DENISON HYDRAULICS

PQ Control Card

020-14133
DECLARATION OF CONFORMITY
per EMC Directive 89/336/EEC and EN45014

MANUFACTURE'S NAME
DENISON HYDRAULICS

MANUFACTURE'S ADDRESS
14249 Industrial Parkway
Marysville, Ohio 43040-9504, USA

declares that the product

PRODUCT NAME
P/Q Control Card

PRODUCT PART NUMBER
DHI 020-14133-0

conforms to the following
product specifications

**EMC:**
- EN50081-1: March 1993 generic emissions for residential, commercial & light industry
- EN55011:7/1992 radiated or conducted EMI - 30-1000MHz
- EN50082-2: 1995 generic immunity for heavy industry
- ENV50140:8/1993 - 10V/m, 80 - 1000MHz Performance Criteria B
- EN61000-4-2, IEC801-2 electrostatic discharge (ESD)
  - 8KV air discharge - Performance Criteria A
  - 4KV contact discharge - Performance Criteria A
- EN61000-4-4: 5/1995 fast transient rejection
  - 2KV power supply wires - Performance Criteria B

The product was tested in an EMC TEST Laboratory and herewith complies with the EMC Directive 89/336 and the CE Marking requirements.

1 The product was tested in a typical system configuration with DENISON HYDRAULICS products or recommended second source products. The tested product was mounted in a NEMA 4 enclosure (or equivalent) and all cables exiting the enclosure were shielded (screened). Enclosure and cable shields were connected to earth ground (PE).

**Supplementary Information**

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See installation & Operation Guidelines under Procedures
THE P/Q Control Card, 020-14133, was designed in conjunction with a special Premier Series pump. The pump is fitted with a directional-proportional control valve, a cam position transducer and optional pressure sensor. These devices are utilized by the P/Q Controller to limit the pump output flow (Q) or limit the system pressure (P) to set values commanded by an external master machine controller, such as a programmable logic controller (PLC). The P/Q Controller automatically switches between Q-and P-control modes to assure that the set point limits for Q and P are not exceeded. A power limit can also be set externally for variable power levels or internally for fixed power limit.

**GENERAL DESCRIPTION**

- Designed to control the P/Q Premier Series Pump P16/P260
- EuroCard format
- Wide power supply input range 21.5–35VDC, 24V nominal
- Auxiliary power sources for transducers and command pots
- Power supply reverse polarity protection
- Self-regulating PWM frequency
- All outputs short-circuit protected
- Differential inputs for command signals
- 4-20mA current inputs from transducers
- Conditioned actual values for P & Q available externally
- Control Ready, Q-Ctrl mode & PWR Limit Ctrl signals externally available
- Selectable isolated ground for logic control signals
- Automatic P/Q mode selection
- Displacement control mode (Q)
- Pressure control mode (P)
- Trapped volume compensation adjustment, with external range switch
- Power limit control mode
- Valve spool position control
- LED control indicators, Front panel
- Diagnostic LED’s on PC board
- Potentiometer adjustments
- Test points, Front panel
- CE Mark

**SYSTEM FEATURES**

- Power limit control mode
- Valve spool position control
- LED control indicators, Front panel
- Diagnostic LED’s on PC board
- Potentiometer adjustments
- Test points, Front panel
- CE Mark
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TECHNICAL SPECIFICATIONS

P/Q DRIVER CARD

POWER SUPPLY VOLTAGE \( U_B \)
- \( U_B \) maximum \( U_{B_{\text{max}}} \)
- \( U_B \) minimum \( U_{B_{\text{min}}} \)

Current Requirement @ \( U_B_{\text{nom}} \)
Fuse, onboard (serviceable)

INPUTS
- \(-Q\)-Command (Flow Setpoint)
- \(-P\)-Command (Sys. PSI Setpoint)
- \(-Q\)-Actual (pump cam angle)
- \(-P\)-Actual (System PSI)
- Power Command (P*Q Setpoint)
- Control Enable
- PSI Compensator RangeSwitch

OUTPUTS
- Solenoids A & B currents \( I_{\text{max}} \)
- \( I_{\text{nom}} \)

