

OptiSPICE

EA Modulator Parameter Extractor Manual

Electroabsorption Modulator Parameter Extractor Software for OptiSPICE

Version 5.2



OptiSPICE

EA Modulator Parameter Extractor Manual

Electroabsorption Modulator Parameter Extractor Software for OptiSPICE

Copyright © 2016 Optiwave

All rights reserved.

All OptiSPICE documents, including this one, and the information contained therein, is copyright material.

No part of this document may be reproduced, stored in a retrieval system or transmitted in any form or by any means whatsoever, including recording, photocopying, faxing, etc., without prior written approval of Optiwave.

Disclaimer

Optiwave makes no representation or warranty with respect to the adequacy of this documentation or the programs which it describes for any particular purpose or with respect to its adequacy to produce any particular result. In no event shall Optiwave, its employees, its contractors, or the authors of this documentation be liable for special, direct, indirect, or consequential damages, losses, costs, charges, claims, demands, or claim for lost profits, fees, or expenses of any nature or kind.

Table of contents

Introduction	1
Main features	2
EA Modulator Parameter Extractor GUI	3
Main parts of the GUI	4
Project Browser	4
Parameter Editor	7
Calculation Output.....	7
Views.....	8
Calculator	9
Status bar	9
Menu bar	10
Toolbars	10
Menus and buttons	10
File menu.....	10
Edit menu	11
View menuWindow menu	11
Quick Start.....	13
Starting Modulator Parameter Extractor	13
Viewing and editing parameters	14
Running a simulation.....	17
Technical Background.....	23

Parameters	23
Main	23
Technical Background	24
References	25
Notes:	26

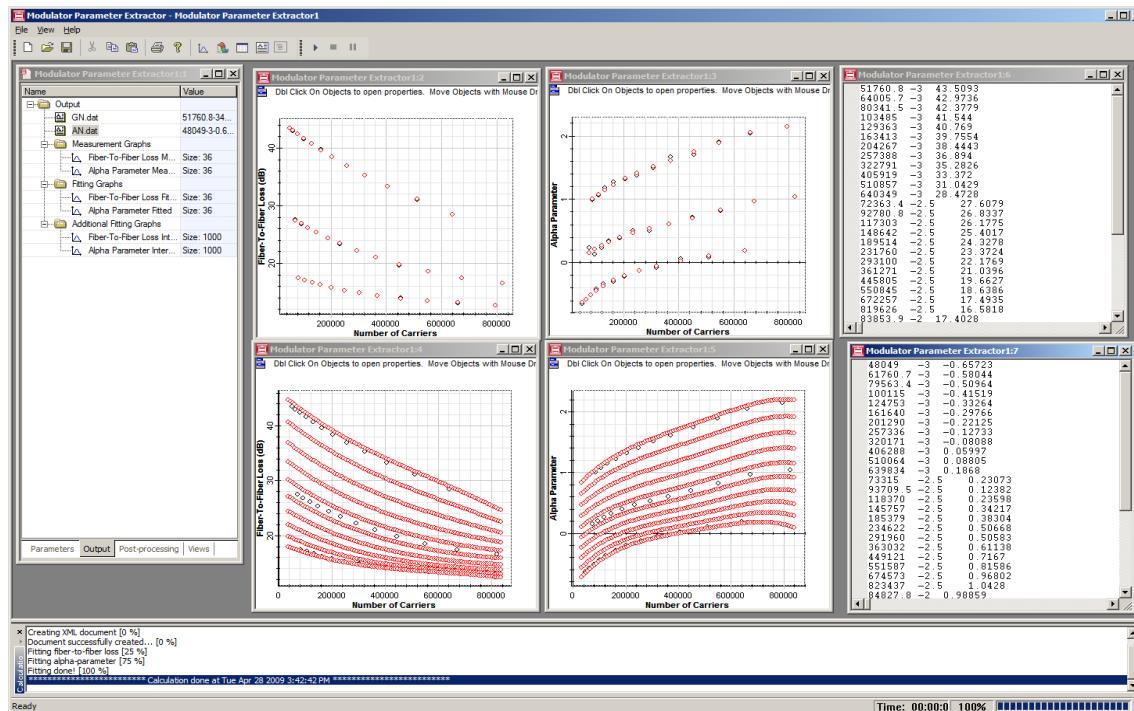
Introduction

The Modulator Parameter Extractor is a software tool that enables parameter fitting of measurements from MQW Electroabsorption Modulators [1] with one or two dimensional functions, using a polynomial form.

Modulator Parameter Extractor generates a polynomial matrix file containing the coefficients of the fitted measurements, calculated from the input measurements such as the dependence of the fiber-to-fiber loss and alpha-parameter on the number of photogenerated carriers and bias voltage.

OptiSPICE uses this file as an input to the Electroabsorption modulator element.

Figure 1 Modulator Parameter Extractor GUI



Main features

The main features of the Modulator Parameter Extractor include:

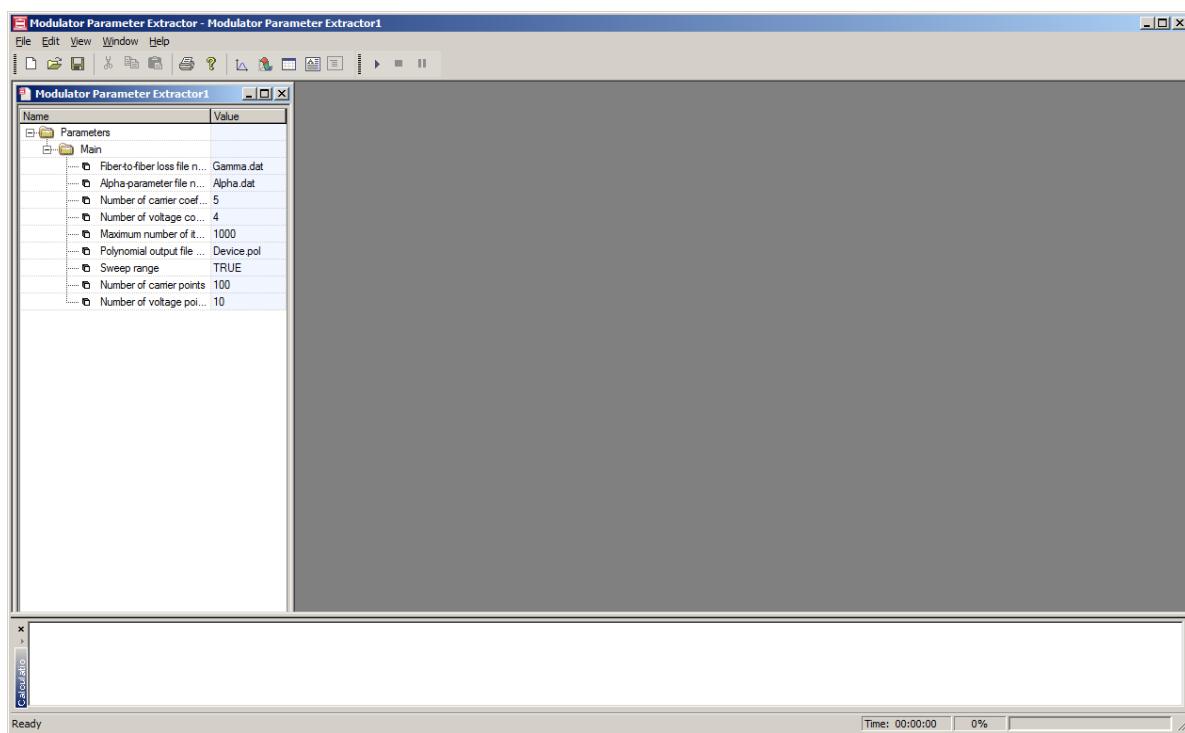
Feature	Description
Graphical user interface	A comprehensive Graphical User Interface (GUI) controls the fiber input parameters, output results, presentation graphics and post-processing.
Numerical engine	The numerical engine employs a 2D polynomial fit that allows for the simultaneous fitting of fiber-to-fiber loss and alpha-parameter on the number of photogenerated carriers and bias voltage.
Visualization capabilities	Powerful & intuitive result management allows users to graph almost any set of results available in design. Results are grouped into resizable, moveable views that supports text, tables, 2D and 3D graphs.
Post-Processing	A waveform calculators that uses standard Microsoft VBScript allows for unparalleled capability and flexibility to analyze simulation results.



