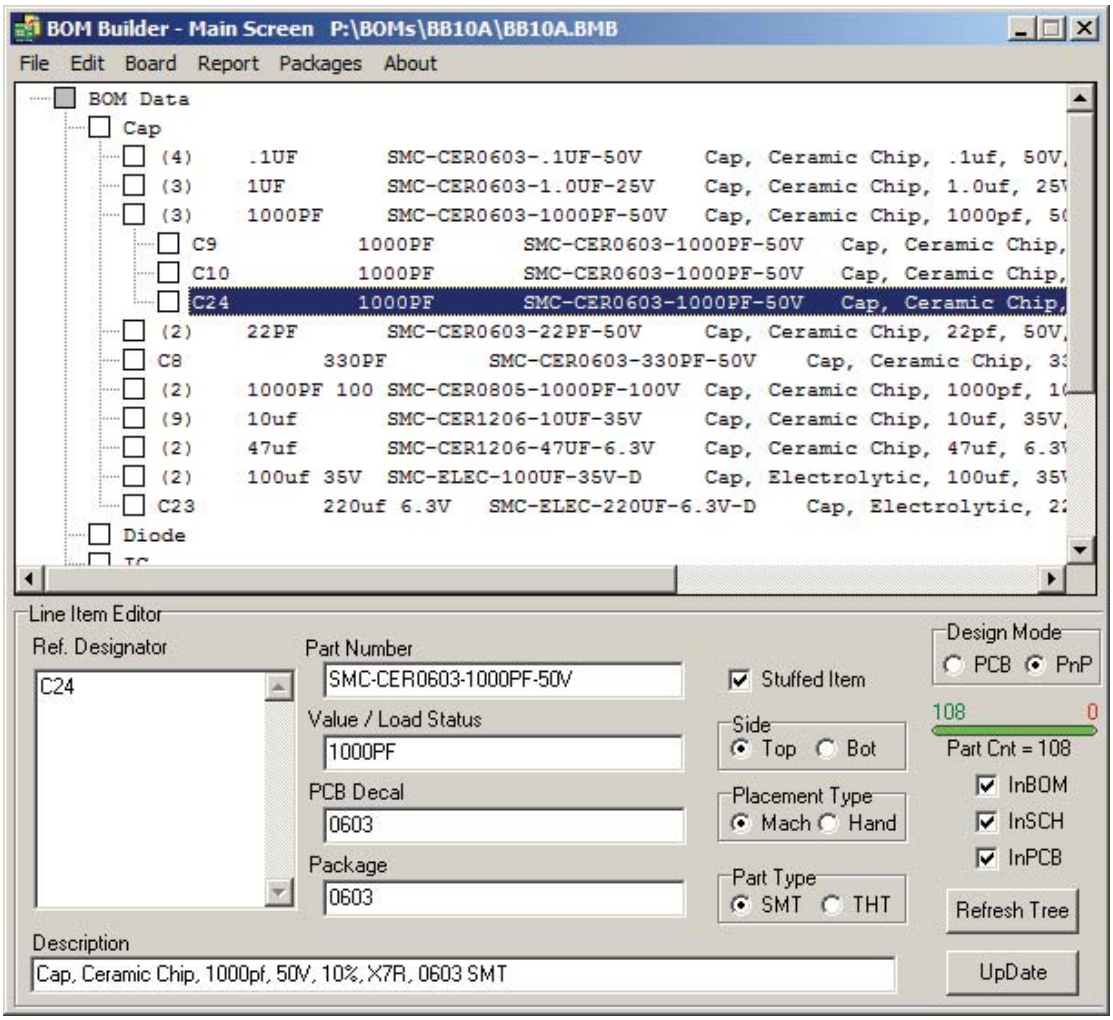
BOM Builder User Manual

Electronic Components Selection Software
for PCB Design and SMT Assembly



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1 Introduction

BOM Builder is a software tool used to prepare electronic component data for automated assembly. This tool is design for use by circuit designers who design circuits and who are responsible for the realization of the final assemblies. Additional features within BOM Builder support component selection, schematic to PCB translation and purchasing functions. Control is provided for reuse of existing component data, the incorporation of new components and the management of design variations. BOM Builder eliminates the need for schematic library attributes and allows PCB decal (i.e. footprint) definitions to be easily linked with purchasing database systems.

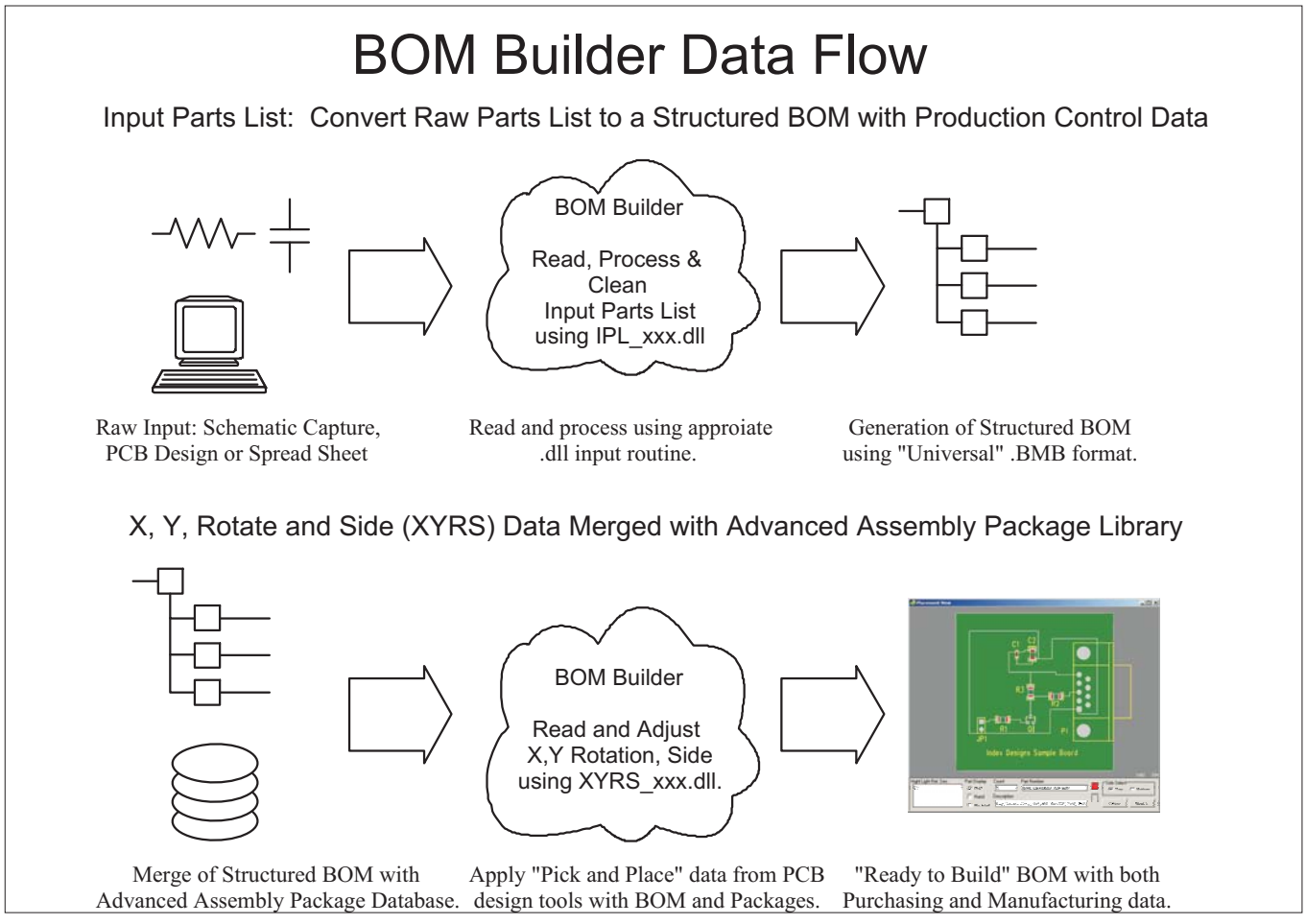
BOM Builder provides the required link to pass data to automated assembly. Index Designs provides data libraries making BOM Builder a unique tool for preparing assembly data.

1.1 Overview

The basic idea is quite simple, BOM Builder is a tool that collects a "Parts List" from schematic report or spreadsheet BOMs and associates that data with physical packages and their X/Y placement on a PCB surface. Several additional data items are collected and merged with this list:

- *Similar parts are merged into Line Items in preparation for Pick and Place setup.*
- *STUFF and NO STUFF status is provided to support construction of build variations.*
- *X, Y, Rotation and Side (TOP or BOT) status (XYRS information) for Pick and Place.*
- *Indicators for through hole, machine-placed and hand-placed components.*

With a parts list and all the component data present, the next questions is "Is all the data right"? BOM Builder is unique in that it presents all this data as a completed assembly image. Using a custom Gerber Reader and package model graphic libraries, BOM Builder shows the resulting data as a final board im-

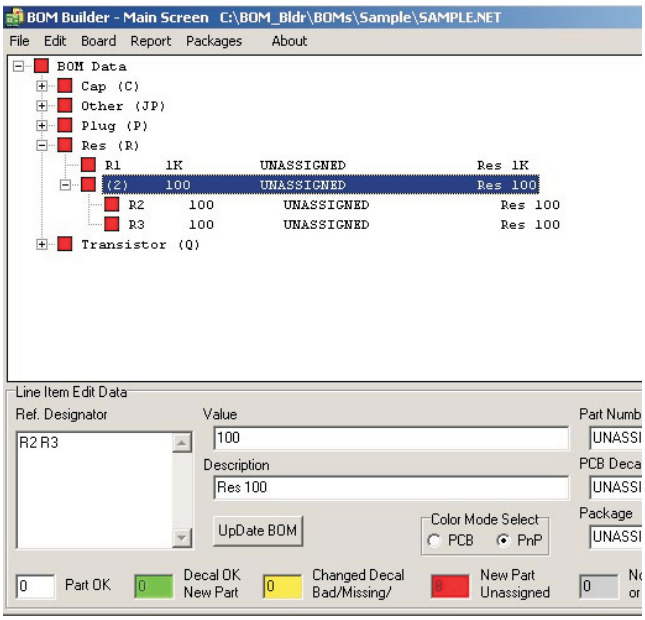


age. This image allows the "form and fit" of the various components to be checked BEFORE an actual bare PCB is fabricated.

The final result of this process is a set of production documents with all the data required to drive the manufacturing process. Data can be viewed and checked before bare PCBs are fabricated or purchased.

1.2 Input Data Overview

BOM Builder automatically sorts components into Line Items and displays the result in a multi-level tree structure. Software logic identifies line items by analyzing the Reference Designators, Component Values and, if they are provided, Part Numbers. As Line Items are formed from the input "Parts List", it is very common that errors are detected. Many BOMs are constructed by hand using Excel or other spreadsheet programs. Such BOMs are often filled with errors and data inconsistencies. BOM Builder includes logic which detects input errors, provides a list, and allows an operator to quickly identify and correct the errors. If two or more parts have the same Part Number but they have different Values or Descriptions, then "Line Item Errors" are reported. If Part Numbers are not provided, BOM Builder will sort by Value and PCB Decal. Errors will also be generated if differences in Descriptions are detected. Accurate formation of Line Items is crucial for automated assembly processes. Errors detected while a job is "on the machine" are very expensive. BOM Builder reduces the number of such errors.



Structured BOM.

Sorting of components into "Line Items" is a fundamental requirement for both manufacturing and purchasing functions.

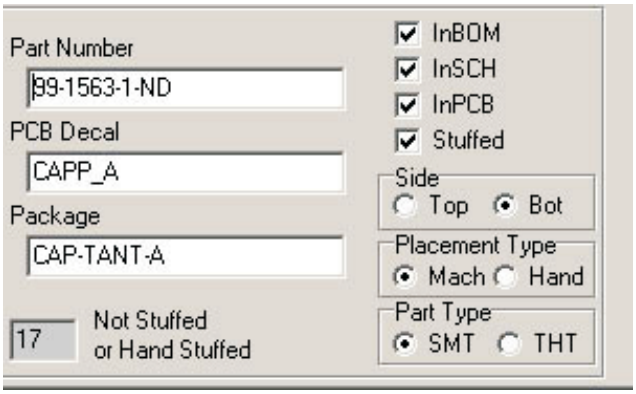
The number of line items in a project directly affects assembly machine setup as each component type requires a separate machine feeding location. Purchasing departments also require a list of required components in line item format. The number of BOM line items directly affects the effort required to purchase material and the effort of kitting components for the assembly process. Setup costs dominate low volume assembly costs and line item counts are the key contributor. Good engineering practices will always attempt to reduce the Line Item counts.

The concept of X, Y, Rotation and Side data being used for assembly is easily visualized. The need for Stuffed, Machine and Hand assembly data is not as obvious until the entire assembly process is considered. A kit of components must be sorted such that the various types of components arrive at the proper workstations. None of the Through Hole parts are required at the pick and place machine. Since some SMT parts cannot be machine placed, they must be hand placed BEFORE the solder reflow process. Through Hole part mounting is accomplished AFTER both top and bottom SMT (Machine and Hand) at yet another workstation. The cost for Hand and Through Hole assembly is much higher than SMT machine assembly and these counts are very important when computing assembly cost.

BOM Builder provides several Manufacturing Controls along with controls for BOM generation and PCB design. It is very common for parts to exist independently in the schematic, PCB design or BOM. These controls identify how component data is used and allows data to be transferred to various company departments in an automated manner.

A fundamental problem with many schematic capture and PCB design tools is they do not consider the various types of data required for assembly. It is very common for a single schematic and PCB design to be used for a number of different assembly variations. In each variation of the design, it is the

number and types of components installed which is different. BOM Builder provides the ability to construct these product variations from a single set of



Manufacturing Controls

schematic and PCB inputs. Since each BOM Builder variation maintains a complete design database, it is always possible to "back check" a BOM to the current CAD data. The ability to verify a variation against CAD design tools is not possible using spreadsheets or other techniques.

1.3 Output Data Overview

Outputs from BOM Builder include PCB design data, BOMs for both purchasing and production, and assembly documentation for assembly and test. Most important is the ability of Index Designs to take the final .BMB file and directly drive a SMT manufacturing process. Advantages of using the .BMB to drive an automated manufacturing process include the ability to:

- *Eliminate the need for schematic design libraries and CAD librarians.*
- *Eliminate errors associated with manual programming of Pick and Place equipment.*
- *Allow usage of cut tape or loose parts.*
- *Order BOMs per Assembly step. Through Hole parts are directed to Through Hole workstations, SMT parts go to the Pick and Place machine.*
- *Enable low-cost stencil and solder paste dispensing.*
- *Eliminate random errors associated with hand assembly.*

Although generation of data for automated assembly is very important, BOM Builder can also prepare data for PCB design. In most CAD tools, data concerning PCB footprints, electrical values and company part numbers is typically inserted into schematics through schematic library attributes. The preparation of these library attributes is time consuming, expensive and error prone.

BOM Builder eliminates the need to populate these schematic CAD libraries with data from purchasing, manufacturing and MRP (Material Resource and Planning) systems. Instead, BOM Builder supports the annotation of circuit components using data from external software systems (i.e. a PartSync parts database) using "point and click" actions with a graphic interface. The result in a significant reduction in schematic CAD library maintenance, while quickly generating accurate BOMs for manufacturing. Changes in MRP, purchasing or manufacturing data do not require changes in schematic library attributes. BOM Builder simply reads the new data and makes it available to circuit designers. Synchronization is automatic.

BOM Builder does not require active connections to advanced "data servers" or SQL engines. Software within BOM Builder sorts tables, forms indexes, cross-links references and provides all internal data-serving requirements. Raw data can simply be transferred as text files using local area networks or web browsers. Engineers can exchange simple files which include all required data.

1.4 Using Dynamic .DLLs

BOM Builder uses dynamically loaded .dll files to read user CAD and component data. There are three major .dll functions and one internal Microsoft Access connection:

- *Input Part List IPL_xxxx.dll*
- *X,Y, Rotation and Side XYRS_xxxx.dll*
- *MRP Data MRP_xxxx.dll*
- *Internal links to PartSync data in Microsoft Access (.mdb) format.*

Various .dll routines are supplied for each function and for various CAD systems. For example, IPL_Protel.dll is used to read Input Parts List from Protel, while the XYRS_Layout_Insert.dll is used to read XYRS data from OrCAD Layout Component Insertion reports. Additional .dlls are provided for reading spreadsheet data (.csv format) and simple text files. BOM Builder stores the selected .dll rou-

tines in the output .bmb file. Multiple BOMs from multiple CAD systems are easily managed using these techniques.

For all IPL_xxx.dlls, the required data consists of Reference Designator, Value, Part Number, PCB Decal and Description. Only the Reference Designator is required, though a structured BOM cannot be built if all the other fields are blank. Typical usage involves using the Reference Designator and part Value as contained in the original schematic.

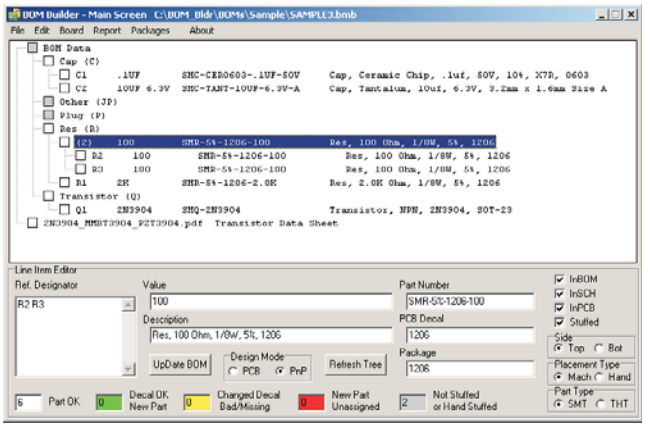
Note: Reference designators must consist of alpha characters followed by numeric characters. Reference designators such as R1, C9999 and SWIT5 are acceptable. Reference Designators such as C5A, GND, +5 or A1_5 are not acceptable.

Data for the XYRS_xxx.dlls requires a Reference Designator, X location, Y location, Rotation, Side and a PCB Deca. Only the PCB Decal is optional. All other fields must exist. Each .dll routine will process its associated file format and will return the extracted data to BOM Builder in the proper format.

BOM Builder can populate its internal search engines with user part data by reading data through the MRP_xxx.dll routine. Internal code provides support for reading and writing PartSync data structures.

1.5 Main Screen

The BOM builder main screen is shown below and is divided into top and bottom sections.



