WOODWARD

Application Note 51593
(Revision -, 2/2024)

Original Instructions

High Output Digital Valve Positioner 12000
HODVP 12K

DVP 12000

Introduction

The High Output Digital Valve Positioner 12000 (HODVP 12K) extends the capability of the existing HODVP platform in two areas.

1. The current 10K DVP can provide up to 25 Amps with maximum 70 °C ambient; however, there is more capacity available at lower ambient temperatures. HODVP 12K increases the maximum current output of the existing 10K DVP from 25 Amps to 28 Amps when used at 55 °C ambient or less. The existing 25 Amp rating remains in place when the 12K DVP is used at temperatures between 55 °C and 70 °C.

2. The 10K DVP cannot be used with spring return actuators because the boost module effectively bypasses the snubber protection built into the power board, and (when back-driven by a spring during a power outage) back EMF can increase power bus voltages above the design limits, resulting in component failures. HODVP 12K features a self-powered snubber, which allows safe operations with spring return actuators (LELA) and ensures adequate margin for known unbalanced applications (LESV).

In alignment with the remainder of the HODVP line, the HODVP 12K has a SIL3 certification.

Performance

The HODVP 12K is a transient power motor drive, which supplies steady state current continuously in a holding position where little power is delivered from the DVP during a position movement condition in which 10kW of power could be delivered from the DVP. Below is a graphical representation of the input current power duty cycle for the HODVP 12K as it pertains to its transient power operation at both 55 °C and 70 °C ambient temperature environments. The 50A input current represents a full power output of the HODVP 12K at 200 Vdc min and is allowed for 30 seconds followed by a 5A input current. Representing a hold operating for 120 seconds, this profile is for a 55 °C ambient temperature environment. The 40A input current represents a full power output of the HODVP 12K at 200 Vdc min and is allowed for 30 seconds followed by a 5A input current representing a hold operating for 120 seconds. This profile for a 70 °C ambient temperature environment can be repeated indefinitely.

Reliability Approach

The HODVP 12K is an extension to the DVP platform's reliability pedigree, utilizing the same design, test, and derating approaches. The HODVP 12K project takes previous methods and extends them based on field experience and continuous improvement. The reliability target is MTTF > 250,000 hours, excluding software and customers' induced failures, i.e., no fault found.

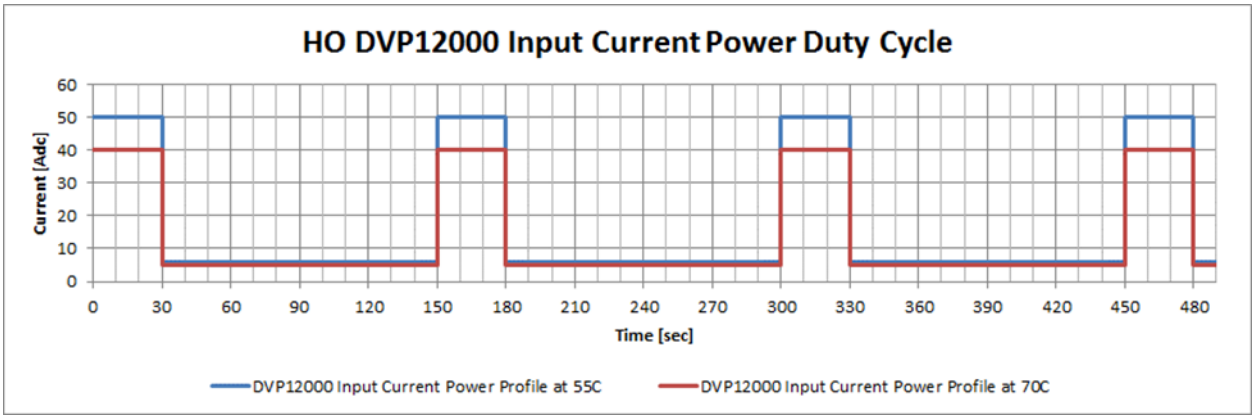

Figure 1. HODVP 12K Power Duty Cycle

Electrical Requirements

Input Voltages and Currents

The HODVP 12K design is a flexible driver solution for Woodward valve and actuator applications. As such, it operates over a broad input voltage range, but is intended to operate with low voltage. If its input voltage effects high voltage, the output remains at current capability. The input must provide a redundant power input; however, the negative (reference) inputs are not isolated from each other.

