Chipsmall Limited consists of a professional team with an average of over 10 year of expertise in the distribution of electronic components. Based in Hongkong, we have already established firm and mutual-benefit business relationships with customers from,Europe,America and south Asia,supplying obsolete and hard-to-find components to meet their specific needs.

With the principle of “Quality Parts,Customers Priority,Honest Operation,and Considerate Service”,our business mainly focus on the distribution of electronic components. Line cards we deal with include Microchip,ALPS,ROHM,Xilinx,Pulse,ON,Everlight and Freescale. Main products comprise IC,Modules,Potentiometer,IC Socket,Relay,Connector.Our parts cover such applications as commercial,industrial, and automotives areas.

We are looking forward to setting up business relationship with you and hope to provide you with the best service and solution. Let us make a better world for our industry!

Contact us

Tel: +86-755-8981 8866 Fax: +86-755-8427 6832
Email & Skype: info@chipsmall.com Web: www.chipsmall.com
Address: A1208, Overseas Decoration Building, #122 Zhenhua RD., Futian, Shenzhen, China

Touch Sensing Software Evaluation Board

Users Guide

Document Number:TSSEVBUG
Rev. 6
7/2010

freescale™
semiconductor

How to Reach Us:

Home Page:
www.freescale.com

E-mail:
support@freescale.com

USA/Europe or Locations Not Listed:
Freescale Semiconductor
Technical Information Center, CH370
1300 N. Alma School Road
Chandler, Arizona 85224
+1-800-521-6274 or +1-480-768-2130
support@freescale.com

Europe, Middle East, and Africa:
Freescale Halbleiter Deutschland GmbH
Technical Information Center
Schatzbogen 7
81829 Muenchen, Germany
+44 1296 380 456 (English)
+46 8 52200080 (English)
+49 89 92103 559 (German)
+33 1 69 35 48 48 (French)
support@freescale.com

Japan:
Freescale Semiconductor Japan Ltd.
Headquarters
ARCO Tower 15F
1-8-1, Shimo-Meguro, Meguro-ku,
Tokyo 153-0064, Japan
0120 191014 or +81 3 5437 9125
support.japan@freescale.com

Asia/Pacific:
Freescale Semiconductor China Ltd.
Exchange Building 23F
No. 118 Jianguo Road
Chaoyang District
Beijing 100022
China
+86 10 5879 8000
support.asia@freescale.com

For Literature Requests Only:
Freescale Semiconductor Literature Distribution Center
1-800-441-2447 or 303-675-2140
Fax: 303-675-2150
LDCForFreescaleSemiconductor@hibbertgroup.com

Document Number: TSSEVBUG
Rev. 6
7/2010

Revision History

To provide the most up-to-date information, the revision of our documents on the World Wide Web will be the most current. Your printed copy may be an earlier revision. To verify you have the latest information available, refer to:

http://www.freescale.com

The following revision history table summarizes changes contained in this document.

Revision Number	Revision Date	Description of Changes
Rev. 1	07/2009	Launch Release.
Rev. 2	09/2009	Updated BOM, schematics, and silk screen.
Rev. 3	10/2009	Updated GPIO port allocation table.
Rev. 4	11/2009	Added Section 2.1.10, “Overlays” and Section 2.3.8.1, “Using the TSSEVB IIC Communication Module” sections.
Rev. 5	12/2009	Added Section 2.1.1, “TSSEVB Modules” and Section 3.1.1, “Re-Programming MC9S08JM60 Comm MCU on the TSSEVB” sections.
Rev. 6	7/2010	Edits done

Chapter 1

Before You Begin

Chapter 2

System Overview

Chapter 3

TSSEVB Interfaces

Chapter 1
Before You Begin

1.1 About This Book

This guide describes the hardware of the Touch Sensing Software Evaluation Board (TSSEVB). The TSSEVB provides all the necessary components to evaluate and use the Touch Sensing Software (TSS).

TSSEVB is built around Freescale's TSS library. The Freescale MC9S08LG32 microcontroller unit uses the TSS library.

This *TSSEVB Users Guide* is written for software, hardware, and system engineers, who are developing their products or software applications using the TSS library to integrate capacitive sensing.

Table 1-1 shows the summary of chapters in this guide.

Table 1-1. TSSEVBUG Summary

Chapter Title	Description
Before You Begin	Lists the prerequisites of reading this book.
System Overview	Provides information about the microcontroller part and its surrounding.
TSSEVB Interfaces	Describes the board design and ways to interface with the board.

1.2 Reference Material

Use this book in conjunction with:

- *Touch Sensing Software Users Guide* (document TSSUG)
- *Touch Sensing Software API Reference Manual* (document TSSAPIRM)
- *Touch Sensing Software EVB Quick Start Guide* (document TSSEVBQSG)

1.3 Conventions

This guide uses the following notations:

- Courier monospaced type indicates commands, command parameters, code examples, expressions, datatypes, and directives.
- Italic type indicates replaceable command parameters.
- All source code examples are in C.

1.4 Acronyms and Abbreviations

BOM	Bill of Material
CPU	Central Processing Unit
Comm MCU	Communication Microcontroller Unit
EGT	Electrode Graphing Tool
FLL	Frequency-Locked Loop
GPIO	General-Purpose Input/Output
IIC	Inter-Integrated Circuit
ICS	Internal Clock Source
LG MCU	MC9S08LG32 Microcontroller Unit
MCU	Microcontroller Unit
OSBDM	Open Source Background Debug Module
PC	Personal Computer
PCB	Printed Circuit Board
QFN	Quad Flat Non-lead package
RAM	Random Access Memory
Rx	Receiver
SCI	Serial Communication Interface
SPI	Serial Peripheral Interface
TSSEVB	Touch Sensing Software Evaluation Board
Tx	Transmitter

Chapter 2
System Overview

2.1 Introduction

This chapter describes the basic components, functionality, and power supply options of TSSEVB. It also includes the schematic and Bill of Materials (BOM) for the TSSEVB. For more information on how to set the Freescale Touch Sensing Software primitives and the development environment, refer to the *Touch Sensing Software API Reference Manual* (document TSSAPIRM).

Features of TSSEVB:

- TSSEVB includes a demonstration application that allows you to start testing TSS within minutes.
- TSSEVB includes a Communication MCU (MC9S08JM60 Comm MCU) that serves as a bridge between the application and the PC to evaluate the Electrode Graphing Tool (EGT) along with TSS.
- TSSEVB includes all the decoding structures supported by TSS along with special electrodes, such as different size electrodes and multiplexed electrodes supported by TSS.
- The EVB also contains a custom on-board display that allows you to explore the software development combining the integrated LCD driver with TSS. The LCD contains special segments to be used with TSS.
- TSSEVB includes an MC9S08LG32 device from the S08 family of 8-bit microcontrollers. The LG family offers improved performance and flexible pin functionality for a wide range of industrial and automotive applications, such as electric metering, home appliances, HVAC systems, and entry level instrument clusters.
- TSSEVB includes an OSBDM module that allows programming of the MC9S08LG32 MCU and the MC9S08JM60 Comm MCU. There is no need to use an external BDM module to load applications into the MC9S08LG32 MCU.
- TSSEVB can be powered using three different sources:
  - Through the USB port
  - Through the mini USB port
  - By connecting the board to the voltage converter included in the TSSEVB kit.

2.1.1 TSSEVB Modules

Figure 2-1 shows the front view of TSSEVB and the main modules present.

