MCP1630 Li-Ion Multi-Bay Battery Charger User's Guide

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MCP1630 LI-ION MULTI-BAY BATTERY CHARGER USER'S GUIDE

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Preface

NOTICE TO CUSTOMERS

All documentation becomes dated, and this manual is no exception. Microchip tools and documentation are constantly evolving to meet customer needs, so some actual dialogs and/or tool descriptions may differ from those in this document. Please refer to our web site (www.microchip.com) to obtain the latest documentation available.

Documents are identified with a "DS" number. This number is located on the bottom of each page, in front of the page number. The numbering convention for the DS number is "DSXXXXXA", where "XXXXX" is the document number and "A" is the revision level of the document.

For the most up-to-date information on development tools, see the MPLAB® IDE on-line help. Select the Help menu, and then Topics to open a list of available on-line help files.

INTRODUCTION

This chapter contains general information that will be useful to know before using the MCP1630 Li-Ion Multi-Bay Battery Charger. Items discussed in this chapter include:

- Document Layout
- Conventions Used in this Guide
- Recommended Reading
- The Microchip Web Site
- Customer Support
- Document Revision History

DOCUMENT LAYOUT

This document describes how to use the MCP1630 Li-Ion Multi-Bay Battery Charger. The manual layout is as follows:

- **Chapter 1. "Product Overview"** – Important information about the MCP1630 Li-Ion Multi-Bay Battery Charger.
- **Chapter 2. "Installation and Operation"** – Includes instructions on how to get started with this user's guide and a description of the user's guide.
- **Appendix A. "Schematic and Layouts"** – Shows the schematic and layout diagrams for the MCP1630 Li-Ion Multi-Bay Battery Charger.
- **Appendix B. "Bill-Of-Materials (BOM)"** – Lists the parts used to build the MCP1630 Li-Ion Multi-Bay Battery Charger.
- **Appendix C. "Evaluation Board Firmware"** – Provides information about the application firmware and where the source code can be found.

CONVENTIONS USED IN THIS GUIDE

This manual uses the following documentation conventions:

DOCUMENTATION CONVENTIONS

Description	Represents	Examples
Arial font:		
Italic characters	Referenced books	*MPLAB® IDE User's Guide*
	Emphasized text	...is the *only* compiler...
Initial caps	A window	the Output window
	A dialog	the Settings dialog
	A menu selection	select Enable Programmer
Quotes	A field name in a window or dialog	"Save project before build"
Underlined, italic text with right angle bracket	A menu path	*File>Save*
Bold characters	A dialog button	Click **OK**
	A tab	Click the **Power** tab
'b*nnnn*	A binary number where *n* is a digit	'b00100, 'b10
Text in angle brackets < >	A key on the keyboard	Press <Enter>, <F1>
Courier font:		
Plain Courier	Sample source code	`#define START`
	Filenames	`autoexec.bat`
	File paths	`c:\mcc18\h`
	Keywords	`_asm, _endasm, static`
	Command-line options	`-Opa+, -Opa-`
	Bit values	`0, 1`
Italic Courier	A variable argument	*`file`*`.o`, where *`file`* can be any valid filename
`0x`*`nnnn`*	A hexadecimal number where *`n`* is a hexadecimal digit	`0xFFFF`, `0x007A`
Square brackets [ ]	Optional arguments	`mcc18 [options]` *`file`* `[options]`
Curly brackets and pipe character: { | }	Choice of mutually exclusive arguments; an OR selection	`errorlevel {0|1}`
Ellipses...	Replaces repeated text	`var_name [, var_name...]`
	Represents code supplied by user	`void main (void) { ... }`

RECOMMENDED READING

This user's guide describes how to use MCP1630 Li-Ion Multi-Bay Battery Charger. Other useful documents are listed below. The following Microchip documents are available and recommended as supplemental reference resources.

MCP1630 Data Sheet, "*High-Speed, Microcontroller-Adaptable, Pulse Width Modulator*", (DS21896)

This data sheet provides detailed information regarding the MCP1630 product family.

THE MICROCHIP WEB SITE

Microchip provides online support via our web site at www.microchip.com. This web site is used as a means to make files and information easily available to customers. Accessible by using your favorite Internet browser, the web site contains the following information:

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- Distributor or Representative
- Local Sales Office
- Field Application Engineer (FAE)
- Technical Support
- Development Systems Information Line

Customers should contact their distributor, representative or field application engineer (FAE) for support. Local sales offices are also available to help customers. A listing of sales offices and locations is included in the back of this document.

Technical support is available through the web site at: http://support.microchip.com

In addition, there is a Development Systems Information Line which lists the latest versions of Microchip's development systems software products. This line also provides information on how customers can receive currently available upgrade kits.

The Development Systems Information Line numbers are:

1-800-755-2345 – United States and most of Canada

1-480-792-7302 – Other International Locations

DOCUMENT REVISION HISTORY

Revision A (March 2005)

- Initial Release of this Document.

NOTES:

Chapter 1. Product Overview

1.1 INTRODUCTION

The MCP1630 Li-Ion Multi-Bay Battery Charger is used to evaluate Microchip's MCP1630, when used in a Single-Ended Primary Inductive Converter (SEPIC) power converter application. The MCP1630 Li-Ion Multi-Bay Battery Charger is capable of charging two single-cell, Li-Ion battery packs in parallel utilizing an input voltage of 10V to 28V. Multiple boards can be daisy-chained for a maximum of sixteen charger bays. The MCP1630 Li-Ion Multi-Bay Battery Charger is intended for use in pseudo-smart battery charger applications in conjunction with battery packs containing Microchip's PS700 Battery Monitor. Standard battery packs can be utilized as well. The MCP1630 Li-Ion Multi-Bay Battery Charger provides a constant-current, constant-voltage charge with preconditioning, cell temperature monitoring and battery pack fault monitoring. Each charger bay provides status and fault indications. The MCP1630 Li-Ion Multi-Bay Battery Charger automatically detects the insertion or removal of a battery pack.

