Technical Note

MT9M002 Global Reset Release

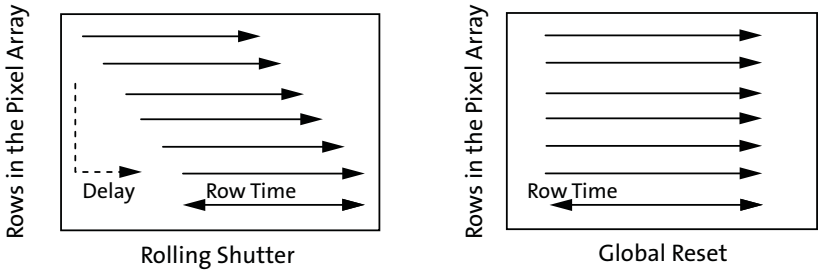
Introduction

This technical note discusses Aptina's MT9M002 CMOS image sensor global reset release (GRR) feature.

GRR versus ERS

The GRR feature enables the active rows in the sensor to be integrated at the same time, addressing the delay between the first and last row using the electronic rolling shutter (ERS) mode. This delay causes the sensor to capture a fast moving object in one position early in the frame integration and at another position nearer to the end—leaving the resulting image to appear skewed diagonally.

Figure 1: Delay Between the First and Last Row in a Rolling Shutter Image



The delay is the inverse of the maximum frame rate of the sensor at its set resolution. For example, the delay between the start of integration between the first and last row for the MT9M002 1.6Mp sensor—configured to run at full resolution and 30 fps—will be 33.33ms.

Equation 1 shows the formula to calculate image skew:

$$Image\ Skew = 1/fps - blanking\ period \quad \text{(EQ 1)}$$

Electromechanical Shutter and Flash

The GRR is a sequence consists of a simultaneous row integration followed by readout. The resulting image is a combination of this sequence. It is important that the light integrated during the readout portion is negligible relative to the integration sequence. For this reason, the use of an electromechanical shutter and/or flash is recommended. The summation of the GRR frame is shown in Equation 2.

$$GRR_{Frame} = Integration + Readout \quad \text{(EQ 2)}$$

GRR Sequence

The GRR sequence will be triggered while the sensor is streaming in ERS mode. A trigger will interrupt a rolling shutter sequence in mid-frame.

The basic elements of the GRR sequence are:

1. A GRR sequence is triggered.
2. All of the rows of the pixel array are placed in reset.
3. All of the rows of the pixel array are taken out of reset simultaneously.
4. All of the rows of the pixel array start to integrate incident light.
5. After the desired integration time, the electromechanical shutter is closed.
6. There are two situations:
   - 6a. In master mode, a single output frame is generated by the sensor. The sensor will output frames with LINE_VALID (LV), FRAME_VALID (FV), PIXCLK, and DOUT.
   - 6b. In slave mode, an ISP or other processor needs to provide proper HD_BAR (LV), and TRIGGER (FV) signals to the sensor. The PIXCLK and DOUT with embedded synchronous data will be generated by the sensor.
7. When the output frame is complete (FV negates), the electromechanical shutter may be opened again. The sensor automatically resumes operation in ERS mode.

Master Mode GRR Register Configuration

Before entering master mode GRR, load the normal ESR master settings file and ensure a correct image size for the sensor output, for example 1440 x 1080. It is necessary to set reserved register R0x30 to "1." Upon exiting GRR mode, return R0x30 to default value "0."

The GRR master mode operation includes:

1. Setting R0x1E = 0x4186. This will enable the global reset and the snapshot mode. To also enable the STROBE signal (for example, when using mechanical shutter) set R0x1E = 0x4196 instead.
2. Waiting for 1ms.
3. Triggering the GRR frame integration:
   3a. Setting TRIGGER to "0" (LOW).
   3b. Waiting for 200ns.
   3c. Setting TRIGGER to "1" (HIGH).
4. Waiting for the GRR frame output.

Notes:
1. In master mode, the trigger control will be generated by either a LOW level on the TRIGGER signal or by writing a "1" to the trigger register bit R0x0B[2].
2. Refer to Figure 2 on page 4 for more details.

Slave Mode GRR Register Configuration

Before entering slave mode GRR mode, load the normal ESR slave settings file and ensure a correct image size for the sensor output, for example 1440 x 1080. It is necessary to set reserved register R0x30 to "1." Upon exiting GRR mode, return R0x30 to default value "0."

The GRR slave mode operation includes:

1. Setting R0x1E = 0x41C6. This will enable the global reset and the snapshot mode. To also enable the STROBE signal (for example, when using mechanical shutter) set R0x1E = 0x41D6 instead.
2. Waiting for 1ms.
3. Triggering the GRR frame integration:
   3a. Setting TRIGGER to "0" (LOW).
   3b. Holding TRIGGER LOW, integration will continue whenever TRIGGER is LOW.
   3c. Setting TRIGGER to "1" (HIGH). This will stop integration. The mechanical shutter should close before TRIGGER goes HIGH and control the actual integration time.
4. Providing HD_BAR (LV) signal to read out image data.

Notes:
1. In slave mode, the TRIGGER signal must be used for GRR frame integration.
2. Refer to Figure 3 on page 4 for more details.