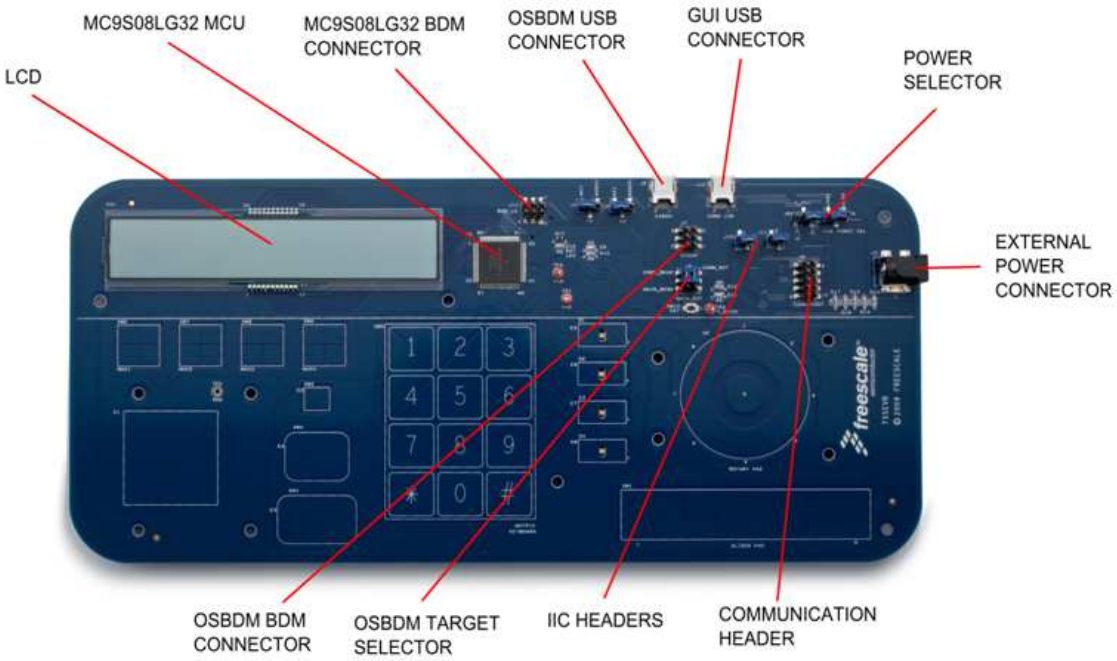


Figure 2-1. TSSEVB front view

Figure 2-2 shows the back view of TSSEVB and the main modules present.

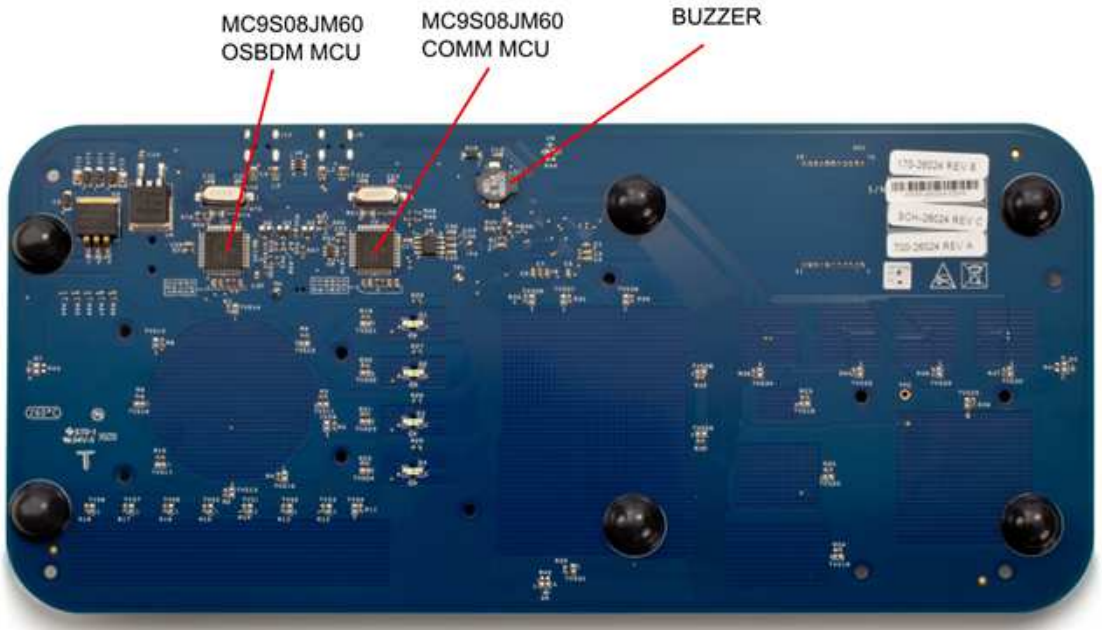


Figure 2-2. TSSEVB back view

2.1.2 Microcontroller Unit (MCU)

MC9S08LG32 drives liquid crystal displays (LCD) with up to 296 segments. The 5V segment LCD MCU, MC9S08LG32 offers improved performance and flexible pin functionality for a wide range of industrial

and automotive applications, such as electric metering, home appliances, HVAC systems, and entry level instrument cluster. The MC9S08LG32 has 32 KB of on-chip programmable flash memory and 2 KB of RAM available.

The MC9S08LG32 provides an LCD driver module, configurable up to 8 × 37 or 4 × 41. The LCD driver module remains active even in low-power modes. It also includes an internal regulated charge pump for contrast control. All LCD pins are multiplexed with GPIOs.

TSSEVB uses the MC9S08LG32 Inter-Integrated Circuit (IIC) module to establish communication with the MC9S08JM60 Comm MCU when the TSSEVB is used along with EGT. To use the IIC module with the EGT, jumpers on headers J10 and J11 respectively must be properly configured. For more information on jumper configurations, refer to Section 2.3, "Header and Jumper Connections."

The EVB includes two MC9S08JM60 MCUs, one is open source BDM that is used to program and debug, while the other is used to communicate with the EGT GUI on a PC.

The MC9S08LG32 includes a Serial Communication Interface (SCI) module. The SCI module can be connected to both MC9S08JM60 MCUs included in the TSSEVB and you can select either by changing the position on J1 and J2 jumpers. The SCI module is included in the TSSEVB for future demo applications.

MC9S08LG32 is packaged in an 80-pin quad flat non-lead package (QFN).

2.1.3 General-Purpose I/O and Peripheral Ports

MC9S08LG32 has nine I/O ports that include a total of up to 69 GPIO pins. Most of these pins are shared with the on-chip peripherals such as timer systems, external interrupts, or keyboard interrupts. When these modules are not controlling the port pins, they revert to GPIO control. Immediately after reset, all 69 GPIO pins are configured as high-impedance general-purpose inputs with internal pull-up devices disabled. The port allocation of the general-purpose I/O and on-chip peripheral functions on the EVB are listed in Table 2-1 along with a brief description.

