Asset Tracker Power Management Platform

MAXREFDES01261

Introduction

The MAXREFDES01261 is a reference design for the asset tracker application based on the Maxim® solution. This reference design is a power management platform for the asset tracker, which includes the MAX77640, MAX32660, MAX77827, and MAX77840. This design demonstrates a small-size, low-power, highly effective, highly accurate, and flexible power management system.

- The MAX32660 is an ultra-low-power, cost-effective, highly integrated microcontroller unit (MCU) designed for battery-powered devices and wireless sensors. It combines a flexible and versatile power management unit with the powerful Arm® Cortex®-M4 with a floating-point unit (FPU).
- The MAX77840 is a high-performance PMIC for latest 3G/4G/5G smartphones and tablets. It includes a single input switched-mode charger with reverse-boost capability. It also has a proprietary ModelGaugeTMvM5 fuel gauge and one SAFEOUT LDO.
- The MAX77640 is a low-IQ power solution. It has three buck-boost regulators and a 150mA LDO, which is suitable for applications where size and efficiency are critical.
- The MAX77827 is a high-efficiency buck-boost regulator targeting one-cell Li-ion and down to 1.8V-rated battery chemistry-powered applications with the lowest typical quiescent current in the industry (6μA). The MAX77827 buck-boost converter provides the most efficient power supply for the RF PA for non-GPS tracker applications utilizing network radio such as NB-IoT, CAT-M1, LTE, etc. to maximize both standby and communication battery life.

The main features and benefits of the design include:

- Integrated solution
- Small size
- Low power
- High accuracy
- Flexible power output

Table 1. Design Specifications

PARAMETER	SYMBOL	MIN	MAX
Battery Voltage	V_{BAT}	3.1V	4.6V
USB Input Voltage	V_{USB}	5V	
Average Operation Current	$I_{OPERATION}$	10mA	
3.3V_1 out	3V3 out	3V	3.6V
3.3V_2 out	3V29 out	3.2V	3.4V
2.93V out	2V93 out	2.90V	2.98V
2.2V out	2V2 out	2.1V	2.3V
1.1V out	1V1 out	1.05V	1.15V

Designed–Built–Tested

This document describes the hardware in Figure 1. It provides a detailed, systematic technical guide to design a small-size, low-power, high effective, and high-accuracy asset tracker power management platform. The design was built and tested. The details follow later in this document.

Design Considerations

The power platform for the asset tracker application must have the following important characteristics and features:

- **Small size:** The asset tracker is portable. The size of the device's individual components becomes even more important as designers try to incorporate more functions into the devices. The number of components that can fit on a device directly determines the number of functions the device can feature.
- **Low power:** They use batteries for the system power supply. Low power means longer use time because of the limited size and energy density of the battery. The portable devices often have two working modes: standby and operation. Most devices are in the standby mode more than 90% of the time. So, the standby current is very important. The system can work for approximately 64 hours if the standby current can be limited within 1mA and operation current is 7mA for a 70mAh battery.
- **Highly effective:** Highly effective power management can reduce heat and make battery lifetime longer. This is more important for portable devices or handsets.
- **Accuracy:** The devices require higher accuracy measures for battery SOC. The market only accepts the more accurate devices.

Design Procedure for the Power Solution

This asset tracker power management platform includes the battery management, SIMO, and controller.

Step 1: Selecting the Battery Management

One-cell battery is used for the asset tracker to save space. The MAX77840 is selected for battery management as it is a highly integrated solution for charging and battery measure.

Step 2: Selecting the Power Management

The system power is mainly for the MAX32660 MCU and external GPS module. One 3.3V rail is used for the MAX32660. The GPS module usually requires three power rails: 3.3V, 1.8V, and 2.9V. The MAX77640 has three buck-boost outputs and one LDO output (three buck-boost regulators) that can be configured to be flexible. So, it is very suitable for this application.