Main Screen

- *The Main Tree in the top section shows a structured view of line items. Color coding in the Main Tree view gives an indication of Existing, New and Unknown parts.*
- *A Line Item Editor area is at the screen bottom. This area allows the user to add, delete or modify the nature of each line item.*
- *The Update button will force all the Line Item Editor fields into the shown reference designators. A Tree Refresh button can be used to redraw the Main Tree when required.*
- *Along the very bottom are the counts of components that fall into various categories.*

File SAMPLE3.BMB has been loaded below and line items are shown. The line item consisting of two resistors, R2 and R3, is selected. Each part is a 100 ohm 1206 resistor and each is to be included in both the BOM and the PCB design. Both are to be placed by pick and place on the top side and each is an SMT type component. When doing compares to the schematic, these parts will be verified since each is checked as being “In The Schematic”.

While the various control flags might look like a significant amount of extra work, most will be automatically set as data is read into BOM Builder.

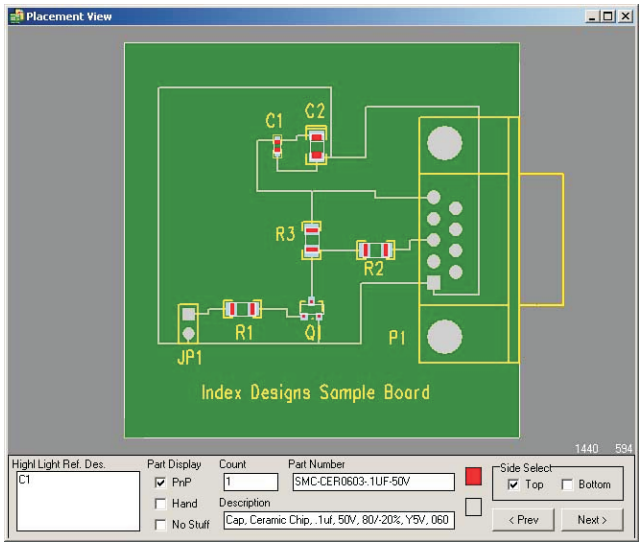
1.6 Assembly View

A unique feature of BOM builder is the ability to show how parts will fit on the surface of the final PCB. Using the Index Designs library of Pick and Place package models, along with an internal Gerber Viewer, BOM Builder can show how packages will fit before the actual PCB is fabricated.

In addition to simply viewing the BOM data, the user can use the Assembly View to:

- *Adjust component position and rotation.*
- *Query a mount location and determine the RefDes, Value, Desc. and Part Number.*
- *Identify the line item to which the part belongs and locate similar parts.*
- *Verify polarized component orientation.*
- *Verify component fit and PCB Decal.*
- *Generate a Smart .PDF containing BOM data and PCB graphics.*

A very important function of the assembly view is to identify how component leads fit on the copper and solder paste deposits. Copper is shown in grey while solder paste is shown in light blue. Package models from Index Designs show metal leads in RED or BLUE depending on the displayed side. The ability to visually inspect how a component lead is positioned in solderpaste and on copper is critically important to product reliability and assembly yield. Further, the setup and programming of automatic assembly equipment is 100% verified.



The ability to automate the collection of assembly data from schematics, PCB designs, CAD tools or spreadsheets, and to combine this data with a library of component models, is unique. The ability to drive an automated assembly line with this data is truly an exceptional capability.

1.7 BOM Builder Does Not:

BOM Builder does not replace the need for an external component database. BOM Builder simply organizes external data into a format that allows a rapid association between BOM line items and external parts data. BOM Builder maintains these links in a local database and can exchange these data structures using simple text files. This process eliminates the need for extensive attributes within schematic CAD tool libraries. BOM builder is a “steal the data as required” environment that keeps a record of what was “stolen” and allows sharing of the “stolen”, but organized, data.

BOM Builder will operate in a standalone manner without a component database. Index Designs provides a limited database of standard parts for companies without internal systems.

1.8 Installing

Installing is very simple, simply download and run the distribution from www.partsync.com. If BOM Builder is already installed, it MUST be removed first. Use the Uninstall Programs function in Windows’ Control Panel. If you have made any changes to the C:\BOM_Bldr\Data\BOM_Bldr.ini file,, backup this file first. Also, if custom PACKAGES have been created backup the Package Data (PACKAGES - BACKUP PACKAGES) then save the C:\BOM_Bldr\Data\BOM_Bldr.ini file.

2 Input Parts Lists

Schematic capture programs are the preferred source of input part data for building a BOM. While many designers use spreadsheets for their BOMs, most spreadsheet users generate these lists by hand and the data is often inconsistent or simply in error. Other sources of data include PCB design software, though once again, this data may not represent what is truly required by the schematic designer. BOM Builder provides a structured way to make clean, correct BOMs. The required data consists of:

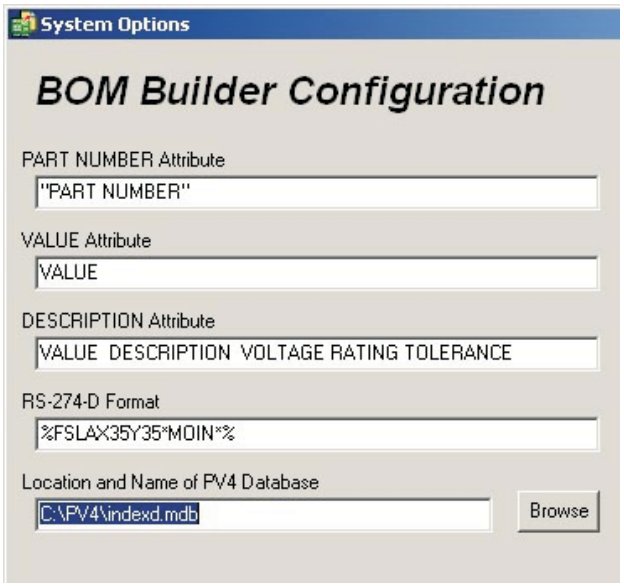
- *RefDes: A simple combination of up to 5 letters followed by a number between 1 and 9999. Valid examples are C1 and RN5. Invalid examples are U5A, J1-1 and +5.*
- *Value: A short text string that provides basic information about a component. Examples are 10K, .1uF and LM555.*
- *Part Number: Optional. A company part number is very useful, as it gives exact definition about the nature of a component.*
- *Description: Optional. Provides useful information for assembly, purchasing and test. BOM Builder will generate default Descriptions.*
- *PCB Decal: Optional. If available from the schematic, it will assist with forming line items. PCB Decal is provided my most XYRS input .dlls and is not required in the parts list.*

The above data items provide the information that is used to form line items. If a Part Number is provided, parts with identical Part Numbers will be merged into a single line item. If parts with identical Part Numbers, but different Values or Descriptions are detected, BOM Builder will report “Line Item Errors”. The nature of these errors should be resolved.

2.1 PADs .ASC Format

BOM Builder contains internal logic to read in PADs .asc files which are generated by the Mentor PowerPCB design tool. This type of .asc file IS NOT the same as a .asc netlist file generated by most schematic capture programs. A PowerPCB .asc file contains all the XYRS data, Decal names, Values and other component attributes. These attributes may or may not contain useful data, dependingon the quality of the schematic and PCB libraries.

Three fields in the System Options screen the selection of PADs attributes to be used as input for various BOM Builder fields.



System Options Screen

The above settings will result in the .asc reader using attribute “PART NUMBER” for BOM Builder part numbers while the VALUE, DESCRIPTION, VOLTAGE RATING and TOLERANCE attributes are all merged for use as a Description. This information is only valid if the PCB designer has carefully prepared component attributes. This is seldom the case.

As the .asc file is read, two conditions are detected and the user must indicate how to proceed. These conditions are:

- *New reference designators are detected.*
- *Should PCB decals be read.*

A PCB design may contain many items that are not found in a final BOM. Examples of these are mounting and tooling holes. If a BOM Builder file already has been edited to where it contains only the required parts, then the user does not want the reader to read in new reference designators. If the user is starting a new BOM Builder file, then reading of all the reference designators is required.

2.2 Schematic Input

BOM Builder reads parts list information from a schematic using one of two different input functions.

- *FILE - OPEN OTHER - PADs NETLIST*
- *Use of IPL_xxxx.dll routines*

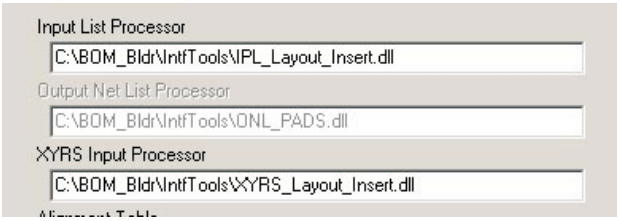
2.3 PADs Netlist

The first is a PADs netlist format which has component information in the *PARTS* section. Like the .asc reader, attributes will be pulled from the netlist according to the attribute names assigned in the Systems Options screen. Many schematic capture programs will generate PADs netlists, but few will populate this netlist with component attributes.

PADs netlists are read using the Main Menu sequence, FILE - OPEN OTHER - PADS NETLIST. While a PADs netlist can also be read using .dll routines, the OPEN OTHER - PADS NETLIST command allows use of named attributes when collecting data. See section 2.1 PADs .ASC format for a description of how this logic operates.

2.4 IPL_xxx.dll Routines

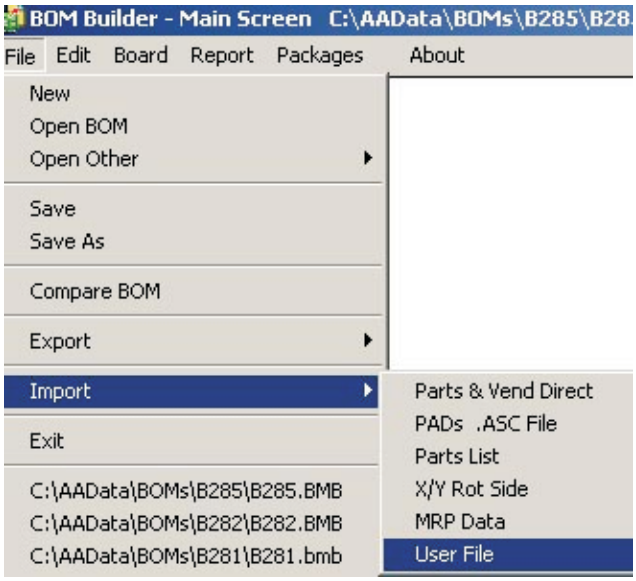
The second method is through a user-selected IPLxxxx.dll file. There are many different IPL_xxx.dll files, each of which supports the reading of a specific report from a specific schematic capture program. A single .dll is selected by using double-clicking on that item's field.



BOM Options .dll Selection

In the above example, .dll routines for reading "OrCAD Layout Component Insertion Reports" are selected for both IPL (Input Parts List) and XYRS (X, Y, Rotation and Side) import functions. When the user selects the generic Import Parts List, the IPL_Layout_Insert.dll will be used. When the user selects the generic XYRS Import, the XYRS_Layout_Insert.dll will be used.

Selecting the "Parts List" menu item will cause BOM Builder to load the IPLxxx.dll and read in a parts list using that .dll. Selecting the "X/Y Rot Side" button will result in BOM Builder using the XYRS_xxxx.dll to read in XYRS data.



Generic Import Functions

The menus items are generic, while the BOM Options setting selects a specific .dll routine. The selected routines, as well as all the other BOM Options, are saved in the final .bmb file.

Within the System Options screen (EDIT - SYSTEM OPTIONS), is a table used to associate component descriptions with reference designators. When a netlist is read, the leading alpha characters of the reference designator are stripped off and the "Ref. Des. To Type List" is searched using the stripped alpha characters. If a match is found, the "Component Type" text is appended to the description field.

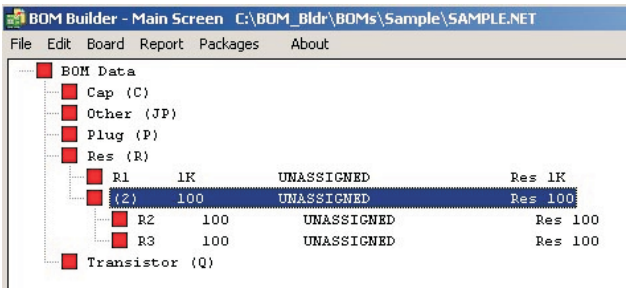
2.5 Import Example

The best description is an example. After starting BOM Builder, use the sequence:

FILE - OPEN OTHER - PADS NETLIST

This sequence will open a dialog box showing a SAMPLE directory. Open this directory and click on the SAMPLE.NET file. (A SAMPLE.PDF file is also located in the SAMPLE directory and it shows the source schematic.) This .net file was constructed in OrCAD Capture using the PADs output format with {Value} in the FOOTPRINT PROPERTY STRING.

When the SAMPLE.NET file is read, a structured BOM tree will be shown in the upper portion of the Main Screen with several red elements. This tree is a view showing the various “BOM Line Items” which are contained in the schematic. Identical items have been grouped together. Click on the red “Res (R)” line which will drop open, and then click on the red “(2) 100” line, which will also open. As “BOM Line Items" in the tree are selected, details about these parts are shown in various fields located in the Line Item Editor section towards the screen bottom. This bottom area is where a user edits BOM line items and where the Update BOM button can be clicked, which will update the BOM database with Line Item Editor data.



Read of SAMPLE.NET

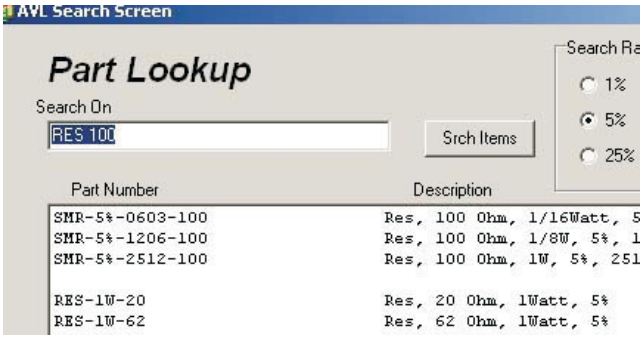
When schematic data is read, the Reference Designator and Value are used to provide the initial data concerning a circuit assembly. The key items are reference designators and component values for electrical parts. The resulting “Parts List” is the starting point for BOM generation.

While many companies generate extensive schematic CAD libraries which include additional data (attributes) about these parts for use in secondary processes (examples of these attributes include Company Part Number, PCB Decal, Vendor Numbers and assembly information), BOM Builder eliminates the need such schematic CAD libraries.

2.6 Part Selection

With SAMPLE.NET read in, all parts are shown as red since most fields are undefined. Click on the “(2) 100” line item under the Res branch, and the Line Item Editor at the screen bottom will show that R2 and R3 are selected and display the current Description as Res 100. A double-click on the Description field will start the search engine, with results shown in the Part Lookup screen.

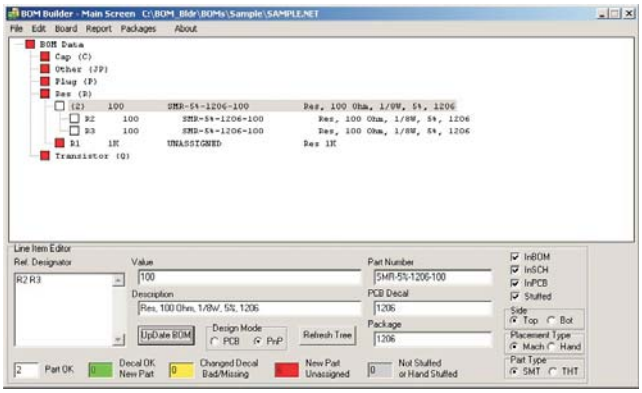
The top matches (three in this case) are 100 ohm resistors in different sizes. Parts are grouped by the



Results of Search on Res 100

quality of the match. In this case, the first three items matched with equal priority.

In the Search Results List, double-click on the 1206 part and the main tree screen will show information about the selected component in the Line Item Editor area. Click on the Update BOM button to save the new data for parts R2 and R3. Notice the R2 - R3 line item is now “white coded” since complete engineering data is now linked. Also notice that both Package and PCB Decal contain “1206”, the Part Number is listed as “SMR-5%-1206-100” and the Description is quite detailed.


"White Coding" of R2 and R3

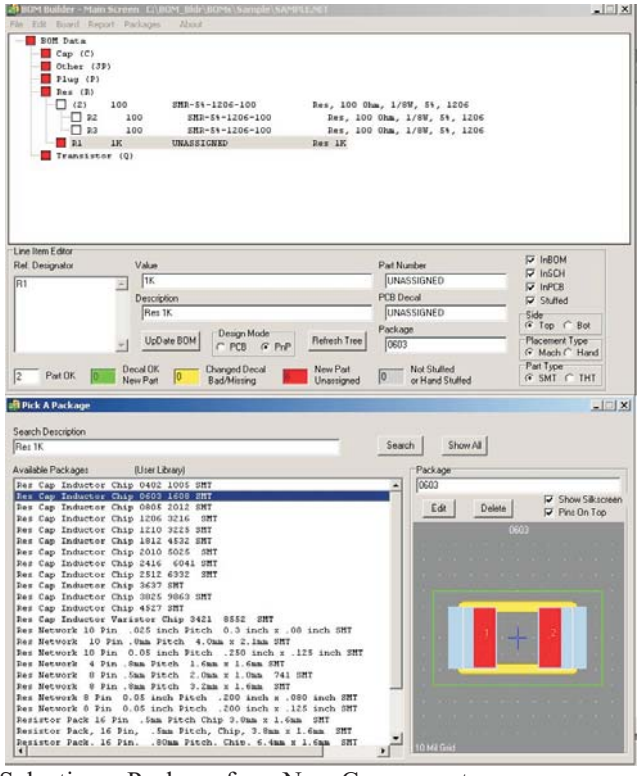
Annotation of components using this technique is a very powerful and unique function of BOM Builder. Just as different schematics and PCB tools are interfaced to BOM Builder through the use of .dll routines, the data which drive the search engine can be read from a user’s parts database (i.e. a PartSync database) through .dll routines. With this ability to rapidly associate data between line items and a company parts database, the need to place attributes in schematic libraries is eliminated.

BOM Builder eliminates the need for these attributes by allowing an engineer to "steal" data from external data sources AFTER the schematic is complete. Schematic generation is much faster and data more accurate since part assignment is a "post" schematic design process. Engineers can concentrate on connectivity with support staff assisting with most part assignments. BOM Builder encourages data reuse by providing a means for collecting information about new components.

2.7 New Part Creation

When designing a circuit assembly, new parts must be introduced into the engineering process. BOM Builder provides a means for identifying new components and allowing a project to continue until new part numbers are generated.

