# MANUFACTURING TEST SEQUENCE DESIGN DESCRIPTION REPORT

# SFT.000079_R1
# P1 HOLDER 2.4
# MT4 (CALIBRATION)

# Table of Contents

# 1 Introduction

## 1.1 Context

This document describes the implementation of the MT4 test sequence for P1 Holder model 2.4.

The reader is expected to be familiar with the following principles:

- G2MT data management [2], in particular Black Board parameter numbering and UEC error codes,
- G2MT DUT MT communication protocol [3].

This document is valid for testers running SFT.000079.RD_R1.

## 1.2 Naming and conventions

For naming of test points and signals, please refer to schematics [1].

All voltage measurement is referenced to ground (AGND) unless otherwise mentioned.

# 2 Test Sequence

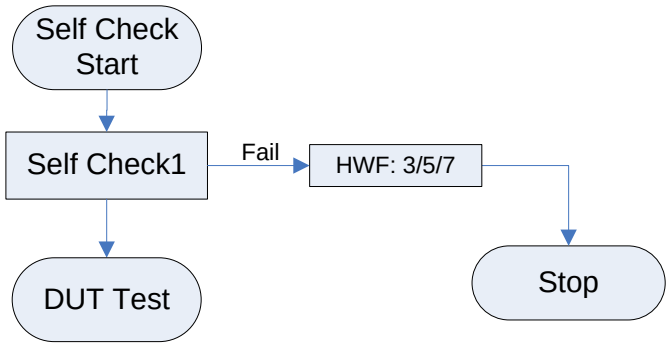
## 2.1 Tester self-check

### 2.1.1 Principle of operation

The tester performs a self-check by measuring multiple voltages to ensure the tester circuitry is working correctly. It checks the voltage readings are within the limits and stop operation if any reading fails the limit check.

Self-check is performed once at TBB start-up and each time just before DUT test.

### 2.1.2 Sequence Diagram




Notes

- For HWF codes, please refer to section 4

Figure 1 – MT4 Self-Check sequence diagram

## 2.2 Test Sequence

### 2.2.1 Principle of operation

MT4 checks for the battery path resistance and performs the heater calibration.

The tester is able to perform golden device sequence to validate the camera settings and function.

### 2.2.2 Detection and test start

The detection is done through UCPm detecting Uch connecting to J1.4 (see [1] page 2).

### 2.2.3 Barcode and identification

The device barcode is scanned for

- Device identification: allows to link the electronic serial number (UID) to the device barcode of production traceability for log file parsing applications,
- Start test signal: using the bar code scan instead of the DUT detection in the jig ensures the device is well in place and the user has removed his hands from the camera image before starting.

#### 2.2.3.1 Read DUT UID and detect protocol

The DUT protocol is detected to differentiate a device to be calibrated (using MT DUT protocol) from a Golden Device (using SCP). Based on the detection, one of the two sequences described in sections 2.2.4 and 2.2.5 is selected.

Invalid UIDs (0000 0000 and FFFF FFFF) are rejected.

### 2.2.4 Device to be calibrated sequence

#### 2.2.4.1 Battery path resistance measure

The battery charging path (contact PCB + wires + battery + canoe) resistance is measured by applying two different currents and measuring the voltage difference to calculate the apparent path resistance. If the measured value is outside the defined limits, the test sequence is aborted.

#### 2.2.4.2 Calibration values check

The calibration values are read from the DUT to verify that the device is not already calibrated. If the device is calibrated, the sequence is terminated with success after logging the read values. Otherwise the calibration sequence described in section 2.2.4.3 is performed.

#### 2.2.4.3 Heater calibration

The purpose of heater calibration is to determinate values corresponding to heater resistances at known temperatures.

The DUT will heat at a default value with the first heating command (see [3]). The value is designed to regulate to a temperature below the target of T1=300°C. A thermal image capture is then performed to measure the actual blade temperature. The set point is then increased according to the difference to the target temperature and a new measure is performed. This is repeated until the actual temperature measured falls within ±0.5°C of the target (299.5…300.5°C). The set point value corresponds to the value to set to obtain a regulated temperature of 300°C and is called R1. The DUT is then issued a command to stores this value for further use.

The same procedure is repeated for a target of T2=360°C, which creates the set point value called “R2”. The DUT is then issued a further command to also store this value for further use.

Next the set point is increased by exactly the difference R2-R1 (RA=R2+R2-R1). This is expected to regulate a temperature TA = T2+T2-T1 = 360 + (360 - 300) = 420 °C. This temperature is measured to confirm the validity of both R1 and R2.

