Technical Note

MT9T013
Recommendations for Image Scaling in Parallel Output Mode

Introduction

This technical note discusses the image scaling capabilities of Micron's MT9T013 CMOS image sensor while the sensor is in parallel output mode. Image scaling allows the user to generate full field, low resolution images at increased frame rates for viewfinder and video applications.

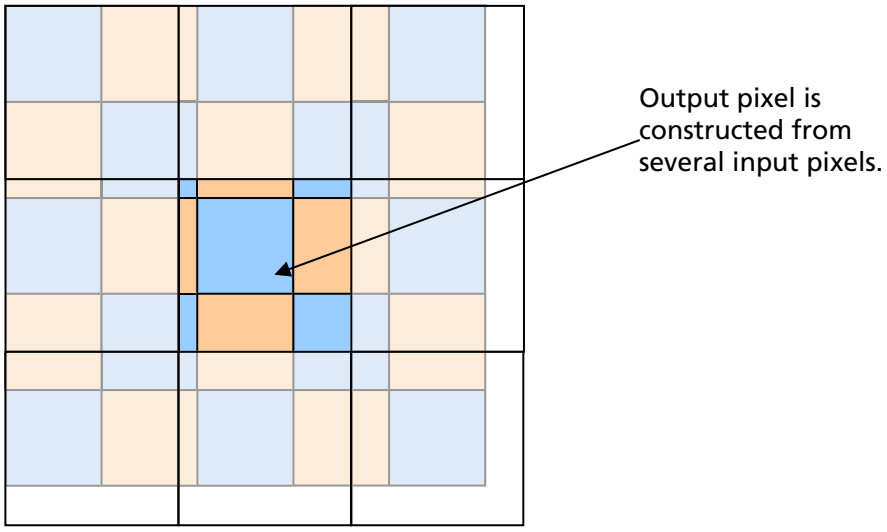
When compared to skipping, scaling is advantageous because it uses all pixel values to calculate the output image which helps avoid aliasing. It is also more convenient than binning because the scale factor varies smoothly and the user is not limited to certain ratios of size reduction.

The MT9T013 sensor is capable of horizontal scaling and full (horizontal and vertical) scaling. The scaling factor is programmable in $1/16^{th}$ steps is used for horizontal and vertical scalers.

Description

Each scaled, output pixel is calculated by taking a weighted average of a group input pixels which is composed of neighboring pixels, as shown in Figure 1.

Figure 1: Scaled Output Overlaid on Input



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The input pixel group size is determined by the scale factor. The scale factor is determined by:

$$Scale\ Factor = \frac{scale\_n}{scale\_m} = \frac{16}{scale\_m} \quad \text{(EQ 1)}$$

$$n \text{ is fixed at } 16 \quad \text{(EQ 2)}$$

$$m \text{ is adjustable with Reg0x0404 (scale\_m)} \quad \text{(EQ 3)}$$

Legal values for m are 16 through 256. Giving the user the ability to scale from 1:1 (m=16) to 1:8 (m=256).

There are two methods of spatial sampling used in scaler mode; Bayer and co-sited sampling. Scaler output is always in Bayer format.

