### kSA Tech Note – kSA BandiT Analog Output Configuration



#### How to configure kSA BandiT analog outputs

The kSA BandiT system supports various data acquisition boards for real-time analog voltage output. It can be custom configured for specific process control and/or data logging applications, including mapping the output channel(s) to the desired voltage range. This tech note describes the steps required to configure kSA BandiT for such an application. For more information see the kSA BandiT user manual.

1. From the Options menu, select Input/Output Devices...

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2. In the *Input/Output Device Options* dialog box, select the *Analog Output Board* tab. From the drop-down menu, select the model of the board present in your system. Most newer systems use the *ACCES IO USB-AIO12-16E 0-10V* board (12-bit resolution) that is referenced in this example. Note that older systems will likely have the *ACCES IO USB-AIO12-16E 0-5V* board (also 12 bit). For each of the desired output channels, verify that the *Voltage range* (0-10V in this case) and *Control channel* are set properly. Channel 0 is prewired to the bottom BNC connector labeled *TEMP OUT* on the back of the kSA BandiT rack and is typically used. Channel 1 is prewired to pins 3 (HI) and 4 (LO) of the *I/O INTERFACE* on the back of the rack (15 pin D connector).

input/Output [	Device Options						×		
Enviror	mental Alarm	Cha	amber Control	Det	Detector Motion Hardware				
Temper	ature Control Hard	lware	Rotation	Monitor	м	ultiAxis Stage			
Spectrometer	s Analog Input E	Board Anal	og Output Board	Digital Input	Digital Input Board Digital Output Board				
Board se Model:	ttings	ACCESS I	ACCESS IO USB-AIO12-16E 0-10V						
Base add	ress (decimal):	0	C-14						
Board nu	mber:	0	Cali	лаце					
- Channel r	nappings								
Board channel	Voltage range	Contro channe	ol Board el channel	Voltage range		Control channel			
0	0 to +10 🔹	Ch. 0	- 8		-	ch. 8	-		
1	0 to +10 🔹	Ch. 1	▼ 9		-	ch. 9	-		
2	T	Ch. 2	- 10		-	ch. 10	-		
3	-	Ch. 3	- 11		-	ch. 11	-		
4	-	Ch. 4	- 12		-	ch. 12	-		
5	-	Ch. 5	- 13		-	ch. 13	-		
6	-	Ch. 6	- 14		-	ch. 14	-		
7	-	Ch. 7	- 15		-	. 15 · · ·	-		
			ОК	Cancel	Apply	He	elp		

3. Next, select the *Calibrate* button to calibrate and/or test the output voltage(s). In the resulting dialog box, select the desired *Output Channel* from the drop-down menu. To calibrate, select



the *Calibrate* radio button. With a DVM connected to the appropriate output channel, adjust the slider to give a reading of precisely 0 volts. Note that the Up/Down arrow keys can be used to move the slider in increments of 4 counts, and the Page Up/Page Down keys can be used to move in increments of 96 counts. Select the *Use Current* button to accept the current value. Repeat this procedure for the maximum voltage (10V in this case). To test the calibration, select the *Test* radio button and move the slider while comparing the display value to the meter reading. Repeat the calibration procedure as needed. Select *OK* to close this dialog box.

