Description

The uCAM (microCAM) is a highly integrated serial camera module which can be attached to any host system that requires a video camera or a JPEG compressed still camera for embedded imaging applications.

The module uses an OmniVision CMOS VGA colour sensor along with a JPEG compression chip that provides a low cost and low powered camera system. The module has an on-board serial interface (TTL or RS232) that is suitable for a direct connection to any host micro-controller UART or a PC system COM port.

User commands are sent using a simple serial protocol that can instruct the camera to send low resolution (160x120 or 80x60) single frame raw images for a quick viewing or high resolution (640x480 or 320x240) JPEG images for storage or viewing.

The uCAM comes in a compact form factor with a built-in lens and a 4-wire connector that provides easy access to both power and serial data.

Features

- Small size, low cost and low powered camera module for embedded imaging applications.
  - uCAM-TTL: 3.3V DC Supply
  - uCAM-232: 5.0V DC Supply
- On-board EEPROM provides a command-based interface to external host via TTL or RS-232 serial link.
- UART: up to 1.2Mbps for transferring JPEG still pictures or raw images.
- On board OmniVision OV7640/8 VGA colour sensor and JPEG CODEC for different resolutions.
- Built-in down sampling, clamping and windowing circuits for VGA, QVGA, 160x120 or 80x60 image resolutions.
- Built-in colour conversion circuits for 2-bit gray, 4-bit gray, 8-bit gray, 12-bit RGB, 16-bit RGB or standard JPEG preview images.
- No external DRAM required.

Applications

- General purpose embedded imaging and control
- Robotics vision, object detection and recognition.
- Industrial control, automotive and medical systems.
- Smart home, video intercoms.
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Proprietary Information

Disclaimer of Warranties & Limitation of Liability

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## 1. Pin Configuration and Summary

<table>
<thead>
<tr>
<th>Pin</th>
<th>Symbol</th>
<th>I/O</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>VCC</td>
<td>P</td>
<td>Main Voltage Supply +ve input pin. uCAM-TTL: 3.0V to 3.6V DC range nominal 3.3V. uCAM-232: 4.5V to 5.5V DC range, nominal 5.0V.</td>
</tr>
<tr>
<td>3</td>
<td>GND</td>
<td>P</td>
<td>Supply Ground.</td>
</tr>
<tr>
<td>4</td>
<td>TX</td>
<td>O</td>
<td>Asynchronous Serial Transmit pin. Connect this pin to host controller Serial Receive (Rx) signal. The host receives data from uCAM via this pin.</td>
</tr>
<tr>
<td>5</td>
<td>RX</td>
<td>I</td>
<td>Asynchronous Serial Receive pin. Connect this pin to host controller Serial Transmit (Tx) signal. The host transmits commands to the uCAM via this pin.</td>
</tr>
<tr>
<td>1, 6, 7, 8</td>
<td>NC</td>
<td>--</td>
<td>No Connect.</td>
</tr>
</tbody>
</table>
2. Pin Description

**VCC pin 2 (uCAM Supply Voltage Input):**
Module supply voltage input pin. This pin must be connected to a regulated supply voltage.
uCAM-TTL : 3.0V to 3.6V DC range, nominal 3.3V.
uCAM-232 : 4.5V to 5.5V DC range, nominal 5.0V.

**GND pin 3 (uCAM Ground):**
Module ground pin. This pin must be connected to ground.

**TX pin 4 (Serial Transmit):**
Asynchronous Serial port Transmit pin, TX. Connect this pin to host Serial Receive (Rx) signal. The host receives data from the uCAM module via this pin.

**RX pin 5 (Serial Receive):**
Asynchronous Serial port Receive pin, RX. Connect this pin to host Serial Transmit (Tx) signal. The host transmits data to the uCAM via this pin.

3. Serial Interface - UART

The uCAM has a dedicated hardware UART that can communicate with a host via this serial port. This is the main interface used by the host to communicate with the module to send commands and receive back data. The primary features are:

- Full-Duplex 8 bit data transmission and reception through the TX and RX pins.
- Data format: 8 bits, No Parity, 1 Stop bit.
- Auto detect Baud rates from 14400 baud up to 115200 baud.
- Selectable Baud rates up to 1228800 bps.

The uCAM is available in 2 models that offer different versions of its serial interface. The uCAM-TTL has low voltage serial TTL levels which can be directly interfaced to a micro-controller and the uCAM-232 has a RS-232 voltage transceiver that can be interfaced to any host system COM port such as a PC.

