Parts Collaboration within The Sunstone ECOsystem℠: PCB123™, LiveBOM™, Digi-Key® & NXP®

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Abstract

Sunstone Circuits' technological collaboration with Digi-Key Corporation and NXP Semiconductor provides Sunstone PCB123 CAD users access to ready-made, certified parts symbols from NXP. Not only is sufficient information provided to ensure accurate physical design, but the collaboration also ensures efficient design with component availability and pricing information. Within the Sunstone ECOsystem℠, these new functional elements provide the end user with a turn-key level of convenience and accuracy, even when working on prototypes and early engineering projects.

Background

In August 2008, IPC made the assertion that 75 percent of the impact on the manufacturability and profitability of a board design occurred in the *design phase*; only 25 percent of the potential impact to make a design profitable takes place after the design is complete. In a survey of PCB designers administered by Sunstone Circuits, the typical prototyping PCB designer spends about 30 percent of the design process managing parts data[1], including searching for the right parts to use.

The process roughly follows this task flow:

1. Identify parts that fulfill the requirements needed (specification).
2. Select the best part, based on pricing and availability (lead time).
3. Identify (or choose) the physical packaging for the part.
4. Determine alternate sources for the part.
5. Find/create a schematic symbol for the part.
6. Find/create a PCB footprint for the part.

[1] For smaller design teams, the percent of time spent managing parts data can be significantly higher.

From the perspective of the IC manufacturer, its role has been to assist the first three steps by providing technical and sales information.

From the perspective of the parts distributor, its role has been to assist with final parts selection and to deliver the actual parts. This means distributors typically assist with steps two through four.

And from the perspective of the PCB CAD vendor – of which Sunstone's PCB123 is one – traditionally only the last two steps warranted attention as the first four have been beyond the scope of the CAD vendor's control.

Not long ago, all this was absolutely true. Parts were sourced in books, magazines or even inventory lists. They were ordered in bulk directly from the IC manufacturers who sometimes required months of lead time before delivery. Many companies would restrict their engineers to using parts the company inventoried and only as a last resort would they embark on the strategic task of inventorying a new part. Also during this era, EDA design tools were typically available only to engineers in the largest electronics design companies. These companies were able to dedicate engineering resources solely to the process of defining, maintaining, and distributing an enterprise-level parts library. And, as a result, traditional EDA software houses built library management tools to support this enterprise-level data management.

The trouble was that while EDA software houses could have moved parts information effectively by collaborating with IC manufacturers and parts distributors, the return on investment was notoriously not worth the effort involved. The result has been ineffective transfer of information whenever a handoff occurs from one supplier to another. The return on investment for vendors has changed, making the availability of parts information throughout the design workflow more feasible.

How the Shift Happened

Looking back, this problem was partially mitigated by parts distributor houses that began maintaining inventoried electronic parts from different manufacturers and reselling them for immediate delivery. The distributors essentially absorbed the lead time from the manufacturer and became a one-stop shop for engineers. The earliest distributors, however, preferred to sell in large quantities and didn't necessarily stock parts from every manufacturer.

Digi-Key Corp., leveraging with the now-ubiquitous Internet, took electronic parts distribution to its maximal conclusion. Digi-Key did this by stocking the entire component product lines of nearly all the major manufacturers. Furthermore, it placed no restrictions on order quantities. If you want just a single resistor, Digi-Key will ship it to you. They made a huge investment in automation to support this sales model.

Knowing that engineers like to read books and hold things in their hands, Digi-Key still produces a thick parts catalog for the industry. However, it's their Web site that serves as a major on-ramp for gathering part specifications and, certainly, for placing orders.

In fact, distributors (especially Digi-Key) have usurped the role of the old company parts inventory. It is general knowledge that PCB designers typically work with a parts Web site

(often Digi-Key) open in a browser alongside their CAD tool, researching as they go.

It was to that end that Digi-Key launched their Web-query access interface in 2008, making it technologically possible to include the inventory and pricing information from Digi-Key's Web site database into the PCB CAD tool environment itself.

What remained missing was a PCB CAD vendor to support the full Digi-Key catalog through a mechanism linking the Digi-Key part numbers to their symbols/footprints and to provide a Bill of-Materials that easily converted into a Digi-Key order form. Such a partnership would provide highly useful functionality for designers and bridge the gap in the existing design process.