INDICATORS, FRONT PANEL
- Power
- CTRL Error
- Q-CTRL Active
- PWR Limit Active

ADJUSTERS, FRONT PANEL
- \(-Q\)-Max
- \(-Q\)-Zero
- Leakage Compensator
- \(-P\)-Max
- \(-P\)-Zero

TEST POINTS, FRONT PANEL
- \(-Q\)-Command
- \(-Q\)-Actual
- \(-P\)-Command
- \(-P\)-Actual
- SV-Command
- SV-Actual
- Power Limit Set Command
- Ground Reference
- Ground Ref (for large test probe)

CONNECTOR TYPE

DHI P/N S20-14133
24VDC nominal
35VDC continuous
21.5VDC continuous
660mA (1.5 Amps max momentary)
1.6A T (slo blo) 5x20mm
0 to +10VDC (differential input impedance 67K ohms)
0 to +10VDC (differential input impedance 67K ohms)
4-20mA into 100 ohm load
4-20mA into 100 ohm load (differential input)
0 to +10VDC (differential input impedance 50K ohms)
15 to 35VDC (input impedance 10K ohms) isolated voltage option
15 to 35VDC (input impedance 10K ohms) isolated voltage option
2.8 Amps (momentary)
850 mA (@ steady state)
Solenooids A & B operate in differential current mode. When A-solenoid increases, B-solenoid decreases and vica versa.

LED Green
LED Red
LED Yellow
LED Yellow
Q-Max adjustment range 40% to 100% @ full Q-command signal
Q-Zero adjustment range +25% to -5%
Leakage compensate adjustment (Dependent on Q-Max & P-Max settings)
P-Max adjustment range 40%-to-104% of transducer rating.
P-Zero adjustment range 0 to 15% of P-Max.
0 to -10VDC (reduced when PWR LMT is active) 1.8K output impedance
-2 to +10VDC 1.8K output impedance
0 to +10VDC (same as input) 1.8K output impedance
0 to +10VDC 1.8K output impedance
0V normal, -10VDC momentary
0V normal, +5VDC momentary
0 to +10VDC
Signal ground, power ground, chassis ground
Test receptacle grounded at Front Panel for ESD immunity.

32-Pin Male DIN 41612 Form D
TECHNICAL SPECIFICATIONS

AMBIENT TEMPERATURES
--OPERATING 0 TO 60°C
--STORAGE -20 to 80°C

PHYSICAL DIMENSIONS
--Card Euro-card 3.94” x 6.30 (100 x 160mm)
--Front Panel 1.99” Wide x 5.05” High 10TE X 3HE (50.5mm x 128.4mm)
--Weight 0.5Lbs (0.23Kg)

Q TRANSDUCER (CAM ANGLE)
--Sensor type Denison P/N 788-30012
--Linear range Linear differential transformer
--Supply voltage 0.236” (±3mm)
--Supply range 18-36VDC (Reverse polarity protected)
--Supply current 50mA
--Output 4-20mA (Extended -3mm = 4mA; Retracted +3mm = 20mA)
--Linearity ±1.5%
--Sensitivity 2.667mA/mm (factory set, do not change)
--Offset ±1mm (user adjustable)
--Operating temperature 0 to 80°C
--Connector type Binder Series 713 5-Pin male M12x1 Threads
--Connector, Mating Denison P/N 721-30108

PRESSURE TRANSDUCER
--Supply voltage Denison P/N 788-50035
--Operating pressure 10-30VDC or ±15VDC (Reverse polarity and overvoltage protected)
--Overload pressure 0 to 5000PSI (350 Bar)
--Burst pressure 200% Operating (will not destroy, but may shift calibration point)
--Output 450% Operating (will cause permanent damage or complete destruction)
--Linearity 0.5% of span
--Operating temperature 0 to 80°C
--Connector type Compact appliance 4-Pole Male
--Connector, Mating Compact 4-Pole Female Hirschmann Series G4W1F P/N 932 157-100
--Environmental NEMA 5 / IP65

VALVE SPOOL TRANSDUCER
--Sensor type Supplied as part of valve assembly
--Linear range Linear differential transformer
--Supply voltage ±0.8mm
--Supply range 18 to 35VDC (Reverse polarity protected)
--Supply current 50mA
--Output 4-20mA (12mA near hydraulic null)
--Sensitivity 2.667mA/mm factory set not not adjust
--Offset factory set do not adjust
--Operating temperature 0 to 80°C
--Connector type Binder Series 713 4-Pin male M12x1 Threads
--Connector, Mating Denison P/N 167-01106-8
The P/Q Controller is applicable for both CW and CCW rotation pumps.
Refer to the block diagram to identify the circuit blocks referenced in the following discussion.

