

LI-OV13850-MIPI-AF SPECIFICATION

**Rev 1.1
Leopard Imaging Inc.**

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LI-OV13850-MIPI-AF SPECIFICATION

Version History

| Version | Description | Release Date |
|---------|-------------------------------|---------------|
| 1.0 | First Release | 3. Jan. 2015 |
| 1.1 | Update OV13850 module to V1.1 | 10. Feb. 2016 |



LI-OV13850-MIPI-AF SPECIFICATION

Key Information

| Module Part# | | LI-OV8865-MIPI-AF |
|--------------------------|--------------|---|
| Module Size | | 27.75 mm (L) x 8.50 mm (W) x 5.70 mm(H) |
| Sensor Type | | OV13850 |
| Array Size | | 4224 x 3136 |
| Power Supply | core | 1.14 ~ 1.26V (1.2V nominal) |
| | analog | 2.6 ~ 3.0V (2.8V nominal) |
| | I/O | 1.7 ~ 3.0 V (1.8V or 2.8V nominal) |
| Lens Size | | 1/3.06" |
| Focus(F.NO) | | 2.2 |
| FOV (D) | | 70° |
| Focal Length | | 3.81 mm |
| Focusing Range | | 10cm to infinity |
| TV Distortion | | < 1.5 % |
| Sensitivity | | TBD |
| Pixel size | | 1.12 um x 1.12 um |
| IR Cutter | | 650 nm |
| Sensor Temperature Range | Operating | -30 ℃ to +85 ℃ |
| | Stable Image | 0 ℃ to +60 ℃ |
| Output Formats | | 10-bit RAW RGB data |
| Support for image sizes | | 13.2MP(4224 x 3136); 10M(16:9 – 4224 x 2376); 4K2K(3840 x 2160); EIS 1080P(2112 x 1188); EIS 720P(1408 x 792); and more |
| Dynamic Range | | TBD |
| Max S/N ratio | | TBD |
| Power Requirement | Active | 199 mW (13MP @ 30 fps, ISP OFF) |
| | Standby | 300uW |
| | XSHUTDOWN | 1 uW |
| Image area | | 4815 um x 3678.3 um |
| Dark Current | | TBD |
| Die Dimensions | | 6210um x 5517um (COB), 6260 um x 5567um (RW) |



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Pin Assignment

| No. | Name | Pin type | Description |
|-----|----------------|----------|---|
| 1 | SDA | I/O | SCCB data |
| 2 | SCL | Input | SCCB input clock |
| 3 | DOVDD1.8V/2.8V | Power | Power for I/O circuit |
| 4 | MCP | Output | MIPI clock positive output |
| 5 | MCN | Output | MIPI clock negative output |
| 6 | GND | Ground | |
| 7 | MDP1 | Output | MIPI data positive output |
| 8 | MDN1 | Output | MIPI data negative output |
| 9 | GND | Ground | |
| 10 | MDP2 | Output | MIPI data positive output |
| 11 | MDN2 | Output | MIPI data negative output |
| 12 | GND | Ground | |
| 13 | MDP3 | Output | MIPI data positive output |
| 14 | MDN3 | Output | MIPI data negative output |
| 15 | GND | Ground | |
| 16 | MDP4 | Output | MIPI data positive output |
| 17 | MDN4 | Output | MIPI data negative output |
| 18 | DVDD1.2V | Power | Power for digital core |
| 19 | XCLK | Input | System input clock |
| 20 | PWDN | Input | Power down (active high with internal pull-down resistor) |
| 21 | RESET | Input | Reset (active low with internal pull-up resistor) |
| 22 | AVDD2.8 | Power | Analog power |
| 23 | AF-VCC2.8V | Power | Power for analog circuit |
| 24 | AF-AGND | Ground | Ground for analog circuit |



Electrical Characteristics

1. Absolute Maximum Ratings

| parameter | absolute maximum rating ^a |
|--|--------------------------------------|
| ambient storage temperature | -40°C to +125°C |
| supply voltage (with respect to ground) | V_{DD-A} 4.5V |
| | V_{DD-D} 3V |
| | V_{DD-IO} 4.5V |
| electro-static discharge (ESD) | human body model 2000V |
| | machine model 200V |
| all input/output voltages (with respect to ground) | -0.3V to $V_{DD-IO} + 1V$ |
| I/O current on any input or output pin | ± 200 mA |

a. exceeding the absolute maximum ratings shown above invalidates all AC and DC electrical specifications and may result in permanent damage to the device. Exposure to absolute maximum rated conditions for extended periods may affect device reliability.

