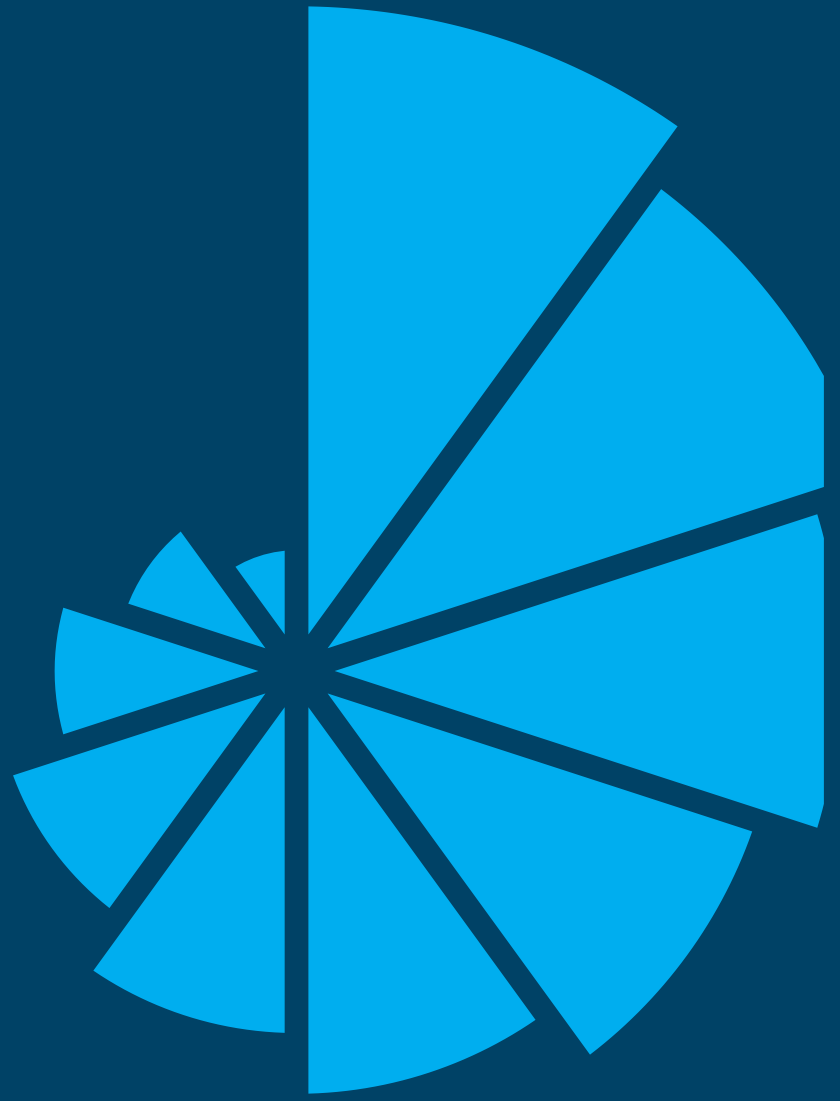
elenos group
DEDICATED RELIABLE CREATIVE

ELENOS World Broadcast Experience · itelco BROADCAST · BE · PRO TELEVISION TECHNOLOGIES

Elenos Group World Broadcast

Green Broadcasting:

A practical discussion about managing energy usage



Innovation lives here

Webinar Schedule

1. Introduction to the Elenos Group
2. Factors affecting FM and TV efficiency – both in analog and digital
2. Selection of the device
3. Planar technology
4. Custom designed power supplies
5. Carefully modelled cooling
6. Ecosaving analysis
7. Questions and Answers

Your host:
Chuck Kelly
VP Market Development

Special Guest:
Alberto Milani
Area Sales Manager

Type any questions you may have <u>at any time</u> in the GoToWebinar interface.

Remember, watching this webinar qualifies for ½ credit towards SBE certification under Category 1.

elenos group

DEDICATED RELIABLE CREATIVE

60,000 Installations

130 Countries

90 Years of Experience

Elenos Group

Elenos
- Founded in **1977** in Ferrara, Italy

Itelco
- Broadcast began in **1962** in Orvieto, Italy

BE
- Established in Quincy, Illinois in **1959**

PROTELEVISION TECHNOLOGIES
- Established in Denmark, over **50** years of experience

The Million Dollar Question

The ~~problem~~: opportunity:

Global Electrical Energy Consumption:

- Has increased by 117% from 1990 to 2017
- Is forecast to increase by a further 51% by 2040

Average Industrial Cost of Electricity:

- Has increased by 111% since 2011
- Ranges from US$0.05/kW/h to $0.40/kW/h depending on your country.
- Given higher costs of generation and limited supply, as well as carbon taxes, costs are expected to continue to rise.

