AR0144 sensormodules

All AR0144 sensormodules output 1280x800 RAW8 (monochrome): the free running ones at 30, 58 or 60 fps, the fsync (`fsin`, `combo`) ones at 30 fps only (see fsync frame rate). They all use the same sensor driver, `com.qti.sensor.ar0144.so`, and are installed in `/usr/lib/camera/` as `com.qti.sensormodule.<name>.bin`. Install only one sensormodule per camera slot. All names start with `ar0144_v2_`, which tells them apart from older `ar0144_*` sensormodules; don't install both for the same slot.

Which sensormodule to use

The name tells you how the camera is synchronized, which i2c address it has and which slot it is plugged into (`<slot>` is the camera slot number at the end of the name).

sensormodule	slots	sync	use it for
`ar0144_v2_<slot>`	0-5	free running	a single AR0144, or cameras that don't need to be synchronized
`ar0144_v2_fsin_<slot>`	0-5	external trigger (fsync)	several AR0144s capturing at the same time, e.g. stereo pairs or multi-camera VIO
`ar0144_v2_combo_<slot>`	0, 6	external trigger (fsync)	two AR0144s sharing one camera port (combo): slot 0 is the first camera, slot 6 the second
`ar0144_v2_combo_nosync_<slot>`	0, 6	free running	as `ar0144_v2_combo_<slot>`, without synchronization
`ar0144_v2_0x20_<slot>`, `ar0144_v2_fsin_0x20_<slot>`, `ar0144_v2_combo_0x20_<slot>`, `ar0144_v2_combo_nosync_0x20_<slot>`	as above	as above	same as the modules without `0x20`, for camera boards whose AR0144 is strapped to i2c address 0x20 instead of the default 0x30
`ar0144_v2_fsin_remap_<slot>`, `ar0144_v2_combo_remap_<slot>`	0-5 / 0, 6	external trigger (fsync)	two AR0144s with the same i2c address on one i2c bus. The kernel moves each sensor to its own address at startup (slots 0-3 and combo slot 0 to 0x32, slots 4, 5 and combo slot 6 to 0x22). This needs kernel support for address remapping.

Choosing between free running and fsync:

- **Free running**: each camera runs on its own clock. Frames of different cameras are not captured at the same time and drift relative to each other.
- **fsync (external trigger)**: every frame starts on a shared trigger pulse, so all triggered cameras start their exposure within a fraction of a millisecond of each other. The frame rate is set by the trigger. Use these modules whenever images from several cameras are processed together.

Timing

mode	sensormodules	pixel clock	row time	readout (800 rows)	frame period
30 fps	free running	74 MHz	20.11 us	16.09 ms	33.36 ms (29.98 fps)
30 fps	fsync	74 MHz	20.11 us	16.09 ms	set by trigger (33.33 ms at 30 Hz)
58 fps	free running	74 MHz	20.11 us	16.09 ms	17.23 ms (58.03 fps)
60 fps	free running	78 MHz	19.08 us	15.26 ms	16.67 ms (59.98 fps)

- The AR0144 has a global shutter: all rows are exposed at the same time, so there is no rolling shutter skew. The readout is the time it takes to read the 800 rows out after the exposure.
- The free running 60 fps mode runs the pixel clock at 78 MHz to reach a full 60 fps. That is above the 74.25 MHz maximum in the datasheet. To stay within spec use 58 fps or less: requests from 31 to 58 fps use the 74 MHz 58 fps mode (1.15 ms vertical blanking at 58 fps), requests for 59 or 60 fps use the overclocked 60 fps mode.
- Frame timestamps are the start of exposure.

fsync frame rate

Run the fsync sensormodules (`fsin`, `combo`, `remap`) with a 30 Hz trigger only. For more than 30 fps use the free running sensormodules.

The limit is the exposure time. In trigger mode the AR0144 starts the exposure on the trigger and reads the frame out after the exposure has ended; exposure and readout don't overlap (in free running mode they do). The sensor only accepts the next trigger once the previous frame is completely read out, so the trigger period has to be at least:

exposure + 16.09 ms readout + ~2.3 ms fixed overhead = exposure + ~18.4 ms

(measured on VOXL2). A trigger that arrives earlier is ignored: that frame is lost, and cameras with different exposures miss different triggers and go out of sync. The maximum exposure for each trigger rate is:

trigger rate	maximum exposure
30 Hz	~15 ms
50 Hz	~1.6 ms
~54 Hz	~0 (only with almost no exposure)
60 Hz	none, every other trigger is missed at any exposure

Only 30 Hz leaves enough exposure for normal (indoor) scenes, so the fsync sensor xml has only a 30 fps mode.