



8040C/8040CLN Rubidium Frequency Standard User Guide

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Revision History

Revision	Date	Change
C.	12 July 2011	Added low phase noise option 8040CLN.

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About this User Guide

Purpose

The 8040C/8040CLN User Guide describes the procedures for unpacking, installing, using, maintaining the 8040C/8040CLN.

Conventions

This guide used the following conventions:

Acronyms and Abbreviations – Terms are spelled out the first time they appear in text. Thereafter, only the acronym or abbreviation is used.

Revision Control – The title page lists the printing date and versions of the product this guide describes.

Typographical Conventions- This guide uses the typographical conventions described in the Table 1 below.

Table 1. Text Formats and Their Meanings

Text that appears this way...	... is
Product User Guide	A document title
SSU CRITICAL	An operating mode, alarm state, status, or chassis label
Select File , Open ...	A menu item to be selected by the user
Press Enter	A named keyboard key
Username :	Command line input or output
A <i>re-timing</i> application	Emphasis on a word or term
Symmetricom does not recommend	Special emphasis on a word or term

Special Notices

Warnings, Cautions, Recommendations, and Notes attract attention to essential or critical information in this guide. The types of information included in each are explained in the following examples.



WARNING All warnings have this symbol. Do not disregard warnings. They are installation, operation, or maintenance procedures, practices, or statements that if not strictly observed, may result in personal injury or loss of life.



ELECTRICAL SHOCK HAZARD All electrical shock hazard warnings have this symbol. To avoid serious personal injury or death, do not disregard electrical shock hazard warnings. They are installation, operation, or maintenance procedures, practices, or statements that if not strictly observed, may result in personal injury or loss of life.



CAUTION All cautions have this symbol. Do not disregard cautions. They are installation, operation, or maintenance procedures, practices, conditions, or statements that if not strictly observed, may result in damage to or destruction of equipment or may cause a long-term health hazard.



CAUTION All Electrostatic Discharge (ESD) cautions have this symbol. They are installation, operation, or maintenance procedures, practices, conditions, or statements that if not strictly observed, may result in electrostatic discharge damage to, or destruction of, static sensitive components of the equipment.



RECOMMENDATION All recommendations have this symbol. Recommendations indicate manufacturer-tested methods or known functionality. They contain installation, operation, or maintenance procedures, practices, conditions, or statements that provide you with important information for optimum performance results.



NOTE All notes have this symbol. Notes contain installation, operation, or maintenance procedures, practices, conditions, or statements that alert you to important information that may make your task easier or increase your understanding.

Limited Product Warranty

1. Hardware and embedded software - For a period of one (1) year from date of shipment by Symmetricom, Symmetricom warrants that all Products shall be free from defects in design, material, and workmanship; shall conform to and perform in accordance with Symmetricom's published specifications, if any; shall be free and clear of any liens and encumbrances; and shall have good and valid title. This warranty will survive inspection, acceptance, and payment by Buyer. Symmetricom does not warrant that the operation of such Products will be uninterrupted or error free. This warranty does not cover failures caused by acts of God, electrical or environmental conditions; abuse, negligence, accident, loss or damage in transit; or improper site preparation.

This warranty shall be null and void in the event (i) Buyer or any third party attempts repair of the goods without Symmetricom's advance written authorization, or (ii) defects are the result of improper or inadequate maintenance by Buyer or third party; (iii) of damage to said goods by Buyer or third party-supplied software, interfacing or supplies; (iv) of improper use (including termination of non-certified third party equipment on Symmetricom's proprietary interfaces and operation outside of the product's specifications) by Buyer or third party; or (v) the goods are shipped to any country other than that originally specified in the Buyer's purchase order.

Goods not meeting the foregoing warranty will be repaired or replaced, at Symmetricom's option, upon return to Symmetricom's factory freight prepaid; provided, however that Buyer has first obtained a return materials authorization number ("RMA Number") from Symmetricom authorizing such return. The RMA Number shall be placed on the exterior packaging of all returns. Symmetricom will pay shipping costs to return repaired or replacement goods to Buyer. Symmetricom reserves the right to disallow a warranty claim following an inspection of returned product. When a warranty claim is questioned or disallowed, Symmetricom will contact Buyer by telephone or in writing to resolve the problem.

