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EQUIPMENT MONITOR AND CONTROL

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EMAC Test-Set Policy

External Customer Owned Test-Set Policy

- Customer is responsible for providing a Functioning Test-Set and Work Instruction on its use

- It is recommended that Customers provide EMAC with basic maintenance parts such as replacement cables and pogo pins

- Customer is responsible for the repair of any issues that arise with the Test-Set.

    o EMAC may assist the Customer with Test-Set Maintenance & Repair at T&M rate of $150/hr. (15-minute minimum billing increment)

        - If it is decided EMAC will perform repairs, it is highly recommended the Customer supplies us with schematics, assembly drawings, etc. for aid in troubleshooting

- It is expected that Test-Sets test a board in a single pass. If it is required to retest a board due to test set issues, the cost of each board may increase depending on how often the retesting is required.

- Any Test Issue can increase the delivery lead-time of the boards

- EMAC has a Board Tracking system we use to track board issues as well as first pass yield and RMA processing. This information can be entered manually or automatically (through an API/Library. When done automatically this reduces test time. EMAC can provide the customer with this API/Library if there is interest in access to the API/Library.

- EMAC has a Test-Programming Application (TPA) which has a Graphic User Interface used to test virtually any board once configured. Speak with an EMAC representative if interested.

EMAC Built Customer Owned Test-Set Policy

- EMAC is responsible for all repairs for the first year of use (from the Test-Set Invoice date)

- If a Test-Set Issue arises after the first year of use, EMAC will perform repairs at a T&M rate of $120/hr. (15 minute minimum billing increment)

- EMAC will attempt to minimize any delay in delivering boards due to a Test-Set Issue

- A Test-Set Maintenance Plan is available for basic Test-Set Preventive Maintenance. Speak with an EMAC representative if interested.

Customer Owned Test-Set Required Information

If a Customer is providing a Test-Set for use by EMAC in test their assemblies then the following information is required.

1. **Required Documentation**:
   - ☐ Test Objectives: Explain the purpose of the test (e.g., functional verification, boundary scan, in-circuit testing).
   - ☐ Test Coverage: Specify which components or functions are being Tested and Programmed
   - ☐ Pass/Fail Criteria: Clearly outline how to determine if the board passes or fails the test
   - ☐ What is the Test Logging Format and how is it performed & retrieved
   - ☐ Programming Details:
     - ▪ Will the test set program the final Deploy Software?
       - ▪ If not, will the Deploy Software need to be programmed before or after testing?
   - ☐ Test-Set Work Instruction

2. **What is the Test-Set Type:**
   - ☐ Jigs & Cables [Level 1/2]
   - ☐ Pogo Pins [Level 3/4]
   - ☐ Other _____

3. **Required Equipment List:**
   - ☐ Test fixture(s)
   - ☐ Specialized cables or adapters
   - ☐ External power supplies
   - ☐ Measurement instruments (oscilloscopes, multimeters, etc.)
   - ☐ Monitor, Computer or software tools
   - ☐ Bar Code Scanner
   - ☐ Other _____

4. **What Items are included with the Test-Set:**
   - ☐ "GO" Board(s) (known good board used to validate the Test-Set)
   - ☐ Cables/Jigs
   - ☐ Power Supplies
   - ☐ Measurement Instruments
   - ☐ Monitor, Computer or software tools
   - ☐ Bar Code Scanner
   - ☐ Other _____

5. **Test-Set Requirements:**
   - ☐ Voltage & Power _____
   - ☐ Compressed Air - PSI: _____
   - ☐ Ethernet Network Connection
   - ☐ Wireless Network Connection
   - ☐ GPS Antenna Connection
   - ☐ Other

6. **Test Procedure / Work Instruction (**Step-by-step instructions on how to use the test set, including):
   - ☐ Setting up the hardware
   - ☐ Connecting the PCBA to the test fixture
   - ☐ Operating the test software (if applicable)
   - ☐ Interpreting the test results
   - ☐ Include safety precautions if applicable.

7. **Test Software** (If the test set includes software, provide):
   - ☐ External
     - ▪ The software installation package
     - ▪ Detailed installation and configuration instructions
     - ▪ Licensing information if required.
     - ▪ Include any necessary drivers or supporting libraries.
     - ▪ Documentation for operating the software (e.g., user manuals)
   - ☐ Internal
     - ▪ What OS does the Test-Set Utilize
     - ▪ What Programming Language does the Test-Set Utilize

8. **Calibration and Maintenance Instructions**:
   - ☐ Explain how to calibrate the test equipment
   - ☐ Specify maintenance intervals and procedures for the test set

9. **Test Points and Interface Details**:
   - ☐ Provide a layout or diagram indicating test points on the PCBA
   - ☐ Detail the electrical characteristics of each test point (e.g., voltage levels, expected waveforms)
   - ☐ Describe connectors, pin mappings, or other interface details

10. **Expected Results**:
    - ☐ Include a table or file showing expected outputs for different test conditions
    - ☐ Provide golden sample data or a reference board for comparison

11. **Troubleshooting Guide**:
    - ☐ Outline common issues that may arise during testing and their solutions
    - ☐ Include error codes or messages that the test software might generate

Test Fixture Level Summary Description

Test Fixture Level I

Level I hardware will typically include a baseboard with standoffs mounted to it for each Unit Under Test (UUT) to be hand installed for testing. Low level programming of each UUT will be done manually (separate from the Test process) by an EMAC testing technician as will Test Logging. Standalone jigs and/or connectors will be manually installed on each UUT individually by the tester. Normally installed mother/daughter boards may be simulated or omitted. Testing automation may be performed at this level for higher efficiency, however only on interfaces that require no extra active hardware to perform (i.e. memory tests, USB, serial ports, etc.).

