INTELLIGENT TELEMETERING OF SUBSCRIBER LINES IN DIGITAL COMMUNICATION SYSTEMS

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This paper briefly describes the implementation of the test system of the PRS digital communication system. The subscriber lines connected directly to a communication terminal unit can't be tested from the exchange in the traditional way. This new test system helps the technician to get maintenance and diagnostics of remotely ended subscriber lines.

1. INTRODUCTION

For the past decade the telecommunication network has seen significant changes in both the type of equipment being installed and the procedures and support used in operating the network. Electronic switches are replacing electromechanical ones, and digital transmission systems, radio and light guide transmission systems are used instead of copper cables.

Microprocessor technology is also allowing more and more intelligence to be built into the network components. Intelligent transmission components can perform self-tests, and can test the other elements of the system. The results of the distributed and automated tests can be watched on a maintenance display at the exchange.

In the case of long established exchanges, the subscriber lines are directly connected to exchanges. The line tests can be performed on-site at a local test desk by a dispatched technician. The traditional measuring methods can not be used in those cases, when the subscriber lines are connected only to a remote control, switch or interface unit, and for example there is a digital transmission system between the remote unit and the exchange. The problem can be solved with one of two ways:

- to lay down a metallic, measuring cable, parallel with digital lines, to access the line to be tested via this channel,

- to examine subscriber lines remotely at the junction points with a remote line test circuit connected to the lines. A centralized test location controls intelligent remote telemeters: sends several commands and receives the result.

Both methods have advantages and disadvantages, too. Advantage of the first one is for example: the maintenance personnel can use the old test desk, and every subscriber line belonging to the same exchange needs only one test equipment. Using the second method the measuring sets are located at the terminal units driving subscriber lines and so eliminate measuring errors because of long measuring lines. The remote line test equipment can test subscriber lines belonging to it automatically and periodically without central command and detects troubles, diagnoses problems often before the customers, themselves are aware of them.

2. DIGITAL TELECOMMUNICATION NETWORK /PRS/

The PRS /PCM Remote System/ is a digital remote switching unit designed to increase the capacity and services of traditional exchanges. The structure of PRS is shown in Fig. 1. The units of PRS, namely PCM Remote Adapter /PRA/, PCM Remote Controllers /PRC/ and PCM Remote Terminals /PRT/ are multimicroprocessor controlled with high reliability. The communication paths between any two units are primer PCM lines at a rate of 2 Mbps. The PRA unit is an interface between an analog exchange and the digital PRS system, and it is located usually in the building of the exchange.

The MMI /Man-Machine-Interface/ unit connected to the PRA has a consol display for the operators of the PRS. PRC is the central controller of the PRS. It assigns the time slots to the incoming and outgoing calls with the help of an electronic microprocessor controlled time-space-time switch, registers the status of subscriber lines, receives the call numbers via MFC from an analog exchange, sends the numbers dialed to the analog exchange via MFC.

