aeroqual

4. Perform span calibration (all modules except CO2 and O3)

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INTRODUCTION

Span calibration should only be performed on modules that've been successfully zero calibrated.

It is performed module by module, one at a time. Each gas module takes between 20 and 40 minutes to calibrate with span gas. Gains are applied using either the **Manual Entry** or the **Calibration** areas of the **Calibration and Service** app.

If you have an AQS 1, use this procedure to span calibrate your NO₂, CO and VOC gas modules. If you have an AQM 65, use it to span calibrate your NO₂, NOx, SO₂, CO, H₂S and VOC gas modules.

If your monitor uses the O_x/O_3 system to measure NO₂, you can also use this guide to span calibrate your Ox module. Note: For monitors using the O_x/O_3 system, you must <u>calibrate the Ox and</u> <u>O3 before any other modules</u>.

Gas modules must be span calibrated in a balance of air. N₂ can't be used.

We recommend you leave any failed modules running in the monitor throughout the zero and span calibration process. After you've calibrated the remaining modules, you can open the door to the monitor and remove the failed modules for inspection.

This procedure assumes you are familiar with how to operate the AirCal 1000.

To understand how often you should perform this service activity, click here.

There is no specific recommended span concentration for each gas module. The calibration engineer should choose a span gas concentration which best suits their calibration needs: Two possible approaches to choosing a span gas concentration are:

- 1. A span gas concentration can be chosen which best represents the concentrations expected at the measuring site.
- 2. A span gas concentration can be chosen which is at 80 % of the full measurement range of the module. This is an approach specified by some manufactures and is written in to the standard operating procedures of some municipal monitoring networks based on reference monitoring equipment.

For example: At your measurement location the range of CO concentrations measured are between 1 and 8 ppm with an average of 4 ppm. You might choose to calibrate the CO module at 5 ppm which in the middle of the expected measurement range and just above the average expected concentration. Or you might just calibrate the CO module at 20 ppm which is 80 % of the full range (0 to 25 ppm).

TOOLS:	DARTS:
 Adjustable spanner (1) 	 AirCal 1000 portable calibrator (1) Calgaz gas cylinders (1) Gas regulator (1)

Step 1 — Assumptions

	Table	8: Span	calibratic	on result	ts	-		T						
Orroaudit AQM65	Module	gain	a value	point	Reading after stabilization 10-minute average	larget span acceptable range (ppm) 10-minute average	Acceptable standard deviation during span calibration 10-minute average	gain	Minimum and maximum recommended gain (ppm)	value	Ratio of gain change	Gain uploaded	changed	Pass / fail
	NO2 (Or)	1.000				span ± 5 %	2 % of span	N/A			Reading after an (should be close	adjustment to 0.000)		
State - State	NO ₂ (direct)		N/A			span ± 5 %	2 % of span			N/A				
	NOx		N/A			span ± 5 %	2 % of span			N/A				
	Ox		N/A			span±5%	2 % of span			N/A				
	Oa		N/A			span ± 5 %	2 % of span			N/A				
	со		N/A			span ± 5 %	2 % of span			N/A				
	VOC		N/A			span ± 5 %	2 % of span			N/A				
	SO ₂		N/A			span ± 5 %	2 % of span			N/A				
	H ₂ S		N/A			span ± 5 %	2 % of span			N/A				
	CO2		N/A			span ± 5 %	2 % of span			N/A				
	Comme	nts												

- This guide assumes:
 - You've already done a zero calibration and the AirCal 1000 is warmed up and stable.
 - The AirCal 1000 is already connected to the gas inlet via a 3-way tee that is open (uncapped) on one side.
 - You've got the correct gas cylinders with gas concentrations that suit your calibration needs. For gas cylinder guidelines, <u>see here</u>.
- Start by recording the current gains for each gas module in the Current gain column in table 8 of the calibration form.

(i) If an Ox module is fitted, NO2 doesn't have a gain adjustment.