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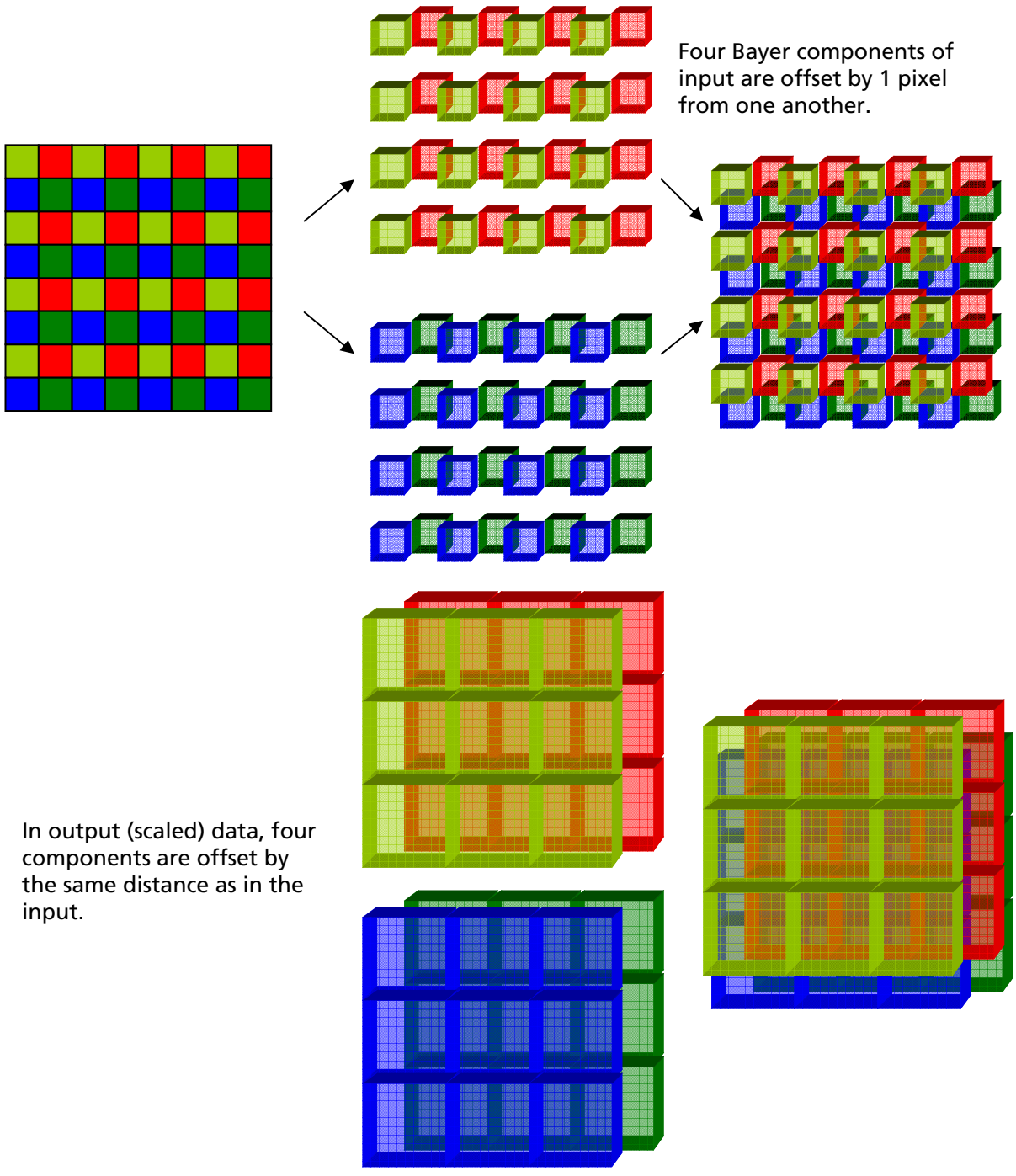
Sampling Modes

Bayer Sampling

In Bayer sampling mode, the four components of the resulting image are offset by the size of one input pixel.

Figure 2: Bayer Sampling



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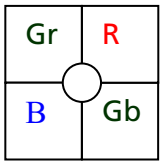
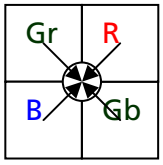
Co-sited Sampling

Co-sited sampling interpolates pixel values from the neighboring pixels while shifting their position to the center of the Bayer set, as shown in Figure 3.

