Validation, verification, and test plans

Test plans are part of the overall systems engineering and development process. In a perfect world, you start with a set of well defined requirements, and you verify that your system meets those requirements.

This is called Verification. Requirements generally should be written in a way that they are easily verifiable. That means, the requirements should be written with the test in mind so that you don't end up frustrating the test engineers 😉

There is a similar idea called Validation. This means checking that the requirements are valid. Many projects fail because they don't have the right requirements to begin with! But we'll leave that for now.

There are four basic verification methods. Inspection, Demonstration, Test, and Analysis.

Inspection is the nondestructive examination of a product or system using one or more of the five senses (visual, auditory, olfactory, tactile, taste). It may include simple physical manipulation and measurements.

Demonstration is the manipulation of the product or system as it is intended to be used to verify that the results are as planned or expected. Think of it as more qualitative than quantitative.

Test is the verification of a product or system using a controlled and predefined series of inputs, data, or stimuli to ensure that the product or system will produce a very specific and predefined output as specified by the requirements.

Analysis is the verification of a product or system using models, calculations and testing equipment. Analysis allows someone to make predictive statements about the typical performance of a product or system based on the confirmed test results of a sample set or by combining the outcome of individual tests to conclude something new about the product or system. It is often used to predict the breaking point or failure of a product or system by using nondestructive tests to extrapolate the failure point.

For example, the requirement could read, "the board shall be purple". And we would just observe and say, "yup, it's purple", and write down that it was verified by inspection.

Remember if you don't test it…it's your opinion, not a fact.

Exercise

Let's develop the test plans that verify the radio board.

So, imagine you're making lots of parts. And you're working with a team of people who all need access to your data, and/or might be taking over testing while you're not available.

In a production environment, tests are performed by multiple people and the data needs to be accessible by people outside of the test group (like Quality Assurance, or the designers, or mission managers).

We want to take and store data in an easily accessible format, so let's create a spreadsheet to tabulate all of the test results.

Make sure it includes information about who performed the test, the date the test was performed, and the serial number of the device under test. We'll also want to indicate which requirement this verifies. Ultimately these are all usually tabulated in what's called a Requirements Verification Test Matrix (RVTM). This provides an easy way to see that all of the requirements have been satisfied. Mostly for managers who don't do a lot, but like everyone to know they're on top of things…but customers sometimes require them too.

So, Let's outline the test plan just for the eFuses on the radio board.

eFuse Test plan for Radio Board

eFuse performance requirements:

1. The 3V3 eFuse output voltage shall be X volts +/- Y volts at Z amps.
2. The 5V eFuse output voltage shall be X volts +/- Y volts at Z amps.
3. The 3V3 eFuse shall trip at X amps.
4. The 5V eFuse shall trip at X amps.
5. The maximum 5V current without tripping shall be X amps.
6. The maximum 3V3 current without tripping shall be X amps.
7. The 5V_Current output shall be calibrated over the expected operating range of currents.
8. The 5V_Current output voltage shall be within the A/D limits of the SAMD21 processor.
9. Each eFuse shall operate within manufacturer specified dissipation limits over the expected operating current range and expected operating temperature range.
10. The eFuse overcurrent signals shall not exceed 3.3V (to protect the SAMD21).
11. More?

Other potential requirements:

1. Workmanship standards (IPC, NASA, etc.)
2. Manufacturing standards (for PCBs)
3. Thermal limits. Verify that the system works over the expected operating temperature range.
4. Reliability tests. Verify that the system can be expected to work over its operational life. See Environmental Stress Screening. Generally, this means operating the system over a temperature range, with on/off power cycling.
5. Anything else? (What about shock and vibration? any mass limits? any material concerns? Are you required to keep track of what's in or on the board?)

What we're trying to test (just for the eFuse):

1. Verify proper assembly (no shorts!)
2. Verify that the eFuse circuits meet requirements.
3. Calibrate the 5V current output.

Required Equipment:

Equipment required (or would be useful)

1. 2 x DC power supplies. One for 3V3, one for 5V. 5V needs to support 2A.
2. Programmable load (Mr. Tom has one), for testing eFuse and current monitor performance.
    a. Voltmeters. Optionally 2, so we can monitor voltage at source and load, but the programmable load reports voltage at the load.
3. IR thermometer (optional) or thermocouple. You can use your fingers too, but it's nice to know what's getting hot and how hot it's getting. (Mr. Tom has one of these too.)

Test Plan:

1. Prestart.
    a. Check for shorts on 3V3 and 5V at H1/H2.
2. Verify eFuse performance.
    a. 3V3 eFuse. (Connected by default)
        i. Connect 3V3 at H1/H2
        ii. Is 3V3 present at the input and output?
        iii. What does the overcurrent pin indicate?
        iv. Cause an overcurrent. What does the part do?
    b. 5V eFuse. (Connected by default)
        i. Connect 5V at H1/H2
        ii. Is 5V present at 5V_LUP signal?
        iii. What does OC5V indicate?
        iv. What voltage is present at 5V_Current?
        v. Attach load.
            1. What load do we need to be able to cause an overcurrent?
        vi. Calibrate the 5V_current signal
            1. Vary the load current using the programmable load.
            2. Record the voltage at each point.
            3. What is a reasonable set of values for the current? Min, max, step?
            4. Is anything getting hot? At max current?