following

- Configuring the Enhanced EVM based on the DIP switch settings.
- Downloading the ZipWirePlus firmware image to the ZipWireDevices
- Creates a socket for the TestExec/UIP Software
- Regenerator State Machine
- Configuring and Managing the ZipWirePlus LICs for Regenerator Application.
- Implements the internal control communication channel between the SRU-C and SRU-R.

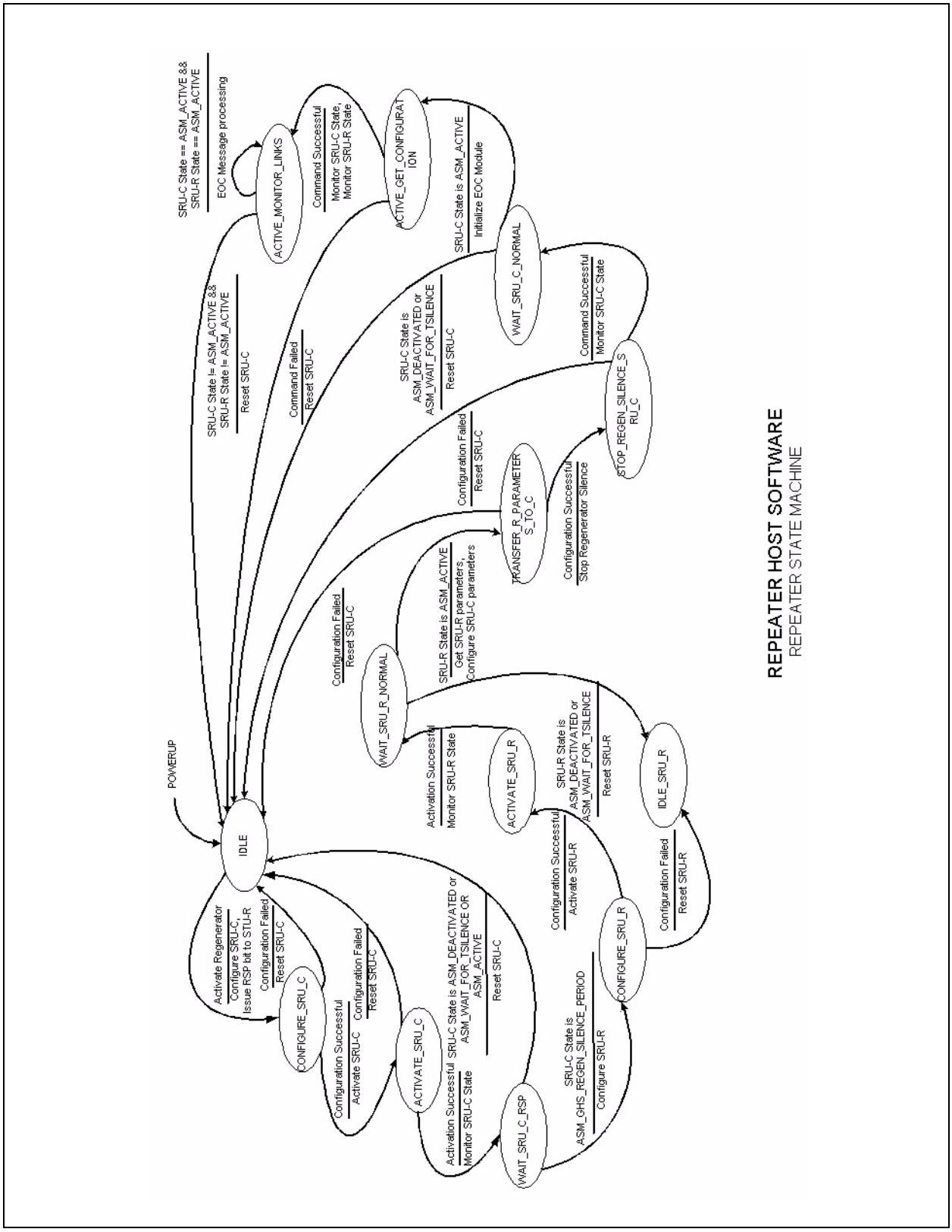
Regenerator Host Software Functionality

The Host Software upon power up configures the Regenerator Enhanced EVM, downloads the ZipWirePlus Firmware image to the ZipWirePlus LICs connected to Slot 1 and Slot 2 respectively. After the code is successfully downloaded, it starts the State Machine to initiate the Repeater Operation. Finally it creates a socket for communication with the TestExec/UIP software.

