Reconfigurable Architecture
For Car Tuners

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Outline

• Introduction
• The ALU Array Architecture
• The Prototype of Broadcasting Receiver with ALU Array
• Conclusion
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Markets of car tuner LSIs in the world

Car navigation systems and DVB-H have become increasingly popular (Europe becomes a situation near Japan)

Satellite digital radios have already been so popular (Most of luxury cars equip with them)

Europe
- FM/AM
- DAB
- DVB

North America
- FM/AM
- XM
- SIRIUS
- HD-Radio

Japan
- FM/AM
- Digital TV
- Digital Radio

Analog radio systems are equipped in most of cars
Car navigation systems with digital terrestrial TV are so popular
New broadcasts, digital radio etc., will start
Benefits of reconfigurable tuner LSIs

Support various broadcasts
- One chip supports various broadcasts in the world
- Japan
  - FM/AM
  - Digital TV
  - Digital Radio
- North America
  - FM/AM
  - XM
  - SIRIUS
  - HD-Radio
- Europe
  - FM/AM
  - DAB
  - DVB

Support customer demands
- One chip is customized to various customer demands
- Specification A
- Specification B
  - Special processing
  - Basic processing

Support updating after release
- Update to the latest version which is solved trouble or has higher performance
- Support a new broadcasting processing
- Downloading

The ALU Array Architecture

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ALU Array Architecture

ALU Array Unit
24 ALUs are arranged in an array.
An ALU connects to only 3 adjacent ALUs in the lower row.

Command Memory
It supplies Command Data (control information data) to ALU Array Unit.

Sequencer
It dynamically controls next processing according to outputs of ALU Array Unit.

Operations of an ALU

Arithmetic operations: +, −
Logical operations: &, |, <<N, >>N (N=0~15)
Comparison operations: ==, <, <=
Selection operations: (c==1)? A : B
(A < B)? A : B
Operation for multiplication: mult
Other operations: sign inversion, through

Bit width of operations: 24bit
Bit width of Commands: 5bit

Sample of mult:
4bit variable × 4bit variable

z = x × y:

Multiplication is executed with a few ALUs by using mult
Motion of ALU Array Unit

It executes processing according to a DFG (Data Flow Graph) generated by our compiler.

It passes outputs of ALUs to inputs of ALUs in the lower row.

It passes outputs of ALUs in the bottom row to inputs of ALUs in the top row through Feedback Path.

Multithread processing in ALU Array Unit

4 independent processing is executed at the same time.

Parallel processing of rows.

Raise utilization rate of ALUs.
The Prototype of Broadcasting Receiver with ALU Array

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The system of prototype of broadcasting receiver

Receivable broadcasts (Applications)
- Japanese digital terrestrial TV "One-Seg"
- FM radio
The method of switching applications

The processor is implemented in FPGAs

The Configuration Data of applications is loaded from ROM to the processor.

Processing in the processor is changed
Evaluation of the processor in the prototype

- **Allocation of applications**
  The processor executes One-Seg processing with 15 cores and FM radio processing with 8 cores

- **Reception tests with real airwaves**
  The processor has realized the real-time reception of both One-Seg and FM radio

- **Switching tests of Applications**
  The processor has realized the switching applications in the time,
  - To One-Seg: 140ms
  - To FM radio: 40ms

  the performance of the processor is suitable for car tuner processing

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**Conclusion**

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Schedule of the future

We have manufactured trial LSIs and evaluated them in fiscal 2007 with supports of NEDO*

The project of NEDO

*NEDO (The New Energy and Industrial Technology Development Organization)

Conclusion

We have developed a reconfigurable processor based on ALU Array for car tuners

We have developed a prototype of broadcasting receiver with the processor

The prototype has realized

• the real-time receptions of both One-Seg and FM radio
• the switching of receptions by changing software in short time

Our processor is an effective device for signal processing of car tuners

We’ll commercialize it by optimizations of the performance
Think GAIA
For Life and the Earth

“GAIA” is a term that encompasses the Blue Planet, “Earth,” and the infinite varieties of “life” that live and breathe on it. It describes the world as a single living organism, where all life and nature co-exist interdependently. SANYO is committed to listening to GAIA’s voice and engaging in activities that are beneficial to life and the Earth.

As a testament to this, SANYO pledges to respond by developing only products that are absolutely essential to life and the Earth. We aim to bequeath a beautiful Earth to future generations. This is SANYO’s Brand Vision—Think GAIA.

To realize this vision, SANYO promotes a threefold approach, focusing on the environment, energy and lifestyle. As a leading provider of Environment- and Energy-related products, SANYO seeks to harness its exclusive, unique technology and innovative creativity to deliver global solutions. All for the Earth. All for life. All for GAIA.