

# BARNARD MICROSYSTEMS LIMITED

*consulting and technology development: providing you with a better solution*

## WaveMaker Layout

*device and circuit layout software*

WaveMaker LAYOUT has been developed over many years to enable you to design the layout of:

- ❑ single and multi-layer printed circuit board metallisation patterns
- ❑ semiconductor devices such as photodiodes
- ❑ GaAs and Si monolithic microwave integrated circuits

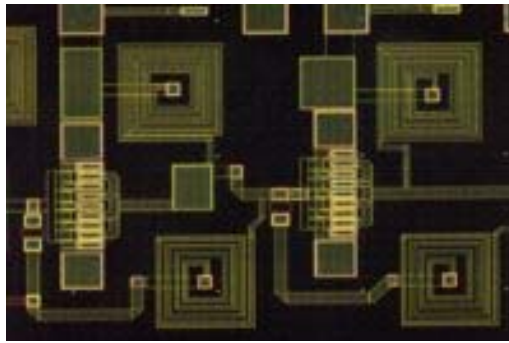
The software runs on a Personal Computer under Microsoft Windows 2000 and XP, and supports the import and export of layout data in the following formats:

AutoCAD DXF revisions 12 and 14	for documentation
Calma GDS II Stream	for device and IC layouts
Gerber (not RS 273)	for PCB layouts
HPGL	for documentation

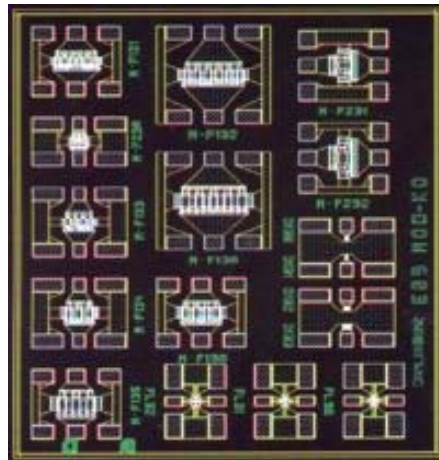


Some of the many features supported by this software are as listed next:

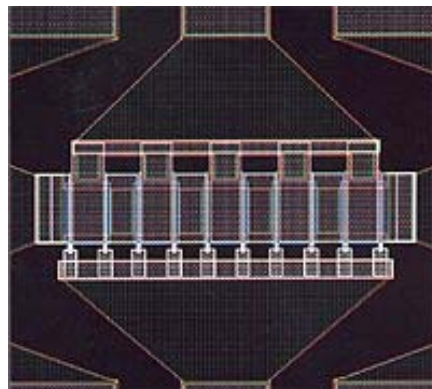
- ❑ xlock points entered to the grid or to an angle relative to the last point
- ❑ define structures 1 nm wide, 1 meter long, or anything in between
- ❑ locate patterns on any or several of the 64 layers available
- ❑ rotate or flip selected shapes at any angle (e.g. 1.2345 degrees)
- ❑ delete, copy or array selected objects (paths, polygons and cells)
- ❑ polygon merge, slice, cutout and oversize (as in over/under expose)



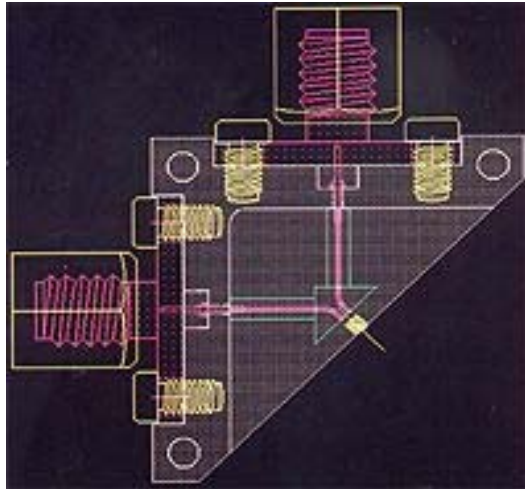
- ❑ drag selected shapes: on dropping them, have them snap into place
- ❑ generate array auto-numbering (e.g. for chip numbering)
- ❑ hop from cell to cell creating designs with up to 20 hierarchy levels
- ❑ clip together structures to create an integrated optics circuit layout
- ❑ view the last 300 commands and system messages
- ❑ UNDO the effects of the previous command (not all commands)
- ❑ get help on commands using the hypertext help system
- ❑ display the co-ordinates of selected polygons



