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 I^2C 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.

Demonstration Circuit 726A-A

(Provides an LTC6903CMS8 with SPI serial interface)

Demonstration Circuit 726A-B

(Provides an LTC6904CMS8 with I^2C serial interface)

Features

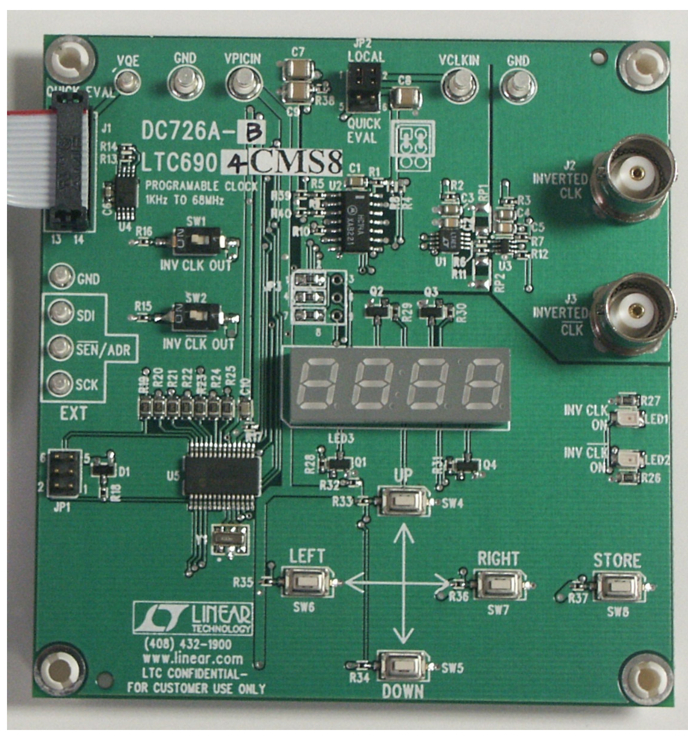
Fout Range: 1.039kHz to 68MHz

High Speed Inverters for driving coax cables

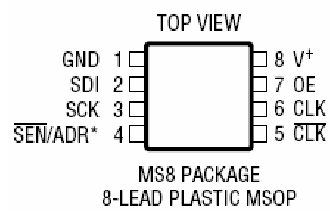
Flexible 3V to 5V operation of a LTC6903/04

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

QuickEval Mode for PC input with a Quick Eval program



LTC6903/LTC6904



* SEN (LTC6903)
ADR (LTC6904)

MS8 PART MARKING

LTC6903	LTABN
LTC6904	LTAES

ELECTRICAL CHARACTERISTICS

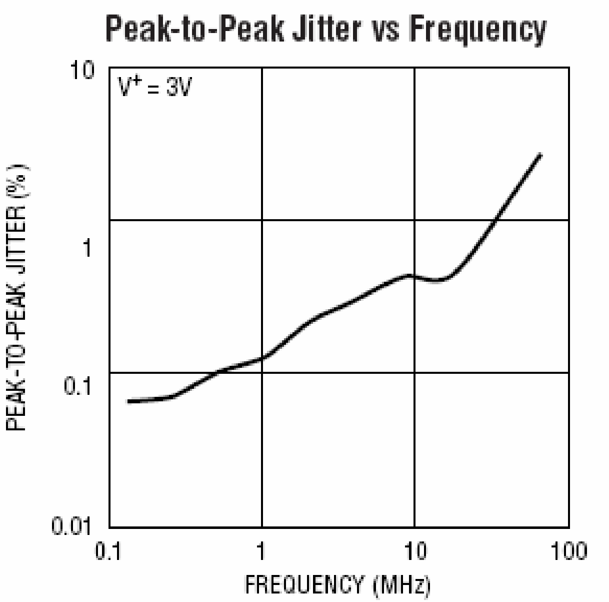
The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at T_A = 25°C. V+ = 2.7V to 5.5V, GND = 0V, unless otherwise noted.

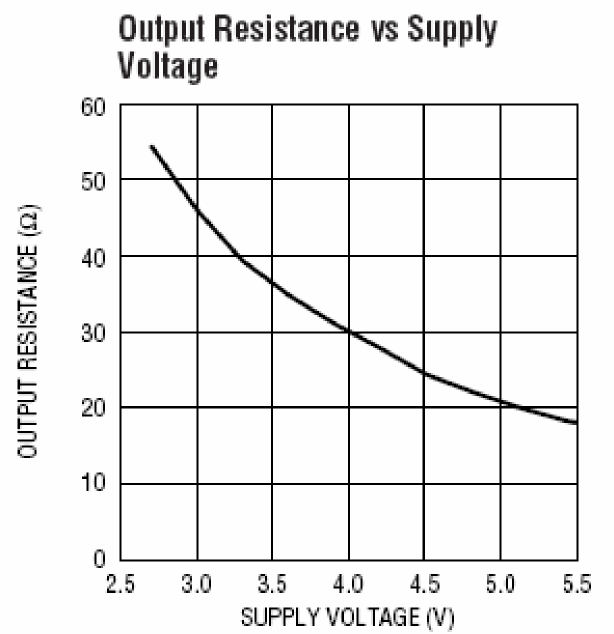
SYMBOL	PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
f_{MAX}	Maximum Operating Frequency				68		MHz
f_{MIN}	Minimum Operating Frequency				1.039		kHz
Δf/ΔT	Frequency Drift Over Temperature				10		ppm/°C
Δf/ΔV	Frequency Drift Over Supply				0.05		%/V
	Long Term Frequency Stability				300		ppm/√kHr
	Timing Jitter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

