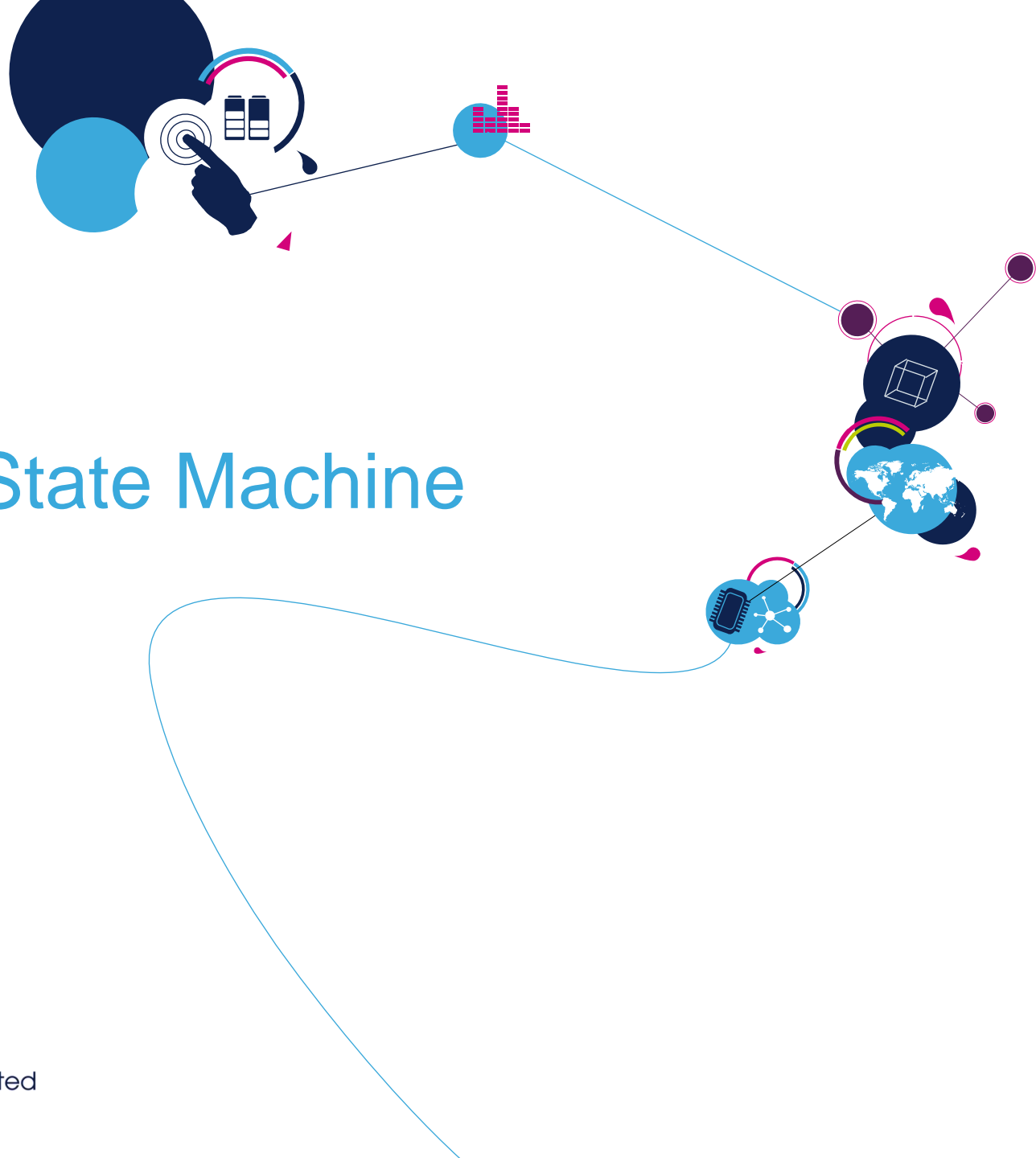


# LIS3DSH State Machine

Version 1.2





**Educational part: What is state machine? How it works?**

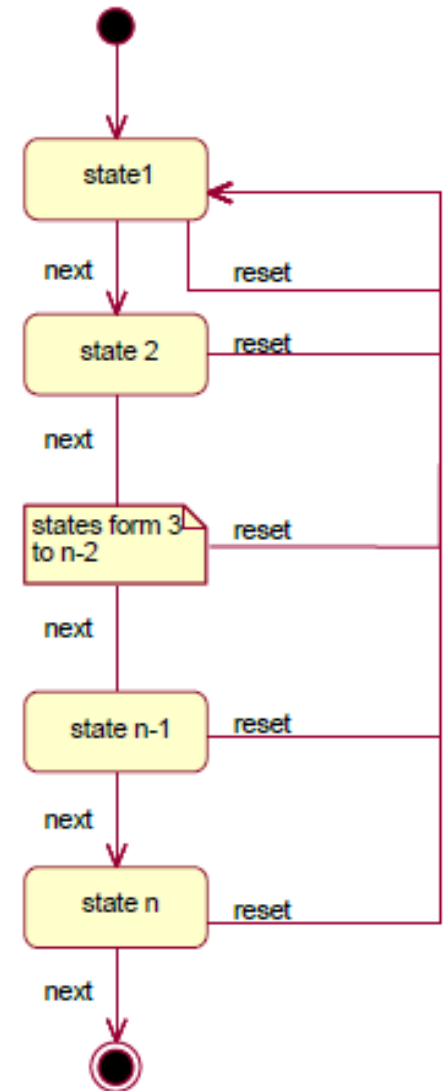
**LIS3DSH overview** and state machines features (structure, parametres, etc.)

**UNICO: PC GUI** with debug support for the LIS3DSH state machine

**LIS3DSH state machine examples, Live Demo**

# What is a state machine

- State Machine (SM) is a set of defined states, with inputs, outputs and transitions between states.
- The machine is in only one state at a time; the state it is in at any given time is called the current state.
- It can change from one state to another when a triggering event or condition occurs, this is called a transition.



- 3-Axis Digital SPI/I2C Accelerometer
- 5 selectable Full Scales: 2, 4, 6, 8, 16g
- 2 programmable embedded **finite-state machines** for interrupt generation
- Very High Resolution (up to **14 bit**) and low noise (**150 $\mu$ g/vHz**)
- Low power consumption: 11 $\mu$ A in Active mode (3.1Hz) and 2 $\mu$ A in Power down mode
- High Flexibility
- P2Pcompatible with LIS3DH