Repeater State Machine

The State Machine will first bring up the link between the SRU-C (ZipWirePlus LIC inserted on Slot 1) and the HTU-R. It will configure the SRU-C and activate it. It monitors the ASM Stage inside the ZipWirePlus device (SRU-C) until it reaches ASM_GHS_REGEN_SILENCE_PERIOD stage("Silent Period").

Figure 1-4. Repeater State Machine



Then the State Machine will bring up the link between SRU-R (ZipWirePlus LIC inserted on Slot 2) and the HTU-C. It will configure and activate the SRU-R. It will monitor the ASM Stage inside the ZipWirePlus device(SRU-R) till it reaches ASM_ACTIVE_STATE. It polls the SRU-R for the Data Rate and Clock Mode information and transfers it to the SRU-C and takes the HTU-R out of "Silence Period" State.

Once both the links(SRU-C to HTU-R and SRU-R to HTU-C) are in NORMAL_OPERATION ("Active"), the State Machine will monitor the links and process EOC messages and handle any errors/exceptions that occur.

The Host Software supports the usage of Test Exec application at any time to monitor the status of the Repeater.

The Host Repeater Code uses the APIs defined in "CX28975 ZipWirePlus Programmers Reference Manual". There are some additional APIs used in Repeater application which are not defined in the Reference Manual and are defined in Section 3.4.2.3.5.

Regenerator Firmware

Regenerator Firmware Overview

The Regenerator firmware implements an ITU G.991.1/ETSI 101 524 compliant regenerator.

Regenerator Firmware Functionality

Prior to activation or configuration the SRU host issues the _DSL_START_REGEN_SILENCE API to the SRU-C. This API instructs the SRU-C to issue the Regenerator Silence Period bit during G.hs session to the HTU-R.

In the G.shdsl span the HTU-R starts the process off by generating R-TONES to the SRU-C. When activated by the SRU host the SRU-C generates C-TONES. When the HTU-R detects the SRU-C's C-TONES it begins the G.HS process by sending a CLR message. The SRU-C responds with a CL message. The HTU-R will indicate it can do all rates and sub-rates. The SRU-C will indicate it also can do all rates and sub-rates. The HTU-R then sends an MR message asking the SRU-C to select the mode. The SRU-C issues a mode select (MS) message with the Regenerator Silence Period (RSP) bit set. When the HTU-R sees the RSP bit set it goes into Regenerator Silence Period for up to 5 minutes. During the RSP time the HTU-R will stop sending R-TONES and the SRU-C will stop sending C-TONES. The HTU-R will start up again when it detects C-TONES again from the HTU-C. Both the SRU-C and HTU-R will go the ASM activation state in the Activation State Manager called REGEN_SILENCE_PERIOD that has a value of 0x1B.

