

Smart pressure transmitters on the market are fast when compared to pressure changes in most processes. Although fast seems to be best, it is not always the case. Some processes are better controlled or monitored with a slower response. To better understand, we need to understand Response Time.

■ RESPONSE TIME 4-20mA

Response Time is the amount of time (in seconds) it takes for the analog output signal to reach 63.2% of an instantaneous full-scale pressure change. Pressure transmitters respond to pressure changes as a first-order system; therefore, derived from an equation used for modeling exponential decay rates, the 63.2% figure represents the output change for the first time constant. An excellent technical definition that does not mean much to us.

In the real world, Response Time consists of two components, Dead Time and Time Constant. It is expressed in the following equation.

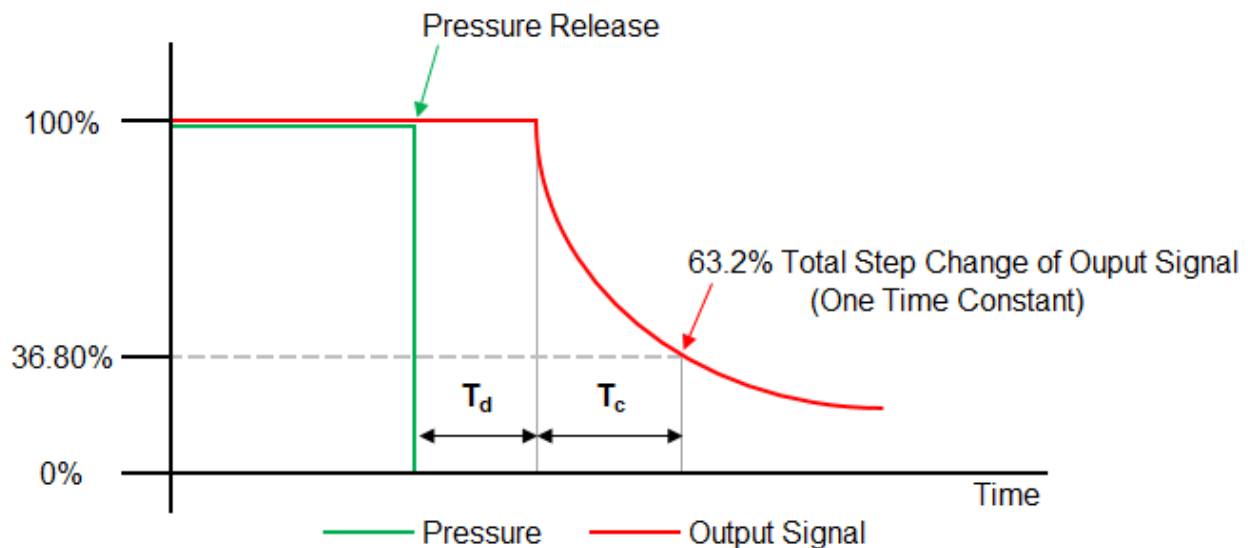
$$RT_t = T_d + T_c$$

Where,

RT_t = Total Response Time

T_d = Dead Time - The amount of time for the transmitter to initially respond to the change in pressure.

T_c = Time Constant - mechanical response time (MRT) + electronic response time (ERT)



Mechanical response time (MRT) is the time it takes for the process pressure change to be conveyed mechanically from the diaphragm to the sensor. MRT can be affected by any number of mechanical factors - spring rate of the diaphragm (which is different for different materials), the type of fill fluid used to convey pressure to the sensor, or the amount of fill fluid.

Electronic response time (ERT) is the amount of time for the sensor signal to be processed and converted to a transmitter output signal. ERT is dependant on converting the signal to an analog (4 to 20mA) output or converting to a digital protocol (BRAIN, HART, FOUNDATION Fieldbus, PROFIBUS).

In all applications, best practice dictates that a transmitter should respond at least as fast as the process changes. Applications, where the transmitter response time should be considered, are differential pressure flow and pressure measurement for compressor surge control.

■ YOKOGAWA PRESSURE TRANSMITTERS

Yokogawa pressure transmitters with Hastelloy C-276 diaphragms (Yokogawa's base diaphragm material) have a response time of 90 ms (including a dead time of 45 ms); making them one of the fastest smart transmitters on the market. However, applications with excessive pulsation can cause this fast response time to affect the pressure measurement adversely. Instead of getting a stable output signal, the device outputs an erratic signal. To solve the issue, Yokogawa offers two different solutions.

