



# RF Power Field Effect Transistor

## N-Channel Enhancement-Mode Lateral MOSFETs

Designed for broadband commercial and industrial applications with frequencies from 470 to 860 MHz. The high gain and broadband performance of this device make it ideal for large-signal, common-source amplifier applications in 32 volt analog or digital television transmitter equipment.

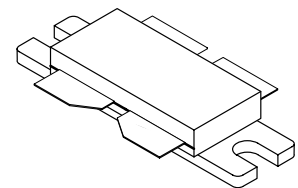
- Typical Narrowband Two-Tone Performance @ 860 MHz:  $V_{DD} = 32$  Volts,  $I_{DQ} = 1600$  mA,  $P_{out} = 270$  Watts PEP  
 Power Gain — 20.2 dB  
 Drain Efficiency — 44.1%  
 IMD — -30.8 dBc
- Typical Narrowband DVBT OFDM Performance @ 860 MHz:  $V_{DD} = 32$  Volts,  $I_{DQ} = 1600$  mA,  $P_{out} = 60$  Watts Avg., 8K Mode, 64 QAM  
 Power Gain — 20.4 dB  
 Drain Efficiency — 29%  
 ACPR @ 3.9 MHz Offset — -57 dBc @ 20 kHz Bandwidth
- Capable of Handling 10:1 VSWR, @ 32 Vdc, 860 MHz, 300 Watts CW Output Power

### Features

- Characterized with Series Equivalent Large-Signal Impedance Parameters
- Internally Matched for Ease of Use
- Designed for Push-Pull Operation Only
- Qualified Up to a Maximum of 32  $V_{DD}$  Operation
- Integrated ESD Protection
- Lower Thermal Resistance Package
- Low Gold Plating Thickness on Leads, 40 $\mu$ m Nominal.
- RoHS Compliant
- In Tape and Reel. R3 Suffix = 250 Units per 56 mm, 13 inch Reel.  
 R5 Suffix = 50 Units per 56 mm, 13 inch Reel.

**MRF6P3300HR3**  
**MRF6P3300HR5**

**470-860 MHz, 300 W, 32 V**  
**LATERAL N-CHANNEL**  
**RF POWER MOSFETS**



**CASE 375G-04, STYLE 1**  
**NI-860C3**

**Table 1. Maximum Ratings**

Rating	Symbol	Value	Unit
Drain-Source Voltage	$V_{DSS}$	-0.5, +68	Vdc
Gate-Source Voltage	$V_{GS}$	-0.5, +12	Vdc
Total Device Dissipation @ $T_C = 25^\circ\text{C}$ Derate above $25^\circ\text{C}$	$P_D$	761 4.3	W W/ $^\circ\text{C}$
Storage Temperature Range	$T_{stg}$	- 65 to +150	$^\circ\text{C}$
Case Operating Temperature	$T_C$	150	$^\circ\text{C}$
Operating Junction Temperature	$T_J$	200	$^\circ\text{C}$

**Table 2. Thermal Characteristics**

Characteristic	Symbol	Value (1,2)	Unit
Thermal Resistance, Junction to Case Case Temperature $80^\circ\text{C}$ , 300 W CW Case Temperature $82^\circ\text{C}$ , 220 W CW Case Temperature $79^\circ\text{C}$ , 100 W CW Case Temperature $81^\circ\text{C}$ , 60 W CW	$R_{\theta JC}$	0.23 0.24 0.27 0.27	$^\circ\text{C}/\text{W}$

1. MTF calculator available at <http://www.freescale.com/rtf>. Select Tools/Software/Application Software/Calculators to access the MTF calculators by product.
2. Refer to AN1955, *Thermal Measurement Methodology of RF Power Amplifiers*. Go to <http://www.freescale.com/rtf>. Select Documentation/Application Notes - AN1955.

**Table 3. ESD Protection Characteristics**

Test Methodology	Class
Human Body Model (per JESD22-A114)	3B (Minimum)
Machine Model (per EIA/JESD22-A115)	C (Minimum)
Charge Device Model (per JESD22-C101)	IV (Minimum)

**Table 4. Electrical Characteristics** ( $T_C = 25^\circ\text{C}$  unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
<b>Off Characteristics</b> <sup>(1)</sup>					
Zero Gate Voltage Drain Leakage Current <sup>(4)</sup> ( $V_{DS} = 68\text{ Vdc}$ , $V_{GS} = 0\text{ Vdc}$ )	$I_{DSS}$	—	—	10	$\mu\text{Adc}$
Zero Gate Voltage Drain Leakage Current <sup>(4)</sup> ( $V_{DS} = 32\text{ Vdc}$ , $V_{GS} = 0\text{ Vdc}$ )	$I_{DSS}$	—	—	1	$\mu\text{Adc}$
Gate-Source Leakage Current ( $V_{GS} = 5\text{ Vdc}$ , $V_{DS} = 0\text{ Vdc}$ )	$I_{GSS}$	—	—	1	$\mu\text{Adc}$

**On Characteristics** <sup>(1)</sup>

Gate Threshold Voltage ( $V_{DS} = 10\text{ Vdc}$ , $I_D = 350\ \mu\text{Adc}$ )	$V_{GS(th)}$	1	2.2	3	Vdc
Gate Quiescent Voltage ( $V_{DS} = 32\text{ Vdc}$ , $I_D = 1600\text{ mAdc}$ , Measured in Functional Test)	$V_{GS(Q)}$	2	2.8	4	Vdc
Drain-Source On-Voltage ( $V_{GS} = 10\text{ Vdc}$ , $I_D = 2.4\text{ Adc}$ )	$V_{DS(on)}$	—	0.22	0.3	Vdc
Forward Transconductance ( $V_{DS} = 10\text{ Vdc}$ , $I_D = 2.4\text{ Adc}$ )	$g_{fs}$	—	7.4	—	S

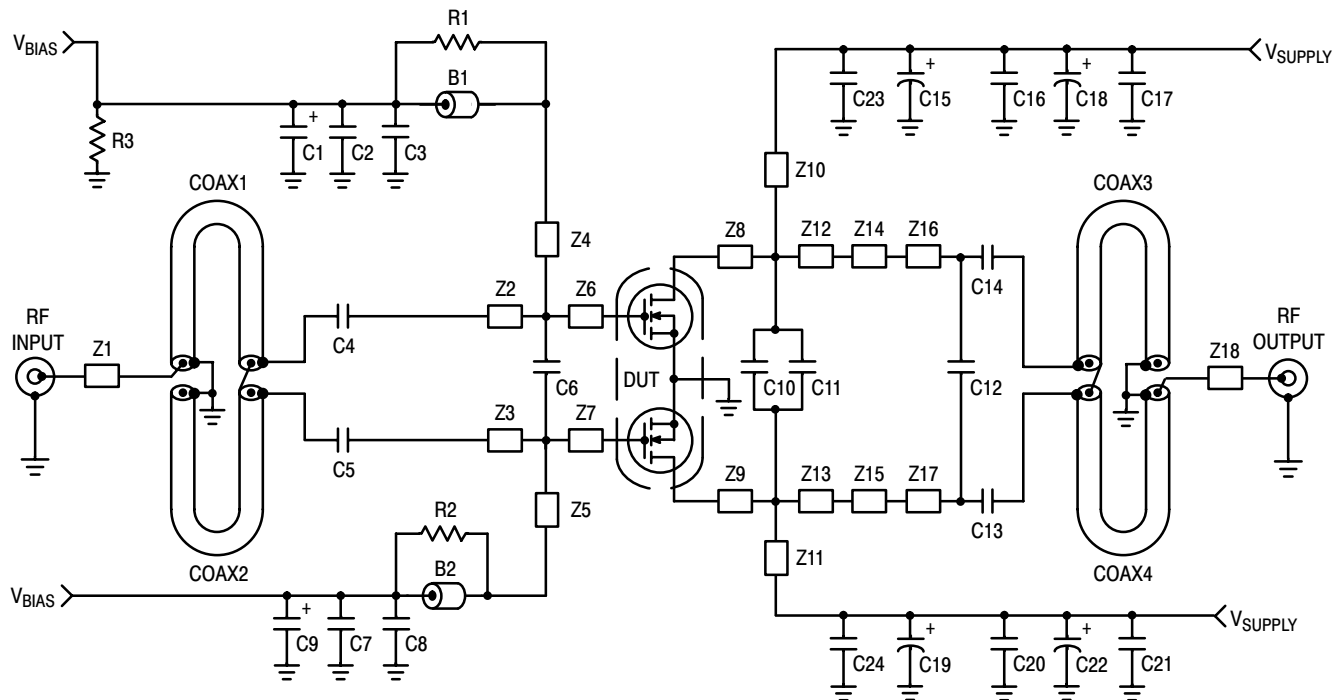
**Dynamic Characteristics** <sup>(1,2)</sup>

Reverse Transfer Capacitance ( $V_{DS} = 32\text{ Vdc} \pm 30\text{ mV(rms)}$ ac @ 1 MHz, $V_{GS} = 0\text{ Vdc}$ )	$C_{rss}$	—	1.4	—	pF
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**Functional Tests** <sup>(3)</sup> (In Freescale Narrowband Test Fixture, 50 ohm system)  $V_{DD} = 32\text{ Vdc}$ ,  $I_{DQ} = 1600\text{ mA}$ ,  $P_{out} = 270\text{ W PEP}$ ,  $f_1 = 857\text{ MHz}$ ,  $f_2 = 863\text{ MHz}$

Power Gain	$G_{ps}$	19	20.2	23	dB
Drain Efficiency	$\eta_D$	41	44.1	—	%
Intermodulation Distortion	IMD	—	-30.8	-28	dBc
Input Return Loss	IRL	—	-24	-9	dB
$P_{out}$ @ 1 dB Compression Point, CW ( $f = 860\text{ MHz}$ )	P1dB	—	320	—	W

1. Each side of the device measured separately.
2. Part internally matched both on input and output.
3. Measurement made with device in push-pull configuration.
4. Drains are tied together internally as this is a total device value.



