Stellaris® Ethernet-Enabled Intelligent Display Module (IDM) Reference Design Kit

User's Manual

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Table of Contents

List of Figures

List of Tables

C H A P T E R   1

Stellaris® Ethernet-Enabled Intelligent Display Module

The Stellaris Intelligent Display Module (IDM) Reference Design (RDK-IDM) is a compact QVGA touch-panel module for automation and instrumentation applications. The design is based on the Stellaris® LM3S6918 microcontroller; a highly integrated controller incorporating a 32-bit ARM® Cortex™-M3 core.

A key feature of the standard IDM is the Power over Ethernet (PoE) power system that facilitates both network and power connections with a single CAT5 cable. 10/100 Ethernet capability connects the IDM to an array of networks—from dedicated industrial networks to the internet. The IDM example software application includes source code for an embedded web server. In addition to the POE-equipped IDM included in the RDK, there is also an IDM28 available. IDM28 has an identical feature set, including 10/100baseT Ethernet, but without the Power over Ethernet capability. Users should start development with the standard RDK-IDM and transition to MDL-IDM28 for production if PoE is not required.

Development of software for the RDK-IDM is simplified by using the StellarisWare® comprehensive graphics library and ARM development tools from our tools partners. The IDM Reference Design Kit includes the touch panel module (MDL-IDM), a documentation CD, power supply, and cables.

This user's manual provides comprehensive information on the reference design hardware and software.

Figure 1-1.   Intelligent Display Module
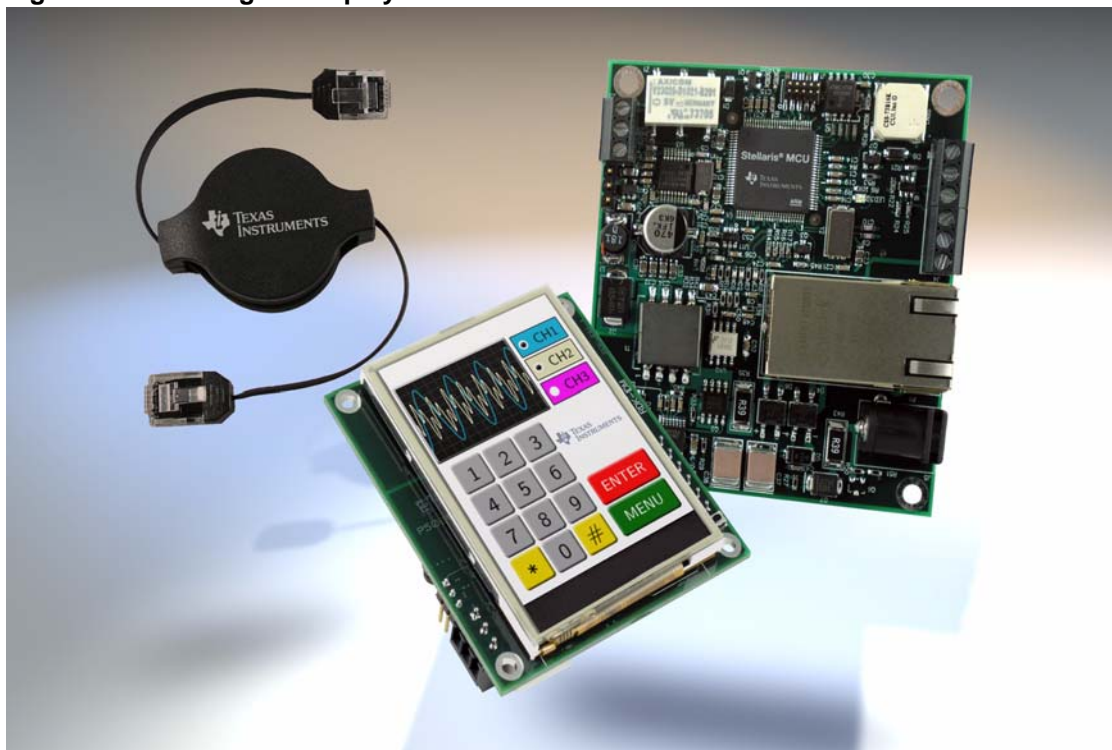
Kit Contents

The RDK-IDM reference design kit supports both the MDL-IDM and the MDL-IDM28, and comes with the following:

- MDL-IDM Intelligent QVGA Touch Panel with Ethernet
- Power supply
  - 24 V/15 W
  - Plug adaptors for US, UK, EU, and Australia
- Retractable Ethernet cable
  - 10/100baseT
- Debug adapter
  - Adapts 10-pin fine-pitch ARM JTAG connector to standard 20-pin connector
- Reference Design Kit CD
  - Complete documentation, including Quickstart and User's Guides
  - Graphical User Interface (GUI) installer
  - Complete source code, schematics, and PCB gerber files

The source code can be modified and compiled using any of the following tools:

- Keil™ RealView® Microcontroller Development Kit (MDK-ARM)
- IAR Embedded Workbench
- Code Sourcery GCC development tools
- Code Red Technologies development tools
- Texas Instruments' Code Composer Studio™ IDE

Using the RDK

The recommended steps for using the RDK are:

- **Follow the Quickstart guide included in the kit.** The Quickstart guide will help get the display module up and running in minutes.

- **Use your preferred ARM tool-chain and the Stellaris Graphics library to develop a touch-panel application.** Software applications are loaded into IDM flash memory using a JTAG/SWD debug interface. See Chapter 3, "Software Development," for the programming procedure. The *Stellaris Graphics Library Software Reference Manual* and the *Stellaris Peripheral Driver Library Software Reference Manual* each contain specific information on software structure and function.

- **Customize and integrate the hardware to suit an end application.** This user's manual is an important reference for understand circuit operation and completing hardware modification.

Board Overview

Figure 1-2 shows an overview of the board.