EA Modulator Parameter Extractor GUI

When you open the Modulator Parameter Extractor, the application looks like [Figure 1](#).

Figure 1 Modulator Parameter Extractor graphical user interface (GUI)



Main parts of the GUI

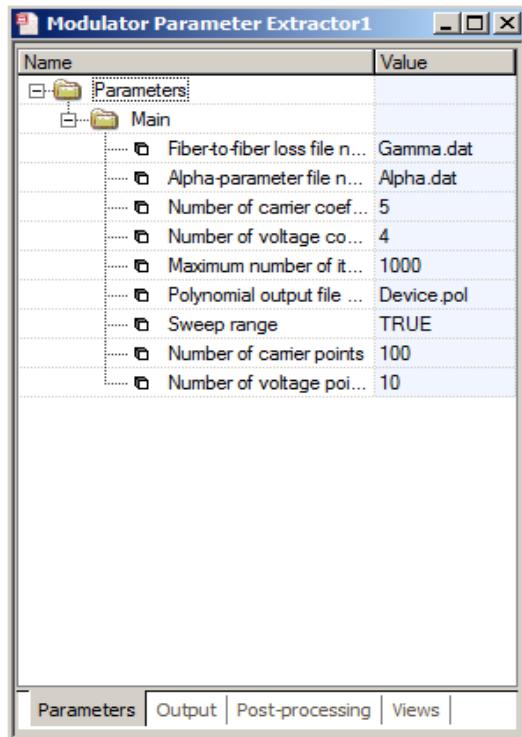
The Modulator Parameter Extractor GUI contains the following main windows:

- Project Browser
 - Parameters tab
 - Output tab
 - Post-processing tab
 - Views tab
- Calculator
- Calculation Output
- Views
- Status bar
- Menu bar

Project Browser

Project browser allows the user to organize the project to achieve results more efficiently, and navigate through the current project. Access parameters, results and views.(see [Figure 2](#)).

Figure 2 Project browser (Parameters tab)



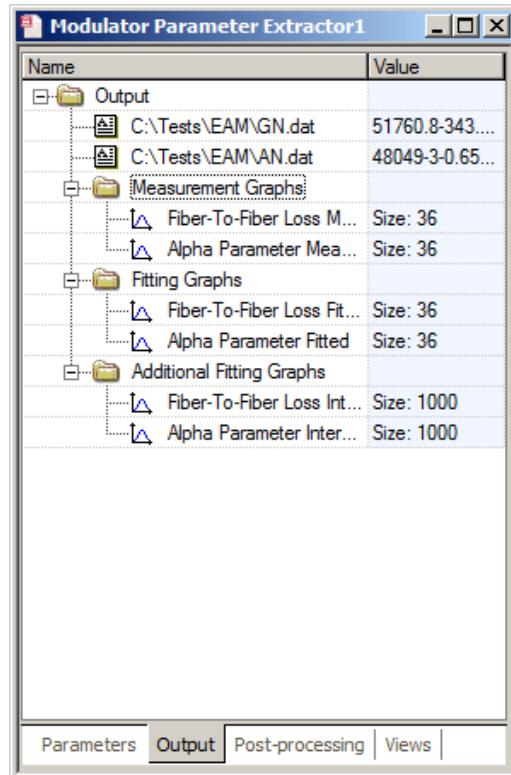
Parameters tab

Lists the properties of the current project. Users can access the parameter editor by double-clicking on any parameter in the list.

Output tab

Displays the results of the calculation (see [Figure 3](#)). User can drag-and-drop results into views or simply double-click on any result in order to launch the default view for a given result.

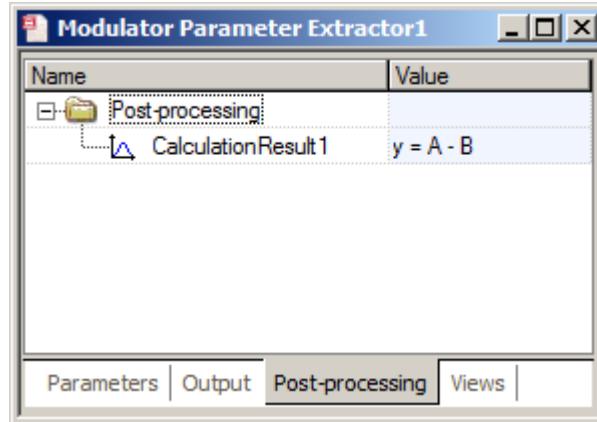
Figure 3 Project browser (Output tab)



Post-processing tab

Displays the post-processed results from the calculator (see [Figure 4](#)). User can drag-and-drop post-processed results into views or simply double-click on any post-processed result in order to launch the default view.

Figure 4 Project browser (Post-processing tab)

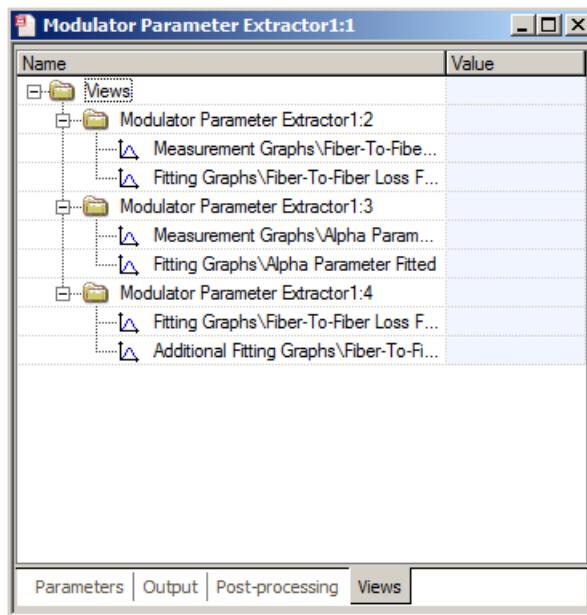


Views tab

Post-processing tab

Displays a list of views that represent active windows containing and displaying results (see [Figure 5](#)).

