SECTION 6 – CD-402B CONTROL DISPLAY UNIT THEORY OF OPERATION

1. General

The CD-402B Control Display Unit establishes and displays the operating status of all VC-401B VHF Communications Transceiver functions (refer to Figure 6-1). Depending upon function selector switch position, the CD-402B function selector deactivates, activates or tests the operation of the receiver.

As the VC-401B becomes activated, it sends display data to the CD-402B. The display data information consists of the last active and standby frequencies input to the VC-401B, system number and transmit annunciator. The system which is controlled by the CD-402B is displayed as system number "1", "2" or "(Blank)". A blank system number display indicates system number 3 or zero. Transmit annunciation (Tx) is displayed each time the push-to-talk switch is pressed and an RF output is present. Two system errors can also be annunciated on the display: FAIL1 – Synthesizer not locked, and FAIL2 – No transmitter power indication.

The CD-402B provides frequency selection (Gray Code) to the VC-401B for selecting the desired operating frequency.

The CD-402B provides a transfer function for swapping the active frequency and standby frequencies the VC-401B, which in turn supplies new display data information back to the CD-402B for display.

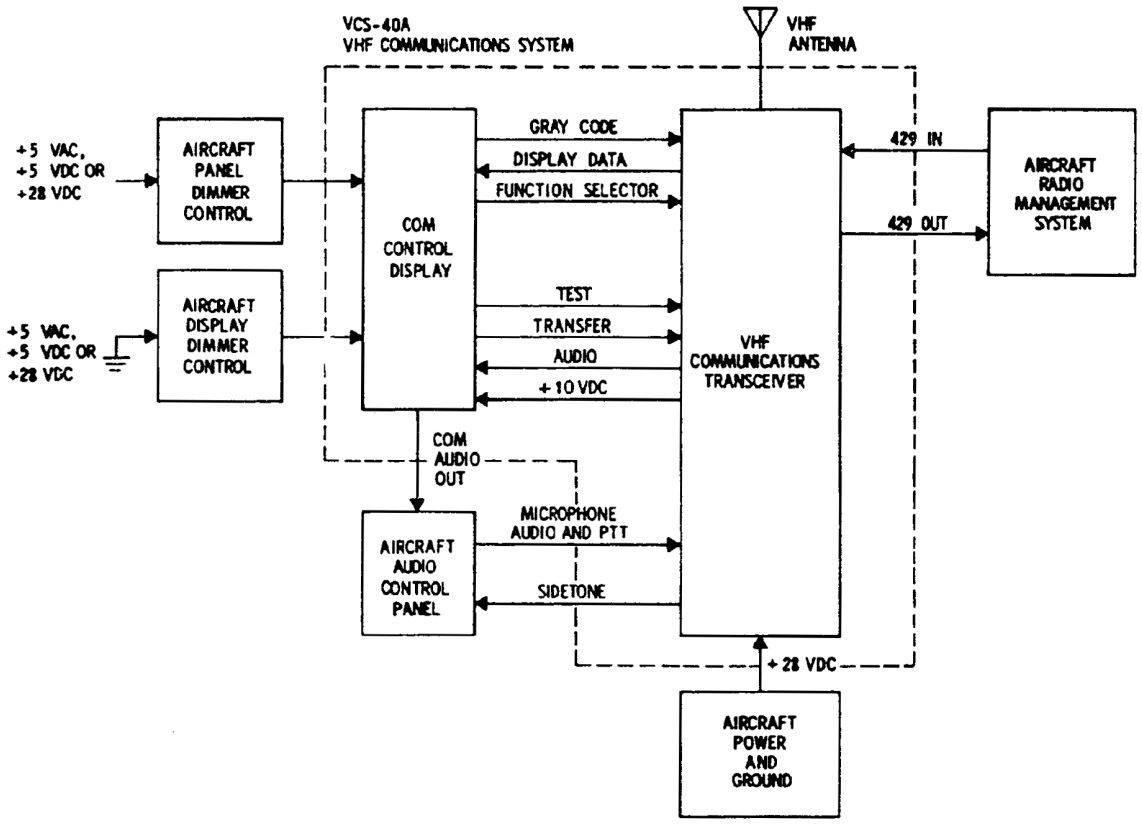

Figure 6-1. Typical VCS-40A Communications System Configuration

The VC-401B supplies audio to the CD-402B volume control for setting the VC-401B audio output to a desired audio output level for direct headphone or speaker use.

