650MHz & 325MHz Sources

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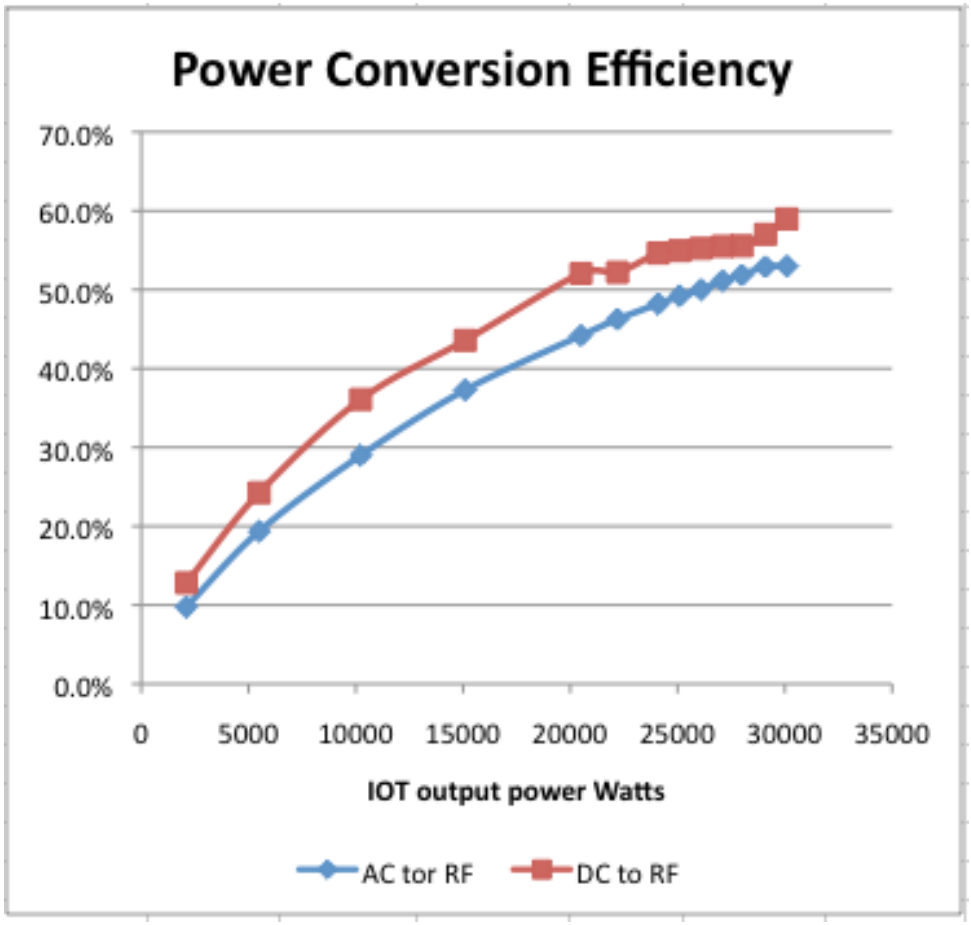
SLAC NATIONAL ACCELERATOR LABORATORY

U.S. DEPARTMENT OF ENERGY | Office of Science

FY11 OBJECTIVES

- Characterize Freescale amplifiers @ 650MHz and 352MHz.
- Compare vs Project X specs
- Evaluate cooling options
- Investigate higher efficiency amplifiers
- What is available commercially?
- Procurement of a 2-3kW amplifier @650MHz, and verify specs.

IOT efficiency – 650MHz 30kW (Fermilab)



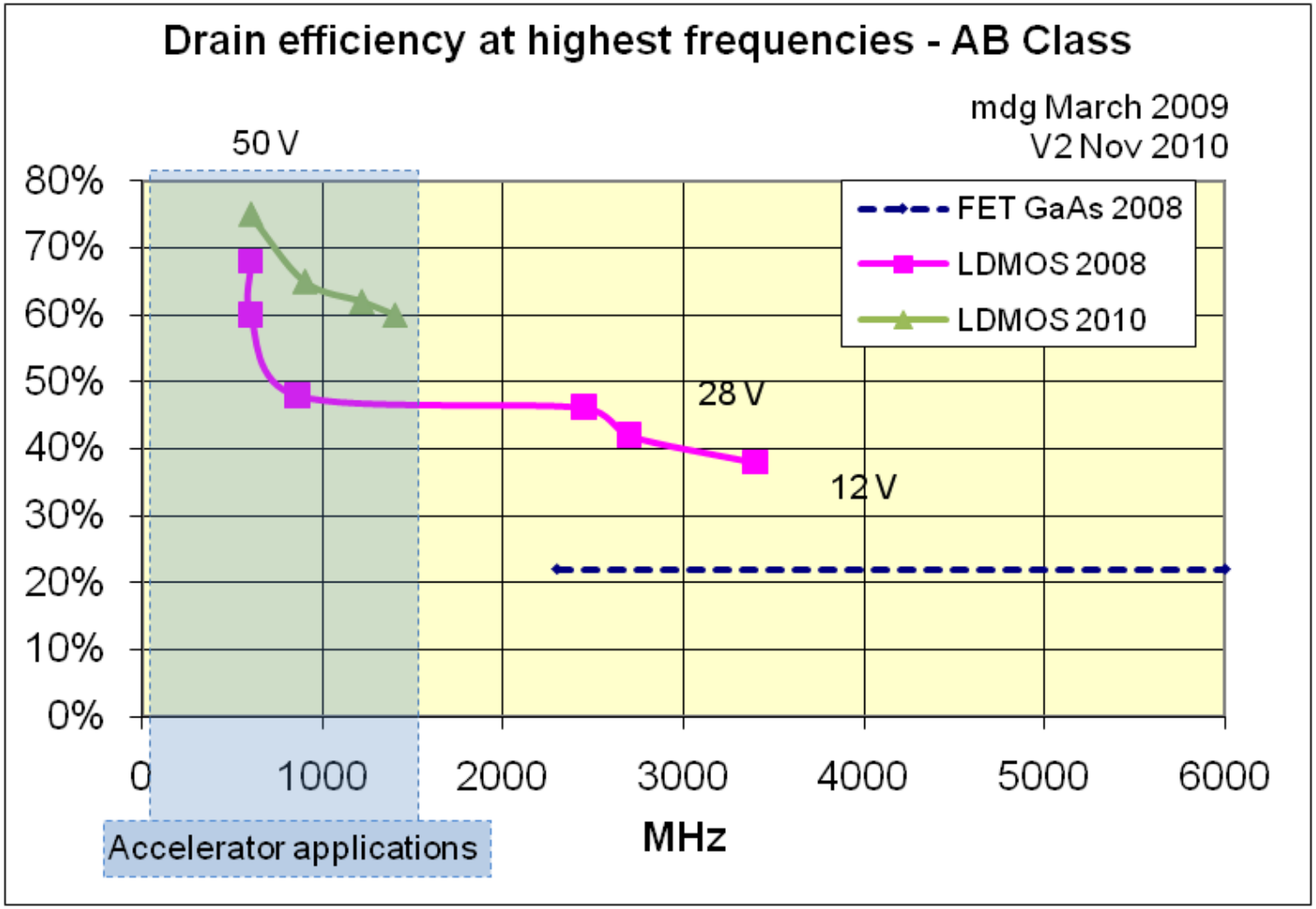
Courtesy of Ralph Pasquinelli @ Fermilab