This chapter covers the following topics:

- What is the MCP1630 Li-Ion Multi-Bay Battery Charger?
- What the MCP1630 Li-Ion Multi-Bay Battery Charger kit includes

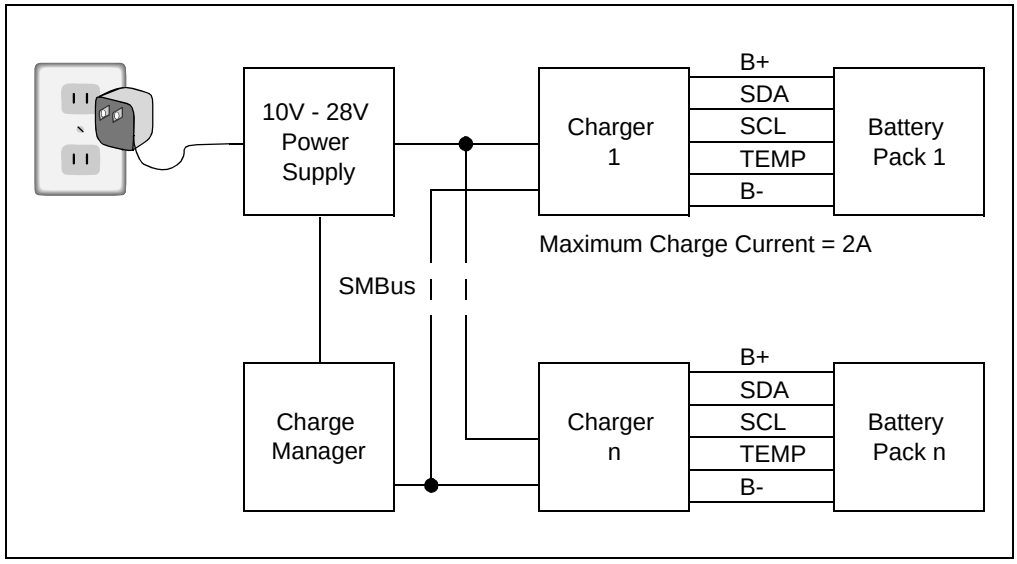


FIGURE 1-1: *MCP1630 Li-Ion Multi-Bay Battery Charger Block Diagram.*

1.2 WHAT THE MCP1630 LI-ION MULTI-BAY BATTERY CHARGER IS

The MCP1630 Li-Ion Multi-Bay Battery Charger is a complete, stand-alone, constant-current, constant-voltage battery charger for single-cell Li-Ion battery packs. Different battery chemistries (i.e. three NiMH or NiCd batteries connected in series) can be charged with minor modifications to the firmware. This board utilizes Microchip's MCP1630 (High-speed PWM MSOP8), MCP6292 (Dual Op Amp MSOP8) and PIC18F2410 (Flash MCU SOIC28). The input voltage range for the MCP1630 Li-Ion Multi-Bay Battery Charger is 10V to 28V. The output is capable of charging at a fast-charge rate of 2A constant current.

An input terminal block is provided to apply an input voltage to the charger and as a convenient means to daisy-chain boards together. Output headers are also provided as a means to connect the external battery packs or simulated battery loads. A programming header is available for updating the firmware contained in the PIC18F2410.

1.3 WHAT THE MCP1630 LI-ION MULTI-BAY BATTERY CHARGER KIT INCLUDES

This MCP1630 Li-Ion Multi-Bay Battery Charger kit includes:

- MCP1630 Li-Ion Multi-Bay Battery Charger (102-00038)
- MCP1630 Li-Ion Multi-Bay Battery Charger User's Guide (DS51515)
- MCP1630, High-Speed, Microcontroller-Adaptable, Pulse Width Modulator Data Sheet (DS21896)

Chapter 2. Installation and Operation

2.1 INTRODUCTION

The MCP1630 Li-Ion Multi-Bay Battery Charger demonstrates Microchip's MCP1630 High-Speed PWM when used in a pseudo-smart battery charger application. The MCP1630 is a High Speed, microcontroller adaptable, pulse width modulator. When used in conjunction with a microcontroller, the MCP1630 will control the power system duty cycle to provide output voltage or current regulation. The microcontroller (PIC18F2410) can be used to regulate output voltage or current, switching frequency and maximum duty cycle. The MCP1630 generates duty cycle while providing fast overcurrent protection based off various external inputs. External signals include the input oscillator, the reference voltage, the feedback voltage and the current sense. The output signal is a square-wave pulse. The power train used for the MCP1630 is a SEPIC.

2.2 FEATURES

The MCP1630 has the following features:

- Programmed Parameters – Modified in firmware
- Factory Settings:
  - Preconditioning charge current = 200 mA
  - Preconditioning threshold = 2.8V
  - Constant-current fast charge = 2A
  - Constant-voltage charge = 4.2V
  - Charge termination threshold = 100 mA
- Overvoltage protection (battery removed)
- Overcharge protection to prevent damaging the battery
- Overcurrent protection in the event of a shorted battery
- Battery-reversal protection
- Input short circuit protection
- Overtemperature protection to prevent the battery from reaching too high a temperature during charge
- Fast charge termination in the event the battery temperature is to high
- Soft-start capability by holding the reference voltage low during power-up
- The MCP1630 terminates charge by detecting a predefined charge current threshold during constant-voltage charge, or a specified elapsed time
- The MCP1630 has the flexibility to optimize the charging algorithm for new battery technology and add proprietary features by modifying the firmware contained in the PIC18F2410. The factory-programmed source code is available
- Ability to adapt to environmental effects, such as ambient temperature

2.3 GETTING STARTED

The MCP1630 Li-Ion Multi-Bay Battery Charger is fully assembled and tested for charging single-cell, Li-Ion battery packs with the recommended charge profile for Li-Ion batteries. This board requires the use of an external input voltage source (+10V to +28V) and external load (battery or simulated battery load). It is recommended that a battery pack containing Microchip's PS700 battery monitor be used to maximize the full benefits of the pseudo-smart battery system with the shortest charge cycle times. Alternatively, standard battery packs or the recommended simulated load can be utilized to evaluate the system performance.

2.3.1 Power Input and Output Connections

Powering the MCP1630 Li-Ion Multi-Bay Battery Charger

1. Apply the input voltage to the input terminal block (JP2). The input voltage source should be limited to the 0V to +28V range. For normal operation, the input voltage should be between +10V and +28V. The input voltage must not exceed an absolute maximum of +35V.
2. Connect the positive side (+) of the input source to pin 1 of JP2. Connect the negative or return side (-) of the input source to pin 2 of JP2. Refer to Figure 2-1.