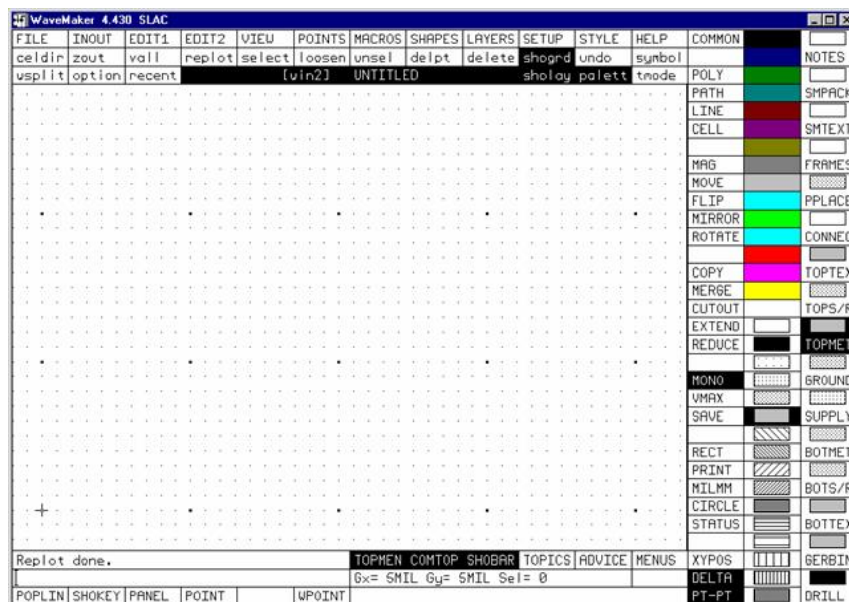
- ❑ set the Y/X viewing aspect ratio from
- ❑ ... with the option of having different values in the X and Y direction 0.001 to 1000.0
- ❑ define the functions associated with the mouse and F keys
- ❑ snap to nearest point on nearest line, to vertex or line centre
- ❑ ... with the option of going down cell hierarchy or not



- ❑ toggle between full screen and split screen representation
- ❑ ... with each screen being in either graphics or text display mode
- ❑ define layer colours, names, fill styles and display status (ON or OFF)
- ❑ save the current system configuration for re-use at a later date
- ❑ access a text file editor capable of editing two files side by side



- ❑ run user defined files containing WaveMaker command sequences
- ❑ add user-defined functions in interpreted BASIC
- ❑ re-arrange the location of commands within menus to suit you
- ❑ create raster scan Gerber output; simulate Gerber exposure
- ❑ export drilling information in the Excellon format
- ❑ export data in the Encapsulated Postscript (EPS) format



- ❑ create a laser plot to the resolution of the laser printer
- ❑ import and export data in HP-GL, DXF, IGES, Gerber, GDS II formats
- ❑ simulate Gerber photo-tool exposure
- ❑ switch window display to monochrome mode prior to screen capture
- ❑ remove the menus and define the window caption

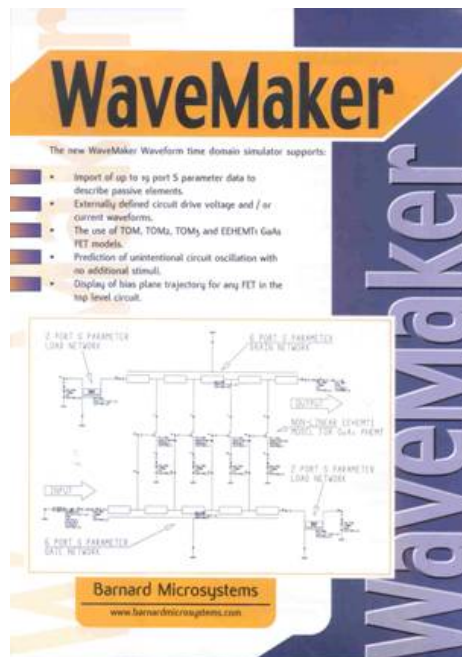
# WaveMaker Waveform

*time domain circuit response simulation software*

## Applications and a brief specification

This new software is intended for the design of circuits in which the conventional time domain and / or the harmonic balance based simulators are inadequate. Circuits and situations that would greatly benefit from the application of this software have some, or all, of the following characteristics:

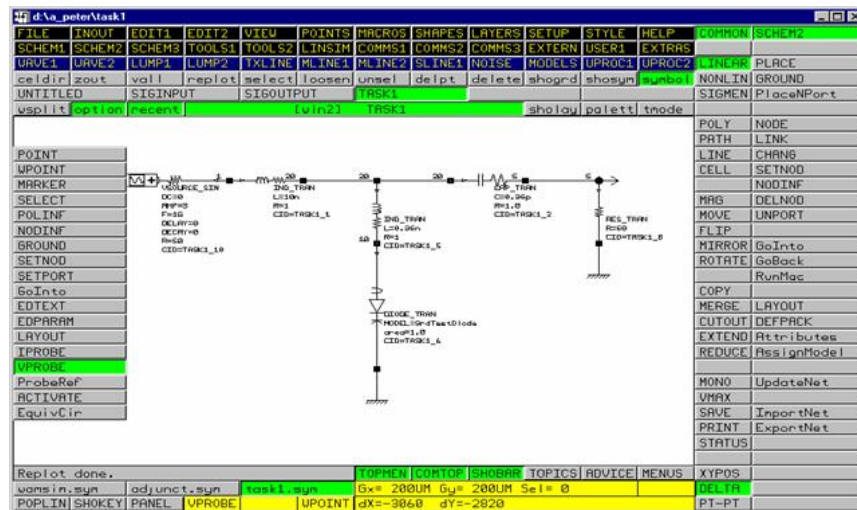
- ❑ complex, externally defined voltage and / or current source driving waveforms
- ❑ signals large enough to cause strongly non-linear operation of the active devices
- ❑ the circuit has an inherently, and strongly, non-linear electrical response
- ❑ the circuit consists of a mixture of microwave passive elements defined by S parameter data and non-linear active devices
- ❑ transient" phenomenon are of interest, such as the start up of unintentional oscillations, or the phase shift as a function of time in a pulsed microwave circuit



Specific examples of situations in which the use of this new software is appropriate are as itemised next:

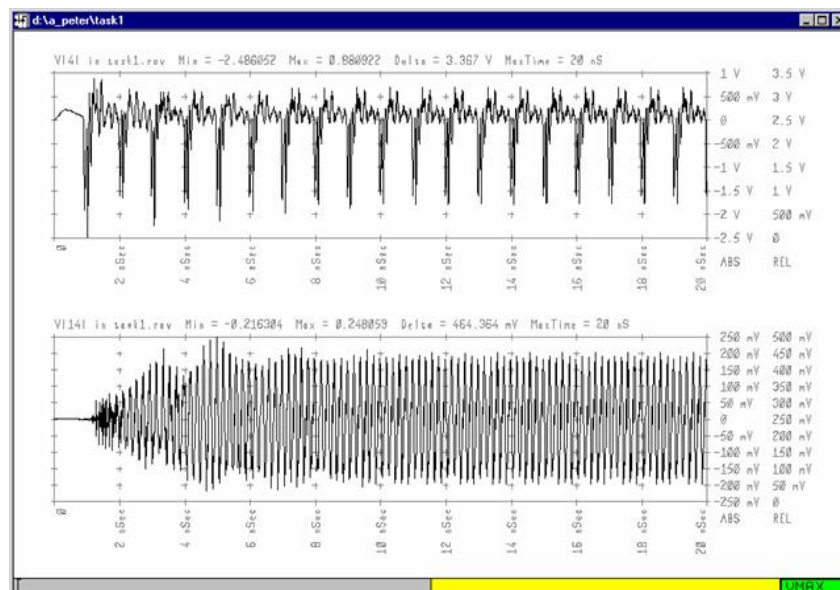
- ❑ whether an amplifier or other such circuit will unintentionally oscillate, without requiring the user to inject any "oscillation start up pulses";
- ❑ the behaviour of a VCO with slow and fast variations in the control voltage (no predictions of phase noise);
- ❑ the response of a transient overload protection circuit;
- ❑ the level of the harmonics generated in a linear amplifier when the amplifier is driven by a high level input signal;

