Remote Subscriber Module Using Optical Fibers

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ABSTRACT: Fiber optics in the communication access network can be placed at the section from the common carrier’s office to the feeder-line point, the section up to the access point adjacent to the user premises, and the section leading to the user’s premises. The remote subscriber module for feeder installation (RSBM-F: Remote Subscriber Module-Feeder), is a joint development between Hitachi, Ltd. and NTT (Nippon Telegraph and Telephone Corporation) for application of fiber optics leading up to the feeder-line point. The RSBM-F terminates the metallic communication line from the subscriber’s premises, converts electric signals into optical signals, and transmits them to the common carrier’s office. RSBM-F is smaller, cheaper and has better maintainability than similar products on the market. Changing the subscriber type from analog to ISDN (integrated services digital network) is easy, since the subscriber line interface circuit carries one subscriber line per card, resulting in a marked improvement in maintenance and administration.

INTRODUCTION
TRENDS in providing a variety of multimedia services have risen sharply as more fiber-optic cables are being installed into subscriber’s premises to establish a high-speed, broadband subscriber network. Fiber optics are usually installed first into the section leading up to the feeder-line point, and then into the section of the network leading up to the vicinity of the user’s premises (see Fig. 1).

Hitachi has joined forces with NTT (Nippon Telegraph and Telephone Corporation) to develop a remote subscriber module for feeder installations (RSBM-F: Remote Subscriber Module-Feeder). This module is used to concentrate existing metallic lines and connect them with the common carrier’s office via fiber optics to the feeder-line point. In this paper, the authors describe the development of a smaller RSBM-F which is more easily maintained, and is lower in cost than similar existing products. The new technology employed in the RSBM-F is also described.

SYSTEM CONFIGURATION AND FEATURES
Fig. 2 shows the RSBM-F system configuration. The unit accommodates analog telephone lines (A), and ISDN (integrated services digital network) subscriber-lines (I) as well as leased-lines, and multiplexes the data from these subscriber-lines and connects them with the common carrier’s office via an optical interface. The common carrier’s office is provided with a line cross-connect module (LXM), which is connected to the existing D70 telephone switching system, an ISDN switching system (ISM) and the next-generation communications switching

Fig. 1—RSBM-F System. The RSBM-F is installed outdoors, for example, along a sidewalk or other public spaces, to establish an optical path from the common carrier’s office to the feeder-line point.
Other components contained within the RSBM-F include a subscriber-line test unit, to check the normality of the line, an alarm and clock unit, a power supply unit, and a battery unit, to maintain communications in the event of commercial power failure.

**OVERVIEW OF ELECTRONIC CIRCUIT SYSTEM**

**Analog Telephone and ISDN Subscriber Termination**

In conventional switching systems, the analog telephone subscriber-line interface circuit and the ISDN subscriber-line interface circuit are accommodated in separate units. Therefore, a connection change needs to be made on the main distribution frame (MDF) to enable an analog subscriber to be provided with ISDN services. In the RSBM-F, the two different types of interface circuits are housed on similar cards of the same size. One subscriber is accommodated on one card to unify the interface electrically and by packaging. The transfer of a subscriber from the analog telephone service to ISDN services, is done simply by changing the subscriber’s card from the analog type to the ISDN type. In case failure occurs, these circuit cards can be easily replaced.

**Leased-Line Termination**

In similar existing modules, the leased-line accommodating unit is situated in the same module housing, but connected to the common carrier’s office via a separate fiber-optic cable.

In the RSBM-F, the leased-line subscriber is assigned to the same fiber-optic cable as the analog and ISDN subscribers, since the cable has a large transmission capacity. Thus, the leased-line unit is provided without the need for optical/electrical conversion, or an extra fiber-optic cable.

**Uninterrupted Transmission Path Changeover**

The optical transmission path between the RSBM-F and the common carrier’s office is duplexed to assure reliability. The two transmission paths have a delay time difference between them because they are generally laid over different routes. Therefore, data loss or other problems could occur when the transmission path in use is changed over to the other.

The RSBM-F employs an uninterrupted system changeover technique to prevent data loss or other trouble at the time of transmission path changeover. This technique basically sets the transmission delay to the time of the slower of the two systems, and the data transmitted through the slower system is buffered by elastic store (ES) memory (see Fig. 3).

