

## OUTLINE:

- WHAT IS LMDS
- TYPES OF LINEARIZERS
- PREDISTORTION LINEARIZERS
- PERFORMANCE EVALUATION
- RESULTS
- CONCLUSIONS

## WHAT IS LMDS?

### LOCAL MULTIPOINT DISTRIBUTION SERVICE

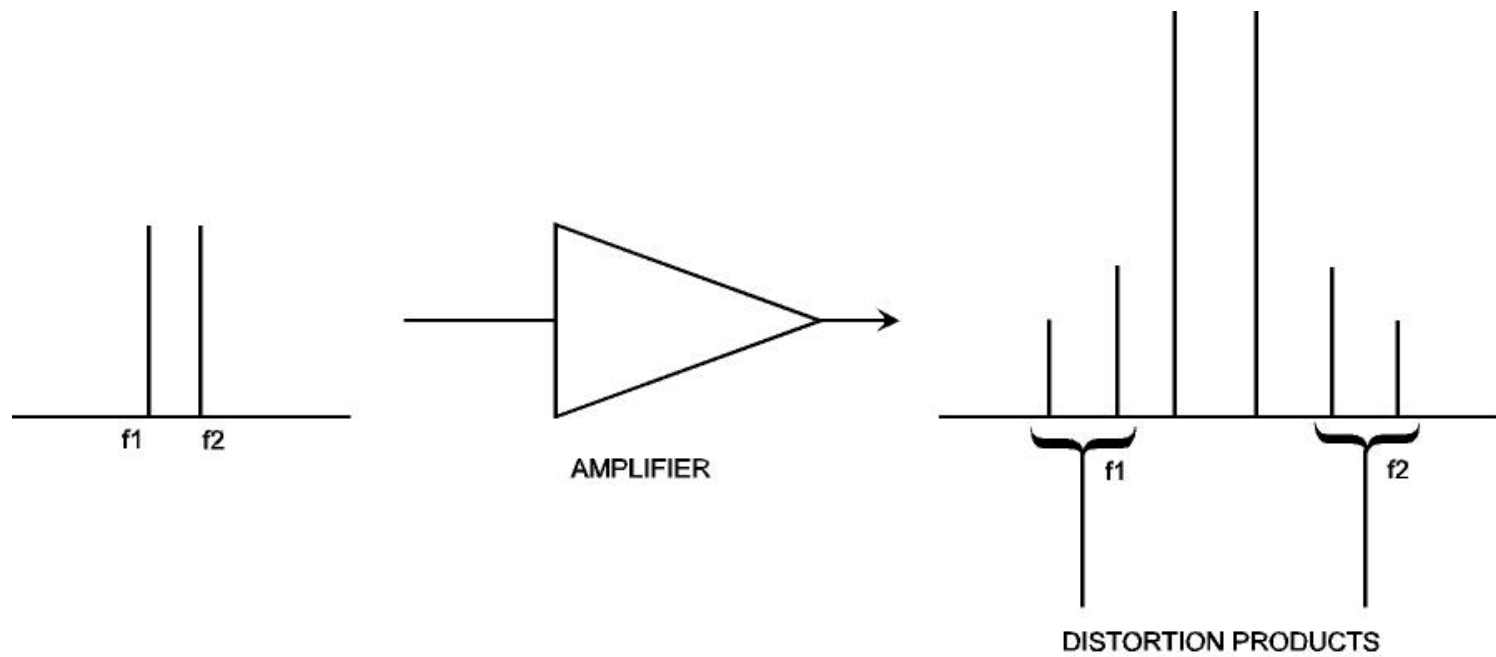
USE OF MILLIMETER WAVES TO TRANSMIT VOICE, DATA, AND VIDEO SIGNALS WITHIN AREAS (CELLS) OF 3-10 MILES IN DIAMETER.

ALLOW LICENSE HOLDERS TO CONTROL UP TO 1.3 GHz IN THE 28 GHz SPECTRUM.

CAN BE USED TO CARRY DIGITAL SIGNALS AT SPEEDS GREATER THAN 1 Gbps.

