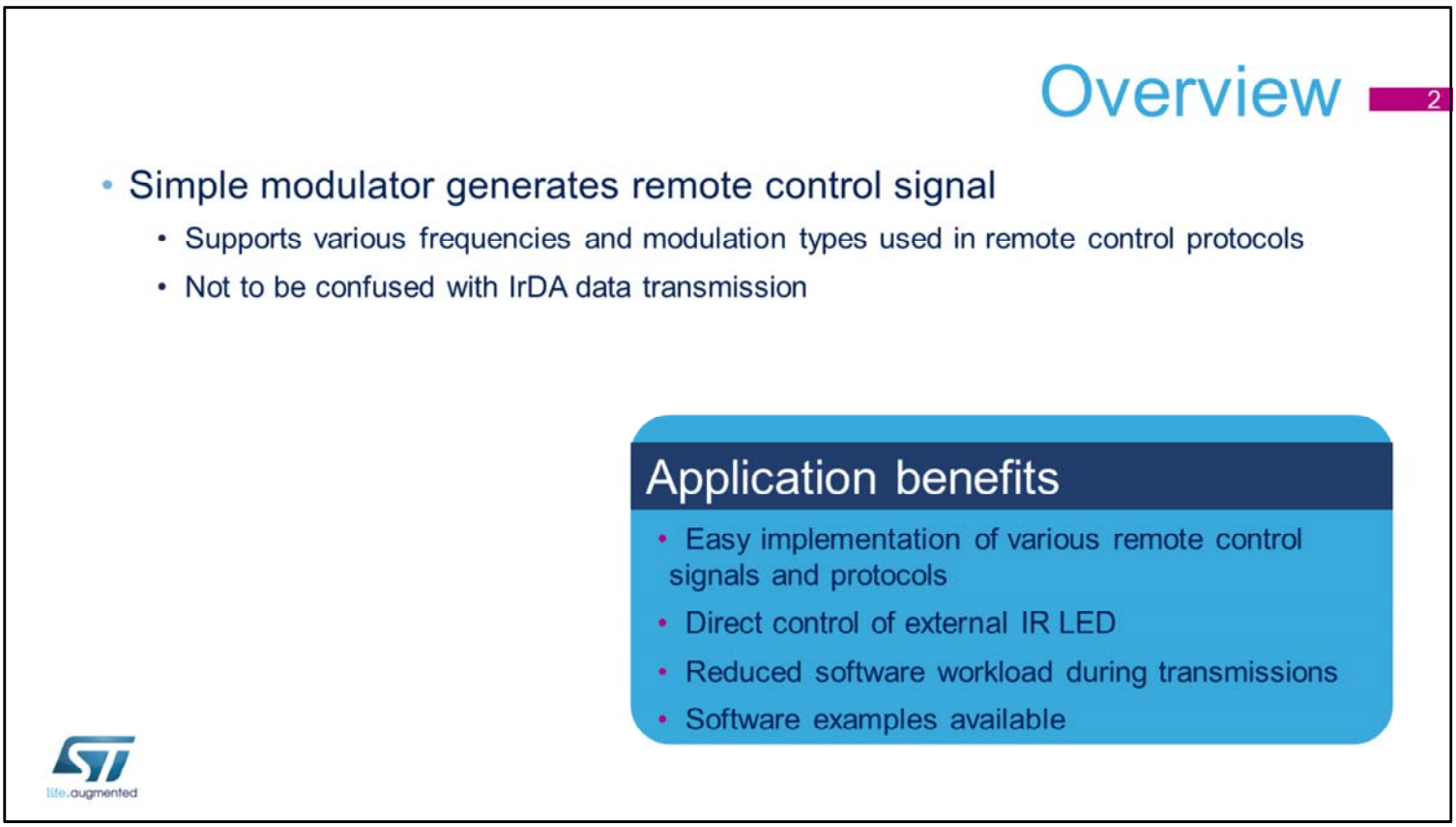
Hello, and welcome to this presentation of the STM32 Infrared Timer. Features of this interface allowing the generation of various IR remote control protocols will be presented.



The Infrared Timer peripheral facilitates the generation of infrared remote control protocols, used in many consumer devices such as TV sets, audio systems, air conditioning units, etc.
The Infrared Timer provides a simple modulator to generate the remote control signal, using Timers 16 and 17 to generate the carrier frequency and modulation signal.
The user can configure a wide range of carrier frequencies and modulations to facilitate the implementation of any remote control protocol.