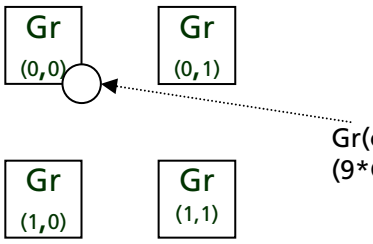
Figure 3: Co-sited Sampling



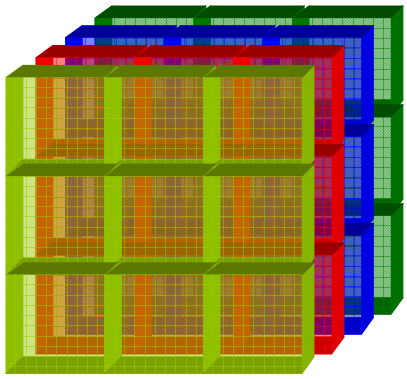
Original Bayer components are offset from one another and from center of set (indicated by circle).



To rectify this so that color components are aligned, the components need to be shifted. To determine the value of the component at the new center, it is interpolated with neighboring pixels of the same component.



In output (scaled) data, four components are aligned with one another.



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Sample Images

Figure 4: Sample Image without Scaling (2048 x 1536)

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Figure 5: Sample Image with Bayer Horizontal and Vertical 1/3 Scaling (684 x 512)

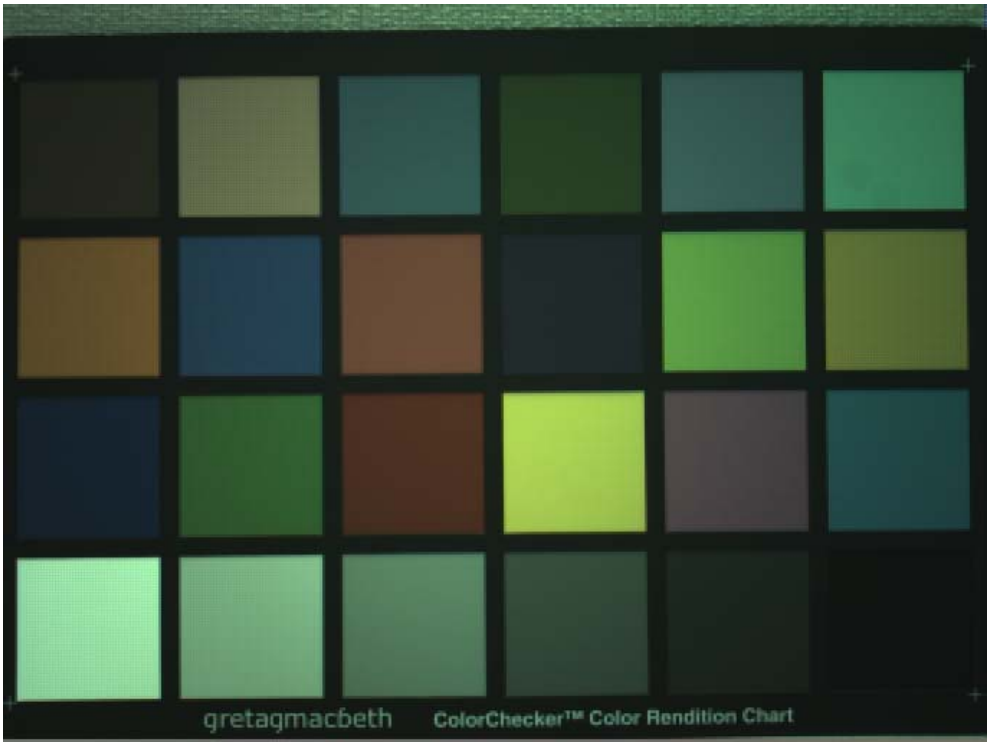

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Figure 6: Sample Image with Co-sited Horizontal and Vertical Scaling (684 x 512)

