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Resistive Temperature Detector (RTD) Reference Design

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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 “DSXXXXA”, where “XXXX” 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 online help files.

INTRODUCTION

This chapter contains general information that will be useful to know before using the RTD Reference Design. 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 RTD Reference Design as a development tool to emulate and debug firmware on a target board. The manual layout is as follows:

- **Chapter 1. “Product Overview”** – Important information about the RTD Reference Design.
- **Chapter 2. “Installation and Operation”** – This chapter includes a detailed description of each function of the demo board and instructions for how to begin using the board.
- **Appendix A. “Schematic and Layouts”** – Shows the schematic and layout diagrams for the RTD Reference Design.
- **Appendix B. “Bill of Materials”** – Lists the parts used to build the RTD Reference Design.

RTD Reference Design

CONVENTIONS USED IN THIS GUIDE

This manual uses the following documentation conventions:

DOCUMENTATION CONVENTIONS

| Description | Represents | Examples |
|--|---|---|
| Arial font: | | |
| Italic characters | Referenced books | <i>MPLAB[®] IDE User's Guide</i> |
| | Emphasized text | ...is the <i>only</i> 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 | <u><i>File>Save</i></u> |
| Bold characters | A dialog button | Click OK |
| | A tab | Click the Power tab |
| N'Rnnnn | A number in verilog format, where N is the total number of digits, R is the radix and n is a digit. | 4'b0010, 2'hF1 |
| Text in angle brackets < > | A key on the keyboard | Press <Enter>, <F1> |
| Courier New font: | | |
| Plain Courier New | 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 |
| | Constants | 0xFF, 'A' |
| Italic Courier New | A variable argument | <i>file.o</i> , where <i>file</i> can be any valid filename |
| Square brackets [] | Optional arguments | mcc18 [options] <i>file</i> [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 the RTD Reference Design. Other useful documents are listed below. The following Microchip documents are available and recommended as supplemental reference resources.

MCP3551 Data Sheet, “Low-Power, Single-Channel 22-Bit Delta-Sigma ADCs” (DS21950)

This data sheet provides detailed information regarding the MCP3551 device.

AN1154 – “Precision RTD Instrumentation for Temperature Sensing” (DS01154)

This application note provides information on the RTD Instrumentation technique for high performance thermal management applications.

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:

- **Product Support** – Data sheets and errata, application notes and sample programs, design resources, user's guides and hardware support documents, latest software releases and archived software
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- Distributor or Representative
- Local Sales Office
- Field Application Engineer (FAE)
- Technical Support

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>

DOCUMENT REVISION HISTORY

Revision A (September 2010)

- Initial Release of this Document.

RTD Reference Design

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Chapter 1. Product Overview

1.1 INTRODUCTION

The following name and assembly number are found on the RTD Reference Design's Printed Circuit Board (PCB):

- 102-00115

1.2 WHAT IS THE RTD REFERENCE DESIGN?

The RTD Reference Design demonstrates how to implement a Resistive Temperature Detector (RTD) and accurately measure temperature. This solution uses the MCP3551 22-Bit Analog-to-Digital Converter (ADC) to measure voltage across the RTD. The ADC and the RTD are referenced using an on-board reference voltage, and the ADC inputs are directly connected to the RTD terminals. This provides a ratio metric temperature measurement. The solution uses a current limiting resistor to bias the RTD. It provides a reliable and accurate RTD instrumentation without the need for extensive circuit compensation and calibration routines.

In addition, this reference design includes a silicon temperature sensor, MCP9804. This sensor is used for comparison only, it is not needed for the RTD instrumentation circuit. The MCP3551 and MCP9804 outputs are read using a USB PIC[®] MCU. This controller is also connected to a PC using USB interface. The Thermal Management software is used to plot the RTD temperature data in strip chart format.

1.3 WHAT THE RTD REFERENCE DESIGN KIT INCLUDES

This RTD Reference Design Kit includes:

- RTD Reference Design, 102-00115
- USB cable
- Important Information Sheet

RTD Reference Design

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Chapter 2. Installation and Operation

2.1 INTRODUCTION

The RTD Reference Design demonstrates Microchip's solution to accurately measure temperature using a 22-bit ADC, MCP3551. This solution eliminates the need for the traditional analog instrumentation system calibration or gain and offset trimming techniques. In addition, the effect of self-heat can be minimized by limiting the RTD biasing current using a single resistor.

This reference design uses the technique described in Application Note AN1154 – “Precision RTD Instrumentation for Temperature Sensing” (DS01154). The RTD Reference Design allows the user to evaluate Microchip's solution to accurately measure temperature using an RTD. RTD resistance availability typically ranges from 100 Ω to 5000 Ω . When biasing an RTD to measure temperature, self-heat due to power dissipation has to be considered. In order to output measurable voltage across the RTD for wide temperature range, the biasing current has to be relatively high. This causes higher power dissipation through heat and skews the temperature reading. This solution uses a ratiometric technique between the RTD resistance and the ADC resolution to achieve high accuracy throughout the entire sensor range.

This solution uses an on-board (local) surface mount RTD and an external RTD. The local and external RTDs are selected using JP2. The MCP9804 temperature sensor is also used to measure local temperature.

The MCP3551 and the MCP9804 serial output lines are connected to a PIC MCU. RTD linearization is computed with the microcontroller. This controller communicates with a PC via the USB interface. The temperature data is then displayed on the PC using the Thermal Management software in strip chart format.