Bridging the Gap

Closing the gap has become the specialty of PCB123, a distribution PCB design tool that bridges the gaps between price/performance and between the processes of PCB design and manufacturing. PCB123 is a full-featured PCB design tool distributed at no cost and without licensing fees. In addition to normal schematic and layout editing roles, PCB123 also performs four key additional functions:

1. Performs real-time DRC checks against a comprehensive set of design rules tailored to the Sunstone Circuits manufacturing processes.
2. Provides an autoplacer, autorouter, and net rules (possible because PCB123 includes a single database that supports both layout and schematic).
3. Presents a real-time fabrication quote for the bare board manufacturing (visible in the upper-right corner of the application window).
4. Allows users to electronically submit orders to Sunstone Circuits once completed via the ORDER button next to quote window.

This seamless integration of schematics and layout with PCB123 Version 3 connects logical and physical design. PCB123 V3 now includes a part taxonomy database that allows for a rich electronic parts information model to be overlaid on an efficient organizational structure. The taxonomy frees engineers from having to learn the library structure of yet another CAD system and includes tools, such as a search engine, for efficiently accessing and creating parts.

Besides being able to search by manufacturer or Digi-Key part number, engineers can search by criteria, including compound terms such as: "4.7K, 1%, 0603". By mapping to the Digi-Key part numbers, engineers can find parts based on virtually any criteria, check on part pricing and availability, and even order parts directly within PCB123.

The Next Step

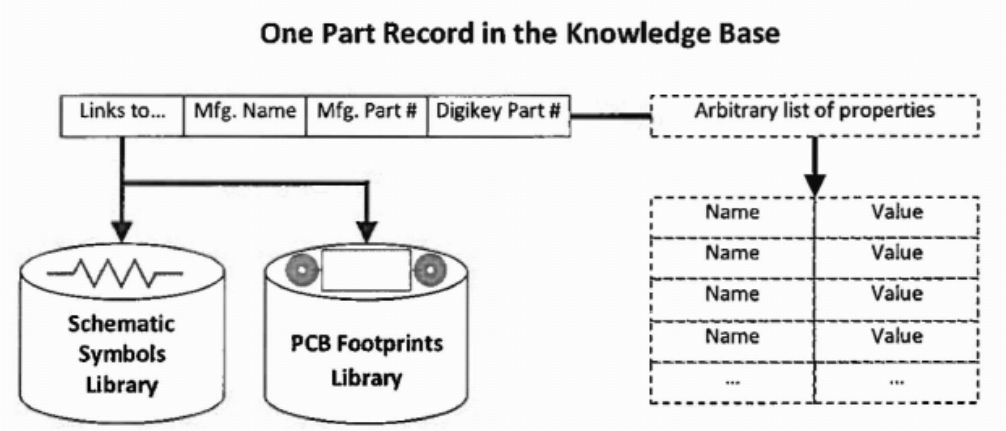
If a semiconductor manufacturing company, such as NXP, embraced this new design dynamic as implemented in PCB123 and developed a comprehensive parts library including both manufacturer and Digi-Key part numbers, it would be seeding the PCB123 design environment with a powerful data set: a complete manufacturer's catalog, with symbols, footprints, and sufficient information to fully implement a LiveBOM query to Digi-Key.

PCB123 users would be able to use ready-made parts, from a known-correct and certifiable

source, with sufficient information to ensure accurate physical design and efficient design through accessible component pricing and availability information.

Applying the Information

The LiveBOM functionality, driven by certified correct, completely defined design symbols and working in concert with online parts information and ordering from Digi-Key, now delivers a turn-key level of convenience even when working on prototypes and early engineering versions.



Data requirements

The above diagram shows what is required to describe a part. Here is a breakdown of the fields:

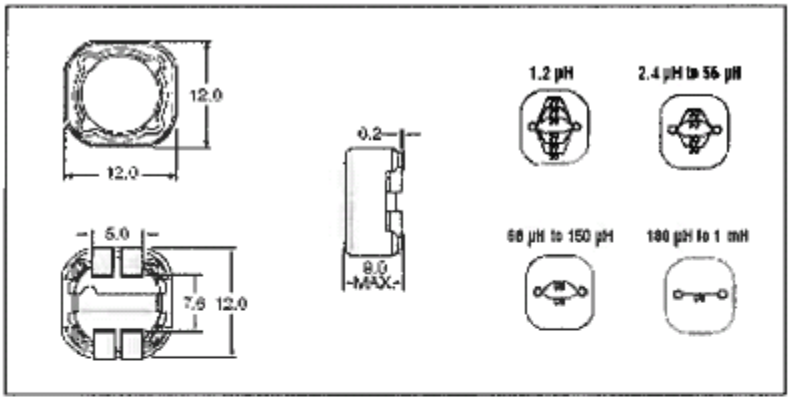
- **Links to...** - PCB123 has a schematic symbol library and a PCB footprint library. These libraries contain the actual graphic symbols that are manipulated in a design. For a part to be useful, it needs to point to the correct symbol to use in the design view. The links consist of the symbol name and the symbol library containing the symbol, the footprint name, and the library containing the footprint.
- **Mfg. Name** - The name of the part manufacturer. NXP, for example.
- **Mfg. Part #** - The manufacturer's part number. The manufacturer's name and part number are the primary keys for part records. Engineers may use Digi-Key to purchase a part, but they uniquely know the part by its manufacturer part number. The NXP parts library includes all NXP parts by part number making searching by part number feasible.
- **Digi-Key Part #** - The corresponding Digi-Key part number for ordering the part. Like the manufacturer part number, this field creates a parts search capability that empowers the user to quickly find a part in the library by reference.
- **Arbitrary list of Properties** - Different parts have different electrical or mechanical characteristics that engineers may be interested in. For instance, resistors have a

resistance value, value tolerance, and power rating. These can be specified using name/value pairs such as Value=2.4 ohms, Tolerance=l%, Power=1/4W.

Where the Data Comes From

The table below was taken from the Digi-Key catalog. It shows a line of surface-mount power inductors by a manufacturer. The parts information provides a drawing of the physical part dimensions, followed by a table of all the parts in the series. Unfortunately, the drawing shown is not detailed enough to use for a reference for part creation; the drawing is merely detailed enough to trigger a mental image of the part for the engineer while searching for parts. To obtain more detailed physical specifications from the component manufacturer, the user will typically visit the manufacturer's Web site (accessible through Digi-Key or the manufacturer directly).

Series CDRH127



Inductance	D.C.R. (Ω) (MAX. at 20°C)	Current (A)	Digi-Key Part No.	Cut Tape Price Each 1	10	100	Tape & Reel* Pricing 500	Sumida Part No.
1.2µH	.0070	9.80	308-1071-1-ND	3.05	2.78	2.07	—	CDRH127-1R2NC
3.5µH	.0135	7.50	308-1073-1-ND	3.05	2.78	2.07	774.00	CDRH127-3R5NC
4.7µH	.0158	6.80	308-1074-1-ND	3.05	2.78	2.07	774.00	CDRH127-4R7NC
6.1µH	.0176	6.60	308-1075-1-ND	3.05	2.78	2.07	774.00	CDRH127-6R1NC
7.6µH	.0200	5.90	308-1076-1-ND	3.05	2.78	2.07	774.00	CDRH127-7R6NC
10µH	.0216	5.40	308-1077-1-ND	3.05	2.78	2.07	774.00	CDRH127-100MC
12µH	.0243	4.90	308-1078-1-ND	3.05	2.78	2.07	774.00	CDRH127-120MC
15µH	.0270	4.50	308-1079-1-ND	3.05	2.78	2.07	774.00	CDRH127-150MC
18µH	.0392	3.90	308-1080-1-ND	3.05	2.78	2.07	774.00	CDRH127-180MC
22µH	.0432	3.60	308-1081-1-ND	3.05	2.78	2.07	774.00	CDRH127-220MC
27µH	.0459	3.40	308-1082-1-ND	3.05	2.78	2.07	774.00	CDRH127-270MC
33µH	.0648	3.00	308-1083-1-ND	3.05	2.78	2.07	774.00	CDRH127-330MC
39µH	.0729	2.75	308-1084-1-ND	3.05	2.78	2.07	774.00	CDRH127-390MC
47µH	0.10	2.50	308-1085-1-ND	3.05	2.78	2.07	774.00	CDRH127-470MC
56µH	0.11	2.35	308-1086-1-ND	3.05	2.78	2.07	774.00	CDRH127-560MC
68µH	0.14	2.10	308-1087-1-ND	3.05	2.78	2.07	774.00	CDRH127-680MC
82µH	0.16	1.95	308-1088-1-ND	3.05	2.78	2.07	774.00	CDRH127-820MC
100µH	0.22	1.70	308-1089-1-ND	3.05	2.78	2.07	774.00	CDRH127-101MC
120µH	0.25	1.60	308-1090-1-ND	3.05	2.78	2.07	774.00	CDRH127-121MC

In this example, one schematic symbol for the inductor, and one footprint symbol, suffices for all the parts in the table.

