**TI Designs**

*Dynamic Field-Powered NFC Reference Design for Data Logging, Access Control, and Security Applications*

**Design Features**

- RF430CL330H Dynamic NFC Transponder Enables Static Tag Emulation
- NFC Type 4B Compliant
- NFC/RFID Protocol Handled in ROM Code
- Passive or Active Operational Modes
- Wireless Sensor Interface
- Uses Either Field or Bus Power

**Featured Applications**

- Replacement Part Authentication
- Access Control and Accountability
- Personal Identification
- Battery-less Sensor Interface
- Security token Transfer
- BLE / Wifi Connection Handover
- Low Power Transfer of Local Data
  - Genuine Part Identification, Maintenance Data, Inspection Data

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**TI Designs**

TI Designs provide the foundation that you need including methodology, testing and design files to quickly evaluate and customize the system. TI Designs help you accelerate your time to market.

**Design Resources**

- **TIDA-00217**
  - Tool Folder Containing Design Files
- **RF430CL330H**
  - Product Folder
- **MSP430FR5969**
  - Product Folder
- **TMP103**
  - Product Folder
- **TPD1E10B06**
  - Product Folder

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## Key Specifications

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>SPECIFICATIONS and FEATURES</th>
<th>DETAILS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field Power Supply Range</td>
<td>2–2.9 V only available while RF field present</td>
<td>See Section 4.2</td>
</tr>
<tr>
<td>Bus Power Supply Range</td>
<td>2–3.6 Vdc, 3 V Nominal</td>
<td></td>
</tr>
<tr>
<td>Typical Read/Write Distance</td>
<td>~ 1–5 cm</td>
<td>See Section 6</td>
</tr>
<tr>
<td>RF Protocol</td>
<td>ISO14443B</td>
<td>See Section 3.1.1</td>
</tr>
<tr>
<td>Data Rate</td>
<td>106-848kbps</td>
<td>See Section 3.1.1</td>
</tr>
<tr>
<td>Typical Data Throughput</td>
<td>Write: 2.0 – 4.8 kbps</td>
<td>See Section 6.1</td>
</tr>
<tr>
<td></td>
<td>Read: 2.3 – 6.2 kbps</td>
<td></td>
</tr>
<tr>
<td>NFC Operating Frequency</td>
<td>13.56 MHz</td>
<td>See Section 3.1.1</td>
</tr>
<tr>
<td>Memory</td>
<td>3 KB SRAM (RF430CL), 64 KB FRAM (MSP430FR)</td>
<td>See Section 3.1.1 and Section 3.1.2</td>
</tr>
<tr>
<td>Wired Interface from Transponder to Application Processor</td>
<td>SPI, I²C</td>
<td>See Section 3.1.1</td>
</tr>
<tr>
<td>Form Factor</td>
<td>1 x 1 inch square PCB</td>
<td>See Section 10</td>
</tr>
<tr>
<td>Field Power Source</td>
<td>NFC Compliant Phone or Tablet</td>
<td>See Table 1</td>
</tr>
<tr>
<td>Temperature Sensor Type and Range</td>
<td>Ambient sensor from –10°C to +100°C</td>
<td>See Section 4.1.4</td>
</tr>
</tbody>
</table>
2 System Description

In many systems, it is imperative that only authentic, inspected, and properly maintained parts are utilized. It is also desirable to enable wireless, field-powered data transfer in order to prevent powering up systems that could have safety risks to human operators. Near Field Communication (NFC) represents an ideal solution for both these problems.

This reference design describes the implementation of a subsystem capable of storing such information and communicating this data to the outside world by way of NFC or I²C/SPI/UART to a connected host controller. The proliferation of NFC enabled devices in the consumer and industrial markets makes NFC a commonly available communication interface which offers the benefits of low power, small form factor, and low cost. In addition to providing replacement part identification, a digital temperature sensor is available for localized sensor data. This reference design addresses component selection, antenna design, proper data encapsulation, and power management.