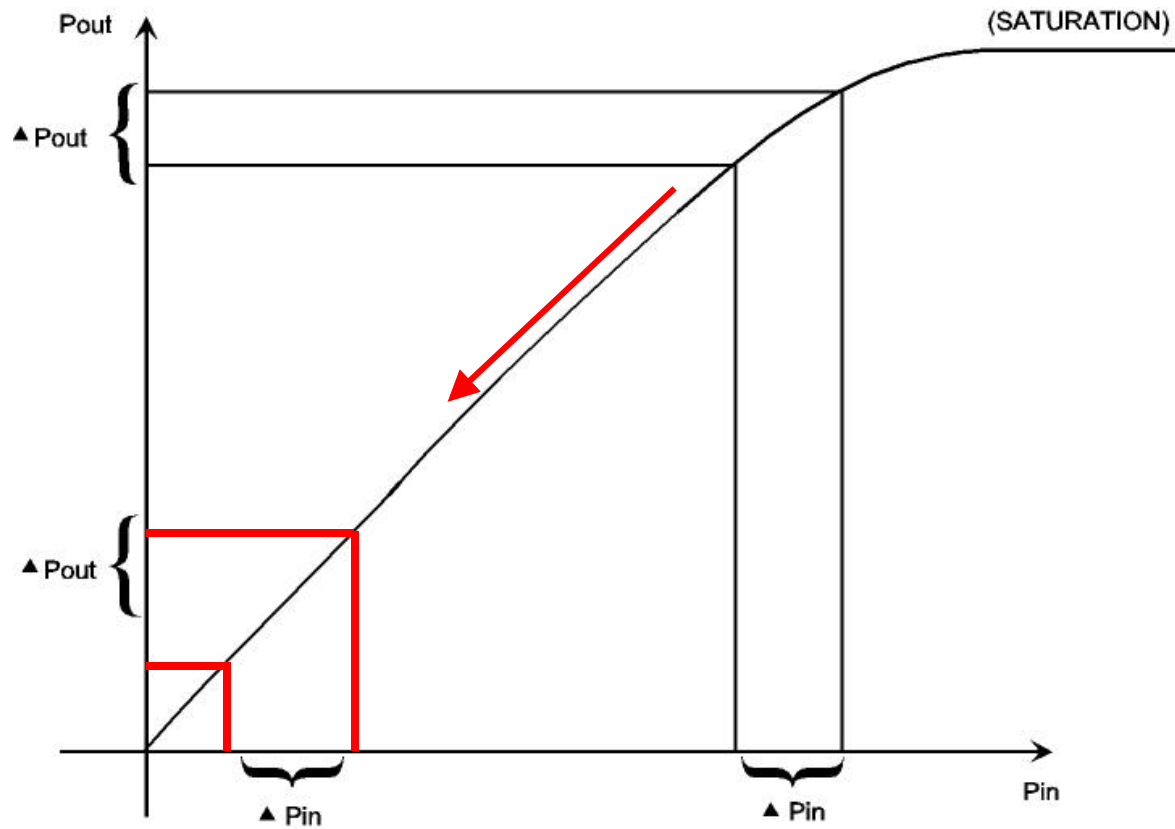
# LMDS IS A MULTI CARRIER SYSTEM

WHEN 2 OR MORE SIGNALS ARE AMPLIFIED CLOSE IN DISTORTION IS PRODUCED



## TO REDUCE DISTORTION TO AN ACCEPTABLE LEVEL

- MUST OPERATE AMPLIFIER AT REDUCED POWER LEVEL (BACKOFF FROM SATURATION)



LMDS TRANSMITS NOT 2, BUT 50 CARRIERS  
OVER A 1 GHz BAND!



For SATISFACTORY PERFORMANCE

TWTAs MUST BACKED OFF  $> 10$  dB

SSPAs MUST BACKED OFF  $> 8$  dB

NEW LMDS WILL TX 100 CARRIERS

WITH COMPLEX DIGITAL MODULATION

THESE SYSTEMS WILL REQUIRE EVEN  $> OPBO!$

## LINEARIZATION

A SYSTEMATIC PROCEDURE FOR REDUCING DISTORTION

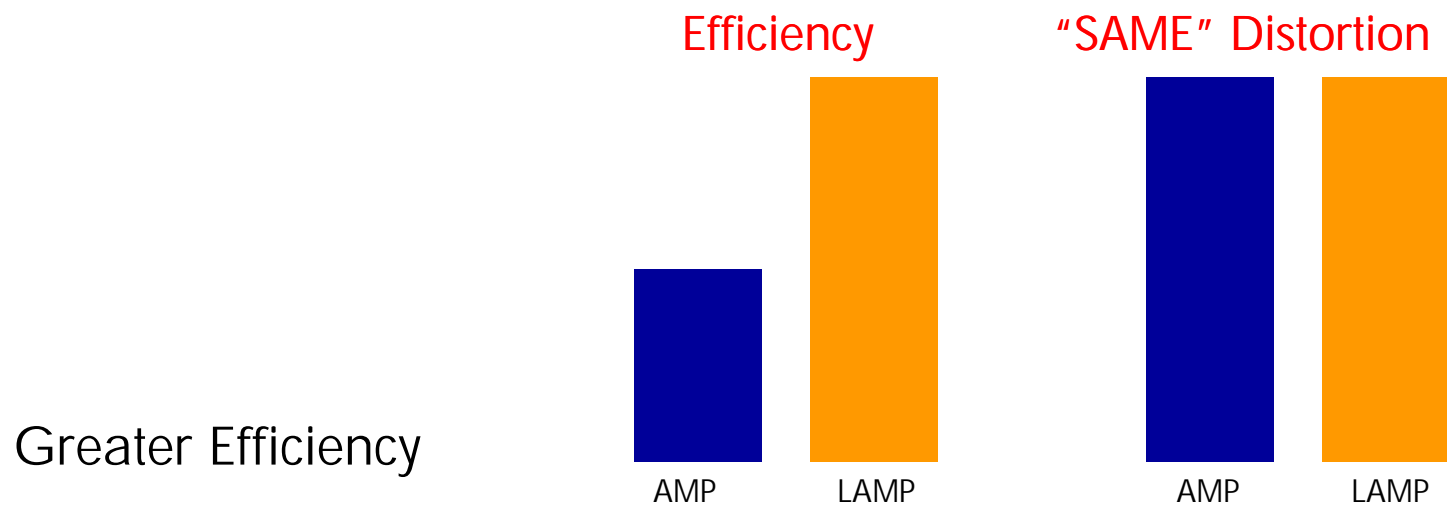
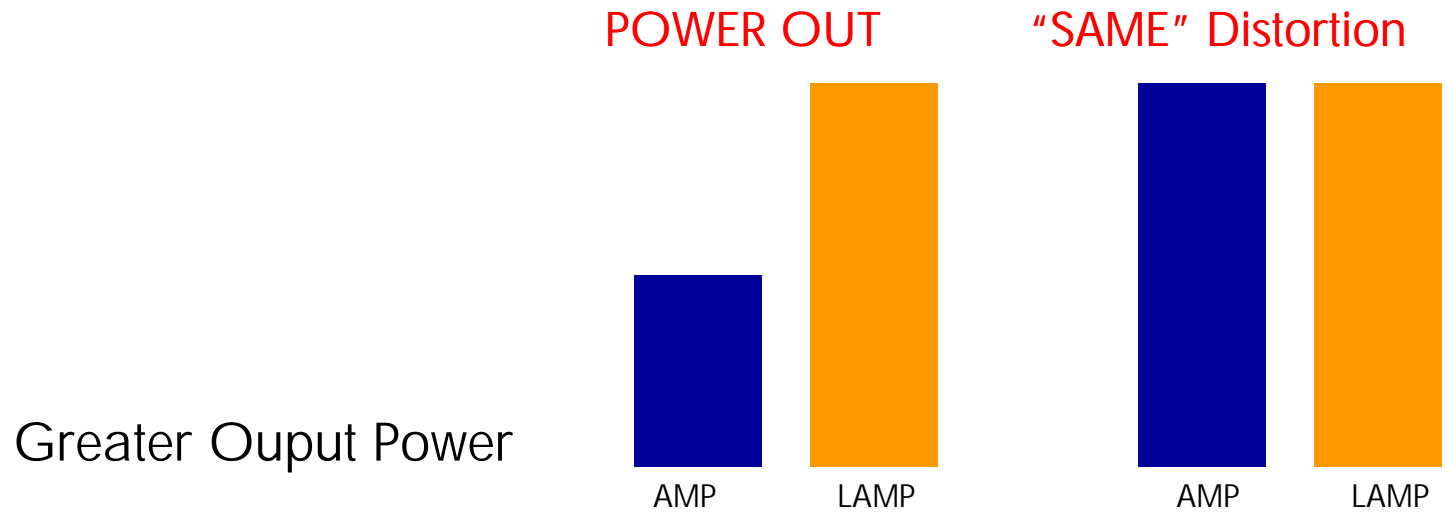
MANY FORMS -

