GPS-Disciplined Rubidium Clock

AR51A-04

Ultra high stability and accuracy
Full military qualification

Key Features

- *Time Accuracy (1PPS): 30ns RMS (50ns under environmental conditions)*
- *Frequency Accuracy: 2E-12*
- *Holdover (without GPS): < 1µs/24 hours*
- *GPS in standalone, common and differential modes*
- *Position Accuracy: 2m (differential mode)*
- *Outputs: 2x10MHz, 14x1PPS (TTL & RS-422), 2x51.2MHz, LAN*
- *Disciplined to GPS or Ext 1PPS*
- *Input and output delay corrections in 10 ns steps*
- *Excellent Phase-Noise under vibration*
- *GPS modes: standalone, differential or common view*
- *Network Time Server: NTP and SNTP server*
- *LAN & RS-232 for command, control and data Operation Temperature: -40 ºC to +55 ºC*
- *22-32 VDC per MIL-STD-704A*

- *1-hour rechargeable battery back-up*
- *Vibration isolator included*
- *Full MIL-STD for military airborne & ground applications*

Description

The AR51A-04 is a fully Militarized GPS-Disciplined Rubidium Clock which offers ultra-high-stability and extraordinary accuracy. The unit is designed for demanding platforms such as airborne, helicopters, UAV's, shipboard and ground mobile. It provides time accuracy of <30ns and < 50ns under all environmental conditions. Frequency accuracy is better than 2E-12. The unit has multiple outputs with very low phase-noise under vibration. Receiver operation modes are: standalone, differential or common-view.

The unit includes a militarized Rubidium-Atomic-Standard which is phase-locked to the GPS or to other external inputs. All outputs are derived from the Rubidium-Atomic-Standard that maintains accurate time and frequency even when GPS reception is interrupted.

The AR51A-04 has been qualified for operation in harsh environments. It was tested for wide temperature range, vibration, shock, altitude, EMI (see more details in the specification). In addition the AR51A-04 was tested by a GPS simulator in many modes of operation and passed real flight tests.
The unit includes a rechargeable battery module which is easily disconnected for ease of maintenance.

Applications

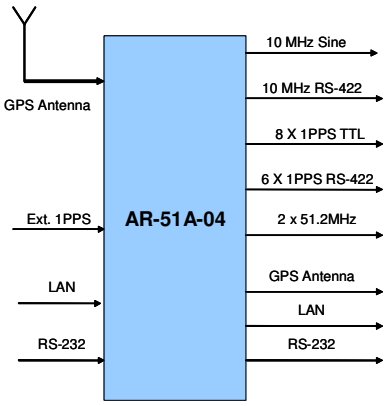
- Secure Communication
- ELINT Receivers
- Electronic warfare
- Radar, Bi-static Radar
- Field calibration
- Telemetry test fields
- C4I (Command, Control, Communications, Computer & Intelligence)

SPECIFICATIONS

All specs are at room temperature, quiescent conditions, sea level ambient unless otherwise specified

Input & Outputs

Outputs	10 MHz Sine wave 12±2dBm / 50Ω
	10 MHz Clock RS-422
	8 X 1PPS TTL 50 Ω, 300µs Puls width, Rise Time < 10ns
	6 X 1PPS RS-422, 300µs Plus width, Rise Time < 10ns
	2 x 51.2 MHz Sine wave 15dBm±2dBm / 50Ω
	GPS antenna (15 VDC)
	LAN: NTP & SNTP for time, navigation, status and BIT
Input	Ext. 1 PPS (for locking to external source)
	GPS Antenna
	LAN for command, control and data: setting time/date, delay correction for 1PPS 10ns steps, mode of operation (disciplining GPS, to Ext 1PPS, holdover, UTC time, GPS Time, Local Time, Day Light Saving) etc.. (see IDD document for more information)
Monitor & Control	RS-232 for command, control and data: setting time/date, delay correction for 1PPS 10ns steps, mode of operation (disciplining GPS, to Ext 1PPS, holdover, UTC time, GPS Time, Local Time, Day Light Saving) etc....(see CLI document for more information)