Table 1. Input Voltage and Current Electrical Requirements

	Characteristics and Conditions	Symbol	Limits Min	Nom	Max	Units
a.	Input Voltage Range	V_{IN}	90	N/A	300	Vdc
b.	Low Input Voltage Range	V_{IN_LOW}	90	120	150	Vdc
c.	High Input Voltage Range	V_{IN_HIGH}	200	220	300	Vdc
d.	Transient Input Current 55C	I_{IN_TRANS}	N/A	N/A	50	Adc
e.	Transient Input Current 70C		N/A	N/A	40	Adc
f.	Steady State Input Current	I_{IN_SS}	N/A	N/A	5	Adc

Output Voltages and Currents

The HODVP 12K provides a three-phase SPV PWM output voltage controlled by the control model reference voltage and can vary from 0V to 283VLL_RMS. In a position movement, the output voltage and current will be AC, and in holding operating it will be DC. Figure 2 is a plot of the peak output current that is achievable versus the input voltage for HODVP12k. Figure 3 is the Power Envelope for the HODVP 12K; 9.7kW is achievable starting at 200

Vdc input and the input current limit is the limiting factor for this output performance.

Table 1: Output Voltage and Current Electrical Requirements

Characteristics and Conditions	Symbol	Limits Min	Limits Nom	Limits Max	Units
a. Output Voltage Range	V_{OUT}	0	N/A	283	V_{LL_RMS}
b. Transient Output Current [1]	I_{OUT_TRANS}	N/A	N/A	40	A
c. Steady State Output Current at 55C	I_{OUT_SS}	N/A	N/A	28	A
d. Steady State Output Current at 70C	I_{OUT_SS}	N/A	N/A	25	A

