Freescale Semiconductor
Technical Data

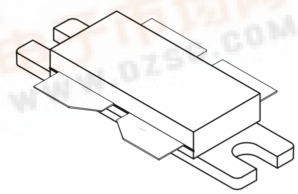
Document Number: MRF6P3300H
Rev. 0, 9/2005

RF Power Field Effect Transistor

N-Channel Enhancement-Mode Lateral MOSFET

MRF6P3300HR3
MRF6P3300HR5

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



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

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
- 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, 40µ″ Nominal.
- Pb-Free and 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.

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°C Derate above 25°C	P_D	761 4.3	W W/°C
Storage Temperature Range	T_{stg}	- 65 to +150	°C
Operating Junction Temperature	T_J	200	°C

Table 2. Thermal Characteristics

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

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

NOTE - **CAUTION** - MOS devices are susceptible to damage from electrostatic charge. Reasonable precautions in handling and packaging MOS devices should be observed.

freescale™

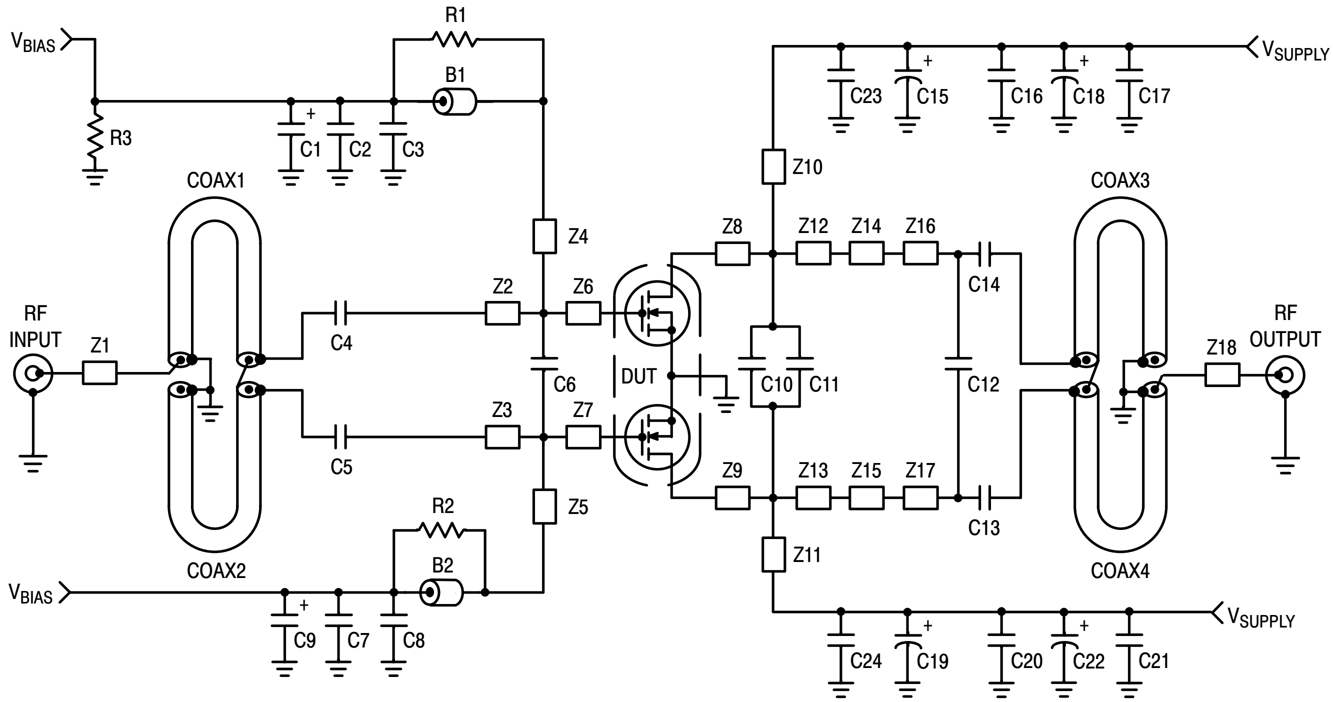
Table 3. ESD Protection Characteristics

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°C unless otherwise noted)

Characteristic	Symbol	Min	Typ	Max	Unit
Off Characteristics(1)					
Zero Gate Voltage Drain Leakage Current (V_{DS} = 68 Vdc, V_{GS} = 0 Vdc)	I_{DSS}	—	—	10	μAdc
Zero Gate Voltage Drain Leakage Current (V_{DS} = 32 Vdc, V_{GS} = 0 Vdc)	I_{DSS}	—	—	1	μAdc
Gate-Source Leakage Current (V_{GS} = 5 Vdc, V_{DS} = 0 Vdc)	I_{GSS}	—	—	1	μAdc
On Characteristics(1)					
Gate Threshold Voltage (V_{DS} = 10 Vdc, I_D = 350 μAdc)	$V_{GS(th)}$	1	2.2	3	Vdc
Drain-Source On-Voltage (V_{GS} = 10 Vdc, I_D = 2.4 Adc)	$V_{DS(on)}$	—	0.22	0.3	Vdc
Forward Transconductance (V_{DS} = 10 Vdc, I_D = 2.4 Adc)	g_{fs}	—	7.4	—	S
Dynamic Characteristics (1,2)					
Reverse Transfer Capacitance (V_{DS} = 32 Vdc ± 30 mV(rms)ac @ 1 MHz, V_{GS} = 0 Vdc)	C_{rss}	—	1.4	—	pF
Functional Tests(3) (In Freescale Narrowband Test Fixture, 50 ohm system) V_{DD} = 32 Vdc, I_{DQ} = 1600 mA, P_{out} = 270 W PEP, f1 = 857 MHz, f2 = 863 MHz					
Power Gain	G_{ps}	19	20.2	23	dB
Drain Efficiency	η_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 MHz)	P1dB	—	320	—	W
Gate Quiescent Voltage (V_{DS} = 32 Vdc, I_D = 1600 mAdc)	$V_{GS(Q)}$	2	2.8	4	Vdc

1. Each side of the device measured separately.
2. Part is internally matched both on input and output.
3. Measurement made with device in push-pull configuration.



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″, ε_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 μF, 50 V Tantulum Chip Capacitors	T491C105K050AS	Kemet
C2, C7, C17, C21	0.1 μF, 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 μF, 50 V Electrolytic Capacitors	MVK50VC47RM8X10TP	Nippon
C18, C22	470 μF, 63 V Electrolytic Capacitors	SME63V471M12X25LL	United Chemi-Con
C23, C24	22 pF 600B Chip Capacitors	600B220FT250XT	ATC
Coax1, 2, 3, 4	50 Ω, Semi Rigid Coax, 2.06″ Long	UT-141A-TP	Micro-Coax
R1, R2	10 Ω, 1/8 W Chip Resistors (1206)	CRCW1206100J	Dale/Vishay
R3	1 kΩ, 1/8 W Chip Resistor (1206)	CRCW1206102J	Dale/Vishay

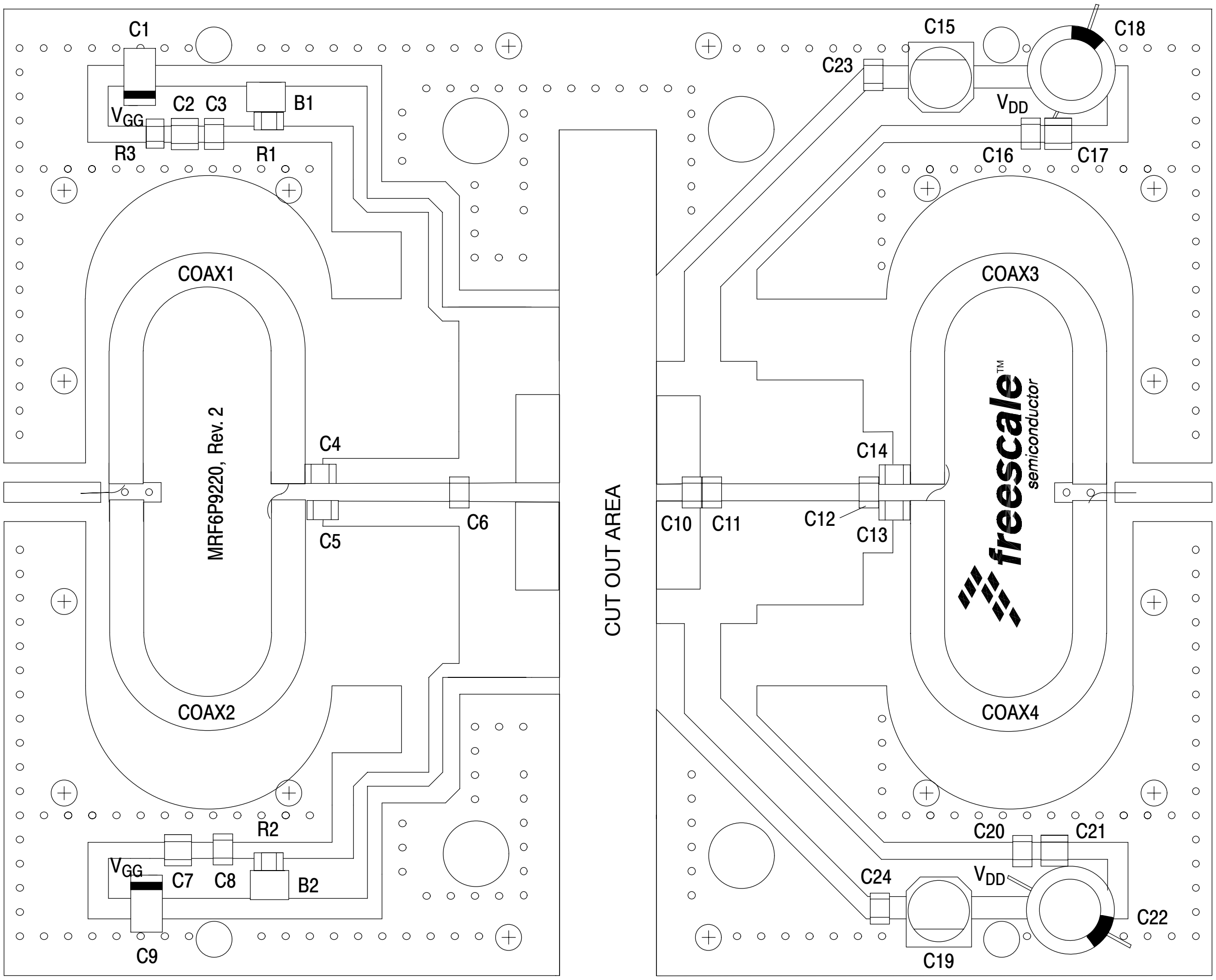


Figure 2. 820-900 MHz Narrowband Test Circuit Component Layout

TYPICAL NARROWBAND CHARACTERISTICS

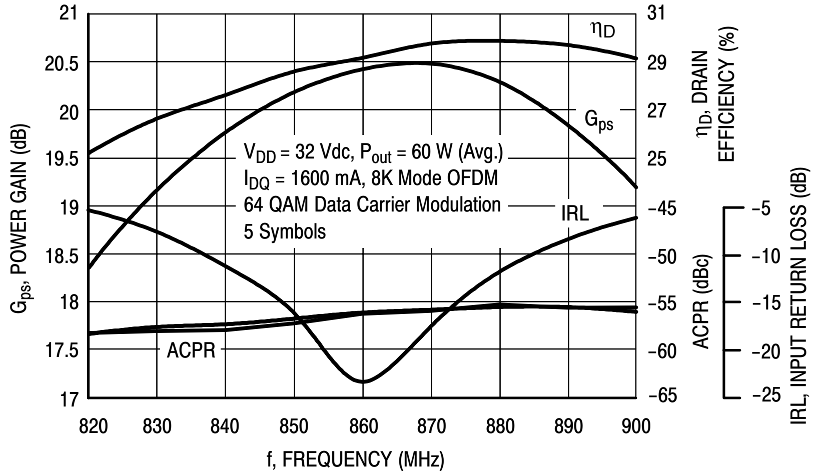


Figure 3. Single-Carrier OFDM Broadband Performance @ 60 Watts Avg.