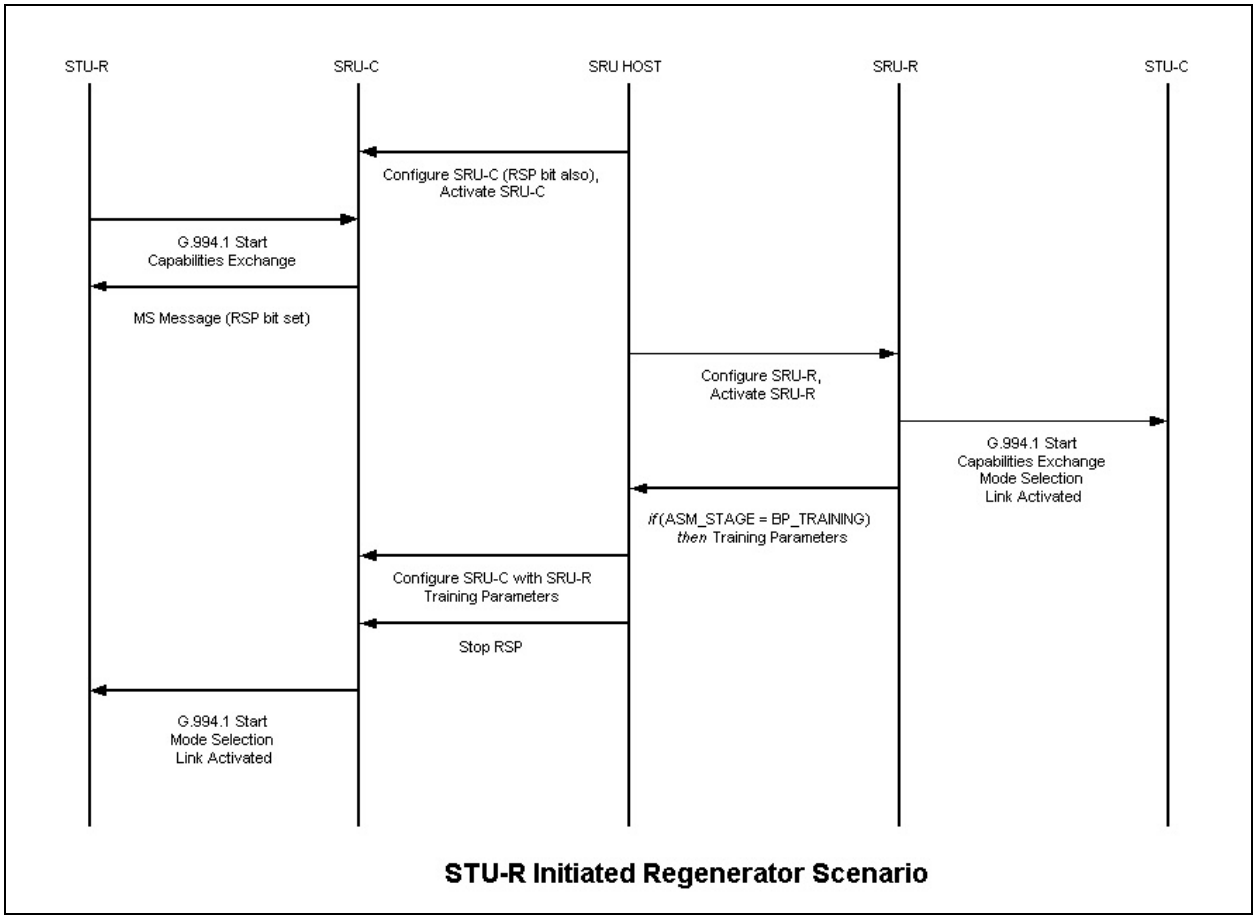
The new activation state was added so the SRU host could detect when the devices is in the RSP state. Also, this new activation stage informs the SRU host when it is time to activate the link between the SRU-R and HTU-C.

The SRU host issues the DSL_ACTIVATION API to the SRU-R device. The SRU-R and HTU-C will start a G.hs session. There will be the capabilities exchange (CLR/CL) messages, mode select messages (MR/MS) then training. The SRU host monitors the activation stages of the SRU-R and waits until the link is in BP_TRAINING ASM activation state. When this state is achieved, the SRU host has enough parameter information to program the SRU-C device. The SRU host issues the _DSL_GHS_GET_FINAL_RATE API (0x81) to get the down stream rate, down stream sub-rate, up stream rate and up stream sub-rate information from the HTU-C to SRU-R link. The data presented to the SRU host is in N rate and I bits format. The data extracted from the API is the total number of timeslots (N rate or Payload Rate) and total number of I-bits (I bit sub rate). This along with the clock configuration is used to configure the SRU-C device. The SRU host issues the _DSL_GHS_REGEN_OVERRIDE API to the SRU-C. This API overrides previous N and I rate configurations already present in the SRU-C.

It also makes the data rate a match between the SRU-R to HTU-C link and the SRU-C to HTU-R link.

The SRU host then issues the _DSL_GHS_STOP_REGEN_SILENCE API to the SRU-C. The SRU-C begins generating C-TONES to the HTU-R. At the HTU-R, when C-TONES are detected, it begins transmitting R-TONES and initiates data transmission by sending a mode request (MR) message asking the SRU-C to issue the mode. The SRU-C responds by issuing a mode select (MS) message with the instruction to train up at the N and I rate programmed into it by the SRU host. From there the SRU-C to HTU-R link will train up to NORMAL_OPERATION. The entire span is in NORMAL_OPERATION (ACTIVE).