FEEDFORWARD AND PREDISTORTION MOST COMMON

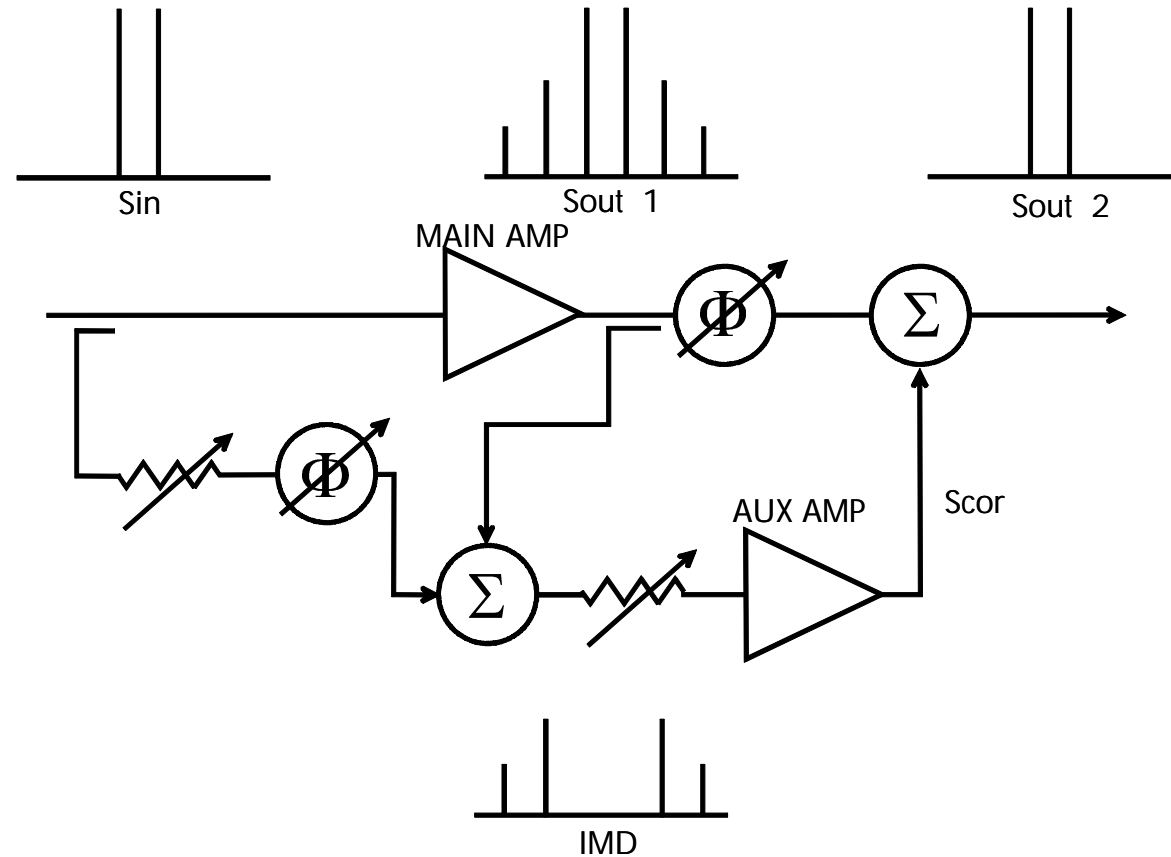
USUALLY EXTRA COMPONENTS ADDED TO A  
CONVENTIONAL AMP

WHEN CONFIGURED AS SUBASSEMBLY OR "BOX" REFERRED  
TO AS A LINEARIZER

# ALLOWS HPA TO OPERATE CLOSER TO SAT



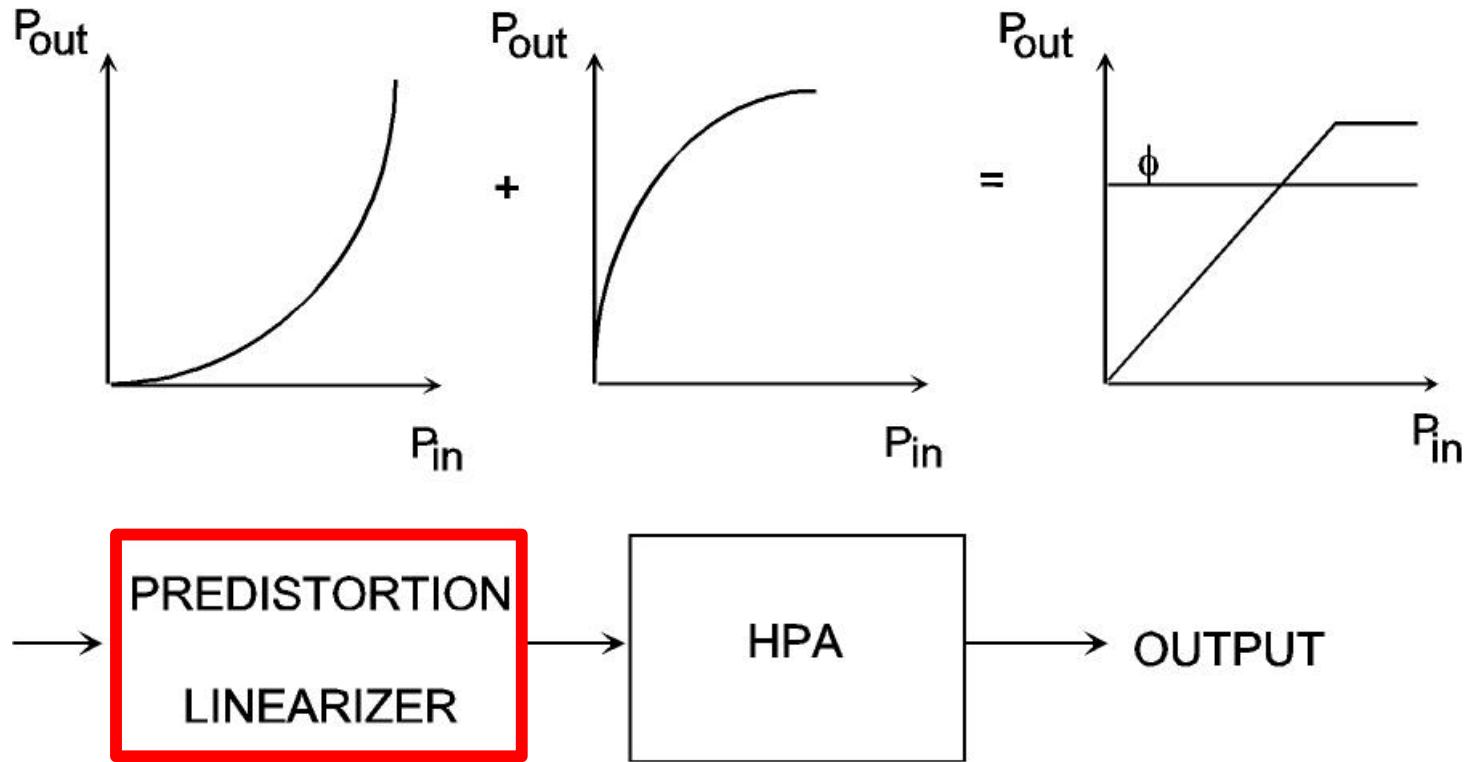
## FEEDFORWARD



- RELATIVELY COMPLEX
- NOT WORKABLE AS STAND-ALONE UNIT
- NOT EFFECTIVE FOR OPBOs < 6 dB
- MOST USEFUL FOR VERY HIGH LINEARITY APPLICATIONS



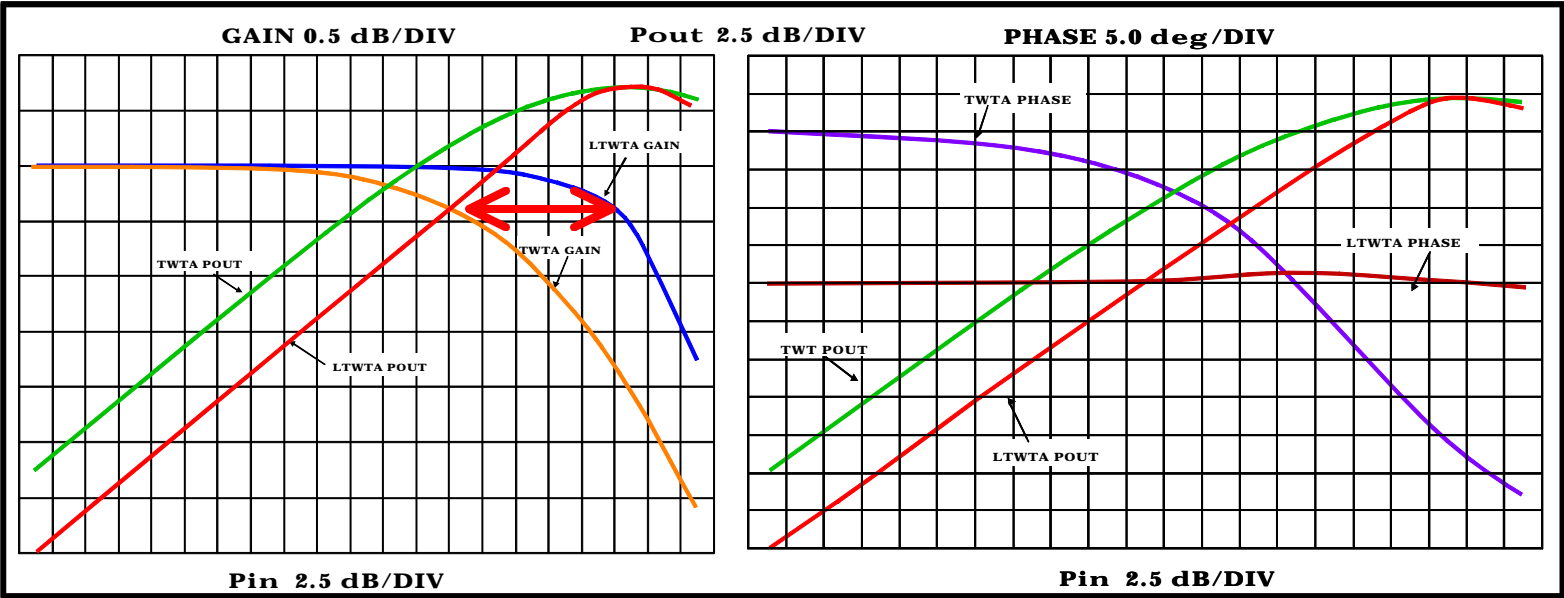
## PREDISTORTION



- RELATIVELY SIMPLE CIRCUITRY
- EASILY IMPLEMENTED AS A STAND-ALONE UNIT
- WIDE BAND (>20% BW)
- MOST POPULAR FOR MICROWAVE APPLICATIONS