Table 2-1. GPIO Port Allocation

MCU Port	TSSEVB Functionality	I/O	Description
PTA0/LCD21	LCD21	I/O	LCD Control pin
PTA1/SCL/LCD22	ER9	I	Rotary Structure Electrode
PTA2/SDA/ADC0/LCD23	EGR1	I	Different Size Electrode
PTA3/KBI4/TX2/ADC1/LCD24	OSBDM_TX/COM_TX	O	SCI Transmitter (future use)
PTA4/KBI5/RX2/ADC2/LCD25	OSBDM_RX/COM_RX	I	SCI Receiver (future use)
PTA5/KBI6/TPM2CH0/ADC3/LCD26	ETK_6	I	Numeric Keyboard Electrode
PTA6/KBI7/TPM2CH1/ADC4/LCD27	Buzzer	O	Buzzer
PTA7/TCLK/ADC5/LCD28	ETK_5	I	Numeric Keyboard Electrode
PTB0/LCD29	ESLIDER1	I	Slider Structure Electrode
PTB1/LCD30	ESLIDER2	I	Slider Structure Electrode

Table 2-1. GPIO Port Allocation (continued)

MCU Port	TSSEVB Functionality	I/O	Description
PTB2/LCD31	ESLIDER7	I	Slider Structure Electrode
PTB3/LCD32	ESLIDER8	I	Slider Structure Electrode
PTB4/LCD37	ESLIDER3	I	Slider Structure Electrode
PTB5/LCD38	ESLIDER4	I	Slider Structure Electrode
PTB6/LCD39	ESLIDER5	I	Slider Structure Electrode
PTB7/LCD40	ESLIDER6	I	Slider Structure Electrode
PTC0/LCD16	LCD16	I/O	LCD Control pin
PTC1/LCD17	LCD17	I/O	LCD Control pin
PTC2/LCD18	LCD18	I/O	LCD Control pin
PTC3/LCD19	LCD19	I/O	LCD Control pin
PTC4/LCD20	LCD20	I/O	LCD Control pin
PTC5/BKGD/MS	MAIN_BKGD	I/O	MCU Programming pin
PTC6/$\overline{\text{RESET}}$	MAIN_RST	I/O	MCU Reset pin
PTD0/LCD0	LCD0	I/O	LCD Control pin
PTD1/LCD1	LCD1	I/O	LCD Control pin
PTD2/LCD2	LCD2	I/O	LCD Control pin
PTD3/LCD3	LCD3	I/O	LCD Control pin
PTD4/LCD4	LCD4	I/O	LCD Control pin
PTD5/LCD5	LCD5	I/O	LCD Control pin
PTD6/LCD6	LCD6	I/O	LCD Control pin
PTD7/LCD7	LCD7	I/O	LCD Control pin
PTE0/LCD8,	LCD8	I/O	LCD Control pin
PTE1/LCD9	LCD9	I/O	LCD Control pin
PTE2/LCD10,	LCD10	I/O	LCD Control pin
PTE3/LCD11	LCD11	I/O	LCD Control pin
PTE4/LCD12	LCD12	I/O	LCD Control pin
PTE5/LCD13	LCD13	I/O	LCD Control pin
PTE6/LCD14	LCD14	I/O	LCD Control pin
PTE7/LCD15	LCD15	I/O	LCD Control pin
PTF0/TX1/KBI3/TPM2CH2/ADC12	ERL1	I	Electrode with LED
PTF1/RX1/TPM1CH0/ADC13	ERL2	I	Electrode with LED
PTF2/SPSCK/TPM1CH1/IRQ/ADC14	ERL3	I	Electrode with LED
PTF3/$\overline{\text{SS}}$/KBI0/TPM2CH5	ES3	I	Different Size Electrode

Table 2-1. GPIO Port Allocation (continued)

MCU Port	TSSEVB Functionality	I/O	Description
PTF4/MISO/KBI1/TPM2CH4	ER2	I	Rotary Structure Electrode
PTF5/MOSI/KBI2/TPM2CH3	ER1	I	Rotary Structure Electrode
PTF6/XTAL	LED_ER2	O	Electrode's LED
PTF7/XTAL	LED_ER1	O	Electrode's LED
PTG0/LCD33	EMUX1	I	Multiplexed Electrode
PTG1/LCD34	EMUX2	I	Multiplexed Electrode
PTG2/LCD35	LED_ER3	O	Electrode's LED
PTG3/LCD36	ER8	I	Rotary Structure Electrode
PTG4/LCD41	EMUX3	I	Multiplexed Electrode
PTG5/LCD42	EMUX4	I	Multiplexed Electrode
PTG6/LCD43	LED_ER4	O	Electrode's LED
PTG7/LCD44	NC	-	—
PTH0/KBI4/ADC6	ETK_4	I	Numeric Keyboard Electrode
PTH1/KBI5/ADC7	ETK_3	I	Numeric Keyboard Electrode
PTH2/KBI6/ADC8	ETK_2	I	Numeric Keyboard Electrode
PTH3/KBI7/ADC9	ETK_1	I	Numeric Keyboard Electrode
PTH4/RX1/KBI2/TPM1CH1/ADC10	ES1	I	Different Size Electrode
PTH5/TX1/KBI3/TPM1CH0/ADC11	ES2	I	Different Size Electrode
PTH6/TPM2CH5/KBI0/ADC15	ERL4	I	Electrode with LED
PTH7/KBI1/TPM2CH4	ER7	I	Rotary Structure Electrode
PTI0/RX2	ER6	I	Rotary Structure Electrode
PTI1/TMRCLK/TX2	ER5	I	Rotary Structure Electrode
PTI2/TPM2CH3/MISO	ER4	I	Rotary Structure Electrode
PTI3/TPM2CH2/MOSI	ER3	I	Rotary Structure Electrode
PTI4/TPM2CH1/SDA/SPSCK	JM2_SDA	I/O	IIC module pin used for communication with the EGT
PTI5/TPM2CH0/SCL/$\overline{SS}$	JM2_SCL	I/O	IIC module pin used for communication with the EGT

2.1.4 Power Supply

Power can be supplied to TSSEVB either through the USB connections by setting J4 or through an external power supply.

- To supply power to the TSSEVB through a USB connection, set the J4 jumper to the selected USB connection.

  - To supply power to the board from the OSBDM, place the J4 jumper on the 1–2 positions.
  - To supply power to the board from the MC9S08JM60 Comm MCU, place the jumper on the 2–3 positions.
- To supply power to the TSSEVB externally, plug the voltage converter included in the TSSEVB kit to the board's barrel connector. When using the external power supply, the voltage from the USB_BDM is automatically disconnected from the board. Refer to section Section 2.3, "Header and Jumper Connections," for more information about how to configure the jumpers.

2.1.5 Buzzer

TSSEVB provides a piezoelectric speaker connected to the PTA6 pin of the MC9S08LG32 microcontroller. This speaker can be easily used with any touch sensing application.

2.1.6 Clock

TSSEVB uses the Internal Clock Source (ICS) of MC9S08LG32 to provide timing to the board. The ICS module contains a Frequency-Locked Loop (FLL) to increase the bus frequency using the internal clock as reference. For more information on the ICS module, refer to the *MC9S08LG32 Reference Manual* (document MC9S08LG32RM).

2.1.7 LCD

TSSEVB provides a custom LCD with special segments that can be used to represent each of the electrodes featured in the board. Depending on the application, these segments can change their functionality. When running the application demo, the LCD allows you to visualize the performance of the electrodes working along with the TSS. You can use the application demo code provided with the TSSEVB documentation as a guideline to configure and use the LCD on any application. The LCD can display up to 4 characters besides the special segments.

2.1.8 TSSEVB Electrodes

The TSSEVB provides all the decoding structures supported by the Touch Sensing Software, and also provides some special electrodes. The TSSEVB features the following electrodes structures.

- Rotary structure formed by 8 electrodes plus one electrode in the middle of the structure.
- Slider structure formed by 8 electrodes.
- Keyboard structure formed by 6 electrodes.
- 4 electrodes with an LED in the middle.
- 4 multiplexed electrodes.
- 4 electrodes of different sizes for user evaluation.

