

Crystals and Oscillators for Next Generation Timing Solutions

INTRODUCTION

This Application Note provides a list of oscillators for use with Microchips timing solutions—1588 & SyncE Network Synchronizer, jitter attenuators, and clock generators—based on industry standards as listed in AN4287.

The oscillators in this document support both physical layer and protocol layer synchronization PLLs. Each of these applications has unique needs and various classes, from low bandwidth with demanding holdover to higher bandwidth and more relaxed holdover, depending on the use case or standard that needs to be met.

As changes in system hardware, software, or configuration may affect the overall performance of the oscillator in any customer system, designers should see Application Note AN4362 “Optimizing the OX-601/OX-502 Performance” for best layout practices on any OCXO.

AN4287 “Oscillator Groups and Classifications” provides a list of classifications based on industry standards and defines the performance needed by the oscillator. AN4287, combined with AN3467, replace the former documents ZLAN-442 and ZLAN-68 respectively.

STANDARDS

AN4287 is a summary of industry standards and related PTP profiles with the associated Group Name for the oscillators used in physical and protocol layer synchronization. Some classifications represent the superset requirements of closely related clocks (where an individual clock requirement may be less than that listed for the superset).

TABLE 1: PHYSICAL AND PROTOCOL STANDARDS REQUIREMENTS BY GROUP

Input Synchronization Layer	Output Synchronization Layer	Clock	Standard	Related PTP Profile	Appx. XO Technology	Current Group Name	Older Group Name	Older Group Name
Physical	Physical	PRC/PRS	G.811	G.8265.1	Rb or higher	zP1	zP1	—
Physical	Physical	ePRS	G.811.1	G.8265.1	Rb or higher	zP2	zP2	—
Physical	Physical	SSU-A	G.812	G.8265.1	Rb or higher	zR1	zA1	A1
Physical	Physical	Stratum 2	G.812	G.8265.1	Rb or higher	zR2	zA3	—
Physical	Physical	Stratum 3E	G.812	G.8265.1	OCXO	zO1	zA2	A2
Physical	Physical	Stratum 3	G.813	—	Mini OCXO	zM1	zC2	C2
Physical	Physical	eEEC_1	G.8262.1	G.8275.1	TCXO	zT1	zD3	—
Physical	Physical	EEC_1	G.8262	G.8275.1	TCXO	zT2	zD2	D2
Physical	Physical	Line Card	None	—	XO	zX1	zE2	E
Physical	Physical/Protocol	PRTC-A	G.8272	G.8275.1, G.8275.2	Rb or higher	zG1	zG1	—
Physical	Physical/Protocol	PRTC-B	G.8272	G.8275.1, G.8275.2	Rb or higher	zG2	zG1	—
Physical	Physical/Protocol	ePRTC-A	G.8272.1	G.8275.1, G.8275.2	Rb or higher	zG3	zG3	—
Physical	Physical/Protocol	ePRTC-B	G.8272.1	G.8275.1, G.8275.2	Rb or higher	zG4	zG4	—
Physical	Protocol	T-GM_1PPS	G.8273.1	G.8275.1, G.8275.2	OCXO+	zO2	zC3	—

TABLE 1: PHYSICAL AND PROTOCOL STANDARDS REQUIREMENTS BY GROUP

Input Synchronization Layer	Output Synchronization Layer	Clock	Standard	Related PTP Profile	Appx. XO Technology	Current Group Name	Older Group Name	Older Group Name
Physical	Protocol	T_GM_RS	G.8273.1	G.8275.1, G.8275.2	OCXO	zO3	zC4	—
Protocol	Physical/Protocol	T-BC-P, T-TSC-P	G.8273.4	G.8275.2	OCXO	zO4	zA5	B
Protocol	Physical/Protocol	T-BC-A, T-TSC-A	G.8273.4	G.8275.2	OCXO	zO5	zA4	B
Protocol	Physical	PEC-S	G.8263	G.8265.1	OCXO	zO6	zA3	A2
Protocol	Physical	PEC_G8261	G.8261	Annex J.3	OCXO	zO7	zB	B
Protocol	Physical/Protocol	T-BC, T-TSC (wo/SyncE)	G.8273.2	G.8275.1	Mini OCXO	zM2	zC1	C1
Protocol	Physical/Protocol	T-BC, T-TSC (w/SyncE)	G.8273.2	G.8275.1	TCXO	zT3	zD1	D2
Protocol	Physical	Line Card	None	—	XO	zX2	zE1	—

PHYSICAL LAYER SYNCHRONIZATION

The oscillator requirements for physical layer synchronization are well defined in a variety of ITU-T and ATIS specifications. Below are the recommended oscillators for each Standard and Profile.

Group zP1, PRC/PRS, G.811, G8265.1 and zP2, ePRC, G.811.1, G.8265.1

- Group zP1. Used in freerun for compliance with E1-based ITU-T G.811 (PRC) requirements as well as T1-based ANSI T1.101 Stratum1 (PRS).
- Group zP2. Used in freerun for compliance with E1-based (ePRC).