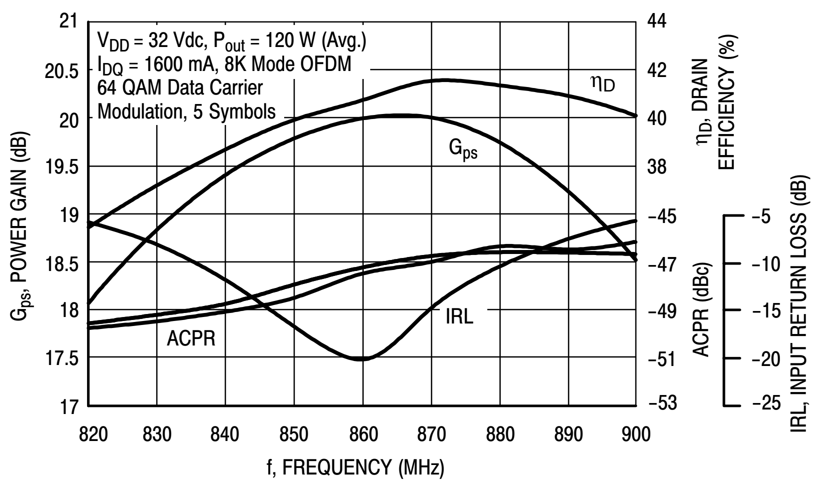


Figure 4. Single-Carrier OFDM Broadband Performance @ 120 Watts Avg.

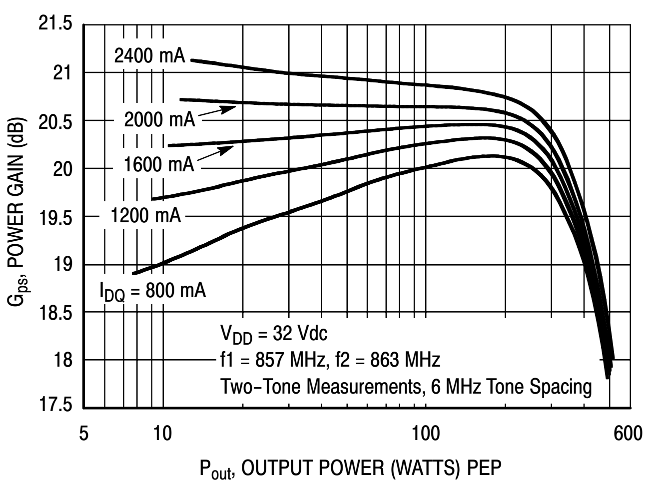


Figure 5. Two-Tone Power Gain versus Output Power

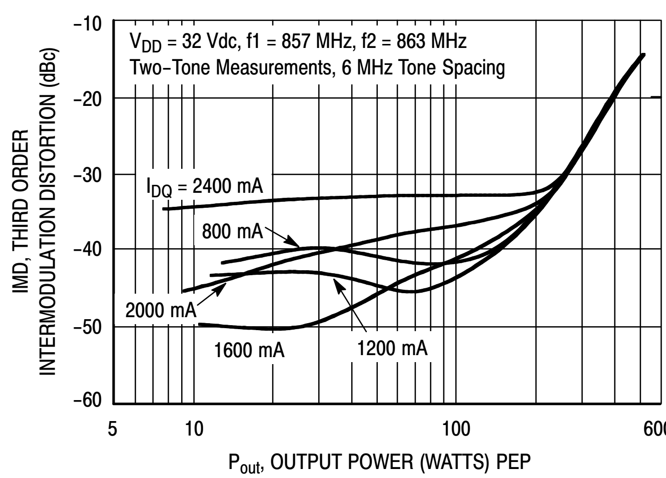


Figure 6. Third Order Intermodulation Distortion versus Output Power

TYPICAL NARROWBAND CHARACTERISTICS

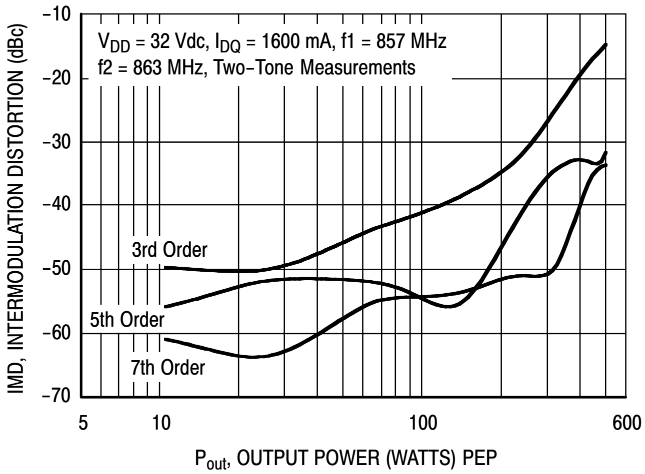


Figure 7. Intermodulation Distortion Products versus Output Power

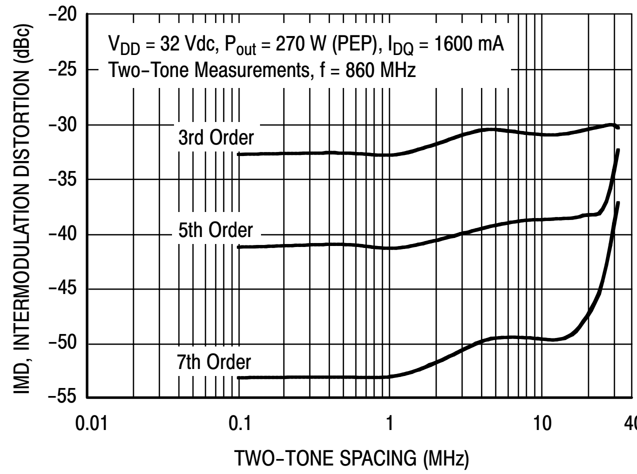


Figure 8. Intermodulation Distortion Products versus Tone Spacing @ 860 MHz

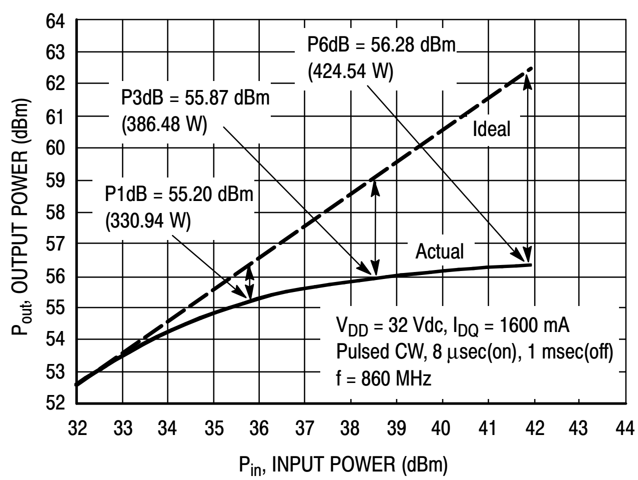


Figure 9. Pulse CW Output Power versus Input Power

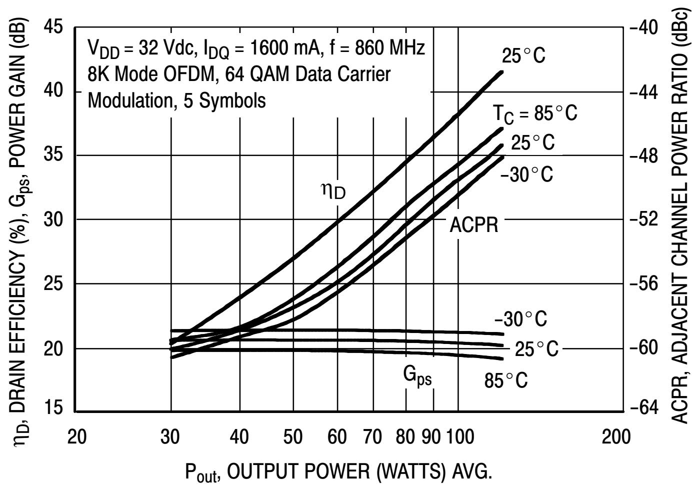


Figure 10. Single-Carrier DVBT OFDM ACPR, Power Gain and Drain Efficiency versus Output Power

