TELEPHONE ALARM BROADCASTING FOR TPS RF SYSTEM

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Abstract

The Taiwan Photon Source (TPS) consists of three 500-MHz RF systems: two sets of RF systems with KEKB-type single-cell SRF modules are used for the 3-GeV storage ring, and one with five-cell Petra cavities at room temperature is used for the booster synchrotron. To monitor the status of the RF systems and to broadcast the error or alarm messages to the RF staff, we developed a telephone alarm broadcasting system; this paper introduces the hardware and software structure of this system.

INTRODUCTION

A third-generation, high-brightness synchrotron light source, Taiwan Photon Source (TPS), is under construction at National Synchrotron Radiation Research Center (NSRRC), and is scheduled to be commissioned at the end of 2013. It consists of a 150-MeV electron linear accelerator, a booster ring and a 3-GeV storage ring.

The booster RF system consists of a five-cell PETRA cavity at room temperature, powered by a retired crowbar-type transmitter that was upgraded to RF output power 100 kW, and a home-made analogue low-level RF system[1]. Two KEKB-type single-cell superconducting RF (SRF) modules will be installed in the storage ring. The RF source of the storage ring is provided by a klystron (300 kW, Thales) with a RF transmitter (Thomson). To protect the SRF cavities from both contamination and performance degradation, two five-cell PETRA cavities at room temperature will serve for the machine commissioning. The routine operation of the two SRF modules is scheduled after the first quarter of 2014.

To maintain the SRF modules in routine operation, some signals of the peripheral systems must be under severe monitoring, such as the level of liquid helium in the dewar of the cryogenic system. Some signals change at a small rate, and trips of such systems are avoidable. The alarm broadcasting system is a tool used to monitor such signals. Once the value of a signal transcends a set limit, the system announces an alarm message to the RF staffs via short text and voice messages. If the weakness is solvable immediately, a system trip is thus avoided. The structure of the alarm broadcasting system is introduced in the following sections.

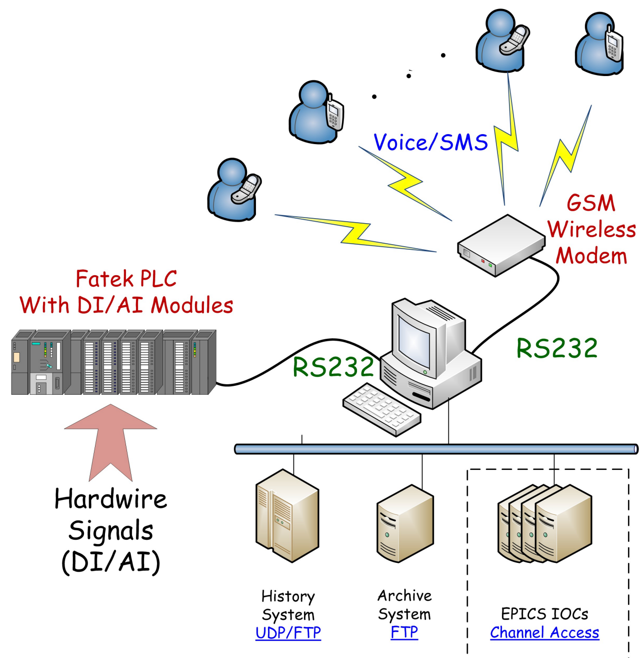

Figure 1: Hardware structure of the broadcasting system

THE TELEPHONE BROADCAST SYSTEM

Hardware Structure

Figure 1 shows the hardware structure of the telephone alarm broadcasting system. The system includes a PC, a set of programmable logic controllers (PLC) and a GSM wireless modem.

Hardwired analogue signals are compared in the PLC with high or low limits to trigger an alarm logic signal. The digital input signals of the PLC are alarm signals themselves. The PLC communicates with the PC via a serial connection. All alarm logics from the hardwire signals are then forwarded to the PC to make a more complicated decision.

In addition to the hardwired signals from the PLC, the PC collects data from the TLS archive systems, i.e. the history and archive systems, and the EPICS IOC [3, 4] through Ethernet. Complicated logic operations, such as combining two or more alarm logic, can be further calculated on this PC to generate the final alarm broadcasting decision.