TABLE 2: CESIUM SOURCES FOR zP1 AND zP2

Part Number	Frequency	Supply	Operating Temp.	Holdover @25°C; Temperature Change during Holdover ±2°C
PRS4500	5 MHz, 10 MHz	–48VDC	0°C to 50°C	100 ns per 14 days
PRS4400	5 MHz, 10 MHz	–48VDC	–5°C to 50°C	100 ns per 14 days
5071A	5 MHz and/or 10 MHz or 0.1 MHz & 1 MHz	120VAC 240VAC	0°C to 55°C	100 ns per 14 days

Group zR1 and zR2

- Group zR1. Used with a 3 mHz filter bandwidth for compliance with E1-based ITU-T G.812 Type I (SSU-A) requirements.
- Group zR2. Used with 1 mHz filter bandwidth for compliance with T1-based Stratum 2 & ITU-T G.812 Type II specifications.

Note these oscillators may NOT be compliant with 3 mHz filter bandwidth E1-based ITU-T G.812 Type I (SSU-A) requirements.

TABLE 3: CESIUM SOURCES FOR zP1 AND zP2

Part Number	Frequency	Supply	Operating Temp.	Size	Holdover @25°C; Temperature Change during Holdover ±2°C
MAC-SA53	10.000 MHz	4.5VDC to 32VDC	–40°C to 75°C	50.8 mm x 50.8 mm	100 ns per 14 days
MAC-SA55	10.000 MHz	4.5VDC to 32VDC	–40°C to 75°C	50.8 mm x 50.8 mm	100 ns per 14 days

Group zR1

Used with 3 MHz filter bandwidth for compliance with E1-based ITU-T G.812 Type I (SSU) requirements.

TABLE 4: OSCILLATORS FOR GROUP zR1

Part Number	Frequency	Supply	Temp. Stability (pk-pk)	Size	Jitter (@ 12 kHz to 5 MHz) max. typ.	
OX-221-0105-20M000	20.000 MHz	3.3V	2 ppb	22 mm x 25 mm	1.5 ps	0.7 ps
OX-221-9133-24M576	24.576 MHz	3.3V	2 ppb	22 mm x 25 mm	0.6 ps	0.35 ps
Part Number	Holdover @25°C; 5°C increase @ T0 slope 0.5°/K				—	—
OX-221-0105-20M000	3.8 µs over 8hrs	1.5 µs over 4hrs	0.27 µs over 1hr	0.13 µs over 30 min.	—	—
OX-221-9133-24M576	3.8 µs over 8hrs	1.5 µs over 4hrs	0.27 µs over 1hr	0	—	—

Group zO1, G812, G8265.1

Used with 1 MHz filter bandwidth for compliance with T1-based Stratum 3E & ITU-T G.812 Type III specifications. Note these oscillators may not be compliant with group zR2, used for 3 MHz filter bandwidth E1-based ITU-T G.812 Type I (SSU) requirements.

TABLE 5: OSCILLATORS FOR GROUP zO1

Part Number	Frequency	Supply	Temp. Stability (pk-pk)	Size	Jitter (@ 12 kHz to 5 MHz) max. typ.	
OX-221-9100-20M000	20 MHz	3.3V	10 ppb	22 mm x 25 mm	0.5 ps	0.3 ps
OX-221-9101-24M576	24.576 MHz	3.3V	10 ppb	22 mm x 25 mm	0.5 ps	0.3 ps
OX-221-9102-49M152	49.152 MHz	3.3V	10 ppb	22 mm x 25 mm	0.5 ps	0.3 ps
OX-221-9115-10M000	10 MHz	3.3V	6 ppb	22 mm x 25 mm	1.5 ps	0.7 ps
OX-4011-EAE-0580-10M000	10 MHz	3.3V	10 ppb	13 mm x 20 mm	1 ps	0.75 ps
OX-4011-EAE-0580-20M000	20 MHz	3.3V	10 ppb	13 mm x 20 mm	0.6 ps	0.44 ps
OX-4011-EAE-0580-24M576	24.576 MHz	3.3V	10 ppb	13 mm x 20 mm	0.5 ps	0.3 ps
OX-4011-EAE-0580-25M000	25 MHz	3.3V	10 ppb	13 mm x 20 mm	0.5 ps	0.3 ps
OX-401-9016-20M000	20 MHz	3.3V	10 ppb	13 mm x 20 mm	0.6 ps	0.44 ps
Part Number	Holdover @25°C; 5°C increase @ T0 slope 0.5°/K				—	—
OX-221-9100-20M000	12 µs over 8hrs	4.5 µs over 4hrs	0.75 µs over 1hr	0.35 µs over 30 min.	—	—
OX-221-9101-24M576	12 µs over 8hrs	4.5 µs over 4hrs	0.75 µs over 1hr	0.35 µs over 30 min.	—	—
OX-221-9102-49M152	12 µs over 8hrs	4.5 µs over 4hrs	0.75 µs over 1hr	0.35 µs over 30 min.	—	—

Part Number	Holdover @25°C; 5°C increase @ T0 slope 0.5°/K				—	—
OX-221-9115-10M000	5.7 µs over 8hrs	2.25 µs over 4hrs	0.275 µs over 1hr	0.22 µs over 30 min.	—	—
OX-4011-EAE-0580-10M000	6 µs over 8hrs	2.25 µs over 4hrs	0.75 µs over 1hr	0.18 µs over 30 min.	—	—
OX-4011-EAE-0580-20M000	6 µs over 8hrs	2.25 µs over 4hrs	0.75 µs over 1hr	0.18 µs over 30 min.	—	—
OX-4011-EAE-0580-24M576	18 µs over 8hrs	6.5 µs over 4hrs	1.1 µs over 1hr	0.5 µs over 30 min.	—	—
OX-4011-EAE-0580-25M000	18 µs over 8hrs	6.5 µs over 4hrs	1.1 µs over 1hr	0.5 µs over 30 min.	—	—
OX-401-9016-20M000	6 µs over 8hrs	2.25 µs over 4hrs	0.75 µs over 1hr	0.18 µs over 30 min.	—	—