Figure 5 Project browser (Views tab)

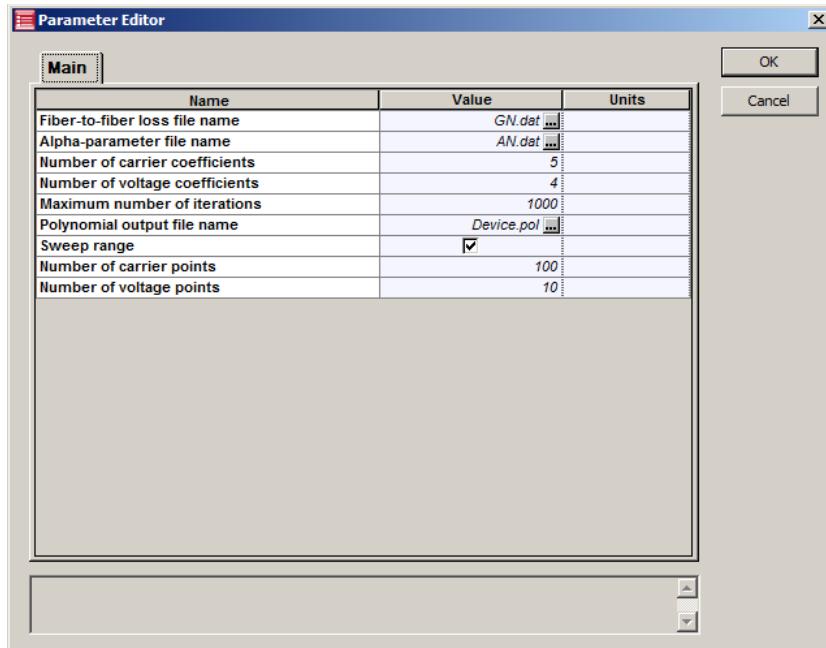


Parameter Editor

Double clicking on any parameter in the Project Browser brings the **Parameter Editor** (see [Figure 6](#)). The Parameter Editor allows you to view the list of global parameters of the active project.

Note: Please refer to the [Technical Background](#) for the description of the parameters listed in the editor.

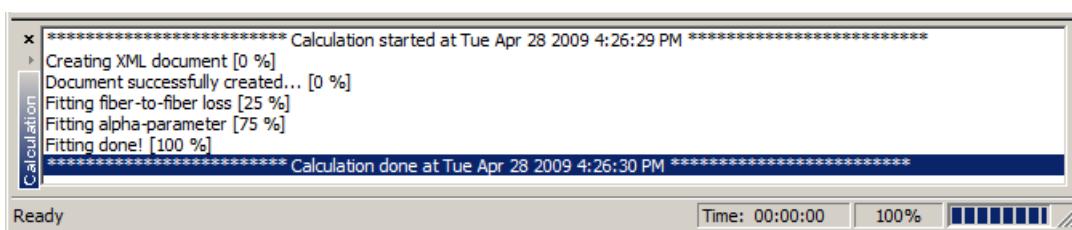
Figure 6 Parameter Editor control



Calculation Output

Information regarding the progress of the calculation is displayed in the Calculation output (see [Figure 7](#)).

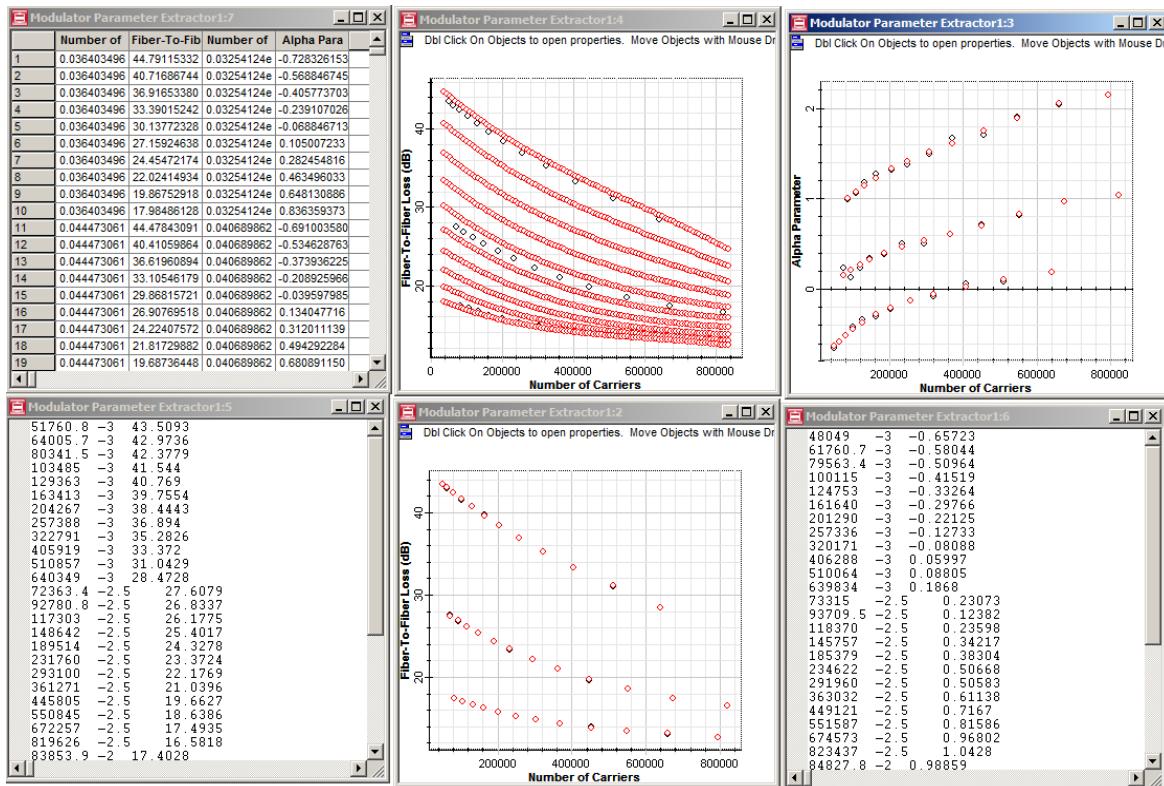
Figure 7 Calculation output



Views

Views are windows that contains results from calculation or post-processing (see [Figure 8](#)). They display 2D, tables and text. A user can create an empty view by clicking in one of the toolbar buttons such as *Create 2D Graph View*, *Create Grid View* or *Create Text View*. Alternatively, by double-clicking on a results a view will be automatically created or by selecting a result and clicking on the context menu (right-click) an selecting *View*.

