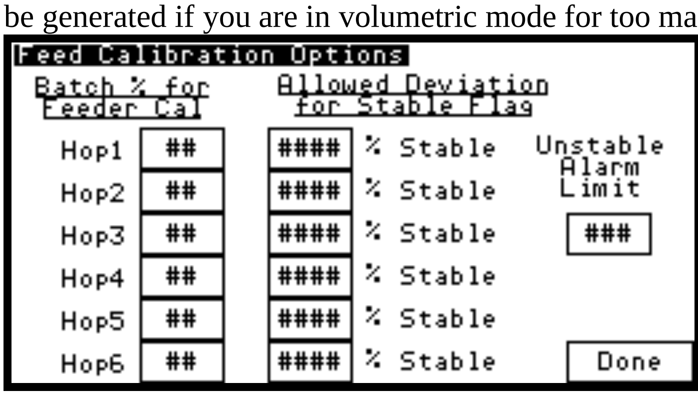
Allen Bradley BD Blender
Advanced Troubleshooting Guide

Written by Keith E. Packard May 14th, 2010

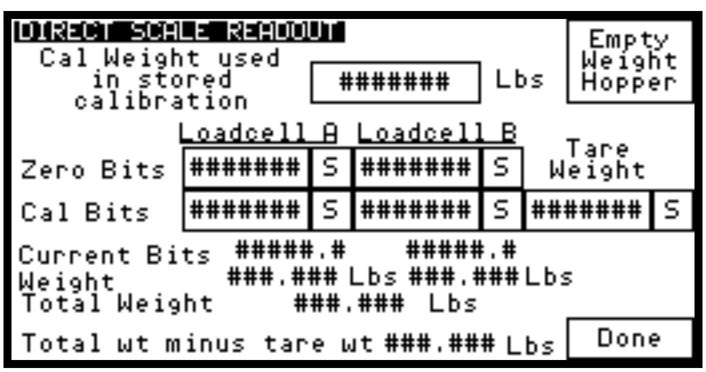
This document is to be used by both ACS service engineers and customer's maintenance technicians. It will help guide your through the troubleshooting process regarding loadcell weighing issues as well as metering gate failures. It will also address some other common problems found with equipment.

The weighing ability of a BD blender is absolutely the most critical part of the blender. Without an accurate weigh system the blender has no other measurement means of distinguishing how much material has been metered. When the loadcell circuit has either electrically or mechanically been damaged the result can be either misreported inventories or as severe as poorly letdown blends. All bets are off when the weigh blender's "weighing circuit" cannot accurately weigh. It is much similar to a car trying to maintain a set speed when the measurement from the speedometer is inaccurate. If the weigh circuit is off by a set amount, but consistent then you would not notice a problem with the blend, but would see the reported usage of the inventories erroneous. However, if the weigh circuit is constantly varying then you would expect the actual finished blend to vary. It is important to realize the what is shown on the screen is exactly what the blender thinks that it metered. That being said it may show that you are hitting your targets even when the finished blend ratios are very wrong (in the case of an inconsistent weight measurement). The blender would compensate for the changing measurement by erroneously putting more or less in. This effect can be reduced by tightening (lowering) the ALLOWED DEVIATION FOR STABLE FLAG on the FEEDER CALIBRATION OPTIONS page (touch ACS icon from the recipe page, enter "5413", then to to CALIBRATION/FEEDER CALIBRATION/CALIBRATION OPTIONS.) Setting these values too small will cause that particular feeder to be in volumetric mode all of the time. An alarm will be generated if you are in volumetric mode for too many cycles.



The loadcell technology that is used in the ACS Allen Bradley BD blenders allow the loadcell to accurately measure down to 0.001 lbs while maintaining the ability to filter out unwanted electrical and mechanical high frequency noise. Without this it would not be possible to accurately meter in low percentage additives.