Group zM1, Stratum3, G.813

Used with 0.1 Hz and higher filter bandwidths for compliance with T1-based hierarchy specifications such as ITU-T G.813 option 2 SEC, ITU-T G.8262 option 2 EEC, Stratum 3 for SNET, Stratum 3 & SMC. Note these oscillators may not be compliant with Group zT2 requirements for E1-Based hierarchy specifications such as ITU-T G.813 option 1 SEC and ITU-T G.8262 option 2 EEC (specifically frequency stability at constant temperature).

TABLE 6: OSCILLATORS FOR GROUP zM1

Part Number	Frequency	Supply	Temp. Stability (pk-pk)	Size	Jitter (@ 12 kHz to 5 MHz) max. typ.	
OX-6011-EAE-1080-10M000	10 MHz	3.3V	20 ppb	7 mm x 9 mm	0.5 ps	0.3 ps
OX-6011-EAE-1080-20M000	20 MHz	3.3V	20 ppb	7 mm x 9 mm	0.3 ps	0.18 ps
OX-6011-EAE-1080-24M576	24.576 MHz	3.3V	20 ppb	7 mm x 9 mm	0.35 ps	0.2 ps
OX-6011-EAE-1080-25M000	25 MHz	3.3V	20 ppb	7 mm x 9 mm	0.35 ps	0.2 ps
OX-5021-EAE-1080-10M000	10 MHz	3.3V	20 ppb	9 mm x 14 mm	0.5 ps	0.3 ps
OX-5021-EAE-1080-20M000	20 MHz	3.3V	20 ppb	9 mm x 14 mm	0.3 ps	0.18 ps
OX-5021-EAE-1080-24M576	24.576 MHz	3.3V	20 ppb	9 mm x 14 mm	0.35 ps	0.2 ps
OX-5021-EAE-1080-25M000	25 MHz	3.3V	20 ppb	9 mm x 14 mm	0.35 ps	0.2 ps
OX-401-9015-98M304	98.304 MHz	3.3V	20 ppb	13 mm x 20 mm	0.3 ps	0.07 ps

Part Number	Holdover @25°C; 5°C increase @ T0 slope 0.5°/K				—	—
OX-6011-EAE-1080-10M000	50 µs over 8hrs	20 µs over 4hrs	4 µs over 1hr	1.9 µs over 30 min.	—	—
OX-6011-EAE-1080-20M000	50 µs over 8hrs	20 µs over 4hrs	4 µs over 1hr	1.9 µs over 30 min.	—	—
OX-6011-EAE-1080-24M576	50 µs over 8hrs	20 µs over 4hrs	4 µs over 1hr	1.9 µs over 30 min.	—	—
OX-6011-EAE-1080-25M000	50 µs over 8hrs	20 µs over 4hrs	4 µs over 1hr	1.9 µs over 30 min.	—	—

Part Number	Holdover @25°C; 5°C increase @ T0 slope 0.5°/K				—	—
OX-5021-EAE-1080-10M000	50 μ s over 8hrs	20 μ s over 4hrs	4 μ s over 1hr	1.9 μ s over 30 min.	—	—
OX-5021-EAE-1080-20M000	50 μ s over 8hrs	20 μ s over 4hrs	4 μ s over 1hr	1.9 μ s over 30 min.	—	—
OX-5021-EAE-1080-24M576	50 μ s over 8hrs	20 μ s over 4hrs	4 μ s over 1hr	1.9 μ s over 30 min.	—	—
OX-5021-EAE-1080-25M000	50 μ s over 8hrs	20 μ s over 4hrs	4 μ s over 1hr	1.9 μ s over 30 min.	—	—
OX-401-9015-98M304	50 μ s over 8hrs	20 μ s over 4hrs	3.5 μ s over 1hr	1.5 μ s over 30 min.	—	—

Group zT1 G8262.1; G8275.1

Used with 1 Hz and higher filter bandwidths for compliance with E1-based hierarchy specifications such as ITU-T G.813 option 1 SEC, ITU-T G.8262 option 1 EEC.

Table 6 shows oscillators suitable for both zT1 and zT2 applications.

TABLE 7: OSCILLATORS FOR GROUP zT1

Part Number	Frequency	Supply	Temp. Stability (pk-pk)	Size	Jitter (@ 12 kHz to 5 MHz) max. typ.	
VT-804A-9002-20M000	20 MHz	3.3V	300 ppb	5 mm x 3.2 mm	450 ps	300 ps

Group zT2 G8262; G8275.1

Used with 1 Hz and higher filter bandwidths for compliance with E1-based hierarchy specifications such as ITU-T G.813 option 1 SEC, ITU-T G.8262 option 1 EEC.

Table 6 shows oscillators suitable for both zT1 and zT2 applications.

