Racal Instruments
http://www.racalinstruments.com

PRODUCT INFORMATION

Time and Frequency Distribution System Model 9480

- **Modular Design Features Plug-In Power Supply and Output Cards**
- **Up to 40 Buffered Frequency Outputs**
- **Ovened or Atomic Standard Options**
- **AC or DC Operation**
- **1 Pulse-Per-Second and Reference Monitor Outputs**
- **Optional Redundant Frequency Changeover and Battery Backup**

Introduction

The 9480 Time and Frequency Distribution System is a modular frequency standard, time standard, and distribution system. It offers a high degree of flexibility for designers of calibration/repair facilities, satellite systems, test systems, and other applications requiring distribution of a frequency and/or time standard.

System capabilities vary from a simple 5-output distribution amplifier card to a complex frequency standard with multi-frequency outputs referenced to both primary and secondary standards.

With field-upgradable options, the 9480 enables users to “build up” the system over a period of time at minimum expense.

Description

The time and frequency mainframe is the heart of the 9480 system. It houses both the power supply and frequency-management sub-system. The mainframe has the capacity for an oven-controlled crystal oscillator or a rubidium frequency standard, an optional battery backup supply, and up to eight, 5-output, distribution amplifier cards. Up to 40 outputs can be distributed from one mainframe.

The instrument operates from a wide range of AC power voltages with the ability to additionally operate via an external DC supply. Upon AC power failure, the unit automatically switches to the external DC supply (if connected). Users may add an optional battery backup capability for maintaining power to the frequency standard in absence of both the mains and external DC power. Front-panel indicators designate which power source is in use.

The 9480 series offers a 1-pulse-per-second and 10 MHz output on the front panel. In addition, users may select five-output distribution amplifier cards with output frequencies of 100 kHz, 1 MHz, 5 MHz, 10 MHz, 13 MHz, or 2.048 MHz.

Applications

The Model 9480 is ideally suited to almost any requirement for a precision time reference, frequency reference, and/or distribution system.

When used for UHF Quasi-Sync or Simulcast system testing, the flexible number of outputs and frequencies remains ideally suited for phase-locking transmitter/receiver base stations. The rubidium standard achieves the desired stability without the need for frequent oscillator calibration or expensive environmental control. When used for satellite ground stations and calibration laboratories, a wide-range of options, including specialized low-noise standards, are available.

Selecting A 9480 System

When selecting a frequency and/or time standard and distribution system, consider the following:

- Frequency standard performance
- Power supply requirements
- Number and frequency of outputs

Using the 9480 With External Frequency Standards

The 9480 series can be used as a frequency distribution system fed by an existing external standard. Users may additionally install an internal standard (see below) as a back-up reference. The 9480 will then automatically switch to its internal standard if the external input is lost, fails, or is removed for calibration.

Internal Standard Options

The 9480 series offers a range of frequency standard options suited for internal fitting. They include an ovened crystal oscillator, low-phase noise, high stability, and a choice of highly-stable rubidium standards.

When selecting a frequency standard, consider the following parameters:

- Aging
- Short-term stability
- Phase noise
- Retrace

Aging

Aging refers to the process by which an oscillator's frequency changes with time, specified in fractions of a Hertz per time period. Also known as long-term stability, aging specifically refers to periods of one day or more.

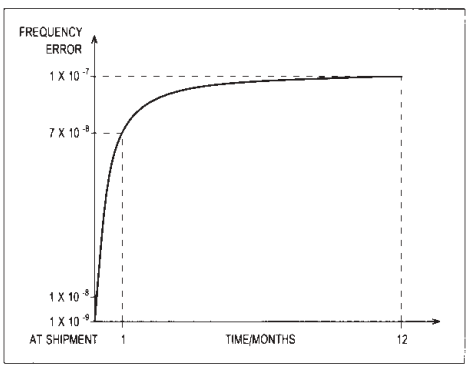

Figure 1. Typical Aging Characteristic

In general, aging occurs exponentially and is greatest during the first month of operation. Figure 1 depicts the typical accuracy characteristic of a high-stability, ovened crystal oscillator in the first year of operation

In some instances, high-quality crystal oscillators may not be sufficient for applications such as UHF quasi-sync or Simulcast Systems, where accuracies approaching 1×10^{-9} are required. Such accuracies are achievable with a crystal but will require frequent adjustment and careful temperature control. In contrast, a rubidium oscillator would only drift by 1×10^{-10} per year.

