EE440 Operational description

EE440 is an E-ink based ESL with a 2.4GHz radio for data communication. This product uses Direct Sequence Spread Spectrum RF technology that allows for an ultra-low power consumption combined with a reduced sensitivity to background noise. That means less interference by other radios that operate in the 2.4GHz band. The radio protocol that is used is based on the IEEE 802.15.4 standard that specifies the physical layer and media access control for low-rate wireless personal area networks. The protocol is entirely implemented, except for some small changes that have to do with the connection protocol to a base station. When the base station is not available the EE440 switches to a non-802.15.4 standard to lower the power. That is especially useful when the EE440 is not being used for a prolonged period of time (e.g. during storage).

The EE440 is intended to be operated in combination with a base station such as the EBS30 which can control a large number of EE440 and other types of ESL of the same family such as EE201.

The ESL is in sleep mode almost the entire time. The device wakes up at regular intervals (called the poll time) and it then transmits a poll request to the base station. When the base station has no data to send, it just acknowledges the poll after which the ESL immediately goes back to sleep. The poll rate is configurable and is set to 20 seconds by default. A higher poll rate will decrease the power consumption but will increase the response time.

Below table shows the power characteristics.

Parameter	Typ	Unit	Remarks
Operating voltage	3.0	V	2x Alkaline AAA size battery
Sleep current	<1	uA	When the transmitter and receiver are idle
Poll time	20	seconds	

The battery supply consists of two pieces of AAA batteries with below specifications:

1. Microcontroller and RF transceiver

U1: cc2530 (TI)

Texas Instruments CC2530 is System on Chip (SoC) solution for 802.15.4, ZigBee. cc2530 has a combined RF transceiver and 8051 MCU, in-system programmable Flash memory. Table 1 shows the cc2530 control specifications. Table 2 shows the radio specifications of cc2530.

Items	Specifications		Remarks
	Type	8051 core 8-bit MCU	
	Internal flash ROM	256KB	
	Internal RAM	8 KB	
	Clock frequency	32 MHz	
LCD	Active area	W 89.6 x H 67.2 mm	
	Number of dots	W 400 x H 300	
	Dot pitch	113 Horizontal 113 Vertical	Dots per Inch
Radio	Modulation	DSSS	
	Frequency	2405 ~ 2480 MHz	Globally approved 2.4GHz band.
	Baud rate	250 Kbits / second	

Table 1. cc2530 specifications

Parameter	Min	Typ	Max	Unit	Remarks
Receiver sensitivity		-97	-89	dBm	Over the entire temp. and operating voltage range
Nominal output power	-3	4.5	7	dBm	
Frequency	2405		2480	MHz	Over the entire temp. and operating voltage range
Transfer rate		250Kbit/s			
RSSI range		100		dB	Signal strength indication that can be reported to the base station

Table 2. cc2530 Radio specifications

2. Antenna

The antenna is a sheet metal PIFA with operating frequency 2405-2480 MHz.
Peak Gain = -4dBi

3. Balun

U3: 2450BM15A0002 (Johanson Technology)

The Balun which is Low Pass Filter integrated passive components has been
implemented in cc2530 RF front-end.

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