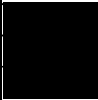# PB540/PB560 CPU PCB
Test Station Requirements Document

Revision History

Revision	Change Order	Author	Approved By	Approval Date	Summary of Change
Rev 00	ECO-R163871	███	Refer to Agile	Refer to Agile	Initial Draft
Rev A	ECO-R167338	███	Refer to Agile	Refer to Agile	Initial Release
Rev B	ECO-R181354	███	Refer to Agile	Refer to Agile	Update to add new PCB P/N 3845800 in Section 1.2 and references to PB560

Contents

1.0   Introduction

The PB540/PB560 CPU PCBA functional tests require dedicated hardware mainly to consist of product components and test software for the UUT CPU board. The test software is to be executed on the UUT hardware and is to use the product keypad and LCD for test execution and results display.

1.1 Purpose

The purpose of this document is to describe the requirements for a Test Station that performs functional tests for the PB540/PB560 CPU.

1.2 Scope

This document applies to the Functional Test Station used to test the PB540/PB560 CPU PCBA P/N 3821300/3845800.

1.3 References

The test specification is developed with reference to the appropriate issue of the following documents at the time of the test development.

[1] PB540/PB560 CPU Manufacturing Test Specification, p/n 10020880
[2] PB540 CPU PCB, Schematic p/n 4096600E03.000

1.4 Definitions, Acronyms and Abbreviations

UUT	Unit under Test
GUI	Graphical User Interface
PROM	Programmable Read Only Memory
NI	National Instruments
CVI	LabWindows CVI, NI C development environment for creating virtual instrumentation.
PCB(A)	Printed Circuit Board (Assembly)
KB	Keyboard
CR	Carriage Return
GRQ	Generic Requirement
TRQ	Test Requirement
OTS	Off the shelf refers to refers to products that have already been designed and commercially produced
MTS	Manufacturing Test Specification

2.0 Test Station Hardware Design

The Test Station shall require the following test hardware to perform the functional tests:

2.1 DC Voltmeter

A Digital DC Voltmeter shall be required to measure the DC Voltages directed by the functional test. The Digital DC Voltmeter basic accuracy should be ±0.3% of reading or better and 4-1/2 digits or more of display.

2.2 Test Fixture

The Test Fixture shall be used to hold the UUT during testing and shall provide access to the UUT for probing the required DC voltage test points. The Test Fixture shall prevent access to any dangerous voltages.

 A method of testing the signal level for the FIO2 signal (J11), External Alarm (J2), and 02 Valve (J21) shall be used.

The following PB540/PB560 assemblies shall be required and contained in the Test Fixture to support testing:

2.2.1   Power Management Board

The PB540/PB560 Power Management board shall be connected in the same manner as used in the product to supply power and test the CPU-Power Management SPI interface.

2.2.2   AC-DC Power Module

The PB540/PB560 plug-on power supply module shall be installed onto the Power Management PCB in the same manner as used in the product to provide power sourced by the AC Mains.

2.2.3   Keypad

The PB540/PB560 keypad shall be connected to the UUT in the same manner as used in the product to initiate the tests and to test the keypad interface.

2.2.4   Buzzer Board

The PB540/PB560 product buzzer board shall be connected to the UUT in the same manner as used in the product to be used for the buzzer board tests.

2.2.5   Turbine with Control Board

The PB540/PB560 Turbine assembly including the Turbine Control Board shall be connected to the UUT in the same manner as used in the product for testing the turbine interface.

2.3 Tester PC

The Tester PC shall be a Pentium III based PC or higher running the XP Operating System or approved software. The PC shall have an Ethernet port, at least one RS232 port and three USB ports available. The Tester PC is to be used to download the UUT software requiring a USB Type A/Mini B cable.

3 Test Station Software Requirements

The test station software shall consist of the UUT test software, Power Management PCB software and the UUT Software download application.

3.1 UUT Test Software

The UUT board test software shall be written in C Language and contain the test software to be executed on the ST10 microcontroller for the functional testing of the UUT. The software shall use the LCD to display test messages, measurements and results and use the keypad to handle test operator input to start tests, etc. The software is downloaded to the UUT in the start of testing.

3.2 Power Management Board Software

The UUT board will use a derivative of the product software in the Power Management Board for testing the CPU-Power Management Board SPI communications interface. This software resides on the Power Management Board as part of the test station. The Power Management Board software will contain the product software for the USB Host controller to allow communications between the PC and the CPU for test software download

3.3 UUT Software Download Application

The UUT Software Download Application is to be executed from the PC to download the UUT ST10 microcontroller software for the functional tests.

3.4 Generic Software Requirements

The test software shall be required to perform the following generic tasks:

Reference	Detail
GRQ[3.4.1]	[MTS 4.19] On power-up, the test software shall boot the UUT, display the board type and S/W version briefly and then the test menu
GRQ[3.4.2]	The test software download process shall use the ST10Flasher PC application program and USB controller software on the Power Management board

3.5 Test Software Requirements

In the following paragraph are described the software requirements to automate the execution of the PB540/PB560 CPU Board functional testing.

