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DACA II Review Task Force Conference Call Minutes
Wednesday June 16, 2021
9:00-10:30 AM Central

Minutes recorded by Patrick Lang
Direct any comments or corrections to: patrick.lang@swri.org

Membership:

The attendance list can be found as attachment # 1.

Agenda:

The proposed agenda can be found as attachment # 2.

Approval of Minutes:

Pat Lang advised that there were no requested changes or comments on the May 11, 2021 minutes. A motion was made by Lang and seconded by Al Lopez to approve the minutes. The motion passed unanimously.

The topic of discussion for this meeting was “System Time Response”.

David Doerr of Lubrizol provided a presentation on System Time Response. The presentation can be found as attachment # 3. This presentation was sent out a couple of weeks before the meeting so the task force members did have the opportunity to review prior to this meeting.

In summary David’s thoughts are:

1) It shouldn't matter what type of filter you are using as long as you meet the time constant requirements.
2) DACA II suggests that only 1st order low pass filters and moving averages are allowable filtering types.
3) Sometimes the system can include both types of filters and it is not always known what the exact type of filtering that is done in transducers and signal conditioners used in a complete system.
4) The document is unclear on what the percentage of the final value of a step change needs to be, i.e., 45%, 63%, 85%?
5) We need to keep things simple when we specify the requirements.

Discussions on David's presentation:

There was some discussion on the fact that some filters vs. others can produce different quality index (QI) results. Does a lower QI really matter to the test result? David asked if we really needed to worry about how the small differences that the different filtering rates yield in a QI if the QI is still good. Does this affect test results? Randy Harmon cautioned that a low QI can indicate poor control and different filtering can influence the QI assessment.

Bob Campbell stated that we just don't know how different levels of control can influence test performance. As a result, we should determine the upper and lower parameter limits that are used for QI assessment based on the performance of the precision matrix stands. We don't have the industry resources to quantify the influences that different levels of control may have on test results.

David Doerr mentioned that an oscillation around the setpoint will result in a bad QI and filtering can influence the resulting QI when a system is oscillating. However, filtering does not address an offset from the targeted setpoint.

Amol mentioned tuning a PID channel with noisy feedback will likely require some additional filtering. This type of filter is not addressed in the DACA II document. A time response check will assess the excursions since it is checking the whole system. John White advised that filtering on a control circuit is different than filtering on logged data that is used to generate the operational summary of a test. DACA II is addressing the filtering on logged data.

David stated that a thermocouple sheath is a first order low pass filter so it is hard to characterize the exact filter type when the thermocouple is part of the total system and is not an electronic filter. Amol commented that the thermocouple type and size are spelled out in the procedure so all labs should have the "filter" influence from the thermocouple when checking a temperature time response.

SwRI Presentation:

John White of SwRI presented his comments on system time response. John's presentation can be found as attachment # 4.

John's presentation started out with showing the filtering effects of both a low pass and moving average-type filter on a simple data set and how both of these filters meet 85% criteria but do yield different QI values. He further described the effects of the two filtering types on a square wave (high frequency) input. The plots demonstrated that all filtering will give you a phase shift.

Discussion:

David commented that all filtering will approach some stable value. Higher order filters will attenuate quicker at higher frequencies.

Randy Harmon stated that in his interpretation the DACA II document doesn't prohibit the use of other filter types, i.e., higher order filters are not prohibited. Dave's interpretation is that it is explicit in that only 1st order low pass and moving average filters are allowable.

John White cautioned that we need to be careful that we do not leave the door open to creative filtering if we are not explicit. Amol stated that he has had to come up with some non-standard filter to handle some of the limits of the older system that he has in his lab. He is not looking to mask any "bad" data, just apply different filtering techniques as needed. David stated that this is a good example of why we don't want to limit the filter type. Bob Campbell commented that we shouldn't be worried about people cheating and that there is a certain level of integrity that is required with standardized testing and we don't need to waste industry resources policing it.

John also feels that when measuring time response, the resolution of the time measurements has to be the same as the logging frequency. No interpolation should be used in the determination of the time constant.

After reviewing both presentations the group was in agreement to not specify a filtering type in the next version of the DACA document. Additionally, a straw poll of the labs on the call agreed that 63% of a step change for the system time response determination is what labs have been adhering to. As a result, the group agrees that it was in order to remove references to the other percentages in the DACA document.

Regarding the actual procedure that is used to determine the time constants in terms of the process used to induce a step change, Pat Lang advised the he located an older document on the TMC website outlining some guideline on how to do it.

Action Item #1:

Pat Lang send out document from TMC website entitled "System Time Response Measurement Guidelines" from 1998 (see attachment #5).

Action Item #2:

Pat Lang will get a MS Word version of the current DACA II document and start marking it up with some of the changes that were decided during this call. Appendix A is likely to see the most changes.

Next meeting Topic:

Pat Lang recommended that for the next meeting we start with a review of the marked up document as identified in action item #2 above and continue discussions on system time response.

