Feed-forward linearization of directly modulated laser for radio over fibre wireless LAN

T Ismail and A J Seeds
Department of Electronic and Electrical Engineering, University College London, Torrington Place, London, WC1E 7JE

Abstract: Feed-forward linearization is applied to directly modulated uncooled laser to reduce the nonlinear distortion at 2.4 GHz for IEEE802.11b wireless LAN standard in a radio over fibre system. Third order intermodulation distortion reduction of approximately 20 dB at 2.4 GHz and a 10 dB reduction over a 500 MHz bandwidth around 2.4 GHz has been achieved, resulting in improved system dynamic range.

1. Introduction
The demand for higher data rate is continuously rising for broadband mobile services such as Wireless LAN and mobile computing. High bandwidth is required to support the increased demand for broadband services resulting in transmission of signals at microwave and mm wave due to congested spectrum at low frequencies. The Industrial Scientific Medical (ISM) band at 2.4 GHz is used for the IEEE802.11b wireless LAN to support data rates of up to 11 Mbps. Higher frequency band at 5.2 GHz is to be used for the IEEE802.11a standard and Hiperlan supporting data rates of up to 54 Mbps. Radio over fibre (ROF) is the most suitable technology to realize these wireless network infrastructures and provides a low cost configuration, because the optical modulated signals are transmitted to the base station through fibre without significant loss and reach the mobile user via RF transmission allowing greater mobility. Figure 1 shows the configuration of a wireless network based on a ROF link. Uncooled directly modulated DFB laser is a key element for these networks in order to reduce size, cost and power consumption. However, the nonlinearity in a directly modulated laser diode imposes fundamental limitations on performance of the fibre based systems and compensation technique is required to reduce the nonlinear effects. By suppressing the third order intermodulation distortion (IMD3), the dynamic range of the overall link is improved.

2. Experimental setup and results
To evaluate the performance of the feed-forward compensation shown in Figure 2, the laser was directly modulated by two carrier signals at 2.4 GHz for the 802.11b band and the detected output signal was measured. Two closely spaced carriers separated by 10 kHz are supplied by combining the outputs of two signal generators in a microwave combiner set to around 2.4 GHz to measure the IMD3 products at 2f1-f2 and 2f2-f1. Microwave isolators are used at the output of the generators to isolate the generators from each other to prevent IMD being generated. The performance of the circuit shown in Figure 3 with and without feed-forward was determined by enabling and then disabling the output of the secondary laser L2 [3]. Microwave amplifiers and phase shifters are required to allow for matching so that the two cancelling signals are equal in amplitude and opposite in phase.
3. Conclusions and further work
Feed-forward linearization has been investigated at 2.4 GHz to compensate third order IMD generated by a directly modulated laser. Suppression of approximately 20 dB has been achieved and 10 dB suppression over a 500 MHz bandwidth at a centre frequency of 2.4 GHz. Since the cancellation of the distortion products essentially depends on amplitude and phase matching further suppression can be achieved with a more accurate matching parameters. Future activities will involve making the feed-forward a much wider system to cover the entire 802.11b frequency band with sufficient cancellation.

References