WOODWARD

Manual 82690
(Revision D, 3/2016)
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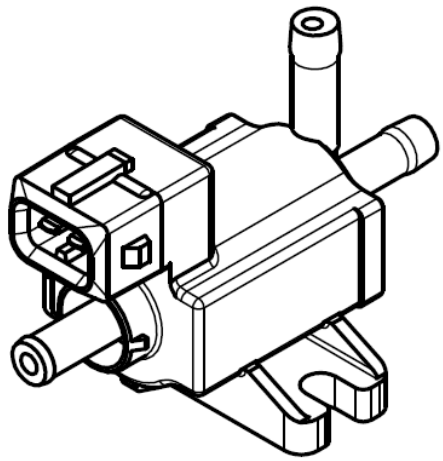

3-way, 24 V Wastegate Valve

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Application Engineering Specification

General Precautions

Read this entire manual and all other publications pertaining to the work to be performed before installing, operating, or servicing this equipment.

Practice all plant and safety instructions and precautions.

Failure to follow instructions can cause personal injury and/or property damage.

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Contents

Illustrations and Tables

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Warnings and Notices

Important Definitions

This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

- **DANGER**—Indicates a hazardous situation which, if not avoided, will result in death or serious injury.
- **WARNING**—Indicates a hazardous situation which, if not avoided, could result in death or serious injury.
- **CAUTION**—Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.
- **NOTICE**—Indicates a hazard that could result in property damage only (including damage to the control).
- **IMPORTANT**—Designates an operating tip or maintenance suggestion.

⚠WARNING

Overspeed / Overtemperature / Overpressure

The engine, turbine, or other type of prime mover should be equipped with an overspeed shutdown device to protect against runaway or damage to the prime mover with possible personal injury, loss of life, or property damage.

The overspeed shutdown device must be totally independent of the prime mover control system. An overtemperature or overpressure shutdown device may also be needed for safety, as appropriate.

⚠WARNING

Personal Protective Equipment

The products described in this publication may present risks that could lead to personal injury, loss of life, or property damage. Always wear the appropriate personal protective equipment (PPE) for the job at hand. Equipment that should be considered includes but is not limited to:

- **Eye Protection**
- **Hearing Protection**
- **Hard Hat**
- **Gloves**
- **Safety Boots**
- **Respirator**

Always read the proper Material Safety Data Sheet (MSDS) for any working fluid(s) and comply with recommended safety equipment.

⚠WARNING

Start-up

Be prepared to make an emergency shutdown when starting the engine, turbine, or other type of prime mover, to protect against runaway or overspeed with possible personal injury, loss of life, or property damage.

⚠WARNING

Automotive Applications

On- and off-highway Mobile Applications: Unless Woodward's control functions as the supervisory control, customer should install a system totally independent of the prime mover control system that monitors for supervisory control of engine (and takes appropriate action if supervisory control is lost) to protect against loss of engine control with possible personal injury, loss of life, or property damage.

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NOTICE

Battery Charging Device

To prevent damage to a control system that uses an alternator or battery-charging device, make sure the charging device is turned off before disconnecting the battery from the system.

Electrostatic Discharge Awareness

NOTICE

Electrostatic Precautions

Electronic controls contain static-sensitive parts. Observe the following precautions to prevent damage to these parts:

- **Discharge body static before handling the control (with power to the control turned off, contact a grounded surface and maintain contact while handling the control).**
- **Avoid all plastic, vinyl, and Styrofoam (except antistatic versions) around printed circuit boards.**
- **Do not touch the components or conductors on a printed circuit board with your hands or with conductive devices.**

To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual *82715*, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules*.

Follow these precautions when working with or near the control.

1. Avoid the build-up of static electricity on your body by not wearing clothing made of synthetic materials. Wear cotton or cotton-blend materials as much as possible because these do not store static electric charges as much as synthetics.
2. Do not remove the printed circuit board (PCB) from the control cabinet unless absolutely necessary. If you must remove the PCB from the control cabinet, follow these precautions:
   - Do not touch any part of the PCB except the edges.
   - Do not touch the electrical conductors, the connectors, or the components with conductive devices or with your hands.
   - When replacing a PCB, keep the new PCB in the plastic antistatic protective bag it comes in until you are ready to install it. Immediately after removing the old PCB from the control cabinet, place it in the antistatic protective bag.

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Chapter 1. Description

Introduction

This specification covers the Woodward 3-way, 24 V wastegate valve. At time of printing this is Woodward part number 1309-6115. Subsequent engineering change control could result in a different part number being used.