Source - https://www.iea.org/data-and-statistics/?country=WORLD&fuel=Electricity%20and%20heat&indicator=Electricity%20consumption

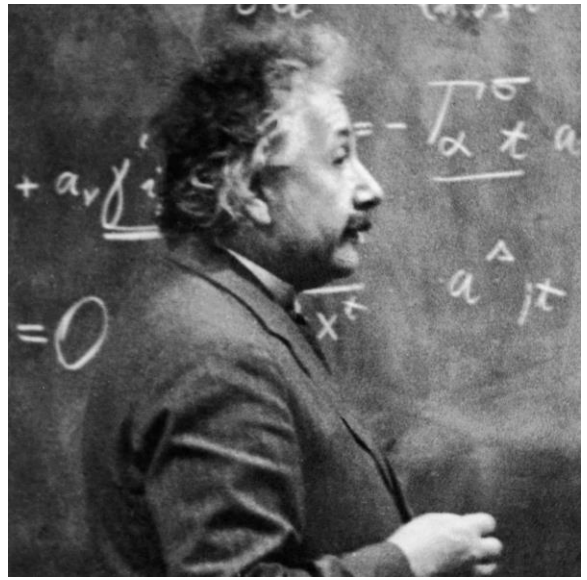
Factors affecting solid state transmitter efficiency in FM or TV:

In analog:

- PA device selection
- PA voltage
- Power supply design
- Combiner and output filter design
- Cooling system design
- Smart control of power by daypart

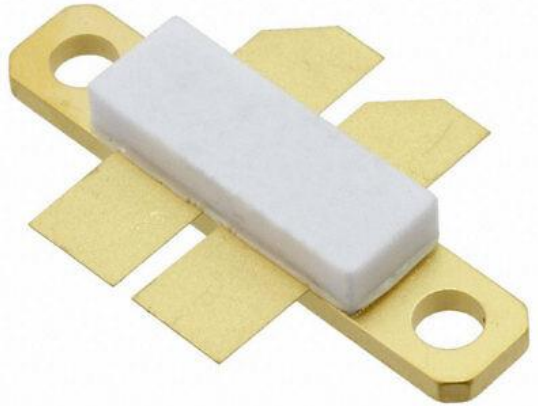
In digital – the same as analog plus:

- MER: Mean Error Ratio
- PAPR: Peak to Average Power Ratio
- Adaptive Pre-Correction
- Doherty technology



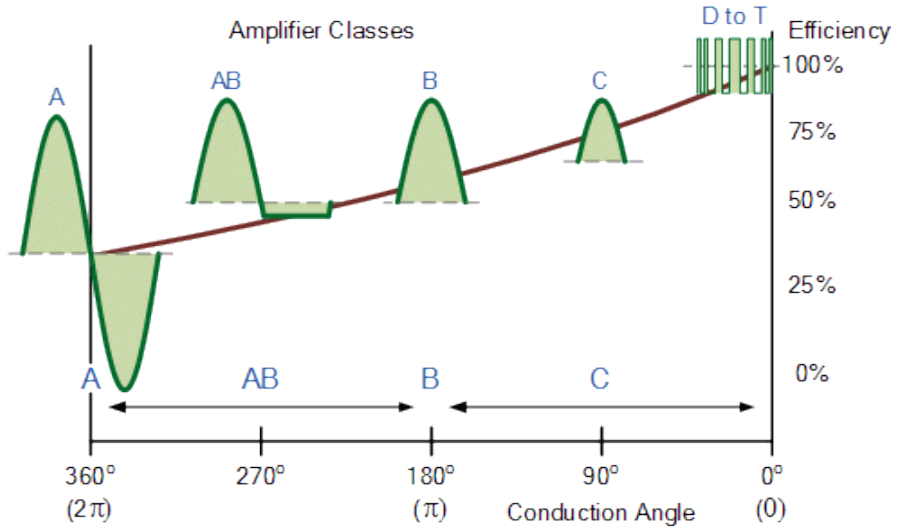
PA device selection:

- Conventional tube
  - ✓ Used in early FM and TV
  - ✓ Relatively low efficiency
  - ✓ Typically single point failure
  - ✓ Finite life
- IOT
  - ✓ Much higher and efficiency for UHF TV
  - ✓ High cost
  - ✓ Single point failure
  - ✓ Finite life
- Bi-polar transistors
  - ✓ Lower efficiency
  - ✓ Potentially longer life
  - ✓ Thermal runaway
  - ✓ Parallel amplifiers – soft failure
- LDMOS transistors
  - ✓ Higher efficiency
  - ✓ Rugged, long life, no thermal runaway
  - ✓ Higher gain and power – less stages
  - ✓ Soft failure



Class F – high efficiency

- Reduced conduction angle provides increased DC to RF efficiency.
- Useful primarily for analog FM.
- Class-F amplifiers boost both efficiency and output by using harmonic resonators in the output network to shape the output waveform into a square wave.

