TM702V00 PRODUCT DESCRIPTION

Overview

The TM702V00 is designed primarily as a power outage notification device. The hardware requirements of this device are a close approximation of the requirements of a TM701V00 gateway device. Hardware features specific to this application include battery-powered operation, a user interface lighted push button and the physical form-factor.

- The complete product consists of a TM702V00 board and Telco Modem module in a plastic enclosure, a wall-wart power transformer and a modular cable to connect to a telephone line.
- User interface consists of a ½ inch square, lighted momentary push button switch.
- Electrical interface consists of a 2.1 mm barrel connector for the external power supply and a dual RJ-11 modular telephone jack.
- The enclosure is a 28mm X 66 mm X 90 mm black ABS plastic enclosure with a door for the 9V battery. A flat insert in one end provides openings for the telephone and power connectors. A square hole in the center of the top surface is used by the lighted push button. A recessed area on the top surrounding the button opening provides for application of an identifying label.

Power Source and Requirements

A. External Power Supply

The external power will be provided by an unregulated 9VDC wall transformer. This power supply will provide the operational power for the device and will also be used to detect line voltage fluctuations (brownouts and blackouts). The rated current from the transformer will be 200 mA. It is necessary to load the transformer to a significant percentage of its rating in order to ensure that the output voltage is proportional to the line voltage. The minion device will normally represent an insignificant load. The voltage measurement circuit will include a 100 ohm, 1 watt resistive divider. This will load the transformer to 50% of its rating and minimize the effect of load changes as the modem is turned on or off.

The external power supply connects to the device with a 2.1 mm barrel connector with (+) on the center pin.

B. Battery

The battery will be a 9V alkaline primary cell. Typical ratings for an industrial alkaline battery show a life of 6 hours with a constant load of 100 ohms and an end-of-life voltage of 5.4 volts. Therefore, the average voltage is about 7.5 volts, average current is about 75 mA and capacity would be about 450 mA-Hours. Since this is a 3.3 volt design and we use a low-dropout regulator the actual life may more than double this figure.

The table shows estimated device longevity while operating on battery power. The last three columns show a life expectancy for the battery after using the modem for three dif-

ferent amounts of time. All of these numbers should be viewed as worst-case estimates; performance in real-world situations should be significantly better

	Maximum Sleep	Normal Sleep (1: 120)	Light Sleep (1: 60)	Continuous Calling	Modem Use During Normal Sleep		
					10 minutes	2 hours	6 hours
Battery	450 mA-H	450 mA-H	450 mA-H	450 mA-H	445 mA-H	394 mA-H	282 mA-H
Minion	30 uA	88 uA	147 uA	7 mA	88 uA	88 uA	88 uA
Modem	55 uA	55 uA	55 uA	21 mA	55 uA	55 uA	55 uA
Lifetime	5294 hours (220 days)	3147 hours (131 days)	2239 hours (93 days)	16 hours	3112 hours (130 days)	2775 hours (115 days)	1972 hours (82 days)

To summarize:

- The battery is only used while the main power is disconnected.
- If the external power is on continuously the battery will last for its rated shelf life.
- The battery life expectancy without external power is four (4) months.
- Each hour of modem use during a power failure will reduce that expectancy by eleven (11) days.

C. Transceiver

Transceiver specified maximum sleep mode current is 5 uA. This design eliminates that current. Transceiver peak current is specified as 12 mA which is well within the drive capability of the output pin. Empirical results show that the operating voltage is typically Vdd - 0.4V; the processor specification lists a minimum of Vdd-0.7V. This represents a slight penalty, typically in reduced receiver sensitivity, that can be eliminated by powering the transceiver directly from the Vdd rail in applications that do not require maximum power conservation.

D. Modem

The modem current is listed as 21 mA max at 3.3 volts during operation and 55 uA max during power-down. The duration of an outage notification call will be approximately 30 seconds which will be the only time that the full-power load will be presented to the battery.

E. Power Regulator

The power supply section of the device provides for both external (wall) and internal (battery) operation. These nominal 9V supplies are regulated down to 3.3V by a Low Dropout analog regulator. Diode protection ensures that reverse connections will not damage the device. The protection diodes also ensure that power is supplied only by the wall transformer during normal operation. The transformer voltage being slightly higher than the bat-

tery voltage reverse-biases the battery protection diode and ensures that no current flows from the battery.