Adjournment:

The meeting was adjourned at 10:30 AM CDT.

Next meeting at the call of the chairman with a tentative date of July 21, 2021 at 10:30 EDT.

Attachment #1

Attendance List

Attendance List for DACA II Document Review Task Force

Name	Company	Present 6-16-21 X= present
Amol Savant	Valvoline	x
Al Lopez	Intertek	x
Bill Buscher		x
Andrew Stevens	Lubrizol	x
George Szappanos		x
David Doerr		x
Jim Matasic		
Randy Harmon	Southwest	x
John White		x
Ron Barthold		x
Khaled Rais		x
Bob Warden		x
Mike Lochte		
Ankit Chaudhry		x
Tom Wirries		x
Chris DesRuieeeau		x
Bob Campbell	Afton	x
Tim Cushing	General Motors	x
Jim Gutzwiller	Infineum	x
Andy Ritchie		x
Michael Tucker	Exxon Mobil	x
Rohit Rao		x
Jason Griffin		x
Robert Stockwell	Oronite	x
Jeff Clark	Test Monitoring Center	
Rich Grundza		
Sean Moyer		x

Attachment #2

Agenda

AGENDA

Data Acquisition and Control Automation II (DACA II) Review Task Force
Virtual Meeting (WebEx)

Patrick Lang – Acting Chairman

Wednesday June 16, 2021– 9:00 AM to 10:30 AM (CDT)

1. Attendance

2. Review of the minutes from the 5-11-21 conference call, distributed on 5-27-21by email from chairman.

3. Review Topic: System Time Response

    3.1. Review LZ presentation
    3.2. Review SwRI presentation
    3.3. Further discussion

4. Determine topic for next meeting

5. New Business

6. Next Meeting: Tentatively Wednesday July 21, 2021 at 10:00 to 11:30 EDT; chairman to send out calendar invite.

7. Adjournment

Attachment # 3

DACA Filtering, Lubrizol Presentation

Lubrizol

DACA II/III System Response Time

Dave Doerr, 5/20/2021

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DACA II's System Response Time

- DACA II is only interested in ensuring that response times are adequately fast so as not to *excessively* improve QI numbers. It shows no desire to measure response precisely or characterize it completely (as it should not).
- DACA II discusses two filter types (as if many others don't exist) and felt the need to differentiate between them:
    - Moving average
    - First order low pass
- DACA II's Appendix A, *TMC Verification of System Filter Characteristics,* is written in a confusing manner due in part to extraneous detail.
- Though it's very unclear, DACA II seems to offer two choices for auditing response time that test developers can chose from and then specify in their test procedure:
    - Method 1 – Use 45% for moving average and 63% for low pass
    - Method 2 – Use 85% for both (response times audited by this method are longer for the same result)

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DACA II's System Response Time

Example from GMOD procedure:

- 3.2.9.2.2: *For first order systems, use the time to 63.2% of the imposed step change; for moving average systems use the time to 45.4% of the imposed step change.*

Table A8: Maximum System Time Response

Parameter	Seconds
Speed	0.10
Torque	0.60
Flow	8.0
Intake Air Pressure	0.75
Exhaust Back Pressure	1.20
Temperatures	2.40

Lubrizol

DACA II's "Two Filter Types"

The moving average filter has a linear response to a step change.

