MCP1630 NiMH Demo Board
User's Guide

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MCP1630 NiMH Demo Board User's Guide

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Preface

INTRODUCTION

This section contains general information that will be useful to know before using the MCP1630 NiMH Charger and Fuel Gauge. This demo board supports the use of the MCP1630, MCP1700, TC1047A, TC54, MCP6042 and the PIC16LF818. This section covers the following topics:

- About this Guide
- Recommended Reading
- The Microchip Internet Web Site
- Customer Support

ABOUT THIS GUIDE

Document Layout

This document describes how to use the MCP1630 NiMH Demo Board User's Guide.

The User's Guide layout is as follows:

- **Chapter 1: Product Overview** – Important information about the MCP1630 NiMH Charger and Fuel Gauge.
- **Chapter 2: MCP1630 NiMH Charger and Fuel Gauge** – This chapter includes instructions on how to get started, as well as a description of the demo board.
- **Appendix A: Schematic and Layouts** – Shows the schematic and layout diagrams for the MCP1630 NiMH Charger and Fuel Gauge.
- **Appendix B: Bill of Materials** – Lists the parts used to build the MCP1630 NiMH Charger and Fuel Gauge.
- **Appendix C: Firmware -** Provides information about the application firmware and where the source code can be found.

RECOMMENDED READING

For more information regarding the MCP1630 device, the following is recommended reading.

MCP1630 Data Sheet, (DS21896)

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

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Microchip provides easy access to our documentation and on-line support through our Worldwide Web Site at www.microchip.com. You can download files from the web site or from our FTP site at ftp:\\.microchip.com.

- The Microchip web site also has an Infrared Design Center web page which centralizes information regarding the IrDA® Standard products.

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- Corporate Applications Engineer (CAE)
- Hot Line

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Corporate applications engineers (CAEs) may be contacted at (480) 792-7627.

In addition, there is a Systems Information and Upgrade Line. This line provides system users a listing of the latest versions of all of Microchip's development systems software products. Plus, this line provides information on how customers can receive any currently available upgrade kits.

The Hot Line Numbers are:

- 1-800-755-2345 for U.S. and most of Canada, and
- 1-480-792-7302 for the rest of the world.

Chapter 1. Product Overview

1.1 INTRODUCTION

The MCP1630 NiMH Demo Board is used to evaluate the Microchip MCP1630 used in a SEPIC power-converter application. The evaluation board is a complete stand-alone 4-cell NiMH battery charger that utilizes an 8V to 15V input capable of charging 4 NiMH batteries in series.

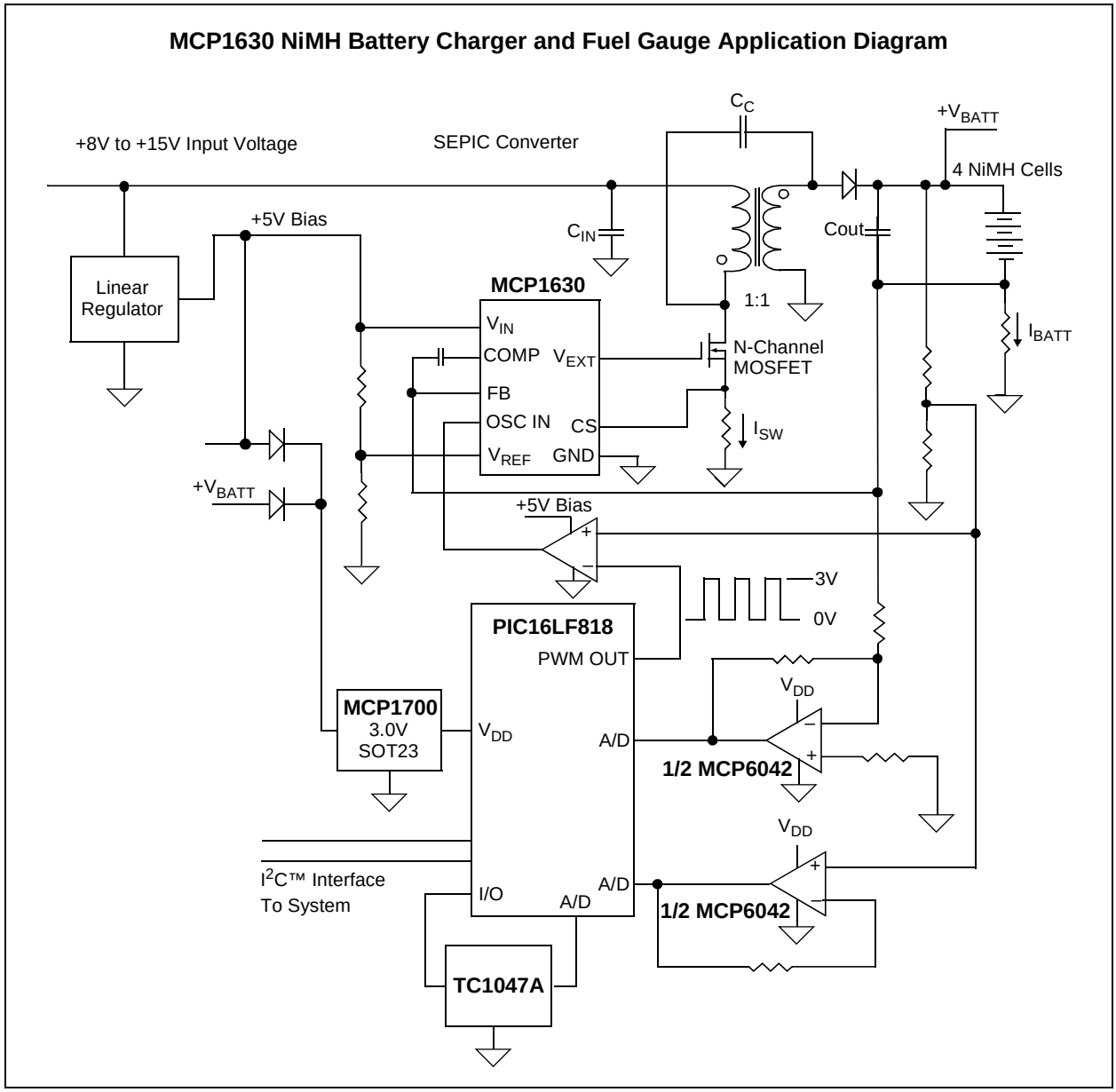


FIGURE 1-1: *NiMH Charger Block Diagram.*

1.2 WHAT IS THE MCP1630 NIMH DEMO BOARD?

The MCP1630 NiMH Demo Board is a complete stand-alone constant current battery charger and simple fuel gauge for four Nickel Metal Hydride series batteries. This board utilizes Microchip's MCP1630 (High-Speed PIC® MCU PWM MSOP-8), MCP1700T (LDO Regulator SOT-23), MCP6042T (Op Amp MSOP-8), PIC16LF818 (MCU Flash 20SSOP), TC54 (Voltage Detector SOT-23A) and TC1047A (Temp-Volt Converter SOT-23B). The input voltage range for the demo board is 8V to 15V. The output is capable of charging four NiMH batterys with up to 1.6V per cell at a fast charge rate of 500 mA contant current.