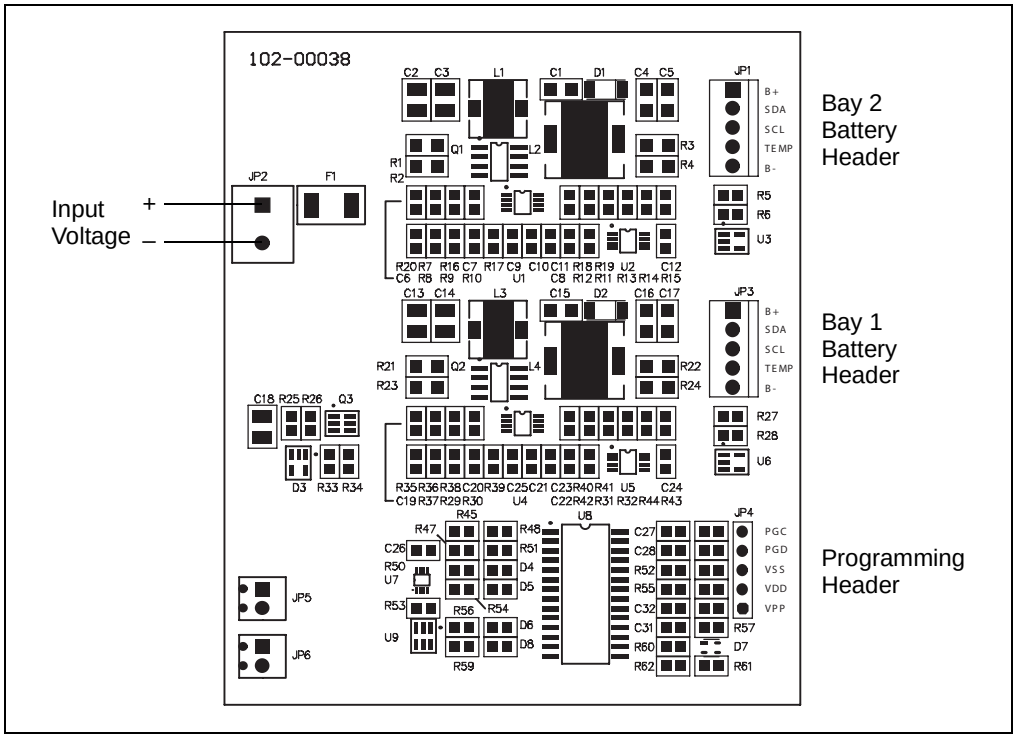


FIGURE 2-1: *Setup Configuration Diagram.*

Apply the load to a battery header.

1. To apply a load to the MCP1630 Li-Ion Multi-Bay Battery Charger, the positive side of the load (B+) should be connected to pin 1 of JP1 or JP3. The negative side of the load (B-) should be connected to pin 5 of JP1 or JP3. Care should be taken when using either electronic loads or ground-referenced loads.
2. A thermistor referenced to B- in the battery pack should be utilized. If a thermistor is not available or desired, a 10 kΩ resistor should be placed between pin 4 and pin 5 of the battery header. Alternatively, the firmware can be modified to ignore the thermistor input.
3. SMBus interface connections are provided at the battery headers for communication with battery packs containing Microchip's PS700. Utilizing a pseudo-smart battery system will provide reduced charge cycle times by compensating for IR voltage drops in the high-current charge path.
4. The code will prevent the board from entering the 2A Fast Charge mode if the battery terminal voltage is less than 2.8V. During power-up, the board will always trickle charge first, so using a purely resistive load will not work for trickle and fast charge current. The best way to evaluate the charger is to use a single-cell, Li-Ion battery pack or the reccomended simulated battery load. Refer to Figure 2-2.

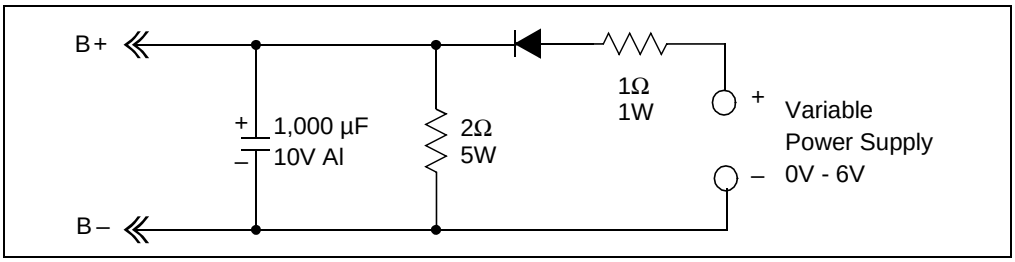


FIGURE 2-2: *Simulated Battery Load.*

Status LEDs

1. Each charger bay has a LED to indicate charge status (D8 for charge bay 1 and D6 for charge bay 2), as well as a LED to indicate a fault (D4 for charge bay 1 and D5 for charge bay 2).

TABLE 2-1: STATUS OUTPUT

CHARGE CYCLE STATE	STATUS (GREEN)	FAULT (RED)
Qualification	OFF	ON
Preconditioning	ON	OFF
Constant Current Fast Charge	ON	OFF
Constant Voltage	ON	OFF
Charge Complete	Flashing (0.5 Hz, 50% duty cycle)	OFF
Safety Timer Fault	Flashing (0.5 Hz, 50% duty cycle)	ON
Cell Temperature Invalid	ON	ON
Battery Disconnected	OFF	ON
Input Power Removed	OFF	OFF

Programming

1. Header JP4 is provided for in-system circuit programming.

NOTES:

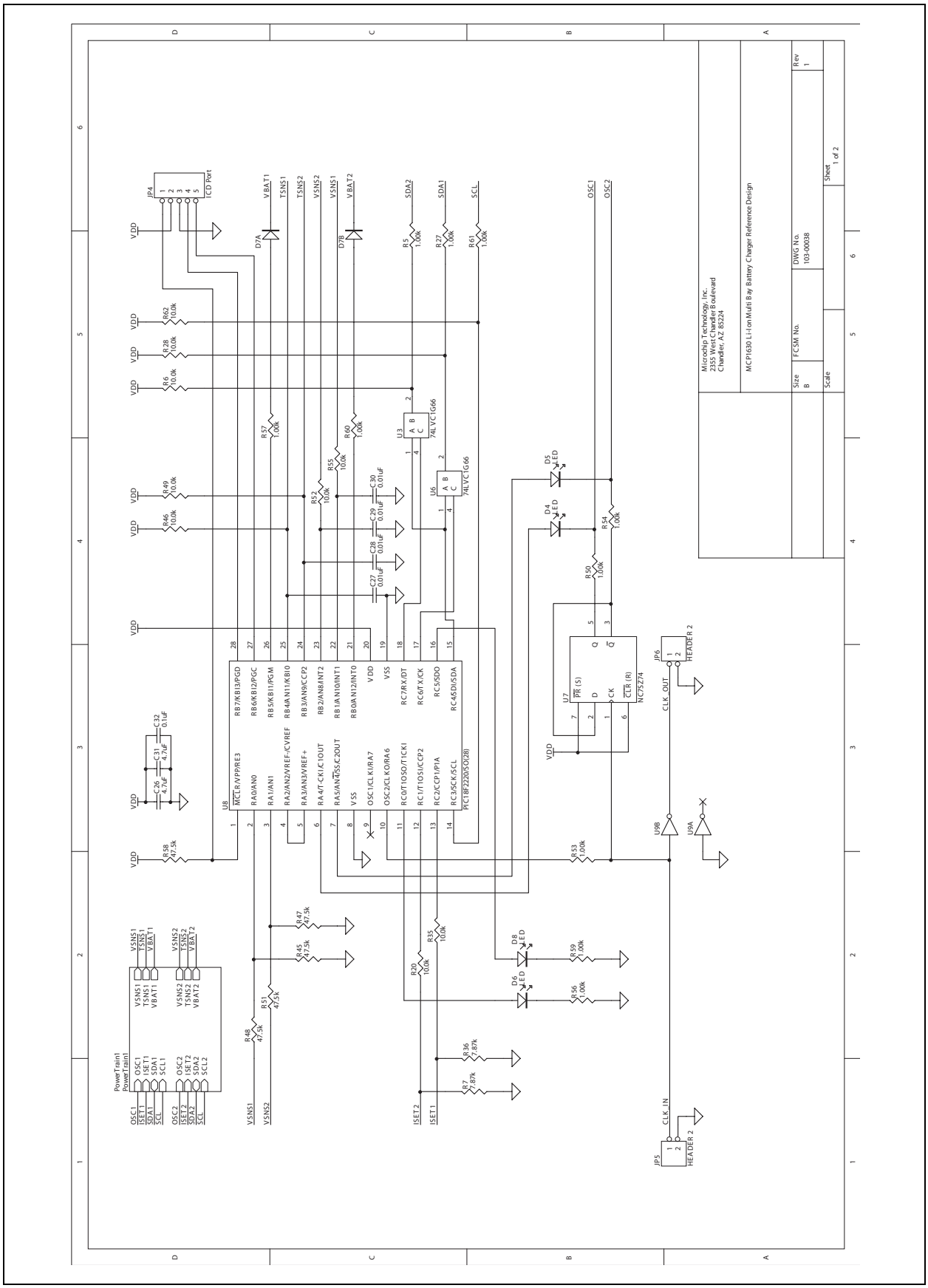
Appendix A. Schematic and Layouts

A.1 INTRODUCTION

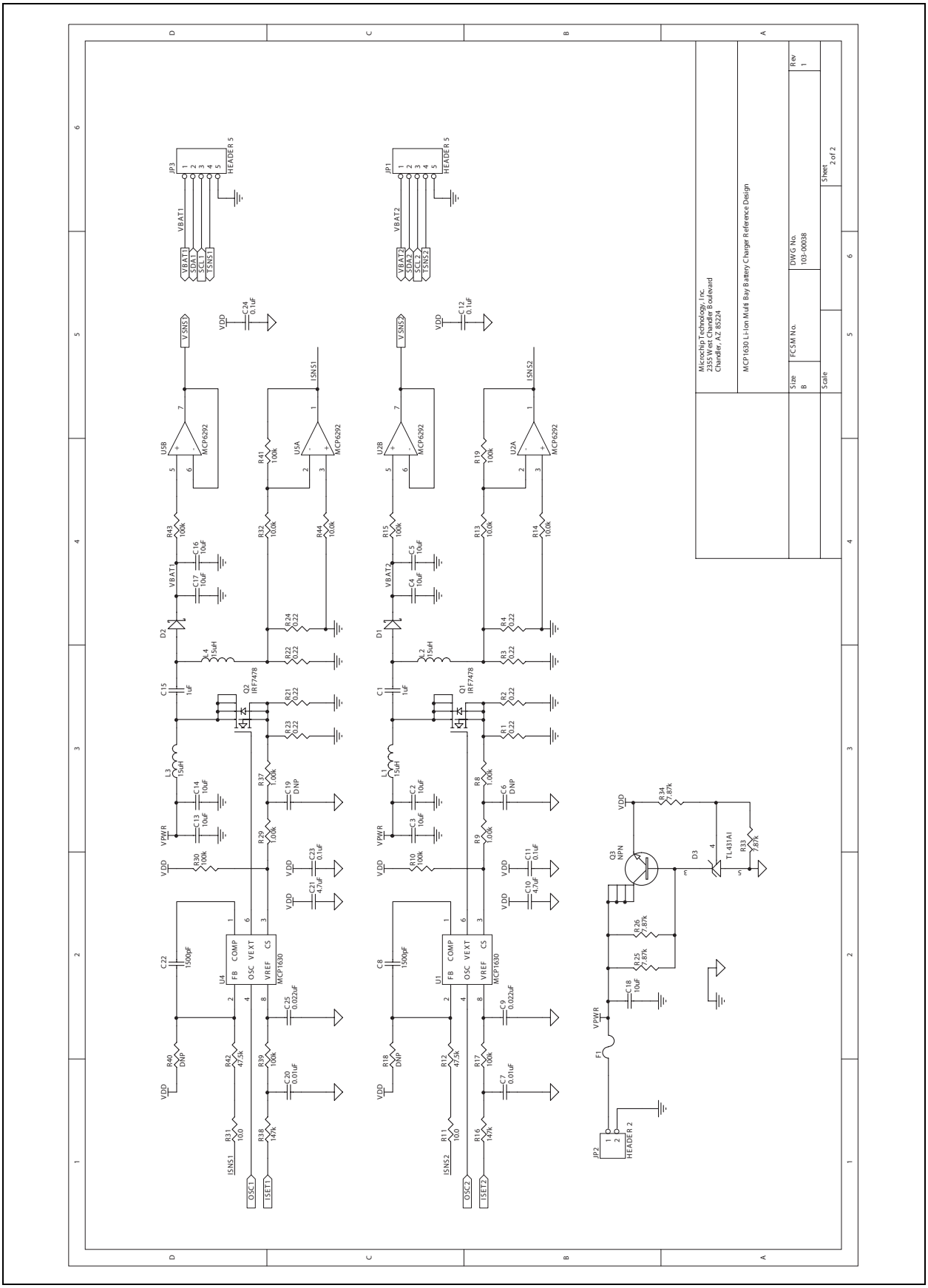
This appendix contains the following schematics and layouts for the MCP1630 Li-Ion Multi-Bay Battery Charger:

- Board Schematic (Sheets 1 and 2)
- Board – Assembly Drawing
- Board – Top Layer
- Board – Mid-Layer 1
- Board – Mid-Layer 2
- Board – Bottom Layer

