BCAM Head (A2038) Manual

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Description

The BCAM Head (A2038) is a Long-Wire Data Acquisition (LWDAQ) device used in one of our Version 2 BCAMs, also known as the 'Double-Ended BCAM'. The A2038 works with two A2040s to drive two TC255P image sensors and four laser diode light sources.

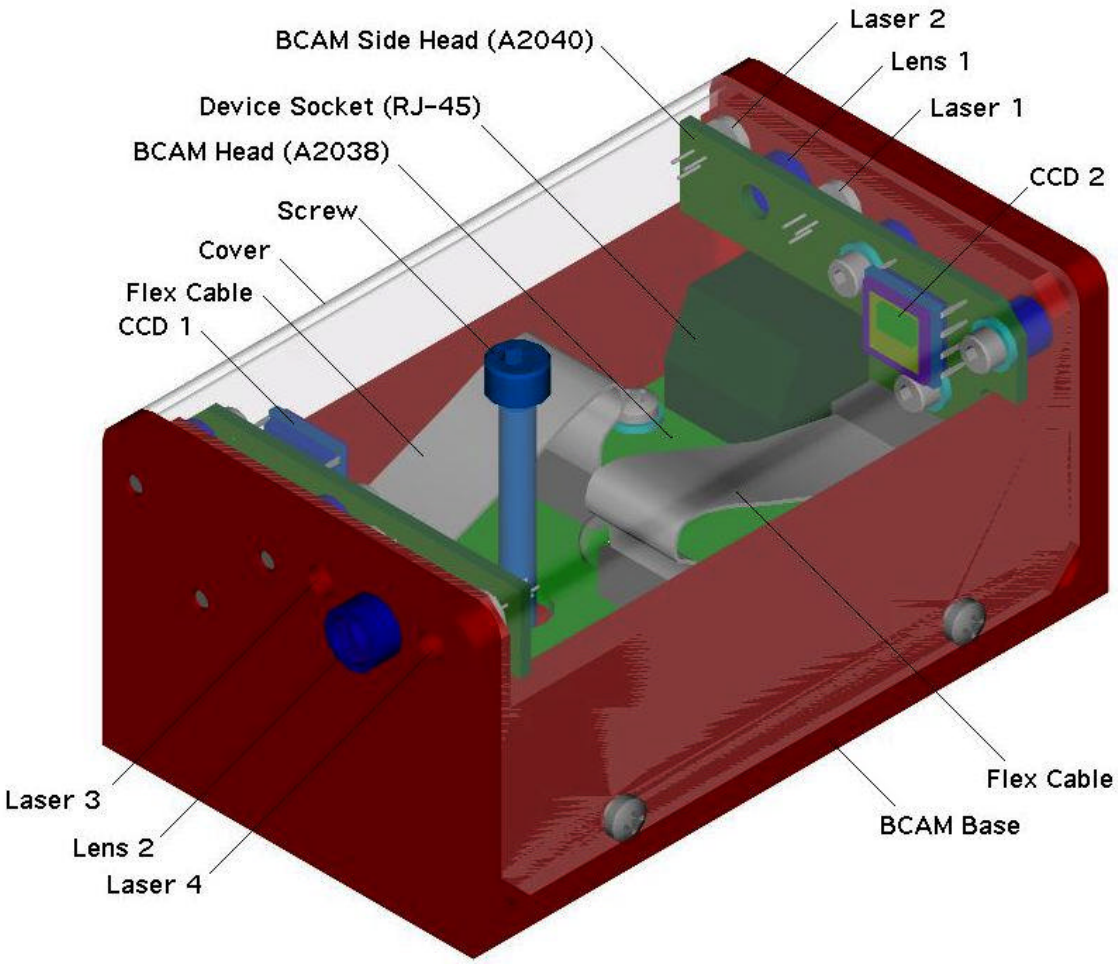

Figure 1: BCAM showing BCAM Head (A2038) and BCAM Side Heads (A2040).

The BCAM connects to a LWDAQ multiplexer or driver via a CAT-5 cable. The DAQ software selects a camera or laser diode in the BCAM with the device element number. On flash jobs, elements one to four select lasers one to four. On image retrieval jobs, elements one and two select cameras one and two.

Warning

Go to the ‘A2038A Design Errors’ for a list of problems with the first version of the A2038.