Input terminals are provided to apply an intput voltage to the charger. Output terminals are also provided as a way to connect the external NiMH batteries or a simulated battery load.

1.3 WHAT THE MCP1630 NIMH DEMO BOARD KIT INCLUDES

This MCP1630 NiMH Demo Board Kit includes:

- The MCP1630 NiMH Demo Board
- MCP1630 NiMH Demo Board User's Guide (DS51505)
- MCP1630 data sheet (DS21896)

Chapter 2. MCP1630 NiMH Demo Board

2.1 INTRODUCTION

The MCP1630 NiMH Demo Board demonstrates Microchip's MCP1630 High-Speed Pulse Width Modulator (PWM) used in a smart battery-charger application. The MCP1630 is a high-speed, microcontroller-adaptable PWM that, when used in conjunction with a microcontroller, will control the power system duty cycle to provide output voltage or current regulation. The PIC16LF818 microcontroller can be used to regulate output voltage or current, switching frequency and maximum duty cycle. The MCP1630 generates pulse-by-pulse duty cycle, provides fast overcurrent protection and utilizes variable external inputs. External signals include the input oscillator and the reference voltage. The power train signals include the current sense and the feedback voltage; the output signal is a square-wave pulse. The power train used for the MCP1630 NiMH Demo Board is a Single-Ended Primary Inductive Converter (SEPIC).

2.2 FEATURES

The MCP1630 NiMH Demo Board has the following features:

- Programmed charge currents:
  - Fast Charge = 500 mA
  - Trickle Charge = 50 mA
  - Top-Off Charge = 25 mA
- Overvoltage protection (battery removed)
- Overcharge protection to prevent the battery from becoming dangerously overcharged
- Overdischarge protection to prevent the battery from being damaged
- Overcurrent protection in the event of a shorted battery
- Battery reversal protection
- Input short circuit protection
- Fast charge termination if the battery or ambient temperature is too high
- Soft-start capability by holding the reference voltage low during power-up
- The MCP1630 NiMH Demo Board terminates charge by detecting a predefined change in voltage with respect to time, a specified temperature or specified elapsed time
- A simple fuel gauge that has a dual MCP6042 amplifier, a 1-channel sense voltage and a 1-channel sense current
- The MCP1630 NiMH Demo Board has the flexibility to optimize the charging algorithm for new battery technology and add proprietary features by coding the microcontroller
- Ability to adapt to environmental effects, such as ambient temperature
- Uses a very low standby current of 29 µA

2.3 GETTING STARTED

The MCP1630 NiMH Demo Board is fully assembled and tested for charging four 1,000 mA/hour NiMH batteries in series from 3.2V to 6V in accordance with the recommended charge profile for NiMH batteries. This board requires the use of an external input voltage source (+8V to +15V) and external load (battery or simulated battery load). It is recommended that four NiMH cells connected in series to act as a load or the recommended simulated load be used.

2.3.1 Power Input and Output Connections

1. Powering the MCP1630 NiMH Demo Board.
   - Apply the input voltage to the surface mount test points provided. The input voltage source should be limited to the 0V to +15V range. For normal operation, the input voltage should be between +8V and +15V. However, the input voltage must not exceed +15V maximum. The source current necessary to regulate the output voltage to 6.4V at 500 mA should be a minimum of approximately 800 mA.
   - Connect the positive side of the input source (+) to test point TP2. Connect the negative (or return side) (–) of the input source to the GND test point TP3. TP2 is located just above TP3 in the upper-left corner of the board.
2. Applying the load to the MCP1630 NiMH Demo Board.
   - To apply a load to the MCP1630 NiMH Demo Board, the positive side of the load (+) should be connected to test point TP1. The negative side of the load (–) should be connected to test point TP4. Care should be taken when using electronic or ground-referenced loads, and never connect TP4 to ground. The battery current sense is referenced in the return leg, so connecting TP4 to ground will short out the current sense. The typical charge current is 50 mA while the battery is in the Trickle Charge mode or the battery voltage is below 0.8V/cell. The current is typically 500 mA when the battery is in the Fast Charge mode and typically 25 mA when the battery is in the Top-off Charge mode. The charge current is automatically regulated by the MCP1630.
   - The code will prevent the board from entering the 500 mA Fast Charge mode if the battery terminal voltage is less than 3.2V (0.8V / Cell). During power up, the board will always trickle charge first, so using a purely resistive load will not work for trickle and fast charge currents. The best way to evaluate the charger is to use four series NiMH batteries or the recommended simulated battery load.