○ SOFTWARE DAMPING

All Yokogawa transmitters have a *software damping* function to extend the ERT of the transmitter. This function includes a Damping Time Constant that can be set as any value from 0.00 to 100.00 seconds. The damping time constant can be set at the factory using the appropriate option code or set in the field using FieldMate or an HHC.

The software damping of the analog signal is set using the digital HART or BRAIN protocol.

● HART Protocol HART 5 HART 7

When shipped, the damping time constant is set to 2.00 sec. Add option code /CA on the transmitter model code to direct the factory to set the damping time constant to the value specified on the Purchase Order.

Regardless of the presence of the /CA option in the model code, the end-user can set the damping time constant to any value from 0.00 to 100.00 seconds using FieldMate or an HHC.



NOTE

The **Quick response** parameter must be enabled to set the damping time constant from 0.00 to 0.49 seconds.

Damping Time Constant Set-up (IM 01C25T01-06EN Section 3.2.5)

□ Setting Pressure Damping Constant

HART Version	DD	DTM	Procedure
HART 5 -or- HART 7	✓	✓	① [Root Menu]→Basic Setup→ Pres Damp ② Set Value

□ Setting Quick response

HART Version	DD	DTM	Procedure
HART 5 -or- HART 7	✓	✓	① [Root Menu]→Detailed Setup→ Signal condition→Quick resp ② Select Off or On

Selection	Description
Off	Pres Damp set from 0.50 to 100.00
On	Pres Damp set from 0.00 to 100.00

Note: The EJX-A Series HART 5 DTM based on FDT1.2 uses a different procedure; please refer to Section 3.2.5 of the HART Communication IM for the correct procedure.

- BRAIN Protocol

When shipped, the damping time constant is set to 2.00 sec. Add option code /CB on the transmitter model code to direct the factory to set the damping time constant to value specified on the Purchase Order.

Regardless of the presence of the /CB option in the model code, the end-user can set the damping time constant to any value from 0.00 to 100.00 seconds using FieldMate of a BT200.



NOTE

The **D50: Quick RESP** parameter must be enabled to set the damping time constant from 0.00 to 0.49 seconds.

Damping Time Constant Set-up (IM 01C25T03-01EN Section (3))

(C30: AMP DAMPING)

```
SET
C30:AMP DAMPING
  2.00 sec
+ 004.00
```

CLR ESC

- ① Enter Value. (4 seconds for example)
- ② Press the ENTER key twice to enter the setting.
- ③ Press the F4 (OK) key.

```
SET
C30:AMP DAMPING
  4.00 sec
```

FEED NO OK

(D50: QUICK RESP)

Selection	Description
Off	AMP DAMPING set from 0.50 to 100.00
On	AMP DAMPING set from 0.00 to 100.00

- **HARDWARE DAMPING**

Select Yokogawa transmitters have options to slow the mechanical response time (MRT). These options increase the base 90 ms response time to 150 ms or even 2200 ms by slowing the time to convey the pressure from the diaphragm to the pressure sensor. These options change the physical design of the transmitter's sensing section. These transmitters retain the *Software Damping* function.

Which should you use? Software Damping or Hardware Damping? Software Damping is sufficient for most applications. The parameter is available on all Yokogawa transmitters. The Hardware Damping, option codes **HD** and **HD2**, should be used in an application that has a known excessive pulsation. The transmitter's repeatability is improved using hardware damping.

Option Code	Model	Capsule	Process Temperature	
			73.4°F	32.0°F
HD	EJA110E EJA130E	M	Approx. 1300 ms	Approx. 2200 ms
	EJX110A EJX130A	H	Approx. 400 ms	Approx. 600 ms
HD2	EJA110E EJA130E	M	Approx. 150 ms	Approx. 175 ms
	EJX110A	H	Approx. 150 ms	Approx. 175 ms

■ CONCLUSION

Response Time of a pressure transmitter is an essential specification in its overall performance. However, faster is not always better. Each application has a unique response time that works best. The transmitter should respond at a rate that yields a good representative stable signal - assuring that the transmitter is not under-detecting conditions (e.g., pressure surges) or outputting a useless unstable signal. Having a pressure transmitter that is fast and can be adjusted to match the process is essential. Yokogawa transmitters offer the ability to adjust the response time, 90 ms to 102.2 s, yielding a robust, stable output signal.

■ RELATED DOCUMENTS

Document No.	Document Title
IM01C25T01-06EN	User's Manual - DPharp HART 5/HART 7 Communication Type
IM01C25T03-01EN	User's Manual - BRAIN Communication Type

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