2. Functional temperature

| parameter | range |
|---------------------------------------|-------------------------------------|
| operating temperature ^a | -30°C to +85°C junction temperature |
| stable image temperature ^b | 0°C to +60°C junction temperature |

a. sensor functions but image quality may be noticeably different at temperatures outside of stable image range

b. image quality remains stable throughout this temperature range



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3. DC Characteristics (-30 °C < T_J < 85 °C)

| symbol | parameter | min | typ | max | unit |
|--|---|------|-----|------|------|
| supply | | | | | |
| V _{DD-A} | supply voltage (analog) | 2.6 | 2.8 | 3.0 | V |
| V _{DD-D} | supply voltage (digital core) | 1.14 | 1.2 | 1.26 | V |
| V _{DD-IO} | supply voltage (digital I/O) | 1.7 | 1.8 | 3.0 | V |
| I _{DD-A} | active (operating) current for 13Mpixel @ 30fps ^a | | 39 | 45 | mA |
| I _{DD-D} | | | 90 | 120 | mA |
| I _{DD-IO} | | | 1 | 10 | mA |
| I _{DDS-SCCB} | standby current ^b | | TBD | | μA |
| I _{DDS-PWDN} | | | TBD | | μA |
| I _{DDS-XSHUTDOWN} | | | TBD | | μA |
| digital inputs (typical conditions: AVDD = 2.8V, DVDD = 1.2V, DOVDD = 1.8V, EVDD = 1.2V) | | | | | |
| V _{IL} | input voltage LOW | | | 0.54 | V |
| V _{IH} | input voltage HIGH | 1.26 | | | V |
| C _{IN} | input capacitor | | | 10 | pF |
| digital outputs (standard loading 25 pF) | | | | | |
| V _{OH} | output voltage HIGH | 1.62 | | | V |
| V _{OL} | output voltage LOW | | | 0.18 | V |
| serial interface inputs | | | | | |
| V _{IL} ^c | SIOC and SIOD | -0.5 | 0 | 0.54 | V |
| V _{IH} | SIOC and SIOD | 1.28 | 1.8 | 3.0 | V |

- a. active current is measured with ISP OFF
b. standby current is measured at room temperature
c. based on DOVDD = 1.8V

4. AC Characteristics

| symbol | parameter | min | typ | max | unit |
|---------------------|-----------------------|-----|-------|-----|------|
| inputs | | | | | |
| f _{CLK} | input clock frequency | 6 | 24 | 64 | MHz |
| t _{CLK} | input clock period | | 41.67 | | ns |
| t _{CLK:DC} | clock duty cycle | 45 | 50 | 55 | % |



5. Timing Characteristics

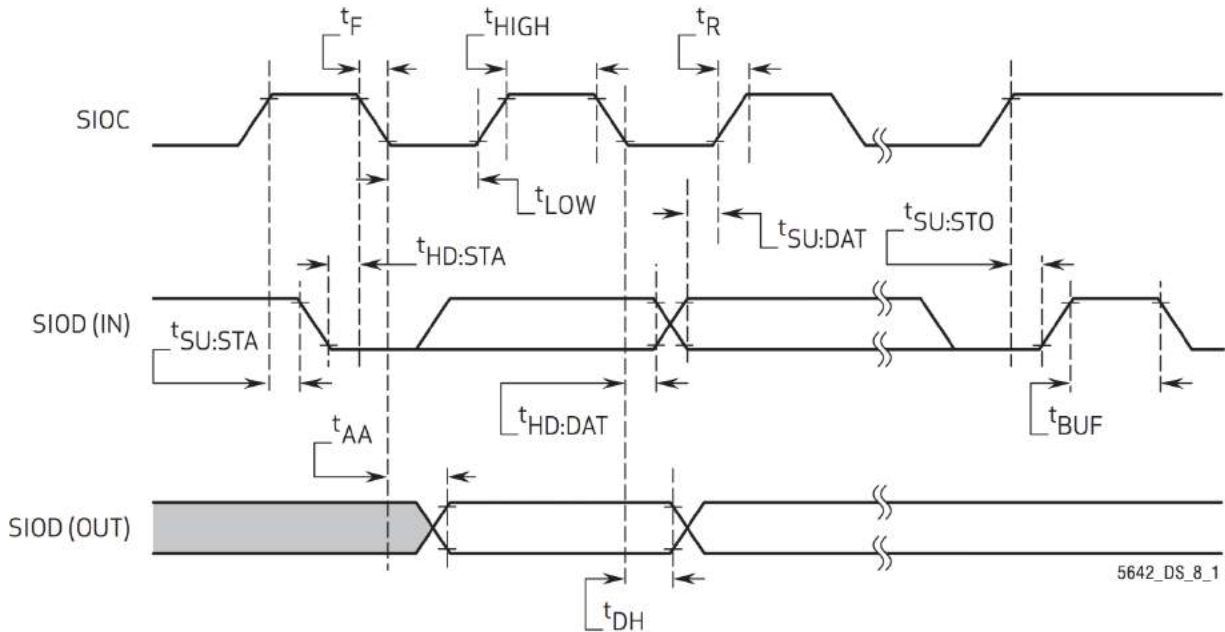
| symbol | parameter | min | typ | max | unit |
|----------------------------|---------------------------------|-----|-----|------------------------------|------|
| oscillator and clock input | | | | | |
| f_{osc} | frequency (EXTCLK) ^a | 6 | 24 | 64 | MHz |
| t_r, t_f | clock input rise/fall time | | | (see footnote ^b) | ns |
| | clock input duty cycle | 45 | 50 | 55 | % |