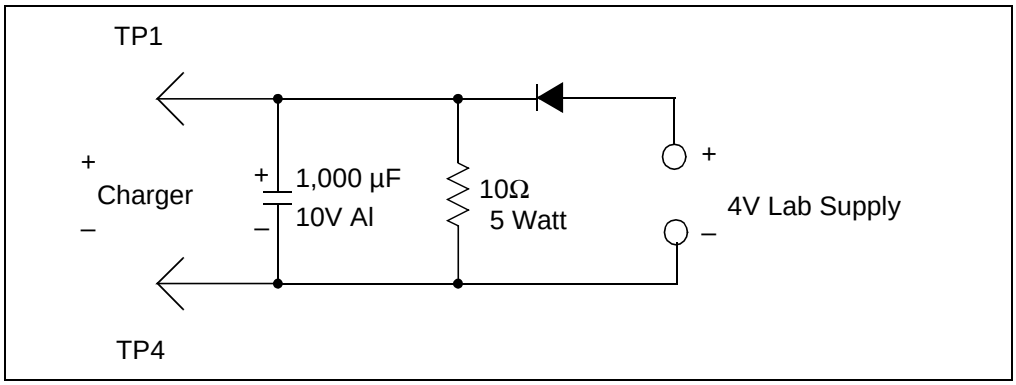


FIGURE 2-1: *Simulated Battery Load.*

3. Status LEDs
   - The MCP1630 NiMH Demo Board has two LEDs. D_1 is a red LED that is used to indicate when input power is available. When the +12V input is connected, D_1 will be illuminated. The other LED (D_9) has two LEDs built into a SOT-23 package. These can be off, red, green or both on (amber). To conserve energy, D_9 is never illuminated when there is no input power. If both LEDs are off, that is an indication there is no power supplied to the board input.
   - Under normal power-up conditions, the charger will begin with a 50 mA trickle charge. The microcontroller will then check the status of the batteries to ensure that they are present, their temperature is within range and the series voltage is within specified charging limits. For visual LED charge status, a dual-color SOT-23 LED is used (D_9).
   - D_9 Status Indication Normal Charge Modes

Normal Charge Mode Board Status	Red LED	Green LED
Initial Trickle Charge (50 mA)	ON (Solid)	OFF
Fast Charge (500 mA)	ON (Solid)	ON (Solid)
Final Trickle Charge (50 mA)	OFF	ON (Solid)
Top Off Charge (25 mA)	OFF	ON (Solid)
Charge Complete (0 mA)	OFF	ON (Blinking, 1 sec).
Initial Trickle Charge (50 mA)	ON (Solid)	OFF

   - D_9 Status Indication for Fault Modes

Fault Mode Board Status	Red LED	Green LED
Overvoltage Initial (Restart Initiated)	ON (Blinking)	OFF
Overvoltage (Persistent, Latched-off after 9 attempts)	ON (Blinking Faster)	OFF
Overcurrent	ON Blinking	OFF

4. With no input connected and 4 NiMH batteries used as a load, the MCP1630 NiMH Demo Board will consume approximately 29 µA from the battery.
5. A temperature sensor is provided for charge termination. The sensor (U2) is located on the back of the printed circuit board. To utilize this feature, batteries should be in physical contact with the temperature sensor.
6. Programming.
   - J1 can be used as a Flash programming port to modify the code for prototype applications. The pinout of J1 matches the required pinout for the Microchip ICD2 programmer.

NOTES:

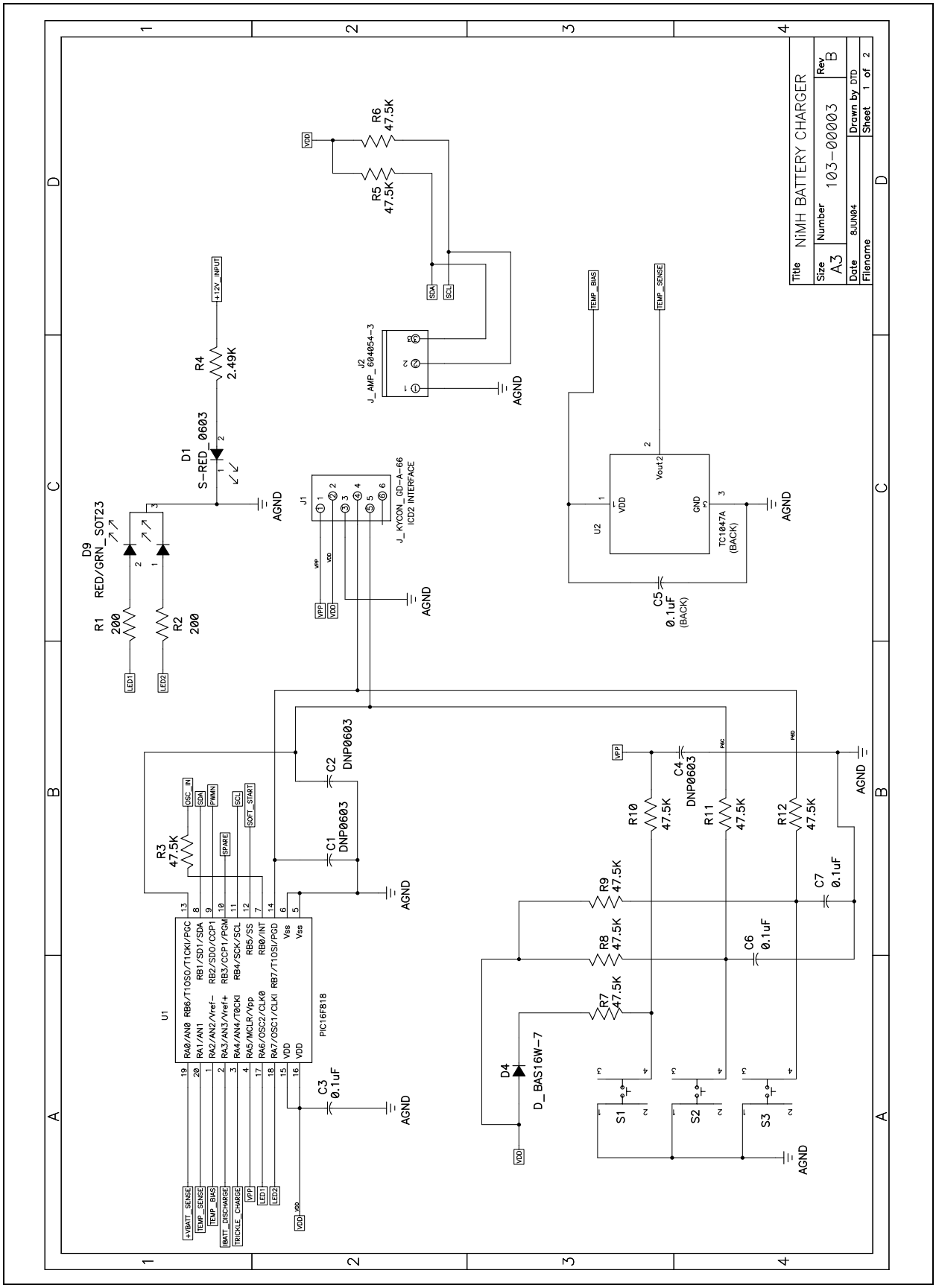
Appendix A. Schematic and Layouts

A.1 INTRODUCTION

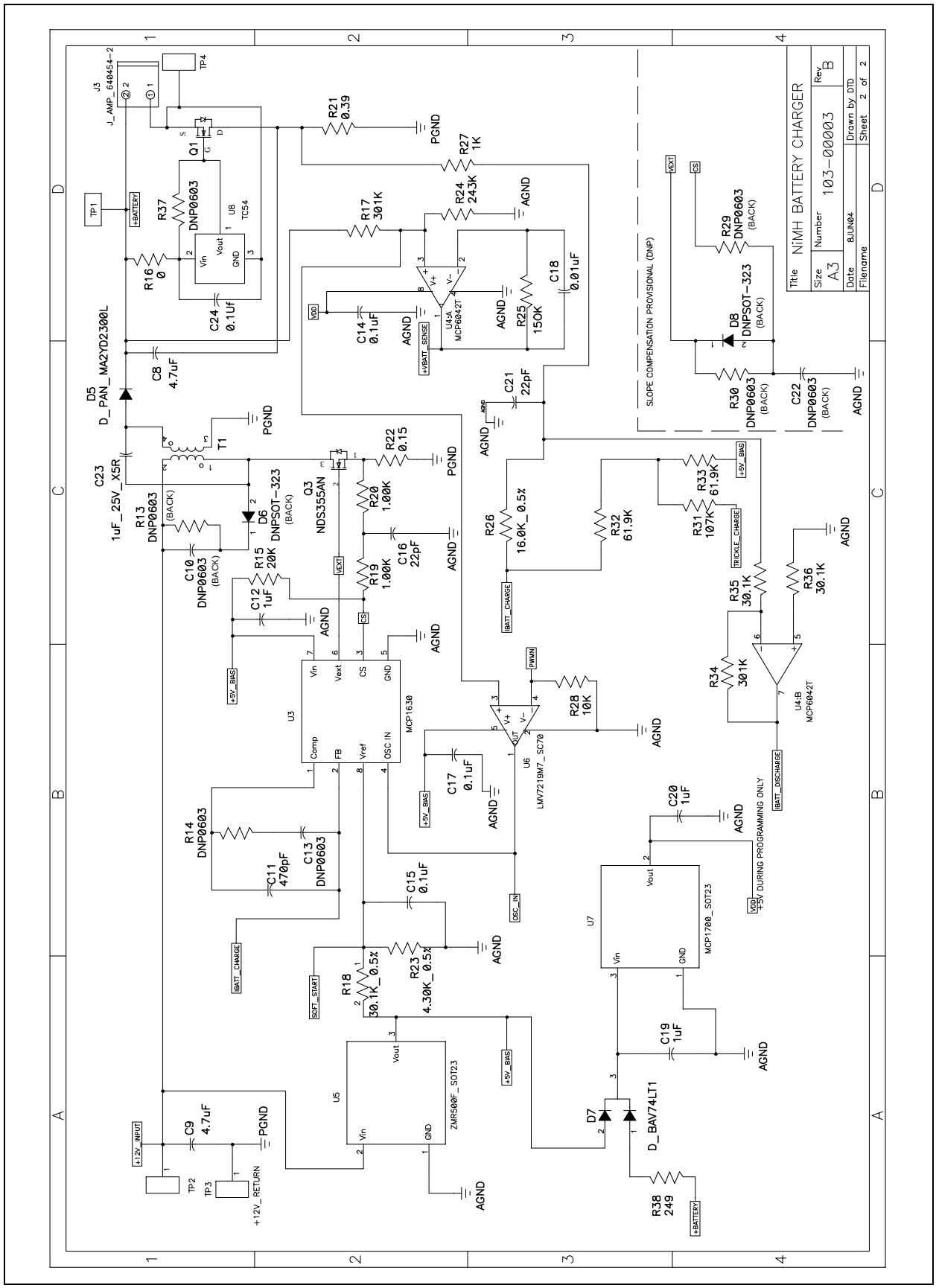
This appendix contains the schematics and layouts for the MCP1630 NiMH Demo Board. The diagrams included in this appendix include:

- Board Schematic
- Board - Top Layer
- Board - Bottom Layer
- Board - Mid Layer 1
- Board - Mid Layer 2