Strobe Control

To support synchronization of the exposure with external events such as a flash or mechanical shutter, the MT9M002 produces a STROBE output signal. By default, this signal is asserted for approximately the time that all rows are simultaneously being exposed, minus the vertical blank time, as shown in Figure 2 and Figure 3. Also indicated in these figures are the leading and trailing edges of STROBE, which can be configured to occur at one of several time points. The leading edge of STROBE occurs at STROBE_Start, and the trailing edge at STROBE_End, which are set to codes shown in Table 1 on page 5.

Figure 2: Master Mode GRR Timing

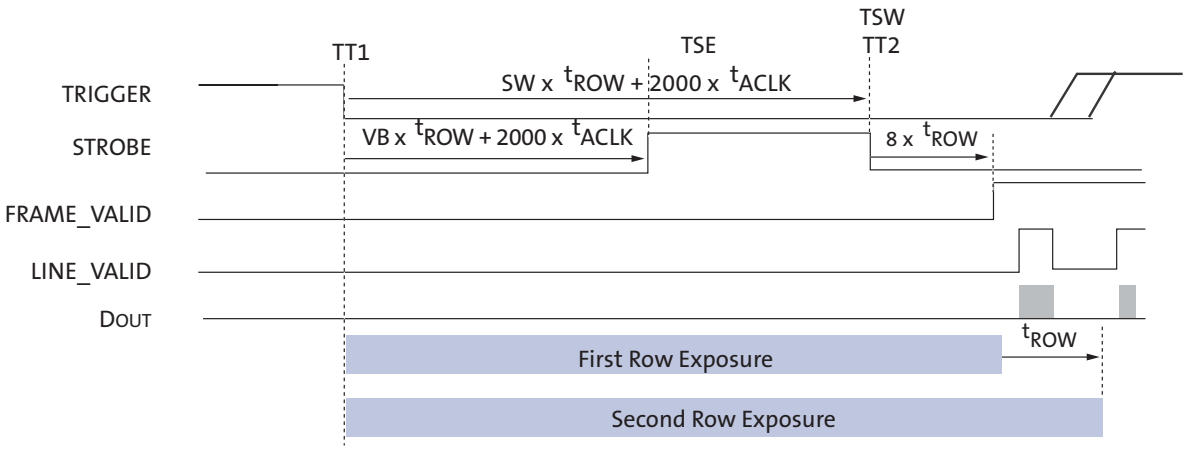


Figure 3: Slave Mode GRR Timing

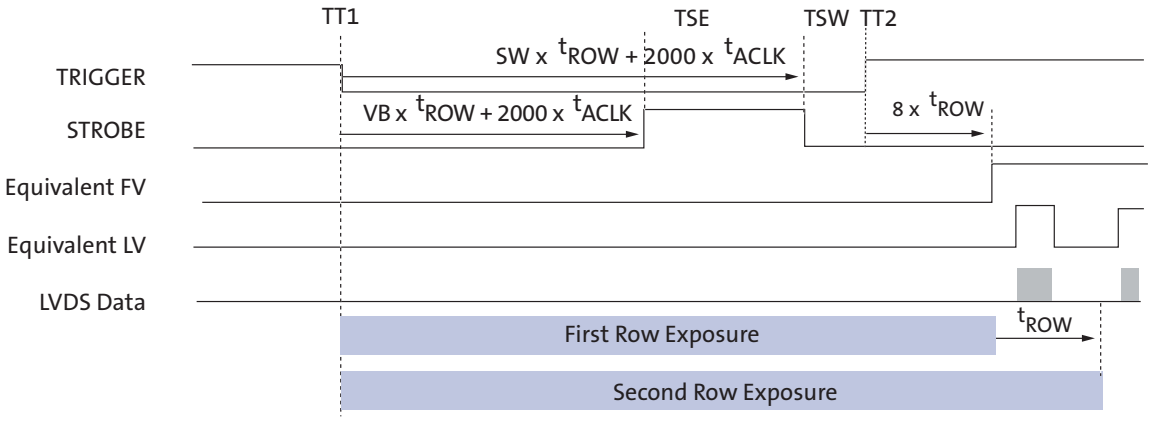


Table 1: STROBE Time points

Symbol	Time point	Code
TT1	Trigger 1 (start of shutter scan)	–
TSE	Start of exposure (all rows simultaneously exposing) offset by VB	1
TSW	End of shutter width (expiration of the internal shutter width counter)	2
TT2	Trigger 2 (start of readout scan)	3

If STROBE_Start and STROBE_End are set to the same time point, the strobe is a ^{t}ROW wide pulse starting at the STROBE_Start time point. If the settings are such that the strobe would occur after the trailing edge of FRAME_VALID, the strobe may be only ^{t}ACLK wide since there is no concept of a row at that time. The sense of the STROBE signal can be inverted by setting Invert_Strobe R0x1E[5] = 1. To use STROBE as a flash in snapshot modes or with a mechanical shutter, set the Strobe_Enable register bit field R0x1E[4] = 1.

Conclusion

For more information on global reset release or for more information on other features, refer to the MT9M002 1/4.5-inch 1.6-Mp CMOS digital image sensor parallel and serial data sheet Rev. E document on Aptina's Web site at www.aptina.com.

Revision History

Rev. C 7/10

- Updated to non-confidential

Rev. B 5/10

- Updated to Aptina template

Rev. A 12/07

- Initial release.

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