Step 2 — Connect cylinders



- Attach (screw on) a gas regulator on to each of your 2 gas cylinders.
- Connect the gas regulators to the gas inlet ports on the back of the AirCal 1000. Use 1/8 inch OD Teflon tubing to make this connection.
- Make sure the connections are leak tight.

NO ₂ (NO ₂) 1.000 V V span ± 5 % 2 % of span NA Image: Constraint of the state	Module	Current gain	Current a value	Span point	Reading after stabilization 10-minute average	Target span acceptable range (ppm) 10-minute average	Acceptable standard deviation during span calibration 10-minute average	New gain	Minimum and maximum recommended gain (ppm)	New a value	Ratio of gain change	Gain uploaded	Reading after gain changed	Pass fail
NOr (direct) NA Image: Span 1 5 % 2 % of span NA NA Image: Span 1 5 % 2 % of span NA Image: Span 1 5 % 2 % of span NA NA Image: Span 1 5 % 2 % of span NA NA Image: Span 1 5 % 2 % of span NA Image: Span 1 5 % 2 % of span NA Image: Span 1 5 % 2 % of span NA Image: Span 1 5 % 2 % of span NA Image: Span 1 5 % 2 % of span Image: Span 1 5 % NA Image: Span 1 5 %	NO2 (Ox)	1.000				span ± 5 %	2 % of span	N/A			Reading after (should be clo	an adjustment se to 0.000)		
NN NA Image: span s 5 % 2 % of span <th< td=""><td>NO₂ (direct)</td><td></td><td>N/A</td><td></td><td></td><td>span ± 5 %</td><td>2 % of span</td><td></td><td></td><td>N/A</td><td></td><td></td><td></td><td></td></th<>	NO ₂ (direct)		N/A			span ± 5 %	2 % of span			N/A				
O. NA Image: Span 15 % 2 % of span Image: Span 15 % 2 % of span Image: NA Image: Span 15 % 2 % of span Image: NA Image: Span 15 % 2 % of span Image: NA Image: Span 15 % 2 % of span Image: NA Image: Span 15 % 2 % of span Image: NA Image: Span 15 % 2 % of span Image: NA Image: Span 15 % 2 % of span Image: NA Image: Span 15 % 2 % of span Image: NA Image: Span 15 % 2 % of span Image: Span 15 % 2 % of span Image: NA Image: Span 15 % 2 % of span Image: Span 15 % 2 % of span Image: Span 15 % 2 % of span Image: Span 15 % 2 % of span 16 % Image: S	NOx		N/A			span ± 5 %	2 % of span			N/A				
OA NA Image: Span ± 5 % 2 % of span Image: Span ± 5 % 2 % of span Image: NA Image: Span ± 5 % 2 % of span Image: NA Image: Span ± 5 % 2 % of span Image: NA Image: Span ± 5 % 2 % of span Image: NA Image: Span ± 5 % 2 % of span Image: NA Image: NA Image: NA Image: Span ± 5 % 2 % of span Image: NA	Ox		N/A			span ± 5 %	2 % of span			N/A				
CO NA Image: Span ± 5 % 2 % of span Image: Span ± 5 % NA Image: Span ± 5 % 2 % of span Image: NA Image: Span ± 5 % 2 % of span Image: NA Image: Span ± 5 % 2 % of span Image: NA Image: Span ± 5 % 2 % of span Image: NA Image: NA Image: NA Image: Span ± 5 % 2 % of span Image: NA Image	O3		N/A			span ± 5 %	2 % of span			N/A				
VOC NA span ± 5 % 2 % of span NA SO2 NA span ± 5 % 2 % of span NA <td>со</td> <td></td> <td>N/A</td> <td></td> <td></td> <td>span ± 5 %</td> <td>2 % of span</td> <td></td> <td></td> <td>N/A</td> <td></td> <td></td> <td></td> <td></td>	со		N/A			span ± 5 %	2 % of span			N/A				
SO2 N/A span ± 5 % 2 % of span N/A	VOC		N/A			span ± 5 %	2 % of span			N/A				
	SO ₂		N/A			span ± 5 %	2 % of span			N/A				
H25 N/A span ± 5 % 2 % of span N/A	H ₂ S		N/A			span ± 5 %	2 % of span			N/A				
CO2 N/A span ± 5 % 2 % of span N/A N/A	CO2		N/A			span ± 5 %	2 % of span			N/A				

Step 3 — Record span point

- Start the calibration gas flowing at your chosen span point.
- Make sure there is excess flow out from the tee at the monitor inlet.
- Record your span gas concentrations in the Span point column.
- (i) You should have also defined this in your <u>calibration run</u>.