TABLE 8: OSCILLATORS FOR GROUP zT2

Part Number	Frequency	Supply	Temp. Stability (pk-pk)	Size	Jitter (@ 12 kHz to 5 MHz) max. typ.	
VT-804A-9001-20M000	20 MHz	3.3V	± 280 ppb	5 mm x 3.2 mm	450 ps	300 ps

Group zX1 (Physical Layer) and zX2 (Protocol Layer)

The oscillators listed in Table 9 are for use with 14 Hz and higher filter bandwidths for T1-based, E1-based, and OTN line card use cases. Also listed are oscillators/crystals for Clock Synthesis applications.

TABLE 9: OSCILLATORS FOR GROUP zX1 AND zX2

Part Number	Size	Frequency	Supply	Temp. Range	Stability	Phase Jitter (12 kHz to 5 MHz)
Crystal Oscillators						
VC-820-9012-20M0000000	3.2 mm x 2.5 mm	25.000 MHz	3.3V	-40°C to 85°C	± 32 ppm	0.300 ps
VC-840-9005-12M8000000	2.5 mm x 2.0 mm	12.800 MHz	3.3V	-40°C to 85°C	± 32 ppm	1.25 ps
VC-820-9013-24M5760000	3.2 mm x 2.5 mm	24.576 MHz	3.3V	-40°C to 85°C	± 32 ppm	0.280 ps

TABLE 9: OSCILLATORS FOR GROUP zX1 AND zX2 (CONTINUED)

Part Number	Size	Frequency	Supply	Temp. Range	Stability	Phase Jitter (12 kHz to 5 MHz)
VC-840-9006-25M0000000	2.5 mm x 2.0 mm	25.000 MHz	3.3V	–40°C to 85°C	±32 ppm	0.340 ps
VC-840-9002-49M1520000	2.5 mm x 2.0 mm	49.152 MHz	3.3V	–40°C to 85°C	±32 ppm	0.130 ps
VC-840-9003-50M0000000	2.5 mm x 2.0 mm	50.000 MHz	3.3V	–40°C to 85°C	±32 ppm	0.130 ps
VCC1-1591-49M1520000	7.0 mm x 5.0 mm	49.152 MHz	3.3V	–40°C to 85°C	±50 ppm	0.080 ps
VC-820-9010-98M3040000	3.2 mm x 2.5 mm	98.304 MHz	3.3V	–40°C to 85°C	±32 ppm	0.045 ps
VCC1-9004-114M2850000	7.0 mm x 5.0 mm	114.285 MHz	3.3V	–40°C to 85°C	±32 ppm	0.040 ps
VC-820-9004-114M2850000	3.2 mm x 2.5 mm	114.285 MHz	3.3V	–40°C to 85°C	±25 ppm	0.040 ps
VC-840A-9004-114M2850000	2.5 mm x 2.0 mm	114.285 MHz	3.3V	–40°C to 85°C	±25 ppm	0.100 ps
VC-820-9014-125M0000000	3.2 mm x 2.5 mm	125.000 MHz	3.3V	–40°C to 85°C	±32 ppm	0.040 ps
Crystals						
VXM7-1366-48M0000000	3.2 mm x 2.5 mm	48.000 MHz	N/A	–40°C to 85°C	±29 ppm	N/A
VXM7-1361-49M1520000	3.2 mm x 2.5 mm	49.152 MHz	N/A	–40°C to 85°C	±29 ppm	N/A
VXM7-1362-50M0000000	3.2 mm x 2.5 mm	50.000 MHz	N/A	–40°C to 85°C	±29 ppm	N/A
VXM7-1363-57M1425000	3.2 mm x 2.5 mm	57.1425 MHz	N/A	–40°C to 85°C	±29 ppm	N/A

PROTOCOL LAYER SYNCHRONIZATION

The oscillator requirements for protocol layer synchronization are not finalized as most of the ITU-T development work on synchronization over packet networks is still under development (in draft status, or incomplete). The following three classifications are used as a guide.

Handling Unknown Deployment Scenarios

When a system is designed to handle a variety of deployment scenarios (unaware networks, partially aware networks, fully aware networks) with differing performance requirements (frequency accuracy, frequency, phase alignment), it is suggested to use a class zO1 oscillator or at least dual footprint a class zO1 oscillator with a lower cost class oscillator (such as Group zO4).

SOURCE AND SERVER CLOCKS

Group zG1

Group zG1. Used for phase synchronization suitable for ITU-T G.8272 (PRTC-A).

TABLE 10: OSCILLATORS FOR GROUP zG1

Part Number	Frequency	Supply	Temp. Stability (pk-pk)	Size	Jitter (@ 12 kHz to 5 MHz) max. typ.	
OX-2281-EAE-5000-10M000	10 MHz	3.3V	1 ppb	22 mm x 25 mm	0.8 ps	0.5 ps
OX-2281-EAE-5000-20M000	20 MHz	3.3V	1 ppb	22 mm x 25 mm	1.2 ps	0.9 ps
Part Number	Holdover @25°C; 4°C increase @ T0 slope 0.5°/K				—	—
OX-2281-EAE-5000-10M000	1.4 µs over 8hrs	0.55 µs over 4hrs	0.1 µs over 1hr	0.05 µs over 30 min.	—	—
OX-2281-EAE-5000-20M000	1.4 µs over 8hrs	0.55 µs over 4hrs	0.1 µs over 1hr	0.05 µs over 30 min.	—	—

Group zG2

Group zG2. Used for phase synchronization suitable for ITU-T G.8272 (PRTC-B).

