ENSCO
Ideas to Reality®

ENSCO Timing, Communications, and Ranging Device (TCR-D)

Software-Defined Radio (SDR) for PNT Applications

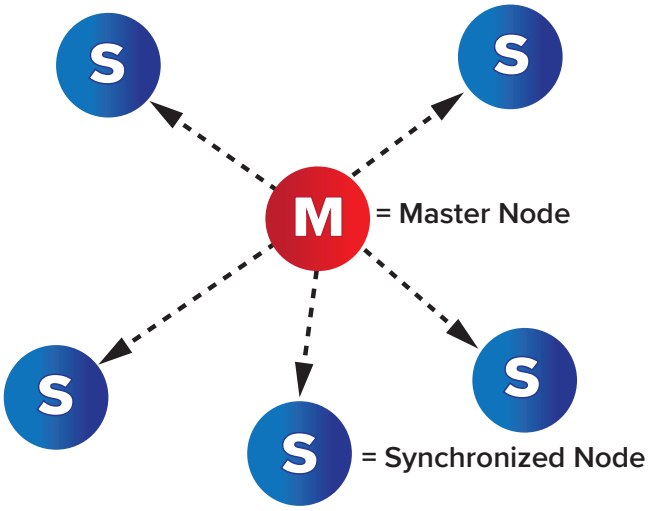
Real-Time RF Measurements of Time, Frequency, and Phase

TCR IP Core measurement technology provides:

- Round-trip time of flight range and Doppler velocity
- Reference frequency and phase offsets
- Time difference of arrival
- Phase difference of arrival
- Concurrent data communication

ENSCO TCR-IP supports a wide range of applications including:

- Wireless time synchronization and dissemination
- Wireless remote clock frequency and phase synchronization
- RF-aided inertial navigation systems
- Distributed GNSS-independent autonomous systems
- Cooperative and collaborative PNT for UAV and UGV systems
- Active safety systems



Time/frequency/phase synchronization architecture

GPS-Denied PNT Application Support

IP modules and software available for the latest generation of TCR-D include:

- Aided Inertial navigation for pedestrian tracking
  - o Collaborative, decentralized fusion support with RF measurements
  - o GPS or GPS-independent solution
- GPS hot start for C/A and P(Y) receivers
- Network time synchronization
- Collaborative fusion filtering (centralized and decentralized)
- RF-only relative positioning
- Wireless time, frequency, and phase synchronization between remotely located systems
- TCR-D platform includes an ARM Cortex A-9 Processor, available for custom user navigation or timing applications

Technology Summary

ENSCO's patented Timing, Communications, and Ranging (TCR) IP core measurement technology provides real-time, high-accuracy timing dissemination and synchronization,

distance and speed measurements for Assured-Positioning, Navigation, and Timing (A-PNT) systems. This TCR IP core measurement technology is embedded in our latest generation of TCR Devices (TCR-Ds) as part of an evaluation kit to easily support testing, evaluation, and integration of our technology into existing System of Systems (SoS) architectures requiring operation in GPS-denied environments.

ENSCO's TCR-Ds support decentralized network operation over long distances with high measurement rates enabling A-PNT capability for a variety of next generation UAV and UGV development efforts. An on-board processor is available to support user specific PNT applications and software.

Specifications — TCR-D 421

Function	Performance
Range of operation	> 1 kilometer with RF line of sight
Measurement rate	Up to 400 independent measurements per second
Ranging accuracy	1 cm RMS in benign environments 50 – 500 cm RMS in typical tactical environments
Velocity accuracy	25 cm/sec RMS
Time transfer precision	15 nanoseconds (3-σ)
RF emissions	5.8 GHz ISM band, designed for FCC compliance
Transmit power	Configurable
Bandwidth	15 MHz
Dimensions	175 x 77 x 34 mm
Weight	420 grams
Antenna connectors	SMA, 50 Ω
Battery	Internal lithium ion, provides > 4 hour continuous operation, or indefinitely with external 5V power
Networking	Decentralized, carrier sense multiple access with collision avoidance (CSMA/CA)
Data communications	Up to 250 kbps
Measurement scheduling	On-demand, scheduled, or user-defined
Measurement distribution	Automatic, point-to-point or broadcast
Measurement duration	Less than 3 milliseconds per round-trip measurement
PNT Application processor	ARM Cortex A9 with embedded Linux, available for user applications
Interfaces	USB, Bluetooth®, Wi-Fi

Evaluation Kit is Now Available

The TCR-D evaluation kit is configured with integrators in mind and includes:

- 4x TCR-D421 devices
- 4x Omni-directional antennas
- 4x Wall chargers & data cables
- 1x Carrying case
- Software to configure operating parameters
- Utilities for parsing logged data
- Programmers guide and interface control documents

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