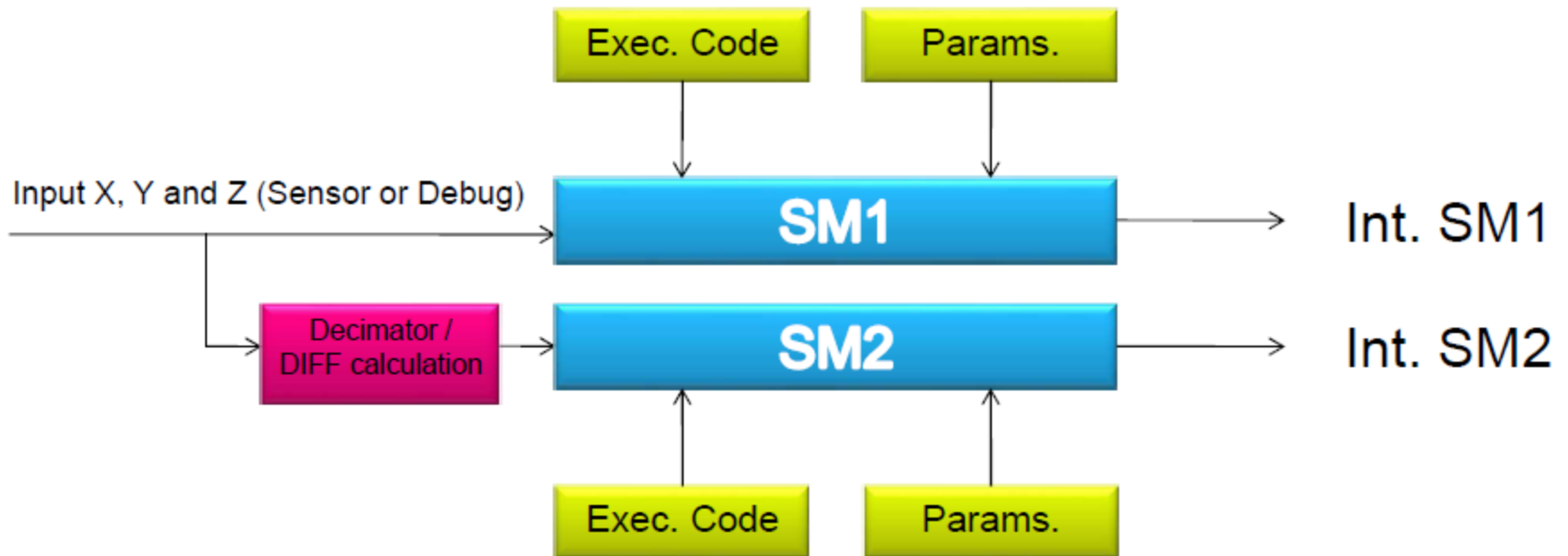


# State Machines of LIS3DSH

- LIS3DSH has **two** independently configurable State Machines(SM)
- Each SM has up to 16 states
- SM can run once or can be continuously running (looping)
- **SM1 and SM2** can run **independently or synchronized** but with **same input data**
- SM1 is performed first
- Input data are 8-bit wide

# State Machine Overview

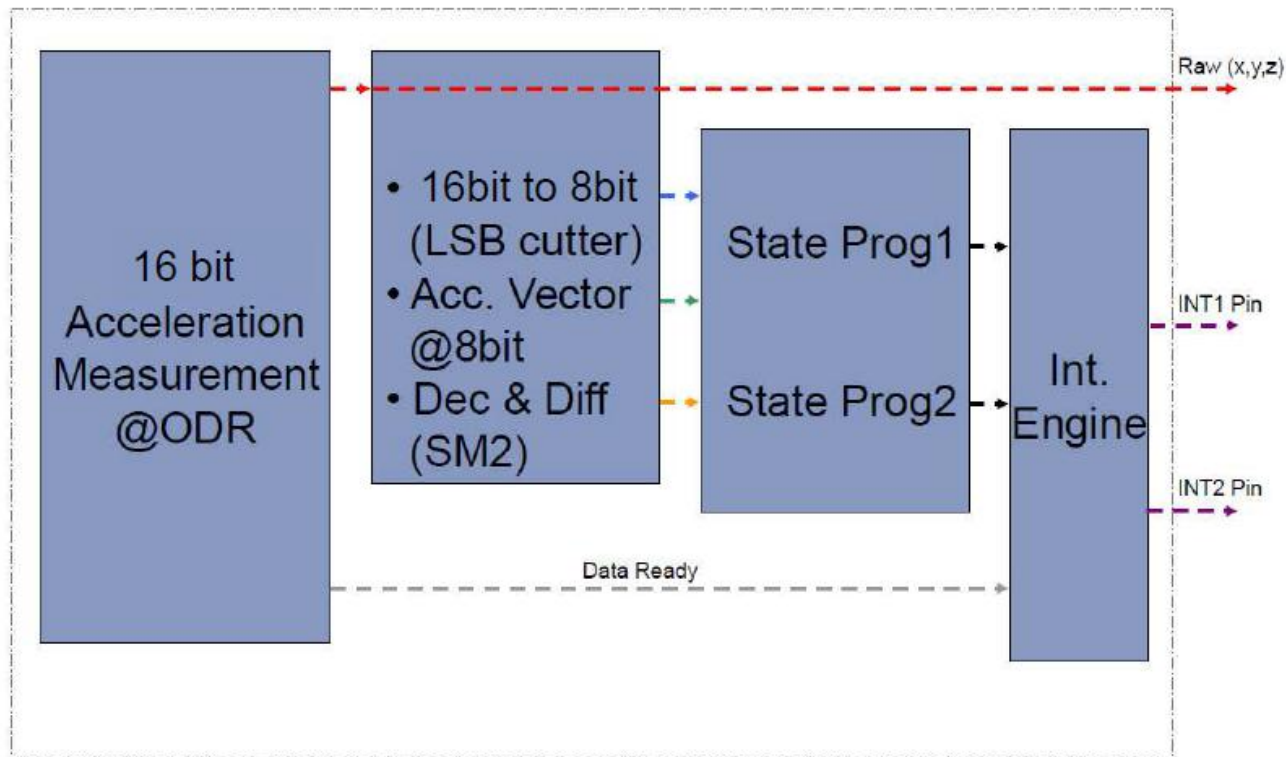
- State-machines are identical with some exceptions:
  - State Program #2 has decimator functionality
  - State Program #2 has DIFF functionality (new data Vs previous data, new data Vs constant)



# State Machine Overview

7

- LIS3DSH data flow:



# State Machine Overview

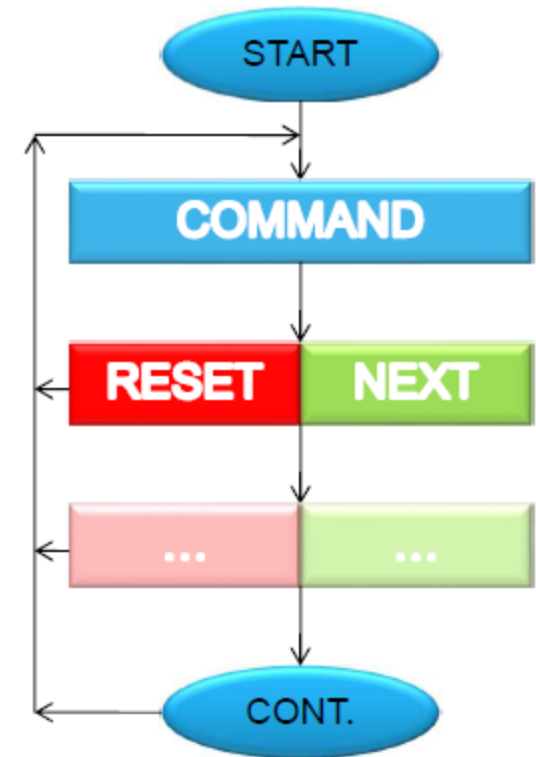
- Each state is configured through the Operation Codes (OPCODE). OPCODES can be divided in two groups:

## NEXT/RESET CONDITIONS:

- RESET condition is in MSB part and NEXT condition is in LSB part of the OPCODE stored in configuration registers.
- RESET condition is evaluated first, NEXT condition is evaluated only if RESET was not valid
- Transition to next state happens when “NEXT condition” is valid
- Transition to reset point happens when “RESET condition” is valid
- If both conditions are not valid, the same conditions are applied to the next sample

## COMMANDS:

- Commands have special tasks for flow control, output and synchronization
- Commands and their parameters are executed as one step command.