The system-level challenges for this design include proper antenna design, power management, and timing requirements to meet a large variety of NFC Reader/Writer devices ranging from NFC enabled phones or tablets to custom designed handheld units.
3 Block Diagram

Figure 1. System Block Diagram

3.1 Highlighted Products

Dynamic Field-Powered NFC Reference Design for Data Logging, Access Control, and Security Applications features the following devices:

- **RF430CL330H**
  - Dynamic NFC Interface Transponder
- **MSP430FR5969**
  - FRAM Mixed Signal Microcontroller
- **TMP103**
  - Digital Temperature Sensor with I2C/SMBUS Expanded Interface
- **TPD1E10B06**
  - Single Channel ESD in 0402 package with 10 pF Capacitance and 6 V Breakdown

For more information on each of these devices, see the respective product folders at [www.ti.com](http://www.ti.com).
3.1.1 RF430CL330H Features

- NFC Tag Type 4B
- ISO14443B Compliant 13.56-MHz RF Interface Supporting up to 848 kbps
- SPI or I²C Interface to Write and Read NDEF Messages to Internal SRAM
- 3KB SRAM for NDEF Messages
- Automatic Checking of NDEF Structure
- Interrupt Register and Output Pin to Indicate NDEF Read or Write Completion

![RF430CL330H Block Diagram](image-url)

*Figure 2. RF430CL330H Block Diagram*
3.1.2 MSP430FR5969 Features

- Embedded Microcontroller
  - 16-Bit RISC Architecture up to 16-MHz Clock
  - Wide Supply Voltage Range (1.8 V to 3.6 V)
- Optimized Ultralow-Power Modes
- Ultralow-Power Ferroelectric RAM (FRAM)
  - Up to 64KB Nonvolatile Memory
  - Ultralow-Power Writes
  - Fast Write at 125 ns Per Word (64KB in 4 ms)
  - Unified Memory = Program + Data + Storage in One Single Space
  - $10^{15}$ Write Cycle Endurance
  - Radiation Resistant and Nonmagnetic
- Intelligent Digital Peripherals
  - 32-Bit Hardware Multiplier (MPY)
  - Three-Channel Internal DMA
  - Real-Time Clock (RTC) With Calendar and Alarm Functions
  - Five 16-Bit Timers With up to Seven Capture/Compare Registers Each
  - 16-Bit Cyclic Redundancy Checker (CRC)
• High-Performance Analog
  – 16-Channel Analog Comparator
  – 14-Channel 12-Bit Analog-to-Digital Converter (ADC) With Internal Reference and Sample-and-Hold
    • 200 kmps at 75-µA Consumption

• Multifunction Input/Output Ports
  – All Pins Support Capacitive Touch Capability With No Need for External Components
  – Accessible Bit-, Byte-, and Word-Wise (in Pairs)
  – Edge-Selectable Wake From LPM on All Ports
  – Programmable Pullup and Pulldown on All Ports

• Code Security and Encryption
  – 128-Bit or 256-Bit AES Security Encryption and Decryption Coprocessor (MSP430FR59xx Only)
  – Random Number Seed for Random Number Generation Algorithms

• Enhanced Serial Communication
  – eUSCI_A0 and eUSCI_A1 Support
    • UART With Automatic Baud-Rate Detection
    • IrDA Encode and Decode
    • SPI at Rates up to 10 Mbps
  – eUSCI_B0 Supports
    • I²C With Multiple Slave Addressing
    • SPI at Rates up to 8 Mbps
  – Hardware UART and I²C Bootstrap Loader (BSL)

• Flexible Clock System
  – Fixed-Frequency DCO With 10 Selectable Factory-Trimmed Frequencies
  – Low-Power Low-Frequency Internal Clock Source (VLO)
  – 32-kHz Crystals (LFXT)
  – High-Frequency Crystals (HFXT)

• Development Tools and Software
  – Professional Development Environments
  – Development Kit (MSP TS430RGZ48C)

