A Novel Approach to Complex Waveform Generation 24GHz Radar Application

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Problem Definition

Introduction

- Many real-time applications require fast and precise waveform generation
- Radar applications, in particular, rely on a complex waveform to ensure the proper sequencing of both TX and RX radar chipsets
- General-purpose MCUs cannot cope with very high-speed signals without significant software overhead
- Signal sequencing typically requires a dedicated peripheral, called “Sequencer”, that is only found in DSPs or high-end radar-targeted SoCs
- These devices are typically more costly than a standard MCU, and the software investment required is quite high due to the non-standardized peripheral

Problem Definition

Objectives & Benefits

Objectives

- Demonstrate that general-purpose MCUs with GTM can perform tasks that are usually designated to specialized processors
- Demonstrate the GTM capabilities in a non-traditional application

Benefits

- Increase software portability among different platforms
- Improve system scalability and flexibility via standardization
- Provide cost-to-value optimization

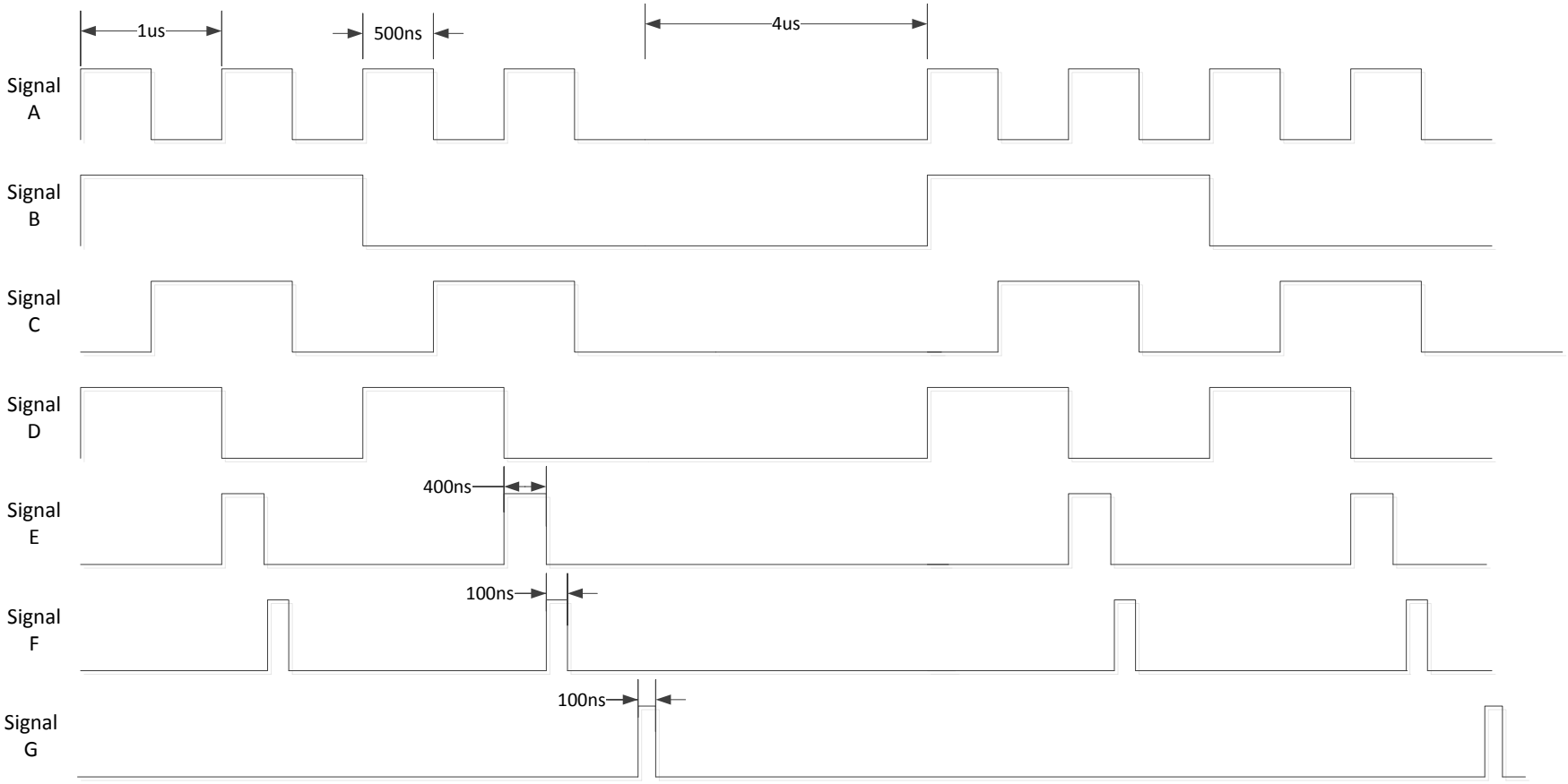
Problem Definition

Waveform Specifications

- Up to 8 output signals
- All signals are derived from a reference signal (signal A)
- 10ns PWM resolution
- Fully configurable number of pulses, and pulse period and duty cycle
- Synchronous trigger of ADC, SPI, and/or DMA at a specific pulse edge
- Selectable repeatability of waveform sequence
- Zero CPU intervention