2.1.9 $\overline{\text{RESET}}$

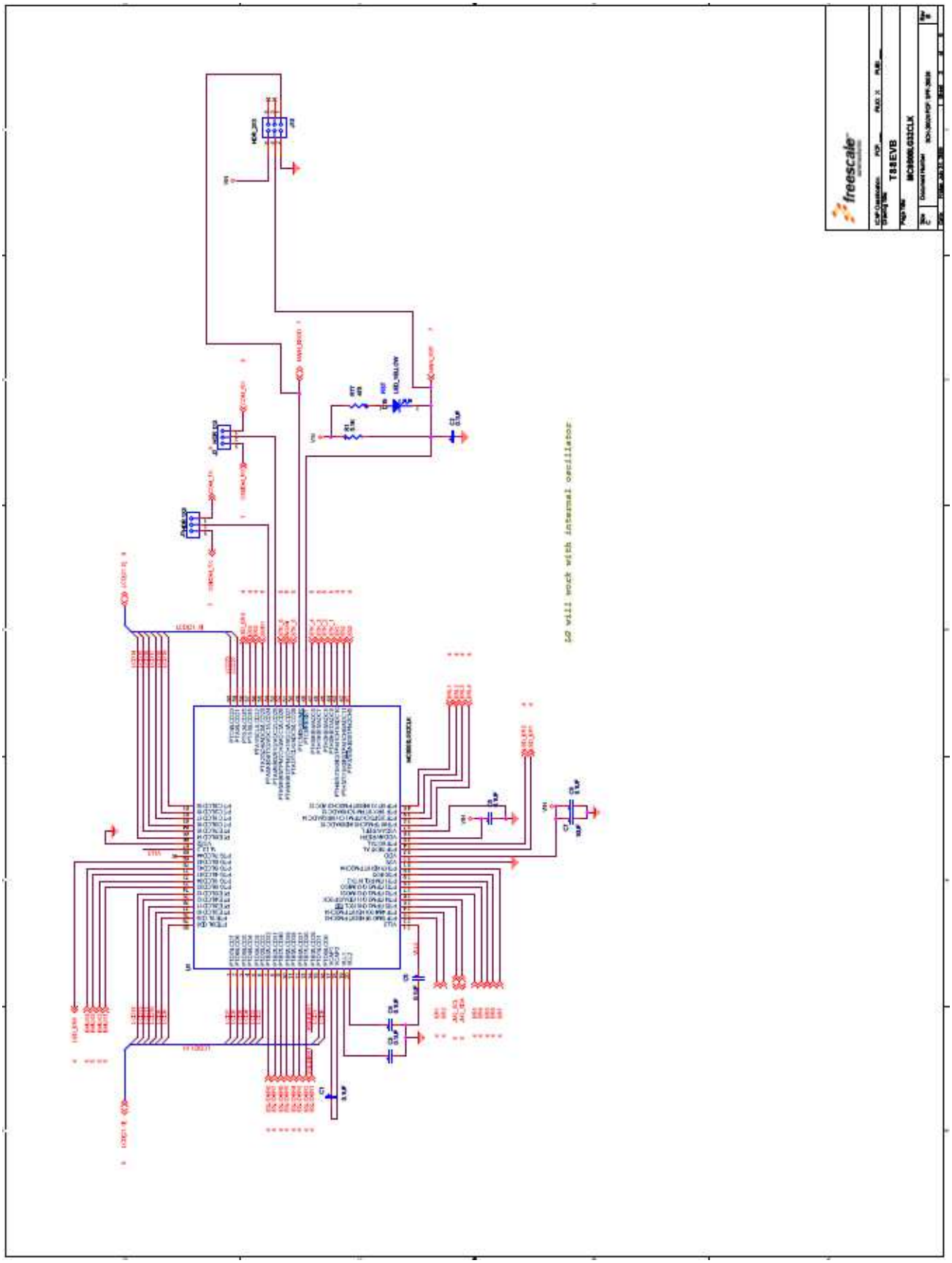
$\overline{\text{RESET}}$ is a dedicated pin with a pull-up device built in. This pin is connected to the 6-pin BDM connector, therefore a development system can directly reset the MCU system. The reset switch (SW10) is active low and provides a way to apply a reset to the MCU. The reset switch is connected directly to the $\overline{\text{RESET}}$ signal of the MC9S08LG32 MCU. A 5.1 kΩ pull-up resistor to V_{DD} on the $\overline{\text{RESET}}$ signal allows normal operation preventing spurious reset detections. When the reset switch is pressed the $\overline{\text{RESET}}$ signal is grounded, and the MCU recognizes a reset.

