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Symmetricom®

8200 Rubidium Oscillator

User's Guide

深圳市儒科电子有限公司

17 December 2009, Rev. A

Part Number: 098-00071-000

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1. How to Use This Guide

This section describes the format, layout, and purpose of this guide.

Purpose of This Guide

This guide provides basic recommendations for designing products to use Symmetricom's 8200 Rubidium Oscillator. The guidelines in this user guide are generic because specific product requirements vary from application to application.

Who Should Read This Guide

This document is intended for professionals who are designing, installing, operating or maintaining time, frequency, and synchronization systems having a requirement for a low profile and highly precise frequency generator.

To use this document effectively, a good understanding of digital technologies, analog frequency generation, and synthesis techniques is helpful.

Guide Structure

This guide contains the following sections:

" 2. Product Description" on page 10 - This section contains a description of the 8200 oscillator and lists its typical applications. It provides information on dimensions, performance, and connector pinouts.

" 3. Specifications" on page 12 - This section contains physical dimensions and both environmental and electrical specifications.

" 4. Design Integration Considerations" on page 16 - This section contains mechanical issues for 8200 oscillator mounting and mating recommendations, including thermal and EMI considerations, external interfaces and grounding, frequency control, susceptibility to noise, and reliability goal.

" 5. Installation and Operation" on page 20 - This section contains the information necessary to properly install and operate the 8200 oscillator, including a simplified theory of operation, maintenance and warranty.

" 6. Symmetricom Serial Interface Protocol" on page 22 - This section describes how to use of the external communications link software.

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Conventions

Note: Notes contain installation, operation, or maintenance procedures, practices, conditions, or statements that alert you to important information, which may make your task easier or increase your understanding.

Warning: To avoid serious personal injury or death, do not disregard warnings. Warnings are installation, operation, or maintenance procedures, practices, or statements, that if not strictly observed, may result in serious personal injury or even death.

Caution: To avoid personal injury, do not disregard cautions. Cautions are installation, operation, or maintenance procedures, practices, conditions, or statements, that if not strictly observed, may result in damage to, or destruction of, the equipment. Cautions are also used to indicate a long-term health hazard.

ESD Caution: To avoid personal injury and electrostatic discharge (ESD) damage to equipment, do not disregard ESD cautions. ESD cautions are installation, operation, or maintenance procedures, practices, conditions, or statements that if not strictly observed, may result in possible personal injury, electrostatic discharge damage to, or destruction of, static-sensitive components of the equipment.

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2. Product Description

This section contains a description of the 8200 rubidium oscillator. It lists its typical applications, and gives information on dimensions, performance, and connector pin-outs.

The 8200 Line of Rubidium Oscillators

The 8200 Rugged Rubidium Oscillator is a high precision, reliable 10 MHz[1] RF signal source. It is specifically designed to operate in harsh environments consistent with military, avionics and industrial applications, where signal medium-term, and long-term frequency stability is essential for mission success. It is designed using COTS (Commercial-Off-The-Shelf) components.

Owing to its overall design, long life Rb lamp, and extended crystal control range, the 8200's permits extended operating periods without maintenance. The 8200 design produces a stable frequency with good short and long term stability, and excellent spur performance.

The 8200 provides a 5V CMOS-compatible Built-in Self Test (BIST) Service and a LOCK alarm signal derived from the basic physics operation.

