TWTA LINEARIZER ADVANTAGE

The addition of a linearizer to a high power amplifier (HPA) improves the amplifier's linearity. A linearizer enables an HPA to provide greater output power and greater efficiency for a given level of distortion. Linearizers are most valuable when combined with a TWTA or Klystron power amplifier (KPA). They also provide useful improvement with an SSPA.

A linearized TWTA (or KPA) will have greater linearity than a comparable SSPA. A linearizer works by correcting an amplifier's gain and phase transfer characteristics. Figure 1 show a comparison between the transfer characteristics of a TWTA and a linearized TWTA (LTWTA). A linearizer moves the 1 dB compression point of the TWTA from about 10 dB from saturation to near saturation. The 1 dB compression point of a typical earth station SSPA is 5 to 6 dB from saturation. A linearizer also reduces the phase change of the TWTA from greater than 40 degrees to about 5 degrees. Some of the performance advantages provided by a linearizer are described in the following paragraphs.

Two Carrier Performance

The measured 2-carrier output spectrum of a TWTA and LTWTA at an output power backoff (OPBO) of 4 dB are shown in Figure 2. A reduction in intermodulation distortion (IMD) of greater than 15 dB is common at this OPBO.

Linearization will provide a greater than 3 dB increase in output power for the 25 dB carrier-to-intermodulation ratio (C/I) required by Intelsat and other satellite operators. A 6 dB increase in TWTA power level is normally achieved for the 30 dB C/I required by some forms of digital modulation. Figure 3 shows a comparison of 2-tone C/I levels with and without linearization. Generally the greater the C/I required, the greater the improvement provided by a LTWTA.