TABLE 11: OSCILLATORS FOR GROUP zG2

Part Number	Frequency	Supply	Temp. Stability (pk-pk)	Size	Jitter (@ 12 kHz to 5 MHz) max. typ.	
OX-2281-EAE-5000-10M000	10 MHz	3.3V	1 ppb	22 mm x 25 mm	0.8 ps	0.5 ps
OX-2281-EAE-5000-20M000	20 MHz	3.3V	1 ppb	22 mm x 25 mm	1.2 ps	0.9 ps
Part Number	Holdover @25°C; 4°C increase @ T0 slope 0.5°/K				—	—
OX-2281-EAE-5000-10M000	1.4 µs over 8hrs	0.55 µs over 4hrs	0.1 µs over 1hr	0.05 µs over 30 min.	—	—
OX-2281-EAE-5000-20M000	1.4 µs over 8hrs	0.55 µs over 4hrs	0.1 µs over 1hr	0.05 µs over 30 min.	—	—

Group zO3 T_GM_RS, G8273.1 G8275.1; G8275.2

Group zO3. Used for fully aware networks with phase synchronization suitable for ITU-T G.8273.1 (T-GM). Here the clock is assumed to operate with a REF-SYNC input and to perform light filtering of a (trusted) GNSS input.

TABLE 12: OSCILLATORS FOR GROUP zO3

Part Number	Frequency	Supply	Temp. Stability (pk-pk)	Size	Jitter (@ 12 kHz to 5 MHz) max. typ.	
OX-6011-EAE-1080-10M000	10 MHz	3.3V	20 ppb	7 mm x 9 mm	0.5 ps	0.3 ps
OX-6011-EAE-1080-20M000	20 MHz	3.3V	20 ppb	7 mm x 9 mm	0.3 ps	0.18 ps
OX-6011-EAE-1080-24M576	24.576 MHz	3.3V	20 ppb	7 mm x 9 mm	0.35 ps	0.2 ps
OX-6011-EAE-1080-25M000	25 MHz	3.3V	20 ppb	7 mm x 9 mm	0.35 ps	0.2 ps
OX-5021-EAE-1080-10M000	10 MHz	3.3V	20 ppb	9 mm x 14 mm	0.5 ps	0.3 ps
OX-5021-EAE-1080-20M000	20 MHz	3.3V	20 ppb	9 mm x 14 mm	0.3 ps	0.18 ps

TABLE 12: OSCILLATORS FOR GROUP zO3 (CONTINUED)

Part Number	Frequency	Supply	Temp. Stability (pk-pk)	Size	Jitter (@ 12 kHz to 5 MHz) max. typ.	
OX-5021-EAE-1080-24M576	24.576 MHz	3.3V	20 ppb	9 mm x 14 mm	0.35 ps	0.2 ps
OX-5021-EAE-1080-25M000	25 MHz	3.3V	20 ppb	9 mm x 14 mm	0.35 ps	0.2 ps
OX-401-9015-98M304	98.304 MHz	3.3V	20 ppb	13 mm x 20 mm	0.3 ps	0.07 ps
Part Number	Holdover @25°C; 5°C increase @ T0 slope 0.5°/K				—	—
OX-6011-EAE-1080-10M000	50 µs over 8hrs	20 µs over 4hrs	4 µs over 1hr	1.9 µs over 30 min.	—	—
OX-6011-EAE-1080-20M000	50 µs over 8hrs	20 µs over 4hrs	4 µs over 1hr	1.9 µs over 30 min.	—	—
OX-6011-EAE-1080-24M576	50 µs over 8hrs	20 µs over 4hrs	4 µs over 1hr	1.9 µs over 30 min.	—	—
OX-6011-EAE-1080-25M000	50 µs over 8hrs	20 µs over 4hrs	4 µs over 1hr	1.9 µs over 30 min.	—	—
OX-5021-EAE-1080-10M000	50 µs over 8hrs	20 µs over 4hrs	4 µs over 1hr	1.9 µs over 30 min.	—	—
OX-5021-EAE-1080-20M000	50 µs over 8hrs	20 µs over 4hrs	4 µs over 1hr	1.9 µs over 30 min.	—	—
OX-5021-EAE-1080-24M576	50 µs over 8hrs	20 µs over 4hrs	4 µs over 1hr	1.9 µs over 30 min.	—	—
OX-5021-EAE-1080-25M000	50 µs over 8hrs	20 µs over 4hrs	4 µs over 1hr	1.9 µs over 30 min.	—	—
OX-401-9015-98M304	50 µs over 8hrs	20 µs over 4hrs	3.5 µs over 1hr	1.5 µs over 30 min.	—	—

BOUNDARY AND CLIENT CLOCKS

Group zO4 and zO5

Group zO4 and group zO5 are related. Used for partially aware networks (3 to 4 nodes) with phase synchronization. Applies to clocks T-BC-P, T-TSC-P, and T-TSC-A. This group is under development in ITU-T G.8273.4 drafts and will be subject to change. The group zO5 covers when the clock is locked to 1PPS, and the group zO4 covers when the clock is locked to PTP. The group is loosely based on oscillator requirements of Stratum 3E.

