One Oscillator – Many Packet Clocks



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Enabling Connectivity

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Clocks

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< 3GPP

- □ 50ppb (Observed in 1ms), $\pm 1.5\mu S$
- □ 16ppb (Network Interface)
- □ 50ppb (Observed in 1ms), $\pm X \mu S$ (Absolute)
- \Box ± Y µS (Relative)

ITU-T SG15 Q13



Impact of Oscillator on Clocks

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< Servo Model



< Free Run

Pull – in Range

< Wander Generation

- MTIE and TDEV requirements
 - Over the operating temperature ranges

< Holdover

Temperature & Ageing effects

< Jitter

Depending on the servo architecture

Oscillator Types





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Node & Equipment Clocks – Traditional

SI No	Clock	Туре	Free Run	Loop filter	FvT	Ageing	Oscillator Technology
1	G.812	Туре І	NA	3mHz	2ppb	0.2ppb/day	OCXO
		Type III	4.6ppm	1mHz	10ppb	1ppb/day	OCXO
2	G.813	Option 1	4.6ppm	1-10Hz	2000ppb	10ppb/day	ТСХО
		Option 2	4.6ppm	0.1Hz	300ppb	40ppb/day	ТСХО

Certain Clocks

SI No	Clock	Туре	Free Run	Loop filter	FvT	Ageing	Oscillator Technology
1	G.8262	Option 1	4.6ppm	1-10Hz	2000ppb	10ppb/day	ТСХО
		Option 2	4.6ppm	0.1Hz	300ppb	40ppb/day	ТСХО

Content Clocks (TBD)

SI No	Clock	Туре	Free Run	Loop filter	FvT	Ageing	Oscillator Technology
1	G.8262.1	Type I?	?	?	?	?	?



Packet Equipment Clock – Master – Frequency

SI No	Clock	Туре	Free Run	Loop filter	FvT	Ageing	Oscillator Technology
1	G.8266	[ITU-T G.812] Type I	NA	3mHz	2ppb	0.2ppb/day	OCXO
		[ITU-T G.812] Type III	4.6ppm	1mHz	10ppb	1ppb/day	OCXO

A Packet Equipment Clock – Frequency

SI No	Clock	Туре	Free Run	Loop filter	FvT	Ageing	Oscillator Technology
1	G.8263	PEC-F	4.6ppm	1mHz	10ppb	1ppb	OCXO

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Full On-Path support Clocks

SI No	Clock	Туре	Free Run	Loop filter	FvT	Ageing	Oscillator Technology
1	T-BC	Option 1	4.6ppm	1-10Hz(SyncE)	2000ppb	10ppb/day	ТСХО
2	T-TSC	Option 1	4.6ppm	1-10Hz(SyncE)	2000ppb	10ppb/day	ТСХО

Transparent Clocks

SI No	Clock	Туре	Free Run	Loop filter	FvT	Ageing	Oscillator Technology
1	T-TC		?	?	?	?	OCXO

Assisted & Partial Support Clocks

SI No	Clock	Туре	Free Run	Loop filter	FvT	Ageing	Oscillator Technology
1	Т-ВС-Р, Т-ВС-А	?	4.6ppm	1mHz	10ppb	1ppb	OCXO
1	T-TSC-P, T-TSC-A	?	4.6ppm	1mHz	10ppb	1ppb	OCXO

CONFIDENTIAL INFORMATION

Multitude of network deployment scenarios



Clocks in Transport Networks

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SG Front-Haul transport proposal - Reference : China Mobile



End-to-end time accuracy for 5G: +/- 130ns

Control Lower Node Error

- Potential new frame structure
- Location Based Services, eMBMS
- □ CA, CoMP & elClC

K Higher Clock Performance

- Application requirements
- Implementation scenarios

< Oscillator focus

- Medium stability
- Medium Holdover

Ideal candidate is a 1ppb temperature stable, <0.2ppb/day ageing device</p>

Olocks in Mobile Networks

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Base Station – Traditional

- Frequency Sync from Backhaul
- GNSS
- Oscillator holdover

SG Base station

- Multiple options
- GNSS Assisted PTP
- SyncE

< Oscillator focus

- Medium stability
- Medium Holdover





Ideal candidate is a 1ppb temperature stable, 0.2ppb/day ageing device

Olocks in Edge/Mini Grand Masters

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Content of Edge/Mini Grand Masters

Clocks with medium term holdover



< Oscillator focus

- Medium stability
- Medium Holdover

 Ideal candidate is a 1ppb temperature stable, 0.2ppb/day ageing device

Overall Performance

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- Temperature Stability
- < Ageing
- Frequency Slope
- **Size**
- < Power
- < Overall Stability
- Phase Holdover

Stratum 3E Clock

- 10ppb
- < 1ppb/day
- < 1ppb/Deg C
- < 25x22, 14x9
- < 0.75W 1.5W
- 4.6ppm
- < 1.5uS/~1 hour

Stratum 3E+ Clock

- < 1ppb
- 0.2ppb/day
- < 0.1ppb/ Deg C
- **<** 24x22
- **<** 0.75W 1.5W
- < 2ppm
- < 1.5uS/~8hours



Advancement in oscillators

Compensation Techniques

- Temperature
- Ageing
- Power supply variation
- Hysteresis Management

Rule of thumb

"The secret of high performing compensated oscillator is a good oscillator"



MTIE for G.8263



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Physical Layer Clocks
 Packet Clocks - F
 Packet Clocks – Time
 Base Station Clocks

- **G**.812
 - Type I
 - Type III
- **G**.813
 - Option 1
 - Option 2
- **G**.8262
 - Option 1
 - Option 2

- **G**.8263
- **G**.8266
 - G.812 Type I
 - G.812 Type III

- **G.8273.2**
 - T-BC (A/B/C)
 - T-TSC (A/B/C)
- **G.8273.3**
- **G.8273.4**
 - T-BC-P
 - T-TSC-P
 - T-BC-A
 - T-TSC-A

- **5**0ppb
- **Δ** ± 1.5μS
- Holdover
 - ± 1.5μS for 8-12 hours

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Thank you