Step 4 — Determine stability

							Table	8: Span	calibratio	on resul	lts									
Real time measuren	nents CO	NO2	NOx	03	Last 10 reading	js PID	Module	Current gain	Current a value	Span point	Reading after stabilization 10-minute average	Target span acceptable range (ppm) 10-minute average	Acceptable standard deviation during span calibration 10-minute average	New gain	Minimum and maximum recommended gain (ppm)	New a value	Ratio of gain change	Gain uploaded	Reading after gain changed	Pass / fail
10:45 PM	0.180	ppm	ppm	ppm	ppm 0.002	ppm	NO2	1.000		-		soan + 5 %	2 % of snan	N/A		-	Reading after a	n adjustment		
10:43 PM	8 992	0.002	0.003	0.001	0.002	0.002	(O _x)	1.000				Span 2 0 re					(should be close	e to 0.000)		
10:43 PM	9.184	0.003	0.004	-0.001	0.000	0.001	(direct)		N/A	-		span ± 5 %	2 % of span	<u> </u>		N/A				
10:42 PM	9.018	0.001	0.003	-0.002	0.002	0.001	NOx		N/A			span ± 5 %	2 % of span			N/A				
10:41 PM	8.880	0.001	0.002	0.000	0.001	0.002	Ox		N/A			span ± 5 %	2 % of span			N/A				
10:40 PM	9.035	0.002	0.003	0.001	0.000	0.000	Oa		N/A			span ± 5 %	2 % of span			N/A				
10:39 PM	8.974	0.001	0.003	0.001	0.002	0.001	co		N/A			span ± 5 %	2 % of span			N/A				+
10:38 PM	8.796	0.003	0.003	0.000	0.001	-0.001	1100			-	-			<u> </u>	2					+
10:37 PM	9.084	0.002	0.002	0.001	0.001	0.000	VOC		N/A			span ± 5 %	2 % of span	<u> </u>		N/A				
10:36 PM	9.192	0.001	0.001	-0.001	0.000	0.000	SO ₂		N/A			span ± 5 %	2 % of span			N/A				
10:35 PM	8.850	0.001	0.002	0.000	0.001	0.000	H ₂ S		N/A			span ± 5 %	2 % of span			N/A				
Average	9.017	0.002	0.003	0.000	0.001	0.001	CO ₂		N/A			span ± 5 %	2 % of span			N/A				
Std Dev	0.137	0.001	0.001	0.001	0.001	0.001	Comme	ents							1		1		1	

- Wait 30 to 40 minutes for the module readings to stabilize towards span air.
- To determine if stabilization is successful:
 - Look at the standard deviation over a ten-minute period in the **Manual Entry** (shown) or **Calibration** areas of the **Calibration and Service** app.
 - See if they fall within the acceptable range listed in the **Acceptable standard deviation during span calibration** column of your calibration form.

