Addressing Fixed Point Design Challenges

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## Fixed Point Design Challenges

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Fixed-Point Concepts

- What is Fixed-Point?
- Fixed-Point Arithmetic
- Fixed-Point Targets

Introducing Fixed-Point Designer

- Fixed-Point Designer Tools

Floating-Point to Fixed-Point Conversion Workflows

- Using the Fixed-Point Tool in Simulink
- Using the Fixed-Point Converter App in MATLAB

Code Generation from Fixed-Point Design

- C/HDL
What is Fixed-Point?
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What is Fixed Point?

**Floating-point:**
- Sign bit
- Exponent Width → Range
- Mantissa / Fraction bits → Precision
- Floating Radix / Decimal Point
  - Same word size, we can increase both precision and range

IEEE 754 single-precision binary floating-point format: binary32*

**Fixed-point:**
- Sign bit
- Whole Number Part → Range
- Fractional Part → Precision
- Fixed Radix / Decimal Point
  - Fixed size, **Trade-off between Precision and Range**

*Picture from http://en.wikipedia.org/wiki/Single_precision_floating-point_format*
Fixed Point Arithmetic

6 + 3.4 \times 10 = 68

3 + 6.8 \times 10 = 34

Fixed Point MCU

102 \div 10 = 10.2
Example: Fixed-Point C hand implementation

```c
void differentialEq( void )
{
    /* Implements a fixed point first order difference equation */

    int Prod;
    long Accum;
    static short lastVal=0;
    short a=0x7eb8; // 0.99 in s16,15
    short oneminusa=0x0148; // .01 in s16,15
    short temp;

    Prod = gAlg_in1 * gAlg_in1;
    temp = Prod >> 15;
    Accum = a*lastVal + oneminusa*temp;
    gAlg_out1 = (short)(Accum >> 15);
    lastVal = gAlg_out1;
}
```

- Convert variables to integer types
- Need lots of comments to understand code
- Keep track of binary point location
Weinmann Develops Life-Saving Transport Ventilator Using Model-Based Design

Challenge
Develop embedded software for an advanced emergency and hospital transport ventilator

Solution
Use MATLAB and Simulink for Model-Based Design to model and simulate the controller, generate production code, and streamline compliance certification

Results
- Code development and reviews accelerated by 50%
- Dozens of design alternatives explored
- 60% of core design reused

“Modeling, simulating, and implementing the ventilator’s embedded software with Simulink greatly simplified compliance certification. The model helped ensure a structured development process and provided thorough documentation and a visual representation of the system for the certification review.”

Dr. Florian Dietz
Weinmann

Link to user story
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Fixed Point ECU Development Process
with Model-Based Design
Fixed Point ECU Development
Using MathWorks Tools
Tools for Converting a Design to Fixed Point

**Fixed-Point Tool for Simulink**
- Requires: Fixed-Point Designer
- Works on: Simulink Blocks
- Stateflow Charts

**Fixed-Point Converter App for MATLAB**
- Requires: Fixed-Point Designer
- MATLAB Code

- Generated by MATLAB 8.5 and Fixed-Point
- Copyright 2015 The MathWorks, Inc.
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Code Generation from Fixed-Point Design

• C/HDL
Workflow using Fixed-Point Tool in Simulink:

1. Prepare for Fixed-Point Conversion
2. Collect Range Information
3. Propose Data Types
4. Apply Data Types
5. Compare Results
6. Generate Code
Workflow using Fixed-Point Converter App in MATLAB:
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**Code Generation from Fixed-Point Design**

- C/HDL
Code Generation
Automatically generate readable C/HDL code

Automatically generate C/HDL code from MATLAB/Simulink/Stateflow
Summary

- Fixed-Point Designer
- Conversion Workflow
  - MATLAB
  - Simulink
- Code Generation
  - C/HDL
## Key Takeaway

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Training Services

*Exploit the full potential of MathWorks products*

Flexible delivery options:

- Public training available in several cities
- Onsite training with standard or customized courses
- Web-based training with live, interactive instructor-led courses

More than 30 course offerings:

- Introductory and intermediate training on MATLAB, Simulink, Stateflow, code generation, and Polyspace products
- Specialized courses in control design, signal processing, parallel computing, code generation, communications, financial analysis and other areas.

[www.mathworks.in/training](http://www.mathworks.in/training)
## Public Trainings in the next Few Months

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Email: training@mathworks.in  
URL: http://www.mathworks.in/services/training  
Phone: 080-6632-6000
Training Certification

- Accelerate professional growth
- Validate proficiency with MATLAB
- Increase productivity and project success

MathWorks Certified MATLAB Associate Examination

Bangalore

29th July & 25th Nov

Pune

3rd June

Recommended Courses
MATLAB Fundamentals (MLBE)

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