Figure 1-2.   IDM Board Overview Diagram
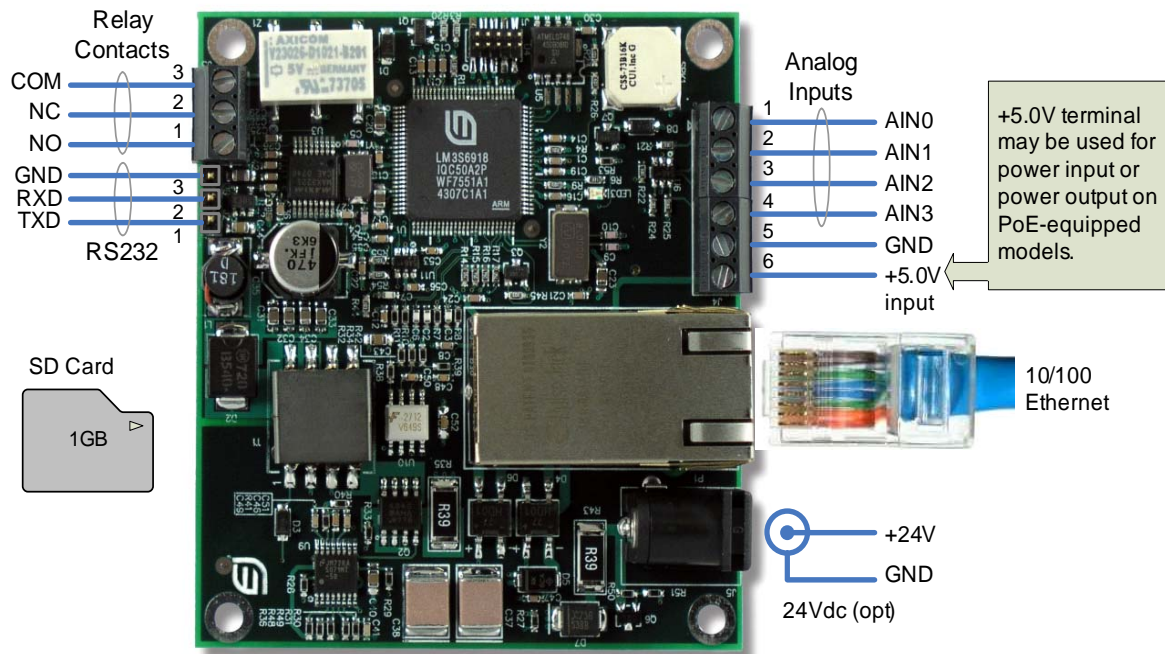
Hardware Description

The IDM design uses a Stellaris® LM3S6918 microcontroller to handle display functions, touch-screen control, networking, and peripheral functions. Only a few additional ICs are needed to complete the design. The entire circuit is built on a compact four-layer printed circuit board. All design files are provided on the RDK-IDM CD.

Block Diagram

Figure 2-1 shows the IDM block diagram.

Figure 2-1.   Intelligent Display Module Block Diagram
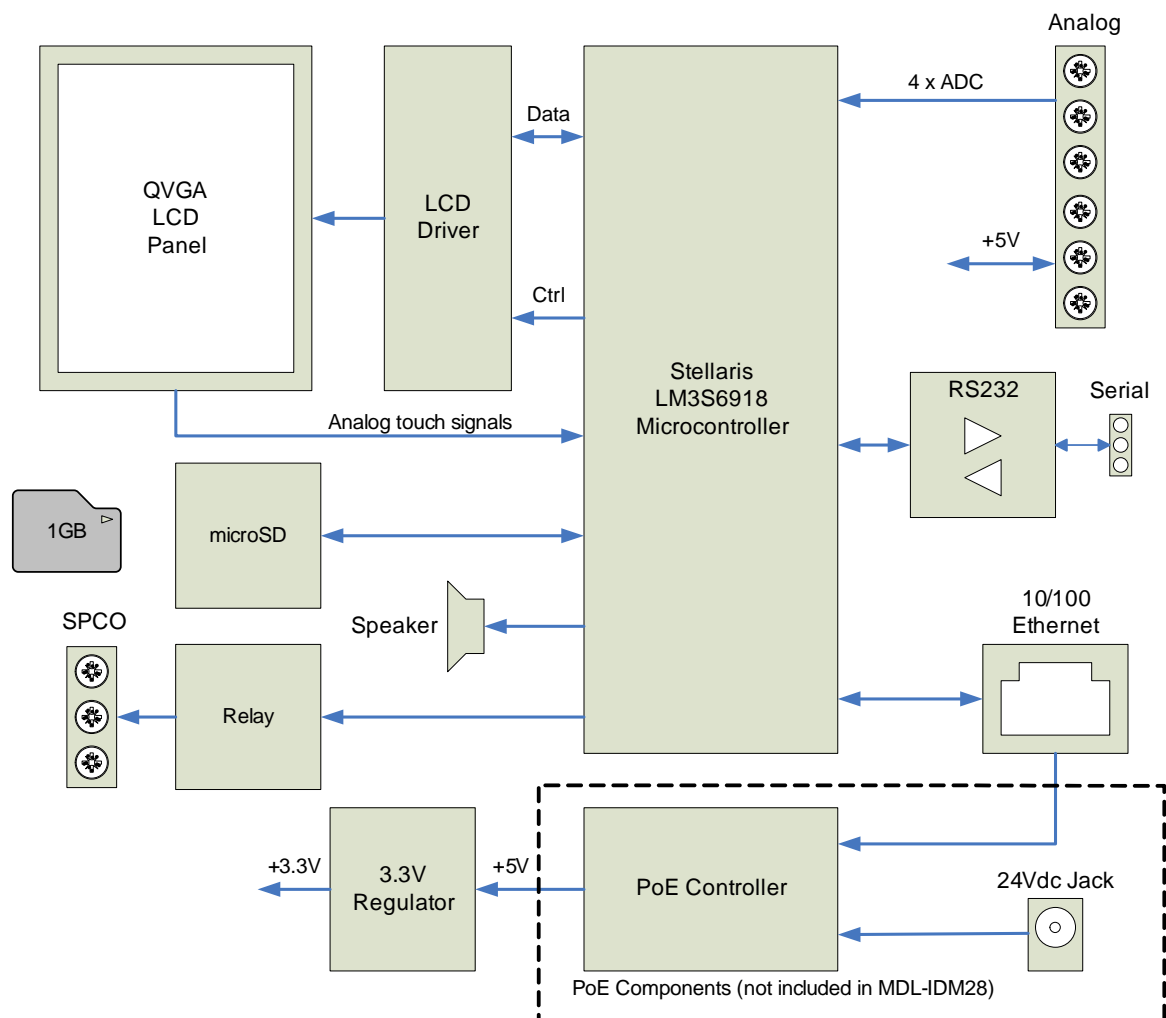
Functional Description

This section describes the IDM's hardware design in detail.

Microcontroller and Networking (Schematic page 1)

Page 1 of the schematics details the microcontroller, Ethernet, and debug interfaces.

Microcontroller

At the core of the IDM is the Stellaris LM3S6918 microcontroller with integrated Ethernet MAC and PHY. The Stellaris microcontroller operates at up to 50 MHz using an internal PLL.

The LM3S6918 microcontroller has an internal LDO voltage regulator that supplies 2.5 V power for internal use. This rail requires only three capacitors for decoupling and is not connected to any other circuits.

A reset switch and R-C network connect to the microcontroller's RSTn input. An external reset circuit is not required by the LM3S6918 microcontroller, so the R-C components simply serve to filter any noise on the reset line.

Debugging

The microcontroller supports JTAG and SWD debugging as well as SWO trace capabilities. To minimize board area, the RDK uses a 0.050" pitch header which matches ARM's fine-pitch definition (Figure 2-2). Some in-circuit debuggers provide a matching connector. Other debuggers can be used with the ADA1 adaptor board included in the RDK.

