MT3620 Real Time Clock / Power Down Application Note

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1. Introduction

The purpose of this document is to show the MT3620 RTC (Real Time Clock) reference design. “RTC mode” is the lowest power consumption state of MT3620, it’s also known as “Power Down mode” in Azure Sphere. This application note explains the MT3620 RTC operation modes, RTC pin definitions, reference schematics, as well as the design for RTC powered by battery.

Contents

2. MT3620 RTC Operation Modes

When MT3620 enters RTC mode (Power Down mode), the whole system enters the lowest power consumption state. In RTC mode, only the RTC block keeps working, PMU is totally shutdown, and all PMU-related power is turned off.

There are two supported RTC modes of operation:

1. RTC function disabled
2. RTC function enabled with clock source: XTAL 32 KHz Oscillator (XOSC)

The RTC functionality is enabled/disabled by RTC_MODE strap pin (RECOVERY_TXD, #135) The RTC clock source is configured by the MT3620 security processor, Pluton. In Azure Sphere, XOSC mode is used by default.

The RTC block is powered by AVDD_3V3_RTC. The AVDD_3V3_RTC **must** be powered all the time (if RTC_MODE strap pin is enabled), or the system will fail to boot up. This can be achieved by permanently connecting AVDD_3V3_RTC to 3.3V system power. However, for applications that require RTC mode even when the main 3.3V system power is removed, a backup power source is required. The minimum AVDD_3V3_RTC working with XOSC is 2.2V.

Table 1. Minimum requirement of AVDD_3V3_RTC for XOSC**RTC Clock Source**	**AVDD_3V3_RTC Minimum**
XOSC	2.2V

3. MT3620 RTC Related Pins

The following are the pin definitions of RTC related pins.

Table 3. RTC pin definitions

Pin #	Pin name	Type	Pin description
71	AVDD_3V3_RTC	PI	Power rail for the RTC
81	PMU_EN	DI	Driving PMU_EN low allows the software to put MT3620 into RTC mode. Driving PMU_EN high prevents the MT3620 from entering RTC mode.
72	RTC_XIN	AI	Real time clock crystal oscillator input.
73	RTC_XOUT	AO	Real time clock crystal oscillator output.
70	WAKEUP	DI	External wakeup from RTC mode (deepest sleep mode)
69	EXT_PMU_EN	DO	External power supply enable output

When RTC functionality is enabled, the AVDD_3V3_RTC must be always powered, or the MT3620 will hang up during the system boot procedure. When RTC functionality is disabled, it's suggested to AVDD_3V3_RTC be powered by normal 3V3 rail.

When RTC functionality is enabled, the PMU_EN should be always set to low. Tying PMU_EN low allows the MT3620 to be put in RTC mode by software. If PMU_EN is tied high, the PMU will be forced to be always on, and the MT3620 will never be able to enter RTC mode.

RTC_XIN / RTC_XOUT are for output/input of XOSC.

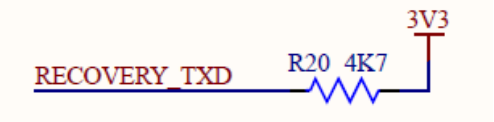
WAKEUP is used for external wakeup from RTC mode and is "active low." When external wake functionality is enabled, WAKEUP should be pulled high. While the MT3620 is in RTC mode, setting WAKEUP low for more than 1 ms will trigger the MT3620 to wake up from RTC mode and begin booting.

EXT_PMU_EN is an output to control an external 3V3 regulator. When the MT3620 enters RTC mode, EXT_PMU_EN will be set to low. When the MT3620 exits RTC mode, EXT_PMU_EN will be set to high.

