**STM32F401RE: USART2 TX via DMA (Repeating Alphabets)**

**Overview**

This project configures **USART2** on the **STM32F401RE** to transmit data via **DMA1**. Specifically:

1. **USART2** is mapped to **PA2** (Alternate Function 7) for TX.
2. **DMA1, Stream 6, Channel 4** is used to repeatedly transmit a string (the English alphabet) from memory.
3. **Interrupts** are used to signal completion of DMA transfers.

**Features**

* **USART2** configured for **9600 baud** at a **16 MHz** system clock.
* **DMA** used to transfer data from memory to **USART2->DR**.
* Data is repeated indefinitely, toggling between waiting for the DMA to finish (using an interrupt) and re-triggering the DMA setup.

**Hardware Setup**

**USART2 Pin Configuration**

| **Signal** | **STM32F401RE Pin** | **Description** |
| --- | --- | --- |
| **USART2\_TX** | **PA2 (AF7)** | Connect this to **Rx** of USB-Serial module |

**USB-Serial Module**

* **3.3V logic** is required (connect the module’s **Rx** to **PA2**).
* Common **GND** between the Nucleo-F401RE board and the USB-Serial module.

**Software Explanation**

**USART2 Initialization**

* PA2 (USART2\_TX) is set to **Alternate Function 7**.
* Baud Rate = **9600**.
* 8-bit data, no parity, 1 stop bit.
* **Transmit Complete (TC) interrupt** is enabled to signal that the data block is fully transmitted.

**DMA1 Initialization**

* **DMA1 clock** is enabled.
* **Stream 6, Channel 4** is selected for **USART2\_TX**.
* **Memory-to-Peripheral** direction, **8-bit data size**, memory increment.
* **Interrupt** is enabled to handle end-of-transfer and errors.

**Data Flow**

1. **Initialize** USART2 & DMA.
2. **Prepare** an array (alphabet string) in memory.
3. **Call DMA1\_Stream6\_setup()** to configure the DMA.
4. **DMA** transfers the data from memory to USART2->DR.
5. **USART2\_IRQHandler** sets a done flag once the transfer is complete.
6. **Infinite loop** repeats the process.

**Project Structure**

.

├── Inc/

│ └── stm32f4xx.h // CMSIS/Device headers

├── Src/

│ └── main.c // Contains USART2 + DMA code

└── README.md // This file

**Building and Uploading**

**Using Keil uVision / STM32CubeIDE**

1. **Open Keil uVision or STM32CubeIDE**.
2. **Create a New Project** for STM32F401RE.
3. **Copy main.c into the Src/ directory**.
4. **Compile and Flash the Project** to **Nucleo-F401RE**.

**Usage**

**1️⃣ Flash the Code to the STM32F401RE**

* Use **Keil uVision** or **STM32CubeIDE**.

**2️⃣ Connect a 3.3V USB-Serial Adapter**

* **Rx** → **PA2** (USART2\_TX)
* **GND** → **GND**

**3️⃣ Open a Serial Terminal**

* **Baud** = **9600**, 8N1.
* Observe repeated alphabet strings.

**Troubleshooting**

**🔴 No Output?**

✅ **Ensure the USB-Serial Module’s Rx pin** is connected to **PA2**. ✅ **Check 3.3V logic** (some modules are 5V only!). ✅ **Verify the correct COM port** in your terminal.

**⚠️ Data Corruption?**

✅ **Check Baud Rate** = 9600. ✅ **Ensure system clock** is indeed 16 MHz.

**License**

This project is licensed under the **MIT License**.

**References**

* [STM32F401RE Datasheet](https://www.st.com/en/microcontrollers-microprocessors/stm32f401re.html)
* [STM32 Reference Manual (RM0368)](https://www.st.com/resource/en/reference_manual/dm00096844.pdf)
* [DMA & USART Info in Programming Manual](https://www.st.com/resource/en/programming_manual/dm00245755.pdf)

**🚀 Summary**

* **USART2 DMA** on **PA2** to repeatedly send the alphabet.
* **DMA1, Stream6, Channel4** → Memory to Peripheral.
* **TC interrupt** signals completion.

**Enjoy your DMA-driven USART experience on STM32F401RE!**