[1] Must not exceed 500ms

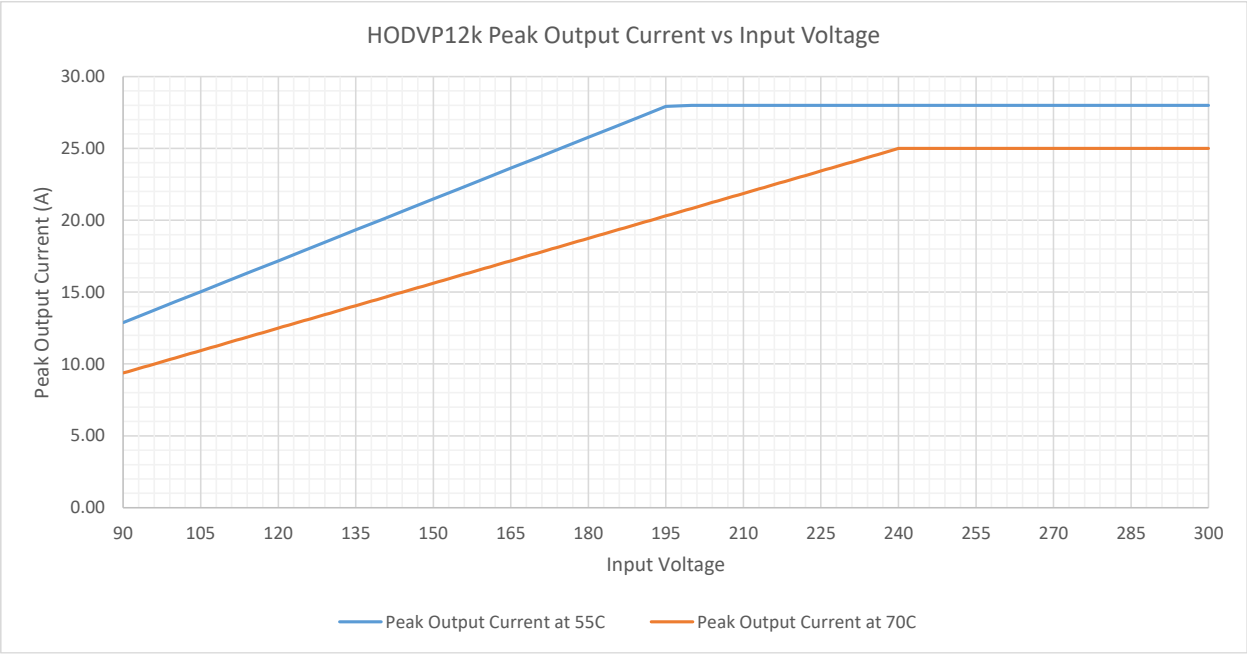

Figure 2. Peak Steady State Output Current vs Input Voltage

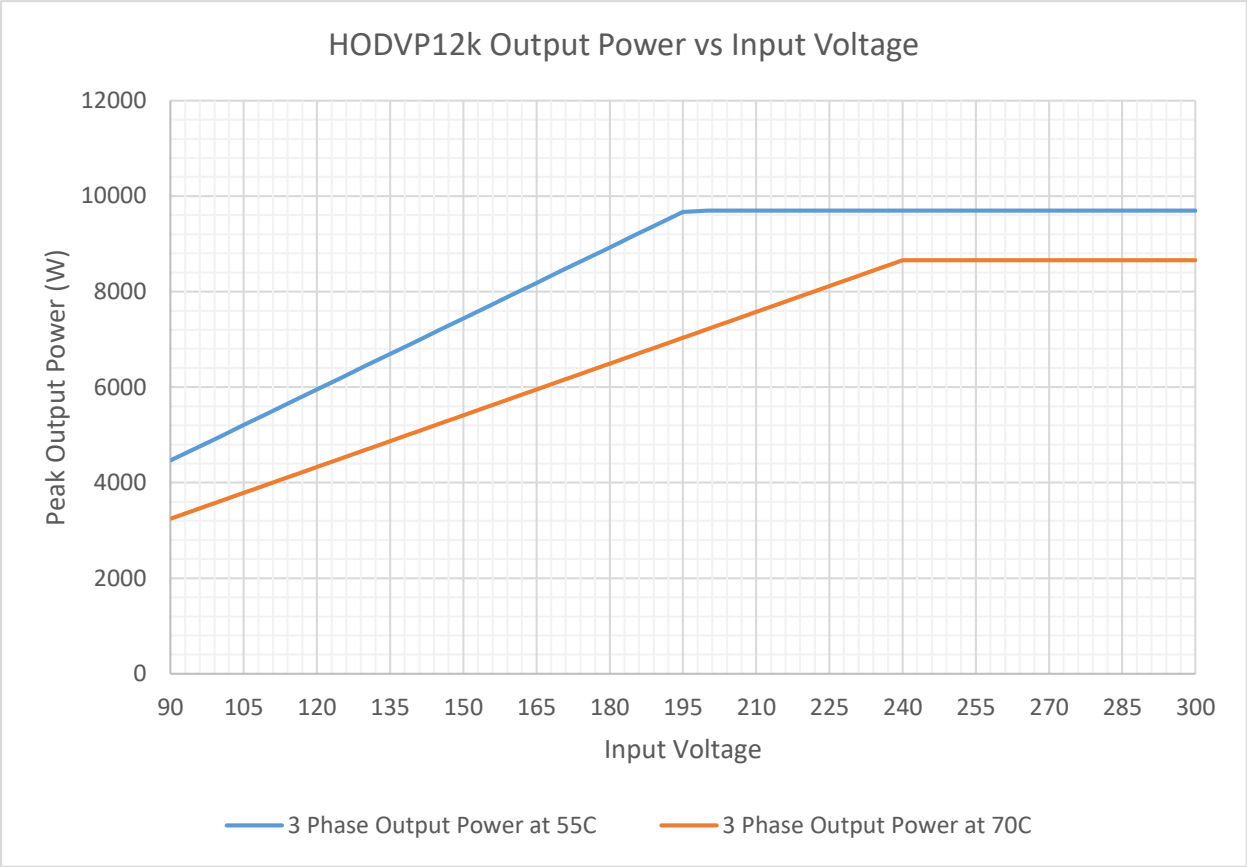

Figure 3. Power Envelope vs Input Voltage

Electromagnetic Compatibility

The HODVP 12K shall meet European EMC Directive 2014/30/EU using the following standard EN 61800-3 (2012), C3, 2nd environment, and an internal Woodward application specific requirement of Low Frequency Conducted Immunity.