Problem Definition

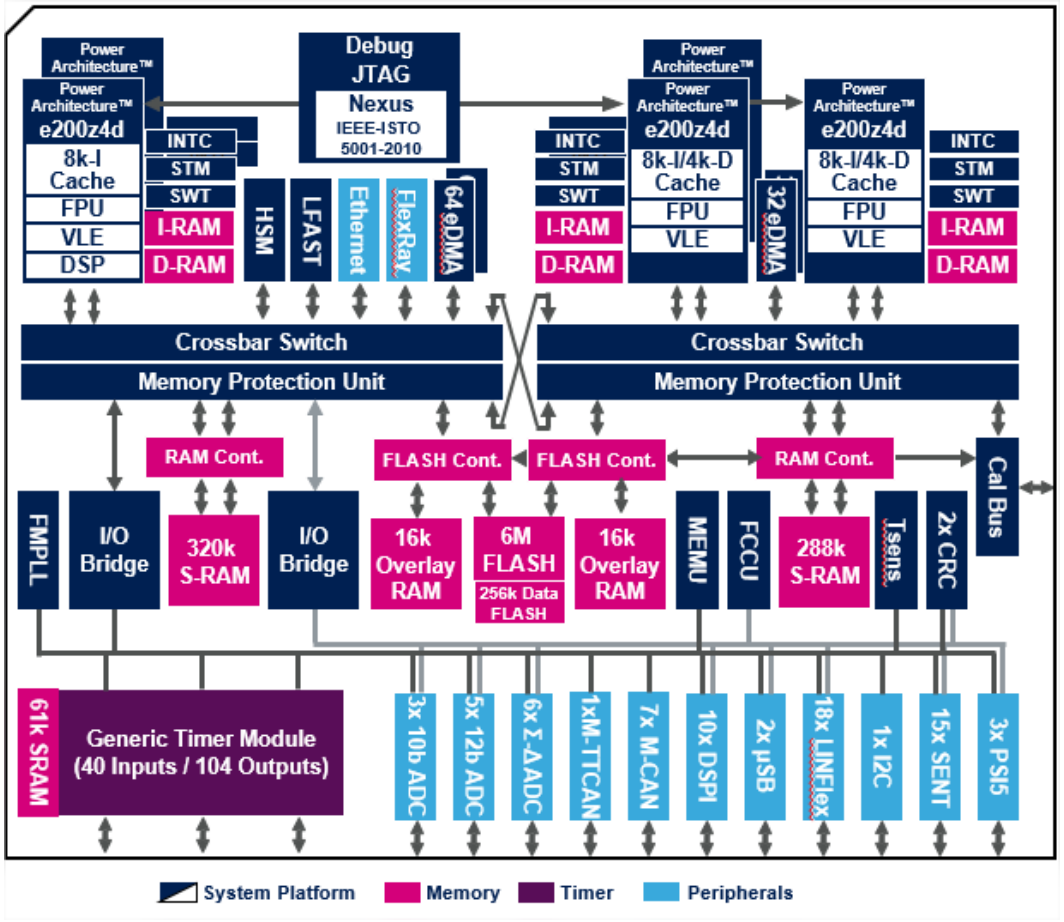
Waveform Specifications



Design Concept

MCU: SPC58NExx

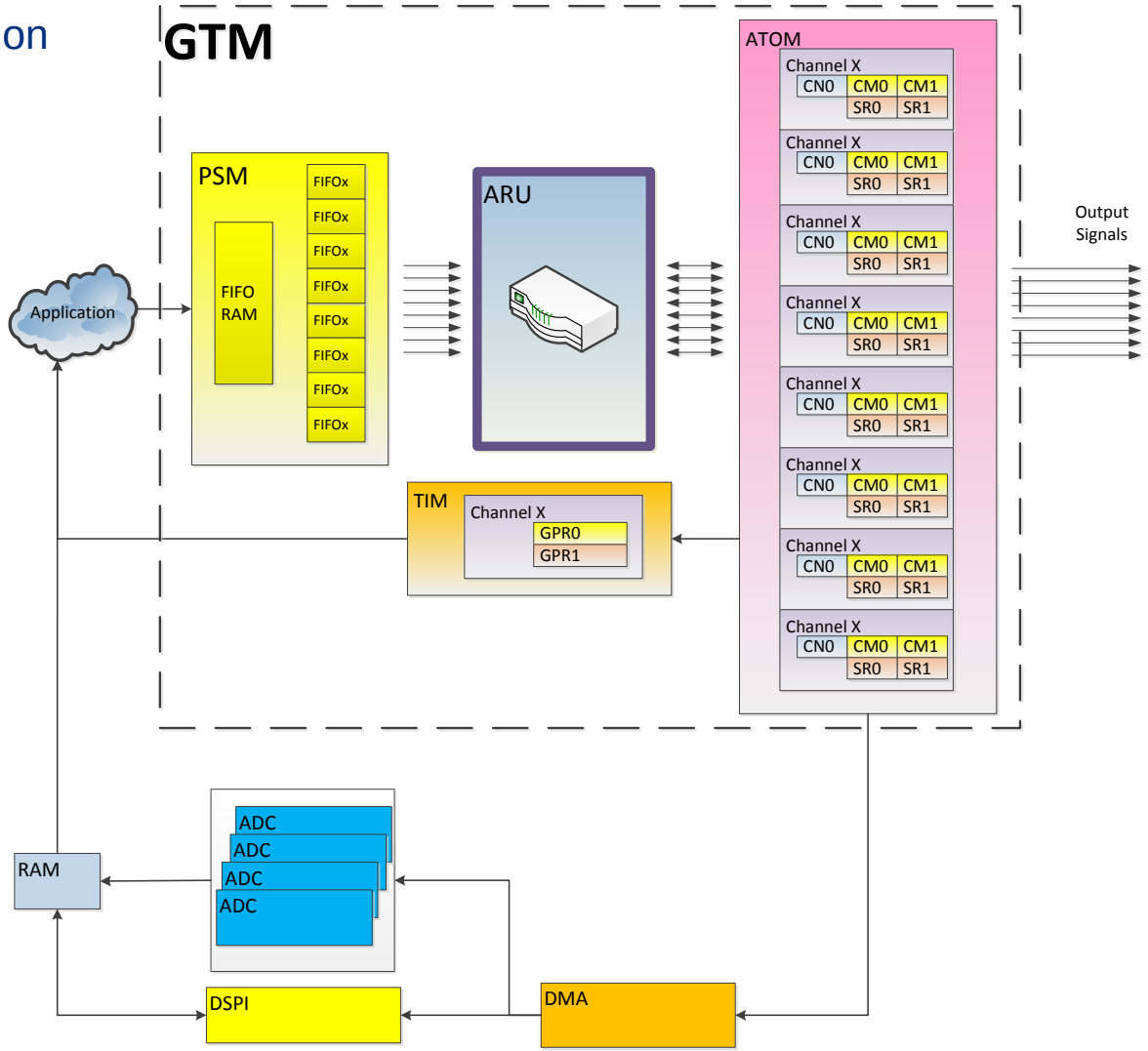
- Performance:
  - 3x e200z4d cores @ 180MHz
  - 700+ DMIPs rating
  - Hardware floating point unit
  - Light weight signal processing instruction set
- Memory:
  - 768KB RAM
  - 6MB Flash
- ADC:
  - 5x 12-bit SAR
  - 3x 10-bit SAR
  - 6x 16-bit SD
- Communication:
  - CAN FD, Ethernet Flexray, DSPI, LIN, SENT, PSI5
- Timed IO:
  - GTM v3.1.4 @ 100MHz
  - 5x TIM, 4x TOM, 5x ATOM, 5 MCS
  - 40 inputs / 104 outputs



Design Concept

System Architecture

- Application
  - Initialization & configuration
  - Radar algorithm
- GTM
  - Autonomous signal generation
  - Event triggering
- ADC
  - Analog data acquisition
  - Automatic data transfer
- SPI
  - Transmission of control data
  - Reception of diagnostics data