2.2 FEATURES

The RTD Reference Design has the following features:

- Surface mount PT100 RTD
- External RTD connector (not included)
- Thermal Management GUI
- 22-Bit ADC MCP3551
- $\pm 1^{\circ}\text{C}$ Maximum accuracy temperature sensor MCP9804
- PIC18F2550 microcontroller
- USB interface to PC

RTD Reference Design

2.3 GETTING STARTED

This section describes how to quickly configure the RTD Reference Design. A simplified block diagram of the configuration is provided in Figure 2-1.

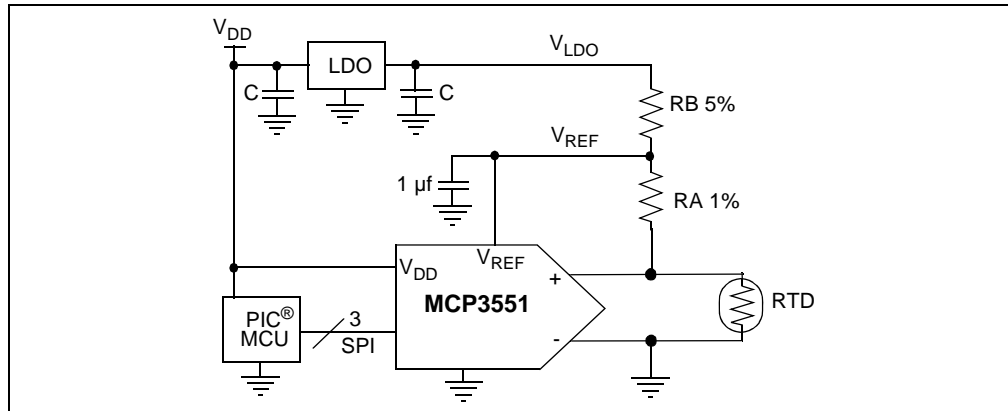


FIGURE 2-1: RTD Reference Design Simplified Block Diagram.

2.3.1 Hardware Setup

1. Connect the USB cable to PC
2. Select JP2 for Local/External RTD
3. Start the Thermal Management software

2.3.2 Software Setup

Once the USB interface is secured, start the Thermal Management Software. When the software starts, if the hardware is successfully detected, the GUI will be displayed (Figure 2-2).

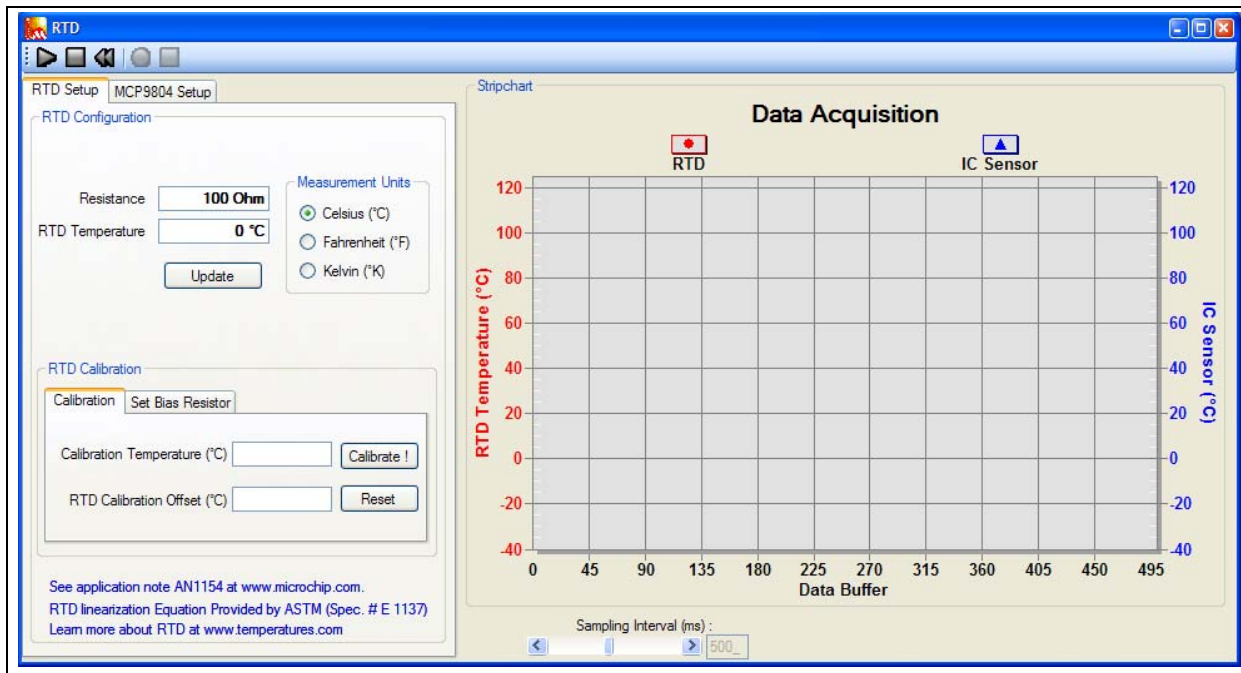


FIGURE 2-2: RTD Reference Design GUI.

Installation and Operation

This Configuration window allows the user to set some parameters, such as measurement unit and calibration temperature.

The **Play**, **Stop**, and **Reset** icons (Figure 2-3) can be used to perform a continuous data-log. The **Record** icon enables the user to data-log to an external file. The logging interval can be adjusted using the Interval Scroll bar from 100 ms to 30s.