• For Complete Module Descriptions, see the SP430FR58xx, MSP430FR59xx, MSP430FR68xx, and MSP430FR69xx Family User’s Guide (SLAU367)
3.1.3 TMP103 Features

- Multiple Device Access (MDA):
  - Global Read/Write Operations
- I²C™-/SMBus™-Compatible Interface
- Resolution: 8 Bits
- Accuracy: ±1°C Typ (−10°C to +100°C)
- Low Quiescent Current:
  - 3 µA Active IQ at 0.25 Hz
  - 1 µA Shutdown
- Supply Range: 1.4 V to 3.6 V
- Digital Output
- Package: 4-Ball WCSP (DSBGA)

Figure 4. TMP103 Block Diagram
3.1.4 TPD1E10B06 Features

- Provides System Level ESD Protection for Low-voltage IO Interface
- IEC 61000-4-2 Level 4
  - ±30kV (Air-Gap Discharge)
  - ±30kV (Contact Discharge)
- IEC 61000-4-5 (Surge): 6A (8/20µs)
- IO Capacitance 12 pF (Typ)
- $R_{\text{DYN}}$ 0.4 Ω (Typ)
- DC Breakdown Voltage ±6 V (Min)
- Ultra Low Leakage Current 100 nA (Max)
- 10 V Clamping Voltage (Max at $I_{\text{PP}} = 1$A)
- Industrial Temperature Range: –40°C to 125°C
- Space Saving 0402 Footprint (1.0 mm × 0.6 mm × 0.5 mm)
4 System Design Theory

4.1 Component Selection

4.1.1 Dynamic Interface Transponder

The RF430CL330H Dynamic NFC Interface Transponder is an NFC Tag Type 4B device that combines a wireless NFC interface and a wired SPI or I^C interface to connect the device to a host. The NDEF message in the SRAM can be written and read from the integrated SPI or I^C serial communication interface and can also be accessed and updated wirelessly via the integrated ISO14443B-compliant RF interface that supports up to 848 kbps. The RF430CL330H was chosen to allow for a low cost, dual interface (wired and wireless) transponder which allows for communication to/from a host controller. This functionality is not possible with a standard passive NFC transponder (wireless only).

4.1.2 Rectification Diodes

To power the microcontroller and temperature sensor by way of the NFC field, the AC voltage on the antenna must be converted to DC using a bridge rectifier. To keep the voltage drop as low as possible, general purpose schottky diodes are used with a typical drop of 0.4 V.

4.1.3 Microcontroller Selection

The MSP430 ultra-low-power (ULP) FRAM platform combines uniquely embedded FRAM and a holistic ultra-low-power system architecture, allowing innovators to increase performance at lowered energy budgets. FRAM technology combines the speed, flexibility, and endurance of SRAM with the stability and reliability of flash at much lower power. The MSP430FR5969 was chosen for the large (64kB) amount of non-volatile memory along with ultra-low power operation, which is important when powering the device from the NFC field.

4.1.4 Digital Temperature Sensor

The TMP103 digital temperature sensor device was chosen to enable temperature measurements in the Dynamic Field-Powered NFC Reference Design for Data Logging, Access Control, and Security Applications. The TMP103 device is a digital output temperature sensor in a four-ball wafer chip-scale package (WCSP). The TMP103 device is capable of reading temperatures to a resolution of 1°C, with only 3 µA active quiescent current at 0.25 Hz. For minimal cost, board space, and current consumption, the addition of the TMP103 device to the subsystem allows for accurate measurements whether powered from the NFC field or wall/battery.