The CD-402B receives its power from the +10 Volt DC input from the VC-401B power supply. Power for the panel lamps and the display lamps that backlight the display is received from external aircraft dimmer controls.

2. General Circuit Theory

Refer to figure 6-2 for the following discussion.

A. Front Panel Controls

The CD-402B Control Display Unit front panel controls establish the operating status of the transceiver. The function selector switch is used to select one of three operating modes: OFF, 25, or 8.33. The function switch supplies a low level output to activate the specific operating mode in the VC-401B Audio/CPU module microprocessor. In the OFF position, the VC-401B is turned off. In the 25 position, the VC-401B is turned on with only the 25 kHz channel tuning enabled. In the 8.33 position, the VC-401B is turned on with both the 25kHz and the 8.33 kHz channel tuning enabled.

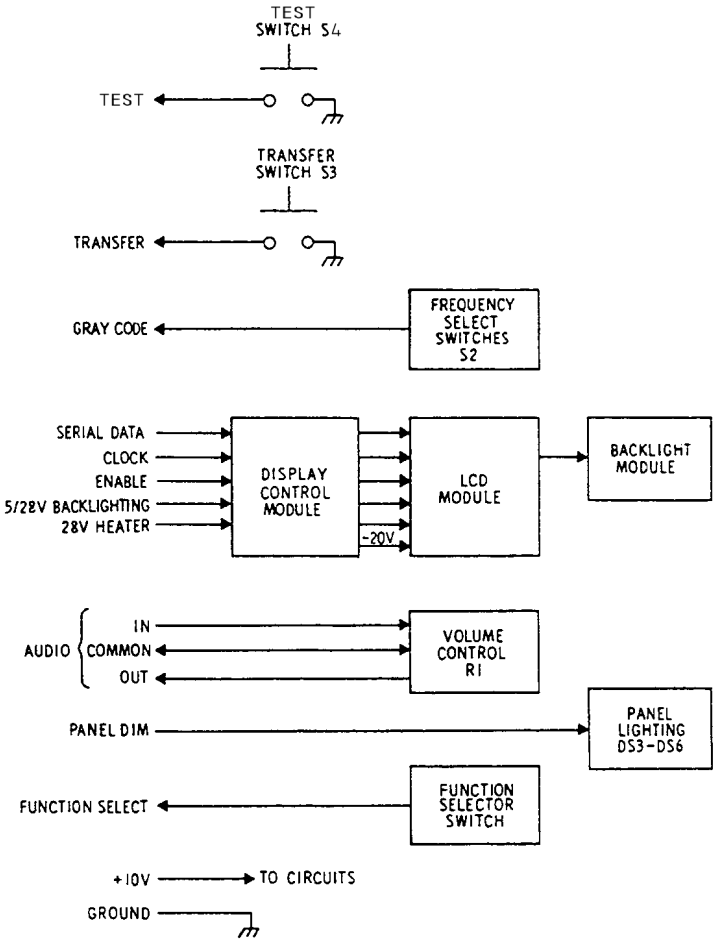

Figure 6-2. Control Display Block Diagram

The CD-402B volume control receives the VC-401B audio output and adjusts it to a desired audio output level for direct headphone or speaker amplifier use.

The Test pushbutton applies a ground potential (TST) to the VC-401B audio/CPU module to inhibit the audio module automatic squelch circuit and permit receiver noise to be heard. This enables the operator to verify the receiver is operational.

The frequency transfer pushbutton switch applies a low level output to the VC-401B CPU module microprocessor. The duration of the low level output determines the action to be taken by the microprocessor: frequency transfer, active frequency tuning, or emergency communications frequency tuning (121.500).

