DIGITAL CLOCK DISTRIBUTOR

CESIUM

(ETSI VERSION)

CONTENTS PAGE

1. GENERAL

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

1.02 Whenever this practice is reissued, the reason for reissue will be given in this paragraph.

2. FUNCTIONAL DESCRIPTION

2.01 The DCD-Cs is a self-contained, atomic primary frequency and time reference. The atomic clock in the DCD-Cs is based on a natural resonant frequency of cesium 133. 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 The 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.

2.05 The synthesizer/modulator sends the corrected frequency from the quartz oscillator to the programmable synthesizer, which develops the output signals of 10 MHz, 5 MHz, 2.048 Mb/s, 2.048 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 may take up to 30 minutes to lock the quartz oscillator frequency to a stable cesium frequency. Warm-up times are dependent on the number of months without power and the storage temperature.

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, and Table A describes the front-panel items.

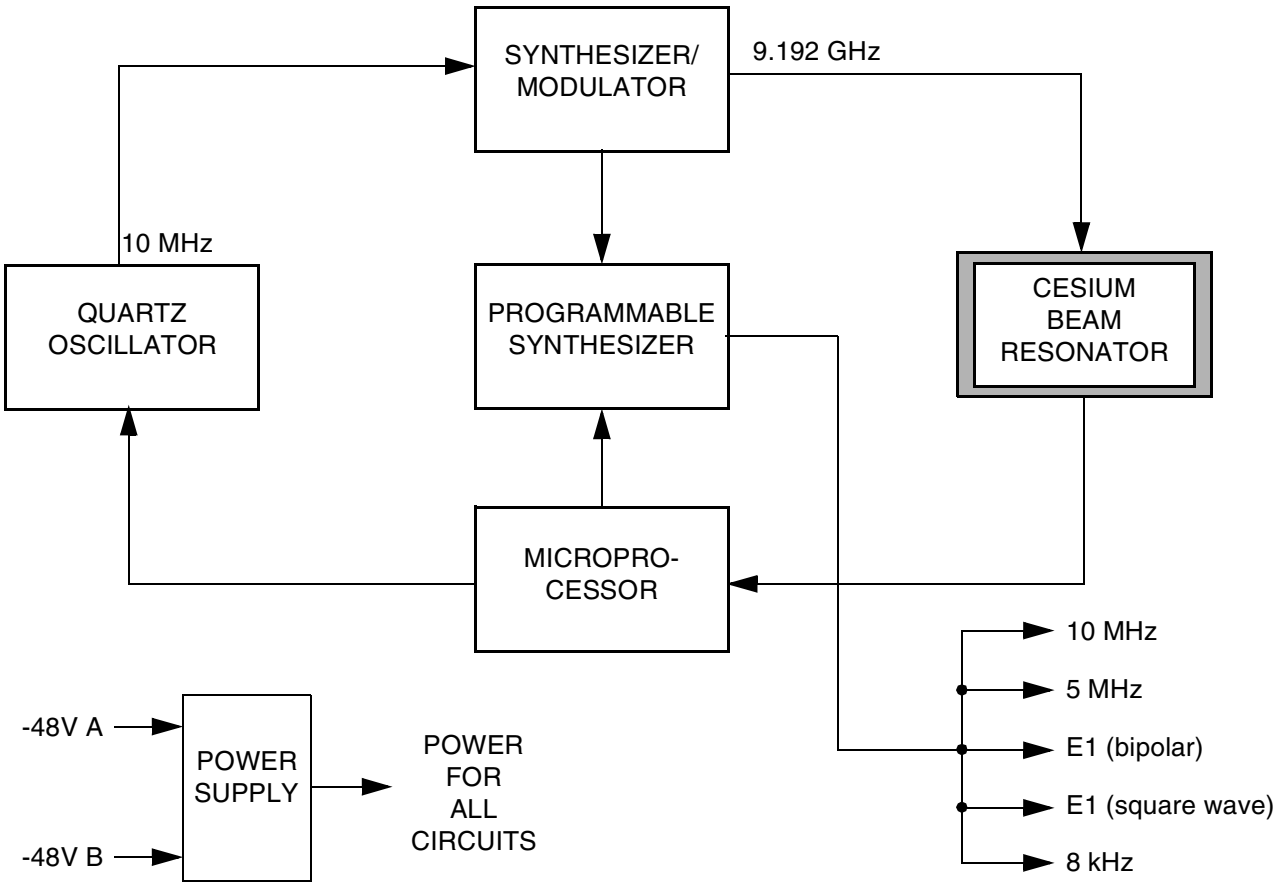
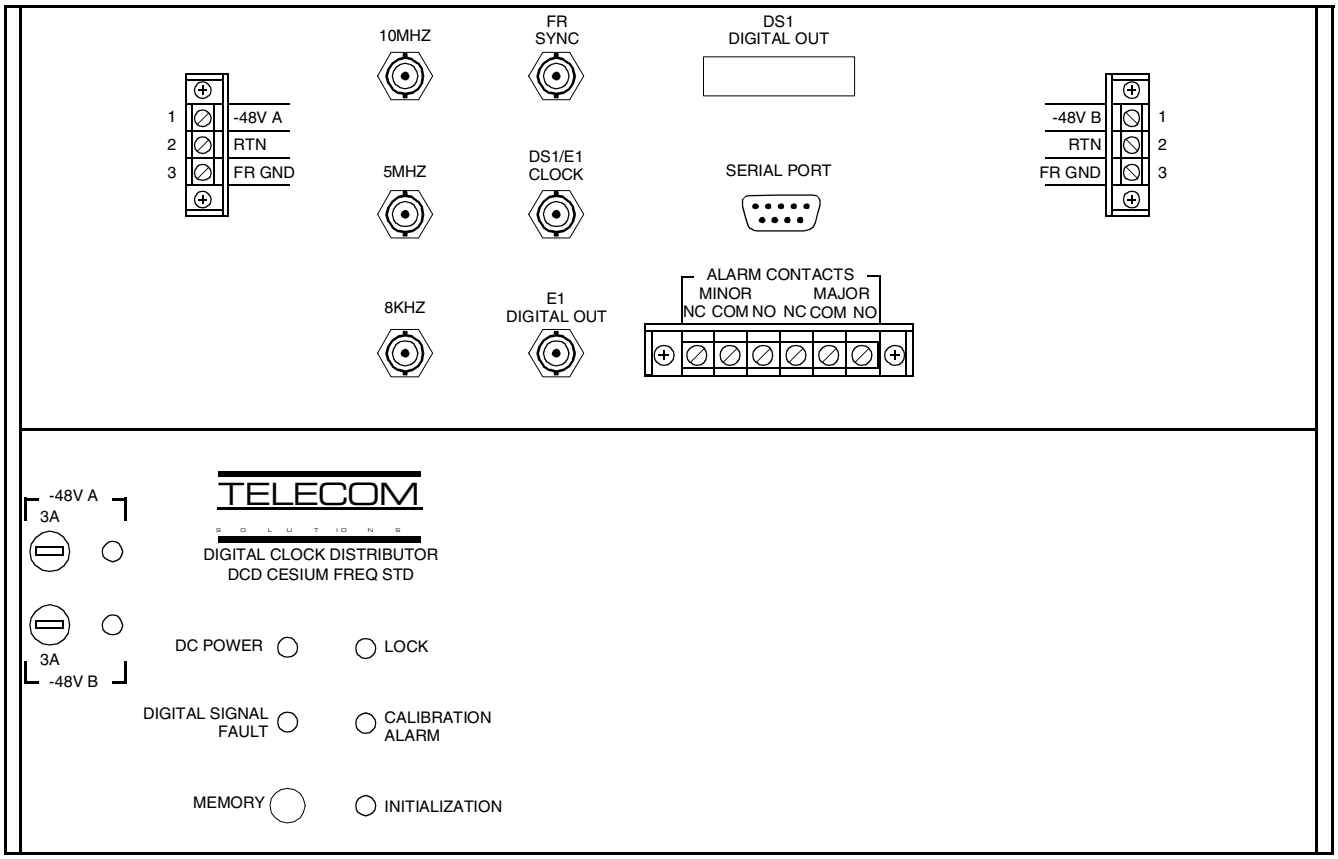


Figure 1. Block Diagram



Note: Controls and indicators are described in Table A.

