

QUICK START GUIDE FOR DEMONSTRATION CIRCUIT 726

PROGRAMMABLE CLOCK 1KHZ TO 68MHZ

LTC6903 & LTC6904

DESCRIPTION

Demonstration circuit 726 is for the evaluation of Linear Technology's programmable oscillator ICs, the LTC6903 and LTC6904. The DC726A-A features the LTC6903 IC in an 8-lead MSOP package. The LTC6903 is a 1kHz to 68MHz oscillator programmable thru a 3-wire digital interface compatible with the SPI serial protocol. The DC726A-B features the LTC6904 IC in an 8-lead MSOP package. The LTC6904 is a 1kHz to 68MHz oscillator programmable thru a 3-wire digital interface compatible with the I²C serial protocol (a Philips Corp. trademark).

The LTC6903 and LTC6904 require no external components and operate over a single power supply range from 2.7V to 5.5V. The maximum frequency error is 1.1% or 1.6% when operating with a single 3V or 5V power supply respectively.

Demonstration circuit 726 is operated in one of two modes:

1. A Local Mode using DC726 as stand-alone demonstration board with external power supplies.

2. A QuickEval mode for interfacing to a USB port of a PC using Linear Technology's DC590 Serial Controller Board and a QuickEval program for Windows 98 or later downloaded from www.linear.com/software.

In Local Mode, a 16-bit serial code is entered in HEX with push-button switches to a 4-digit LED display. The HEX code is read by PIC (Peripheral Interface Controller) that updates the control word of the LTC6903/LTC6904.

In QuickEval Mode, the DC726 PIC shuts down when it is connected to a DC590A. Control of the LTC6903/LTC6904 is thru a PC with a QuickEval program which uses either a frequency or a HEX code input. The frequency or HEX code input entered on the computer display, is sent as a 16-bit serial word to the DC726A-A/B.

**Design files for this circuit board are available.
Call the LTC Factory.**

LTC is a trademark of Linear Technology Corporation

Demonstration Circuit 726A-A

(Provides an LTC6903CMS8 with SPI serial interface)

Demonstration Circuit 726A-B

(Provides an LTC6904CMS8 with I²C serial interface)

Features

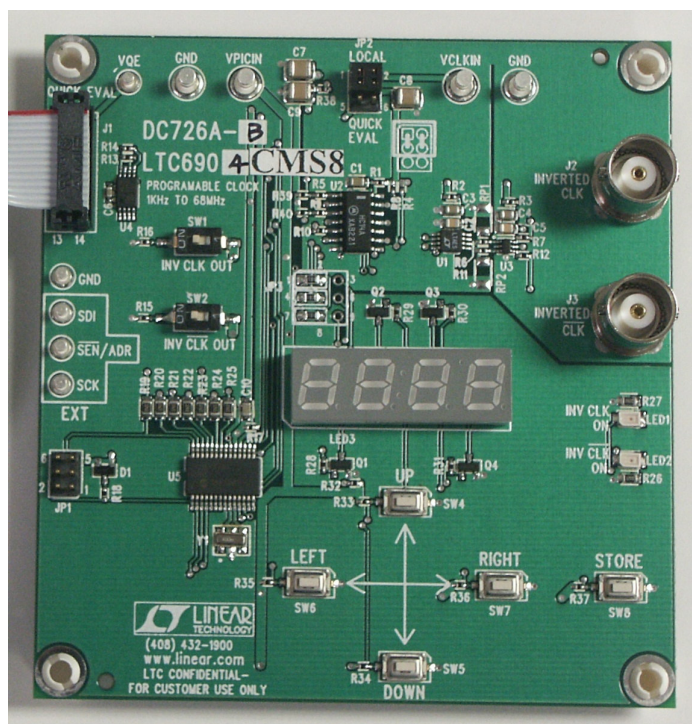
Fout Range: 1.039kHz to 68MHz

High Speed Inverters for driving coax cables

Flexible 3V to 5V operation of a LTC6903/04

Local Mode for stand-alone operation (No PC required)

QuickEval Mode for PC input with a Quick Eval program

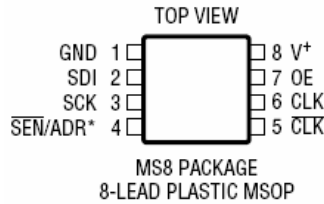


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LTC6903/LTC6904

*SEN (LTC6903)
ADR (LTC6904)



MS8 PART MARKING
LTC6903 LTABN
LTC6904 LTAES

ELECTRICAL CHARACTERISTICS The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at $T_A = 25^\circ\text{C}$. $V^+ = 2.7\text{V}$ to 5.5V , $\text{GND} = 0\text{V}$, unless otherwise noted.

| SYMBOL | PARAMETER | CONDITIONS | MIN | TYP | MAX | UNITS |
|---------------------|----------------------------------|------------------------------------|--------|-------|-----|---------------------------|
| f_{MAX} | Maximum Operating Frequency | | | 68 | | MHz |
| f_{MIN} | Minimum Operating Frequency | | | 1.039 | | kHz |
| $\Delta f/\Delta T$ | Frequency Drift Over Temperature | | | 10 | | ppm/ $^\circ\text{C}$ |
| $\Delta f/\Delta V$ | Frequency Drift Over Supply | | | 0.05 | | %/V |
| | Long Term Frequency Stability | | | 300 | | ppm/ $\sqrt{\text{kHzr}}$ |
| | Timing Jitter (See Graph) | 1.039kHz to 8.5MHz | | 0.4 | | % |
| | | 1.039kHz to 68MHz | | 1 | | % |
| | Duty Cycle | 1.039kHz to 1MHz | ● 49 | 50 | 51 | % |
| | | 1.039kHz to 68MHz | | 50 | | % |
| R_{OUT} | Output Resistance | CLK, CLK Pins, $V^+ = 2.7\text{V}$ | | 45 | | Ω |
| V_{OH} | High Level Output Voltage | $V^+ = 5.5\text{V}$, 4mA Load | ● 4.8 | 5.3 | | V |
| | | $V^+ = 2.7\text{V}$, 4mA Load | ● 2 | 2.3 | | V |
| | | $V^+ = 5.5\text{V}$, 1mA Load | ● 5.2 | 5.45 | | V |
| | | $V^+ = 2.7\text{V}$, 1mA Load | ● 2.3 | 2.55 | | V |
| V_{OL} | Low Level Output Voltage | $V^+ = 5.5\text{V}$, 4mA Load | ● 0.15 | 0.3 | | V |
| | | $V^+ = 2.7\text{V}$, 4mA Load | ● 0.25 | 0.45 | | V |
| | | $V^+ = 5.5\text{V}$, 1mA Load | ● 0.05 | 0.15 | | V |
| | | $V^+ = 2.7\text{V}$, 1mA Load | ● 0.05 | 0.2 | | V |