Click on the "R1 1K" line item in the main tree, which will display R1 and Res 1K in the Line Item Editor fields. Part Number, PCB Decal and Package are all UNASSIGNED. Double-click on the "Package" field which will open the Pick A Package screen and start the package search engine. Move the windows as shown below.



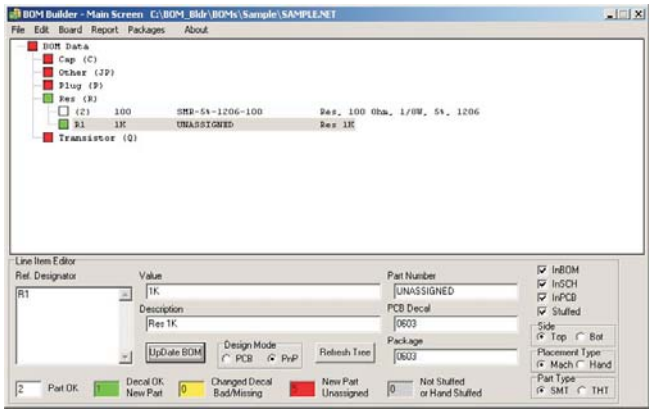
Selecting a Package for a New Component

You might need to click on the "Search" button to execute the search. Click on the: "Res Cap Inductor Chip 0603 1608 SMT" line in the "Available Packages" list. You will see 0603 filled into the Package field in the line item editor and at the same time, the "Part Type" field will change to SMT.

At this point, you have selected a new package for R1 but the BOM has not yet been updated. Click on the Update BOM button in the Line item editor. Several actions will take place when Update BOM is clicked.

- *A User Table is searched for any PCB Decal names that have been associated with the 0603 package.*
- *Either a matching PCB Decal name or the Package name is filled into the PCB decal Field.*
- *The BOM database is updated from the fields in the Line Item Editor area.*
- *R1 becomes "green coded". All the required data is present for PCB design and manufacturing. Purchasing data is not available as no Part Number has been assigned. (New parts don't have numbers.)*

The resulting screen is shown below.



Green Coded Part after Update BOM

BOM Builder allows construction of line items which are "technically incomplete", while enabling the design and manufacturing process to continue. Green indicates the PCB process can continue but there are open issues with this line item.

With the green "R1 1K" item selected, click on the STUFFED check box (which will remove the check mark) then click on the "Update BOM" button. This identifies that this part is not to be stuffed, and causes the color to change to grey. Additional check boxes allow parts to be independently marked as IN BOM, IN PCB Design or included IN SCHEMATIC. BOM Builder includes logic for comparing different BOM versions or comparing new schemat-

ics to existing BOMs. The " In SCH" bit is used in this checking logic. There is also a "Part Type" field which allows a part to be marked as SMT or Through Hole (THT). This setting, along with the Top and Bottom side status, is typically set automatically. There are occasions where manual control of these and other flags is required.

PCB assembly houses require that material be sorted by technology (SMT or THT) and side (Top or Bottom). Key to efficient and timely assembly is having the correct material at the correct workstations. Machine operators and programmers need exact listings of the material that must be processed.

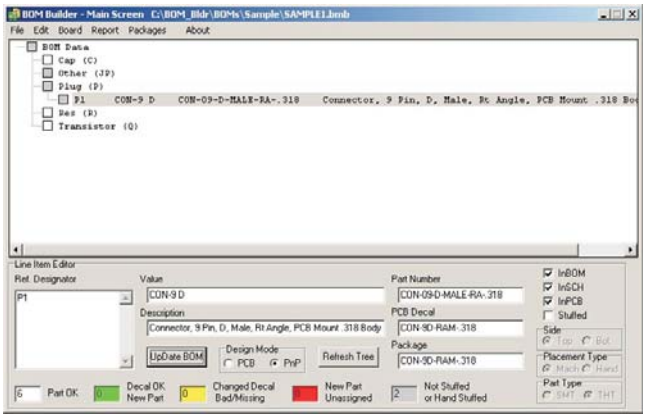
At the bottom of the main tree screen, is a "Design Mode" group of radio button. Click on the PCB (PCB Design Mode) button and coded parts turn to yellow. While these parts have PCB decals assigned, there are no corresponding entries in the User Decal Table. The yellow indicates that there may be a problem with the PCB decal assignments. The color of the line items is different for different design phases. PCB is associated with PCB Design while PnP (Pick N Place) is associated with assembly processes. Also notice that when a "Design Mode" button is clicked, the count of components for each color state is recalculated and shown in the bottom color boxes.

Continue selecting each line item in the main tree view and then naming each part by double-clicking on each Description, then selecting the below parts from the part search engine results. The final part assignments will be:

C1 SMC-CER0603-.1UF-50V
C2 SMC-TANT-10UF-6.3V-A
P1 CON-09-D-MALE-RA-.318
JP1 POST-025-1X2
R1 SMR-5%-0603-1.0K
R2 SMR-5%-1206-100
R3 SMR-5%-1206-100
Q1 SMQ-2N3904

Select P1 and change it to be HAND stuffed. Do the same for JP1. These parts are through hole devices and they cannot be automatically placed. Unless these parts are marked as HAND, they will show as yellow in the PnP color mapping mode.

Save the final BOM as SAMPLE1.BMB using the FILE - SAVE AS menu. Edit the name of the file to SAMPLE1.bmb in the SAMPLE directory. This



SAMPLE1.BMB Final Status

output .bmb file has all the linked data, setup, and options recorded in a single text file format.

2.8 Part List Summary

The most important aspect of reading the input parts list is getting the Value and Descriptions correct. If a Part Number is read, IT MUST BE CORRECT. It is this information that drives the assembly process and bad data is guaranteed to deliver mis-stuffed assemblies.

Part Numbers are key to data reuse. Accurate procurement, manufacturing, PCB footprint selection and the programming of automatic assembly equipment rely on having verified data. Maintaining a single accurate component database requires a significant effort that few organizations master. Keeping multiple independent databases for schematic entry, PCB design, purchasing and manufacturing is extremely difficult. BOM Builder is a unique tool for merging data from multiple databases.

3 Reading Gerber Images

A major feature of BOM Builder is giving users the ability to visualize and verify BOM and physical assembly data. Just as a PCB design tool shows how traces will be rendered into Gerber fies (then into copper), BOM Builder shows how components are "rendered" on a Pick and Place machine. The Assembly Vie screen is actually a "software Pick and Place" engine that shows physical package data on an image of the final PCB. Generation of that PCB image requires several Gerber files, the construction of graphic data for each layer, and the alignment of those layers into a color graphic image.

Three Gerber files are required for each side (Top and Bottom) of the PCB that contains machine or hand mounted components. These required layers are Copper, Solder Paste and Silkscreen. Reading of Gerber data is complicated by the need to align the layers and locate actual components. The steps are:

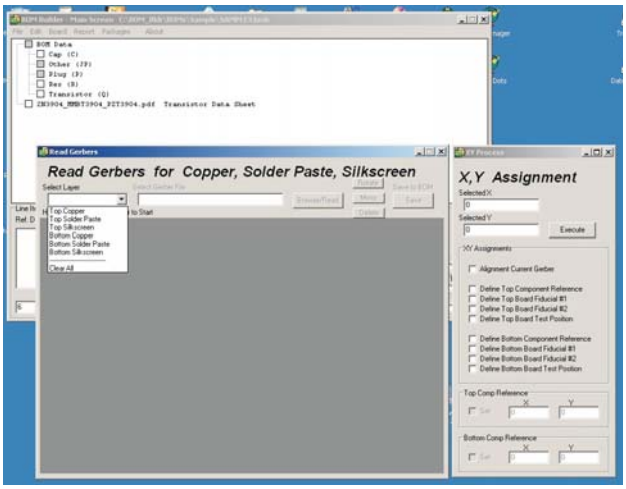
- *Align Gerbers: While many CAD tools will output Gerber data relative to the same X,Y location, some uneducated users still "Center" Gerber plots. This results in random offsets which requires all layers to be manually aligned. This would not be a problem except these same few designers fail to place a consistent object in all the layers to enable manual alignment.*
- *Mirror or Rotate: All Gerber files should be provided as "View Through the Top". The orientation must be the same as the component location (XYRS) information.*
- *Set Component X,Y Reference: The 0,0 point for the component XYRS data must be defined. Often this is 0,0 but not always.*

BOM Builder reads Gerber data and generates internal display lists for graphic display. RS-274-X polygons are rendered as "Cross Hatch" areas and "Clear" polygons are ignored.

3.1 Selecting Layers - Read

Selecting the BOARD - READ GERBER menu opens two windows, Read Gerber and X,Y Assignment. These screens are shown below.

The drop-down list in the Select Layer control allows the user to select a layer for data transfer. When a layer is selected, any Gerber data that already exists for that layer will be placed in the grey graphic screen. The mouse can be used to click and select graphic items from that screen. As items are



Select Gerber layer

selected their X Y locations are placed in the X,Y Assignment screen, and the selected item is highlighted in white. Pressing the Delete key will delete a selected item. Line items can be selected by clicking on a center or endpoint. Round items are selected at their center.

Click on the BROWSE READ button to read an external RS-274-X Gerber file. Note that a layer must be selected before BROWSE READ can be selected. Very limited support is provided for RS-274-D files as special .dll files are required for reading the aperture tables. See file C:\BOM_Bldr\IntfTools\Gerb_Apertures.txt for details.

Once read, the image will be fit to the screen and a blue cross will show the 0,0. Buttons allow an image to be mirrored or rotated. The Save button will copy the graphic image into the BOM Builder database and the Gerber image can then be saved with the BOM.

3.2 Align Gerber Layers

The X,Y Assignment screen will accept X and Y parameters and will use these to modify the current Gerber image or database according to a series of check boxes. These check boxes control how the X Y values are used to modify Top and Bottom side settings.

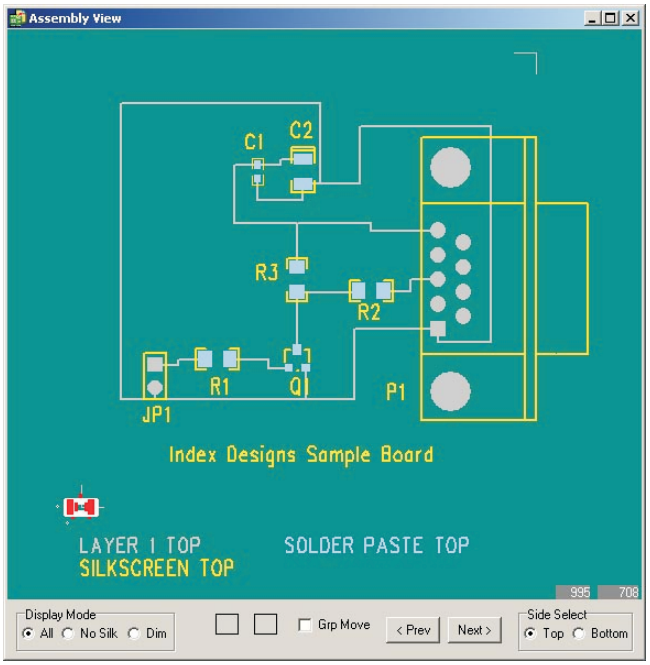
- *Align Current Gerber*
- *Define Component 0,0 Reference Point*

- *Define Board Fiducials 1 and 2*
- *Define Board Test Position*

In order for BOM Builder to overlay the Copper, Solder Paste and Silkscreen Gerber files into a single image, the various Gerber Layers must be aligned. When the Align Gerber check box is checked, and the user clicks the Execute button, the currently selected X Y location is subtracted from Gerber X Y locations. This results in the selected X Y location becoming the new Gerber 0,0 location. (Do not confuse this with the Component X Y Reference Point.) Unaligned Gerber files can be easily aligned if there is a common graphic object in each layer.

Each time the Align Current Gerber is checked and processed, a copy of the selected X Y location is saved in the BOM Options screen in a Gerber Offsets area. Also in that area is an Enable flag. If the Enable flag is checked, then these X Y offsets will be automatically applied to Gerber files as they are read in. Since most Gerber files are constructed using identical offsets, this automatic usage simplifies the reading of multiple files. If Gerber files have been "centered" (which is a very bad idea), then the user should uncheck the Enable flag and perform alignment manually.

Once a Gerber file has been read and adjusted, it must be saved to the currently selected layer by clicking the Save button. This Gerber image will be saved with other BOM data and will eventually be written into the final .bmb file.



Sample2.bmb Gerber read Parts at 0,0

The Component X,Y Reference location is very important. When XYRS information is read from PCB CAD tool files, it is this point which is used as the graphic 0,0 reference point. If this point is not set correctly, components cannot be correctly located on the board image. BOM Builder contains Angle, Offset and Translation (AOT) logic that will adjust for XYRS data not being defined for the component centroid. In order for this logic to operate correctly, the Component Reference Point must be set correctly. This reference location will be marked with a red + sign.

If the Component Reference Point is not set correctly, any attempts to use AOT logic or Group Moves will fail. The 0,0 Component Reference Point must be accurately defined.

Each PCB side with machine-mounted parts must include the definition of two board alignment fiducials. When a check box is checked, and the Execute button is clicked, the selected X Y values will be used for the corresponding fiducial X,Y location. Fiducial 1 will be drawn as a small circle with a + sign. Fiducial 2 will be drawn using a small circle. Both markers are drawn in red.

Automatic placement equipment requires a location where the board height can be safely sensed. This test position must be clear of components and large holes. The Board Test Position sets this location, and it is marked with a small circle and X.

At the bottom of the X,Y Assignment window is a flag and X,Y field for both the Top and Bottom sides. As the Component Reference Point is set for each side, the associated check box will be set. The X,Y location from the Gerber object will be placed in the X and Y fields. The 0,0 of a Gerber is related to the Component Reference Point through these X Y locations. The display of these locations can help when unknown Gerber files and XYRS files must be debugged.

3.3 Read Gerber Example

The C:\BOM_Bldr\SAMPLE directory contains a set of Gerber files generated from Mentor's

PowerPCB CAD system. Also included is a file containing all the component XYRS data:

- *ART01.PHO (Top Side Copper)*
- *SST0126.PHO (Top Side Silkscreen)*
- *SMD0123.PHO (Top Side Solder Paste)*

By reading these Gerbers and position text into BOM Builder, an image of the PCB can be generated. The following steps will read these Gerber files and construct a board image:

- *Open the SAMPLE1.BMB file created in Chapter 2.*
- *Use BOARD - READ GERBER to open the Gerber Read screen.*
- *Use Layer Select to select Top Copper.*
- *Click the Browse/Read button and navigate to the C:\BOM_Bldr\BOMs\Sample directory and Open the ART01.PHO file.*
- *In the X,Y Alignment screen, enter 1000 in both the Selected X and Selected Y fields or click on the lower left corner of the lower left board edge mark. (A 1000 x 1000 mil offset was used when creating this Gerber.) Check the Align Gerbers check box and click Execute.*
- *Save the Copper Gerber image to the BOM using the Save button.*
- *Use Layer Select to select Top Solder Paste. Use Browse/Read to Open file SMD0123.PHO. This file was automatically aligned, so save to the BOM using the Save button.*
- *Use Layer Select to select Top Silkscreen. Use the Browse/Read to Open file SST0126.PHO. This was automatically aligned, so save to the BOM using the Save button.*
- *Close the Read Gerber window.*
- *Use FILE - SAVE AS to save the file as SAMPLE2.bmb in the C:\BOM_Bldr\Sample directory.*

At this point, the board Gerber files have been read into the BOM. Use the BOARD - ASSEMBLY VIEW to view the merged Gerbers, along with all the parts sitting at location 0,0. The resulting merged image is shown below.

The above image shows the Copper in gray, Silkscreen in yellow and Solder Paste in light blue. All components are located at 0,0 since the XYRS information has not yet been read.

4 XYRS & Placement Data

Data concerning component locations and rotations is probably the most important type of data used during automated assembly. Without good data, everything else is just “hand assembly”. Many machine operators have to “hand adjust” placement data using an actual PCB as the target. Nothing could be more prone to errors for a number of reasons. Silkscreens which direct hand placement are often removed from pads and vias, if the silkscreen even exists at all. Camera views on machines are limited, and working with a limited view can result in errors. In contrast, BOM Builder contains the tools to “get it right” at design time, which improves data accuracy and reduces assembly time.

As important as XYRS data is to the assembly process, there are no standards for CAD data input or data being sent out to assembly equipment. Combined with these issues are other sets of problems:

- *Stuffing options*
- *Mount order*
- *Missing orientation marks*
- *Missing fiducials*
- *Different rotation directions*
- *Package build variations*
- *Machine orientation*

The generation of XYRS data for parts that are machine mounted must be sorted by side. A single sorting scheme is not sufficient to drive automated assembly. Various pieces of data must be provided for complete and accurate assembly. Incomplete data results in delays and errors.

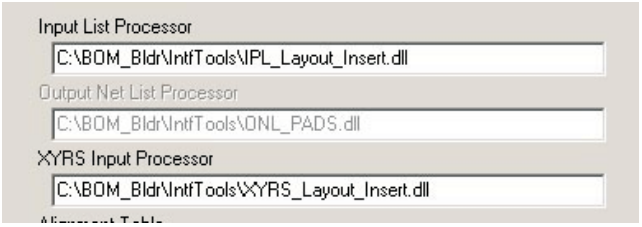
Index Designs has addressed these issues through the construction of standard package data and by coding BOM Builder to record and reuse rotation data. This process consists of:

- *Reading CAD XYRS data*
- *Adjusting positions*
- *Recording and reusing of adjustment data*

4.1 XYRS .DLL Routines

The use of a XYRS_xxxx.dll requires that the XYRS data format be known. A number of .dll routines are provided for various CAD programs. New .dll routines are easily written if the CAD data format is known.

A single XYRS_xxxx.dll routine is selected through the BOM Options screen. A double-click on the XYRS Input Processor field will allow the user to select the appropriate XYRS_xxxx.dll file.



BOM Options Fields for .dll Selection

When the main menu “IMPORT - X/Y Rot Side” item is clicked, the above pre-selected .dll file will be used to read several pieces of data:

- *Reference designator*
- *X and Y location*
- *Rotation*
- *Side*
- *PCB decal*

Since XYRS data is generated by PCB CAD tools, the actual PCB Decal (i.e. footprint name) associated with each reference designator is often available. PCB Decal data is key to alignment reuse. Most PCB designers are very careful about PCB decal assignments since one wrong decal and a new PCB fabrication cycle is required. PCB decals are very similar to Index Designs’ package models (i.e. footprints can be created from package models) and these footprint name assignments serve as the “Key Link” between manufacturing data and the PCB design. When using the Group Move function to adjust component positions, this correction data is associated with theses “Key Links”. These linkages are collected while BOM Builder is operating, and they are saved in Alignment, Offset and Translation (AOT) files.

