

# Agilent 81250 ParBERT SONET/SDH Frame Generator

## **User's Guide**



**Agilent Technologies**

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### Manual Part Number

5988-5231EN

### Revision

Revision 5.0, November 2002

Printed in Germany

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# Introduction to the Frame Generator

The SONET/SDH Frame Generator (referred to as the Frame Generator) is a software application for generating SONET and SDH frames for ParBERT.

## What the Frame Generator Does

The Frame Generator allows one or more structured patterns (also known as frames) to be specified and generated for SONET testing by ParBERT. It provides you with a graphical user interface (GUI) for entering basic frame patterns, and lets you modify (manually) the resulting frame files.

See *“Using the Frame Generator” on page 7* for more information on how to use the frame generator.

## Installing the Software

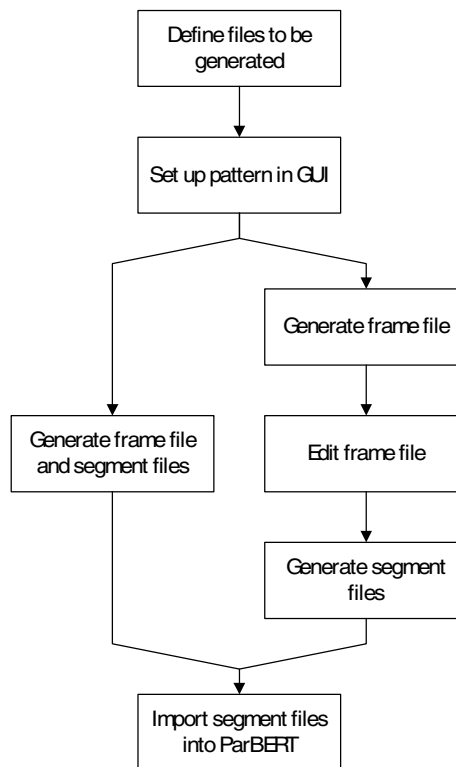
The Frame Generator is part of the ParBERT installation. If you would like to install the Frame Generator on another computer (for example, to generate and edit frame files on a laptop), use the normal ParBERT installation CD, and select only the Frame Generator installation.



# Using the Frame Generator

This topic provides a short overview of what you have to do to generate frames for use in ParBERT.

The following figure provides an overview of the workflow.



**Figure 1 SONET Workflow**

The following steps have to be performed to generate SONET frames for ParBERT:

1. If not all files are needed, the files to be generated can be selected. The dialog box for this is opened over *File -> Generation Setting*. By default, all files are selected. See “*Selecting the Files to be Generated*” on page 11 for details.

2. The settings for the frames to be generated are made on the GUI. See “*How Frames are Generated*” on page 13 for information about the Frame Generator.

3. The selected files are generated by selecting the *File Save Menu* button.

This opens the *Save as* dialog box, where you can select the file name and path for the files to be generated.

See “*Generating Frame Files*” on page 8 for details.

4. Import the files into ParBERT.

See “*Importing Frames into ParBERT*” on page 9 for more information.

In case the frames have to be modified, the following must be done:

5. The frame files are edited. Any text editor can be used for this (that can handle the size), such as WordPad.

“*Editing Frame Files*” on page 9 provides notes about what should be considered when editing frame files.

6. The segment files are generated from the frame files by selecting *File -> Convert Frame(s)*.

This generates the necessary segment files for the ParBERT analyzer and generator.

See “*Converting Frame Files*” on page 12 for more information.

You can then import these files to ParBERT.

## Generating Frame Files

The GUI provides various fields for configuring the patterns. See “*Graphical User Interface Reference*” on page 23 for information about the various GUI elements.

It is recommended to read “*How Frames are Generated*” on page 13. Here you can find information about SONET frames, and how the various frame sections are manipulated.

When you have made your settings, select *File -> Save as*, click *File Save Menu*, or click the Save File button. This opens up the *Save As* dialog box, where you can select the file path and name.



# Importing Frames into ParBERT

When the frames have been generated, they have to be imported to ParBERT, where SONET tests can then be carried out.