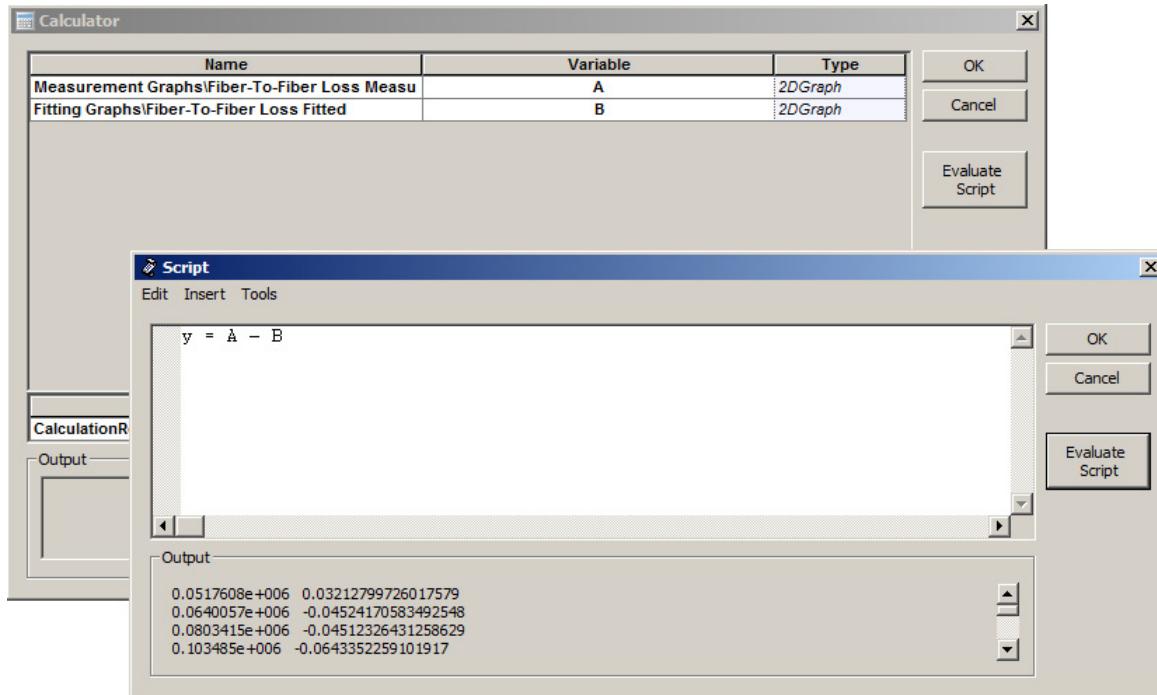
Figure 8 Multiple views



Calculator

The **Calculator** control allows you to operate on the output results to create new results and graphs. By selecting one or more results or 2D graphs the user can select the Calculator on the context menu (right-click). In order to create a new results the user provides a script (Microsoft VBScript Language) that operates on the available variables - the output results MUST be provided to the Y variable.

Figure 9 Calculator



Status bar

Displays useful hints about using the Modulator Parameter Extractor, the time and progress of the calculation (see [Figure 10](#)).

Figure 10 Status bar



Menu bar

Contains the menus that are available in the Modulator Parameter Extractor (see [Figure 11](#)). Many of these menu items are also available as buttons on the toolbars or from other lists.

Figure 11 Menu bar



Toolbars

You can select the toolbars that you want to have available in the main layout window. The toolbar options include:

Standard		Contains the buttons to perform all typical windows application actions, in addition to create views options.
Calculation		Calculate, pause or stop the project calculation.

Menus and buttons

This section describes the menus and buttons available in the Modulator Parameter Extractor.

File menu

File menu item	Toolbar button	Description
New (Ctrl+N)		Create a new project.
Open (Ctrl+O)		Open an existing project. Select the project from the Open dialog box.
Close		Close the active (current) project. You are prompted to save changes.
Save (Ctrl+S)		Save the active (current) project under the current name in the default location.
Save As		Save the active (current) project with a different name and in a location that you select.
Print (Ctrl+P)		Print the active (current) project.
Print Setup		Set up the printer, page size, orientation, and other printing options.



File menu item	Toolbar button	Description
Print Preview		Preview the active (current) project.
Calculate (Ctrl+F5)		Calculate the active (current) project.
Recent files		List the most recent files that you worked on.
Exit		Exit the application. You are prompted to save changes to the project.

Edit menu

Edit menu item	Toolbar button	Description
Undo (Ctrl+Z)		Undo the last change made in the active (current) layout. You can undo all actions until the last saved operation.
Cut (Ctrl+X)		Remove all selected objects and place them on the clipboard.
Copy (Ctrl+C)		Copy selected objects to the clipboard. The selected objects remain in the active project.
Paste (Ctrl+V)		Copy objects from the clipboard and paste them in a user-defined location—the same layout, a new subsystem, or a new layout.

View menuWindow menu

View menu item	Toolbar button	Description
Toolbars		
Standard		Select to display the Standard toolbar.
Calculation		Select to display the Calculation toolbar.
Status Bar		Select to display the Status Bar .

Window menu item	Toolbar button	Description
Cascade		Arranges all open views in a cascading format.
Tile		Arranges all open views in a tile format.
Arrange icons		Lines up minimized views at the bottom of the application.

Help menu

Help menu item	Description
About Modulator Parameter Extractor	Provides information about Optiwave Corporation—mailing address, telephone and fax numbers, E-mail address, and URL.



Quick Start

This section describes how to run a project, edit parameters, and obtain results.