TYPICAL NARROWBAND CHARACTERISTICS

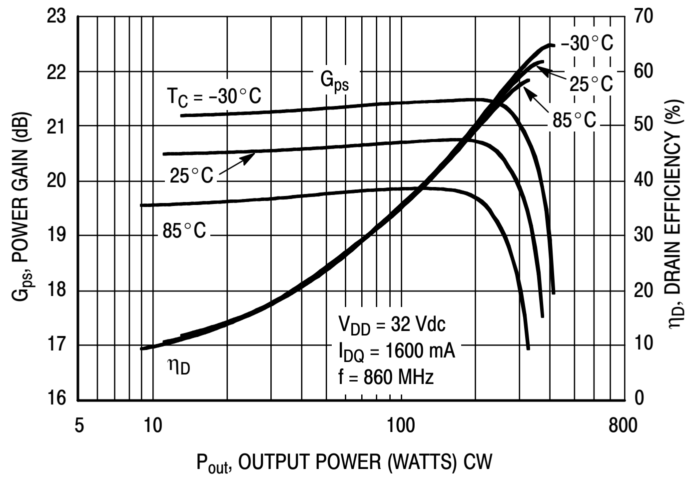


Figure 11. Power Gain and Drain Efficiency versus CW Output Power

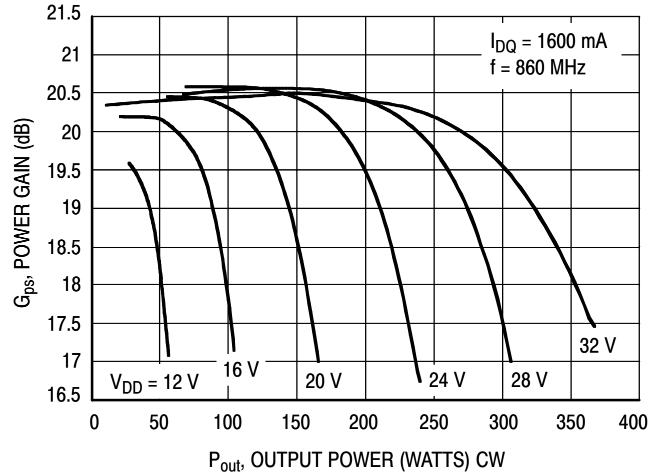
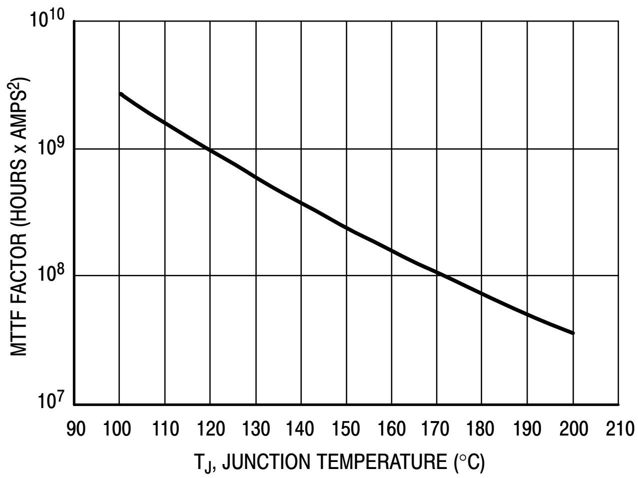


Figure 12. Power Gain versus Output Power



This above graph displays calculated MTTF in hours x ampere^2 drain current. Life tests at elevated temperatures have correlated to better than ±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

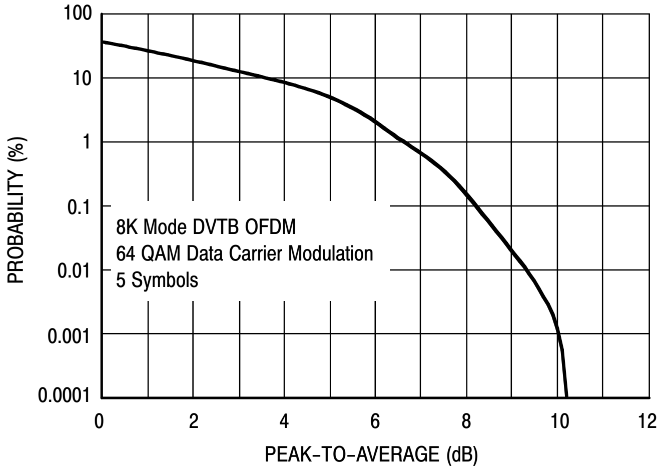


Figure 14. Single-Carrier DVTB OFDM

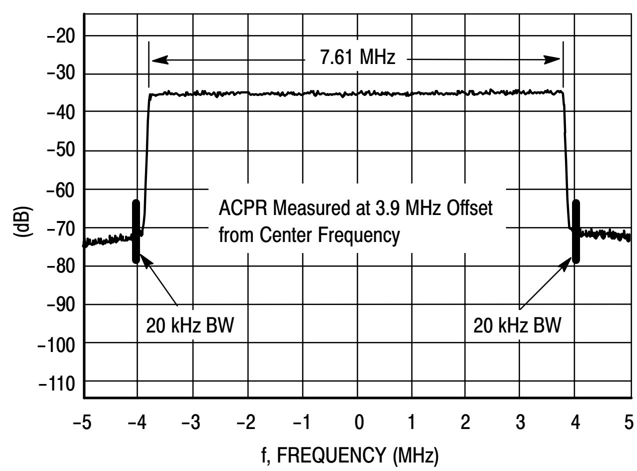


Figure 15. 8K Mode DVBT OFDM Spectrum

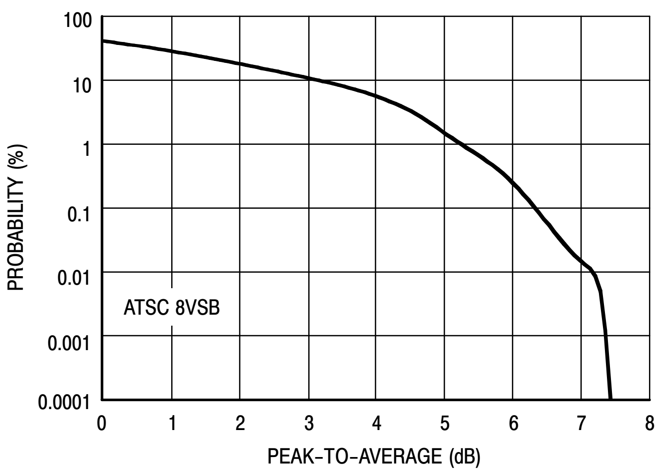


Figure 16. Single-Carrier ATSC 8VSB

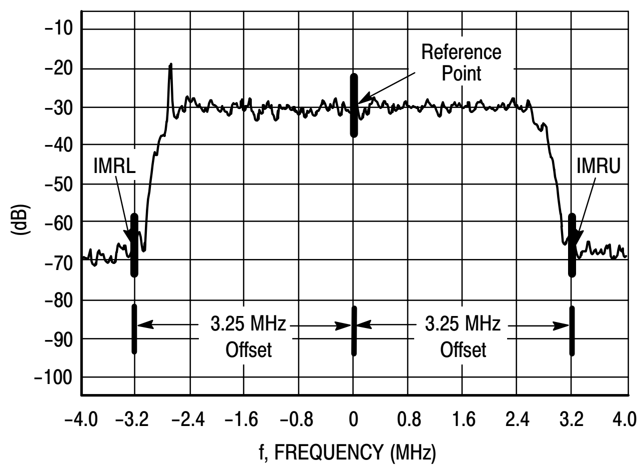
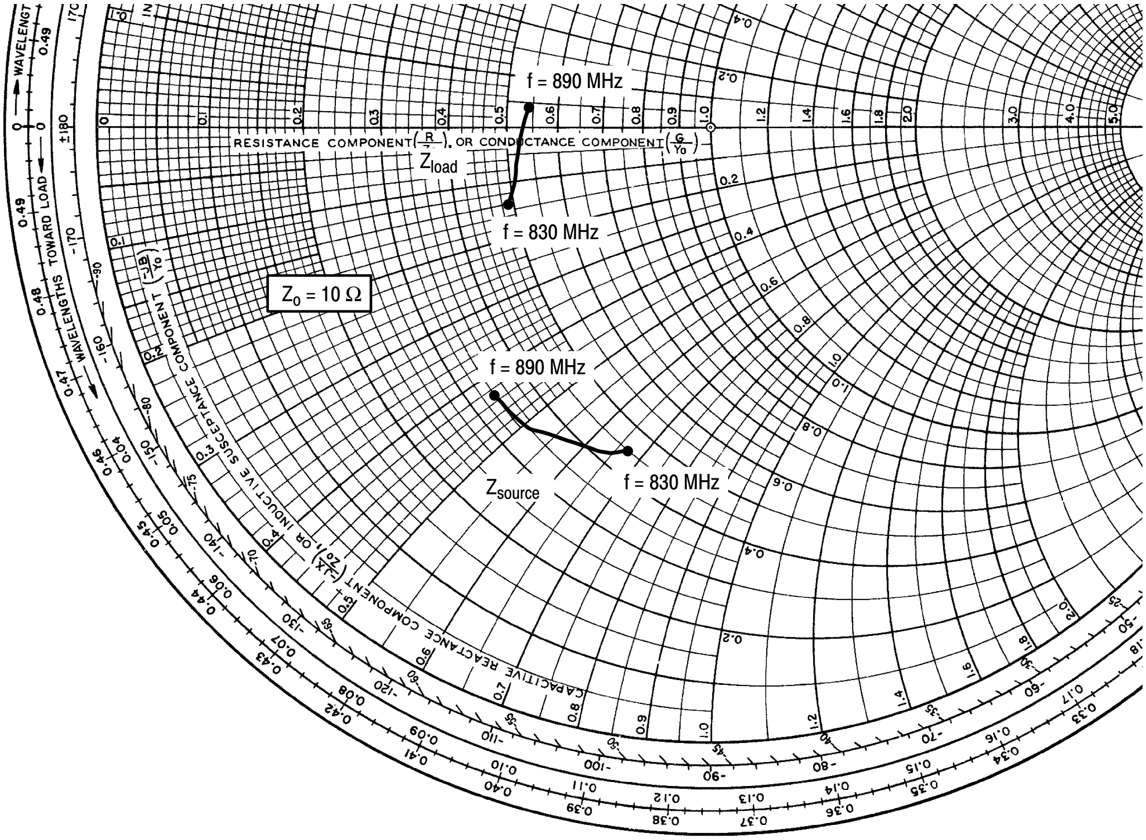


Figure 17. ATSC 8VSB Spectrum



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

f MHz	Z_{source} Ω	Z_{load} Ω
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.

