TELECOM SOLUTIONS
a division of SymmetriCom, Inc.

DIGITAL CLOCK DISTRIBUTOR
CESIUM
(ANSI VERSION)

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1. GENERAL

1.01 This practice provides information for installing, testing, and maintaining Telecom Solutions' Digital Clock Distributor-Cesium Clock (DCD-Cs).

1.02 This practice was reissued for the following reasons (changes are marked with change bars):

- The nominal warm-up time was changed to 60 minutes.
- Table A was changed to further define the LOCK lamp.
- Table B was changed to show the cable termination impedance.
- Part 4A was changed to change part numbers.
- Figure 4 was changed to add mounting ears for a 23-inch rack.
- Part 4C was changed to show TRS connections.
- Chart 1 was changed to further explain the power-on process.
- Table F was changed to reflect correct signal levels and typical warm-up time.

2. FUNCTIONAL DESCRIPTION

2.01 The DCD-Cs is a self-contained, atomic primary-frequency reference. The atomic clock in the DCD-Cs is based on a natural resonant frequency of the cesium 133 atom. Since all outputs are referenced to an atomic primary frequency standard, precise frequency signals are obtained without reference to another standard. See Figure 1.

2.02 A quartz oscillator sends a 10-MHz signal to the synthesizer/modulator. The synthesizer/modulator multiplies the 10-MHz signal to 9.192 GHz. This signal is fed to the cesium beam resonator as an interrogation signal.

2.03 The cesium beam resonator contains several internal frequency control circuits. One of these circuits develops an error signal that varies in proportion to the difference between the interrogation frequency and the cesium resonant frequency. The error signal is at its highest when the interrogation frequency equals the resonant frequency.

2.04 The microprocessor receives the error signal from the cesium beam resonator, and sends control signals to the quartz oscillator to move the quartz oscillator frequency toward the cesium resonant frequency.

