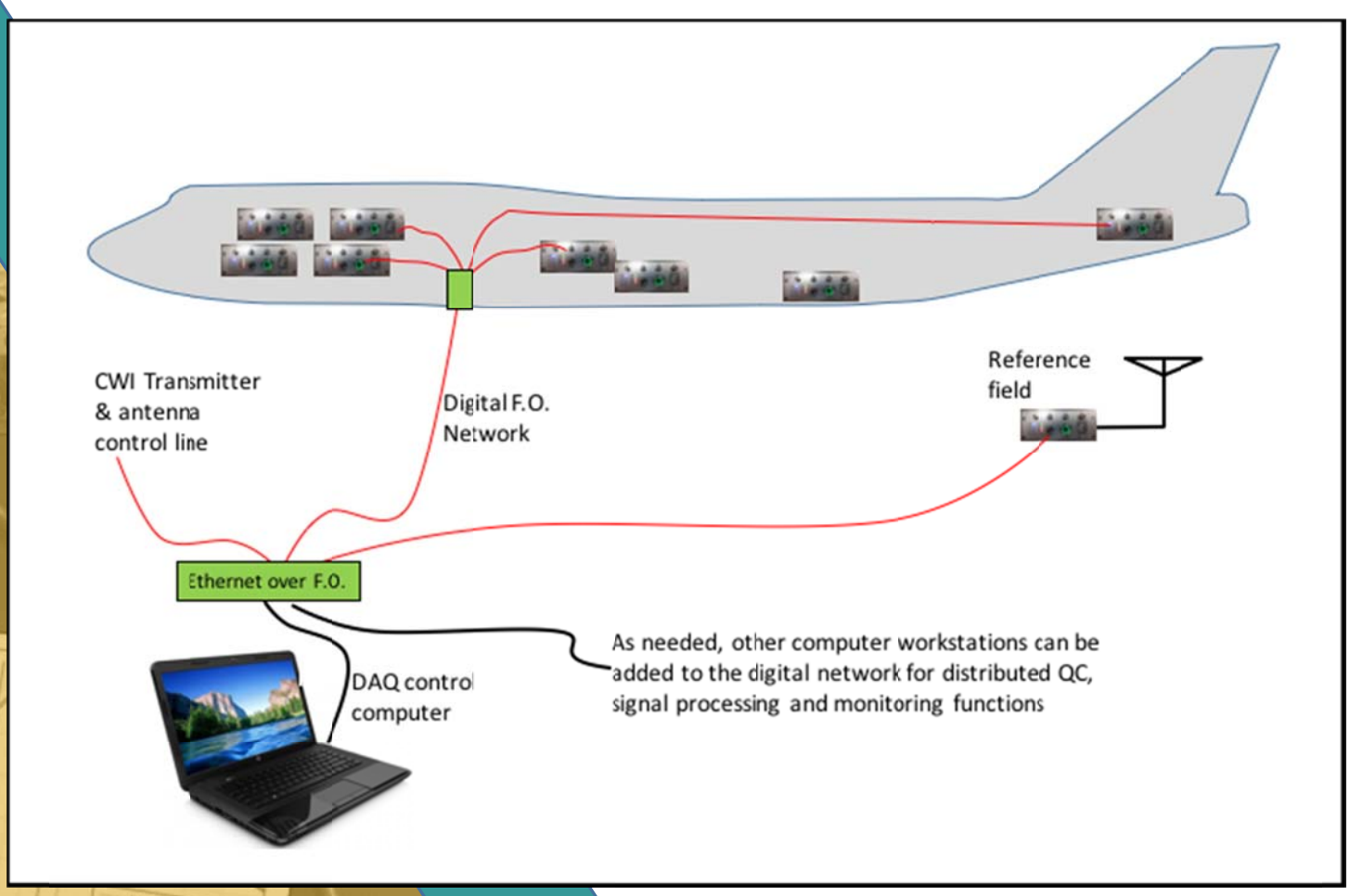
CWI-Net 2.0

Optimized for Stepped CWI Testing



SCIENTIFIC
APPLICATIONS &
RESEARCH
ASSOCIATES

JUNE 2017

The need for CWI Testing

Continuous Wave Illumination (CWI) is a low power, high dynamic range and cost-effective test technique required and recommended by the following HEMP Military Standards:

- MIL-STD-3023 → Aircraft
- MIL-STD-188-125 → Facility (Fixed and Mobile)
- MIL-STD-4023 → Ship

As an example, MIL-STD-3023 requires CWI testing that includes HEMP Protection System (HPS) performance for the manufacturing phase as well as Hardness Surveillance over the life cycle of the operational aircraft.