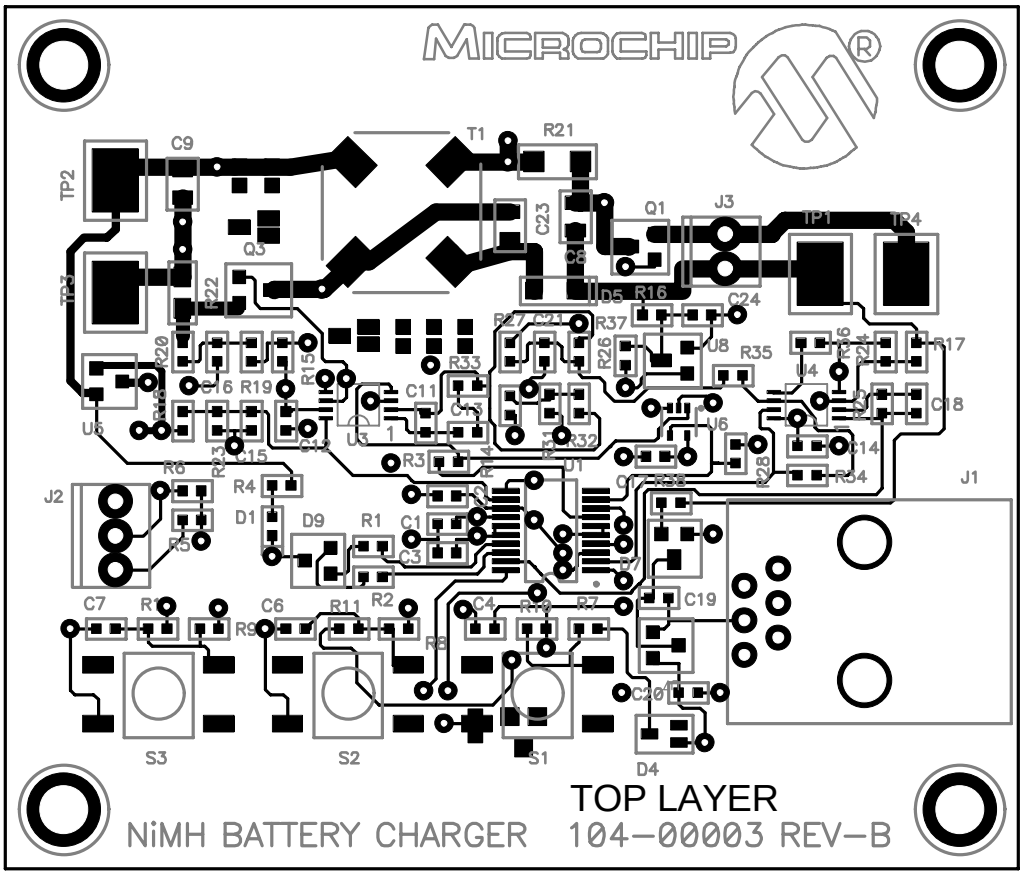
A.2 BOARD SCHEMATIC - PAGE 1



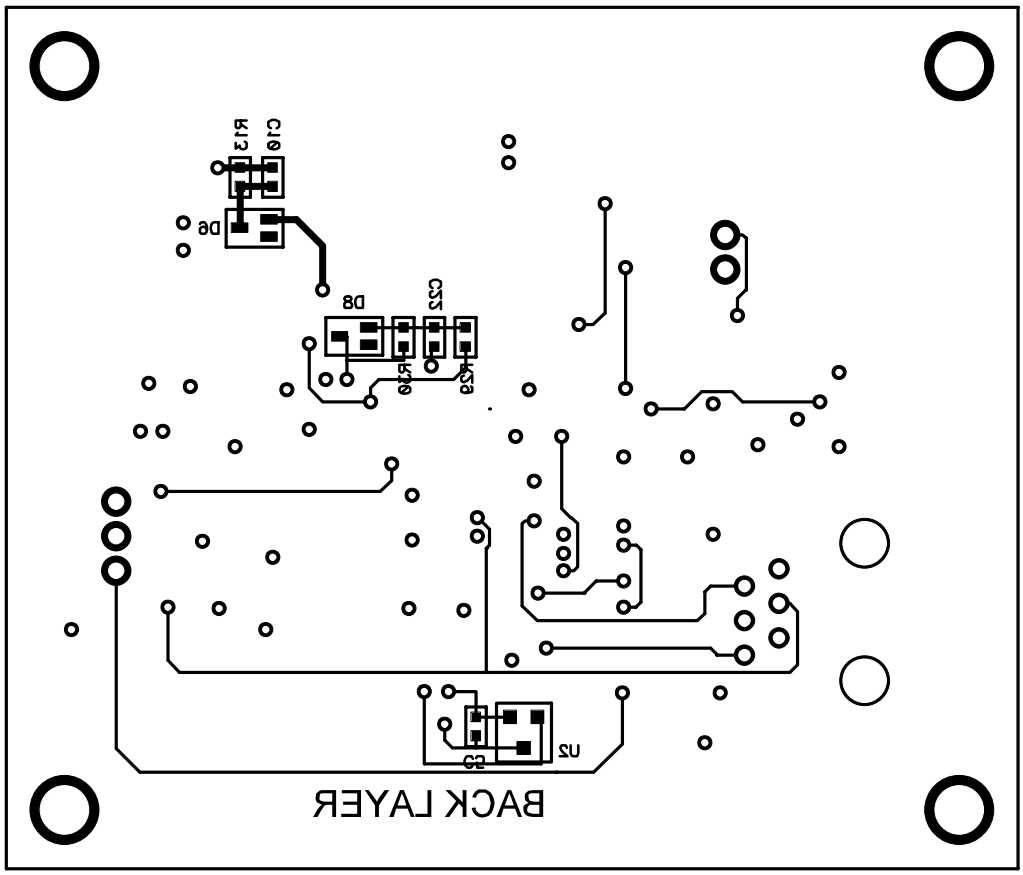
A.3 BOARD SCHEMATIC - PAGE 2



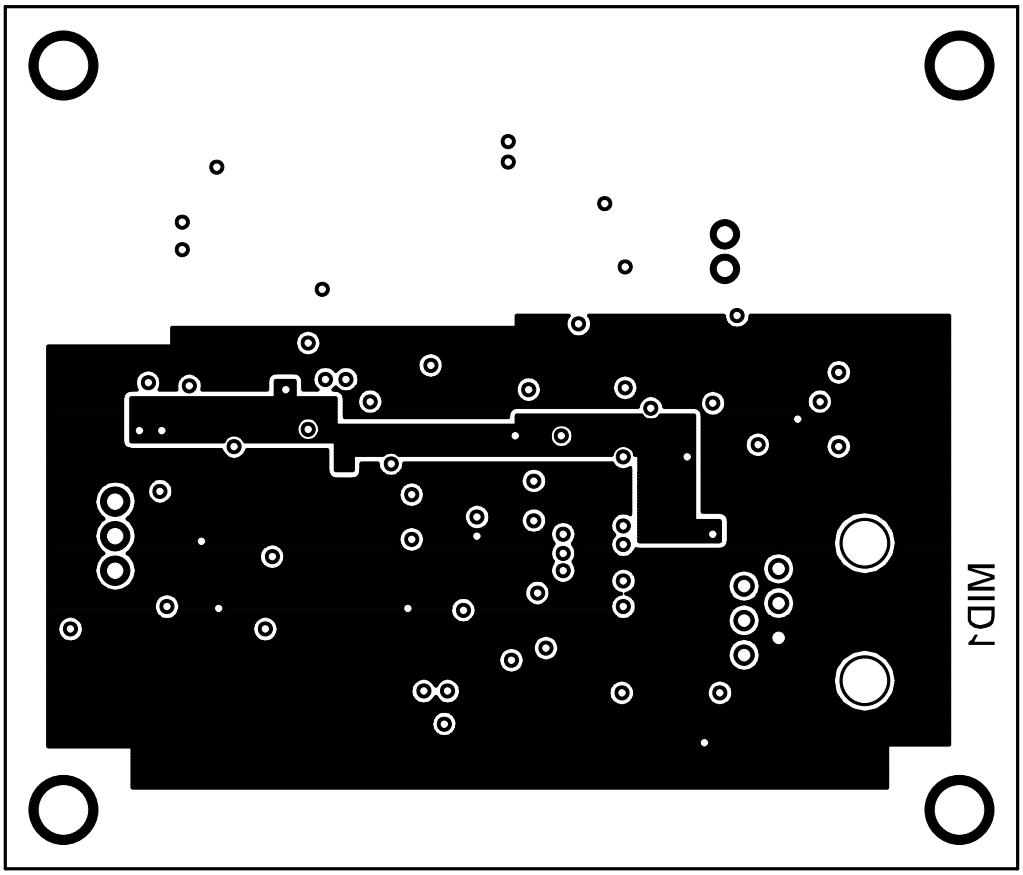
A.4 BOARD - TOP LAYER



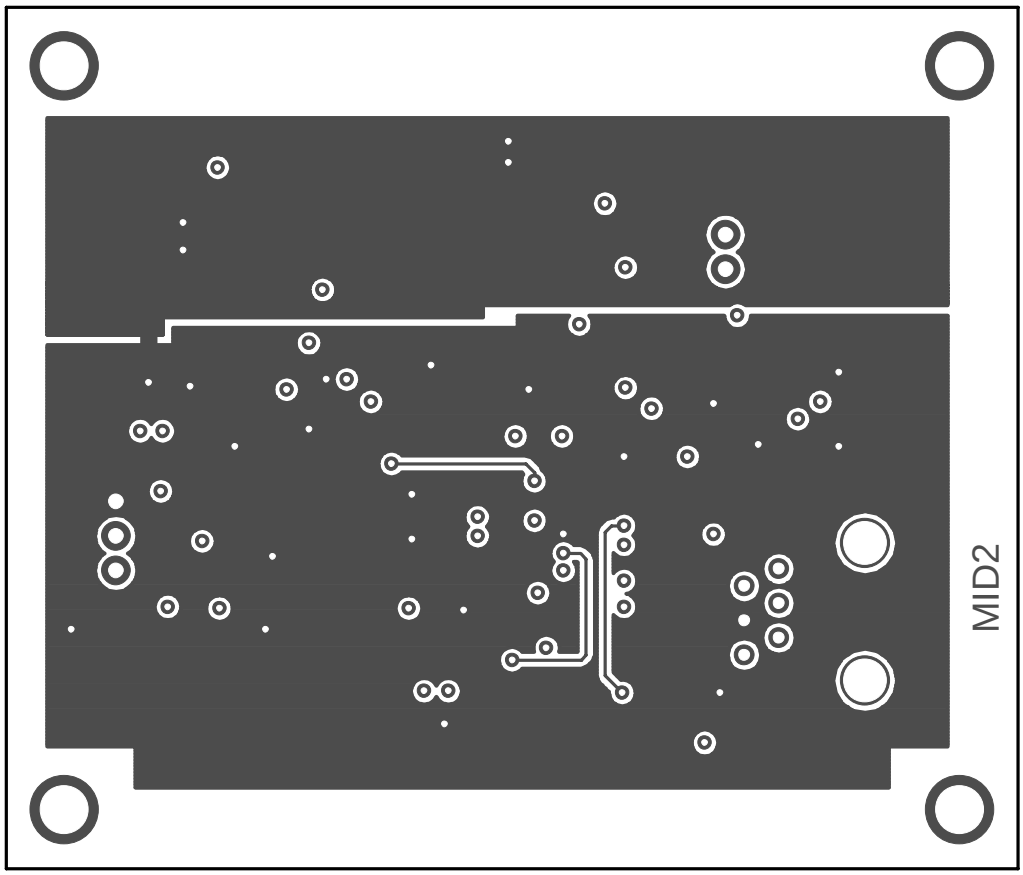
A.5 BOARD - BOTTOM LAYER



A.6 BOARD - MID LAYER 1



A.7 BOARD - MID LAYER 2



NOTES:

Appendix B. Bill Of Materials (BOM)

TABLE B-1: BILL OF MATERIALS

Reference Designator	Qty	Description	Manufacturer	Manufacturer Part Number
Q3	1	MOSFET N-CH 30V 1.7A 3-SSOT	Fairchild® Semiconductor	NDS355AN
Q1	1	HEX/MOS N-CH 20V 4.2A SOT-23	International Rectifier	IRLML2502TR
C18	1	Capacitor, 10000 pF, 50V, Ceramic, X7R 0603	Kemet®	C0603C103K5RACTU
C3,C5,C6,C7,C14, C15,C17,C24	8	Capacitor .10 µF, 10V, Ceramic, X7R 0603	Kemet	C0603C104K8RACTU
C12,C19,C20	3	Capacitor, Ceramic, 1.0 µF 10V 10% X5R 0603	Murata® Electronics North America	GRM188R61A105KA61D
C16,C21	2	Capacitor, Ceramic, 22 pF, 50V, NP0 0603	Kemet	C0603C220J5GACTU
C11	1	Capacitor,Ceramic, 470 pF, 50V, NP0 0603	Panasonic® - ECG	ECJ-1VC1H471J
C1,C2,C4,C10, C13,C22	6	DNP0603	Not Used	Not Used
C23	1	Capacitor, Ceramic, 1 µF, 25V, X5R 0805	Panasonic - ECG	ECJ-2FB1E105K