The PRT is the terminal unit of PRS. The metallic, analog subscriber lines are connected directly to it. PRT has subscriber interface circuits for each subscriber. It consists of principally SLIC /Subscriber Line Interface Circuit/ and CODEC unit with BORSCHT functions. The PRT generally controls and monitors the subscriber sets on physical level: detects the change of
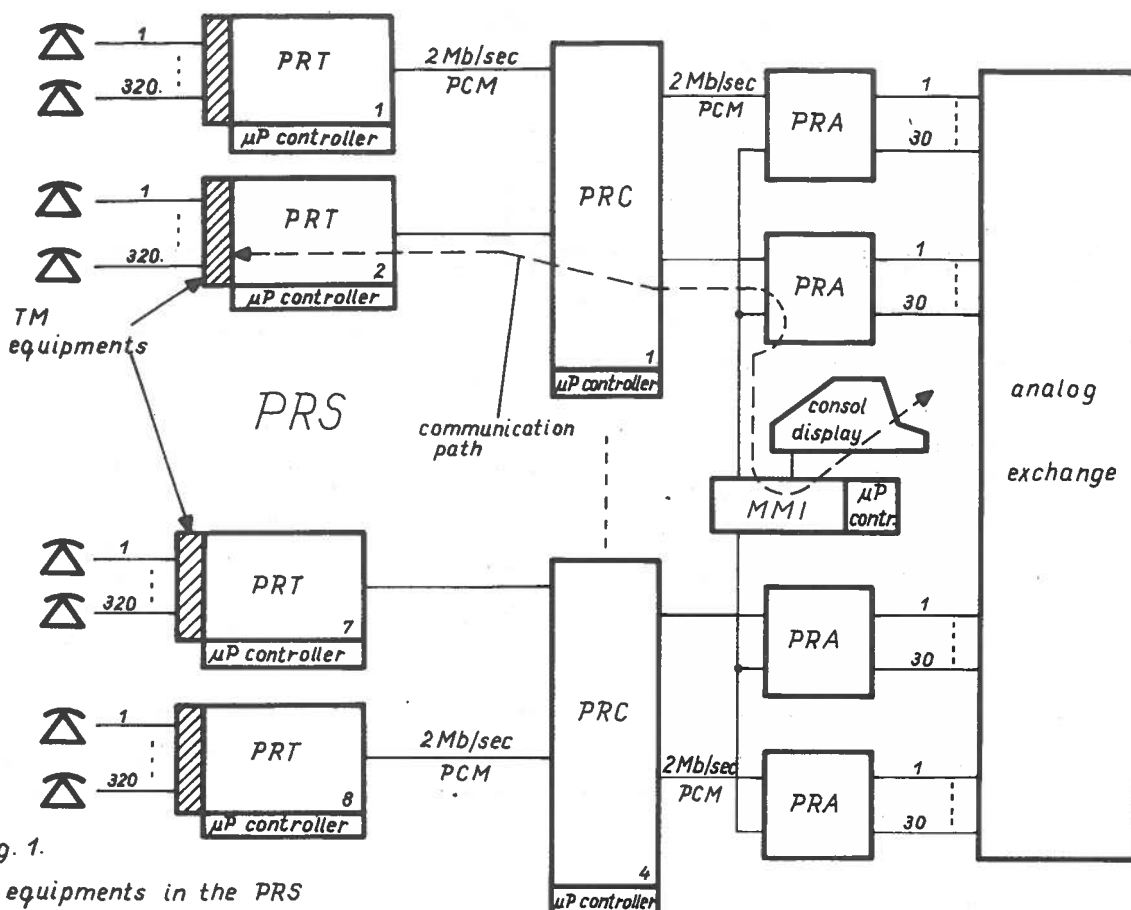
Fig. 1.

TM equipments in the PRS

hook status, identifies the call numbers, rings the selected subscribers, e.t.c.

Note, that there is a long distance between the exchange, where the maintenance staff is located and the less reliable network of subscriber lines. Therefore a telemetering unit /TM/ was made into each PRT to test the electrical state of lines. The telemetering unit connects to two test buses:

- subscriber line test bus,
- internal test bus.

A test relay was put in between each SLIC and its subscriber line, and this relay can connect them to the test buses: SLIC will be connected to the internal test bus, and the line to the subscriber line test bus /Fig. 2/.

The Telemetering unit is a general purpose measuring and testing equipment with microprocessor control. It can be controlled in two ways:

- from the exchange, from the maintenance consol display with intelligent commands; the results of the tests are given back to the display. The commands and the results are passed through: consol display – MMI – PRA – PRC – PRT – TM and back,
- the second way of TM control is the direct PRT control for periodically testing the essential characteristics of sub-

scriber lines and subscriber circuits. In this way an error message will be transmitted to the consol display only if a measurement results out of specified range is detected.

3. TELEMETERING IN PRS

There are much test jobs on both of the test buses. You can test or measure following parameters of the subscriber lines:

- foreign potential on the lines,
- insulation resistance between the lines and the ground,
- loop resistance,
- capacitance between the lines,
- detection of "switched on" condition of subscriber set,
- dial speed testing, and
- "Howler tone" generation.

The tests on the internal test bus /at the SLIC/ are the following:

- loop current /at several terminations/,
- ground symmetry,
- mismatch /reflection/,
- transmission loss from exchange to subscriber,
- noise in quiet channel, and
- ringing signal detection.

