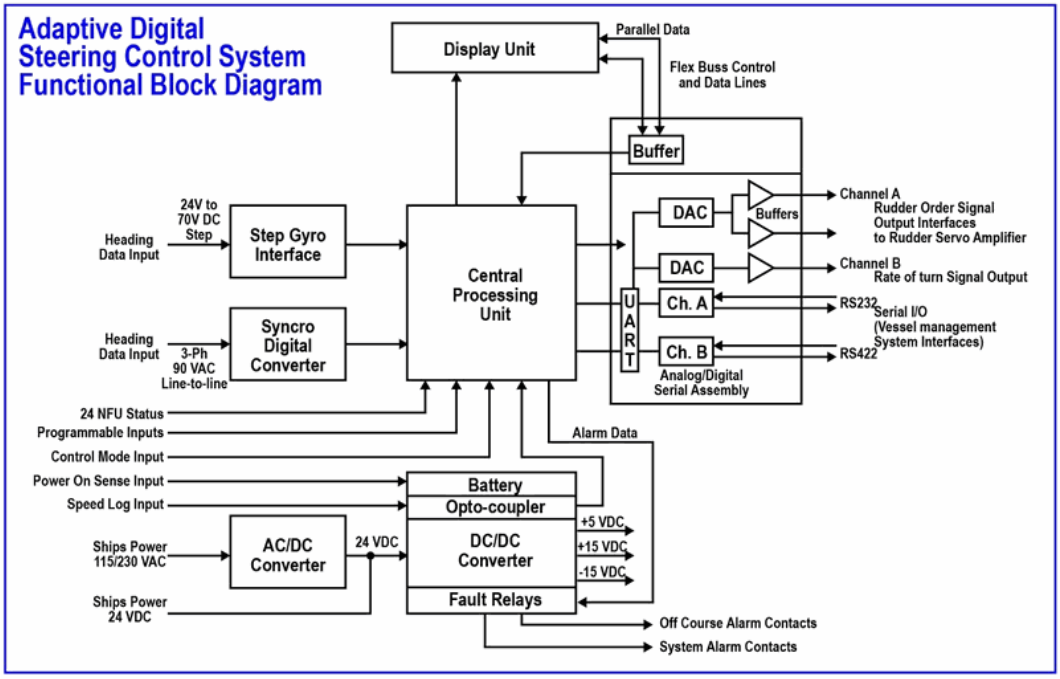

Q604 - Electrical, Electronic, & Control Engineering

1. As shown in the illustrated adaptive digital steering control system functional block diagram and listed system interface signals table, what would the rudder order signal output voltage to the rudder servo amplifier be for a rudder order of 20 degrees left rudder, assuming left rudder signals are negative and right order signals are positive in polarity

EL-0191



Adaptive Digital Steering System Interface Signals

Inputs	
Speed log input Pulsed Serial	 200 pulse nautical mile (PPNMI) format (contact closure) RS-232 (channel A or C) or RS-422 (channel B) communications in NMEA 0183 format, $VBW, $VHW
Navigator (vessel management system) input	Serial data for heading order, rate order, and cross track error information in RS-232 or RS-422 communication on channel A, B or C, in NMEA format $APB, $HSC, $HTR, $HTC or $XTE
Compass Step data Syncro	Positive or negative step data (24 or 70 V) 1X, 90X or 360X
Data Serial data	 $HDT (on channels A, B or C)
Mode switch sense contact	External switched opened or closed to inform autopilot to change from Standby mode to an automatic mode
NFU sense contacts	External contacts to indicate when the NFU Controller is active
Power failure circuits	Closed contacts on external power switch to activate power failure alarm
Outputs	
Interface to external rudder Servo control amplifiers	Bipolar analogue voltage proportional to the rudder order. ± 11.25 V (maximum limit) equal to ± 45° or rudder
Rate of turn interface	Bipolar analogue voltage proportional to a turn rate indicator. ± 4.5 V (Max) equal to ± 90° turn/min. Resolution equal to 0.5°/min.