4.1.5 ESD Protection

The TPD1E10B06 Single Channel ESD protection device was chosen to protect the Spy Bi-Wire (2-wire JTAG) programming interface. The device offers over ±30KV IEC air-gap, over ±30KV contact ESD protection, and has an ESD clamp circuit with a back-to-back diode for bipolar or bidirectional signal support. The 10 pF line capacitance is suitable for a wide range of applications supporting data rates up to 400 Mbps. The 0402 package is industry standard and convenient for component placement in space saving applications. The TPD1E10B06 is characterized for operation over ambient air temperature of −40°C to 125°C.
4.2 Field Power

In order to operate from field power, AC voltage on the antenna is rectified to DC using a half bridge rectifier. The schematic snippet below shows the external rectifier diodes and storage capacitor as used in this reference design. It is important to use Schottky diodes for minimal voltage loss. The RF430CL330H internally limits the voltage to 3 V, which provides ~2.6 V to the connected microcontroller after the ~0.4 V drop from the schottky diodes.

![Figure 6. Half Bridge Rectifier](image)

4.3 Antenna Design

In order to keep a small form factor, this reference design utilizes an antenna coil wrapped around the outside edge of the PCB instead of a separated antenna coil. This design allows for the largest antenna size and maximizes usage of available PCB area. When designing such an antenna, it is important to keep spacing of at least 3mm from large ground plane areas for optimum range performance. The measured antenna coil inductance and resulting tuning capacitor are shown below. For more information regarding antenna design, see Application Report, *RF430CL330H Practical Antenna Design Guide (SLOA197).*

- Lant = 1.97 µH
- Ctune = 33 pF
4.4 **NDEF Data Encapsulation**

The NFC Forum defines a data format for NFC messages called NDEF (NFC Data Exchange Format). Utilization of a common data format allows for all NFC compliant devices to exchange data in a "well known" format. NDEF allows for many different record types ranging from simple text records, URL, Vcard, and Bluetooth Connection Handover just to name a few. In this document, we will utilize the short text record type. This format is shown in Figure 7.

NDEF messages are written in the RF430CL330H SRAM by way of the I²C interface and then read out by way of the NFC wireless interface or vice versa. A simple “Hello, World!” text record example is shown in Figure 8. When changing the NDEF message, it is important to properly update the appropriate fields, especially length fields. If these fields are not properly formatted, the NDEF parser in the NFC reader device will not parse the data correctly. For additional details of NDEF, please refer to the NDEF specification available from the NFC Forum.

```c
/* NDEF File for Hello, World! */
0x00, 0x14, /* NLEN; NDEF length (20 byte long message) */
0xD1, /* Record Header */
0x01, /* Type Length (1 byte) */
0x10, /* Payload Length (16 bytes) */
0x54, /* Type T = text */
0x65, 0x6E, /* 'e', 'n', */
0x48, 0x65, 0x6C, 0x6C, 0x6f, 0x2c, 0x20, 0x77, 0x6f, 0x72, 0x6c, 0x64, 0x21
```

**Figure 7. NDEF Record Format**

```c
/* Hello, world! NDEF data; Empty NDEF message, length should match NLEN */
0x48, 0x65, 0x6C, 0x6f, 0x2c, 0x20, 0x77, 0x6f, 0x72, 0x6c, 0x64, 0x21
```

**Figure 8. NDEF Message Example**
4.5 Software Control

The Dynamic Field-Powered NFC Reference Design for Data Logging, Access Control, and Security Applications includes an example firmware project which provides communication from the MSP430FR5969 to the RF430CL330H and TMP103. This includes writing an example NDEF message and also formatting measured temperature data as NDEF. The MSP430 uses eUSCI_B0 (enhanced Universal Serial Communication Interface) to control both devices located on the same I²C bus. Each device is selected as required using the unique I²C address. The RF430CL330H is first initialized with the following steps. The associated C code can be seen in Figure 9.