AOT files can be read and saved automatically or manually. Several options in the BOM Builder .ini file control this operation. Adjustment data from these .AOT files are used when reading XYRS data from a PCB CAD tool. The result is BOM Builder

"learns" about the PCB decals from a specific CAD tool and only new components require adjustment. Existing components are correctly placed automatically using existing data.

4.2 Read XYRS Example

Use the FILE - OPEN BOM to read in the file: C:\BOM_Bldr\Sample\sample2.bmb . Use the EDIT - BOM OPTIONS to show the BOM Options screen. Double-click on the XYRS Input Processor field and a File Open dialog box is displayed with a number of XYRS_xxx.dll files shown. Using this dialog box, select the XYRS_PADSXYPositions.dll file, then click Open. This filename will then be shown in the XYRS Input Processor field. Close the BOM Options screen using the upper right X button.

When the BOARD - ASSEMBLY VIEW screen is opened, all the components can be seen at the 0,0 location. Use the main screen's FILE - IMPORT - X/Y Rot Side to read in PCB position data from:

C:\BOM_Bldr\BOMs\Sample\POSITIONS.txt

Click OK on the "XYRS Unit Select Form" and several action will take place.

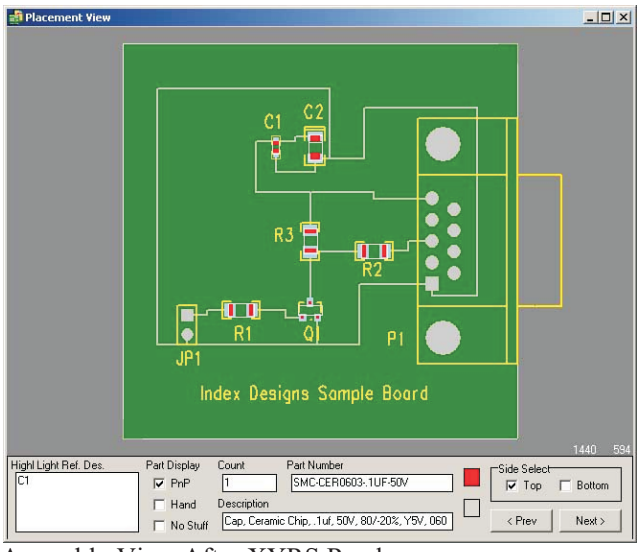
- *XYRS Data is read.*
- *Component locations in the Assembly View screen are updated.*
- *A XYRS_Log.txt result file is created and opened in the default system editor for .txt files.*

As XYRS data is read, the incoming reference designators are checked against existing BOM components. If a new item is detected in the XYRS data, it is flagged. If a BOM component does not receive XYRS data, then this is noted at the end of the log text. Missing or extra items could indicate errors with the Input Parts List.

The resulting Assembly View screen is shown below. In this example, the X,Y locations for the various components will all be represented at the true component centroids.

If PCB Decals had been constructed with origins at pin 1 locations, or with rotation orientations different from the Index Designs libraries, the location of the shown components will be offset.

Use the main menu FILE - SAVE AS to save the complete database as SAMPLE3.bmb. All Gerber files, part images, and BOM line items are saved in the .bmb file. When the file SAMPLE3.BMB is opened, the board can be viewed. Using BOM Builder, users can view the BOM, component placement and stuffing options BEFORE a bare board is fabricated. This feature can detect bad PCB decals which could result in expensive re-spins and delays.



Assembly View After XYRS Read

4.3 XYRS Adjustments

Close the XYRS_Log.txt editor and check the Group Move (GRP Move) check box in the Assembly View screen. If required, adjust the size and positions of the main screen and Assembly View screen such that both can be seen at the same time.

Moving the mouse cursor over a component in the Assembly View will display information about that component. A left-click on an Assembly View component will highlight that component in the main screen. Clicking on items in the main screen will select that component in the Assembly View. The ESC key will cause the Assembly View to again show all components.

PgUp and PgDn keys will zoom in and out of the Assembly View. When zoomed in, a mouse right-click will pan the display. When the mouse is over a component, a Cntl-right-click will rotate that component AND ALL OTHERS of the same type if GRP MOVE is checked. Cntl-left-click will pick up a part and attach it to the mouse cursor.

Cntl-right-click will rotate the attached part. A left-click will drop the component at the current location. If GRP Move is checked, all other components of the same PCB_Decal and Package will be relocated by the same amount.

Keyboard arrow keys can also be used to move components. Zoom in and left-click on Q1. Information about Q1 is shown in the upper right. Press and hold the ALT key. While the ALT is down, the arrow keys will move Q1 in 1 mil increments. If the ALT and Shift keys are held down, each arrow key press will move the component by 5 mils.

Do not press and hold the arrow keys down, the automatic key rate might be faster than the board is redrawn.

4.4 Adjusting Component Reference Points

As previously mentioned, the 0,0 Component Reference Point is very important. The ability to automatically adjust component positions using Group Move and AOT logic depends on BOM Builder knowing the reference point for component values read from CAD tool data.

While any “good” PCB design will have this point clearly marked, some PCB designers forget to include this datum. In these cases where it is not possible to set the reference point using something in a Gerber file, it is possible to set these points using the Assembly View editor.

If there is a single component where the centroid of the component is known, that component can be “placed” and the Component Reference Point set. Typical components that work with this scheme are large QFP packages. Any package will work if the PCB designer has constructed the PCB decal with the 0,0 at the decal center.

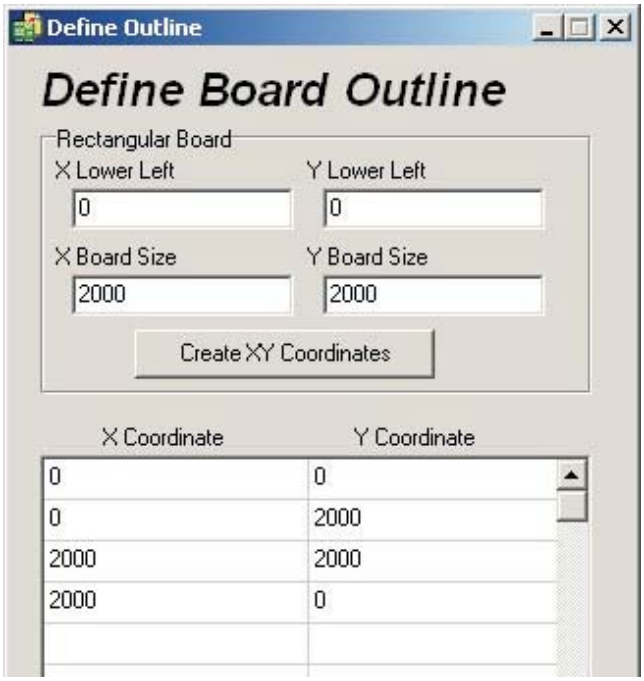
Using Cntl-Alt-left-click, a part can be picked up and moved just as if a Cntl-left-cleck had been used. The difference is when the component is dropped. Dropping the part in this case does not move the part, instead software computes the X,Y differences and applies this to the Component Reference Point. The result is the “moved” component moves to the correct location and all other parts move at the same time. It is not parts being moved, only the reference point. A dialog box will ask if these offsets should be used for both sides, the answer is typically yes.

There is one more scheme for adjusting the Component Reference Points which is done using arrow keys. A Cntl-R will start a Reference Point Mode of operation, where ALT-arrow keys will adjust the Component Reference Point for the currently viewed side. Adjustments are in 1 mil increments and holding down the Shift key will move in 5 mil increments.

4.5 Board Outline

BOM Builder allows the definition of a board outline. Currently, this outline serves only as a cosmetic function, the centering and color control for the Assembly View screen. This outline can be defined in one of two manners:

- *Using the BOARD - DEFINE OUTLINE main menu function*
- *Using the Cntl-B function in Assembly View*



Outline Dimensions for SAMPLE Board

With the SAMPLE3 file loaded, use the BOARD - DEFINE OUTLINE sequence to open the Define Outline screen. The top portion of the screen is a shortcut for generating outlines for rectangular and square boards. The bottom section is a sequence of X,Y values that make up the points of the board outline.

When the Create Coordinates button in the top section is clicked, the bottom section will be populated with a set of X,Y values. The Create Board Outline button at the screen bottom will actually generate the outline from the sequence of X,Y locations.

The SAMPLE board is 2.0 inches x 2.0 inchese in size and the numbers can be entered in mils or mm. Any number with a decimal point is considered mm. Any number without a decimal point is considered mils.

All X,Y values are referenced to the Component Reference Point. The user must know the lower left location and the board size. If the Component Reference Point is not correct, the outline will not be drawn in the correct position.

With the SAMPLE3 file loaded, open the Assembly View window and notice the tick marks in each board corner. Also notice the 0,0 reference point in the lower left. With the Assembly View window selected, press a Cntl- to enter board outline mode.

Using the mouse, left-click the lower left corner. Then left-click the upper left corner. A pink line will be drawn showing the first segment of the new board outline. Mouse clicks will pick the nearest point in either of the three Gerber layers. The closest point is used for the X,Y location of an outline point. Continue by selecting the upper right, then lower right corners. Press another Cntl-B to end the board outline mode, and the completed image is displayed.

Save the final image to SAMPLE3.BMB.

4.6 Manual Placement

If a board is relatively small and XYRS data is not available, then parts must be hand located. The Assembly View contains logic and a “placement sequence list” to assist with this tedious chore. The placement list allows a user to zoom in on a section of the board and then enter a list of components that can be viewed at that zoom factor.

With the Assembly View window selected, enter a Cntl-P to open the Placement Sequence window. Enter a number of reference designators with a space between each reference designator. Press the Enter key when done. This list of reference designators will be displayed in the lower left.

Press the ESC key and the component for the first reference designator will be attached to the cursor. Left-clicking will drop this component while Cntl-right-click will rotate the component. When the component is dropped, it is removed from the Placement Sequence List. Pressing the ESC key will take the next component from the list and that part can be placed.

This logic allows a user to zoom in to a good working level and then place components without a lot of zoom and pan operations.

4.7 Verifying Placement

Verification of component placement and orientation is critical for accurate assembly. BOM Builder contains links between the main tree’s structured BOM and the Assembly View screen for cross-probing type operation. When both screens are positioned on the computer desktop such that both are visible, component checking is simplified.

A click on a main tree line item will highlight the selected components in the Assembly View. Since components within a single line item can be located on different sides of a board, there are red and blue indicators in the Assembly View screen to indicate the counts on each side.

If the user is zoomed in and a single component is selected, that component will be centered in the Assembly View screen. If more than one component is selected, the midpoint is centered.

When the main screen is selected, the arrow keys will move down tree line items. This movement is done in a manner that speeds component checking. At Index Designs, this scheme is used to verify that each part is reasonably placed and the orientation of polarized parts is correct.

If the user clicks on a component in the Assembly View screen, information about that component is placed in the upper left and that component is identified in the main screen tree.

4.8 XYRS Summary

The key to successful automatic assembly is good data. XYRS data and Component Reference Point data are typically a “throw it over the wall” issue for most PCB designers, but operating in this mode requires manufacturing people to sometimes guess

about what is required, and this leads to assembly errors. As components become smaller, there is less room for reference designators and incomplete data results in project delays.

BOM Builder contains the tools to automatically “get it right the first time”, but PCB designers must be aware of the required data.

5 Package Select & Editor

BOM Builder can access a large number of predefined physical package models for electronic components. These package models are contained in a database named PackData.mdb and editable by the PackEdit program. (Note: Package Editor was originally a tool within BOM Builder, but as of 2018, has been carved out as a standalone tool. Nevertheless BOM Builder still retains the ability to access PackData.mdb and open the PackEdit tool.)

Unlike typical PCB libraries that provide footprints for PCB design, BOM Builder/PackEdit define packages as components. Footprints often vary as PCB routing complexity changes. In contrast, use of package models provides a consistent foundation from which footprints can be constructed. Additionally, the ability to display package model geometry allows verification of CAD tool PCB footprints, as package lead positions are overlaid on PCB copper associated with footprints.

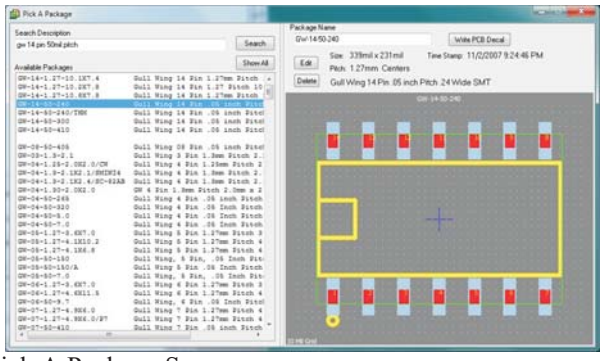
Included within PackEdit tool is a footprint designer that is driven by package data. An assorted array of packages and footprints are easily constructed. Packages can be written for exchange with other users, and PCB footprints can be generated for PADs and Altium CAD tools (among others). The PackData.mdb package model database is available from within both BOM Builder and PartSync, in addition to PackEdit.

From within BOM Builder, two screens are used to select, edit or generate new package models. The “Pick A Package” screen allows a single package to be selected from the PackData.mdb database. A search engine is included to assist with locating a specific package. The Package Editor screen allows existing packages to be changed or new packages created.

5.1 Pick A Package Screen

The Pick A Package screen is shown below, and it allows users to select a package from the existing library.

The top field is the Search Description and it is this text that drives the search engine. In the above example, “gw 14pin 50mil pitch” was used to locate the existing gull wing type packages which had 14 pins. Search results are shown in the "Available Packages" grid and the top item is a .24 inch wide package (standard SOIC 14 package). Clicking on a line in the Available Package area shows both the package name, GW-14-50-240, and the graphic. Grid dots in the graphic display give an indication of the actual size.



Pick A Package Screen

Note that both 50 mil and 1.27mm pitches were found. Internally, packages are built with 1um resolution and the search engine converts both mil and mm units to microns. There is a large array of industry standard naming conventions (e.g. SOIC, TSOP, TTSOP) that get converted to gull wing internally. All searches are performed on the package description. The package name is not important for searching. When generating new packages, follow the existing description as an example. When adding a new name, we suggest starting the name with Z-xxx, where xxx is the user’s initials.

The Show All button will display all packages, with sorting by the package name. Using a consistent functional naming scheme helps when trying to locate specific packages. Using the Z-xxx syntax for package names helps a user locate their own specific custom package. Adding a special keyword in the description helps to locate specific components in the search engine.

The Show All button provides a listing alphabetical by package name, which is sometimes easier for viewing and selecting a package. Two buttons, Edit and Delete, allow the user to edit or delete the currently selected package. The Package Editor is a very powerful tool and is described in the following section.

A PCB footprint can be written using the Write PCB Decal button. A PADs-formatted decal is written as a .d file. Many PCB design tools can read these .d files as the starting point for footprints.

Packages can be deleted using the Delete button, while the Edit button copies the selected package into the Package Editor.

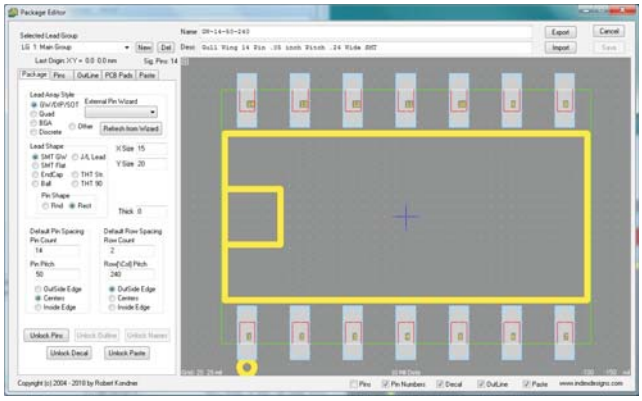
5.2 Package Editor

The Package Editor allows users to define body and lead shapes for new electronic components. A series of tab controls select various fields for package generation, while a graphic view is provided for data display and graphic editing. Tab labels and their function are:

- *Lead Groups - enables defining lead groups as multiple groups of pins.*
- *Package – assigns general package shape, pin counts and default lead shapes.*
- *Pins - controls pin numbering, connection offsets and package side*
- *PCB Pads - controls generation of PCB decal (footprint)*
- *Paste - controls generation of solder paste apertures*

5.3 Package Tab

General package shapes are controlled using the top set of radio buttons. BGA, gull wing (includes SOIC, TSOP, SOT and others) and quad packages are the basic styles, while a drop-down list is used to select external “Pin Wizards”.



Package Editor

A Pin Wizard is an external program which is executed whenever its name is selected from the drop-down list box. This list box is populated with all the filenames of all the .exe files found in the C:\BOM_Bldr\PinWizards directory. These programs can be DOS or Windows programs. Each program will typically accept user input and will generate a text file that defines pin placements, shapes and types. Documentation can be found in the PINWIZARDS directory in the file PINDATA_Sample.txt. A sample program can be found in the file SampleWizard.dpr.

Once a package shape is selected, using the Package Style radio buttons, the pin counts, pin pitch, row count and pin pitch fields can be used to further define a package. If a Pin Wizard was used to generate the package, these controls are greyed out and disabled. If a GW/DIP/SOT package was selected and a pin count of 3 and row count of 2 are entered, a classic SOT-23 style package will be displayed.

The Default Leads group is used to initialize leads as through hole (THT), surface mount (SMT) size and shape. Toe Position is used by IPC-7351 rule sets when forming PCB decals. All leads default to these values when the package data structure is initialized. Users can edit these on a pin-by-pin basis by double-clicking on a graphic lead when the Package Tab is selected.

While the Package Tab is selected, a double-click on a graphic pin will allow editing of pin data items. Several of these items are found in the default groups, but several are new. Circuit Type allows pins to be defined as Signal, Mount or Shield pins. Signal pins are the most common, as they are the pins used to pass electrical signals. Mount and Shield pins were defined to support higher level functions associated with drill size selection and netlist error checking. Side is typically used for card edge connectors, where copper shapes need to be defined on specific sides.

Pin locks are flags used to identify that a user has modified specific pin parameters and the automatic generation of pin data or positions must be altered for that pin. When a pin lock is set, the color of that pin changes, which indicates that pin locks are active for that pin.

A Reset Pin Locks button is provided to unlock all pins. Clicking this button will reset pin locations, pin shapes, outlines, decal shapes and solder paste shapes.

Pin Positions can be altered by clicking on a pin while the Package Tab is selected. Pins can be dragged by their top, bottom, left, right or center.

