

CMCU

Clock Monitoring and Control Unit

The CMCU is a high-performance 10.23 MHz master clock generation unit for satellite navigation systems. Two frequency synthesizers can select independently between two input 9.99 to 10.01 MHz Atomic Clock frequency references as a basis for the master clock generation. One of the two synthesizer outputs is selected to provide the master clock for the payload and is distributed to up to four identical outputs. The output signal of the second synthesizer provides a hot redundant alternative for the master clock with seamless switching (no distortion of the output signal). A phase meter monitors the output phase of the active synthesizer against the hot redundant one.

Maximum reliability is achieved through a design without microcontroller. The TM TC interface is implemented as hard wired logic and can be addressed by serial and high level commands. A phase synchronous output switching between active and redundant synthesizer is available. Optional features like parameter-based clock drift compensation or synthesizer adaptation to source characteristics can be implemented.
The CMCU can be operated with rubidium, passive hydrogen maser and caesium clocks to form a complete timing subsystem. The CMCU in the Galileo configuration operates with passive hydrogen maser and rubidium clocks.

Key Features

- Master timing reference generation (10.23 MHz) for NAV payloads
- Direct digital frequency synthesis with hyper-fine tuning steps to correct frequency drifts of atomic clocks while not degrading their performance
- Frequency comparison system determines drifts between two atomic clocks
- Seamless switching capability
- Frequency distribution networks
- High phase stability over temperature drifts
- 4 x 2 switch matrix with high isolation to prevent degradation of clock stability
- Capability to monitor discrete clock interfaces

Main application fields

- Navigation payloads (global or regional)
- High-performance communication systems
- Scientific applications
- GNSS overlay systems

Customers / Applications

- Galileo FOC
- DLR
- ISRO (Indian regional navigation satellite system)

Support

- EGSE including high-precision time generation and verification equipment
- Expertise in high-precision timing subsystems

Budgets

• Mass	5.2 kg
• Volume	270 x 216 x 137 mm³
• Power (average)	21 W

Interfaces

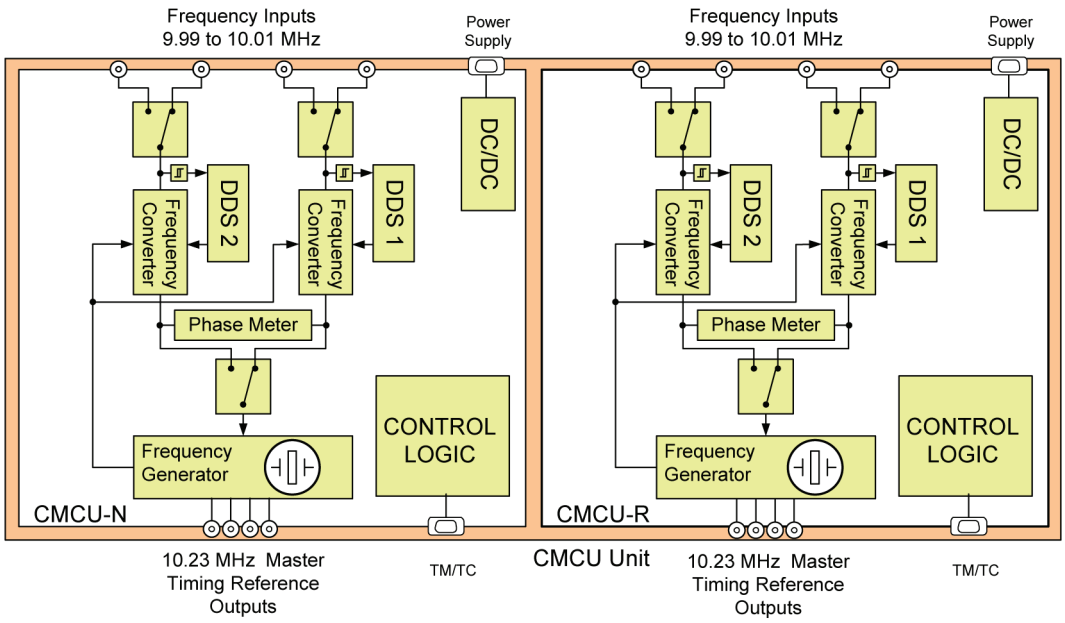
• Power bus	26–48.5 V (adaptable)
• Clock inputs	9.99...10.1 MHz (adaptable) 5..13 dBm Analogue, digital and thermistor inputs for clock telemetry
• Output signal	10.23 MHz, -1...7 dBm (adaptable)
• Control & Monitoring	MIL-STD-1553B or RS422 high level command. Discrete analogue & digital telemetry.

Environments

• Temperature:	Operating	-15 °C to +45 °C
	Non-operating	-40 °C to +60 °C
• Radiation tolerance:		up to 100 kRad
• Reliability		0.9927 over 12 years

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CMCU block diagram



CMCU functions and performance

Functions

- 4 x 2 switch matrix for clock selection
- Frequency synthesizer: 10.00 MHz -> 10.23 MHz
- Frequency fine tuning and adjustment
- Seamless switching capability for smooth change between reference atomic clocks
- Phase meter to monitor hot redundant against active clock
- Storage of phase measure-ment results upon retrieval
- Second unit in cold redundancy
- Optional conversion of other input clock frequencies if a mix of clock technologies is desired

Performance

Input frequency f^{in}:	9.99...10.01 MHz
Output frequency f^{out}:	10.23 MHz
Step Size (Δf/f):	± 1 x 10^{-15}
Setting range (Δf/f):	± 1 x 10^{-8}
Phase Noise:	CMCU output
1 Hz	-100 dBc/Hz
10 Hz	-124 dBc/Hz
100 Hz	-139 dBc/Hz
1 KHz	-149 dBc/Hz
10 KHz	-154 dBc/Hz
100 KHz	-154 dBc/Hz
Discrete spurious and harmonics	-80 dBc (f ± 1 MHz) -60 dBc (outside f ± 1 MHz)

Short-term frequency residual stability:	Residual ADEV
1s	Performance:
10s	6.4 x10^{-14}
100s	2.0 x10^{-14}
1,000s	6.4 x10^{-15}
10,000s	2.0 x10^{-15}
Phase meter resolution	3 ps
Phase sensitivity	
Temperature	<10ps/K
Magnetic field	<100ps/Gauss
Power supply	<10ps/V

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