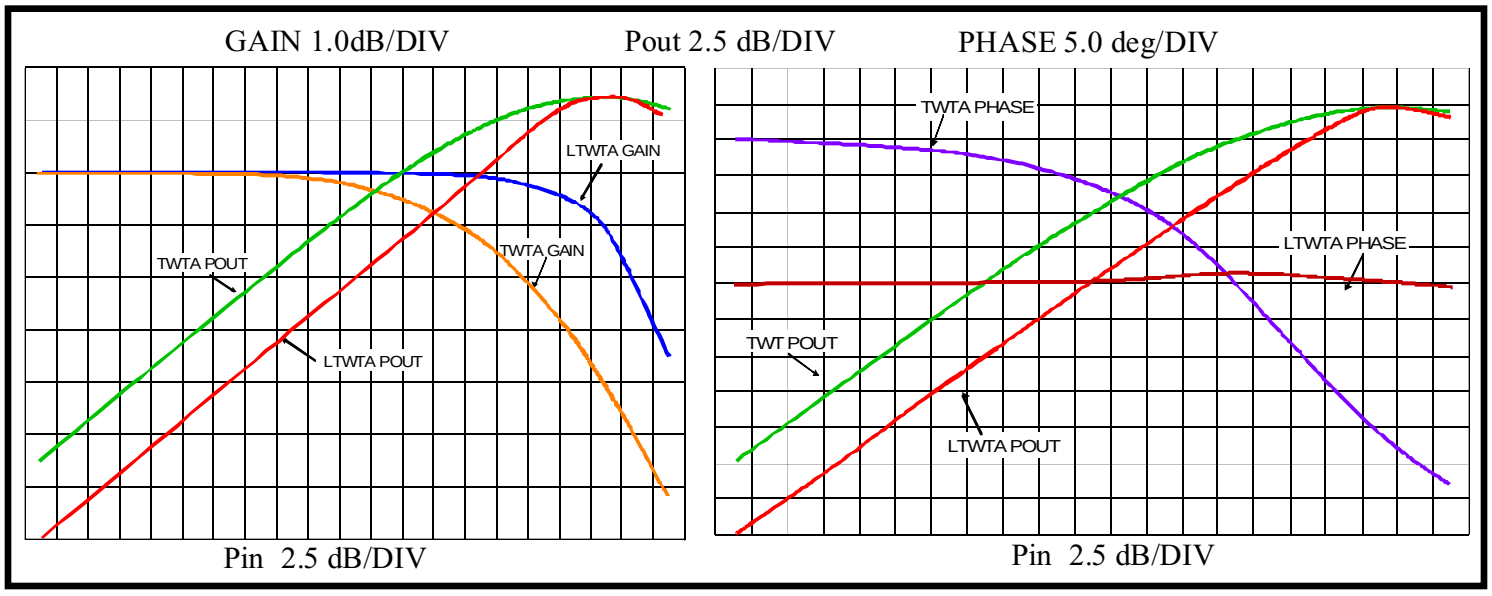

Figure 1. Linearizers work by correcting a TWTA's gain and phase characteristics. The 1 dB compression point is moved from about 7 dB from saturation to near saturation. Small signal linearized and nonlinearized gain are shown equal for purposes of comparison.

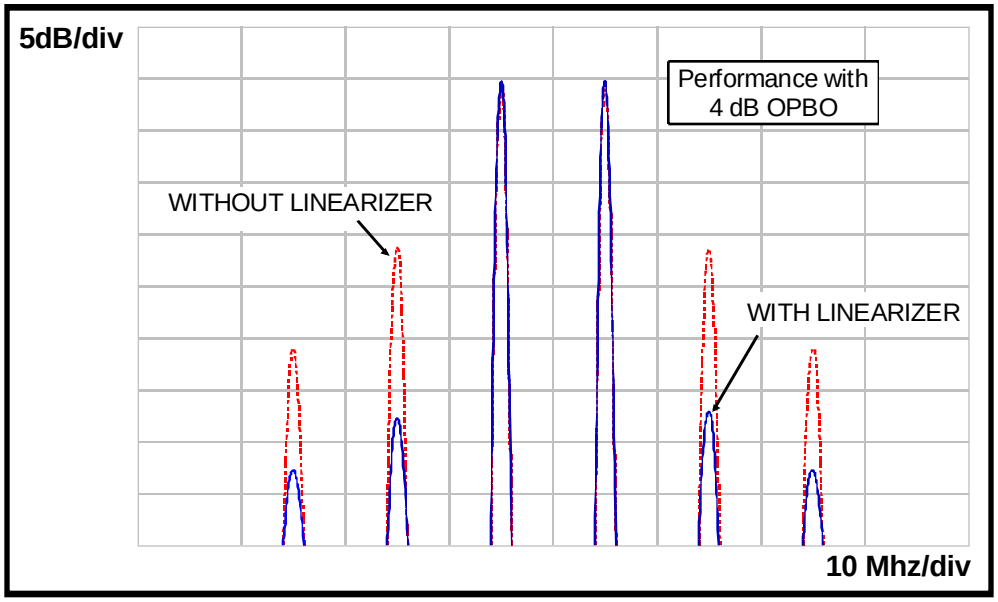

Figure 2.
A two-tone C/I improvement of greater than 15 dB is common at 4 dB OPBO.

At a 25 dB C/I an even greater increase in output power, 4 to 5 dB, is possible if performance at greater OPBO is sacrificed. Figure 4 shows the C/I performance that can be achieved by optimizing a LTWTA for operation close to saturation. Similarly it is possible to optimize an LTWTA for high C/I, >50 dB, at higher OPBO.

Efficiency

Linearization also provides a large improvement in HPA efficiency. For operation at a C/I of 25 dB, TWTA efficiency is usually more than doubled.

Multi-Carrier Performance

The linearizer advantage increases as the number of carriers is increased. Figure 5 shows the spectrum of an earth station TWTA transmitting multi-carrier traffic with and without linearization. For a given C/I the increase in output power provided by a LTWTA is always greater as the number of carriers is increased. Noise Power Ratio, NPR, is a measure of C/I when an infinite number of carriers are present. Figure 6 shows a comparison of NPR for a TWTA and LTWTA. Linearization supplies more than a 4 dB increase in output power for a NPR (C/I) of 25 dB.