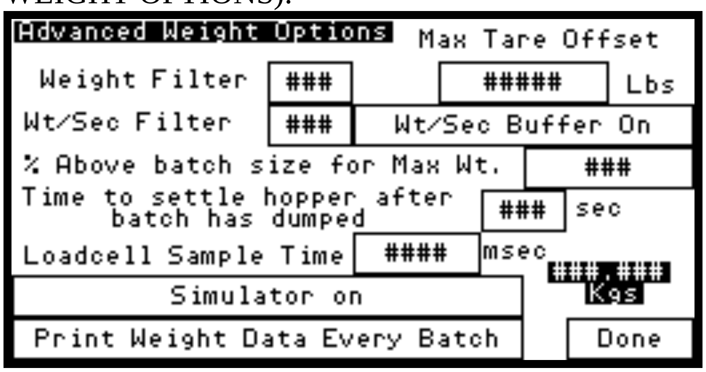
This is done by several means. The first part of this is handled by the conversion process in which the parallelogram Wheatstone bridge loadcell is converted from an analog millivolt device to an analog frequency device. This process is handled by the Calex conversion module. After converting the signal to a frequency the resulting frequency is analyzed for consistency using a proprietary software algorithm within the PLC itself. The result is that the loadcell's millivolt output is converted into "CURRENT BITS" which is displayed on the DIRECT SCALE READOUT page (touch the ACS icon from the recipe page, enter "5413", then touch CALIBRATION, and finally touch DIRECT SCALE READOUT.)   During a standard scale calibration these CURRENT BITS are recorded into the appropriate ZERO BITS (value recorded when nothing is on the loadcell), CAL BITS (value recorded when the calibration weight is hanging on the loadcell), and TARE WEIGHT (calculated value of weigh hopper itself after recording the ZERO and CAL BITS). These numbers are constantly being used in conjunction with the CURRENT BITS for each loadcell to calculate the CURRENT WEIGHT for each loadcell. It is not entirely pertinent to understand the calculation in order to determine loadcell problems. However, it is important to understand that this is where you begin whenever you suspect a problem. Comparing these recorded numbers to what they should be will quickly point out your real problem. You can either manually calculate what these values should be using this manual or use pre-recorded known "good" values for your comparison. It is most efficient to use the pre-recorded values for comparison to identify which loadcell circuit has the problem. However, this will not tell you if the problem is with the mechanics of the blender, the loadcell, or the Calex module without further troubleshooting. That is where this document comes in.



Loadcells that are used by ACS are resistive devices that upon excitation will resultantly put out a small electrical signal in the millivolt DC range. The excitation is a 10 VDC signal that comes from the Calex conversion module. For every volt of excitation the loadcell will generate 2mv/V DC at max load. For instance a 5 kg loadcell with a 5 kg weight placed on it would output 2*10=20mVDC. This is true for all of our loadcells. The excitation is always 10 VDC with a maximum output of 20mVDC for every size BD blender regardless of age, model, or serial number. This makes it very easy to test the loadcell. The loadcell bracket and bolts weigh .69 lbs on all models up to and including the BD-2500. The BD-4000 and BD-6000 have brackets that weigh .94 lbs. Using this you could use an electrical meter that can accurately measure at the millivolt DC range. By hanging a weight you can then measure the resulting mVDC output. It should be withing +/- 10% of what you expect it to be or your loadcell has a problem. Before changing the loadcell remove the loadcell cover and with the weight hanging on the loadcell bracket use a standard business card to run between the loadcell bracket and the loadcell. Do the same on the bottom loadcell bracket. The card should move freely without using any force except for precisely where the 2 bolts hold it on to the top and bottom bracket. If it is touching anywhere then you will need to determine why. Causes could range from an overstrained loadcell to a bent loadcell bracket. A quick fix to a bent bracket is to add standard washers between the loadcell and the bracket. If it is an overstrained loadcell it will show up when you retest after adding the washers. We will get into the actual calculations after further explanation.

