

MI CCD library

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# Chapter 1

## MI CCD Linux driver

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Driver and associated documentation cannot be distributed without prior agreement from MI.

This is driver for MI CCD camera. You will need to link with libmiccd.a to get working binary, e.g. assuming libmiccd.a resides in /usr/local/lib, headers in /usr/local/include, and you are using cc for C compiler, link your code code.c with this library with:

```
cc -o code -I/usr/local/include code.c /usr/local/lib/libmiccd.a
```

With exception of miccd\_open all functions takes as the first parameter pointer to structure identifying camera. The return value is 0 for success, negative for system errno value, and positive for error reply from camera itself.

The library does not need any kernel driver - access to USB bus through /dev/bus/usb, available in all recent kernels, is enough.

### 1.1 Function list

All function are documented under [global function list](#). Following links to their definition in order you will use them in the code.

- [miccd\\_open\(\)](#)
- [miccd\\_open\\_firmware\\_reload\(\)](#)
- [miccd\\_info\(\)](#)
- [miccd\\_open\\_shutter\(\)](#)
- [miccd\\_close\\_shutter\(\)](#)
- [miccd\\_read\\_frame\(\)](#)
- [miccd\\_close\(\)](#)

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## Chapter 2

# Data Structure Index

### 2.1 Data Structures

Here are the data structures with brief descriptions:

<a href="#">camera_info_h_t</a>	. . . . .	7
<a href="#">camera_info_t</a>		
Camera information structure	. . . . .	7
<a href="#">camera_t</a>		
Camera support structure	. . . . .	8





## Chapter 3

# File Index

### 3.1 File List

Here is a list of all documented files with brief descriptions:

<a href="#">/home/petr/miccd/include/miccd.h</a>	
Prototypes for MI CCD library functions . . . . .	<a href="#">11</a>



## Chapter 4

# Data Structure Documentation

### 4.1 camera\_info\_h\_t Struct Reference

#### Data Fields

- uint32\_t [id](#)  
*camera unique identifier*
- uint8\_t [hwrevision](#)  
*camera hardware revision*
- uint8\_t **filters**
- uint16\_t **FIFOlines**
- uint16\_t [w](#)  
*chip width [pixels]*
- uint16\_t [h](#)  
*chip height [pixels]*
- uint16\_t [pw](#)  
*pixel width [nm]*
- uint16\_t [ph](#)  
*pixel height [nm]*
- char [description](#) [15]  
*camera description*
- char [serial](#) [15]  
*camera serial number*
- char [chip](#) [15]  
*camera chip identification*

The documentation for this struct was generated from the following file:

- /home/petr/miccd/include/[miccd.h](#)

### 4.2 camera\_info\_t Struct Reference

Camera information structure.

```
#include <miccd.h>
```

## Data Fields

- `uint32_t id`  
*camera unique identifier*
- `uint16_t hwrevision`  
*camera hardware revision*
- `uint16_t w`  
*chip width [pixels]*
- `uint16_t h`  
*chip height [pixels]*
- `uint16_t pw`  
*pixel width [nm]*
- `uint16_t ph`  
*pixel height [nm]*
- `char description [15]`  
*camera description, is not NULL terminated*
- `char serial [15]`  
*camera serial number, is not NULL terminated*
- `char chip [15]`  
*camera chip identification, is not NULL terminated*

### 4.2.1 Detailed Description

Camera information structure.

Contains fields retrieved from camera. Can be used to distinguish different cameras.

The documentation for this struct was generated from the following file:

- `/home/petr/miccd/include/miccd.h`

## 4.3 camera\_t Struct Reference

Camera support structure.

```
#include <miccd.h>
```

### Public Types

- `enum { NORMAL = 0, LOW, ULTRA_LOW }`  
*readout mode*

## Data Fields

- `int fd`  
*file descriptor of the camera*
- `uint8_t binx`  
*binning in x*
- `uint8_t biny`  
*binning in y*
- `uint16_t w`

- exposure width*
- uint16\_t [h](#)
- exposure height*
- enum camera\_t:: { ... } [mode](#)
- readout mode*
- [model\\_t](#) **model**

#### 4.3.1 Detailed Description

Camera support structure.

Holds various camera variables which cannot be retrieved from camera.

The documentation for this struct was generated from the following file:

- [/home/petr/miccd/include/miccd.h](#)



## Chapter 5

# File Documentation

### 5.1 /home/petr/miccd/include/miccd.h File Reference

Prototypes for MI CCD library functions.

