Texas Instruments

CDCM7005 (BGA Package) Evaluation Module Manual

HPA/High Speed Communications

User's Guide

2005

Clock Drivers

SCAU013A

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Preface

Read This First

About This Manual

This manual explains how to use the CDCM7005 evaluation module (EVM) and provides guidelines to build the customer's own systems. The manual includes schematics, layout, bill of materials, and a software description.

How to Use This Manual

This document contains the following chapters:

- ❏ Chapter 1—Introduction
- ❏ Chapter 2—Quick Start
- ❏ Chapter 3—EVM Hardware
- ❏ Chapter 4—Serial Peripheral Interface (SPI) Software
- ❏ Chapter 5—Schematics, Board Layout, and Parts List

Related Documentation From Texas Instruments

- ❏ CDCM7005 Data Sheet, SCASXXX, Texas Instruments

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If You Need Assistance. . .

If you need assitance with this device, please email
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Contents

1 Introduction 1-1
1.1 CDCM7005 Functional Block Diagram 1-2

2 Quick Start 2-1

3 EVM Hardware 3-1
3.1 Board View and Connector Location 3-2
3.2 Hardware Configuration 3-3
3.2.1 Power Supply (P1, P2) 3-3
3.2.2 Onboard Switches and Indicators (SW1−SW2, D1−D4) 3-3
3.2.3 Programming Interfaces (J30, J31) 3-3
3.2.4 Loop Filter (J32−J34) 3-4
3.2.5 High-Speed Outputs and Inputs (J1−J4, J6−J11, J13, J14, J22, and J23) . . . 3-4
3.2.6 VCXO Inputs and Outputs (J16−J18) 3-4
3.2.7 AC-Coupling at PRI_REF (C1, R4, R6) and SEC_REF (C5, R13, R15) 3-5

4 Serial Peripheral Interface (SPI) Software 4-1
4.1 Functional Description 4-2
4.2 Software Installation 4-2

5 Application Level Circuit Diagram 5-1
5.1 Application Circuit Diagram 5-2
5.1.1 Passive Loop Filter 5-2
5.1.2 External Active Loop Filter Using OPA341 5-3

6 Parts List, Board Layouts, and Schematics 6-1
6.1 Parts List 6-2
6.2 Board Layout 6-4
6.3 Schematic 6-9

Figures

3−1 Board View 3-2
4−1 Screen View 4-2
5−1 CDCM7005 With a Passive Loop Filter Configuration 5-2
5−2 CDCM7005 With an External Active Loop Filter Using OPA341 5-3
6−1 Component View and Silkscreen (Top Side) 6-5
6−2 Component View and Silkscreen (Bottom Side) 6-6
6−3 Top Layer View 6-7
6−4 Bottom Layer View 6-8
6−5 Ground Plane View 6-9
6−6 Power Layer View 6-10

Tables

3−1 Connectors, Switches, and Indicators 3-4
3−2 Filter Configurations 3-5

Chapter 1

Introduction

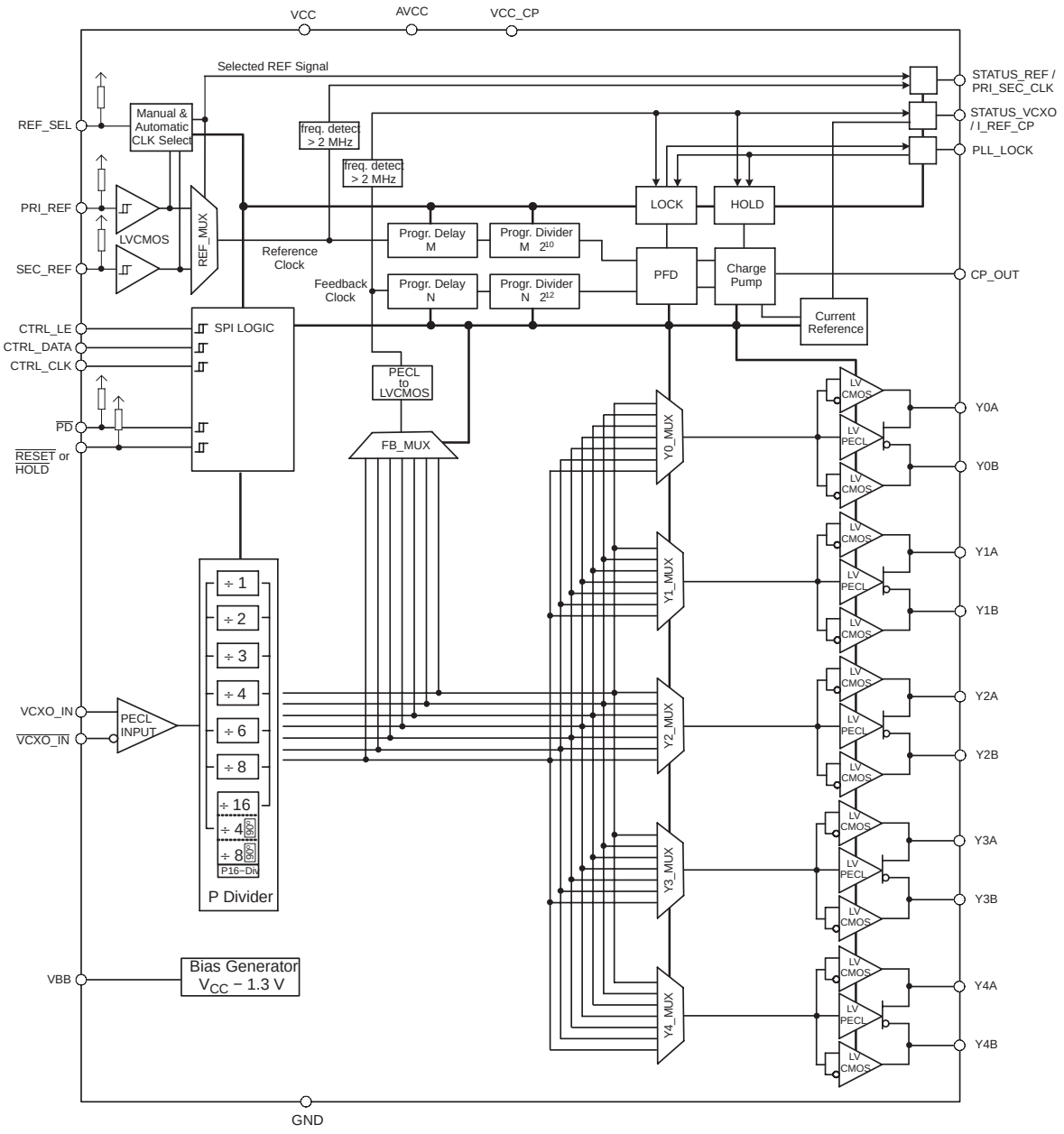
The CDCM7005 is a high-performance, low phase noise and low skew clock synchronizer that synchronizes an on-board voltage controlled crystal oscillator (VC(X)O) frequency to an external reference clock. The device operates up to 1.3 GHz. The PLL loop bandwidth and damping factor can be adjusted to meet different system requirements by selecting the external VC(X)O, loop filter components, frequency for PFD, and charge pump current. Each of the five differential LVPECL and five LVCMOS pair outputs can be programmed by a serial peripheral interface (SPI). The SPI allows individual control of the frequency and enable/disable state of each output. As the system requires external components like a loop filter and VC(X)O, this EVM provides an easy method to evaluate and modify the performance and parameters of the clock system in conjunction with the specific customer application. Loop bandwidth can be selected as low as 10 Hz or less, allowing the device to clean the system's clock jitter.

In non PLL mode, the CDCM7005 can be used as a simple LVPECL or LVCMOS buffer with divider options.

Topic **Page**

1.1 CDCM7005 Functional Block Diagram 1-2

1.1 CDCM7005 Functional Block Diagram



Chapter 2

Quick Start

In order to setup the EVM quickly and to take some measurements at default settings, the following actions are required:

- ❑ Supply 3.3 V to P1, LED D4 will be on.
- ❑ Apply a single-ended reference clock to the reference clock input PRI_REF (pin A1) or SEC_REF (pin B1). For default setting, the reference clock must be 1/8th of the VC(X)O frequency. If REF_SEL is set to 1, then PRI_REF is selected. If REF_SEL is set to 0, then SEC_REF is selected. This selection can be realized via J26 (header 1 and 2 is high; header 2 and 3 is low).
- ❑ Connect Y0/Y0B (or Y1/Y1B) to oscilloscope in order to check an output signal. Ensure the oscilloscope has 50 Ω to ground termination.

After power up, D1 is on if there is a valid reference clock and D2 is on if there is a valid VC(X)O clock for the CDCM7005. If D3 turns on, then the reference clock and the VC(X)O clocks are phase locked.