Performance

			Mode of operation:	**Disciplined to GPS or to Ext. 1PPS**	**Free running Rubidium-Standard (holdover)**
Time (1PPS)	**Long- term Accuracy**			<30 ns RMS; < 50ns RMS under environmental conditions	< 1µs/day (typical), 5µs/week (typical)
Frequency	**Long Term Stability**			<2E-12	5E-11 / month drift in holdover
	Short Term Stability			<3E-11 @ 1sec ; <3E-12 @ 100sec	
	Temperature Stability			±3E-10 over -40℃ to +55℃ ; ±2.5 E-10 over -40℃ to +55℃ (typical)	
	Phase Noise			Quiescent	Under Vibration (including Shock Mount) Typical
		10MHz		<-95 dBc/Hz @ 10Hz <-130 dBc/Hz @ 100Hz <-148 dBc/Hz @ 1KHz <-152 dBc/Hz @ 10KHz	<-90 dBc/Hz @ 10Hz <-128 dBc/Hz @ 100Hz <-140 dBc/Hz @ 1KHz <-155 dBc/Hz @ 10KHz
		51.2MHz		<-100 dBc/Hz @ 10Hz <-130 dBc/Hz @ 100Hz <-140 dBc/Hz @ 1KHz <-140 dBc/Hz @ 10KHz	<-72 dBc/Hz @ 10Hz <-115 dBc/Hz @ 100Hz <-130 dBc/Hz @ 1KHz <-144 dBc/Hz @ 10KHz
	Harmonics (10MHz)			-45 dBc	
	Spurious (10MHz)			<-85dBc (±100KHz from carrier) <-75dBc (offset>100KHz from carrier)	
	Warm-up			5E-10 within <7 min, 5E-11 within < 60 min, 1E-11 within <4hrs	
RS232 Output	**Serial Time & Location**			Time, date, location and status, 19,200bps, 1 frame/sec	
	Protocol (RS232)			10 frames/sec	
LAN				NTP, SNTP	
				10/100 Base-T - All Commands, Control and Communication, TOD, Location. Support any client which comply for NTP Standards protocol ver. 3.0	

[Hz]	BW [Hz]	[G^2/Hz]	Background
68	7	0.300	15-2000 Hz 0.010 G^2/Hz
136	14	0.075	
204	20	0.033	
272	27	0.019	

SPECIFICATIONS *(continu)*

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Power Supply	
Operating Voltage	28 VDC per MIL-STD-704A
Current	<2.5A @ warm-up ; <1A @steady state 25℃
Battery Back-Up	1 hour operation (25℃) 16 hours charge

GPS Receiver		
General	L1, C/A code, 12 channel continuous tracking, All-In-View	
Dynamic	Velocity 0 to 515 m/s, Acceleration 4g, Jerk 4g/s	
Altitude	–1000 to 18000 m	
Update data	10 Hz	
Accuracy (PDOP<3, W/O SA)	Position	2 m RMS in differential modes ; 3 m RMS in common mode ; 15m RMS in standalone mode
	Velocity	0.05 m/s RMS
1PPS Accuracy	40 ns RMS	
TTFF (Time To First Fix)	20 sec typical (with current ephemeris) ; 50 sec typical (without ephemeris); Cold Start: 2 min typical (@25C)	

GPS Antenna			
Available Antenna	**Airborne** *(AccuBeat P/N: EM30035)*	Frequency:	L1,L2 GPS ANTENNA: 1227 MHz ±10 MHz; 1575 MHz ± 10 MHz
		Gain:	36 dB ± 2db
	Ground *(AccuBeat P/N: EM30036)*	Frequency:	L1 GPS Antenna
		Gain:	36 dB

Dimensions & Weight		
Without vibration isolator	Dimensions	241 (w) x 128 (h) x 246 (d) mm
	weight	4.0 kg
With vibration isolator tray and battery module	Dimensions	280 (w) x 183 (h) x 352 (d) mm
	Weight	8.0 Kg (Unit + 2.5 kg battery + 1.5 kg shock absorber tray)

Environmental	
Temperature	Operating: -40℃ to +55℃ Storage: -40℃ to +85℃
Temperature/ Altitude	MIL-STD-810C. Method 520.1, procedure III modified, 45000 feet (with internal battery 9000feet
Vibration	MIL-STD-810D, Method 514.3 Cat.6 Level 0.01g²/Hz 2 hours per axis (with Shock Mount) Various vibration spectra 5-2000 Hz with 5.2 g RMS, 2 hours per axis.
Transportation vibration	MIL-STD-810D, Meth.514.3, Cat. I Fig. 514,3-1,2,3 (1Hr per Axis)
Bench-handling Shock	MIL-STD-810E, Method 516.4, Proc. 6
Shock (operation)	MIL-STD-810E, Method 516.4, Proc 6, (20g, ramp, 11msec 3 axis total 18 Shocks –all with Shock Mount)
Crash Safety Shock	MIL-STD-810E, Method 516.4, Proc 6, (40g, ramp, 11msec 3 axis total 12 Shocks –all with Shock Mount)
Rapid decompression	MIL-STD-810E, Method 500.3, Procedure 3
Explosive atmosphere	MIL-STD-810E, Method 511.3, Procedure 1
EMI / RFI	MIL-STD-461C, CE03, CS01,CS02, CS06, RE01, RE02, RS01, RS02, RS03, CE06,CS03, CS04, CS05 RTCA/DO160-Lighting induced curent, bulk cable injection
Humidity	95% RH, MIL-STD-810E, Method 507.3, Proc. I Cycle 3 Fig 507.3-1
Dust	MIL-DTD-810E Method 510.3
Water drip	MIL-STD-810E, Method 506.3, Procedure 2
Fungus	MIL-STD-810E, Method 508.4 analysis
Salt Fog	MIL-STD-810E, Method 509.3, Procedure 1 analysis