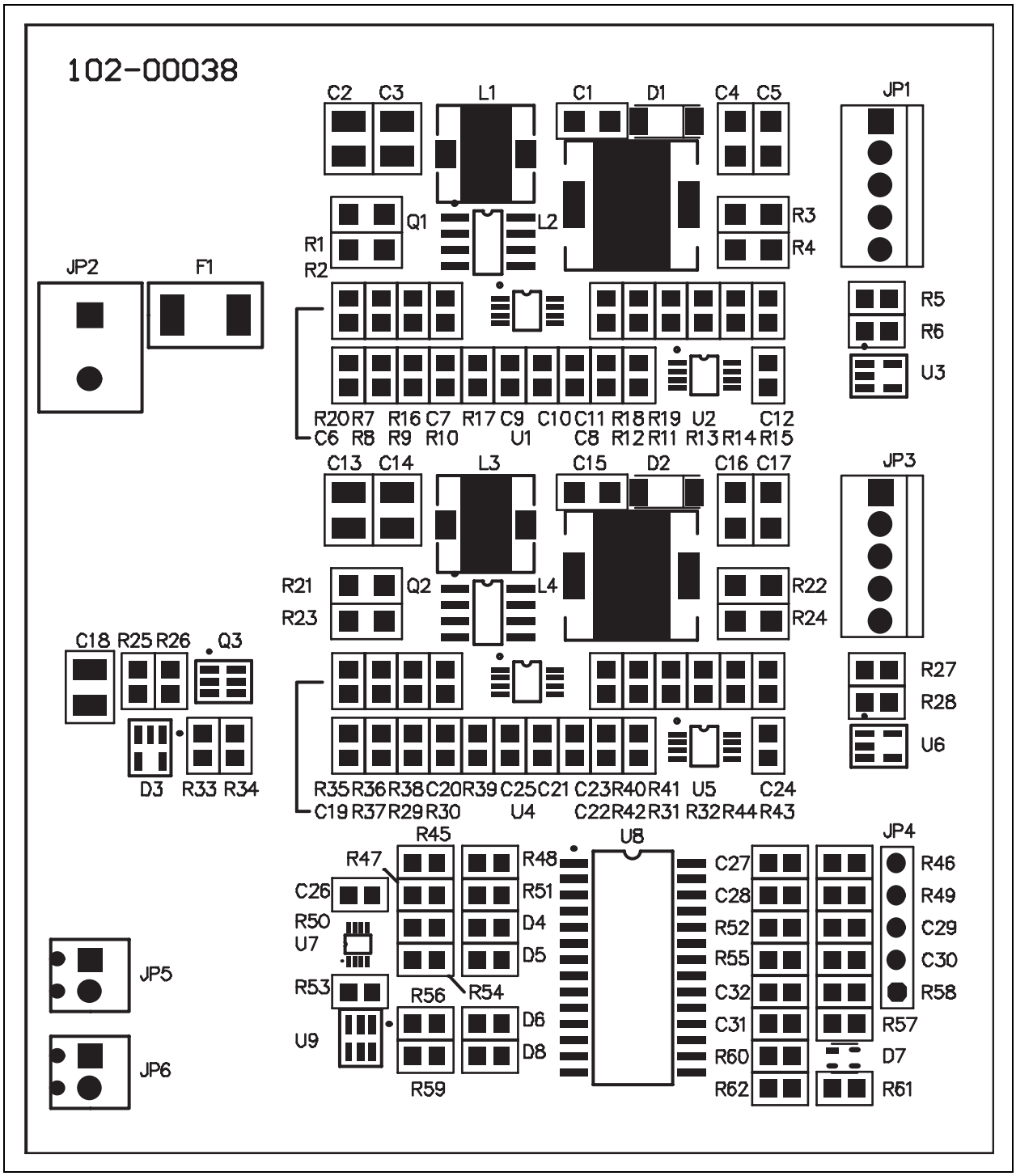
A.2 BOARD SCHEMATIC – SHEET 1



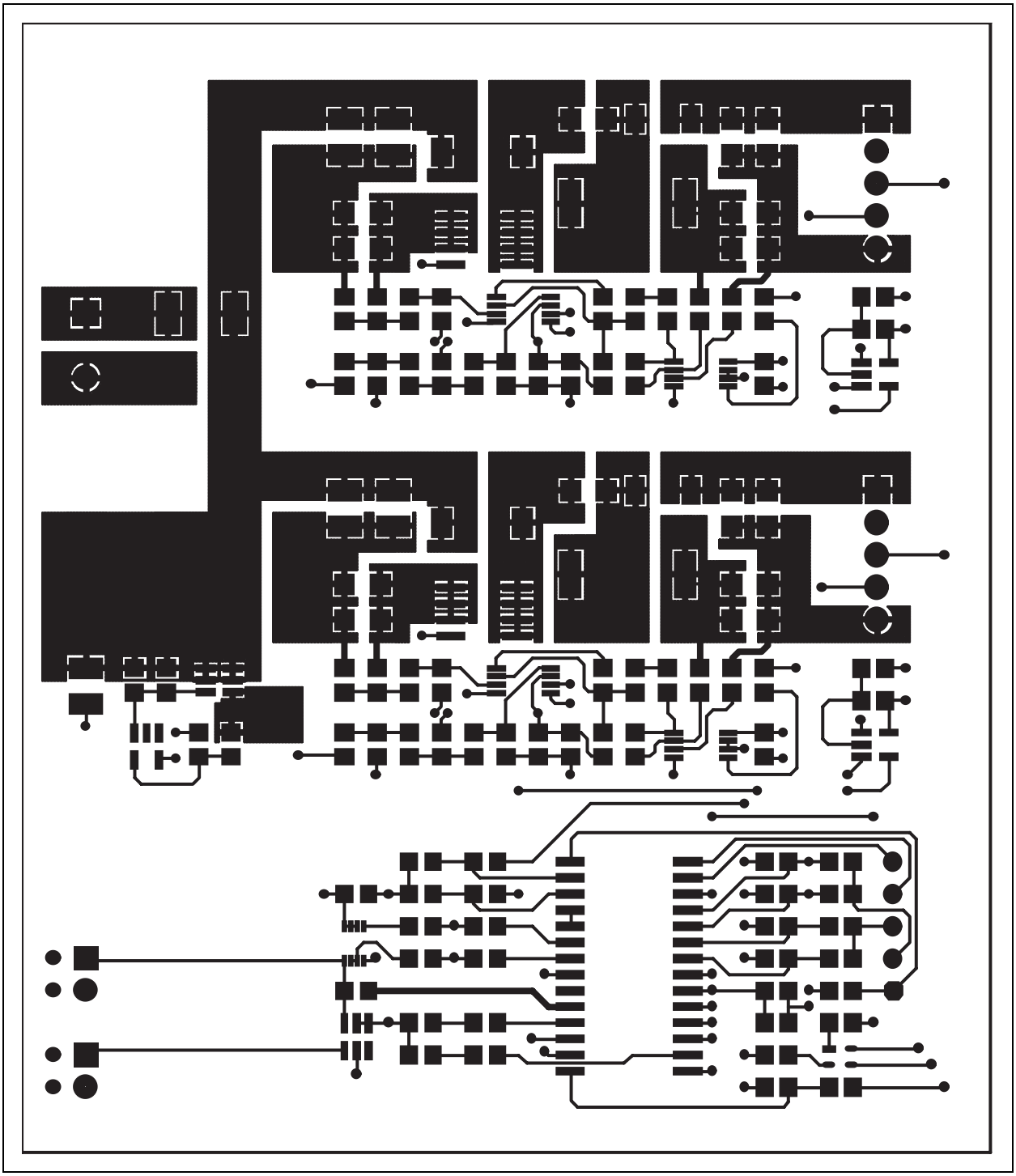
A.3 BOARD SCHEMATIC – SHEET 2



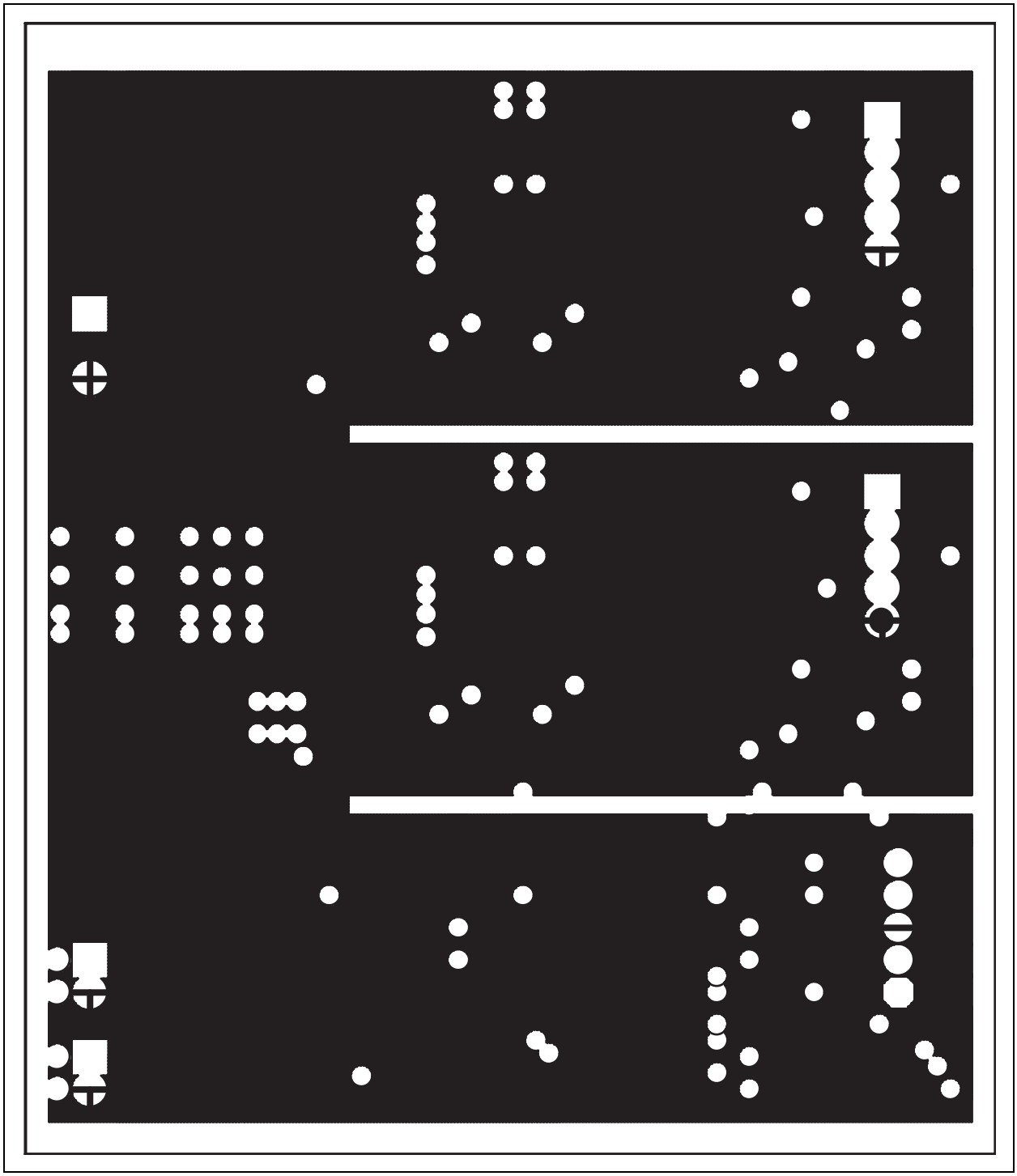
A.4 BOARD – ASSEMBLY DRAWING



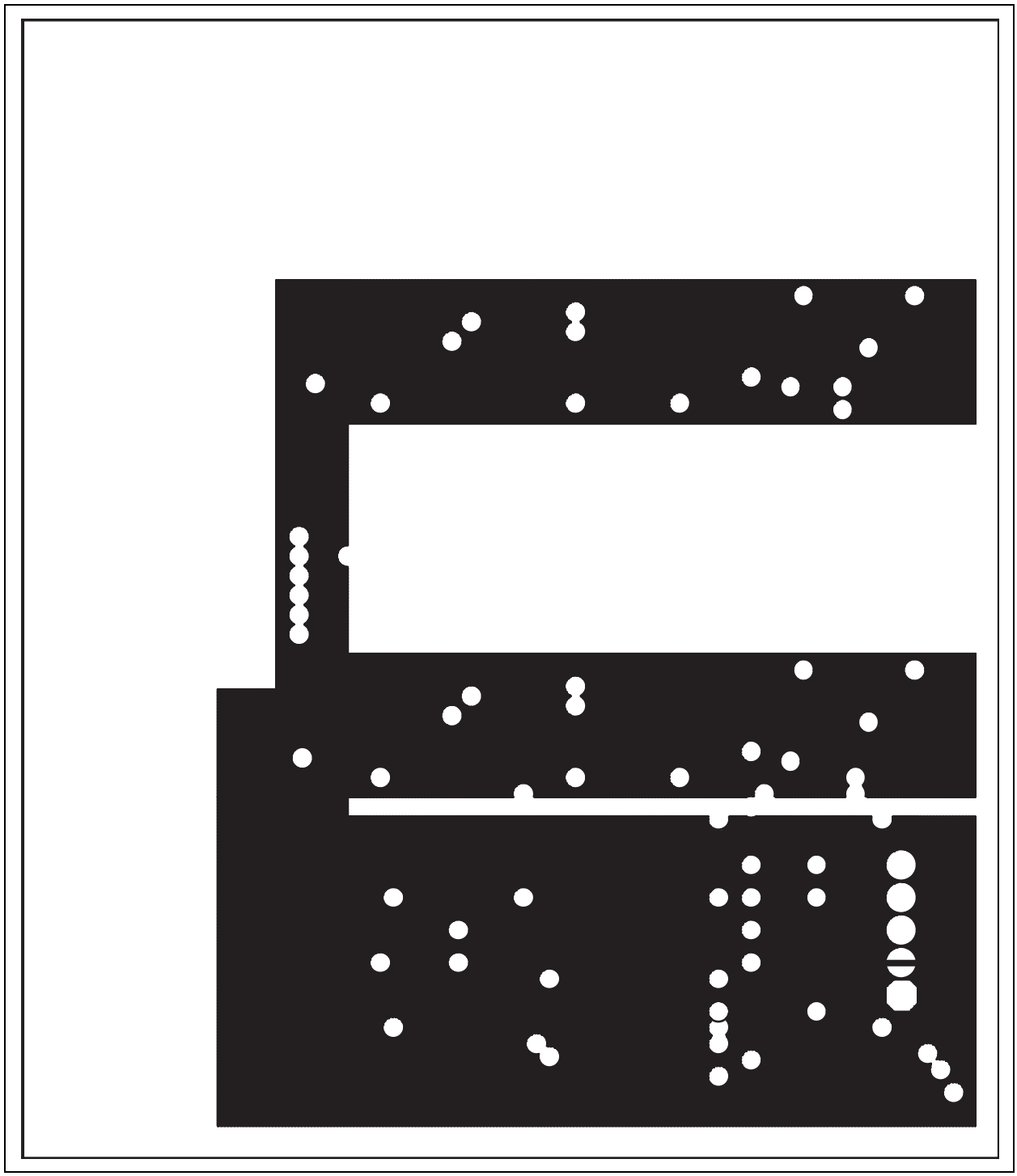
A.5 BOARD – TOP LAYER



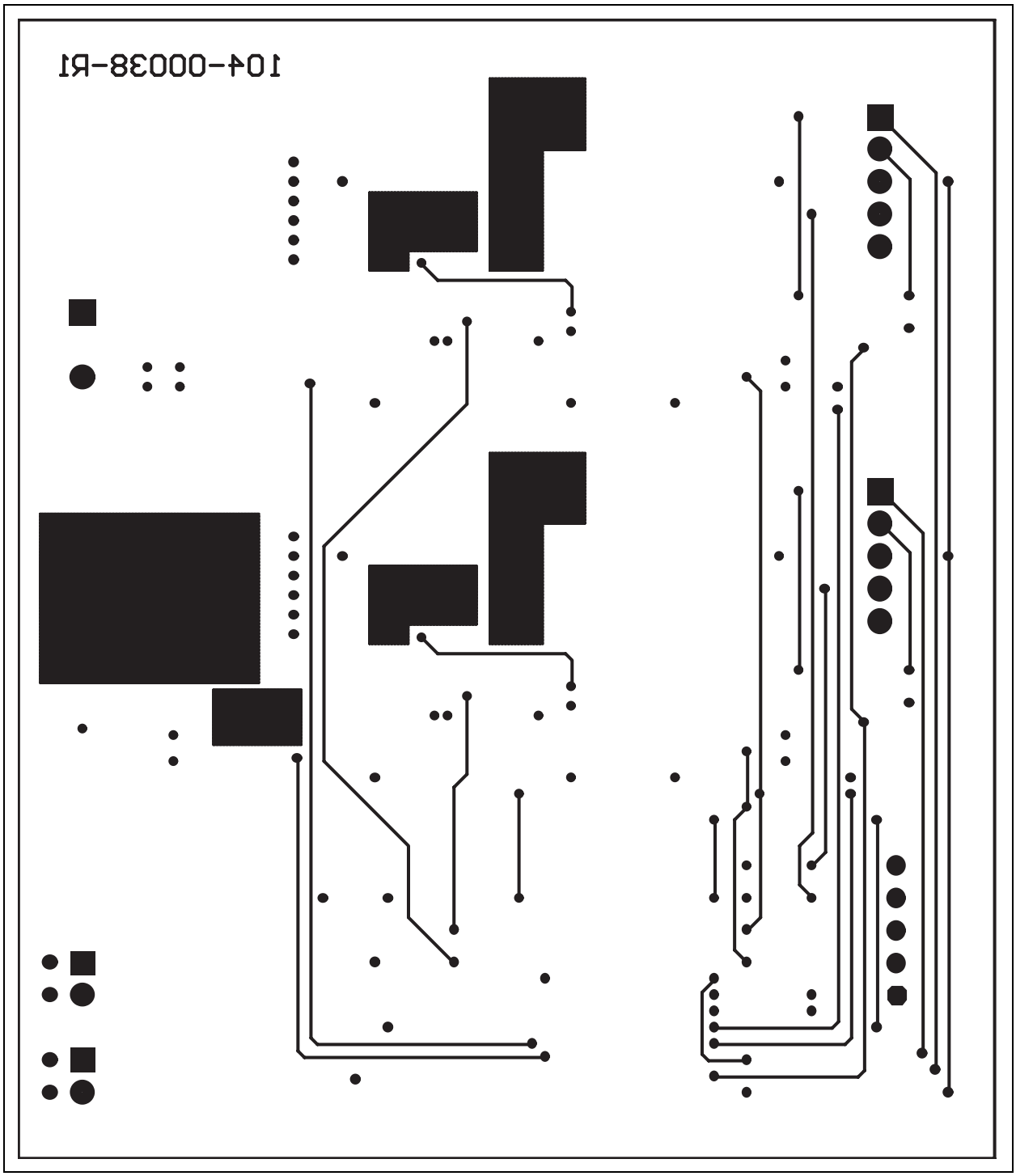
A.6 BOARD – MID-LAYER 1



A.7 BOARD – MID-LAYER 2



A.8 BOARD – BOTTOM LAYER



Appendix B. Bill-Of-Materials (BOM)

TABLE B-1: BILL-OF-MATERIALS (BOM)

Qty	Reference	Description	Mfgr.	Part Number
2	C1, C15	1 µF, X7R Ceramic, 50V, 1206	TDK Electronic Co., LTD	C3216X7R1H105K
5	C2, C3, C13, C14, C18	10 µF, Y5U Ceramic, 50V, 1210	Panasonic®	ECJ-4YF1H106Z
4	C4, C5, C16, C17	10 µF, X5R Ceramic, 10V, 1206	Panasonic	ECJ-3YB1A106M