Z1, Z18	0.401" x 0.810" Microstrip	Z10, Z11	1.054" x 0.150" Microstrip
Z2, Z3	0.563" x 0.810" Microstrip	Z12, Z13	0.225" x 0.507" Microstrip
Z4, Z5	1.643" x 0.058" Microstrip	Z14, Z15	0.440" x 0.335" Microstrip
Z6, Z7	0.416" x 0.727" Microstrip	Z16, Z17	0.123" x 0.140" Microstrip
Z8, Z9	0.191" x 0.507" Microstrip	PCB	Arlon GX-0300-55-22, 0.030", $\epsilon_r = 2.5$

Figure 1. 820-900 MHz Narrowband Test Circuit Schematic

Table 5. 820-900 MHz Narrowband Test Circuit Component Designations and Values

Part	Description	Part Number	Manufacturer
B1, B2	Ferrite Beads, Short	2743019447	Fair-Rite
C1, C9	1.0 $\mu$ F, 50 V Tantalum Chip Capacitors	T491C105K050AS	Kemet
C2, C7, C17, C21	0.1 $\mu$ F, 50 V Chip Capacitors	CDR33BX104AKWS	Kemet
C3, C8, C16, C20	1000 pF 100B Chip Capacitors	100B102JP50X	ATC
C4, C5, C13, C14	100 pF 100B Chip Capacitors	100B101JP500X	ATC
C6, C12	8.2 pF 600B Chip Capacitors	600B8R2BT250XT	ATC
C10	9.1 pF 600B Chip Capacitor	600B9R1BT250XT	ATC
C11	1.8 pF 600B Chip Capacitor	600B1R8BT250XT	ATC
C15, C19	47 $\mu$ F, 50 V Electrolytic Capacitors	MVK50VC47RM8X10TP	Nippon
C18, C22	470 $\mu$ F, 63 V Electrolytic Capacitors	SME63V471M12X25LL	United Chemi-Con
C23, C24	22 pF 600B Chip Capacitors	600B220FT250XT	ATC
Coax1, 2, 3, 4	50 $\Omega$ , Semi Rigid Coax, 2.06" Long	UT-141A-TP	Micro-Coax
R1, R2	10 $\Omega$ , 1/8 W Chip Resistors (1206)	CRCW1206100J	Dale/Vishay
R3	1 k $\Omega$ , 1/8 W Chip Resistor (1206)	CRCW1206102J	Dale/Vishay

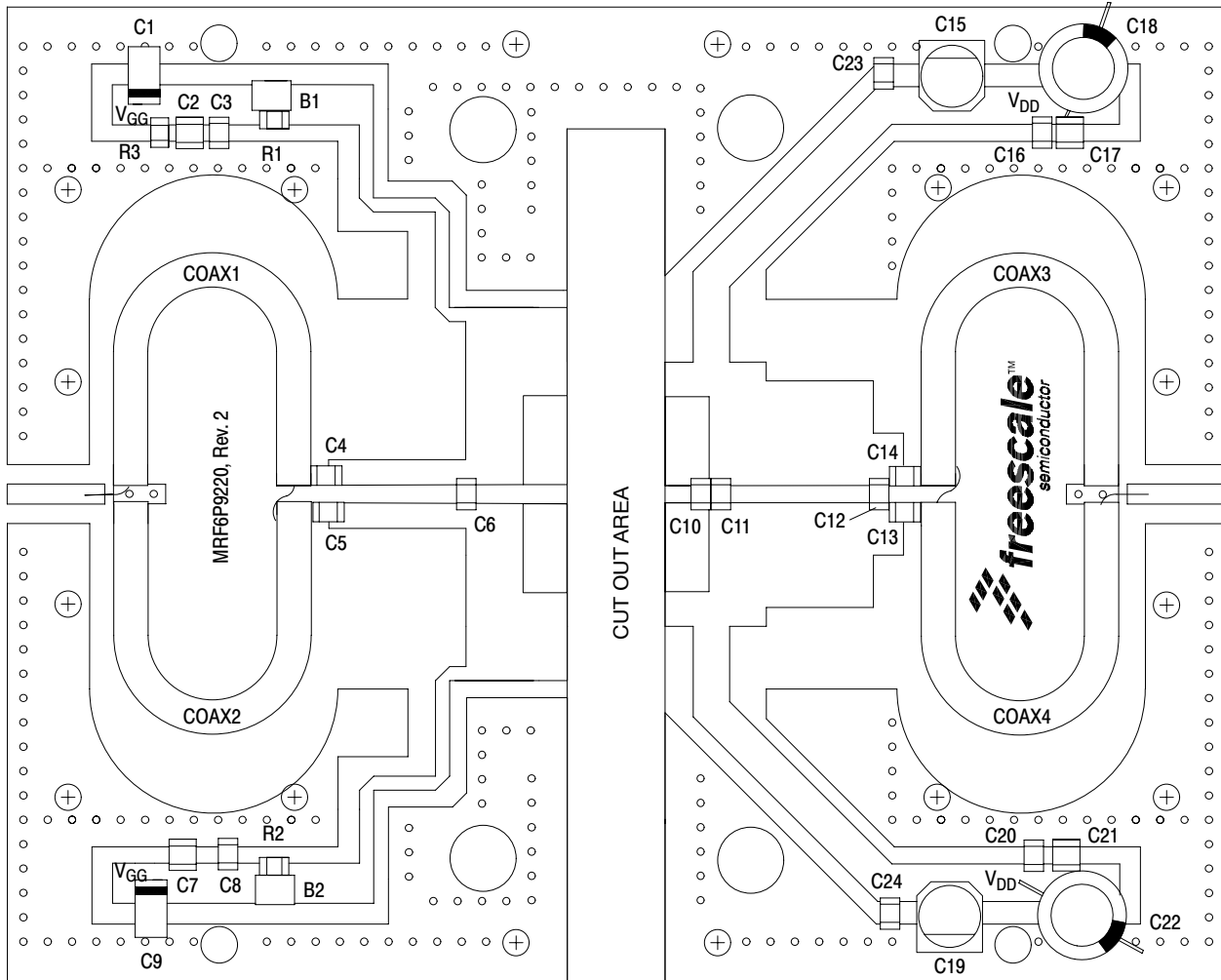


Figure 2. 820-900 MHz Narrowband Test Circuit Component Layout

## TYPICAL NARROWBAND CHARACTERISTICS

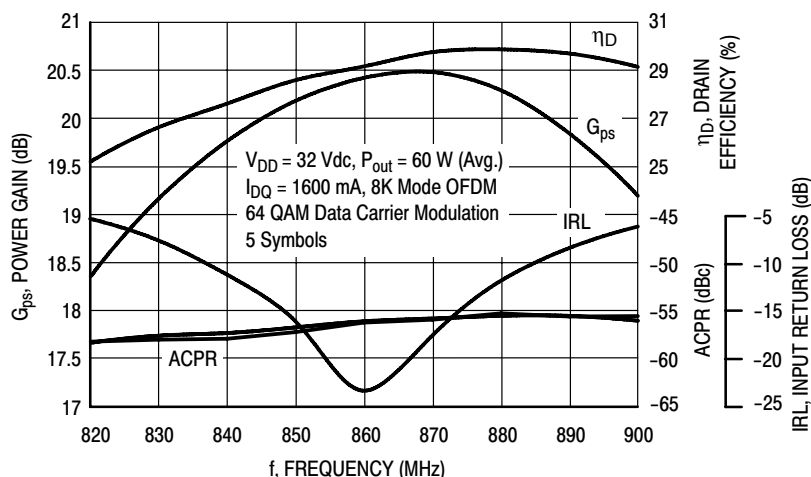


Figure 3. Single-Carrier OFDM Broadband Performance @ 60 Watts Avg.

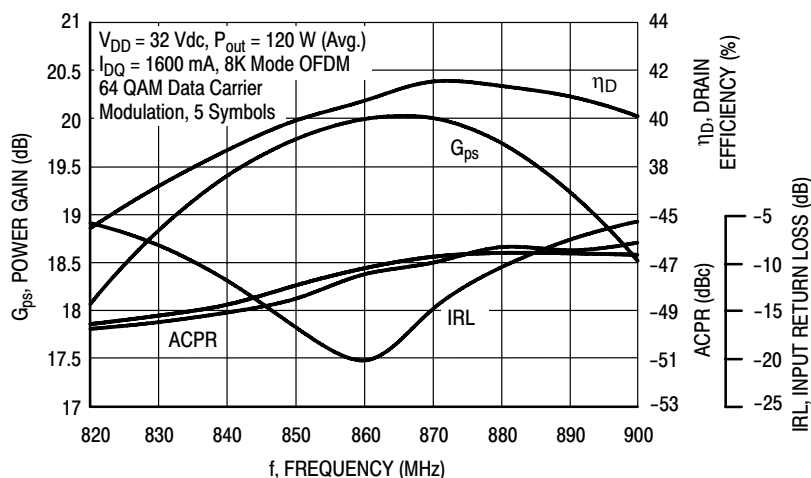


Figure 4. Single-Carrier OFDM Broadband Performance @ 120 Watts Avg.