SARA offers the small, fast, portable, distributed and low maintenance CWI-Net 2.0 instrumentation system as a package to quickly deploy and instrument multiple test points throughout an asset in support of CWI testing. CWI-Net operates over a closed digital network using a single inexpensive multimode fiber to each node. CWI-Net's frequency range (10kHz-1GHz) and dynamic range (~-140dBm to 0dBm) satisfy requirements for aircraft, facility and ship CWI testing.

CWI-NET 2.0 System Level Benefits

CWI-NET 2.0 instrumentation system takes full advantage of experience gained through decades of CWI testing. In addition to hardware and software features described in the following sections, the instrumentation system boasts the following advantages over legacy instrumentation systems:

- Developed based on COTS digital networks and single board computer subsystem that will not go obsolete – but get faster, more energy efficient, smaller and more reliable over time
- Easy to setup and operate with fast frequency scanning speed
- Reduces time on asset
- Minimizes operator errors
- Extends to unlimited number of parallel CWI nodes
- Offers integrated voice and data communication to control computer

Key benefits of the CWI-NET 2.0 node include:

- Small enough to fit in small A/C bays: H: 2.75", L: 15.00", W: 5.00"
- Distance between nodes can be 100's of meters, thanks to the range of digital fiber optics
- Data recorded at the test point location thus taking advantage of the full dynamic range of spectrum analyzers
- Spectrum analyzer operation, records magnitude only
- Fast data acquisition rate – ~5x faster than MIIS 1.0 for 10Hz and 100 Hz resolution bandwidths. CWI-Net 2.0 is also significantly faster than the PHST van when 8 or more nodes are deployed as shown below.

Table 1: PHSTS/CWI-Net Timing Comparison

# Test Points	# Freq. steps	Minutes for PHST Van to Clear 32 Test Points	Minutes for 8-MIIS's to Clear 32 Test Points	Minutes for 12-MIIS's to Clear 32 Test Points	Minutes for 16-MIIS's to Clear 32 Test Points	Minutes for 24-MIIS's to Clear 32 Test Points	Minutes for 32-MIIS's to Clear 32 Test Points	
32	1,162	12.0	10.8	8.5	6.2	6.2	3.9	
# Test Points	# Freq. steps	Minutes for PHST Van to Clear 48 Test Points	Minutes for 8-MIIS's to Clear 48 Test Points	Minutes for 12-MIIS's to Clear 48 Test Points	Minutes for 16-MIIS's to Clear 48 Test Points	Minutes for 24-MIIS's to Clear 48 Test Points	Minutes for 32-MIIS's to Clear 48 Test Points	Minutes for 48-MIIS's to Clear 48 Test Points
48	1,162	14.0	16.2	11.6	9.3	7.0	7.0	4.6

Similar to all CWI systems, CWI-Net 2.0 utilizes two major components, the transmit (TX) subsystem and the receive (RX) subsystem. CWI-Net control software is tailorable to each facility's existing signal generator, amplifiers, high power RF switches, and antennas, protecting existing investments.

CWI-Net 2.0 CWI Node

The CWI-Net 2.0 node shown in Figure 1 comprises the heart of the RX system, consisting of an RF receiver with preamp and attenuation, on-board data processing, TCP/IP communications, battery and power supply, all in a ruggedized RF shielded enclosure designed to withstand harsh field conditions yet fit into tight spaces. The CWI-Net DAQ control software steers the TX and RXs to the desired frequency. Each receiver's gain is adjusted on the fly at each node, independently, to ensure sufficient SNR and prevent front-end saturation. Thanks to SARA's proprietary algorithms, a system of 16 parallel nodes can acquire 6 frequencies per second at 100 Hz RBW; and an impressive 4 frequencies per second at 10 Hz RBW.

Each node has four switchable 50Ω inputs with 80dB isolation, so that up to four probes can be connected at each node location – with one port scanned during each stepped CW sweep. Detachable, rechargeable battery packs are easily removed and replaced in the field by locking clips. The packs are designed for 9 hours of continuous sweeping (100% duty cycle); inter-sweep setup times will extend the life of the pack. Front panel lights indicate to the on-board crew that the node is ready (SYS), connected to the network (NET), and whether it is in use and acquiring (DAQ), as well as which port is active.