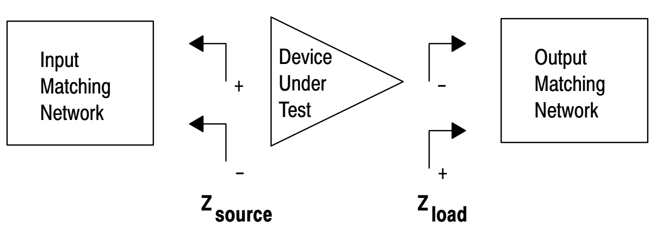
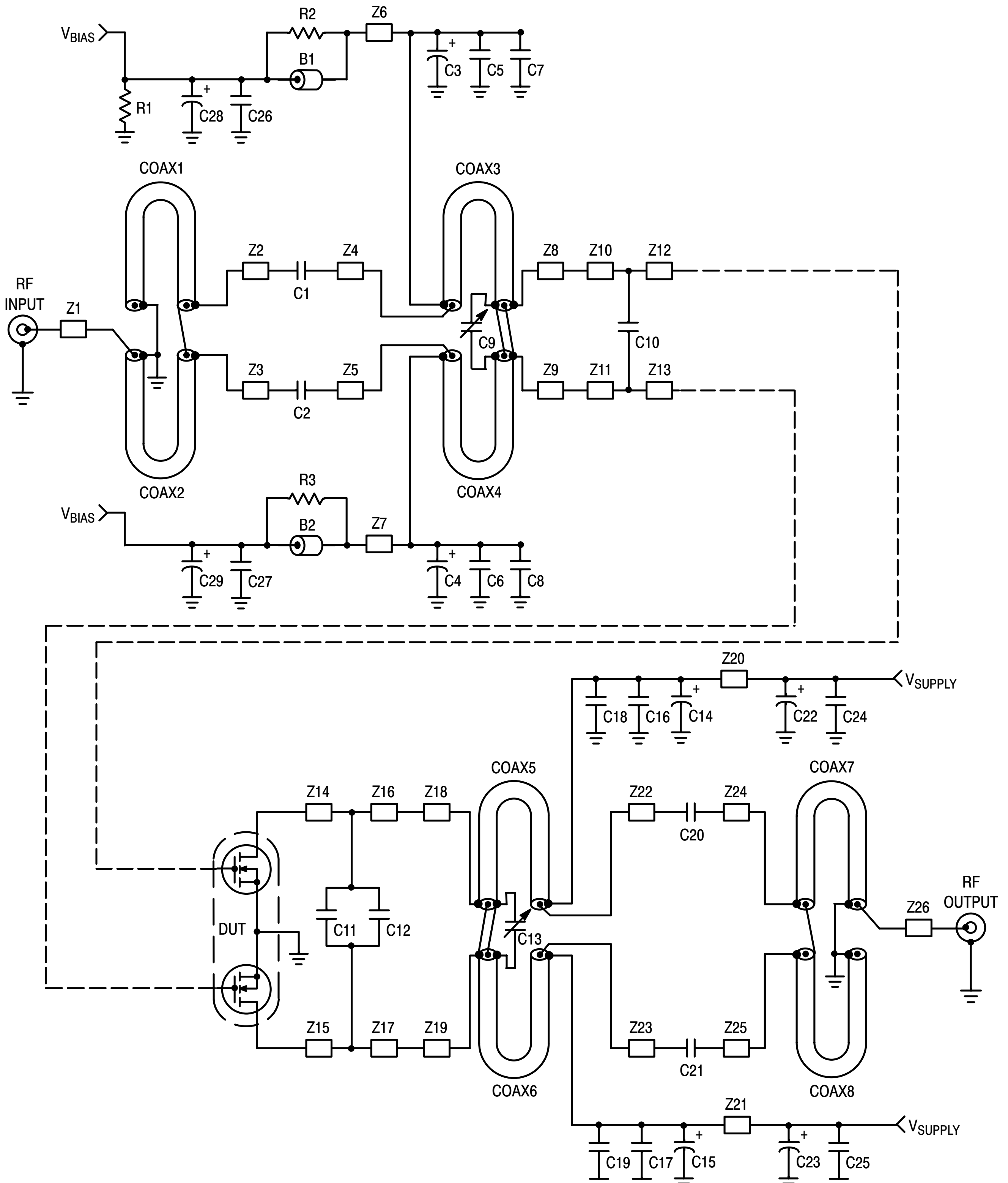


Figure 18. 820-900 MHz Narrowband Series Equivalent Source and Load Impedance



Z1, Z26	0.351″ x 0.081″ Microstrip	Z14, Z15	0.276″ x 0.420″ Microstrip
Z2, Z3	0.139″ x 0.214″ Microstrip	Z16, Z17	0.072″ x 0.420″ Microstrip
Z4, Z5	0.364″ x 0.214″ Microstrip	Z18, Z19	0.072″ x 0.031″ Microstrip
Z6, Z7	1.154″ x 0.051″ Microstrip	Z20, Z21	1.404″ x 0.141″ Microstrip
Z8, Z9	0.086″ x 0.100″ Microstrip	Z22, Z23	0.363″ x 0.214″ Microstrip
Z10, Z11	0.184″ x 0.802″ Microstrip	Z24, Z25	0.139″ x 0.214″ Microstrip
Z12, Z13	0.164″ x 0.802″ Microstrip	PCB	Arlon GX-0300-55-22, 0.030″, ε_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 μF, 50 V Electrolytic Capacitors	515D107M050BB6A	Vishay
C5, C6, C16, C17	220 nF, 100 V Chip Capacitors	C1812C224K5RAC	Kemet
C7, C8, C18, C19	0.01 μF, 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 μF, 63 V Electrolytic Capacitors	NACZF471M63V	Nippon
C24, C25, C26, C27	0.1 μF, 50 V Chip Capacitors	CDR33BX104AKWS	Kemet
C28, C29	10 μF, 50 V Electrolytic Capacitors	ECE-V1HA100SP	Panasonic
Coax1, 2, 7, 8	50 Ω, Semi Rigid Coax, 3.00″ Long	UT-141C-50-SP	Micro-Coax
Coax3, 4, 5, 6	25 Ω, Semi Rigid Coax, 3.00″ Long	UT-141C-25	Micro-Coax
R1	1 kΩ, 1/8 W Resistor (1206)	CRCW1206102J	Dale/Vishay
R2, R3	10 Ω, 1/8 W Resistors (1206)	CRCW1206100J	Dale/Vishay

