

TimeLink



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Application Note

Redundant Time & Frequency Architecture for Ground Station Operations

Using TMG3420 (x2), TMD1132-2R, TMD2214-2R, and TMD1101-2R

1. Introduction

Modern ground stations require highly reliable and accurate time and frequency references to ensure safe and efficient operation of mission-critical subsystems such as telemetry, tracking, command (TT&C), radar timing, and countdown management. Redundancy and robust signal distribution are therefore essential.

This application note describes a **fully redundant time and frequency synchronization architecture** using TimeLink equipment:

- **Two TMG3420** GNSS/IRIG/NMEA-disciplined Time & Frequency Generators (Redundant A/B Sources)
- **TMD1132-2R** Redundant 1PPS Distributor
- **TMD2214-2R** Redundant 10 MHz Frequency Distributor
- **TMD1101-2R** Redundant IRIG-B Modulated Signal Distributor

The system provides seamless switching, stable frequency outputs, and large-scale distribution for ground station environments.

2. System Objectives

A ground station timing system must:

- Provide a **stable and accurate GNSS-disciplined reference** for system timing
- Guarantee **automatic redundancy** in case of equipment failure or signal loss
- Distribute **1PPS, IRIG-B, and 10 MHz** to multiple subsystems
- Ensure **fast fault detection** and reliable switchover
- Support long cable runs, EMI-heavy environments, and isolated distribution paths
- Maintain timing continuity during GNSS outages via high-stability OCXO holdover

The architecture presented below meets all of these requirements.

3. System Overview

3.1 Redundant Master Time Sources

Two **TMG3420** units operate in parallel as **Source A** and **Source B**. Each unit provides:

- 1PPS (TTL)

- IRIG-B00x (DCLS) or IRIG-B12x (AM)
- 10 MHz low-phase-noise signal
- GNSS-disciplined UTC reference

Both units feed into the redundant distribution modules.

3.2 Redundant Distribution Modules

TMD1132-2R – 1PPS Redundant Distributor

- Accepts dual 1PPS inputs from TMG3420 A/B
- Automatic or manual switching
- 10 independently isolated outputs
- Fast fault detection and switchover

TMD2214-2R – 10 MHz Redundant Frequency Distributor

- Accepts two 10 MHz references
- Ultra-low-noise internal amplification
- 12 filtered, isolated RF outputs
- Automatic redundancy handling

TMD1101-2R – IRIG-B Redundant Modulated Distributor

- Accepts dual IRIG-B AM (B12x) sources
- 10 outputs with adjustable amplitude
- Redundant PSU and redundant inputs

4. Typical Ground Station Architecture

A representative redundant time-frequency setup for a ground station is shown below:

Primary TMG3420 (Source A)