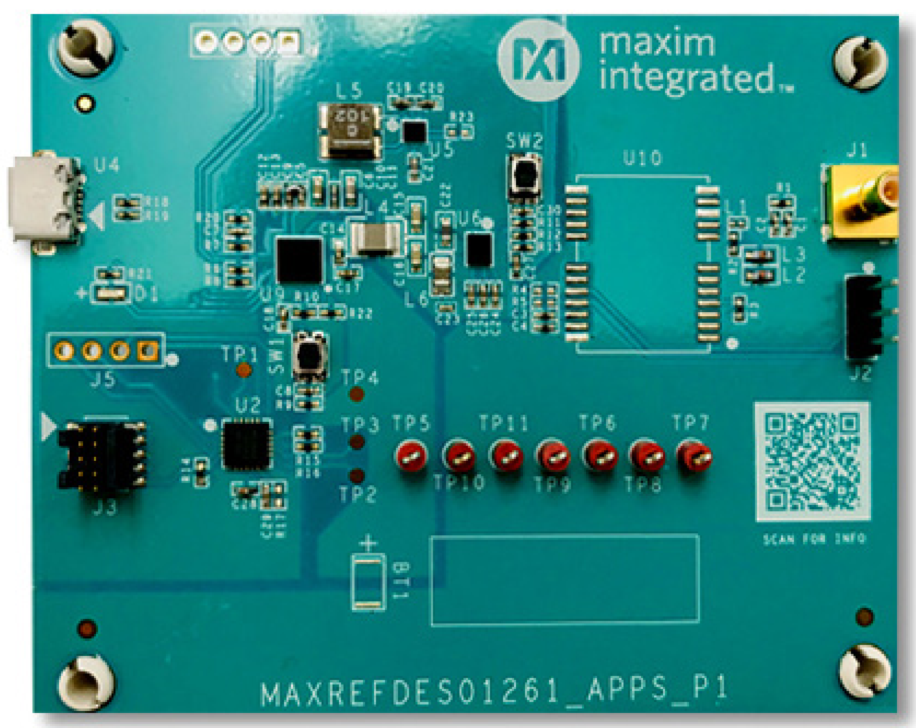

Figure 1. MAXREFDES01261 hardware.

Step 3: Calculating the Current

The current of the MAX32660 MCU is calculated as:

$$I_{MCU} = 96MH_Z \times \frac{85\mu A}{MH_Z} = 8.16mA$$

where 96MHz is the maximum frequency of the MAX32660 MCU with an average of 85μA/MHz. So, its maximum power is about 15mW.

The other parts are very low-power chips or module with a 125mAH battery. It can continue working for more than ten hours.

Detailed Description of Hardware

Figure 2 shows the MAXREFDES01261 block diagram. The USB supplies power and charges the battery when the asset tracker is plugged in the USB socket. The battery powers the whole system if there is no USB.