Figure 2-2.   Debug Connection Pinout
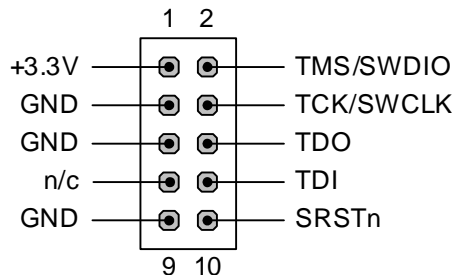
Ethernet

The Ethernet jack (P1) integrates a RJ-45 connector, Ethernet magnetics, surge suppression, and additional pins for Ethernet power connection. The jack supports power over the two unused CAT-5 pairs as well as the signal pairs. The Power over Ethernet (PoE) circuit is covered on page 3 of the schematic.

A single LED provides Ethernet link and traffic information. Refer to the LM3S6918 microcontroller data sheet for information on the display modes for this LED. The schematic and PCB have provision for an LED to be mounted on the LCD side of the display. This capability would allow a short light-pipe to provide front-panel display of Ethernet traffic.

LCD Panel and Peripherals (Schematic page 2)

Page 2 of the schematics contains the LCD panel connections, serial communication, relay, speaker, analog inputs, and a microSD card slot.

LCD Panel

The LCD panel (U2) is a 2.8" TFT panel with an integrated controller (ILI9320). The display memory resides in the LCD panel, allowing the microcontroller to access the panel as a peripheral. The LCD panel requires only a 3 V power supply which also simplifies system design.

A 16-bit data path is used to improve access rates. Only two control lines (RDn, WRn) are required for reading and writing to the panel. A third signal (RS) selects between memory and control register access. In order to meet reset signal timing requirements. The microcontroller also controls the panel's reset signal (RSTn).

The LCD panel incorporates a white LED backlight which is controlled by the microcontroller using PC6/CCP3 and MOSFET Q3. Most applications will use backlighting at full brightness by setting GPIO PC6 HIGH. Because the forward voltage of each LED is typically 3.5 V, the 75Ω resistors set LED current to 20mA for a total panel current of 80mA.

For additional LCD panel information, refer to the data sheets on the RDK-IDM CD and LCD driver source code in the StellarisWare Graphics library.

Touch Panel

Four ADC channels and four GPIO lines connect directly to the resistive touch panel, allowing the microcontroller to manage all aspects of operation.

X and Y axis position measurements are made independently.

For X-axis measurement, GPIO pins PC4 and PC5 are set HIGH and LOW respectively to form a resistor divider between 3 V and 0 V. The voltage on ADC6 and ADC7 indicates the X-axis position.

To measure the Y-axis position, PD0 and PD1 are set HIGH and LOW respectively and the voltage on ADC4 or ADC5 is measured.

Software controls calibration and finger press detection functions.

RS232 Serial Port

The MAX2331 (U3) line transceiver interfaces between UART 1 and the RS232 port pins. The transceiver incorporates a power saving feature that turns off its internal power supply if a valid RS232 level is not present on its receive pin. This feature should be considered if connecting to a device other than a PC serial port.

Relay

A single-pole, double-throw relay is available for general-purpose use. When connecting an external load, do not exceed the ratings listed in the MDL-IDM data sheet. If an inductive load is used and powered from a DC source, a flywheel diode should be connected across the load to reduce arcing as the relay switches off.

Analog Inputs

Four analog inputs add measurement capability to the IDM. Refer to the MDL-IDM data sheet for electrical limits for these inputs. A transient voltage suppressor (U6) adds electrostatic discharge (ESD) protection.

Audio Transducer

SPK1 is a small magnetic audio transducer which is driven by PC7/CCP4 through a small power MOSFET. CCP4 can be configured to generate a free running tone at the required frequency. Note that the audio transducer is polarized.

MicroSD Card Slot

Standard microSD media may be used for image or data storage. The SD card is wired for use in SPI mode, rather than the 1-bit or 4-bit SD modes.

Power Supplies (Schematic page 3)

The third schematic page contains the complete Power over Ethernet (PoE) power supply circuit.

PoE Operation (applies to MDL-IDM only)

PoE (IEEE 802.3af) is a specification for supplying 48 V at up to 15 W to a device over a standard CAT5 cable. The IDM can operate in Mode A, where power is received from Ethernet signal lines, or in Mode B, where power is received from the unused signal pairs.

All PoE signaling, including device class identification, is handled by an LM5071 controller. Implementation of the 802.3af standard does not require software or Ethernet transactions.

The PoE controller's under-voltage lock-out circuit prevents the IDM from operating at less than 35 V. In order to support an alternative 24 Vdc power source, a simple circuit using transistor Q6, changes the under-voltage lock-out to around 12 V when a local supply is present.

The IDM's PoE circuit is fully isolated to 250 Vdc. The voltage potential between the Ethernet signals and GND on the module must not exceed this limit under both normal and fault conditions.

The PoE switching power supply generates 5 Vdc power for backlighting, audio transducer, and the relay. A 5 Vdc power output is available on the terminal block for powering external sensors. A 3.3 V LDO voltage regulator provides microcontroller and digital circuit power.

+5 V Operation (applies to MDL-IDM28 only)

MDL-IDM28 does not support PoE operation. Instead, an external +5 V supply must be provided to the terminal block (see Figure 1-2 on page 9). The power supply should provide +5 V ±5% at 300 mA.

CHAPTER 3

Software Development

This chapter provides general information on software development as well as instructions for Flash memory programming.

Software Description

The software provided with the IDM provides access to all of the peripheral devices supplied in the design. The Stellaris Peripheral Driver Library is used to operate the on-chip peripherals, the Stellaris Graphics Library is used to render graphical displays on the touch screen, and a set of board-specific drivers are provided to access the off-chip functionality on the IDM.

The Stellaris Graphics Library provides two levels of support for rendering graphical elements. In the lowest level, basic drawing primitives are provided, such as lines, circles, rectangles, and text rendering. Each primitive supports clipping to a single clipping rectangle, allowing only a portion of the display to be affected by the drawing primitives. Building upon the drawing primitives is a widget set, which combines the drawing of graphical elements with reactions to pointer events (in this case, presses on the touch screen). The widget set includes push buttons, check boxes, radio buttons, and drawing canvases. By using the widget set, complex interactive graphical displays can be constructed quickly.

A set of drivers for the on-board peripherals is also provided. This includes a driver for the touch screen, the audio transducer, the relay, the analog inputs, and the MicroSD card. Since the PoE signaling is handled entirely in hardware and, therefore, imposes no requirements upon the software, any of the TCP/IP stacks that support the Stellaris Ethernet interface can be used on the module.

The IDM is also supplied with a set of example applications that utilize the Stellaris Peripheral Driver Library and the Stellaris Graphics Library, along with the board-specific drivers for the on-board peripherals. These applications demonstrate the capabilities of the IDM, and provide a starting point for the development of the final application for use on the IDM. All example applications are integrated with the Stellaris boot loader to allow automatic firmware updates to be performed over Ethernet using the LM Flash Programmer application.