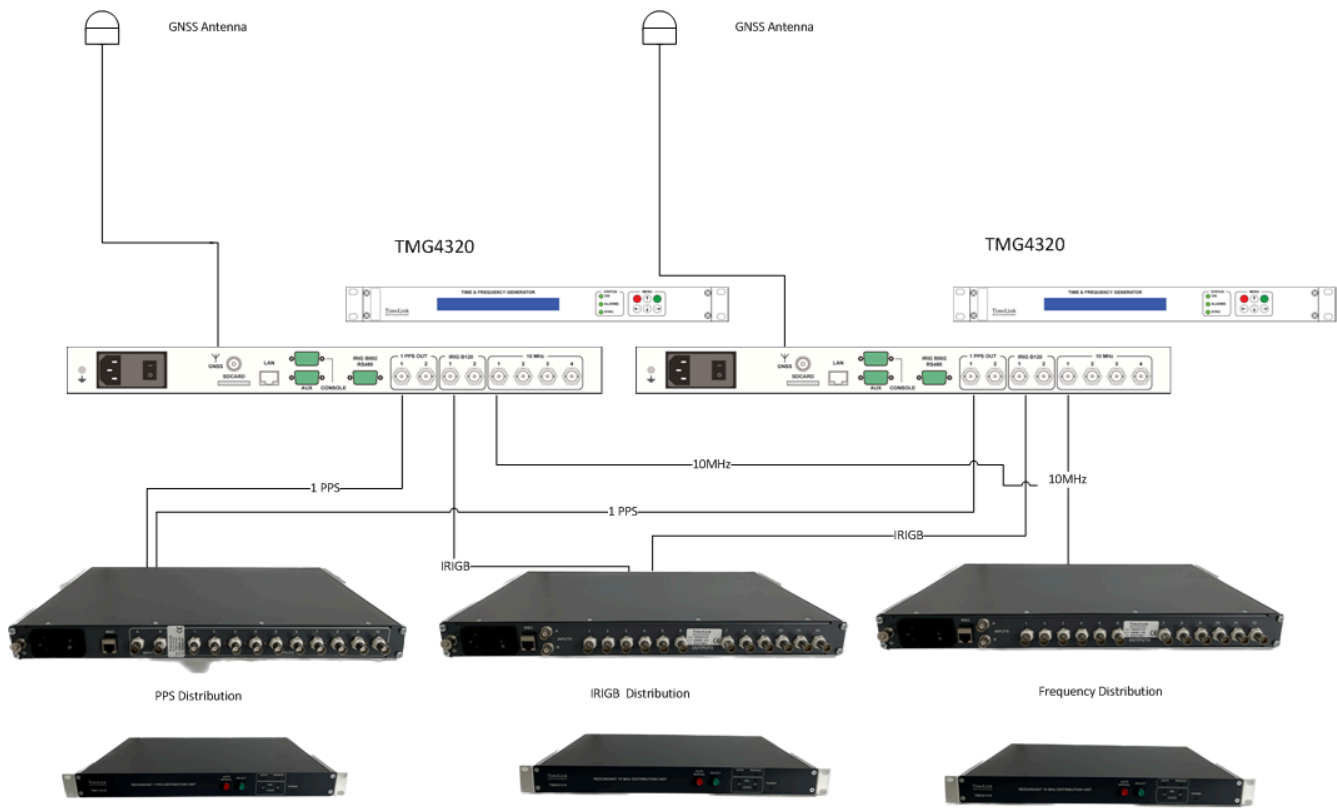
- GNSS → 1PPS, IRIG-B, 10 MHz

Secondary TMG3420 (Source B)

- GNSS → 1PPS, IRIG-B, 10 MHz

Redundant Distribution Layer

- TMD1132-2R (1PPS distribution)
- TMD2214-2R (10 MHz distribution)
- TMD1101-2R (IRIG-B AM modulated distribution)



Subsystem Outputs

The distributors spread signals to:

- Telemetry acquisition system
- Tracking/trajectory system
- Radar timing units
- Launch and countdown control systems
- Mission computer time stamping
- RF frequency converters and uplink chains
- Time displays and monitoring consoles

5. Redundancy Mechanism

5.1 Automatic Source Switching

Each distributor (TMD1132-2R, TMD2214-2R, TMD1101-2R) includes:

- Automatic mode with failure detection
- Manual override (Source A / B)
- Front-panel status indicators
- Network remote control (HTTPS/SNMPV3)

Failure conditions triggering switchover:

- Loss of input signal amplitude
- Signal distortion
- Power supply failure on one unit

5.2 Timing Continuity

The TMG3420's internal OCXO ensures:

- Holdover stability $< \pm 2 \times 10^{-10}$ /day
- Sub-microsecond drift over short GNSS outages

This allows seamless operations even during GNSS degradation.

6. Recommended Cable Interfaces

- **IRIG-B AM**: 50–600 Ω coaxial, BNC
- **10 MHz**: 50 Ω coax, phase-stable cable for long runs
- **1PPS**: shielded twisted pair (RS422 recommended for long distances)

7. Monitoring and Supervision

All equipment supports remote monitoring:

- SNMP v2c/v3 for alarms and system health
- HTTPS web configuration & Status
- SYSLOG for event logging (TMG3420)
- OCXO status and GNSS lock indicators

This allows integration into a ground station Network Management System (NMS).

8. Conclusion

This redundant architecture provides an extremely robust, precise, and maintainable time and frequency reference system suitable for critical ground station operations. Using dual TMG3420 time sources and redundant TimeLink distribution modules (TMD1132-2R, TMD2214-2R, TMD1101-2R), the station benefits from:

- Full signal redundancy
- High-stability GNSS-disciplined references
- Large-scale, isolated output distribution
- Comprehensive supervision and diagnostics

This configuration is well-suited for satellite ground stations, launch operations, tracking centers, and mission-critical timing infrastructures.

Note : it can be configured without redundancy using one TMG3420 and single input distributor.