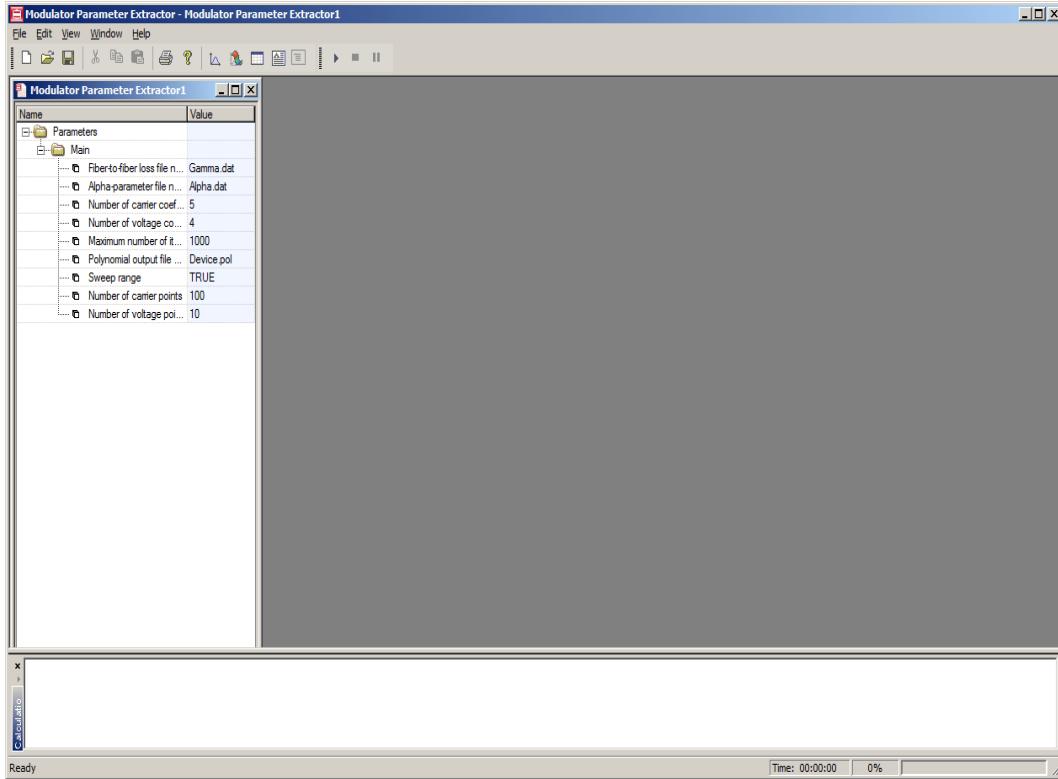
Starting Modulator Parameter Extractor

To start **Modulator Parameter Extractor**, perform the following action.

Action

- From the **Start** menu, select **Programs > Optiwave Software> OptiSPICE 1> Modulator Parameter Extractor**.
*Modulator Parameter Extractor loads and the graphical user interface appears
(see [Figure 1](#)).*

Figure 1 Modulator Parameter Extractor graphical user interface (GUI)



Viewing and editing parameters

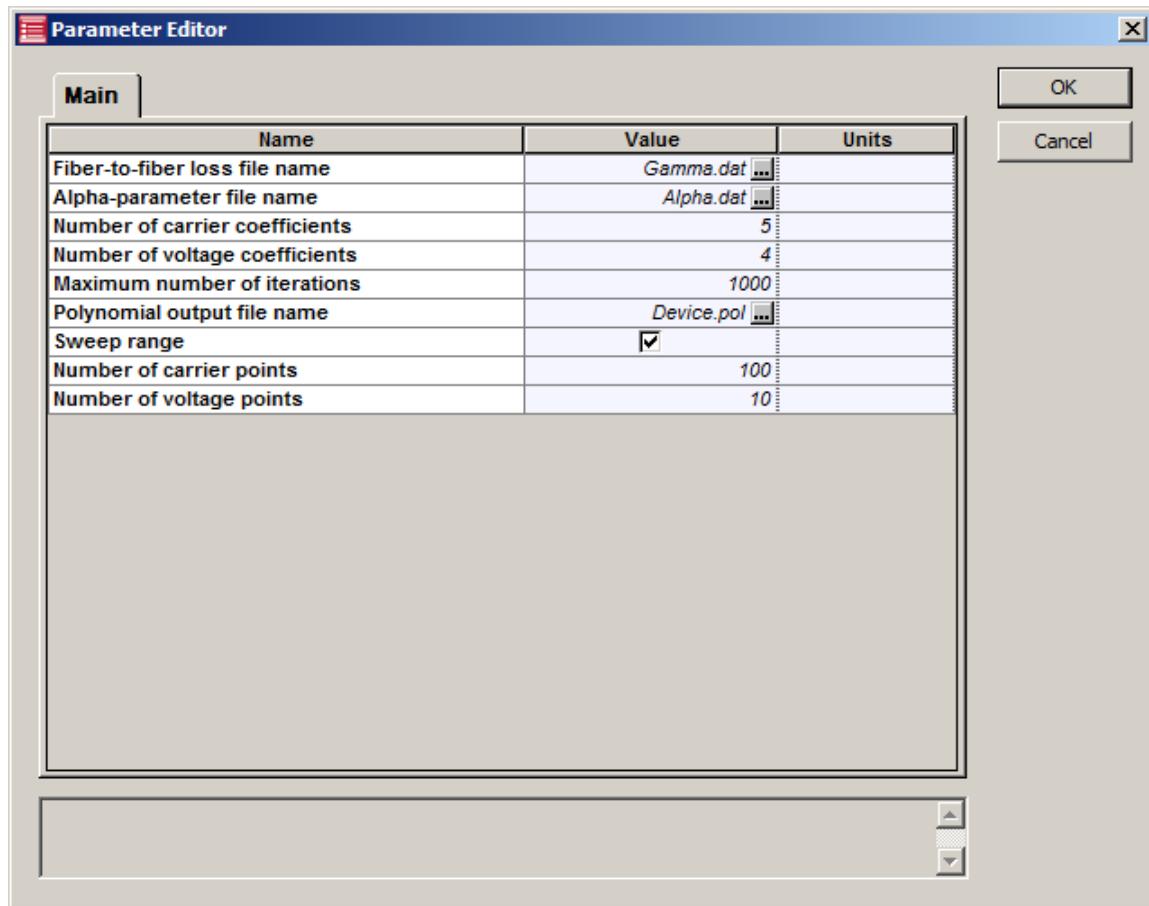
To view and edit the project parameters perform the following action.

Action

- In the **Project Browser**, double-click on any parameter in the **Parameters** tab to view and edit the parameters for the project.
*The **Parameter Editor** (see [Figure 2](#)) dialog box appears.*



Figure 2 Parameter Editor



Parameters are organized by categories. **Filter Parameter Extractor** has one category represented by a tab in the dialog box:

- Main

Each category has a set of parameters. Parameters have the following properties:

- Name
- Value
- Unit

For a detailed description of each parameter please refer to [Technical Background](#).