Includes:

- Fans
- Filaments
- Bias supply
- Ion pump
- Controls

Does not include power for the solid state driver amplifiers.

DRAIN EFFICIENCY



OTHER FACTORS

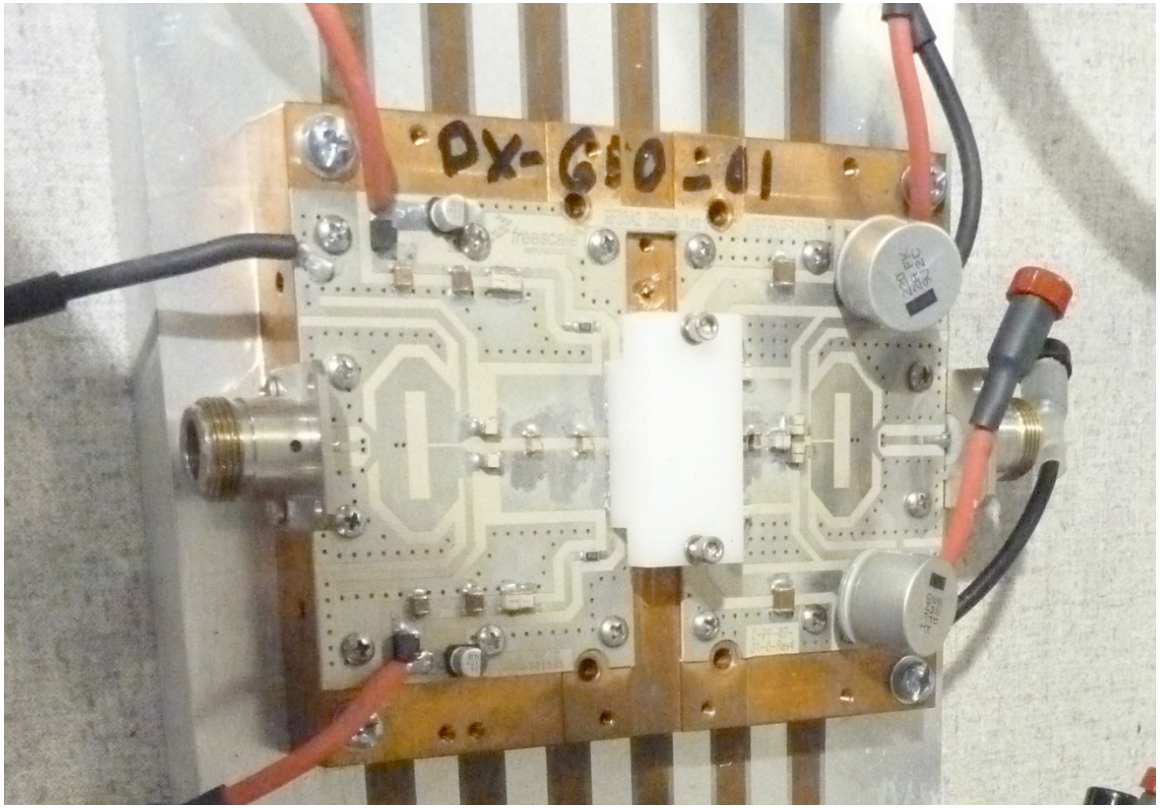
Manuf	Device	Gain dB	VSWR	°C/W	Effic	W
NXP	BLF548	25 (100MHz)	10:1	0.5	55	150
	BLF574	26 (100MHz)	13:1	0.23	72	600
	BLF578	26 (100MHz)	13:1	0.15	75	1000
FREESCALE	MRF6VP3450	22 (860MHz)	10:1	0.27	44	450
	MRFE6VP61K25	23 (230MHz)	65:1	0.15	74	1250
	MRF6VP41	20 (450MHz)	10:1	0.15	64	1000