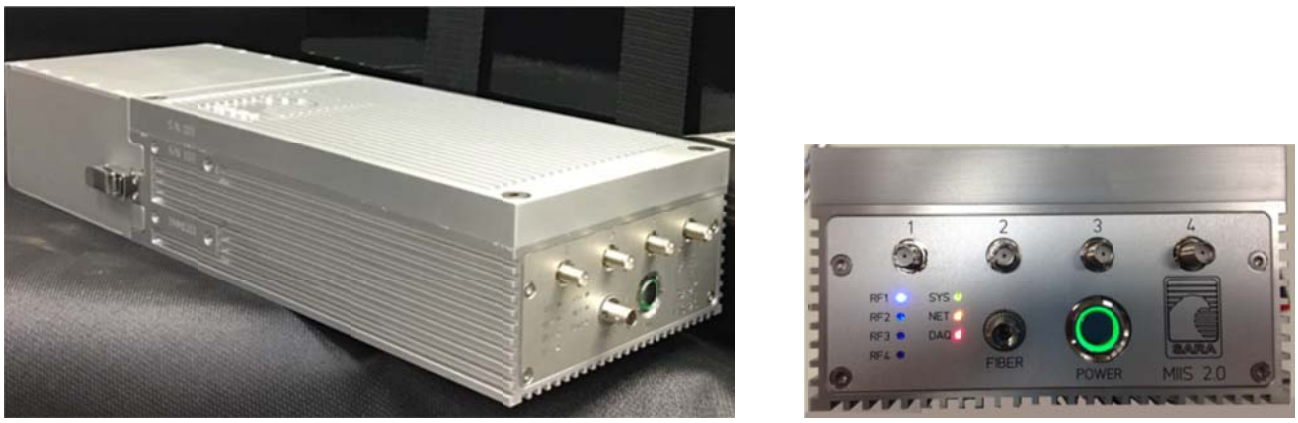


Figure 1: MIIS 2.0 Node. Top Left: Side View. Bottom: Front view with indicators. Dimensions of a node with battery attached are: H: 2.75", L: 15.00", W: 5.00".

CWI-Net 2.0 Control Software

CWI-Net data acquisition control software is reliable and easy to use (see Figure 2). The CWI-Net data acquisition libraries are robust so that even an accidental node disconnects are recoverable, even in mid-sweep, and there is no required power-up sequence for nodes and LAN. All nodes are identifiable in software by the serial number, which is clearly engraved on the node case. The libraries are written in Python, and are callable from existing high level mission control software written in other languages like MATLAB or LabView. This preserves customer investment in legacy tools which embody detailed operational practices and lessons learned, and minimizes up-front retraining time and cost. Benefits include:

- Capable of managing dozens of nodes without requiring software updates
- Choose nodes to scan (if others are not ready)
- Accidental disconnection of a node during a scan does not stop other nodes from completing the scan
- Instant data QC views during and after the scan

Figure 2: CWI-Net 2.0 Control GUI, 8-port fiber optics Ethernet switch, and node interconnected.

CWI-Net 2.0 Integrated Signal Processing Capabilities

SARA has 24 years of experience developing customized toolboxes for DTRA, NAVAIR, the UK MoD, Qinetiq, DARPA, and Northrop-Grumman, based on MATLAB/WIFF/Database software to manage, exchange, QC, and analyze waveforms customizable to facility operational practices. Delivered workstations include Dream, ToDream, IDAWS, TFAWS and CSAWS. These tools are fully integrated with the CWI-Net 2.0 control software and can run by any computer on the digital network. The benefits of SARA's signal processing toolboxes include:

- Time tested user friendly signal processing and database software
  - Based on DTRA SWORD and WIFF Standards
- QC tools
  - Instantly verify signal quality, compare to historical data (for HM/HS)
- Extrapolation tools
  - Bell, DoD, 461, 2169 (for classified machines) etc. built-in
  - Time Domain

    - Norms calculation
    - Minimum phase calculation
- Direct Drive Tools
    - Damped sine fit to norms
    - Stieglitz-McBride and Matrix Pencil damp sine fit
- Wide variety of Import/Export
- Classification Markings on figures