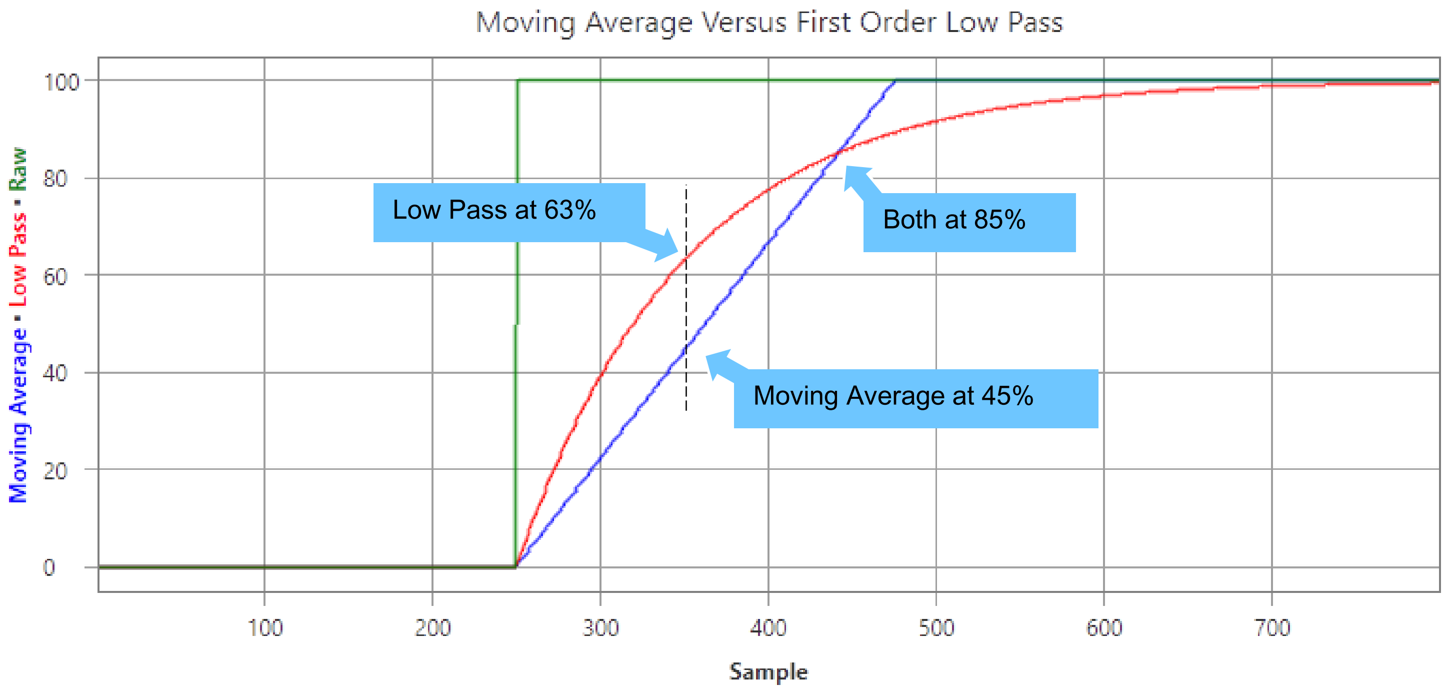
- The count (number of samples averaged) of the filter shown is 222 (100/0.45) samples.

The 1st order low pass filter has an exponential response to a step change.

- The time constant (time to reach 63%) of the filter shown is 100 samples.

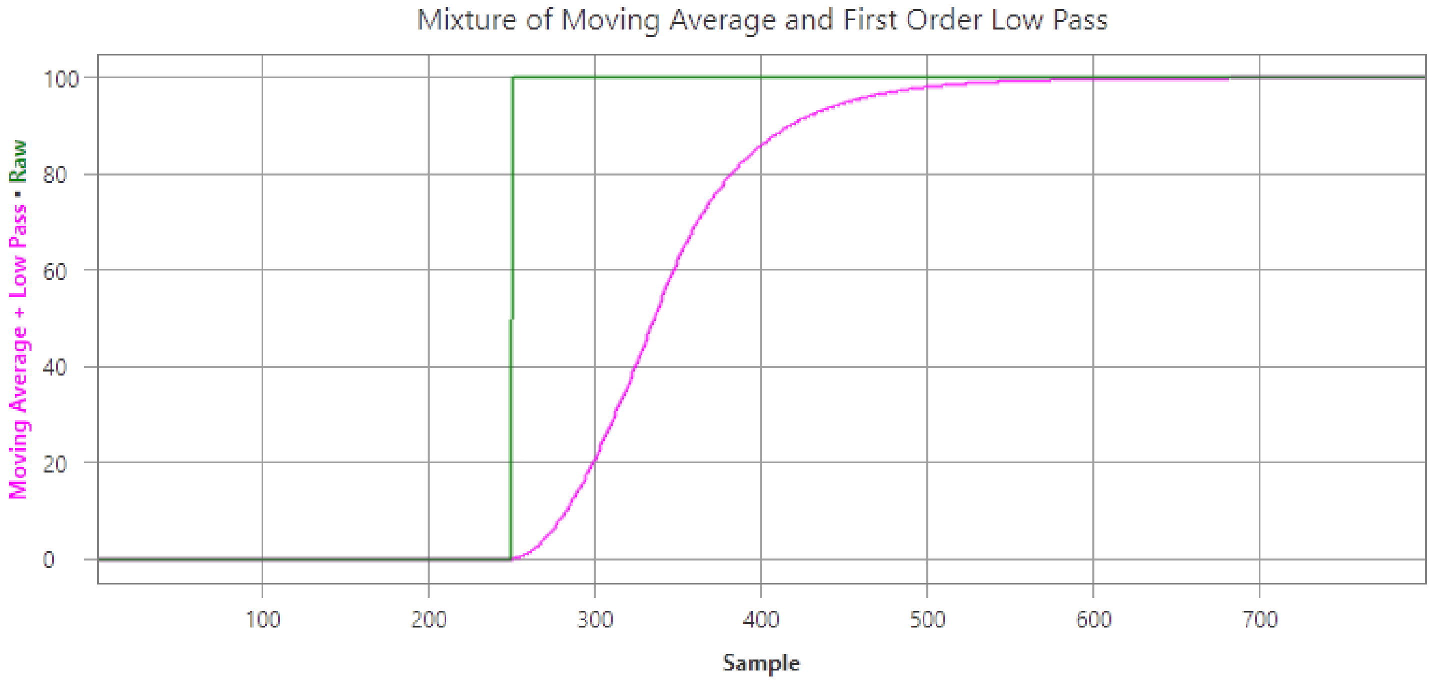
DACA II says the two filter types will "produce ***roughly equivalent*** smoothing of data" ***if***

