

Confronto tra le principali caratteristiche dei ricevitori TCI 753/759 e R&S ESME

Schede tecniche

Principali caratteristiche TCI 753 (1/2)

Model 753 Specifications Overview

General Receiver Specifications

Frequency Range	20 MHz to 8.5 GHz (VLF option to 9 kHz, SHF/EHF options to 40 GHz)
Instantaneous Bandwidth	10/80 MHz
Noise Figure	12 dB typical: 2 MHz to 30 MHz 8 dB typical: 20 MHz to 3 GHz 12 dB typical: 3 GHz to 6 GHz 20 dB typical: 6 GHz to 8.5 GHz
Input 3rd Order Intercept Point (out-of-band)	15 dBm typical in urban mode 30 dBm typical in congested mode
Phase Noise	-110 dBc/Hz @ 10 kHz offset, typical
Tuning Speed	1 millisecond typical
Gain Control	>120 dB
Tuning Resolution	1 Hz
Basic Demodulation	AM, FM, PM, CW, SSB (LSB, USB, ISB), Pulse, I/Q
A/D Resolution	16 Bits
Client Digital Interface	1 GbE (10GbE optional, for rack mount only)
Timing Reference (1PPS)	GPS, GLONASS, Galileo, SBAS Galileo
Time Stamp Accuracy	50 nsec typical
Integrated Processor	Two System-on-Modules (SOMs) with multi-core processors, 8 GB RAM, 2 TB type M.2 SSD

Signal Analysis & Recording Options

Number of DDC Channels	8-CH
DDC Bandwidths	>50 Bandwidths between 78 Hz and 2 MHz
I/Q Resolution	16-bits
I/Q Streaming via LAN	8-CH Narrow Band Streaming

Signal Analysis, Recognition, Classification and Decoding Options

Signal Detector & Designer	SDAD
Automatic Modulation Classifier	AMC
Narrowband Decoding Unit	NDU
Vector Signal Analysis	VSA
Demodulation	Additional, optional demodulators are available, such as: AM, FM, SSB (LSB, USB, ISB), DSB, PSK2, PSK4, PSK8, OQPSK, FSK2, FSK4, MSK, QAM, OFDM, MFSK (HF only)

Principali caratteristiche TCI 753 (2/2)

Physical & Environmental Characteristics	
Processor Size / Weight	Outdoor IP67: 20" (508 mm) wide x 16" (406 mm) deep x 13" (330 mm) high / 24 lbs. (10.9 kg). Dimensions and weight include sunshield Rack Mount: 19" (483 mm) wide x 18" (457 mm) deep x 1.75" (44.5 mm) high (1U) / 15.4 lbs. (7kg)
IP Protection Level	Outdoor Unit: IP67 Rack Mount: Not applicable
Input Voltage	Outdoor IP67: 12 -16 VDC (110 -240 VAC 50/60Hz to DC power supply provided) Rack Mount: 110– 240 VAC (50/60 Hz)
Power	50 W typical
Operating temperature	-30 to +55° C
Relative humidity	Outdoor IP67: 0 to 100% (condensing) Rack Mount: 5 to 95% (non-condensing)
Network Interfaces	Gigabit Ethernet (modems optional)
Measurements and Functions	
BIST	Built-In-Self-Test
ITU Measurements (Bandwidth, Frequency, Modulation, Field Strength, Direction Finding in multi-unit configuration)	Bandwidth Measurement per ITU-R SM.443(-4) Frequency Measurement per ITU-R SM.377 Modulation Measurement per ITU-R SM.328 Field Strength Measurement per ITU-R SM.378(-7)
I/Q output time stamped for TDOA	TDOA Measurement
Spectrum Occupancy (f1-f2 and channel) including spectrum display	Spectrum Occupancy per ITU R SM.1880(-2)

