

## TECH NOTE

# Maximizing Transmitter Efficiency:

*A Study of the Ecreso FM 5kW*



POWERFUL  
PERFORMANCE



POWERFUL  
CONTROL



POWERFUL  
SAVINGS

## Maximizing Transmitter Efficiency: A Study of the Ecreso FM 5kW

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*Efficiency is one of the most important criterion when choosing a new FM Transmitter for your network. Given that high efficiency means you can broadcast at the same power level while reducing your utility power consumption and heat dissipation, this choice has a direct technical and financial impact on your station.*

*This document seeks to outline some important considerations that you should bear in mind when evaluating transmitters on the basis of efficiency and then proceeds to examine in detail the efficiency offered by the new ECRESO FM 5kW Transmitter. With efficiency of up to 76%, the ECRESO FM 5kW has been designed to provide the highest efficiency and greatly reduced operating costs.*

### Transmitter Efficiency Considerations

When enquiring about the efficiency of a transmitter we usually expect a simple answer (Output Power divided by Power Consumption); a single percentage figure, hopefully a high one. However, the reality is usually very different and the true efficiency experienced on site can vary greatly depending on the multiple factors involved.

A first consideration is the accuracy of the equipment. There is a wide range of external equipment available to measure power consumption and RF output and these vary greatly in terms of both cost and accuracy. It is worth noting that, when measuring the RF output power of a transmitter, the accuracy will never be better than  $\pm 3\%$  (this is the ideal level that is usually unachievable). With highly accurate and calibrated tools or using internal measurements of the ECRESO FM 5kW itself, it will be possible to achieve  $\pm 5\%$  accuracy and, with a standard wattmeter with plugs, somewhere between  $\pm 5$  and  $\pm 10\%$ . If we apply these accuracy figures to the output power of a 5kW transmitter, it translates to potential errors from  $\pm 250\text{W}$  up to  $\pm 500\text{W}$ . We could measure a transmitter as being 70% efficient when, in reality it was only 66% (and vice versa!). Therefore, when comparing the efficiency of various transmitters, it is recommended to perform the measurements in the same conditions and using the same tools to ensure a level playing field.

A second consideration ought to be the conditions; internal, external, and environmental; in which the transmitter will be operating. Given that typically, the efficiency of components will be reduced as temperature increases, a site that experiences high average temperatures or is located at a high altitude will require more energy than others. With a higher temperature and lower air pressure, more cooling will be required and the site will require more electricity.

The configuration of the transmitter in terms of RF output power and frequency etc, will also impact on the operation of many internal elements such as powers supplies and MOSFETs as well as external equipment like cavity filters, multiplexers and the antenna system. The performance of all these elements combined will impact directly on the actual efficiency of the system.

Additionally, it is not just the performance of each individual component or module within a high power FM transmitter that matters but also the interaction between them. In addition to the efficiency of the power supplies & amplifiers themselves, it is also important to consider how they interconnect (are there cable losses?) and how they interact (amplifier-coupler matching).

Finally, efficiency considerations are not limited to the transmitter. The complete program distribution chain should be considered and efficiency calculated including devices before the transmitter (receiver, sound processor, RDS encoder, stereo encoder, monitoring etc) and after the transmitter (rigid lines, cavity filter, combiner, feeder, antenna system).

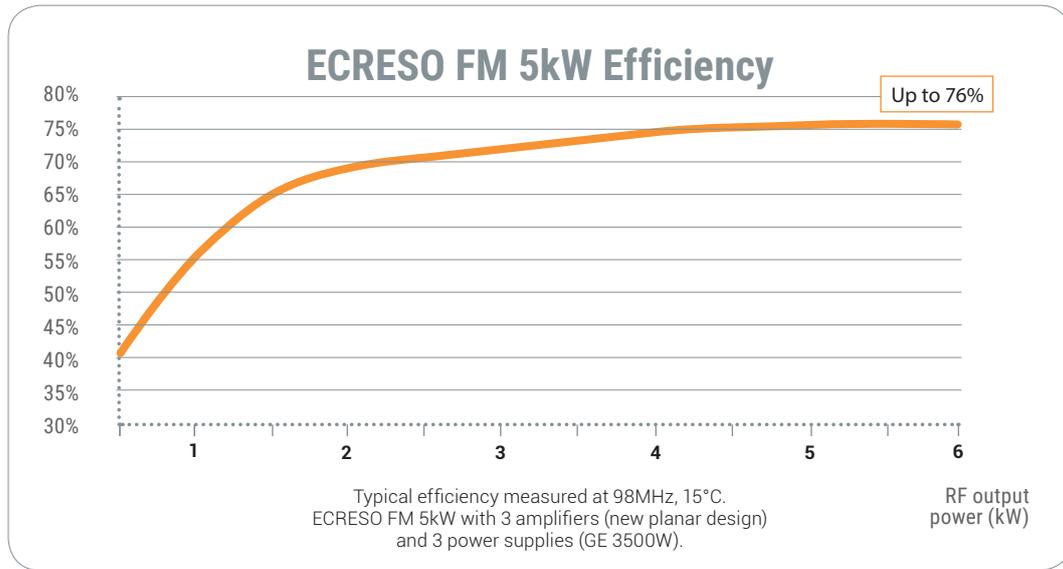
In the following sections, we will examine the efficiency at each main stage of the ECRESO FM 5kW and understand the effects of different configurations, versions or conditions, on the overall efficiency.