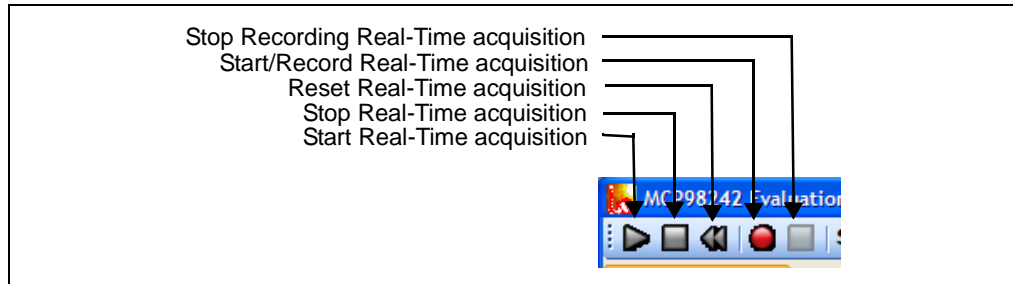


FIGURE 2-3: Real-Time Acquisition.

The RTD temperature is linearized using ASTM specification #E 1137. The linearization is implemented in the PIC MCU.

The Data Acquisition charting tool can be customized by double-clicking the chart, as shown in Figure 2-4. Additional options are available by right-clicking the chart. The user can also zoom into a specific plot range by clicking and dragging the section. The data in the chart can also be exported using the **Export** button.

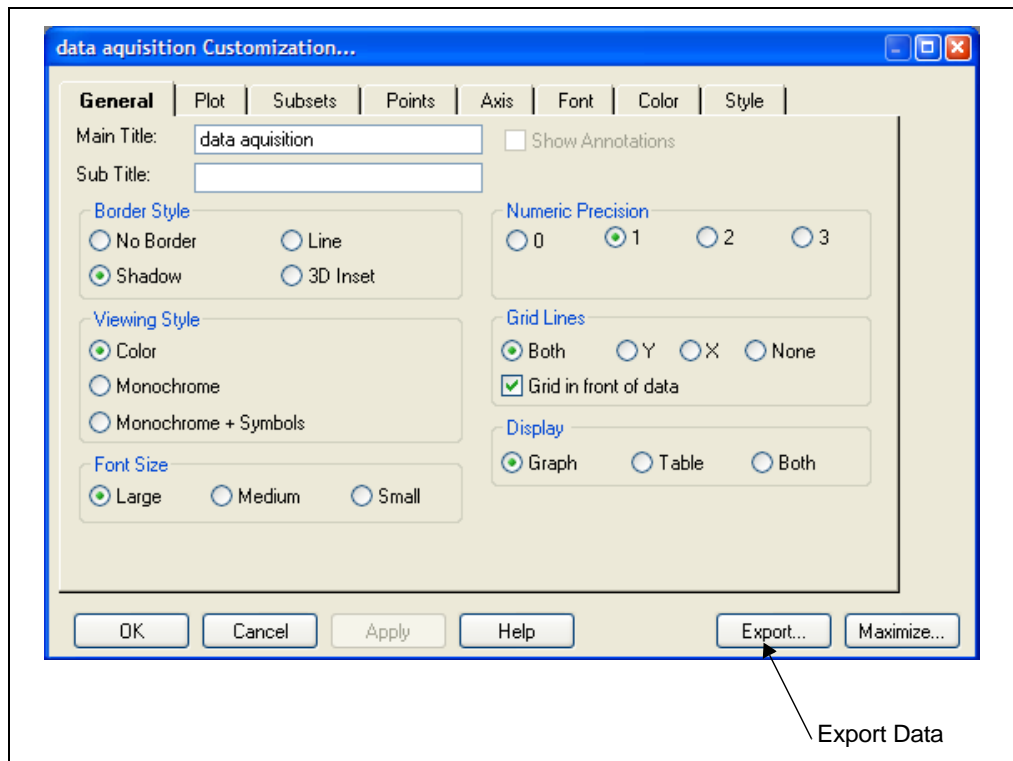


FIGURE 2-4: Chart Setup Options.

RTD Reference Design

2.3.3 Sensor Calibration

2.3.3.1 RTD SETUP

The RTD sensor can be calibrated using the GUI. Once the RTD is exposed to the dies calibration temperature, simply type in the temperature in the Calibration Temperature field and click the **Calibrate** button. When the temperature is calibrated and the calibration offset is stored in the PIC MCU EEPROM, the calibration offset is displayed in the RTD Calibration Offset text box. The **Reset** button resets the calibration offset to “0”.

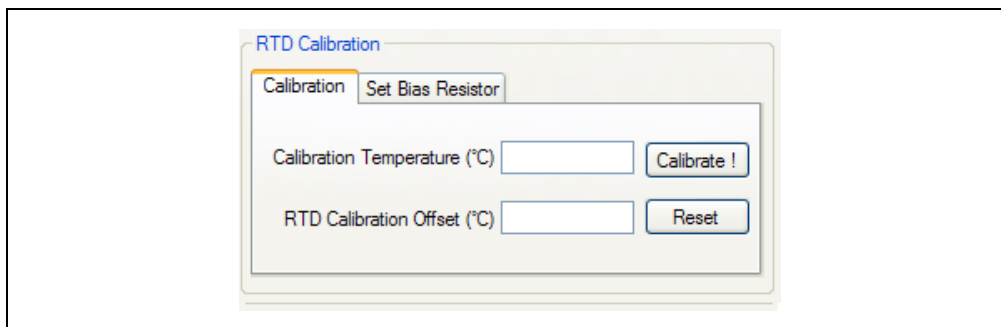


FIGURE 2-5: Sensor Calibration.