- A momentary low level output interchanges the active and standby frequencies. Another momentary low level output reverts the active and standby frequencies back to their original state.
- A low level output of two to three seconds duration causes the standby frequency to disappear and allows tuning of the active frequency instead of the standby frequency as normal.
- Another two to three second low level output restores the standby frequency display and the standby frequency tuning.
- In the event of a total display failure, pressing and holding the frequency transfer pushbutton for seven seconds causes the VC-401B to retune to an active frequency of 121.500 MHz. Knowing that the VC-401B is tuned to 121.500 MHz, a new frequency can be tuned by counting the number of detent stops as the frequency selector knobs are rotated.

The two concentric frequency selector switches are used to select the desired communications frequency. During rotation, the microprocessor detects the logic input to the VC-401B. The frequency is then incremented or decremented by the appropriate amount. The detected frequency is then routed from the VC-401B CPU module back to the CD-402B and displayed.

The large frequency knob increments (clockwise rotation) or decrements (counter-clockwise rotation) the frequency being tuned by one MHz for every detent stop.

The small frequency knob increments (clockwise rotation) or decrements (counter-clockwise rotation) the frequency being tuned by 25 kHz for every detent stop when the function selector switch is in the 25 position. If the function selector switch is in the 8.33 position, the small frequency knob sequences through a list of both 25 kHz and 8.33 kHz channels (see Table 6-1).

B. Display Drivers

The processor in the VC-401B outputs a serial data word, clock pulse, and an enable signal which is applied to the display control module line receivers and then to the display drivers contained within the CD-402B LCD module.

C. Displays

The multi-segment display contains a contact on the edge of the module leading to each liquid crystal segment. A segment is activated or darkened by a voltage applied to a contact from the display driver. The individual segments are arranged to form the desired characters (annunciators, numbers, or letters) when the appropriate combinations of segments are activated.

Table 6-1 Frequency-Channel Pairing

Frequency (MHz)	Channel Spacing (kHz)	Channel Name
118.0000	25	118.000
118.0000	8.33	118.005
118.0083	8.33	118.010
118.0167	8.33	118.015
118.0250	25	118.025
118.0250	8.33	118.030
118.0333	8.33	118.035
118.0417	8.33	118.040
118.0500	25	118.050
118.0500	8.33	118.055
118.0583	8.33	118.060
118.0667	8.33	118.065
118.0750	25	118.075
118.0750	8.33	118.080
118.0833	8.33	118.085
118.0917	8.33	118.090
118.1000	25	118.100
.	.	
.	.	
.	.	
136.9750	25	136.975
136.9750	8.33	136.980
136.9833	8.33	136.985
136.9917	8.33	136.990

D. Display Lighting

For night or other dark conditions, a backlight module containing 6 incandescent lamps are inserted behind the dichroic LCD module. Depending on the particular module selected, the backlight lamp voltage may be +5 Volts AC/DC or +28 Volts DC.

E. Panel Lighting

Four incandescent lamps (+28 Volt DC or +5 Volt AC/DC) provide panel lighting. A connection of the appropriate voltage to either connector terminal adequately illuminates the function nomenclature.

3. Detailed Circuit Theory

The display control module provides five functions:

- Interfaces the front panel switches to the rear connector to set up operating conditions in the VC-401B.
- Interfaces +10 Volts DC input to all +10 Volts DC points on the display control.
- Converts +10 Volts DC input to -20 Volts DC to provide the voltage necessary to light the LCD display segments.
- Interfaces aircraft +28 Volts DC to provide heater voltage for the LCD module
- Filters and removes anomalies from the input data clock and enable signals from the VC-401B before applying the signals to the display driver board.

A. Front Panel Interface

(1) Function Selector Switch

The display control module interfaces the control signals from the front panel to the VC-401B (refer to Figure 6-3). In the 25 and 8.33 positions, function selector switch S1B supplies a ground potential (p/s enable) through P1001/J2001, pin 12 to the display control module. This module supplies the p/s enable ground potential to the VC-401B power supply module via the external connector J2002/P1002, pin 14, enabling power to be supplied to the system and +10 Volts DC to the CD-402B.

In the 8.33 position, function selector switch S1A, pin 3, supplies a ground potential to the display control module via P1001/J2001, pin 24, and to the external connector, J2002/P1002, pin 5. This signal is used by the VC-401B audio/CPU module to enable the VC-401B to tune the 8.33 kHz channels along with the 25 kHz channels.