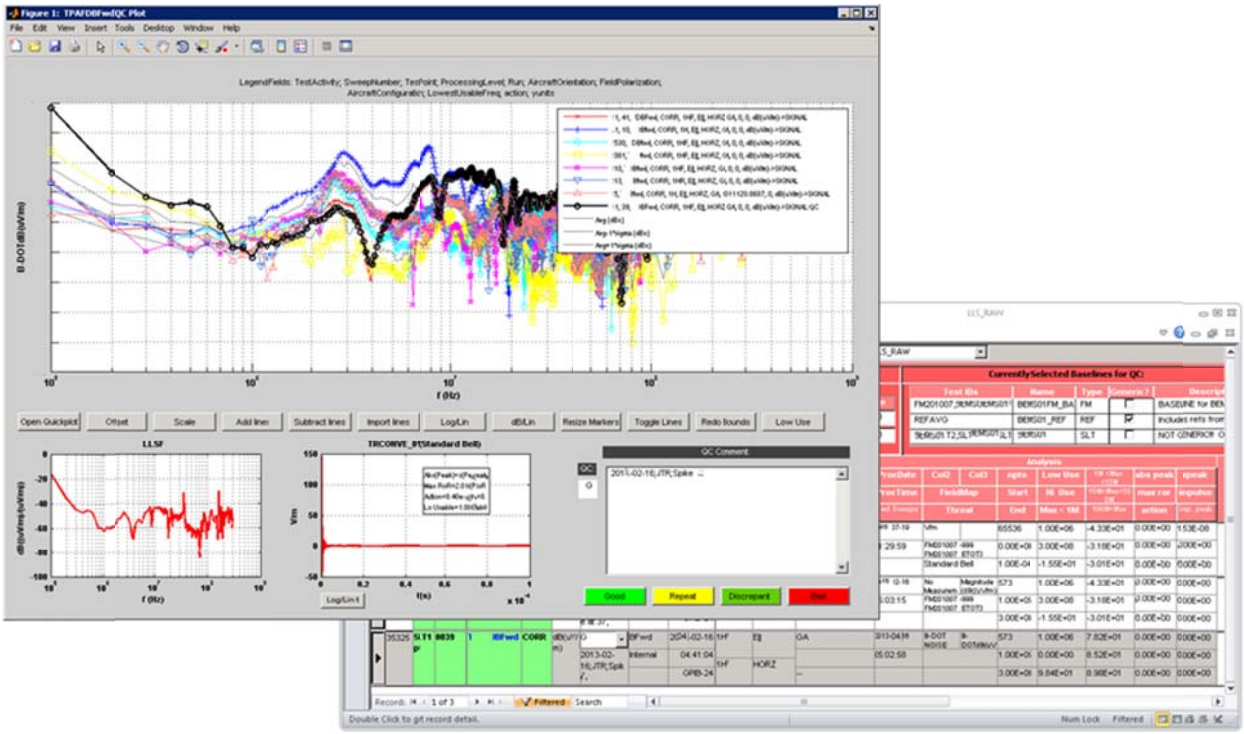


Figure 2: Aircraft test data management and analysis toolkit interface.

CWI-Net 2.0 Hardware Specifications

The data sheet for CWI-Net 2.0 is shown in Table 2.

CWI-Net 2.0 Pricing

Instrumentation pricing will depend on detailed customer specification. Regardless of the customer specifications, the system pricing will be significantly lower than competing Network Analyzer-based systems that depend of analog fiber telemetry.

Please contact SARA for a price quote.

CONTACT US

For more information, please call or email:

- Mr. Justin Eagan (714) 224-4410, jeagan@sara.com
- Mr. John Robinson, (719) 302-3117, jrobinson@sara.com
- Dr. Parviz Parhami (714) 224-4410, pparhami@sara.com

Table 2. CWI-Net 2.0 Data Sheet.

Data Rates

	Frequency Steps per Second				
# Nodes	1	4	6	12	16
10 Hz RBW	4.3	4.2	4.1	4.0	3.8
100 Hz RBW	8.2	7.4	7.5	6.7	6.3
	Average Time per Frequency Step (ms)				
# Nodes	1	4	6	12	16
10 Hz RBW	232	237	242	253	261
100 Hz RBW	122	135	133	150	159

Amplitude

Parameter	Conditions	Value
Signal Inputs		50 Ohm, 4-input
3dB Bandwidth	lower	10 kHz
	upper	1400 MHz
Minimum Detectable Signal Level	100 Hz RBW	-135 dBm
Maximum Input		+0 dBm
Bandpass flatness	10 kHz to 1400 MHz	± 1 dB

Environmental

Parameter	**Conditions**	**Value**
Operational Temp.	Node with battery	-20C to +50C
Storage Temp.	Node without battery	
	Battery	
Power Consumption	Run-Time @ 100% duty cycle	9 hours

Input/Output Connectors

Connector	**Type**
Node Optical Conn.	ST
Node RF Conn.	SMA(F)
Switch Optical Conn.	SFP

Physical Dimensions & Weight

Parameter	**Value**
Dimensions	H: 2.75" (69.85mm) L: 15.00" (381.00mm) W: 5.00" (127.00mm)
Weight (incl. battery)	10.1 lbs

Accessories

4-node Battery Charger Case	8-port Fiber<>Ethernet Switch
4-node Ruggedized Carrying Case	