3.1 Single Byte Timing

A single byte serial transmission consists of the start bit, 8-bits of data followed by the stop bit. The start bit is always 0, while a stop bit is always 1. The LSB (Least Significant Bit, Bit 0) is sent out first following the start bit. Figure 3.1 shows a single byte transmission timing diagram.

![Figure 3.1: Single Byte Timing Diagram](image)

3.2 Command Sequence Timing

A single command consists of 6 continuous single byte serial transmissions. The following Figure 3.2 shows an example of the SYNC (AA0D00000000h) command.
3.3 Auto-Baud Detect

The module can auto-detect the baud rate of the incoming command. The host should make connection with one of the following baud rates:

- 14400 bps
- 56000 bps
- 57600 bps
- 115200 bps

The module will keep using the last baud rate until the next power cycle.

3.4 Setting the Baud Rates

You can set Baud rates using the Set Baud command.

\[
\text{Baud rate} = \frac{14.7456\text{MHz}}{2 \times (2^{\text{2nd Divider}} + 1) / 2 \times (1^{\text{1st Divider}} + 1)}
\]

The maximum Baud rate you can get is 1228800, which is achieved by following two combinations,

- 1\text{st Divider} = 0
- 2\text{nd Divider} = 2
  
  Or

- 1\text{st Divider} = 2
- 2\text{nd Divider} = 0

Note: Baud rate changes holds until “full reset” command is sent or Power cycle occurs. So, you can synchronise at last used Baud rate or any of the Auto-detect Baud rate.
4. Command Set

The uCAM module supports a total of 10 commands:

<table>
<thead>
<tr>
<th>Command</th>
<th>ID Number</th>
<th>Parameter1</th>
<th>Parameter2</th>
<th>Parameter3</th>
<th>Parameter4</th>
</tr>
</thead>
<tbody>
<tr>
<td>INITIAL</td>
<td>AA01h</td>
<td>00h</td>
<td>Colour Type</td>
<td>RAW Resolution (Still Image only)</td>
<td>JPEG Resolution</td>
</tr>
<tr>
<td>GET PICTURE</td>
<td>AA04h</td>
<td>Picture Type</td>
<td>00h</td>
<td></td>
<td>00h</td>
</tr>
<tr>
<td>SNAPSHOT</td>
<td>AA05h</td>
<td>Snapshot Type</td>
<td>Skip Frame (Low Byte)</td>
<td>Skip Frame (High Byte)</td>
<td>00h</td>
</tr>
<tr>
<td>SET PACKAGE</td>
<td>AA06h</td>
<td>08h</td>
<td>Package Size (Low Byte)</td>
<td>Package Size (High Byte)</td>
<td>00h</td>
</tr>
<tr>
<td>SIZE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Set Baud Rate</td>
<td>AA07h</td>
<td>1st Divider</td>
<td>2nd Divider</td>
<td>00h</td>
<td>00h</td>
</tr>
<tr>
<td>RESET</td>
<td>AA08h</td>
<td>Reset Type</td>
<td>00h</td>
<td></td>
<td>XXh*</td>
</tr>
<tr>
<td>DATA</td>
<td>AA0Ah</td>
<td>Data Type</td>
<td>Length Byte 0</td>
<td>Length Byte 1</td>
<td>Length Byte 2</td>
</tr>
<tr>
<td>SYNC</td>
<td>AA0Dh</td>
<td>00h</td>
<td>00h</td>
<td></td>
<td>00h</td>
</tr>
<tr>
<td>ACK</td>
<td>AA0 Eh</td>
<td>Command ID</td>
<td>ACK Counter</td>
<td>00h / Package ID Byte 0</td>
<td>00h / Package ID Byte 1</td>
</tr>
<tr>
<td>NAK</td>
<td>AAOFh</td>
<td>00h</td>
<td>NAK Counter</td>
<td>Error Number</td>
<td>00h</td>
</tr>
<tr>
<td>LIGHT</td>
<td>AA13h</td>
<td>Frequency Type</td>
<td>00h</td>
<td>00h</td>
<td>00h</td>
</tr>
</tbody>
</table>

*If the parameter is 0xFF, the command is a special Reset command and the module responds to it immediately.

4.1 INITIAL (AA01h)

The host issues this command to configure the preview image size and colour type. After receiving this command, the module will send out an ACK command to the host if the configuration was successful. Otherwise, a NAK command will be sent out.

