A Safe Public Address System For Accelerator Rooms

Erland Müller – erland.mueller@desy.de

– MPS – Hamburg

International Workshop on Accelerator Operations, Trieste, September 2007

Abstract

Accelerator rooms have to be cleared of persons, before beam operation can be permitted. At DESY a combination of safety procedures and a relay based interlock system is employed: Accelerators are thoroughly searched and a door interlock prevents unsupervised access. Additionally, visual and audible warnings should alert anyone accidentally left behind in accelerator rooms to escape or to activate emergency stop. Beam permission therefore requires the sounding of an automatically generated announcement, reduced illumination and flashing or rotating beacons.

How do we then ensure, the audible warning was indeed transmitted? An inaudible pilot frequency is added to the announcement and its level is detected at the far end of the wiring connecting the speakers to the amplifier. If the level is good, a relay will signal correct operation to the interlock logic.

The poster explains the micro-controller run PA system, shows relevant block diagrams and the collaboration with the personnel interlock. This set-up currently is used at FLASH, Linac2 and DESY2 accelerators. For PETRA3 we are developing a PC controlled variant.

Introduction

Operators in the control room do not see much detail of the relay logic safeguarding accelerator operations. A GUI shows the actual status of the computer surveyed, relay controlled personnel interlock system (Fig. 1). This interface also explains the underlying logic; the visual and audible warnings can be started only if all preconditions are met: The door interlock has to be set (guaranteeing the accelerator rooms have been searched), all keys have to sit in their key boxes (no supervised access to accelerator rooms) and no emergency stop button must be engaged.

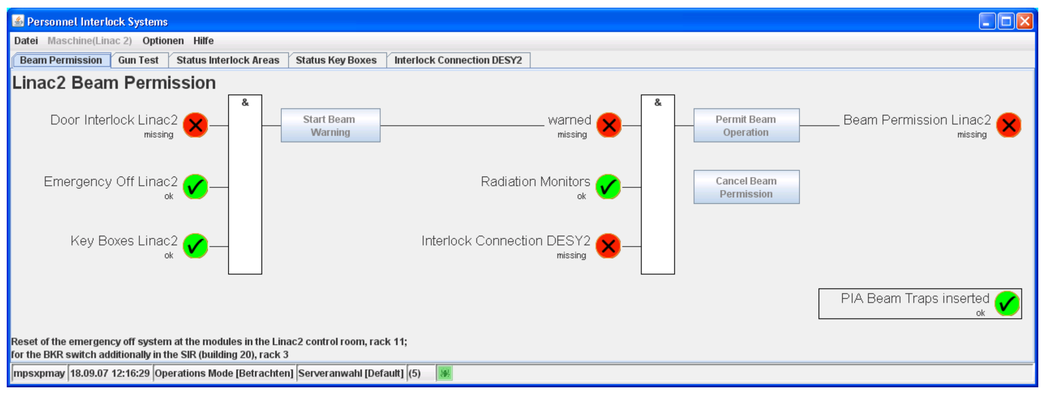

Fig. 1: Screen shot of beam permission operation program

The preconditions given, operators can start visible and audible warnings by mouse click. While the PA system is transmitting the warning a closed relay contact starts a hardware timer, which after 90 seconds enables the “warned” state. If any precondition is not met, warnings and warned state is reset unconditionally..

PA System Overview

The PA system is composed of the integrated PA controller, power amplifiers and speakers. It is connected to the intercom system, the contingency PA, the relay logic and one or two field computers. We call the PA control integrated, because it unites the formerly separate devices: Solid state voice player, multiplexer and controller unit, amplifier supervision and mixer.

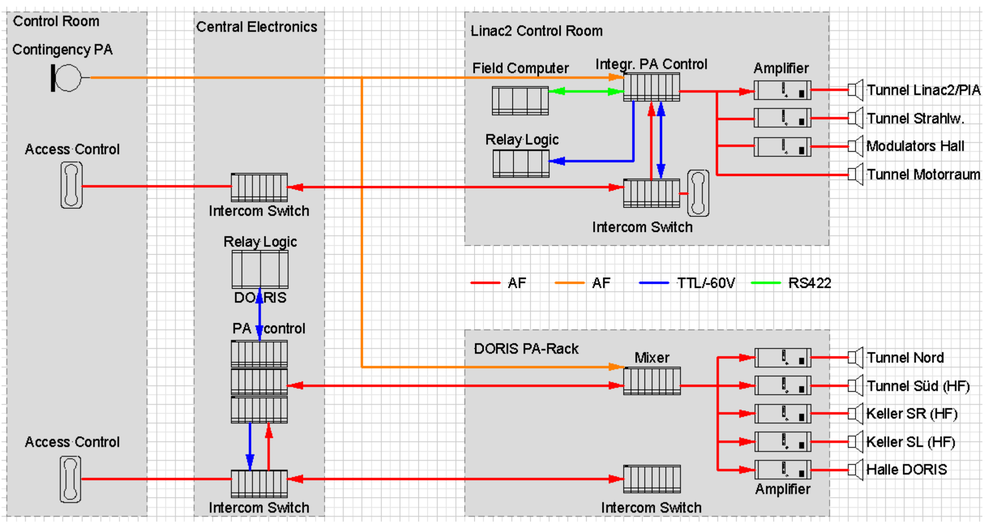

Fig. 2: PA system signal flow diagram (simplified)