#### Data Structures

- struct [camera\\_info\\_t](#)  
*Camera information structure.*
- struct [camera\\_info\\_h\\_t](#)
- struct [camera\\_t](#)  
*Camera support structure.*

#### Enumerations

- enum [model\\_t](#) {  
    **G10300, G10400, G10800, G11200,**  
    **G11400, G12000, G2, G3,**  
    **G3\_H, GX\_BI** }  
*Camera model.*

#### Functions

- int [miccd\\_open](#) (int32\_t id, [camera\\_t](#) \*camera)  
*Open connection to camera with given product ID.*
- int [miccd\\_open\\_firmware\\_reload](#) (int32\_t id, [camera\\_t](#) \*camera)  
*Similar to miccd\_open, just force the library to reload camera firmware.*
- int [miccd\\_close](#) ([camera\\_t](#) \*camera)  
*Close connection to camera.*
- int [miccd\\_info](#) ([camera\\_t](#) \*camera, [camera\\_info\\_t](#) \*info)  
*Retrieve camera information structure from camera.*
- int [miccd\\_info\\_h](#) ([camera\\_t](#) \*camera, [camera\\_info\\_h\\_t](#) \*info)  
*Retrieve camera information structure from camera.*
- int [miccd\\_g1\\_mode](#) ([camera\\_t](#) \*camera, int bit16, int lownoise)  
*Set G1 camera mode.*
- int [miccd\\_mode](#) ([camera\\_t](#) \*camera, uint8\_t mode)  
*Set camera mode.*

- int `miccd_clear` (`camera_t` \*camera)  
*Clear camera CCD.*
- int `miccd_hclear` (`camera_t` \*camera)  
*Clear horizontal register.*
- int `miccd_shift_to0` (`camera_t` \*camera)  
*Shifts rows till first imagine row.*
- int `miccd_shift` (`camera_t` \*camera)  
*Shift camera rows.*
- int `miccd_vshift_clear` (`camera_t` \*camera, uint16\_t v)  
*Shift camera rows.*
- int `miccd_hshift_clear` (`camera_t` \*camera, uint16\_t h)  
*Shift camera columns.*
- int `miccd_read_frame` (`camera_t` \*camera, uint8\_t hbinning, uint8\_t vbinning, uint16\_t x, uint16\_t y, uint16\_t w, uint16\_t h, char \*data)  
*Readout camera chip.*
- int `miccd_read_data` (`camera_t` \*camera, uint32\_t data\_size, char \*data, uint16\_t w, uint16\_t h)
- int `miccd_open_shutter` (`camera_t` \*camera)  
*Open camera shutter.*
- int `miccd_close_shutter` (`camera_t` \*camera)  
*Close camera shutter.*
- int32\_t `miccd_start_exposure` (`camera_t` \*camera, uint16\_t x, uint16\_t y, uint16\_t w, uint16\_t h, float exposure)  
*Start exposure.*
- int `miccd_abort_exposure` (`camera_t` \*camera)  
*Abort exposure on G1 camera.*
- int `miccd_filter` (`camera_t` \*camera, uint8\_t filter)  
*Change filter in camera filter wheel.*
- int `miccd_set_cooltemp` (`camera_t` \*camera, float temp)  
*Set camera cooling temperature.*
- int `miccd_chip_temperature` (`camera_t` \*camera, float \*temp)  
*Retrieve chip temperature.*
- int `miccd_environment_temperature` (`camera_t` \*camera, float \*temp)  
*Retrieve environmental (surrounding) temperature.*
- int `miccd_power_voltage` (`camera_t` \*camera, uint16\_t \*voltage)  
*Retrieve camera voltage.*
- int `miccd_gain` (`camera_t` \*camera, uint16\_t \*gain)  
*Retrieve camera gain.*
- int `miccd_fan` (`camera_t` \*camera, int8\_t fan)  
*Switch on/off camera fan.*
- int `miccd_read_eeprom` (`camera_t` \*camera, uint8\_t offset, uint8\_t size, void \*buf)  
*Read EEPROM data from the camera.*

### 5.1.1 Detailed Description

Prototypes for MI CCD library functions.

### 5.1.2 Function Documentation

#### 5.1.2.1 int miccd\_abort\_exposure ( camera\_t \* camera )

Abort exposure on G1 camera.



## Parameters

<i>camera</i>	camera structure filled in <a href="#">miccd_open()</a> call
---------------	--

## Returns

0 on success, negative error code on (-errno) on failure

**5.1.2.2 int miccd\_chip\_temperature ( camera\_t \* camera, float \* temp )**

Retrieve chip temperature.

## Parameters

<i>temp</i>	pointer to float to store chip temperature (in degrees C).
<i>camera</i>	camera structure filled in <a href="#">miccd_open()</a> call

## Returns

0 on success, negative error code on (-errno) on failure

**5.1.2.3 int miccd\_clear ( camera\_t \* camera )**

Clear camera CCD.