a. for input clock range 6~64MHz, the OV13850 can tolerate input clock period jitter up to 600ps peak-to-peak

b. for clock input rise/fall time, max is 27% of whole clock period

6. SCCB timing

a. SCCB interface timing



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b. SCCB interface timing Specification^{ab}

| symbol | parameter | conditions | min | typ | max | unit |
|---------------------|---|--------------------------------------|---------------------------|-----|-----|------|
| f _{SIOC} | SIOC clock frequency | | | 400 | 400 | kHz |
| t _{HIGH} | SIOC clock high period | V _{PADVDD} =1.8V | 0.6 | | | μs |
| t _{LOW} | SIOC clock low period | V _{PADVDD} =1.8V | 1.3 | | | μs |
| t _{BUF} | bus free time before new start cycle | V _{PADVDD} =1.8V | 1.3 | | | μs |
| t _{HD:STA} | start of transmission hold time | V _{PADVDD} =1.8V | 0.6 | | | μs |
| t _{SU:STA} | start of transmission setup time | V _{PADVDD} =1.8V | 0.6 | | | μs |
| t _{SU:STO} | stop of transmission setup time | V _{PADVDD} =1.8V | 0.6 | | | μs |
| t _{SU:DAT} | input data in setup time | V _{PADVDD} =1.8V | 100 | | | ns |
| t _{HD:DAT} | input data in hold time | V _{PADVDD} =1.8V | 0 | | | μs |
| t _{VD:DAT} | time for data signal from SIOC low to SIOD output | V _{PADVDD} =1.8V | | | 0.9 | μs |
| t _{VD:ACK} | time for ACK signal from SIOC low to SIOD output | V _{PADVDD} =1.8V | | | 0.9 | μs |
| t _{r SIOD} | SIOD clock rising time | V _{PADVDD} =1.8V, 30~70% | 20 | | 300 | ns |
| t _{f SIOD} | SIOD clock falling time | V _{PADVDD} =1.8V, 30~70% | 20×(VDD / 5.5V) = 6.55 | | 300 | ns |

7. Format and frame rate

| format | resolution | max frame rate | methodology | 10-bit output MIPI data rate |
|---------------------|-------------|-------------------|------------------------|---------------------------------|
| 13.2 megapixel | 4224 x 3136 | 30 fps | full resolution | 4-lane @ 1200 Mbps/lane |
| 2112x1568 | 2112x1568 | 60 fps | 2x2 binning | 4-lane @ 640 Mbps/lane |
| EIS 1080p | 2112x1188 | 60 fps | cropping + 2x2 binning | 4-lane @ 640 Mbps/lane |
| EIS 720p | 1408x792 | 60 fps | cropping + 2x2 binning | 4-lane @ 640 Mbps/lane |
| 720p | 1280x720 | 120 fps | cropping + 2x2 binning | 4-lane @ 640 Mbps/lane |
| 10 megapixel (16:9) | 4224x2376 | 30 fps | cropping | 4-lane @ 1200 Mbps/lane |



8. Power Up Sequence

| case | XSHUTDOWN | PWDNB | power up sequence requirement |
|------|-----------|-------|--|
| 1 | GPIO | DOVDD | Refer to figure 2-4 1. DOVDD rising must occur before DVDD rising 2. AVDD rising can occur before or after DOVDD rising 3. XSHUTDOWN rising must occur after AVDD, DOVDD and DVDD are stable |
| 2 | DOVDD | GPIO | Refer to figure 2-5 1. AVDD rising occurs before DOVDD rising 2. DOVDD rising occurs before DVDD 3. PWDNB rising occurs after DVDD rising |

a. Power Up Sequence (case 1)

