CBPF

Front-End Electronics Test System Status Information

(After ASDQ++ boards TEST at CERN)

LHCb Technical Note

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Abstract

A Front-End Electronics Test System (FEET) is being implemented in order to test the Front-end electronics (FEE), in the production line, for the LHCb Muon System. This document discusses some aspects related to the test of ASDQ++ boards. FEET presently enables 5 different tests: Connectivity, Crosstalk, Noise, Sensitivity and Rate-Method tests. The system has detected 25 channels with problems out of 640 tested channels.

Content

1 Introduction

The **Front-End Electronics Test System** (FEET) [1] is being implemented to test the FEE for the LHCb Muon System. The System was implemented in order to be compatible with the ASDQ++ [2-4-5] and the CARIOCA [3] boards. A total of 40 ASDQ++ boards were tested at CERN. The test results were used to evaluate the FEET System, as it is implemented now, and they will be discussed in this document, as well some Rate Method related aspects.

2 Test Results

The ASDQ++ boards were separated into two groups, the new ones which arrived at CERN without any previous test and the ones which were already available at CERN by the tests period.

The routine for the tests was based on the diagram presented in the Fig.1. Once a channel presents a problem in the **Connectivity Test**, opened or short-circuited channel, the other tests, **Crosstalk**, **Noise** and **Sensitivity Test,** ignore the defective channel except for the **Rate Method Test** [4].

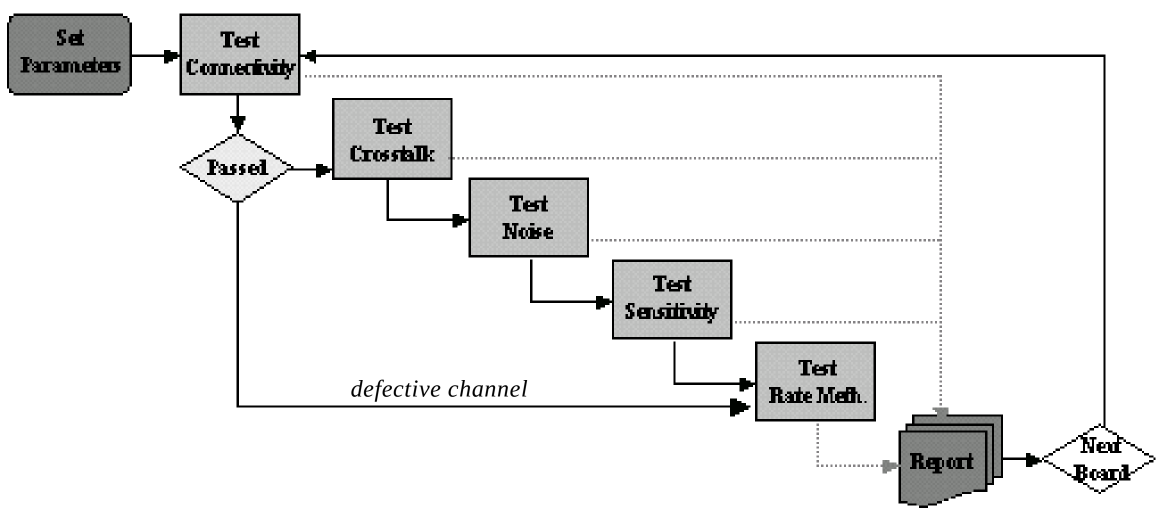


Fig. 1 - Test Routine

A 150pF input capacitor was used for all the tests. The used threshold value is the one measured at the ASDQ++ board input; only in the Crosstalk Test the threshold was measured at the PCB connector named ST1, which corresponds to the threshold on the chip.

In the Connectivity Test, 14 new ASDQ++ boards presented problems while all the boards already available at CERN did not show any serious problem.

2.1 Test Report

The software allows to save all the data measured through the test and, when the test is finished, it generates a report file (.htm). The report given comes with the board name, error messages, test tables (with test parameters), date, and some relevant test conditions at the end. It begins as shown in Fig.2.