The second part of the loadcell circuit involves checking the amplifier settings of the Calex conversion modules. The Calex 6255 is the current standard module used by ACS. This module has a built in amplifier, can handle up to 50 mVDC input while outputing up to a 10 kHZ signal. In the older units ACS used a Calex 8555. The 8555 did not have a built in amplifier and relied on an external amplifier designed by ACS (identified as a 1"x1" small board that wired below the Calex with 8 dip switches on it). The 8555 could handle 50mV as well, but only output 5 kHZ. The built in amplifier's gain of the 6255 is also different then the gain of the ACS designed amplifier. The 6255's built in amplifier can be accessed by using a small screw driver to apply pressure to the clear plastic front of the module and then pushing inward to release it from it's captive edge. Below you will find 8 dipswitches. **ONLY 2 DIPSWITCHES SHOULD EVER BE TURNED ON WHEN USING THE CALEX 6255 WITH BUILT IN AMPLIFIER** (results in a gain of x2). **YOU SHOULD NEVER USE AN CALEX 6255 WITH AN EXTERNAL ACS AMPLIFIER** (remove it and wire loadcell directly to the Calex 6255). This could happen if you had an original BD blender with the 8555 and ordered a replacement Calex module. Doing this will possibly damage or destroy the 6255. Also turning on to many switches on the 6255's built in amplifier can damage or destroy the module. **ONLY 1 DIPSWITCH SHOULD EVER BE TURNED ON WHEN USING THE CALEX 855 WITH EXTERNAL ACS AMPLIFIER**. If you are using the 8555 with external amplifier then you can essentially double your accuracy by ordering replacement 6255 units and removing the external amplifier.

Understanding the relational ratio of the Calex module's input to output is critical. The output value can be measured using a Fluke meter that has DC frequency capability such as the model 83. If you do not have a meter that measures frequency then you can rely on the BD blenders DIRECT SCALE READOUT for this. It is important to realize that prior to version 4.x the displayed CURRENT BITS for a loadcell actually was the frequency output by the Calex. For instance 3000.4 bits shown on the screen was 3000.4 Hz output by the Calex. Since 4.x software you have the ability to effectively dictate the sampling rate and filter values by modifying the LOADCELL SAMPLE RATE on the ADVANCED WEIGHT OPTIONS page (touch ACS icon from main recipe page and enter "5413", then touch the ACS icon again and enter "3145348" to gain access to the ACS ENGINEERING ONLY section where you will find ADVANCED WEIGHT OPTIONS).



If the sample time is set to 500 msec then the displayed CURRENT BITS is actually half the measured output from the Calex. These parameters are here to allow ACS to fit this blender control to a multitude of models past and present and should not be changed unless guided to by either the DEFAULT PARAMETERS SHEET or by the software developer. Modifying these values can cause catastrophic error in the actual measurement.

Loadcell Calculation Table using 4.9 SOFTWARE with CALEX 6255 MODULES

Blender	Load Cell Bracket (lbs.)	Load Cell Size (kg)	Target Zero Bits	Minimum Zero Bits	Maximum Zero Bits	Expected Milivolts
BD-500	0.69	3	428	385	471	2.1 ± 0.2
BD-900	0.69	5	257	231	283	1.28 ± .13
BD-2500	0.69	10	128	115	141	.64 ± .6
BD-4000	0.94	15	113	102	125	.57 ± .6
BD-6000	0.94	20	85	76	94	0.43 ± .4
Blender	**Calibration Weight (lbs.)**	**Load Cell Size (kg)**	**Target Cal Bits**	**Minimum Cal Bits**	**Maximum Cal Bits**	**Expected Milivolts**
BD-500	5	3	3458	3112	3805	17.3 ± 1.7
BD-900	8	5	3166	2849	3482	15.8 ± 1.6
BD-2500	15	10	2856	2570	3141	14.3 ± 1.4
BD-4000	30	15	3750	3375	4125	18.75 ± 1.9
BD-6000	30	20	2812	2531	3094	14.1 ± 1.4

THE ACTUAL CALCULATIONS

Now that we have a basic understanding of what each part does we can use this knowledge to definitively determine where the problem is.