Device in Operation

When capturing images, the A2038’s power consumption is the same as that of an Inplane Sensor Head (A2036), and it acts in all respects like an A2036 except that you can switch between the two CCDs connected to the A2038 by writing a one or a two to its LWDAQ driver’s Device Element Register. Another difference between the two circuits is that the A2038 supports anti-blooming exposures.

When a CCD pixel fills up with light-induced charge, the charge will, unless something is done to stop it, flow into neighboring pixels and cause them to saturate as well. A bright spot in an image can turn into a large, bright disk. The spread of excess charge is called ‘blooming’. The TC255P image sensor provides an anti-blooming clock input that you can pulse during an exposure, and which gets rid of excess charge before it can spread into neighboring pixels. The anti-blooming process does, however, degrade the linearity of the pixel response, so we do not use it when we take BCAM images. Nevertheless, when we take diagnostic images of the field of view of the BCAM, with exposure times of a few hundred milliseconds, an anti-blooming exposure is useful, because it makes sure that bright reflective objects, or overhead lights, do not flood the image.

When flashing its lasers, the A2038’s power consumption is not the same as that of an Inplane Mask Head (A2034). The lasers get their power from a 100-uF capacitor on the A2038. The charge stored in this capacitor is sufficient to drive any one of the lasers for 20 ms, after which the capacitor is exhausted, and the laser will turn off almost completely. You can still see it shining dimly, but it will be transmitting less than 0.1% of its normal power. The capacitor charges up ten times less quickly than it discharges

through a single laser. If you flash a laser for 20 ms, you must allow 200 ms for the capacitor to charge up again.

We put two BCAMs 12 m apart and looked at a laser in one of them with the camera in the other. Our optimal exposure time was 4 ms. After a 1-ms flash, the capacitor needs 10 ms to charge up, which is less time than it takes to transfer the image out of the CCD. The capacitor charges from the –15 V supply, drawing at most 5 mA.

Specification

The A2038 is complies with the LWDAQ Specification.

Device Type: 2 (TC255P)
Device Elements: 1-4 for laser diodes 1-4, 1-2 for cameras 1-2
Command Bit Allocation: 1:DCEN (direct clock enable), 2:SRGI (serial register gate digital), 3:SAGD (storage area gate digital), 4:IAGD (image area gate digital), 5:ABGD (anti-blooming gate digital), 6:ABGEN (anti-blooming enable), 7:LB (loop-back), 8:WAKE, 9:CCD1 (select first sensor), 10-13:ON1-ON4 (select lasers 1 to 4).

Here is a diagram provided by Joe Rothberg (University of Washington), showing the names of the lasers and cameras (CCDs). Note that the CCDs and lasers share channel numbers. The driver knows that flash jobs are directed towards the light sources, and image retrieval jobs are directed towards the CCDs.

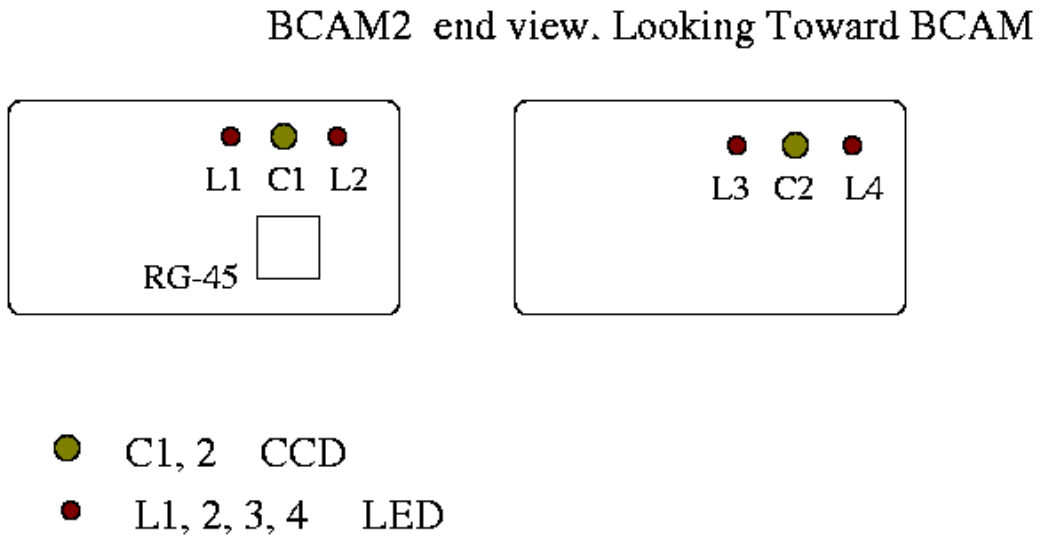

Figure 2: Names of the lasers and cameras/CCDs. (Thanks to Joe Rothberg for this diagram.)