- 1) Moving average reaches 45% at same time as low pass reaches 63%, or
- 2) Both reach 85% at the same time



DACA II's "Two Filter Types"

- DACA II doesn't consider that systems using moving average filtering *necessarily* combine moving average and low pass filtering.
- For example, the thermal mass in a TC responds to changes in temperature as a *mechanical low pass filter*. When a moving average filter is then applied by downstream software, the final measurement has been filtered by a ***mixture*** of the two. Note how the "S" shape differs markedly from the shape of the two contributing filters.



Real-world mixing of moving average and low-pass filters creates a blend of characteristics, i.e., a *different* filter

DACA II's "Two Filter Types"

- Most filters found in nature and in analog electronics are first order low pass characterized by time to 63%.
- Use of inexpensive embedded processors opens the door to many types of filters: Gaussian, Blackman, multiple passes of moving average, multiple passes of low pass, higher order low pass, countless more, and countless mixtures.
- Labs may not know the type of filtering that manufacturers have integrated into their transducers and signal conditioners using analog and digital techniques.
- DACA II says, "only first order low pass or moving average filters shall be used." For the reasons given above, this is no longer a practical recommendation.

Recommendations

- **DACA III should not attempt to allow certain types of filters and exclude others.**
  - This is neither practical nor reasonable. Filters of many types, often unknown to the user, exist inside transducers, signal conditioners, and other components. Even A/D chips (analog to digital converters) employ methods for over-sampling and averaging.
- **DACA III should not attempt to differentiate between filter types because, 1) there are too many, and 2) multiple types are usually combined within the same system.**
  - It just isn't practical to customize an audit method for each possible filter and filter combination.
  - We must simply accept that two systems that audit alike may not provide the same level of smoothing. (How bad is that anyway?)
- **DACA III should recommend response time audits to measure time to [some standard]% of step change regardless of filter type.**
  - It appears that this was the thinking behind DACA II's 85% method, but it wasn't made very clear. (Which, if any, test procedures specify the 85% method?)
  - 63% is good choice because it is commonly used and understood.
  - Based on the work of DACA II, 54% (average of 45 and 63) might be a better choice. Existing specifications based on the 45%/63% method could probably remain unchanged. DACA III could recommend a multiplication factor for converting existing specifications that are based the 85% method.