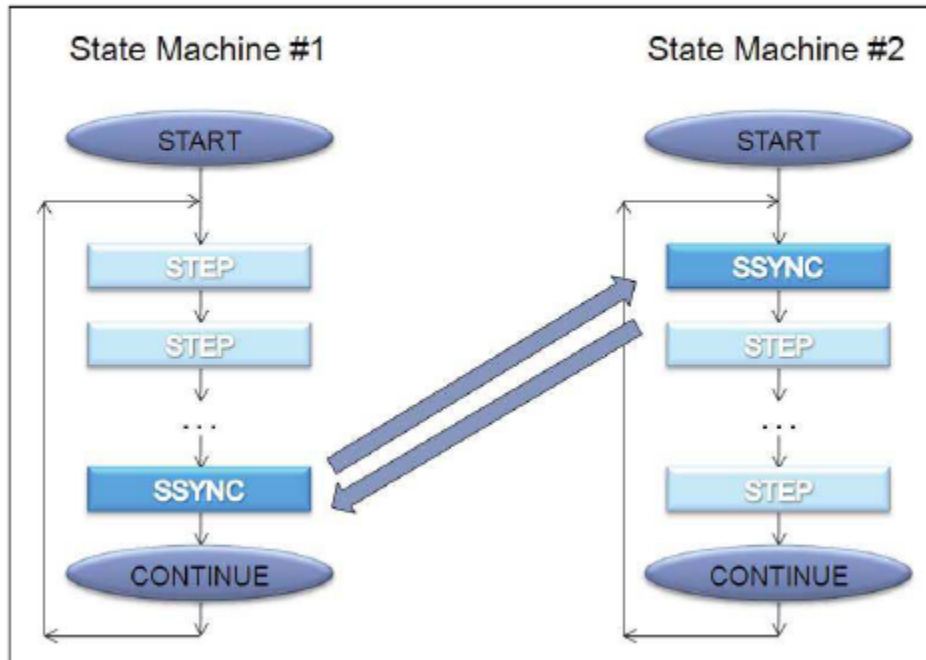


# State Machine Overview

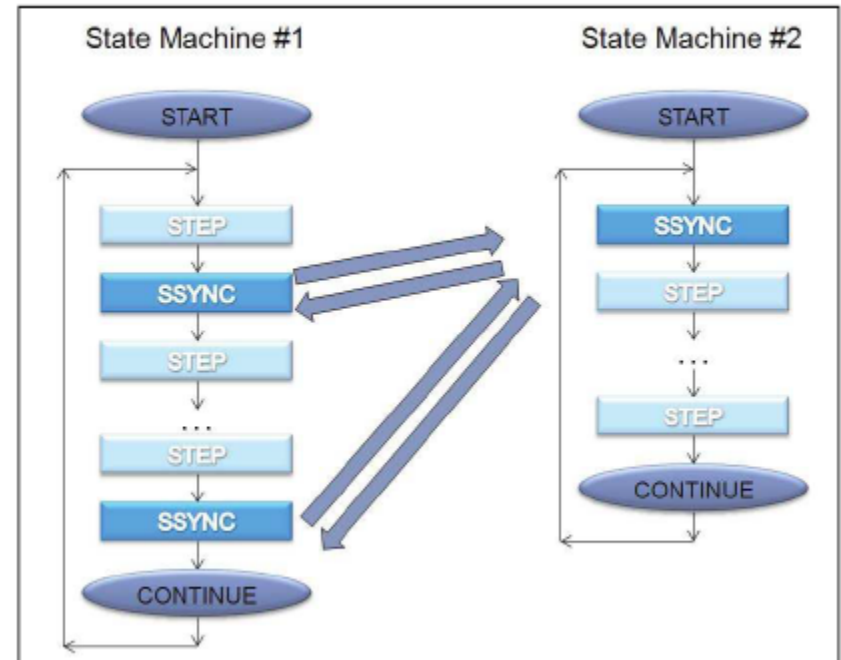
- Sequential synchronization (SSYNC command):
- Each state machine has 16 states that can be combined up to 32 sequential states
- State machine B can act as sub-function for State machine A (parameters can be totally different than main program)
- Host can change inactive State Program when other State Program is running
- State Program A can toggles execution to State Program B and viceversa