## Editing Frame Files

The Frame Generator allows one or more structured patterns (or frames) to be specified and generated. The pattern is written into a frame file and/or segment file. The segment file can be imported into the ParBERT.

The following is an example of the start of an \*.hfm file.

```
#Col.          Rows of OC-3          Rows of ignore_flags
#              R1 R2 R3 R4 R5 R6 R7 R8 R9  R1 R2 R3 R4 R5 R6 R7 R8 R9
#-----
C1.1          f6  0 ff 6a  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
C1.2          f6  0 55 6a  0  0  0  0  0 60  0  0  0  0  0  0  0  0  0
C1.3          f6  0 aa 6a  0  0  0  0  0 60  0  0  0  0  0  0  0  0  0
#-----
C2.1          28  0 aa  a  0  0  0  0  0 60  0  0  0  0  0  0  0  0  0
C2.2          28  0 55  a  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
C2.3          28  0 f0  a  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
#-----
C3.1           1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
C3.2           1 df  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
C3.3           1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
#-----
C4.1           0  0  0  0  1  1  0  0  0  0  0  0  0  0  0  0  0  0  0
C4.2           0  0  0  0  1  1  0  0  0  0  0  0  0  0  0  0  0  0  0
C4.3           0  0  0  0  1  1  0  0  0  0  0  0  0  0  0  0  0  0  0
#-----
C5.1           0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
C5.2           0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
C5.3           0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
#-----
C6.1           0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
C6.2           0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
C6.3           0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
#-----
C7.1           0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
```

```

C7.2      0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
C7.3      0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
#-----
C8.1      0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
C8.2      0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
C8.3      0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

```

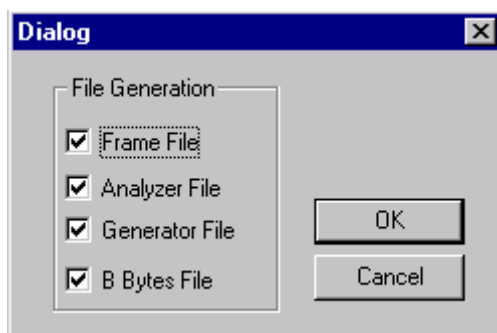
These files can be edited by any editor as text file. For better recognition of the relevant lines, each line begins with a counter with the format C<column>.<sts-nr>.

Please note the following when you edit frame files:

- It is recommended only to edit patterns that have *not* been scrambled. Otherwise, the changed bytes have to be scrambled manually.
- “#” comments out a line (you can add any number of comment lines).
- Do not edit parity bytes. When frame files are converted, all parity bytes are recalculated. Any changes you made to parity bytes are lost.
- The synchronizing pattern in row 3, column 1 to 6 may be edited. However, there may be problems if this pattern is not unique within the frame.

## Selecting the Files to be Generated

You can optionally select the files to be generated. By default, all files are generated. You can change this selection in a dialog box that opens when you select *File -> Generation Setting*.



**Figure 2** File generation dialog box

You can select from the following files:

- *Frame Files* (\*.hfm)  
These files are in an human-readable intermediate format that can only be interpreted by the SONET tool.
- *Analyzer Files* (\*.ana.seg)  
These files are imported into ParBERT for the analyzer.
- *Generator Files* (\*.gen.seg)  
These files are imported into ParBERT for the generator.
- *B Bytes Files* (\*.bbs)  
These files are for information only about the generated parity bytes (B1 to B3 bytes).

**Automatic Production** If you are *not* going to edit the frame files, you have to select *Analyzer File* and *Generator File*.

**Manual Production** If you are going to edit the frame files, you only have to select *Frame File*.

# Converting Frame Files

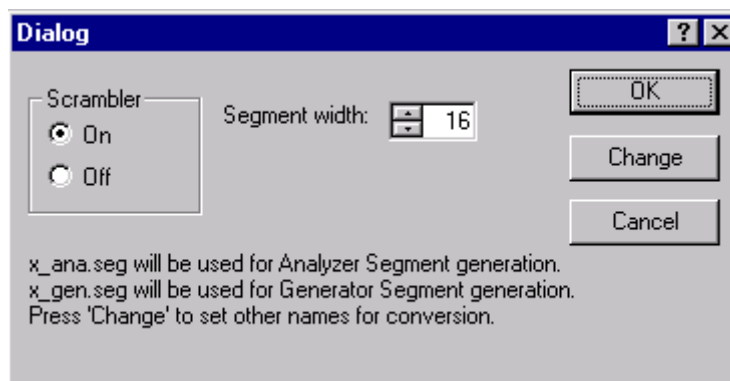
Once the frame files have been generated (and edited), they must be converted to segment files for use by ParBERT.