EMAC will work with the client to determine a sufficient testing standard and for the required interfaces. (For example, analog inputs can be tested by mounting potentiometers on a face plate for each channel that the tester will rotate to each extent for the test.) A Level I test fixture will not be extremely durable or made for high throughput. Subsequently, it will also have the longest programming and testing times per UUT due to the mostly manual process. No function testing of radios will be performed at this level, but serial communication to the device will be confirmed. Also see: Software (on the last page).

- o Best use application: LOW THROUGHPUT (Good for protos and small production runs)
- o Typical test fixture Mean Time Between Repair: ~1000+ UUT cycles
- o Typical maintenance requirements: MODERATE/HIGH
- o Typical UUT programming/test time: <10-12 min (not necessarily guaranteed based on project)

Test-Fixture Level II

Level II hardware will include the same style of baseboard w/standoffs and jigs for the UUT as Level I, any simple tests that would be manual for Level I will be automated for Level II (if possible). Normally installed mother/daughter boards may be simulated or omitted. Where applicable, minimal active circuitry might be installed on the base plate for various test automation. (For example, and referencing the Level I example above, a small, external microcontroller can be used to continuously sweep a PWM frequency thereby replicating the same response of the technician sweeping the potentiometer. This microcontroller may also be used to control power to the UUT, test digital inputs, protocol busses, etc.). Even a few pogo pins may be introduced for select connections.

A Level II test fixture essentially takes a Level I test fixture and enhances it for more efficiency/throughput and less tester interaction. This keeps construction, material and development costs much closer to a Level I test fixture than to a Level III test fixture. Testing times at this level are considerably faster when testing through production which makes Level II much more suited for light to moderate production throughput. Level II test fixtures may ultimately suffer some of the same durability issues as Level I due to jigs and wires constantly being connected and flexed, respectively. If moderately high throughput is expected, a simple pogo board can be requested at this level as well, but typically only for wider pitched, through hole components. Test Logging will usually will be done automatically, but low-level programming will still be done manually by an EMAC testing technician. The fixture will typically be equipped (where applicable) with a small, pogo programmer port or header for faster, more efficient programming. No function testing of radios will be performed at this level, but serial communication to the device will be confirmed. Also see: Software (on the last page)

- o Best use application: MODERATE THROUGHPUT
- o Typical test fixture Mean Time Between Repair: ~2000+ UUT cycles
- o Typical Maintenance requirements: MODERATE
- o Typical UUT programming/test time: <6 - 8 min (not necessarily guaranteed based on project)

Test-Fixture Level III

Level III hardware may introduce a full pogo pin/plate solution for high throughput testing. It will either include or have upgraded all of the circuitry included in Level II, as well as the potential addition of a dedicated processor/IO board for additional automation. In addition, mother/daughter boards intended for the project may be included for better function testing. A manual clamping mechanism may be included for quick and easy installation and uninstallation of each UUT. Low level programming would normally be automated and support added for the EMAC TPA allowing for automated Testing and Logging.

Level III test fixtures are tailored for moderate to high volume production runs with a focus on efficiency, speed and throughput. These test fixtures are built for robustness and will require much less maintenance than the previous two levels. These test fixtures typically require test points routed into the bottom layer of the PCB for pogo access which means it also requires foresight during the PCB design process. No function testing of radios will be performed at this level, but serial communication to the device will be confirmed. Also see: Software (on the last page).

- o Best use application: HIGH THROUGHPUT (Good for higher volume production)
- o Typical test fixture Mean Time Between Repair ~5000+ UUT cycles
- o Typical Maintenance requirements: LOW
- o Typical UUT programming/test time: <3-4 min (not necessarily guaranteed based on project)

Test-Fixture Level IV

EMAC will work with the client to customize a "single push button" solution. A concurrent, multi-UUT test fixture can also be requested at this level. Using a similar pogo and manual (or automatic) clamping mechanism (or multiples) of Level III, an EMAC testing technician will load the UUT(s) into the fixture and press a "Start" button. The test fixture will program and function test each UUT with no interaction from the technician. When finished, the fixture will alert the technician of the PASS/FAIL state of the UUT(s).

This is EMAC's most comprehensive and robust solution for testing. It's also the fastest. This level of test fixture is best suited for very high volume, sustainable designs due to development time and material costs. In addition, mother/daughter boards intended for the project may be included for better function testing. Function testing of radios can be requested at this level. Also see: Software (below).

- o Best use application: VERY HIGH, SUSTAINABLE THROUGHPUT
- o Typical test fixture Mean Time Between Repair: 10,000+ UUT cycles
- o Typical Maintenance requirements: VERY LOW
- o Typical UUT programming/test time: <1-2 min per Test Head
  (not necessarily guaranteed based on project)

Software

All levels of test fixtures for UUT's, with the exception of Level I, generally include standard support for EMAC TPA (Testing and Programming Application). The TPA provide a robust Graphic User Interface and provide extensive Test data logging.

The TPA utilizes a EMAC UUT Server for both in-house testing or Stand-Alone operation at a customer facility. The EMAC UUT Server has grown to include a conglomerate of function tests that are all easily available by simply creating a yaml configuration file. This allows for consistent, reliable and robust testing without adding additional software development time. At any level above a client can also opt for EMAC to provide a simple, menu driven testing/function application in lieu of the TPA.

NOTE: UUT server tests have been/will be designed so that the same test can be used at any level, with potential custom additions/modifications to Levels III or IV test fixtures. For example, this allows the customer to use a similar TPA configuration when moving from Level II to Level III.