# State Machine Overview

- **SSYNC: SM1 + SM2 for 32 states SM**

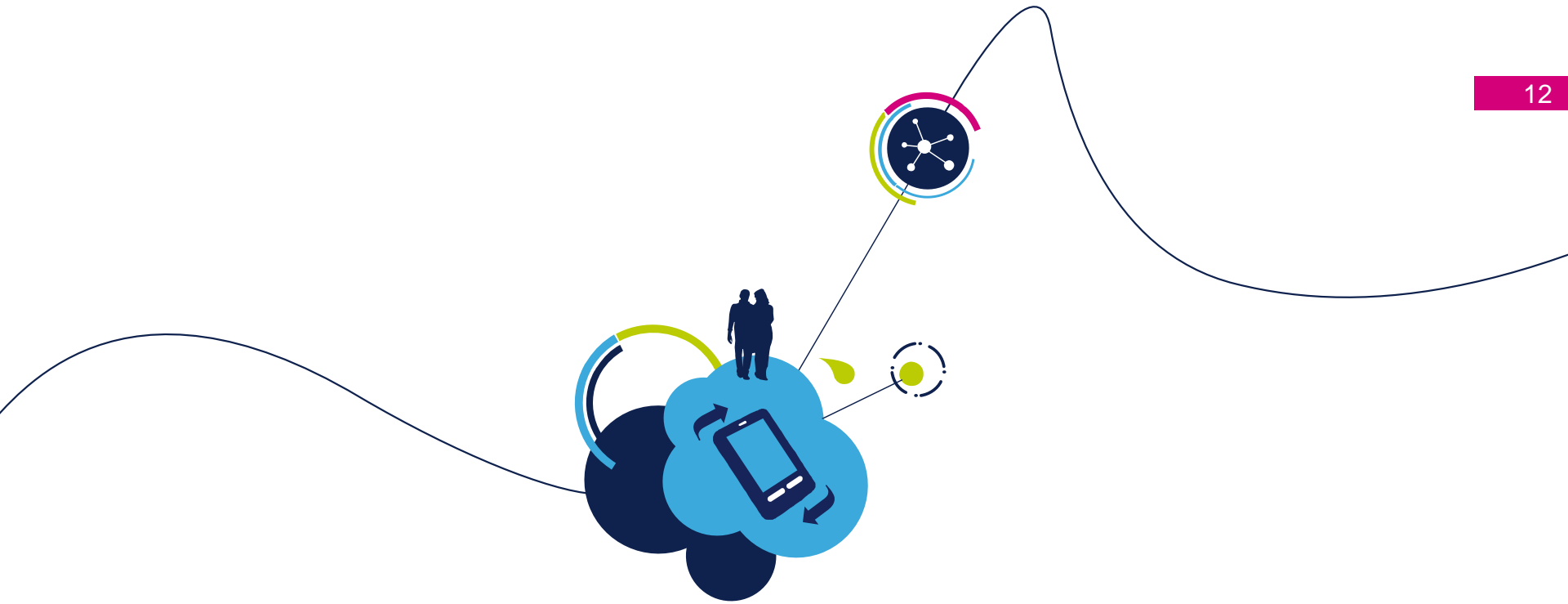


- **SSYNC: SM2 as sub-routine of SM1**



# State Machine Parameters

- 4 independent Timers
- 2 independent Masks (x, y, z, v)
- 3 independent acceleration Thresholds @8bit (Signed, Unsigned)
- Peak Detection function



# Unico

## State Machine programs development

## State Machine button

The screenshot shows the Unico software interface. At the top, a red arrow points to a button in the toolbar labeled "State Machine button". The main area is divided into two columns for "State Machine #1" and "State Machine #2". Each column contains a table of states with columns for state number, code, command, and state value. To the right of these tables are control panels for "Manage State Machine functions" (Read, Write, Visualize), "Examples" (Load, Save as Example), and "Pattern" (Load).

State Machine #1	State Machine #2
S0 (0x40) DPC CMD GNTH1 T11 0x 51	S0 (0x60) DPC CMD STOP 0x 00
S1 (0x41) DPC CMD GNTH1 T11 0x 51	S1 (0x61) DPC CMD STOP 0x 00
S2 (0x42) DPC CMD NOP GNTH2 0x 06	S2 (0x62) DPC CMD STOP 0x 00
S3 (0x43) DPC CMD T13 LNTH2 0x 38	S3 (0x63) DPC CMD STOP 0x 00
S4 (0x44) DPC CMD NOP T14 0x 04	S4 (0x64) DPC CMD STOP 0x 00
S5 (0x45) DPC CMD GTTH1 T11 0x 51	S5 (0x65) DPC CMD STOP 0x 00
S6 (0x46) DPC CMD T12 GNTH2 0x 26	S6 (0x66) DPC CMD STOP 0x 00
S7 (0x47) DPC CMD T13 LNTH2 0x 38	S7 (0x67) DPC CMD STOP 0x 00
S8 (0x48) DPC CMD NOP T14 0x 04	S8 (0x68) DPC CMD STOP 0x 00
S9 (0x49) DPC CMD GTTH1 T11 0x 51	S9 (0x69) DPC CMD STOP 0x 00
S10 (0x4A) DPC CMD CONT 0x 11	S10 (0x6A) DPC CMD STOP 0x 00
S11 (0x4B) DPC CMD STOP 0x 00	S11 (0x6B) DPC CMD STOP 0x 00
S12 (0x4C) DPC CMD STOP 0x 00	S12 (0x6C) DPC CMD STOP 0x 00
S13 (0x4D) DPC CMD STOP 0x 00	S13 (0x6D) DPC CMD STOP 0x 00
S14 (0x4E) DPC CMD STOP 0x 00	S14 (0x6E) DPC CMD STOP 0x 00
S15 (0x4F) DPC CMD STOP 0x 00	S15 (0x6F) DPC CMD STOP 0x 00

MEMS Division Demonstration kit selected = STEVAL-MKJAT2V1 (L163SDH) Version = 0.8.0.8 Beta CONFIDENTIAL

**Read, Write and Visualize the current state machine**

**Load or Save State Machine Configuration**

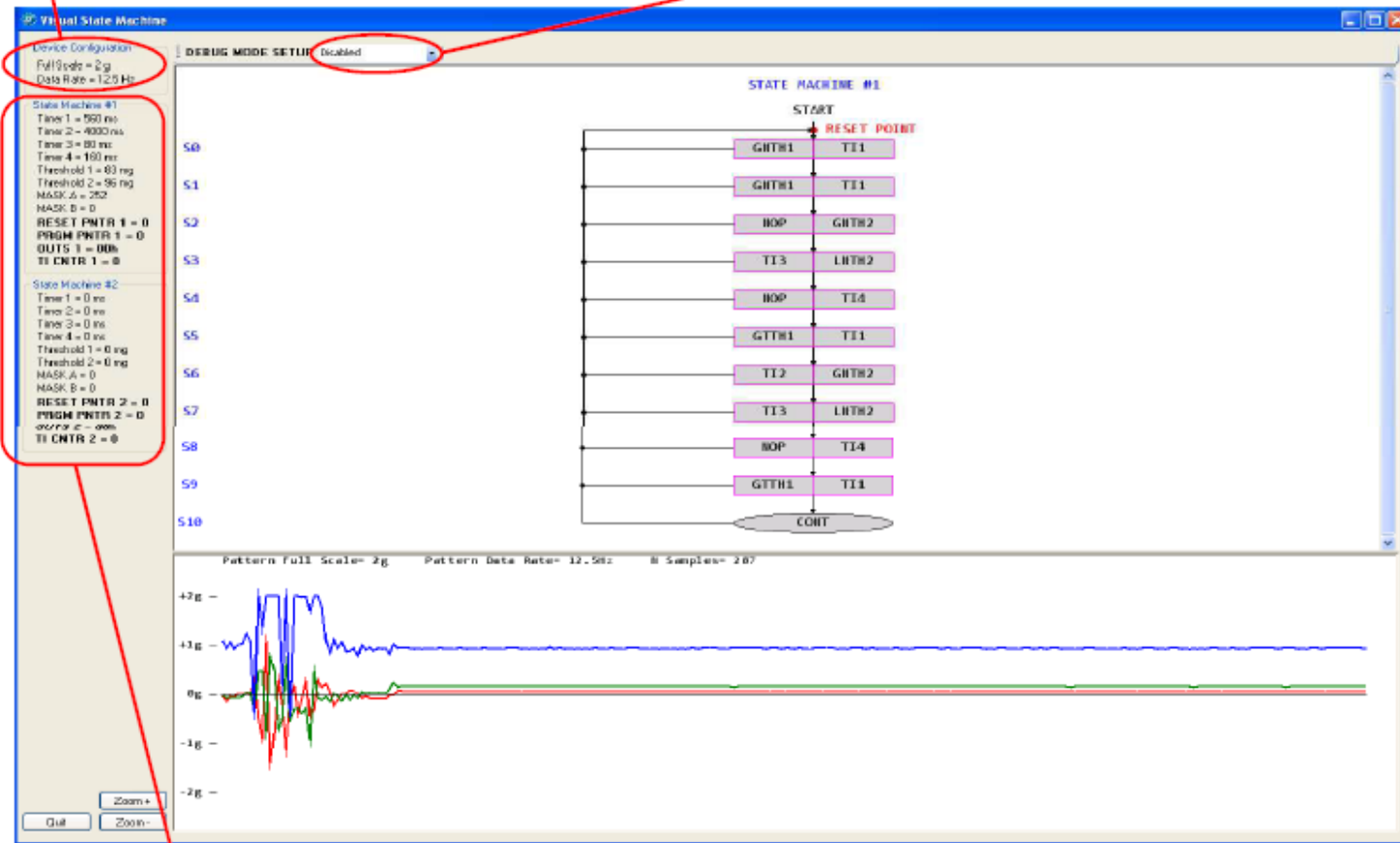
**Load Data Pattern to test the State Machine**