3.5.1 LCD Contrast Test [MTS 4.2]

Requirement	Description
TRQ[3.5.1]	The test shall allow the test operator to adjust the LCD contrast to either increase or decrease the contrast to verify that a sufficient range of contrast is available.

3.5.2 Keypad Interface Test [MTS 4.3]

Requirement	Description
TRQ[3.5.2]	The test will individually turn ON/OFF the red and orange alarm Leds and the ventilate Led so that each Led can be verified to be either ON or OFF. The test will individually check the: Ventilate, +, - , Valid and Alarm Inhibit button for closure. The test will instruct the test operator to press each button then check that the button has been pressed. If an incorrect button is pressed an error is to be displayed.

3.5.3 RAM Memory Test [MTS 4.4]

Requirement	Description
TRQ[3.5.3]	The test shall write into the RAM memory address locations space from 0x200000 to 0x28000 with 0xAAAA, the test shall read back the memory locations and check the value written matches that read from the memory location. If a verification failure occurs, display failed memory address and data, and exit.

The test shall write into the RAM memory address locations space from 0x200000 to 0x28000 with 0x5555, the test shall read back the memory locations and check the value written matches that read from the memory location. If a verification failure occurs, display failed memory address and data, and exit.

The test shall write into the RAM memory address locations space from 0x200000 to 0x28000 with 0xAA, the test shall read back the memory locations and check the value written matches that read from the memory location. If a verification failure occurs, display failed memory address and data, and exit.

The test shall write into the RAM memory address locations space from 0x200000 to 0x28000 with 0x55, the test shall read back the memory locations and check the value written matches that read from the memory location. If a verification failure occurs, display failed memory address and data, and exit |

3.5.4 Real Time Clock Test [MTS 4.5]

Requirement	Description
TRQ[3.5.4]	The test shall initialize the real time clock and set the time and date to a pre-defined setting. The real time clock will be set to run and compared against a software operated clock driven by a 1mSec interrupt. If the hours, minutes or seconds differ from the real time clock to the software clock then the test will fail. (see MTS for test limits)

3.5.5 EEPROM Test [MTS 4.6]

Requirement	Description
TRQ[3.5.5]	The test will initialize the EEPROM by writing 0xFF to the 32 bytes in each of the 128 pages of memory. For each page, a location is to be defined as starting from Page *32 to (Page+1) * 32. The test will then write the data value defined as the address from Page *32 to (Page+1) * 32 to the memory location. The test will read back the locations to verify the address value written. The test will write 0xFF to initialize the EEPROM to the 32 bytes in the 128 pages. The test will indicate any verification errors.

3.5.6 NAND-FLASH Test [MTS 4.7]

Requirement	Description
TRQ[3.5.6]	The test will verify the NAND Flash interface by reading 4 bytes of the Flash ID information at address 0x500000. The first byte will be checked to be one of recognized manufacturer ID codes and the second byte will be checked to be one of the recognized flash characteristic ID codes specified in the MTS. The test will fail if there is not a match in either the manufacturer ID or characteristic ID codes.

3.5.7 Event FLASH Test [MTS 4.8]

Requirement	Description
TRQ[3.5.7]	The test will verify the Event Flash device by writing and reading the flash locations from 0x100000 to 0x17FFFF. The flash device will be read address 0x100000 to verify the Flash manufacturer ID matches one of the recognized manufacturer ID codes specified in the MTS. The Flash device is then to erased and verified all locations are erased. The Flash device is written to the 16 bit value of the address location as the data value. The Flash locations are then read back to check that the data read matches the expected 16 bit address value written. The test will indicate any verification failures.

3.5.8 Buzzers Test [MTS 4.9]

Requirement	Description
TRQ[3.5.8]	The test will turn ON the two buzzers on the Buzzer PCB using the INV_STOP signal and verify using the A/D signal TESTBUZ that the buzzer is ON (see MTS limit). The test will turn OFF the buzzers on the Buzzer PCB using the INV_STOP signal and verify using the A/D signal TESTBUZ that the buzzer is OFF (see MTS limit). The test will setup the PWM module in the ST10 uController for the pulse width modulated buzzer signal PWM-BUZ. The test will turn ON the buzzers on the Buzzer PCB using the PWM-BUZ signal and verify using the A/D signal TESTBUZ that the buzzer is ON (see MTS limit).. The test will turn OFF the buzzers on the Buzzer PCB using the PWM-BUZ signal and verify using the A/D signal TESTBUZ that the buzzer is OFF (see MTS limit).. The test will turn ON the security buzzer using the SEC-BUZ signal and ask the test operator to verify that the buzzer is ON. The test will turn OFF the security buzzer using the SEC-BUZ signal and ask the test operator to verify that the buzzer is OFF.