Figure 2. DCD-Cs

Table A. Controls and Indicators

INDICATOR	DESCRIPTION
UPPER HALF	
-48V A	Terminal for A battery
RTN	Terminal for A battery return
FR GND	Terminal for frame ground (do not connect to RTN terminal)
10MHz	BNC connector for 10-MHz sine-wave output
5MHz	BNC connector for 5-MHz sine-wave output
8KHZ	BNC connector for 8-kHz sine-wave output
FR SYNC	(Factory test only)
DS1/E1 CLOCK	BNC connector for 2.048-MHz E1 pulse output
E1 DIGITAL OUT	BNC connector for 2.048-Mb/s E1 output (complies with G.703, Table 6)
DS1 DIGITAL OUT	(Not used)
SERIAL PORT	(Factory test only)
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)
LOWER HALF	
-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 output of the dc-to-dc converter is out of specification. 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.
MEMORY	(Not used)
LOCK	Lamp that lights red if the frequency control loop is unstable. Normally green.
CALIBRATION ALARM	Lamp that lights yellow if the internal self-tests exceed preset 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 and while start-up routines are executing. Normally off.

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 consists of part number 990-43100-02, which consists of 090-43100-02 (Cesium, E1, Rear Panel), and 093-432100-02 (Hardware Kit). The Hardware Kit consists of 8 machine screws 12-24 x 1/2", and this practice.

Note: Save packing material. All equipment returned must be packed in the original packing material. Contact Telecom Solutions' Customer Technical Assistance Center (CTAC) at 408-433-7907 if additional packaging is needed.

1. Refer to Figure 3 and attach the mounting ears in the correct position as required.

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.