Functions

The A2038 provides exposure of the TC255P with and without anti-blooming, and drives four light sources. When connected to a pair of A2040s, as shown in Figure 1, the A2038 drives four lasers and two TC255P CCDs.

Anti-blooming exposures are good for certain long-exposure diagnostic pictures, but they compromise the linearity of the pixel response. To expose the CCD with the anti-blooming disabled, execute the following sequence of driver jobs after specifying the device type (2) and the device element (1 or 2 to select camera 1 or 2): move_job (clears the CCD), wake_job (leaves the CCD to gather light), some kind of delay or a flash_job for the exposure time, alt_move_job (moves the image into the CCD's storage area), read_job (moves the image into the driver memory).

An anti-blooming exposure, on the other hand, requires the following sequence: move_job, toggle_job (toggles the CCD's anti-blooming gate for a specified period of time), alt_move_job, read_job. Note that the exposure is timed by the toggle_job, for which your software writes the exposure time to the driver. See the driver manual for details of how you would specify the exposure to the driver.

To flash one of the A2038 lasers, select the laser by writing its device element number to the driver, write the exposure time to the exposure timer on the driver, and execute a flash_job.

To measure the propagation delay of signals travelling from the driver to the A2038 and back again, you execute the loop_job and read the loop time out of the driver. The A2038 is asleep when it powers up, and goes to sleep when you execute a sleep_job.

How to Set Up the Device

Connect the A2038 one or two A2040s with two twelve-way flex connectors. Connect the A2038 to a Long-Wire driver or multiplexer with a CAT-5 eight-way, straight-through cable. You can use shielded or unshielded.

Once you are capturing images, you will need to adjust the exposure time until you get the image you want. If the exposure time is too long, the image will be white. If it is too short, it will be black. The black image from a working A2038 is, however, different from the black image from a broken A2038, or one that is not connected. Each driver introduces its own noise, but this will be less than the noise present in the black image from a working head.

A2038A Design Errors

The A2038A +5V sleep-state current consumption is 50 mA. The sleeping power consumption of the A2038A is around 250 mW, violating the LWDAQ specification by an order of magnitude. If you have several sleeping BCAMs attached to a single LWDAQ multiplexer, their +5 V current consumption generates a voltage drop in the cable joining the driver and the multiplexer (the root cable). The A2038A can operate with a +5 V supply as low as 3.5 V, but the CAT-5 conductor resistance can be as high as 1-Ohm per 10 m. With a 30-m root cable, four BCAMs can be connected to the multiplexer with confidence, and possibly up to six if your cable has lower resistance than the maximum specified for CAT-5.

When you send the A2038A to sleep, the capacitor that powers the lasers discharges. If you want to flash one of the lasers, you must wake up the A2038A at least 100 ms before you do so. Another feature of this design error is that, when you unplug the BCAM after it has been awake, or when you send it to sleep, all four lasers flash at the same time. Therefore, when you capture BCAM images, with one BCAM looking at another, you should wake both BCAMs up, wait for 100 ms, clear the CCD, flash the laser, read out the image, and only then send the two A2038A BCAMs to sleep.

Power Consumption

We picked an A2038B at random and measured its power consumption in three states. The A2038B was connected to two fully-populated BCAM Side Heads (A2040B).

State	+15 V	-15 V	+5 V	Total Power
Asleep	10 µA	10 µA	2.9 mA	14 mW
Awake (0 images/s)	37 mA	35 mA	3.2 mA	1.1 W
Awake (6 images/s)	38 mA	38 mA	3.4 mA	1.2 W
Flashing (10% duty)	36 mA	41 mA	3.4 mA	1.2 W

Table 1: Power consumption of the A2038B

Schematic

Contact us if you would like a copy of the schematic.