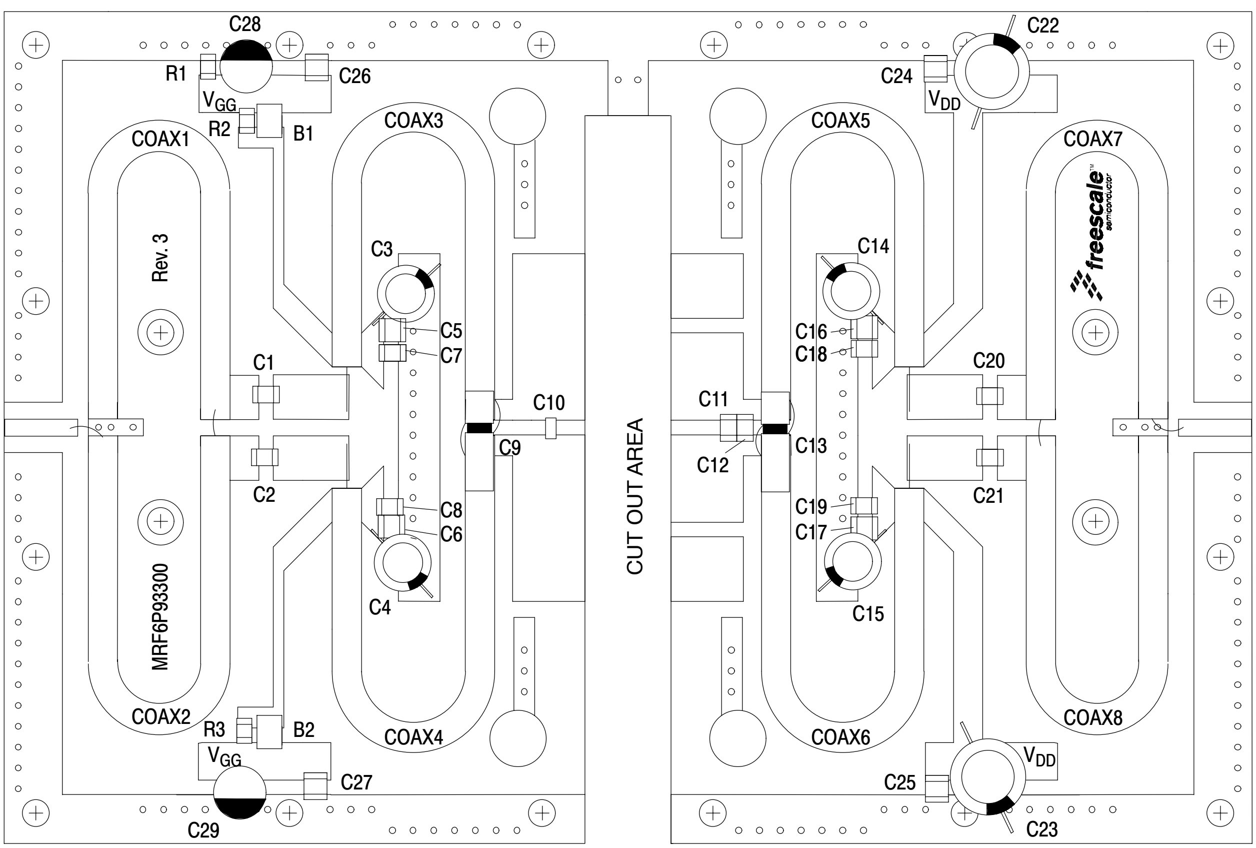


Figure 20. 470-860 MHz Broadband Test Circuit Component Layout

TYPICAL TWO-TONE BROADBAND CHARACTERISTICS

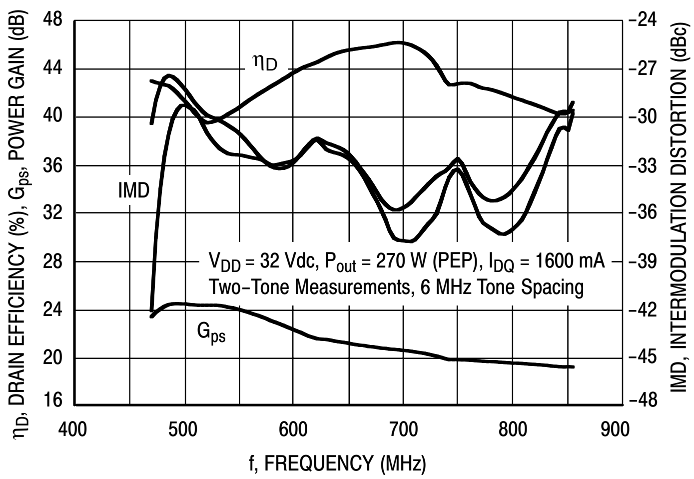


Figure 21. Two-Tone Broadband Performance @ P_{out} = 270 Watts PEP

TYPICAL TWO-TONE BROADBAND CHARACTERISTICS

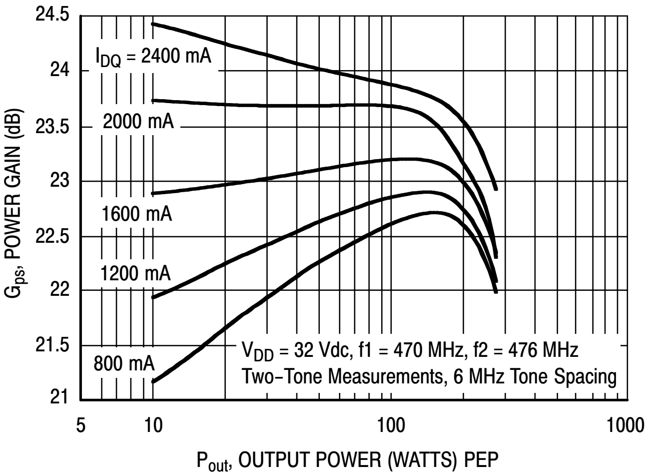


Figure 22. Two-Tone Power Gain versus Output Power @ 473 MHz

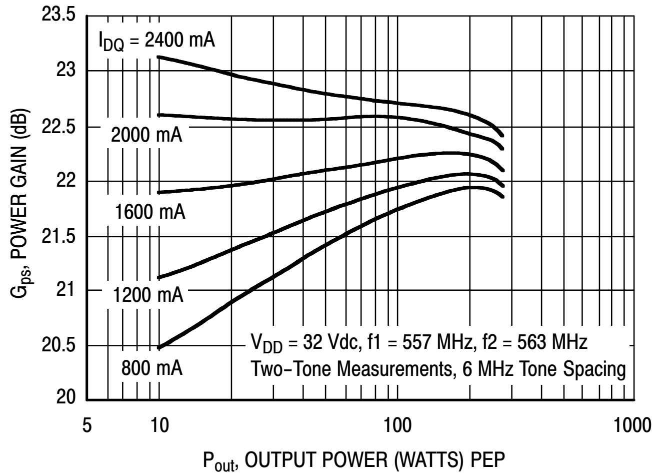


Figure 23. Two-Tone Power Gain versus Output Power @ 560 MHz

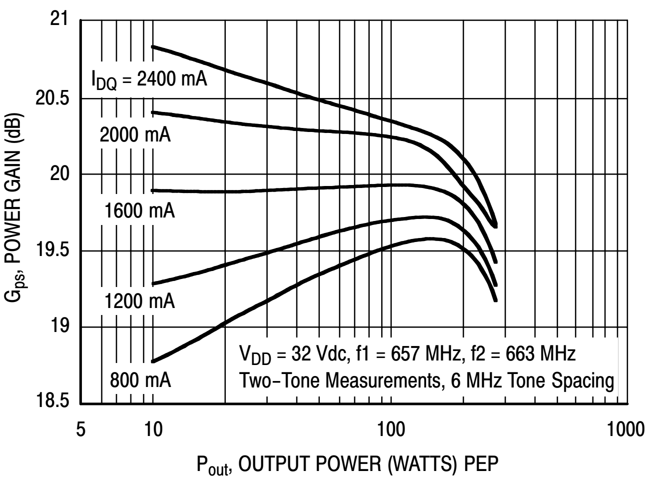


Figure 24. Two-Tone Power Gain versus Output Power @ 660 MHz

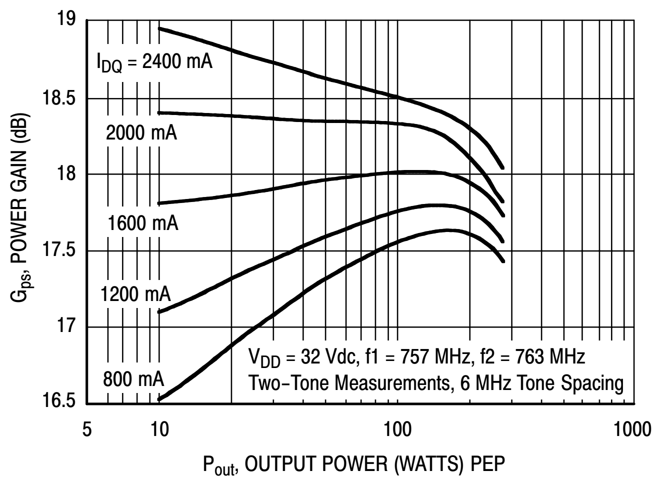


Figure 25. Two-Tone Power Gain versus Output Power @ 760 MHz

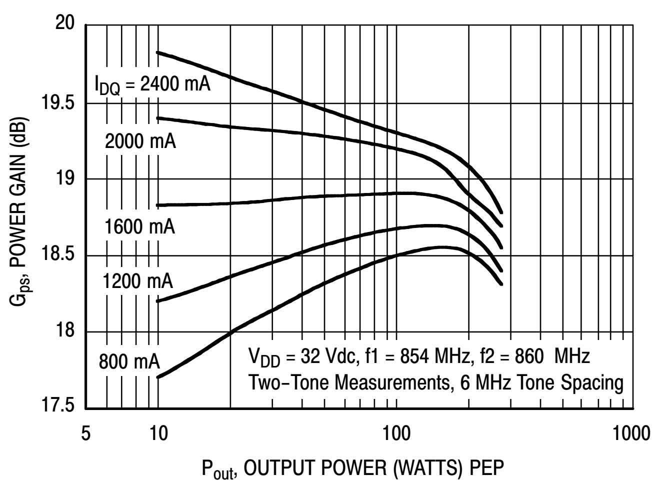


Figure 26. Two-Tone Power Gain versus Output Power @ 857 MHz

TYPICAL TWO-TONE BROADBAND CHARACTERISTICS

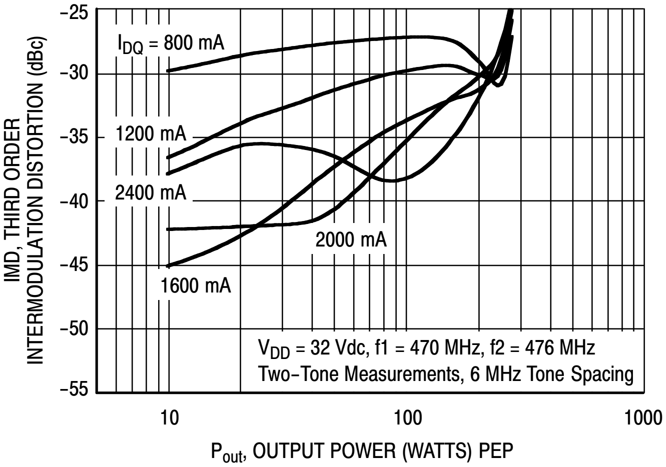


Figure 27. Third Order Intermodulation Distortion versus Output Power @ 473 MHz

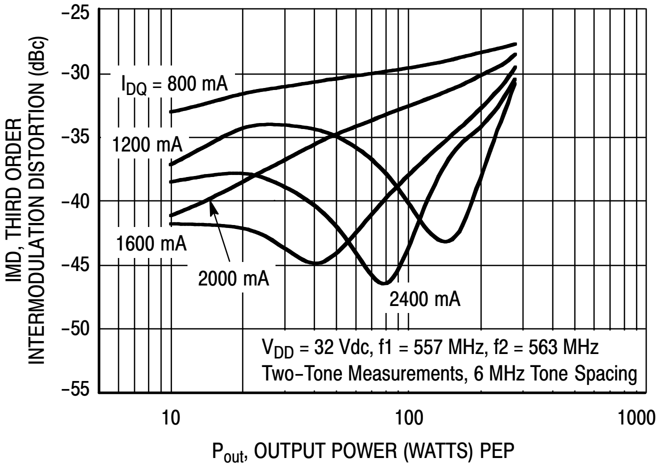


Figure 28. Third Order Intermodulation Distortion versus Output Power @ 560 MHz

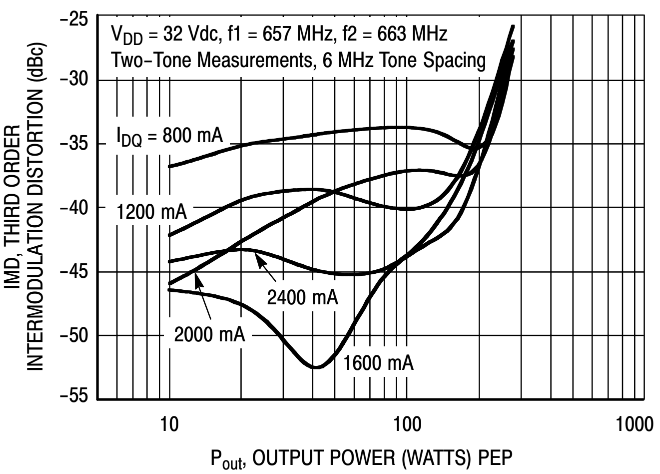