Although rubidium standards are more expensive than crystal oscillators, they maintain a longer calibration cycle than crystal, which can save costly calibration downtime.

Short-Term Stability

Short-term stability is the characterization of oscillator-frequency changes over periods shorter than 100 s.

An Allan Variance calculation is often used to characterize the short-term stability of precision oscillators. This statistical method presents the average variance in frequency over a given time and selected sample interval.

Phase Noise

Phase noise measures the random fluctuations in frequency or phase due to noise. It is normally measured in a 1 Hz bandwidth at various offsets from the fundamental frequency. The standard generates close-to-carrier phase noise. At offsets of 1 MHz or more, noise may occur due to the frequency distribution system. The 9480 was designed with special low-noise amplifier technology throughout to minimize phase noise.

Retrace

Many reference oscillators, particularly quartz, experience a frequency offset known as retrace error, caused by removing and re-applying power as described in Figure 2.

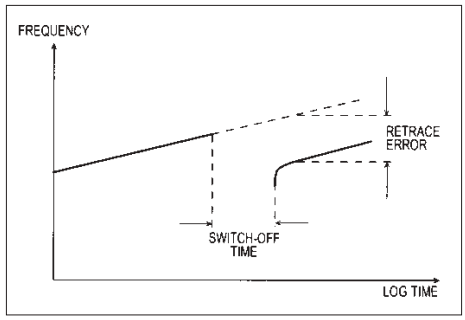

Figure 2. Retrace Error

In order to prevent retrace error, the 9480 can be fitted with an internal battery option, which maintains supply to the oscillator in the event of the loss of unit power.

Available Standards

04A is a fast warm-up, oven-controlled crystal oscillator with an aging characteristic of 3×10^{-9}/day; warms-up in less than 6 minutes.

04F is a precision oven-controlled crystal oscillator combining 2×10^{-10}/day aging with very low phase noise.

FR-LP is a new, low cost, highly stable rubidium atomic oscillator with a one-month drift of 5×10^{-11}; warms-up in less than 11 minutes.

FRK-H is an ultra-stable rubidium atomic oscillator with a one-month drift of 1×10^{-11}.

Power Supplies

The 9480 Series has a flexible power supply. Available configurations ensure the maintenance of a continuously power frequency standard, thus eliminating retrace problems. The primary power ranges from 90 to 254 VAC; with power absent, the unit automatically selects an externally applied 23.4-30 VDC (if present). If DC is absent, the 9480 selects the internal rechargeable battery (optional) for maintaining continuous power to the reference for at least one hour.

Frequency and Number of Outputs

There are up to 8 plug-in output distribution cards at the year of the 9480 mainframe. Each output card contains 5 buffered outputs available in frequencies of 100 kHz, 1 MHz, 5 MHz, 10 MHz, and 13 MHz. Also available are 2.048 MHz and 13 MHz TTL output cards.

Front panel LEDs continuously monitor and report output card status.

Dual Redundancy Configuration

When the availability of a frequency standard is of critical importance, a 9480 system can be configured to have both primary and secondary external standards. In this case (see Figure 3), by utilizing a reference changeover card (RCO option), the 9480 automatically changes over to an external secondary frequency standard if the external primary standard fails.

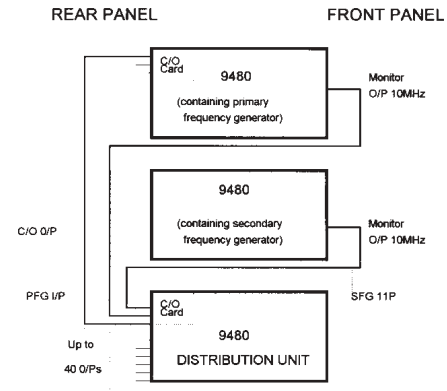

Figure 3. 9480's configured for high availability of the Frequency Standards using the RCO option.