Once the PC announces an alarm, it sends control codes via the serial communication to awaken the GSM wireless modem. A short message, which describes the machine

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status, is sent to RF staffs. Through a stereo audio cable connected between the PC and the GSM modem, audio messages are broadcast individually to predefined persons.

Software Architecture

Alarm Decision Loop Figure 2 shows the decision loop of the alarm system. In this loop, the alarm status of all signals might be set or released depending on the signal alarm configuration.

Monitoring a signal might be scheduled or manually disabled. For example, when the machine is shut down for weekly maintenance, parts of the signals should be off monitoring. The schedule of signals and their enabled properties hence become tested at the beginning of this loop. If the signal is disabled or not in the schedule, the program bypasses this one and continues checking the next signal.

If the signal has monitoring enabled, the program then verifies the alarm state of the signal. If the signal is not in the alarm state, the program then tries to obtain the signal value from the external resources and to test the signal whether it attains the user-defined limit. Otherwise, the program must verify whether the alarm state of the signal could be reset.

Two reset strategies for the alarm state are defined in this program. The state can be reset by either a timer or the inverse logic operation of the alarm condition. After the alarm signal is reset, this signal becomes remonitored by the program.

Alarm Queue Processing When a sub-system of the storage ring is malfunctioning, the RF system might also be shut down. The alarm state of many signals might be switched on at the same time. Broadcasting all messages of the alarm monitoring signals is extremely impractical. A queue processing loop serves to avoid this situation.

As shown in Fig. 2, when a signal transcends a limit and switches to its alarmed state, the signal becomes inserted into a queue. After the decision loop is finished, the program tests whether the queue is empty.

Figure 3 illustrates the contents of the processing loop for the alarm queue. At the beginning of the loop, the program tests the size of the queue. This loop handles only a non-empty queue. If the queue is non-empty, this loop sorts the signals in the queue according to the priority of the signals. An enhanced priority of the signal correlates with a more important signal. In addition to the priority sorting, an emergent signal might also exist in the list of monitoring. An emergent signal means that the signal is the most important and requires urgent attention. For example, the cryogenic system is essential to SRF cavities; some parts of the cryogenic signals that are more important than others, such as the level of liquid helium in the vessel, might be set to be emergent. If an emergent signal exists in the processing queue, the program processes this signal first, and next processes the signal of maximum priority.

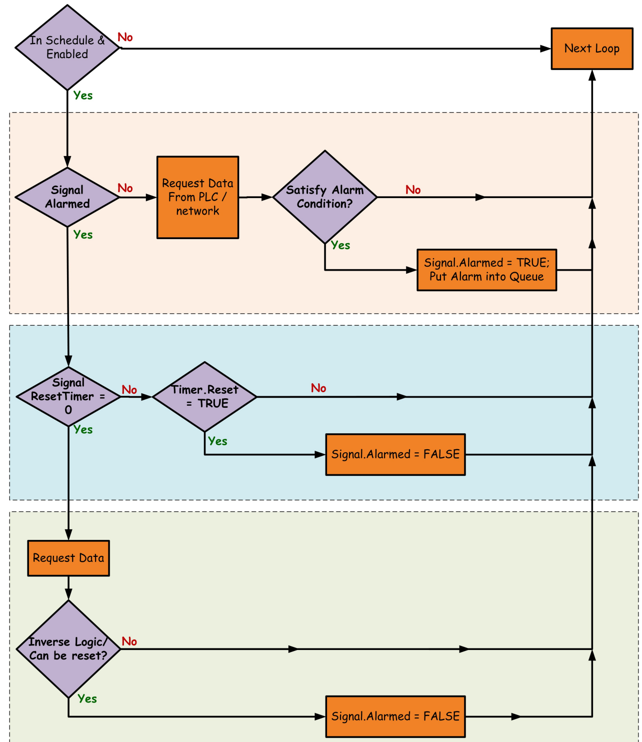

Figure 2: Architecture of the decision loop of the alarm system

Alarm Publication Subroutine When a signal is in process at the end of the alarm queue (Fig. 3), the program counter transfers into the alarm publication subroutine. Figure 4 describes the procedure of the subroutine for alarm publication. Information about the alarm contact persons is stored in each individual alarm signal. Each alarm signal might contain various contact persons with varied priority. This subroutine therefore checks the telephone book, which comprises a collection of contact persons. If the phone book is not empty, the contact persons of the alarm-activated signal are placed into a queue and sorted in an order according to the priority of the contact person. The subroutine then connects to the GSM wireless modem, sends a short text message and voice message to the contact person sequentially, and finally disconnects the link with the modem.