When the Control Enable signal is present, the P/Q Control Card accepts two primary control signals—flow (Q-CMD) and pressure (P-CMD) at their respective differential input amplifiers (1&2). The cam position transducer on the pump measures the pump displacement angle and provides actual flow information to the Q-Actual input. The pressure transducer monitors system pressure and provides the actual pressure information to the P-Actual input. The actual value signals are converted from current-to-volts, adjusted for zero point and scaled for maximum at amplifiers (3) & (4), before being compared to their respective command signals at control amplifiers (5) & (6). The control amplifiers produce signals (Q-ERR) & (P-ERR), representing the errors between the commanded values and the actual values. The Least-Error-Gate (7) output is the lesser of the two error signals and is also the command signal (SV-CMD) for the control-valve amplifier. In this fashion the pump operating point is controlled by the loop with the least error.

The control valve is regulated by the spool position loop. The SV-CMD (Least-Error-Gate output) is the command value. The spool position signal, SV-Actual, is provided by a position transducer that is part of the valve. The SV-Actual signal is converted from current-to-volts, zeroed and scaled for maximum by amplifier (8), before being compared to the command signal at amplifier (9). The spool position error, SV-ERR, is the command signal for the Pulse-Width-Modulated (PWM) power amplifier which modulates the coil currents to the control valve. An amplitude-adjustable dither signal is imposed at the PWM power amplifier to keep the valve spool in constant motion, and hence reduce hysteresis.

When in Q-Cont mode an adjustment is provided to compensate for pressure dependent system leakage. With proper adjustment of the Leakage Compensator adjuster (12), the Q-CMD signal is automatically corrected for system pressure changes.

The pressure control loop can be adjusted to compensate for trapped oil volume in actuators and hydraulic lines. The onboard PSI compensator switch, SW1, has 16 settings. The externally controlled PSI Compensator Range Selector activates a second range of compensator adjustments. The two ranges overlap and thus provide pairs of compensation points that can be switched on and off externally during a machine cycle to compensate for varying trapped volumes or pressure changes.

The P/Q control card can also provide power limiting. The power level (P * Q) can be set onboard with a potentiometer (13) for a constant power level or it can be set externally via the PWR SET CMD input (when using the external PWR SET CMD the internal setting must be at min). The PWR SET CMD signal is divided by system P-actual signal at block (11). The result is a power limited Q command signal which is compared with the existing Q-CMD input at the Least-Value-Gate(14). The lesser of the two signals is passed to the Q control amplifier (5).

Front panel LED's show system status. The green POWER LED indicates supply voltage Ub and ±15VDC is present. The yellow Q-CTRL ACTIVE LED is lit when the pump cam angle position (Q) loop is being controlled by the controller; when the LED is off the pump is in pressure limit mode. The PWR LIMIT ACTIVE LED is lit when the Q-CMD signal is reduced by the power limiter circuit (11)(14). The red CTRL ERROR LED is lit when any one of the following fault monitor circuits detect an error: CAM, broken wire from transducer or out-of-range signal; PSI, broken wire from transducer or out-of-range signal; VAL, broken wire or out-of-range signal; PSB, out of balance ±15VDC; ERR, excess-control error, SV-CMD, for >1 second; OVR, over-current or short-circuit at the PWM power amplifier (10). Any detected fault will lite the CTRL ERROR LED and force a high-to-low signal change at the CTRL Ready terminal, A4. The OVR fault monitor will also shut-off the PWM power amplifier to protect the electron-ic drivers. The P/Q Driver Card must be de-energized to reset the OVR monitor. All fault monitors have diagnostic LED's on the board to help isolate any fault condition.

Front panel adjustments of zero and max for Q & P and leakage compensation permit easy setup of system parameters.