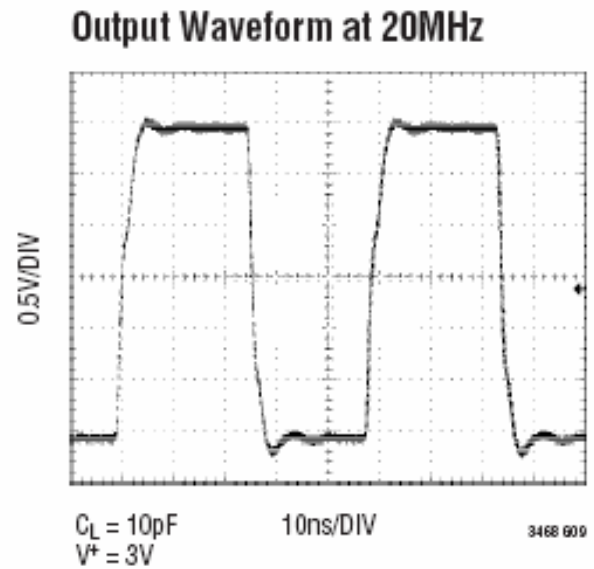
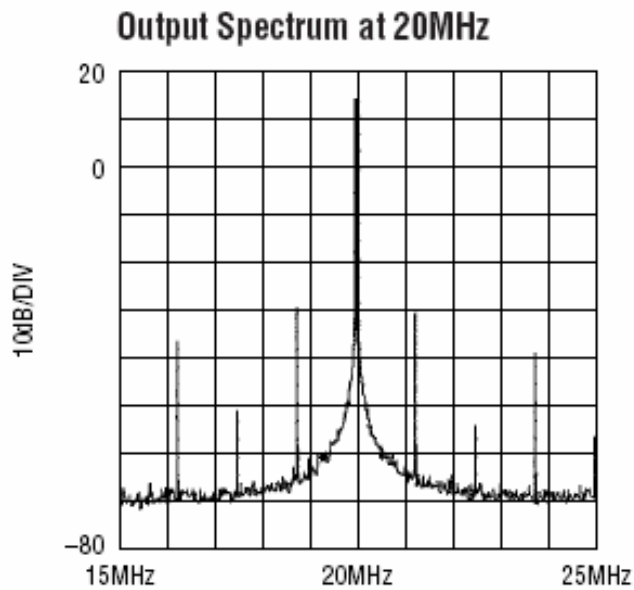
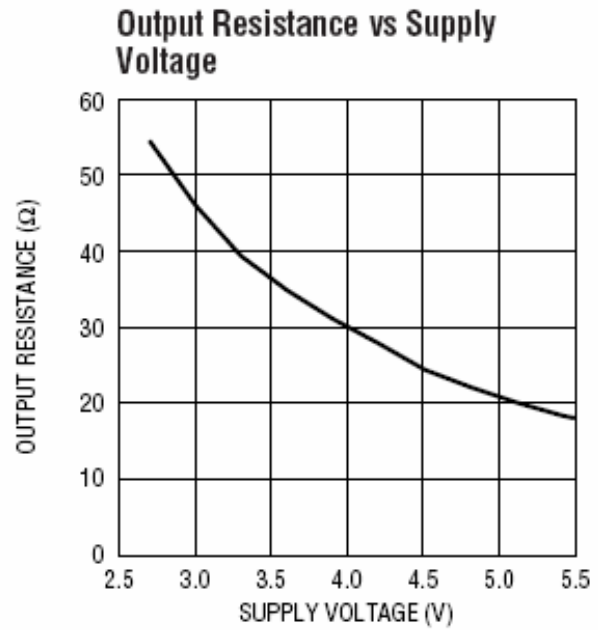
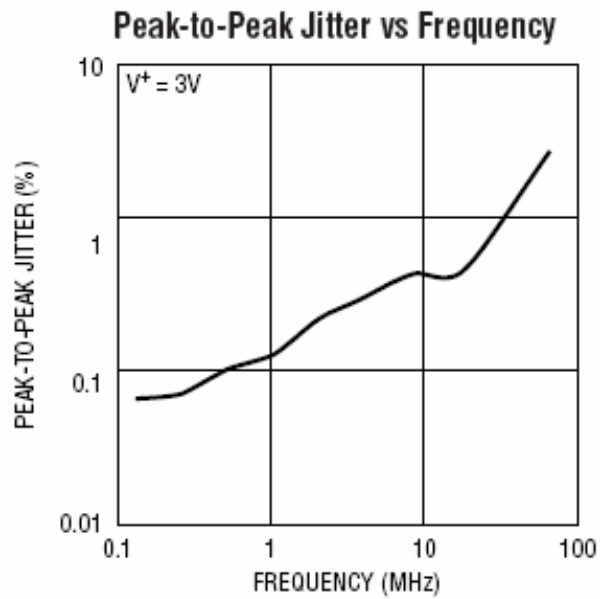
| SYMBOL | PARAMETER | CONDITIONS | MIN | TYP | MAX | UNITS |
|--------------|----------------------------|-----------------------------------------------------------------------------------------------------------------------------------|-----|-----|------------|-------|
| Δf_i | Initial Frequency Accuracy | $f = 1.039\text{kHz}$, $V^+ = 3\text{V}$, $C_{\text{LOAD}} = 5\text{pF}$ | | | ± 0.75 | % |
| Δf | Total Frequency Accuracy | Single Output Active: Over All Settings, $V^+ = 2.7\text{V}$, $C_{\text{LOAD}} = 5\text{pF}$ | | 0.5 | 1.1 | % |
| | | Over All Settings, $V^+ = 5.5\text{V}$, $C_{\text{LOAD}} = 5\text{pF}$ | | 0.5 | 1.6 | % |
| | | LTC6903CMS8, LTC6904CMS8: Over All Settings, $V^+ = 2.7\text{V}$, $C_{\text{LOAD}} = 5\text{pF}$ | ● | 0.5 | 1.65 | % |
| | | Over All Settings, $V^+ = 5.5\text{V}$, $C_{\text{LOAD}} = 5\text{pF}$ | ● | 0.5 | 2 | % |
| | | LTC6903HMS8, LTC6903IMS8, LTC6904HMS8, LTC6904IMS8: Over All Settings, $V^+ = 2.7\text{V}$, $C_{\text{LOAD}} = 5\text{pF}$ | ● | 0.5 | 1.9 | % |
| | | Over All Settings, $V^+ = 5.5\text{V}$, $C_{\text{LOAD}} = 5\text{pF}$ | ● | 0.5 | 2.2 | % |