4.1.1 Colour Type

The uCAM can support 7 different colour types as follow:

- 2-bit Gray Scale (RAW, 2-bit for Y only) 01h
- 4-bit Gray Scale (RAW, 4-bit for Y only) 02h
- 8-bit Gray Scale (RAW, 8-bit for Y only) 03h
- 8-bit Colour (RAW, 332(RGB)) 04h
- 12-bit Colour (RAW, 444(RGB)) 05h
- 16-bit Colour (RAW, 565(RGB)) 06h
- JPEG 07h
4.1.2 RAW Resolution

<table>
<thead>
<tr>
<th>Resolution</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>80 x 60</td>
<td>01h</td>
</tr>
<tr>
<td>160 x 120</td>
<td>03h</td>
</tr>
<tr>
<td>320 x 240</td>
<td>05h</td>
</tr>
<tr>
<td>640 x 480</td>
<td>07h</td>
</tr>
<tr>
<td>128 x 128</td>
<td>09h</td>
</tr>
<tr>
<td>128 x 96</td>
<td>0Bh</td>
</tr>
</tbody>
</table>

4.1.3 JPEG Resolution

The uCAM embedded JPEG Code can support only multiples of 16 pixels, therefore the JPEG preview mode can only support following image sizes. It is different from the RAW preview mode.

<table>
<thead>
<tr>
<th>Resolution</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>80 x 64</td>
<td>01h</td>
</tr>
<tr>
<td>160 x 128</td>
<td>03h</td>
</tr>
<tr>
<td>320 x 240</td>
<td>05h</td>
</tr>
<tr>
<td>640 x 480</td>
<td>07h</td>
</tr>
</tbody>
</table>

4.2 GET PICTURE (AA04h)

The host issues this command to request a picture from the uCAM.

4.2.1 Picture Type

- Snapshot Picture 01h
- Preview (RAW) Picture 02h
- JPEG Picture 05h

4.3 SNAPSHOT (AA05h)

The uCAM will hold a single frame of still picture data in its buffer after receiving this command.

4.3.1 Snapshot Type

- Compressed Picture (JPEG) 00h
- Uncompressed Picture (RAW) 01h

4.3.2 Skip Frame Counter

The number of dropped frames can be defined before capture occurs. “0” keeps the current frame, “1” captures the next frame, and so on.
4.4 SET PACKAGE SIZE (AA06h)

The host issues this command to change the size of the data package which is used to transmit the compressed JPEG image data from the uCAM to the host. This command should be issued before sending SNAPSHOT or GET PICTURE commands to the uCAM.

**Note:** The size of the last package varies for different JPEG image sizes.

### 4.4.1 Package Size

The default size is 64 bytes and the maximum size is 512 bytes.

<table>
<thead>
<tr>
<th>byte 0</th>
<th>byte N</th>
</tr>
</thead>
<tbody>
<tr>
<td>ID</td>
<td>Data Size</td>
</tr>
<tr>
<td>(2 bytes)</td>
<td>(2 bytes)</td>
</tr>
</tbody>
</table>

- **ID:** Package ID, starts from zero for an image
- **Data Size:** Size of image data in the package
- **Verify Code:** Error detection code, equals to the lower byte of sum of the whole package data except the verify code field. The higher byte of this code is always zero. i.e. verify code = lowbyte(sum(byte[0] to byte[N-2]))

**Note1:**

Once the host receives the image size from the uCAM, the following simple equation can be used to calculate the number of packages that will be received according to the package size set. The package settings only apply for compressed JPEG images.

\[
\text{Number of packages} = \frac{\text{Image size}}{\text{Package size} - 6}
\]

**Note2:**

As the transmission of an uncompressed (RAW) image does not require the package mode, it is not necessary to set the package size for an uncompressed image. All of the pixel data for the RAW image will be sent continuously until completion.

**Note3:**

Package size must not be odd or multiple of 16

4.5 SET BAUD RATE (AA07h)

The host can set the Baud rates using this command. There could be several different combinations the two divisors can be set to achieve a particular baud rate. Say, to achieve 921600 you can set

1st divider 01h, 2nd divider 01h  OR  1st divider 00h, 2nd divider 03h  OR  1st divider 03h, 2nd divider 00h

### 4.5.1 Baud Rates

<table>
<thead>
<tr>
<th>Baud Rate (bps)</th>
<th>7200</th>
<th>9600</th>
<th>14400</th>
<th>..........</th>
<th>737280</th>
<th>921600</th>
<th>1228800</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Divider(Hex)</td>
<td>FFh</td>
<td>BFh</td>
<td>7Fh</td>
<td>..........</td>
<td>00h</td>
<td>03h</td>
<td>02h</td>
</tr>
<tr>
<td>2nd Divider(Hex)</td>
<td>01h</td>
<td>01h</td>
<td>01h</td>
<td>..........</td>
<td>04h</td>
<td>00h</td>
<td>00h</td>
</tr>
</tbody>
</table>
4.6  **RESET (AA08h)**

The host can reset the uCAM by issuing this command.