Front-End Eletronics Test Station - FEET **11/04/2003**

BOARD asdqp 1001

ERROR MESSAGES

ch3 Open channel
ch5 Open channel
ch6 Open channel

CONNECTIVITY TABLE (%)

	Ch0	Ch1	Ch2	Ch3	Ch4	Ch5	Ch6	Ch7	Ch8	Ch9	Ch10	Ch11	Ch12	Ch13	Ch14	Ch15
Ch0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ch1	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Fig. 2 - Final Report Document

2.2 Connectivity Test

It is the simplest test but the one that will recognize more errors, in a very fast way. If there is any opened or short-circuited channel it is recognized by this test and with its results we can avoid doing the other tests on the failing channel. A table from the ASDQp1008 is shown in Fig.3.

CONNECTIVITY TABLE [%]

	Ch0	Ch1	Ch2	Ch3	Ch4	Ch5	Ch6	Ch7	Ch8	Ch9	Ch10	Ch11	Ch12	Ch13	Ch14	Ch15
Ch0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ch1	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ch2	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0
Ch3	0	0	0	100	100	0	0	0	0	0	0	0	0	0	0	0
Ch4	0	0	0	100	100	0	0	0	0	0	0	0	0	0	0	0
Ch5	0	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0
Ch6	0	0	0	0	0	0	100	0	0	0	0	0	0	0	0	0
Ch7	0	0	0	0	0	0	0	100	0	0	0	0	0	0	0	0
Ch8	0	0	0	0	0	0	0	0	100	0	0	0	0	0	0	0
Ch9	0	0	0	0	0	0	0	0	0	100	0	0	0	0	0	0
Ch10	0	0	0	0	0	0	0	0	0	0	100	0	0	0	0	0
Ch11	0	0	0	0	0	0	0	0	0	0	0	100	0	0	0	0
Ch12	0	0	0	0	0	0	0	0	0	0	0	0	100	0	0	0
Ch13	0	0	0	0	0	0	0	0	0	0	0	0	0	100	0	0
Ch14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100	0
Ch15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100

Fig. 3 - ASDQp1008 Connectivity Test Table

2.3 Crosstalk Test

Crosstalk is the second test to be done in the FEET test sequence. For this test we worked with threshold around 285mV. It was possible to see some interference between channels but it is still not possible to tell if this interference comes from the ASDQ due to shielding imperfection on the FEET system. At the used threshold, the new ASDQ++ boards have not presented much crosstalk problems while the other ones presented some. With an improvement on the shielding we believe this problem will be solved without much difficulty. A table from ASDQp1009 is shown in Fig.4.

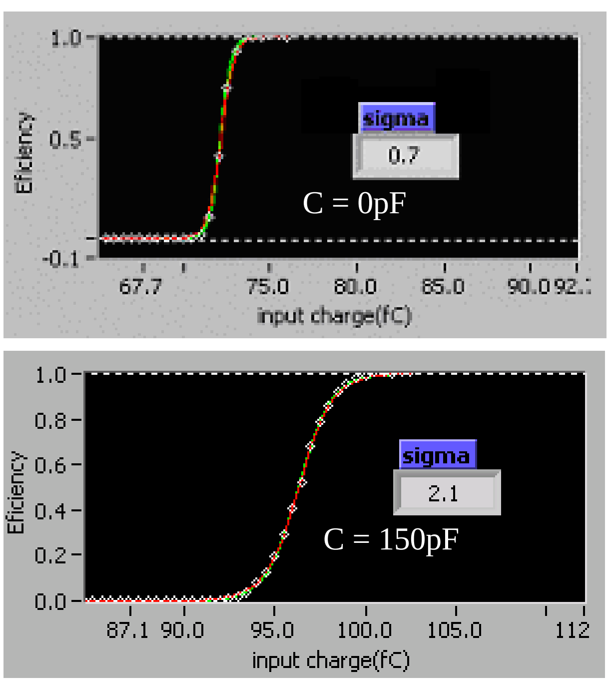
CROSSTALK TABLE (%)