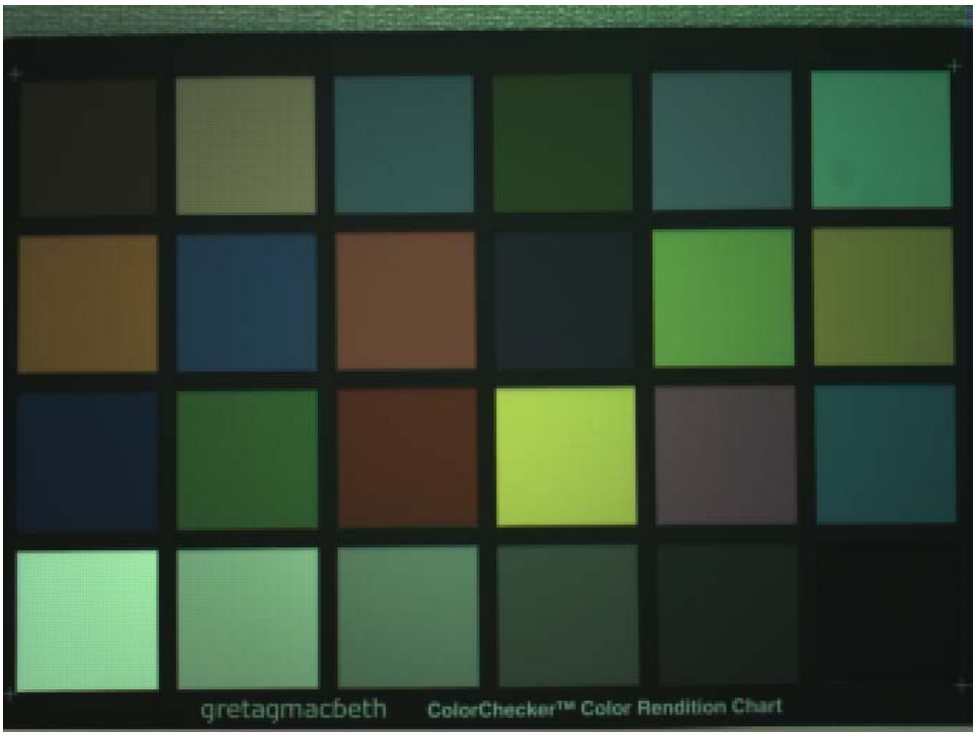

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Figure 7: Sample Image with Bayer Horizontal 1/3 Scaling (684 x1536)