- the interactions (particularly reflected signals) between MMICs connected through the use of transmission lines;
- the operation of ultra wide band (UWB) circuits, as used in UWB RADAR and other systems;
- the phase shift added to a single frequency input signal as a function of time in a pulsed RF circuit (causing "time varying beam skew" when such circuits are used in a phased array RADAR system), resulting from dispersive effects in the PHEMT. For example, the circuit supply voltage may be pulsed ON for 1 uSec, during which time the circuit functions as a power amplifier operating at around 10 GHz, after which the power is turned OFF for around 2.5 mSec. Such a phase shift will not be indicated through the use of a steady state simulator, such as one based on the use of the Harmonic Balance technique



The waveforms in a circuit that is operated in a strongly non-linear manner, such as:

- a Step Recovery Diode (SRD) based circuit for impulse generation;
- a Non Linear Transmission Line (NLTL) based circuit;
- a Schottky Barrier Diode (SBD) based signal sampling circuit;



The response of a circuit to complex, base-band, driving signals such as:

- ❑ a 10 GBit/sec Non-Return-to-Zero (NRZ) Pseudo Random Bit Sequence (PRBS) as encountered in optical communications modules and circuits;
- ❑ a very wide bandwidth noise or pseudo-noise signal (such as WCDMA);
- ❑ high bit rate, parallel data bus signals. As an example, in an 8 bit wide, 1 GBit/sec, data bus, the complex electrical characteristics of the 8 coupled microstrip data tracks could be defined through the use of an electromagnetic simulator as a 16 port S parameter data set;

The response of a circuit:

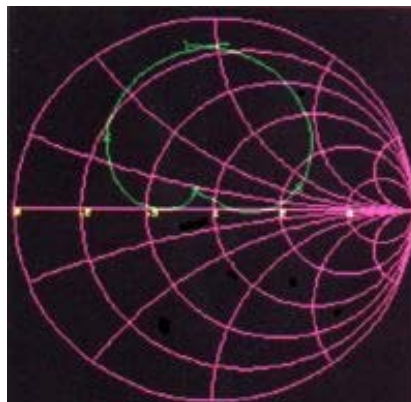
- ❑ in an electrically noisy environment;
- ❑ to signals picked up from a nearby, high power, RADAR system;
- ❑ to impulses picked up from a nearby UWB RADAR system;
- ❑ to signals picked up from a nearby, high power, electronic warfare system;
- ❑ to an electromagnetic pulse (EMP) from a nuclear explosion, or other such powerful source.

The Impulse software on its own can be used to visualise the response of a passive element or circuit section in the time domain. If the visualisation indicates that part of the response appears to occur before time  $t=0$ , then the "non-causal" or "unphysical" response needs to be corrected before the data is used in any simulation. The cause of such an "unphysical" response could result from the over de-embedding of measurement data, or inaccuracies in the closed form mathematical equations used to predict the real and imaginary parts of the circuit response as a function of frequency.

WaveMaker linear microwave circuit simulator (included with WaveMaker Waveform)  
The WaveMaker linear microwave circuit simulation software is used to predict the S parameter characteristics of a linear microwave circuit. The circuit can consist of the following elements:

- ❑ RLC ideal lumped components
- ❑ microstrip lines and discontinuities
- ❑ stripline elements
- ❑ elements defined by their S parameter data

The circuit description can be defined through the use of a text editor to define the netlist, or through the use of the in-built schematic capture capabilities of the software.



The predicted circuit response can be displayed on a rectangular graph, in Smith chart form (for S<sub>nn</sub>) or in tabular format, and / or can be exported as a Touchstone format S parameter data file.

The software supports the optimisation of circuit element parameters to cause the overall circuit or sub-circuit response to more closely match the specified goals. The optimisation approaches supported include both random and gradient types. This feature is also used to derive the values for the circuit element parameters from network analyser measurements on the circuit.

Changes can be made to the circuit element values or the circuit topology, and the new circuit response can be superimposed on the old circuit response to get a clear idea of the effect of any changes made.

Through the use of the in-built Fast Fourier Transform, the user can visualise the waveform at the output of a linear network when that network is subjected to a user-defined, input driving waveform.