Source Code

The complete source code for the IDM is included on the RDK-IDM CD. Refer to the Quickstart Guide for a detailed description of initial RDK hardware set up and how to install the source code. The source code and binary files are installed in the DriverLib tree.

Tool Options

The source code installation includes directories containing projects and/or makefiles for the following tool-chains:

- Keil™ RealView® Microcontroller Development Kit (MDK-ARM)
- IAR Embedded Workbench
- Code Sourcery GCC development tools
- Code Red Technologies development tools
- Texas Instruments' Code Composer Studio™ IDE

Evaluation versions of these tools may be downloaded from www.ti.com/stellaris. Note that, due to code size restrictions, the evaluation tools may not build all example programs for the IDM. A full license is necessary to re-build or debug all examples.

Instructions on installing and using each of the evaluation tools can be found in the Quickstart guides (for example, Quickstart-Keil, Quickstart-IAR) which are available for download from the evaluation kit section of our web site at www.ti.com/stellaris.

For detailed information on using the tools, refer to the documentation included in the tool chain installation or visit the website of the tools supplier.

Programming the IDM

The IDM software package includes pre-built binaries for each of the example applications. If you installed DriverLib to the default installation path of C:/DriverLib, you can find the example applications for the IDM in "C:/DriverLib/boards/rdk-idm".

The LM Flash Programmer is a free tool for programming Stellaris microcontrollers. It can be used in two modes to update the firmware on the IDM. All IDM example applications are designed for use with the Stellaris boot loader which supports updating of the main application firmware over Ethernet. Alternatively, the LM Flash Programmer utility can be used in conjunction with any Stellaris evaluation board to program the IDM. The Stellaris evaluation board acts as a USB-to-JTAG/SWD hardware interface and should be used in cases where the boot loader image is not present or where the main application image is not behaving correctly and cannot receive the Ethernet signal telling it to transfer control to the boot loader. However, in normal operation, it is more convenient to program via Ethernet.

To program example applications into the IDM using the Ethernet-based firmware update:

1. Install the LM Flash Programmer utility on a Windows PC.

2. Ensure that the IDM is connected to the same subnet of your Ethernet as the Windows PC that will be used to program the device.

3. Apply power to the IDM.

4. Run LM Flash Programmer.

5. In the Configuration tab, select "Manual Configuration - see below" in the "Quick Set" list.

6. Select "Ethernet Interface" in the list below "Interface" and fill in the IP and MAC addresses for the IDM you are trying to program. Each example application shows this information somewhere on the IDM display. Note that it may take several seconds for the IP address to be allocated.

7. If your PC has multiple network adapters, select the appropriate adapter in the "Ethernet Adapter" list.

8. Move to the Program tab and click the Browse button. Navigate to the example applications directory (the default location is "C:/DriverLib/boards/rdk-idm/").

9. Each example application has its own directory. Navigate into the example directory that you want to load and then go to the /gcc directory which contains the binary (*.bin) files. Select the application binary file and click Open. Files that start with a "bl_" prefix are boot loader images and cannot be updated using this method.

10. Click the Program button to start the download process.

11. The program starts once the download is complete.

To replace the boot loader image or to program example applications into the IDM using a Stellaris evaluation board to provide JTAG/SWD functionality:

1. Install LM Flash Programmer on a Windows PC.

2. Connect the 10-pin to 20-pin adapter (included in the RDK) to the evaluation board ribbon cable. This converts the standard 20-pin ARM header on the evaluation board to a fine pitch ARM header.

3. Carefully connect the socket of the adaptor board to J1 on the IDM.

4. Apply power to the IDM and connect the evaluation board (available separately) to a USB port.

5. Run LM Flash Programmer.

6. In the Configuration Tab use the Quick Set control to select LM3S6965. These settings are compatible with the LM3S6918 implementation on the IDM.

7. Move to the Program Tab and click the Browse button. Navigate to the example applications directory (the default location is "C:/DriverLib/boards/rdk-idm/).

8. Each example application has its own directory. Navigate into the example directory that you wish to load and then into the /gcc directory which contains the binary (*.bin) files. Files named with a "bl_" prefix are Stellaris boot loader images while those without the prefix are main application images. Select the binary file and click Open.

9. Set the "Erase Method" to "Erase Necessary Pages" and check the "Verify After Program" box.

NOTE: Setting "Erase Entire Flash" when attempting to replace a main application image will erase the boot loader image and result in a hang when the IDM next boots. If this occurs, reflash a boot loader image using these instructions.

10. If flashing a boot loader image, set the "Program Address Offset:" value to 0x0000. If programming a main application image, set this value to 0x1000.

11. Next, click on the Program button to start the Erase, Download, and Verify process.

12. Program execution will start once Verify is complete.

The Debuggers in each of the tool-chains also include Flash programming capabilities, including support for high-performance in-circuit debug interfaces.

The IDM design uses a Stellaris® LM3S6918 microcontroller to handle display functions, touchscreen control, networking, and peripheral functions. Only a few additional ICs are necessary to complete the design. The entire circuit is built on a compact four-layer printed circuit board. All design files are provided on the RDK-IDM CD.
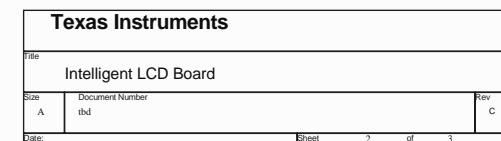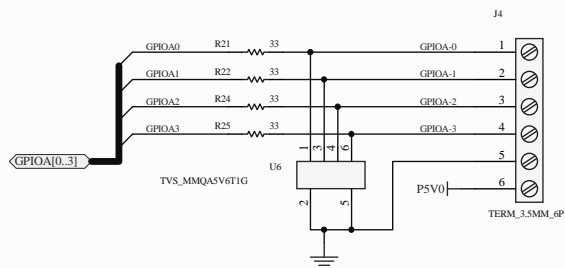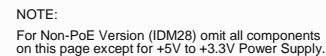
APPENDIX A

Schematics

This sections contains the schematic diagrams for the Intelligent Display Module.