The telemetering unit can perform two complex tests, examining how the connec-
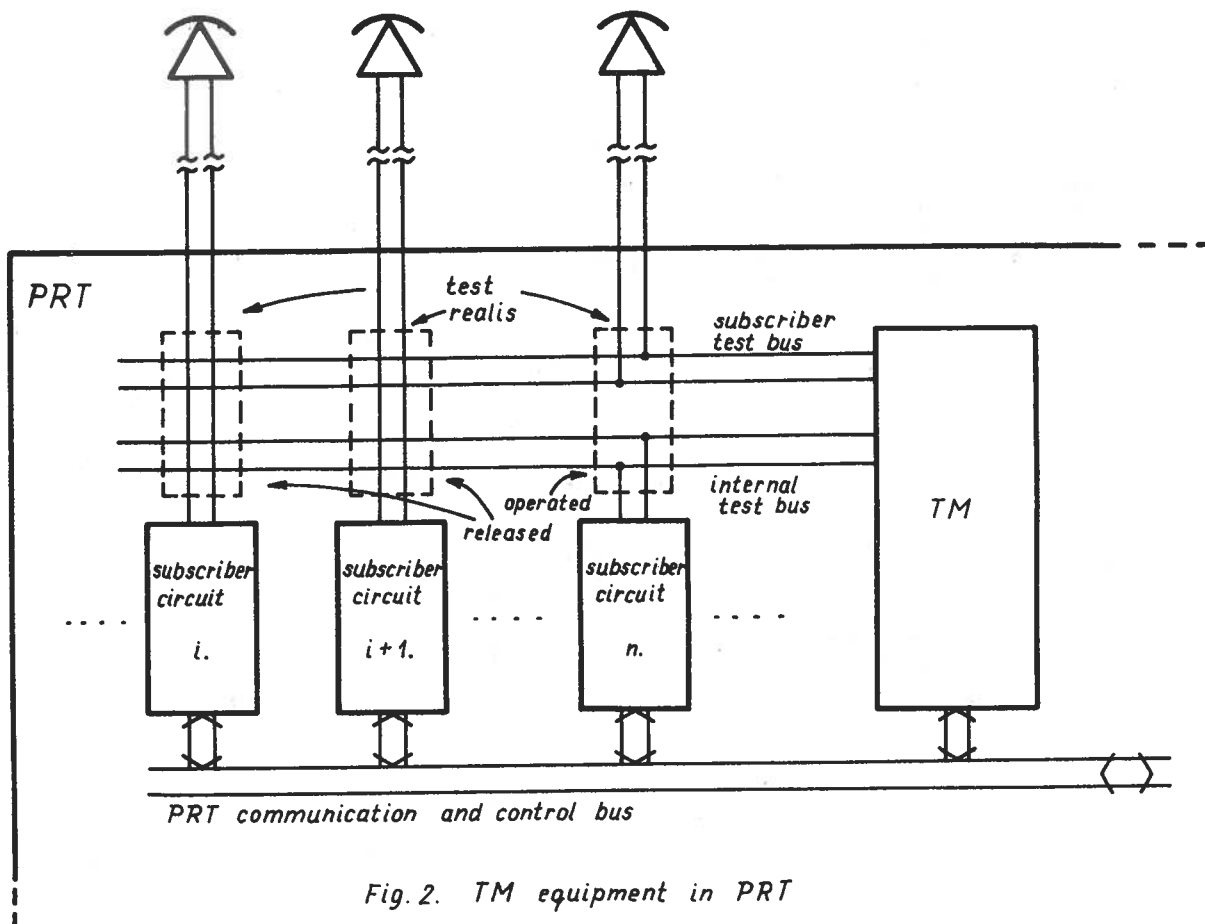
Fig. 2. TM equipment in PRT

tion builds up between the exchange and a subscriber:

- call originated at the exchange,
- call originated at the subscriber.

The functional structure of Telemetering unit is shown in Fig. 3. For every measurement at first the unknown signal is converted into proportional voltage, then the voltage is converted into a binary number by 8 and 12 bit A/D converters. The software computes the value of resistance and mismatching factor e.t.c.

Every functional unit of the Telemetering equipment has one or more reference signals and reference circuits. Measuring results on references are compared with expected values.

If the test results are in the expected ranges, the unit is good and it is able to do the work with given precision.

If there is "a little" difference between tests and expected values, the Telemetering unit begins an automatic self-recalibration, then it starts the real measurement.