4. MT3620 RTC Reference Layout

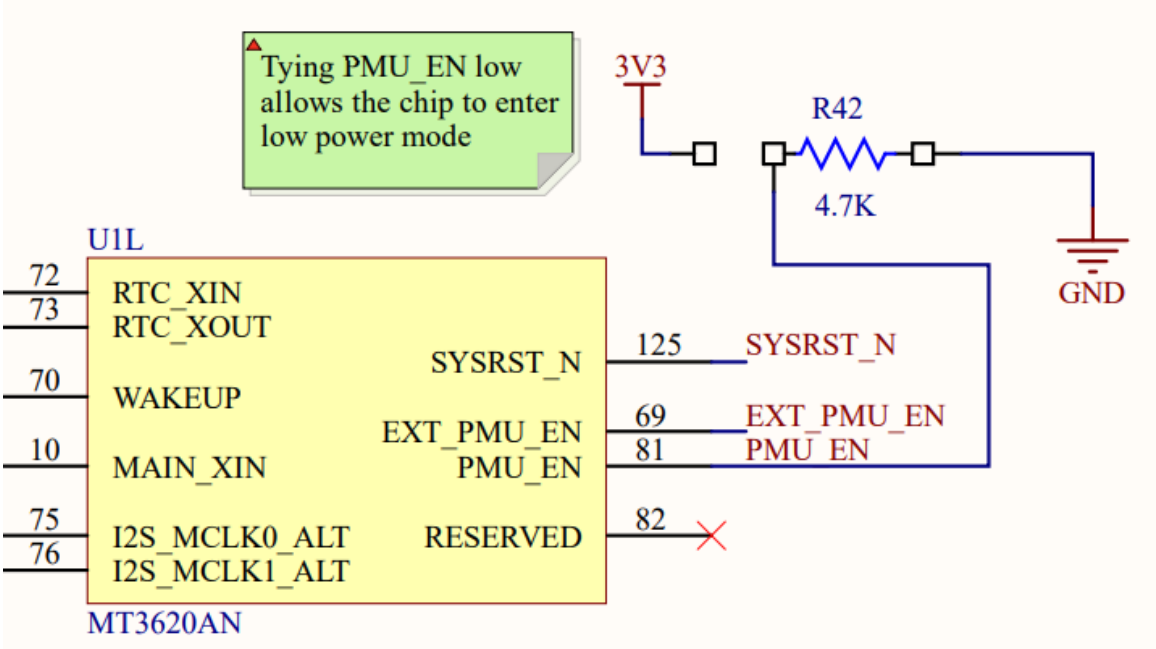
4.1 Strapping

When RTC functionality is enabled, the RECOVERY_TXD (#135) should be tied high. For power consumption concern, it could be replaced by higher value resistor.



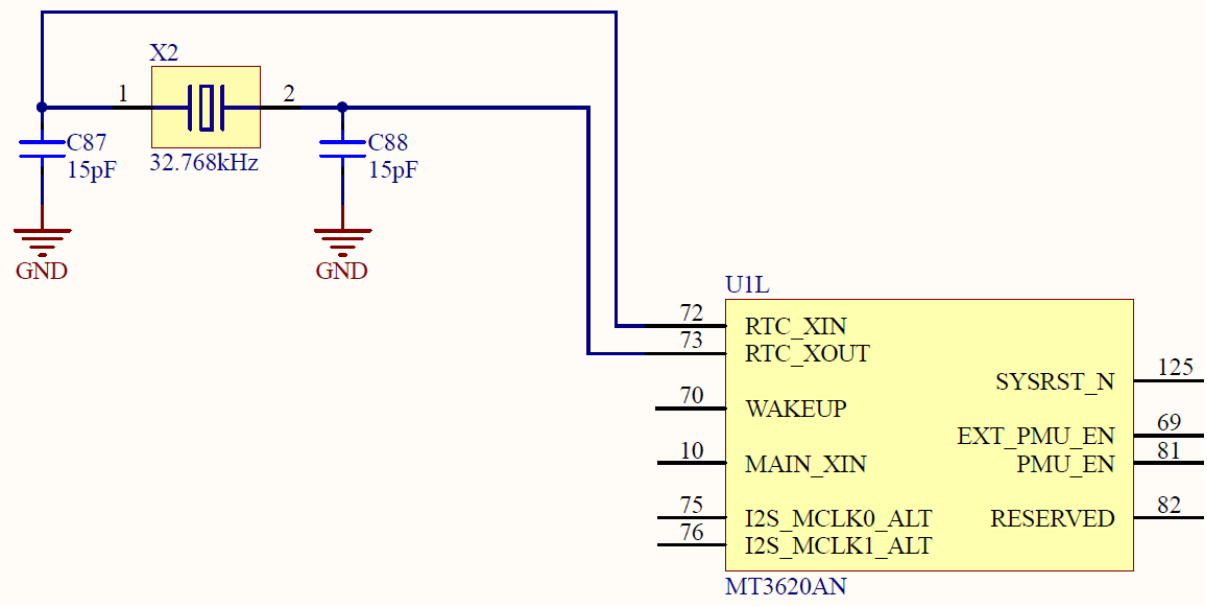
4.2 PMU_EN

PMU_EN should be tied low to allow the MT3620 to enter RTC mode. 4.7K Ohm is used in the current reference circuit. For power consumption concern, it could be replaced by higher value resistor.



4.3 External RTC Clock Source

RTC_XIN / RTC_OUT are used for connecting an external RTC clock source.