Each state can be programmed selecting either the code or through the interface

# Unico – Debug mode DISABLED

Actual device's configuration (FS, ODR)

Debug MODE **Enable/Disable** command

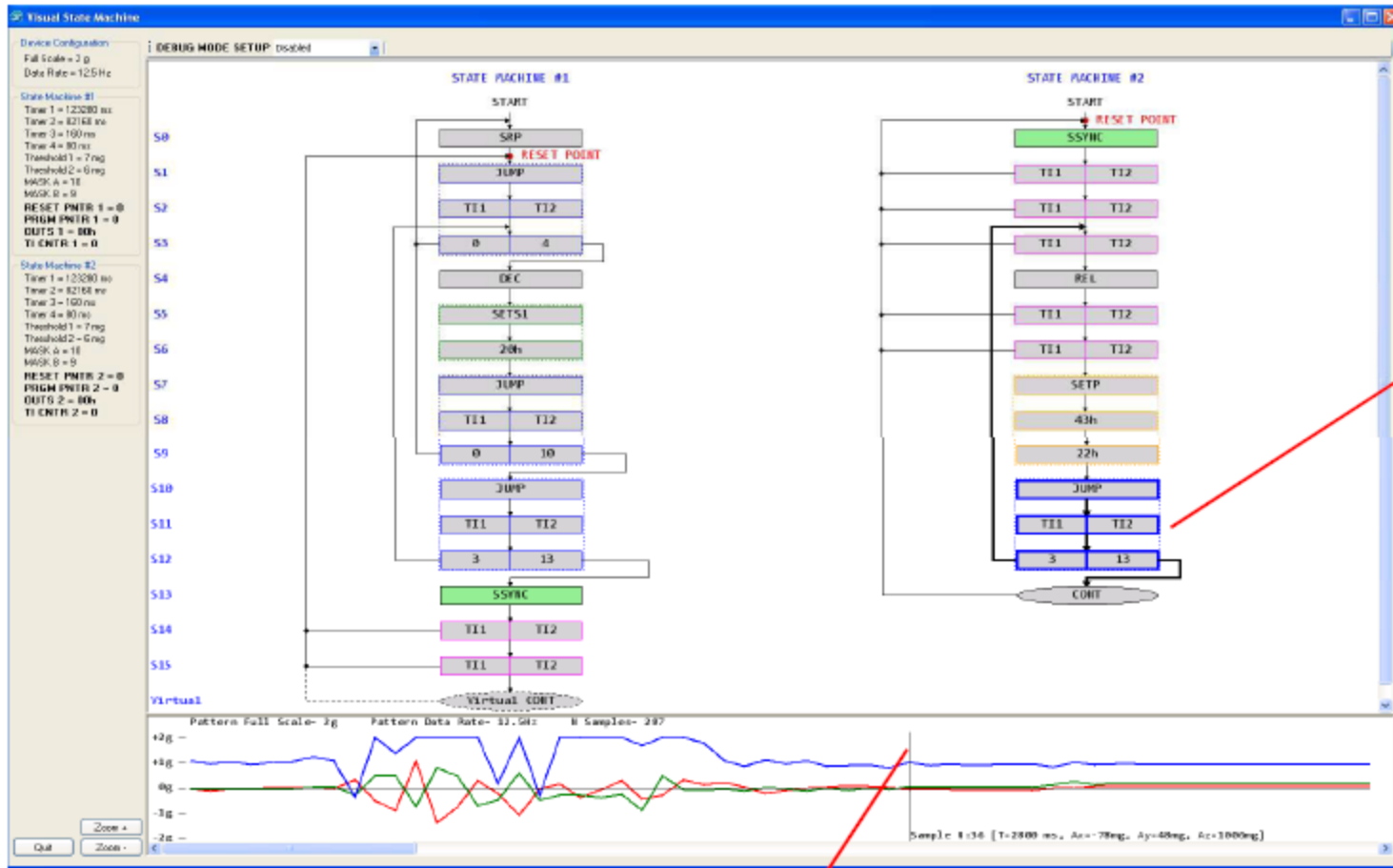


State Machine Flow

Loaded Data Pattern Waveform /Info

**NOTE:** State machines parameters are reported with Unit of Measurement indicated: their values are related to both corresponding registers value and device's FS/ODR in use.