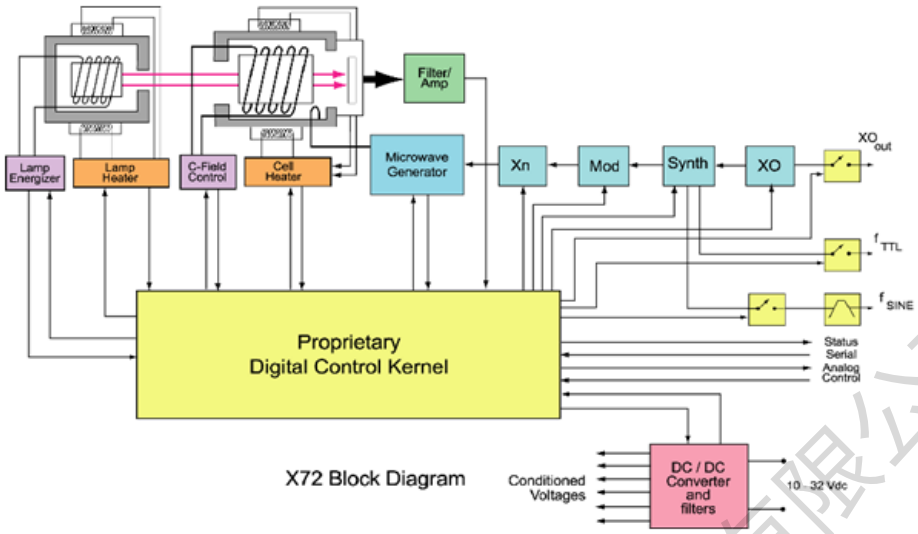
This lock signal indicates when the output frequency is locked to the atomic resonance of rubidium. When more control over the device is desired, an extensive command control status dialog is available.

In addition to controlling the operation of the oscillator, the microprocessor's built-in firmware allows an external host computer to communicate with the embedded controller through a serial port connection. This allows precise frequency control, the dynamic frequency selection, the ability to enable and disable outputs, to query the system's health, and acquire information about the unit's serial number, operating temperature, fault history, initiate a self test, and other performance indicators. The protocol used is Symmetricom's proprietary Symmetricom Serial Interface Protocol (see " 6. Symmetricom Serial Interface Protocol" on page 22), or SSIP.

The simplified block diagram that follows, shows the importance of the digital control in the unit, how it controls and monitors all aspects of operation, such as the heater circuits of the physics package, as well as the selection of outputs.

[1] Other frequencies are available. Consult factory for details.

Figure 2.1 Simplified Block Diagram



8200 Standard Oscillator

The standard performance 8200 oscillator provides a 10MHz sine-wave output along with a 15 pin connector for monitoring and controlling the module. The core component in this module is based on Symmetricom's X72 rubidium oscillator. Since the X72's inception, several thousand units have been deployed in various applications. The 8200 improves upon this robust design by using a ruggedized housing and an extensive qualification process to provide rubidium performance over diverse environmental conditions.

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3. Specifications

Environmental Requirements

Temperature:

- Operating: -40º C to +80 º C base-plate Standard 8200

- Storage: -55º C to +95º C
- Sensitivity: <3.0E-10 over op. temp. range

Thermal shock (non-operating):

MIL-STD-202, Method 107, Test Condition A, 10 cycles -55° C to 85º C

Orientation sensitivity:

<5.0E^{-11} for any orientation

Pressure sensitivity:

<1.0E^{-13}/mbar

Altitude

- Operating: Sea level to 40,000' (12,192 m)
- Non-operating: Sea level to 80,000' (24,384 m)

Magnetic field sensitivity: dc(<=2Gauss)

<= ±4.0E^{-11}/Gauss

Relative humidity (operating):

0 to 95% RH per MIL-STD-810, Method 507.4

Salt fog:

MIL-STD-810, Method 509.4

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Vibration: MIL-STD-810, Method 514.5, Procedure I

- Operating: Category 24, Minimum Integrity, 7.7 grms @ 0.04 g^2/Hz 20 Hz -1kHz, 15 min/axis (maintain lock)
- Non-operating: Category 24, Minimum Integrity, 15.4 grms @ 0.16 g^2/Hz 20 Hz -1kHz, 30 min/axis

Shock: MIL-STD-202, Method 213

- Operating: 30g, 11msec, half-sine (maintain lock)
- Non-operating: 50g, 11msec, half-sine

EMI

- MIL-STD-461
- Emissions: CE102, RE102
- Susceptibility: CS101, CS114, RS103

MTBF:

MIL-HDBK-217F, 90,000 hours. Ground fixed @ +40ºC base-plate

On-Off cycling endurance:

5000 cycles at 10ºC base-plate

Input connector:

(1) DB-15 (All input power, monitoring)

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Dimensions - 8200

Height: 0.95”

Width: 4.00”

Depth: 4.63”

Volume: 17.6 in^3

Weight: <1.5 lbs

Electrical Specifications

Electrical Specifications - 8200

Characteristics

All limits are given at base-plate temperature of 25°C, and Supply Voltage of 25VDC unless noted otherwise.