This is done by the following:

- Selecting *File -> Convert Frame(s)*.
- Clicking the Convert Frames button.

These both open the *Open* dialog box, where you can select the \*.htm file to be converted.

After you have entered a file name and clicked *Open*, the following dialog box should appear:



**Figure 3** Convert Files dialog box

The *Scrambler* should be set to *On*, the *Segment width* can be adjusted.

See also "*Scrambler*" on page 24 and "*Segment width*" on page 25.

The text in the dialog box indicates which files will be generated. If files that you need are not listed (for example, if you need to generate segment files for the analyzer, but these are not shown), or if an error message appears, check the settings in the *Generation Settings* dialog box (see "*Selecting the Files to be Generated*" on page 11).

These files will be generated and overwritten without any further notice. If you want to save the files under different names, you have to click *Change* instead of *OK*.

This opens the *Open* dialog box, where you can enter a different file name for each file to be generated. After you have changed or accepted all file names, the files are converted.

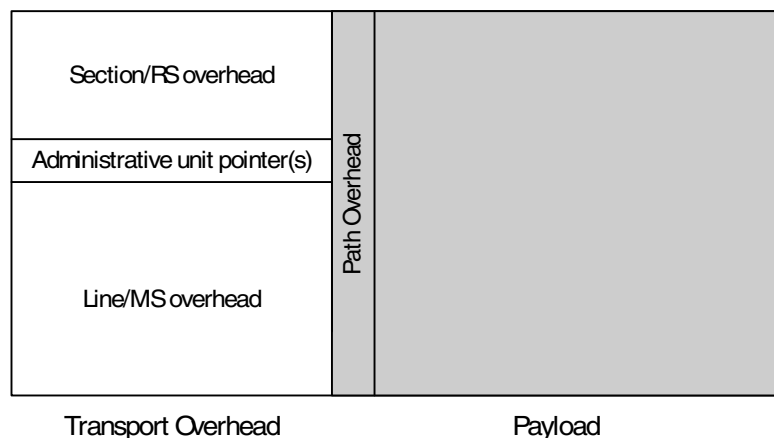
# How the Frame Generator Works

The following sections provide detailed specifications of the following:

- How the Frame Generator generates frames  
This is described in the following section.
- Coded Mark Inversion (CMI) coding  
See “*CMI Coding*” on page 20.
- Synchronizing pattern  
See “*Synchronizing Pattern*” on page 20.

## How Frames are Generated

The Frame Generator generates frames based on the settings made in the GUI. The following figure shows the different components of a frame.



**Figure 4 SONET Frame Structure**

See the following sections for more information:

- “*SONET Section Overhead and SDH RS Overhead Details*” on page 18  
This section describes how the section overhead is generated.
- “*SONET Line Overhead and SDH MS Overhead Details*” on page 17  
This section describes how the line overhead and multiplexer overhead are generated.
- “*SONET Path Overhead and SDH HP Overhead Details*” on page 16  
This section describes how the path overhead is generated.
- “*Payload Details*” on page 15  
The section describes how the payload is generated.

## BIP Coding

The SONET specification calls for Bit Interleaved Parity (BIP) of error monitoring. For the monitored section of signal, an error code is defined so that all there is an even number of 1s in the X bits, counting the monitored section and the error code. This is illustrated in the following figure.

	Xbits								
	1	0	1	1	0	0	1	1	– Error code
	1	1	0	1	0	0	0	1	of frame
Even number	1	0	1	1	1	1	0	1	
of 1s	0	1	1	1	0	1	1	1	
	1	0	1	1	0	0	1	1	
	0	0	0	1	1	0	1	1	

**Figure 5 BIP-8 coding**

To ensure that the signal is correctly transferred, the error code byte of one frame is stored in a byte of the next frame. The receiver compares the calculated parity with the byte stored in the next frame to determine if the frame arrived correctly.