4.6.1  **Reset Type**

- **00h**: Resets the whole system. The uCAM will reboot and reset all registers and state machines.
- **01h**: Resets the state machines only.

4.7  **DATA (AA0Ah)**

The uCAM issues this command to inform the host the type and the size of the image data which is ready for transmitting to the host.

4.7.1  **Data Type**

- **Snapshot Picture**: 01h
- **Preview (RAW) Picture**: 02h
- **JPEG Preview Picture**: 05h

4.7.2  **Length**

These three bytes represent the length of data of the Picture that is ready for transmission back to the host.

4.8  **SYNC (AA0Dh)**

Either the host or the uCAM module can issue this command to make a connection. The ACK command must be sent out after receiving this command. Refer to Section 5.2 for more details.

4.9  **ACK (AA0Eh)**

This command indicates the success of the last operation. After receiving any valid command, the ACK command must be sent out except when getting preview data. The host can issue this command to request image data package with the desired package ID after receiving the DATA command from the uCAM. The host should send this command with package ID F0F0h after receiving a package to end the package transfer.

**Note:** the field “command ID” should be 00h when request is for image data package.

4.9.1  **Command ID**

The command with that ID is acknowledged by this command.

4.9.2  **ACK Counter**

For debug only.

4.9.3  **Package ID**

For acknowledging the DATA command, these two bytes represent the requested package ID. For acknowledging other commands, these two bytes are set to 00h.
4.10 NAK (AA0Fh)

This command indicates corrupted transmission or unsupported features.

4.10.1 NAK Counter

For debug only.

4.10.2 Error Number

<table>
<thead>
<tr>
<th>Error Description</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Picture Type Error</td>
<td>01h</td>
</tr>
<tr>
<td>Picture Up Scale</td>
<td>02h</td>
</tr>
<tr>
<td>Picture Scale Error</td>
<td>03h</td>
</tr>
<tr>
<td>Unexpected Reply</td>
<td>04h</td>
</tr>
<tr>
<td>Send Picture Timeout</td>
<td>05h</td>
</tr>
<tr>
<td>Unexpected Command</td>
<td>06h</td>
</tr>
<tr>
<td>SRAM JPEG Type Error</td>
<td>07h</td>
</tr>
<tr>
<td>SRAM JPEG Size Error</td>
<td>08h</td>
</tr>
<tr>
<td>Picture Format Error</td>
<td>09h</td>
</tr>
<tr>
<td>Picture Size Error</td>
<td>0Ah</td>
</tr>
<tr>
<td>Parameter Error</td>
<td>08h</td>
</tr>
<tr>
<td>Send Register Timeout</td>
<td>0Ch</td>
</tr>
<tr>
<td>Command ID Error</td>
<td>0Dh</td>
</tr>
<tr>
<td>Picture Not Ready</td>
<td>0Fh</td>
</tr>
<tr>
<td>Transfer Package Number Error</td>
<td>10h</td>
</tr>
<tr>
<td>Set Transfer Package Size Wrong</td>
<td>11h</td>
</tr>
<tr>
<td>Command Header Error</td>
<td>F0h</td>
</tr>
<tr>
<td>Command Length Error</td>
<td>F1h</td>
</tr>
<tr>
<td>Send Picture Error</td>
<td>F5h</td>
</tr>
<tr>
<td>Send Command Error</td>
<td>FFh</td>
</tr>
</tbody>
</table>

4.11 LIGHT (AA13h)

The host issues this command to change the light frequency (hum) response of the uCAM.

4.11.1 Light Frequency Type

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>50Hz</td>
<td>00h</td>
</tr>
<tr>
<td>60Hz</td>
<td>01h</td>
</tr>
</tbody>
</table>
5. Command Protocol

This section outlines command usage and protocol transaction between the host and the uCAM module.