The GUI also enables users to set the RTD biasing resistor value, R_9 . If a resistor other than a 100Ω RTD resistor is connected, then replace R_9 (for operation and details refer to AN1154). The **Reset** button sets R_9 to the default value of 6800Ω .

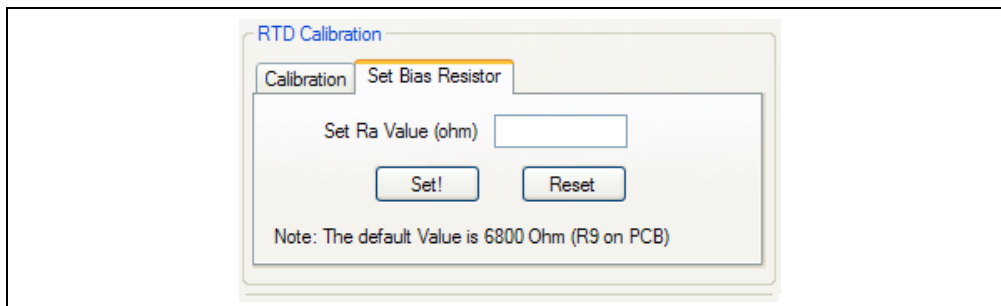


FIGURE 2-6: Setting RTD Biasing Resistor.

2.3.3.2 MCP9804 SETUP

The MCP9804 is a silicon temperature sensor which measures temperature with $\pm 0.25^{\circ}\text{C}$ nominal and $\pm 1^{\circ}\text{C}$ maximum accuracy from -40°C to $+125^{\circ}\text{C}$. This sensor has multiple user programmable features such as Alert Output limits, output hysteresis and mode (see Figure 2-7). The output mode can be set up as either comparator or interrupt output with active-high or active-low levels. The temperature measurement resolution can also be set up.

The screenshot displays the 'MCP9804 Setup' web interface. It features several configuration sections:

- MCP9804 Configuration:**
 - Hysteresis:** Radio buttons for 0°C (selected), 1.5°C, 3°C, and 6°C.
 - Resolution:** Radio buttons for 0.5°C (selected), 0.25°C, 0.125°C, and 0.0625°C.
 - Conversion:** Radio buttons for Continuous (selected) and Shutdown.
- Alert Output Control:**
 - Enable Alert Pin
 - Alert Mode:** Radio buttons for Comparator (selected) and Interrupt.
 - Alert Polarity:** Radio buttons for Active High and Active Low (selected).
 - Buttons for DeAssert and Int. Clear.
 - Alert output for critical Limit Only.
- Temp. Limit Lock:**
 - Tcritical Lock
 - Twindow Lock
 - Reset device Vdd to clear this option
- Registers:**
 - Enable Sensor
 - Update Registers button
 - Capability: 0x00
 - Resolution: 0x0
 - Config: 0x00
 - Temp.: 0 °C
 - Tupper: 0 °C
 - Tlower: 0 °C
 - Tcritical: 0 °C
 - Manu ID: 0x00
 - DevID/Rev: 0x00

FIGURE 2-7: MCP9804 Setup.

RTD Reference Design

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Appendix A. Schematic and Layouts

