ST com STM32C0 Interconnect Matrix Instructions

Contents

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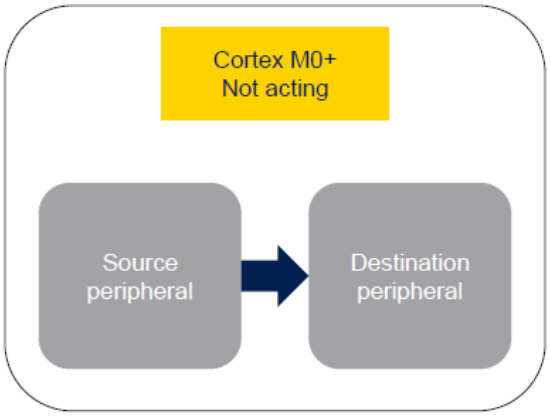
ST com STM32C0 Interconnect Matrix

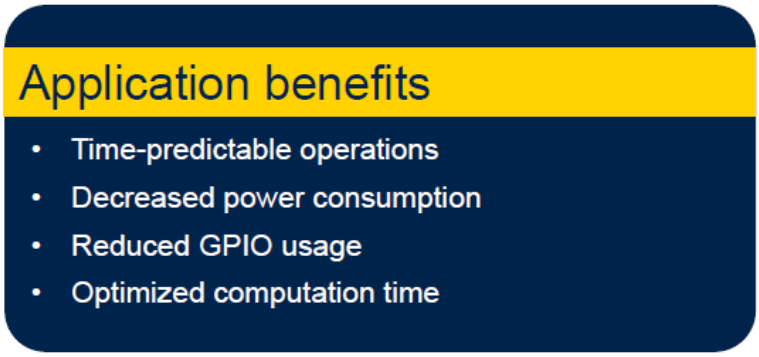
STM32C0 – Interconnect Matrix (IMX)

Hello and welcome to this presentation of the STM32 Interconnect Matrix. It covers the main features of this matrix, which is widely used to connect various internal peripherals between each other.

Overview

- Provides direct connections between peripherals





The Interconnect Matrix integrated inside STM32 products provides direct connections between peripherals. Applications benefit from these interconnections to ensure time-predictable operations, to decrease power consumption by avoiding complex management of peripheral communications through reading/writing registers using CPU instructions and, in some cases, to reduce the need to loop the signal from a source to a destination through dedicated GPIOs.

Key features

- Direct, autonomous connections between peripherals
- Removes latency induced by software handling
- Saves CPU resources
- Removes the need for looping signals through dedicated GPIOs
- Can operate during Sleep low-power mode

The Interconnect Matrix offers two main features. First, it ensures direct and autonomous connections between peripherals, allowing to remove latency in regards to software handling, thus saving GPIO and CPU resources. Secondly, the interconnection between peripherals operate during sleep mode.

Sources and destinations

Plenty of interconnect possibilities available

Source peripherals	
Interrupts	EXTI
Timers	TIM1, TIM3, TIM14, TIM16, TIM17
Connectivity IPs	USART1, USART2
Analog IPs	ADC, Temperature Sensor, VREFINT
Clocks	HSE, LSE, LSI, MCO, MCO2
RTC	RTC
SoC event	System error
Destination peripherals	
Timers	TIM1, TIM3, TIM14, TIM16, TIM17
Connectivity IPs	IRTIM
Analog IPs	ADC1
DMA	DMAMUX

- This slide indicates the list of source and destination peripherals.
- Source peripherals are EXTIs, timers, USARTs, analog IPs, clocks, RTC and System Error.
- Destination peripherals are timers, Infrared Interface, analog IPs and DMAMUX.
- The interconnect matrix is further described in the STM32C0 Reference Manual.

Application examples

From	To	Purpose
TIM1, TIM3, TIM14, and TIM17	TIM1 and TIM3	Some of the TIMx timers are linked together internally for timer synchronization or chaining When one timer is configured in Master mode, it can reset, start, stop or clock the counter of another timer configured in Slave mode
TIM1, TIM3 and EXTI	ADC	Timers and EXTI can be used to generate an ADC triggering event
ADC	TIM1	ADC can provide trigger event through watchdog signals to TIM1
HSE, LSE, LSI, MCO, MCO2 and RTC	TIM14, TIM16, and TIM17	External clocks (HSE, LSE), internal clock (LSI), Microcontroller Output Clock (MCO), RTC clock and RTC wakeup interrupt, can be selected as inputs to capture channel 1 of some of timers The timers allow calibrating or precisely measuring internal clocks such as HSI or LSI, using accurate clocks such as LSE or HSE/32 for timing reference

This slide and the next one describe the various possible uses for the interconnect matrix:

- Synchronizing or chaining timers, for example allowing a master timer to reset or trigger a second slave timer
- Triggering an ADC through a timer or EXTI event
- Triggering a timer through an ADC watchdog signal when a predefined threshold value is crossed by the analog input
- Calibrating HSI and LSI clocks, for example measuring the external oscillator LSE frequency by a timer clocked by the calibrated internal oscillator.