2. Software - Symmetricom warrants that for a period of ninety (90) days from date of shipment by Symmetricom the accompanying media will be free from defects in materials and workmanship under normal use. The physical media warranty does not apply to defects arising from misuse, theft, vandalism, fire, water, acts of God or other similar perils. Symmetricom will not be liable for any damages caused by the Buyer's failure to fulfill its responsibilities as stated above.

3. THE FOREGOING WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, ANY IMPLIED WARRANTIES OF TITLE, MERCHANTABILITY, OR FITNESS FOR A PARTICULAR PURPOSE HOWSOEVER ARISING.

4. Limitation of Liability - The remedies provided herein are the Buyer's sole and exclusive remedies. In no event or circumstances will Symmetricom be liable to Buyer for indirect, special, incidental or consequential damages, including without limitation, loss of revenues or profits, business interruption costs, loss of data or software restoration, or damages relating to Buyer's procurement of substitute products or services. Except for liability for personal injury or property damage arising from Symmetricom's negligence or willful misconduct, in no event will Symmetricom's total cumulative liability in connection with any order hereunder or Symmetricom's Goods, from all causes of action of any kind, including tort, contract, negligence, strict liability and breach of warranty, exceed the total amount paid by Buyer hereunder. SOME JURISDICTIONS DO NOT ALLOW CERTAIN LIMITATIONS OR EXCLUSIONS OF LIABILITY, SO THE ABOVE LIMITATIONS OR EXCLUSIONS MAY NOT APPLY TO ALL BUYERS.

Introduction

Overview

This manual contains procedures and information for proper installation and operation of the Symmetricom 8040C/8040CLN Rubidium Frequency Standard.

Purpose of Equipment

The 8040C/8040CLN is a highly accurate and stable Rubidium frequency reference standard that provides atomic clock performance in a user-configurable 1 U rack-mount chassis. Each of the connectors can be individually programmed to generate any of the following frequency outputs:

- 1, 5 or 10 MHz sine wave
- 1, 5 or 10 MHz square wave
- 1 PPS

The 8040C uses Symmetricom's model SA.22C Rubidium as its internal oscillator, and provides direct user control via an RS-232 to perform the following tasks:

- Adjust the SA.22C Rubidium oscillator frequency.
- Syntonize (tune) the SA.22C to an external 1 PPS input.

Factory Configurations

Part Number	Description
15230-101	Six Outputs, Standard Performance.
15230-102	Twelve Outputs, Standard Performance.
15230-104	Six Outputs, Low Phase Noise
15230-105	Twelve Outputs, Low Phase Noise
15230-106	Twelve Outputs (all 10MHz sine), Standard Performance
15230-111	Twelve Outputs (all 10MHz sine), Low Phase Noise, DC power

Installation

Mounting

The Symmetricom 8040C mounts in standard 19-inch equipment racks, and takes up 1U of vertical space (1.75"). The chassis depth is 12 inches. For best performance, the operating environment should have a stable temperature. In addition, ensure that there are no strong magnetic fields (>2 gauss) in the vicinity of the shelf since the unit's Rubidium oscillator is sensitive to DC and AC magnetic fields.

Power Connection/Fuse/Voltage

The Symmetricom 8040C is powered from an AC source or optionally from a 24VDC source. (See Power Requirements, page 15). The AC fuse is located inside the AC connector/filter on the rear panel. To change the fuse, open the cover on the rear panel AC connector by applying a screwdriver to the connector's cover slot. Once the cover is open, the fuse holder may be removed for inspection or replacement.

The Symmetricom 8040C/8040CLN may be powered from 90 or 240 VAC. The 8040C automatically detects the input voltage therefore no manual configuration is required.



ELECTRICAL SHOCK HAZARD - Use a locally approved power cord or power cord adapter for connection to the power source.

Signal Connections

Output signal cables may be connected in any order to the rear panel BNC connectors.

