

170W Ka Wideband Space Traveling-Wave Tube (TWT)

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ABSTRACT

In satellite systems, on-board repeaters shall deliver always more RF power. Specifically in Ka-Band applications like HDTV or the Internet, the satellite Capacity must be increased to improve the Data Rate Transfer. To satisfy this demand, Thales Electron Devices (TED) has qualified a conduction cooled TWT (TH4816C) and a radiation cooled TWT (TH4816R). These TWTs deliver more than 170W in narrow Ka band ($\leq 1.5\text{GHz}$) and more than 160W in wide band (1.5 to 2.9GHz). This paper describes the main technical characteristics of the TH4816 family design and the main performances (industrial batch) over 2.9GHz in Ka band.

Introduction

To address the global trend of RF power increase in Ka frequency band, TED has extended the current TH3990 capabilities from 130W up to 170W with the TH4816. Benefiting from the TH3990 Space unrivalled experience with high reliability proven in orbit, the TH4816 development phase up to qualification covered :

- Space qualification at sub-assembly level (including some margin tests)
- Engineering Models manufacturing and tests
- EQM qualification, margin tests demonstration
- Industrial pre-series of a few FM TWTs

Several tens of units have already been ordered and are currently on the standard production cycle.

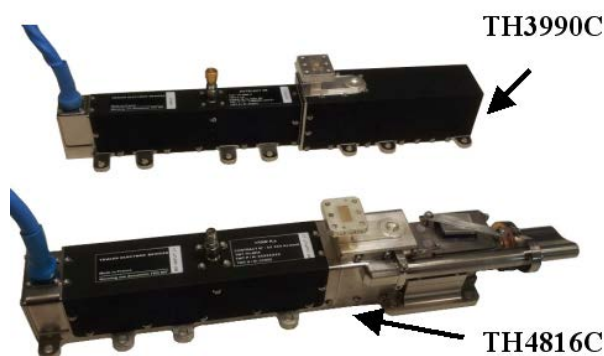


Figure 1 : TH4816C (170W) & TH3990C (130W)

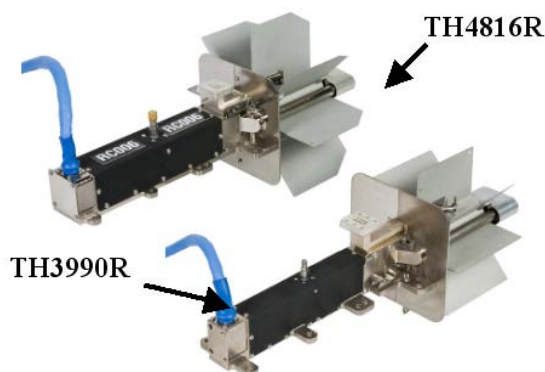


Figure 2 : TH4816R (170W) & TH3990R (130W)

Design and Typical Figures

The main difference between the conduction and radiation cooled version is located on the housing only.

Gun

Compared to TH3990, the gun size was increased to withstand 10kV high voltage class. More than 15 years of life time is reached with high reliability. The optics dimensions were designed to optimize the beam parameters at this Higher Power Level.

Line

The external dimensions of the delay line are the same as the TH3990. A periodic permanent magnet stack was optimized to minimize the helix current.

Instantaneous frequency bandwidth goes from 1GHz to 2.9GHz with saturated RF gain higher than 50 dB. The RF output design is the same as the TH3990. It enables to keep the technological heritage and manufacturing process.

Collector

A four-stage depressed collector allows to reach an averaged efficiency of 63% over 2.9GHz.

Housing

Mechanical interface between TH4816 footprint and payload is the same as for TH3990.

Measurements

Table 1 summarizes the typical main performances of TH4816 over 2.9GHz compared to the TH3990 (over 1GHz).

Performances @ 25°C	TH3990	TH4816
Useful Bandwidth	2.5 GHz	2.9GHz
Pout min	120 W	160W
Vk	6600 V	7300
Ik	75 mA	93mA
Vwehnelt	-5 V	-5 V
Vion barrier	160 V	160 V
Vc1	3600 V	4000
Vc2	3000 V	3200
Vc3	2250 V	2400 V
Vc4	750 V	900 V
Pin @ saturation	-5 dBm	-2 dBm
Direct efficiency	26%	25%
Averaged Global efficiency	63%	63%
Phase shift	47°	48°
Mass (CC/RC)	680 g/ 950g	890 g / 1200 g

Table 1 : Typical characteristics for TH3990 over 1GHz and TH4816 over 2.9GHz

Conclusion

After qualification, TED completed industrial Pre-series tubes for both cooling types, the main results being presented over wideband. Measurements demonstrated high reproducibility, associated with high level of RF and electrical performances over the whole Ka band from 17.3 to 21.2GHz. Electrical/Thermal and Mechanical margins already validated on the TH3990 design, and demonstrated in-orbit, are kept in the TH4816 version to secure full mission compatibility.