Chapter 3

EVM Hardware

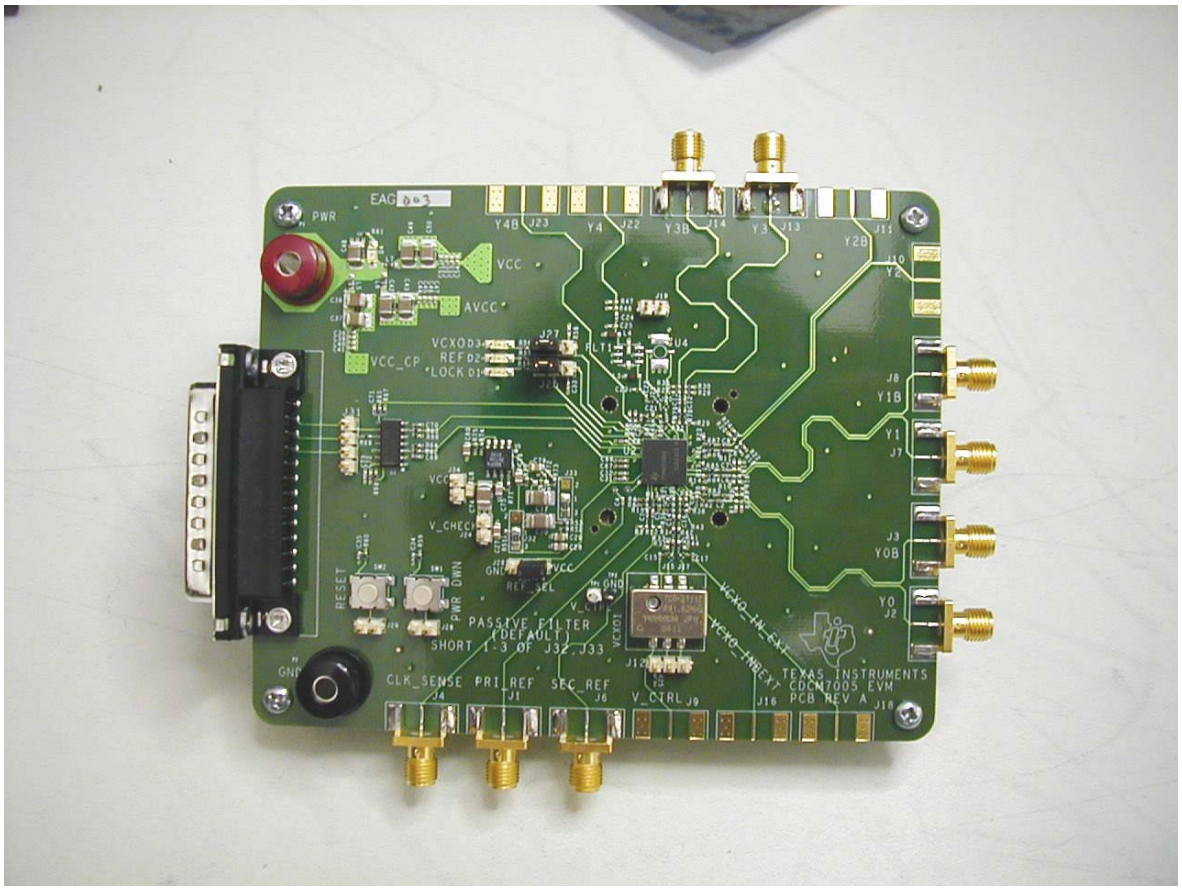
This chapter discusses the EVM hardware.

Topic **Page**

3.1	Board View and Connector Location	3-2
3.2	Hardware Configuration	3-3

3.1 Board View and Connector Location

Figure 3−1. Board View



3.2 Hardware Configuration

This section describes the board configuration using on-board jumpers and solder bridges.

3.2.1 Power Supply (P1, P2)

- Supply 3.3 V ±10% on P1 and P2 using a stabilized external power supply.
  - **WARNING: Never supply more than 3.6 V on P1.**

3.2.2 Onboard Switches and Indicators (SW1−SW2, D1−D4)

- Push SW1 to enter the power-down mode of the CDCM7005 device. Then all current sources are switched off, all outputs are switched into 3-state, and all dividers (M, N, and P) are reset to default.
- Push SW2 to enter the reset mode of the device. The charge pump (CP) is switched to 3-state and all counters (N, M, P) are rest to zero (the initial divider settings are maintained in SPI.
- The three status outputs of the CDCM7005 are fed to LED indicators. D1 on indicates a valid reference input clock signal. D2 is on if the VC(X)O input clock is valid and D3 turns on if the PLL has been locked.
- D4 indicates power supply

Note:

In case of a low input impedance of the VC(X)O control voltage input, there is a possibility D3 may not turn on to indicate locking.

3.2.3 Programming Interfaces (J30, J31)

The SPI of the device is used for writing to the control register of the device. It consists of three control lines CTRL_CLK, CTRL_DATA, and CTRL_LE. There are four 30-bit wide RAM registers, which can be addressed by the two LSBs of a transferred word. Every transmitted word must have 32 bits, starting with MSB. After supplying power or activating the power-down mode, the registers are loaded with the device default values internally (see the CDCM7005 data sheet, SCAS793). However, if specific register settings are required for any applications, there are two ways to program the device externally:

- Connect the parallel port cable to the PC and EVM parallel port. This needs control S/W (see Chapter 4).

3.2.4 Loop Filter (J32−J34)

The loop filter is one of the key elements determining the loop bandwidth of the PLL. The loop filter converts the charge pump current into the control voltage for the voltage controlled oscillator. The phase difference between the input clocks of the phase frequency detector determines the width of the charge pump output current pulses. These high frequency pulses are transformed into a voltage to control the oscillator.

Basically, three types of loop filters are implemented on the EVM.

- Passive loop filter
- External active loop filter using an external low-noise OPA.

Filter types can be selected by soldering bridges J32−J34, see Table 3−1. Control voltage of the VC(X)O can be measured at J9 or TP1. If an external OPA is used, it needs to be switched on by connecting J34. For example, passive filter operation is provided when pads 1 and 3 of J33 are solder bridged and pads 1 and 3 of J32 are solder bridged.

Default setting: Passive Loop Filter

Table 3−1. Filter Configurations

Bridge	Passive Filter	Active With An External OPA
J33	1−3	1−2
J34	Open	Closed
J32	1−3	1−2

3.2.5 High-Speed Outputs and Inputs (J1−J4, J6−J11, J13, J14, J22, and J23)

The CDCM7005 drives five differential LVPECL outputs. All PECL outputs are ac-coupled and terminated with 150 Ω to GND. This is in contrast to typical LVPECL termination, which requires V_{CC} − 2 V as termination voltage. The reason is to simplify the power supply scheme. The device output's trace impedance is 50 Ω and traces are matched in length. All outputs have options for pullup and pulldown resistors.

When the CDCM7005 is powered up, it defaults to five LVPECL outputs. However, this EVM is configured as follows:

- Y0 − Y2 = LVPECL
- Y3, Y4 = LVCMOS (in addition Y4 has an option for a custom filter)

The reference input clock signal has to be applied to J1 or J6. The reference input clock signal can be sensed on J4. In this case, close the bridge J5 (the oscilloscope's 50 Ω may be used to terminate the 50-Ω trace). The reference input clock sense line is matched to the LVPECL outputs line to avoid any additional delay offset. The input is ac-coupled (C4).

3.2.6 VC(X)O Inputs and Outputs (J16−J18)

The CDCM7005 requires an external VC(X)O in order to complete the PLL loop. The VC(X)O adjusts the frequency and phase depending on the control voltage level coming from the loop filter and provide the input clock to the LVPECL block.

Another option would be to use an external source via J16 and J18.

3.2.7 AC-Coupling at PRI_REF (C1, R4, R6) and SEC_REF (C5, R13, R15)

An ac-coupling is provided at PRI_REF and SEC_REF to ease the use of the CDCM7005 with different signaling levels (LVCMOS, LVPECL, LVDS,...). However, the ac-coupling will increase the PLL stabilization time after power up due to transient effects. It also increases the switching time between PRI_REF and SEC_REF in case of automatic reference clock switching. Therefore, the ac-coupling must be removed for optimized system performance (C1 and C5 has to be replaced with an 0-Ω resistor and R4, R6, R13, and R15 have to be removed).

Chapter 4

Serial Peripheral Interface (SPI) Software(1)

This chapter discusses the serial peripheral interface software.

Topic **Page**

4.1	**Functional Description**	**4-2**
4.2	**Software Installation**	**4-2**

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4.1 Functional Description

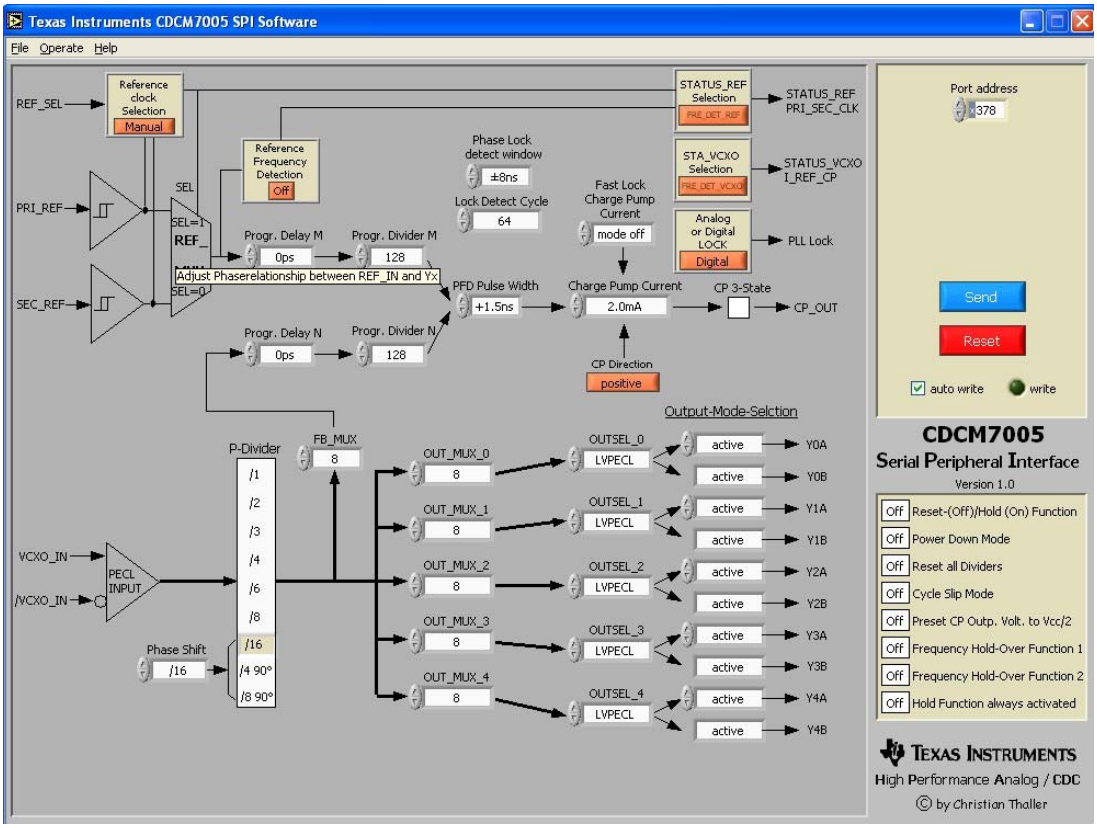
Programming software here as described is intended for programming the internal control register of the CDCM7005. The software runs under Windows 2000 / XP / XP *64. A quick installation is required prior to use. See the *Software Installation* section.

There are several cases where programming is mandatory.