4	C6, C19, R18, R40	DNP		
6	C7, C20, C27, C28, C29, C30	0.01 µF, X7R Ceramic, 50V, 0805	Panasonic	ECJ-2VB1H103K
2	C8, C22	1500 pF, X7R Ceramic, 100V, 0805	Panasonic	ECJ-2VB2A152K
2	C9, C25	0.022 µF, X7R Ceramic, 50V, 0805	Panasonic	ECJ-2VB1H223K
4	C10, C21, C26, C31	4.7 µF, X5R Ceramic, 6.3V, 0805	Panasonic	ECJ-2FB0J475M
5	C11, C12, C23, C24, C32	0.1 µF, X7R Ceramic, 16V, 0805	Panasonic	ECJ-2VB1C104K
2	D1, D2	Schottky Diode, 40V, 3A, SMA	Diodes Inc.	B340A-13
1	D3	Shunt Regulator, SOT23-5	Texas Instruments Inc.	TL431IDBVR
2	D4, D5	Red LED, 0805	Lumex® Opto/Components	SML-LXT0805IW-TR
2	D6, D8	Green LED, 0805	Lumex Opto/Components	SML-LXT0805GW-TR
1	D7	Dual Schottky, 45V, 75 mA, S-MINI 4P	Panasonic	MA4ZD0300L