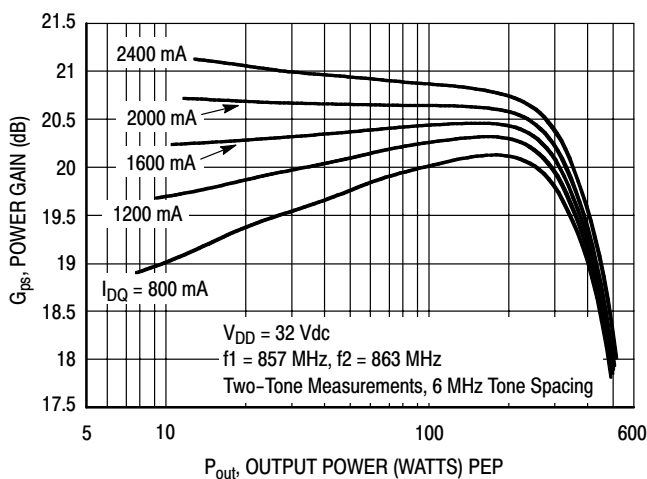


Figure 5. Two-Tone Power Gain versus Output Power

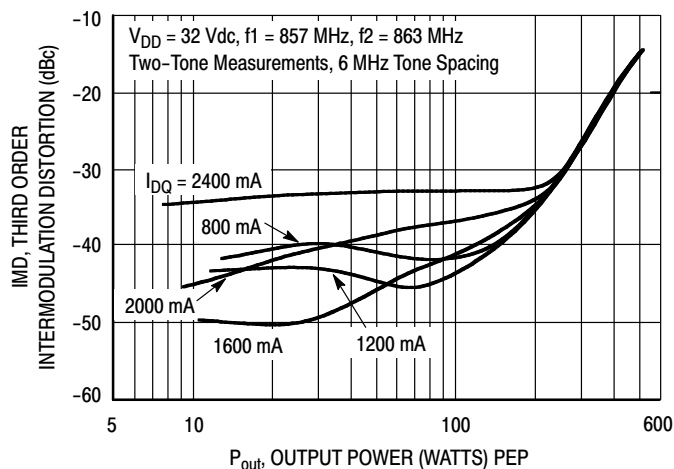


Figure 6. Third Order Intermodulation Distortion versus Output Power

## TYPICAL NARROWBAND CHARACTERISTICS

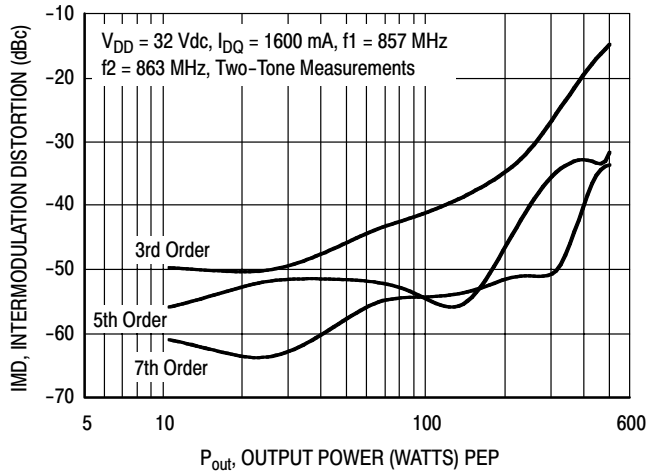


Figure 7. Intermodulation Distortion Products versus Output Power

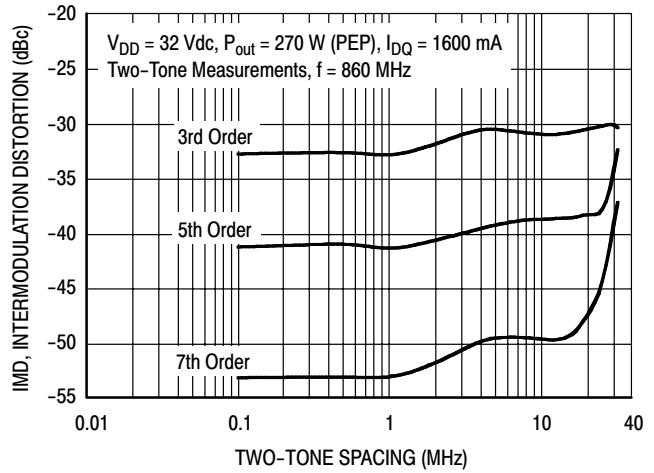


Figure 8. Intermodulation Distortion Products versus Tone Spacing @ 860 MHz

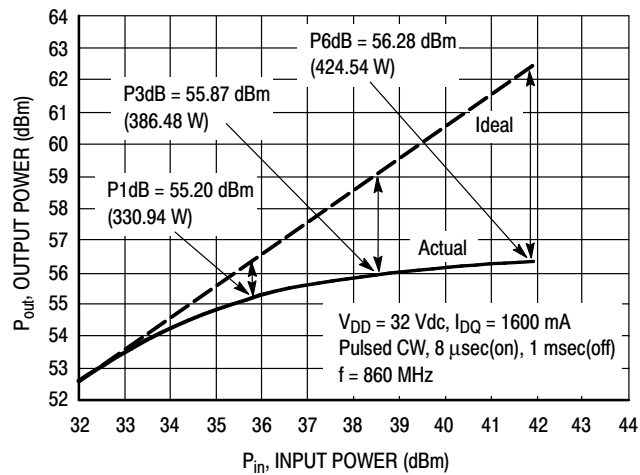


Figure 9. Pulse CW Output Power versus Input Power

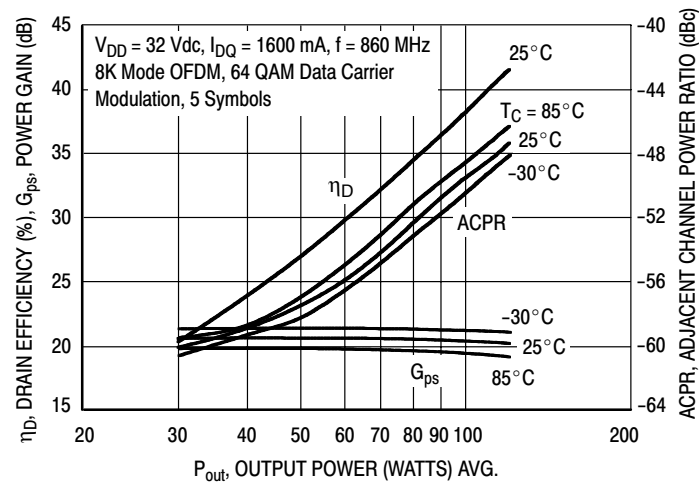
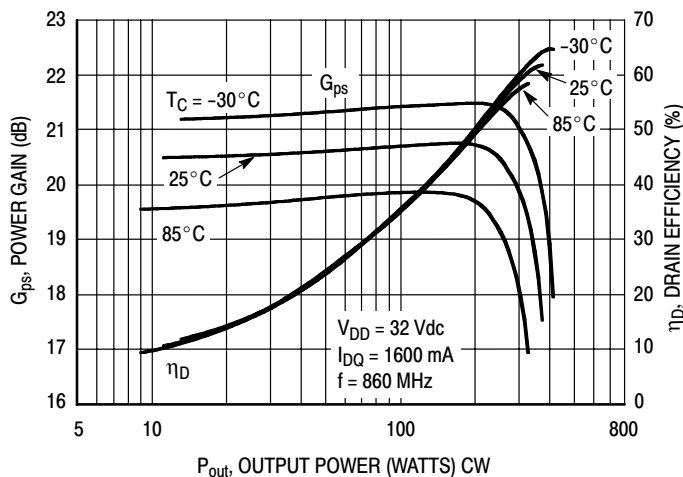
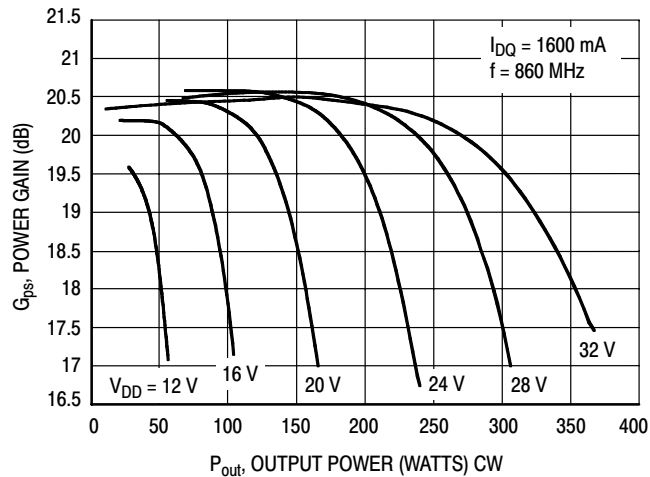


Figure 10. Single-Carrier DVBT OFDM ACPR, Power Gain and Drain Efficiency versus Output Power

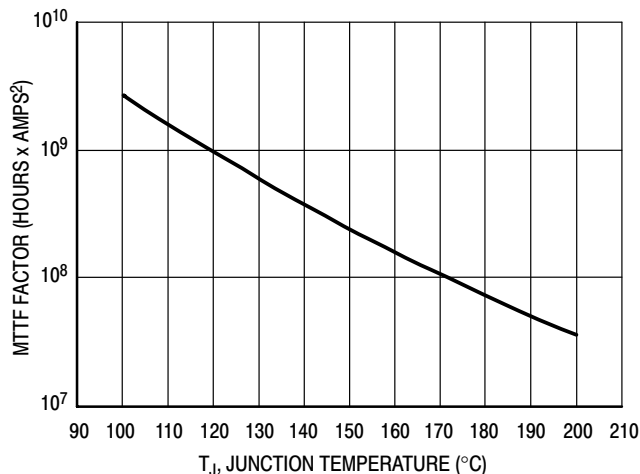
### TYPICAL NARROWBAND CHARACTERISTICS



**Figure 11. Power Gain and Drain Efficiency versus CW Output Power**



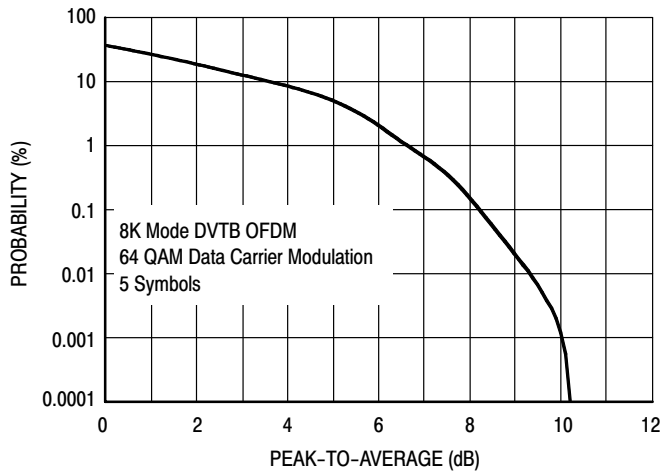
**Figure 12. Power Gain versus Output Power**



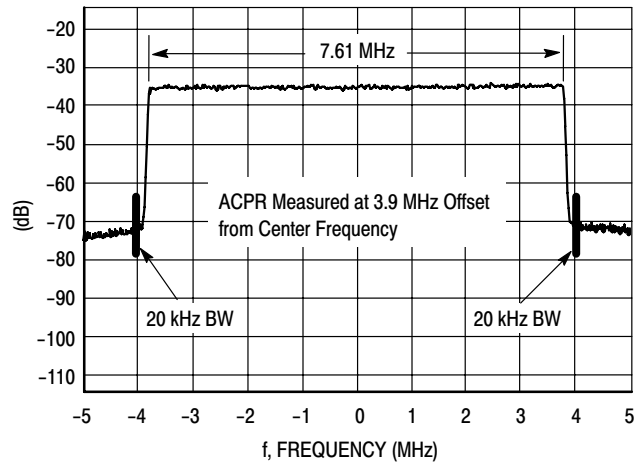
This above graph displays calculated MTTF in hours x ampere<sup>2</sup> drain current. Life tests at elevated temperatures have correlated to better than  $\pm 10\%$  of the theoretical prediction for metal failure. Divide MTTF factor by  $I_D^2$  for MTTF in a particular application.