As a rule of thumb here are some examples:

- ❏ Use of active loop filter
- ❏ Change of divider ratio or disable of certain LVPECL/LVCMOS outputs
- ❏ Select between LVPECL or LVCMOS output
- ❏ Change of phase offset, (Delay M/N), or selection of 90’ or 180’ phase shift
- ❏ Change of charge pump output current.
- ❏ Widening the lock detect window

Figure 4−1. Screen View



4.2 Software Installation

Follow the steps below in order to install the SPI control software:

1) Download the CDCM7005 SPI Software from the TI Website (www.ti.com)
2) Run program setup.exe
3) Reboot your computer
4) Run the software from Start −> Programs −> CDCM7005 SPI

Chapter 5

Application Circuit Diagram

This chapter discusses the application circuit diagram.

Topic **Page**

5.1 Application Circuit Diagram 5-2

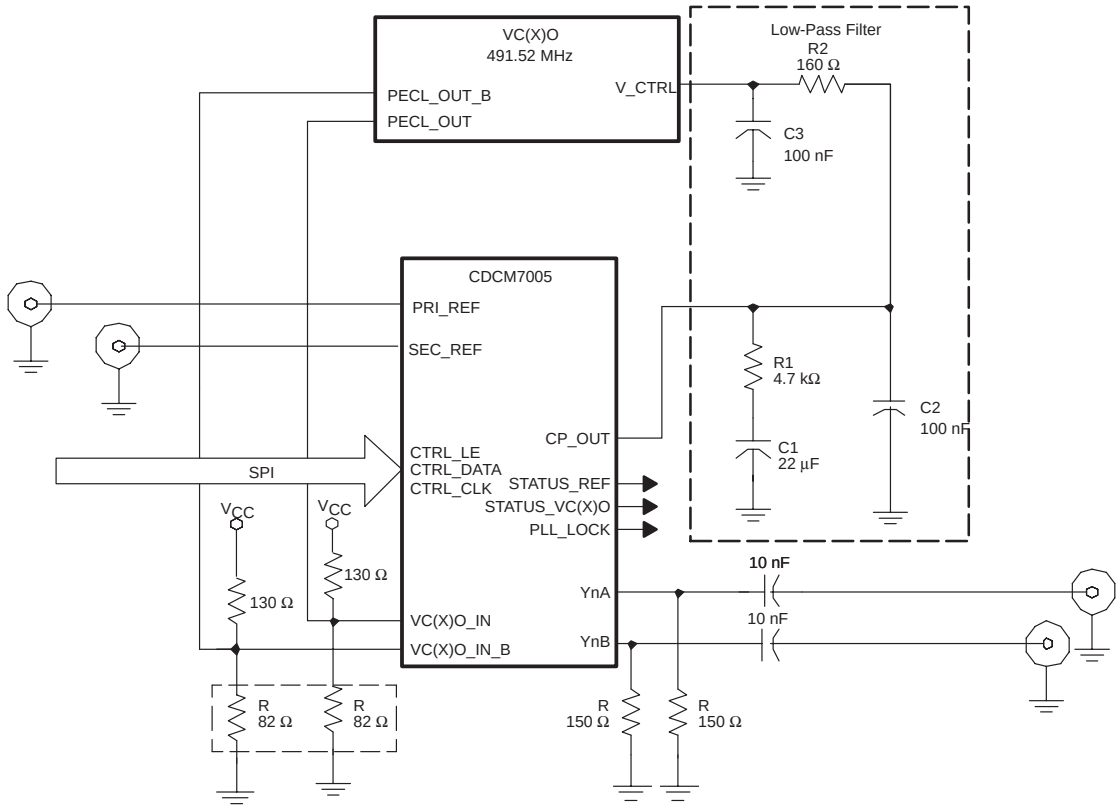
5.1 Application Circuit Diagram

The following applications sections the two loop filter configurations are discussed.

5.1.1 Passive Loop Filter

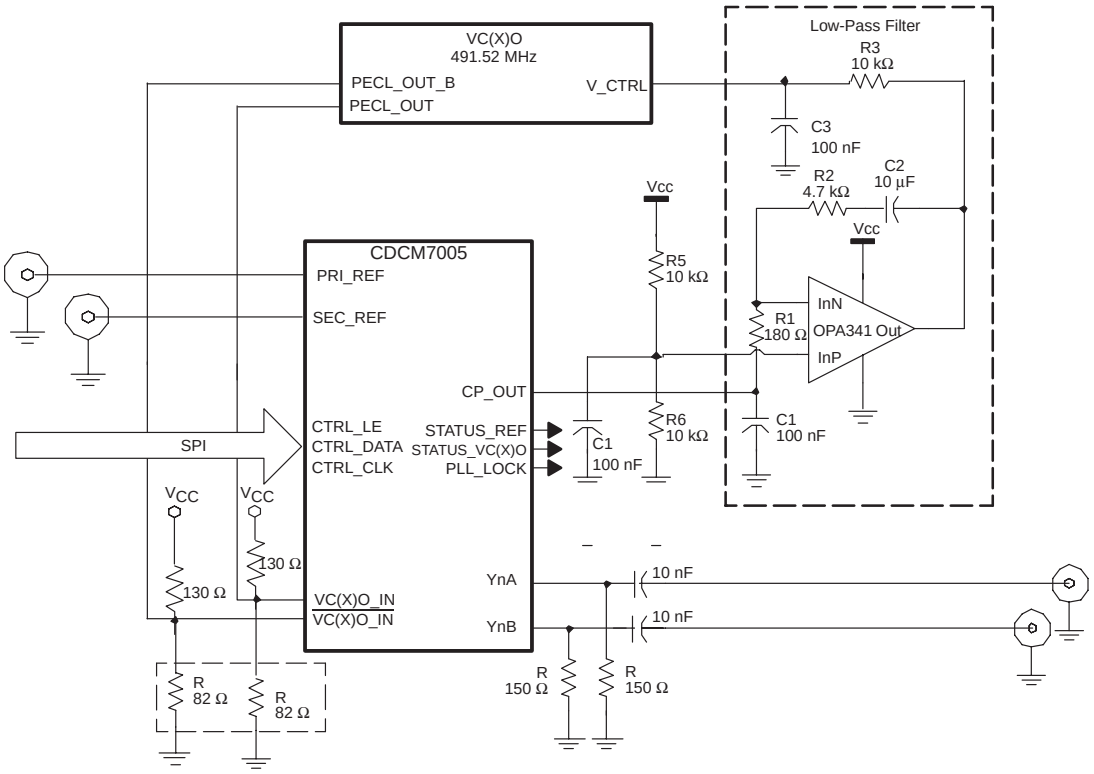
The passive loop filter is a second order filter (two poles, one zero). The zero is required for the overall loop stability. R1, C1, and C2 generate the dominant pole of the system. A second pole is introduced by R2 and C3.

Figure 5−1. CDCM7005 With a Passive Loop Filter Configuration



5.1.2 External Active Loop Filter Using OPA341

Figure 5−2. CDCM7005 With a External Active Loop Filter Using OPA341



Chapter 6

Parts List, Board Layout, and Schematic

This chapter contains the parts list, board layout, and schematic for the CDCM7005 EVM.

Topic **Page**

6.1	Parts List	6-2
6.2	Board Layout	6-4
6.3	Schematic	6-8

6.1 Parts List

Item	QTY	Reference Designator	Footprint	Part	Part Number
1	24	C1−C9, C12, C13, C15, C17, C26, C40, C41, C46, C47, C53, C54, C56−C58, C66	smd_cap_0402	10 nF	Panasonic ECJ−0EB1E103K
2	2	C72, C10	smd_cap_0402	100 nF	Panasonic ECJ−0EB1E104K
3	7	C11, C32, C62−C64, C68, C73	smd_cap_0402	100 pF	Panasonic ECJ−0EB1E101K
4	2	C14, C16	smd_cap_0402	0 Ω	Panasonic ERJ−2GE0R00X
5	1	C18	smd_cap_0402	1000 pF	Panasonic ECJ−0EB1E102K
6	1	C19	smd_cap_0603	1 µF	Panasonic ECJ−1VF1C105Z
7	2	C20, C22	smd_cap_0402	0.1 µF	Panasonic ECJ−0EB1A104K
8	1	C21	smd_cap_0402	10 nF	Panasonic ECJ−0EB1E103K
9	1	C23	smd_cap_0402	NU 1.1 pF	NU Rohm MCH155A1R1CK
10	1	C24	smd_cap_0402	22 pF	Panasonic ECJ−0EC1H220J
11	1	C25	smd_cap_0402	NU 1 pF	NU Rohm MCH155A1R1CK
12	7	C27−C29, C75, C76, C79, C80	smd_cap_0805	0.1 µF	Panasonic ECP−U1C104MA5
13	1	C30	smd_cap_1210	22 µF	Murata GRM32ER71A226KE20L
14	1	C31	smd_cap_0402	22 nF	Panasonic ECJ−0EB1E104K
15	3	C33−C35	smd_cap_0402	10 nF	Panasonic ECJ−0EF1H103Z
16	4	C36, C42, C48, C49	smd_cap_1210_pol	22 µF	Panasonic ECS−T1CC226R
		C49	smd_cap_1210_pol	22 µF	Panasonic ECS−T1CC226R
17	5	C37, C43, C50, C55, C65	smd_cap_1210_pol	10 µF	Panasonic ECS−H1CC106R
18	3	C38, C44, C51	smd_cap_0402	100 nF	Yageo 04022F104Z7B20D
19	3	C39, C45, C52	smd_cap_0402	33 nF	AVX 0402YD333KAT2A
20	4	C59−C61, C67	smd_cap_0402	2.2 nF	AVX 0402YC223KAT2A
21	3	C69−C71	smd_cap_0402	10 pF	Panasonic ECD−G0E100C