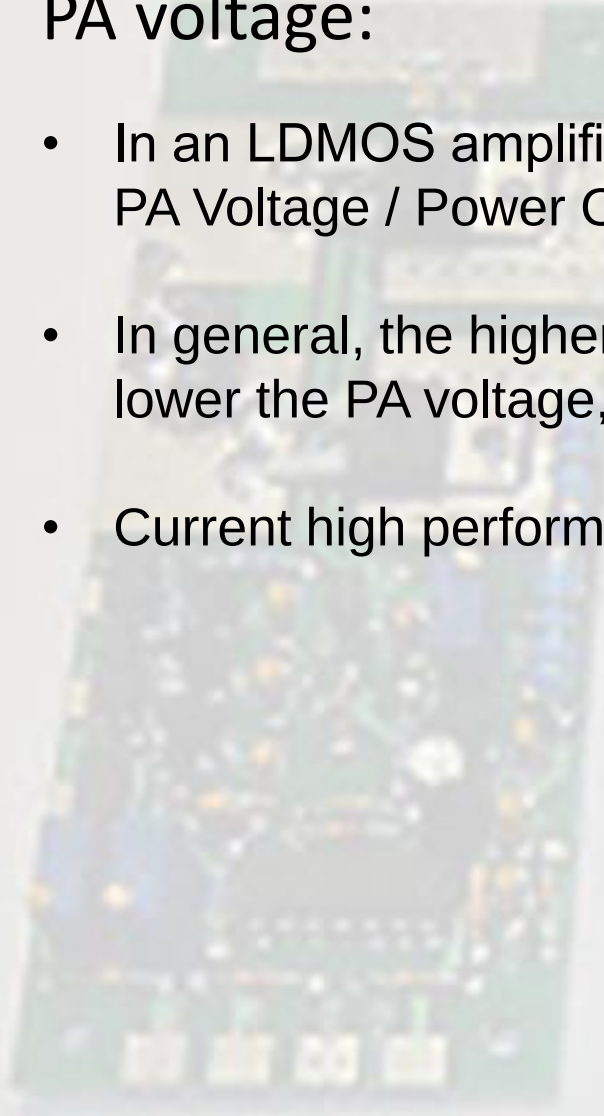
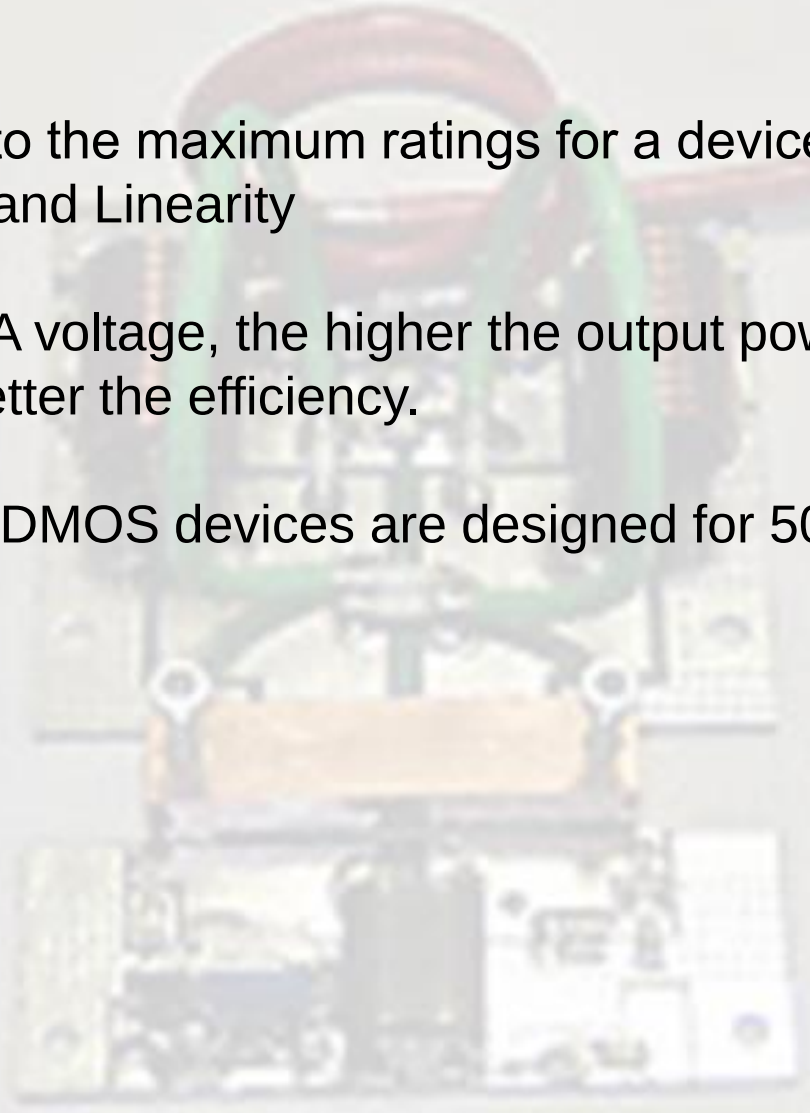


- Integrated ESD protection
- Excellent ruggedness
- High efficiency
- Excellent thermal stability
- Designed for broadband operation (HF to 600 MHz)

Class-F graphic credit Electronic-Tutorials.ws

PA voltage:

- In an LDMOS amplifier, up to the maximum ratings for a device, there's a tradeoff between PA Voltage / Power Output and Linearity
- In general, the higher the PA voltage, the higher the output power and/or linearity. The lower the PA voltage, the better the efficiency.
- Current high performance LDMOS devices are designed for 50V operation


Power supply design:

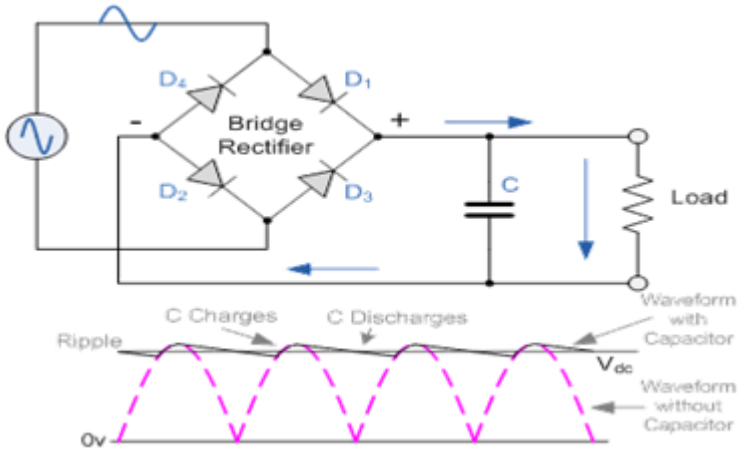
Rather than use an off-the-shelf power supply designed for computer clean rooms, the Elenos Group has designed its own power supplies, optimizing:

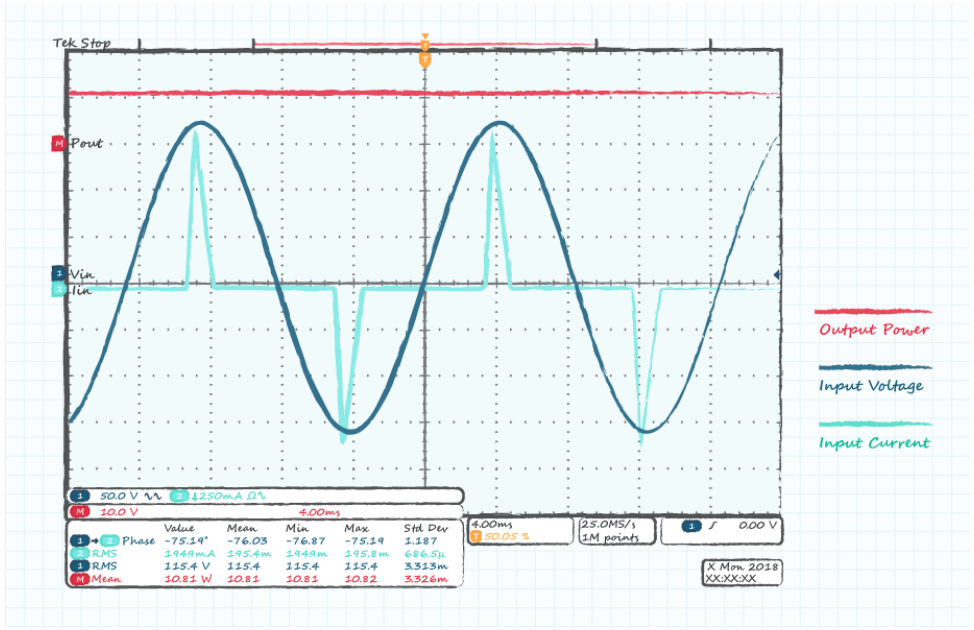
- ✓ AC to DC efficiency
- ✓ Reliability under real-world transmitter room conditions
- ✓ Communications for fast control and monitoring
- ✓ Field serviceability

The importance of Power Factor in power supply design

The relationship between power supply input voltage and input current is critical in the design of high efficiency power supplies.

The ratio of apparent power and useful power is the PF, where
1 is ideal.





Combiner and output filter design:

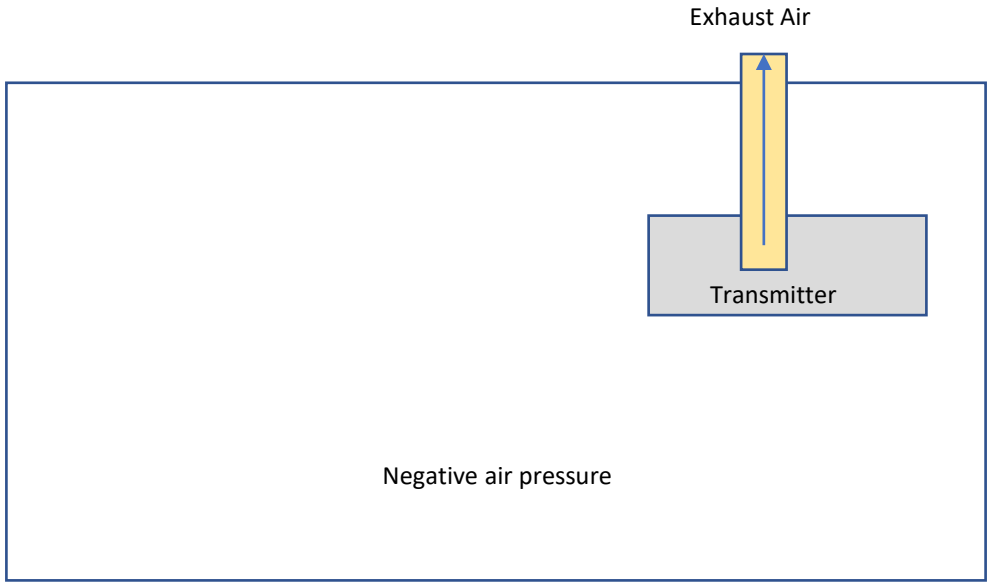
When maximizing efficiencies, even small losses count!