The following example is given for reference using a BD-500 with 4.9 software and Calex 6255 Modules.

(LOADCELL SIZE IN KG) = 3 kg … this is printed on the loadcell itself
(LOADCELL SIZE IN LBS) = 3 * 2.2 = 6.6 lbs
(MAXIMUM OUTPUT OF LOADCELL) = 20 mVDC …this is always the case
(CAL WEIGHT IN LBS) = 5 lbs
(BRACKET WEIGHT IN LBS)= .69 lbs
(CALEX INPUT MAX) = 50 mVDC … this is always the case
(CALEX OUTPUT MAX) = 10,000 Hz …this is only 5 kHZ for the 8555 units
(AMP GAIN) = 2 …this is always the case if set correctly
(LOADCELL SAMPLE TIME) = 500 msec …this is parameter dependent (3.x software was 1000 msec

FIRST STEP…
CALCULATE EXPECTED MILLIVOLTS WITH CAL WEIGHT HANGING ON LOADCELL

Expected MV
= (MAXIMUM OUTPUT OF THE LOADCELL)*
(CAL WEIGHT IN LBS + BRACKET WEIGHT IN LBS) / (LOADCELL SIZE IN LBS)

= 20 * (5 + .69) / 6.6
= 17.24 mVDC +/- 10% = 1.7 mVDC allowed variance

SECOND STEP…
CALCULATE EXPECTED FREQUENCY OUTPUT BY CALEX MODULE

Expected HZ
= (CALEX OUTPUT MAX) *
(actual mVDC measured above * AMP GAIN) / (CALEX INPUT MAX)

= 10,000* (17.32 * 2) / (50) … notice that we didn't use "17.24", but used the
actual measured mVDC from the loadcell
= 6928 Hz

FINAL STEP…
CONVERT TO WHAT THE DISPLAY SHOULD BE SHOWING FOR CURRENT BITS

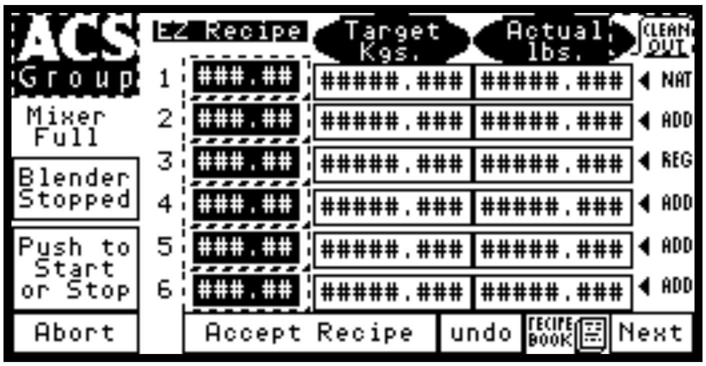
Displayed Current Bits
= (actual output frequency from Calex from above) *
(LOADCELL SAMPLE TIME) / (1000 mseconds in a second)

= 6928 * 500 / 1000
= 3464 bits displayed on screen

Using the previous shown example and a little common sense trouble shooting you should be able to definitively determine if your loadcells and Calex modules are good or bad. **If the Calex module is shown to be bad you should never attempt to adjust the ZERO or SPAN dials on the module to compensate, but should replace the failed units. Making adjustments to either the ZERO or SPAN dials on the Calex module can cause nonlinearity issues with the module. These dials are factory set by Calex and should not be modified by ACS or our customers.**

Weigh Hopper Isolation

There are several other things to look for after testing out the loadcells and Calex modules. The first and most important is the mechanical integrity of the blender. Using the manual clean out page (Accessed from the recipe page) verify that the weigh hopper and all feed hoppers open and close quickly and completely. Repeat this test several times for all devices. If you have intermittent failure then examine further to resolve this mechanical problem before proceeding.