Item	QTY	Reference Designator	Footprint	Part	Part Number
22	2	C74	smd_cap_1210	10 µF	Murata GRM32DR61E106KA12L
		C77	smd_cap_1210	10 µF	Murata GRM32DR61E106KA12L
23	1	C78	smd_cap_0805	NU	Panasonic ECP−U1C104MA5
24	3	D1−D3	smd_led_1206	Amber	Lite−On LTST−C150AKT
25	1	D4	smd_led_1206	GREEN	Lite−On LTST−C150KGKT
26	1	FLT1	ts−38s	TS−38S	Toyocom Filter
27	7	J1−J4, J6−J8	sma_alt	SMA	Johnson Comp 142−0701−841
28	1	J5	jumper2	HEADER 2	
29	9	J9−J11, J13, J14, J16, J18, J22, J23	sma_alt	NU_SMA	Johnson Comp 142−0701−841
30	4	J12, J25, J26, J27	hdr3_100ctr	HDR3	Header 3 pos, 0.1 ctr
31	2	J17, J15	smd_bridge_0402	SMD3P_BRIDGE	Panasonic ERJ−2GE0R00X
32	1	J19	jumper2	HDR2	Header 2 pos, 0.1 ctr
33	2	J21, J20	smd_bridge_0402	SMD3P_BRIDGE	Panasonic ERJ−2GE0R00X
34	3	J24, J28, J29	jumper2	HDR2	Header 2 pos, 0.1 ctr
35	1	J30	dcon25m	PARALLEL PORT	SPC Technology DB−25P−PCB
36	1	J31	jumper4	HDR4	Header 4 pos, 0.1 ctr
37	2	J33, J32	JUMPER3_SMD_WVIA_CD C7005	HDR 3_cdc7005	Use 0 W to short pins (see assy dwg)
38	1	J34	jumper2	HDR2	Header 3 pos, 0.1 ctr
39	1	L1	smd_cap_0603	75 Ω at100 MHz	Murata BLM18BA750SN1D
40	1	L2	smd_cap_0603	470 nH	Murata LQW18ANR47J00D
41	2	L4, L3	smd_cap_0603	180 nH	Panasonic ELJ−FJR18JF2
42	3	L5−L7	smd_cap_0603	75 Ω at 100 MHz	Murata BLM18BA750SN1D
43	1	L8	smd_cap_0805	2.2 nH	J W Miller Magnetics PM0805−2N2M
44	1	P1	banana_jack	PWR_IN	SPC Technologies 845R
45	1	P2	banana_jack	GND	SPC Technologies 845B
46	18	R1, R2, R7, R9, R10, R11, R16, R18−R20, R22, R24, R26, R27, R30, R35, R48, R50	smd_res_0402	NU 100 Ω	Panasonic ERJ−2RKF1000X
47	2	R3, R12	smd_res_0402	NU	Panasonic ERJ−2GEJ510X

Item	QTY	Reference Designator	Footprint	Part	Part Number
48	7	R4, R6, R13, R15, R62, R63, R65	smd_res_0402	100 Ω	Panasonic ERJ−2RKF1000X
49	6	R5, R8, R14, R17, R21, R23	smd_res_0402	150 Ω	Panasonic ERJ−2RKF1500X
50	10	R25, R57, R59, R60, R68−R71, R74, R75	smd_res_0402	10 kΩ	Panasonic ERJ−2RKF1002X
51	2	R28, R45	smd_res_0402	NU 0 Ω	Panasonic ERJ−2GE0R00X
52	4	R29, R32, R49, R80	smd_res_0402	NU 150 Ω	Panasonic ERJ−2RKF1500X
53	2	R38, R31	smd_res_0402	130 Ω	Panasonic ERJ−2GEJ131X
54	10	R33, R34, R41, R42, R82,−R87	smd_res_0402	0 Ω	Panasonic ERJ−2GE0R00X
55	2	R43, R36	smd_res_0402	82 Ω	Panasonic ERJ−2GEJ820X
56	2	R37, R44	smd_res_0402	NU	NU
57	2	R39, R40	smd_res_0402	62 W	Panasonic ERJ−2GEJ620X
58	2	R47, R46	smd_res_0402	NU 100	Panasonic ERJ−2RKF1000X
59	4	R51, R64, R66, R67	smd_res_0402	100 kΩ	Panasonic ERJ−2RKF1003X
60	1	R52	smd_res_0402	160 Ω	Panasonic ERJ−2RKF1002X
61	2	R53, R72	smd_res_0402	4.7 kΩ	Panasonic ERJ−2RKF1472X
62	3	R54−R56	smd_res_0402	750	Panasonic ERJ−2GEJ131X
63	1	R58	smd_res_0402	NU 12K 1%	Panasonic ERJ−2RKF4121X
64	1	R61	smd_cap_0402	1.5 kΩ	Panasonic ERJ−2RKF1501X
65	1	R73	smd_res_0402	180 Ω	Panasonic ERJ−2RKF1472X
66	3	R78, R79, R81	smd_res_0402	22 Ω	Panasonic ERJ−2GEJ220X
67	2	SW2, SW1	switch_reset	SW PUSHBUTTON	KT11P3JM
68	2	TP1, TP2	testpin_30dia	T POINT R	Test point
69	1	U2	mbga_pt8mm_64_skt	CDCM7005	Texas Instruments CDCM7005
70	1	U3	soic14	SN74LV125	Texas Instruments SN74LV125AD
71	1	U4	soic_round_4	NU SGA−4586	NU Sirenza SGA−4586
72	1	U5	soic8	OPA341	Texas Instruments OPA341UA
73	1	VCXO1	VCXO_6	VCXO_6	Toyocom VCXO
74	4	MP3	STAND OFF		Legs for PCB
75	4	MP2	SCREW		Legs for PCB

6.2 Board Layout

Figure 6−1. Component View and Silkscreen (Top View)

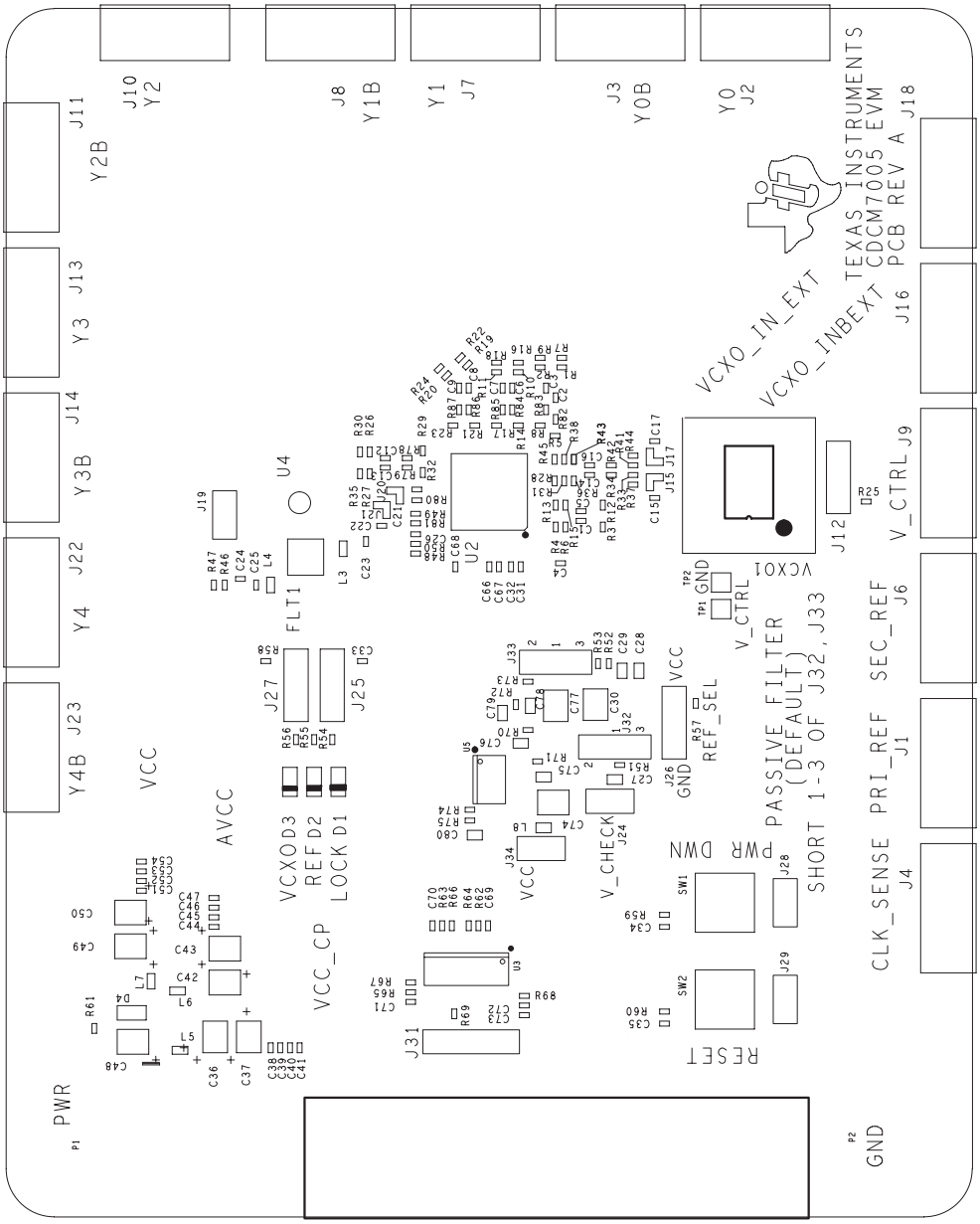


Figure 6−2. Component View and Silkscreen (Bottom View)