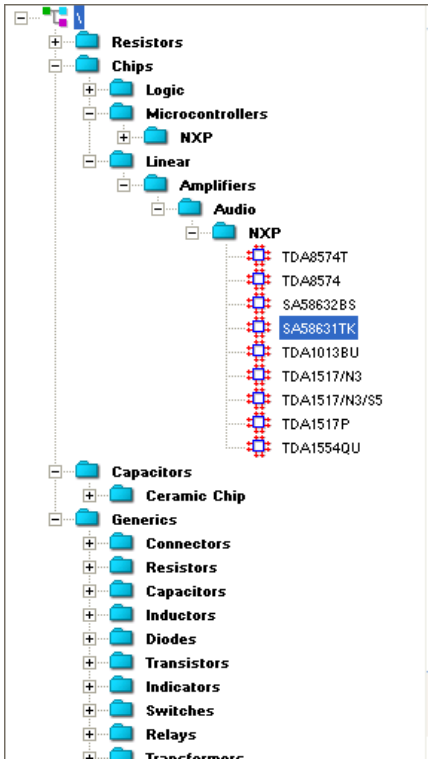
When a PCB123 user needs to create a parts symbol from scratch, PCB123's Knowledge Base Wizard (KBWizard) feature is one method for developing the part symbols. The KBWizard presents the user with a form that can be filled out which – using shorthand notation – allows for an entire series of parts to be created. The KBWizard also contains a spreadsheet view of parts that allow for tabular manipulation of the parts data.

The schematic symbol and PCB footprint can be (must be) graphically browsed and assigned to a whole series or just a select few parts. In this way, all the parts in the table can be described at once.

How the Data is organized

The PCB123 Knowledge Base is not just a flat list of parts organized in sequential fashion. Instead, the Knowledge Base employs a tree structure, called the *taxonomy*.

There is a fixed first level to the taxonomy that provides a rough categorization for parts. Within these categories, part families are created or selected in the Knowledge Base Wizard. The picture to the right shows where the parts from the above table would be created.

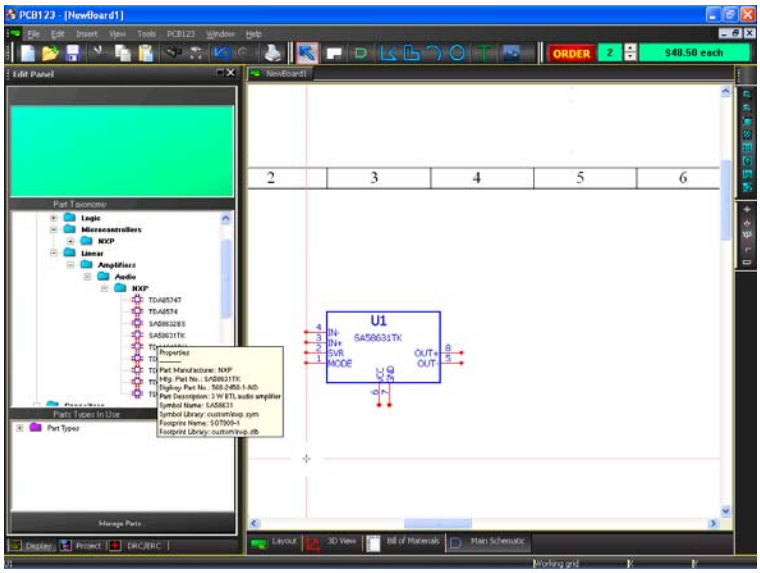


One of the benefits of organizing the data like this is to cut down on the amount of data present in the Knowledge Base. This data reduction is accomplished through *inheritance*.

Properties can be attached to any node in the tree and any part below that node will *inherit* that property. For example, the top-level Audio Amplifier node may specify the schematic symbol of all of the potential thousands of parts it should use, which will be represented in each subsequent part below. In this way, a rich and flexible information model can be specified, while keeping the data requirements to a minimum.