C8,C9	2	Capacitor, Ceramic, 4.7 µF, 16V, X5R 0805	Panasonic - ECG	ECJ-2FB1C475K
D4	1	Diode Switch, 75V, 200MW, SOT-323	Diodes Inc.	BAS16W-7
D7	1	Diode Switch, Dual CC, 50V, SOT-23	ON Semiconductor®	BAV74LT1
D5	1	Diode, Schottky, 25V, 1.0A, Mini-2P	Panasonic - SSG	MA2YD2300L
D6,D8	2	DNPSOT-323	Not Used	Not Used
T1	1	8th-PAK, SMT, Dual, Inductor	BH Electronics®	511-1016
J2	1	Conn Header, Vert 3pos .100 Tin	AMP/ Tyco Electronics	640454-3
J3	1	Conn Header, Vert 2pos .100 Tin	AMP/ Tyco Electronics	640454-2
J1	1	Modjack Rt< 6p6c Black	Kycon	GD-A-66
D1	1	LED, 660NM, Super Red, Diff 0603SMD	Lumex® Opto/ Components Inc.	SML-LX0603SRW-TR
D9	1	LED, Dual, Red/Green/Clear SOT-23	Lumex Opto/ Components Inc.	SSL-LX15IGC-RP-TR
U6	1	IC Comparator, R-R Out, SC-70-5	National Semiconductor™	LMV7219M7
U3	1	High Speed, PIC, PWM, MSOP8	Microchip Technology Inc.	MCP1630
U7	1	IC, LDO Reg, 250 ma, 3.0V, SOT-23	Microchip Technology Inc.	MCP1700T-3002E/TT
U4	1	IC Op Amp, 1 µa, 1.4V, Dual R-R, MSOP8	Microchip Technology Inc.	MCP6042T-I/MS
U1	1	IC MCU Flash, 1k x 14, EEPROM, 20SSOP	Microchip Technology Inc.	PIC16LF818-I/SS
R16	1	Resistor, ZEROΩ ,1/10W, 5%, 0603 SMD	Panasonic - ECG	ERJ-3GEY0R00V