	Ch0	Ch1	Ch2	Ch3	Ch4	Ch5	Ch6	Ch7	Ch8	Ch9	Ch10	Ch11	Ch12	Ch13	Ch14	Ch15
Ch0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ch1	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ch2	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0
Ch3	0	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0
Ch4	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0	0
Ch5	0	0	0	0	0	100	0	0	0	0	0	0	0	0	0	0
Ch6	0	0	0	0	0	0	100	0	0	0	0	0	0	0	0	0
Ch7	0	0	0	0	0	1	0	100	0	0	0	0	0	0	0	0
Ch8	0	0	0	0	0	0	0	0	100	0	0	0	0	0	0	0
Ch9	0	0	0	0	0	0	0	0	0	100	0	0	0	0	0	0
Ch10	0	0	0	0	0	0	0	0	0	0	100	0	0	0	0	0
Ch11	0	0	0	0	0	0	0	0	0	0	0	100	0	0	0	0
Ch12	0	0	0	0	0	0	0	0	0	0	0	0	100	0	0	0
Ch13	0	0	0	0	0	0	0	0	0	0	0	0	0	100	0	0
Ch14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100	0
Ch15	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	100

Fig. 4 - ASDQp1009 Crosstalk Test Table

2.4 Noise Test

The Noise tests presented very stable results and the S-curve acquisition and fitting worked as expected, having no errors through all the tests. Fig.5 shows the ASDQp1009 test table, and two S-curves (data and fitting results), for none and 150pF input capacitance.



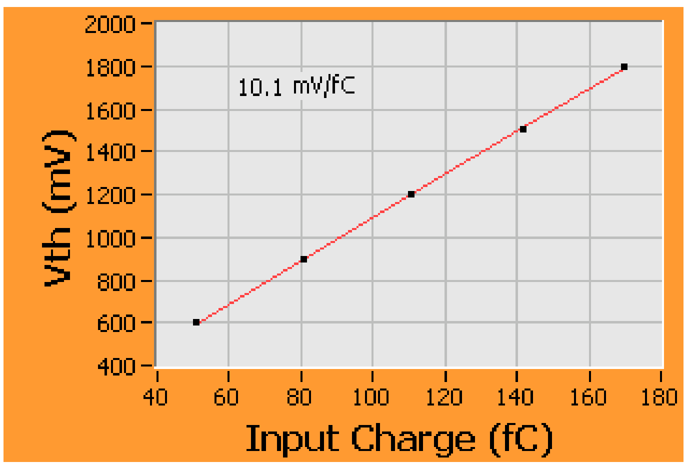
NOISE TABLE

	sigma (fC)	true th (fC)
Ch0	2.1	97.4
Ch1	2.0	95.6
Ch2	2.0	94.3
Ch3	2.0	96.9
Ch4	2.1	93.1
Ch5	2.1	97.4
Ch6	2.3	94.0
Ch7	2.2	94.7
Ch8	2.1	98.5
Ch9	2.2	98.7
Ch10	2.1	97.6
Ch11	1.9	96.9
Ch12	2.2	96.8
Ch13	2.1	98.5
Ch14	2.1	98.9
Ch15	2.2	96.9

Fig. 5 - Noise Acquisition Graphics and ASDQp1009 Noise Test Table

2.5 Sensitivity Test

Sensitivity tests have also shown very stable results. Fig.6 shows the ASDQp1010 channel-7 graphic and the ASDQp1005 board sensitivity test results. The new ASDQ++ boards sensitivity, with C = 150pF input capacitance, was somewhat around 10mV/fC. Although better calibration is needed it is possible to see the stability between the channels.