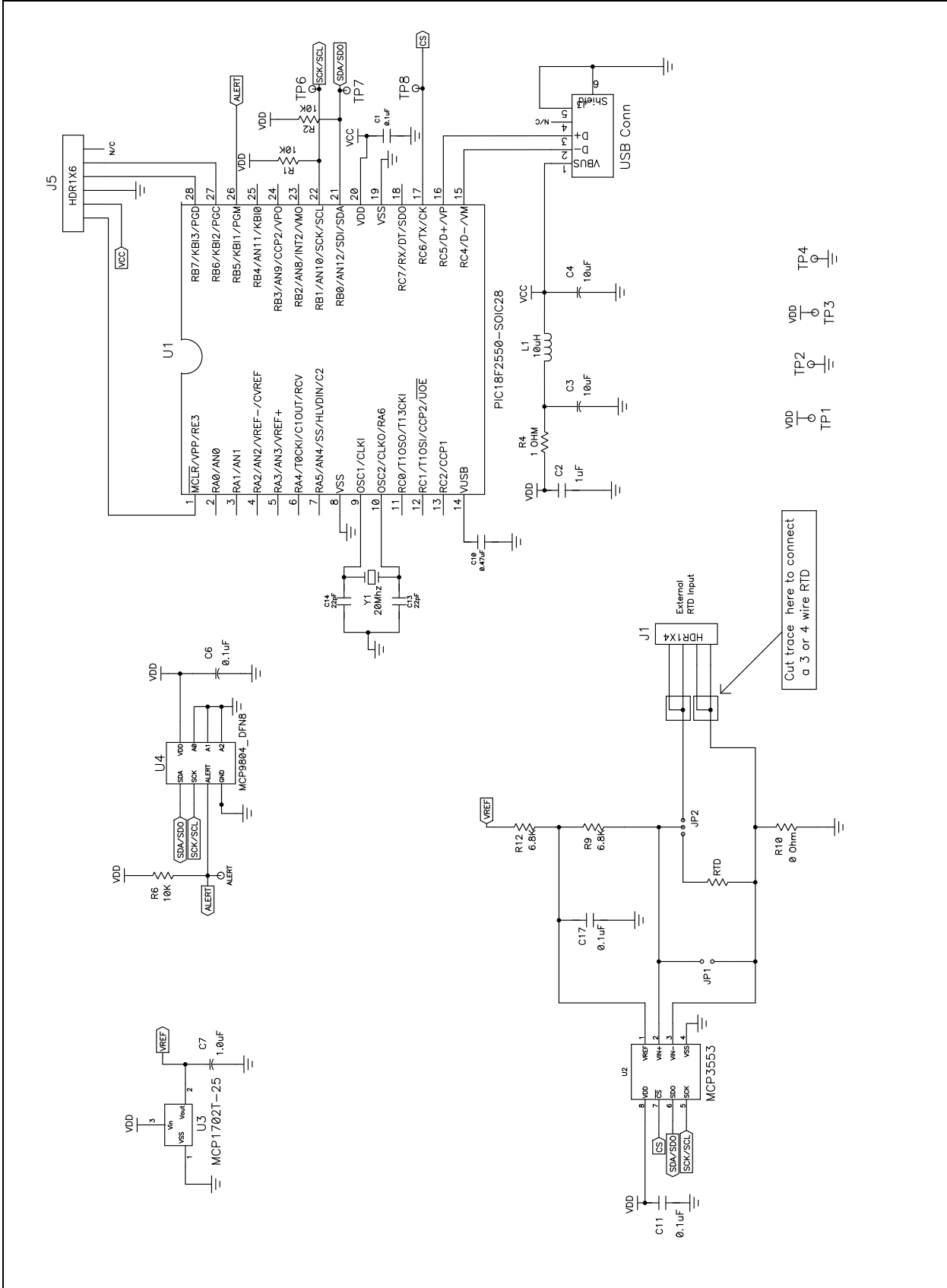
A.1 INTRODUCTION

This appendix contains the following schematics and layouts for the RTD Reference Design:

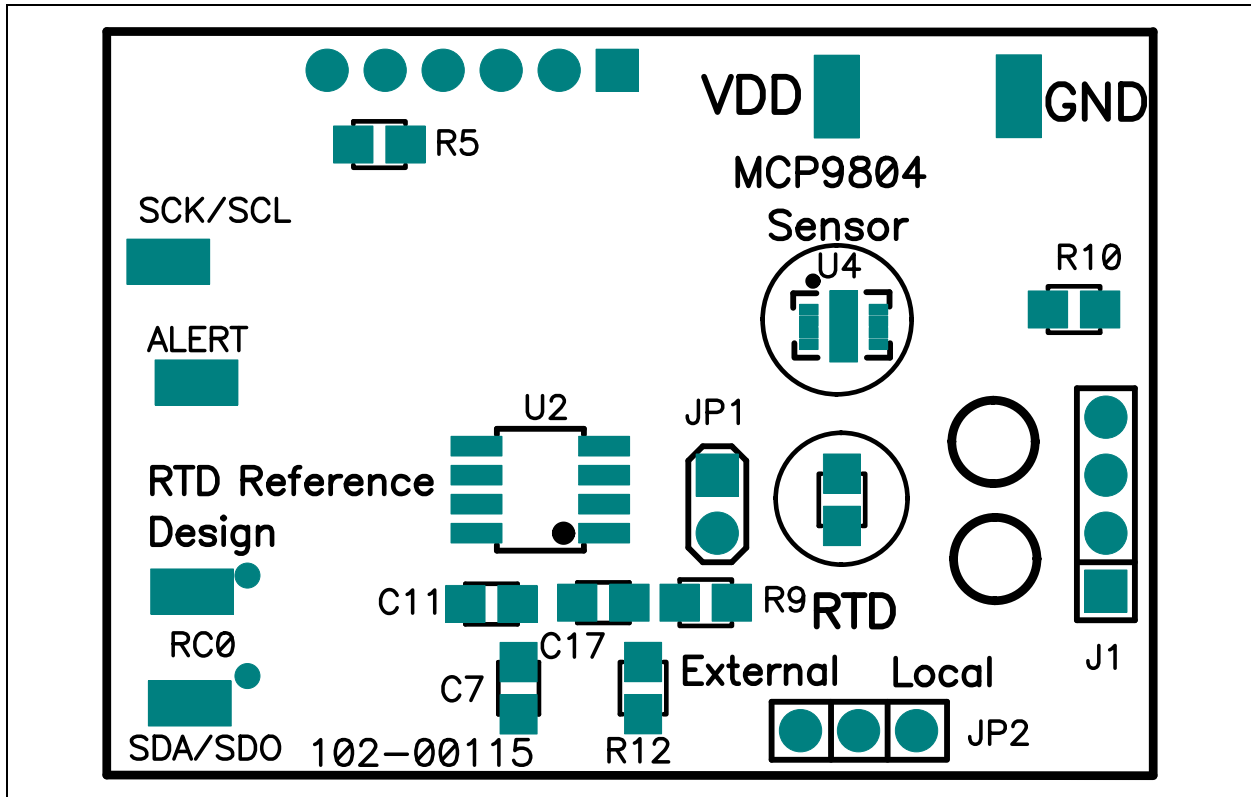
- Board – Schematic
- Board – Top Silk and Pads
- Board – Top Layer
- Board – Bottom Silk and Pads
- Board – Bottom Layer