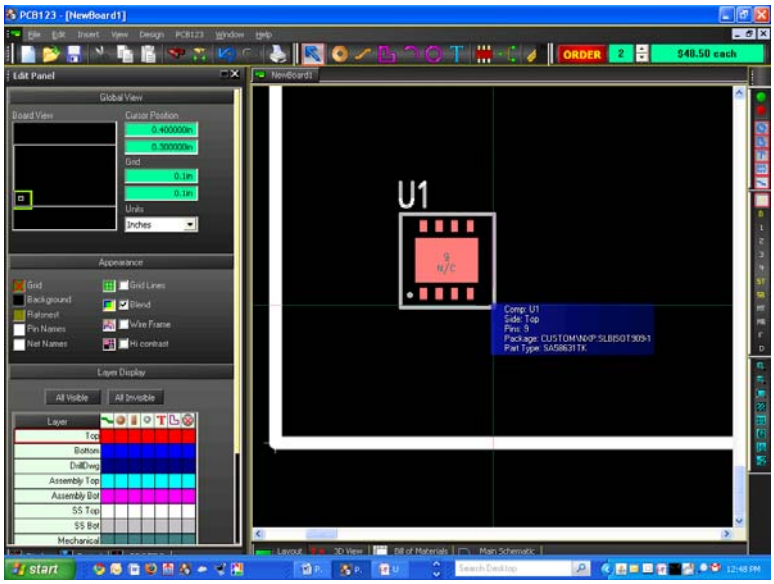
Applying the Technology to Create a Solution

The power of the component taxonomy structure becomes apparent when used in conjunction with the other functions. When the taxonomy is pre-populated with a large number of predefined symbols (both schematic and layout), such as the NXP library, and called out with either a manufacturer's part number or a Digi-Key part number, users have an innovative resource at their disposal.

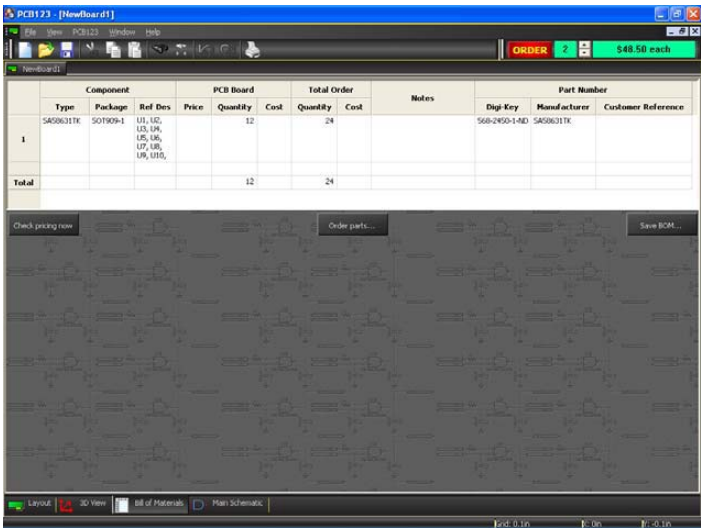


The first sample screen shot (bottom right) shows how parts from the NXP library are ready for review (parameter information presented in the tool tip) and placement on the schematic as a part of the design.

Simultaneously, the associated footprint is being placed on the layout view of the design (as seen in the screen shot below). Note that corresponding tool tip information is available from the footprint as well. Hovering the mouse pointer over the footprint exposes the blue box tool tip information. Reference designators are automatically synchronized; as the schematic's electrical network is further developed, "rat's nest" connections appear in the layout, ready to lead the user through the place-and-route process. It is worthwhile to note that, in this specific example, the part information has been reviewed and certified as correct by NXP; the user can use this part with confidence that the landing pads will match the part later, when the fabricated PCB and the component itself are assembled together.



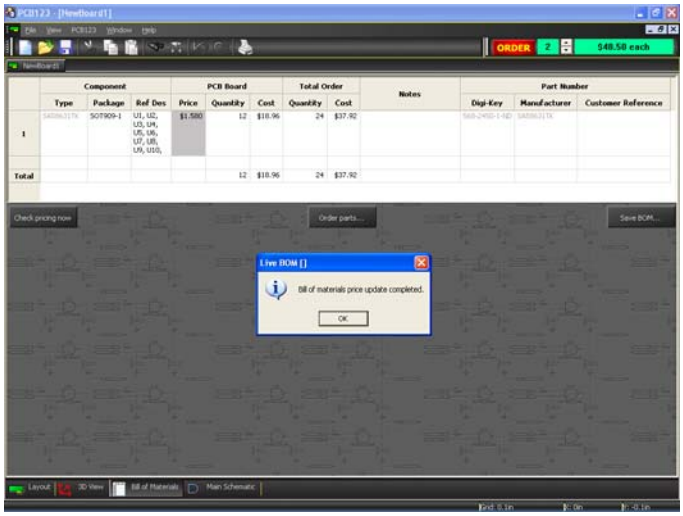
LiveBOM functionality, exclusive to PCB123, also tracks design progress with a Bill of Materials (BOM) that stays synchronized with both the schematic and the layout views. At any time, the user can select the BOM tab and perform queries on the parts currently selected by accessing Digi-Key's up-to-the-moment parts availability and pricing.