# PERFORMANCE EVALUATION

MAGNITUDE & PHASE IMPORTANT INDICATORS OF PERFORMANCE  
\*\* OBTAINED WITH POWER SWEEP \*\*



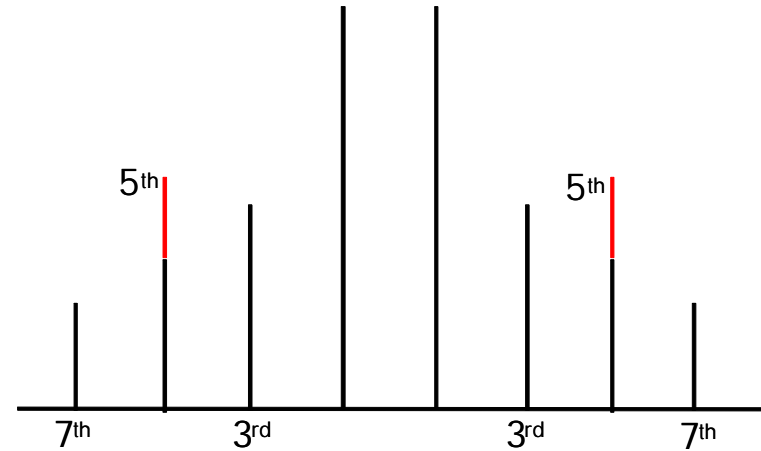
SEPARATION OF 1 dB COMPRESSION AND SATURATION  
PROVIDES GAGE FOR COMPARISON

## C/I (CARRIER TO IMD) MEASUREMENT

- MANY DIFFERENT STANDARDS MAKE COMPARISON DIFFICULT
- DATA USUALLY PRESENTED REL TO BACKOFF FROM SAT
- SAT. POINT SHOULD BE SINGLE CARRIER SAT
- 2 CARRIER SAT ABT 1 dB LOWER
- CAN NOT USE 3 OR 5 dB COMPRESSION FOR SAT POINT
- BOTH IPBO AND OPBO USED... IPBO CAN BE MISLEADING
- BEST TO REFER TO OPBO
- **OUTPUT LEVEL IS WHAT'S IMPORTANT!**

## OFTEN RESULTS PRESENTED FOR C/I3 ONLY

With Linearizers, not uncommon for 5th order terms to be greater than 3rds or of same order