Figure 29. Third Order Intermodulation Distortion versus Output Power @ 660 MHz

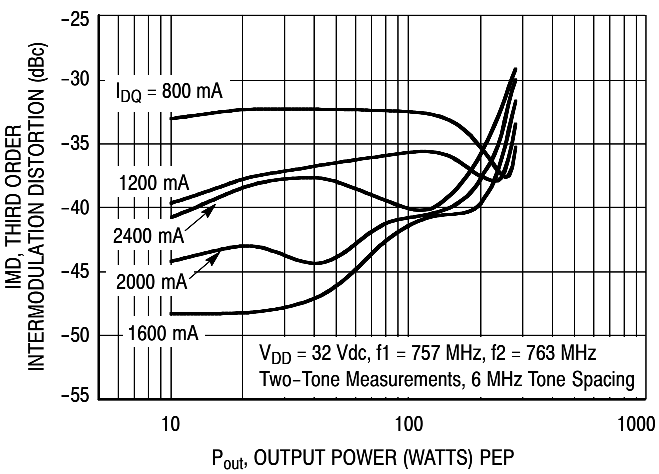


Figure 30. Third Order Intermodulation Distortion versus Output Power @ 760 MHz

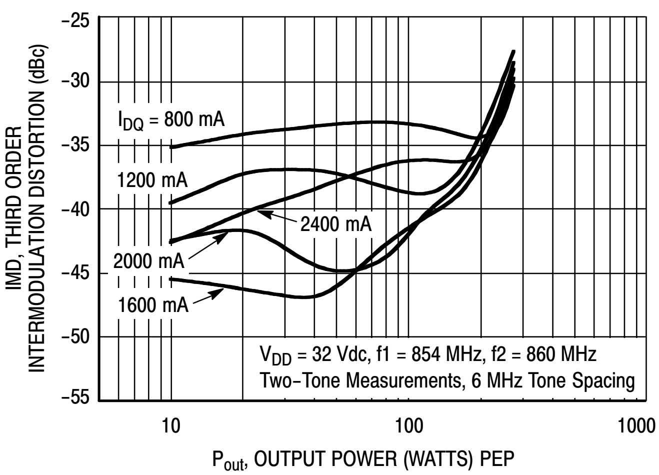


Figure 31. Third Order Intermodulation Distortion versus Output Power @ 857 MHz

TYPICAL TWO-TONE BROADBAND CHARACTERISTICS

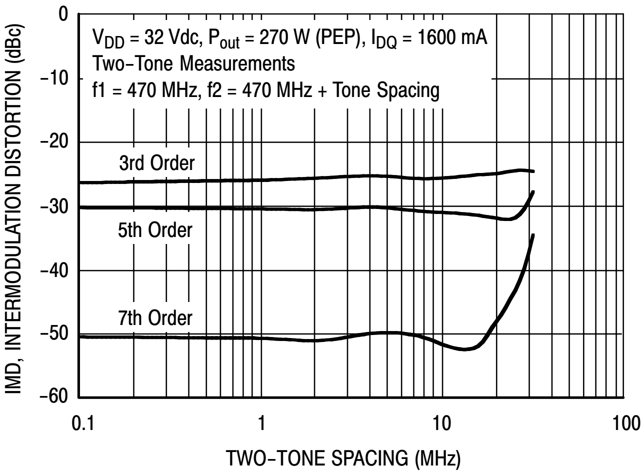


Figure 32. Intermodulation Distortion Products versus Tone Spacing @ 470 MHz

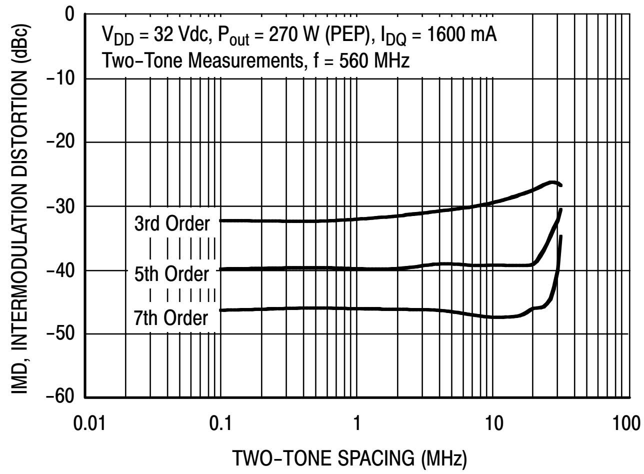


Figure 33. Intermodulation Distortion Products versus Tone Spacing @ 560 MHz

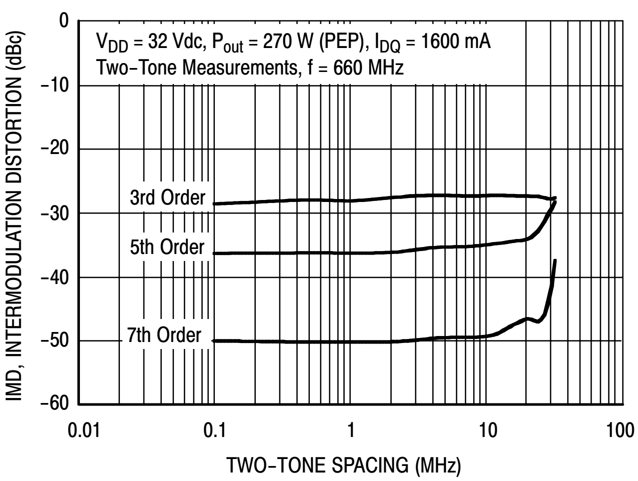


Figure 34. Intermodulation Distortion Products versus Tone Spacing @ 660 MHz

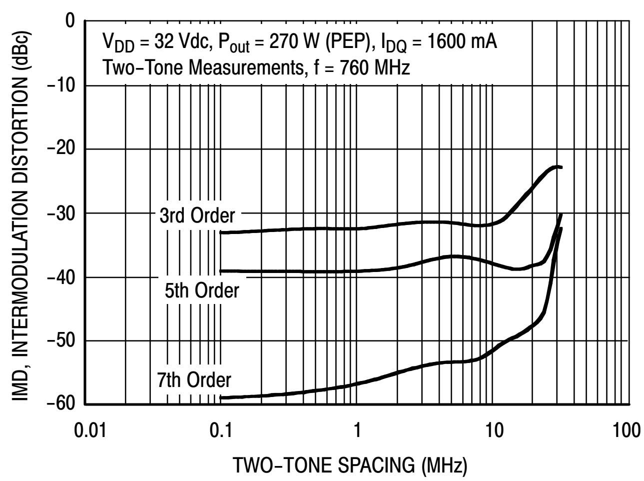


Figure 35. Intermodulation Distortion Products versus Tone Spacing @ 760 MHz

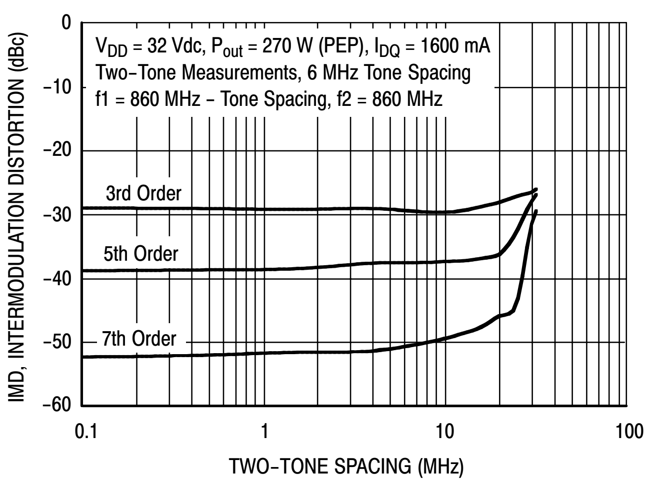


Figure 36. Intermodulation Distortion Products versus Tone Spacing @ 860 MHz

TYPICAL DVBT OFDM BROADBAND CHARACTERISTICS

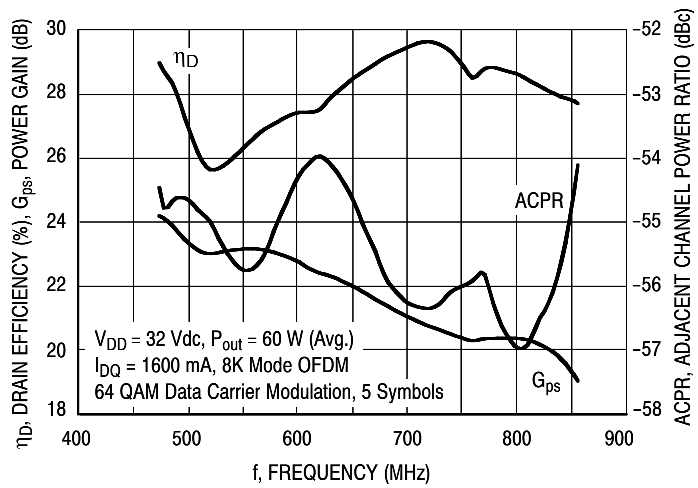


Figure 37. Single-Carrier OFDM Broadband Performance @ 60 Watts Avg.