- IDM Microcontroller and Networking on page 20
- IDM LCD Panel and Peripherals on page 21
- IDM Power over Ethernet Circuit on page 22

Stellaris Microcontroller

U1

LCD_DB8	26	PA0/U0RX
LCD_DB9	27	PA1/U0TX
LCD_DB10	28	PA2/SSI0CLK
LCD_DB11	29	PA3/SSI0FSS
LCD_DB12	30	PA4/SSI0RX
LCD_DB13	31	PA5/SSI0TX
LCD_DB14	32	PA6/CCP1
LCD_DB15	33	PA7/I2C1SDA

PB0/CCP0	66	LCD_DB0
PB1/CCP2	67	LCD_DB1
PB2/I2S0SCL	70	LCD_DB2
PB3/I2C0SDA	71	LCD_DB3
PB4/C0-	92	LCD_DB4
PB5/C1-	91	LCD_DB5
PB6/C0+	90	LCD_DB6
PB7/TRST	89	LCD_DB7

P3V3

R1 10K

LCD_DB[0..15]

Debug

P3V3
R3 10K R4 10K

J1
CON-HDR-2X5-050_0

Reset
SW1
KMR221GLFS
(bottom side)

C1 0.1UF

TCK/SWCLK	80	PC0/TCK/SWCLK
TMS/SWDIO	79	PC1/TMS/SWDIO
TDI	78	PC2/TDI
TDO	77	PC3/TDO/SWO
TOUCH_XP	25	PC4/CCP5
TOUCH_XN	24	PC5/C1+/C0o
LCD_BL	23	PC6/CCP3
SOUND	22	PC7/CCP4

PD0	10	TOUCH_YP
PD1	11	TOUCH_YN
PD2/U1RX	12	RXD
PD3/U1TX	13	TXD
ADC7	95	TOUCH_YN
ADC6	96	TOUCH_YP
ADC5	99	TOUCH_XN
ADC4	100	TOUCH_XP

SSICLK	72	PE0/SSI1CLK
ARD_CS_N	73	PE1/SSI1FSS
SSIRX	74	PE2/SSI1RX
SSITX	75	PE3/SSI1TX

PF0	47	LCD_RD_N
PF1	61	LCD_WR_N
PF2/LED1	60	LCD_RS
PF3/LED0	59	

GPIOA0	1	ADC0
GPIOA1	2	ADC1
GPIOA2	5	ADC2
GPIOA3	6	ADC3

GPIOA[0..3]

| LCD_RST_N | 19 | PG0/I2C1SCL |
| RELAY | 18 | PG1 |

| LM_RST_N | 64 | RST |

| XTALNPHY | 17 | XTALNPHY |
| XTALPPHY | 16 | XTALPPHY |

25MHz Y1

C4 18PF   C5 18PF

8MHz Y2
C9 18PF C10 18PF

| OSC0 | 48 | OSC0 |
| OSC1 | 49 | OSC1 |

| 52 | XOSC0 |
| 53 | XOSC1 |

50	WAKE
51	HIB
65	CMOD0
76	CMOD1

9	GND
15	GND
21	GND
33	GND
39	GND
42	GND
45	GND
54	GND
57	GND
63	GND
69	GND
82	GND
85	GND
86	GND
87	GND
94	GND
4	AGND
97	AGND

LM3S6918

| MDIO | 58 | MDIO |
R9 10K P3V3

TXOP	43	TXOP
TXON	46	TXON
RXIP	40	RXIP
RXIN	37	RXIN

| ERBIAS | 41 | |
R2 12.4K, 1%
P3V3

| AVDD | 3 | AVDD |
| AVDD | 98 | AVDD |

VDD33	8
VDD33	20
VDD33	32
VDD33	36
VDD33	44
VDD33	56
VDD33	68
VDD33	81
VDD33	83
VDD33	84
VDD33	93

C11 0.1UF

12.4K 1% resistor required on Pin 41 for compatibility with future LM3S6918 revisions. See product change notification.

| VBAT | 55 |
| LDO | 7 |

C13 0.01UF C14 0.01UF C15 0.1UF C16 0.1UF C17 4.7UF
P3V3

P2V5

VDD25	14
VDD25	38
VDD25	62
VDD25	88

C18 0.01UF C19 0.1UF C20 4.7UF

R7 49.9, 1% R8 49.9, 1%
C2 10pF C3 10pF
C8 0.1UF

R10 49.9, 1% R11 49.9, 1%
C6 10pF C7 10pF
C12 0.01UF

P3V3

Ethernet PoE 10/100baseT

P1
RJ45_PoE_JK0-0044

ISOLATED

ISOLATED

GL GR

VC2N
VC2P
VC1N
VC1P

Power LEDs
P3V3
LED1 OMIT
R60 330
LED2 (bottom side) Green
LED1

Ethernet LEDs
LED4 (bottom side)
LED3 Green
R6 330
LED0
LED3 OMIT

PF3/LED0

Texas Instruments

Title: Intelligent LCD Board

| Size | Document Number | Rev |
| A | tbd | C |

Date: | Sheet 1 of 3

2.8" TFT LCD Panel

Texas Instruments

Title: Intelligent LCD Board

Size	Document Number	Rev
A	tbd	C

Date: Sheet 2 of 3

microSD Card Slot

24V - 48V

Power Input

PJ-102AH

ISOLATED

V_EXT_IN

R43
0.39 ohm, 1W, 1%

D7
S3BB-13-F

R50
24.9K, 1%

R51
24.9K, 1%

Q6
CMPT5401

C37
4.7uF, 100V

C38
4.7uF, 100V

R27
590K, 1%

R28
24.9K, 1%

D3
MMSD4148

T1
XFMR_C1588-AL

POE_VIN

POE_SEC

D2
MBRS540T3

POE_DC

L1
0.18uH

P5V0

C31
10uF, 6.3V

C32
10uF, 6.3V

C33
10uF, 6.3V

C34
10uF, 6.3V

C35
470UF

C36
0.1UF

R52
OMIT

C1P

D4
HD01

AC1

AC2

C1N

C2P

D6
HD01

AC1

AC2

C2N

D5
SMAJ60A

C47
0.1UF

R49
100K, 1%

R48
200K, 1%

POE_AUX

POE_VCC

POE_VC

POE_PRI

+5V to +3.3V 300mA Power Supply

P3V3

U8
PQ1X331M2ZPH
Vin Vout
Vc   GND   Nr
NR

C42
4.7UF

C45
0.1UF

C41
0.047uF

R31

R30

C40
1.0uF, 16V

R29
20.0, 1%

POE_UVLOC

POE_UVLORTN

POE_UVLO

POE_RSIG

U9
LM5071MT-50
1 VIN   VCC 10
2 RSIG
5 UVLO   OUT   9
6 UVLORTN CS 13
4 AUX
3 RCLASS COMP 12
14 RT   FB 11
15 SS   ARTN 16
7 VEE   RTN   8

POE_VCC

POE_OUT

POE_CS

R33
100, 1%

C46
1000pF

R35
0.39 ohm, 1W, 1%

Q2
Si4848DY

POE_RCLASS

POE_RT

POE_SS

R36
150, 1%

R41
12.4K, 1%

C49
0.047uF

R32

C43
10.0, 1%

C44
1.0uF, 16V

R56
10K

R34
22.1k, 1%

R38
590, 1%

C48
1000pF

POE_C

R39
1.00K, 1%

POE_LED

POE_CMP

C50
OMIT

POE_FB

R42
7.32K, 1%

U10
FOD2712
2 C   LED 8
1 nc1   COMP 6
4 nc4   FB   7
3 E   GND   5

POE_COMP

C51
0.047uF

R40
1.00K, 1%

NOTE:
For Non-PoE Version (IDM28) omit all components
on this page except for +5V to +3.3V Power Supply.