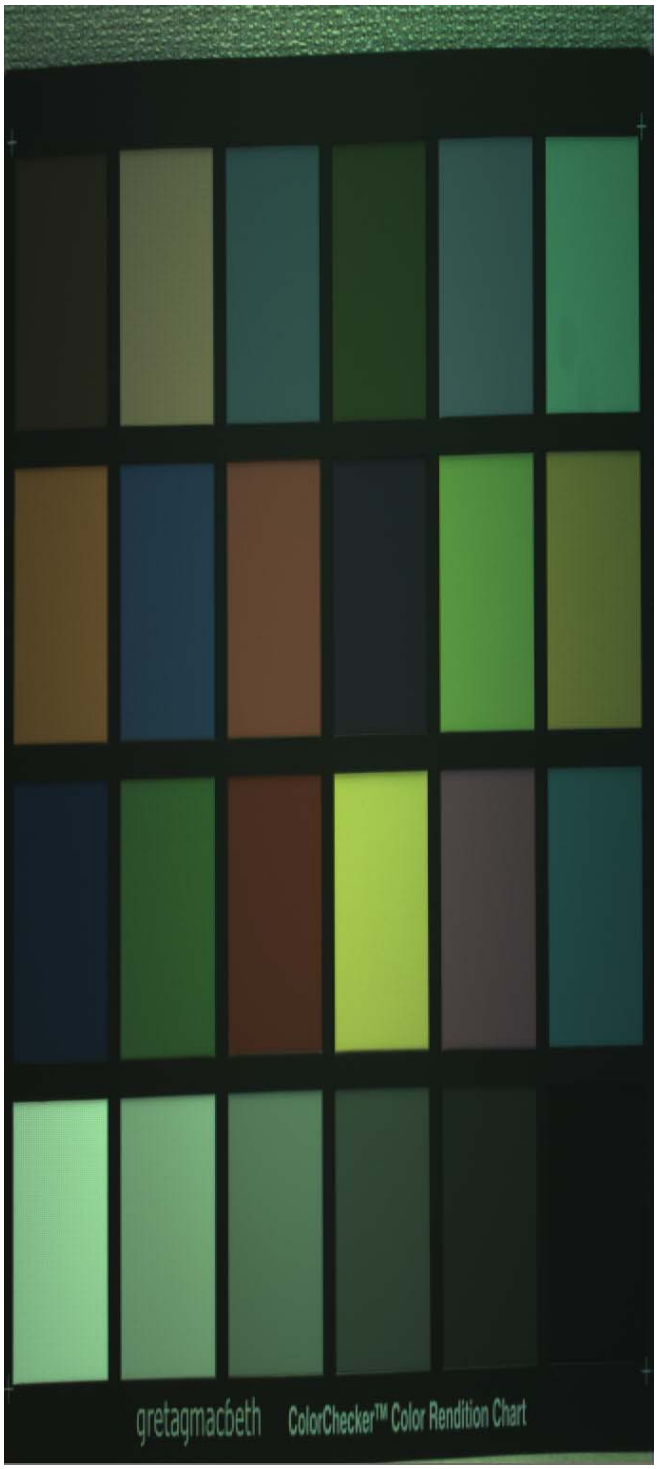

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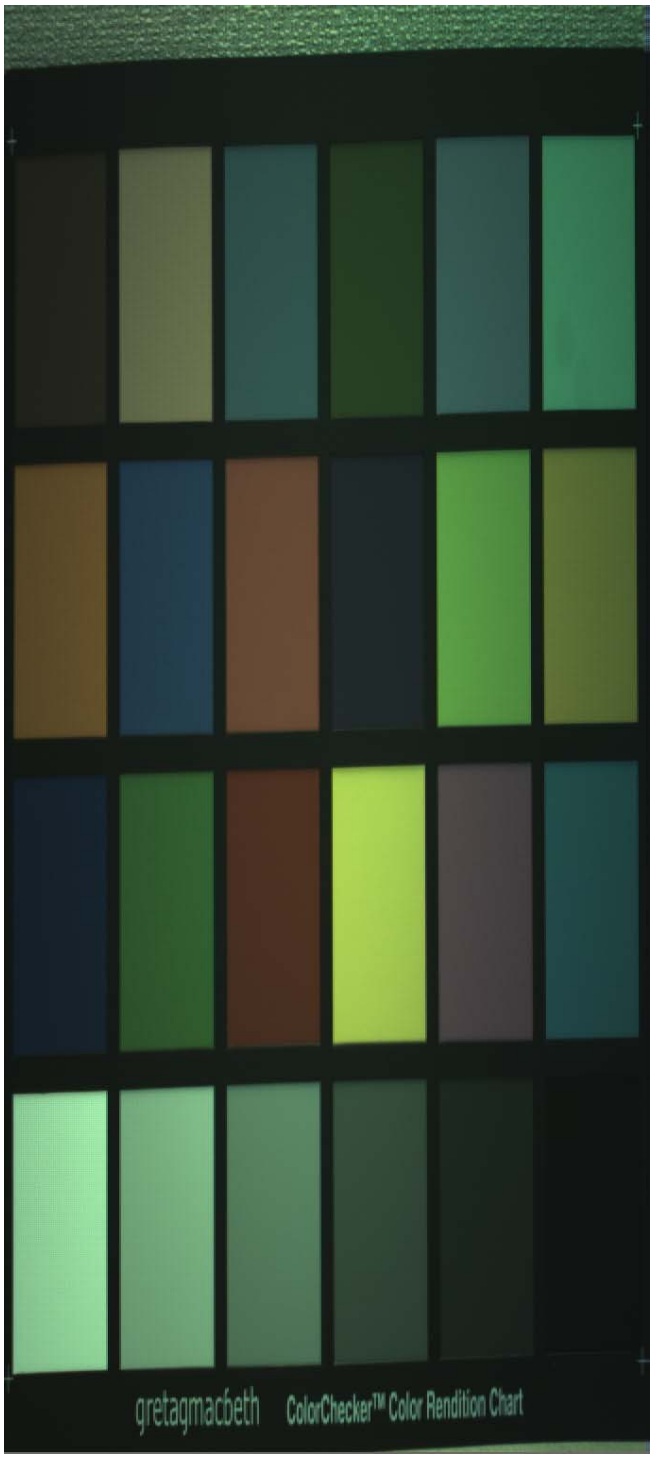
Figure 8: Sample Image with Co-sited Horizontal 1/3 Scaling (684 x1536)