The software can also predict the yield of a microwave circuit subject to user defined criteria. The spread in the FET parameters can be predicted through, for example, the use of the GaAsCode FETpro software. FETpro can be used to predict the S parameters for a variety of nominally identical FETs. WaveMaker LINSIM can then perform a set of circuit simulations in which WaveMaker will sequentially use the S parameter data for the nominally identical FETs. WaveMaker will produce a set of predicted S parameter responses for the circuit, from which the user can get the software to display histograms, cumulative distributions and circuit yield predictions.

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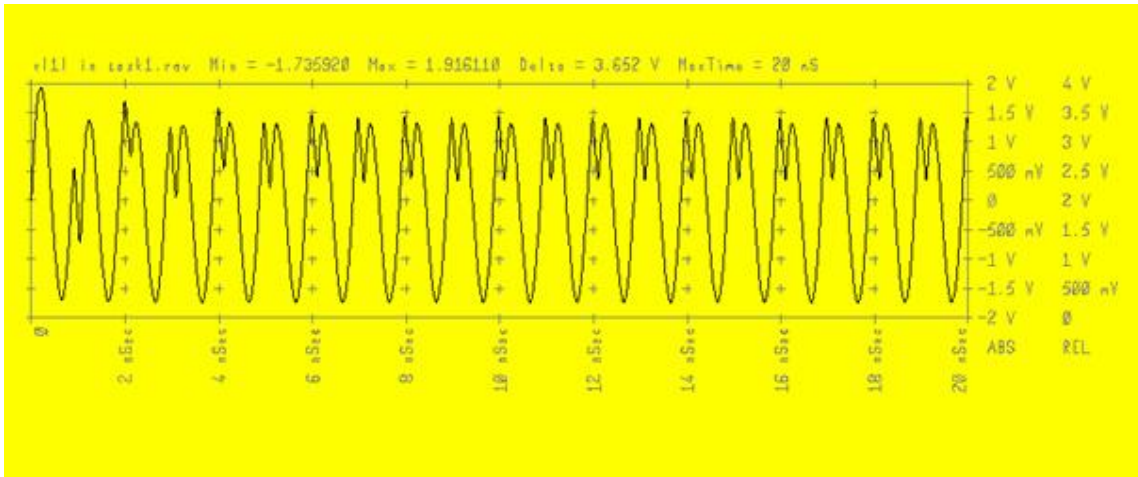
## Outline "impulse" Software Specifications

- ❑ S or Y parameters defined in a data file using the well-known Touchstone ® format.
- ❑ First frequency point need not be zero: if it is less than 1.0% of the second frequency, the software will assume this to be the zero frequency entry.
- ❑ The interval between all the adjacent frequency points (with the first point assumed to be at zero Hz) must be the same, and must equal the value of the second frequency point.
- ❑ Data for structures with from one to 19 ports may be used.
- ❑ Any of the S or Y parameters may exhibit gain (ie. S<sub>mn</sub> > 1.0).

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## Elements supported in WaveMaker Waveform

- ❑ resistor
- ❑ capacitor
- ❑ inductor
- ❑ Voltage Controlled Voltage Source with optional use of delay
- ❑ Voltage Controlled Current Source with optional use of delay
- ❑ d.c. voltage and current sources
- ❑ sine wave voltage and current sources
- ❑ external waveform controlled voltage and current sources
- ❑ Import of 1 to 19 port S or Y parameter data blocks
- ❑ Standard SPICE compatible diode model
- ❑ TOM, TOM2, TOM3, Cobra and EEHEMT1 GaAs FET models



WaveMaker Waveform simulation software:

- ❑ will calculate equivalent circuit model (including noise sources) values for each active device at quiescent bias point.
- ❑ will display bias voltages and currents on the circuit schematic.
- ❑ will generate a data base containing the predicted voltages at each node in the circuit.
- ❑ can be used to superimpose bias plane trajectory on FET IV characteristics.

## **Barnard Microsystems Limited**

ADDRESS	Barnard Microsystems Limited 134 Crouch Hill London N8 9DX United Kingdom
TEL	+44 (0) 208 341 0566
FAX	+44 (0) 208 341 0583
WaveMaker software	<a href="mailto:wavemaker@barnardmicrosystems.com">wavemaker@barnardmicrosystems.com</a>