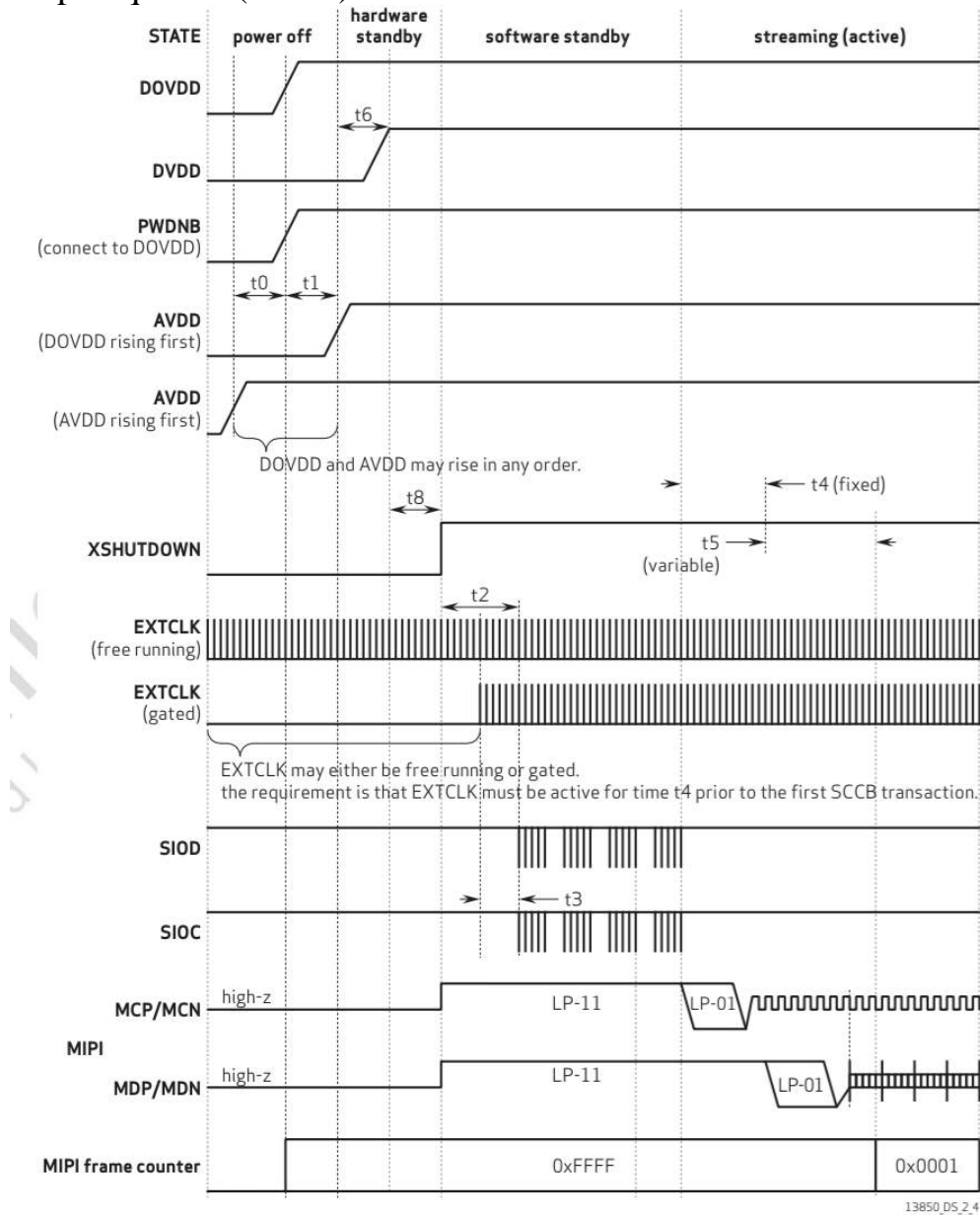


Figure 2-4

b. Power Up Sequence (case 2)