5.1 SYNC Command

```
HOST                   uCAM

SYNC (AA 0D 00 00 00 00)  
|                     |  
| Ack (AA 0E 0D xx 00 00) |
|                     |  
SYNC (AA 0D 00 00 00 00)  
|                     |  
| Ack (AA 0E 0D xx 00 00) |
```
5.2 Connecting to the uCAM

Send the SYNC command until receiving the ACK command from uCAM (usually an ACK command is received after sending the SYNC command 25 times). This must be performed following a power-up.

Note1:
The host should send the SYNC command one by one continuously until receiving the ACK and SYNC commands back from the uCAM module. Sometimes up to 25 to 60 SYNC commands maybe required before the module will respond. After receiving the response, the host should reply with the ACK command to finalise the synchronisation process.

Note2:
After synchronising and establishing a communications link with the uCAM, allow up to 1-2 seconds before capturing the first image. The uCAM needs this time to allow its AGC and AEC circuits to stabilise, otherwise the received image luminance maybe too high or too low.
5.3 INITIAL, GET PICTURE, SNAPSHOT, SET PACKAGE SIZE, RESET Commands

INITIAL, GET PICTURE, SNAPSHOT, SET PACKAGE SIZE, RESET

ACK
5.4 Taking SNAPSHOT Pictures

Make sure a connection is established first (Section 5.2 Connecting to the uCAM) before using the following communications.

5.4.1 Example: JPEG Snapshot Picture (640 x 480 resolution)
**Note:**
xx : Don’t care  ~~ : Image size returned by uCAM
* : Due to a bug in the uCAM firmware, if the last package is the same size as the package size, then rather than send an ACK a reset command should be sent with the 'Special Reset' and 'Reset State machines only' options set. Note that you may need to pause for a couple of milliseconds before sending this reset, to ensure it is accepted.

**5.4.2 Example: Snapshot Picture (160 x 120 resolution, 16bit colour, uncompressed/RAW picture)**

```
INITIAL
preview, VGA
(AA 01 00 06 03 zz)
```

```
ACK
(AA 0E 01 xx 00 00)
```

```
SNAPSHOT
uncompressed picture
(AA 05 01 00 00 00)
```

```
ACK
(AA 0E 05 xx 00 00)
```

```
GET PICTURE
Snapshot picture
(AA 04 01 00 00 00)
```

```
ACK
(AA 0E 04 xx 00 00)
```

```
DATA
snapshot picture
(AA 0A 01 ~~ ~~ ~~)
```

```
ACK
(AA 0E 0A xx 01 00)
```

```
Image Data
complete picture
```

**Note:**
xx : Don’t care
zz : 01, 03, 05 or 07. Don’t care in RAW mode
~~ : Image size returned by uCAM
### 5.5 JPEG Preview Pictures (Video)

Make sure a connection is established first (Section 5.2 Connecting to the uCAM) before using the following communications.

#### 5.5.1 Example: JPEG Preview Picture (320 x 240 resolution)

- **INITIAL**
  - JPEG preview, VGA
  - (AA 01 00 07 yy 05)
- **ACK**
  - (AA 0E 01 xx 00 00)
- **SET PACKAGE SIZE**
  - 512 Bytes
  - (AA 06 08 00 02 00)
- **ACK**
  - (AA 0E 06 xx 00 00)
- **GET PICTURE**
  - JPEG preview picture
  - (AA 04 05 00 00 00)
- **ACK**
  - (AA 0E 04 xx 00 00)
  - ACK
  - Package ID: 0000h
  - (AA 0E 00 00 00 00)
  - Image Data Package
  - 512 bytes, ID: 0000h
- **ACK**
  - Package ID: 0001h
  - (AA 0E 00 00 01 00)
  - Image Data Package
  - 512 bytes, ID: 0001h
- **ACK**
  - Package ID: F0F0h
  - (AA 0E 00 00 F0 F0)
  - Last Image Data Package

1 FRAME
**Note:**

xx : Don't care  
yy : 01 or 03. Don't care in JPEG mode  
~~ : Image size returned by uCAM  
* : Due to a bug in the uCAM firmware, if the last package is the same size as the package size, then rather than send an ACK a reset command should be sent with the 'Special Reset' and 'Reset State machines only' options set. Note that you may need to pause for a couple of milliseconds before sending this reset, to ensure it is accepted.