Description	Conditions	Min	Typ	Max	Units
Supply Voltage		15		32	VDC
Frequency Accuracy at shipment		$-5*10^{-11}$		$5*10^{-11}$	
Power consumption during warm-up				20	W
Warm up time to lock	@ -40°C base-plate			8	Mins
	@ 25°C base-plate			6	Mins
Time to <$1E^{-9}$	@ -40°C base-plate			10	Mins
	@ 25°C base-plate			8	Mins
Power consumption operating (28Vdc)	@ -40°C base-plate			16	W
	@ 25°C base-plate			12	W
	@ 80°C base-plate			8	W
RF Output Amplitude		0.5	0.7		Vrms
Harmonic Distortions				-30	dBc
Spurious	<150MHz 147.5MHz +/-300kHz >150MHz			<-75 <-70 <-80	dBc dBc dBc
Short-Term Stability (Allan Deviation), tested after 30 min of operation	@t = 1s			$<3*10^{-11}$	
	@t = 10s			$<1*10^{-11}$	
	@t = 100s			$<3*10^{-12}$	

Description	Conditions	Min	Typ	Max	Units
SSB Phase Noise (static)	@1Hz @10Hz @100Hz @1kHz @10kHz			-72 -92 -128 -140 -148	dBc/Hz
Aging rate after 30 days of operation	Per month			$5*10^{-11}$	
	10 years			$1*10^{-9}$	
Analog Frequency Control (Optional)	Control Voltage range 0 to 5 VDC			$\pm1.5*10^{-9}$	
Digital Frequency Control	Resolution			$\pm1*10^{-12}$	
	Range			$\pm1*10^{-6}$	

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4. Design Integration Considerations

This section provides information on mounting, mating connectors, operating temperature, electrical interface, EMI, and noise susceptibility.