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Attachment # 4

DACA Filtering, SwRI Presentation

DACA II/III System Response Time

SOUTHWEST RESEARCH INSTITUTE®

Prepared By: John White, Randy Harmon, Ron Barthold

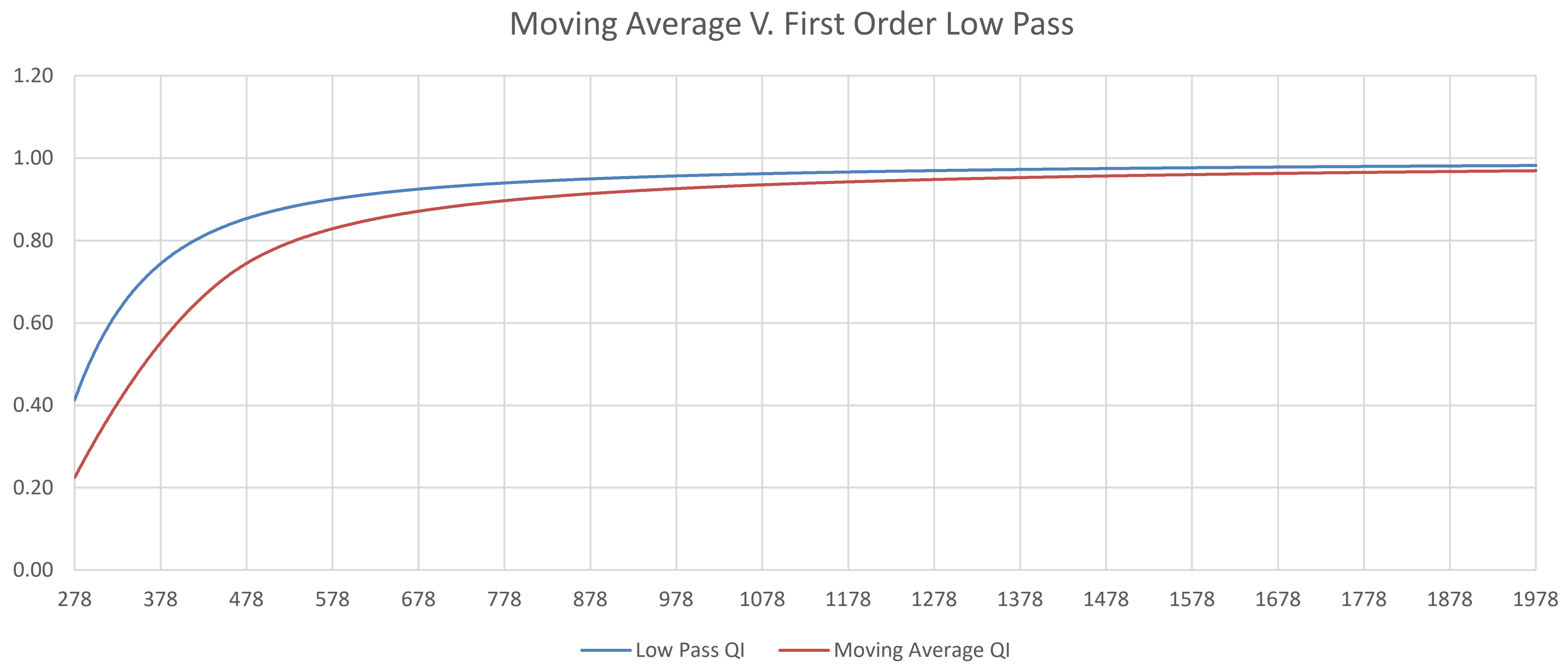
June 2021

DACA II Filter Types

- Low pass filter using a 1 kHz sample rate and a filter time of .1s
- 220 Sample moving average filter
- These satisfy the 85% "roughly equivalent" DACA II definition.
- Low pass is more sensitive to small shifts but takes longer to reach final value

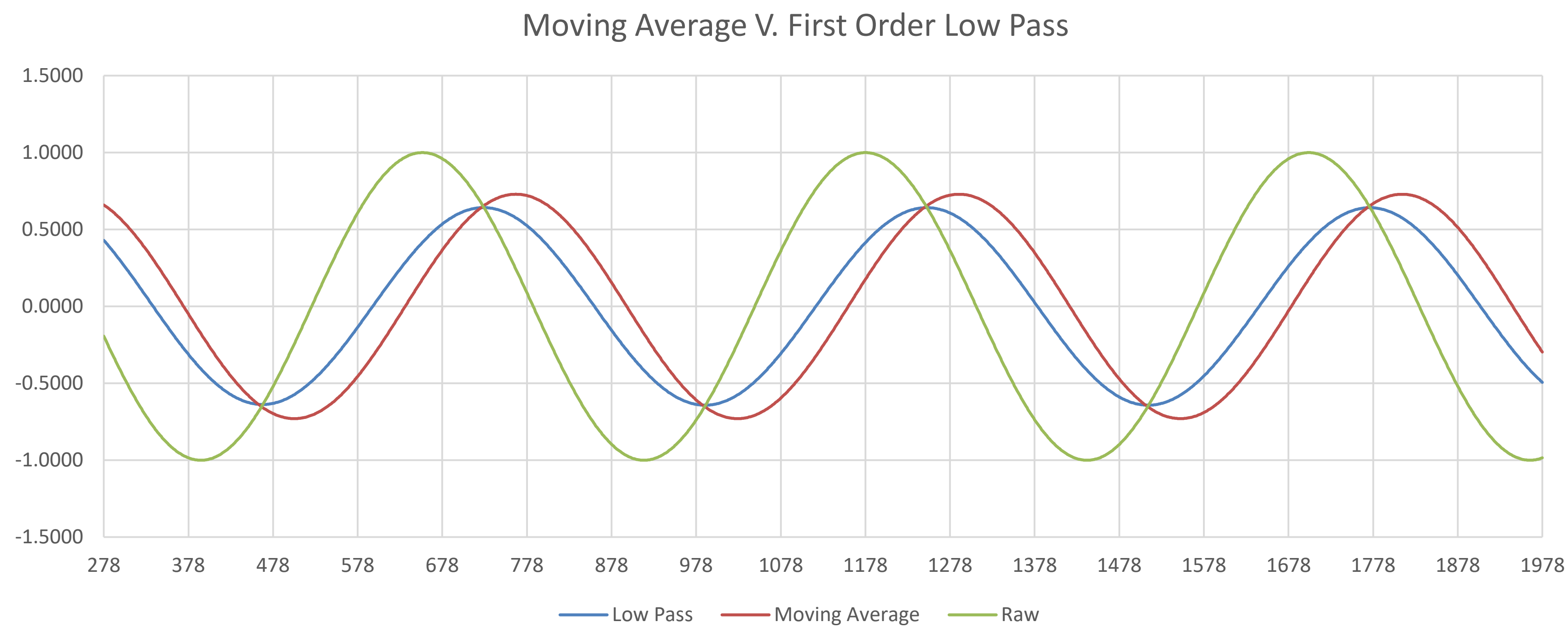
QI Response by Filter Type

- Using the 85% equivalent filters, calculate QI using lower limit of 0 and upper limit of 2.
- Both filters will produce the same QI, but at different rates.