TABLE B-1: BILL OF MATERIALS (CONTINUED)

Reference Designator	Qty	Description	Manufacturer	Manufacturer Part Number
R19, R20, R27	3	Resistor, 1.00 kΩ, 1/16W, 1%, 0603 SMD	Panasonic - ECG	ERJ-3EKF1001V
R4	1	Resistor, 2.49 kΩ, 1/16W, 1%, 0603 SMD	Panasonic - ECG	ERJ-3EKF2491V
R23	1	Resistor, 4.3 kΩ, 1/16W, .5%, 0603 SMD	Susumu Co Ltd	RR0816P-432-D
R28	1	Resistor, 10.0 kΩ, 1/16W, 1%, 0603 SMD	Panasonic - ECG	ERJ-3EKF1002V
R25	1	Resistor, 150 kΩ, 1/16W, 1%, 0603 SMD	Panasonic - ECG	ERJ-3EKF1503V
R26	1	Resistor, 16.0 kΩ, 1/16W, .5%, 0603 SMD	Susumu Co Ltd	RR0816P-163-D
R15	1	Resistor, 20 kΩ, 1/16W, .1%, 0603 SMD	Panasonic - ECG	ERA-3YEB203V
R35,R36	1	Resistor, 30.1 kΩ, 1/16W, 1%, 0603 SMD	Panasonic - ECG	ERJ-3EKF3012V
R18	1	Resistor, 30.1 kΩ, 1/16W, .5%, 0603 SMD	Susumu Co Ltd	RR0816P-3012-D-47C
R3,R5,R6,R7, R8,R9,R10,R11, R12	9	Resistor, 47.5 kΩ,1/16W, 1%, 0603 SMD	Panasonic - ECG	ERJ-3EKF4752V
R32,R33	2	Resistor, 61.9 kΩ, 1/16W, 1%, 0603 SMD	Panasonic - ECG	ERJ-3EKF6192V
R31	1	Resistor, 107 kΩ, 1/16W, 1%, 0603 SMD	Panasonic - ECG	ERJ-3EKF1073V
R1,R2	2	Resistor, 200Ω, 1/16W, 1%, 0603 SMD	Panasonic - ECG	ERJ-3EKF2000V
R38	1	Resistor, 249Ω, 1/16W, 1%, 0603 SMD	Panasonic - ECG	ERJ-3EKF2490V
R24	1	Resistor, 243 kΩ, 1/16W, 1%, 0603 SMD	Panasonic - ECG	ERJ-3EKF2433V
R17,R34	2	Resistor, 301 kΩ, 1/16W, 1%, 0603 SMD	Panasonic - ECG	ERJ-3EKF3013V
R13,R14,R29, R30,R37	5	DNP0603	Not Used	Not Used
R22	1	Resistor, .15Ω, 1/8W, 5%, 0805 SMD	Panasonic - ECG	ERJ-6RSJR15V
R21	1	Resistor, .39Ω, 1/4W, 1%, 1206 SMD	Panasonic - ECG	ERJ-8RQFR39V
S1,S2,S3	3	Switch Tact, 6mm, 260GF SMT	E-Switch, Inc.	TL3301NF260QG
U8	1	IC Volt Detector, 2.9V, SOT23A	Microchip Technology Inc.	TC54VC2902ECB713
U2	1	IC Temp-Volt Conv Prec, SOT-23B	Microchip Technology Inc.	TC1047AVNBTR
TP1,TP2, TP3,TP4	4	PC Test Point Compact SMT	Keystone Electronics®	5016
U5	1	IC V_{REG}, Mini, 5V, 50 ma SOT-23	Zetex® Inc.	ZMR500FTA

Appendix C. Evaluation Board Firmware

C.1 DEVICE FIRMWARE

For the latest version of the MCP1630 NiMH Demo Board User's Guide firmware, visit the Microchip web site at www.microchip.com.