Step 5 — Determine need for adjustment

Module	Current gain	Current a value	Span point	Reading after stabilization 10-minute average	Target span acceptable range (ppm) 10-minute average	Acceptable standard deviation during span calibration 10-minute average	New gain	Minimum and maximum recommended gain (ppm)	New a value	Ratio of gain change	Gain uploaded	Reading after gain changed	Pass / fail
NO2 (Ox)	1.000				span ± 5 %	2 % of span	N/A			Reading after a (should be closed	in adjustment ie to 0.000)		
NO2 (direct)		N/A			span ± 5 %	2 % of span			N/A				
NOx		N/A			span ± 5 %	2 % of span			N/A				
Ox		N/A			span ± 5 %	2 % of span			N/A				
O3		N/A			span ± 5 %	2 % of span			N/A				
со		N/A			span ± 5 %	2 % of span			N/A				
VOC		N/A			span ± 5 %	2 % of span			N/A				
SO2		N/A			span ± 5 %	2 % of span			N/A				
H2S		N/A			span ± 5 %	2 % of span			N/A				
CO2		N/A			span ± 5 %	2 % of span			N/A				

- Record the stabilized reading from the 10-minute average in the Reading after stabilization column.
- If the stabilized value is within the accepted range (see Target span acceptable range column), no gain adjustment is needed. Write pass in the Pass / fail column and move on to next module.
- If the stabilized value is outside the accepted range, you need to make a gain adjustment.

Step 6 — Manually calculate gain

	Table Module	8: Span gain	calibratio	Span point	Reading after stabilization 10-minute average	Target span acceptable range (ppm) 10-minute average	Acceptable standard deviation during span calibration 10-minute average	New gain	Minimum and maximum recommended gain (ppm)	New a value	Ratio of gain change	Gain uploaded	Reading after gain changed	Pass / fail
	NO2 (Ox)	1.000				span ± 5 %	2 % of span	N/A			Reading after an (should be close	adjustment to 0.000)		
	NO2 (direct)		N/A			span ± 5 %	2 % of span			N/A				_
	NOx		N/A			span ± 5 %	2 % of span			N/A				
New gain = current gain x (span concentration / gas reading)	Ox		N/A			span ± 5 %	2 % of span	_		N/A				
5 5 11 5 5	O3		N/A			span ± 5 %	2 % of span			N/A				
	co		N/A	_		span ± 5 %	2 % of span			N/A				
	VOC		N/A	-		span ± 5 %	2 % of span			N/A				
	SO ₂		N/A		-	span ± 5 %	2 % of span			N/A				
	H ₂ S		N/A			span ± 5 %	2 % of span			N/A				
	CO ₂		N/A			span ± 5 %	2 % of span			N/A				
	Comm	ents												

- If you're using the Manual Entry area to upload gain adjustments, you need to calculate your new gain using the equation shown.
- To make the calculation, you need to know the:
 - Current gain
 - Span gas concentration
 - Gas module reading
- Record the calculated gain in the **New gain** column.

Step 7 — Automatically calculate gain

					Table	8: Span	calibratio	on resul	ts			_						
12:30 12:40 art calibration run	12:50 Offset Gain	13:00	13:10	13:20	Module	Current gain	Current a value	Span point	Reading after stabilization 10-minute average	Target span acceptable range (ppm) 10-minute average	Acceptable standard deviation during span calibration 10-minute average	New gain	Minimum and maximum recommended gain (ppm)	New a value	Ratio of gain change	Gain uploaded	Reading after gain changed	Pass / fail
evious calibrations	Current gain New ga 1.000 1.001 Recommend	Apply New gai	n = current gain x spar reading	a concentration /	NO2 (Ox) NO2 (direct) NOx	1.000	N/A N/A			span ± 5 % span ± 5 % span ± 5 %	2 % of span 2 % of span 2 % of span	N/A		N/A N/A	Reading after a (should be clos	n adjustment e to 0.000)		
	Time	Current	Average	Std Dev	Ox Oa		N/A N/A			span ± 5 % span ± 5 %	2 % of span 2 % of span			N/A N/A				
	1:24:00 PM 1:23:00 PM	2.1	-0.3 -0.6	2.0	co		N/A			span ± 5 %	2 % of span			N/A				
	1:22:00 PM 1:21:00 PM	2.0	-0.8 -0.9	1.6	SO2		N/A			span ± 5 %	2 % of span			N/A				
	1:20:00 PM	-0.1	-0.9	1.4	H ₂ S CO ₂		N/A N/A			span ± 5 %	2 % of span 2 % of span			N/A N/A				
	1:18:00 PM	-0.9	-0.6	1.6	Comm	ents							84 - L					
	1:17:00 PM 1:16:00 PM	-3.2	-0.3	1.6														
	1:15:00 PM	-1.5	0.5	0.9														

- If you're using the **Calibration** area to upload gain adjustments, select the correct gas channel and click the **Recommend** button to calculate the gain for your selected gas.
- Record the calculated gain in the **New gain** column.
- To learn more about the functionality in the **Calibration** area, <u>go here</u>.