| SYMBOL | PARAMETER | CONDITIONS | MIN | TYP | MAX | UNITS |
|--------|------------------------------|-----------------------------------------------------------------------------------|-----|-----|-----|-------|
| t_r | Output Rise Time (10% - 90%) | $V^+ = 5.5\text{V}$, $R_{\text{LOAD}} = \infty$, $C_{\text{LOAD}} = 5\text{pF}$ | | 1 | | ns |
| | | $V^+ = 2.7\text{V}$, $R_{\text{LOAD}} = \infty$, $C_{\text{LOAD}} = 5\text{pF}$ | | 1 | | ns |
| t_f | Output Fall Time (10% - 90%) | $V^+ = 5.5\text{V}$, $R_{\text{LOAD}} = \infty$, $C_{\text{LOAD}} = 5\text{pF}$ | | 1 | | ns |
| | | $V^+ = 2.7\text{V}$, $R_{\text{LOAD}} = \infty$, $C_{\text{LOAD}} = 5\text{pF}$ | | 1 | | ns |

| SYMBOL | PARAMETER | CONDITIONS | MIN | TYP | MAX | UNITS |
|--------------|---------------------------------------------|----------------------------------------------------|-------|------|-----|-------|
| V_S | Supply Voltage | Applied Between V^+ and GND | ● 2.7 | | 5.5 | V |
| I_S , SHDN | V^+ Supply Current, Shutdown | $V_S = 2.7\text{V}$ | ● | 0.25 | 0.6 | mA |
| | | $V_S = 5.5\text{V}$ | ● | 0.6 | 2.2 | mA |
| I_S , DC | V^+ Supply Current, Single Output Enabled | $f = 68\text{MHz}$, 5pF Load, $V^+ = 2.7\text{V}$ | ● | 3.6 | 7 | mA |
| | | $f < 1\text{MHz}$, $V^+ = 2.7\text{V}$ | ● | 1.7 | 3.1 | mA |
| | | $f = 68\text{MHz}$, 5pF Load, $V^+ = 5.5\text{V}$ | ● | 7 | 15 | mA |
| | | $f < 1\text{MHz}$, $V^+ = 5.5\text{V}$ | ● | 1.9 | 4.5 | mA |

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A “LOCAL MODE” TEST PROCEDURE

1. Using **Figure 1** as a guide, connect to a DC726 a 5V and 3V power supply and oscilloscope (J2 to channel 1 and J3 to channel 2).
2. Set JP2 to the “LOCAL” position.
3. Set SW1 to ON and SW2 to OFF (the ON position is to the left).
4. Turn Power On.
 - A. When a DC726 is powered-up for the first time the four digit LED display on the board will read 0 0 0 0 and channel 1 of the oscilloscope will show a 1.039kHz square-wave (LED 1 is On and LED 2 is Off).
 - B. If a DC726 is powered-up after it has been used to set the on-board clock to a frequency other than 1.039kHz, the four digit LED display will indicate the hex code that represents the frequency setting stored previously using SW8.
 - C. Set the LED display to the hex code for a 3.2MHz clock frequency (bAbA, see **Example** next page).
 - D. Oscilloscope channel 1 should show a 3.2MHz square-wave with a “low” voltage at 0V and a “high” voltage equal to Vclk (Vclk is the voltage of the external power supply connected to VCLKIN. The clock period is 312.5 nS).
 - E. Set SW2 to ON.
 - F. Oscilloscope channel 2 should show the inverted version of the square-wave shown on channel 1 and the least significant hex digit on the LED display should change to 8 (the PIC controller reads the SW2 position and updates the LED display).

A “QUICKEVAL” TEST PROCEDURE

(The **QUICKEVAL DEMO PROGRAM** must be loaded and running on a PC.

Downloading the Quick Eval System Software

Go to www.linear.com

Click on “**Design Support**”

Click on “**Design Simulation and Device Models**”

Click on “**Download**” under

“**Quick Eval System Software**”

NOTE! the “*QuickEval-II System Software*”

is not required for DC726 evaluation.

1. Using **Figure 2** as a guide, connect to a DC726 a Linear Technology DC590 QuickEval serial controller card with a 14-conductor ribbon cable (to J1), a voltmeter (the plus lead to VQE and minus lead to GND) and an oscilloscope (J2 to channel 1 and J3 to channel 2).
2. Using a USB cable connect the DC590 controller to a USB port of a PC.
3. Set JP2 to the “QUICK EVAL” position.
4. Set SW1 to ON and SW2 to OFF.
5. Run the QuickEval program
 - A. The PC display will show a QuickEval program window with the following prompt:
Found Device LTC6903 (or LTC6904)
Click OPEN to begin the QuickEval program window and the user input window will appear (see Figures 3 or 4).
 - B. The voltmeter should read 5V \pm 0.25V (this is the voltage supplied by the QuickEval board).
 - C. Enter a clock frequency or a Hex code in the user input window and observe the corresponding change of the DC726 output on the oscilloscope display.

SETTING THE 4-DIGIT LED DISPLAY

The frequency of an LTC6903/LTC6904 output (f_{clk}) is a function of a divider variable OCT and a frequency range variable DAC. A 4-bit binary number OCT, a 10-bit binary number DAC and a 2-bit binary number for output control make up the 16-bit serial control word (Tables 1 to 3).

On DC726 board the 4-digit LED display must be set to a HEX code that is the equivalent to a 16-bit control word for a specified frequency. Using any of the UP, DOWN, LEFT or RIGHT switches (SW4-SW7) on a DC726 board will instantly update the clock frequency, f_{clk} . SW8 stores a hex setting and switches SW1 and SW2 turn on or off the clock output at J2 and J3 respectively (the ON position for SW1 and SW2 is to the left).