RTD Reference Design

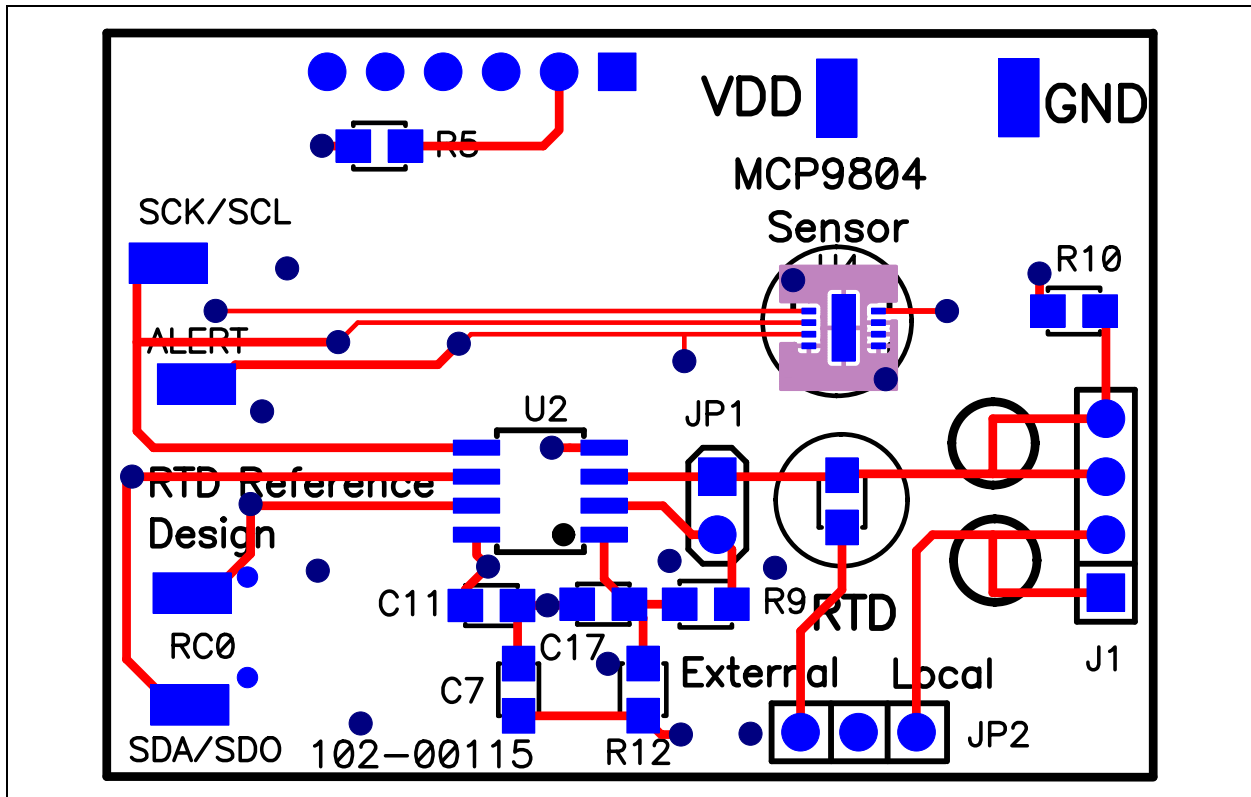
A.2 BOARD – SCHEMATIC



A.3 BOARD – TOP SILK AND PADS

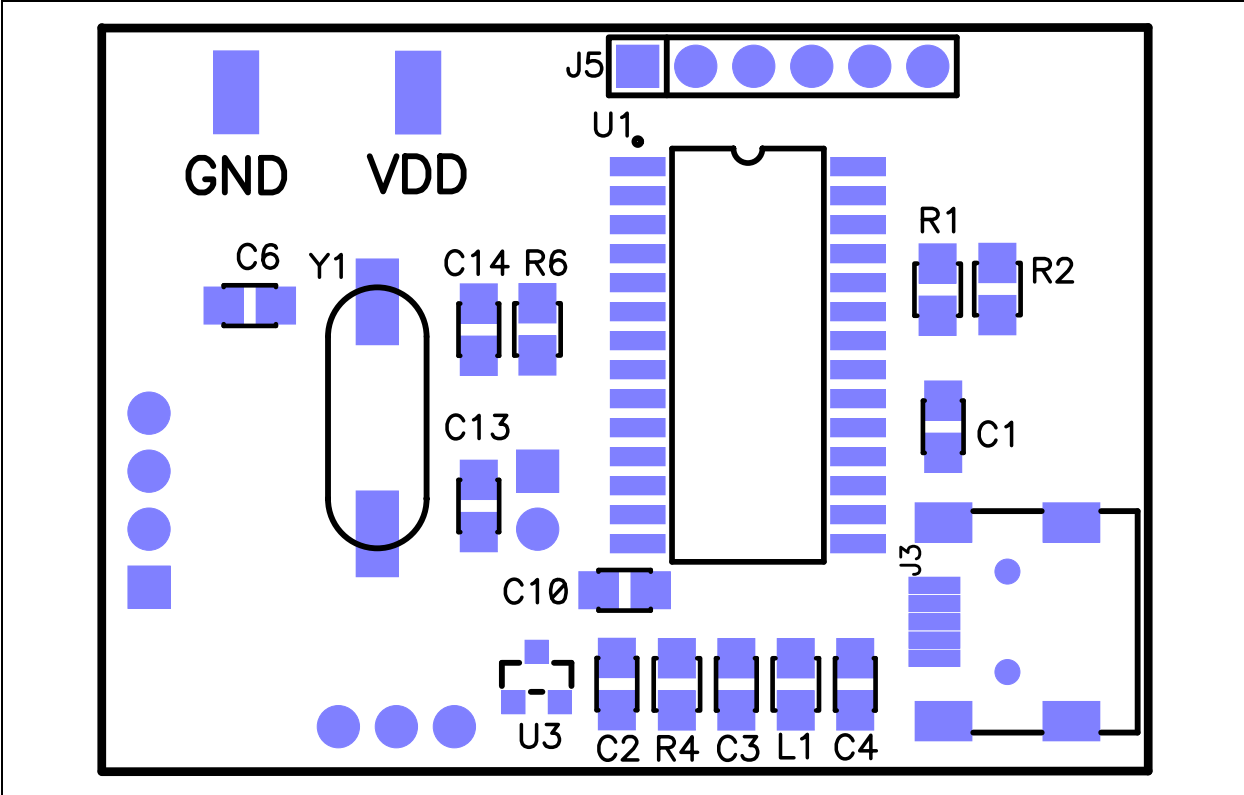


A.4 BOARD – TOP LAYER

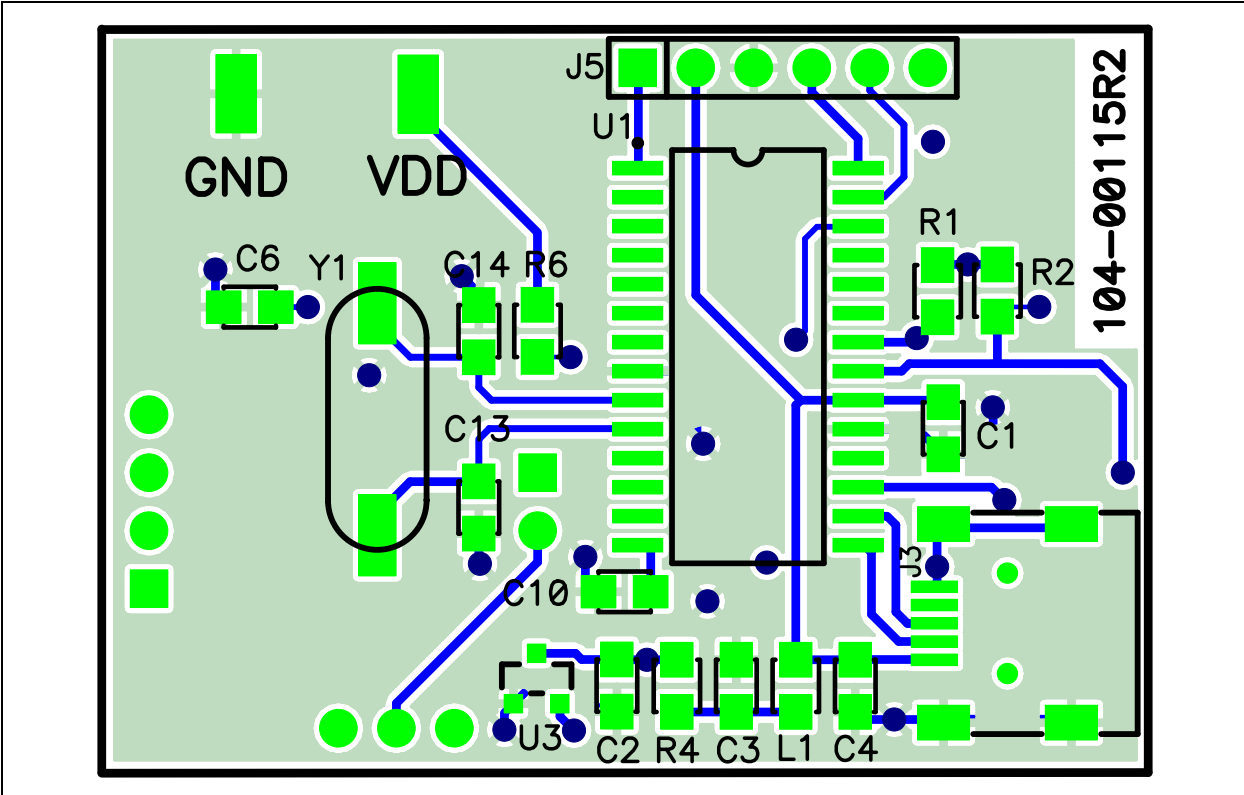


RTD Reference Design

A.5 BOARD – BOTTOM SILK AND PADS



A.6 BOARD – BOTTOM LAYER



Appendix B. Bill of Materials
TABLE B-1: BILL OF MATERIALS

| Qty | Reference | Description | Manufacturer | Part Number |
|-------------------|------------------|---|-------------------------------|-------------------|
| 4 | C1, C6, C11, C17 | CAP .1UF 25V CERAMIC X7R 0805 | Panasonic® – ECG | ECJ-2VB1E104K |
| 2 | C2, C7 | CAP 1.0UF 16V CERAMIC X7R 0805 | Kemet® Electronics | C0805C105K4RACTU |
| 2 | C3, C4 | CAP 10UF 10V CERAMIC F 0805 | Panasonic – ECG | ECJ-2FF1A106Z |
| 1 | C10 | CAP .47UF 16V CERAMIC X7R 0805 | Panasonic – ECG | ECJ-2YB1C474K |
| 2 | C13, C14 | CAP 22PF 50V CERM CHIP 0805 SMD | Panasonic – ECG | ECJ-2VC1H220J |
| 1 | J2 | CONN TERM BLOCK 2.54MM 4POS | Phoenix Contact | 1725672 |
| 1 | J3 | CONN MINI USB RCPT RA TYPE B SMD | Tyco Electronics | 1734035-2 |
| 1 | J5 | DO NOT POPULATE HEADER 1X6 | — | — |
| 1 | JP1 | DO NOT POPULATE SHUNT ECONOMY 2POS .100 TIN | Tyco® Electronics/Amp | 2-382811-1 |
| 1 | JP1 | DO NOT POPULATE CONN HEADER VERT 2POS .100 TIN | Tyco Electronics/Amp | 3-644695-2 |
| 1 | JP2 | CONN HEADER VERT 2POS .100 TIN | Tyco Electronics/Amp | 3-644695-2 |
| 1/16 ² | JP2 | 3 POS Jumper Switch | ITW® Pancon | JSC416G0 |
| 1 | L1 | INDUCTOR 10UH 100MA 0805 | Murata Electronics® | LQM21FN100M70L |
| 1 | PCB | RoHS Compliant Bare PCB, RTD Reference Board | Microchip Technology Inc. | 104-000115 |
| 3 | R1, R2, R6 | RES 10.0K OHM 1/8W 1% 0805 SMD | Panasonic – ECG | ERJ-6ENF1002V |
