

# Lattice iCE40 Mobile Solutions

The iCE40™ Ultra Low Power FPGA family is designed to address always on functions in mobile consumer devices. These functions extend from IR sub-systems, custom connectivity as well as sensor management solutions.

The nature of always on functions present challenges to mobile designers due to constant current drain from the battery. By leveraging 40-nm low-power CMOS process and low power circuit design, the iCE40™ family delivers the lowest active and standby power consumption solutions in the market. This enables applications like sensor management in smartphones to collect and analyze multiple sensor data streams in realtime and transform data in to information while keeping processors in low their lowest power mode.

iCE40™ Ultra Low Power FPGAs are offered in ultra-small form factor packages, which makes it well suited for area constrained applications like smartphones and tablets.



## Key Features

### ■ Flexible Logic Architecture

- Multiple devices with 384 to 7680 LUTs
- Up to 18 I/O pins WLCSP package
- Up to 178 I/O in BGA package

### ■ Ultra-low Power Devices

- Advanced 40 nm ultra-low power
- As low as 45  $\mu$ W standby power

### ■ Embedded and Distributed Memory

- Up to 128 Kbits sysMEM™ Embedded Block RAM

### ■ Integrated Hard Cores

- Hard I2C & SPI Cores
- Low Power & High-Speed Strobe Generator
- Flexible Device Configuration through SPI

### ■ Flexible On-Chip Clocking

- Six low-skew global signal resources
- Phase Lock Loops

### ■ Ultra-Small Form Factor

- As small as 16-pin WLCSP package 1.40mm x 1.48mm

iCE40 Device Selection Guide								
	LP Series (Low Power)					LM Series (Low Power, Hard IP)		
Features	LP384	LP640	LP1K	LP4K	LP8K	LM1K	LM2K	LM4K
Logic Cells	384	640	1280	3520	7680	1100	2048	3520
Typical ( $\mu$ A, @ 0KHz, 1.2V Vcc)		100	100	360	360	95	95	95
Embedded RAM Bits	0	64K	64K	80K	128K	64K	80K	80K
Phase-Locked Loop Core	-	-	1	2	2	1	1	1
I <sup>2</sup> C Core	-	-	-	-	-	1	2	2
SPI Core	-	-	-	-	-	1	2	2
Low Power Strobe Generator	-	-	-	-	-	1	1	1
High Frequency Strobe Generator	-	-	-	-	-	1	1	1
24mA Current Sink	-	3	3	-	-	3	3	3
Packages <sup>1</sup>	I/O Pins (dedicated I/Os)							
16-ball WLCSP (1.40 x 1.48 mm)		10(2) <sup>2</sup>	10(2) <sup>2</sup>					
25-ball WLCSP (1.71 x 1.71 mm)						18(2) <sup>2</sup>	18(2) <sup>2</sup>	18(2) <sup>2</sup>
36-ball ucBGA (2.5 x 2.5 mm)	25(2)		25(2) <sup>3</sup>			25(2)	25(2)	25(2)
49-ball ucBGA (3 x 3 mm)	37(2)		35(2) <sup>3</sup>			35(2)	35(2)	35(2)
81-ball ucBGA (4 x 4 mm)			63(2) <sup>3</sup>	63(2) <sup>4</sup>	63(2) <sup>4</sup>			
121-ball ucBGA (5 x 5 mm)			95(2) <sup>3</sup>	93(2)	93(2)			
81-ball csBGA <sup>2</sup> (5 x 5 mm)			62(2) <sup>3</sup>					
32-pin QNF (5 x 5 mm)	21(4)							
121-ball csBGA (6 x 6 mm)			92(2) <sup>3</sup>					
225-ball ucBGA (7 x 7 mm)				178(3)	178(3)			
84-pin QNFS <sup>2</sup> (7 x 7 mm)			67(2) <sup>3</sup>					

1. Packages: WLCSP - 0.35 mm pitch chip scale ball grid array, csBGA - 0.5 mm pitch Chip-Scale Ball Grid Array, ucBGA - 0.4 mm pitch Chip-Scale Ball Grid Array, caBGA - 0.8 mm pitch Ball Grid Array