A DC726 can be set to a specific clock frequency by connecting a frequency counter to a J2 or J3 output and toggling SW5-SW7 until the desired frequency is shown on the counter display. In addition, the 4-digit LED display can be set to a Hex code corresponding to a specified f_{clk} by using the following conversion:

f_{clk} to 4-digit HEX Conversion

1. Specify a clock frequency, f_{clk} and use Table 1 to find the OCT number.
2. Convert the OCT decimal number to hex. The OCT number in hex is the Hex digit #1 (see Table 2 and Figure 5).

Example: Set f_{clk} to 3.2MHz

with J2 output ON and J3 output OFF.

3.2MHz is in the frequency range corresponding to OCT number 11 (Table 1). Decimal 11 is in hex number **b** (Table 4).

3. Use the DAC equation to calculate the DAC decimal number.

In the above **Example**, the DAC decimal number for OCT 11 and f_{clk} 3.2MHz is equal to 686 (to the nearest integer).

4. Convert the DAC decimal number to a binary number. The binary equivalent of decimal 686 is 1010101110.

5. Convert the D11 to D8 digits of the DAC binary number to a hex equivalent number (Hex digit #2).

For the **Example**, the first four most significant binary digits are 1010 and the hex equivalent is **A**.

6. Convert the D7 to D4 digits of the DAC binary number to a hex equivalent number (Hex digit #3).

For the **Example**, the first four most significant binary digits are 1011 and the hex equivalent is **b**.

7. Hex digit #4 must be set to a hex number that is the binary equivalent of the two least significant binary digits of the DAC binary number (D3 and D2) grouped with the two output control digits D1 and D0 (see table 2 and 3).

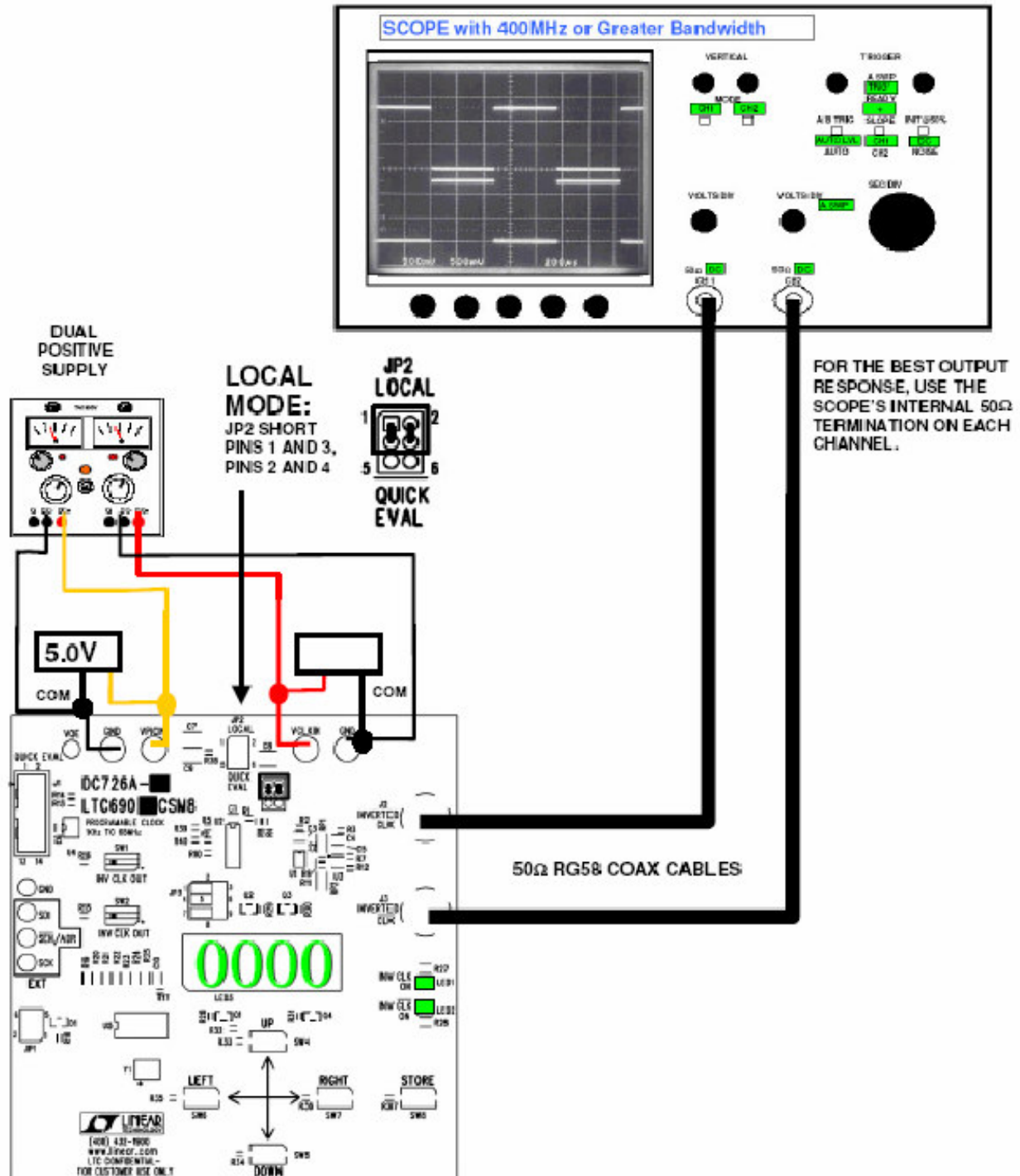
For the **Example**, the last two digits of the DAC binary number are 10 and the output control digits are 10 (see table 3) and the four least significant digits of the 16-bit control word should be 1010 and the hex equivalent for digit #4 is **A**.

The 4-digit hex code for the **Example** is **bAbA**.