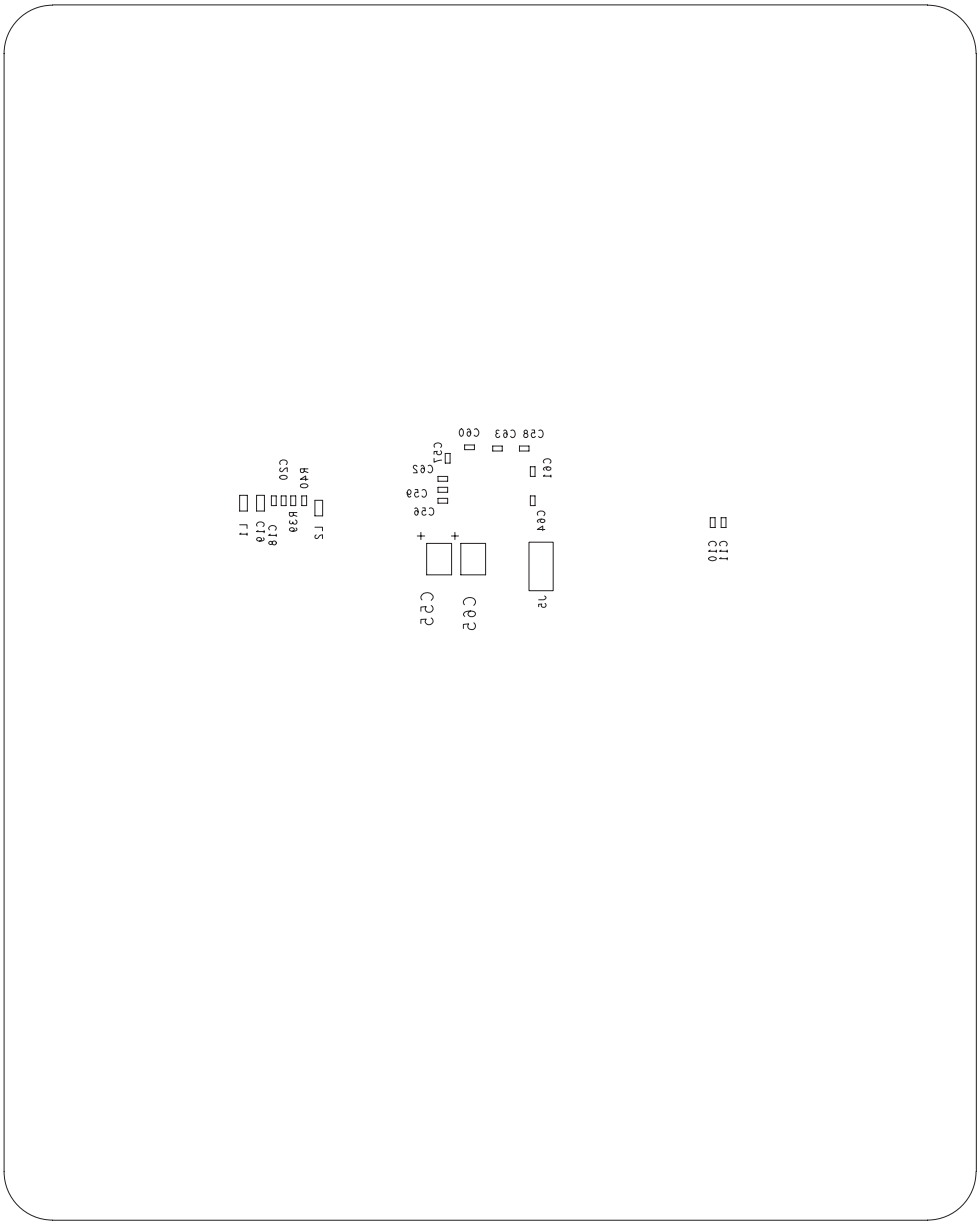


Figure 6−3. Top Layer View

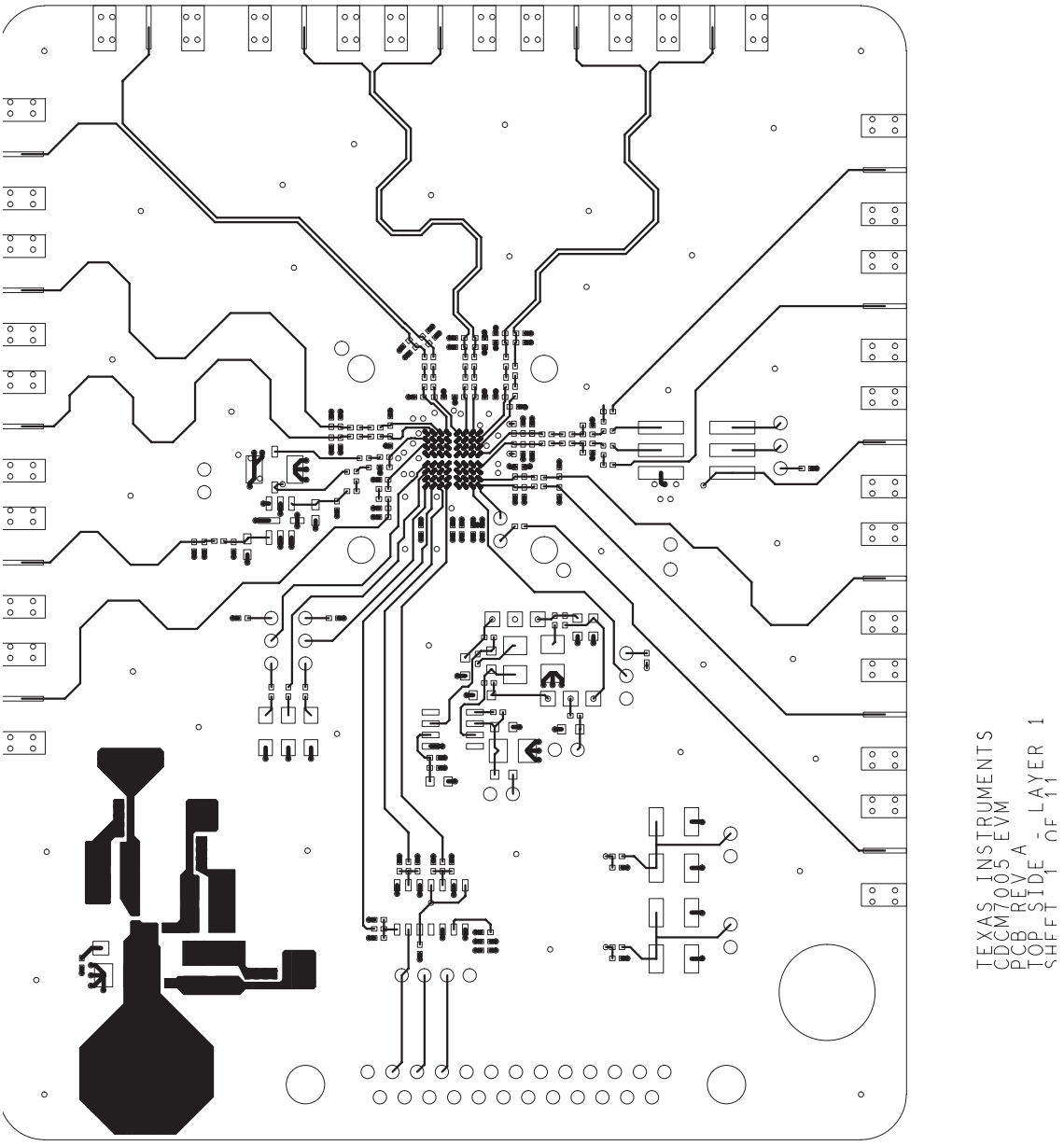


Figure 6−4. Bottom Layer View

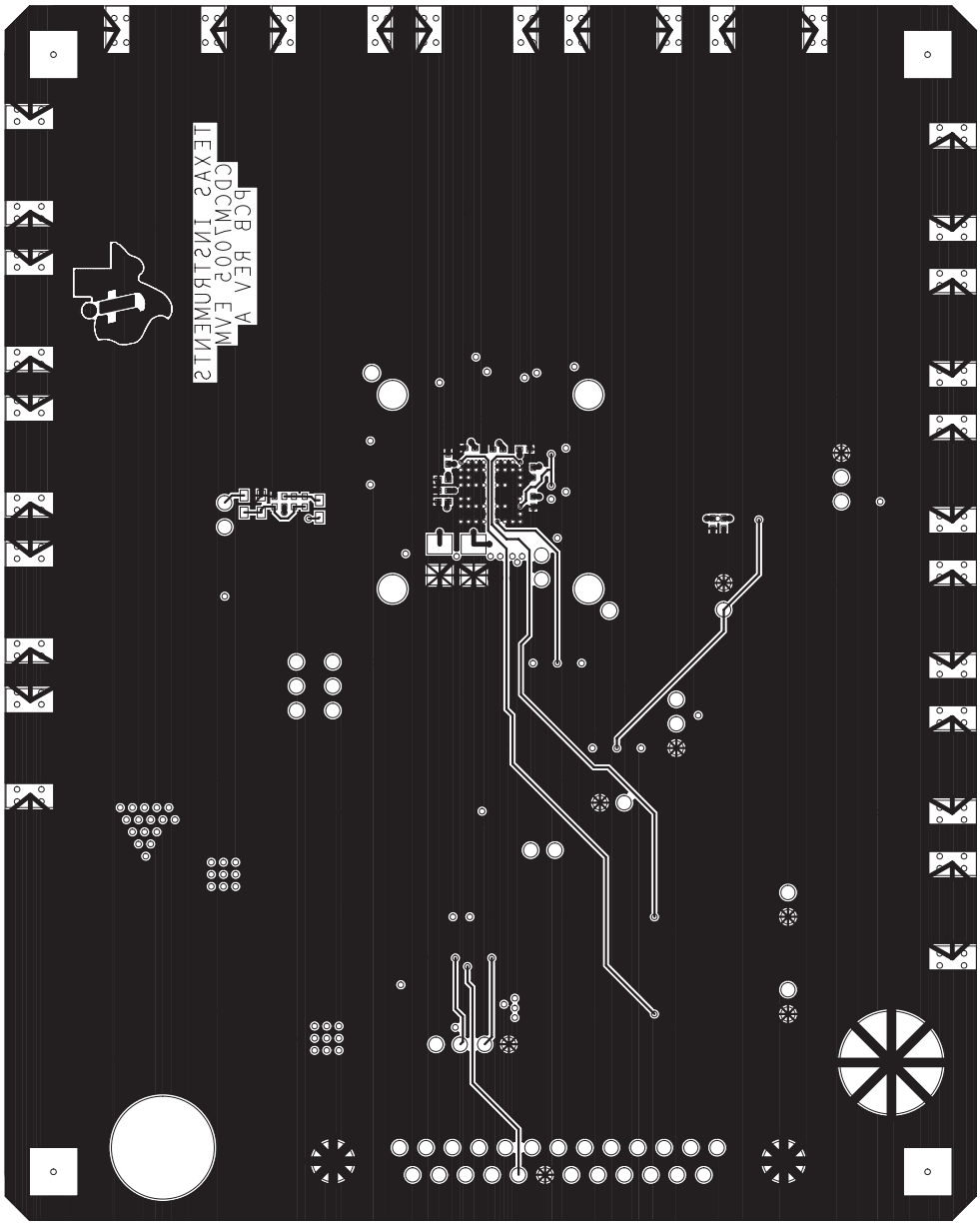