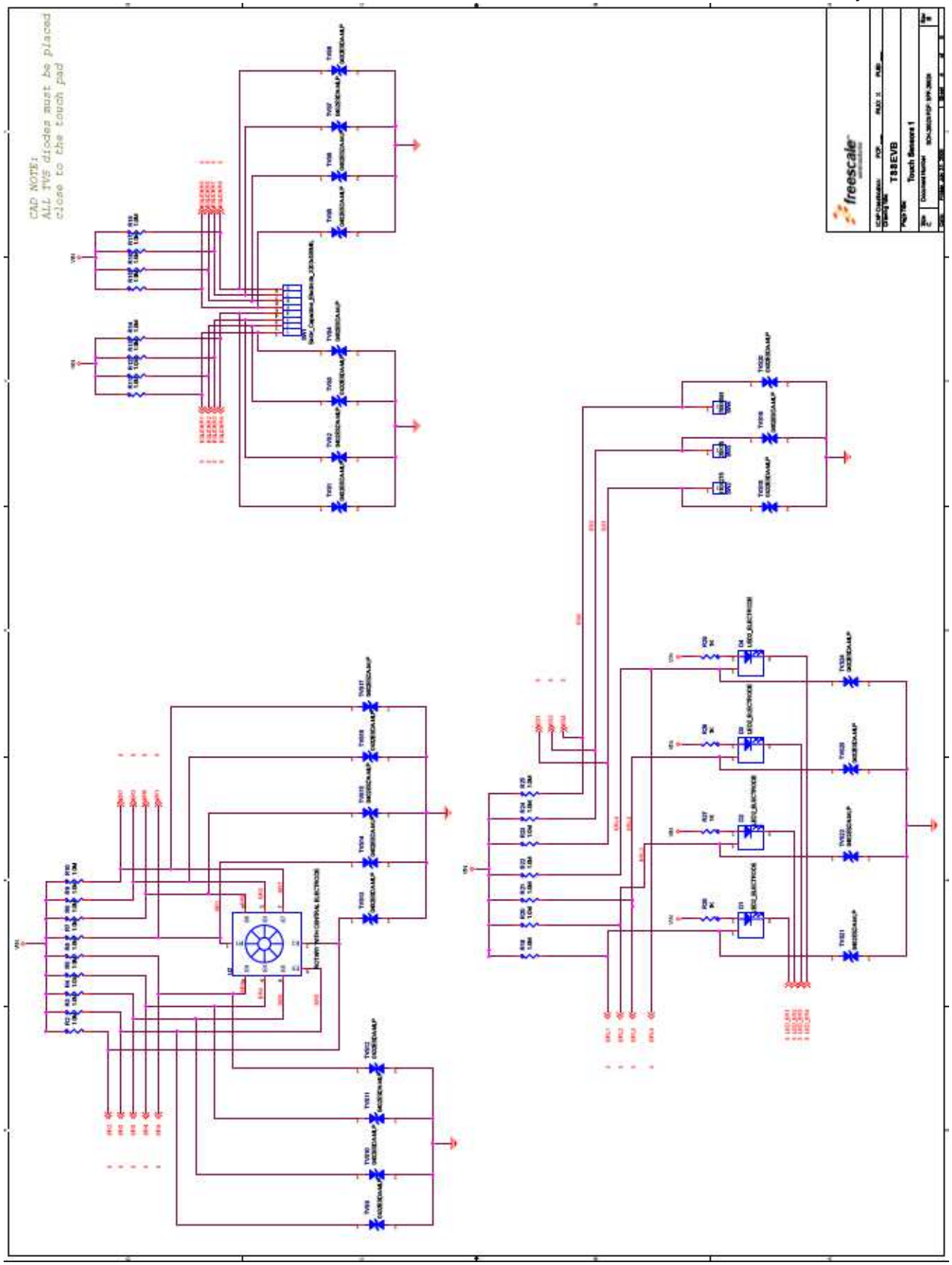
2.1.10 Overlays

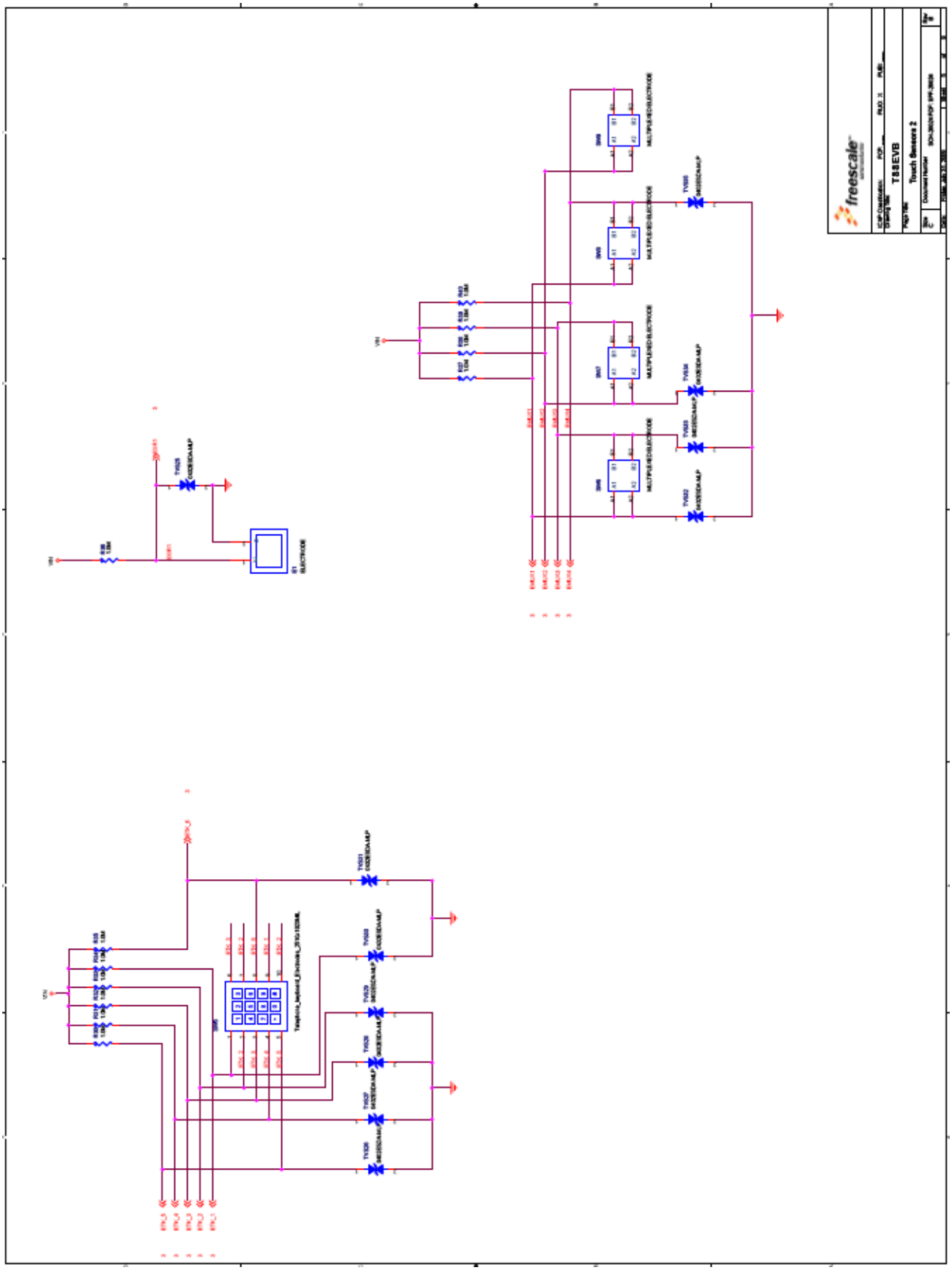
TSSEVB includes two detachable overlays provided by KEE Group. These overlays have an adhesive that can be used to place the overlay over the electrodes. These overlays can be used to test different dielectric constants placed over the electrodes. The overlays can be placed, and removed many times while retaining adherence.

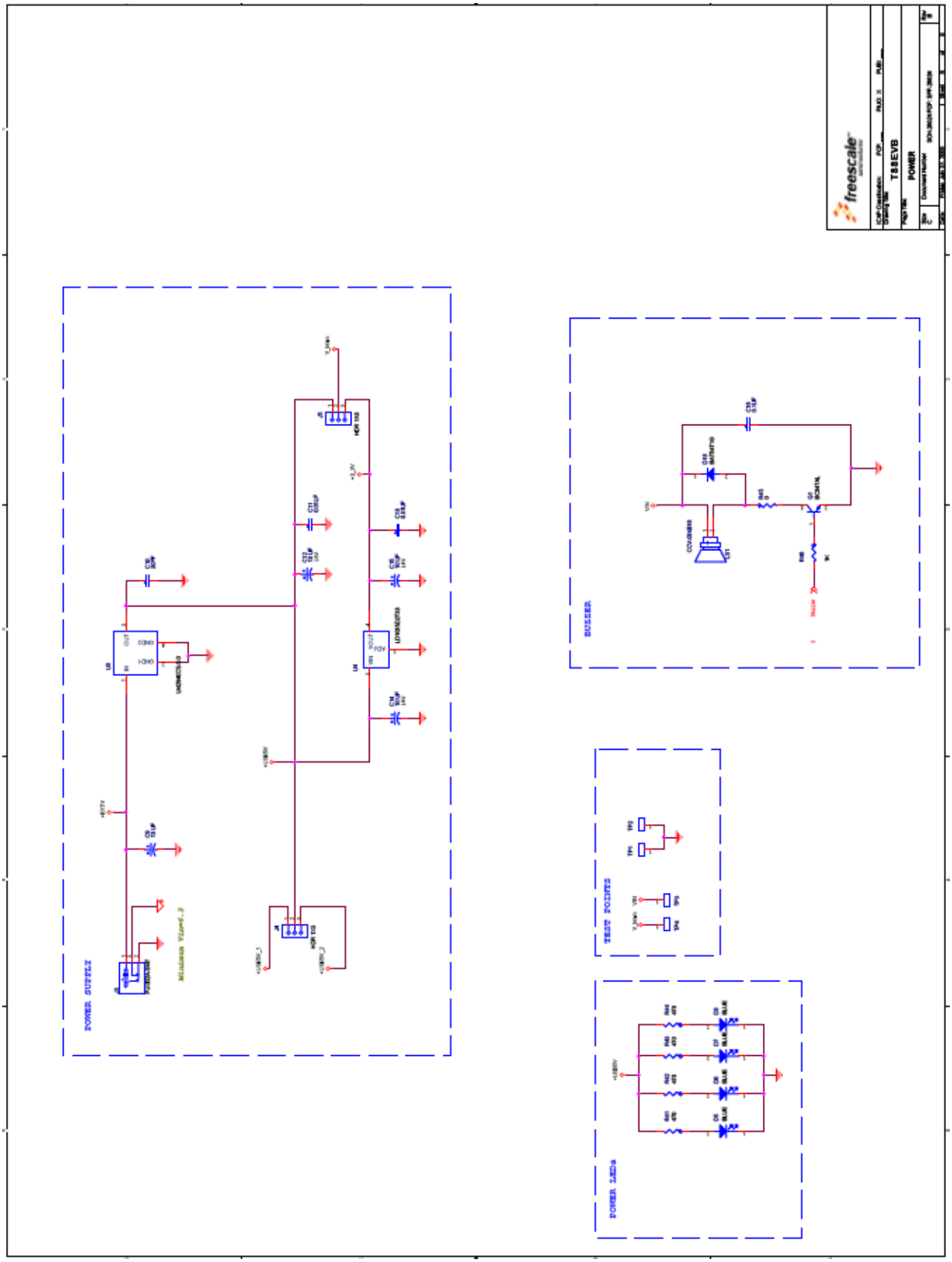
2.2 Schematic and Bill of Materials (BOM)