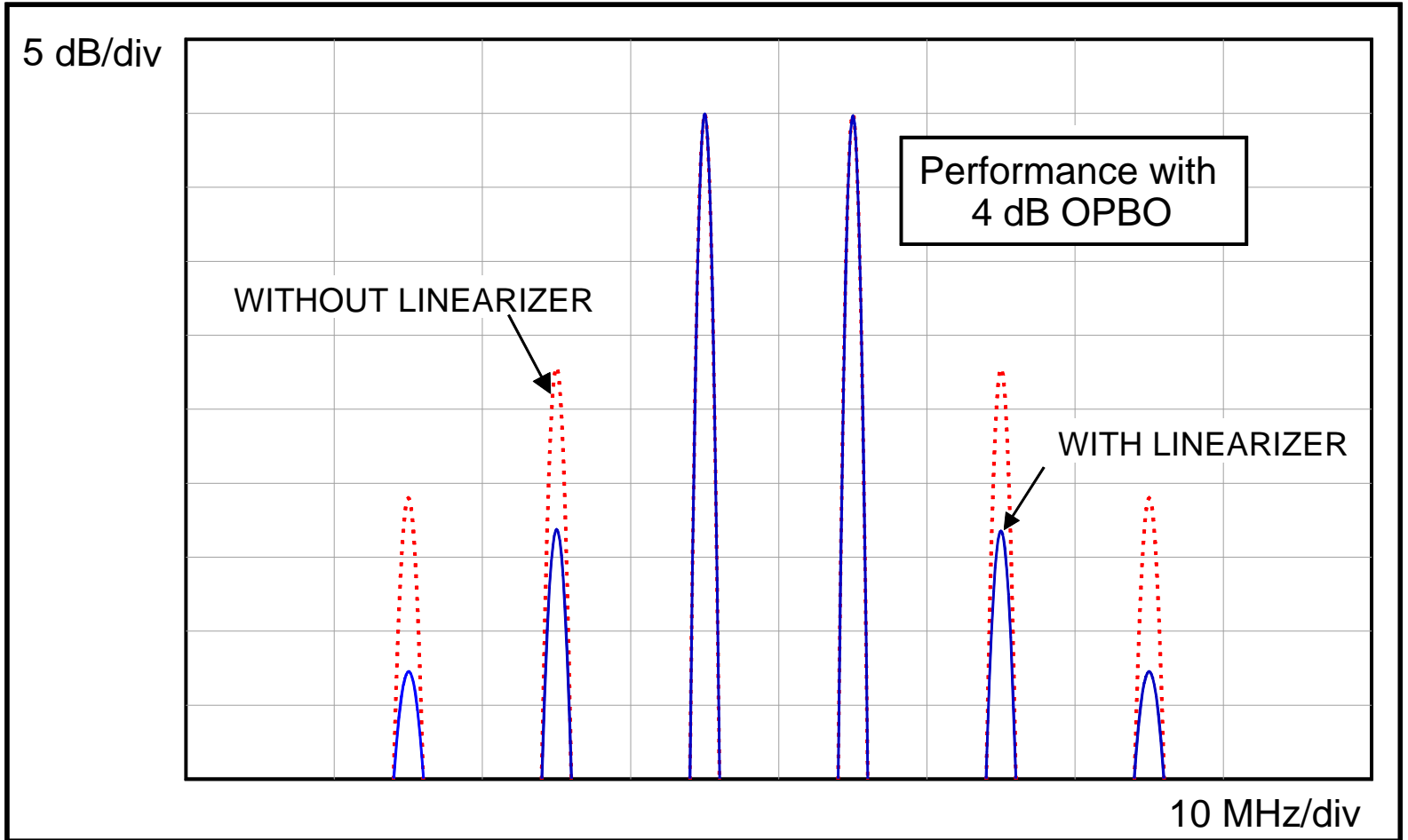


$$C/I \text{ total} = C / \sqrt{E_3^2 + E_5^2 + E_7^2 + \dots}$$

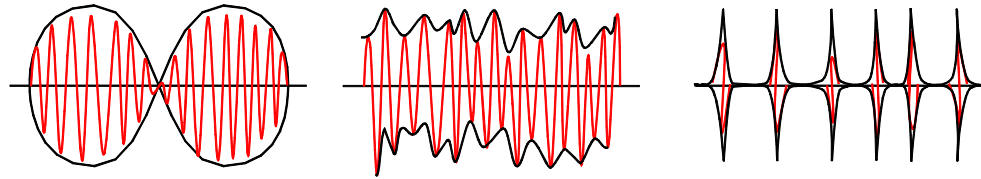
Total C/I preferred to C/I3

C/Imin is a good compromise

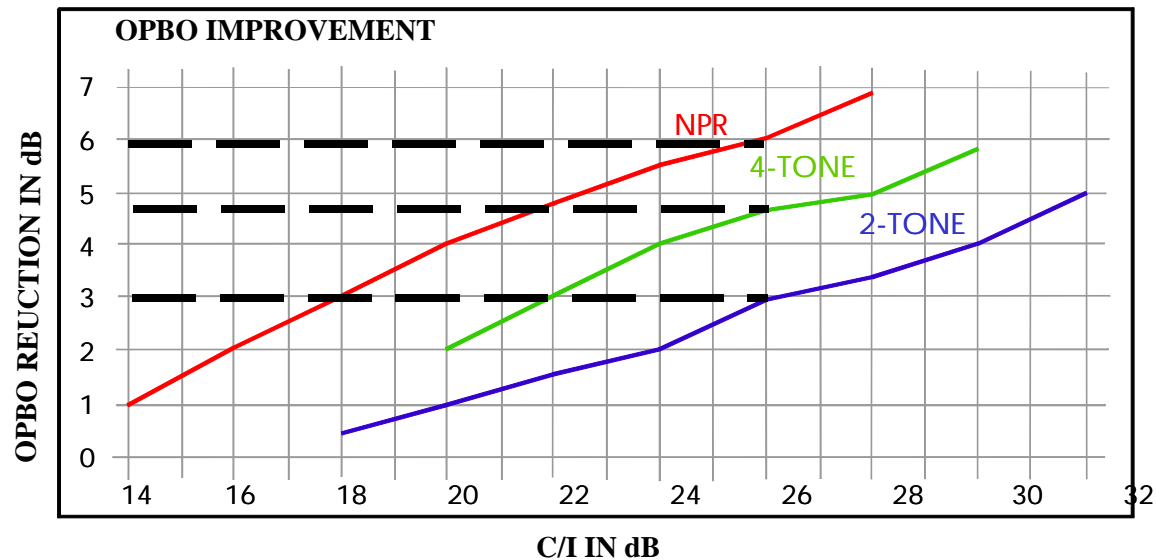