NOTE: The operations described in the remaining paragraphs of this section describe the unit operating in 25kHz channel spacing mode. If the unit is in the 8.33 kHz channel spacing mode, the three 8.33 kHz channel names will be displayed in sequence between each 25 kHz channel. The sequence is: 000, 005, 010, 015, 025, 030, 035, 040, 050, 055, etc.

(2) Frequency Transfer Pushbutton Switch

The transfer (XFR) pushbutton switch S3 supplies a ground potential only if pushed when the function selector switch is in the 25 or 8.33 positions (refer to figure 6-3). When the XFR pushbutton is depressed, a ground potential is supplied to the VC-401B CPU module input mode MUX circuit via P1001/J2001, pin 1, display control module tie point E3, to tie point E1, back through the display control module and out through J2002/P1002, pin 19, P1004(A)/J1004(A), pin M or P1001(B)/J1001(B), pin 56. Here, the ground potential causes the VC-401B CPU module to interchange the active frequency display and the standby frequency display.

Pressing and holding the XFR pushbutton two to three seconds causes the standby frequency display to disappear allowing the operator to change the active frequency setting. Pressing and holding the XFR pushbutton for another two seconds restores the standby frequency display.

Pressing and holding the XFR pushbutton for seven seconds causes the VC-401B to retune to 121.500 MHz. This procedure can be used in the event there is a display failure.