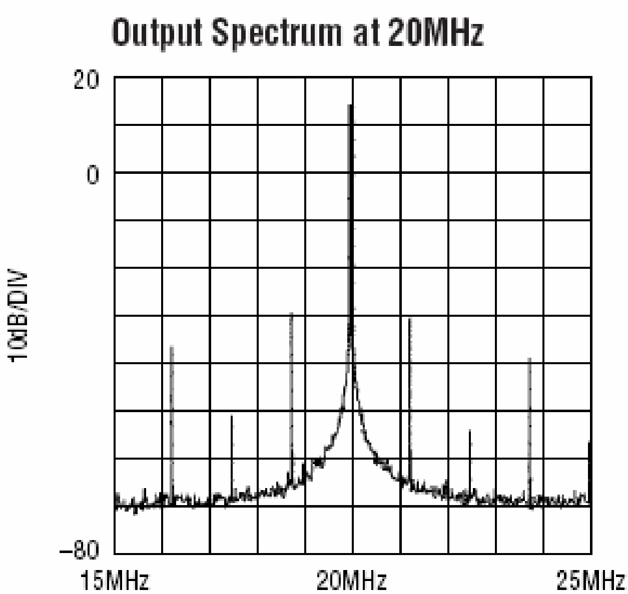
SYMBOL	PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
Δfi	Initial Frequency Accuracy	f = 1.039kHz, V+ = 3V, C_{LOAD} = 5pF				±0.75	%
Δf	Total Frequency Accuracy	Single Output Active: Over All Settings, V+ = 2.7V, C_{LOAD} = 5pF Over All Settings, V+ = 5.5V, C_{LOAD} = 5pF			 0.5 0.5	 1.1 1.6	 % %
		LTC6903CMS8,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

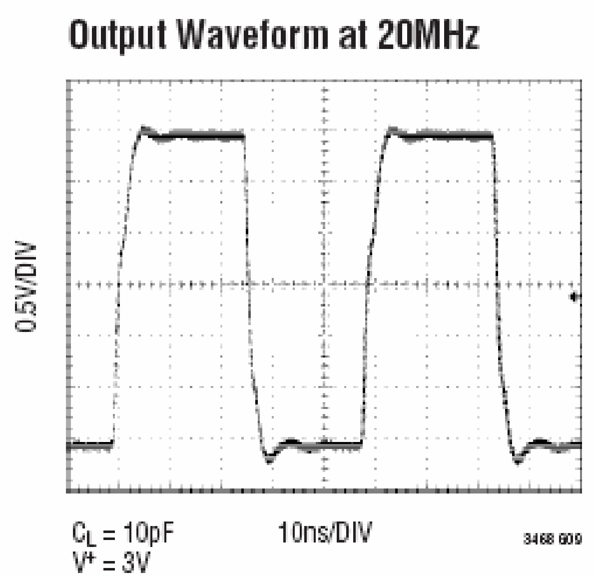
SYMBOL	PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
t_r	Output Rise Time (10% - 90%)	V+ = 5.5V, R_{LOAD} = ∞, C_{LOAD} = 5pF V+ = 2.7V, R_{LOAD} = ∞, C_{LOAD} = 5pF			1 1		ns ns
t_f	Output Fall Time (10% - 90%)	V+ = 5.5V, R_{LOAD} = ∞, C_{LOAD} = 5pF V+ = 2.7V, R_{LOAD} = ∞, C_{LOAD} = 5pF			1 1		ns ns

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 = 2.7V V_S = 5.5V	● ●		0.25 0.6	0.6 2.2	mA mA
I_S, DC	V+ Supply Current, Single Output Enabled	f = 68MHz, 5pF Load, V+ = 2.7V f < 1MHz, V+ = 2.7V f = 68MHz, 5pF Load, V+ = 5.5V f < 1MHz, V+ = 5.5V	● ● ● ●		3.6 1.7 7 1.9	7 3.1 15 4.5	mA mA mA mA


Peak-to-Peak Jitter vs Frequency
V+ = 3V
PEAK-TO-PEAK JITTER (%)
10
1
0.1
0.01
0.1
1
10
100
FREQUENCY (MHz)


Output Resistance vs Supply Voltage
OUTPUT RESISTANCE (Ω)
60
50
40
30
20
10
0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
SUPPLY VOLTAGE (V)


Output Spectrum at 20MHz
10dB/DIV
20
0
–80
15MHz
20MHz
25MHz


Output Waveform at 20MHz
0.5V/DIV
CL = 10pF
V+ = 3V
10ns/DIV
3468 G09

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 ±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.**