# TYPICAL 2-TONE C/I IMPROVEMENT AT 4 dB OPBO GREATER THAN 15 dB



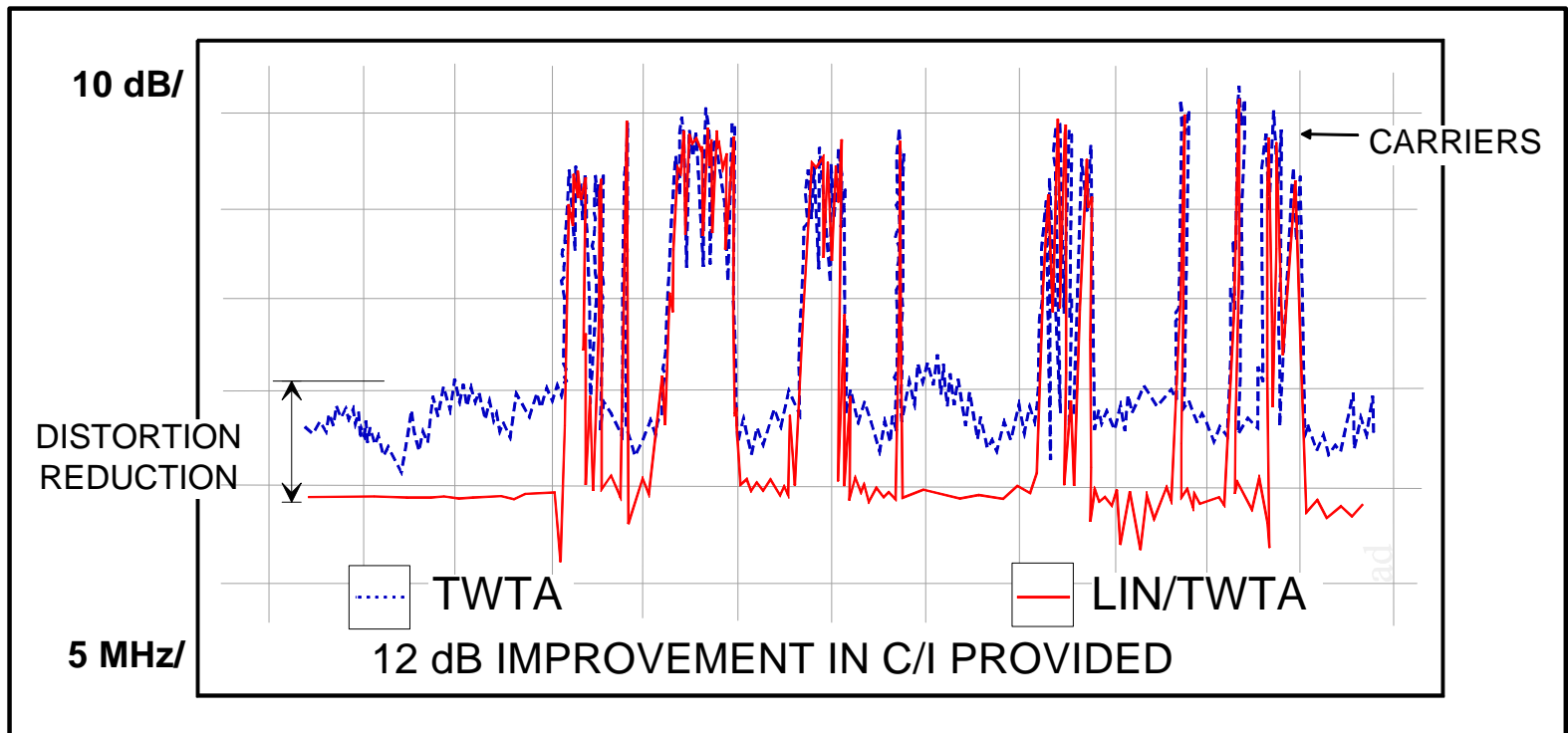
## MULTIPLE CARRIERS (N > 2)



- EXERCISE OVER RANGE  $P_{pk} = 2NP_{av}$
- NO SIMPLE RELATIONSHIP BETWEEN C/I FOR 2 AND N CARRIER CASE
- GREATER IMPROVEMENT (REDUCTION IN OPBO) FOR A GIVEN C/I AS N INCREASES