# Unico – Debug mode DISABLED

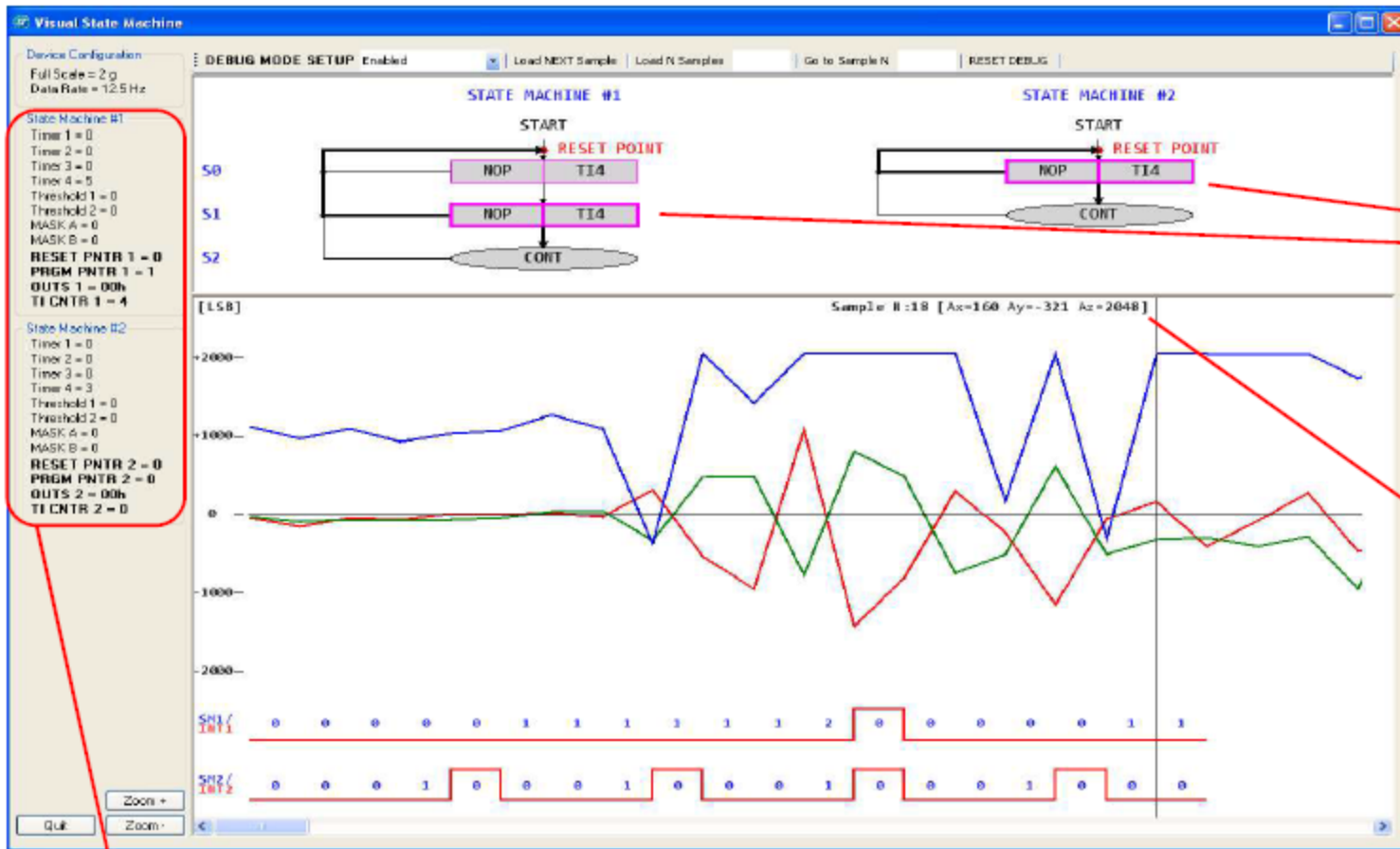


When Debug is disabled it's possible to highlight a command and its arrows just clicking on it

When Debug is disabled it's possible to visualize the info of each sample just clicking on it



# Unico – Debug mode ENABLED



Current state (according to Program pointer value) is highlighted.

Reset point moves according to Reset pointer value.

Last Loaded Sample info [in LSB]

State machines & INTERRUPT evolution

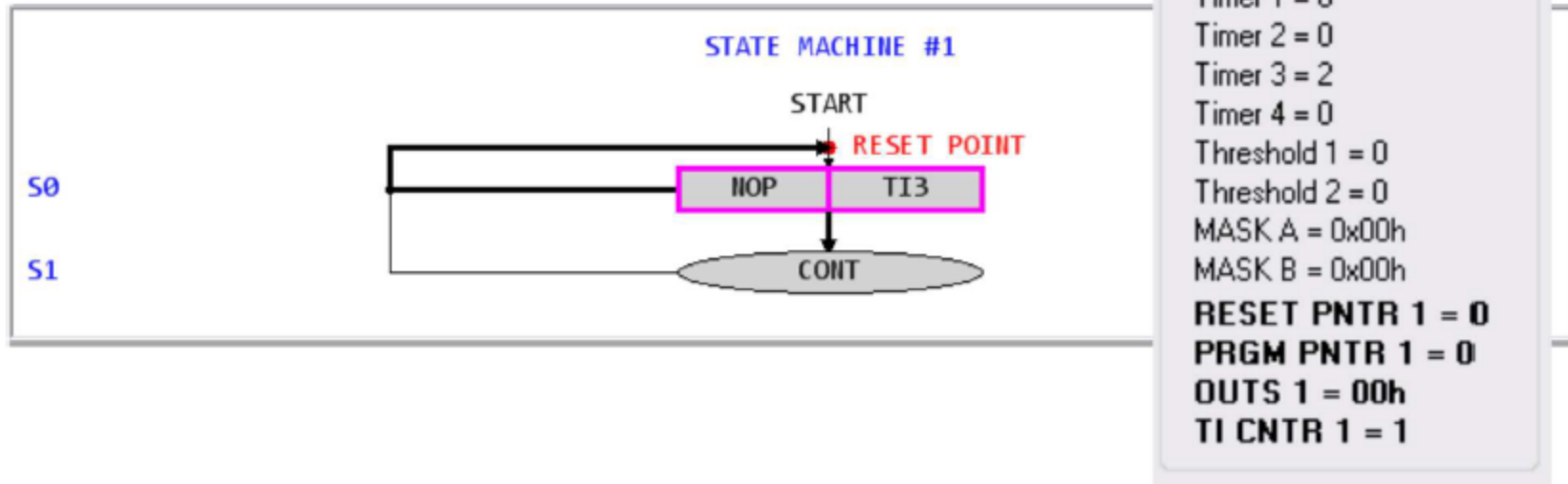
**NOTE 1:** Units of Measurement are meaningless when Debug mode is Enabled; State machines parameters are related only to registers' values.