Figure 1. "LOCAL MODE" TEST SET-UP

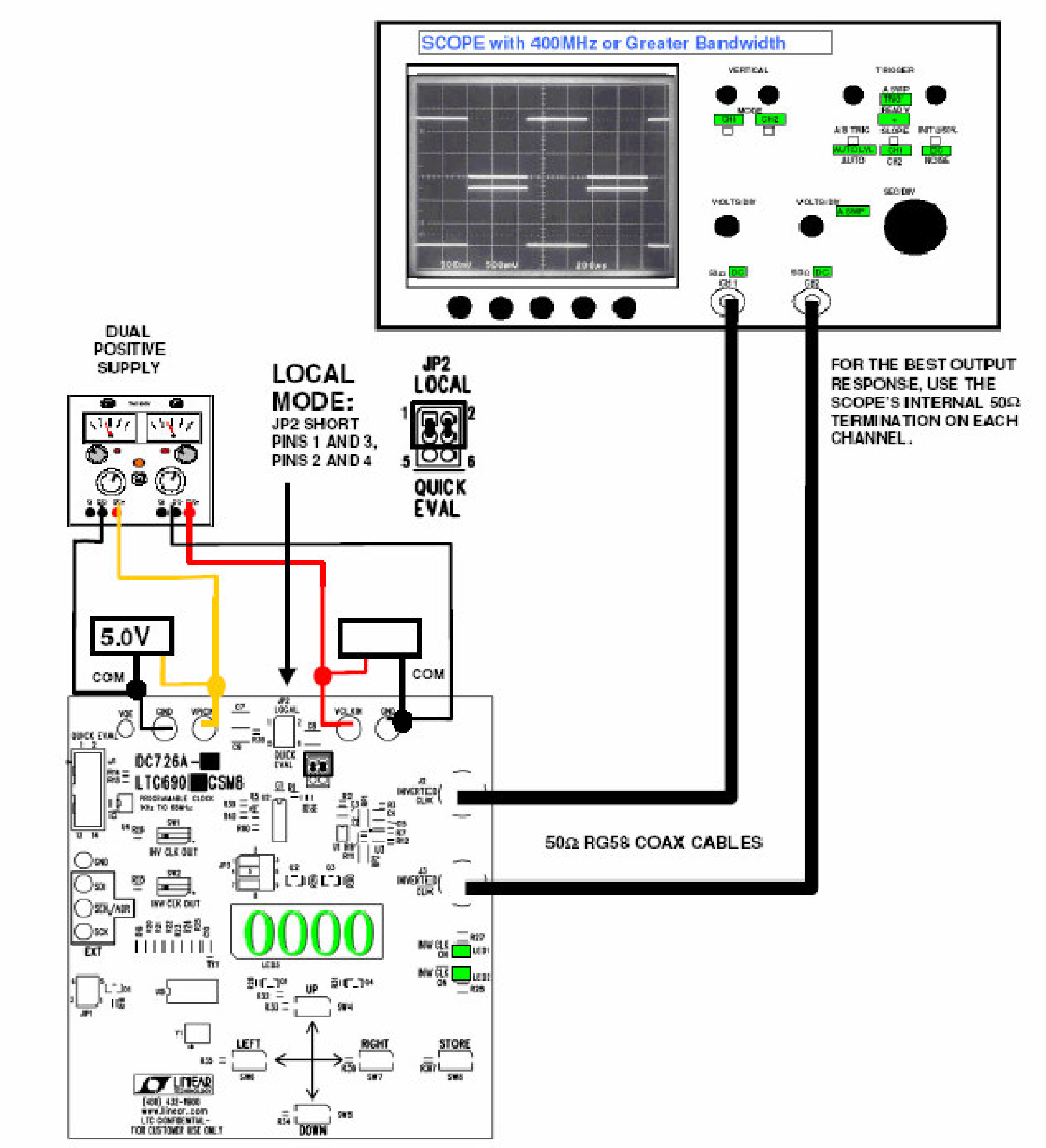


Figure 2. "QUICKEVAL MODE" TEST SET-UP