PROVIDES GREATER THAN A 10 dB REDUCTION  
MULTI-CARRIER DISTORTION



# LTI Has Developed Ka-Band Linearizers

For TWTAs, Klystrons and SSPAs



- All Bands 26-31 GHz
- Easy to Tune
- Full Digital Control

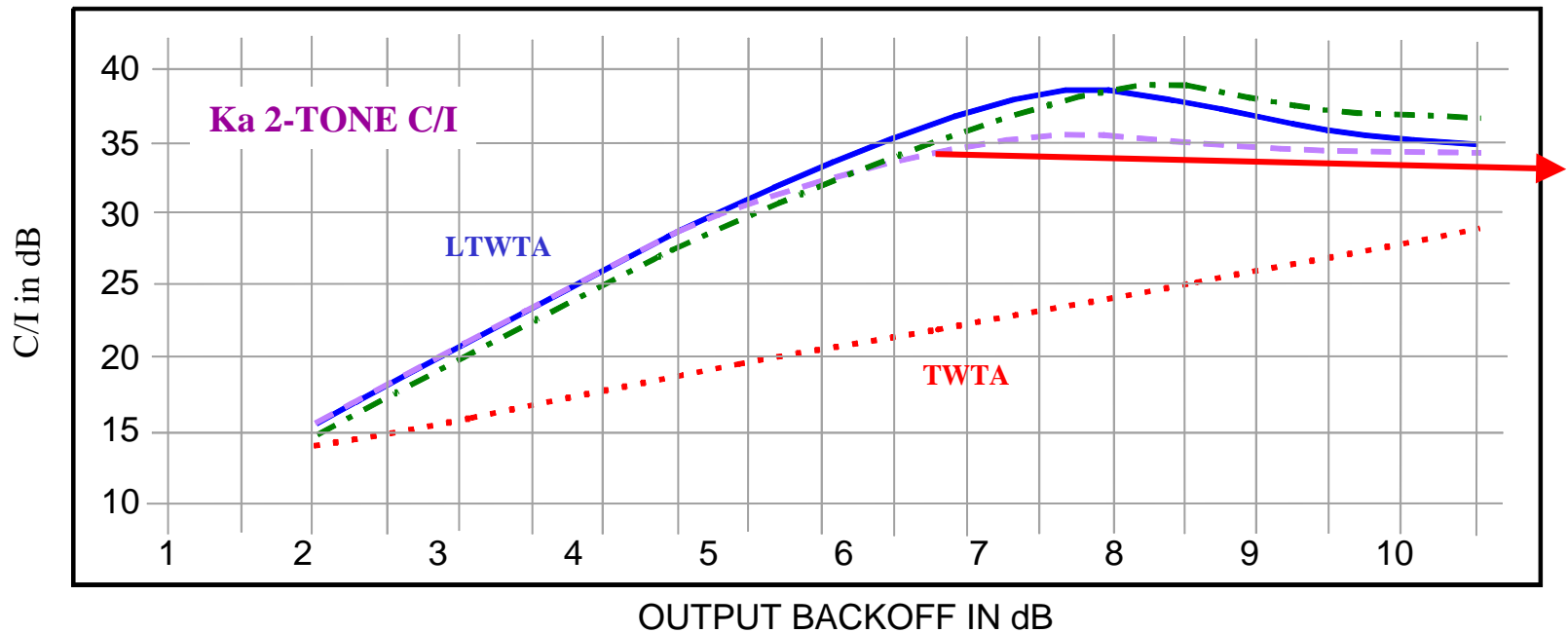
Predistortion Linearizers Can Give TWTAs  
an Effective 4X Power Increase with Multicarrier Traffic