Environ	mental Alarm	Chambe	r Control	Detector	Motion Hardware	USB AIO-1216 10 V
trometers	s Analog Input E	Board Analog Ou	utput Board	Digital Input Board	Digital Output Boa	G Step 1: Select Output Channel Output Control
Board set	tings		A 1012 1/5 0	101/		Channel 0  Calibrate
Base addr Board pur	ress (decimal):	0	Calibra	te	•	Step 2: Set 0 volt counts Enter the number of counts that produces exactly 0 volts: 0.000
Channel m	nappings					The Current's button.
Board channel	Voltage range	Control channel	Board channel	Voltage range	Control channel	Use Current
0	0 to +10 🔹	Ch. 0	- 8	•	Ch. 8 👻	Enter the number of counts that produces
1	0 to +10 🔻	Ch. 1	• 9	•	Ch. 9 💌	exactly voltage above or use the sldier in "Calibrate" mode to adjust the output then
2	-	Ch. 2	- 10	-	Ch. 10 👻	press the "Use Current" button.
3	-	Ch. 3	- 11		Ch. 11 👻	65507 Use Current
4	-	Ch. 4	- 12	-	Ch. 12 👻	Step 4: Test Output
5	~	Ch. 5	- 13	~	Ch. 13 👻	Using "Test" mode, adjust the output to a Counts: 69
6	~	Ch. 6	- 14	~	Ch. 14 👻	voltmeter.
7	~	Ch. 7	- 15	~	Ch. 15 👻	Step 5: Note Calibration Notes
						Make note of the calibration settings for use with this board, they are saved in the registry, not the board itself. Arrow Up/Dn move 10 mv.
						OK Cancel



Environ	mental Alarm	Chambe	er Control	Detector	Motion Hardware	USB AIO-1216 10 V	
Temper ctrometer:	ature Control Hard s Analog Input B	ware loard Analog O	Rotation Mo utput Board	onitor Digital Input Board	MultiAxis Stage Digital Output Boar	c Step 1: Select Output Channel	Output Control
Board set	tings	ACCESS TO US	P 41012 165 0	10/	-	Channel 0	<ul> <li>Calibrate</li> <li>Test</li> </ul>
Base add Board nur	ress (decimal): nber:	0	Calibra	ate	•	Step 2: Set 0 volt counts Enter the number of counts that produces exactly 0 volts, or use the sidier in "Calibrate" mode to adjust the output then press the	Volts: 10.000
Board channel	Voltage range	Control channel	Board channel	Voltage range	Control channel	69 Use Current	
0	0 to +10 🔻	Ch. 0	• 8	-	Ch. 8 👻	Enter the number of counts that produces	
1	0 to +10 🔻	Ch. 1	<b>▼</b> 9	-	Ch. 9 👻	exactly voltage above or use the sldier in "Calibrate" mode to adjust the output then	
2		Ch. 2	- 10	-	Ch. 10 👻	press the "Use Current" button.	
3	-	Ch. 3	- 11	-	Ch. 11 🔍	65507 Use Current	
4	-	Ch. 4	- 12	-	Ch. 12 🔻	Step 4: Test Output	
5	-	Ch. 5	- 13	-	Ch. 13 👻	Using "Test" mode, adjust the output to a	Country 65506
6	v	Ch. 6	- 14		Ch. 14 👻	desired voltage then verify the output with a voltmeter.	Counts: Costo
7		Ch. 7	- 15		Ch. 15 👻		
						Step 5: Note Calibration Make note of the calibration settings for use with this board, they are saved in the registry, not the board itself.	Notes Page Up/Dn move 96 counts. Arrow Up/Dn move 4 counts.
						ОК	ancel

- 4. Select **OK** to close the **Input/Output Device Options** dialog box.
- 5. From the *Acquire* menu, select *BandiT Temperature...*



6. In the *BandiT Temperature Acquisition* dialog box, select the *Advanced...* button.



[None]	Config
C	
Substrate material:	GaAs
Archive name:	blah blah
Ouration:	Hour Min Sec
🔘 Continuou	s (no data saved)
All availab	le data from source
Turn off Light So	urce at end of run
Measurem	nent Mode
🔘 Ba	ndEdge
O Py	rometry/Blackbody
🔘 Ba	ndEdge/Pyrometry/Blackbody
Contro	l Light Source based on mode

7. In the *Advanced Acquisition Options* dialog box, select the *Temperature Error Handling* tab. To determine the output voltage in the event of an error, select either *Leave Temperature Output* (analog) Stable or Set Temperature Output (analog) to OV.