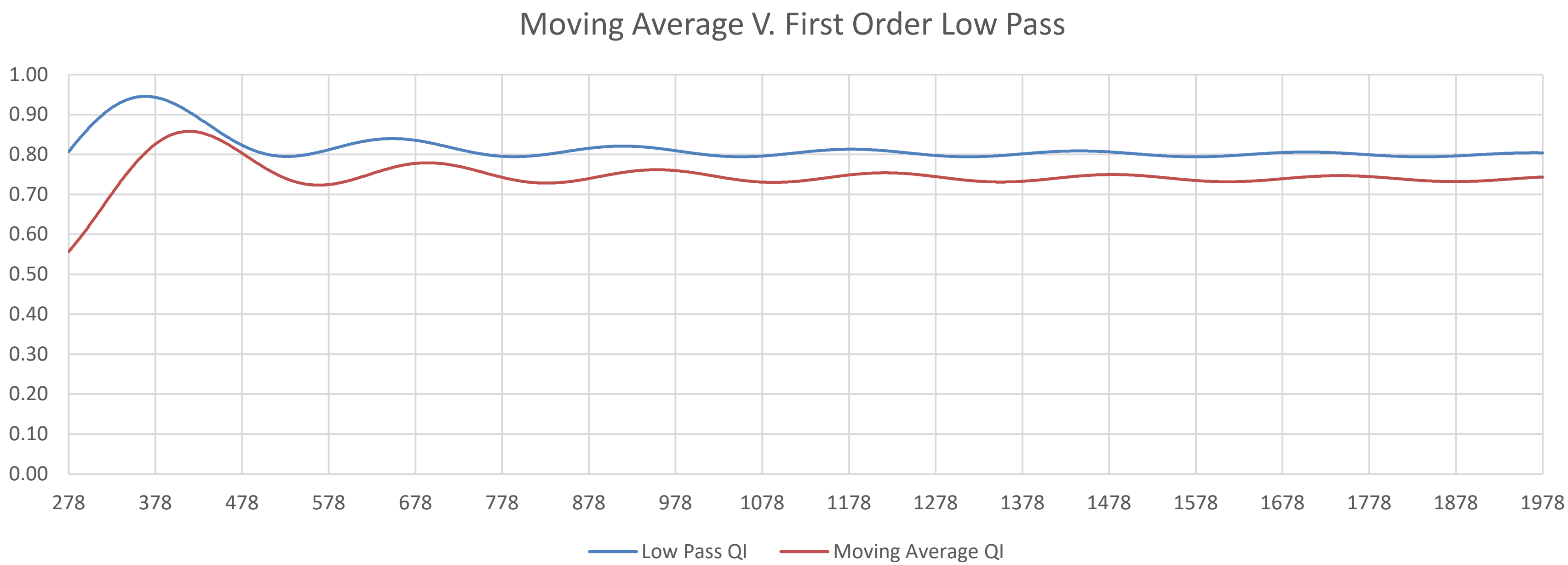
Sine Wave Response

85% equivalent filters responding to a sine wave input. This response will produce different QI's due to attenuation.