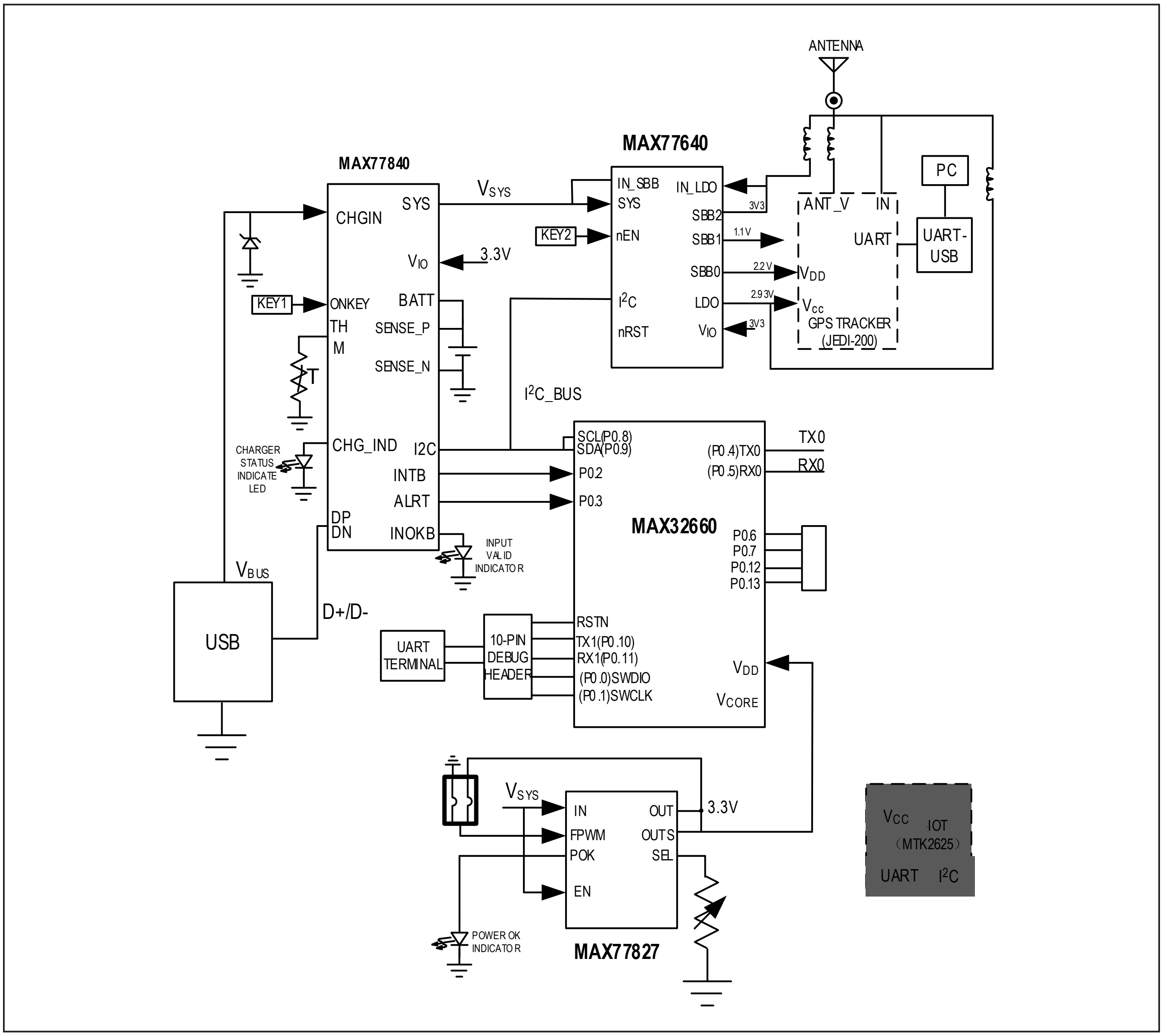

Figure 2. MAXREFDES01261 block diagram.

Microcontroller

The MAXREFDES01261 uses the MAX32660 as its MCU. This chip is dedicated for the low-power-application market for use in wearable applications. The Arm Cortex-M4 meets all the requirements as it is small, uses low power, and has a lot of memory. The SW1 button manually resets the respective MCU.

Battery Measurement

The MAX77840 is ideally suited for portable devices such as handsets and ultraportable media players. The charger features a single input, which works for adapter/USB-type inputs. The ModelGaugeTM M5 provides accurate battery fuel gauging and operates with extremely low battery current (25µA typ) during the standby or sleep mode to extend battery life. The interaction between the ModelGauge™ M5 and charger provides superior charging experiences and eliminates the need of the AP's assistance. The ModelGauge™ m5 algorithm combines the excellent short-term accuracy and linearity of a coulomb counter with the long-term stability of a voltage-based fuel gauge, along with temperature compensation to provide industry-leading fuel-gauge accuracy. A two-wire I^2C interface provides access to data and control registers.

Power Supply

The MAX77640 is a low-IQ power solution for applications where size and efficiency are critical. The device integrates a three-output single-inductor multiple-output (SIMO) buck-boost regulator, a 150mA LDO, and a three-channel current-sink driver. The SIMO operates on an input between 2.7V and 5.5V. The outputs are independently programmable between 0.8V and 5.25V depending on the options. Each output is a buck-boost with unerring transition between the buck and boost operations. The SIMO can support > 300mA loads (1.8V_{OUT} and 3.7V_{IN}). The 150mA LDO provides ripple rejection for noise-sensitive applications. The current sinks can be programmed to create custom-patterned blinks in LEDs. The device integrates a power sequencer to control the power-up/down order of each output. An I^2C serial interface further configures the device.

The MAX77827 is a high-efficiency buck-boost regulator targeting one-cell Li-ion and down to 1.8V-rated battery chemistry-powered applications with the lowest typical quiescent current in the industry (6µA). It supports input voltages of 1.8V to 5.5V and an output voltage range of 2.3V to 5.3V. The peak efficiency of 96% makes the IC one of the best solutions as a DC/DC converter to supply a rail for battery-powered portable applications. Two GPIO pins are available to support the force PWM-enabled function and power-OK (POK) indica-tor. The MAX77827 is used to power the MAX32660 and/or network radio modules such as NB-IoT, CAT-M1, LTE, etc.

The battery must be small and supply enough energy for the earbuds to continue working. A 125mAh, 3.7V Li+ battery is chosen. The charge rate is usually 1C, which means the charge current has a maximum of 125mA. Its stop voltage is 3V.

Data Communication

The asset tracker board leaves the interface (power rails and UART) for the external GPS module. The GPS mod-ule is connected to the board and cooperates with the related GUI. It can perform data communication when needed.