Eight front panel test points are provided for easy access for monitoring key points in the circuit during setup or fault analysis. The front panel test point labels are descriptive and correspond with the labels on the block diagram. The Q-CMD test point value is the polarity-inverted Q-CMD input modified by the PWR limiter circuit when the PWR LIMIT ACTIVE LED is lit. The P-CMD testpoint value is the same magnitude and polarity as the P-CMD input. The SV-CMD test point represents the system deviation from the commanded value. The polarity can be either positive or negative, the value is normally small during steady-state conditions; large values are momentary when the control card makes corrections in responds to command changes or system conditions. The PWR SET test point value is either the internal or external PWR SET CMD. Q-Actual, P-Actual and SV-Actual test point values are the conditioned signals from their respective sensors. Two front panel GND test points are provided to accommodate different size test lead probes.

The status indicators Q-CTRL ACTIVE, PWR LIMIT ACTIVE and CTRL READY are also available at the the card I/O connector. The Q-Actual and P-Actual values are also available at the I/O connector. The above signals may be connected to a system control PLC for information purposes.

The CTRL ENABLE & PSI COMPS. RANGE SELECTOR signals are optically coupled to provide isolation if required. Jumper J1 is factory jumpered to 1-2 for internal ground. Set jumper to 2-3 for isolated ground.
762-40015 24VDC POWER SUPPLY MOUNTING HOLES

DIMENSIONS IN INCHES (MILLIMETERS)

OUTPUT: 24VDC @ 4.5 A
INPUT: 85 - 265VAC
50/60 Hz
EUROCARD HOLDER
701-00007-8
721-30108-0 Mating Connector for Cam Position (Q) Transducer

5-Terminal Connector

167-011106-8 Mating Connector for Valve-Spool Position Transducer

4-Terminal Connector

**Note:** During initial wiring take care not to interchange the above connectors. They appear identical, but one is a 4-Terminal and one is a 5-Terminal. The different terminal count for each connector will prevent accidental interchange of the transducers cables during routine system maintenance. The 5-Terminal will fit on the 4-Terminal but not visa versa. The wiring is identical for the two connectors, hence no damage will occur if the 5-Terminal is accidentally plugged into the 4-Terminal transducer.
Wiring diagram for 2-Wire pressure transducer, 788-50035, using ±15VDC power supply.
Wiring diagram for 2-Wire pressure transducer, 788-50035, when supply voltage $U_s$ does not exceed 30 volts.

Wiring Diagram for 2-Wire pressure transducer, 788-50035, when using an isolated power supply.
PROCEDURES

INSTALLATION & OPERATION GUIDELINES

- For EMC compatibility see section entitled EMC Installation Guidelines.
- Use Denison Hydraulics recommended power supply P/N 762-40015.
- Use shielded wire on all command and transducer signals. Tie card end of shield to earth ground. Leave other end of shield open.
- Maximum cable length 1000ft with 16AWG wire.
- For safety always turn off power to electronics and hydraulics before removing or inserting PQ Driver Card.
- Monitor test points with high impedance test equipment->100K ohms.
To comply with European EMC Directive 89/336 PQ Driver Card must be installed in NEMA4 enclosure or equivalent.

All cables entering the enclosure must be shielded. Shields to be grounded on one end only at PQ Driver Card 0 volt potential. Other end of shield to be left open.

Use separate cables, as shown, for command signals, DC Reference voltages, high-current solenoid valves and AC power mains.

Separate low-voltage cables from AC power cables.
The above table is a guide for optimizing the pressure control loop. The pressure control loop is dependent on system trapped oil volume--hydraulic lines, actuators and pump. In combination with 16 SW1 settings and the ‘ON/OFF’ remotely operated range selector switch a broad selection of volumes to match the system is available--54cu in (1/4Gal) to 2028cu in (9 Gals). If the trapped volume changes during the machine cycle due to valve opening and closing, the remote range selector switch can be operated concurrently to switch between two levels of volume. For example, SW1-A with Range Selector OFF is 693 cu in, with Range Selector ON it is 1247 cu in.

Other factors such as operating pressure and the stiffness of the hydraulic system affect the settings. The above table is based on system pressure of 5000 PSI and bulk modulus of 100,000 PSI.

For larger trapped volumes consult factory.
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