### 5.5.2 Example: Preview Picture (80 x 60 resolution, 12bit colour, uncompressed/RAW preview picture)

**Note:**

xx : Don't care  
zz : 01, 03, 05 or 07. Don't care in RAW mode  
~~ : Image size returned by uCAM
6. Development and Support Tools

6.1 microUSB – USB to Serial Bridge

The micro-USB module is a USB to Serial bridge adaptor that provides a convenient physical link between the PC and any embedded serial device. A range of custom made micro-USB devices such as the uUSB-MB5 and the uUSB-CE5 are available from 4D Systems (must be purchased separately). The micro-USB module provides power and a serial interface (TTL levels) directly to the uCAM-TTL module that can be used with the demo software.

6.2 Embedded Display Modules

The following display modules, available from 4D Systems, are ideal for many embedded applications with the uCAM-TTL camera.

- **uOLED-96-G1(GFX):** 0.96", 96x64, 65K colour 4DGL Platform OLED module
- **uOLED-128-G1(GFX):** 1.5", 128x128, 65K colour 4DGL Platform OLED module
- **uOLED-160-G1(GFX):** 1.7", 160x128, 65K colour 4DGL Platform OLED module
6.3 Demo PC Software Tool

Demo software is available for Windows based PC systems to test the uCAM.

Following diagrams show how to connect the uCAM-TTL and uCAM-232 to a PC to use with the test software.
7. Specifications and Ratings

### Recommended Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>uCAM-232</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supply Voltage (VCC)</td>
<td></td>
<td>4.5</td>
<td>5.0</td>
<td>5.5</td>
<td>V</td>
</tr>
<tr>
<td>Input Voltage Range</td>
<td>RX pin</td>
<td>-25</td>
<td>--</td>
<td>25</td>
<td>V</td>
</tr>
<tr>
<td><strong>uCAM-TTL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supply Voltage (VCC)</td>
<td></td>
<td>3.0</td>
<td>3.3</td>
<td>3.6</td>
<td>V</td>
</tr>
<tr>
<td>Input Voltage Range</td>
<td>RX pin</td>
<td>GND</td>
<td>--</td>
<td>VCC</td>
<td>V</td>
</tr>
<tr>
<td><strong>uCAM-232, uCAM-TTL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operational Delay</td>
<td>After Synchronising</td>
<td>1000</td>
<td>2000</td>
<td>--</td>
<td>ms</td>
</tr>
<tr>
<td>Operating Ambient Temp.</td>
<td></td>
<td>-15</td>
<td>+70</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>RH 95% max.</td>
<td>-40</td>
<td>+85</td>
<td>°C</td>
<td></td>
</tr>
</tbody>
</table>

### Global Characteristics based on Operating Conditions

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>uCAM-232</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supply Current (ICC)</td>
<td>VCC = 5.0V</td>
<td>60</td>
<td>64</td>
<td>80</td>
<td>mA</td>
</tr>
<tr>
<td>Output Voltage Range</td>
<td>TX pin</td>
<td>-5.0</td>
<td>--</td>
<td>5.0</td>
<td>V</td>
</tr>
<tr>
<td><strong>uCAM-TTL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supply Current (ICC)</td>
<td>VCC = 3.3V</td>
<td>58</td>
<td>62</td>
<td>76</td>
<td>mA</td>
</tr>
<tr>
<td>Output Voltage Range</td>
<td>TX pin</td>
<td>GND</td>
<td>--</td>
<td>2.4</td>
<td>V</td>
</tr>
</tbody>
</table>

### Optical Characteristics

<table>
<thead>
<tr>
<th>Item</th>
<th>Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Image Sensor</td>
<td>1/4” OmniVision CMOS, 300K pixels</td>
</tr>
<tr>
<td>Pixel Size</td>
<td>5.6um x 5.6um</td>
</tr>
<tr>
<td>SNR</td>
<td>45dB</td>
</tr>
<tr>
<td>Dynamic Range</td>
<td>60dB</td>
</tr>
<tr>
<td>White Balance</td>
<td>Automatic</td>
</tr>
<tr>
<td>Exposure</td>
<td>Automatic, self regulating, 1/50(1/60) – 1/100,000(sec)</td>
</tr>
<tr>
<td>Lens viewing angle(3 options)</td>
<td>60 degrees, 90 degrees, 120 degrees</td>
</tr>
</tbody>
</table>

### Ordering Information

**Order Code:**
- uCAM-TTL (Shipped with 120 degree angle lens)
- uCAM-232 (Shipped with 120 degree angle lens)

**Package:** 150mm x 95mm (ZIF Bag dimensions).

**Note:** 60 degree and 90 degree lenses are provided on request.
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