Module Test: an Overview

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Introduction

- MTWG: Module Test Working Group
- Start writing a document on test procedures and quality assurance on beginning of July 2000
- Since then 2 (full day) meetings on Jul 12 and Sep 6
- A lot of work in progress to point out all aspects and possible problems of module testing, big writing effort too.
- Many open points under discussion: test list, HW & SW setup, test vs location, etc.
- Reference web page on Firenze H.E. server (no pw since august) http://hep.fi.infn.it/CMS/moduletest/wg.html webmaster Raffaello D'Alessandro, page(master?) MM….

Test Flow between Production Centers

- Hybrids Centers: Industry, Institutes (+P.A.)
  → qualified Hybrid
- Gantry Centers
  → qualified assembled module (if qualif. possible)
- Bonding Centers
  → bond-qualified module
- Burn-in Centers
  → burn-qualified module
- Rods/Petals Center
  → qualified rods and petals
- Integration centers
  → qualified tracker

Shipping ?

- In between the previous steps there are parts traveling around the world…..
- Packaging and shipping problems should be addressed: it is not a task of the MTWG…. But someone should think about it !
- It is anyway a very delicate and important phase of production, could have a large impact on the tests to be done and on the final yield!

What is needed beforehand….

- **A fully qualified APV25 !**

From the tracker electronics System Meeting on 19-20 Sep:

- APV25-S1 performance is optimal, yield is very high
- 84% of the chips passed all tests
- Only a small number were damaged during dicing (tests performed on ~ 500 chips)
- Good results from first irradiation tests and SEU
- Test list: digital functionality, I2C, power supply currents, pipeline pedestals, gain, analog output pedestals
- Production tests on wafer
- NO MEASUREMENT OF NOISE ……..
- Possible plans to investigate “early mortality” (if any)?

Testing at Hybrid Centers

(From U. Goerlach July presentation)

Functionality Tests during Production ***(Tests carried out by the manufacturer):***

Power consumption
(in standard I2C configuration)

I2C control (R/W cycles ca 100-1000)

Read-out test:

correct response to T1, reset and cal_request

analogue differential output levels

For IB: I2C and power lines for opto-hybrid

Þ simple, compact and portable set-up

In Strasbourg verify performances (deeper) on samples

Test Definitions

- FAST TEST = LV power on, send W/R commands via I2C, then measure:

  currents, pedestals, channel noise, both in peak and deconvolution with fully automated procedure (about 5 minutes, excluding connection time, that should be anyway short). We can possibly add a 2 point internal calibration (1 and 3 MIPs) for special purposes. Readout errors in frame header will be signaled automatically by the system.
- All at room temperature, in clean room, humidity ctrl.
- Use default values for APV as given by APV experts

Deep Test

- DEEP TEST = FAST TEST +
- Extended internal calibration
- Longer I2C readout cycles
- SNR measurement with beta source
- Readout signal generated from penetrating laser

Hybrids at CERN

- Fast test upon arrival
- Bond Pitch Adapter
- Fast test after bonding
- Some burn-in to be defined (?)
- Qualified hybrid
- Write DAQ to results to DB

Last steps must be done with a "qualification setup", because this is a possible starting point to write in DB numbers that will be compared during module's life.

Testing at Gantry Centers

Bari Brussels Lyon Perugia Wien USA

- Optical inspection upon arrival
- Fast test
- Assembling on the gantry
- Optical inspection
- Fast test
- Packaging

The I-V curve of the sensors could be useful in case of problems, but it is not foreseen at this stage. Problems with the equipment needed to do that. Risk/benefit high!

Testing at Bonding Centers 1

Aachen Bari Firenze Karlsruhe Padova Pisa Strasbourg Torino USA Wien Zurich

Before bonding:

Optical inspection (microscope), fast test + calib.

After bonding:

Bonding tests according to Alan's WG prescriptions

Then at room T and controlled humidity:

I-V curve and Fast test

Thermal cycling, +20 ^{o}C to -20 ^{o}C, power OFF, requires a (simple) climatic chamber

Fast test, Back plane pulsing, at Vbias=Voperation and Vbias=Vmax<~Vbreak, red-led/infrared/laser scan

Testing at Bonding Centers 2

- Module qualified
- Write to DB; from now on we MUST have the test setup directly interfaced to DB
- No possibility for the operator to write into DB if some parameters are not the “standard common ones”.

A possible option:

Test with penetrating laser (1064 nm) and/or with a beta ^{90}Sr source will be helpful during Milestone 200, but very complex to be done during production, especially in structures like petals and rods.

Very time consuming !

Testing at Burn in Centers 1

Aachen* Brussels Karlsruhe Lyon* Louvain Pisa* Strasbourg USA* Wien Zurich

- The burn in problems require a long and detailed study to be correctly solved: work is in progress !
- Many variables to be kept under control during repeated thermal cycles, ranging from +20 ^{o}C to -15 ^{o}C:

LV currents, APV performance, DCU, I-Vbias, Vbreak,

I vs. time, I vs. Temperature (see draft on web for details).

- Interlocks always active on crucial parameters (I, T, humidity etc.).
- Never exceed limits, it is dangerous ! Permanent damages!

Testing at Burn in Centers 2

- Cooling: needed absolutely, but it is still unclear if it can be similar to the final one.
- We are not going to test the thermal properties of our modules: that must be studied very carefully BEFORE, so as to ensure thermal exchange will be enough to cool down even the most irradiated detectors. (Is it a weak point?)
- T measured on the hybrids, no T probes on detectors.
- SNR measurements only on sample basis (if at all possible)
- What we should not do: thermal cycles for finding APV failures

Hardware 1

- Each production step, from hybrid to full integration, will have specific hardware needs
- One of the tasks of MTWG is to find out common setups for common needs
- As a first approximation we have identified 2 possible DAQ setups:
  - 1: for Hybrid centers (and industry) and Gantry centers
  - 2: for Bonding, Burn in and Integration centers (qualification)

    Number 2 must have capabilities to read more modules at the same time, connected in CMS scheme, and to be interfaced to climatic chambers for burn in.

Hardware 2

- Since April the Lyon group is in charge of studying and testing a DAQ system which could be fit for most of the experimental requirements (presented at July meeting)
- Now it is under evaluation a possible expansion with VME interfacing, to give even more flexibility to the setup for the future
- Aachen group has shown a test setup (in September) which could be useful for the initial steps of production chain (one hybrid/module). It is a simple and low cost system.
- There is interest in the Tracker community for both systems

Hardware 3

- Estimated number of setups to be installed:
  - 10-15 of type 1
  - 16-20 of type 2
- **During production, for compatibility reasons, and for quality assurance all the qualification setups must be identical**
- Comparison of results and traceability of failures are at the highest priority
- The problem of climatic chambers (or cold boxes) has still to be discussed
- A few ideas on the subject and some prototypes under construction, many problems to solve.

Remarks

- We will learn a lot with Milestone 200 production, and we will refine our testing strategy
- We will try to circulate our draft on testing procedures as soon as possible
- We are now aiming at the best approximation with present knowledge