



CERN-Data Handling Division
DD/85/20
September 1985

CERN Contribution to the Analog Readout Electronics
of the TEC Mark J at DESY

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August 85

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1. INTRODUCTION

This note summarises the work done by CERN for the analog readout electronics of the TEC Mark J at DESY.

The equipment was shipped to ETH Zurich by end July 85 to be installed for a test in September at DESY and later in the Mark J detector.

The TEC Mark J detector is considered as a prototype for the central detector for L3.

2. CONFIGURATION

The analog readout electronics designed and constructed at CERN comprises

- 24 pre-amplifier units (+ 6 spares)
- 168 x 60m coax. readout cables (10 km, 2.8 mm diam.)
- 24 cable equalizer amplifier units (+ 6 spares)
- 1 remote controled test pulse generator connected to each of the 168 channels
- power supplies with remote control and safety interlocks
- TEC track pulse simulator for the adjustment of the pulse shaping amplifiers constructed by the university of Siegen.

Each pre-amplifier unit contains seven channels each consisting of

- 7 pre-amplifiers (2 modules thick film hybrid circuits)
- HT-breakdown protection circuits (2 modules)
- test pulse injection
- HT distribution and decoupling network for the anode wires
- 3 m coax. cable transmitting the signal to an interconnection point outside the chamber

The pre-amplifier units are incorporated in the TEC chamber assembly. After having been amplified in the pre-amplifier the track signals are transmitted via 30 m long cables to the cable equalizers located in a rack outside the confined area of Mark J. The cable equalizers send the signals via 30 m long cables to the counting room, compensating the losses in the cables and restoring the original pulse form. They also provide for an additional 3.2 times signal amplification.

A block diagram of the electronics is shown in fig.1.

Complete details of the electronics can be found in annex 1.

3. DESIGN PRINCIPLES

3.1 Pre-amplifier

The pre-amplifier type MSD2 developed for silicon microstrip signal readout by P.Jarron, CERN was chosen to replace the original design by J.Paradiso, ETH Zurich. As explained in detail in ref.1, it has the following advantages

- 4 times lower power consumption
- better linearity
- much smaller size due to thick film hybrid technology
- commercially available

3.2 Signal Transmission by Coax. Cables

Coax. cables are used for signal transmission because for single ended TEC type fast signals they assure about 10 times smaller cross coupling between neighbouring channels than flat cables or twisted pairs.

3.3 Very High Reliability

In Mark J the pre-amplifier units will be very difficult to access for replacement. To avoid the need of replacing them, special measures were taken to ensure very high reliability:

HT capacitor aging

All HT capacitors were aged during 100 hours at 85 C. By this action 3% of the capacitors were detected which otherwise would probably have failed during the experiment, putting the corresponding channel or even the half segment of the chamber out of operation. For details see annex 2.

Improved HT protection circuit

The traditional diode circuit which was supposed to protect the input of the pre-amplifiers from the effects of HT breakdowns in the chamber had proved not to be 100% efficient. It was replaced by a new one which did not fail during 10 million test discharges.

4. REPORT ON FINAL TEST RESULTS

Annex 3 shows the results of the tests undertaken after the system was completed and assembled. The pre-amplifier output signals as a response to a test pulse are listed for later reference.

5. WORK PERFORMED FOR TEC MARK J

In Annex 4 the contributions of CERN to TEC MARK J are listed in detail.

6. COST AND FINANCING

Annex 5 presents a review of the material cost of the TEC analog readout electronics. The main points are:

6.1 Total Material Cost

The total material cost amounts to 67 000 sFr.

6.2 Financing

ETH has payed 45 000 sFr.

CERN has contributed 22 000 sFr.

CERN's contribution is about 1/3 of the total cost. The major part of it consists of labour for wiring representing the equivalent of 19 000 sFr. For further details see Annex 5.

6.3 Comparison with the 1984 estimation

The original estimate in June 84 was 54 000 sFr. [ref.2]

The difference between cost and estimation is due to the following facts

- transmission of the signals over 60 m
instead of 30 m 4 500 sFr.
- more sophisticated HT breakdown protection
- mechanical cost is now included
- remote power control 1 200 sFr.
- more spare parts than originally foreseen
- higher cost of MSD2 2 500 sFr.

Taking these modifications and improvements into account the final material cost remains well within the estimates.

References

1. H.Anders: Comparison between the Pre-amplifier developed by EHT Zurich for TEC with the Pre-amplifier developed by CERN, 21.DEZ.83; included in the 'Minutes of the Vertex Chamber Group Meeting, DESY, 16/03/84'.
2. Minutes of the Vertex Chamber Subgroup Meeting, Zurich, 12-14/06/84, p.17-18/2 (L.Sohet).

Annexes

1. TEC MARK J Analog Readout, Electrical and Mechanical Drawings.
2. Status after Aging of the HT Capacitors.

3. Tests on the TEC Analog Readout Electronics.
4. Work performed by CERN for TEC MARK J.
5. Budget Status of TEC Analog Readout Electronics.

Note: As the annexes 1 to 3 contain technical details (circuit diagrams, component layout, mechanical details, detailed test results) and annex 5 financial details which are not of general interest they are not normally attached to these notes. The authors will be pleased to send them on request.