The drag mode can be selected using a right-click in the graphic area or by using modeless commands DT, DB, DL, DR and DC for Drag Top, Drag Bottom, Drag Left, Drag Right and Drag Center. Modeless commands are commands typed on the keyboard. After pressing the ESC key to remove focus from another control, press the D key. A modeless command window will appear which shows various commands which start with D.

The Modeless P command can also be used to select a pin for moving. To use the P command, first make sure no field is being edited by hitting the ESC key. Enter a P followed by a pin number. For example, enter P1 to move pin 1. The pin will highlight, and the cursor will change shape. Arrow keys must be used to move the pin by grid units, as the mouse is locked out. Grid units can be changed using the Modeless G command. For example, G25 sets both X and Y grids to 25 mils. Entering G25 100 will set the X grid to 25 mils and the Y grid to 100 mils.

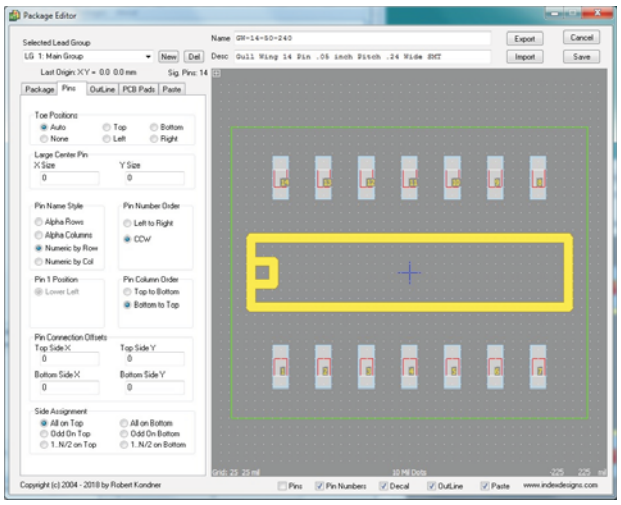
The origin for grid movement depends on how the pin was selected. When a pin is selected using a left-lick, the pin is moved on a grid referenced to the package origin. The package origin is shown graphically as a blue cross. If a pin is selected using the Modeless P command, the movement is referenced to the starting pin position. This allows the user to move a pin by a specific distance using the grid settings, even when the starting position of the pin is “off grid” from the package origin.

The above editing scheme is similar for both PCB Pads and Paste (solderpaste aperature) definitions. A left-click moves the graphic, and a double click edits the nature of the graphic. If the PCB Pads tab is selected, PCB Pads (i.e. footprint pads) are edited. If the Paste tab is selected, then solderpaste graphics are edited.

5.4 Pins Tab

At the screen top are controls for forming lead groups. The use of lead groups simplifies the construction of complex packages, for example D connectors. A set of signal pins can be defined with a proper pitch in group 1, while mounting holes can be added as group 2. Always define Lead Group 1 well first. Add additional lead groups afterwards.

Buttons in the Lead Array Style group will build a default array of leads in a common pattern for the



Package Editor Pins Tab

selected lead group. Changing these buttons completely rewrites the pins for the selected lead group while other lead groups are not affected. Delete lead groups starting with the highest first.

Details for these lead array styles are supplied by the Default Pin Spacing and Default Row Spacing regions. Pin spacing is typically set to Centers with Pin Count set to the total number of pins. Pitch is the spacing between pins. Some package datasheets will show a dimension for pitch to inside or outside pin edges. The Inside and Outside buttons will help.

Lead Shape settings are designed to provide extra details about the leads in a group. Most of the settings are for future 3D shape construction features, but a few are used now. SMT GW and THT Str (Straight) are the most common. The Rnd and Rect buttons form Round and Rectangular pin definitions. XSize and YSize fields define the size of the package pin area that actually solders to the PCB. These will be drawn in red. Pins are drawn in red and they represent the metal areas of the package. PCB decals will be defined later based on these red pins.

Various fields in the Package Editor accept dimensions for lengths or spacings. Units for these fields can be entered in either mil or mm formats. The logic is quite simple. If the parameter is entered with a decimal point, it is considered as mm. If there is no decimal point, then it is considered as mils. The user can force a particular unit by including mm, mil or a “ (quote character). Entering mil forces the number as mils. Entering mm forces the

number as millimeters. Entering a " (quote character) forces inch units. For example, 5 and .127 and .005" all refer to 5/1000 of an inch. Entering 2.5mil or 5mm overrides the decimal point rule.

A simple mathematical expression (very simple) can also be entered. A length parameter can be followed by a * / + or - operator sign to indicate multiplication, division, addition or subtraction. For example, 200/2 is decoded as 100 mils. The units for the length are defined by the characters BEFORE the operator sign. For example 10+1.5 is decoded as 11.5 mils, while 10.+1.5 is decoded as 11.5mm.

The origin for grid movement depends on how the pin was selected. When a pin is selected using a left-lick, the pin is moved on a grid referenced to the package origin. The package origin is shown graphically as a blue cross. If a pin is selected using the Modeless P command, the movement is referenced to the starting pin position. This allows the user to move a pin by a specific distance using the grid settings, even when the starting position of the pin is "off grid".

The above editing scheme is similar for both PCB Pads and Paste (solderpaste aperature) definitions. A left-click moves the graphic, and a double click edits the nature of the graphic. If the PCB Pads tab is selected, PCB Pads (i.e. footprint pads) are edited. If the Paste tab is selected, then solderpaste graphics are edited.

The Pins tab includes a number of additional controls for defining PCB footprint pads. IPC-7351 uses a syntax of Toe, Heel and Side when building PCB footprints from packages. Pins in a lead group can be defined as having Toes at the Top, Bottom, Left and Right side of a pin. Setting None forces all pins to be considered as only having Sides. Auto will assign the Toe positions on an automatic basis. Double-clicking a pin enables assigning Toe position as required.

Control for pin number assignments is through buttons and check boxes located on the Pins tab. If a package was defined using an external Pin Wizard, then all these controls are grey and disabled. If the overall package shape was defined using a radio button on the Package tab, then these controls will be active. Additional pin functions can be accessed using a right-click on the package graphic.

To manually insert a new pin, first click on an existing pin of the correct, or close, size and shape for the new pin. Drag the pin to where you want a new pin. Right-click and select Insert Pin. The starting pin is returned to its original position and a new pin is created.

Delete Pin does not completely delete a pin. Instead, it simply makes a pin show as black and removes the pin from any exported footprints. Select a pin with a left-click, right-click and select Delete Pin. The pin is drawn in black. A second delete restores the pin to being present. This function is used to remove pins from BGA packages where accidental deletes need to be restored.

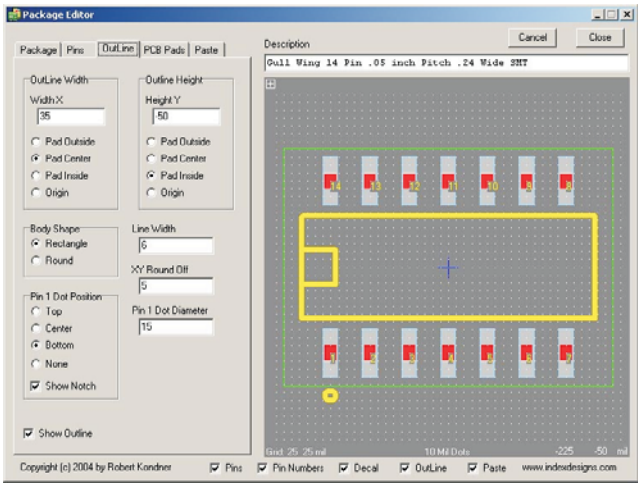
Most BGA, connector and/or IC pin number formats can be defined using both numeric and alphanumeric pin numbers. DIN connectors with multiple rows, top/bottom-mounted connectors, and card edge connectors are automatically numbered. Pin connection offsets allow the connection points to be modified for parts such as card edge connectors. Side assignments work with pin numbers, which in turn are defined by other buttons. The number of combinations is considerable.

A large center pin can be constructed using two fields in the Large Center Pin Area. This allows thermal heat sink pads to be easily added for the construction of QFN and similar packages.

5.5 Outline Tab

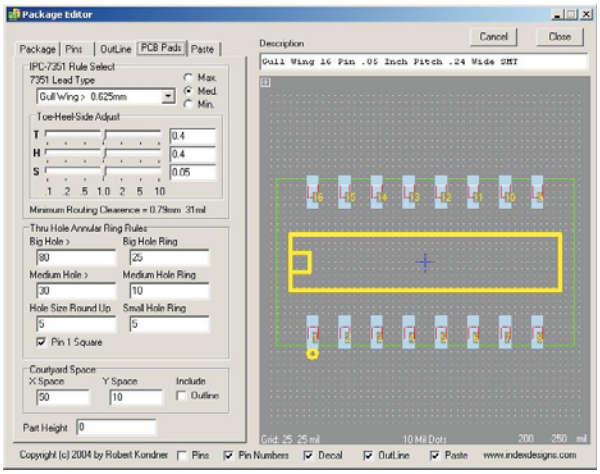
The Outline tab allows the user to modify the size and shape of the package outline. Additional fields allow control of line widths, placement grid and pin 1 indicators.

A left-click will allow a user to pick up and move line segments or corners. A right-click allows a user to insert additional corners or new outline sections. To add a new outline section, right-click, select Insert Outline, then left-click where the shape is to begin. Click to add corners, double-click to end.



5.6 PCB Pads Tab

A key function of the Package Editor is to apply various rule sets to lead data for the purpose of generating PCB land patterns (i.e. decals/footprints). Rules are defined using simple text files in the BOM_Bldr\Data directory. See the files IPC7351Rules.txt and ThruRules.txt for details.



Package Editor PCB Pads Tab

A set of sliders and text boxes allows the user to adjust PCB land pattern size. These sliders provide logarithmically-adjusted scale factors which are applied to the IPC-7351 rule settings. Component class rules are selected using the drop-down box. Class rules are multiplied by the slider scale factor and the results are placed in the text box. A user can enter their own required Toe, Heel or Side settings by entering values in the text boxes. Each pin includes a WHITE line which indicates the component Toe position.

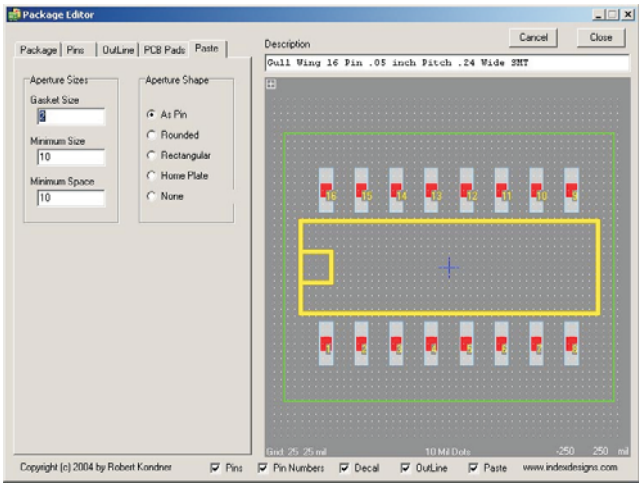
Through hole rules are quite simple, with values shown in the .txt file following the arrangement of fields in the Thru Hole Annular Ring Rules group. These 6 parameters force minimal annular rings for large, medium and small holes. The Round Up field forces computed annular rings to round up to specific intervals.

Annular rings are not computed directly from lead diameters, but from required drill sizes. In the BOM_Bldr\Data directory is a file, DrillRules.txt. This file is used to map Through Hole pin diameters to a user defined set of drill sizes. The purpose of this logic is to control (reduce) the number of drill sizes called out in a complete job.

The component Courtyard attribute is a definition of the space around a component, while Part Height is an indication of component height. These fields are stored with the package data and are reserved for use by physical modeling software. The Courtyard can encompass space for just the pads or, if Include Outline is checked, the outline shape positions will be included in Courtyard calculations.

5.7 Paste Tab

When manufacturing surface mount assemblies, the solder paste apertures are extremely important. For small and fine pitch components, solderpaste apertures cannot be reliably extracted from PCB land patterns. Instead, a completely independent data structure must be defined to control solderpaste apertures.



BOM Builder includes logic for generating custom solderpaste apertures. Fields are provided to define aperture shape and Gasket spacing. Gasket spacing

is defined as an area of PCB pad material that must gasket the area exposed by the solderpaste aperture. The goal is to prevent solderpaste leakage during the solderpaste printing process which can result in solder shorts during reflow.

Home Base aperture shapes are often used to reduce solder ball formation on small chip components. Pick and Place machines apply forces which tend to squeeze solderpaste out from under small chip components, with the result being the formation of solder balls during reflow. The Home Base shape for a solderpaste aperature reduces squeeze-out and reduces the chance of solder ball formation.

5.8 Color Control Check Boxes

Several check boxes are used to control the generation of graphic images. Pin numbers can be selected using the Pin Number check box. The remaining check boxes result in their associated items being drawn as either solids shapes or as outlines.

5.9 Description Field

The description field is VERY important. The Index Designs package search engine uses this description for database storage and lookup. The user should use existing descriptions as guideline when generating descriptions for new packages.

5.10 Toe Positions

As mentioned previously, Toe positions are used to control PCB decal generation using IPC-7351 rules. Package Editor software displays Toe position by drawing a white line on the Toe side of each pin.

5.11 Pin Names

Each pin on a Package has an internal number and a user number. Unless the user manually modifies the user pin number, it will be the same as the internal number. While the automatic pin numbering logic in the Package Editor works for most new packages, there are times when it is required to modify default numbers. A right-click will allow the user to select “Re-Number Pin” mode which will start the renumbering process.

After selecting the Re-Number Pin option from the right-click menu, the user can then left-click on the first pin to be re-numbered. This pin will be re-numbered to 1 by default. As pins are left-clicked, they will receive sequential numbers. If the user wants to start numbering at a number greater than 1, the keyboard can be used to change the number of the last key re-numbered. Simply type on the keyboard to change the pin number of the last pin that was re-numbered.

Alphanumeric pin numbers such as A!, B27 for AA5 are allowed. Additional left-click re-numbering will advance the numeric part of the numeric pin numbers.

As the first pin is re-numbered, the Unlock Names button on the Package tab will be enabled. This button being active indicates that automatic pin numbering is disabled. Clicking this button will re-enable automatic pin numbering. Clicking this button while active will delete any user pin numbers.

Hit the ESC key when re-numbering is finished.

6 Export & Reports

BOM Builder includes a number of export function in the FILE - EXPORT main menu. These export functions provide data in various forms to external applications. Included are outputs for OrCAD Capture update .upd files, Excel .csv files, PADS .asc files, PartSync structured part lists.

6.1 OrCAD Update Export

The Cadence Allegro/OrCAD schematic capture tool (Capture) uses a simple but powerful file format to back annotate just about anything back into a schematic. While BOM Builder maintains very detailed structures for part attributes, many users still wish to duplicate the footprint information by back annotating their Capture schematics. BOM Builder will generate a .upd file which Capture requires to back annotate footprint information into the source schematic.

Power Logic users are just plain out of luck. It is not possible to back annotate PART TYPE information into a Power Logic schematic.

6.2 Excel CSV Export

BOM Builder will format part information into a .csv format for reading by Microsoft Excel and many other spreadsheet programs. The user is prompted for two inputs:

- *Destination File Name*
- *Count of Boards to Build*

After the file name is selected, the Board Information screen is shown. The user should enter a number in the Number of Boards to Build field, as this will be used as a multiplier for the output Count field. Each line item is output as a single row with the following output fields:

- *Find Number*
- *Part Count multiplied by Boards to Build Count*
- *Reference Designators*
- *Part Number*
- *PCB Decal*
- *Index Designs Package Name*
- *Description*

6.3 Parts & Vendors Export

Export to Parts & Vendors is probably the most important function within BOM Builder. This function takes the current BOM and generates a structured parts list within the Parts & Vendors database. Note that only those parts with valid Parts & Vendors Part Numbers can be transferred. If a job contains new parts the Parts & Vendors database (or any MRP database) must have these new parts created first.

Once a BOM has been exported into Parts & Vendors automatic purchasing and inventory control is possible. Kitting, generating RFQs, generating POs and a number of functions are available. Also available are ECO controls which help to maintain a consistent product configuration.

Please see the Import Section for information about reading MRP data from Parts & Vendors and how that data is distributed to multiple designers and how it is synchronized using the Index Designs indexing software.

6.4 User Files

BOM Builder allows a user to embed various file types within a .bmb file. Embedded files can be of any type and used for any purpose. Examples of such files include:

- *Device Programming Data*
- *Test Instructions*
- *Assembly Instructions*
- *Documentation*

User files are attached using the FILE - IMPORT - USER FILE and they are extracted using FILE - EXPORT - USER FILE. To remove a copy of the file, the file must first be selected in the main screen tree structure. Using FILE - EXPORT - USER FILE will extract the file from the BOM and place a copy in the C:\BOM_Bldr\AttachedFiles directory. If this file type has an associated application, then that application will be invoked to open the file. To import a file, the user is presented with an Open file dialog. The selected file will be read and embedded into the BOM Builder database.

User files can also be deleted. Select the file in the main screen tree structure and use the EDIT - DE-

LETE USER FILE function. The file will be removed from the BOM Builder database.

6.5 Export Netlist to PCB

BOM Builder exports design data to PCB design systems through the Netlist to PCB export function. The resulting PADs .asc file format is not only very common among PCB design tools, but it merges netlist, attributes and component decal selections into a single file. The export process for this file starts with reading an existing file PADs file and then writing a new version of the file to a second directory.

After selecting FILE - EXPORT - NETLIST TO PCB DESIGN, the user is prompted for an input netlist file. This file is read, and the user is prompted for an output netlist file. The user will be directed toward a different directory with the file name for writing the same as the input file name. The input file is read and written to the output netlist file. During the transfer, input file *PARTS* data is re-written with the PCB decal information contained in the BOM Builder database. This allows all components to be assigned PCB decal data without annotation data being placed in the source schematic. This simplifies the use of schematics generated by:

- *Outside consultants*
- *Different schematic capture programs*
- *Same capture tools but different libraries*
- *Sample schematic from evaluation kits*

Both input and output file names are saved in the BOM Options screen, as they are used for the netlist transfer. Once valid file names exist in these BOM Options fields, the user is no longer prompted for file names. The transfer takes place immediately. As the decal names are transferred, they can be translated as described in the next section.

6.6 Decal Map Table

A Decal Map Table (EDIT - DECAL MAP) is included, which allows PCB decal names to be translated as they are written to the output PADS .asc file. This logic allows a single MRP system with a single set of PCB decal names to drive multiple PCB design tools, where each tool uses different libraries. PCB design service organizations can use a single in-house set of PCB decal mappings and still prepare input files for PCB design using customer libraries.