Mechanical Drawings - 8200

Figure 4-1: Isometric View

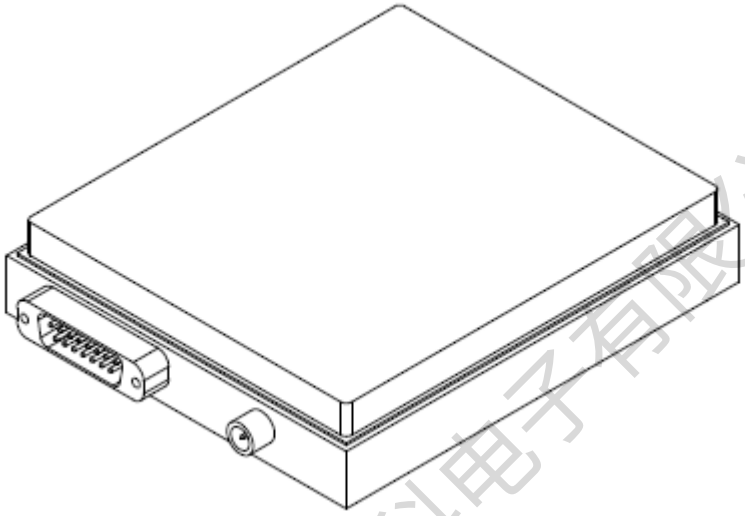
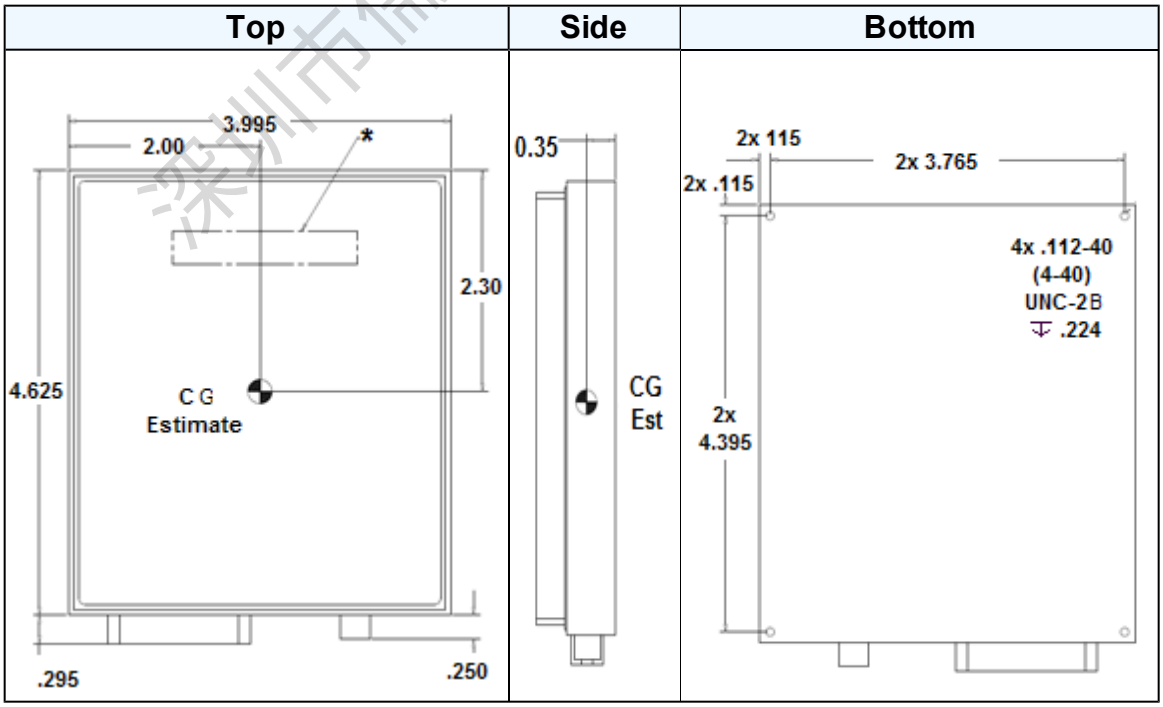
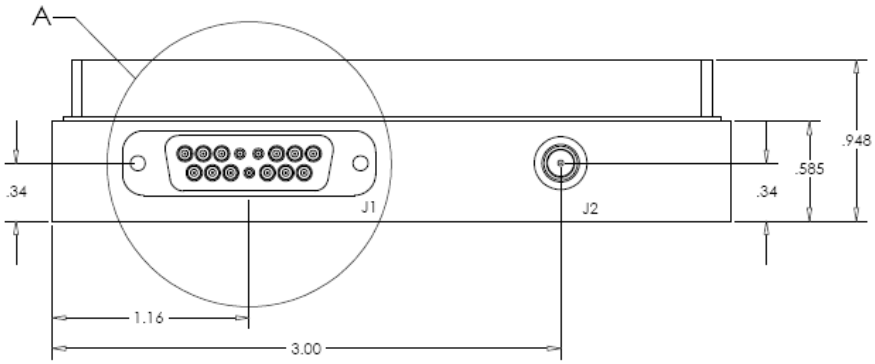


Figure 4-2: Dimensions



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Figure 4-3: Front



Mechanical Considerations

Mounting Recommendations

To mount the oscillator, use the four mounting holes located at the corners of its base plate with four .112-40 (4-40) stainless steel screws. Be aware that the minimum penetration depth to mount the unit is 0.2 inch (5.08 mm), and the maximum is 0.25 inch (6.35 mm).

Thermal Considerations

Thermal Tape

In order to achieve the highest ambient operating temperature for the oscillator operating base plate temperature, Symmetricom recommends that the bottom ("base plate") of the oscillator has good thermal contact to the mounting surface. It is also very important to maintain a uniform temperature into the base plate of the 8200 through its mounting points. The oscillator operates normally without thermal tape. However, in some field applications, the tape may simplify customer system thermal design requirements.

Warning: To avoid personal injury, attach the oscillator to a heat sink to prevent it from becoming too hot to touch.

The oscillator maximum base plate temperature described in the specifications is based on a unit covered on five sides with one inch foam to simulate free convection in air with the heat sink/base plate exposed to forced air.

If there is airflow over the unit's top cover, the oscillator's maximum operating base plate temperature increases by 1 or 2° C, and its power consumption at a given base plate temperature also increases by a few tens of milliwatts.