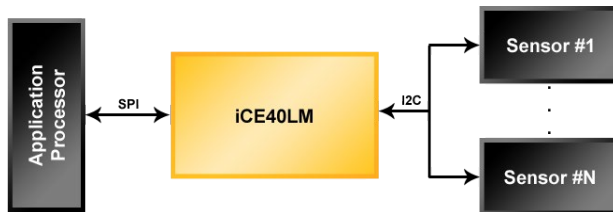
2. No PLL available

3. No 24mA current sink

4. Only 1 PLL available

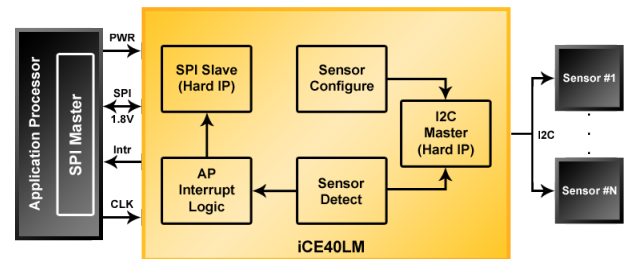
# Solution Examples

## Sensor Hub



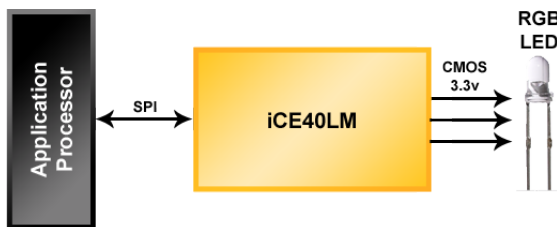
- Monitors numerous sensors to allow an applications processor to sleep longer
- Connects to multiple sensors via I2C bus
- Aggregates sensor data
- Sends sensor data via SPI bus to an applications processor

## Sensor Manager / Pre-Processor & Pedometer



- Prioritizes and handles all sensor interrupts
- Collects Data streams from multiple sensors via I2C
- Parses, processes, and loads into FIFO buffers in preparation for Processor
- Decides when necessary to wake up the processor

## RGB LED Driver

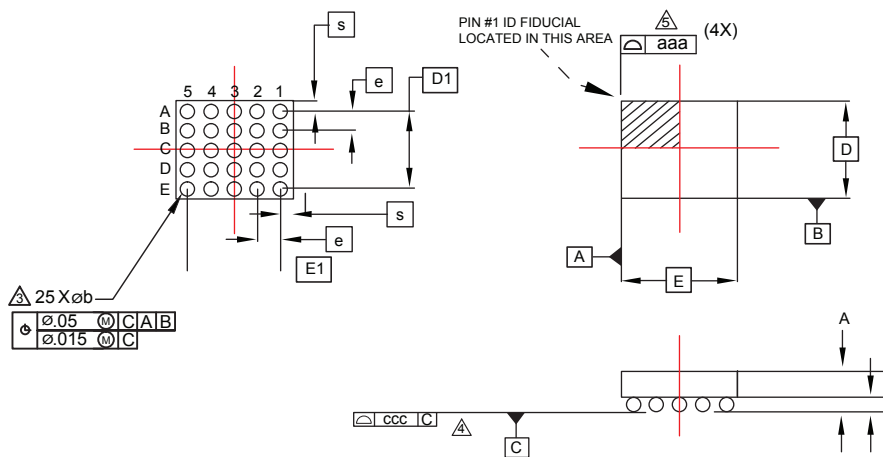


- Drives and controls 3 LEDs or 1 RGB LED with 24mA current sink for color mixing and status indication
- Connects to an applications processor via SPI

## Infrared Tx/Rx



- Infrared (IR) transmit (Tx) and receive (Rx) capable
- IR Tx consumes 335 LUTs, IR Tx/Rx 418 LUTs
- Performs all necessary infrared PWM functions
- Interfaces to an applications processor via SPI bus
- Allows plug-n-play addition of remote control feature to mobile devices



REF.	Min.	Nor.	Max.
A	0.413	0.452	0.491
A1	0.122	0.152	0.182
b	0.188	0.218	0.248
D	1.40 BSC		
E	1.48 BSC		
D1	1.05 BSC		
E1	1.05 BSC		
e	0.35 BSC		
aaa	0.03		
ccc	0.03		
r	-	0.175	-
s	-	0.175	-

iCE40LP1K  
16-WLCSP  
0.35mm Pitch

REF.	Min.	Nor.	Max.
A	0.413	0.452	0.491
A1	0.122	0.152	0.182
b	0.188	0.218	0.248
D	1.71 BSC		
E	1.71 BSC		
D1	1.40 BSC		
E1	1.40 BSC		
e	0.35 BSC		
aaa	0.03		
ccc	0.03		
s	-	0.155	-

iCE40LM4K  
25-WLCSP  
0.35mm Pitch

Applications Support  
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