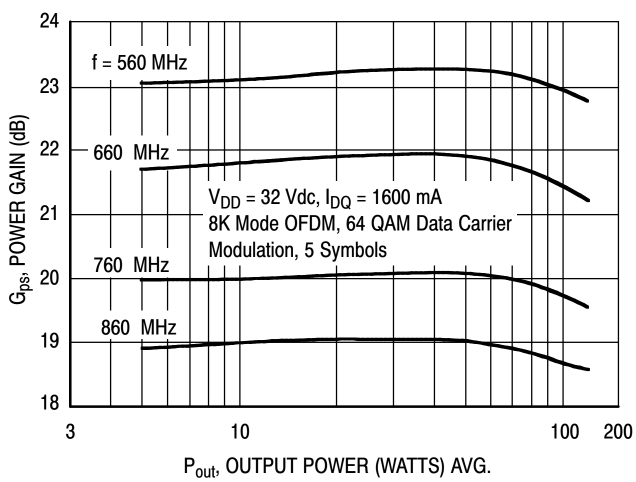


Figure 38. Single-Carrier DVBT OFDM Power Gain versus Output Power

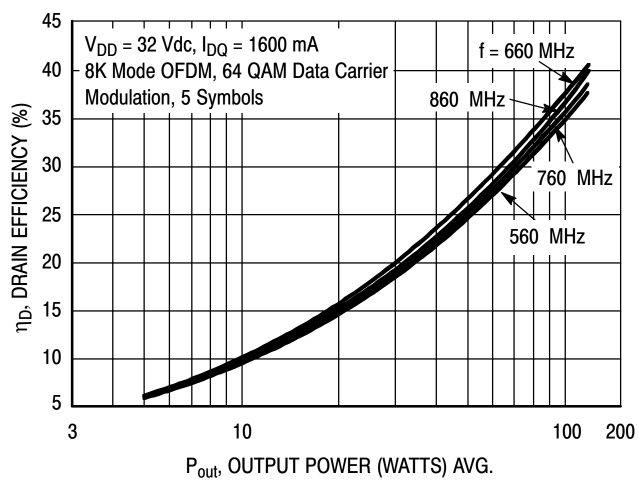


Figure 39. Single-Carrier DVBT OFDM Drain Efficiency versus Output Power

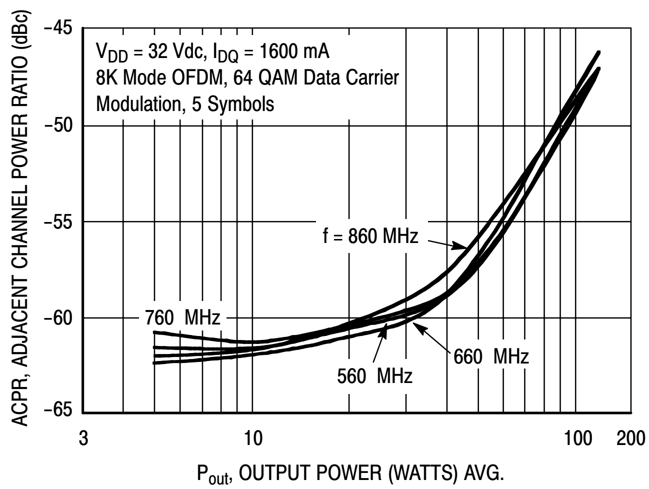


Figure 40. Single-Carrier DVBT OFDM ACPR versus Output Power

TYPICAL CW BROADBAND CHARACTERISTICS

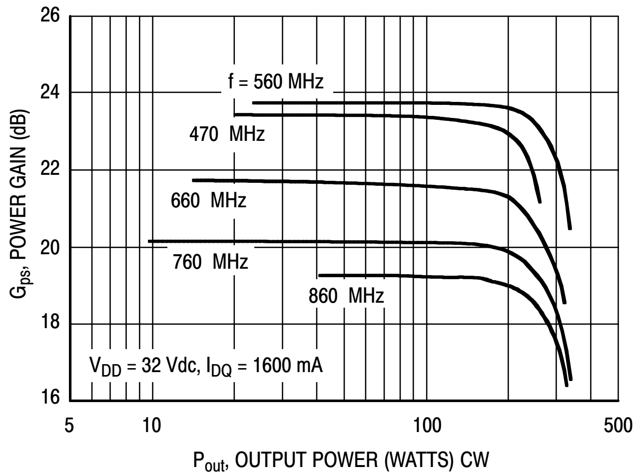


Figure 41. CW Power Gain versus Output Power

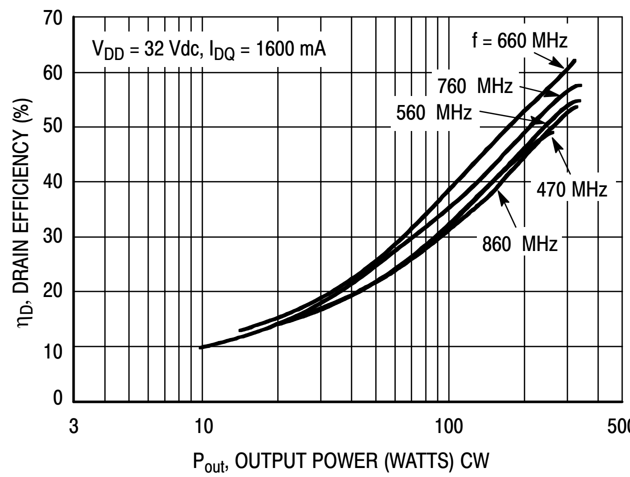


Figure 42. CW Drain Efficiency versus Output Power

TYPICAL CW BROADBAND CHARACTERISTICS

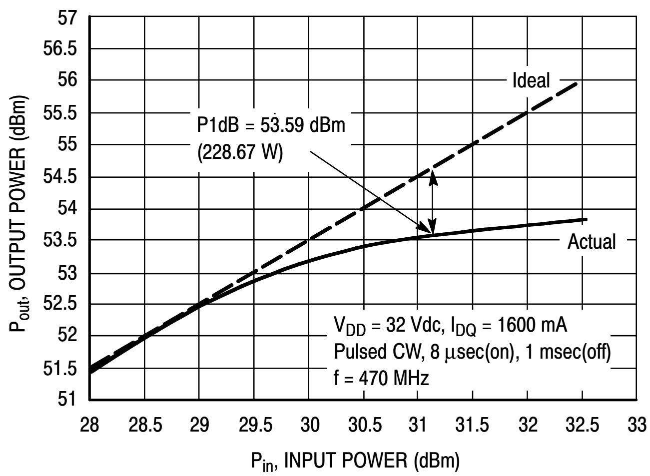


Figure 43. Pulse CW Output Power versus Input Power @ 470 MHz

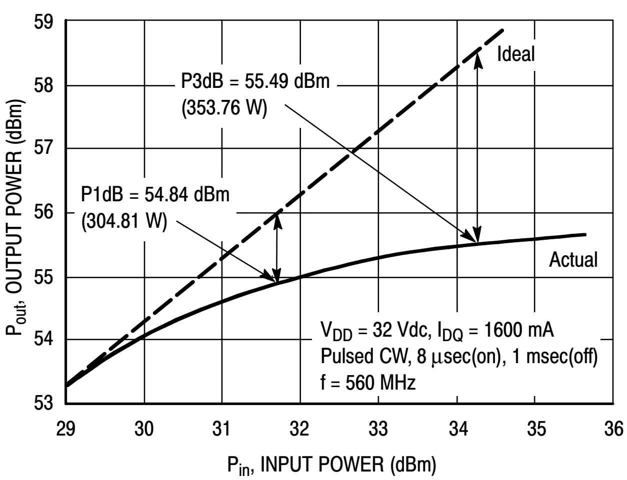


Figure 44. Pulse CW Output Power versus Input Power @ 560 MHz

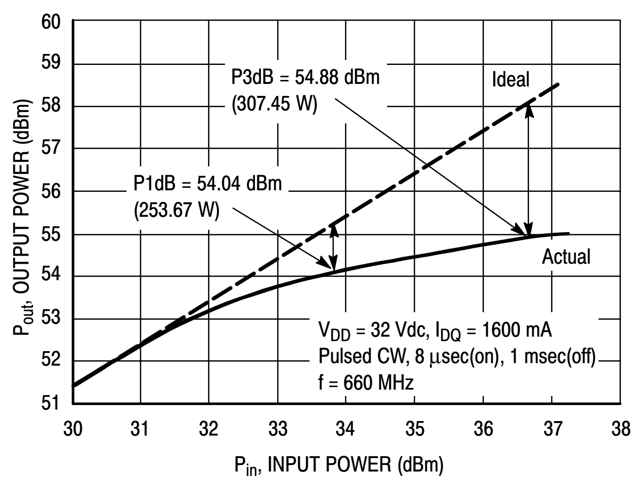


Figure 45. Pulse CW Output Power versus Input Power @ 660 MHz

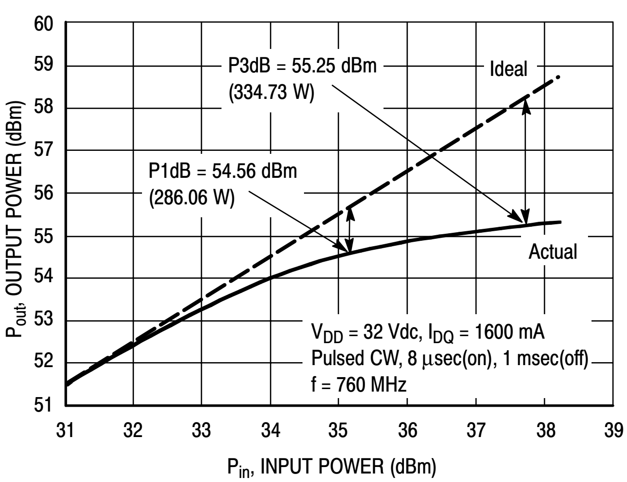


Figure 46. Pulse CW Output Power versus Input Power @ 760 MHz

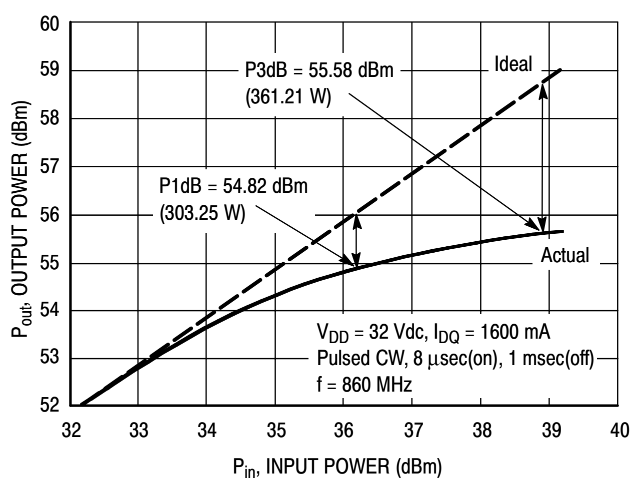


Figure 47. Pulse CW Output Power versus Input Power @ 860 MHz

TYPICAL ATSC 8VSB BROADBAND CHARACTERISTICS

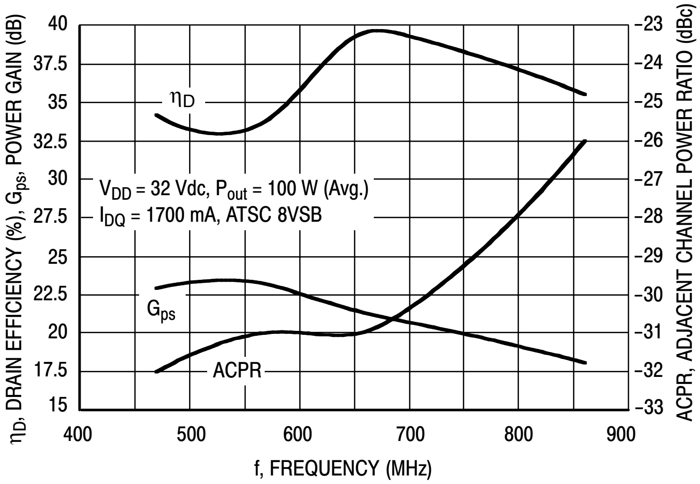


Figure 48. Single-Carrier ATSC 8VSB Broadband Performance @ 100 Watts Avg.