Figure 6−5. Ground Plane View

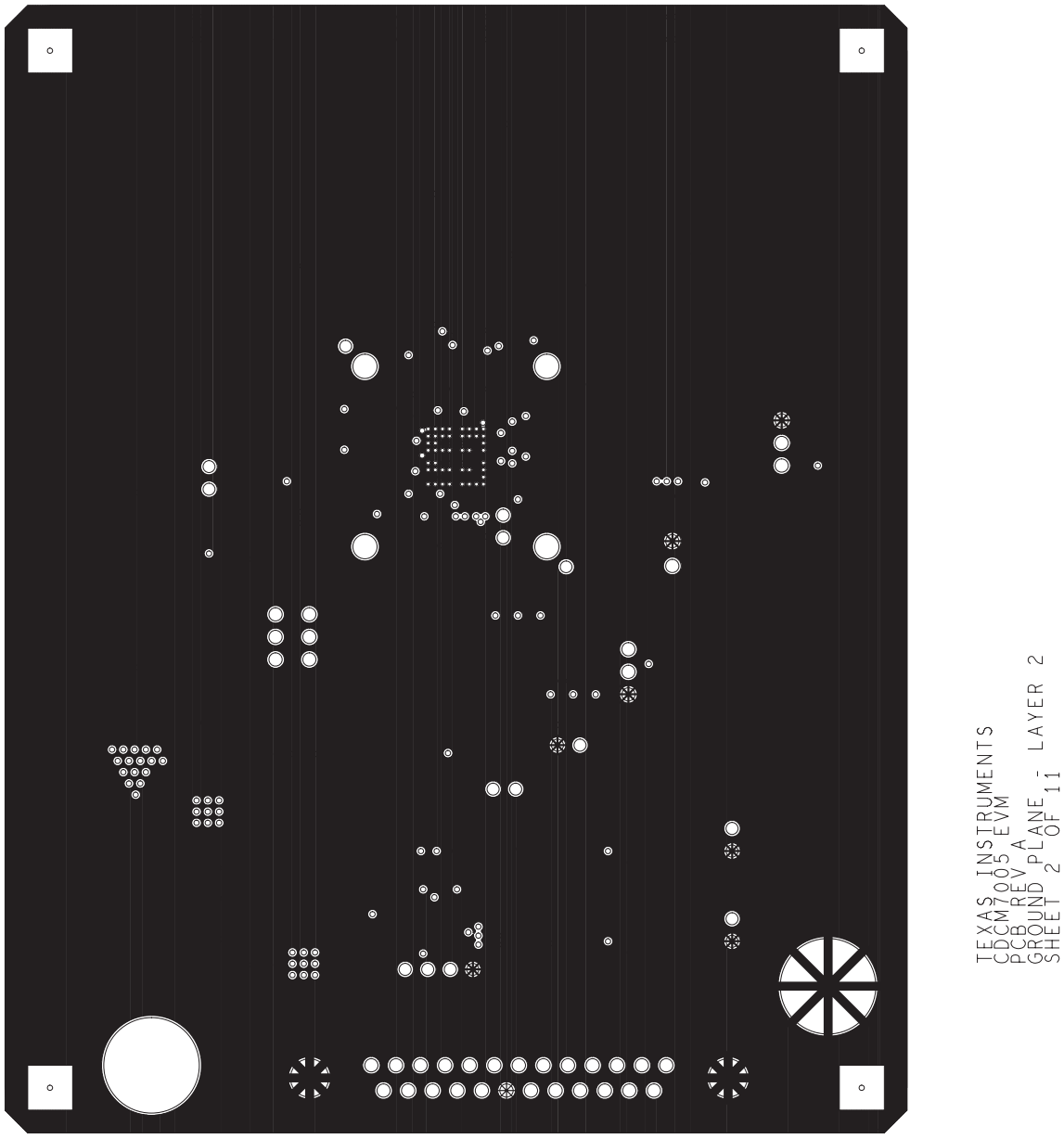
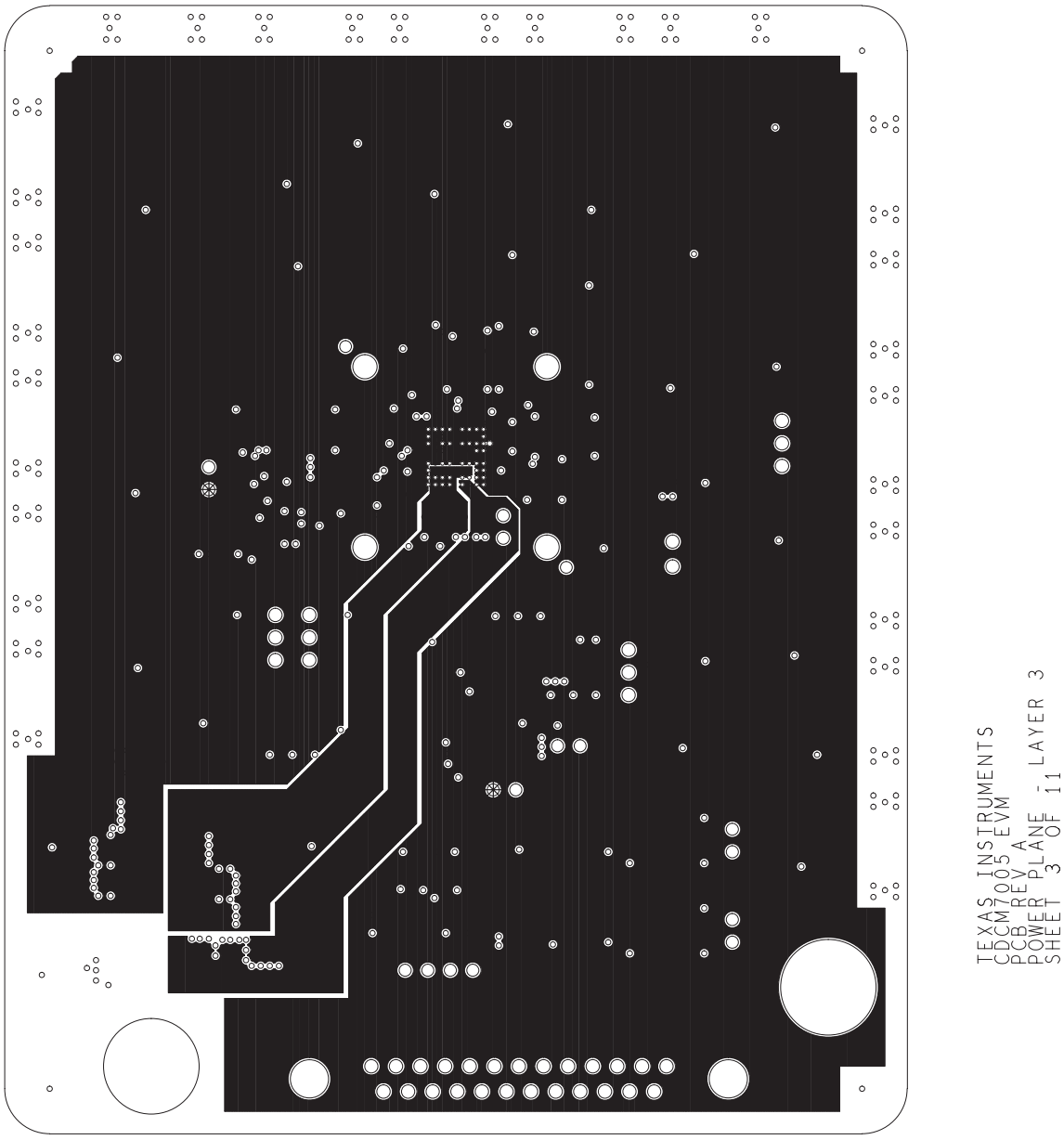
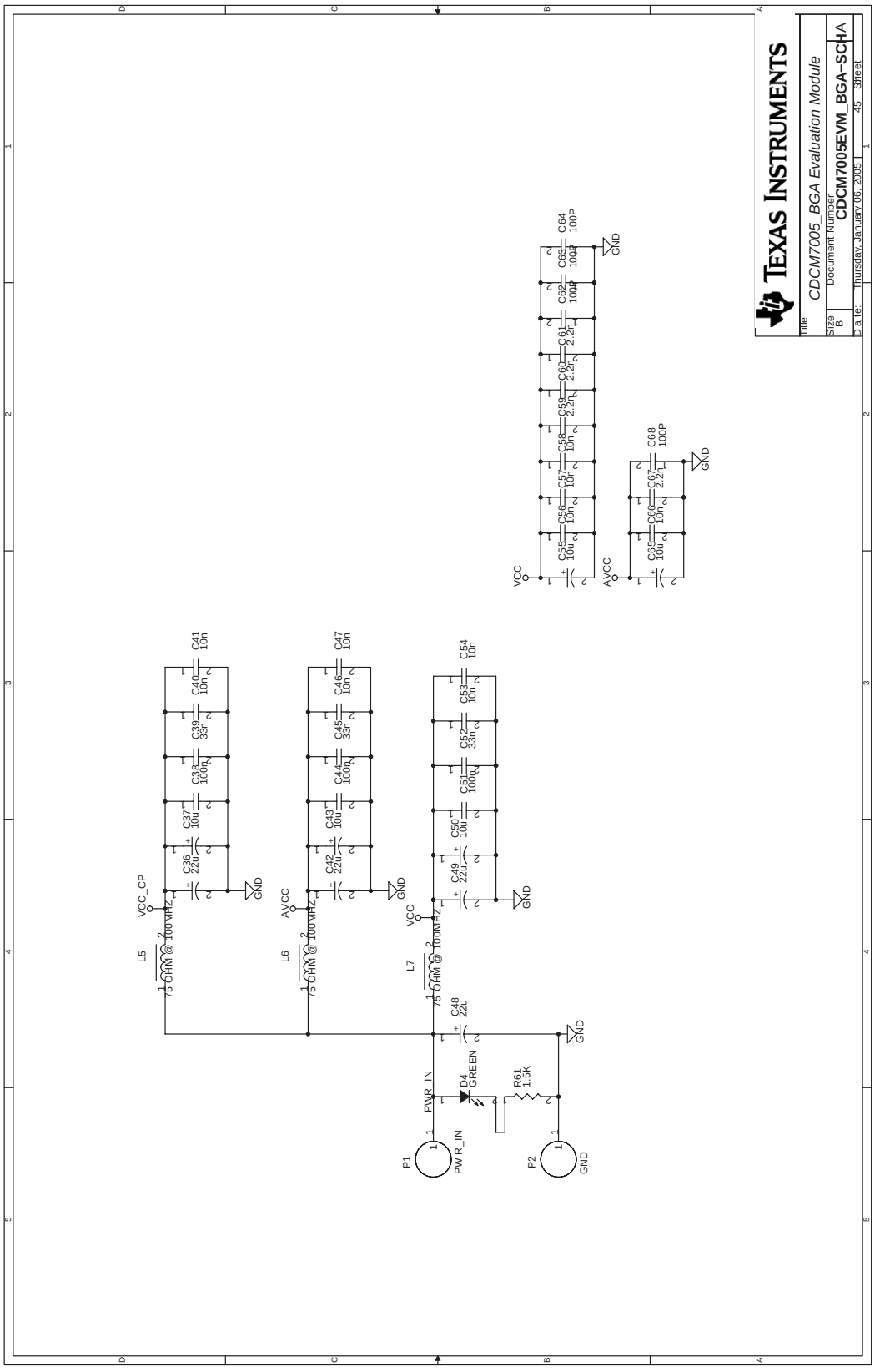