- There are two sub-groups: Group zO4 and group zO4. Currently these are the same from oscillator perspective.
- There are two sub-groups: Group zO5 and group zO5. Currently these are the same from oscillator perspective.

TABLE 13: OSCILLATORS FOR GROUP zO4 AND zO5

Part Number	Frequency	Supply	Temp. Stability (pk-pk)	Size	Jitter (@ 12 kHz to 5 MHz) max. typ.	
OX-221-9115-10M000	10 MHz	3.3V	6 ppb	22 mm x 25 mm	1.5 ps	0.7 ps
OX-221-9100-20M000	20 MHz	3.3V	10 ppb	22 mm x 25 mm	0.5 ps	0.3 ps
OX-221-9101-24M576	24.576 MHz	3.3V	10 ppb	22 mm x 25 mm	0.5 ps	0.3 ps

TABLE 13: OSCILLATORS FOR GROUP zO4 AND zO5 (CONTINUED)

Part Number	Frequency	Supply	Temp. Stability (pk-pk)	Size	Jitter (@ 12 kHz to 5 MHz) max. typ.	
OX-221-9102-49M152	49.152 MHz	3.3V	10 ppb	22 mm x 25 mm	0.5 ps	0.3 ps
OX-221-9115-10M000	10 MHz	3.3V	6 ppb	22 mm x 25 mm	1.5 ps	0.7 ps
OX-4011-EAE-0580-10M000	10 MHz	3.3V	10 ppb	13 mm x 20 mm	1.0 ps	0.75 ps
OX-4011-EAE-0580-20M000	20 MHz	3.3V	10 ppb	13 mm x 20 mm	0.6 ps	0.44 ps
OX-4011-EAE-0580-24M576	24.576 MHz	3.3V	10 ppb	13 mm x 20 mm	0.5 ps	0.3 ps
OX-4011-EAE-0580-25M000	25 MHz	3.3V	10 ppb	13 mm x 20 mm	0.5 ps	0.3 ps
OX-401-9016-20M000	20 MHz	3.3V	10 ppb	13 mm x 20 mm	0.6 ps	0.44 ps
Part Number	Holdover @25°C; 5°C increase @ T0 slope 0.5°/K				—	—
OX-221-9115-10M000	5.7 µs over 8hrs	2.25 µs over 4hrs	0.275 µs over 1hr	0.22 µs over 30 min.	—	—
OX-221-9100-20M000	12 µs over 8hrs	4.5 µs over 4hrs	0.75 µs over 1hr	0.35 µs over 30 min.	—	—
OX-221-9101-24M576	12 µs over 8hrs	4.5 µs over 4hrs	0.75 µs over 1hr	0.35 µs over 30 min.	—	—
OX-221-9102-49M152	12 µs over 8hrs	4.5 µs over 4hrs	0.75 µs over 1hr	0.35 µs over 30 min.	—	—
OX-221-9115-10M000	5.7 µs over 8hrs	2.25 µs over 4hrs	0.275 µs over 1hr	0.22 µs over 30 min.	—	—
OX-4011-EAE-0580-10M000	6 µs over 8hrs	2.25 µs over 4hrs	0.75 µs over 1hr	0.18 µs over 30 min.	—	—
OX-4011-EAE-0580-20M000	6 µs over 8hrs	2.25 µs over 4hrs	0.75 µs over 1hr	0.18 µs over 30 min.	—	—
OX-4011-EAE-0580-24M576	18 µs over 8hrs	6.5 µs over 4hrs	1.1 µs over 1hr	0.5 µs over 30 min.	—	—
OX-4011-EAE-0580-25M000	18 µs over 8hrs	6.5 µs over 4hrs	1.1 µs over 1hr	0.5 µs over 30 min.	—	—
OX-401-9016-20M000	6 µs over 8hrs	2.25 µs over 4hrs	0.75 µs over 1hr	0.18 µs over 30 min.	—	—

Group zO6

TABLE 14: OSCILLATORS FOR GROUP zO6

Part Number	Frequency	Supply	Temp. Stability (pk-pk)	Size	Jitter (@ 12 kHz to 5 MHz) max. typ.	
OX-221-9115-10M000	10 MHz	3.3V	6 ppb	22 mm x 25 mm	1.5 ps	0.7 ps
OX-221-9100-20M000	20 MHz	3.3V	10 ppb	22 mm x 25 mm	0.5 ps	0.3 ps
OX-221-9101-24M576	24.576 MHz	3.3V	10 ppb	22 mm x 25 mm	0.5 ps	0.3 ps

TABLE 14: OSCILLATORS FOR GROUP zO6 (CONTINUED)