## Parameters

<i>camera</i>	camera structure filled in <a href="#">miccd_open()</a> call
---------------	--

## Returns

0 on success, negative error code on (-errno) on failure

**5.1.2.4 int miccd\_close ( camera\_t \* camera )**

Close connection to camera.

## Parameters

<i>camera</i>	camera structure filled in <a href="#">miccd_open()</a> call
---------------	--

## Returns

0 on success, negative error code on (-errno) on failure.

**5.1.2.5 int miccd\_close\_shutter ( camera\_t \* camera )**

Close camera shutter.

## Parameters

<i>camera</i>	camera structure filled in <a href="#">miccd_open()</a> call
---------------	--

## Returns

0 on success, negative error code on (-errno) on failure

5.1.2.6 `int miccd_environment_temperature ( camera_t * camera, float * temp )`

Retrieve environmental (surrounding) temperature.

## Parameters

<i>temp</i>	pointer to float to store environmental temperature (in degrees C).
<i>camera</i>	camera structure filled in <a href="#">miccd_open()</a> call

## Returns

0 on success, negative error code on (-errno) on failure

**5.1.2.7 int miccd\_fan ( camera\_t \* camera, int8\_t fan )**

Switch on/off camera fan.

## Parameters

<i>fan</i>	turn fan on/off (boolean)
<i>camera</i>	camera structure filled in <a href="#">miccd_open()</a> call

## Returns

0 on success, negative error code on (-errno) on failure

**5.1.2.8 int miccd\_filter ( camera\_t \* camera, uint8\_t filter )**

Change filter in camera filter wheel.

Change filter in camera filter wheel. Filters are counted from 0.

## Parameters

<i>filter</i>	filter number. Filters are counted from 0.
<i>camera</i>	camera structure filled in <a href="#">miccd_open()</a> call

## Returns

0 on success, negative error code on (-errno) on failure

**5.1.2.9 int miccd\_g1\_mode ( camera\_t \* camera, int bit16, int lownoise )**

Set G1 camera mode.

## Parameters

<i>camera</i>	camera structure filled in <a href="#">miccd_open()</a> call
<i>bit16</i>	if 16 bit readout should be enabled
<i>lownoise</i>	lownoise mode enabled

**5.1.2.10 int miccd\_gain ( camera\_t \* camera, uint16\_t \* gain )**

Retrieve camera gain.

## Parameters

<i>gain</i>	pointer to integer to store gain level
<i>camera</i>	camera structure filled in <a href="#">miccd_open()</a> call

**Returns**

0 on success, negative error code on (-errno) on failure

**5.1.2.11 int miccd\_hclear ( camera\_t \* camera )**

Clear horizontal register.

**Parameters**

<i>camera</i>	camera structure filled in <a href="#">miccd_open()</a> call
---------------	--

**Returns**

0 on success, negative error code on (-errno) on failure

**5.1.2.12 int miccd\_hshift\_clear ( camera\_t \* camera, uint16\_t h )**

Shift camera columns.

This is equal to serial shift - only serial register is shifted by given number of pixels.

**Parameters**

<i>camera</i>	camera structure filled in <a href="#">miccd_open()</a> call
<i>h</i>	number of pixels for serial shift

**Returns**

0 on success, negative error code on (-errno) on failure

**5.1.2.13 int miccd\_info ( camera\_t \* camera, camera\_info\_t \* info )**

Retrieve camera information structure from camera.

**Parameters**

<i>camera</i>	camera structure filled in <a href="#">miccd_open()</a> call
<i>info</i>	camera descriptor structure, filled on successfull return with camera data

**Returns**

0 on success, negative error code on (-errno) on failure

**5.1.2.14 int miccd\_info\_h ( camera\_t \* camera, camera\_info\_h\_t \* info )**

Retrieve camera information structure from camera.

Works only for G3 H and newer models.

**See also**

[miccd\\_info](#)

5.1.2.15 `int miccd_mode ( camera_t * camera, uint8_t mode )`

Set camera mode.

## Parameters

<i>camera</i>	camera structure filled in <a href="#">miccd_open()</a> call
<i>mode</i>	camera mode (0 - normal, 1 = low noise; 2 = ultra low noise; 2 is not available on G1)

## Returns

0 on success, negative error code on (-errno) on failure

5.1.2.16 `int miccd_open ( int32_t id, camera_t * camera )`

Open connection to camera with given product ID.

## Parameters

<i>id</i>	camera product ID. If set to 0, the first found camera will be connected. You can use <a href="#">miccd_info(camera,info)</a> call to retrieve its product ID
<i>camera</i>	camera support structure

## Returns

opened file descriptor for camera, negative error code on error. Error code is negative errno value.

## See also

[miccd\\_info\(camera,info\)](#)

5.1.2.17 `int miccd_open_firmware_reload ( int32_t id, camera_t * camera )`

Similar to [miccd\\_open](#), just force the library to reload camera firmware.