**Figure 13. MTTF Factor versus Junction Temperature**

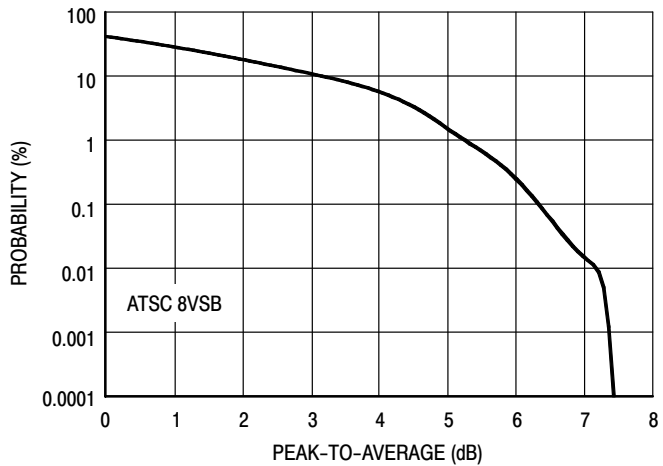
## DIGITAL TEST SIGNALS



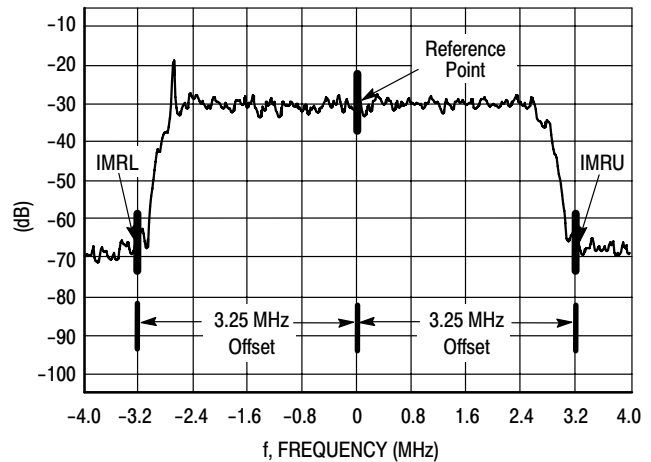
**Figure 14. Single-Carrier DVTB OFDM**



**Figure 15. 8K Mode DVBT OFDM Spectrum**

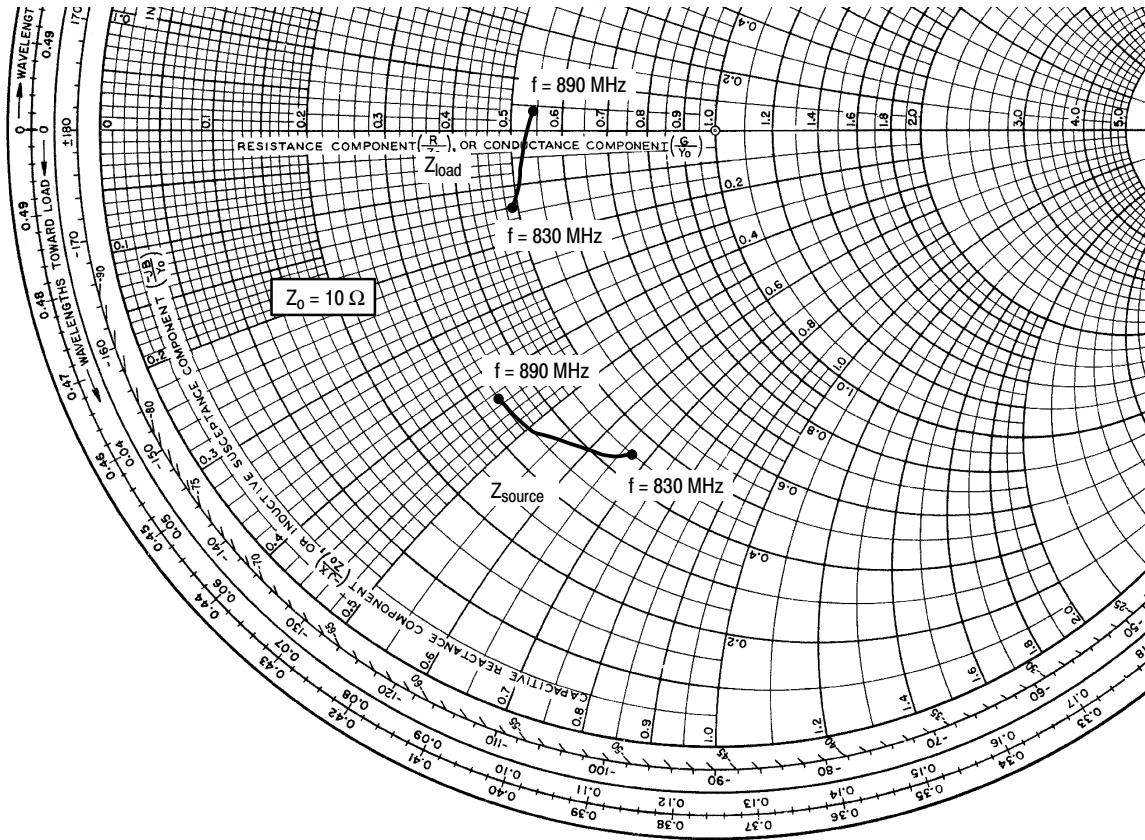


**Figure 16. Single-Carrier ATSC 8VSB**



**Figure 17. ATSC 8VSB Spectrum**





$V_{DD} = 32 \text{ Vdc}$ ,  $I_{DQ} = 1600 \text{ mA}$ ,  $P_{out} = 270 \text{ W PEP}$

f MHz	$Z_{source}$ $\Omega$	$Z_{load}$ $\Omega$
830	$4.52 - j6.73$	$4.89 - j1.35$
845	$4.22 - j6.38$	$5.06 - j1.01$
860	$3.89 - j5.81$	$5.18 - j0.58$
875	$3.54 - j5.10$	$5.27 - j0.11$
890	$3.39 - j4.32$	$5.36 + j0.43$

$Z_{source}$  = Test circuit impedance as measured from gate to gate, balanced configuration.

$Z_{load}$  = Test circuit impedance as measured from drain to drain, balanced configuration.

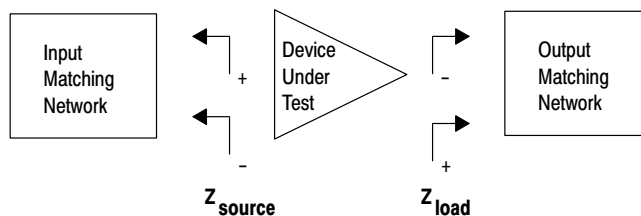
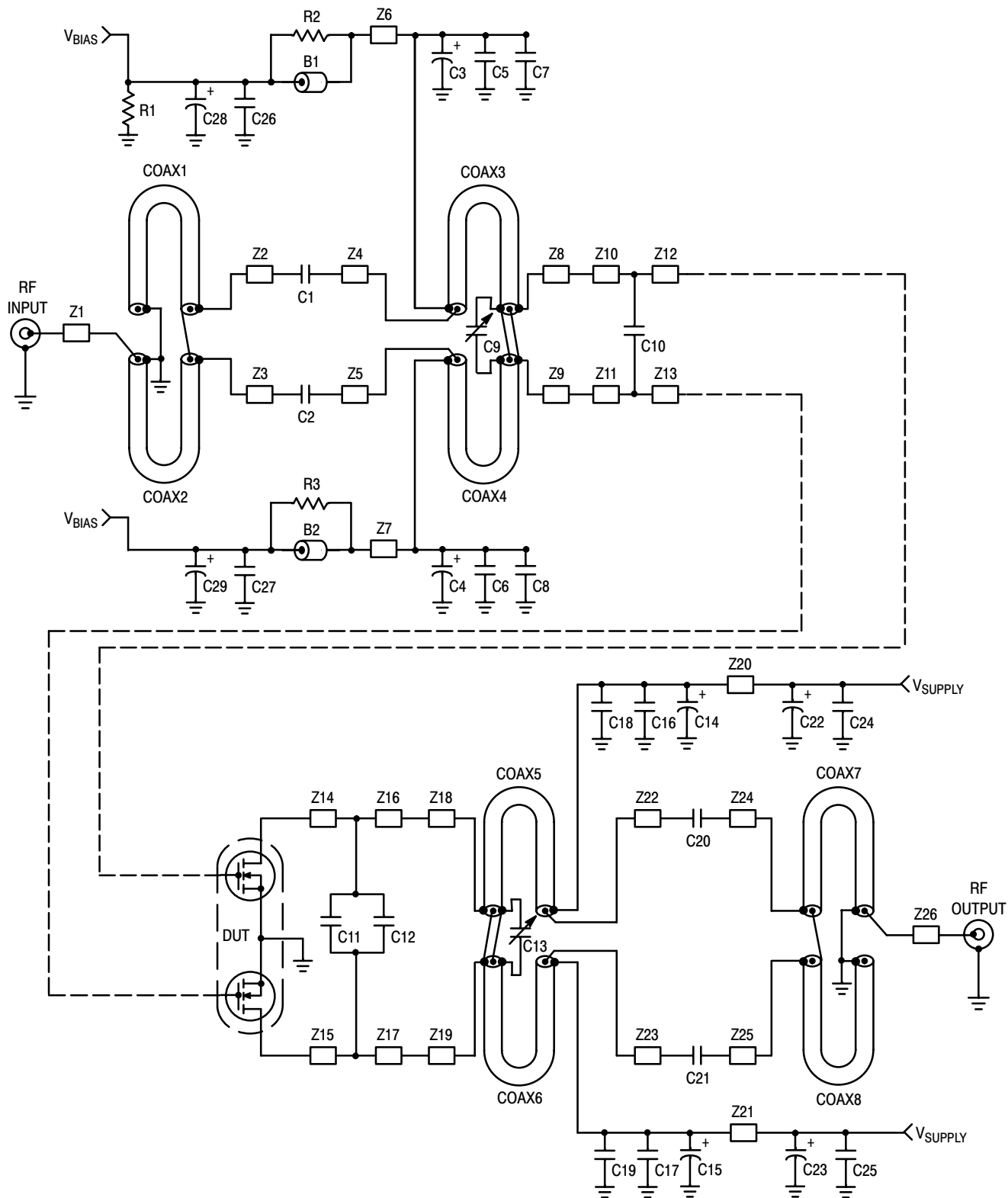


Figure 18. 820-900 MHz Narrowband Series Equivalent Source and Load Impedance



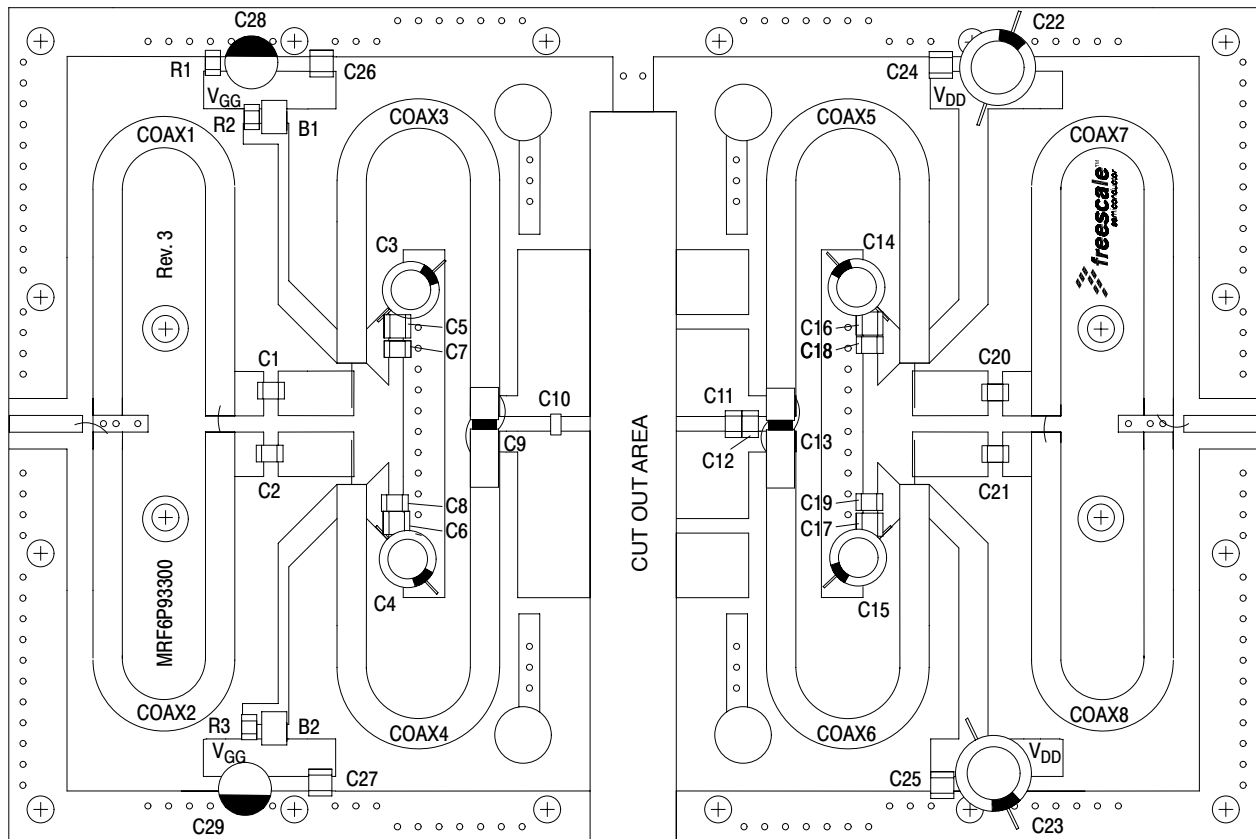
Z1, Z26 0.351" x 0.081" Microstrip  
 Z2, Z3 0.139" x 0.214" Microstrip  
 Z4, Z5 0.364" x 0.214" Microstrip  
 Z6, Z7 1.154" x 0.051" Microstrip  
 Z8, Z9 0.086" x 0.100" Microstrip  
 Z10, Z11 0.184" x 0.802" Microstrip  
 Z12, Z13 0.164" x 0.802" Microstrip

Z14, Z15 0.276" x 0.420" Microstrip  
 Z16, Z17 0.072" x 0.420" Microstrip  
 Z18, Z19 0.072" x 0.031" Microstrip  
 Z20, Z21 1.404" x 0.141" Microstrip  
 Z22, Z23 0.363" x 0.214" Microstrip  
 Z24, Z25 0.139" x 0.214" Microstrip  
 PCB Arlon GX-0300-55-22, 0.030",  $\epsilon_r = 2.5$

