rakon

Introduction

O-RAN concepts are revolutionising the RAN industry, opening up the eco system for everyone to participate outside the telecom infrastructure vendor community. Such a multi-vendor open approach encourages innovation, healthy competition, and brings the best cost versus benefit outcome for all players and eventually the end user.

Traditional base station architectures have been centred around Base Band Units (BBUs) and Remote Radio Heads or Units (RRHs/RRUs). New 5G network topologies are evolving. Significant changes are occurring in radio technology, as well as in connectivity between base band processing and radio functions. The functions are restructured as Central Units (CU), Distribution Units (DU), Access Units (AU) and RRUs. The functions are split across various network levels depending on the focussed application. Applications include enhanced Mobile Broadband (eMBB) ultra-Reliable Low Latency Communications (uRLLC) and massive Machine Type Communications (mMTC).

Synchronisation in radio heads

Frequency accuracy of 50 ppb and Time Alignment Error (TAE) as low as 130 ns are fundamental requirements for air interfaces to support advanced 5G applications. The new DU/RRU connectivity necessitates packet-based synchronisation techniques between the BBU and the RRU. The inherent low packet rate and packet delay variation require the clock recovering servo systems to have low bandwidth filtering and support from a compensated oscillator.

High frequency stability solutions

Rakon's 5G RRH solutions include Hybrid TCXOs and Ultra Stable TCXOs with industry leading performance. Hybrid TCXOs provide very low temperature sensitivity and therefore, low measuring rate frequency variation with temperature (0.5 ppb/°C). This feature helps to improve the dynamic performance of low bandwidth servo systems. Rakon's Neptune™ – a 50 ppb temperature stability analogue TCXO – is the first of its kind. It is available in industry standard footprints and consumes lower power than comparable solutions. The harsh environmental performances demanded by outdoor radios include higher operational temperature ranges (up to 105 °C) and low *g*-sensitivity. Rakon TCXOs are also featured with low temperature sensitivity (10 ppb/°C) to address superior servo performances under quick temperature changes.

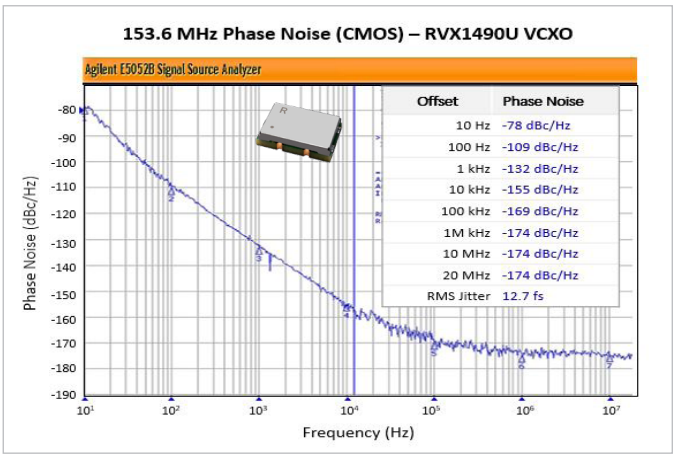



Oscillators	Ultra Stable TCXO	Hybrid TCXO	ASIC OCXO	XMEMS® OCXO
Frequency (MHz)	1.25 to 100	10 to 50	10 to 50	10 to 50
Footprint (mm)	7x5, 5x3	7x5	14x9, 9x7, 7x5	14x9
Stability* (ppb)	±100	±20	±5	±3
Ageing (ppb/day)	< ±10	< ±3	< ±1	< ±0.5
Slope (ppb/°C)	20	2	0.5	0.1
Holdover (hours, 1.5 µs)	–	–	0.5 – 2	6 – 8
Power (steady state)	0.035 W	0.4 W	0.4 W	0.4 W

* Temperature range: -40 to 85°C. 95 °C and 105°C options available on request.

Ultra low phase noise solutions

5G spectral frequencies range from <1 to 100 GHz. Initial trials are focusing on frequencies typically below 6 GHz and are dependent on the frequency spectrum available. Such frequencies are demanding low phase noise reference clocks to support higher data rates based on higher QAM rates. Reference clock phase noise should be minimised to reduce contribution to Error Vector Magnitude (EVM) masks, enabling higher QAM rates and therefore increased bandwidth. The traditional VCXOs used to filter close-in phase noise in RF synthesizers, generate high phase noise when multiplied to higher orders. For instance, a Rakon Ultra Low Noise VCXO RVX1490U offers ultra low noise jitter (~12 fs over a 12 kHz – 20 MHz bandwidth) and floor noise below -174 dBc/Hz. and in particular for mmWave applications.