- Resistive dividers are used to establish measurement points for A/D converters used to measure the voltages of each supply. The measurement points must be between 0 and 3.3V, the range of the A/D converter using the regulated Vdd as a reference.
- A 100 ohm, 1 watt divider chain scales the external supply to 1/4 of its value and provides a load for the transformer. A series diode protects the analog input against reverse connection or inadvertent use of an AC transformer.
- A 1 Mohm divider scales the battery to 1/4 of its value and presents an insignificant continuous drain on the battery. A 0.1 uF capacitor is used to provide charge storage at the measurement point to ensure accurate measurements by the A/D converter. A series diode protects against accidental battery reversal.

F. Microcontroller

Low-power consumption:

- - < 0.6 mA typical @ 3V, 4 MHz
- -20 ∝A typical @ 3V, 32 kHz
- -< 1 ∝A typical standby current

Transceiver

The radio transceiver is a single-chip design utilizing an ASH receiver manufactured by RF Monolithics. It provides operation on a single frequency in the 900 MHz ISM band with a power output of less than 1mW. Modulation is via On-Off Keying and data is encoded using a Manchester algorithm.

Power to the entire transceiver circuit may optionally be provided by a microcontroller output pin. This allows for complete power-down of the transceiver circuitry without relying on the mode control lines. Transceiver specified maximum sleep mode current is 5 uA. This design eliminates that current. Transceiver peak current is specified as 12 mA which is well within the drive capability of the output pin. Empirical results show that the operating voltage is typically Vdd -0.4V; the processor specification lists a minimum of Vdd-0.7V. This represents a slight penalty, typically in reduced receiver sensitivity, that can be eliminated by powering the transceiver directly from the Vdd rail in applications that do not require maximum power conservation.

- Two I/O lines control the operating mode of the transceiver and select power-down, transmit, or receive mode.
- Two I/O lines control the output power level for the transmitter. When the transceiver is in transmit mode the actual output power is controlled by the current into an analog pin. The microcontroller adjusts this current by modifying levels into a resistive network.
- A single I/O line receives the raw data from the receiver. The firmware detects the falling edges of this data stream and decodes the Manchester data forming the data packet

Minion current requirements are 7 mA at 3.3 volts and 30 uA during sleep with the real-time clock running. Normal MinionNet operations turn the radio transceiver on for one second every two minutes when operating on battery power.

Microcontroller

The microcontroller is a PIC controller from Microchip Technologies. The single-chip controller combines processor, flash program store, EEPROM non-volatile data storage, RAM memory, clock oscillator, real-time clock, parallel I/O ports, serial I/O and A/D converters.

- The asynchronous serial I/O port provides communication with the modem module. Asynchronous data and commands are transferred at 2400 baud.
- I/O port controls the reset line to the modem.
- I/O port connects to the LED indicator through a 330 ohm current limiting resistor.
- I/O port connects to the push button which switches a 10K ohm pull-up resistor to ground when pressed.
- I/O port connects to the switched contact of the external power supply barrel connector. Since this contact switches to ground and is closed when the external power supply is NOT connected, care must be exercised with power consumption. A long-time-constant RC network is connected to the contact. The firmware will periodically drive the pin high for a period of time, then switch to input to detect the charge, if present. The capacitor will be grounded if the external supply is not connected. This eliminates the continuous drain that would be associated with a simple pull-up resistor. A 10K resistor and 0.1 uF capacitor yield a 1 mSec time constant. The firmware will control the interval between tests and thus the effective current consumption which will run as high as 300 uA during the test.
- Six I/O ports are used to control the radio transceiver as described below.
- Two A/D converter channels are used to measure the voltage level of the external power supply and the battery. The 3.3V Vdd is used as the reference.
- The processor clock operates at 4 MHz using a crystal oscillator. The processor clock oscillator stops during sleep mode to conserve power.
- The real-time clock oscillator uses a 32 KHz crystal and provides very low current drain during sleep mode while ensuring accurate interval measurement for wake-up.
- The I^2C interface is connected to an optional single-chip non-volatile serial memory with a capacity of up to 32K bytes. 10K ohm pull-up resistors are required for SCL and SDA on the I^2C bus.