1. **Calculations leading to Eq. (12.77) below assume that the amplitude signal experiences a delay mismatch of ΔT . Please repeat the calculations but assuming that the phase signal experiences a delay mismatch of ΔT instead.**

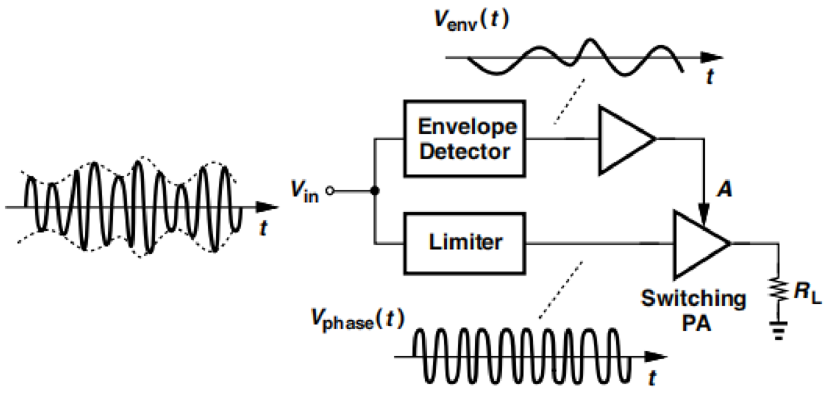

Figure 12.46 *Envelope elimination and restoration.*

12.7.2 Polar Modulation Issues

Polar modulation entails a number of issues. First, the mismatch between the delays of the envelope and phase paths corrupts the signal in Fig. 12.46. To formulate this effect, we assume a delay mismatch of ΔT and express the output as

$$V_{out}(t) = A_0 V_{env}(t - \Delta T)\cos[\omega_0 t + \phi(t)]. \tag{12.75}$$

For a small ΔT, $V_{env}(t - \Delta T)$ can be approximated by the first two terms in its Taylor series:

$$V_{env}(t - \Delta T) \approx V_{env}(t) - \Delta T \frac{dV_{env}(t)}{dt}. \tag{12.76}$$

It follows that

$$V_{out}(t) \approx A_0 V_{env}(t)\cos[\omega_0 t + \phi(t)] - \Delta T \frac{dV_{env}(t)}{dt}\cos[\omega_0 t + \phi(t)]. \tag{12.77}$$

Assuming the phase signal experiences a delay mismatch of ΔT

$$V_{out} = A_0 V_{env}(t)\cos[\omega_0(t-\Delta T) + \emptyset(t-\Delta T)] = A_0 V_{env}(t)\cos\left[\omega_0 t - \omega_0 \Delta T + \emptyset(t) - \Delta T \cdot \frac{d\emptyset(t)}{dt}\right]$$

$$\therefore V_{out} = A_0 V_{env}(t)\cos[\omega_0 t + \emptyset(t)]\cos\left[\left(\omega_0 + \frac{d\emptyset(t)}{dt}\right)\Delta T\right] + A_0\, V_{env}(t)\sin[\omega_0 t + \emptyset(t)]\sin\left[\left(\omega_0 + \frac{d\emptyset(t)}{dt}\right)\Delta T\right]$$

Assume $\Delta T \ll \frac{1}{\omega_0 + \frac{d\emptyset(t)}{dt}}$

$$\therefore V_{out} \approx A_0 V_{env}(t)\cos[\omega_0 t + \emptyset(t)] + \Delta T\left(\omega_0 + \frac{d\emptyset(t)}{dt}\right) A_0 V_{env}(t)\sin[\omega_0 t + \emptyset(t)]$$

From the second term, we can also conclude that this mismatch ΔT leads to substantial spectral regrowth.

1. **Why is it necessary to design matching network in power amplifier, and what is the difference between large signal impedance matching in power amplifier and small signal impedance matching?**

Without matching network, we should have a big voltage at the output of PA, which would break down the transistor in PA. The network transfers the load resistance to a lower value so that smaller voltage swings still deliver the required power.

Large signal impedance matching would change the DC operating point while the small signal impedance matching would not.

2. **What's the defect of PA forward linearization?**

It is difficult to design a OTA with a gain of $\frac{1}{A_v}$ and make all the OTAs work at a high frequency.

3. **Please explain the AM-PM Conversion in Polar modulation Realization**

As $V_{DD,PA}$ swings up and down to track $A_0V_{env}(t)$, the parasitic capacitance C_{DB} varies, so the phase signal is corrupted by the envelope signal.