Application

The purpose of this valve is to provide control of a wastegate valve on turbocharged engines.

The product is approved for use with the OH1.2MD, OH2.2, successors to the OH2.2 system, and OH6.

The valve is a 3-way valve.

Storage

The valve must be stored in the original packing until installed on the engine. Introduction of foreign substances in the valve openings must be prevented. The unit can be stored at any temperature between –40 and +85 °C for long term.

Installation Instructions

The valve is designed for on-engine or chassis mounting. Minimizing vibration through good bracket and mounting practices will improve valve life.

The device should be mounted in an environment that will never exceed 130 °C, even for hot soak condition, nor see compressed air that is in excess of 130 °C.

The air source should be free of particulate matter. Either filtered intake air or compressed air that has been filtered should be used.

The valve can be mounted in any direction if the air source is dry, but if there is significant water or oil mist in the air source, the valve should be mounted in a vertical direction as shown below in Figure 1-1.

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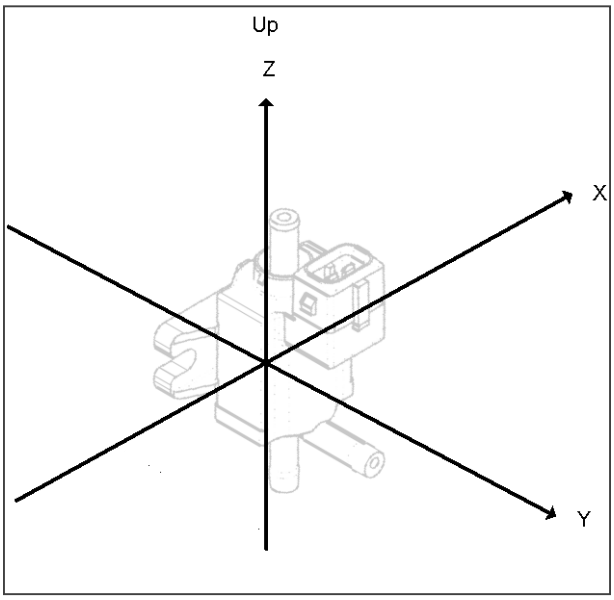

Figure 1-1. Mounting Orientation for Valve without Dry Air Source

Figure 1-2 shows the footprint and mounting tab dimensions for the valve. The recommended mounting fastener is an M5 hex or socket head screw on each mounting tab, with a flat washer between the head and the plastic valve tab. Use of a thread-locking feature in the fastener system is recommended (either locknut or thread-locking compound). The fasteners should be tightened with an applied torque of 3 ± 0.5 N·m. The base of the valve must be supported by the mounting surface.