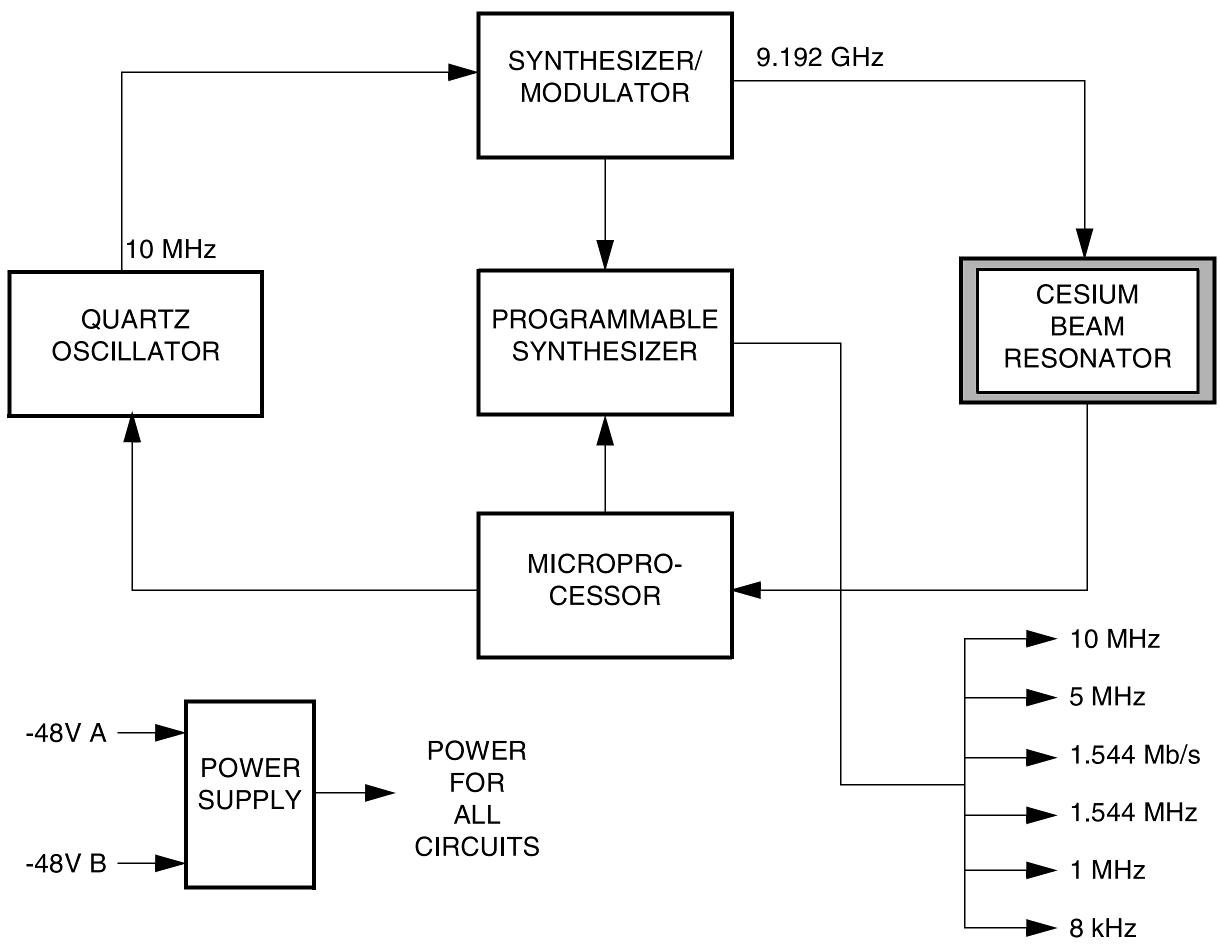


Figure 1. Block Diagram

2.05 The synthesizer/modulator sends the corrected frequency from the quartz oscillator to the programmable synthesizer, which develops the output clock