3.5.9 O2 Valve Test [MTS 4.10]

Requirement	Description
TRQ[3.5.9]	The test will set CD-O2 HIGH and LOW to toggle the 02-VALVE signal. The test will verify the 02-VALVE signal in the HIGH and LOW states

3.5.10 Exhalation Valve Control Test [MTS 4.11]

Requirement	Description
TRQ[3.5.10]	The test will Set CD_Valve signal to high to turn V2 Valve ON and measure the A/D signal MES_I_Valve signal to be greater than MTS limit The test will Set CD_Valve signal to low to turn V2 Valve OFF and measure the A/D signal MES_I_Valve signal to be less than MTS limit.

3.5.11 Flow Sensors Test [MTS 4.12]

Requirement	Description
TRQ[3.5.11]	The test will measure and display the inspiratory and exhalation flow sensors at zero flow and display the measurements. The inspiratory and exhalation flow measurements from the uC A/D shall be tested to be within the limits in the MTS. The test will indicate if the measurements do not test within the limits.

3.5.12 Pressure Sensors Test [MTS 4.13]

Requirement	Description
TRQ[3.5.12]	The test will measure, process and display the four PB540/PB560 pressure measurements: Internal (Patient), Exhalation Valve, Proximal and Barometric. The test will display the minimum and maximum readings for the measurements. 1. Read the A/D Patient Pressure value and process as follows: Patient Pressure value = $((A/D\ Value – 175) * 1344)/1000$ Test the Patient Pressure value to be to be within the limits in the MTS 2. Read the A/D Exhalation valve pressure value and process as follows: Exhalation value pressure = $((A/D\ Value – 175) * 1344)/1000$ Test the Exhalation Valve Pressure value to be to be within the limits in the MTS 3. Read the A/D Proximal pressure and process as follows: Proximal Pressure value = $((A/D\ Value – 175) * 1344)/1000$ Test the Proximal Pressure value to be within the limits in the MTS 4. Read the A/D Barometric pressure and process as follows: Barometric Pressure value = $((A/D\ Value – 175) * 1344)/1000$ Test the Barometric Pressure value to be within the limits in the MTS

3.5.13 FIO2 Test [MTS 4.14]

Requirement	Description
TRQ[3.5.13]	The test will measure the FIO2 A/D output with the specified voltage applied on J11 pin 2 and check the FIO2 A/D output to be within the specified limits in the MTS. The test will display the minimum and maximum readings.

3.5.14 Power Management PCB Interface Test [MTS 4.15]

Requirement	Description
TRQ[3.5.14]	The test will check the SPI 1 communication to the USB Host Controller on the Power Management PCB by sending a command frame to inquire if a USB key is connected on port 1. If the connection status returned is 12 indicating that a USB key is not connected then the test passes. Any other data returned will be a test error and to be displayed. The test will check SPI 0 communication to the PIC controller on the Power Management PCB by first initializing the SPI, then transmitting the test number as data. The test will check that the correct data is received back from the Power Management PCB.

3.5.15 Alarm Repeater Test [MTS 4.16]

Requirement	Description
TRQ[3.5.15]	The test will open and close the external alarm relay and verify the relay operation. The test will send and receive data via the external alarm UART and verify the correct data is received back.

3.5.16 Turbine Test [MTS 4.17]

Requirement	Description
TRQ[3.5.16]	The test will setup the UUT's ST10 Microcontroller PWM 0 signal to set the turbine speed and timer/capture registers to measure the speed. The test will setup the temperature/resistance linearization curve for the thermistor to obtain the temperature reading. The test will measure the turbine temperature to be within the limits specified in the MTS. The turbine speed will be checked with the turbine enabled and then disabled. With the turbine is enabled, the brake is OFF and the PWM signal set to 2500, the speed shall be checked to be greater than or equal to the limit specified in the MTS, With the turbine disabled, the speed shall be checked to be less than or equal to the limit specified in the MTS. The turbine speed will be checked with the PWM 0 signal set to 4096, toggling the brake ON and OFF and the speed shall be less than or equal to limit specified in the MTS.

3.5.17 Watchdog Timer Test [MTS 4.18]

Requirement	Description
TRQ[3.5.17]	The test will stop the toggling of the watchdog input of the microprocessor supervisor IC and check that the board performed a reset. If the board does not reset the test fails and an error message is to be displayed.

3.5.18 DC Voltage Measurements Tests[MTS 4.1]

Requirement	Description
TRQ[3.5.18]	The following DC Voltages are to be measured and checked to be within the limits specified in the MTS: 1. +5VDC at the output of the 5V regulator supply 2. +3.3VDC at the output of the 3.3V regulator supply 3. +5VDC Reference at the output of the +5V reference circuit (IC21) 4. +10VDC Reference at the output of the +10V reference circuit (IC23)