Step 8 — Apply gain adjustment

													C	alibratio	on parar	neters													
_															NO2			O3 raw	PM2.5 raw	PM2.5						\frown			
Table 8	: Span ca	libration res	sults											Gain	1.000	1.000	1.200	1.000	1.000	1,000	1.000	1.000	1.000						
Module	Gurrent gain	Durrent Spar a value poin	n Readin after stabilis	ation rang	rget span ceptable nge (ppm)	Acceptable standard deviation	New gain	Minimum and maximum recommended	New a value	Ratio of gain change	Gain uploaded	Reading Pa after gain fa changed	s/	Offset	-5.3	0.0	0.0	0.0	0.0	0.0	0.00	0.0	0.0		12:30 12:40	12:50	13:00	13:10	13:20
			10-min averag	ave	erage	during span calibration 10-minute		gain (ppm)	L					а	1.100		2.550									Offset Gain			
			_	_		average			-				_	b			1.870								art calibration run	Children Count			
(O ₁)	1.000		_	spa	an ± 5 %	2 % of span	NA	<u> </u>	_	(should be cic	ose to 0.000)						Saug cha	mana2	Cancel	Car	10					Lunco	New gain	ew gain = current gain x sp. irrent reading	in concentration /
(drect)		NIA	_	spa	an ± 5 %	2 % of span			NA				_				Save che	inges:	Cancer	50	C.				evious calibrations	1.000	1.001		
NO.		AlA	_	spa	an ± 5 %	2 % of span			NA				Re	eal time	measu	rements						La	st 10 rea	adings 🛩		Recommend	Apply		
Ox		AWA		spa	an ± 5 %	2 % of span			NA													011							
01		NA		spa	an ± 5 %	2 % of span			NA						ppb			ppb	PM2.5 raw µg/m ³	PM2.5 µg/m ³				Inlet		Time	C	rrent Average	Std Dev
00		A'A		spa	an ± 5 %	2 % of span			NA				1:5	57 p.m.	3.0	27.0	29.2	26.8	2.2	2.1	15.92	53.3	6.4	Sample		1:24:00 PM		2.1 -0.3	2.0
VOC		NIA		spa	an ± 5 %	2 % of span			NA				1-6	56 n m	3.4	27.6	29.0	26.6	2.0	1.8	16.02	53.6	6.6	Sample		1:23:00 PM		2.5 -0.6	1.8
SO2		NA		spa	an ± 6 %	2 % of span			NA				1.5	55 0 00	2.5	20.4	20.4	27.0	1.6	1.5	15.00	54.1	6.7	Cample		1:22:00 PM		2.0 -0.8	1.6
HaS		AIA		spa	an ± 5 %	2 % of span			NA				1	55 p.m.	5.5	20.4	29.4	27.0	1.0	1.5	13.90	J+.1	0.7	Sample		1:21:00 PM		0.8 -0.9	1.4
000		AN		spa	an 1.5%	2 % of span			NA				10	54 p.m.	3.5	28.6	29.8	21.3	1.3	1.2	15.89	54.0	6.6	Sample		1:20:00 PM		-0.1 -0.9	1.4
Comme	rts												1:5	53 p.m.	2.6	27.7	30.1	27.2	1.7	1.6	15.79	54.0	6.5	Sample		1:19:00 PM		-0.9 -0.8	1.5
													1:5	52 p.m.	3.1	26.9	29.1	26.7	1.7	1.6	15.73	53.7	6.3	Sample		1:18:00 PM		-2.3 -0.6	1.6
													1:5	51 p.m.	4.2	27.4	28.3	26.0	1.9	1.7	15.88	53.6	6.5	Sample		1:17:00 PM		-3.2 -0.3	1.6
													1:5	50 p.m.	4.4	28.3	28.7	26.3	1.6	1.5	15.92	54.0	6.6	Sample		1:16:00 PM		-2.7 0.1	1.3
													1:4	49 p.m.	3.6	27.9	29.2	26.8	1.6	1.5	15.90	53.8	6.5	Sample		1:15:00 PM		-1.5 0.5	0.9

