Fiber-Optic Distributed Temperature Sensing System FTS3500

1. Outline

The OPTHERMO fiber-optic distributed temperature sensing system is a product of Sumitomo Electric Industries, Ltd. and is one of the component technologies used in infrastructure monitoring and maintenance systems. There are currently two models in the OPTHERMO lineup: the FTR3000 (a short distance model at an accessible price) and the FTR3000X (a long-distance and high-performance model at a higher price). By limiting its functions, the FTR3000 has offered the most reasonable price in Japan among equivalent products. However, it is 10 years since FTR3000 was introduced to the market, and therefore it was time for the product to be updated with functional enhancements and other changes. We have now developed a successor model, the FTS3500, which offers better performance while still maintaining the lowest price in Japan.

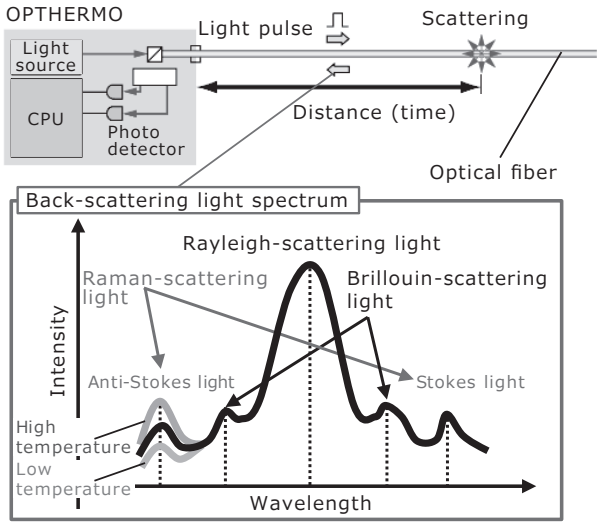

Fig. 1. OPTHERMO measurement mechanism

2. Features of OPTHERMO

OPTHERMO can measure both distance and temperature along an optical fiber cable, by utilizing the optical fiber itself as a thermal sensor. As OPTHERMO can measure the thermal distribution along an optical fiber cable that has been laid out over a long distance, it is utilized as a thermal monitoring system that can detect thermal abnormalities in a wide variety of infrastructures, including power cables and tunnels, and in smaller facilities such as belt conveyers. With regard to thermal monitoring for power cables in particular, OPTHERMO is often used together with the dynamic rating system (DRS), which calculates a power cable conductor's temperature and maximum allowable load current in real time based on the OPTHERMO data and the load current. Currently, investment in infrastructures is active in emerging markets, and thus demand for OPTHERMO is expected to grow.

OPTHERMO utilizes the optical time-domain reflectometer (OTDR) technology that is widely used in optical fiber testing. OPTHERMO injects light pulse into the optical fiber, and then extracts the Raman back-scattering light of which intensity varies by the temperature where the scattering occurs. The temperature can be calculated based on the ratio of the Stokes and anti-Stokes light intensity (Fig. 1). At the same time, the distance is calculated from the time between the injection of light pulse into the optical fiber and the arrival of the Raman-scattering light. The intensity of the Raman-scattering light is extremely weak—less than 1/100,000 of the light source. To detect the Raman-scattering light effectively, OPTHERMO uses a large core diameter graded-index (GI) fiber, which has high coupling efficiency, as its optical fiber thermal sensor. The FTS3500 is designed to be exclusively used with this GI fiber. Note that we also offer different product lineups that support single-mode (SM) fiber designed for optical communications as some customers prefer to use their existing optical cables for monitoring purposes.

3. Features of the FTS3500

Table 1 shows the specifications of the FTS3500 and its predecessor, the FTR3000. As the FTS3500 may be chosen to upgrade an existing FTR3000, the casing dimensions and the interfaces of the FTS3500 are compatible with FTR3000. The external appearance of the FTS3500 is shown in Photo 1.

In the course of developing the FTS3500, the technologies gained through development of the FTR3000X, the existing higher model, have been incorporated into the FTS3500 to achieve a better spatial resolution and sampling interval. The spatial resolution is the minimum distance needed to detect temperature changes and the performance improvement of this function is particularly significant. Figure 2 provides a definition of the spatial

Table 1. Specification of the FTR3000 and FTS3500

	FTR3000	FTS3500
Operation temperature [°C]	0 - 40	Same as the left
Power supply voltage [V]	DC:10.5 - 13.5 AC: 90 - 264	Same as the left
Dimension W×D×H [mm]	300×160×37	Same as the left
Weight [kg]	2.5	2.0
Optical fiber type	GI 50/125	Same as the left
Measurement range [m]	2200	Same as the left
Sampling interval [m]	1.0	0.25/0.5/1.0
Temperature accuracy*1 @2 km [°C]	≤ ±1.0 (Typ) ≤ ±2.0 (Max)	Same as the left
Spatial resolution [m]	3.0	1.0/1.5/3.0
Temperature resolution*2 @2 km [°C]	≤ 1.0 (Typ) ≤ 2.0 (Max)	Same as the left

*1 Temperature accuracy: Maximum Deviation between true temperature and average value of 50 temperature OPTHERMO measured.
*2 Temperature resolution: One standard deviation of 50 temperature OPTHERMO measured.

Photo 1. External appearance of FTS3500

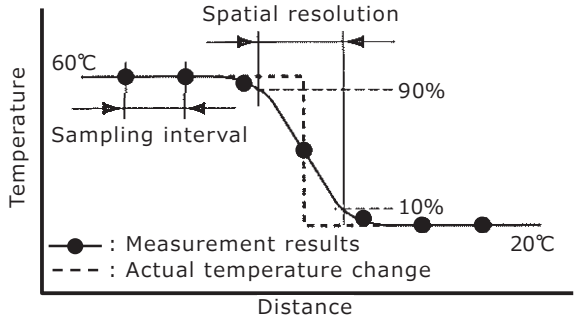

Fig. 2. Spatial resolution

resolution. There has been great demand for an improvement in the spatial resolution and this was one of the major functional enhancements required for the FTS3500. By narrowing the pulse width of the input light, the spatial resolution that used to be approximately 3.0 meters in conventional models was significantly shortened to 1.0 meter in the new model. In the FTR3000, the sampling interval was fixed at 1.0 meter and now the FTS3500 offers a range of sampling intervals of 0.25, 0.5, and 1.0 meter in the same way as the FTR3000X. We were able to confirm that the FTS3500's functions were equivalent to or better than those of the FTR3000, and that it is a trustworthy upgrading of the FTR3000 or equivalent third-party products.

4. Conclusion

We have developed the OPTHERMO FTS3500, a successor model to the FTR3000. The dimensions and interfaces of the FTS3500 are compatible with the FTR3000, and, therefore, the FTS3500 can be upgraded from the older model without adjustment. The price remains as the lowest in Japan, which was one of the significant benefits of the FTR3000. In terms of performance, the new model offers temperature detection in much finer intervals compared to its predecessor through improvements in the spatial resolution and sampling interval. We plan to actively promote this product for general long-distance temperature monitoring, as with previous models, but also for a wider range of purposes such as for belt conveyers, which need temperature detection in smaller intervals, or for fire detection in tunnels.