Thermal resistance J-C

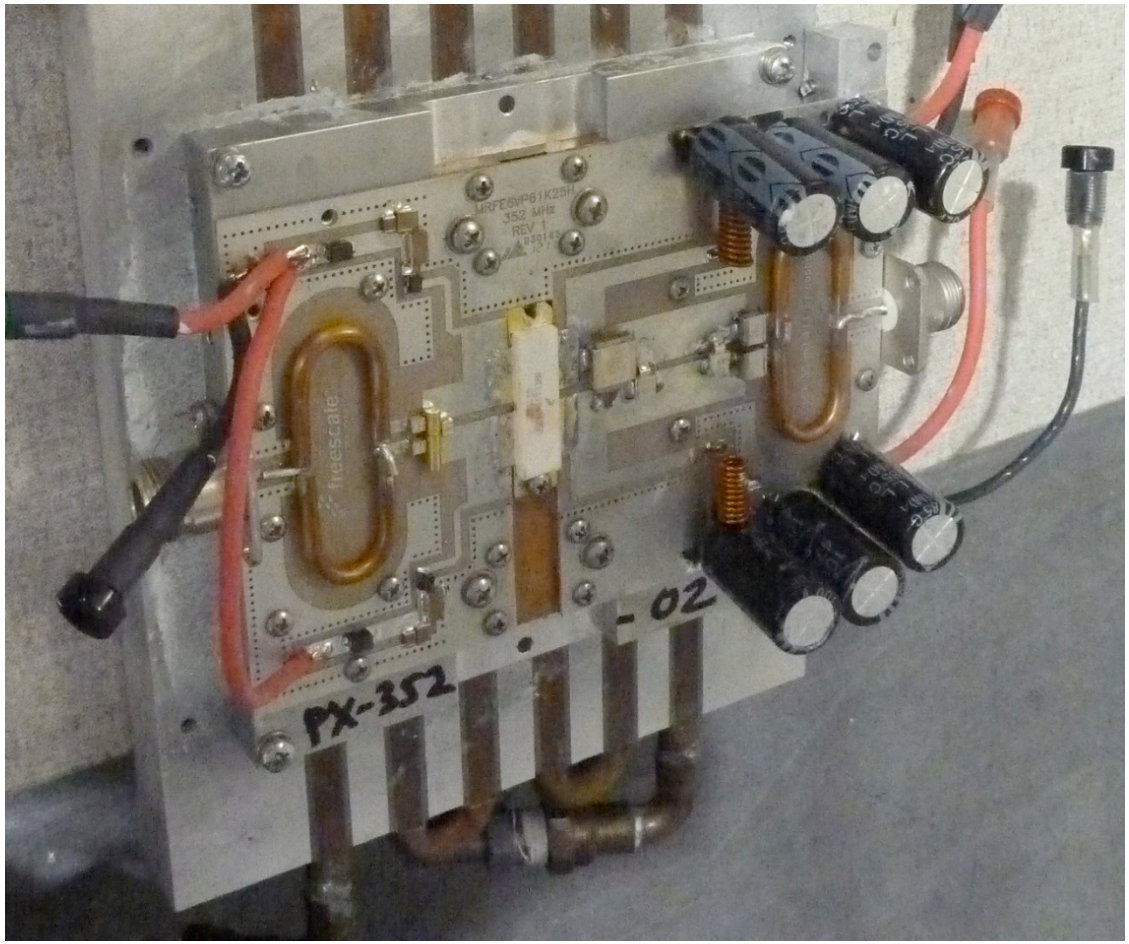
Efficiency: drain efficiency Pout/ Pin (where Pin is power to the drain)