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Register Settings for Scaler in Parallel Output Mode

The following sequence provides 1/3 scaling in parallel output mode:

1. It is assumed that the sensor will be in parallel output mode before implementing the following sequence for scaler operation (Reg0x301A, Bit 7 = 1).
2. Set Reg0x0100 = 0x0000 to disable streaming and place the sensor in low power mode.
3. Set Reg0x0104 = 0x0001 to inhibit register updates. Register changes will remain pending until this bit is returned to "0."
4. Set Reg0x0344 = 8, first desired column of visible pixels to be read out.
5. Set Reg0x0346 = 8, first desired row of visible pixels to be read out.
6. Set Reg0x0348 = 2055, the last desired column of visible pixels to be read out.
7. Set Reg0x034A = 1543, the last desired row of visible pixels to be read out.
8. Set Reg0x034C = 684, the proper X output size of the displayed image.
9. Set Reg0x034E = 512, the proper Y output size of the displayed image.
10. Set Reg0x0400 = 0x0001 to enable horizontal scaling or 0x0002 for horizontal and vertical scaling.
11. Set Reg0x0404 = 0x0030, to select desired scale factor.
12. Set Reg0x0104 = 0x0000 to allow register updates.
13. Set Reg0x0100 = 0x0001 to enter streaming mode.