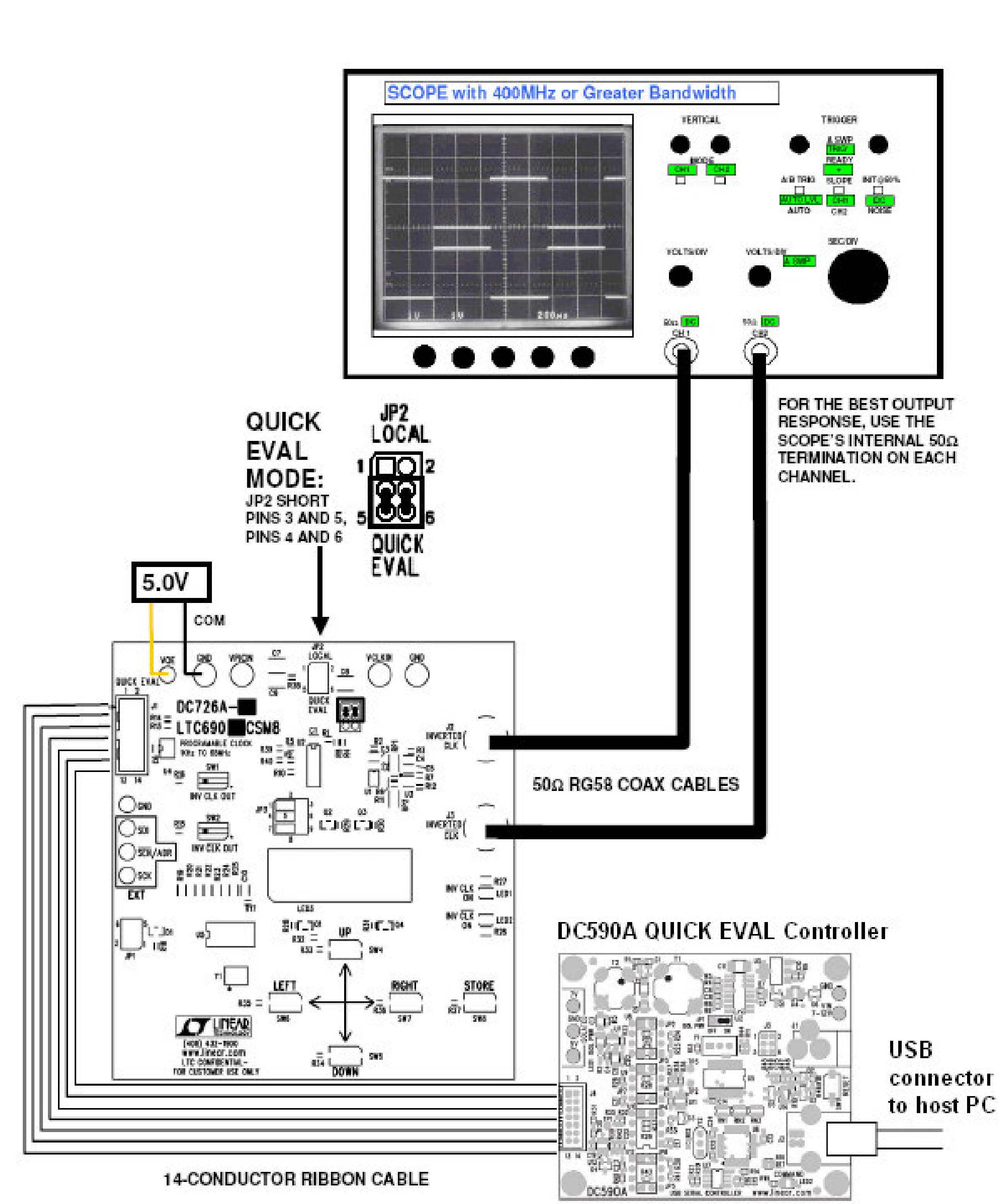


Figure 3. Frequency input (68000000Hz) in QuickEval Mode.

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".