Detailed Description of Software

The MAXREFDES01261 software is mainly MAX32660 firmware (i.e. main loop) including the fuel gauge as well as SIMO/PMIC configurations.

Main Loop

The MAXREFDES01261 firmware is based on an infinite-loop design model. The MCU configures itself after power-up. It has the fuel gauge (MAX77840) and SIMO (MAX77860) configurations. The MCU updates the sys-tem status data every 30s via the UART. Figure 3 shows the flow of the main loop.

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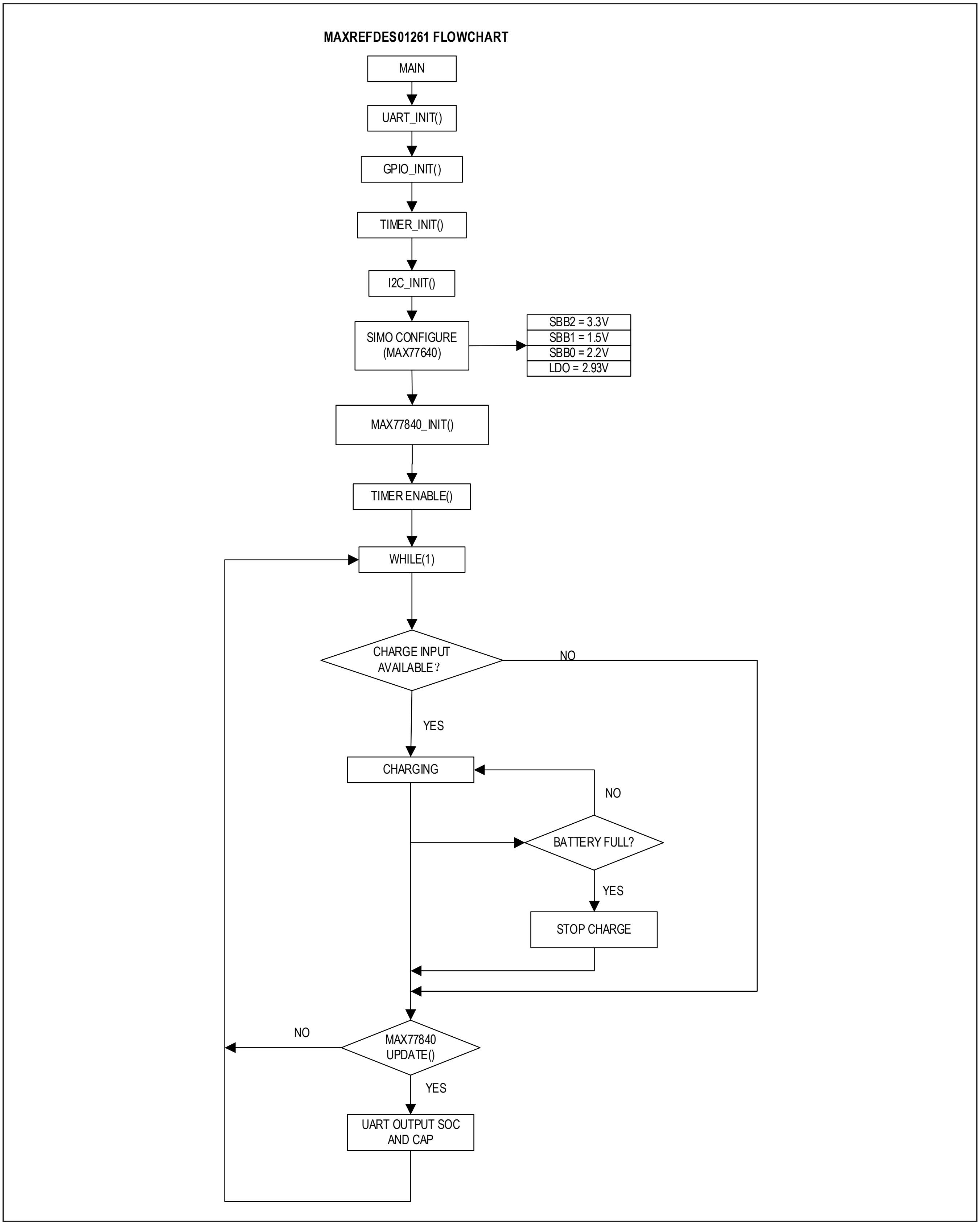

Figure 3. Asset tracker power management platform main function flowchart.

Operation Overview

The MAXREFDES01261 operation is simple. It is connected to the USB socket to charge and display information. The board supplies the GPS module different power rails to work when the external GPS module is connected to it.