signals of 10 MHz, 5 MHz, 1 MHz, 1.544 Mb/s, 1.544 MHz, and 8 kHz.

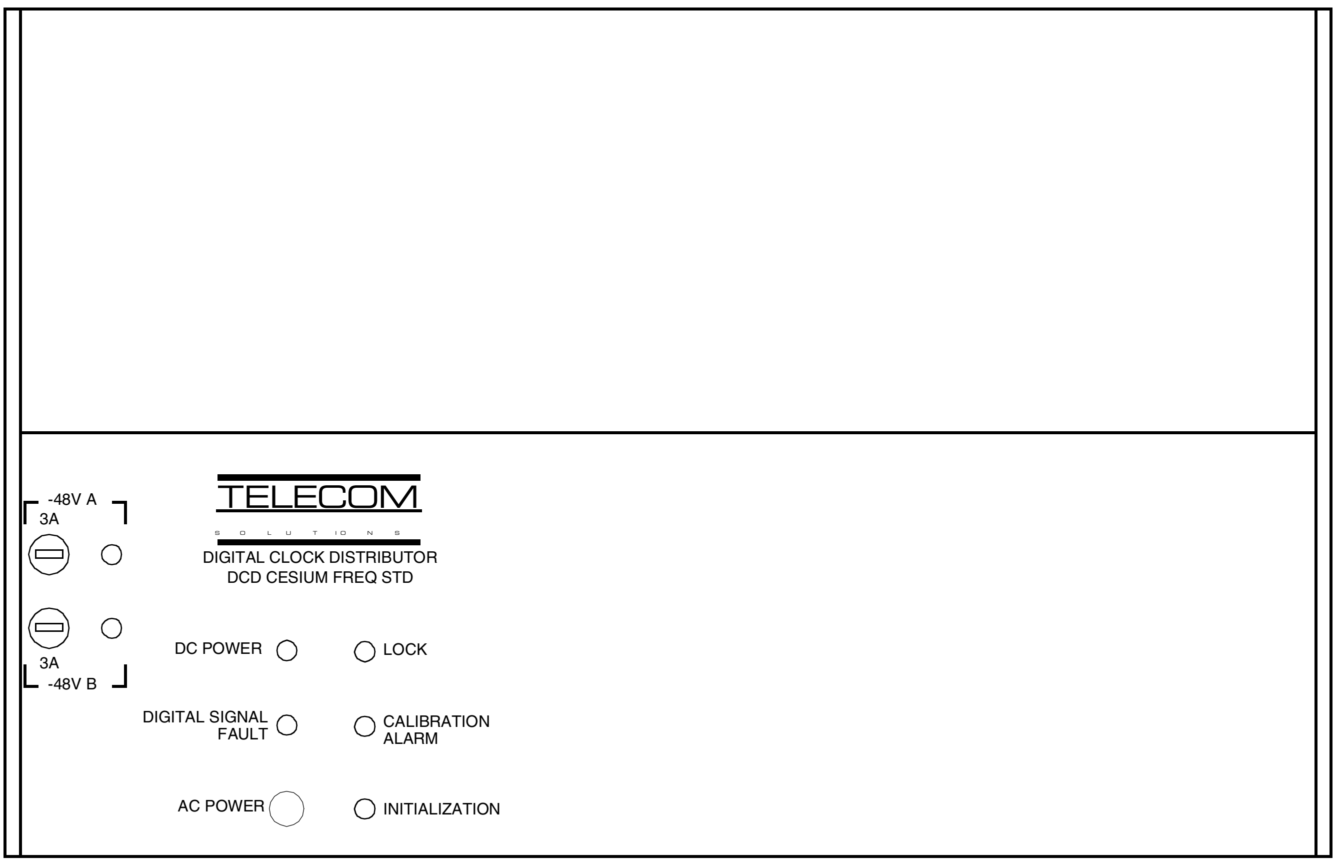
2.06 The microprocessor performs self-tests when power is first applied and periodically during normal operation.