| 1 | R4 | RES 1.0 OHM 1/8W 1% 0805 SMD | Panasonic – ECG | ERJ-6RQF1R0V |
| 2 | R9, R12 | RES 6.8K OHM 1/10W .1% 0805 SMD | Panasonic – ECG | ERA-6YEB682V |
| 1 | R10 | RES 0.0 OHM 1/8W 5% 0805 SMD | Panasonic – ECG | ERJ-6GEY0R00V |
| 1 | R11 | PLATINUM RTD CHIP TEMPERATURE SENSOR SMD (RTD) | ENERCORP Instruments Ltd. | PCS 1.1503.1 |
| 8 | TP1-TP8 | TEST POINT PC COMPACT SMT | Keystone Electronics® | 5016 |
| 1 | U1 | 28/40/44-Pin, High-Performance, Enhanced Flash, USB Microcontrollers with nanoWatt Technology | Microchip Technology Inc. | PIC18F2550-I/SO |
| 1 | U2 | IC ADC 22BIT 2.7V 1CH SPI 8SOIC | Microchip Technology Inc. | MCP3551-E/SN |
| 1 | U3 | Low Dropout Positive Voltage Regulator | Microchip Technology Inc. | MCP1701T-5002I/CB |
| 1 | U4 | 2-Wire High-Accuracy Temperature Sensor | Microchip Technology Inc. | MCP9804T-E/MC |
| 1 | Y1 | CRYSTAL 20.0000 MHZ SERIES SMT | CTS® Electronic Components | ATS200SM |

Note 1: The components listed in this Bill of Materials are representative of the PCB assembly. The released BOM used in manufacturing uses all RoHS-compliant components.

2: Jumper switch comes in strips of 16 switches. Cut individual jumper switch as needed.



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82-2-558-5934

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Tel: 886-2-2500-6610
Fax: 886-2-2508-0102

Thailand - Bangkok
Tel: 66-2-694-1351
Fax: 66-2-694-1350

EUROPE

Austria - Wels
Tel: 43-7242-2244-39
Fax: 43-7242-2244-393

Denmark - Copenhagen
Tel: 45-4450-2828
Fax: 45-4485-2829

France - Paris
Tel: 33-1-69-53-63-20
Fax: 33-1-69-30-90-79

Germany - Munich
Tel: 49-89-627-144-0
Fax: 49-89-627-144-44

Italy - Milan