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As the base plate temperature continues to increase, the unit eventually loses lock. Above a base plate temperature of +80° C, the resonator, or lamp heaters shut down as control point temperatures are exceeded, and the unit temperature coefficients increase to approximately $6xE^{-10}$° C.

External Interfaces and Grounding

8200 Connectors

Figure 4-7: Connector Placement

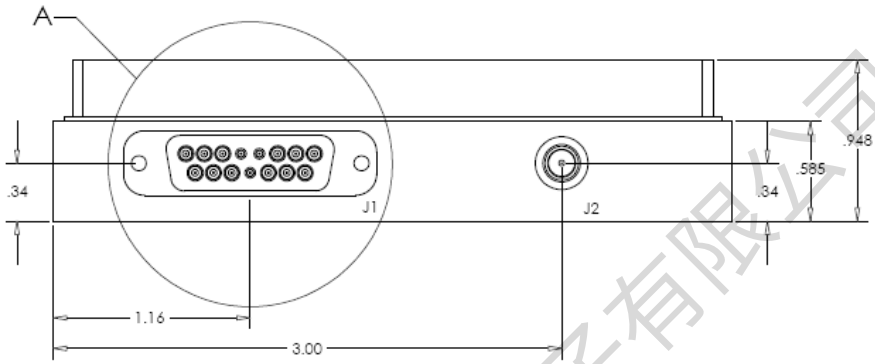
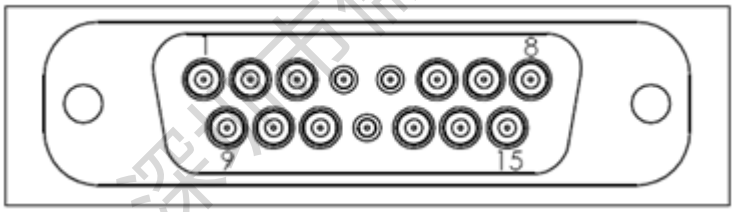


Figure 4-8: Connector J1 ("D" Connector Plug 15 Pins, MIL-RF-24308)



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Connector J1 Signals

Pin#	Signal Name	Type	Signal Function
1, 2	PWR In	PWR	+ Power input +15 to +32 Vdc - all power pins must be connected.
3	D_OUT	Output	UART data out at ACMOS logic levels.
4, 5	GND	GND	- Power & signal return - all grounds must be connected.
6	NC	-	Not connected. Pin shall be left floating
7	LOCK	Output	If low, indicates Rb oscillator is locked.
8	GND	GND	- Power & signal return - all grounds must be connected.
9	NC	-	Not connected.Pin shall be left floating
10	DIN	Input	Input UART data in at ACMOS logic levels.
11	FREQ CTRL (Optional)	Analog	Analog Frequency control - analog input between 0 - 5 Vdc.
12	GND	GND	- Power & signal return - all grounds must be connected.
13	NC	-	Not connected. Pin shall be left floating
14	SERVICE	Output	Indicates unit is nearing limits of frequency control and that Service is required within several months.
15	GND	GND	- Power & signal return - all grounds must be connected.

Connector J2 Signal

10 MHz SINE OUT

(SMA MALE, MIL-PRF-39012)

8200 RF Outputs

RF Output Impedance versus Frequency

The active RF output impedance for the 8200 is a nominal 50 Ω at 10 MHz, but is a widely varying impedance at other frequencies. You must take this into consideration if the 8200 rf output is driving a non-buffered filter. Note that the 8200 is specified as delivering 0.7 Vrms (typical) into a 50 Ω resistance load. Loads that present complex impedance or resonances affect signal amplitude. The 8200 can drive a properly terminated transmission line of 50 Ω characteristic impedance.

Note: 390 pf capacitor from the 10 MHz sine output to the sine return is required within four inches of the output connector. It can be located across the 50 Ω terminator.

If the sine output port is disabled, its characteristic impedance remains the same.

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5. Installation and Operation

This section provides information on details to consider when installing the 8200 and the procedure to follow when turning on the unit. There is an explanation of the start-up sequence, monitoring performance, and theory of operation. It also contains a troubleshooting guide, customer support information, and warranty information.

Installation

Site Selection

The 8200 can be mounted in any orientation. In environments that approach the operating limits of the 8200, ensure that the temperature limits are not exceeded.