- ✓ The Elenos Group uses the latest in computer modeling techniques to assure the lowest possible losses.
- ✓ Stripline technology is used for precise assembly and reduced variability.

Cooling system design for efficiency

The choice of cooling systems can often make a substantial difference in overall energy usage:

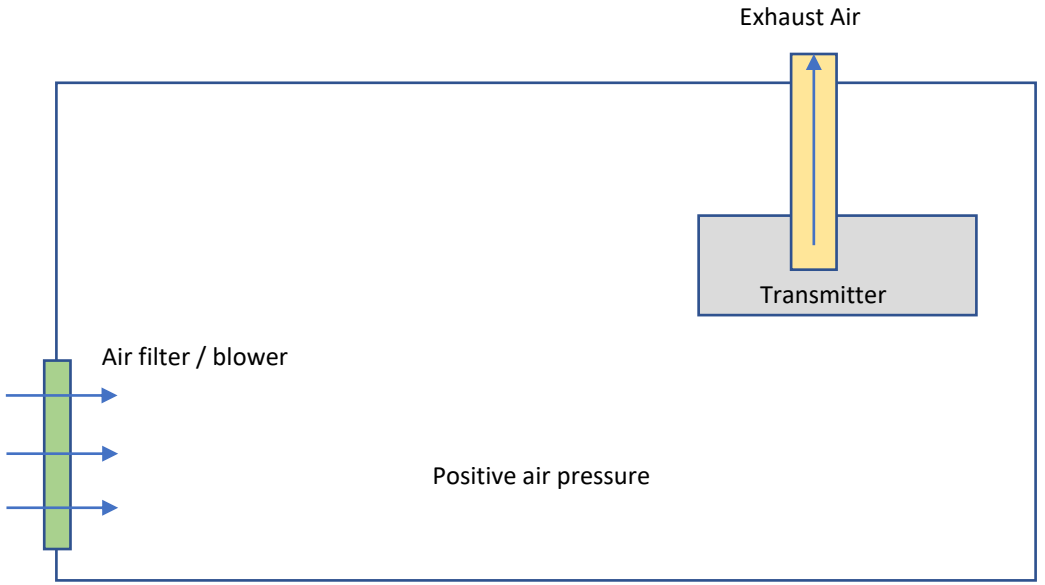
- Transmitter efficiency is better for liquid cooled transmitters, but the external pumps and heat exchanger must be considered.
- In evaluating air cooled units the differential cost in cooling the room should be considered. AC costs can add 20% to the energy consumption. Variable speed blowers can reduce energy use as well.
- In some sites, with moderate outside ambient temperatures, a positive pressure cooling system might make sense.



Cooling system design for efficiency

The choice of cooling systems can often make a substantial difference in overall energy usage:

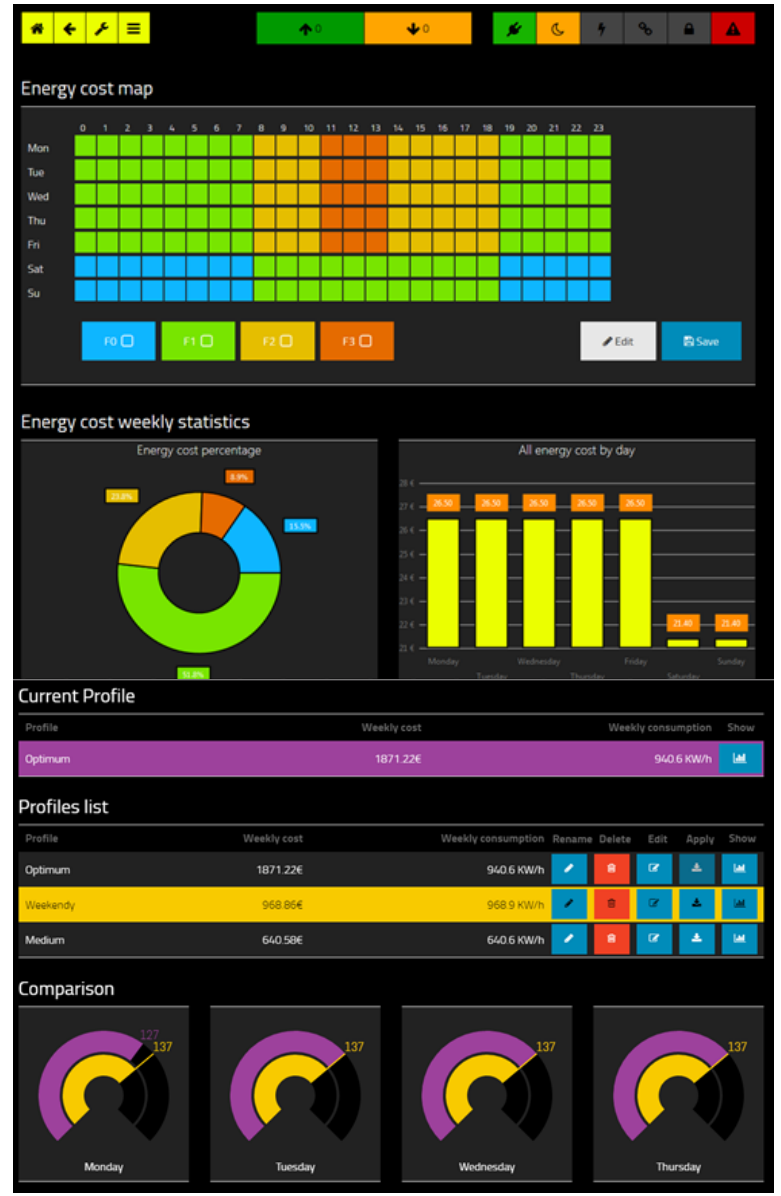
- Transmitter efficiency is better for liquid cooled transmitters, but the external pumps and heat exchanger must be considered.
- In evaluating air cooled units the differential cost in cooling the room should be considered. AC costs can add 20% to the energy consumption. Variable speed blowers can reduce energy use as well.
- In some sites, with moderate outside ambient temperatures, a positive pressure cooling system might make sense.



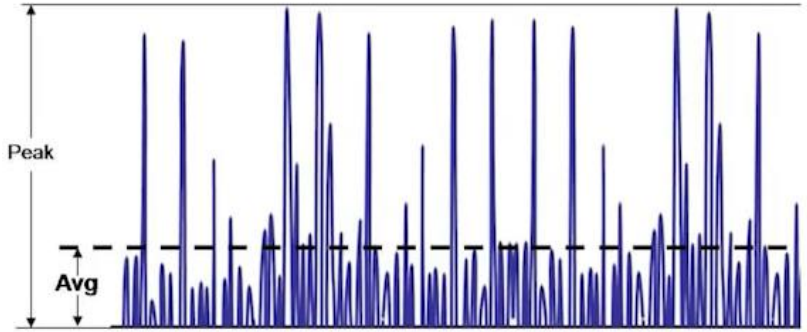
Smart control of power by daypart

Many Elenos Group transmitters include a unique power level scheduler:

- Allows the automatic reduction of power at specific hours and days
- Based on listenership coverage needs and variable power company daypart costs
- Calculates savings automatically allowing intelligent business decisions to be made
- Amount of power reduction may be limited by government regulations



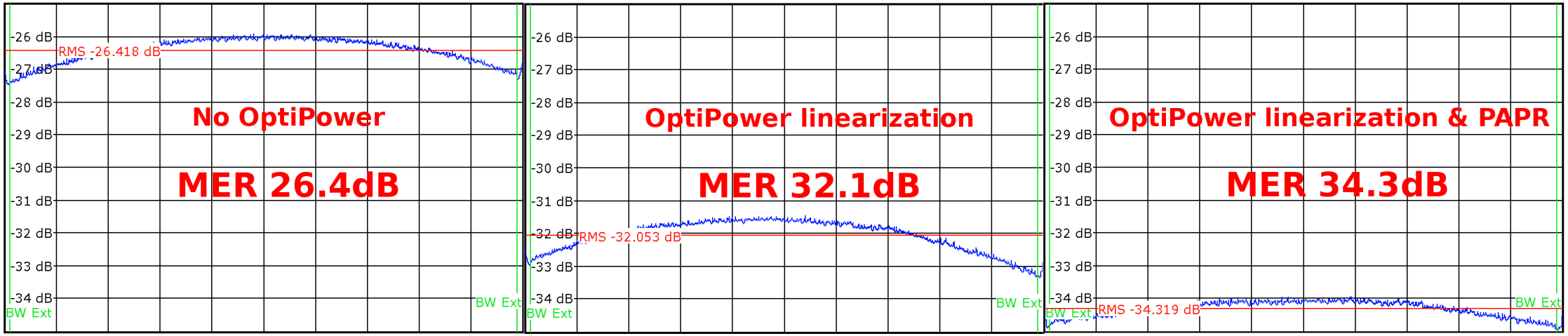
Digital tradeoffs: MER and PAPR versus power consumption