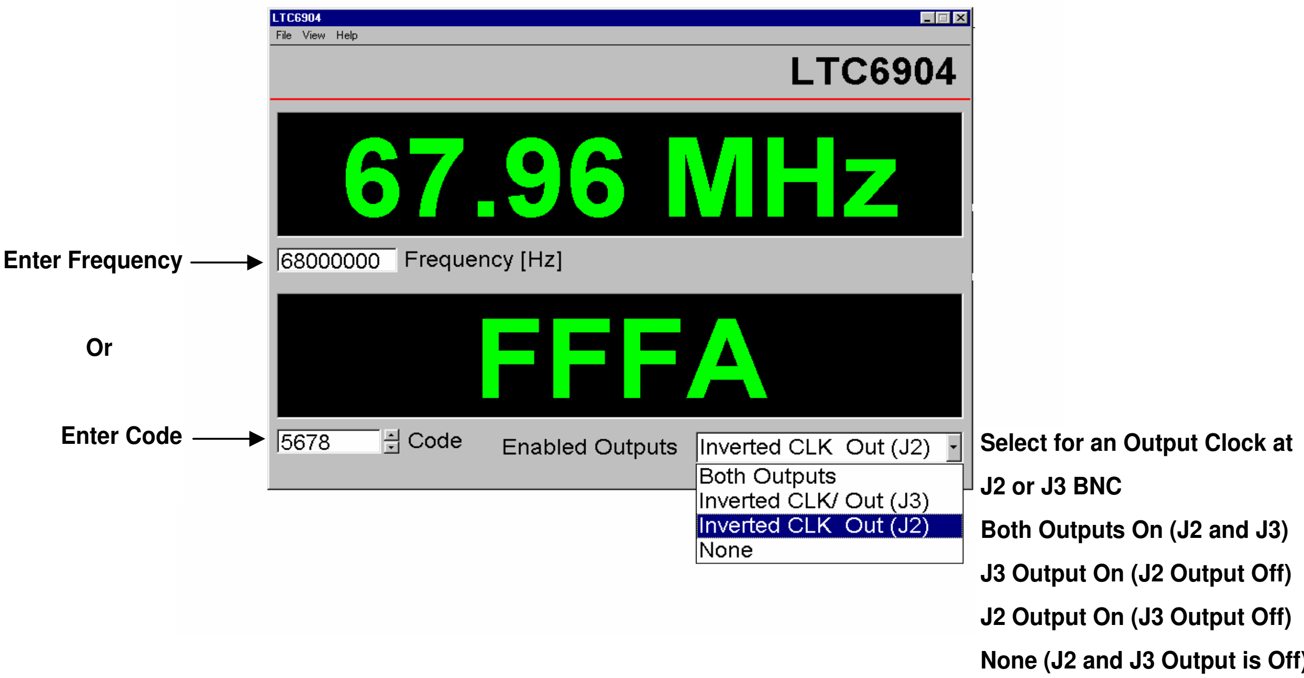
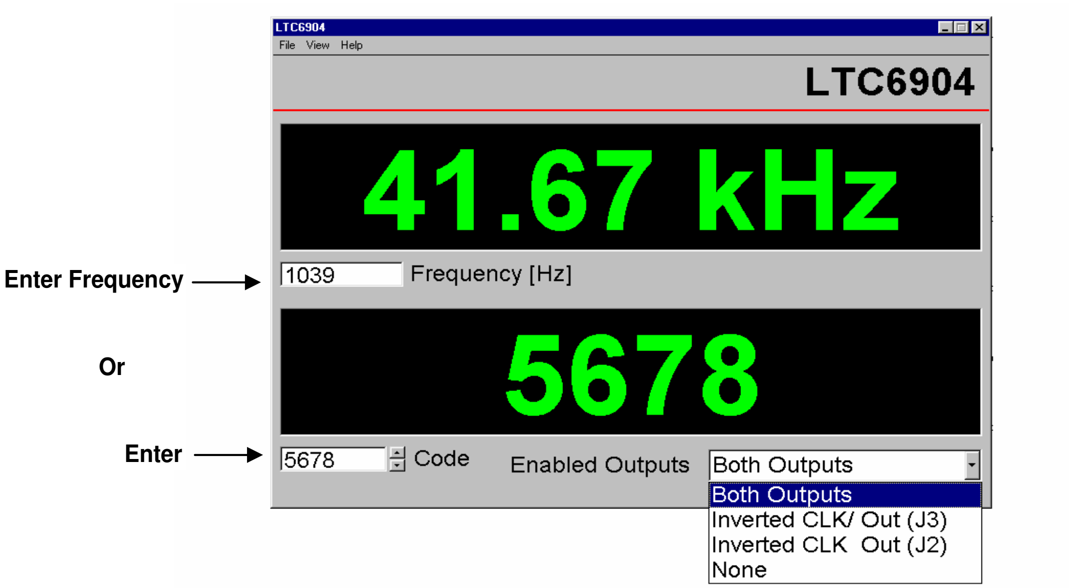


Figure 4. Code input in HEX (5678) in QuickEval Mode.

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".



The clock frequency equation as a function of OCT and DAC

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

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

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	
OCT3	OCT2	OCT1	OCT0	#1 Hex digit (D15-D12)

D11	D10	D9	D8	
DAC9	DAC8	DAC7	DAC6	#2 Hex digit (D11-D8)

D7	D6	D5	D4	
DAC5	DAC4	DAC3	DAC2	#3 Hex digit (D7-D4)

D3	D2	D1	D0	
DAC1	DAC0	CNF1	CNF0	#4 Hex digit (D3-D0)

Table 3.