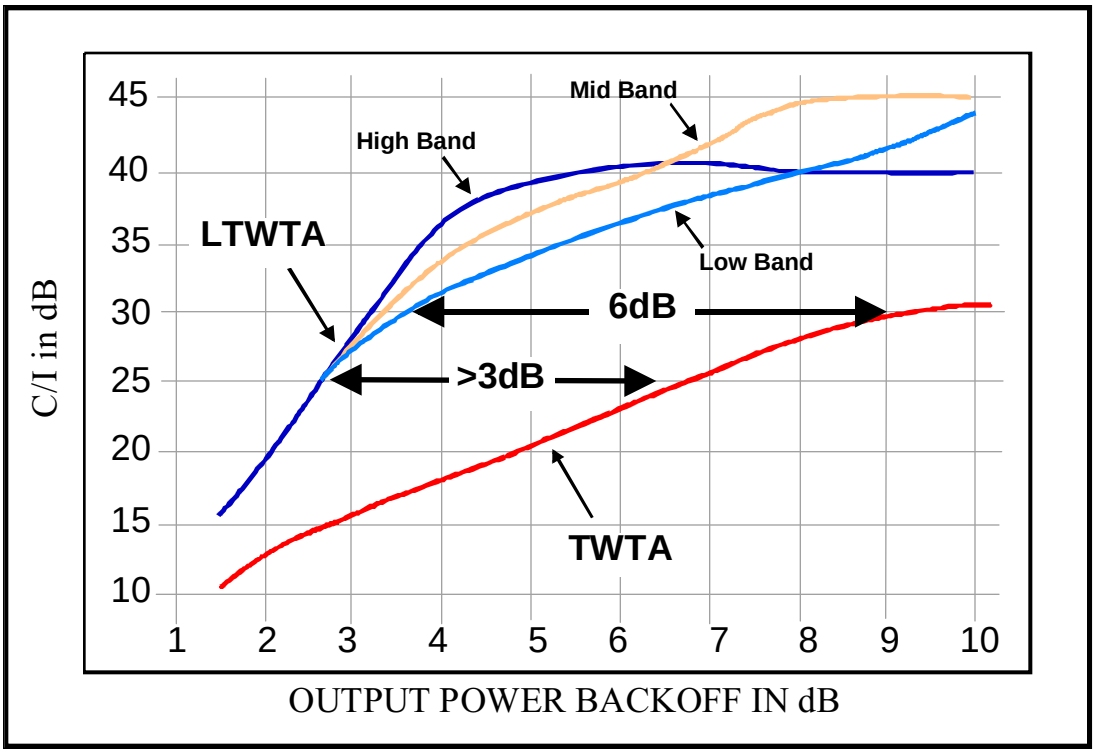

Figure 3.
A 4 X increase (6 dB) in output power for a 2-tone C/I of 30 dB is provided by linearizing a TWTA.