Maximum power

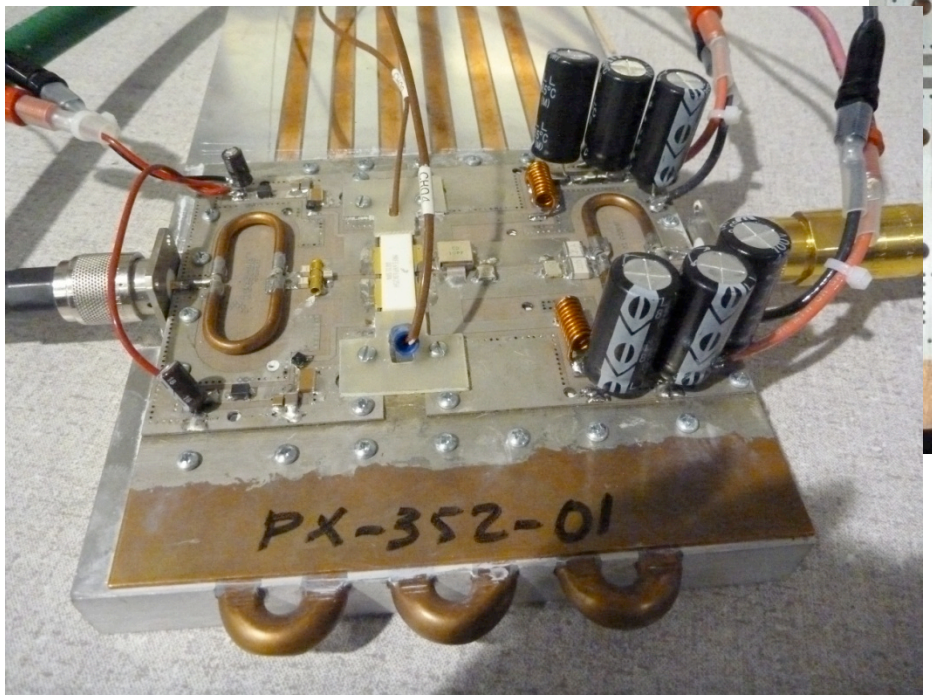
Freescale 650MHz/500W

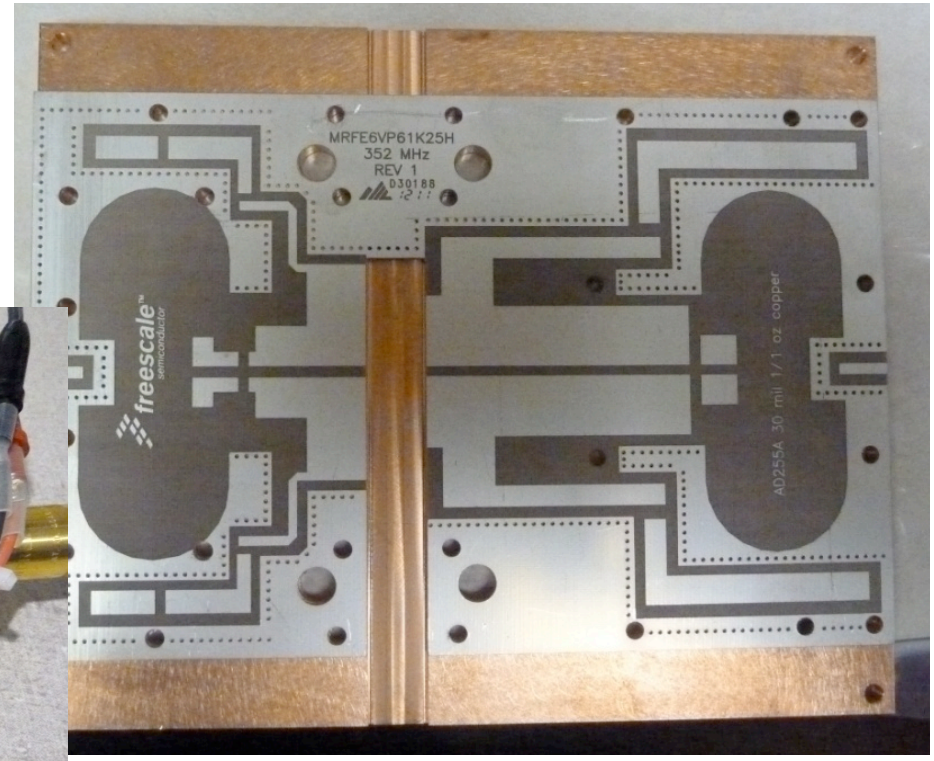


Freescale 352MHz/1.25kW

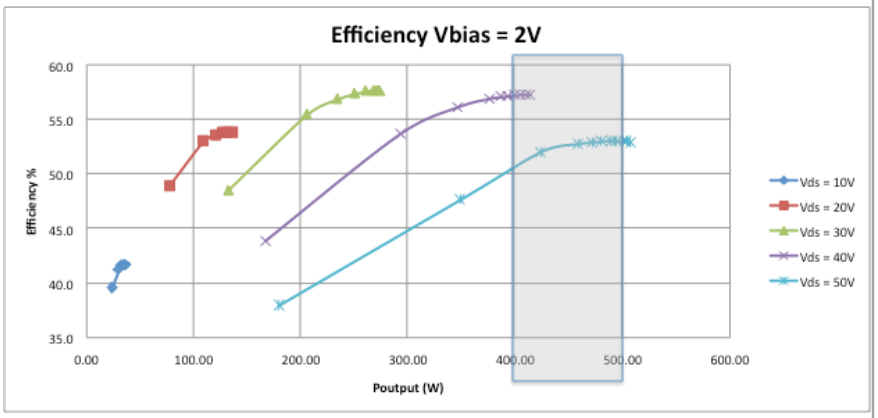


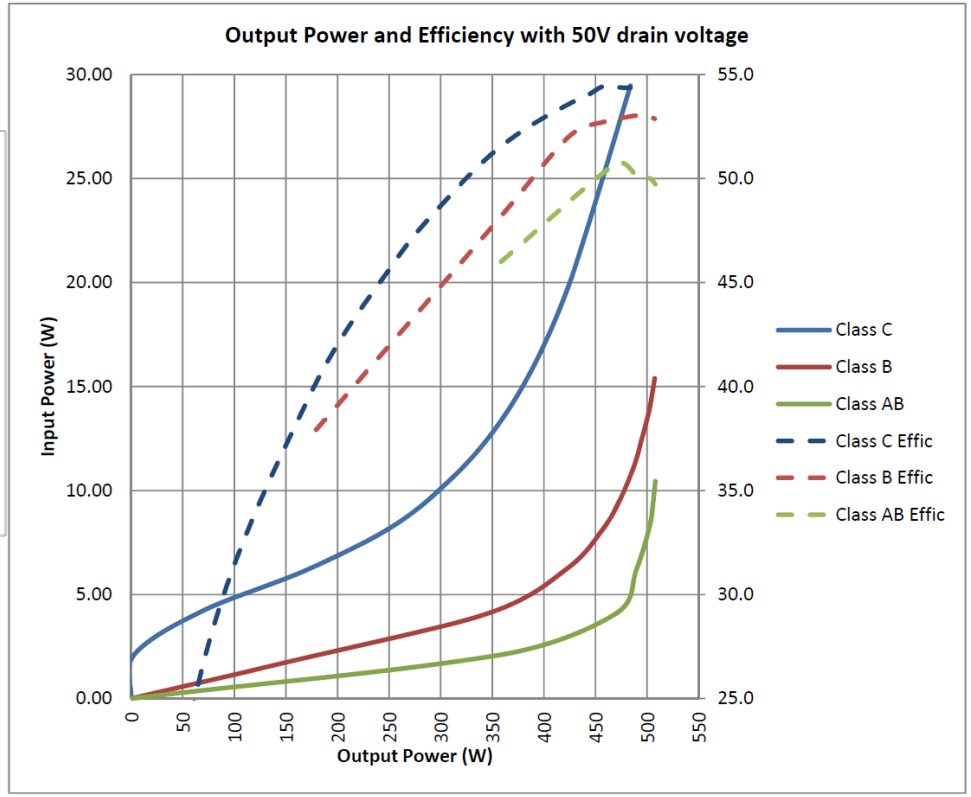
