# Technical Note

## MT9T012 Revision 1 Features

## Introduction

This technical note addresses the Micron® MT9T012 Revision 1 CMOS image sensor, which adds an additional processing step to the digital data path in order to provide color-dependent lens correction (position-dependent digital gain control). This revision has a number of additional functional changes to improve the operation of the sensor.

### Identification

The MT9T012 Revision 1 is distinguished from earlier revisions by the value of its revision_number register (Reg0x0002). For Revision 1, this register has the value "1."

### Additional Registers

Table 1 shows the register list and default value for new registers in this revision.

**Table 1: New Register List and Default Value**

1 = read-only, always 1; 0 = read-only, always 0; d = programmable; ? = read-only, dynamic

| Register Name | Address (Hex) | Data Format (Binary) | Default Value (Hex) |
|---|---|---|---|
| lens_correction | 0x318A–0x318B | d000 0000 0000 0000 | 0x0000 |
| | 0x3600–0x3601 | TBD | UNDEFINED |
| | 0x3696–0x3697 | — | UNDEFINED |

### Changes To Default Register Values

Table 2 shows registers whose default values have changed for this revision. The change to the default value of revision_number distinguishes Revision 1 from earlier revisions. The change to the default value of digital_gain_max corrects an error in the declaration of the maximum supported digital gain; it does not reflect a change to the digital gain capability of the sensor. The other default changes are intended to optimize imaging performance under some conditions.

**Table 2: Register List showing Changes to Default Value**

1 = read-only, always 1; 0 = read-only, always 0; d = programmable; ? = read-only, dynamic

| Register Name | Address (Hex) | Data Format (Binary) | Default Value (Hex) |
|---|---|---|---|
| revision_number | 0x0002 | 0000 0000 | 0x01 |
| digital_gain_max | 0x1086–0x1087 | 0000 0111 0000 0000 | 0x0700 |
| Reserved | 0x308C–0x308D | — | 0x0507 |
| Reserved | 0x309E–0x309F | — | 0x1410 |
| Reserved | 0x30E8–0x30E9 | — | 0xEFC1 |

**Table 2: Register List showing Changes to Default Value (continued)**
1 = read-only, always 1; 0 = read-only, always 0; d = programmable; ? = read-only, dynamic

| Register Name | Address (Hex) | Data Format (Binary) | Default Value (Hex) |
|---|---|---|---|
| Reserved | 0x30F0–0x30F1 | — | 0x764D |
| Reserved | 0x30F6–0x30F7 | — | 0xF01A |
| Reserved | 0x30FE–0x30FF | — | 0x9176 |
| Reserved | 0x3100–0x3101 | — | 0x9176 |
| Reserved | 0x3102–0x3103 | — | 0xBF9B |
| Reserved | 0x3104–0x3105 | — | 0xEEC2 |

## Lens Correction

The lens correction function is disabled by default. It is enabled by setting lens_correction[15] = 1 and disabled by setting lens_correction[15] = 0. The lens correction configuration registers (Reg0x3600-3697) are UNDEFINED after reset. They must be initialized before enabling the lens correction function. The lens correction configuration registers should only be written while the lens correction function is disabled. The lens correction function should only be enabled and disabled while the sensor is in software standby.

The settings for the lens correction configuration registers are a function of the optical system in use.

## Additional Subsampling Mode

MT9T012 Revision 1 supports an additional subsampling value, y_odd_inc = 7. This provides a mechanism for reducing the amount of frame data associated with a full-frame image, which also allows the frame rate to be increased. In contrast, images of equivalent size generated by the integrated scaler will be of higher image quality (will not suffer from the same subsampling image artifacts) but do not allow the frame rate to be increased.

When subsampling is enabled, it may be necessary to adjust the x_addr_end and y_addr_end settings. The values for these registers are required to correspond with rows/columns that form part of the subsampling sequence. For an x_odd_inc = 3, or a y_odd_inc = 3, the adjustment should be made in accordance with the following rule:

remainder = (addr_end - addr_start + 1) AND 2

if (remainder == 0) addr_end = addr_end - 2

For a y_odd_inc = 7, the adjustment should be made in accordance with the following rule:

remainder = (y_addr_end - y_addr_start + 1) AND 7

if (remainder == 0) y_addr_end = y_addr_end - 6

if (remainder == 6) y_addr_end = y_addr_end - 4

if (remainder == 4) y_addr_end = y_addr_end - 2

## Correction to Embedded Data

MT9T012 Revision 1 generates the x_odd_inc and y_odd_inc values in the correct position in the embedded data. In previous revisions, the values for x_odd_inc and y_odd_inc were swapped in the embedded data.

## Correction to ccp2_signalling_mode Behavior

MT9T012 Revision 1 allows the setting of ccp2_signalling_mode to be changed from “1” (the default value) to” 0,” and from “0” to “1.” In previous revisions, the sensor would not operate correctly if the ccp2_signalling mode was changed from “0” to “1.”

## Correction to PLL Divisors Updates

A change to the value of ccp2_signalling_mode causes the PLL settings to change, in order to meet the SMIA clocking model. MT9T012 Revision 1 changes these settings while the sensor is in software standby. In previous revisions, the settings were not changed until the sensor entered streaming mode; this could result in the PLL losing lock, resulting in an undetected bad frame being generated from the sensor.

## Correction to Behavior when Horizontal Mirror is Enabled/Disabled

MT9T012 Revision 1 generates a bad frame when image_orientation[0] is toggled (enable or disable horizontal mirror). When mask_corrupted_frames = 1, this bad frame is masked within the sensor. In previous revisions, the bad frame was generated at the sensor output regardless of the setting of mask_corrupted_frames.