Figure 19. 470-860 MHz Broadband Test Circuit Schematic

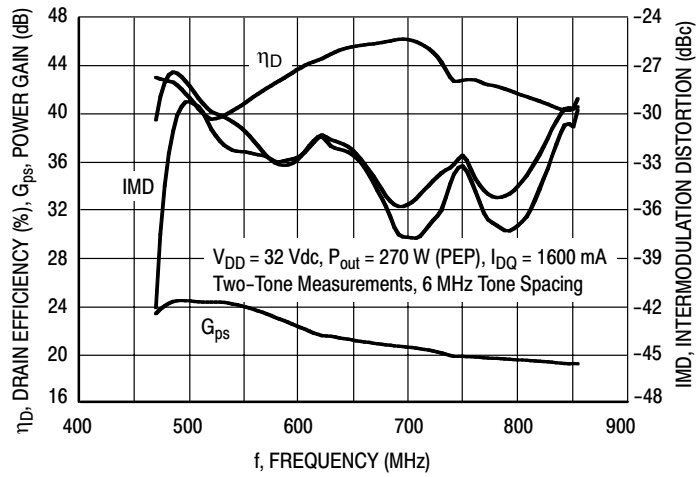
**Table 6. 470-860 MHz Broadband Test Circuit Component Designations and Values**

Part	Description	Part Number	Manufacturer
B1, B2	Ferrite Beads, Short	2743019447	Fair-Rite
C1, C2, C20, C21	43 pF 600B Chip Capacitors	700B430FW500XT	ATC
C3, C4, C14, C15	100 $\mu$ F, 50 V Electrolytic Capacitors	515D107M050BB6A	Vishay
C5, C6, C16, C17	220 nF, 100 V Chip Capacitors	C1812C224K5RAC	Kemet
C7, C8, C18, C19	0.01 $\mu$ F, 100 V Chip Capacitors	C1210C103J1RAC	Kemet
C9, C13	0.8-8.0 pF Variable Capacitors, Gigatrim	27291SL	Johanson
C10	15 pF 600B Chip Capacitor	600S150FT250XT	ATC
C11	16 pF 600B Chip Capacitor	600B160FT250XT	ATC
C12	4.3 pF 600B Chip Capacitor	600B4R3BT250XT	ATC
C22, C23	470 $\mu$ F, 63 V Electrolytic Capacitors	NACZF471M63V	Nippon
C24, C25, C26, C27	0.1 $\mu$ F, 50 V Chip Capacitors	CDR33BX104AKWS	Kemet
C28, C29	10 $\mu$ F, 50 V Electrolytic Capacitors	ECE-V1HA100SP	Panasonic
Coax1, 2, 7, 8	50 $\Omega$ , Semi Rigid Coax, 3.00" Long	UT-141C-50-SP	Micro-Coax
Coax3, 4, 5, 6	25 $\Omega$ , Semi Rigid Coax, 3.00" Long	UT-141C-25	Micro-Coax
R1	1 k $\Omega$ , 1/8 W Resistor (1206)	CRCW1206102J	Dale/Vishay
R2, R3	10 $\Omega$ , 1/8 W Resistors (1206)	CRCW1206100J	Dale/Vishay



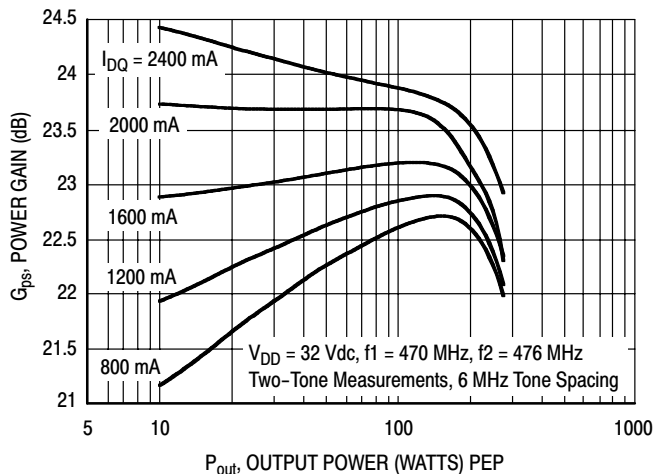
**Figure 20. 470-860 MHz Broadband Test Circuit Component Layout**

## TYPICAL TWO-TONE BROADBAND CHARACTERISTICS

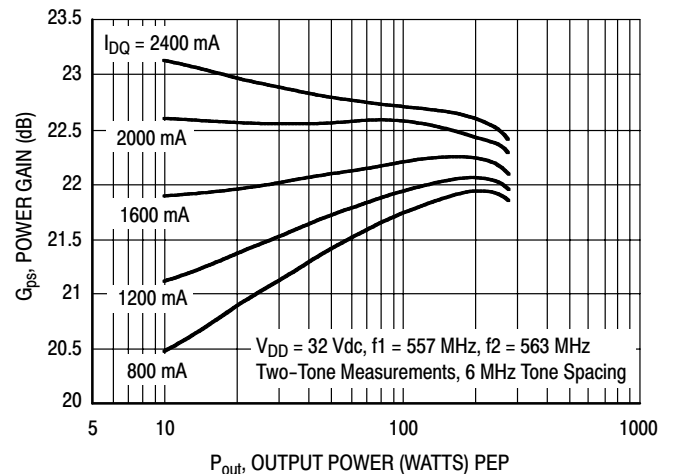


**Figure 21. Two-Tone Broadband Performance @  $P_{out} = 270$  Watts PEP**

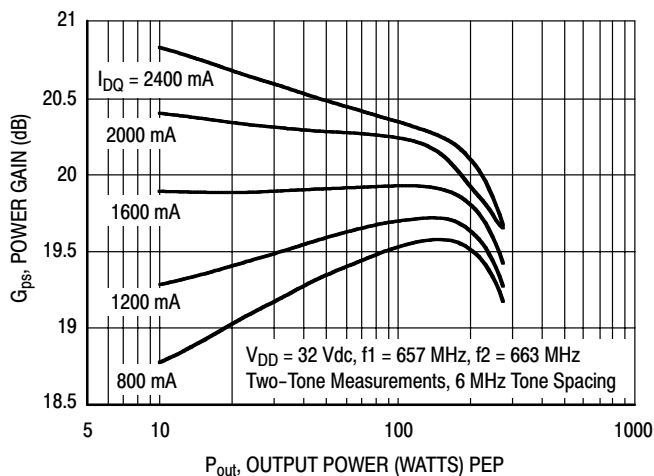
## TYPICAL TWO-TONE BROADBAND CHARACTERISTICS



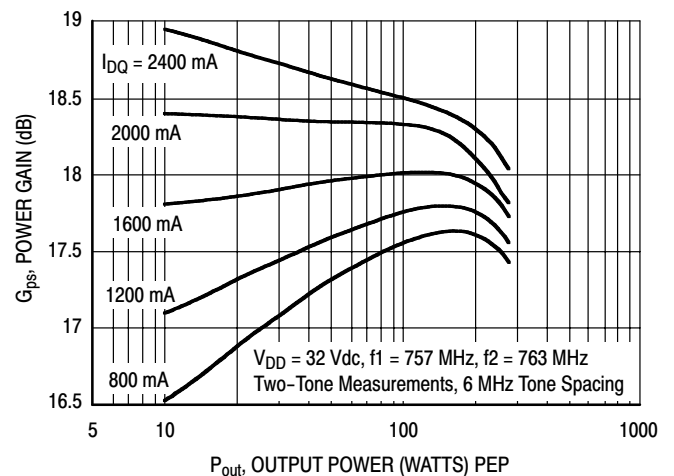
**Figure 22. Two-Tone Power Gain versus Output Power @ 473 MHz**



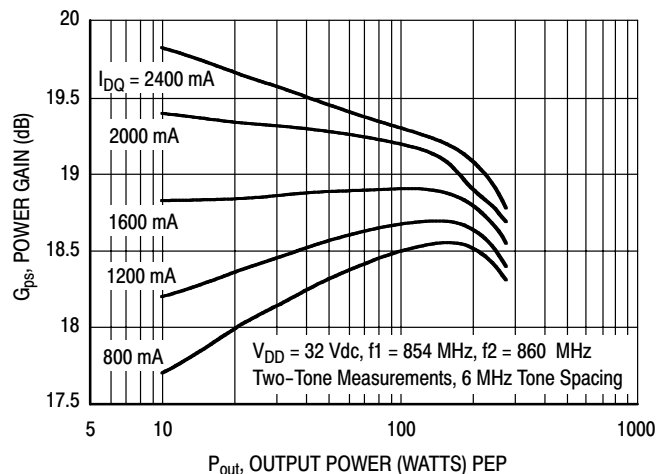
**Figure 23. Two-Tone Power Gain versus Output Power @ 560 MHz**



**Figure 24. Two-Tone Power Gain versus Output Power @ 660 MHz**

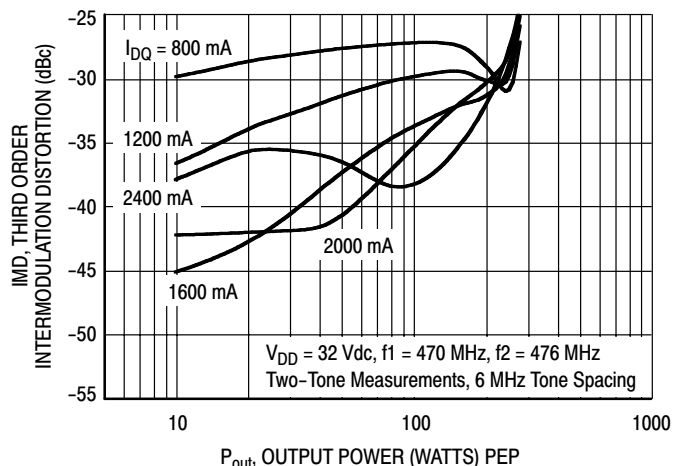


**Figure 25. Two-Tone Power Gain versus Output Power @ 760 MHz**

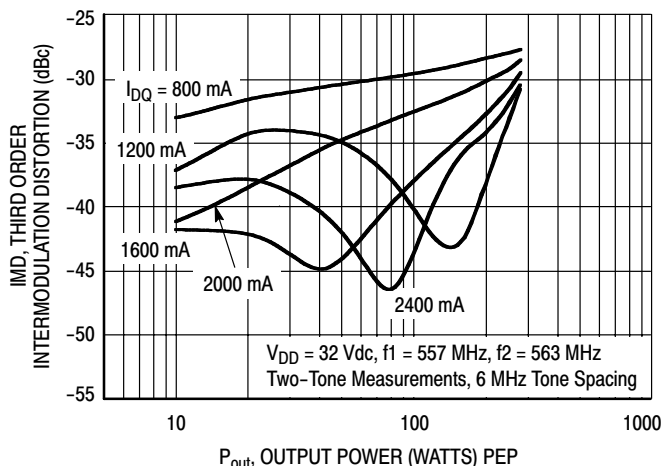


**Figure 26. Two-Tone Power Gain versus Output Power @ 857 MHz**

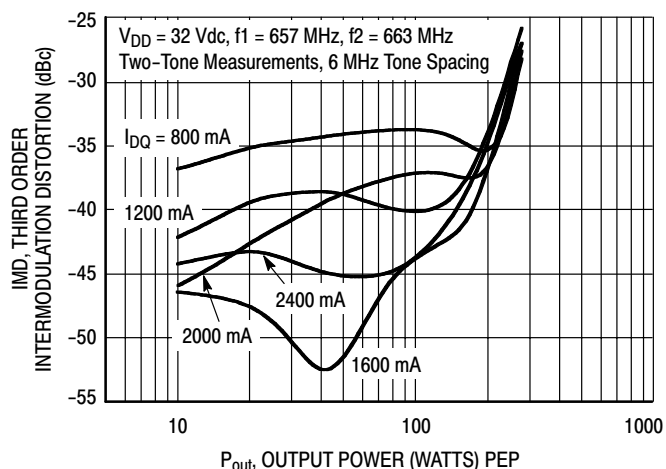
## TYPICAL TWO-TONE BROADBAND CHARACTERISTICS



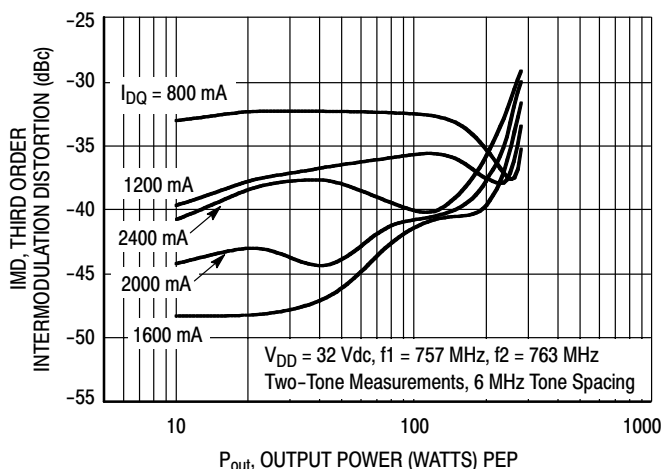
**Figure 27. Third Order Intermodulation Distortion versus Output Power @ 473 MHz**