The screen shot on the right shows the LiveBOM view for this same design, after having initiated a total of 12 NXP SA58631TK audio amplifiers. In the upgraded PCB123 V3.2, LiveBOM now includes a per-piece BOM view, as well as a total-quantity rollup, based off the board quantity specified in the tool's ORDER function at the upper right-hand corner of the application window. The columns on the table are user-specifiable. The NOTES column, as well as the CUSTOMER REFERENCE column, is an open text field in which users can enter their own information. Entered information is stored with the design BOM until the user changes the contents of the field.

The Impact on Designers

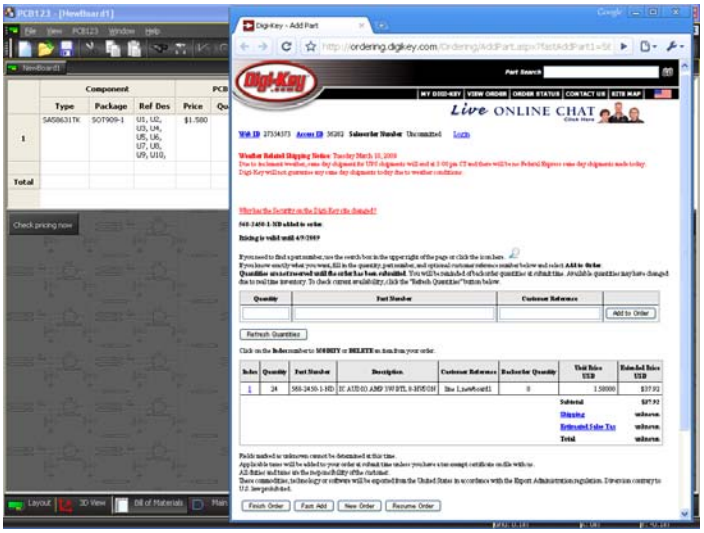
At the point that the user wishes to check pricing and availability, they simply click on the button labeled CHECK PRICING NOW, located at the bottom-left of the BOM form. The screen shot to the left shows the same BOM, now populated with the per-part pricing in a traditional BOM model. Because the user specified a board quantity of two, LiveBOM goes a step further and provides the total parts cost required to build the entire order, including any resulting quantity price breaks.



Not only can users interactively track the board fabrication costs, but they can track the design against a given budget for components.

The Impact on Purchasers

PCB123 V3.2 and LiveBOM improve communication between designers. They also improve communication between the engineering team and the purchasing department. With one unambiguous specified BOM including the manufacturer's part number and Digi-Key's part number, the purchasing department is automatically ready to issue the purchase order.



PCB123 V3.2 and Digi-Key have collaborated to further streamline the parts ordering process as illustrated in the screen shot to the right. When users select the ORDER PARTS button, PCB123 opens a browser window straight to a Digi-Key order form, pre-populating the form with the same components and quantities found in the LiveBOM Bill of Materials. Users simply click through the form, placing the order for the components necessary to assemble the specified number of PCBs.

Once the parts ordering process is complete, the boards and components can be shipped to the user separately for fabrication. Or, an assembly house like Screaming Circuits can be the recipient for both the parts order and the bare board order.

Conclusion

The collaboration between Digi-Key, NXP, and Sunstone Circuits is the result of three industry leaders realizing that design methodologies are outdated, and that by increasing accuracy and efficiency in the design process, manufacturability and profitability increase. Parts availability, pricing, and compatibility issues are now even more important to design success than traditional Design Rule checks, such as trace-and-space rules. Putting more control in the hands of designers by giving them access to high-quality parts data, symbols, and ordering/availability information, the Sunstone ECOsystem significantly reduces project turn times and thus safeguards a company's bottom line.

For more information, please visit:

http://www.SunstoneECOsystem.com

http://www.Sunstone.com