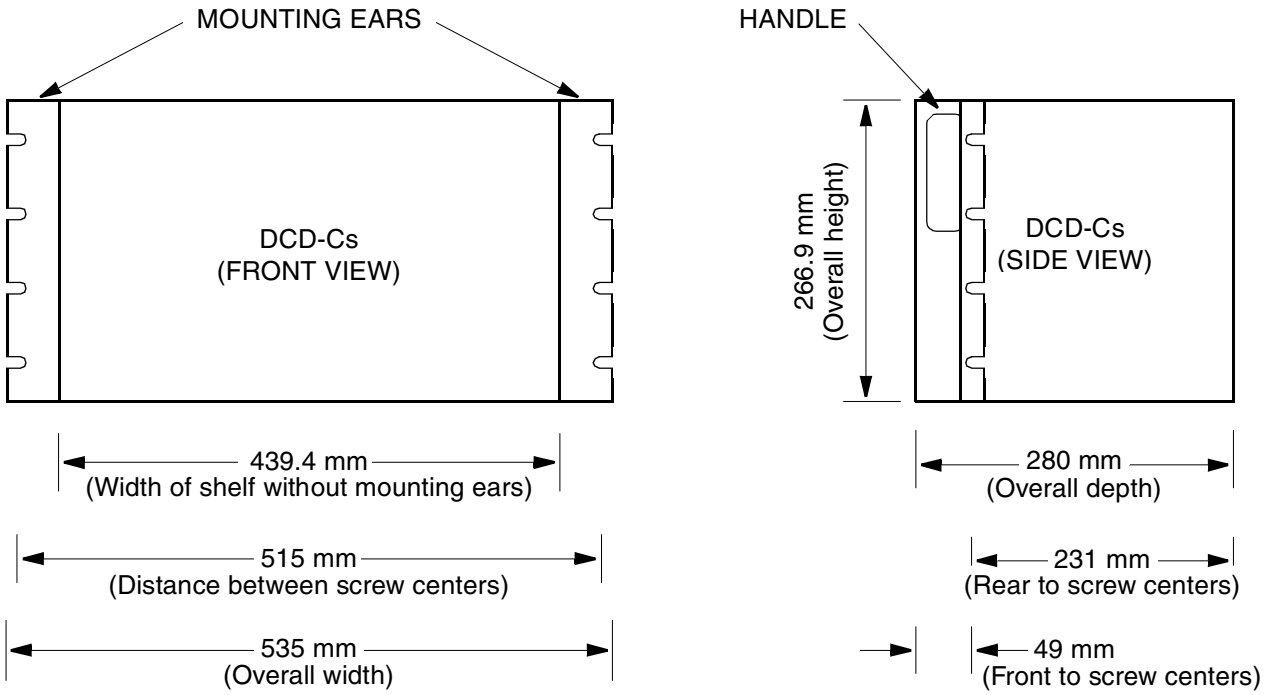


Figure 3. DCD-Cs Dimensions

B. Power and Ground

4.02 Refer to Figure 4 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.

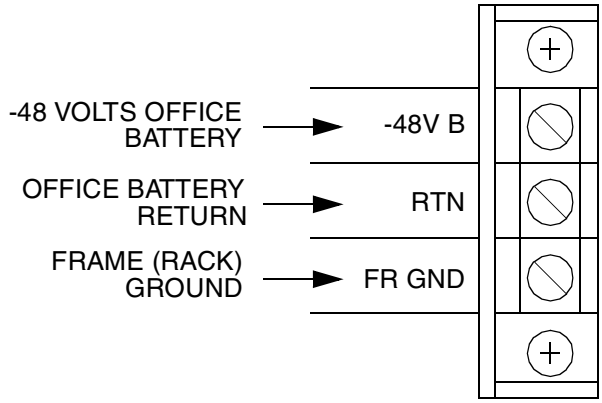


Figure 4. Power Terminal Block

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. Outputs

4.05 Use the appropriate connector type when connecting the output signals.

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	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. If this occurs, the DIGITAL SIGNAL FAULT lamp will remain lit after the INITIALIZATION lamp goes off. If the DIGITAL SIGNAL FAULT lamp has remained lit, continue with the steps below.	
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.
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 B 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 B. Storage Power-on 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 life 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 C.

Table C. 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 D to troubleshoot the DCD-Cs. If the problem persists or isn't listed, call Telecom Solutions Customer Technical Assistance Center at 408-428-7907.

8. SPECIFICATIONS

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

Table D. Troubleshooting

LAMP	STATE	RECOMMENDED ACTION
-48V A	Red	Check fuse, replace if bad. If the fuse is good, check office battery A power.
-48V B	Red	Check fuse, replace if bad. If the fuse is good, check office battery B power.
DC POWER	Red or off	Check incoming power for correct specifications. If adequate current is available at a voltage within specifications, call CTAC.
DIGITAL SIGNAL FAULT	Red	No action required for 30 minutes. The output is not locked to the cesium source for some time during warm-up or start-up. If this lamp lights during normal operation, or stays lit for more than 30 minutes, call CTAC.
LOCK	Red	No action required during warm-up or start-up. Otherwise, call CTAC. The frequency control loop internal to the cesium beam resonator control circuitry is not stable.
CALIBRATION ALARM	Yellow	Call CTAC. Internal self-tests indicate that the DCD-Cs is still functional but requires service soon.
INITIALIZATION	Yellow	No action required for 30 minutes. This is a normal condition during warm-up or start-up; no error detection is in progress while this lamp is on. If this lamp lights during normal operation, or stays lit for more than 30 minutes, call CTAC.

Table E. Specifications

ITEM	SPECIFICATION
Accuracy	$\pm 5 \times 10^{-12}$ from 0°C to 50°C $\pm 2 \times 10^{-12}$ at 25°C with up to 2 gauss magnetic field (dc; ac, 50, 60, 400 Hz)
Reproducibility	$\pm 3 \times 10^{-12}$
Settability (Frequency)	1×10^{-15} (Range: $\pm 1 \times 10^{-9}$)
Stability $\sigma_y(\tau)$ Averaging Time (τ) 1 s 10 s 100 s 1,000 s 10,000 s	 2×10^{-11} 2×10^{-11} 5×10^{-12} 2×10^{-12} 5×10^{-13}
SSB Phase Noise (1 Hz Bandwidth) Offset from Carrier (f) 1 Hz 10 Hz 100 Hz 1,000 Hz	 @ 10 MHz -90 dBc -120 dBc -140 dBc -150 dBc
Spectral Purity: Harmonics Spurious Signals Signal-to-noise ratio in 30-kHz noise BW	@ 10 MHz / @ 5 MHz <-40 dBc / <-40 dBc <-80 dBc / <-80 dBc >81 dB
Outputs	Label / Connector / Freq / Level / Impedance / Wave shape 10 MHZ / BNC / 10 MHz / 1 V rms / 50 Ω / sine wave 5 MHZ / BNC / 5 MHz / 1 V rms / 50 Ω / sine wave 8 KHZ / BNC / 8 kHz / TTL / 50 Ω / pulse DS1/E1 CLOCK / BNC / 2.048 MHz / TTL / 50 Ω / square wave E1 DIGITAL OUT / BNC / 2.048 Mb/s / E1 / 75 Ω / bipolar Note: The E1 DIGITAL OUT signal is CCITT G.703/Table 6 compliant
Warm-Up Time	30 minutes (may be longer after extended storage or elevated storage temperatures)
Input Voltage	-22 V dc to -56 V dc (-48 volts dc nominal)
Input Power	65 W warm-up 48 W operating
Operating Temperature	0°C to +50°C
Dimensions	439.4 mm wide (excluding rack mounting ears) 266.9 mm high 1280 mm deep (including handles)
Weight	20.4 kg

Table F. 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.