- If the new gain is within the accepted range (see the Minimum and maximum recommended gain column), you can upload your new gain.
 - If you're using the **Manual Entry** area, click the appropriate cell, type in the new value and click **Save**.
 - If you're using the **Calibration** area, simply click the **Apply** button.

(i) It might take several minutes for the gain to be applied and to see the changed readings.

If the new gain is outside the accepted range, don't upload the gain. Write fail in the Pass / fail column and move on to next module.

Step 9 — Calculate ratio of gain change

	Table	8: Span (Current gain	calibratic	on resul Span point	ts Reading after stabilization 10-minute average	Target span acceptable range (ppm) 10-minute average	Acceptable standard devlation during span calibration 10-minute average	New gain	Minimum and maximum recommended gain (ppm)	New a value	Ratio of gain change	Gain uploaded	Reading after gain changed	Pass / fail
	NO2 (Ox)	1.000				span ± 5 %	2 % of span	N/A			Reading after a (should be clos	adjustment o 0.000)		
	NO ₂ (direct)		N/A			span ± 5 %	2 % of span			N/A				
	NOx		N/A			span ± 5 %	2 % of span			N/A				
Gain change ratio = new gain / current gain	Ox		N/A			span ± 5 %	2 % of span			N/A				
	Oa		N/A			span ± 5 %	2 % of span			N/A				
	со		N/A			span ± 5 %	2 % of span			N/A				
	VOC		N/A			span ± 5 %	2 % of span			N/A				
	SO ₂		N/A			span ± 5 %	2 % of span			N/A				
	H ₂ S		N/A			span ± 5 %	2 % of span			N/A				
	CO2		N/A			span ± 5 %	2 % of span			N/A				
	Comme	ents												

- Calculate and record the ratio of the gain change using the equation shown.
- Record the ratio in the **Ratio of gain change** column.

Module	Current gain	Current a value	Span point	Reading after stabilization 10-minute average	Target span acceptable range (ppm) 10-minute average	Acceptable standard deviation during span calibration 10-minute average	New gain	Minimum and maximum recommended gain (ppm)	New a value	Ratio of gain change	Gain uploaded	Reading after gain changed	Pass fail
NO2 (Ox)	1.000				span ± 5 %	2 % of span	N/A			Reading after a (should be clos	idjustment o 0.000)		
NO2 (direct)		N/A			span ± 5 %	2 % of span			N/A				
NOx		N/A			span ± 5 %	2 % of span			N/A				
Ox		N/A			span ± 5 %	2 % of span			N/A				
Oa		N/A			span ± 5 %	2 % of span			N/A				
со		N/A			span ± 5 %	2 % of span			N/A				
VOC		N/A			span ± 5 %	2 % of span			N/A				
502		N/A			span ± 5 %	2 % of span			N/A				
H2S		N/A			span ± 5 %	2 % of span			N/A				
002		N/A			span ± 5 %	2 % of span			N/A				

Step 10 — Record applied gain

- Record the offset you uploaded in the Gain uploaded column.
- Wait 2 or 3 minutes then record the current reading in the Reading after gain changed column.
- Confirm the reading is within acceptable limits. If yes, write pass in the Pass / fail column. If not, write fail.
- Move on to next module.

Step 11 — Purge gas lines



- Deliver zero air for 10 minutes to purge (clean) the gas lines.
- Move on to next module.

For further support, contact <u>Technical Support</u>.