Principali caratteristiche R&S ESME

- ► High-performance ITU-compliant spectrum monitoring from 8 kHz to 40 GHz (base unit: 20 MHz to 6 GHz)
- ► Accurate ITU-compliant AOA direction finding from 300 kHz to 8.2 GHz (base unit: 20 MHz to 6 GHz) and support of TDOA and hybrid radiolocation over the entire frequency range
- ► One of the most linear receivers on the market, optimized for measuring weak signals in dense spectrum environments with up to 80 MHz realtime bandwidth (base unit: 20 MHz)
- ► Fast panorama scanning with scan speeds up to 110 GHz/s
- ► Cutting-edge signal measurement capabilities, including polychrome spectrum display
- ► Simultaneous frequency domain and time domain analysis up to 20 MHz
- ► Dedicated 80 MHz wideband I/Q streaming and recording concept with real-time replay and processing
- ► Integrated hardware-accelerated multichannel digital signal processing supports massive narrowband channelization, automatic detection and classification in combination with external R&S®CA120 signal analysis software

Alcuni punti specifici di confronto

Figura di rumore

ESME

Noise figure

8 kHz to 32 MHz ⁴	normal mode	
	400 kHz $\leq f \leq$ 30 MHz	\leq 15 dB, typ. 12 dB
	$f >$ 30 MHz	\leq 18 dB, typ. 16 dB
20 MHz to 6 GHz ⁴	low noise mode	
	20 MHz $\leq f \leq$ 3600 MHz	\leq 10 dB (X44 V/UHF1), typ. 7 dB \leq 12 dB (X43 V/UHF2, X42 V/UHF3), typ. 9 dB
	3600 MHz $< f \leq$ 6000 MHz	\leq 12 dB (X44 V/UHF1), typ. 7 dB \leq 14 dB (X43 V/UHF2, X42 V/UHF3), typ. 9 dB
2.2 GHz to 18 GHz	low noise mode	
	2.2 GHz $\leq f <$ 10 GHz	\leq 9 dB
	10 GHz $\leq f \leq$ 18 GHz	\leq 11 dB

TCI 753

Noise Figure

12 dB typical: 2 MHz to 30 MHz
8 dB typical: 20 MHz to 3 GHz
12 dB typical: 3 GHz to 6 GHz
20 dB typical: 6 GHz to 8.5 GHz

Alcuni punti specifici di confronto

Rumore di fase

R&S ESME

Oscillator phase noise	$8 \text{ kHz} \leq f \leq 32 \text{ MHz}$	$\leq -130 \text{ dBc (1 Hz) at 1 kHz offset (meas.)}$
	$20 \text{ MHz} \leq f \leq 650 \text{ MHz}$	$\leq -115 \text{ dBc (1 Hz) at 10 kHz offset (meas.)}$
	$650 \text{ MHz} < f \leq 6 \text{ GHz}$	$\leq -103 \text{ dBc (1 Hz) at 10 kHz offset (meas.)}$
	$2.2 \text{ GHz} \leq f \leq 18 \text{ GHz}$	$\leq -94 \text{ dBc (1 Hz) at 10 kHz offset (meas.)}$

TCI 753

Phase Noise	-110 dBc/Hz @ 10 kHz offset, typical
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Alcuni punti specifici di confronto

Punto di Intercetta del 3° ordine /

ESME

Third-order intercept point (TOI) ³		
8 kHz to 32 MHz	low distortion mode (150 kHz spacing, at -6 dBm)	
	1 MHz ≤ f ≤ 32 MHz	≥ 30 dBm, typ. 35 dBm
20 MHz to 6000 MHz	low distortion mode (2.8 MHz spacing, at -10 dBm)	
	20 MHz ≤ f ≤ 100 MHz	≥ 15 dBm (X44 V/UHF1), typ. 23 dBm ≥ 17 dBm (X43 V/UHF2, X42 V/UHF3), typ. 23 dBm
	100 MHz < f < 650 MHz	≥ 20 dBm (X44 V/UHF1), typ. 27 dBm ≥ 20 dBm (X43 V/UHF2, X42 V/UHF3), typ. 27 dBm
	650 MHz < f ≤ 6000 MHz	≥ 23 dBm (X44 V/UHF1), typ. 27 dBm ≥ 23 dBm (X43 V/UHF2, X42 V/UHF3), typ. 27 dBm
2.2 GHz to 18 GHz	low distortion mode (2.8 MHz spacing, at -10 dBm)	
	2.2 GHz ≤ f ≤ 18 GHz	≥ 12 dBm