- -2.25 VDC
- -4.0 VDC
- **-5.0 VDC**
- +5.0 VDC

Note:
A 20-degree left rudder order results in -5.0 VDC. The system's scale is 0.25 V per degree (11.25 V for 45 degrees), and left rudder signals are negative, therefore the output is -5.0 VDC.

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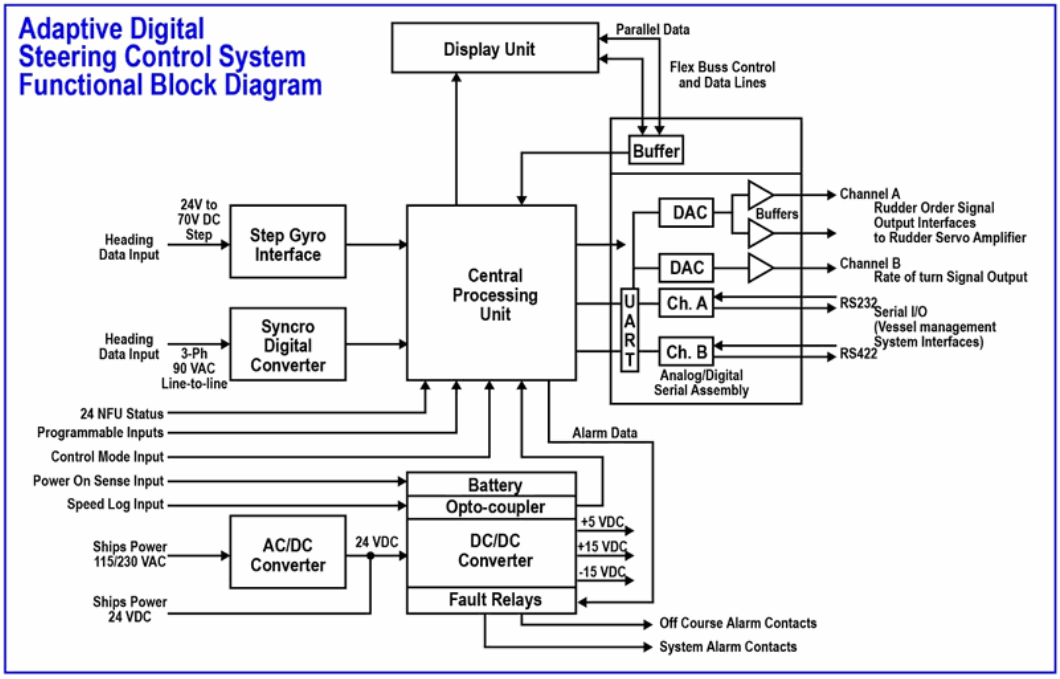
2. As shown in the illustrated adaptive digital steering control system functional block diagram and listed system interface signals table, what would the rudder order signal output voltage to the rudder servo amplifier be for a rudder order of 15 degrees right rudder, assuming left rudder signals are negative and right order signals are positive in polarity

EL-0191



Adaptive Digital Steering System Interface Signals

Inputs	
Speed log input Pulsed Serial	 200 pulse nautical mile (PPNMI) format (contact closure) RS-232 (channel A or C) or RS-422 (channel B) communications in NMEA 0183 format, $VBW, $VHW
Navigator (vessel management system) input	Serial data for heading order, rate order, and cross track error information in RS-232 or RS-422 communication on channel A, B or C, in NMEA format $APB, $HSC, $HTR, $HTC or $XTE
Compass Step data Syncro	Positive or negative step data (24 or 70 V) 1X, 90X or 360X
Data Serial data	 $HDT (on channels A, B or C)
Mode switch sense contact	External switched opened or closed to inform autopilot to change from Standby mode to an automatic mode
NFU sense contacts	External contacts to indicate when the NFU Controller is active
Power failure circuits	Closed contacts on external power switch to activate power failure alarm
Outputs	
Interface to external rudder Servo control amplifiers	Bipolar analogue voltage proportional to the rudder order. ± 11.25 V (maximum limit) equal to ± 45° or rudder
Rate of turn interface	Bipolar analogue voltage proportional to a turn rate indicator. ± 4.5 V (Max) equal to ± 90° turn/min. Resolution equal to 0.5°/min.