If there is a significant difference between the values, the microprocessor decides so, that the given part of equipment went wrong, and it sends an error message to the consol display.
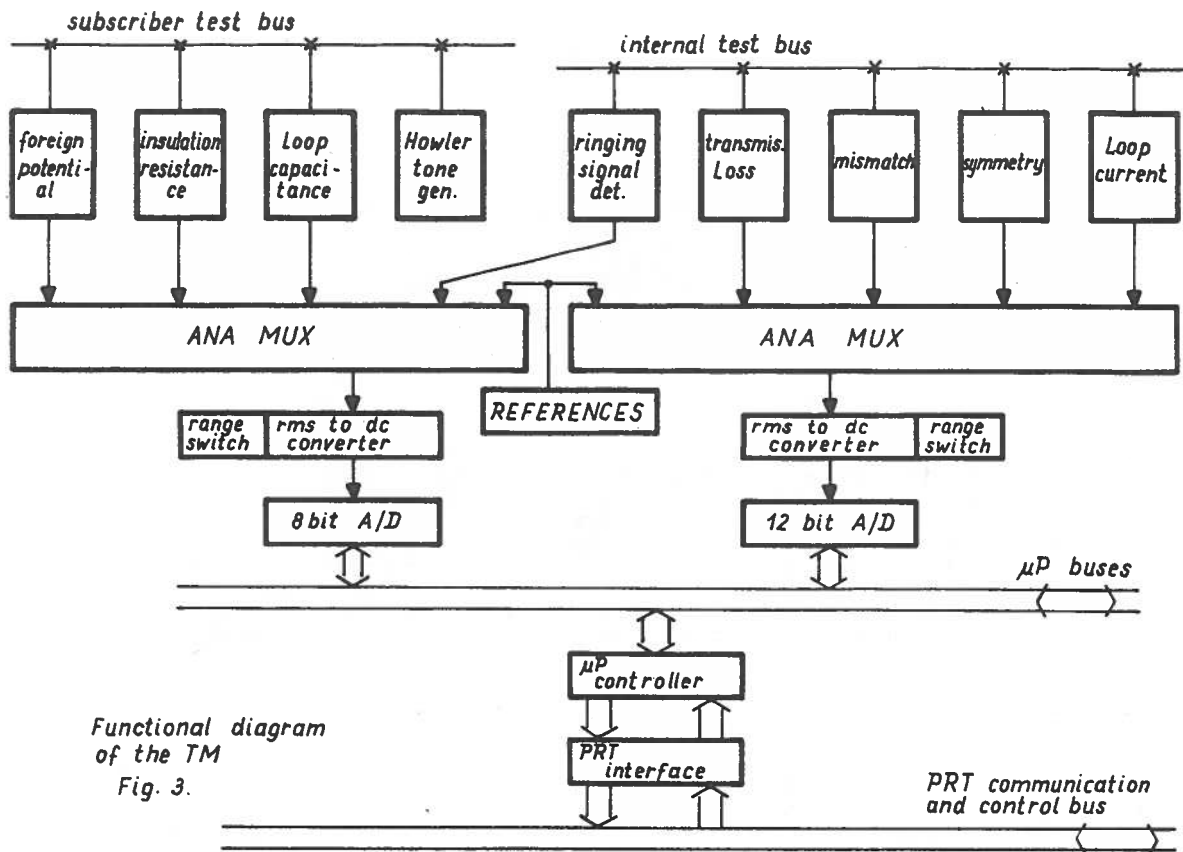
This permanent self testing of Telemetering unit guarantees high confidence level of measurement results.

The communication connection consists of two communication channels between PRT and TM and they are back ups for each other. The commands and results are intelligent messages with error protection, and "message level hand-shake" is used. If no acknowledge arrives to the sender in "time-out" the PRT or TM changes over the communication channel and an error message is sent to the consol display.

The commands include what to do, and in which form the results should be sent. There are two forms of them:

- "go/no go" type results: the TM unit compares the measured values to programable expected values, and if they are in the range, then "go" is transmitted back, in the other case "no go" is chosen,
- "numerical value" type results: the TM performs the given command and the numerical value of the measured signal is transmitted as a signed BCD value.

Error-statistics can be collected about subscriber lines and interface circuits. The TM unit tests the lines and circuits periodically under direct PRT control and it can give an error message at the first error detection of a given subscriber, or it can collect an error-statistics. This

subscriber test bus

internal test bus

| foreign potenti-al | insulation resistan-ce | Loop capaci-tance | Howler tone gen. | | ringing signal det. | transmis. Loss | mismatch | symmetry | Loop current |

ANA MUX   ANA MUX

| range switch | rms to dc converter | REFERENCES | rms to dc converter | range switch |

8 bit A/D   12 bit A/D

μP buses

μP controller

PRT interface

PRT communication and control bus

Functional diagram
of the TM
Fig. 3.

statistics can be requested from the con-
sol and the TM automatically sends an er-
ror message only after N /programmable num-
ber/ error detections. This possibility
can filter out the random faults.

4. CONCLUSIONS

The flexible and modular structure of the
Telemetering unit allows easy incorpora-

tion of any further desires.

This Telemetering unit has solved the new
problems of maintenance of subscriber
lines in digital telecommunication systems
Other telemetering units, operating with a
similar method may be used in radio tele-
communication or light-guide transmission
systems, too.