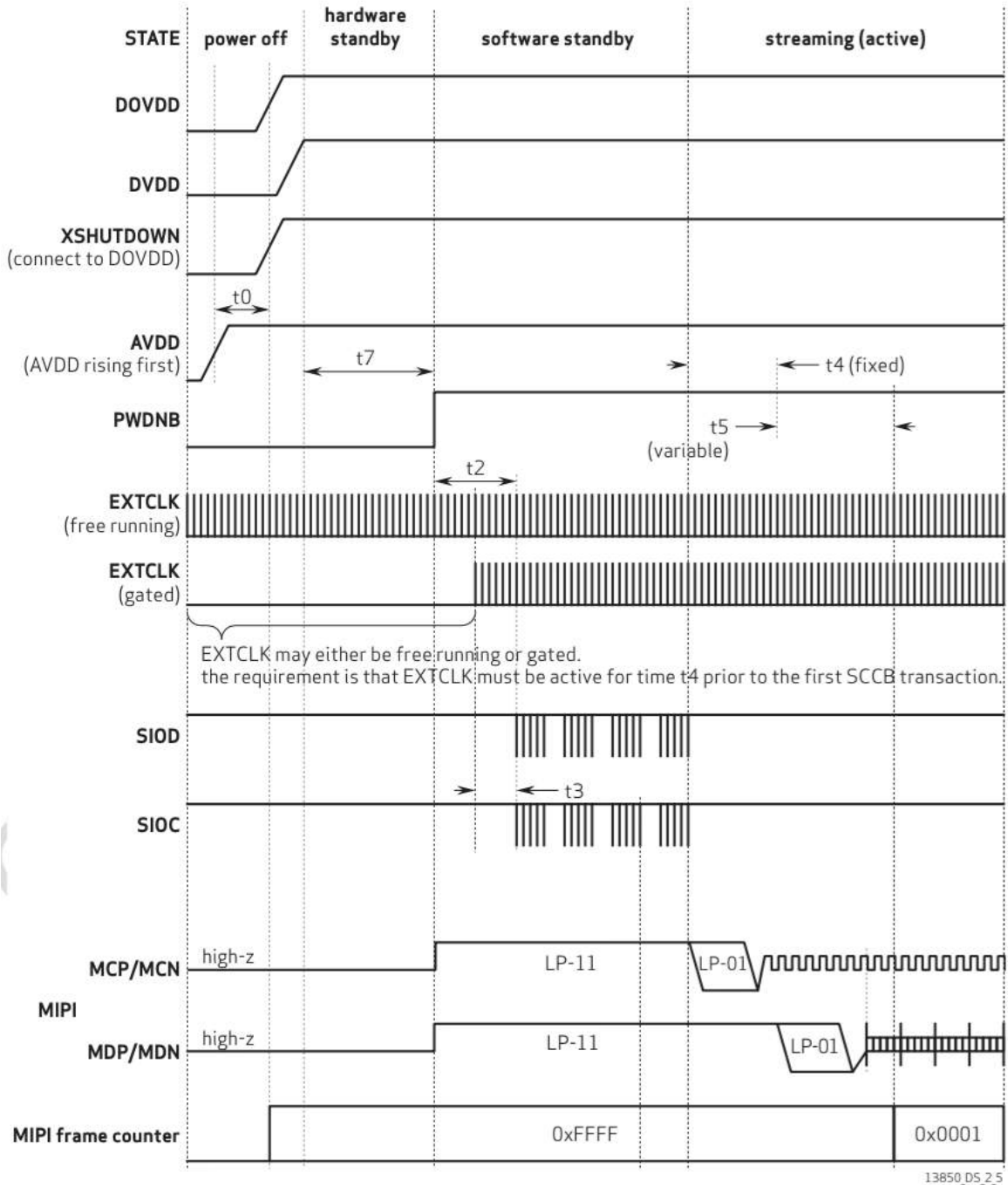


Figure 2-5



c. Power Up Sequence Timing Constraints

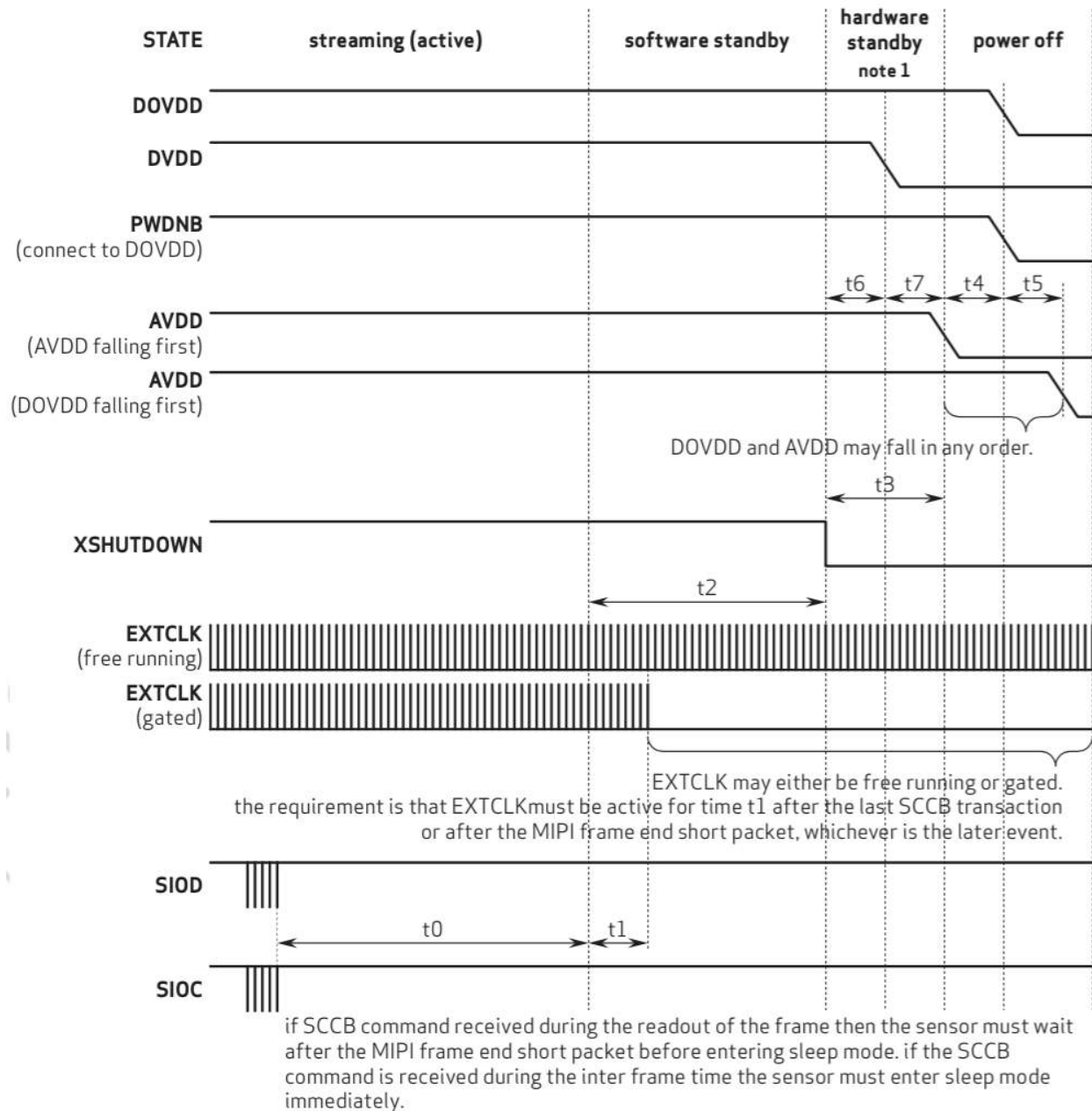
| constraint | label | min | max | unit |
|--|-------|----------------------------------|----------|---------------|
| AVDD rising – DOVDD rising | t0 | 0 | ∞ | ns |
| DOVDD rising – AVDD rising | t1 | | | ns |
| XSHUTDOWN rising – first CCI transaction | t2 | 8192 | | EXTCLK cycles |
| minimum number of EXTCLK cycles prior to the first CCI transaction | t3 | 8192 | | EXTCLK cycles |
| entering streaming mode – first frame start sequence (fixed part) | t4 | | 10 | ms |
| entering streaming mode – first frame start sequence (variable part) | t5 | delay is the exposure time value | | lines |
| AVDD or DOVDD, whichever is last – DVDD | t6 | 0.0 | ∞ | ns |
| DVDD - PWDNB rising | t7 | 10 | ∞ | ms |
| DVDD - XSHUTDOWN rising | t8 | 10 | ∞ | ms |

9. Power Down Sequence

| case | XSHUTDOWN | PWDNB | power down sequence requirement |
|------|-----------|-------|---|
| 1 | GPIO | DOVDD | Refer to figure 2-6 1. software standby recommended 2. pull XSHUTDOWN low for low power consumption 3. cut off DVDD, then it will be in hardware standby state for minimum power consumption 4. pull AVDD and DOVDD low in any order |
| 2 | DOVDD | GPIO | Refer to figure 2-7 1. software standby recommended 2. pull PWDNB low for low power consumption 3. cut off DVDD, then it will be in hardware standby mode for minimum power consumption 4. turn off DOVDD 5. turn off AVDD |



a. Power Down Sequence (case 1)