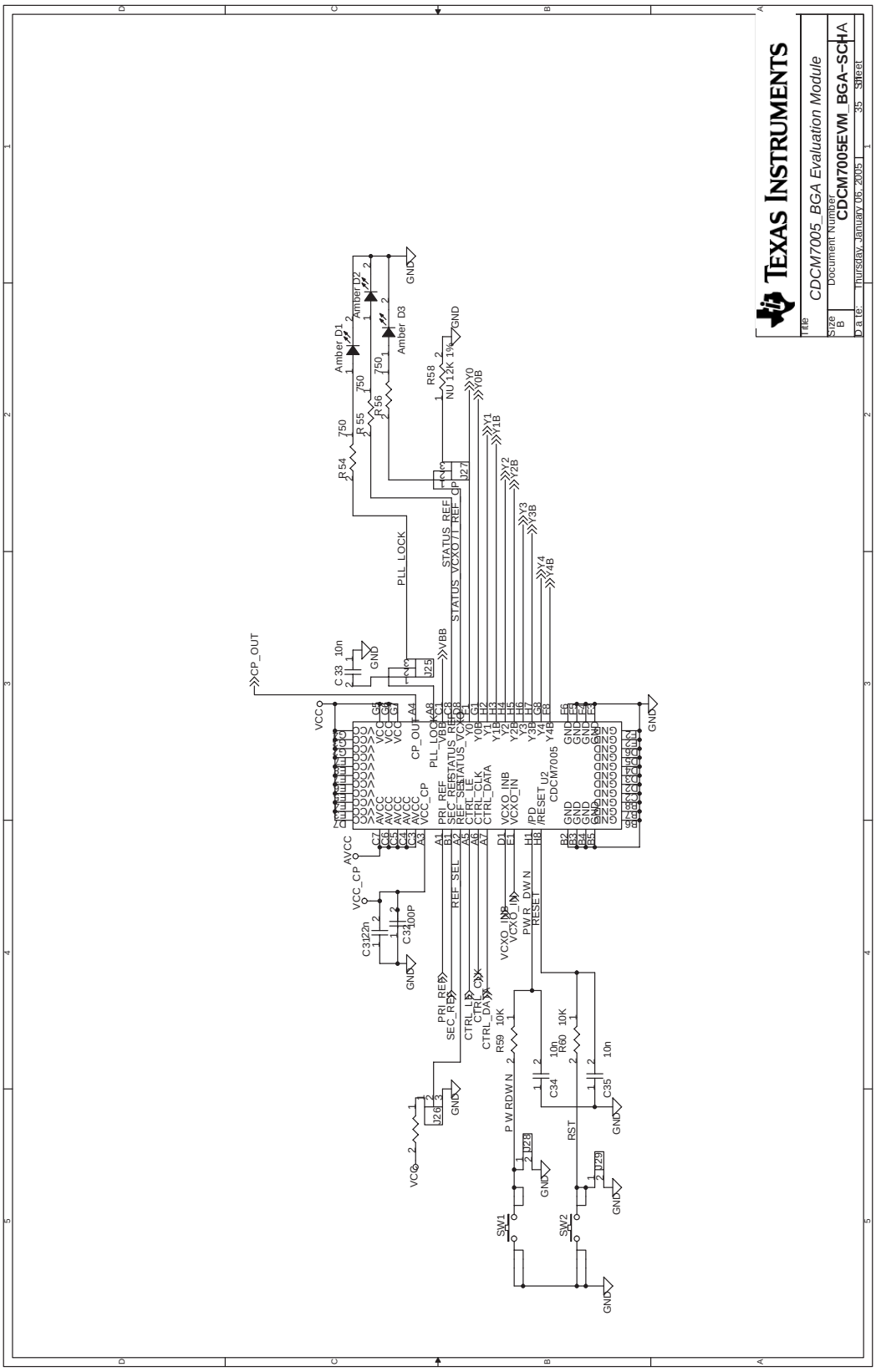
Figure 6−6. Power Layer View

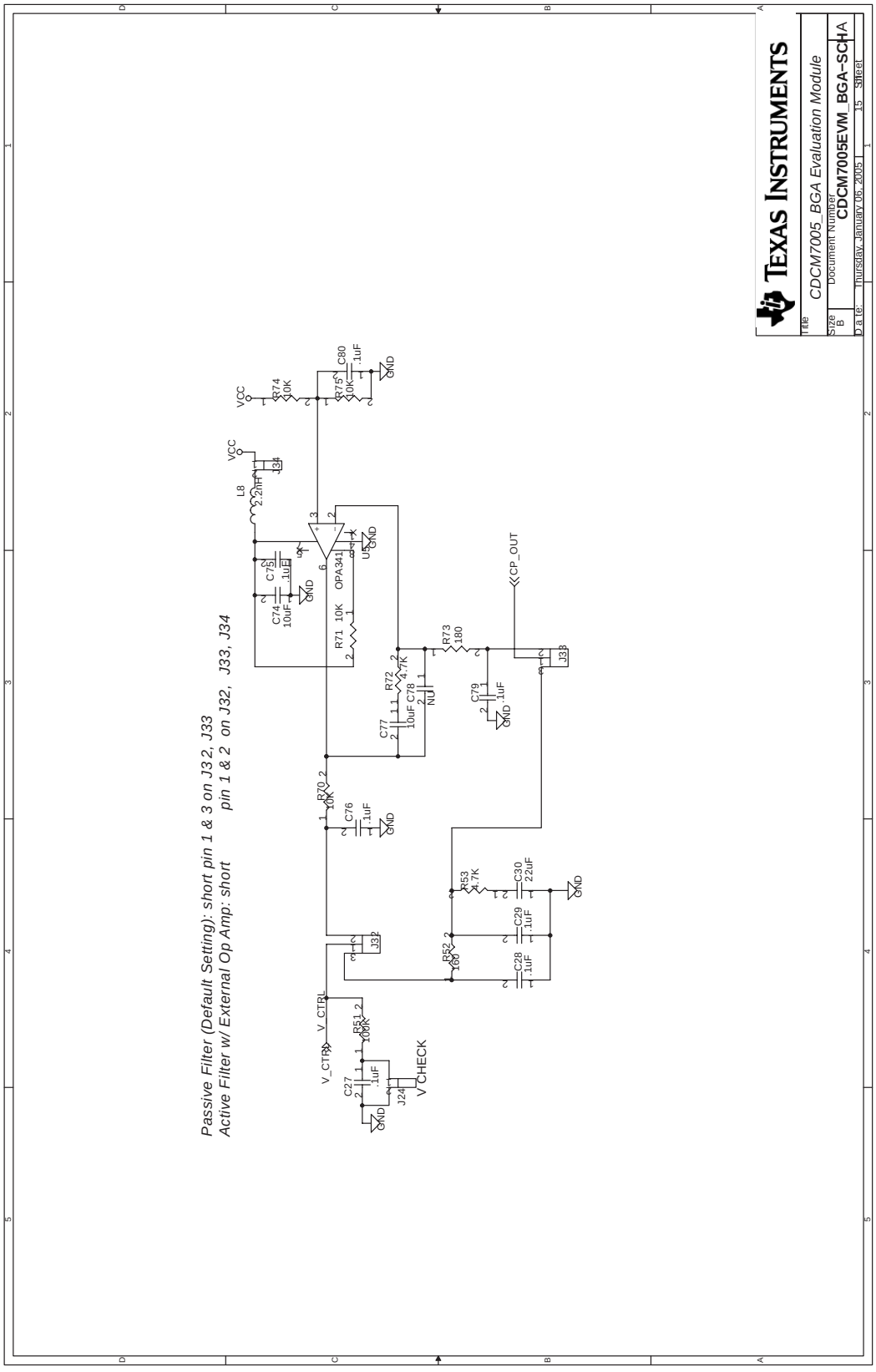


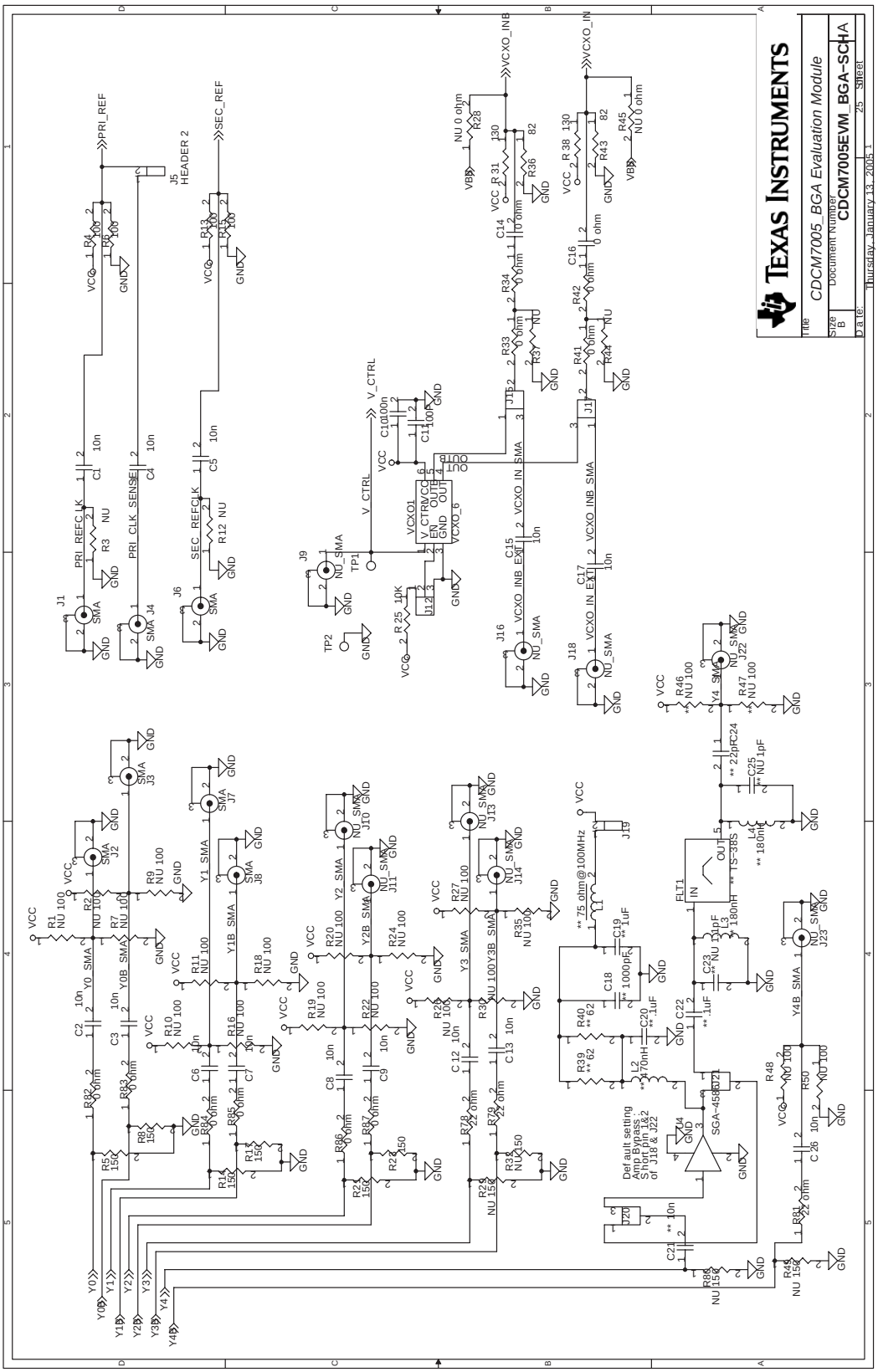
6.3 Schematic

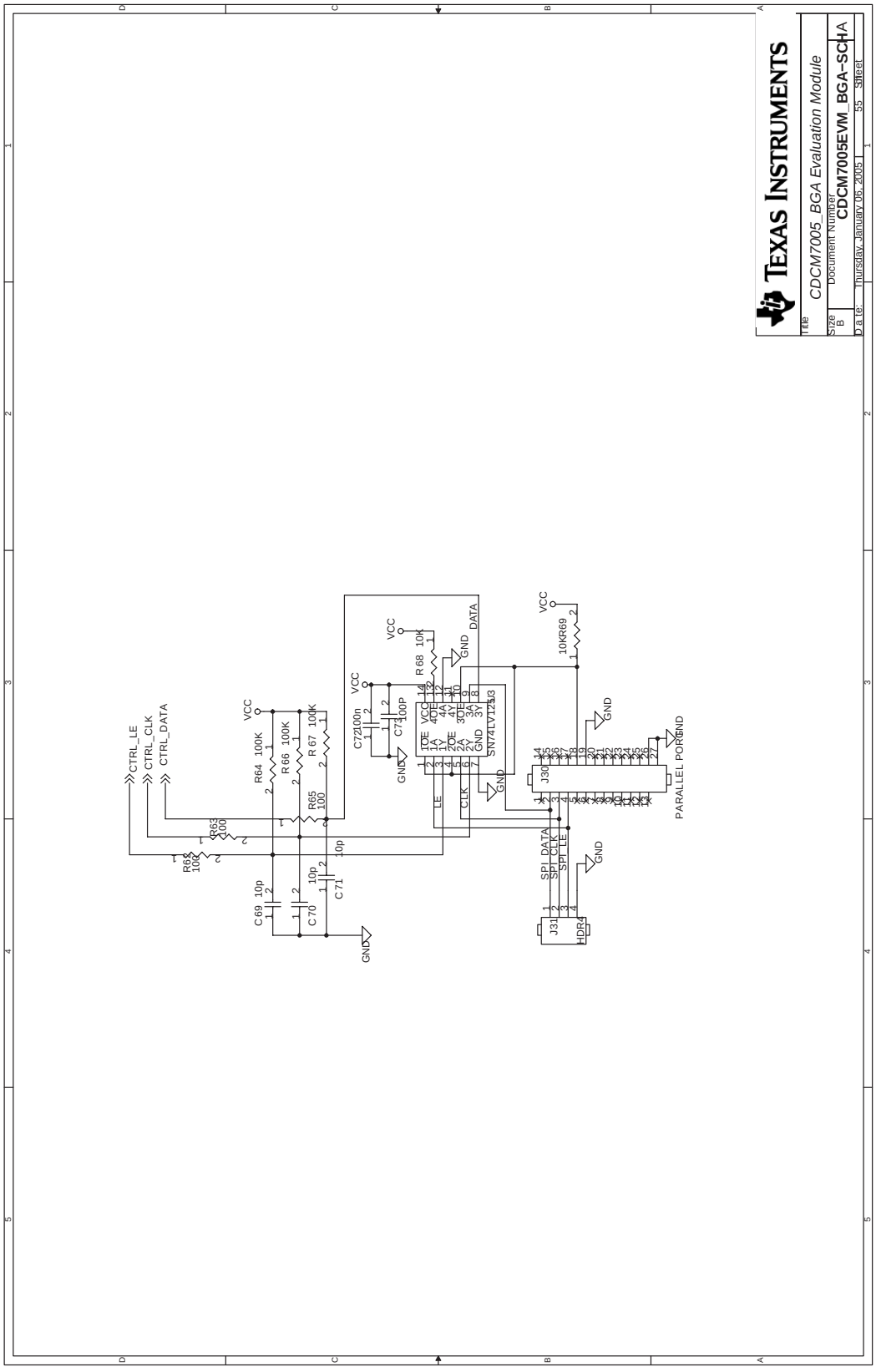
The following pages contain the schematic for the CDCM7005.


TEXAS INSTRUMENTS
CDCM7005_BGA Evaluation Module
CDCM7005EVM_BGA-SCH
A
Thursday, January 06, 2005
Sheet
45
VCC_CP
AVCC
VCC
GND
L5 75 OHM @ 100MHZ
L6 75 OHM @ 100MHZ
L7 75 OHM @ 100MHZ
C36 22u
C37 10u
C38 100n
C39 33n
C40 10n
C41 10n
C42 22u
C43 10u
C44 100n
C45 33n
C46 10n
C47 10n
C48 22u
C49 22u
C50 10u
C51 100n
C52 33n
C53 10n
C54 10n
C55 10u
C56 10n
C57 10n
C58 10n
C59 2.2n
C60 2.2n
C61 2.2n
C62 100P
C63 100P
C64 100P
C65 10u
C66 10n
C67 2.2n
C68 100P
D4 GREEN
R61 1.5K
P1 PWR_IN
P2 GND


TEXAS INSTRUMENTS
CDCM7005_BGA Evaluation Module
CDCM7005EVM_BGA-SCH
Rev A
Size B
Document Number
Date: Thursday, January 06, 2005
Sheet 35
CDCM7005
PLL_LOCK
STATUS_REF
STATUS_VCXO/1
PRI_REF
SEC_REF
REF_SEL
CTRL_CLK
CTRL_DATA
VCXO_INB
VCXO_IN
/PD
/RESET
Y0B
Y1B
Y2B
Y3B
Y4B
CP_OUT
VCC
AVCC
VCC_CP
GND
Amber D1
Amber D2
Amber D3
R54 750
R55 750
R56 750