Reliability, Maintainability, Testability		
MTBF		6,713 Hrs. 45℃,AUC; 9,014 Hrs. 30℃,AUC; as per MIL-HBK-217F N2 (Include battery)
Built-In-Test (BIT)		87% - O level; 90% - I level
Display LED's		Lock to Rb, Lock to GPS, Lock to External, LAN, Power and Battery
MTTR	**O Level**	17 min to replace failed unit
	I Level	37 min to replace failed module

SPECIFICATIONS *(continu)*

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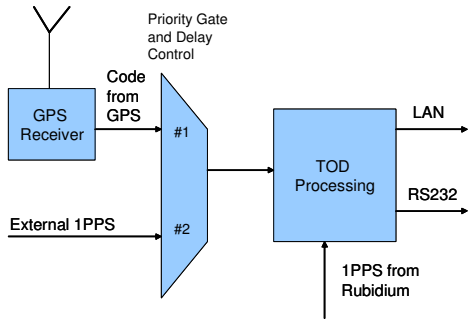
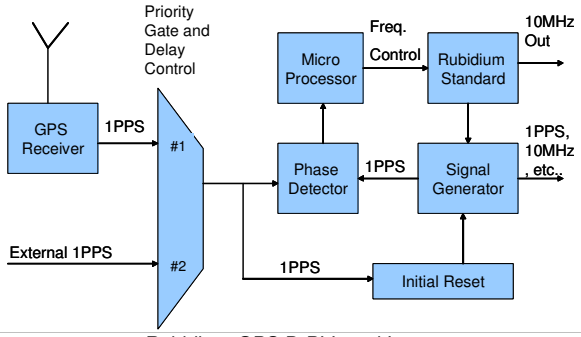
Principles of Operation

The following block diagrams depict the operation of the AR51A-04. The unit includes a Rubidium Standard and accepts Input from either internal GPS receiver or external 1PPS signal. All outputs are derived from the internal Rubidium Clock, which is phase locked via a digital PLL to the internal GPS receiver or to the external input. Thus, the Rubidium Clock - frequency and time - follows the GPS on average. If GPS reception is lost for a time period, the Rubidium Clock continues to maintain accurate time and frequency. The unit can control, via LAN, GPS and external 1PPS inputs and output delay corrections.

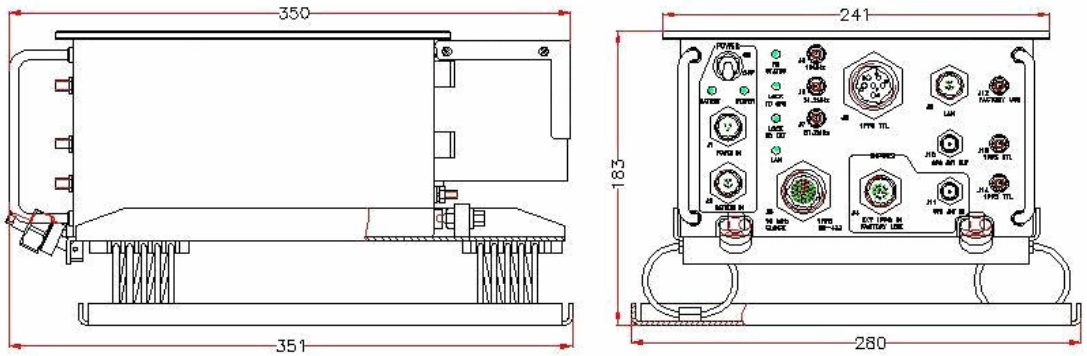


Data flow & Inputs Selection



Rubidium-GPS D-PLL and Inputs

Mechanical ICD



Electrical ICD

Connector	Type
J1 - Supply	D38999/24WA98PN
J2 – Battery in	D38999/24WD35SN
J3 – 10MHz Clock and 6X 1PPS RS-422 outputs	D38999/24WD35SB
J4 – Extern lock Input and Factory use	D38999/24WB35SN
J5 – 10 MHz sine output	SMA
J6 and J7 other frequency	SMA
J8 - 6X 1PPS TTL outputs	D38999/24WE06BN
J9 – LAN	D38999/24WA35SA
J10 – GPS Antenna output	TNC
J11 – GPS Antenna Input	TNC
J12 – Factory use	SMA
J13 and J14 – 1PPS TTL	SMA