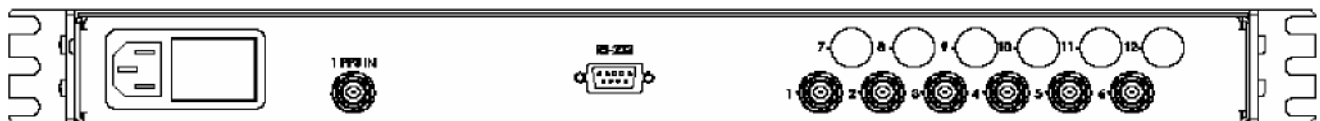


Figure 1: 8040C/8040CLN Standard Configuration – Rear Panel

Output Signals

The standard Symmetricom 8040C/8040CLN has six BNC output connectors. The outputs are factory-programmed as described in Table 2.

Table 2: Factory Settings for Standard Outputs

BNC #	Signal
1	10 MHz Sine wave
2	10 MHz Sine wave
3	10 MHz Sine wave
4	5 MHz Sine wave
5	1 MHz Sine wave
6	1 PPS
7–12	Optional. Not included in the base configuration

Input Signals

The 1 PPS IN connector takes a 1 PPS input from an external source, such as a GPS receiver or Cesium frequency standard, which is then used to discipline the 8040C's Rubidium oscillator. See *Disciplining to External 1 PPS* on page 8.

Console

The RS-232 connector on the 8040C/8040CLN's back panel provides a command line interface to perform the following tasks:

- Adjust the Rubidium oscillator's frequency
- Synchronize to an external 1 PPS input

Table 3. RS-232 Connector Pin-Out

DB9-F	Function
3	TX (Transmit Data)
2	RX (Receive Data)
5	GND (Signal Ground)

Note: Requires a null modem cable (DTE).

Operation

Powering Up

Connecting the power cord from the 8040C/8040CLN to the AC or DC source provides power to the unit. For the DC version, on the power cord apply:

- +24VDC on the red wire.
- Ground or return on the black wire.

The POWER LED illuminates immediately thereafter. The LOCK LED illuminates within five minutes, indicating that the 8040C's frequency accuracy is within $\pm 5 \times 10^{-8}$ of absolute frequency. Removing the power cord from the IEC receptacle on the rear panel turns the power off.

Indicator LEDs



CAUTION: Do not use the Symmetricom 8040C as a reference source until the LOCK indicator is turned on.

The three LED indicators on the front panel provide a cursory view of the 8040C/8040CLN operating status.

POWER is lit when AC or DC power is applied to the unit.

LOCK is lit when the unit's Rubidium oscillator reaches operating temperature and its frequency output is within specifications.

1 PPS SYNC is lit when a valid external 1 PPS signal is applied to 1 PPS IN.

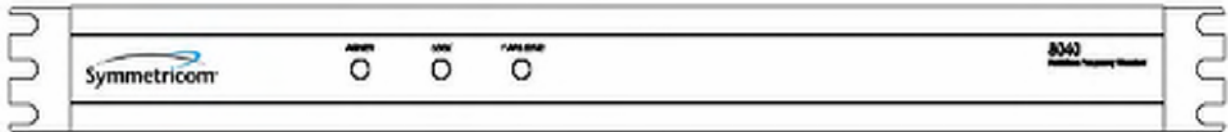


Figure 2: Symmetricom 8040C/8040CLN Front Panel

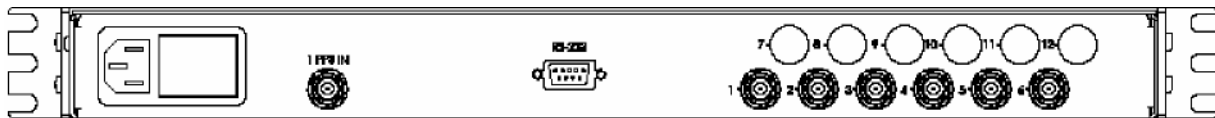


Figure 3: Symmetricom 8040C/8040CLN Rear Panel

Adjusting Oscillator Frequency

There are two reasons to adjust the unit's frequency output:

- To adjust for the effects of aging on the Rubidium oscillator's frequency
- To syntonize (or tune) the Rubidium oscillator's frequency to that of a more accurate primary frequency source.