Freescale-SLAC 352MHz/1.25kW



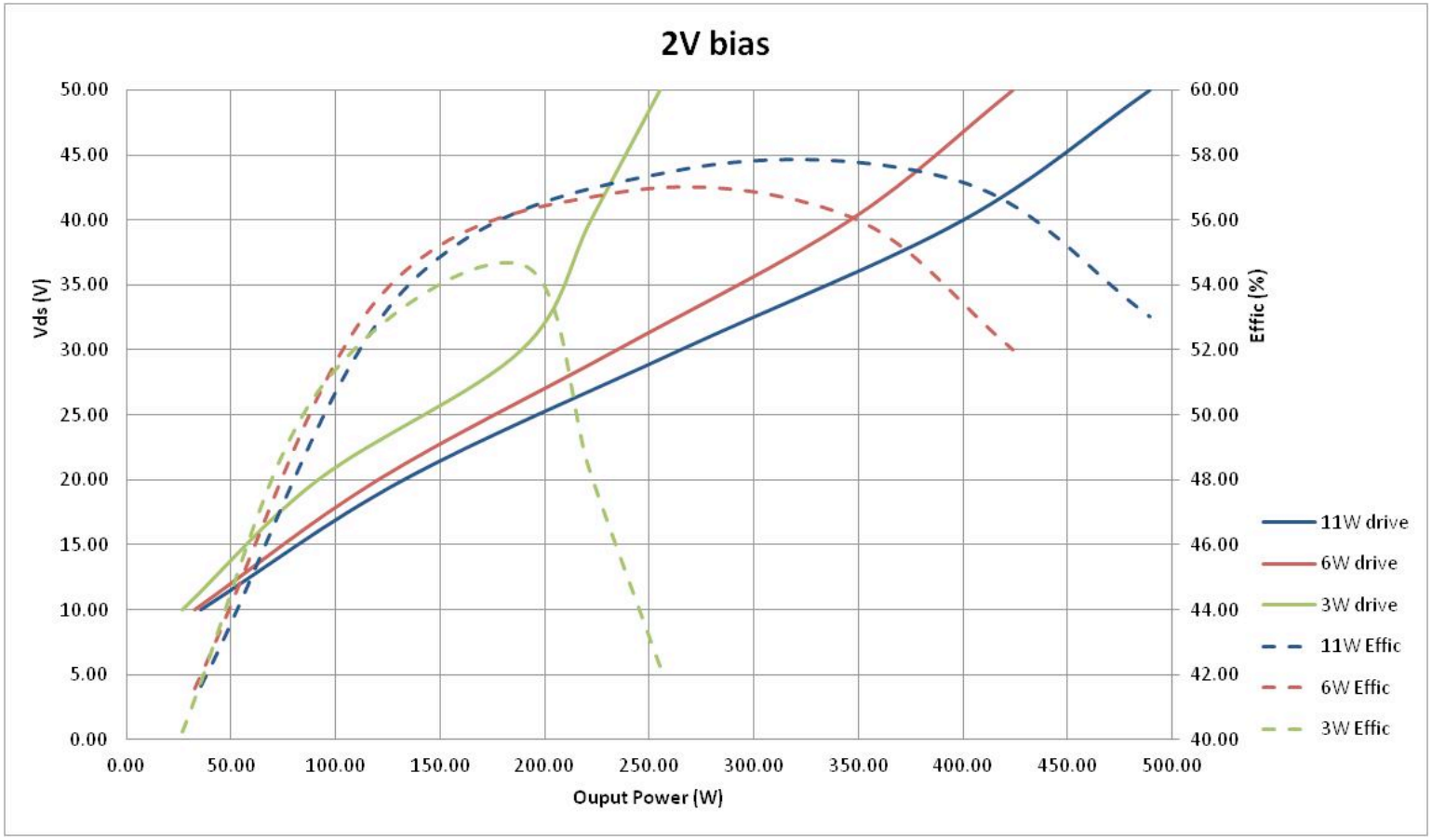


Efficiency – 650MHz

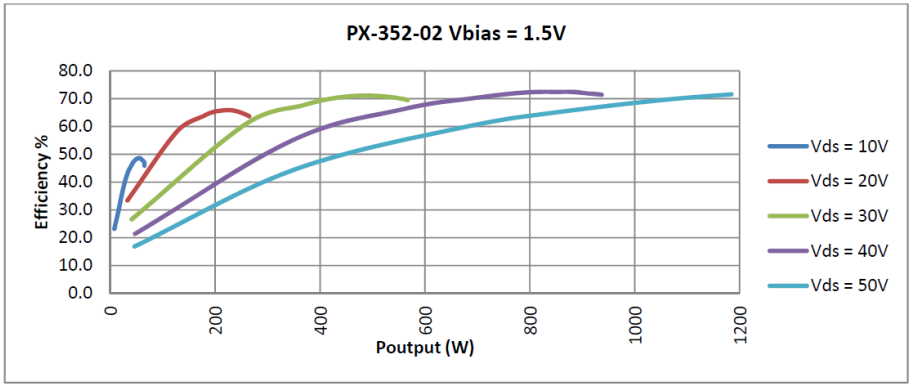


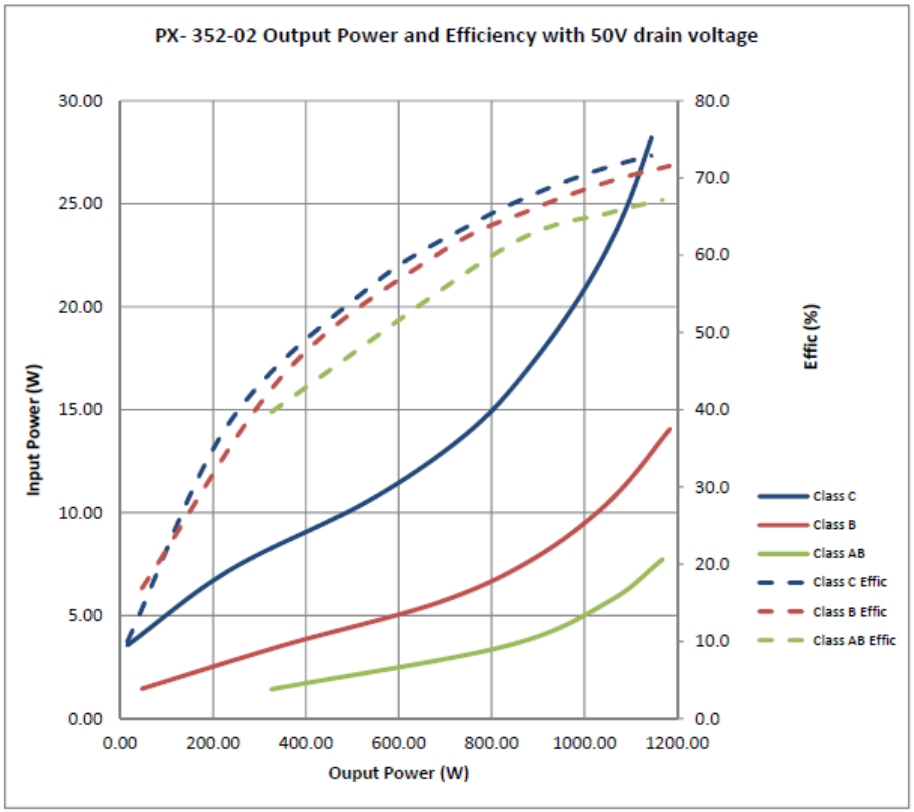


Output Pwr & Efficiency 650MHz

