Notes re 2016 version Jain PCB and firmware

1. The valve may be adjusted according to a measurement of pressure or paddlewheel rotation OR the valve may be adjusted according to some percentage of travel derived from a table look up which is adjusted according to free spin rate.
2. The algorithm which relates percent valve open/close to desired volumetric flow rate currently resides at the Manager side. The free spin rate must be known in order to interpret the table. The table inherently incorporates knowledge of the nozzle type.
3. In a system *without* flow transducers, free spin rate must be known by the Manager and open-close / close-open times must be known by the Sprinkler.
4. We now recognize that the “opening valve dance” cannot take place until the pressure in the big pipe is stable.
5. At startup, the valve must close and we know not of where it was, so no useful info is obtained from the first closure.
6. The purpose of the opening valve dance is to determine:
   1. How long does it take to fully open?
   2. How long does it take to fully close?
   3. What is the free spin rate when fully open? Is it stable?
   4. What is the flow rate when fully open? Is it stable?
7. Note that if there is air in the line, the flow transducer does not accurately determine the flow rate.
8. In a system *without* flow transducers, therefore, the Manager must command the opening dance and the sprinkler then reports back either success or failure and if successful, the report includes the free spin rate – which then allows the Manager to determine % open/close.

Questions to be explored:

1. In that the valve motion can be moderated by means of PWM in this new design, we have a different read on the duration of time it takes to open and/or close the valve and the algorithm must be clear about how to measure/determine proper position by use of timing (open loop) or, in the case of flow-rate closed-loop control with a transducer in the system, proper setting.
   1. Consider a curve such as this below:
   2. We see a startup transient which is on the order of 1% of the entire closed\_2\_open duration. This limits our ability to set the valve to a low value, such as 2% with any accuracy.
   3. The shown use of PWM is important to avoid excess current transients, but could be AVOIDED in cases where there is NO flow sensing.
   4. If flow sensing is involved, the purpose of the use of PWM would be to avoid excessive battery drain during the controlled motion toward a flow rate target (overshoot / undershoot / critical damping, etc).
2. When should the “valve calibration” dance actually take place. We know it is not appropriate to assume that at startup we can just “do it.” Therefore, there must be some way in which the system can know that the pressure in the big pipe is stable. THIS IS A MANAGER FUNCTION of critical importance in systems without flow transducers. In systems ***with*** flow transducers, there is no need for the opening dance (other than maintenance or if we cannot achieve the desired flow.) Below are thoughts regarding systems ***without*** flow transducers. How can Manager know when to command the opening dance.....
   1. idea 1:
      1. When the center pivot initially “powers up” we must assume the manager is somehow aware of the time at which the tech turned on the CP pump.
      2. Given that awareness, we can force a valve cal onto all of the sprinklers after some duration of time has passed.
   2. idea 2:
      1. Blue box issues a command..... The blue box knows when the most recent startup message was received from the sprinkler. That is, the blue box knows approximately when any given sprinkler last restarted, and the blue box knows WHY that last sprinkler restart took place.
      2. If the operator wants to start watering the field, he will send commands to the various sprinklers with the prescriptive watering information. The manager will then be informed as to when the last valve cal took place. (Let’s assume that the sprinkler EEPROM has this info and can inform the manager)
      3. BUT the manager does not know if the pressure in the pipe is stable! The manager can open any valve fully and see if the spin rate is stable....
   3. idea 2: The sprinkler knows when it was last powered up, approximately, because it was either joined when the program restarted or soon thereafter. Thus there is a time tag which can indicate to the sprinkler firmware how long it’s been since restart.
      1. We could
3. Conclusion as of now (Jan 29 2016)
   1. add a manager command to “do the dance.” If the dance shows that the there is instability, be sure to note that in the LV program. Without a stable dance, MANAGER must refuse to begin the actual prescriptive watering process.
   2. Manager can already command a sprinkler (say the one at the very end of the pipe) to open its valve fully. And then Manager can repeatedly ask that particular sprinkler what is its free spin rate over some period of time. And then Manager can decide whether the pipe pressure is stable. (algorithm TBD).
   3. If the firmware sees a flow measurement transducer and is told to water at a given flow rate and the flow rate is unstable, the firmware must work toward control and shout out to the manager if the flow rate for some reason is not controllable, out of range, etc.
   4. If the firmware does not see a flow measurement transducer and is told to water at a given valve setting (time-based), the firmware will use the last know open-close or close-open time stored in EEPROM.
   5. The firmware also has stored in its EEPROM the last known free spin rate, which it can report to the manager.
   6. If either the o-c, c-o, or the free spin rate is out of range or inconsistent or stale (criteria??), then the firmware should force the dance.