- -1.33 VDC
- -3.75 VDC
- **+3.75 VDC**
- +5.0 VDC

Note:
The system's voltage output is proportional to the rudder angle, with ±11.25 V representing ±45. Therefore, the voltage per degree is 0.25 V. A 15-degree right rudder requires a positive voltage, resulting in an output of +3.75 VDC.

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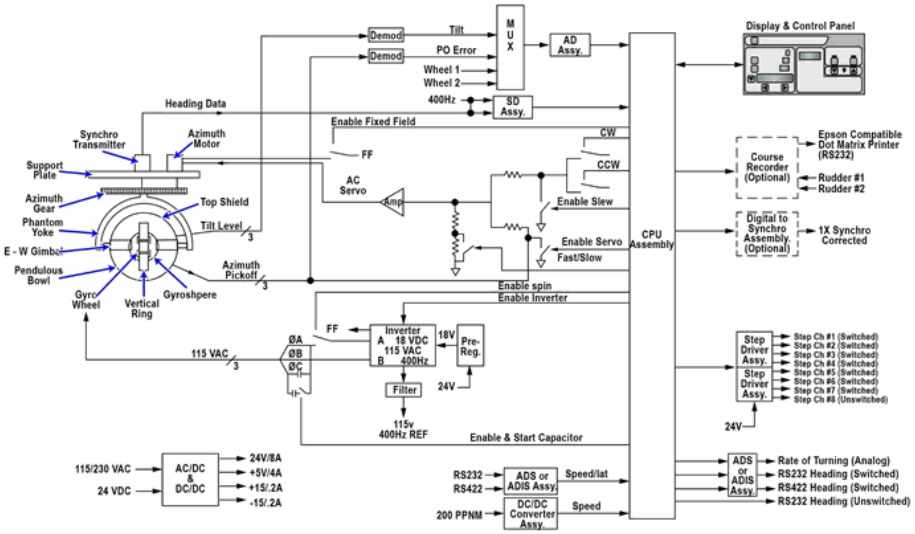
3. As shown in the illustrated digital gyrocompass functional block diagram and the associated communication protocols table, what would the rate of turn signal voltage be if the rate of turn is 30 degrees per minute to port? Assume that the rate of turn to port signal voltage is negative in polarity and that the rate of turn to starboard signal voltage is positive in polarity

EL-0194

Digital Gyrocompass Functional Block Diagram



Digital Gyrocompass Communication Protocols

Inputs	
Speed: Pulsed Serial Manual	Automatic: 200 ppnm Automatic from digital sources, RS-232/422 in NMEA 0183 format $VBW, $VHW, $VTG Manually via the control panel
Latitude	Automatic from the GPS via RS-232/422 in NMEA format $GLL, $GGA Automatic from digital sources via RS-232/422 in NMEA 0183 format $GLL Manually via the control panel
Outputs	
Rate of Turn	50 mV per deg/min (± 4.5 VDC full scale = ± 90°/min) NMEA 0183 format $HEROT, X.XXXX, A*hh<CR><LF> 1 Hz, 4800 baud
Step Repeaters	Eight 24 VDC step data outputs. (An additional 12-step data output at 35 VDC or 70 VDC from the optional transmission unit) 7 — switched, 1 — unswitched
Heading Data	One RS-422, capable of driving up to 10 loads in NMEA 0183 format $HEHDT, XXX.XXX, T*hh<CR><LF> Two RS-232, each capable of driving one load in NMEA 0183 format $HEHDT, XXX>XXX, T*hh<CR><LF> 10 Hz, 4800 baud 1 — 232 switched, 1 — 232 unswitched, 1 — 422 switched
Alarm Outputs	A relay and a battery-powered circuit activates a fault indicator and audible alarm during a power loss. Compass alarm NO/NC contacts. Power alarm — NO/NC contacts
Course Recorder	(If fitted) RS-232 to dot matrix printer
Synchro Output	(If fitted) 90 V line-to-line with a 115 VAC 400 Hz reference. Can be switched or unswitched