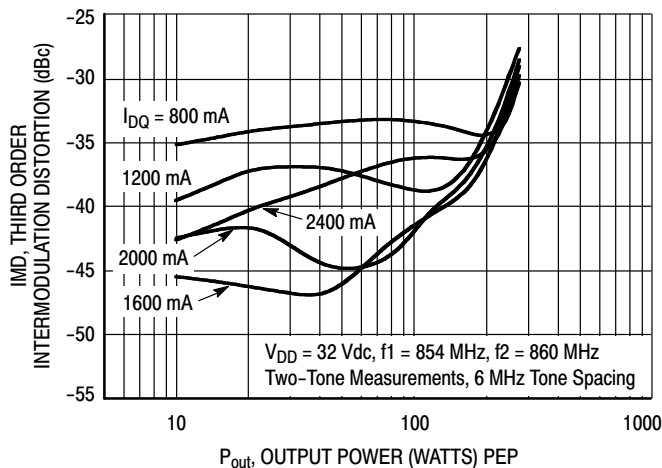
**Figure 28. Third Order Intermodulation Distortion versus Output Power @ 560 MHz**



**Figure 29. Third Order Intermodulation Distortion versus Output Power @ 660 MHz**

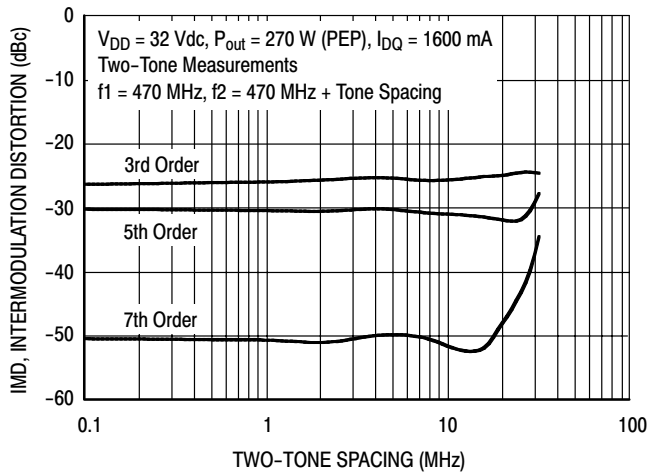


**Figure 30. Third Order Intermodulation Distortion versus Output Power @ 760 MHz**

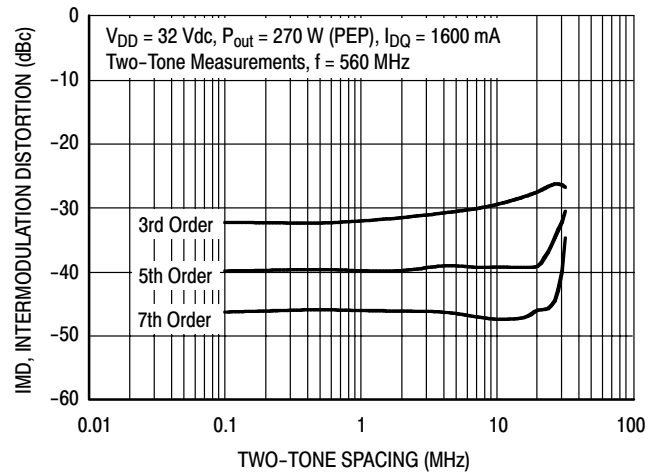


**Figure 31. Third Order Intermodulation Distortion versus Output Power @ 857 MHz**

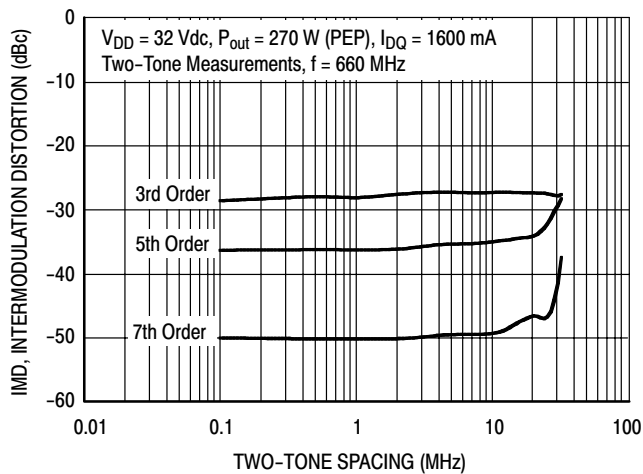
## TYPICAL TWO-TONE BROADBAND CHARACTERISTICS



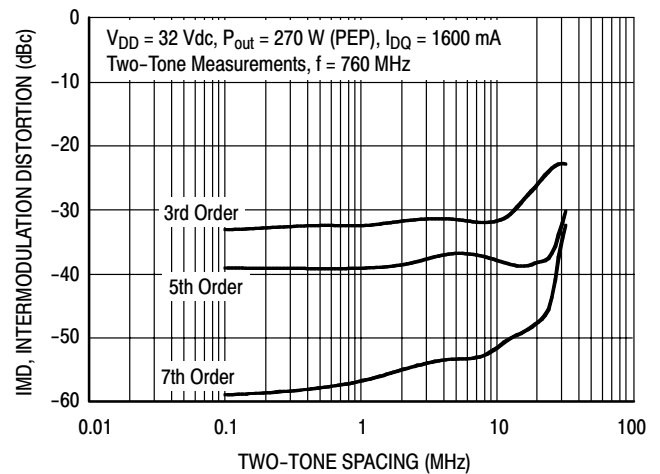
**Figure 32. Intermodulation Distortion Products versus Tone Spacing @ 470 MHz**



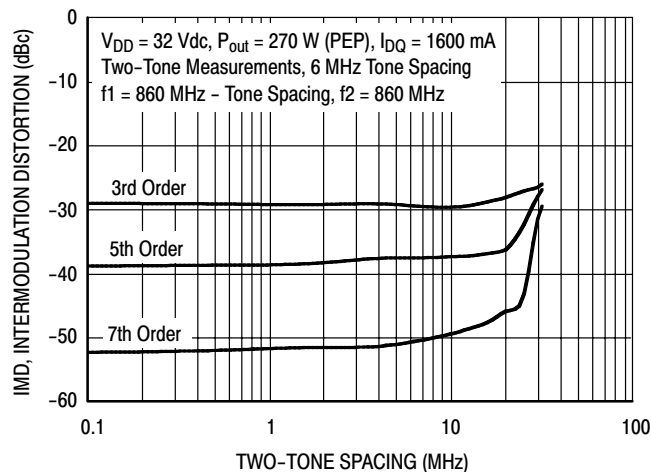
**Figure 33. Intermodulation Distortion Products versus Tone Spacing @ 560 MHz**



**Figure 34. Intermodulation Distortion Products versus Tone Spacing @ 660 MHz**

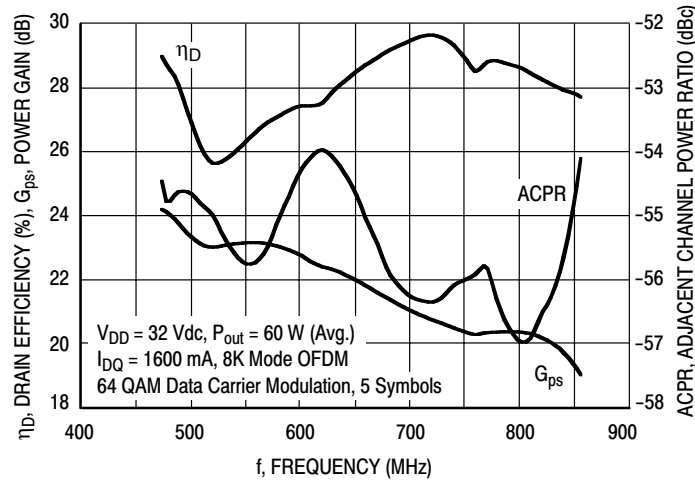


**Figure 35. Intermodulation Distortion Products versus Tone Spacing @ 760 MHz**

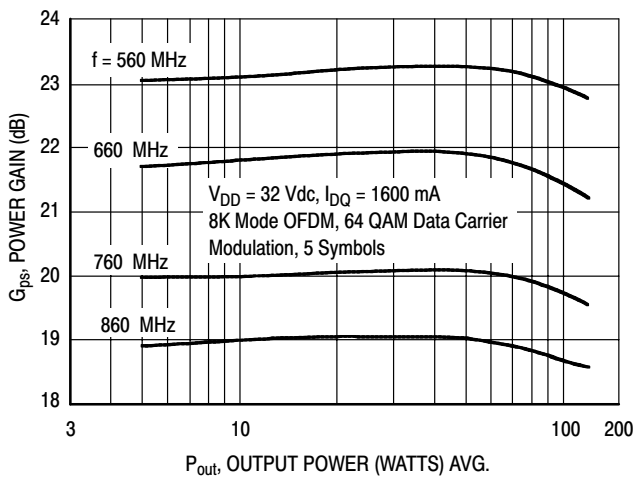


**Figure 36. Intermodulation Distortion Products versus Tone Spacing @ 860 MHz**

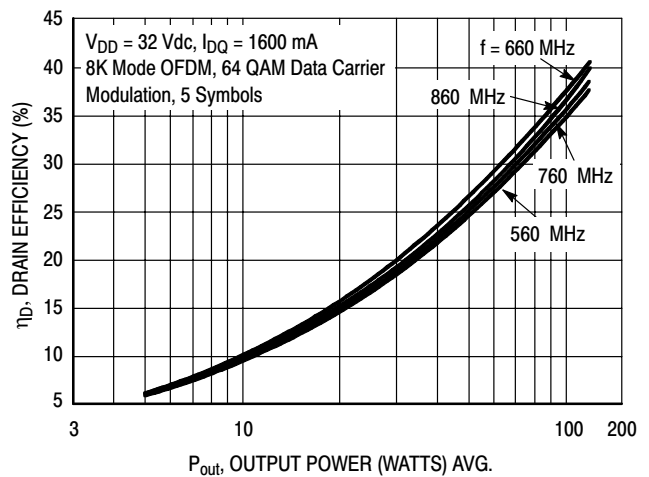
## TYPICAL DVBT OFDM BROADBAND CHARACTERISTICS



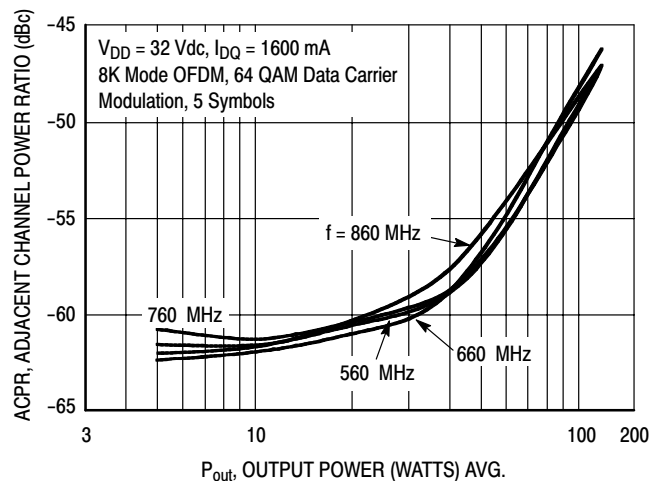
**Figure 37. Single-Carrier OFDM Broadband Performance @ 60 Watts Avg.**