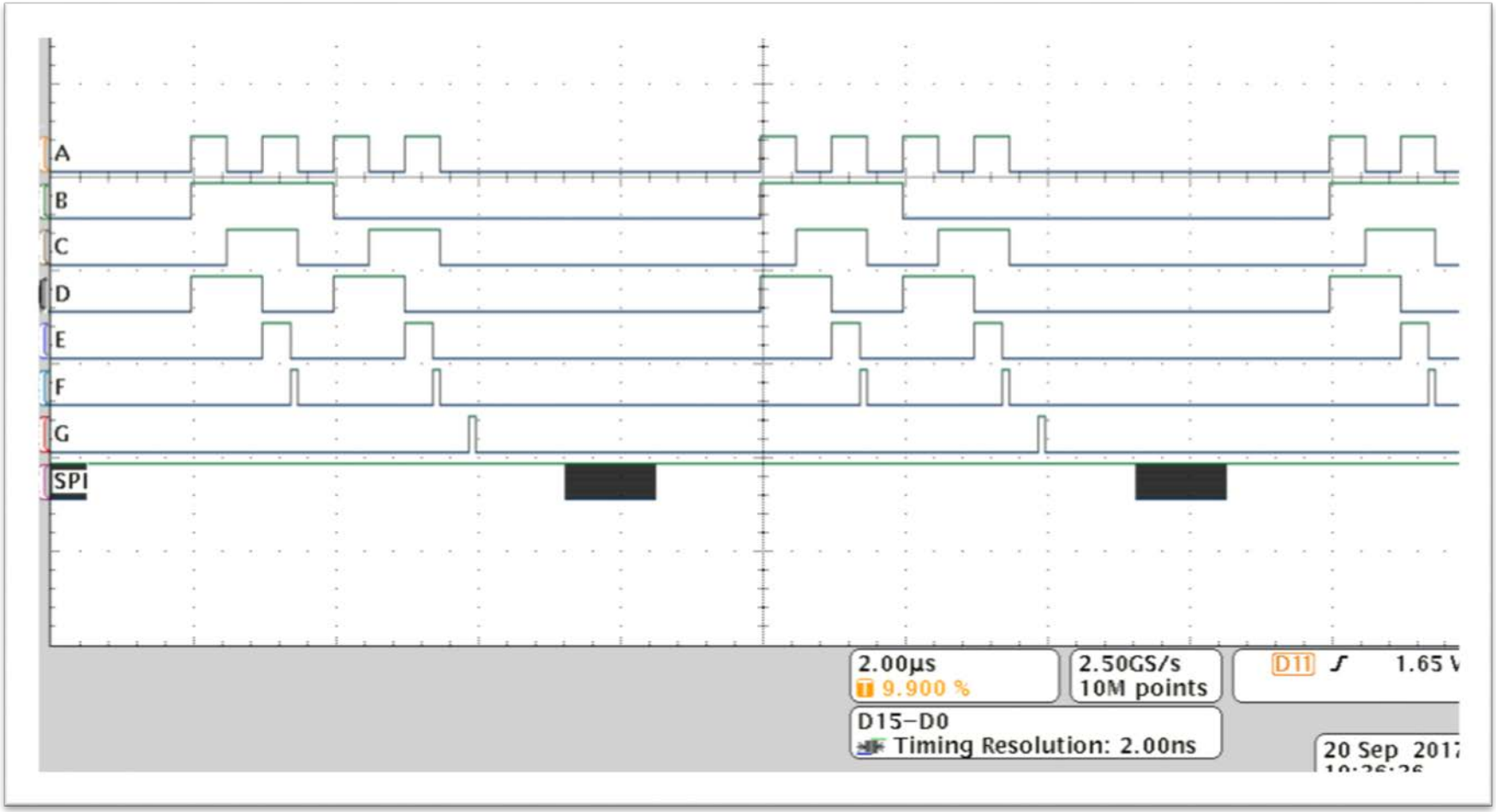
Design Concept

GTM

- Parameter Storage Module (PSM)
  - Buffer up of waveform parameters (periods & duty cycles)
  - Allow for period and duty cycle updates autonomously
- Advanced Router Unit (ARU)
  - Transfer of waveform data from PSM to ATOM in a deterministic manner
  - ARU trip time dictates the minimum pulse period that can be supported
- ARU-connected Timer Output Module (ATOM)
  - Output of waveform signals
  - Double buffering of pulse parameters to overcome ARU trip time
- Timer Input Module (TIM)
  - Monitor of waveform generated sequences
  - Trigger end-of-sequence service interrupt
- Multi-Channel Sequencer (MCS)
  - Not used in this design
  - Could perform configuration and end-of-sequence servicing instead of CPU

Results & Discussions

Output Signals



Conclusion

Limitations

- PWM resolution
  - Linked to the GTM system clock
  - Typically in the range of ns for general-purpose MCUs
- PWM period
  - Linked to ARU trip time
- ADC performance
  - Resolution, speed, conversation time, and accuracy
  - Typically no more than 12-bit @ 1MSPS in general-purpose MCUs
- RAM
  - No more than 1MB is general-purpose MCUs
- Hardware accelerators
  - Typically no radar specific math accelerators, like FFT, in general-purpose MCUs

Conclusion

Summary

- Radar-like complex waveform generation
  - No specialized IPs
  - Fully autonomous
  - No CPU intervention
- Leveraging the GTM
  - Simple to complex tasks
  - High portability due to the GTM’s wide adoption
- The ST SPC58NExx MCU
  - General-purpose
  - Built-in software scalability
  - Standardized peripheral set
  - Optimized system cost

Thank You !