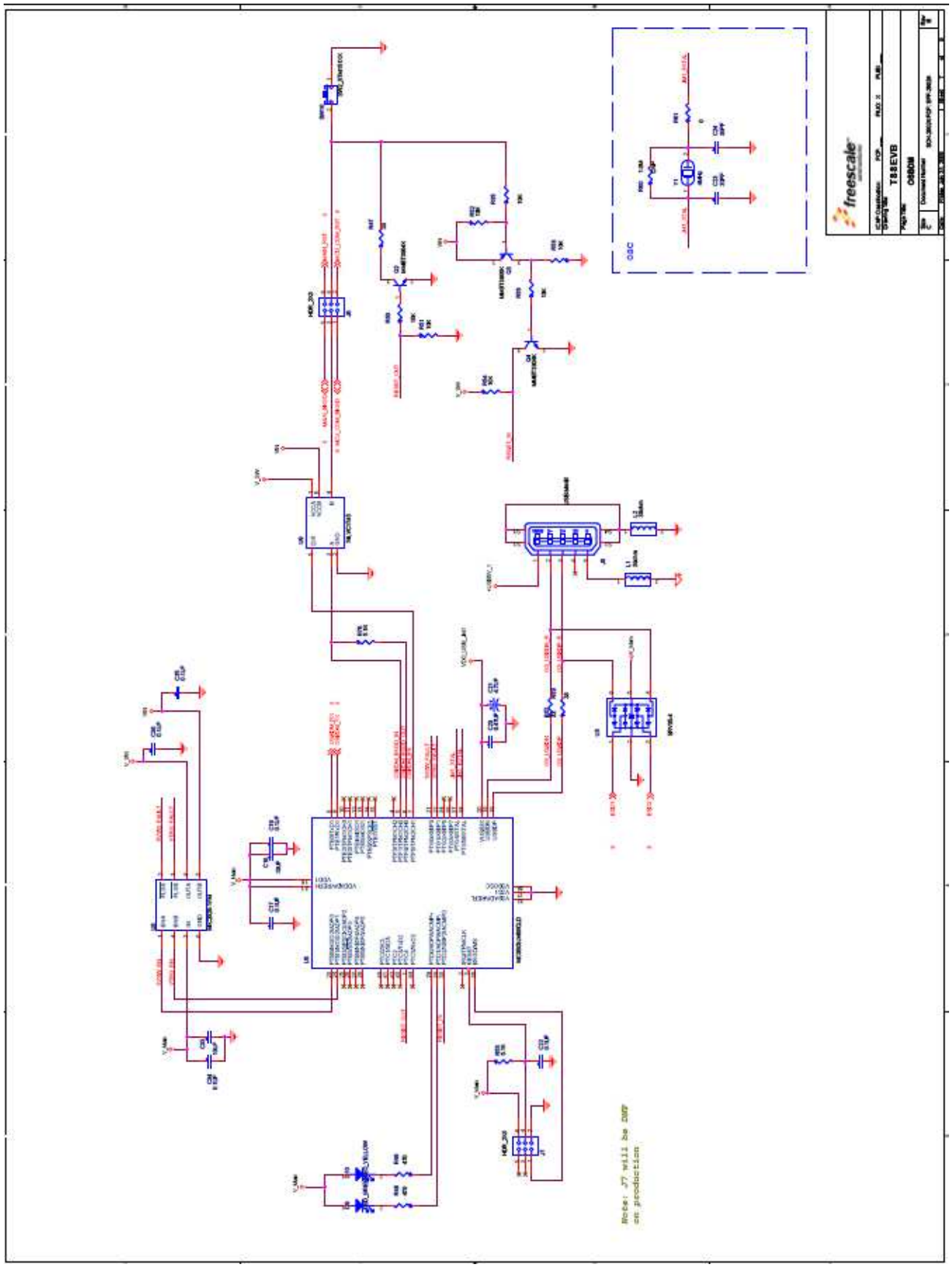
This section contains the 13192-EVB schematic and BOM.