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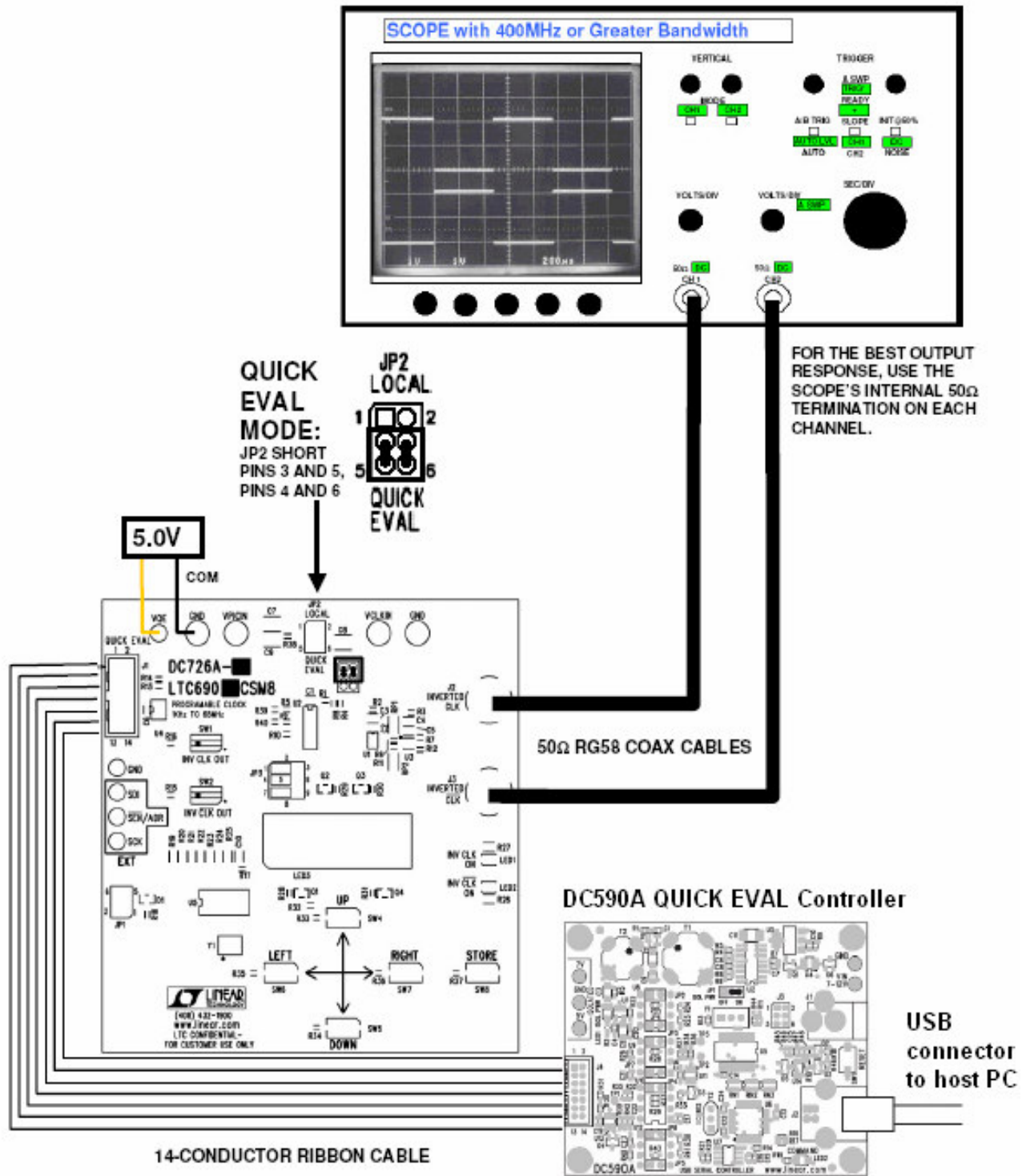
Figure 1. "LOCAL MODE" TEST SET-UP



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Figure 2. "QUICKEVAL MODE" TEST SET-UP



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Figure 3. Frequency input (68000000Hz) in QuickEval Mode.

The QuickEval program displays the actual LTC6903/04 clock frequency and 16-bit control word in HEX.

The 5678 shown in the Code entry box, is a previous code input and is a “don’t care”.

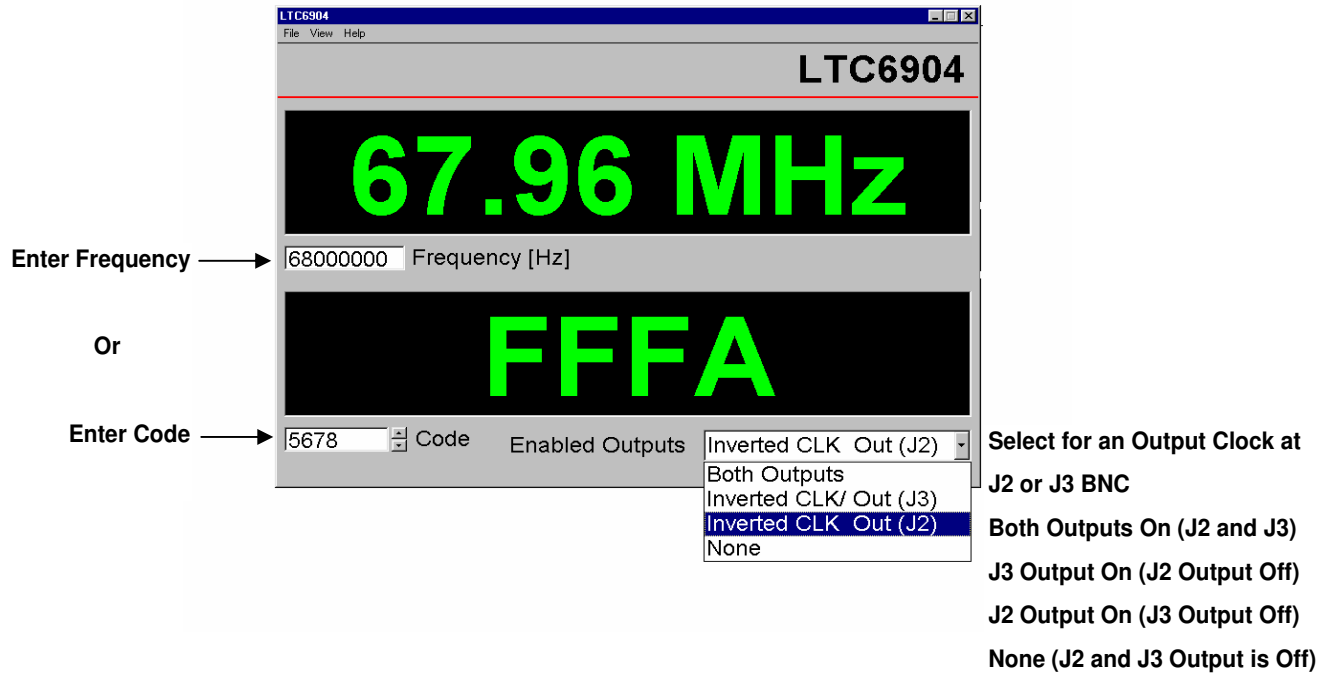
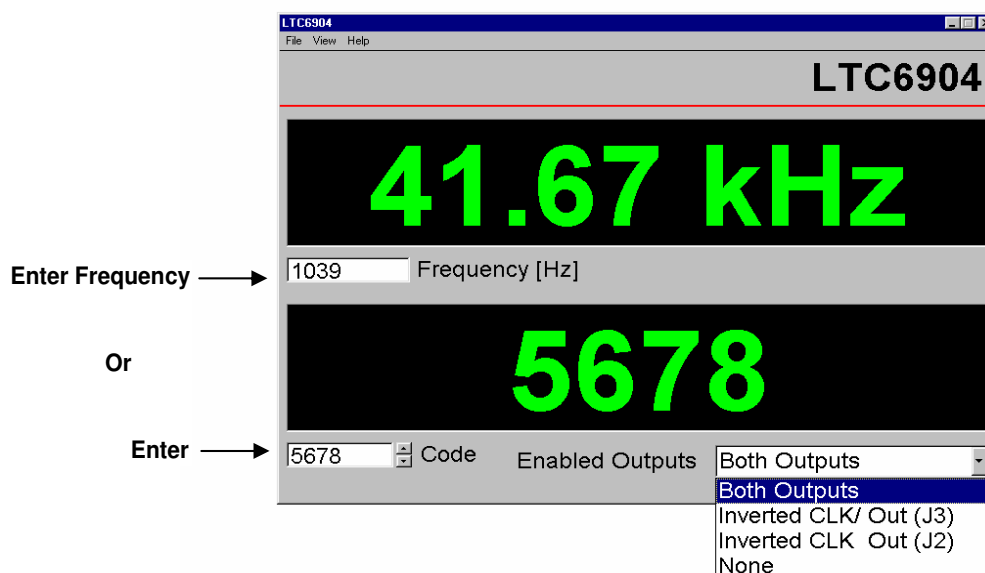