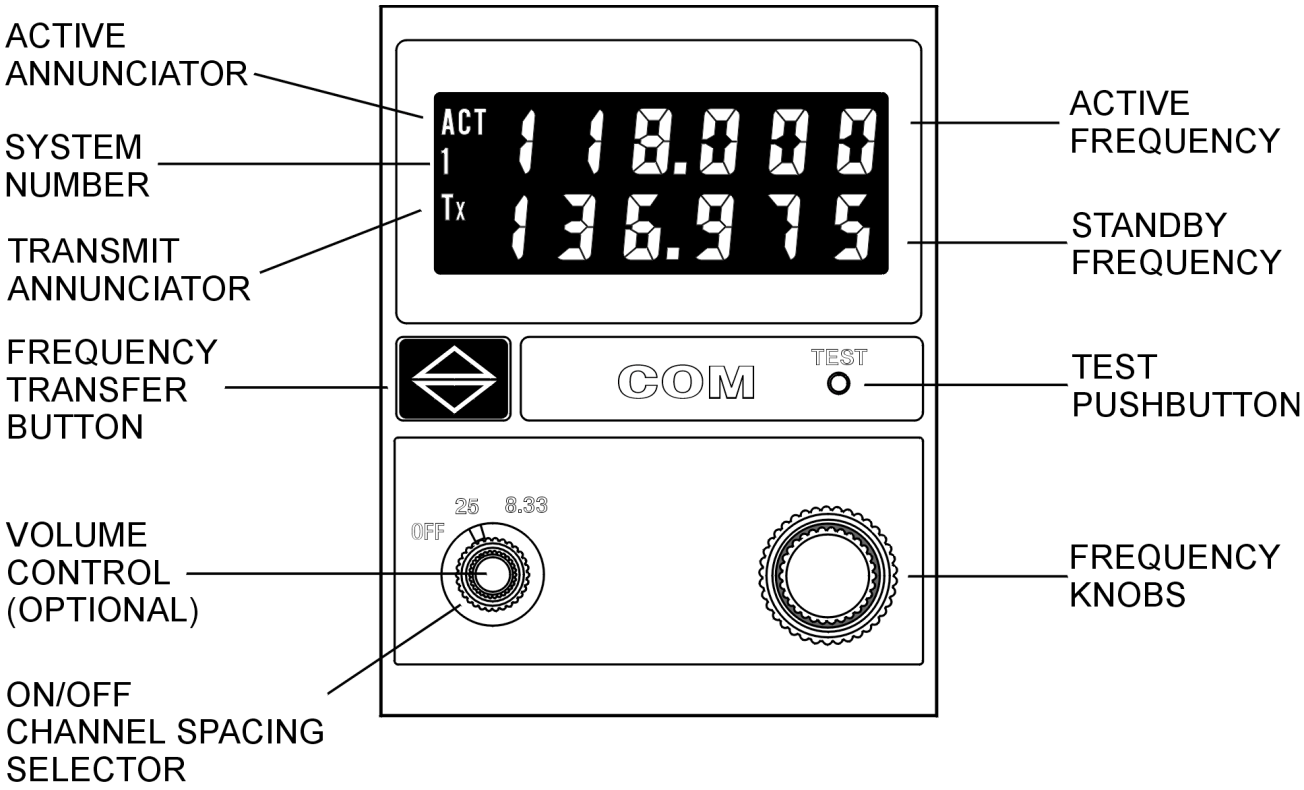

Figure 6-3. CD-402B Front Panel Controls

Knowing the system automatically retunes to 121.500 MHz, the operator can select a desired frequency by incrementing (clockwise rotation) or decrementing (counterclockwise rotation) the frequency selector switch. The outer (large) knob tunes the whole megahertz frequencies (1MHz, 2 MHz, 3 MHz, etc., for clockwise rotation or 9 MHz, 8 MHz, 7 MHz, etc., for counterclockwise rotation) and the inner (smaller) knob tunes the fractional megahertz frequencies (25 kHz, 50 kHz, 75 kHz, etc., for clockwise rotation or 00 kHz, 75 kHz, 50 kHz, etc., for counterclockwise rotation).

(3) Test Pushbutton Switch

Pressing the Test pushbutton S4 supplies a ground potential (TST) to the VC-401B audio/CPU module via P1001/J2001, pin 24, the display control module, J2002/P1002, pin, to inhibit the audio module automatic squelch circuit and permit receiver noise to be heard. This enables the operator to verify the receiver is operational.

(4) Frequency Selector Switch

Frequency selector switch S2 is a dual wafer, 24 position, 15° detent rotary switch used to select frequencies in 1 MHz steps and 25 kHz steps. Each wafer sets up a gray code logic input to the VC-401B CPU module microprocessor when it is rotated. The CPU module microprocessor detects and counts the number of gray code logic changes and the direction of switch rotation (refer to table 6-1).

Table 6-1 assumes that in the initial switch position “0”, both outputs are open (high). Switching to the next switch position, either clockwise or counterclockwise, changes the gray code logic output. For clockwise rotation, pin 8 supplies a low level output and pin 11 remains high. Conversely, for counterclockwise rotation, pin 8 remains high and pin 11 supplies a low level output. Switching to position “2” causes both pins 8 and 11 to supply a low level output. As the frequency selector switch is rotated, the VC-401B CPU module microprocessor senses the gray code logic changes and the pattern of the gray code logic changes to set up the next frequency for operation.

KNOB MOVEMENT CLOCKWISE	SWITCH S1002 A/B		KNOB MOVEMENT COUNTERCLOCKWISE	SWITCH S1002 A/B	
	PIN 8	PIN 11		PIN 8	PIN 11
0	HI	HI	0	HI	HI
1	LO	HI	1	HI	LO
2	LO	LO	2	LO	LO
3	HI	LO	3	LO	HI
4	HI	HI	4	HI	HI

Table 6-2. Selector Switch Gray Code Logic Output

Refer to figure 6-3. Outer knob S2A routes its gray code logic output (GC 1A, GC 1B) through P1001/J2001, pins 11 and 20, display control module, J2002/P1002, pins 15 and 7, to the VC-401B audio/CPU module.

Inner knob S2B routes its gray code logic output (GC 2A, GC 2B) through P1001/J2001, pins 9 and 10, display control module, J2002/P1002, pins 17 and 16, to the VC-401B audio/CPU module.

(5) Volume Control (Optional)

Refer to figure 6-3. Audio is supplied from the VC-401B audio module to the CD-402B display control module through P1002/J2002, pins 10 and 1, and through J2001/P1001, pins 26 and 14 to volume control (audio adjust) R1. The center wiper of R1 is used to select the desired audio level output. The audio output is then routed through P1001/J2001, pin 8, display control module, and out to J2002, pin 18 where it can be used for direct headphone or speaker amplifier use.

(6) Panel Lighting

Depending upon the version of the CD-402B Control Display Unit, four 28 Volt incandescent lamps powered by the +28 Volts DC aircraft panel dimmer voltage source or four 5 Volt incandescent lamps powered by the +5 Volts DC or +5 Volts AC aircraft panel dimmer voltage source provides panel lighting. Refer to figure 6-3.