Program Download Interface

The standard JTAG J3 is used for the asset tracker board coding and firmware update.

UART Communication Interface

The output value of this design can be displayed on the PC with a common UART terminal. Figure 4 shows the correct configuration of the terminal based on the serial port utility.

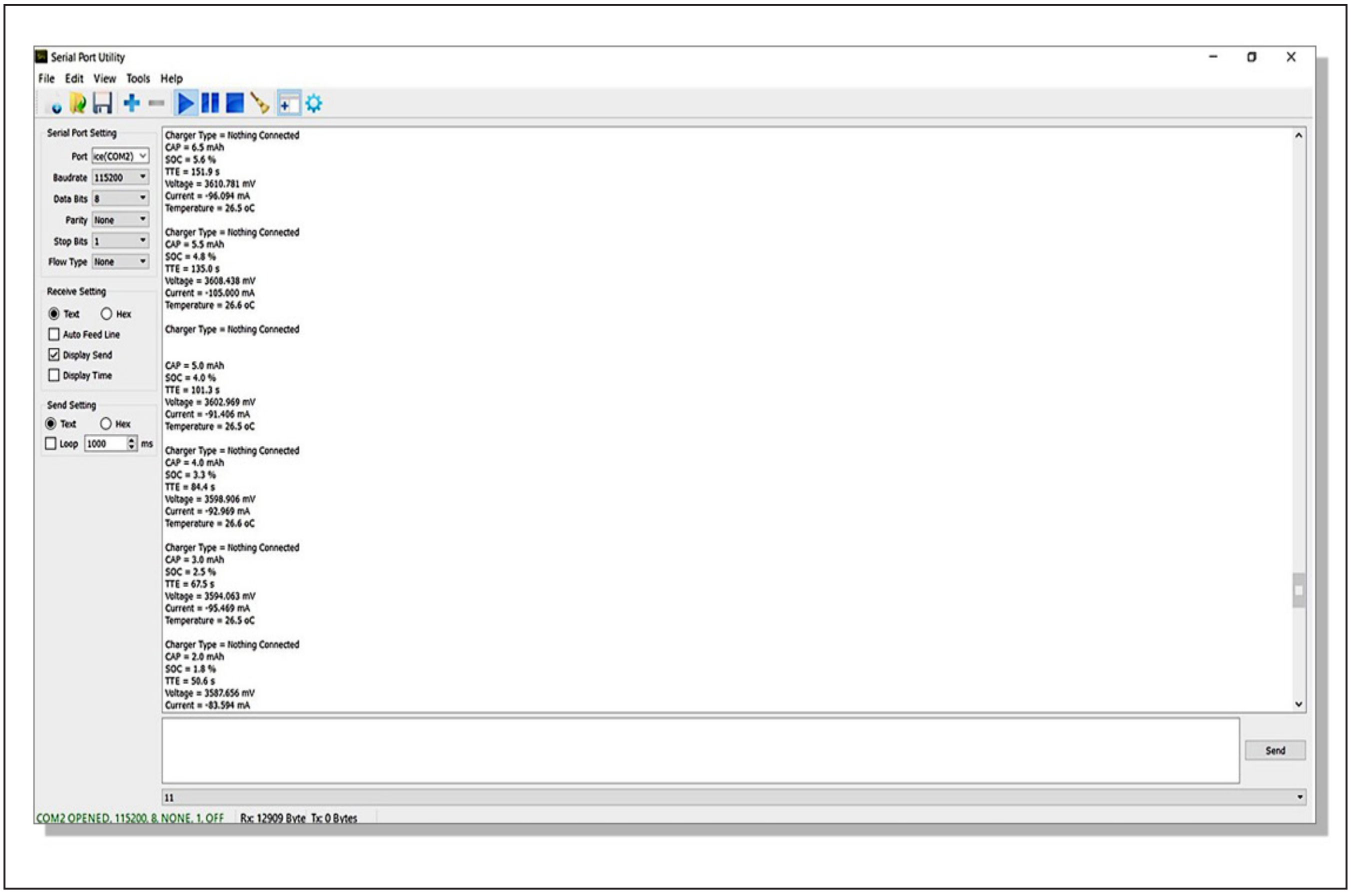

Figure 4. Asset tracker output window.

Design Resources

Download the complete set of **Design Resources** including schematics, bill of materials, PCB layout, and test files.

Revision History

REVISION NUMBER	REVISION DATE	DESCRIPTION	PAGES CHANGED
0	10/20	Initial release	—