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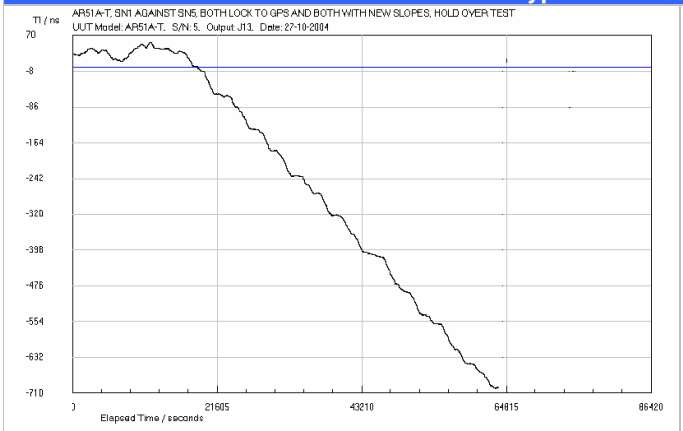
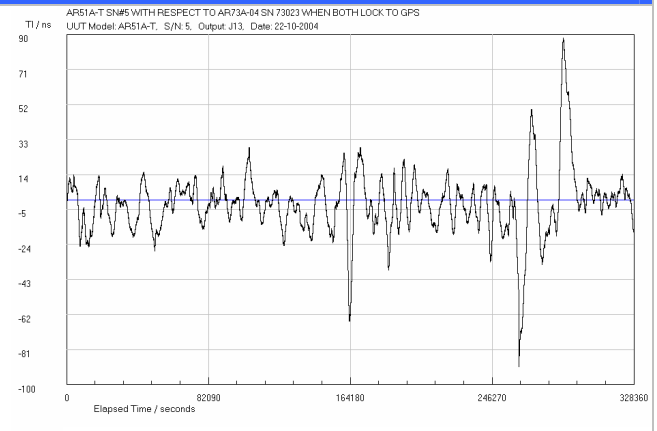
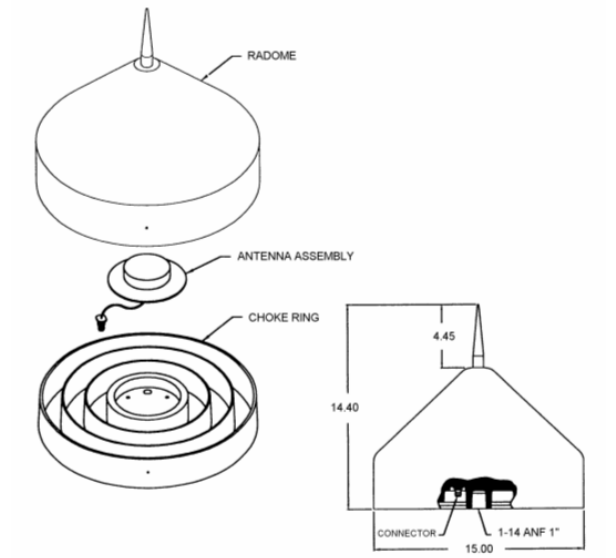
Typical Performance Plots



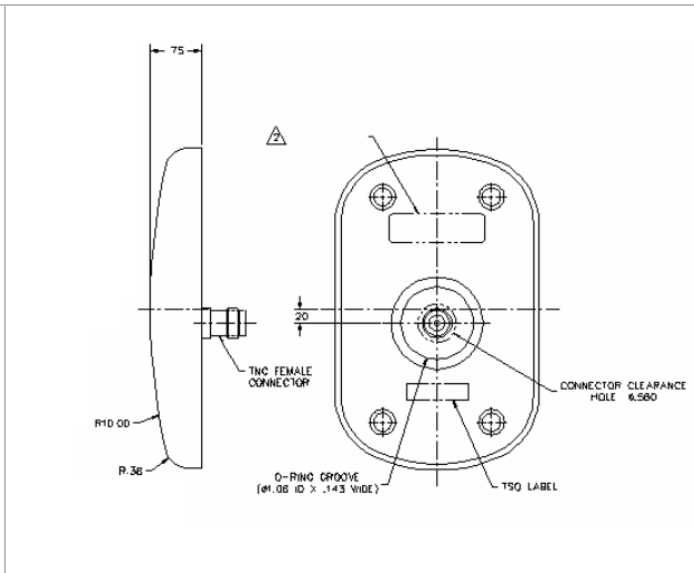
Typical time error in Holdover (without GPS) – 710ns in ~64000s



Typical time error fluctuations when disciplined to GPS



Ground Antenna



Airborne Antenna

HOW TO ORDER

ACCESSORIES	AccuBeat P/N:
AR51A-04	AR51004
Battery	AA50408
Vibration isolator	MU50012
Airborne L1,L2 GPS Antenna 36 dBm	EM30035
Ground L1 GPS Antenna 36 dBm	EM30036
Antenna Cable	Contact Factory

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