POE_VEE

C52
1500pF, 250V

ISOLATED

History

Rev	Date	Description
0	12/21/07	Prototype release
A	1/10/08	Change to 16 bit LCD IF
B	2/7/08	Change LCD to -F03 Omit C35 & C50 Add R56 & R57 Remove U4 & U5; Add microSD Add LED1, LED2, & LED4 Change sound to P5V0 Change to 3.3V regulator
C	8/18/08	Populate C35. Add VDD connection to R10,R11. Add 12.4K to U1.41 for future compatibility. Add notation for non-PoE variant.

Texas Instruments

Title
Intelligent LCD Board

Size	Document Number	Rev
A	tbd	C

Date: Sheet   3   of   3

APPENDIX B

Bill of Materials (BOM)

Table B-1 provides the BOM for the IDM28 module (MDL-IDM28) and Table B-2 on page 26 provides the BOM for the IDM RDK (RDK-IDM).

Table B-1. MDL-IDM28 Bill of Materials

Item	Ref	Qty	Part Number	Description	Mfg	Supplier	Stock No
1	C2,C3,C6,C7	4	C0603C100J5GACTU	Capacitor 10pF 50V 5% Ceramic NPO/COG 0603	Kemet	Mouser	80-C0603C100J5G
2	C4,C5,C9,C10	4	C0603C180J5GACTU	Capacitor 18pF 50V 5% Ceramic NPO/COG 0603	Kemet	Mouser	80-C0603C180J5G
3	C1,C8,C11, C15,C16,C19 ,C21,C22,C24,C25,C26, C27,C28, C29,C30, C36,C45,C47	18	ECJ-1VB1H104K	Capacitor 0.1uF 00603 50V X7R 5%	Panasonic	Digikey	PCC2398CT-ND
4	C12,C13, C14,C18, C53,C54, C55,C56	8	C0603C103J5RACTU	Capacitor, 0.01uF 50V 5% 0603 X7R	Kemet	Mouser	80-C0603C103J5R
5	C17,C20, C23,C42	4	LMK212BJ475KG-T	Capacitor 4.7uF 16V X5R 0805	Taiyo Yuden	Digikey	587-1298-2-ND
6	C31,C32, C33,C34	4	C0805C106K9PACTU	Capacitor 10uF 6.3V X5R 0805	Kemet	Mouser	80-C0805C106K9P
7	C35	1	EEE-FK0J471GP	Capacitor, 470uF 6.3V Electro, Low Z, SMT Size F	Panasonic	Digikey	PCE4308CT-ND
8	C37,C38	2	C5750X7R2A475M	Capacitor 4.7uF 100V X7R 2220	TDK	Digikey	445-1450-2-ND
9	C40,C43, C44	3	C0805C105Z4VACTU	Capacitor 1uF 16V Y5V 0805	Kemet	Mouser	80-C0805C105Z4V
10	C41,C49,C51	3	ECJ-1VB1H473K	Capacitor 0.047uF 50V X7R 0603	Panasonic	Digikey	PCC2286CT-ND
11	C46,C48	2	C0603C102K5RACTU	Capacitor 1000pF 0603 X7R 50V 10%	Kemet	Digikey	399-1082-1-ND
13	C52	1	GRM188R72E152KW07D	Capacitor 1500pF 250V X7R 0603	Murata	Digikey	490-3528-1-ND
14	D1,D3,D8	3	MMSD4148T1G	Diode, Switching 200mA 100V SOD-123	OnSemi	Digikey	MMSD4148T1GOSCT-ND
15	D2	1	MBRS540T3	Diode, Schottky 5A 40V SMC	OnSemi	Digikey	MBRS540T3GOSCT-ND
16	D4,D6	2	HD01-T	Rectifier, Bridge 0.8A 100V MiniDIP SMT	Diodes	Digikey	HD01DICT-ND
17	D5	1	SMAJ60A-E3/1	TVS 60V 400W DO-214AC	Vishay	Digikey	SMAJ60A-E3/1GI-ND
18	D7	1	S3BB-13-F	Diode, 3A 100V SMB	Diodes	Digikey	S3BB-FDICT-ND
19	J1	1	M50-3600542	Connector, 2x5 Header 1.27mm pitch, SMT	Harwin	Mouser	855-M50-3600542

Table B-1. MDL-IDM28 Bill of Materials (Continued)

Item	Ref	Qty	Part Number	Description	Mfg	Supplier	Stock No
20	J2	1	90120-0763	Header 1x3 0.1" pitch un-shrouded	Molex	Digikey	WM8085-ND
21	J3	1	ED555/3DS	Terminal Block 3 pos LP 3.5mm black	On Shore Tech	Digikey	ED1515-ND
22	J4	1	ED555/6DS	Terminal Block 6 pos LP 3.5mm black	On Shore Tech	Digikey	ED1518-ND
23	J5	1	PJ-102AH	Connector, 2.1mm DC power socket high-current	CUI	Digikey	CP-102AH-ND
24	LED1,LED3	2	LTST-C171GKT	LED, 0805 SMT Green	LiteOn	Mouser / Arrow	LTST-C171GKT
25	L1	1	DO1813H-181MLB	Inductor 0.18uH 10A DO1813H	Coilcraft	Coilcraft	DO1813H-181MLB
27	P1	1	JK0-0044	Connector, RJ45 with PoE 10/100 magnetics, shielded TH	Pulse	Sager	JK0-0044
28	Q1,Q3,Q7	3	NDS331N	Mosfet N-Ch SOT-23 20V 1.3A	Fairchild	Arrow	NDS331N
29	Q2	1	Si4848DY	Mosfet N-Ch SO-8 150V 3.7A	Vishay	Digikey	SI4848DY-T1-E3CT-ND
31	Q6	1	CMPT5401	Transistor, PNP 150V 500mA SOT-23	Central Semi	Mouser	610-CMPT5401
32	R1,R3,R4,R9, R20,R23,R26 ,R44,R45,R5 4,R55,R56,R 58, R59	14	ERJ-3GEYJ103V	Resistor, 10K 5% 0603	Panasonic	Digikey	P10KGCT-ND
33	R6,R60	2	ERJ-3GEYJ331V	Resistor 330 ohms 5% 0603	Panasonic	Digikey	P330GCT-ND
34	R7,R8,R10,R 11	4	ERJ-3EKF49R9V	Resistor 49.9 Ohms 1% 0603	Panasonic	Digikey	P49.9HCT-ND
35	R14,R15,R16 ,R17	4	ERJ-3GEYJ750V	Resistor, 75 ohms 5% 0603	Panasonic	Digikey	P75GCT-ND
36	R21,R22,R24 ,R25,R57	5	ERJ-3GEYJ330V	Resistor, 33 ohms 5% 0603	Panasonic	Digikey	P33GCT-ND
37	R27	1	ERJ-3EKF5903V	Resistor 590K 1% 0603	Panasonic	Digikey	P590KHCT-ND
38	R28,R50,R51	3	ERJ-3EKF2492V	Resistor 24.9K 1% 0603	Panasonic	Digikey	P24.9KHCT-ND
39	R29	1	ERJ-3EKF20R0V	Resistor 20.0 1% 0603	Panasonic	Digikey	P20.0HCT-ND
40	R30	1	ERJ-3EKF3322V	Resistor 33.2K 1% 0603	Panasonic	Digikey	P33.2KHCT-ND
41	R31,R39,R40	3	ERJ-3EKF1001V	Resistor 1.00K 1% 0603	Panasonic	Digikey	P1.00KHCT-ND
42	R32	1	ERJ-3EKF10R0V	Resistor 10.0 1% 0603	Panasonic	Digikey	P10.0HCT-ND
43	R33	1	ERJ-3EKF1000V	Resistor 100 1% 0603	Panasonic	Digikey	P100HCT-ND
44	R34	1	ERJ-3EKF2212V	Resistor 22.1K 1% 0603	Panasonic	Digikey	P22.1KHCT-ND
45	R35,R43	2	ERJ-1TRQFR39U	Resistor 0.39 1% 2512	Panasonic	Digikey	PT.39YCT-ND
46	R36	1	ERJ-3EKF1500V	Resistor 150 1% 0603	Panasonic	Digikey	P150HCT-ND
47	R38	1	ERJ-3EKF5900V	Resistor 590 1% 0603	Panasonic	Digikey	P590HCT-ND
48	R2, R41	2	ERJ-3EKF1242V	Resistor 12.4K 1% 0603	Panasonic	Digikey	P12.4KHCT-ND
49	R42	1	ERJ-3EKF7321V	Resistor 7.32K 1% 0603	Panasonic	Digikey	P7.32KHCT-ND
50	R48,R53	2	ERJ-3EKF2003V	Resistor 200K 1% 0603	Panasonic	Digikey	P200KHCT-ND