## Payload Details

The payload choices are:

All 1s, all 0s, alternate 1s and 0s, various PRBS options, a binary file and a pattern editor.

It is important to consider the possible lengths of the PRBS with respect to the supported frame sizes. The following table shows the payload sizes generated at various rates:

**Table 1 Rates and payload sizes**

Rate	Payload size
STS-768	4.755.456 bits
STS-192	1.188.864 bits
STS-48	297.216 bits
STS-12	74.304 bits
STS-3	18.576 bits

The PRBS have the following lengths and polynomials:

**Table 2 PRBS lengths and polynomials**

PRBS	Length	Polynomial
PRBS 5	31 bits	$x^5 + x^4 + x^2 + x^1 + x^0$
PRBS 7	127 bits	$x^7 + x^6 + x^0$ , inverted
PRBS 9	511 bits	$x^9 + x^5 + x^0$
PRBS 11	2,047 bits	$x^{11} + x^9 + 1$ , not inverted as CCITT 0.152
PRBS 15	32,767 bits <sup>a</sup>	$x^{15} + x^{14} + 1$ , inverted, as CCITT 0.151
PRBS 20	1,048,575 bits <sup>b</sup>	$x^{20} + x^{17} + 1$ , not inverted as CCITT 0.151
PRBS 23	8 388,607 bits <sup>c</sup>	$x^{23} + x^{18} + 1$ , inverted, as CCITT 0.151
PRBS 31	2,147,483,657 bits <sup>c</sup>	$x^{31} + x^{28} + x^0$

<sup>a</sup> Fits within an STS-48 frame.

<sup>b</sup> Fits within an STS-192 frame.

<sup>c</sup> Exceeds the STS-768 frame size, but is included to provide some longer runs.

The PRBS generators are initialized to all ones. The ones are shifted to the left by the number of bits expressed by the order of the polynomial (for example, PRBS 7: `0xffffffff << 7`).

The PRBS runs continuously and bulk-fills all payload bytes.

The payload fill starts at channel 1, row 1, column 5.

**NOTE** Please pay attention to the following when defining the payload fill.

- This is a bulk fill of the payload space, not a fill of each individual payload channel.
- Since this is a repeating frame, there is a discontinuity of the PRBS at the boundary between the last payload byte and the first payload byte in the next transmitted frame if the number of generated frames is not a multiple of the PRBS length (for example,  $2^7 - 1$  frames are needed to create a continuous PRBS 7 payload).
- The fill start address of the PRBS payload is channel 1, row 1, column 5, which corresponds to a pointer with the address of  $522_{Dec}$ .
- When a binary file is selected as payload, there will be a chance that the synchronizing pattern for the ParBERT appears also within the payload. If so, the ParBERT will not be able to synchronize.

## SONET Path Overhead and SDH HP Overhead Details

This section describes how the path overhead is handled (and manipulated) with the application.

### B3 Byte

**General** A path error monitoring function is implemented in the SONET specification. This function is incorporated as BIP-8 code, which is stored in the B3 byte of each frame. See *“BIP Coding” on page 14* for details about BIP-8 coding.

The path error monitoring code of a frame is calculated from the path overhead and payload of the previous frame (and includes the frame's B3 byte).

**Single B3 Error** When a BIP (B3) error is selected, a single B3 error per frame is generated.

To generate a B3 error (in channel one only), one bit in a selected payload byte is complimented (that is, it is XORed with 0000 0100).

The selected payload byte is the byte positioned to the right of the B3 byte, located at channel 1, row 6, column 5. The B3 byte itself remains unchanged.



## G1 Path Status Byte

The G1 path status byte is affected by the following alarms:

- L-AIS / MS-AIS
- HP-REI
- L-RDI / MS-RDI

Depending on which alarm is selected, the G1 path status byte is affected as follows:

- No errors: 0000 0000
- AIS on: xxxx 0111
- HP-REI: 0001 0000

## All Other Path Overhead

All other path overhead bytes will contain 0000 0000 prior to scrambling.