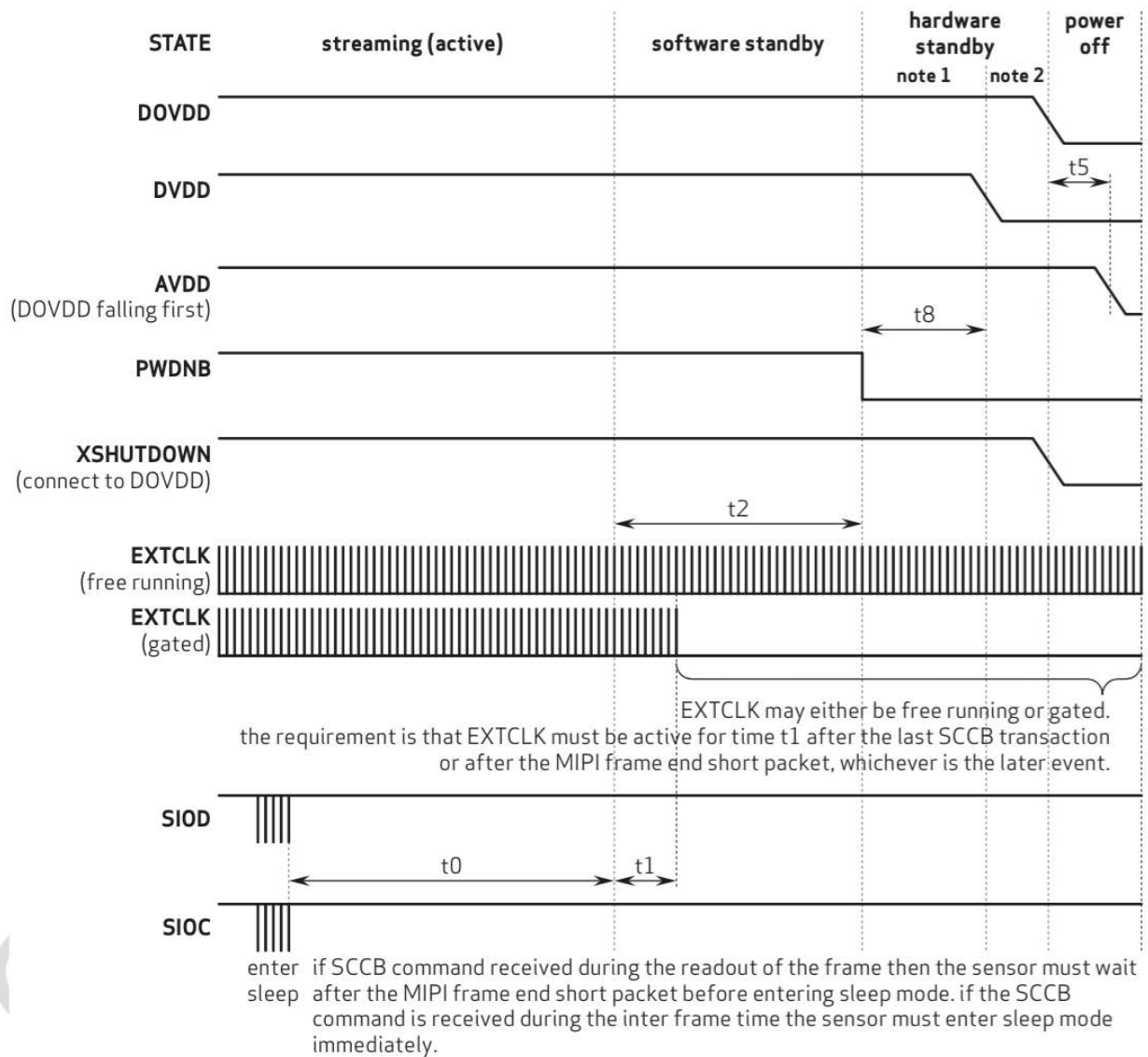
note 1 with minimum power consumption

13850_DS_2_6

Figure 2-6



b. Power Down Sequence (case 2)