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Input 3rd Order Intercept Point (out-of-band)	15 dBm typical in urban mode 30 dBm typical in congested mode
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Alcuni punti specifici di confronto

Risoluzione conv. A/D

ESME

Resolution	20 MHz bandwidth	16 bit
	> 20 MHz bandwidth (multifunction board)	12 bit

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A/D Resolution	16 Bits
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Alcuni punti specifici di confronto

Precisione Time Stamp ESME/753

Timestamps

Timestamp accuracy ^{13, 14} over frequency	with external reference frequency, with regard to externally supplied PPS	
	20 MHz to 50 MHz	< ±100 ns
	50 MHz to 6000 MHz	< ±100 ns, ±50 ns (typ.)
	HF option	
	1 MHz to 5 MHz	< ±200 ns
Timestamp accuracy ^{13, 14, 15, 16} , GNSS aided	5 MHz to 32 MHz	< ±100 ns, ±50 ns (typ.)
	standard deviation for 2000 measurements	< 10 ns
		when equipped with synthesizer 1166.3170 with product index ≥ 08.00
		< 50 ns with other synthesizers

Time Stamp Accuracy

50 nsec typical

Sensibilità in funzione della frequenza con il Direction Finder R&S DDF255

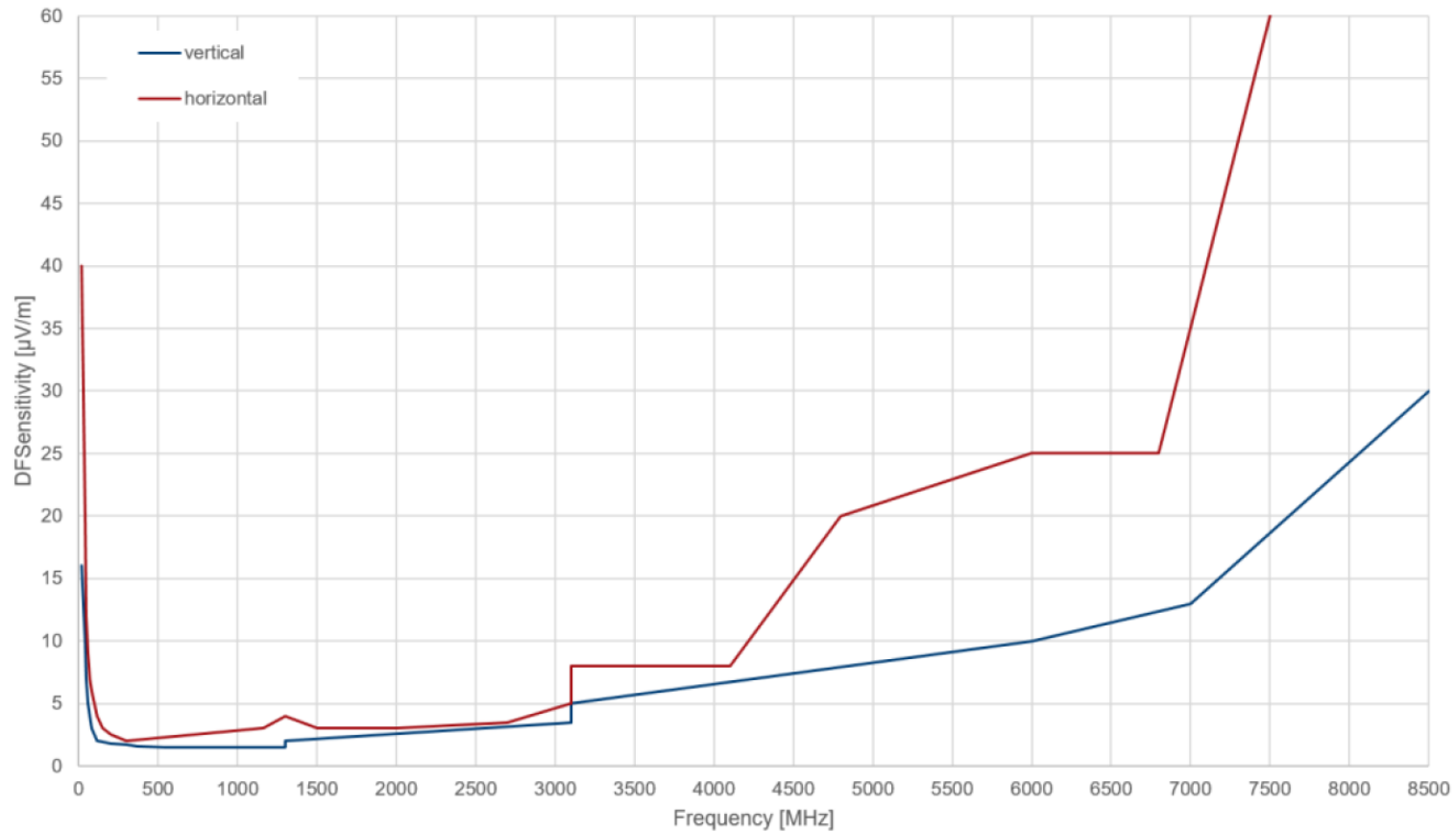


Fig. 1: DF sensitivity with R&S®DDF255 (low-noise mode, 5° RMS, 5 s, 1.33 kHz) (meas.)