2.07 When power is applied, the DCD-Cs typically takes less than 60 minutes to lock the quartz oscillator frequency to a stable cesium atomic frequency. Due to the precise internal calibration required, a cesium clock requires more warm-up time the longer the unit has remained without power.

2.08 The power supply contains a dc-dc converter that supplies power for all circuits.

3. CONTROLS AND INDICATORS

3.01 Figure 2 shows the front panel indicators and Table A describes those indicators. Figure 3 shows the rear panel connectors and Table A describes those connectors.

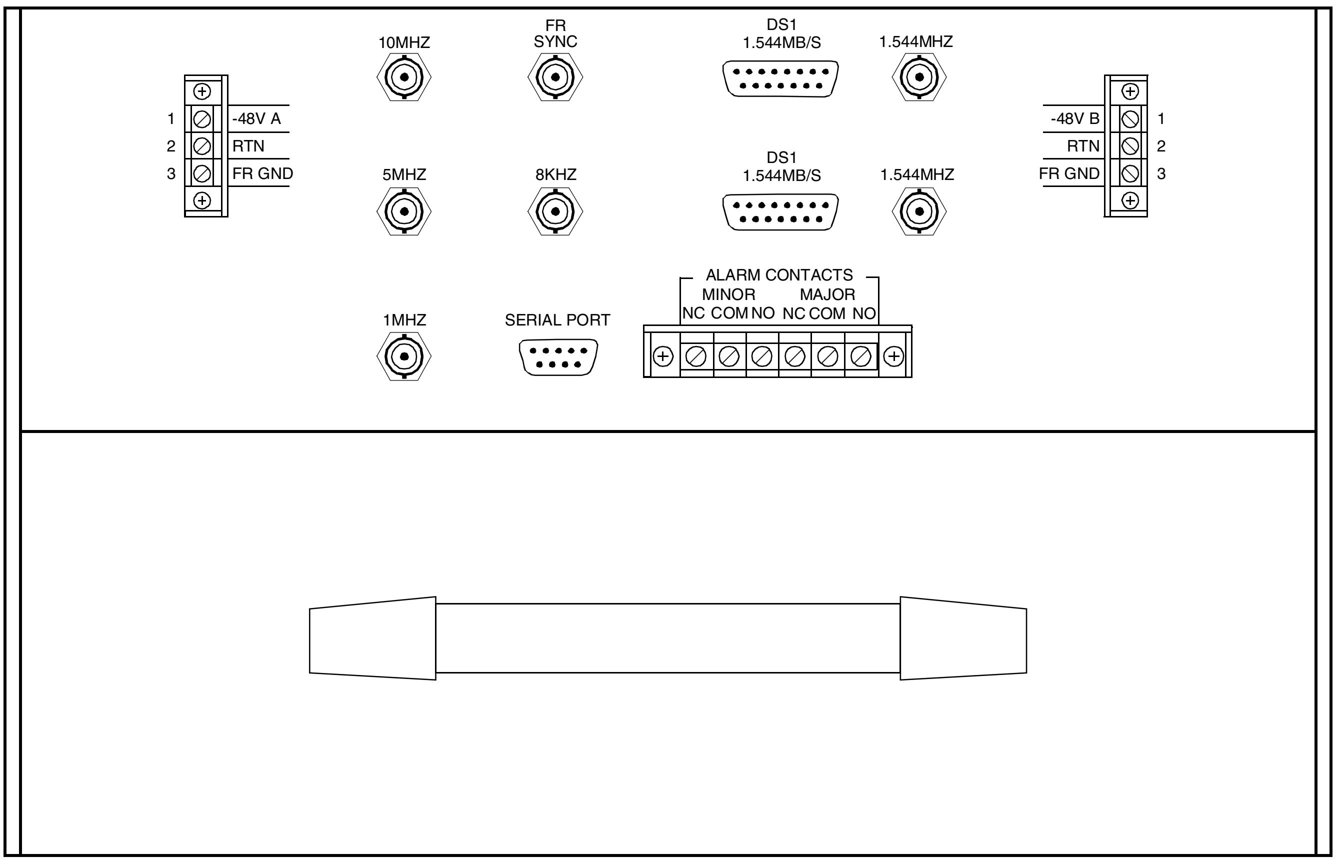


Note: Indicators are described in Table A.

Figure 2. DCD-Cs

Table A. Indicators

INDICATOR	DESCRIPTION
-48V A	Lamp that lights red to indicate a blown battery A fuse (3 A). Normally off.
-48V B	Lamp that lights red to indicate a blown battery B fuse (3 A). Normally off.
DC POWER	Lamp that indicates the status of the internal dc-to-dc converter: green (normal) indicates the output of the dc-to-dc converter is within specifications; red indicates the output of the dc-to-dc converter is out of specifications. Off indicates loss of battery input.
DIGITAL SIGNAL FAULT	Lamp that lights red if the output is not locked to the cesium source (may occur during warm-up). Normally off.
AC POWER	(Not used)
LOCK	Lamp that lights red if the frequency control loop becomes unstable. Normally green, indicating the frequency control loop is stable. Off during warm-up.
CALIBRATION ALARM	Lamp that lights yellow if the internal self-tests exceed the control voltage end-of-range thresholds. If yellow, the unit is still functional but requires service. Contact Telecom Solutions as soon as possible. Normally off.
INITIALIZATION	Lamp that lights yellow during warm-up. Normally off.



Note: Connectors are described in Table A.

Figure 3. DCD-Cs (Rear View)

