



LO and CLK generation modules for LLRF system of European XFEL

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10 Hz ...1 MHz 10 Hz ...10 MHz

 10^{7}

ABSTRACT

The European XFEL is a new generation of Free-Electron Laser (FEL) machines. Its superior performance is achieved with the new LLRF front-end electronics. The frontend electronics design is focused on achieving ultra-low phase noise which contributes to the quality of the electromagnetic field of superconducting RF cavities in accelerating modules, stability of accelerated electron bunches arrival time and finally to the output laser light of FEL. Other important goals for LLRF system are drift minimization, remote control and diagnostics, high reliability and serviceability. This is achieved introducing to all subsystems highly integrated PCB modules that can accommodate all the system requirements. One of the crucial subsystems of the LLRF front-end is Local Oscillator (LO) generation and Clock (CLK) generation module (LOGM). The LO signal is used in superheterodyne receiver of the LLRF field detector. The CLK signal is used as a low jitter sampling clock for analog-todigital converters of the LLRF digitizer.

These high performance signals allow precise control of electromagnetic field in accelerating RF cavities of the LINAC. This paper presents a family of ultra-low phase noise LO and CLK generation modules



 $f_{RF} = f_{REF} K/M$

×G

IF3 1191,67

Jlo

> 80 dB

freq [MHz]

IF3 1408,33

REF 1300

Universal LOGM

- The same signal synthesis concept but in modular design
- Modules reconfiguration by hardware settings and assembly options
- Input reference frequency f_{RF} = 300 ÷ 6000 MHz
- Output f_{IO} range: $f_{RF} \pm \max 200 \text{ MHz}$
- Output *f*_{CLK} range: max 300 MHz





SIGNAL SYNTHESIS

• LO synthesis method: mixing technique

$$f_{LO} = f_{RF} \pm f_{IF}$$
 $f_{LO} = f_{REF} \left(\frac{K}{M} \pm \frac{G}{N} \right)$





• Signal filtering is crucial to keep low jitter and high spurious-free-range

1354 MHz LOGM

• Double-balanced mixer used as a frequency converter from 1300 MHz REF to 1354.16 MHz LO

RF 54,167

- Multistage frequency divider for 54.16 MHz IF and 81.25 MHz CLK generation with Reset
- PCB integration and solid metal packaging for improved EMI/EMC



Examples of frequency variants for Universal LOGM

f _{REF} [MHz]	Х	М	N	Y	f _{LO} [MHz]	f _{сιк} [MHz]	f _{ıF} [MHz]
704	2	3	5	3	727.47	117.33	23.47
1300	2	8	3	4	1354.17	81.25	54.17
2856	2	12	10	3	2903.60	119.00	47.60
3000	4	6	10	3	3025.00	125.00	25.00
3900	4	12	6	3	3954.16	81.25	54.16
5712	4	12	10	3	5759.60	119.00	47.60



LOGM CRATE PACKAGING