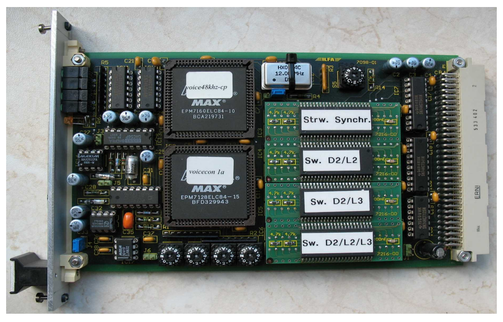

Fig. 3: Solid state voice player

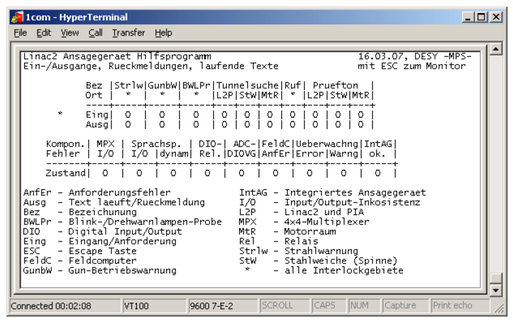

Fig. 4: PA controller program screen

Fig. 5: Integrated PA controller (front view)

The PA Controller's Features

The solid state voice players can store up to 12 different announcements, of which three can be transmitted simultaneously in 5 separate accelerator areas and the control room also. One 12 W power stage is integrated, sufficient for smaller rooms. There are 5 audio frequency inputs for connection to neighbouring accelerators, operator announcements and the contingency PA system. Not shown in Fig. 6 are the 16 relay outputs, 4 digital I//O-ports, two serial RS422 devices and one VT-100 terminal connector.

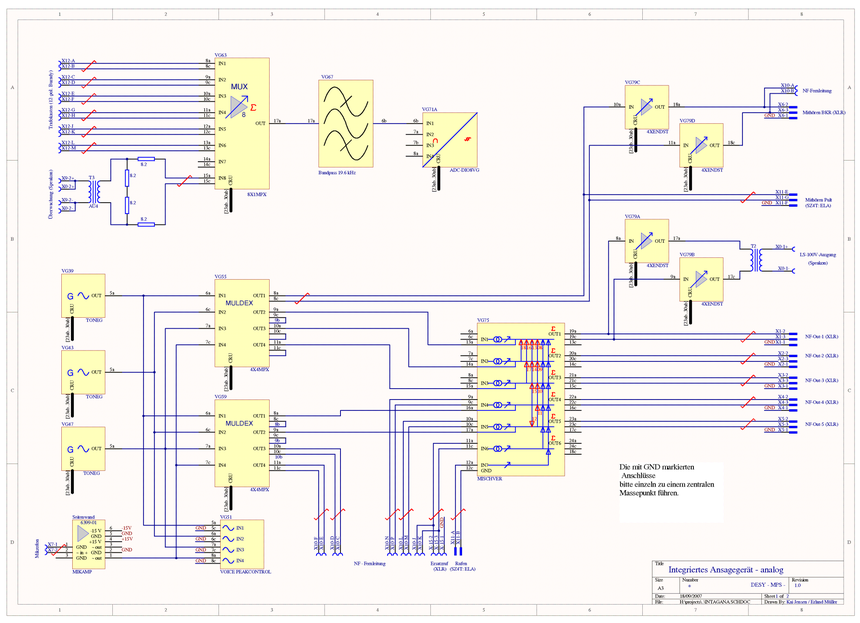

Fig. 6: Integrated PA control crate wiring diagram

Automatic Supervision

A pilot frequency of 19.6 kHz is added to the stored announcement “beam warning”. The far end of the lines connecting the speakers is fed back to the PA controller crate. This signal is filtered and rectified, before AD conversion (Fig. 6). If its level is within a predefined range and no other errors are identified, two relays are activated, signalling correct warning to the personnel interlock relay logic.

To date the supervision inhibited beam permission once: An otherwise undetected power supply failure of an amplifier had prevented proper audible warning.

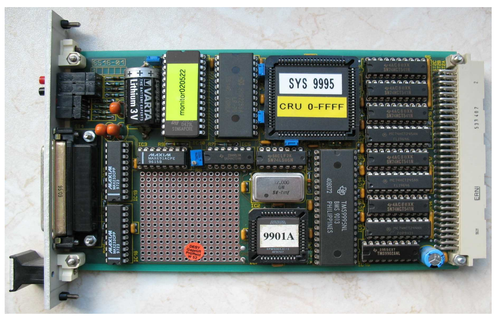

Fig 7: TMS 9995 µC board (above)

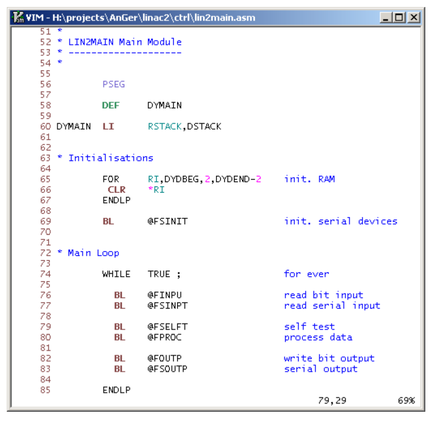

Fig. 8: Main loop of the program (right)

Acknowledgements

Dietrich Ramert developed the modular concept, designed the high quality audio modules and wrote the original software. Oliver Matzen designed and built the solid state voice player module and the microprocessor board. Kai Jensen took care of the crate's assembly and installation. The screen shot (Fig. 1) is provided by the GUI's author: Andreas Labudda. The photographs are by Stefan May. Thank you all.