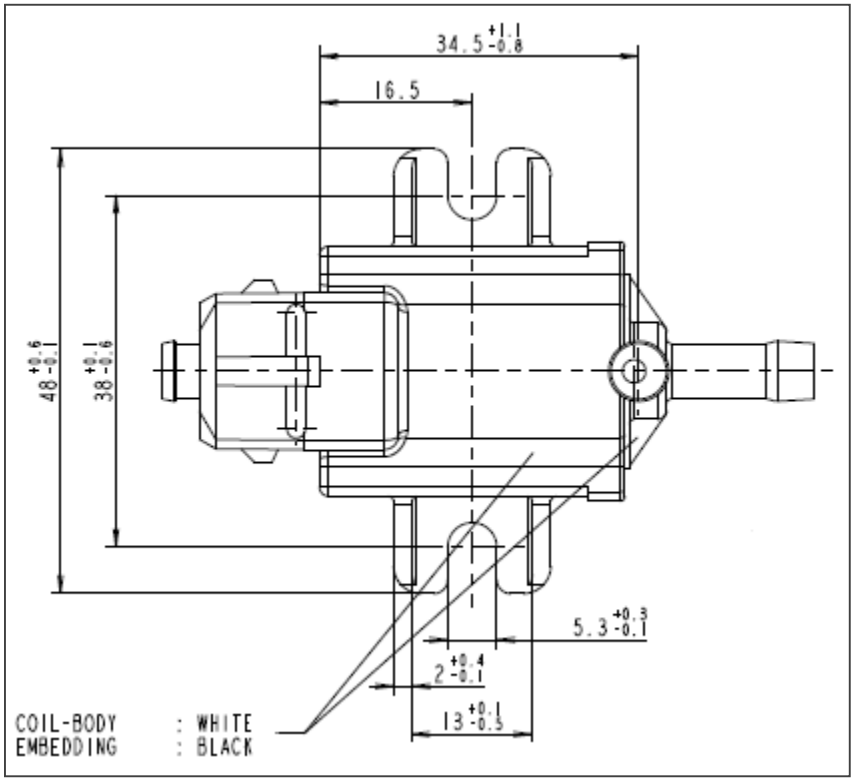

Figure 1-2. Dimensions of the 3-Way Valve

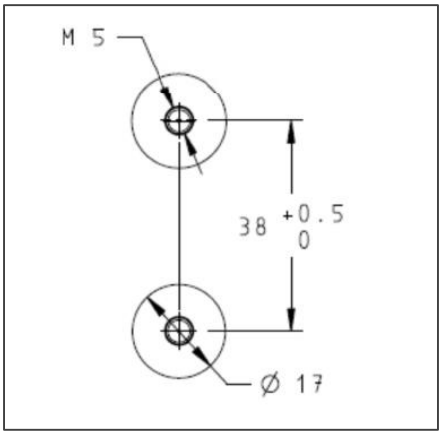

Figure 1-3. Mounting Hole Dimensions

To ensure good connector continuity, it is essential that not only the connector on the component side is according to specification, but that the material quality and exact fit of the cable harness connector are also guaranteed. Clamp the wire harness 50 to 150 mm from the back of the connector. The valve needs to be mounted in such a manner that no doors or other moving objects come into contact with the sensor, mating connector, or wires near the sensor. Route or protect the wiring harness from the valve so that the wires are not stepped on during normal maintenance.

The valve should be mechanically connected to the wastegate control system as shown in Figure 1-4. If the air source (Connection #1) is from boosted intake air, it must be after the intercooler (but also before the fuel/air mixer) to prevent overheating the valve. The return (Connection #2) must be plumbed to the engine intake air after the air cleaner but before the compressor. If the wastegate valve is mounted vertically, Connection #2 can be connected to a piece of hose ≥ 16 cm long to act as a draft tube. The hose must also be vertical to prevent dirt and water from entering the valve. However, Woodward strongly recommends that Connection #2 be routed back to the engine air intake for all installations.

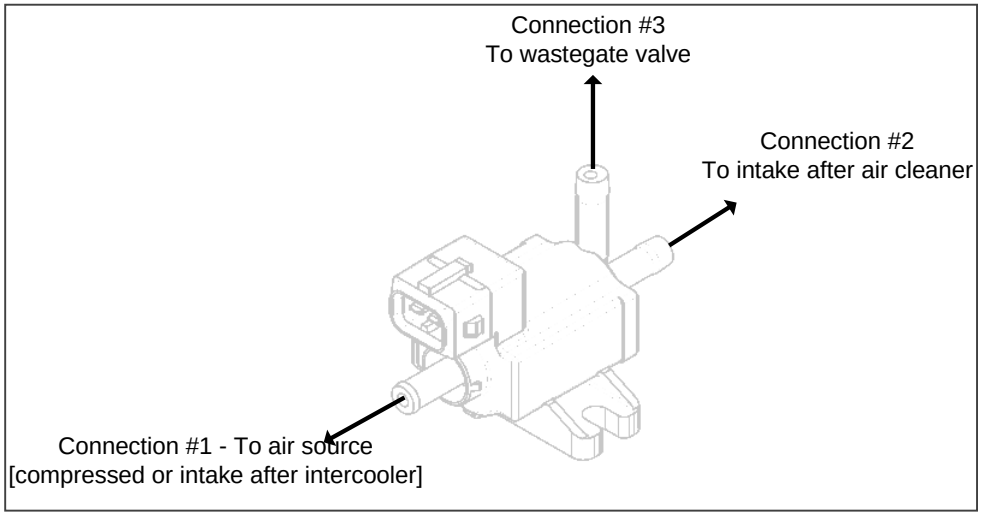

Figure 1-4. Connections for 3-Way Valve

Although the fittings to the wastegate valve are identical, the correct connection of the lines is very important. If the two lines are switched, the system will not

control boost pressure properly, and low boost or overboost of the engine will occur.

The source of the pressure can come from the engine boost pressure or the vehicle system pressure (but not both). For information on the advantages/disadvantages of these two options, please contact Woodward. If the vehicle system pressure is used, an air pressure regulator must be used to reduce the air pressure from 8 to 10 bar to approximately 2 bar (depending on the wastegate diaphragm spring force). If engine boost pressure is used, the pre-throttle pressure should be plumbed directly to the wastegate control valve.