Table B. Connectors

INDICATOR	DESCRIPTION
-48V A	Terminal for A battery
RTN	Terminal for A battery return
FR GND	Terminal for frame ground (do not connect to RTN terminal)
10 MHz	BNC connector for 10-MHz sine-wave output (50 ¾ termination)
5 MHz	BNC connector for 5-MHz sine-wave output (50 ¾ termination)
1 MHz	BNC connector for 1-MHz sine-wave output (50 ¾ termination)
FR SYNC	(Factory test only)
8 KHZ	BNC connector for 8-kHz TTL pulse output (50 ¾ termination)
SERIAL PORT	(Factory test only)
DS1 1.544 MB/S	15-pin D-connector for 1.544-Mb/s DS1 output (framed all ones) (100 ¾ termination)
DS1 1.544 MB/S	15-pin D-connector for 1.544-Mb/s DS1 output (framed all ones) (100 ¾ termination)
1.544 MHZ	BNC connector for 1.544-Mb/s square-wave TTL clock output (50 ¾ termination)
1.544 MHZ	BNC connector for 1.544-Mb/s square-wave TTL clock output (50 ¾ termination)
ALARM CONTACTS (MINOR and MAJOR)	Terminals for minor and major alarms: connection between NC and COM terminals provides normally closed contacts; connection between NO and COM terminals provides normally open contacts.
-48V B	Terminal for B battery
RTN	Terminal for B battery return
FR GND	Terminal for frame ground (do not connect to RTN terminal)

4. INSTALLATION

A. Mounting

4.01 Carefully unpack the DCD-Cs and inspect for damage. Notify Telecom Solutions' Customer Service Department if damage is found. The DCD-Cs is part number 990-43100-01, which consists of 090-43100-01 (ANSI Cesium Frequency Standard), 093-43100-01 (Hardware Kit), and this manual. The Hardware Kit consists of 8 machine screws 12-24 x 1/2" two 3-ampere spare fuses, and a panel adapter. The panel adapter fits the DCD-Cs in 23-inch racks.

Note: Save packing material. All equipment returned must be packed in the original packing material. Contact Telecom Solutions' Customer Technical Assistance Center (CTAC) at 408 428 7907 (U.S.A.) or +44 1604 586 710 (U.K.) if additional packaging is needed.

1. Refer to Figure 4 and attach the mounting ears in the correct position as required. Use the 8 machine screws in the Hardware Kit.

2. Mount the DCD-Cs at the desired rack position using appropriate screws. Align the mounting holes so that at least two screws on each side can be installed.