# SONET Line Overhead and SDH MS Overhead Details

## Pointer Bytes

All H1 bytes will be set to “not new data” and contain offset zero (0110 0000).

All H2 bytes will contain offset zero (0000 0000).

All H3 bytes are undefined when there are no pointer negative justifications; (pointer increment and decrement are not available), H3 will be used to allow a fixed B2 value, see “*Single B2 Error*” on page 18 below.

## K2 Byte

The K2 byte is only set for the first frame.

It is affected by the following alarms:

- L-AIS / MS-AIS
- L-RDI / MS-RDI

Depending on which alarm is selected, the K2 byte is set as follows:

- No errors: 0000 0000
- AIS on: 0000 0111
- RDI on: 0000 0110

For the alarm condition, no other action is taken concerning any payload or other overhead bytes, these are all unchanged from the normal (no errors) state.

The K2 bytes in all other frames are unused and are set to 0000 0000.

## B2 Bytes

**General** A path error monitoring function is implemented in the SONET specification. This function is incorporated as BIP-8 code, which is stored in the B2 bytes of each frame. See “*BIP Coding*” on page 14 for details about BIP-8 coding.

The path error monitoring code of a frame is computed over all bits of the previous STM-N frame, except for the first three rows of SOH, and is placed in the B2 bytes of the current frame before scrambling.

**Single B2 Error** You can specify a single B2 error per frame.

To generate a B2 error (in channel one only), bit 3 in the pointer H3 byte is complimented.

The B2 byte itself remains unchanged.

## All Other Line Overhead

All other line overhead bytes contain 0000 0000 prior to scrambling.

# SONET Section Overhead and SDH RS Overhead Details

## B1 Byte

**General** A section error monitoring function is implemented in the SONET specification. This function is incorporated as BIP-8 code, which is stored in the B1 bytes of each frame. See “*BIP Coding*” on page 14 for details about BIP-8 coding.

The section error monitoring code of a frame is computed over all bits of the previous STM-N frame *after* scrambling, and is placed in the B1 byte of the current frame *before* scrambling.

**Single B1 Error** The user can specify a single B1 error per frame.

To generate a B1 error (for channel 1 only), one 1 of a selected byte is complimented (the byte is XORed with 0000 0001).

The selected byte is located at channel 1 (SONET) or channel 1-a (SDH), row 3, column 1. This byte is unused by the signal.

The B1 byte itself remains unchanged.

## Framing

A complete framing pattern (3, 12, 48, 192, 768 x F6 + 3, 12, 48, 192, 768 x 28) is generated.

## Out Of Frame (OOF)

Out Of Frame is generated by inverting the first A1 byte (F6 becomes 09), and the first A2 byte (28 becomes D7).

## J0/Z0 Section Trace/Growth Bytes

For SONET, the STS-768 ID J0 byte will always be 1.

For SDH, the STM-256 ID J0 bytes will be numbers 1, 2, 3 to 0.

For SDH, the undefined Z0 bytes will be set to AA (1010 1010) (the physical sequence will be: 1, 2, 3, 4, ... 255, 0, AA, AA, ... AA, AA).

Similar numbering applies to all other frames.

## All Other Section Overhead

All other section overhead bytes will contain 0000 0000 prior to scrambling, except the D1, D2 and D3 bytes, which are used for synchronizing.

## CMI Coding

CMI coding is a method of converting binary data into an electrical signal. Bits with the value 1 are given bipolar levels (alternating positive/negative voltages). Bits with the value 0 are represented by two voltage levels, a negative then positive level, within the same time span normally used for one digit. This type of code maintains the signal at the digital clock rate, improving signal synchronization.

For example: Binary 0 1 1 0 1 0 1 1

is converted to: 01 11 00 01 11 01 00 11

**NOTE** When CMI coding is used, the frequency of the ParBERT has to be doubled.

**NOTE** There are a few combinations of settings where the generated synchronizing pattern is not unique (for example, segment width 8, STS 48 and STS 192). This can be a problem with very regular CMI pattern but should not appear with other widths.

## Synchronizing Pattern

ParBERT needs a synchronizing pattern of 48 bits per channel (where segment width = 1). This pattern is inserted in the D1, D2 and D3 bytes of the section overhead as long as needed.