SENSITIVITY TABLE

	mV/fC	offset (mV)
Ch0	10.0	81.8
Ch1	10.1	52.4
Ch2	10.0	81.8
Ch3	10.0	66.1
Ch4	9.8	68.1
Ch5	9.9	63.6
Ch6	9.8	87.1
Ch7	10.0	41.1
Ch8	10.1	35.7
Ch9	10.2	84.7
Ch10	10.1	71.9
Ch11	10.0	79.6
Ch12	10.1	78.9
Ch13	10.1	95.3
Ch14	10.1	86.7
Ch15	10.0	91.7

Fig.6 - ASDQp1004 channel0 Sensitivity Graphic and ASDQp1015 Test Table

2.6 Rate Method Test

From the ASDQp1001 Rate Method test table, it is easy to see how channels 3, 4 and 5 are different due to an open connection. Their behavior is like a channel with input capacitance equal to zero, a clear indication to localize the problem. With the four first columns it is possible to rebuild the test curves. Each graphic contains two curves; each curve is related with a different gain set-up of the ASDQ++ chip. The *vertex frequency* represents the y-axis value and the *th_pedestal* represents the x-axis value of the crossing point between both curves, the third and fourth columns represent the x-axis value when y=0.

Fig. 8 shows a good channel behavior of the Rate Method test and Fig. 9 shows an opened channel. Both tested by FEET.

RATE METHOD	vertex_frequency (Hz)	th_pedestal (mV^2)	IATT0V_Xmax (mV^2)	IATT3V_Xmax (mV^2)	slope_0V	slope_3V
Ch0	1630059093	14	71	36	-372	-966
Ch1	1214477328	14	76	39	-340	-856
Ch2	1083974762	13	69	34	-371	-989
Ch3	3574234279	10	29	18	-1126	-2727
Ch4	616347886	12	71	34	-345	-926
Ch5	66066940478	7	26	16	-1334	-2702
Ch6	52513460393	7	26	17	-1295	-2572
Ch7	61693822371	13	55	27	-596	-1836
Ch8	1924862212	12	67	33	-388	-1045
Ch9	3729955810	9	63	33	-406	-937
Ch10	670512540	13	73	36	-338	-893
Ch11	817210111	10	66	32	-363	-931
Ch12	918700736	12	69	34	-360	-942
Ch13	1051200036	13	75	38	-337	-845
Ch14	6433002500	11	59	28	-469	-1311
Ch15	20777431782	11	60	28	-486	-1361

Fig. 7 - ASDQp1001 Rate Method Test Table

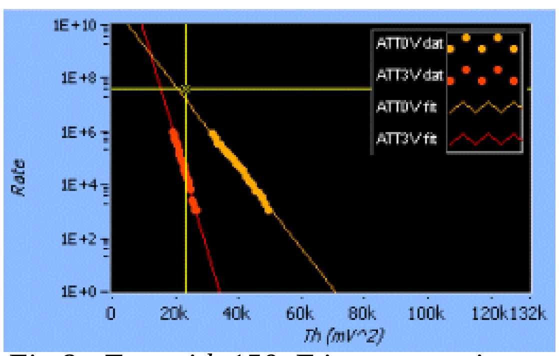


Fig.8 - Test with 150pF input capacitor

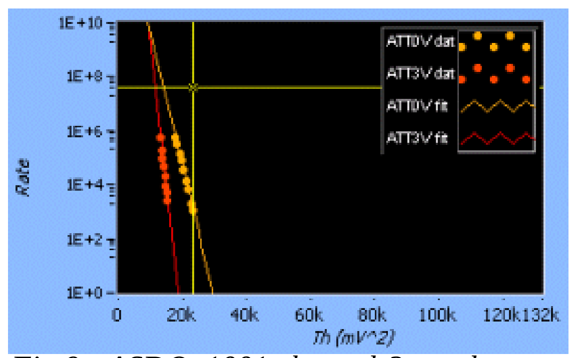


Fig.9 - ASDQp1001 channel-3 result

In a well-behaved channel test, the curve parameters, given by the rate method table, provide important information but different kind of problems are expected and some times these parameters are not enough to describe a channel behavior through the Rate Method test. Fig. 10 and 11 show the graphic result of two open channels, the ASDQp1002 channel 7 and ASDQp1017 channel 5, Although the channel in the Fig. 11 test is open, the Rate Method parameters would respect the values expected. These results show that a diagnostic on the fitting mean squared error (mse) must be taken in account in order to, in case the test presents an mse over the expected value, indicate whether examinations on the data points should be made.