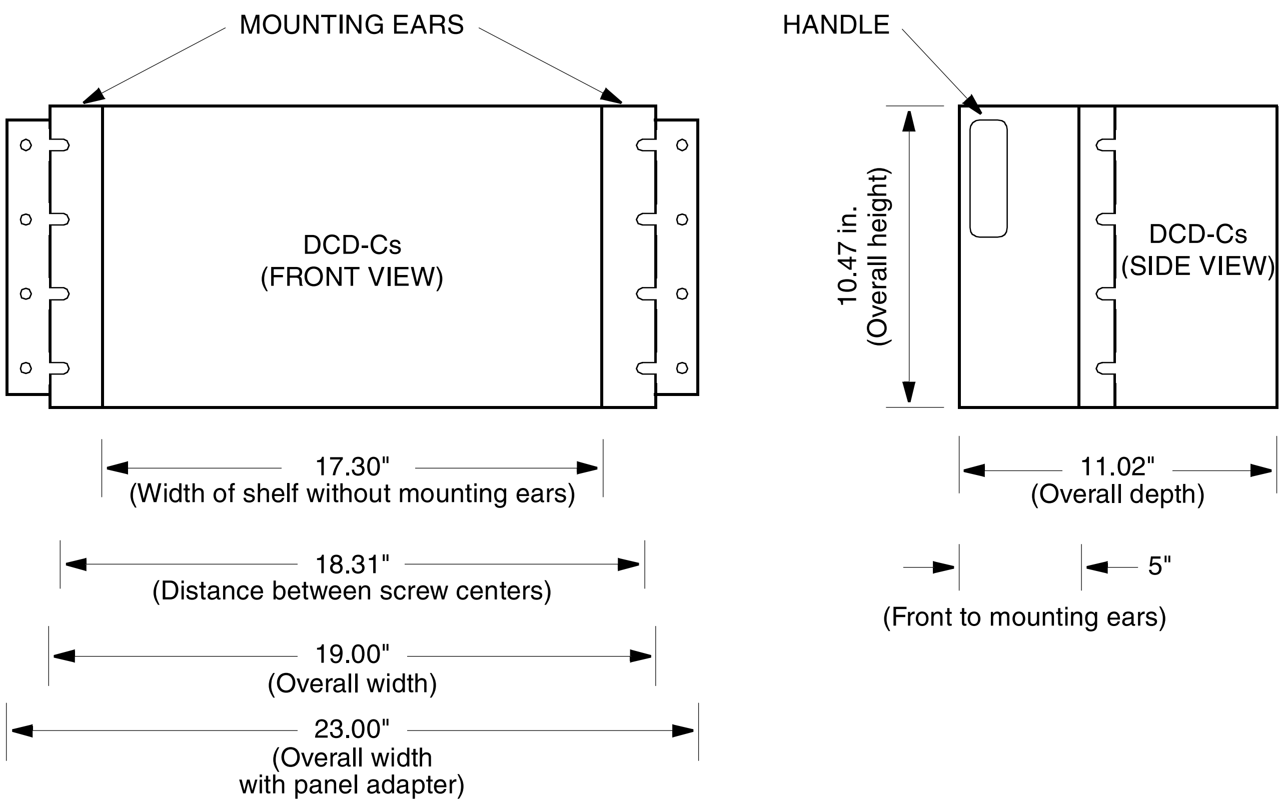


Figure 4. DCD-Cs Dimensions

B. Power and Ground

4.02 Refer to Figure 5 when making power and ground connections.

Frame Ground

4.03 Use 22 gauge solid wire to connect from the frame-ground terminal (FR GND) on the power terminal blocks to frame (rack) ground on the frame or cabinet in which the DCD-Cs is installed.

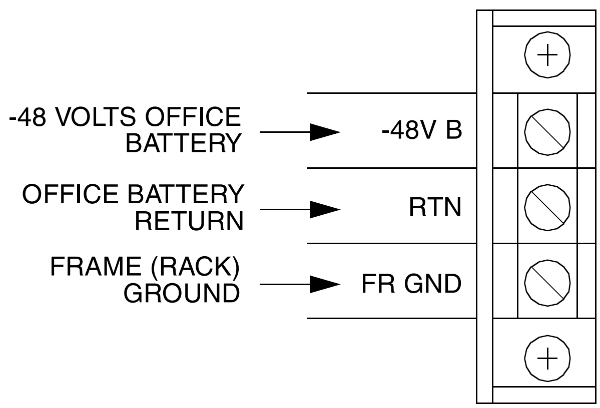


Figure 5. Power Terminal Block

Power

Warning: Ensure that power is not applied to the DCD-Cs before instructed in the power-on procedure.

4.04 Use 22 gauge stranded wire to connect the office -48 volt supply to the power connector. Connect the A battery feed to the terminals on the left and the B battery feed to the terminals on the right. Connect the negative side of the battery feed to the terminal labeled -48V and the positive side of the battery feed to the terminal labeled RTN.

C. Inputs/Outputs

4.05 Use the appropriate connector type when connecting the output signals. For the DS1 outputs (D connectors), the following pinouts apply:

Signal	Pin
DS1 + (Tip)	1
DS1 - (Ring)	2
Signal Ground (Shield)	3

5. POWER-UP AND TESTING

5.01 To power the DCD-Cs and test for proper operation, follow the procedure in Chart 1.

Chart 1. Power-Up

STEP	PROCEDURE
Use this Chart to apply power to the DCD-Cs and test for proper operation.	
1	Apply power to the DCD-Cs after installing as described in Part 4, Installation.
2	***Note:*** The DCD-Cs may take less than 60 minutes to achieve its normal operating state. After 2 hours, observe all front-panel lamps (except the DIGITAL SIGNAL FAULT lamp). ***Requirement:*** The front-panel lamps display normal states as listed below. -48V A off -48V B off DC POWER green LOCK green CALIBRATION ALARM off INITIALIZATION off
3	After another 2 minutes, observe the DIGITAL SIGNAL FAULT lamp. ***Requirement:*** The DIGITAL SIGNAL FAULT lamp is off. If the DIGITAL SIGNAL FAULT lamp is off, skip to Step 8. If the DIGITAL SIGNAL FAULT lamp is lit, continue with this procedure by reading the note below.
Note: The ion beam pump current may exceed the fault threshold limit when power is first applied. This condition is normal for cesium clocks that have been without power for a time. If this condition occurs, the DIGITAL SIGNAL FAULT lamp will remain lit more than 2 minutes after the INITIALIZATION lamp goes off. Cycling the power according to the following steps brings the current within limits.	
4	Remove power to the DCD-Cs.
5	After 30 seconds, reapply power to the DCD-Cs.
6	After the INITIALIZATION lamp goes off, wait 2 minutes, then observe the DIGITAL SIGNAL FAULT lamp. ***Requirement:*** The DIGITAL SIGNAL FAULT lamp is off. If the DIGITAL SIGNAL FAULT lamp is off, skip to Step 8, if the DIGITAL SIGNAL FAULT lamp remains lit, continue with the next step.
7	Repeat Steps 4, 5, and 6 as required (up to 3 times). If the requirement of Step 6 cannot be met after 3 attempts, contact Telecom Solutions' Customer Technical Assistance Center (CTAC) at 408 428 7907 (U.S.A.) or +44 1604 586 710 (U.K.).
8	This procedure is completed.

6. STORAGE

6.01 At temperatures under 35ºC, the DCD-Cs may be stored up to two years without periodic maintenance. If the DCD-Cs is stored at temperatures above 35ºC for more than two years, the DCD-Cs must be operated periodically.

6.02 If extended periods of storage are anticipated, the DCD-Cs must be operated periodically. Table C gives the power-on interval as a function of expected storage temperature. The minimum period of operation with the LOCK indicator lit is 15 minutes.

Table C. Storage Power-Up Intervals

STORAGE TEMPERATURE	POWER-ON INTERVAL
<35ºC	24 months
40ºC	20 months
50ºC	12 months
60ºC	4 months
70ºC	1 month

6.03 The operating lifetime of the cesium beam tube is governed by the consumption of cesium as the cesium beam is formed.

6.04 Extended high temperature storage reduces the expected operating life of the cesium beam tube. The reduction in tube life expectancy for each year at a given temperature may be approximated by Table D.

Table D. Reduction in Life Expectancy

IF STORED AT THIS TEMPERATURE FOR 1 YEAR	REDUCTION IN LIFE EXPECTANCY
40ºC	20 days
50ºC	1 months
60ºC	2 months
70ºC	4 months

7. MAINTENANCE

A. Routine Maintenance

7.01 No routine maintenance is required on the DCD-Cs.

B. Corrective Maintenance

7.02 Use Table E to troubleshoot the DCD-Cs. If the problem persists, or isn't listed, call Telecom Solutions Customer Technical Assistance Center (CTAC) at 408 428 7907 (U.S.A.) or +44 1604 586 710 (U.K.).

8. SPECIFICATIONS

8.01 Table F lists the specifications of the DCD-Cs, and Table G defines the specification terms.

Table E. Troubleshooting

LAMP	STATE	ALARM	RECOMMENDED ACTION
-48V A	Lit red	Minor (See note)	Check fuse, replace if bad. If the fuse is good, check office battery A power.
-48V B	Lit red	Minor (See note)	Check fuse, replace if bad. If the fuse is good, check office battery B power.
DC POWER	Lit red, or off	Major	Check incoming power for correct specifications. If voltage is within specifications, call CTAC.
DIGITAL SIGNAL FAULT	Lit red	Major	No action required during warm-up. If this lamp lights during normal operation, or stays lit after warm-up, call CTAC.
LOCK	Lit red, or off	Major	No action required during warm-up. If this condition occurs during normal operation, call CTAC.
CALIBRATION ALARM	Lit yellow	Minor	Call CTAC. Internal self-tests indicate that the DCD-Cs is still functional, but requires service within 1 year.
INITIALIZATION	Lit yellow	Major	No action required during warm-up. If this lamp lights during normal operation, or stays lit after warm-up, call CTAC.
Note: If both the -48V A and -48V B lamps are lit, a major alarm is activated.			