For +28 Volts DC aircraft panel dimmer voltage, +28 Volts DC is routed through J2002, pin 8, display control module, J2001/P1001, pin 19 to light 28 Volt incandescent lamps DS3, DS4, DS5, and DS6.

For +5 Volt DC or AC aircraft panel dimmer voltage, +5 Volts AC/DC is routed through J2002, pin 9, display control module, J2001/P1001, pin 18 to light 5 Volt incandescent lamps DS3, DS4, DS5 and DS6.

(7) 5/28V Backlighting

An aircraft display dimmer control voltage of +28 or +5 Volts AC/DC is routed through J2002, pin 12, display control module to J2005/P1005, pin 2 for use in the backlighting module (refer to Figure 6-3).

(8) CD-402B Input Power

When the CD-402B function selector is switched to the 25 or 8.33 position, the VC-401B power supply becomes energized to supply the necessary operating voltages throughout the system. The VC-401B CPU module 10 Volt regulator U2010 supplies +10 Volts DC to the CD-402B via P1002/J2002, pin 11 to the display control module (refer to figure 6-3).

The +10 Volts DC input at J2002, pin 11 is fed through a low pass RC filter consisting of R2001 and C2002 before it is supplied to the remaining CD-402B circuitry. Capacitors C2001 and C2003 provide additional filtering of the DC voltage.

After filtering, +10 Volts is supplied to voltage converter U2003 where the +10 Volts DC input is converted to -10 Volt DC. The -10 Volt DC output is then fed through blocking diode CR2001 to the input of a second voltage converter (U2001) where it is converted to -20 Volts. The -20 Volt output is filtered by capacitor C2013, and appears across resistor R2006 where additional regulation is provided for use in the LCD module.

(9) CD-402B Display Data Signals

Three display data signals are received from the VC-401B CPU module as display clock (DISPLAY CLK) at J2002, pin 24, display data (DISPLAY DATA) at J2002 pin 22, and display enable (DISPLAY ENABLE) at J2002, pin 20.

NOTE: Since the circuitry for all three of the display data signals is the same, only one of the circuits will be described. The description will be on the display clock circuit.

The display clock input signal is fed through a low pass RC filter consisting of R2002 and C2004 and direct coupled to Schmitt-Trigger U2004A (refer to figure 6-4). Schmitt-Trigger U2004A inverts the display clock signal and direct couples it to NAND gate U2002D, pin 12. Pin 13 of NAND gate U2002D is constantly high because of no input signal to Schmitt-Trigger U2004C.

With a constant high at U2002D, pin 13, the inverted signal from U2004A to U2002D, pin 12 governs the output response. Refer to figure 6-5 for a typical display clock signal.

From the timing diagram (figure 6-5) it can be seen that when both NAND gate inputs (U2002, pins 12 and 13) are high. NAND gate output U2002, pin 11 will be low. When NAND gate U2002D, pin 12 goes low, NAND gate output U2002, pin 11, goes high. Thus, the input signal to U2002D, pin 12 is inverted again at the output of the NAND gate: here, the output signal is routed to the display driver module through J2005/P1005, pin 5.

Resistors R2005A and R2005B are pull-down resistors to ensure that the inputs of U2004A and U2004C are at a low level when there is no activity.