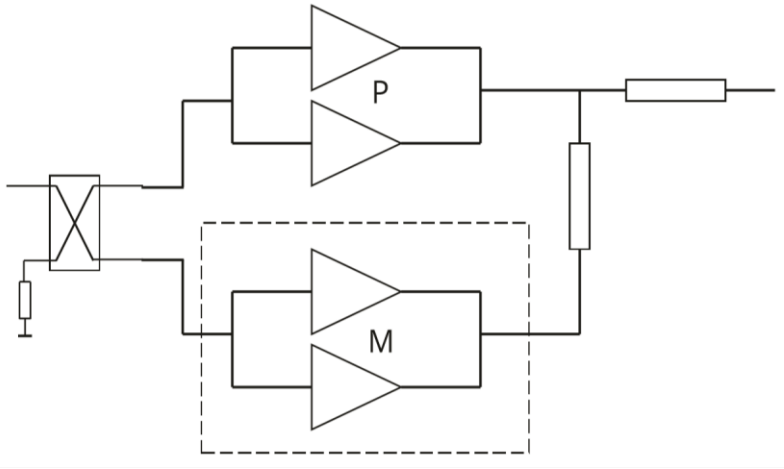
- In digital FM or TV, there are many simultaneous carriers which are constantly adding and subtracting, resulting in a signal which has a significant amplitude component.
- The ratio of the Peak to the Average Power is known as PAPR.
- Since the transmitter must be able to handle the peak signal without distortion, the amplifier average power is reduced, and the efficiency is reduced.
- MER or Mean Error Ratio is the distortion that results from any non-linearity.
- If the drive to the PA is increased to the point that the peaks are clipped, the PAPR decreases, the MER decreases, and the efficiency improves.
- There are algorithms that dynamically calculate the instantaneous peaks and strategically reduce their amplitude to increase average power and efficiency while maximizing MER.

Digital: Adaptive Precorrection

- To maximize MER, while lowering the PAPR, and raising the power output and efficiency, manufacturers have employed adaptive pre-correction in which a sample of the output is analyzed, and precorrection curves are automatically generated and applied in the modulation process.
- This process is computationally intensive, but can yield dramatic results, improving the MER, efficiency, and/or power output of the amplifier.