Table F. Specifications

<table>
<tr><th>ITEM</th><th>SPECIFICATION</th></tr>
<tr><td>Accuracy</td><td>$\pm 5 \times 10^{-12}$ from 0°C to +50°C</td></tr>
<tr><td>Stability $\sigma_y(\tau)$
Averaging Time (τ)
1 s
10 s
100 s
1,000 s
10,000 s</td><td>

2×10^{-11}
2×10^{-11}
5×10^{-12}
2×10^{-12}
5×10^{-13}</td></tr>
<tr><td>Outputs</td><td><table>
<tr><th>Label</th><th>Connector</th><th>Freq</th><th>Level</th><th>Impedance</th><th>Wave shape</th></tr>
<tr><td>10 MHZ</td><td>BNC</td><td>10 MHz</td><td>1 V rms</td><td>50 Ω</td><td>sine wave</td></tr>
<tr><td>5 MHZ</td><td>BNC</td><td>5 MHz</td><td>1 V rms</td><td>50 Ω</td><td>sine wave</td></tr>
<tr><td>1 MHZ</td><td>BNC</td><td>1 MHz</td><td>1 V rms</td><td>50 Ω</td><td>sine wave</td></tr>
<tr><td>8 KHZ</td><td>BNC</td><td>8 kHz</td><td>TTL</td><td>50 Ω</td><td>pulse</td></tr>
<tr><td>DS1 1.544 MB/S</td><td>DB15</td><td>1.544 Mb/s</td><td>DS1</td><td>100 Ω</td><td>bipolar</td></tr>
<tr><td>DS1 1.544 MB/S</td><td>DB15</td><td>1.544 Mb/s</td><td>DS1</td><td>100 Ω</td><td>bipolar</td></tr>
<tr><td>1.544 MHZ</td><td>BNC</td><td>1.544 Mb/s</td><td>TTL</td><td>50 Ω</td><td>square wave</td></tr>
<tr><td>1.544 MHZ</td><td>BNC</td><td>1.544 Mb/s</td><td>TTL</td><td>50 Ω</td><td>square wave</td></tr>
</table></td></tr>
<tr><td>Warm-Up Time</td><td><60 minutes typical, 2 hr max</td></tr>
<tr><td>Input Voltage</td><td>-22 V dc to -56 V dc (-48 V dc nominal)</td></tr>
<tr><td>Input Power</td><td>65 W warm-up
48 W operating</td></tr>
<tr><td>Operating Temperature</td><td>0°C to +50°C</td></tr>
<tr><td>Storage Temperature</td><td>-40°C to +50°C</td></tr>
<tr><td>Humidity (Operating)</td><td>95% up to +50°C</td></tr>
<tr><td>Magnetic Field</td><td>0 to 2 gauss</td></tr>
<tr><td>Dimensions</td><td>17.30" wide (excluding rack mounting ears)
10.47" high
11.02" deep (including handles)</td></tr>
<tr><td>Weight</td><td>48 lb</td></tr>
</table>

Table G. Specification Terms

TERM	MEANING
Stability	Describes the spontaneous movements in the output frequency of the cesium source measured over prescribed time periods. The quantity used to describe the deviation of these measurements about the nominal center frequency is either the allan variance or time variance. Large values indicate poor stability; conversely, small values indicate good stability.
Accuracy (Lifetime) (As used here, refers only to frequency accuracy, not time accuracy)	Represents the degree to which the cesium output frequency conforms to UTC at standard environmental conditions (e.g. temperature). Accuracy is a fundamental descriptor of a cesium oscillator because it is a free-running device uninfluenced by external controls.
Warm-up Time	The time required to stabilize the temperature-regulating element surrounding the oscillator.
Operating Temperature	The temperature range over which the specifications are met unless specifically stated otherwise.
Nonoperating Temperature	The temperature range over which the unit can be stored without damage.