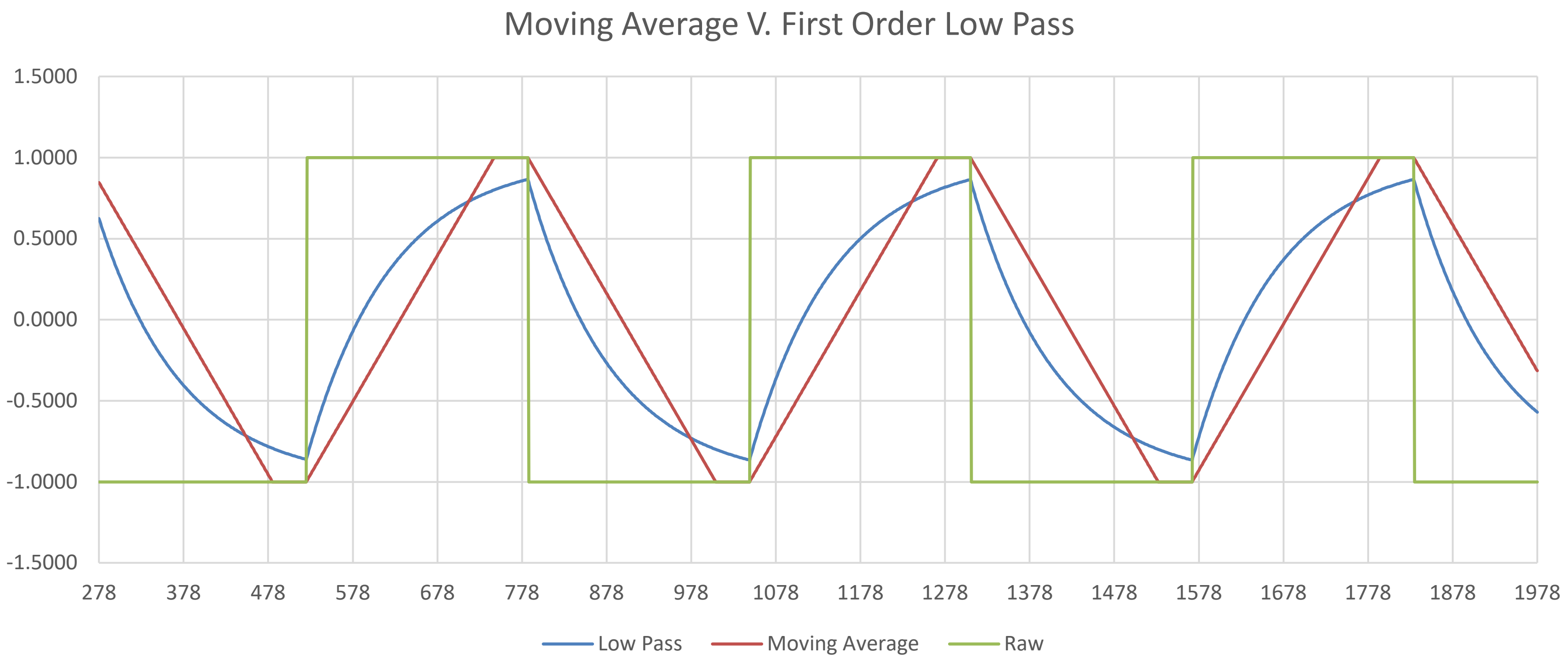
QI Response to Different Filter Types

- QI calculated on sine wave data using an upper limit of 1 and lower limit of -1.
- Moving Average final = .73
- Low Pass final = .79



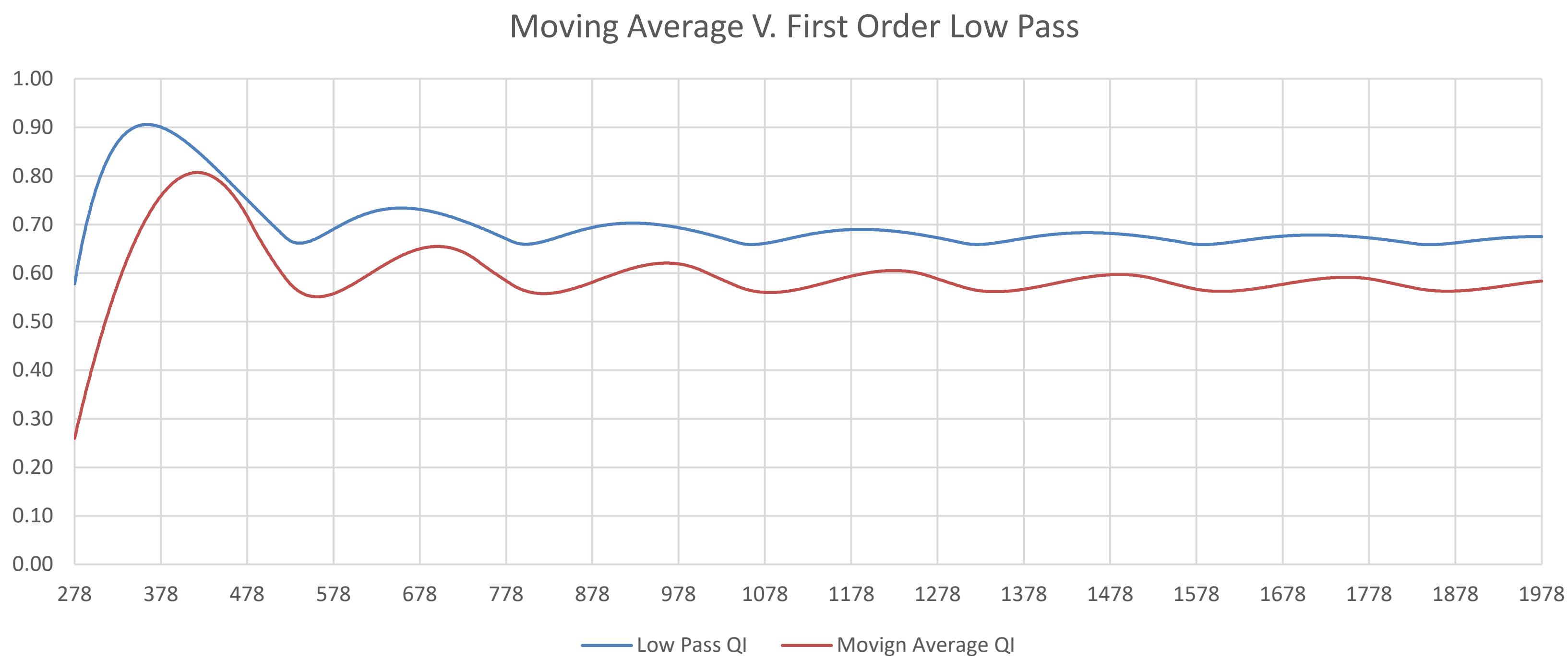
Square Wave Response

85% equivalent filters responding to a square wave. This input has a higher frequency component.