Tel: 39-0331-742611
Fax: 39-0331-466781

Netherlands - Drunen
Tel: 31-416-690399
Fax: 31-416-690340

Spain - Madrid
Tel: 34-91-708-08-90
Fax: 34-91-708-08-91

UK - Wokingham
Tel: 44-118-921-5869
Fax: 44-118-921-5820

08/04/10

Компания «Life Electronics» занимается поставками электронных компонентов импортного и отечественного производства от производителей и со складов крупных дистрибьюторов Европы, Америки и Азии.

С конца 2013 года компания активно расширяет линейку поставок компонентов по направлению коаксиальный кабель, кварцевые генераторы и конденсаторы (керамические, пленочные, электролитические), за счёт заключения дистрибьюторских договоров

Мы предлагаем:

- Конкурентоспособные цены и скидки постоянным клиентам.
- Специальные условия для постоянных клиентов.
- Подбор аналогов.
- Поставку компонентов в любых объемах, удовлетворяющих вашим потребностям.
- Приемлемые сроки поставки, возможна ускоренная поставка.
- Доставку товара в любую точку России и стран СНГ.
- Комплексную поставку.
- Работу по проектам и поставку образцов.
- Формирование склада под заказчика.
- Сертификаты соответствия на поставляемую продукцию (по желанию клиента).
- Тестирование поставляемой продукции.
- Поставку компонентов, требующих военную и космическую приемку.
- Входной контроль качества.
- Наличие сертификата ISO.

В составе нашей компании организован Конструкторский отдел, призванный помогать разработчикам, и инженерам.

Конструкторский отдел помогает осуществить:

- Регистрацию проекта у производителя компонентов.
- Техническую поддержку проекта.
- Защиту от снятия компонента с производства.
- Оценку стоимости проекта по компонентам.
- Изготовление тестовой платы монтаж и пусконаладочные работы.