The Symmetricom 8040C/8040CLN is a secondary frequency standard (i.e., much more accurate than a quartz frequency standard, but not as accurate as a Cesium primary frequency standard). By comparing the Symmetricom 8040C/8040CLN to an external Cesium standard or GPS receiver, it can be readjusted periodically to match the primary standard's greater accuracy.

The 8040C/8040CLN output frequency is adjusted by using the RS-232 interface.

The "f" command allows the user to adjust the output frequency in parts <1E-11.



NOTE: A typical external counter does not have a resolution or accuracy high enough to set this device, so do not reset the frequency unless established metrology methods are used for frequency measurement resolution of <1 E-1 1.

Example:

1. At the **r >** prompt, enter **f**
 - a. For a 5E-11 change, enter "**f5<CR>**"
 - b. For a -5E-11 change, enter "**f-5<CR>**"
2. Press **ENTER**
3. At the **r >** prompt, enter "**t**"
4. Under the "**t**", enter **5987717** (this is the pass code save command)
5. Press **ENTER** (unless changes are saved they will not be recorded)
6. Response "Tuning Data Save"

Disciplining to External 1 PPS

1 PPS Disciplining

The advent of low cost GPS technology has brought about its widespread use throughout the telecommunications industry. The GPS system provides 1 PPS with extremely good long-term stability (e.g., <1E-12 averaged over 24 hours). However the short-term stability of this signal is not suitable due to inherent noise perturbations in GPS related to background noise, atmospheric conditions, cross talk, multipath, and instabilities in the oscillators of GPS satellites and GPS receivers.

In order to provide the required stability for telecommunications, system designers must combine the benefits of short-term stability (such as from a Rubidium or low noise OCXO) with long-term stability (such as from GPS, Loran-C, GLONASS, or Cesium). In the past, external disciplining circuitry was required to combine short-term and long-term stability. The traditional approach involved adding an external circuit to the oscillator that had a phase lock loop detector to handle disciplining algorithms.

Symmetricom is a leader in time and frequency design and has pioneered the use of Rubidium oscillators in telecommunications. The model SA.22C Rubidium oscillator in the Symmetricom 8040C/8040CLN provides an important new feature – built-in disciplining to a 1 PPS input from an external reference. This new feature eliminates the need for additional external disciplining circuitry. The 8040C/8040CLN is inherently capable of

disciplining to an external primary reference to remove frequency offsets due to long-term aging.

Operation

Connect the 1 PPS source to the 1 PPS IN on the rear panel of the 8040C/8040CLN. The 8040C/8040CLN's Symmetricom Synchronization Adaptive Algorithm (SSAA) qualifies the 1 PPS input reference by detecting 256 valid 1 PPS input pulses and determining the number of outliers based on the time constant. An outlier is detected when the absolute time difference between the input 1 PPS and its expected time is greater than 1 microsecond. Once the SSAA detects two outliers (two bad 1 PPS pulses) or no input 1 PPS, the algorithm places the 8040C/8040CLN into flywheel (holdover) mode. The flywheel mode provides for Rubidium short-term and long-term stability without the benefit of an external reference. The 8040C/8040CLN remains in flywheel mode until 256 "good" 1 PPS input pulses are detected. Once the number of outliers is less than 2, the unit disciplines to the external reference. This implementation was designed to support applications where the reference input is a GPS receiver without serial communications between the receiver and the 8040C/8040CLN. There are two modes of operation for the 1 PPS input: manual and automatic.

Manual Control

The manual mode is beneficial to applications where the quality of 1 PPS is worse than 50 nanoseconds, or applications where the noise profile is well known and a deterministic solution yielding more control to the system designer is desired. The manual mode requires the user to input two parameters, which are tau (or time constant) and dampening factor. Tau is expressed in seconds and determines the PLL time constant for following a step in phase for the reference. The range of tau is 5 to 100,000 seconds. Tau values outside of this range put the unit in automatic disciplining mode. The dampening factor determines the relative response time and ringing in response to each step. There are no limitations for the dampening factor value; however, values between 0.5 and 2 are strongly recommended.

