AN14450

i.MX RT117x ADC的时钟和IO选择

第2.0版—2024年11月5日 应用笔记

文档信息

信息	内容
关键词	AN14450、i.MX RT117x、时钟源、ADC
摘要	本文档涵盖了一些设计相关的注意事项，以此可避免发生同步性和噪声污染相关的问题。

1 介绍

i.MX RT117x芯片集成了两个12位ADC和一个名为ADC外部触发控制器（ADC_ETC）的管理外设。为了实现最高的性能并规避潜在的问题，在使用这些外设时需要考虑多方面的设计因素。

本文档介绍了一些设计需要注意的事项，以避免发生同步性和噪声污染相关的问题。尽管在一些情况下，ADC_ETC/ADC1/ADC2的设置灵活性可能会对精度和串扰产生微小影响，但这些影响可以很方便地通过有意识的前瞻性设计加以缓解。

2 时钟架构

ADC_ETC非常适合使用PWM外设进行的电机控制器设计的场景。这些设计通常使用多个ADC通道，并且需要管理触发以及FIFO，可能会增加软件的复杂性。

2.1 时钟源

如图1所示，ipg_clk（即bus_clk）为ADC_ETC提供时钟信号。每个ADC都有自己的时钟，可以有不同的时钟源。

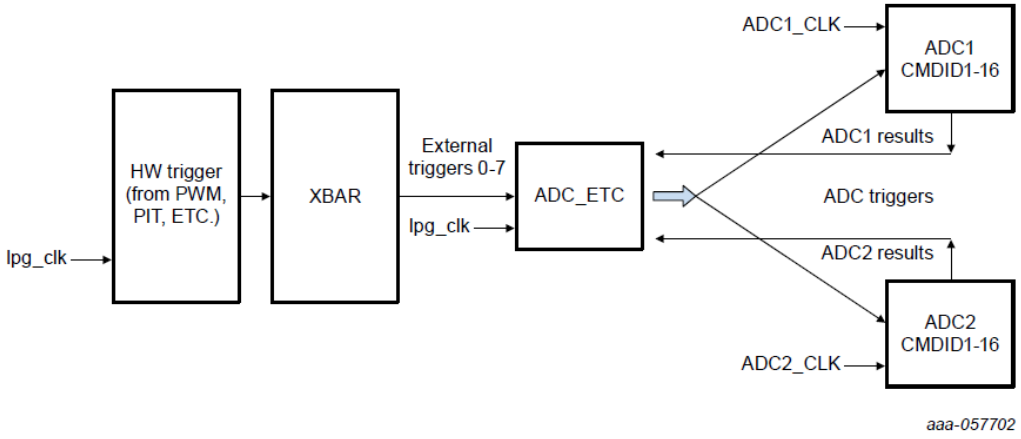

图1. 硬件触发/ADC_ETC/ADC1/ADC2时钟源

3 时钟选择注意事项

选择ADC的时钟源时，需要考虑高度同步系统的属性。ipg_clk及其等效时钟可以同步许多外设；同时，ipg_clk还为ADC_ETC提供时钟信号。

3.1 ADC_ETC和ADC的时钟

ADC具有独立的时钟分支。当接收到触发信号时，ADC_ETC的触发信号会与ADC时钟同步。确切的时钟同步输出取决于ipg_clk和adc_clk之间的相位关系。这种同步关系在复位或断电/上电后可能会略有变化，但在系统启动并运行一段时间后会保持一致。

此外，ipg_clk还为ADC_ETC的外部触发源（PWM、PIT等）提供时钟信号。

3.2 噪声同步性

由于电路板的布局和外设的使用方式的影响，ADC转换过程中可能会耦合少量不可避免的噪声。尽管如此，ADC仍能满足其精度规格要求。这些外设的噪声可能是与ipg_clk同步的数据或时钟产生的噪声。

如果时钟源（ipg_clk和adc_clk）是同相的，并且ADC_ETC的硬件触发信号也是由ipg_clk导出的，并且在时序方面是重复的，那么ADC的采样时间从一次转换到下一次转换的过程中都是精确的。

然而，这种采样时间的精确性有时会引发问题。精确的转换时间可能会导致采样捕捉到与ipg_clk同步的低水平噪声。在对ADC数据信号进行FFT分析时，可以观察到低水平重复信号的出现。

3.3 串扰同步性

另一个潜在的问题来自两个ADC之间的信号。如果两个ADC使用相同的时钟源，则两个ADC输入（ADC1和ADC2）之间可能会出现一些串扰。由于相对时钟相位上的微小时序差异，串扰严重程度可能在复位后或断电/上电后会有所不同。

ADC触发可能有以下两种情况下：

1. ADC_ETC执行同步转换时，两个ADC同时收到触发信号，两个同时转换的通道可能会受到影响。
2. ADC以其他方式触发，所用时间大致相同，并且转换速率较高。

4 减少噪声和串扰同步性的影响

本节详细介绍了减少噪声同步性和串扰同步性影响的方法，这需要仔细规划。

4.1 减少噪声同步性影响

为了避免噪声同步性带来的影响，可以采用一种简单有效的方法。这种不良影响主要源于噪声的时钟源、触发信号和ADC转换之间的精确同步。因此，最简单的方法是ADC采用一个不与ipg_clk锁相的时钟源。

ipg_clk通常是从一个PLL导出的，该PLL源自24MHz晶振。所有PLL都是由该晶振驱动的，因此在复位或上电后，它们都是锁相的。

i.MX RT1170还有另外两个内置振荡器，分别是RC48和RC400。这两个振荡器是内部振荡器，不以晶振作为来源或参考。使用这两个振荡器中的任意一个产生的时钟作为adc_clk，可防止噪声同步问题的发生。

4.2 减少串扰同步性影响

采用与噪声同步性类似的解决方案，也有助于减少串扰同步性影响。

I/O也在串扰同步中有一定的影响。应避免对GPIO_AD_12到GPIO_AD_17（含）的IO同时进行转换。

两个ADC共用这些IO。它们分别对应于每个ADC上的ADC输入端3A、3B、4A、4B、5A和5B。

为了减少参考通道之间的串扰影响，建议采取以下两项措施：

1. 使用GPIO_AD_12至GPIO_AD_17的IO作为ADC输入，但不要在与其他通道同时触发的模式下使用这些IO。
2. 为每个ADC设置不同的时钟源。例如，在ADC1上使用PLL，在ADC2上使用RC400，就可以解决这个问题。

5 结论

这些小问题涉及低电平信号，对大多数场景的影响微乎其微。但解决这些问题仍然需要进行仔细的规划并详细地实施。

6 修订历史

表1总结了对本文档的修订情况。

表1. 修订历史

文档编号	发布日期	说明
AN14450 v.2.0	2024年11月5日	• 将RT117x更新为i.MX RT117x • 编辑方面有些小改动
AN14450 v.1.0	2024年10月28日	首次公开发布

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