## Maximizing Transmitter Efficiency: A Study of the Egreso FM 5kW

### ECRESO FM 5kW Transmitter Efficiency

#### Higher efficiency at each stage

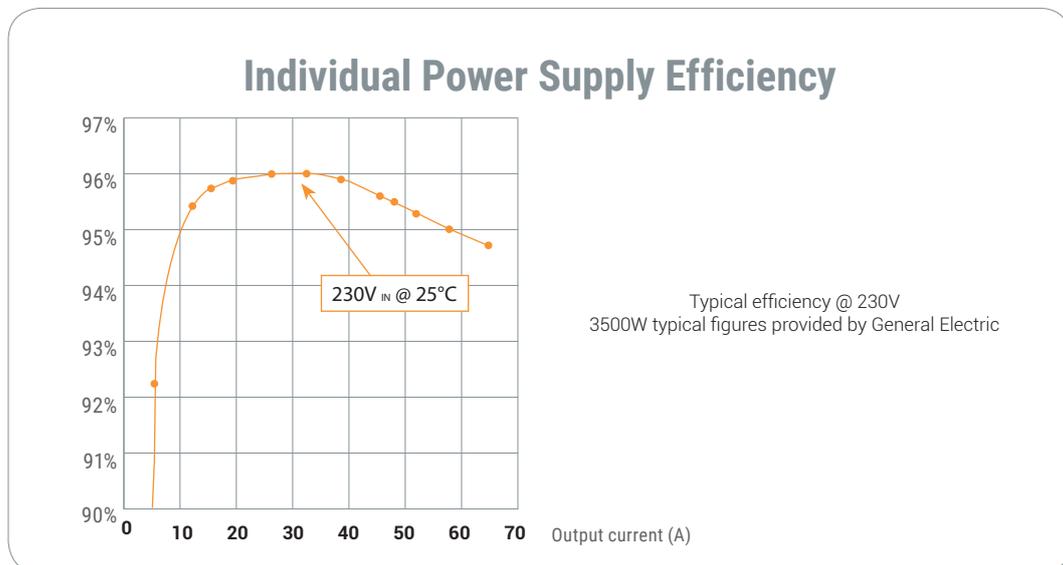
The ECRESO FM 5kW Transmitter includes several redundant stages and, depending on the configuration, version, or environment, the overall efficiency will vary. The following chart shows the typical efficiency of the ECRESO FM 5kW. As program input equipment and cooling stages are specific to each installation, these are dealt with separately later in this document. However, all main parts of the ECRESO FM 5kW are included in the following figures: power supplies, power amplifiers, passive coupler, RF filter and control unit as well as any losses between internal connectors and cabling.



The ECRESO FM 5kW maintains a consistent efficiency (<5% variation) on the entire FM band (87.5MHz to 108MHz). To better understand the values outlined in the graph above, let's examine each of the main modules in turn.