Finally, the device receives a last command that:

- Computes R3 for 548°C by extrapolation of R1 and R2,
- Stores the complete calibration data in FLASH with the valid CRC, thus validating the MIB.

The sequence goes back to the previous section 2.2.4.2 to read the actual calibration values from the DUT and terminate the sequence.

### 2.2.5 Golden Device sequence

#### 2.2.5.1 Software version check

In order to verify that the inserted device is a valid Golden Sample, the software version is read from the DUT and must be 1.192.x. If different version is obtained, the sequence is aborted with an error message.

#### 2.2.5.2 Verification sequence

If the inserted DUT is found to be a valid Golden Device, its UID is logged (to trace the device use for the check), the battery charging current is set to 1000mA (compensating the energy used to heat) and a start heating command is sent to the DUT.

After 9.5 seconds, thermal images are taken for 1 second duration to compute the blade temperature providing an average centred on 10 seconds after start, which is the definition for the calibration temperature. The result is compared with the expected Golden Device temperature (320°C) to validate the camera settings and function.

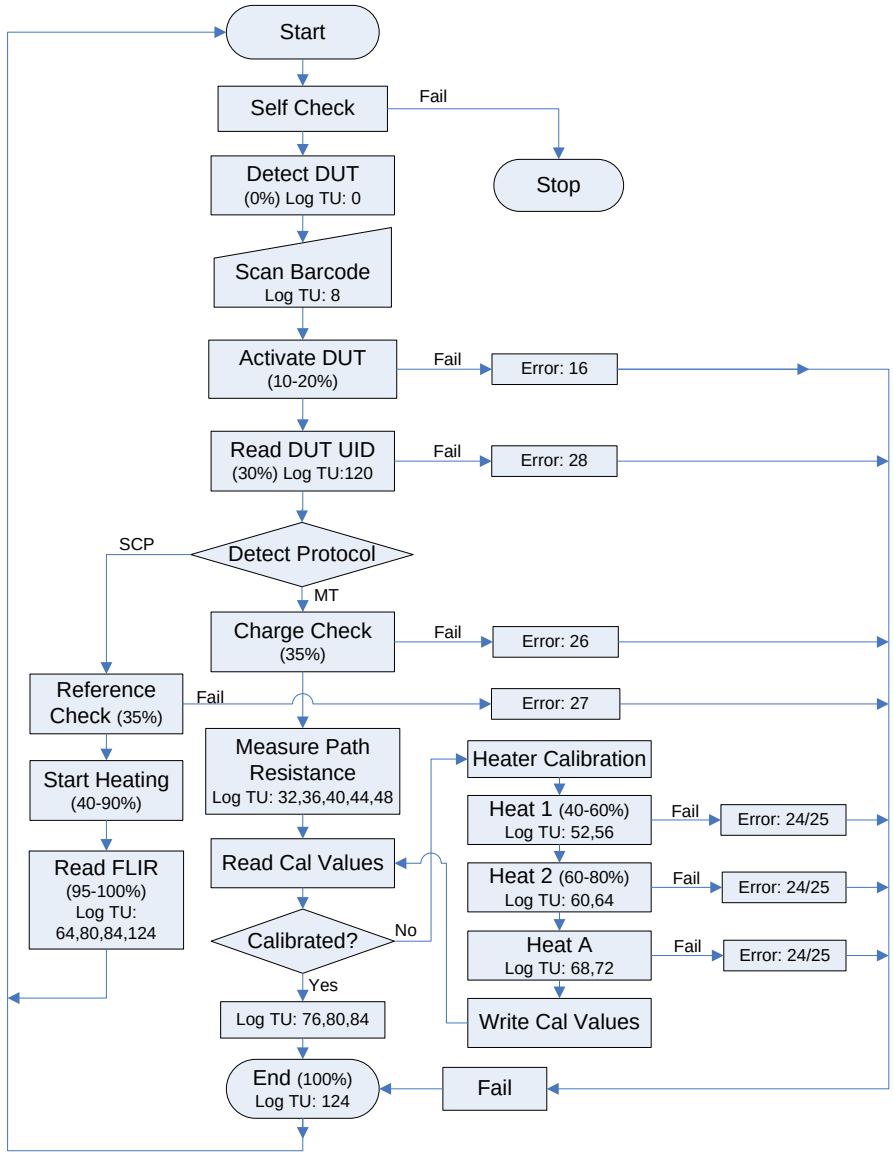
The results are written to a log file for the TBB (not DUT). The sequence is completed.

### 2.2.6 Test results

If all measured values are within limits, the test is PASS.

As soon as one test fails due to a measurement out of limits, the test sequence is stopped and failed.