Table B-1.   MDL-IDM28 Bill of Materials (Continued)

Item	Ref	Qty	Part Number	Description	Mfg	Supplier	Stock No
51	R49	1	ERJ-3EKF1003V	Resistor 100K 1% 0603	Panasonic	Digikey	P100KHCT-ND
52	SPK1	1	CSS-73B16K	Transducer, Audio 2.5-4.5V 16ohm 8.5mm SMD	CUI	Digikey	102-1197-1-ND
53	SW1	1	KMR221GLFS	Switch, Momentary Tact 200gmf 2.8x4.6mm	C&K / ITT	Digikey	401-1427-1-ND
54	T1	1	C1588-AL	Transformer, Flyback 7W for LM5070	Coilcraft	Coilcraft	C1588-AL
55	U1	1	LM3S6918	IC, Microcontroller ARM Cortex TQFP-100	Luminary	Luminary	LM3S6918
56	U2	1	KWH028Q02-F03	LCD Panel, 2.8" with Touch Screen	Formike	Formike	KWH028Q02-F03
57	U3	1	MAX3221CAE+	IC, RS232 Driver/Receiver 1/1 SSOP-16	Maxim	Digikey	MAX3221CAE+-ND
58	U4	1	AT45DB081D-SU	IC, Data Flash 1Mbit 2.7V SOIC-8	Atmel	Digikey	AT45DB081D-SU-ND
59	U6,U11	2	MMQA5V6T1G	TVS, Quad 5.6V 50W SC-74	On Semi	Digikey	MMQA5V6T1GOSCT-ND
60	U8	1	PQ1X331M2ZPH	IC, Voltage regulator 3.3V 300mA SOT23-5	Sharp	Digikey	425-2333-2-ND
61	U9	1	LM5071MT-50/NOPB	IC, PoE PD Interface w/AUX & PWM controller	National Semi	Future Electronics	LM5071MT-50-LF
62	U10	1	FOD2712R1V	Optically Isolated Error Amplifier	Fairchild	Digikey	FOD2712R1VCT-ND
63	Y1	1	NX5032GA-25.000000MHZ	Crystal, 25.00MHz 5.0x3.2mm SMT	NDK	Digikey	644-1041-2-ND
64	Y2	1	NX8045GB-8.000000MHZ	Crystal, 8.00MHz 8.0x4.5mm SMT	NDK	Digikey	644-1018-2-ND
65	Z1	1	V23026D1021B201	Relay 1C 1A 5V	Tyco	Digikey	PB285CT-ND
66		1	tbd	PCB, RDK-IDM-B	tbd	tbd	tbd
67		2	4008	Tape, Double-sided adhesive 0.125" thick 1.0" x 2.0" cut piece	3M	Digikey	3M4008-ND for 36 yd roll
68	P2	1	2908-05WB-MG	Socket, microSD	3M	Mouser	517-2908-05WB-MG
69		1	D1002861	LCD Screen Decal, "Luminary Micro"	Drake	Drake	D1002861
—	—	146	—	—	—	—	**TOTAL PCB ITEMS**

			Additional Parts for Reference Design Kit				
70	z	4	2028	Standoff, 0.625" long 0.187" round aluminum 4-40	Keystone	Mouser	534-2028
71	P2	4	NSP-4-4-01 H542-ND	Machine Screw 4-40 x 0.25" nylon phillips or equivalent lead-free 4-40 machine screw	Richco	Digikey	NSP-4-4-01-ND H542-ND

Table B-2 provides the BOM for the RDK-IDM.

Table B-2. RDK-IDM Bill of Materials

Item	Ref	Qty	Part Number	Description	Mfg	Supplier	Stock No
1	C2,C3,C6, C7	4	C0603C100J5GACTU	Capacitor 10pF 50V 5% Ceramic NPO/COG 0603	Kemet	Mouser	80-C0603C100J5G
2	C4,C5,C9, C10	4	C0603C180J5GACTU	Capacitor 18pF 50V 5% Ceramic NPO/COG 0603	Kemet	Mouser	80-C0603C180J5G
3	C1, C8, C11, C15, C16, C19, C21, C22, C24, C25, C26, C27, C28, C29, C30, C36, C45	17	ECJ-1VB1H104K	Capacitor 0.1uF 00603 50V X7R 5%	Panasonic	Digikey	PCC2398CT-ND
4	C12,C13,C14,C18,C53,C54,C55, C56	8	C0603C103J5RACTU	Capacitor, 0.01uF 50V 5% 0603 X7R	Kemet	Mouser	80-C0603C103J5R
5	C17,C20,C23,C42	4	LMK212BJ475KG-T	Capacitor 4.7uF 16V X5R 0805	Taiyo Yuden	Digikey	587-1298-2-ND
7	C35	1	EEE-FK0J471GP	Capacitor, 470uF 6.3V Electro, Low Z, SMT Size F	Panasonic	Digikey	PCE4308CT-ND
9	C44	1	C0805C105Z4VACTU	Capacitor 1uF 16V Y5V 0805	Kemet	Mouser	80-C0805C105Z4V
14	D1,D8	2	MMSD4148T1G	Diode, Switching 200mA 100V SOD-123	OnSemi	Digikey	MMSD4148T1GOSCT-ND
19	J1	1	M50-3600542	Connector, 2x5 Header 1.27mm pitch, SMT	Harwin	Mouser	855-M50-3600542
20	J2	1	90120-0763	Header 1x3 0.1" pitch un-shrouded	Molex	Digikey	WM8085-ND
21	J3	1	ED555/3DS	Terminal Block 3 pos LP 3.5mm black	On Shore Tech	Digikey	ED1515-ND
22	J4	1	ED555/6DS	Terminal Block 6 pos LP 3.5mm black	On Shore Tech	Digikey	ED1518-ND
24	LED1,LED3	2	LTST-C171GKT	LED, 0805 SMT Green	LiteOn	Mouser / Arrow	LTST-C171GKT
27	P1	1	JK0-0044	Connector, RJ45 with PoE 10/100 magnetics, shielded TH	Pulse	Sager	JK0-0044
28	Q1,Q3,Q7	3	NDS331N	Mosfet N-Ch SOT-23 20V 1.3A	Fairchild	Arrow	NDS331N