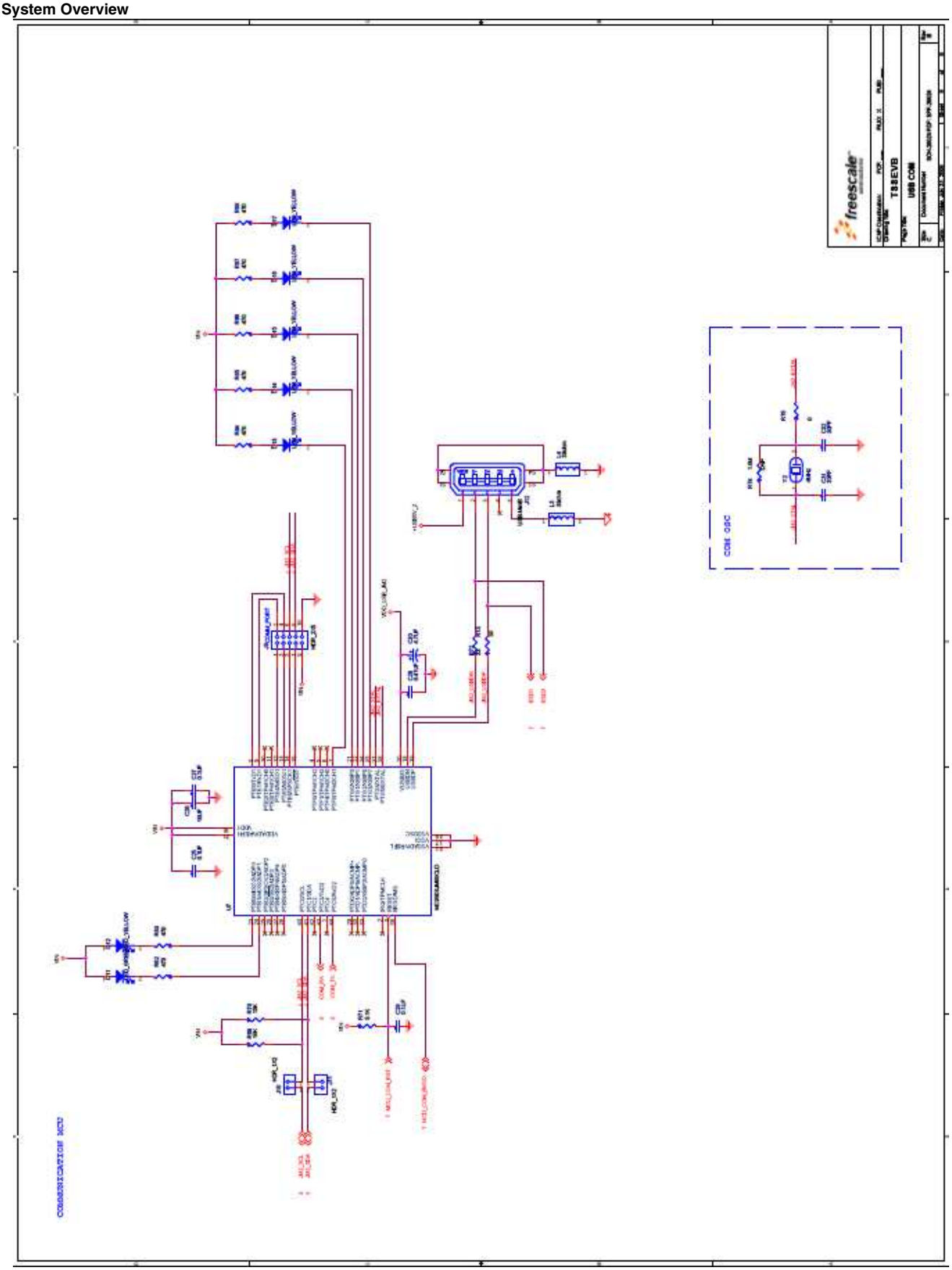


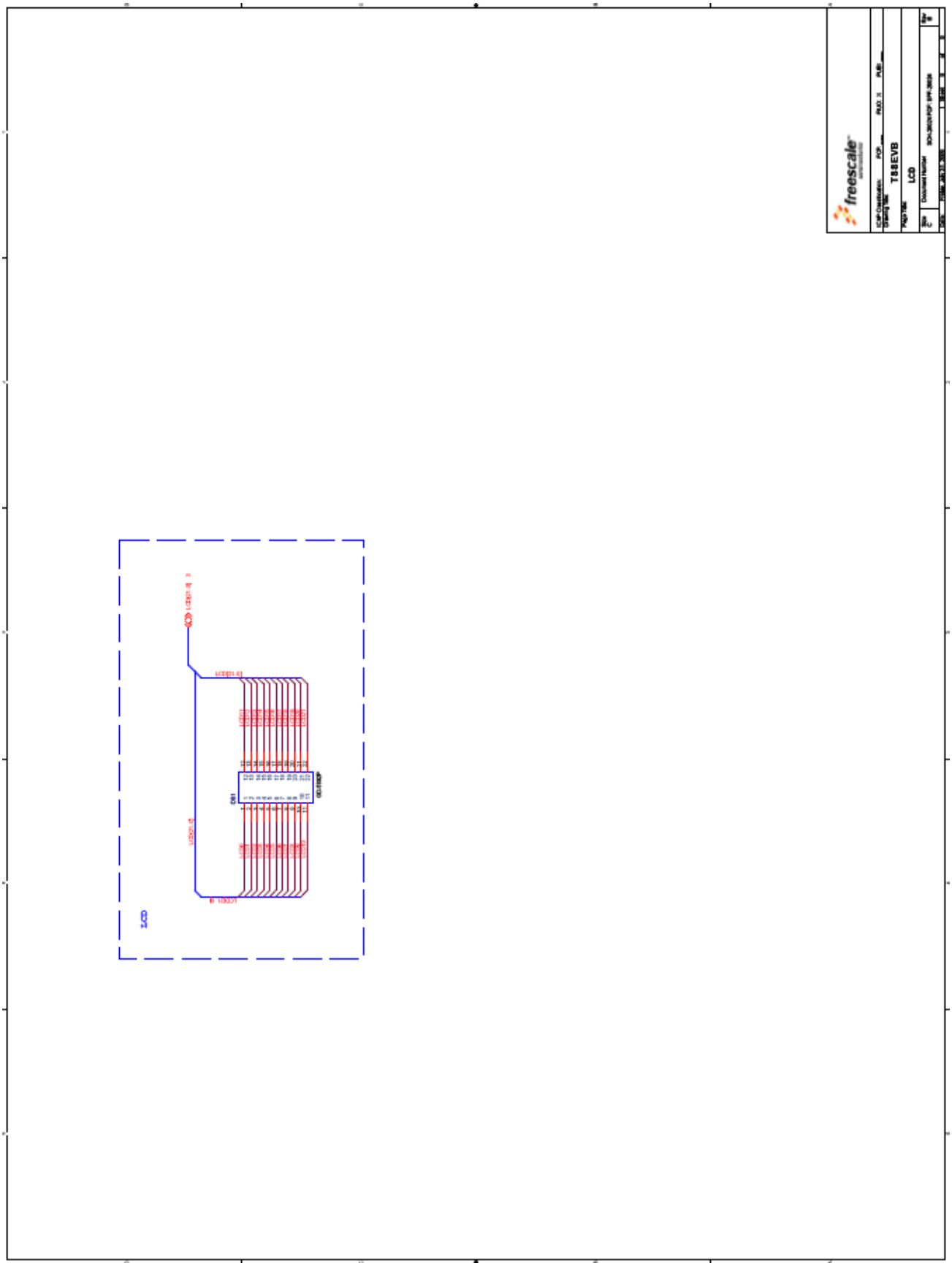

CAD NOTE:
ALL TVS diodes must be placed
close to the touch pad
freescale
T88EVB
Touch Sensors 1




freescale
T88EVB
POWER
BUZZER
TEST POINTS
POWER LEDs


freescale
T88EVB
OSC
Note: J7 will be DNP
on production




freescale
T88EVB
LCD

2.2.1 TSSEVB Bill of Materials

Table 2-2. TSSEVB Bill of Materials

Item	BOM.Qty	Manufacturers.Mfr. Name	Manufacturers.Mfr. Part Number	BOM.Ref Des
1	4	NIC COMPONENTS CORP	NTC-T106M16TRAF	C9,C12,C14,C15
2	17	KEMET	C0603C104K3RAC	C1,C2,C3,C4,C5,C6,C8,C16,C17,C19,C22,C25,C27,C29,C34,C35,C36
3	2	KEMET	C0603C474K4PAC	C20,C28
4	4	PANASONIC	ECJ1VB0J106M	C7,C18,C26,C33
5	2	KEMET	C0805C103KARACTU	C11,C13
6	2	AVX	TACL475K010R	C21,C30
7	5	AVX	06033A300KAT2A	C10,C23,C24,C31,C32
8	4	PANASONIC	EXCML20A390U	L1,L2,L3,L4
9	4	KEYSTONE ELECTRONICS	5005	TP1,TP2,TP3,TP4
10	4	SAMTEC	TSM-103-01-S-SV	J1,J2,J4,J5
11	1	SAMTEC	TSM-105-01-S-DV-A-P	J9
12	3	SAMTEC	TSM-103-01-S-DV-P-TR	J6,J7,J13
13	2	SAMTEC	TSM-102-01-SM-SV-P-TR	J10,J11
14	1	CUI STACK	PJ-002A-SMT	J3
15	2	MOLEX	0675031340	J8,J12
16	2	ABRACON CORP	ABLS-4.000MHZ-B2-T	Y1,Y2
17	1	TEXAS INSTRUMENTS	SN74LVC1T45DBVR	U9
18	1	MICREL	MIC2026-1YM	U8
19	2	FREESCALE SEMICONDUCTOR	MC9S08JM60CLD	U5,U7
20	1	NATIONAL SEMICONDUCTOR	LM2940CS-5.0/NOPB	U3
21	1	ST MICROELECTRONICS	LD1085D2T33R	U4
22	1	FREESCALE SEMICONDUCTOR	MC9S08LG32CLK	U1
23	4	LITE ON	LTST-C190TBKT	D5,D6,D7,D8
24	2	KINGBRIGHT	AP1608MGC	D9,D11
25	8	KINGBRIGHT	AP1608SYCK	D10,D12,D13,D14,D15,D16,D17,D19
26	1	S-TEK INC	GD-5892P	DS1
27	4	KOA SPEER	RK73H1JTTD5101F	R1,R53,R71,R76

Table 2-2. TSSEVB Bill of Materials (continued)