Output Control

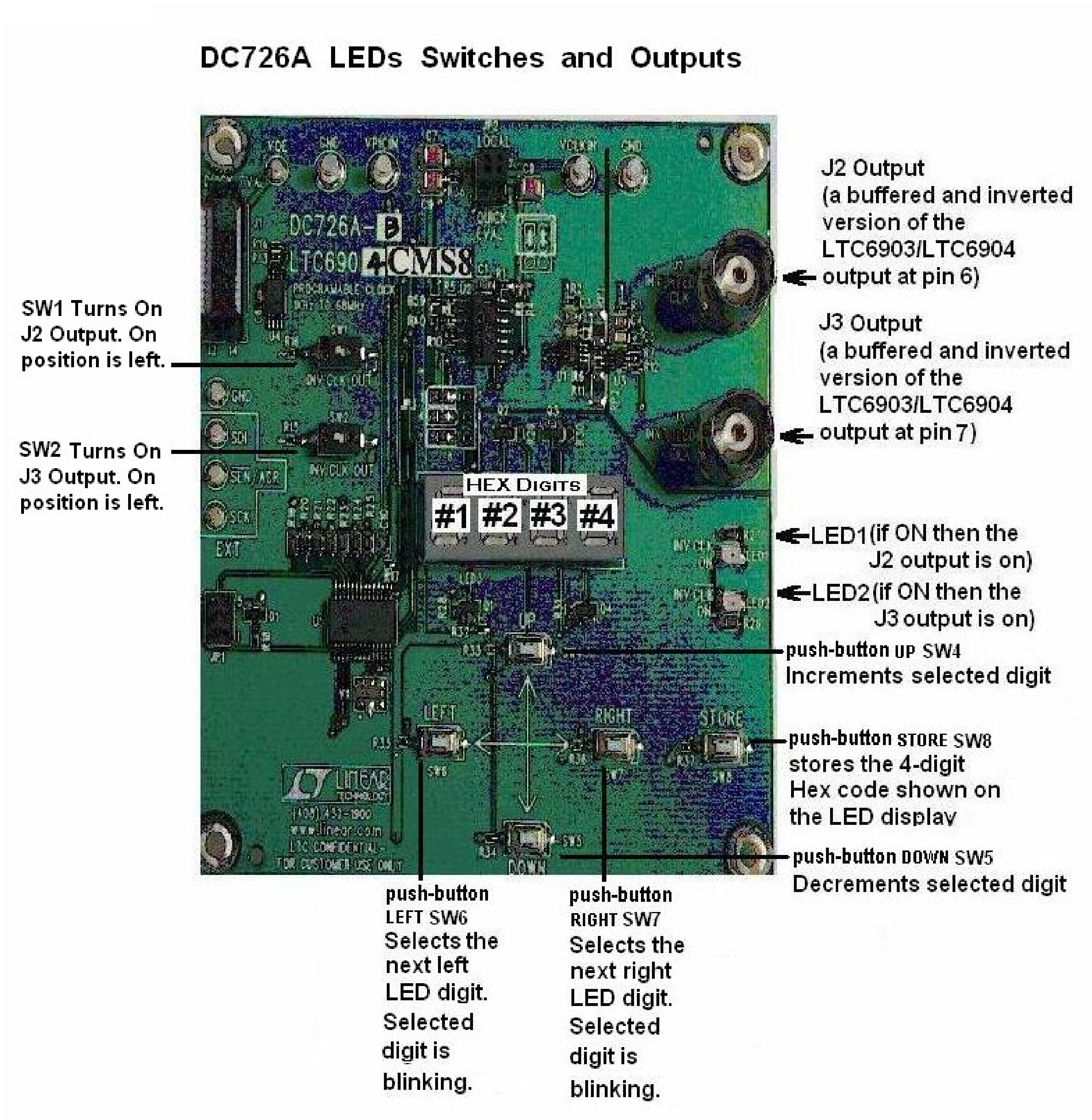
CNF1	CNF0	J2 Output	J3 Output
0	0	ON	ON
0	1	OFF	ON
1	0	ON	OFF
1	1	low power state	

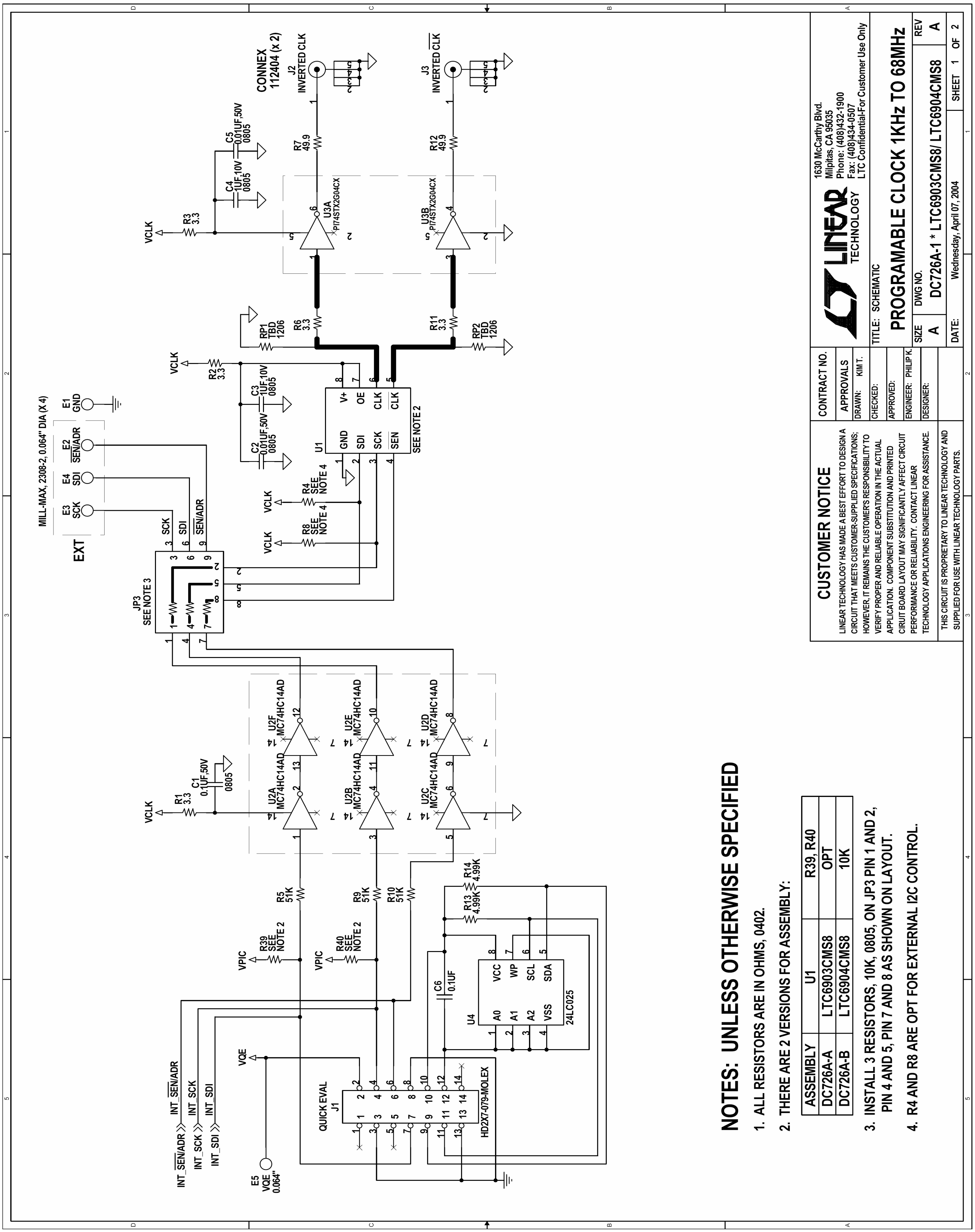
Table 4.