Turn the power off to the blender and use appropriate lockout/safety measures before performing the next step. Once safe open the blender's front access door and examine the way that the weigh hopper sits on the brackets, it's mechanical clearance, and the attached airline. If you notice that the air cylinder for the weigh hopper is directly in front of you then you have found a major problem. The cylinder on all models is on the back side of the weigh hopper. If you can see it directly in front of you then it is installed backwards. This causes interference with the front door when closed and can cause inaccurate weighing (resulting in poor blend accuracy).

Next ensure that the weigh hopper sits squarely on all 4 corners and does not toggle on a bent tab. This causes the hopper to mechanically oscillate for lengthy times causing the initial weight snapshot to be incorrect resulting in the final metered amount to be different then displayed.

Ensure that the weigh hopper is not being pinched between the loadcell brackets, but is sitting freely with about 1/8"-1/4" of movement on each side. Pinching the weigh hopper causes the loadcells to be side loaded which results in drift of the loadcell signal.

Ensure that the weigh hopper does not touch anything in the back of the blender (behind the weigh hopper).

Ensure that the airline hangs freely without tugging on the weigh hopper, yet doesn't hang down hitting the mixer. If the blender is a BD-500 or BD-900 ensure that the airline is no larger than 5/32". Some older units were shipped with ¼" airline which can push as mush as 0.040 lbs erroneously on the weigh hopper resulting in high error in the lower letdown ingredients.

Weigh Hopper Dump and Mixer High Level Prox Testing

As mentioned in the last section it may be necessary to watch the blender run for several batches to catch a weigh hopper that is not dumping all of its material. If material is left in the weigh bin the blender will automatically tare out this amount and will begin making another batch. This does not necessarily cause a problem. However, if the second batch cannot fit into the weigh bin then a HOPPER OVER MAX ALARM will occur causing the blender to abort the current batch. This will dump an erroneous batch into the process that may not have any color.

Also if the Mixer High Level prox is not working properly then it can cause the blender to intermittently overfill the mix chamber. This prevents the weigh hopper from dumping its material properly and can even push upwards on the weigh hopper as the mixer turns. This will ultimately cause the same condition as above.

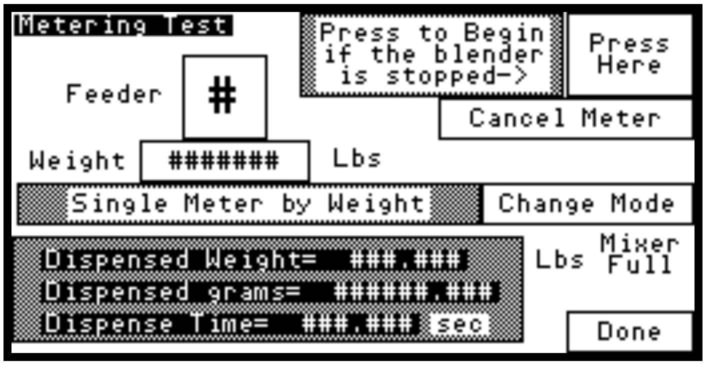
Hopper Metering Gate Failure

This is probably the most difficult item to determine without performing the appropriate testing. Typically a hopper's metering gate will not fail to the point of not opening, but instead may stick causing longer than normal mechanical cycles. This "sluggish" gate will result in overshooting. Many times overshooting is not noticed until an ingredient like "slip" or a foaming agent is introduced.

The speed of a gate is critical in being able to meter in accurately without overshooting as well as metering in very low percentages. The speed of the gate is a factor of several things: mechanical friction of the physical gate, air solenoid speed, and air quality/pressure. The higher the pressure the quicker the gate. However, setting pressures higher than 80 psi will cause the gate to mechanically fail before it's time and is not recommended.

The first test leaves a lot of room for interpretation, but can be important to an experienced technician. Doing this test when things are working well may help you understand what to expect. Have the operator drain the blender completely, remove the compressed air from the blender and lockout the electrical supply, then using the quick disconnect style fittings on each air cylinder remove both the black and white airlines. Upon reaching up inside the blender you should be able to easily slide back and forth the gate. At this point you should use a flashlight to inspect the guide rods for any galding. Replace any gates that either stick or are galded.