This map table is driven by text files which can be read or written using any text editor. Two columns exist in the table, “Local Decal/RefDes” and “Target Decal”. As BOM parts are processed, their reference designator and PCB decal are compared to the first column, and if a match is found, the target decal in the second column is written to the PADS .asc file. The result is a PCB decal name translation.

The syntax of the first column allows a single reference designator or a series of reference designators to be renamed. It is also possible to rename on a PCB decal basis or a combination of a reference designator and PCB decal name. Examples of this syntax are:

- *R21 :Component R21 will be output using table target decal.*
- *R* :All components with “R” as their initial set of reference designator letters will be output using the table target decal. (RN2 would not be changed as its initial set of reference designator letters is “RN” and not “R”.*
- *1206 :All components currently assigned PCB decal 1206 will be output using the table target decal.*
- *C*0603 :All components with “C” as their initial set of reference designator letters AND a current PCB decal of 0603 will be output as the target decal.*
- *If no match is made, the PCB decal is output directly.*

No changes are made to the current BOM during this process. The changes to the decal names apply only to the decal names written in the *PART* section in the output netlist. Multiple sets of mapping tables can be maintained and selected in the EDIT - DECAL MAP screen.

6.7 Purchasing BOM Report

The main menu sequence REPORT - PURCHASING BOM will generate a list of materials required for board assembly. The Board Information screen will be shown where the user can specify the number of boards to be built. The count of components

in each line item will be multiplied by this board count.

A report preview screen will allow the user to review and print the report. In addition to printing, an Adobe Acrobat file (.pdf) can be directly generated. If a .pdf is generated, it will be opened, and the Acrobat functions make it easy to send, email or print copies.

Only parts marked as IN BOM and STUFFED will be included. This allows board variations to be easily constructed within BOM Builder.

6.8 Assembly BOM

The Assembly BOM is very similar to a Purchasing BOM except that the parts are sorted by assembly process requirements. The sorting categories are:

- *Machine Parts - top and bottom side*
- *Hand SMT - top side*
- *Hand SMT - bottom side*
- *Through Hole - top side*
- *Through Hole - bottom side*
- *Not Stuffed*

Color coding is used to define side information. Topside components are marked using alternating colors of red and white. Bottom side components are marked using alternating colors of blue and white. The first part in a side group is always in red or blue, so there is no ambiguity about which side a part is located. Machine parts are all marked with alternating colors of green and white. No distinction is made for top and bottom machine parts. No-stuffed parts are shown in alternating gray and white.

Dividing parts into these categories speeds production, as it allows various component types to be routed to different work locations. Hand SMT parts must be mounted before reflow of their associated side. Through hole parts are mounted after SMT is complete. The not-stuffed list is important during final inspection.

Including all non-stuffed components in the BOM and marking them as “Not Stuffed” is very important. Final inspection must verify if any required parts are missing. The only way required parts can be verified is if “No Stuff” parts are identified.

6.9 Kitting Labels

BOM builder contains a Kitting Labels report which generates a set of labels to be used when materials are collected prior to assembly. As with other reports, the Board Information screen is opened and the user should set the Number of Boards to Build as required. The quantities for each line item will be multiplied by this number, and used for the labels generated.

Kitting labels are generated 10 per page using a standard 4 inch x 2 inch format. Either adhesive labels can be printed, or standard 8.5 x 11 letter paper can be printed. Cutting the printed pages with scissors or a paper cutter produces a single label for each required line item. Description, part number and reference designators are included on each label, which simplifies component identification. A standard barcode is also printed on each label in a “2 of 5" format.

6.10 Board Image

A complete image of the PCB can be printed using the REPORT - BOARD IMAGE menu sequence. Gerber files will be printed first followed by Package graphics. How the image is scaled depends on whether or not a board outline has been defined.

If the board outline is defined, then the board image will be scaled such that the board outline is fit onto the printed page. Landscape vs Portrait printing will be automatically adjusted to fill the printed page. If the board outline is not defined, then the board will be sized to include the entire Gerber file image along with all components.

The main use of the Board Image is component verification. Package libraries from Index Designs contain orientation marks for polarized components. Users MUST verify the rotations of these components. Thin white body lines and orientation marks must be compared with silkscreen or copper patterns which indicate orientation. If the user failed to include such information in the Gerber data, they will probably get it right the next time.

The Gerber files for the BOM Builder silkscreen images can be setup differently than the actual PCB silkscreen image. A significant amount of fine

dense text that would not print on a real PCB can be included in the BOM builder image. Further, BOM Builder will show any silkscreen over top of the copper image. Unlike a real PCB, the silkscreen image is not broken by pads or vias.

6.11 Smart .PDF

The REPORT - SMART .PDF report is similar to the Board Image report except for two major functions:

- *Output is to an Adobe Acrobat .pdf file.*
- *BOM Information is placed into the .pdf file.*

The result is a .pdf file that can be opened in Acrobat Reader and the Acrobat hand cursor can be used to inspect component information. Moving the hand cursor over a component will result in a tool tip being displayed with Part Number, Value and Description data.

The resolution of this file is 1000 dpi and all data is saved in vector format. Even at significant zoom factors, the PCB image is quite accurate, yet the file size is reasonably small.

6.12 Set Default Printer

The REPORT - SET DEFAULT PRINTER function allows a user to set a default printer for various reports. When a printer is selected, the name of this printer is saved to the .ini file. When BOM Builder is started, it uses the printer name from the .ini file to select a printer.

Assembly BOM, Production BOM and Printing Label reports check if a default printer has been specified. If no printer has been specified, or if the printer name found in the .ini file is not found, these reports will prompt the user to select a printer.

7 Import Function

The usefulness of BOM Builder relies on its ability to import and arrange data from various sources. By reading data from MRP systems, PCB CAD tools, and its own package model database, custom CAD libraries can be eliminated from the board design flow. Up-to-date information from the parts database is always available to design engineers. All data can be transferred as simple text files since BOM Builder contains all the required data server logic, and all required data tables are stored within simple file structures.

Several of these import functions are based on dynamically loaded .dll files which are easily constructed for various data sources. Each .dll is only 50 or 100 lines of code, and the .dll used for a specific function is defined though fields in the System Options screen.

The BOM Builder import functions will process data from:

- *MRP database systems*
- *PartSync & other databases*
- *PADs .asc files (see Section 2.1)*
- *Input Parts List .dll files (see Section 2.4)*
- *X/Y Rotation Data from PCB design tools (see Section 4.1)*
- *Excel .csv files*
- *Text files from CAD tools*

7.1 MRP Data

The feeding of MRP (Materials Resources and Planning) data into BOM Builder is very important, as BOM Builder does not replace an external part database. At a minimum, BOM Builder needs the user to have a component database with a Part Number, Description and fields for PCB Decal/Package associations. PartSync is an excellent small database tool that includes many purchasing features and ECO (Engineering Change Order) functions. Many companies have existing database systems, and the MRP Data Import function is how data is moved from these external systems to BOM Builder.

The MRPData.txt file can be distributed to all design engineers who wish to have access to such data. Each time BOM Builder is started, the time and date stamp is read from MRPData.txt, and it is compared to the time and date of the last update. When a new file is found, it is processed at startup, which leaves all engineers using fresh, consistent data. The MRPData.txt file can be transferred via a local network, written to all engineers using simple batch files, or even downloaded over the Internet using a web browser.

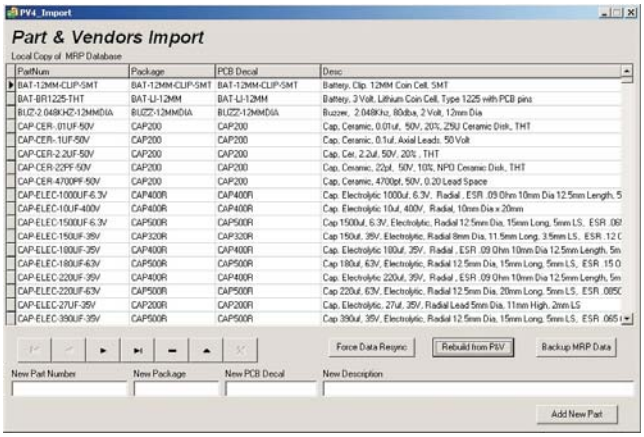
7.2 Parts & Vendors Import

The Parts & Vendors Import screen allows control over the local copy of the MRP Database within BOM Builder. There are three different methods of setting up this data.

- *Preferred: Reading from Parts & Vendors*
- *Using MRPData.txt file from a MRP system.*
- *Dumb: Building it by hand.*

The ideal process is to automate the collection of data that will be used in forming BOMs and the driving of the manufacturing process. A single point source of data is preferred, one where a minimum of Part Number, PCB Decal and Description are available. The saving of Package definitions in this database is advantageous but BOM Builder AOT (Angle, Offset and Translation) logic can learn and provide package names if required.

Selecting FILE - IMPORT - PARTS&VENDORS DIRECT displays the PV4 Import screen which is shown below. In the top section is a database grid that shows the contents of the local BOM Builder



Parts & Vendors Import Screen

MRP image. Several buttons allow synchronization and backup, and several fields are provided for adding new parts or attributes.

A grid showing all the existing MRP components is displayed along with their Package and PCB decal assignments. In the screen's lower right corner is a "Rebuild from P&V" button. Clicking this button will delete the existing MRP database and will start a rebuild from the Parts & Vendors database through an ODBC connection. Do not click the rebuild button, since chances are, you have neither the P&V database nor the proper ODBC connection. If you click Rebuild without the proper setup, all you will get is an empty database.

Once P&V is set up and its first user field (User1) contains PCB decal and package data, then pushing the Rebuild button will extract data from the P&V database. This extracted data is written to internal tables, external file MRPData.txt, and is used to synchronize the Index Designs search engine. Be sure to verify the path for the P&V database file (.mdb file) which is shown in the System Options screen.

Data is extracted from the P&V Title and Details fields to form a description. The User1 field is used to provide a PCB Decal and Package name.

The format of data in the P&V User1 field is quite simple. It is a text string which includes two names separated by one or more spaces. The first name in the string is the PCB decal associated with the current part and the second name is the Package. For Example:

CR1206 1206

If the User1 field for a part contains the above string, the PCB decal for that part will be CR1206 and the Package will be 1206. If the User1 field contains only a single name, that single name will be used for both the PCB Decal and Package. If the User1 field is blank, the part will not be included in the BOM Builder database or the MRPData.txt file.

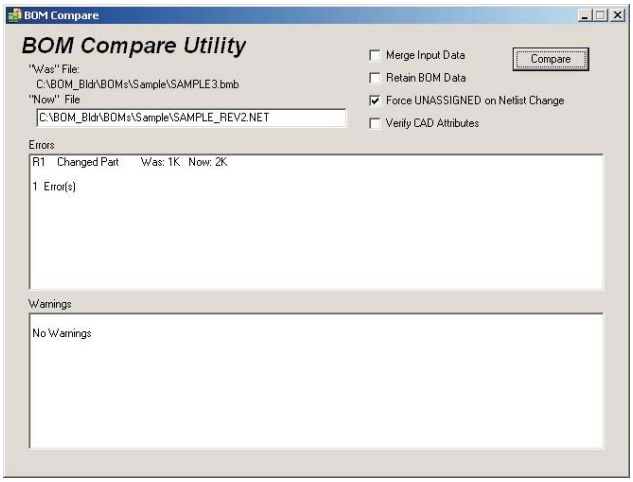
7.3 BOM Compare

A compare function has been included that detects and reports difference between two BOMs. This compare function will also accept a PADs netlist as input, though the number of possible detectable differences is reduced. Several check boxes provide processing options when comparing a netlist.

The bottom portion of the BOM Compare screen contains text fields where errors and warnings are reported. Clicking on strings in these text areas will open copies of these regions in a text editor. Several check boxes provide additional control:

- *Merge Input Data will result in differences being applied to the BOM.*
- *Retain BOM Data will maintain BOM data for fields not read during netlist compares.*
- *Force Unassigned will force Package and PCB decals to UNASSIGNED during netlist compares.*
- *Verify CAD Attributes will test input PADs attributes during netlist compares.*

The reason for the above flags is that a completed BOM with full details might be compared to a



BOM Compare Screen

PADs netlist which has missing, incomplete or simply bad data. These flags control how netlist data is treated and how the BOM is optionally updated.

An example has been provided in the SAMPLE directory, which provides a netlist to compare with the SAMPLE3.BMB file. A new netlist has been created which has a different value (2K) for R1. With SAMPLE3.BMB loaded, use the main menu FILE - COMPARE sequence to select the file SAMPLE_REV2.NET. When the File Compare Utility screen is shown, click on the Compare button.

Parts will be compared, and R1 will be shown as changed. Click on the Merge Input Data check box so that it becomes checked. Then click on the Com-

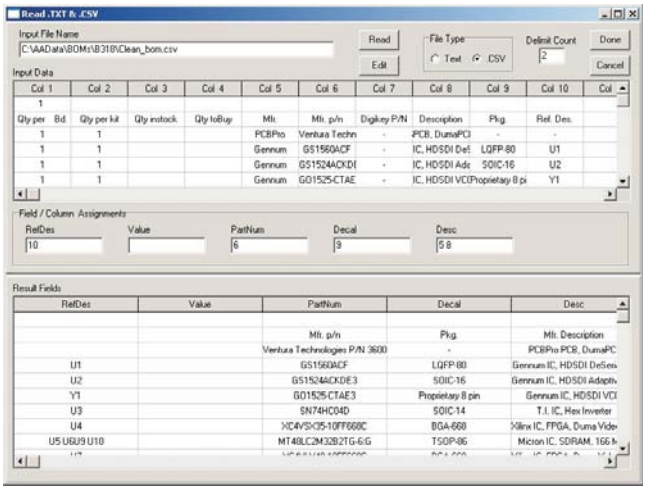
pare button again. This time, the error will be gone as the difference has been merged into the BOM. Close the Compare Utility window and observe that R1 is now red. When the changed part was merged to the BOM database, prior package and PCB selections are removed and selections must be made.

7.4 Excel .CSV and .TXT Import

In many cases, data about input parts is provided as a spreadsheet. This is unfortunate, as hand-generated spreadsheets are typically incomplete, inconsistent, out of date or just wrong. Despite these problems, many engineers continue to use spreadsheets, so BOM Builder includes several .dll functions for reading spreadsheet data.

The TXT_CSV read function is used to read text reports that are generated directly by many CAD tools. When reading these .txt files, the key issue is what determines field boundaries. When reading .txt files, space characters are used to delimit fields. The number of spaces required to delimit a field is controlled by a "delimit" count. Tab characters will also serve as a delimiter of input fields.

In all cases, the spreadsheet or text file must be inspected for invalid or inconsistent fields. Spreadsheet files must be exported as a .csv file. A generic .csv/.txt import engine has been provided that will read the .csv or .txt file and allow input fields to be converted into a set of output fields. A sample screen is shown below.



CSV and TXT Import Screen

The top portion of the screen contains the input data, and the bottom portion the results. In the center is a set of "Input to Results" mapping entries, one for each result field. These center entries select input fields as data sources for result fields. Data from the .csv or .txt file is read, and the input data columns are formed. Result fields are then created from the input columns as determined by the input field number in the center "Fields / Columns" section. Any input column may be used any number of times or not at all. The number and name of the results fields varies depending on the code in the .dll routine. Result fields are provided for the required and optional IPL or XYRS data field requirements.

Each Field / Column entry defines which input columns are used as data for the results section. The names of the Field / Column sections are the same as the results columns. The numbers in those center fields select the .csv or .txt input columns by number.

Several XYRS_TXT_CVS_xxxxx.dll files are provided. These routines process the X and Y values as either inch, mm, mils (1/1000 inch) or as microns (10**-6 meters). Be sure to set up the CW and CCW flags in BOM Options before using these routines to read XYRS data. Proper application of this data requires the "sense" of rotation input.

At the screen top are Read and Edit buttons. The Edit button will invoke the appropriate editor for the selected file type. The Read button will read the input file and regenerate the results fields. If the Field / Column number in the screen center is changed, the Read button must be clicked to regenerate the results columns.

Finally, when the result data "looks good", the Done button will return the result array to BOM Builder.

8 Misc Functions

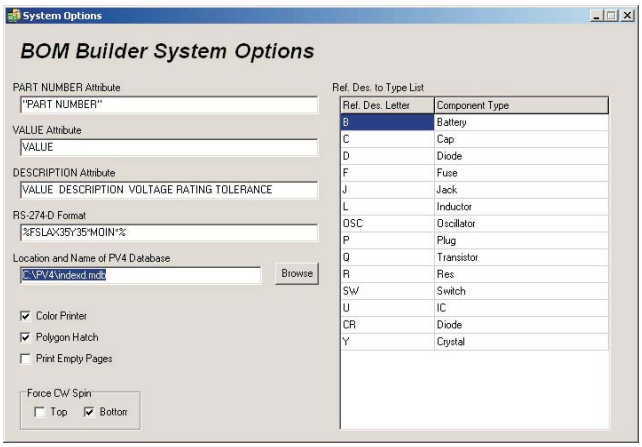
This chapter describes a number of remaining BOM Builder functions. These functions provide control for:

- *Schematic Back Annotation*
- *Gerber Options*
- *Part and Gerber Deletion*
- *Package and AOT Data Control*
- *Board Information*

These subjects and others are covered in the following sections.

8.1 System Options

The System Options screen, shown below, contains a number of fields and check boxes that control various BOM Builder features.



System Options Screen

The first three fields contain default attribute selection for BOM Builder attributes when importing PADs netlist and .asc files. When a new BOM is created (FILE - NEW), these fields are copied into the identical fields in the BOM Options, which become part of the saved BOM. When saving and reading BOMs, it is the BOM Option fields that exchange data. System Options are only used for new BOM generation.

Notice that PART NUMBER is enclosed in double quotes. If an attribute name contains a space character, then enclosing that field in double quotes preserves that space in the name. Not using these double quotes in the above example would result in attribute PART and attribute NUMBER being extracted and merged.

The next field specifies the Gerber input format when reading RS-274-D type Gerber files. D-Code aperture data for RS-274-D files must be read in using a .dll routine. If no apertures are read, or any are missing, BOM Builder will render these items using 10 mil round apertures. See file Gerb_Apertures.txt in the C:\BOM_Bldr\IntfTools directory. A simple solution is to convert -D files to -X files using Gerber reader programs. RS-274-X is suggested. In all but a few cases, -D reading is not possible.

Three check boxes allow for control of printing options. While color printing can be disabled, the use of a color printer is highly recommended. BOM Builder does not render “clear layers” in RS-274-X polygons, which can result in some “GND planes” hiding tracks and pads. Using a cross hatch display for “dark layer” polygons solves this problem. The printing of pages for board sides which do not contain parts can be enabled with the third check box.