Part Number	Frequency	Supply	Temp. Stability (pk-pk)	Size	Jitter (@ 12 kHz to 5 MHz) max. typ.	
OX-221-9102-49M152	49.152 MHz	3.3V	10 ppb	22 mm x 25 mm	0.5 ps	0.3 ps
OX-221-9115-10M000	10 MHz	3.3V	6 ppb	22 mm x 25 mm	1.5 ps	0.7 ps
OX-4011-EAE-0580-10M000	10 MHz	3.3V	10 ppb	13 mm x 20 mm	1.0 ps	0.75 ps
OX-4011-EAE-0580-20M000	20 MHz	3.3V	10 ppb	13 mm x 20 mm	0.6 ps	0.44 ps
OX-4011-EAE-0580-24M576	24.576 MHz	3.3V	10 ppb	13 mm x 20 mm	0.5 ps	0.3 ps
OX-4011-EAE-0580-25M000	25 MHz	3.3V	10 ppb	13 mm x 20 mm	0.5 ps	0.3 ps
OX-401-9016-20M000	20 MHz	3.3V	10 ppb	13 mm x 20 mm	0.6 ps	0.44 ps
Part Number	Holdover @25°C; 5°C increase @ T0 slope 0.5°/K				—	—
OX-221-9115-10M000	5.7 µs over 8hrs	2.25 µs over 4hrs	0.275 µs over 1hr	0.22 µs over 30 min.	—	—
OX-221-9100-20M000	12 µs over 8hrs	4.5 µs over 4hrs	0.75 µs over 1hr	0.35 µs over 30 min.	—	—
OX-221-9101-24M576	12 µs over 8hrs	4.5 µs over 4hrs	0.75 µs over 1hr	0.35 µs over 30 min.	—	—
OX-221-9102-49M152	12 µs over 8hrs	4.5 µs over 4hrs	0.75 µs over 1hr	0.35 µs over 30 min.	—	—
OX-221-9115-10M000	5.7 µs over 8hrs	2.25 µs over 4hrs	0.275 µs over 1hr	0.22 µs over 30 min.	—	—
OX-4011-EAE-0580-10M000	6 µs over 8hrs	2.25 µs over 4hrs	0.75 µs over 1hr	0.18 µs over 30 min.	—	—
OX-4011-EAE-0580-20M000	6 µs over 8hrs	2.25 µs over 4hrs	0.75 µs over 1hr	0.18 µs over 30 min.	—	—
OX-4011-EAE-0580-24M576	18 µs over 8hrs	6.5 µs over 4hrs	1.1 µs over 1hr	0.5 µs over 30 min.	—	—
OX-4011-EAE-0580-25M000	18 µs over 8hrs	6.5 µs over 4hrs	1.1 µs over 1hr	0.5 µs over 30 min.	—	—
OX-401-9016-20M000	6 µs over 8hrs	2.25 µs over 4hrs	0.75 µs over 1hr	0.18 µs over 30 min.	—	—

Group zO7

Group zO7. This group may also be used for unaware networks with relaxed frequency synchronization requirements, based on ITU-T G.8261 Appendix VI profiles. May be suitable for 5G applications.

TABLE 15: OSCILLATORS FOR GROUP zO7

Part Number	Frequency	Supply	Temp. Stability (pk-pk)	Size	Jitter (@ 12 kHz to 5 MHz) max. typ.	
OX-6011-EAE-1080-10M000	10 MHz	3.3V	20 ppb	7 mm x 9 mm	0.5 ps	0.3 ps
OX-6011-EAE-1080-20M000	20 MHz	3.3V	20 ppb	7 mm x 9 mm	0.3 ps	0.18 ps

TABLE 15: OSCILLATORS FOR GROUP zO7 (CONTINUED)

Part Number	Frequency	Supply	Temp. Stability (pk-pk)	Size	Jitter (@ 12 kHz to 5 MHz) max. typ.	
OX-6011-EAE-1080-24M576	24.576 MHz	3.3V	20 ppb	7 mm x 9 mm	0.35 ps	0.2 ps
OX-6011-EAE-1080-25M000	25 MHz	3.3V	20 ppb	7 mm x 9 mm	0.35 ps	0.2 ps
OX-5021-EAE-1080-10M000	10 MHz	3.3V	20 ppb	9 mm x 14 mm	0.5 ps	0.3 ps
OX-5021-EAE-1080-20M000	20 MHz	3.3V	20 ppb	9 mm x 14 mm	0.3 ps	0.18 ps
OX-5021-EAE-1080-24M576	24.576 MHz	3.3V	20 ppb	9 mm x 14 mm	0.35 ps	0.2 ps
OX-5021-EAE-1080-25M000	25 MHz	3.3V	20 ppb	9 mm x 14 mm	0.35 ps	0.2 ps
OX-401-9015-98M304	98.304 MHz	3.3V	20 ppb	13 mm x 20 mm	0.3 ps	0.07 ps
Part Number	Holdover @25°C; 5°C increase @ T0 slope 0.5°/K				—	—
OX-6011-EAE-1080-10M000	50 µs over 8hrs	20 µs over 4hrs	4 µs over 1hr	1.9 µs over 30 min.	—	—
OX-6011-EAE-1080-20M000	50 µs over 8hrs	20 µs over 4hrs	4 µs over 1hr	1.9 µs over 30 min.	—	—
OX-6011-EAE-1080-24M576	50 µs over 8hrs	20 µs over 4hrs	4 µs over 1hr	1.9 µs over 30 min.	—	—
OX-6011-EAE-1080-25M000	50 µs over 8hrs	20 µs over 4hrs	4 µs over 1hr	1.9 µs over 30 min.	—	—
OX-5021-EAE-1080-10M000	50 µs over 8hrs	20 µs over 4hrs	4 µs over 1hr	1.9 µs over 30 min.	—	—
OX-5021-EAE-1080-20M000	50 µs over 8hrs	20 µs over 4hrs	4 µs over 1hr	1.9 µs over 30 min.	—	—
OX-5021-EAE-1080-24M576	50 µs over 8hrs	20 µs over 4hrs	4 µs over 1hr	1.9 µs over 30 min.	—	—
OX-5021-EAE-1080-25M000	50 µs over 8hrs	20 µs over 4hrs	4 µs over 1hr	1.9 µs over 30 min.	—	—
OX-401-9015-98M304	50 µs over 8hrs	20 µs over 4hrs	3.5 µs over 1hr	1.5 µs over 30 min.	—	—

Meet MTIE/TDEV target for constant temperature and limited variable temperature range.