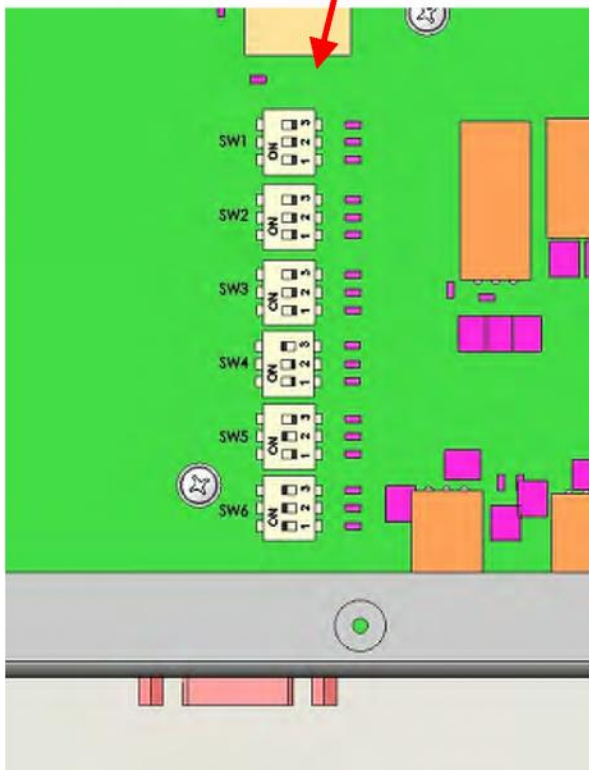
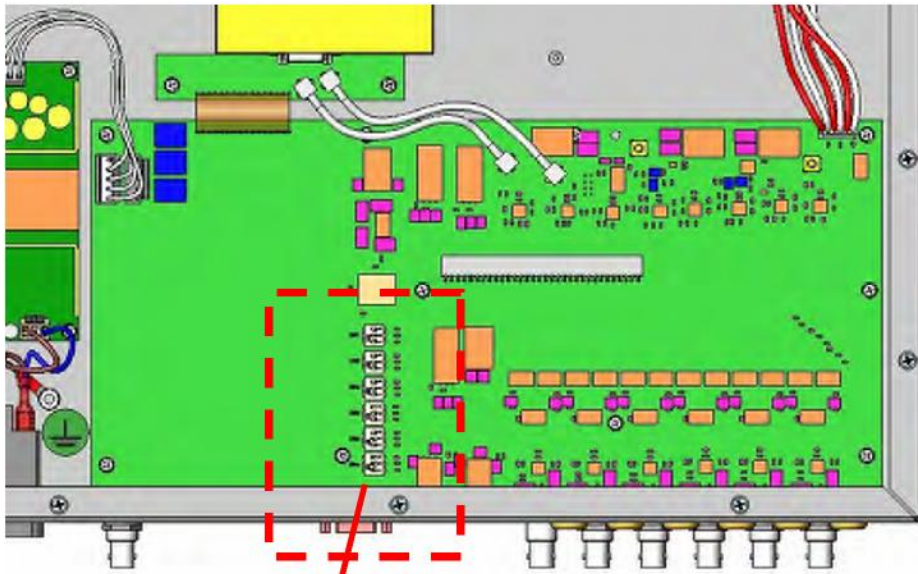
Automatic Control

The automatic mode requires no user inputs to the SA.22C Rubidium oscillator. Automatic mode is adaptive and changes the SSAA time constant as changes in the 1 PPS reference are detected. The automatic mode is optimized for a 1 PPS input with up to 50 nanoseconds RMS of noise such as from a GPS timing receiver. Since short-term jitter of 50 nanoseconds is typically present on 1 PPS from a GPS reference, the automatic mode is generally suitable for most applications.

Configuring Outputs

The 8040C/8040CLN has the unique capability of providing flexible output configurations. To change the output configuration of your 8040C/8040CLN:

1. Unplug the 8040C/8040CLN from the AC or DC power source and remove the top cover by removing the Phillips head screws around the perimeter of the unit.
2. Locate the main PCB inside the 8040C/8040CLN as indicated in Figure 4 and identify the dipswitches shown in Figure 5. *Each dipswitch configures the output format on its corresponding BNC* (e.g., SW1 configures the output format on BNC1).