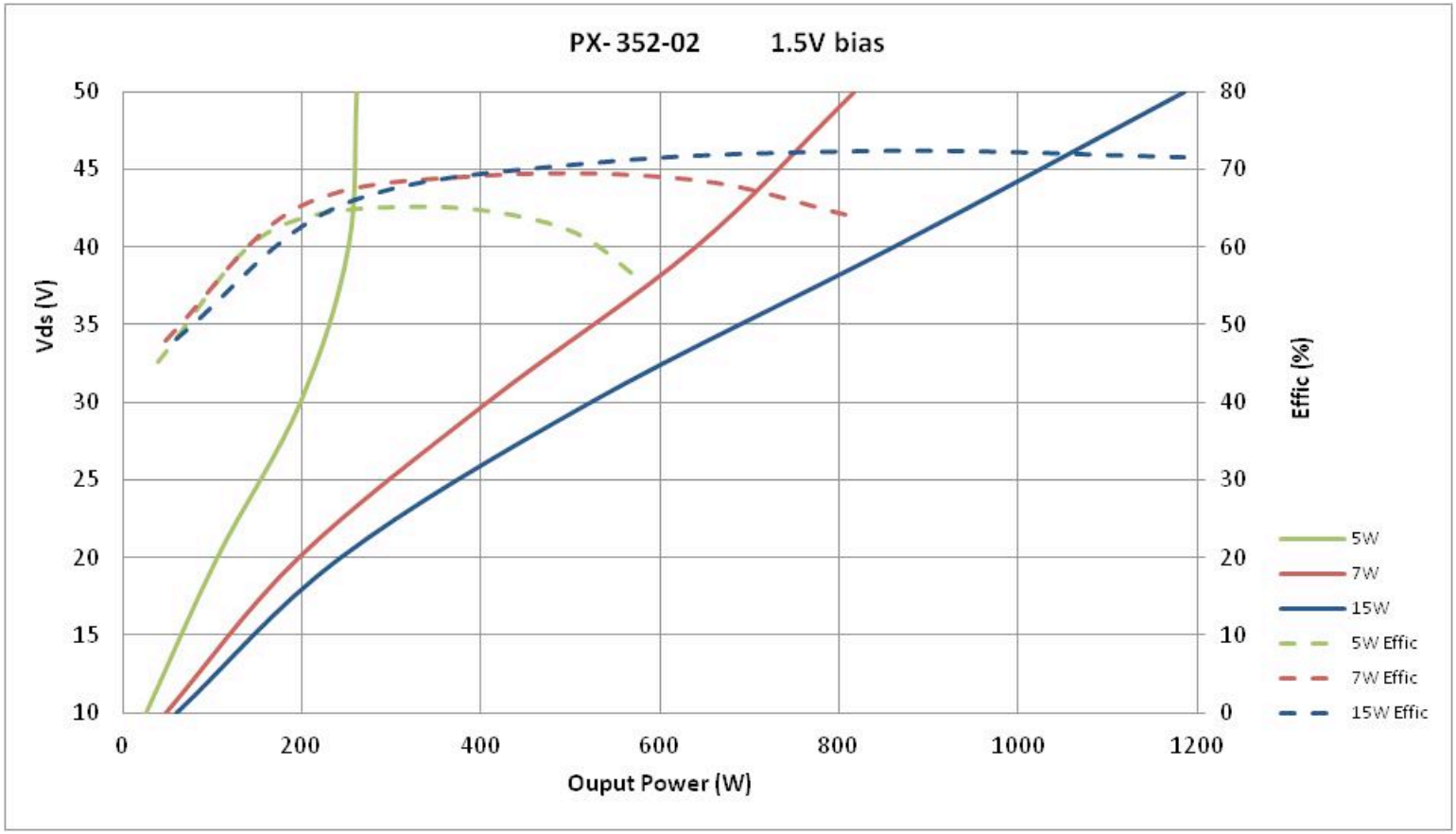


Efficiency – 352MHz





Output Pwr & Efficiency 352MHz

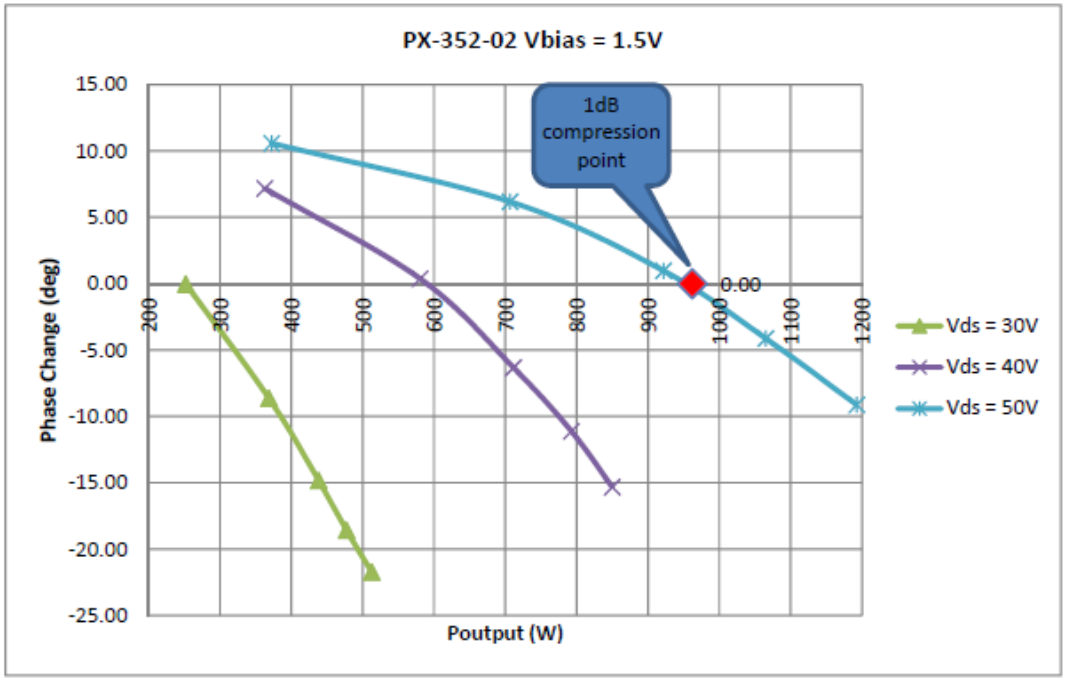


Phase change – 352MHz

•Steady state: Phase change in time ~0.7deg over one hour running at ~1.2kW.