To properly adjust component rotations using AOT (Angle, Offset and Translate) data, BOM Builder needs to know the rotation sense of the PCB design tool used to generate the Gerbers. This would be the same program that generates the XYRS information, and BOM Builder must rotate parts in the correct direction.

It is very possible that a user might deal with multiple CAD systems, each with different spin direction. While there are direction controls in the System Options screen, there are also controls in the BOM Options screen. When a new BOM is generated, the System Options check boxes are copied to the BOM Options check boxes. When BOMs are read or written, check box status is saved and restored with the BOM Options check boxes. This allows the spin direction control data to follow the BOM, allowing Group Moves to operate correctly at all times.

The right side of the System Options screen contains a table used to form associations between Reference Designator letters and electrical functions. When BOM Builder forms line items, the initial letters of each component’s reference designator are used to associate that component with a function. Components are grouped into identical “functional areas” and the main screen tree is sorted by functions in an alphabetic manner. This is how BOM builder knows that R’s are resistors and C’s are ca-

pacitors. Unknown reference designator letters are mapped into the "Other" function.

Users should populate the righthand side table with their own definitions. Having parts sorted by function is a great way to locate parts and assists with manufacturing and test. This table is saved to and restored from disk as BOM builder is closed and reopened.

8.2 Delete Functions

The main menu's Edit menu contains delete functions for Parts, All Parts and All Gerbers. Delete Part will delete the parts defined in the Line Item Editor located in the lower portion of the main screen.

Delete All Parts will remove all parts, but will maintain Gerber images and BOM parameters. This is different from the FILE - NEW function, which deletes parts, Gerber images and resets all BOM parameters. Delete All Gerbers simply deletes all Gerber images. These functions are very useful, as new revisions of a design are made, since a significant amount of data can be reused.

8.3 Renumber

It is common practice for a PCB designer to renumber, or re-annotate, all reference designators on a PCB. This process results in a design where it is easier to locate components during assembly or test. When renumbering a PCB, a WAS IS list is often generated, which is used to identify old and new reference designators. BOM Builder will read this list and update all reference designators accordingly. A sample of this list would be:

C1 C27
Q7 Q1

In the above example, C1 is renamed to C7 and Q7 is renamed to Q1. When reading the WAS IS list, every BOM component is checked for receiving a new reference designator. Components that do not receive new reference designators are checked for deletion. If another component has been renamed to the old WAS reference designator value, then the component that did not receive a new name is deleted. If two or more components are mapped to the same new reference designator, then only the first will be renamed. In all cases, errors are generated.

Error conditions are checked during the process, and if detected, an error report is generated. The user will be given the count of errors and the errors report will be opened in the default text editor.

When EDIT - RENUMBER is selected using the main menu, the user will be prompted for the WAS IS text file. Any file contents that cannot be used to update a BOM component are reported in the error report. Extra or missing references are also reported. If errors are encountered, the user should resolve the error BEFORE the modified file is saved. It is not possible to recover an old version once a renumbered BOM is saved. Do not save the BOM until processing completes with no errors. Always spot check the conversions.

8.4 Package Utilities

Several functions are provided in the main menu PACKAGE function for the control of Package Libraries.

- *Update Cache: Update all BOM graphics from the package database.*
- *Edit Packages: Open Package Select screen where packages can be selected and edited.*
- *Backup: Save all Packages to PackageBackup.txt file.*
- *Restore: Delete Package Library and restore from the PackageBackup.txt file.*

When packages are backed up, any existing backup file is renamed down through an _Old, _Older and _Oldest sequence. Restore should only be used if the BOM Builder package database has become corrupted. When the package database library is restored, any unsaved packages will be lost.

The format for the PackageBackup.txt file is identical to the PackageData.txt file found in the c:\BOM_Bldr directory. Each time BOM Builder is started, it checks the date of PackageData.txt. When a new date is detected, PackageData is read and the local package database is updated. All packages contain time stamps, which prevents old data from overwriting new data.

PackageData.txt is the vehicle by which Index Designs distributes current package information. Placing a new copy of PackageData.txt in the C:\ BOM_Bldr directory is all that is required to update

BOM Builder with the latest package information. Index Designs libraries are specially marked and they will ALWAYS be restored from PackageData.txt. Users who wish to generate their own packages should use a $ character as the first character of the package name. This will place user packages at the beginning of the "Show All" list and keep them separate from Index Designs packages.

8.5 AOT Files

AOT (Angle, Offset and Translation) files are used to store data about how a user's PCB decals are converted to Index Designs package names. Included is information about how the XYRS data associated with those decals is positioned relative to the Index Designs package.

The construction of AOT files is semi-automatic, as new user PCB decals are encountered during the reading of XYRS or IPL data. As a user assigns a package name to a line item, that package name becomes associated with the PCB decal for that line item. During checking, an operator might position and/or rotate the package graphics in preparation for machine placement. All these Angle, Offset and Translation parameters are saved in a local database and this database is eventually saved to an .AOT file. Whenever a new part with a known PCB decal is accepted, these AOT translations can be applied via a manual or automatic means.

The "Save Package Map to AOT" and "Apply AOT File to BOM" functions in the main menu's PACKAGE menu are the manual means for controlling AOT data. In each case, the user is prompted for an AOT file to use for transfer.

Automatic AOT logic is controlled by two .ini file variables and the .AOT filename specified in the BOM Options Alignment Table field. The two .ini variables are AOTEnabled and AutoAOT. Both are boolean variables (0 or 1) and they function as follows.

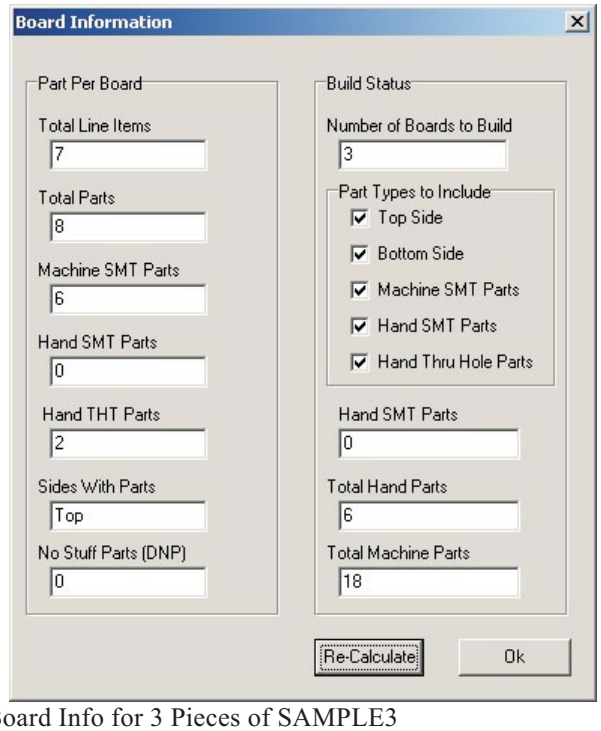
If AOTEnabled is 0, then all automatic AOT logic is disabled. This is very useful for a service organization where a number of different .AOT file must be maintained. When disabled, operators will never receive messages about missing AOT files or prompts about saving AOT data. This setting simplifies BOM Builder operation, requires manual processing of AOT data.

If AutoAOT = 1, then a single AOT filename will be used and most AOT file prompts are eliminated. When a BOM is closed and new AOT data exists, the user will be prompted about saving AOT data. This is the default mode for BOM Builder. These settings are appropriate for individual engineers who always work with a single PCB design tool and set of PCB decal libraries.

When AOTEnabled = 1 and AutoAOT = 0, then full scale AOT logic is active. AOT files are read as BOMs are opened, and the user is prompted if files are missing or if AOT data must be saved. This is an Expert mode designed for service organizations who must deal with many PCB designers and libraries and who generate all the AOT files in house.

8.6 Board Information

The main menu's BOARD - BOARD INFO function gives the user a quick overview of line item counts, part counts and the relative difficulty of board assembly. A multiplier is included that allows total part counts to be evaluated. The lefthand side is a display of various counts while the righthand side allows selection of quantities of boards and part types to mount.



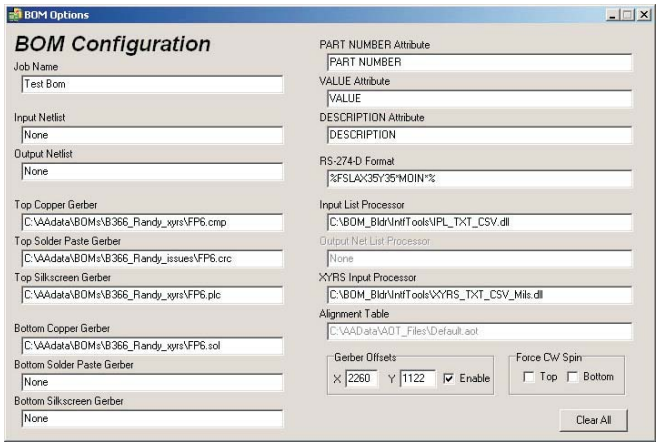
Board Info for 3 Pieces of SAMPLE3

In the above example, three pieces of SAMPLE3 are to be built including all SMT and Through Hole components. The total number of machine-placed parts is 18, and the total number of hand-placed parts is 6.

Several reports will cause the Board Information screen to be displayed prior to running the report. This gives the user a chance to set the Number of Boards to Build field, which is then used as a multiplier for part totals.

8.7 BOM Options

A BOM Options window is used to configure various parameters associated with a single BOM. This window is accessed from the main menu using EDIT - BOM OPTIONS.



BOM Options Screen

Use a double-click on any of the file name fields to open a file selection dialog.

The top line allows the user to enter a board name that will be included on all reports. This name is saved in the .bmb file with all other BOM parameters and is restored when a .bmb is read.

Input and output netlist file names are used to simplify the appending of PCB decal names to PADs netlists. The BOM Builder EXPORT - NETLIST to PCB DESIGN function uses these fields as the source and destination file names. As the input file is read, the input PCB decal field for each part is replaced with the data from the BOM Builder PCB decal field. The result is an output file with PCB decals selected from a company MRP system. Using BOM Builder in this manner eliminates the need to duplicate the MRP database parts in CAD libraries. Double-click to select a different input file name.

Gerber file name fields are automatically filled in as Gerber files are selected in the Read Gerber screen. The names are displayed here for convenience. Double-click to select a different file name.

Various attribute fields allow a user to define the attribute names used to populate BOM Builder fields during PADs netlist and .asc file reading. Three BOM Builder fields, Value, Part Number and Description, can each contain a number of attribute names. If any single attribute name contains a space, then that attribute name should be enclosed by “ characters.

The RS-274-D field is used when reading RS-274-D Gerber files. Note that aperture files are read using .dll libraries. See file Gerb_Apertures.txt in the C:\BOM_Bldr\IntfTools directory for more information.

Three .dll files provide control of several input and output processes. These files are used during Import and Export as their name suggests. See the Export and Import chapters for more details. A double-click can be used to select different .dll processors.

AOT files are used to control part X/Y placement and rotation as required by a specific set of user CAD libraries. Assuming the Component Reference Points have been correctly set, an AOT file adjusts the component placements to where they become synchronized with Index Designs libraries. AOT files are automatically generated as a user corrects part placements when GROUP MOVE is enabled. See the XYRS chapter.

As Gerbers are read and aligned, the last set of alignment coordinates are retained in the Gerber Offsets box. These offsets are used during subsequent Gerber reads, which simplifies Gerber alignment. A check box is provided to disable the automatic use of these offsets. This is required when Gerbers are “centered” or otherwise ill-prepared.

A set of check boxes are provided to change the “spin direction” used in BOM Builder. These allow BOM Builder to operate properly with CAD tools which rotate in a clockwise direction. Individual controls are provided for both top and bottom sides.

9 CAD File Formats

BOM Builder supports several different CAD Tools:

9.1 Eagle

Index Designs provides a script that prepares a single file used for both
IPL and XYRS input. See file C:\BOM_Bldr\IntfTools\ Eagle_XYRS-IPL_Script.ulp

A sample output of this script is shown below:

```
Layer = Top
```

Report Origin = (0.0, 0.0)

Units used = mil

RefDes, LocationX, LocationY, Rotation, Value, Package

C1, 26.92, 13.59, 0, 6.8pf, C0402

C2, 11.83, 13.34, 270, 10pf, C0402

C3, 11.98, 9.84, 270, 10pf, C0402

C4, 20.70, 3.34, 270, 0.01uf, C0402

9.2 OrCAD Layout

The Component Insertion Report from OrCAD layout drives both IPL and XYRS
input functions. This is a standard report. A sample is shown below

****

* *

* INSERTION LIST REPORT *

* *

* E:\ORCAD\DESIGNS\myboard.MAX *

* Wed Jun 22 13:03:02 2005 *

* *

****

REF DES VALUE FOOTPRINT XCOORD YCOORD ROTATION BOARDSIDE

C8 0.1uF SM/C_0805 1800.00 m -858.00 m 270 BOTTOM

C9 22nF SM/C_1206 865.00 m -2400.00 m 0 TOP

C12 0.1uF SM/C_0805 1950.00 m -168.00 m 270 BOTTOM

C13 1nF SM/C_0805 1810.30 m 1600.30 m 225 TOP

C15 1.5nF SM/C_0805 909.68 m -2109.70 m 0 TOP

C16 4.7nF SM/C_1206 1364.03 m 1894.03 m 225 TOP

C17 0.1uF SM/C_0805 -998.00 m 1960.00 m 0 BOTTOM

C18 22nF SM/C_1206 600.00 m -1855.00 m 90 TOP

C5 10nF SM/C_1206 215.00 m 2620.00 m 0 TOP

9.3 PADs XY Location Report

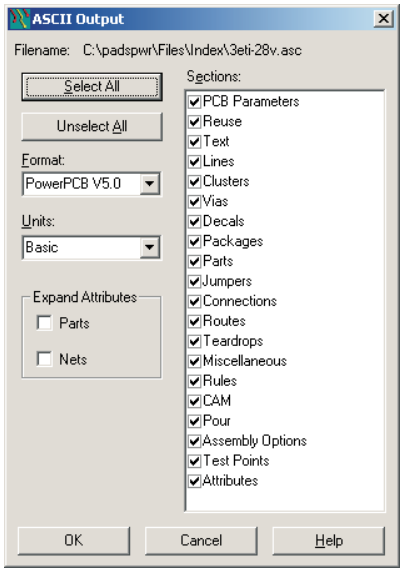
A PADs XY Location report can be generated from within PADs, using a supplied Basic script named “XY Locations”. Click on “Tools - Basic Scripting - Basic Scripts” and you will see a list of scripts. If the"XY Locations" script is not seen, click the “Load File” button and load from directory:

C:\padspwr\ole\unsupported_user_samples\XY Positions.bas

Running this script generates a “Positionsxxxx.txt” file where xxxs is some random set of digits.

Sample PADs XY Location Report:

```
RefDes      X           Y           Rot.        Exact
(FREE)    Side
C1    775.0000   1475.0000  270     EXACT    (FREE)   Top
C2    975.0000   1475.0000  270     EXACT    (FREE)   Top
JP1   325.0000   625.0000   180     EXACT    (FREE)   Top
P1    1625.0000  1000.0000  090     EXACT    (FREE)   Top
Q1    950.0000   650.0000   000     EXACT    (FREE)   Top
R1    600.0000   650.0000   000     EXACT    (FREE)   Top
R2    1275.0000  950.0000   000     EXACT    (FREE)   Top
R3    950.0000   1000.0000  090     EXACT    (FREE)   Top
```



9.4 PADs .ASC File Generation

PADs .asc files contain XYRS, Input Part List and PCB decal information. Depending on the design environment, it might also contain company part numbers. The user should always generate a .asc file when possible.

To generate a .asc file in PADs, complete the PADs ASCII Output screen as shown to the left.

Files - Export - <filename> Save

Then select the output contents and format:

SELECT ALL Format Power PCB V5.0 Units BASIC

The .asc file is generated and written to disk.

9.5 Protel

There are a large number of Protel products, and each seems to have differences. The two common formats seem to be the XYRS format and the Netlist format.

XYRS Format:

Sample Protel XYRS Report:

```
Designator Pattern  Mid X  Mid Y  Ref X  Ref Y  Pad X  Pad Y TB  Rotation
```

U5 SM/SOT-23A 4766mil 1959mil 4808mil 1922mil 4808mil 1922mil T 0.000

R12 1206 3418mil 1799mil 3418mil 1744mil 3418mil 1744mil T 0.000

R4 1206 6310mil 2462mil 6310mil 2518mil 6310mil 2518mil T 0.000

R3 1206 6490mil 2046mil 6546mil 2046mil 6546mil 2046mil T 0.000

R2 1206 6151mil 2748mil 6096mil 2748mil 6096mil 2748mil T 0.000

C4 CASE-F 7792mil 2590mil 7662mil 2590mil 7662mil 2590mil T 0.000

Sample Protel Netlist Format for Input Parts List

[

C1

PCB_Decal

Value

]

9.6 PCAD

P-CAD Format

(They seem to have the same data in two formats. The second is a .csv format.)