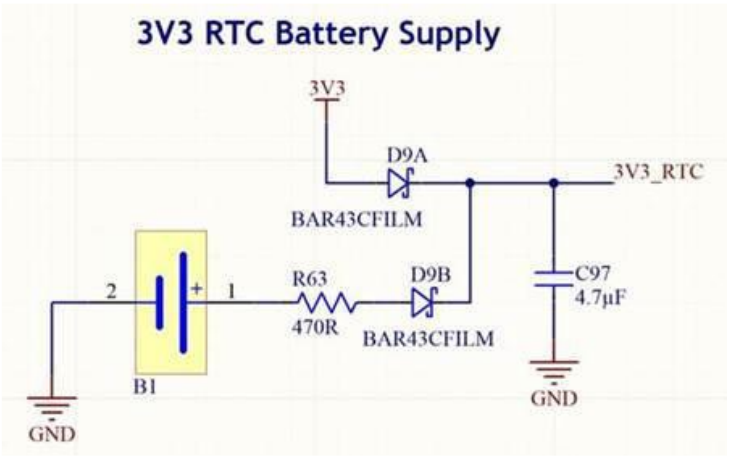

X2
1
2
C87
15pF
32.768kHz
C88
15pF
GND
GND
U1L
72
RTC_XIN
73
RTC_XOUT
70
WAKEUP
10
MAIN_XIN
75
I2S_MCLK0_ALT
76
I2S_MCLK1_ALT
SYSRST_N
125
EXT_PMU_EN
69
PMU_EN
81
RESERVED
82
MT3620AN

5. MT3620 RTC Battery Supply

The RTC requires an external battery connection to maintain its functionality while the MT3620 is not powered by the system. The suggested battery type is CR2032, which can provide almost two years of operation.
The battery life can be calculated by dividing the capacity by the average current required. For example, if the battery storage capacity is 170mAh (assumed usable) and the average current required is 10 µA, the battery life will be at least:

170,000 µAh / 10 µA = 17,000 h = 1.9 years

The battery must be connected to the MT3620 via a Schottky diode circuit for isolation. The Schottky diode circuit allows the MT3620 RTC-well to be powered by the system power when it is available, or a battery when the system power is not available. To do this, the diodes are set to be reversed biased when the system power is not available. A standby power supply should be used in a mobile system to provide continuous power to the RTC when available, which will significantly increase the RTC battery life and thereby the RTC accuracy. The following is an example of a diode circuit that is used.



One common backup power source used in many devices is a primary cell battery (e.g. a CR2032 coin cell). In order to ensure system availability when using such a battery, designers should take care to use a circuit that allows the 3V3_RTC to be sourced from either the battery or 3V3 system power. The circuit guarantees that even if the battery becomes depleted, the system will continue to start up if main system power is available. The circuit has the added benefit of minimizing power draw on the battery when system power is available, extending battery life.

Several items should be noticed here:

- When the main 3V3 supply is present, D9B prevents the main supply from charging the battery.
- D9A prevents the battery from powering other parts of the system that are connected to the main 3V3 supply when operating from the battery alone.
- BAR43 Schottky diodes have a low forward voltage drop which is advantageous in this application, since it helps maximize the useful operating life of the battery.
- Lithium-based primary coin cells can tolerate a small charging current, up to certain limits, without adversely affecting their operating life. Therefore, the reverse leakage current of the diodes should also be taken into consideration, particularly if the system will be operating in a hot environment (>50°C), since the reverse leakage current is proportional to temperature.

- R63 is included to limit the charging current to a safe level in the event D9B fails closed-circuit.
- The 4.7uF cap provides additional smoothing when switching between battery and main 3V3 (there is also a 100nF capacitor on the 3V3_RCT line (not shown above), located close to the MT3620)

6. MT3620 Current Consumption

Power mode	Description	Details		Typical current consumption	Hardware wake-up latency
		Subsystem	Power state		
RTC mode	Only RTC domain is on. Memory is not retained, requires a cold boot to resume.	Pluton CM4 subsystem	Off	0.01mA or 0.02mA (*1)	24ms (crystal and PLL lock, PMU time
		CA7 subsystem	Off		
		CM4F I/O subsystems	Off		
		Wi-Fi subsystem	Off		
		Buses/peripherals	Off		
Worst-case power consumption, no Wi-Fi	All subsystems apart from Wi-Fi running at full speed	Pluton CM4 subsystem	On	220mA Worst case 380mA (*2)	N/A, 650us WiFi subsystem resume latency
		CA7 subsystem	On		
		IO 0/1 CM4 subsystems	On		
		Wi-Fi subsystem	Light sleep		
		Buses/peripherals (*3)	On		
Worst-case power consumption with Wi-Fi (*2)	All subsystems running at full speed, Wi-Fi very active	Pluton CM4 subsystem	On	520mA (*4) Worst case 750mA (*2)	N/A
		CA7 subsystem	On		
		IO 0/1 CM4 subsystems	On		
		Wi-Fi subsystem	On		
		Buses/peripherals (*3)	On		
		RF (A or G Band)	On		
		Flash (*5)	On		

Note *1: 0.01mA/0.02mA with/without external 3.3v source PMIC control switch respectively.

Note *2: The current values are measured under typical case (TT silicon and 25C/1.15V) and the TDP (maximum thermal design power) includes simulation worst case condition (TT/125C/1.15V/MC99, MC99 is PTPX power simulation library).

Note *3: It depends on how busy the peripherals are and how they are configured.

Note *4: This data is based on 100% Wi-Fi transmission on the 5GHz band at 14dBm.

Note *5: Depends on I/O loading and flash power consumption.

7. Document Revision History

Revision	Date	Description
1.0	2020/02/19	Initial release.