Figure 1-5. HTU-R Initiated Regenerator Scenario



Regenerator Firmware Additional APIs

This section describes the APIs added to the ZipWirePlus firmware for Regenerator Application.

DSL_GHS_START_REGEN_SILENCE

DSL_GHS_START_REGEN_SILENCE			C	R
This command is issued to the SRU-C by the SRU Host, prior to activation. It configures the HTU-R to set the Regenerator Silent Bit in the Mode Select message during G.994.1 Session.				
C Constant	Opcode	Type	Incoming Bytes	Outgoing Bytes

DSL_GHS_START_REGEN_SILENCE			C	R
_DSL_GHS_START_REGEN_SILENCE	0x5C	Control	1	None
Incoming Parameters				
Byte	Content	Description		
1	0x00	N/A		

DSL_GHS_STOP_REGEN_SILENCE

DSL_GHS_STOP_REGEN_SILENCE			C	R
This command is issued to the SRU-C by the SRU Host to take the link between SRU-C and HTU-R out of Regenerator Silence Period.				
C Constant	Opcode	Type	Incoming Bytes	Outgoing Bytes
_DSL_GHS_STOP_REGEN_SILENCE	0x5B	Control	1	None
Incoming Parameters				
Byte	Content	Description		
1	0x00	N/A		

DSL_GHS_REGEN_RATE_OVERRIDE

DSL_GHS_REGEN_RATE_OVERRIDE			C	R
This API is used by the SRU Host to override the N and I rate settings in in the SRU-C. The new N and I settings are gathered by the SRU Host from the SRU-R, then transferred to the SRU-C prior to the second G.994.1 Session, while HTU-R is in Regenerator Silence Period. The clocking mode of the SRU-R is also transferred to the SRU-C. SRU-C places down rates, up rates and clock mode in G.hs MS message to configure the HTU-R.				
C Constant	**Opcode**	**Type**	**Incoming Bytes**	**Outgoing Bytes**
_DSL_GHS_REGEN_RATE_OVERRIDE	0x5D	Control	5	None
Incoming Parameters				
Byte	**Content**	**Description**		
1	Final down rate	Represented in N rate. Rate = N *64.		
2	Final down sub-rate	Represented in I sub-rate. Sub-rate = I * 8.		
3	Final up rate	Represented in N rate. Rate = N *64. Must be the same as down rate.		
4	Final up sub-rate	Represented in I sub-rate. Sub-rate = I * 8. Must be the same as down sub-rate.		
5	Clock mode	Clock mode:0 = Plesiosynchornous.1 = Plesiosynchronous with NTR.2 = Synchronous3 = hybrid		

DSL_GHS_GET_FINAL_RATE

DSL_GHS_GET_FINAL_RATE			C	R
This API is used by the SRU host to get the final rate achieved by the link between the HTU-C and SRU-R. These down rate, down sub-rate, up rate and up sub-rate will be used to program the SRU-C to HTU-R link.				
C Constant	**Opcode**	**Type**	**Incoming Bytes**	**Outgoing Bytes**
DSL_GHS_GET _FINAL_RATE	0x81	Status	0	4
Outgoing Parameters				
Byte	**Content**	**Description**		
1	Final down rate	Represented in N rate. Rate = N *64.		
2	Final down sub-rate	Represented in I sub-rate. Sub-rate = I * 8.		
3	Final up rate	Represented in N rate. Rate = N *64. Must be the same as down rate.		
4	Final up sub-rate	Represented in I sub-rate. Sub-rate = I * 8. Must be the same as down sub-rate.		

