Time–bandwidth product of chirped sech² pulses: application to phase–amplitude-coupling factor measurement: addendum

P. Lazaridis, G. Debarge, and P. Gallion

Département Communications, École Nationale Supérieure des Télécommunications, 46, rue Barrault, 75634 Paris Cedex 13, France

Received October 9, 1995

In a recent Letter[1] we derived the Fourier transform of a chirped sech² pulse and the analytical expression of its time–bandwidth product. This was done so that we could propose a corrected formula for the evaluation of the phase–amplitude-coupling factor from gain-switching spectra. An equivalent result was derived in the context of mode locking in solid-state lasers in Appendix 1 of Ref. 2, which we were not aware of when we submitted our Letter. However, whereas both references discuss the case of a symmetrical pulse, realistic gain-switching pulses are asymmetrical under most of the biasing conditions and consequently so are their power spectra. A better adapted, and more general, pulse shape would be the asymmetrical sech² pulse shape defined by

$$\pi(t) = \frac{2}{\exp(at) + \exp(-bt)} = \exp\left(\frac{b-a}{2}\,t\right)\operatorname{sech}\left(\frac{b+a}{2}\,t\right). \tag{1}$$

The chirped asymmetrical sech² pulse is then given by

$$E(t) = [\pi(t + t_0)]^{1+j\alpha}, \tag{2}$$

with $t_0 = \ln(b/a)/(a + b)$ for the maximum to be at $t = 0$. The power spectrum of this pulse is expressible in terms of gamma functions of a complex argument as

$$|\tilde{E}(\omega)|^2 = \frac{4}{(a+b)^2|\Gamma(1+j\alpha)|^2} \times \left|\Gamma\left(\frac{a}{a+b} + j\,\frac{\omega + a\alpha}{a+b}\right)\right|^2 \times \left|\Gamma\left(\frac{b}{a+b} + j\,\frac{\omega - b\alpha}{a+b}\right)\right|^2, \tag{3}$$

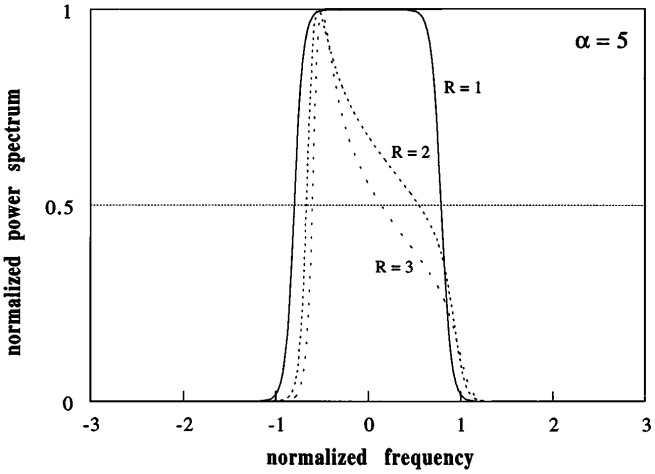

Fig. 1. Normalized power spectra of chirped symmetrical and asymmetrical sech² pulses as a function of the asymmetry ratio R.

where α is the laser phase–amplitude-coupling factor. It is easily seen that in the symmetrical case when $a = b = 1$ Eq. (3) corresponds to Eq. (5) of Ref. 1. In Fig. 1 one can notice the difference between chirped symmetrical and asymmetrical sech² pulses, where $R = b/a$ is the asymmetry ratio and $\alpha = 5$ is assumed. In fact, asymmetrical spectra give a better match to experimentally observed results. Unfortunately, in this much more general case no simple time–bandwidth product formula was found. Consequently, some kind of fitting procedure should be used in order to extract the asymmetry ratio R and the phase–amplitude-coupling factor from experimentally measured gain-switching power spectra.

References

1. P. Lazaridis, G. Debarge, and P. Gallion, Opt. Lett. **20,** 1160 (1995).
2. K. P. Komarov, A. S. Kuch'yanov, and V. D. Ugozhayev, Opt. Commun. **57,** 279 (1986).

0146-9592/96/020164-01$6.00/0