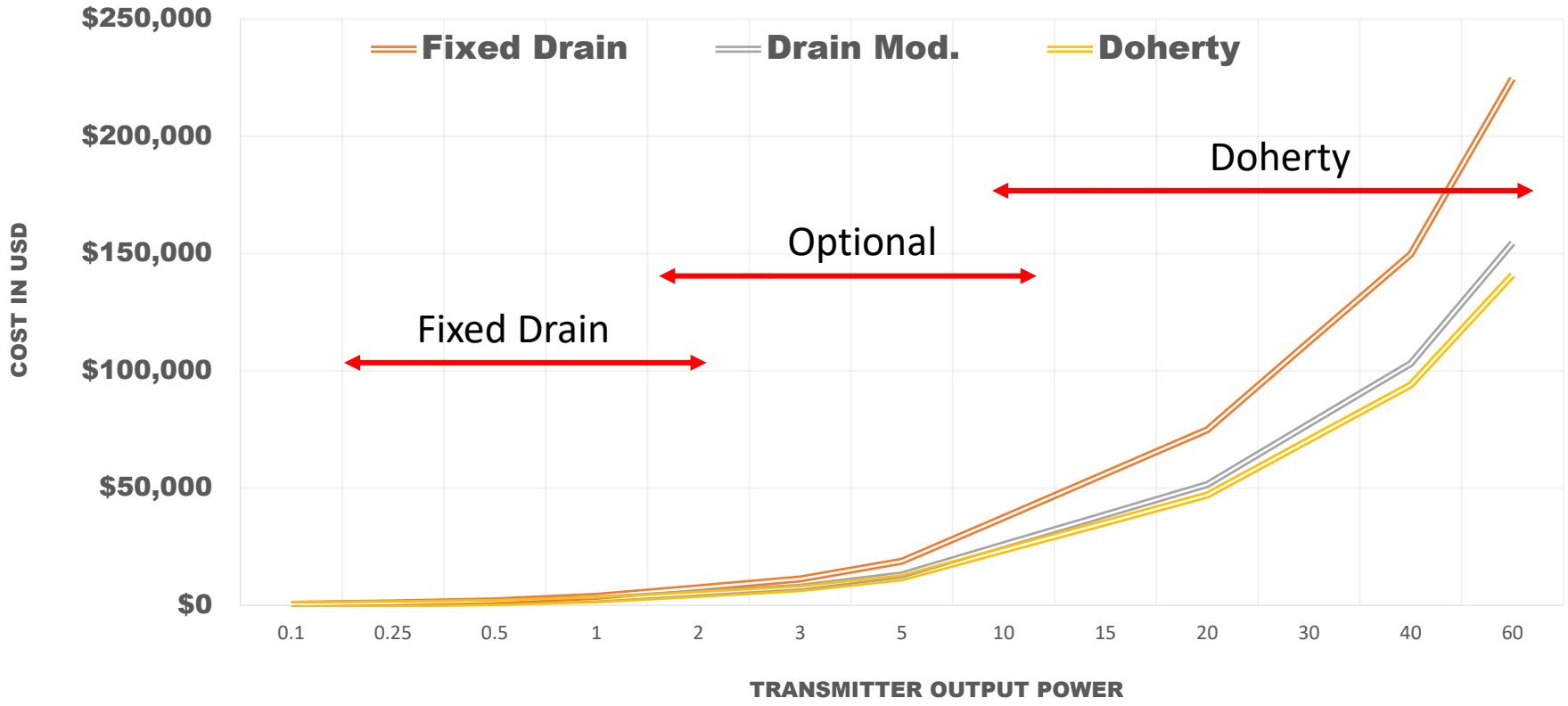


Digital: Doherty amplification



- The Doherty amplifier, patented by William Doherty nearly 80 years ago, uses two PA's, termed "main" and "peak".
- The main amplifier operates in normal class AB, while the peak amplifier operates in class C, and is only active during the peaks.
- This approach maximizes efficiency, because the main amplifier is operated at a lower PAPR, as the peaks are handled by the extra amplifier.
- The design of the splitting and combining circuits are critical to maintain performance over a wide bandwidth.
- This is the current standard for digital television today, and is responsible for virtually doubling the efficiency of DTV transmitters.

Operating cost analysis



Based on 24 hours 365 days per year operation, $0.1 KW/H electricity cost.

Let's see how it can save you money – and help save the environment

Energy Savings Calculator			
Chuck Kelly - July 7, 2020			
ckelly@elenosgroup.com			
Input information:			
Country	UNITED STATES		US Dollar
Cost per kW/H		0.12	USD per hour
Hours of operation per day		24	Hours per day
Transmitter Power		10	Kilowatts
Efficiency of old transmitter		52%	Estimated AC to RF
Efficiency of new transmitter		72%	Estimated AC to RF
Calculated kW/h per year old		168,577	Kilowatt hours per year
Calculated kW/h per year new		121,750	Kilowatt hours per year
Electrical cost per year old		20,229	USD
Electrical cost per year new		14,610	USD
Annual Estimated Savings		5,619	USD
Carbon Footprint Savings		41.8	Tons of CO_2 per year

Summary

- Recent advances in solid state devices, amplifier and power supply technologies are all improving both FM and TV transmitter efficiencies.
- Digital transmitters have experienced the most dramatic recent improvements.
- These improvements can result not only in a reduced carbon footprint, but in substantial savings in operating costs which can help improve the ROI of the new transmitter.
- As energy costs are predicted to rise in the coming years, it's a valuable exercise to analyze your energy consumption in all areas in the station, from replacing incandescent bulbs with LED, to using a higher efficiency HVAC system, and your transmitter system.

Time for your questions!

Thank you

elenos group
DEDICATED RELIABLE CREATIVE

We know how valuable your time is, and we are honored that you chose to spend time with us. Please check out our upcoming webinar schedule at: www.elenosgroup.com/webinar/ For further information, contact:

International - Luca Bergonzini:	l.bergonzini@elenosgroup.com
Asia/Pacific - Frank Massa:	f.massa@elenos.com
Africa - Giulio Bussolari:	g.bussolari@elenos.com
Brazil - Mattia Carrà:	m.carra@elenosgroup.com
Europe - Mirko Panzica:	m.panzica@elenosgroup.com
LATAM Elenos FM Radio - Ernesto Azuaje:	e.azuaje@elenosgroup.com
LATAM BE FM Radio - Daniel Bizet:	dbizet@bdcast.com
LATAM TV - Ricardo Jimenez:	r.jimenez@elenosgroup.com
Middle East – Marco Mosca:	m.mosca@elenos.com
Russia, Eastern Europe and Central Asia – Oxana Klim:	o.klim@elenos.com
USA Central and Canada - Joe Myers:	jmyers@bdcast.com
USA East USA - Frank Grundstein:	fgrundstein@bdcast.com
USA West / Marti - John Lackness:	jlackness@bdcast.com
USA AudioVault - Gene McAneny:	gmcaneny@bdcast.com
International BE Direct - Bob Demuth:	bdemuth@bdcast.com

ELENOS

Elenos
Headquarters:

44028 Via Amendola 9 - Poggio Renatico FE Italy Telephone +39 0532 82 99 65 –
Fax +39 0532 82 91 77

www.elenos.com - info@elenos.com

BE

Broadcast Electronics
Headquarters:

4100 North 24th Street Quincy, IL 62305
Phone: (217)-224-9600
Fax: (217)-224-9607

www.bdcast.com - bdcast@bdcast.com

itelco

Itelco
Headquarters:

05018 Via Dell'Innovazione 2 - Orvieto TR
Italy Telephone +39 0763 96 03 00 –
Fax +39 0763 34 18 10

www.itelco.tv/ - info@itelco-electrosys.com

PRO TELEVISION

ProTelevision
Headquarters:

Valhøjs Allé 176, 1st floor - DK-2610 Rødovre - Denmark Telephone: +45 44700000

www.protelevision.com - sales@ProTelevision.com