Figure 4. Code input in HEX (5678) in QuickEval Mode.

The QuickEval program displays the actual LTC6903/04 clock frequency that corresponds to the Code 5678.

The 1039Hz shown in the Frequency entry box, is a previous frequency input and is a “don’t care”.



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PROGRAMABLE CLOCK 1KHZ TO 68MHZ

The clock frequency equation as a function of OCT and DAC

$$f_{CLK} = 2^{OCT} \cdot \frac{2078 \text{ (Hz)}}{\left(2 - \frac{DAC}{1024}\right)}$$

$$DAC = 2048 - \frac{2078 \text{ (Hz)} \cdot 2^{(10+OCT)}}{f_{CLK}}$$

Table 1.

Frequency Range vs OCT Setting

| $f_{CLK} \geq$ | $f_{CLK} <$ | OCT |
|----------------|-------------|-----|
| 34.05MHz | 68.03MHz | 15 |
| 17.02MHz | 34.01MHz | 14 |
| 8.511MHz | 17.01MHz | 13 |
| 4.256MHz | 8.503MHz | 12 |
| 2.128MHz | 4.252MHz | 11 |
| 1.064MHz | 2.126MHz | 10 |
| 532kHz | 1063kHz | 9 |
| 266kHz | 531.4kHz | 8 |
| 133kHz | 265.7kHz | 7 |
| 66.5kHz | 132.9kHz | 6 |
| 33.25kHz | 66.43kHz | 5 |
| 16.62kHz | 33.22kHz | 4 |
| 8.312kHz | 16.61kHz | 3 |
| 4.156kHz | 8.304kHz | 2 |
| 2.078kHz | 4.152kHz | 1 |
| 1.039kHz | 2.076kHz | 0 |

Table 2.

The 16-bit Serial Control Word

| | | | | |
|------|------|------|------|------------------------|
| D15 | D14 | D13 | D12 | #1 Hex digit (D15-D12) |
| OCT3 | OCT2 | OCT1 | OCT0 | |
| D11 | D10 | D9 | D8 | #2 Hex digit (D11-D8) |
| DAC9 | DAC8 | DAC7 | DAC6 | |
| D7 | D6 | D5 | D4 | #3 Hex digit (D7-D4) |
| DAC5 | DAC4 | DAC3 | DAC2 | |
| D3 | D2 | D1 | D0 | #4 Hex digit (D3-D0) |
| DAC1 | DAC0 | CNF1 | CNF0 | |

Table 3.

Output Control

| CNF1 | CNF0 | J2 Output | J3 Output |
|------|------|-----------------|-----------|
| 0 | 0 | ON | ON |
| 0 | 1 | OFF | ON |
| 1 | 0 | ON | OFF |
| 1 | 1 | low power state | |

Table 4.