R58 NU 12K 1%
R59 10K
R60 10K
C33 10n
C34 10n
C35 10n
C31 100P
C32 22n
U25
U26
U27
U28
U29
SW1
SW2
PWR_DWN
RESET
RST


Passive Filter (Default Setting): short pin 1 & 3 on J32, J33
Active Filter w/ External Op Amp: short pin 1 & 2 on J32, J33, J34
TEXAS INSTRUMENTS
Title
CDCM7005_BGA Evaluation Module
Size B
Document Number
CDCM7005EVM_BGA-SCH
A
Date: Thursday, January 06, 2005
Sheet 15 1
VCC
R74 10K
R75 10K
C80 .1uF
GND
L8 2.2nH
J34
C75 .1uF
C74 10uF
R71 10K
U5 OPA341
R73 180
R72 4.7K
C77 10uF
C78 NU
C79 .1uF
CP_OUT
J33
R70 10K
C76 .1uF
R53 4.7K
C30 22uF
C29 .1uF
C28 .1uF
R52 100
J32
V_CTRL
R51 100K
C27 1uF
J24
VCHECK


TEXAS INSTRUMENTS
CDCM7005_BGA Evaluation Module
CDCM7005EVM_BGA-SCH
Rev A
Size B
Document Number
Sheet 25
Date: Thursday, January 13, 2005


TEXAS INSTRUMENTS
Title
CDCM7005_BGA Evaluation Module
Size
B
Document Number
CDCM7005EVM_BGA-SCH
A
Date:
Thursday, January 06, 2005
Sheet
1
55
CTRL_LE
CTRL_CLK
CTRL_DATA
VCC
R64 100K
R66 100K
R67 100K
R65 100
R63 100
R68 10K
C72 100n
C73 100P
C69 10p
C70 10p
C71 10p
GND
R 68 10K
DATA
SN74LV125
LE
CLK
J30
PARALLEL PORT
10KR69
SPI_DATA
SPI_CLK
SPI_LE
J31
HDR4