

## High-Power Multiport Optical Amplifier for CATV

### 1. INTRODUCTION

It is some time now since the convergence between telecommunications and broadcasting technologies has been advocated, and, in line with this, the Triple Play Service has been implemented and is expanding rapidly which provides the three services of Internet access, video distribution and (optical) IP phone over a single broadband connection using the FTTH (fiber to the home) or CATV. Reducing the cost per subscriber constitutes an absolute requirement to make such a new service to proliferate. And increasing the output power of individual optical amplifiers in the video distribution system is known as an effective solution to this cost reduction requirement. Accordingly, we have adopted a new technological approach to develop a high-power multiport optical amplifier for video distribution using erbium/ytterbium (Er/Yb) co-doped double-clad fiber and multi-mode pumping LD, which is different from conventional optical amplifiers.

### 2. FEATURES

Figure 1 shows an appearance of the high-power multiport optical amplifier developed here. In its casing measuring 160 mm (L) x 121.5 mm (W) x 29.5 mm (H) excluding heat radiating fins, the amplifier integrates output control circuitry provided with communication functions and an output branching splitter, achieving amplification of  $-3$ -dBm input signal to an output signal power of  $+20$  dBm x 16 ports, i.e.  $+33$  dBm in total.

In terms of optical configuration, the amplifier adopts two-stage configuration to minimally suppress noise deg-

radation at the time of analog signal transmission. Its pre-amplifier stage realizes low noise by employing an erbium-doped fiber amplifier (EDFA) commonly used. And the booster amplifier is a clad-pump amplifier, whereby an Er/Yb co-doped double-clad fiber is pumped by 980-nm multimode pumping LDs, realizing low noise and high output power simultaneously. The Er/Yb co-doped double-clad fiber has a flower-shaped cross-section for its cladding where pumping light propagates, enhancing the probability with which the multimode pumping light launched into can effect low-loss transmission in the core where rare earth elements are doped.

The amplifier operates on a single DC  $+5$ -V power supply. A user-friendly interface using RS232 is provided to enable various settings and information collection, making external setting and modification also possible during operation. Various output control modes are available including automatic level control (ALC), automatic gain control (AGC), automatic current control (ACC) and automatic pump power control (APC), and these mode selection can be changed as desired along with target setting. Setting for various alarm functions related with operation of the optical amplifier is also supported, and a protection function against loss of input power is provided.

### 3. CHARACTERISTICS

Figures 2 and 3 show the wavelength dependence of the optical output signal power per port at an optical input power of 0 dBm and that of the noise figure (NF), respectively. It can be seen that noise figure of 5.5 dB or less, equivalent to that of ordinary EDFAs, is achieved at an



Figure 1 Appearance of high-power multiport optical amplifier for CATV.

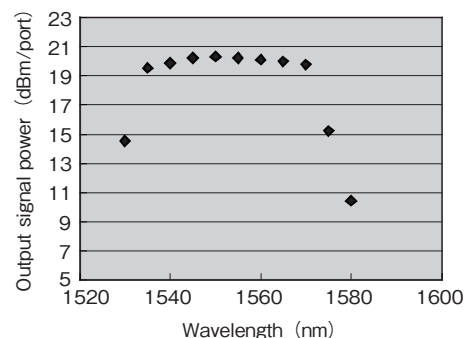
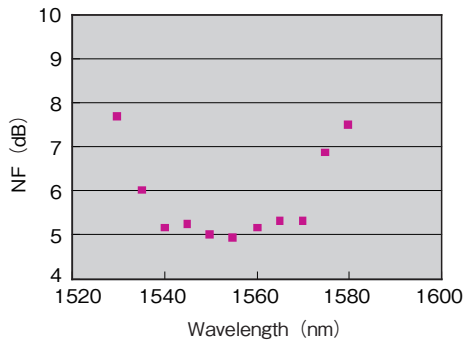


Figure 2 Input signal wavelength dependence of optical signal output power (input signal power: 0 dBm).

input signal wavelength range of 1540~1560 nm. Moreover, in the analog transmission characteristics evaluation using an external modulator for optical transmitter,



**Figure 3** Input signal wavelength dependence of noise figure (input signal power: 0 dBm).

**Table 1** Specifications of high-power multiport optical amplifier.

| Item                         | Specification                              |
|------------------------------|--|
| Wavelength                   | 1540~1560 nm                               |
| Input signal power           | -3~+10 dBm                                 |
| Output signal power per port | $\geq +20$ dBm/port                        |
| Output power uniformity      | $\leq 1.0$ dB                              |
| Noise figure                 | $\leq 5.5$ dB @ $P_{in}=0$ dBm,<br>1550 nm |
| Polarization dependent gain  | $\leq 0.5$ dB                              |
| Power supply voltage         | Single, DC +5 V                            |
| Power consumption            | $\leq 40$ W @ $P_{out} \geq +20$ dBm/port  |

it has been confirmed that both the composite second order distortion (CSO) and composite triple beat distortion (CTB) satisfy an adequate level of -73 dB or less. The power consumption is about 40 W. Table 1 shows the basic characteristics of the high-power multiport optical amplifier developed here.

#### 4. CONCLUSION

A high-power multiport optical amplifier for video distribution has been developed aimed at the FTTH market. Despite its compact size and low power consumption of 40 W, the amplifier has achieved an output signal power of +20 dBm x 16 ports, i.e. +33 dBm in total, unattainable with conventional EDFAs, using erbium/ytterbium co-doped double-clad fiber and multi-mode pumping LDs. The optical amplification technology for high output power is expected to be applied not only in the FTTH market but also in various fields.

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