High Reliability

Racal has many years of experience in the supply and manufacture of frequency standards and distribution systems. The 9480 series is constructed with proven components and assemblies. The power supply module, distribution cards, and external reference cards are all pluggable enabling rapid fault identification and minimal repair time.

Future Expansion

The 9480 series allows future expansion at minimal cost. For example, if more outputs are required then only additional output cards need be purchased. Upgrading from a quartz standard to a rubidium is also possible, without the need to purchase an additional mainframe.

9480 SPECIFICATIONS

OUTPUT CHARACTERISTICS

Available Frequencies (sinewave)
100 kHz, 1, 5, 10, and 13 MHz

Available Frequencies (TTL)
2.048 and 13 MHz

Card Outputs (per card)
Channels: 5
Frequencies: 1

Mainframe Outputs (max)
Cards per Mainframe: 8
Channels per Mainframe: 40

Amplitude
Sinewave: +13 dBm ±2 dBm, 50 Ω
TTL: 5 V, nominal

VSWR
< 1.3:1

Isolation
Between Outputs: > 40 dB
Between Cards: > 60 dB

Output Protection
Short Circuit: Indefinite
Reverse Power: < 500 mW
Applied DC: < 30 V

Spectral Purity
Harmonics: < -35 dBc
Sub-harmonics: < -70 dBc
Spurious: < -70 dBc

TIMEBASE CHARACTERISTICS

Ovened Quartz (Option 04A)
Aging Rate: 3 x 10^{-9}/day
Warm-up @ 25° C : < 6 min. to 1 x 10^{-7}
Accuracy at Shipment: ±1 x 10^{-8}

Ovened Quartz (Option 04F)
Aging Rate: 2 x 10^{-10}/day, 3 x 10^{-8}/year
Allan Variance: 5 x 10^{-11} over 10 s
Phase Noise: -145 dBc/Hz @ 1 kHz offset
Warm-up @ 25° C : < 20 min. to 1 x 10^{-8}

Rubidium FR-LP (Option FR-LP)
Frequency Drift: 5 x 10^{-11}/month
Frequency Retrace: ±2.5 x 10^{-11}
Allan Variance: 2.5 x 10^{-12} over 100 s
Phase Noise (1 Hz offset): -75 dBc/Hz
Phase Noise (10 Hz offset): -89 dBc/Hz
Phase Noise (100 Hz offset): -128 dBc/Hz
Phase Noise (1 kHz offset): -140 dBc/Hz
Phase Noise (10 kHz offset): -147 dBc/Hz
Warm-up @ 25° C < 11 min. to 4 x 10^{-10}

Rubidium FRKH (Option FRKH)
Frequency Drift: ±1 x 10^{-11}/month
Allan Variance: < 1 x 10^{-12} over 100 s
Warm-up @ 25° C < 10 min. to 2 x 10^{-10}

External Standard Input
Frequency (standard): 10 MHz
Frequency (Opt DIV): > 1 MHz, sub-multiple of 10 MHz
Input Range: 100 mV to 1 Vrms
Maximum Input: 5 Vrms
Input Impedance: 50 Ω

PANEL I/O

Front Outputs
Monitor: 10 MHz, 0.3 Vpk-pk, BNC, 50 Ω
1 PPS: 1 Pulse/second, 0.3 Vpk-pk, BNC, 50 Ω

Front Indicators
Output Failure: One per output card, flashes on failure
Frequency Lock: On when frequency standard is locked
External Input: On when external standard is applied
Power Source: Three (3) LED's, AC, DC or Battery
Alarm: On for any failed output.