**Figure 38. Single-Carrier DVBT OFDM Power Gain versus Output Power**



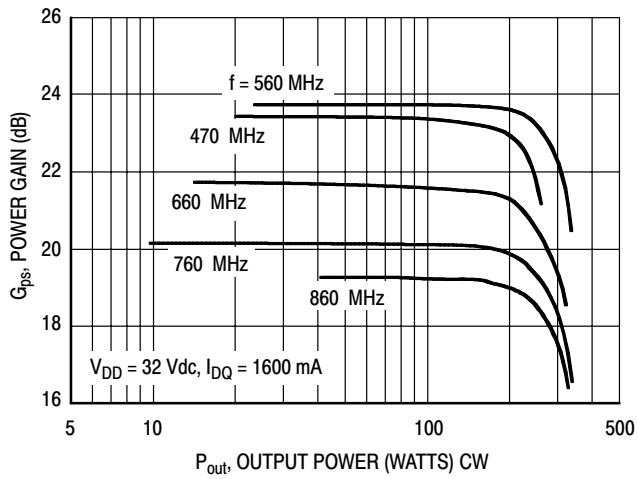
**Figure 39. Single-Carrier DVBT OFDM Drain Efficiency versus Output Power**



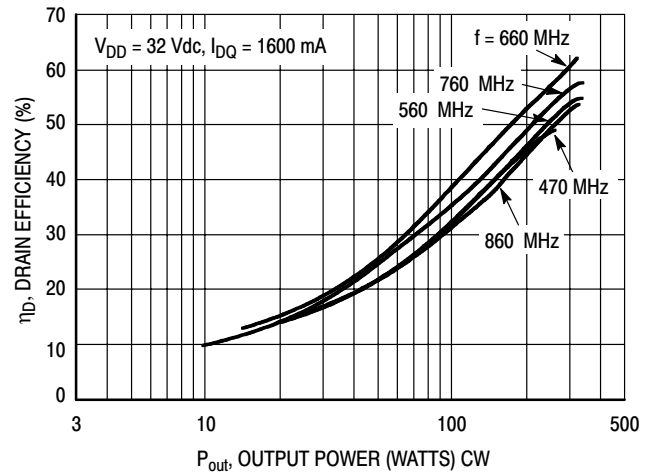
**Figure 40. Single-Carrier DVBT OFDM ACPR versus Output Power**



## TYPICAL CW BROADBAND CHARACTERISTICS

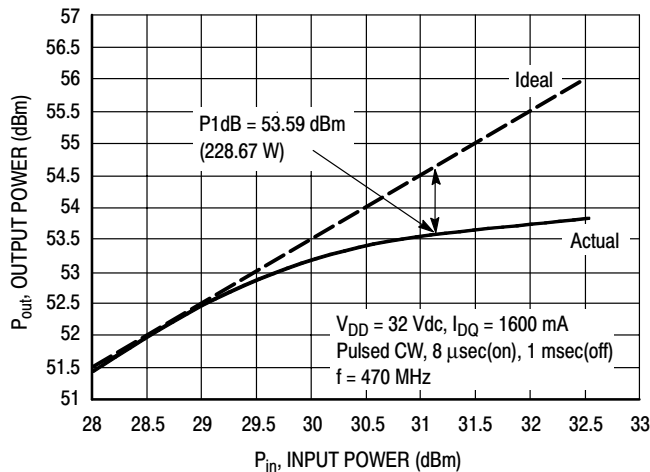


**Figure 41. CW Power Gain versus Output Power**

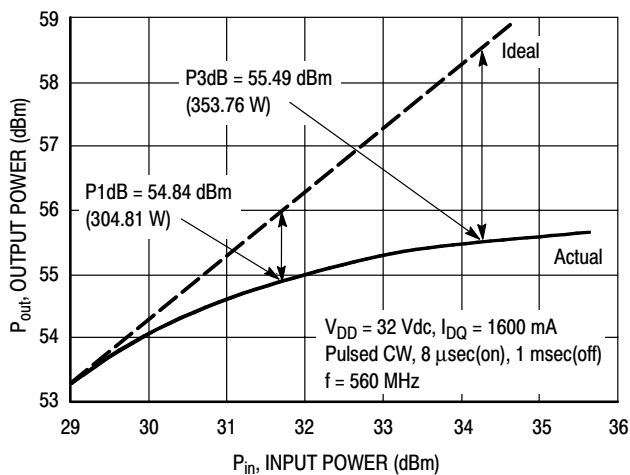


**Figure 42. CW Drain Efficiency versus Output Power**

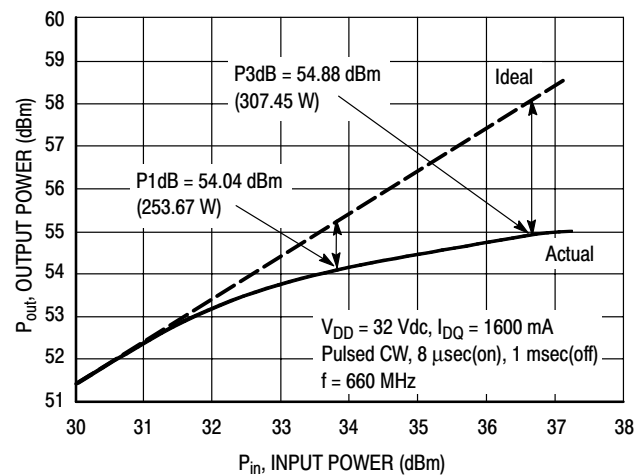
## TYPICAL CW BROADBAND CHARACTERISTICS



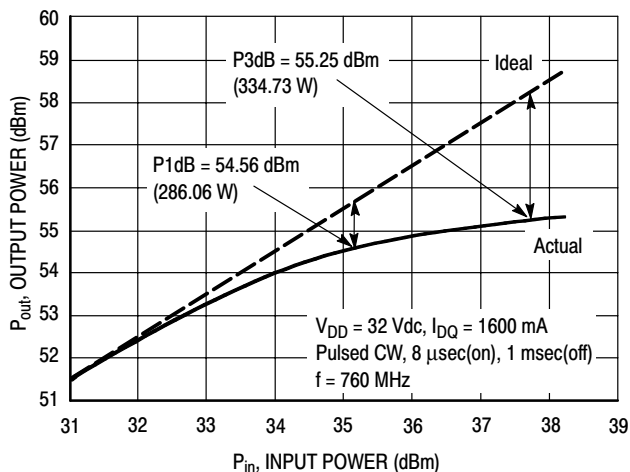
**Figure 43. Pulse CW Output Power versus Input Power @ 470 MHz**



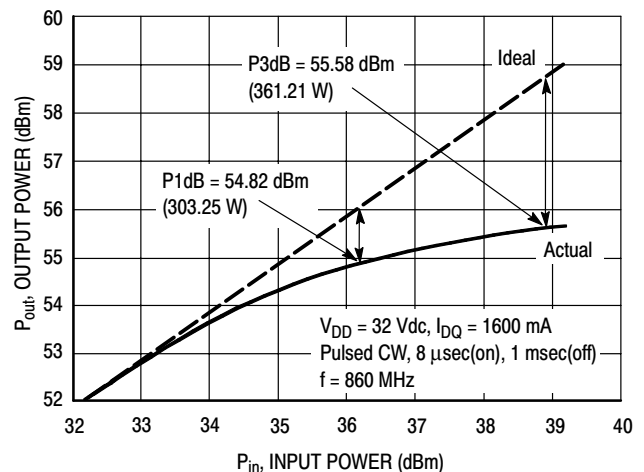
**Figure 44. Pulse CW Output Power versus Input Power @ 560 MHz**