**NOTE 2:** Boldfaced parameters are REAL TIME updated.

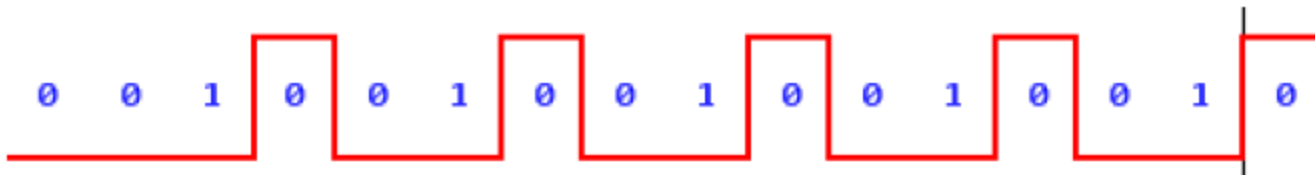


1. Toggle
2. Wake Up
3. Free Fall
4. Double Tap
5. SSYNC

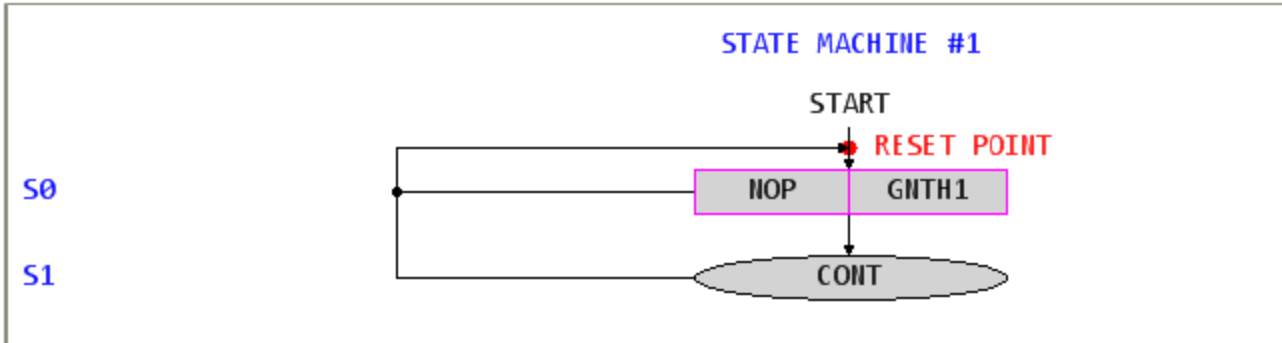
TI3 = 0x02h



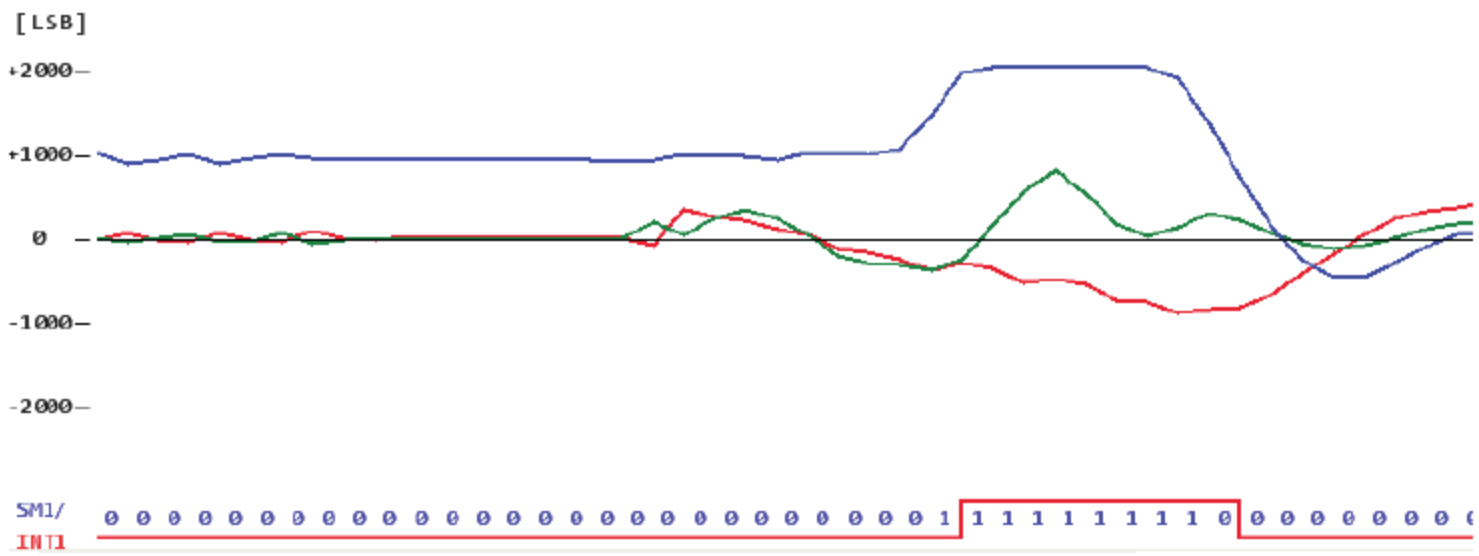
SM1/  
INT1

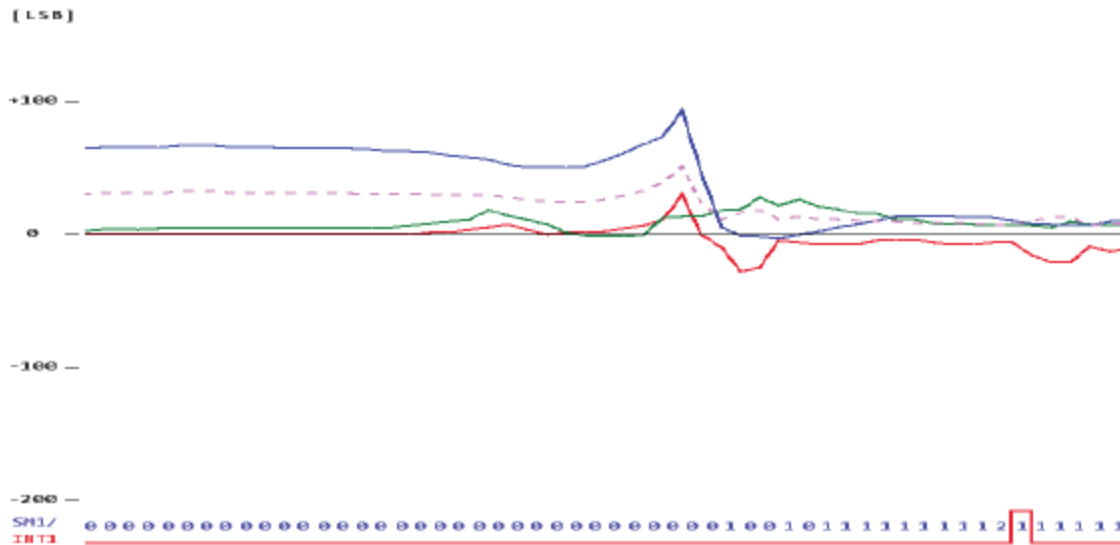
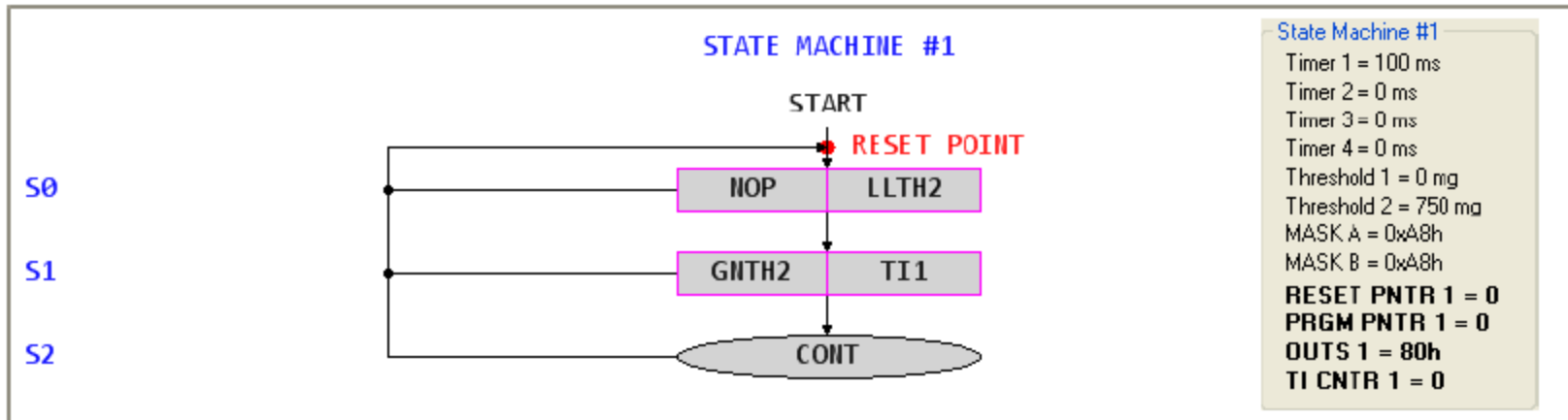