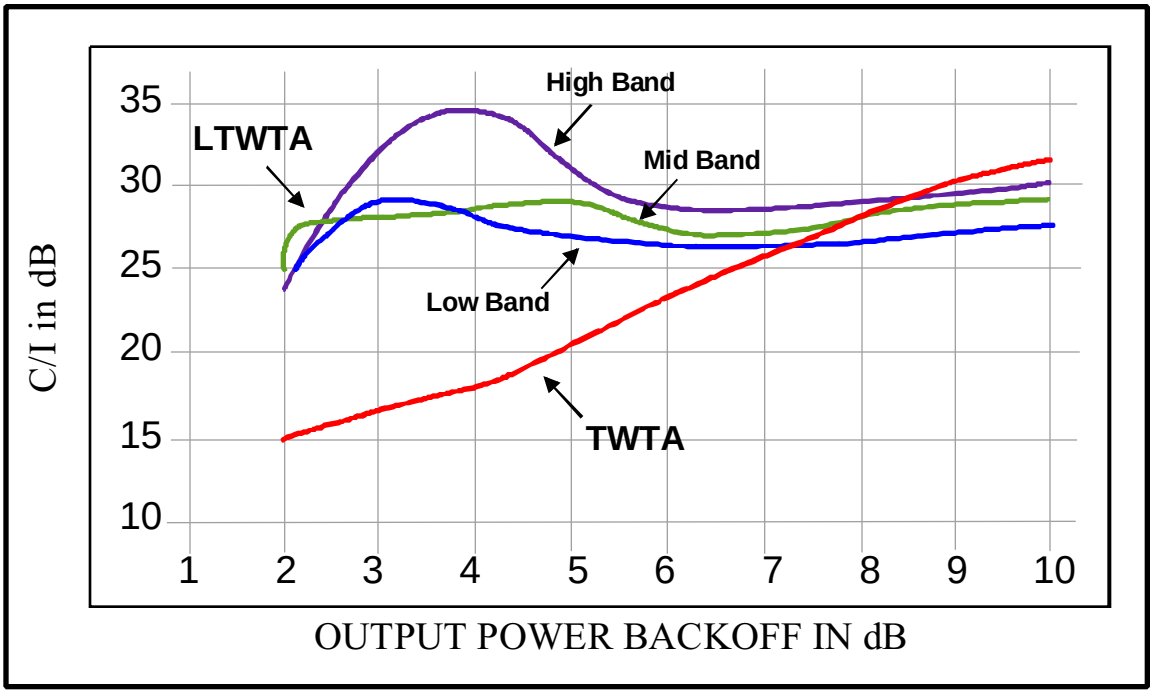

Figure 4.
A C/I of 25 dB can be achieved at slightly more than 2 dB OPBO by compromising C/I at greater OPBO.

Spectral Regrowth and Single Carrier Performance

HPAs transmitting single carrier digital signals must also be operated at reduced power to keep modulation induced distortion products below the 25 dB level required by satellite operators. This form of distortion is known as Spectral Regrowth (SR). To keep SR under control most earth station TWTAs are operated at 2.5 ~ 3.5 dB OPBO. With a LTWTA this OPBO can be reduced to about 0.5 dB. Figure 7 shows that the equivalent SR can be achieved by operating a LTWTA at 0.25 dB OPBO as is obtained without linearization at 2.5 dB OPBO. Figure 8 illustrates expected SR for a TWTA and LTWTA as a function of OPBO.