Key features

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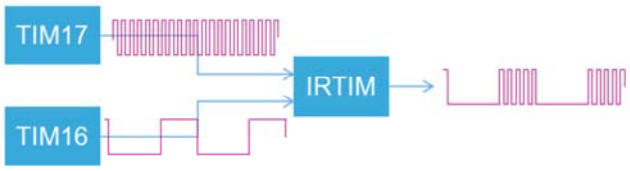
Flexible & simple

- Signal generation driven by hardware
  - Configurable carrier frequency
- Protocol flow controlled by software
  - Flexibility to support required protocol



Application benefits

- Direct drive of IR LED, no additional components needed
- Supports RC5, RC6, RCA, SIRC, …
- Flexible software-generated modulation control to adopt various protocols
- Low software overhead

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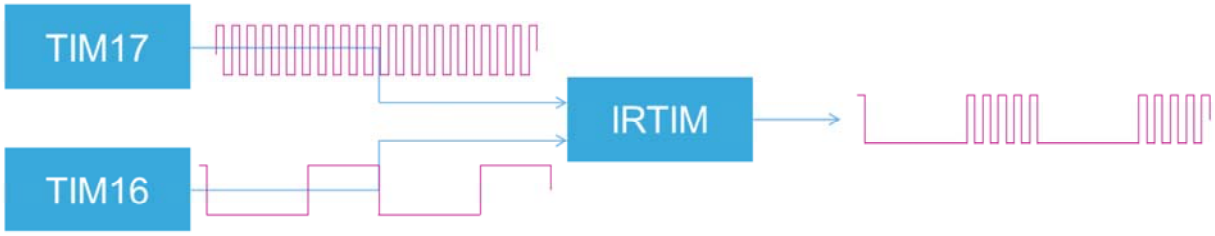
The Infrared Timer provides hardware support to generate remote control signals. The carrier frequency is generated autonomously by the timer, while the modulation waveform is controlled by software. This allows flexibility to support any required infrared remote control protocol. The Infrared Timer automatically combines the carrier frequency and the modulation waveform into a signal controlling the infrared LED that transmits IR control signals to the controlled device. The application does not require external transistors, as the infrared LED can be driven directly by the GPIO pin. Many remote control protocols including RC5, RC6, SIRC and others can be implemented and supported due to flexible and simple modulation control. The CPU workload is limited to the control of the modulation signal only.

Block diagram

- TIM17 - Carrier frequency generator
- TIM16 - Modulation waveform generator
- IRTIM - Signal modulator



Block diagram consists of:
- Timer 17, used as a carrier frequency generator.
- Timer 16, used as the modulated waveform generator.
- The Infrared Timer block contains the signal modulator which combines the carrier frequency and the modulation waveform into the remote control signal.

Carrier frequency generator

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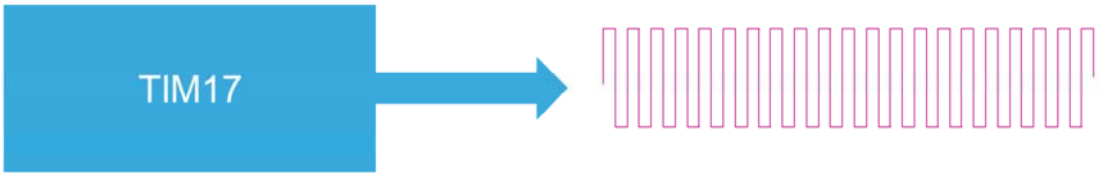
Compatible with any remote control protocol

- Carrier frequency is generated by TIM17
  - Typical frequency in the range of 34 – 40 kHz
  - Timer configured to PWM mode with 50% duty cycle
  - No interrupt is needed
  - Refer to timer section for detailed description of timer configuration registers



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Timer 17 generates the carrier frequency for the remote control protocol used in the application.
The carrier frequency can be configured to any frequency needed by the chosen protocol, including typical frequencies in the range of 34 to 40 kilohertz. This is done by configuring Timer 17 into PWM mode with a 50% duty cycle. Once the timer is started, it does not require additional software control including interrupts.
For a detailed description on how to configure Timer 17, please refer to the timer section in the reference manual.