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Example – 1/3 Scaling in ini Register Settings

```
[No Scaling for 2048x1536]
REG=0x100, 0x0000          // MODE_SELECT
DELAY=300
REG=0x104, 0x0001          // GROUPED_PARAMETER_HOLD
REG=0x344, 8               // X_ADDR_START
REG=0x346, 8               // Y_ADDR_START
REG=0X348, 2055            // X_ADDR_END
REG=0X34A, 1543            // Y_ADDR_END
REG=0x34C, 2048            // X_OUTPUT_SIZE
REG=0x34E, 1536            // Y_OUTPUT_SIZE
REG=0x382, 0x0001          // X_ODD_INC
REG=0x386, 0x0001          // Y_ODD_INC
REG=0x400, 0x0000          // SCALING_MODE H and V
REG=0x402, 0x0000          // Spatial_sampling
REG=0x404, 0x0010          // SCALE_M
REG=0x104, 0x0000          // GROUPED_PARAMETER_HOLD
REG=0x100, 0x0001          // MODE_SELECT

[Scaling with 1/3 Horizontal and Vertical 684x512 Bayer sampling]
REG=0x100, 0x0000          // MODE_SELECT
DELAY=300
REG=0x104, 0x0001          // GROUPED_PARAMETER_HOLD
REG=0x344, 8               // X_ADDR_START
REG=0x346, 8               // Y_ADDR_START
REG=0X348, 2055            // X_ADDR_END
REG=0X34A, 1543            // Y_ADDR_END
REG=0x34C, 684             // X_OUTPUT_SIZE
REG=0x34E, 512             // Y_OUTPUT_SIZE
REG=0x382, 0x0001          // X_ODD_INC
REG=0x386, 0x0001          // Y_ODD_INC
REG=0x400, 0x0002          // SCALING_MODE H and V
REG=0x402, 0x0000          // Spatial_sampling Bayer
REG=0x404, 0x0030          // SCALE_M
REG=0x104, 0x0000          // GROUPED_PARAMETER_HOLD
REG=0x100, 0x0001          // MODE_SELECT

[Scaling with 1/3 Horizontal only 684x1536 Bayer sampling]
DELAY=300
REG=0x104, 0x0001          // GROUPED_PARAMETER_HOLD
REG=0x344, 8               // X_ADDR_START
REG=0x346, 8               // Y_ADDR_START
REG=0X348, 2055            // X_ADDR_END
REG=0X34A, 1543            // Y_ADDR_END
REG=0x34C, 684             // X_OUTPUT_SIZE
REG=0x34E, 1536            // Y_OUTPUT_SIZE
REG=0x382, 0x0001          // X_ODD_INC
REG=0x386, 0x0001          // Y_ODD_INC
REG=0x400, 0x0001          // SCALING_MODE H
REG=0x402, 0x0000          // Spatial_sampling Bayer
REG=0x404, 0x0030          // SCALE_M
REG=0x104, 0x0000          // GROUPED_PARAMETER_HOLD=
REG=0x100, 0x0001          // MODE_SELECT
```

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```
[Scaling with 1/3 Horizontal and Vertical 684x512 Co-sited sampling]
REG=0x100, 0x0000 // MODE_SELECT
DELAY=300
REG=0x104, 0x0001          // GROUPED_PARAMETER_HOLD
REG=0x344, 8               // X_ADDR_START
REG=0x346, 8               // Y_ADDR_START
REG=0X348, 2055            // X_ADDR_END
REG=0X34A, 1543            // Y_ADDR_END
REG=0x34C, 684             // X_OUTPUT_SIZE
REG=0x34E, 512             // Y_OUTPUT_SIZE
REG=0x382, 0x0001          // X_ODD_INC
REG=0x386, 0x0001          // Y_ODD_INC
REG=0x400, 0x0002          // SCALING_MODE H and V
REG=0x402, 0x0001          // Spatial_sampling Co-sited
REG=0x404, 0x0030          // SCALE_M
REG=0x104, 0x0000          // GROUPED_PARAMETER_HOLD
REG=0x100, 0x0001          // MODE_SELECT

[Scaling with 1/3 Horizontal only 684x1536 Co-sited Sampling]
REG=0x100, 0x0000          // MODE_SELECT
DELAY=300
REG=0x104, 0x0001          // GROUPED_PARAMETER_HOLD
REG=0x344, 8               // X_ADDR_STAR
REG=0x346, 8               // Y_ADDR_START
REG=0X348, 2055            // X_ADDR_END
REG=0X34A, 1543            // Y_ADDR_END
REG=0x34C, 684             // X_OUTPUT_SIZE
REG=0x34E, 1536            // Y_OUTPUT_SIZE
REG=0x382, 0x0001          // X_ODD_INC
REG=0x386, 0x0001          // Y_ODD_INC
REG=0x400, 0x0001          // SCALING_MODE H only
REG=0x402, 0x0001          // Spatial_sampling Bayer
REG=0x404, 0x0030          // SCALE_M
REG=0x104, 0x0000          // GROUPED_PARAMETER_HOLD
REG=0x100, 0x0001          // MODE_SELECT
```

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Conclusion

For more information on image scaling in parallel output mode, or for more information on these features, refer to the MT9T013 data sheet located on Micron's Web site: www.micron.com/imaging.

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Revision History

Rev A. 11/06

- Initial release

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