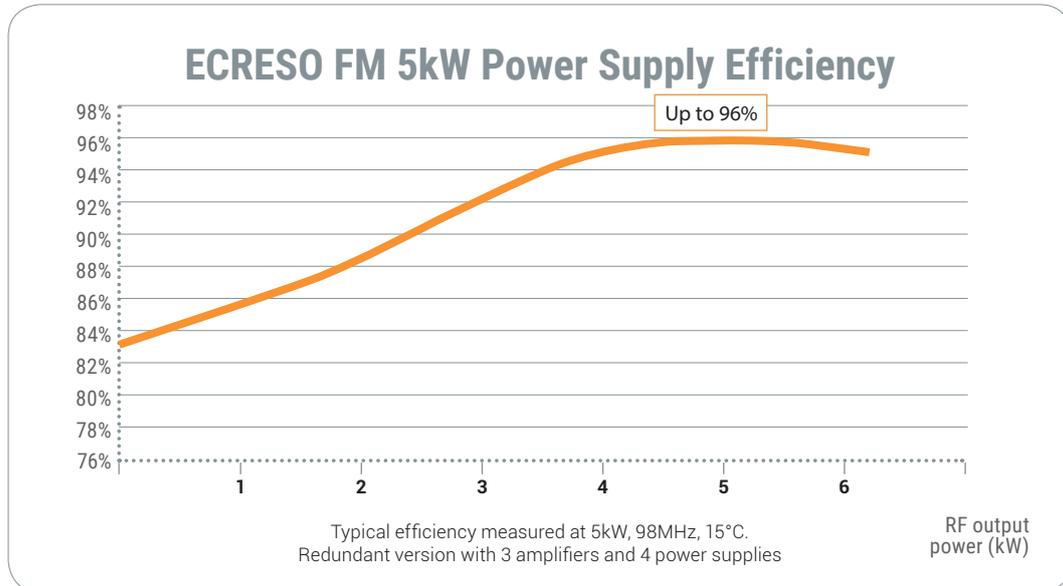
#### Power Supplies

In order to achieve the best efficiency shown above, the power supply stage is critical. The ECRESO FM 5kW has been designed with the best choice of power supply providing up to 96% efficiency. They are also hot-swappable, power factor controlled, and provide extensive measurements displayed on the ECRESO FM 5kW Web interface.



## Maximizing Transmitter Efficiency: A Study of the Egreso FM 5kW

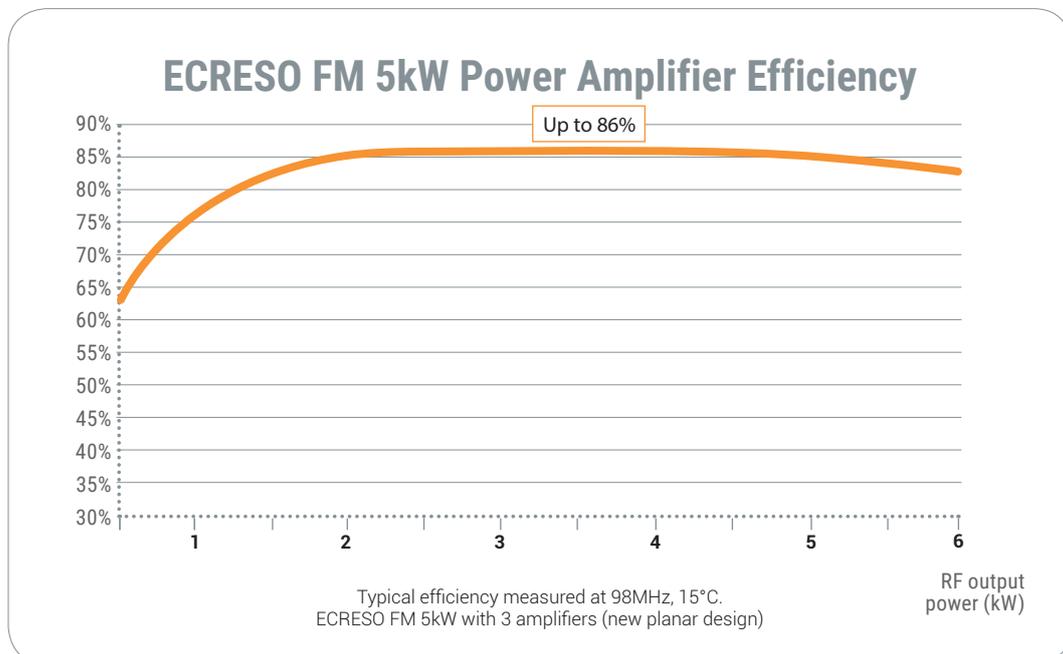
For maximum redundancy, the ECRESO FM 5kW uses from 3 to 4 x 3500W, active sharing power supplies. The efficiency of the complete power supply stage depends on several criteria: the number of redundant power supplies, power load (frequency and output power), current, voltage, temperature and more. The following chart indicates the typical efficiency of the complete power supply stage (4 PSUs in this example) when used within the ECRESO FM 5kW.



### Power Amplifiers

Power amplifiers play a key role with regards the global efficiency of the transmitter. While MOSFETs and power supplies may render their highest efficiency levels in differing operating conditions, the design of the Egreso FM 5kW has been carefully engineered to find the highest possible combined efficiency.

The ECRESO FM 5kW includes 3 x 2200W hot swappable powers amplifiers, 6 MOSFETs in total, with a new planar design and the highest efficiency available on the market; up to 86%. This high efficiency is maintained even when the output power is reduced, as shown in the following chart.