Table B-2. RDK-IDM Bill of Materials (Continued)

Item	Ref	Qty	Part Number	Description	Mfg	Supplier	Stock No
32	R1, R3, R4, R9, R20, R23, R26, R44, R45, R54, R55, R58, R59	13	ERJ-3GEYJ103V	Resistor, 10K 5% 0603	Panasonic	Digikey	P10KGCT-ND
33	R6,R60	2	ERJ-3GEYJ331V	Resistor 330 ohms 5% 0603	Panasonic	Digikey	P330GCT-ND
34	R7,R8,R10, R11	4	ERJ-3EKF49R9V	Resistor 49.9 Ohms 1% 0603	Panasonic	Digikey	P49.9HCT-ND
35	R14,R15,R 16,R17	4	ERJ-3GEYJ750V	Resistor, 75 ohms 5% 0603	Panasonic	Digikey	P75GCT-ND
36	R21,R22,R 24,R25,R5 7	5	ERJ-3GEYJ330V	Resistor, 33 ohms 5% 0603	Panasonic	Digikey	P33GCT-ND
48	R2	1	ERJ-3EKF1242V	Resistor 12.4K 1% 0603	Panasonic	Digikey	P12.4KHCT-ND
50	R53	1	ERJ-3EKF2003V	Resistor 200K 1% 0603	Panasonic	Digikey	P200KHCT-ND
52	SPK1	1	CSS-73B16K	Transducer, Audio 2.5-4.5V 16ohm 8.5mm SMD	CUI	Digikey	102-1197-1-ND
53	SW1	1	KMR221GLFS	Switch, Momentary Tact 200gmf 2.8x4.6mm	C&K / ITT	Digikey	401-1427-1-ND
55	U1	1	LM3S6918	IC, Microcontroller ARM Cortex TQFP-100	Luminary	Luminary	LM3S6918
56	U2	1	KWH028Q02-F03	LCD Panel, 2.8" with Touch Screen	Formike	Formike	KWH028Q02-F03
57	U3	1	MAX3221CAE+	IC, RS232 Driver/ Receiver 1/1 SSOP-16	Maxim	Digikey	MAX3221CAE+-ND
58	U4	1	AT45DB081D-SU	IC, Data Flash 1Mbit 2.7V SOIC-8	Atmel	Digikey	AT45DB081D-SU-ND
59	U6,U11	2	MMQA5V6T1G	TVS, Quad 5.6V 50W SC-74	On Semi	Digikey	MMQA5V6T1GOSCT-ND
60	U8	1	PQ1X331M2ZPH	IC, Voltage regulator 3.3V 300mA SOT23-5	Sharp	Digikey	425-2333-2-ND
63	Y1	1	NX5032GA-25.000000MHZ	Crystal, 25.00MHz 5.0x3.2mm SMT	NDK	Digikey	644-1041-2-ND
64	Y2	1	NX8045GB-8.000000MHZ	Crystal, 8.00MHz 8.0x4.5mm SMT	NDK	Digikey	644-1018-2-ND
65	Z1	1	V23026D1021B201	Relay 1C 1A 5V	Tyco	Digikey	PB285CT-ND
66		1	tbd	PCB, RDK-IDM-C	tbd	tbd	tbd
67		2	4008	Tape, Double-sided adhesive 0.125" thick 1.0" x 2.0" cut piece	3M	Digikey	3M4008-ND

Table B-2. RDK-IDM Bill of Materials (Continued)

Item	Ref	Qty	Part Number	Description	Mfg	Supplier	Stock No
68	P2	1	2908-05WB-MG	Socket, microSD	3M	Mouser	517-2908-05WB-MG
69		1	D1002861	LCD Screen Decal, "Luminary Micro"	Drake	Drake	D1002861
—	—	**97**	—	—	—	—	**TOTAL PCB ITEMS**

Component Details

This appendix contains details on component locations, including:

- Component placement plot for top (Figure C-1)
- Component placement plot for bottom (Figure C-2)

Figure C-1.   Component Placement Plot for Top
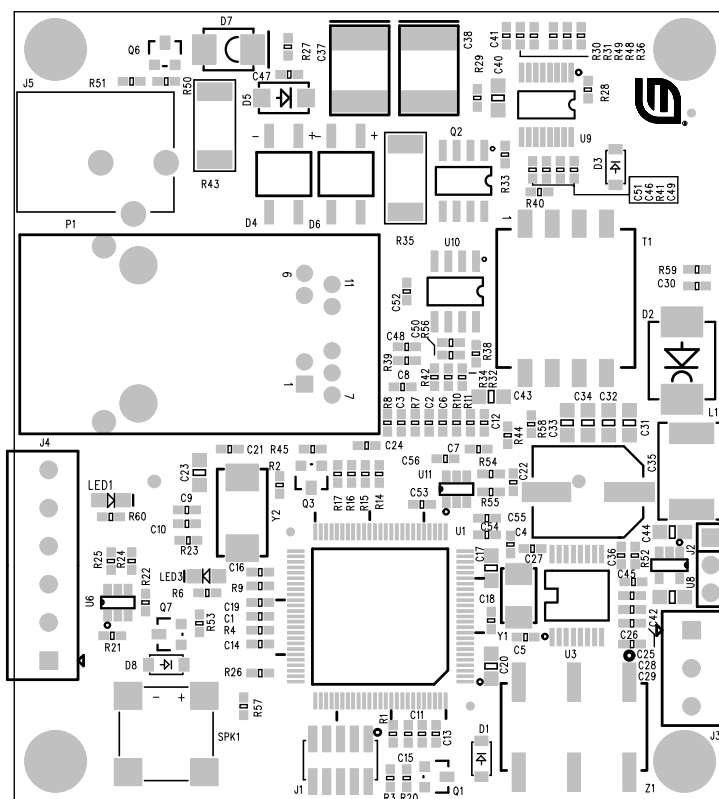
Figure C-2.   Component Placement Plot for Bottom