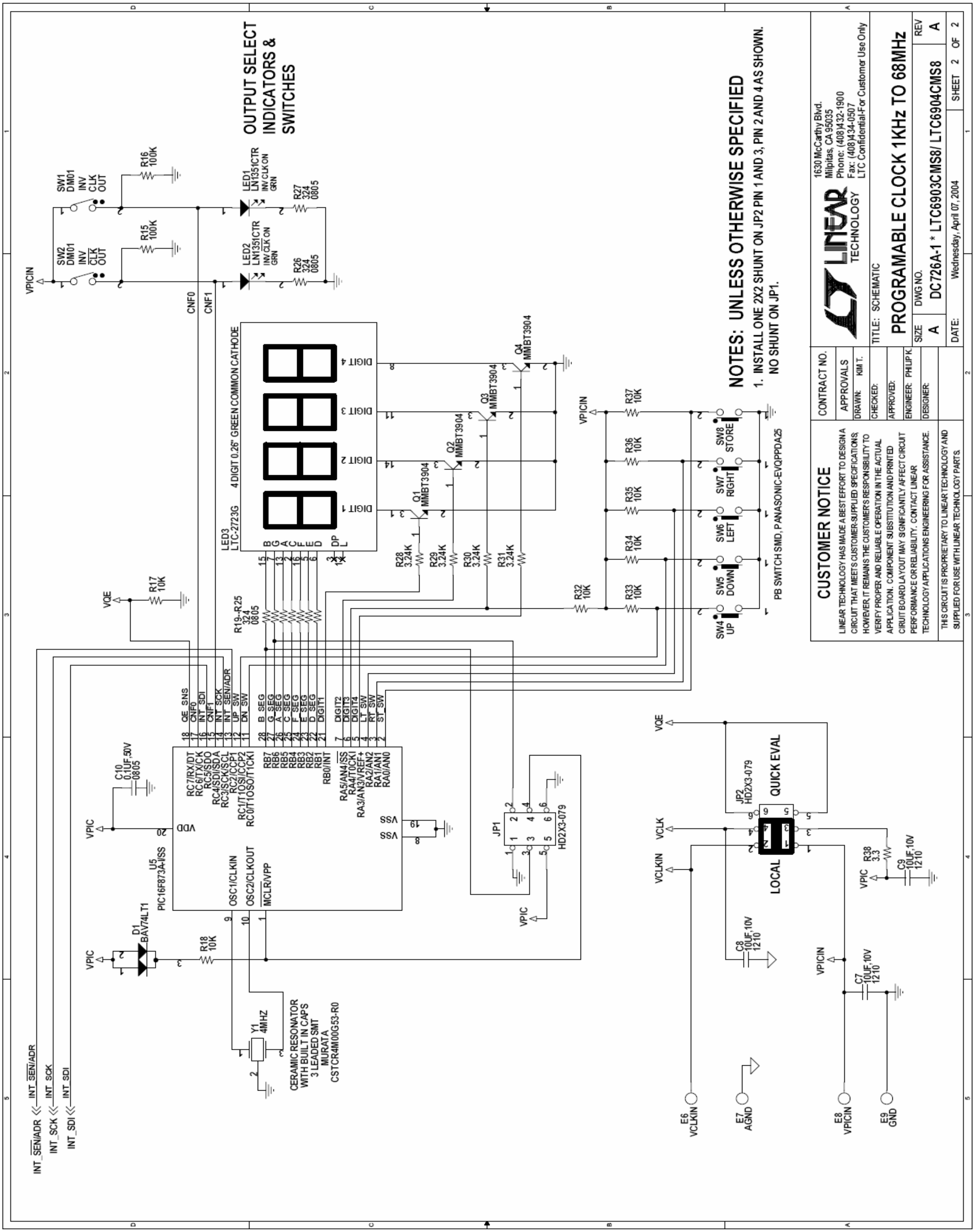
Decimal — 4-bit Binary — Hex

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

Figure 5.