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### Cabling and Coupling Losses

The ECRESO FM 5kW Transmitter offers the best combined efficiency across the power supplies and MOSFET but the interconnection of these modules also matters. Two main connections must be considered:

- Power distribution between the power supplies and the amplifiers. The ECRESO FM 5kW uses high quality cables with Radlok connectors. These ensure a high level of reliability and reduce power losses.
- RF power lines. The ECRESO FM 5kW provides direct connections (no RF cabling) between the hot swappable amplifiers and the passive 3 way coupler, thus reducing the possibility of losses.

### Program Input Equipment

The efficiency calculation should also take any associated program input equipment into consideration. Those devices are often overlooked because of their typically low consumption but, when several are required and stacked in the PIE rack, it will have an impact on the global efficiency. Program input equipment usually includes devices such as routers, audio codecs, satellite receivers, sound processors, FM receivers, stereo encoders, RDS encoders and backup playlist systems.

The standard version of the ECRESO FM 5kW includes a 100W exciter with very high efficiency (for that power level) of up to 57%. The overall power consumption of this exciter is about 150W. With the redundant version of the ECRESO FM 5kW, a backup exciter (RF OFF) must also be added which brings the total consumption of the exciter stage to 175W.

The ECRESO FM 5kW's exciters also benefit from several built-in features which eliminate the need for external equipment. This saves up to 235W (2.6% efficiency) of power as well as saving on cabling and space. When external devices must be used, most of them can still be integrated into the ECRESO FM 5kW slide rack. The table below details some common types of program input equipment that can be integrated into the ECRESO FM 5kW and their consumption.

EQUIPMENT	ECRESO FM 5kW Integration
FM Exciter 100W (150W)	+150W (-1.5% efficiency)
Backup FM Exciter (25W)	+23W (-0.3% efficiency)
APT IP Codec (45W)	+45W (-0.5% efficiency)
RDS Encoder (45W)	+0W (built-in)
Sound processor (60W)	+0W (built-in)
Audio backup (60W)	+0W (built-in)
Stereo encoder (45W)	+0W (built-in)
Silence detect / audio switch (25W)	+0W (built-in)

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### Cooling System

The ECRESO FM 5kW can be delivered in several air cooling configurations. Each different configuration results in different power consumption requirements, as described below.

#### *With External Cooling*

The ECRESO FM 5kW can use an external cooling system at the site which will push and extract the air from the transmitter. This approach has some benefits in term of maintenance and cost reduction, especially when the cooling system feeds several transmitters at the site. It also makes sense when an air cooling system already exists at the site.

The “external cooling” version of the ECRESO FM 5kW has been designed especially for this type of application. It does not include internal fans or their associated power supplies as the cooling is managed independently at the site. The recommended air flow required to operate the transmitter in this configuration is 927m<sup>3</sup>/h. Based on this figure and your transmitter site conditions, you can evaluate roughly the consumption of your own system.

#### *With Internal Cooling*

Using internal cooling is the most common approach and can improve efficiency because the ECRESO FM 5kW will automatically adjust its fan speeds depending on the temperature of the amplifiers as well as the overall transmitter status. Running the transmitter with an ambient temperature in the nominal range (5 to 45°C), the internal cooling system will consume between 100W and 300W (consumption to be used for efficiency calculation). Note that this figure may be higher than stated when there is a failure within the system that would require an automatic increase of the air flow.

In the redundant version, the ECRESO FM 5kW includes dual inlet fans, dual outlet fans and dual power supplies. You may think that this would have a significant impact on the efficiency but the system has been designed to adjust the fan speed to deliver the cooling actually needed, so the efficiency is not affected as the additional consumption is negligible. In other words, in the redundant version, the transmitter will monitor the temperature of the power amplifiers and automatically adjust the speed of all fans to provide the same level of air flow required. With dual fans, each fan will run at half the speed of a single fan system so the power consumption is the same but the benefits of redundancy are much greater.

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### Benefits

#### *Cost Savings*

Higher efficiency means you can broadcast at the same power level while reducing your utility power consumption and heat dissipation. As a result, significant savings can be achieved on your electricity bills and cooling systems.

#### *Longer Lifespan*

With higher efficiency, components are operating at a lower temperature, so there are fewer failures and the transmitter has a longer lifespan. Maintenance and repair costs are also reduced.

### Summary

Throughout this document, we have established that, when sourcing a high power FM transmitter; there are significant benefits to be gained from ensuring that the transmitter selected offers the highest possible efficiency.

When comparing the stated efficiencies of various transmitters, care should be taken to ensure that a like-for-like comparison is made as different manufacturers may use different methods of measurement and even minor variations in the result can have a major impact on the power consumption and, therefore costs.

Lastly, we have demonstrated how efficiency has been a key consideration at every stage in the intelligent design of the ECRESO FM 5kW Transmitter. This has resulted in a highly professional FM Transmitter system that offers exceptional performance with minimized operating costs.

**Contact us for further information about our high power range and redundancy solutions.**



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