Advanced Acquisition Optio	ns			X
Pyrometric Oscillations		I/O Settings	Data Bin	ining
General Prompts	Docun	nent Generation	Start/Stop	Trigger
Pause/Resume Trigger	r	Inputs	Dela	зу
Device Output Control		Temperatur	e Error Handli	ng
If Signal is below noise © Leave Temperatu © Set Temperatu	e floor o ature O.	r confidence is belo <u>itput (analog) Stabl</u> ut (analog) to 0V	w threshold:	
OK	C	ancel Ap	oly	Help

 Next, select the *Device Output Control* tab. Select the *Enable device output control* checkbox. Then select the *Edit output mappings...* button.

P	ause/Resume 1	Trigger		Delay				
Pyromet	tric Oscillations		I/O Settings	Data Binning				
General	Prompts	Docum	ent Generation	Start/Stop Trigge				
Device	Output Contro	al I	Temperature Error Handling					
✓ Enable	device output c	ontrol						
E	Edit output map	pings						

9. In the *Device Output Control Mappings* dialog box, enter the following settings for each output channel:



ce Output Control Mappings										
Output Device	Control channel	Parameter		Rect / line #	Para ra Low	ameter inge High	Volta outp Low	ge ut High	Boxcar smooth	Set to Mir at End
Analog Output Cont 👻	Ch. 0 🔻	Band Edge Temperature	•	0	0	1000	0	10	1 -	<b>V</b>
Analog Output Cont 👻	Ch. 1 🔻	Pyrometer Temperature	•	0	0	1000	0	10	1 -	<b>V</b>
[None]	-	[None]	-	0	0	0	0	0	1 -	
[None]		[None]	-	0	0	0	0	0	1 -	
[None]	-	[None]	-	0	0	0	0	0	1 -	
[None]		[None]	-	0	0	0	0	0	1 -	
[None]	-	[None]	-	0	0	0	0	0	1 -	
[None]	-	[None]	-	0	0	0	0	0	1 -	
								O	<	Cancel

- a) Select the desired output *Parameter* from the drop-down menu. Note that one can select from a variety of different parameters.
- b) Enter the desired *Parameter range* and corresponding *Voltage output* range.
- c) The *Boxcar smooth* drop-down menu allows for smoothing of the output using a moving average, a.k.a. boxcar. A setting of *N* results in each data point being averaged with the (*N*-1)/2 neighboring data points on either side. Note that *N* must be odd. The default value is 1, *i.e.* no smoothing.
- d) The *Set to Min at End* checkbox will force the output voltage to go to the minimum value (0V in this example) at the end of the acquisition.

Note that the data set drop-down menu applies only to the kSA BandiT Multi-Wafer application, in which each marker is assigned a separate data set. In that case, only the voltage(s) corresponding to the specified marker is output. For more information see the kSA BandiT user manual.

- 10. Select **OK** to close this dialog box, and once again to close the **Advanced Acquisition Options** dialog box.
- 11. Verify that the analog input device to which kSA BandiT is connected is configured for the correct voltage to temperature mapping



12. Note that there may be applications for which it is advantageous to customize the output mapping to achieve greater resolution. For example, consider the case of a 0-10V kSA BandiT output with 12-bit DAC resolution. In this case, the smallest voltage step that could be resolved is 10V/4096 = 2.4 mV. If one were to map a temperature in the 0-1000°C range to a 0-10V output, the scaling factor would be 10 mV/°C. Given the 2.4 mV resolution, the smallest temperature step that could be resolved in this case is 2.4 mV / (10mV/°C) = 0.24°C. If instead, one were to adjust the mapping such that the 0-10V output corresponds to 500-1000°C, the scaling factor would now be 20 mV/°C, meaning that the smallest temperature step that could be resolved at the expense of a reduced range. In some cases, this represents a good trade-off, as many users are primarily concerned with a relatively small range around the process temperature. Also note that if a higher maximum temperature is desired, one could simply shift the mapping, *e.g.* to 750-1250°C.

#### kSA BandiT Analog Output Mapping Tech Note — Mar 18, 2020

#### About k-Space Associates, Inc.

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