Sensibilità in funzione della frequenza con il TCI 647D

DF System Sensitivity**

Frequency (MHz)	Field Strength (dBμV/m)		Frequency (MHz)	Field Strength (dBμV/m)	
	Vertical Polarization	Horizontal Polarization		Vertical Polarization	
20	-12	-1	4000	-5	
100	-21	-8	5000	-4	
500	-21	-5	6000	-3	
1000	-15	-1	7000	+1	
2000	-10	+1	8000	+3	
3000	-7	+3	8500	+4	

**System sensitivity is the field strength required to provide specified DF accuracy at 10 dB SNR when the Model 647D antenna is installed in a typical TCI 700 Series SMS system, including antenna noise figure, coax cable losses, and receiver noise figure; referenced to 1 Hz bandwidth and with 1-second DF averaging. Local installation conditions may affect sensitivity and DF accuracy.

Confronto tra Sensibilità in funzione della frequenza dei due sistemi DF, dopo la conversione alla stessa unità di misura e condizioni

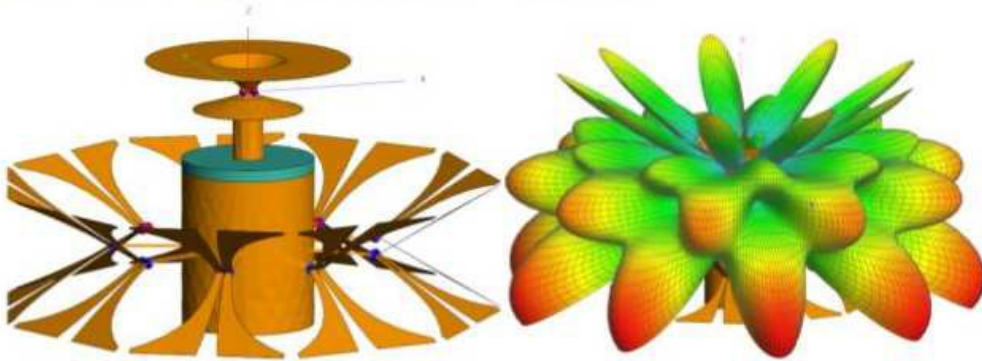
f [MHz]	vertical polarization [dB μ V/m]		horizontal polarization [dB μ V/m]	
	TCI DF + model 647D	R&S ESME + ADD597	TCI DF + model 647D	R&S ESME + ADD597
20	-12	-4	-1	4
100	-21	-22	-8	-16
500	-21	-25	-5	-21
1000	-15	-25	-1	-19
2000	-10	-20	1	-18,5
3000	-7	-18	3	-15
4000	-5	-12		
5000	-4	-10		
6000	-3	-8		
7000	1	-6		
8000	3	-1		
8500	4	1		