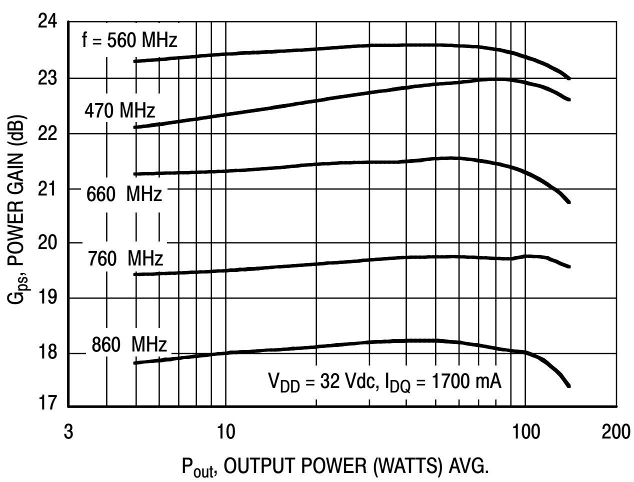


Figure 49. Single-Carrier ATSC 8VSB Power Gain versus Output Power

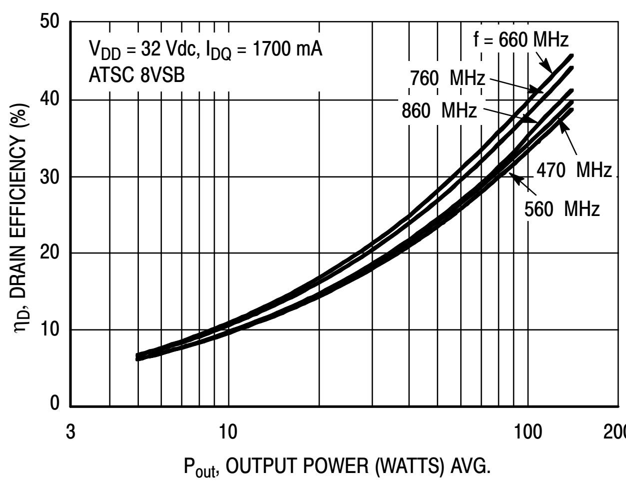


Figure 50. Single-Carrier ATSC 8VSB Drain Efficiency versus Output Power

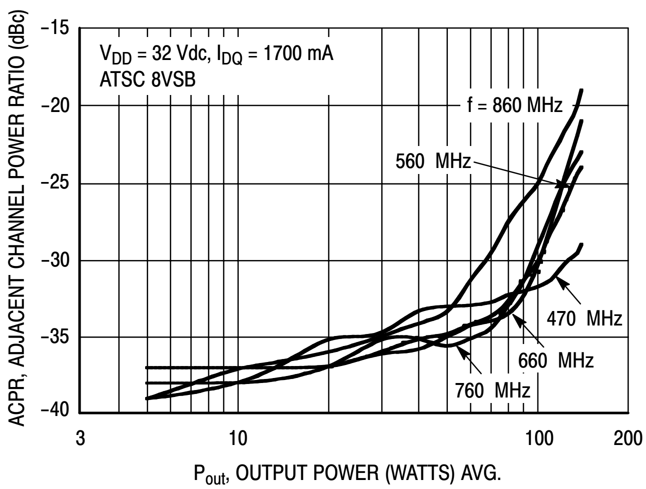


Figure 51. Single-Carrier ATSC 8VSB ACPR versus Output Power

TYPICAL PAL B/G BROADBAND CHARACTERISTICS

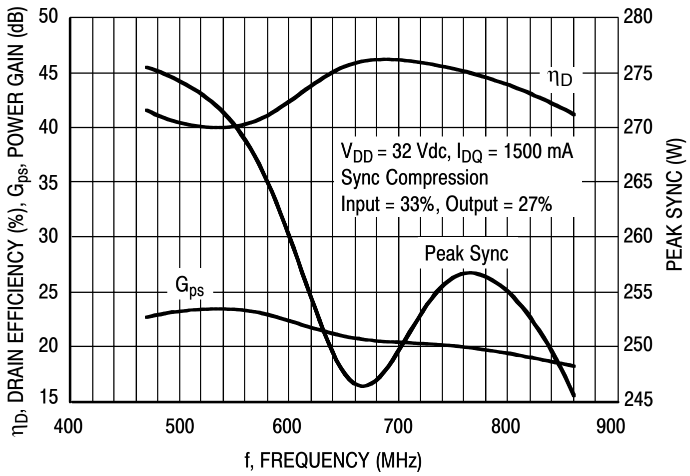
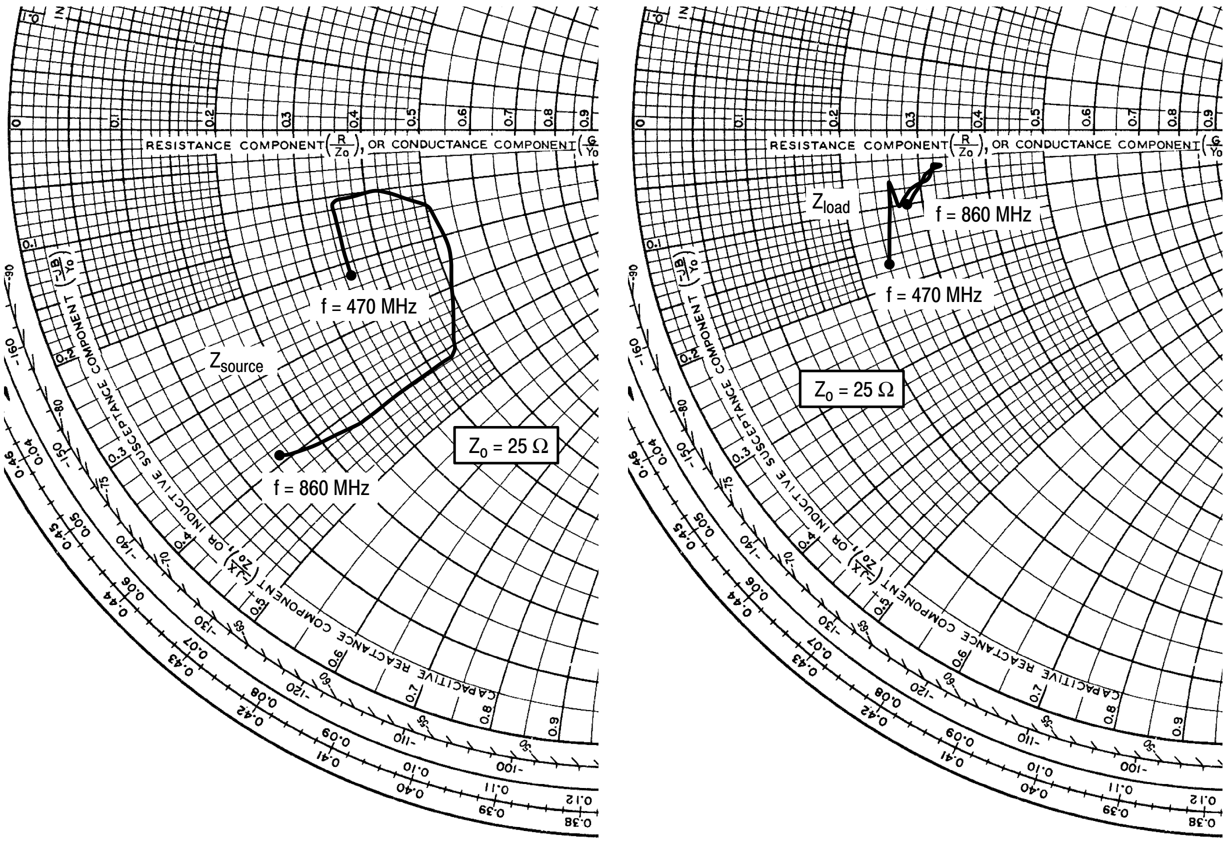


Figure 52. Peak Sync, Power Gain and Drain Efficiency versus Frequency



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

f MHz	Z_{source} Ω	Z_{load} Ω
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.

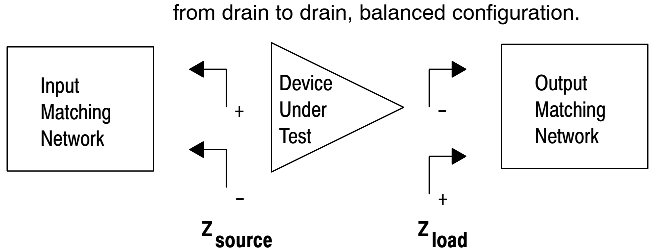
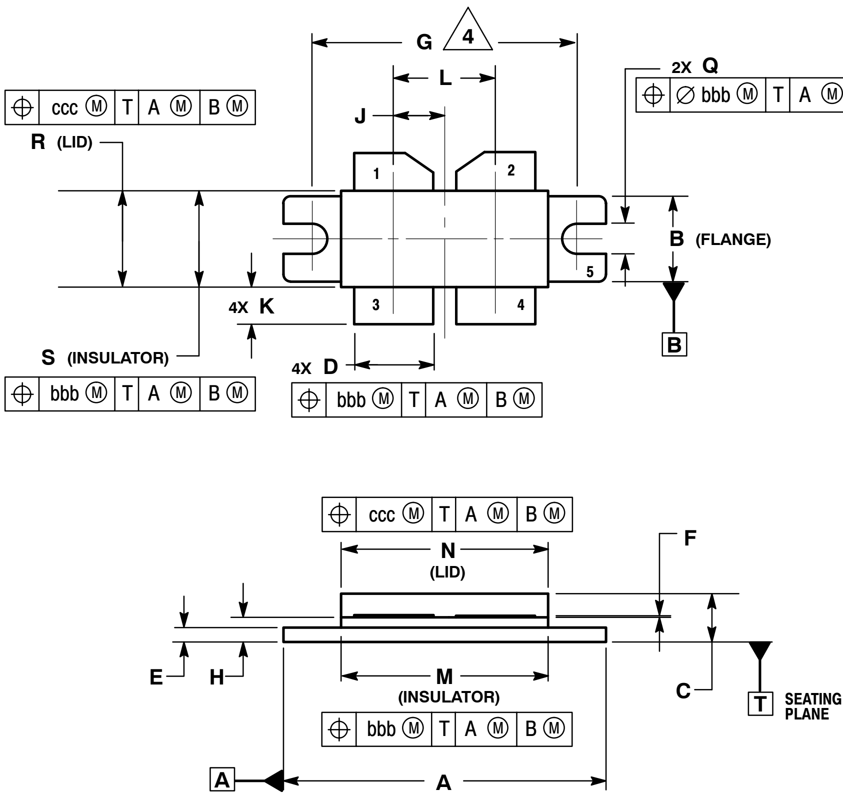


Figure 53. 470-860 MHz Broadband Series Equivalent Source and Load Impedance

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.

	INCHES		MILLIMETERS	
DIM	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 F
NI-860C3

How to Reach Us:

Home Page:
www.freescale.com

E-mail:
support@freescale.com

USA/Europe or Locations Not Listed:
Freescale Semiconductor
Technical Information Center, CH370
1300 N. Alma School Road
Chandler, Arizona 85224
+1-800-521-6274 or +1-480-768-2130
support@freescale.com

Europe, Middle East, and Africa:
Freescale Halbleiter Deutschland GmbH
Technical Information Center
Schatzbogen 7
81829 Muenchen, Germany
+44 1296 380 456 (English)
+46 8 52200080 (English)
+49 89 92103 559 (German)
+33 1 69 35 48 48 (French)
support@freescale.com

Japan:
Freescale Semiconductor Japan Ltd.
Headquarters
ARCO Tower 15F
1-8-1, Shimo-Meguro, Meguro-ku,
Tokyo 153-0064
Japan
0120 191014 or +81 3 5437 9125
support.japan@freescale.com

Asia/Pacific:
Freescale Semiconductor Hong Kong Ltd.
Technical Information Center
2 Dai King Street
Tai Po Industrial Estate
Tai Po, N.T., Hong Kong
+800 2666 8080
support.asia@freescale.com

For Literature Requests Only:
Freescale Semiconductor Literature Distribution Center
P.O. Box 5405
Denver, Colorado 80217
1-800-441-2447 or 303-675-2140
Fax: 303-675-2150
LDCForFreescaleSemiconductor@hibbertgroup.com