

# Enabling the Nokia ECI for Smartphones

## Enhancement Control Interface using the iCE40 Ultra-Low Density FPGA

### Market Dynamics

Smartphones are growing with a year-over-year growth percentage of more than 75% as of Q2'11 (see Table 1). The main driver for smartphone growth is digital convergence. A smartphone is now a phone, a media player, a PDA, and a gaming device. Smartphones also offer a high-quality audio/video experience with users now listening to music and watching video.

Global Smartphone Vendor Shipments (Millions of Units)	Q2'10	Q2'11
Apple	8.4	20.3
Samsung	3.1	19.2
Nokia	23.8	16.7
Others	27.1	53.8
Total	62.4	110.0
Global Smartphone Vendor Market Share (%)	Q2'10	Q2'11
Apple	13.5%	18.5%
Samsung	5.0%	17.5%
Nokia	38.1%	15.2%
Others	43.4%	53.8%
Total	100.0%	48.9%
Growth Year-over-Year %	50.4%	76.3%

Figure 1: Global Smartphone Vendor Shipments from Gartner, Inc.

As smartphones are increasingly used as personal entertainment devices, consumers are demanding more flexible control options (e.g. music player control features without turning on the phone). Many of these control functions, whether for music, video or games, require access to the earphone jack.

Typical earphones used in smartphones have four wires worked into one jack consisting of a left and right channel, ground and a microphone. See Figure 2.

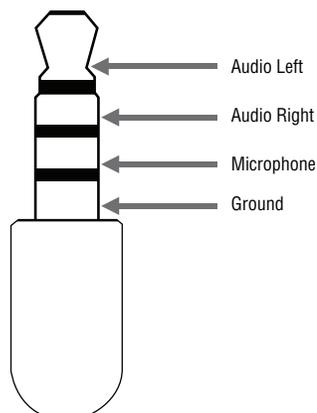


Figure 2: Earphone jack

Current earphone structure is ideal for audio in and out, but not ideal for data transfer. But the kinds of accessories being plugged into this port have aspired to be much more than this. They have controls for volume, mute, play, fast forward, reverse, and pause, but no easy, obvious way to communicate that functionality to the smartphone itself.

### Designer's Challenge

This is where ingenuity has taken over. Designers have found ways of borrowing these simple signals and using them to double as data wires over which these extra functions can be communicated. The simplicity of the wiring is compensated by extra complexity in the communication scheme, and yet it all has to be simple, small, low-cost, and low-power enough to work in the smartphone format.

Nokia has developed the Enhancement Control Interface (ECI). ECI initially was a proprietary interface, but Nokia has recently opened up their ECI to drive adoption in smartphones built by other companies.

As a newly available capability, the challenge is that other phone makers don't have access to application processors that support this standard. New application processors under development now may include such features, but they may not be available for several years. Aggressive phone providers do not want to wait, yet their options are limited by the stringent requirements of the smartphone.

In most systems, the obvious solution is to use an FPGA that can act as a bridge between the ECI and an interface that the application processor already has, like SPI/I<sup>2</sup>C. To do this, there are certain requirements:

- Power consumption needs to be at a trivial level compared to that of standard FPGAs.
- Because of the space constraints inside a phone, the footprint occupied by the FPGA has to be tiny.
- The presence of the FPGA can't measurably affect the bill of materials for assembling the phone.
- There are a variety of analog functions required for bridging the ECI to SPI/I<sup>2</sup>C; the FPGA requires some way of implementing the analog circuitry.

## Lattice ECI Solution

Lattice has implemented a SPI-to-Nokia ECI bridge in an iCE40™ FPGA that acts as a proxy (bridge) between the processor transport level ECI host and the ECI device. The ECI host's transport level packets are translated into a SPI data protocol and communicated to the processor through the iCE40 SPI slave. (This SPI slave can be customized further to I<sup>2</sup>C or any other preferred interface.) The CMD parses and interprets these SPI data and translates them to ECI physical level packets to drive and control the ECI-AV slave device. The ECI signal of the ECI-AV is a single data line, usually multiplexed over the microphone line of the ECI-AV connector. It is used to exchange information between master and slave, such as ECI device identification, storing and reading permanent or temporary information, setting or reading I/O pins of the device as well as notifying slave state changes to the master.

## Features

- The device acts as a proxy between the AP ECI master and device through the SPI interface.
  - FPGA detects plug insertion and removal
  - Notification of plug detect, comparator changes, FIFO/CMD status and ECI slave interrupts through interrupt to the AP
  - Provides learning sequence information to the AP
  - Supports SPI slave of Mode 1 interface (CPHA = 1 and CPOL = 0)
  - Supports 64-byte FIFO depth
  - Configurable selection of interrupt event sources
  - AP provides the following through the SPI interface:
    - Command
    - Number of data/address bytes following command
    - Number of bytes to be read for the read operation

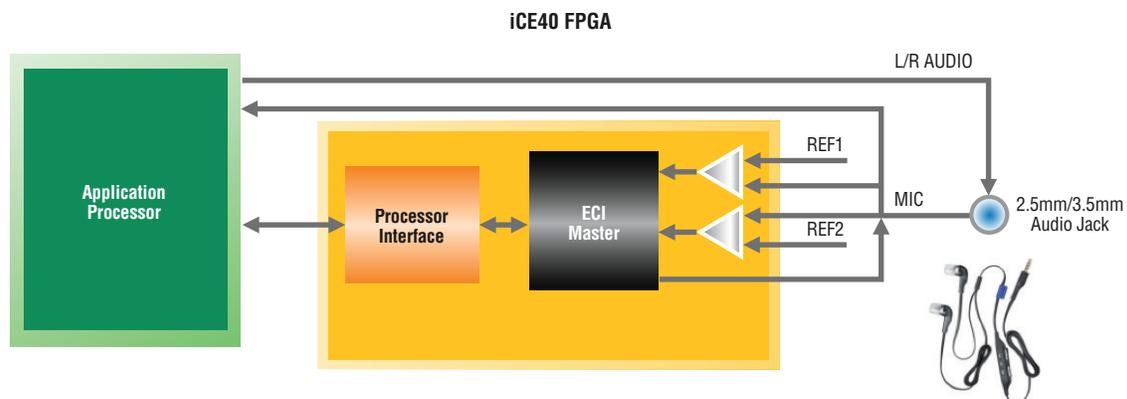


Figure 3: Lattice ECI implementation

## Applications Support

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