SUMMARY

A telephone alarm broadcasting system for TPS RF system is being developed. A PC collects data from the PLC and networks. A powerful logic computation is built into the software, which makes the system flexible. A GUI, as shown in Fig. 5, is applied also for users to verify and to record the status of each monitoring signal. The alarm broadcasting system monitors the signals, announces unhealthy signal messages to RF staff, and eventually prevents the RF system from unnecessary trips.

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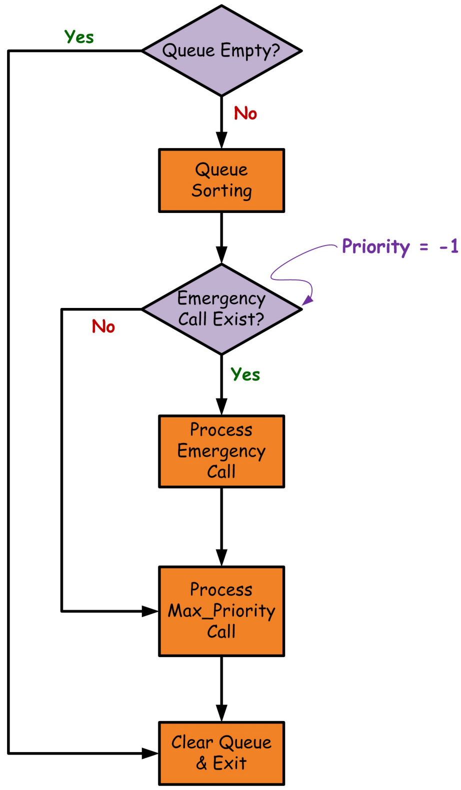

Figure 3: Queue processing

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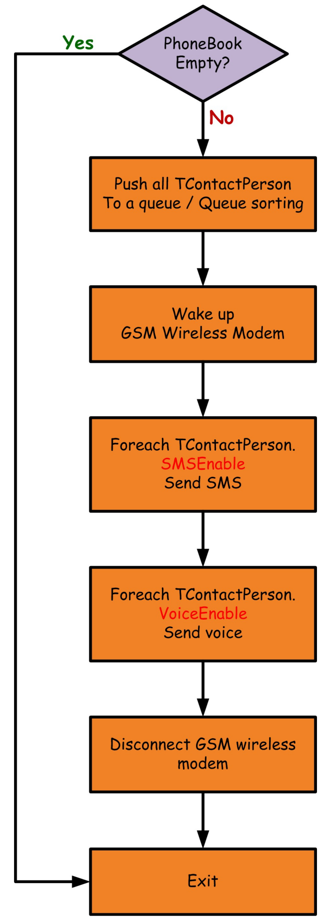

Figure 4: Alarm publication subroutine

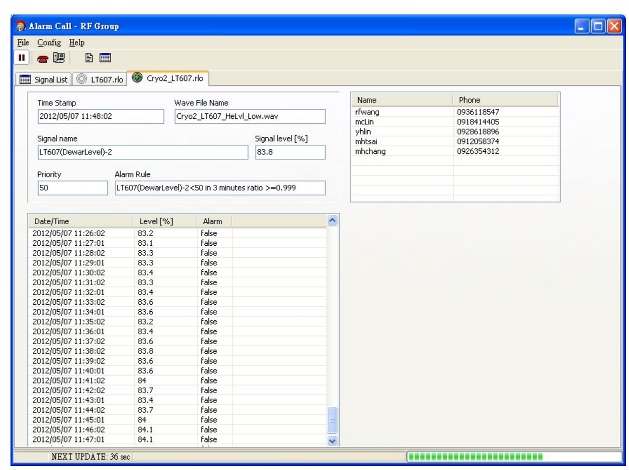

Figure 5: Screenshot of the alarm broadcasting software