The source of the pressure should never exceed 3 bar.

After proper tuning of the boost PID, the length of line between the valve and the wastegate should not be increased or decreased substantially without revalidation of the boost PID.

Circuit Diagram

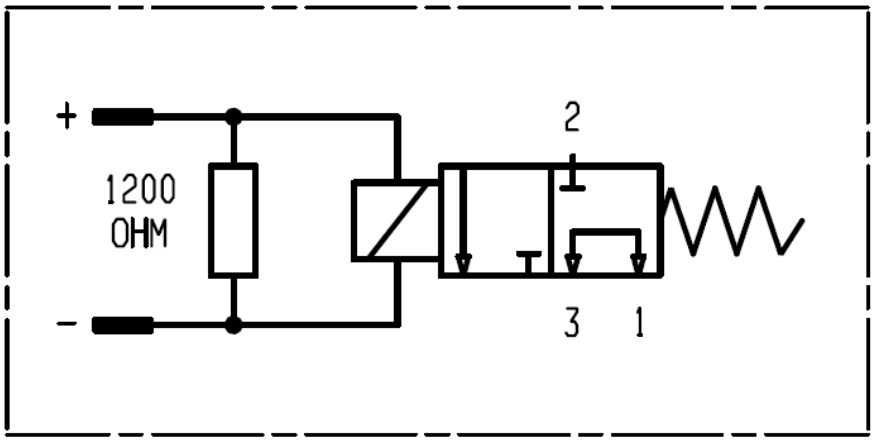

Figure 1-5. Electrical Schematic for 3-Way Valve

- When the valve is not energized, the flow path is connection 1 to 3.
- When the valve coil is fully energized, the flow path is connection 2 to 3.
- When the valve is modulated with a controlled duty cycle, the flow path is alternately diverted between connection 2 and 3 to create the desired pressure control.

OH1.2MD

The (+) terminal is connected to battery power that is controlled by the power relay in the system. This is the main power relay.

The (–) terminal is connected to the OH1.2 ECM pin P1 (Boost PWM).

OH2.2 and Newer

The (+) terminal is connected to battery power that is controlled by the power relay in the system. This is the main power relay.

The (–) terminal is connected to the PCM-HD pin J2-B21 (LS04_WGCV).

OH6

The (+) terminal is connected to battery power that is controlled by the power relay in the system. This is the main power relay.

The (–) terminal is connected to the SECM112 pin CF2 (LS04_WGCV).

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Chapter 2.
Technical Data

Electrical Specifications of Wastegate Valve

Parameter *	Value	Unit
Nominal voltage	24	V
Operating voltage range	20 – 32	V
Minimum actuating voltage (at p1/2/3 = 0 kPa)	≤ 15	V
Maximum release voltage (at p1/2/3 = 0 kPa)	≥ 3	V
Maximum duty cycle	100	%
Maximum current consumption (at 24 V, -40 °C and 100% dc)	≤0.38	A
Coil resistance range	90 ± 4.5	Ω
Maximum inductance (at 120 Hz frequency and begin of lift)	≤ 235	mH

*—Unless otherwise specified the test temperature is 20 °C.

Mechanical Specifications of Wastegate Valve

Parameter *	Value	Unit
Minimum cycle durability (at P1 = 80 ± 5 kPa, connection plugged, 27 V, frequency = 32 Hz and duty cycle = 50%)	≥330 million	Cycles
Vibration resistance (at product, frequency range = 20 to 350 Hz)	30	g
Maximum pressure P1 (at p3 = 0 kPa)	300	kPa
Continuous Operation Temperature	–30 to +130	°C

*—Unless otherwise specified the test temperature is 20 °C.

Flow and Leakage Specifications of Wastegate Valve

Parameter *	Value	Unit
Maximum leakage ** (new to 10 million cycles)	≤ 0.05	L/min
Maximum leakage ** (10 to 110 million cycles)	≤ 0.5	L/min
Minimum flow energized (at P3 = - 30 ± 0.5 kPa)	≥ 8	L/min
Minimum flow not energized (at P3 = - 30 ± 0.5 kPa)	≥ 10	L/min

*—Unless otherwise specified the test temperature is 20 °C.