Decimal — 4-bit Binary — Hex

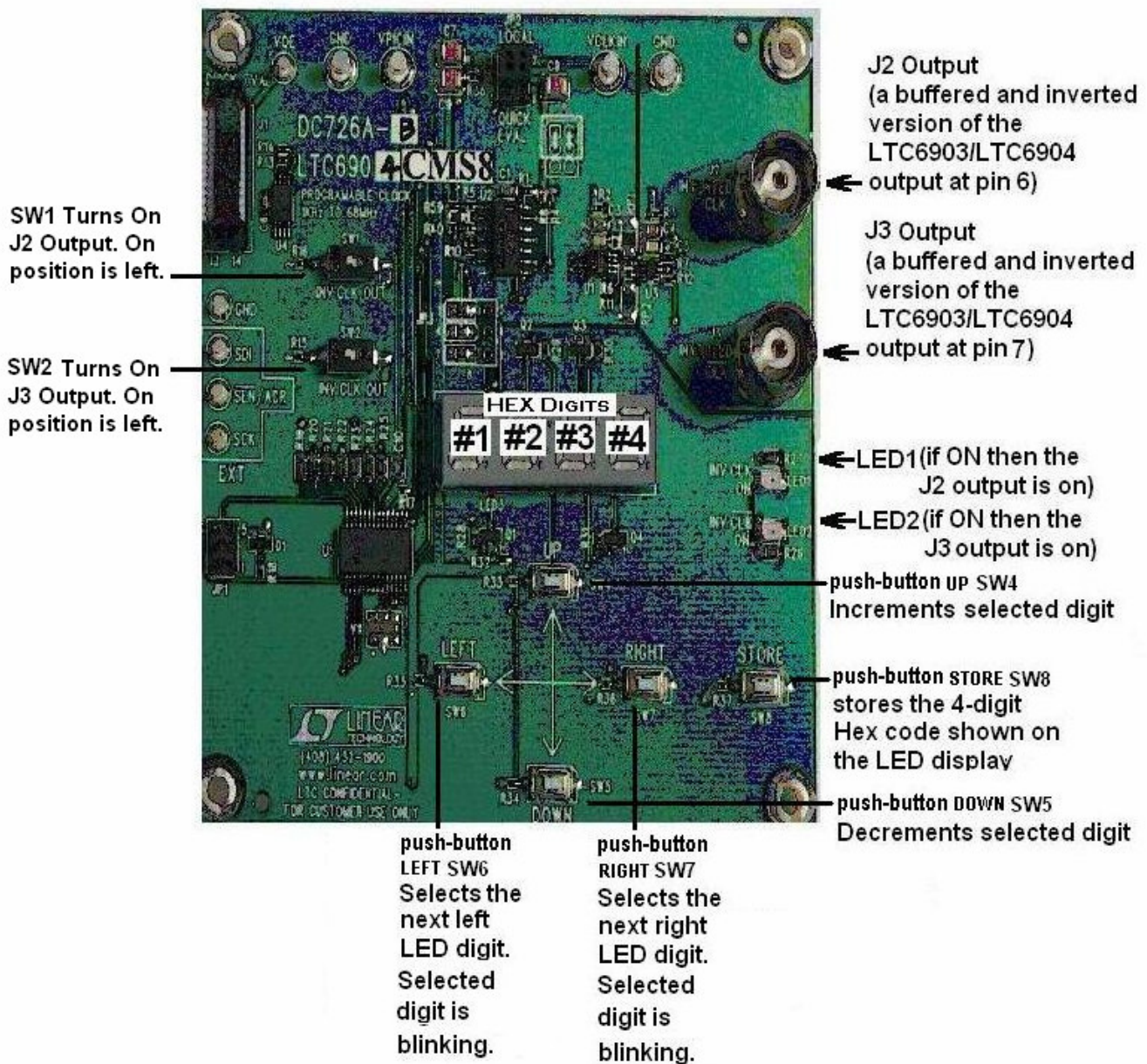
| Dec | Binary | Hex | Dec | Binary | Hex |
|-----|--------|-----|-----|--------|-----|
| 0 | 0000 | 0 | 8 | 1000 | 8 |
| 1 | 0001 | 1 | 9 | 1001 | 9 |
| 2 | 0010 | 2 | 10 | 1010 | A |
| 3 | 0011 | 3 | 11 | 1011 | b |
| 4 | 0100 | 4 | 12 | 1100 | C |
| 5 | 0101 | 5 | 13 | 1101 | d |
| 6 | 0110 | 6 | 14 | 1110 | E |
| 7 | 0111 | 7 | 15 | 1111 | F |

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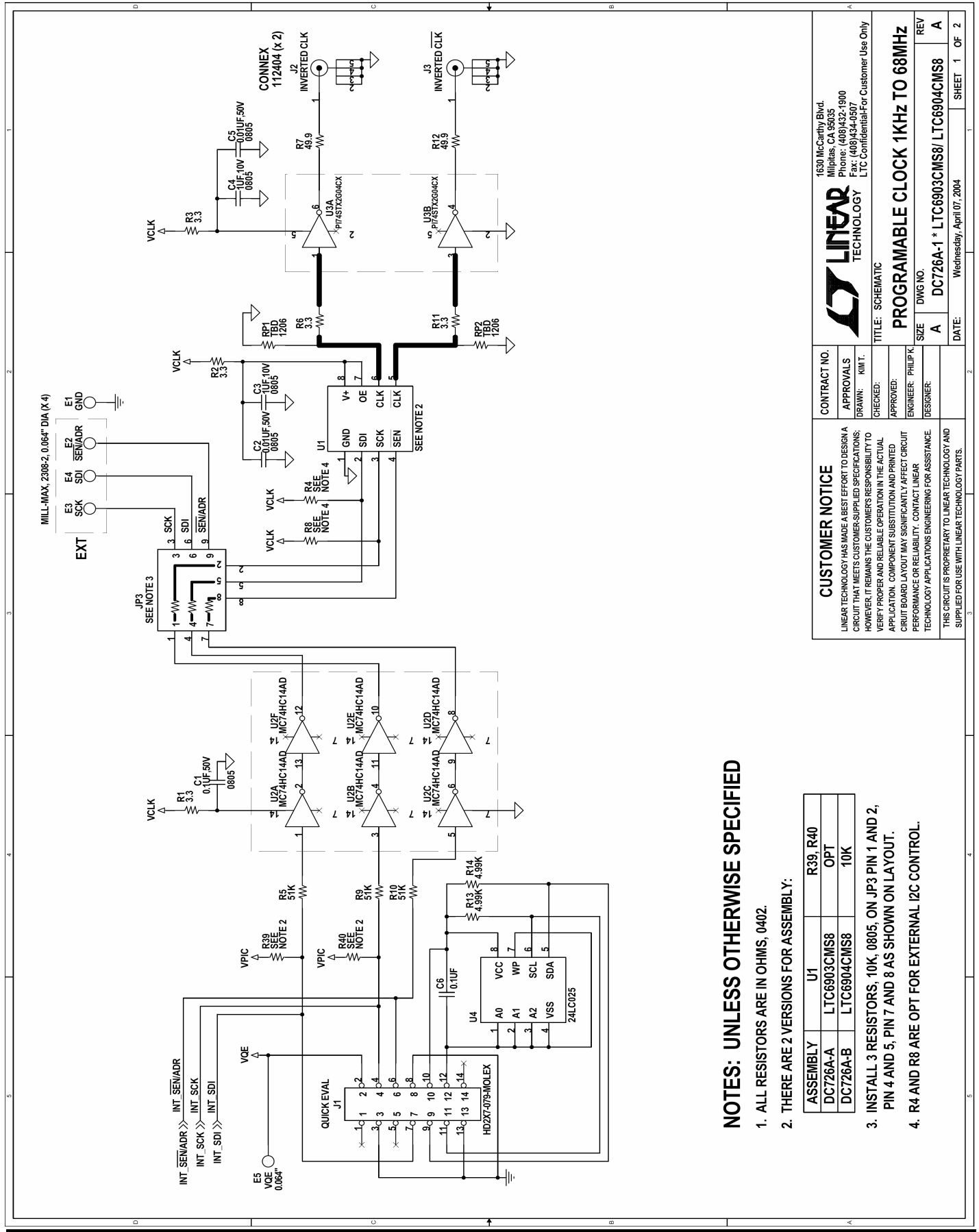
Figure 5.

