TMC

System Time Response Measurement Guidelines

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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