1. Write NDEF message into SRAM starting at address 0x0000
2. Write Interrupt Enable register (enable end of write and end of read interrupts)
3. Write Interrupt Enable register (enable end of write and end of read interrupts)

```c
/* Configure RF430CL330H for Typical Usage Scenario */
/* Write Continuous(0, FRAM_Message, 48); */
//write NDEF memory with Capability Container + NDEF message
Write_Continuous(0, FRAM_Message, 48);
//Enable interrupts for End of Read and End of Write/
Write_Register(INT_ENABLE_REG, EOW_INT_ENABLE + EOR_INT_ENABLE);
//Configure INTO pin for active low and enable RF
Write_Register(CONTROL_REG, INT_ENABLE + INTO_DRIVE + RF_ENABLE);
```

Figure 9. RF430CL330H Initialization Procedure
4.6 **Temperature Management Implementation**

- **MSP430 Initialization**
- Initialize NDEF memory with Constant Data (capability container and record header)
- Read TMP103 register 0x00 (temperature data)
- Convert to Fahrenheit
- Update NDEF memory with temperature data in C and F
- Enable RF = 1
- RF Interface active (no modifications via serial interface)
- Modifications via serial interface required?
- Yes
  - RF Busy = 0?
    - No
      - Wait for ~1-2ms or End-of-Read/Write Interrupts
    - Yes
      - Reset RF430CL330H
- No

*Figure 10. Temperature Measurement Firmware Flow*
5 Getting Started

After programming the Reference Design board, all that is necessary is to place the board near an NFC-compliant device's NFC antenna. The message that is programmed into the reference design board will then automatically appear on the phone or tablet's screen.

Figure 11. Dynamic Field-Powered NFC Reference Design for Data Logging, Access Control, and Security Applications Board
6 Test Results

The Reference Design was tested with several different NFC compliant devices, in order to determine the actual range of operation and data read/write throughput. Results for both field-powered and battery/line powered conditions are shown in this section for range of operation. The communication range of the reference design varies based on the NFC reader/writer implementation of each tested device.

<table>
<thead>
<tr>
<th>Phone/Tablet/Reader</th>
<th>Field Powered</th>
<th>Battery/Line Powered</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nexus 4</td>
<td>1.4 cm</td>
<td>2.1 cm</td>
</tr>
<tr>
<td>Nexus 5</td>
<td>1.4 cm</td>
<td>2.1 cm</td>
</tr>
<tr>
<td>Nexus 7</td>
<td>1.4 cm</td>
<td>1.9 cm</td>
</tr>
<tr>
<td>Samsung S4</td>
<td>1.3 cm</td>
<td>2.0 cm</td>
</tr>
<tr>
<td>TRF7970AEVM</td>
<td>3.0 cm</td>
<td>4.5 cm</td>
</tr>
</tbody>
</table>

6.1 Throughput Results

Data throughput varies based on the NFC reader/writer implementation of each tested device. The conditions for the data throughput testing are listed in Table 2, along with the test results for several NFC compliant devices.

- Data Rate: 106 kbps
- Payload size: 2,306 Bytes
- Start/End Time marks: ReqB command / Deselect response

<table>
<thead>
<tr>
<th>Phone/Tablet/Reader</th>
<th>Write Throughput</th>
<th>Read Throughput</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nexus 4</td>
<td>4.8 kbps</td>
<td>6.2 kbps</td>
</tr>
<tr>
<td>Nexus 5</td>
<td>3.1 kbps</td>
<td>4.1 kbps</td>
</tr>
<tr>
<td>Nexus 7</td>
<td>4.3 kbps</td>
<td>5.9 kbps</td>
</tr>
<tr>
<td>Samsung S4</td>
<td>2.0 kbps</td>
<td>2.3 kbps</td>
</tr>
<tr>
<td>TRF7970A (NFC Link)</td>
<td>2.3 kbps</td>
<td>4.5 kbps</td>
</tr>
</tbody>
</table>
6.2 Antenna Measurements

Figure 12 and Figure 13 show measurement results from the antenna tuning procedure. Antenna tuning is necessary in order to keep the antenna resonant at the NFC operating frequency of 13.82 MHz to maximize data and power transfer.

