

## Product Resources Release to Manufacturing (RTM) Standards

### 1. Bill of Materials (BOM)

There are two basic types of BOMs.

- a. The Single Level BOM which describes the Material which is used on a single Assembly.
- b. The Exploded BOM which describes all the Material used on a single Product and is arranged in levels based on Sub-Assemblies.

The Bill of Material must have:

- a. Part Identification to tie the identified component to a Part Definition.
- b. Quantity
- c. Reference Designations (bubble numbers) to tie the identified component to a drawing detailing how it is placed in the product.

### 2. Part Definition.

The Part Definition describes a Component or Assembly which is used on the Product. The Part can be a Commercial Off-The-Shelf (COTS) component or a Custom component (e.g., machined, sheet metal, or molded parts, custom Printed Circuit Board Assemblies, etc.). The minimum Part Definition information that Product Resources requires is:

- a. Part Name (preferably, a number) and Description – this is necessary to uniquely identify the Part.
- b. COTS Part - Part Manufacturer (supplier is usually acceptable) and Manufacturer's Part Number.
- c. Custom Part – A Document, Drawing or set of Files which describes the Part. This could describe a sub-assembly, machined part, or PCBA, etc. See the Appendix for additional information. It is vital that these documents are revision controlled.

### 3. Receiving Inspection Requirements

If any of the procured material requires special inspection upon receipt, this documentation should describe which features need to be measured or otherwise checked for conformance. Many times, this information is part of the Part Definition and upon receipt, we can reference those documents to make measurements of the critical dimensions. In other cases, a specific inspection document is made. It would make sense that the document we use upon receipt be the same document the supplier used to ship. Once everything is running smoothly, it is easy to utilize the suppliers certification of compliance to eliminate the need for the inspection.

### 4. Assembly Documentation

The Assembly Documentation describes how the parts on the BOM are assembled into the Sub-Assembly or at the top level, the Product. The Assembly Documentation can be any combination of assembly drawings, procedures, wire run lists, photographs, datasheets, and other items that make the assembly clear.

These drawings show each component, tying the drawn component to the BOM using the Reference Designation field (also called bubble number). The Assembly drawing contains any notes required to assemble the product properly including:

- a. Assembly steps
- b. Torque specifications on fasteners (if necessary),
- c. Adhesive or Lubrication requirements
- d. Adjustments, shims required, etc.
- e. Cleanliness specifications
- f. Special Processes necessary for proper assembly and performance.

#### 5. Calibration and Test Procedures

Calibration procedures are necessary if any adjustments are needed to be made to the product. This is common in an electronic instrument, but also for mechanical alignment of parts that need precision positioning.

The test procedures detail the steps and criteria to demonstrate proper operation of the product. It can be as simple as a functional test, or as complex as necessary based on the product operation and risk plan. It should include:

- a. Setup and Equipment required to perform the testing.
- b. Test Steps
- c. Expected Operation
- d. Pass/Fail criteria

The Test Procedures also typically identify requirements for Device History Records, Serialization and Lot Numbering (if desired), application of NRTL marks.

#### 6. Production Fixtures and special tools

If there are Fixtures necessary for the proper assembly, alignment, or testing of the product, details of the Fixture must be provided. If it is a custom fixture, the fixture must be described so that Product Resources can buy it or build it. Special tools (most commonly, crimping tools) should be identified.

#### 7. Product Packaging and Ancillary Material

We consider the packaging of the product to be an integral part of the product and the top level BOM, but not everyone does it that way so here we will break it out separately. The packaging includes and cartons, crates, blocking, foam, plastic wrap, etc. If there are any special packaging instructions, include those as well.

Ancillary materials such as consumables, tools, manuals, certificates of quality, quick start guides, etc., should also be considered and outlined.

## Appendix – Custom Part Documentation

1. Machined and Sheet Metal Parts. When ordering from a machine shop, we will send both a Drawing and a STEP file in most cases.

- CAD Output – STEP file. This file will be used by the machine shops to program the shape of the part. Having a STEP file saves setup time and reduces errors.
- Drawing – the drawing is necessary to detail material, finish specifications, added components (e.g., swage nuts), critical dimensions and tolerances. It is expensive to hold all dimensions on a machined part to the tightest tolerances, but some dimensions are more critical than others. The drawing is used by the machine shop for their inspection purposes. Product Resources uses the Drawing as the definition of the part and for our incoming inspection.