DC Bus Powered Dynamic Brake

The HODVP 12K DC bus powered dynamic brake shall provide the PGND referenced voltage to operate dynamic brake used for dissipating back EMF when the electric motor turns into a generator. It is only required to function when the main auxiliary power supply can no longer provide the required voltage to operate the dynamic brake circuit.

The self-powered dynamic brake is only required for boost module HODVPs ,as the boost diodes block the DC bus coming back to feed the main auxiliary power supply source. When input power is removed under compressing load for a variable geometry actuator or spring return valve, the HODVP dc bus voltage will rise from back drive energy with high enough potential to fail the HODVP boost or inverter stage.

Software Requirements

Output Current Limiter

The output current limiter will not be designated from temperature, rather by valve type. The valve type will be configured from the valve/actuator ID module. The output current limiter will be a parameter loaded from the valve type. The output current in terms of current limiter must be computed phase current from the equation below. The output current limiter is a peak controlled current limit from the control model.

Input Current Limiter

The input current limiter will not be designated from temperature, rather valve type. The valve type will be configured from the valve/actuator ID module. The input current limiter will be a parameter loaded from the valve type. The input current limit does not directly control the peak input current in a closed loop form but with the output current limits based on input voltage should help provide peak current limit. The input current limiter is based on an Amp*seconds integrator.

HODVP 12K Operating at 55 °C

This temperature range references the valve types that will require the 28 Apk current output. Temperature has little to do with it from a software perspective other than to track the system to which the HODVP 12K is integrated.

Table 3. HODVP 12K Current Limiters -40 °C to 55 °C

Limiter	Model	Settings (Apk)	Time (seconds)	Cool Down Time (seconds)
HODVP12000 (-40 °C to 55 °C)				
Maximum Peak Output	HODVP 12K	40	N/A	N/A
Peak Transient Output	HODVP 12K	40	0.500	60.0
Mid Transient Output	HODVP 12K	N/A	N/A	N/A
Steady State Output	HODVP 12K	28	Continuous	0.0
Maximum Allowable Input	HODVP 12K	50	N/A	N/A
Input Current Limiter -Peak	HODVP 12K	40	30	120
Input Current Limiter -Mid	HODVP 12K	N/A	N/A	N/A
Input Current Limiter -Steady State	HODVP 12K	6	Continuous	0.0

HODVP 12K Operating at 70 °C

This temperature range references the valve types that will require the 25 Apk current output. Temperature has little to do with it from a software perspective other than to track the system to which the HODVP 12K is integrated.

Table 4. HODVP 12K Current Limiters -40 °C to 70 °C

Limiter	Model	Settings (Apk)	Time (seconds)	Cool Down Time (seconds)
HODVP12000 (-40 °C to 70 °C)				
Maximum Peak Output	HODVP 12K	40	N/A	N/A
Peak Transient Output	HODVP 12K	40	0.500	60.0
Mid Transient Output	HODVP 12K	N/A	N/A	N/A
Steady State Output	HODVP 12K	25	Continuous	0.0
Maximum Allowable Input	HODVP 12K	40	N/A	N/A
Input Current Limiter -Peak	HODVP 12K	40	30	120
Input Current Limiter -Mid	HODVP 12K	N/A	N/A	N/A
Input Current Limiter -Steady State	HODVP 12K	5	Continuous	0.0

Ambient Temperature Warnings and Alarms

The ambient temperature warning and alarm is based on the steady state output current limit. This is one of the unique challenges of a dual-rated part which the HODVP 12K handles well.

Fan Speed

The fan speed changes from low to high speed for three different occasions—the first being heat sink temperature threshold, the second is heat sink temperature sensor failures/errors on both heat sink temperature sensors, and the third is output current. With the dual rated HODVP 12K, the fan speed algorithm is different based on the Steady State Output Current Limit.

Summary

The DVP product family is the long term off-board driver technology for gas turbine products. It has been designed for use with both LAT and BLDC motor technologies that have become standard for Woodward ICS products. The HODVP 12K extends that platform to include applications that move to complete the electrification of heavy frame gas turbines.

Released

We appreciate your comments about the content of our publications.

Send comments to: industrial.support@woodward.com

Please reference publication 51593.

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