![Figure 12. Coil Inductance (1.9785 µH)](image1)

![Figure 13. Resonant Frequency and Bandwidth](image2)

\[
BW = f_2 - f_1 \\
Q = \frac{f_{res}}{BW} \\
Q = \frac{13.82\text{ MHz}}{498.8\text{ kHz}} \\
Q = 27.7
\] (1)
6.3 Application Specific Results

As seen in Figure 14, the reference design transmits the local temperature data to the NFC-compliant device in both Celsius and Fahrenheit format. The firmware is written to re-transmit this data every four seconds while the Reference Design remains in the NFC RF field.

Figure 14. Temperature Application

In Figure 15, the Reference Design firmware is programmed to transmit a part authentication ID number. This demonstrates a supply chain part authentication application. Encryption of the data transmission is not implemented in this firmware, but is an easy addition with the MSP430FR5969 device's built-in AES module.

Figure 15. Part ID Authentication Application
7 Schematics

To download the schematics for the Dynamic Field-Powered NFC Reference Design for Data Logging, Access Control, and Security Applications, see the design files at TIDA-00217.

Figure 16. Dynamic Field-Powered NFC Reference Design for Data Logging, Access Control, and Security Applications Schematic
To download the bill of materials (BOM) for the Dynamic Field-Powered NFC Reference Design for Data Logging, Access Control, and Security Applications, see the design files at TIDA-00217. Table 3 shows the BOM for the reference design.