Original R&S measurements are made using different RMS (3°) and measurement bandwidth (1.33kHz) settings, for a better comparison the corresponding values for 2°RMS (+3dB) and bandwidth of 1Hz are calculated (-31,25dB)

Precisione della misure del livello di campo

4.5.4.1 Reflections from DF antenna elements

The nine 'fan' antenna elements used for direction-finding are close to the bicone monitoring antenna and large compared to the wavelength in UHF/SHF. Hence, the antenna pattern of the monitoring antenna is affected and no more circular. This can be simulated, as shown below.



Simulated structure of TCI model 647D (left), 3D antenna pattern of bicone antenna at 900 MHz (right)

4.5.4.2 Reflections from side-arm lightning protection

Reflections caused by the side-arm lightning protection affect the horizontal antenna pattern and result in level and field strength measurement errors, as described below.

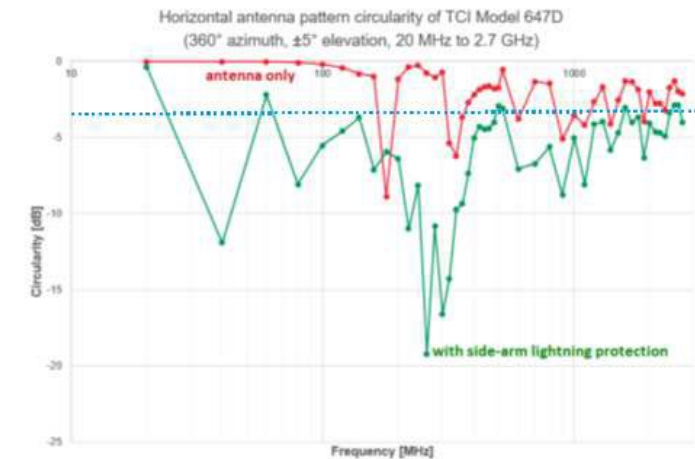
4.5.4.3 Antenna pattern circularity not ITU-compliant

The ITU Handbook on Spectrum Monitoring, edition 2011 recommends that the deviation of the horizontal radiation diagram of the measuring antenna from a non-directional diagram should not exceed 3 dB.

In many cases, the DF antenna is used for monitoring, too. In such systems, the DF antenna becomes the measuring antenna and must be in line with above-mentioned requirement.

TCI DF antennas do not fulfill this requirement due to reflections from the 'fan' antenna elements and from the side-arm lightning protection, as described above. Simulations show that the deviation by far exceeds 3 dB, see diagram for details.

This is not in line with the ITU Handbook on Spectrum Monitoring, edition 2011, chapter 4.4.3.2.2.



Simulated horizontal antenna pattern of TCI model 647D DF antenna

R&S DF antennas feature integrated lightning protection that does not impair the antenna pattern circularity and is in line with the ITU Handbook on Spectrum Monitoring.

4.5.4.4 Field strength measurement accuracy not ITU-compliant

Due to the irregularities in the horizontal antenna pattern described above, field strength measurements with TCI DF antennas are unreliable and often wrong, especially in fixed monitoring systems requiring side-arm lightning protection.

R&S DF antennas feature integrated lightning protection that does not impair the field strength measurement and is in line with the ITU Handbook on Spectrum Monitoring.