Group zM2

Group zM2. Used for fully aware BC networks with phase synchronization suitable for ITU-T G.8273.2 T-BC and TTSC.

Note that the first revision of ITU-T G.8273.2 is published based on use of SyncE, but additional amendments and revisions are expected to clarify items such as wander generation and holdover stability when SyncE is not present. Therefore, deviations (tougher requirements) from these requirements may be expected, especially related to wander generation (at 0.05 Hz) and holdover stability under variable temperature.

- There are two sub-groups: Group zM2, group zM2, group zM2, and group zM2. These are different from an oscillator perspective (only groups zM1 and zM2 are the same).

TABLE 16: OSCILLATORS FOR GROUP zM2

Part Number	Frequency	Supply	Temp. Stability (pk-pk)	Size	Jitter (@ 12 kHz to 5 MHz) max. typ.	
OX-6011-EAE-1080-10M000	10 MHz	3.3V	20 ppb	7 mm x 9 mm	0.5 ps	0.3 ps
OX-6011-EAE-1080-20M000	20 MHz	3.3V	20 ppb	7 mm x 9 mm	0.3 ps	0.18 ps
OX-6011-EAE-1080-24M576	24.576 MHz	3.3V	20 ppb	7 mm x 9 mm	0.35 ps	0.2 ps
OX-6011-EAE-1080-25M000	25 MHz	3.3V	20 ppb	7 mm x 9 mm	0.35 ps	0.2 ps
OX-5021-EAE-1080-10M000	10 MHz	3.3V	20 ppb	9 mm x 14 mm	0.5 ps	0.3 ps
OX-5021-EAE-1080-20M000	20 MHz	3.3V	20 ppb	9 mm x 14 mm	0.3 ps	0.18 ps
OX-5021-EAE-1080-24M576	24.576 MHz	3.3V	20 ppb	9 mm x 14 mm	0.35 ps	0.2 ps
OX-5021-EAE-1080-25M000	25 MHz	3.3V	20 ppb	9 mm x 14 mm	0.35 ps	0.2 ps
OX-401-9015-98M304	98.304 MHz	3.3V	20 ppb	13 mm x 20 mm	0.3 ps	0.07 ps
Part Number	Holdover @25°C; 5°C increase @ T0 slope 0.5°/K				—	—
OX-6011-EAE-1080-10M000	50 µs over 8hrs	20 µs over 4hrs	4 µs over 1hr	1.9 µs over 30 min.	—	—
OX-6011-EAE-1080-20M000	50 µs over 8hrs	20 µs over 4hrs	4 µs over 1hr	1.9 µs over 30 min.	—	—
OX-6011-EAE-1080-24M576	50 µs over 8hrs	20 µs over 4hrs	4 µs over 1hr	1.9 µs over 30 min.	—	—
OX-6011-EAE-1080-25M000	50 µs over 8hrs	20 µs over 4hrs	4 µs over 1hr	1.9 µs over 30 min.	—	—
OX-5021-EAE-1080-10M000	50 µs over 8hrs	20 µs over 4hrs	4 µs over 1hr	1.9 µs over 30 min.	—	—
OX-5021-EAE-1080-20M000	50 µs over 8hrs	20 µs over 4hrs	4 µs over 1hr	1.9 µs over 30 min.	—	—
OX-5021-EAE-1080-24M576	50 µs over 8hrs	20 µs over 4hrs	4 µs over 1hr	1.9 µs over 30 min.	—	—
OX-5021-EAE-1080-25M000	50 µs over 8hrs	20 µs over 4hrs	4 µs over 1hr	1.9 µs over 30 min.	—	—
OX-401-9015-98M304	50 µs over 8hrs	20 µs over 4hrs	3.5 µs over 1hr	1.5 µs over 30 min.	—	—

Group zT3

Used for fully aware BC networks when combined with EEC option 1 reference chain, with phase synchronization suitable for ITU-T G.8273.2 T-BC and T-TSC, with SyncE.

TABLE 17: OSCILLATORS FOR GROUP zT3

Part Number	Frequency	Supply	Temp. Stability (pk-pk)	Size	Jitter (@ 12 kHz to 5 MHz) max. typ.	
VT-804A-9002-20M000	20 MHz	3.3V	300 ppb	5 mm x 3.2 mm	450 ps	300 ps

Group zX2

The oscillators listed in [Table 5](#) are also used to meet zX2, 14 Hz and higher filter bandwidths for PTP line cards in ITU-T G.8273.2 Class C applications. This standard is focused on 5G backhaul applications.

GENERAL NOTES

See AN4287 for additional notes on performance testing and standards.

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ISBN: 978-1-6683-4141-4

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