Lower rates are restricted to lower segment widths (see table below).

The following patterns are used:

- For scrambled and non-scrambled frames:

Five fixed bytes: 0xff 0x55 0xaa 0xaa 0x55

Followed by one counter byte: 0xf0, 0xe1, ... 0x0f

The complete pattern would be, for example:

0xff 0x55 0xaa 0xaa 0x55 0xf0

- For CMI-coded frames (doubled frequency): 0xf5 0xaa 0x5f

When inserting a binary payload, you have to make sure that this pattern (with scrambling) is not used within the payload.

The following table shows how the payload size is determined by the segment width and the different rates.

**Table 3 Possible Combinations of Rate and Segment Width**

Segment width <sup>a</sup>	STM-1 / STS-3	STM-4 / STS-12	STM-16 / STS-48	STM-64 / STS-192	STM256 / STS-768
1	48 Bits	48 Bits	48 Bits	48 Bits	48 Bits
2	96 Bits	96 Bits	96 Bits	96 Bits	96 Bits
4	192 Bits	192 Bits	192 Bits	192 Bits	192 Bits
8	384 Bits	384 Bits	384 Bits	384 Bits	384 Bits
12	576 Bits	576 Bits	576 Bits	576 Bits	576 Bits
16	768 Bits	768 Bits	768 Bits	768 Bits	768 Bits
D1-D3 (in Bits)	72 Bits	288 Bits	1152 Bits	4608 Bits	18432 Bits

<sup>a</sup> Note: The areas in gray are unavailable combinations.



# Graphical User Interface Reference

The Frame Generator's Graphical User Interface (GUI) is relatively simple; the following is a short description of the GUI elements, tool bar and menus.

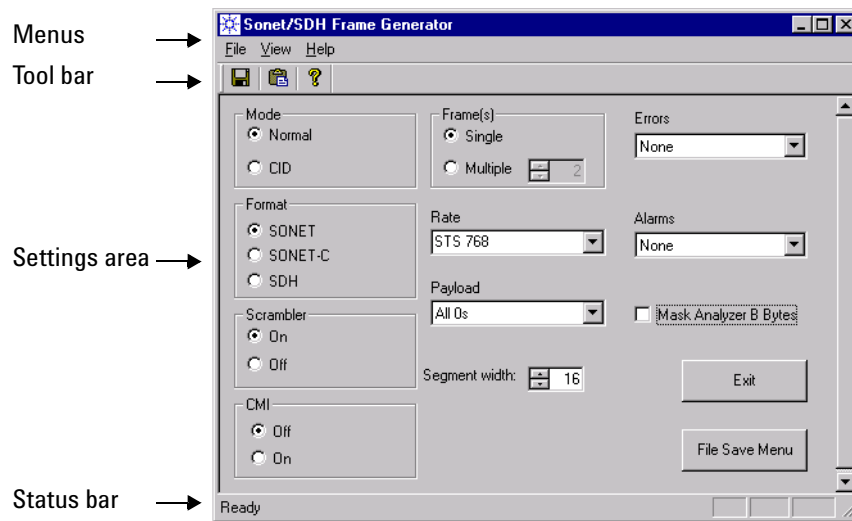


Figure 6 SONET GUI

# Settings Area

**NOTE** Some elements of the setting area are invisible if you select *CID* for *Mode*. The invisible elements are not available for *CID*.

The following is a list of the elements of the settings area:

- *Mode*  
Defines the following modes.
  - *Normal* specifies a single frame of a SONET/SDH signal.
  - *CID* specifies a Consecutive Identical Digit pattern.
- *Format*  
Defines the frame format to be generated; can either be *SONET*, *SONET-C*, or *SDH*.
- *Scrambler*  
Determines whether or not the payload is scrambled. The SONET / SDH 2<sup>7</sup> PRBS standard is used for scrambling.
- *CMI*  
Defines whether or not the frame is coded in the Coded Mark Inversion format, which means doubled frequency.  
If you select CMI, make sure you double the frequency on the ParBERT.  
See “CMI Coding” on page 20 for more information.
- *Frame(s)*  
Determines how many patterns are to be generated in the frame file.
  - *Single* specifies one pattern.
  - *Multiple* lets you select the number of patterns to be generated.