### 2.2.7 Sequence Diagram




Notes

- Percentage in () refer to the progress display during the testing
- For parameters numbers, please refer to section 3.3
- For error codes, please refer to section 4

Figure 2 – MT4 test sequence diagram

# 3 Parameters

## 3.1 Principle

Parameters are used to log information and results generated during the test sequence. The following sections describe the parameter numbers allocation within the blackboard range and provide a detailed list of used parameters for MT4.

## 3.2 Black Board map

MT4 uses Test Unit 1.

The first parameter number in the Test Unit range (PNUM_BASE for TU1) is 1024 (0x0400).

The range length (PNUM_RANGE for TU1) is 128.

The first parameter number for golden device (PNUM_BASE for TBB) is 64 (0x0040).

The range length for golden device (PNUM_RANGE for TBB) is 64.

See Table 1 for a complete view of the MT4 Black Board parameters number map.

Note: Area marked as Free may be used by other testers.

| Section | PNum (Hexadecimal) | PNum (decimal) | Offset in Section | Description |
|---|---|---|---|---|
| 0 | 0x0000<br>0x003F | 0<br>63 | 0<br>63 | TBB Reserved |
| | **0x0040**<br>**0x007F** | **64**<br>**127** | **64**<br>**127** | **Monitoring (Golden Device)** |
| | 0x0080<br>0x07FF | 128<br>2047 | 128<br>2047 | Free |
| 1 | 0x0800<br>0x083F | 2048<br>2111 | 0<br>63 | TU Reserved |
| | 0x0840<br>0x0BFF | 2112<br>3071 | 64<br>1023 | Free |
| | **0x0C00**<br>**0x0C7F** | **3072**<br>**3199** | **1024**<br>**1151** | **MT4** |
| | 0x0C80<br>0x0FFF | 3200<br>4095 | 1152<br>2047 | Free |

| Section | PNum (Hexadecimal) | PNum (decimal) | Offset in Section | Description |
|---|---|---|---|---|
| 2 | 0x1000<br>0x103F | 4096<br>4159 | 0<br>63 | TU Reserved |
| | 0x1040<br>0x17FF | 4160<br>6143 | 64<br>2047 | Free |
| … | … | … | … | |
| 31 | 0xF800<br>0xF83F | 63488<br>63551 | 0<br>63 | TU Reserved |
| | 0xF840<br>0xFFFF | 63552<br>65535 | 64<br>2047 | Free |

Table 1 - Black Board parameters number map for MT4

## 3.3 Parameter list

Table 2 - Parameter list for P1 Holder 2.2 MT4 – DUT test provides the list of parameters generated by the test sequence. The value given in the first column is the offset from PNUM_BASE (1024).

Example: TBB UID (offset 0) in TU 1 has PNUM: 2048 + 1024 + 0 = 3072 (0x0C00).

| Offset | Description | Format / unit |
|---|---|---|
| 0 | TBB UID | UID |
| 8 | DGS barcode | BARCODE_COMPRESS |
| 32 | Battery measure U1 | 0.1mV |
| 36 | Battery measure I1 | 1mA |
| 40 | Battery measure U2 | 0.1mV |
| 44 | Battery measure I2 | 1mA |
| 48 | Battery R path | 1mΩ |
| 52 | AVG T1 | 0.01°C |
| 56 | MAX T1 | 0.01°C |
| 60 | AVG T2 | 0.01°C |
| 64 | MAX T2 | 0.01°C |

| Offset | Description | Format / unit |
|---|---|---|
| 68 | AVG TA | 0.01°C |
| 72 | MAX TA | 0.01°C |
| 76 | R1 | 0.918 mΩ |
| 80 | R2 | 0.918 mΩ |
| 84 | R3 | 0.918 mΩ |
| 120 | UID | UID |
| 124 | Overall test result | UEC |

Table 2 - Parameter list for P1 Holder 2.2 MT4 – DUT test

### 3.3.1 TBB (Golden device)

The first parameter number in the TBB range (TBB_BASE) is 64 (0x0040).

Example: Golden Device UID would have PNUM: 0 + 64 + 0 = 64 (0x0040).

| Offset | Description | Format / unit |
|---|---|---|
| 0 | Golden Device UID | UID |
| 16 | AVG T | 0.01°C |
| 32 | MAX T | 0.01°C |
| 60 | Overall test result | UEC |

Table 3 - Parameter list for P1 Holder 2.2 MT4 – TBB / camera check

# 4 Error codes

## 4.1 Principle

Error codes are used to provide detailed information about failures that may occur during the test sequence. An actual error code would appear in parameter 124 (see 3.3).