**Subscriber-Line Testing**

The subscriber-line test unit conducts testing to check for any abnormality in the user’s premises or on the subscriber line. Fig. 4 illustrates the control over the subscriber-line test unit. The out-channel system has been used for the same purpose, where the test center accessed the subscriber-line test equipment via the database to link the directory number of the subscriber under test with the test equipment over an exclusive
testing control route. The present RSBM-F employs the in-channel control system to originate a call (as if placing an actual telephone call) using the directory number data on the subscriber to be tested, and to have the call terminated at the subscriber-line test unit over the common speech route of the public network.\(^{(2)}\)

PACKAGING

Since the RSBM-F is to be installed outside,\(^{(3)}\) it was necessary to assess its housing characteristics. A packaging design, including parts selection, housing construction, and module configuration, was conducted, taking into consideration precautions against rain, temperature and humidity, noise, and electromagnetic compatibility (EMC).

Table 1 lists the specifications for the RSBM-F (Fig. 5).

<table>
<thead>
<tr>
<th>Item</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subscriber capacity</td>
<td></td>
</tr>
<tr>
<td>Public lines</td>
<td>Analog or ISDN lines: 512 (one card for one subscriber, slot free for analog and ISDN card)</td>
</tr>
<tr>
<td>Leased lines</td>
<td>Low-speed leased lines: 24 High-speed leased lines: 3</td>
</tr>
<tr>
<td>Environmental requirements for installation</td>
<td>–30 to 40°C (Inside cabinet: –20 to 80°C) Less than 95%</td>
</tr>
<tr>
<td>Grounding</td>
<td>Type 3 (100 ohms)</td>
</tr>
<tr>
<td>Module size (cm)</td>
<td>110 width × 45 depth × 150 height, or less</td>
</tr>
</tbody>
</table>

Fig. 4—Subscriber-Line Testing Control. For Subscriber-line testing, a call may be placed similarly to a regular telephone call.

Module Configuration (Unit Installation in Housing)

Fig. 6 shows the RSBM-F module configuration, and the unit installation in its housing.

The key aspect in the physical design is the compact housing (110 cm wide, 45 cm deep, and 150 cm high, or less) which enables it to be installed along a sidewalk as narrow as two meters. The interior construction allows installation and maintenance work inside the unit to be done only from the front side. The following points describe the design of the housing.

- Subscriber-line accommodating unit: To attain compactness, a 4-unit configuration is employed (two units installed vertically, in two rows horizontally). The two units (in two tiers) on the front row are pivoted for increased installation and maintenance efficiency, enabling work to be performed on the units in the rear row.
- Common control unit, and leased-line accommodating unit: These units are designed as movable or drawer types, and are installed in two tiers to ease installation and maintenance.
- Cooling fans: These fans accelerate air circulation in the module by blowing the heat generated by individual units first to the upper part of the housing, then downward along the inner side of the housing doors, and finally outside.
Fig. 6—RSBM-F Module Configuration.

The housing is compact and maintainability is improved through the employment of pivoting or drawer-type unit construction.

- Main distribution frame (MDF) unit: The MDF unit is installed in the uppermost part of the housing to assure better accessibility, and automatic MDF installation.

Housing Construction

The important requirements for the housing construction are to meet the environmental needs for weather-tightness, temperature and humidity, and EMC, while assuring ease of installation and maintenance. The following design techniques were employed for the housing construction:

- Housing: Stainless steel is used in order to realize all-weather-tightness (waterproofing), anticorrosion measures), and EMC countermeasures.
- Battery unit: The battery unit has a door that can be opened or closed independently of the main unit.
- Main unit: Aluminum is used for the main unit doors for better heat radiation. The doors are corrugated to increase radiation efficiency, and shading panels are attached to the outside of the doors to decrease the sunlight effect.
- Wattmeter unit: A separate door, independent of the main unit, is included to enable work to be performed on the wattmeter unit without other devices in the main unit being affected.

CONCLUSIONS

The RSBM-F, with new technologies in design engineering, is well suited to handle the application of fiber optics to the subscriber-line termination system.

Key features are: One subscriber-per-card accommodation of the subscriber-line interface, leased-line accommodation, and no-hit changeover, compact module and low-cost through improved packaging. The authors believe the RSBM-F is a product that will contribute to extensive application of fiber optics to subscriber-lines.

REFERENCES

(2) Miyasaka et al., “Discussions on Subscriber Line Test Equipment Configuration Suitable for Optical Access System,” IEICE General Meeting ’95 [Institute of Electronics, Information and Communication Engineers (IEICE)].

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