Front Controls
Reset Button: Resets latched alarm
Adjust: Frequency standard fine adjustment (recessed)

Rear Inputs

External Reference (standard): BNC, 10 MHz
External Reference (opt DIV): BNC, ≥ 1 MHz, sub-multiple of 10 MHz
Diagnostic: 9-pin D-Sub, reset, AC/DC*, Osc. Lock, Rb control, Ext. Ref. Present, Batt. On, Alarm
DC Input: 2-pin, polarized connector, fused, reverse-protected
AC Input: 90-254 V, fused

OPTIONAL FEATURES

Option DIV

Enables the use of an external reference ≥ 1 MHz and a sub-multiple of 10 MHz

Option BBU

Battery backup maintaining power for ≥ 1 hour to the internal reference if AC and DC power fail

Option PSO

Power-supply service option allows removal of PSU for service without power loss to the 9480

Option RCO

Reference changeover option when primary and secondary external references are used

GENERAL

Power Requirements

AC: 90-127 V, 193-254 V, 45-440 Hz, 60 VA max
DC: 23.4-30 VDC, 1.5 A max after warm-up, fused, reverse power protected
BBU (optional): Internal rechargeable battery

Voltage Range Selection

Rear panel switch

Accessories Furnished

19" Rack Mount, Handles, Power Cord, User's Manual

ENVIRONMENTAL

Temperature

Operating: 0° C to 50° C
Storage: -40° C to 70° C

Humidity

95% RH @ 40° C

Weight

Without BBU: 33.5 lbs. (12.5 kg)
With BBU: 37 lbs. (13.8 kg)

Dimensions

5.37" H x 16.73" W x 18.52" D

EMC

CE, Mil-Std-461C, RE02 (<1GHz), CE03, CS02, CS06, RS03

Safety

CE, EN61010-1

ORDERING INFORMATION

Model	Description	Part Number
9480	Time and Frequency Mainframe	R-9480
	Frequency Standards	
Option FRKH	High-Stability Rubidium Frequency Standard	R-11-9047
Option FR-LP	Rubidium Frequency Standard	R-11-9214
Option 04F	Low Phase Noise Oscillator	R-11-9062
Option 04A	Fast Warm-up Oscillator	R-11-9048
	Output Cards	
Option 10	5 x 10 MHz Output Card	R-11-9077
Option 5	5 x 5 MHz Output Card	R-11-9048
Option 1	5 x 1 MHz Output Card	R-11-9079
Option 100	5 x 100 kHz Output Card	R-11-9080
Option 13	5 x 13 MHz Output Card	R-11-9076
Option 13A	5 x 13 MHz TTL Output Card	R-11-9111
Option 2048	5 x 2.048 MHz TTL Output Card	R-11-9081
	Other Options	
Option BBU	Battery Backup (> 1 Hour)	R-11-9044
Option DIV	Allows integer divisions of an external 10 MHz to be accepted	R-11-9082
Option RCO	Reference Changeover Card	R-11-9087

Example: Model 9480/FR-LP 2 x -10/-5/-BBU is a 9480 mainframe with FR-LP rubidium standard, two 10 MHz output cards, one 5 MHz output card and, battery backup option. Supplies:

- 10 x 10 MHz outputs
- 5 x 5 MHz outputs
- All with Rubidium, 5 x 10^{-11} stability.
- Battery backup capability

CE The CE Mark indicates that the product has completed and passed rigorous testing in the area of RF Emissions, Immunity to Electromagnetic Disturbances and complies with European electrical safety standards.

Racal Instruments, Inc., 4 Goodyear St., Irvine, CA 92618-2002. Tel: (800) RACAL-ATE, (800) 722-2528, (949) 859-8999; FAX: (949) 859-7139
Racal Instruments Ltd., 480 Bath Road, Slough, Berkshire, SL1 6BE, United Kingdom. Tel: +44 (0) 1628 604455; FAX: +44 (0) 1628 662017
Racal Systems Electronique S.A., 18 Avenue Dutartre, 78150 LeChesnay, France. Tel: +33 (1) 3923 2222; FAX: +33 (1) 3923 2225
Racal Systems Elettronica Srl, Strada 2-Palazzo C4, 20090 Milanofiori Assago, Milan, Italy. Tel: +39 (0)2 5750 1796; FAX +39 (0)2 5750 1828
Racal Instruments GmbH, Technologiepark Bergisch Gladbach, Friedrich-Ebert-Strasse, D-51429 Bergisch Gladbach, Germany. Tel: +49 2204 8442 00; FAX: +49 2204 8442 19
Racal Australia Pty Ltd., 3 Powells Road, Brookvale, NSW 2100, Australia. Tel: +612 9936 7000; FAX: +612 9936 7036

RACAL

2.0 9-01