==========

Report Origin = (0.0, 0.0)

Units used = mil

RefDes	Layer	LocationX	LocationY	Rotation	Fixed
C1	Bottom	5787.0	5473.0	180.0	No
C2	Bottom	5857.5	5194.5	0.0	No
C3	Top	5934.0	4595.0	180.0	No
C4	Top	5934.0	4938.0	180.0	No
C5	Bottom	6934.0	4821.0	270.0	No
C6	Bottom	7188.5	4726.0	90.0	No
C7	Bottom	5877.5	5567.5	0.0	No

The second format is shown below. The Value field has been generated such that it will contain the schematic Value attribute or Part Number. Many designers will use the Value attribute for passives, and the Part Number attribute for IC-type devices. IC-type devices often have a blank Value attribute. A script that substitutes the Part Number if the Value is blank, helps to provide BOM Builder with consistent data about parts.

```
Report Origin = (0.0, 0.0)
```

Units used = “mil”

“RefDes”,"PatternName","Type","Value","Layer","LocationX","LocationY","Rotation"

“C1”,”RC0805","CAP0805","0.33uF","Top","8500.0","3545.0","90.0"

“C2”,”CAPTANTC","CAPTANTC","15 uF 10V","Top","7946.0","3424.0","270.0"

“C3”,”RC0603","CAP0603","0.1uF","Top","5430.0","3800.0","180.0"

“C4”,”RC0603","CAP0603","0.1uF","Top","5375.0","3905.0","270.0"

“C5”,”RC0603","CAP0603","0.1uF","Top","8065.0","2695.0","90.0"

“R1”,”RC0805","RES0805","DNI","Top","7345.0","3405.0","0.0"

“R2”,”RC0805","RES0805","50","Top","5705.0","3350.0","180.0"

“R13”,”RC0805","RES0805","331","Top","3495.0","1525.0","0.0"

“U1”,”PWP-20","TPS767XX","TPS76733","Top","8243.0","3465.0","180.0"

“U2”,”SOT223-5","REG103G","REG103GA-5","Top","5600.0","3975.0","270.0"

“U3”,”SOT223-5","REG103G","REG103GA-5","Top","8250.0","2525.0","180.0"

“U4”,”TQ144","XC95288XL-TQ144","XC95288XL-TQ144","Top","6494.7","3205.5","0.0"

9.7 Ultiboard

“Ultiboard Information Export File”

“Design Name : LEDModule(LEDModule) - Parts Centroids”

“Report Date : 12 September 2005"

“Report Time : 10:40"

“_____”

“REFDES”,"VALUE","SHAPE","X_CENTRE[nm]","Y_CENTRE[nm]","ROT","SIDE","TYPE"

“C1”,”100pF","C0603","53238400","36118800","0","TOP","SMD"

“C2”,”100nF","C0603","32052000","108534200","90","TOP","SMD"

“C3”,”100nF","C0603","42516800","108534200","90","TOP","SMD"

“C4”,”100nF","C0603","48793400","6096000","270","TOP","SMD"

“C5”,”100nF","C0603","42824400","9067800","0","BOTTOM","SMD"

“C6”,”100nF","C0603","63601600","23114000","270","BOTTOM","SMD"

9.8 Graffy

In the PCB layout module, File -> Export -> Archive generates the PCB archive file .

$$ GRAFFY Technical Graphics Editor

$$ Revision : W.11.06

$$ Archival Date (M/D/YYYY) : 9/18/2006

$$ Archival Time : 8:36 AM

UNITS INCH,10000;

LOCK 45.0000;

GRID 0.0250,2 0.0000,0.0000;

9.9 Allegro

The Cadence Allegro export functions produce files using a semicolon as a field delimiter character. There is one set of fields for the Input Parts List and another for XYRS information. XYRS info is in mils (1/1000 inch).

Parts List:

```
PartNumber;Description;Package;RefDes
```

10MQ100N-ND;International Rectifier 100V 1.5A Schottky SMA;SMA;D3

160-1435-1-ND;Lite-On Inc Green LED 0603 80mCandela LED;0603_LED;D2,D1

240-1018-1-ND;FB 0805 500mA 600 Ohm Ferrite Bead;0805; L18,L17, L16,L15

296-14174-5-ND;TI OPA569 Power Amplifier, R2R 2A;TSSOP20;U6,U8

296-17549-ND;TI Dual 14bit D/A Converter;TQFP48G;U18,U17,U16,U15

296-17730-1-ND;TI THS4509 Diff. Amp.;QFN16;U30,U29,U28,U27

XYRS Information

```
RefDes;PartNumber;X;Y;Rot;Side
```

U22;296-17999-ND;1173.57;4236.72;180.000;Back

U21;296-17999-ND;2270.00;4780.00;180.000;Back

U20;296-17999-ND;4690.00;4780.00;180.000;Back

U19;296-17999-ND;5615.00;4245.00;180.000;Back

C49;399-3098-1-ND;840.00;1420.00;180.000;Top

C40;399-3691-1-ND;6150.00;2755.00;0.000;Back

C216;495-1509-1-ND;780.00;4540.00;270.000;Back

9.10 Proteus

Proteus XYRS files have the following form:

```
LABCENTER PROTEUS PICK AND PLACE FILE
====================================
```

Component positions for G:\mydir\myfile.LYT

Fields: Part ID, Value, Package, Layer, Rotation, X, Y

Units: Rotation - degrees, X, Y - thou

Notes: The X, Y value is the centre of package as drawn in ARES.

The origin for these values is the Output Origin.

The values are a guide only and must be checked manually when setting up automatic insertion equipment.

“U1",”LT1366","SOP8.225",TOP,270,-3962.5,2025

“U8",”LT1366","SOP8.225",TOP,270,-3962.5,1625

“U13",”LM4120","SOP_23_5",TOP,0,-4055,542.5

“C18",”1.0uf","0805",TOP,0,-3907,595

“C19",”0.1uf","0805",BOT,0,-3842,735

“R25",”54.9K","0805",TOP,270,-3750,1992

10 Package Names

A key component in the BOM Builder software environment is a library of electronic component packages. There are two major purposes for these packages:

- *Present the user with a graphic image of how the packages will fit on the final PCB.*
- *Set up programming data for pick and place equipment.*

When constructing a new a BOM, previously used parts can be assigned a package name automatically while new parts must be assigned a package name manually. In order to locate and select the proper package name for a new part, a description has been assigned to each package as a search aid. In addition to the description, the package name is formed in a manner which helps to identify package style and key dimensions.

A package search engine is provided to assist with locating packages in the package model database. Package descriptions include information about overall shape, important dimensions, and appropriate functional information. The search engine takes user inputs and finds packages with matching descriptions.

Before creating new packages, carefully study existing packages. Observe how packages are named and study their descriptions. Careful checking might identify an existing package that matches a new part, or a similar package can be used as a starting point.

10.1 Package Descriptions

Every package in the PackData.mdb package model database includes a description. These descriptions feed the “search indexer” which allows these packages to be “found” as users search using known package parameters. A key point to remember is that “packages” are not “components”. An SOIC-14 package could be a resistor network, analog IC or a transistor array. A pick and place machine does not care what is inside a package, only the dimensions and pin locations are important.

The first portion of every package description is the “style” and pin count. Style must be VERY CAREFULLY defined. Industry standard names (if there are any) for many packages use ambiguous names. Packages like SOIC, TSOP, SSOP are all GULL WING style devices. All packages with leads on two sides which come out and then down are named Gull Wing. The search engine will resolve most common names for these devices to Gull Wing packages.

After the initial style characters is a pin count, at least for most components. Some package styles imply a fixed number of pins, so pin counts are not included, for example in an 0603 package. If a common package does have a different number of leads, then include the pin count in the name and description. For example, some filter components come in 0805 packages, but with 3 leads. This description should include “3 pins” and the name will include a -3L

At the end of the description, include SMT or THT to help identify the assembly style of the package. A package with a single SMT-type lead is SMT. Only packages with all THT leads are THT packages.

10.2 Package Name

While BOM Builder includes a package search engine to assist with locating packages, most CAD library tools only provide an alphanumeric sort on decal (footprint) name. BOM Builder also provides a similar sort based on package names. For this reason, package names should be VERY CAREFULLY chosen.

The most important step in defining a package name is knowing the package “style” and reviewing how existing packages of that style are named. To help with this process, the following sections describe the existing package styles in the BOM Builder library.

10.3 Dimension Convention

The BOM Builder Package Editor, PackEdit (note: as of 2018, PackEdit has been made a standalone Windows application, but is still callable from within BOM Builder) uses a simple but powerful scheme to define units. Any length dimension without a decimal point is considered as in mils (1/1000 inch). Any dimension with a decimal point is considered as mm.

When naming a package, use this convention. If a package is primarily defined in metric, use mm. Otherwise, use mils. Be consistent.

10.4 Gull Wing & QFP

Packages with leads which stick out from the body on two sides are called Gull Wing (GW). If leads stick out on 4 sides, then the package is a QFP. Industry names like TQFP and VQFP are all considered as QFP style packages. SOIC, TSOP, SSOP, SOP, MSOP are all Gull Wing packages.

Gull Wing packages are named with a "GW-" followed by the number of pins. For pin counts less than 10 add a leading zero. Following the pin count is the pin pitch followed by "width across leads". For example, a standard 8-pin SOIC is a **GW-08-50-240**. This device has 8 pins, 50 mil pitch and is .24 inches from lead tip to lead tip. The description for this part is:

Gull Wing 8 Pin .05 inch Pitch .24 Wide SMT

QFP packages use an aaaaXbbbb notation to indicate the X Size (aaaa) and Y Size (bbbb). For example, a 144 pin QFP with .5mm pin pitch is named **QFP-144-.5-22.0X22.0** and the description is:

QFP 144 Pin, .5mm Pitch, 22mm x 22mm SMT

10.5 Industry Standard Styles

Deciding on which package names are industry standard is very difficult, as no two people in the industry seem to have the same standards. Still, there are a few standard names. Style names like SOT, BGA and SOJ are quite common, though additional parameters are required. Diodes names like SMA, SMB and SMC are probably the most well-defined names, while names such as SOIC and TTSOP could mean lots of different packages.

Another set of "industry standard" names are the numeric chip type components. Examples are 0603, 0805 and 1206. The descriptions for these contain both the inch and metric names. Several of these have 3 or 4 leads. Their names include a -3L or -4L at the end.

10.6 BGA, Connector, SOJ and PLCC

In general, these are straightforward in naming. All parts start with the style, pin count, and pitch, followed by size. SOJ are like Gull Wings in that they have leads on 2 sides, except they bend in and under the part. PLCC parts are like QFP parts in that they have leads on 4 sides. PLCC parts are like SOJ packages in that leads bend down and under, forming a "J" lead.

Sockets are connectors. A socket for a PLCC component has totally different dimensions than the PLCC component it accepts. When placing a socket at a location, be sure to select a socket for the device, as sockets take more room and this could offer a surprise during assembly.

10.7 LCC, LCQ and QFN

All these packages are leadless where their leads are flush with the bottom of the package. These packages offer a unique set of assembly challenges. LCC packages have leads on two sides or have 4 pins where the 4 pins are in the corners. LCQ parts have pins on 4 sides. QFN packages have leads on 4 sides and they include a thermal tab. QFN parts are singled out, as they require special assembly processing.

10.8 Inductors

Inductors come in a wide variety of strange shapes and sizes. Inductors use IND as the style followed by pin count if the pin count is greater than 2. Pin pitch is included if it is obvious, and finally the X and Y size is included. See the current package library for examples of inductor names.

10.9 Functional Names

While the idea of naming packages is to avoid including functionality, sometimes it is the best solution. Examples of such names include:

- *LED Led packages are all over the spectrum.*
- *SW for switch. Highly unique. Many SW devices cannot be machine mounted.*
- *CAP Some capacitors have unique and industry standard packages.*
- *RN Chip resistor networks. Many sizes that are unique to this electrical function.*
- *TP Test points*
- *XFORM Transformers have unique size, pin styles and thickness.*
- *XTAL Crystals and Ceramic Resonators*

Try to avoid functional data in names. Place functional information in descriptions, which is general in nature. Component part numbers like LM555 or 4N35 should rarely be contained in package names of descriptions.

11 Keyboard Shortcuts

BOM Builder incorporates a number of keyboard shortcuts in several different screens. These key codes are used to reduce BOM coding effort and to control special functions.

11.1 Main Tree Screen

The main tree screen must be the window with focus for the following keys to function. The function is applied to the part or parts identified in the Line Item Editor area.

- *F5 Toggle STUFFED Status*
- *F6 Set Machine SMT Status*
- *F7 Set Hand SMT Status*
- *F8 Set Hand THT Status*
- *ESC Clear Line Item Editor Area*
- *^F Open Part Search Screen*
- *^Z Toggle Auto Zoom Mode*
- *^E Launch Windows Explorer*

The Part Search screen allows the user to search on either a reference designator or general text. Text search will display a number of line items in the lower screen area. A left-click on these items will adjust the main tree's cursor position to the selected item.

Auto Zoom is a feature which allows rapid inspection of part placement. When Cntl-Z is pressed, Auto Zoom will toggle on and off. When it toggles on, a beep is generated as confirmation. When the Assembly View is displayed, Auto Zoom will force the Assembly View to the proper zoom and center for displaying the details of part placement. As subsequent parts are selected in the main tree, the zoom and center will be automatically adjusted to show these parts. Auto Zoom is automatically disabled if the user does a manual zoom (Page Up or Page Down) in the Assembly View window. Another Cntl-Z will turn Auto Zoom back on.

Pressing Ctrl-E will launch Windows Explorer. The directory opened will either be the default BOM directory or, if a .bmb file is loaded, the directory where that .bmb file is located..

11.2 Read Gerbers Screen

Several keys are used to modify the Gerber image view and data.

- *Page Up Zoom In*
- *Page Down Zoom out*
- *Home Zoom to show all data*
- *Insert Center to current mouse position*

The Delete key will delete the currently selected Gerber shape. Shapes are selected using mouse clicks and they are highlighted when selected. The remaining keys allow the user to zoom and pan in the graphic display.

11.3 Pick A Package Screen

Several keys and mouse buttons allow the user to preview how a component will "fit" on PCB Gerber images before a final package is selected.

- *ALT [SHIFT] Arrow Up Down Left Right*
- *ESC Clear GREEN Preview*
- *CTRL Right Click*

Whenever a Package is selected in the Available Packages area, and the Assembly View screen is open, the currently selected main tree item is displayed using the Pick A Package selection. This display is only a temporary display, so it is shown in GREEN to indicate the difference from a normal package display. Normal package assignments are always shown in red or blue and never green. This display allows a user to see now alternate packages might fit on the user PCB image.

ALT-arrow keys can be used to adjust positions. Positions are adjusted my 1 mil (25.4 um) for each arrow key hit. If the Shift key is pressed with the ALT key, movements are in 5 mil (127 um) steps. These adjustments are only temporary. They are discarded when the green package is removed.

A right-click with the mouse on an Available Package will cause the displayed GREEN package to rotate by 90 Degrees. Again, this rotation is only temporary. Final rotations require XYRS data and/or adjustments in the Assembly View screen.

11.4 Package Editor Screen

Several keys are used to control the generation of new packages:

- *Page Up Zoom In*
- *Page Down Zoom Out*
- *Home Zoom to show all data*
- *Insert Pan and Insert Pin control*

Insert will center the graphic screen at the current mouse pointer unless the user is adding a pin. When Insert Pin mode has been selected, the Insert key will cause a new pin to be inserted at the current mouse location. The size and shape of this new pin is copied from the pin selected when the Insert Pin mode was initiated.

The Page Up, Page Down and Home keys provide control over the zoom and pan of the displayed graphics. These function as in other graphic windows.

11.5 Assembly View

Assembly View has the most complicated set of keyboard commands as compared to other BOM Builder screens.

- *Page Up Zoom In*
- *Page Down Zoom out*
- *Home Zoom to show all data*
- *ESC Clear current special modes*
- *Various Mouse Clicks*
- *ALT [SHIFT] Arrow Keys*
- *^B Set Board Outline*
- *^P Set list of Ref Des for manual placement*
- *^R Adjust Component Reference Point*
- *^C Copy screen graphic to clipboard*
- *F5 Toggle STUFFED Status*
- *F6 Set Machine SMT Status*
- *F7 Set Hand SMT Status*
- *F8 Set Hand THT Status*

The Page Up, Page Down and Home keys are similar to these functions in other screens. These keys allow the user to zoom in and out and control the graphic display.

The ALT-arrow keys (with the option of Shift) serve two functions. The normal mode is used to adjust the position of the currently selected part. Parts are selected using a left-click and the selection data is shown on the screen upper left. Using ALT-arrow keys, this part can be repositioned in 1mil (25.4 um) steps. Including the Shift key changes this to 5 mil (127 um) steps. While most placement is done using XYRS data, these keys allow fine tuning of placement data.

During Adjust Component Reference Point mode, which is entered using Cntl-R, the arrow keys adjust the XY placement reference point. The final effect is that all parts move relative to the Gerber image. Normal movements are 1 mil while the Shift key provides 5 mil (25.4 um and 127 um) moves.

The Cntl-B key is used to start Board Outline mode. In this mode, the user can click on Gerber items to select the XY points of the board outline. The Backspace key can be used to remove previous points.

To support documentation requirements, the Cntl-C key will copy the current graphic image to the Windows clipboard, which allows the image to be incorporated in emails, reports or other desktop applications.

While most components will be placed using XYRS data, there are occasions where parts are placed by hand. To simplify this task, the Cntl-P key allows the user to specify a sequence of parts, by reference designator, to manually place. This allows the user to concentrate on a single area of the board and complete all the components in that section. Parts from the list will be “cycled” to the graphic cursor using the ESC key.

The F5-F8 keys provide the same functions as they do in the main tree screen. The currently selected Assembly View part is changed according to the key pressed. The ESC key will cancel any current command and deselect any current modes. If there are additional parts in the Placement List (Cntl-P function), then the next reference designator in that list will be used, and that part’s graphic will be attached to the cursor for placement. Various mouse clicks are also used to adjust component positions. Please see the XYRS chapter for these functions.

12 INI File Variables

BOM Builder maintains a number of configuration setting in file BOM_Bldr.ini located in the c:\BOM_Bldr\Data directory. There are three major sections:

- *Forms: Size and locations of forms.*
- *Files: List of previously opened files.*
- *Defaults: Many system wide parameters.*

When BOM Builder is opened it reads the INI file and saves setting in memory. When BOM Builder is closed it re-writes the .INI file. If sections of the INI file are deleted before it is read default value will be used and these default value will be written. This is especially useful if a form becomes positioned off screen and can not be manually repositioned. Simply delete the forms section from the INI file and defaults for all form positions will be re-established.

12.1 Parameter Definitions

PV_File	Location of Parts & vendors database
PCBPath	Dir of default PADs directory for PCB Designs.
AOTEnable AutoAOT DefaultAOT	Used to enable AOT processing and, if so, if automatic AOT processing is used the DefaultAOT names the file.
GerberFormat GerberRotate	Initial gerber format in 274-X format. Default Rotation.
PartTypeFile	File used to relate Ref des letters to a part type name.
IPL_FileName XYRS_Filename MRP_FileName ONL_Filename	Defult file names for .dll processors and MRP input data.
DescAttributes ValueAttributes PartNumAttribute	Each is a list of PADs “Field Names” used to form Desc., Value and Part Number.
ColorPrinter	Used to alter printing colors
MRPDataDate DecalDataDate	Time stamps used to detect changing Package Data and MRP Data.
LibUpdateDir	Default directory used to distribute Package and MRP Data. These are “Sniffed” for new data each time BOM Builder is started.
StartupCount	Tracks count of program starts.
KitLabelYOffset	Used to center printing of assembly kit labels.
PrintEmptyPages	Used to control printing of Top or Bottom when no parts are detected on that side.
ForceCWTop ForceCWBot	Set default spin direction for XYRS imports.
DefaultPinter	Last Printer Selected
IgnoreAbsentParts	Disables warning messages about non-stuffed parts.
AutoAsmView	Auto. Open of Assembly View
AutoAsmNotes	Auto. Open of Note Files