Figures 4 & 5: Dipswitch Locations for Configuring Outputs

- Use the dipswitch positions shown in Table 4 to generate a specific output format on a specific BNC. For example, to generate 10 MHz TTL on BNC3, set SW3 position 1 to ON, position 2 to OFF, and position 3 to OFF.

Table 4: Output Configuration Table

Output Format	Position 1	Position 2	Position 3
10 MHz Sine	OFF	OFF	OFF
10 MHz TTL	ON	OFF	OFF
5 MHz Sine	OFF	OFF	ON
5 MHz TTL	ON	OFF	ON
1 MHz Sine	OFF	ON	OFF
1 MHz TTL	ON	ON	Off
1 PPS	ON	ON	ON

- After setting the outputs, replace the top cover and apply power.

Console

The Symmetricom Serial Interface Protocol (SSIP) provides user communication with the 8040C/8040CLN through the serial port when the unit is connected to a host PC or terminal. All “developer-mode” commands are single-letter format.

Host Terminal Emulator Setup

Set up the comm port of the PC with the following configuration:

- Data rate (Baud/BPS - see note below)
- No parity
- 8 data bits
- 1 stop bit
- No local echo (unit echoes)
- No hardware or software flow control

All SSIP commands are a single ASCII letter. The baud rate of the

8040C/8040CLN is 57.6K.

Note: Requires a null modem cable (DTE).

Specifications

All performance is at an ambient temperature of 25°C (77° F) unless otherwise specified.

Outputs

Sine Wave

Frequency	1MHz, 5MHz, & 10 MHz
Amplitude	1V RMS
Harmonic	< -40 dBc
Non Harmonic	< -60 dBc (< -80 dBc with Low Phase Noise option)
Connector	BNC - Female
Load Impedance	50 Ohms
Location	Rear Panel

Square Wave

Frequency	1MHz, 5MHz, & 10 MHz
Amplitude	>3V Peak
Format	TTL
Pulse Width	50% Duty Cycle
Connector	BNC - Female
Load Impedance	50 Ohms
Location	Rear Panel

Timing Outputs

Format	1 PPS
Amplitude	>3V
Pulse Width	400 nS
Rise Time	<20 nS
Jitter	< 10ps RMS
Connector	BNC - Female
Load Impedance	50 Ohms
Location	Rear Panel

Timing Inputs

Quantity	(1) 1 PPS Sync Input
Amplitude	TTL Compatible
Connector	BNC - Female
Load Impedance	High Z
Location	Rear Panel

Stability

	Standard	Low Noise
Averaging Time	Allan Deviation	Allan Deviation
1 sec.	<3.0E-11	<1.5E-11
10 sec.	<1.0E-11	<8.0E-12
100 sec.	<3.0E-12	<2.5E-12

GPS Disciplining

Time to lock	</=1000 sec.
Freq Accuracy	+/-1E-12
1 PPS Accuracy	+/-30 nS

Aging

Monthly	<5E-11 (after 30 days of operation)
Yearly	<5E-10
Accuracy at Shipment	<+/-5.0E-11
Retrace	<+/- 5E-11 (24hrs on, 24 hrs off, 24 hrs on)
Control Range	+/-1E-6 with 1E-12 resolution

Warm-up Time

Time to Lock	5 minutes
Time to <1 E-9	<8 minutes

SSB Phase Noise

Phase Noise	Standard	Low Noise
Offset (Hz)	10 MHz Output	10 MHz Output
1	-72 dBc	-100 dBc
10	-95 dBc	-130 dBc
100	-130 dBc	-144 dBc
1,000	-140 dBc	-150dBc
10,000	-148 dBc	-150dBc