DSL_GHS_REGEN_DIAGNOSTIC

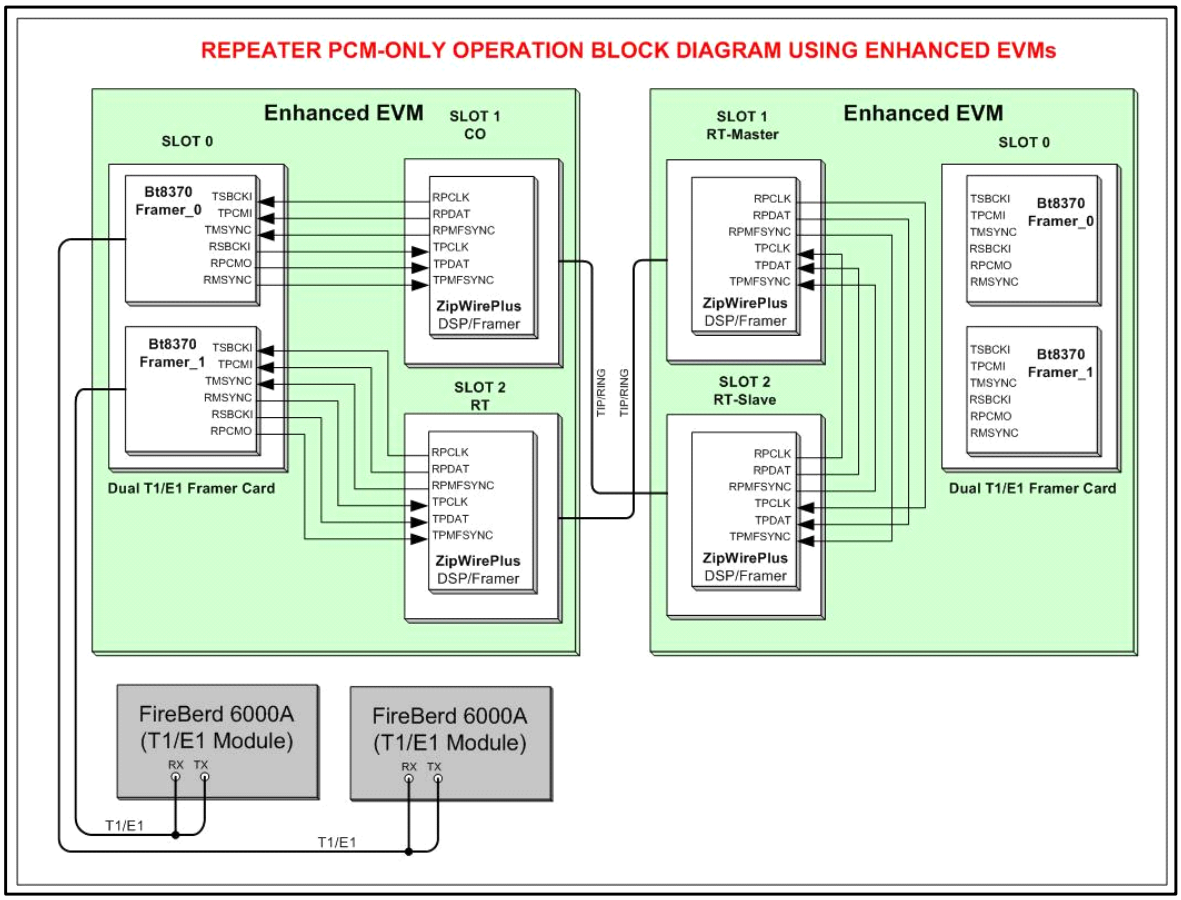
_DSL_GHS_REGEN_DIAGNOSTIC			C	R
_DSL_GHS_REGEN_DIAGNOSTIC is a control API that allows the SRU host to take an HTU-R or SRU-R out of Regenerator Silence Period (RSP) and begin the training startup process for diagnostic purposes. To use this command the HTU-R or SRU-R must have previously been configured (via G.994.1) to the RSP mode.				
C Constant	**Opcode**	**Type**	**Incoming Bytes**	**Outgoing Bytes**
_DSL_GHS_REGEN_DIAGNOSTIC	0x5E	Control	1	None
Incoming Parameters				
Byte	**Content**	**Description**		
1	0x00	N/A		

Enhanced EVM Setup

The procedure for configuring the Enhanced EVM is described in detail in the Enhanced EVM User's guide.

The Figure explains the pin interconnections for this application.

Figure 1-6. Single Span Repeater Operation Block Diagram



References

- ZipWirePlus Datasheet
- G.shdsl Standard: ITU G.991.2
- SDSL Standard: ETSI 101 524
- CX28975 ZipWirePlus Programmers Reference Manual
- Enhanced EVM Users Guide (to be released soon)