note 1 with low power consumption

note 2 with minimum power consumption

13850_DS_2_7

Figure 2-7

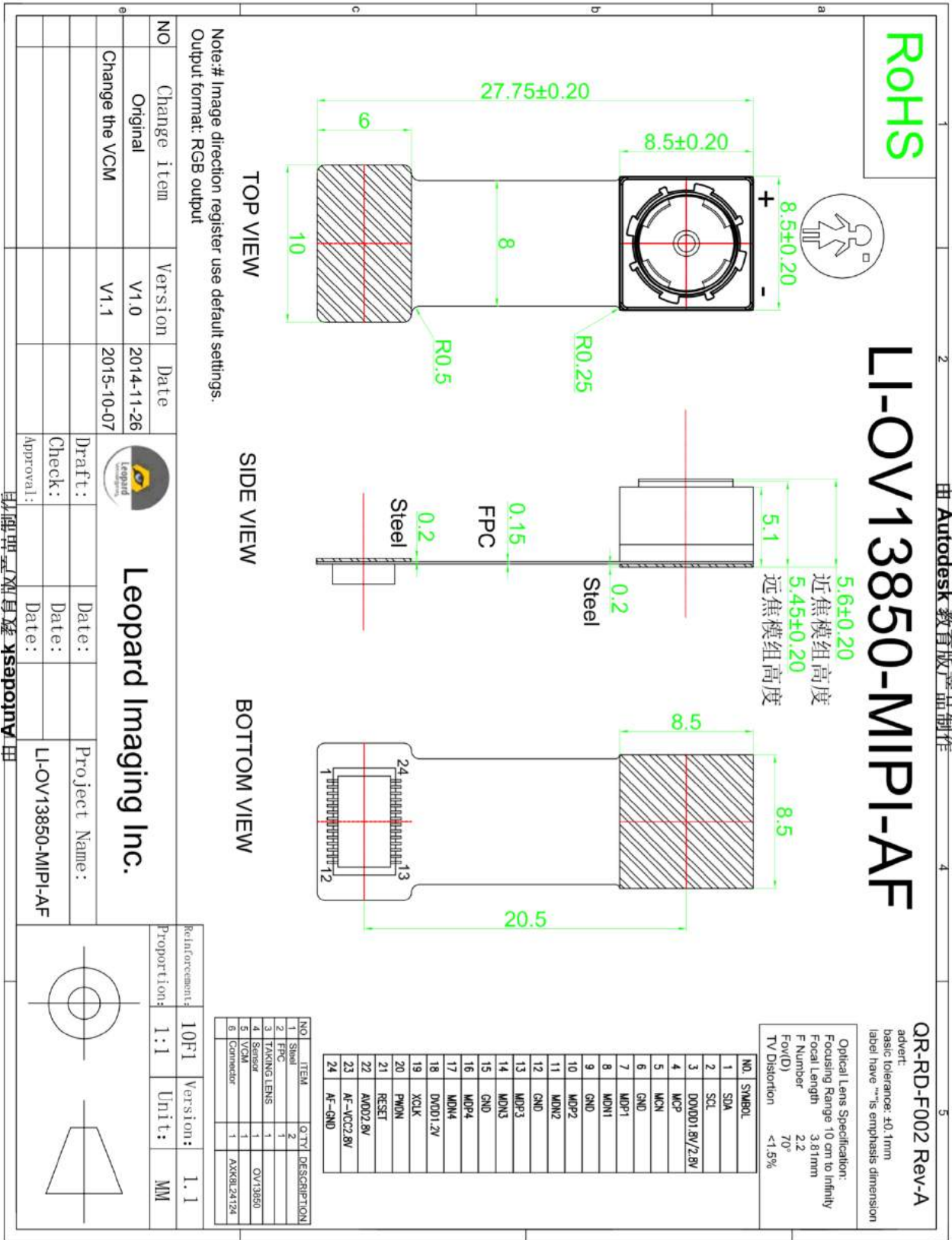


c. Power Down Sequence Timing Constraints

| constraint | label | min | max | unit |
|---|-------|--|-----|---------------|
| enter software standby SCCB command device in software standby mode | t0 | when a frame of MIPI data is output, wait for the MIPI end code before entering the software for standby; otherwise, enter the software standby mode immediately | | |
| minimum of EXTCLK cycles after the last SCCB transaction or MIPI frame end | t1 | 512 | | EXTCLK cycles |
| last SCCB transaction or MIPI frame end, XSHUTDOWN falling | t2 | 512 | | EXTCLK cycles |
| XSHUTDOWN falling – AVDD falling or DOVDD falling whichever is first | t3 | 0.0 | | ns |
| AVDD falling – DOVDD falling | t4 | AVDD and DOVDD may fall in any order, the falling separation can vary from 0 ns to infinity | | |
| DOVDD falling – AVDD falling | t5 | | | |
| XSHUTDOWN falling – external DVDD falling | t6 | 0.0 | | ns |
| external DVDD falling – AVDD falling or DOVDD falling whichever is first | t7 | 0.0 | | ns |
| PWDNB falling – external DVDD falling | t8 | 0.0 | | ns |



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