# FOR 50 CARRIER LMDS

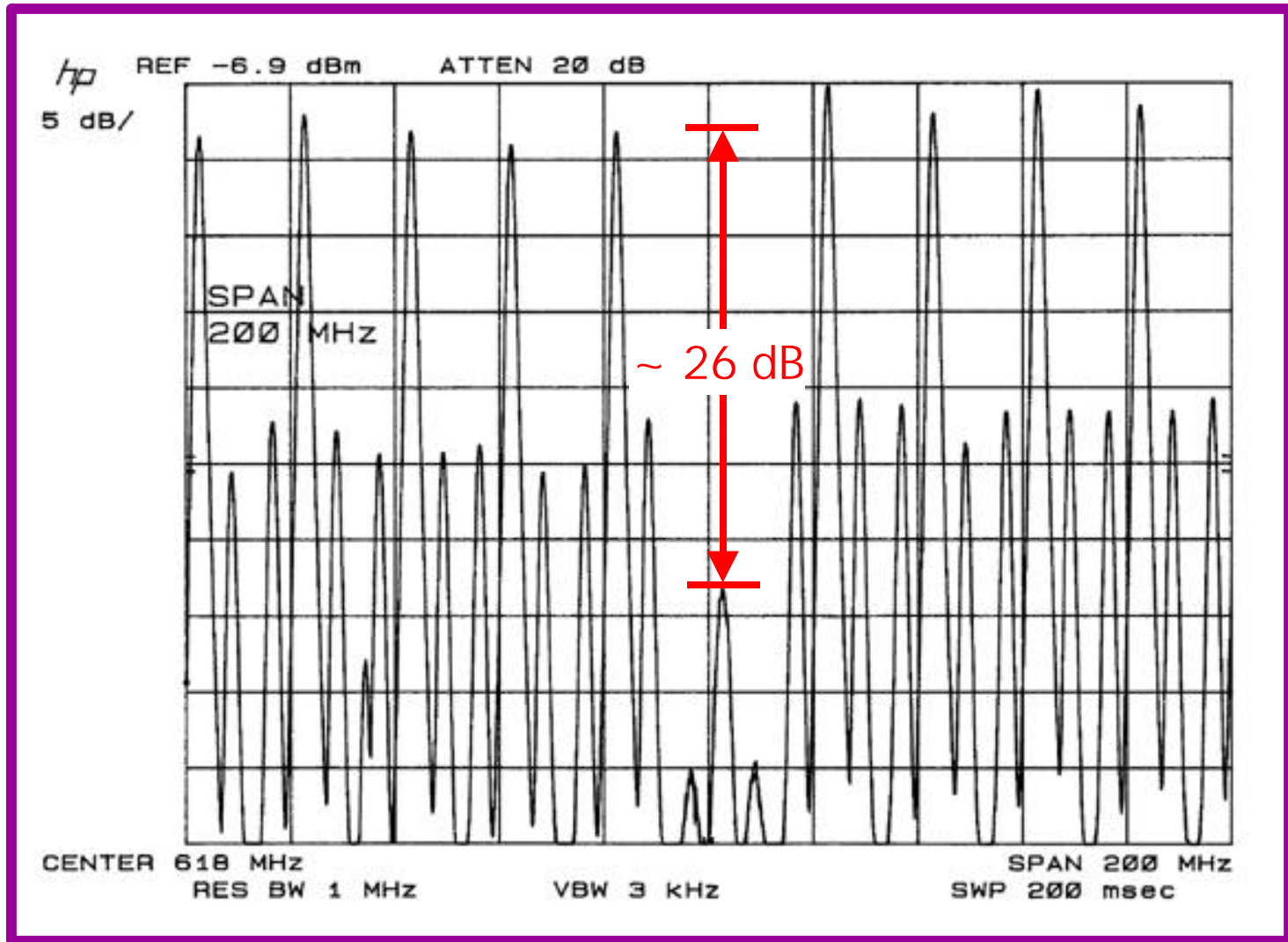
A MULTI-CARRIER C/I OF 26 dB REQUIRED

$$C/I_n \approx C/I_2 - 8 \text{ dB} \quad \text{or} \quad C/I_2 \approx 26 + 8 = 34 \text{ dB}$$

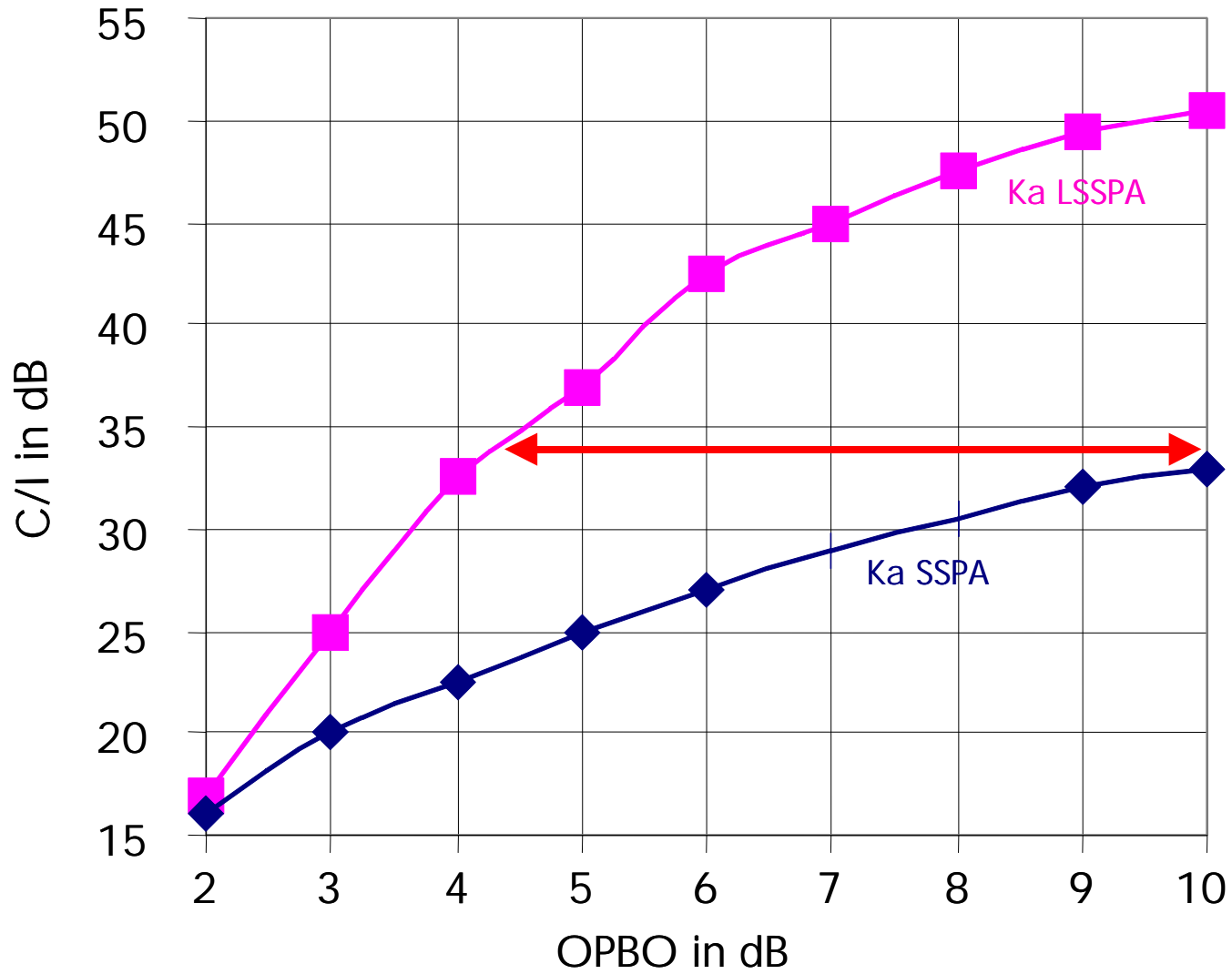


LINEARIZING A Ka-BAND TWTA YIELDS > 6 dB OF POWER

# LMDS SYSTEM 12 TONE C/I TEST WITH TWTA AT 4 dB OPBO



# LINEARIZING A Ka-BAND SSPA ALSO YIELDS > 6 dB OF POWER



## CONCLUSION:

LINEARIZERS GREATLY INCREASE THE AVAILABLE POWER OF LMDS HPAs.

AT Ka-BAND LINEARIZERS CAN PROVIDE MORE THAN A 4-FOLD INCREASE IN POWER FOR BOTH TWTAs, KPAs AND SSPAs.

LINEARIZERS ARE ESSENTIAL FOR NEW ENHANCED LMDS HPAs BECAUSE OF THE VERY HIGH LINEARITY REQUIRED.