DC726A LEDs Switches and Outputs



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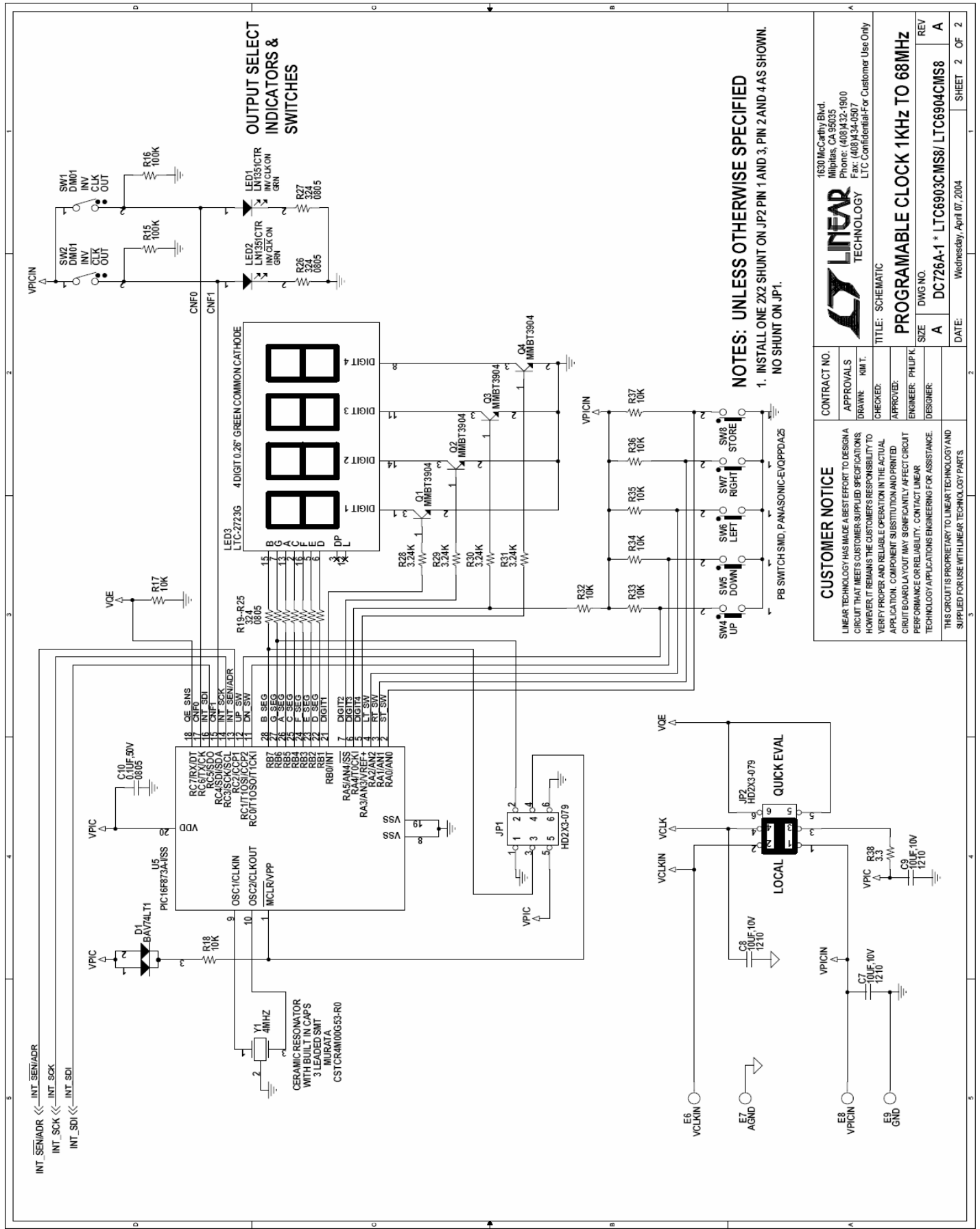
PROGRAMMABLE CLOCK 1KHz TO 68MHz



| | | | |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--|-----------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| CUSTOMER NOTICE LINEAR TECHNOLOGY HAS MADE A BEST EFFORT TO DESIGN A CIRCUIT THAT MEETS CUSTOMER-SUPPLIED SPECIFICATIONS; HOWEVER, IT REMAINS THE CUSTOMER'S RESPONSIBILITY TO VERIFY PROPER AND RELIABLE OPERATION IN THE ACTUAL APPLICATION. COMPONENT SUBSTITUTION AND PRINTED CIRCUIT BOARD LAYOUT MAY SIGNIFICANTLY AFFECT CIRCUIT PERFORMANCE OR RELIABILITY. CONTACT LINEAR TECHNOLOGY APPLICATIONS ENGINEERING FOR ASSISTANCE. THIS CIRCUIT IS PROPRIETARY TO LINEAR TECHNOLOGY AND SUPPLIED FOR USE WITH LINEAR TECHNOLOGY PARTS. | | CONTRACT NO. APPROVALS DRAWN: KIM T. CHECKED: APPROVED: ENGINEER: PHILIP K. DESIGNER: | LINEAR TECHNOLOGY 1630 McCarthy Blvd. Milpitas, CA 95035 Phone: (408) 434-1000 Fax: (408) 434-1657 LTC Confidential For Customer Use Only |
| PROGRAMMABLE CLOCK 1KHz TO 68MHz | | SIZE A | REV A |
| DC726A-1 * LTC6903CMS8/ LTC6904CMS8 | | DATE: Wednesday, April 07, 2004 | SHEET 1 OF 2 |

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PROGRAMMABLE CLOCK 1KHZ TO 68MHZ



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