QI Response to Different Filter Types

- QI calculated on square wave data using an upper limit of 1 and lower limit of -1.
- Moving Average final = .56
- Low Pass final = .66



Recommendations

- DACA III should specify a total system time response characterization that is filter independent. This fits more with system uncertainty analysis.
  - *For example, time to reach 85% of final output.*
  - *Remove Appendix A section 1 (Characterize computer-based filtering).*

- If you remove the following, you could open the door to creative software filtering.
  - *To ease configuration, verification, and understanding, only first order low pass or moving average filters shall be used in computer software filtering. – Appendix A*

- Time response resolution should be no greater than the sampling time.
  - *For example, if you are sampling your data at .1 s, then your time response should be to the tenth of a second (i.e. no interpolation).*

- Be more specific on how the time response measurements are collected to account for dead time.
  - *For example, use of switch to indicate when the thermocouple was inserted in the bath. For flow measurements, use of a shutoff valve rather than turning off a pump to have a sharper cut off.*

Questions?

Attachment # 5

TMC System Time Response Measurement Guidelines, Version Date 1998

TMC

System Time Response Measurement Guidelines

5/27/1998

The following information is to assist laboratories in measuring system time response.

System time response refers to the time that a complete data acquisition system takes to log a step change for a given parameter. **The complete data acquisition system takes into account sensor, any associated wiring leads or piping along with signal conversion, computer processing and any other manipulation of data to the point of logging that would be in place during normal test operation.** During TMC lab visits engineers should note sensor information (manufacturer, model number, principal employed for measurement, thermocouple type (J, K) or RTD, grounded or ungrounded. Also, make note of unusual wiring, piping layout and the use of snubbers, condensate traps or electrical capacitance caps in control panels.

A system time response can be determined by measuring the amount of time to reach a certain percentage of an imposed step change. For this document, the value of 63.2 % of the amount of the imposed step change will be used for 1st order systems. For linear moving average channels 45.4% should be used.

In order to provide an accurate measurement of system time response, a channel should be used to display a triggering switch that indicates when the stimulus was imposed. In addition, because some system time responses are in the millisecond range, an adequate sampling rate should be used to record values. **Typically, a system that can log values of 10 hertz or more frequent is necessary to measure an accurate system time response.** Recommended step changes are shown below. If these step change deltas are inadequate, step changes should be at least 100 times the resolution of the measurement system and representative of typical operating conditions when possible. Permanent digital record of the response values and triggering are to be made. Data interpreted from graphical screen displays is not recommended.

The techniques used to measure response time for typical parameter are as follows:

Parameter	Step Change
Temperature	Quickly insert probe at ambient conditions into ice/distilled water mixture @ 0± 5 °C to cover the length of the probe. Care must be exercised to insure that handling of the thermocouple does not change the initial temperature reading, i.e. the temperature plot should be flat prior to inserting into ice bath.
Pressure	Pressurize system to 400 ± 5 kpa (~ 60 psig) for high pressure channels and 35 ± 3 kpa (~ 5 psig) for low pressure channels from the measurement probe (to include the entire system), then instantly release pressure through the use of an electric solenoid actuated valve to atmosphere. Valve must have an exit diameter large relative to the diameter of the pressure measurement line. The pressure source leg should have a shut-off valve so that the pressure source can be removed prior to testing. All lines should be as short as possible. To, operate, the system is pressurized with the calibrated pressure source (typically this is a standard transducer calibration rig), the shut-off valve closed, and the pressure source removed. The solenoid is then triggered, releasing the pressure. Response time pertains to the response to the release in pressure.
Torque	Apply load to dynamometer arm to achieve 120 ± 12 Nm of torque. Then remove applied weights quickly from the load cell. For a typical Midwest 1014 dynamometer with arm ~ 15.75" use 70 lb weight.

Speed	Configure a small electric motor to operate at 2000± 5 r/min speed using the appropriate speed sensor. Remove transducer to simulate step change to 0 rev/min. An alternative and less desirable method is to impose a step change equivalent to 2000 r/min at the sensor connection through a frequency generator.
Flow	Flow meters and the like require special procedures to impose a step input on the system. For flow meters, in general, the system is filled with the appropriate fluid and operated. At the desired time, the fluid pump is switched off and the system response is measured. Other systems will require some other procedure that will have to be determined. Step inputs are typically test area dependent.

[A] IIIE=160 Nm, VE=95 Nm, VIA=98 Nm, IVA=25 Nm