DC726A LEDs Switches and Outputs
J2 Output (a buffered and inverted version of the LTC6903/LTC6904 output at pin 6)
J3 Output (a buffered and inverted version of the LTC6903/LTC6904 output at pin 7)
SW1 Turns On J2 Output. On position is left.
SW2 Turns On J3 Output. On position is left.
HEX DIGITS
#1 #2 #3 #4
LED1 (if ON then the J2 output is on)
LED2 (if ON then the J3 output is on)
push-button UP SW4 Increments selected digit
push-button STORE SW8 stores the 4-digit Hex code shown on the LED display
push-button DOWN SW5 Decrements selected digit
push-button LEFT SW6 Selects the next left LED digit. Selected digit is blinking.
push-button RIGHT SW7 Selects the next right LED digit. Selected digit is blinking.


CONNEX
112404 (x 2)
J2
INVERTED CLK
J3
INVERTED CLK
VCLK
R3
3.3
C4
1UF,10V
0805
C5
0.01UF,50V
0805
R7
49.9
R12
49.9
U3A
PI74STX2G04CX
U3B
PI74STX2G04CX
R6
3.3
R11
3.3
RP1
TBD
1206
RP2
TBD
1206
R2
3.3
C3
1UF,10V
0805
C2
0.01UF,50V
0805
U1
GND
SDI
SCK
SEN
V+
OE
CLK
CLK
SEE NOTE 2
MILL-MAX, 2308-2, 0.064" DIA (X 4)
E1
GND
E2
SEN/ADR
E4
SDI
E3
SCK
EXT
R4
SEE
NOTE 4
R8
SEE
NOTE 4
JP3
SEE NOTE 3
R1
3.3
C1
0.1UF,50V
0805
U2A
MC74HC14AD
U2B
MC74HC14AD
U2C
MC74HC14AD
U2D
MC74HC14AD
U2E
MC74HC14AD
U2F
MC74HC14AD
R5
51K
R9
51K
R10
51K
R13
4.99K
R14
4.99K
R39
SEE
NOTE 2
R40
SEE
NOTE 2
VPIC
C6
0.1UF
U4
24LC025
A0
A1
A2
VSS
VCC
WP
SCL
SDA
VQE
QUICK EVAL
J1
HD2X7-079-MOLEX
INT_SEN/ADR
INT_SCK
INT_SDI
E5
VQE
0.064"
NOTES: UNLESS OTHERWISE SPECIFIED
1. ALL RESISTORS ARE IN OHMS, 0402.
2. THERE ARE 2 VERSIONS FOR ASSEMBLY:
ASSEMBLY | U1 | R39, R40
DC726A-A | LTC6903CMS8 | OPT
DC726A-B | LTC6904CMS8 | 10K
3. INSTALL 3 RESISTORS, 10K, 0805, ON JP3 PIN 1 AND 2, PIN 4 AND 5, PIN 7 AND 8 AS SHOWN ON LAYOUT.
4. R4 AND R8 ARE OPT FOR EXTERNAL I2C CONTROL.
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)432-1900
Fax: (408)434-0507
LTC Confidential-For Customer Use Only
TITLE: SCHEMATIC
PROGRAMABLE CLOCK 1KHz TO 68MHz
SIZE A
DWG NO.
DC726A-1 * LTC6903CMS8/ LTC6904CMS8
REV A
DATE: Wednesday, April 07, 2004
SHEET 1 OF 2


OUTPUT SELECT
INDICATORS &
SWITCHES
NOTES: UNLESS OTHERWISE SPECIFIED
1. INSTALL ONE 2X2 SHUNT ON JP2 PIN 1 AND 3, PIN 2 AND 4 AS SHOWN.
NO SHUNT ON JP1.
PB SWITCH SMD, PANASONIC-EVQPPDA25
4 DIGIT 0.26" GREEN COMMON CATHODE
LED3
LTC-2723G
U5
PIC16F873A-I/SS
QUICK EVAL
LOCAL
CERAMIC RESONATOR
WITH BUILT IN CAPS
3 LEADED SMT
MURATA
CSTCR4M00G53-R0
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THIS CIRCUIT IS PROPRIETARY TO LINEAR TECHNOLOGY AND SUPPLIED FOR USE WITH LINEAR TECHNOLOGY PARTS.
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Milpitas, CA 95035
Phone: (408)432-1900
Fax: (408)434-0507
LTC Confidential-For Customer Use Only
TITLE: SCHEMATIC
PROGRAMABLE CLOCK 1KHz TO 68MHz
SIZE A
DWG NO. DC726A-1 * LTC6903CMS8/ LTC6904CMS8
REV A
DATE: Wednesday, April 07, 2004
SHEET 2 OF 2