### 2. Molded Parts:

Molded parts have couple of steps to their manufacture. First the tooling must be made for the mold. The tool maker will need:

- CAD Output – STEP file. This file will be used to generate the tooling for the parts. The tool maker will modify the mold to fit the process equipment the supplier will use to manufacture the part.
- Drawing – the drawing is necessary to detail material, inserts, over-molding requirements, color and texture specifications, critical dimensions and tolerances.

The first articles generated from the mold will be used to validate the mold for production. It is generally a two-step process, first to get the dimensions and performance correct, then to apply the finish texture to the part.

The part manufacturer (molder) will require a Drawing detailing the critical dimensions, finish, warp and twist specifications, and any inserts to be added. Product Resources uses this drawing (which may be different from the drawing the tool maker used) as the definition of the part and for our incoming inspection purposes.

### 3. Cable Assemblies:

Cable assemblies are documented like any other assembly, calling out the material and quantity. In addition, cables usually have:

- Label requirements (each end of the cable and in the middle if necessary)
- Length requirements for wires.
- A schematic or wire run list detailing how the connections are made.
- Quality Standards (e.g. IPC-A-620 Class 2)
- Special Tooling or Test Requirements

#### 4. Printed Circuit Board Assemblies (PCBA)

The PCBA requires several files to describe both the Printed Circuit Board (PCB) itself and the components that are to be assembled onto the board. The PCB supplier will need:

- PCB Artwork files – this will be either an ODB++ file or other electronic file or a set of Gerber files detailing the “artwork” used for the PCB manufacture. The artwork usually includes files for:
  - Top and Bottom Silkscreen (if desired)
  - Top and Bottom Solder Mask
  - Top and Bottom Solder Paste
  - Top and Bottom Copper
  - Inner Layer Copper for each layer.
  - Drill file
  
- PCB Detail drawing – this document details the fabrication of the PCB including:
  - Board Dimensions. If necessary, include details on how to separate the boards in a pallet.
  - Board Overall Thickness and tolerance.
  - Copper Weight (or thickness) for each layer.
  - Internal layer separation dimensions (core thicknesses) and tolerance.
  - Hole size, tolerance, and plating requirements.
  - Material Specifications (e.g., FR4, UL 94V-0 flammability, etc.)
  - Warp and Twist tolerances (e.g., 10 mils/inch)
  - Solder Mask type, color, and tolerances (e.g., SMOBC, Green, 20 mils etch to mask registration)
  - Silkscreen type, color (e.g., Non-conductive Ink, white)
  - RoHS compliance requirements (RoHS compliance should be stated)
  - Board finish plating requirements (e.g., ENIG)
  - Board fabrication standards (e.g., IPC-A-600, Class 2)
  - Required Regulatory Markings (e.g., UL 94V-0 or UL File No)

PCB Assembly Files – these documents are for the Assembly group.

- Bill of Material with:
  - Part Description (e.g. Capacitor, 0.1uF, 35v, 0805)
  - Quantity
  - Part Reference Designation (e.g. C1, C2, C9, etc.)
  - Part Manufacturer
  - Manufacturer's Part Number (and alternates if available)
- Pick and Place file – this file will be used by automated placement equipment to position the component.
- CAD File(s) – Along with the pick and place file, the CAD file can be helpful for programming the automated placement equipment. The CAD data would be an additional file exported by PCB design software, typically in ODB++, IPC-D-365 (.ipc), or PADS ASCII (.asc) formats. These files have more detail than the Gerber files.
  
- Assembly Drawing with any notes on:
  - special components or processes (swage nuts installed, heatsink installation, wires soldered to the board).
  - Assembly Standards (e.g. IPC-A-610, Class 2)
  - RoHS compliance process requirements

5. Software – There are many different pieces of software that may be necessary for manufacturing.

These include:

- HEX or ELF files for loading into microcontrollers
- The software that loads the HEX or ELF files
- Test Software
- User Interface Software

The software varies widely with the type of product and the methods of installing that software are just as varied.

We have developed checklists for engineers to use when releasing documentation to be sure they have covered the detail and notes needed for the part. They are hardly exhaustive, but they are a good starting point. See our website [here](#).