## Parameters

<i>id</i>	camera product ID. If set to 0, the first found camera will be connected. You can use <a href="#">miccd_info(camera,info)</a> call to retrieve its product ID
<i>camera</i>	camera support structure

## Returns

opened file descriptor for camera, negative error code on error. Error code is negative errno value.

## See also

[miccd\\_info\(camera,info\)](#)  
[miccd\\_open\(id,camera\)](#)

5.1.2.18 `int miccd_open_shutter ( camera_t * camera )`

Open camera shutter.

## Parameters

<i>camera</i>	camera structure filled in <a href="#">miccd_open()</a> call
---------------	--

**Returns**

0 on success, negative error code on (-errno) on failure

5.1.2.19 `int miccd_power_voltage ( camera_t * camera, uint16_t * voltage )`

Retrieve camera voltage.

**Parameters**

<i>voltage</i>	pointer to integer to store voltage level
<i>camera</i>	camera structure filled in <a href="#">miccd_open()</a> call

**Returns**

0 on success, negative error code on (-errno) on failure

5.1.2.20 `int miccd_read_eeprom ( camera_t * camera, uint8_t offset, uint8_t size, void * buf )`

Read EEPROM data from the camera.

**Parameters**

<i>offset</i>	read EEPROM from this offset
<i>size</i>	size of buffer to read
<i>camera</i>	camera structure filled in <a href="#">miccd_open()</a> call

**Returns**

0 on success, negative error code on (-errno) on failure

5.1.2.21 `int miccd_read_frame ( camera_t * camera, uint8_t hbinning, uint8_t vbinning, uint16_t x, uint16_t y, uint16_t w, uint16_t h, char * data )`

Readout camera chip.

Read data from camera and stored them in provided buffer. You can call this function anytime, but most probably you will prefer to call [miccd\\_open\\_shutter\(\)](#) and [miccd\\_close\\_shutter\(\)](#) before to accumulate some light on the camera.

**Parameters**

<i>camera</i>	<a href="#">camera_t</a> structure filled in <a href="#">miccd_open()</a> call
<i>hbinning</i>	frame horizontal binning
<i>vbinning</i>	frame vertical binning
<i>x</i>	ROI x start
<i>y</i>	ROI y start
<i>w</i>	ROI width
<i>h</i>	ROI height
<i>data</i>	pointer to buffer allocated to hold data. Must be large enough to hold all data from camera (e.g. at least $w/hbinning * h/vbinning * 2$ bytes).

**Returns**

0 on success, negative error code on (-errno) on failure

See also

[miccd\\_open\\_shutter](#)  
[miccd\\_close\\_shutter](#)

#### 5.1.2.22 int miccd\_set\_cooltemp ( camera\_t \* camera, float temp )

Set camera cooling temperature.

Parameters

<i>temp</i>	target cooling temperature in degrees C. Please consult camera documentation for details of its cooling capabilities.
<i>camera</i>	camera structure filled in <a href="#">miccd_open()</a> call

Returns

0 on success, negative error code on (-errno) on failure

#### 5.1.2.23 int miccd\_shift ( camera\_t \* camera )

Shift camera rows.

Parameters

<i>camera</i>	camera structure filled in <a href="#">miccd_open()</a> call
---------------	--

Returns

0 on success, negative error code on (-errno) on failure

#### 5.1.2.24 int miccd\_shift\_to0 ( camera\_t \* camera )

Shifts rows till first imagine row.

This jump over prescan region. After calling this function serial register holds first pixel of first non-prescan (image) row.

Parameters

<i>camera</i>	camera structure filled in <a href="#">miccd_open()</a> call
---------------	--

Returns

0 on success, negative error code on (-errno) on failure

#### 5.1.2.25 int32\_t miccd\_start\_exposure ( camera\_t \* camera, uint16\_t x, uint16\_t y, uint16\_t w, uint16\_t h, float exposure )

Start exposure.

Works only with G1 camera.

Parameters



<i>camera</i>	camera structure filled in <a href="#">miccd_open()</a> call
<i>exposure</i>	exposure length in seconds. If it is < 0, then the frame will be read out (no exposure will occurs). Start of the exposure should be triggered by call to miccd_clear.

**Returns**

0 on success, negative error code on (-errno) on failure

**See also**

[miccd\\_clear](#)

**5.1.2.26 int miccd\_vshift\_clear ( camera\_t \* camera, uint16\_t v )**

Shift camera rows.

This is equal to paraller shift - full rows of camera data are read out and discarded.

**Parameters**

<i>camera</i>	camera structure filled in <a href="#">miccd_open()</a> call
<i>v</i>	number of rows for paraller shift

**Returns**

0 on success, negative error code on (-errno) on failure



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