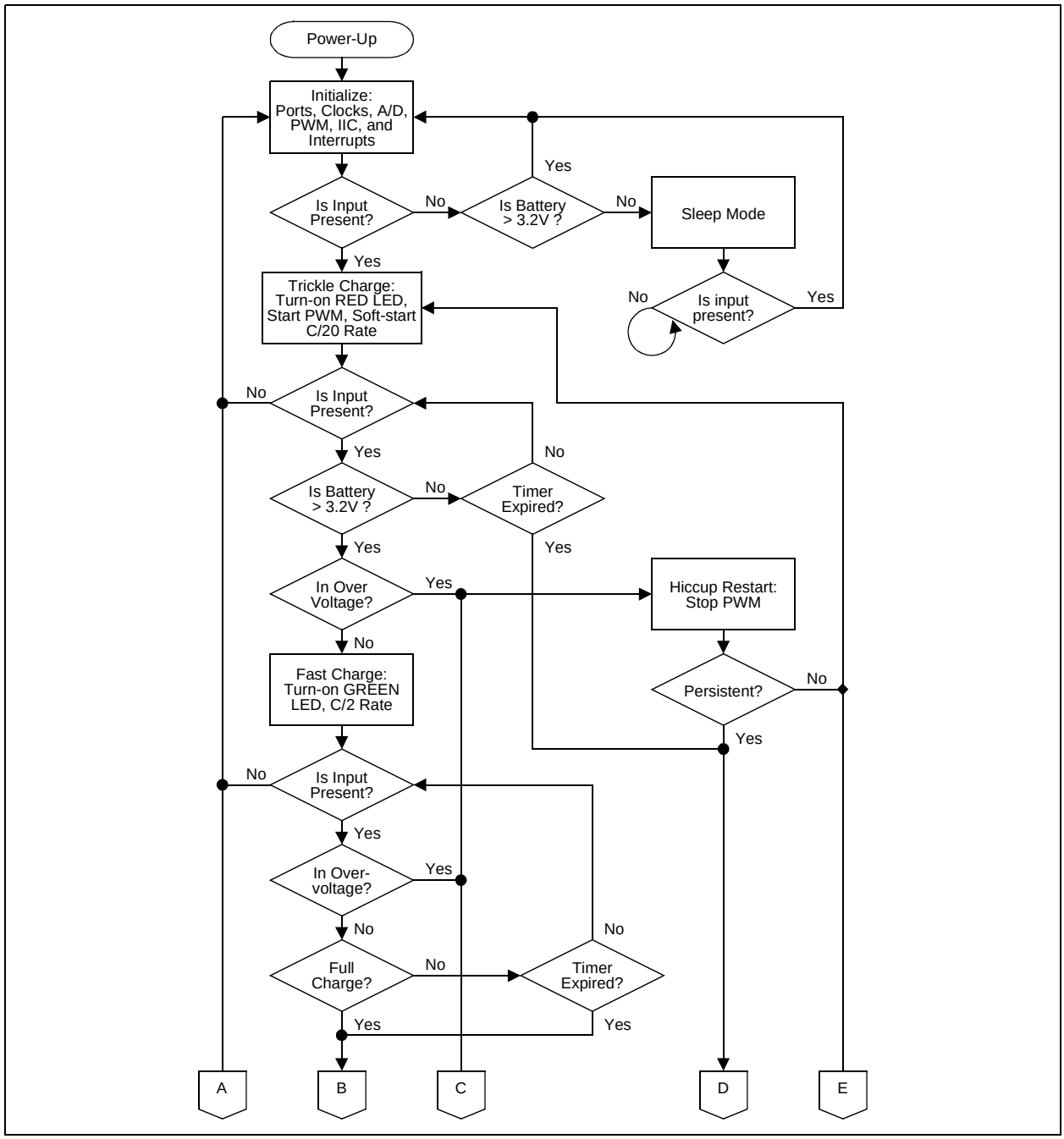


FIGURE C-1: *Firmware Flowcharge - Page 1.*

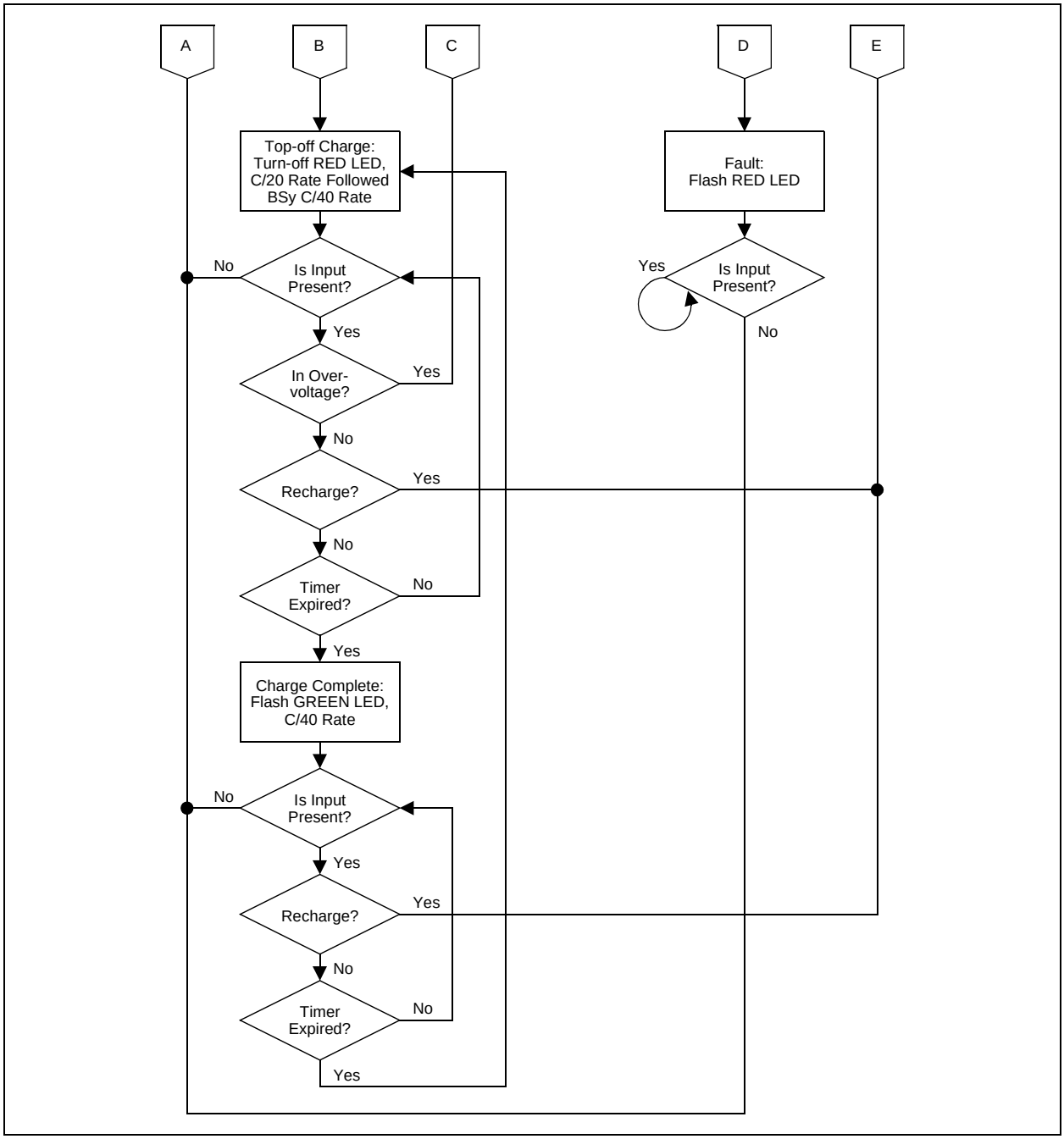


FIGURE C-2: *Firmware Flowchart - Page 2.*

NOTES:

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