- -0.5 VDC
- -1.0 VDC
- **-1.5 VDC**
- +1.5 VDC

Note:
The rate-of-turn signal is 50 mV per degree per minute. A 30-degree-per-minute turn to port results in a voltage of -1.5 VDC, as port turns are indicated by negative polarity.

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4. Before working on an electric cargo winch master switch or controller, what should be done?

- heat the switch box to remove any moisture
- spray the gasket surface with a solvent
- drain condensate from the box
- **open the circuit breaker in the power supply and tag-out**

Note:
De-energize and tag-out the power supply breaker before working on an electric cargo winch master switch or controller to prevent electric shock or arc flash.

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5. Before work may safely commence on a high voltage system, what must first be done after disconnection and isolation?

- The circuit must be tested and proved dead first with an off-line tester, then grounded.
- **The circuit must be tested and proved dead first with a live-line tester, then grounded.**
- The circuit must be grounded first, then tested and proved dead with an off-line tester.
- The circuit must be grounded first, then tested and proved dead with a live-line tester.

Note:
After disconnecting and isolating a high-voltage system, it must first be tested and proven de-energized using a live-line tester before grounding.

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6. In order for a live-line tester to be used to test and prove dead a high voltage circuit, what must be done to verify the ability of the tester to detect a voltage?

- The live-line tester need not be checked prior to testing the circuit to be worked upon as long as it has not been declared inoperative.
- The live-line tester should be checked by connecting to a known high voltage source only before testing the circuit to be worked upon.
- **The live-line tester should be checked by connecting to a known high voltage source before and after the circuit to be worked upon is tested.**
- The live-line tester should be checked by connecting to a known high voltage source only after testing the circuit to be worked upon.

Note:
A live-line tester must be verified on a known live source before and after use to ensure continuous functionality and reliable voltage detection.

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7. What will happen to a carbon resistor operating in electrical equipment that is NOT properly cooled?

- it will change its value inversely proportional to the amount of heat generated and time in service
- its reliability factor will increase
- **its reliability factor will decrease**
- it will always operate at the same ohmic value

Note:
Overheating a carbon resistor reduces its reliability and increases the likelihood of failure due to accelerated aging and material degradation.

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8. What is the third color band on a resistor used to indicate?

- **number of zeros following the first two significant figures in the resistance value**
- first significant figure of the resistance
- second significant figure of the resistance
- tolerance of the resistor

Note:
The third band on a resistor indicates the multiplier, which represents the number of zeros following the first two significant figures in the resistance value.

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9. Why is copper often used as an electrical conductor?

- has high resistance at low temperatures
- has a highly polished surface
- **is able to pass current with little opposition**
- holds insulation together well

Note:
Copper's low electrical resistance allows current to flow with minimal opposition, making it suitable for electrical conductors.

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10. What is the reason that some electric cables are formed of stranded wire?

- stranded wire increases the current carrying capability for a given size wire
- **stranded wire increases their flexibility over solid wire and reduces skin effect losses**
- stranded wire decreases the weight for a given size wire
- stranded wire assures good conductivity at junction points

Note:
Stranded wire is primarily used for its increased flexibility compared to solid wire, which is essential for cables subjected to bending, movement, and vibration. While it can also reduce skin effect losses, this is a secondary benefit.