<table>
<thead>
<tr>
<th>Designator</th>
<th>Quantity</th>
<th>Value</th>
<th>Description</th>
<th>Package Reference</th>
<th>PartNumber</th>
<th>Manufacturer</th>
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</thead>
<tbody>
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<td>IPCB</td>
<td>1</td>
<td></td>
<td>Printed Circuit Board</td>
<td></td>
<td>ISE4003</td>
<td>Any</td>
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<tr>
<td>C1</td>
<td>1</td>
<td>0.47uF</td>
<td>CAP, CERM, 0.47uF, 25V, +/-10%, X7R, 0603</td>
<td>0603</td>
<td>GRM188R71E474KA12D</td>
<td>MuRata</td>
</tr>
<tr>
<td>C2, C5, C6</td>
<td>3</td>
<td>0.1uF</td>
<td>CAP, CERM, 0.1uF, 16V, +/-10%, X7R, 0402</td>
<td>0402</td>
<td>GRM155R71C04KA88D</td>
<td>MuRata</td>
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<tr>
<td>C3, C4, C7</td>
<td>3</td>
<td>1uF</td>
<td>CAP, CERM, 1uF, 16V, +/-10%, X7R, 0603</td>
<td>0603</td>
<td>GRM188R71C105KA12D</td>
<td>MuRata</td>
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<td>C8</td>
<td>1</td>
<td>100uF</td>
<td>CAP, CERM, 100uF, 16V, +/-20%, X5R, 1206_190</td>
<td>1206_190</td>
<td>C3216X5R1A107M160AC</td>
<td>TDK</td>
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<td>C10</td>
<td>1</td>
<td>33pF</td>
<td>CAP, CERM, 33pF, 50V, +/-5%, C0G/NP0, 0402</td>
<td>0402</td>
<td>GRM1555C1H330JA01D</td>
<td>MuRata</td>
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<td>0402</td>
<td>GRM155R71C010KA01D</td>
<td>MuRata</td>
</tr>
<tr>
<td>C13</td>
<td>1</td>
<td>1000pF</td>
<td>CAP, CERM, 1000pF, 16V, +/-10%, X7R, 0402</td>
<td>0402</td>
<td>GRM155R71C102KA01D</td>
<td>MuRata</td>
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<tr>
<td>D1, D2</td>
<td>2</td>
<td>35V</td>
<td>Diode, Schottky, 35V, 0.1A, SOD-523F</td>
<td>SOD-523F</td>
<td>CDBU0130L</td>
<td>Comchip Technology</td>
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<tr>
<td>D3</td>
<td>1</td>
<td>Orange</td>
<td>LED, Orange, SMD</td>
<td>1.6x0.8x0.8mm</td>
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<td>D4</td>
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<td>J3</td>
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<td>R1, R4</td>
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<td>0</td>
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<td>CRCW04020000020ED</td>
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<tr>
<td>R2, R3</td>
<td>2</td>
<td>4.75k</td>
<td>RES, 4.75k ohm, 1%, 0.063W, 0402</td>
<td>0402</td>
<td>CRCW04024K75FKED</td>
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<tr>
<td>R5, R6</td>
<td>2</td>
<td>1.0k</td>
<td>RES, 1.0k ohm, 1%, 0.063W, 0402</td>
<td>0402</td>
<td>CRCW04021K00FKED</td>
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<td>R7, R9</td>
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<td>10.0k</td>
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<td>0402</td>
<td>CRCW040210K0FKED</td>
<td>Vishay-Dale</td>
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<tr>
<td>R8</td>
<td>1</td>
<td>47.5k</td>
<td>RES, 47.5k ohm, 1%, 0.063W, 0402</td>
<td>0402</td>
<td>CRCW040247K5FKED</td>
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<tr>
<td>U1</td>
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<td>Mixed Signal Microcontroller, RGZ0048B</td>
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<td>MSP430FR5969IRG2</td>
<td>Texas Instruments</td>
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<tr>
<td>U2</td>
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<td>DYNAMIC NFC INTERFACE TRANSPONDER, PW0014A</td>
<td>PW0014A</td>
<td>RF430CL3301CPW</td>
<td>Texas Instruments</td>
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<tr>
<td>U3</td>
<td>1</td>
<td></td>
<td>Low-Power, Digital Temperature Sensor with Two-Wire Interface in W CSP, YFF0004AAA</td>
<td>YFF0004AAA</td>
<td>TMP103AYFF</td>
<td>Texas Instruments</td>
</tr>
<tr>
<td>U4, U5, U6, U7</td>
<td>4</td>
<td>ESD in 0402 Package with 10 pF Capacitance and 6 V Breakdown, 1 Channel, -40 to +125 degC, 2-pin X2SON (DYP), Green (RoHS &amp; no SnBr)</td>
<td>DYP0002A</td>
<td>TPD1E10606DPYR</td>
<td>Texas Instruments</td>
<td></td>
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<tr>
<td>C9, C14</td>
<td>0</td>
<td>CAP, CERM, xxxF, xxxV, [TempCo], xxx%, [PackageReference]</td>
<td>Used in PnP output</td>
<td>Used in BOM report</td>
<td>Used in BOM report</td>
<td></td>
</tr>
<tr>
<td>C11</td>
<td>0</td>
<td>39pF</td>
<td>CAP, CERM, 39pF, 50V, +/-5%, C0G/NP0, 0402</td>
<td>0402</td>
<td>GRM1555C1H390JA01D</td>
<td>MuRata</td>
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<tr>
<td>FID1, FID2, FID3, FID4, FID5, FID6</td>
<td>0</td>
<td>Fiducial mark. There is nothing to buy or mount.</td>
<td>Fiducial</td>
<td>N/A</td>
<td>N/A</td>
<td></td>
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<tr>
<td>J1</td>
<td>0</td>
<td>Header male, 2x1, 50mil, TH</td>
<td>2x1 Header</td>
<td>GRPB021VWN-RC</td>
<td>Sullins Connector Solutions</td>
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<tr>
<td>J2</td>
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<td>Header, 6x1, 50mil, TH</td>
<td>Header, 6x1, TH</td>
<td>GRPB061VWN-RC</td>
<td>Sullins Connector Solutions</td>
<td></td>
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<tr>
<td>J4, J5</td>
<td>0</td>
<td>Header, 1x1, Tin, TH</td>
<td>Header, 1x1, 50mil, TH</td>
<td>TMS-101-02-T-S</td>
<td>Samtec</td>
<td></td>
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9 Layer Plots

To download the layer plots for the Dynamic Field-Powered NFC Reference Design for Data Logging, Access Control, and Security Applications, see the design files at TIDA-00217. Figure 17 through Figure 24 show the layer plots for the Reference Design board.