**—For leak test there are two modes (both measure leakage at connection 1:

1. Apply voltage ≥ 18 V, P3 = 60 – 5 kPa, plug connection 2
2. No voltage applied, P1 = 80 – 5 kPa, plug connection 3

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Transfer Function of Duty Cycle to Pressure

OH1.2MD, OH2.2, and Successors to OH2.2

The valve supplier measures the two points below on 100% of valves.
P1 = 300 ± 5 kPa
Frequency = 32 Hz
Voltage = 27 V
Measurement Points:

1. Duty-cycle = 30 ± 1 % -> P3 = 270 ± 30 kPa
2. Duty-cycle = 80 ± 1 % -> P3 = 65 ± 30 kPa

Figure 2-1 compares the steady-state pressure control performance of the 2-way and 3-way valves. Compared to the Woodward 2-way wastegate valve, the pressure at 100% DC for the 3-way valve goes to 0 (outlet pressure). For the 2-way valve, the pressure goes to about 1/6 of the inlet pressure.

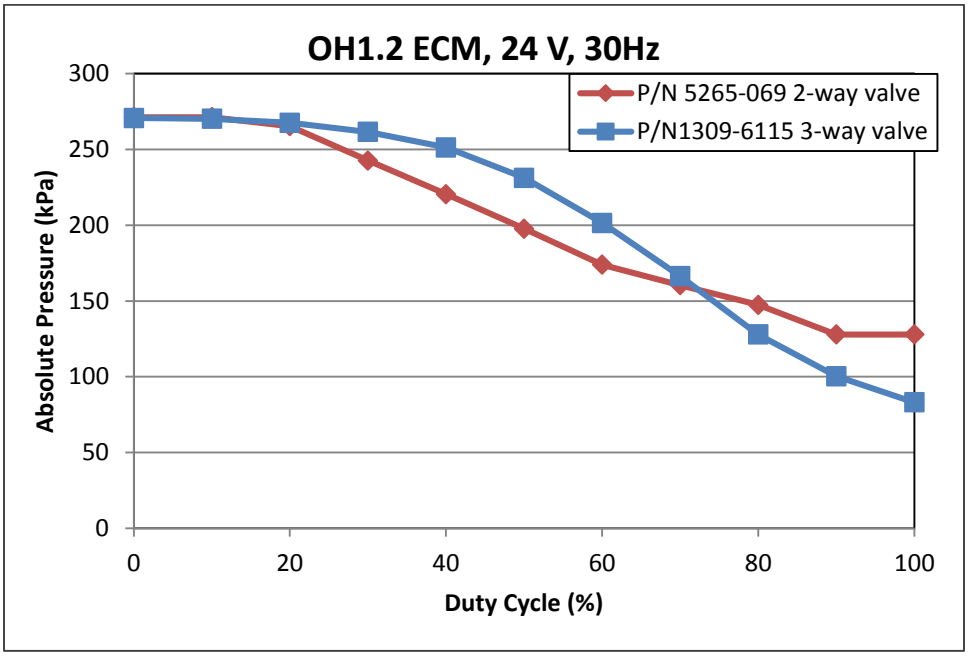

Figure 2-1. Outlet Pressure for OH1.2MD System

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Figure 2-2 shows the transfer functions of the 2-way and 3-way valves when powered by the OH2.2 controller.

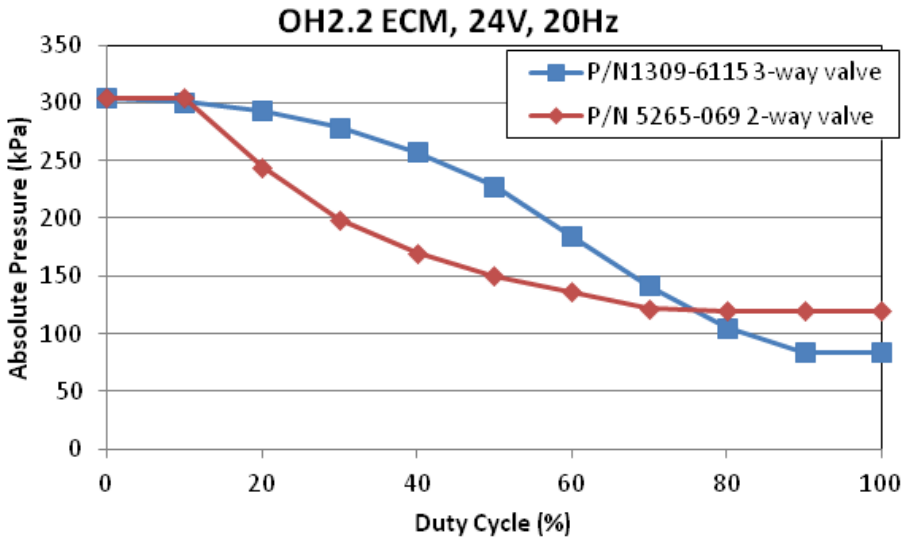

Figure 2-2. Outlet Pressure with OH2.2 System

OH6

The valve supplier measures the two points below on 100% of valves.
P1 = 300 ± 5 kPa gage
Frequency = 32 Hz
Voltage = 27 V
Measurement Points:

1. Duty-cycle = 30 ± 1 % -> P3 = 270 ± 30 kPa
2. Duty-cycle = 80 ± 1 % -> P3 = 65 ± 30 kPa

The 1309-6115 was tested on OH6 under the same conditions except the frequency was changed to 25 Hz to match typical system applications. Figure 2-3 shows the outlet pressure as a function of duty cycle for the 3-way valve.

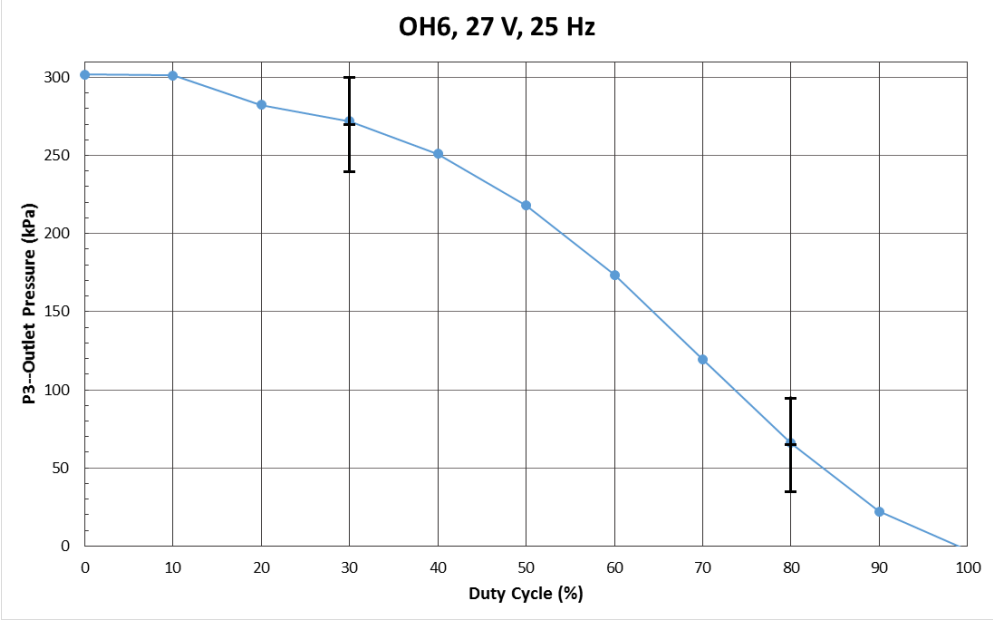

Figure 2-3. Outlet Pressure with OH6 System

Wastegate Pressure Response

OH1.2MD, OH2.2, and Successors to OH2.2

The purpose of this test was to provide reference data between the 3-way control valve and the Woodward 2-way 24 V wastegate valve (part number 5265-069) for typical pressure response of the wastegate control pressure. System setup is shown below in Figure 2-4.

For all tests the following conditions are held constant:
P1 or valve inlet pressure = 300 kPa absolute
Driver Frequency = 30 Hz
Voltage = 24 V
Volume of hose and wastegate actuator = 60 mL