## Addition of PLL Lock Timer

MT9T012 Revision 1 implements a PLL lock timer and powers down the PLL VCO while the sensor is in software standby. As a result, the power consumption is reduced while the sensor is in software standby. When the sensor enters streaming mode (mode_select = 1) streaming does not commence until the PLL has acquired lock. This change introduces a new state to the System State machine, as shown in Figure 1 on page 4. The effect of RESET# on the system state and the configuration of the PLL in the different states are shown in Table 3 on page 4.

**Figure 1: MT9T012 Revision 1 System States**

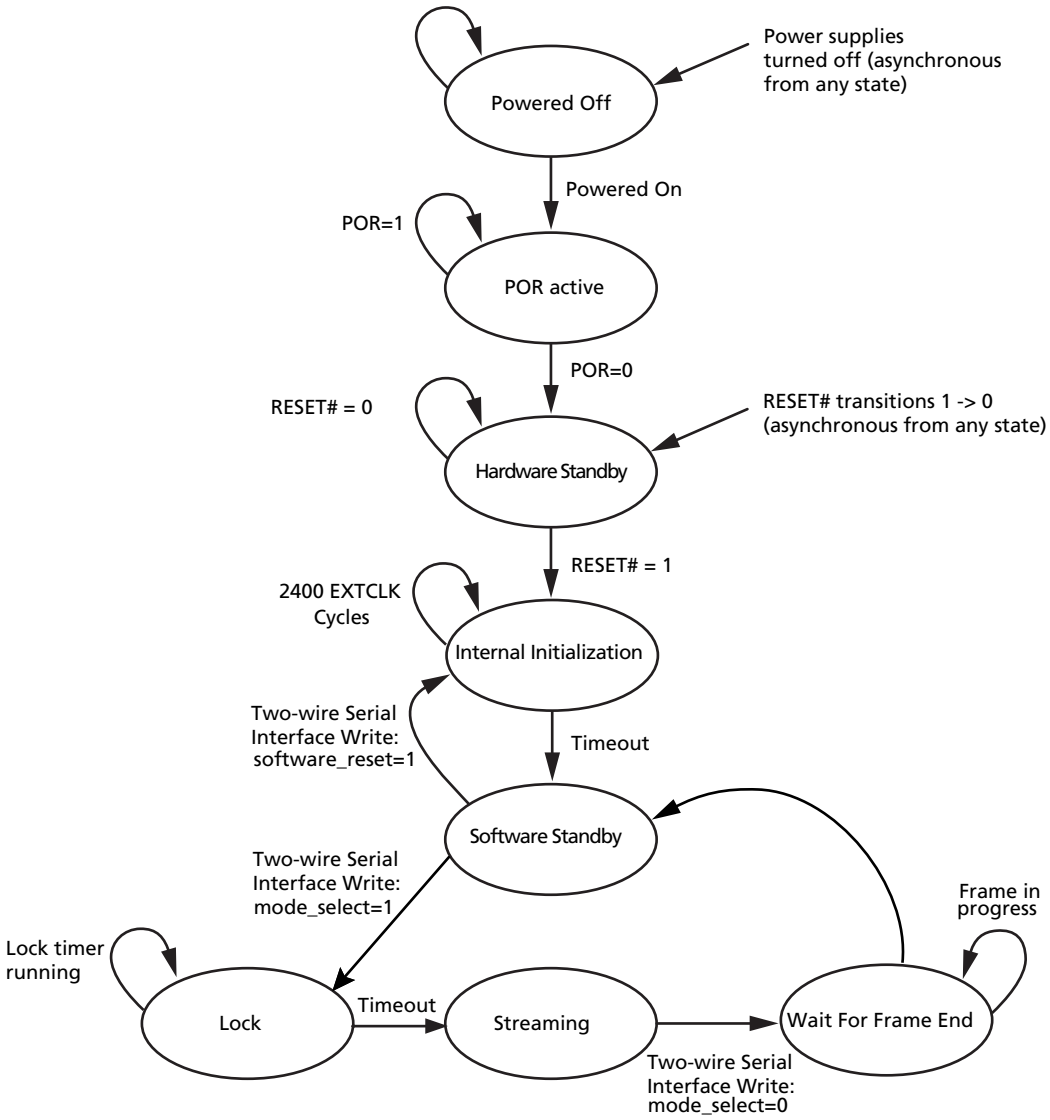


**Table 3: RESET# and PLL in System States**

| State | RESET# | PLL |
|---|---|---|
| Powered off | x | VCO powered down |
| POR Active | x | |
| Hardware Standby | 0 | |
| Internal Initialization | 1 | VCO powered down, PLL clock outputs bypassed by EXTCLK |
| Software Standby | | |
| Lock | | VCO running, PLL clock outputs active |
| Streaming | | |
| Wait for frame end | | |

## PLL VCO Power-down

In the MT9T012 Revision 1, the PLL VCO is automatically powered down when the sensor is in streaming mode. Reg0x301A-B[5] has no influence upon the operation of the PLL VCO. In previous revisions, the PLL VCO remained powered while the sensor was in streaming mode and could be manually powered down by setting Reg0x301A-B[5] = 1.

## Correction to ADC Monotonicity

MT9T012 Revision 1 exhibits monotonic gain changes as a result of changes in the LSB of the gain control. In previous revisions, changes in the LSB of the gain control could result in non-monotonic gain changes.

# Conclusion

For more information on MT9T012 Revision1 features, refer to the latest data sheet located at Micron's Web site at www.micron.com/imaging.

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# Revision History

**Rev A. . . . . 3/06**

- Initial release