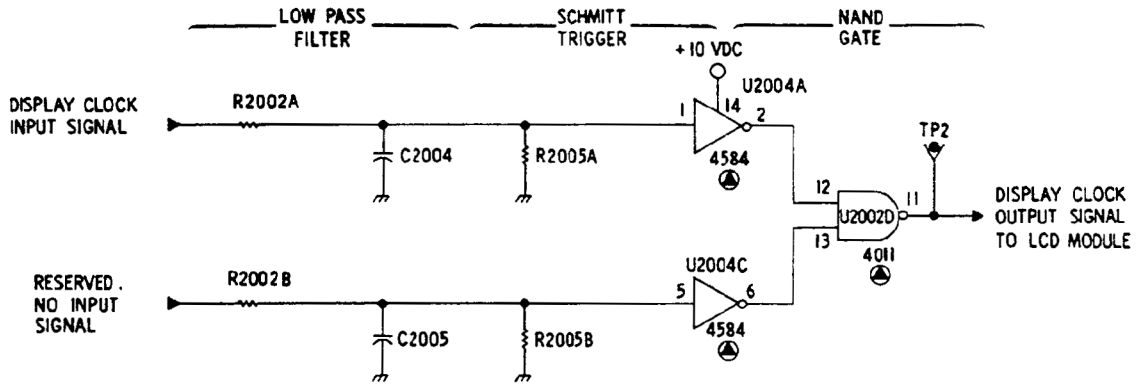

Figure 6-4. Typical Display Control Circuit partial Schematic

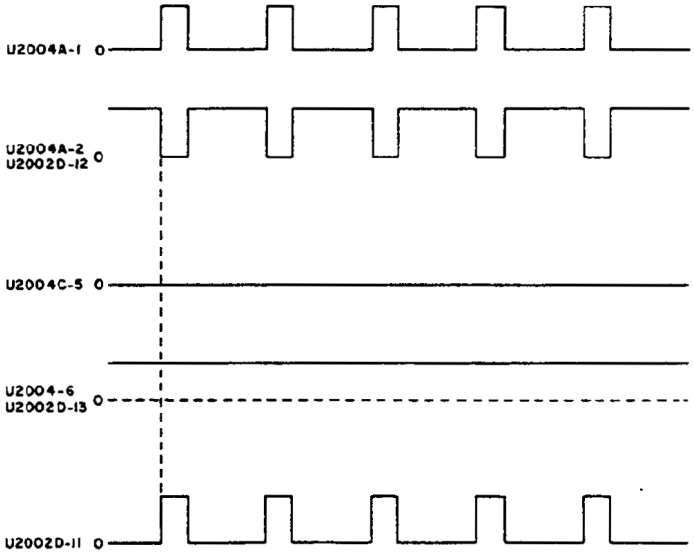

Figure 6-5. Display Clock Signal

The previous circuit description is valid for the remaining two circuits, (display data and display enable) though the timing diagrams will be different. Figure 6-6 illustrates typical clock, data and enable signal activity.

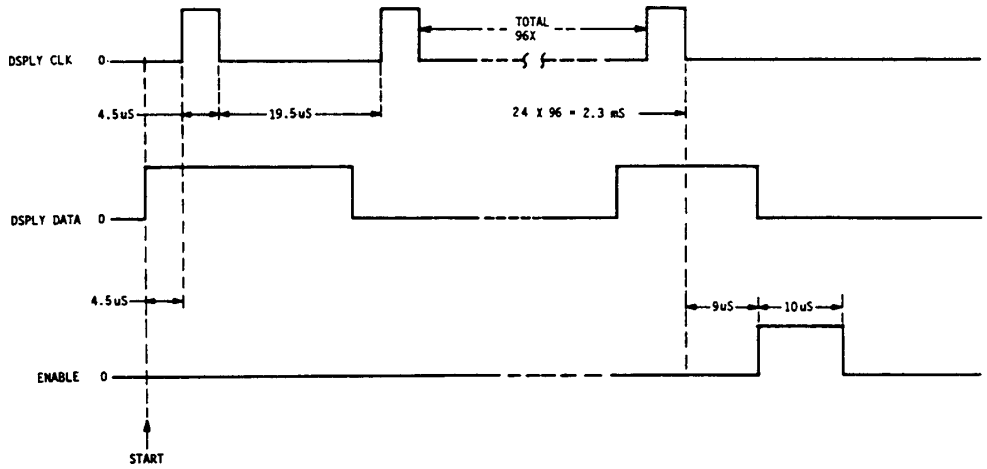

Figure 6-6. Display Clock, Display Data And Display Enable Signal Timing Diagram

(10) 28VDC Heater

At temperatures below 32°F (0° C) the dichroic display automatic heater turns on to warm the LCD module. At temperatures above 50°F (+10° C) the heater will turn off. See figure 6-3. Aircraft +28 Volts DC is routed from P1002/J2002, pin 13 through the display control module to the LCD module via J2005/P1005, pin 6.