1	F1	Polyswitch, 2.0A, Resettable, MINISMDC	Raychem®	MINISMDC200-2
2	JP1, JP3	Connector Header, 5 Pos., 2.54mm, Friction Lock, HDR1X5-FL	Molex®/Waldon®	22-23-2051
1	JP2	Connector Terminal Block, 2-Pos., 5.08mm, TB508-2	Phoenix Contact	1729128
1	JP4	Connector Header, 5 Pos., 2.54mm, HDR1X5	Molex	22-03-2051
2	JP5, JP6	Connector Terminal Block, 2-Pos., 2.54mm, TB254-2	Phoenix Contact	1725656
2	L1, L3	Power Inductor, 15 µH, 1.47A, CDRH74	Sumida Corporation®	CDRH74-150MC
2	L2, L4	Power Inductor, 15 µH, 3.6A, CDRH104R	Sumida Corporation	CDRH104R-150NC
2	Q1, Q2	N-channel MOSFET, SOIC8	International Rectifier	IRF7478
1	Q3	NPN Transistor, SOT23-6	Zetex® Inc.	ZXT10N50DE6TA
8	R1, R2, R3, R4, R21, R22, R23, R24	0.22Ω, 1/4W, Chip Resistor, 1206	Panasonic	ERJ-8RQFR22V