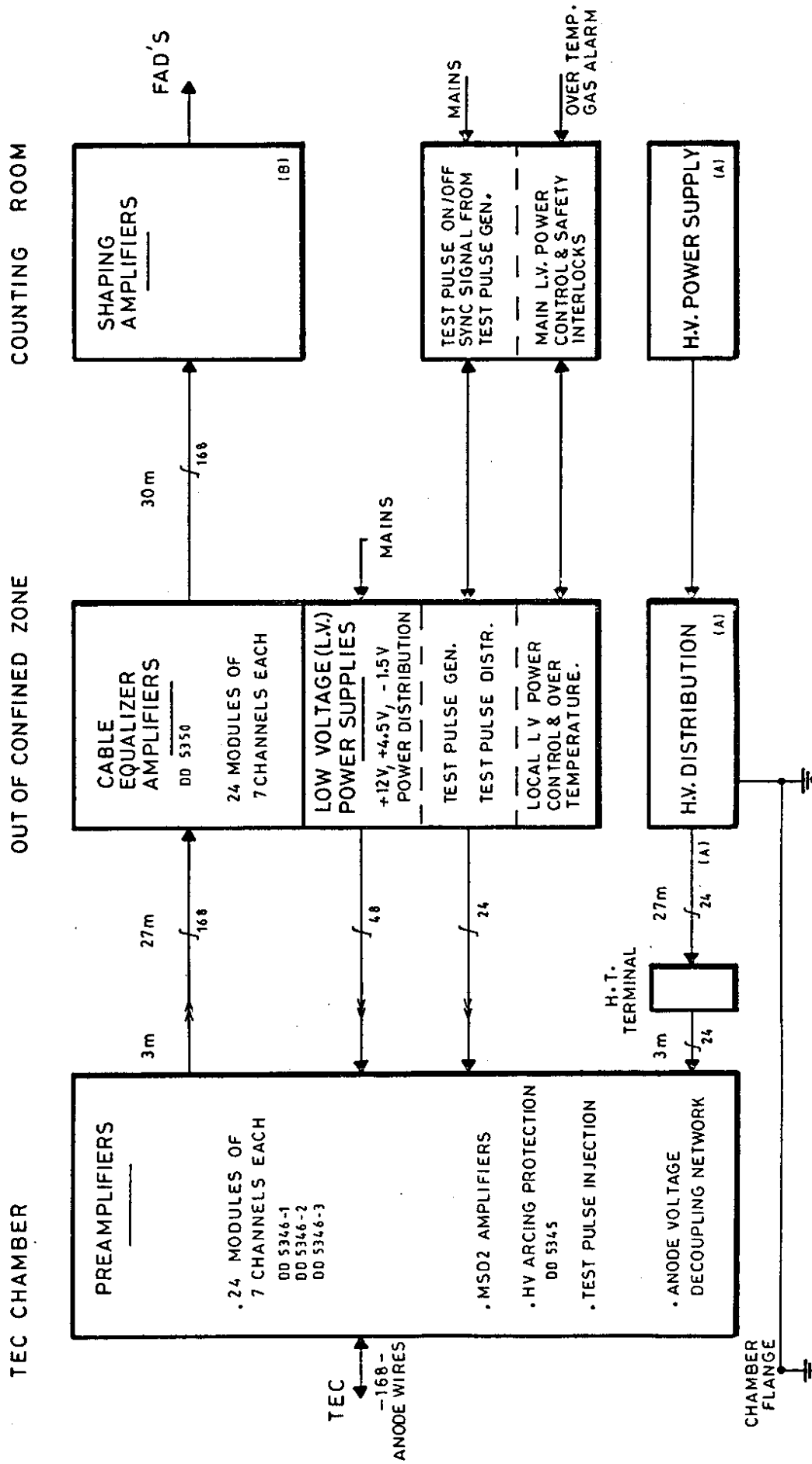


Fig. 1 — Block Diagram of the TEC MARK-J Analog Readout.

ANNEX 4

WORK PERFORMED BY CERN FOR TEC MARK J.

- = Development of the circuits for TEC ANALOG READOUT.
 - H.T. breakdown protection.
 - Test pulse injection circuit.
 - Cable Equalizer Amplifier.
 - TEC pulse simulator.
- = Design, construction, wiring and test of 3 crates.
 - Power control unit & safety interlocks.
 - L.V. power supplies and test pulse generator unit.
 - Cable Equalizer Amplifiers unit.
- = "Burn in" at 85°C and 4 KV during 100 hours of 1000 high voltage capacitors.
Measurement of the leakage current of these capacitors.
- = Wiring, assembling and tests of 30 TEC preamplifier units.
- = Test and adjustment of 30 Cable Equalizer Amplifiers.
- = Labelling cables (1300 labels) and construction of cable-forms.
- = Assembly and global test of the system.
- = Technical documentation.
- = Test set-up for 2 chamber segments for the tests carried out in Aachen and Hamburg during spring 85.
- = Design and construction of a TEC pulse simulator.
- = Technical participation during test carried out at Zurich, Aachen and Hamburg.