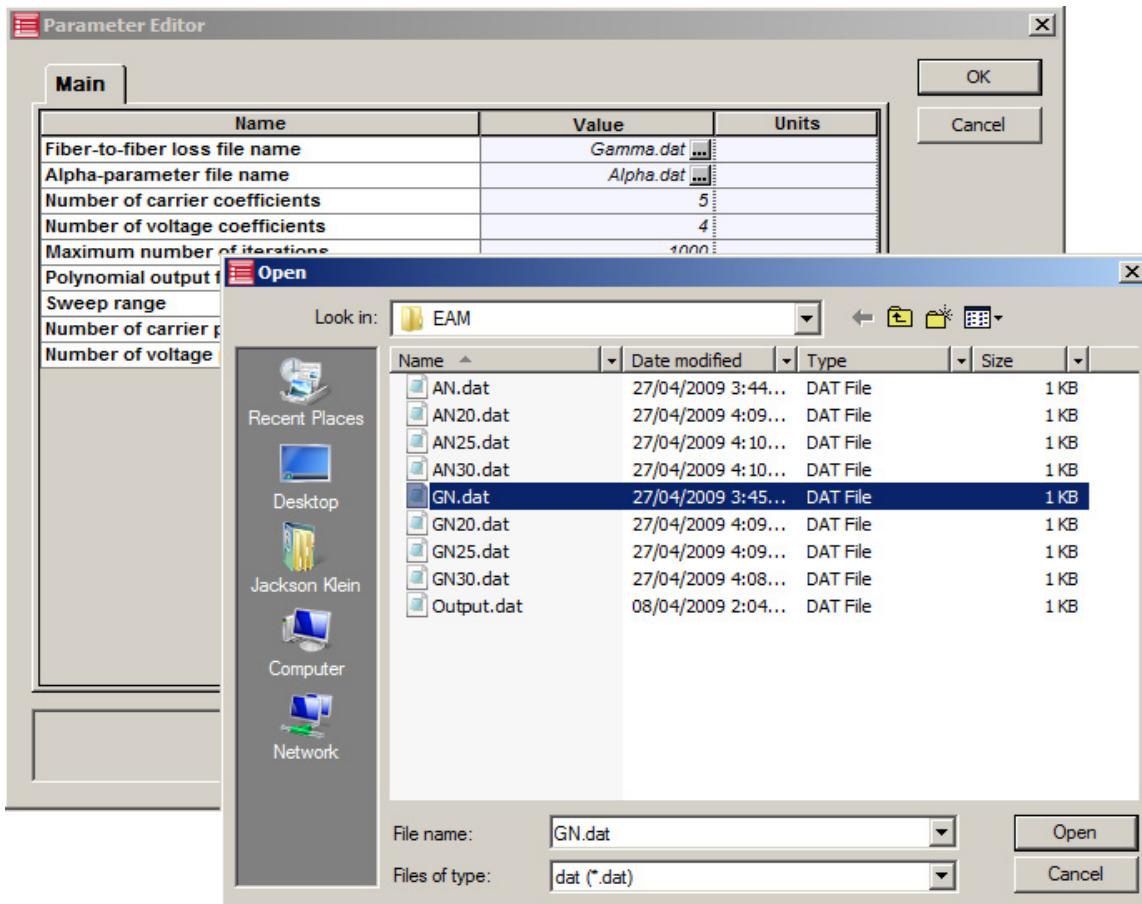
Parameter settings to create a fiber library for OptiSPICE

To create a fiber library for OptiSPICE perform the following actions.

Step	Action
1	In the Project Browser , double-click on any parameter in the Parameters tab to view and edit the parameters for the project. <i>The Parameter Editor (see Figure 2) dialog box appears.</i>
2	Provide the <i>Fiber-to-fiber loss</i> and <i>Alpha-parameter file name</i> parameters - their location is the file destination and the root name for the library (see Figure 3).
3	In the Parameter editor, click on 'OK'.



Figure 3 Settings to create a fiber library.



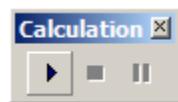
Running a simulation

To run a simulation again with the current modulator parameters and create a library file for OptiSPICE, perform the following procedure.

Step Action

- In the Calculation toolbar, click on 'Play' (see Figure 5).
The Calculations starts (see Figure 5).

Figure 4 Calculation toolbar



QUICK START

Figure 5 Calculation Output



At the end of the calculation the output tab will contain the results of the simulation.



Visualizing results

To view the results from the calculation, perform the following action.

Action

- 1 In the **Project Browser**, click on the **Output tab** to view the results for the project (see [Figure 6](#))
The list of results for the polynomial fitting includes input measurement files (input fiber-to-fiber loss and alpha-parameter) and 2D Graphs (measurement and fitted fiber-to-fiber loss and alpha-parameter)
- 2 Double-click on Fiber-to-Fiber Loss Fitted result.
The 2D Graph view appears (see [Figure 7](#)).

Figure 6 Output results

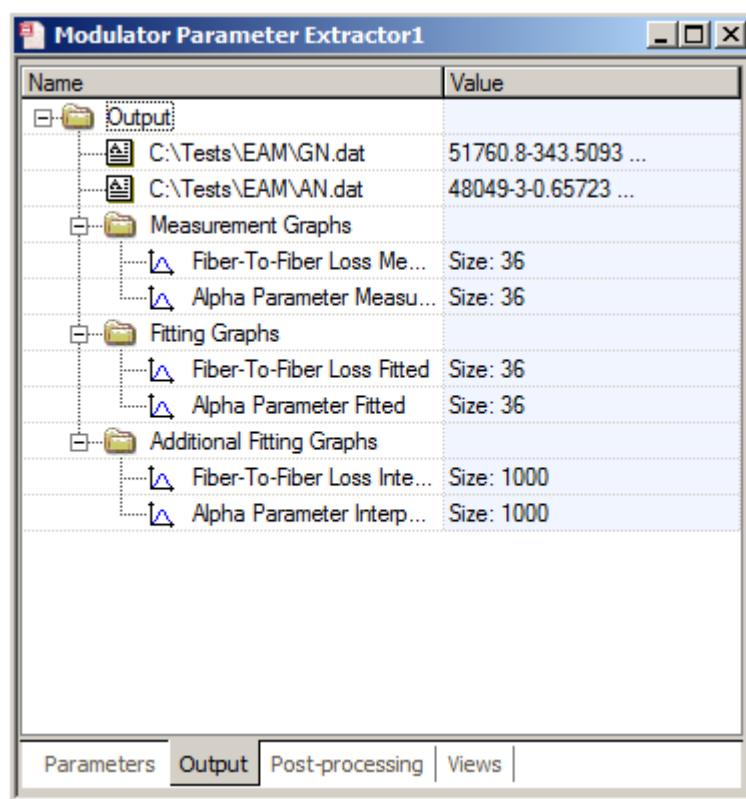
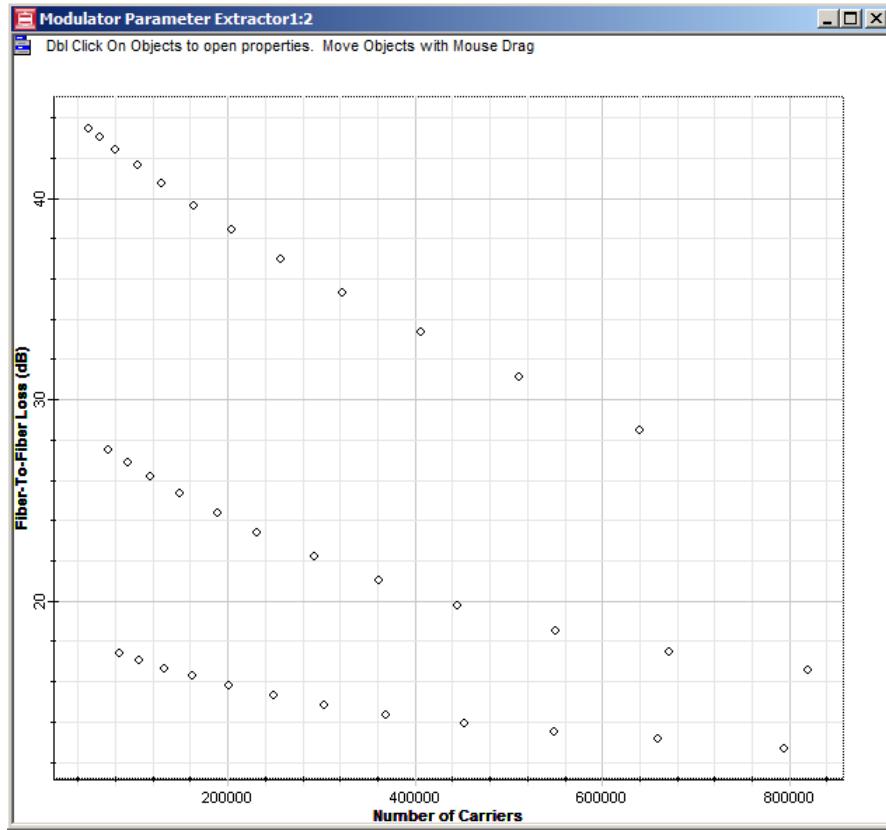