TABLE B-1: BILL-OF-MATERIALS (BOM) (CONTINUED)

Qty	Reference	Description	Mfgr.	Part Number
14	R5, R8, R9, R27, R29, R37, R50, R53, R54, R56, R57, R59, R60, R61	1.00 kΩ, 1/10W, Chip Resistor, 0805	Panasonic	ERJ-6ENF1001V
13	R6, R13, R14, R20, R28, R32, R35, R44, R46, R49, R52, R55, R62	10.0 kΩ, 1/10W, Chip Resistor, 0805	Panasonic	ERJ-6ENF1002V
6	R7, R25, R26, R33, R34, R36	7.87 kΩ, 1/10W, Chip Resistor, 0805	Panasonic	ERJ-6ENF7871V
8	R10, R15, R17, R19, R30, R39, R41, R43	100 kΩ, 1/10W, Chip Resistor, 0805	Panasonic	ERJ-6ENF1003V
2	R11, R31	10.0Ω, 1/10W, Chip Resistor, 0805	Panasonic	ERJ-6ENF10R0V
7	R12, R42, R45, R47, R48, R51, R58	47.5 kΩ, 1/10W, Chip Resistor, 0805	Panasonic	ERJ-6ENF4752V
2	R16, R38	147 kΩ, 1/10W, Chip Resistor, 0805	Panasonic	ERJ-6ENF1473V
2	U1, U4	PWM Building Block, MSOP8	Microchip Technology Inc.	MCP1630-I/MS
2	U2, U5	Dual Op Amp 10 MHz, MSOP8	Microchip Technology Inc.	MCP6292-E/MS
2	U3, U6	Bilateral Switch, SOT23-5	Texas Instruments Inc.	SN74LVC1G66DBVR
1	U7	D-Type Flip-Flop, US8	Fairchild®	NC7SZ74K8X
1	U8	Enhanced Flash, SOIC28	Microchip Technology Inc.	PIC18F2410-I/SO
1	U9	Dual Inverter, SOT23-6	Texas Instruments Inc.	SN74LVC2G14DBVR

Appendix C. Evaluation Board Firmware

C.1 DEVICE FIRMWARE

For the latest version of the MCP1630 Li-Ion Multi-Bay Battery Charger firmware, visit our web site at www.microchip.com.

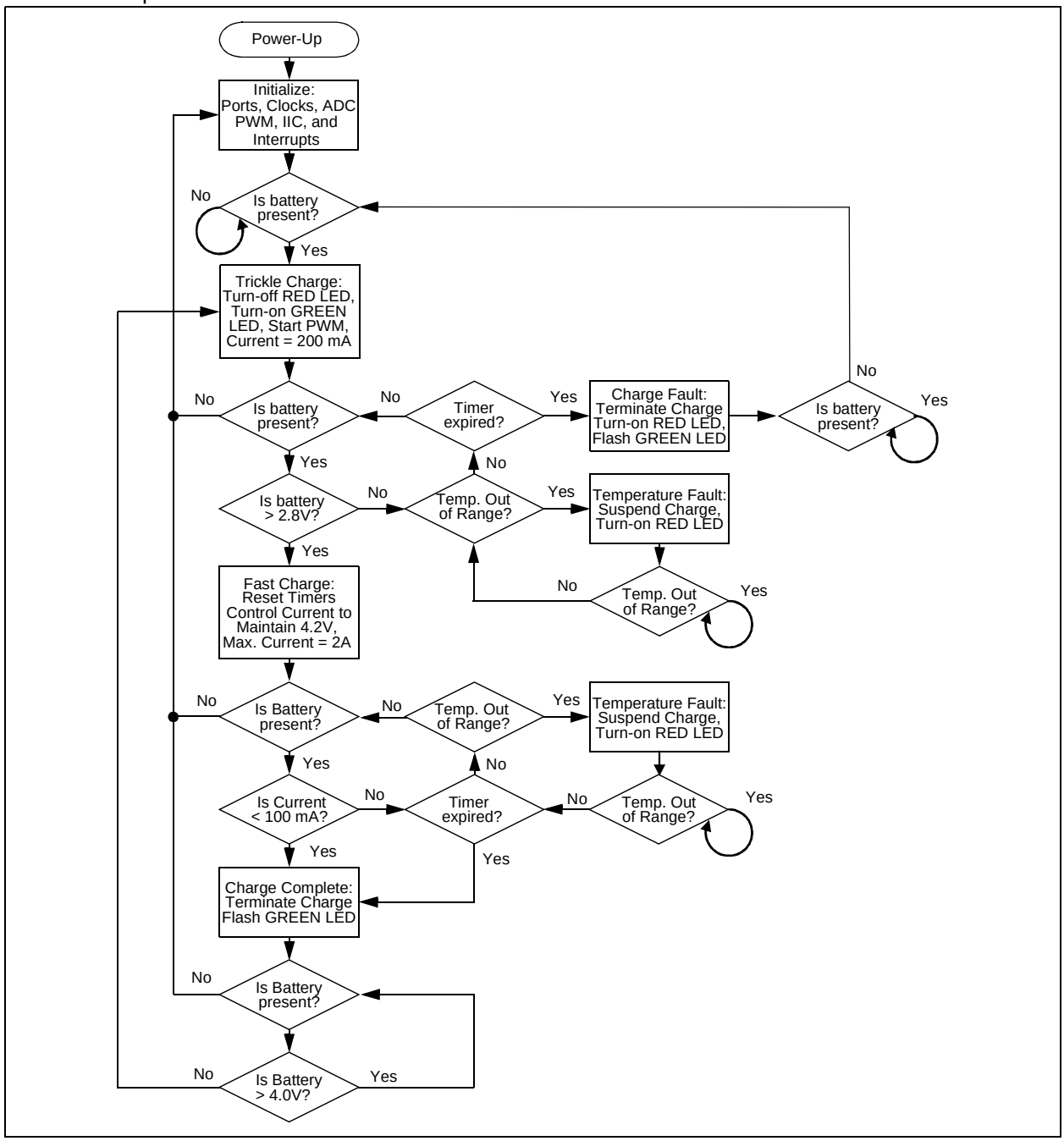


FIGURE C-1: *Firmware Flowchart - Page 1*

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Fax: 81-45-471-6122

Korea - Seoul
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Fax: 82-2-558-5932 or
82-2-558-5934

Singapore
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Taiwan - Hsinchu
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Denmark - Ballerup
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France - Massy
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Germany - Ismaning
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10/20/04