The following section provides a detailed list of hardware fault code and DUT test error code specific for MT4.

For generic G2MT error codes (not listed in the tables), see [2].

### 4.1.1 Self-check

| HWF | Name | Description |
|---|---|---|
| 3 | HWF_VMIDSCMIN | V33 self-check failed. The measured value is below the lower limit. |
| 4 | HWF_VMIDSCMAX | V33 self-check failed. The measured value is above the upper limit. |
| 5 | HWF_UPCALSCMIN | R13/R15 self-check failed. The measured value is below the lower limit. |
| 6 | HWF_UPCALSCMAX | R13/R15 self-check failed. The measured value is above the upper limit. |
| 7 | HWF_UMCALSCMIN | R14/R16 self-check failed. The measured value is below the lower limit. |
| 8 | HWF_UMCALSCMAX | R14/R16 self-check failed. The measured value is above the upper limit. |

Table 4 – Self-Check Hardware Fault codes for MT4

### 4.1.2 DUT Testing

| Code | Name | Description |
|---|---|---|
| 16 | TR_FAIL_DUT_ACTIVATE | The device did not reply to CRX driven high by the tester by driving CTX high within 500 ms. |
| 24 | TR_FAIL_HEAT_START | The DUT did not acknowledge the HeatStart command by asserting CTX low (timeout) |
| 25 | TR_FAIL_HEAT_STABLE | The DUT did not signal temperature regulation stability by asserting CTX high (timeout) |
| 26 | TR_FAIL_CHARGING_PATH | No or insufficient current flowing through the battery charging path before battery test |
| 27 | TR_FAIL_NOT_REF | The inserted device is not a GOLDEN DEVICE |
| 29 | UEC_P_DUT_PROTOCOL | The DUT protocol (MT or SCP) could not be identified |

Table 5 – Error codes for MT4 DUT

### 4.1.3 TBB (Golden device)

| Code | Name | Description |
|---|---|---|
| 9 | UEC_C_APP_P_FLIRDRIFT | The golden device check is out of range (FLIR camera measure drift) |

Table 6 – Error codes for MT4 golden device check

## 5 Implementation reference

The tester hardware is based on a G2MT MT4 TBB with tester PCB ASM.000256.RD (TBB HW specification 1.0).
The tester firmware is implemented based on G2MT_lib for TBB HW specification 1.0 (MSP430F2418).

## 6 Design Details

N/A

## 7 Known issues

None

## 8 References

[1] ASM.000256.RD_R1 Schematics

[2] G2MT Data management specification 1.0

[3] G2MT MT DUTCom specification 1.0

## 9 Review and approval

Please refer to PDIMS DAW and associated signature page.

# 10 Abbreviations

| Abbreviations | : | |
|---|---|---|
| ADC | : | Analog-to-Digital Conversion |
| AVG | : | Average (for FLIR temperature readings) i.e. blade measurement |
| CRC | : | Cyclic Redundancy Check |
| DUT | : | Device Under Test |
| FPD | : | Functional Product Design |
| FW | : | Firmware |
| HW | : | Hardware |
| HWF | : | Hardware Fault (code) |
| MAX | : | Maximum (for FLIR temperature readings) i.e. hottest pixel on blade |
| MIB | : | Manufacturing Integration Block |
| MT | : | Manufacturing Testing |
| PCB | : | Printed Circuit Board |
| PDIMS | : | Product Data Management (Software) |
| PMI | : | Philip Morris International |
| SCP | : | Simple Chained Protocol |
| TBB | : | Test Building Block |
| TU | : | Test Unit |
| UEC | : | Unified Error Code |
| UID | : | Unique Identifier |

For complete definition, refer to PMI OPS Glossary and/or PMI RD Glossary

# SIGNATURE PAGE

## SFT.000079_R1 MANUFACTURING TEST SEQUENCE DESIGN DESCRIPTION

## FOLDER Details:

**File Name**: SFT.000079_R1-MT4 P1M24 Holder Sequence Design Description Report.docx
**File Description**:
**Folder Number**: FOLDER0213285
**Folder Version:** 1

## DAW Details:

**DAW Number**: DAW-000896
**DAW Type:**
**Project:** PDev|ZRH Product Development|J-1002RDA0016
**Status:** Approved

## SIGNATURES

This document(s) has been reviewed and signed by:

| Name | Role | Justification | Date |
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| Bernauer, Dominique (dbernaue) | Author/Owner | In Approval | Dec 1, 2015 5:14:43 PM |
| Farine, Robin (rfarine) | | In Approval | Feb 18, 2016 7:32:02 AM |