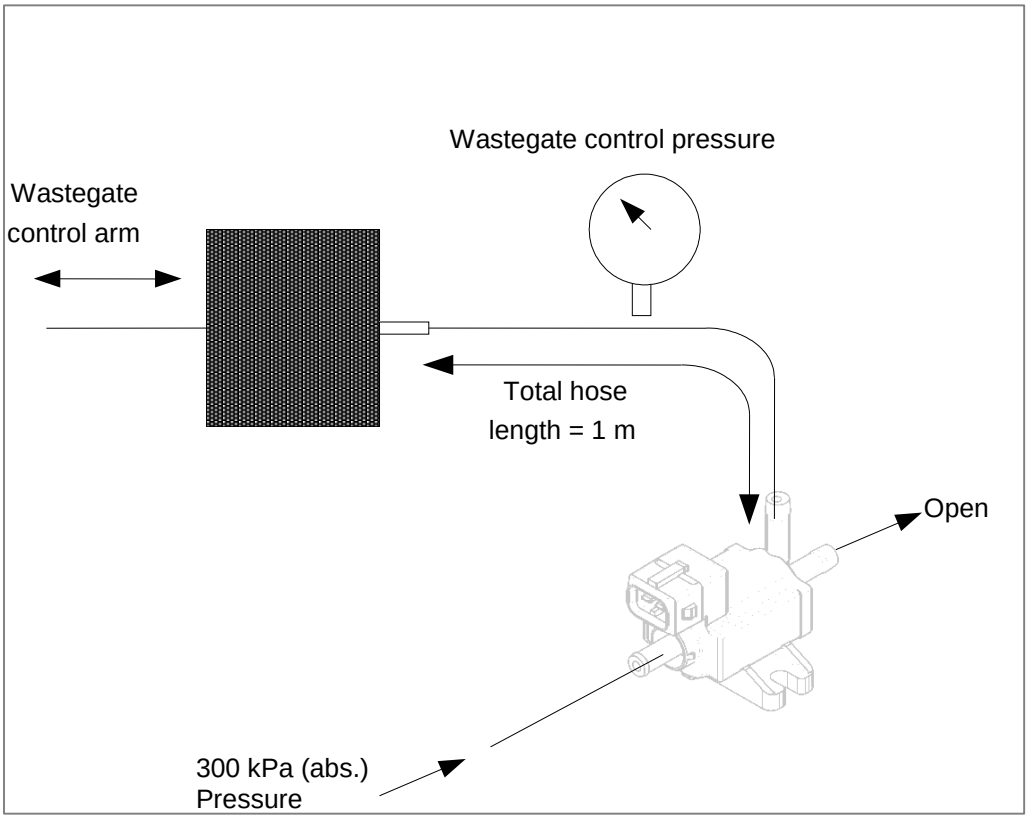

Figure 2-4. Bench Test Set-up for OH1.2MD and OH2.2

Response times to step changes in commanded duty cycle are shown in Table 2-1. The time constant "τ" is defined as time when the pressure reaches 63% of change from the initial condition.

Table 2-1. Time Response for Valves with OH1.2MD and OH2.2 Systems

30 Hz Controller	Command (DC)	P/N 1309-6115 3-way		P/N 5265-069 2-way	
		τ (ms)	Outlet Pressure Δ[1] (kPa abs.)	τ (ms)	Outlet Pressure Δ[1] (kPa abs.)
OH2.2	0 to 100%	185	300 to 90	150	300 to 125
	100% to 0%	125	90 to 300	255	125 to 300
	0 to 60%	235	300 to 175	200	300 to 125
	60% to 0%	80	175 to 300	260	125 to 300
OH1.2	0 to 100%	180	300 to 90	150	300 to 125
	100% to 0%	115	90 to 300	245	125 to 300
	0 to 60%	210	270 to 200	170	200 to 175
	60% to 0%	100	200 to 270	255	175 to 200

[1]Outlet pressure range given for reference, actual outlet pressure curve will depend upon the available inlet pressure.

Table 2-2 summarizes the pressure fluctuation at a fixed duty-cycle with a supply pressure of 300 kPa absolute for an OH2.2 driver at 30 Hz and 24 V.

Table 2-2. Pressure Fluctuation for OH1.2MD and OH2.2 Systems

Peak-to-Peak Pressure Fluctuation (kPa)		
DC Command	P/N1309-6115 3-way	P/N 5265-069 2-way Valve
30%	31	25
50%	28	22
70%	30	17

OH6

For OH6, the test conditions were modified slightly.
P1 or valve inlet pressure = 300 kPa gage
Driver Frequency = 25 Hz
Voltage = 27 V
Volume of hose and wastegate actuator = 60 mL