**Figure 45. Pulse CW Output Power versus Input Power @ 660 MHz**

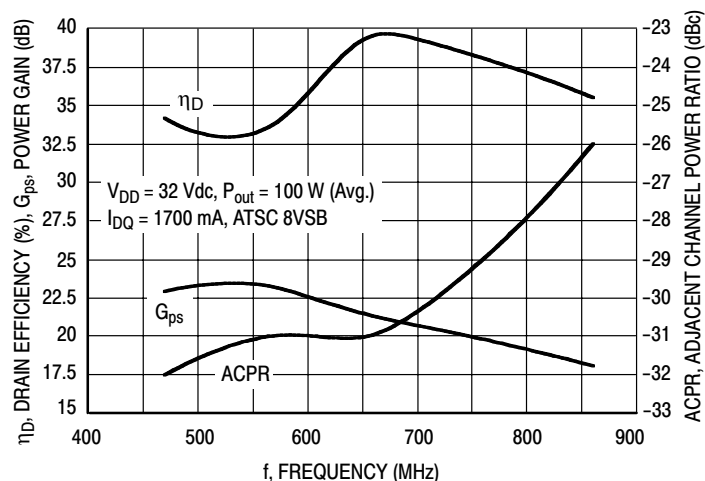


**Figure 46. Pulse CW Output Power versus Input Power @ 760 MHz**

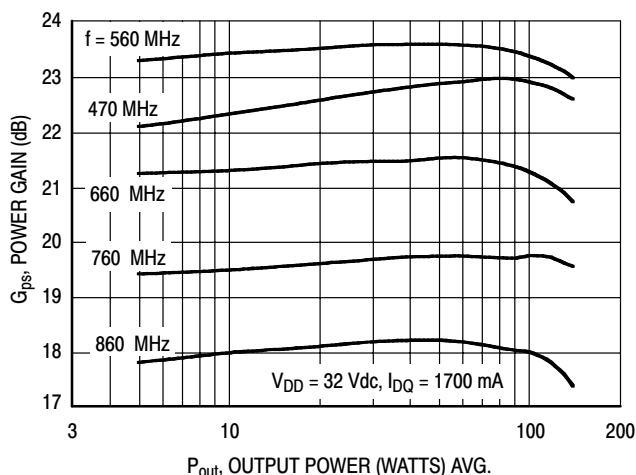


**Figure 47. Pulse CW Output Power versus Input Power @ 860 MHz**

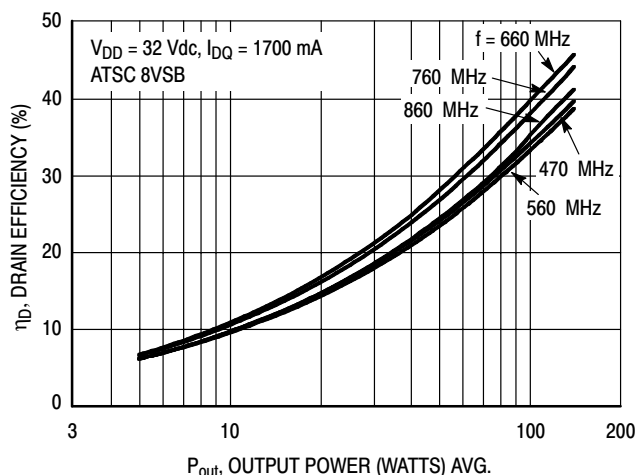
## TYPICAL ATSC 8VSB BROADBAND CHARACTERISTICS



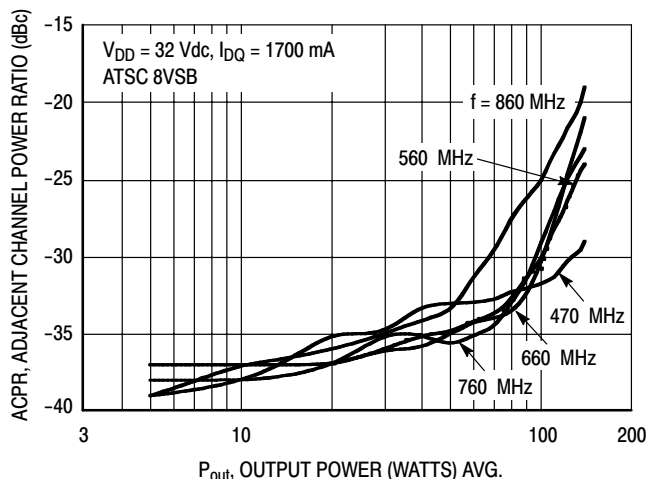
**Figure 48. Single-Carrier ATSC 8VSB Broadband Performance @ 100 Watts Avg.**



**Figure 49. Single-Carrier ATSC 8VSB Power Gain versus Output Power**

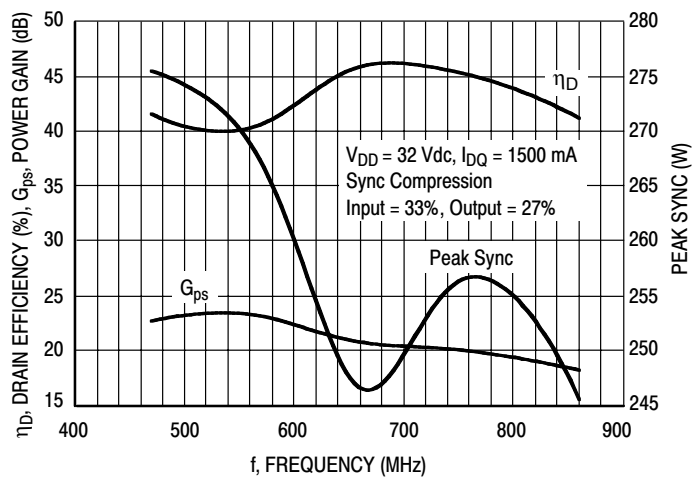


**Figure 50. Single-Carrier ATSC 8VSB Drain Efficiency versus Output Power**

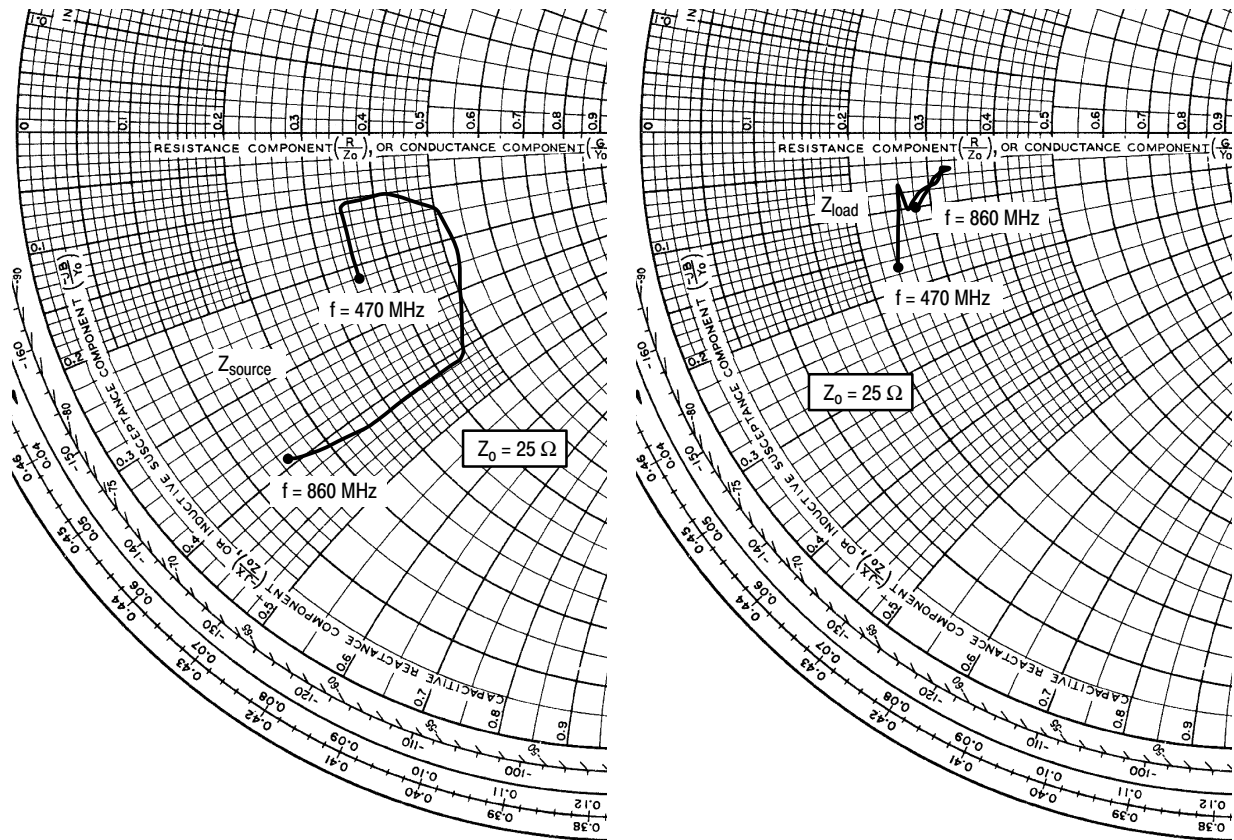


**Figure 51. Single-Carrier ATSC 8VSB ACPR versus Output Power**

## TYPICAL PAL B/G BROADBAND CHARACTERISTICS



**Figure 52. Peak Sync, Power Gain and Drain Efficiency versus Frequency**



$V_{DD} = 32 \text{ Vdc}$ ,  $I_{DQ} = 1600 \text{ mA}$ ,  $P_{out} = 270 \text{ W PEP}$

f MHz	$Z_{source}$ $\Omega$	$Z_{load}$ $\Omega$
470	8.77 - j5.43	6.09 - j4.37
510	8.74 - j4.17	6.39 - j1.65
560	8.86 - j2.87	6.69 - j2.45
610	10.55 - j2.45	7.36 - j1.95
660	12.41 - j3.53	7.73 - j1.75
710	13.11 - j6.04	7.95 - j1.20
760	11.29 - j10.15	8.18 - j1.36
810	6.81 - j10.41	7.81 - j1.60
860	3.73 - j9.66	6.94 - j2.49

$Z_{source}$  = Test circuit impedance as measured from gate to gate, balanced configuration.

$Z_{load}$  = Test circuit impedance as measured from drain to drain, balanced configuration.

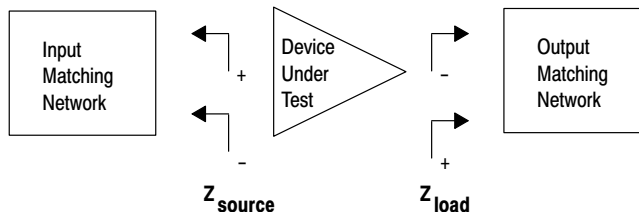
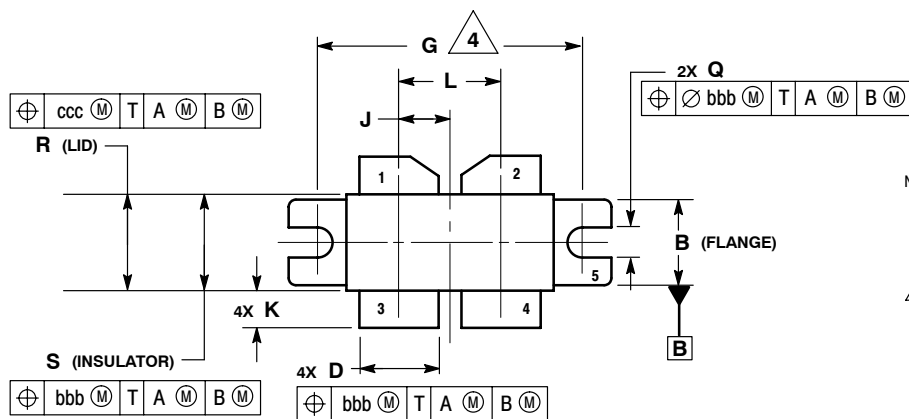


Figure 53. 470-860 MHz Broadband Series Equivalent Source and Load Impedance

MRF6P3300HR3 MRF6P3300HR5

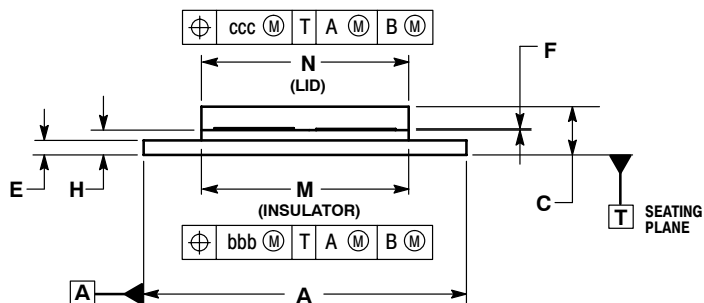
# NOTES

# PACKAGE DIMENSIONS



- NOTES:
1. CONTROLLING DIMENSION: INCH.
  2. INTERPRET DIMENSIONS AND TOLERANCES PER ASME Y14.5M-1994.
  3. DIMENSION H TO BE MEASURED 0.030 (0.762) AWAY FROM PACKAGE BODY.
  4. RECOMMENDED BOLT CENTER DIMENSION OF 1.140 (28.96) BASED ON 3M SCREW.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	1.335	1.345	33.91	34.16
B	0.380	0.390	9.65	9.91
C	0.180	0.224	4.57	5.69
D	0.325	0.335	8.26	8.51
E	0.060	0.070	1.52	1.78
F	0.004	0.006	0.10	0.15
G	1.100 BSC		27.94 BSC	
H	0.097	0.107	2.46	2.72
J	0.2125 BSC		5.397 BSC	
K	0.135	0.165	3.43	4.19
L	0.425 BSC		10.8 BSC	
M	0.852	0.868	21.64	22.05
N	0.851	0.869	21.62	22.07
Q	0.118	0.138	3.00	3.30
R	0.395	0.405	10.03	10.29
S	0.394	0.406	10.01	10.31
bbb	0.010 REF		0.25 REF	
ccc	0.015 REF		0.38 REF	



- STYLE 1:  
 PIN 1: DRAIN  
 2: DRAIN  
 3: GATE  
 4: GATE  
 5: SOURCE

**CASE 375G-04  
 ISSUE G  
 NI-860C3**

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