Figure 17. Top Overlay
Figure 18. Top Solder Mask
Figure 19. Top Layer
Figure 20. Bottom Layer
Figure 21. Bottom Solder Mask
Figure 22. Bottom Overlay
Figure 23. Board Dimensions
**Figure 24. Drill Drawing**

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Hole Count</th>
<th>Tool Size</th>
<th>Plated Hole Type</th>
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<tr>
<td>9</td>
<td>1</td>
<td>0.87mm (0.0345in)</td>
<td>PTH Round</td>
</tr>
<tr>
<td>22</td>
<td>1</td>
<td>0.87mm (0.0345in)</td>
<td>PTH Round</td>
</tr>
<tr>
<td>5</td>
<td>100</td>
<td>0.60mm (0.0236in)</td>
<td>PTH Round</td>
</tr>
<tr>
<td>8</td>
<td>2</td>
<td>0.60mm (0.0236in)</td>
<td>PTH Round</td>
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<tr>
<td>12</td>
<td>2</td>
<td>0.60mm (0.0236in)</td>
<td>PTH Round</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>0.60mm (0.0236in)</td>
<td>PTH Round</td>
</tr>
</tbody>
</table>

Drill Table
10 Altium Project

To download the Altium project files for the Dynamic Field-Powered NFC Reference Design for Data Logging, Access Control, and Security Applications, see the design files at TIDA-00217. Figure 25, Figure 26, and Figure 27 show the layout for the Reference Design board.
12 Gerber Files

To download the Gerber files for the Dynamic Field-Powered NFC Reference Design for Data Logging, Access Control, and Security Applications, see the design files at TIDA-00217.

![Fabrication Drawing](image)

Figure 28. Fabrication Drawing

13 Assembly Drawings

To download the assembly drawings for the Dynamic Field-Powered NFC Reference Design for Data Logging, Access Control, and Security Applications, see the design files at TIDA-00217.

![Top Overlay](image)

![Bottom Overlay](image)

Figure 29. Top Overlay

Figure 30. Bottom Overlay

14 Software Files

To download the software files for the Dynamic Field-Powered NFC Reference Design for Data Logging, Access Control, and Security Applications, see the design files at TIDA-00217.
15 References

For additional references, see the following:
1. RF430CL330H Data Sheet, Dynamic NFC Interface Transponder (SLAS916)
2. MSP430FR5969 Data Sheet, MSP430FR59xx Mixed-Signal Microcontrollers (SLAS704)
3. TMP103 Data Sheet, Low-Power, Digital Temperature Sensor with Two-Wire Interface in WCSP (SBOS545)
4. TPD1E10B06 Data Sheet, Single Channel ESD Protection Device in 0402 Package (SLLSEB1)
About the Authors

EVAN D. CORNELL is a Systems Architect at Texas Instruments where he is responsible for developing reference design solutions for the industrial segment. Evan brings to this role experience in system-level analog, mixed-signal, and power management design. Evan earned his Master of Electrical and Computer Engineering (M.Eng.) and Bachelor of Science (BS) in Electrical Engineering from the Rose-Hulman Institute of Technology in Terre Haute, IN. Evan is a member of the Institute of Electrical and Electronics Engineers (IEEE).

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JASON KRIEK is a Digital Field Applications Engineer at Texas Instruments where he is responsible for supporting MCU and Wireless Connectivity products. His specific areas of expertise include embedded microcontrollers and related analog and digital sensing systems and transceivers operating at frequencies from 13.56 MHz to 2.45 GHz. Jason brings innovative and creative solutions to life that are driven by his passion for the combination of the technologies that he supports in his role. He earned his Bachelor degree in Electrical Engineering from ITT in Davie, Florida and he has been at TI since 2010.
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