Environmental & Physical

General

Operating Temperature	0 C to 50 C (32 F - 122 F)
Temperature Coefficient	<3E-10
Storage Temperature	-40 C to 71 C (-40 F to 160 F)
Humidity	95% RH, Non-condensing from 0 C to 50 C (32 F - 122 F)
Magnetic Field Sensitivity	DC (+/-2 Gauss) <4E-11/Gauss
Altitude (operating)	0 – 15240 meters (0 to 50,000 feet)

Remote System Interface and Control

Protocol	RS-232-C (DTE Configuration)
Connector	9-pin female rectangular D subminiature type
Location	Rear panel
Protocol	8 Data Bits
Stop	1 Stop bit
Baud Rate	57600

AC Power Requirements

Voltage	90 to 240 VAC
Frequency	47 to 63 Hz
Power (Operating)	25W (Operating)
Power (Warm Up)	45W (Warm Up)

DC Power Requirements

Voltage	18 to 36 VDC (24 Nominal)
Power (Operating)	25W (Operating)
Power (Warm Up)	45W (Warm Up)

Fuses

AC Input	TO 2.0A, 250 V, slow blow <ul style="list-style-type: none">▪ BUSSMAN GDC-2A▪ LITTELFUSE 218002
DC Input	TO 5.0A, 250 V, fast blow <ul style="list-style-type: none">▪ BUSSMAN GDB-5A▪ LITTELFUSE 217005

Dimensions

Height	1.75" (1 UI) (44mm)
Width	19" (48 cm)
Depth	12" (30.5 cm)
Weight	<6 lbs (<2.7 kg)

Options

Introduction

There are two optional configurations for the 8040C/8040CLN, the Twelve Output option and the Low Phase Noise option. The additional outputs require an additional circuit card that provides six configurable outputs that are set up the same as in the standard unit. The Low Phase Noise option can be purchased with either the standard six outputs or with the optional twelve outputs.

Twelve Output Option

With the Twelve Output option, the six additional outputs on channels 7 through 12 come pre-configured the same as channels 1 through 6 in the standard configuration. They can be reprogrammed as described in Configuring Outputs (page 9).

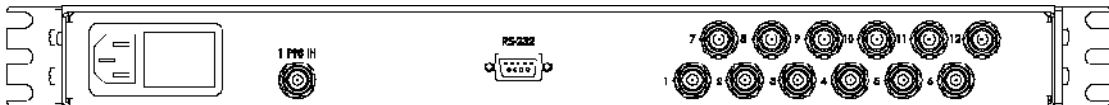


Figure 6: Back Panel of 8040C/8040CLN with the Twelve Output Option

Table 10: Output Connections

BNC	Signal
7	10 MHz Sine wave
8	10 MHz Sine wave
9	10 MHz Sine wave
10	5 MHz Sine wave
11	1 MHz Sine wave
12	1 PPS
1-6	Standard Configuration

Low Phase Noise Option

The Low Phase Noise option does not require different operator instructions. This option provides improved phase noise specifications as described in specifications section of this manual.

Technical Support

Maintenance

This unit is designed to be maintenance-free. However, the following guidelines should be observed:

- Keep the unit clean, using a slightly water-moistened cloth.
- Keep it free from excessive dirt and moisture.
- Avoid cycling the power off and on more than is necessary.

If the unit requires servicing or repair, please contact Symmetricom Customer Assistance to obtain a Return Materials Authorization (RMA) using one of the numbers provided below.

Customer Assistance

<http://www.symmetricom.com/Contact/Customer Assistance Centers/>

Customer Assistance Center Telephone Numbers:

- Worldwide (Main Number): 1-408-428-7907
- USA, Canada, Latin America including Caribbean, Pacific Rim including Asia, Australia and New Zealand: 1-408-428-7907
- USA toll-free: 1-888-367-7966 (1 -888-FOR-SYMM)
- Europe, Middle East & Africa: 49 700 32886435

Preparation for Shipment

Turn off the Symmetricom 8040C/8040CLN prior to shipment by removing the AC or DC power cord from the rear panel. Package the instrument in its original packing, if possible. If the original packing materials are not available, pack the unit in a reinforced cardboard carton using foam to take up any space inside the carton. Do not use foam popcorn or crushed paper for packing.

Contact the Customer Assistance department before returning the unit to Symmetricom.

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