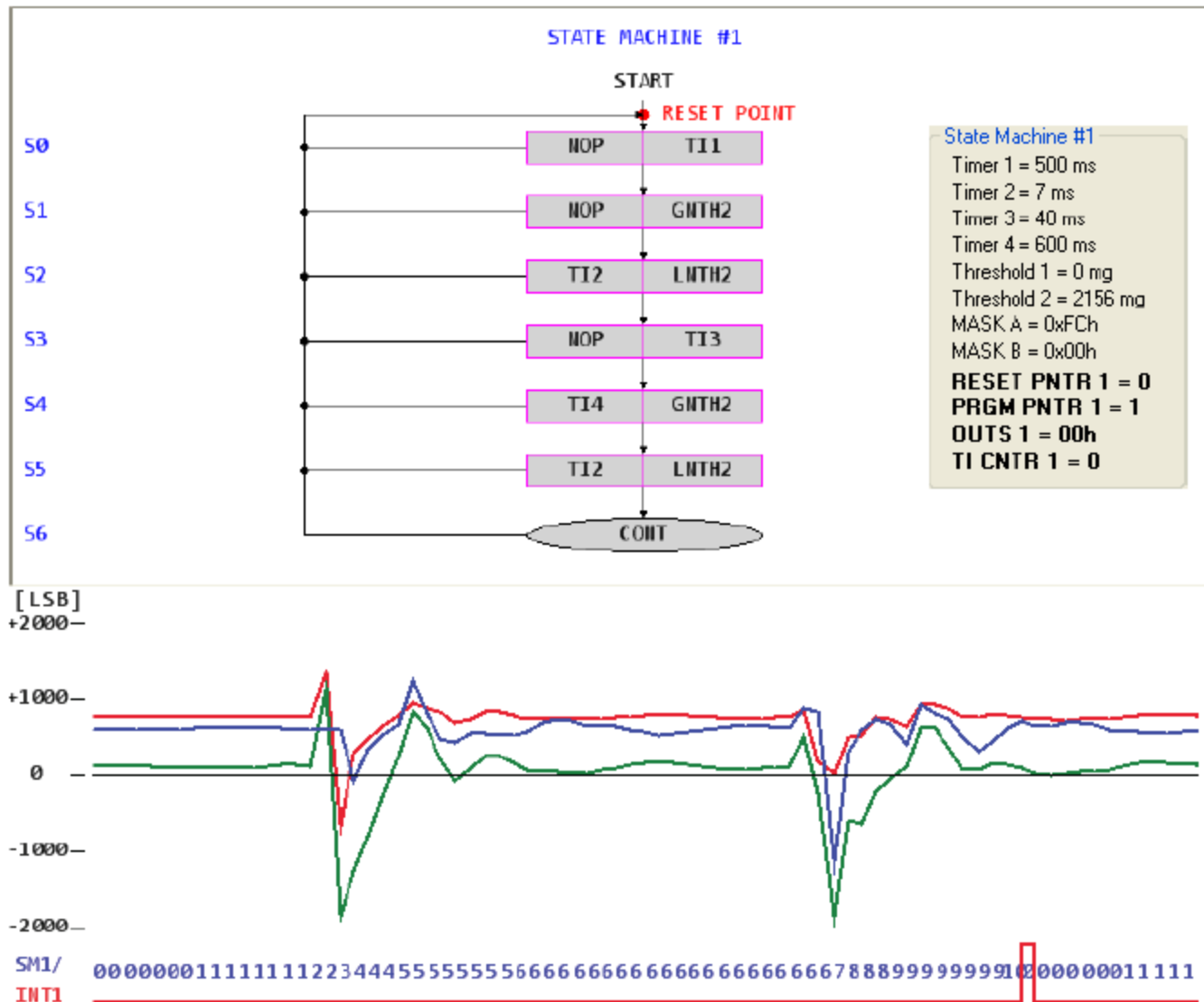
# Wake up



**State Machine #1**  
 Timer 1 = 0 ms  
 Timer 2 = 0 ms  
 Timer 3 = 0 ms  
 Timer 4 = 0 ms  
 Threshold 1 = 2656 mg  
 Threshold 2 = 0 mg  
 MASK A = 0xFCh  
 MASK B = 0xFCh  
**RESET PNTR 1 = 0**  
**PRGM PNTR 1 = 0**  
**OUTS 1 = 00h**  
**TI CNTR 1 = 0**










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  - Product and Application problems – answering detailed technical questions
- Providing
  - Design consulting (Schematic, PCB and Software)
  - Technical Trainings

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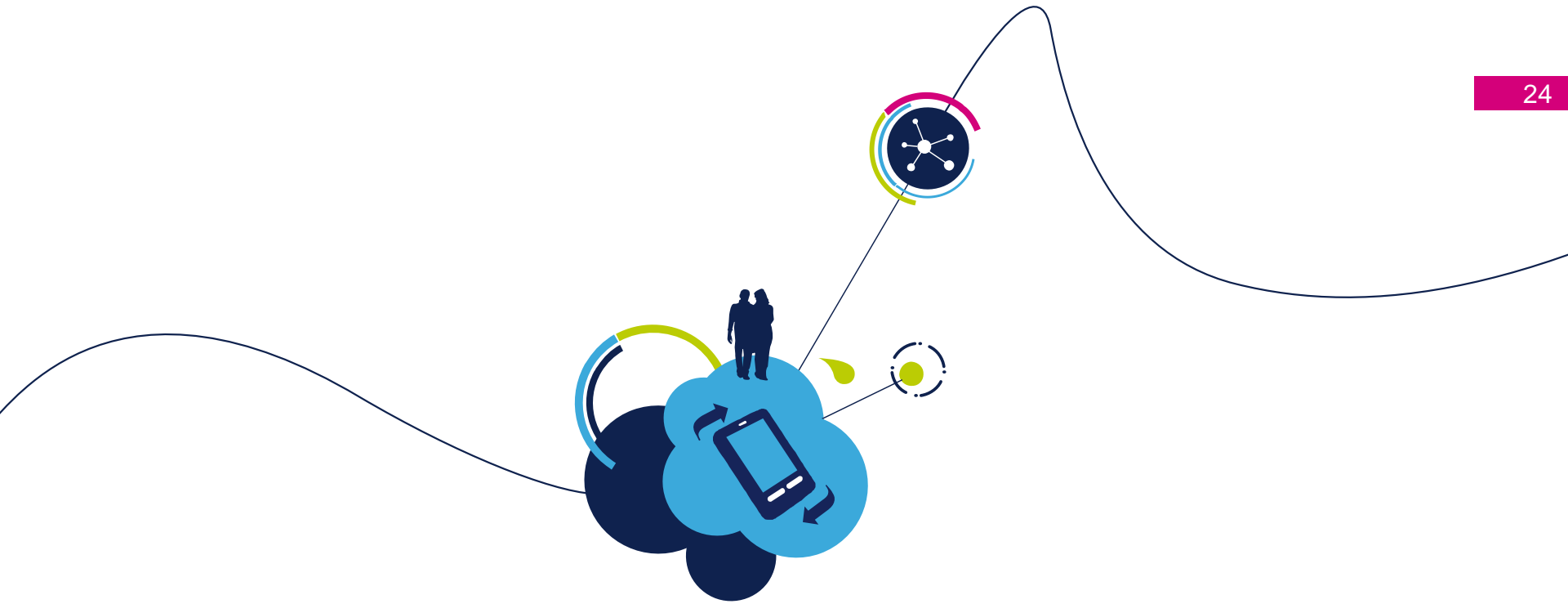
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Help Desk

		
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Contact email: [AMS-support-EMEA@st.com](mailto:AMS-support-EMEA@st.com)



Thank you !