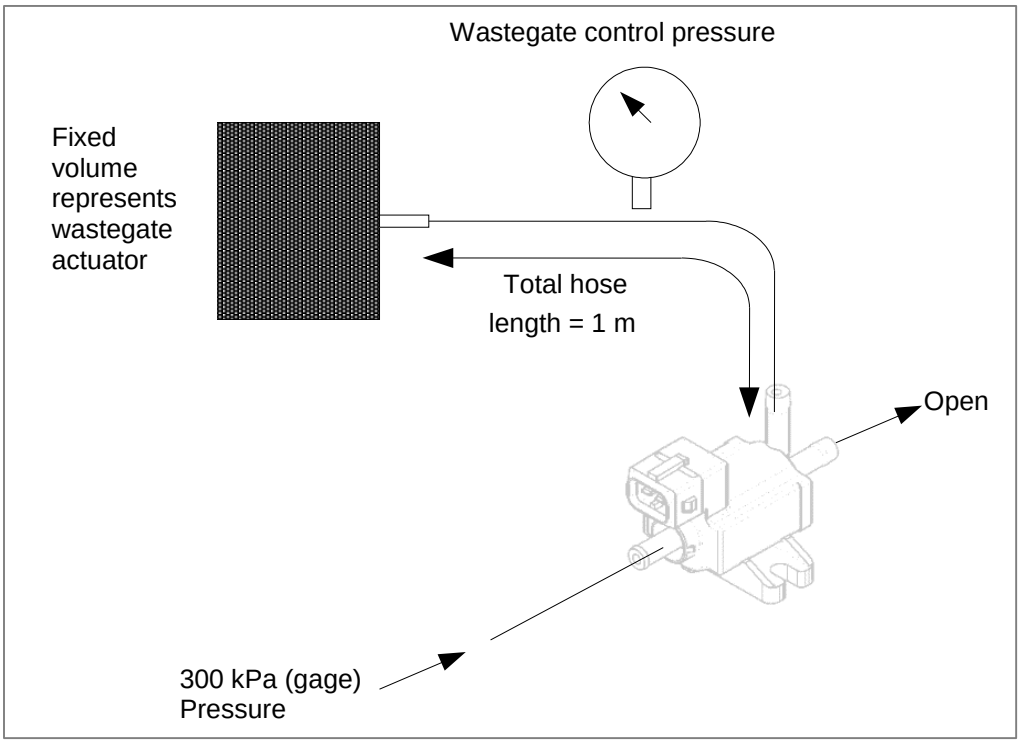

Figure 2-5. Bench Test Set-Up for OH6

Response times to step-changes in commanded duty-cycle are shown in Table 2-3. The time constant "τ" is defined as time when the pressure reaches 63% of change from the initial condition.

Table 2-3. Time Response for Valves with the OH6 System

25 Hz Controller	**Command (DC)**	**P/N 1309-6115 3-way**	
		τ (ms)	**Outlet Pressure Δ[1] (kPa)**
OH6	0 to 100%	172	302 to -3
	100% to 0%	123	-2 to 299
	0 to 60%	182	301 to 173
	60% to 0%	86	173 to 301

[1]Outlet pressure range given for reference, actual outlet pressure curve will depend upon the available inlet pressure.

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Table 2-4 summarizes pressure fluctuation at the location of the wastegate actuator for a specified duty-cycle. Operating conditions were as follows: inlet pressure of 300 kPa with an OH6 driver at 25 Hz and 27 V.

Table 2-4. Pressure Fluctuation for the OH6 System

Peak-to-Peak Pressure Fluctuation (kPa)	
DC Command	**P/N1309-6115 3-way**
30%	24
50%	35
70%	34
90%	22

End-of-Line Test by Supplier

100% of all valves will undergo the following functional tests (per the specifications given above):

- Actuating voltage
- Release voltage
- Leakage with and without current applied per the specification
- Flow rate with and without current applied
- Pressure at connector 3 for two different duty cycles 30% and 80%

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Chapter 3.
Valve Application Review

Application Checklist

For full application warranty of the product, the following items at a minimum should be reviewed:

- Review engine mounting per specification outline in Chapter 1 of this publication.
- Currently the valve is validated for the OH1.2MD, OH2.2, successors to the OH2.2 systems, and OH6. Use with the OH1.2, 2.0, or 2.1 systems is not allowed.
- The use of control frequency over 32 Hz is not allowed. Lower frequencies increase valve life but cause larger peak-to-peak pressure fluctuations at the valve outlet. If the valve is operated faster than 32 Hz, there is the risk that the valve will start to float which will make boost control unpredictable.
- The wastegate valve must not be fully energized when boost control is not required (*e.g.* idle). When the valve is fully energized for long periods of time, the life of the valve is shortened due to heat generated by the solenoid.
- The inlet pressure to the valve must never exceed 300 kPa.
- The complete calibration of the boost control system is not covered in this document. Please contact Woodward for system-level support.

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