Modulation waveform generator

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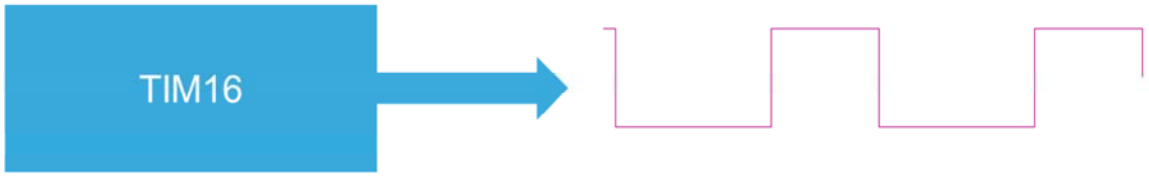
Compatible with any remote control protocol

- Modulation signal is generated by TIM16
  - Typical pulse duration in the range of 100 µs to 100 ms
  - Timer configured to Output Compare mode
  - Output compare interrupt is used to control data flow
  - Refer to timer section for detailed description of timer configuration registers

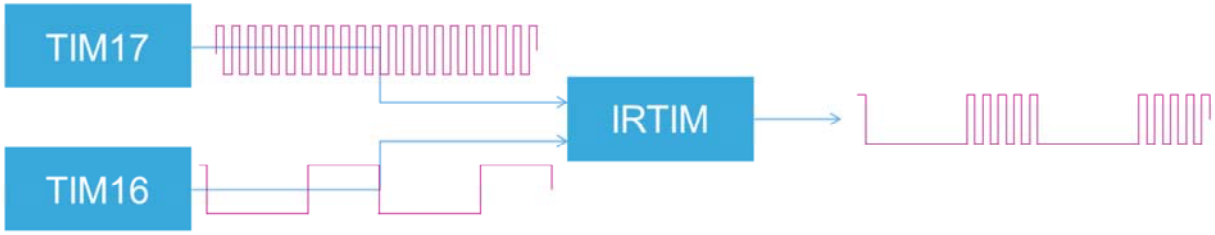


Timer 16 generates the modulation waveform for the remote control protocol used in the application.
The Timer is configured in output compare mode, using the output compare interrupt to generate pulses representing a logical 0 or 1 and control the modulation of the data flow.
For a detailed description of how to configure Timer 16, please refer to timer section in the reference manual.

IRTIM modulator

Compatible with any remote control protocol

- IRTIM modulator is a simple gate
- Output signal is created by gating carrier frequency from TIM17 by a modulation signal from TIM16
  - Synchronization with TIM17 is used to avoid spikes and glitches



The Infrared Timer modulator is a simple gate, gating the carrier frequency from Timer 17 by a modulation waveform from Timer 16.
To avoid spikes and glitches on the output waveform, the Infrared Timer gate is synchronized with the carrier frequency from Timer 17.

IR_OUT pin

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Direct IR LED drive

- IRTIM output (IR_OUT pin) enabled in GPIO_AFR register
- IR_OUT pin supports direct IR LED drive
- High sink driver capability on PB9 up to 20 mA
  - Activated through the SYSCFG_CFGR1 register, bit I2C_PB9_FMP

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The Infrared Timer output is an alternate GPIO feature, configurable in the GPIO AFR registers.
The IR OUT pin can directly drive the infrared LED, especially on pin PB9, where the high sink driver capability is supported. This feature can be activated through the system configuration register.

Interrupts

Interrupt event	Description
TIM16	Used to control modulation flow.

No interrupt is associated directly with the Infrared Timer, however, the Timer 16 interrupt is used to control the modulation of the output signal.

Low-power modes

Mode	Description
Run	Active.
Sleep	Active. Peripheral interrupts cause the device to exit Sleep mode.
Low-power run	Active.
Low-power sleep	Active. Peripheral interrupts cause the device to exit Low-power sleep mode.
Stop 0/Stop 1	Frozen. Peripheral registers content is kept.
Stop 2	Frozen. Peripheral registers content is kept.
Standby	Powered-down. The peripheral must be reinitialized after exiting Standby mode.
Shutdown	Powered-down. The peripheral must be reinitialized after exiting Standby mode.

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The Infrared Timer can be active only in Run and Sleep modes. In all other low-power modes (including Stop, Standby and Shutdown modes), the Infrared Timer must be disabled.

Related peripherals

- Refer to additional trainings linked to this peripheral:
  - Timers (TIM16 and TIM17 configuration)
  - GPIO (IRTIM_OUT configuration)
  - System configuration (SYSCFG_CFGR1 register)
  - Interconnect matrix (TIM16 and TIM17 connection)

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The listed peripherals influence Infrared Timer behavior. Please refer to the additional peripheral trainings for complete information.

Differences with STM32L47x/48x devices

- On STM32L41x/42x/43x/44x/45x/46x devices, there is no TIM17 hence the TIM15 is used instead

This slide presents the key differences between baseline STM32L47x/48x devices and other devices.
The TIM15 is used instead of TIM17 on STM32L41x/42x/43x/44x/45x/46x devices.