Figure 7 Refractive index profile



The contents of GN.dat (fiber-to-fiber loss) and AN.dat (alpha-parameter) input parameters are depicted in [Figure 8](#). Finally, the polynomial function matrix (Device.pol) is depicted [Figure 9](#).



Figure 8 Measurements of fiber-to-fiber loss and alpha-parameter.

GN.dat - Notepad

File	Edit	Format	View	Help
51760.8	-3	43.5093		
64005.7	-3	42.9736		
80341.5	-3	42.3779		
103485	-3	41.544		
129363	-3	40.769		
163413	-3	39.7554		
204267	-3	38.4443		
257388	-3	36.894		
322791	-3	35.2826		
405919	-3	33.372		
510857	-3	31.0429		
640349	-3	28.4728		
72363.4	-2.5	27.6079		
92780.8	-2.5	26.8337		
117303	-2.5	26.1775		
148642	-2.5	25.4017		
189514	-2.5	24.3278		
231760	-2.5	23.3724		
293100	-2.5	22.1769		
361271	-2.5	21.0396		
445805	-2.5	19.6627		
550845	-2.5	18.6386		
672257	-2.5	17.4935		
819626	-2.5	16.5818		
83853.9	-2	17.4028		
105674	-2	17.103		
132940	-2	16.6244		
162946	-2	16.264		
201134	-2	15.7837		
248878	-2	15.3021		
303448	-2	14.8194		
368943	-2	14.3944		
452187	-2	13.9668		
549077	-2	13.4779		
659628	-2	13.1056		
794748	-2	12.6703		

AN.dat - Notepad

File	Edit	Format	View	Help
48049	-3	-0.65723		
61760.7	-3	-0.58044		
79563.4	-3	-0.50964		
100115	-3	-0.41519		
124753	-3	-0.33264		
161640	-3	-0.29766		
201290	-3	-0.22125		
257336	-3	-0.12733		
320171	-3	-0.08088		
406288	-3	0.05997		
510064	-3	0.08805		
639834	-3	0.1868		
73315	-2.5	0.23073		
93709.5	-2.5	0.12382		
118370	-2.5	0.23598		
145757	-2.5	0.34217		
185379	-2.5	0.38304		
234622	-2.5	0.50668		
291960	-2.5	0.50583		
363032	-2.5	0.61138		
449121	-2.5	0.7167		
551587	-2.5	0.81586		
674573	-2.5	0.96802		
823437	-2.5	1.0428		
84827.8	-2	0.98859		
106726	-2	1.05933		
130026	-2	1.17743		
161495	-2	1.2658		
203856	-2	1.31847		
247588	-2	1.37705		
306383	-2	1.49462		
369315	-2	1.66543		
455353	-2	1.70561		
548342	-2	1.90559		
661762	-2	2.04604		
794267	-2	2.15068		

Figure 9 Contents of the file generated by the Modulator Parameter Extractor.

```

Modulator Parameter Extractor1:2
* Fitting of Fiber Loss and Alpha Parameter (functions of voltage and number of carriers)
* Created Wed Apr 29 2009 4:13:05 PM

* Number of carriers x voltage coefficients
5 4

* Range of fitted number of carriers (from/to)
51760.8 819626

* Range of fitted voltage (from/to)
-3 -2

* Fiber loss coefficients
5.64326 4.35663 3.94593 1.72773
9.1366e-005 1.11488 0.983437 0.153316
1.73295e-011 -1.46383 -2.50029 -0.424231
-9.79499e-018 2.01183 0.257244 0.154469
-8.90643e-023 1.11231 0.95159 0.189361

* Alpha parameter coefficients
1.71131 2.21627 0.940519 0.0110702
2.2745e-005 1.17038 0.801822 0.16415
-3.097e-011 1.29738 0.829695 0.185513
1.90579e-017 1.48022 0.602062 0.15712
-7.49725e-024 1.58509 0.417691 0.126425

```

Saving the project and closing Modulator Parameter Extractor

To save the project and close the Modulator Parameter Extractor, perform the following procedure.

Step Action

- 1** From the **File** menu, select **Save** or **Save As...**
- 2** From the **File** menu, select **Exit**.
Modulator Parameter Extractor closes.



Technical Background

Parameters

Main

Name and description	Default value	Default unit	Value range
Fiber-to-fiber loss file name File containing the measurements of the number of carriers, voltage and fiber-to-fiber loss	Gamma.dat		
Alpha-parameter file name File containing the measurements of the number of carriers, voltage and alpha parameter	Alpha.dat		
Number of carrier coefficients The number of carrier coefficients for the numerical fitting	5		[1, 100]
Number of voltage coefficients The number of voltage coefficients for the numerical fitting	4		[1, 100]
Maximum number of iterations The filename with the refractive index profile	1000		[1, 10000]
Polynomial output file name The output file containing the list polynomial coefficients for fiber-to-fiber and alpha parameters for the modulator	Device,pol		
Sweep range Defines whether to evaluate the fitted polynomial function using additional number of carrier and voltage values	YES		[YES,NO]
Number of carrier points Number of additional carrier points for sweep	100		[1, 10000]