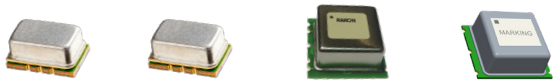


Issue: V5, Oct 2023

Front-haul synchronisation

synchronisation in CD/DU equipment is more advanced than the traditional BBU synchronisation techniques. With the development of packet-based technologies, multiple reference options like GNSS, IEEE 1588, SyncE, and other external references, are available for synchronisation. Rakon's reference clock oscillators support the various servo technologies with medium to long-term holdover (1 – 24 hours) capabilities.

According to ITU-T standards, which define the required synchronisation performance of the transport equipment, the Telecom Boundary Clocks of type C and D will have a time error as low as 5 to 15 ns. To support such low error across the operating temperature range, stable reference clocks are required. Rakon has a comprehensive range of OCXO technologies, including conventional, hybrid, and ultra-reliable ASIC based OCXOs. Across the range, our products achieve temperature stabilities of 1 – 50 ppb and ageing performance of 0.2 – 1 ppb/day are achievable.



OCXO	ROM1490E	ROM1490X	ROX2522S3	ROX2522S2
Temp. stability*	±5 ppb	±3 ppb	1 ppb pk=pk	0.5 ppb pk-pk
Life time accuracy	±2.5 ppm	±2.5 ppm	±2 ppm	±0.3 ppm
Ageing	< ±1 ppb/day	< ±0.5 ppb/day	< ±0.3 ppb/day	< 0.2 ppb/day
Slope	0.5 ppb/°C	0.1 ppb/°C	0.2 ppb/°C	0.01 ppb/°C
Holdover (1.5 µs)	2 hours	7 hours	8 hours	12 hours
Power (steady state)	0.4 W	0.4 W	0.5 W	1.5 W
Reliability (FIT)	150	150	200	200

* Temperature range: -40 to 85°C. All products are hermetically sealed.

DUs and telecom grandmaster clocks

Long holdover solutions

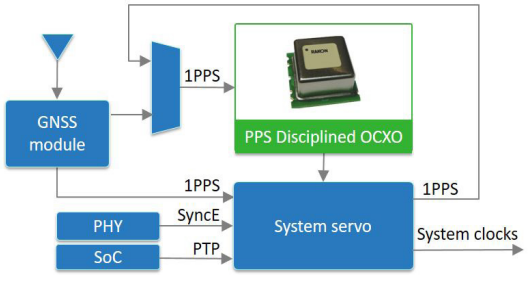
Traditionally, the core of the network has incorporated high-end long holdover telecom grandmaster clocks supported by atomic reference clocks. With the synchronisation hierarchy flattening, telecom grandmaster clocks are now being positioned towards the edge of the network. With this change there are now 'edge', 'mini', and 'integrated' grandmasters offering GNSS connectivity, backed up by PTP/SyncE with limited holdover capabilities.

Rakon's PPS Disciplined OCXOs offer long holdover (1.5 µs over 24 – 48 hours) to support such telecom grandmaster clock designs. When working in conjunction with an industry standard GNSS module, the PPS Disciplined OCXO uses a 1PPS input to compensate for ageing and therefore guaranteeing the phase error on defined temperature excursions.

PPS Disciplined OCXO	ROD2522S2	ROD3827T2	ROD5242T1
Temp. stability*	0.5 ppb pk-pk	0.5 ppb pk-pk	0.1 ppb pk-pk
Life time accuracy	±1 ppm	±1 ppm	±1 ppm
Ageing	< 0.2 ppb/day	< 0.2 ppb/day	< 0.1 ppb/day
Sensitivity	0.2 ppb/°C	0.2 ppb/°C	0.1 ppb/°C
Phase holdover (1.5 µs)	24 hours	24 hours	48 hours
Power (steady state)	1.5 W	2.0 W	2.5 W

* Temperature range: -40 to 85°C. Up to 95°C options available on request.

Application diagram



For more details please email: sales@rakon.com

Issue: V5, Oct 2023