The 8200 is sensitive to external dc and ac magnetic fields (refer to specification) and should not be installed in locations subjected to strong magnetic fields from transformers or large power supplies. An external magnetic field under 2 gauss should not result in measurable frequency offsets for 8200.

An Rb frequency standard is a very precise component and you should employ optimum practices for its use. Avoid using a power source that is also providing power to fans or equipment that generates high current pulses.

8200 Start-up Sequence

When power is connected to connector J1, the 8200 begins its warm-up cycle. After six minutes the rubidium oscillator reaches a locked condition and its output signals will stabilize. The accuracy at shipment is $<\pm 5xE^{-11}$ at 25° C, typical.

Note: Signals appear at the outputs immediately after power is applied to the unit, but these output signals are not stable until after the oscillator has locked.

After eight minutes the accuracy of the 8200 oscillator is $<1xE^{-9}$. Performance of the 8200 unit varies according to the application profile specified by the customer at time of order. To monitor performance and selectively modify it using the SSIP firmware included in the unit, connect the unit to the COM port of a PCvia Developer's Kit cable and adapter (Symmetricom P/N 054-00269-000).

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6. Symmetricom Serial Interface Protocol

This appendix provides information on communicating with the 8200 through the serial port. It includes output examples and a description of commands.

Important! Use Developer's Kit (Symmetricom P/N 054-00269-000) to connect unit to RS232 port of PC.

Using the Symmetricom Serial Interface Protocol

The Symmetricom Serial Interface Protocol (SSIP) permits external communication with the 8200 through the serial port connector J1 when the unit is connected to a host PC. All "developer-mode" commands are a single ASCII letter and require no termination. Of the eight RUN MODE commands, three require the host to supply data.

Host Terminal Emulator Setup

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

- Data rate (baud or B.P.S. - baud rate) of the 8200 is 57.6K
- No parity
- 8 data bits
- 1 stop bit
- No local echo (unit echoes)
- No hardware or software flow control

Note: The 8200's UART connections are based on 5 Vdc logic levels. RS232 Adapter (Symmetricom p/n 054-00269-000) required to connect 8200 to PC.

Data Format

Run Mode Data Format (Customer Mode)

8200 outputs are all decimal data as "ASCII Coded Hex" except for echoed characters. Do not convert data to decimal when transmitting to the 8200. All data are sent to the 8200 and received back as "ASCII Coded Hex". The following example shows how data are encoded.

Note: Flow control is not permitted in "Run Mode".

Data sent to the 8200 in run mode should not be encoded.

The following is an example of output from the 8200 after power is applied to the unit.

Example

```
X 7 2 by Symmetricom, Inc., Copyright 2004

SDCP Version 4.24 of 4/2004; Loader Version 2
```

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```
Mode CN1B Flag 0005 Unit serial code is 0311BB0198-h, current tuning
state is 6

Crystal: 3938700hz, ACMOS: 989680.00000000hz, Sine: 989680.00000000hz

Ctl Reg: 0204, Res temp off: BFC53F7D., Lamp temp off: C003B7E9.

FC: disabled, Srvc: low


r>
```

Adjust Frequency (commands f and t)

User Output to the 8200		Command Name and Description
Command	**DATA**	
f	Desired frequency change from free running center frequency in parts to E^{-11} Example: for a $+100xE^{-11}$ change: “100<cr>” Example: for a $-100xE^{-11}$ change: “–100<cr>”	**Adjust Frequency** Adjust Unit output frequency. Used to discipline the unit. The smallest incremental frequency change is $2xE^{-12}$ (or “f.2”). Any value less than this will still be used. Max value that can be used at one time is $4E^{-8}$. For larger frequency changes, repeated steps equal to or smaller than $4E^{-8}$ should be used. Unit always powers up at free running factory set frequency, unless “T” command is used. This command is always relative to the free running frequency.
t		**Save tuning data** Saves current DDS frequency, so the changes made with “f” command become permanent. The command is password protected. The password is “5987717”.

Factory Mode

Data output from the 8200 in factory mode is not intended for users outside the factory and is not described in this document.

Caution: Using factory mode can result in the erasure of firmware on the 8200 rendering it inoperable and making it necessary to return the unit to the factory for re-programming.

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