**NOTE** When setting up the frame files, please keep the ParBERT memory restrictions in mind. The available memory depends on the data generator/analyzer modules installed and on the port frequency. For example, a ParBERT 43G system equipped with eight E4861B modules and running at a data rate above 42.67 Gbit/s can have a memory capacity of 16 Mbit per channel.



- *Rate*

The rate available depends on the selected *Format*. The following rates are available:

SONET (-C)	SDH
STS-768 (39.81312 Gb/s)	STM-256
STS-192 (9.95328 Gb/s)	STM-64
STS-48 (2.48832 Gb/s)	STM-16
STS-12 (622.08 Mb/s)	STM-4
STS-3 (155.52 Mb/s)	STM-1

- *Payload*

This field defines how the payload is generated. You have the following choices:

- All 0s
- All 1s
- Alternate 1, 0
- Various PRBS settings
- *Edit pattern*

This opens the *Pattern Editor*, which allows you to enter a pattern (see following description).

- *From file*

This opens up a dialog box, where you can select the file to be used as payload.

This must be a binary file.

See "*Payload Details*" on page 15 for more information.

- *Segment width*

Lets you define the segment width used. This has to match multiplexer type used.

- *Pattern Editor*

Allows you to define a pattern (0s and 1s) for the payload to be generated. The bits entered are repeated to fill up the payload.

- *Errors*

Allows you to specify errors that are to be generated in the first frame.

SONET (-C)	SDH
S-BIP (B1)	RS-BIP (B1)
L-BIP (B2)	MS-BIP (B2)
P-BIP (B3)	HP-BIP (B3)
None	None

- *Alarms*

Allows you to specify alarms that are to be generated in the patterns.

SONET (-C)	SDH
OOF	OOF
L-AIS	MS-AIS
L-FERF	MS-RDI
P-FEBE	HP-REI
None	None

- *Mask Analyzer B Bytes*

When you select this option, the B bytes (error monitoring bytes) for the analyzer are masked.

- *File Save Menu* button

Opens the File Save dialog box, where you can select a file name and path for the frame files to be generated. See “*Generating Frame Files*” on page 8 for more information.

- *Exit* button

Closes the application.

# Menu

The Frame Generator contains the following menus, which enable you to save files and change appearances of the application:

- *File* menu
- *View* menu
- *Help* menu

These are described in the following sections.

## File Menu

The *File* menu contains the following elements:

- *Save as ...*

Opens the *File Save* dialog box, where you can select a file name and path for the frame files to be generated. See “*Generating Frame Files*” on page 8 for more information.
- *Convert Frames*

Opens the *Open* dialog box, where you can select files that are to be converted into frames that can be imported into ParBERT. See “*Converting Frame Files*” on page 12 for more information.
- *Exit*

Closes the application.
- *Generation Setting*

Opens up a dialog box that lets you select which files are to be generated. You can select any combination of the following:

  - *Frame Files*
  - *Analyzer Files*
  - *Generator Files*
  - *B Bytes Files*

See “*Settings Area*” on page 24 for more information.

## View Menu

The *View* menu contains the following elements:

- *Tool Bar*  
Shows/hides the tool bar.
- *Status Bar*  
Shows/hides the status bar.

## Help Menu

The *Help* menu contains the following elements:

- *about\_frame\_gen*  
Opens up a message box that informs you about the version number.
- *Help*  
Opens the Online Help.

## Tool Bar

The tool bar provides you quick access to most important Frame Generator functions. The following tools are available:



Opens the *Save as ...* dialog box, where you can select the name and path of the files to be saved. See “*Generating Frame Files*” on page 8 for more information.



Opens the *Open* dialog box, where you can select the previously generated files to be converted. See “*Converting Frame Files*” on page 12 for more information.



Opens a message box that informs you about the version of the software.

# Status Bar

The status bar at the bottom of the GUI provides information about the status of the application. It also provides “pop-up” type tips for the menus and tools (when the mouse moves over a tool, for example, the status bar shows what the tool does).



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