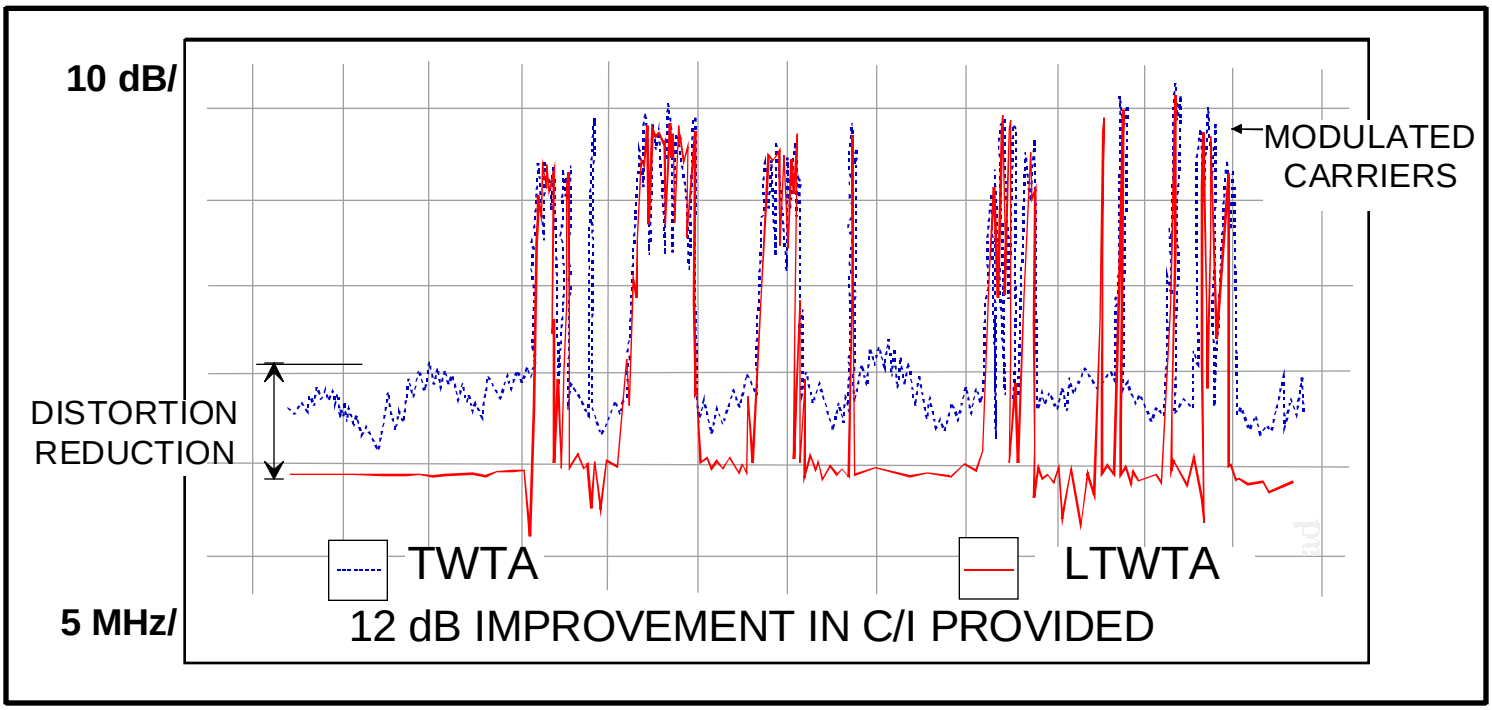

Figure 5. The increase in output power provided by an LTWTA for a given C/I is always greater as the number of carriers is increased.

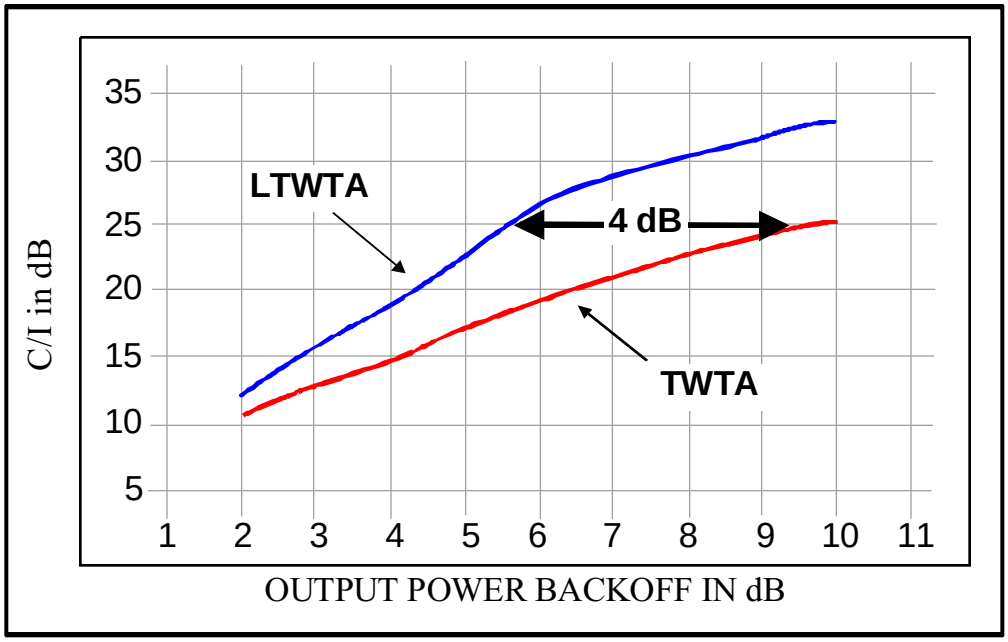

Figure 6.
NPR predicts amplifier perfor-mance with many carriers. More than a 4 dB increase in real out-put power is pro-vided by a linearizer for an NPR of 25 dB.