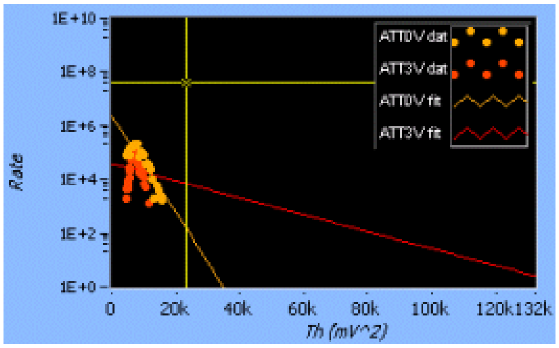


Fig10 - ASDQp1002 channel 7 result

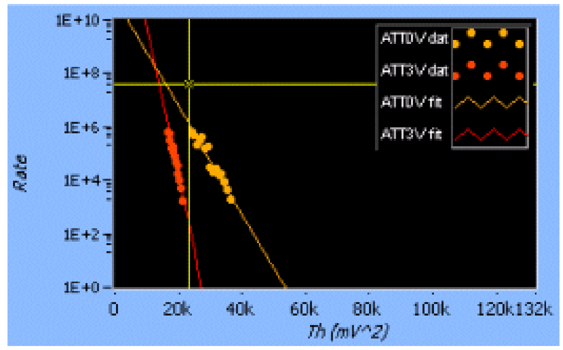


Fig.11 - ASDQp1017 channel 5 result

3 ASDQ++ Board Problems

The positive-board problems were quickly investigated and most of them were found in the input transistor pin connections as listed in table 1, full information about ASDQ++ board can be found in Ref.[5].

ASDQp1001
Channel 03 – component Q68, base lead is not connected to GND
Channel 05 – component Q24, base lead is not connected to GND
Channel 06 – component Q47, base lead is not connected to GND

ASDQp1002
Channel 7 – component Q69, base lead is not connected to GND

ASDQp1004
Channel 04 – component Q1, base lead is not connected to GND

ASDQp1007
Channel 08 – component Q2, base lead is not connected to GND

ASDQp1008
Channel 03 and 04 – short-circuited between component pads R102-R104

ASDQp1012
Channel 00 – component Q0, base lead is not connected to GND

ASDQp1017
Channel 5 – unknown (Open Channel)

ASDQp1018
Channel 12 – component Q3, emitter lead is connected to GND

Table 1 – Problems found on the boards after diagnostics indication. Transistors are indicated by Q.

Table 2 indicates the defective channels for the negative boards given by the FEET test diagnostics. It should be investigated where the problems are located.

ASDQn0003
- Channel 01 – Open Channel
- Channel 02 – Open Channel
- Channel 03 – Open Channel
- Channel 04 – Open Channel
- Channel 05 – Open Channel
- Channel 06 – Open Channel
- Channel 07 – Open Channel
- Channel 14 – Open Channel

ASDQn0008
- Channel 01 – Open Channel
- Channel 15 – Noisy Channel

ASDQn0009
- Channel 01 – Open Channel

ASDQn0013
- Channel 01 – Open Channel

ASDQn0014
- Channel 06 – Open Channel

ASDQn0017
- Channel 03 – Open Channel

Table 2 – Problems found on the negative boards by FEET diagnostics.

4 Conclusions

This note describes the first results obtained with the FEET System. All the results meet the expectation. Connectivity, Sensitivity, Noise and Rate Method are working correctly. For the Crosstalk test it was concluded that a better shielding system on the FEET injector board is needed, and an accurate calibration might also be needed. These improvements would provide better results in all test methods.

A full paper with all information about FEET System is being prepared and, soon, it will be available.

References

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[6] V. Radeka, "Low Noise Techniques in Detectors", Ann. Rev. Necl. Part. Sci. 217-277 (1988).