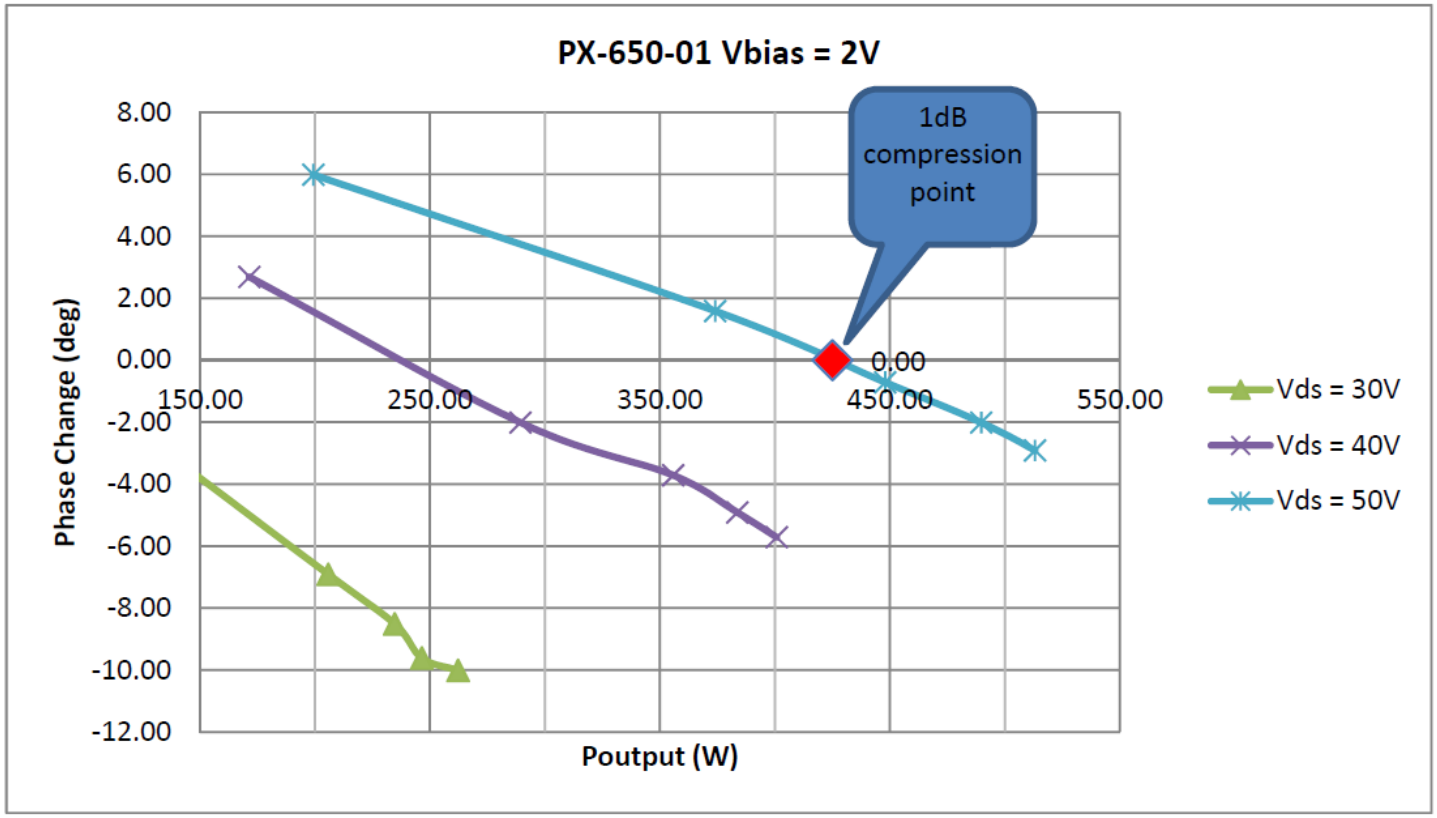
•With temperature: Phase change with temperature: ~0.5deg for a 3°C temperature change at the baseplate.

•With drain voltage:

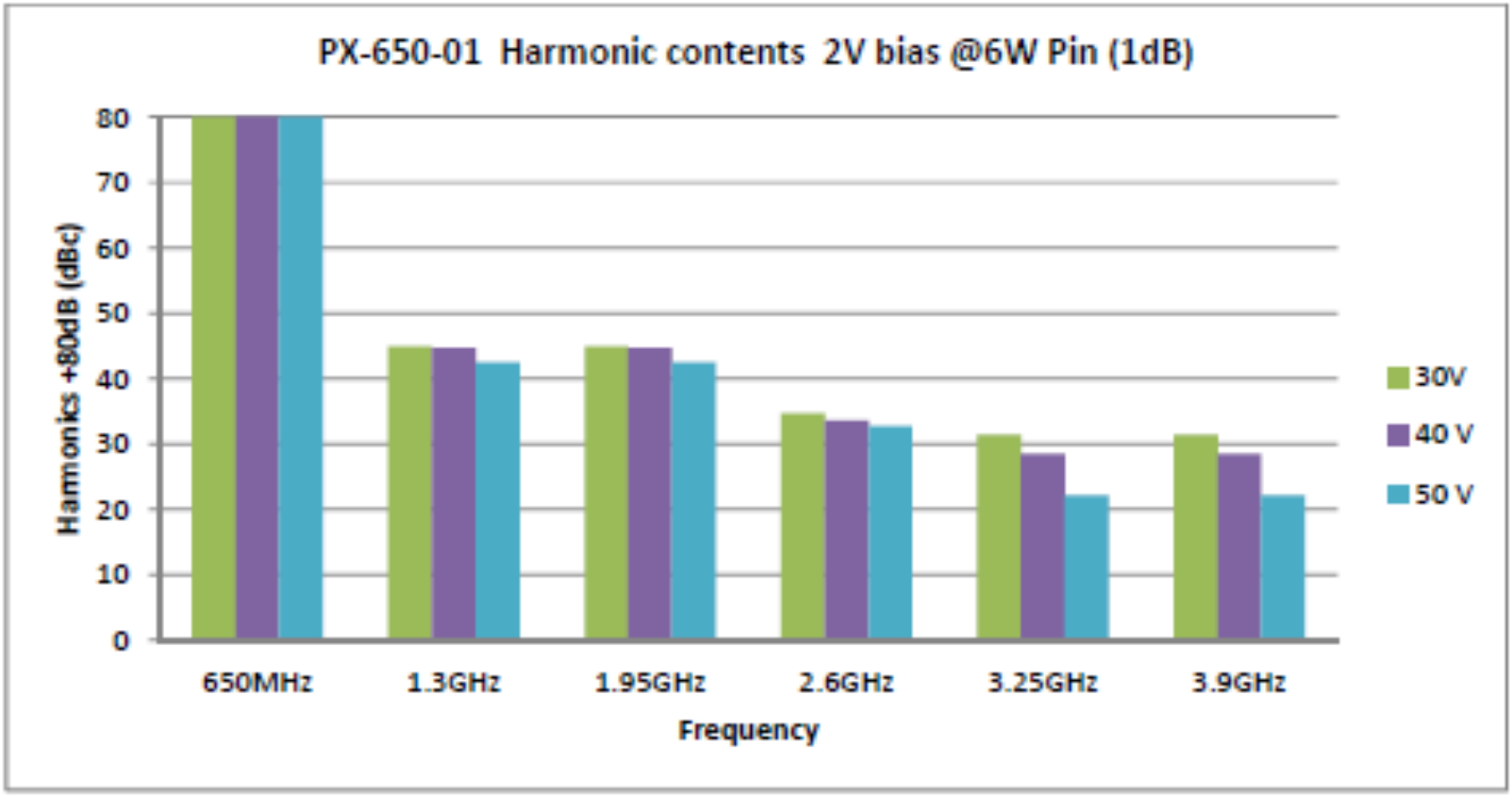


Phase change – 650MHz

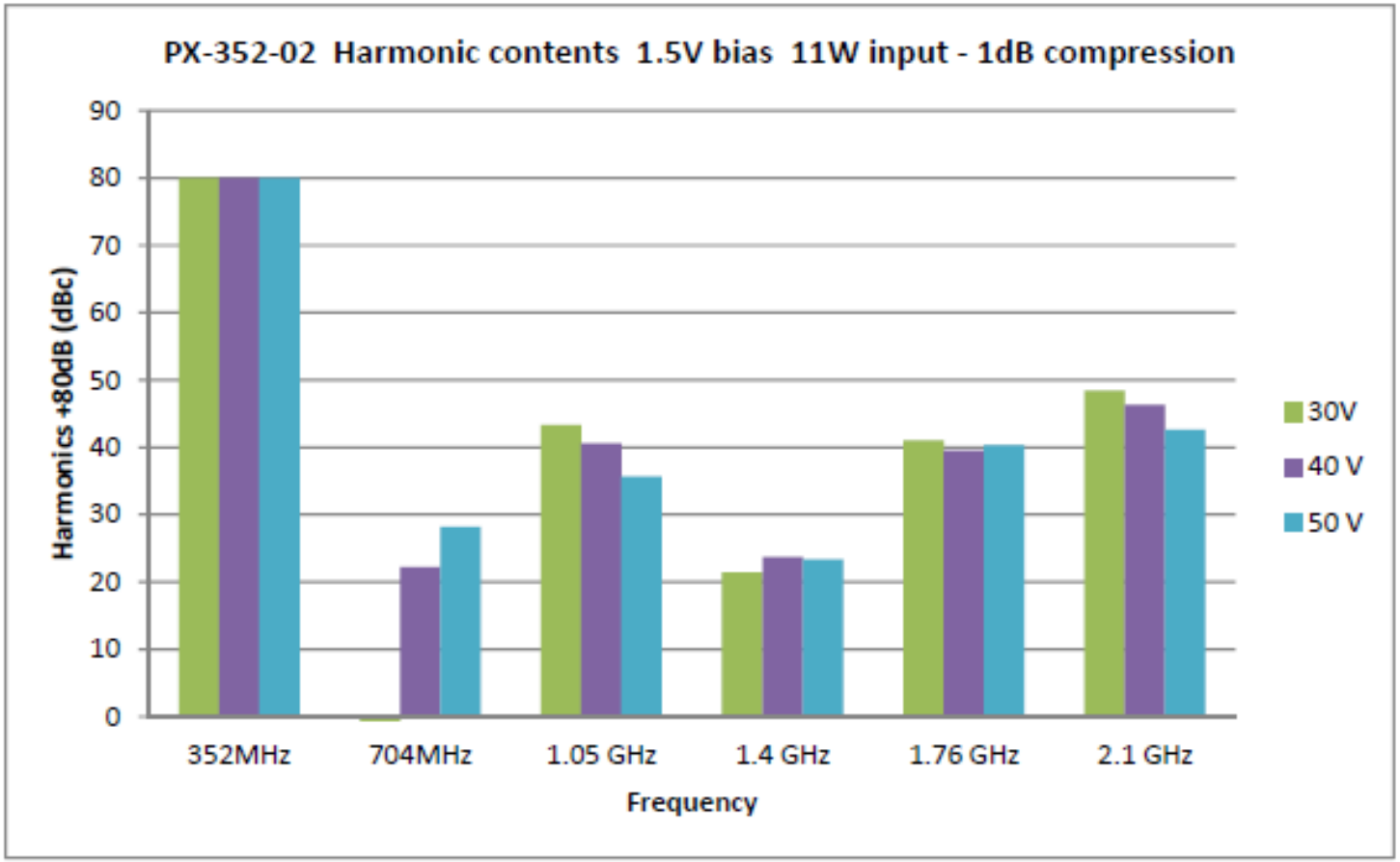
- With drain voltage:



Harmonics – 650MHz



Harmonics – 352MHz



CONCLUSIONS

- The class B amplifier (close to) gave overall best results with a gain of about 20dB at 1dB compression.
- The 352MHz amplifier outputs up to 1.2kW and has an efficiency in the order of 70% at 1dB compression.
- The 650MHz amplifier outputs up to 500W and has an efficiency in the order of 50-55% at 1dB compression.
- Harmonics and phase shift as expected
- Transistor cooling is manageable

FUTURE WORK

- Further optimize for cooling: Test Lytron coldplate. Run current setup with SLAC carrier (continuous max power). Verify thermal dissipation is still adequate. (delidded transistors)
- Extended runtime
- Combine two 1kW modules.
- Can it handle full reflection?
- 325MHz
- Class F amplifier for higher efficiency

Future work

Have vendors build RF source 650MHz >2.5kW:

- 7 companies bidding: Integra, CPI, CPC, Comtech, Empower, TOMCO and Nautel.
- One from Australia (TOMCO)
- Efficiency seems to be the most difficult parameter to achieve (we asked for >50% AC to RF)
- Dimension vs efficiency