If the gates pass the visual inspection and manual test then you are ready to perform a METERING TEST. This test allows you to determine the smallest amount of material that a gate can dispense. If the smallest amount is 0.050 lbs then during a retry that will be the smallest amount it puts in. If you only needed to add .004 lbs and retried, then you can see you would overshoot by 0.046 lbs.



Always use SINGLE METER BY WEIGHT and a WEIGHT value of .001 Lbs (or Kgs). Touch "PRESS HERE" and it will do the rest. It first empties the weigh bin, then meters a single meter based on the hoppers mechanical parameters. After completion it will show you how much it actually dispensed. Repeat this test many times on a hopper to analyze the hopper. Using the MECHANICAL OPTIONS page you can lower the GATE CYCLE TIME until you achieve the smallest non-zero value for DISPENSED WEIGHT. If you set it too small you will get HOPPER X OUT OF MATERIAL alarms during normal operation even if there is material. This is caused by the hopper generating more than 10 retries in a meter. While lowering the GATE CYCLE TIME you will see at some point the DISPENSED WEIGHT does not lower. This is when you have went beyond the mechanical speed limitations of the gate/solenoid.

Hopper 3 is typically a square gate designed only for regrind. This large square edge will cause it to have the slowest gate speed. Second would be the major ingredients such as your virgin hoppers with the stroke limiter in the most outer position. The fastest performing gates would be the additive hoppers with the stroke limiters in the most inner position. If you find that a gate is not performing then swap the air solenoid with a different hopper temporarily by changing the airlines right at the solenoid and retesting. If it is still slow then re-inspect the gate for friction and replace.

VACUUM OR COMPRESSED AIR LOADERS

Sometimes all of the previously mentioned items check out. It is possible that the problem is with the vacuum receiver flapper or the compressed air loader. If either the flapper is not sealing or the air loaders filter is not venting enough air then you will be placing either positive or negative pressure in the supply hopper. This will either restrict or promote the flow of the material through the gate. This is very difficult to capture and is best tested by turning off the loading device and retesting the blend in the process. If the blender works correctly with the loader turned off then you will need to fix the loader's issue.

MECHANICAL LOW FREQUENCY VIBRATION

Although the blender can filter out high frequency mechanical and electrical noise it has a limit to the low frequency vibration that can occur before effecting the accuracy. In much the same manner as it would be impossible to accurately weigh yourself sitting on a scale in the back of a pickup truck driving down a bumpy road. Intermittent mechanical vibration will be ignored by the blender if the parameters are correctly set. However, continuous interference will result in poor accuracy and volumetric operation. If it is not possible to eliminate the mechanical vibration then it is best to mount the blender beside the machine and convey the blended material up to the process. Another alternative is to mezzanine mount the blender and let gravity feed the process.

FINAL NOTE ON DEFAULT PARAMETERS

In the back of the manual there is an Excel spreadsheet that shows the default parameters for each model blender we sell. This is how the blenders ship from the factory. Over the years we have made modifications to this chart. The most notably was that in earlier models we had a much shorter mix time. It is advised that you have at least a 10 second mix time. This will not affect the throughput of the blender as it takes more than 10 seconds for the blender to weigh and meter the batch. Setting this value too short will cause color to vary.

These parameters are a good start when manufacturing a blender. However, once the customer installs and runs the blender it is a good idea that they write down each “actual” parameter for the future event that it is erroneously modified by their personnel or in the event that the PLC needs to be replaced. Without these parameters they will be required to perform another startup as they did when they first received the blender.

If after recording the “actual” parameters you determine that the values are far from what they should be then it is advised to contact service to see if there is either a mechanical or electrical issue with the blender.

CONCLUSION

There are always circumstances that will not be covered in a document such as this. However, with proper use and understanding this document should make troubleshooting more clear and concise with less guesswork. I have used this process every time I've worked on batch blenders and have always been successful at resolving the problem. I hope you find this manual to assist you the same.