Item	BOM.Qty	Manufacturers.Mfr. Name	Manufacturers.Mfr. Part Number	BOM.Ref Des
28	9	KOA SPEER	RK73B1JTTD103J	R50,R51,R52,R54,R55,R56,R58,R69,R70
29	5	VENKEL COMPANY	CR0603-10W-102JT	R26,R27,R28,R29,R46
30	3	BOURNS	CR0805-J/-000ELF	R45,R61,R75
31	35	BOURNS	CR0603-JW-105ELF	R2,R3,R4,R5,R6,R7,R8,R9,R10,R11,R12,R13,R14,R15,R16,R17,R18,R19,R20,R21,R22,R23,R24,R25,R30,R31,R32,R33,R34,R35,R36,R37,R38,R39,R40
32	5	VISHAY INTERTECHNOLOGY	CRCW060333R0JNEA	R47,R57,R59,R72,R73
33	14	VENKEL COMPANY	CR0603-10W-471JT	R41,R42,R43,R44,R48,R49,R62,R63,R64,R65,R66,R67,R68,R77
34	1	ON SEMICONDUCTOR	BC847ALT1G	Q1
35	1	SEMTECH CORP	SRV05-4.TCT	U6
36	1	VISHAY INTERTECHNOLOGY	BAT54W-V-GS08	D18
37	2	FAIRCHILD	MMBT3904K	Q2,Q4
38	1	FAIRCHILD	MMBT3906K	Q3
39	1	CUI STACK	CCV-084B16	LS1
40	1	E SWITCH	TL1015BF160QG	SW10
41	1	LITE ON	LTST-C230TBKT	—

2.2.2 TSSEVB Silk Screen

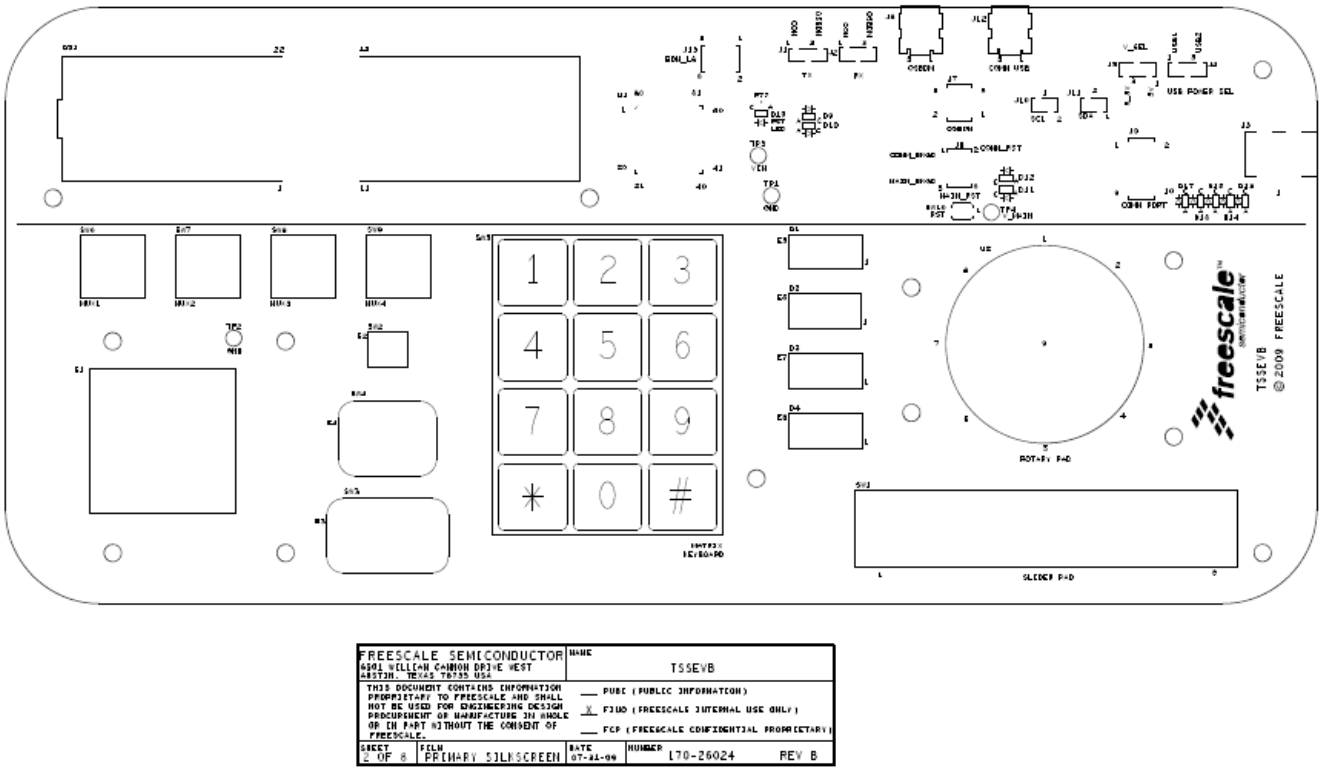


Figure 2-3. TSSEVB Silk Screen

2.3 Header and Jumper Connections

2.3.1 USB Power Selection

1. To supply power to the TSSEVB with the USB OSBDM source, place the jumper on 1–2 position.

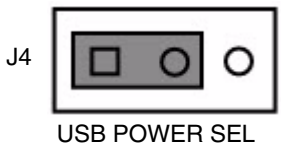


Figure 2-4. Jumper Placement for USB OSBDM Source

2. To supply power to the TSSEVB with the USB COMM source, place the jumper on 2–3 position.

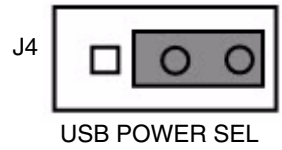


Figure 2-5. Jumper Placement for USB COMM Source

2.3.2 External Power Supply

External power supply can be applied to J3. A minimum of 6.25 V must be applied. When J3 is plugged, the USB power options are disabled.

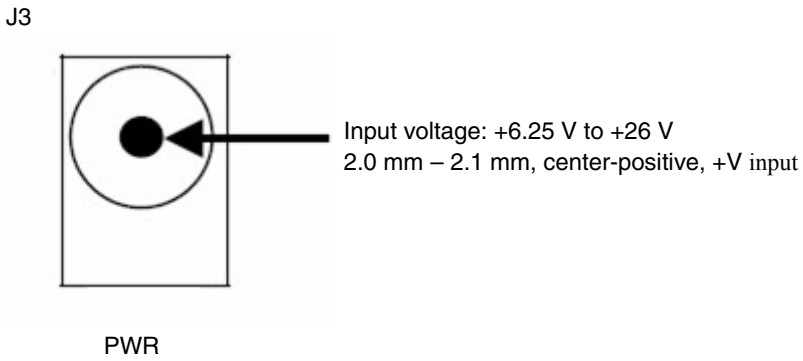


Figure 2-6. Jumper Placement for External Power Supply

2.3.3 Voltage Selection

The system can be operated at 5 V or 3.3 V. Place a jumper on J5 for voltage selection.

1. To supply 5 V to the TSSEVB, place the jumper on 1–2 position.

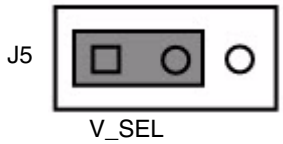


Figure 2-7. Jumper Placement for 5 V

2. To supply 3.3 V to the TSSEVB, place the jumper on 2–3 position.

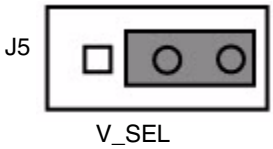


Figure 2-8. Jumper Placement for 3.3 V