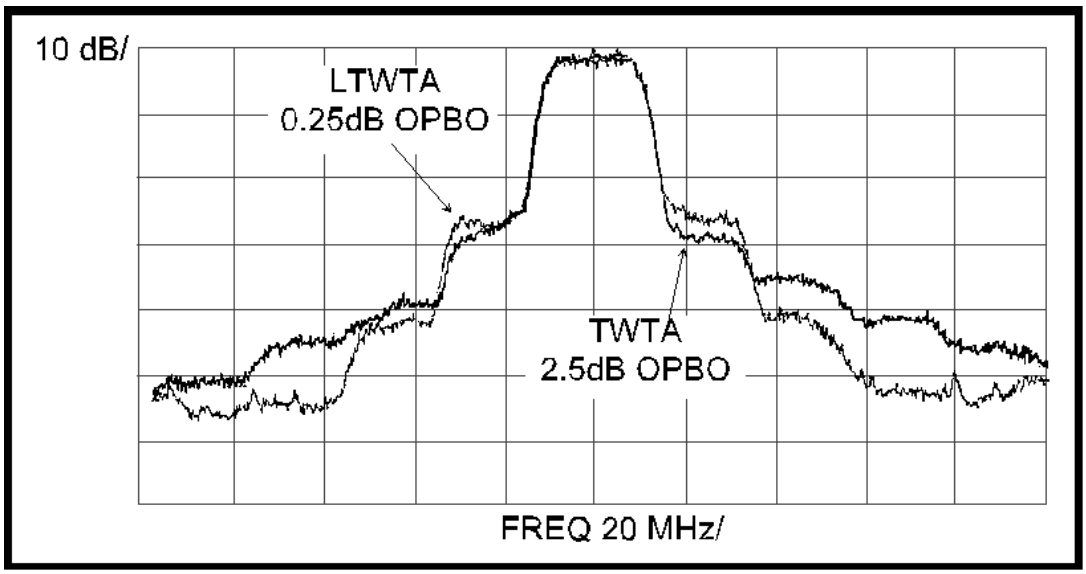

Figure 7.
Linearization of a TWTA transmitting a single QPSK modulated carrier can provide more than a 2 dB increase in real output power for a 25 dB SR requirement.

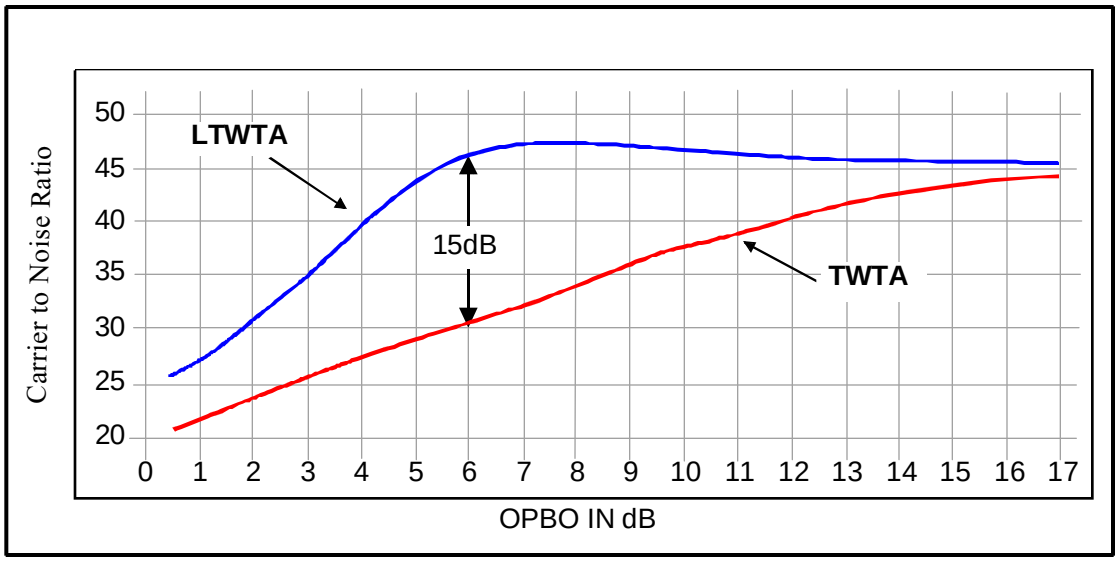

Figure 8.
Reduction in spec-tral regrowth by an LTWTA. At 6 dB OPBO SR is reduced more than 15 dB.

Linearizer Technology, Inc.
http://www.lintech.com
3Nami Lane, Unit C-9 Hamilton NJ, 08619
Telephone: (609) 584-8424 Fax: (609) 631-0177