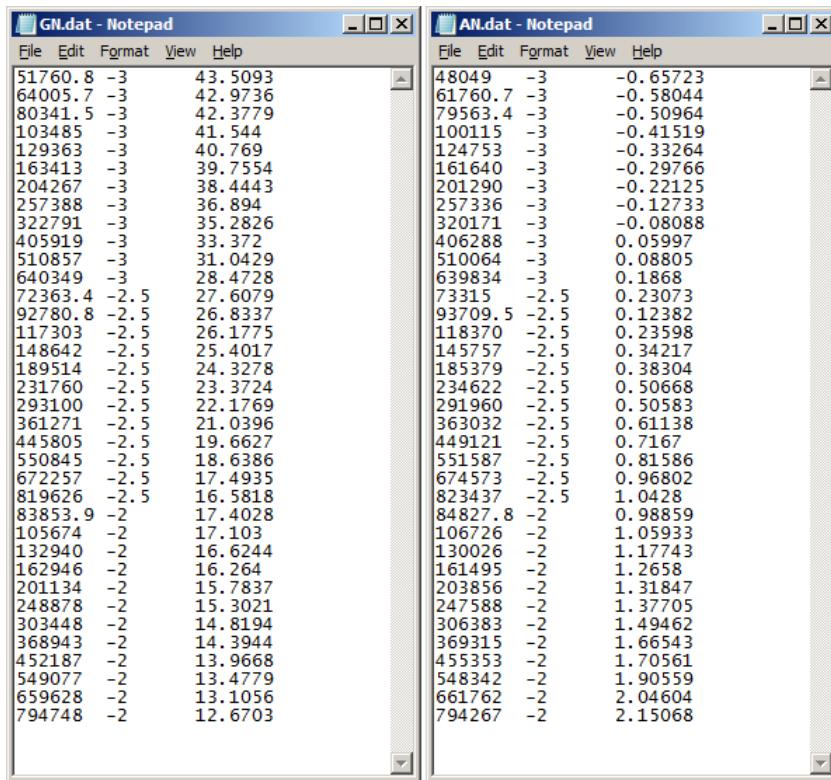
Name and description	Default value	Default unit	Value range
Number of voltage points Number of additional voltage points for sweep	10		[1, 10000]

Technical Background

Modulator Parameter Extractor employs a polynomial fitting algorithm. The user provides two files (parameter *Fiber-to-fiber loss filename* and *Alpha-parameter filename*) containing the electroabsorption modulator measurements.

The fiber-to-fiber loss and alpha parameter file format is a list with the number of carriers, the bias voltage and the measurement (loss or alpha parameter) as depicted in [Figure 1](#), or a list with the bias voltage and the measurement (if number of carriers is not available), as depicted in [Figure 1](#).

Figure 1 Measurements of fiber-to-fiber loss and alpha-parameter.



The figure shows two windows of the Windows Notepad application. The left window is titled "GN.dat - Notepad" and the right window is titled "AN.dat - Notepad". Both windows display text files with data. The "GN.dat" file contains approximately 100 lines of data, each consisting of three numbers separated by spaces. The first column starts with 51760.8 and ends with 794748. The second column starts with -3 and ends with -2. The third column starts with 43.5093 and ends with 12.6703. The "AN.dat" file also contains approximately 100 lines of data, each consisting of three numbers separated by spaces. The first column starts with 48049 and ends with 794267. The second column starts with -3 and ends with -2. The third column starts with -0.65723 and ends with 2.15068.

Row	Column 1	Column 2	Column 3
1	51760.8	-3	43.5093
2	64005.7	-3	42.9736
3	80341.5	-3	42.3779
4	103485	-3	41.544
5	129363	-3	40.769
6	163413	-3	39.7554
7	204267	-3	38.4443
8	257388	-3	36.894
9	322791	-3	35.2826
10	405919	-3	33.372
11	510857	-3	31.0429
12	640349	-3	28.4728
13	72363.4	-2.5	27.6079
14	92780.8	-2.5	26.8337
15	117303	-2.5	26.1775
16	148642	-2.5	25.4017
17	189514	-2.5	24.3278
18	231760	-2.5	23.3724
19	293100	-2.5	22.1769
20	361271	-2.5	21.0396
21	445805	-2.5	19.6627
22	550845	-2.5	18.6386
23	672257	-2.5	17.4935
24	819626	-2.5	16.5818
25	83853.9	-2	17.4028
26	105674	-2	17.103
27	132940	-2	16.6244
28	162946	-2	16.264
29	201134	-2	15.7837
30	248878	-2	15.3021
31	303448	-2	14.8194
32	368943	-2	14.3944
33	452187	-2	13.9668
34	549077	-2	13.4779
35	659628	-2	13.1056
36	794748	-2	12.6703

Row	Column 1	Column 2	Column 3
1	48049	-3	-0.65723
2	61760.7	-3	-0.58044
3	79563.4	-3	-0.50964
4	100115	-3	-0.41519
5	124753	-3	-0.33264
6	161640	-3	-0.29766
7	201290	-3	-0.22125
8	257336	-3	-0.12733
9	320171	-3	-0.08088
10	406288	-3	0.05997
11	510064	-3	0.08805
12	639834	-3	0.1868
13	73315	-2.5	0.23073
14	93709.5	-2.5	0.12382
15	118370	-2.5	0.23598
16	145757	-2.5	0.34217
17	185379	-2.5	0.38304
18	234622	-2.5	0.50668
19	291960	-2.5	0.50583
20	363032	-2.5	0.61138
21	449121	-2.5	0.7167
22	551587	-2.5	0.81586
23	674573	-2.5	0.96802
24	823437	-2.5	1.0428
25	84827.8	-2	0.98859
26	106726	-2	1.05933
27	130026	-2	1.17743
28	161495	-2	1.2658
29	203856	-2	1.31847
30	247588	-2	1.37705
31	306383	-2	1.49462
32	369315	-2	1.66543
33	455353	-2	1.70561
34	548342	-2	1.90559
35	661762	-2	2.04604
36	794267	-2	2.15068

Figure 2 Alternative measurements of fiber-to-fiber loss and alpha-parameter.

The image shows two separate windows of Microsoft Notepad. The left window is titled 'Gamma.dat - Notepad' and contains the following data:

Column 1	Column 2
-2	20
-1.9	18.25
-1.8	16.5
-1.71	14.8
-1.6	12.5
-1.5	10.1
-1.4	8.8
-1.3	7.1
-1.2	6.1
-1.1	5
-1	4.1
-0.9	3.25
-0.8	2.5
-0.7	2
-0.6	1.6
-0.5	1.3
-0.4	1
-0.3	0.52
-0.2	0.25
0	0

The right window is titled 'Alpha.dat - Notepad' and contains the following data:

Column 1	Column 2
-2	-5.8
-1.9	-3.8
-1.8	-1.8
-1.71	-0.64
-1.6	-0.2
-1.5	0.2
-1.4	0.28
-1.3	0.36
-1.2	0.42
-1.1	0.46
-1	0.5
-0.9	0.62
-0.8	0.74
-0.7	0.88
-0.6	1.04
-0.5	1.2
-0.4	1.36
-0.3	1.52
-0.2	1.88
0	3

Parameters *Number of carrier and voltage coefficients* defines the number of coefficients of the polynomial for the numerical fitting. The user can set parameter *Sweep range* to true in order to create additional fitting graphs. Parameters *Number of carrier and voltage points* define the additional number of points used to calculate the additional graphs.

If the number of carriers is not available, the fitting will ignore the parameter *Number of carrier coefficients*.

After the calculation a polynomial function matrix file is generated.

References

- [1] N. Cheng, John C. Cartledge, "Measurement-Based Model for MQW Electroabsorption Modulators", Journal of Lightwave Technology, VOL. 23, NO. 12, December 2005, pp. 4265-4269.

Notes:



Optiwave
7 Capella Court
Ottawa, Ontario, K2E 7X1, Canada

Tel.: 1.613.224.4700
Fax: 1.613.224.4706

E-mail: support@optiwave.com
URL: www.optiwave.com