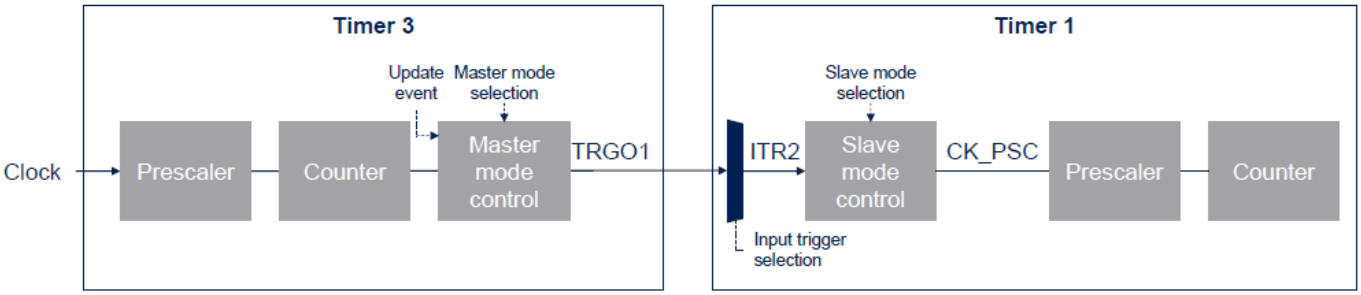
From	To	Purpose
Internal analog sources (Temperature Sensor and VREFINT)	ADC	Internal temperature sensor output voltage V_{TS} and internal reference voltage V_{REFINT} are connected to ADC input channels
System errors	TIM1, TIM16, and TIM17	CSS, CPU hardfault, RAM parity error can generate system errors in the form of timer break toward TIM1, TIM16, and TIM17 ➢ Protection of timer-driven power switches
TIM16, TIM17, USART1, and USART2	IRTIM	TIMx_OC1 output channel of TIM16 or TIM17 timers, associated with USART1 or USART2 transmission signal, can generate the infrared output waveform
TIM14 and EXTI	DMAMUX	TIM14 general-purpose timer and EXTI, can be used as triggering event to DMAMUX

Other use cases

- Monitoring the temperature of a connected internal temperature sensor or VREFINT
- Protecting timer-driven power switches through the direct connection of System Error signals to the timer break input
- Infrared pulse modulation signal waveform generation using 2 timers
- Triggering a DMA data transfer by a timer.

Timer synchronization example

- Timer 3 can act as a prescaler for Timer 1



This slide shows a simple example of timer synchronization. The Timer 3 is used as the Master Timer and can reset, start, stop or clock the Timer 1 configured in Slave mode. In this example, Timer 3 is clocking the Timer 1 so that it acts as a prescaler for Timer 1. The Master Mode Selection field allows selected information to be sent in master mode to slave timers for synchronization (TRGO): reset, enable, update, compare. In this example, the update option is selected. The Slave Mode Selection field configures the slave mode operation: disabled, encoder, reset, gated, external clock or combined reset. In this example, the external clock mode is selected.

Low-power modes

From	To	Run	Sleep
TIM1, TIM3, TIM14, TIM16, and TIM17	TIM1 and TIM3	✓	✓
TIM1, TIM3 and EXTI	ADC	✓	✓
ADC	TIM1	✓	✓
HSE, LSE, LSI, MCO, MCO2 and RTC	TIM14, TIM16 and TIM17	✓	✓
Internal analog sources (Temperature Sensor, VREFINT, VBAT)	ADC	✓	✓
System errors	TIM1, TIM16 and TIM17	✓	✓
TIM16, TIM17, USART1, and USART2	IRTIM	✓	✓
TIM14	DMAMUX	✓	✓

Peripherals can be interconnected using the Interconnect Matrix even when the circuit is in a low-power sleep mode. Regarding the STM32C0, all supported interconnections between peripherals are functional in both run and sleep modes.

References

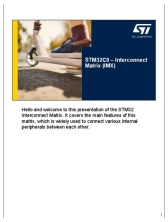
- For more details, please refer to:
- Reference manuals for STM32C0 microcontrollers
- Peripherals presentations linked to this IMX peripheral
- Timers (TIM)
- Analog-to-Digital Converter (ADC)
- Extended interrupts and event Controller (EXTI)
- DMA Request Multiplexer (DMAMUX)
- Infrared Interface (IRTIM)
- Reset and Clock Control (RCC)
- Real-Time Clock (RTC)

For more details about the Interconnect Matrix, refer to the reference manual for STM32C0 microcontrollers. Refer also to the following presentations for more information if needed:

- Timers (TIM)
- Analog-to-Digital Converter (ADC)
- Extended interrupts and event Controller (EXTI)
- DMA Request Multiplexer (DMAMUX)
- Infrared Interface (IRTIM)
- Reset and Clock Control (RCC)
- Real-Time Clock (RTC)

Thank you

Documents / Resources

	**ST com STM32C0 Interconnect Matrix** [pdf] Instructions STM32C0 Interconnect Matrix, Interconnect Matrix, STM32C0 Matrix, Matrix, STM32C0

References

- **STMicroelectronics Trademark List - STMicroelectronics**